Bluetooth® class 1 evaluation boards using:
GS-BT2416C1DB and GS-BT2416C1DBAT1

Introduction

This user manual details the GS-BT2416C1DB.xxx which is a Bluetooth® class 1 evaluation board including an RF antenna. The suffix xxx identifies the firmware release. There is no suffix for HCI commands and AT1 is the suffix for AT commands.

The GS-BT2416C1DB is a board with downloaded FW which enables the user to interface the Bluetooth® module with HCI commands.
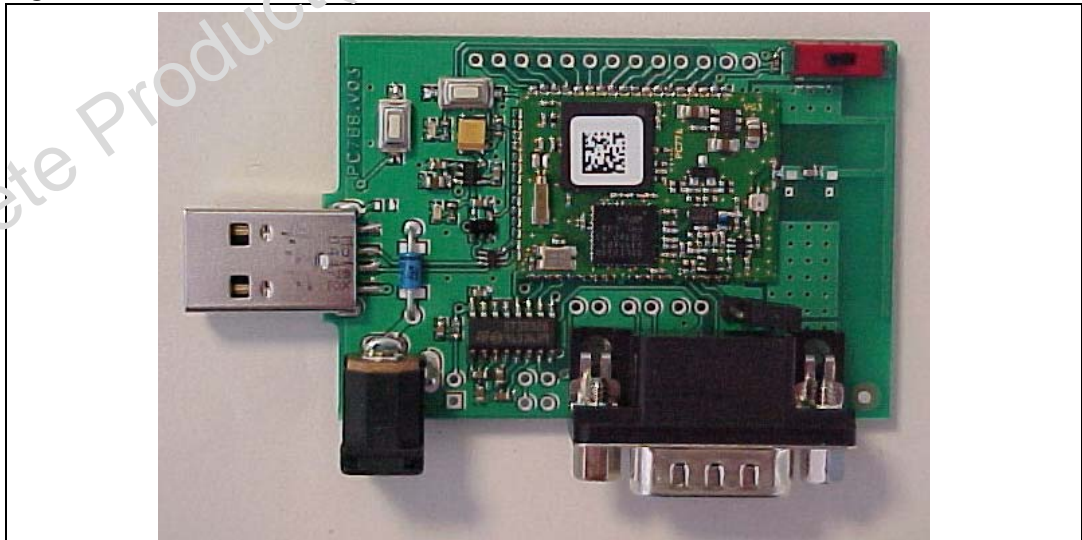
The GS-BT2416C1DBAT1 is a board with downloaded FW which enables the user to create a Bluetooth® link with simple AT commands. AT commands are sent by means of the serial line which is accessible by the DB9 connector.

The GS-BT2416C1DB.xxx board can be supplied by an external 5 V DC source or via the USB port.

Features

- Bluetooth® V1.2 board
- Serial interface on DB9 connector
- USB connection
- PCB antenna on board
- Single 5 V supply voltage
- CE / FCC compliant

Figure 1.   GS-BT2416C1DB.xxx board

Contents

1 Recommended operating conditions

Table 1.   Recommended operating conditions

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
VDD	Board supply voltage	-20 °C < T < 70 °C	4	5	6	V
T_{stg}	Operating ambient temperature		-20		+70	°C

2 I/O connections

Table 2.   Board connections

		Description
J1	1	Boot signal - If connected to GND, the module can download – see also JP1.
	2	Reset: A low level on this pin forces the module to reset state; a 100 k / 100 nF is present on the board.- see also S3.
J2		USB port When the USB port is connected, the 5 V USB is used (by the 3.3 V regulator) to supply the BT module and the board itself. When the USB port is used, do not supply an ext. 5 V to J4 power plug. The USB port is not used for AT version.
J3		Serial line port (DB9 male connector) A level translator to adapt the BT digital levels to the RS232 standard levels is present on the board.
J4		Vcc power supply plug (5 V) When 5 V input is used on this plug, do not connect USB port.

Table 2.   Board connections (continued)

		Description
	1	GPIO 15
	2	GPIO 14
	3	GPIO 13
	4	GPIO 12
	5	GPIO 11
	6	GPIO 10
J5	7	GPIO 9
	8	GPIO 8
	9	GPIO 7
	10	GPIO 4
	11	GPIO 3
	12	GPIO 2
	13	GPIO 0
JP1		Boot. If connected to GND, the module can download
JP2		DB9 connector connection – see *Figure 3: Board schematic*
JP3		DB9 connector connection – see *Figure 3: Board schematic*
JP4		DB9 connector connection – see *Figure 3: Board schematic*
JP5		DB9 connector connection – see *Figure 3: Board schematic*
JP6		DB9 connector connection – see *Figure 3: Board schematic*
S1		N.O. push button connected to BT module GPIO6; when activated a low level is applied to GPIO6, otherwise GPIO6 is at high level. Not used for AT commands version
S2		Switch connected to GPIO3 (10 kΩ pull-up to 3.3 V) In AT version this switch is used to select command / data mode
S3		Reset – push button acting on the module reset pin.
L1		LED connected to BT module GPIO1 On AT version this LED shows when a Bluetooth® connection is ON (LED ON)
L2		LED showing the presence of the 3.3 V internal voltage – Bluetooth® module supply voltage

3 Board layout

Figure 2. Board component layout
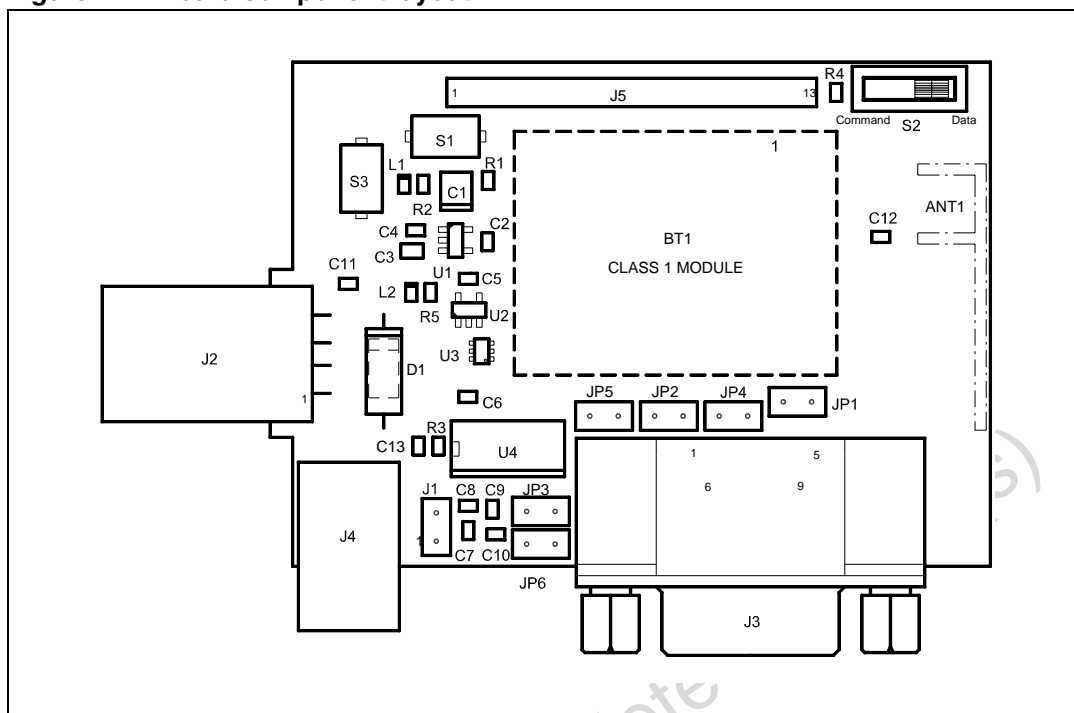
4 Board schematic

Figure 3. Board schematic

5 Downloading

The user has the possibility to download his own file to the GS-BT2416C1DB.xxx:

● Connect the board to a PC using an RS232 cable connected to COM1 / COM2

● Put a jumper on JP1 (Boot pin to low level)

● Connect the power supply cable to the board at +5 V ext Vin

● Open the "flash loader" program

● Choose UART in the transportation layer section

● Choose the appropriate COM1 / COM2 port

● Choose the firmware to be downloaded in the "firmware" section

Figure 4. Flash loader info
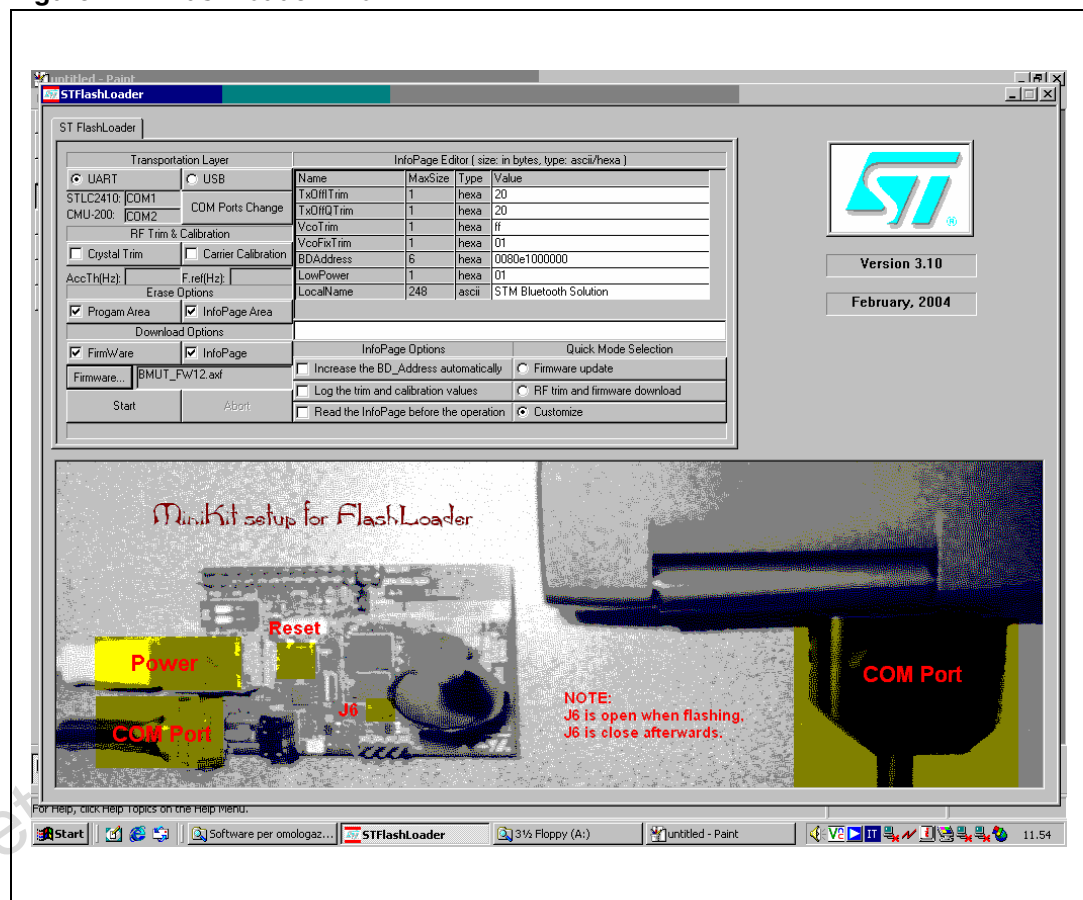
1. Press start: on the dialog bar "reset the board" appears

2. Power the board (a reset is generated): on the dialog bar the % of the downloading appears.

6 Certifications

6.1 CE

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

● EN 300 328 V 1.6.1 (2004-11): "Electromagnetic compatibility and radio spectrum Matters (ERM); wideband transmission systems; data transmission equipment operating in the 2.4 GHz ISM band and using wideband modulation techniques; Harmonized EN covering essential requirements under article 3.2 of the RandTTE directive"

● 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."

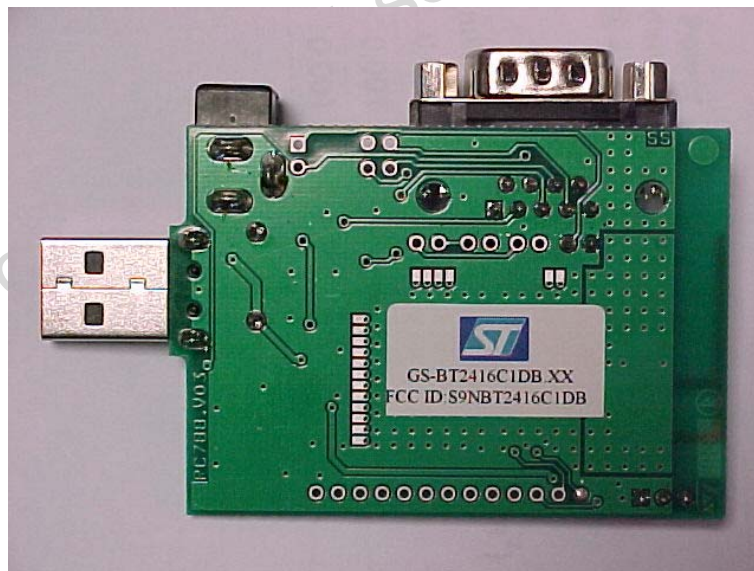● EN 60950-1: "Information technology equipment - safety - part 1: general requirements".

6.2 FCC

FCC part 15, subpart C

This board has the following FCC ID:

FCC ID:S9NBT2416C1DB

Figure 5.   Label position

6.2.1 FCC statement

This device complies with part 15 of the FCC rules. Operation is subject to the following two conditions:

(1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Note: *This equipment has been tested and found to comply with the limits for a class B digital device, pursuant to part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications.*

However, there is no guarantee that interference will not occur in a particular installation.

If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

● Reorient or relocate the receiving antenna

● Increase the separation between the equipment and receiver

● Connect the equipment into an outlet on a circuit different from that to which the receiver is connected

Consult the dealer or an experienced radio/TV technician for help.

Antenna

Our board type GSBT2416C1DB is for OEM integrations only. The end-user product will be

professionally installed in such a manner that only the authorized antennas are used.

Caution: Any changes or modifications not expressed approved by the party responsible for compliance could cause the module to cease to comply with FCC rules part 15, and thus void the user's authority to operate the equipment.

6.2.2 Label instruction

Module type: Bluetooth® class 1 board, GSBT2416C1DB
(GSBT2416C1DB module + PC 788 carrier board)

FCC-ID: S9NBT2416C1DB

This intends to inform you how to specify the FCC ID of our Bluetooth® board GSBT2416C1DB on your final product.

Based on the public notice from FCC, the product into which the our transmitter module is installed must display a label referring to the enclosed module.

The label should use wording such as "contains transmitter module FCC ID: S9NBT2416C1DB or "contains FCC ID: S9NBT2416C1DB, any similar wording that expressed the same meaning may be use.

It shows an example below

Contains FCC ID: S9NBT2416C1DB

6.2.3 Special requirement for modular application

The following requirements are fulfilled:

1. The modular transmitter must have its own RF shielding:

The RF module fulfils the emission requirements of the FCC rules without additional shielding.

2. The modular transmitter must have buffered modulation/data inputs:

The module has a memory management unit inside of the IC. The processor interfacing with the external application by means general purpose I/O (GPIO), UART, USB, PCM, I2C, SPI. The processor interfaces also the RF part of the module exchanging data and commend with it. Inside the processor a flash memory is available to download the customer application and the Bluetooth® profiles.

3. The modular transmitter must have its own power supply regulation:

The module contains an own voltage regulation. In case of changes in the supply voltage VCC (for example caused by temperature changes or other effects), the internal voltage will be stabilized.

4. The modular transmitter must comply with the antenna requirements of Section 15.203 and 15.204:

The RF module is for OEM (original equipment manufacturer) integration only. The end-user product will be professionally installed in such a manner that only the authorized antenna is used.

5. The modular transmitter must be tested in a stand-alone configuration:

The RF module was tested in a stand-alone configuration.

6. The modular transmitter must be labelled with its own FCC ID number:

The RF module will be labelled with its own FCC ID number. When the module is installed inside the end-product, the label is not visible. The OEM manufacturer is instructed how to apply the exterior label.

7. The modular transmitter must comply with any specific rule or operating requirements applicable to the transmitter and the manufacturer must provide adequate instructions along with the module to explain any such requirements:

The EUT is compliant with all applicable FCC rules. Detail instructions are given in the product users guide.

8. The modular transmitter must comply with any applicable RF exposure requirements.

Table 3.   RF exposure evaluation distance

Channel	Frequency	Output power to antenna (Erp)	Power density @ 20 cm	Distance where the exposure level reaches the limit	Limits
(No.)	(MHz)	(dBm)	(mW/cm^2)	(cm)	(mW/cm^2)
00	2402,00	15,47	0,009	1,879	1
38	2440,00	15.75	0,008	1,941	1
78	2480,00	14.93	0,008	1,764	1

The RF module operates at low power level so it does not exceed the commission's RF exposure guidelines limits; furthermore, spread spectrum transmitters operate according to the section 15.247 are categorically excluded from routine environmental evaluation.

7 AT commands appendix

This section is applicable to the evaluation board with the AT command downloaded FW (GS-BT2416C1DBAT1).

The purpose of this section is to describe all the necessary steps to establish a connection between two Bluetooth® GS-BT2416C1DBAT1 evaluation boards in a serial line /cable replacement application.

(This connection example is also given in the GS-BT2416C1.AT1 datasheet, Appendix A.

7.1 Setup and connect

Two PCs and two GS-BT2416C1DBAT1 boards are needed to perform the connection

Figure 6.   Basic setup
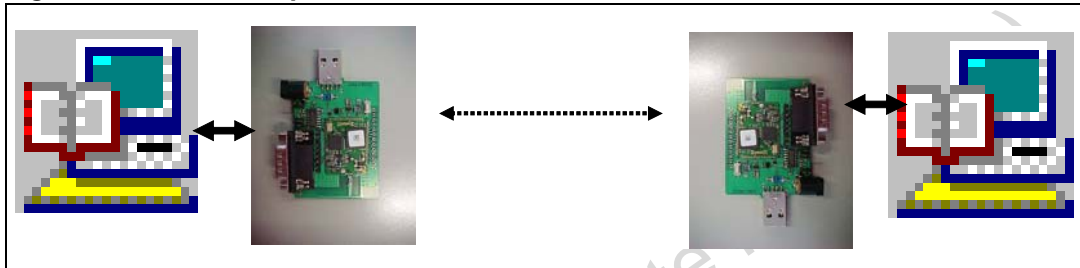
7.2 Steps to connect

(Please refer to the GS-BT2416C1.AT1 datasheet, Appendix A for the meaning of the AT commands)

● Designate a GS-BT2416C1DBAT1 board to be used as "client" and suppose it has the address 0080E1000001. Hereafter this board will be referred to as "client"

● Designate a GS-BT2416C1DBAT1 board to be used as "server" and suppose it has the address 0080E1000002. Hereafter this board will be referred to as "server"

● Connect the server board to a PC using an RS232 cable

● Connect the client board to a PC using an RS232 cable

● Open the hyperterminal program on both PCs and set the communication line with the following parameters:

– Select the proper COM line (COM1, COM2……)

– Baud rate: 9600 (default baud rate of GS-BT2416C1/AT module)

– Data bits: 8

– Parity: none

– Stop bits: 1

– Flow control: none

– In ASCII setup, set flag line ends with line feed

– In ASCII setup, set flag echo characters typed locally

● Power the client board with the external 5 V: on the PC screen connected to the client should appear + READY

● Power the server board with the external 5 V: on the PC screen connected to the Server should appear + READY

● Configure the client board using the following commands in *Table 4*: (GPIO3 client must be low to select command mode - S2 switch in command mode).

Table 4. Client setup

Command	Answer	Notes
AT	ok	Check module ready
AT+BTCMODE = 0	ok	
AT+BTPMODE = 1	ok	
AT+BTDMODE = 0	ok	Not discoverable
AT+BTSECMODE = 1	ok	
AT+BTENCMODE = 0	ok	
AT+BTNAME = "SPP client"	ok	Set client name
AT+BTCLASS = 52020C	ok	

● Configure the server board using the following commands in *Table 5*: (GPIO3 Server must be low to select command mode- S2 switch in command mode)

Table 5. Server setup

Command	Answer	Notes
AT	ok	Check module ready
AT+BTCMODE = 1	ok	
AT+BTPMODE = 1	ok	
AT+BTDMODE = 1	ok	Discoverable
AT+BTSECMODE = 1	ok	
AT+BTENCMODE = 0	ok	
AT+BTPINCODE = "1234"	ok	Pin code
AT+BTNAME = "SPP server"	ok	Set server name
AT+BTCLASS = 52020C	ok	
AT+BTREGPORT = "SPP port"	ok	Name of service offered

After the configuration of the server board, GPIO3 must be put HIGH to select DATA MODE which enables the Server board to receive and transmit DATA.

● Inquiry and available services

Before establishing a connection, the Client has to know which Bluetooth® devices are present and which services are offered, and therefore the client:

1. first performs the inquiry by the command:
   AT+BTINQ=xx
   where xx is the inquiry time (i.e. 10 sec -> AT+BTINQ=10).
   The answer is a list of present Bluetooth® connectable devices. One of the devices should be our SPP Server:
   +BTNQRES:0080E1000002,"SPP Server"
   OK

2. then asks which kind of service is available with the command:
   AT+BTRPORTS=0080E1000002
   The answer is:
   +BTRPORT:"SPP Port",1
    serial port profile, port 1 (can be 1,2…)
   OK

● Once the client knows the device present and the service offered, the Client finalizes the connection with the command:
   AT+BTCONNECT=0080E1000002,1,"1234",1,0
   OK

At this point the connection is established and GPIO1 (indicating the connection status) on both Client and Server boards becomes high.

On the GS-BT2416C1DBAT1 board an LED is connected to GPIO1 and therefore the connection is also shown by an LED which is on.

GPIO3 on the client board must now be put at HIGH level allowing the client to send and receive DATA from the server.

● Disconnection

To disconnect, the client has to put its GPIO3 LOW (Command mode) (changing from high to low on GPIO3 appears on the client PC screen as +READY) and sends the command:

AT+BTDISCONNECT OK

The result is the disconnection of the link client / server, and GPIO1 on both client and Server boards returns to low (the LEDs go off).

7.3 Macro instructions

The MACRO concept with the commands AT+BTMACROSTART, AT+BTMACROSTOP and AT+MACROCLEAR has been introduced with version 1.2.1.8 of AT1 SW.

These commands work in such a way that all commands written between the AT+BTMACROSTART and AT+BTMACROSTOP commands are stored inside the internal flash memory and executed at each power up of the module.

Note: *When you insert a command between MACROSTART and MACROSTOP you do not have immediate execution of the command, but only storing in flash memory. The module answers with OK or ERROR from a syntax point of view. Execution is active at the next power on.*

That means, after writing the commands between the two macro commands, the module could work in stand-alone without needing to program it at each power on.

The MACROCLEAR command erases all commands stored.

As an example: suppose the previous modules always have the final address 01 (client) and 02 (server) and we already know which connection to get.

Write the following sequence of commands in client and server module (see *Table 6*). After the MACROSTOP command, they are stored in the internal memory of the corresponding module.

Table 6. Macro example

Client	Server
AT+BTMACROSTART	AT+BTMACROSTART
AT+BTCMODE = 0	AT+BTCMODE = 1
AT+BTPMODE = 1	AT+BTPMODE = 1
AT+BTDMODE = 0	AT+BTDMODE = 1
AT+BTSECMODE = 1	AT+BTSECMODE = 1
AT+BTENCMODE = 0	AT+BTENCMODE = 0
AT+BTNAME = "SPP client"	AT+BTPINCOD = "1234"
AT+BTCLASS = 52020C	AT+BTNAME = "SPP server"
AT+BTCONNECT = 0080E1000002,1,"1234",10,5	AT+BTCLASS = 52020C
AT+BTMACROSTOP	AT+BTREGPORT = "SPP port"
	AT+BTMACROSTOP

Note that:

● When the address module to connect is known, the inquiry command can be omitted

● The BTCONNECT command has been set to 10 retries at 5 sec intervals.

After the modules have been programmed, you can power off and power on again the modules themselves. At a certain point the modules will be connected to each other (LED on) without any intervention.

The sequence of powering on does not matter. The only rule to follow is that, once the Client has been powered on, the Server must be powered in the time set by the 10 retries at 5 sec intervals.

During the macro execution the module answers with "OK" or "ERROR" for each command executed. This feedback can be eliminated using the AT+ECHO=OFF command.

7.4 Module BT address

Each module has its own address which identifies the module itself in the network. The above examples were used with addresses 0080E1000001 and 0080E1000002.

Modules on the GS-BT2416C1DBAT1 board may have different addresses. Before starting to send commands, the module address can be found with the command AT+BTSETTINGS=? which shows the relevant information of the module including the BT address.

7.5 Point-to-point connections

Modules with AT command firmware can only perform point-to-point connections which means that only one connection can be activated at once. A module can be connected to several other modules, but it has to disconnect from the previous connection before activating a new one. *Figure 7* shows an example of Client C1 which needs to connect to Server S1,S2,..Sn:

Figure 7. Point-to-point connection
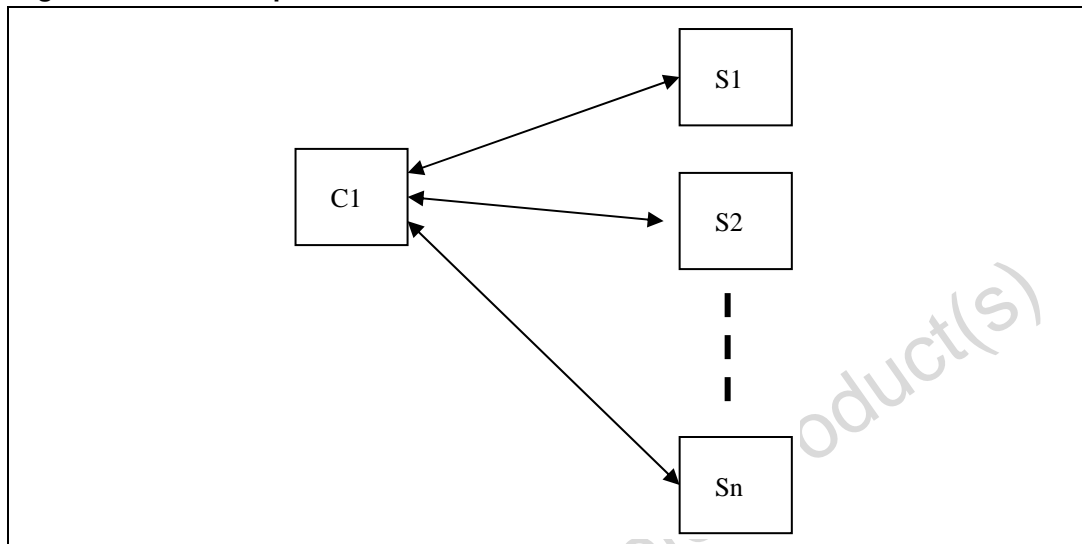
In this case the following procedure must be used:

● C1 establishes the connection to S1 to exchange data

● C1 disconnects from S1 using the command AT+BTDISCONNECT

● C1 establishes the connection to S2 to exchange data

● C1 disconnects from S2 using the command AT+BTDISCONNECT

● C1 establishes the connection to Sn to exchange data… and so on.

8 Revision history

Table 7. Document revision history

Date	Revision	Changes
22-Oct-2007	1	Initial release
23-May-2008	2	Added: *Section 6.2: FCC on page 8*

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