Bluetooth® Classic BT 3.0 modules
A Comprehensive User Guide
• Section 1. Blue Modules overview
  • Introduction, Certification, Hardware and Firmware architecture, integration mode, support tools

• Section 2. Hardware Features
  • SPBT2632C2A
  • SPBT2632C1A
  • STEVAL-SPBTxATVx

• Section 3. Software Features
  • SW Architecture, AT Commands and Configuration Variables
  • UART Configuration
  • GPIOs Configuration
  • Basic Procedures
  • SmartCable
  • Remote Mode
  • Multipoint
  • Power Modes
  • Security
  • Communication with Smart Phones
  • COD setting
  • Upgrading Firmware
Section 1
Blue Modules overview
Blue Modules characteristics

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<th>Key features</th>
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<th>SPBT2632C1A.AT2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core devices</td>
<td>STM32 ARM-Cortex-M3 MCU + STLC2690 <em>Bluetooth IC</em></td>
<td>STM32 ARM-Cortex-M3 MCU + STLC2690 <em>Bluetooth IC</em></td>
</tr>
<tr>
<td>Class</td>
<td>Class 2, typ output 0dBm</td>
<td>Class 1, typ output 10dBm</td>
</tr>
<tr>
<td>Bluetooth standard</td>
<td><em>Bluetooth 3.0</em></td>
<td><em>Bluetooth 3.0</em></td>
</tr>
<tr>
<td>SPP and AT2 command</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Antenna and shield</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Low power mode</td>
<td>with external LPO (Low Power Oscillator)</td>
<td>✓</td>
</tr>
<tr>
<td>Pin count</td>
<td>16</td>
<td>24</td>
</tr>
<tr>
<td>Form factor</td>
<td>Micro-sized: 11.6 x 13.5 mm</td>
<td>Small: 15 x 27 mm</td>
</tr>
<tr>
<td>Supply voltage range</td>
<td>2.1 ÷ 3.6 V</td>
<td>2.1 ÷ 3.6 V</td>
</tr>
<tr>
<td>Voltage regulator</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Clock integrated</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>WLAN coexistence</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Operating temperature</td>
<td>-40 ÷ 85 °C</td>
<td>-40 ÷ 85 °C</td>
</tr>
</tbody>
</table>
# Blue Modules characteristics

<table>
<thead>
<tr>
<th>Key features</th>
<th>SPBT2632C2A.AT2</th>
<th>SPBT2632C1A.AT2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High Speed CPU Mode 32 MHz</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ACL data 115 KBAud UART at max throughput (Master)</td>
<td>23 mA</td>
<td>23 mA</td>
</tr>
<tr>
<td>ACL data 115 KBAud UART at max throughput (Slave)</td>
<td>27.5 mA</td>
<td>27.5 mA</td>
</tr>
<tr>
<td>Connection, no data traffic, Master</td>
<td>9.1 mA</td>
<td>9.1 mA</td>
</tr>
<tr>
<td>Connection, no data traffic, Slave</td>
<td>11.2 mA</td>
<td>11.2 mA</td>
</tr>
<tr>
<td>Connection 375 ms sniff with LPO (Low Power Oscillator)</td>
<td>490 µA*</td>
<td>490 µA</td>
</tr>
<tr>
<td>Page/inquiry scan, without deep sleep</td>
<td>9.5 mA</td>
<td>9.5 mA</td>
</tr>
<tr>
<td>Page/inquiry scan, with deep sleep, no LPO</td>
<td>2.7 mA</td>
<td>-</td>
</tr>
<tr>
<td>Page/inquiry scan, with deep sleep and LPO</td>
<td>520 µA*</td>
<td>520 µA</td>
</tr>
<tr>
<td>Standby, without deep sleep</td>
<td>8.6 mA</td>
<td>8.6 mA</td>
</tr>
<tr>
<td>Standby with deep sleep, no LPO</td>
<td>1.7 mA</td>
<td>-</td>
</tr>
<tr>
<td>Standby with deep sleep and LPO</td>
<td>70 µA*</td>
<td>60 µA</td>
</tr>
</tbody>
</table>

* With external clock
## Blue Modules characteristics (3/3)

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<th>SPBT2632C1A.AT2</th>
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<tbody>
<tr>
<td><strong>Pin counting</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reset (NRST) pin</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Boot pin</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>4 pins for UART interface (TX, RX, CTS, RTS)</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>6x bottom pins JTAG interface (JTDI, JTD0, JTMS, JTCK, JTRST, NRST)</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>GPIOs</td>
<td>7 and LPO input</td>
<td>16</td>
</tr>
<tr>
<td>GPIO High Level</td>
<td>2.1 V</td>
<td>2.1 V</td>
</tr>
<tr>
<td><strong>Interfaces</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High speed UART</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>I²C only for Apple code processor interface</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><strong>RF characteristics</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Antenna Load</td>
<td>50 Ω</td>
<td>50 Ω</td>
</tr>
<tr>
<td>Sensitivity Level (BER &lt; 0.001 with DH5)</td>
<td>-86 dBm</td>
<td>-90 dBm</td>
</tr>
<tr>
<td>Maximum Output Power (50 Ω load)</td>
<td>0 dBm</td>
<td>+10 dBm</td>
</tr>
</tbody>
</table>
## Blue Modules - Certifications

- Blue Modules are CE and Bluetooth® certified.
- Radio type compliant for US, Canada and Japan

<table>
<thead>
<tr>
<th>Product</th>
<th>QD ID</th>
<th>CE Statement of opinion*</th>
<th>FCC and IC</th>
<th>Japan Type Certification</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPBT2632C1A.AT2</td>
<td><strong>B019224</strong></td>
<td>0447-ARAM00002</td>
<td>FCC ID: X3ZBTMOD3</td>
<td>Work in Progress</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Measurements in accordance with:</td>
<td></td>
<td></td>
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<tr>
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<td>EN 300 328 V 1.7.1 (2006-10)</td>
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<td>EN 301 489-17 V 2.1.1 (2009)</td>
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<td></td>
<td>EN 60950-1:2006</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>CE 0051  🅿️</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPBT2632C2A.AT2</td>
<td><strong>B019224</strong></td>
<td>0448-ARAM00003</td>
<td>FCC ID: X3ZBTMOD5</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Measurements in accordance with:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
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<td>EN 300 328 V 1.7.1 (2006-10)</td>
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<tr>
<td></td>
<td></td>
<td>CE 0051  🅿️</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Reports available on request
Blue Modules hardware architecture

TX Power: +10 dBm.  
RX Sensitivity: -90 dBm  
Size: 15 x 27 mm

TX Power: +0 dBm.  
RX Sensitivity: -86 dBm  
Size: 11.6 x 13.5 mm
Blue Modules firmware architecture

**Integrated Firmware**

- **AT2 Interpreter (abSerial)**
  - SPP
  - SDAP
  - iAP

**Bluetooth Protocol Stack**

- **GAP**
  - Discovers and connects to other devices
  - Security (authentication)
  - idle mode procedure: inquiry, linking, paging, connection

- **SDP**
  - Locates/describes services from/to other devices

- **SPP**
  - Emulates legacy serial communication
  - Cable replacement

- **iAP**
  - Supports communication with Apple iOS Bluetooth enabled device*

**Hardware Components**

- Bluetooth radio
- μP
- Flash RAM
- UART
- GPIOs
- Voltage regulator
- Crystal
- Antenna
- Bandpass filter
- LPO clock
- Supply Voltage
- Baseband/LC
- L2CAP
- LMP/LM
- RFCOMM
- Service Discovery Profile (SDP)
  - Emulates legacy serial communication
  - Cable replacement
- iPod Accessory Protocol (iAP)

*Apple iOS Bluetooth enabled device indicates compatibility with Apple iOS devices.
The Blue Modules Firmware integrates a layer of AT-like commands (abSerial) on top of the Bluetooth stack. They have a very simple syntax and allow Firmware configuration and Bluetooth connection management.

### Blue Modules part number

<table>
<thead>
<tr>
<th>SPBT2632C2A.AT 2</th>
<th>Class 2 profile, enhanced FW</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPBT2632C1A.AT 2</td>
<td>Class 1 profile, enhanced FW</td>
</tr>
</tbody>
</table>

#### Key features

<table>
<thead>
<tr>
<th>Feature</th>
<th>AT2 command</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bluetooth version</td>
<td>3.0</td>
</tr>
<tr>
<td>Point-to-point communication</td>
<td>✔</td>
</tr>
<tr>
<td>Multipoint communication</td>
<td>✔</td>
</tr>
<tr>
<td>Remote commands</td>
<td>✔</td>
</tr>
<tr>
<td>Sniff mode</td>
<td>✔</td>
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</table>

#### Profiles

<table>
<thead>
<tr>
<th>Profile</th>
<th>AT2 command</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPP</td>
<td>✔</td>
</tr>
<tr>
<td>iAP</td>
<td>✔</td>
</tr>
</tbody>
</table>

#### Smart Phone support

<table>
<thead>
<tr>
<th>OS</th>
<th>AT2 command</th>
</tr>
</thead>
<tbody>
<tr>
<td>Android</td>
<td>✔</td>
</tr>
<tr>
<td>iPhone</td>
<td>✔</td>
</tr>
</tbody>
</table>
Connect the Blue Modules with your favorite host processor via the UART interface.

**Integration Modes**

**PC**
- **AT commands**
- **UART**
- **SPBT2x32Cxx**
  - **USB/Serial Bridge**
  - **Bluetooth Dongle**

**Embedded System**
- **Host** (i.e. STM32F)
- **AT commands**
- **SPBT2x32Cxx**
  - **UART**
  - **Peripherals**

**Reference Design**
STEVAL-SPBTxATV3
## Order codes

<table>
<thead>
<tr>
<th>Order code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPBT2632C2A.AT2</td>
<td>Bluetooth V3.0, Class2, antenna, AT2 command Firmware</td>
</tr>
<tr>
<td>SPBT2632C1A.AT2</td>
<td>Bluetooth V3.0, Class1, antenna, AT2 command Firmware</td>
</tr>
</tbody>
</table>

## Evaluation boards

<table>
<thead>
<tr>
<th>Order code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>STEVAL-SPBT3ATV3</td>
<td>USB dongle, evaluation board for SPBT2632C2A.AT2</td>
</tr>
<tr>
<td>STEVAL-SPBT4ATV3</td>
<td>USB dongle, evaluation board for SPBT2632C1A.AT2</td>
</tr>
</tbody>
</table>

## Other tools

<table>
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<th>Technical Documentation</th>
<th>Promotional Documentation</th>
<th>Technical support</th>
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</thead>
<tbody>
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<td>Datasheets</td>
<td>Marketing presentation on <a href="http://www.st.com">www.st.com</a></td>
<td>Contact us @ <a href="mailto:onlinesupport@st.com">onlinesupport@st.com</a></td>
</tr>
<tr>
<td>Application note</td>
<td>Product briefcase on <a href="http://my.st.com">MyST</a></td>
<td></td>
</tr>
<tr>
<td>AT command user manual</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Section 2
Hardware Features
SPBT2632C2A
Hardware Features
SPBT2632C2A Hardware Features

- Bluetooth 3.0 Compliant
- Integrated Chip Antenna
- Max Output Power transmission:
  - 0 dBm
- Small form factor:
  - 11.5 x 13.5 mm
- External Communication interfaces:
  - UART
  - 7 GPIO
  - LPO
- 3.3V single supply voltage, integrated voltage regulator
- Integrated 26 MHz quartz oscillator
- Operating temperature range:
  - -40º ~ +85 ºC
SPBT2632C2A Pinout

STLC2690 (package WFBGA48)

STM32F103 (package BGA64)

7 Configurable GPIOs

I²C (MFI only)

I²C (Alt config for MFI only)

UART Interface
## SPBT2632C2A Characterization Figures

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Voltage, Vin</td>
<td>---</td>
<td>+2.1</td>
<td>+2.5</td>
<td>+3.6</td>
<td>V</td>
</tr>
<tr>
<td>Operating Temperature Range</td>
<td>---</td>
<td>-40</td>
<td>---</td>
<td>+85</td>
<td>°C</td>
</tr>
<tr>
<td>Signal Pin Voltage</td>
<td>---</td>
<td>---</td>
<td>+2.1</td>
<td>---</td>
<td>V</td>
</tr>
<tr>
<td>Radio Rec. Sensitivity Level</td>
<td>BER &lt; 0.001 with DH5</td>
<td>---</td>
<td>-86</td>
<td>---</td>
<td>dBm</td>
</tr>
<tr>
<td>Radio Transmitter Output Power</td>
<td>50 Ω Load</td>
<td>---</td>
<td>0</td>
<td>---</td>
<td>dBm</td>
</tr>
</tbody>
</table>

### Power Consumption. High Speed CPU Mode: 32 MHz

<table>
<thead>
<tr>
<th>Condition</th>
<th>Average</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACL data 115 KBaud UART at Max throughput (Master)</td>
<td>23</td>
<td>mA</td>
</tr>
<tr>
<td>ACL data 115 KBaud UART at Max throughput (Slave)</td>
<td>27.5</td>
<td>mA</td>
</tr>
<tr>
<td>Connection, no data traffic, Master</td>
<td>9.1</td>
<td>mA</td>
</tr>
<tr>
<td>Connection, no data traffic, Slave</td>
<td>11.2</td>
<td>mA</td>
</tr>
<tr>
<td>Connection 375 ms sniff (external LPO required)</td>
<td>490</td>
<td>µA</td>
</tr>
<tr>
<td>Standby, (page/inquiry scan), without deep sleep</td>
<td>8.6 (9.5)</td>
<td>mA</td>
</tr>
<tr>
<td>Standby, (page/inquiry scan), with deep sleep, no external LPO</td>
<td>1.7 (2.7)</td>
<td>mA</td>
</tr>
<tr>
<td>Standby, (page/inquiry scan), with deep sleep, with external LPO</td>
<td>70 (520)</td>
<td>µA</td>
</tr>
</tbody>
</table>
SPBT2632C2A Characterization with External Low Power Oscillator (1/2)

- **LPO: Low Power Oscillator**
  (32.768kHz External clock, Tolerance: ±150ppm)

- LPO is connected to the CPU and Radio IC.

- LPO standard of Radio IC ($V_{DD} = 1.8V$) is:
  - Duty cycle: min 40%, max 60%
  - Low level Input Voltage ($V_{IL}$): Min = 0, Max = 0.5V
  - High level Input Voltage ($V_{IH}$): Min = 1.2V, Max = 1.8V

- On the other hand, CPU STM32F103 ($V_{DD} = 2.1V$) is:
  - Duty cycle: Min 30%, Max 70%
  - Low level Input Voltage ($V_{IL}$): Min = $V_{SS}$, Max = 0.3 $V_{DD}$
  - High level Input Voltage ($V_{IH}$): Min = 0.7$V_{DD}$, Max = $V_{DD}$
CPU power supply is supplied from the 2.1V LDO in the module. Therefore, $0.7 \times V_{DD} = 0.7 \times 2.1 = 1.47\,V$ ($V_{IH\text{ Min}}$) next, $V_{IH}$ is dominated by the MCU side.

- **Specification of LPO that satisfies the standards of both:**
  - Duty cycle: Min 40%, Max 60%
  - Low level Input Voltage ($V_{IL}$): Min = 0, Max = 0.5V
  - High level Input Voltage ($V_{IH}$): Min = 1.47V, Max = 1.8V

- **LPO operation check method:**
  Put to Sniff mode, connected by state without communication for 10 minutes (Sniff mode), if it is maintained, it becomes the LPO judgment OK
SPBT2632C1A
Hardware Features
• Bluetooth 3.0 Compliant
• Integrated Chip Antenna
• Max Output Power transmission:
  • +10 dBm
• Small form factor:
  • 15 x 27 mm
• External Communication interfaces:
  • UART
  • 16 Configurable GPIOs
• 3.3V single supply voltage, integrated voltage regulator
• Integrated 26 MHz and 32 kHz quartz oscillators
• Operating temperature range:
  • -40º ~ +85 ºC
SPBT2632C1A Pinout

STM32F103 (package BGA64)

Shield

UART Interface

I2C (MFI only)

16 Configurable GPIOs
### Parameter

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<tr>
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<td>Radio Transmitter Output Power</td>
<td>50 Ω Load</td>
<td>---</td>
<td>---</td>
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### Power Consumption. High Speed CPU Mode: 32 MHz

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<td>70 (520)</td>
<td>μA</td>
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STEVAL-SPBTxATV
Hardware Features
Example: STEVAL-SPBT3ATV3

- Plug&Play Solution
- Reference designs and evaluation boards
- Evaluation tool of the integrated abSerial AT-like commands layer (abSerial)
- Power Supplied via the USB interface
- Compact and Small form factor
- LEDS connected to GPIO for testing purposes
- UART/USB bridge from Silicon Lab requires to install the correspondent driver on your PC

Refer to the related Application Notes to get started with schematics and basic procedures
SPBT2632C2A Reference Design
STEVAL-SPBT3ATV3 BOM, Gerber and Schematic available on the ST website.
See detailed information and schematic in the

Application Note: AN4127
«Demonstration board for Bluetooth® module class 2 SBT2632C2A.AT2»
STEVAL-SPBT4ATV3

SPBT2632C1A Reference Design
STEVAL-SPBT4ATV3 BOM, Gerber and Schematic available on the ST website.
See detailed information and schematic in the

Application Note: AN4128
«Demonstration board for Bluetooth® module class 1 SBT2632C1A.AT2»
Section 3
Software Features
Software Architecture, AT Commands and Configuration Variables
Modes of Operation

- The Firmware supports Multiple Modes of Operation:
  - Command Mode
  - Bypass Mode
  - Remote Mode
  - Sniff Mode
  - Deep Sleep Mode
  - Multipoint/Broadcast Mode

- Commands and Responses are handled only while the application is in Command Mode

- In Bypass Mode the data stream is transferred directly from the UART and the Bluetooth SPP

- In Remote Mode a node can be remotely configured (only in AT2)

- Sniff Mode is a low power consumption operation mode (only in AT2)

- Deep Sleep Mode is a low power consumption status mode

- Multipoint/Broadcast Mode manages connections between a master and multiple slaves
Operation Flow

Module is not connected

- Configure
- Bonding
- Device Discovery

Module is connected

- Deep Sleep Mode
- Sniff Mode
- Remote Mode
- Multipoint Broadcast Mode

Data Transfer Mode
  - SPP Profile Usage -

StandBy CommandMode/

Connect with Remote Device

Active ByPassMode/

Smart Cable

ByPass

Escape from Bypass Mode

Active CommandMode/

Disconnect

Configure
### AT2 Commands

<table>
<thead>
<tr>
<th>Category</th>
<th>List of Commands</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Reset</strong></td>
<td>Reset</td>
</tr>
<tr>
<td><strong>Device Information</strong></td>
<td>BtcVersion, Build, DefaultLocalName, LocalName, GetBdAddress, Version</td>
</tr>
<tr>
<td><strong>GPIO Use</strong></td>
<td>GPIOConfig, GPIORead, GPIOWrite</td>
</tr>
<tr>
<td><strong>Serial Configuration</strong></td>
<td>ChangeBaud, ChangeDefaultBaud, HostEvent, StreamingSerial</td>
</tr>
<tr>
<td><strong>Mode management</strong></td>
<td>Escape Seq. ^#%$^%, Remote Commands Seq. @#%@@@% Bypass</td>
</tr>
<tr>
<td><strong>Device Discovery</strong></td>
<td>Discovery</td>
</tr>
</tbody>
</table>

### List of Commands

<table>
<thead>
<tr>
<th>Category</th>
<th>List of Commands</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bonding</strong></td>
<td>Bond, DisableBond, EnableBond, EraseBondTable, ShowDev</td>
</tr>
<tr>
<td><strong>Connection</strong></td>
<td>SPP(Dis)Connect, LinkDisconnect, SmartCableSetup, DeleteSmartCable, IAP(Dis)Connect, RoleSwitch, PassKeyAccept, ReadClock</td>
</tr>
<tr>
<td><strong>Configuration</strong></td>
<td>Config, Cptest</td>
</tr>
<tr>
<td><strong>Page/Inquiry timing</strong></td>
<td>UpdateInquiryScan, UpdatePageScan</td>
</tr>
<tr>
<td><strong>SleepModes</strong></td>
<td>(Exit)Sniff</td>
</tr>
</tbody>
</table>

The list and syntax of AT2 Commands are described in the User Manual UM1547.
# AT(2) Configuration Variables

<table>
<thead>
<tr>
<th>Category</th>
<th>List of Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Device Information</strong></td>
<td>BuildVersion BD_ADDR DeviceName COD</td>
</tr>
<tr>
<td><strong>UART Configuration</strong></td>
<td>Streaming Serial UartBaudRate UartParity UartDataBits UartStopBits UartTimeout HostEvents</td>
</tr>
<tr>
<td><strong>Hardware Configuration</strong></td>
<td>CpuMHz HciBaudRate SPIEnable SPIMode I2CEnable UseExtLPO HSE_MHz *</td>
</tr>
<tr>
<td><strong>Security</strong></td>
<td>PIN BondingAllowed EnableEncryption DefaultSecurity DefaultAuthentication MITMEvent</td>
</tr>
<tr>
<td><strong>Power Modes</strong></td>
<td>AutoSniff AutoSniffTimeout AutoSniffInterval HostShallowSleepEnable HostDeepSleepEnable GPIO_HostKeepAwake GPIO_HostWakeup AllowSniff</td>
</tr>
<tr>
<td><strong>Mode</strong></td>
<td>MPMode RmtEscapeSequence</td>
</tr>
<tr>
<td><strong>Radio</strong></td>
<td>UseSmallPackets EnableAFH EnablePowerControl QoS_latency PageScan InquiryScan</td>
</tr>
<tr>
<td><strong>Smartphones</strong></td>
<td>EnableIAP IAPAppID iAPProtocolStrMain iAPProtocolStrAlt CPI2CMode SPP128UUID AltCPIGPIO</td>
</tr>
<tr>
<td><strong>Smartphone hidden variables</strong></td>
<td>AccName AccManufacturer AccModelNumber AccSerialNumber</td>
</tr>
<tr>
<td><strong>Others</strong></td>
<td>ATReply</td>
</tr>
</tbody>
</table>

The complete list for AT2 Configuration Variables and their default values are described in the User Manual UM1547.
UART Configuration
UART Configuration

The module allows to connect an external Host Processor via the UART interface.

Four signals are provided with the UART interface. The TXD and RXD are used for data while the CTS and RTS pins are used for the Hardware flow control.

- The **baud rate** is configurable in the **1200-921600** range of values. It can be changed by using the correspondent variables or at commands.
- Default serial port configuration is **115200/8/n/1**. The correspondent variables can be used to change the UART parameters.
- To enable the use of the flow control the **streamingserial** variable/command can be used.
GPIO Configuration
The integrated Firmware configures the GPIOs as in the following table.

- **Active Status Probe (MCU RUN):** always on when the radio is in active mode; Blinking when the radio is in deep sleep mode
- **Connection Status Probe:** always on when the module is connected

<table>
<thead>
<tr>
<th></th>
<th>GPIO1</th>
<th>GPIO2</th>
<th>GPIO3</th>
<th>GPIO4</th>
<th>GPIO5:GPIO7</th>
<th>GPIO8:GPIO16</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPBT2632C2A</td>
<td>Output/Connection Status Probe</td>
<td>Input/ Pulled-down BOOT</td>
<td>Input/ Pulled-down</td>
<td>Output/ Active Status Probe</td>
<td>Input/ Pulled-down</td>
<td>---</td>
</tr>
<tr>
<td>SPBT2632C1A</td>
<td>Output/ Connection Status Probe</td>
<td>Input/ Pulled-down BOOT</td>
<td>Input/ Pulled-down</td>
<td>Output/ Active Status Probe</td>
<td>Input/ Pulled-down</td>
<td>Input/ Pulled-up</td>
</tr>
</tbody>
</table>

- GPIOs can be reconfigured with the following commands
  - `AT+AB gpioconfig [GPIO pin] [I/O]`
  - `AT+AB gpioRead  [GPIO pin]`
  - `AT+AB gpioWrite [GPIO pin] [1/0]`

- **Special Use.** In the modules SPBT2632C1A the GPIO11 and GPIO12 can be also reconfigured as I²C clock and I²C data for integration of an MFI coprocessor
Basic Procedures
Device Discovery Procedure

Host

Device 0

Module

Device 1

Device n

AT+AB Discovery

AT−AB DiscoveryPending

AT−AB DiscoveryPending n

Command Mode - Not Connected

Setup

Inquiry Response 1

Inquiry Response n

Page Dev1

Page Success

Name Req Procedure

Disconnect

AT−AB Device “BDAddr1” “Name1”

Name Req is repeated for Device 2

Up to 10 devices
Device Discovery Allowed

- Var35 InquiryScan = True (module Discoverable)
- Var35 InquiryScan = False (module Non-discoverable)

Var35 InquiryScan

- True (default)
  - Discoverable (Visible in the device discovery of the host)
    - AT Command: UpdateInquiryScan 0

- False
  - Non-discoverable (Not visible in the device discovery of the host)
    - AT Command: UpdateInquiryScan 2

¹ Please refer to User Manual for AT command details
Bonding Procedure

- Bonding is used for device pairing. The bonding effect is the generation of an encryption LinkKey.
- By default, modules are configured with bonding allowed, meaning the device is always allowed to accept bonding request.
• Var33 BondingAllowed = True (automatically allow Bond)
• Var33 BondingAllowed = False (Bond not allowed)

Pairing (Bond) from the new Bluetooth Device is not allowed.
It is possible SPP/iAP Connect for devices already stored into the bonding table.

1 Please refer to User Manual for AT command details
Connection with a Remote Device

Procedure

Host

Module

Device A

Device B

Device A

Device B

AT+AB SPPConnect BDAddrB

AT-AB – BypassMode -

AT-AB ConnectionUp

SPP Connection Established

Command Mode- Not Connected

Setup

ByPass Mode - Connected

Data Exchange

Setup

Command Mode- Not Connected

AT-AB ConnectionUp

AT-AB – BypassMode -
Connection Allowed

- Var34 PageScan = True (module Connectable)
- Var34 PageScan = False (module Non-connectable)

AT Command: UpdatePageScan 0¹

AT Command: UpdatePageScan 1¹

¹ Please refer to User Manual for AT command details
Once a connection has been established between host and remote device, the host can put the abSerial interface back into command mode by using the Escape Sequence. Once back in command mode, new commands can be issued.
Disconnect with a Remote Device Procedure

Device A

Host

Module

Device B

Host B

ByPass Mode - Connected

Data Exchange

Command Mode - Connected

SPP Connection Down

Not Connected

AT-AB SPPConnectionClosed

AT-AB ConnectionDown

AT-AB -CommandMode-

AT+AB SPPDisconnect

^#^$^%
SmartCable
**The Smart Cable feature establishes an SPP link to the designed remote device automatically and at the startup time**

- **Replace the need for AT connection commands**
- **If a link is disconnected, The Smart cable feature will automatically reconnect the link without user interaction**
- **Enabled with the command**
  
  **AT+AB SmartCableSetup [bd address] [attempts] [interval]**
  
  - The Bdaddress of the designed remote device is saved in the NV memory
  - The feature is active after a reset
  - Attempts and Interval define the paging options of the companion device
- **AT+AB DeleteSmartCable command removes the Smart Cable settings**

Remote Companion Device
BDAddress: 12345678

AT+AB smartcablessetup 12345678 10 100
Allows this device to automatically connect with the remote companion at the startup with no user interaction
Remote Mode
Remote Mode

- A remote device can be controlled and configured by a BlueTooth link
- This function is typically used to remotely configure UART or GPIOS of a Remote Device
- The Remote Mode Feature is enabled starting from the AT2 version of the firmware

To enable a remote node to be remotely controlled the following variable must be set:

\[ \text{RmtEscapeSequence} = \text{true} \]
Multipoint
AT2 enables multipoint or broadcast connection modes to handle connections between a master and multiple slaves

- To select a connection mode the configuration variable **MPMode** must be used

<table>
<thead>
<tr>
<th>MPMode Variable</th>
<th>Use Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>MPMode = 0 (Def.)</td>
<td>Point To Point</td>
</tr>
<tr>
<td>MPMode = 1</td>
<td>Multipoint</td>
</tr>
<tr>
<td>MPMode = 2</td>
<td>Broadcast</td>
</tr>
</tbody>
</table>

- Use Multipoint when a message needs to be sent to multiple slaves uniquely identified by an ID. When a message is sent by a slave to the master, it is also uniquely identified by the ID of the sender. An header defined by the protocol described in the following table is used with each packet of data

<table>
<thead>
<tr>
<th>Dest/Source Node</th>
<th>Length</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 byte</td>
<td>3 bytes</td>
<td>Up to 315 bytes</td>
</tr>
<tr>
<td>Node Id from 0 to 9, 1 ASCII decimal digit</td>
<td>3 ASCII decimal digit from 001 to 315</td>
<td>Up to 315 bytes</td>
</tr>
</tbody>
</table>

- Use Broadcast when a message needs to be broadcasted to multiple slaves.
AT2: Broadcast and Multipoint Use Modes (2/2)

### Multipoint

- **Master**
  - MPMode=1
  - 1- Node ID 0 → Slave1
  - 2- Node ID 1 → Slave2

- **Slave1**
  - MPMode=0
  - 1- ID0 → Master

- **Slave2**
  - MPMode=0
  - 2- ID1 → Master

### Broadcast

- **Master**
  - MPMode=2
  - 1- Node ID 0 → Slave1
  - 2- Node ID 1 → Slave2

- **Slave1**
  - MPMode=0
  - 1- ID0 → Master

- **Slave2**
  - MPMode=0
  - 2- ID1 → Master

---

- **Actions**
  - 1 - Sppconnect Slave1Addr
  - 2 - Sppconnect Slave2Addr
  - 3
  - 5 - SppDisconnect 0
  - 6 - SppDisconnect 0

Power Modes
• **Active Mode**
  - Standard mode operation

• **Sniff Mode**
  - Sniffing is a process of listening for specific types of commands that occur periodically. The sniff mode is used to reduce the power consumption of the device as the receiver can be put into standby between sniff cycles.
  - Requiring the use of an LPO, sleep mode is supported only by the modules SPBT2632C2A.AT2 and SPBT2632C1A.AT2
  - Sniff mode requires to set few dedicated configuration variables. It can be remotely activated with commands or can be automatically activated at the connection time.

• **Deep Sleep Mode**
  - The Deep Sleep Mode temporarily halts the BT controller chip’s operation by stopping the 26 MHz main crystal.
  - Deep Sleep is activated by setting related configuration variables.
  - Scheduled CPU activity, timers, remote link activity, and GPIO wakeup will resume active mode.
The use of DSM and Sniff are enabled via the following set of Configuration Variables and Commands

<table>
<thead>
<tr>
<th>Variable/Command</th>
<th>Impacted Power Mode</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>HostDeepSleepEnable</td>
<td>DSM/Sniff</td>
<td>Enables deep sleep mode. Mandatory for DSM. Advised for the Sniff Mode.</td>
</tr>
<tr>
<td>GPIO_HostWakeUp</td>
<td>DSM</td>
<td>GPIO register used to wake-up the module after it enters deep sleep mode. A setting of none means that this function is disabled.</td>
</tr>
<tr>
<td>GPIO_HostKeepAwake</td>
<td>DSM</td>
<td>GPIO register used to prevent the module from entering deep sleep mode. A setting of none means that this function is disabled.</td>
</tr>
<tr>
<td>AllowSniff</td>
<td>Sniff</td>
<td>Enables Sniff Mode</td>
</tr>
<tr>
<td>AutoSniff</td>
<td>Sniff</td>
<td>Enables automatic Sniff Mode</td>
</tr>
<tr>
<td>AutoSniffTimeout</td>
<td>Sniff</td>
<td>The inactivity timeout in seconds. After this time passed, Starts AutoSniff</td>
</tr>
<tr>
<td>AutoSniffInterval</td>
<td>Sniff</td>
<td>Sniff Slot interval applied AutoSniff</td>
</tr>
<tr>
<td>UseExtLPO</td>
<td>DSM/Sniff</td>
<td>A 32.768kHz low power oscillator needs to be connected to enable Sniff Mode</td>
</tr>
<tr>
<td>AT+AB sniff [BDAddress] [Sniff Int]</td>
<td>Sniff</td>
<td>Used to switch a remote device from active mode to sniff mode</td>
</tr>
<tr>
<td>AT+AB exit sniff [BDAddress]</td>
<td>Sniff</td>
<td>Used to switch a remote device from sniff mode to active mode</td>
</tr>
</tbody>
</table>
Deep Sleep WakeUp

- GPIO WakeUp. abSerial supports the GPIO-based Deep Sleep Wakeup
  - For example, the following variable configuration set GPIO3 to be used with this purpose.

    AT+AB config GPIO_HostWakeUp = 3
    AT+AB config GPIO_HostKeepAwake = 3
    AT+AB config HostDeepSleepEnable = true

- The DSM will be enabled as long as the GPIO3 is maintained low.

- **Radio WakeUp.** When DSM is activated the module is still able to accept a connection request from a remote device.

- If a connection request is received the module goes awake and return to sleep when the connection is closed.
Sniff mode

• To enter in Sniff mode Deep sleep variable must be configured as per following table
  • For example, the following variable configuration set GPIO3 to be used with this purpose.
    
    | Command                                      | Setting                  |
    |----------------------------------------------|--------------------------|
    | AT+AB config GPIO_HostWakeUp                 | 3                        |
    | AT+AB config GPIO_HostKeepAwake              | 3                        |
    | AT+AB config HostDeepSleepEnable             | true                     |

• The DSM will be enabled as long as the GPIO3 is maintained low

• To enter in sniff mode, once deep sleep mode is active, the variable allowsniff must be true

• The sniff can be automatic or enabled via AT command
  1. Automatic: the variable autosniff is set true
  2. Manual: the module is set into sniff mode using the command AT+AB sniff [Bdaddress of the device to be placed into Sniff Mode]
**ACTIVE MODE**

Configuration Summary
- HostDeepSleepEnable = false
- GPIO_HostKeepAwake = none
- GPIO_HostWakeup = none
- AllowSniff = false

---

**DEEP SLEEP MODE**

Configuration Summary
- HostDeepSleepEnable = true
- GPIO_HostKeepAwake = 3
- GPIO_HostWakeup = 3
- AllowSniff = false

---

**SNIFF MODE**

Configuration Summary
- HostDeepSleepEnable = true
- GPIO_HostKeepAwake = 3
- GPIO_HostWakeup = 3
- AllowSniff = true
- UseExtLPO=true

The values refer to an SPBT2632C1A.AT2; Slave Mode; CPU Speed: 32MHz; LPO Enabled
Security
• To maintain security, Bluetooth devices can use keys to verify the identity of other devices (Pairing/Authentication) and to modify data to make the data private (Encryption)

• Blue Modules implement the Bluetooth 2.1 security features for the Authentication and the Encryption

• When Paired with companion devices, Blue Modules support:
  • **Legacy Pairing** with 2.0 or earlier Bluetooth versions
  • **Secure Simple Pairing** with 2.1 or newer Bluetooth versions
Security features in Blue Modules are managed with a set of configuration variables:

- **AlwaysBonding** (boolean) to establish device connectability
- **PIN**: PIN used when pairing is required by a companion device (only for communication with 2.0 or earlier deprecated Bluetooth devices)
- **DefaultSecurity**: Establishes the security level i.e. the authentication level with a companion device.
  - **Possible Values**:
    - 1 - No Security;
    - 2/3 - Legacy Security for 2.0/earlier Bluetooth devices (deprecated)
    - 4 - SSP enabled. This value also supports legacy pairing with Bluetooth 2.0/earlier
- **Encryption**: (Boolean) Establishes if an encryption key is used
- **DefaultAuthentication**: establishes which level of SSP authentication is enabled.
  - **Possible Values**:
    - 4. SSP Just Works (no MITM protection)
    - 5. SSP pairing modes (with MITM protection setting the variable MITMEvent true)
## AT2 Default Security Configuration

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Variable Number</th>
<th>Default Value</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>BondingAllowed</td>
<td>Var33</td>
<td>True</td>
<td>Device is always connectable</td>
</tr>
<tr>
<td>Pin</td>
<td>Var06</td>
<td>1234</td>
<td>Used only when connection is with 2.0 devices or earlier</td>
</tr>
<tr>
<td>DefaultSecurity</td>
<td>Var40</td>
<td>4</td>
<td>SSP enabled</td>
</tr>
<tr>
<td>DefaultAuthentication</td>
<td>Var41</td>
<td>5</td>
<td>MITM protection by asking for a confirmation message during pairing</td>
</tr>
<tr>
<td>MIMTEvent</td>
<td>Var55</td>
<td>False</td>
<td>Sends pairing passkey to the main UART</td>
</tr>
<tr>
<td>EnableEncryption</td>
<td>Var39</td>
<td>True</td>
<td>Encryption Key is used</td>
</tr>
</tbody>
</table>
Communication with Smart Phones
Communication with Smart Phones

- AT2 supports communication with Smart Phone, i.e. Android and Apple devices
- Supporting Apple iPhone and other iOS Bluetooth data oriented connections requires a proprietary profile called iAP
- MFI is a licensing program from Apple, to develop electronic accessories that connect to iPod, iPhone, and iPad
- Apple Accessory devices must utilize an iPod Authentication Co-processor (CP)
- Blue Modules are MFI ready and fully integrate the IAP protocol
- The MFI Apple Co-processor connected via the I2C pins

AT2 implements both the MFI protocol and the iAP profile

- Buy the chipset from Apple
  - v2.0B chip Renesas SO8
  - v2.0C chip Infineon USON8
- Set the CPI2CMode Variable of the module
  - CPI2CMode = 2 for v2.0B
  - 3 for v2.0C
### Configuration for communication with iAP Devices

#### Commands/Configuration Variables

<table>
<thead>
<tr>
<th>Commands/Configuration Variables</th>
<th>Use/Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AT2 Configuration</strong></td>
<td></td>
</tr>
<tr>
<td>COD</td>
<td>240404</td>
</tr>
<tr>
<td>EnableEncryption</td>
<td>true</td>
</tr>
<tr>
<td>DefaultSecurity</td>
<td>4</td>
</tr>
<tr>
<td>EnableIAP</td>
<td>true</td>
</tr>
<tr>
<td><strong>Application Customization</strong></td>
<td></td>
</tr>
<tr>
<td>iAPAppID</td>
<td>A1B2C3D4E5</td>
</tr>
<tr>
<td>iAPProtocolStrmain</td>
<td>Com.AmpedRFTech.Demo</td>
</tr>
<tr>
<td>iAPProtocolStrAlt</td>
<td>Com.AmpedRFTech.ProtocolAlt</td>
</tr>
<tr>
<td>CPI2CMode</td>
<td>3 (MFI Coprocessor v2.0c)</td>
</tr>
<tr>
<td>AccName</td>
<td>Amped-Test</td>
</tr>
<tr>
<td>AccManufacturer</td>
<td>Amped RF</td>
</tr>
<tr>
<td>AccModelNumber</td>
<td>Test-Model</td>
</tr>
<tr>
<td>AccSerialNumber</td>
<td>Amp’ed Up!</td>
</tr>
<tr>
<td><strong>iAP Commands</strong></td>
<td></td>
</tr>
<tr>
<td>AT+AB IAPConnect [BDAddress]</td>
<td>To connect a remote device with the IAP profile</td>
</tr>
<tr>
<td>AT+AB IAPDisconnect</td>
<td>To disconnect from a IAP session</td>
</tr>
</tbody>
</table>
Communication Speed

- **SPP Connect**
  - Actual value up to 500Kbps

- **iAP Connect**
  - **Max speed theoretically possible:**
    - iPhone4/iPad2: up to 100Kbps
    - iPhone4S/iPad3: up to 250Kbps
    - iPhone5/iPad4(mini): up to 250Kbps
  - **Actual value (BTM ➔ Apple):**
    - iPad3: up to 150Kbps
    - iPad1: up to 90Kbps
CoD setting
CoD setting

• CoD (Class of Device) is set by default 240404 corresponding to headset device

• The CoD can be changed using the AT command

• AT+AB config var30= [CoD]

• CoD value list can be retrieved at SIG website: [https://www.bluetooth.org/en-us/specification/assigned-numbers/baseband](https://www.bluetooth.org/en-us/specification/assigned-numbers/baseband)
Upgrading Firmware
Upgrading Firmware Procedure

The Firmware on the Bluetooth nodes can be upgraded for bug fixing or for taking advantage of the introduction of new features. The Firmware upgrading is enabled via the UART interface of the module.
Firmware Upgrading Procedure

Different options are possible to upgrade the Firmware from the host via the UART

- The recommend procedure is using the AT command
  - AT+AB InvalidateApplication
  - And follow instruction on next slide

- Alternative procedures
  - Using the Flash Bootloader (based on the Y-Modem protocol) of the STM32
    - The Flash Bootloader is activated in two different ways:
      - Acting on the GPIO2 pin of the module
      - Using a special-purpose at-command
    - It can be used/tested by using the Y-Modem transmitter function integrated in the Hyperterminal or other terminal tool
Upgrading with the Flash Loader – AT command

- **User FLOW Description:**
  - Insert the dongle in a USB slot of the PC
  - Open an HyperTerminal (115200:8:none:1:none)
  - Send the command “AT+AB InvalidateApplication
    (it deletes the abSerial application currently running on the module)
  - The module enters the boot state presenting the Main menu choices
  - Select option 1 (download application image)
  - Use the Y-modem function integrated in the HyperTerminal and select the file to download
  - The process Terminates with “Programming Completed Successfully!”
  - Reset the module
Upgrading with the Flash Loader - GPIO2

- **User FLOW Description**
  - Put the GPIO2 to 0 (use a jumper between the dongle PADs, for STEVAL-SPBT3ATV3 PAD4 and 9, for STEVAL-SPBT4ATV3 PAD5 and 13) for details refer to module application note
  - Insert the dongle in a slot
  - Open an HyperTerminal on the PC (115200:8:none:1)
  - Reset the module
  - The module enters in the boot state and three different Main menu choices are presented
  - In 5 seconds select option 1 (download application image) otherwise the module automatically enters the option 2 (execute application)
  - Use the Y-modem function integrated in the HyperTerminal by selecting the image file to download
  - The process terminates with “Programming Completed Successfully!”
  - Remove the jumper
  - Reset the module
Thank you