INDUSTRIAL SHIELDS

RASPBERRY PLC FAMILY

RASPBERRY PLC FAMILY

RASPBERRY PLC FAMILY Quick User Guide

Revised, October 2020

Preface

This User Guide is been implemented by Boot & Work, S.L. working under the name Industrial Shields.

Purpose of the manual

The information contained in this manual can be used as a reference to operate and get a better understanding of the technical data of the signal modules, power supply modules and interface modules.

Intended Audience

This User Guide is intended for the following audience:

- Persons in charge of introducing automation devices.
- Persons who design automation systems.
- Persons who install or connect automation devices.
- Persons who manage working automation installation.

Warnings:

- Unused pins should not be connected. Ignoring the directive may damage the controller.
- Before using this product, it is the responsibility of the user to read the product's User Guide and all accompanying documentation.
- Industrial Shields PLCs must be powered between 12Vdc and 24Vdc. If a higher voltage is supplied to the equipment can suffer irreversible damage.
- Maintenance must be performed by qualified personnel familiarized with the construction, operation, and hazards involved with the control.
- Maintenance should be performed with the control out of operation and disconnected from all sources of power.
- The Industrial Shields Family PLCs are Open Type Controllers. It is required that you install the Raspberry PLC in a housing, cabinet, or electric control room. Entry to the housing, cabinet, or electric control room should be limited to authorized personnel.
- Inside the housting, cabinet or electric control room, the Industrial Shields PLC must be at a minimum distance from the rest of the components of a minimum of 25 cm, it can be severely damaged.
- Failure to follow these installation requirements could result in severe personal injury and/or property damage. Always follow these requirements when installing Raspberry family PLCs.

- In case of installation or maintenance of the PLC please follow the instructions marked in the Installation and Maintenance section on the User Guide.
- Do not disconnect equipment when a flammable or combustible atmosphere is present.
- Disconnection of equipment when a flammable or combustible atmosphere is present may cause a fire or explosion which could result in death, serious injury and/or property damage.
- Inside the encapsulated, there are supercapacitors if 25F which can be dangerous. Be careful with them.

Table of Contents

INDUSTRIAL SHIELDS

1 General Description RASPBERRY PLC FAMILY Product

1.1 Reference Table

Reference Table				
Model	RAM Memory			Accessory
	2GB RAM	4GB RAM	8GB RAM	with FAN
PLC Raspberry General Family				
Raspberry PLC Ethernet CPU (Raspberry Pi 4B 2GB RAM Included + 8GB pSLC SIM W/Linux)	012002000400	012003000000	012004000000	xxxxxxxxxxxF
Raspberry PLC Ethernet 21 I/Os Analog/Digital PLUS (Raspberry Pi 4B 2GB RAM Included + 8GB pSLC SIM W/Linux)	012002000600	012003000200	012004000200	xxxxxxxxxxxF
Raspberry PLC Ethernet 42 I/Os Analog/Digital PLUS (Raspberry Pi 4B 2GB RAM Included + 8GB pSLC SIM W/Linux)	012002000100	012003000400	012004000400	xxxxxxxxxxxF
Raspberry PLC Ethernet 58 I/Os Analog/Digital PLUS (Raspberry Pi 4B 2GB RAM Included + 8GB pSLC SIM W/Linux)	012002000300	012003000600	012004000600	xxxxxxxxxxxF
Raspberry PLC Ethernet 19R I/Os Analog/Digital PLUS (Raspberry Pi 4B 2GB RAM Included + 8GB pSLC SIM W/Linux)	012002000500	012003000100	012004000100	xxxxxxxxxxxF
Raspberry PLC Ethernet 38R I/Os Analog/Digital PLUS (Raspberry Pi 4B 2GB RAM Included + 8GB pSLC SIM W/Linux)	012002000700	012003000300	012004000300	xxxxxxxxxxxF
Raspberry PLC Ethernet 57R I/Os Analog/Digital PLUS (Raspberry Pi 4B 2GB RAM Included + 8GB pSLC SIM W/Linux)	012002000800	012003000500	012004000500	xxxxxxxxxxxF
Raspberry PLC Ethernet 38AR I/Os Analog/Digital PLUS (Raspberry Pi 4B 2GB RAM Included + 8GB pSLC SIM W/Linux)	012002000900	012003000700	012004000700	xxxxxxxxxxxF
Raspberry PLC Ethernet 53ARR I/Os Analog/Digital PLUS (Raspberry Pi 4B 2GB RAM Included + 8GB pSLC SIM W/Linux)	012002001000	012003000800	012004000800	xxxxxxxxxxxF
Raspberry PLC Ethernet 57AAR I/Os Analog/Digital PLUS (Raspberry Pi 4B 2GB RAM Included + 8GB pSLC SIM W/Linux)	012002001100	012003000900	012004000900	xxxxxxxxxxxF
Raspberry PLC Ethernet 54ARA I/Os Analog/Digital PLUS (Raspberry Pi 4B 2GB RAM Included + 8GB pSLC SIM W/Linux)	012002001100	012003001000	012004001000	xxxxxxxxxxxF
Raspberry PLC Ethernet 50RRA I/Os Analog/Digital PLUS (Raspberry Pi 4B 2GB RAM Included + 8GB pSLC SIM W/Linux)	012002000000	012003001100	012004001100	xxxxxxxxxxxF
PLC Raspberry GPRS Family				
Raspberry PLC Ethernet & GPRS (Raspberry Pi 4B 2GB RAM Included + 8GB pSLC SIM W/Linux)	016002000000	016003000000	016004000000	xxxxxxxxxxxF
Raspberry PLC & GPRS 21 I/Os Analog/Digital PLUS (Raspberry Pi 4B 2GB RAM Included + 8GB pSLC SIM W/Linux)	016002000200	016003000200	016004000200	xxxxxxxxxxxF
Raspberry PLC & GPRS 42 I/Os Analog/Digital PLUS (Raspberry Pi 4B 2GB RAM Included + 8GB pSLC SIM W/Linux)	016002000400	016003000400	016004000400	xxxxxxxxxxxF
Raspberry PLC & GPRS 58 I/Os Analog/Digital PLUS (Raspberry Pi 4B 2GB RAM Included + 8GB pSLC SIM W/Linux)	016002000600	016003000600	016004000600	xxxxxxxxxxxF
Raspberry PLC & GPRS 19R I/Os Analog/Digital PLUS (Raspberry Pi 4B 2GB RAM Included + 8GB pSLC SIM W/Linux)	016002000100	016003000100	016004000100	xxxxxxxxxxxF
Raspberry PLC & GPRS 38R I/Os Analog/Digital PLUS (Raspberry Pi 4B 2GB RAM Included + 8GB pSLC SIM W/Linux)	016002000300	016003000300	016004000300	xxxxxxxxxxxF
Raspberry PLC & GPRS 57R I/Os Analog/Digital PLUS (Raspberry Pi 4B 2GB RAM Included + 8GB pSLC SIM W/Linux)	016002000500	016003000500	016004000500	xxxxxxxxxxxF
Raspberry PLC & GPRS 38AR I/Os Analog/Digital PLUS (Raspberry Pi 4B 2GB RAM Included + 8GB pSLC SIM W/Linux)	016002000700	016003000700	016004000700	xxxxxxxxxxxF
Raspberry PLC & GPRS 53ARR I/Os Analog/Digital PLUS (Raspberry Pi 4B 2GB RAM Included + 8GB pSLC SIM W/Linux)	016002000800	016003000800	016004000800	xxxxxxxxxxxF
Raspberry PLC & GPRS 57AAR I/Os Analog/Digital PLUS (Raspberry Pi 4B 2GB RAM Included + 8GB pSLC SIM W/Linux)	016002000900	016003000900	016004000900	xxxxxxxxxxxF
Raspberry PLC & GPRS 54ARA I/Os Analog/Digital PLUS (Raspberry Pi 4B 2GB RAM Included + 8GB pSLC SIM W/Linux)	016002001000	016003001000	016004001000	xxxxxxxxxxxF
Raspberry PLC & GPRS 50RRA I/Os Analog/Digital PLUS (Raspberry Pi 4B 2GB RAM Included + 8GB pSLC SIM W/Linux)	016002001100	016003001100	016004001100	xxxxxxxxxxxF

1.2 Zones Table

	Zones Table			
Model	**Zone 0**	**Zone A**	**Zone B**	**Zone C**
Raspberry PLC Ethernet CPU	☑	-	-	-
Raspberry PLC 21+	☑	Analog / Digital	-	-
Raspberry PLC 42+	☑	Analog / Digital	Analog / Digital	-
Raspberry PLC 58+	☑	Analog / Digital	Analog / Digital	Analog / Digital
Raspberry PLC 19R	☑	Relay	-	-
Raspberry PLC 38R	☑	Relay	Relay	-
Raspberry PLC 57R	☑	Relay	Relay	Relay
Raspberry PLC 38AR	☑	Analog / Digital	Relay	-
Raspberry PLC 53ARR	☑	Analog / Digital	Relay	Relay
Raspberry PLC 57AAR	☑	Analog / Digital	Analog / Digital	Relay
Raspberry PLC 54ARA	☑	Analog / Digital	Relay	Analog / Digital
Raspberry PLC 50RRA	☑	Relay	Relay	Analog / Digital

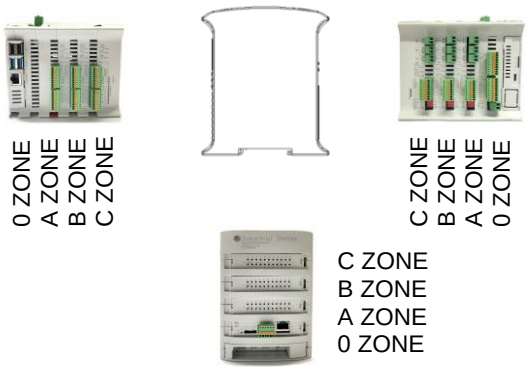
1.3 Measures Table

	Measures Table			
Model	**Height (mm)**	**Width (mm)**	**Depth (mm)**	**Weight (g)**
Raspberry PLC Ethernet CPU	119.5	70.1	101	373
Raspberry PLC 21+	119.5	94.7	101	490
Raspberry PLC 42+	119.5	119.3	101	598
Raspberry PLC 58+	119.5	143.9	101	710.5
Raspberry PLC 19R	119.5	94.7	101	490
Raspberry PLC 38R	119.5	119.3	101	598
Raspberry PLC 57R	119.5	143.9	101	710.5
Raspberry PLC 38AR	119.5	119.3	101	598
Raspberry PLC 53ARR	119.5	143.9	101	710.5
Raspberry PLC 57AAR	119.5	143.9	101	710.5
Raspberry PLC 54ARA	119.5	143.9	101	710.5
Raspberry PLC 50RRA	119.5	143.9	101	710.5

1.4 Zone - Nomenclature

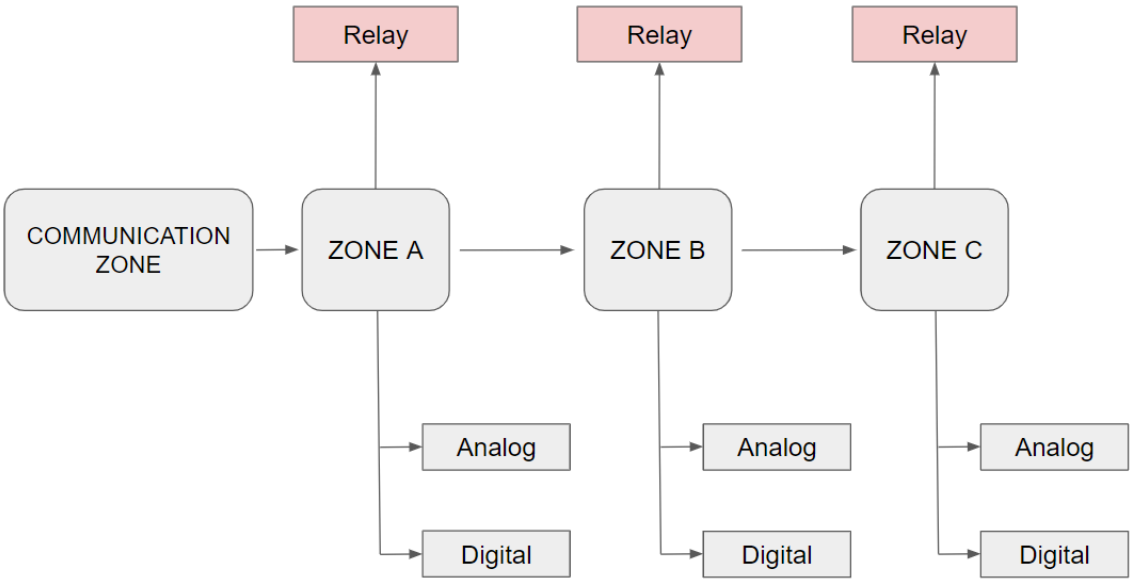
The nomenclature shown in this point will be used in the whole User Guide, so it is important to understand this nomenclature.

The nomenclature to differentiate the zones is based on Alphanumeric values, being 0 the internal communication shield and A, B or C the I/Os or Relay shield.



- The inputs in the zone A/B/C are named IX.X, being X any number suitable in the Shield. Outputs are named as QX.X.

1.5 Zone Distribution



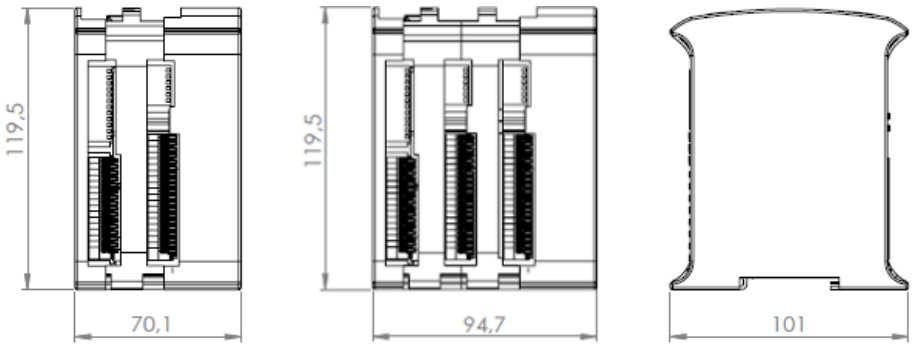
This is the possible zones scheme, whether the zone is Analog/Digital or Relay depends on your device, you can consult it on the Zones Table. The distribution of the different features that provide the Raspberry PLC Family are described below.

1.6 Zone Features

Shield	Zone Characteristics
Communication Shield	(2x) Ethernet (4x) USB (1x) I2C (1x) TTL (2x) HALF Duplex RS-485 (1x) SPI external Port (1x) RTC (1x) Bluetooth (1x) Wi-Fi (1x) µSD Socket (1X) CAN (x1) µHDMI
Analog Shield	13 Inputs: 8 Digital Outputs, 3 of which can work as Analog Output 8 Outputs: 13 Digital inputs, 6 of which can work as Analog Input
Relay Shield	6 Inputs: 6 Digital Inputs, 4 of which can work as Analog Input 11 Outputs: 8 Relay Outputs 3 Digital Outputs, 3 of which can work as Analog Output

1.7 Mechanical dimension

These are the possible mechanical dimensions, you can consult the specific measures for your device on the measures table.



1.8 General Features

CONECTABLE PLC RASPBERRY 24 VCC		
MODEL TYPE	**Controller General Specifications**	**Information**
Input Voltage	12 to 24 Vdc	Fuse Protection (2.5 A) Polarity protection
I max.	1.5 A	
Size	Consult the Measure Table section	
Clock Speed	1.5 GHz	
Flash Memory	-	
SRAM	2 - 4 - 8 GB	
Communications	I2C – Ethernet (x2) – USB (x4) – (x2) RS485 – SPI – WiFi – Bluetooth - Serial TTL – CAN - µSD - RTC	MAX485 – W5500
Digital GPIO25 (3.3 V)	3.3 V ⎓	
An/Dig Input 10bit (0-10Vcc)	0 to 10Vac Rated Voltage: 10Vac 5 to 24Vdc I min: 2 to 12 mA Galvanic Isolation Rated Voltage: 24 Vdc ⎓	
Digital Isolated Input (24Vcc)	5 to 24Vdc I min: 2 to 12 mA Galvanic Isolation Rated Voltage: 24 Vdc ⎓	
*** Interrupt isolated Input HS** (24Vcc)	5 to 24Vdc I min: 2 to 12 mA Galvanic Isolation Rated Voltage: 24Vdc ⎓	
Analog Output 8 bits (0 - 10 Vcc)	0 to 10 Vdc I max: 20 mA Separated PCB Ground ⎓	
Digital Isolated Output (24 Vcc)	5 to 24 Vdc I max: 70 mA Galvanic Isolation Diode Protected for Relay ⎓	I max 24 Vdc: 410 mA
Relay Output (220 Vac)	24 VDC / 220 VAC I max: 5 A Galvanic Isolation Diode Protected for Relay ⎓	

PWM Isolated Output 8 bits (24 Vcc)	5 to 24 Vdc I max: 70 mA Galvanic Isolation Diode Protected for Relay ⎓	
Expandability	I2C: 127 elements – Serial Port RS485	
*** By using this type of signal can no longer use Digital signal (24Vdc)**		

2 Technical Specifications:

2.1 General Specifications:

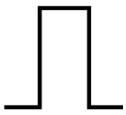
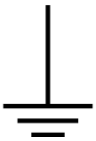
Item		RASPBERRY PLC ETHERNET 58 I/Os PLUS
Power supply voltage	**DC power supply**	12 to 24Vdc ⎓
Operating voltage range	**DC power supply**	11.4 to 25.4Vdc ⎓
Power consumption	**DC power supply**	30 W max.
External power supply	**Power supply voltage**	24 Vdc ⎓
	Power supply output capacity	700 Ma
Insulation resistance		20MΩ min.at 500Vdc between the AC terminals and the protective earth terminal.
Dielectric strength		2.300 VAC at 50/60 Hz for one minute with a leakage current of 10mA max. Between all the external AC terminals and the protective ground terminal.
Shock resistance		80m/s^2 in the X, Y and Z direction 2 times each.
Ambient temperature (operating)		0º to 50ºC with Raspberry OS Lite / 0º to 40º with Raspberry OS Desktop
Ambient humidity (operating)		10% to 90% (no condensation)
Ambient environment (operating)		With no corrosive gas
Ambient temperature (storage)		-20º to 60ºC
Power supply holding time		2ms min.
Weight		Consult the Measure Table section

2.2 Performance Specification:

Raspberry Board	**Raspberry Pi 4**
I/O control method	Combination of the cyclic scan and immediate refresh processing methods.
Programming language	Linux applications : Python, C++, etc.
Program capacity (SRAM)	2 – 4 - 8 GB
EEPROM	4 MB/512 KB
Clock Speed	1.5 GHz
CPU	Broadcom BCM2711, Quad core Cortex-A72 (ARM v8) 64-bit SoC @ 1.5GHz

2.3 Symbology

Table that includes all the symbology that is used in the serigraph of the RASPBERRY PLC FAMILY:

Symbol	Standard No. / Standard Title	Standard Reference No. / Symbol Title	Symbol Meaning
	IEC 60417 / Graphical symbols for use on equipment	5031 / Direct Current	Indicates that the equipment is suitable for direct current only; to identify relevant terminals
	IEC 60417 / Graphical symbols for use on equipment	5032 / Alternating Current	Indicates that the equipment is suitable for alternating current only; to identify relevant terminals
	IEC 60417 / Graphical symbols for use on equipment	5130 / Pulse General	To identify the control by which a pulse is started.
	IEC 60417 / Graphical symbols for use on equipment	5017 / Earth, Ground	To identify an earth (ground) terminal in cases where neither the symbol 5018 nor 5019 is explicitly required.
	IEC 60417 / Graphical symbols for use on equipment	5115 / Signal lamp	To identify the switch by means of which the signal lamp(s) is (are) switched on or off.
	Medical Devices Directive 93/42/EEC	CE Marking	CE marking indicates that a product complies with applicable European Union regulations

	ISO 7000/ Graphical symbols for use on equipment	0434B / Warning symbol	Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury
	ISO 7000/ Graphical symbols for use on equipment	5036 / Dangerous Voltage	To indicate hazards arising from dangerous voltages

3 Precautions

Read this manual before attempting to use the RASPBERRY PLC FAMILY and follow its descriptions for reference during operation.

3.1 Raspberry Board

The RASPBERRY PLC FAMILY includes a Raspberry Pi 4 Board as controller.

3.2 Intended Audience

This manual is intended for technicians, which must have knowledge on electrical systems.

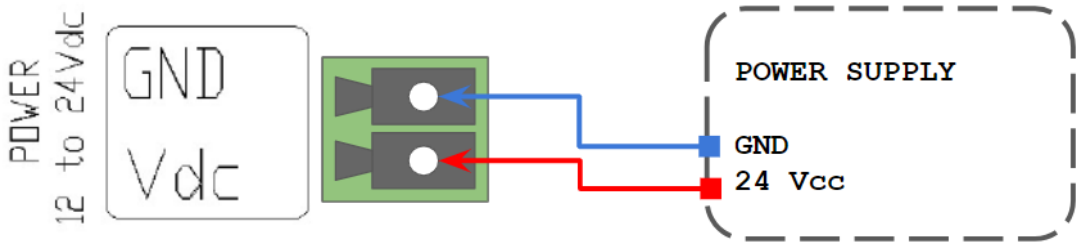
3.3 General Precautions

The user must operate Raspberry PLC according to the performance specifications described in this manual.

Before using the RASPBERRY PLC FAMILY under different conditions from what has been specified in this manual or integrating into nuclear control systems, railroad systems, aviation systems, vehicles, combustion systems, medical equipment, amusement machines, safety equipment and other systems, machines, and equipment that may have a serious influence on lives and property if used improperly, consult your INDUSTRIAL SHIELDS representative. Ensure that the rating and performance characteristics of the Raspberry PLC are sufficient for the systems, machines, and equipment, and be sure to provide the systems, machines, and equipment double safety mechanisms. This manual provides information for programming and operating the Raspberry PLC.

4 How to connect PLC to power supply

- Raspberry PI Family PLCs are 12-24Vdc supplied. IMPORTANT: The polarity **IS NOT REVERSAL!**
- Make sure that the live and GND connector of the power supply match the PLC.
- Make sure that the power supply mains output is not higher than 24Vdc.



- Suggested power suppliers

Compact DIN rail power supply. Assembled on 35mm DIN Rail:
- 24Vdc
- 10A
- 240W

Industrial Shields power supplies provide parallel operation, overvoltage protection, and overcurrent protection. There is a LED inductor for power status, the power supply is certified according to UL.

The standard, Part 1 of IEC 61010, sets the general safety requirements for the following types of electrical devices and their accessories, regardless of where use of the device is intended.

The equipment must be powered from an external power source in accordance with IEC 61010-1, whose output is MBTS and is limited in power according to section 9.4 of IEC 61010-1.

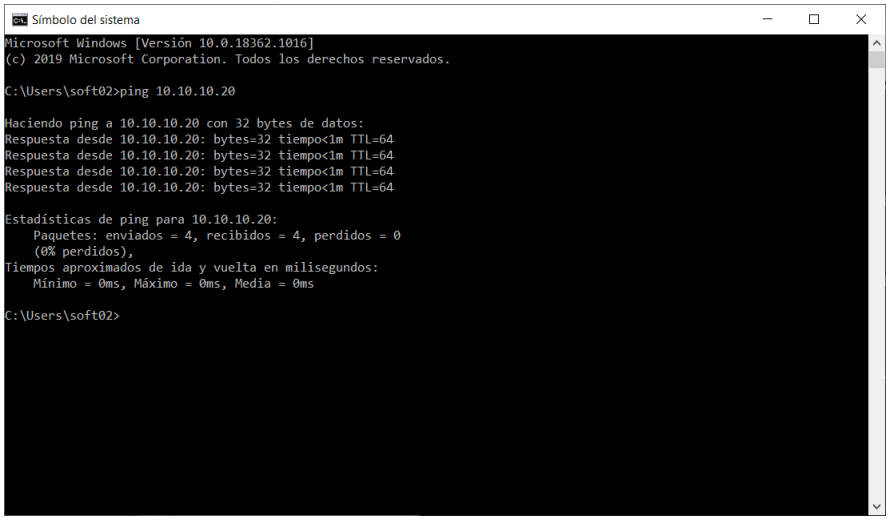
Warning:

Once the equipment is installed inside an electrical cabinet, the MTBS cables of the equipment must be separated from the dangerous voltage cables.

5 How to access to the Raspberry PLC

5.1 Raspberry PLC access

To facilitate the connection to the Raspberry PLC, our company has set a default IP for it. For the first time of use, an Ethernet connection between the Raspberry PLC and a PC will be necessary. The Raspberry is given with the local IP address **10.10.10.20/24**, the default user is **pi** and the password is **raspberry**. For connecting to it, you must change your local address for being in the same local network as the Raspberry. After the first connection you can add users or change each user's password anytime. In order to know if the Raspberry is connected and the Ethernet connection is going on, a ***ping*** command can be run on the terminal (for windows users enter ***cnm*** in the windows searching tab to open it):



The steps to follow for both Linux and Windows are explained below:

5.1.1 Linux

In order to access the Raspberry PLC, Linux users have to enter by SSH protocol, which should have been installed before by the user. As has been said, the Raspberry is given with a local IP address by default for making an easier path for the customer. So, first of all we have to check if our local **Ethernet Network** is set with the same local IP address as our raspberrian device. In case that you do not know how to set it, check the section 6 of the guide. As have been mentioned before, you can use the ***ping*** command with the address 10.10.10.20 as option:

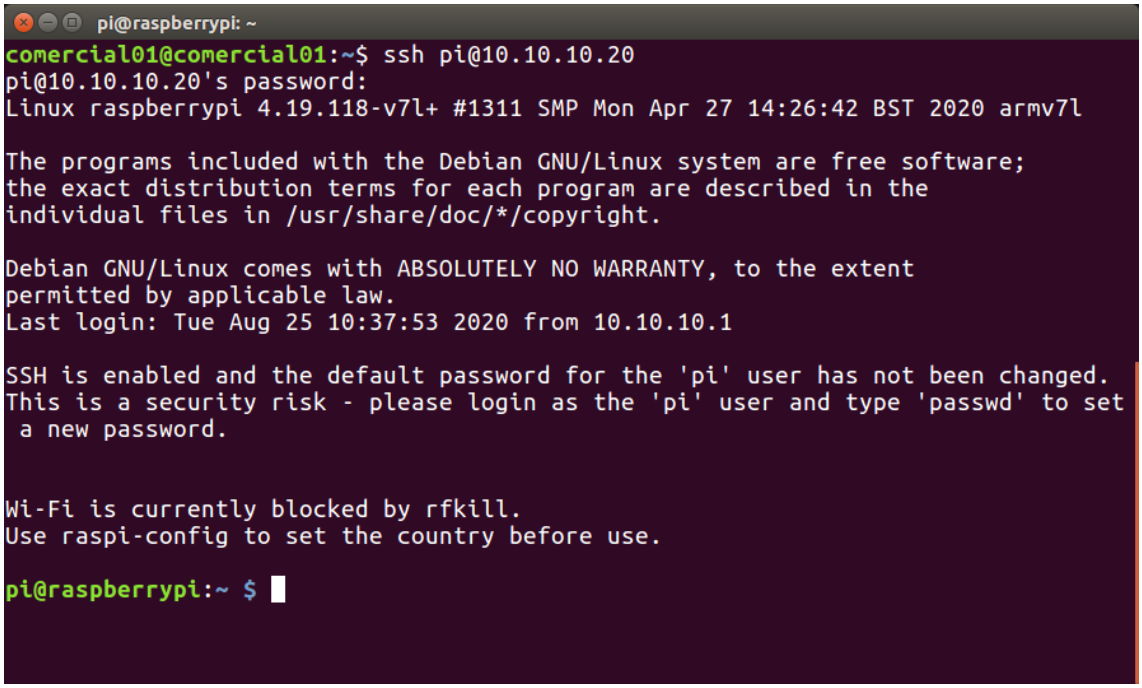
```
$ping 10.10.10.20
```

If the ping works successfully means that our connection is ready. If not you can check section 6 again or read our blog about changing the local IP.

For accessing to the Raspberry PLC we will run the command ***ssh*** shown below:

```
$ssh pi@10.10.10.20
```

The connection will start, but first the password provided before will be required. If the username and password are correct, you can start the SSH session.



When an SSH connection is made for the first time, the server delivers the server's public key to the SSH client. The system will alert you to this and offer you the option of accepting the key or rejecting it. You have to accept the key, as it will be stored in the register and will be used to contrast it with the one sent by the server on each connection. If for some reason the key changes, a new notice is generated in which the authenticity of the received key will be raised, since someone could be posing as the server to which we want to connect.

Once connected, will be a full access to the Raspberry PLC and the user will be able to control it and set the functions needed. Also new users or the password could be changed as the device IP. The commands for going through the Raspberry are the same as the Linux terminal. The most useful are the following:

- cd: to navigate through the Linux files and directories.
- ls: is used to view the contents of a directory.
- cat: it is used to list the contents of a file on the standard output.
- mkdir: use mkdir command to make a new directory
- rm: is used to delete directories and the contents within them.
- touch: allows you to create a blank new file.

In order to logout and closing the connection, just type ***exit*** in the Raspberry terminal.

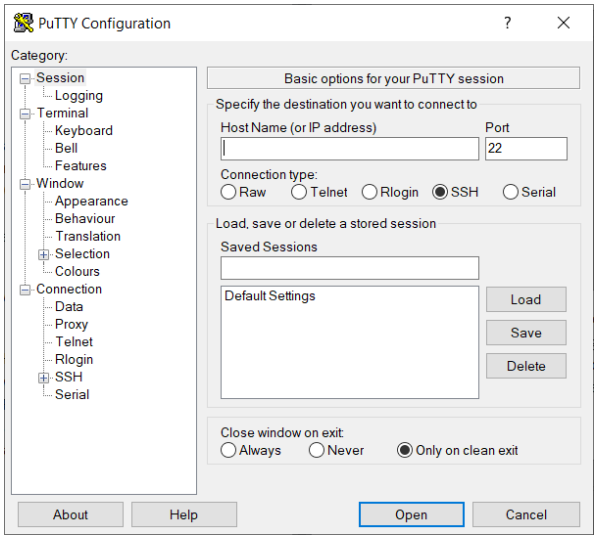
5.1.2 Windows

For the Windows users, we recommend using the open-source terminal emulator PuTTy ssh client. The latest release of PuTTY can be downloaded from the official web which contains download links for the latest released version of PuTTY.

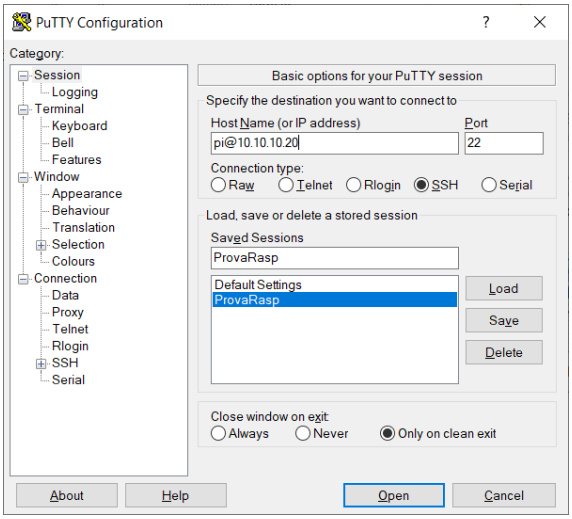
https://www.chiark.greenend.org.uk/~sgtatham/putty/latest.html

For connecting to it, you must change your local address for being in the same local network as the Raspberry. You can use the ***ping*** command with the address 10.10.10.20 as option in the windows terminal. The windows terminal can be found typing ***cnm*** on the windows search bar.

After having installed PuTTY run the program and the following window should be opened. If it is not the same, click on the top left corner the option ***Session.***



For setting up PuTTY the Raspberry IP must be entered on the ***HostName*** field and make sure that the port 22 is being used and the ***SSH*** option is selected on the ***Connection Type***. After all the settings have been done, click on the ***Open*** button to run the program. For a faster start in subsequent sessions, before run the program, enter a name on ***Saved Sessions*** and click on the ***Save*** button (a double click on the named configuration will execute the program with the saved configurations).



When you start the connection, the terminal window will be opened. Enter your username ***pi*** and press *Enter*, then enter your password ***raspberry***. If the username and password are correct, you can start the SSH session.

When an SSH connection is made for the first time, the server delivers the server's public key to the SSH client. PuTTy will alert you to this and offer you the option of accepting the key or rejecting it. You have to accept the key, as it will be stored in the register and will be used to contrast it with the one sent by the server on each connection. If for some reason the key changes, PuTTy will generate a new notice in which the authenticity of the received key will be raised, since someone could be posing as the server to which we want to connect.

Once connected, will be a full access to the Raspberry PLC and the user will be able to control it and set the functions needed. Also new users or the password could be changed as the device IP. The commands for going through the Raspberry are the same as the Linux terminal. The most useful are the following:

- cd: to navigate through the Linux files and directories.
- ls: is used to view the contents of a directory.
- cat: it is used to list the contents of a file on the standard output.
- mkdir: use mkdir command to make a new directory
- rm: is used to delete directories and the contents within them.
- touch: allows you to create a blank new file.

For closing the connection, just type ***exit*** in the Raspberry terminal.

6 How to change the IP

To access to the Raspberry PLC, the PLC must be on the same local network as the computer which we are working with. For changing the IP we must have connected our PC to an Ethernet connection. By default, the computers are given an IP address of the 192.xxx.xxx.xxx or 172.xxx.xxx.xxx type but will be necessary to change it to the 10.10.10.xxx as the PLC. As we will work with an Ethernet interface, the WiFi interface IP must not be changed.

6.1 Linux

For changing the IP is not necessary to know the actual one that we have, but it is essential to know the interface name on we are working. For knowing it, we will run a ***ip*** command with the option ***a***.

```
$ip a
```

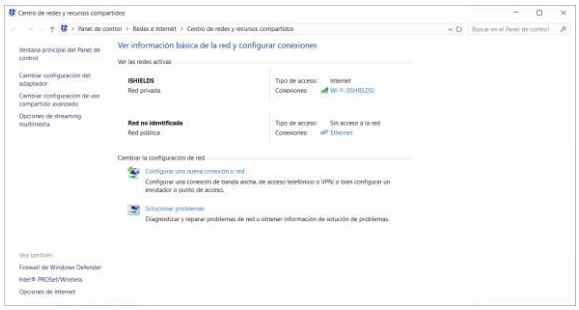
All the PC's interfaces will be shown and we will have to look for the one named ***enp*** as will be the Ethernet one. In order to change it, we will use the "**ifconfig**" program, install if not by default in the system. To change your IP address on Linux, use the "ifconfig" command followed by the name of your network interface and the new IP address to be changed on your computer. This command have to be call being administrator, to be able to perform the command below, we need to use su or sudo command.

```
$sudo ifconfig <interface_name> 10.10.10.1 netmask 255.255.255.0
```

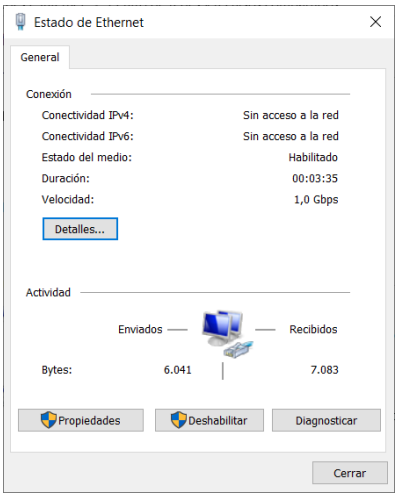
Now the IP should be changed. In order to check it, run again the ***ip a*** command. If not, repeat the process or check out our website's blog about changing the IP addresses.

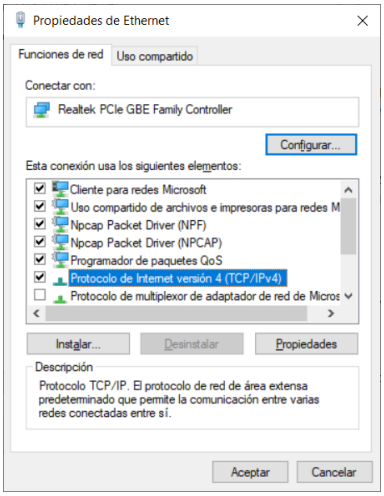
6.2 Windows

The first step is to open the Control Panel. The quickest way to get to it is by clicking on Start and typing it. In the Control Panel, you can click on the ***Network and Internet*** category and then click on ***Network and Sharing Center***. If you are in icon view, just click directly on ***Network and Sharing Center***. An Ethernet connection must be shown, if not make sure that the Ethernet wire is connected to the Raspberry PLC.

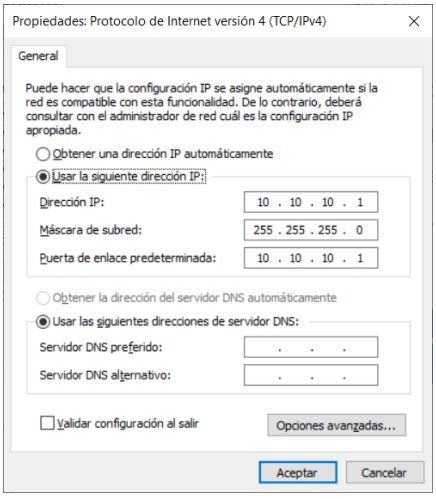


Then we must click on the Ethernet connection and a window about the state of it will be shown, where we can check all the details of the Ethernet connection. For changing the IP click on the ***Properties*** button. Then search for ***Internet Protocol Version 4 (TCP/IPv4)*** and click again on the ***Properties*** button.





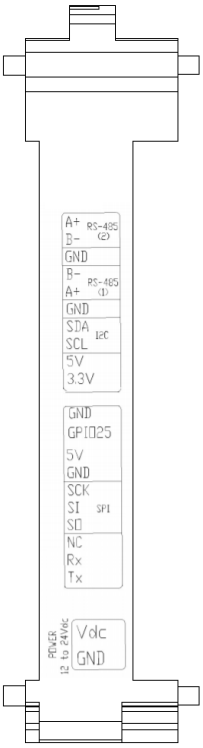
Finally, a window will be displayed where we will be able to change the IP address. Choose the second option and enter the following IP as the following image. Then choose ***Accept*** button and in the ***Proprieties of Ethernet*** also. Finally close the window and the IP will have been changed. In order to check it, click on the network details or run the ***ipconfig*** on the Windows terminal. If not, repeat the process or check out our website's blog about changing the IP addresses.



7 Raspberry PLC Family Pinout

7.1 0 Zone connection (Communications)

Base (common unit)		
0 Zone		
PLC Connector	*Raspberry Pin*	Function
A+	-	RS485(2)
B-	-	RS485(2)
GND	-	GND
B-	-	RS485(1)
A+	-	RS485(2)
GND	-	GND
SDA	*GPIO2*	I2C
SCL	*GPIO3*	I2C
5V	-	Power Supply
3.3V	-	Power Supply
GND	-	GND
GPIO25	*GPIO25*	RASPBERRY Pin
5V	-	Power Supply
GND	-	GND
SCK	*GPIO11*	SPI/SS
SI	*GPIO10*	SPI/SS
SO	*GPIO9*	SPI/SS
NC	-	Not Connected
RX	*GPIO15*	RX
TX	*GPIO14*	TX
Vdc	-	Power Supply
GND	-	GND



Communication Pins

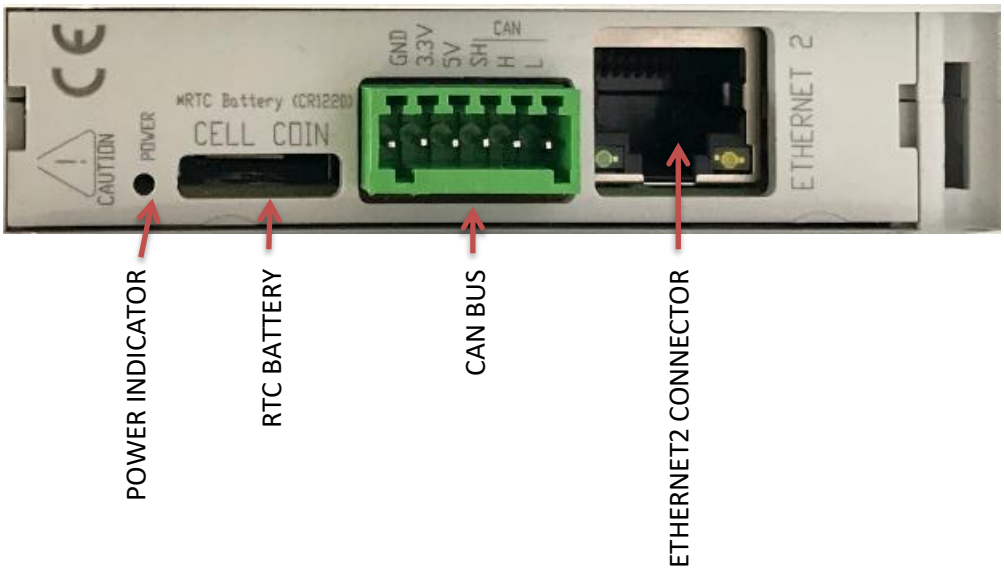
Power supply connectors (24Vdc – GND)

SS: Chip Select pins. These pins can act as TTL, so they can work for the Chip Select pin of any device.

Right Side

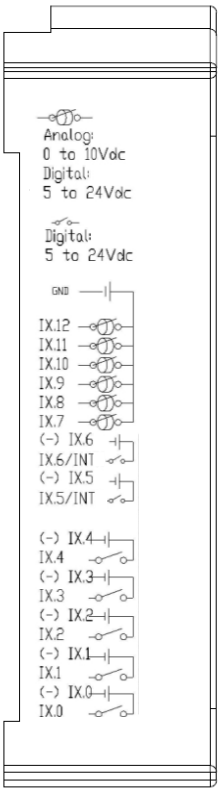
Upper Side

Left Side



7.1 Analog/Digital Zone connection (I/Os)

X Zone	
Raspberry PLC Connector	Function
IX.12	Analog / Digital In
IX.11	Analog / Digital In
IX.10	Analog / Digital In
IX.9	Analog / Digita In
IX.8	Analog / Digital In
IX.7	Analog / Digital In
(-)IX.6	GND I0.6
IX.6/INT[1]	Interrupt X In
(-)IX.5	GND I0.5
IX.5/INT[1]	Interrupt X In
(-)IX.4	GND I0.4
IX.4	Digital Input
(-)IX.3	GND I0.3
IX.3	Digital Input
(-)IX.2	GND I0.2
IX.2	Digital Input
(-)IX.1	GND I0.1
IX.1	Digital Input
(-)IX.0	GND I0.0
IX.0	Digital Input



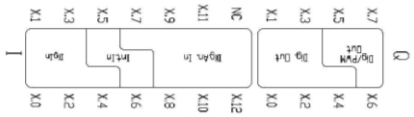
Analog / Digital Inputs

Digital / Interrupt Inputs (isolated)

Digital Inputs (isolated)

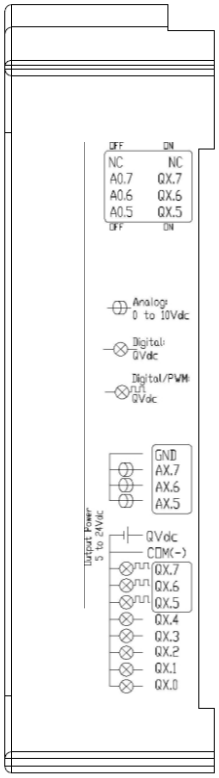
[1] See the Interrupt Equivalence Table in Section 7.4

Top Zone



Led indicator I/Os state

X Zone	
Raspberry PLC Connector	Function
GND	GND
AX.7[2]	Analog Out
AX.6[2]	Analog Out
AX.5[2]	Analog Out
Q/Vdc	External Isolated Out Vdc
COM(-)	External Isolated Out GND
QX.7[2]	Digital/PWM Out
QX.6[2]	Digital/PWM Out
QX.5[2]	Digital/PWM Out
QX.4	Digital Out
QX.3	Digital Out
QX.2	Digital Out
QX.1	Digital Out
QX.0	Digital Out



Configuration Switch
(See Section 8 to select the correct configuration for outputs)

Analog Outputs

Voltage Supply/Reference for

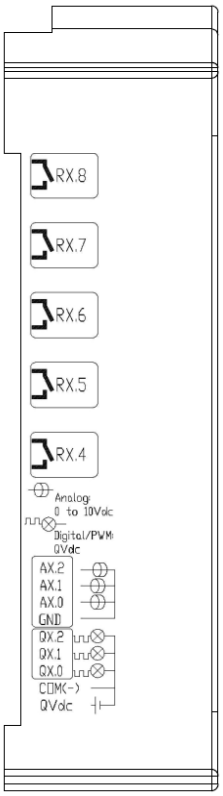
Digital/PWM Outputs (isolated)

Digital Outputs

[2] See Section 8 to select the correct configuration for outputs.

7.2 Relay Zone connection (I/Os)

X Zone	
M-Duino Connector	**Function**
RX.8	Relay Out
RX.7	Relay Out
RX.6	Relay Out
RX.5	Relay Out
RX.4	Relay Out
AX.2[3]	Analog Out
AX.1[3]	Analog Out
AX.0[3]	Analog Out
GND	GND
QX.2[3]	Digital/PWM Out
QX.1[3]	Digital/PWM Out
QX.0[3]	Digital/PWM Out
GNDCOM	External Isolated Out GND
24VCOM	External Isolated Out Vdc

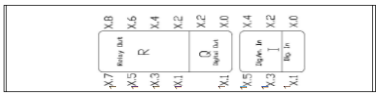


Relay Outputs

Analog Outputs

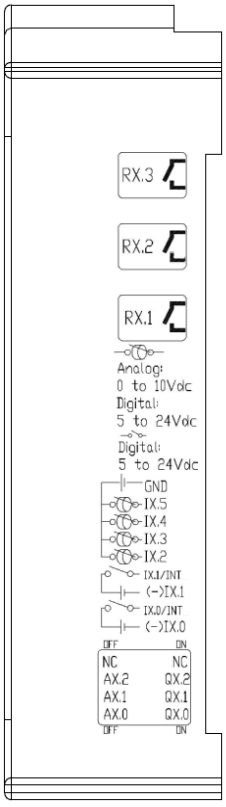
PWM/Digital Outputs

Top Zone



Led indicator I/Os state

C Zone	
M-Duino Connector	**Function**
RX.3	Relay Out
RX.2	Relay Out
RX.1	Relay Out
GND	GND
IX.5	Analog/Digital Input
IX.4	Analog/Digital Input
IX.3	Analog/Digital Input
IX.2	Analog/Digital Input
IX.1/INT[4]	Interrupt X In
(-)IX.1	GND I0.1
IX.0/INT[4]	Interrupt X In
(-)IX.0	GND I0.0



Relay Outputs

Analog Inputs

Interrupts/Digital Inputs (Isolated)

Configuration Switch
(See Section 8 to select the correct configuration for outputs)

[3] See Section 8 to select the correct configuration for outputs.
[4] See the Interrupt Equivalence Table in Section 7.4

7.3 Interrupt equivalence table

See the Reference Table in order to know the specific device details.

ZONE	ANALOG/DIGITAL	RELAY	RASPBERRY PIN
A	0.5	0.0	GPIO13
	0.6	0.1	GPIO12
B	1.5	1.0	GPIO27
	1.6	1.1	GPIO4
C	2.5	2.0	GPIO17
	2.6	2.1	GPIO16

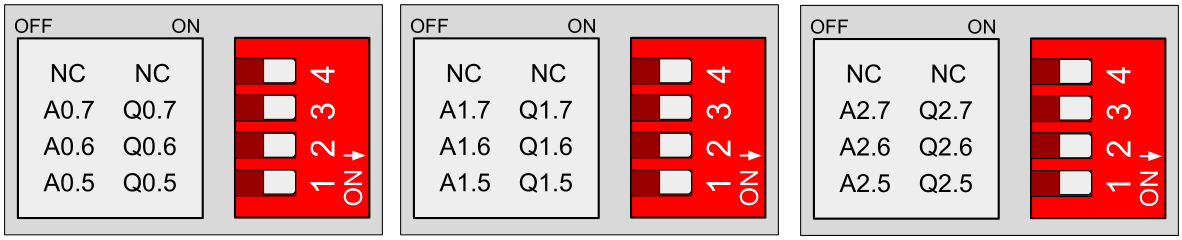
8 Switch Configuration

8.1 Analog / Digital Zone

ZONE A		
SWITCH	ON	OFF
NC	-	-
Q0.7	Q0.7	A0.7
Q0.6	Q0.6	A0.6
Q0.5	Q0.5	A0.5

ZONE B		
SWITCH	ON	OFF
NC	-	-
Q1.7	Q1.7	A1.7
Q1.6	Q1.6	A1.6
Q1.5	Q1.5	A1.5

ZONE C		
SWITCH	ON	OFF
NC	-	-
Q2.7	Q2.7	A2.7
Q2.6	Q2.6	A2.6
Q2.5	Q2.5	A2.5

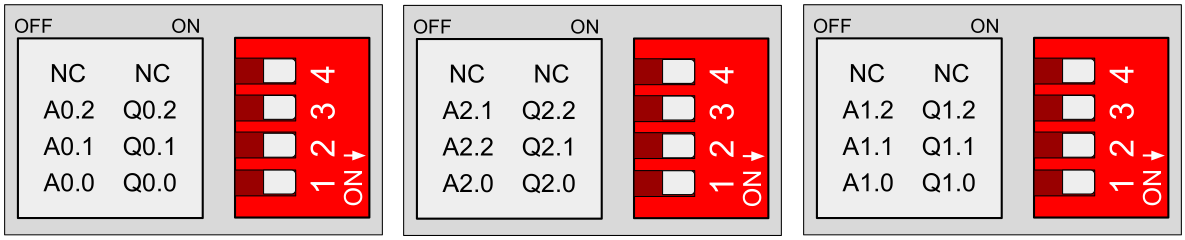


8.1 Relay Zone

ZONE A		
SWITCH	ON	OFF
NC	-	-
Q0.2	Q0.2	A0.2
Q0.1	Q0.1	A0.1
Q0.0	Q0.0	A0.0

ZONE B		
SWITCH	ON	OFF
NC	-	-
Q1.2	Q1.2	A1.2
Q1.1	Q1.1	A1.1
Q1.0	Q1.0	A1.0

ZONE C		
SWITCH	ON	OFF
NC	-	-
Q2.2	Q2.2	A2.2
Q2.1	Q2.1	A2.1
Q2.0	Q2.0	A2.0



For the Analog Shield if a switch is set to ON, it can only act as Digital Output. If it is set to OFF it can only act as an Analog Output.

If it is desired to use a Digital Output the pin must be set to ON and the pin that will provide this digital output is represented with QX.X, being X any number of the tables above.

If it is desired to use an Analog Output the pin must be set to OFF and the pin that will provide this analog output is represented with AX.X, being X any number of the tables above.

9 I/O RASPBERRY PLC 3.3V pins

The RASPBERRY PLC FAMILY has some of the Raspberry PI 4 board pins available. These pins can be programmed according to Raspberry features such as I/O's operating at 3.3V or any additional features present in the pins (for example I2C communication in pins SCL and SDA). As these pins are directly connected to the Raspberry PI 4 board, they are not as well protected as the normal inputs. These pins are mainly meant to be used as prototyping.

The Raspberry board available pins are summarized in the table below. In order to access to these pins some extra considerations must be taken in consideration.

PLC terminal	Raspberry pin
TX	GPIO 14
RX	GPIO 15
MISO 0	GPIO 9
MOSI 0	GPIO 10
SCLK 0	GPIO 11
GPIO25	GPIO 25

***IMPORTANT:** Do not connect the terminals in the chart above to voltages higher than 3.3V. These terminals provide direct access to the Raspberry board.

There are some special conditions depending on these 3.3V. Now it is going to be shown the considerations to operate with these pins.

9.1 Serial – RX/TX

The Serial protocol can work also as a 3.3V pin. These pins should be used only in case that all the 3.3V pins are already performing a function. If using both interfaces at the same time the Raspberry board will get blocked.

These pins are not established with a pull-up or a pull-down configuration by default. The Arduino board allows the pins to be set in a pull-up configuration. Otherwise, an external pull-up or pull-down circuit could be set.

9.2 SPI0 – MISO/MOSI/SCK

These pins can only work as a 3.3V pins if the RS-485 protocol is not going to be used. As the RS-485 protocol uses the SPI to communicate with the Raspberry board, both behaviours cannot happen at the same time as the RS-485 would not work.

These pins are not established with a pull-up or a pull-down configuration by default. The Raspberry board allows the pins to be set either in a pull-up or pull-down configuration. Otherwise, an external pull-up or pull-down circuit could be set.

9.3 GPIO25

GPIO25 is a Raspberry PI 4 GPIO pin that can be set as an input or output. It does not have any default function, so it can be configured without any restrictions. The pin is powered at 3.3 volts; a higher voltage might be dangerous for the device.

This pin is not established with a pull-up or a pull-down configuration by default. If the pin has to be used, it might require a pull-up or pull-down configuration for prevention. The Raspberry Pi 4 allows the pin to be set in both configurations; however, it can be set an external pull-up or pull-down circuit in order to correctly work with this pin.

10 Equivalence Table

10.1 Pin-Out

Raspberry Pinout	PLC Pinout
NC	-
GPIO2	SDA
GPIO3	SCL
GPIO4	INT31
GND	-
GPIO17	INT30
GPIO27	INT20
GPIO22	IRQ SPI 485
NC	-
GPIO10	MOSI 0
GPIO9	MISO 0
GPIO11	SCLK 0
GND	-
GPIO 0	-
GPIO5	IRQ SPI CAN
GPIO6	IRQ SPI ETH
GPIO13	INT10
GPIO19	MISO 1
GPIO26	FAN CONTROL
GND	-

Raspberry Pinout	PLC Pinout
5V	-
5V	-
GND	-
GPIO14	TX
GPIO15	RX
GPIO18	INT21
GND	-
GPIO23	UPS CONTROL FROM RASPI
GPIO24	UPS CONTROL TO RASPI
GND	-
GPIO25	GPIO25
GPIO8	CS SPI0 CAN
GPIO7	CS SPI0 ETH
GPIO1	-
GND	-
GPIO12	INT11
GND	-
GPIO16	CS SPI1 485
GPIO 20	MOSI 1
GPIO21	SCLK 1

10.1.1 Analog/Digital Devices Analog I/Os

Analog Inputs		
PLC Pinout	**Chip ADDR**	**Chip INDEX**
Zone A		
I0.7	0x4a	0
I0.8	0x4a	1
I0.9	0x4b	0
I0.10	0x48	2
I0.11	0x48	0
I0.12	0x48	1
Zone B		
I1.7	0x49	0
I1.8	0x4a	3
I1.9	0x4b	2
I1.10	0x4b	3
I1.11	0x4a	2
I1.12	0x49	1
Zone C		
I2.7	0x49	3
I2.8	0x49	2
I2.9	0x48	3
I2.10	0x4b	1

Analog Outputs		
PLC Pinout	**Chip ADDR**	**Chip INDEX**
Zone A		
A0.5	0x40	10
A0.6	0x40	1
A0.7	0x40	0
Zone B		
A1.5	0x40	3
A1.6	0x40	5
A1.7	0x40	8
Zone C		
A2.5	0x41	2
A2.6	0x41	1
A2.7	0x41	0

10.1.2 Digital I/Os

Digital Inputs			
PLC Pinout	Chip ADDR	Chip INDEX	GPIO
Zone A			
I0.0	ADDR = 0x21	5	-
I0.1	ADDR = 0x21	3	-
I0.2	ADDR = 0x21	2	-
I0.3	ADDR = 0x21	1	-
I0.4	ADDR = 0x21	0	-
I0.5	-	-	GPIO = 13
I0.6	-	-	GPIO = 12
Zone B			
I1.0	ADDR = 0x20	2	-
I1.1	ADDR = 0x20	1	-
I1.2	ADDR = 0x20	0	-
I1.3	ADDR = 0x21	7	-
I1.4	ADDR = 0x21	6	-
I1.5	-	-	GPIO = 17
I1.6	-	-	GPIO = 16
Zone C			
I2.0	ADDR = 0x20	6	-
I2.1	ADDR = 0x20	5	-
I2.2	ADDR = 0x20	7	-
I2.3	ADDR = 0x20	4	-
I2.4	ADDR = 0x20	3	-
I2.5	-	-	GPIO = 27
I2.6	-	-	GPIO = 4

Digital Outputs		
PLC Pinout	Chip ADDR	Chip INDEX
Zone A		
Q0.0	0x40	15
Q0.1	0x40	14
Q0.2	0x40	13
Q0.3	0x40	12
Q0.4	0x40	11
Q0.5	0x40	10
Q0.6	0x40	1
Q0.7	0x40	0
Zone B		
Q1.0	0x40	2
Q1.1	0x40	9
Q1.2	0x40	6
Q1.3	0x40	4
Q1.4	0x40	7
Q1.5	0x40	3
Q1.6	0x40	5
Q1.7	0x40	8
Zone C		
Q2.0	0x41	6
Q2.1	0x41	7
Q2.2	0x41	5
Q2.3	0x41	4
Q2.4	0x41	3
Q2.5	0x41	2
Q2.6	0x41	1
Q2.7	0x41	0

10.1.3 Relay Devices Analog I/Os

Analog Inputs		
PLC Pinout	Chip ADDR	Chip INDEX
Zone A		
I0.2	0x4a	0
I0.3	0x4a	1
I0.4	0x4b	0
I0.5	0x48	2
Zone B		
I1.2	0x49	0
I1.3	0x4a	3
I1.4	0x4b	2
I1.5	0x4b	3
Zone C		
I2.2	0x49	3
I2.3	0x49	2
I2.4	0x48	3
I2.5	0x4b	1

Analog Outputs		
PLC Pinout	Chip ADDR	Chip INDEX
Zone A		
A0.0	0x40	10
A0.1	0x40	1
A0.2	0x40	0
Zone B		
A1.0	0x40	3
A1.1	0x40	5
A1.2	0x40	8
Zone C		
A2.0	0x41	2
A2.1	0x41	1
A2.2	0x41	0

10.1.4 Digital I/Os

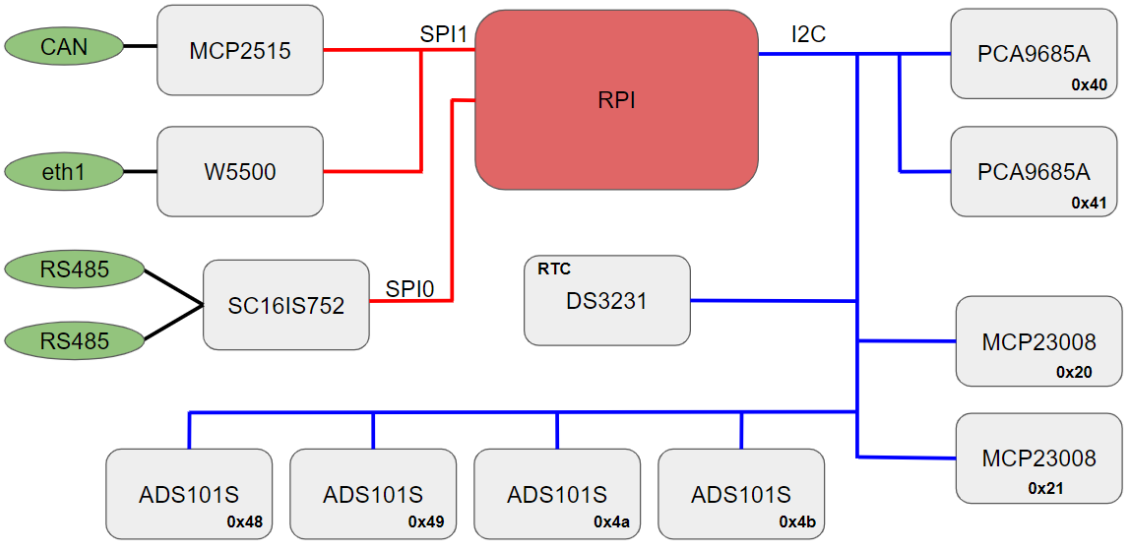
Digital Inputs	
PLC Pinout	GPIO
Zone A	
I0.0	13
I0.1	12
Zone B	
I1.0	27
I1.1	4
Zone C	
I2.0	17
I2.1	16

Digital Outputs		
PLC Pinout	Chip ADDR	Chip INDEX
Zone A		
Q0.0	0x40	10
Q0.1	0x40	1
Q0.2	0x40	0
Zone B		
Q1.0	0x40	3
Q1.1	0x40	5
Q1.2	0x40	8
Zone C		
Q2.0	0x41	2
Q2.1	0x41	1
Q2.2	0x41	0

10.1.5 Relay

Relay		
PLC Pinout	Chip ADDR	Chip INDEX
Zone A		
R0.1	0x21	3
R0.2	0x21	5
R0.3	0x21	1
R0.4	0x21	2
R0.5	0x40	11
R0.6	0x40	12
R0.7	0x40	13
R0.8	0x40	14
Zone B		
R1.1	0x20	1
R1.2	0x20	2
R1.3	0x21	7
R1.4	0x20	0
R1.5	0x40	7
R1.6	0x40	4
R1.7	0x40	6
R1.8	0x40	9
Zone C		
R2.1	0x20	5
R2.2	0x20	6
R2.3	0x20	4
R2.4	0x20	7
R2.5	0x41	3
R2.6	0x41	4
R2.7	0x41	5
R2.8	0x41	7

11 Internal I2C and SPI Connections



12 Input & Output control

For the Input & Output control of the device there are two commands for working with both digital and analogic pins. These functions are for setting the value or getting its actual information.

12.1 Set Value

The ***set*** function will initialize the pin. We will provide the pin with which we are going to work and the value that will be set. If we are working as the **analogical option**, the value will work in a range from *0* to *100* percent. Otherwise, for the **digital option** a logical *1* will turn on the pin while a *0* will stop it. In the case that we want to control a **relay option**, it will work out as a digital option, where a logical 1 will turn on the device and the logical 0 will shutdown it.

By default, if not value option is provided it will be initialized as a 1 for the Digital and for the Relay or a 50% for the Analogic. If any other options are chosen, an error code will warn us. In order to call the function, we will do the following:

```
./set-digital-output <output> <value>
./set-analog-output <output> <value>
./set-relay <output> <value>
```

 Warning:

There are some pins that both can work as digital or analogue. In this case, if we have used these pins before in either digital or analogic and we want to switch its mode, we must call the set function providing *stop* to the value option; otherwise there will be a system error. If a reboot is done, it is not necessary to do it.

The pins which can operate with both Analog/Digital configurations are:

- 0.5
- 0.6
- 0.7
- 1.5
- 1.6
- 1.7
- 2.5
- 2.6
- 2.7

```
./set-digital-output Q0.5 1
./set-digital-output Q0.5 stop
./set-analog-output A0.5 50
```

As for the relay option, we can call the function as the following example:

```
./set-relay R0.5 1
```

12.2 Get Value

The ***get-[option]-input*** function will show the value of the selected input pin. It will only be provided the pin with which we are going to work.

In order to call the function, we will do the following:

```
./get-digital-input <input>
./get-analog-input <input>
```

As for the **get-temp** function, it will return the actual temperature of the device. Any parameter must be passed, as calling the function itself will return the temperature in milli-degrees.

In order to call the function, we will do the following:

```
./get-temp
```

12.3 Fan Functions

12.3.1 Start Fan

The **start-fan** function will activate the fan of the Raspberry PLC on the moment that the command is called. Consider that, if there is any temperature control system by default, the start-fan function could disable it.

```
./start-fan
```

12.3.2 Stop Fan

The **stop-fan** function will deactivate the fan of the Raspberry PLC on the moment that the command is called. Consider that, if there is any fan control system by default, the stop-fan function could disable it.

```
./stop-fan
```

Warning:

Note that calling these functions can alter the behaviour of the temperature control system in the event of any.

13 A & B Zone Features: Communications & RTC & uSD

13.1 RS-485

Raspberry PLC is provided with two RS-485 channel communications. Both of them are half-duplex and are controlled via the SPI0 bus.

13.2 I2C

The I2C protocol is meant to work in a pull-up configuration. A pull-up configuration means that when the pin is at rest (nothing connected to it) it always reads a HIGH value. In this case it reads 3.3V when nothing is connected. The pull-up configuration is established by default in these pins.
If it is meant to work them as a GPIO at 3.3V, it has to be considered that they are pull-up inputs.

13.3 SPI

The Raspberry PLC pins used for the SPI bus are summarized in the table below. The MISO, MOSI and CLOCK pins are the same for all the connected devices, while the SS pin, conversely, will be unique for each one.

Function	PLC connection	Raspberry board pin
MISO 0	SO	GPIO 9
MOSI 0	SI	GPIO 10
CLOCK 0	SCK	GPIO 11
MISO 1	SO	GPIO19
MOSI 1	SI	GPIO20
CLOCK 1	SCK	GPIO21
Reset	Reset	Reset
SS	SCL/SDA/RX/TX	GPIO2/GPIO3/GPIO15/GPIO14

13.4 TTL

Raspberry PLC has one TTL ports, RX/TX. TTL is accessed with the function Serial (pins GPIO14 and GPIO15 of the Raspberry PI 4).

13.5 Ethernet

Raspberry PLC has two Ethernet ports, eth1 and eth0. The Ethernet port controller is based on W5500 IC and it generates the eth1 interface, while the eth0 interface is automatically generated by the Raspberry PI 4.

In the RASPBERRY PLC FAMILY, W5500 IC communicates to the Raspberry PI 4 via SPI1 bus.

13.6 RTC

Raspberry PLC RTC Module is based on the DS3231 Chip. This chip works with the I2C protocol communication, so it is required to have enabled the I2C protocol. It is powered by a button battery (CR1216 or CR1220).

13.7 uSD

The micro SD contains all the configurations to work properly with the Raspberry PLC. Consequently, the micro SD should not be manipulated because without it the Raspberry PLC would not work correctly.

14 Revision Table

Revision Number	Date	Changes
0	30/10/2020	First implementation

About Industrial Shields:

Direction: Fàbrica del Pont, 1-11

Zip/Postal Code: 08272

City: Sant Fruitós de Bages (Barcelona)

Country: Spain

Telephone: (+34) 938 760 191 / (+34) 635 693 611

Mail: industrialshields@industrialshields.com