

使用M030G的 I2C 读取NCT7712Y 温度传感器

NuMicro® 32位系列微控制器范例代码介绍

文件信息

应用简述	本范例代码使用 M030G I2C 来读取 NCT7712Y 温度传感器
BSP 版本	M030G_Series_BSP_CMSIS_V3.02.000
开发平台	NuMaker-M030GTD V1.2

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1. 概述

微控制器广泛的应用在不同的环境温度下，Nuvoton NuMicro® Cortex®-M0 M030G/M031G 系列搭配 NCT7712Y 高精度的温度传感器，以此可以随时监控当下的温度。此范例程序将说明如何使用 I2C 取得温度传感器的温度值。

1.1 原理

NCT7712Y 是一颗高精度的温度传感器芯片。NCT7712Y 内建一组 12bit 的 ADC，以 0.0625°C 的分辨率转换监测的温度值。

1.1.1 NCT7712Y 寄存器介绍

NCT7712Y 寄存器列表，如图 1-1 所示。

Idx	Register Name	Attr	Dft	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	LDT Readout	RO	0000	MNTREG_LT[12:0]/MNTREG_LT[11:0], 1'b0													RSV		EM
1	Configuration	RW	6080	OS	R[1:0]		F[1:0]		POL	TM	SD	CR[1:0]		AL	EM	RSV			
2	LT Low Alert Temp	RW	2580/ 4B00	LTLL[12:0]/LTLL[11:0], 1'b0													RSV		
3	LT High Alert Temp	RW	2800/ 5000	LTHL[12:0]/LTHL[11:0], 1'b0													RSV		
FD	CID (Chip ID)	RO	D1B5	16'hD1B5															
FE	VID (Vendor ID)	RO	50	8'h50								RSV							
FF	DID (Device ID)	RO	10	8'h10								RSV							

图 1-1 NCT7712Y 寄存器列表

NCT7712Y 温度读出寄存器，如图 1-2 所示。

Location : Address 00h

Type : Read Only

Power on default value : 00h

BIT	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
NAME	Local Diode Temperature Readout Value. The real temperature value calculation is referred to TEMPERATURE MEASUREMENT DATA FORMAT.															
VALUE	Sign	MNTREG_LT_MSB[10:4]						MNTREG_LT_LSB [3:0]			RSV			0		
		*MNTREG_LT_MSB[11:4]						*MNTREG_LT_LSB [3:0]			RSV			*1		

* The extended mode 13-bit configuration when EM bit is set 1'b1.

BIT	DESCRIPTION
15-0	The MNTREG_LT_MSB is an integer part. The MNTREG_LT_LSB is a decimal part.

图 1-2 NCT7712Y 温度读出寄存器

NCT7712Y配置寄存器描述，如图 1-3所示。

BIT	15	14	13	12	11	10	9	8
NAME	OS	R[1:0]		F[1:0]		POL	TM	SD
DEFAULT	0	1	1	0	0	0	0	0
BIT	7	6	5	4	3	2	1	0
NAME	CR[1:0]		AL	EM	RSV			
DEFAULT	1	0	0	0				

BIT	FLAG NAME	DESCRIPTION
15	OS	One Shot : Write 1 ADC will monitor one time If read '1' indicates ADC is busy converting, '0' indicates ADC is idle status.
14-13	R	Converter Resolution : 00: decimal point set 1 bit (0.5°C) 01: decimal point set 2 bits (0.25°C) 10: decimal point set 3 bits (0.125°C) 11: decimal point set 4 bits (0.0625°C)
12-11	F	Fault Queue : 00=1 times (default), 01=2 times, 10=4 times, 11=6 times
10	POL	Polarity : The polarity bit lets the user adjust the polarity of the ALERT pin output. If the POL bit is set to 0 (default), the ALERT pin becomes active low. When POL bit is set to 1, the ALERT pin becomes active high and the state of the ALERT pin is inverted. 0: low active 1: high active
9	TM	Mode Alert : ALERT output mode: 1=interrupt mode, 0=compare interrupt mode
8	SD	Shutdown : 1 indicates deep shut-down is enable
7-6	CR	Conversion Rate: 00 : 0.25Hz conversion rate; 01 : 1Hz conversion rate; 10 : 4Hz conversion rate; 11 : 8Hz conversion rate
5	AL	Alert status (read only) : Comparator mode (real time) status.
4	EM	Extended Mode : 0: normal mode: 12 bit, -128~-127.9375 1: extended mode: 13 bit, (temperature register, high- & low-limit registers)

图 1-3 NCT7712Y 配置寄存器描述

1.2 资料格式

NCT7712Y 提供 I2C 存取内部寄存器，支援 I2C Byte 读/写 和 Word 读/写 协议。

1.2.1 温度传感器公式

温度传感器可感应温度范围为 $-50^{\circ}\text{C} \sim +128^{\circ}\text{C}$ ，温度资料格式采用 12 位元 2 的补数，如表格 1-1 所示。

TEMPERATURE	12-BITS DIGITAL OUTPUT
$+128^{\circ}\text{C}$	0111 1111 1111
$+127.9375^{\circ}\text{C}$	0111 1111 1111
$+25^{\circ}\text{C}$	0001 1001 0000
$+1^{\circ}\text{C}$	0000 0001 0000
$+0.125^{\circ}\text{C}$	0000 0000 0010
$+0^{\circ}\text{C}$	0000 0000 0000
-0.125°C	1111 1111 1110
-1°C	1111 1111 0000
-25°C	1110 0111 0000
-50°C	1100 1110 0000

表格 1-1 温度资料格式采用 12 位元 2 的补数

1.2.2 资料写到内部寄存器的格式

资料写到内部寄存器的格式，如图 1-4 所示。

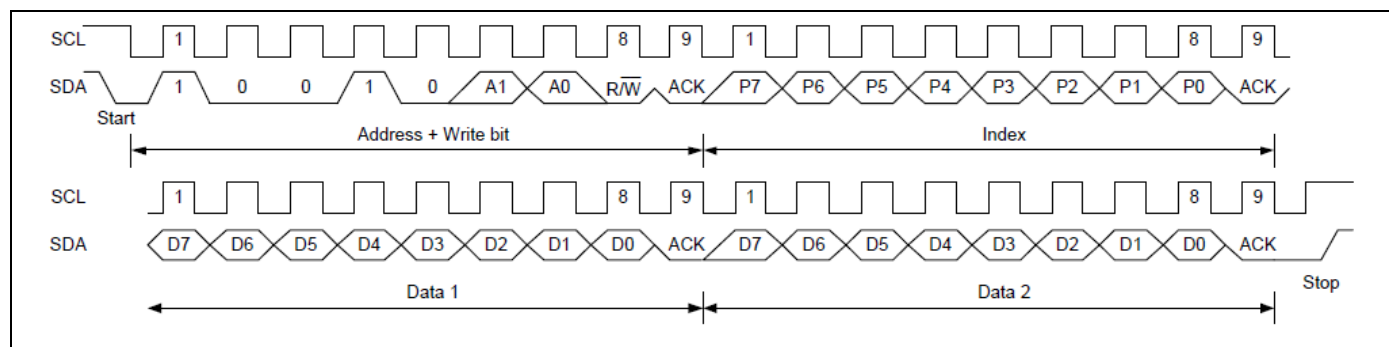


图 1-4 资料写到内部寄存器的格式

1.2.3 从内部寄存器读取资料的格式

从内部寄存器读取资料的格式，如图 1-5 所示。

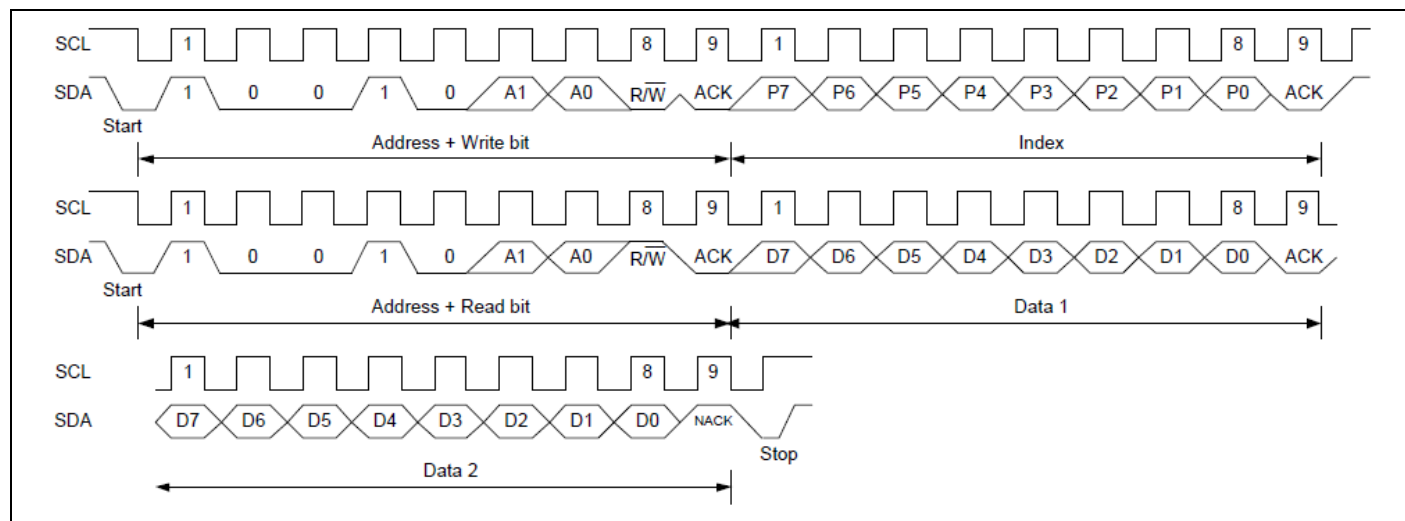


图 1-5 从内部寄存器读取资料的格式

1.2.4 设备地址设定

NCT7712Y 的设备地址设定，如图 1-6 所示。

ADR pin connection	Interface Address
V _{SS}	1001_000xb
V _{DD}	1001_001xb
SDA	1001_010xb
SCL	1001_011xb

图 1-6 设备地址设定

注1. 以上使用图片来自 NCT7712Y 规格书。

1.3 执行结果

1.3.1 I2C 读出寄存器资料

用 I2C 读出的寄存器资料，如图 1-7 所示。

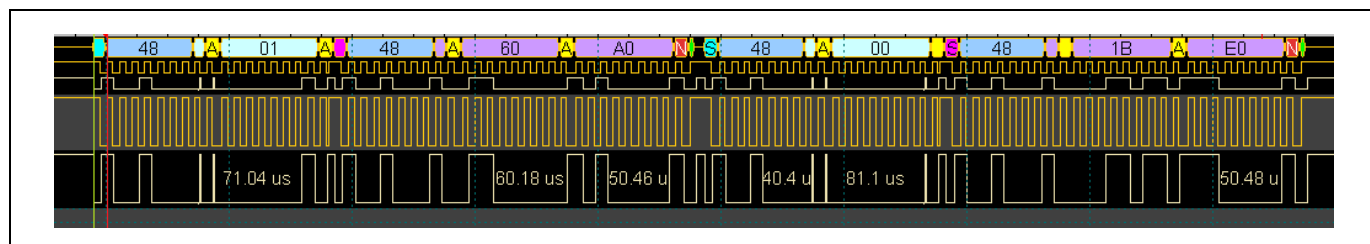


图 1-7 用 I2C 读出的寄存器资料

读出资料是 01beh，LSB bit0 ~ bit3 是保留的不使用。

Hexadecimal	Decimal	Temperature (°C)
01beh	446	27.8750

1.3.2 透过 UART 输出当前的温度值

透过 UART 将当前的温度值输出，如图 1-8 所示。

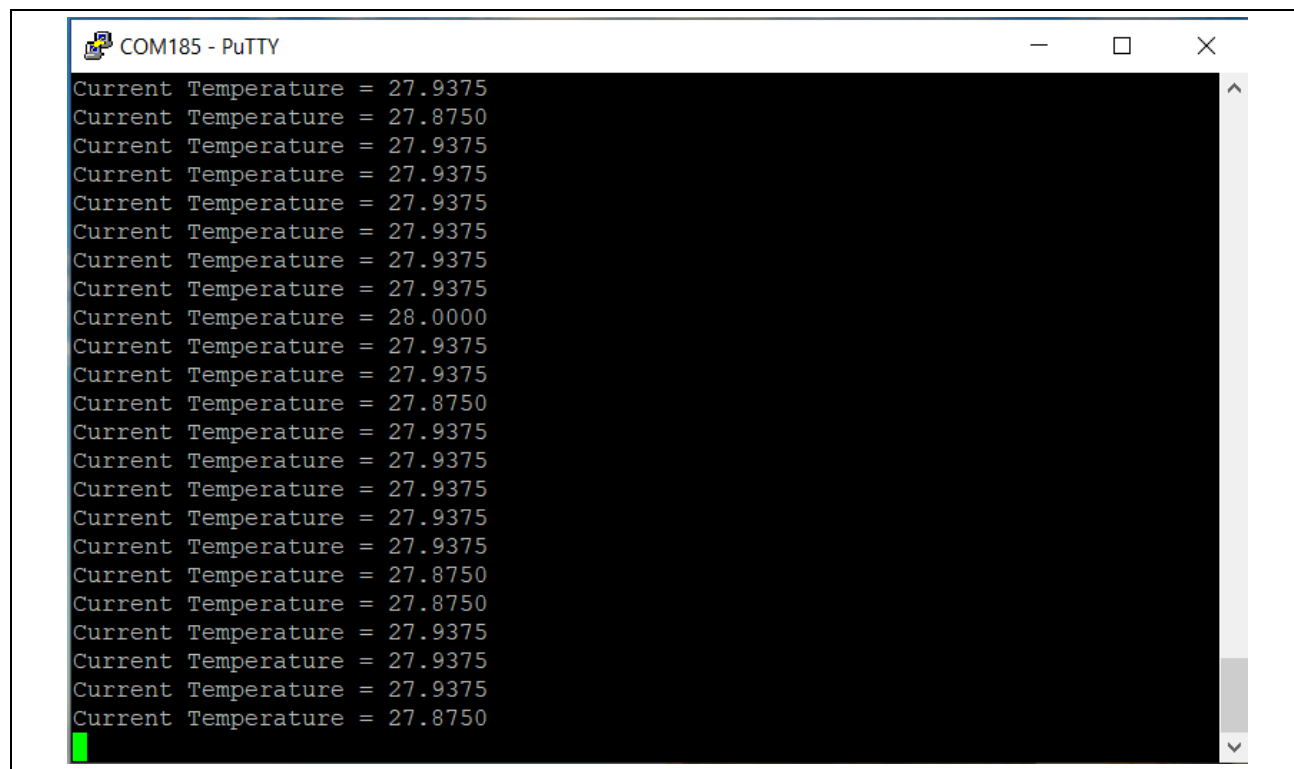


图 1-8 输出当前的温度值

2. 代码介绍

2.1 主程序流程图

主程序流程图，如图 2-1 所示。

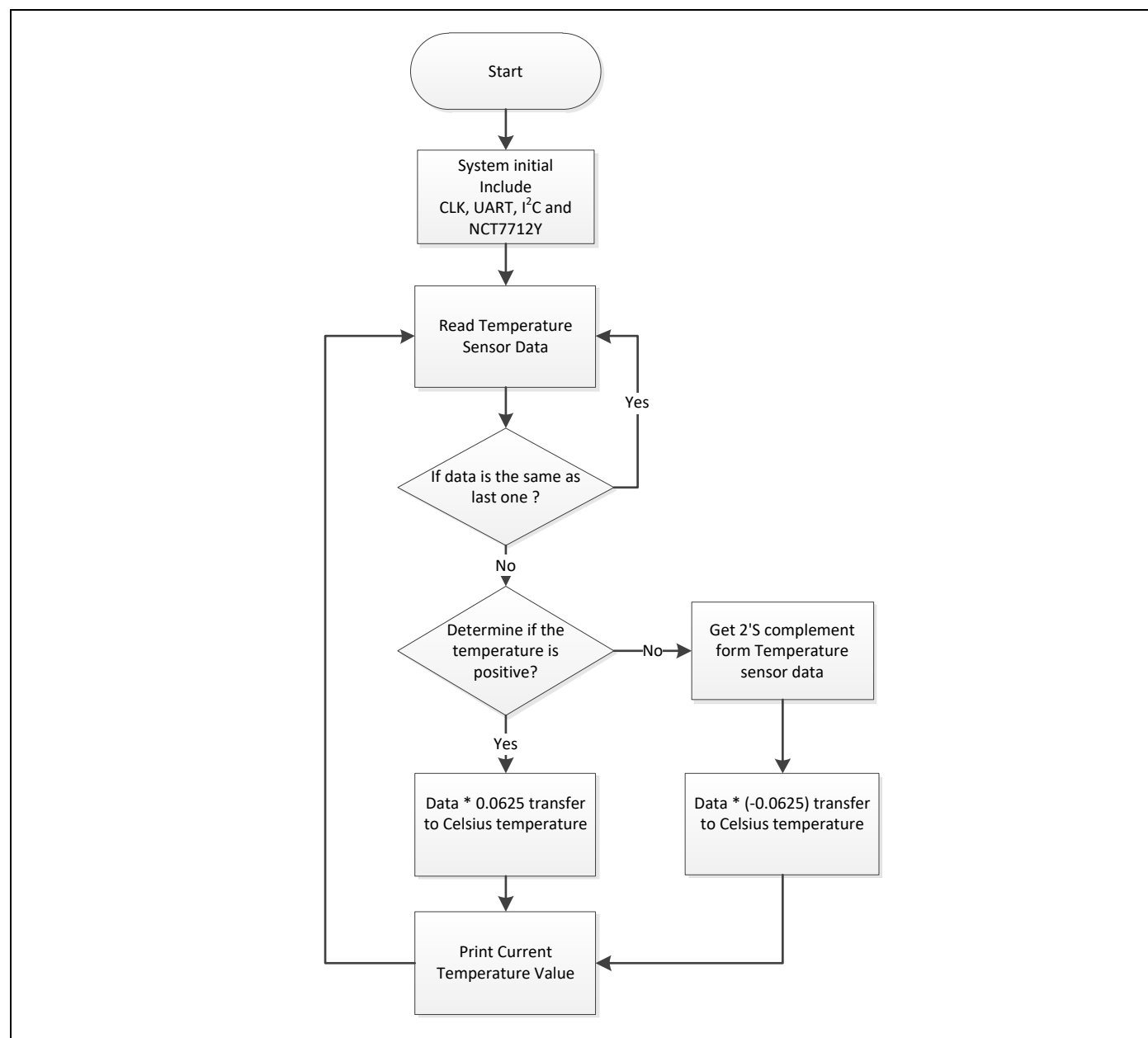


图 2-1 主程序流程图

2.2 定义 NCT7712Y

定义 NCT7712Y 地址, 资料 and 寄存器

```
#define OPT_NCT7712Y_RAWDATA
#define NCT7712Y_SLAVE_ADDR      0x48    // NCT7712Y ADR pin is Low
#define NCT7712Y_REG_WIDTH       0x02    // register data width 2 bytes
#define NCT7712Y_DATA_READY      BIT15    // NCT7712Y DataReady flag in bit-15 of Config.
#define NCT7712Y_REG_TEMP        0x00    // temp data in regIndex 0x00
#define NCT7712Y_REG_CONFIG      0x01    // Config. register in regIndex 0x01
```

2.3 设置 NCT7712Y 配置寄存器

设置 NCT7712Y 配置寄存器和描述说明

```
void NCT7712Y_set_data(uint8_t u8RegIndex)
{
    uint8_t u8i2cBuf[2];

    u8i2cBuf[0] = 0x60; // High Byte : Converter Resolution : 0.0625 ;
    u8i2cBuf[1] = 0x80; // Low Byte : Conversion Rate : 4Hz conversion rate;
    /*-----*/
    /* bit3~0 :    Reserved                                         */
    /* bit4   :    Extended Mode :                                  */
    /*          0: normal mode: 12 bit, -128~127.9375;              */
    /*          1: extended mode: 13 bit;                            */
    /*          (temperature register, high- & low-limit registers) */
    /* bit5   :    Alert status (read only)                          */
    /*          Comparator mode (real time) status;                 */
    /* bit7~6 :    Conversion Rate :                                 */
    /*          00 : 0.25Hz conversion rate;                         */
    /*          01 : 1Hz conversion rate;                            */
    /*          10 : 4Hz conversion rate;                            */
    /*          11 : 8Hz conversion rate;                            */
    /* bit8   :    Shutdown :                                       */
    /*          1 indicates deep shun-down is enable;               */
    /* bit9   :    Mode Alert :                                     */
    /*          ALERT output mode:                                  */
    /*          1=interrupt mode;                                    */
    /*          0=compare interrupt mode;                           */
    /* bit10  :    Polarity :                                       */
    /* The polarity bit lets the user adjust the polarity of the ALERT pin output. */
    /* If the POL bit is set to 0 (default), the ALERT pin becomes active low.      */
    /* When POL bit is set to 1, the ALERT pin becomes active high                  */
    /* and the state of the ALERT pin is inverted.                                */
    /* 0: low active                                                         */
    /* 1: high active                                                         */
    /* bit12~11: Fault Queue :                                          */
    /* bit14~13: Converter Resolution :                                  */
    /*          00: decimal point set 1 bit (0.5'C)                    */
    /*          01: decimal point set 2 bits (0.25'C)                  */
    /*          10: decimal point set 3 bits (0.125'C)                 */
    /*          11: decimal point set 4 bits (0.0625'C)                */
    /*-----*/
```

```

/* bit15 : One Shot : */
/* Write 1 ADC will monitor one time */
/* If read '1' indicates ADC is busy converting, '0' indicates ADC is idle status. */
/*-----*/

I2C_WriteMultiBytesOneReg(I2C0, NCT7712Y_SLAVE_ADDR, u8RegIndex, u8i2cBuf,
NCT7712Y_REG_WIDTH);
}

```

2.4 获取 NCT7712Y 资料

获取 NCT7712Y 温度资料。

```

static uint32_t NCT7712Y_get_data(uint8_t u8RegIndex)
{
    uint32_t u32NCT7712YData;
    uint8_t u8i2cBuf[2];

    u8i2cBuf[0] = 0x00;
    u8i2cBuf[1] = 0x00;
    I2C_ReadMultiBytesOneReg(I2C0, NCT7712Y_SLAVE_ADDR, u8RegIndex, u8i2cBuf,
NCT7712Y_REG_WIDTH);
    u32NCT7712YData = u8i2cBuf[0];
    u32NCT7712YData <<= 8;
    u32NCT7712YData &= 0xff00;
    u32NCT7712YData |= u8i2cBuf[1];
    return u32NCT7712YData;
}

```

3. 软件与硬件需求

3.1 软件需求

- BSP 版本
 - M030G_Series_BSP_CMSIS_V3.02.000
- IDE 版本
 - Keil uVersion 5.36

3.2 硬件需求

- 电路组件
 - NuMaker-M030GTD V1.2
- 脚位连接示意图
 - 将 I2C_SDA (PB.4) pin 脚连接到 NCT7712Y_SDA (Pin6) 和 I2C_SCL (PB.5) pin 脚连接到 NCT7712Y_SCL (Pin1) , 并将 NCT7712Y_ADR (Pin4) 连接到 V_{ss} , 将 slave address 设定为 0x48h , 与 NCT7712Y 进行通讯 , 以获取此范例程序量测结果的温度值。

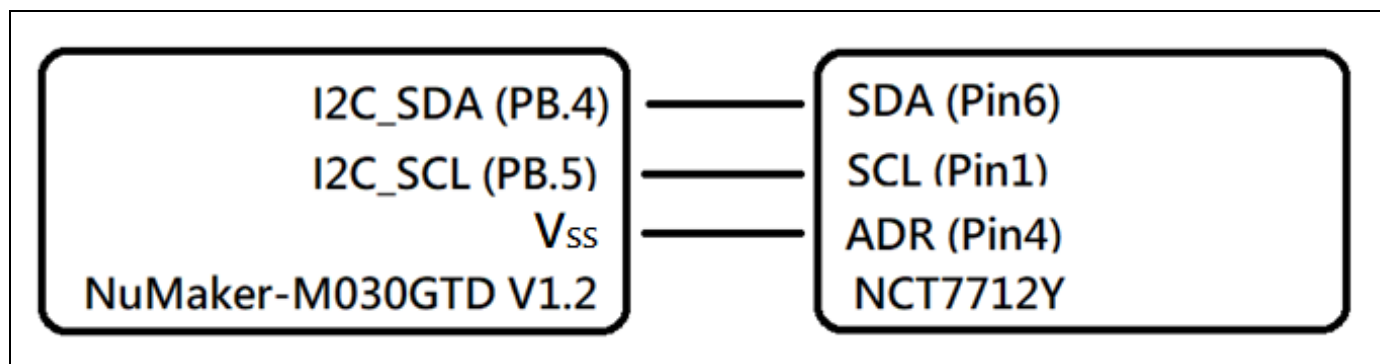


图 3-1 脚位连接示意图

4. 目录信息

目录结构如图 4-1 所示。








 EC_M030G_Read_NCT7712Y_Thermal_Sensor_V1.00		
 Library	Sample code header and source files	
 CMSIS	Cortex® Microcontroller Software Interface Standard (CMSIS) by Arm® Corp.	
 Device	CMSIS compliant device header file	
 StdDriver	All peripheral driver header and source files	
 SampleCode		
 ExampleCode	Source file of example code	

图 4-1 目录信息

5. 范例程序执行

1. 根据目录信息章节进入 ExampleCode 路径中的 KEIL 文件夹，双击 *ThermalSensor_Measure.uvprojx*。
2. 进入编译模式界面
 - 编译
 - 下载代码至内存
 - 进入 / 离开仿真模式
3. 进入仿真模式界面
 - 执行代码

6. 修订纪录

Date	Revision	Description
2022.08.26	1.00	初始发布。

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