Bluetooth® BTC 2 Modules

User guide version V1.3
Software version V0.9

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Information

Document information	
Title	Bluetooth® BTC 2 User guide
Subtitle	Version 1.3 - Software Version V0.9
Document type	Hardware integration and software management manual
Document status	Release for Bluetooth® BTC 2 V0.9

This document applies to the following products

Name	Reference	Status	Firmware version
Bluetooth® BTC 2 Integrated antenna	ARF7678AA	Available	V0.9
Bluetooth® BTC 2 RF out pin	ARF7678BA	Available	V0.9
Bluetooth® BTC 1 Integrated antenna	ARF7680AA	To be released	
Bluetooth® BTC 1 RF out pin	ARF7680BA	To be released	
Bluetooth® BTC 1 U.FL connector	ARF7681AA	To be released	

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Technical Support

Website

Our website contains many useful information : modules and stand alone products information, user guides, configuration software and technical documents which can be accessed 24 hours a day.

Email

If you have technical problems or cannot find the required information in the provided documents, contact our Technical Support by email. Use our dedicated email address (arf@adeunis-rf.com) rather than any personal email address of our staff. This makes sure that your request is processed as soon as possible.

Helpful Information when Contacting Technical Support

When contacting Technical Support please have the following information ready:

- Product type (e.g. BTC2 module ref ARF7678),
- Firmware version (e.g. V0.9)
- Clear description of your question or the problem
- A short description of the application
- Your complete contact details

1. BTC Bluetooth® modules REGULATORY CONSIDERATIONS

We ADEUNIS RF
283 rue LOUIS NEEL, 38920 CROLLES, France

declare under our own responsibility that the products

Name Bluetooth® BTC1&2 modules
Reference(s) ARF7678AA, 7678BA, 7680AA, 7680BA, 7681AA

to which this declaration refers conform with the relevant standards or other standardising documents :

- EN 300-328 V1.8.1 (2012-06)
- EN EN 60950-1/2001 + A11 (2004)
- EN 301 489-1 (v1.8.1) (2008-04)
- EN 301 489-3 (v1.4.1) (2002-08)

According to the RTTE Directive 99/5/EC

Notes:

- Receiver class (if applicable): 3
- CE marking applies only to End Products: Because this equipment is only a subassembly, conformity testing has been reduced (equipment has been design in accordance to standards but full testing is impossible). Manufacturer of End Products, based on such a solution, has to insure full conformity to be able to CE label marking.

Crolles, 18 June 2012 Hervé Vincent, CEO

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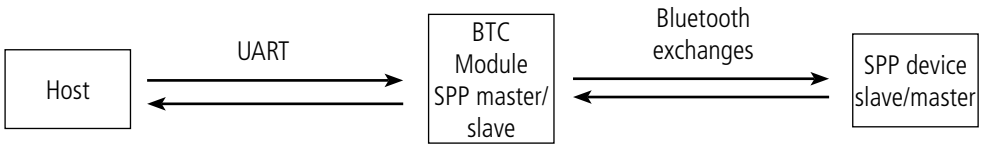
2. Module overview

2.1. Adeunis RF concept

BTC-DATA or BTC is the abbreviation used for Adeunis-RF Data Bluetooth® module, class1 or class2.

BTC implements an AT command interpreter, the Bluetooth® protocol stack, the Bluetooth® profiles and the low level firmware. It therefore presents a simple AT command interface to a host processor and abstracts all the complexities of Bluetooth® to the host.

The host system can interface to BTC through a serial interface, using the ASCII commands that BTC firmware supports (AT Commands).



2.2. Module functionality

The BTC Bluetooth® modules enable Bluetooth® compliant duplex communications in the worldwide 2.45 GHz frequency band.

The main purpose is to establish a communication from a serial port to another by using Bluetooth® SPP profile.

Data exchange and set-up are only done through an UART data port. The BTC Bluetooth® modules offer two modes : command mode and transparent mode.

- The command mode is used to established Bluetooth® communications and set/get parameters.
- The transparent mode is used for data exchange.

2.3. Technical Specifications

Technical specifications	
Embedded profiles	SPP
Bluetooth	Bluetooth core specifications 2.1 + EDR
Module configuration	Through AT commands
Radio data rate	Up to 3Mbps EDR
UART Data rate	From 9.6kbps to 921.6kbps
UART TTL Ports	TxD – RxD – TRS – CTS
Frequency	FHSS / 2.402 to 2.480 GHz
RF radiated power	Class2 : +2dBm
RF sensitivity	Up to -86dBm for BER 10-3
Operating range	Up to 100m (Class2 - external antenna - line of sight) Up to 20m (Class2 - ceramic antenna - line of sight)
Operating Voltage	3.3V typ (2.85V to 3.6V)
Consumption (Class2)	Receiver : 40mA Transmitter : 60mA
Operating temperature	-40°C / +85°C
Dimensions	Class 2 : 22 x 14 x 3 mm
Standards compliance	EN 300-228 / EN 301-489 / FCC part 15 / IC

2.4. BTC module range of products

The BTC range is made up of 5 modules.

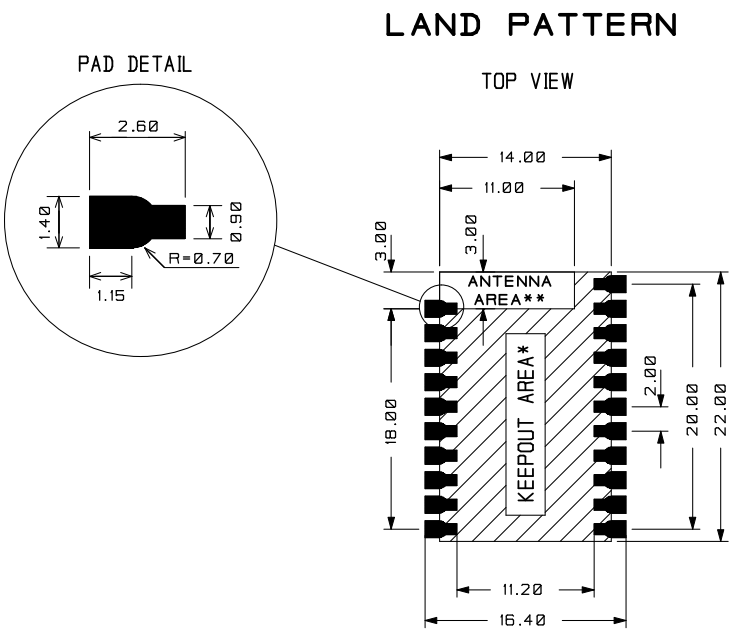
- Class 1 : with antenna, with UFL connector, without antenna and connector
- Class 2 : with antenna, without antenna and connector

The 2 modules are pin-to-pin compatible

3. Main characteristics

3.1. Form factor and footprint

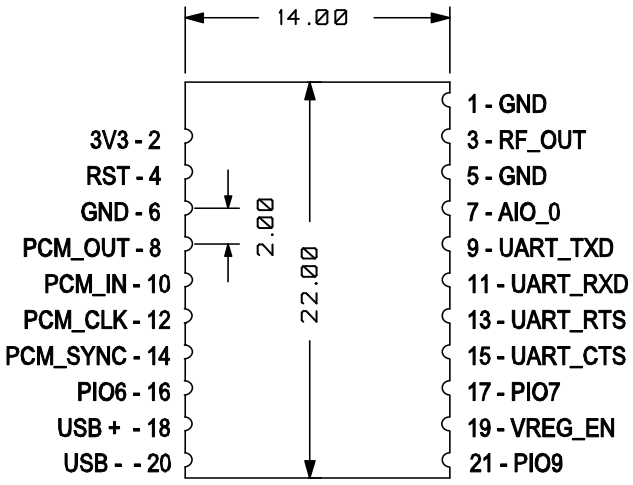
Footprint of BTC2 module



Note : dxf and gerber files are available on request

3.2. Pin description

3.2.1 Pinout of BTC2 module



3.2.2 Pin configuration

Pin module	Pin name	i/O	Description	Recommended IO polarization
1	GND			
2	3V3	in	Module regulated power supply	3.3V typ (2.85V to 3.6V)
3	RF_OUT			
4	RESET	in	Reset active HIGH (>5ms) Internal pull down	Can be left unconnected
5	GND			
6	GND			
7	AIO_0	in		MUST BE LEFT UNCONNECTED
8	PCM_OUT			MUST BE LEFT UNCONNECTED
9	UART_TXD	out		
10	PCM_IN			MUST BE LEFT UNCONNECTED
11	UART_RXD	in		
12	PCM_CLK			MUST BE LEFT UNCONNECTED
13	UART_RTS	out	UART request to send active low	Low level when ready to accept incoming data on UART_RX
14	PCM_SYNC			MUST BE LEFT UNCONNECTED
15	UART_CTS	in	UART clear to sent active low	Pull-down enable BTCL UART_TX
16	PIO6		General purpose input or specific I/O feature	When unused can be left unconnected
17	PIO7		General purpose input or specific I/O feature	When unused can be left unconnected
18	USB+			MUST BE LEFT UNCONNECTED
19	VREG_EN	in	High level : enable BT device regulator Low level : disable BT device regulator	Pull-up for enabling BT device When pulled down module consumption is lower than 100 µA
20	USB-			MUST BE LEFT UNCONNECTED
21	PIO9		General purpose input or specific I/O feature. Can be used to restore default UART settings	When unused can be left unconnected

3.3. Electrical characteristics

3.3.1 Absolute maximum ratings

Parameter	Min	Typ	Max	Unit	Conditions
Supply voltage	-0.3		3.6	V	
Storage Temperature range	-40		+125	°C	
Input RF level			+10	dBm	
Voltage on any pin	-0.3		3.6	V	

3.3.2 General specifications

Parameter	Min	Typ	Max	Unit	Conditions
Supply Voltage Range	2.85	3.3	3.6	V	
Temperature Range	-40		+85	°C	
Transmitter consumption		60		mA (*)	
Receiver consumption		35	40	mA	
Stand by consumption (*2)			100	µA	

(*) Consumption measured in conducted mode.
(*2) VREG-EN tied low.

3.3.3 Digital specifications

The table below summarizes all the different electrical input/output generic characteristics of the modules.

Input/Output Terminal Characteristics (Digital)					
Digital Terminals Min Typ Max Unit		**Min**	**Typ**	**Max**	**Unit**
Input Voltage Levels					
VIL input logic level low	2.7V ≤ VDD ≤ 3.0V	-0.4	-	0.8 V	V
VIH input logic level high		0.7VDD	-	VDD+0.4	V
Output Voltage Levels					
VOL output logic level low, (Io = 4.0mA), 2.7V ≤ VDD ≤ 3.0V		-	-	0.2	V
VOL output logic level low, (Io = 4.0mA), 1.7V ≤ VDD ≤ 1.9V		-	-	0.4	V
VOH output logic level high, (Io = -4.0mA), 2.7V ≤ VDD ≤ 3.0V		VDD-0.2	-	-	V
VOH output logic level high, (Io = -4.0mA), 1.7V ≤ VDD ≤ 1.9V		VDD-0.4	-	-	V
Input and Tristate Current with:					
Strong pull-up		-100	-40	-10	µA
Strong pull-down		10	40	100	µA
Weak pull-up		-5.0	-1.0	-0.2	µA
Weak pull-down		0.2	1.0	5.0	µA
I/O pad leakage current		-1	0	1	µA
CI Input Capacitance		1.0	-	5.0	pF

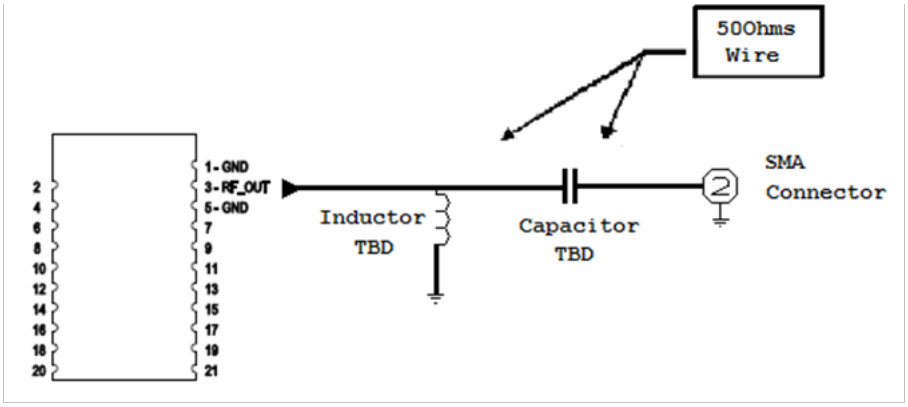
3.3.4 Radio characteristics

Radio characterictics	
Bluetooth	Bluetooth core specifications 2.1 + EDR
Radio data rate	Up to 3Mbps EDR
Frequency	FHSS / 2.402 to 2.480 GHz
RF radiated power	Class2 : +2dBm
RF sensitivity	Up to -86dBm for BER 10-3
Operating range	Up to 100m (Class2 - external antenna - line of sight) Up to 20m (Class2 - ceramic antenna - line of sight)

3.4. Antenna

- The footprint of the inductor and capacitor are useful to ensure good impedance matching between antenna and BTC modules.
- For a quick set-up, we recommend not to get the self, to install the capacitor to 10 pF (or replace it by a short circuit or a 0 ohm resistor) and solder a 3 cm length wire behind the capacitor.

Class 2 Module's antenna matching

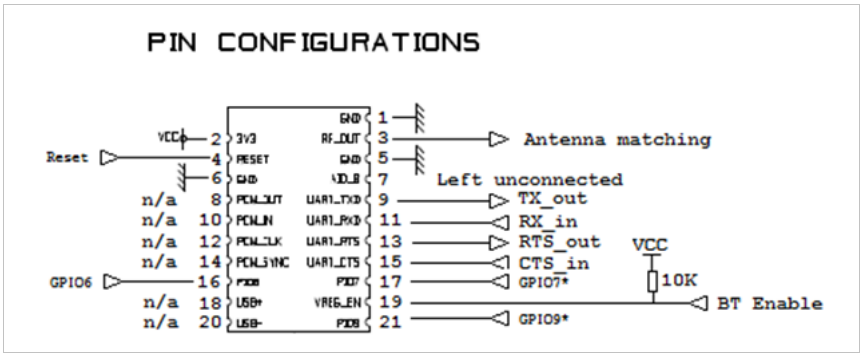


3.5. Suggested hardware design

For all GPIOs, there are internal configurable pull up.

GPIO 7*: can be used for command/data mode switching

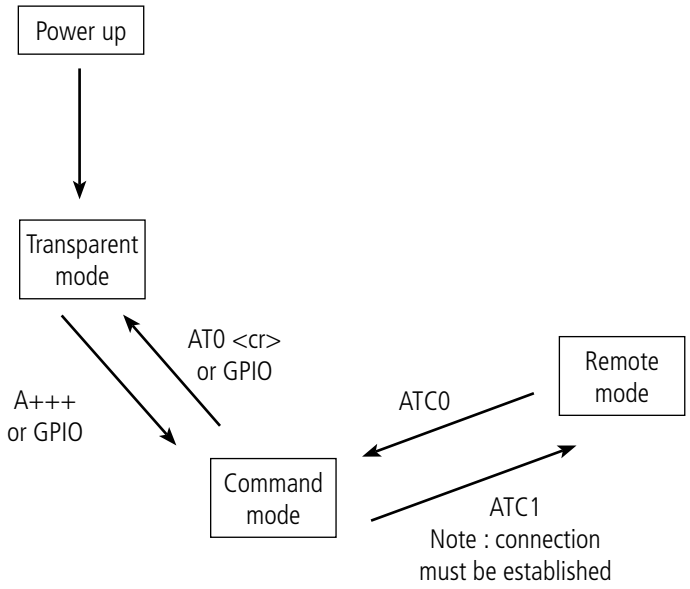
GPIO9*: can be used for restoring default UART settings



4. Communication basics

There are two different modes in BTC: Command mode and Transparent mode.
Transparent mode (also called data mode) is the mode activated after the startup.

Default settings : 9600, 8bits, 1 stop, no parity, HW flow control Enabled



4.1. Transparent / Data Mode (default mode)

Data mode allows completely transparent traffic between two connected SPP Bluetooth® devices. This is a full duplex connection where all bytes received on the local UART are transmitted to the connected device. Equally, all bytes received wirelessly are transmitted to the local UART. BTC will always boot in transparent mode and will be discoverable. Any device can then connect to it and exchange data. To put it into command mode, the user will have to issue the 'A+++' sequence.

4.2. Command Mode

In command mode, BTC will expect AT Commands from the host. The AT Commands are used to change settings or perform actions (such as inquiry, connect to a Bluetooth® device, disconnect, etc.).This mode is used to perform configuration control and various actions.

5. Quick configurations

There is two scenarios to quickly establish a Bluetooth® SPP connection to be able to transmit datas :

- BTC module as a Slave (connection performed by another BT device)
- BTC module as a Master (connection established by the BTC module)

To start you need to have:
a) Adeunis Development board containing the BTC module. Please contact info@adeunis.fr for more information on ordering and product codes.
b) A host with a serial port running a terminal.

Connect your host to your BTC module using the serial port. By default, BTC uses the following UART settings:
9600, 8bits, 1 stop, no parity, HW flow control Enabled

A second Bluetooth® device (can also be a BTC module).

Once the settings are loaded on your terminal, power up the module. You should see an 'ARF767x BT Vx,xx' prompt appear on the screen of the terminal. Then the BCT module is ready to operate (active mode is transparent).

5.1. Use BTCL as a slave

At startup the BTC module is discoverable and ready to accept an incoming SPP connection.

So on your BT master device you can :
1. Perform a discovery to find out the BTC slave module ; the BTC module address is 00 18 B2 xx xx xx, and the default device name is «Serial Port Device»
2. Ask for the device available service (which is SPP for BTC module)
3. Connect on the Port Com
4. When the connection is established you can send and receive data on both side (from the terminal of you master, and the terminal of your BTCL slave)

5.2. Use BTC as a master

At startup the BTC module is in data mode. To establish the BT connection an perform the data exchange you have to:

1. To enter command mode using the A+++ sequence

Command	Response
A+++	O#CR#LF

2. To perform a discovery / inquiry to find out the slave module.

Command	Response
ATINQ#CR	Address=0018B2010ACA, ClassOfDevice=000000#CR#LF Address=3859F9CCB893, ClassOfDevice=3E010C#CR#LF Address=0021FE8ABF33, ClassOfDevice=5A020C#CR#LF

3. Establish the SPP connection using the MAC address of the remote device

Command	Response
ATD 0018B2010ACA#CR	O#CR#LF

4. Go back to data mode using the ATO command

Command	Response
ATO#CR	O#CR#LF

5. Then exchange the data

6. Main features

6.1. Command Syntax

Command syntax : COMMAND#CR
Ex: AT&V#CR

Note: additional #LF will be silently discarded
Ex: AT&V#CR#LF also accepted

Response syntax: RESPONSE#CR#LF
or RESPONSE1#CR#LFRESPONSE2#CR#LF...
or specific string if specified #CR#LF

Ex: O#CR#LF
Ex: S200=0018B2010984#CR#LFS201=serial#CR#LF …

Standard response: O#CR#LF Successful completion
E#CR#LF Error (syntax error, invalid parameter)
D#cr#LF Link disconnection while remote mode active

Notation used: Bracket identifies optional parameters. For example ATINQ command is equivalent to ATINQ 10,10.
Comma is used as value or parameter delimiter. For example ATS218=30,0,0

6.2. AT Bluetooth® commands

The AT commands specific to Bluetooth® are summarized below. When optional parameter are not given after the command, the command will automatically take as parameters, the optional parameters values that are shown in the second column.

The Bluetooth® command cannot be used in remote mode.

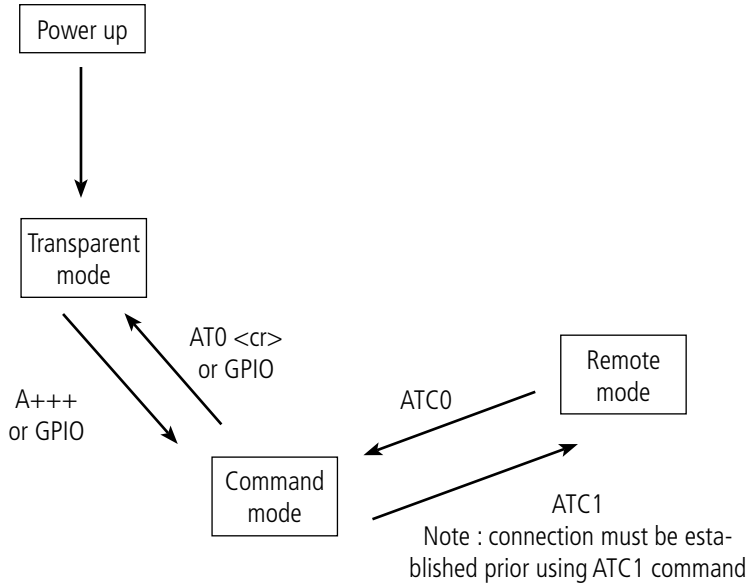
Bracket identifies optional parameters. For example ATINQ command is equivalent to ATINQ 10,10.

Command (link/profile oriented)	Optional default value	Description
ATINQ [Max Device],[Timeout]	10, 10	Searches Bluetooth® devices in the area for a maximum number of devices and a maximum period of timeout (in multiples of 1.28s with a maximum of 48) Response : O#CR#LF (no device discovered) or Address=0018B2010ACA, ClassOfDevice=000000#CR#LF Address=78CA39C51227, ClassOfDevice=3A0104#CR#LF ... O#CR#LF
ATD Bluetooth_Address		Establishes a connection with a given Bluetooth® address. Response: O#CR#LF (connection established) E#CR#LF NO_CARRIER#CR#LF
ATH		Terminates Bluetooth® connection Response : O#CR#LF or E#CR#LF

AT&RSSI		Returns the Receiver Signal Strength of the last received frame. RSSI > -70 dBm : Excellent receipt -70 > RSSI > -80 dBm : Good receipt -80 > RSSI > -90 dBm : Poor receipt RSSI < -90 dBm : Bad receipt Response: E#CR#LF (**link not established**) or -xx dBm<cr><lf>
AT&L	All	Link status. Response: E#CR#LF (no connection established) Or Disconnection cause Or (one or several) LINK SPP1 remoteaddr 0#CR#LF
ATO		Enter Transparent mode

6.3. Switching between Modes

BTC will not switch automatically between modes. The following diagram indicates the commands or sequences to switch between modes.



Note 1 : A+++ is not an AT command but a predefined sequence. The A+++ sequence is accepted only if a silence (no other character) is detected before and after
Note 2: GPIO (PIO7) can be used to switch from transparent to command mode and vice-versa.
Note 3: GPIO (PIO9) can be used at start-up to restore default UART settings.

6.4. AT setup commands & registers

The BTC module has many registers that can be configured to enable the module to behave differently depending on the use cases. These registers can be modified when in command mode using the AT Command 'ATSx='. At factory, the modules are loaded with the factory default values.

The setup commands and registers are summarized below. **The setup commands can be used in remote mode.**

Command	Description
AT&V or AT/S	Shows all registers
AT&W	Write all registers in non volatile memory
AT&F or ATR	Restore factory default register value
ATSn?	Displays the Sn Register content where n represents the register number

ATSn=m	Sets the Sn register value with 'm'. N represents the register number
ATI or AT/V	Returns information on the firmware (Version Number, etc.)
ATRST	Restart the module. Caution : if parameter change have not been saved before using this command the parameter update will be lost.

Registers

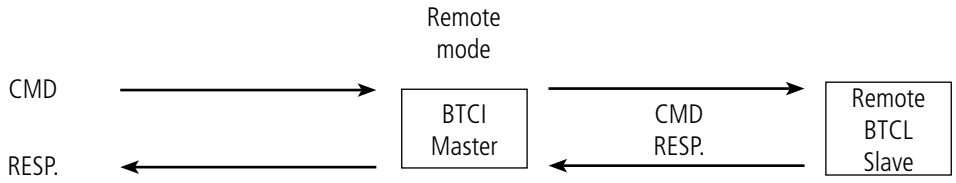
A description of the Registers is in the table below:

Register	Description (Values)	Factory default Value
S200	Local Bluetooth® address (Read Only)	-
S201	Local device name (lower or equal than 32 bytes)	«Serial Port Device»
S202	Auto connect mode: 0=disable, 1=autoconnect on reset and power up, 2 = autoconnect on GPIO (DTR)	0
S203	Remote Bluetooth® address for SPP (If auto connect is enabled, this Bluetooth® address is used) Syntax for writing S203 ATS203=123456789012#CR	0,0,0h
S204	Reconnection on management (0: no reconnection, N: number of retries, 255: always)	255
S205	Pin Code for connection on legacy device (lower or equal to 16 bytes) Required for a connection on legacy device which is configured with pin code requested on connection. (ex: ARF52 with S205=PinCode) Legacy device : Bluetooth® Core Specification 2.0 + EDR and earlier versions	0
S208	Class of Device SPP=0000h, HFD =408h Syntax for writing S208 ATS208=123456#CR (value is hexadecimal) Tips: on Android OS, some stack doesn't support class of device 0000h. Set S208 to another value when using Android (example : S208=1).	000000h
S210	UART Baud rate in bits/s ('4'=9600, '5'=19200. '6'=38400, '7'=57600, '8'=115 200, '9'=230400, '10'=460800, '11'=921600)	4
S211	UART Data length ('8'=8bit)	8
S212	UART Parity bit ('1'=none, '2'=odd, '3'=even)	1
S213	UART Stop bit ('1'=1 stop bit, '2'=2 stop bits)	1
S214	A+++ Command time out (Time duration for detecting the A+++ patern in 20ms units: from 1 to 255x20ms)	50
S215	UART Flow control management ('0'= disable RTS/CTS management, '1'=enable RTS/CTS management). Modifying is enabled after ATO command which reboot the system. Caution: if the save command (AT&W) is not used before this reboot, last register updates will not be retained. When upgrading this register value use the following command sequence for exiting the command mode: AT&W#CR ATO#CR	
S242	GPIO features configuration	0x0000

S243	GPIO Read input register Bit2 Bit3 Bit4 Bit5 Bit6 Bit7 Bit8 Bit9 Bit10 Bit11	 PIO2 PIO3 PIO4 PIO5 PIO6 PIO7 PIO8 PIO9 PIO10 PIO11	 (value 0x0004) (value 0x0008) (value 0x0010) (value 0x0020) (value 0x0040) (value 0x0080) (value 0x0100) (value 0x0200) (value 0x0400) (value 0x0800)	xxxx

7. Advanced features

7.1. Remote Mode



Before all, a connection must be established.

In remote mode, commands transmitted to the local UART interface are sent wirelessly (via the SPP link) to the connected device. So commands are interpreted by the remote device instead of the local device.

From the Master module (the one controlling the Slave): When the host send ATC1 command to the module, the module will enter into Remote Mode. It will therefore transparently send the AT commands through to the Bluetooth® link and the remote module. When it will receive an ATC0 command, it will return to command mode.

From the Slave module (The receiving module). When the slave receives ATC1 over the Bluetooth® link, it will enter the Remote Mode. In this mode it will ignore the UART and accept commands from the SPP link over Bluetooth®. If any registers are modified, the master must send the AT&W command as the Slave will reboot when it receives the ATC0 to leave Config mode or when the connection is lost.

This mode can be used for example to configure the remote UART in order to perform an SPP connection between both applications.

Only setup commands can be used to configure the remote device.
The Bluetooth® commands cannot be used in remote mode.

If a link disconnection occurs during remote mode control:

- On local device, any valid remote command will return the response D#CR#LF instead of a successful feedback (Currently no response feedback, only ATC0 can be used to exit remote mode). In this case, the local device stays in remote control mode until receiving the ATC0 command. This is done for preventing unexpected change on local device.

- On remote device, the device will be restart (after a 20s timeout)

7.2. Auto-connection

Auto connection setup is performed using S202, S203 and S204 registers.

S202 register is used for enabling auto connection:
- Auto-connect can be performed at startup (S202=1)
- or can be GPIO driven ((S202=2)
- S202=0 disable auto-connection feature

S203 register defines the MAC address used for auto-connection.

Startup string at power up

[RX] - ARF767x BT V0,90<CR><LF>

Go to command mode to configure the Auconnection
[TX] - A+++
[RX] - O<CR><LF>

Set the mac @ for autoconnection
[TX] - ATS203=0018B2001023<CR>
[RX] - O<CR><LF>

Activate the Auconnection
[TX] - ATS202=2<CR>
[RX] - O<CR><LF>

Enable the Auconnection feature
[TX] - ATS242=40<CR>
[RX] - O<CR><LF>

By default PIO9 is High, so the link is not established
[TX] - AT&L<CR>
[RX] - E<CR><LF>

Pull PIO9 from High to Low
After a While, the connection is established

[TX] - AT&L<CR>
[RX] - LINK SPP1 0018B2001023 0<CR><LF>

7.3. Multi SPP mode

To be released

7.4. GPIO management

BTC has configurable I/O that can be used for :
- Reading local input
- Reset UART settings and S216 register to default (well known value)
- Automatic connection management : one line (DTR input) is externally asserted for requesting a connection, a second line (DSR output) indicates either the connection has been established or released.
- Data mode / command switching (equivalent to ATO/A+++)

For all I/O the default configuration (S242=0000) is:
- **Input with internal pup, excepted AIO0**. Each Input can be read using register S243.
- All I/O features are disabled **excepted the UART Reset feature;** This feature must be always accessible

7.4.1 GPIO feature activation (S242 register)

S242 register allows to enable GPIO feature.

This first table describes local feature while the second contains the I/O used for reporting remote I/O (DUN capability).

S242-bit number	S242-bit value	name	Available I/O feature
b1-0	xx		free
B3-2	00 (value 0x0000)	PIO6 In	Local Input
	01 (value 0x0004)	Out	DSR/ PIO6 (out) reflect the connection status • Level 0 -> connection established • Level 1 -> connection released S242 value 0x0004

B5-4	00 (value 0x0000)	PIO7 In	Local Input
	01 (value 0x0010)	PIO7 In	PIO7 (in) switching from data to command mode • Falling edge -> data mode activation • Rising edge-> command mode activation S242 value 0x0010
B7-6	00 ** (value 0x0000)	PIO9 In	Local Input
	01 ** (value 0x0040)	out	DTR/ PIO09 (in) acts as connection request • falling edge is a connection request • Rising edge is a disconnection request S242 value 0x0040

Note **:

- At startup PIO9 level (configured as an input with pull up) is always checked for restoring default UART value; If a low level is detected, then the default UART setting and S216 register value are restored. **The level 0 duration must be ≥ 500ms**.
- If default value restoration has been done the PIO9 DTR feature cannot be enabled (prevention of I/O conflict)

8. Version history

User guide version	Contents
V1.0	Document layout update
V1.1	Declaration of conformity updated
V1.2	Document update
V1.3	Register S243 updated