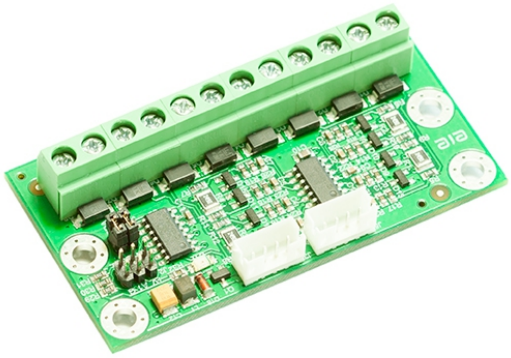
I2C-AI418ML

I2C-bus Voltage and Current Analog Input Board with over-voltage protection



Features

- 4 channels of analog inputs
- MCP3424, 12,14,16 and 18-bit
- Input voltage range: 0-5V, 0-10V
- Input current range: 0-20mA, 4-20mA, 0-40mA
- I2C bus interface 100Khz, 400Khz, 3.4Mhz
- Programmable Gain Amplifier(PGA)
- On-board pull-up resistors for I2C bus
- Up to 8 boards on a bus
- Compatible with most microcontrollers
- Single supply operating voltage: 2.7V to 5.5V
- Inverse polarity protection circuit for supply voltage
- 30V over voltage protections for each channel
- Input transient suppression for each channel

Introduction

This is an analog to digital converter board over I2C bus; I2C ADC BOARD. The board has 4 analog inputs. Each input can be connected to voltage or current source, so you can connect 0-5v or 0-10v to each input when you want to measure voltage. While, you can connect 0-20ma, 4-20ma or 0-40ma to each input when you want to measure current. Each input has over-voltage protection circuit. The over- voltage protection circuit can protect continuous voltage; up to 30volt. This circuit protects board damaging from human error and wrong connection. Also, each input has transient suppression device. This device protects board from external transient voltage when the input is connecting to long wires of sensor. There is ADC on board to convert the analog value to digital value. Resolution of ADC can be selected: 12,14,16, and 18 bits. The most significant bit (MSB) of digital value is used for a sign bit. For this board, the sign bit is away zero. It represents a plus sign. The digital value can be accessed by microcontroller through I2C bus. The PGA of ADC can be programmed through I2C bus too. The bus speed is compatible to standard mode: 100Khz, 400Khz, and 3.4Mhz. Address of each board is selected by two jumpers. The address can be eight different addresses. So you can connect eight boards together on a bus. The board has two of 10Kohm pull-up resistors for I2C bus lines, and you can enable or disable them by jumpers. However the 10Kohm resistor is suitable for 100KHz bus speed. The board needs only single supply voltage from 2.7V to 5.5V.

Diagram

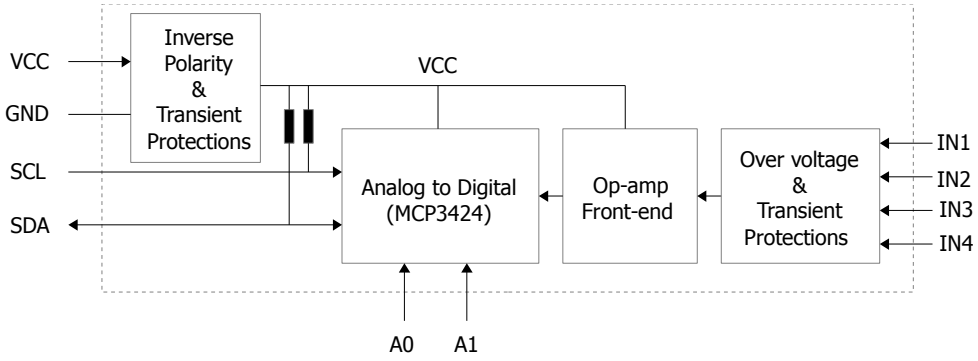


Figure 1: Block Diagram

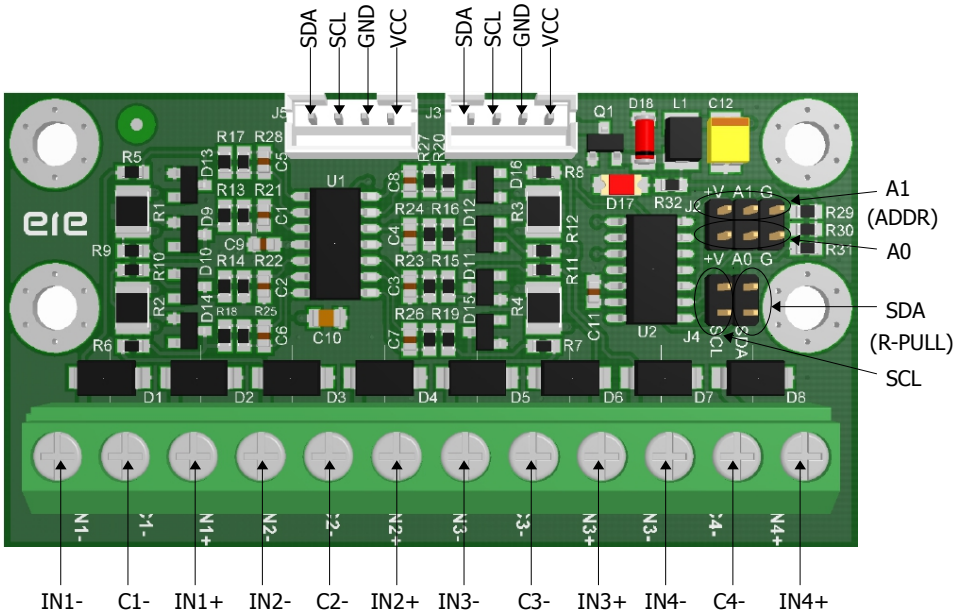


Figure 2: Board Layout

Table 1: Pin Descriptions

Symbol	Description
VCC	Power supply input voltage.
GND	Ground.
SCL	I2C bus serial clock signal.
SDA	I2C bus serial data signal.
R-PULL (SDA)	A jumper for selecting 10K pull-up resistor of SDA.
R-PULL (SCL)	A jumper for selecting 10K pull-up resistor of SCL.
A0	A jumper for selecting address of A0.
A1	A jumper for selecting address of A1.
IN1+… IN4+	Positive voltage and positive current for INPUT1 to INPUT4
IN1-... IN4-	Negative voltage for INPUT1 to INPUT4
C1-... C4-	Negative current for INPUT1 to INPUT4 (connect to IN1-..IN4- when input is current)

Analog Inputs

You can connect voltage and current sources to input connectors of the board. The voltage of each channel can be 0-5V or 0-10V. While, the current of each channel can be 0-20mA, 4-20mA or 0-40mA.

Voltage and Current Connection

A figure shows how to connect voltage sources and current sources to input connectors of the board.

When you want to connect voltage source to the board, the positive wire of the voltage source must be connected to the Inx+, and the negative wire of the voltage source must be connected to INx-. While, you leave the Cx- alone.

When you want to connect current source to the board, the positive wire of the current source must be connected to the Inx+, and the negative wire of the current source must be connected to INx- and Cx-. On the other hand, you must short INx- to Cx- when the current source is connected to the board.

Voltage and current outputs from any sensors are connected to the board as same as the figure.

x *means channel number 1,2,3, and 4*

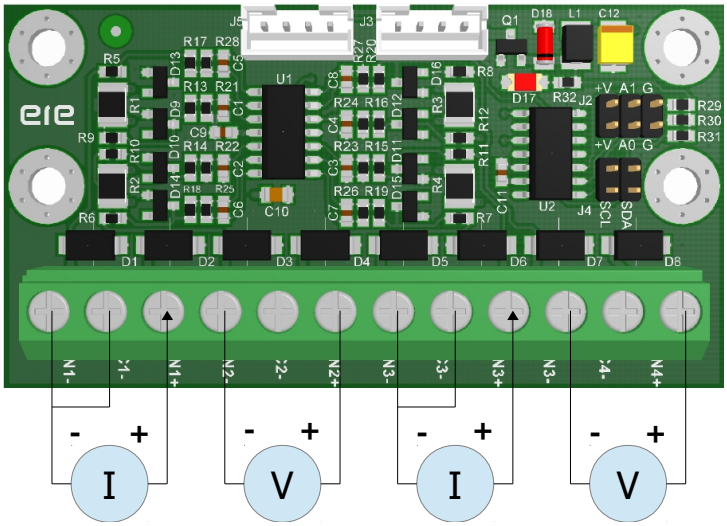


Figure 3: Input Source Connection

Table 2: Gain and Scale

Input Source	PGA	Analog Full Scale	12-bit max code	14-bit max code	16-bit max code	18-bit max code
0-5V	2	5.585V	2047	8191	32767	131071
0-10V	1	11.170V	2047	8191	32767	131071
0-20mA	2	22.431mA	2047	8191	32767	131071
4-20mA	2	22.431mA	2047	8191	32767	131071
0-40mA	1	44.863mA	2047	8191	32767	131071

MSB bit of digital code is a sign bit. For this board the sign bit(MSB) is away zero, It represents positive value.

VREF is voltage reference; internal of MCP3424 chip. The value is 2.048V

PGA is a programmable gain of MCP3424. The user defines via I2C bus.

Front-End Gain(FEG) is a gain of op-amp circuit of each channel.

Front-End Gain(FEG) of this board is $\frac{33}{180}$

Analog Full Scale is a maximum value of input signal when digital code is maximum. This value can be calculated by

Analog Full Scale = $(\frac{VREF}{PGA})(\frac{1}{FEG})$

You can use the following formula if you want to know value of input voltage from digital code that read over I2C bus.

input voltage = $(\frac{code}{max\,code})(\frac{VREF}{PGA})(\frac{1}{FEG})$

You can use the following formula to calculate value of input current if input signal comes from current source.

input current = $\frac{input\,voltage}{249}$

I2C bus Pull-Up Registers

The I2C bus needs resistors for pulling up SCL and SDA lines. The board has two 10Kohm resistors for this purpose. These resistors can be enabled by closing jumpers. These resistors have to be enabled if there is no any resistor on the bus lines.

The bus usually needs only one resistor on a line when many boards are connected together on the bus. Connecting many resistors on a bus line makes bus stronger. But the strong bus is needed when the bus is working at high frequency. While, the 10Kohm is suitable for 100KHz bus frequency.

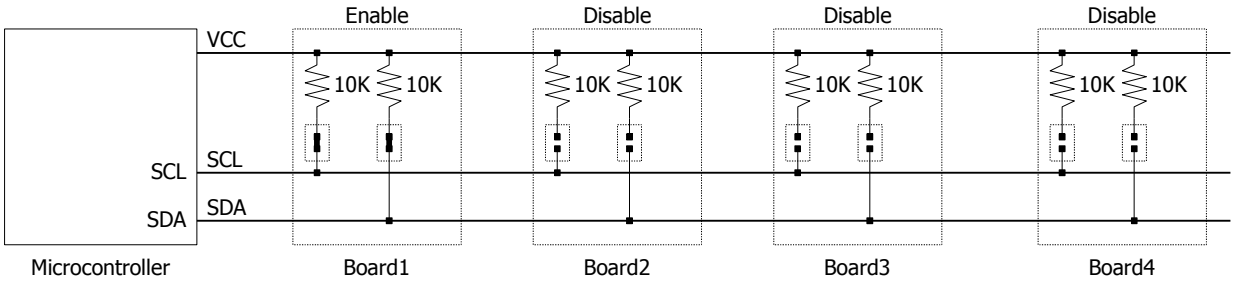


Figure 4: I2C bus resistors

Interfacing

LED on board turns on when you apply VCC into the board. The SCL and SDA pins must be connected to SCL and SDA pins of microcontroller respectively. Remember pull-up resistors must be enabled when there is no external pull-up resistor on the bus lines.

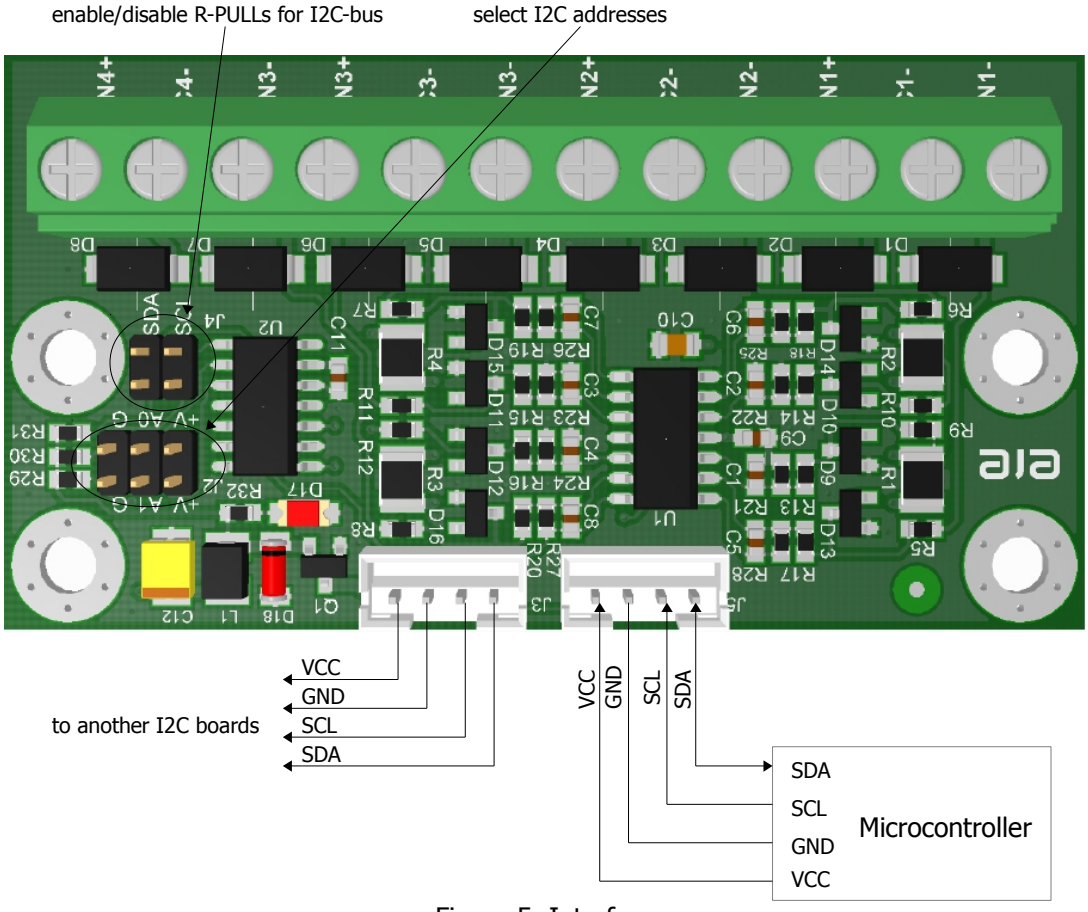


Figure 5: Interface

The boards can be connected together up to 8 boards on a bus.

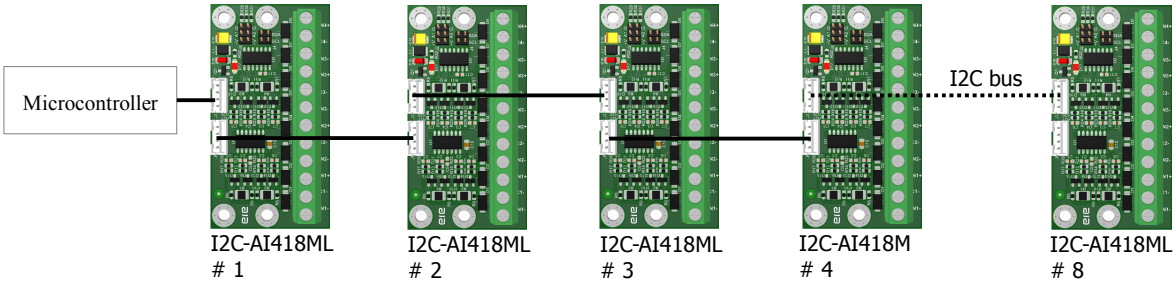


Figure 6: Connecting many boards on a bus

Address

The board is addressed by 2 jumpers making 8 different addresses.

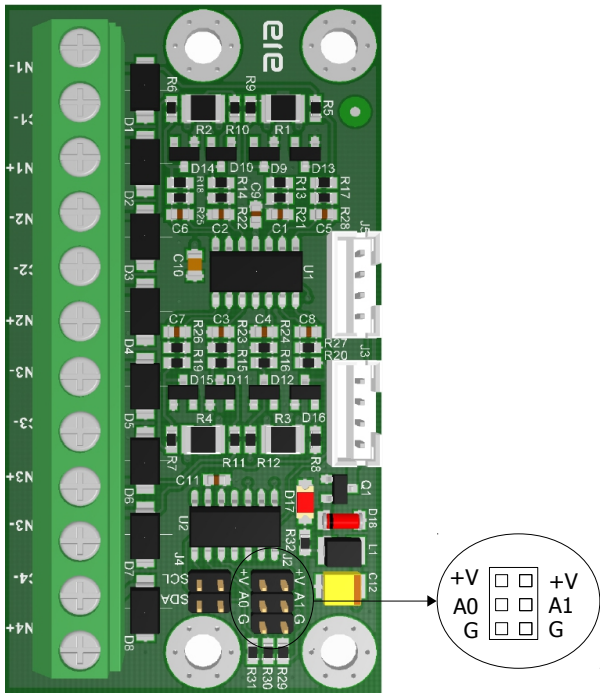
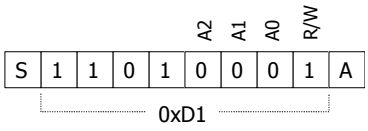
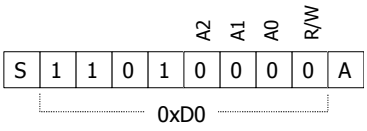
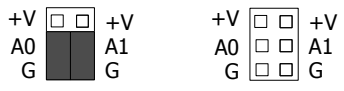


Figure 7: Address Jumpers

Table 3: Address Setting

Address Byte for Reading	Address Byte for Writing	Jumper Setting
		

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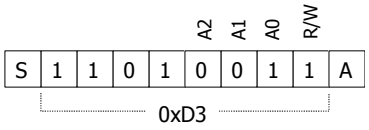
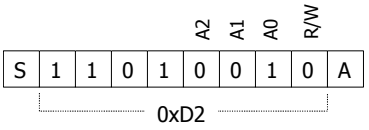
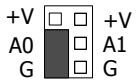
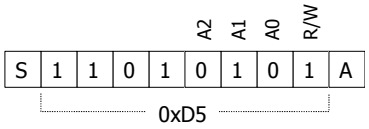
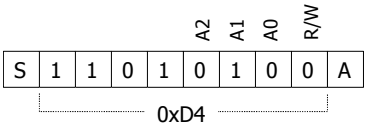
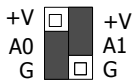
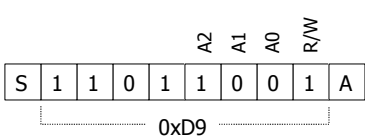
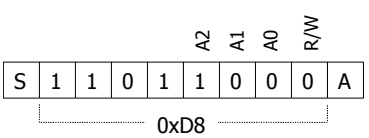
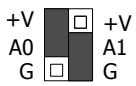
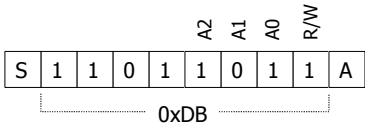
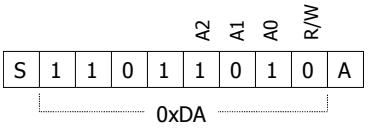
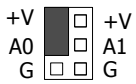
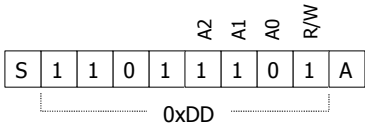
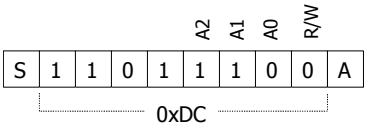
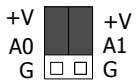
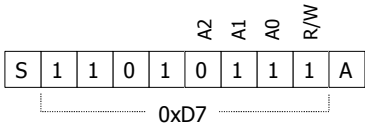
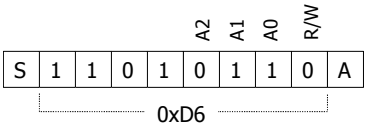
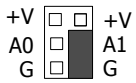
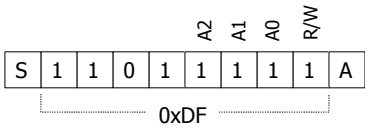
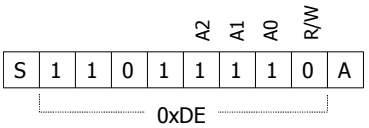
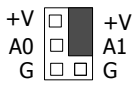
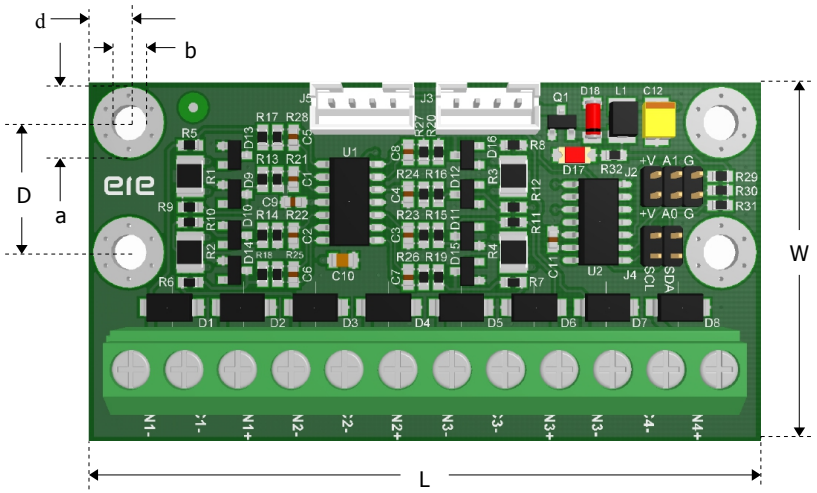
		
		
		
		
		
		
		

Table 4: Specification

Operating voltage	2.7V – 5.5V	
Interfacing	I2C bus	
Number of boards on bus (max)	8 boards	
Bus frequency (max)	100Khz, 400Khz, 3.4Mhz	
Number of input channel	4 channels	
Input voltage range	0-5V, 0-10V	
Input current range	4-20mA, 0-20mA, 0-40mA	
Input over voltage (max)	30V	
Input transient voltage suppression	Peak pulse Power Dissipation (max)	400W
	Peak Forward Surge Current @8.3ms (max)	40A

Dimensions



unit	inch	mm
L	2.657	67.50
W	1.417	36.00
D	0.511	13.00
a	0.279	7.10
b	0.141	3.60
d	0.157	4.00

Figure 8: Board Dimension