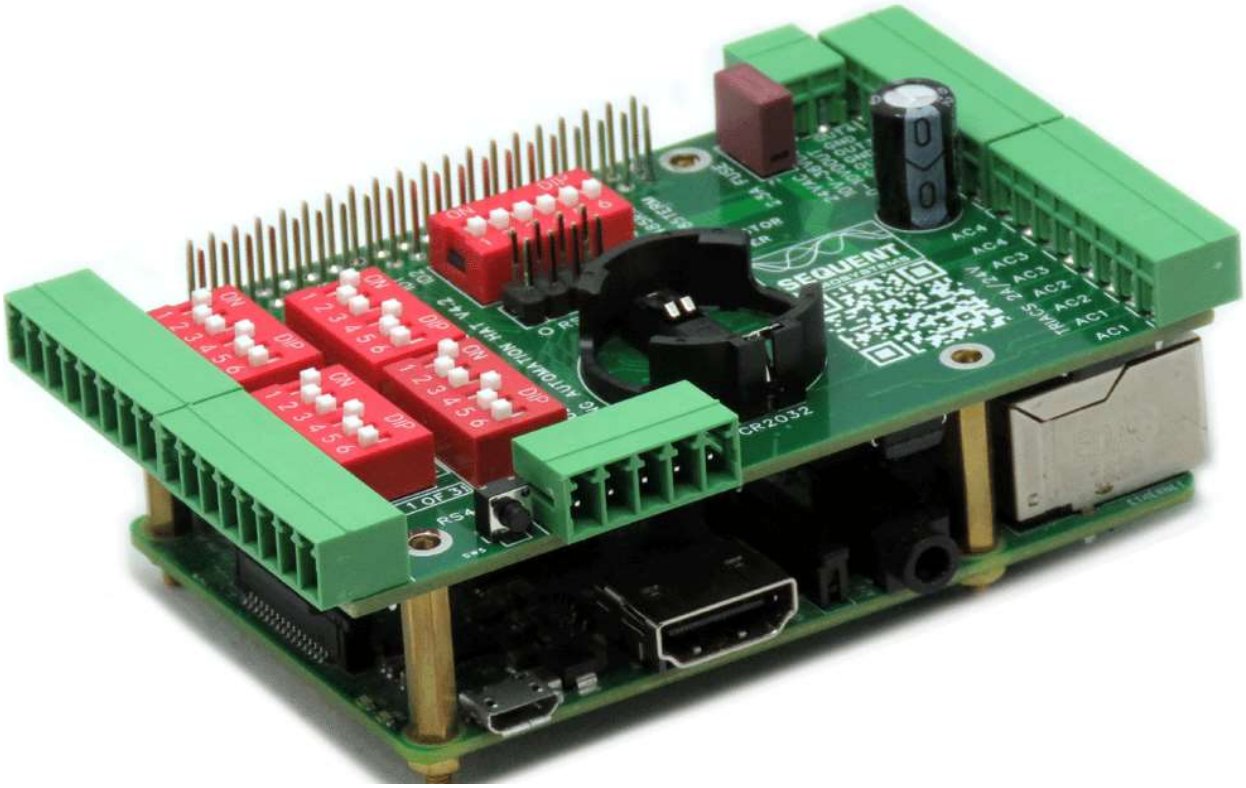
BUILDING AUTOMATION Card for RASPBERRY Pi

USER'S GUIDE VERSION 4.2

SequentMicrosystems.com

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GENERAL DESCRIPTION



The second generation of our Building Automation Card brings to the Raspberry Pi platform all the inputs and outputs required for Building Automation Systems. 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.

Eight universal inputs, individually selectable, let you read 0-10V signals, count contact closures, or measure temperatures using 1K or 10K thermistors. Four 0-10V programmable outputs can control light dimmers or other industrial devices. Four 24VAC TRIAC outputs can control AC relays or heating and cooling equipment. LED indicators show status of all outputs. An RS485/MODBUS ports permit almost unlimited expandability. Last but not least, a new 1-WIRE port can be used to read the temperature from up to 32 DS18B20 sensors.

TVS diodes on all inputs protect the card for external ESD. On-board fuse protects it from accidental shorts. A single 24V AC or DC power source supplies also 5V/3A for Raspberry Pi.

FEATURES

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

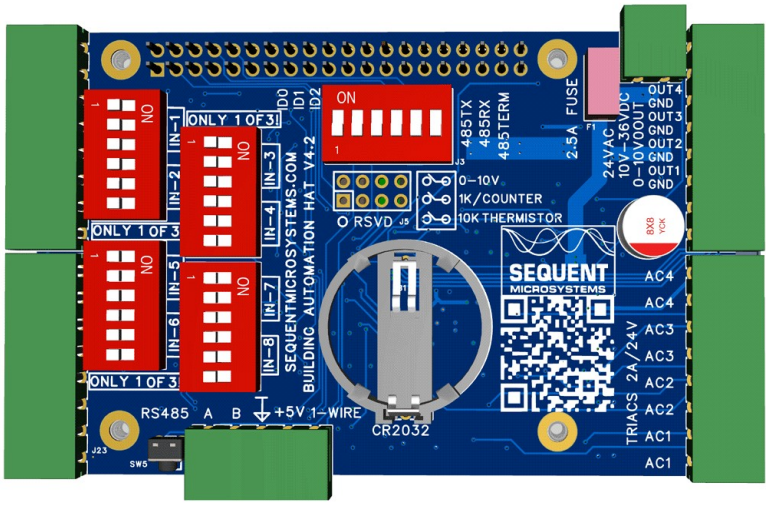
- Four 0-10V Outputs
- Four TRIAC Outputs with 1A/48VAC drivers
- Four General Purpose LED's
- RS485/MODBUS port
- Real time clock with battery backup
- On-board push-button
- 1-WIRE interface
- TVS protection on all inputs
- On-board Hardware Watchdog
- 24VAC/DC power supply

All inputs and outputs use pluggable connectors which permit easy wiring access when multiple cards are stacked. Up to eight Building Automation Cards can be stacked on top of one Raspberry Pi. The cards share a serial I2C bus using only two of the Raspberry Pi's GPIO pins to manage all eight cards.

The four general purpose LED's can be associated with the analog inputs or other controlled processes. An on-board push button can be programmed to cut inputs, override outputs or shut down the Raspberry Pi.

WHAT IS IN YOUR KIT

1. Building Automation Card for Raspberry Pi

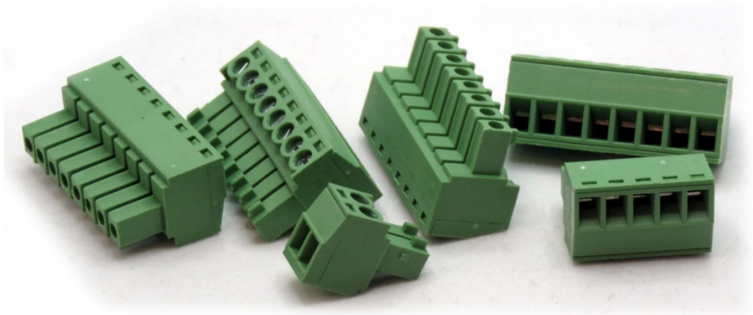


2. Mounting hardware



   a. Four M2.5x19mm male-female brass standoffs
   b. Four M2.5x5mm brass screws
   c. Four M2.5 brass nuts

3. All the required female mating connectors.

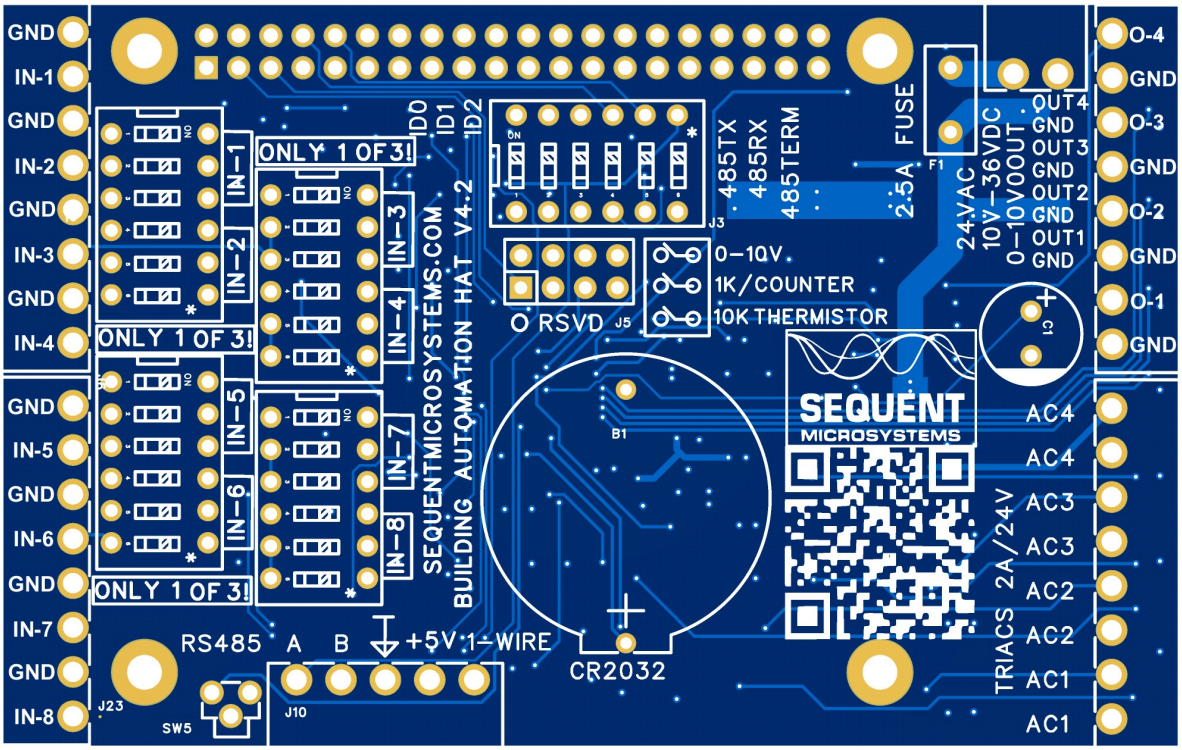


QUICK START-UP GUIDE

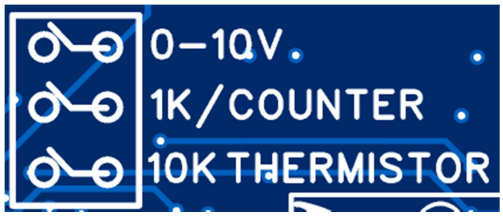
1. Plug your Building Automation Card on top of your Raspberry Pi and power up the system.
2. Enable I2C communication on Raspberry Pi using raspi-config.
3. Install the software from github.com:
    a. ~$ git clone https://github.com/SequentMicrosystems/megabas-rpi.git
    b. ~$ cd /home/pi/megabas-rpi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

    The program will respond with a list of available commands.

BOARD LAYOUT



Left side: Universal Inputs 1-8. Each input can be configured using 3 DIP Switches. One of the three switches has to be on at any time. The input selection is shown in the following diagram and on the silkscreen:



Bottom side: RS485 and 1-Wire Communication Port; Pushbutton which can interrupt or shut down Raspberry Pi.

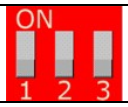
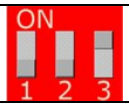
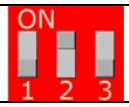
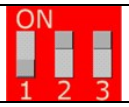
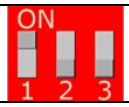
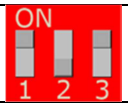
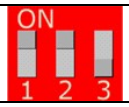
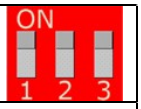
Right Side: Triac Outputs 1-4; 0-10V Outputs 1-4;

Top right side: Power connector. The board can be powered with 24VAC/1A or 10V-36VDC. It will supply 5V and up to 3A to Raspberry Pi.

STACK LEVEL SWITCHES

The left three positions of the DIP Switch J3 are used to select the stack level of the card:



DIP-SW								
STACK	0	1	2	3	4	5	6	7
I2C	0x18	0x19	0x1A	0x1B	0x1C	0x1D	0x1E	0x1F

RS-485/MODBUS COMMUNICATION

The Building Automation 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 the three switches on the right of the J3 DIP switch. The rightmost switch labeled 485TERM on the silkscreen enables the RS485 120 ohms terminator. Set this on if the HAT is last on the RS485 chain. The next two switches labeled 485TX and 485RX route the RS485 port to the local processor or to Raspberry Pi. Set the switches OFF to drive the RS485 from the local processor, or ON to use the Raspberry Pi.

If Raspberry Pi drives the RS485 port, the Building Automation 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

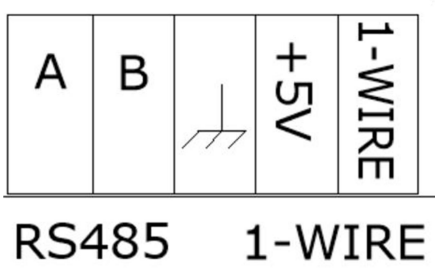
If switces are OFF, the card operates as MODBUS slave and implements the MODBUS RTU protocol. Any MODBUS master can access all the card's inputs, and set all the outputs using standard MODBUS commands. A detailed list of commands implemented can be found on GitHub:

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

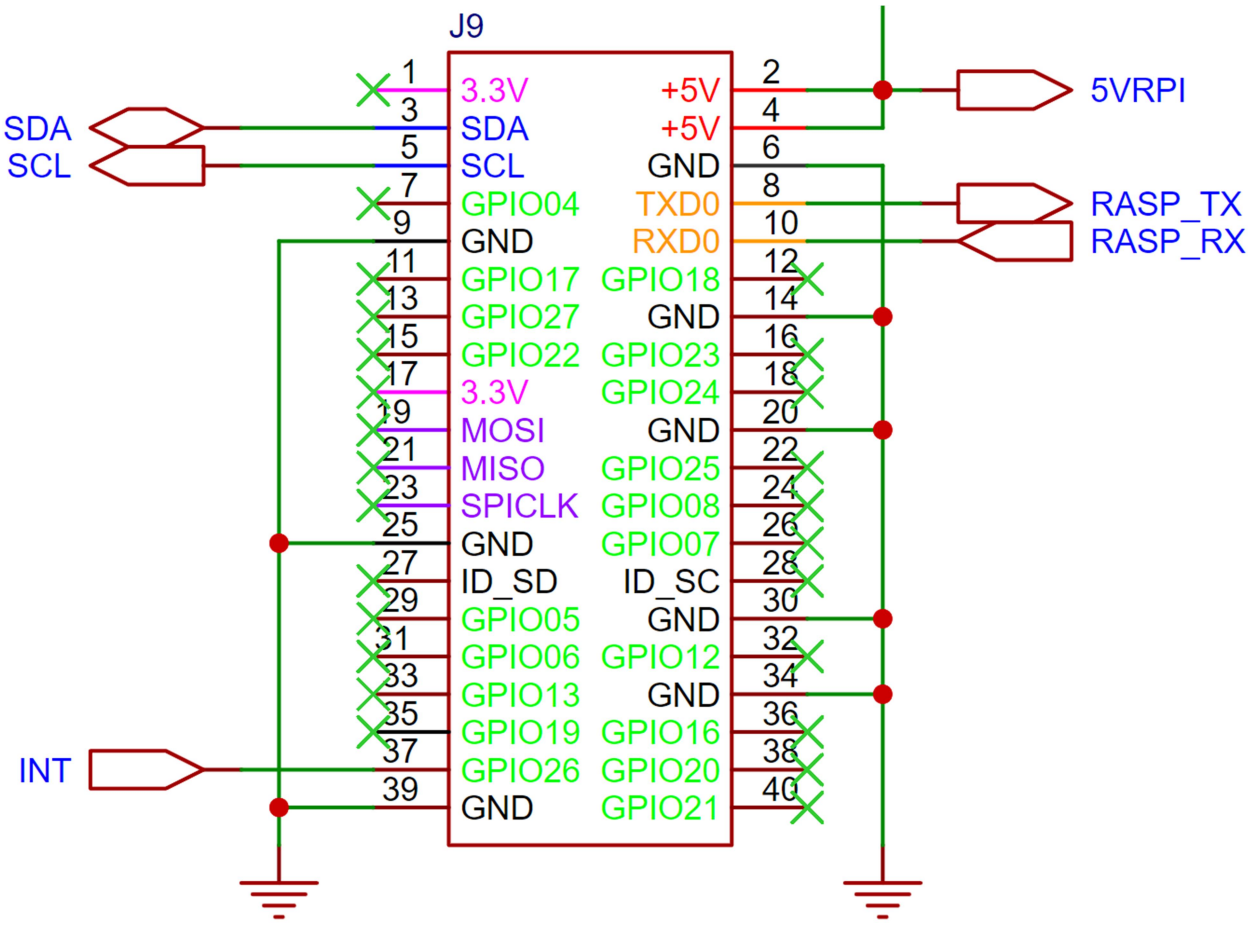
In both configurations the local processor needs to be programmed to release (switches ON) or control (switches OFF) the RS485 signals. See the command line online help for further information.

1-WIRE INTERFACE

A standard 1-Wire interface shares the 5 pin connector with the RS-485 port. 5V power and ground pins are also available.



RASPBERRY PI HEADER



POWER REQUIREMENTS

The Building Automation 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 a 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 the Raspberry Pi, and a 3.3V regulator powers the digital circuits. Isolated DC-DC converters are used to power the relays.

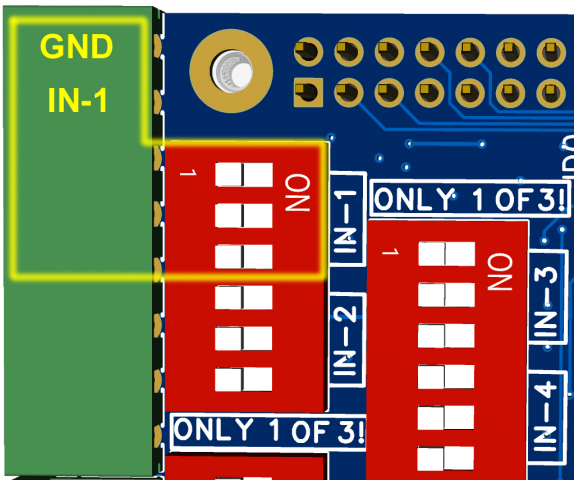
If multiple Building Automation Cards are stacked on top of each other, we recommend using a single 24VDC/AC power supply to power all the cards. The user must split the cable and run the wires to each card.

POWER CONSUMPTION:

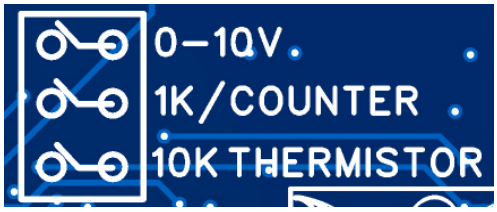
- 50 mA @ +24V

UNIVERSAL INPUTS

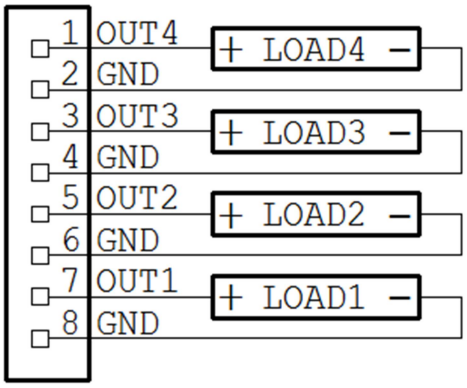
The Building Automation Card has eight universal inputs which can be selected to measure 0-10V signals, 1K or 10K thermistors or contact closure/event counters up to 100Hz. Each input is allocated three positions of a six positions DIP switch as shown in the following example:



The DIP Switch configuration is shown in the following diagram, and also on the card's silkscreen:

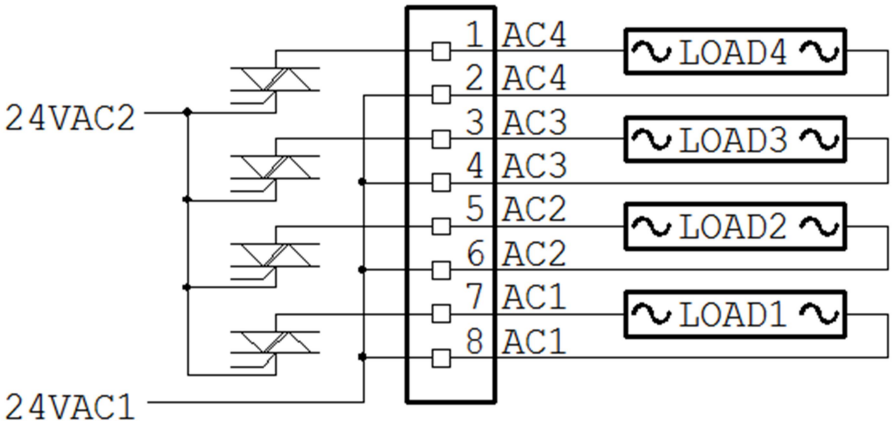


0-10V OUTPUTS



0-10V OUTPUTS CONFIGURATION. MAX LOAD = 10mA

TRIAC OUTPUTS



TRIAC OUTPUTS CONFIGURATION. MAX LOAD = 1A

HARDWARE WATCHDOG

The Building Automation Card contains a built-in hardware watchdog which will guarantee that your mission-critical project will continue running even if the Raspberry Pi software hangs up. After power up the watchdog is disabled, and it 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.

The Raspberry Pi needs to issue a reset command on the I2C port before the timer on the watchdog expires. 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 as 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 the 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 FUSE: 2.5A

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: 13 BITS

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.

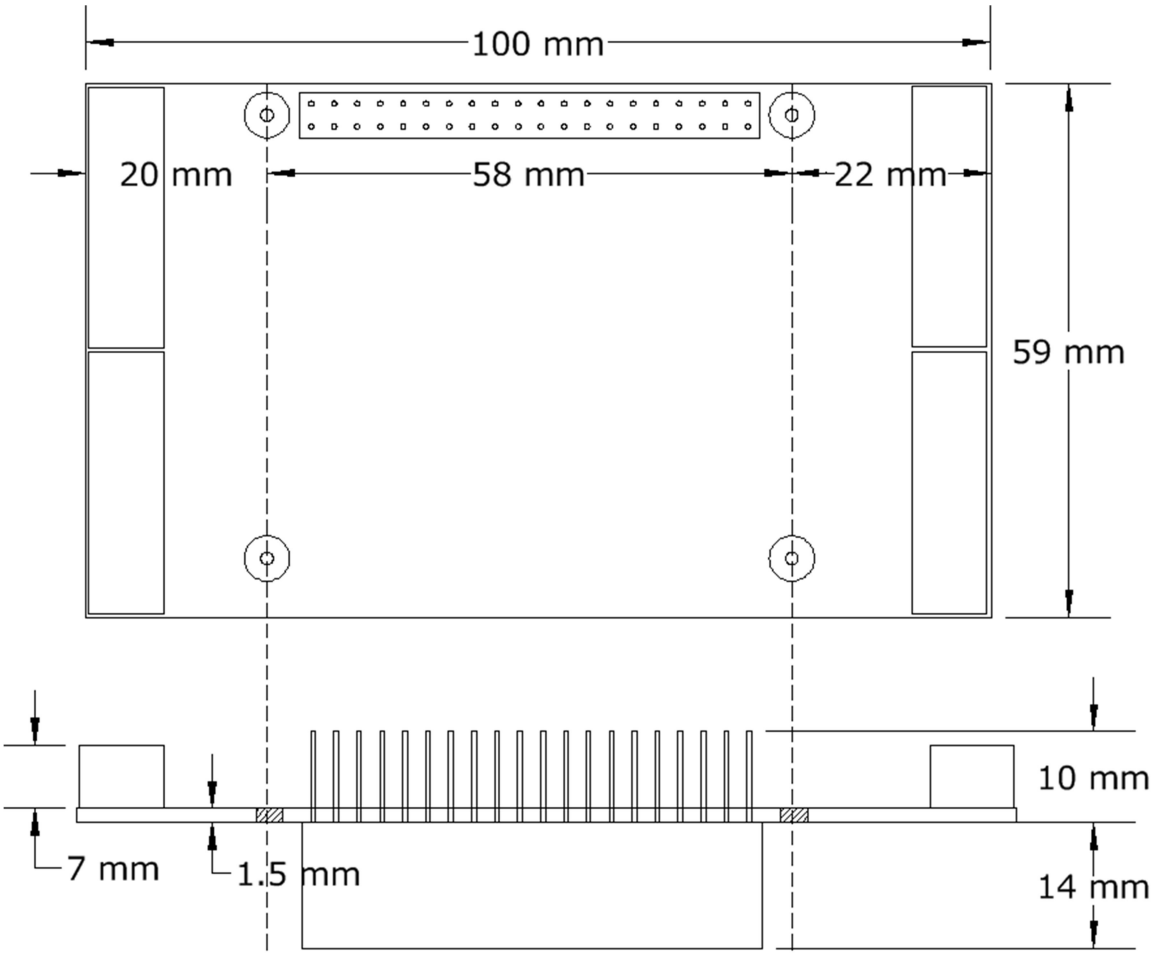
Analog outputs are PWM synthesized using 16 bit timers. PWM values range from 0 to 4,800.

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

ERRATA

The silkscreen of the Version 4.2 of the Building Automation Card has an error on the function of the DIP switches for selecting the input type. The correct silkscreen is shown below. It applies to each of the eight analog/digital inputs on the left side of the board.

