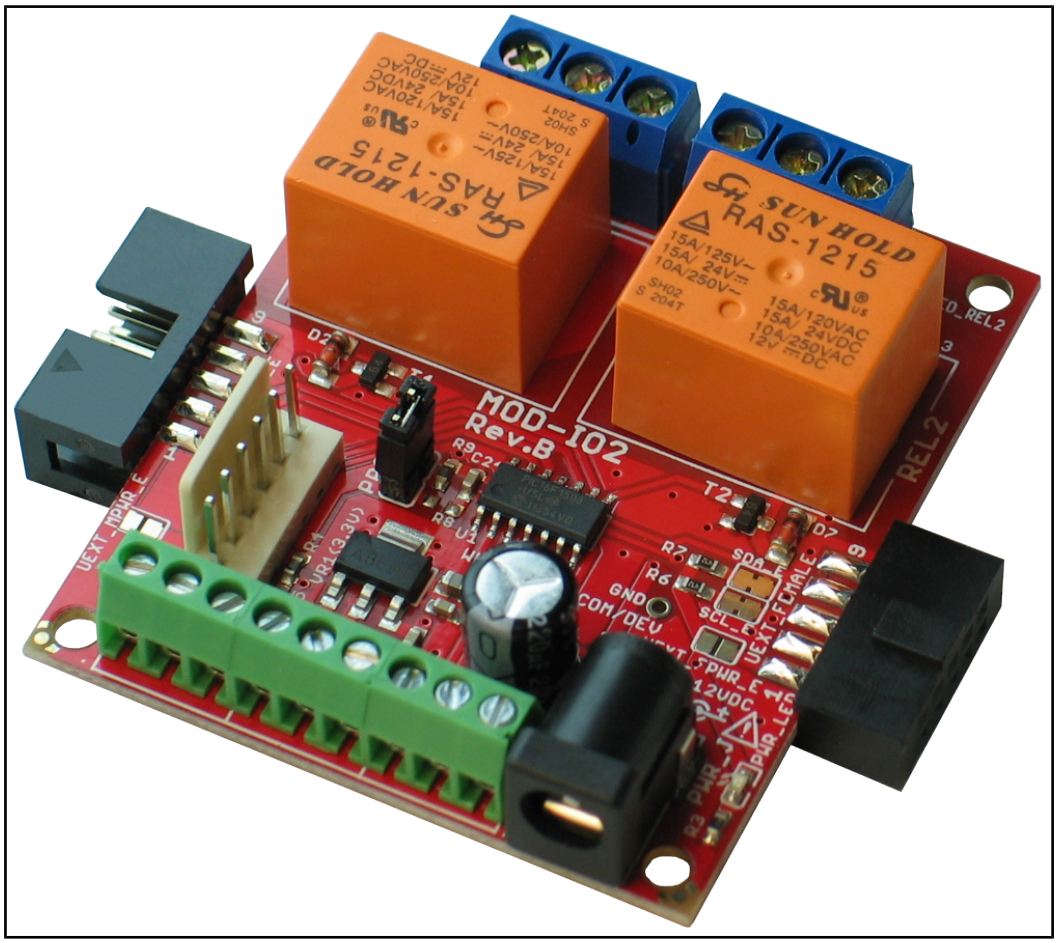

MOD-IO2 extension board
USER'S MANUAL

Revision C, October 2013
Designed by OLIMEX Ltd, 2012

lead-free

All boards produced by Olimex LTD are ROHS compliant

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It is possible that the pictures in this manual differ from the latest revision of the board.

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THERE IS NO WARRANTY FOR THE DESIGN MATERIALS AND THE COMPONENTS USED TO CREATE MOD-IO2. THEY ARE CONSIDERED SUITABLE ONLY FOR MOD-IO2.

Table of Contents

CHAPTER 1 OVERVIEW

1. 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.

1.1 Features

- PIC16F1503 microcontroller
- ICSP 6 pin connector for in-circuit programming with PIC-ICD2-POCKET and PIC-KIT3 or other compatible programmer/debugger.
- 9-pin terminal screw connector for 7 GPIOs 3.3V and GND
- PWR jack for 12VDC
- 7 GPIOs which could implement different functionality as PWM, SPI, I2C etc.
- 2 relay outputs with 15A/250VAC contacts with screw terminals
- RELAY output status LEDs
- Both male and female UEXT connectors
- Four mounting holes 3.3 mm (0.13")
- UEXT female-female cable included
- FR-4, 1.5 mm (0.062"), soldermask, white silkscreen component print
- dimensions 61x52 mm (2.4 x 2.05")

1.2 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 the better choice. Designs which need optocouplers should consider MOD-IO. In a lot of the other cases MOD-IO2 might be the better choice since it is possible to stack multiple MOD-IO2's over each other.

MOD-IO has a better power supply with the option to be supplied in the range of 8-30VDC.

1.3 Target market and purpose of the board

MOD-IO2 is an extension development board which can interface other Olimex boards via UEXT connector it adds add 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 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.

1.4 Organization

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

- 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

2. 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.

2.1 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.

2.2 Requirements

In order to set up the MOD-IO2 optimally, the following items are required:

- Any OLIMEX board that has an UEXT connector
- 12V source of power

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

- PIC ICSP compatible programmer – not that the connector for the ICSP programing is the standard 0.1" 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

2.3 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 PWR_LED

2.4 Firmware and basic usage under Linux

Upon powering initially the board's red PWR_LED and the green LED_REL1 should turn on.

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 3.

To use the firmware with not-Linux enabled host boards please refer to the README.txt in the archive that contains the firmware sources.

Firmware revisions are not backwards compatible. The firmware revisions define different MOD-IO2 board addresses and different command set.

For instance, firmware 3 has address 0x21 BUT the thing is the whole protocol should now comply with the i2c-tools for Linux (here: http://www.lm-sensors.org/wiki/I2CTools). Which means there is no need to use the custom i2ctool command that was used in firmware versions 1 and 2. Forget about i2ctool command – it was custom made and is no longer used.

2.4.1 What are the commands

The commands are the ones from the i2c-tools – i2cdetect, i2cdump, i2cget, i2cset. More information might be found here: http://www.lm-sensors.org/wiki/i2cToolsDocumentation.

2.4.2 How to control the firmware

Use the above commands and the information in the README.txt file to send (i2cset) and receive (i2cget) different data. The README.txt might be found in firmware 3's archive: https://www.olimex.com/Products/Modules/IO/MOD-IO2/resources/MOD-IO2_firmware_v3.zip.

2.4.3 Some examples for setting/reading MOD-IO2's peripherals

-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 – I2C number (usually either 1 or 2);
0x21 – board address (0x21 should be used for writing);
0x40 – relay operations (as seen in the README.txt);
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 analog inputs/outputs:

```
i2cset –y 2 0x21 0x10,
```

and then the read command

```
i2cget –y 2 0x21,
```

where

0x10 is the first analog IO;

The big thing here is that to read you actually 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 number or 0x00 or 0x08 or 0xFF whether you have the GPIO floating or set to 0V or set to 3.3V.

-Reading the ID of MOD-IO2:

```
i2cset –y 2 0x21 0x20,
```

```
i2cget –y 2 0x21,
```

where

0x20 is the ID according to the README.txt

Expected result: on the terminal you would receive 0x23.

-Setting all analog IOs at high level:

```
i2cset –y 2 0x21 0x01 0x01,
```

where

0x01 according to the README.txt is SET_TRIS is used to define port directions;
0x01 is the high level (for low level use 0x00).

-Reading all analog IOs:

```
i2cset –y 2 0x21 0x01
i2cget –y 2 0x21
```

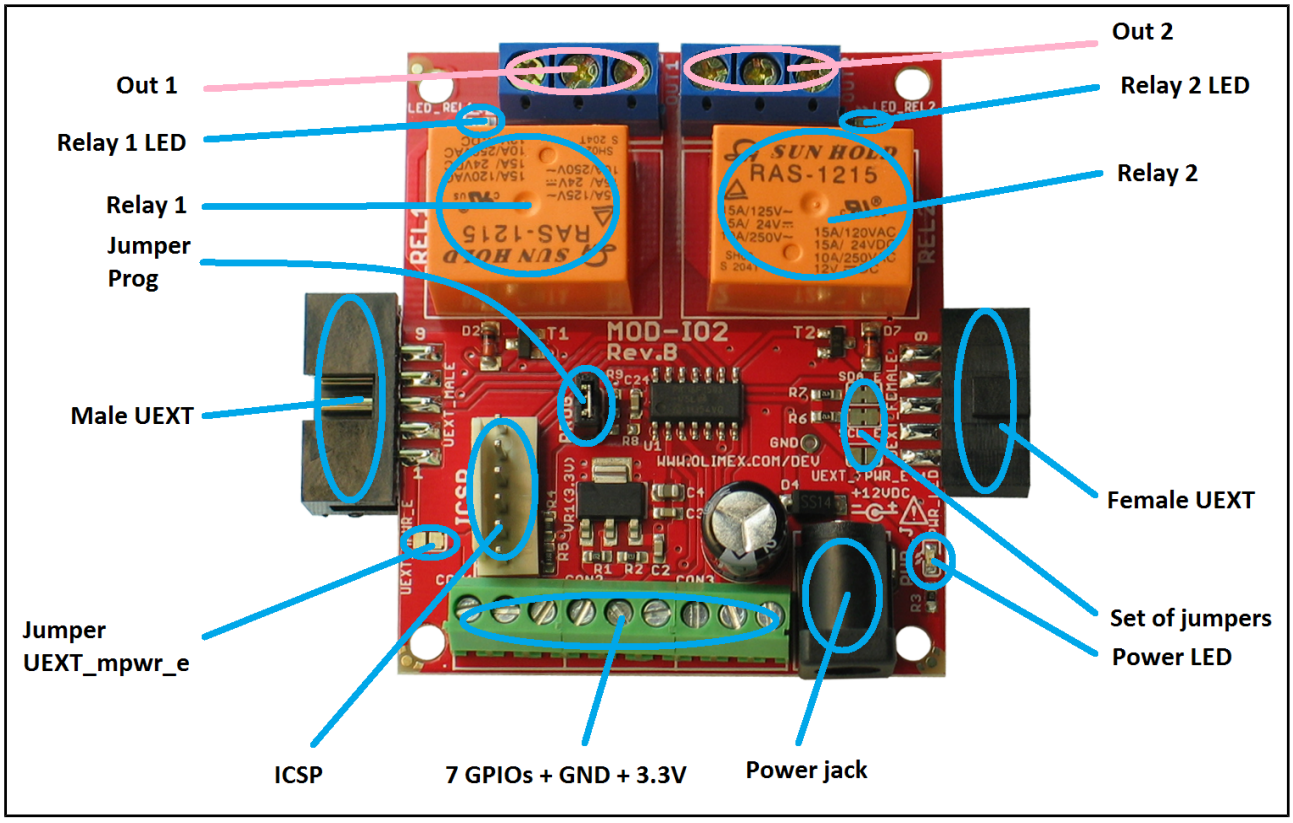
Detailed explanation of the preloaded software may be found in the demo package available at our web-page.

CHAPTER 3 MOD-IO2 BOARD DESCRIPTION

3. 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.

3.1 Layout (top view)



CHAPTER 4 THE PIC16F1503 MICROCONTROLLER

4. 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.

4.1 The PIC16F1503 features

- Enhanced Mid-range Core with 49 Instruction, 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
- 8 Channel 10-bit ADC with Voltage Reference
- 5-bit Digital to Analog Converter (DAC)
- MI2C, 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

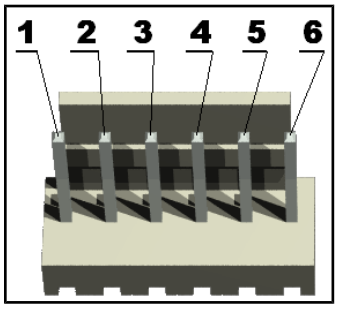
5. Introduction to the chapter

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

5.1 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 the Olimex's PIC-KIT3 debuggers.

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



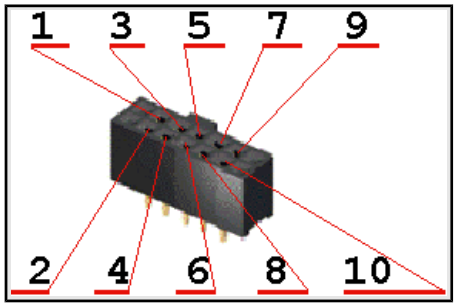
5.2 UEXT modules

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

5.2.1 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.

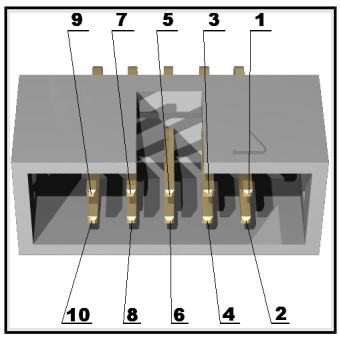
Female UEXT			
Pin #	Signal name	Pin #	Signal name
1	+3.3V	6	SDA
2	GND	7	Not connected
3	Not connected	8	Not connected
4	Not connected	9	Not connected
5	SCL	10	Not connected



5.2.2 Male connector

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

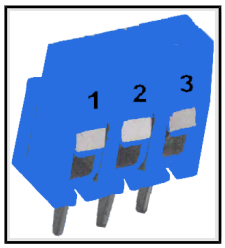
Male UEXT			
Pin #	Signal name	Pin #	Signal name
1	+3.3V	6	SDA
2	GND	7	Not connected
3	Not connected	8	Not connected
4	Not connected	9	Not connected
5	SCL	10	Not connected



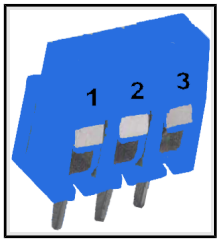
5.3 Relay output connectors

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

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



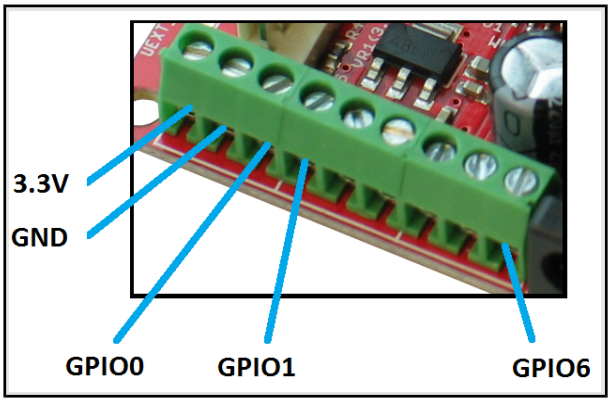
REL2 - OUT2	
Pin #	Signal name
1	COM - common
2	NO – normal open
3	NC – normal closed



5.4 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.

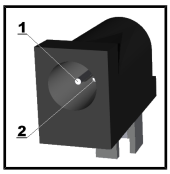
Pin #	Signal name
1	3.3V
2	GND
3	GPIO0
4	GPIO1
5	GPIO2
6	GPIO3
7	GPIO4
8	GPIO5
9	GPIO6



5.5 PWR Jack

The power jack used is the typical 2.5mm one used by Olimex in most of our products. You should provide 12 @ 1A to the board.

Pin #	Signal Name
1	Power Input
2	GND



5.6 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.

5.6.1 PROG

When closed this jumper allows addressing a single MOD-IO2 (the one with the closed jumper) over all others stacked to it – since initially all connected MOD-IO2 boards have the same address. After you have closed PROG on one of the MOD-IO2s you can communicate with that one via the UEXT using the commands found in the commands list that can be found on the product's web page.

Default position is open.

5.6.2 SDA_E/SCL_E

When you have more than one MOD-IO2 connected you need to keep those two jumpers closed, else the I2C line will be disconnected.

The default positions for both jumpers are closed/soldered.

5.6.3 UEXT_FPWR_E

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

Default position is open/unsoldered.

5.6.4 UEXT_MPWR_E

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

The default position is open/unsoldered.

5.7 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

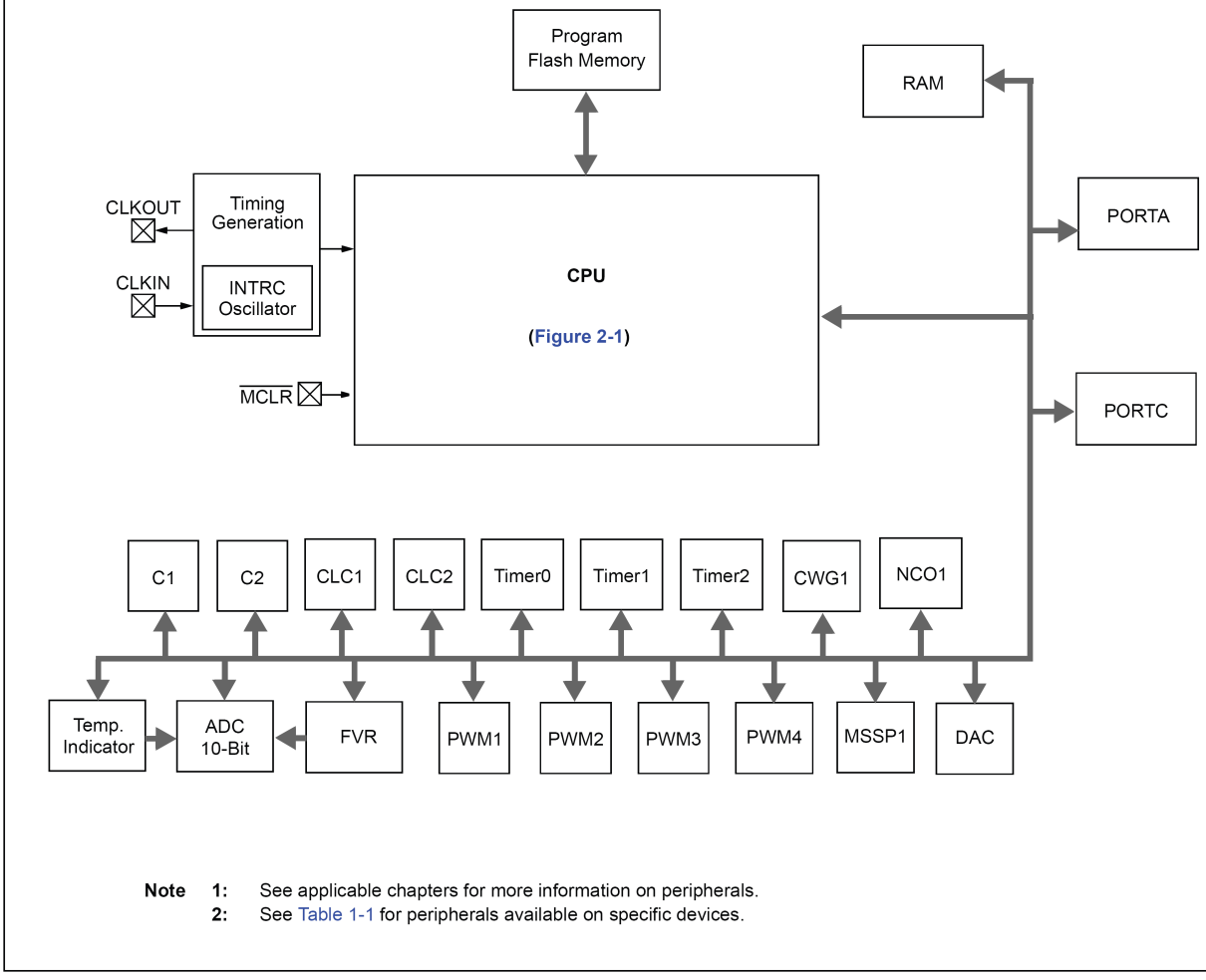
CHAPTER 6 BLOCK DIAGRAM AND MEMORY

6. 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.

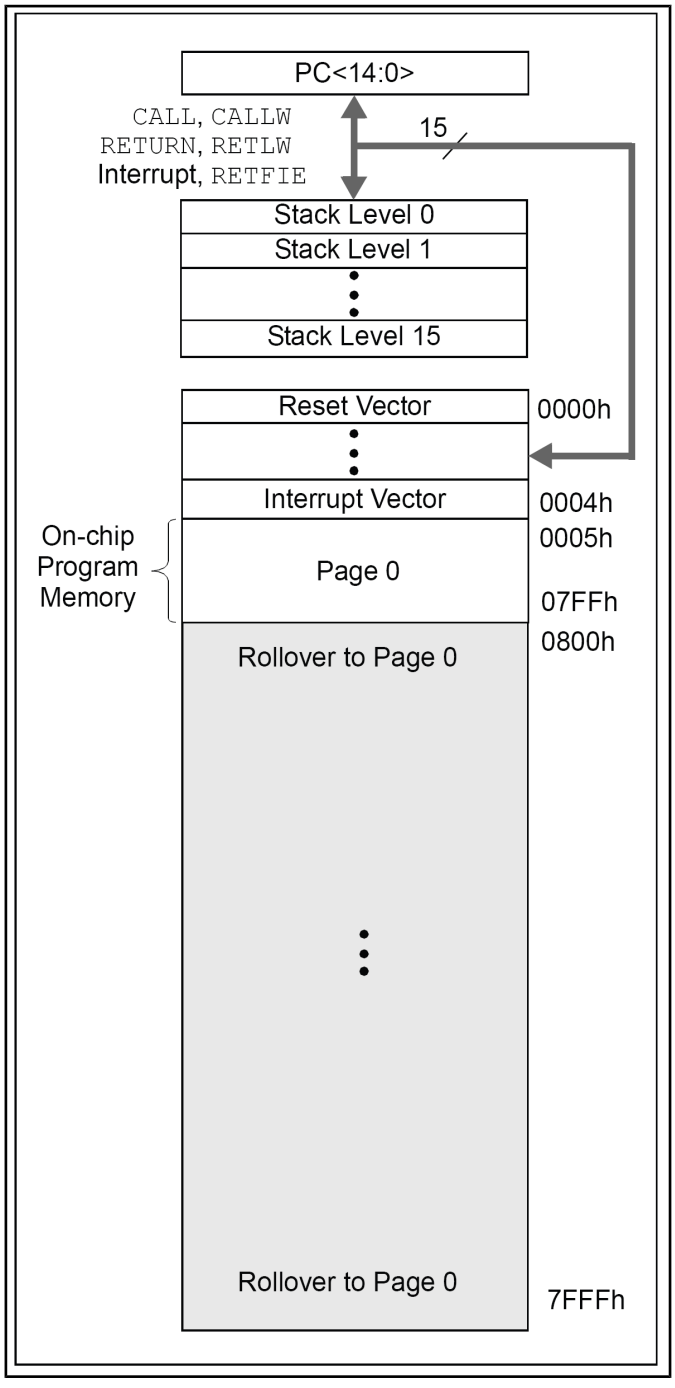
6.1 Processor block diagram

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.

6.2 Physical memory map



CHAPTER 7 SCHEMATICS

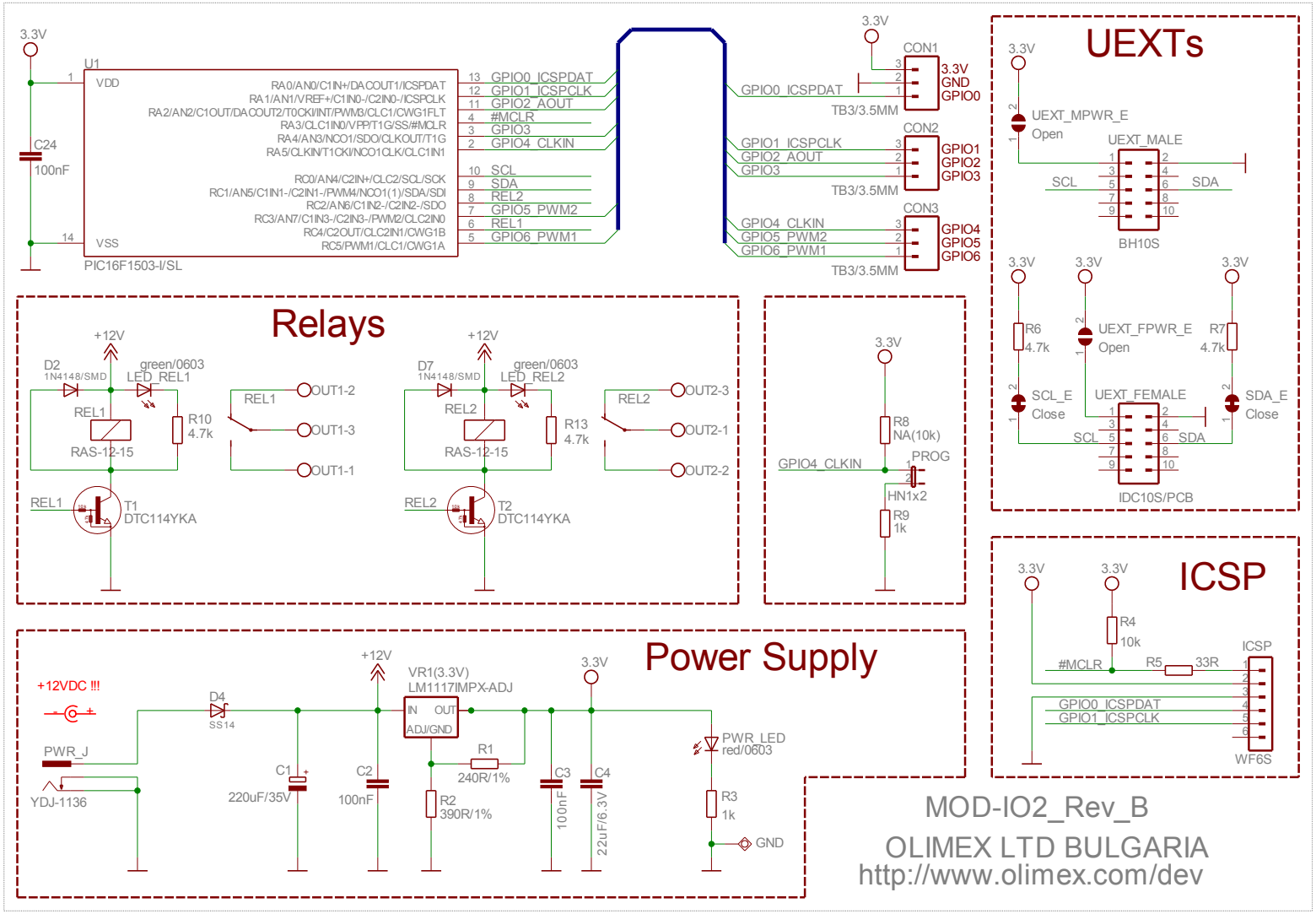
7. Introduction to the chapter

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

7.1 Eagle schematic

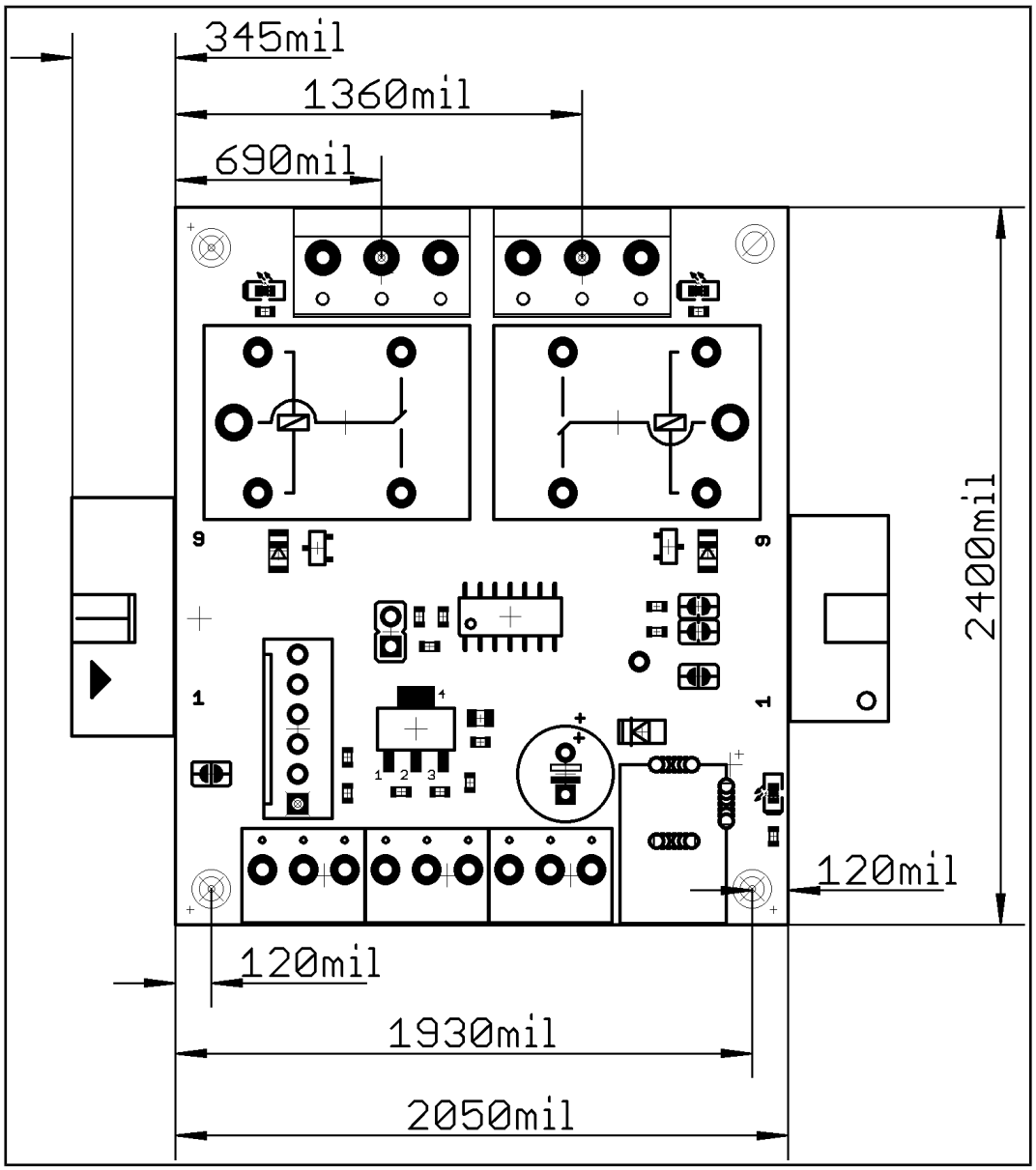
MOD-IO2 schematic is visible for reference here. You can also find it on the web page for MOD-IO2 at our site: . They are located in HARDWARE section.

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


3.3V
U1
VDD
VSS
PIC16F1503-I/SL
C24
100nF
GPIO0_ICSPDAT
GPIO1_ICSPCLK
GPIO2_AOUT
#MCLR
GPIO3
GPIO4_CLKIN
SCL
SDA
REL2
GPIO5_PWM2
REL1
GPIO6_PWM1
CON1
CON2
CON3
TB3/3.5MM
3.3V
GND
GPIO0
GPIO1
GPIO2
GPIO3
GPIO4
GPIO5
GPIO6
UEXTs
UEXT_MPWR_E
Open
UEXT_MALE
BH10S
R6
4.7k
R7
4.7k
UEXT_FPWR_E
SCL_E
Close
SDA_E
UEXT_FEMALE
IDC10S/PCB
Relays
+12V
D2
1N4148/SMD
green/0603
LED_REL1
REL1
R10
4.7k
RAS-12-15
T1
DTC114YKA
OUT1-2
OUT1-3
OUT1-1
D7
LED_REL2
REL2
R13
4.7k
T2
OUT2-3
OUT2-1
OUT2-2
R8
NA(10k)
PROG
HN1x2
R9
1k
ICSP
R4
10k
R5
33R
WF6S
Power Supply
+12VDC !!!
PWR_J
YDJ-1136
D4
SS14
VR1(3.3V)
LM1117IMPX-ADJ
IN
OUT
ADJ/GND
C1
220uF/35V
C2
100nF
R1
240R/1%
R2
390R/1%
C3
100nF
C4
22uF/6.3V
PWR_LED
red/0603
R3
1k
GND
MOD-IO2_Rev_B
OLIMEX LTD BULGARIA
http://www.olimex.com/dev

7.2 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 does not include the PCB.

CHAPTER 8 REVISION HISTORY AND SUPPORT

8. Introduction to the chapter

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

8.1 Document revision

Revision	Changes	Modified page#
A, 27.08.12	- Initial creation	All
B, 16.10.12	- Fixed several leftovers from the template which were referencing wrong processors and boards - Updated links	6, 10, 20
C, 24.10.13	- Updated Disclaimer to fit the open-source nature of the board - Added few examples and firmware version 3 explanation - Updated Product support - General formatting improvements	2 7 23 All

8.2 Board's revision

Revision, date	Revision notes
B, 18.06.12	Initial release

8.3 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 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 from 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.

8.4 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 clearly 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 lack of knowledge on the customers 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 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 permitted within 7 days from the date of receipt of merchandise. After such time, all sales are considered final.

Returns of incorrect 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 which 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 on 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.