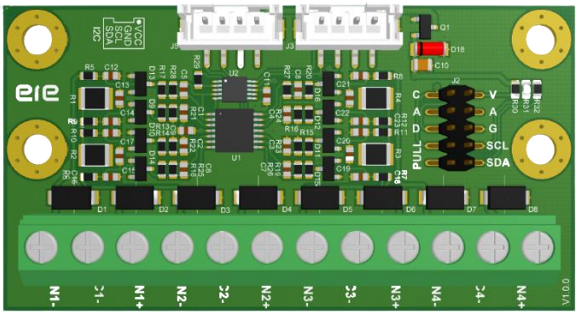
I2C-AI416ML

4-20mA, 0-10V Front-End to Digital through I2C bus.



1. Features

- 4 Channels of analog inputs
- Voltage on each input: 0-5V, 0-10V
- Current on each input: 0-20mA, 4-20mA, 0-40mA, 0-80mA
- 16-bit ADC, ADS1115
- I2C bus speed 100Khz, 400Khz, 3.4Mhz
- On board availability pull-up resistors on I2C lines
- Up to 4 boards on a single bus
- Operating power supply voltage: 2.7V to 5.5V
- Inverse polarity protection circuits for power supply
- Over voltage protections for inputs
- Transient voltage protection for inputs
- EMI/RFI filter
- Low pass noise filter
- Programable digital filter
- Programable data rate

2. Introduction

This is an I2C bus analog to digital converter board. Voltage and current sources can be connected to each input of the board. The board converts the analog values to digital values then the digital values can be processed by a microcontroller. The microcontroller reads the digital values from the board through an I2C bus. The I2C ADC board has four inputs. Each input accepts voltage 0-5V and 0-10V or accepts current 0-20mA, 4-20mA, 0-40mA and 0-80mA. The resolution of digital values of the board is 16 bits. The most significant bit (MSB) is used for a sign bit.

The board needs only a single supply voltage from 2.7V to 5.5V for operation. The I2C bus is compatible with the standard 100Khz, 400Khz and 3.4Mhz modes.

The I2C bus addresses are selected by setting jumpers, therefore the board can be configured to one of four addresses. This means that four boards can be connected on a single bus. The board has a pair of 10K ohm pull-up resistors for I2C lines. These resisters can be enabled or disabled with jumpers. The board has input transient protection, over voltage protection and EMI/RFI filter.

3. Diagram

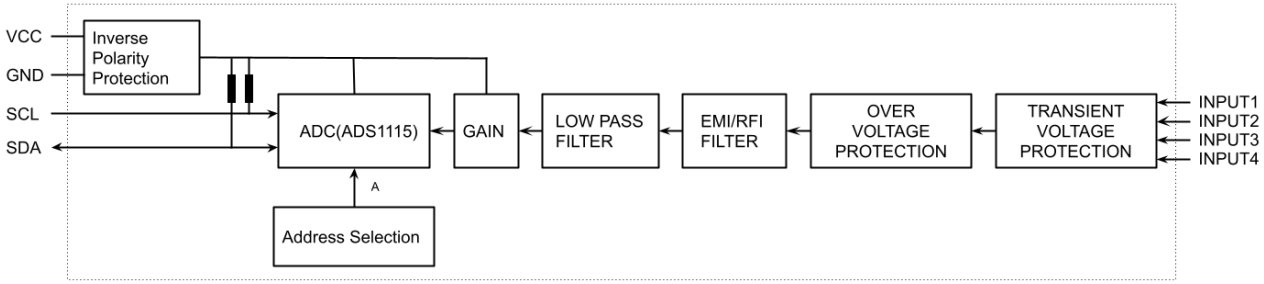


Figure 1: Diagram

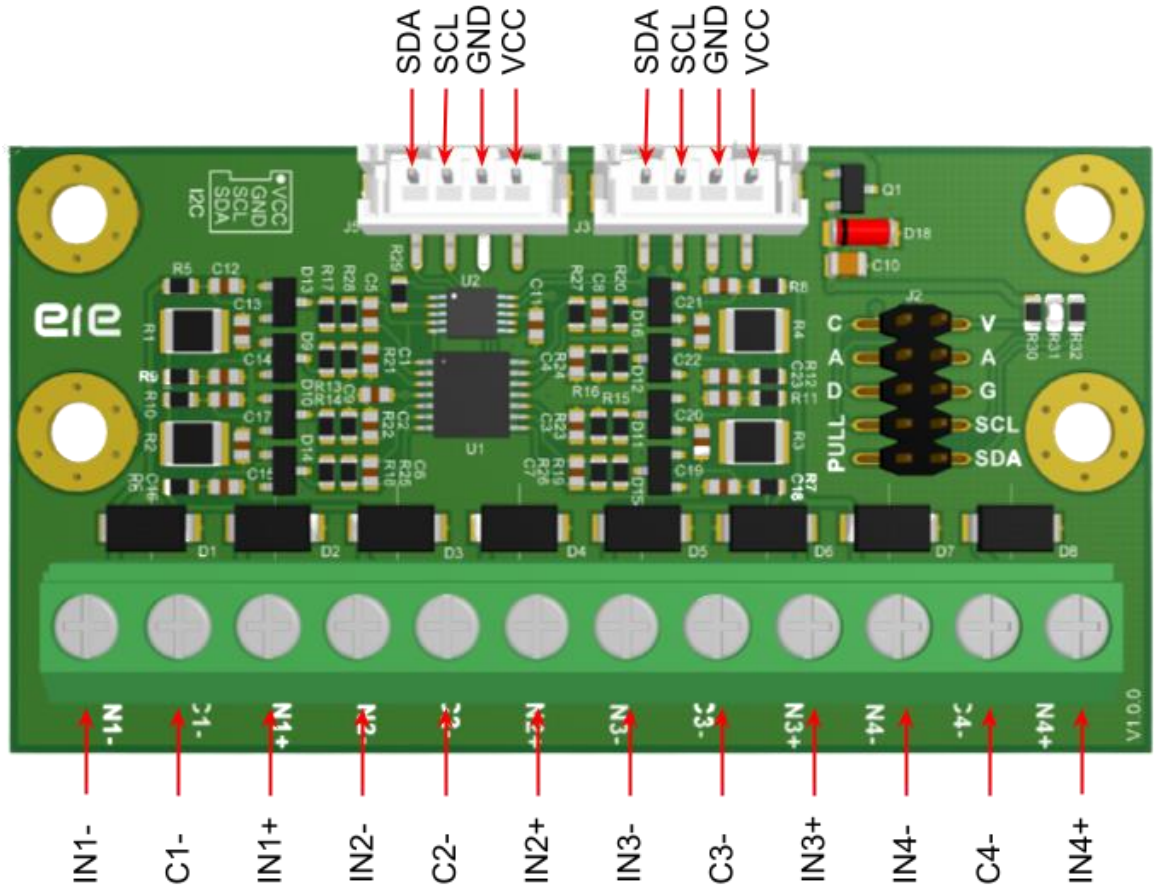


Figure 2: Board Layout

Table 1: Signal Descriptions

Symbol	Descriptions
VCC	Power supply voltage.
GND	Ground.
SCL	I2C bus serial clock signal.
SDA	I2C bus serial data signal.
PULL (SDA)	A jumper for selecting a 10K ohms pull-up resistor on the SDA line.
PULL (SCL)	A jumper for selecting a 10K ohms pull-up resistor on the SCL line.
A (jumper)	An ADDR address pin of ADS1115.
V (jumper)	A VCC signal pin. The address pin can connect to this pin for selecting one of four different addresses.
G (jumper)	A GND signal pin. The address pin can connect to this pin for selecting one of four different addresses.
C (jumper)	A SCL signal pin. The address pin can connect to this pin for selecting one of four different addresses.
D (jumper)	An SDA signal pin. The address pin can connect to this pin for selecting one of four different addresses.

IN1+… IN4+	Positive voltage and positive current for INPUT1 to INPUT4. The positive current means that the current flows into the board.
IN1-... IN4-	Negative voltage for INPUT1 to INPUT4
C1-... C4-	Negative current for INPUT1 to INPUT4 (connect to IN1-… IN4- when an input is current). The negative current means that the current flows out of the board.

4. Analog Inputs

Voltage and current sources can be connected to inputs of the board. The voltage of each channel can be 0-5V and 0-10V. Therefore, the current of each channel can be 0-20mA, 4-20mA, 0-40mA and 0-80mA.

5. Voltage and Current Connection

When a voltage source connects to an input of the board. The positive and the negative poles of the voltage source must connect to the INx+ and INx- pins of the board respectively while the Cx- pin is unconnected.

While a current source connects to an input of the board. The output wire of the current source must connect to the INx+ pin, and the positive wire of the current source must connect to a positive pole of a power supply. The INx- and Cx- must be shorted together and connected to the negative pole of the power supply.

The power supply (Vs) must have voltage enough for a sensor operation because the voltage, 1.24V will drop across the inputs of the board when current, 20mA flows through a loop. An example if a sensor needs 9V at least for operation. The power supply voltage (Vs) must be 10.24V at least.

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

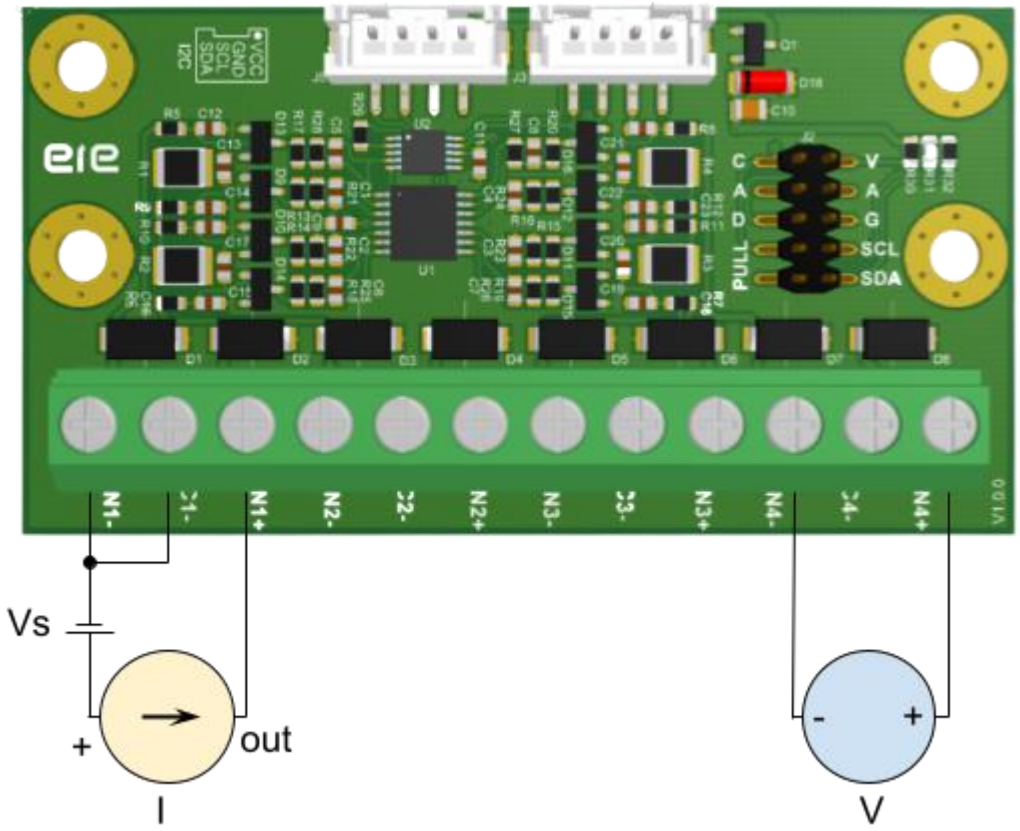


Figure 3: Input Connection

Table 2: Gains and Scales Setting

Input Sources	Full Scale Range (FSR)	Front-End Gain (FEG)	Input Full Scale	Max. code
0 - 5 V	1.024 V	0.2	5.120 V	32767
0 - 10 V	2.048 V	0.2	10.240 V	32767
0 - 20 mA	0.256 V	0.2	20.645 mA	32767
4 - 20 mA	0.256 V	0.2	20.645 mA	32767
0 - 40 mA	0.512 V	0.2	41.290 mA	32767
0 - 80 mA	1.024 V	0.2	82.258 mA	32767

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

Full Scale Range (FSR) is the full-scale input voltage range of the ADS1115. Setting this value through I2C bus.

Front-End Gain (FEG) is a gain of front-end op-amp circuit of each channel. The Front-End Gain (FEG) of the board is $\frac{36}{180.1}$ or ~0.2.

Input Full Scale is the maximum value of an input signal when the digital code is maximum. This value can be calculated by

Input Full Scale = $(\frac{FSR}{FEG})$

An input voltage can be known by calculated from a digital code that read through the I2C bus.

Input Voltage = $(\frac{code}{Max\_code})(\frac{FSR}{FEG})$

Therefore, if the input signal is current. The value of the current can be known by calculated.

Input Current = $\frac{Input\_Voltage}{62}$

6. I2C Bus pull-up Registers

The I2C bus needs a pair of resistors for pulling-up SCL and SDA lines. The board has a pair of 10K ohms resistors for this purpose. These resistors can be enabled by closing jumpers. These resistors must be enabled if there isn't any resistor on the I2C bus.

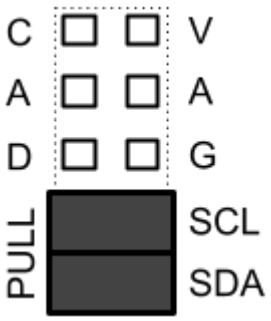


Figure 4: Enable PULL-UP resistors.

The bus usually needs only a pair of resistors when boards are connected on a single bus. More pairs of resistors make the bus strong. However, a strong bus is needed for high frequency of clock signal. The 10K ohms resisters are suitable for 100KHz bus frequency.

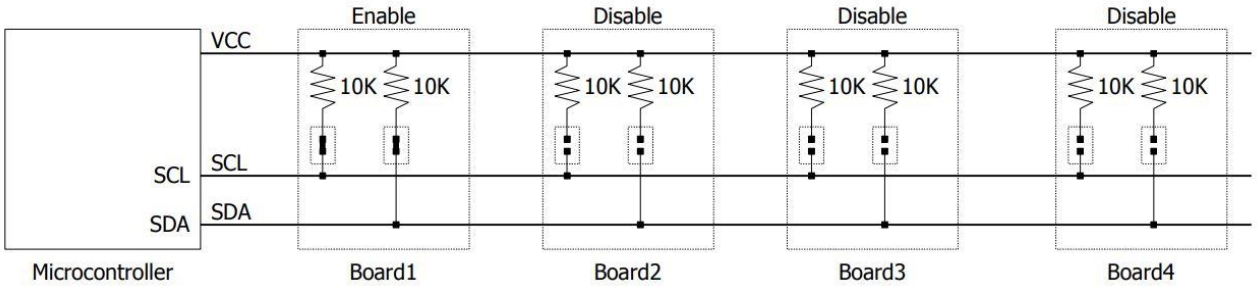


Figure 5: I2C bus pull-up resisters

7. Interfacing

The VCC must be supplied from a microcontroller board. The SCL and SDA pins must be connected to SCL and SDA pins of the microcontroller respectively. Remember, the pull-up resistors must be enabled when there is no external pull-up resistor on the bus. The boards can be connected to 4 boards on a single bus.

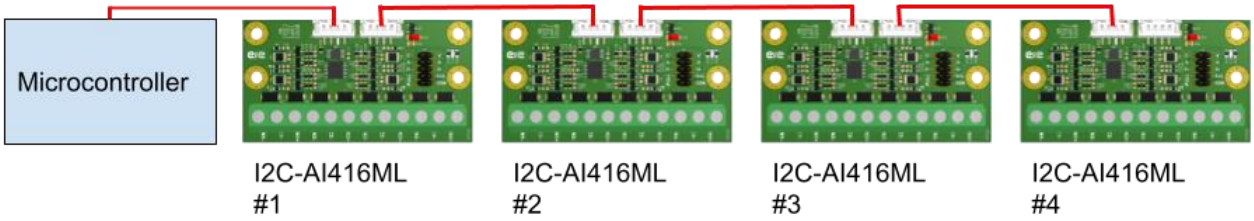


Figure 6: Multiple boards on a single bus

8. Address

The board is addressed by jumpers to make 4 different addresses.

Table 3: Address Setting

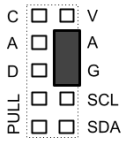
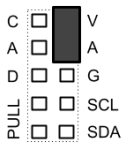
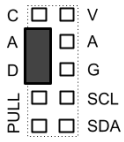
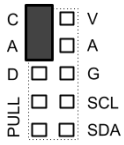
7-BIT I2C ADDRESSES	ADDR PIN CONNECTS TO	JUMPER SETTING
1001000 (48H)	GND	
1001001 (49H)	VCC	
1001010 (4AH)	SDA	
1001011 (4BH)	SCL	

Table 4: Specification

Operating voltage	2.7V – 5.5V	
Interface	I2C bus	
Boards on a single bus (max.)	4 boards	
I2C bus frequency	100Khz, 400Khz, 3.4Mhz	
Input channels	4 channels	
ADC resolution	16-bit (MSB bit is a sign bit)	
Input voltage ranges	0-5V, 0-10V	
Input current ranges	4-20mA, 0-20mA, 0-40mA, 0-80mA	
Input voltage drop @20mA	1.24V	
Current loop resistance	62 ohms	
Filters	Low pass, EMI/RFI filters	
Input over voltage protection (max.)	30V	
Input transient protection	Peak pulse power dissipation	400W
	Peak forward surge current @8.3ms (max.)	40A

9. Application

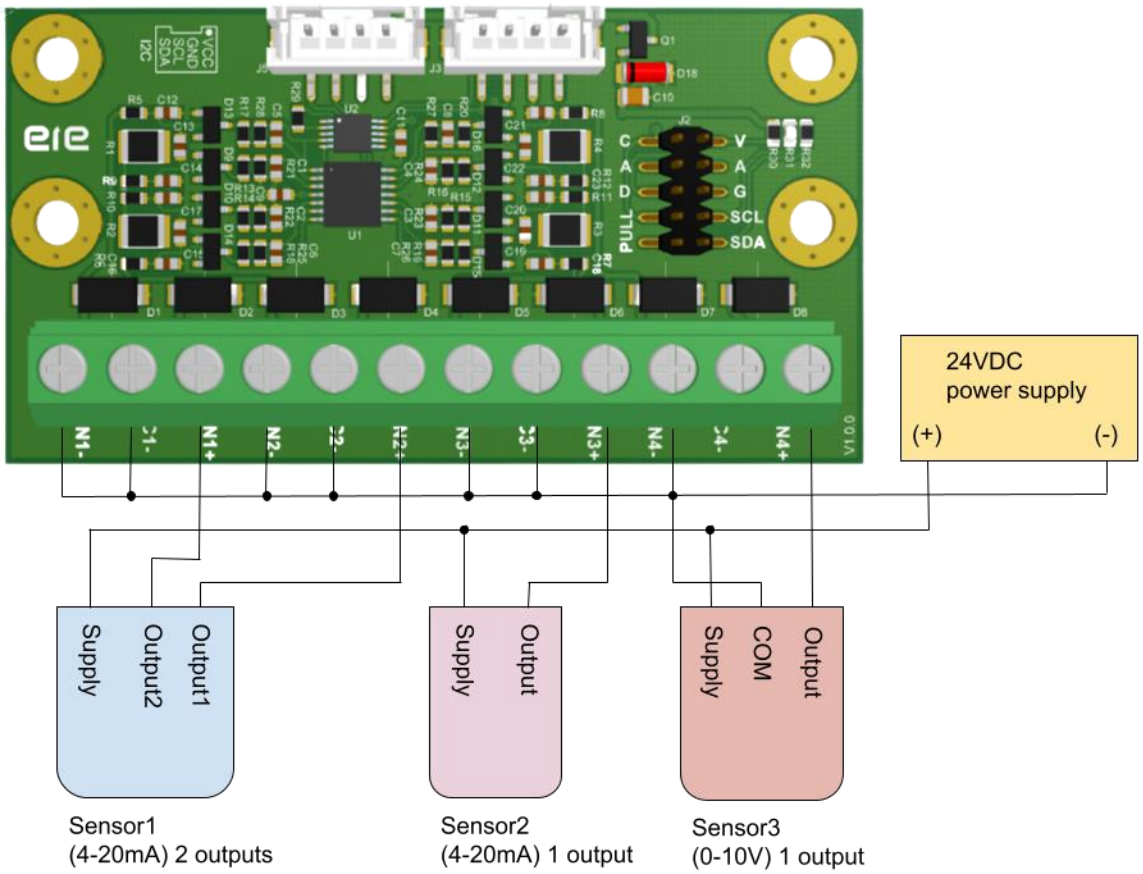


Figure 6: Sensors are connecting to a board.

10. Dimensions

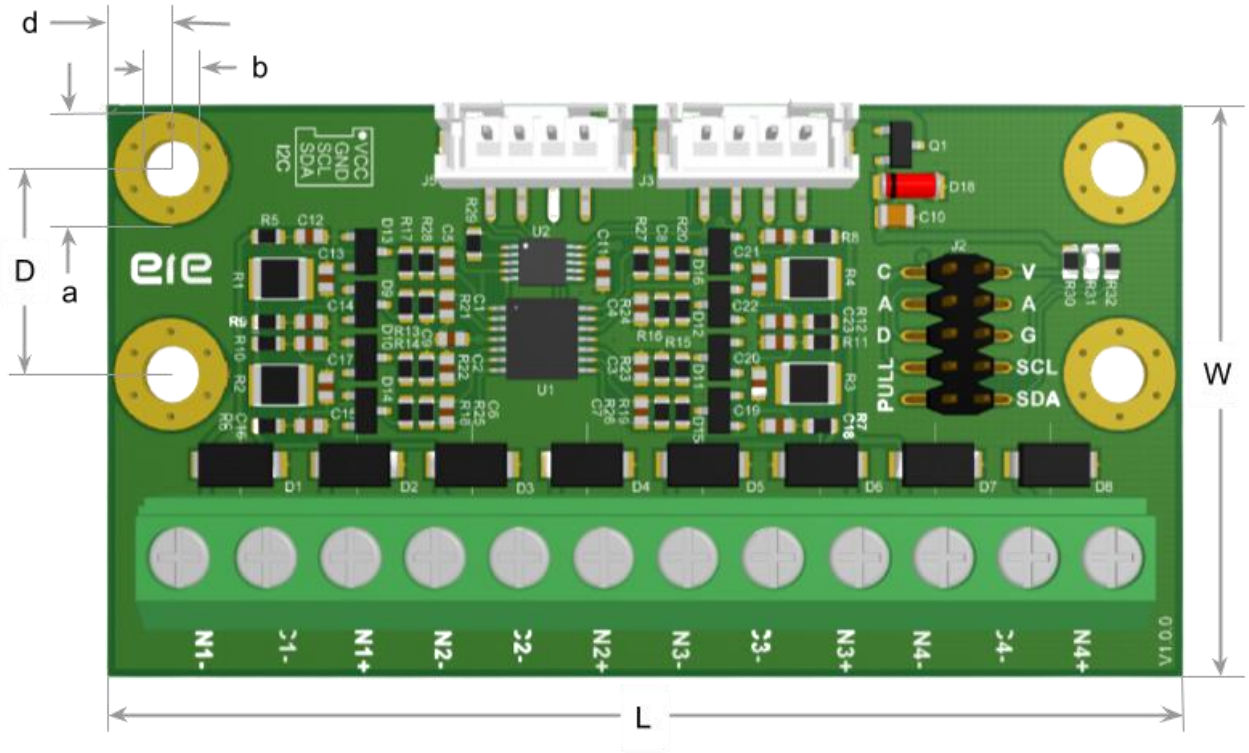


Figure 7: Board Dimensions

Table 5: Board Dimensions

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

Declaration

ERE Company Limited continues to improve our products. Therefore, we reserve the right to change the specifications at any time without notice.