USER GUIDE COLLINE IO

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Document Revision History

Table 1: Document Revision History

Version	Issue Date	Brief description of Change
V1.0	21/11/2018	First Version of this document

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LIST OF TABLES

1 GENERAL INFORMATION

The present document describes the User Guide of the Input/output board called CollineIO.

CollineIO is able to manage digital inputs, digital outputs, analogue inputs and analogue outputs. In this document every connection will be described so the user can connect appropriately to all the inputs/outputs.

CollineIO can work in two different modes:

- **Slave board.** An external CPU (the master) sends and receives commands to CollineIO which acts accordingly. The master can use the RS-485 or RS-232 port to send these commands, which are Modbus RTU compatible. A complete list of commands can be found in CP038-DOC02-ComProtocol document.
- **Master Board.** In this case the user can use the board to write its own software. A complete set of free tools allow to develop easily the full application. User can attach a touchpanel or display to build a complete HMI interface.

1.1 Acronyms

AC, Alternating current

ADC, Analog Digital Converter

ASIC, Application Specific Integrated Circuit

BGA, Ball Grid Array

BOM, Bill Of materials

CAN, Controller Area Network

DAC, Digital Analog Converter

DC, Direct Current

DSP, Digital Signal Processor

EEPROM, Electrically Erasable PROM

FPGA, Field Programmable Gate Array

HMI, Human Machine Interface

ICD, Interface Control Document

I2C, Inter-Integrated Circuit, Serial bus data communication protocol

I/O, input/output

NO, Normally Open

NC, Normally Close

NDA, Non-Disclosure Agreement

OC, Open Circuit

PCB, Printed Circuit Board

PSOC, Programmable System On-Chip

RAM, Random Access Memory

RTC, Real Time Clock

RTU, Remote Terminal Unit

SC, Short Circuit

SMD, Surface Mount Device

SMT, Surface Mount Technology

SPI, Serial Peripheral Interface

TBD, To Be defined

TBC, To Be Confirmed

2.1 Document Property

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3.1 References

- Communication Protocol, CP038_DOC02_ComProtocol
- Schematic CollinelO board

2 GENERAL VIEW OF THE BOARD

The following is an image of CollinelO board.

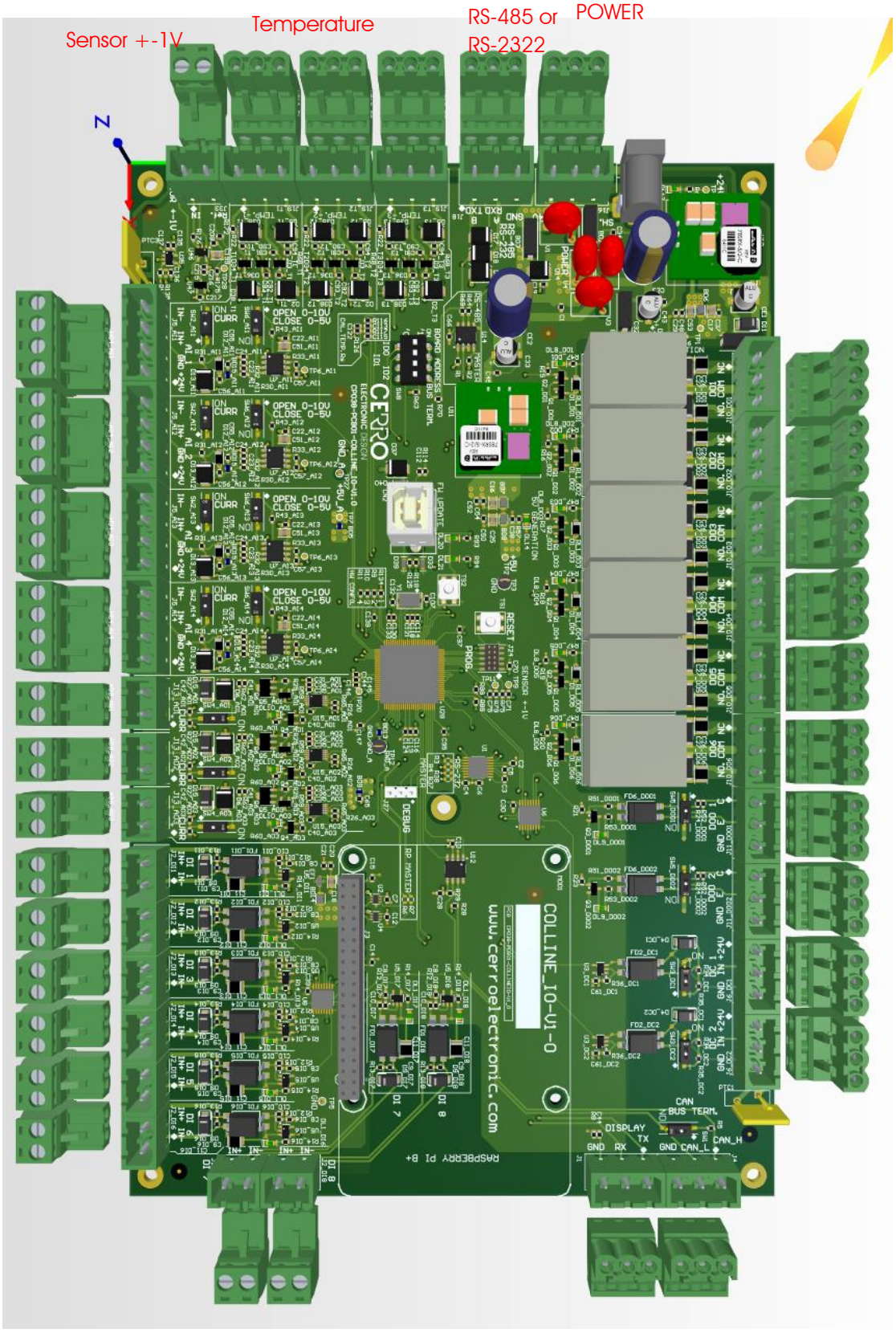

Figure 1: General view of CollinelO

3 WORKING MODES

CollineIO can work as a slave as master IO

1.3 CollineIO as a Slave

In this mode, CollineIO board is waiting for commands coming from a Master, which is in charge of all the processing of the application. The board is continuously waiting for commands.

Commands can be sent from the master using the RS-485 or RS-232 port. Commands are Modbus RTU compatible. A complete list of commands can be found in CP038-DOC02-ComProtocol document.

Master systems can be any CPU connected to the RS-485 or RS-232 (configurable by hardware) or a RaspberryPi (student or amateur) or any other CPU format size compatible to RapberryPi, as for example, i.MX6UL Module from Digi (industrial applications mostly). RaspberryPi can be connected to the own embedder connector of the board.

Next figure shows a typical application of the CollineIO working as a slave.

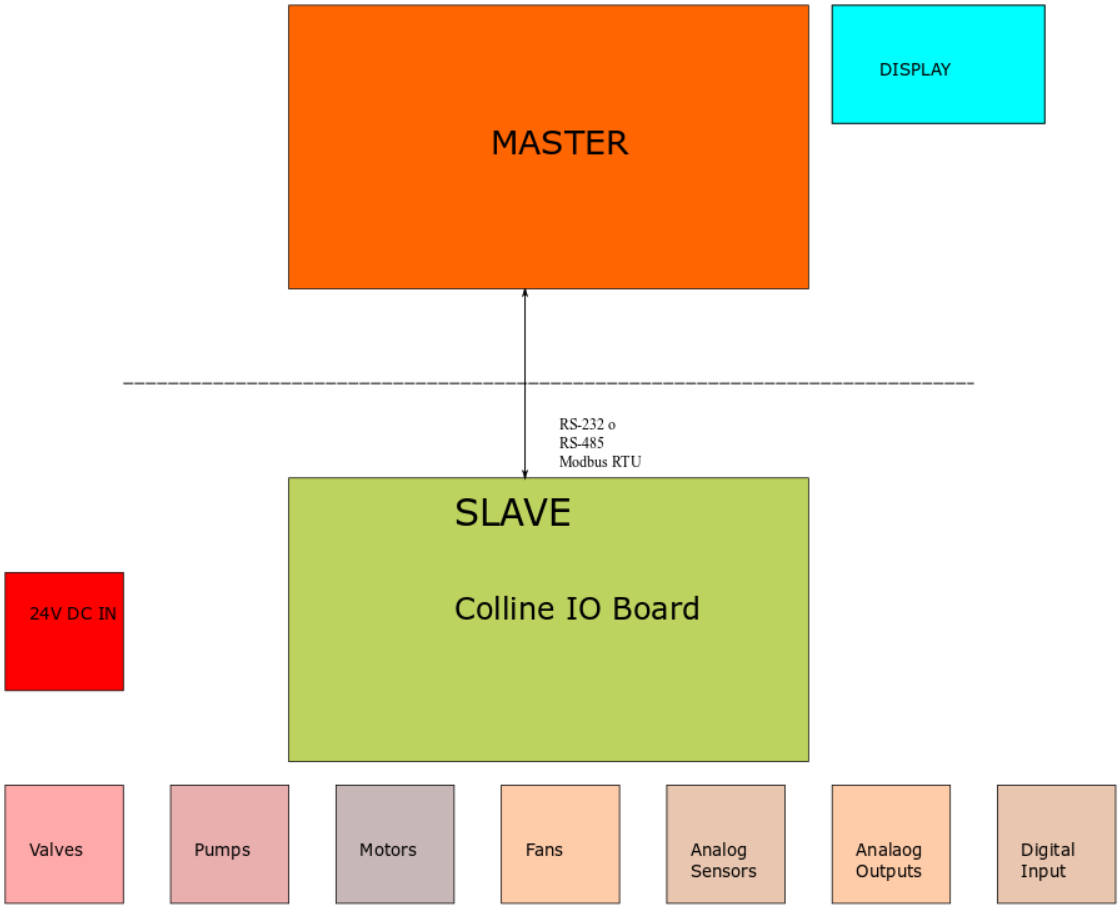

Figure 2: Master-Slave Configuration

In this configuration the application is in the external master and when it needs to know the state of a sensor or modify any input/output, sends a command to the slave and waits for the answer. Master could have its own display.

CollineIO board is in charge of reading sensors, changing outputs, etc.

The application is developed by the customer on the Master system.

On board connector allows to connect RaspberryPi Model B (educational or amateur) or i.MX6UL module Digi (industrial). None supplied at the delivery.

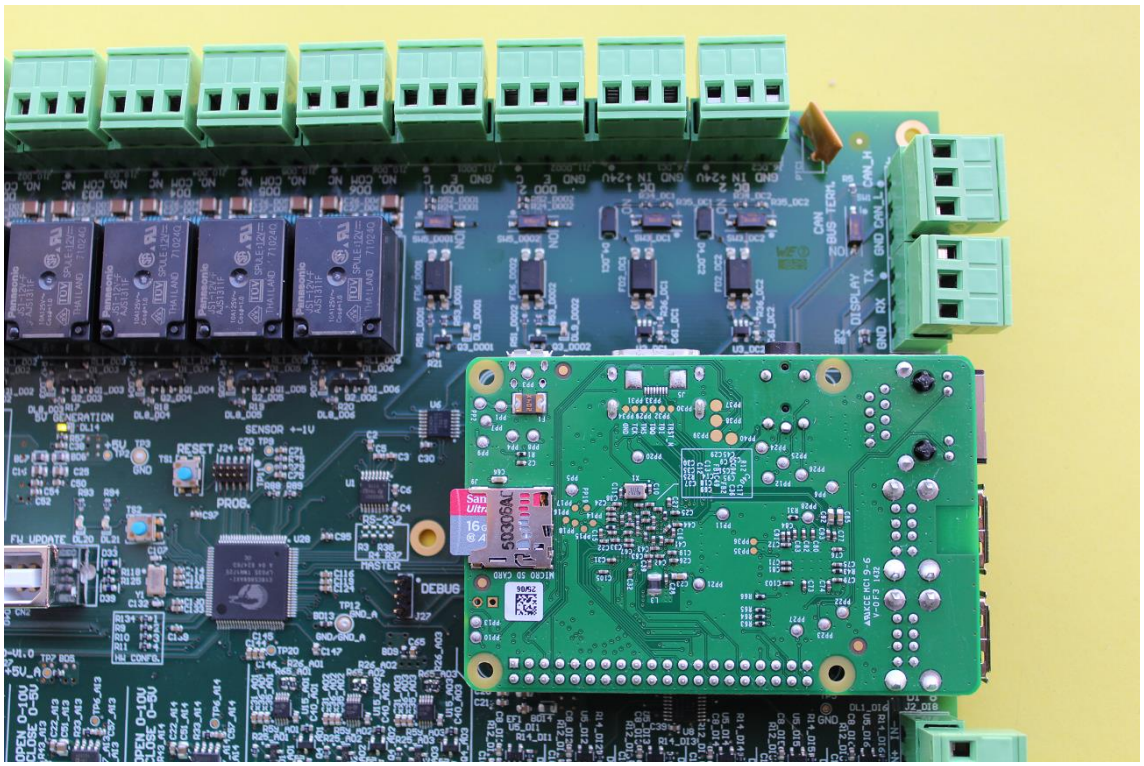

Figure 3: CollinelO with RaspberryPI

2.3 CollinelO as Master

The other way CollinelO can work is as a complete master system. The application is developed in the own board.

Next figure shows a typical application of the CollinelO working as a Master.

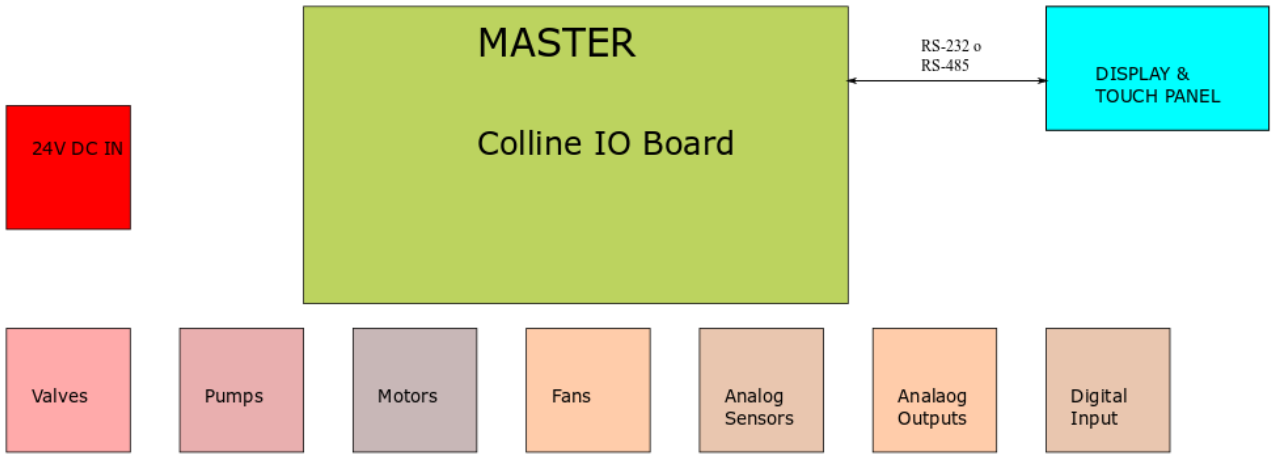

Figure 4: Master Configuration

Customer application can be developed in C using PSOC Creator, a free IDE developed by Cypress Semiconductor.

Cerro supplies basic functions to manage inputs and outputs and the user is in charge to develop its own application.

Some options for display: size (4.2,"5", 7", 10") with or without touch panel ca be supplied if ordered.

Optional: Cerro can develop the full application for customer. Just ask us.

4 BOARD FEATURES

1.4 Communications

- RS-485 (R termination for BUS RS-485 available through microswitch)
- RS-232
- CAN
- USB for FW uploading
- MODBUS RTU (slave mode)

2.4 Digital Input

- 8 General opto-isolated inputs, maximum 30V, with on board led to indicate the state of each input.
- 2 Pulse/Counter inputs able to count pulse frequency inputs up to 5Khz.

3.4 Analog Input

- 4 Input channels, hardware configurable: 0-20mA, 4-20mA, 0-5V & 0-10V.
- Each channel can be configured as voltage/current input using an integrated microswitch.
- One additional channel for a high precision sensor in the ±1V range (for example, pH sensor).
- 20 bits ADC resolution.

4.4 Digital Output

- 6 channels based on power relay (10A), with NO and NC contacts available. Includes snubber filter and status LED for each output.
- 2 opto-isolated channels. Pull-up resistor connected to 24V, configurable using an integrated microswitch. Includes a status LED for each output.

5.4 Analog Output

- 3 channels 0-20mA, 4-20mA, 0-5V or 0-10V. Current or voltage configurable with microswitch
- 8 bits DAC resolution

6.4 Temperature

- 3 PT-100 channels, ±1ºC

7.4 Power Supply

- External 24VDC

8.4 Internal Microprocessor

PSOC5 LP family of microprocessor by Cypress. Based on ARM Cortex-M3 core and a large variety of selectable digital and analog peripherals.

9.4 External CPU Connection

- RS-485 or RS-232 port for external CPU.
- On board connector for RaspberryPi (recommended for students or amateurs) or i.MX6UL Module from Digi (industrial environments). Any other CPU raspberryPi format size compatible can be also connected. These are not supplied

10.4 Expandable System. Bus Configuration ID.

On board switches to configure up to 7 board IDs that can be connected in the same RS-485 Bus.

11.4 Board Connectors

For easy connection to the board, terminal blocks Wire-To-Board Connector, 5.08 mm pitch, are used for all the connection. The matching connector is supplied with the board so customer can start to work immediately.

Figure 5: Wire-to Board connector.

12.4 Dimension & Thickness

Figura 1: PSOC programmer screenshot

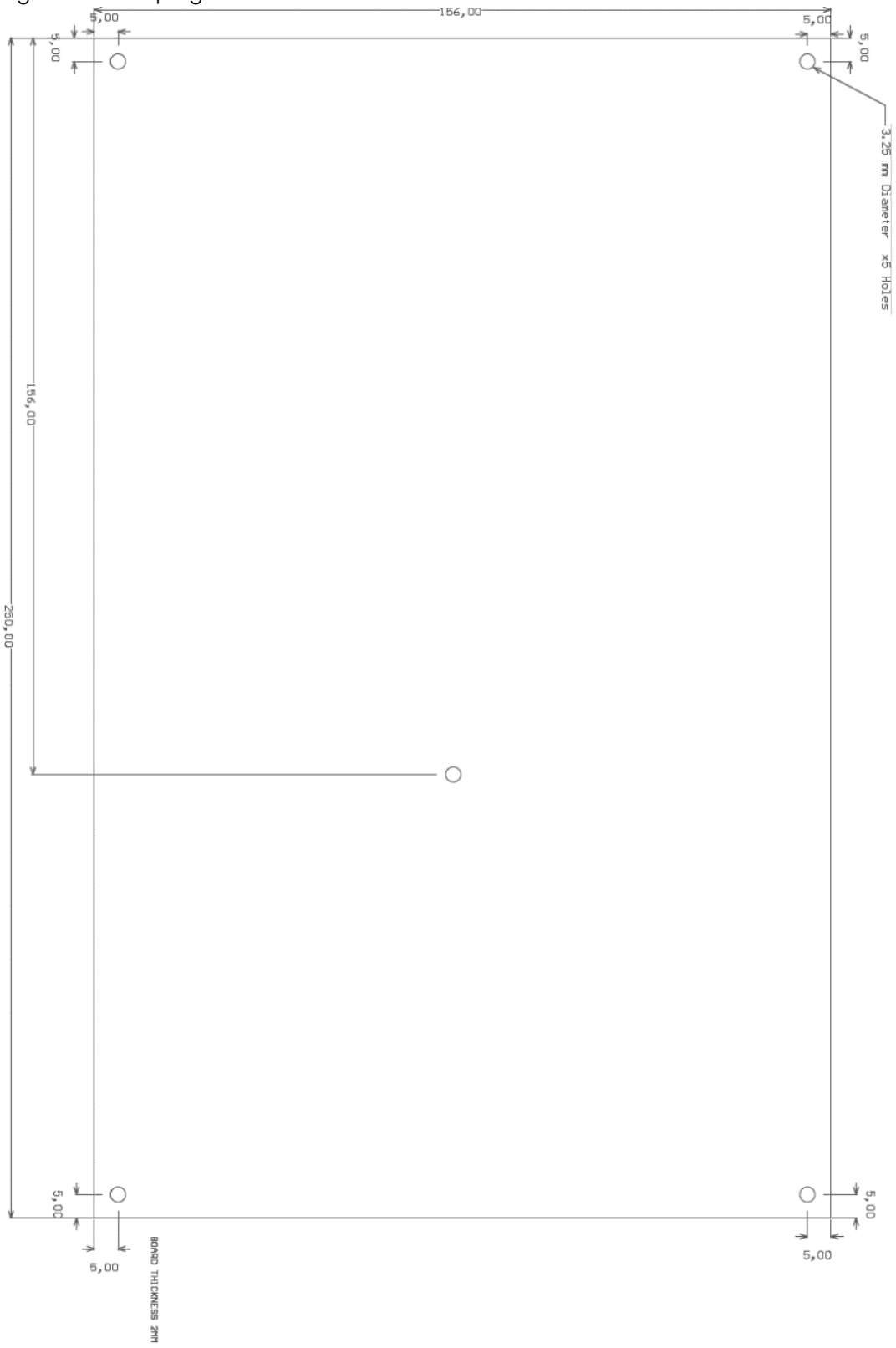

Figure 6: CollinelO dimensions

Dimensions: 250x156mm. Five holes for fixing M3.

Thickness: 2mm

5 DETAILED DESCRIPTION

1.5 Power input connector

Using J16 (see Figure 7: Power Connectors) we supply power to the board.

Board accepts +24V DC. On the board there is indication for position of +24V, GND and shield, if used.

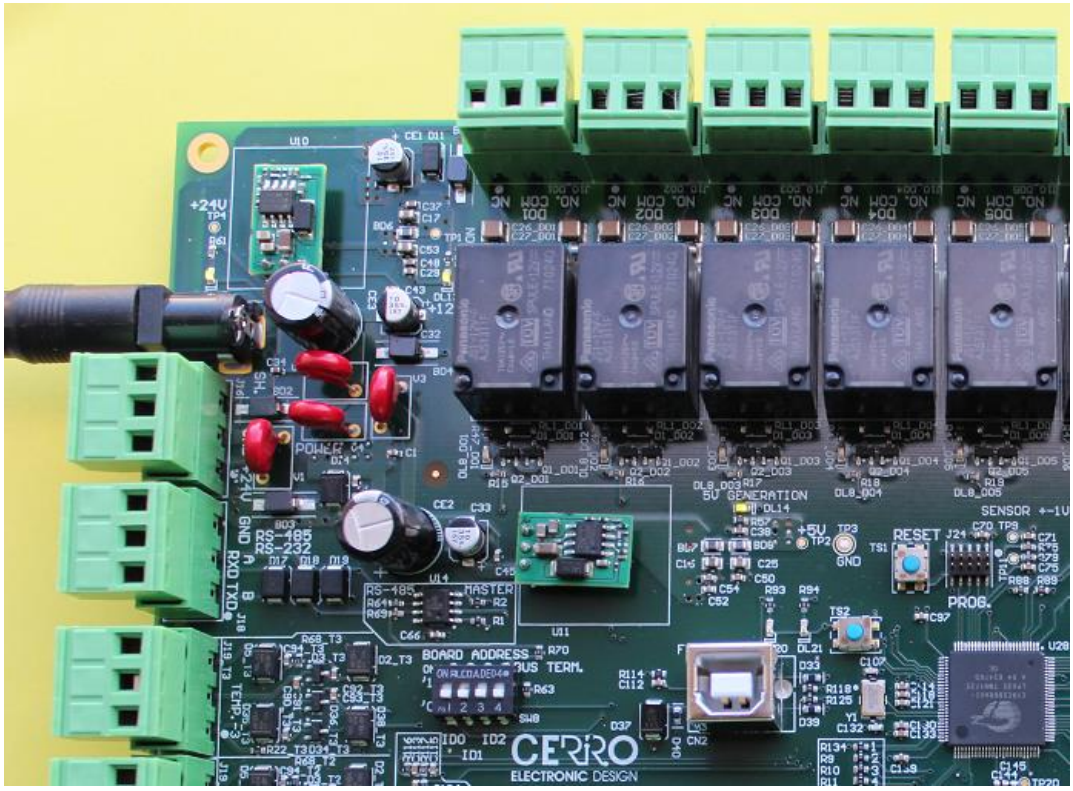

Figure 7: Power Connectors

CN1 is another power supply input, used mainly for test and debug purposes. Next figure shows the polarity of the input jack.

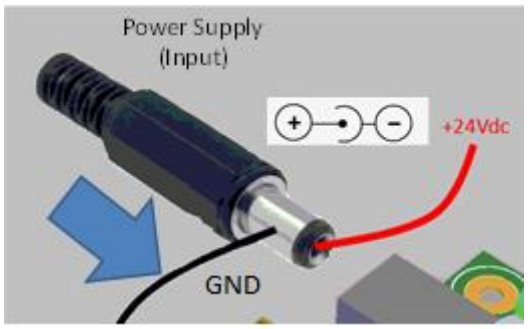

Figure 8 : Jack Polarity

During the tests we have used desktop power supply model XP POWER, AEB70US24, Farnell code 1634821, which is +24V/60W.

Once the power supply has been connected, three leds indicate the presence of +24V, +12V and +5V as can be seen in the next figure. +12V & +5V are internal generated voltages used for the board.

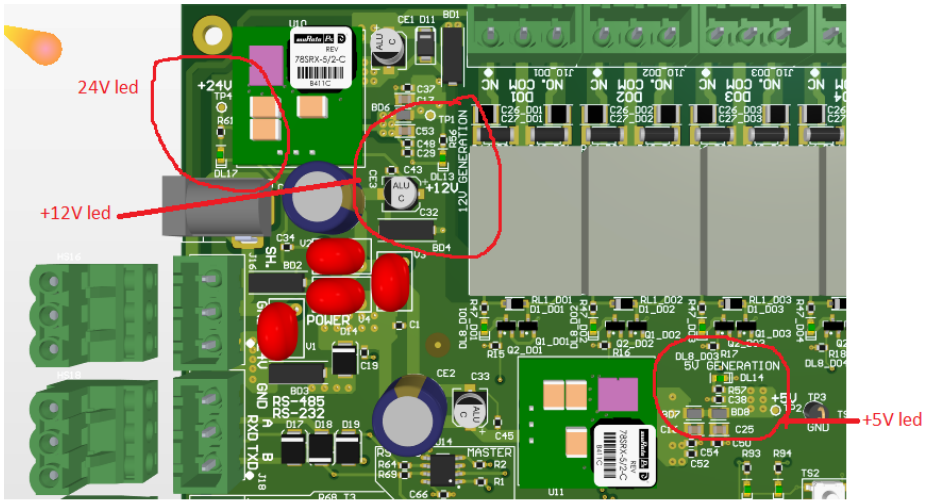

Figure 9: LEDs of power supply presence

Maximum Input Current: 400 mA

Maximum Input Power= 24x400mA= 10W

2.5 Board Start-Up

Once you supply power to the board, LED DL21 (see Figure 10: Resistor for RS-485/RS-232 and RaspberryPi) will light saying that board waits for a firmware upgrade (see chapter 14 FW UPDATE). After two seconds, DL21 turns off and DL20 starts blinking, indicating board is ready to communicate with master.

	Boot (2 seconds)	Normal functioning
DL21	On	Off
DL20	Off	Blink

6 RS-485/RS-232 CONNECTOR. BOARD ID.

1.6 Configuration for RS-232 or 485

CollinelO when acting as slave can receive commands from RS-485 or RS-232. The commands can come from and external device or from a RaspberryPi connected on the own board.

Next table shows the resistor configuration:

Table 2: HW configuration for Communication

	Resistor Mounted	Resistor Not Mounted
RS-485	R1, R2=0 Ohms R64, R69= 10 Oms	R3, R4 =0 Ohms R37, R38 = Ohms R6, R7= 0 Ohms
RS-232 (from External)	R3, R4 =0 Ohms R37, R38 = Ohms	R1, R2=0 Ohms R64, R69= 10 Ohms R6, R7= 0 Ohms
RS-232 From and embedded CPU(for example RaspberryPi)	R6, R7= 0 Ohms	R1, R2=0 Ohms R64, R69= 10 Oms R3, R4 =0 Ohms R37, R38 = Ohms

Next figure shows the place for the resistor and a RS-485 configuration:

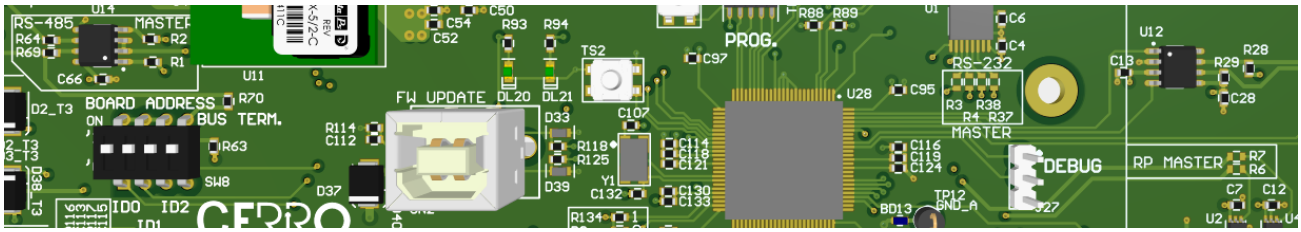

Figure 10: Resistor for RS-485/RS-232 and RaspberryPi

2.6 Communication parameters

Communication is stablished using RS-485/RS-232 protocol with the following features:

Table 3: Rs-485 Parameters

Baud rate	115.200bps
Configuration	Half Duplex
Mode	RTU
Baud	115200
Data bits	8
Stop Bits	1

parity	None

On Figure 11: ID address bus configuration, can be seen the pin-out for connector J18.

Up to 7 CollineIO boards can be connected on the same bus. The address of each board can be configured using microswitch SW8.

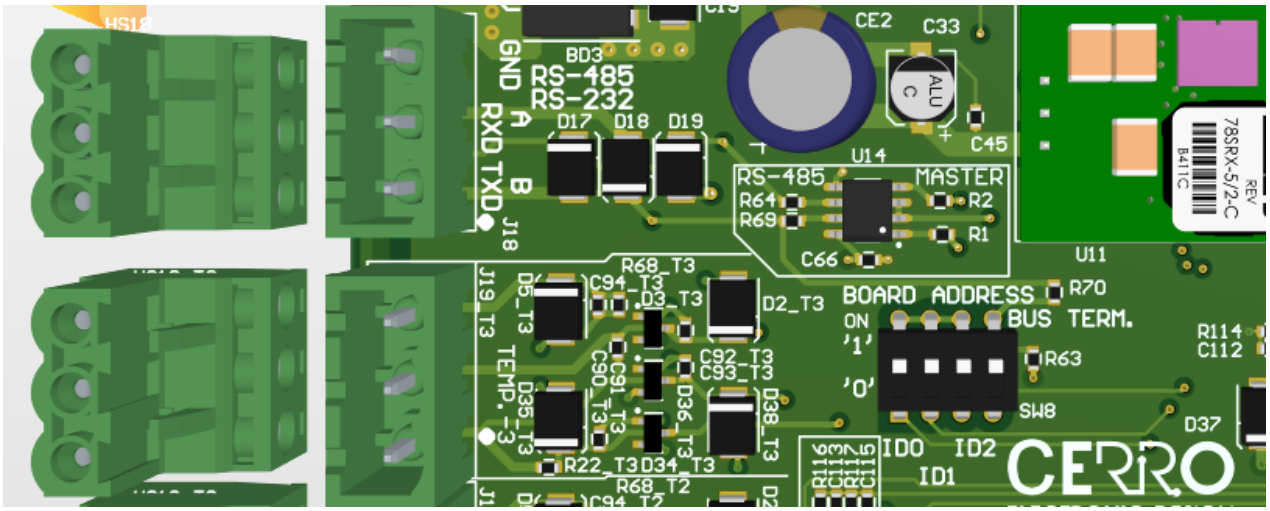

Figure 11: ID address bus configuration

So, for example ID=1; ID0= "On", ID1=ID2= "Off"

Please note that address "0" is not allowed. The address 0 is reserved to identify a broadcast exchange (a master message to all boards in the bus). Not implemented in this project.

The ID address is read at the boot up of the board, so if you change the address make sure to reset or power cycle the board.

3.6 Bus termination

It is recommended RS-485 bus have termination resistors at the start and the end. CollineIO Boards allows to add the termination resistor using the last position of the SW8. In "On" position termination is added.

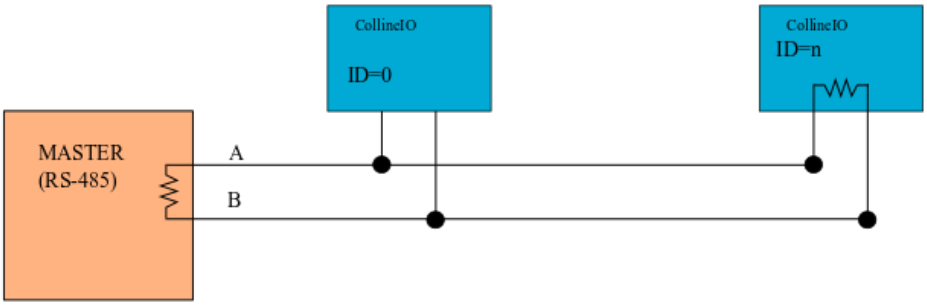

Figure 12: RS-485 Bus terminated

4.6 Embedded Connector for RaspberryPi or similar

On board connector for RaspberryPi (recommended for students or amateurs) or i.MX6UL Module from Digi (industrial environments). Any other CPU raspberryPi format size compatible can be also connected. These are not supplied.

Next figure shows a RaspberryPi Connected to the Board

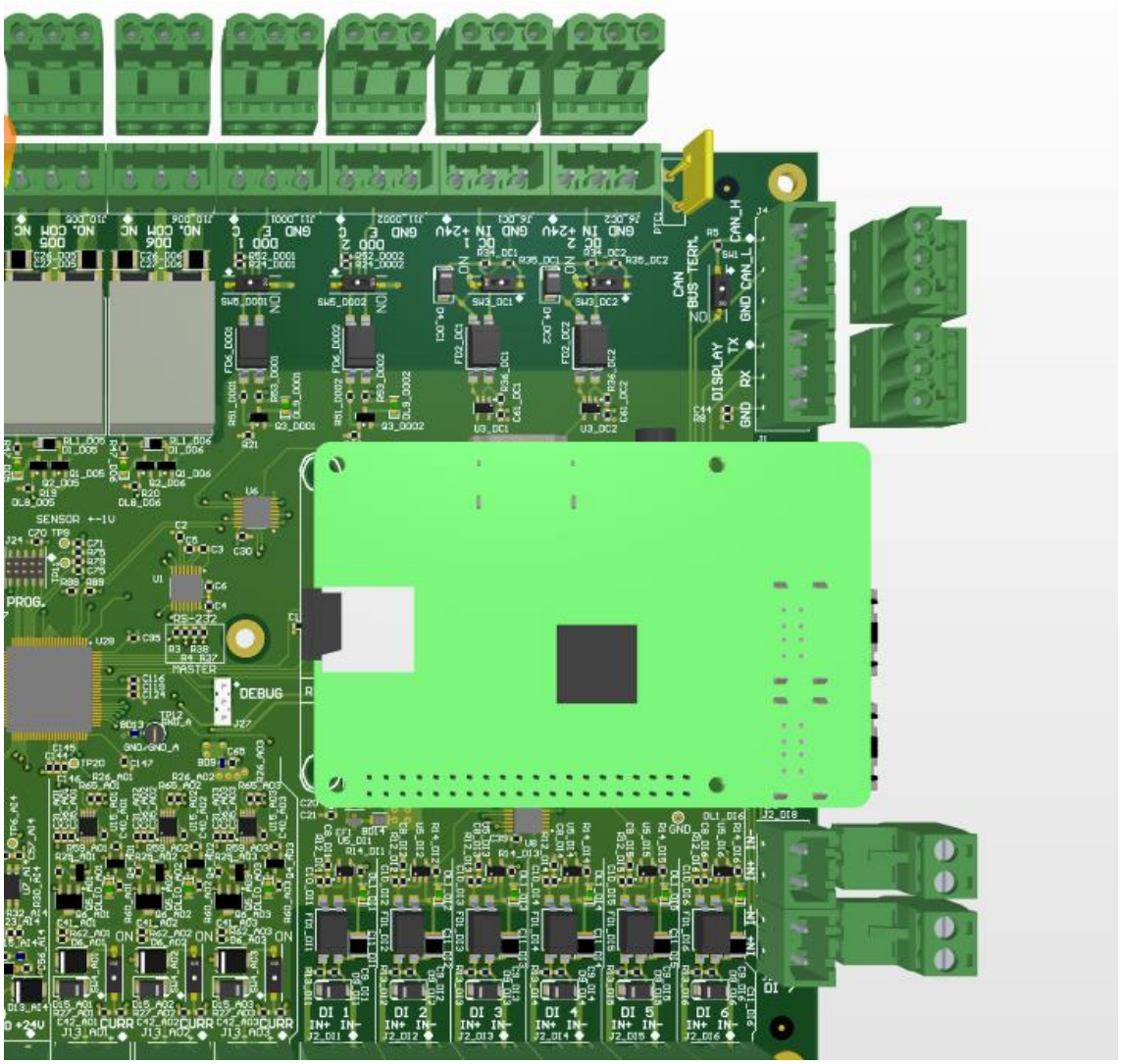

Figure 13: CollinelO with a RaspberryPI

7 DIGITAL OUTPUTS

There are two different types of Digital outputs:

(1) Relay 250VAC 10A, Connectors J10_DO1 to J10_DO6.
(2) Optic Couplers, Connectors J11_DOO1 and J11_DOO2.

Next figure shows the position of connector for these outputs.

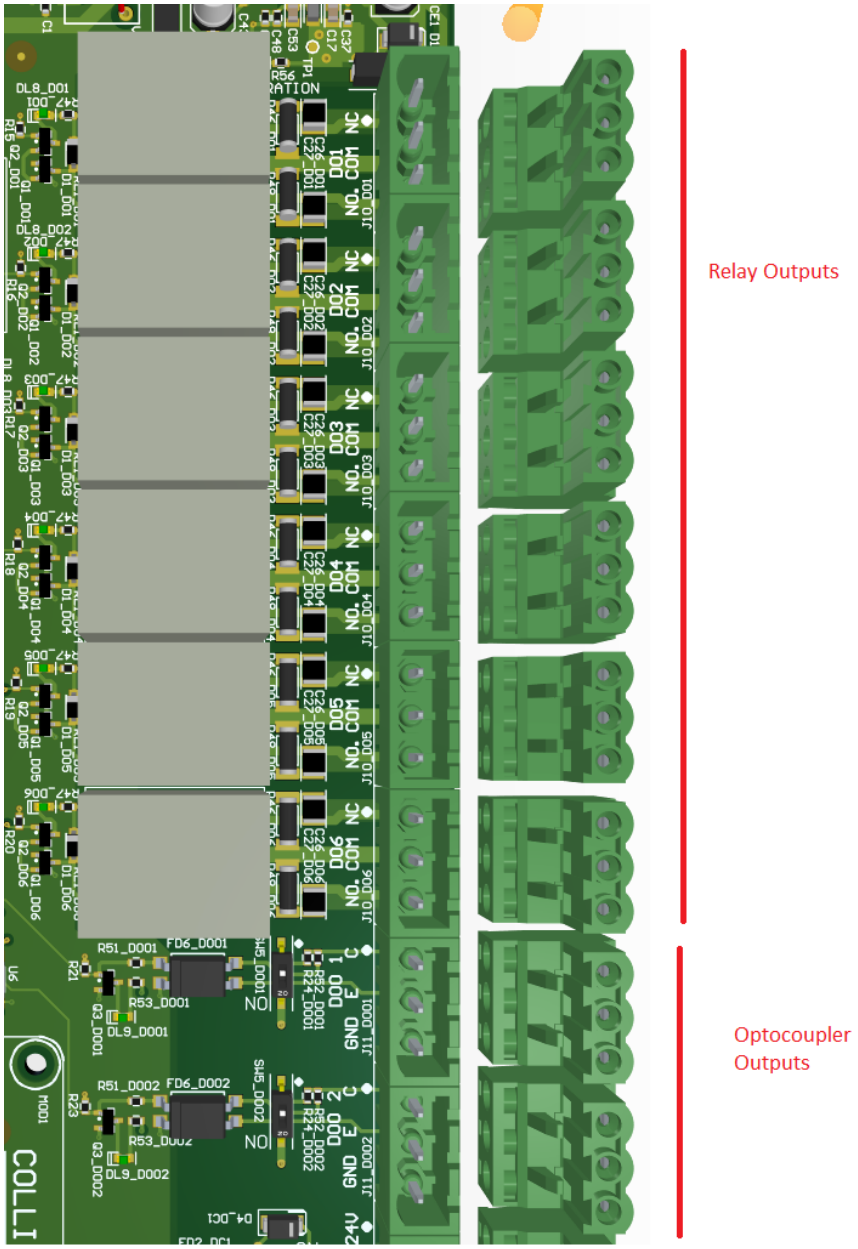

Figure 14: Connectors for Digital Outputs

1.7 Connection for Standard Relays: DO1-8

The connection to these relays allows connection COM-NO (Common to Normally Open) or COM-NC (Common to Normally Close). See two following chapters.

These outputs use the following relay: Panasonic JS1-12V-F, (Farnell Code: 1200953), 10A 250VAC, 5A 30VDC.

A LED for each output indicates if the signal is Open or Close.

2.7 Connection for Optic Couplers Output: DOO1-2

The schematic diagram is the following.

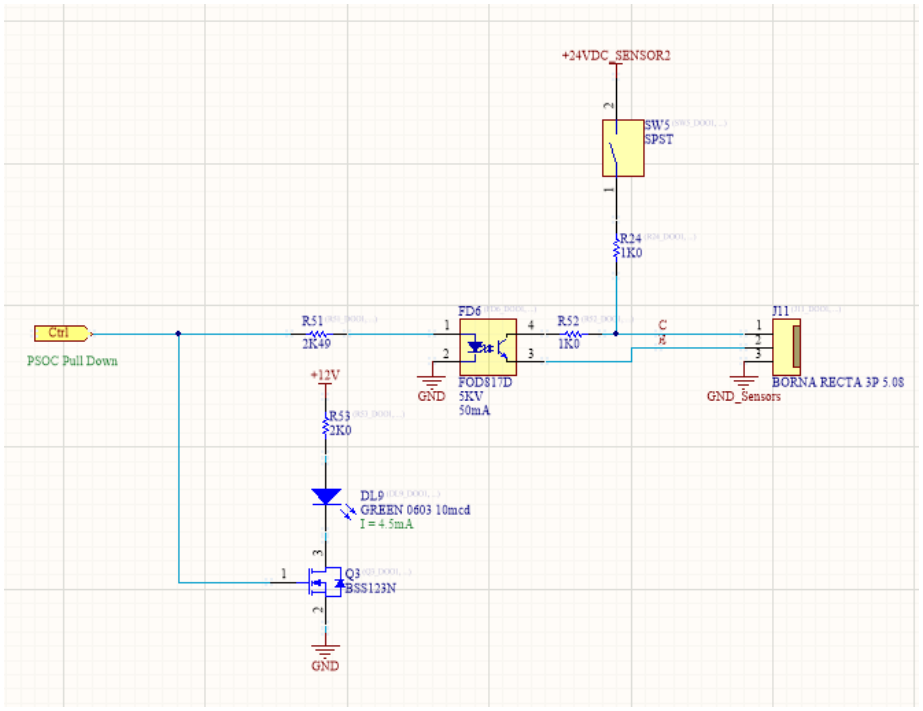

Figure 15: Optocoupler outputs schematic diagram

Maximum inputs are 30VDC. Current is limited by R52, 1K.

These outputs are in the J11 connectors

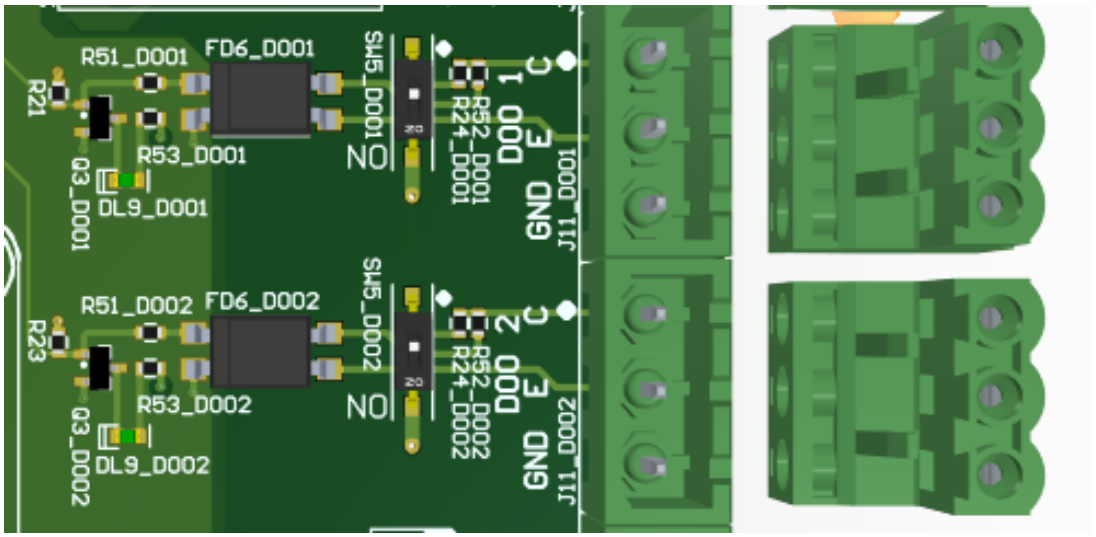

Figure 16: Optocouplers outputs

It is easy to understand the connection if both, Figure 15: Optocoupler outputs schematic diagram and Figure 16: Optocouplers outputs, are checked.

If the output need a pull-up to 24V, SW5_DOO1 and SW5_DOO2 can be used for this purpose.

When output is activated LEDs DL9_DOO1 and DL9_DOO2 will be "on".

8 DIGITAL INPUTS

There are two different types of Digital inputs:

(1) Standard
(2) Digital counter or pulse counters

Next figure shows the position of connector for these outputs.

1.8 Standard Digital Inputs

The schematic for these inputs is:

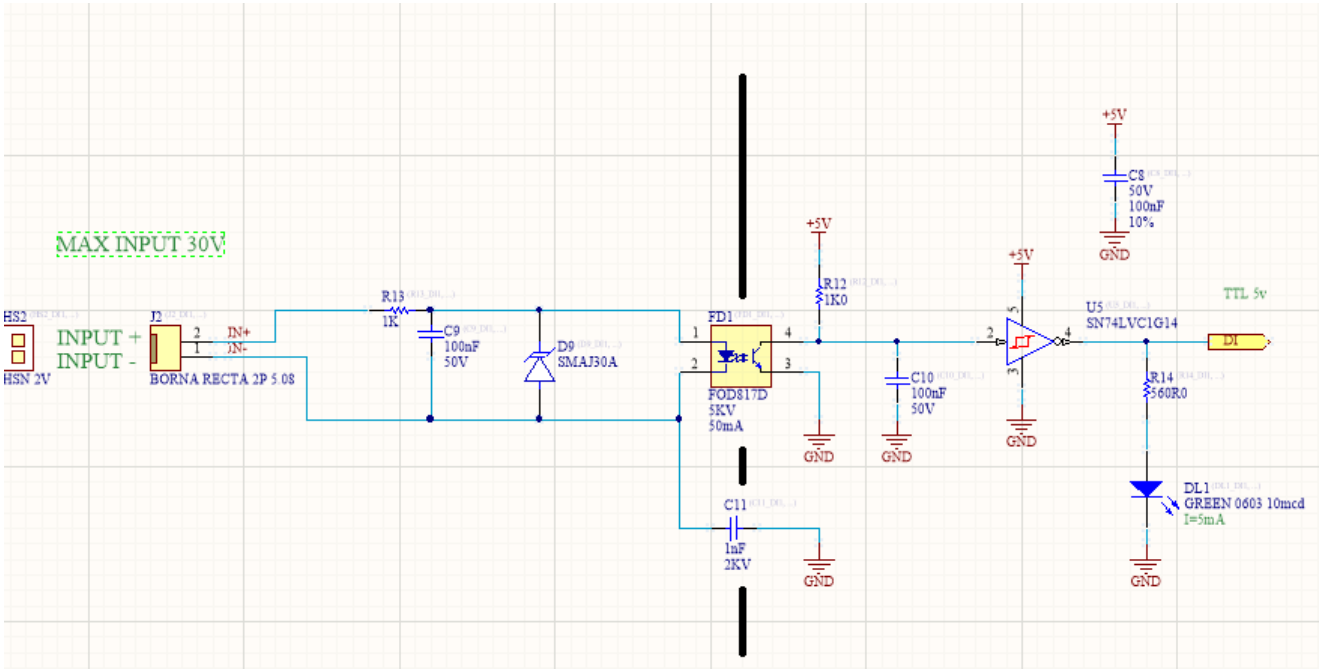

Figure 17: Schematic for Digital inputs

Maximum input 30V. Current is limited by R13 1K.

Inputs are optoisolated and have a led to indicate the state.

The connectors for these inputs:

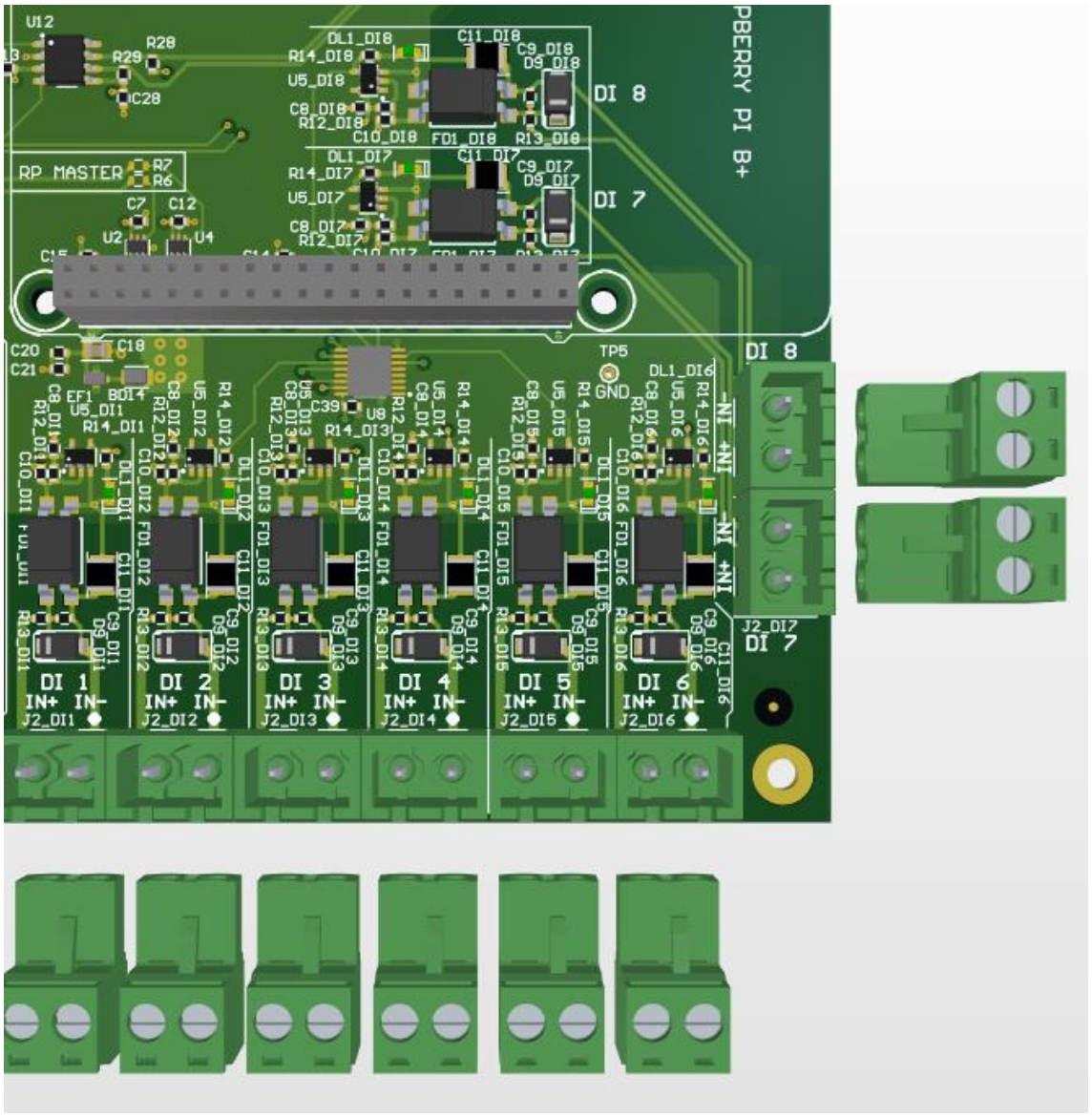

Figure 18: Digital Inputs 1 to 8

Each input has its circuitry close to the input connector except DI 7 and 8 which are located close to the RaspberryPi pin header.

The way to connect these inputs is shown in next figures:

Figure 19: Digital Input "Off"

Figure 20: Digital input "On"

2.8 Digital Pulse Input Counters: DC1-2

There are 2 digital pulse input counters, with the following features:

- Frequencies: up to 5Khz
- Pull-up configurable

Next figure gives us the input schematic for these entries:

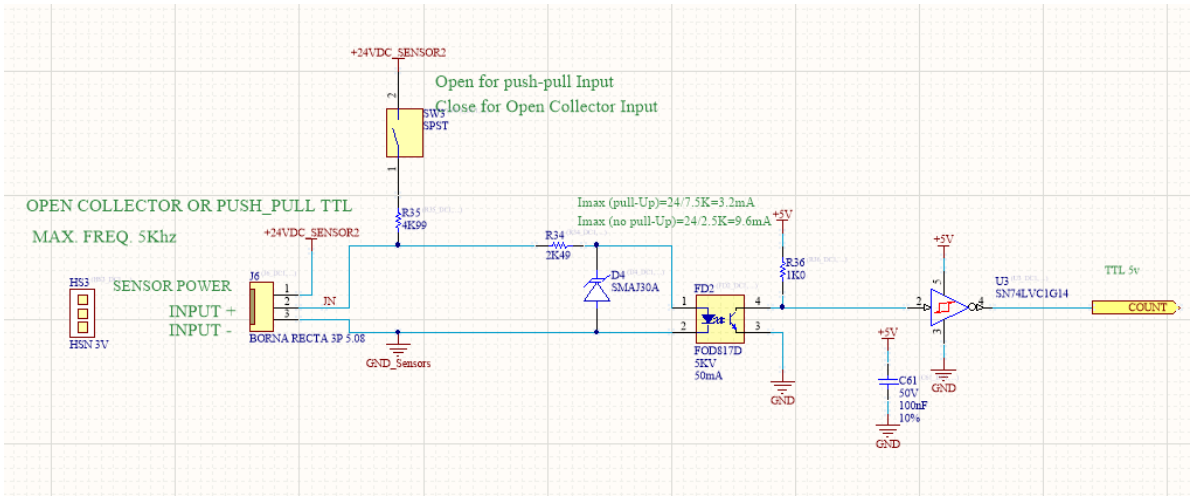

Figure 21: Digital Counter Schematic

Maximum input voltage 30V.

The connectors on board for these inputs are:

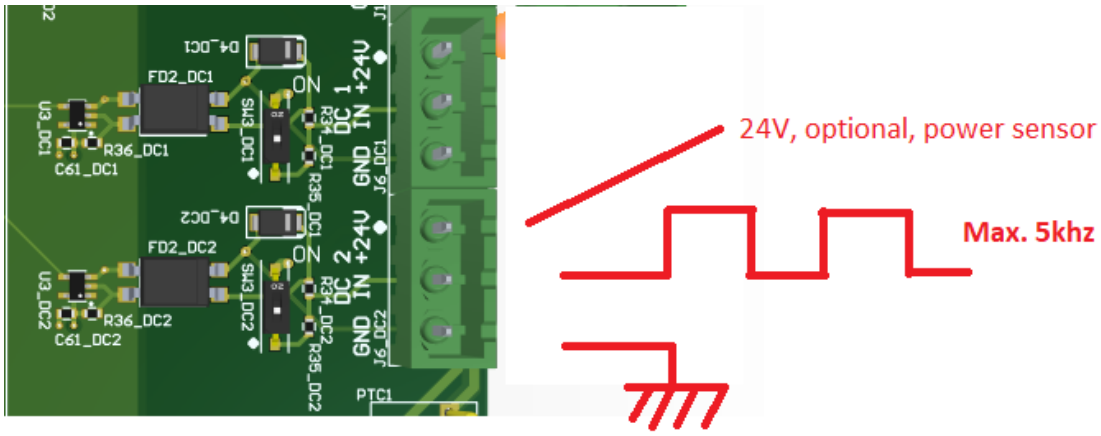

Figure 22: Connectors for input pulse counters

9 ANALOGUE OUTPUTS:AO1-3

Analogue outputs connectors are situated on: J13_AO1 to J13_AO3

These outputs can supply 0-10V or 0-20mA. There are one slide switches for each channel to configure voltage or current output. For example, for AO_1 (Analogue Output number 1) SW4_AO1 if in "ON" position will provide voltage output. For SW4_AO1 in "OFF" will provide a current output.

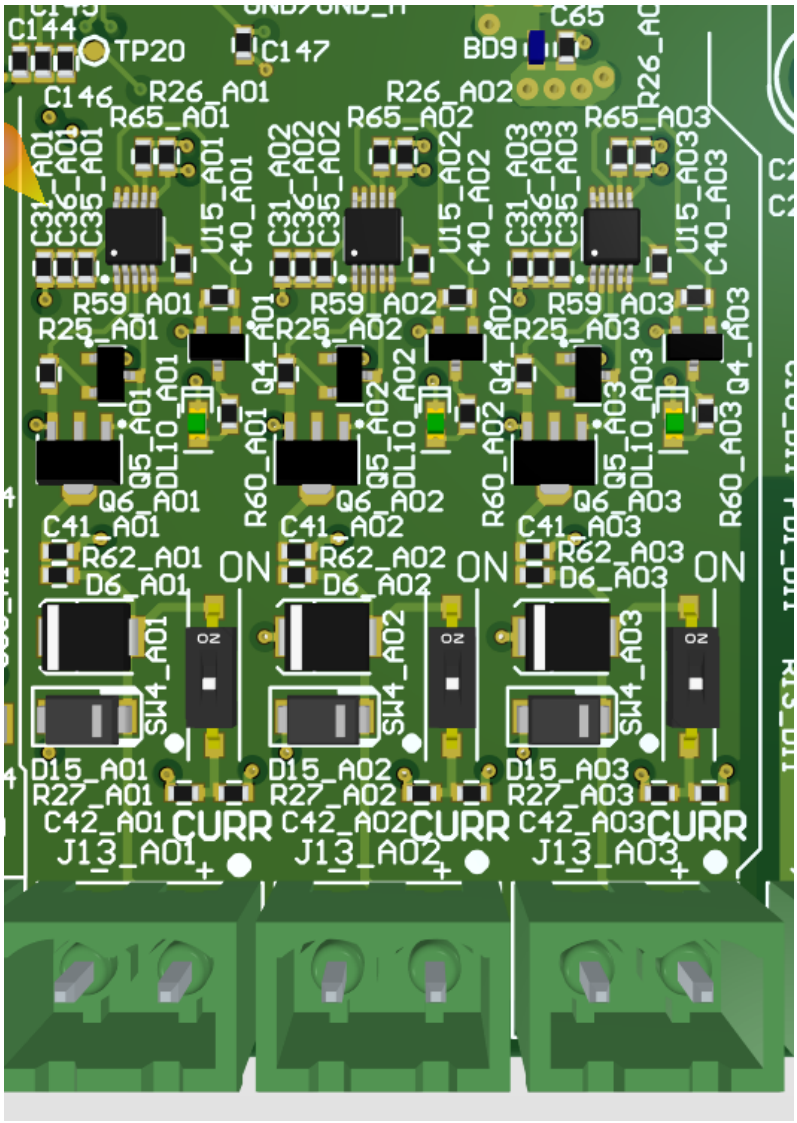

Figure 23: Partial view of Ro40 for Analogue Outputs

The next figure shows a method to measure the analogue outputs:

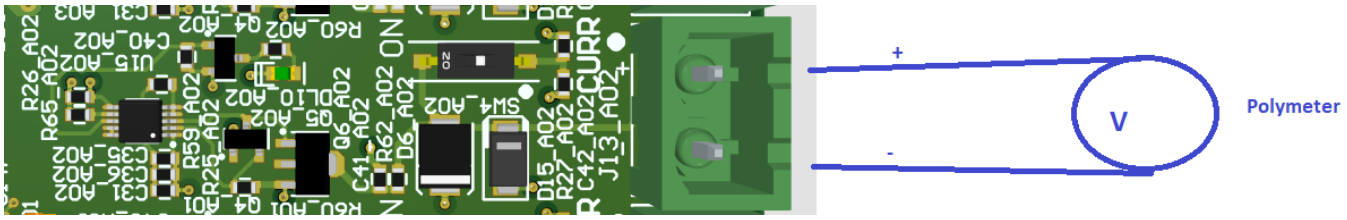

Figure 24: Measuring an analogue voltage output

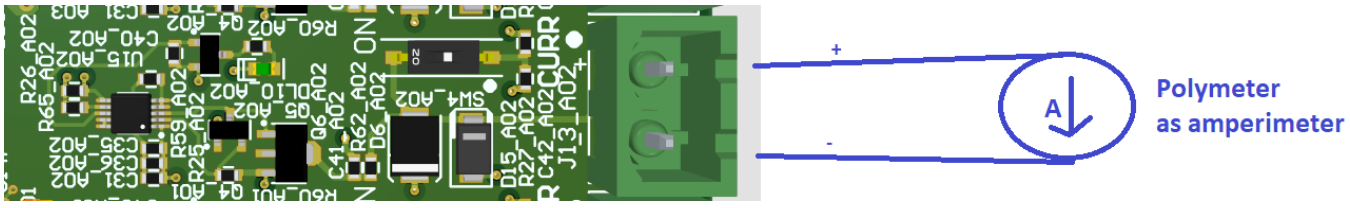

Figure 25:Measuring an analogue current output

An error detection circuit activates a led for each Channel (DL10_AOx)) in case the output current cannot correctly flow. It indicates a wire break, high load resistor, or loss of headroom for the current output to the positive supply. (It does not work in case of voltage ouput is selected.

10 ANALOGUE INPUTS:AI1-7

Analogue Input channels can measure 0-10V or 0-20mA inputs. There are 4 channels: AI_1 to AI_4.

Connectors for these inputs are: J5_AI1 to J5_AI4.

A partial view of the board for the analogue inputs can be seen in next figure.

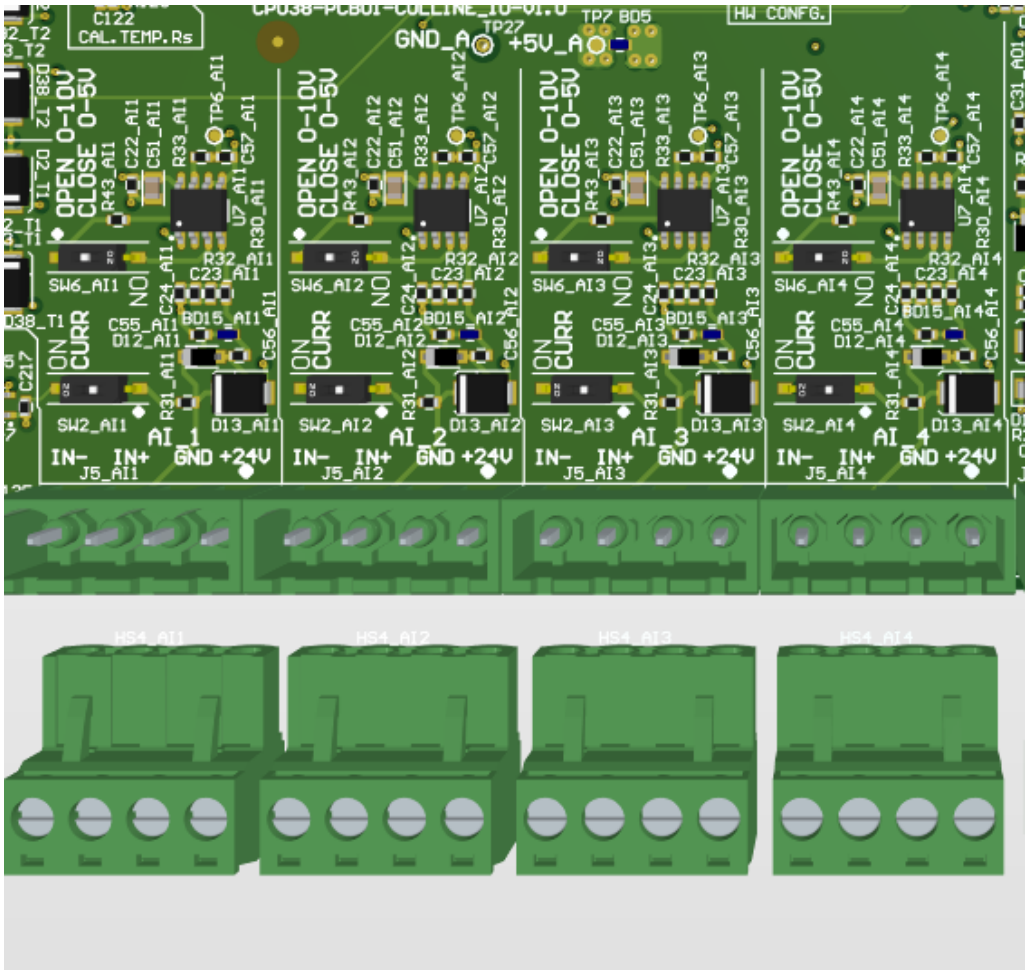

Figure 26: Analogue Inputs

1.10 Analogue Input to Measure Voltage connection

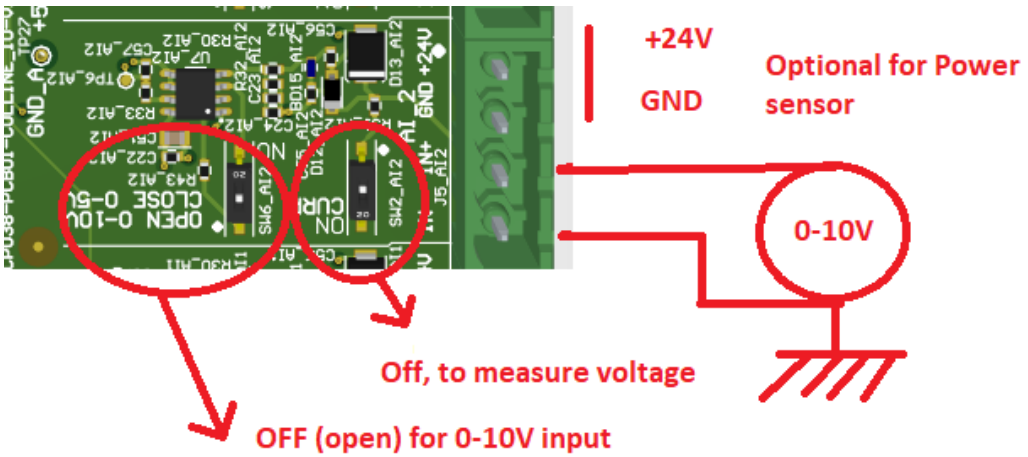

Figure 27: Analogue Voltage Input sensor connection for 0-10V input

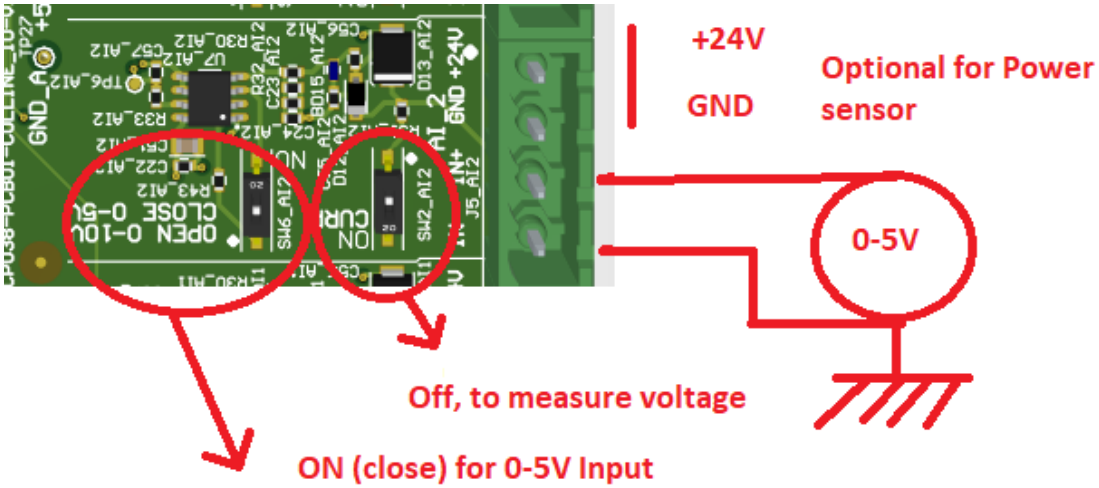

Figure 28: Analogue Voltage Input sensor connection for 0-5V input

2.10 Analogue Input to Measure Current Connection

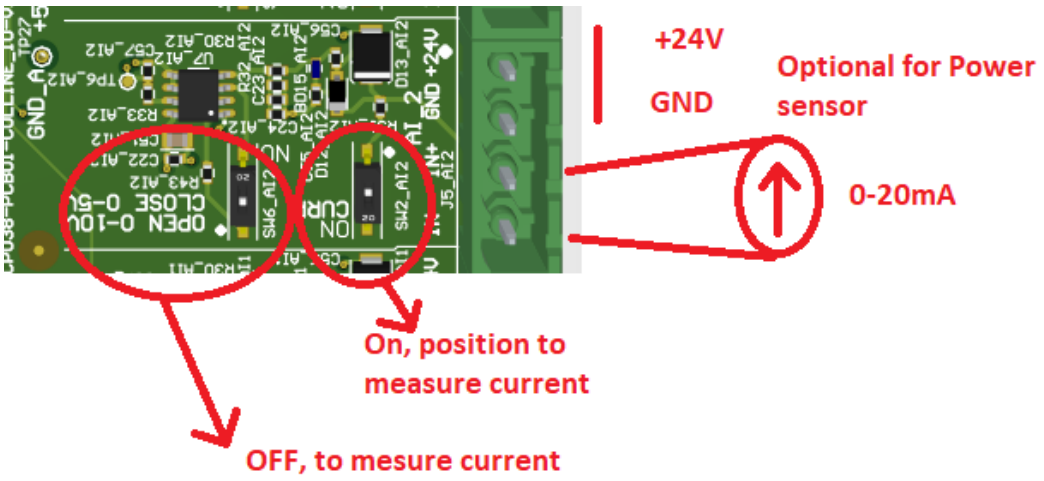

Figure 29: Analogue Current Input sensor connection

11 TEMPERATURE SENSOR INPUTS

There are three inputs for temperature measurements using a Pt-100 (not supplied).

Next picture shows de connectors:

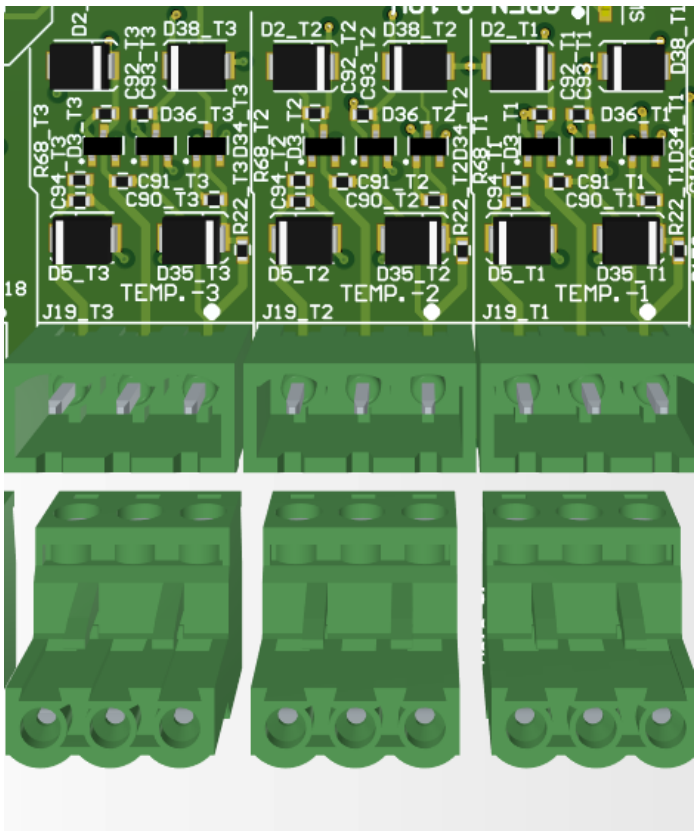

Figure 30: Temperature Connectors

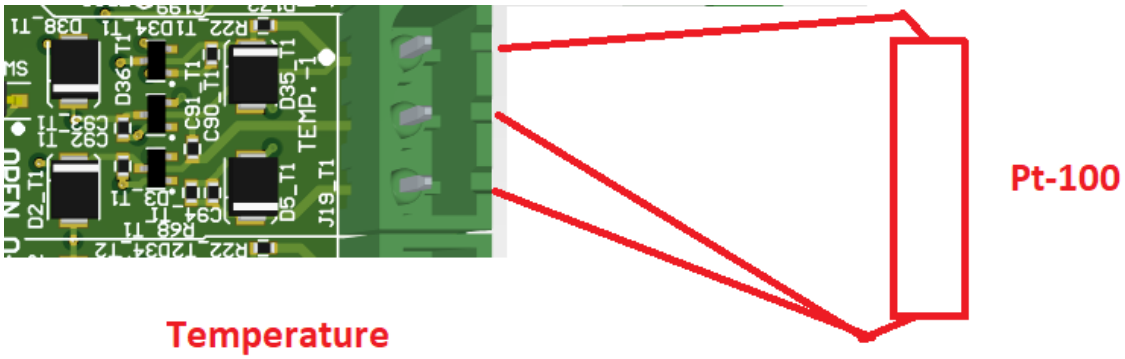

Figure 31: PT-100 sensor connection

12 SENSOR +-1V Connection

There is a connection for a sensor in the ±1V range. Next figure shows the connector and the way to connect:

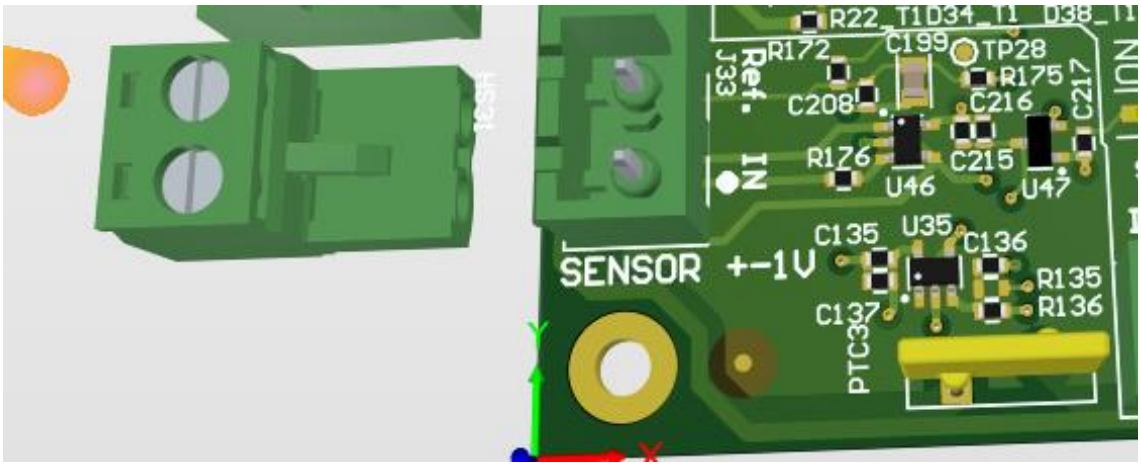

Figure 32: Partial View of the sensor ±1V connector

13 CAN & RS-232 DEDICATED PORTS

The board has a CAN and RS-232 dedicated ports. See next figure:

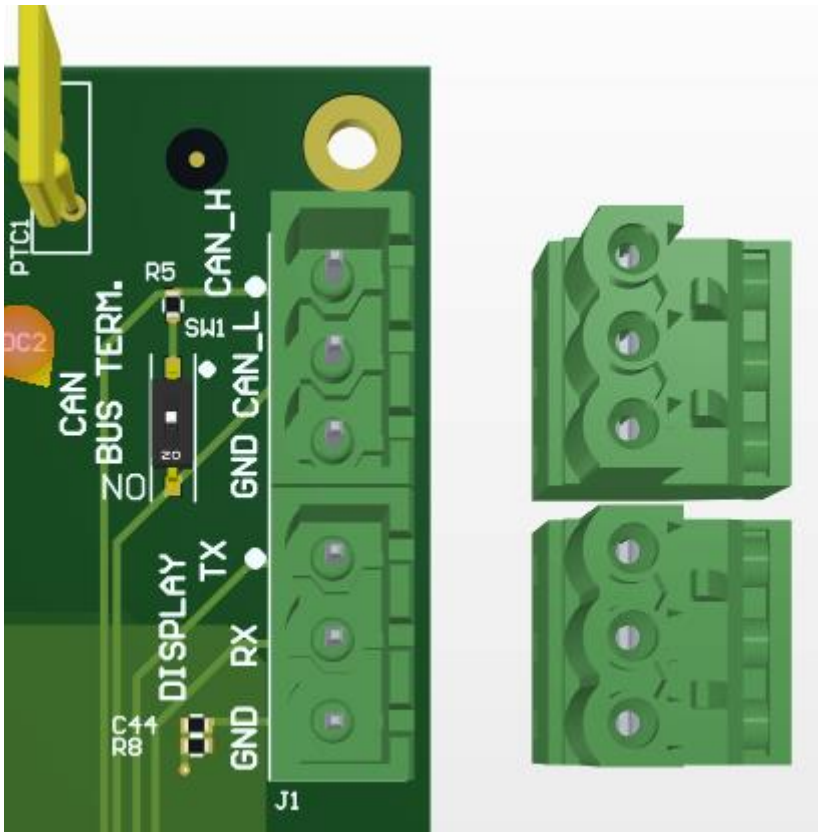

Figure 33: CAN and RS-232 PORTS

CAN bus can be terminated with a 120 Ohms resistor if SW1 is in "ON" position.

On RS-232 port a display with this interface can be connected. This allows a smart display/touch panel to be added when board is in Master mode.

14 FW UPDATE

To update the internal firmware of the board, we need "Bootloader Host", simply programme that can be found in PSOC Creator, a free IDE made by Cypress Semiconductor used for the developing of the application. Please download and install if not already done.

Bootloader Host can be found on [PSOC Creator x.x] Tools> Bootloader Host.

Please connect a USB cable between your computer and CN2.

After a successful firmware upload, the image shows on the application is similar to the following:

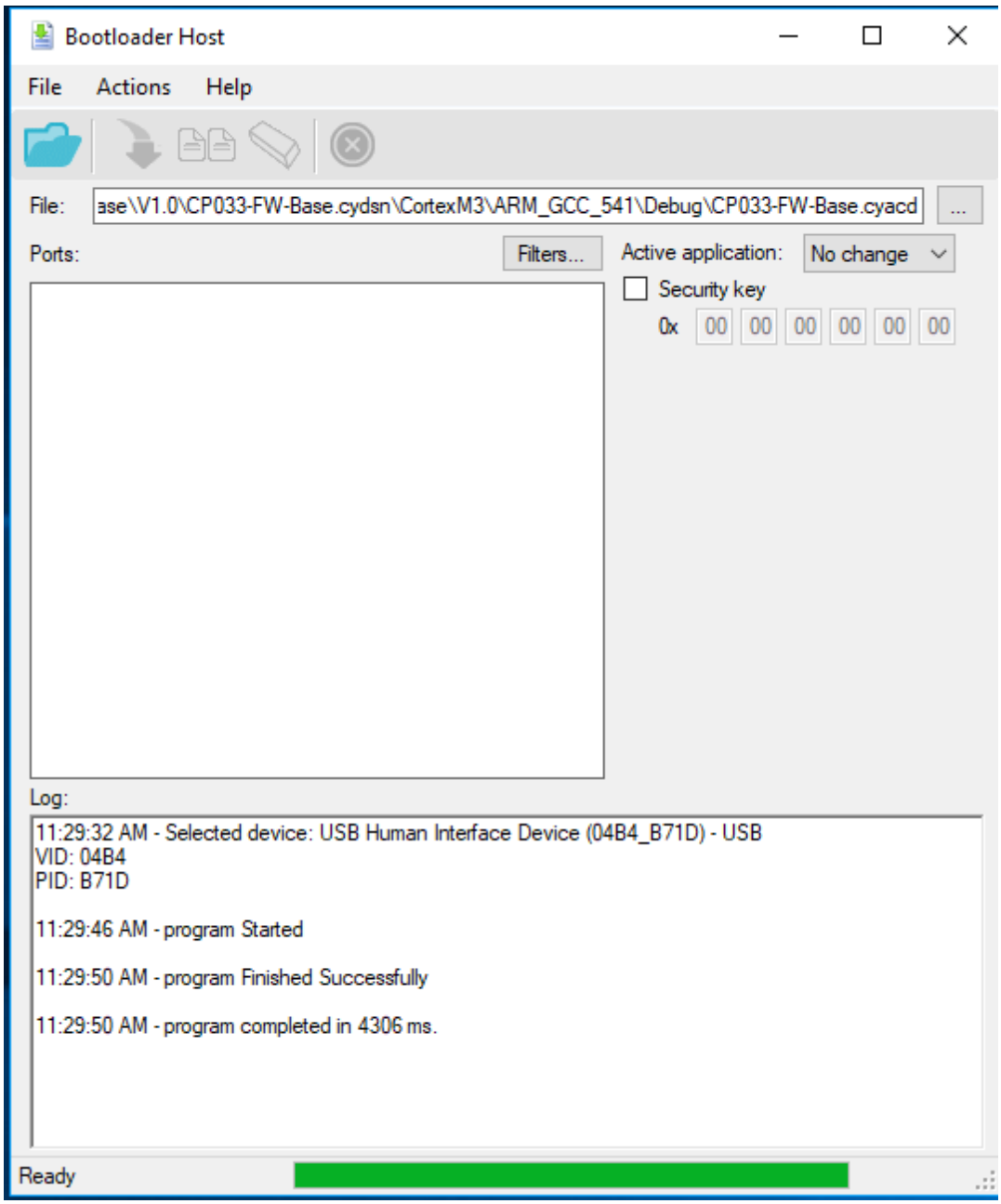

Figure 34: Bootloader Host

The upload file has a name similar to: CP038-FW01-CollineIO-Vx.x.cyacd

When the board is switched on or after a reset, the DL21 LED will remain lit, indicating that the card is waiting for new firmware. When this happens, we have to select the port that appears in Bootloader Host and give the "Program" button. This can be done during the first two seconds, after this time, the firmware that is currently recorded will take control.

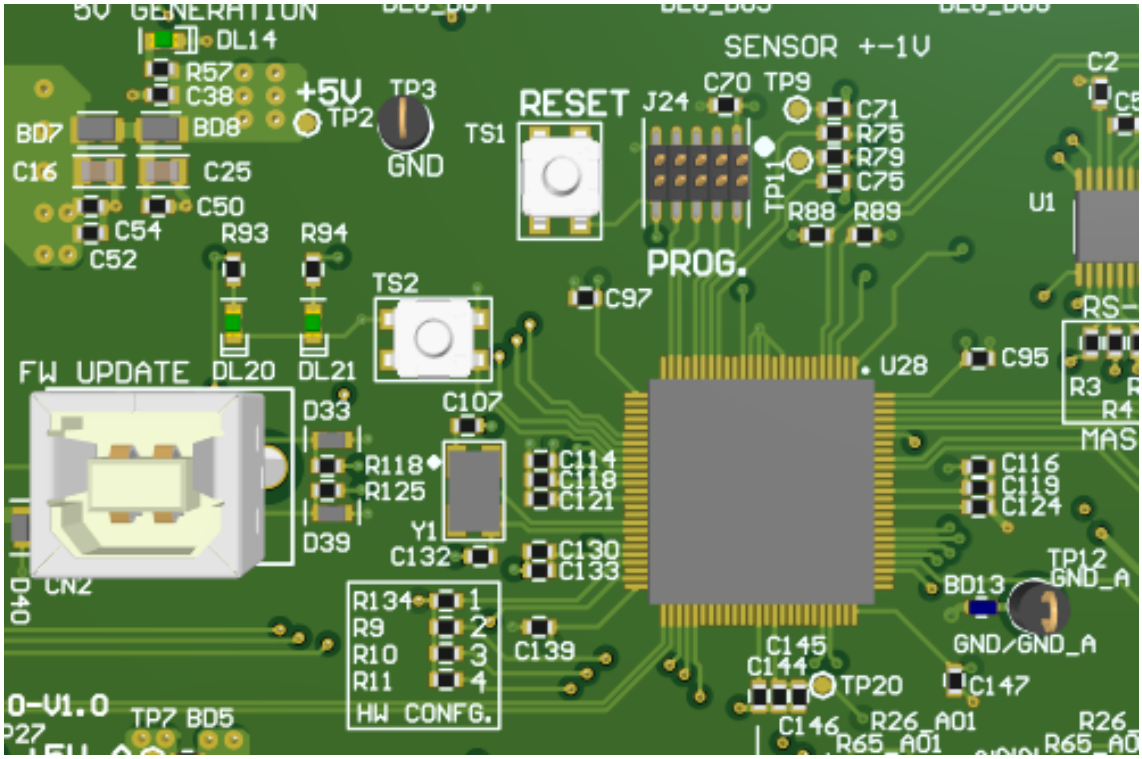

Figure 35: USB and Programming Connector

15 BOOTLOADER FIRMWARE (PRODUCTION)

This operation will only have to be carried out once, when the cards have been manufactured at CERRO.

Bootloader is the firmware that allows firmware update using USB port.

For programming, the following material will be necessary:

- Programmer KIT CY8CKIT-002 - **Miniprog3**
  Farnell code: 1753960 (Figure 36: Miniprog programmer from Cypress).
  See Figure 36: Miniprog programmer from Cypress
- **PSOC Programmer**, free software for programming. Download from ww.Cypress.com
- File: **CP033- bootloader.hex** (supplied by Cerro) and can be found in the Project (see Figure 37: Bootloader FW localization on project).

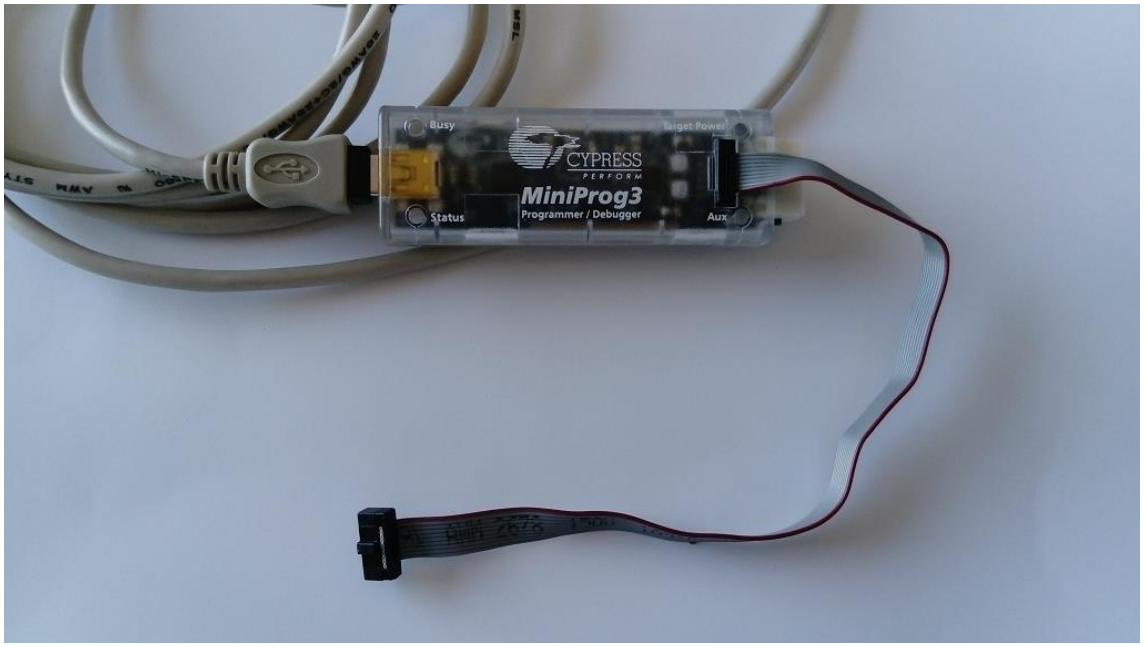

Figure 36: Miniprog programmer from Cypress

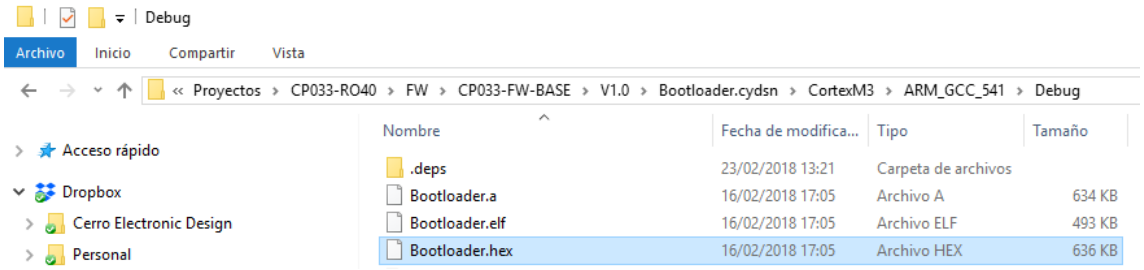

Figure 37: Bootloader FW localization on project

Miniprog must be connected on J24, connector with the label PROG, see Figure 35: USB and Programming Connector. Please pay attention to the polarity.

Next figure shows PSOC programmer after a first recording of the bootloader firmware

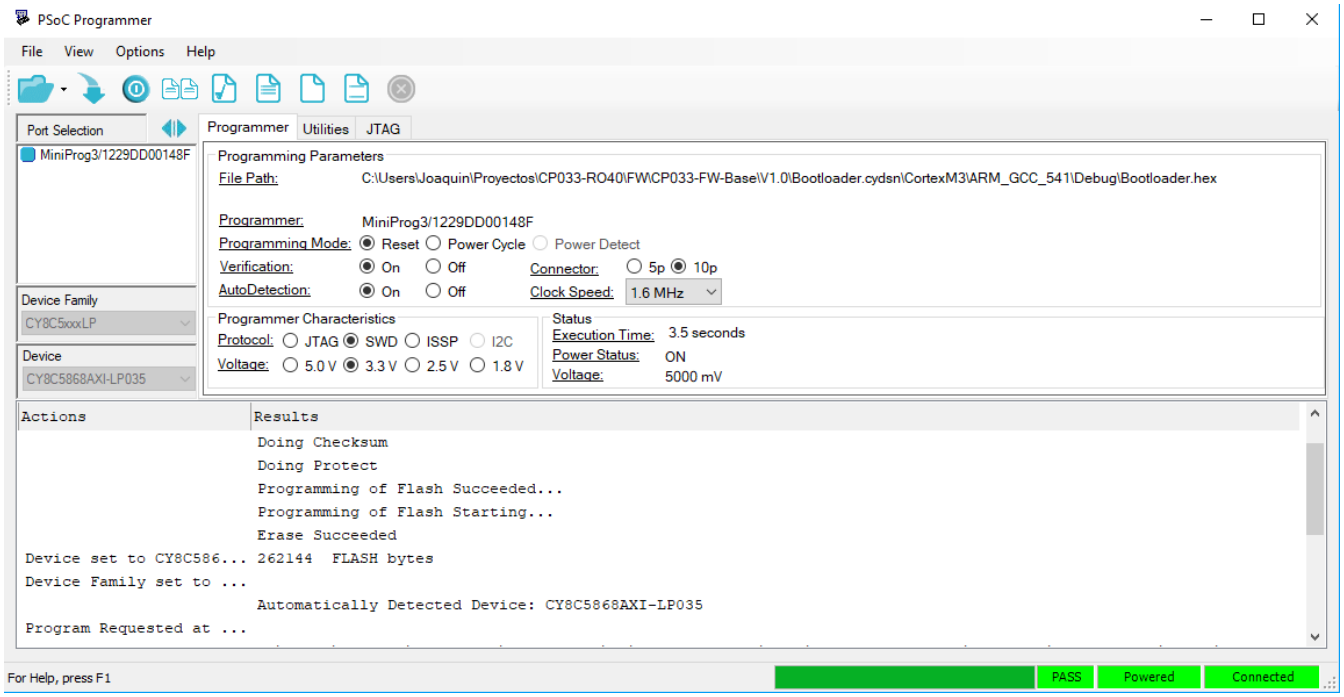

Figura 1: PSOC programmer screenshot