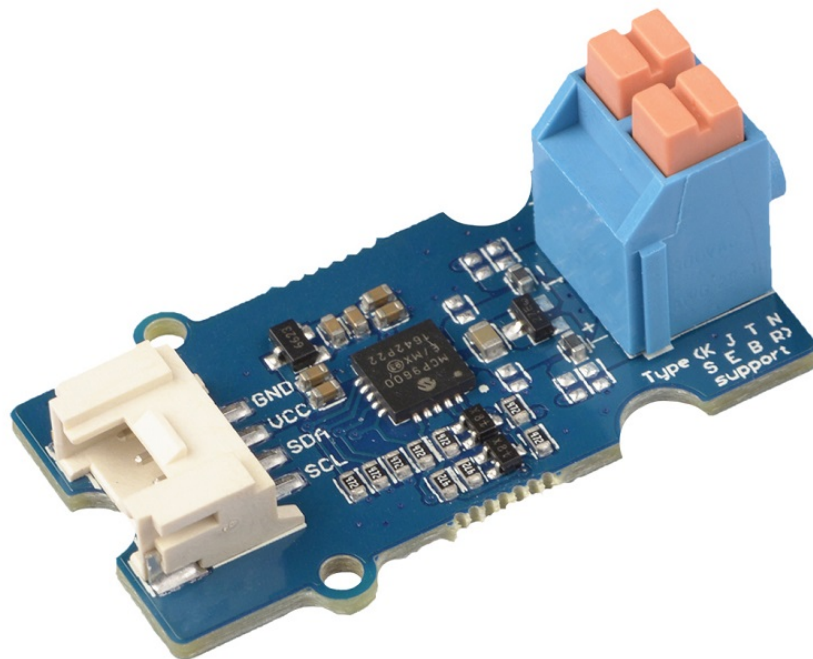


# Grove - I2C Thermocouple Amplifier (MCP9600)



The Grove - I2C Thermocouple Amplifier (MCP9600) is a thermocouple-to-digital converter with integrated cold-junction and I2C communication protocol. This module is designed to be used in conjunction with a k-type thermocouple. The thermocouples have a much larger measurement range than thermistors. For example,

this [k-type thermocouple](#)

[<https://www.seeedstudio.com/Thermocouple-Temperature-Sensor-K-Type-1M-p-3132.html>] on our website has a measurement range of -50°C to +600°C.

We also provide the alert function for this module, you can use the programmable alert pin to provide an interrupt signal to the controller.

Again, this module can't work alone, it must work with a k-type thermocouple, if you do not have one, you can consider

[Thermocouple Temperature Sensor K Type-1M](#)

[<https://www.seeedstudio.com/Thermocouple-Temperature-Sensor-K-Type-1M-p-3132.html>] in our bazaar.



[<https://www.seeedstudio.com/Grove-I2C-Thermocouple-Amplifier-%28MCP9600%29-p-3199.html>]

## Version

Product Version	Changes	Released Date
Grove - I2C Thermocouple Amplifier (MCP9600)	Initial	Aug 2018

## Features

- Integrated Cold-Junction Compensation
- Supported Types (designated by NIST ITS-90): Type K, J, T, N, S, E, B and R
- Four Programmable Temperature Alert Outputs:
  - Monitor Hot- or Cold-Junction
  - temperatures
  - Detect rising or falling temperatures
  - Up to 255°C of Programmable Hysteresis
- Programmable Digital Filter for Temperature
- Low Power

**Note**

The Grove - I2C Thermocouple Amplifier (MCP9600) do support Type K, J, T, N, S, E, B and R on hardware, however, at present, our library do not support any other kind of thermocouple except K type.

## Specification

Item	Value
Operating Voltage	3.3V/5V
Ambient Temperature	-40°C ~ +125°C
Storage Temperature	-65°C ~ +150°C
Max. Junction Temperature	+150°C
Hot-Junction Accuracy	±1.5°C (Max.)
Measurement Resolution	Hot and Cold-Junctions: 0.0625°C (typical)
Interface	I <sup>2</sup> C
I <sup>2</sup> C Address	0x60(default) / 0x67(optional)
Size	L: 40mm W: 20mm H: 18mm
Weight	4.8g
Package size	L: 130mm W: 85mm H: 20mm
Gross Weight	11g

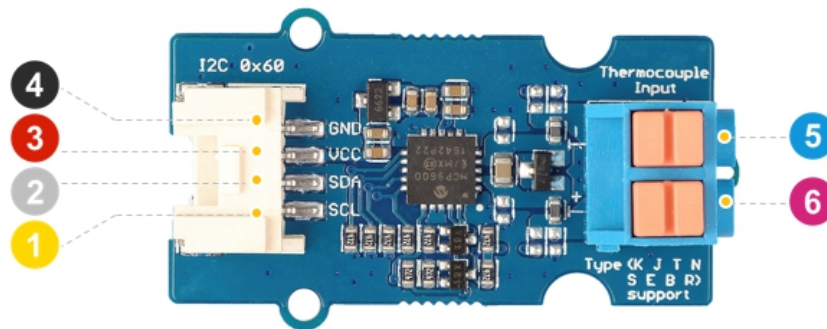
## Applications

- Petrochemical Thermal Management
- Hand-Held Measurement Equipment
- Industrial Equipment Thermal Management

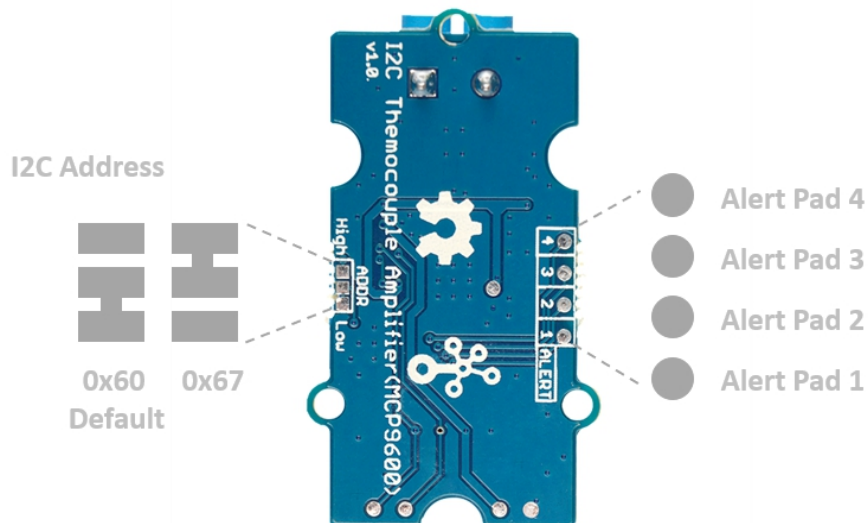
- Ovens
- Industrial Engine Thermal Monitor
- Temperature Detection Racks

## Hardware Overview

### Pin Map

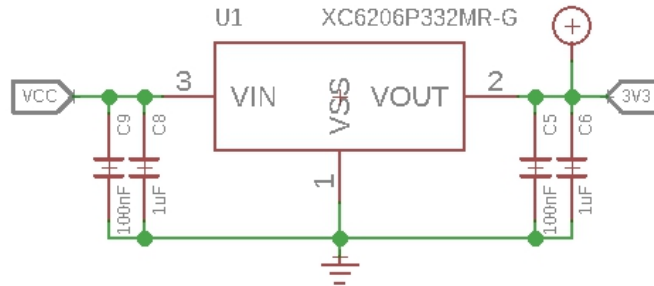


- 4 GND: connect this module to the system GND
- 3 VCC: you can use 5V or 3.3V for this module
- 2 SDA: I<sup>2</sup>C serial data
- 1 SCL: I<sup>2</sup>C serial clock
- 5 T -: Thermocouple Input, negative pole
- 6 T +: Thermocouple Input, positive pole



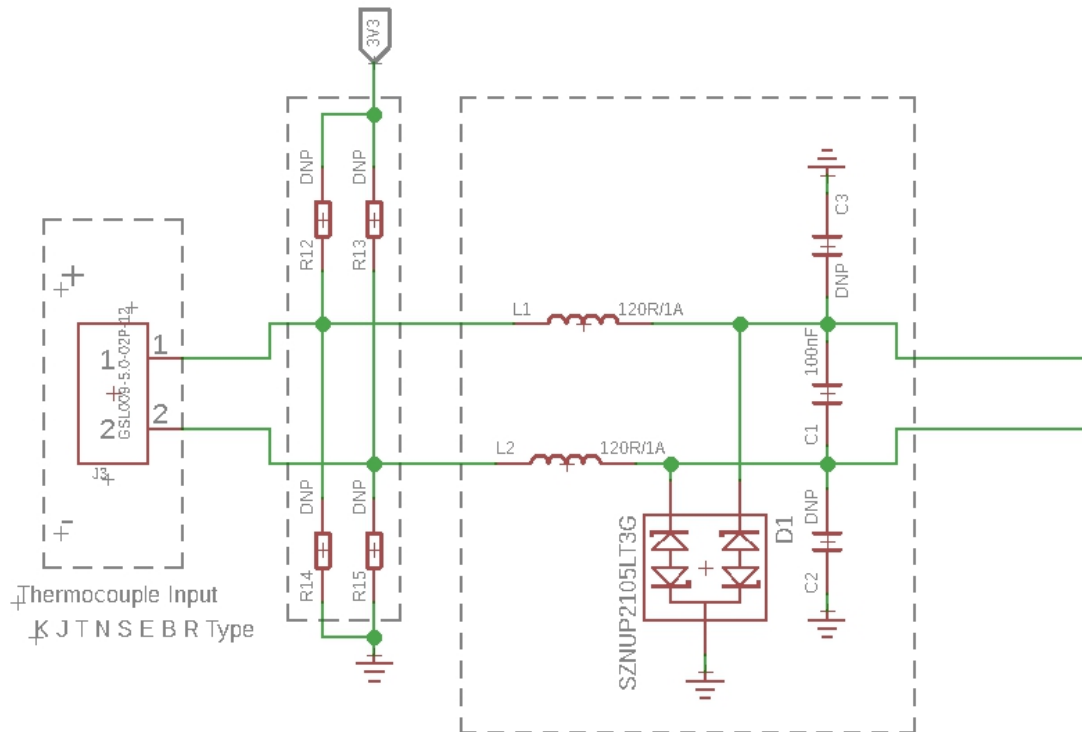
## Schematic

### Power



The operating voltage range of MCP9600 is 2.7V ~ 5.5V, we use a power conversion chip *XC6206P332MR-G* to provide a stable 3.3V for the MCP9600.

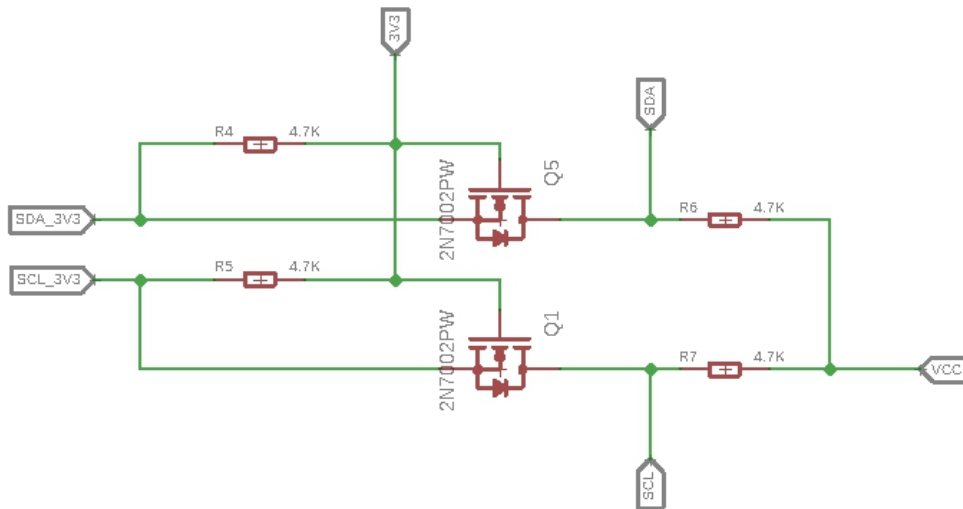
### Input Jack



Because of the small signal levels involved, we take a lot measures to filter the noise.

- **1--L1,L2** We use thermocouple up to 1 meter long. Such long wires can be regarded as antennas, which will receive spatial electric field interference and generate high frequency noise. So we use two inductances to filter the high frequency noise.
- **2--C1** It is strongly recommended by the chip manufacturer to add a 100nF ceramic surfacemount differential capacitor, placed across the T+ and T- pins, in order to filter noise on the thermocouple lines.
- **3--D1** We use the SZNUP2105LT3G DUAL BIDIRECTIONAL VOLTAGE SUPPRESSOR to protect this module from ESD(Electro-Static discharge).

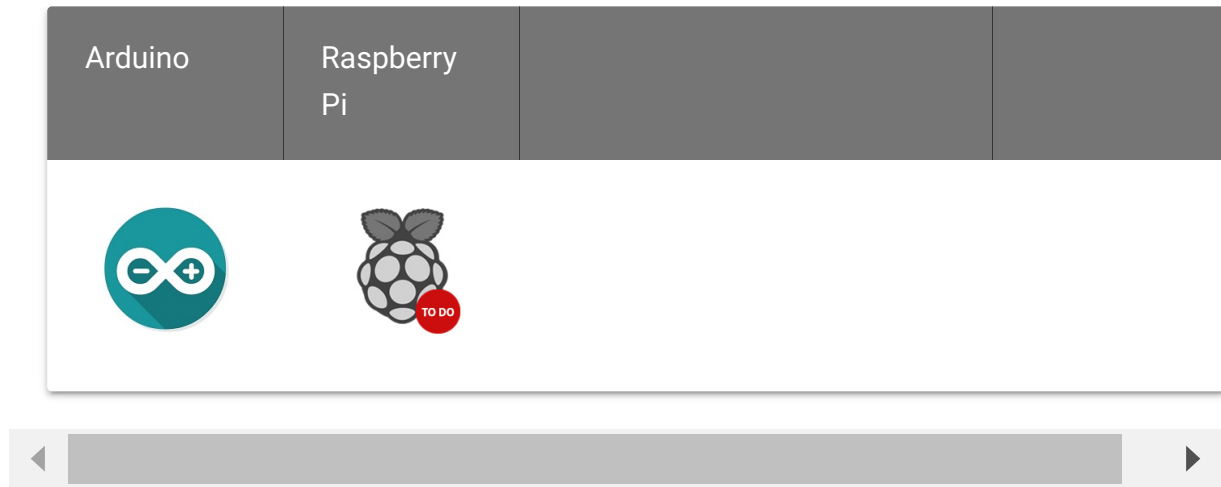
### Bi-directional level shifter circuit



This is a typical Bi-directional level shifter circuit to connect two different voltage section of an I<sup>2</sup>C bus. The I<sup>2</sup>C bus of this sensor use 3.3V, if the I<sup>2</sup>C bus of the Arduino use 5V, this circuit will be needed. In the schematic above, **Q1** and **Q5** are N-Channel MOSFET [2N7002A](https://files.seeedstudio.com/wiki/Grove-I2C_High_Accuracy_Temperature_Sensor-MCP9808/res/2N7002A_datasheet.pdf) [https://files.seeedstudio.com/wiki/Grove-I2C\_High\_Accuracy\_Temperature\_Sensor-MCP9808/res/2N7002A\_datasheet.pdf], which act as a bidirectional switch. In order to better understand this part, you can refer to the [AN10441](https://files.seeedstudio.com/wiki/Grove-I2C_High_Accuracy_Temperature_Sensor-MCP9808/res/AN10441.pdf) [https://files.seeedstudio.com/wiki/Grove-I2C\_High\_Accuracy\_Temperature\_Sensor-MCP9808/res/AN10441.pdf]

## Platforms Supported



**Caution**

The platforms mentioned above as supported is/are an indication of the module's software or theoretical compatibility. We only provide software library or code examples for Arduino platform in most cases. It is not possible to provide software library / demo code for all possible MCU platforms. Hence, users have to write their own software library.

## Getting Started

### Play With Arduino

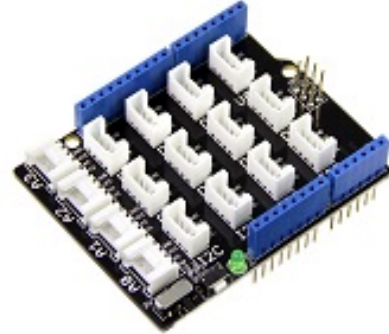
### Hardware

### Materials required

Seeeduino V4.2



Base Shield



[Get One Now](#)

[<https://www.seeedstudio.com/Seeeduino-V4.2-p-2517.html>]

[Get One Now](#)

[<https://www.seeedstudio.com/Base-Shield-V2-p-1378.html>]

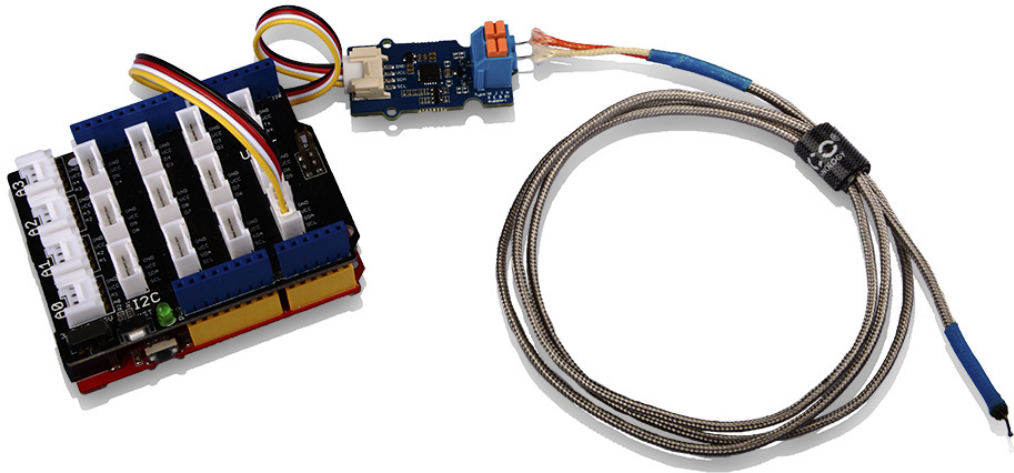


#### Note

**1** Please plug the USB cable gently, otherwise you may damage the port. Please use the USB cable with 4 wires inside, the 2 wires cable can't transfer data. If you are not sure about the wire you have, you can click [here](https://www.seeedstudio.com/Micro-USB-Cable-48cm-p-1475.html) [<https://www.seeedstudio.com/Micro-USB-Cable-48cm-p-1475.html>] to buy

**2** Each Grove module comes with a Grove cable when you buy. In case you lose the Grove cable, you can click [here](https://www.seeedstudio.com/Grove-Universal-4-Pin-Buckled-20cm-Cable-%285-PCs-pack%29-p-936.html) [<https://www.seeedstudio.com/Grove-Universal-4-Pin-Buckled-20cm-Cable-%285-PCs-pack%29-p-936.html>] to buy.

- **Step 1.** Connect the Grove - I2C Thermocouple Amplifier (MCP9600) to port **I<sup>2</sup>C** of Grove-Base Shield.
- **Step 2.** Plug Grove - Base Shield into Seeeduino.
- **Step 3.** Connect Seeeduino to PC via a USB cable.

**Note**

If we don't have Grove Base Shield, We also can directly connect this module to Seeeduino as below.

Seeeduino	Grove Cable	Grove - I2C Thermocouple Amplifier
GND	Black	GND
5V / 3.3V	Red	VCC
SDA	White	SDA
SCL	Yellow	SCL

**Software**

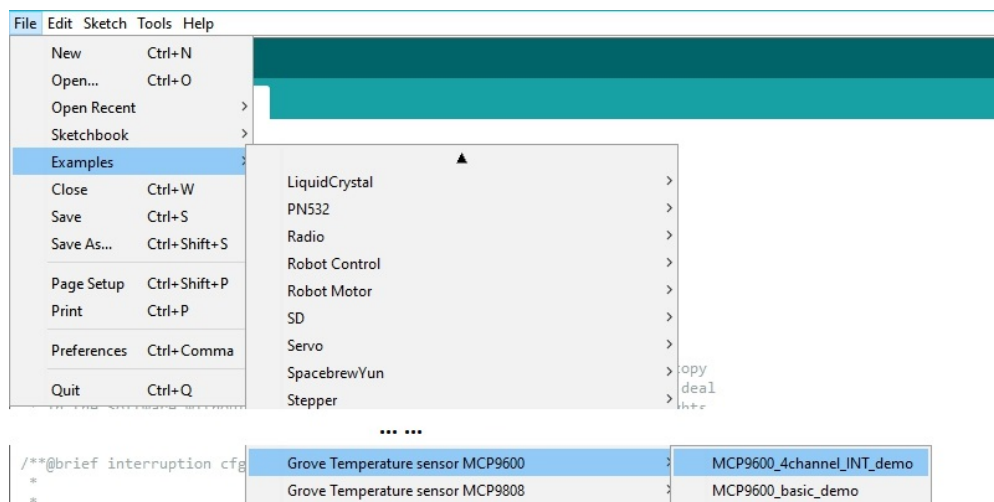


### Note

If this is the first time you work with Arduino, we strongly recommend you to see [Getting Started with Arduino](https://wiki.seeedstudio.com/Getting_Started_with_Arduino/) [https://wiki.seeedstudio.com/Getting\_Started\_with\_Arduino/] before the start.

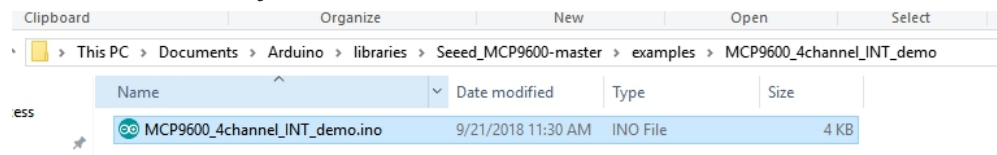
- **Step 1.** Download the [Seed\\_MCP9600](https://github.com/Seeed-Studio/Seeed_MCP9600) [https://github.com/Seeed-Studio/Seeed\_MCP9600] Library from Github.
- **Step 2.** Refer to [How to install library](https://wiki.seeedstudio.com/How_to_install_Arduino_Library) [https://wiki.seeedstudio.com/How\_to\_install\_Arduino\_Library] to install library for Arduino.
- **Step 3.** Restart the Arduino IDE. Open the example, you can open it in the following three ways:


- Open it directly in the Arduino IDE via the path: **File** → **Examples** → **Grove Temperature sensor MCP9600** → **MCP9600\_4channel\_INT\_demo**.



- Open it in your computer by click the **MCP9600\_4channel\_INT\_demo.ino** which you can find in the folder **XXXX\Arduino\libraries\Seed\_MCP9600-master\examples\MCP9600\_4channel\_INT\_demo, XXXX**

is the location you installed the Arduino IDE.



- c. Or, you can just click the icon  in upper right corner of the code block to copy the following code into a new sketch in the Arduino IDE.

```

1  #include "Seeed_MCP9600.h"
2
3  #ifndef ARDUINO_SAMD_VARIANT_COMPLIANCE
4      #define SERIAL SerialUSB
5  #else
6      #define SERIAL Serial
7  #endif
8
9  MCP9600 sensor;
10
11  /**@brief interruption cfg.
12  *
13  *
14  * */
15  err_t sensor_INT_config()
16  {
17      err_t ret=NO_ERROR;
18      CHECK_RESULT(ret,sensor.set_filt_coefficients(FILT_
19
20      for(int i=0;i<4;i++)
21      {
22          /*Conver temp num to 16bit data*/
23          CHECK_RESULT(ret,sensor.set_alert_limit(i,senso
24          /*Set hysteresis.for example,set hysteresis to .
25          the temp exceed limitation,and the interruption
26          CHECK_RESULT(ret,sensor.set_alert_hys(i,2));
27
28          /*Set when interruption generated the pin's st
29          CHECK_RESULT(ret,sensor.set_alert_bit(i,ACTIVE_
30

```

```
31     CHECK_RESULT(ret,sensor.clear_int_flag(i));
32
33     /*default is comparator mode*/
34     CHECK_RESULT(ret,sensor.set_alert_mode_bit(i,CO
35
36     /*Set alert pin ENABLE.*/
37     CHECK_RESULT(ret,sensor.set_alert_enable(i,ENAB
38
39
40
41     }
42
43     /*device cfg*/
44     CHECK_RESULT(ret,sensor.set_cold_junc_resolution(CO
45     CHECK_RESULT(ret,sensor.set_ADC_meas_resolution(ADC
46     CHECK_RESULT(ret,sensor.set_burst_mode_samp(BURST_3
47     CHECK_RESULT(ret,sensor.set_sensor_mode(NORMAL_OPER.
48
49     return NO_ERROR;
50 }
51
52
53 err_t get_temperature(float *value)
54 {
55     err_t ret=NO_ERROR;
56     float hot_junc=0;
57     float junc_delta=0;
58     float cold_junc=0;
59     bool stat=true;
60
61     CHECK_RESULT(ret,sensor.check_data_update(&stat));
62     if(stat)
63     {
64         CHECK_RESULT(ret,sensor.read_hot_junc(&hot_junc
65         CHECK_RESULT(ret,sensor.read_junc_temp_delta(&j
66
67         CHECK_RESULT(ret,sensor.read_cold_junc(&cold_ju
68
69         *value=hot_junc;
70     }
71     else
```

```
72     {
73         SERIAL.println("data not ready!!");
74     }
75
76     return NO_ERROR;
77 }
78
79
80 void setup()
81 {
82     SERIAL.begin(115200);
83     delay(10);
84     SERIAL.println("serial start!!");
85     if(sensor.init(THER_TYPE_K))
86     {
87         SERIAL.println("sensor init failed!!");
88     }
89     sensor_INT_config();
90 }
91
92
93
94 void loop()
95 {
96     float temp=0;
97     u8 byte=0;
98     u8 stat=0;
99
100
101     get_temperature(&temp);
102     SERIAL.print("temperature =====");
103     SERIAL.println(temp);
104
105     sensor.read_INT_stat(&stat);
106
107     SERIAL.println(" ");
108     SERIAL.println(" ");
109
110     delay(1000);
111 }
```

**Note**

There are 2 demos in the library:

**MCP9600\_basic\_demo.ino**

This example is a sample use of temperature sensor, you need to poll for data.

**MCP9600\_4channel\_INT\_demo.ino**

here are four alert pads on the sensor module which connect to alert pin. You can set temperature limits by calling the API we provided. The alert pin outputs low when the temperature value beyond limit. You can attach alert pin to a interrupt pin of host, To improve the efficiency of program operation.

- **Step 4.** Upload the demo. If you do not know how to upload the code, please check [How to upload code](https://wiki.seeedstudio.com/Upload_Code/) [https://wiki.seeedstudio.com/Upload\_Code/].
- **Step 5.** Open the **Serial Monitor** of Arduino IDE by click **Tool->Serial Monitor**. Or tap the `Ctrl + Shift + M` key at the same time. Set the baud rate to **115200**.

**Success**

If every thing goes well, when you open the Serial Monitor, you will see the temperature value and the alert information.

```

1  serial start!!
2  version =4011
3
4  temperature =====>>25.81
5
6
7  temperature =====>>27.62
8
9
  
```

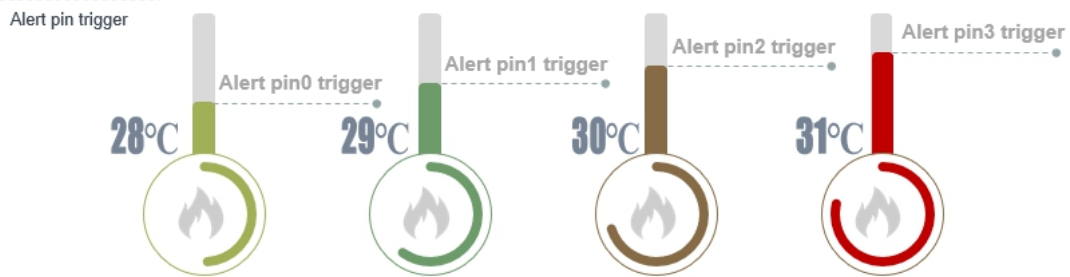




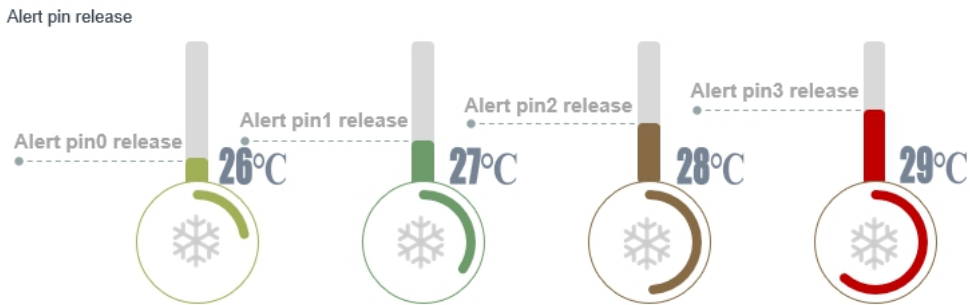
```
10 temperature =====>>29.37
11 channel 0generate interruption!!!
12 channel 1generate interruption!!!
13
14
15 temperature =====>>30.81
16 channel 0generate interruption!!!
17 channel 1generate interruption!!!
18 channel 2generate interruption!!!
19
20
21 temperature =====>>31.56
22 channel 0generate interruption!!!
23 channel 1generate interruption!!!
24 channel 2generate interruption!!!
25 channel 3generate interruption!!!
26
27
28 temperature =====>>28.56
29 channel 0generate interruption!!!
30 channel 1generate interruption!!!
31 channel 2generate interruption!!!
32
33
34 temperature =====>>27.33
35 channel 0generate interruption!!!
36 channel 1generate interruption!!!
37
38
39 temperature =====>>26.71
40 channel 0generate interruption!!!
```

## Alert Function

### Temperature Up



### Temperature Down



As you can see, there is a hysteresis when the temperature rises and the temperature drops trigger an interrupt. e.g., when the temperature rises, when it reaches 28°C, the alert pin0 will trigger, and when the temperature drops, the limit point becomes 26°C. Only when the temperature become lower than 26 °C, the alert pin0 will release.

hysteresis= 28°C-26°C = 2°C

Alert pin 1, alert pin2 and alert pin3 follow the same principle. You can change the hysteresis value and the limit by modify the line 23 and line 26.

```

1  CHECK_RESULT(ret,sensor.set_alert_limit(i,sensor.covert_t
2  /*Set hysteresis.for example,set hysteresis to 2°C,when tl
3  the temp exceed limitation,and the interruption flag will
4  CHECK_RESULT(ret,sensor.set_alert_hys(i,2));

```

Use the parameter **i** to choose the alert pin number, and parameter **28** is the limit value, as for hysteresis, we use the function **sensor.set\_alert\_hys(i,2)**. The parameter **2** is the hysteresis value.

## Schematic Online Viewer



## Resources

- **[Zip]** [Grove - I2C Thermocouple Amplifier \(MCP9600\) Eagle Files](https://files.seeedstudio.com/wiki/Grove-I2C_Thermocouple_Amplifier-MCP9600/res/Grove%20I2C%20Thermocouple%20Amplifier(MCP9600).zip) [https://files.seeedstudio.com/wiki/Grove-I2C\_Thermocouple\_Amplifier-MCP9600/res/Grove%20I2C%20Thermocouple%20Amplifier(MCP9600).zip]
- **[Zip]** [Seeed MCP9600 Library](https://github.com/Seeed-Studio/Seeed_MCP9600/archive/master.zip) [https://github.com/Seeed-Studio/Seeed\_MCP9600/archive/master.zip]
- **[PDF]** [Datasheet of MCP9600](https://files.seeedstudio.com/wiki/Grove-I2C_Thermocouple_Amplifier-MCP9600/res/MCP9600.pdf) [https://files.seeedstudio.com/wiki/Grove-I2C\_Thermocouple\_Amplifier-MCP9600/res/MCP9600.pdf]

## Project

This is the introduction Video of this product, simple demos, you can have a try.



# Tech Support

Please do not hesitate to submit the issue into our [forum](#)

[<https://forum.seeedstudio.com/>]



[[https://www.seeedstudio.com/act-4.html?utm\\_source=wiki&utm\\_medium=wikibanner&utm\\_campaign=newproducts](https://www.seeedstudio.com/act-4.html?utm_source=wiki&utm_medium=wikibanner&utm_campaign=newproducts)]