Telegea Smart Hub

Hardware Description

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1 Overview

The *Telegea Smart Hub* is an embedded electronical device. It is powered externally by low voltage. It connects to external sensors and other devices via dedicated interfaces and bus systems. Furthermore it features digital input/output connectors for on/off functions, status/pulse detection and pulse counting. Several connectors are provided to add optional extension modules to extend the devices functionality.

This revision of the document describes the revision R3C0 of the PCB.

Illustration 1 shows the location of the various connectors available on the *Telegea Smart Hub* motherboard. The connectors are described in detail in section 4.

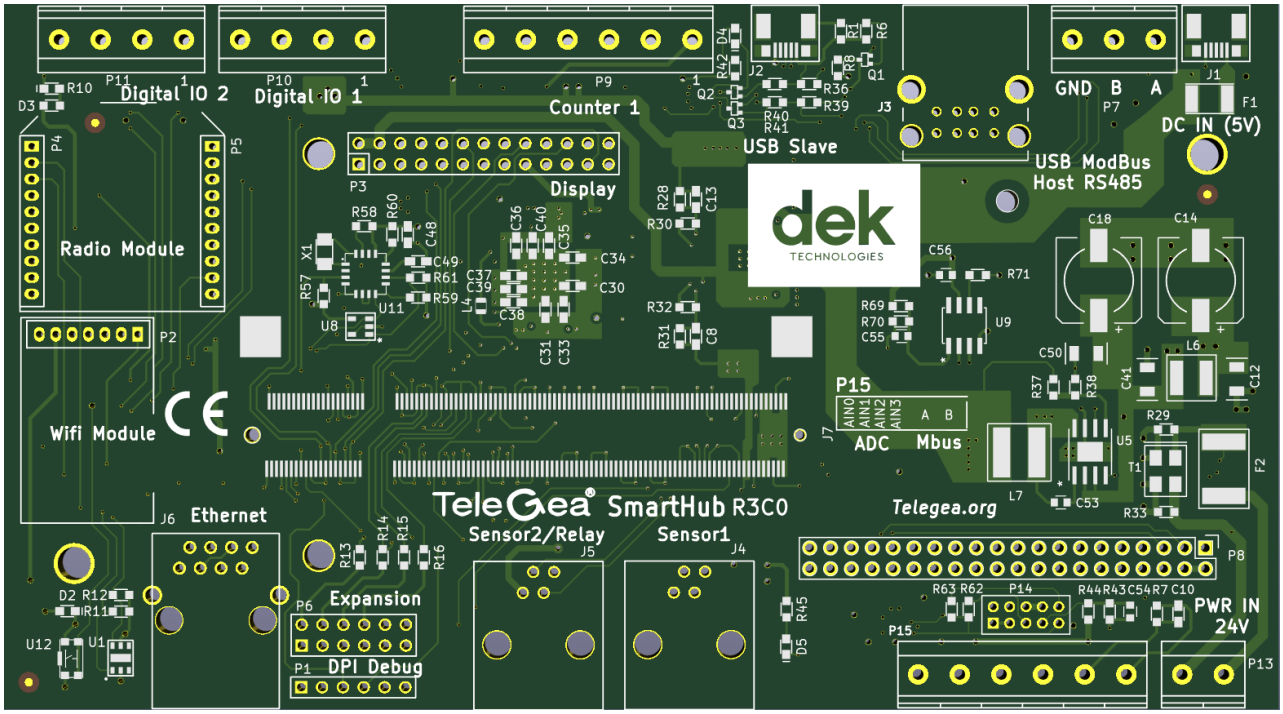


Illustration 1: Location of connectors and sockets on the Telegea Smart Hub motherboard

	Designator	Brief Desciption	Link to Detailed Description
1	P11, Digital IO 2	Screw Terminals for Counters, Status signals and generic digital IO	Section 4.1, Page 6
2	P10, Digital IO 1		
3	P9, Counter 1		
4	J2, USB Slave	USB Socket (Slave/Boot) – for updating device SW	Section 4.2, Page 7
5	J3, USB Host	USB Socket (Host) – for USB devices such as Flash Drives or relay cards	Section 4.3, Page 7
6	P7, RS485	Screw Terminals for Modbus RS485 Interface	Section 4.4, Page 7
7	J1, DC IN	USB Socket – Power Supply only	Section 4.5, Page 8
8	P4 + P5, XBee Module	X-Bee compliant Expansion Socket	Section 4.6, Page 9
9	P3, Display	Connector for LCD Touch Screen	Section 4.7, Page 10
10	P2, Wifi Module	Extension Socket for Wifi Module	Section 4.8, Page 12
11	P12, Compute Module	Socket for Raspberry Pi Compute Module	Section 4.9, Page 12
12	J6, Ethernet	RJ45 Ethernet Socket	Section 4.10, Page 13
13	P1, DPI Debug	Debug Port Interface	Section 4.11, Page 13
14	P6, Expansion	Expansion Socket	Section 4.12, Page 13
15	J5, Sensor2/Relay	Sensor / Relay card Connector (I^2C)	Section 4.13, Page 14
16	J4, Sensor1	Sensor Connector (SPI)	Section 4.14, Page 16
17	P15, ADC / Mbus	Screw Terminals for ADC inputs and M-Bus	Section 4.15, Page 16
18	P13, AC IN	Screw Terminals for AC Power	Section 4.17, Page 19
19	P8	Extension socket for custom modules	Section 4.18, Page 19
20	P14	Jumper block for ADC channel configuration	Section 4.16, Page 17

2 References

[1] USB 2.0 specification
http://www.usb.org/developers/docs/usb20_docs

[2] IEEE 802.3 Ethernet standard
https://standards.ieee.org/about/get/802/802.3.html

[3] PiTFT Plus Assembled 320x240 2.8" TFT + Resistive Touchscreen
https://www.adafruit.com/products/2298

[4] Adafruit PiTFT Plus 320x240 2.8" TFT + Capacitive Touchscreen
https://www.adafruit.com/products/2423

[5] WIFI-2 - OEM WiFi USB module
http://www.acmesystems.it/WIFI-2

[6] RaspberryPi Copmpute Module
https://www.raspberrypi.org/products/compute-module

3 Extension Modules

Extension modules are optional add on cards which extend the devices functionality. They can be plugged into the dedicated motherboards socket if the provided functionality is needed.

The following extension modules are supported:

- XBee shaped communication modules (e.g Bluetooth, Zigbee)
- Wifi module
- Touch screen module
- Custom extension modules (e.g. M-Bus master module)

Warning: Power Consumption of all extension modules (including Display) should not exceed xxx mA

4 Interface Description

4.1 Screw Terminal Block for Digital IO and Counters (Designator P9, P10 and P11)

Illustration 2 shows a detailed view of the Terminal Blocks for connecting Digital Inputs (status signals) and Pulse Counter type inputs such as from flow meters, energy meters, etc. The inputs on this terminal are expected to be open collector/open drain type or dry contacts with pulses being registered if the attached device pulls the signal line to low (GND outputs as supplied on these terminal blocks).

To generate a logic high level when the input is open, the Compute Module internal pull-up resistors on the relevant GPIO pins need to be enabled.

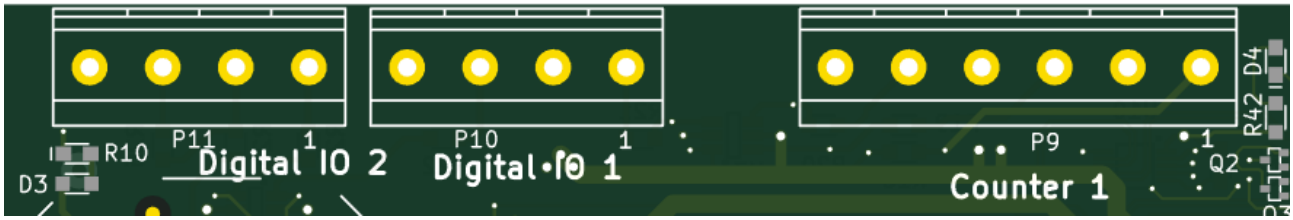


Illustration 2: Detailed View of Counter Terminal

The inputs are ESD protected.

Pin #	Name	Direction	Description
P9-1	COUNT1	Input	Counter Input 1 (GPIO19 of CM)
P9-2	GND	Power Out	0V reference
P9-3	COUNT2	Input	Counter Input 2 (GPIO20 of CM)
P9-4	GND	Power Out	0V reference
P9-5	COUNT3	Input	Counter Input 3 (GPIO21 of CM)
P9-6	GND	Power Out	0V reference
P10-1	STATUS1	Input	Status Input 1 (GPIO26 of CM)
P10-2	GND	Power Out	0V reference
P10-3	STATUS2	Input	Status Input 2 (GPIO27 of CM)
P10-4	GND	Power Out	0V reference
P11-1	RESERVED1	Input/Output	Generic Inputs/Outputs (GPIO12 of CM)
P11-2	1-WIRE	Input/Output	Generic Inputs/Outputs (GPIO13 of CM) with 4.7KOhm pullup
P11-3	3.3V	Power Out	
P11-4	GND	Power Out	0V reference

Table 1: Counter Screw Terminal Pin Description

Symbol	Parameter	Conditions		Min	Typ	Max	Units
V_{in}	Input Signal Voltage	Typically these inputs should be left floating if not used or the signal is inactive.		0	--	3.3	V
V_{ESD}	ESD Protection − Peak Discharge Voltage at any Input			8	--	--	kV

Table 2: Ratings for Digital IO and Counter Screw Terminals

4.2 Micro USB Socket (Designator J2)

Note: This connector is not mounted on PCB revision R3C0.

This connector is a standard USB slave socket (Micro-B) and this interface conforms to the standard USB specifications [1] .

4.3 USB Socket (Host) (Designator J3)

This connector is a standard 2 port USB host socket (Type-A) and this interface conforms to the standard USB specifications [1].

4.4 Screw Terminal Block for RS485 Connection (Designator P7)

Illustration 3 shows a detailed view of the Terminal Block for connecting Modbus slave devices. This interface provides serial communication connectivity according to the RS485 standard.

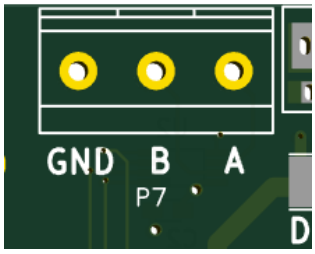


Illustration 3: Detailed View of Modbus Terminal

Pin #	Name	Direction	Description
1	A	Bidirectional	Data + signal
2	B	Bidirectional	Data - signal
3	GND	Power Out	0V reference

Table 3: Modbus Terminal Pin Description

Symbol	Parameter	Min	Typ	Max	Units
V_I	Voltage range at A or B Inputs	-13		16.5	V
V_{IH}	High-level input voltage (Driver, driver enable, and receiver enable inputs)	2		Vcc	V
V_{IL}	Low-level input voltage (Driver, driver enable, and receiver enable inputs)	0		0.8	V
V_{ID}	Differential input voltage	-12		12	V
I_O	Output current, Driver	-60		60	mA
I_O	Output current, Receiver	-8		8	mA

Table 4: RS485 Terminal Ratings

4.5 USB Socket (for Power Supply only) (Designator J1)

Note: This connector is not mounted on PCB revision R3C0.

This socket can be used to provide 5V DC to the system.

Warning: Only one method of power supply shall be used, either 24V AC/DC via connector P13 or 5V DC via this connector.

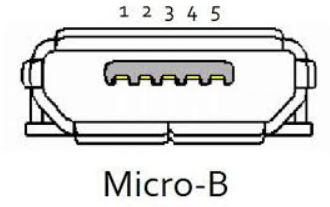


Illustration 4: Micro USB-B socket Pinout (Power Supply)

Pin #	Name	Direction	Description
1	+5V	Power In	
2	n/a	--	Not used
3		--	
4		--	
5	GND	Power In	

Table 5: USB Power Supply Pin Description

Symbol	Parameter	Conditions		Min	Typ	Max	Units
I_{pwr_DC}	Current Consumption			?		2000	mA
							V
							mA

Table 6: Ratings for USB Power Supply Connector

Warning: The actual current draw is somewhat dependant on extension modules that are being connected as well as the programming of the Raspberry Compute Module. Care has to be taken that the overall current consumption does not exceed 2A.

4.6 XBee compatible Expansion Socket (Designator P4/P5)

Illustration 5 shows a detailed view of the headers if the XBee compatible expansion socket. These headers are designed to accommodate an XBee shaped communication module e.g. Bluetooth, Zigbee.

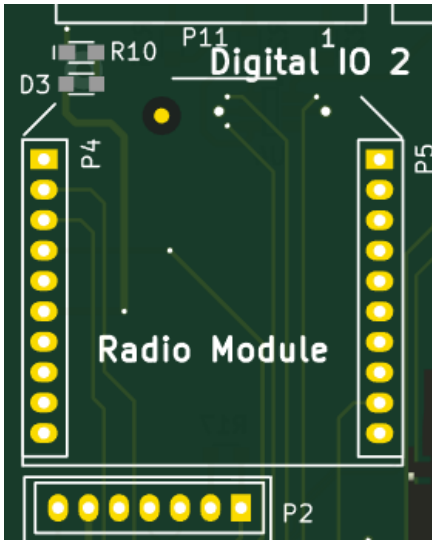


Illustration 5: Detailed View of X-Bee compatible Expansion Socket

Pin #	Name	Direction	Description
P4-1	3V3	Power out	3.3V Power supply for module
P4-2	TX	Output	RS232 transmit line (shared with debug port P1)
P4-3	RX	Input	RS232 receive line (shared with debug port P1)
P4-4	RTS	Output	RS232 RTS line
P4-5	N.C	--	Not connected
P4-6	HBEAT	Input	Heartbeat signal from module connected to on-board led
P4-7	N.C	--	Not connected
P4-8	N.C	--	Not connected
P4-9	N.C	--	Not connected
P4-10	GND	Power Out	0V reference
P5-1	N.C	--	Not connected
P5-2	N.C	--	Not connected
P5-3	N.C	--	Not connected
P5-4	N.C	--	Not connected
P5-5	N.C	--	Not connected
P5-6	N.C	--	Not connected
P5-7	N.C	--	Not connected
P5-8	N.C	--	Not connected
P5-9	CTS	Output	RS232 CTS line
P5-10	N.C	--	Not connected

Table 7: XBee compatible expansion headers Pin Description

4.7 Display Connector (Designator P3)

Illustration 6 shows a detailed view of the display connector. This connector is designed to accommodate the Adafruit 2.8'' PiTFT TFT + Touchscreen module (resistive and capacitive) for Raspberry Pi 2 ([3] and [4]) but is not limited to this. Other RaspberryPi compatible add-on cards can be connected. It is mainly compatible with the standard Raspberry Pi GPIO header.

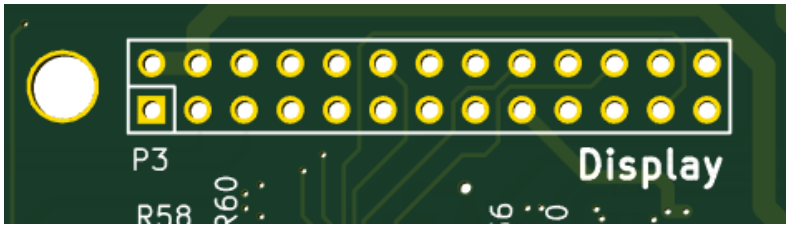


Illustration 6: Detailed View of Display Connector

Pin #	Name	Direction	Description
1	+3V3	Power Output	3.3V supply voltage for use by Display
2	+5V	Power Output	5V supply voltage for use by Display
3	LCD_TP_SDA1	Bidirectional	GPIO2 of CM
4	+5V	Power Output	5V supply voltage for use by Display
5	LCD_TP_SCL1	Output	GPIO3 of CM
6	GND	Power Output	0V Reference
7	N.C	--	Not connected
8	RS232_TXD1	Output	RS232 transmit line (shared with debug port P1 and P4)
9	GND	Power Output	0V Reference
10	RS232_RXD1	Intput	RS232 receive line (shared with debug port P1 and P4)
11	N.C	--	Not connected
12	LCD_LITE	Output	GPIO18 of CM
13	N.C	--	Not connected
14	GND	Power Output	0V Reference
15	N.C	--	Not connected
16	N.C	--	Not connected
17	+3V3	Power Output	3.3V supply voltage for use by Display
18	LCD_TP_IRQ	Input	GPIO24 of CM
19	LCD_SPI0_MOSI	Output	GPIO10 of CM
20	GND	Power Output	0V Reference
21	LCD_SPI0_MISO	Input	GPIO9 of CM
22	LCD_DC		GPIO25 of CM
23	LCD_SPI0_SCLK	Output	GPIO11 of CM
24	LCD_SPI0_CE0N	Output	GPIO8 of CM
25	GND	Power Output	0V Reference
26	LCD_SPI0_CE1N	Output	GPIO7 of CM

Table 8: Display Connector Pin Description

4.8 Extension Header for Wifi module (Designator P2)

Illustration 7 shows a detailed view of the extension header for Wifi module [5]. This header carries the signals of a USB port plus additiona controls and is designed for the Wifi extension module.

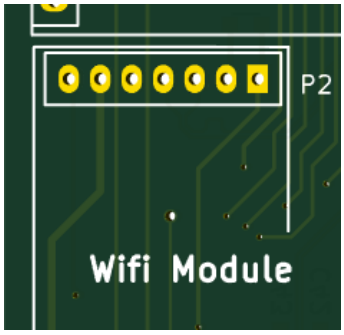


Illustration 7: Detailed View of Wifi module Expansion Socket

Pin #	Name	Direction	Description
1	WIFI_TX_EN	Output	Switch radio on/off
2	3V3	Power Output	3.3V supply voltage for use by Wifi module
3	USB_N	Bidiretional	Connectet to on-board USB hub host port
4	USB_P	Bidiretional	Connectet to on-board USB hub host port
5	GND	Power Output	0V Reference
6	LED	Input	
7	WIFI_WPS_EN	Output	Activate WPS function

Table 9: Wifi Header Pin Description

4.9 SO-DIMM Socket for Raspberry Pi Compute Module (Designator J11)

Illustration 8 shows a detailed view of the socket for the Raspberry Pi Compute Module [6]. This module contains the system CPU and the flash memory. It is necessary for the system to work and is always mounted on the motherboard. Both Compute Module 1 and 3 can be used in this socket.

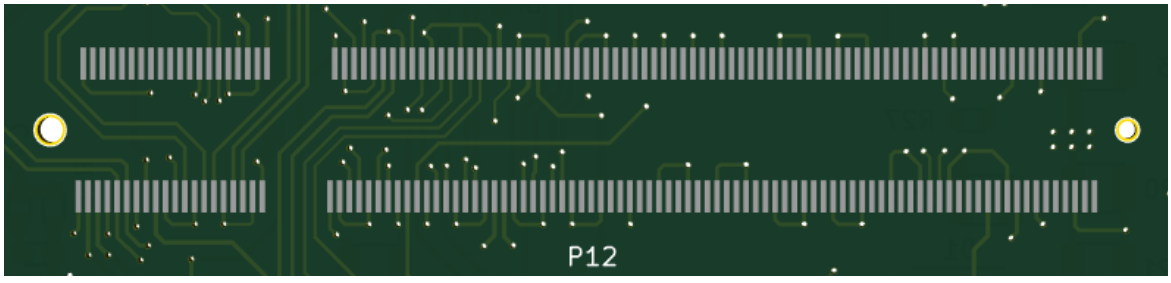


Illustration 8: Detailed View of Raspberry Pi Compute Module Socket

Warning: *The Raspberry Compute Module comes in a form factor commonly used for Computer Memory Modules. The pin assignment of memory modules is however different and as such memory modules shall not be inserted into this socket.*
Likewise there are other SoM's out there that use the SO-DIMM form-factor. There is currently no standard covering the use of this form-factor for SoM's and as such any other SoM than the Raspberry Compute Module is most likely not compatible with this motherboard.

4.10 Ethernet Socket (Designator J6)

This connector is a standard 8P8C (RJ45) Ethernet socket and this interface conforms to the standard Ethernet specifications [2] .

4.11 Debug Port Header (Designator P1)

Illustration 9 shows a detailed view of the debug port header. This header is designed for the debug module extension DPI and carries RS232 serial line singals.

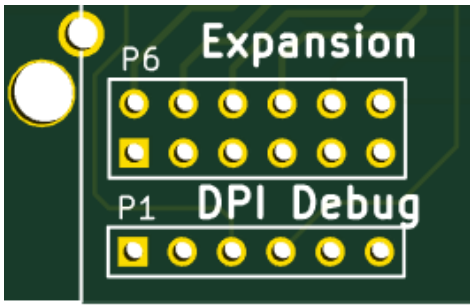


Illustration 9: Detailed View of the Generic Expansion and Debug Port Headers

Pin #	Name	Direction	Description
1	3V3	Power Output	3.3V supply voltage for use by Wifi module
2	N.C	--	Not connected
3	RXD1	Input	RS232 receive line (shared with Xbee expansion socket P4 and P3)
4	TXD1	Output	RS232 transmit line (shared with Xbee expansion socket P4 and P3)
5	N.C	--	Not connected
6	GND	Power Output	0V Reference

Table 10: Debug Port Header Pin Description

4.12 Generic Expansion Header (Designator P6)

This header is designed as generic expansion for Input/Output signals (see Illustration 9).

Pin #	Name	Direction	Description
1	+3V3	Power Out	Provides +3.3V (with reference to GND available on Pins 5,7,9 and 11 on this header)
2	EXP_GPIO01	Programmable	GPIO40 of CM
3	+3V3	Power Out	Provides +3.3V (with reference to GND available on Pins 5,7,9 and 11 on this header)
4	EXP_GPIO02	Programmable	GPIO34 of CM
5	GND	Power Out	
6	EXP_GPIO03	Programmable	GPIO35 of CM
7	GND	Power Out	
8	EXP_GPIO04	Programmable	GPIO41 of CM
9	GND	Power Out	
10	RUN		
11	GND	Power Out	
12	GPIO47_CTL_1V8		

Table 11: Generic Expansion Header Description

Symbol	Parameter	Conditions		Min	Typ	Max	Units
I_{+3V3}	Current Draw from +3.3V supply	--	--	0	--	?	mA
U_{+3V3}	Output Voltage Level +3.3V			?	3.3	?	V
U_{EXP_GPIOx}	GPIO Input Voltage	--	--	0		?	V

Table 12: Ratings for Expansion Header P6

4.13 Sensor2/Relay (I^2C)(Designator J5)

Illustration 10 shows a detailed view of the Sensor connectors. These connectors are standard 6P4C (RJ14) sockets. They are used to connect both Dallas 1-Wire bus temperature sensors and DHT22 (1-wire) or SHT21 (I2C, 2-wire) temperature and humidity sensors.

On this connector SHT sensors can work in native I2C mode and GPIO mode. DHT22 sensors can only work in GPIO mode.

Furthermore the EMO-R8 relay cards can be controlled via the I2C bus on this connector.

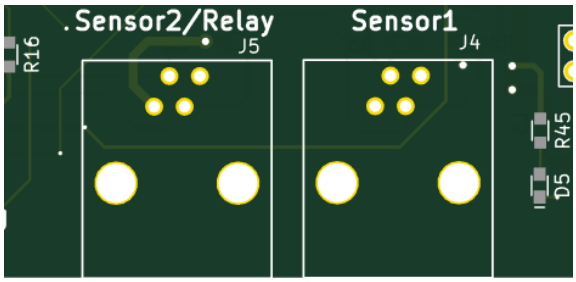


Illustration 10: Detailed View of the Sensor Connector sockets

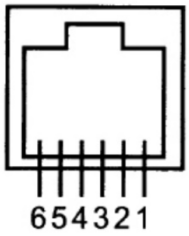


Illustration 11: Front View of the Sensor Connector socket

Pin #	Name	Direction	Description
1	N.C	--	Not connected
2	3V3	Power Output	3.3V supply voltage for external sensors
3	I2C_SDA1	Bidirectional	I2C data signal or Generic IO with 10K pullup
4	I2C_SCL1	Output	I2C clock signal with 10K pullup
5	GND	Power Output	0V Reference
6	N.C	--	Not connected

Table 13: Sensor Connector1 Pin Description

4.14 Sensor Connector 1 (SPI) (Designator J4)

Note: This connector is not mounted on PCB revision R3C0.

Same as chapter 4.13

On this connector SHT sensors can work only in GPIO mode. DHT22 sensors can work in SPI mode and GPIO mode.

Pin #	Name	Direction	Description
1	N.C	--	Not connected
2	3V3	Power Output	3.3V supply voltage for external sensors
3	SPI0_MOSI	Output	SPI Master Out Slave In signal with 10K pullup
4	SPI0_MISO	Input	SPI Master In Slave Out signal or Generic IO with 10K pullup
5	GND	Power Output	0V Reference
6	N.C	--	Not connected

Table 14: Sensor Connector1 Pin Description

4.15 Screw Terminal Block for ADC inputs and M-Bus (Designator P15)

Illustration 12 shows a detailed view of the screw terminal block for ADC inputs and M-Bus.

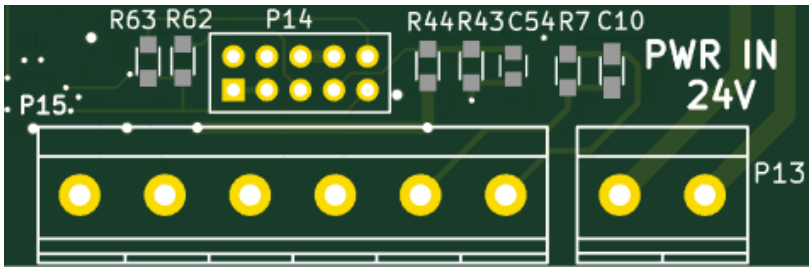


Illustration 12: Detailed View of the Terminal Block for ADC inputs and M-Bus

Pin #	Name	Direction	Description
1	AIN0	Input	Analog input signal to ADC channel 0
2	AIN1	Input	Analog input signal to ADC channel 1
3	AIN2	Input	Analog input signal to ADC channel 2
4	AIN3	Input	Analog input signal to ADC channel 3
5	MbusA	Bidirectional	M-Bus serial connection A (if M-Bus add-on module is connected))
6	MbusB	Bidirectional	M-Bus serial connection B (if M-Bus add-on module is connected) Connected to GND

Table 15: Terminal Block for ADC inputs and M-Bus Pin Description

4.16 Jumper block for ADC channel configuration (Designator P14)

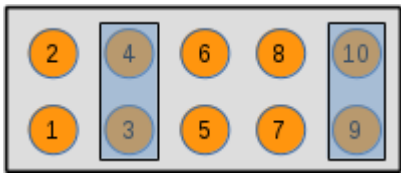
The Telegea Smart Hub provides different operating modes for the analog inputs. While inputs AIN1 and AIN2 are directly connected to the ADC channels 0 and 1, the inputs AIN3 and AIN4 as well as the signal on the PWR IN terminals can be configured for AC voltage measurements. The desired operating mode can be selected with the jumpers of the P14 header.

External input mode

This mode is used to connect the external analog input signals on terminals AIN1-AIN4 directly to the ADC chip. The inputs can be used both in single and differential mode.

Input	Description	ADC channel
AIN1	External input (+/-2.048V)	chan 0
AIN2	External input (+/-2.048V)	chan 1
AIN3	External input (+/-2.048V)	chan 2
AIN4	External input (+/-2.048V)	chan 3

Use the following jumper settings on P14 header:

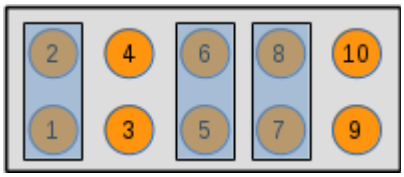


Internal input mode

In this mode the SmartHubs power supply signal can be measured without external connections. This is done by connecting the AC power supply signal from the PWR IN connector via a differential amplifier circuit internally to the ADC channel 2. Alternatively the AC power signal can be connected to the AIN3/4 terminals which is routed to the ADC channel 3 after scaling and adding a voltage bias.

Input	Description	ADC channel
AIN1	External input (+/-2.048V)	chan 0
AIN2	External input (+/-2.048V)	chan 1
AIN3	External AC input 1 (24Vac)	chan 3
AIN4	External AC input 2 (24Vac)	chan 3
PWR1	AC Power 1	chan 2
PWR2	AC Power 2	chan 2

Use the following jumper settings on P14 header:



4.17 Screw Terminal Block for DC Power (Designator P13)

Pin #	Name	Direction	Description
1	24V	Input	AC power inputs
2	24V	Input	

Table 16: AC Power Connector Description

Symbol	Parameter	Conditions		Min	Typ	Max	Units
V_{IN}	Supply Voltage (AC)	--	--	9	24	30	V (AC)

Table 17: AC Power Ratings

4.18 Extension socket for custom modules (Designator P8)

Illustration 13 shows a detailed view of the Extension socket for custom modules (add ons). These custom modules are developed to add specific interfaces like e.g. an M-Bus master interface.

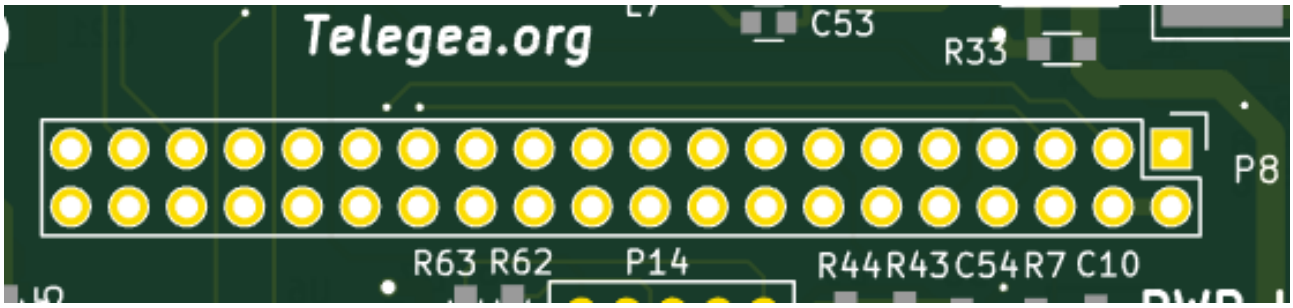


Illustration 13: Detailed View of the Extension socket for custom modules

Pin #	Name	Direction	Description
1	N.C.	--	Not connected
2	VCC5	Power Output	5V supply voltage for add-on module
3	I2C_SDA	Bidirectional	I2C data
4	VCC5	Power Output	5V supply voltage for add-on module
5	I2C_SCL	Output	I2C clock
6	GND	Power Output	0V Reference
7	N.C.	--	Not connected
8	USB_N	Bidirectional	USB data line for add-on module
9	GND	Power Output	0V Reference
10	USB_P	Bidirectional	USB data line for add-on module
11	N.C.	--	Not connected
12	N.C.	--	Not connected
13	MBUS_A	Bidirectional	M-Bus data line from M-Bus add-on module
14	GND	Power Output	0V Reference
15	N.C.	--	Not connected
16	N.C.	--	Not connected
17	N.C.	--	Not connected
18	N.C.	--	Not connected
19	SPI_MOSI	--	SPI MOSI data
20	GND	Power Output	0V Reference
21	SPI_MISO.	--	SPI MISO data
22	N.C.	--	Not connected
23	SPI_CLK	--	SPI clock
24	SPI_CE0	--	SPI chip enable 0
25	GND	Power Output	0V Reference
26	SPI_CE1	--	SPI chip enable 1
27	N.C.	--	Not connected
28	N.C.	--	Not connected
29	MBUS_STS	Input	M-Bus status signal from M-Bus add-on module
30	GND	Power Output	0V Reference
31	N.C.	--	Not connected
32	N.C.	--	Not connected
33	N.C.	--	Not connected
34	GND	Power Output	0V Reference
35	GPIO39	--	GPIO39 of CM
36	MBUS_PWREN	Output	M-Bus power enable signal to M-Bus add-on module
37	GPIO43	--	GPIO43 of CM
38	GPIO34	--	GPIO34 of CM
39	GND	Power Output	0V Reference
40	GPIO40	--	GPIO40 of CM

Table 18: Extension socket for custom modules Pin Description

5 Integrated components

5.1 I²C bus

The following components are connected to the I²C-1 bus of the Compute Module.

I²C address	Component
0x48	A/D converter (ADS1015)
0x50	EEPROM (AT24C02D)
0x69	Real Time Clock (CBC34803)

Table 19: I2C bus connections

The I²C-0 bus is connected to the Sensor2/Relay connector where external components can be connected.

5.2 Serial ports

The following components are connected to the serial ports.

Port	Component
UART0 (AMA0)	RS485 converter (SN65HVD72D)
UART1 (S0)	X-Bee module / DPI debug port / P3 (shared)

Table 20: Serial port connections

Note: RS485 direction control is done via RTS0 signal (GPIO17).

5.3 Sensors

The following sensors are integrated on-board.

Connection	Component
GPIO44/GPIO45	Temperature/Humidity sensor (SHT21)

Table 21: Sensor connections

5.4 User interface

The following user interface components are integrated on-board.

Connection	Component
GPIO36	Push button (connects to GND)
ACT led	Yellow led

Table 22: Sensor connections