

M263 I²C驱动TDK CH101模块

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 M263 I ² C 驱动 TDK CH101，实现测距功能
BSP 版本	M263_Series_BSP_CMSIS_V3.00.003
开发平台	NuMaker-M263KI V1.1

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1 概述

本示例代码使用M263的I²C接口驱动CH101模块实现测距的功能。

CH101是一种超声测距模块，可对距离最大1.2m的目标提供准确的距离测量。与其他类型的ToF测距仪（例如红外（IR）传感器）不同，CH101不受物体颜色或透明度的影响，并且可在所有照明条件下工作。

本示例代码中使用了TDK的EV_MOD_CH101-03-01模组。该模块板集成了CH101超声波传感器设备，全向声学外壳组件，电容和FPC / FFC连接器，通过I²C接口与主控MCU通信，可以在4 cm至1.2m的测距范围内执行音高捕捉和脉冲回波测距。

本文部分引用了TDK 网站关于CH101的描述介绍及资料。

1.1 原理

CH101使用压电微机械超声换能器（PMUT）将声音的短脉冲发射到空气中。在击中物体时，这些波朝PMUT反射，使其振动并产生电信号。通过内置的应用专用集成电路（ASIC）测量，声波从发出到返回PMUT的声音所需的时间，称为飞行时间（ToF）。使用声音速度（室温343米/秒），系统可以确定与对象的距离。

测距公式如下：

$$Range (R) = C \times \frac{ToF}{2} \quad C(\text{声音速度}) = 343 \text{ m/s}.$$

CH101可通过I²C接口对其进行控制和读取，读写框图如下图所示：

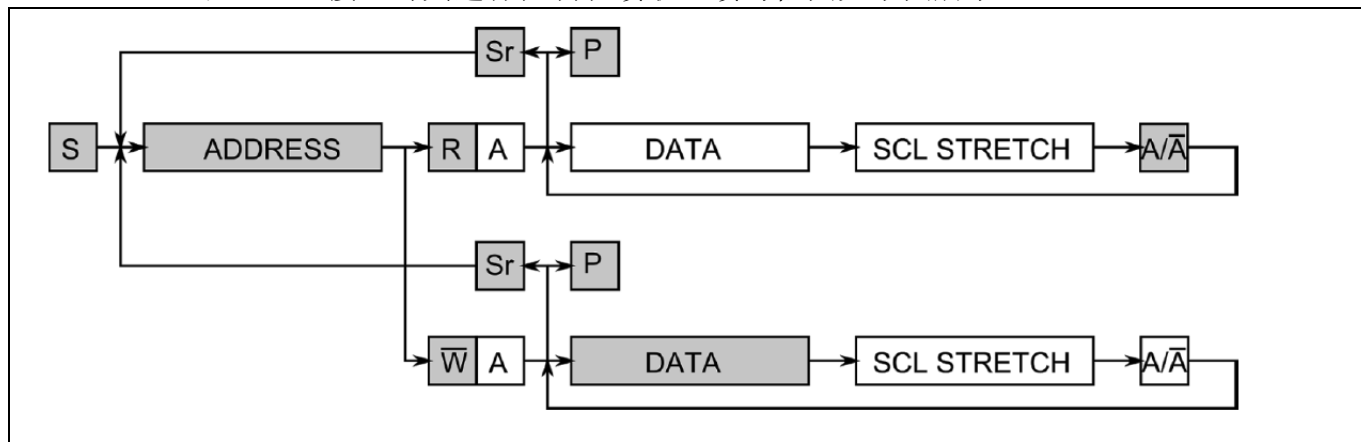
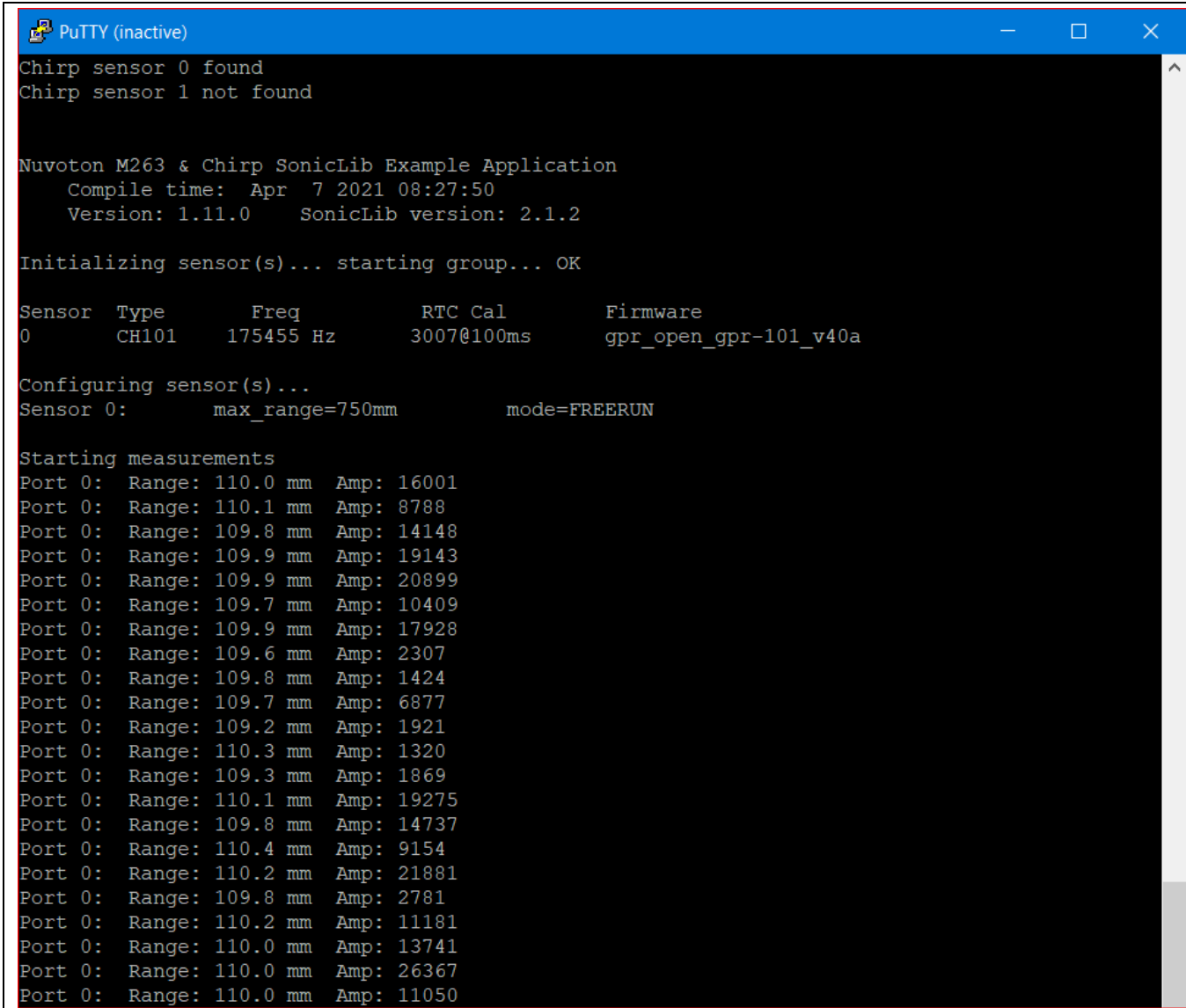


图 1-1 读写逻辑框图

关于 CH101 模块的详细信息，请参考的数据手册及应用手册。网址如下：

<https://invensense.tdk.com/products/ch101/#documentation>

1.2 执行结果



```
PuTTY (inactive)
Chirp sensor 0 found
Chirp sensor 1 not found

Nuvoton M263 & Chirp SonicLib Example Application
  Compile time: Apr  7 2021 08:27:50
  Version: 1.11.0   SonicLib version: 2.1.2

Initializing sensor(s)... starting group... OK

Sensor  Type      Freq      RTC Cal      Firmware
0       CH101     175455 Hz    3007@100ms   gpr_open_gpr-101_v40a

Configuring sensor(s)...
Sensor 0:      max_range=750mm      mode=FREERUN

Starting measurements
Port 0:  Range: 110.0 mm  Amp: 16001
Port 0:  Range: 110.1 mm  Amp: 8788
Port 0:  Range: 109.8 mm  Amp: 14148
Port 0:  Range: 109.9 mm  Amp: 19143
Port 0:  Range: 109.9 mm  Amp: 20899
Port 0:  Range: 109.7 mm  Amp: 10409
Port 0:  Range: 109.9 mm  Amp: 17928
Port 0:  Range: 109.6 mm  Amp: 2307
Port 0:  Range: 109.8 mm  Amp: 1424
Port 0:  Range: 109.7 mm  Amp: 6877
Port 0:  Range: 109.2 mm  Amp: 1921
Port 0:  Range: 110.3 mm  Amp: 1320
Port 0:  Range: 109.3 mm  Amp: 1869
Port 0:  Range: 110.1 mm  Amp: 19275
Port 0:  Range: 109.8 mm  Amp: 14737
Port 0:  Range: 110.4 mm  Amp: 9154
Port 0:  Range: 110.2 mm  Amp: 21881
Port 0:  Range: 109.8 mm  Amp: 2781
Port 0:  Range: 110.2 mm  Amp: 11181
Port 0:  Range: 110.0 mm  Amp: 13741
Port 0:  Range: 110.0 mm  Amp: 26367
Port 0:  Range: 110.0 mm  Amp: 11050
```

图 1-2 执行结果

2 代码介绍

芯片初始化，并查询 CH101 模块是否接在了开发板上：

```
void chbsp_board_init(ch_group_t *grp_ptr) {

    /* Make local copy of group pointer */
    sensor_group_ptr = grp_ptr;

    /* Initialize group descriptor */
    grp_ptr->num_ports = CHBSP_MAX_DEVICES;
    grp_ptr->num_i2c_buses = CHBSP_NUM_I2C_BUSES;
    grp_ptr->rtc_cal_pulse_ms = CHBSP_RTC_CAL_PULSE_MS;

    /* Unlock protected registers */
    SYS_UnlockReg();
    /* Init System, IP clock and multi-function I/O. */
    SYS_Init();
    /* Lock protected registers */
    SYS_LockReg();

    /* Init I2C0 */
    I2C0_Init();

    /* Configure UART0: 921600, 8-bit word, no parity bit, 1 stop bit. */
    UART_Open(UART0, 921600);

    ext_int_init();

    /* Probe I2C bus to find connected sensor(s) */
    find_sensors();
}
```

软件设置模块为 CH_MODE_FREERUN 模式，由模块内部 RTC 产生 100ms 时间间隔，通过 INT 引脚通知 M263 通过 I²C 读取相关寄存器的值。

```
/*
 * handle_data_ready() - get and display data from all sensors
 *
 * This routine is called from the main() loop after all sensors have
 * interrupted. It shows how to read the sensor data once a measurement is
```

```

* complete. This routine always reads out the range and amplitude, and
* optionally will read out the amplitude data or raw I/Q for all samples
* in the measurement.
*
* See the comments in app_config.h for information about the amplitude data
* and I/Q readout build options.
*
*/
static uint8_t handle_data_ready(ch_group_t *grp_ptr) {
    uint8_t dev_num;
    int num_samples = 0;
    uint8_t ret_val = 0;

    /* Read and display data from each connected sensor
     * This loop will write the sensor data to this application's "chirp_data"
     * array. Each sensor has a separate chirp_data_t structure in that
     * array, so the device number is used as an index.
     */

    for (dev_num = 0; dev_num < ch_get_num_ports(grp_ptr); dev_num++) {
        ch_dev_t *dev_ptr = ch_get_dev_ptr(grp_ptr, dev_num);

        if (ch_sensor_is_connected(dev_ptr)) {

            /* Get measurement results from each connected sensor
             * For sensor in transmit/receive mode, report one-way echo
             * distance, For sensor(s) in receive-only mode, report direct
             * one-way distance from transmitting sensor
             */

            if (ch_get_mode(dev_ptr) == CH_MODE_TRIGGERED_RX_ONLY) {
                chirp_data[dev_num].range = ch_get_range(dev_ptr,
                                                            CH_RANGE_DIRECT);
            } else {
                chirp_data[dev_num].range = ch_get_range(dev_ptr,
                                                            CH_RANGE_ECHO_ONE_WAY);
            }

            if (chirp_data[dev_num].range == CH_NO_TARGET) {
                /* No target object was detected - no range value */
            }
        }
    }
}

```

```

        chirp_data[dev_num].amplitude = 0; /* no updated amplitude */

        printf("Port %d:          no target found          ", dev_num);

    } else {
        /* Target object was successfully detected (range available) */

        /* Get the new amplitude value - it's only updated if range
         * was successfully measured. */
        chirp_data[dev_num].amplitude = ch_get_amplitude(dev_ptr);

        printf("Port %d:  Range: %0.1f mm  Amp: %u  ", dev_num,
               (float) chirp_data[dev_num].range/32.0f,
               chirp_data[dev_num].amplitude);
    }

    /* Store number of active samples in this measurement */
    num_samples = ch_get_num_samples(dev_ptr);
    chirp_data[dev_num].num_samples = num_samples;

    /* Optionally read amplitude values for all samples */
#ifdef READ_AMPLITUDE_DATA
    uint16_t    start_sample = 0;
    ch_get_amplitude_data(dev_ptr, chirp_data[dev_num].amp_data,
                          start_sample, num_samples, CH_IO_MODE_BLOCK);

#ifdef OUTPUT_AMPLITUDE_DATA
    printf("\n");
    for (uint8_t count = 0; count < num_samples; count++) {

        printf("%d\n",  chirp_data[dev_num].amp_data[count]);
    }
#endif
#endif

    /* Optionally read raw I/Q values for all samples */
#ifdef READ_IQ_DATA
    display_iq_data(dev_ptr);
#endif

    /* If more than 2 sensors, put each on its own line */
    if (num_connected_sensors > 2) {

```

```

        printf("\n");
    }
}
printf("\n");

return ret_val;
}

```


3 软件与硬件需求

● 软件需求

■ BSP 版本

◆ M261_Series_BSP_CMSIS_V3.00.003

■ IDE 版本

◆ Keil uVersion 5.33

● 硬件需求

■ 电路组件

◆ NuMaker-M263KI

◆ EV_MOD_CH101-03-01

■ 示意图

M263KI 通过 I²C 接口与 EV_MOD_CH101-03-01 模组连接。

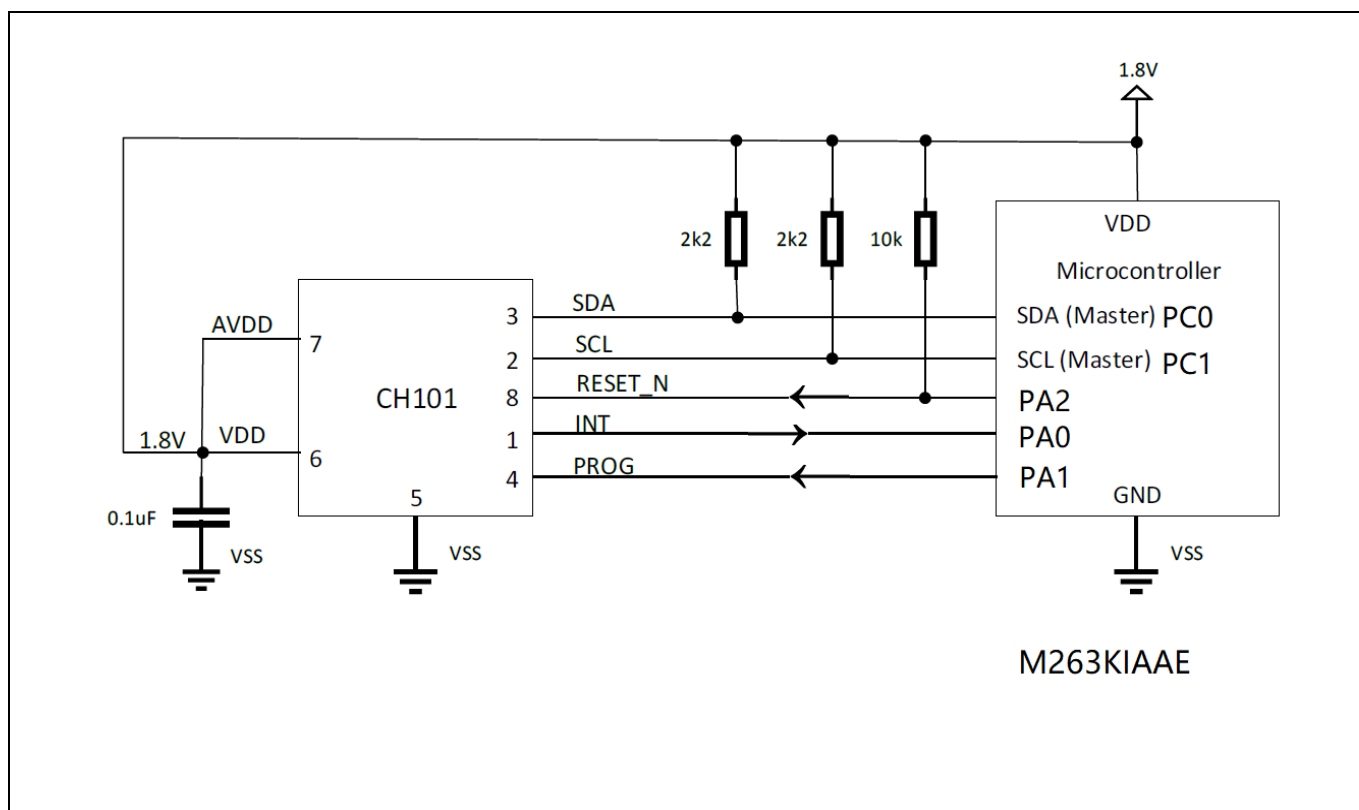


图 3-1 引脚连接

[illegible]

Rev 1.00

4 目录信息










 EC_ M263_I2C_TDK_CH101_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
 ThirdParty	
 Chirpmicro	Chirp SonicLib sensor API

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 *M263_I2C_TDK_CH101.uvprojx*。
2. 进入编译模式界面
 - a. 编译
 - b. 下载代码至内存
 - c. 进入 / 离开仿真模式
3. 进入仿真模式界面
 - a. 执行代码

6 修订纪录

Date	Revision	Description
2021.05.06	1.00	1. 初始发布.

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