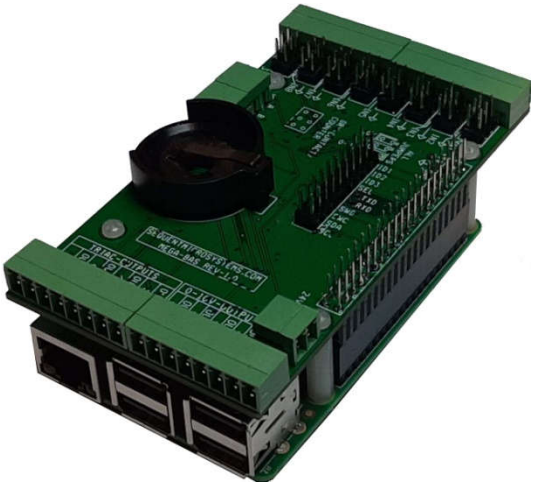
RASPBERRY PI I/O EXPANSION CARD

for BUILDING AUTOMATION

USER'S GUIDE VERSION 1.0

GENERAL DESCRIPTION



The second generation of our Building Automation card brings to the Raspberry Pi platform all the building blocks required for Building Automation projects. Stackable to 8 levels, the card works with all Raspberry Pi versions, from Zero to 4.

Two of the Raspberry Pi's GPIO pins are used for I2C communication. Another pin is allocated for the interrupt handler, leaving 23 GPIO pins available for the user.

FEATURES at a glance:

- Eight jumper settable universal, analog/digital inputs
    - 0-10V Inputs or
    - Contact Closure Counter Inputs or
    - 1K/10K Temperature Sensor Inputs

- Four 0-10V Outputs
- Four TRIAC Outputs with 1A/48VAC drivers
- Four General Purpose LED's
- RS485 in and out ports
- Real time clock with battery backup
- On-board push-button
- TVS on all inputs
- On-board Hardware Watchdog
- 24VAC/DC power supply

All inputs and output use pluggable connectors which permit easy wiring access when multiple cards are stacked.

The four general purpose LED's can be associated with the analog inputs or other controlled processes.

The on-board push button can be programmed to cut inputs or override outputs.

WHAT IS IN YOUR KIT

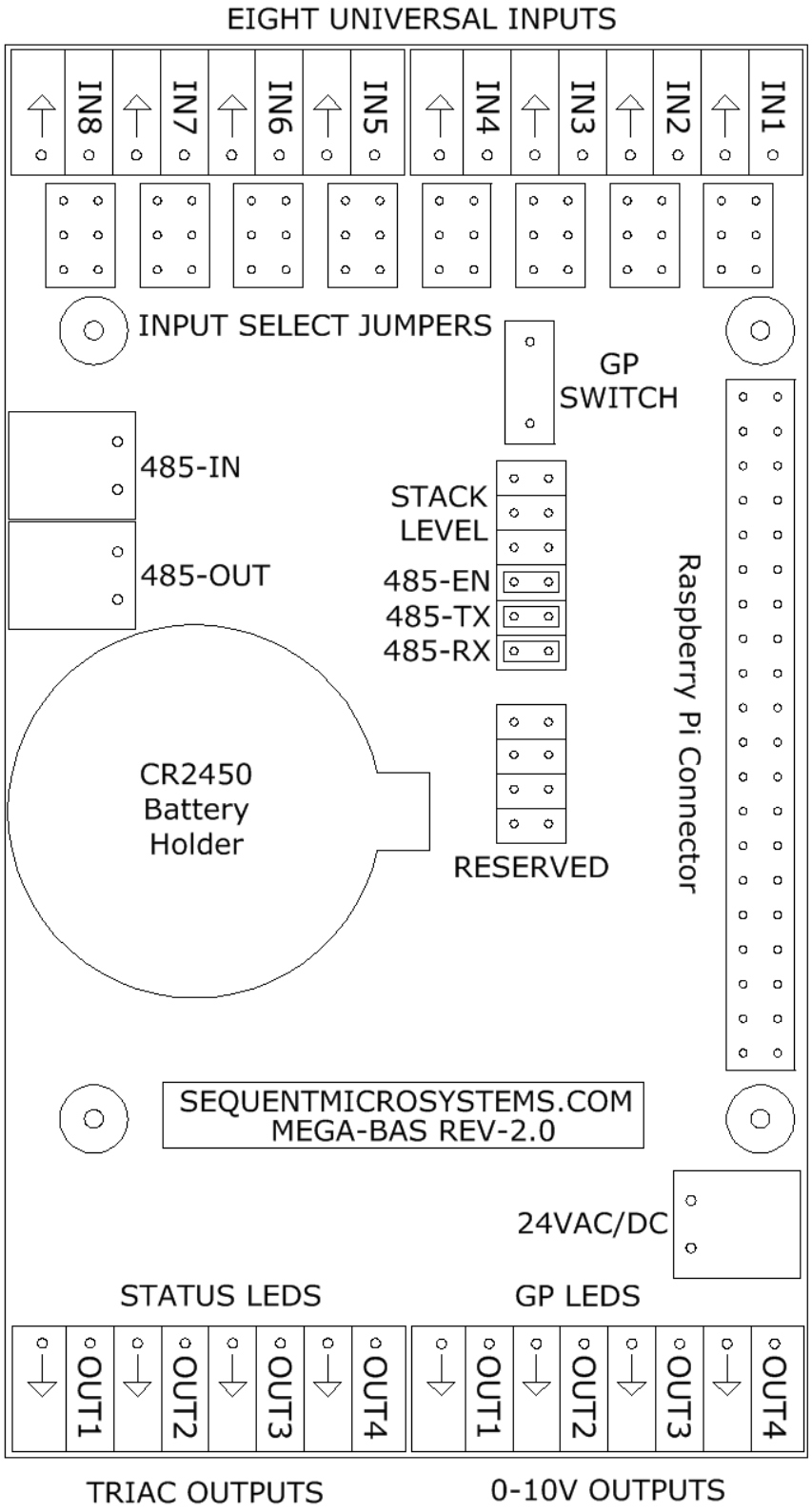
1. MEGA-BAS add-on card for Raspberry Pi
2. Mounting hardware
    a. Four M2.5x18mm male-female nylon standoffs
    b. Four M2.5x5mm nylon screws
    c. Four M2.5 nylon nuts
3. Two jumpers. You do not need the jumpers when using only one MEGA-BAS card. See STACK LEVEL JUMPERS section on page 6 if you plan to use multiple MEGA-BAS cards.
4. Four 8-pin female mating connectors.

QUICK START-UP GUIDE

1. Plug your MEGA-BAS card on top of your Raspberry Pi and power up the system.
2. Enable I2C communication on Raspberry Pi using raspi-config.
3. Install the MEGA-BAS software from github.com:
    a. ~$ git clone https://github.com/SequentMicrosystems/megabas-rpi.git
    b. ~$ cd /home/pi/megabas-rpi
    c. ~/megabas-rpi$ sudo make install
4. ~/megabas-rpi$ megabas

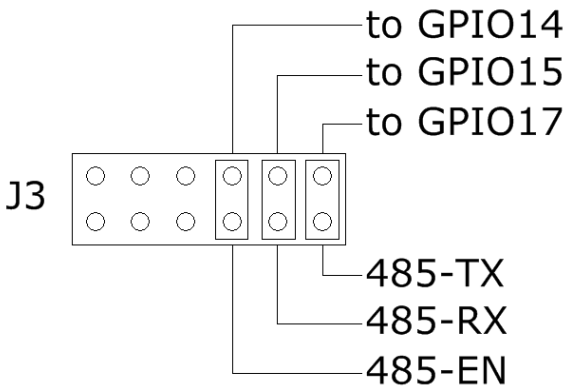
    The program will respond with a list of available commands.

BOARD LAYOUT



RS-485/MODBUS COMMUNICATION

The MEGA-BAS card contains a standard RS485 transceiver which can be accessed both by the local processor and by Raspberry Pi. The desired configuration is set from three bypass jumpers on configuration connector J3.



If jumpers are installed, Raspberry Pi can communicate with any device with an RS485 interface. In this configuration the MEGA-BAS card is a passive bridge which implements only the hardware levels required by the RS485 protocol. To use this configuration, you need to tell the local processor to release control of the RS485 bus:

~$ megabas [0] wcfgmb 0 0 0 0

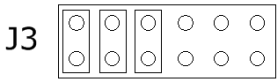
If jumpers are removed, the card operates as MODBUS slave and implements the MODBUS RTU protocol. Any MODBUS master can access all the card's inputs, and set all the outputs using standard MODBUS commands. A detailed list of commands implemented can be found on GitHub:

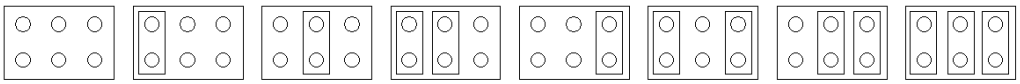
https://github.com/SequentMicrosystems/megabas-rpi/blob/master/Modbus.md

In both configurations the local processor needs to be programmed to release (jumpers installed) or control (jumpers removed) the RS485 signals. See the command line online help for further information.

STACK LEVEL JUMPERS

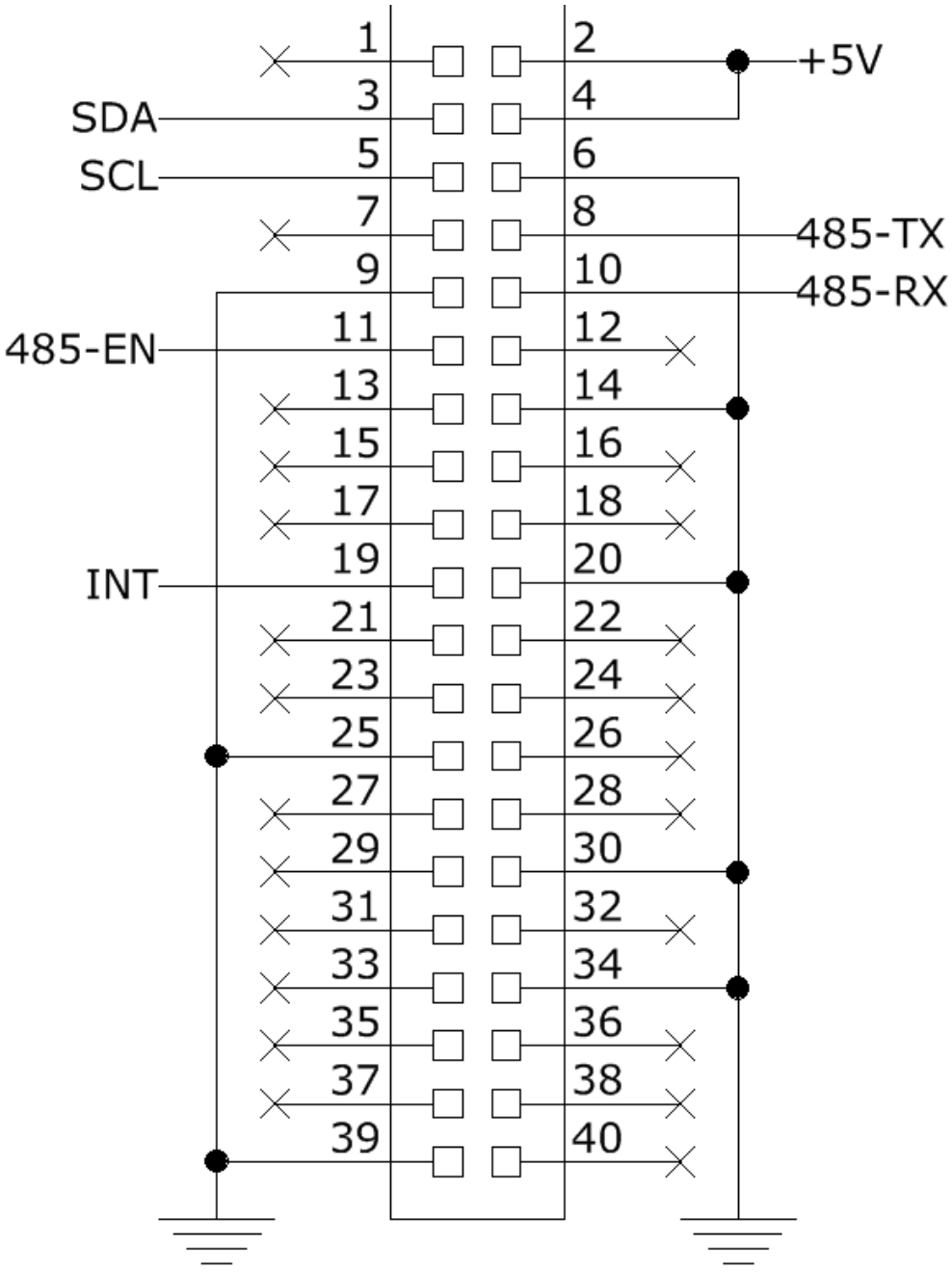
The left three position of the J3 connector are used to select the stack level of the card:





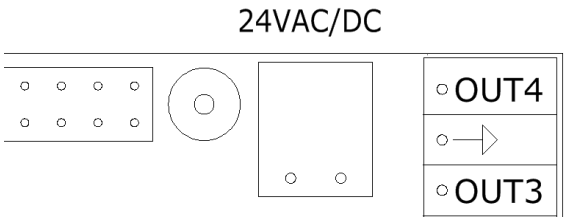
STACK LEVEL:	0	1	2	3	4	5	6	7
I2C ADDRESS:	0x18	0x19	0x1A	0x1B	0x1C	0x1D	0x1E	0x1F

RASPBERRY PI HEADER



POWER REQUIREMENTS

The MEGA-BAS card requires an external 24VDC/AC regulated power supply. Power is supplied to the board through the dedicated connector in the upper right corner (see BOARD LAYOUT). The boards accepts either DC or AC power source. If a DC power source is used, polarity is not important.



A local 5V regulator supplies up to 3A power to Raspberry Pi, and a 3.3V regulator powers the digital circuits. Isolated DC-DC converters are used to power the relays.

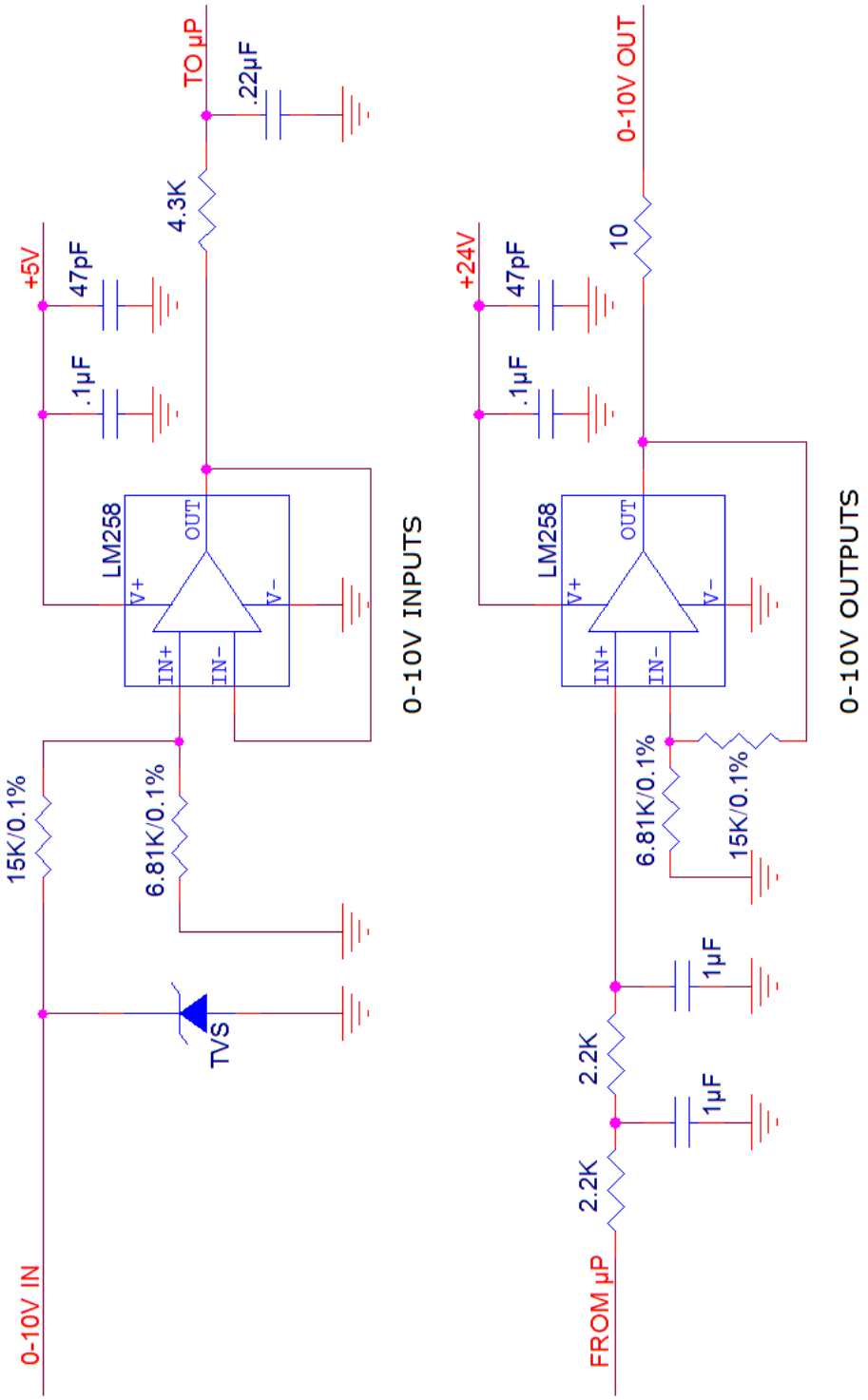
WE RECOMMEND USING ONLY THE 24VDC/AC POWER SUPPLY TO POWER THE RASPBERRY PI CARD

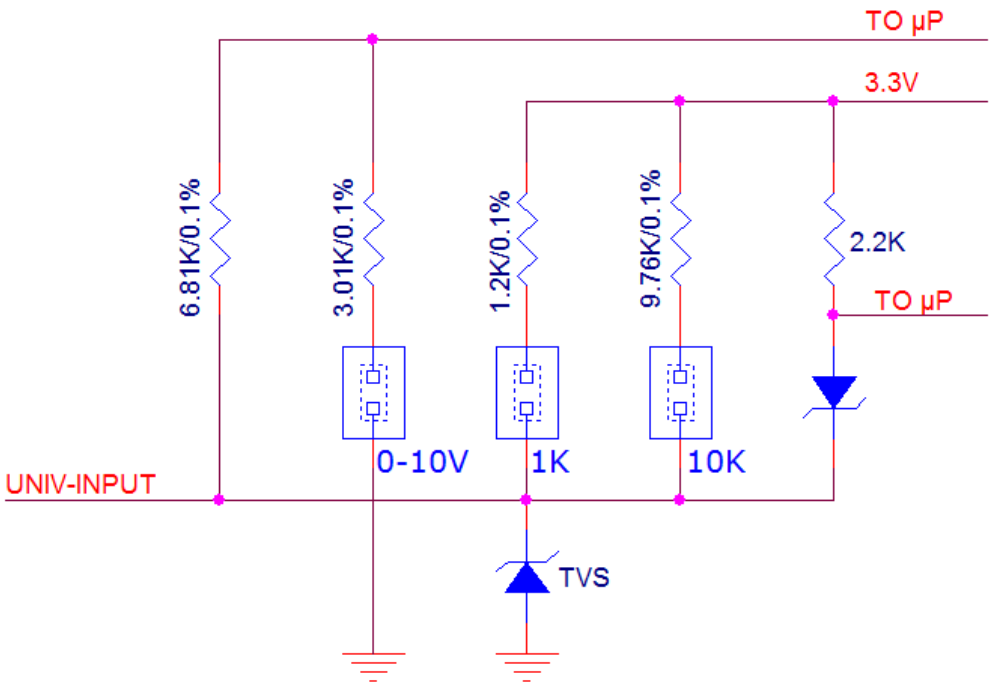
If multiple MEGA-BAS cards are stacked on top of each other, we recommend using a single 24VDC/AC power supply to power all the cards. The user must split the cable and run the wires to each MEGA-BAS card.

POWER CONSUMPTION:

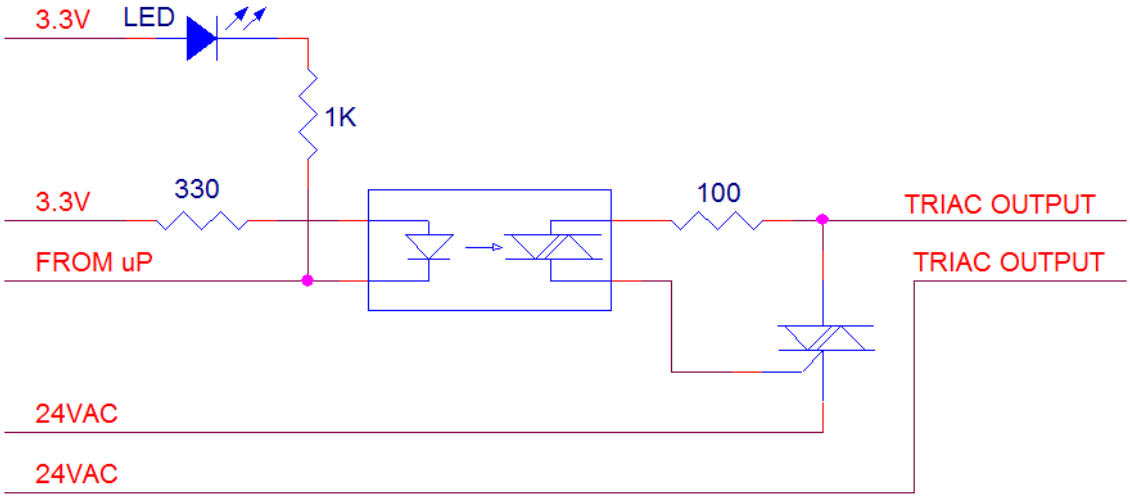
- 50 mA @ +24V (all relays OFF)
- 150 mA @ +24V (all relays ON)

SCHEMATICS


0-10V INPUTS
0-10V IN
15K/0.1%
6.81K/0.1%
TVS
TO µP
.22µF
4.3K
+5V
47pF
.1µF
LM258
OUT
V+
V-
IN+
IN-
0-10V OUTPUTS
FROM µP
2.2K
2.2K
1µF
1µF
6.81K/0.1%
15K/0.1%
+24V
47pF
.1µF
10
0-10V OUT



UNIVERSAL INPUTS



TRIAC OUTPUTS

HARDWARE WATCHDOG

The MEGA-BAS card contains a built-in hardware watchdog which will guarantee that your mission-critical project will continue running even if Raspberry Pi software hangs up. After power up the watchdog is disabled, and becomes active after it receives the first reset.

The default timeout is 120 seconds. Once activated, if it does not receive a reset from Raspberry Pi within 2 minutes, the watchdog cuts the power and restores it after 10 seconds.

Raspberry Pi needs to issue a reset command before the timer on the watchdog expires. The command can be sent either on the I2C port , or by toggling GPIO13 (Pin 33 on the GPIO connector). The timer period after power up and the active timer period can be set from the command line. The number of resets is stored in flash and can be accessed or cleared from the command line. All the watchdog commands are described by the online help function.

ANALOG INPUTS/OUTPUTS CALIBRATION

All the analog inputs and outputs are calibrated at the factory, but firmware commands permit the user to re-calibrate the board, or to calibrate it to better precision. All inputs and outputs are calibrated in two points; select the two points as close to possible to the two ends of scale. To calibrate the inputs, the user must provide analog signals. (Example: to calibrate 0-10V inputs, the user must provide a 10V adjustable power supply). To calibrate the outputs, the user must issue a command to set the output to a desired value, measure the result and issue the calibration command to store the value.

The values are stored in flash and the input curve is assumed to be linear. If a mistake is made during calibration by typing the wrong command, a RESET command can be used to reset all the channels in the corresponding group to factory values. After RESET calibration can be restarted.

The board can be calibrated without a source of analog signals, by calibrating first the outputs and then routing the calibrated outputs to corresponding inputs. The following commands are available for calibration:

CALIBRATE 0-10V INPUTS:	megabas <id> cuin <channel> <value>
RESET CALIBRATION OF 0-10V INPUTS:	megabas <id> rcuin
CALIBRATE 10K INPUTS:	megabas <id> cresin <channel> <value>
RESET 10K INPUTS:	megabas <id> rcresin
CALIBRATE 0-10V OUTPUTS:	megabas <id> cuout <channel> <value>
STORE CALIBRATED VALUE IN FLASH:	megabas <id> alta_comanda <channel> <actual_value>
RESET CALIBRATION OF 0-10V OUTPUTS:	megabas <id> rcuout

HARDWARE SPECIFICATIONS

ON BOARD RESETTABLE FUSE: 1A

0-10V INPUTS:

- Maximum Input Voltage: 12V
- Input Impedance: 20KΩ
- Resolution: 12 bits
- Sample rate: tbd

CONTAC CLOSURE INPUTS

- Maximum count frequency: 100 Hz

0-10V OUTPUTS:

- Minimum Output Load: 1KΩ
- Resolution: tbd

TRIAC OUTPUTS:

- Maximum Output Current: 1A
- Maximum Output Voltage: 120V

LINEARITY OVER FULL SCALE

Analog inputs are processed using 12 bit A/D converters internal to the on-board processor. The inputs are sampled at 675 Hz.

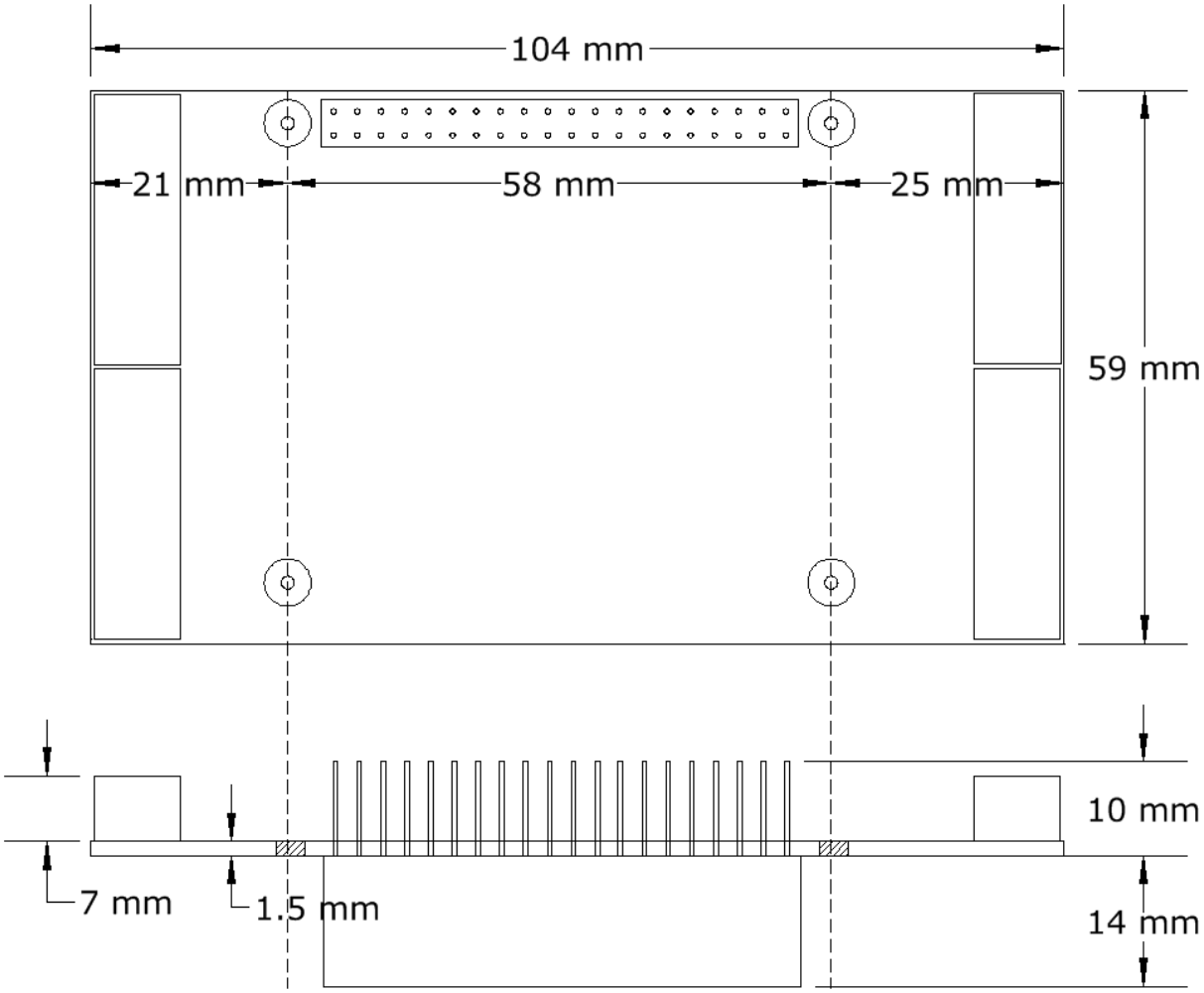
Analog outputs are PWM synthesized using 16 bit timers. PWM values range from 0 to 4,800.

All inputs and outputs are calibrated at test time at the end points and values are stored in flash.

After calibration we checked the linearity over full scale and obtained the following results:

Channel	Max Error	%
0-10V IN	15µV	0.15%
0-10V OUT	10µV	0.1%

MECHANICAL SPECIFICATIONS



SOFTWARE SETUP

1. Have your Raspberry Pi ready with the latest OS.

2. Enable I2C communication:

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

```
1. Change User Password      Change password for default user
2. Network Options           Configure network settings
3. Boot Options              Configure options for start-up
4. Localisation Options      Set up language and regional settings to match..
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 version
9. About raspi-config        Information about this configuration
```

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

3. Install the megabas software from github.com:

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

4.
```
~$ cd /home/pi/megabas-rpi
```

5.
```
~/megaioind-rpi$ sudo make install
```

6.
```
~/megaioind-rpi$ megabas
```

The program will respond with a list of available commands.

Type "megabas -h" for online help.

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

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

~/megabas-rpi$ git pull

~/megabas-rpi$ sudo make install
```