GS-BT2416C1.H

Bluetooth® class 1 module with embedded HCI FW

Features

- Bluetooth® specification V.1.2 compliant
- Transmission rate up to 721 Kbps
- Output power class 1 (20 dBm max)
- Working distance up to 100 meters
- ACL and SCO links
- AFH interference resistance
- Supports USB (1.1) /UART/PCM (pulse code modulation)/SPI/ I²C interfaces
- Optimized link manager and control
- Support wireless LAN coexistence in collocated scenario
- Integrated 4 Mbit Flash, 64 Kbytes RAM, 4 Kbytes ROM
- 3.3 V single supply voltage
- Hardware based UART flow control

Applications

- Serial cable replacement
- Industrial control
- Laptops
- POS terminals
- Data acquisition equipment
- Internet access points
- Machine control
- Sensor monitoring
- Robotic and biomic control
- Security control
- Patient monitoring
- Audio gateway applications
- Hands-free sets
- Wireless printers
- Cordless terminals
- Laptops, PCs and accessories
- Hand held devices and accessories
- HID devices (keyboard, mouse, joystick, game controller...)

Description

ST Bluetooth® modules are highly integrated for easy implementation in embedded applications. Class 1 modules enable wireless communication with other Bluetooth® enabled devices up to 100 m away. The GS-BT2416C1.H integrates on a unique FR4 PCB support: BT 1.2 radio and baseband, memory, 32 kHz and 13 MHz oscillator, Vreg as well PA function. The module embeds customer framework up to HCI level allowing interoperability with HCI top resident on Host. The antenna has not been included in order to grant a degree of freedom to the user in selecting the most suitable design and placement between external and integrated antenna that could be SMA aerial or a low cost antenna trace designed on PCB. For more details pleas refer to GS-BT2416C1DB application note. The GS-BT2416C1.H is the HCI module of the GS-BT2416C1.xx series. GS-BT2416C1.H is BQB pre-qualified. Conformance testing through Bluetooth® qualification program enables a fast time to market after system integration by ensuring a high degree of compliance and interoperability.

Contents

1 Certifications

- CE compliant (IMQ Exp. opinion 0081-AREF00017)
  - Safety EN60950-1 (2001)
  - EMC EN301 489 17V1.2.1
  - Radio ES 300 328 V1.6.
  - FCC certified on GS-BT2416C1DB (for a more exhaustive explanation, please refer to GS-BT2416C1DB application note)
  - FCC ID: S9NBT2416C1DB
- BQB compliant

2 Maximum ratings

2.1 Absolute maximum ratings

Absolute maximum ratings (see *Table 1*) indicate limits beyond which damage to the device may occur. Sustained exposure to these limits will adversely affect device reliability.

Operating ranges (see *Table 2*) define the limits for functional operation and parametric characteristics of the module. Functionality outside these limits is not implied.

Table 1. Absolute maximum ratings

Symbol	Parameter	Values		Unit
		Min	Max	
V_{DD}	Module supply voltage		4	V
V_{IN}	Input voltage on any digital pin	Vss_1-0.5	Vdd+0.3	V
T_{stg}	Storage temperature	-40	+85	°C
T_{sold}	Soldering temperature		240	

2.2 Operating ranges

Table 2. Operating ranges

Symbol	Parameter	Conditions	Values			Unit
			Min	Typ	Max	
V_{DD}	Module supply voltage	- 20 °C < T < 70 °C	3.13	3.3	3.47	V
T_{stg}	Operating ambient temperature		-20		+70	°C

3 Electrical characteristics

3.1 DC I/O specification

Table 3. DC input / output specification

Symbol	Parameter	Conditions	Values			Unit
			Min	Typ	Max	
V_{il}	Low level input voltage	3.13 V < V_{DD} < 3.47 V			0.8	V
V_{ih}	High level input voltage	3.13 V < V_{DD} < 3.47 V	2			V
V_{hyst}	Schmitt trigger hysteresis	3.13 V < V_{DD} < 3.47 V	0.4			V
V_{ol}	Low level output voltage	Io load = pin drive capability			0.15	V
V_{oh}	High level output voltage	Io load = pin drive capability	V_{DD}- 0.15			V

4 Bluetooth® section

Table 4. Bluetooth® section

Symbol	Parameter	Conditions	Values			Unit
			Min	Typ	Max	
CHs	Channel space			1		MHz
Hop	Hopping			1600		Hops/ sec
13M CK	System clock			13		MHZ
	System clock stability	- 20 °C to 70 °C	- 20		20	ppm
LP CK	Low power clock			32		kHz
	Low power clock accuracy		- 200		200	ppm
Tra	Transmission rate asynchronous				721	Kbits/ sec
Trs	Transmission rate synchronous				432	Kbits/ sec
Iop	Operation current TX mode			180		mA
	Operation RX mode			60		mA

4.1 RF performance characteristics

In the performance characteristics table the following applies:

- Test condition: nominal
  - Voltage typical Vdd 3.3 V
  - Temperature typical T_A = 25 °C

Parameters are given at antenna pin

Table 5. Transmitter and receiver performance characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
TX Pout	TX output power	2.402 GHz		18	20	dBm
		2.441 GHz		18	20	dBm
		2.480 GHz		18	20	dBm
ACP	TX output spectrum adjacent channel power	IM-NI = 2		- 36		dBm
		IM-NI ≥ 3		- 44		dBm
RX sens	Receiver sensitivity	@BER 0.1 %		- 84		dBm

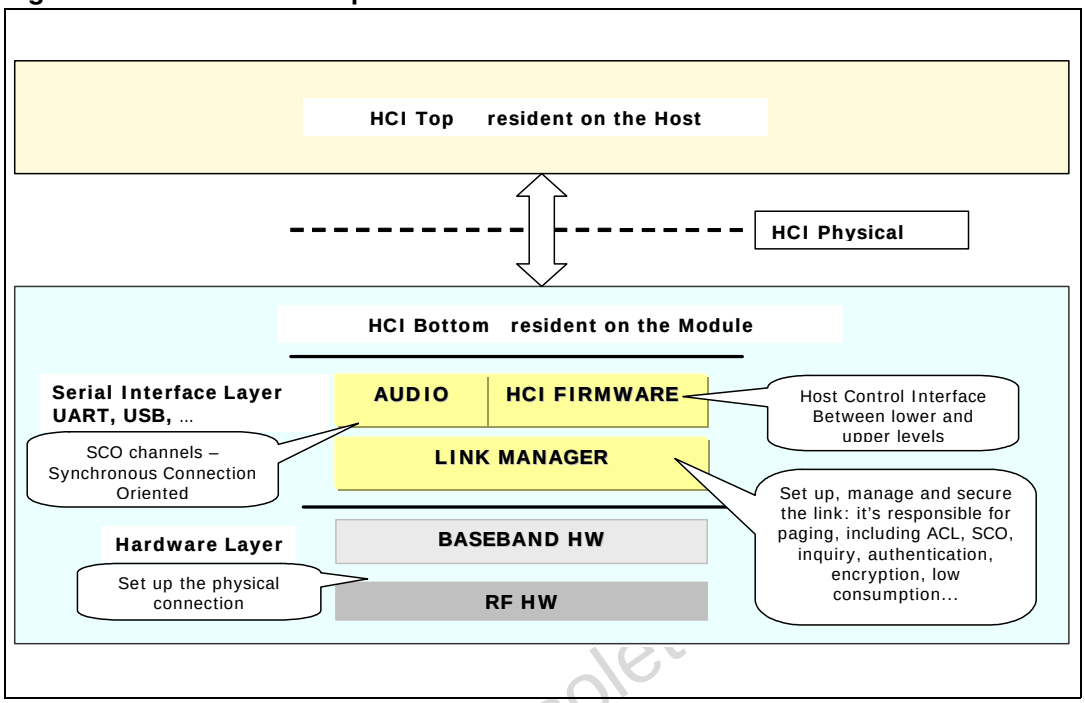
Table 6. Synthesizer performance characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
RF in RF out	Input and output frequency range		2402		2480	MHz
TX out	TX output spectrum at -20 dB Bandwidth			920	1000	kHz
ΔF	TX initial carrier frequency tolerance		- 75		75	kHz
lΔF –pn l	TX carrier frequency drift	DH1 data packet			25	kHz
		DH3 data packet			40	kHz
		DH5 data packet			40	kHz
lΔF/50μsl		Drift rate			20	Hz

5 Integrate firmware

The GS-BT2416C1.H includes customer framework up to HCI (host control interface)

Figure 1. HCI firmware implementation



5.1 Features

The module with HCI embedded is interoperable with qualified BT stack protocols and suitable for any BT applications.

5.2 Command interface

The HCI commands are accessible through the serial port using the host control SW any HCI SW for example bluesoleil (most popular Bluetooth® PC open SW).

5.3 Usage scenarios

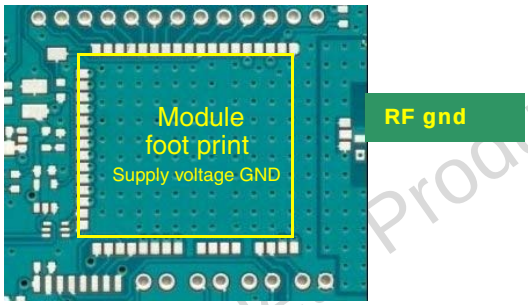
The module with embedded HCI FW is completely open to any custom implementation, strictly depending on the BT stack and profiles that will be added. Module can be configured both as master or slave. Master can support point to point connection or standard point to multi point Pico net up to seven points.

6 Application information

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

- Module is usually put on a motherboard, avoid that traces with switching signals are routed below the module. The best 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 2. Module foot print



6.1 Antenna reference

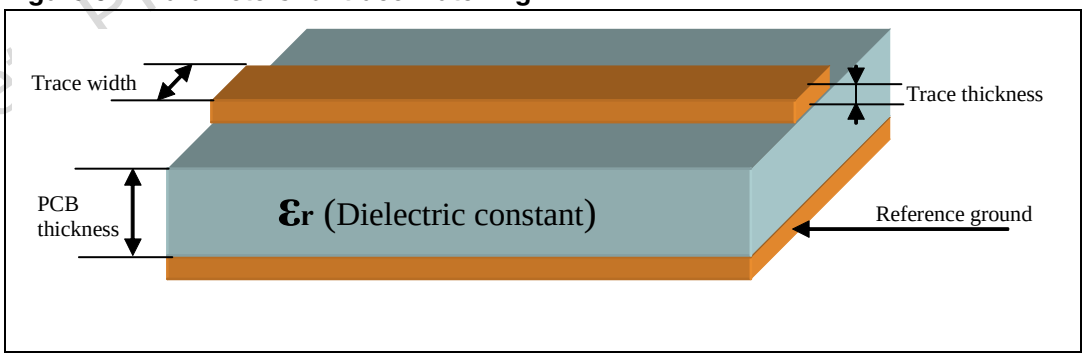
RF output pin must be connected to an antenna which could be:

- Antenna directly printed on the pcb (*Figure 3.*)
- Integrated antenna as, for example, antenova® 30-30-A5839-01, Murata ANCV12G44SAA127, pulse W3008, Yageo CAN4311153002451K. (*Figure 4.*)
- External antenna connected by means a SMA connector (*Figure 5.*)

Figure 3. Antenna on PCB **Figure 4. Antenna examples** **Figure 5. SMA connector for external antenna**

- Despite of the type of antenna chosen, the connection between the RF out pin and the antenna must be executed in such a way that the connection trace must be matched to have characteristic impedance (Z0) of 50 Ω to get the maximum power transfer.
- Matching for 50 Ω is depending on the various factors, elements to be taken into consideration are:
  - Type of material, i.e. FR4
  - The electrical characteristics of the material, i.e. the εr, electric constant at 2.4 GHz
  - Mechanical dimensions of the PCB and traces, i.e. PCB thickness, trace/ reference ground thickness, trace width, trace thickness.
  - Just to give an example, using a 1 mm thick FR4 board, with an εr = 4.3 at 2.4 GHz, with Cu thickness of 41 µm, the resulted width of 50 Ω strip-line is 1.9 mm (Microstrip type calculation).

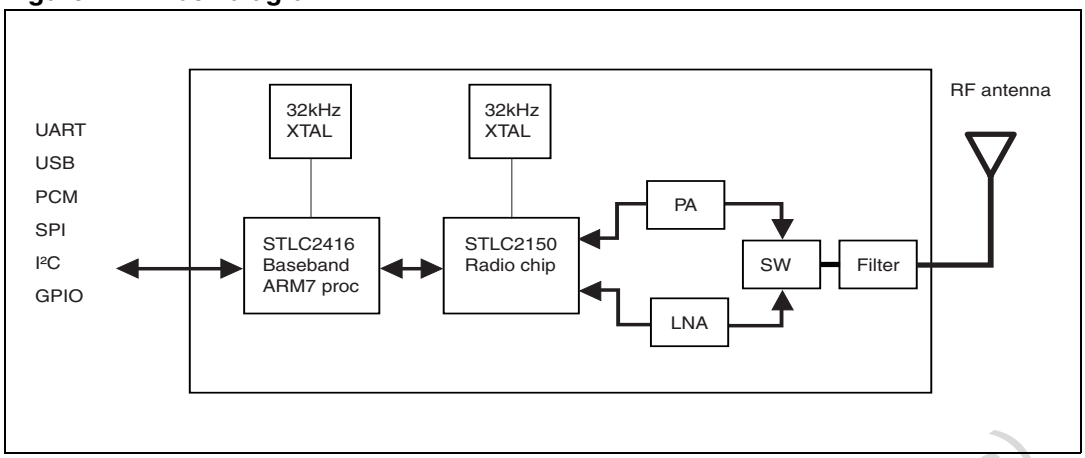
Figure 6. Parameters for trace matching



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

7 Block diagram

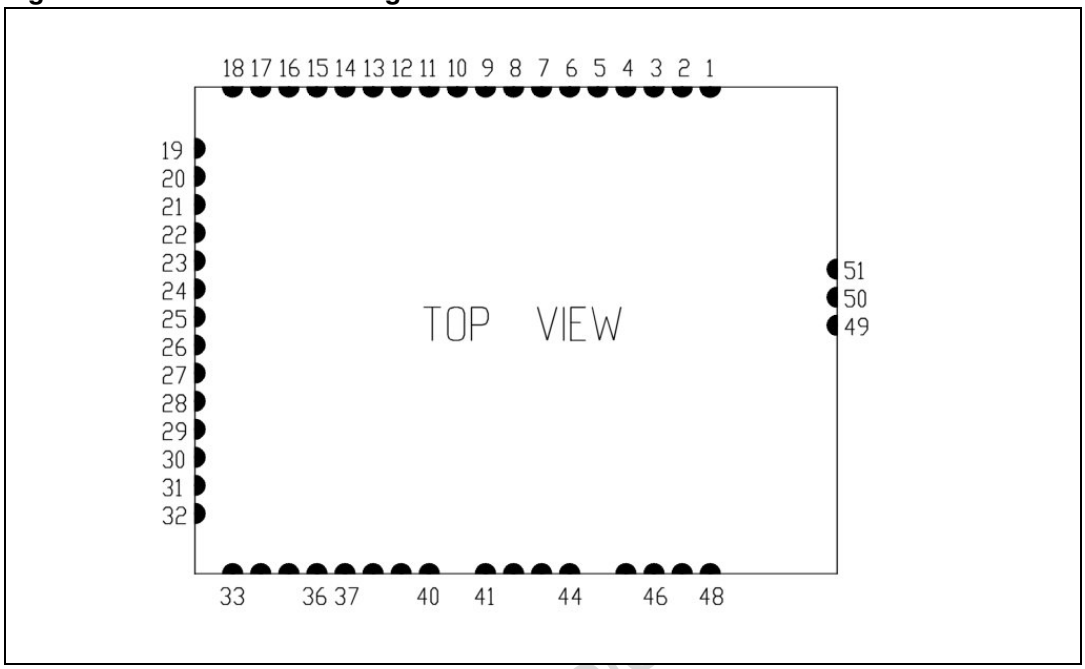
Figure 7. Block diagram



8 Pin settings

8.1 Pin connections

Figure 8. Pin connection diagram



8.2 Pin descriptions

Table 7. Pin descriptions

Pin N°	Name	I/O	Description
Power, ground and system signal			
1	Vss_1	---	GND
2	Vdd	---	Module supply voltage- single 3.3 V
41	1V8	O	1.8 V digital supply out (test purpose) to be left not connected
42	3V3	O	3.3 V I/O power supply out (test purpose) to be left not connected
43	Vss_1	---	GND (test purpose) to be left not connected
44	2V7	O	2.7 digital core supply out (test purpose) to be left not connected
45	RESET	I	Reset pin (active low)
46	BOOT	I	External downloading enable (active low) internally pull-upped to 1.8 V by 10 kΩ
13	LP CLOCK OUT	O	32 kHz out
26	INT1	I	External Interrupt signal internally connected to VSS1 with 10 kΩ / If not used connect to VSS1
General purpose signals			
3	GPIO0	I/O	General purpose I/O line
4	GPIO1	I/O	General purpose I/O line
5	GPIO2	I/O	General purpose I/O line
6	GPIO3	I/O	General purpose I/O line
7	GPIO4	I/O	General purpose I/O line
8	GPIO5	I/O	General purpose I/O line
10	GPIO7	I/O	General purpose I/O line
11	GPIO8	I/O	General purpose I/O line
12	GPIO9	I/O	General purpose I/O line
14	GPIO11	I/O	General purpose I/O line
No connect signals			
9	----	I/O	Not to be used internally used for RX/TX switch
15	----	I/O	Not to be used internally used for TX gain setting
16	----	I/O	Not to be used internally used for TX gain setting
17	----	I/O	Not to be used internally used for TX gain setting
18	----	I/O	Not to be used internally used for TX gain setting

Table 7. Pin descriptions (continued)

Pin N°	Name	I/O	Description
Test interface signals			
19	TDI	---	JTAG pin
20	TDO	---	JTAG pin
21	TMS	---	JTAG pin
22	NTRST	---	JTAG pin
23	TCK	---	JTAG pin If not used connect to VSS1
I2C interface signals			
24	I2C_dat	I/O	I2C bus interface data to be connected to VDD with 10 kΩ resistor
25	I2C_clk	I/O	I2C bus interface clock to be connected to VDD with 10 kΩ resistor
PCM interface signals			
27	PCM_SYNC	I/O	PCM 8 kHz synch
28	PCM_CLK	I/O	PCM clock
29	PCM_A	I/O	PCM data in/out
30	PCM_B	I/O	PCM data in//out
USB interface signals			
31	USB_DN	I/O	USB data - If not used connect to VSS1
32	USB_DP	I/O	USB data + If not used connect to VSS1
UART interface signals			
33	UART2_RXD	I	UART2 data input If not used connect to VDD
34	UART2_TXD	O	UART2 data output
35	UART2_I1	I	UART2 clear to send input If not used connect to VDD
36	UART2_02	O	UART2 ready to send output
47	UART10_TXD	O	UART1 data output
48	UART11_RXD	I	UART1 data input If not used connect to VDD
SPI interface signals			
37	SPI_FRM	I/O	Synchronous serial interface frame synch
38	SPI_CLK	I/O	Synchronous serial Interface clock
39	SPI_TXD	O/T	Synchronous serial Interface transmit data
40	SPI_RXD	I	Synchronous serial Interface receive data If not used connect to VSS1
Antenna signals			
49	Vss_2 (RF GND)	---	RF GND
50	+ANTENNA	---	Antenna out
51	Vss_2 (RF GND)	---	RF GND

9 Soldering

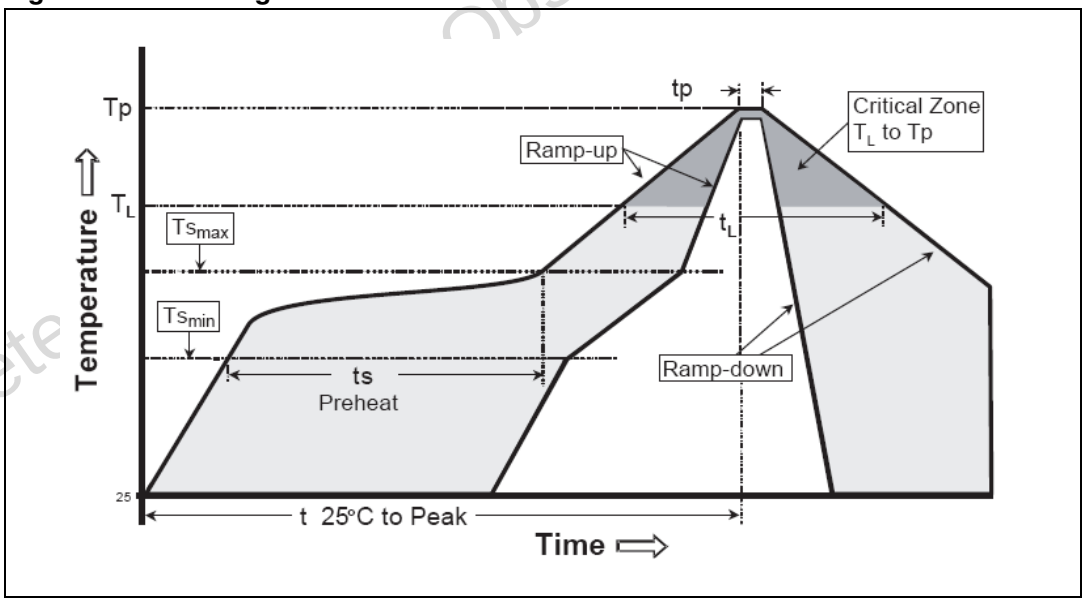
Soldering phase has to be execute with care: in order to avoid undesired melting phenomenon, particular attention has to be take on the set up of the peak temperature.

Here following some suggestions for the temperature profile based on IPC/JEDEC J-STD-020C, July 2004 recommendations.

Table 8. Soldering

Profile feature	PB free assembly
Average ramp up rate (T_{SMAX} to TP)	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 40 – 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 9. Soldering



10 Mechanical dimensions

In order to meet environmental requirements, ST offers these devices in ECOPACK® packages. These packages have a lead-free second level interconnect. The category of second level interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK is an ST trademark. ECOPACK specifications are available at: www.st.com.

Figure 10. Mechanical dimensions

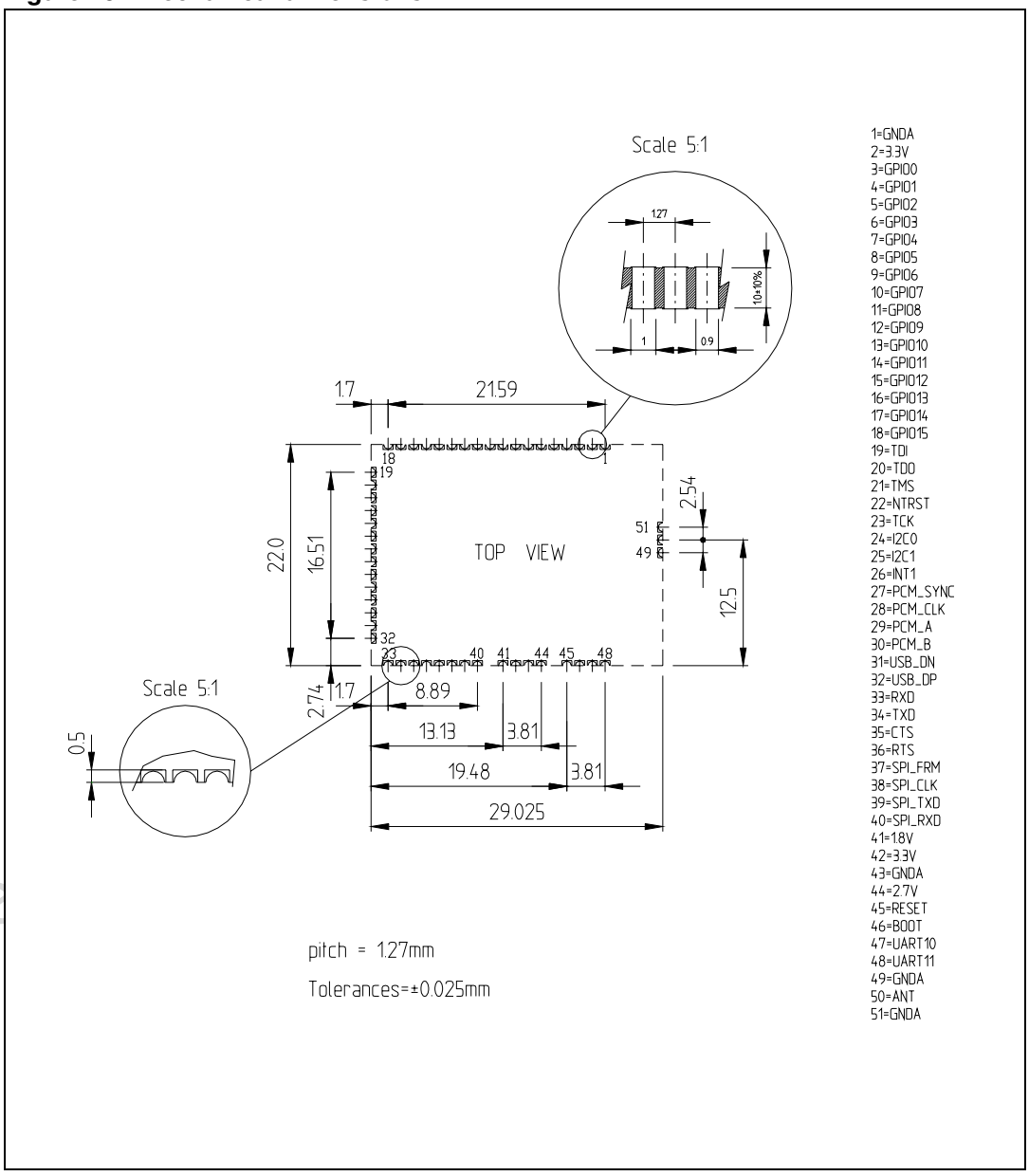
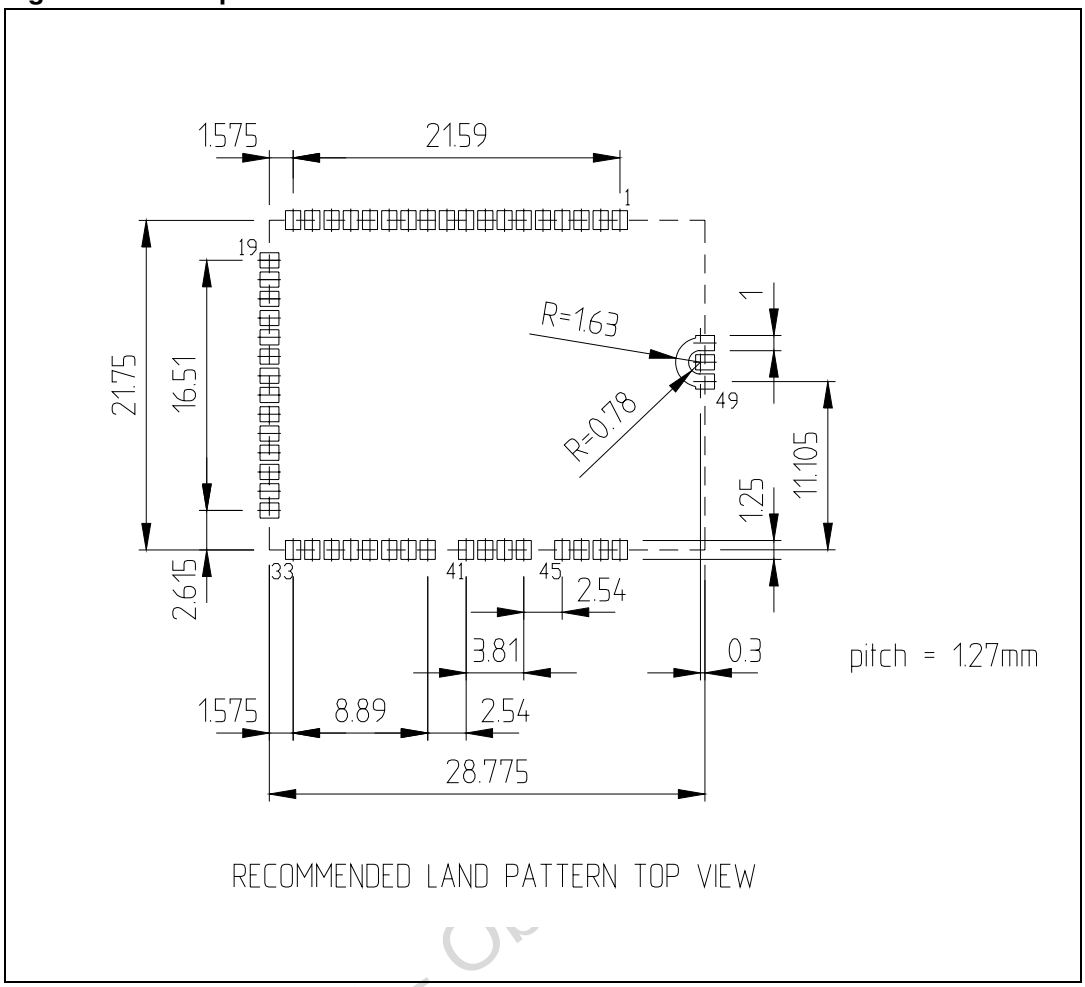
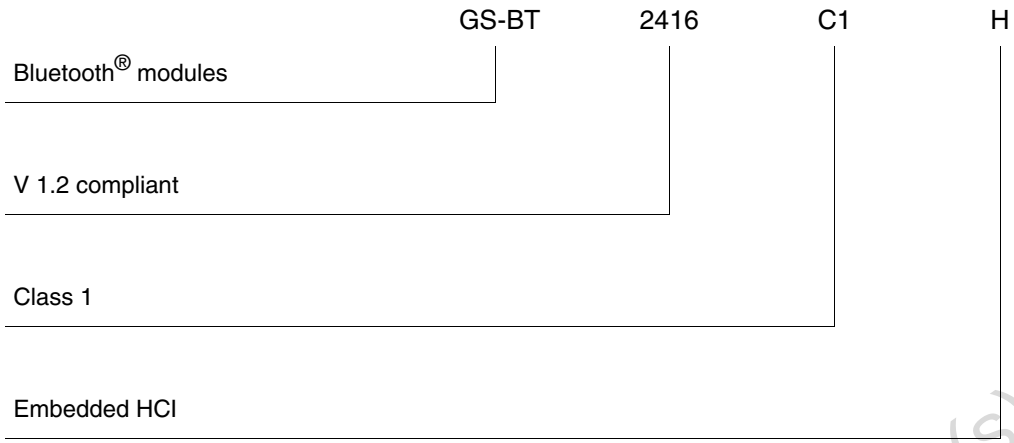


Figure 11. Land pattern



11 Ordering information scheme

Table 9. Ordering information scheme



12 Revision history

Table 10. Revision history

Date	Revision	Changes
31-Aug-2006	1	First release
27-May-2008	2	Updated: Cover page Added: *Section 9 on page 14*

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