

OLIMEX
MOD-IO2
Extension Board



OLIMEX MOD-IO2 Extension Board User Manual

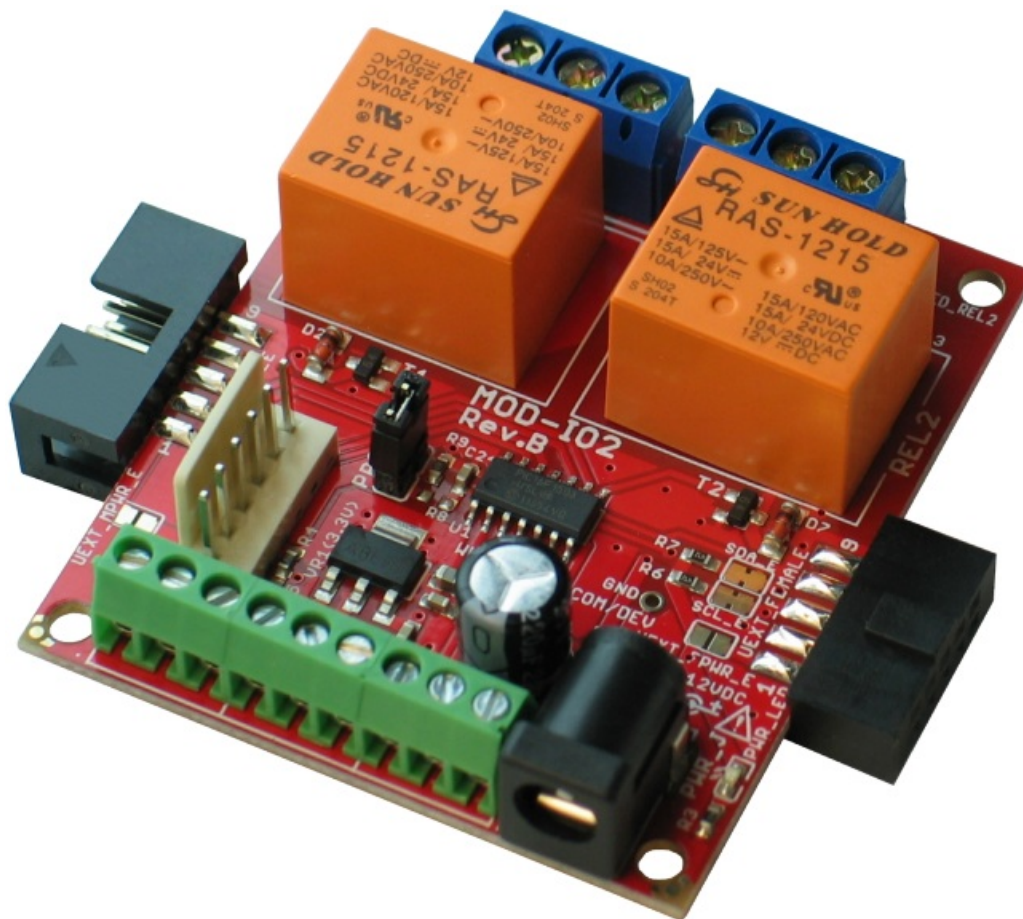
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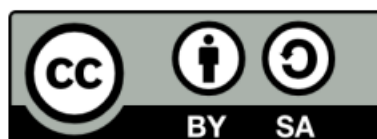
OLIMEX MOD-IO2 Extension Board



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CHAPTER 1 OVERVIEW

Introduction to the chapter

Thank you for choosing the MOD-IO2 single-board computer from Olimex! This document provides a user's guide for the Olimex MOD-IO2 board. As an overview, this chapter gives the scope of this document and lists the board's features. The differences between the members of the MOD-IO2 and MOD-IO boards are mentioned. The document's organization is then detailed. The MOD-IO2 development board enables code development of applications running on the microcontroller PIC16F1503, manufactured by Microchip.

Features

- PIC16F1503 microcontroller pre-loaded with open-source firmware for easier interfacing, especially with Linux-enabled boards
- Uses I2C, allows I2C address change
- Stack-able, UEXT male and female connectors
- 9-pin terminal screw connector for 7 GPIOs, 3.3V and GND
- 7 GPIOs which could be used for different purposes such as PWM, SPI, I2C, ANALOG IN/OUT, etc.
- 2 relay outputs with 15A/250VAC contacts with screw terminals
- RELAY output status LEDs
- ICSP 6-pin connector for in-circuit programming and updating with PIC-KIT3 or other compatible tool
- PWR jack for 12V DC
- Four mounting holes 3.3mm ~ (0.13)"
- UEXT female-female cable included
- FR-4, 1.5mm ~ (0.062)", red solder mask, white silkscreen component print
- Dimensions: (61 x 52)mm ~ (2.40 x 2.05)"

MOD-IO vs MOD-IO2

MOD-IO2 is a smaller input output extension module compared to MOD-IO both in terms of size and in terms of functionality, however, in a lot of situations, MOD-IO2 might provide a better choice. Designs that need optocouplers should consider MOD-IO. Additionally, MOD-IO has a better power supply with the option to provide voltage in the 8-30VDC range.

Target market and purpose of the board

MOD-IO2 is an extension development board that can interface with other Olimex boards via the UEXT connector it adds RELAYs and GPIOs. Multiple MOD-IO2s are stackable and addressable. The firmware allows you to interact with the board using simple commands and yet if you wish you can modify the firmware for your needs.

If you work with any of our development boards with UEXT connector and you need more GPIOs and RELAY outputs you can add these by connecting MOD-IO2 to your development board. This board allows easy interfacing to 2 relays and 7 GPIOs. MOD-IO2 is stackable and addressable – these boards can be plugged together and you can add as many inputs and outputs as you want! 2-4- 6-8 etc! MOD-IO2 has a PIC16F1503 microcontroller and the firmware is open-source and available for modification. The board is a very good addition to most of the Olimex boards if you need analog GPIOs and relays.

Organization

Each section in this document covers a separate topic, organized as follows:

- Chapter 1 is an overview of the board usage and features
- Chapter 2 provides a guide for quickly setting up the board
- Chapter 3 contains the general board diagram and layout
- Chapter 4 describes the component that is the heart of the board: the PIC16F1503
- Chapter 5 covers the connector pinout, peripherals, and jumper description
- Chapter 6 shows the memory map
- Chapter 7 provides the schematics
- Chapter 8 contains the revision history, useful links, and support information

CHAPTER 2 SETTING UP THE MOD-IO2 BOARD

Introduction to the chapter

This section helps you set up the MOD-IO2 development board for the first time. Please consider first, the electrostatic warning to avoid damaging the board, then discover the hardware and software required to operate the board. The procedure to power up the board is given, and a description of the default board behavior is detailed.

Electrostatic warning

MOD-IO2 is shipped in a protective anti-static package. The board must not be exposed to high electrostatic potentials. A grounding strap or similar protective device should be worn when handling the board. Avoid touching the component pins or any other metallic element.

Requirements

To set up the MOD-IO2 optimally, the following items are required:

- A board with a free data UART or any OLIMEX board that has a UEXT connector
- 12V source of power for the relay operation; it should fit the on-board power jack

If you wish to reprogram the board or modify the firmware you will also need:

- PIC compatible programmer – not that the connector for the ICSP programming is a 0.1" 6-pin one. We have a cheap compatible PIC16F1503 programmer based on Microchip's PIC-KIT3.
- Some of the suggested items can be purchased by Olimex, for instance:
- PIC-KIT3 – Olimex programmer capable of programming PIC16F1503 SY0612E – power supply adapter 12V/0.5A for European customers, comes with a power jack that fits the connector of MOD-IO2

Powering the board

The board is powered by the power jack. You should provide 12V DC. For the European customers, we sell an affordable power supply adapter 12V/0.5A – SY0612E. If you power the board correctly, the on-board PWR_LED will turn on.

Firmware description and basic usage under Linux

There is firmware loaded on the PIC of the board that allows easier use of MOD-IO2 via I2C protocol. The firmware of MOD-IO2 has gone through several iterations. The latest firmware revision is revision 4.3. To use the firmware with not-Linux enabled host boards please refer to the README.PDF in the archive that contains the firmware sources. Firmware revisions 1, 2, and 3 are NOT compatible. These firmware revisions define different MOD-IO2 board addresses and different command sets. Firmware revisions 3, 3.1, and 3.02 (3. xx), and 4.3 are

compatible. Please note that the custom firmware might NOT support all of the hardware capabilities of MODIO2. In some cases, you might need to adapt the firmware to use the hardware of MOD-IO2 to its full potential!

Custom software tool for controlling MOD-IO2 under Linux

To make things even simpler we have written a software tool for controlling MOD-IO2 under

Linux. You might find it here

<https://github.com/OLIMEX/OLINUXINO/tree/master/SOFTWARE/UEXT%20MODULES/>

MOD-IO2/Linux-access-tool

This software tool requires a Linux-enabled board. The tool works with MOD-IO2 units loaded with firmware revision 3 or newer. For full compatibility with the custom software tool, your MODIO2 board needs to use firmware revision 3.02 or newer. To use the tool simply place the file “modio2tool” on your board. Navigate to the folder where you placed it and type “./modio2tool -h” to get help on all of the available commands.

Most of the commands require the hardware I2C number as defined in your Linux distribution with parameter -B X, where X is the number of the I2C interface. Note that by default the software is set for use with hardware I2C interface #2 and board ID 0x21 – if your setup is different you would need to specify every time by using -B X (X is the hardware I2C number) and -A 0xXX (XX is the I2C address of the module).

Some examples of the usage of modio2tool and MOD-IO2 in Linux:

- – Bringing up the help menu:
- ./modio2tool -h
- , where
- ./modio2tool – executes the binary
- -h – parameter used to request the help information

Expected result: the format of commands would be shown and a list of commands would be printed.

- – Switching on both relays:
- ./modio2tool -B 0 -s 3
- , where
- -B 0 – sets the board to use its hardware I2C #0 (typically either “0”, “1”, or “2”)
- -s 3 – “s” is used to turn on the relays; “3” specifies to turn on both relays (use “1” or “2” for only the first or only the second relay)

Expected result: a specific sound would occur and relay LEDs would turn on.

- – Switching off both relays:
- ./modio2tool -B 0 -c 3
- , where
- B 0 – sets the board to use its hardware I2C #0 (typically either “0”, “1”, or “2”)
- c 3 – “c” is used to switch off the state relays; “3” specifies to turn off both relays (use “1” or “2” for only the first or only the second relay)

Expected result: a specific sound would occur and the relay LEDs would turn off.

- – Reading the status of the relays (available since MOD-IO2's firmware revision 3.02): `./modio2tool -B 0 -r`
- , where
- -B 0 – sets the board to use its hardware I2C #0 (typically either “0”, “1”, or “2”)
- -r – “r” is used to read the relays;

Expected result: the state of the relays will be printed. 0x03 means that both relays are on (equivalent to the binary 0x011).

Reading analog inputs:

- `./modio2tool -B 0 -A 1`
- , where
- -B 0 – sets the board to use its hardware I2C #0 (typically either “0”, “1”, or “2”)
- -A 1 – “A” is used to read the analog input; “1” is the analog input that is read – you can use “1”, “2”, “3” or “5” since not all AN signals are available.

Expected result: The voltage of the AN would be printed. If there is nothing connected it can be anything like “ADC1: 2.311V”.

- Changing the I2C address – if you use more than one MOD-IO2 (available since MOD-IO2's firmware revision 3.02)
- `./modio2tool -B 0 -x 15`
- , where
- -B 0 – sets the board to use its hardware I2C #0 (typically either “0”, “1”, or “2”)
- -x 15 – “x” is used to change the I2C address of the board; “15” is the desired number – it is different from the default “0x21”.
- Expected result: the board would have a new I2C address and you would need to specify it with -A 0xXX if you wish to use the modio2tools in the future.
- For more information refer to the help returned by modio2tools or to modio2tools's source code.

I2C-tools for controlling MOD-IO2 under Linux

Instead of the custom program mentioned in 2.4.1, you might use the popular Linux tool “i2c-tools”.

Download it with apt install i2c-tools

MOD-IO2 has been compatible with i2c tools since the release of its firmware 3. In that case, the commands are the most popular ones from the i2c-tools – `i2cdetect`, `i2cdump`, `i2cget`, `i2cset`. Use the above commands and the information about the firmware to send (`i2cset`) and receive (`i2cget`) different data. The information about the firmware is located in a README.pdf file in the archive of the firmware; the archive containing the latest firmware (4.3) might be found here:

https://www.olimex.com/Products/Modules/IO/MOD-IO2/resources/MOD-IO2_firmware_v43.zip

Some examples for setting/reading MOD-IO2's peripherals in Linux using i2c-tools

- – Turning on the relays:
- `i2cset -y 2 0x21 0x40 0x03`
- , where

- i2cset – command for sending data;
- -y – to skip the y/n confirmation prompt;
- 2 – board's hardware I2C number (typically 0 or 1 or 2);
- 0x21 – board address (0x21 should be used for writing);
- 0x40 – Turn on or off relay operation (as seen in the firmware README.pdf);
- 0x03 – should be interpreted as binary 011 – turns on both relays (0x02 would turn only second relay, 0x01 only the first, 0x00 would turn both off – 0x03 again would turn them off also);

Expected result: a specific sound would occur and relay lights would turn on.

Reading the status of the relays (available since MOD-IO2's firmware revision 3.02):

- i2cset -y 2 0x21 0x43 and then the read command
- i2cget -y 2 0x21
- , where
- i2cset – command for sending data;
- -y – to skip the y/n confirmation prompt;
- 2 – I2C number (usually 0, 1, or 2);
- 0x21 – board address (0x21 should be used for writing);
- 0x43 – read relay operations (as seen in the firmware README.pdf);

Expected results: 0x00 – meaning both relays are off; 0x03 – should be interpreted as binary 011, e.g. both relays are on; etc.

Reading analog inputs/outputs:

- i2cset -y 2 0x21 0x10 and then the read command
- i2cget -y 2 0x21
- , where
- 0x10 – the first analog IO;

The big thing here is that to read you have to write ("that you would read"). Read is a combination of i2cset and i2cget!

Expected results: on the terminal, you would receive random and changing numbers or 0x00 0x08, or 0xFF whether you have the GPIO floating or set to 0V or set to 3.3V.

- – Setting all analog IOs at a high level: i2cset -y 2 0x21 0x01 0x01
- , where
- 0x21 – the I2C address of the MOD-IO2
- 0x01 – according to the README.pdf is SET_TRIS is used to define port directions;
- 0x01 – the high level (for the low-level use 0x00)

Reading all analog IOs

- i2cset -y 2 0x21 0x01
- i2cget -y 2 0x21

- Detailed explanations of the preloaded software may be found in the demo package available on our web page.
- Changing I2C device address – if you use more than one MOD-IO2 (available since MODIO2's firmware revision 3.02) `i2cset 2 0x21 0xF0 0xHH`
- where

0xF0 is the command code for I2C change

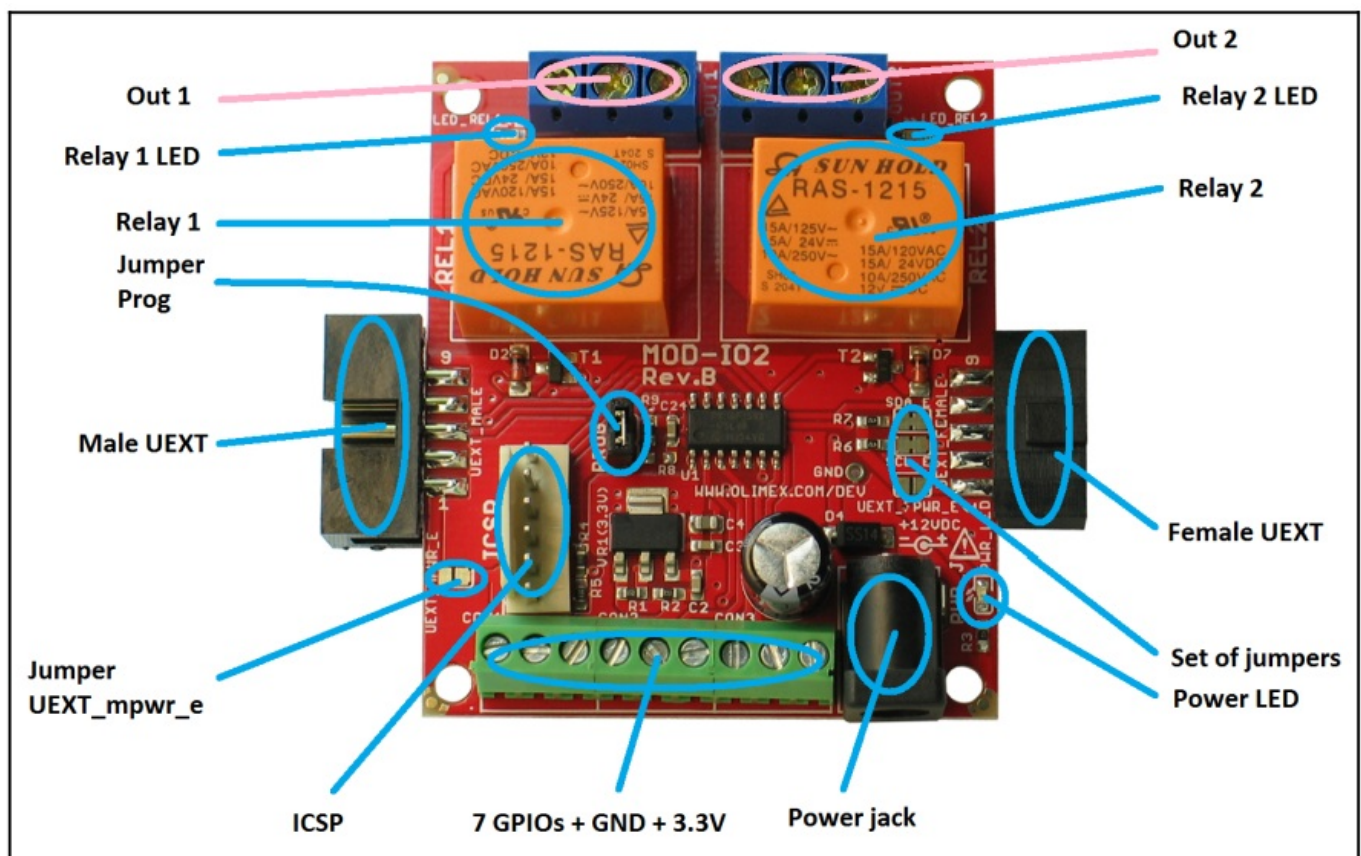
HH is a new address in hexadecimal format Note that the PROG jumper must be closed to be able to change the address. If you forget the number of the address you can use the modio2tool to find the address, the command and parameter would be "modio2tool -l". You can also reset the default address (0x21) with the command and parameter "modio2tool -X".

CHAPTER 3 MOD-IO2 BOARD DESCRIPTION

Introduction to the chapter

Here you get acquainted with the main parts of the board. Note the names used on the board differ from the names used to describe them. For the actual names check the MOD-IO2 board itself.

Layout (top view)



CHAPTER 4 THE PIC16F1503 MICROCONTROLLER

Introduction to the chapter

In this chapter is located the information about the heart of MOD-IO2 – its PIC16 microcontroller. The information below is a modified version of the datasheet provided by its manufacturers from Microchip.

The PIC16F1503 features

- Enhanced Mid-range Core with 49 Instructions, 16 Stack Levels
- Flash Program Memory with self-read/write capability
- Internal 16MHz oscillator
- 4x Standalone PWM Modules
- Complementary Waveform Generator (CWG) Module
- Numerically Controlled Oscillator (NCO) Module
- 2x Configurable Logic Cell (CLC) Modules
- Integrated Temperature Indicator Module
- Channel 10-bit ADC with Voltage Reference
- 5-bit Digital to Analog Converter (DAC)
- I2C, SPI
- 25mA Source/Sink current I/O
- 2x 8-bit Timers (TMR0/TMR2)
- 1x 16-bit Timer (TMR1)
- Extended Watchdog Timer (WDT)
- Enhanced Power-On/Off-Reset
- Low-Power Brown-Out Reset (LPBOR)
- Programmable Brown-out Reset (BOR)
- In-Circuit Serial Programming (ICSP)
- In-Circuit Debug using a Debug Header
- PIC16LF1503 (1.8V – 3.6V)
- PIC16F1503 (2.3V – 5.5V)

For comprehensive information on the microcontroller visit the Microchip's web page for a datasheet. At the moment of writing the microcontroller datasheet can be found at the following link:

<http://ww1.microchip.com/downloads/en/DeviceDoc/41607A.pdf>.

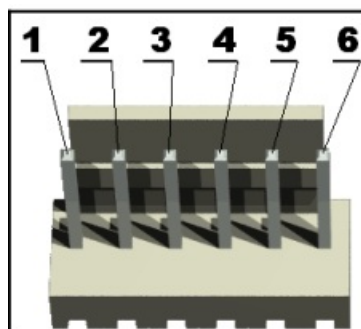
CHAPTER 5 CONNECTORS AND PINOUT

Introduction to the chapter

In this chapter are presented the connectors that can be found on the board all together with their pinout and notes about them. Jumper functions are described. Notes and info on specific peripherals are presented. Notes regarding the interfaces are given.

ICSP

The board can be programmed and debugged from the 6-pin ICSP. Below is the table of the JTAG. This interface can be used with Olimex's PIC-KIT3 debuggers.



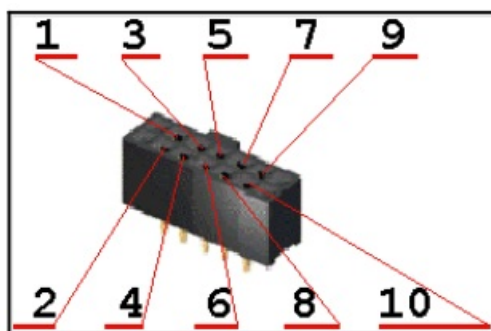
ICSP			
Pin #	Signal Name	Pin #	Signal Name
1	MCLAREN	4	GPIO0_ICSPDAT
2	+3.3V	5	GPIO0_ICSPCLK
3	GND	6	Not connected

UEXT modules

MOD-IO2 board has two UEXT connectors (male and female) and can interface with Olimex's UEXT boards. For more information on UEXT please visit: <https://www.olimex.com/Products/Modules/UEXT/>

Female connector

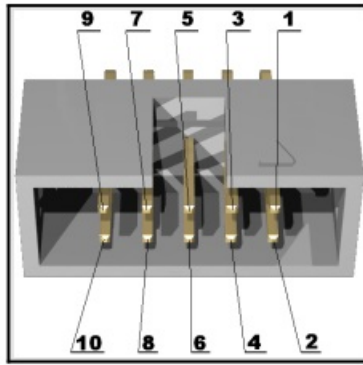
The female connector is used either to connect to a board directly (without using the female-female cable) or to connect the module to another MOD-IO2 – to create a stackable module that can be addressed via the I2C. Remember to change the I2C address of each board when using multiple boards. By default, the I2C address is 0x21.



Female UEXT			
Pin #	Signal name	Pin #	Signal name
1	+3.3V	6	SDA
2	GND	7	Not connected
3	Not connected	8	Not connected
4	Not connected	9	Not connected
5	SCL	10	Not connected

Male connector

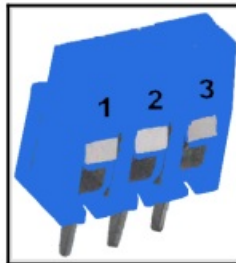
The male connector is used with the ribbon cable in the package to connect to another male UEXT or to connect to another MOD-IO2.



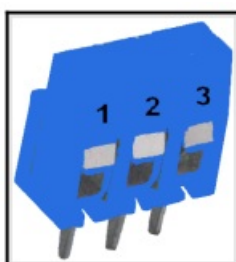
Male UEXT			
Pin #	Signal name	Pin #	Signal name
1	+3.3V	6	SDA
2	GND	7	Not connected
3	Not connected	8	Not connected
4	Not connected	9	Not connected
5	SCL	10	Not connected

Relay output connectors

There are two relays in MOD-IO. Their output signals are the standard Normal Closed (NC), Normal Open (NO), and Common (COM).



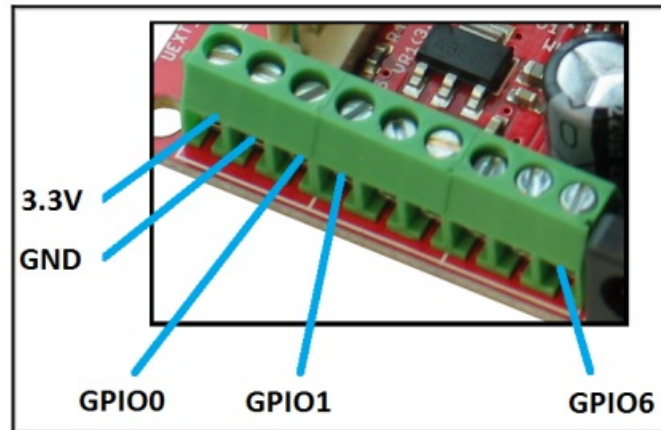
REL1 – OUT1	
Pin #	Signal name
1	NO – normal open
2	NC – normal closed
3	COM – common



REL2 – OUT2	
Pin #	Signal name
1	COM – common
2	NO – normal open
3	NC – normal closed

GPIO connectors

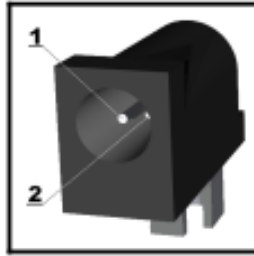
The GPIO connectors can be used to implement PWM, I2C, SPI, etc. Note that the names of each pin are also printed at the bottom of the board.



Pin #	Signal name	Analog Input
1	3.3V	–
2	GND	–
3	GPIO0	AN0
4	GPIO1	AN1
5	GPIO2	AN2
6	GPIO3	AN3
7	GPIO4	–
8	GPIO5	AN7
9	GPIO6	PWM

PWR Jack

The DC barrel jack has a 2.0mm inner pin and a 6.3mm hole. More information about the exact component might be found here: <https://www.olimex.com/wiki/PWRJACK> For European customers, we also stock and sell basic power supply adapters compatible with the power jack.



Pin #	Signal name
1	Power Input
2	GND

Jumper description

Please note that almost all (except PROG) of the jumpers on the board are SMD-type. If you feel insecure in your soldering/cutting technique it is better not to try adjusting SMD jumpers. Also if you feel incapable of removing the PTH jumper with hands better use tweezers.

PROG

PTH jumper required to change I2C address via software means. Used to restrict changing I2C address. If you want to change the I2C address you need to close it. The default position is open.

SDA_E/SCL_E

When you have more than one MOD-IO2 connected you need to keep those two jumpers closed, or else the I2C line will be disconnected. The default positions for both jumpers are closed.

UEXT_FPWR_E

If closed provide 3.3V at the female UEXT connector. (be careful since if you close that jumper also you close the male one on the next MOD-IO2 line this might cause an electrical burn to the board. The default position is open.

UEXT_MPWR_E

If closed provide 3.3V at the male UEXT connector. (be careful since if you close that jumper and also, close the female one on the next MOD-IO2 line this might cause an electrical burn to the board. The default position is open.

Additional hardware components

The components below are mounted on MOD-IO2 but are not discussed above. They are listed here for completeness: Relay LEDs + Power LED.

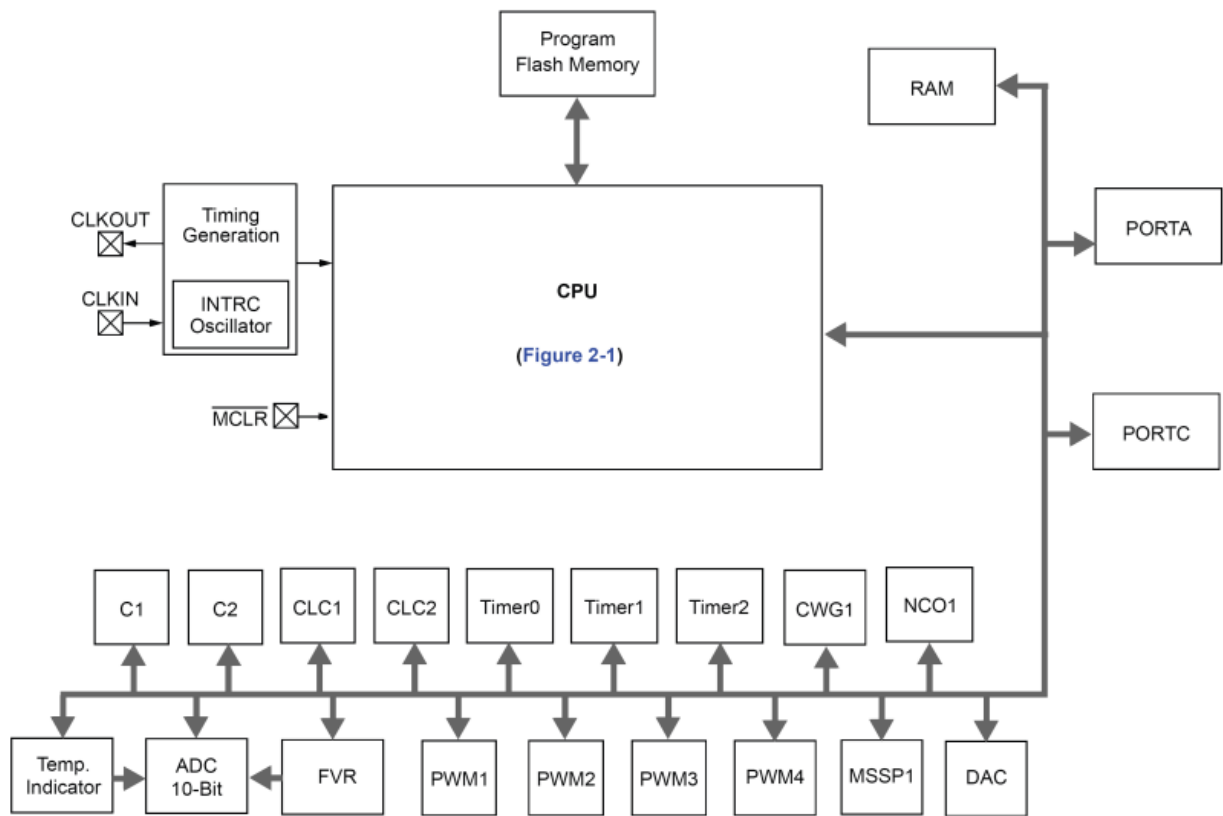
CHAPTER 6 BLOCK DIAGRAM AND MEMORY

Introduction to the chapter

Down this page, you can find a memory map for this family of processors. It is strongly recommended to refer to the original datasheet released by Microchip for one of higher quality.

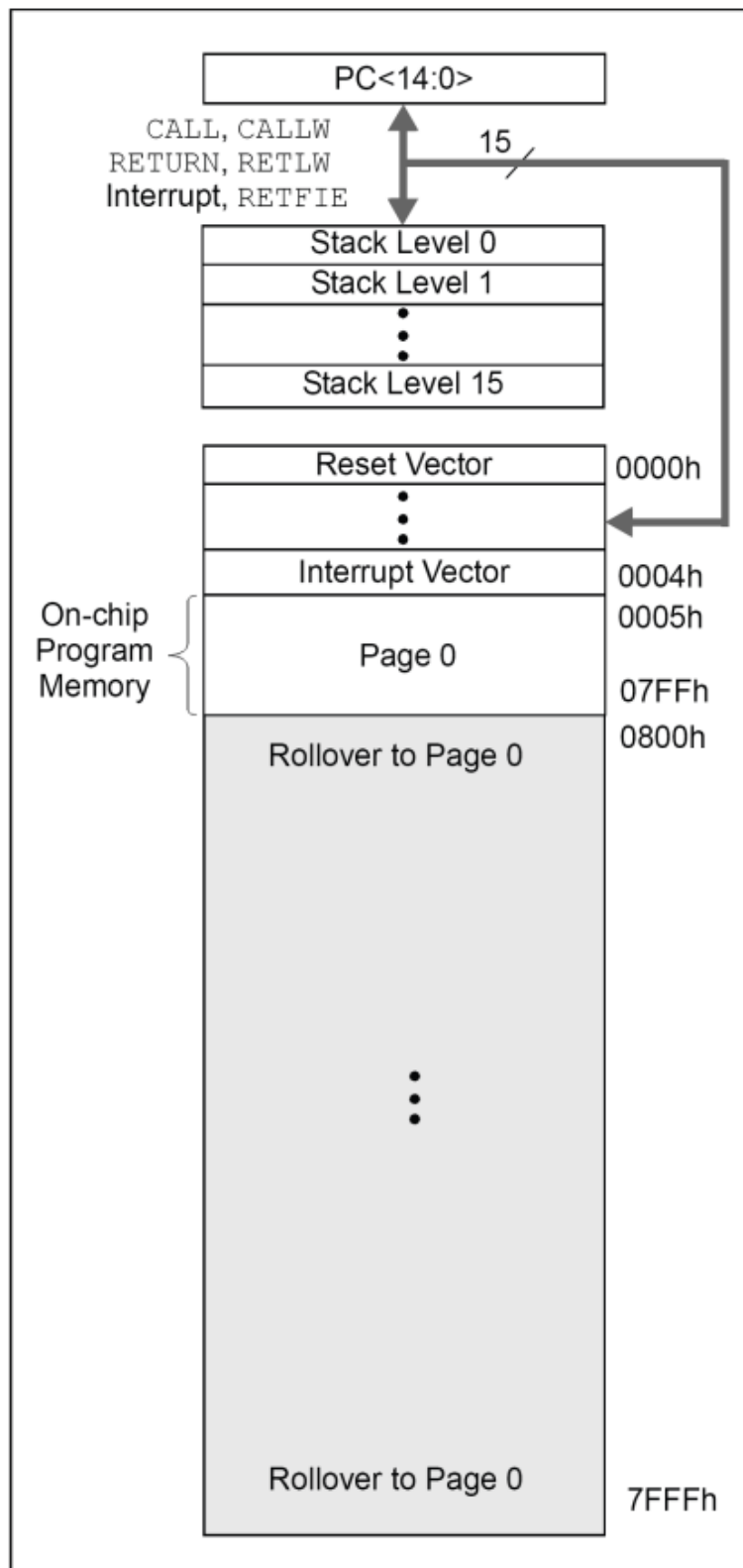
Processor block diagram

FIGURE 1-1: PIC16(L)F1503 BLOCK DIAGRAM



- Note**
- 1: See applicable chapters for more information on peripherals.
 - 2: See [Table 1-1](#) for peripherals available on specific devices.

Physical memory map



CHAPTER 7 SCHEMATICS

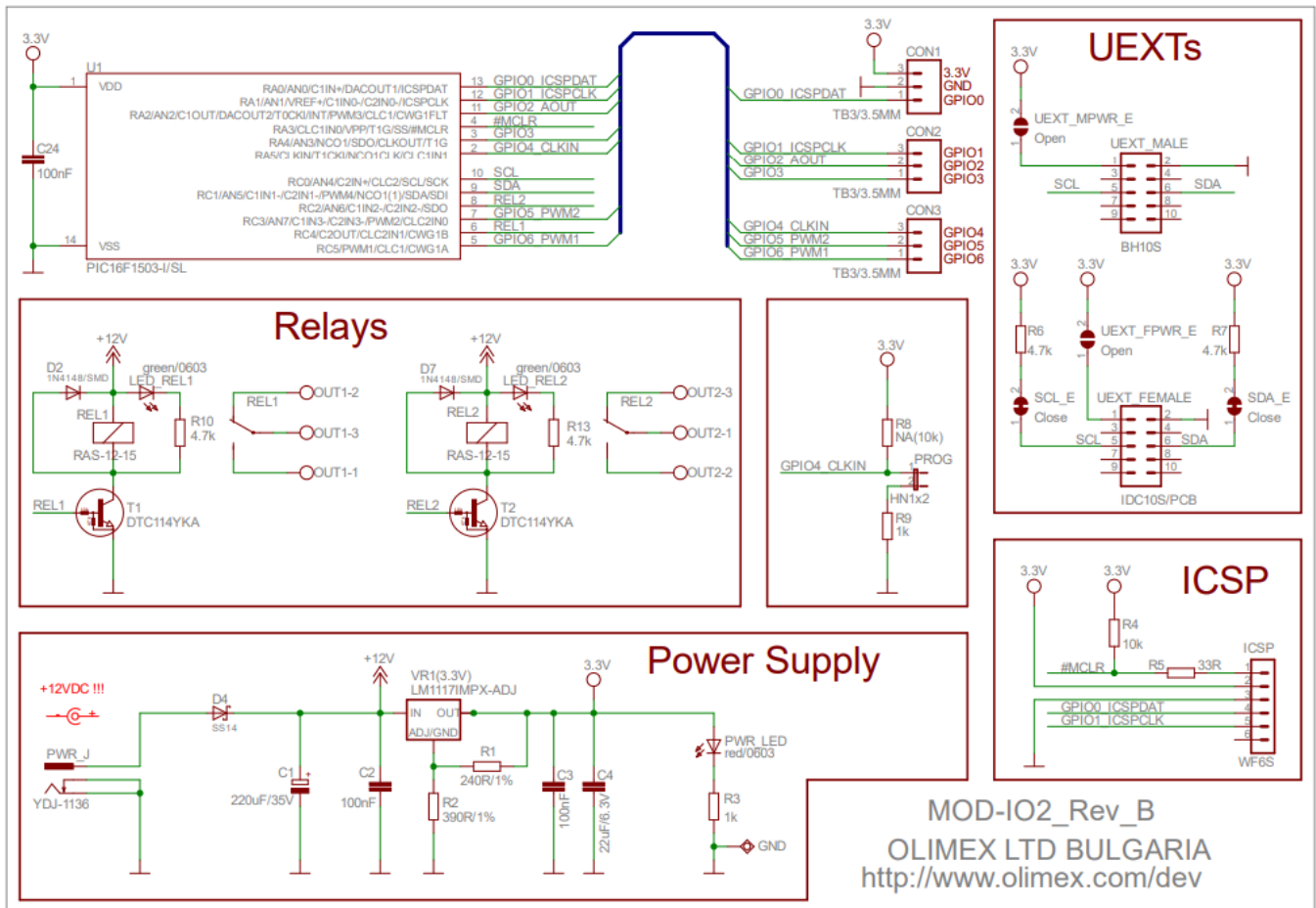
Introduction to the chapter

In this chapter are located the schematics describing logically and physically MOD-IO2.

Eagle schematic

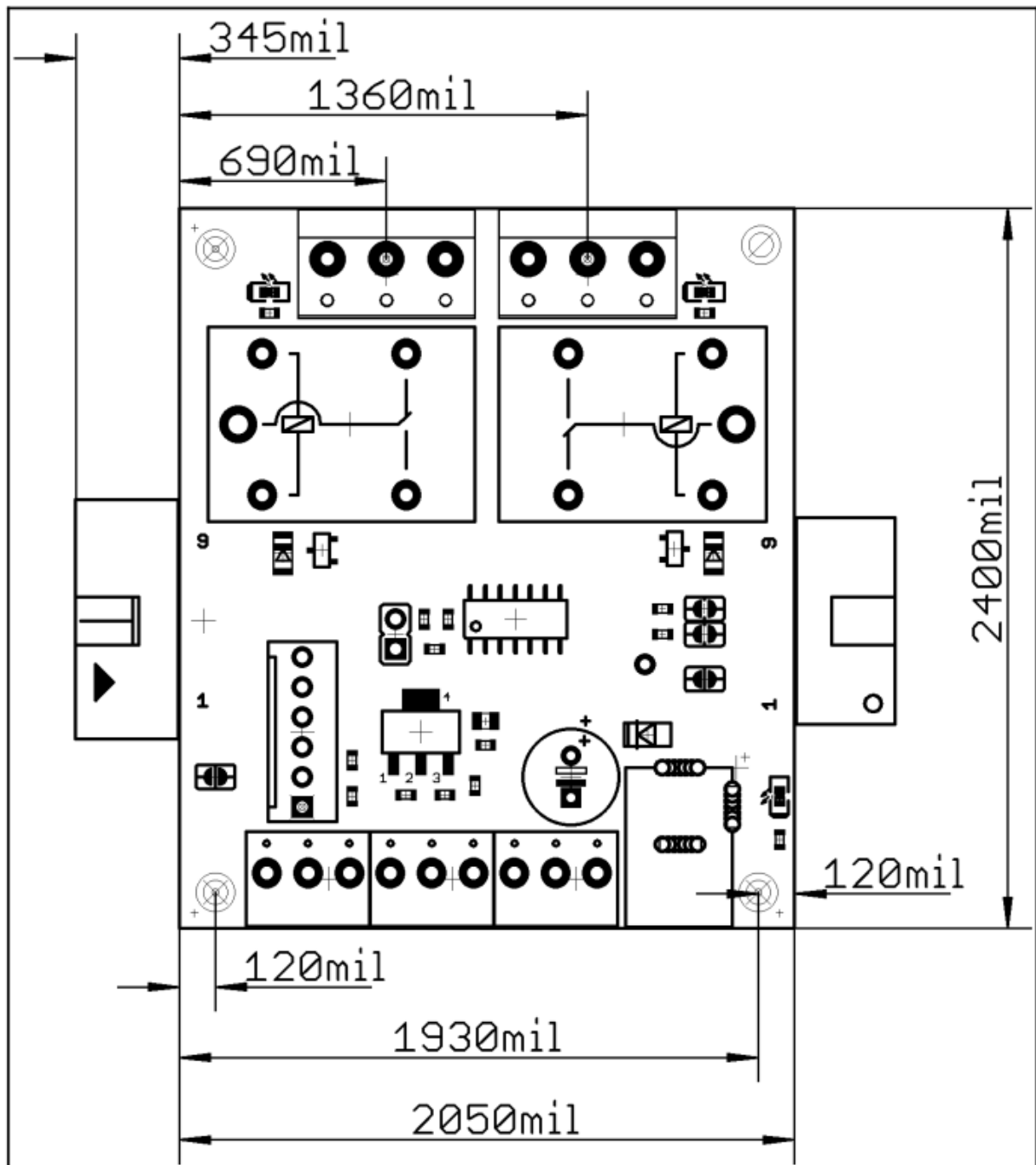
MOD-IO2 schematic is visible for reference here. You can also find it on the web page for MODIO2 at our site: <https://www.olimex.com/Products/Modules/IO/MOD-IO2/open-source-hardware> They are located in the **HARDWARE** section.

The EAGLE schematic is situated on the next page for quicker reference.



Physical dimensions

Note that all dimensions are in mils.



The three highest elements on the board in order from the tallest to the shortest are relay T1 – 0.600" (15.25 mm) over the pcb; relay T2 – 0.600" (15.25 mm); ICSP connector – 0.450" (11.43 mm). Note that the above measures do not include the PCB.

CHAPTER 8 REVISION HISTORY AND SUPPORT

Introduction to the chapter

In this chapter, you will find the current and the previous versions of the document you are reading. Also, the web page for your device is listed. Be sure to check it after purchase for the latest available updates and examples.

Document revision

Revision	Changes	Modified page#
A, 27.08.12	– Initial creation	All
	– Fixed several leftovers from the	
B, 16.10.12	template which was referencing wrong processors and boards	6, 10, 20
	– Updated links	
	– Updated Disclaimer to fit the open-source nature of the board	2
C, 24.10.13	– Added a few examples and firmware version 3 expla nation	7
	– Updated Product support	23
	– General formatting improvements	All
	– Updated the manual to reflect	
D, 27.05.15	latest firmware revision 3.02 – Added information about the new	7, 8, 9, 10, 11
	Linux tool – modio2tools	
E, 27.09.19	– Updated the manual to reflect the latest firmware re vision 4.3	7, 8, 9, 10, 11
F, 17.05.24	– fixed wrong info about the I2C address change com mand	13, 19

Board's revision

Revision, date	Revision notes
B, 18.06.12	Initial release

Useful web links and purchase codes

The web page you can visit for more info on your device is <https://www.olimex.com/mod-io2.html>.

ORDER CODES

- MOD-IO2 – the version of the board discussed in this document
- MOD-IO – the bigger version with optocouplers and an 8-30VDC power range option
- PIC-KIT3 – Olimex programmer capable of programming MOD-IO2
- SY0612E – power supply adapter 12V/0.5A for MOD-IO2 – 220V (European compatibility)

The latest price list can be found at <https://www.olimex.com/prices>.

How to order?

You can purchase directly from our online shop or any of our distributors. Note that usually, it is faster and cheaper to purchase Olimex products from our distributors. List of confirmed Olimex LTD distributors and resellers:

<https://www.olimex.com/Distributors>.

Check <https://www.olimex.com/> for more info.

Product support

For product support, hardware information, and error reports mail to: support@olimex.com. All document or hardware feedback is welcome. Note that we are primarily a hardware company and our software support is limited. Please consider reading the paragraph below about the warranty of Olimex products.

All goods are checked before they are sent out. In the unlikely event that goods are faulty, they must be returned, to OLIMEX at the address listed on your order invoice. OLIMEX will not accept goods that have been used more than the amount needed to evaluate their functionality.

If the goods are found to be in working condition, and the lack of functionality is a result of a lack of knowledge on the customer's part, no refund will be made, but the goods will be returned to the user at their expense. All returns must be authorized by an RMA Number. Email support@olimex.com for the authorization number before shipping back any merchandise. Please include your name, phone number, and order number in your email request.


Returns for any unaffected development board, programmer, tools, and cables are permitted within 7 days from the date of receipt of merchandise. After such time, all sales are considered final. Returns of incorrectly ordered items are allowed subject to a 10% restocking fee. What is unaffected? If you hooked it to power, you affected it. To be clear, this includes items that have been soldered to or have had their firmware changed. Because of the nature of the products we deal with (prototyping electronic tools), we cannot allow returns of items that have been programmed, powered up, or otherwise changed post-shipment from our warehouse. All returned merchandise must be in its original mint and clean condition. Returns on damaged, scratched, programmed, burnt, or otherwise 'played with' merchandise will not be accepted.

All returns must include all the factory accessories that come with the item. This includes any In-Circuit-Serial-

Programming cables, anti-static packing, boxes, etc. With your return, enclose your PO#. Also, include a brief letter of explanation of why the merchandise is being returned and state your request for either a refund or an exchange. Include the authorization number on this letter and the outside of the shipping box. Please note: It is your responsibility to ensure that returned goods reach us. Please use a reliable form of shipping. If we do not receive your package we will not be held liable. Shipping and handling charges are not refundable. We are not responsible for any shipping charges of merchandise being returned to us or returning working items to you.

The full text might be found at <https://www.olimex.com/wiki/GTC#Warranty> for future reference.

Documents / Resources

	<p>OLIMEX MOD-IO2 Extension Board [pdf] User Manual MOD-IO2 Extension Board, MOD-IO2, Extension Board, Board</p>
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References

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- [Products](#)
- [OLINUXINO/SOFTWARE/UEXT MODULES at master · OLIMEX/OLINUXINO · GitHub](#)
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