SensiBLE – Certified Product combining MCU, Sensors and Bluetooth.
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1 Overview
1.1 General Information

The SensiBLE is a high performance System on Module. SensiBLE integrates Micro Controller, variety of Sensors and BLE connectivity. It provides an ideal building block that easily integrates with a wide range of target markets requiring rich functionality. SensiBLE Compact, cost effective and with low power consumption.

SensiBLE IoT Module is a World’s smallest system-on-board (SoB), self-contained, low-power, outperform Micro-Controller, multiple MEMS sensors and wireless Bluetooth Low Energy connectivity.

The SensiBLE enables wireless connectivity, not requiring any RF experience or expertise. It provides a complete RF platform in a tiny form factor and being a certified solution optimizes the time to market of the final applications.

SensiBLE IoT Module is a Bridging-the-Gap solutions to any embedded design. Fit to the vast array of battery-powered applications requiring the integration of Multiple Sensors with BLE connectivity without compromising on cost and power consumption.

SensiBLE Capable to work down to 2v.

Supported products:

1. Base Part numbers
SIMBA : SensiBLE Module (Base part number)
SIMBA-BAT-CR2032 : Battery Holder (Coin Battery) + CR2032 battery
SIM-DB1-JC : Development Board with JTAG Connector (w/o SensiBLE Module)
SIM-DB1-SL : Development Board with ST-LInk (w/o SensiBLE Module)

2. SensibleBLE Module Versions
SIMBA-BASE : module with MCU + BLE + SIMBA-BAT-CR2032
SIMBA-STD : module with most of sensors (*) + BLE + SIMBA-BAT-CR2032
SIMBA-PRO : Full configuration sensors + BLE + SIMBA-BAT-CR2032
(*)Not include microphone and Buzzer.

3. Eval Kit part Number
SIMBA-DKL - Development Kit (SIMBA-DB-21 + SIMBA-PRO + CR2032 battery)
SIMBA-DKJ - Development Kit (SIMBA-DB-11 + SIMBA-PRO + CR2032 battery)

Schematics:
SIMBA-DB-11 - Development Board with JTAG Connector (w/o SensiBLE Module)
SIMBA-DB-21 - Development Board with ST-LInk (w/o SensiBLE Module)
Software:
BLUEMicrosystem1
MOTENV1

Contact SensiEDGE support services for further information:
mailto:Support@SensiEDGE.com.
1.2 Feature’s Summary

<table>
<thead>
<tr>
<th>Product Type</th>
<th>Module</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimension</td>
<td>30 x 20 x 10 mm</td>
</tr>
<tr>
<td>Bluetooth</td>
<td>v4.1 Bluetooth Low Energy 2.4GHz</td>
</tr>
<tr>
<td>BLE Certified Module</td>
<td>SPBTLE-RF</td>
</tr>
<tr>
<td>Technology</td>
<td>Bluetooth Smart sensor and hub device.</td>
</tr>
<tr>
<td>BLE Chipset</td>
<td>ST BlueNRG-MS</td>
</tr>
<tr>
<td>Antenna</td>
<td>On Board</td>
</tr>
<tr>
<td>RF Conn/ Antenna</td>
<td>Chip Antenna</td>
</tr>
<tr>
<td>Internal High Speed Clock</td>
<td>32MHZ crystal oscillator</td>
</tr>
<tr>
<td>External Low Power Clock</td>
<td>32.768KHZ</td>
</tr>
<tr>
<td>Tx power</td>
<td>+ 4 dBm</td>
</tr>
<tr>
<td>Rx sensitivity</td>
<td>-88 dBm</td>
</tr>
<tr>
<td>link budget</td>
<td>92dB</td>
</tr>
<tr>
<td>Data Rate Bluetooth</td>
<td>1Mb/s</td>
</tr>
<tr>
<td>Host Interface BT</td>
<td>SPI</td>
</tr>
<tr>
<td>CE qualified</td>
<td>CE qualified</td>
</tr>
<tr>
<td>FCC/IC Certified</td>
<td>FCC/IC Certified</td>
</tr>
<tr>
<td>BQE Qualified</td>
<td>BQE qualified (in progress)</td>
</tr>
<tr>
<td>Processor</td>
<td>ARM® 32-bit Cortex®-M4 CPU with FPU</td>
</tr>
<tr>
<td>Microcontroller</td>
<td>STM32L476RG</td>
</tr>
<tr>
<td>Sensors</td>
<td></td>
</tr>
<tr>
<td>Accelerometer, Gyroscope</td>
<td>LSM6DS3</td>
</tr>
<tr>
<td>Magnetic sensor</td>
<td>LIS3MDL</td>
</tr>
<tr>
<td>Pressure sensor</td>
<td>LPS25H</td>
</tr>
<tr>
<td>Relative humidity &amp; temperature</td>
<td>HTS221</td>
</tr>
<tr>
<td>Digital MEMS Microphone</td>
<td>MP34DT01-M</td>
</tr>
<tr>
<td>Ambient Light Sensor</td>
<td>APDS-9250</td>
</tr>
<tr>
<td>User Input</td>
<td></td>
</tr>
<tr>
<td>RG LED</td>
<td>LTST-C195KGJRKT</td>
</tr>
<tr>
<td><strong>User Button</strong></td>
<td>TL1014</td>
</tr>
<tr>
<td>-----------------------</td>
<td>----------------------</td>
</tr>
<tr>
<td><strong>Buzzer</strong></td>
<td>ME05140SMC03</td>
</tr>
<tr>
<td><strong>Data Logger</strong></td>
<td>4Mbit SPI_Flash</td>
</tr>
<tr>
<td><strong>Serial Flash</strong></td>
<td>AT25XE041B-MHN-T</td>
</tr>
<tr>
<td><strong>Mounting Type</strong></td>
<td>Two 14pins/1.27 pitch female</td>
</tr>
<tr>
<td><strong>Pin-Header Connector</strong></td>
<td>PS3M34-114GBOTB-U</td>
</tr>
</tbody>
</table>

**Extension Interface**

- **GPIO**: 18
- **I2C**: 2
- **SPI**: 2
- **USART**: 2
- **UART**: 2
- **ADC (12 bit)**: 4 ch
- **USB**: OTG FS
- **PWM**: 5
- **SDIO**: 1
- **CAN (2.0B Active)**: 1

**Power Interface**

- **Cell Battery**: $2 < Vin < 3.6$
- **Coin Cell Battery**: CR2025, CR2032
- **Rechargeable Battery**: Yes (external board)
- **Mini-USB**: Yes (on Carrier Board)
- **External Power**: $4.5v < Vin < 7v$

**Dimensions**

- **SIMBA**: 20mm * 30mm
- **SIMBA height with Battery**: 10.43mm * 7.5mm
- **Battery Holder**: 20 * 22.50
1.3 Block Diagram

The system based on 6 main block’s:

- Connectivity
- Micro Controller
- Extensions & Power
- Sensors
- Data Logger
- User Interface

Figure 1 Sensible Block Diagram
2 Main Hardware Components

This section summarizes the main hardware building blocks of the SensiBLE Module. Part of the Connectivity used by the SensiBLE module for internal connection between MCU and Sensors. Microphone using DFSDM interface, Sensors connected to MCU using I²C1, while BLE module and Data Logger connected via SPI1.

Figure 2 SensiBLE Internal & External Connections Diagram

Rest of unused Interfaces is free for user to interconnect with external world:
- 18 I/O
- PWM
- I²C1, I²C2
- SPI2, SPI3
- USART 2, USART3
- UART4, UART5
- CAN
- SD
- ADC
2.1 Microcontroller
2.1.1 STM32L476

The SensiBLE module contains ST’s STM32L476xx MCU. The STM32L476RG device are the ultra-low-power microcontrollers based on the high-performance ARM® Cortex®-M4 32-bit RISC core operating at a frequency of up to 80 MHz. The Cortex-M4 core features a Floating point unit (FPU) single precision which supports all ARM single-precision data-processing instructions and data types. It also implements a full set of DSP instructions and a memory protection unit (MPU) which enhances application security.

2.2 Bluetooth
2.2.1 SPBTLE-RF

The SensiBLE module contains ST’s SPBTLE-RF. The SPBTLE-RF is an easy to use Bluetooth® Smart master/slave network processor module, compliant with Bluetooth® v4.1. The SPBTLE-RF B-SmarT module supports multiple roles simultaneously, and can act at the same time as Bluetooth Smart sensor and hub device.

2.3 Sensors

The SensiBLE module contains verity of sensors:
- ST’s 3D accelerometer and 3D gyroscope
- ST’s 3-Axis Magnetometer
- ST’s humidity and temperature
- ST’s pressure sensor
- ST’s digital microphone
- Avago’s Digital RGB, IR and Ambient Light Sensor

2.3.1 LSM6DS3: inertial module: 3D accelerometer and 3D gyroscope

The LSM6DS3 is a system-in-package featuring a 3D digital accelerometer and a 3D digital gyroscope. Enabling always-on low-power features for an optimal motion experience.

2.3.2 LIS3MDL: 3-Axis Magnetometer

The LIS3MDL is an ultra low-power high-performance 3-Axis Magnetometer. This device offers the unique flexibility for designers to implement movement and position detection in space-constrained products such as personal navigation devices.

2.3.3 HTS221TR: humidity and temperature
The HTS221 is an ultra compact sensor for relative humidity and temperature. It includes a sensing element consists of a polymer dielectric planar capacitor structure and a mixed signal ASIC to provide the measurement information through digital serial interfaces.

2.3.4 LPS25H: pressure sensor

The LPS25H is an ultra compact absolute piezoresistive pressure sensor. It includes a monolithic sensing element capable to detect.

2.3.5 MP34DT01-M: digital microphone

The MP34DT01-M is an ultra-compact, low-power, omnidirectional, digital MEMS microphone built with a capacitive sensing element and an IC interface. The sensing element, capable of detecting acoustic waves, is manufactured using a specialized silicon micromachining process dedicated to produce audio sensors.

2.3.6 APDS-9250: Digital RGB, IR and Ambient Light Sensor

The Avago APDS-9250 is a low-voltage digital RGB, IR and ambient light sensor device that converts light intensity to digital output signal. The color-sensing feature is useful in applications such as LED RGB backlight control, solid-state lighting, reflected LED color sampler and fluorescent light color temperature detection. With the IR sensing feature, the device can be used to read the IR content in certain lighting condition and detect the type of light source.

2.4 Data Logger

2.4.1 AT25XE041B

The SensiBLE module contains Adesto® AT25XE041B. Adesto’s AT25XE041B is a serial flash memory device. Flexible erase architectures with page erase and block erase sizes make this memory ideal for data storage applications. AT25XE products feature ultra low-energy operation for active current, Program and Erase operations, as well as improved standby energy consumption. The device contains a specialized One-Time Programmable (OTP) security register usable for unique device serialization, system-level electronic serial number storage, and locked key storage.

2.5 User Interface

The SensiBLE module contains verity of user interfaces:

- TongKeElectronics’s Buzzer (PB11)
- IL SWITCH’s Button (PC13)
- Lite-On’s RG-LED (Led G @ PA5, Led R @ PC6)
2.5.1 LTST-C195KGJRKT Magnetic Buzzer

TongKE Electronics Buzzer based on Electro-Magnetic Acoustic Transducer for non-contact sound generation and reception using electromagnetic mechanisms.

2.5.2 SS304BS Button

IL SWITCH’s is a Side push Surface Horizontal operating direction button.

2.5.3 LTST-C195KGJRKT Dual color chip LED

Lite-On’s SMD Red/Green LED based 2 separate LED’s in a package, allows two colors (red and green), while only having 4 pins (Dual set cathode and anode) miniature sizes and special configurations for space-sensitive applications. The color of the LED depends on the polarity of the connection, allowing separate and both colors at the same time.
### 3 External Connectors

The SensiBLE exposes two low profile connectors. First J1 is 14 pin while Second J2 is 13 pin Board to Board connectors. The recommended mating connectors for Custom board interfacing are:

**Pin Name:** J1, J2

- **J1** - 14 pins 1row 1.27 Female
- **J2** - 13 pins 1row 1.27 Female

<table>
<thead>
<tr>
<th>Pin #:</th>
<th>Pin Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schematic Name:</td>
<td>MCU name description</td>
</tr>
<tr>
<td>Type:</td>
<td>Pin type &amp; direction</td>
</tr>
<tr>
<td></td>
<td>S – Power Pin and/or Ground Pin</td>
</tr>
<tr>
<td></td>
<td>I/O – GPIO</td>
</tr>
</tbody>
</table>

**Func (#):** Function Number 1 to 4

**Description:** Description of the Pin
### 3.1 Pin Mux

Table 3.1 and Table 3.2 explain function of connectivity pins in SensiBLE module as well Pin MUX and alternate function available.

#### Table 3.1 - J1 SensiBLE Module – Alternate Function

<table>
<thead>
<tr>
<th>Pin #</th>
<th>Schematic Name</th>
<th>Type</th>
<th>Func1</th>
<th>Func2</th>
<th>Func3</th>
<th>Func4</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>+5V_USB</td>
<td>S</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Input voltage from USB +5V</td>
</tr>
<tr>
<td>2</td>
<td>VDD</td>
<td>S</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>+3.3V from voltage regulator</td>
</tr>
<tr>
<td>3</td>
<td>PB1</td>
<td>I/O</td>
<td>TIM3_CH4</td>
<td>TIM3_CH3N</td>
<td>ADC12_16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>PC4</td>
<td>I/O</td>
<td>ADC12_13</td>
<td>USART3_TX</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>PB12</td>
<td>I/O</td>
<td>SPI2_NSS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>PB13</td>
<td>I/O</td>
<td>SPI2_SCK</td>
<td>I2C2_SCL</td>
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<td></td>
<td></td>
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<tr>
<td>7</td>
<td>PB14</td>
<td>I/O</td>
<td>SPI2_MISO</td>
<td>I2C2_SDA</td>
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<tr>
<td>8</td>
<td>PC3</td>
<td>I/O</td>
<td>SPI2_MOSI</td>
<td>ADC123_14</td>
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<td></td>
<td></td>
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<tr>
<td>9</td>
<td>PA3</td>
<td>I/O</td>
<td>USART2_RX</td>
<td>TIM2_CH4</td>
<td>TIM5_CH4</td>
<td>TIM15_CH2</td>
<td></td>
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<tr>
<td>10</td>
<td>PA2</td>
<td>I/O</td>
<td>USART2_TX</td>
<td>TIM2_CH3</td>
<td>TIM5_CH3</td>
<td>TIM15_CH1</td>
<td>ADC12_7</td>
</tr>
<tr>
<td>11</td>
<td>JTCK/SW CLK</td>
<td>I/O</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Serial clk pin SWD</td>
</tr>
<tr>
<td>12</td>
<td>JTMS/SW DAT</td>
<td>I/O</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Serial data pin SWD</td>
</tr>
<tr>
<td>13</td>
<td>nReset</td>
<td>I/O</td>
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<td></td>
<td></td>
<td>Reset pin</td>
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<tr>
<td>14</td>
<td>GND</td>
<td>S</td>
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<td></td>
<td></td>
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<td>Ground pin</td>
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</table>
Table 3.2 - J2 SensiBLE Module – Alternate Function

<table>
<thead>
<tr>
<th>Schematic Name</th>
<th>Type</th>
<th>Func1</th>
<th>Func2</th>
<th>Func3</th>
<th>Func4</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 PB5</td>
<td>I/O</td>
<td>TIM3_CH2</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 GND</td>
<td>S</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Ground pin</td>
</tr>
<tr>
<td>3 PA12</td>
<td>I/O</td>
<td>OTG_FS_DP</td>
<td>CAN1_TX</td>
<td></td>
<td></td>
<td>CAN/USB</td>
</tr>
<tr>
<td>4 PA11</td>
<td>I/O</td>
<td>OTG_FS_DM</td>
<td>CAN1_RX</td>
<td></td>
<td></td>
<td>CAN/USB</td>
</tr>
<tr>
<td>5 PA10</td>
<td>I/O</td>
<td>TIM1_CH3</td>
<td>OTG_ID</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 PD2</td>
<td>I/O</td>
<td>SDMMC_CMD</td>
<td>UART5_RX</td>
<td></td>
<td></td>
<td>SDIO_CMD</td>
</tr>
<tr>
<td>7 PC12</td>
<td>I/O</td>
<td>SDMMC_CK</td>
<td>UART5_TX</td>
<td></td>
<td></td>
<td>SDIO_CLK</td>
</tr>
<tr>
<td>8 PC11</td>
<td>I/O</td>
<td>SDMMC_D3</td>
<td>USART3_RX</td>
<td>UART4_RX</td>
<td>SPI3_MISO</td>
<td>SDIO_DATA3</td>
</tr>
<tr>
<td>9 PC10</td>
<td>I/O</td>
<td>SDMMC_D2</td>
<td>USART3_TX</td>
<td>UART4_TX</td>
<td>SPI3_SCK</td>
<td>SDIO_DATA2</td>
</tr>
<tr>
<td>10 PC9</td>
<td>I/O</td>
<td>SDMMC_D1</td>
<td>TIM3_CH4</td>
<td>TIM8_CH4</td>
<td></td>
<td>SDIO_DATA1</td>
</tr>
<tr>
<td>11 PC8</td>
<td>I/O</td>
<td>SDMMC_D0</td>
<td>TIM3_CH3</td>
<td>TIM8_CH3</td>
<td></td>
<td>SDIO_DATA0</td>
</tr>
<tr>
<td>12 I2C1_SCL</td>
<td>I/O</td>
<td>I2C1_SCL</td>
<td></td>
<td></td>
<td></td>
<td>I2C1 bus clock</td>
</tr>
<tr>
<td>13 I2C1_SDA</td>
<td>I/O</td>
<td>I2C1_SDA</td>
<td></td>
<td></td>
<td></td>
<td>I2C1 bus data</td>
</tr>
</tbody>
</table>
4 Microcontroller

4.1 STM32L476

4.1.1 General Description

The STM32L476xx are the ultra-low-power microcontrollers based on the high performance ARM Cortex-M4, 32-bit RISC core operating at a frequency of up to 80 MHz. The Cortex-M4 core features a Floating-point unit (FPU) single precision, which supports all ARM single-precision data-processing instructions and data types. It also implements a full set of DSP instructions and a memory protection unit (MPU) which enhances application security.

The STM32L476 embed high-speed memories (Flash memory up to 1 Mbyte, up to 128 Kbyte of SRAM), an extensive range of enhanced I/Os and peripherals connected to two APB buses, two AHB buses and a 32-bit multi-AHB bus matrix. The STM32L476 embed several protection mechanisms for embedded Flash memory and SRAM: readout protection, write protection, proprietary code readout protection and Firewall.

The devices offer fast 12-bit ADCs (5 Msps), an internal voltage reference buffer, a low-power RTC, two general-purpose 32-bit timer, two 16-bit PWM timers dedicated to motor control, seven general-purpose 16-bit timers, and two 16-bit low-power timers. The Micro Controller support digital filter for external sigma delta modulators (DFSDM).

In addition, 1 capacitive sensing button is available.

They also feature standard and advanced communication interfaces.
- Two I2Cs (I2C1 connected internally to Sensors).
- Three SPIs (SPI1 connected internally to BLE and Serial Flash).
- Two USARTs, two UARTs.
- One SDMMC
- One CAN
- One USB OTG full-speed

The STM32L476xx operates in the -40 to +85 C (+105 C junction), -40 to +105 C (+125 C junction) and -40 to +125 C (+130 C junction) temperature ranges from a 1.71 to 3.6 V power supply. A comprehensive set of power-saving modes allows the design of low power applications.

4.1.2 Features

- Core: ARM® 32-bit Cortex®-M4 CPU
  - Frequency up to 80 MHz
  - FPU - Floating Point Unit
  - DSP instructions
  - Adaptive real-time accelerator (ART Accelerator™) allowing 0-wait-state execution from Flash memory
  - MPU – Memory Protecting Unit
– 100DMIPS/1.25DMIPS/MHz (Dhrystone 2.1)
– 14-channel DMA controller
– True random number generator
– CRC calculation unit, 96-bit unique ID

• Memories
  – Up to 1 MB Flash, 2 banks read-write, proprietary code readout protection
  – Up to 128 KB of SRAM including 32 KB with hardware parity check

• Ultra-low-power with FlexPowerControl
  – 300 nA in VBAT mode: supply for RTC and 32x32-bit backup registers
  – 30 nA Shutdown mode (5 wakeup pins)
  – 120 nA Standby mode (5 wakeup pins)
  – 420 nA Standby mode with RTC
  – µA Stop 2 mode, 1.4 µA Stop 2 with RTC
  – 100 µA/MHz run mode
  – Batch acquisition mode (BAM)
  – 4 µs wakeup from Stop mode
  – Brown out reset (BOR) in all modes except shutdown
  – Interconnect matrix

• Clock Sources
  – 4 to 48 MHz crystal oscillator
  – 32 kHz crystal oscillator for RTC (LSE)
  – Internal 16 MHz factory-trimmed RC (±1%)
  – Internal low-power 32 kHz RC (±5%)
  – Internal multispeed 100 kHz to 48 MHz oscillator, auto-trimmed by LSE (better than ±0.25 % accuracy)
  – 3 PLLs for system clock, USB, audio, ADC
  – RTC with HW calendar, alarms and calibration

• 1 capacitive sensing channels: support touchkey

• Timers
  – 16x timers: 2 x 16-bit advanced motor-control, 2 x 32-bit and 5 x 16-bit general purpose, 2x 16-bit basic, 2x low-power 16-bit timers (available in Stop mode), 2x watchdogs, SysTick timer

• digital filters for sigma delta modulator

• Analog
  – Rich analog peripherals (independent supply)
  – 12-bit ADC 5 Msps, up to 16-bit with hardware oversampling, 200 µA/Msps

• Communication:
  – 10x communication interfaces
  – USB OTG 2.0 full-speed, LPM and BCD
  – 2x I2C FM+(1 Mbit/s), SMBus/PMBus
  – 2x USARTs (ISO 7816, LIN, IrDA, modem)
  – 2x USARTs (ISO 7816, LIN, IrDA, modem)
  – 2x SPIs
- CAN (2.0B Active)
- SDMMC interface

- Development support: serial wire debug (SWD).
- 1.71 V to 3.6 V power supply
- -40 °C to 85/105/125 °C temperature range

4.1.3 Block Diagram

Figure 3 SensiBLE’s MCU Block Diagram

(*) Some of the peripherals are connected internally on-board sensors, others are available at extension connector (list).
5 Bleutooth

5.1 SPBTLLE-RF

5.1.1 General Description

The SPBTLLE-RF is a single-mode Bluetooth low energy master/slave network processor module compliant with Bluetooth® v4.1.

The SPBTLLE-RF B-SmarT module integrates a 2.4 GHz RF radio the ST BlueNRG-MS on which a complete power-optimized stack for Bluetooth single mode protocol runs, providing

- Master, slave role support
- GAP: central, peripheral, observer or broadcaster roles
- ATT/GATT: client and server
- SM: privacy, authentication and authorization
- L2CAP
- Link Layer: AES-128 encryption and decryption

The BlueNRG-MS radio embeds nonvolatile Flash memory allows on-field stack upgrading.

In addition, according the Bluetooth specification v4.1 the SPBTLLE-RF B-SmarT module provides:

- Multiple roles simultaneously support
- Support simultaneous advertising and scanning
- Support being slave of up to two masters simultaneously
- Privacy V1.1
- Low duty cycle directed advertising
- Connection parameters request procedure
- LE Ping
- 32 bits UUIDs
- L2CAP connection oriented channels

The SPBTLLE-RF B-SmarT module is equipped with Bluetooth low energy profiles in C
Application resides in the SensiBLE’s host application processor STM32L476, is interfaced with the SPBTLE-RF B-SmarT module through an application controller interface protocol, which is based on a standard SPI interface.

**Figure 4  Embedded Bluetooth Low Energy Protocol Stack**

The entire Bluetooth Smart stack and protocols are embedded in the BLE Module.

The SensiBLE enables wireless connectivity, not requiring any RF experience or expertise. It provides a complete RF platform in a tiny form factor and being a certified solution optimizes the time to market of the final applications.

5.1.2  Features

- Bluetooth v4.1 compliant
  - Supports master and slave modes
  - Multiple roles supported simultaneously
- Embedded Bluetooth low energy protocol stack
  - GAP, GATT, SM, L2CAP, LL, RFPHY
- Bluetooth low energy profiles provided separately
- Bluetooth radio performance:
  - Embedded ST BlueNRG-MS
  - Tx power: + 4 dBm
  - Rx sensitivity: -88 dBm
  - Provides up to 92 dB link budget with excellent link reliability
- Host interface
  - SPI, IRQ, and RESET
  - On-field stack upgrading available via SPI
- AES security co-processor
- Certification
  - CE qualified
  - FCC, IC modular approval certified
  - BQE qualified (in progress)
- On-board chip antenna
- Operating supply voltage: from 1.7 to 3.6 V
- Operating temperature range: -40 °C to 85 °C

5.1.3 Block Diagram

**Figure 5** SPBTLE-RF HW Application Block Diagram

5.1.4 SPBTLE-RF Connections and Signals:

SPBTLE-RF Bluetooth NRG Certified Module soldered on top of SensiBLE PCB to gain the Certification done previously by the SPBTLE-RF. The module connected by SPI1.

**Figure 6** SPBTLE-RF Schematic Connections
<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Pin #</th>
<th>Description</th>
<th>V max Tolerant</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPI_IRQ</td>
<td>O</td>
<td>4</td>
<td>SPI IRQ (slave has data for master)</td>
<td>Vin</td>
</tr>
<tr>
<td>SPI_CLK</td>
<td>I</td>
<td>7</td>
<td>SPI Clock (max. 8 MHZ)</td>
<td>Vin</td>
</tr>
<tr>
<td>SPI_MISO</td>
<td>O</td>
<td>8</td>
<td></td>
<td>Vin</td>
</tr>
<tr>
<td>SPI_MOSI</td>
<td>I</td>
<td>9</td>
<td></td>
<td>Vin</td>
</tr>
<tr>
<td>SPI_CS</td>
<td>I</td>
<td>10</td>
<td></td>
<td>Vin</td>
</tr>
<tr>
<td>Vin</td>
<td></td>
<td>5</td>
<td>Vin</td>
<td>(1.7V – 3.6V max)</td>
</tr>
<tr>
<td>GND</td>
<td></td>
<td>6</td>
<td>GND</td>
<td></td>
</tr>
<tr>
<td>BT_Reset</td>
<td>I</td>
<td>11</td>
<td>Reset Input (active low &lt; 0.35Vin)</td>
<td>(1.7V – 3.6V max)</td>
</tr>
<tr>
<td>EXT_LPCLK</td>
<td>I</td>
<td>1</td>
<td>Not connected</td>
<td></td>
</tr>
<tr>
<td>GPIO2</td>
<td>I/O</td>
<td>2</td>
<td>Not connected</td>
<td></td>
</tr>
<tr>
<td>ANA TEST 0</td>
<td>I</td>
<td>3</td>
<td>Not connected</td>
<td></td>
</tr>
</tbody>
</table>
6 Sensors

6.1 3D accelerometer and 3D gyroscope

6.1.1 General Description

The LSM6DS3 is a system-in-package featuring both high-performance 3-axis digital accelerometer and 3-axis digital gyroscope.

The integrated power-efficient modes are able to reduce the power consumption down to 1.25 mA in high-performance mode, combining always-on low-power features with superior sensing precision for an optimal motion experience for the consumer thanks to ultra-low noise performance for both the gyroscope and accelerometer.

The LSM6DS3 delivers best-in-class motion sensing that can detect orientation and gestures in order to empower application developers with features and capabilities that are more sophisticated than simply orienting their devices to portrait and landscape mode.

The event-detection interrupts enable efficient and reliable motion tracking and contextual awareness, implementing hardware recognition of free-fall events, 6D orientation, tap and double-tap sensing, activity or inactivity, and wakeup events.

The LSM6DS3 supports main OS requirements, offering real, virtual and batch mode sensors. In addition, the LSM6DS3 can efficiently run the sensor-related features specified in Android, saving power and enabling faster reaction time. In particular, the LSM6DS3 has been designed to implement hardware features such as significant motion, tilt, pedometer functions, time stamping and to support the data acquisition of an external magnetometer with ironing correction (hard, soft).

6.1.2 Features

- Power consumption: 0.9 mA in combo normal mode and 1.25 mA in combo high-performance mode up to 1.6 kHz.
- “Always-on” experience with low power consumption for both accelerometer and gyroscope
- Smart FIFO up to 8 kbyte data buffering based on features set
  - 100% efficiency with flexible configurations and partitioning
  - possibility to store timestamp
- Event-detection interrupts (fully configurable):
  - free-fall
  - wakeup
  - 6D orientation
  - tap and double-tap sensing
  - activity / inactivity recognition
- Specific IP blocks with negligible power consumption and high-performance:
  - pedometer functions: step detector and step counters
  - tilt detection (Android compliant)
  - significant motion (Android compliant)
• Data rate synchronization with external trigger for reduced sensor access and enhanced fusion
• Compliant with Android K and L
• Hard, soft ironing for external magnetic sensor corrections
• ±2/±4/±8/±16 g full scale
• ±125/±245/±500/±1000/±2000 dps full scale
• Analog supply voltage: 1.71 V to 3.6 V
• Independent IOs supply (1.62 V)
• Compact footprint, 2.5 mm x 3 mm x 0.83 mm
• SPI/I²C serial interface with main processor data synchronization feature
• Embedded temperature sensor
• ECOPACK®, RoHS and “Green” compliant

6.1.3 Block Diagram

Figure 7 LSM6DS3 HW Application Diagram

The LSM6DS3 has three operating modes available:
• only accelerometer active and gyroscope in power-down
• only gyroscope active and accelerometer in power-down
• both accelerometer and gyroscope sensors active with independent ODR

6.1.4 Connections and Signals

Figure 8 LSM6DS3 Schematic Connections
<table>
<thead>
<tr>
<th>Pin#</th>
<th>Name</th>
<th>Mode 1 function</th>
<th>Mode 2 Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SDO/SA0</td>
<td>SPI 4-wire interface serial data output (SDO)</td>
<td>SPI 4-wire interface serial data output (SDO)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I²C Least significant bit of the device address (SA0)</td>
<td>I²C Least significant bit of the device address (SA0)</td>
</tr>
<tr>
<td>2</td>
<td>SDx</td>
<td>Connect to VDDIO or GND</td>
<td>I²C Serial data master (MSDA)</td>
</tr>
<tr>
<td>3</td>
<td>SCx</td>
<td>Connect to VDDIO or GND</td>
<td>I²C Serial data master (MSDA)</td>
</tr>
<tr>
<td>4</td>
<td>INT1</td>
<td></td>
<td>Programmable interrupt 1</td>
</tr>
<tr>
<td>5</td>
<td>VDDIO(1)</td>
<td></td>
<td>Power supply for I/O pins</td>
</tr>
<tr>
<td>6</td>
<td>GND</td>
<td></td>
<td>0 V supply</td>
</tr>
<tr>
<td>7</td>
<td>GND</td>
<td></td>
<td>0 V supply</td>
</tr>
<tr>
<td>8</td>
<td>VDD(2)</td>
<td></td>
<td>Power supply</td>
</tr>
<tr>
<td>9</td>
<td>INT2</td>
<td>Programmable interrupt 2 (INT2)/Data enable (DEN)</td>
<td>Programmable interrupt 2 (INT2)/Data enable (DEN)/ I²C master external synchronization signal (MDRDY)</td>
</tr>
<tr>
<td>10</td>
<td>NC(3)</td>
<td></td>
<td>Leave unconnected</td>
</tr>
<tr>
<td>11</td>
<td>NC(3)</td>
<td></td>
<td>Leave unconnected</td>
</tr>
<tr>
<td>12</td>
<td>CS</td>
<td>I²C /SPI mode selection (1:SPI idle mode / I²C communication enabled; 0:SPI communication mode/ I²C disabled)</td>
<td>I²C /SPI mode selection (1:SPI idle mode / I²C communication enabled; 0:SPI communication mode/ I²C disabled)</td>
</tr>
<tr>
<td>13</td>
<td>SCL</td>
<td>I²C serial clock (SCL)</td>
<td>I²C Serial clock (SCL)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SPI serial port clock (SPC)</td>
<td>SPI Serial port clock (SPC)</td>
</tr>
<tr>
<td>14</td>
<td>SDA</td>
<td>I²C serial data (SDA)</td>
<td>I²C Serial data (SDA)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SPI serial data input (SDI)</td>
<td>SPI Serial data input (SDI)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3-wire interface serial data output (SDO)</td>
<td>3-wire interface serial data output (SDO)</td>
</tr>
</tbody>
</table>
6.2 Magnetic Sensor

6.2.1 General Description

The SensiBLE module contains ST’s LIS3MDL. The LIS3MDL is an ultra-low-power high-performance three-axis magnetic sensor. The LIS3MDL has user-selectable full scales of ±4/±8/±12/±16 gauss. The self-test capability allows the user to check the functioning of the sensor in the final application. The device may be configured to generate interrupt signals for magnetic field detection.

6.2.2 Features

- Wide supply voltage, 1.9 V to 3.6 V
- Independent IO supply (1.8 V)
- ±4/±8/±12/±16 gauss selectable magnetic full scale
- Continuous and single-conversion modes
- 16-bit data output
- Interrupt generator
- Self-test
- I2C digital output interface
- Power-down mode/low-power mode
- ECOPACK®, RoHS and “Green” compliant

6.2.3 Block Diagram

**Figure 9 LIS3MDL Block Diagram**
6.2.4 Connections and Signals

Figure 10 LIS3MDL Schematic Connections

Table 3 LIS3MDL Pin Assignment

<table>
<thead>
<tr>
<th>Pin#</th>
<th>Name</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SCL</td>
<td>$I^2C$ Serial clock (SCL)</td>
</tr>
<tr>
<td></td>
<td>SPC</td>
<td>SPI serial port clock (SPC)</td>
</tr>
<tr>
<td>2</td>
<td>Reserved</td>
<td>Connect to GND</td>
</tr>
<tr>
<td>3</td>
<td>GND</td>
<td>Connect to GND</td>
</tr>
<tr>
<td>4</td>
<td>C1</td>
<td>Capacitor connection ($C_1=100\text{nf}$)</td>
</tr>
<tr>
<td>5</td>
<td>Vdd</td>
<td>Power supply</td>
</tr>
<tr>
<td>6</td>
<td>Vdd_IO</td>
<td>Power supply for I/O pins</td>
</tr>
<tr>
<td>7</td>
<td>INT</td>
<td>interrupt</td>
</tr>
<tr>
<td>8</td>
<td>DRDY</td>
<td>Data Ready</td>
</tr>
<tr>
<td>9</td>
<td>SDO</td>
<td>SPI serial data output (SDO)</td>
</tr>
<tr>
<td></td>
<td>SA1</td>
<td>$I^2C$ less significant bit of the device address (SA1)</td>
</tr>
<tr>
<td>10</td>
<td>CS</td>
<td>SPI enable</td>
</tr>
<tr>
<td></td>
<td></td>
<td>/SPI mode selection</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1: SPI idle mode / $I^2C$ communication enabled;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0: SPI communication mode / $I^2C$ disabled)</td>
</tr>
<tr>
<td>11</td>
<td>SDA</td>
<td>$I^2C$ serial data (SDA)</td>
</tr>
<tr>
<td></td>
<td>SDI</td>
<td>SPI serial data input (SDI)</td>
</tr>
<tr>
<td></td>
<td>SDO</td>
<td>3-wire interface serial data output (SDO)</td>
</tr>
<tr>
<td>12</td>
<td>Reserved</td>
<td>Connect to GND</td>
</tr>
</tbody>
</table>
6.3 Humidity and Temperature Sensor

6.3.1 General Description

The SensiBLE module contains ST’s HTS221. The HTS221 is an ultra compact sensor for relative humidity and temperature. It includes a sensing element and a mixed signal ASIC to provide the measurement information through digital serial interfaces. The sensing element consists of a polymer dielectric planar capacitor structure capable of detecting relative humidity variations.

6.3.2 Features

- 0 to 100% relative humidity range
- Supply voltage: 1.7 to 3.6 V
- Low power consumption: 2 µA @ 1 Hz ODR
- Selectable ODR from 1 Hz to 12.5 Hz
- High rH sensitivity: 0.004% rH/LSB
- Humidity accuracy: ± 3.5% rH, 20 to +80% rH
- Temperature accuracy: ± 0.5 °C, 15 to +40 °C
- Embedded 16-bit ADC
- 16-bit humidity and temperature output data
- I²C interfaces
- Factory calibrated
- Tiny 2 x 2 x 0.9 mm package
- ECOPACK® compliant

6.3.3 Block Diagram

**Figure 11 HTS221 Block Diagram**
6.3.4 Connections and Signals

Figure 12 HTS221 Schematic Connections

Table 4 HTS221 Pin Assignment

<table>
<thead>
<tr>
<th>Pin #</th>
<th>Name</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Vdd</td>
<td>Power Supply</td>
</tr>
<tr>
<td>2</td>
<td>SCL</td>
<td>$I^2C$ serial clock (SCL)</td>
</tr>
<tr>
<td>3</td>
<td>DRDY</td>
<td>Data Ready output signal</td>
</tr>
<tr>
<td>4</td>
<td>SDA</td>
<td>$I^2C$ serial data (SDA)</td>
</tr>
<tr>
<td>5</td>
<td>GND</td>
<td>Ground</td>
</tr>
<tr>
<td>6</td>
<td>SPI enable</td>
<td>$I^2C$ /SPI mode selection</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1: SPI idle mode / $I^2C$ communication enabled</td>
</tr>
</tbody>
</table>
6.4 Pressure Sensor

6.4.1 General Description

The SensiBLE module contains ST’s LPS25H. The LPS25H is an ultra compact absolute piezoresistive pressure sensor. It includes a monolithic sensing element and an IC interface able to take the information from the sensing element and to provide a digital signal. The sensing element consists of a suspended membrane realized inside a single mono-silicon substrate.

6.4.2 Features

- 260 to 1260 mbar absolute pressure range
- High-resolution mode: 1 Pa RMS
- Low power consumption:
  - Low resolution mode: 4 µA
  - High resolution mode: 25 µA
- High overpressure capability: 20x full scale
- Embedded temperature compensation
- Embedded 24-bit ADC
- Selectable ODR from 1 Hz to 25 Hz
- I²C interfaces
- Embedded FIFO
- Supply voltage: 1.7 to 3.6 V
- High shock survivability: 10,000 g
- Small and thin package
- ECOPACK® lead-free compliant

6.4.3 Block Diagram

Figure 13 LPS25H Block Diagram
6.4.4 Connections and Signals

**Figure 14 LPS25H Schematic Connections**

![Schematic Diagram]

**Table 5 LPS25H Pin Assignment**

<table>
<thead>
<tr>
<th>Pin Number</th>
<th>Name</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Vdd IO</td>
<td>Power supply for I/O pins</td>
</tr>
<tr>
<td>2</td>
<td>SCL SPC</td>
<td>$I^2C$ Serial clock (SCL) SPI serial port clock (SPC)</td>
</tr>
<tr>
<td>3</td>
<td>Reserved</td>
<td>Connect to GND</td>
</tr>
<tr>
<td>4</td>
<td>SDA SDI SDI/SDO</td>
<td>$I^2C$ Serial data (SDA) 4-wire SPI serial data input (SDI) 3-wire serial data input/output (SDI/SDO)</td>
</tr>
<tr>
<td>5</td>
<td>SDO SA0</td>
<td>$I^2C$ 4-wire SPI serial data output (SDO) less significant bit of the device address (SA0)</td>
</tr>
<tr>
<td>6</td>
<td>CS</td>
<td>SPI enable $I^2C$ / SPI mode selection (1: SPI idle mode / communication enabled; 0: SPI communication mode / $I^2C$ disabled)</td>
</tr>
<tr>
<td>7</td>
<td>INT_DRDY</td>
<td>Interrupt or Data Ready</td>
</tr>
<tr>
<td>8</td>
<td>GND</td>
<td>0V supply</td>
</tr>
<tr>
<td>9</td>
<td>GND</td>
<td>0V supply</td>
</tr>
<tr>
<td>10</td>
<td>VDD</td>
<td>Power supply</td>
</tr>
</tbody>
</table>
6.5 Digital Microphone

6.5.1 General Description

The SensiBLE module contains ST’s MP34DT01-M. The MP34DT01-M is an ultra-compact, low-power, omnidirectional, digital MEMS microphone built with a capacitive sensing element and an IC interface. The sensing element, capable of detecting acoustic waves. Able to provide a digital signal externally in PDM format. The MP34DT01-M has an acoustic overload point of 120 dBSPL with a 61 dB signal-to-noise ratio and –26 dBFS sensitivity.

6.5.2 Features

- Single supply voltage
- Low power consumption
- 120 dBSPL acoustic overload point
- 61 dB signal-to-noise ratio
- Omnidirectional sensitivity
  - 26 dBFS sensitivity
- PDM output
- HCLGA package
- Top-port design
- SMD-compliant
- EMI-shielded
- ECOPACK®, RoHS, and “Green” compliant

6.5.3 Block Diagram

TBD

6.5.4 Connections and Signals

Figure 15 MP34DT01-M Schematic Connections
<table>
<thead>
<tr>
<th>Pin #</th>
<th>Pin name</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Vdd</td>
<td>Power supply</td>
</tr>
<tr>
<td>2</td>
<td>LR</td>
<td>Left/Right channel selection</td>
</tr>
<tr>
<td>3</td>
<td>CLK</td>
<td>Synchronization input clock</td>
</tr>
<tr>
<td>4</td>
<td>DOUT</td>
<td>Left/Right PDM data output</td>
</tr>
<tr>
<td>5 (ground ring)</td>
<td>GND</td>
<td>0 V Supply</td>
</tr>
</tbody>
</table>
6.6 Digital RGB, IR and Ambient Light Sensor

6.6.1 General Description

The SensiBLE module contains Avago’s APDS-9250. The Avago APDS-9250 is a low-voltage digital RGB, IR and ambient light sensor device that convert light intensity to digital output signal. The device supports I2C-bus interface and has a programmable interrupt controller that takes minimal micro-controller (MCU) resources. The color-sensing feature is useful in applications such as LED RGB backlight control, solid-state lighting, reflected LED color sampler and fluorescent light color temperature detection. With the IR sensing feature, the device can be used to read the IR content in certain lighting condition and detect the type of light source.

6.6.2 Features

- Colour and Ambient Light Sensing (CS-RGB and ALS)
  - Accuracy of Correlated Color Temperature (CCT)
  - Individual channels for Red, Green, Blue and Infared
  - Approximates Human Eye Response with Green Channel
  - Red, Green, Blue, Infrared and ALS Sensing
  - High Sensitivity in low lux condition - Ideally suited for Operation Behind Dark Glass
  - Wide Dynamic Range: 18,000,000: 1
  - Up to 20-Bit Resolution
- Power Management
  - Low Active Current - 130 µA typical
  - Low Standby Current - 1µA typical
- I2C-bus Fast Mode Compatible Interface
  - Up to 400kHz (I2C Fast-Mode)
  - Dedicated Interrupt Pin

6.6.3 Block Diagram

Figure 16 APDS-9250 Block Diagram
6.6.4 Connections and Signals

Figure 17 APDS-9250 Schematic Connections

![Schematic Diagram]

Table 7 APDS-9250 Pin Assignment

<table>
<thead>
<tr>
<th>Pin</th>
<th>Name</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SCL</td>
<td>I</td>
<td>$I^2C$ Serial Clock input Terminal – Clock Signal for I2C Serial Data</td>
</tr>
<tr>
<td>2</td>
<td>SDA</td>
<td>I/O</td>
<td>Serial Data I/O for $I^2C$</td>
</tr>
<tr>
<td>3</td>
<td>VDD</td>
<td>Supply</td>
<td>Power Supply Voltage</td>
</tr>
<tr>
<td>4</td>
<td>INT</td>
<td>O</td>
<td>Interrupt – Open Drain</td>
</tr>
<tr>
<td>5</td>
<td>NC</td>
<td></td>
<td>No Connect</td>
</tr>
<tr>
<td>6</td>
<td>GND</td>
<td>Ground</td>
<td>Power Supply Ground. All Voltage and reference to GND.</td>
</tr>
</tbody>
</table>
7 Serial Flash

7.1 AT25XE041B

7.1.1 Description

The Adesto® AT25XE041B is a serial interface Flash memory device designed for use in applications in which program code is shadowed from Flash memory into embedded or external RAM for execution. The flexible erase architecture of the AT25XE041B, with its page erase granularity it is ideal for data storage as well, eliminating the need for additional data storage devices. The erase block sizes of the AT25XE041B have been optimized to meet the needs of today's code and data storage applications. By optimizing the size of the erase blocks, the memory space can be used much more efficiently. Because certain code modules and data storage segments must reside by themselves in their own erase regions, the wasted and unused memory space that occurs with large sectored and large block erase Flash memory devices can be greatly reduced. This increased memory space efficiency allows additional code routines and data storage segments to be added while still maintaining the same overall device density. The device also contains a specialized OTP (One-Time Programmable) Security Register that can be used for purposes such as unique device serialization, system-level Electronic Serial Number (ESN) storage, locked key storage, etc. The AT25XE041B supports read, program, and erase operations.

7.1.2 Features

- Single 1.65V - 3.6V Supply
- Serial Peripheral Interface (SPI) Compatible
  - Supports SPI Modes 0 and 3
  - Supports Dual-I/O Operation
- 85MHz Maximum Operating Frequency
  - Clock-to-Output (tV) of 6 ns
- Flexible, Optimized Erase Architecture for Code + Data Storage Applications
  - Uniform 4-Kbyte Block Erase
  - Uniform 32-Kbyte Block Erase
  - Uniform 64-Kbyte Block Erase
  - Full Chip Erase
- Hardware Controlled Locking of Protected Sectors via WP Pin
- 128-byte, One-Time Programmable (OTP) Security Register
  - 64 bytes factory programmed with a unique identifier
  - 64 bytes user programmable
- Flexible Programming
  - Byte/Page Program (1 to 256 Bytes)
  - Dual-Input Byte/Page Program (1 to 256 Bytes)
  - Sequential Program Mode Capability
- Fast Program and Erase Times
  - 2ms Typical Page Program (256 Bytes) Time
  - 45ms Typical 4-Kbyte Block Erase Time
  - 360ms Typical 32-Kbyte Block Erase Time
- 720ms Typical 64-Kbyte Block Erase Time
  - Automatic Checking and Reporting of Erase/Program Failures
- Software Controlled Reset
- JEDEC Standard Manufacturer and Device ID Read Methodology
- Low Power Dissipation
  - 200nA Ultra Deep Power Down current (Typical)
  - 5µA Deep Power-Down Current (Typical)
  - 25µA Standby current (Typical)
  - 3.5mA Active Read Current (Typical)
- Endurance: 100,000 Program/Erase Cycles
- Data Retention: 20 Years
- Complies with Full Industrial Temperature Range

7.1.3 Block Diagram

**Figure 18 AT25XE041B Block Diagram**

![AT25XE041B Block Diagram](image)

7.1.4 Connections and Signals

**Figure 19 APDS-9250 Schematic Connections**

![APDS-9250 Schematic Connections](image)
<table>
<thead>
<tr>
<th>Symbol</th>
<th>Name and Function</th>
<th>Asserted State</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS</td>
<td>CHIP SELECT: Asserting the CS pin selects the device. When the CS pin is deasserted, the device will be deselected and normally be placed in standby mode (not Deep Power-Down mode), and the SO pin will be in a high-impedance state. When the device is deselected, data will not be accepted on the SI pin. A high-to-low transition on the CS pin is required to start an operation, and a low-to-high transition is required to end an operation. When ending an internally self-timed operation such as a program or erase cycle, the device will not enter the standby mode until the completion of the operation.</td>
<td>Low</td>
<td>Input</td>
</tr>
<tr>
<td>SCK</td>
<td>SERIAL CLOCK: This pin is used to provide a clock to the device and is used to control the flow of data to and from the device. Command, address, and input data present on the SI pin is always latched in on the rising edge of SCK, while output data on the SO pin is always clocked out on the falling edge of SCK.</td>
<td>-</td>
<td>Input</td>
</tr>
<tr>
<td>SI (I/O)</td>
<td>SERIAL INPUT: The SI pin is used to shift data into the device. The SI pin is used for all data input including command and address sequences. Data on the SI pin is always latched in on the rising edge of SCK. With the Dual-Output Read commands, the SI Pin becomes an output pin (I/O) in conjunction with other pins to allow two bits of data on (I/O-0) to be clocked out on every falling edge of SCK. To maintain consistency with the SPI nomenclature, the SI (I/O) pin will be referenced as the SI pin unless specifically addressing the Dual-I/O modes in which case it will be referenced as I/O. Data present on the SI pin will be ignored whenever the device is deselected (CS is deasserted).</td>
<td>-</td>
<td>Input/Output</td>
</tr>
<tr>
<td>SO (I/O)</td>
<td>SERIAL OUTPUT: The SO pin is used to shift data out from the device. Data on the SO pin is always clocked out on the falling edge of SCK. With the Dual-Output Read commands, the SO Pin remains an output pin (I/O) in conjunction with other pins to allow two bits of data on (I/O-0) to be clocked out on every falling edge of SCK. To maintain consistency with the SPI nomenclature, the SO (I/O) pin will be referenced as the SO pin unless specifically addressing the Dual-I/O modes in which case it is referenced as I/O. The SO pin will be in a high-impedance state whenever the device is deselected (CS is deasserted).</td>
<td>-</td>
<td>Input/Output</td>
</tr>
<tr>
<td>WP</td>
<td>WRITE PROTECT: The WP pin controls the hardware locking feature of the device. Please refer to “Protection Commands and Features” on page 17 for more details on protection features and the WP pin. The WP pin is internally pulled-high and may be left floating if hardware controlled protection will not be used. However, it is recommended that the WP pin also be externally connected to Vcc whenever possible.</td>
<td>Low</td>
<td>Input</td>
</tr>
<tr>
<td>HOLD</td>
<td>HOLD: The HOLD pin is used to temporarily pause serial communication without deselecting or resetting the device. While the HOLD pin is asserted, transitions on the SCK pin and data on the SI pin will be ignored, and the SO pin will be in a high-impedance state. The CS pin must be asserted, and the SCK pin must be in the low state in order for a Hold condition to start. A Hold condition pauses serial communication only and does not have an effect on internally self-timed operations such as a program or erase cycle. Please refer to “Hold” on page 35 for additional details on the Hold operation. The HOLD pin is internally pulled-high and may be left floating if the Hold function will not be used. However, it is recommended that the HOLD pin also be externally connected to Vcc whenever possible.</td>
<td>Low</td>
<td>Input</td>
</tr>
<tr>
<td>Vcc</td>
<td>DEVICE POWER SUPPLY: The Vcc pin is used to supply the source voltage to the device. Operations at invalid Vcc voltages may produce spurious results and should not be attempted.</td>
<td>-</td>
<td>Power</td>
</tr>
<tr>
<td>GND</td>
<td>GROUND: The ground reference for the power supply. GND should be connected to the system ground.</td>
<td>-</td>
<td>Power</td>
</tr>
</tbody>
</table>
8 Absolute Maximum Characteristics

TBD
9 Operational Characteristics

9.1 Power supplies
TBD

9.2 Power Consumption
TBD
10 DC Electrical Characteristics

TBD
11 Environmental Specifications

TBD
12 Mechanical Drawings

12.1 SensiBLE Module: SIMBA

Figure 20 SensiBLE Top and Down View [mm]

12.2 Battery Holder: SIMBA-BAT-CR2032

Figure 21 SensiBLE Battery Holder Top and Down View [mm]
12.3 *Sensi*BLE Module with Coin Battery: SIMBA-PRO

Figure 22 SensiBLE Module with Coin Battery Side View [mm]

![Side View [mm]](image)