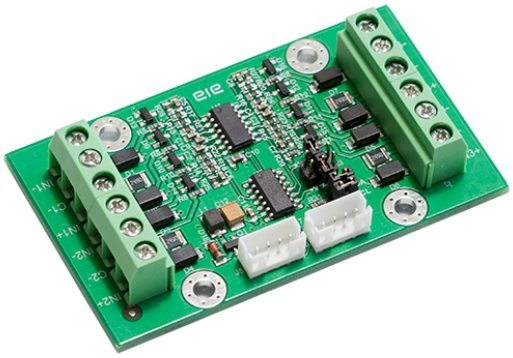
I2C-AI418M

I2C bus Voltage and Current Analog Input Board; Din-Rail supports



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 input channel
- Input transient suppression for each input channel
- Supports Din-rail PCB holder

Introduction

This is an analog to digital converter board through 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 30 volt. 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. The board has ADC on board to converts the analog value to digital value. The ADC can be selected resolution: 12,14,16,and 18-bit. The most significant bit (MSB) 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 microcontrollers 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 ,and you can enable or disable them by jumpers. The 10Kohm resistor is suitable for 100KHz bus speed. The board needs only single supply voltage from 2.7V to 5.5V ,and the board can be plugged on din-rail PCB holder.

Diagram

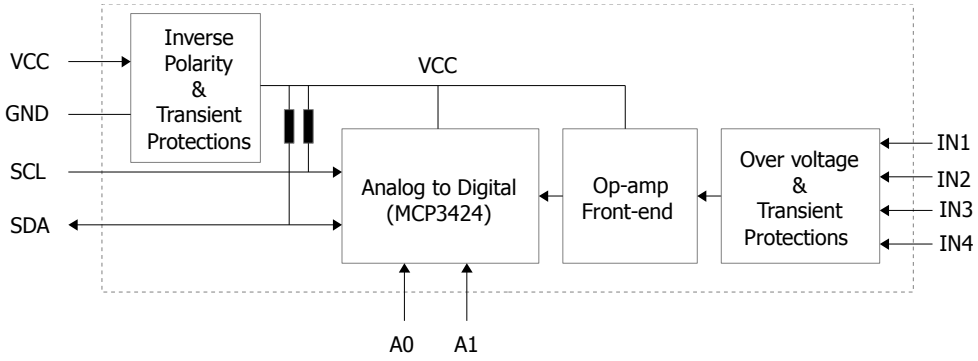


Figure 1: Block Diagram

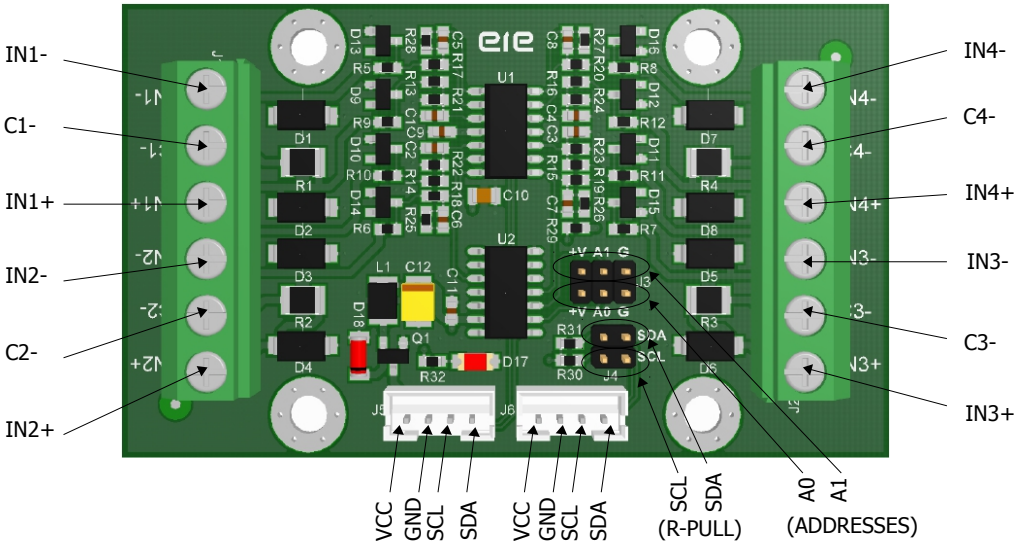


Figure 2: Board Layout

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 (connected to IN1-..IN4- when input is current)

Analog Inputs

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

Voltage and Current Connections

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

When user wants 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-. But Cx is leaved alone.

When user wants 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 connect to Inx- and Cx-. It means the user must short INx- to Cx- when 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*

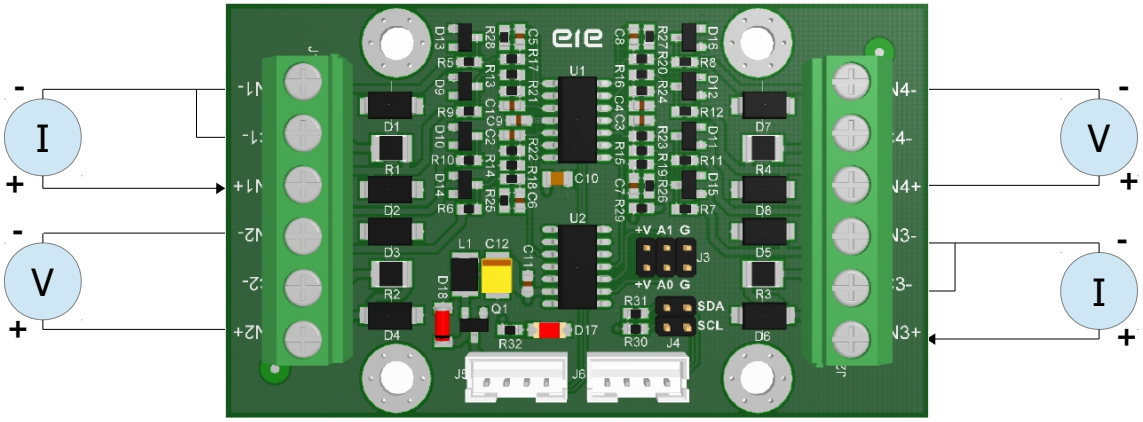


Figure 3: voltage and current connections

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 through 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 = $(\frac{VREF}{PGA})(\frac{1}{FEG})$

If the user wants to know input voltage from digital code that read over I2C bus. The user can use the following formula

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

If input signal is current. The user can use the following formula to calculate the input current.

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 jumpers. These resistors must be enabled if there is no resistor on the bus.

Each line of bus usually needs only one resistor when many boards are connected together on a bus. However, many resistors on bus line make bus line strong. Also the strong bus is needed when the bus is working at high frequency. In fact, the 10Kohm is suitable for 100KHz bus frequency.

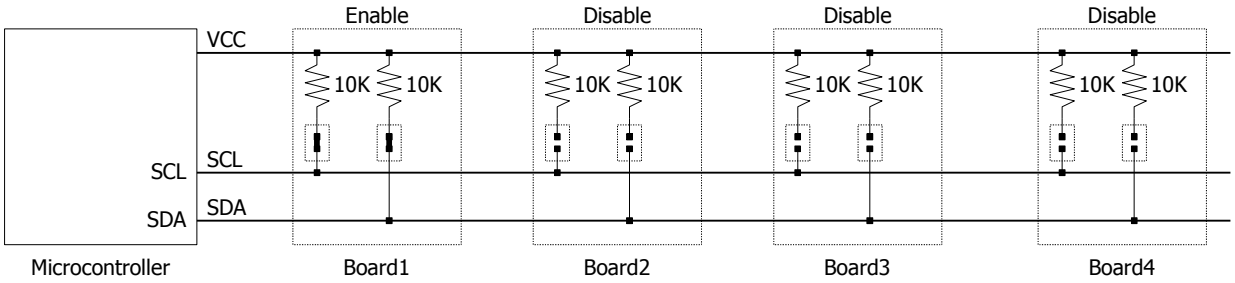


Figure 4: I2C bus resistors

Interfacing

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

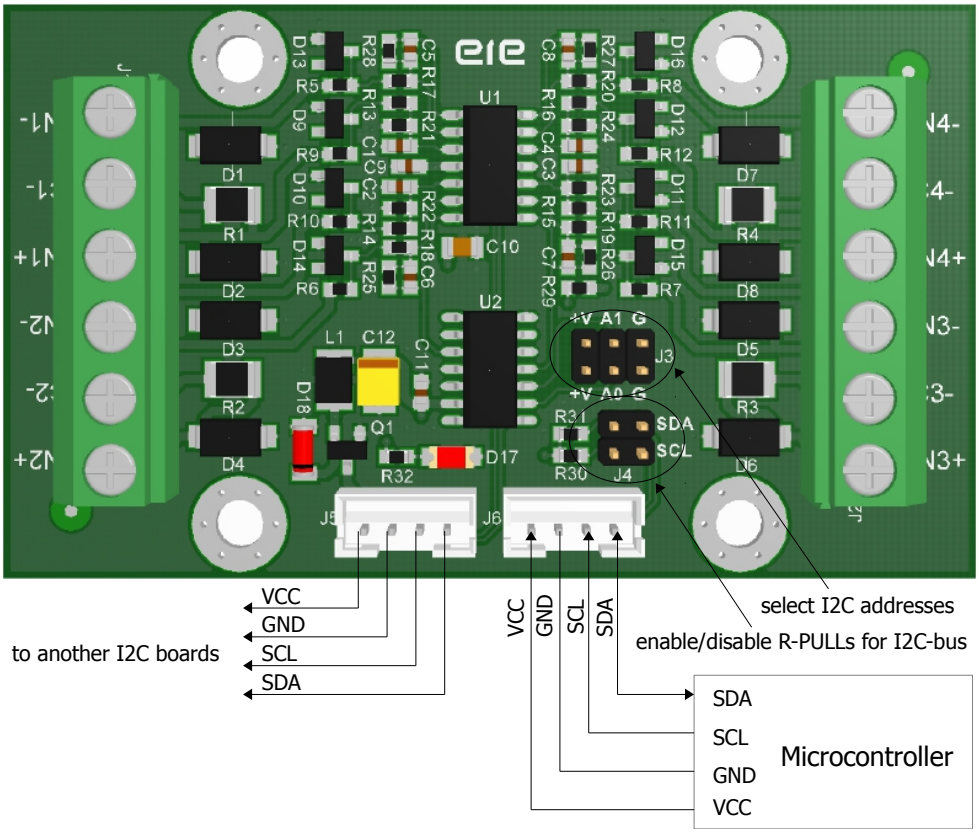


Figure 5: Interfacing

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

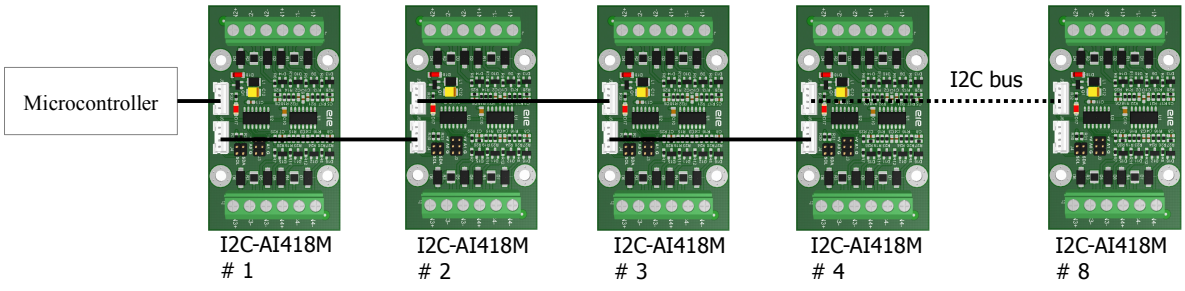


Figure 6: 8-boards on bus

Address

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

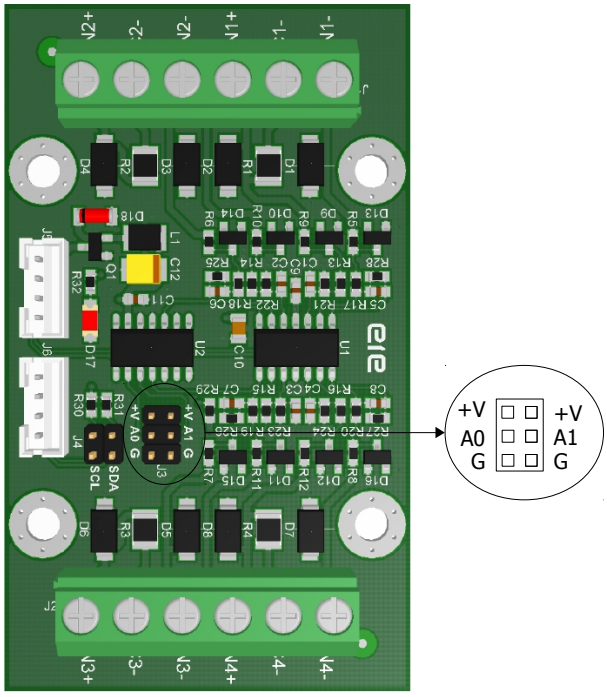


Figure 7: Address Jumpers

Table 3: Address Setting

Address Byte for Reading	Address Byte for Writing	Jumper Setting
A2 A1 A0 R/W S 1 1 0 1 0 0 0 1 A 0xD1	A2 A1 A0 R/W S 1 1 0 1 0 0 0 0 A 0xD0	+V A0 G +V A1 G +V A0 G +V A1 G
A2 A1 A0 R/W S 1 1 0 1 0 0 1 1 A 0xD3	A2 A1 A0 R/W S 1 1 0 1 0 0 1 0 A 0xD2	+V A0 G +V A1 G
A2 A1 A0 R/W S 1 1 0 1 0 1 0 1 A 0xD5	A2 A1 A0 R/W S 1 1 0 1 0 1 0 0 A 0xD4	+V A0 G +V A1 G

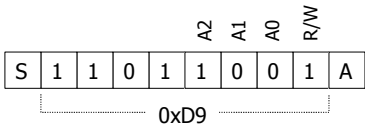
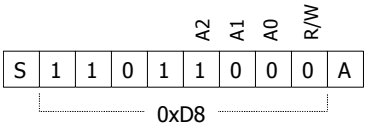
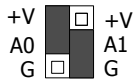
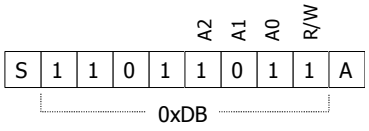
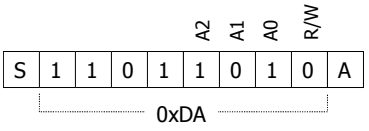
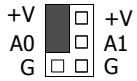
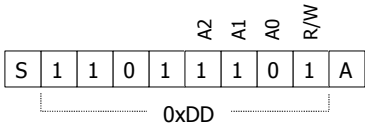
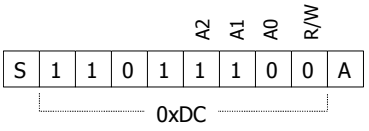
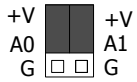
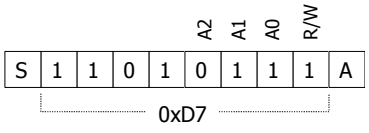
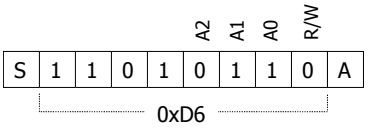
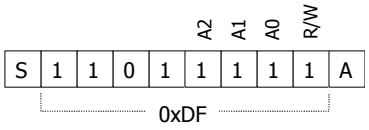
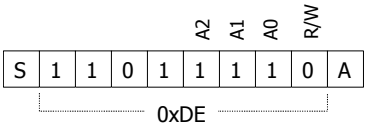
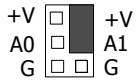
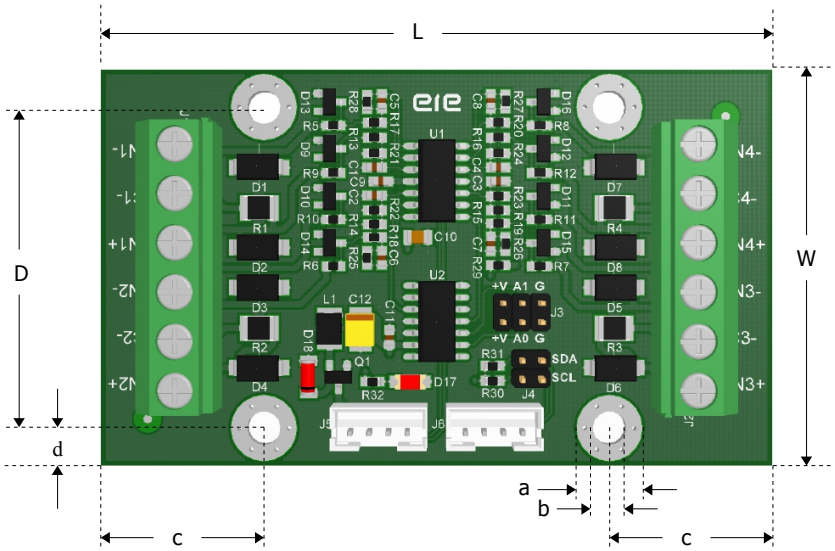
Address Byte for Reading	Address Byte for Writing	Jumper Setting
		
		
		
		
		

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 ,and 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	2.834	72.00
W	1.673	42.50
D	1.358	34.50
a	0.279	7.10
b	0.141	3.60
c	0.688	17.50
d	0.157	4.00

Figure 8: Board dimensions