

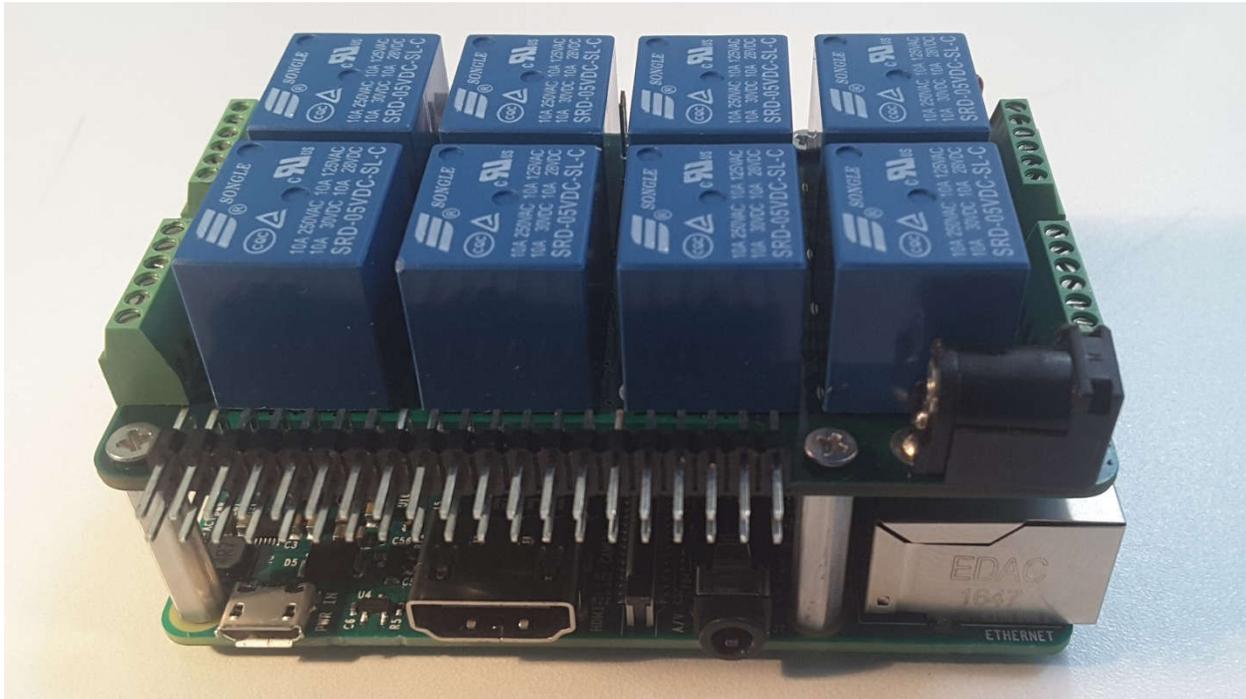
# RASPBERRY PI MEGA-IO EXPANSION CARD

[www.sequentmicrosystems.com](http://www.sequentmicrosystems.com)

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## GENERAL DESCRIPTION



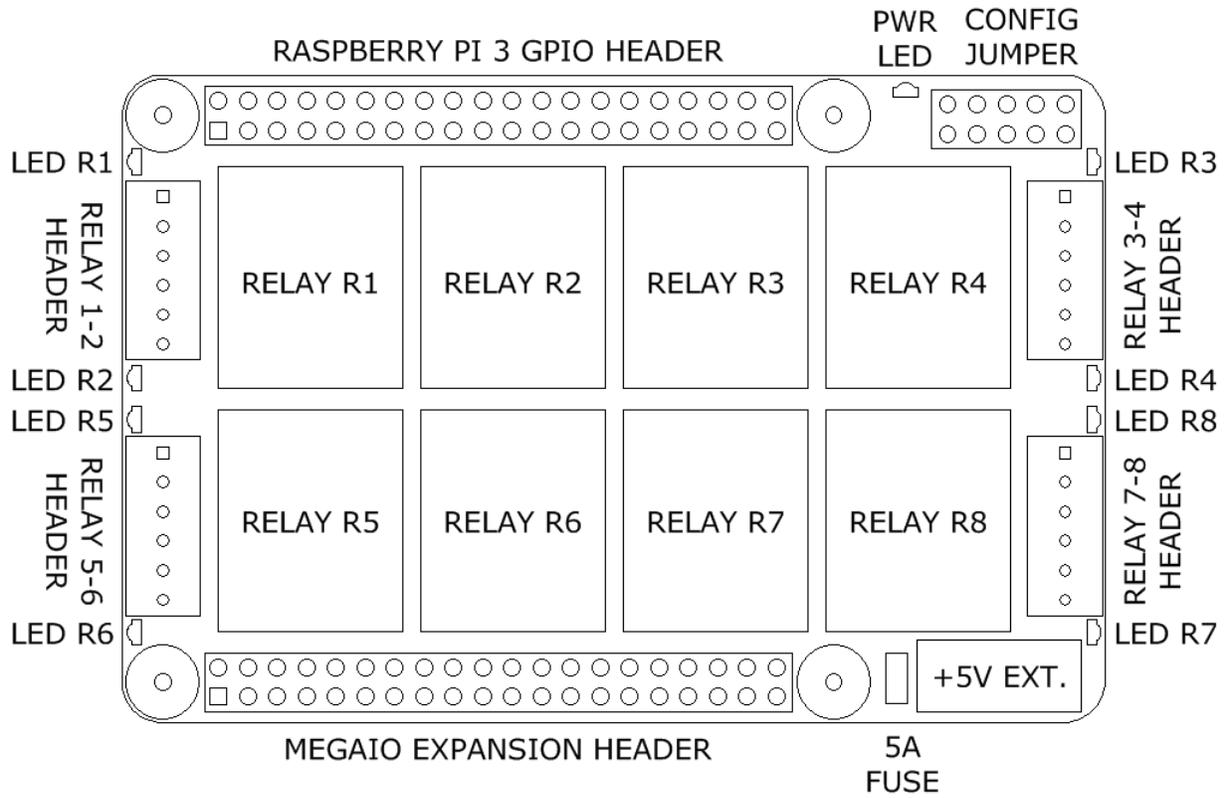
The MEGA-IO is a stackable expansion card for Raspberry Pi B+, 2, 3 and Zero. Two of the Raspberry Pi's GPIO pins (pin 3 and pin 5) are used for I2C communication. Pins 8 and 10 are used for firmware programming, but are available to the user as GPIO. Pin 7 is allocated for the interrupt handler, leaving 23 GPIO pins available for the user. MEGA-IO adds the following I/O functions:

- Eight on-board relays
- Eight 12 bit A/D inputs
- Eight optically isolated inputs
- One 12 bit DAC Output
- Four open collector outputs
- Six GPIO's

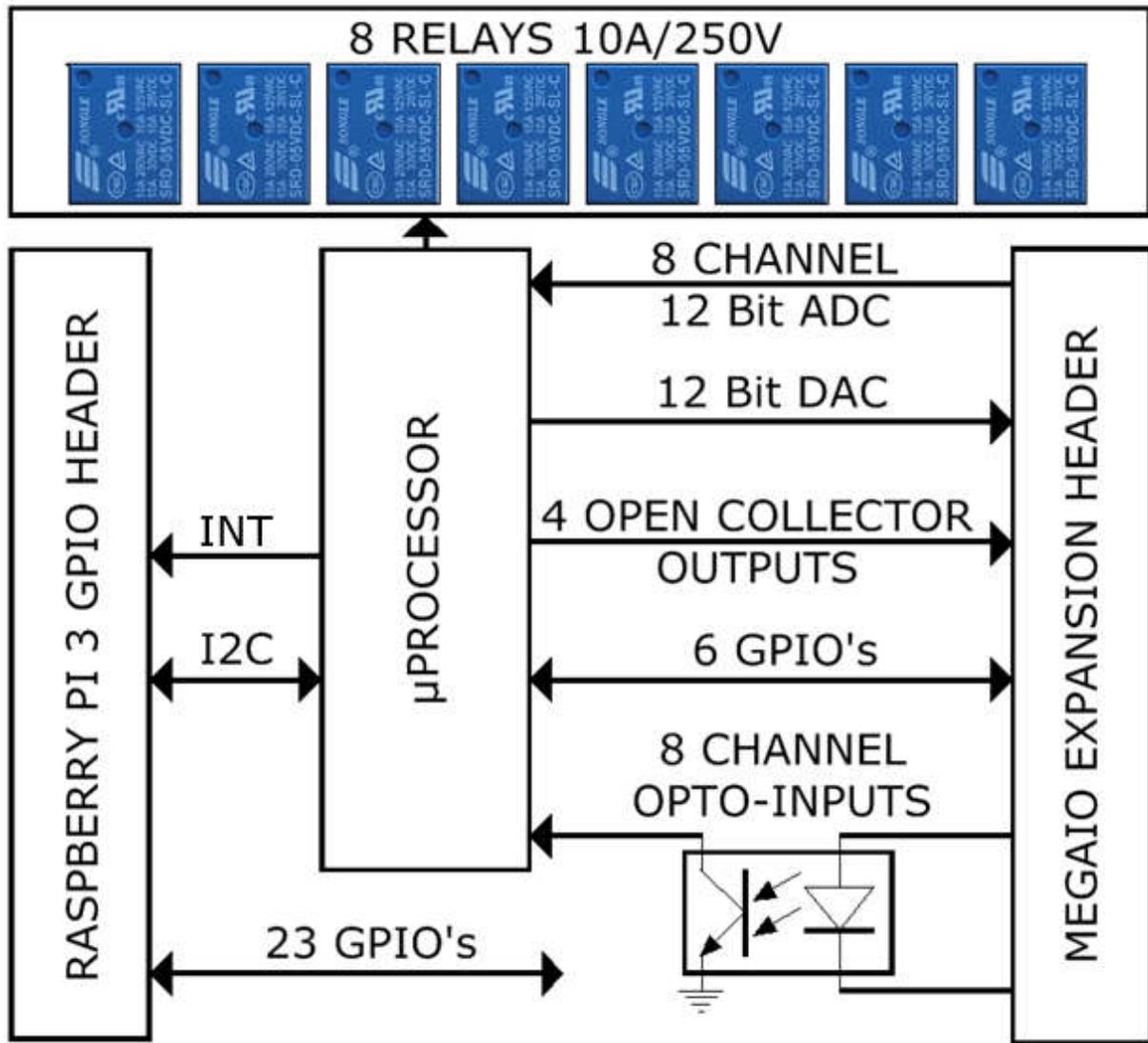
Up to four MEGA-IO cards can be stacked on top of a Raspberry Pi.

Any of the inputs of the MEGA-IO can be configured as interrupt inputs.

# BOARD LAYOUT



# BLOCK DIAGRAM



## COMPONENT DESCRIPTION

The top 40 pin header plugs into the Raspberry Pi GPIO header and passed through the pins to the next MEGA-IO expansion card.

The bottom 40 pin header is a right angle connector for I/O expansion.

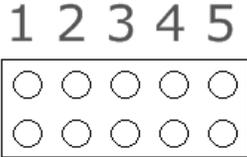
The eight Relays are numbered from upper left to lower right. Numbering the Relays is important to associate them correctly with the Relay Headers and Relay LEDs. The Relays are SPST, with three output pins labeled COM, NO and NC.

The Relay LEDs are right angle, to permit visual inspection of the relays status when multiple cards are stacked.

The Power LED in the upper right corner shows when power is applied to the board.

# CONFIGURATION JUMPERS

The 2x5 pin jumper installed in the upper right corner of the MEGA-IO card has the following functions:



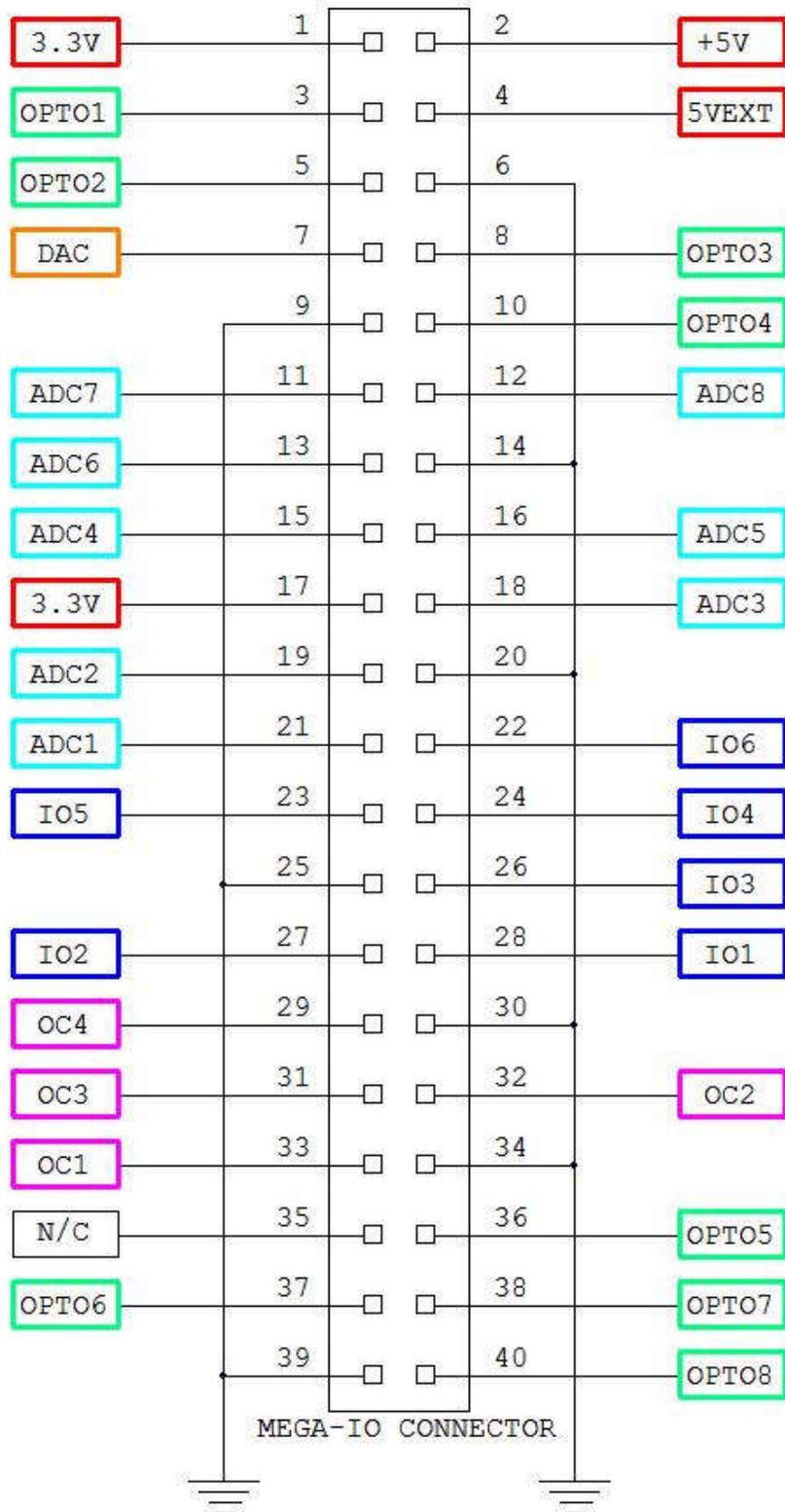
Position 1-2: Factory use only.

Position 3: Processor reset.

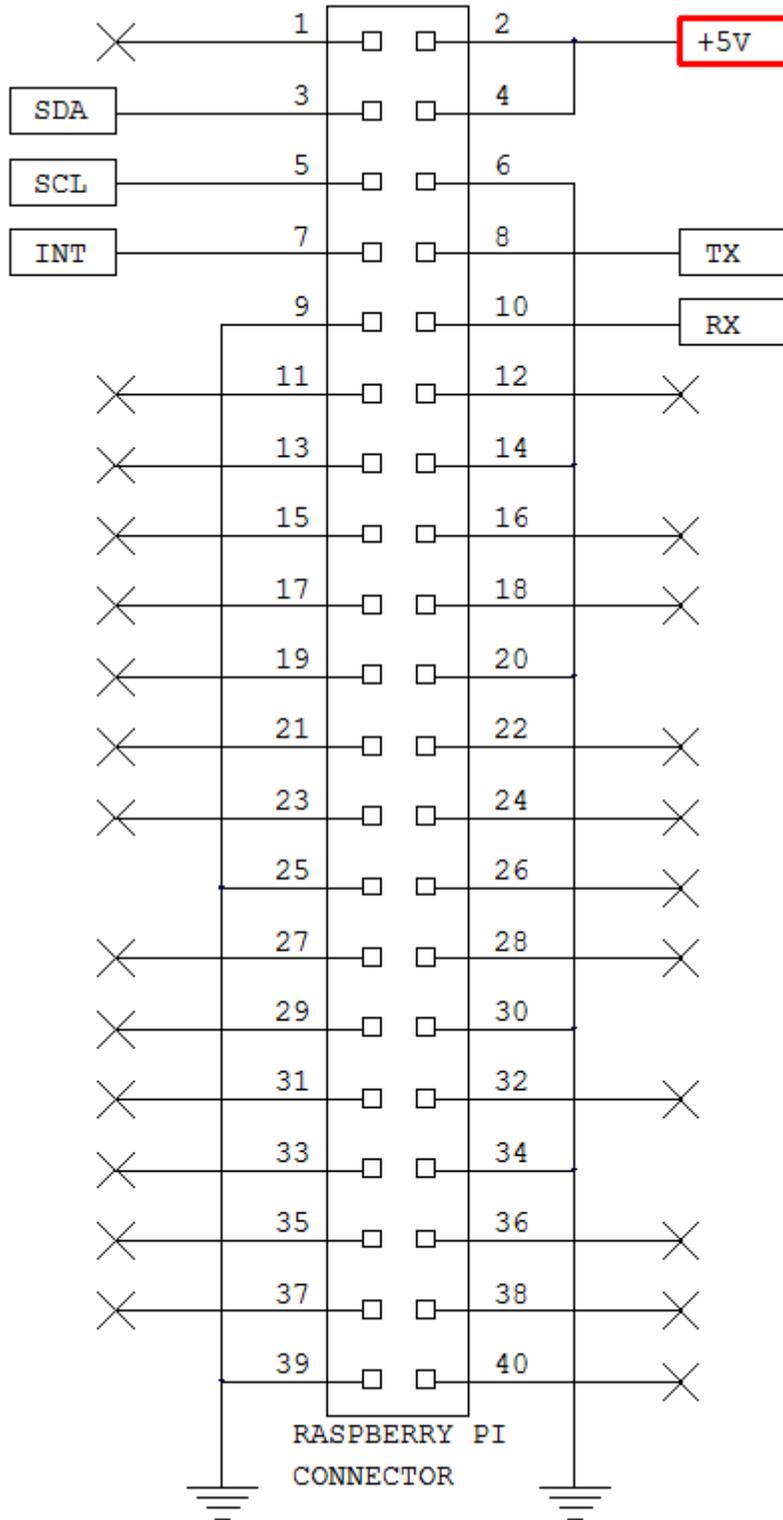
Position 4-5: Stack Level. These two jumpers permit addressing multiple MEGA-IO cards on the I2C bus. No jumpers need to be installed if only one card is present. If two or more cards are stacked up, the card I2C address 0 - 3 is as follows:

ID Jumper	000	001	010	011
Stack level	1	2	3	4
I2C Address	0x31	0x32	0x33	0x34

## MEGA-IO HEADER



## RASPBERRY PI HEADER



## RELAY HEADERS

### RELAYS 1-2 HEADER

Pin#		
1	R1-COM	□
2	R2-COM	○
3	R2-NC	○
4	R2-NO	○
5	R1-NC	○
6	R1-NO	○

### RELAYS 3-4 HEADER

Pin#		
1	R4-COM	□
2	R3-COM	○
3	R3-NO	○
4	R3-NC	○
5	R4-NO	○
6	R4-NC	○

### RELAYS 5-6 HEADER

Pin#		
1	R5-COM	□
2	R6-COM	○
3	R6-NC	○
4	R6-NO	○
5	R5-NO	○
6	R5-NC	○

### RELAYS 7-8 HEADER

Pin#		
1	R8-COM	□
2	R7-COM	○
3	R7-NO	○
4	R7-NC	○
5	R8-NO	○
6	R8-NC	○

## POWER REQUIREMENTS

The Mega-IO card requires +5V power, supplied either from the Raspberry Pi expansion bus, or from its own 2.1mm power jack. The on-board relays are connected to the +5V. A local 3.3V regulator powers the rest of the circuits.

**Only one +5V source can be used to power both the Raspberry Pi and the Mega-IO card.**

Raspberry Pi 3 current consumption:                      250 mA @ +5V

Mega-IO current consumption:                              60 mA @ +5V (all relays OFF)

800 mA @ +5V (all relays ON)

The USB connector which powers the Raspberry Pi can supply maximum 1.5A.

The jack which powers the Mega-IO card can supply 3A. We strongly recommend using this jack and a 5V regulated power supply rated at 3A or higher.

The Mega-IO card can be stacked up to four levels. A multi-stack configuration can be powered from any of the cards. A four stack needs 500 mA for electronic circuits, leaving 2.5A for relays. With some margin of error, not more than 24 relays can be ON at the same time.

**In the rare event that your application uses four Mega-IO cards and requires that all relays be ON at the same time, you need a power source that can supply minimum 4A. You also need to split the power cable and feed the +5V through two Mega-IO cards.**

## HARDWARE SPECIFICATIONS

MICROCONTROLLER: STM8L151C3T6

### SIX GPIO pins:

- Operating voltage: 3.3V
- CPU frequency: 16 MHz
- Touch sensing capability: Yes
- Maximum input voltage: 4V
- Series protection resistor: 51 Ohms
- Output Low Level: Maximum 0.45V
- Output High Level: Minimum 2.6V

### FOUR OPEN COLLECTOR OUTPUTS:

- Driver: ULN2003F12FN-7
- Output Low Voltage: 0.6V
- Max Pull Up Voltage: 20V
- Maximum sink per channel: 100mA @ 3.3V Logic Input, 140mA @ 5.0V Logic Input
- ESD: 4kV HBM, 1kV CDM

### EIGHT 12 bit ADC:

- Sample rate: Up to 1 Msps
- Input low pass filter: 0.22 $\mu$ F/51  $\Omega$

### ONE 12 bit DAC:

- Resistive load: Minimum 5 K $\Omega$
- Output impedance: Maximum 10 K $\Omega$
- Capacitive load: Maximum 50 pF
- Settling time: Maximum 12  $\mu$ s
- Update rate: Maximum 1 Msps

#### OPTOISOLATORS:

- Transceiver: TLP293-4
- LED current limit resistor: 1 K $\Omega$
- Input Forward Current: Typical 5 mA, maximum 50 mA
- Input Reverse Voltage: 5V
- Input Forward Voltage: 1.25V @ 10 mA
- Isolation Resistance: Minimum 10<sup>12</sup>  $\Omega$
- Isolation Voltage: Typical 10,000 V

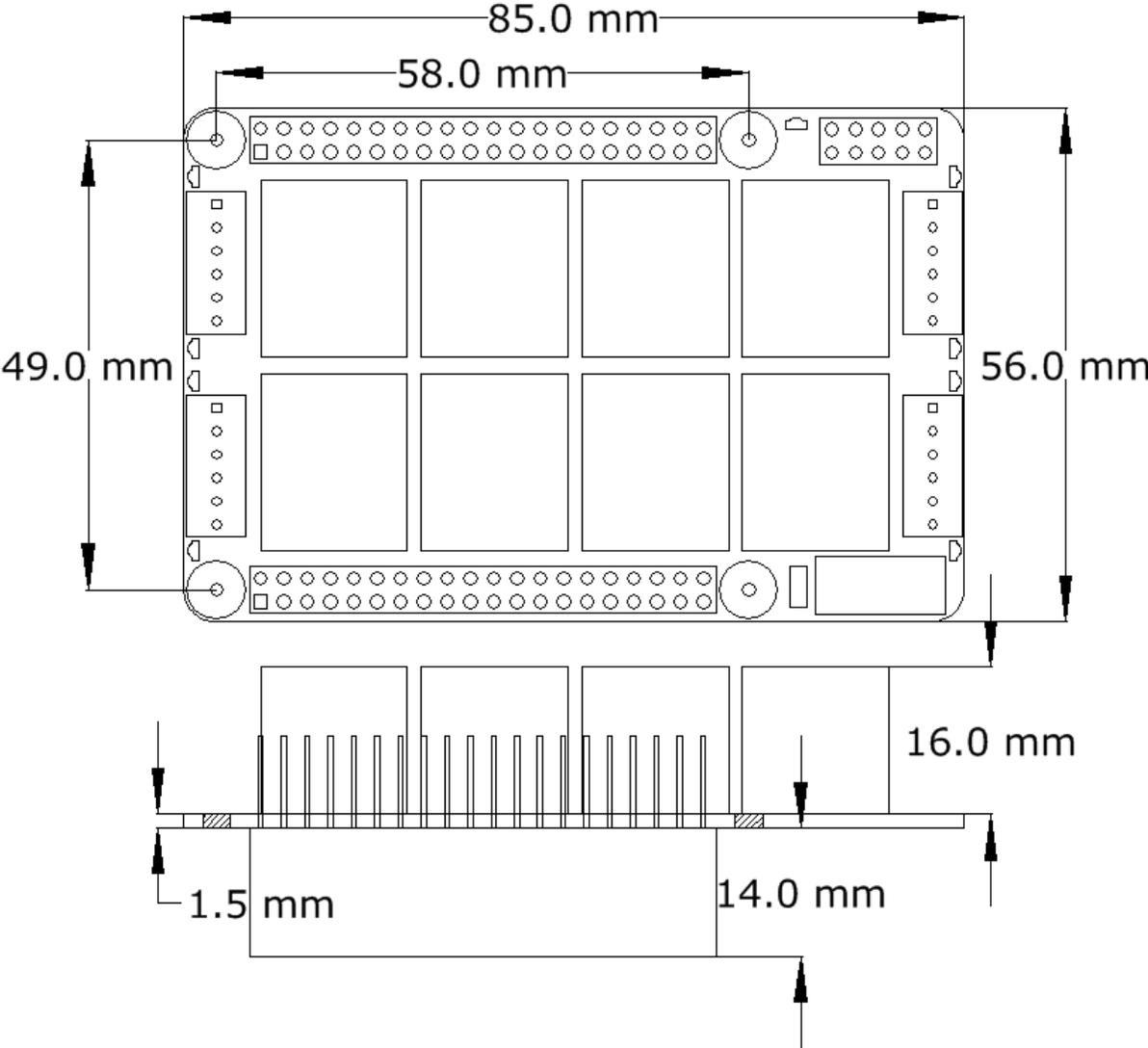
#### RELAYS: SRD-05VDC-SL-C

- Relay maximum current/voltage: 10A/250V
- PCB maximum current/voltage: 5A/48V

#### POWER CONSUMPTION:

- 60 mA @ +5V (all relays OFF)
- 800 mA @ +5V (all relays ON)

**MECHANICAL SPECIFICATIONS**



## SOFTWARE SETUP

1. Have your Raspberry Pi ready with the [latest OS](#).
2. Install the [Wiring Pi](#) library (many thanks to Gordon Henderson)
3. Enable I2C communication:

```
~$ sudo raspi-config
```

```
1 Change User Password Change password for the default user
2 Hostname                Set the visible name for this Pi on a
3 Boot Options            Configure options for start-up
4 Localisation Options    Set up language and regional settings
5 Interfacing Options     Configure connections to peripherals
6 Overclock               Configure overclocking for your Pi
7 Advanced Options        Configure advanced settings
8 Update                  Update this tool to the latest versio
9 About raspi-config      Information about this configuration

P1 Camera                Enable/Disable connection to the Raspber
P2 SSH                    Enable/Disable remote command line access
P3 VNC                    Enable/Disable graphical remote access
P4 SPI                    Enable/Disable automatic loading of SPI
P5 I2C                    Enable/Disable automatic loading of I2C
P6 Serial                 Enable/Disable shell and kernel messages
P7 1-Wire                 Enable/Disable one-wire interface
P8 Remote GPIO            Enable/Disable remote access to GPIO pins
```

4. Install the megaio software from github.com:

```
~$ git clone https://github.com/SequentMicrosystems/megaio-rpi.git
```

5. 

```
~$ cd /home/pi/megaio-rpi
```
6. 

```
~/megaio-rpi$ sudo make install
```
7. 

```
~/megaio-rpi$ megaio
```

The program will respond with a list of available commands.

Type "`megaio -h`" for online help.

After installing the software, you can update it to the latest version with the commands:

1. 

```
~$ cd /home/pi/megaio-rpi
```

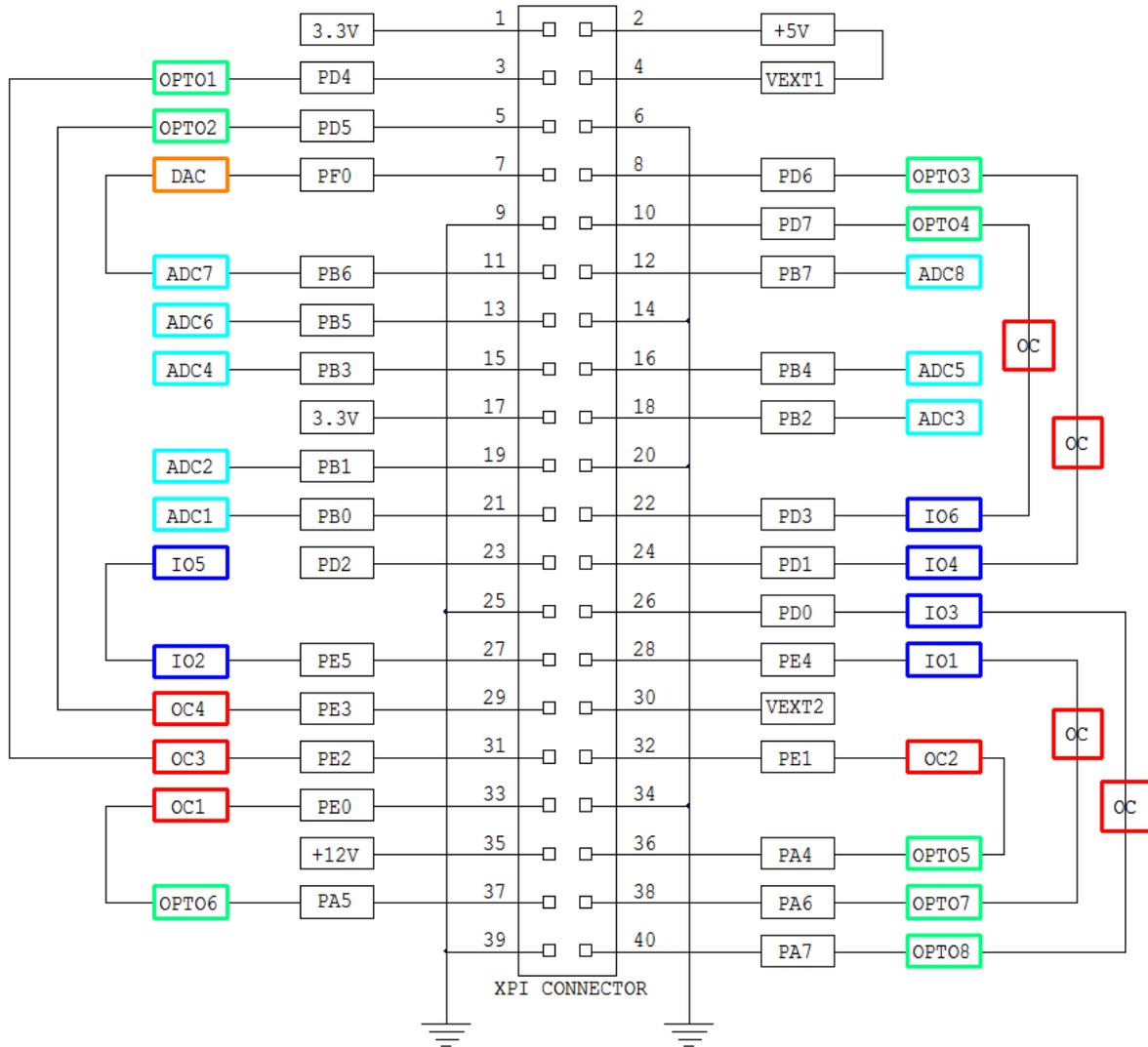


2. ~/megaio-rpi\$ **git pull**
3. ~/megaio-rpi\$ **sudo make install**

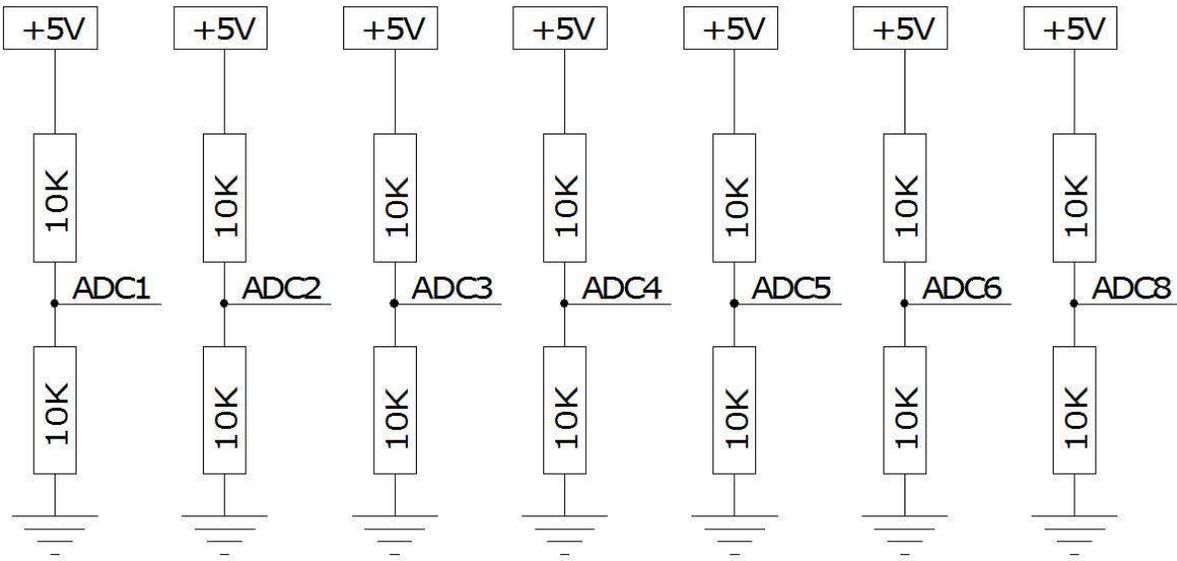
# MEGA-IO AD-ON CARDS

## MEGA-IO SELF-TEST CARD

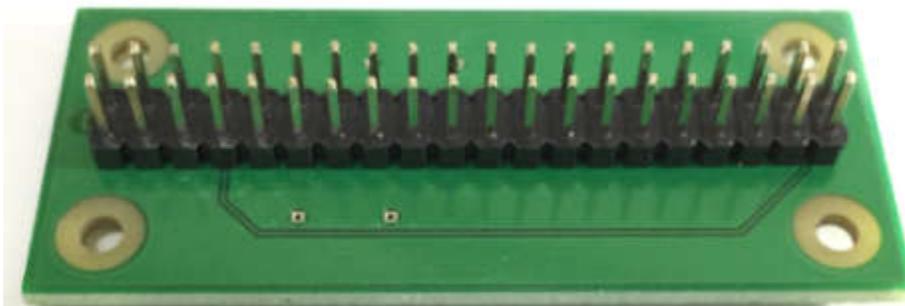
The self-test card routes all the inputs to outputs, as shown in the following diagram:



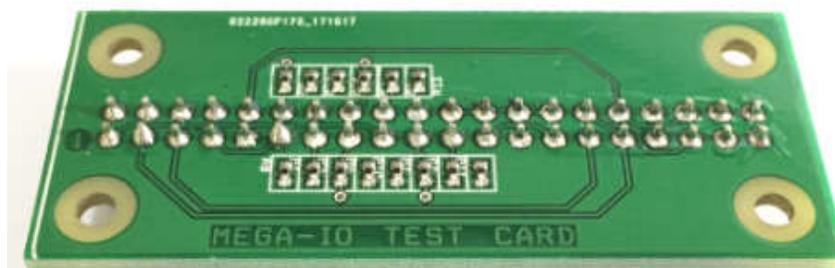
ADC7 analog input is used to test the analog output (DAC). The other seven analog inputs are connected to resistor dividers:



If the self-test card is present, the MEGA-IO can be tested using the command “megaio [0:3] test”. The software will cycle all relays until any key is pressed, then will report the status of all the inputs and outputs.



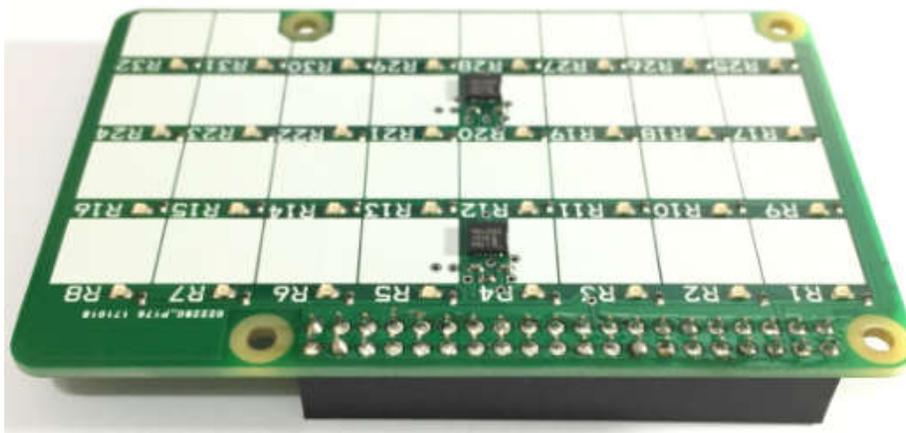
Self-test card top view



Self-test card back view

## MEGA-IO LED-CARD

The LED card plugs into the Raspberry Pi expansion connector. Its main function is to show in top-view the status of the relays, but it can be used as a general purpose, 32 LED card to show the status of any input or output.



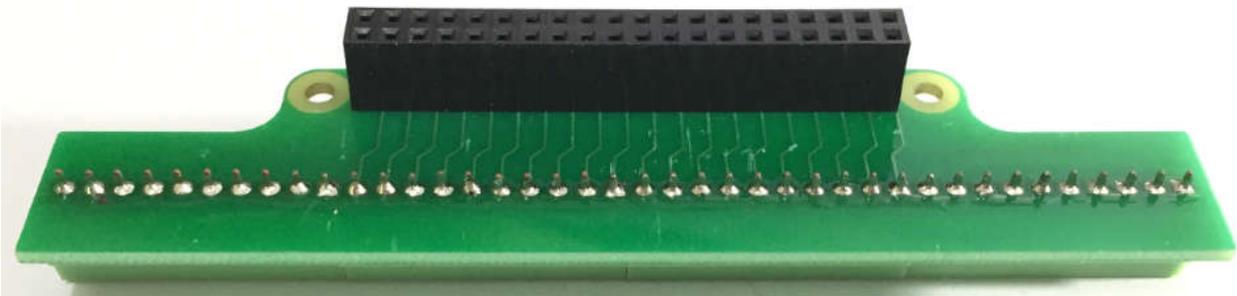
Any LED can be turned on or off using the command “megaio led [1-32] on/off”

## MEGA-IO BREAK-OUT CARD

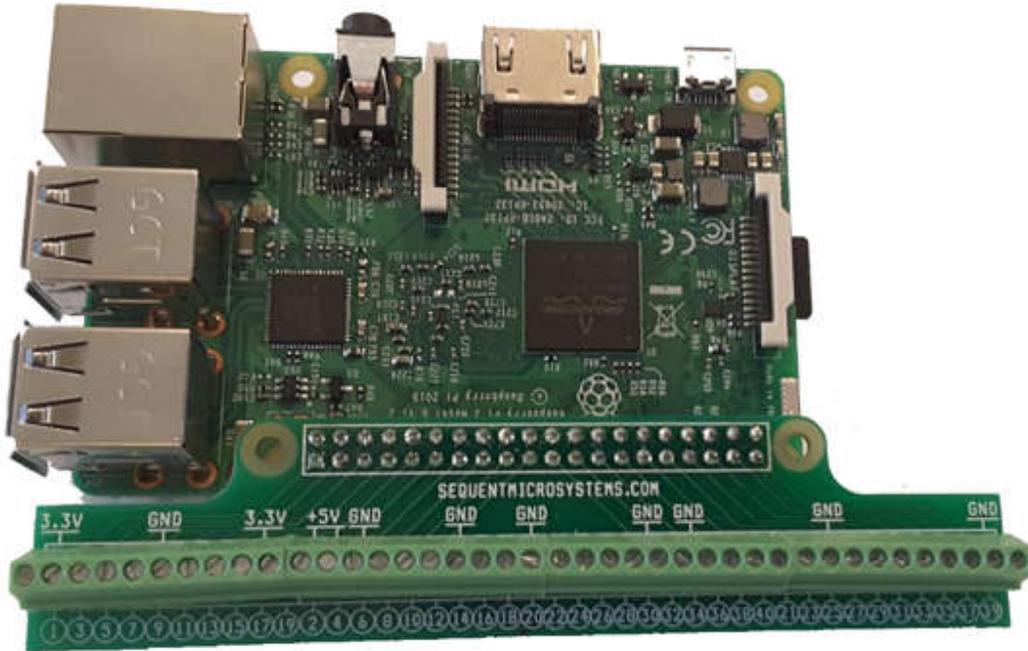
The Break-out card plugs into the MEGA-IO expansion connector and brings all the IO pins to screw-type terminal blocks. It can be used also as a break-out card for the Raspberry Pi GPIO connector.



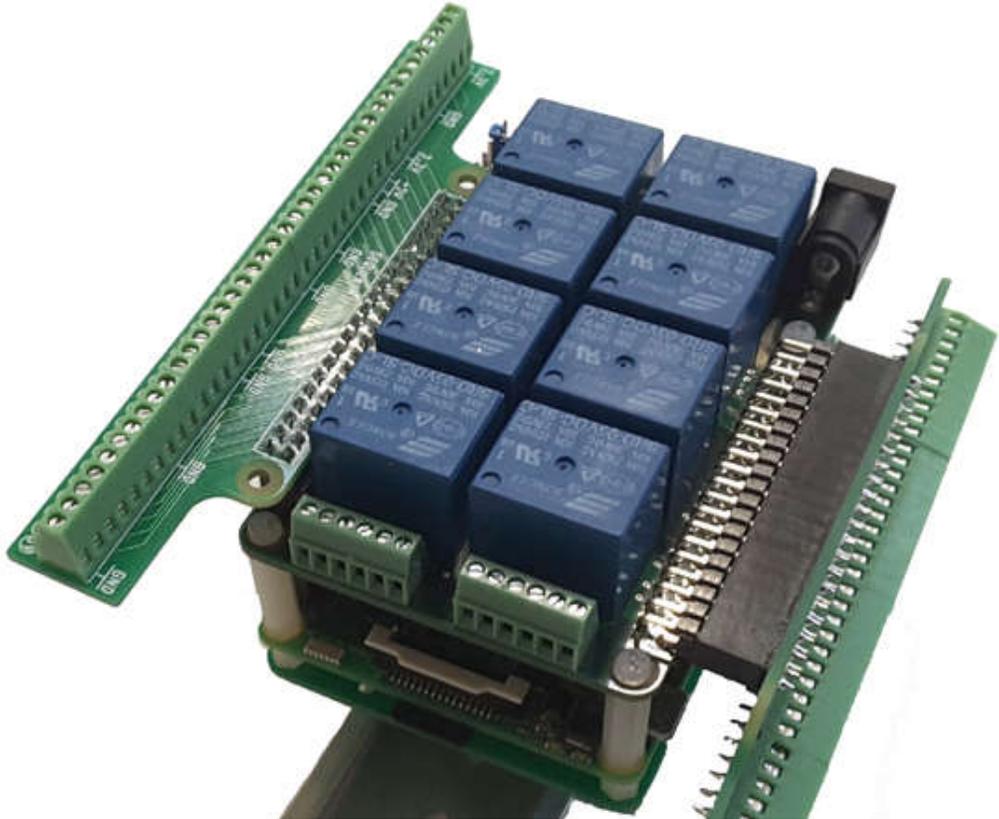
Break-out card top view



Break-out card back view



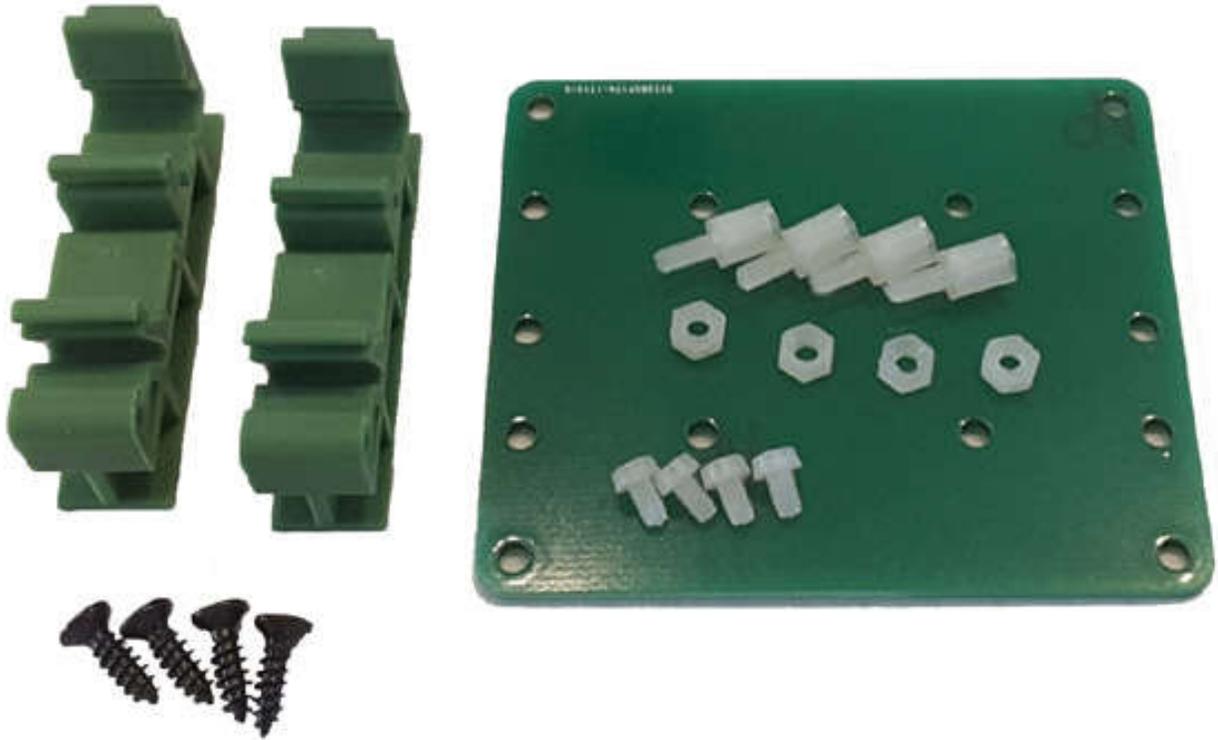
Raspberry Pi with Break-out card



Break-out cards for MEGA-IO and Raspberry Pi

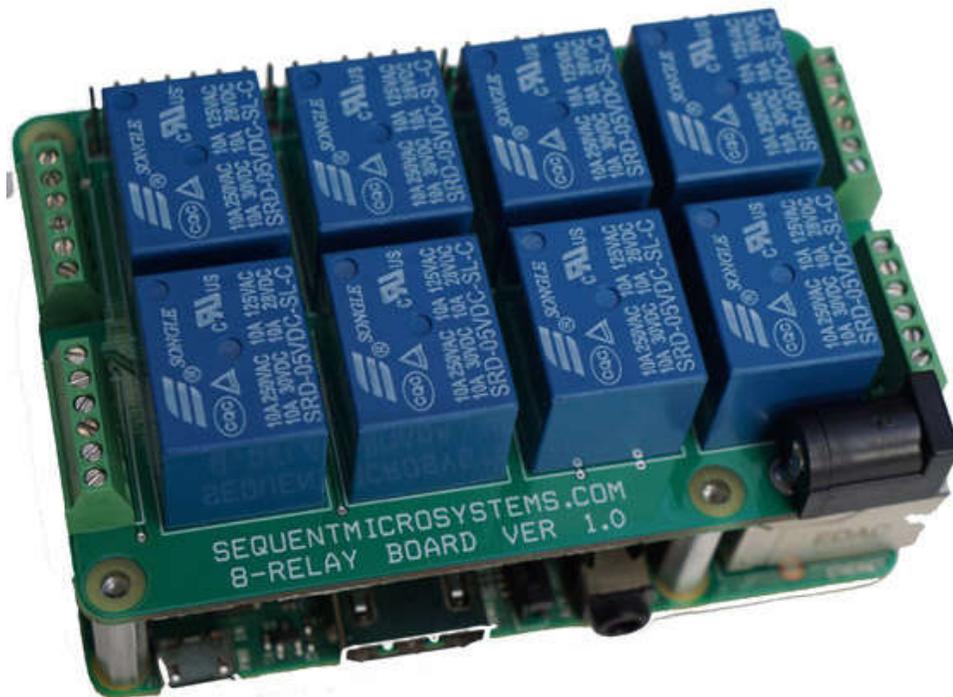
## DIN-RAIL KIT for RASPBERRY PI

The DIN-Rail Kit permits mounting any Raspberry Pi on a DIN-Rail. It contains all the necessary screws and stand-offs.



## 8-RELAY ADD-ON BOARD

The 8-RELAY board is an inexpensive add-on board that can be mixed with the MEGA-IO card when more relays are needed, without adding more IO functions. The board is similar with the MEGA-IO, but all the IO functions have been removed in order to save cost. Up to four MEGA-IO and 8-RELAY cards can be mixed in any configuration. A LED-CARD can be added to the stack as well.



## MEGA-IO TESTING WITHOUT A TEST CARD

The analog and digital I/O's of the MEGA-IO card can be self-tested without a self test card by running a one wire jumper between one input and one output. The I/O's under test need to be disconnected from any external sources. The following commands are available for one wire self testing:

### OPEN COLLECTOR OUTPUT TO OPTO-ISOLATED INPUT:

Command: `megaio [0:3] test-opto-oc [1:8] [1:4]`

Example: `megaio 0 test-opto-oc 1 2`

This command requires a jumper from +5V (pin 2) to VEXT1 (pin 4) to power the OPTO-INPUTS, and another jumper from OPTO1 (pin 3) to OC2 (pin 32). The software will set the output low and high and check the values on the input.

### DIGITAL INPUT TO DIGITAL OUTPUT:

Command: `megaio [0:3] test-io [1:6] [1:6]`

Example: `megaio 0 test-io 2 5`

This command requires a jumper from IO2 (pin 27) to IO5 (pin 23).

ANALOG I/O self test command: `megaio [0:3] test-dac-adc [1:8]`

Example: `megaio 0 test-dac-adc1`

This command requires a jumper from DAC (pin 7) to ADC1 (pin 21). The software will set the DAC output to 0, 25%, 50% and 100% of the full scale, and measure the corresponding values on the ADC input.

The MEGA-IO card can also be tested using its own IO Commans. Here are examples for testing all IO functions:

#### 1) IO Test

- Connect pin 27 to pin 28 (IO1 to IO2)
- Set IO1 as output : `pi@raspberrypi:~$ megaio 0 iodwrite 1 0`
- Read IO2 pin : `pi@raspberrypi:~$ megaio 0 ioread 2` (Response should be 0)
- Write IO1 pin: `pi@raspberrypi:~$ megaio 0 iowrite 1 1`

- Read IO2 pin : pi@raspberrypi:~\$ megaio 0 ioread 2 (Response should be 1)

## 2) DAC - ADC test

- Connect pin 7 to pin 11 (DAC to ADC channel 7)

- Write DAC value 0: pi@raspberrypi:~\$ megaio 0 awrite 0 (0V)

- Read ADC channel 7: pi@raspberrypi:~\$ megaio 0 aread 7 (Response should be less than 150 )

- Write DAC value 2000: pi@raspberrypi:~\$ megaio 0 awrite 2000 (1.6V)

- Read ADC channel 7: pi@raspberrypi:~\$ megaio 0 aread 7 (Response should be 2000 +/-75 )

- Write DAC value 4095: pi@raspberrypi:~\$ megaio 0 awrite 4095 (3.3V)

- Read ADC channel 7: pi@raspberrypi:~\$ megaio 0 aread 7 (Response should be more than 3950)

## 3) Open collector output - Opto-coupled input

- Connect pin 2 to pin 4 (5V to Opto 5V external)

- Connect pin 3 to pin 33 (Opto channel 1 to open collector channel 1)

- Set OFF OC channel 1 : pi@raspberrypi:~\$ megaio 0 ocwrite 1 0

- Read opto channel 1: pi@raspberrypi:~\$ megaio 0 optread 1 ( Response should be 0)

- Set ON OC channel 1 : pi@raspberrypi:~\$ megaio 0 ocwrite 1 1

- Read opto channel 1: pi@raspberrypi:~\$ megaio 0 optread 1 ( Response should be 1)