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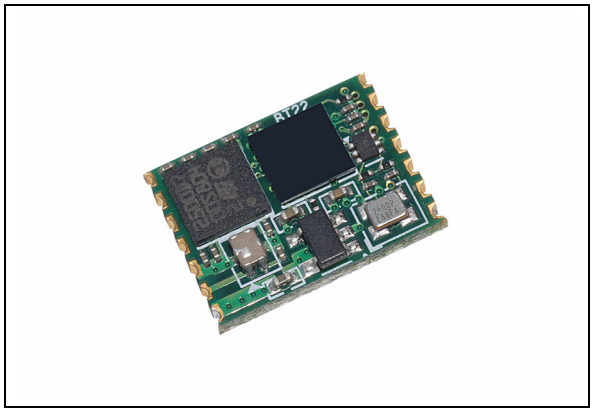
SPBT2532C2.AT

Bluetooth® technology class-2 module

Features

- Bluetooth® specification compliant V2.1
- Output power class-2
- Transmission rate up to 2 Mbps with EDR
- Packet types supported:
  - ACL: DM1, DM3, DM5, DH1, DH3, DH5, 2-DH1, 2-DH3, 2-DH5
- Adaptive frequency hopping (AFH)
- Efficient and flexible support for WLAN coexistence in collocated scenario
- Communication interfaces and I/Os:
  - Fast UART up to 3.25 Mbit/s
  - 4 general purpose I/O
- User interface:
  - AT command set
- Memory:
  - 256 Kbytes Flash memory
  - 48 Kbytes RAM memory
- 3.3 V single supply voltage
- No external oscillator required
- Module size: 10.5 x 13.5 mm



Description

The SPBT2532C2.AT is a micro-sized Bluetooth module, designed to ensure maximum performance in a minimum space. It includes all the functions, and only those, required for a wireless modem. Even the pin count is optimized, including supply input, UART and 4 GPIOs for AT command communication.

Alternative I/Os configuration is possible but only default configuration is compatible with AT command.

Embedded Bluetooth AT firmware implements all Bluetooth core protocols and serial port profile (SPP) to replicate UART data traffic over a Bluetooth link. The module can be fully controlled using AT commands. SW is embedded inside the micro re-programmable Flash memory.

Contents

1 RoHS compliance

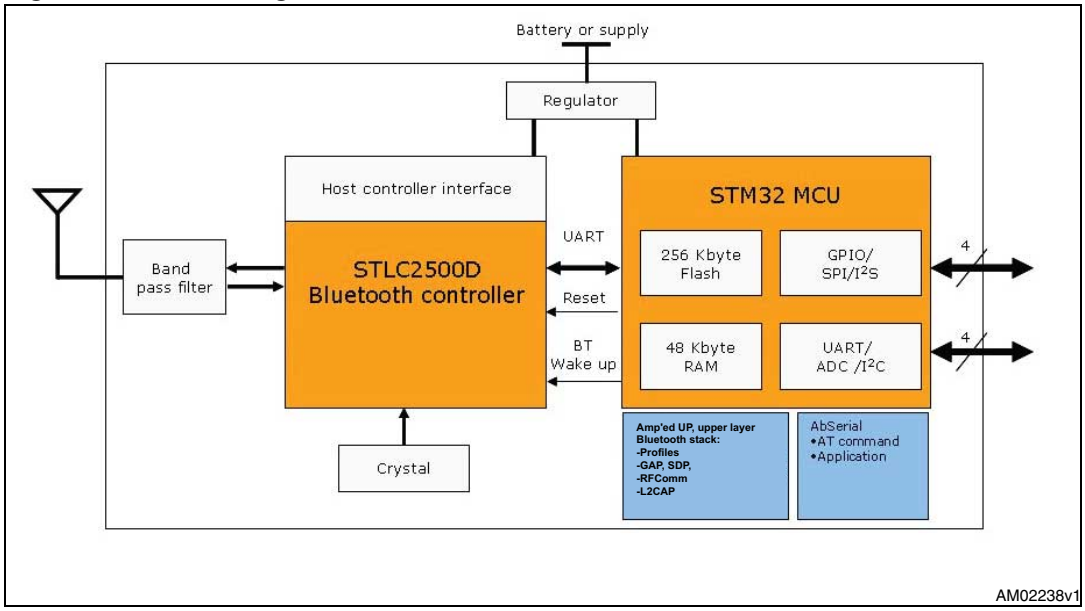
ST modules are RoHS compliant and being based on ST devices comply with ECOPACK® norms implemented by ST.

2 Application

- Serial cable replacement
- Industrial control
- Data acquisition equipment
- Machine control
- Sensor monitoring
- Security control

3 Block diagram

Figure 1. Block diagram



4 Electrical characteristics

4.1 Absolute maximum ratings

Table 1. Absolute maximum ratings

Rating	Min	Typ	Max	Unit
Storage temperature range	-55	-	+105	C
Supply voltage, V_{IN}	-0.3	-	+ 5.0	V
RF input power	-	-	+10	dBm
Input voltage on 5 V tolerant pin	-0.3	-	+5.5	V
Input voltage on non-5 V tolerant pin	-0.3	-	+4.0	V

4.2 Operating ranges

Operating ranges define the limits for functional operation and parametric characteristics of the module.

Functionality outside these limits is not implied

Table 2. Operating ranges

Rating	Min	Typ	Max	Unit
Operating temperature rating @ CPU 32MHz – 16MHz	-40	-	55	°C
Operating temperature rating @ CPU 8MHz	-40	-	85	°C
Supply voltage V_{IN}	2.8	3.0	3.6	V
Signal pin voltage	-	3.0	-	V
RF frequency	2400	-	2483.5	MHz

4.3 Power consumption

- CPU 32MHz, maximum operating temperature 55°C
- UART supports up to 921 Kbps
- Data throughput up to 2 Mbps

Table 3. High speed CPU mode

Modes	Avg	Unit
Typical power consumption		
ACL data 115 KBaud UART at max throughput (Master)	41.0	mA
ACL data 115 KBaud UART at max throughput (Slave)	41.0	mA
Connection, no data traffic, master	28.9	mA
Connection, no data traffic, slave	34.5	mA
Standby, and page/inquiry scan, without deep sleep	28.0	mA
Standby, and page/inquiry scan, with deep sleep	3.1	mA

4.4 DC I/O specification

Table 4. DC input / output specification

Symbol	Parameter	Conditions	Min	Max	Unit
V_{IL}	Low-level input voltage	V_{IN} = 3.0 V (pin 8)	-	0.9	V
V_{IH}	High-level input voltage	V_{IN} = 3.0 V (pin 8)	2.1	-	
V_{OL}	Low-level output voltage	V_{IN} = 3.0 V (pin 8)	-	0.4	
V_{OH}	High-level output voltage	V_{IN} = 3.0 V (pin 8)	2.2	-	
I_{OL}	Low-level output current	V_{OL} = 0.4 V	-	4.0	mA
I_{OH}	High-level output current	V_{OH} = 2.2 V	-	4.0	
R_{PU}	Pull-up resistor	Resistor turned on	80	120	kΩ
R_{PD}	Pull-down resistor	Resistor turned on	80	120	

5 Bluetooth parameters

5.1 RF performance characteristics

In the performance characteristics table the following applies:

- Test condition: nominal
- Voltage: typical, V_{IN} = 3.0 V
- Temperature: typical T_A = 25 °C

Table 5. RF performance characteristics

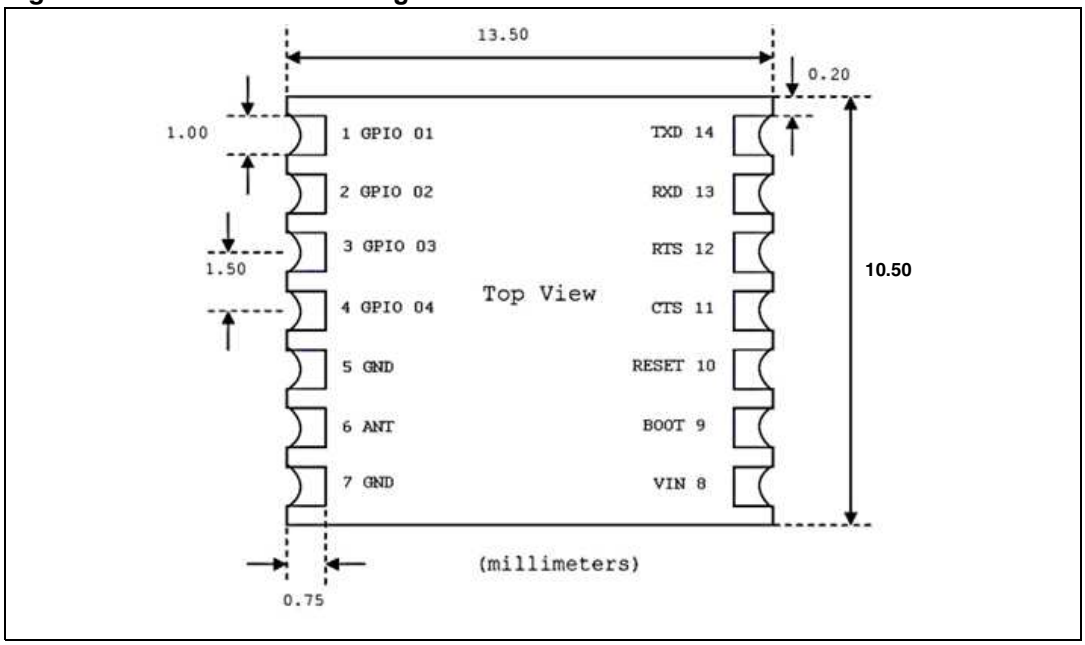
Parameters	Conditions	BT spec	Typical	Unit
Antenna load			50	Ω
Radio receiver				
Sensitivity level	BER < 0.001 with DH5	-70	-85	dBm
Maximum usable level	BER < 0.001 with DH1	-20	+8	dBm
Input VSWR			2.5:1	
Radio transmitter				
Output power	50 load	-6 to +4	+2	dBm
Initial carrier frequency tolerance		±75	±30	kHz
20 dB bandwidth for modulated carrier		≤1000	930	kHz

Note: For more complete data, please refer to STM STLC2500D datasheet.

6 Pin settings

6.1 Pin connections

Figure 2. Pin connection diagram



6.2 Pin description

Table 6. Pin description

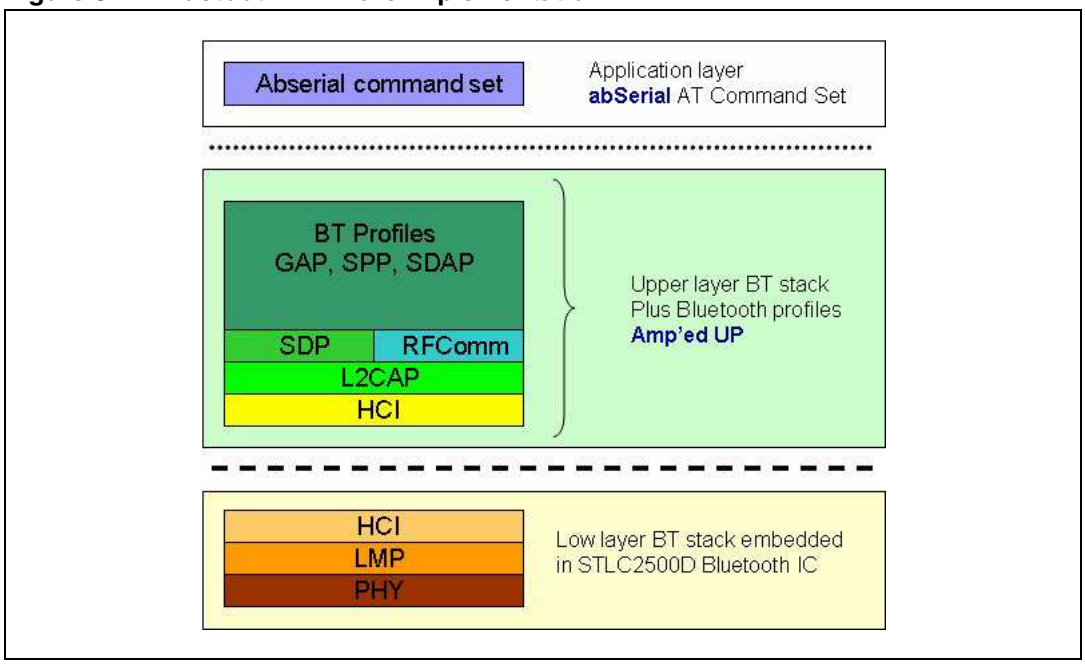
Pin n°	Name	Type	Description	ALT function (1) (2)
UART interface				
13	RXD	I	Receive data	ADC3
14	TXD	O	Transmit data	ADC2
11	CTS	I	Clear to send (active low)	ADC0/I^2C Data/Aux Uart Rx
12	RTS	O	Request to send (active low)	ADC1/I^2C Clock/Aux Uart Tx
Antenna				
6	ANT	RF I/O	50 Ω Rx/Tx antenna port	
Reserved				
9	Reserved	I	Boot 0	
Power and ground				
8	V_{in}		V_{in}	
5, 7	GND		GND	
Reset				
10	RESETN	I	Reset input (active low for 5 ms);	
GPIO – general purpose input/output				
1	GPIO [1]	I/O	General purpose input/output	SPI MISO
2	GPIO [2]	I/O	General purpose input/output	SPI MOSI/I^2S_SD
3	GPIO [3]	I/O	General purpose input/output	SPI SCLK/ I^2S_CK
4	GPIO [4]	I/O	General purpose input/output	SPI SS/I^2S_WS

1. ADC pin functions are not 5V tolerant, when used as ALT pin function. Otherwise the I/O pins are all 5V tolerant.
2. Please note that the usage of ALT function is dependant upon the firmware that is loaded into the module, and is beyond the scope of this document. The AT command interface uses the main UART by default.

7 Software architecture

The SPBT2532C2.AT includes the Bluetooth full protocol stack with upper layers and profiles.

Figure 3. Bluetooth firmware implementation



8 Hardware design

Notes:

- All unused pins should be left floating; do not ground.
- All GND pins must be well grounded.
- Traces should not be routed underneath the module.

8.1 Component drawing

Figure 4. Pin placement

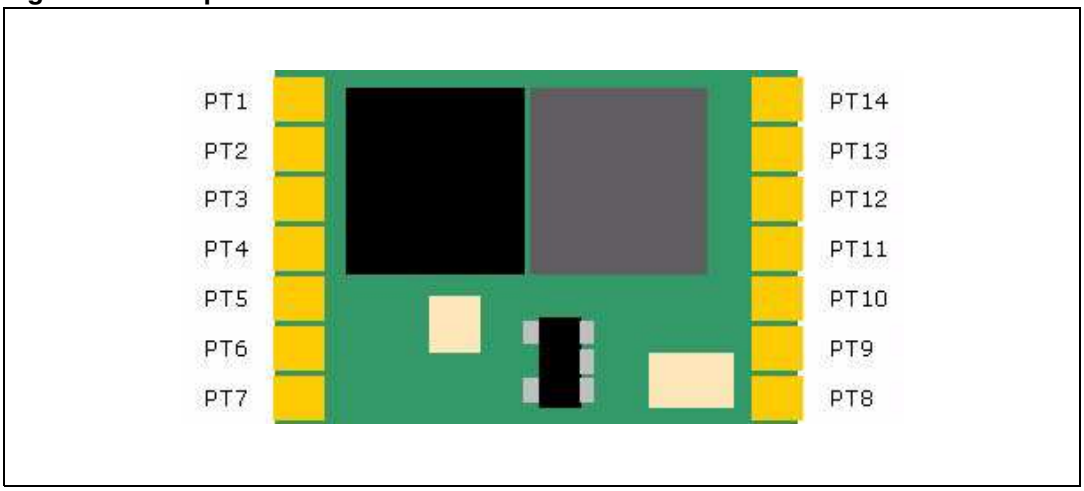
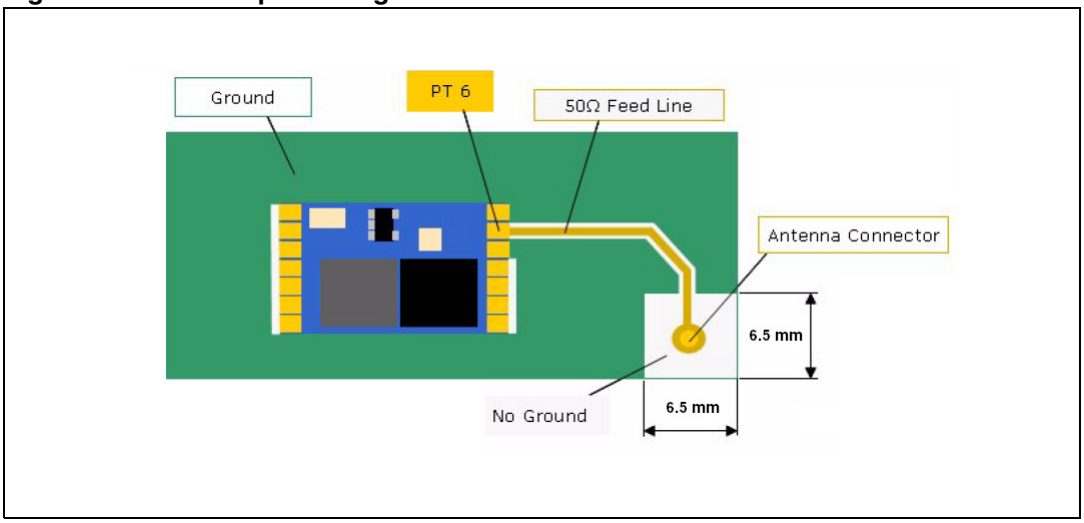


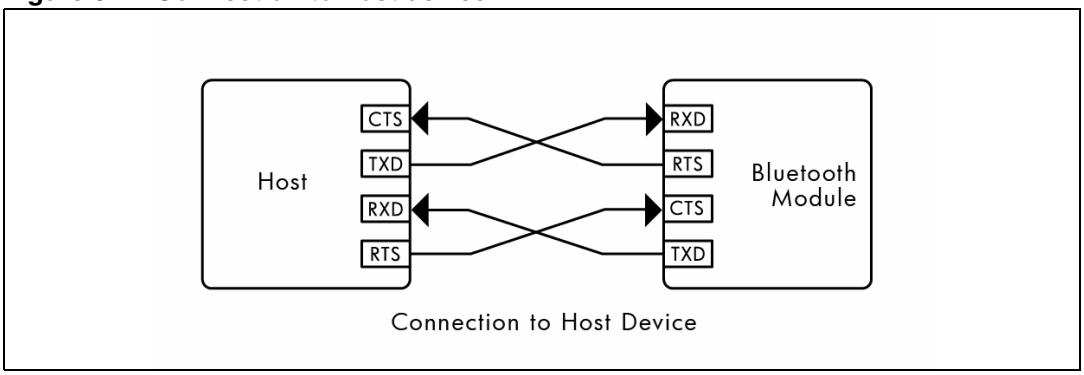
Figure 5. Ground plane diagram



8.2 UART interface

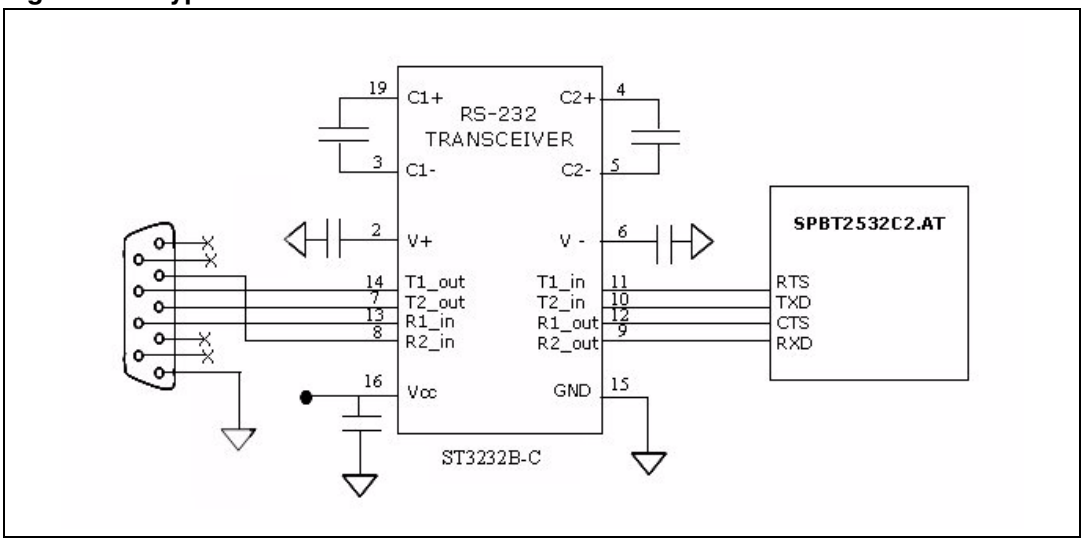
Four signals are provided with the UART interface. The TXD and RXD pins are used for data while the CTS and RTS pins are used for flow control.

Figure 6. Connection to host device



8.3 Typical circuit

Figure 7. Typical RS232 circuit

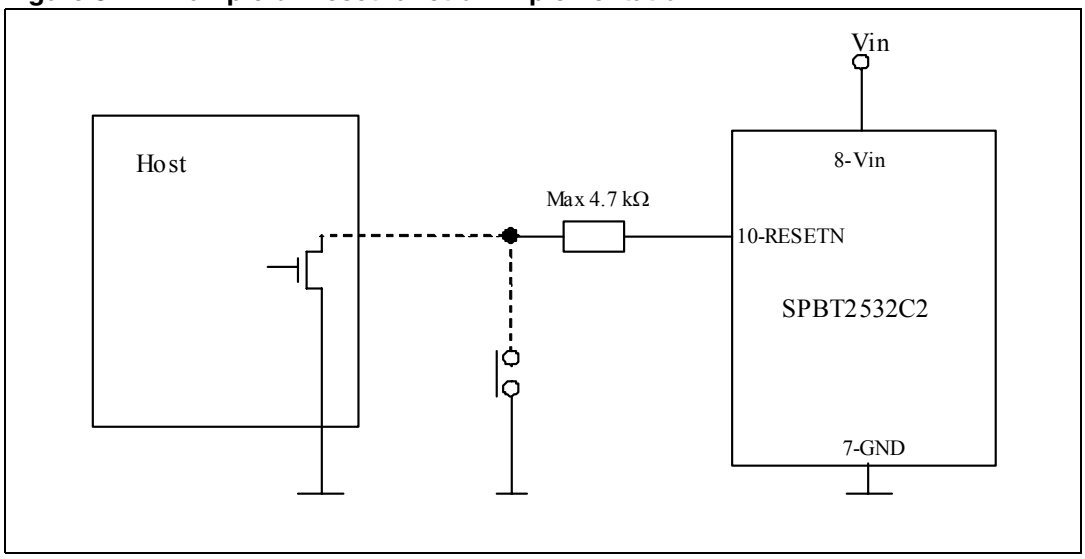


8.4 Reset function

Module reset is simply performed by forcing at low level pin 10. Reset can be operated manually or via host. Manually reset: Pin 10 is driven by a simple push button. Host controlled reset: Pin 10 is driven by an host I/O port.

Reset pin can be also left open; in this case the reset function will be performed at each module power on; since the reset pin is internally connected to the module supply voltage by a 40 kΩ (typ) resistor and to GND by a 220 nF capacitor.

Figure 8. Example of Reset function implementation



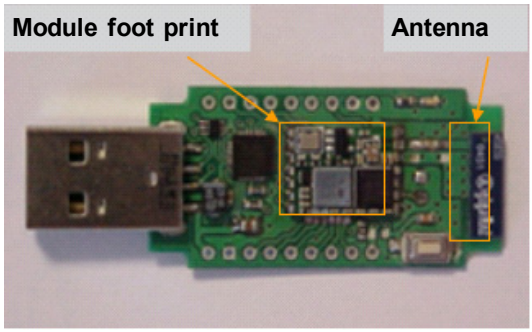
9 Application information

Here below there are some suggestions to better implement the module in the final application.

- Avoid that traces with switching signals are routed on the motherboard below the module. The best condition would be to have a ground plane underneath the module
- Connect the supply voltage ground of the module with the other grounds present on the motherboard in a star way.

Keep the RF ground separate from the module supply voltage ground; the two grounds are already connected inside the module in one point, see below a possible implementation.

Figure 9. Example of antenna integration on the STEVAL-SPBT2ATV2



9.1 Antenna choice

RF output pin must be connected to an antenna which could be:

- Antenna directly printed on the PCB (*Figure 10*)
- Integrated SMD antenna, including but not limited to following examples (*Figure 11*):
  - Johanson Technology 2450T18A100S
  - Antenova 30-30-A5839-01
  - Murata ANCV12G44SAA127
  - Pulse W3008
  - Yageo CAN4311153002451K
- External antenna connected by means a SMA connector (*Figure 12*)

Figure 10. Antenna printed on PCB

Figure 11. SMD antenna

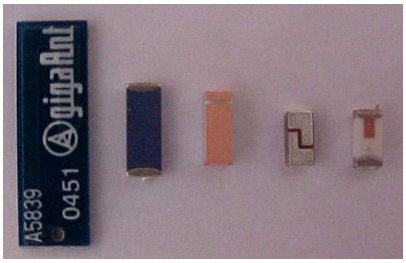
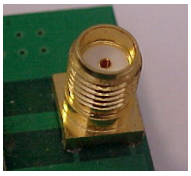


Figure 12. SMA connector for external antenna



9.2 Antenna coupling

Despite of the type of antenna chosen, the connection between the RF out pin and the antenna must be realized to get the maximum power transfer.

As a general rule the characteristic impedance (Z0)of the connection must be fixed at the value of 50 Ω. The connection trace must be matched to respect such a condition.

50 Ω matching depends on various factors and elements that must be taken into consideration:

- Type of material, i.e. FR4 or others.
- The electrical characteristics of the material, among them the electric constant, εr, at 2.4 GHz.
- PCB and traces mechanical dimensions:
  - PCB thickness
  - reference ground thickness
  - trace width
  - trace thickness

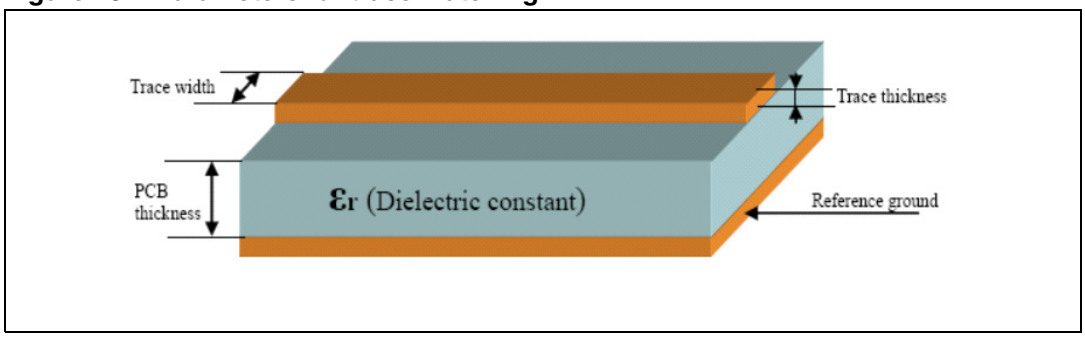
9.3 Example of trace calculation

Example of strip-line calculation:

- To get a strip-line of 50 Ω, using a 1 mm thick FR4 board, with an εr = 4.3 at 2.4 GHz, with Cu thickness of 41 µm, the strip-line width must be 1.9 mm (Micro strip type calculation).

Tools for calculating the characteristic impedance, based on the physical and mechanical characteristics of the PCB, can be easily found on the web.

Figure 13. Parameters for trace matching



10 Soldering

Soldering phase has to be executed with care: In order to avoid undesired melting phenomenon, particular attention has to be taken on the set up of the peak temperature.

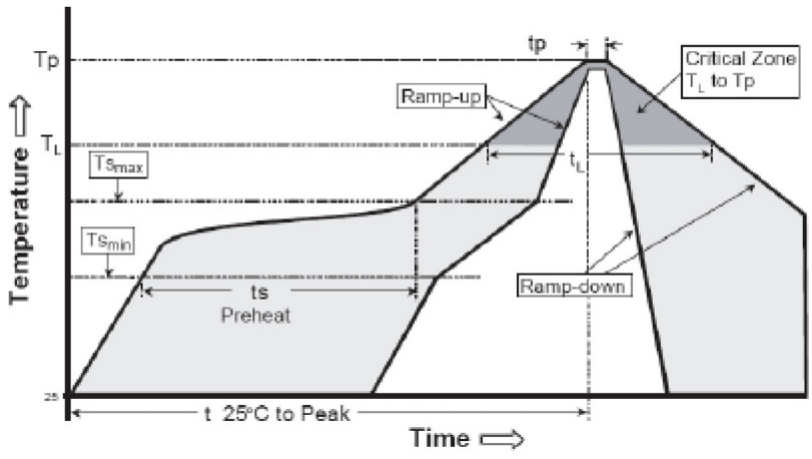
Here following some suggestions for the temperature profile based on

IPC/JEDEC J-STD-020C, July 2004 recommendations.

Table 7. Soldering

Profile feature	PB-free assembly
Average ramp up rate (T_{SMAX} to T_P)	3°C / sec max
Preheat Temperature min (T_S min) Temperature max (T_S max) Time (t_S min to t_S max) (t_S)	 150 °C 200 °C 60-100 sec
Time maintained above: Temperature T_L Time t_L	 217 °C 60-70 sec
Peak temperature (T_P)	240 + 0 °C
Time within 5 °C of actual peak temperature (t_P)	10-20 sec
Ramp down rate	6 °C / sec
Time from 25 °C to peak temperature	8 minutes max

Figure 14. Soldering



Appendix A Certifications

A.1 FCC compliance

FCC qualification is strictly related to RF section design; therefore it doesn't apply to the module without antenna on board.

However, the SPBT2532C2.AT module even if not formally qualified, is FCC compliant. In fact it is a sub-set of the qualified module with antenna, SPBT2532C2A.AT; FCC ID X3ZBTMOD2.

The list of the tests needed for final compliance and certification for the target application must be verified with the certification body.

A.2 CE certification

CE qualified (expert opinion): 0307-ARAJ00079

Measurements have been performed in accordance with (report available on request):

- EN 300 328 V 1.7.1 (2004-11) [(a)],
- EN 301 489-17 V 1.2.1:2002 [(b)],
- EN 60950-1, [(c)]

A.3 BQB certification

BQB qualified design, QD ID: B016360

Product type: End Product

TGP version: Core 2.1/2.1 + EDR TCRL-2009-1

Core spec version: 2.1/2.1 +EDR

Product descriptions: Bluetooth Module

a. EN 300 328 V 1.7.1 (2004-11): "electromagnetic compatibility and radio spectrum Matters (ERM); Wideband transmission systems; data transmission equipment operating in the 2.4GHZ ISM band and using wideband modulation techniques; harmonized EN covering essential requirements under article 3.2 of the R&TTE directive"

b. EN 301 489-17 V 1.2.1:2002: "electromagnetic compatibility and radio spectrum Matters (ERM); electromagnetic compatibility (EMC) standard for radio equipment and services; part 17: specific condition for 2.4 GHz wideband transmission systems and 5 GHz high performance RLAN equipment".

c. EN 60950-1: "Information technology equipment - safety - part 1: General requirements"

Appendix B

Appendix B gives a basic overview of the abSerial v1.2 FW, a third party IP developed by Amp'edeRF. AbSerial, a simple set of AT commands, provides an easy to use interface for module configuration and for usage of serial cable replacement service built on top of Bluetooth serial port profile.

Figure 15. SW developer

B.1 Purpose

Appendix B provides a short introduction to abSerial interface, including list of definitions and acronyms and an overview recalling FW main features.

Appendix C provides a detailed description of each command supported by abSerial v 1.2. Each command description explains parameters, the expected behavior and response of command.

Error responses are also detailed in Appendix E.

To provide feedback or to request assistance on abSerial commands please contact onlinesupport@st.com

B.2 Definitions and acronyms

The following acronyms are used in this document.

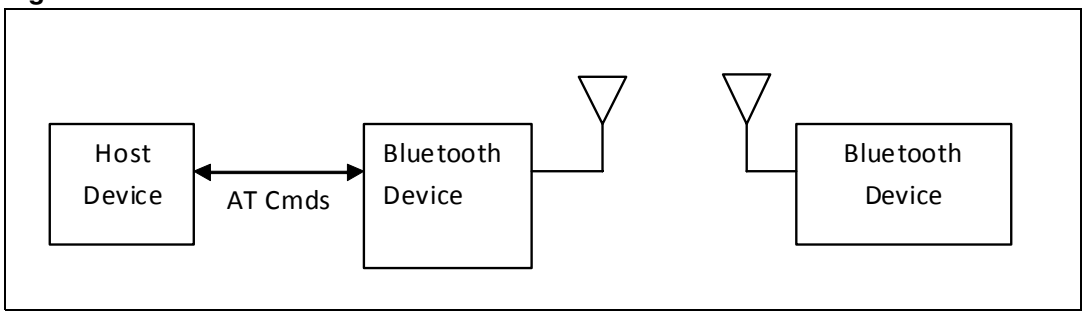
Table 8. Definitions and acronyms

Term	Description/Meaning
ASCII	American standard code for information Interchange, a standard describing encoding of characters; the use in this document is strictly US 7-bit
BD	Bluetooth device
DCD	Modem signal “data carrier detect”; indication from a modem that a connection has been made through, for example, a dialup connection
DTE	Data terminal entity, e.g., a computer
DTR	Modem signal “data terminal ready”; indication to a modem that the data terminal is ready for a connection
DUN	Dialup networking (profile)
GPIO	General purpose input-output
LAN	Local area network
PIN	Personal identification number
SPP	Serial port profile
UART	Universal asynchronous receiver-transmitter

B.3 abSerial interface overview

abSerial is a cable replacement application that provides point-to-point communication between two Bluetooth devices. A serial port is used to communicate with a host device through an AT command interface as shown below.

Figure 16. Communications between hosts



abSerial provides the following basic features:

- Point-to-point connection – abSerial only supports a connection with one device at a time.
- Serial port profile – SPP is supported with abSerial for both Client and Server application.
- Command and bypass modes – it is possible to switch between command and bypass (data transmit/receive) modes during an active connection
- Security – Bonding and data encryption provides a secure link between two devices.
- Multiple device bonding – special security keys can be exchanged with multiple devices to allow different devices to securely connect with abSerial.
- Variable baud rates – the serial port can be configured for the following baud rates: 1200, 2400, 4800, 9600, 19.2k, 38.4k, 57.6k, 115.2k (default), 230.4k, 460.8k, 921.6k

B.4 Factory defaults

The follow factory defaults applies to products delivered with v1.2 FW.

- UART: 115200 baud, no parity, 1 stop bit, 8 data bits
- Local name: “Amp’ed UP!”
- Class of device: misc device
- Profile: SPP (serial port profile)
- Service name: “AMP-SPP”
- Deep sleep: disabled
- Page and inquiry scan: 1.28 s interval, 11 ms duration
- Security: disabled
- Bonding PIN: “1234”
- Bonding allowed: always enabled

Appendix C Commands list

This chapter details the each of the abSerial AT commands including brief descriptions of behavior, syntax of the command, context of the command, and types of responses.

This abSerial reference guide covers the following commands:

Table Key:

√ – command is supported in this release

Table 9. abSerial command summary

Command	abSerial v1.2
Bond	✓
BtcVersion	✓
Build	✓
Bypass	✓
ChangeBaud	✓
ChangeDefaultBaud	✓
Config	✓
DefaultLocalName	✓
DeleteSmartCable	✓
DisableBond	✓
Discovery	✓
EnableBond	✓
EraseBondTable	✓
GetBdAddress	✓
GPIOConfig	✓
GPIORead	✓
GPIOWrite	✓
HostEvent	✓
LinkDisconnect	✓
LocalName	✓
PortDisconnect	✓
Reset	✓
RoleSwitch	✓
SetOrigPin	✓