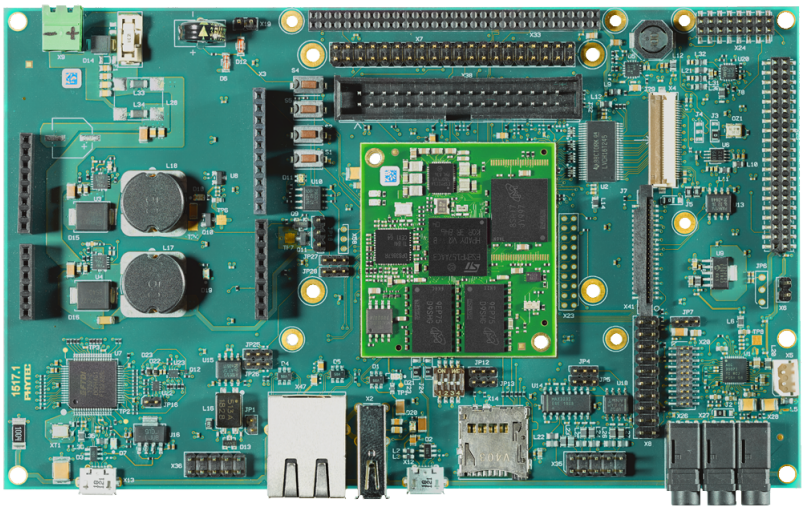
Hardware Manual - phyCORE-STM32MP15x/ phyBOARD-Sargas (1534.1/1517.2) (L-875e.A3)



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Hardware Manual - phyCORE-STM32MP15x/phyBOARD-Sargas (1534.1/1517.2) (L-875e.A3)	
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1 Preface

As a member of PHYTEC's phyCORE® product family, the phyCORE-STM32MP15x is one of a series of PHYTEC System on Modules (SOMs) that can be populated with different controllers and, therefore, offers various functions and configurations. PHYTEC supports a variety of 8/16/32/64 bit controllers in two ways:

(1) As the basis for Rapid Development Kits which serve as a reference and evaluation platform

(2) As insert-ready, fully functional phyCORE® OEM modules, which can be embedded directly into the user's peripheral hardware design.

Implementation of an OEM-able SOM subassembly as the "core" of your embedded design allows for increased focus on hardware peripherals and firmware without expending resources to "re-invent" microcontroller circuitry. Furthermore, much of the value of the phyCORE® module lies in its layout and test.

Production-ready Board Support Packages (BSPs) and Design Services for our hardware will further reduce development time and risk and allows for increased focus on product expertise. Take advantage of PHYTEC products to shorten time-to-market, reduce development costs, and avoid substantial design issues and risks. With this new innovative full system solution, new ideas can be brought to market in the most timely and cost-efficient manner.

For more information go to:

http://www.phytec.de/de/leistungen/entwicklungsunterstuetzung.html

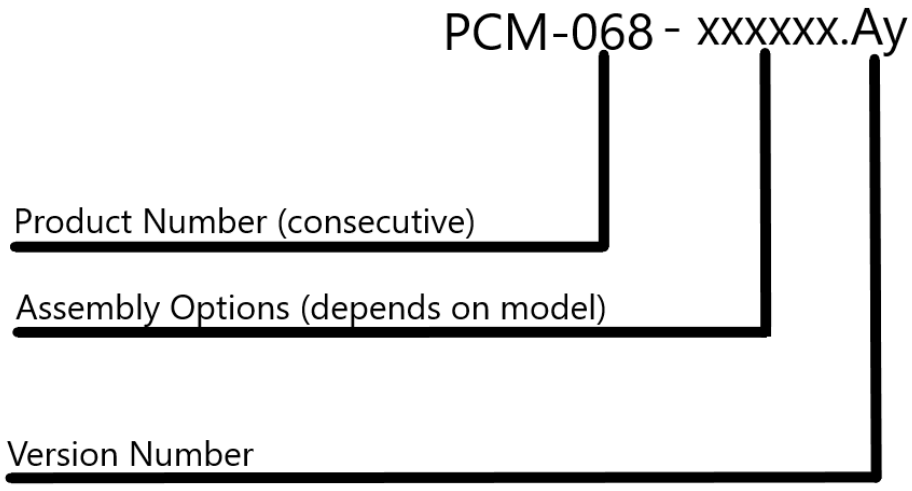
or

http://www.phytec.eu/europe/oem-integration/evaluation-start-up.html

1.1 Ordering Information

The part numbering of the phyCORE has the following structure:

FIGURE 1: Ordering Information



1.2 Product Specific Information and Technical Support

In order to receive product-specific information on all future changes and updates, we recommend registering at:
http://www.phytec.de/de/support/registrierung.html or http://www.phytec.eu/europe/support/registration.html

For technical support and additional information concerning your product, please visit the support section of our website which provides product-specific information, such as errata sheets, application notes, FAQs, etc.
https://www.phytec.de/produkte/system-on-modules/phycore-stm32mp15x/
or
https://www.phytec.eu/en/produkte/system-on-modules/phycore-stm32mp15x

1.3 Declaration of Electro Magnetic Conformity of the PHYTEC phyCORE®-STM32MP15x CE

PHYTEC System on Module (henceforth products) are designed for installation in electrical appliances or as dedicated Evaluation Boards (i.e.: for use as a test and prototype platform for hardware/software development) in laboratory environments.

Warning

PHYTEC products lacking protective enclosures are subject to damage by ESD and, therefore, must be unpacked, handled, or operated in environments in which sufficient precautionary measures have been taken with respect to ESD dangers. It is also necessary that only appropriately trained personnel (such as electricians, technicians, and engineers) handle and/or operate these products. Moreover, PHYTEC products should not be operated without protection circuitry if connections to the product's pin header rows are longer than 3 m.

PHYTEC products fulfill the norms of the European Union's Directive for Electro Magnetic Conformity only in accordance with the descriptions and rules of usage indicated in this hardware manual (particularly with respect to the pin header row connectors, power connector, and serial interface to a host-PC).

Implementation of PHYTEC products into target devices, as well as user modifications and extensions of PHYTEC products, is subject to renewed establishment of conformity to, and certification of, Electro Magnetic Directives. Users should ensure conformance following any modifications to the products as well as the implementation of the products into target systems.

1.4 Product Change Management and Information Regarding Parts Populated on the SOM / Carrier Board

With the purchase of a PHYTEC SOM / Carrier Board, you will, in addition to our HW and SW offerings, receive free obsolescence maintenance service for the hardware we provide. Our PCM (Product Change Management) Team of developers, is continuously processing, all incoming PCNs (Product Change Notifications) from vendors and distributors concerning parts that are used in our products.

Possible impacts on the functionality of our products, due to changes in functionality or obsolesce of a certain part, are constantly being evaluated in order to take the right measures in purchasing or within our hardware/software design.

Our general philosophy here is: **We never discontinue a product as long as there is a demand for it.**

Therefore, we have established a set of methods to fulfill our philosophy:

Avoiding strategies:

- Avoid changes by evaluating the longevity of parts during the design-in phase.
- Ensure the availability of equivalent second source parts.
- Stay in close contact with part vendors to be aware of roadmap strategies.

Change management in the rare event of an obsolete and non-replaceable part:

- Ensure long-term availability by stocking parts through last-time buy management according to product forecasts.
- Offer long-term frame contracts to customers.

Change management in case of functional changes:

- Avoid impacts on product functionality by choosing equivalent replacement parts.
- Avoid impacts on product functionality by compensating changes through HW redesign or backward-compatible SW maintenance.
- Provide early change notifications concerning functional relevant changes to our products.

Therefore, we refrain from providing detailed part-specific information within this manual, which can be subject to continuous changes, due to part maintenance for our products.
In order to receive reliable, up-to-date, and detailed information concerning parts used for our product, please contact our support team through the contact information given within this manual.

1.5 PHYTEC Documentation

PHYTEC will provide a variety of hardware and software documentation for all of our products. This includes any or all of the following:

- **QS Guide**: A short guide on how to set up and boot a phyCORE board along with brief information on building a BSP, the device tree, and accessing peripherals.
- **Hardware Manual**: A detailed description of the System on Module and accompanying carrier board.
- **Yocto Guide**: A comprehensive guide for the Yocto version the phyCORE uses. This guide contains an overview of Yocto; an introduction, installing and customizing the PHYTEC BSP; how to work with programs like Poky and Bitbake; and much more.
- **BSP Manual**: A manual specific to the BSP version of the phyCORE. Information such as how to build the BSP, booting, updating software, device tree, and accessing peripherals can be found here.
- **Development Environment Guide**: This guide shows how to work with the pre-programmed programs Eclipse and Qt Creator. It includes instructions for running demo projects for these programs on a phyCORE product. Information on how to set up a Linux host PC is also included.
- **Pin Muxing Table**: Starting in 2019, all phyCORE SOMs will have an accompanying pin table (in Excel format). This table will show the complete default signal path, from processor to carrier board. The default device tree muxing option will also be included. This gives a developer all the information needed in one location to make muxing changes and design options when developing a specialized carrier board or adapting a PHYTEC phyCORE SOM to an application.

On top of these standard manuals and guides, PHYTEC will also provide Product Change Notifications, Application Notes, and Technical Notes. These will be done on a case-by-case basis. All documentation can be found on the applicable download page of our products.

2 Conventions, Abbreviations, and Acronyms

This hardware manual describes the PCM-068 System on Module, referred to as phyCORE-STM32MP15x, and the corresponding single-board computer PCM-939, the phyBOARD-Sargas STM32MP15x. The manual specifies phyCORE-STM32MP15x and phyBOARD-Sargas's design and function. Precise specifications for the STMicroelectronics® STM32MP15x microcontrollers can be found in the enclosed Microcontroller Data Sheet/User's Manual.

Note

We refrain from providing detailed, part-specific information within this manual (due to part maintenance for our products), which can be subject to continuous changes. Please read the section Product Change Management and Information Regarding Parts Populated on the SOM / Carrier Board within the Preface.

Note

The BSP delivered with the phyCORE®-STM32MP15x usually includes drivers and/or software for controlling all components such as interfaces, memory, etc. Programming close to hardware at the register level is not necessary in most cases. For this reason, this manual contains no detailed description of the controller's registers or information relevant to software development. Please refer to the *STM32MP157C Reference Manual*, if such information is needed to connect customer-designed applications.

2.1 Conventions

The conventions used in this manual are as follows:

- Signals that are preceded by an "n", "/", or “#” character (e.g.: nRD, /RD, or #RD), or that have a dash on top of the signal name are designated as active low signals. That is, their active state is when they are driven low or are driving low.
- A "0" indicates a logic zero or low-level signal, while a "1" represents a logic one or high-level signal.
- The hex numbers given for addresses of I^2C devices always represent the 7 MSB of the address byte. The correct value of the LSB which depends on the desired command (read (1), or write (0)) must be added to get the complete address byte. E.g. given address in this manual 0x41 => complete address byte = 0x83 to read from the device and 0x82 to write to the device
- Tables that describe jumper settings show the default position in **bold, blue text.**
- Text in *blue italic* indicates a hyperlink within, or external to the document. Click these links to quickly jump to the applicable URL, part, chapter, table, or figure.
- References made to the phyCORE-Connector always refer to the high-density Samtec connector on the undersides of the phyCORE-STM32MP15x System on Module.

2.2 Types of Signals

Different types of signals are brought out at the phyCORE-Connector. The following table lists the abbreviations used to specify the type of signal.

TABLE 1: Signal Types

Signal Type	Description	Abbreviation
Power	Supply voltage input	PWR_I
Power	Supply voltage output	PWR_O
Ref-Voltage	Reference voltage output	REF_O
Input	Digital input	I
Output	Digital output	O
IO	Bidirectional input/output	I/O
OC-Bidir PU	Open collector input/output with pull up	OC-BI
OC-Output	Open collector output without pull up requires an external pull up	OC
OD-Output	Open-drain output without pull up requires an external pull up	OD
5V Input PD	5 V tolerant input with a pull-down	5V_PD
LVDS Input	Differential line pairs 100 Ohm LVDS level input	LVDS_I
LVDS Output	Differential line pairs 100 Ohm LVDS level output	LVDS_O
TMDS Output	Differential line pairs 100 Ohm TMDS level output	TMDS_O
USB IO	Differential line pairs 90 Ohm USB level bidirectional input/output	USB_I/O
ETHERNET Input	Differential line pairs 100 Ohm Ethernet level input	ETH_I
ETHERNET Output	Differential line pairs 100 Ohm Ethernet level output	ETH_O
ETHERNET IO	Differential line pairs 100 Ohm Ethernet level bidirectional input/output	ETH_I/O

Signal Type	Description	Abbreviation
MIPI DSI Output	Differential line pairs 100 Ohm MIPI DSI level output	DSI_O

2.3 Abbreviations and Acronyms

Many acronyms and abbreviations are used throughout this manual. Use this table to navigate unfamiliar terms used in this document.

TABLE 2: Abbreviations and Acronyms

Abbreviation	Definition
BSP	Board Support Package (Software delivered with the Development Kit, including an operating system (Windows or Linux) preinstalled on the module and Development Tools).
CB	Carrier Board: used in reference to the phyCORE Development Kit Carrier Board.
DFF	D flip-flop.
EMB	External memory bus.
EMI	Electromagnetic Interference.
GPI	General-purpose input.
GPIO	General-purpose input and output.
GPO	General-purpose output.
IRAM	Internal RAM: the internal static RAM on the STMicroelectronics® STM32MP15x microcontroller.
J	Solder jumpers; these types of jumpers require solder equipment to remove and place.
JP	Solderless jumpers; these types of jumpers can be removed and placed by hand with no special tools.
PCB	Printed circuit board.
PDI	PHYTEC Display Interface: defined to connect PHYTEC display adapter boards, or custom adapters

Abbreviation	Definition
PEB	PHYTEC Extension Board
PMIC	Power management IC
PoE	Power over Ethernet
POR	Power-on reset
RTC	Real-time clock.
SMT	Surface mount technology.
SOM	System on Module; used in reference to the PCM-068 / phyCORE®-STM32MP15x module
Sx	User button Sx (e.g., S1, S2, etc.) used in reference to the available user buttons, or DIP-Switches on the carrier board.
Sx_y	Switch y of DIP-Switch Sx; used in reference to the DIP-Switch on the carrier board.

3 phyCORE-STM32MP15x Introduction

The phyCORE-STM32MP15x belongs to PHYTEC's phyCORE System on Module family. The phyCORE SOMs represent the continuous development of the PHYTEC System on Module technology. Like its mini-, micro-, and nano MODUL predecessors, phyCORE boards integrate all core elements of a microcontroller system on a sub-miniature board and are designed in a manner that ensures their easy expansion and embedding in peripheral hardware developments.

Independent research indicates approximately 70 % of all EMI (Electro-Magnetic Interference) problems are caused by insufficient supply voltage grounding of electronic components in high-frequency environments. The phyCORE board design features an increased pin package, which provides for the dedication of approximately 20 % of all connector pins on the phyCORE boards to Ground. This improves EMI and EMC characteristics and makes it easier to design complex applications meeting EMI and EMC guidelines using phyCORE boards, even in high-noise environments.

phyCORE boards achieve their small size through modern SMD technology and multi-layer design. In accordance with the complexity of the module, 0201-packaged SMT components and laser-drilled microvias are used on the boards, providing phyCORE users with access to this cutting-edge miniaturization technology for integration into their own design.

The phyCORE-STM32MP15x is a sub-miniature (40 mm x 44 mm) insert-ready System on Module populated with the STMicroelectronics® STM32MP15x microcontroller. Its universal design enables its insertion in a wide range of embedded applications. All controller signals and ports extend from the controller to high-density pitch, or surface mount technology (SMT) connectors (all pitch 0.5 mm) aligning two sides of the board, allowing it to be plugged or soldered into any target application like a "big chip".

The descriptions in this manual are based on the STMicroelectronics STM32MP157C. No description of compatible microcontroller derivative functions is included, as such functions are not relevant for the basic functioning of the phyCORE-STM32MP15x. Precise specifications for the controller populating the board can be found in the applicable controller technical reference manual or datasheet.

Note

- Most of the controller pins have multiple multiplexed functions. As most of these pins are connected directly to the phyCORE-Connector, the alternative functions are available by using the STM32MP15x's pin muxing options. However, the following list of features is in regard to the specification of the phyCORE-STM32MP15x and the functions defined therein. Therefore, the indicated number of certain interfaces, CS signals, etc., is perhaps smaller than available on the controller. Please refer to the *STM32MP157C Reference Manual* to learn more about alternative functions. In order to utilize a specific pin's alternative function, the corresponding registers and the device tree must be configured within the appropriate driver of the BSP.

Tip

- STMicroelectronics provides software for pin muxing. For further information about the pin muxing tool, refer to STM32CubeMX.

3.1 phyCORE-STM32MP15x Features

The phyCORE-STM32MP15x offers the following features:

- Insert-ready, sub-miniature (44 mm x 40 mm) System on Module (SOM) sub-assembly in low EMI design, achieved through advanced SMT technology
- Populated with the STMicroelectronics® STM32MP157C[1] microcontroller (TFBGA361 packaging)
- Up to 2 ARM-Cortex-A7 cores (clock frequency up to 800 MHz) + ARM-Cortex-M4 core up to 209 MHz
- Boot from different memory devices (SD card, QSPI NOR-Flash, NAND-Flash, eMMC)
- Controller signals and ports extend to two high-density pitch (0.5 mm) Samtec connectors, aligning two sides of the board, enabling the phyCORE-STM32MP15x to be plugged into any target applications like a "big chip"
- Single supply voltage of +5.0 V with on-board power management
- All controller-required supplies are generated on-board
- Improved interference safety achieved through multi-layer PCB technology and dedicated ground pins
- 256 MB (up to 1 GB[2]) 32-bit wide DDR3L RAM
- 4 GB (up to 32 GB[2]) onboard eMMC, or 128 MB (up to 1 GB[2]) onboard SLC NAND flash
- 4 MB (up to 16 MB[2]) Quad SPI NOR flash (bootable)
- 4 kB (up to 32 kB[2]) I^2C EEPROM
- 4x UART interfaces
- 2x High-speed USB 2.0 interfaces (1 x USB host and 1 x USB OTG)
- 1x 10/100/1000 Mbit/s Ethernet interface. Either with an Ethernet transceiver on the phyCORE-STM32MP15x, allowing for direct connection to an existing Ethernet network, or without an onboard transceiver and provision of the RGMII signals at TTL-level (10/100/1000 Mbit/s) at the phyCORE-Connector instead[1]
- 2x I^2C interfaces
- 2x SPI interfaces (NAND/QSPI)
- 1x CAN FD interface
- 1x MIPI DSI interface
- 1x Parallel 18-bit RGB display interface with HDMI-CEC
- 1x 10-bit parallel camera interface
- 1x SAI Audio interface
- 1x MDIO interface
- 3x Secure Digital I/O MultiMediaCard interfaces (SDMMC) up to 8-bit (SD / eMMC / SDIO)
- Several dedicated GPIOs[3]
- Several AD conversion and filter inputs digital (DFSDM)
- 2x 12-bit DAC outputs
- 1x JTAG/Serial-wire debug interface with trace ports and debug trigger I/Os
- I^2C Real-Time Clock[1] with a very low-power operation, independent from the CPU-supply
- Power Management IC (PMIC)
- Available for different temperature grades (Product Temperature Grades)

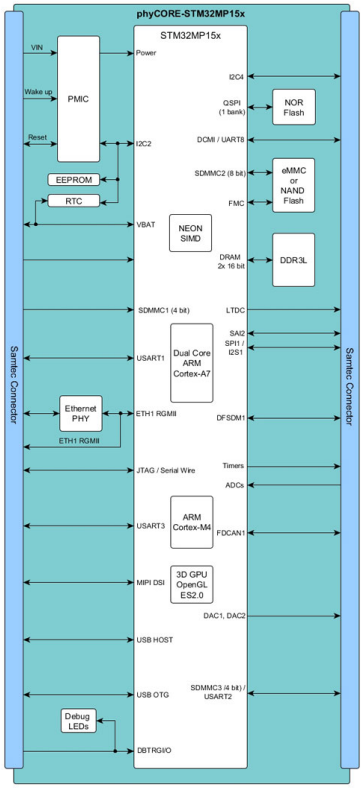
Warning

Samtec connectors guarantee optimal connection and proper insertion of the phyCORE-STM32MP15x. Please make sure that the STM32MP15x module is fully plugged into the mating connectors of the carrier board. Otherwise, individual signals may have bad contact or no contact at all.

1. Please refer to the order options described in the Preface, or contact PHYTEC for more information about additional module configurations.
2. The maximum memory size listed is as of the printing of this manual.
   Please contact PHYTEC for more information about additional or new module configurations available.
3. Almost every controller port that connects directly to the phyCORE-Connector may be used as GPIO by using the STM32MP15x's pin muxing options.

3.2 phyCORE-STM32MP15x Block Diagram

FIGURE 2: phyCORE-STM32MP15x Block Diagram



3.3 phyCORE-STM32MP15x Component Placement

FIGURE 3: phyCORE-STM32MP15x Component Placement (Top View)

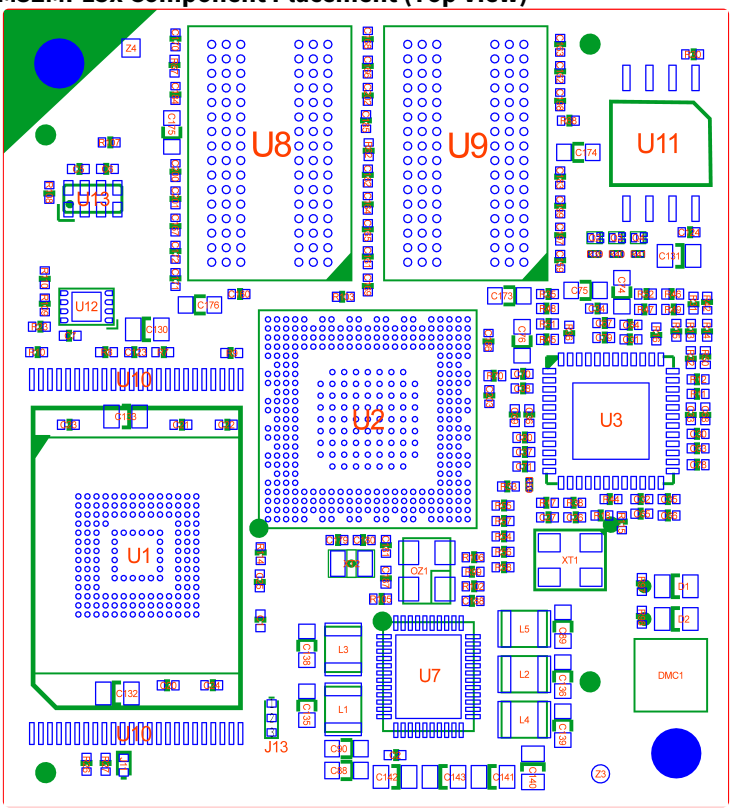
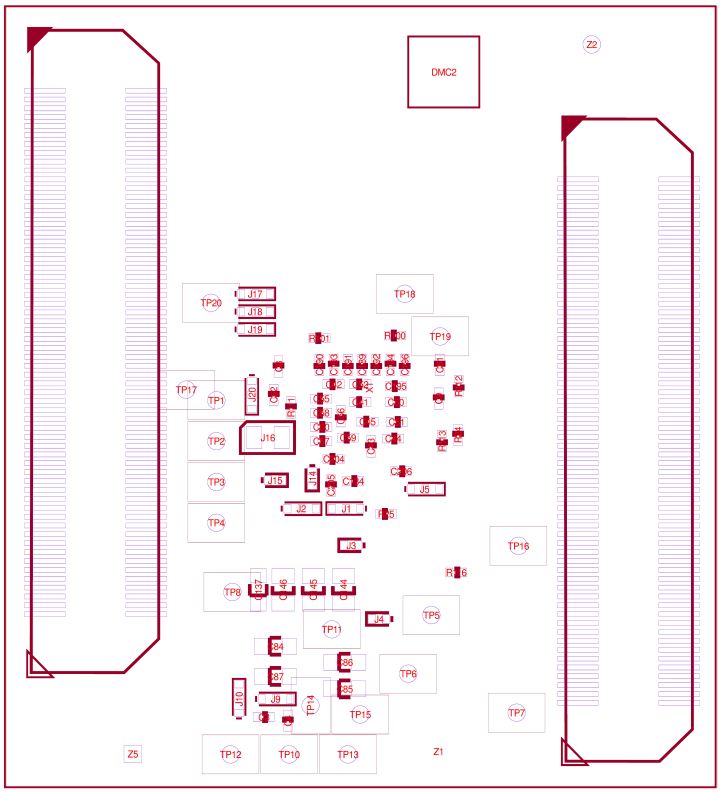


FIGURE 4: phyCORE-STM32MP15x Component Placement (Bottom View)



3.4 phyCORE-STM32MP15x Minimum Operating Requirements

Warning

We recommend connecting all available +5 V input pins to the power supply system on a custom carrier board housing the phyCORE-STM32MP15x and, at a minimum, the matching number of GND pins neighboring the +5 V pins. In addition, proper implementation of the phyCORE-STM32MP15x module into a target application also requires connecting all GND pins. Refer to section Power for more information.

4 Pin Description

Warning

Module connections **must** not exceed their expressed maximum voltage or current. Maximum signal input values are indicated in the corresponding controller manuals/datasheets. As damage from improper connections varies according to use and application, it is the user's responsibility to take appropriate safety measures to ensure that the module connections are protected from overloading through connected peripherals.

As the image Pinout of the phyCORE-Connector indicates, all controller signals selected extend to surface mount technology (SMT) connectors (0.5 mm). These connectors line two sides of the module (referred to as phyCORE-Connectors). This enables the phyCORE-STM32MP15x to be plugged into any target application like a "big chip".

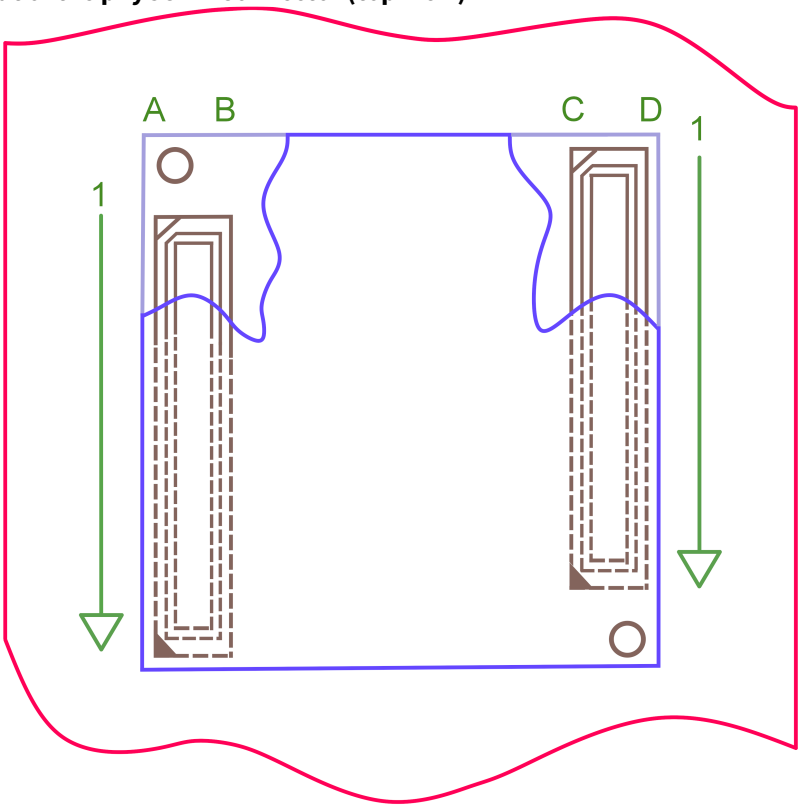
The numbered scheme for the phyCORE-Connector is based on a two-dimensional matrix in which column positions are identified by a letter and row positions by a number. The pin numbering values increase as you move across the board from left to right. The numbered matrix can be aligned with the phyCORE-STM32MP15x (viewed from above; phyCORE-Connector pointing down) or with the socket of the corresponding phyCORE carrier board/ user target circuitry. The upper left-hand corner of the numbered matrix (pin X1A1) is covered by the corner of the phyCORE-STM32MP15x. The numbering scheme is always in relation to the PCB as viewed from above, even if all connector contacts extend to the bottom of the module.

The numbering scheme is consistent for both the module's phyCORE-Connector as well as the mating connector on the phyCORE carrier board or target application. This reduces the risk of pin identification errors considerably.

Since the pins are precisely defined according to the numbered matrix described above, the phyCORE-Connector is usually assigned a single designator for its position (X1, for example). This way, the phyCORE-Connector comprises a single, logical unit regardless of the fact that it could consist of more than one physically socketed connector.

The following figure illustrates the numbered matrix system. It shows a phyCORE-STM32MP15x with SMT phyCORE-Connectors on its underside (defined with dotted lines) as it would be mounted on a carrier board. In order to facilitate understanding of the pin assignment scheme, the diagram presents a cross-view of the phyCORE module showing these phyCORE-Connectors mounted on the underside of the module’s PCB.

FIGURE 5: Pinout of the phyCORE-Connector (top view)



The Pinout table below provides an overview of the pinout of the phyCORE-Connector X1 with signal names and descriptions specific to the phyCORE-STM32MP15x. It also provides the appropriate signal level interface voltages listed in the (Signal) Level column, (Signal) Type, as well as information regarding the controller pin. The signal type includes also information about the signal direction.[4] A description of the signal types can be found in the table Signal Types.

In addition to the table in this manual, PHYTEC provides a complete pinout table for the phyCORE-STM32MP15x and PHYTEC carrier board as a downloadable Excel sheet (phyCORE-STM32MP1_Pinout_Table.A0_public.xls). This table includes signal names, pin muxing paths, and descriptions specific to the phyCORE-STM32MP15x and the phyBOARD-Sargas. It also provides the appropriate signal type and a functional grouping of the signals. The signal type also includes information about the signal direction. A table describing the signal types can be found on a second tab sheet in the Excel file.

4. The specified direction indicated refers to the standard phyCORE use of the pin.

Warning

- The STMicroelectronics® STM32MP15x is a multi-voltage-operated microcontroller and, as such, special attention should be paid to the interface voltage levels to avoid unintentional damage to the microcontroller and other on-board components. Please refer to the STMicroelectronics STM32MP15x Reference Manual for details on the functions and features of controller signals and port pins.
- The phyCORE-STM32MP15x has three dedicated boot signals which are brought out on the phyCORE-Connector and are used to configure specific boot options. Please make sure that these signals are not driven by any device on the baseboard during a reset. The signals that may affect the boot configuration are described in section Boot Mode Selection.
- It is necessary to avoid voltages at the IO pins of the phyCORE-STM32MP15x, which are sourced from the supply voltage of peripheral devices attached to the SOM during power-up or power-down. These voltages can cause a current flow into the controller, especially if peripheral devices attached to the interfaces of the STM32MP15x are supposed to be powered while the phyCORE-STM32MP15x is in suspend mode or turned off. To avoid this, bus switches either supplied by VDD (3.3 V) on the phyCORE side or having their output enabled to the SOM controlled by the VDD signal must be used (see Supply Voltage for External Logic).

Tips

- Most of the controller pins have multiple, multiplexed functions. As most of these pins are connected directly to the phyCORE-Connector, the alternative functions are available by using the STM32MP15x's pin muxing options. Signal names and descriptions in the accompanying table, however, are in regard to the specification of the phyCORE-STM32MP15x and the functions defined. Please refer to the STMicroelectronics STM32MP15x Reference Manual or the schematic to get to know about alternative functions. In order to utilize a specific pin's alternative function, the corresponding registers must be configured within the appropriate driver of the BSP.
- The following tables describe the full set of signals available at the phyCORE-Connector according to the phyCORE-STM32MP15x specification. However, the availability of some interfaces is order-specific (e.g., SDMMC2, RGMII). This means some signals might not be available on your module.
- If the phyCORE-STM32MP15x is delivered with the carrier board, the pin muxing might be changed within the appropriate BSP in order to support all features of the carrier board. If so, information on the differences from the pinout given in the following tables can be found in the carrier board's documentation (see phyCORE-STM32MP15x on the phyBOARD-Sargas SBC).

TABLE 3: Pinout of the phyCORE-STM32MP15x X1, Row A

Pin No.	Signal Name	Level	Type	Pin Name	BGA361-Pad	Description
A1	X_MIPI_DSI_CLKN	1.2 V	DSI_O	DSI_CKN	A16	MIPI DSI clock negative output
A2	X_MIPI_DSI_CLKP	1.2 V	DSI_O	DSI_CKP	B16	MIPI DSI clock positive output
A3	GND					
A4	X_MIPI_DSI_DATA0N	1.2 V	DSI_O	DSI_D0N	B15	MIPI DSI data0 negative output
A5	X_MIPI_DSI_DATA0P	1.2 V	DSI_O	DSI_D0P	C15	MIPI DSI data0 positive output
A6	GND					
A7	X_MIPI_DSI_DATA1N	1.2 V	DSI_O	DSI_D1N	A17	MIPI DSI data1 negative output
A8	X_MIPI_DSI_DATA1P	1.2 V	DSI_O	DSI_D1P	B17	MIPI DSI data1 positive output
A9	X_MIPI_DSIHOST_TE/PD13	3.3 V	I	PD13	AA19	MIPI DSI tearing effect input

Pin No.	Signal Name	Level	Type	Pin Name	BGA361-Pad	Description
A10	GND					
A11	X_SDMMC2_DATA0/PB14	3.3 V	I/O	PB14	C13	SD/SDIO/eMMC card data line 0
A12	X_SDMMC2_DATA1/PB15	3.3 V	I/O	PB15	B12	SD/SDIO/eMMC card data line 1
A13	X_SDMMC2_DATA2/PB3	3.3 V	I/O	PB3	A11	SD/SDIO/eMMC card data line 2
A14	X_SDMMC2_DATA3/PB4	3.3 V	I/O	PB4	B13	SD/SDIO/eMMC card data line 3
A15	X_SDMMC2_DATA4/PA8	3.3 V	I/O	PA8	A13	SD/SDIO/eMMC card data line 4
A16	X_SDMMC2_DATA5/PA9	3.3 V	I/O	PA9	A8	SD/SDIO/eMMC card data line 5
A17	X_SDMMC2_DATA6/PC6	3.3 V	I/O	PC6	B14	SD/SDIO/eMMC card data line 6
A18	X_SDMMC2_DATA7/PD3	3.3 V	I/O	PD3	D14	SD/SDIO/eMMC card data line 7

Pin No.	Signal Name	Level	Type	Pin Name	BGA361-Pad	Description
A19	GND					
A20	X_SDMMC2_CMD/PG6	3.3 V	I/O	PG6	A10	SD/SDIO/eMMC card bidirectional command/ response signal
A21	X_SDMMC2_CLK/PE3	3.3 V	O	PE3	C9	SD/SDIO/eMMC card clock
A22	GND					
A23	X_SDMMC3_D0/PF0	3.3 V	I/O	PF0	D8	SDIO SDMMC3 interface
A24	X_SDMMC3_D1/PF4	3.3 V	I/O	PF4	D9	
A25	X_SDMMC3_D2/PF5	3.3 V	I/O	PF5	D7	
A26	X_SDMMC3_D3/PD7	3.3 V	I/O	PD7	D10	
A27	X_SDMMC3_CMD/PF1	3.3 V	I/O	PF1	A5	
A28	X_SDMMC3_CK/PG15	3.3 V	O	PG15	B7	
A29	GND					

Pin No.	Signal Name	Level	Type	Pin Name	BGA361-Pad	Description
A30	X_DCMI_HSYNC/PH8	3.3 V	I	PH8	D5	DCMI Horizontal synchronization / Data valid
A31	X_DCMI_VSYNC/PB7	3.3 V	I	PB7	D11	DCMI Vertical synchronization
A32	X_DCMI_PIXCLK/PA6	3.3 V	I	PA6	AC8	DCM Pixel clock
A33	GND					
A34	X_DCMI_DATA5/PI4	3.3 V	I	PI4	E4	DCMI data5
A35	X_DCMI_DATA6/PE5	3.3 V	I	PE5	C11	DCMI data6
A36	X_DCMI_DATA7/PI7	3.3 V	I	PI7	F2	DCMI data7
A37	X_DCMI_DATA8/PI1	3.3 V	I	PI1	E3	DCMI data8
A38	X_DCMI_DATA9/PH7	3.3 V	I	PH7	W4	DCMI data9
A39	GND					
A40	X_LCD_R2/PC10	3.3 V	O	PC10	D15	LCD data red2

Pin No.	Signal Name	Level	Type	Pin Name	BGA361-Pad	Description
A41	X_LCD_R3/PB0	3.3 V	O	PB0	AB6	LCD data red3
A42	X_LCD_R4/PH10	3.3 V	O	PH10	C2	LCD data red4
A43	X_LCD_R5/PH11	3.3 V	O	PH11	C4	LCD data red5
A44	X_LCD_R6/PH12	3.3 V	O	PH12	B2	LCD data red6
A45	X_LCD_R7/PE15	3.3 V	O	PE15	D3	LCD data red7
A46	GND					
A47	X_LCD_G2/PH13	3.3 V	O	PH13	D1	LCD data green2
A48	X_LCD_G3/PE11	3.3 V	O	PE11	A4	LCD data green3
A49	X_LCD_G4/PH15	3.3 V	O	PH15	B1	LCD data green4
A50	X_LCD_G5/PH4	3.3 V	O	PH4	B3	LCD data green5
A51	X_LCD_G6/PI11	3.3 V	O	PI11	P4	LCD data green6
A52	X_LCD_G7/PI2	3.3 V	O	PI2	E2	LCD data green7

Pin No.	Signal Name	Level	Type	Pin Name	BGA361-Pad	Description
A53	GND					
A54	X_UART4_RX/PB2	3.3 V	I	PB2	Y16	UART4 serial data receive signal
A55	X_USART1_TX/PZ7	3.3 V	O	PZ7	J3	USART1 serial data transmit signal
A56	X_SPI16_MOSI/PZ2	3.3 V	I/O	PZ2	Z2	SPI1 master output/slave input
A57	X_SPI16_NSS/PZ3	3.3 V	I/O	PZ3	G4	SPI1 slave select (active low)
A58	X_LCD_BL_PWM/PI0	3.3 V	O	PI0	C1	PWM output (e.g. to control the brightness)
A59	X_PI3	3.3 V	I/O	PI3	E1	GPIO PI3 (LCD Touch-IRQn in)
A60	X_PD9	3.3 V	I/O	PD9	K1	GPIO PD9 (LCD Reset out)

TABLE 4: Pinout of the phyCORE-STM32MP15x X1, Row B

Pin No.	Signal Name	Level	Type	Pin Name	BGA361-Pad	Description
B1	GND					
B2	X_JTAG_nTRST	3.3 V	I	NJTRST	B19	JTAG test reset (active low)
B3	X_JTAG_TDI	3.3 V	I	JTDI	A20	JTAG test data input
B4	X_JTAG_TMS/SWDIO	3.3 V	I / I/O	JTMS-SWDIO	C20	JTAG test mode select / Serial wire data in/ out
B5	X_JTAG_TCK/SWCLK	3.3 V	I	JTCK-SWCLK	B20	JTAG test clock / Serial wire clock
B6	X_JTAG_TDO/TRACESWO	3.3 V	O	JTDO-TRACESWO	A19	JTAG test data output / Trace asynchronous data out
B7	GND					
B8	X_SDMMC1_D0/PC8	3.3 V	I/O	PC8	D18	SDMMC1 interface is normally used for external SDCard (boot option)
B9	X_SDMMC1_D1/PC9	3.3 V	I/O	PC9	D17	
B10	X_SDMMC1_D2/PE6	3.3 V	I/O	PE6	C10	

Pin No.	Signal Name	Level	Type	Pin Name	BGA361-Pad	Description
B11	X_SDMMC1_D3/PC11	3.3 V	I/O	PC11	D16	
B12	X_SDMMC1_CMD/PD2	3.3 V	I/O	PD2	D12	
B13	GND					
B14	X_SDMMC1_CK/PC12	3.3 V	O	PC12	D13	SDMMC1 interface clock out
B15	X_SDMMC1_CKIN/PE4	3.3 V	I	PE4	D19	SDMMC1 clock feedback in
B16	X_SDMMC1_CDIR/PB9	3.3 V	O	PB9	B10	UART4 TXD
B17	X_SDMMC1_D0DIR/PF2	3.3 V	O	PF2	A14	SDMMC1 dat0 direction out
B18	X_SDMMC1_D123DIR/PE14	3.3 V	O	PE14	C6	SDMMC1 dat123 direction out
B19	GND					
B20	X_FMC_DATA0/PD14	3.3 V	I/O	PD14	L3	Address / Data 0
B21	X_FMC_DATA1/PD15	3.3 V	I/O	PD15	J2	Address / Data 1
B22	X_FMC_DATA2/PD0	3.3 V	I/O	PD0	B8	Address / Data 2

Pin No.	Signal Name	Level	Type	Pin Name	BGA361-Pad	Description
B23	X_FMC_DATA3/PD1	3.3 V	I/O	PD1	B9	Address / Data 3
B24	X_FMC_DATA4/PE7	3.3 V	I/O	PE7	AA11	Address / Data 4
B25	X_FMC_DATA5/PE8	3.3 V	I/O	PE8	AC13	Address / Data 5
B26	X_FMC_DATA6/PE9	3.3 V	I/O	PE9	AA9	Address / Data 6
B27	X_FMC_DATA7/PE10	3.3 V	I/O	PE10	Y15	Address / Data 7
B28	GND					
B29	X_FMC_nWAIT/PD6	3.3 V	I	PD6	D2	Input for external ready/ busy (wait) signal (active low)
B30	X_FMC_nOE/PD4	3.3 V	O	PD4	B6	Output enable/ Read enable (active low)
B31	X_FMC_nCE/PG9	3.3 V	O	PG9	Y13	Chip select 1
B32	X_FMC_CLE/PD11	3.3 V	O	PD11	AC10	Command latch enable
B33	X_FMC_ALE/PD12	3.3 V	O	PD12	Y18	Address latch enable

Pin No.	Signal Name	Level	Type	Pin Name	BGA361-Pad	Description
B34	X_FMC_nNWE/PD5	3.3 V	O	PD5	A7	Write enable (active low)
B35	GND					
B36	X_DCMI_DATA0/PH9	3.3 V	I	PH9	C5	DCMI data0
B37	X_DCMI_DATA1/PC7	3.3 V	I	PC7	B11	DCMI data1
B38	X_DCMI_DATA2/PE0	3.3 V	I	PE0	D6	DCMI data2
B39	X_DCMI_DATA3/PE1	3.3 V	I	PE1	C8	DCMI data3
B40	X_DCMI_DATA4/PH14	3.3 V	I	PH14	C3	DCMI data4
B41	GND					
B42	X_LCD_B2/PG10	3.3 V	O	PG10	AB11	LCD data blue2
B43	X_LCD_B3/PG11	3.3 V	O	PG11	Y7	LCD data blue3
B44	X_LCD_B4/PE12	3.3 V	O	PE12	B4	LCD data blue4
B45	X_LCD_B5/PI5	3.3 V	O	PI5	F3	LCD data blue5

Pin No.	Signal Name	Level	Type	Pin Name	BGA361-Pad	Description
B46	X_LCD_B6/PB8	3.3 V	O	PB8	AB10	LCD data blue6
B47	X_LCD_B7/PD8	3.3 V	O	PD8	K3	LCD data blue7
B48	GND					
B49	X_LCD_HSYNC/PI10	3.3 V	O	PI10	T1	LCD horizontal sync
B50	X_LCD_VSYNC/PI9	3.3 V	O	PI9	H4	LCD vertical sync
B51	X_LCD_DE/PE13	3.3 V	O	PE13	A3	LCD data enable
B52	X_LCD_CLK/PG7	3.3 V	O	PG7	AC14	LCD clock
B53	GND					
B54	X_SPI16_SCK/PZ0	3.3 V	I/O	PZ0	G3	SPI1 clock signal
B55	X_USART1_RX/PZ6	3.3 V	I	PZ6	H1	USART1 RXD serial data receive signal
B56	X_SPI16_MISO/PZ1	3.3 V	I/O	PZ1	G1	SPI1 master input/slave output

Pin No.	Signal Name	Level	Type	Pin Name	BGA361-Pad	Description
B57	X_SPI1_MOSI/PB5	3.3 V	I	PB5	Y8	CAN FD2 serial data receive signal
B58	X_SPI1_NSS/PA15	3.3 V	I/O	PA15	C19	HDMI-CEC
B59	GND					
B60	X_PI8	3.3 V	I/O	PI8	L4	GPIO PI8

TABLE 5: Pinout of the phyCORE-STM32MP15x X1, Row C

Pin No.	Signal Name	Level	Type	Pin Name	BGA361-Pad	Description
C1	X_FDCAN1_RX/PA11	3.3 V	I	PA11	AA18	CAN FD1 serial data receive signal
C2	X_FDCAN1_TX/PA12	3.3 V	O	PA12	AB19	CAN FD1 serial data transmit signal
C3	GND					
C4	X_QSPI_BK1_DATA0/PF8	3.3 V	I/O	PF8	AC11	QSPI Bidirectional IO0
C5	X_QSPI_BK1_DATA1/PF9	3.3 V	I/O	PF9	AA14	QSPI Bidirectional IO1
C6	X_QSPI_BK1_DATA2/PF7	3.3 V	I/O	PF7	AB12	QSPI Bidirectional IO2
C7	X_QSPI_BK1_DATA3/PF6	3.3 V	I/O	PF6	AA13	QSPI Bidirectional IO3
C8	X_QSPI_BK1_nCS/PB6	3.3 V	O	PB6	Y14	QSPI chip select for bank 1 (low active)
C9	X_QSPI_CLK/PF10	3.3 V	O	PF10	Y12	QSPI clock signal
C10	GND					
C11	X_ADC1_INN1	0 V - VREF	ANA_I	ANA0	U3	ADC1 IN1-

Pin No.	Signal Name	Level	Type	Pin Name	BGA361-Pad	Description
C12	X_ADC1_INP1	0 V - VREF	ANA_I	ANA1	U4	ADC1 IN1+
C13	X_ADC1_INN2/PF12	0 V - VREF	ANA_I	PF12	Y9	ADC1 IN2-
C14	X_PVD_IN/ADC1_INN15/PA3	0 V - VREF	ANA_I	PA3	U2	ADC1 IN15-
C15	VREF	1.8 V - VDDA	PWR_I		R4	Analog Reference in/out
C16	X_DACOUT1/PA4	0 V - VREF	ANA_O	PA4	V4	DAC OUT1
C17	X_DACOUT2/PA5	0 V - VREF	ANA_O	PA5	V3	DAC OUT2
C18	GND					
C19	X_BOOT0	3.3 V	5V_PD	BOOT0	N1	BOOT0 config in
C20	X_BOOT1	3.3 V	5V_PD	BOOT1	N4	BOOT1 config in
C21	X_BOOT2	3.3 V	5V_PD	BOOT2	M2	BOOT2 config in
C22	GND					
C23	X_DFSDM1_DATIN0/PG0	3.3 V	I	PG0	AC2	DFSDM1 data0 in

Pin No.	Signal Name	Level	Type	Pin Name	BGA361-Pad	Description
C24	X_DFSDM1_DATIN1/PC3	3.3 V	I	PC3	W2	DFSDM1 data1 in
C25	X_DFSDM1_DATIN3/PF13	3.3 V	I	PF13	Y5	DFSDM1 data2 in
C26	X_DFSDM1_CKIN1/PG3	3.3 V	I	PG3	T4	DFSDM1 clock in
C27	X_DFSDM1_CKOUT/PD10	3.3 V	O	PD10	B5	DFSDM1 clock out
C28	GND					
C29	X_ETH1_RGMII_RXD0/PC4	3.3 V	I	PC4	AC7	ETH1 RGMII receive data 0
C30	X_ETH1_RGMII_RXD1/PC5	3.3 V	I	PC5	AB7	ETH1 RGMII receive data 1
C31	X_ETH1_RGMII_RXD2/PH6	3.3 V	I	PH6	Y11	ETH1 RGMII receive data 2
C32	X_ETH1_RGMII_RXD3/PB1	3.3 V	I	PB1	AA7	ETH1 RGMII receive data 3
C33	X_ETH1_RGMII_RX_CTL/PA7	3.3 V	I	PA7	AB8	ETH1 RGMII receive control (RX_DV + RX_ER)
C34	X_ETH1_RGMII_RX_CLK/PA1	3.3 V	I	PA1	AA4	ETH1 RGMII receive clock
C35	GND					

Pin No.	Signal Name	Level	Type	Pin Name	BGA361-Pad	Description
C36	X_ETH1_RGMII_TXD0/PG13	3.3 V	O	PG13	AA2	ETH1 RGMII transmit data 0
C37	X_ETH1_RGMII_TXD1/PG14	3.3 V	O	PG14	AA1	ETH1 RGMII transmit data 1
C38	X_ETH1_RGMII_TXD2/PC2	3.3 V	O	PC2	Y2	ETH1 RGMII transmit data 2
C39	X_ETH1_RGMII_TXD3/PE2	3.3 V	O	PE2	Y1	ETH1 RGMII transmit data 3
C40	X_ETH1_RGMII_TX_CTL/ PB11	3.3 V	I/O	PB11	AB1	ETH1 RGMII transmit control (TX_EN + TX_ER)
C41	X_ETH1_RGMII_GTX_CLK/ PG4	3.3 V	O	PG4	AB2	ETH RGMII transmit clock
C42	GND					
C43	X_ETH1_MDC/PC1	3.3 V	O	PC1	AA6	Ethernet management data clock
C44	X_ETH1_MDIO/PA2	3.3 V	I/O	PA2	AC3	Ethernet management data I/O
C45	X_ETH1_nINT/PG12	3.3 V	I	PG12	K4	Ethernet interrupt (low active)

Pin No.	Signal Name	Level	Type	Pin Name	BGA361-Pad	Description
C46	X_ETH1_RGMII_CLK125/PG5	3.3 V	I	PG5	Y6	External clock RX provided by the Ethernet PHY
C47	GND					
C48	X_RTC_EVI	3.3 V	I-PD	RTC_EVI		RTC external event input; 10 kΩ pull-down
C49	X_nRTC_INT	3.3 V	OD	RTC_INTn		RTC interrupt output; open-drain; active low
C50	X_RTC_CLKOUT	3.3 V	O	RTC_CLKO		RTC Clock output
C51	X_PWR_ON	3.3 V	O	PWR_ON	R2	Power-ON output
C52	VBUS_SW	5.0 V	PWR_O	PMIC-SWOUT		5 V / 500 mA USB-host power out
C53	VBUS_OTG	5.0 V	PWR_O	PMIC-VBUSOTG		5 V / 500 mA USB-OTG power out
C54	GND					
C55	VDD_BUCK4	3.3 V	PWR_O	PMIC-BUCK4		3.3 V / 1 A PMIC-BUCK4 out

Pin No.	Signal Name	Level	Type	Pin Name	BGA361-Pad	Description
C56	VDD_BUCK4	3.3 V	PWR_O	PMIC-BUCK4		3.3 V / 1 A PMIC-BUCK4 out
C57	GND					
C58	VCC5V_IN	5.0 V	PWR_I	PMIC-VIN		5 V main supply voltage
C59	VCC5V_IN	5.0 V	PWR_I	PMIC-VIN		5 V main supply voltage
C60	VCC5V_IN	5.0 V	PWR_I	PMIC-VIN		5 V main supply voltage

TABLE 6: Pinout of the phyCORE-STM32MP15x X1, Row D

Pin No.	Signal Name	Level	Type	Pin Name	BGA361-Pad	Description
D1	GND					
D2	X_USB_OTG_VBUS	5.0 V	PWR_I	OTG_VBUS	AC19	USB OTG VBUS input
D3	X_USB_OTG_D2P	3.3 V	USB_I/O	USB_DP2	AC16	USB OTG data plus
D4	X_USB_OTG_D2M	3.3 V	USB_I/O	USB_DM2	AB16	USB OTG data minus
D5	GND					
D6	X_USB_HOST_D1M	3.3 V	USB_I/O	USB_DM1	AB17	USB host data minus
D7	X_USB_HOST_D1P	3.3 V	USB_I/O	USB_DP1	AC17	USB OTG data plus
D8	X_USB_OTG_ID/PA10	3.3 V	I	PA10	Y17	USB OTG ID Pin
D9	GND					
D10	X_USART3_RX/PB12	3.3 V	I	PB12	AC5	USART3 RXD in
D11	X_USART3_TX/PB10	3.3 V	O	PB10	Y3	USART3 TXD out
D12	X_USART3_RTS/PG8	3.3 V	O	PG8	AB9	USART3 RTS out

Pin No.	Signal Name	Level	Type	Pin Name	BGA361-Pad	Description
D13	X_USART3_CTS/PB13	3.3 V	I	PB13	AA10	USART3 CTS in / CAN FD2 RXD
D14	GND					
D15	X_SAI2_SD_A/PI6	3.3 V	I/O	PI6	F4	SAI2 SDA
D16	X_SAI2_SD_B/PF11	3.3 V	I/O	PF11	Y10	SAI2 SDB
D17	X_SAI2_SCK_B/PH2	3.3 V	I/O	PH2	AB4	SAI2 SCKB
D18	X_SAI2_MCLK_B/PH3	3.3 V	I/O-O	PH3	AA3	SAI2 MCLKB
D19	X_SAI2_FS_B/PC0	3.3 V	I/O	PC0	AB5	SAI2 FSB
D20	GND					
D21	X_I2C4_SCL/PZ4	3.3 V	O	PZ4	G2	I2C4 is used for internal I^2C devices
D22	X_I2C4_SDA/PZ5	3.3 V	I/O	PZ5	H2	
D23	X_I2C1_SCL/PF14	3.3 V	I/O	PF14	AC4	I2C1 SCL out

Pin No.	Signal Name	Level	Type	Pin Name	BGA361-Pad	Description
D24	X_I2C1_SDA/PF15	3.3 V	I/O	PF15	Y4	I2C1 SDA I/O
D25	X_I2C2_SDA/PH5	3.3 V	I/O	PH5	A2	GPIO PH5
D26	GND					
D27	X_DBTRGI/PA14	3.3 V	I	PA14	T2	External trigger input to the cross trigger interface (CTI)
D28	X_DBTRGO/PA13	3.3 V	O	PA13	N2	External trigger output from the cross trigger interface (CTI)
D29	GND					
D30	X_ETH_A+	3.3 V	ETH_I/O	ETH-PHY		Ethernet data A+
D31	X_ETH_A-	3.3 V	ETH_I/O	ETH-PHY		Ethernet data A-
D32	GND					
D33	X_ETH_B+	3.3 V	ETH_I/O	ETH-PHY		Ethernet data B+
D34	X_ETH_B-	3.3 V	ETH_I/O	ETH-PHY		Ethernet data B-

Pin No.	Signal Name	Level	Type	Pin Name	BGA361-Pad	Description
D35	GND					
D36	X_ETH_C+	3.3 V	ETH_I/O	ETH-PHY		Ethernet data C+
D37	X_ETH_C-	3.3 V	ETH_I/O	ETH-PHY		Ethernet data C-
D38	GND					
D39	X_ETH_D+	3.3 V	ETH_I/O	ETH-PHY		Ethernet data D+
D40	X_ETH_D-	3.3 V	ETH_I/O	ETH-PHY		Ethernet data D-
D41	GND					
D42	X_ETH_LED0_LINK	3.3 V	OD	ETH-PHY_LED0		Ethernet link LED output
D43	X_ETH_LED1_GBIT	3.3 V	OD	ETH-PHY_LED1		Ethernet Gb indication LED output
D44	X_ETH_LED2_ACT	3.3 V	OD	ETH-PHY_LED2		Ethernet traffic LED output
D45	X_ETH_GPIO0	3.3 V	I/O	ETH-PHY_GPIO0		Ethernet PHY GPIO0 (Ethernet PHY (U3))

Pin No.	Signal Name	Level	Type	Pin Name	BGA361-Pad	Description
D46	X_ETH_GPIO1	3.3 V	I/O	ETH-PHY_GPIO1		Ethernet PHY GPIO1 (Ethernet PHY (U3))
D47	X_PG1	3.3 V	I/O	PG1	W1	GPIO PG1
D48	X_PF3	3.3 V	I/O	PF3	U1	GPIO PF3
D49	X_MCO2/PG2	3.3 V	O	PG2	V2	Master clock out
D50	GND					
D51	X_nRESET	3.3 V	I/O-OD	NRST	M3	Reset in/out open drain with 10 kΩ pull-up
D52	X_nPMIC_INT/PA0	3.3 V	I	PA0	AB3	Input for interrupt from PMIC or external
D53	X_WAKEUP3/PC13	3.3 V	I/O	PC13	K2	GPIO PC13 (PMIC-Wakeup in)
D54	X_nPONKEY	3.3 V	I	PMIC-PONKEYn		PMIC power-on key (active low)
D55	VDD_LDO1		PWR_O	PMIC-LDO1		PMIC-LDO1 programmable output

Pin No.	Signal Name	Level	Type	Pin Name	BGA361-Pad	Description
D56	VDD	3.3 V	PWR_O	VDD		3.3 V VDD out (only for reference)
D57	VBAT	1.8 V - 3.6 V	PWR_I	RTC_VBKUP		1.8 V to 3.6 V backup supply
D58	GND					
D59	VCC5V_IN	5.0 V	PWR_I	PMIC-VIN		5 V main supply voltage
D60	VCC5V_IN	5.0 V	PWR_I	PMIC-VIN		5 V main supply voltage

5 Jumpers

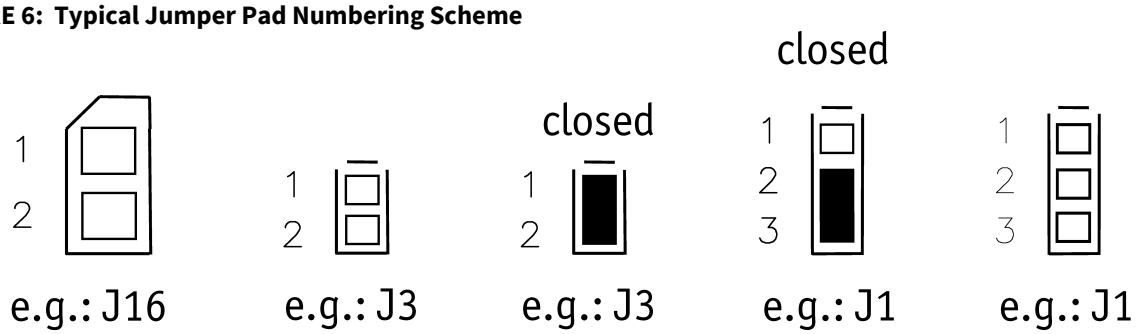
For configuration purposes, the phyCORE-STM32MP15x has several solder jumpers, some of which have been installed prior to delivery. The figure below, Typical Jumper Pad Numbering Scheme, illustrates the numbering scheme for the various solder jumper pads. Jumper Locations (Top View) and Jumper Locations (Bottom View) indicate the location and the default configuration of the solder jumpers on the board.

Table Jumper Settings provides a functional summary of the solder jumpers, which can be changed to adapt the phyCORE-STM32MP15x to specific design needs. It shows their default positions, and possible alternative positions and functions. A detailed description of each solder jumper can be found in the applicable chapter listed in the table.

Tip

Jumpers not listed should not be changed as they are installed with regard to the configuration of the phyCORE-STM32MP15x.

FIGURE 6: Typical Jumper Pad Numbering Scheme



If manual jumper modification is required, please ensure that the board, as well as surrounding components and sockets, remain undamaged while desoldering. Overheating the board can cause the solder pads to loosen, rendering the module inoperable. If soldered jumpers need to be removed, the use of a desoldering pump, desoldering braid, an infrared desoldering station, desoldering tweezers, hot air rework station, or other desoldering method is strongly recommended. Follow the instructions carefully for whatever method of removal is used.

Warning

If any modifications to the module are performed, regardless of their nature, the manufacturer guarantee is voided.

FIGURE 7: Jumper Locations (Top View)

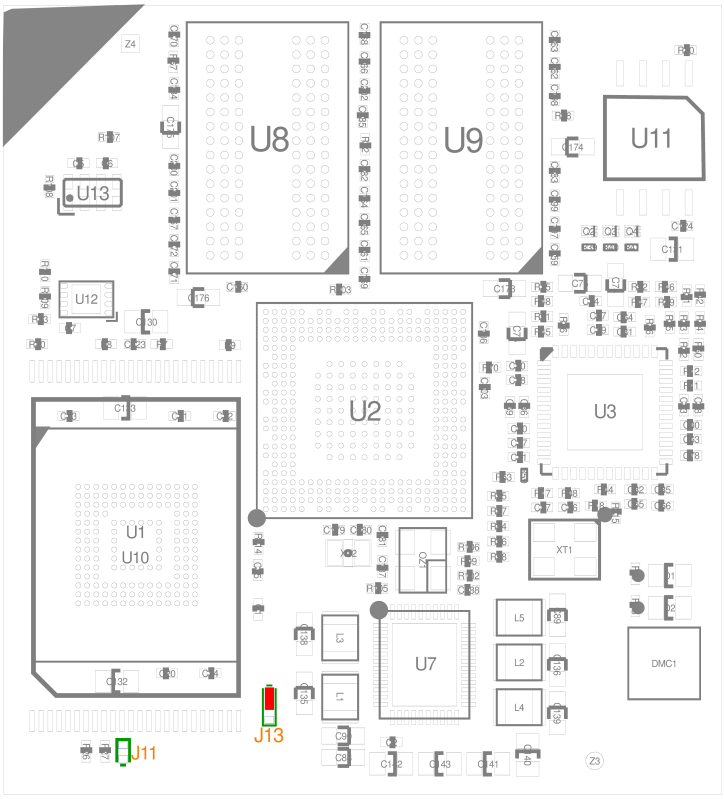
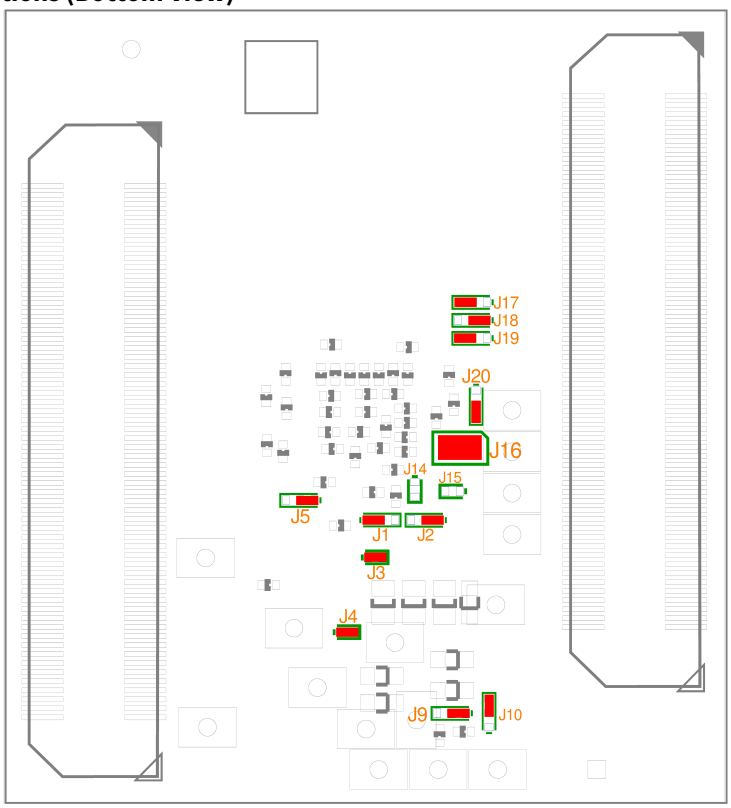


FIGURE 8: Jumper Locations (Bottom View)



Pay special attention to the “TYPE” column to ensure you are using the correct type of jumper (0 Ohms, 10k Ohms, etc…). The jumpers are 0402 packages with a 1/8 W or better power rating. The jumpers (J = solder jumper) have the following functions.

TABLE 7: Jumper Settings

Jumper	Position	Description	Type	Section
J1	**1+2**	**PDR_ON connected to VDD, VDD OK detector enabled**	0402	Power Supply Supervisor
	2+3	PDR_ON connected to GND, VDD OK detector disabled		
J2	**1+2**	**PDR_ON_CORE connected to VDD, VDD_{CORE} OK detector enabled**	0402	
	2+3	PDR_ON_CORE connected to GND, VDD_{CORE} OK detector disabled		
J3	open	Interrupt output from PMIC not used, PA0 freely available at X1D52	0402	
	closed	**Interrupt output from PMIC connected to X_nPMIC_INT/PA0**		
J4	open	Wake-up input from PMIC not used, PC13 freely available at X1D53	0402	
	closed	**Wake-up input from PMIC connected to X_WAKEUP3/PC13**		

Jumper	Position	Description	Type	Section
J5	**1+2**	**Only external RTCs are supplied through the VBAT input (D57), while the STM32MP15x backup domain V_{sw} is supplied by the main system power VDD**	0402	Backup Power Supply
	2+3	External RTC and STM32MP15x backup domain V_{sw} supplied via backup supply input pin VBAT (D57)		
J9	**1+2**	Voltage resulting from jumper J10 configuration (VDD or VDD_BUCK4) connected to PMIC's LDO regulators 2 and 5 input	0402	
	2+3	VCC5V_IN selected as the supply voltage for the PMIC's LDO regulators 2 and 5		
J10	1+2	VDD_BUCK4 used as Ethernet supply voltage (VDD_ETH_3V3) and jumper J9 input (pin 1)	0402	
	2+3	VDD used as Ethernet supply voltage (VDD_ETH_3V3) and jumper J9 input (pin 1)		
J13	**1+2**	**write protection of the NAND flash device U10 is only enabled during RESET**	0402	NAND Flash

Jumper	Position	Description	Type	Section
	2+3	write protection of the NAND flash device U10 permanently enabled		
J14	**open**	VREF not connected to VDDA (for STM32MP15x internal reference or external VREF from X1C15)	0402	
	closed	VREF connected to VDDA (supplied by VDD (J16) or VDDA (J15) of the PMIC's LDO5)		
J15	**open**	STM32MP15x's VDDA is not connected to PMIC's VDDA (J16 must be closed!)	0402	
	closed	VDDA connected to VDDA of the PMIC's LDO5 (J16 must be open!)		
J16	open	VDDA not connected to VDD (J15 must be closed!)	0805	
	closed	VDDA connected to VDD (J15 must be open!)		
J17	1+2	Boot configuration input BOOT0 connected to VDD	10 k 0402	Boot Mode Selection
	2+3	**Boot configuration input BOOT0 connected to GND**		

Jumper	Position	Description	Type	Section
J18	**1+2**	**Boot configuration input BOOT1 connected to VDD**	10 k 0402	
	2+3	Boot configuration input BOOT1 connected to GND		
J19	1+2	Boot configuration input BOOT2 connected to VDD	10 k 0402	
	2+3	**Boot configuration input BOOT2 connected to GND**		
J20	1+2	1V8 regulator disabled if VDD < 2.25 V, VDDA1V8_REG pin must be connected to VDD or a dedicated 1.65 V - 1.98 V supply (1.8 V typ.)	0402	
	2+3	1V8 regulator enabled, VDD must be > 2.25 V		

6 Power

The phyCORE-STM32MP15x operates off a single power supply voltage. The following sections discuss the primary power pins on the phyCORE-Connector X1 in detail.

6.1 Primary System Power (VCC5V_IN)

The phyCORE-STM32MP15x is powered by a primary voltage supply with a nominal value of +5 V. On-board switching regulators generate the voltage supplies required by the STM32MP15x MCU and on-board components from the primary 5 V supplied to the SOM. For proper operation, the phyCORE-STM32MP15x must be supplied with a voltage source of 5 V ±5 % with 3 A load at the VCC5V_IN pins on the phyCORE-Connector X1.

VCC5V_IN: X1 → C58, C59, C60, D59, D60

Connect all +5 V VCC input pins to your power supply and all available GND pins. Please refer to the section Pin Description for information on additional GND Pins located at the phyCORE-Connector X1.

Warning

As a general design rule, all GND pins must be connected to a solid ground plane.

6.2 Power Management IC (PMIC) (U7)

The phyCORE-STM32MP15x provides an onboard Power Management IC (PMIC) at position U7 to generate different voltages required by the microcontroller and the onboard components. The PMIC supports many functions such as different power management functionalities like dynamic voltage control, different low power modes, and regulator supervision. It is connected to the STM32MP15x via the onboard I^2C bus (I2C4). The I^2C address of the PMIC is 0x33.

External voltages:

- VCC5V_IN 5 V main supply voltage
- VBAT 3 V Backup Supply for RTC and STM32MP15x backup domain V_{sw} (optionally)
- VDD I/O supply voltage output
- VDD_BUCK4 PMIC BUCK4 converter output
- VDD_LDO1 PMIC LDO1 output

6.3 Supply Voltage for External Logic

The voltage level of the phyCORE's logic circuitry is VDD (3.3 V), which is derived from the SOM main input voltage VDD5V_IN. In order to follow the power-up and power-down sequencing mandatory for the STM32MP15x, external devices have to be supplied by the I/O supply voltage VDD or VDD_BUCK4 (3.3 V), which is brought out at pin X1D56 (VDD) and pins X1C55 + X1C56 (VDD_BUCK4) of the phyCORE-Connector. The use of VDD ensures that external components are only supplied when the supply voltages of the STM32MP15x are stable.

VDD_BUCK4 (3.3 V / max. 1 A) output at pins X1C55 and X1C56 can also be used to supply external circuits connected to the phyCORE-STM32MP15x.

Warning

- The current draw for **VDD** must not exceed **10 mA**. Consequently, this voltage should only be used as a reference, for level shifters or switch supply voltage from other sources, not for supplying purposes. If devices with higher power consumption are connected to the phyCORE-STM32MP15x, their supply voltage should be switched on and off by the use of the VDD or VDD_BUCK4 signal. This way, the power-up and power-down sequencing will be considered even if the devices are not supplied directly by VDD. Additionally, a voltage supervisor should be added to the carrier board. This supervisor should be powered by VDD and hold X_nRESET (X1D51) low, as long as the externally generated voltages are not in proper shape.
- Take care not to overload the VDD_BUCK4 output or exceed the thermal limits of the PMIC on the phyCORE-STM32MP15x!

6.4 Backup Power (VBAT)

To back up the RTC at U13 and, optionally, the STM32MP15x's backup domain V_{sw}, an external voltage source of 1.8 V to 3.6 V can be connected to the VBAT pin D57.

If jumper J5 is closed at 1+2 (default setting), only the RTC at U13, which has an extremely low backup current consumption of typ. 40 nA @3 V (max. 500 nA) is supplied by the backup source.

Additionally, it is possible to supply the STM32MP15x's internal RTC, some registers, and SRAM via backup domain V_{sw} by the VBAT voltage if jumper J5 is set to 2+3.

Tip

In order to get the minimum power consumption to back up the RTC while the main supply voltage is not available, jumper J5 must be closed at 1+2 (default configuration). Otherwise, the STM32MP15x's backup domain V_{sw} will be supplied by the backup voltage source, too.

6.5 Power Supply Supervisor

The STM32MP15x has an integrated power-on reset (POR)/ power-down reset (PDR) circuitry coupled with a Brownout reset (BOR) circuitry. Two jumpers (J1 and J2) allow the configuration of the power supply supervisor.

- J1 connects PDR_ON either to VDD or to GND, enabling or disabling the power-down reset (PDR). If PDR is enabled, the PDR supervisor monitors the VDD power supply. A reset is generated when VDD drops below a fixed threshold.
- J2 connects PDR_ON_CORE either to VDD or to GND, enabling or disabling the power-down reset VDDCORE (PDR_VDDCORE). If PDR_VDDCORE is enabled, the PDR_VDDCORE supervisor monitors the VDDCORE power supply. A VDDCORE domain reset is generated when VDDCORE drops below a fixed threshold.

The following configurations are possible:

TABLE 8: PDR supervisor enable/disable

J1	PDR supervisor enable/disable
1+2	**PDR_ON connected to VDD, VDD OK detector enabled**

J1	PDR supervisor enable/disable
2+3	PDR_ON connected to GND, VDD OK detector disabled

J2	PDR_ON_CORE supervisor enable/disable
1+2	**PDR_ON_CORE connected to VDD, VDDCORE** OK detector enabled
2+3	PDR_ON_CORE connected to GND, VDDCORE OK detector disabled

Warning

When the PDR_ON pin is connected to GND (internal reset OFF), the VBAT functionality is no more available, and the VBAT pin must be connected to VDD by ensuring that jumper J5 is closed in the default position 1+2.

6.6 CPU Core Frequency Scaling

The STM32MP15x on the phyCORE-STM32MP15x is able to scale the clock frequency and voltage. This is used to save power when the full performance of the CPU is not needed. Scaling the frequency and voltage is referred to as 'Dynamic Voltage and Frequency Scaling' (DVFS).

The phyCORE-STM32MP15x BSP supports the DVFS feature. The Linux kernel provides a DVFS framework that allows each CPU core to have a min/max frequency as well as the applicable voltage and a governor that governs these values depending on the system load. Depending on the STM32MP15x variant used, several different frequencies are supported. Further details on how to configure this governor can be found in the phyCORE-STM32MP15x BSP Manual.

7 Reset

The X_nRESET signal (Pin X1D61) on the phyCORE-Connector is designated as the reset input/output. Holding this pin low triggers a hard reset of the module. X_nRESET can be used to prevent the boot-up of the STM32MP15x. This can be used as a startup as described in the section Power Management IC.

8 System Boot Configuration

Most features of the STM32MP15x microcontroller are configured and/or programmed during the initialization routine. Other features, which impact program execution, must be configured prior to initialization via pin termination.

The system start-up configuration includes:

- Boot mode selection
- Boot device selection
- Boot device configuration

The internal ROM code is the first code executed during the initialization process of the STM32MP15x after POR. The ROM code detects the boot mode and configuration by using the boot mode pins (BOOT[2:0]).

8.1 Boot Mode Selection

The boot mode of the STM32MP15x microcontroller is determined by the configuration of three boot mode inputs BOOT[2:0] of the STM32MP15x during the reset cycle of the operational system.

Configuration circuitry (10 kΩ pull-up and pull-down resistors on jumpers J17 to J19 connected to BOOT[2:0]) is located on the phyCORE-STM32MP15x, so no further settings are necessary. The boot configuration of pins BOOT[2:0] on the standard phyCORE-STM32MP15x module is 0b010. Consequently, the system will try to boot from eMMC first.

Additionally, the boot mode inputs are brought out at the phyCORE-Connector pins X_BOOT[2:0] (X1C21, X1C20, X1C19). Hence, the specific boot configuration settings, which are set by the on-board configuration resistors, can be changed by modifying jumpers J17 to J19 on the module or by connecting a configuration resistor (e.g., <1 kΩ pull-up) to the BOOT signal pins at the phyCORE-Connector.

The table phyCORE-STM32MP15x Boot Modes shows the possible settings and the resulting boot configuration of the STM32MP15x.

TABLE 9: phyCORE-STM32MP15x Boot Modes

Boot Mode	BOOT2 (J19 / X1C21)	BOOT1 (J18 / X1C20)	BOOT0 (J17 / X1C19)
UART/USB-HS device	0 (J19: 2+3)	0 (J18: 2+3)	0 (J17: 2+3)
QSPI NOR Flash on QSPI-BK1	0 (J19: 2+3)	0 (J18: 2+3)	1 (J17: 1+2)
eMMC on SDMMC2	**0 (J19: 2+3)**	**1 (J18: 1+2)**	**0 (J17: 2+3)**
SLC NAND Flash on FMC	0 (J19: 2+3)	1 (J18: 1+2)	1 (J17: 1+2)
Reserved	1 (J19: 1+2)	0 (J18: 2+3)	0 (J17: 2+3)
SD card on SDMMC1	1 (J19: 1+2)	0 (J18: 2+3)	1 (J17: 1+2)
UART/USB-OTG-HS device	1 (J19: 1+2)	1 (J18: 1+2)	0 (J17: 2+3)

Boot Mode	BOOT2 (J19 / X1C21)	BOOT1 (J18 / X1C20)	BOOT0 (J17 / X1C19)
Reserved	1 (J19: 1+2)	1 (J18: 1+2)	1 (J17: 1+2)

Warning

Make sure that the boot mode inputs X_BOOT[2:0] (X1C21, X1C20, X1C19) are not driven by any device on the carrier board during reset. This is to avoid accidental changes to the boot configuration.

9 System Memory

The phyCORE-STM32MP15x provides five types of on-board memory:

- 1x bank of 32-bit DDR3L RAM: 256 MB (up to 1 GB)
- eMMC: 4 GB (up to 128 GB)
  or
  SLC NAND flash: 128 MB (up to 1 GB)
- Quad SPI NOR flash: 4 MB (up to 16 MB)
- I^2C-EEPROM: 4 kB (up to 32 kB)

Details for each memory type used on the phyCORE-STM32MP15x are below.

9.1 DDR3L-SDRAM (U8, U9)

The RAM memory of the phyCORE-STM32MP15x is comprised of two 16-bit wide DDR3L-SDRAM chips (U8, U9). The memory devices are connected to the dedicated DDRPHYC SDRAM interface of the STM32MP15x microcontroller.

The DDR3-SDRAM memory is accessed starting at address 0xC000 0000.

The DDR memory subsystem of the STM32MP15x is composed of the DDRCTRL and the DDRPHYC and provides a complete memory interface. Typically, the DDR3-RAM initialization is performed by a boot loader or operating system following a power-on reset and must not be changed at a later point by any application code. When writing custom code independent of an operating system or boot loader, the DDRPHYC SDRAM interface and the DDRCTRL must be initialized by accessing the appropriate configuration registers on the STM32MP15x controller. Refer to the *STM32MP15x Reference Manual* to access and configure these registers.

9.2 Flash Memory (U1, U10)

Use of Flash as non-volatile memory on the phyCORE-SM32MP1 provides an easily reprogrammable means of code storage. The phyCORE-STM32MP15x can be equipped with either an eMMC (U1) memory device or a NAND flash (U10) as non-volatile memory.

9.2.1 eMMC Memory (U1)

The main flash memory of the STM32MP15x is a managed NAND (eMMC) flash device populated at U1. The eMMC device is programmable with 3.3 V. No dedicated programming voltage is required. The eMMC Flash memory is connected to the second Secure Digital Input/Output MultiMediaCard interface (SDMMC2) of the STM32MP15x. For more information about the SDMMC interfaces, please refer to the *STM32MP15x Reference Manual*.

If the phyCORE-STM32MP15x is equipped with a NAND flash at U10 instead of the eMMC device (see next section), SDMMC2 is available at the phyCORE-Connector X1.

TABLE 10: SDMMC2 Interface Signal Location at X1

SOM Connector Pin	SOM Signal Name	Signal Level	Signal Type	Description
A11	X_SDMMC2_DATA0/PB14	3.3 V	I/O	SD/SDIO/eMMC card data line 0
A12	X_SDMMC2_DATA1/PB15	3.3 V	I/O	SD/SDIO/eMMC card data line 1
A13	X_SDMMC2_DATA2/PB3	3.3 V	I/O	SD/SDIO/eMMC card data line 2
A14	X_SDMMC2_DATA3/PB4	3.3 V	I/O	SD/SDIO/eMMC card data line 3
A15	X_SDMMC2_DATA4/PA8	3.3 V	I/O	SD/SDIO/eMMC card data line 4
A16	X_SDMMC2_DATA5/PA9	3.3 V	I/O	SD/SDIO/eMMC card data line 5
A17	X_SDMMC2_DATA6/PC6	3.3 V	I/O	SD/SDIO/eMMC card data line 6
A18	X_SDMMC2_DATA7/PD3	3.3 V	I/O	SD/SDIO/eMMC card data line 7
A20	X_SDMMC2_CMD/PG6	3.3 V	I/O	SD/SDIO/eMMC card bidirectional command/ response signal
A21	X_SDMMC2_CLK/PE3	3.3 V	O	SD/SDIO/eMMC card clock

Note

Other interface signals (SDMMC_CKIN, SDMMC_CDIR, SDMMC_D0DIR, SDMMC_D123DIR) belonging to the second Secure Digital Input/Output MultiMediaCard interface (SDMMC2) are also available at different pins of the phyCORE-Connector. However, the standard pin muxing of the phyCORE-STM32MP15x assigns other functions to these pins. Hence, the pin muxing must be changed if signals SDMMC_CKIN, SDMMC_CDIR, SDMMC_D0DIR, and SDMMC_D123DIR are needed.
Please refer to the *STM32MP15x Data Sheet* for details on the pin-muxing options.

9.2.2 NAND Flash Memory (U10)

Alternatively to the eMMC memory at U1, a NAND flash can be populated at U10. The NAND Flash memory is connected to the STM32MP15x's Flexible Memory Controller (FMC) interface with a bus width of 8-bits. NCE1 (FMC_NCE/PG9) of the FMC interface selects the NAND Flash at U10. The FMC interface is also available at the phyCORE-Connector and can be used if no NAND flash is mounted on U10. These signals are available without changing the pin multiplexing of the phyCORE-STM32MP15x.

TABLE 11: FMC Interface Signal Location at X1

SOM Connector Pin	SOM Signal Name	Signal Level	Signal Type	Description
B20	X_FMC_DATA0/PD14	3.3 V	I/O	Address / Data 0
B21	X_FMC_DATA1/PD15	3.3 V	I/O	Address / Data 1
B22	X_FMC_DATA2/PD0	3.3 V	I/O	Address / Data 2
B23	X_FMC_DATA3/PD1	3.3 V	I/O	Address / Data 3
B24	X_FMC_DATA4/PE7	3.3 V	I/O	Address / Data 4
B25	X_FMC_DATA5/PE8	3.3 V	I/O	Address / Data 5
B26	X_FMC_DATA6/PE9	3.3 V	I/O	Address / Data 6
B27	X_FMC_DATA7/PE10	3.3 V	I/O	Address / Data 7
B29	X_FMC_nWAIT/PD6	3.3 V	I	Input for external ready/busy (wait) signal (active low)
B30	X_FMC_nOE/PD4	3.3 V	O	Output enable/ Read enable (active low)
B31	X_FMC_nCE/PG9	3.3 V	O	Chip select 1

SOM Connector Pin	SOM Signal Name	Signal Level	Signal Type	Description
B32	X_FMC_CLE/PD11	3.3 V	O	Command latch enable
B33	X_FMC_ALE/PD12	3.3 V	O	Address latch enable
B34	X_FMC_nNWE/PD5	3.3 V	O	Write enable (active low)

The flash devices are programmable with 3.3 V. No dedicated programming voltage is required.

As of the printing of this manual, these NAND flash devices generally have a life expectancy of at least 100,000 erase/program cycles and a data retention rate of 10 years.

Any parts that are footprint (TSOP48) and functionally compatible may be used with the phyCORE-STM32MP15x.

9.2.2.1 NAND Flash Write Protection Control (J13)

Jumper J13 controls the write protection feature of the NAND flash at U10. Setting this jumper to position 1+2 protects the flash against write access during a power-on reset cycle. Setting this jumper to 2+3 protects the NAND flash permanently against write cycles.

The following configurations are possible:

TABLE 12: NAND Flash Write Protection State

J13	NAND Flash Write Protection State
1+2	**Write protection is enabled during power-on reset**
2+3	Write protection is enabled permanently

9.3 Quad SPI NOR Flash (U11)

The QSPI NOR flash memory of the phyCORE-STM32MP15x at U11 is available on most standard configurations of the SOM and can be used to store configuration data or any other general-purpose data. Besides this, it can also be used as a boot device and recovery boot device and is, therefore, suitable for applications that require a small code footprint or small RTOSes.

Tips

Using a QSPI Flash can eliminate the need to install eMMC or NAND flash memory on the SOM. This could reduce BOM costs, free up the ports used as SDMMC2 or FMC interface for other devices to be connected to the phyCORE-STM32MP15x, and remove the need for doing the bad block management that is required when using NAND flash.

The device is connected to bank 1 of the STM32MP15x's Quad-SPI interface (QUAD SPI) and can be accessed through QUADSPI_BK1_NCS. The control registers for QSPI are mapped between addresses 0x58003000 and 0x58003FFF. Please see the *STM32MP15x Reference Manual* for detailed information on the registers.

In order to allow connecting an external Quad SPI flash if the phyCORE-STM32MP15x comes without an onboard Quad SPI flash, the QSPI signals are available at phyCORE-Connector X1.

TABLE 13: QSPI Interface Signal Location at X1

SOM Connector Pin	SOM Signal Name	Signal Level	Signal Type	Description
C4	X_QSPI_BK1_DATA0/PF8	3.3 V	I/O	QSPI Bidirectional IO0
C5	X_QSPI_BK1_DATA1/PF9	3.3 V	I/O	QSPI Bidirectional IO1
C6	X_QSPI_BK1_DATA2/PF7	3.3 V	I/O	QSPI Bidirectional IO2
C7	X_QSPI_BK1_DATA3/PF6	3.3 V	I/O	QSPI Bidirectional IO3
C8	X_QSPI_QSPI_BK1_nCS/PB6	3.3 V	O	QSPI chip select for bank 1 (low active)
C9	X_QSPI_QSPI_CLK/PF10	3.3 V	O	QSPI clock signal

Note

The interface signals for the second bank of the Quad-SPI interface (QUAD SPI) are also available at different pins of the phyCORE-Connector. However, the standard pin muxing of the phyCORE-STM32MP15x assigns other functions to these pins. Hence, the pin muxing must be changed if a second QSPI flash should be connected...
Please refer to the *STM32MP15x Data Sheet* for details on the pin-muxing options.

As of the printing of this manual, these SPI Flash devices generally have a life expectancy of at least 100,000+ erase/program cycles and a data retention rate of 20 years. This makes the OSPI NOR flash a reliable and secure solution to store the first and second-level bootloaders.

9.4 I²C EEPROM (U12)

The standard configuration of the phyCORE-STM32MP15x is populated with a non-volatile 4 kB I²C EEPROM at U12. This memory can be used to store configuration data or other general-purpose data. This device is accessed through I²C port 4 on the STM32MP15x. The control registers for I²C port 4 are mapped between addresses 0x5C002000 and 0x5C0023FF. Please see the *STM32MP15x Reference Manual* for detailed information on the registers.

The I²C EEPROM populating the phyCORE-STM32MP15x has the ability to configure the address for the memory area and the additional ID page using chip-enabled signals E0 to E2. The four upper address bits of the device are fixed at '1010' (see *M24C32 datasheet*). Chip-enable signals E0 to E2 are fixed and connected to GND. The resulting addresses are 0x50 for the memory array and 0x58 for the additional ID page.

9.4.1 EEPROM Write Protection Control (R23)

Mounting a 10 kΩ resistor at R23 will cause the EEPROM to enter write-protect mode, thereby disabling write access to the device. In the default configuration, resistor R23 is not mounted, which means write access to the device is allowed.

The following configurations are possible:

TABLE 14: EEPROM Write Protection States via R23

R23	EEPROM Write Protection State
open	**Write access allowed**
10 kΩ resistor mounted	EEPROM is write-protected

10 Serial Interfaces

The phyCORE-STM32MP15x provides numerous dedicated serial interfaces, some of which are equipped with a transceiver/PHY to allow direct connection to external devices, and others can be muxed to other pins. The STM32MP15x has some more interfaces that can be used by individual pin muxing. This chapter only describes the predefined interfaces.

1. 1x High-speed USB OTG interface (extended directly from the second port of the STM32MP15x's USB high-speed PHY)
2. 1x High-speed USB host interface (extended directly from the first port of the STM32MP15x's USB high-speed PHY)
3. 1x Gbit Ethernet interface
4. 2x I^2C interfaces
5. 1x Serial Peripheral Interfaces (SPI)
6. 3x UART interfaces
7. 2x CAN FD interfaces
8. 3x SDIO interfaces
9. 1x SAI interface

The following sections of this chapter detail each of these serial interfaces and any applicable configuration jumpers.

10.1 USB OTG Interface

The phyCORE-STM32MP15x provides a high-speed USB OTG interface that uses the STM32MP15x's embedded high-speed USB OTG IP-Core connected to the second port of the embedded USB high-speed PHY. The USB OTG IP-Core supports both device and host functions and is fully compliant with the On-The-Go Supplement to the USB 2.0 specification. It can also be configured as a host-only or device-only controller. An external USB Standard-A (for USB host), USB Standard-B (for USB device), or USB mini-AB (for USB OTG) connector is all that is needed to interface the phyCORE-STM32MP15x USB OTG functionality. The applicable interface signals can be found on the phyCORE-Connector X1 as shown in the following table.

TABLE 15: Location of the USB OTG Signals at X1

SOM Connector Pin	SOM Signal Name	Signal Level	Signal Type	Description
D2	X_USB_OTG_VBUS	5.0 V	PWR_I	USB OTG VBUS input
D3	X_USB_OTG_D2P	3.3 V	USB_I/O	USB OTG data plus
D4	X_USB_OTG_D2M	3.3 V	USB_I/O	USB OTG data minus
D8	X_USB_OTG_ID/PA10	3.3 V	I	USB OTG ID Pin
C53	VBUS_OTG	5.0 V	PWR_O	VBUS supply voltage from PMIC

Warning

X_USB_OTG_VBUS **must be** supplied with 5 V for proper USB functionality.

10.2 USB Host Interface

The phyCORE-STM32MP15x provides a high-speed USB OTG interface that uses the STM32MP15x's embedded high-speed USB OTG IP-Core connected to the second port of the embedded USB high-speed PHY. The USB OTG IP-Core supports both device and host functions and is fully compliant with the On-The-Go Supplement to the USB 2.0 specification. It can also be configured as a host-only or device-only controller. An external USB Standard-A (for USB host), USB Standard-B (for USB device), or USB mini-AB (for USB OTG) connector is all that is needed to interface the phyCORE-STM32MP15x USB OTG functionality. The applicable interface signals can be found on the phyCORE-Connector X1 as shown in the following table.

TABLE 16: Location of the USB host Signals at X1

SOM Connector Pin	SOM Signal Name	Signal Level	Signal Type	Description
D6	X_USB_HOST_D1M	3.3 V	USB_I/O	USB host data minus
D7	X_USB_HOST_D1P	3.3 V	USB_I/O	USB OTG data plus
C52	VBUS_SW	5.0 V	PWR_O	VBUS supply voltage from PMIC

10.3 Ethernet Interface

Connection of the phyCORE-STM32MP15x to the World Wide Web or a local area network (LAN) is possible using the onboard GbE PHY at U3. It is connected to the RGMII interface (ETH1) of the STM32MP15x. The PHY operates with a data transmission speed of 10 Mbit/s, 100 Mbit/s, or 1000 Mbit/s. Alternatively, the RGMII (ETH1) interface, which is available on the phyCORE-Connector, can be used to connect an external PHY. In this case, the onboard GbE PHY (U3) must not be populated (section RGMII Interface).

10.3.1 Ethernet PHY (U3)

With an Ethernet PHY mounted at U3, the phyCORE-STM32MP15x has been designed for use in 10Base-T, 100Base-T, and 1000Base-T networks. The 10/100/1000Base-T interface with its LED signals extends to phyCORE-Connector X1.

TABLE 17: Location of the Ethernet Signals at X1

SOM Connector Pin	SOM Signal Name	Signal Level	Signal Type	Description
D30	X_ETH_A+	3.3 V	ETH_I/O	Ethernet data A+
D31	X_ETH_A-	3.3 V	ETH_I/O	Ethernet data A-
D33	X_ETH_B+	3.3 V	ETH_I/O	Ethernet data B+
D34	X_ETH_B-	3.3 V	ETH_I/O	Ethernet data B-
D36	X_ETH_C+	3.3 V	ETH_I/O	Ethernet data C+
D37	X_ETH_C-	3.3 V	ETH_I/O	Ethernet data C-
D39	X_ETH_D+	3.3 V	ETH_I/O	Ethernet data D+
D40	X_ETH_D-	3.3 V	ETH_I/O	Ethernet data D-
D42	X_ETH_LED0_LINK	3.3 V	OD	Ethernet link LED output
D43	X_ETH_LED1_GBIT	3.3 V	OD	Ethernet Gb indication LED output
D44	X_ETH_LED2_ACT	3.3 V	OD	Ethernet traffic LED output

The onboard GbE PHY supports HP Auto-MDIX technology, eliminating the need for a direct connect LAN or cross-over patch cable. It detects the TX and RX pins of the connected device and automatically configures the PHY TX and RX pins accordingly. The Ethernet PHY also features an auto-negotiation to automatically determine the best speed and duplex mode.

The Ethernet PHY is connected to the RGMII interface (ETH1) of the STM32MP15x. Please refer to the *STMicroelectronics STM32MP15x Reference Manual* for more information about this interface.

In order to connect the module to an existing 10/100/1000Base-T network, some external circuitry is required. The required termination resistors on the analog signals (X_ETH_A±, X_ETH_B±, X_ETH_C±, X_ETH_D±) are integrated into the chip, so there is no need to connect external termination resistors to these signals. Connection to external Ethernet magnetics should be done using very short signal traces. The A+/A-, B+/B-, C+/C-, and D+/D- signals should be routed as 100 Ohm differential pairs. The same applies to the signal lines after the transformer circuit. The carrier board layout should avoid any other signal lines crossing the Ethernet signals.

Warning

Please refer to the Ethernet PHY datasheet when designing the Ethernet transformer circuitry or request the schematic of the applicable carrier board (phyBOARD-Sargas STM32MP15x).

10.3.1.1 Ethernet PHY GPIOs

The Ethernet PHY mounted on the phyCORE-STM32MP15x provides two additional GPIOs. These are available at pins D45 (X_ETH_GPIO0) and D46 (X_ETH_GPIO1) of the phyCORE-Connector X1. They can be configured by the appropriate registers of the Ethernet PHY.

10.3.2 MAC Address

In a computer network such as a local area network (LAN), the MAC (Media Access Control) address is a unique computer hardware number. For a connection to the internet, a table is used to convert the assigned IP number to the hardware's MAC address. In order to guarantee that the MAC address is unique, all addresses are managed in a central location. PHYTEC has acquired a pool of MAC addresses. The MAC address of the phyCORE-STM32MP15x can be found on a sticker (with 2D matrix code) attached to the module. This number is a 12-digit HEX value.

The MAC address of the module is also programmed in the appropriate OTP (STM32MP15x's on-chip one-time programmable memory). Assigned OTP registers in the STM32MP15x:
OTP_57[31:0] = MAC_ADDR[31:0]
OTP_58[15:0] = MAC_ADDR[47:32]

10.3.3 RGMII Interface

In order to use an external Ethernet PHY instead of the on-board GbE PHY at U3, the RGMII interface (ETH1) of the STM32MP15x is brought out at phyCORE-Connector X1.

Warning

The GbE PHY (U3) must not be populated on the module if the RGMII interface is used.
Anyway, it is not recommended to remove the Ethernet PHY and other components affecting the use of an externally connected Ethernet PHY to the module, as this will void the manufacturer's warranty. The phyCORE-STM32MP15x can be ordered without an Ethernet PHY if an external Ethernet PHY is to be connected

TABLE 18: Location of the RGMII Interface Signals at X1

SOM Connector Pin	SOM Signal Name	Signal Level	Signal Type	Description
C29	X_ETH1_RGMII_RXD0/PC4	3.3 V	I	ETH1 RGMII receive data 0
C30	X_ETH1_RGMII_RXD1/PC5	3.3 V	I	ETH1 RGMII receive data 1
C31	X_ETH1_RGMII_RXD2/PH6	3.3 V	I	ETH1 RGMII receive data 2
C32	X_ETH1_RGMII_RXD3/PB1	3.3 V	I	ETH1 RGMII receive data 3
C33	X_ETH1_RGMII_RX_CTL/PA7	3.3 V	I	ETH1 RGMII receive control (RX_DV + RX_ER)
C34	X_ETH1_RGMII_RX_CLK/PA1	3.3 V	I	ETH1 RGMII receive clock
C36	X_ETH1_RGMII_TXD0/PG13	3.3 V	O	ETH1 RGMII transmit data 0
C37	X_ETH1_RGMII_TXD1/PG14	3.3 V	O	ETH1 RGMII transmit data 1
C38	X_ETH1_RGMII_TXD2/PC2	3.3 V	O	ETH1 RGMII transmit data 2
C39	X_ETH1_RGMII_TXD3/PE2	3.3 V	O	ETH1 RGMII transmit data 3
C40	X_ETH1_RGMII_TX_CTL/PB11	3.3 V	I/O	ETH1 RGMII transmit control (TX_EN + TX_ER)

SOM Connector Pin	SOM Signal Name	Signal Level	Signal Type	Description
C41	X_ETH1_RGMII_GTX_CLK/PG4	3.3 V	O	ETH RGMII transmit clock
C43	X_ETH1_MDC/PC1	3.3 V	O	Ethernet management data clock
C44	X_ETH1_MDIO/PA2	3.3 V	I/O	Ethernet management data I/O
C45	X_ETH1_nINT/PG12	3.3 V	I	Ethernet interrupt (low active)
C46	X_ETH1_RGMII_CLK125/PG5	3.3 V	I	External clock RX provided by the Ethernet PHY

Note

It is strongly recommended to place the Ethernet PHY on the Carrier Board close to the pins of the SOM's Ethernet interface to achieve a trace length of less than 100 mm.

Tip

ETH_CLK is available at pins X1B57 (X_SPI1_MOSI/PB5 and X1D12 (X_USART3_RTS/PG8) of the phyCORE-Connector if an external Ethernet PHY is to be connected without a quartz.

10.4 I2C Interface

The Inter-Integrated Circuit (I2C) interface is a two-wire, bidirectional serial bus that provides a simple and efficient method for data exchange among devices. The STM32MP15x contains several identical and independent multi-master fast-mode plus I2C modules. They are multiplexed with other signals. Please check the STMicroelectronics STM32MP15x Reference Manual for further information. One of these I2C modules (I2C4) is used on the phyCORE STM32MP15x and is available at phyCORE-Connector X1. A second one (I2C1) is predefined for external usage. The following table lists the I2C ports on the phyCORE-Connector:

TABLE 19: I2C2 Interface Signal Locations at X1

SOM Connector Pin	SOM Signal Name	Signal Level	Signal Type	Description
D21	X_I2C4_SCL/PZ4	3.3 V	O	I2C4 SCL (clock out) with internal 2 kΩ pull-up to VDD, used for internal I^2C devices (PMIC, RTC, EEPROM)
D22	X_I2C4_SDA/PZ5	3.3 V	I/O	I2C4 SDA (data I/O) with internal 2 kΩ pull-up to VDD, used for internal I^2C devices (PMIC, RTC, EEPROM)
D23	X_I2C1_SCL/PF14	3.3 V	O	I2C1 SCL (clock out) for external I^2C devices; an external pull-up resistor is needed.
D24	X_I2C1_SDA/PF15	3.3 V	I/O	I2C1 SDA (data I/O) for external I^2C devices; an external pull-up resistor is needed.

I2C4 is used for the SOM internal PMIC communication and should not be used for external devices.

10.5 SDIO Interface

The SDIO interfaces can be used to connect external SD cards, eMMC, or any other device requiring an SDIO interface (i.e Wi-Fi, I/O expansion, etc.) The phyCORE bus features three SDIO interfaces. One of the phyCORE-STM32MP15x SD interfaces (SDMMC2) supports 8-bit bus width and is internally used for eMMC.

The tables below show the location of the different interface signals on the phyCORE-Connector.

TABLE 20: SDMMC1, SDMMC2, and SDMMC3 Interface Locations at X1

SOM Connector Pin	SOM Signal Name	Signal Level	Signal Type	Description
A11	X_SDMMC2_DATA0 / PB14	3.3 V	I/O	SDMMC2 D0 /eMMC (do not connect this pin if eMMC is used on the SOM)
A12	X_SDMMC2_DATA1 / PB15	3.3 V	I/O	SDMMC2 D1 /eMMC (do not connect this pin if eMMC is used on the SOM)
A13	X_SDMMC2_DATA2 / PB3	3.3 V	I/O	SDMMC2 D2 /eMMC (do not connect this pin if eMMC is used on the SOM)
A14	X_SDMMC2_DATA3 / PB4	3.3 V	I/O	SDMMC2 D3 /eMMC (do not connect this pin if eMMC is used on the SOM)
A15	X_SDMMC2_DATA4 / PA8	3.3 V	I/O	SDMMC2 D4 /eMMC (do not connect this pin if eMMC is used on the SOM)
A16	X_SDMMC2_DATA5 / PA9	3.3 V	I/O	SDMMC2 D5 /eMMC (do not connect this pin if eMMC is used on the SOM)

SOM Connector Pin	SOM Signal Name	Signal Level	Signal Type	Description
A17	X_SDMMC2_DATA6 / PC6	3.3 V	I/O	SDMMC2 D6 /eMMC (do not connect this pin if eMMC is used on the SOM)
A18	X_SDMMC2_DATA7 / PD3	3.3 V	I/O	SDMMC2 D7 /eMMC (do not connect this pin if eMMC is used on the SOM)
A20	X_SDMMC2_CMD / PG6	3.3 V	I/O	SDMMC2 CMD /eMMC (do not connect this pin if eMMC is used on the SOM)
A21	X_SDMMC2_CLK / PE3	3.3 V	O	SDMMC2 CLK /eMMC (do not connect this pin if eMMC is used on the SOM)
B8	X_SDMMC1_D0 / PC8	3.3 V	I/O	SDMMC1 D0 (to boot from external SDCARD)
B9	X_SDMMC1_D1 / PC9	3.3 V	I/O	SDMMC1 D1 (to boot from external SDCARD)
B10	X_SDMMC1_D2/PE6	3.3 V	I/O	SDMMC1 D2 (to boot from external SDCARD)

SOM Connector Pin	SOM Signal Name	Signal Level	Signal Type	Description
B11	X_SDMMC1_D3 / PC11	3.3 V	I/O	SDMMC1 D3 (to boot from external SDCARD)
B12	X_SDMMC1_CMD / PD2	3.3 V	I/O	SDMMC1 CMD (to boot from external SDCARD)
B14	X_SDMMC1_CK / PC12	3.3 V	O	SDMMC1 CLK (to boot from external SDCARD)
B15	X_SDMMC1_CKIN / PE4	3.3 V	I/O-I	GPIO PE4
B16	X_SDMMC1_CDIR / PB9	3.3 V	I/O-O	GPIO PB9 / UART4 TXD
B17	X_SDMMC1_D0DIR / PF2	3.3 V	I/O-O	GPIO PF2
B18	X_SDMMC1_D123DIR / PE14	3.3 V	I/O-O	GPIO PE14
A23	X_SDMMC3_D0 / PF0	3.3 V	I/O	SDMMC3 D0

SOM Connector Pin	SOM Signal Name	Signal Level	Signal Type	Description
A24	X_SDMMC3_D1 / PF4	3.3 V	I/O	SDMMC3 D1
A25	X_SDMMC3_D2 / PF5	3.3 V	I/O	SDMMC3 D2
A26	X_SDMMC3_D3 / PD7	3.3 V	I/O	SDMMC3 D3
A27	X_SDMMC3_CMD / PF1	3.3 V	I/O	SDMMC3 CMD
A28	X_SDMMC3_CK / PG15	3.3 V	O	SDMMC3 CLK

10.6 Universal Asynchronous Interface

The phyCORE-STM32MP15x provides several high-speed universal asynchronous interfaces. Only three are described here as U(S)ARTs. Please refer to the STMicroelectronics STM32MP15x Reference Manual or Pin Muxing Tool if you need more U(S)ARTs. The following tables show the location of the signals on the phyCORE-Connector.

TABLE 21: USART3 Signal Locations at X1

SOM Connector Pin	SOM Signal Name	Signal Level	Signal Type	Description
D10	X_USART3_RX/PB12	3.3 V	I	USART3 RXD in
D11	X_USART3_TX/PB10	3.3 V	O	USART3 TXD out
D12	X_USART3_RTS/PG8	3.3 V	O	USART3 RTS out
D13	X_USART3_CTS/PB13	3.3 V	I	USART3 CTS in

TABLE 22: USART1 and UART4 Signal Locations at X1

SOM Connector Pin	SOM Signal Name	Signal Level	Signal Type	Description
A55	X_USART1_TX/PZ7	3.3 V	O	USART1 TXD out
B55	X_USART1_RX/PZ6	3.3 V	I	USART1 RXD in
A54	X_UART4_RX/PB2	3.3 V	I	UART4 RXD in
B16	X_SDMMC1_CDIR/PB9	3.3 V	O	UART4 TXD out

10.7 CAN FD Interface

The STM32MP15x provides two CAN FD interfaces (FDCAN1 and FDCAN2). These CAN FD interfaces are available on the phyCORE-STM32MP15x connector X1.

TABLE 23: CAN FD Interface Signal Locations at X1

SOM Connector Pin	SOM Signal Name	Signal Level	Signal Type	Description
C1	X_FDCAN1_RX/PA11	3.3 V	I	CAN FD1 RXD in
C2	X_FDCAN1_TX/PA12	3.3 V	O	CAN FD1 TXD out
B57	X_SPI1_MOSI/PB5	3.3 V	I	GPIO PB5 / CAN FD2 RXD in
D13	X_USART3_CTS/PB13	3.3 V	O	USART3 CTS in / CAN FD2 TXD out

10.8 SPI Interface

The STM32MP15x provides one dual-mode Quad-SPI interface (QSPI) and up to six SPI interfaces. The Quad interface (QSPI-BK1) is directly connected to an optional on-board OSPI Flash (U11) see chapter 9.4. One SPI interface (SPI1) is predefined on the connector X1.

TABLE 24: SPI1 Interface Signal Locations at X1

SOM Connector Pin	SOM Signal Name	Signal Level	Signal Type	Description
A56	X_SPI16_MOSI/PZ2	3.3 V	O	SPI1 MOSI out
A57	X_SPI16_NSS/PZ3	3.3 V	O	SPI1 nSlaveSlect out
B54	X_SPI16_SCK/PZ0	3.3 V	O	SPI1 SCLK out
B56	X_SPI16_MISO/PZ1	3.3 V	I	SPI1 MISO in

10.9 Audio Interface (SAI)

The Synchronous Audio Interface (SAI) on the phyCORE-STM32MP15x is a full-duplex, serial interface that enables communication with a variety of serial devices, such as standard codecs, signal digital processors (SDPs), microprocessor peripherals, and popular industry audio codecs that implement the inter-IC sound bus standard (I2S), PDM, and SPDIF standard. The STM32MP15x provides different possibilities for using the SAI modules.

The main purpose of this interface is to connect to an external codec, such as I2S. The SAI is intended to be used in synchronous mode. The tables below show the locations of the SAI2 sources:

TABLE 25: SAI2 Interface Signal Locations at X1

SOM Connector Pin	SOM Signal Name	Signal Level	Signal Type	Description
D15	X_SAI2_SD_A/PI6	3.3 V	I/O	SAI2 SDA
D16	X_SAI2_SD_B/PF11	3.3 V	I/O	SAI2 SDB
D17	X_SAI2_SCK_B/PH2	3.3 V	I/O	SAI2 SCKB
D18	X_SAI2_MCLK_B/PH3	3.3 V	I/O-O	SAI2 MCLKB
D19	X_SAI2_FS_B/PC0	3.3 V	I/O	SAI2 FSB

10.10 General Purpose I/Os

All STM32MP15x port pins not used by any of the other interfaces can be muxed and used as GPIO without harming other features of the phyCORE-STM32MP15x:

TABLE 26: GPIO Pin Locations at X1

SOM Connector Pin	SOM Signal Name	Signal Level	Signal Type	Description
A58	X_PI0	3.3 V	I/O	GPIO PI0 (LCD dim PWM out)
A59	X_PI3	3.3 V	I/O	GPIO PI3 (LCD Touch-IRQn in)
A60	X_PD9	3.3 V	I/O	GPIO PD9 (LCD Reset out)
B15	X_SDMMC1_CKIN/PE4	3.3 V	I/O-I	GPIO PE4 / SDMMC1 clock in
B16	X_SDMMC1_CDIR/PB9	3.3 V	I/O-O	GPIO PB9 / UART4 TXD
B17	X_SDMMC1_D0DIR/PF2	3.3 V	I/O-O	GPIO PF2 / SDMMC1 dat0 direction out
B18	X_SDMMC1_D123DIR/PE14	3.3 V	I/O-O	GPIO PE14 / SDMMC1 dat123 direction out
B57	X_SPI1_MOSI/PB5	3.3 V	I/O	GPIO PB5 / CAN FD2 RXD in
B58	X_SPI1_NSS/PA15	3.3 V	I/O	GPIO PA15 / HDMI-CEC
C23	X_DFSDM1_DATIN0/PG0	3.3 V	I/O-I	GPIO PG0 / DFSDM1 D0
C24	X_DFSDM1_DATIN1/PC3	3.3 V	I/O-I	GPIO PC3 / DFSDM1 D1

SOM Connector Pin	SOM Signal Name	Signal Level	Signal Type	Description
C25	X_DFSDM1_DATIN3/PF13	3.3 V	I/O-I	GPIO PF13 / DFSDM1 D2
C26	X_DFSDM1_CKIN1/PG3	3.3 V	I/O-I	GPIO PG3 / DFSDM1 CK-in
C27	X_DFSDM1_CKOUT/PD10	3.3 V	I/O-O	GPIO PD10 / DFSDM1 CK-out
D25	X_I2C2_SDA/PH5	3.3 V	I/O	GPIO PH5
D27	X_DBTRGI/PA14	3.3 V	I/O-I	Debug Trigger-In / GPIO PA14
D28	X_DBTRGO/PA13	3.3 V	I/O-O	Debug Trigger-out / GPIO PA13
D47	X_PG1	3.3 V	I/O	GPIO PG1
D48	X_PF3	3.3 V	I/O	GPIO PF3
D49	X_MCO2/PG2	3.3 V	I/O-O	GPIO PG2
D52	X_nPMIC_INT/PA0	3.3 V	I/O-I	GPIO PA0 (PMIC-IRQn out)
D53	X_WAKEUP3/PC13	3.3 V	I/O	GPIO PC13 (PMIC-Wakeup in)

Besides these pins, most of the STM32MP15x signals which are connected directly to the module connector can be configured to act as GPIOs, due to the multiplexing functionality of most controller pins. Normally, pins with signal type I/O are able to work as a GPIO.

11 ADC, DAC, and Filter Inputs

The STM32MP15x provides analog-to-digital conversion and vice versa, as well as digital filters for sigma-delta modulators (DFSDM). The pin muxing and the pin assignment of the phyCORE-Connector allow these features to be used.

11.1 Analog-to-Digital Conversion Inputs

The Analog-to-Digital conversion inputs provide 4 analog input signals. The table below lists the location of the analog input signals and possible functions assigned to them.[3]

TABLE 27: Location of the Analog Inputs and Outputs in X1

SOM Connector Pin	SOM Signal Name	Signal Level	Signal Type	Description
C11	X_ADC1_INN1	analog	ANA_I	ADC1 IN1- analog input
C12	X_ADC1_INP1	analog	ANA_I	ADC1 IN1+ analog input
C13	X_ADC1_INN2/PF12	analog / 3.3 V	ANA_I	ADC1 IN2- analog input
C14	X_PVD_IN/ADC1_INN15/PA3	analog / 3.3 V	ANA_I	ADC1 IN15- analog input
C15	VREF	analog	ANA-REF	Analog Reference in/out
C16	X_DACOUT1/PA4	analog / 3.3 V	ANA_O	DAC OUT1 analog output
C17	X_DACOUT2/PA5	analog / 3.3 V	ANA_O	DAC OUT2 analog output

Jumper J14 allows the voltage source for the analog inputs' reference voltage (VREF) at X1C15 to be connected directly on the SOM to the analog supply (VDDA). VDDA can be supplied by VDD (J16=default) or via VDDA from PMIC-LDO5 (J15). see Jumper J14, J15, and J16 in Jumpers.

3. Almost every controller port that connects directly to the phyCORE-Connector may be used as GPIO by using the STM32MP15x's pin muxing options.

11.2 DFSDM Interface

The STM32MP15x provides a filter for the sigma-delta modulator (DFSDM) with up to 8 channels/6 filters. On the phyCORE-STM32MP15x are 3 data inputs with a clock signal to use the DFSDM interface at X1.

TABLE 28: DFSDM1 Interface Signal Locations at X1

SOM Connector Pin	SOM Signal Name	Signal Level	Signal Type	Description
C23	X_DFSDM1_DATIN0/PG0	3.3 V	I	DFSDM1 D0 input
C24	X_DFSDM1_DATIN1/PC3	3.3 V	I	DFSDM1 D1 input
C25	X_DFSDM1_DATIN3/PF13	3.3 V	I	DFSDM1 D2 input
C26	X_DFSDM1_CKIN1/PG3	3.3 V	I	DFSDM1 CK input
C27	X_DFSDM1_CKOUT/PD10	3.3 V	O	DFSDM1 CK output

12 Debug Interface

The phyCORE-STM32MP15x is equipped with a JTAG/Serial-wire debug interface to control the STM32MP15x's debug features with industry-standard debugging tools. It allows downloading program code into the external flash, internal controller RAM, or debugging programs currently being executed.

A trace port allows data to be captured for logging and analysis. Additionally, trigger pins and two LEDs facilitate debugging.

12.1 JTAG/Serial-Wire Debug Interface

The location of the JTAG and Serial-wire debug interface pins on the phyCORE-Connector X1 are shown in the table below:

TABLE 29: JTAG/Serial-Wire Interface Signal Locations at X1

SOM Connector Pin	SOM Signal Name	Signal Level	Signal Type	Description
B2	X_JTAG_nTRST	3.3 V	I	JTAG test reset (active low)
B3	X_JTAG_TDI	3.3 V	I	JTAG test data input
B4	X_JTAG_TMS/SWDIO	3.3 V	I / I/O	JTAG test mode select / Serial wire data in/out
B5	X_JTAG_TCK/SWCLK	3.3 V	I	JTAG test clock / Serial wire clock
B6	X_JTAG_TDO/TRACESWO	3.3 V	O	JTAG test data output / Trace asynchronous data out[5]

Note

The single wire trace on the TRACESWO pin is only available for the Cortex-M4 core. To trace all cores' activity, a parallel trace port must be used. Please refer to the *STM32MP15x Datasheet* for information regarding ports providing the trace port signals TRACED[15:0] and TRACECLK.

5. TRACESWO is multiplexed with JTDO. This means that a single wire trace is only available when using the serial wire debug interface, not when using JTAG.

12.2 Debug Trigger / Status LEDs

The phyCORE-STM32MP15x features two debug trigger pins and two status LEDs.

TABLE 30: Debug Trigger Signal Locations at X1

SOM Connector Pin	SOM Signal Name	Signal Level	Signal Type	Description
D27	X_DBTRGI/PA14	3.3 V	I	External trigger input to the cross trigger interface (CTI)
D28	X_DBTRGO/PA13	3.3 V	O	External trigger output from the cross trigger interface (CTI)

The two LEDs D1 (green) and D2 (red) are connected to PA14 and PA13, respectively.

D1 indicates the following statuses:

- During the boot phase, in case of boot failure, the PA13 pin is set to low open-drain, and LED D2 lights bright.
- During UART/USB boot, the PA13 pin toggles open-drain at a rate of about 5 Hz until a connection is started, and LED D2 blinks fast.
- With BOOT[2:0] = 0b100 (no boot, used for specific debug), PA13 toggles open-drain at a rate of about 5 kHz, LED D2 lights weak.
- In all other cases, the PA13 is kept in its reset value, that is, high-z until the software setting, LED D2, is off.

The behavior of the green LED D1 at the external trigger input PA14 depends on the type of signal applied to this port.

Please refer to application note AN5031 from ST for more information regarding the use of the debug trigger ports.

12.3 UART Virtual Com Port

The phyCORE-STM32MP15x uses UART4 to support debugging if a virtual com port is needed as an addition to the JTAG interface. UART4 also works as a standard console in the Linux BSP.

TABLE 31: Debug UART Signal Locations at X1

SOM Connector Pin	SOM Signal Name	Signal Level	Signal Type	Description
A54	X_UART4_RX/PB2	3.3 V	I	UART4 serial data receive signal
B16	X_SDMMC1_CDIR/PB9	3.3 V	O	UART4 serial data transmit signal

12.4 Hardware Debug Port (HDP)

The Hardware Debug Port allows the observation of internal signals. By using multiplexers, up to 16 signals for each 8-bit output can be observed. All STM32MP15x hardware debug port signals are available at the phyCORE-Connector as an alternate function. Please make sure that a port is not mandatory for the function of the phyCORE-STM32MP15x before changing the muxing to use the Hardware Debug Port feature. More information about the Hardware Debug Port can be found in the *STM32MP15x Reference Manual*.

13 Display Interfaces

The phyCORE-STM32MP15x provides an 18-bit parallel digital RGB (Red, Green, Blue) and a MIPI DSI interface to connect appropriate displays to the module.

13.1 Parallel Display Interface

The STM32MP15x provides a 24-bit parallel digital RGB (Red, Green, Blue) display interface and delivers signals up to WXGA (1366×768) @60 fps resolution. All signals are available at different controller ports as alternate functions. As some of the controller ports are needed for other functions, the parallel display interface of the phyCORE-STM32MP15x is specified as an 18-bit interface only. The table below shows the location of the specified display interface signals on the phyCORE-Connector.

TABLE 32: Parallel Display Interface Signal Locations

SOM Connector Pin	SOM Signal Name	Signal Level	Signal Type	Description
A40	X_LCD_R2/PC10	3.3 V	O	LCD data red2
A41	X_LCD_R3/PB0	3.3 V	O	LCD data red3
A42	X_LCD_R4/PH10	3.3 V	O	LCD data red4
A43	X_LCD_R5/PH11	3.3 V	O	LCD data red5
A44	X_LCD_R6/PH12	3.3 V	O	LCD data red6
A45	X_LCD_R7/PE15	3.3 V	O	LCD data red7
A47	X_LCD_G2/PH13	3.3 V	O	LCD data green2
A48	X_LCD_G3/PE11	3.3 V	O	LCD data green3
A49	X_LCD_G4/PH15	3.3 V	O	LCD data green4
A50	X_LCD_G5/PH4	3.3 V	O	LCD data green5
A51	X_LCD_G6/PI11	3.3 V	O	LCD data green6
A52	X_LCD_G7/PI2	3.3 V	O	LCD data green7

SOM Connector Pin	SOM Signal Name	Signal Level	Signal Type	Description
B42	X_LCD_B2/PG10	3.3 V	O	LCD data blue2
B43	X_LCD_B3/PG11	3.3 V	O	LCD data blue3
B44	X_LCD_B4/PE12	3.3 V	O	LCD data blue4
B45	X_LCD_B5/PI5	3.3 V	O	LCD data blue5
B46	X_LCD_B6/PB8	3.3 V	O	LCD data blue6
B47	X_LCD_B7/PD8	3.3 V	O	LCD data blue7
B49	X_LCD_HSYNC/PI10	3.3 V	O	LCD horizontal sync
B50	X_LCD_VSYNC/PI9	3.3 V	O	LCD vertical sync
B51	X_LCD_DE/PE13	3.3 V	O	LCD data enable
B52	X_LCD_CLK/PG7	3.3 V	O	LCD clock

Note

All parallel display signals are available as alternate functions at other pins of the phyCORE-Connector, too. Hence, by changing the pin muxing and the device tree, even a full 24-bit parallel display interface can be implemented. Further information about other ports and therefore other pins of the phyCORE-STM32MP15x providing signals of the display interface can be found in the STM32MP15x data sheet.

13.1.1 Supplementary Signals

In addition, signal X_LCD_BL_PWM/PI0 can be used as a PWM output to control the display backlight.

The STM32MP15x embeds an HDMI-CEC controller that provides hardware support for the consumer electronics control (CEC) protocol. The HDMI-CEC signal is available at the phyCORE-Connector and can be used together with the parallel RGB display signals to build an HDMI interface with the CEC feature.

The table below shows the location of the two supplementary signals on the phyCORE-Connector.

TABLE 33: Supplementary Signals to Support the Display Connectivity

SOM Connector Pin	SOM Signal Name	Signal Level	Signal Type	Description
A58	X_LCD_BL_PWM/PI0	3.3 V	O	PWM output (e.g., to control a backlight)
B58	X_SPI1_NSS/PA15	3.3 V	I/O	HDMI-CEC[6]

6. To use the HDMI-CEC signal, a 27 kΩ resistor must be added externally.

13.2 MIPI DSI (Display Serial Interface)

If the phyCORE-STM32MP15x is equipped with an STM32MP157x microprocessor a MIPI DSI interface with 2 data lanes up to 1 GHz each is also available to connect a display to the module. The table below shows the location of the MIPI display interface signals on the phyCORE-Connector.

TABLE 34: MIPI DSI Signal Locations

SOM Connector Pin	SOM Signal Name	Signal Level	Signal Type	Description
A1	X_MIPI_DSI_CLKN	1.2 V	DSI_O	MIPI DSI clock negative output
A2	X_MIPI_DSI_CLKP	1.2 V	DSI_O	MIPI DSI clock positive output
A4	X_MIPI_DSI_DATA0N	1.2 V	DSI_O	MIPI DSI data0 negative output
A5	X_MIPI_DSI_DATA0P	1.2 V	DSI_O	MIPI DSI data0 positive output
A7	X_MIPI_DSI_DATA1N	1.2 V	DSI_O	MIPI DSI data1 negative output
A8	X_MIPI_DSI_DATA1P	1.2 V	DSI_O	MIPI DSI data1 positive output
A9	X_MIPI_DSIHOST_TE/PD13	3.3 V	I	MIPI DSI tearing effect input

Tip

Connecting a MIPI-DSI to a FlatLink (LVDS) converter to the MIPI display interface on a custom carrier board leads to a larger selection of displays and the possibility of connecting cheaper displays.

14 Parallel Camera Interface (DCMI)

The STM32MP15x offers one synchronous parallel camera interface (DCMI) that can receive high-speed data flows with up to 14 data lines (D13-D0) and a pixel clock line (DCMI_PIXCLK) with a programmable polarity so that data can be captured on either the rising or the falling edge of the pixel clock.

On the phyCORE-STM32MP15x, the camera interface is brought out as parallel interfaces with 10 data bits, HSYNC, VSYNC, and PIXCLK. The upper DCMI data bits D13... D10 is used for other features of the phyCORE-STM32MP15x.

The locations of the parallel camera interface signals are shown below:

TABLE 35: Parallel Camera Interface Signal Locations

SOM Connector Pin	SOM Signal Name	Signal Level	Signal Type	Description
A30	X_DCMI_HSYNC/PH8	3.3 V	I	DCMI Horizontal synchronization / Data valid
A31	X_DCMI_VSYNC/PB7	3.3 V	I	DCMI Vertical synchronization
A32	X_DCMI_PIXCLK/PA6	3.3 V	I	DCM Pixel clock
A34	X_DCMI_DATA5/PI4	3.3 V	I	DCMI data5
A35	X_DCMI_DATA6/PE5	3.3 V	I	DCMI data6
A36	X_DCMI_DATA7/PI7	3.3 V	I	DCMI data7
A37	X_DCMI_DATA8/PI1	3.3 V	I	DCMI data8
A38	X_DCMI_DATA9/PH7	3.3 V	I	DCMI data9
B36	X_DCMI_DATA0/PH9	3.3 V	I	DCMI data0
B37	X_DCMI_DATA1/PC7	3.3 V	I	DCMI data1
B38	X_DCMI_DATA2/PE0	3.3 V	I	DCMI data2

SOM Connector Pin	SOM Signal Name	Signal Level	Signal Type	Description
B39	X_DCMI_DATA3/PE1	3.3 V	I	DCMI data3
B40	X_DCMI_DATA4/PH14	3.3 V	I	DCMI data4

Note

All parallel camera interface signals, including DCMI data bits D13... D10 are available as an alternate functions at other pins of the phyCORE-Connector, too. Hence, by changing the pin muxing and the device tree, even a full 14-bit parallel camera interface can be implemented. Further information about other ports and therefore other pins of the phyCORE-STM32MP15x providing signals of the camera interface can be found in the STM32MP15x data sheet.

Tip

Using the phyCORE's parallel camera interface DCIM, together with an I^2C bus, an additional clock, and a GPIO, facilitates easy implementation of a CMOS camera interface compliant with PHYTEC's camera interface standards phyCAM-P or phyCAM-S+ (requires an external deserializer) on a custom carrier board.

15 Real-Time Clocks (RTCs)

For real-time or time-driven applications, the phyCORE-STM32MP15x provides two RTCs. Besides the internal RTC of the STM32MP15x, the phyCORE-STM32MP15x has an external RTC mounted at U13.

The RTCs are supplied by the main system power if available. When the main system power is off, they can also be powered by a secondary voltage source of 1.8 V to 3.6 V (typ. 3 V) connected to VBAT (D57). The VBACKUP input of the external RTC is permanently connected to VBAT, while jumper J5 must be closed at 2+3 to connect the STM32MP15x's VBAT input, too.

15.1 RTC of the STM32MP15x

The signals of the STM32MP15x's on-chip RTC are available at phyCORE-Connector X1.

The following table lists the signals of the RTC on the phyCORE-Connector:

TABLE 36: STM32MP1 RTC Interface Signal Locations at X1

SOM Connector Pin	SOM Signal Name	Signal Level	Signal Type	Description
A12	X_SDMMC2_DATA1 / PB15	3.3 V	I	RTC 50 or 60 Hz reference clock input
A54	X_UART4_RX / PB2	3.3 V	O	RTC output 2
B60	X_PI8	3.3 V	O	RTC output 2[7] / RTC low-speed clock output
C27	X_DFSDM1_CKOUT / PD10	3.3 V	I	RTC 50 or 60 Hz reference clock input
D53	X_WAKEUP3 / PC13	3.3 V	I/O	RTC output 1[7] / RTC timestamp input[7]/ RTC low-speed clock output[7]

Note

As can be seen from the signal names, by default, most RTC pins are assigned to other functions within the included BSP. The pin muxing must be changed, and the device tree must be adapted in order to use the RTC's signals.

7. These signals are also available in VBAT mode.

15.2 External RTC (U13)

The standard configuration of the SOM provides an additional, external RTC at U13. The newest generation of RTC from Micro Crystal is characterized by an extremely low backup current of only 40 nA. As the external RTC uses less power than the STM32MP15x's internal RTC (> 1 µA), it is recommended to be used for applications that require backing up the RTC for a long time. In a normal operation state, the RTC power is supplied from the SOM voltage VDD. To back up the external RTC when the main supply voltage VDD is not available, a secondary voltage source of 1.8 V to 3.6 V (typ. 3.3 V) must be attached to the phyCORE-STM32MP15x at the VBAT pin D57.

In order to get the minimum power consumption to back up the RTC while the main supply voltage is not available, jumper J5 must be closed at 1+2 (default configuration). Otherwise, the STM32MP15x's backup domain V_{SW} will also be supplied by the backup voltage source. The RTC is programmed via I2C4 at address 0x52. All three signals of the RTC (clockout, external event input, and interrupt output) are available at the phyCORE-Connector.

TABLE 37: RTC Signal Locations at X1

SOM Connector Pin	SOM Signal Name	Signal Level	Signal Type	Description
C48	X_RTC_EVI	3.3 V	I-PD	External event input; 10 kΩ pull-down; remains active also in VBACKUP power state.
C49	X_nRTC_INT	3.3 V	OD	Interrupt output; open-drain; active low; requires a pull-up resistor
C50	X_RTC_CLKOUT	3.3 V	O	Clock output: low in VBACKUP power state.
D57	VBAT	1.8 V - 3.6 V	PWR_I	3 V / <1 µA RTC Backup Supply

16 Technical Specifications

The physical dimensions of the phyCORE-STM32MP15x are represented in the figures phyCORE-STM32MP15x Mechanical Dimensions (profile view) and phyCORE-STM32MP15x Mechanical Dimensions (top view). The module's profile is approximately 4.8 mm thick from the tallest component on the top to the tallest component on the bottom (excluding the phyCORE connectors). The maximum component height (excluding connectors X1 and X2) is approximately 1.25 mm on the bottom (connector) side of the PCB and approximately 2 mm on the top (microcontroller) side. The PCB is approximately 1.55 mm thick. The distance from the surface of the carrier board to the highest component on the top side of the board is approximately 8.55 mm.

FIGURE 9: phyCORE-STM32MP15x Mechanical Dimensions (profile view)

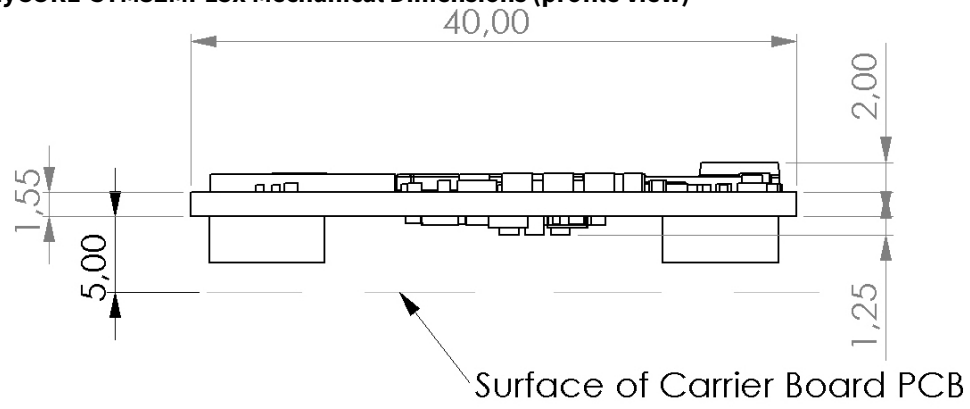
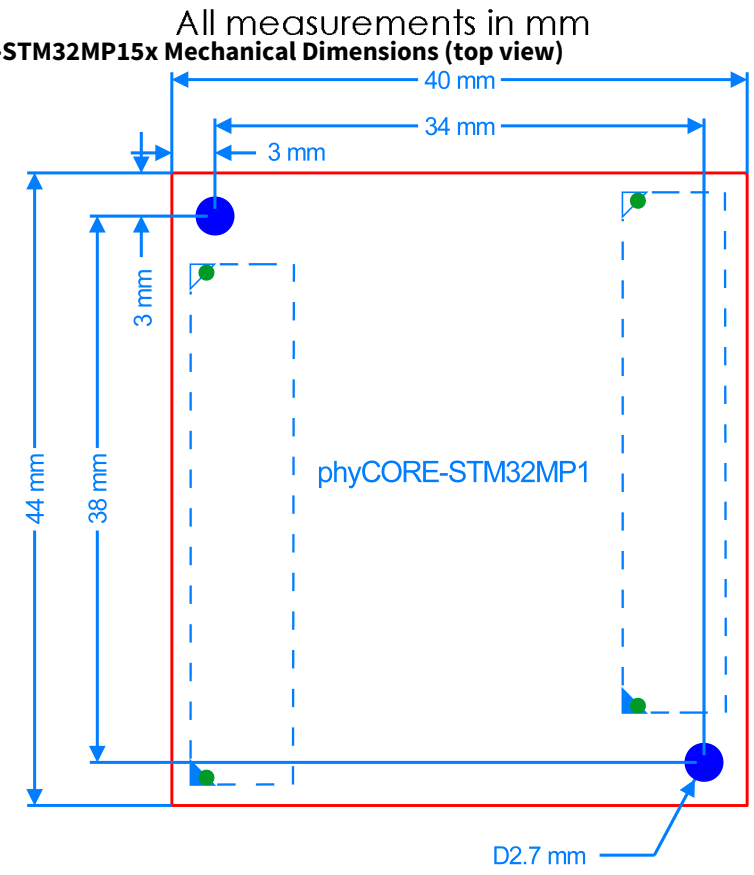


FIGURE 10: phyCORE-STM32MP15x Mechanical Dimensions (top view)



Tip

To facilitate the integration of the phyCORE-STM32MP15x into your design, the footprint of the phyCORE-STM32MP15x can be downloaded (Integrating the phyCORE-STM32MP15x).

Additional specifications:

TABLE 38: Technical Specifications

Dimensions:	40 mm x 44 mm x 4.8 mm (excluding the phyCORE-Connectors)
Weight:	11.3 g
Storage Temperature:	-40 °C to +125 °C
Operating Temperature:	Refer to Product Temperature Grades
Humidity:	95 % r.F. not condensed
Operating Voltage:	5 V +/- 5%
Power Consumption:	phyCORE-STM32MP15x Power Consumption

These specifications describe the standard configuration of the phyCORE-STM32MP15x as of the printing of this manual.

16.1 phyCORE-STM32MP15x Power Consumption

The values listed in the table below are a guideline to determine the required dimensions of the power supply circuitry on a carrier board. They do not take application-specific load situations into account. These values have been generated by looking at the maximum power consumption measured using different load scenarios and adding a voltage source of 5 V. These values are based on internal PHYTEC testing. Customers need to consider their application power requirements to ensure they do not generate a load greater than the values listed here.

TABLE 39: phyCORE-STM32MP1 Power Consumption

Maximum Power Requirements	3 W without external load
SOM: phyCORE STM32MP157CA,1GR/8GeM/16MSF @650Mhz condition: in Linux prompt SOM only VCC5V_IN = 5 V supply, boot from eMMC	1.2 W typ.
SOM: phyCORE STM32MP157CA,1GR/8GeM/16MSF @650Mhz condition: memtester running SOM only VCC5V_IN = 5 V supply, boot from eMMC	1.5 W max.

Required Supply Voltage (VCC5V_IN)	4.75 V to 5.5 V / 3 A
Ramp-Up Time	< 1 sec.
Backup Supply Voltage (VBAT)	1.2 V to 5.5 V / 1 uA (ULP-RTC only) 1.4 V to 3.6 V / 2.5 mA (with STM32MP15x VBAT Supply)

Additionally, there are some values that cannot be tested. Situations such as suspending to RAM, suspend freeze, and standby mode must be tested on a case-by-case basis to ensure the application's power consumption stays within the guidelines stated above.

Tip

For further information and assistance regarding your application's power consumption, please contact PHYTEC sales.

16.2 Product Temperature Grades

Warning

The right temperature grade for the module greatly depends on the use case. It is necessary to determine if the use case suits the temperature range of the chosen module (see below). A heat spreader can be used if temperature compensation is required.

The feasible operating temperature of the SOM highly depends on the use case of your software application. Modern high-performance microcontrollers and other active parts, such as the ones described within this manual, are usually rated by qualifications based on tolerable junction or case temperatures. Therefore, making a general statement about minimum or maximum ambient temperature ratings for the described SOM is not possible.

However, the above-mentioned parts are available at different temperature qualification levels by the producers. We offer our SOMs in different configurations, making use of those temperature qualifications. To indicate which level of temperature qualification is used for active and passive parts of a SOM configuration, we have categorized our SOMs into three temperature grades. The table Product Temperature Grades describes these grades in detail. These grades describe a set of components that, in combination, add up to a useful set of product options with different temperature grades. This enables us to make use of cost optimizations depending on the required temperature range.

In order to determine the right temperature grade and whether the minimum or maximum qualification levels are met within an application, the following conditions must be defined by considering the use case:

- Determined the processing load for the given software use case
- Maximum temperature ranges of components (see Product Temperature Grades)
- Power consumption resulting from a baseload and the calculating power required (in consideration of peak loads as well as time periods for system cooldown)
- Surrounding temperatures and existing airflow in case the system is mounted into a housing
- Heat resistance of the heat dissipation paths within the system along with the considered usage of a heat spreader or a heat sink to optimize heat dissipation

TABLE 40: Product Temperature Grades

Product Temperature Grade	Controller Temperature Range (Junction Temperature)	RAM (Case Temperature)	Other (Ambient)
I	Industrial: -40 °C to +125 °C	Industrial: -40 °C to +95 °C	Industrial: -40°C to +85 °C
X	Extended Commercial: -20 °C to +105 °C	Industrial: -40 °C to +95 °C	Industrial: -40 °C to +85 °C
C	Commercial: 0 °C to +95 °C	Consumer: 0 °C to +95 °C	Consumer: 0 °C to +70 °C

16.3 Connectors on the phyCORE-STM32MP15x

TABLE 41: SOM Connectors

Manufacturer	Samtec
phyCORE-Connector (X1)	
Number of pins per contact rows	240 pins (4 rows of 60 pins each)
Samtec part number (lead-free)	REF-177857-02
PHYTEC part number (lead-free)	VB211
Height	5 mm

Information on the receptacle sockets that correspond to the connectors populating the underside of the phyCORE-STM32MP15x is provided below. The given connector height indicates the distance between the two connected PCBs when the module is mounted on the corresponding carrier board. In order to get the exact spacing, the maximum component height (1.25 mm) on the bottom side of the phyCORE must be subtracted.

TABLE 42: Mating Connector

Manufacturer	Samtec
phyCORE-Connector (X1)	
Number of pins per contact rows	240 pins (4 rows of 60 pins each)
Samtec part number (lead-free)	REF-177862-03
PHYTEC part number (lead-free)	VM240

Height	5 mm

Please refer to the corresponding data sheets and mechanical specifications provided within the category *Module Connector* in the download section of the phyCORE-STM32MP15x web page.

17 Hints for Integrating and Handling the phyCORE-STM32MP15x

17.1 Integrating the phyCORE-STM32MP15x

Design Rules

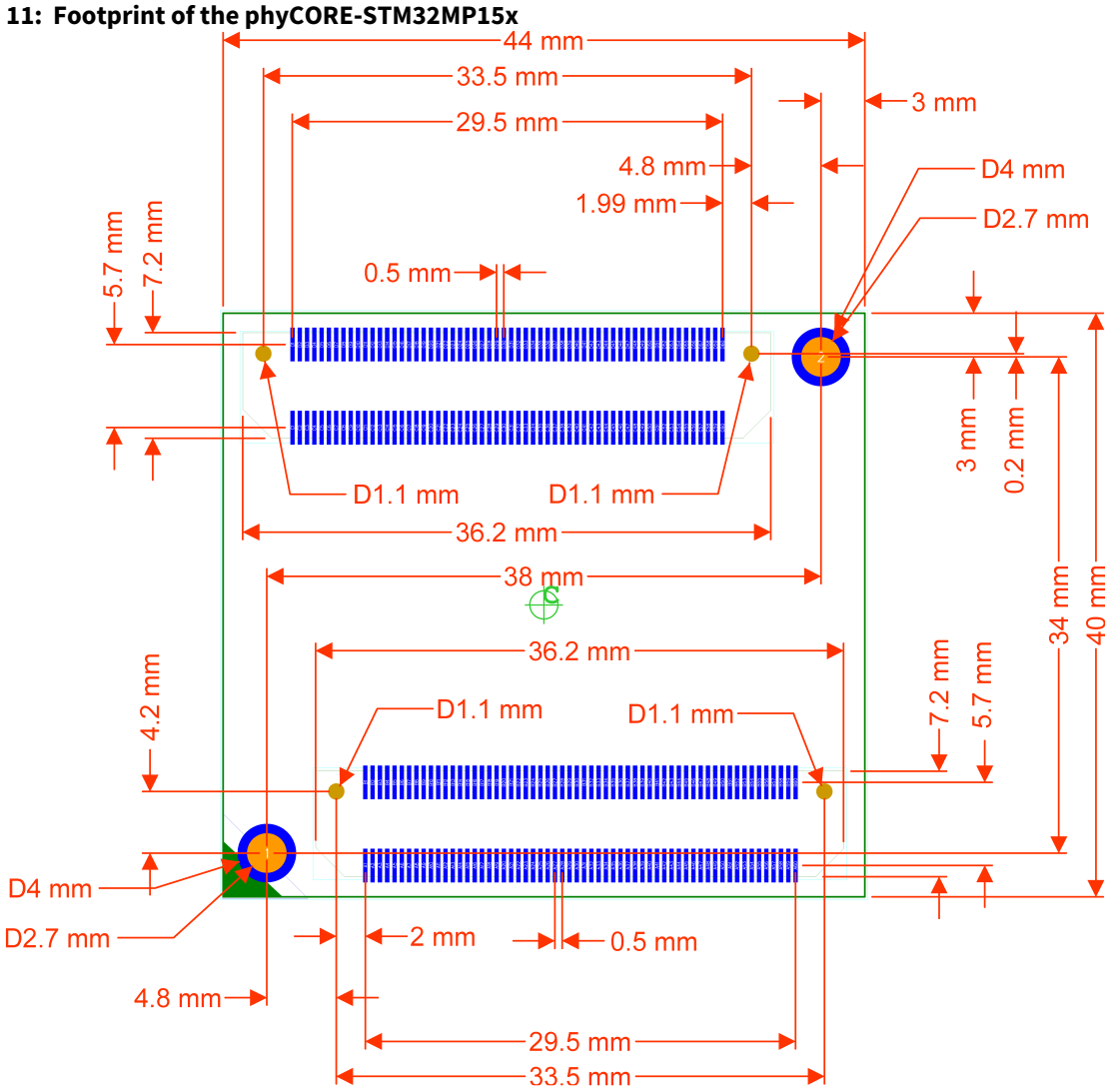
Successful integration in the user target circuitry greatly depends on adherence to the layout design rules for the GND connections of the phyCORE module. For maximum EMI performance, we recommend as a general design rule to connect all GND pins to a solid ground plane. But at least all GND pins neighboring signals which are being used in the application circuitry should be connected to GND.

Additional Information and Reference Design

Besides this hardware manual, more information is available to facilitate the integration of the phyCORE-STM32MP15x into customer applications.

1. The design of the phyBOARD Sargas STM32MP15x can be used as a reference for any customer application.
2. Many answers to common questions can be found at https://www.phytec.de/produkte/system-on-modules/phycore-stm32mp15x/#downloads/ or https://www.phytec.eu/en/produkte/system-on-modules/phycore-stm32mp15x?lang=en/#downloads/
3. The links within the categories Dimensioned Drawing and Altium lead to the layout data as shown in the image below. The use of this data allows the phyCORE-STM32MP1 SOM to be integrated into your design as a single component.
4. Different support packages are available for support in all stages of embedded development. Please visit https://www.phytec.de/support/ueberblick/ or https://www.phytec.eu/support/support-packages/ or contact our sales team for more details.
5. Many answers to common questions can be found at:
   https://www.phytec.de/produkte/system-on-modules/phycore-stm32mp15x/
   or
   https://www.phytec.eu/en/produkte/system-on-modules/phycore-stm32mp15x

FIGURE 11: Footprint of the phyCORE-STM32MP15x



17.2 Handling the phyCORE-STM32MP15x

phyCORE Module Modifications

The removal of various components, such as the microcontroller or the standard quartz, is not advisable given the compact nature of the module. Should this nonetheless be necessary, please ensure that the board, as well as surrounding components and sockets, remain undamaged while desoldering. Overheating the board can cause the solder pads to loosen, rendering the module inoperable. If soldered components need to be removed, the use of a desoldering pump, desoldering braid, an infrared desoldering station, desoldering tweezers, a hot air rework station, or other desoldering methods is strongly recommended. Please carefully follow the instructions for the method of removal chosen.

Warning

If any modifications to the module are performed, regardless of their nature, the manufacturer's guarantee is null and void.

18 phyCORE-STM32MP15x on the phyBOARD-Sargas SBC

18.1 Hardware Overview

The phyBOARD-Sargas STM32MP15x single-board computer (SBC) for phyCORE-STM32MP15x is a low-cost, feature-rich software development platform supporting the STMicroelectronics STM32MP15x microcontroller. Due to numerous standard interfaces, the phyBOARD-Sargas STM32MP15x can serve as the bedrock for any application. At the core of the phyBOARD-Sargas is the PCM-068/phyCORE-STM32MP15x System On Module (SOM) containing the processor, DDR3L RAM, eMMC Flash, power regulation, supervision, and other core functions required to support the STM32MP15x processor. Surrounding the SOM is the PCM-939/phyBOARD-Sargas STM32MP15x, adding power input, buttons, connectors, signal breakout, and Ethernet connectivity, along with other peripherals.

The PCM-068 System On Module connects to the phyBOARD-Sargas STM32MP15x by using two high-density connectors.

18.2 phyBOARD-Sargas Single Board Computer Concept

PHYTEC Single Board Computers (phyBOARDS) are fully equipped with all mechanical and electrical components necessary for a fast, secure start-up. Subsequent communication to and programming of the applicable PHYTEC System on Modules (SOM) is made easy. phyBOARDs are designed for evaluation, testing, and prototyping of PHYTEC System on Modules in laboratory environments prior to their use in customer-designed applications.

This modular development platform concept includes the following components:

- The **phyCORE-STM32MP15x Module** is populated with the STM32MP15x microcontroller and all applicable SOM circuitry, such as LPDDR3 SDRAM, eMMC-Flash, Ethernet-PHY, PMIC, etc.
- The **phyBOARD-Sargas Carrier Board** offers all essential components and connectors for a start-up, including interface connectors such as **USB**, **Ethernet,** or **Audio** which enable the use of the SOM's interfaces with a standard cable.

The carrier board can also serve as a reference design for developing custom target hardware in which the phyCORE SOM can be deployed. Carrier board schematics are available under a Non-Disclosure Agreement (NDA). Reuse of carrier board circuitry enables users of PHYTEC SOMs to shorten time-to-market, reduce development costs, and avoid substantial design issues and risks.

SBCplus Concept

The SBCplus concept was developed to meet the many small differences in customer requirements with little development effort. This greatly reduces the time-to-market. The core of the SBCplus concept is the SBC design library (a kind of construction set) that consists of a large number of function blocks (so-called "building blocks") that are continuously being refined and updated.

Recombining these function blocks allows PHYTEC to develop a customer-specific SBC within a short time. We are able to deliver production-ready custom single-board computers within a few weeks at very low costs. The already developed SBCs, such as the phyCORE-STM32MP15x carrier board, each represent a combination of different customer wishes. This means all necessary interfaces are already available on the standard versions, allowing PHYTEC SBCs to be integrated into a large number of applications without modification. For any necessary detail adjustment, extension connectors are available which allow a wide variety of functions to be added.

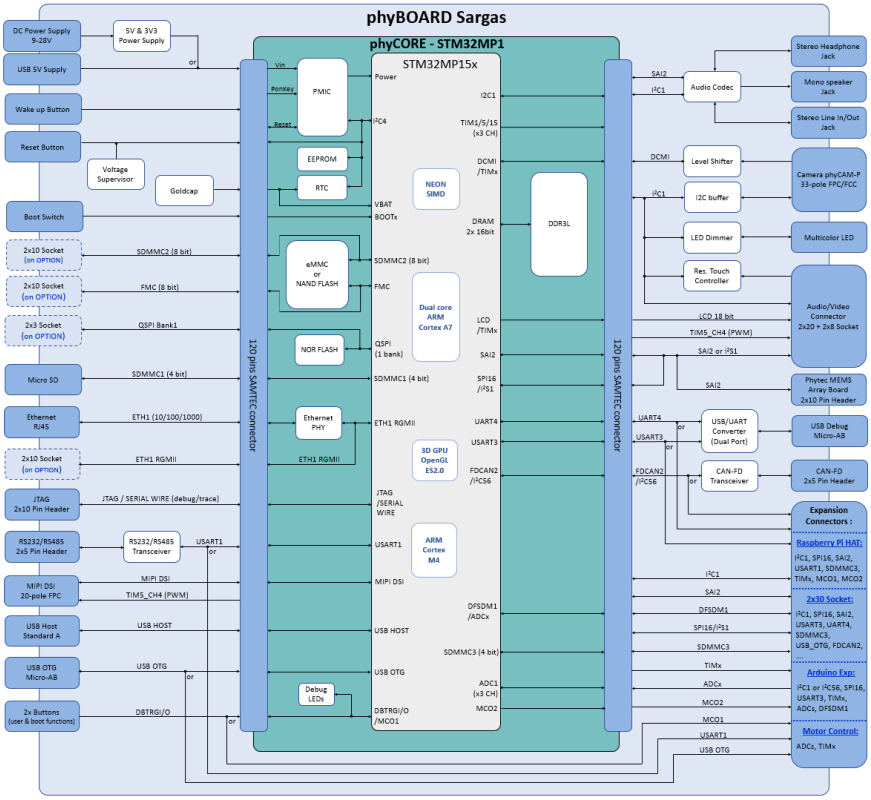
18.3 phyBOARD-Sargas Features

The phyBOARD -Sargas STM32MP15x supports the following features:

- Developed in accordance with PHYTEC's SBCplus concept (SBCplus Concept)
- Populated with PHYTEC's phyCORE-STM32MP15x SOM
- Dimensions of 160 mm × 100 mm
- Boot from eMMC, SD Card, NAND, NOR, over USB OTG (DFU mode), or over UART
- 9-28 VDC power supply or USB-C 5V Supply
- 1x RJ45 jack for 10/100/1000 Mbps Ethernet
- 1x USB 2.0 host interface brought out to an upright USB Standard-A connector.
- 1x USB OTG interface available at a USB Micro-AB connector
- 1x USB Debug interface (UART-USB FTDI converter)
- 1x Secure Digital / MultiMedia Memory Card interface brought out to a Micro-SD connector
- 1x phyCAM-P interface (PHYTEC parallel camera interface)
- 1x MIPI DSI interface (compatible with Raspberry PI MIPI DSI pinout connector)
- 1x LCD RGB 18-bit interface (to connect PHYTEC PEB-AV module)
- 1x micro MEMS specific connector interface (to connect PHYTEC MEMS Array board)
- 1x CAN FD transceiver (data rates up to 5 Mbit/s in the CAN FD fast phase)
- 1x RS-232 or RS-485 transceiver supporting USART1, including handshake signals with data rates of up to 1 Mbps (2×5 pin header 2.54 mm)
- 1x CryptoAuthentication Device
- Reset button
- ON/OFF/Wakeup button
- 2x user buttons
- 1x multicolor LED
- Audio Codec (Mono Speaker output, Stereo Headset, and Line in/out)
- 1x JTAG interface
- Goldcap Backup supply for RTC
- Expansion connectors for different interfaces:
    - Raspberry Pi HAT
    - Arduino Shield
    - Motor Control
    - Expansion (PHYTEC specific)
    - Audio/Video (PHYTEC specific)

18.4 Block Diagram

FIGURE 12: phyBOARD-Sargas STM32MP1 Block Diagram



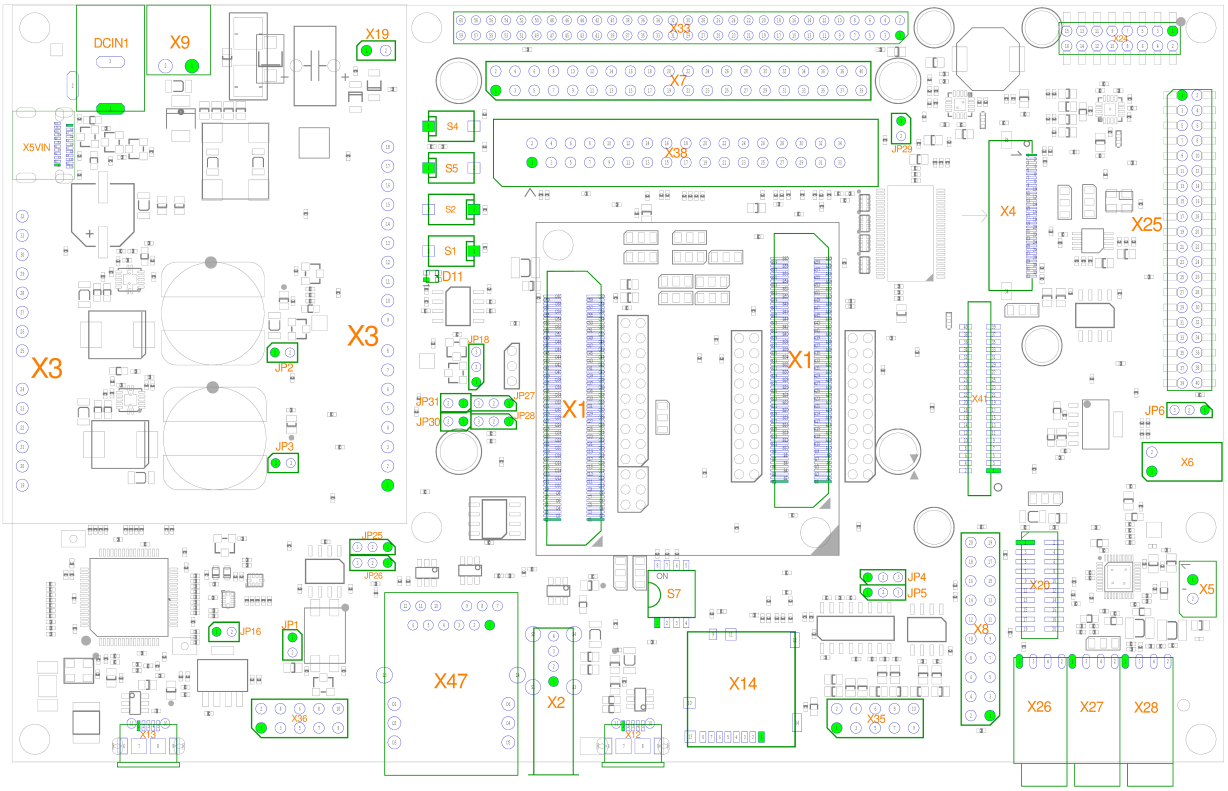
19 phyBOARD-Sargas STM32MP15x Components

Note

For easy reference, Pin 1 for each component has been highlighted.

19.1 phyBOARD-Sargas Component Placement Diagram

FIGURE 13: phyBOARD-Sargas Components



19.1.1 phyBOARD-Sargas Component Overview

The phyBOARD-Sargas STM32MP15x features many different interfaces and is equipped with the components listed in the table phyBOARD-Sargas Connectors and Pin Header. For a more detailed description of each component, refer to the appropriate section listed in the table below. The image phyBOARD-Sargas Components highlights the location of each component for easy identification.

19.1.2 Connectors and Pin Headers

The table below lists all available connectors on the phyBOARD-Sargas.

TABLE 43: phyBOARD-Sargas Connectors and Pin Header

Reference Designator	Description	Section
X1	phyCORE-Connector (Samtec 2 x 60 pins, 0.5 mm pitch)	phyCORE-STM32MP15x SOM Connectivity
X2	USB host connector (USB 2.0 Standard-A)	Universal Serial Bus USB Connectivity
X3	Arduino Shields Connector (socket connector, 2.54 mm pitch)	Arduino Shields Connectivity
X4	phyCAM-P camera connector (33-pin Hirose FFC-connector, 0.5 mm pitch)	Camera Connectivity
X5	Mono Speaker output (2-pole Molex SPOX, 2.5 mm pitch)	Audio Connectivity
X5VIN	USB-C 5V Standard Supply voltage input	5V USB-C Supply Voltage Input (X5VIN)
X6	External Backlight Power (1×2 pin header, 2.54 mm pitch)	External Backlight Power Connectivity
X7	Raspberry Pi HAT Connector (2×20 pin header, 2.54 mm pitch)	Raspberry Pi HAT Connectivity
X8	JTAG (2×10 pin header, 2.54 mm pitch)	Debugging Connectivity
X9	9V-28V DC Supply voltage input (Phoenix Socket)	Power
DCIN1	9V-28V DC Supply voltage input (DC10 Power Socket)	Power
X12	USB On-The-Go connector (USB Micro-AB)	Universal Serial Bus USB Connectivity
X13	Debug USB (USB Micro-AB)	Debugging Connectivity
X14	microSDHC card slot	Secure Digital Memory/ MultiMedia Card
X19	Connector for external Backup Battery (1×2 pin header, 2.54 mm pitch)	VBAT

Reference Designator	Description	Section
X20	Microphone Array Board Connector (2x10 pin header, 1.27 mm pitch)	Microphone Array Connector
X24	Audio/ Video 2 (2×8 dual entry socket, 2 mm pitch)	Audio/Visual Connectors
X25	Audio/ Video 1 (2×20 dual entry socket, 2 mm pitch)	
X26	Stereo Line Output (3,5mm Stereo Audio Jack)	Audio Connectivity
X27	Stereo Line Input (3,5mm Stereo Audio Jack)	
X28	Headset (3,5mm Stereo Audio Jack)	
X33	Expansion Connector (2×30 socket, 2mm pitch)	Expansion Connector
X35	RS485 / RS232 (2x5 pin header, 2.54 mm pitch)	RS232 / RS485 Connector
X36	CAN FDCAN2 (2x5 pin header, 2.54 mm pitch)	CAN FD
X38	Motor Control Connector (2×17 pin header, 2.54 mm pitch)	Motor Control Connector
X41	MIPI-DSI Connector (20 position FPC, 1 mm pitch)	MIPI-DSI
X47	Ethernet Connector (10/100/1000 Base-T RJ45 with Integrated magnetic and LED)	Ethernet

Warning

Ensure that all module connections do not exceed their expressed maximum voltage or current. Maximum signal input values are indicated in the corresponding controller User's Manual/Data Sheets. As damage from improper connections varies according to use and application, it is the user‘s responsibility to take appropriate safety measures to ensure that the module connections are protected from overloading through connected peripherals.

19.1.3 LEDs

The phyBOARD-Sargas is populated with one programmable RGB LED. See Multicolor (RGB) LED (D11) for more information.

TABLE 44: phyBOARD-Sargas LED Descriptions

LED	Color	Description	Section
D11	RGB	User-programmable RGB LED	Multicolor (RGB) LED

19.1.4 Switches

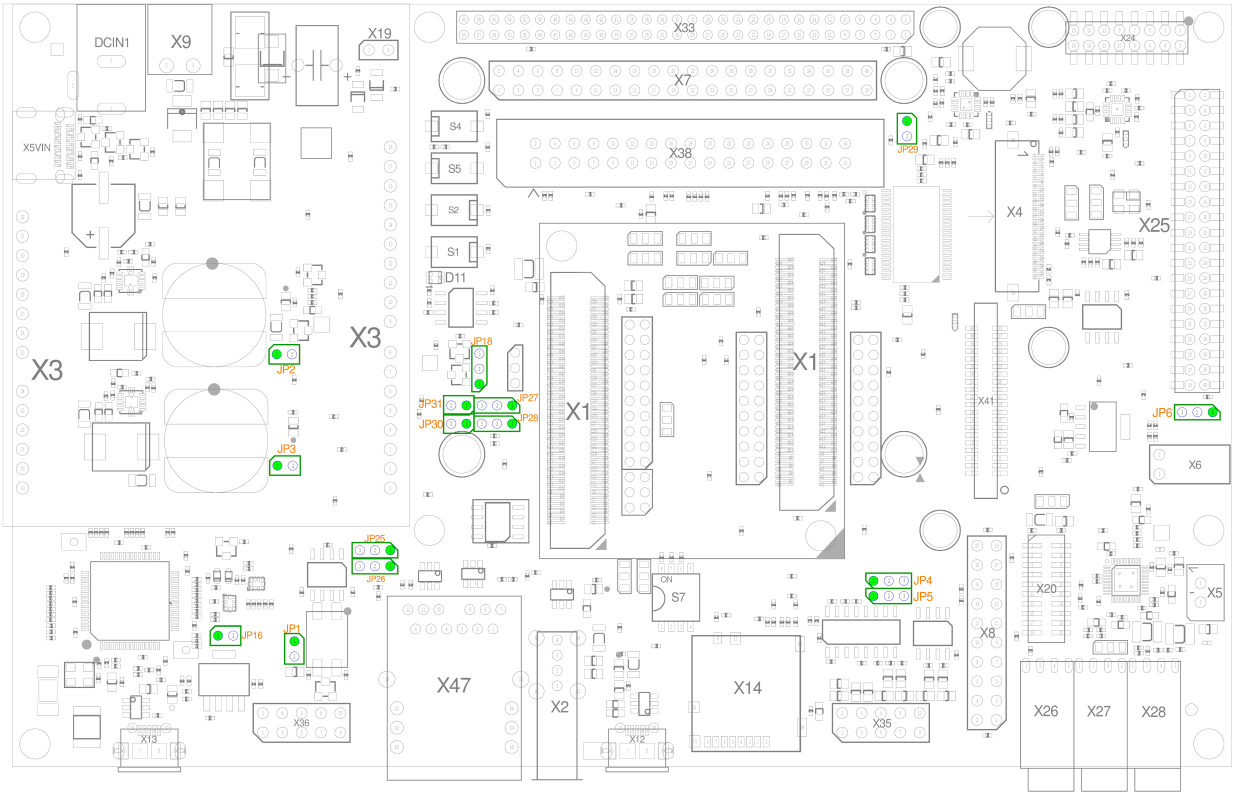
The phyBOARD-Sargas is populated with several switches. The table below shows their functions.

TABLE 45: phyBOARD-Sargas Switch Descriptions

Switch	Description	Section
S1	System Reset	System Reset
S2	System ON/OFF/Wake-up	System Wake-up
S4	User 1	User Programmable Buttons
S5	User 2	
S7	Boot Selection	Boot Switch

19.1.5 Jumpers

FIGURE 14: phyBOARD-Sargas Jumper Locations



The phyBOARD-Sargas comes pre-configured with several jumpers (JP). The jumpers enable the flexible configuration of a limited number of features for development purposes. The table below shows the function of each jumper.

TABLE 46: phyBOARD-Sargas Jumper Descriptions

Reference	Position	Description	Section
JP1	**closed**	**120 Ohm termination resistor installed on the CAN bus**	CAN FD
	open	no termination resistor	
JP2	**closed**	**U3 output (5V/3A) connected to VCC5V_IN**	5V USB-C Supply Voltage Input
	open	U3 output (5V/3A) not used	
JP3	**closed**	**U4 output (3.3V/3A) connected to VCC3V3_IN**	

Reference	Position	Description	Section
	open	U4 output (3.3V/3A) not used	
JP4	**1+2**	**X_USART1_RX/PZ6 connected to RS232 transceiver (U14)**	RS232 / RS485 Connector
	2+3	X_USART1_RX/PZ6 connected to RS485 transceiver (U18)	
	open	USART1 on RPI connector X7	
JP5	**1+2**	**X_USART1_TX/PZ7 connected to RS232 transceiver (U14)**	RS232 / RS485 Connector
	2+3	X_USART1_TX/PZ7 connected to RS485 transceiver (U18)	
JP6	**1+2**	**VCC_BL connected to VIN**	External Backlight Power Connectivity
	2+3	VCC_BL connected to X_VBL (opt. ext. BCKL power on X6)	
JP16	**closed**	**X_USART3_RX/PB12 & X_USART3_TX/ PB10 connected to X3 and X33**	Debugging Connectivity --- Arduino Shields Connectivity --- Expansion Connector
	open	X_USART3_RX/PB12 & X_USART3_TX/ PB10 connected to 2nd Debug FTDI (U7) port, if USB cable plug on X13, else connected on X3 and X33	
JP18	**1+2**	**3V3 from U4 L7986 (Carrier Board)**	Power
	2+3	3V3 from VDD_BUCK4 (SOM)	
JP25	1+2	X_FDCAN2_TX/PB13 connected to X33	CAN FD --- Expansion Connector
	2+3	**X_FDCAN2_TX/PB13 connected to CAN FD transceiver (U15)**	
JP26	1+2	X_FDCAN2_RX/PB5 connected to X33	CAN FD --- Expansion Connector
	2+3	**X_FDCAN2_RX/PB5 connected to CAN FD transceiver (U15)**	

Reference	Position	Description	Section
JP27	**1+2**	**X_I2C1_SDA/PF15 connected to X3**	Arduino Shields Connectivity ----- I2C5/I2C6 Interface
	2+3	X_USART1_RTS/PA12 connected to X3	
JP28	**1+2**	**X_I2C1_SCL/PF14 connected to X3**	Arduino Shields Connectivity ----- I2C5/I2C6 Interface
	2+3	X_USART1_CTS/PA11 connected to X3	
JP29	closed	Level Shifter (U2) enabled (needed when using phyCAM-P)	Camera Connectivity
	open	**Level Shifter (U2) disabled**	
JP30	**closed**	**X_USART1_CTS/PA11 connected to RS232 transceiver (U14)**	RS232 / RS485 Connector
	open	X_USART1_CTS/PA11 not connected to RS232 transceiver	
JP31	**closed**	**X_USART1_RTS/PA12 connected to RS232 (U14) & RS485 transceiver (U18)**	RS232 / RS485 Connector
	open	X_USART1_RTS/PA12 is not connected to RS232 (U14) & RS485 transceiver (U18)	

Warning

Due to the small footprint of the solder jumpers (J), PHYTEC does not recommend manual jumper modifications. This may also render the warranty invalid. Only the removable jumper (JP) is described in this section. For information on the solder jumpers, see Soldering Jumpers. Contact our sales team if you need jumper configurations different from the default configuration.

19.2 phyBOARD-Sargas Component Details

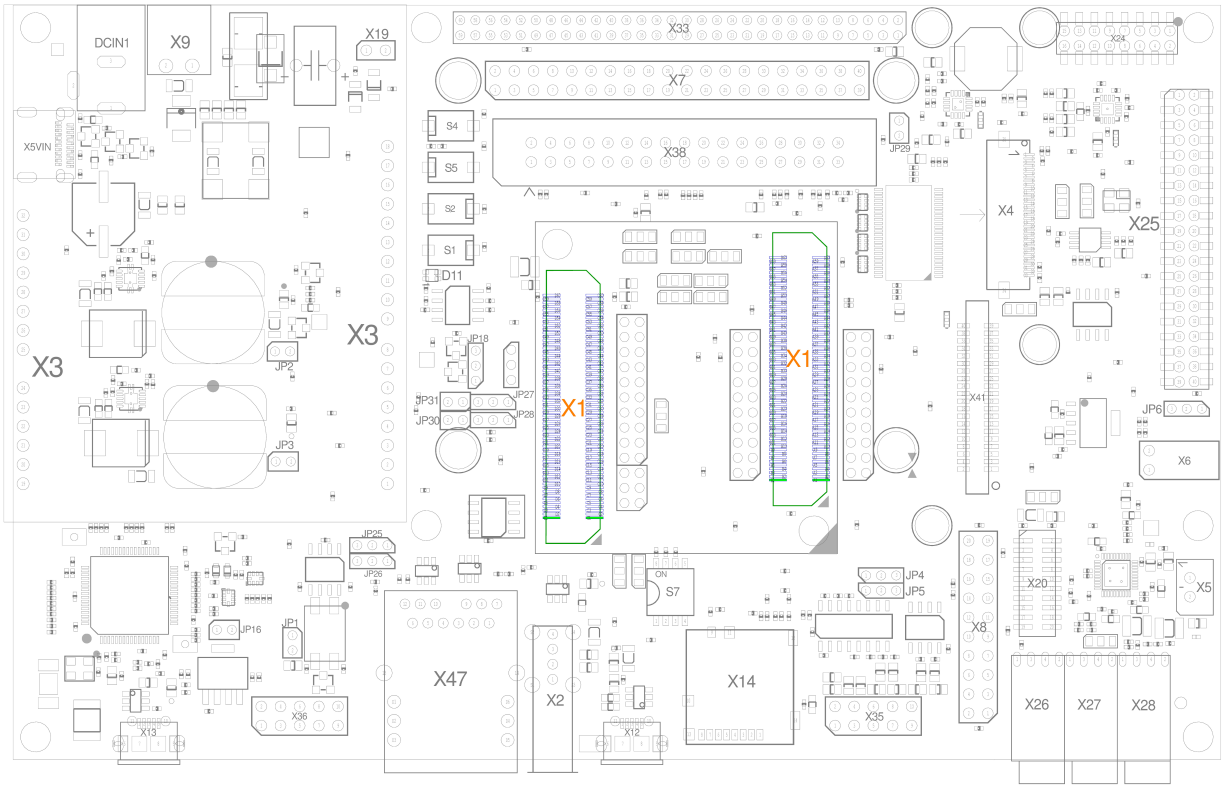
This section provides a more detailed look at the phyBOARD-Sargas components. Each subsection details a particular connector/interface and associated jumpers for configuring that interface.

Tip

When possible, we also provide any useful information regarding design considerations for components. This can be used if you plan to design your own carrier board.

19.2.1 phyCORE-STM32MP15x SOM Connectivity (X1)

FIGURE 15: phyCORE Connection (X1)

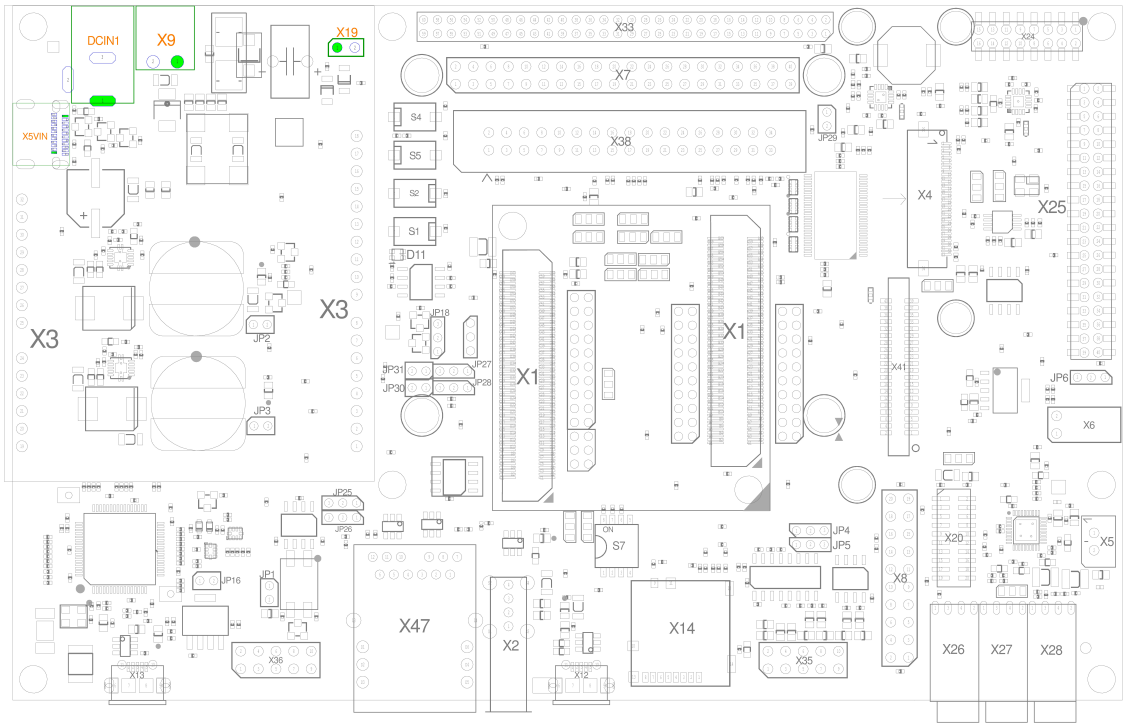


19.2.2 Power (X9, DCIN, X5VIN, X19)

Warning

Do not change modules or jumper settings while the phyBOARD-Sargas is supplied with power!

FIGURE 16: Powering Scheme

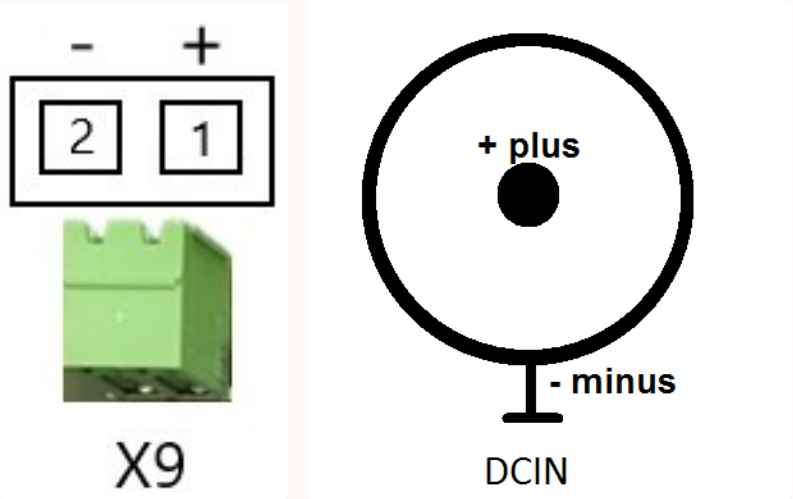


The phyBOARD-Sargas can be supplied with power in 3 different ways: on **X9**, **DCIN**, or **X5VIN** (5V USB-C Supply). The required current load capacity for all power supply solutions depends on the specific configuration of the phyCORE mounted on the phyBOARD-Sargas, the particular interfaces enabled while executing software, as well as whether an optional expansion board is connected to the carrier board.

19.2.2.1 9 V to 28 V Supply Voltage Inputs (X9, DCIN)

Warning

Please note the polarity of the power component X9 and the DCIN jack. Ensure that your power adapter is correctly set up to use the polarity as shown below.



The board can be supplied by a standard 12VDC or 24VDC adapter, either on X9 or DCIN connector. A 24VDC adapter with a minimum supply of 1A is recommended.

X9 is a 2-pole Phoenix Contact MINI COMBICON base strip 3.5 mm connector. DCIN is a barrel jack connector (DC Power socket).

TABLE 47: X9 and DCIN Pin Assignment

Interface Pin #	Signal	Signal Type	Signal Level	Description
1	X_VIN	PWR_I	9-28V	phyBOARD Power Supply
2	GND_IN	-	-	Ground

Note

The phyBOARD-Sargas is equipped with two step-down switching regulators (L7986) when using 9-28V as power input:

- U3: 5V/3A max to supply the phyCORE-STM32MP15x (VCC5V_IN) and the 5V phyBOARD-Sargas components (VCC5V)
- U4: 3.3V/3A max to supply all the 3.3V phyBOARD-Sargas components (VCC3V3)

Tip

For power consumption consideration, instead of using the phyBOARD 3.3V supply from U4, it is possible to use 3.3V from VDD_BUCK4 coming from the SOM. In this case, **JP18** must be changed to JP18=2+3.

19.2.2.2 5V USB-C Supply Voltage Input (X5VIN)

The board can also be supplied by a standard 5 V USB-C cable on X5VIN (female USB-C connector), instead of using a 9 V-28 V supply on X9 or DCIN connectors.

On this standard USB-C connector, only the power signals are connected. Data signals are not connected.

Warning

To power the board using the USB-C connector, the following jumper settings must be set:

- **JP18** = 2+3: VCC3V3 is supplied from VDD_BUCK4 (SOM)
- remove jumpers on **JP2** and **JP3** so to disconnect the unused 5V/3V3 Regulators of the phyBOARD (U3+U4)

19.2.2.3 VBAT (X19)

To back up the RTC on the module, a secondary voltage source of 1.8 V to 3.6 V (typ. 3.0 V) can be attached to the phyCORE-STM32MP15x at pin X1D57. This voltage source supplies the backup voltage domain VBAT of the STM32MP15x, as well as the module's external RTC when the primary system power (VCC5V_IN) is removed.

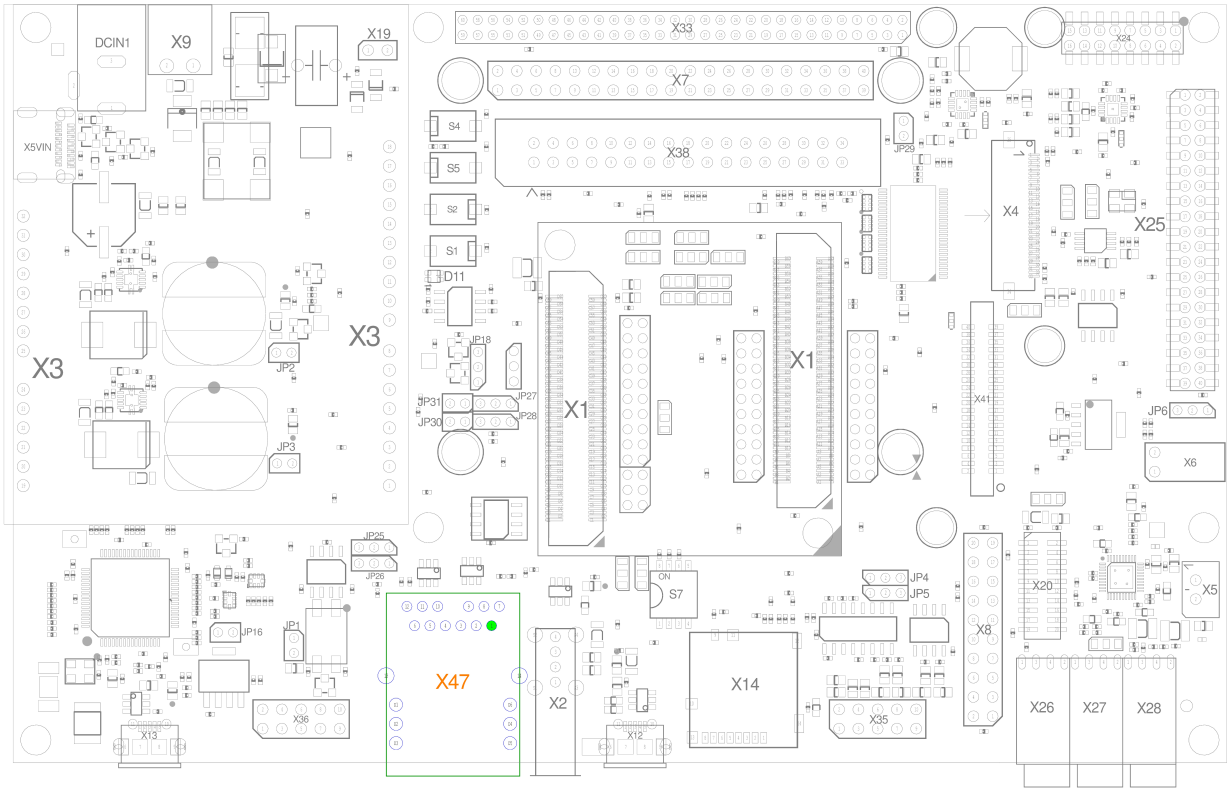
The phyBOARD-Sargas is equipped with a rechargeable backup battery at C199. If the backup battery is not installed at C199, connector **X19** can serve as a connector for an external backup source. The pinout of the 1x2-pin header connector (2.54 mm pitch) is the following.

TABLE 48: X19 Pin Assignment

Interface Pin #	Signal	Signal Type	Signal Level	Description
1	VBAT	PWR_I	1.8 V to 3.6 V (typ. 3.0 V)	external backup voltage
2	GND	-	-	Ground

19.2.3 Ethernet (X47)

FIGURE 17: Ethernet Connector (X47)



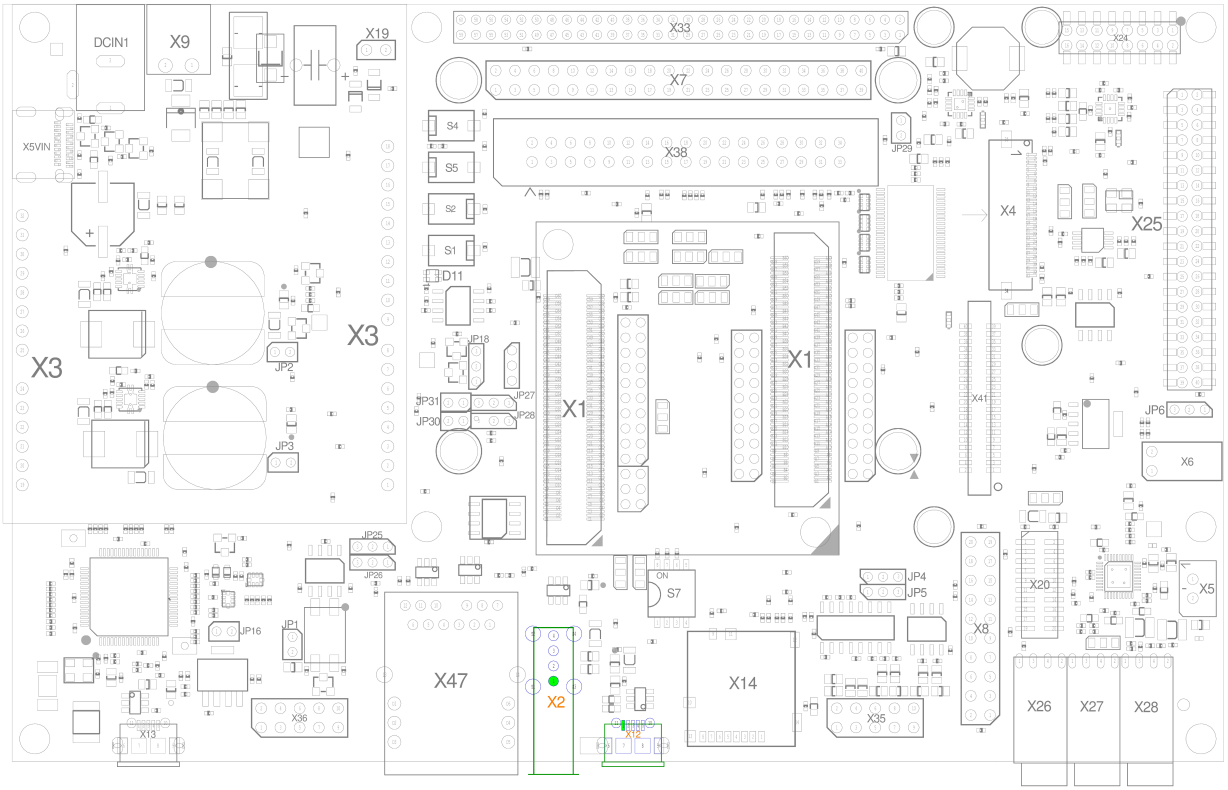
The phyBOARD-Sargas is equipped with an RJ45 connector supporting a 10/100/1000Base-T network connection. The LEDs for LINK (green) and SPEED (yellow) indications are integrated into the connector. The Ethernet transceiver supports Auto MDI-X, eliminating the need for a direct connect LAN or cross-over path cable. They detect the TX and RX pins of the connected device and automatically configure the PHY TX and RX pins accordingly.

19.2.3.1 Ethernet Design Consideration

The data lanes should be routed with a differential impedance of 100 Ohm. The center taps of each pair's transformer have to be connected to GND through a 100nF capacitor. The X_ETH_LED signals are open-drain outputs of the SOM without resistors, so they should be connected to the cathodes of the LEDs through a resistor.

19.2.4 Universal Serial Bus USB Connectivity (X2, X12)

FIGURE 18: USB Connectors (X2 and X12)



The phyBOARD-Sargas is equipped with two USB 2.0 interfaces:

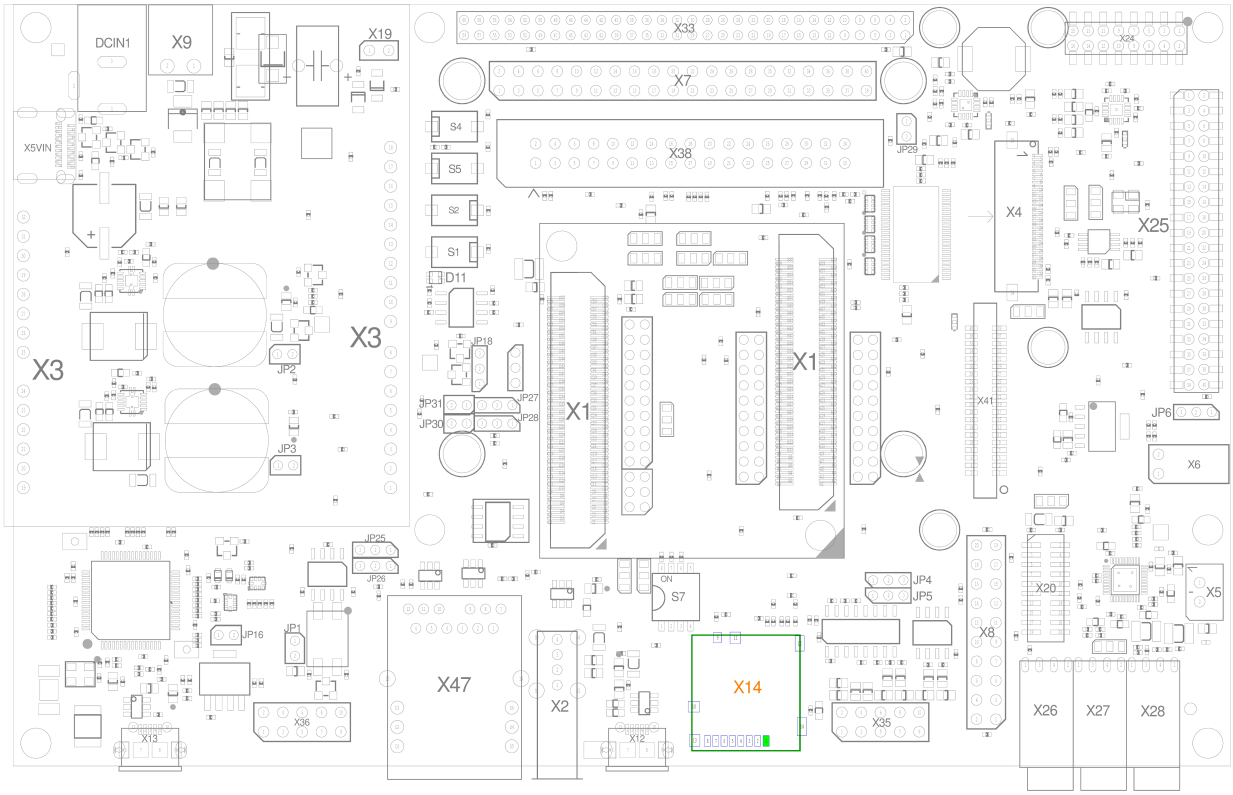
1. One USB Host on X2 (USB Type A)
2. One USB OTG on X12 (USB micro-AB). USB OTG devices are capable of initiating a session, controlling the connection, and exchanging host and peripheral roles with each other.

19.2.4.1 USB Design Consideration

The data lanes should be routed with a differential impedance of 90 Ohm.

19.2.5 Secure Digital Memory/ MultiMedia Card (X14)

FIGURE 19: microSDHC card slot (X14)



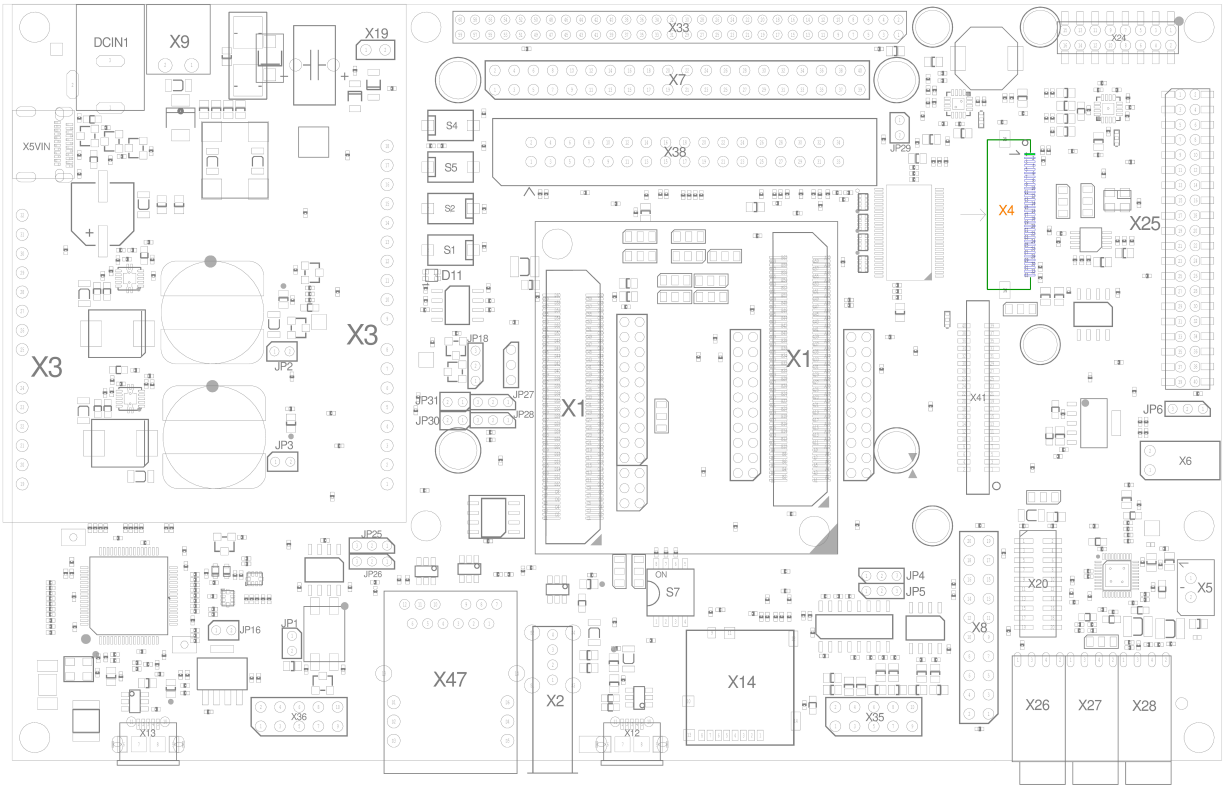
The phyBOARD-Sargas provides a standard microSDHC card slot at X14 for microSD-Cards. It features card detection, a lock mechanism, and a smooth extraction function by pushing the card in and out. DIP switch S7 provides a toggle between SD card Boot and other Boot modes (refer to Boot Switch for further information).

19.2.5.1 SD / MM Card Design Considerations

- Series resistors might be required to adapt the drive strength of the card and the SOM output. The trace length between CLK, CMD, and DATA lanes should be matched.
- 10k pull-ups are also necessary on the command line and the data lines.
- The SDMMC signals for the SD card should be routed with a 50 Ohm impedance.

19.2.6 Camera Connectivity (X4)

FIGURE 20: phyCAM-P Camera Connector (X4)



The phyBOARD-Sargas provides one parallel interface for camera connectivity at connector X4 (33-pin Hirose FFC-connector, 0.5 mm pitch). The parallel version of the phyCAM interface offers an extremely simple and cost-effective way to integrate the camera into a system. The data and control signals are transmitted in parallel via a 33-pin FFC cable. This reduces the interface effort to a minimum and still enables compatibility of the camera types. Reserved pins allow access to special functions such as trigger input or light control. Image data can be transferred with up to 10-bit grayscale resolution or color depth.

phyCAM-P is particularly suitable for the device-internal installation of cameras. The cable length can be up to 30 cm. General information and design guidelines about phyCAM-P can be found on our specific website page: https://www.phytec.eu/products/embedded-imaging/phycam-embedded-camera-modules/

Note

A Level Shifter (U2) is populated on the phyBOARD to adapt the DCMI signal levels between the phyCAM-P and the phyCORE. By default, this Level Shifter is not enabled. To enable it, **JP29 must be populated**.

Note

The table below describes the camera signals when using the phyCAM-P BSP feature. By default, this feature is not enabled (not supported by BSP yet). Currently, every X_DCMI signal is configured as a GPIO by default.

TABLE 49: X4 Pin Assignment

Interface Pin #	Signal Name	phyCORE Signal Name (before/after Level Shifters)	Signal Type	Signal Level	Description	Jumper Setting
1	VCC_CAM	-	PWR_O	3.3V/2.8V/1.8V	Power Supply [8]	-
2	VCC_CAM_PG	-	Analog	VCC_CAM	VCC_CAM power good signal	-
3	CAM_VSET	-	Analog	cf. phyCAM datasheet	Power Voltage Set [8]	-
4	CAM_CTRL2	-	I/O	VCC_CAM	Control Signal 2 **left open** or connected to Ground or VCC_CAM	**J4 open**
5	CAM_MCLK	-	**O**	**VCC_CAM**	**27Mhz Camera Master Clock coming from oscillator OZ1 (+ level shifter U6)**	**J3 2+3**
		X_MCO2 / PG2	O	VCC_CAM	27Mhz Camera Master Clock coming from X_MCO2/PG2 (+ level shifter U6)	J3 1+2
6	GND	-	-	-	Ground	-

7	CAM_PCLK	X_DCMI_PIXCLK / PA6	I	VCC_CAM	Camera Pixel Clock	-
8	GND	-	-	-	Ground	-
9	CAM_DD0	X_DCMI_DATA0 / PH9	I	VCC_CAM	Camera Signal 0	-
10	CAM_DD1	X_DCMI_DATA1 / PC7	I	VCC_CAM	Camera Signal 1	-
11	GND	-	-	-	Ground	-
12	CAM_DD2	X_DCMI_DATA2 / PE0	I	VCC_CAM	Camera Signal 0	-
13	CAM_DD3	X_DCMI_DATA3 / PE1	I	VCC_CAM	Camera Signal 0	-
14	GND	-	-	-	Ground	-
15	CAM_DD4	X_DCMI_DATA4 / PH14	I	VCC_CAM	Camera Signal 0	-
16	CAM_DD5	X_DCMI_DATA5 / PI4	I	VCC_CAM	Camera Signal 0	-

17	GND	-	-	-	Ground	-
18	CAM_DD6	X_DCMI_DATA6 / PE5	I	VCC_CAM	Camera Signal 0	-
19	CAM_DD7	X_DCMI_DATA7 / PI7	I	VCC_CAM	Camera Signal 0	-
20	GND	-	-	-	Ground	-
21	CAM_DD8	X_DCMI_DATA8 / PI1	I	VCC_CAM	Camera Signal 0	-
22	CAM_DD9	X_DCMI_DATA9 / PH7	I	VCC_CAM	Camera Signal 0	-
23	GND	-	-	-	Ground	-
24	CAM_LV	X_DCMI_HSYNC / PH8	I	VCC_CAM	Camera HSYNC Signal	-
25	CAM_FV	X_DCMI_VSYNC / PB7	I	VCC_CAM	Camera VSYNC Signal	
26	GND	-	-	-	Ground	-

27	CAM_CTRL1	-		VCC_CAM	Control Signal 1 **connected to Ground** or to VCC_CAM	**J5 1+2**
28	CAM_I2C_SCL	X_I2C1_SCL / PF14	O	VCC_CAM	I^2C1 clock Signal (with I2C buffer U13)	-
29	CAM_I2C_SDA	X_I2C1_SDA / PF15	I/O	VCC_CAM	I^2C1 data Signal (with I2C buffer U13)	-
30	GND	-	-	-	Ground	-
31	VCC_CAM_PG	-	-	VCC_CAM	VCC_CAM power good signal	
32	VCC_CAM	-	PWR_O	3.3V/2.8V/1.8V	Power Supply	-
33	VCC_CAM	-	PWR_O	3.3V/2.8V/1.8V	Power Supply	-
34, 35	Not Connected	-	-	-	-	-

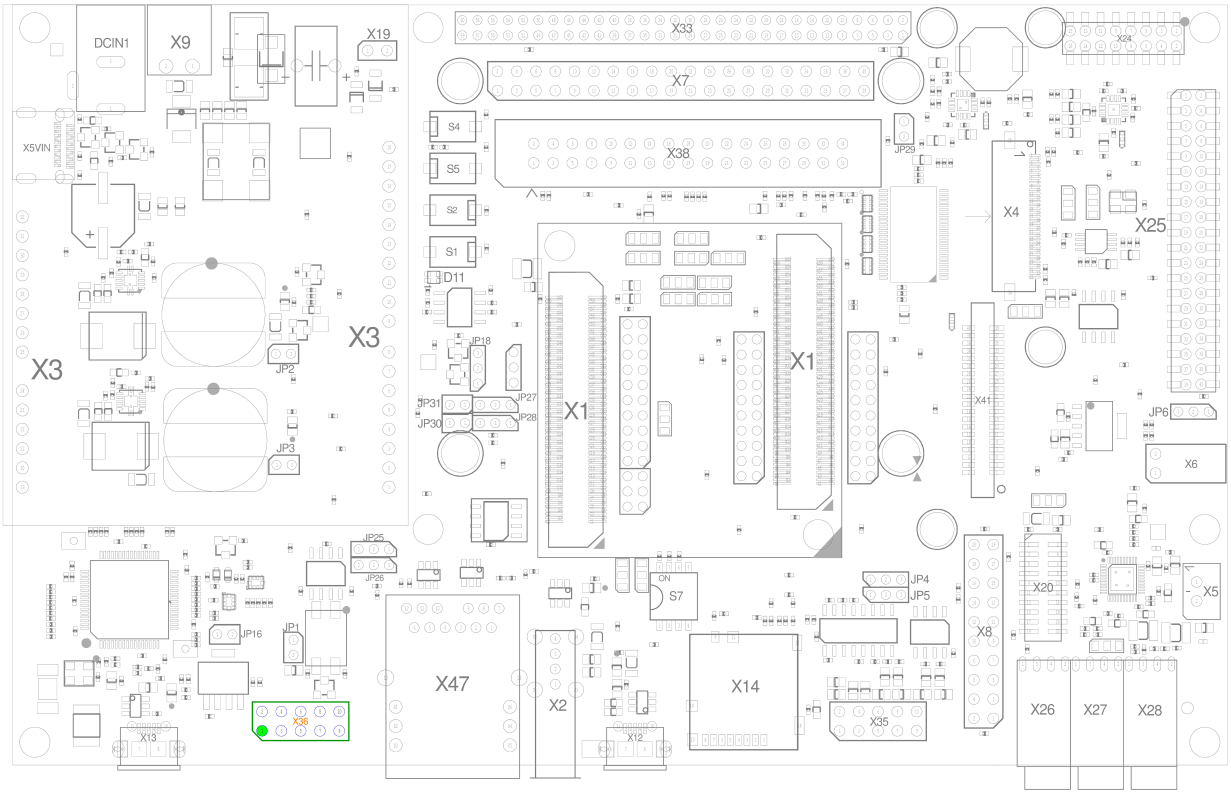
8. The supply voltage VCAM can be different for various camera modules (3.3V/2.8V/1.8V). Please refer to the detailed descriptions of specific phyCAMs. The phyBOARD-Sargas is equipped with an adaptive power supply (U5). Reading the resistance value of pin 31, the phyCAM-P detect configures the phyBOARD voltage regulator with the CAM_VSET pin.

19.2.6.1 phyCAM-P camera Design Consideration

The DCMI signals should be routed with a 50 Ohm impedance.

19.2.7 CAN FD (X36)

FIGURE 21: CAN FD Connector (X36)



The phyBOARD-Sargas is equipped with a CAN FD transceiver at **U15** connected to the STM32MP15x **FDCAN2** interface. The CAN bus is available at X36 (2x5 pin header; 2.54mm pitch). A **120 Ohm** resistor (**R141**) is present on the CAN bus when the JP1 jumper is populated. This resistor is not present when JP1 is removed.

The CAN with Flexible Data-Rate (CAN FD) is an updated extension of the original CAN protocol. This enables extra data bytes and flexible bit rates. In general, the CAN FD offers 3 benefits to regular CAN:

1. **Increased Data Length**
   CAN FD supports up to 64 data bytes per data frame vs. 8 data bytes for regular CAN.
2. **Increased Speed**
   CAN FD supports dual bit rates: normal 1Mbit/s bit rate of a regular CAN and data bit rates up to 5Mbit/s, depending on network and transceiver types. TJA1051T/3 transceiver (**U15**) on the phyBOARD-Sargas supports data bit rates up to 5Mbit/s

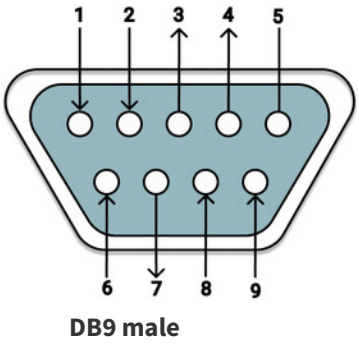
3. **Improved Reliability**
   CAN FD uses an improved cyclic redundancy check (CRC), lowering the risks of undetected errors.

TABLE 50: X36 Pin Assignment

Interface Pin #	Signal Name	Signal Type	Signal Level	Description	Jumper Setting
1	Not Connected	-	-	-	
2	GND	-	-	Ground	
3	X_CANL	CAN_I/O Low	CAN standard	Negative CAN lane	**JP25/JP26 2+3**
4	X_CANH	CAN_I/O High	CAN standard	Positive CAN lane	**JP25/JP26 2+3**
5	GND	-	-	Ground	
6, 7, 8, 9, 10	Not Connected	-	-	-	

An adapter cable (pin header to DB9 male connector) can be plugged into X36 to facilitate the use of the CAN FD interface. The following figure shows the signal mapping of the DB9 male connector:

TABLE 51: DB9 Male Connector Pinout



DB9 male

DB9 male pin #	CAN signal
6	GND
2	X_CANL
7	X_CANH
3	GND

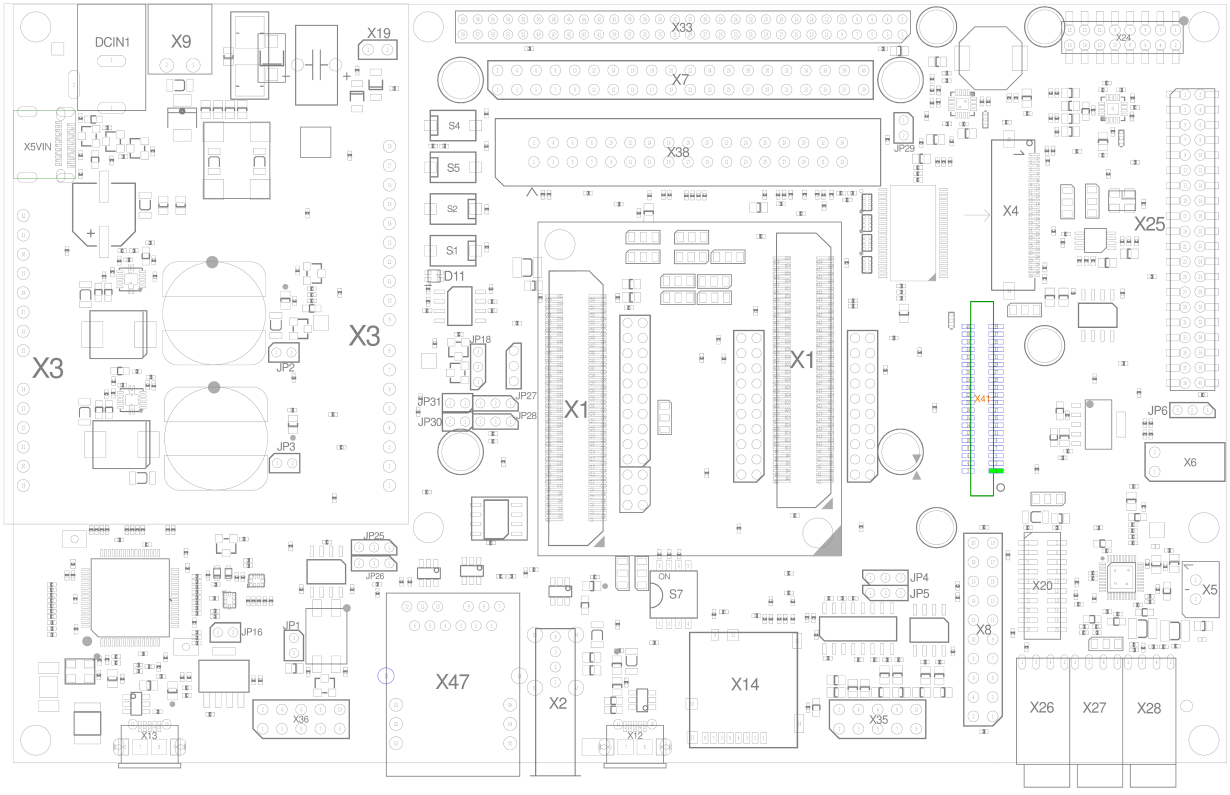
19.2.7.1 CAN Design Consideration

The CAN bus lanes (X_CANL/X_CANH) should be routed with a differential impedance of 120 Ohm.

19.2.8 Audio / Visual Connectivity

19.2.8.1 MIPI-DSI (X41)

FIGURE 22: MIPI-DSI Connector (X41)



20 position FPC, 1 mm pitch to connect a MIPI DSI display. The connector pinout is compatible with the Raspberry Pi MIPI DSI display connector.

Compatible MIPI DSI displays:

- STMicroelectronics MB1407 DSI display (480x800 pixels)
- Raspberry Pi Foundation 7'' Touchscreen Display (800x480 pixels)

TABLE 52: X41 Pin Assignment

Interface Pin #	Signal Name	Signal Type	Signal Level	Description
1	GND	-	-	Ground
2	Not Connected	-	-	-
3	X_MIPI_DSI_DATA1N	DSI_O	1.2V	MIPI DSI Data 1 Negative Lane
4	Not Connected	-	-	-
5	X_MIPI_DSI_DATA1P	DSI_O	1.2V	MIPI DSI Data 1 Positive Lane
6	Not Connected	-	-	-
7	GND	-	-	Ground
8	Not Connected	-	-	-
9	X_MIPI_DSI_CLKN	DSI_O	1.2V	MIPI DSI Clock Negative Lane
10	Not Connected	-	-	-
11	X_MIPI_DSI_CLKP	DSI_O	1.2V	MIPI DSI Clock Positive Lane
12	Not Connected	-	-	-

13	GND	-	-	Ground
14	Not Connected	-	-	-
15	X_MIPI_DSI_DATA0N	DSI_O	1.2V	MIPI DSI Data 0 Negative Lane
16	Not Connected	-	-	-
17	X_MIPI_DSI_DATA0P	DSI_O	1.2V	MIPI DSI Data 0 Positive Lane
18	Not Connected	-	-	-
19	GND	-	-	Ground
20	Not Connected	-	-	-
21	X_I2C1_SCL/PF14	O	3.3V	I^2C1 clock Signal
22	Not Connected	-	-	-
23	X_I2C1_SDA/PF15	I/O	3.3V	I^2C1 data Signal
24	Not Connected	-	-	-
25	GND	-	-	Ground

26	Not Connected	-	-	-
27	VCC3V3	PWR_O	3.3V	3.3 V phyBOARD Supply
28	Not Connected	-	-	-
29	VCC3V3	PWR_O	3.3V	3.3 V phyBOARD Supply
30	Not Connected	-	-	-
31	GND	-	-	Ground
32	Not Connected	-	-	-
33	X_AV_INT/PI8	I	3.3V	
34	Not Connected	-	-	-
35	X_MIPI_DSIHOST_TE/PD13	I/O	3.3V	
36	Not Connected	-	-	-
37	X_LCD_BL_PWM/PI0	O	3.3V	
38	Not Connected	-	-	-

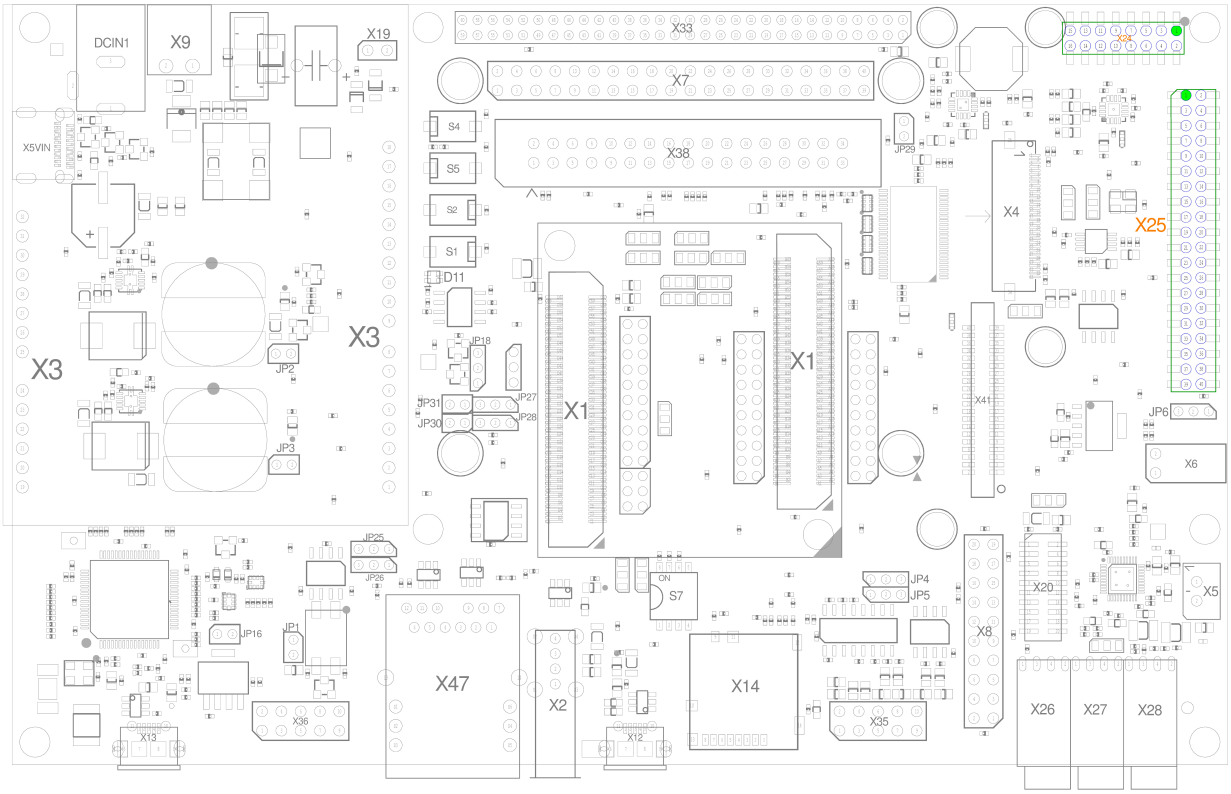
39	LCD_RESET	I/O	3.3V	
40	Not Connected	-	-	-

19.2.8.2 MIPI DSI Design Consideration

The MIPI DSI Data and Clock lanes should be routed with a differential impedance of 100 Ohm.

19.2.8.3 Audio/Visual Connectors (X24 and X25)

FIGURE 23: Audio/Visual Connector (X24 and X25)



The audio/video (A/V) connectors (X24 and X25) provide an easy way to add typical A/V functions to the phyBOARD-Sargas. Standard interfaces such as parallel display, SAI (or SPI/I2S), and I2C, as well as different supply voltages, are available at the two A/V female dual entry connectors. A special feature of these connectors is their connectivity from either the top or the bottom of the board.

Tip

PHYTEC delivers expansion boards like the HDMI interface (PEB-AV-01) or LCD screen module (PEB-AV-02) that can be plugged into those two connectors. The PEB-AV-02 module is used to connect a capacitive/ resistive touchscreen 7'' display. For the resistive touchscreen, the phyBOARD is equipped with an STMPE811 resistive touchscreen driver at **U20 (I²C address 0x44 or 0x41)**.

TABLE 53: X24 Pin Assignment

Interface Pin #	Signal Name	SOM signal Name (when different)	Signal Type	Signal Level	Description	Jumper Setting
1	X_AUDIO_CK	**X_SAI2_SCK_B/PH2**	**O**	**3.3V**	**SAI2 transmit bit clock**	**J17 2+1**
		X_SPI16_SCK/PZ0	O	3.3V	SPI1 (or SPI6) Serial Clock Output [9]	J17 2+3
2	X_AUDIO_SYNC	**X_SAI2_FS_B/PC0**	**O**	**3.3V**	**SAI2 transmit frame Sync**	**J18 2+1**
		X_SPI16_NSS/PZ3	O		SPI1 or SPI6 Slave Select[10]	J18 2+3
3	X_AUDIO_RXD	**X_SAI2_SD_A/PI6**	**I**	**3.3V**	**SAI2 receives data**	**J19 2+1**
		X_SPI16_MISO/PZ1	I		SPI1 or SPI6 Master Input Slave Output [11]	J19 2+3
4	X_AUDIO_TXD	**X_AUDIO_TXD**	**O**	**3.3V**	**SAI2 transmits data**	**J20 2+1**
		X_SPI16_MOSI/PZ2	O		SPI1 or SPI6 Master output Slave input [12]	J20 2+3
5	X_AV_INT/PI8	X_PI8	I	3.3V	A/V Interrupt	-
6	X_LCD_PWCTRL/PA4	X_DACOUT1/PA4	O	3.3V	LCD power control	-

7	GND	-	-	-	Ground	-
8	X_LCD_RST/PD9	X_PD9	I/O	3.3V	GPIO used for LCD Reset	-
	X_nRESET	-	Reset	3.3V	System Reset	-
9	TS_X+	-	I/O/ANA_I	3.3V	Resistive Touch Input X+ of **U20** (refer to **STMPE811** datasheet for details)	-
10	TS_X-	-	I/O/ANA_I	3.3V	Resistive Touch Input X- of **U20** (refer to **STMPE811** datasheet for details)	-
11	TS_Y+	-	I/O/ANA_I	3.3V	Resistive Touch Input Y+ of **U20** (refer to **STMPE811** datasheet for details)	-
12	TS_Y-	-	I/O/ANA_I	3.3V	Resistive Touch Input Y- of **U20** (refer to **STMPE811** datasheet for details)	-
13	VCC3V3	-	PWR_O	3.3V	3.3 V phyBOARD Supply	-
14	GND	-	-	-	Ground	-
15	X_I2C1_SCL/PF14	-	O	3.3V	I^2C1 clock Signal	-

16	X_I2C1_SDA/PF15	-	I/O	3.3V	I^2C1 data Signal	-

9. X_SPI16_SCK/PZ0 can be configured as I2S1_CK (I^2S1 Serial Clock line) with BSP device tree modifications
10. X_SPI16_NSS/PZ3 can be configured as I2S1_WS (I^2S1 Word Select line) with BSP pin muxing modification
11. X_SPI16_MISO/PZ1 can be configured as I2S1_SDI (I^2S1 Serial Data line) with BSP pin muxing modification
12. X_SPI16_MOSI/PZ2 can be configured as I2S1_SDO (I^2S1 Serial Data line) with BSP pin muxing modification

TABLE 54: X25 Pin Assignment

Interface Pin #	Signal Name	Signal Type	Signal Level	Description
1, 2, 3	GND	-	-	Ground
4	X_LCD_R2/PC10	O	3.3V	LCD data R2
5	X_LCD_R3/PB0	O	3.3V	LCD data R3
6	GND	-	-	Ground
7	X_LCD_R4/PH10	O	3.3V	LCD data R4
8	X_LCD_R5/PH11	O	3.3V	LCD data R5
9	X_LCD_R6/PH12	O	3.3V	LCD data R6
10	X_LCD_R7/PE15	O	3.3V	LCD data R7
11, 12, 13	GND	-	-	Ground
14	X_LCD_G2/PH13	O	3.3V	LCD data G2
15	X_LCD_G3/PE11	O	3.3V	LCD data G3
16	GND	-	-	Ground

17	X_LCD_G4/PH15	O	3.3V	LCD data G4
18	X_LCD_G5/PH4	O	3.3V	LCD data G5
19	X_LCD_G6/PI11	O	3.3V	LCD data G6
20	X_LCD_G7/PI2	O	3.3V	LCD data G7
21, 22, 23	GND	-	-	Ground
24	X_LCD_B2/PG10	O	3.3V	LCD data B2
25	X_LCD_B3/PG11	O	3.3V	LCD data B3
26	GND	-	-	Ground
27	X_LCD_B4/PE12	O	3.3V	LCD data B4
28	X_LCD_B5/PI5	O	3.3V	LCD data B5
29	X_LCD_B6/PB8	O	3.3V	LCD data B6
30	X_LCD_B7/PD8	O	3.3V	LCD data B7
31	GND	-	-	Ground

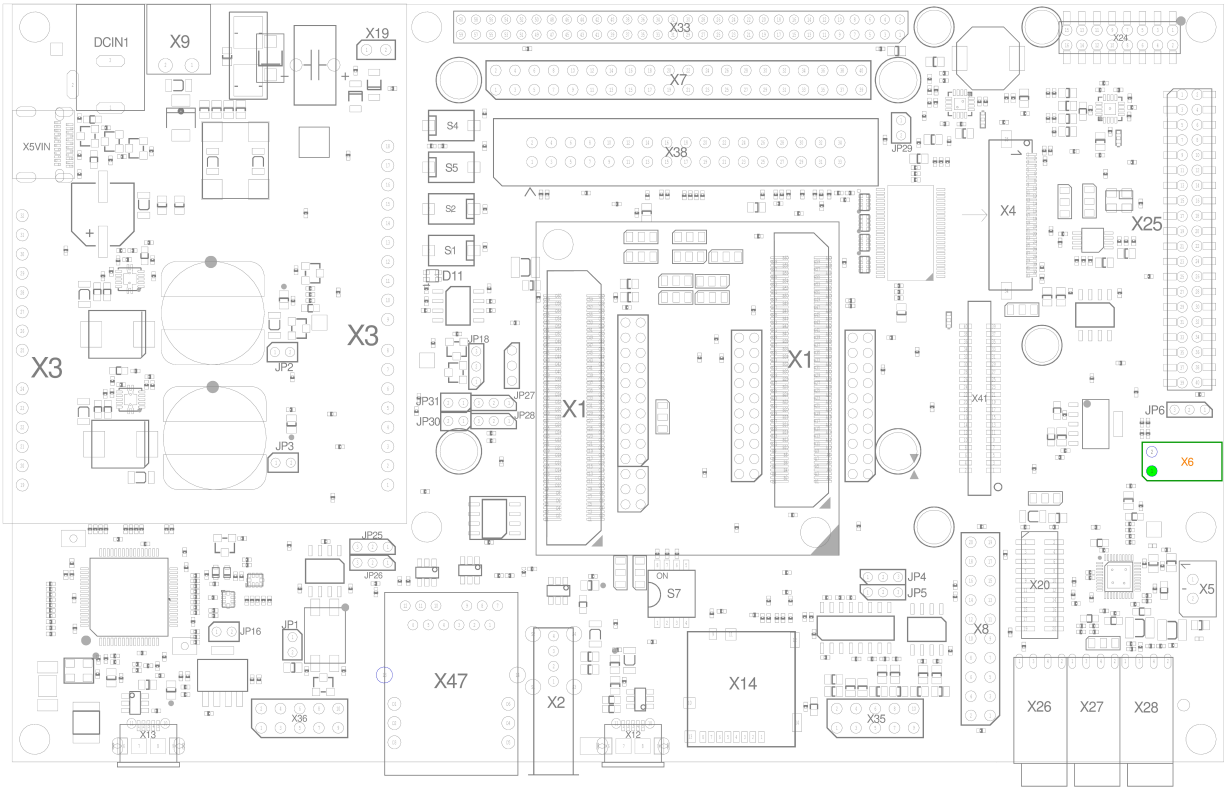
32	X_LCD_CLK/PG7	O	3.3V	LCD pixel clock
33	X_LCD_DE/PE13	O	3.3V	LCD data Enable
34	X_LCD_HSYNC/PI10	O	3.3V	LCD Horizontal synchronization
35	X_LCD_VSYNC/PI9	O	3.3V	LCD Vertical synchronization
36, 37	GND	-	-	Ground
38	X_LCD_BL_PWM/PI0 (named X_PI0 on SOM)	O	3.3V	PWM output for LCD backlight
39	VCC_BL	PWR_O	-	Optional Backlight power supply output
40	VCC5V	PWR_O	5V	5 V phyBOARD Supply

19.2.8.4 LCD Design Consideration

The LCD signals should be routed with a 50 Ohm impedance.

19.2.8.5 External Backlight Power Connectivity (X6)

FIGURE 24: Optional External Backlight Power Connector (X6)



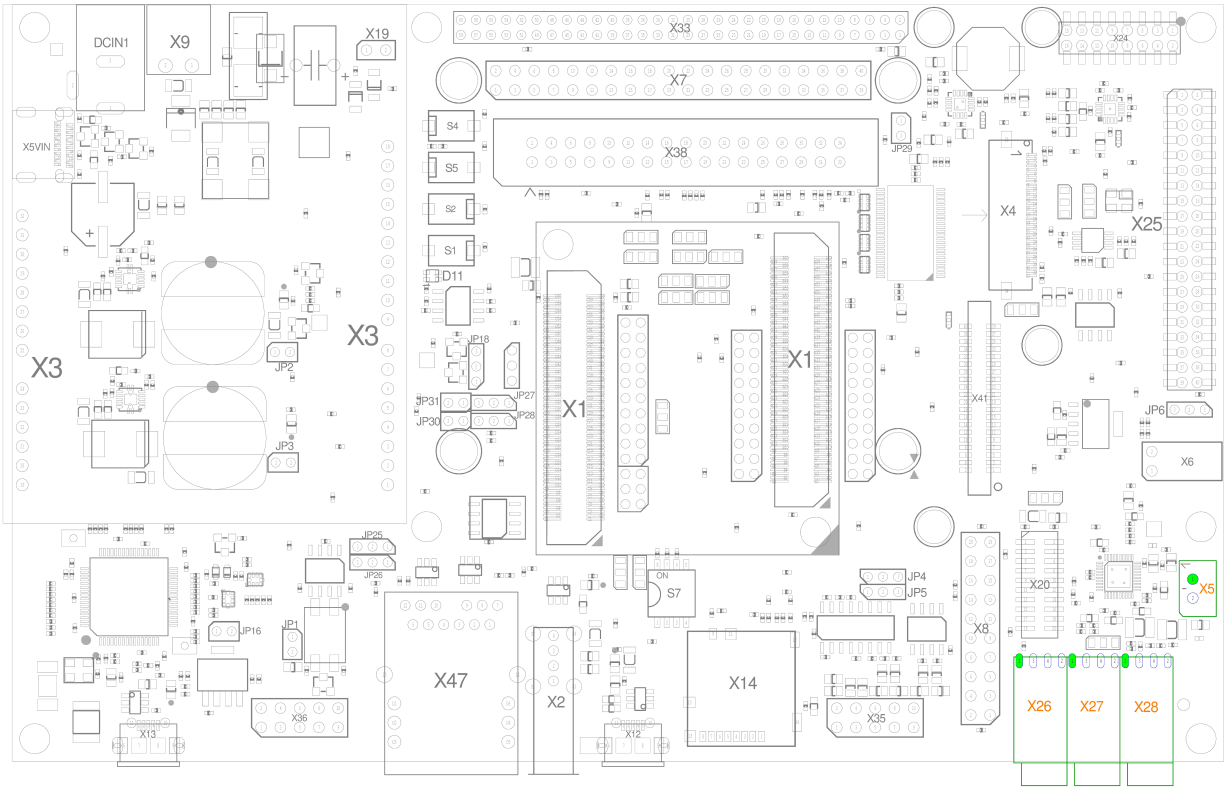
When using a custom display, a specific voltage might be needed for the backlight power supply (VCC_BL). This connector allows an external power supply to be attached for this purpose. By default, VCC_BL is connected to the phyBOARD-Sargas power supply (VIN) by jumper **JP6=2+1**.

TABLE 55: X6 Pin Assignment

Interface Pin #	Signal Name	Signal Type	Signal Level	Description
1	X_VBL	any voltage	PWR_I	Optional External Power Supply for LCD Backlight when JP6 = 2+3
2	GND	-	-	Ground

19.2.9 Audio Connectivity (X5, X26, X27, X28)

FIGURE 25: Audio Connectors (X5, X26, X27, X28)



The audio interface provides a method of exploring and using STM32MP15xx's audio capabilities. The phyBOARD-Sargas is populated with a **TLV320AIC3007** audio codec (**U1**). The audio codec is connected to the STM32MP15x's SAI interface to support :

- Stereo line output/input at 3,5mm Stereo Audio Jacks X26/X27
- Headset at 3,5mm Stereo Audio Jack X28 (stereo Headphone with mono microphone)
- A direct mono speaker output (Mono Class-D 1W BTL 8Ω Speaker Driver) is available at Molex connector X5.

The audio codec can be configured via **I²C1 at address 0x18**.

It is possible to disable the Audio Codec with Jumper J39. Closing Jumper J39 at 1+2 connects the reset input of the audio codec to GND which holds the Audio Codec in a reset state.

Jumper J2 can be used to configure the headset jack detection:

- **J2 1+2: detection using dc-coupled Stereo Headphone output connection**
- J2 2+3: detection using a Capless Headphone output connection

For additional information regarding special interface specifications, refer to the TLV320AIC3007 audio codec reference manual.

TABLE 56: X5 Pin Assignment

Interface Pin #	Signal Name	Signal Type	Signal Level	Description

1	SPOP	ANA_O	Analog	Speaker Output Positive Lane (U1 LINE1LP)
2	SPOM	ANA_O	Analog	Speaker Output Negative Lane (U1 LINE1RP)

TABLE 57: X26 Pin Assignment

Interface Pin #	Signal Name	Signal Type	Signal Level	Description
1	GND	-	-	Ground
2	Not Connected	-	-	-
3	LINE_OUT_R	ANA_O	Analog	Audio Line Output right channel
4	LINE_OUT_L	ANA_O	Analog	Audio Line Output right channel

TABLE 58: X27 Pin Assignment

Interface Pin #	Signal Name	Signal Type	Signal Level	Description
1	GND	-	-	Ground
2	Not Connected	-	-	-
3	LINE_IN_R	ANA_I	Analog	Audio Line In right channel
4	LINE_IN_L	ANA_I	Analog	Audio Line In left channel

TABLE 59: X28 Pin Assignment

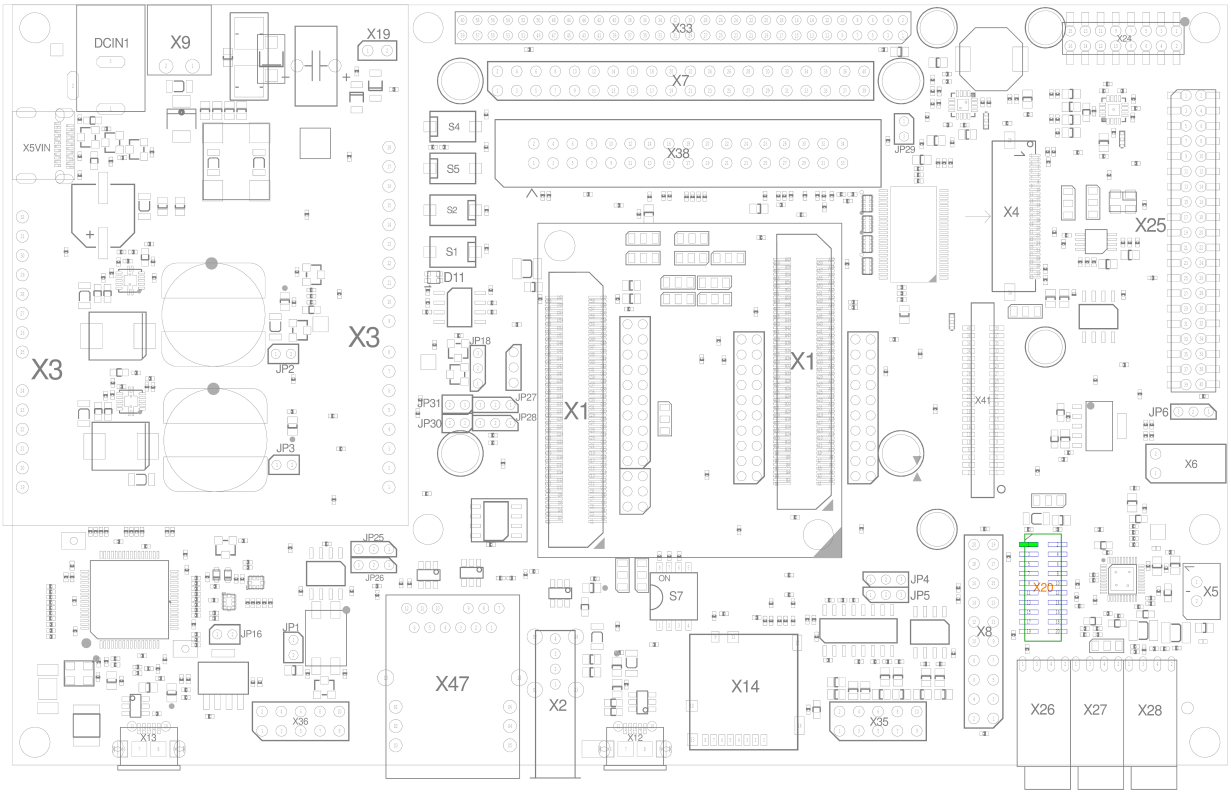
Interface Pin #	Signal Name	Signal Type	Signal Level	Description
1	GND	-	-	Ground
2	MIC_IN	ANA_I	Analog	Microphone Input
3	HEAD_PHONE_R	ANA_O	Analog	Headphone Output right
4	HEAD_PHONE_L	ANA_O	Analog	Headphone Output left

19.2.9.1 Audio Codec Design Consideration

Analog Ground (AGND) used for the Audio Codec should be connected to the Ground (GND) through a PCB Star Point (J9 + J10 on phyBOARD-Sargas).

19.2.10 Microphone Array Connector (X20)

FIGURE 26: Microphone Array Connector (X20)



This specific connector connects a PHYTEC custom board equipped with a 7 I²S/TDM Output Digital Microphone Array and 12 RGB LEDs. This board was developed for recognition with echo and noise suppression and adaptive Beamforming. This allows for the acoustic detection of the person speaking and the greatest possible suppression of ambient noise. Thus it is also suitable for use in loud environments.

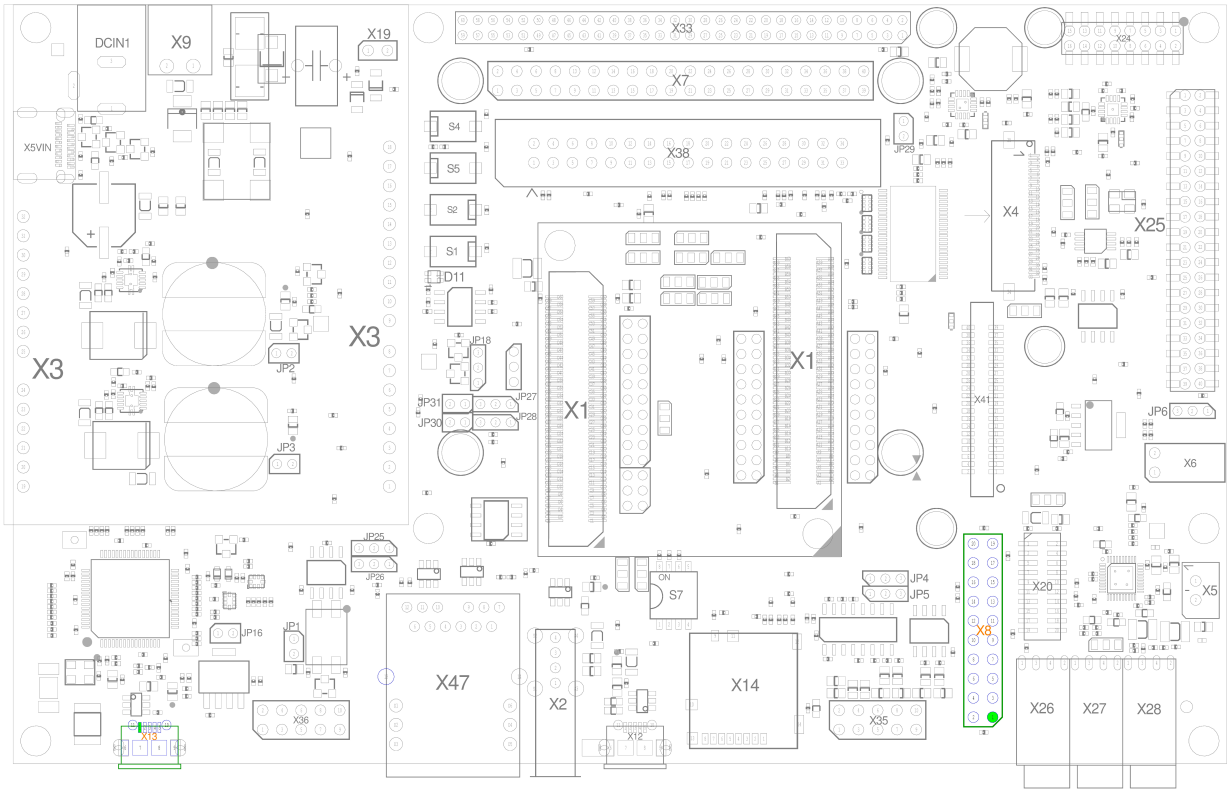
TABLE 60: X20 Pin Assignment

Interface Pin #	Signal Name	Signal Type	Signal Level	Description
1	VCC5V	PWR_O	5V	5 V phyBOARD Supply
2	VCC3V3	PWR_O	3.3V	3.3 V phyBOARD Supply
3	Not Connected	-	-	-
4	GND	-	-	Ground
5	Not Connected	-	-	-
6	X_I2C1_SCL/PF14	O	3.3V	I^2C1 clock Signal
7	GND	-	-	Ground
8	X_I2C1_SDA/PF15	I/O	3.3V	I^2C1 data Signal
9	X_SAI2_SCK_B/PH2	O	3.3V	SAI2 transmit bit clock
10	GND	-	-	Ground
11	X_SAI2_FS_B/PC0	O	3.3V	SAI2 transmit frame Sync
12	X_SAI2_SD_A/PI6	I	3.3V	SAI2 receives data

13	X_SAI2_SD_B/PF11	O	3.3V	SAI2 transmits data
14, 15, 16, 17	Not Connected	-	-	-
18	GND	-	-	Ground
19	X_nRESET	Reset	3.3V	System reset
20	Not Connected	-	-	-

19.2.11 Debugging Connectivity (X8, X13)

FIGURE 27: Debugging Connectivity (X8, X13)



19.2.11.1 JTAG Connector (X8)

The phyBOARD-Sargas JTAG interface is accessible at the pin header connector X8. It also supports Serial Wire Debug (SWD).

TABLE 61: X8 Pin Assignment

Interface Pin #	Signal Name	Signal Type	Signal Level	Description
1	VCC3V3	PWR_O	3.3V	3.3 V phyBOARD Supply
2	VCC3V3	PWR_O	3.3V	3.3 V phyBOARD Supply
3	X_JTAG_nTRST	I	3.3V	JTAG Test Reset
4	GND	-	-	Ground
5	X_JTAG_TDI	I	3.3V	JTAG Test Data In
6	GND	-	-	Ground
7	X_JTAG_TMS/SWDIO	I/O	3.3V	JTAG Test Mode Select / SWD Single bi-directional data pin
8	GND	-	-	Ground
9	X_JTAG_TCK/SWCLK	I	3.3V	JTAG Test Clock
10	GND	-	-	Ground
11	JTAG_RTCK	O	3.3V	JTAG Return Test Clock

12	GND	-	-	Ground
13	X_JTAG_TDO/TRACESWO	O	3.3V	JTAG Test Data Out / SWD Output trace port
14	GND	-	-	Ground
15	X_nRESET	Reset	3.3V	System Reset
16, 17, 18, 19, 20	GND	-	-	Ground

19.2.11.2 USB Debug Connector (X13)

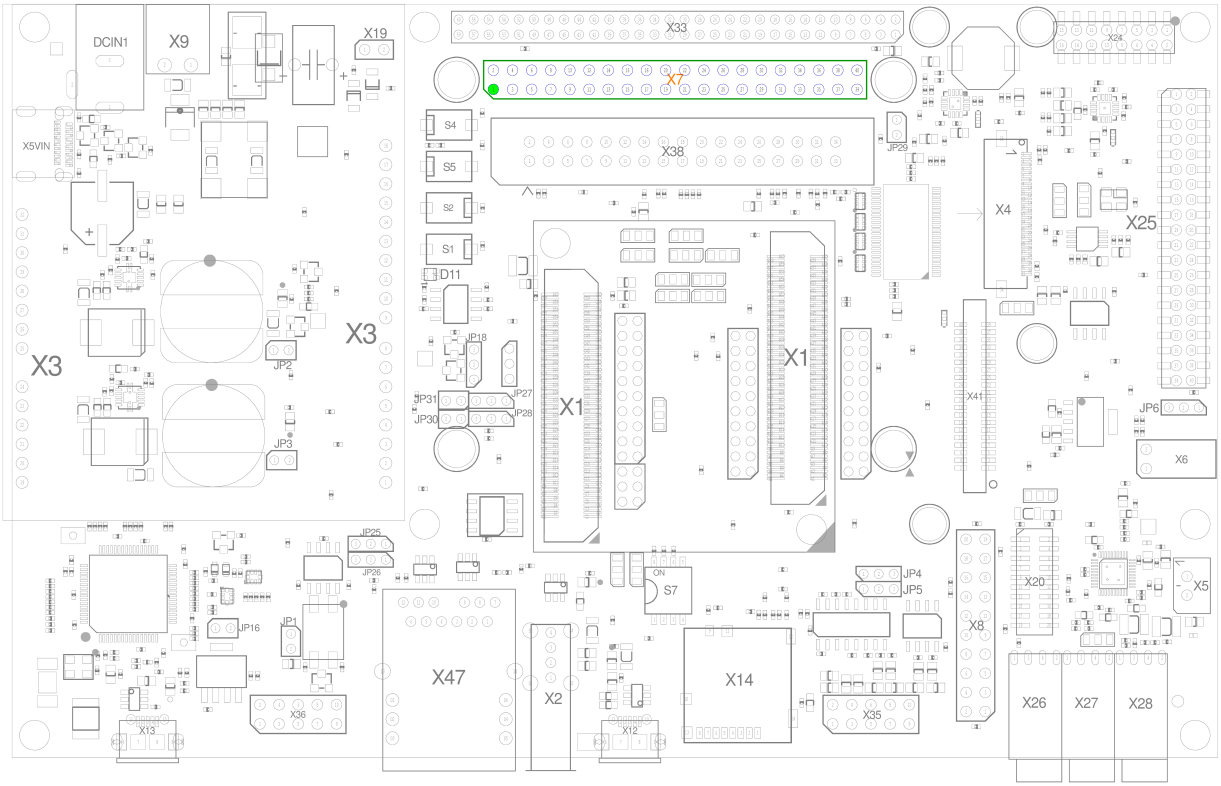
- The main debug interface is **UART4**. It is connected to a **UART-to-USB Converter** (**U7**) via a **Multiplexer** (**U23**). When a USB cable is plugged in at X13 (USB Micro-AB), the UART4 will be available at the connector. Otherwise, it is routed to the expansion connector (X33). The actual routing is shown by the blue **LED D7**. Further UART information can be found in the section Expansion Connector.
- A second UART (**USART3**) is also available on the USB Debug, only when jumper **JP16** is removed. USART3 is connected to a **UART-to-USB Converter** (**U7**) via a **Multiplexer** (**U22**). When a USB cable is plugged in at X13 and JP16 is removed, the USART3 will be available at the connector. Otherwise, it is routed to the expansion connector (X33).

19.2.11.3 USB Design Consideration

The data lanes should be routed with a differential impedance of 90 Ohm.

19.2.12 Raspberry Pi HAT Connectivity (X7)

FIGURE 28: Raspberry Pi HAT Connector (X7)



2×20 pin header, 2.54 mm pitch, compatible with the official Raspberry Pi HAT connector pinout. The advantages of this connector are:

- Raspberry Pi HAT boards (official or from the community) can be plugged into the phyBOARD-Sargas and driven by the phyCORE-STM32MP15x
- Existing Raspberry Pi application code can be reused to run on Cortex A7 (Linux).

TABLE 62: X7 Pin Assignment

Interface Pin #	Signal Name	SOM Signal Name (when different)	Signal Type	Signal Level	Description	Jumper / 0Ω Res Setting
1	VCC3V3	-	PWR_O	3.3V	3.3 V phyBOARD Supply	-
2	VCC5V	-	PWR_O	5V	5 V phyBOARD Supply	-
3	X_I2C1_SDA/PF15	-	I/O	3.3V	I^2C1 data Signal	-
4	VCC5V	-	PWR_O	5V	5 V phyBOARD Supply	-
5	X_I2C1_SCL/PF14	-	O	3.3V	I^2C1 clock Signal	-
6	GND	-	-	-	Ground	-
7	X_DBTRGO/PA13	-	I/O	3.3V	GPIO or External trigger output from CTI	-
8	X_USART1_TX/PZ7	-	O	3.3V	USART1 Transmit Data	-
9	GND	-	-	-	Ground	
10	X_USART1_RX/PZ6	-	I	3.3V	USART1 Receive Data	-

11	X_USART1_RTS/PA12	X_FDCAN1_TX/PA12	O	3.3V	USART1 Request To Send [13][14]	-
12	**RPI_PCM_CLK/PWM0 (X_SAI2_SCK_B/PH2)**	**-**	**O**	**3.3V**	**SAI2 transmit bit clock**	**J21 2+1**
	RPI_PCM_CLK/PWM0 (TIM1_CH2/PE11)	X_LCD_G3/PE11	O	3.3V	TIM1 positive channel 2	J21 2+3 & **R240 mounted**
13	X_SDMMC3_D3/PD7	-	I/O	3.3V	SD/SDIO data line 3	-
14	GND	-	-	-	Ground	-
15	X_SDMMC3_CK/PG15	-	O	3.3V	SD/SDIO clock	
16	X_SDMMC3_CMD/PF1	-	I/O	3.3V	SD/SDIO bidirectional command/response signal	-
17	VCC3V3	-	PWR_O	3.3V	3.3 V phyBOARD Supply	-
18	X_SDMMC3_D0/PF0	-	I/O	3.3V	SD/SDIO data line 0	-
19	X_SPI16_MOSI/PZ2	-	O	3.3V	SPI1 (or SPI6) Master output Slave input	-
20	GND	-	-	-	Ground	-

21	X_SPI16_MISO/PZ1	-	I	3.3V	SPI1 (or SPI6) Master Input Slave output	-
22	X_SDMMC3_D1/PF4	-	I/O	3.3V	SD/SDIO data line 1	-
23	X_SPI16_SCK/PZ0	-	O	3.3V	SPI1 (or SPI6) Serial Clock Output	-
24	X_SPI16_NSS/PZ3	-	O	3.3V	SPI1 (or SPI6) Slave Select	-
25	GND	-	-	-	Ground	-
26	X_CEC/PA15	X_SPI1_NSS/PA15	I/O	3.3V	GPIO or HDMI-CEC controller signal	-
27	X_I2C1_SDA/PF15	-	I/O	3.3V	I^2C1 data Signal	-
28	X_I2C1_SCL/PF14	-	O	3.3V	I^2C1 clock Signal	-
29	X_MCO2/PG2	-	O	3.3V	Microcontroller Clock Output 2	-
30	GND	-	-	-	Ground	-
31	X_TIM15_CH1N/PE4	X_SDMMC1_CKIN/PE4	O	3.3V	TIM15 negative channel 1	-

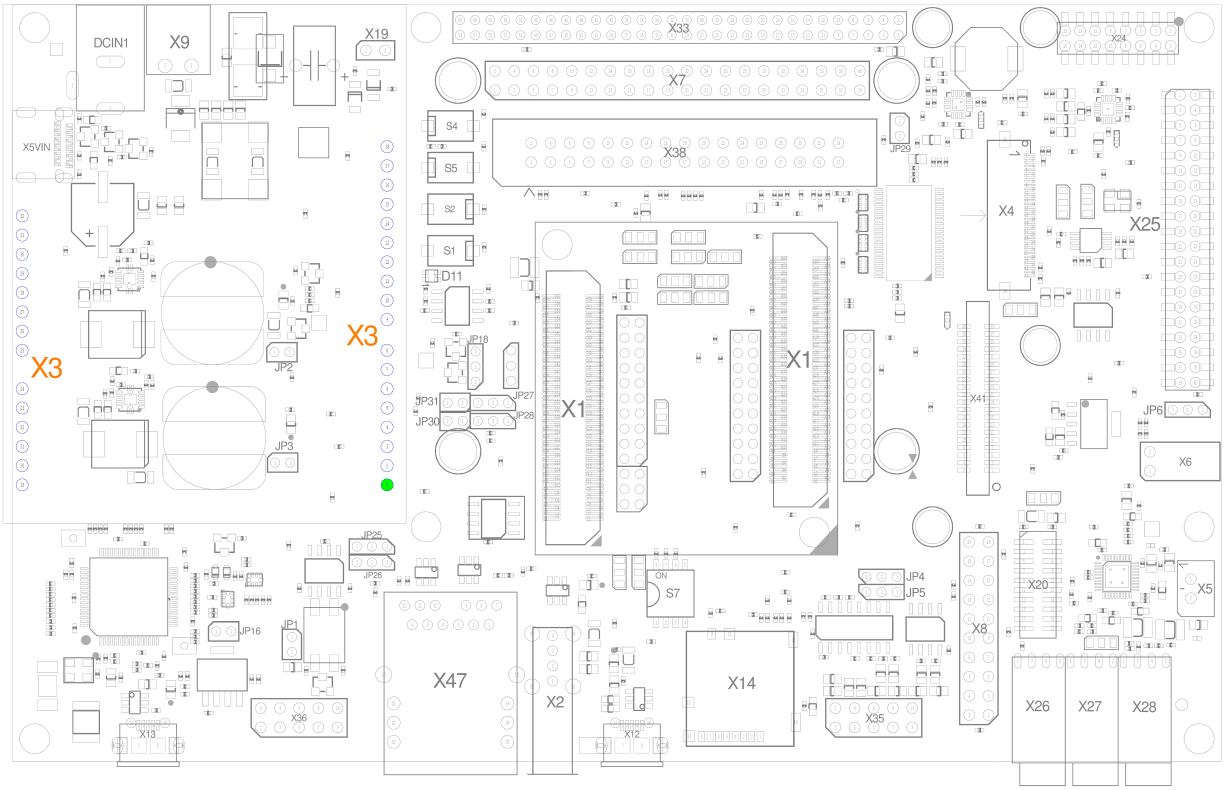
32	**RPI_GPIO_PWM0 (X_PH5)**	**X_I2C2_SDA/PH5**	**I/O**	**3.3V**	**GPIO**	**J22 2+1**
	RPI_GPIO_PWM0 (TIM1_CH2/PE11)	X_LCD_G3/PE11	O		TIM1 positive channel 2	J22 2+3 & **R240 mounted**
33	**RPI_GPIO_PWM1 (X_PF2)**	**X_SDMMC1_D0DIR/PF2**	**O**	**3.3V**	**GPIO**	**J35 2+1**
	RPI_GPIO_PWM1 (X_DACOUT2_TIM8_CH1N/ PA5)	X_DACOUT2/PA5	O	3.3V	DAC output or TIM8 negative channel 1	J35 2+3
34	GND	-	-	-	Ground	-
35	X_SAI2_FS_B/PC0	-	O	3.3V	SAI2 transmit frame Sync	-
36	X_USART1_CTS/PA11	X_FDCAN1_RX/PA11	I	3.3V	USART1 Clear To Send [13] [14]	-
37	X_SDMMC3_D2/PF5	-	I/O	3.3V	SD/SDIO data line 2	-
38	X_SAI2_SD_B/PF11	-	O	3.3V	SAI2 transmits data	-
39	GND	-	-	-	Ground	-

40	X_SAI2_SD_A/PI6	-	I	3.3V	SAI2 receives data	-

13. X_USART1_RTS/PA12 and X_USART1_CTS/PA11 can also be used as a second phyBOARD I2C bus interface (I2C5_SDA/I2C6_SDA and I2C5_SCL/I2C6_SCL). Cf. See I2C56 Connectivity.
14. X_USART1_RTS/PA12 and X_USART1_CTS/PA11 can also be pin-muxed (in BSP) as FDCAN1_TX/FDCAN1_RX signals (second CAN FD interface without transceiver).

19.2.13 Arduino Shields Connectivity (X3)

FIGURE 29: Arduino shields Connector (X3)



The Arduino shield connector is composed of 32 sockets (four single row connectors, 2.54mm pitch). The pinout is compatible with the Arduino Uno Rev3 Shield connector :

- **Socket 1x8:** power supply and Reset signal
- **Socket 1x6 (pins A0 to A5):** analog signals
- **Socket 1x10 (pins D8 to D15):** I/O signals (GPIO, I2C/CAN, SPI, PWM, or DFSDM)
- **Socket 1x8 (pins D0 to D7):** I/O signals (GPIO, UART, PWM, or DFSDM)

The advantages of these connectors are :

- Most STM32 **NUCLEO Eval boards** or **Arduino community Eval boards** can be plugged into the phyBOARD-Sargas
- Existing Firmware can run on Cortex M4

By default, only one of the I^2C signals is used on the phyBOARD (I2C1). But in case one other I^2C bus is needed (must be controlled by Cortex-M4, for example), Jumpers **JP27** and **JP28** are provided to use I2C5 or (I2C6) bus from the phyCORE instead of I2C1 (only for the Arduino shield connector).

Note

The **Signal Type** shown in the table below contains the signals configured in the **Arduino/MotorControl device tree expansion files (BSP),** which are **not activated by default**. By default, except USARTs, I2C1, and SPI16, all the other signals are GPIOs.

TABLE 63: X3 Pin Assignment

Interface Pin #	Arduino Pin ID	Signal Name	SOM Signal Name (when different)	Signal Type	Signal Level	Description	Jumper / 0Ω Res setting
1	D0	X_USART3_RX_ARD_EXP / PB12	X_USART3_RX / PB12	I	3.3V	X_USART3_RX/ PB12 is connected to this Interface Pin if JP16 is populated. If JP16 is not populated, X_USART3_RX/ PB12 is connected when there is no VCC_FTDI_3V3 supply (USB Debug cable not plugged on X13)	**JP16 1+2** or JP16 open+ no VCC_FTDI_3V3 supply

2	D1	X_USART3_TX_ARD_EXP / PB10	X_USART3_TX / PB10	O	3.3V	X_USART3_TX/ PB10 signal is connected to this Interface Pin if JP16 is populated. If JP16 is not populated, X_USART3_TX/ PB10 is connected when there is no VCC_FTDI_3V3 supply (USB Debug cable not plugged on X13)	**JP16 1+2** or JP16 open+ no VCC_FTDI_3V3 supply
3	D2	X_DFSDM1_DATIN3 / PF13	-	I/O	3.3V	**GPIO** or DFSDM1 Input from Channel 3	-
4	D3	TIM4_CH2 / PB7	X_DCMI_VSYNC / PB7	O	3.3V	TIM4 positive channel 2	**R241 mounted**
5	D4	X_DFSDM1_DATIN1 / PC3		I/O	3.3V	**GPIO** or DFSDM1 Input from Channel 1	-

6	D5	TIM15_CH1 / PE5	X_DCMI_DATA 6 / PE5	O	3.3V	TIM15 positive channel 1	**R242 mounted**
7	D6	ARD_D6_PWM (TIM12_CH2/PH9)	X_DCMI_DATA 0 / PH9	I/O	3.3V	**GPIO** or TIM12 positive channel 2	J36 2+1 & **R244 mounted**
		ARD_D6_PWM (**X_DFSDM1_CKOUT/ PD10**)	**-**	**I/O**	**3.3V**	**GPIO** or DFSDM1 Clock Output	**J36 2+3**
8	D7	X_DFSDM1_DATIN0 / PG0	-	I/O	3.3V	**GPIO** or DFSDM1 Input from Channel 0	-
9	D8	X_TIM8_BKIN2 / PG3	X_DFSDM1_CKIN1 / PG3	I/O	3.3V	**GPIO** or TIM8 Break Input 2	-
10	D9	X_TIM1_CH4 / PE14	X_SDMMC1_D123DIR / PE14	O	3.3V	TIM1 positive channel 4	-
11	D10	ARD_D10_SPI_SS/PWM (X_PG8)	X_USART3_RTS / PG8	I/O	3.3V	GPIO	J37 2+1

		ARD_D10_SPI_SS/PWM (**X_SPI16_NSS / PZ3**)	**-**	**O**	**3.3V**	**SPI1 (or SPI6) Slave Select**	**J37 2+3**
12	D11	ARD_D11_SPI_MOSI/ PWM X_TIM15_CH1N / PE4	X_SDMMC1_CKIN / PE4	O	3.3V	TIM15 negative channel 1	J38 2+1
		ARD_D11_SPI_MOSI/ PWM (**X_SPI16_MOSI / PZ2**)	**-**	**O**	**3.3V**	**SPI1 (or SPI6) Master Output Slave Input**	**J38 2+3**
13	D12	X_SPI16_MISO / PZ1	-	I	3.3V	SPI1 (or SPI6) Master Input Slave Output	-
14	D13	X_SPI16_SCK / PZ0	-	O	3.3V	SPI1 (or SPI6) Serial Clock Output	-
15	GND	GND	-	-	-	Ground	-
16	AREF	Not Connected	-	-	-	-	-

17	D14	ARD_D14_I2C_SDA (**X_I2C1_SDA / PF15**)	**-**	**I/O**	**3.3V**	**I²C1 data Signal**	**JP27/JP28 2+1**
		ARD_D14_I2C_SDA (X_USART1_RTS / PA12)	X_FDCAN1_TX / PA12	O	3.3V	USART1 Request To Send [15][16]	JP27/JP28 2+3
18	D15	ARD_D15_I2C_SCL (**X_I2C1_SCL / PF14**)	**-**	**O**	**3.3V**	**I²C1 clock Signal**	**JP27/JP28 2+1**
		ARD_D15_I2C_SCL X_USART1_CTS / PA11	X_FDCAN1_RX / PA11	I	3.3V	USART1 ClearTo Send [15] [16]	JP27/JP28 2+3
19	A5	X_ADC1_INN2 / PF12	-	ANA_I	0-VREF	ADC1 Input INN2 or INP6	-
20	A4	ADC1_INP13_INN12 / PC3	X_DFSDM1_DATIN1 / PC3	ANA_I	0-VREF	ADC1 Input INP13 or INN12	**R238 mounted**
21	A3	ADC2_INP2 / PF13	X_DFSDM1_DATIN3 / PF13	ANA_I	0-VREF	ADC2 Input INP2	**R234 mounted**

22	A2	X_PVD_IN/ ADC1_INP15 / PA3	-	ANA_I	0-VREF	**ADC1 Input INP15** or Power Programmable Voltage Detector Input	-
23	A1	X_ADC1_INP1	-	ANA_I	0-VREF	ADC1 Input INP1	-
24	A0	X_ADC1_INN1	-	ANA_I	0-VREF	ADC1 Input INN1	-
25	VIN	Not Connected	-	-	-	-	-
26, 27	GND	GND	-	-	-	Ground	-
28	5V	VCC5V	-	PWR_O	5V	5 V phyBOARD Supply	-
29	3.3V	VCC3V3	-	PWR_O	3.3V	3.3 V phyBOARD Supply	-
30	RESET	X_nRESET	-	Reset	3.3V	System ResetSystem Reset	-
31	IOREF	VCC3V3	-	PWR_O	3.3V	3.3 V phyBOARD Supply	-

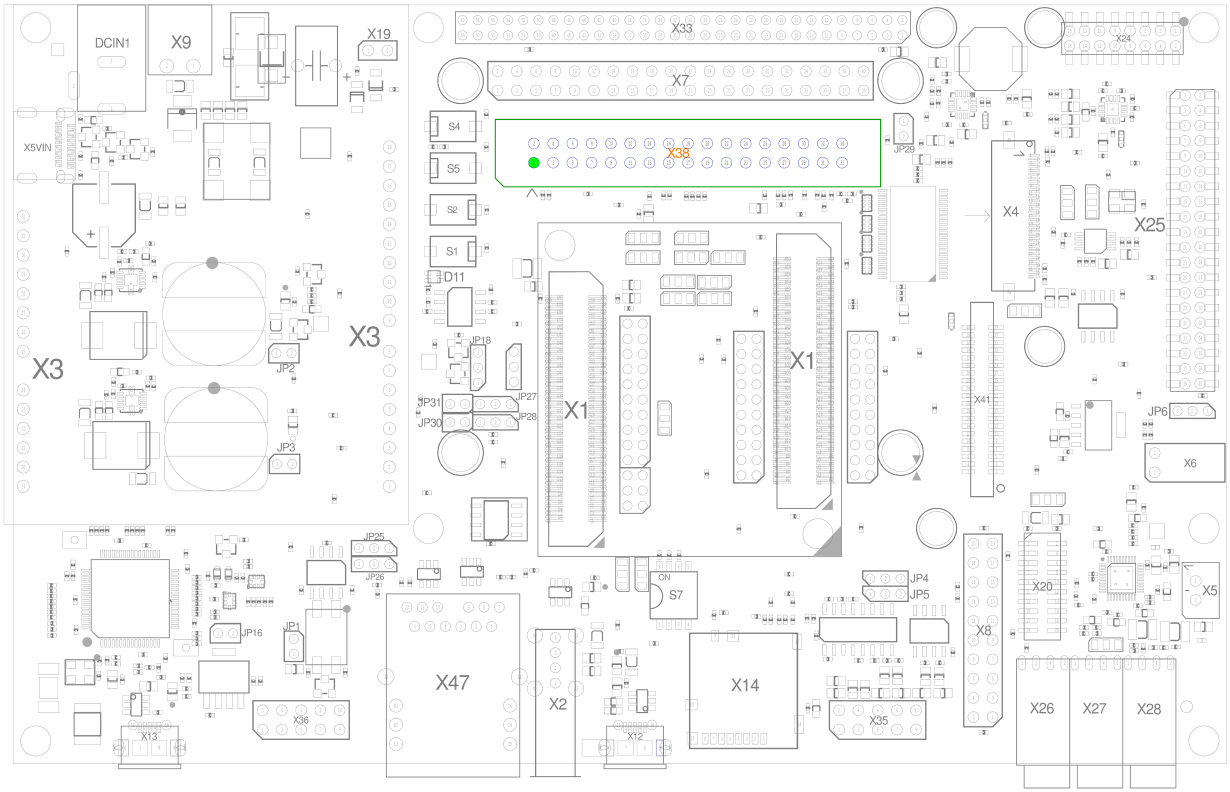
32	RESERVED	Not Connected	-	-	-	-	-

1 X_USART1_RTS/PA12 and X_USART1_CTS/PA11 can also be used as a second phyBOARD I2C bus interface
5. (I2C5_SDA/I2C6_SDA and I2C5_SCL/I2C6_SCL). Cf. See I2C56 Connectivity.

1 X_USART1_RTS/PA12 and X_USART1_CTS/PA11 can also be pin muxed (in BSP) as FDCAN1_TX/FDCAN1_RX
6. signals (second CAN FD interface without transceiver).

19.2.14 Motor Control Connector (X38)

FIGURE 30: Motor Control Connector (X38)



2×17 pin header, 2.54 mm pitch. Compatible with STM32 motor control power eval boards **STEVAL-x**. It is also possible to connect **X-NUCLEO-IHMx** STM32 motor control eval boards using the X-NUCLEO-IHM09M1 adaptor.

Note

The **Signal Type** shown in the table below contains the signals configured in the **Arduino/MotorControl device tree expansion files (BSP),** which are **not activated by default**. By default, except for USART and LCD signals, all the other signals are GPIOs.

TABLE 64: X38 Pin Assignment

Interface Pin #	Signal Name	SOM Signal Name (when different)	Signal Type	Signal Level	Description	Jumper / 0Ω Res Setting	Motor Control Function
1	X_TIM8_BKIN2 / PG3	X_DFSDM1_CKIN1 / PG3	I/O	3.3V	**GPIO** or TIM8 Break Input 2	-	EmergencySTOP
2	GND	-	-	-	Ground	-	-
3	TIM8_CH1 / PI5	X_LCD_B5 / PI5	O	3.3V	TIM8 positive channel 1	**R228 mounted**	U HighPhase Control (PWM output)
4	GND	-	-	-	Ground	-	-
5	X_DACOUT2_TIM8_CH1N / PA5	X_DACOUT2 / PA5	O	3.3V	TIM8 negative channel 1		U Low Phase Control (PWM output)
6	GND	-	-	-	Ground	-	-
7	TIM8_CH2 / PC7	X_DCMI_DATA1 / PC7	O	3.3V	TIM8 positive channel 2	**R230 mounted**	V High Phase Control (PWM output)
8	GND	-	-	-	Ground	-	-
9	TIM8_CH2N / PB0	X_LCD_R3 / PB0	O	3.3V	TIM8 negative channel 2	**R231 mounted**	V Low Phase Control (PWM output)

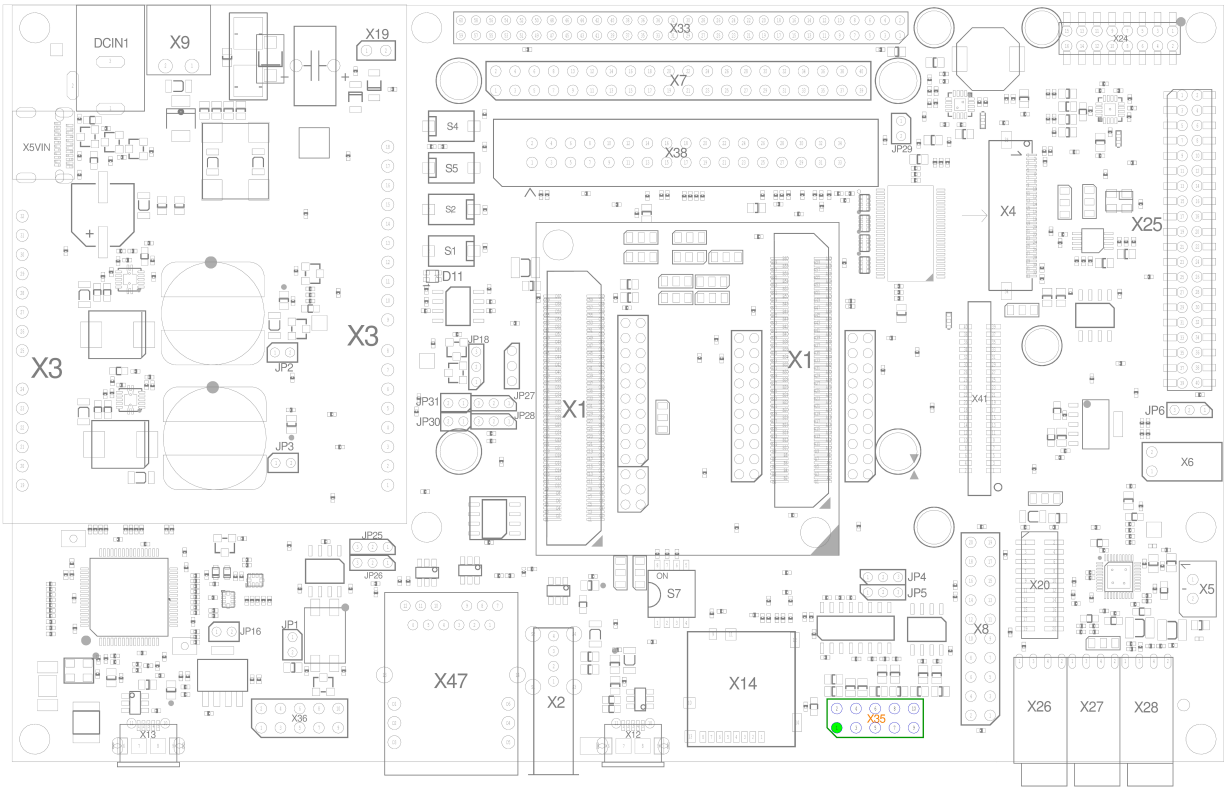
10	GND	-	-	-	Ground	-	-
11	TIM8_CH3 / PI7	X_DCMI_DATA7 / PI7	O	3.3V	TIM8 positive channel 3	**R239 mounted**	W High Phase Control (PWM output)
12	GND	-	-	-	Ground	-	-
13	TIM8_CH3N / PH15	X_LCD_G4 / PH15	O	3.3V	TIM8 negative channel 3	**R232 mounted**	W Low Phase Control (PWM output)
14	X_PVD_IN/ ADC1_INP15 / PA3	-	ANA_I	0-VREF	ADC1 input INP15	-	Bus Voltage sensing
15	X_ADC1_INN2 / PF12	-	ANA_I	0-VREF	ADC1 input INN2 or INP6	-	Current phase A
16	GND	-	-	-	Ground	-	-
17	X_ADC1_INN1	-	ANA_I	0-VREF	ADC1 input INN1	-	Current phase B
18	GND	-	-	-	Ground	-	-
19	X_ADC1_INP1	-	ANA_I	0-VREF	ADC1 input INP1	-	Current phase C

20	GND	-	-	-	Ground	-	-
21	X_LCD_PWCTRL / PA4	X_DACOUT1 / PA4	I/O	3.3V	GPIO	-	bypass Relay NTC resistor
22	GND	-	-	-	Ground	-	-
23	TIM3_CH1 / PA6	X_DCMI_PIXCLK / PA6	O	3.3V	TIM3 positive channel 3	**R270 mounted**	Dissipative Brake (PWM output)
24	GND	-	-	-	Ground	-	-
25	VCC5V	-	PWR_O	5V	5 V phyBOARD Supply	-	-
26	ADC1_INP13_INN12 / PC3	X_DFSDM1_DATIN1 / PC3	ANA_I	0-VREF	-	**R238 mounted**	Heat sink (temperature monitor)
27	**TIM1_CH2/PE11**	**X_LCD_G3/PE11**	**I**	**3.3V**	**TIM1 positive channel 2**	**R240 mounted**	Power Factor Correction (PFC) Synchronisation (timer input capture)
	X_USART1_RTS / PA12	X_FDCAN1_TX / PA12	I	3.3V	TIM1_ETR	R275 mounted	Timer 1 external Trigger input (optional)

28	VCC3V3	-	PWR_O	3.3V	3.3 V phyBOARD Supply	-	-
29	X_TIM1_CH4 / PE14	X_SDMMC1_D123DIR / PE14	O	3.3V	TIM1 positive channel 4	-	Power Factor Correction (PFC) (PWM output)
30	GND	-	-	-	Ground	-	-
31	TIM5_CH1/PH10	X_LCD_R4/PH10	O	3.3V	TIM5 positive channel 1	**R245 mounted**	Encoder / Hall / BEMF - phase A (Quadrature encoder input)
32	GND	-	-	-	Ground	-	-
33	TIM5_CH3/PH12	X_LCD_R6/PH12	O	3.3V	TIM5 positive channel 3	**R249 mounted**	Encoder / Hall / BEMF - phase B (Quadrature encoder input)
34	TIM5_CH4/PI0	X_PI0	O	3.3V	TIM5 positive channel 4	**R246 mounted**	Encoder / Hall / BEMF - phase C (Quadrature encoder input)

19.2.15 RS232 / RS485 Connector (X35)

FIGURE 31: RS232 / RS485 Connector (X35)

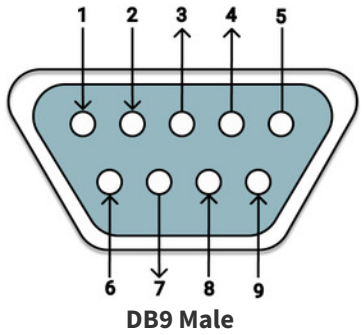


The phyBOARD-Sargas is equipped with an RS232 transceiver (**U14**) and RS485 transceiver(at **U18**). Both are connected to the phyBOARD-Sargas **USART1** interface, so jumpers must be set correctly to select which interface to use (RS232 or RS485). The RS232 transceiver (MAX3232ESE) operates at data rates up to 250 kbit/s. The RS485 transceiver (SN65HVD12D) operates up to 1Mbit/s.

TABLE 65: X35 Pin Assignment

Interface Pin #	Signal Name	Signal Type	Signal Level	Description	Jumper Setting
1, 2, 10	Not Connected	-	-	-	
3	**X_RS232_RX**	**RS232_I**	**RS232 standard**	**RS232 Receive Data**	**JP4 1+2**
4	X_RS232_RTS	RS232	RS232 standard	RS232 Request to Send signal	JP31 closed
5	**X_RS232_TX**	**RS232_O**	**RS232 standard**	**RS232 Transmit Data**	**JP5 1+2**
6	X_RS232_CTS	RS232	RS232 standard	RS232 Request to Clear signal	JP30 closed
7	X_RS485_A	RS485_I/O	RS485 standard	RS485 A signal	JP4/JP5 2+3
8	X_RS485_B	RS485_I/O	RS485 standard	RS485 B signal	JP4/JP5 2+3
9	GND	-	-	Ground	

An adapter cable (pin header to DB9 male connector) is plugged by default on X35 on the phyBOARD-Sargas STM32MP15x Kit to facilitate the use of the RS232/RS485 interface. The following figure shows the signal mapping of the DB9 male connector:



DB9 Male

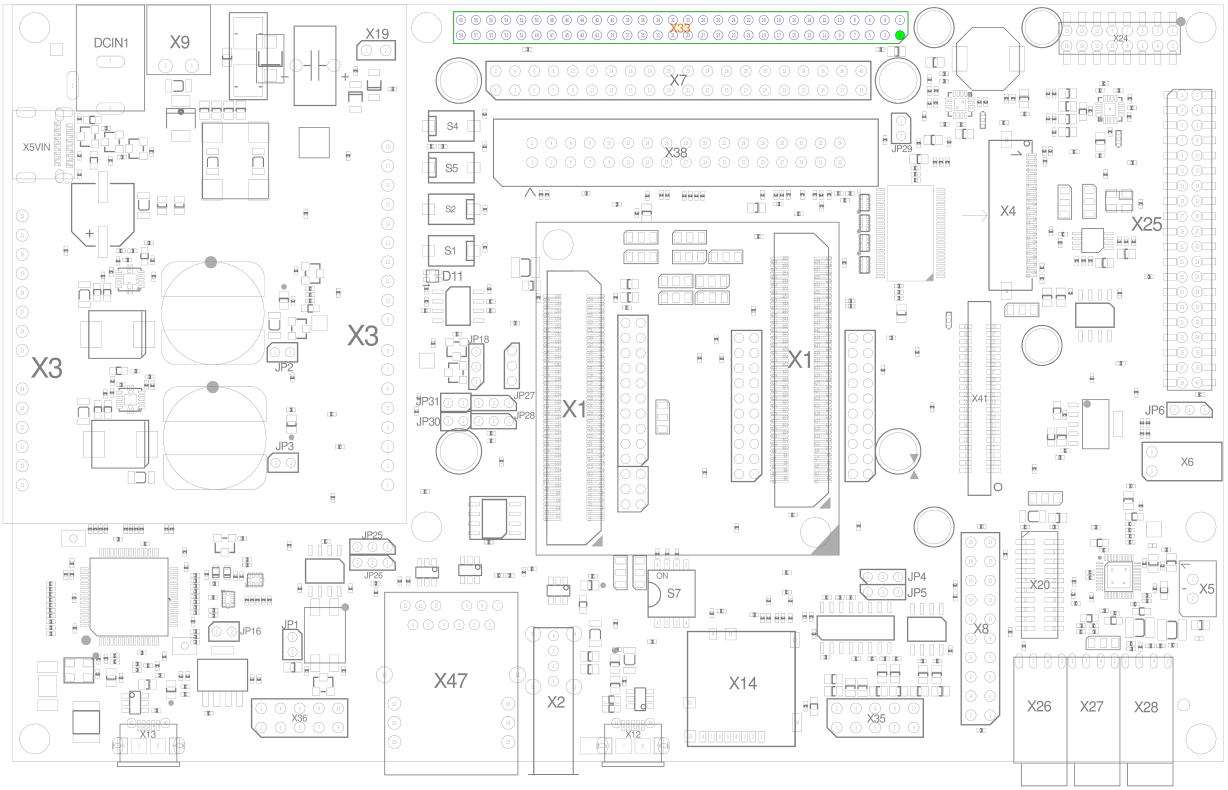
DB9 male pin #	RS232/RS485 signal
2	X_RS232_RX
7	X_RS232_RTS
3	X_RS232_TX
8	X_RS232_CTS
4	X_RS485_A
9	X_RS485_B
5	GND

19.2.15.1 RS485 Design Considerations

The RS485 bus lanes (X_RS485_A/X_RS485_B) should be routed with a differential impedance of 120 Ohm.

19.2.16 Expansion Connector (X33)

FIGURE 32: Expansion Connector (X33)



The expansion connector X33 provides an easy way to add other functions and features to the phyBOARD-Sargas. Standard interfaces such as SPI, USB OTG, SDMMC, U(S)ARTs, or I^2C are available at the expansion connector. Additionally, other power supplies or signals from the phyCORE-STM32MP15x are available on it. The expansion connector is intended to be used with a PHYTEC PEB-x expansion board or custom expansion boards.

TABLE 66: X33 Pin Assignment

Interface Pin #	Signal Name	SOM Signal Name (when different)	Signal Type	Signal Level	Description	Jumper Setting
1	VCC3V3	-	PWR_O	3.3V	3.3 V phyBOARD Supply	-
2	VCC5V	-	PWR_O	5V	5 V phyBOARD Supply	-
3	VCC1V8	-	PWR_O	1.8V	1.8 V phyBOARD Supply	-
4	GND	-	-	-	Ground	-
5	X_SPI16_NSS/PZ3	-	O	3.3V	SPI1 or SPI6 Slave Select	-
6	X_SPI16_MOSI/PZ2	-	O	3.3V	SPI1 or SPI6 Master output Slave input	-
7	X_SPI16_MISO/PZ1	-	I	3.3V	SPI1 or SPI6 Master Input Slave output	-
8	X_SPI16_SCK/PZ0	-	O	3.3V	SPI1 or SPI6 Serial Clock Output	-
9	GND	-	-	-	Ground	-

Interface Pin #	Signal Name	SOM Signal Name (when different)	Signal Type	Signal Level	Description	Jumper Setting
10	X_UART4_RX_EXP / PB2	X_UART4_RX / PB2	I	3.3V	UART4 Receive Data X_UART4_RX/PB2 is connected to this pin when there is no VCC_FTDI_3V3 supply (USB Debug cable not plugged on X13)	no VCC_FTDI_3V3 supply
11	X_I2C1_SDA/PF15	-	I/O	3.3V	I^2C1 data Signal	-
12	X_UART4_TX_EXP / PB9	X_UART4_TX / PB9	O	3.3V	UART4 Transmit Data X_UART4_TX/PB9 is connected to this pin when there is no VCC_FTDI_3V3 supply (USB Debug cable not plugged on X13)	no VCC_FTDI_3V3 supply
13	X_I2C1_SCL/PF14	-	O	3.3V	I^2C1 clock Signal	-
14	GND	-	-	-	Ground	-
15	X_SAI2_MCLK_B / PH3	-	-	-	SAI2 Master Clock	-

Interface Pin #	Signal Name	SOM Signal Name (when different)	Signal Type	Signal Level	Description	Jumper Setting
16	X_SAI2_SD_B / PF11	-	O	3.3V	SAI2 transmits data	-
17	X_SAI2_SCK_B / PH2	-	O	3.3V	SAI2 transmit bit clock	-
18	X_SAI2_FS_B/PC0	-	O	3.3V	SAI2 transmit frame Sync	-
19	GND	-	-	-	Ground	-
20	X_SAI2_SD_A / PI6	-	I	3.3V	SAI2 receives data	-
21	X_USB_DP2_EXP	X_USB_OTG_D2P	USB_I/O	3.3V	USB 2.0 Positive Lane	J23/J24 2+3
22	X_USB_DM2_EXP	X_USB_OTG_D2M	USB_I/O	3.3V	USB 2.0 Negative Lane	J23/J24 2+3
23	X_nRESET	-	Reset	3.3V	System Reset	-
24	GND	-	-	-	Ground	-

Interface Pin #	Signal Name	SOM Signal Name (when different)	Signal Type	Signal Level	Description	Jumper Setting
25	X_SDMMC3_CMD / PF1	-	I/O	3.3V	SD/SDIO bidirectional command/response signal	-
26	X_SDMMC3_D0 / PF0	-	I/O	3.3V	SD/SDIO data line 0	-
27	X_SDMMC3_CK / PG15	-	O	3.3V	SD/SDIO clock	-
28	X_SDMMC3_D1 / PF4	-	I/O	3.3V	SD/SDIO data line 1	-
29	GND	-	-	-	Ground	-
30	X_SDMMC3_D2 / PF5	-	I/O	3.3V	SD/SDIO data line 2	-
31	X_USART3_RX_ARD_EXP / PB12	X_USART3_RX / PB12	I	3.3V	USART3 Receive Signal	**JP16 1+2** or JP16 open+ no VCC_FTDI_3V3 supply

Interface Pin #	Signal Name	SOM Signal Name (when different)	Signal Type	Signal Level	Description	Jumper Setting
32	X_SDMMC3_D3 / PD7	-	I/O	3.3V	SD/SDIO data line 3	-
33	X_USART3_TX_ARD_EXP / PB10	X_USART3_TX / PB10	O	3.3V	USART3 Transmit Signal	**JP16 1+2** or JP16 open+ no VCC_FTDI_3V3 supply
34	GND	-	-	-	Ground	-
35	VREF	-	PWR_I/O		ADC VREF pin (Refer to the SM32MP1 datasheet for the signal level)	-
36	X_PWR_ON	-	O	3.3V	PWR_ON STM32MP15x output pin (connected to PWRCTRL PMIC input pin)	-
37	VBUS_SW	-	PWR_O	5V	VBUS USB HOST Voltage Supply from PMIC	-
38	X_RTC_EVI	-	I	3.3V	phyCORE external RTC Event input	-

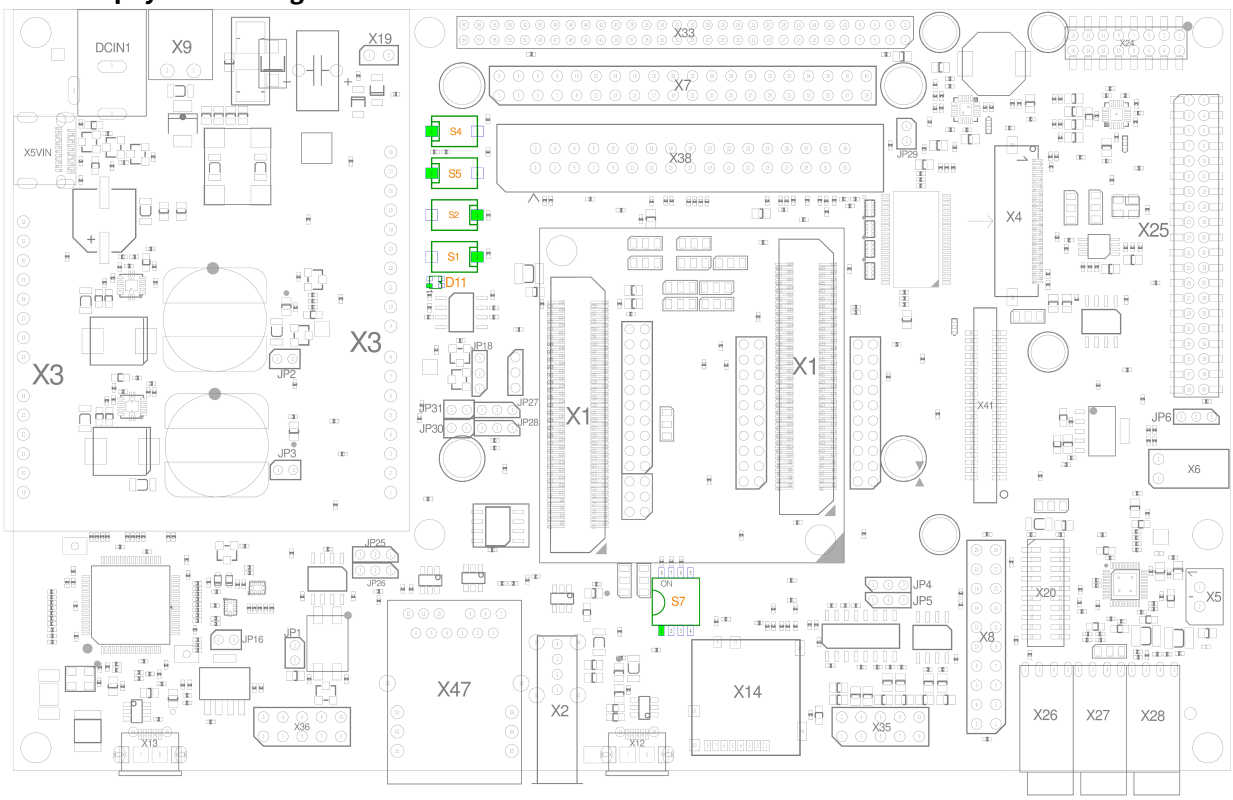
Interface Pin #	Signal Name	SOM Signal Name (when different)	Signal Type	Signal Level	Description	Jumper Setting
39	X_RTC_CLKOUT	-	O	3.3V	phyCORE external RTC clock output	-
40	X_nRTC_INT	-	O	3.3V	phyCORE external RTC interrupt output	-
41	GND	-	-	-	Ground	-
42	X_DBTRGO/PA13	-	I/O	3.3V	**GPIO** or External trigger output from CTI	-
43	X_DBTRGI/PA14	-	I/O	3.3V	**GPIO** or External trigger input to CTI	-
44	X_WAKEUP3/PC13	-	I/O	3.3V	PMIC wakeup pin input / STM32MP15x PC13 pin	-
45	X_nPMIC_INT/PA0	-	O	3.3V	PMIC interrupt output	-
46	GND	-	-	-	Ground	-
47	X_DFSDM1_CKOUT / PD10	-	O	3.3V	DFSDM1 Clock output	-

Interface Pin #	Signal Name	SOM Signal Name (when different)	Signal Type	Signal Level	Description	Jumper Setting
48	X_PG8	-	I/O	3.3V	GPIO	-
49	X_FDCAN2_TX_EXP / PB13	X_USART3_CTS / PB13	O	3.3V	FDCAN2 transmits data	JP25/JP26 1+2
50	X_FDCAN2_RX_EXP / PB5	X_SPI1_MOSI / PB5	I	3.3V	FDCAN2 receives data	JP25/JP26 1+2
51	GND	-	-	-	Ground	-
52	X_nPONKEY	-	I	3.3V	PONKEYn PMIC pin	-
53	X_USB_OTG_ID / PA10	-	I/O	3.3V	ID Pin of USB OTG Port	-
54	X_USB_OTG_VBUS	-	PWR_I	5V	USB OTG VBUS input	-
55	VBUS_OTG	-	PWR_O	5V	USB OTG Supply Voltage Supply from PMIC	-
56	GND	-	-	-	Ground	-
57	VDD	-	PWR_O	3.3V	VDD power supply from PMIC	-

Interface Pin #	Signal Name	SOM Signal Name (when different)	Signal Type	Signal Level	Description	Jumper Setting
58	VDD_BUCK4	-	PWR_O	3.3V	VDD_BUCK4 power supply from PMIC	-
59	GND	-	-	-	Ground	-
60	VDD_LDO1	-	PWR_O	1.7 - 3.3V	VDD_LDO1 power supply from PMIC	-

19.2.17 phyBOARD-Sargas LED and Switches

FIGURE 33: phyBOARD-Sargas LED and Switch Locations



19.2.17.1 Multicolor (RGB) LED (D11)

The phyBOARD-Sargas provides one multicolor (RGB) LED (D11) for the user application. The LED is controlled with an LED dimmer **PCA9533/01 (U10)** and supplied by VCC5V.

The LED dimmer can be accessed via **I2C1 at address 0x62** and dynamically controls the LED with 3 PMW signals. The table below shows the signals from the LED dimmer (U10) that control the RGB colors:

TABLE 67: Multicolor LED Configuration

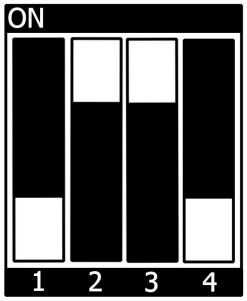
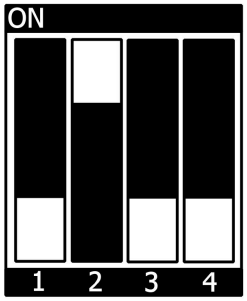
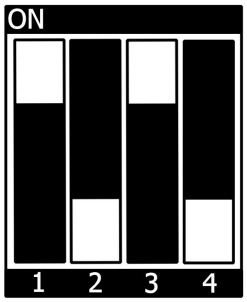
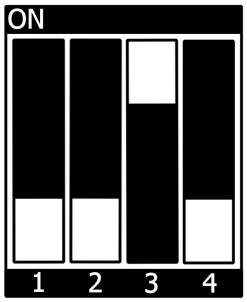
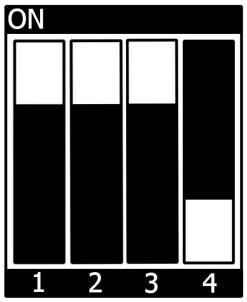
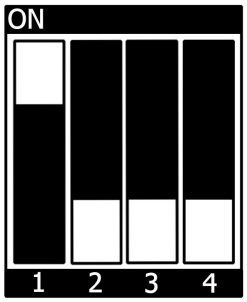
U10 pin #	U10 Pin name	Signal name	Description
1	LED0	RGB_LED_RED	PWM controlling Red Color
2	LED1	RGB_LED_GREEN	PWM controlling Green Color
3	LED2	RGB_LED_BLUE	PWM controlling Blue Color

19.2.17.2 Boot Switch (S7)

The phyBOARD-Sargas has six defined boot sources that can be selected with DIP switch S7 (see Boot Mode Selection for more information).

The figures below show a visual representation of each S7 boot mode switch setting:

TABLE 68: Boot Switch Settings

NOR	**SD Card**
	
eMMC	**NAND**
	
UART/USB	
	

Boot Mode Design Considerations

Bootpin voltages have to be valid when X_nRESET is released.

19.2.17.3 System Reset (S1)

The phyBOARD-Sargas is equipped with a System Reset switch at S1 (push button).

Pressing this switch will toggle the X_nRESET pin (X1 Pin D51) of the phyCORE-STM32MP15x to the low state, causing the module to reset with a complete power cycle.

19.2.17.4 System ON/OFF/Wake-up (S2)

The phyBOARD-Sargas is equipped with an ON/OFF/Wake-up switch at S2 (push button).

Pressing this switch will toggle the X_nPONKEY pin (X1 Pin D54) of the phyCORE-STM32MP15x to the low state. On the phyCORE, this signal is directly connected to the PMIC PONKEYn input pin.

- A long keypress enables powering OFF the system.
- A single keypress enables powering ON the system or waking up from any low-power mode.

> **Note**
>
> This behavior depends on the BSP configuration. More information can be found in the STM32MP15x and STPMIC1A datasheets.

19.2.17.5 User Programmable Switches (S4, S5)

The phyBOARD-Sargas is equipped with two User Programmable Switches S4, and S5 (push buttons).

Those switches allow any Software application to use them as an event source:

- Pressing the S4 switch will toggle to X_DBTRGO/PA13 Low state (on the phyCORE-STM32MP15x, it will light up the LED red D2).
- Pressing the S5 switch will toggle to X_DBTRGI/PA14 Low state (on the phyCORE-STM32MP15x, it will light up LED green D1).

20 Additional System-Level Hardware Information

20.1 Soldering Jumpers and 0 Ohm resistors

Numerous soldering jumpers and 0 Ohm resistors allow the phyBOARD-Sargas to be configured according to various application needs.

20.1.1 Soldering Jumpers

TABLE 69: Soldering Jumpers Descriptions

Reference	Position	Description	Section
J2	**1+2**	**Audio Jack/Headset detection: dc coupling**	Audio Connectivity (X5, X26, X27, X28)
	2+3	Audio Jack/Headset detection: capless application	
J3	1+2	CAM_MCLK from X_MCO2/PG2 pin	Camera Connectivity (X4)
	2+3	**CAM_MCLK from 27MHz oscillator (OZ1)**	
J4	1+2	CAM_CTRL2 to GND	Camera Connectivity (X4)
	2+3	CAM_CTRL2 to VCC_CAM	
	not mounted	**CAM_CTRL2 not connected**	
J5	**1+2**	**CAM_CTRL1 to GND**	Camera Connectivity (X4)
	2+3	CAM_CTRL1 to VCC_CAM	
J7	1+2	X_nRESET to X24	Audio/Visual Connectors (X24 and X25)
	2+3	**X_LCD_RST/PD9 to X24**	
J8	1+2	I2C address of STMPE811 (U20) = 0x41	Audio Connectivity (X5, X26, X27, X28)
	2+3	**I2C address of STMPE811 (U20) = 0x44**	

Reference	Position	Description	Section
J9	**closed**	**GND connected to AGND via a star point**	Audio Connectivity (X5, X26, X27, X28)
J10	**closed**	**GND connected to AGND via a star point**	Audio Connectivity (X5, X26, X27, X28)
J17	**1+2**	**X_SAI2_SCK_B/PH2 connected to X24**	Audio/Visual Connectors (X24 and X25)
	2+3	X_SPI16_SCK/PZ0 connected to X24	
J18	**1+2**	**X_SAI2_FS_B/PC0 connected to X24**	Audio/Visual Connectors (X24 and X25)
	2+3	X_SPI16_NSS/PZ3 connected to X24	
J19	**1+2**	**X_SAI2_SD_A/PI6 connected to X24**	Audio/Visual Connectors (X24 and X25)
	2+3	X_SPI16_MISO/PZ1 connected to X24	
J20	**1+2**	**X_SAI2_SD_B/PF11 connected to X24**	Audio/Visual Connectors (X24 and X25)
	2+3	X_SPI16_MOSI/PZ2 connected to X24	
J21	**1+2**	**X_SAI2_SCK_B/PH2 connected to X7**	Raspberry Pi HAT Connectivity (X7)
	2+3	TIM1_CH2/PE11 (X_LCD_G3/PE11) connected to X7	
J22	**1+2**	**X_PH5 connected to X7**	Raspberry Pi HAT Connectivity (X7)
	2+3	TIM1_CH2/PE11 (X_LCD_G3/PE11) connected to X7	

Reference	Position	Description	Section
J23	**1+2**	**X_USB_OTG_D2M connected to X12**	Universal Serial Bus USB Connectivity (X2, X12) ----- Expansion Connector (X33)
	2+3	X_USB_OTG_D2M connected to X33	
J24	**1+2**	**X_USB_OTG_D2P connected to X12**	Universal Serial Bus USB Connectivity (X2, X12) ----- Expansion Connector (X33)
	2+3	X_USB_OTG_D2P connected to X33	
J29	1+2	TPS62150 Step-Down Converter (U5) disabled	Camera Connectivity (X4)
	2+3	**TPS62150 Step-Down Converter (U5) enabled**	
J35	**1+2**	**X_PF2 connected to X7**	Raspberry Pi HAT Connectivity (X7)
	2+3	X_DACOUT2_TIM8_CH1N/ PA5 connected to X7	
J36	1+2	TIM12_CH2/PH9 (X_DCMI_DATA0/ PH9) connected to X3	Arduino Shields Connectivity (X3)
	2+3	**X_DFSDM1_CKOUT/PD10 connected to X3**	
J37	1+2	X_PG8 connected to X3	Arduino Shields Connectivity (X3)
	2+3	**X_SPI16_NSS/PZ3 connected to X3**	
J38	1+2	X_TIM15_CH1N/PE4 connected to X3	Arduino Shields Connectivity (X3)
	2+3	**X_SPI16_MOSI/PZ2 connected to X3**	

Reference	Position	Description	Section
J39	1+2	Audio Codec (U1) nRESET pin connected to Ground (U1 disabled)	Audio Connectivity (X5, X26, X27, X28)
	2+3	**Audio Codec (U1) nRESET pin connected to X_nRESET (U1 enabled)**	

20.1.2 0 Ohm Resistors

Those resistors have no functional impact and should always be mounted. Most of the phyBOARD-Sargas TIMERs signals are alternate functions of X_LCD_x or X_DCMI_x signals (configured by Software Pin muxing in the BSP). For better schematic visibility and to avoid any signal length routing issue when using LCD or DCMI function, 0 Ohm resistors are mounted by default between X_LCD or X_DCMI and TIMx_CHy signals. Additionally, two X_DFSDM signals are used as ADC on the phyBOARD, so the same logic has been done for those two signals.

TABLE 70: 0 Ohm Resistor Descriptions

Reference	Populated	Description	Section
R228	**mounted**	TIM8_CH1/PI5 connected to PI5 MPU pin (= X_LCD_B5/PI5)	Motor Control Connector (X38)
	not mounted	TIM8_CH1/PI5 Not connected to PI5 MPU pin	
R230	**mounted**	TIM8_CH2/PC7 connected to PC7 MPU pin (= X_DCMI_DATA1/PC7)	Motor Control Connector (X38)
	not mounted	TIM8_CH2/PC7 Not connected to PC7 MPU pin	
R231	**mounted**	TIM8_CH2N/PB0 connected to PB0 MPU pin (= X_LCD_R3/PB0)	Motor Control Connector (X38)
	not mounted	TIM8_CH2N/PB0 Not connected to PB0 MPU pin	
R232	**mounted**	TIM8_CH3N/PH15 connected to PH15 MPU pin (= X_LCD_G4/PH15)	Motor Control Connector (X38)
	not mounted	TIM8_CH3N/PH15 Not connected to PH15 MPU pin	

Reference	Populated	Description	Section
R234	**mounted**	ADC2_INP2/PF13 connected to PF13 MPU pin (= X_DFSDM1_DATIN3/PF13)	Arduino Shields Connectivity (X3)
	not mounted	ADC2_INP2/PF13 Not connected to PF13 MPU pin	
R238	**mounted**	ADC1_INP13_INN12/PC3 connected to PC3 MPU pin (= X_DFSDM1_DATIN1/PC3)	Arduino Shields Connectivity (X3) ----- Motor Control Connector (X38)
	not mounted	ADC1_INP13_INN12/PC3 Not connected to PC3 MPU pin	
R239	**mounted**	TIM8_CH3/PI7 connected to PI7 MPU pin (= X_DCMI_DATA7/PI7)	Motor Control Connector (X38)
	not mounted	TIM8_CH3/PI7 Not connected to PI7 MPU pin	
R240	**mounted**	TIM1_CH2/PE11 connected to PE11 MPU pin (= X_LCD_G3/PE11)	Raspberry Pi HAT Connectivity (X7) ----- Motor Control Connector (X38)
	not mounted	TIM1_CH2/PE11 Not connected to PE11 MPU pin	
R241	**mounted**	TIM4_CH2/PB7 connected to PB7 MPU pin (= X_DCMI_VSYNC/PB7)	Arduino Shields Connectivity (X3)
	not mounted	TIM4_CH2/PB7 Not connected to PB7 MPU pin	
R242	**mounted**	TIM15_CH1/PE5 connected to PE5 MPU pin (= X_DCMI_DATA6/PE5)	Arduino Shields Connectivity (X3)
	not mounted	TIM15_CH1/PE5 Not connected to PE5 MPU pin	
R244	**mounted**	TIM12_CH2/PH9 connected to PH9 MPU pin (= X_DCMI_DATA0/PH9)	Arduino Shields Connectivity (X3)
	not mounted	TIM12_CH2/PH9 Not connected to PH9 MPU pin	

Reference	Populated	Description	Section
R245	**mounted**	TIM5_CH1/PH10 connected to PH10 MPU pin (= X_LCD_R4/PH10)	Motor Control Connector (X38)
	not mounted	TIM5_CH1/PH10 Not connected to PH10 MPU pin	
R246	**mounted**	TIM5_CH4/PI0 connected to PI0 MPU pin (= X_LCD_BL_PWM/PI0)	Motor Control Connector (X38)
	not mounted	TIM5_CH4/PI0 Not connected to PI0 MPU pin	
R249	**mounted**	TIM5_CH3/PH12 connected to PH12 MPU pin (= X_LCD_R6/PH12)	Motor Control Connector (X38)
	not mounted	TIM5_CH3/PH12 Not connected to PH12 MPU pin	
R270	**mounted**	TIM3_CH1/PA6 connected to PA6 MPU pin (= X_DCMI_PIXCLK/PA6)	Motor Control Connector (X38)
	not mounted	TIM3_CH1/PA6 Not connected to PA6 MPU pin	

Due to the small footprint of the jumpers / 0 Ohm resistors, we do not recommend manual jumper/resistor modifications. This may render the warranty invalid. Please contact our sales team if you need one of the configurations described below.

20.2 I²C Connectivity

20.2.1 I2C4 Interface

The I²C4 interface is intended to be used for the SOM only. But the interface is available on the SOM connector:

pin X1.D21 = X_I2C4_SCL/PZ4 and pin X1.D22 = X_I2C4_SDA/PZ5

This bus is also used for security purposes. This is why on the phyBOARD, the **Crypto Authentification ATECC508A** device (**U24**) is connected to this **I2C4 bus at address 0x60**. Otherwise, this bus is not available on phyBOARD-Sargas expansion connectors.

20.2.2 I2C1 Interface

The I^2C1 interface is intended to be used for the phyBOARD only (not used on the SOM). The table below provides a list of the expansion connectors and pins with I^2C1 connectivity

TABLE 71: I2C1 Interface Pin Locations

Connector	Connector Pin #	Signal name	Jumper setting
X20	6	X_I2C1_SCL/PF14	
	8	X_I2C1_SDA/PF15	
X24	15	X_I2C1_SCL/PF14	
	16	X_I2C1_SDA/PF15	
X3	17	X_I2C1_SDA/PF15	**JP27/JP28 1+2**
	18	X_I2C1_SCL/PF14	**JP28/JP28 1+2**
X7	3	X_I2C1_SDA/PF15	
	5	X_I2C1_SCL/PF14	
	27	X_I2C1_SDA/PF15	
	28	X_I2C1_SCL/PF14	
X33	11	X_I2C1_SDA/PF15	
	13	X_I2C1_SCL/PF14	
X41	21, 22	X_I2C1_SCL/PF14	
	23, 24	X_I2C1_SDA/PF15	

20.2.3 I2C5/I2C6 Interface (possible additional I2C interface)

I^2C5 (or I^2C6) is a possible additional I2C interface that is available on expansion connectors (X3 or X7), in case X_USART1_CTS/PA11 and X_USART1_RTS/PA12 signals are not used for USART1 flow control. In this case, the pin muxing (BSP) must be changed to configure those signals as an I2C bus. The table below provides a list of the expansion connectors and pins with I^2C5/I^2C6 connectivity:

TABLE 72: I2C5/I2C6 Interface Pin Locations

Connector	Connector Pin #	Signal name	Jumper Setting
X3	17	X_USART1_RTS/PA12 (I2C56_SDA)	**JP27/JP28 2+3**
	18	X_USART1_CTS/PA11 (I2C56_SCL)	**JP28/JP28 2+3**
X7	11	X_USART1_RTS/PA12 (I2C56_SDA)	
	36	X_USART1_CTS/PA11 (I2C56_SCL)	

If needed, **2K pull-ups** can be mounted on the I²C5/I²C6 bus: X_USART1_RTS/PA12 (SDA) with resistor R273 and X_USART1_CTS/PA11 (SCL) with resistor **R274**.

20.2.4 I2C4 and I2C1 Connectivity

To avoid any conflicts when connecting external I²C devices to the phyBOARD-Sargas, the addresses of the onboard I²C devices must be considered. The table below lists the addresses already in use and shows only the default address. The I²C addresses are hexadecimal in an 8-bit representation. In Linux, a 7-bit representation may be used. In this case, the address value must be shifted one digit to the right. The specification refers to the write address (bit 0 = 0), and the read address is increased by 1 according to bit 1 = 1.

TABLE 73: I2C Addresses in Use

Board	Prod. No.	Device	Address used (7 MSB)
I2C4			
phyCORE	PCM-068	RTC (RV-3028-C7)	0x52
		EEPROM (M24C32)	0x50
		PMIC (STPMIC1)	0x33 and 0x58
phyBOARD	PCM-939	CryptoAuthentication Device (ATECC508A)	0x60
I2C1			
phyBOARD	PCM-939	RGB LED (PCA9533/01)	0x62
		Audio Codec (TLV320AIC3007)	0x18
		Resistive Touch driver (STMPE811)	0x44 by default **(J8=2+3)** (or 0x41 with J8=1+2)

Board	Prod. No.	Device	Address used (7 MSB)
AV-Adapter HDMI	PEB-AV-01	HDMI Core (TDA19988)	0x70
		CEC Core (TDA19988)	0x34
AV-Adapter Display (with 7'' EDT Display)	KPEB-AV-02	Touchscreen driver (EDT ft5x06)	0x38

Warning

Additional I2C devices can be added to the I2C1 bus through the different expansion connectors (with PHYTEC expansion boards or custom boards). In this case, all the I2C device addresses must be unique to avoid conflict.

21 Revision History

Changes in this manual	Version #	Changes in this manual
15.06.2020	L-875e.A0	Preliminary Manual Describes the phyCORE-STM32MP15x SOM Version: 1534.1 Describes the phyBOARD-Sargas PCB Version: 1517.2
23.02.2022	L-875e.A1	Re-release
29.07.2022	L-875e.A2	PDF version
25.02.2026	L-875e.A3	Added information about JP4 Updated Power Consumption Information Updated format

22 Contact Information

If you have any questions, design considerations, or are interested in further information, please contact your nearest PHYTEC office.

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