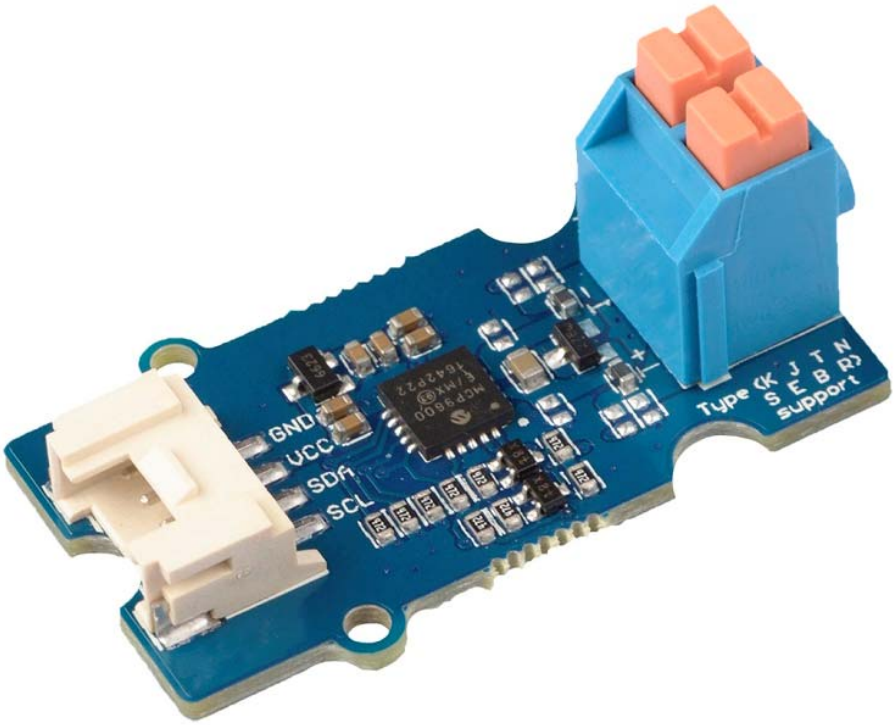


Grove - I2C Thermocouple Amplifier (MCP9600)

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 on our website has a measurement range of -50℃ to +600℃.

We also provide the alert function for this module, you can use the progarammable 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 in our bazaar.

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. If you have any needs in this regard, please contact our email: techsupport@seeed.cc.

Specification

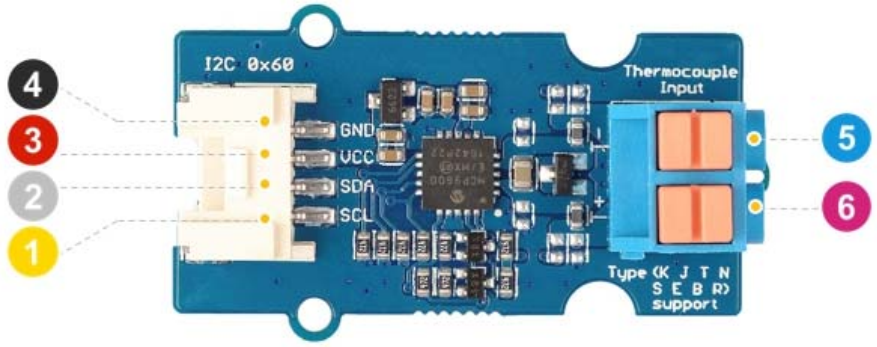
Item	Value
Operating Voltage	3.3V/5V
Ambient Temperature	-40℃ ~ +125℃
Storage Temperature	-65℃ ~ +150℃
Max. Junction Temperature	+150℃
Hot-Junction Accuracy	±1.5°C (Max.)
Measurement Resolution	Hot and Cold-Junctions: 0.0625°C (typical)
Interface	I^2C
I^2C Address	0x60(default) / 0x67(optional)

Applications

- Petrochemical Thermal Management
- Hand-Held Measurement Equipment
- Industrial Equipment Thermal Management
- Ovens
- Industrial Engine Thermal Monitor
- Temperature Detection Racks

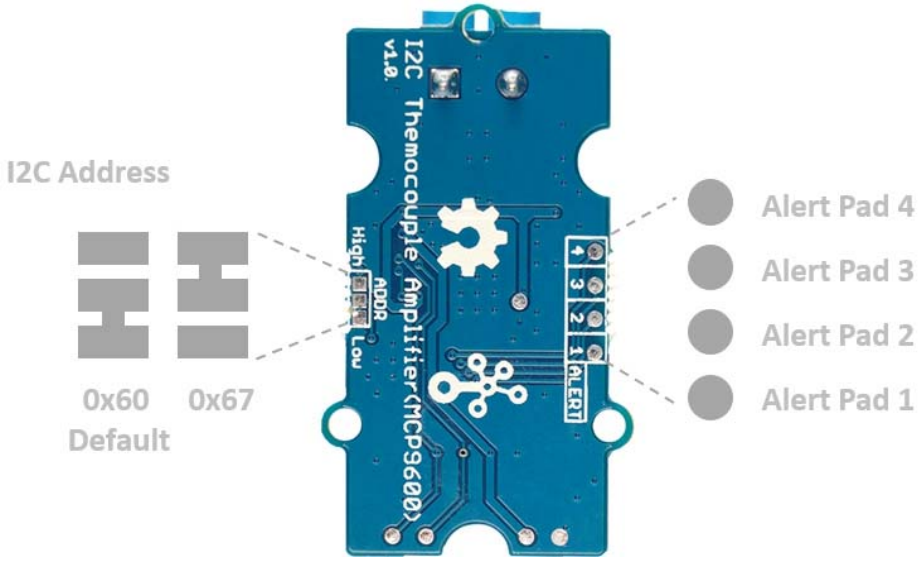
Hardware Overview

Pin Map



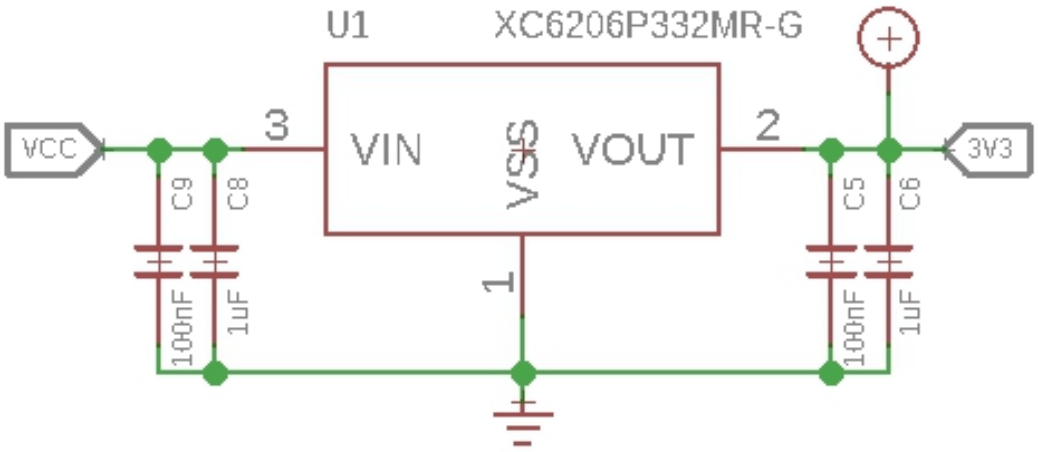
4 GND: connect this module to the system GND
3 VCC: you can use 5V or 3.3V for this module
2 SDA: I²C serial data
1 SCL: I²C serial clock

5 T -: Thermocouple Input, negative pole
6 T +: Thermocouple Input, positive pole



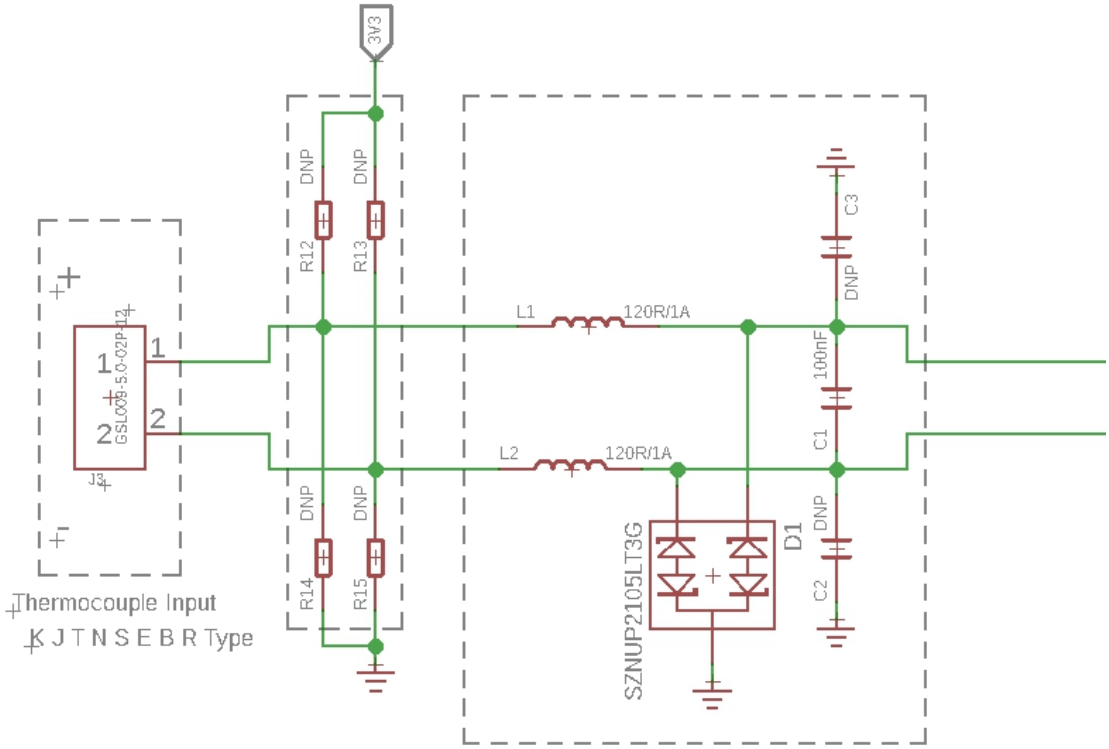
Schematic

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.

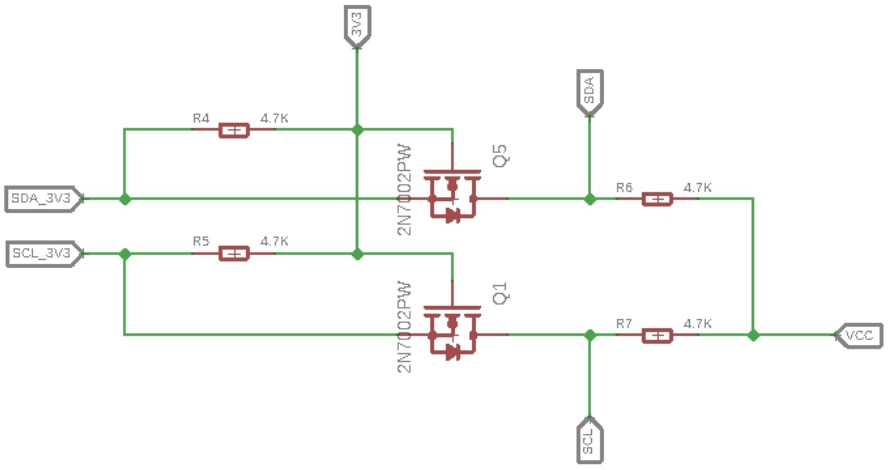
Input Jack



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 I²C bus. The I²C bus of this sensor use 3.3V, if the I²C bus of the Arduino use 5V, this circuit will be needed. In the schematic above, **Q1** and **Q5** are N-Channel MOSFET 2N7002A, which act as a bidirectional switch. In order to better understand this part, you can refer to the AN10441

Platforms Supported

Arduino	Raspberry Pi	BeagleBone	Wio	LinkIt ONE
				

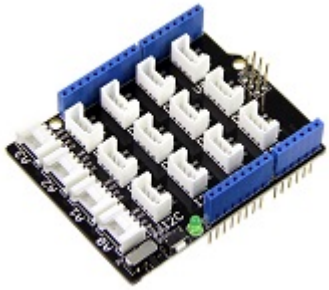
Caution
The platforms mentioned above as supported is/are an indication of the module's hardware or theoritical compatibility. We only provide software library or code examples for Arduino platform in most cases. It is not possible to provide software library / demo code for all possible MCU platforms.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

Getting Started

Play With Arduino

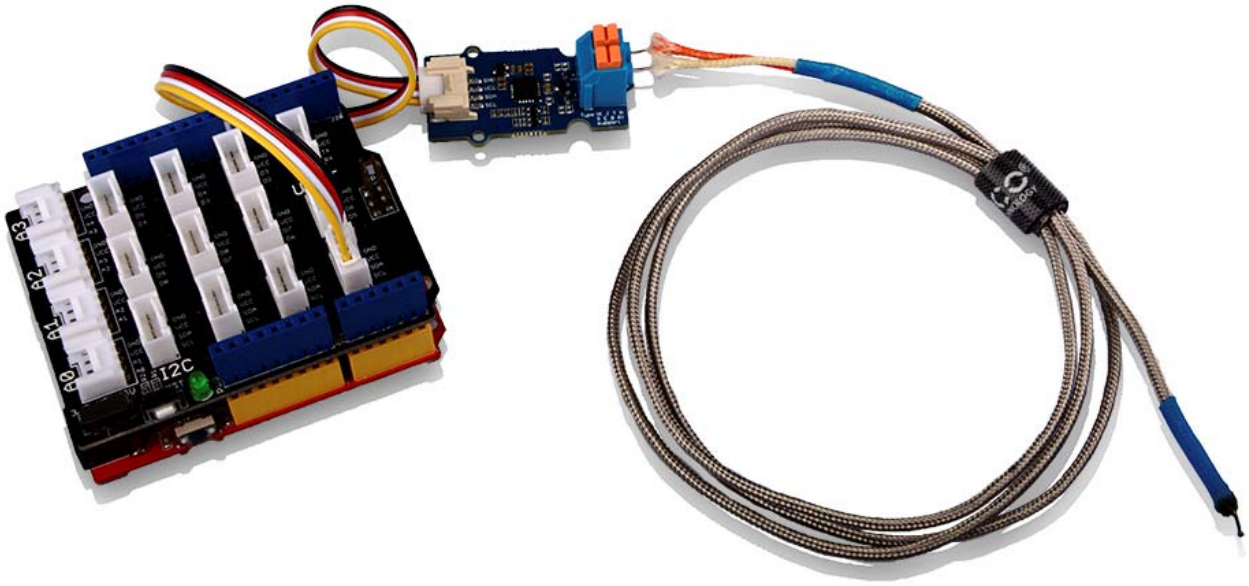
Hardware

Materials required

Seeeduino V4.2	Base Shield	Grove - I2C Thermocouple Amplifier
		

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 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 to buy.

- **Step 1.** Connect the Grove - I2C Thermocouple Amplifier (MCP9600) to port **I²C** 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.

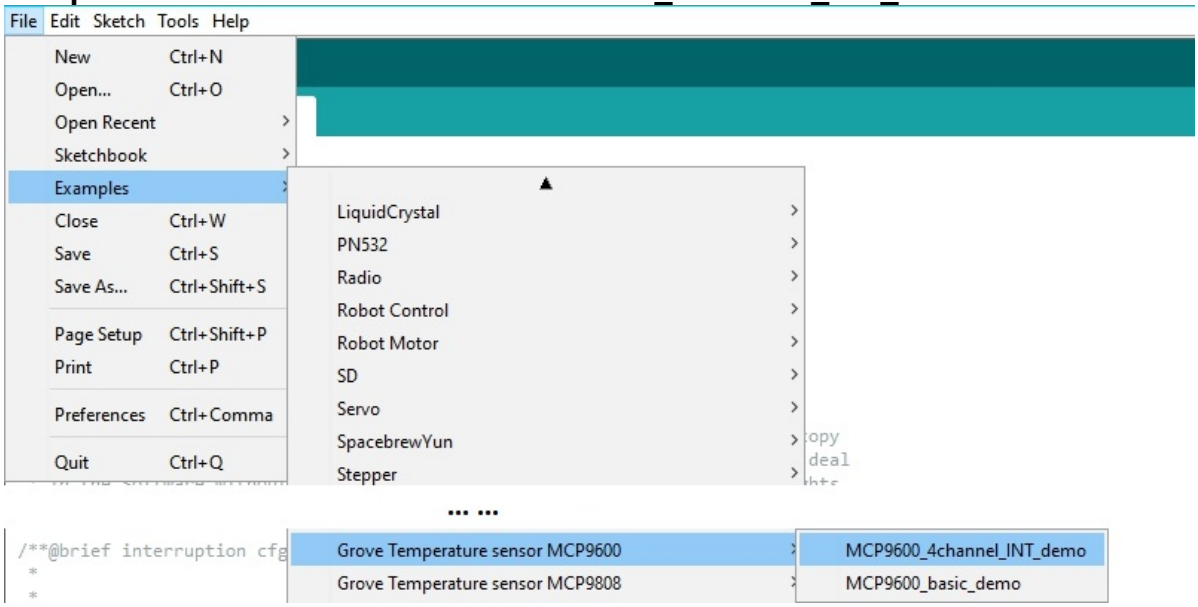
Seeeduino	Grove Cable	Grove - I2C Thermocouple Amplifier
GND	Black	GND
5V / 3.3V	Red	VCC
SDA	White	SDA
SCL	Yellow	SDA

Software

Note
If this is the first time you work with Arduino, we strongly recommend you to see Getting Started with Arduinobefore the start.

- **Step 1.** Download the Seeed_MCP9600 Library from Github.
- **Step 2.** Refer to How to install library to install library for Arduino.
- **Step 3.** Restart the Arduino IDE. Open the example, you can open it in the following three ways：

a. Open it directly in the Arduino IDE via the path: **File → Examples → Grove Temperature sensor MCP9600 → MCP9600_4channel_INT_demo**.



b. Open it in your computer by click the **MCP9600_4channel_INT_demo.ino** which you can find in the folder **XXXX\Arduino\libraries\Seeed_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.

```
#include "Seeed_MCP9600.h"

#ifdef ARDUINO_SAMD_VARIANT_COMPLIANCE
  #define SERIAL SerialUSB
#else
  #define SERIAL Serial
#endif

MCP9600 sensor;

/**@brief interruption cfg.
 *
 *
 * */
err_t sensor_INT_config()
{
    err_t ret=NO_ERROR;
```

```
18    CHECK_RESULT(ret,sensor.set_filt_coefficients(FILT_MID));
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,sensor.covert_temp_to_reg_form(28+i)));
24        /*Set hysteresis.for example,set hysteresis to 2℃,when the INT limitation is 30℃,interruption will
25be generated when
26        the temp ecceed limitation,and the interruption flag will stay unless the temp below 30-
272(limitation-hysteresis) 28℃. */
28        CHECK_RESULT(ret,sensor.set_alert_hys(i,2));
29
30         /*Set when interruption generated the pin's status*/
31        CHECK_RESULT(ret,sensor.set_alert_bit(i,ACTIVE_LOW));
32
33        CHECK_RESULT(ret,sensor.clear_int_flag(i));
34
35        /*default is comparator mode*/
36        CHECK_RESULT(ret,sensor.set_alert_mode_bit(i,COMPARE_MODE));
37
38        /*Set alert pin ENABLE.*/
39        CHECK_RESULT(ret,sensor.set_alert_enable(i,ENABLE));
40
41
42
43    }
44
45    /*device cfg*/
46    CHECK_RESULT(ret,sensor.set_cold_junc_resolution(COLD_JUNC_RESOLUTION_0_25));
47    CHECK_RESULT(ret,sensor.set_ADC_meas_resolution(ADC_14BIT_RESOLUTION));
48    CHECK_RESULT(ret,sensor.set_burst_mode_samp(BURST_32_SAMPLE));
49    CHECK_RESULT(ret,sensor.set_sensor_mode(NORMAL_OPERATION));
50
51    return NO_ERROR;
52}
53
54
55err_t get_temperature(float *value)
56{
57    err_t ret=NO_ERROR;
58    float hot_junc=0;
59    float junc_delta=0;
60    float cold_junc=0;
61    bool stat=true;
62
63    CHECK_RESULT(ret,sensor.check_data_update(&stat));
64    if(stat)
65    {
66        CHECK_RESULT(ret,sensor.read_hot_junc(&hot_junc));
67        CHECK_RESULT(ret,sensor.read_junc_temp_delta(&junc_delta));
68
69        CHECK_RESULT(ret,sensor.read_cold_junc(&cold_junc));
70
71        *value=hot_junc;
72    }
73    else
```

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

Note
There are 2 demos in the library:

MCP9600_basic_demo.ino
This example is a sample use of temperature sensor,you need to polling for data.

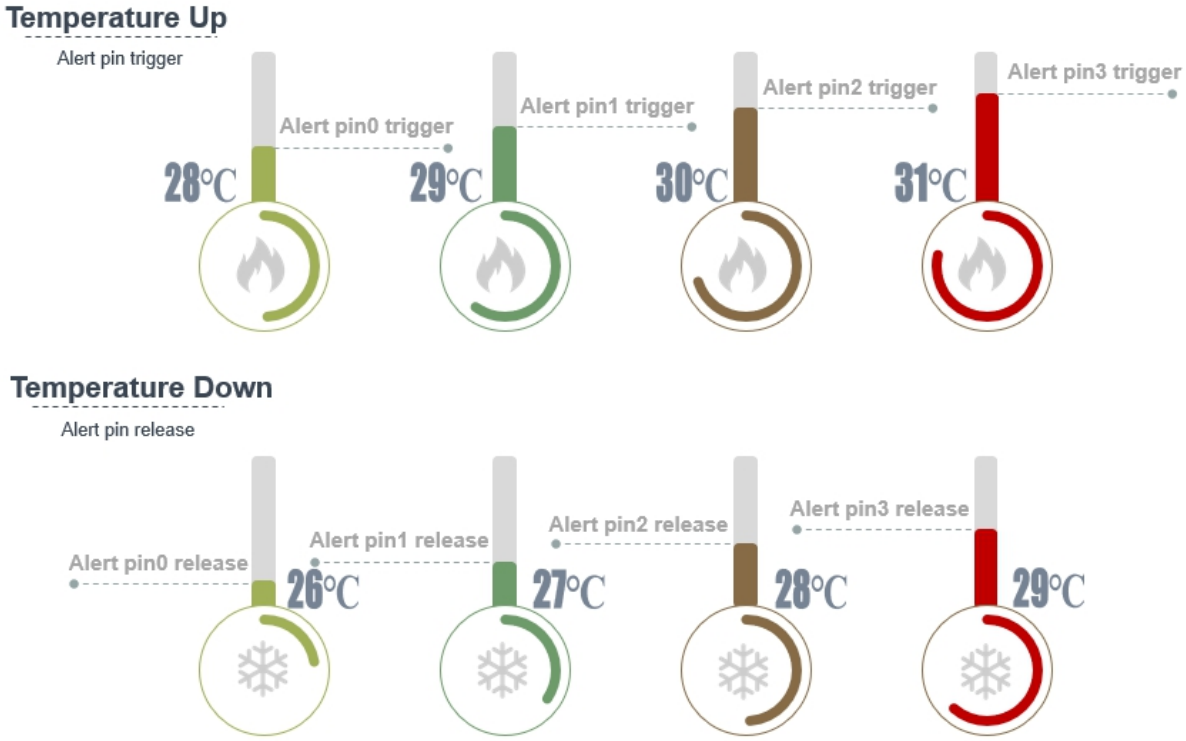
MCP9600_4channel_INT_demo.ino
here are four alert pads on the sensor module which connect to alert pin.You can set temperature limits by calling the API we provided.The alert pin outputs low when the temperature value beyond limit.You can attach alert pin to a interrupt pin of host,To improve the efficiency of program operation.

- **Step 4.** Upload the demo. If you do not know how to upload the code, please check How to upload code.
- **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.

```
serial start!!
version =4011

temperature ==============================>>25.81


temperature ==============================>>27.62


temperature ==============================>>29.37
channel 0generate interruption!!!
channel 1generate interruption!!!

temperature ==============================>>30.81
channel 0generate interruption!!!
channel 1generate interruption!!!
channel 2generate interruption!!!

temperature ==============================>>31.56
channel 0generate interruption!!!
channel 1generate interruption!!!
channel 2generate interruption!!!
channel 3generate interruption!!!

temperature ==============================>>28.56
channel 0generate interruption!!!
channel 1generate interruption!!!
channel 2generate interruption!!!

temperature ==============================>>27.33
channel 0generate interruption!!!
channel 1generate interruption!!!

temperature ==============================>>26.71
channel 0generate interruption!!!
```

Alert Function



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℃, the alert pin0 will trigger, and when the temperature drops, the limit point becomes 26℃. Only when the temperature become lower than 26 ℃, the alert pin0 will release.

$$hysteresis=28℃-26℃=2℃$$

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.

```
1CHECK_RESULT(ret,sensor.set_alert_limit(i,sensor.covert_temp_to_reg_form(28+i)));
2/*Set hysteresis.for example,set hysteresis to 2℃,when the INT limitation is 30℃,interruption will be
3generated when
4the temp ecceed limitation,and the interruption flag will stay unless the temp below 30-2(limitation-
  hysteresis) 28℃. */
  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.

Tech Support

Please do not hesitate to submit the issue into our forum