SMART Home Real-Time IOT Device

Version 1.0

Technical Documentation

SMART Home

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Purpose of Documentation

The purpose of this documentation is to give the reader a general picture about the *SMART Home Real-Time IOT Device*. Instead of listing every detail, the document is functioning as a *guide* to introducing the device.

Proprietary Notice

Product Status

The information in this document is not final. The device is under development status: Work-In-Progress.

Feedback on this product

If you have any comments or suggestions about this product, contact the owner of this document with the product name.

Contact Address

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Introduction

This chapter describes the *SMART Home Real-Time IOT Device*. It contains the following sections:

- Introduction of *the SMART Home Real-Time IOT Device*
- Components

Introducing the SMART Home Real-Time IOS Device

SMART Home Real-Time IOT Device is a sensor platform intended for smart home applications or home monitoring. The main data processing unit is a STM32f411 Nucleo board, which is assigned to communicate with the sensors and process its raw data.

The main sensor component is the BME280 Environmental sensor, which is capable of measuring temperature, humidity and pressure. The sensor can communicate with the microcontroller using I2C communication protocol

The device is capable of Real-Time environmental monitoring using FreeRTOS. The device's main features are temperature, humidity and pressure measuring. The raw data coming from the sensor is converted to SI metrics.

After connecting the device with USB, the user can see the measured data sent with USART communication protocol.

Components

SMART Home Real-Time IOT Device contains the following:

- ARM Cortex-M4 microprocessor on the STM32f411 Nucleo board.
- Bosch BME280 Environmental sensor
- FreeRTOS for real-time operation software

About the STM32f411 Nucleo board

The STM32F411XC/XE devices are based on the high-performance Arm® Cortex® -M4 32-bit RISC core operating at a frequency of up to 100 MHz. The Cortex®-M4 core features a Floating-point unit (FPU) single precision which supports all Arm single-precision dataprocessing instructions and data types. It also implements a full set of DSP instructions and a memory protection unit (MPU) which enhances application security.

Figure 1. STM32f411 Nucleo board

The STM32F411xC/xE incorporate high-speed embedded memories (up to 512 Kbytes of Flash memory, 128 Kbytes of SRAM), and an extensive range of enhanced I/Os and peripherals connected to two APB buses, two AHB bus and a 32-bit multi-AHB bus matrix.

All devices offer one 12-bit ADC, a low-power RTC, six general-purpose 16-bit timers including one PWM timer for motor control, two general-purpose 32-bit timers. They also feature standard and advanced communication interfaces.

Source: www.st.com

About the Bosch BME280 Environmental sensor

General Description

The BME280 is a combined digital humidity, pressure and temperature sensor based on proven sensing principles. The sensor module is housed in an extremely compact metal-lid LGA package with a footprint of only 2.5 x 2.5 mm2 with a height of 0.93mm. Its small dimensions and its low power consumption allows the implementation in battery driven devices.

The BME280 achieves high performance in all applications requiring humidity and pressure measurement. The humidity sensor provides an extremely fast response time for fast context awareness applications and high overall accuracy over a wide temperature range.The pressure sensor is an absolute barometric pressure sensor with extremely high accuracy and resolution.

The integrated temperature sensor has been optimized for lowest noise and highest resolution. Its output is used for temperature compensation of the pressure and humidity sensors and can also be used for estimation of the ambient temperature.

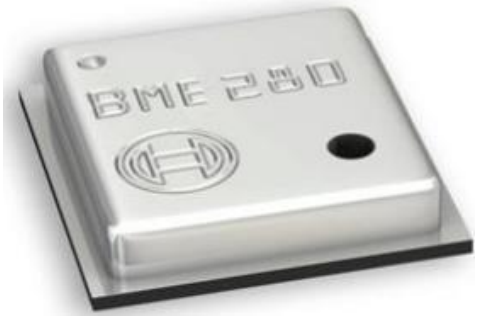

Figure 2. Bosch BME280 Environmental sensor

Operating range:

- Temperature: -40…..+85 °C
- Relative humidity: 0….100%
- Pressure: 300…..1100 hPa

Source: Bosch Sensortec

About the FreeRTOS Real-Time Operating System

General Description

FreeRTOS is a class of RTOS that is designed to be small enough to run on a microcontroller - although its use is not limited to microcontroller applications.

Microcontrollers are used in deeply embedded applications (those applications where you never actually see the processors themselves, or the software they are running) that normally have a very specific and dedicated job to do. The size constraints, and dedicated end application nature, rarely warrant the use of a full RTOS implementation - or indeed make the use of a full RTOS implementation possible. FreeRTOS therefore provides the core real time scheduling functionality, inter-task communication, timing and synchronization primitives only. This means it is more accurately described as a real time kernel, or real time executive. Additional functionality, such as a command console interface, or networking stacks, can then be included with add-on components.

Figure 3. FreeRTOS real-time operating system

Source: www.freertos.org

Connecting the sensor

The BME280 Environmental sensor has the following pins connected:

Power pins:

- Vin is the power pin. The sensor chip uses 3V DC, with an integrated voltage regulator that will take 3-5V DC. Connected to the microcontroller 3.3V pin.
- 3Vo is the 3.3V output from the voltage regulator, not used.
- GND is the common ground for power and logic, connected to GND

I2C logic pins:

- SCK is the I2C clock pin connected to the microcontroller SCL pin.
- SDI is the I2C data pin, connected to the microcontroller SDA pin.

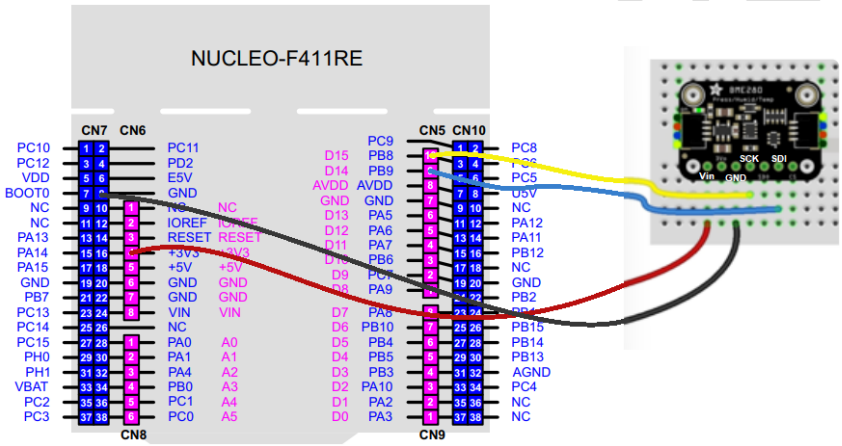

Figure 4. Sensor wiring

Peripherals

The main peripherals used in the project are the following:

- GPIO – General purpose Input/Output pins
- USART – Universal Synchronous Asynchronous Receiver Transmitter
- I2C – Inter-Integrated Circuit

GPIO

The GPIO or the General-Purpose Input Output pins are necessary for the device. The Peripherals (I2C, USART) are using input and outputs as a connection to the microcontroller.

USART

The USART or Universal Synchronous Asynchronous Receiver Transmitter is used for the communication between the user PC device and the microcontroller.

I2C

The I2C or Inter-Integrated Circuit protocol is used for the communication between the BME280 Environmental sensor and the microcontroller

Initialization

Main initialization progress consists of the following:

- STM32f411 System
- Peripherals
- FreeRTOS

System initialization

The first task is to configure the microcontroller main system. This contains the following:

- Main clock

Peripheral initialization

After the system configuration is done, the peripherals are next:

- GPIO
- USART
- I2C

FreeRTOS initialization

The device is running on a Real-Time OS, but before using it needs to be configured.

Task setup

The device has x independent tasks:

- TaskA
- TaskB
- TaskC