SMART®
Modular Technologies
A SOLECTRON COMPANY

Bluetooth Mini Module
Assembly No. ASY90147-1, 2&3

Technical Specifications

Version 1.1

Communication Products Division
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Table of Contents

1. Document Status

Revision	Date	Comments
0.5	September 6, 2002	First draft
0.9	September 23, 2002	Modified Table 1.
0.92	October 11, 2002	Modified Table 1, mechanical drawing, HCI stack features and reflow chart.
0.94	December 6, 2002	Modified Table 1 and mechanical drawing.
1.0	December 10, 2002	First formal release version.
1.1	July, 31, 2003	Minor modifications to reflect address changes and deletion of information, and the three different modules –1, -2,and -3

To make a request for change, correction, additions or information on references, please contact:

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2. Reference

[1] Specification of the Bluetooth System, Version 1.1, February 22, 2001.
[2} BC02-SM-003Pa, "HCIStack1.1v16.3 Software Release Note", Novemb er 2002.

3. Scope

The intention of this specification is to provide a general guideline on the integration of a Bluetooth Mini module. The product specification complies with Bluetooth Specification 1.1 [1].

4. Module General Features and Chipset Description

4.1 Module General Features

The Smart Modular Technologies' Bluetooth Mini module is based on a single chip design. The module can be configured as USB or UART. It is a complete Bluetooth system. The module is offered in three versions:

1. 90147-1: USB configuration up to the HCI level
2. 90147-2: UART configuration up to the HCI level
3. 90147-3: UART configuration with SPP profile preloaded

The module has the following general main features:

- Small footprint 52-pin BGA package with 0.8mm ball and1.27mm pitch (14.43mm x 21.47mm x 3.0mm).
- Highly integrated small, thin module built with high-density mounting technology.
- Class II device.
- On board pin out for direct 50Ω RF trace connection.

- Fully compliant with Bluetooth specification v1.1.
- Full speed HCI UART.
- USB v1.1 compliant and USB2.0 compatible.
- Pulse Code Modulation (PCM) interface.
- Programmable Parallel Input Output (PIO) ports.
- Serial Peripheral Interface (SPI).
- Low power 1.8V operation.
- Full speed Bluetooth ™ operation.
- Full speed USB interface supports OHCI and UHCI host interface.
- Full piconet support.
- 8Mbit external flash.
- Very low power consumption in active and standby modes.
- Support for low power sleep modes.
- Firmware upgradeable via UART, USB or SPI interface.
- RF Shielding Can.
- Conforms to FCC Part 15, ICAN RSS-210, ETSI, ARIB ST-T66, CE and (per customers request for other countries' EMI standards).
- Temperature range: -20°C to +95°C.

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5. Mechanical Drawing:

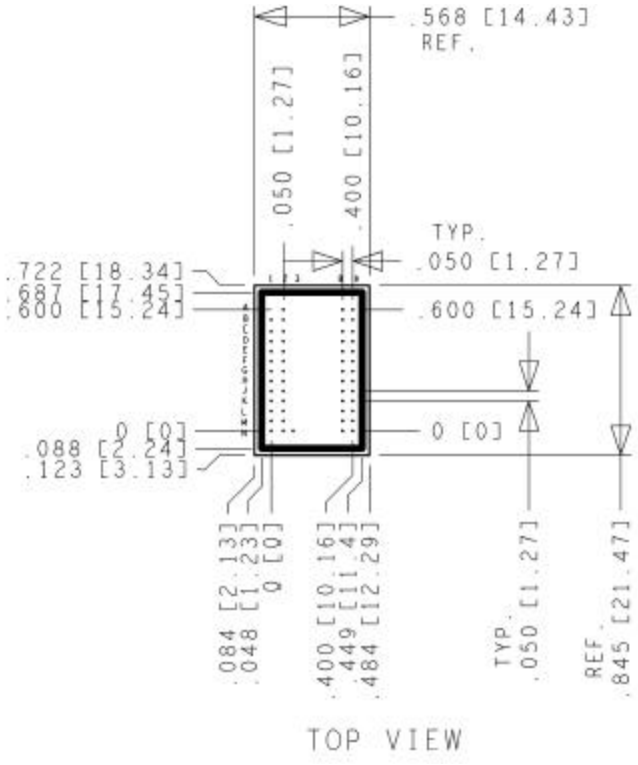

Figure 1. Mechanical drawing of Bluetooth Mini module.

6. Interface Definitions:

Table 1. Bluetooth Mini module interface definitions

Pin#	Name	Type	Note
A2	GND	GND	Ground
A8	VIN_3.3V	I	3.3V input
A9	VIN_3.3V	I	3.3V input
B1	N/C		No Connection
B2	N/C		No Connection
B8	GND	GND	Ground
B9	GND	GND	Ground
C1	PCM_IN	I	PCM synchronous data input
C2	N/C		No Connection
C8	N/C		No Connection
C9	N/C		No Connection
D1	PCM_OUT	O	PCM synchronous data output

D2	PCM_SYNC	I/O	PCM synchronous data SYNC
D8	PIO[10]	I/O	Programmable I/O terminal
D9	PIO[2]	I/O	USB_PULL_UP
E1	PCM_CLK	I/O	PCM synchronous data clock
E2	RXD	I	UART data input active high
E8	PIO[5]	I	USB_DETACH
E9	PIO[11]	I/O	Programmable I/O terminal
F1	CTS	I	UART clear to send active low
F2	TXD	O	UART data output active high
F8	PIO[9]	I/O	Programmable I/O terminal
F9	PIO[8]	I/O	Programmable I/O terminal
G1	SPI_MOSI	I	Serial Peripheral interface data input
G2	RTS	O	UART request to send active low
G8	PIO[7]	I/O	Programmable I/O terminal
G9	PIO[6]	I/O	CLK_REQ
H1	USB D+	I/O	USB data plus
H2	SPI_CLK	I	Serial Peripheral interface clock
H8	PIO[1]	I/O	Control output for external PA Class I application only
H9	RST	I	Hardware reset, 3.3V±10% for > 5ms
J1	USB D-	I/O	USB data minus
J2	SPI_CSB	I	Select for Synchronous Serial Interface active low
J8	NC		No Connection
J9	NC		No Connection
K1	SPI_MISO	O	Serial Peripheral interface data output
K2	PIO[0]	I/O	Control output for external LNA (if fitted)
K8	N/C		No Connection
K9	N/C		No Connection
Pin#	**Name**	**Type**	**Note**
L1	PIO[4]	I/O	USB_ON
L2	N/C		No Connection
L8	N/C		No connection
L9	N/C		No connection
M1	PIO[3]	I/O	USB_WAKE_UP
M2	N/C		No connection
M8	N/C		No connection
M9	N/C		No connection
N1	ANT	RF I/O	50 Ω RX/TX connection to antenna
N2	GND	GND	Ground
N3	N/C		No connection
N8	GND	GND	Ground
N9	GND	GND	Ground

7. General Specifications

Table 2. General Specifications

Item	SPECIFICATION
Carrier Frequency	2400MHz to 2483.5MHz
Modulation	GFSK, 1Mbps, 0.5BT Gaussian
Channel Intervals	1MHz
Number of Channels	79
Frequency Hopping	1600 hops/sec, 1MHz channel space
Receive Sensitivity	-82 dBm typ. @0.1% BER
Transmission Power	+4dBm max.
Maximum Data Throughput	Asynchronous : 721kbps/57.6kbps Synchronous : 432.6kbps/432.6kbps
Output Interface	Full speed UART (921.6kbps), USB (12Mbits/s), PCM, SPI and PIO.
Reset	Hardware and Software
Power Supply	3.3V±10%
Operating Voltage	1.8V for the BT chip
Operating Temperature Range	-20°C to 95°C
Storage Temperature Range	-40°C to 150°C
Dimensions	14.43 mm x 21.47mm x 3.0mm
Antenna Interface	Direct 50 Ω RF trace contact

8. Bluetooth Mini Module Block Diagram

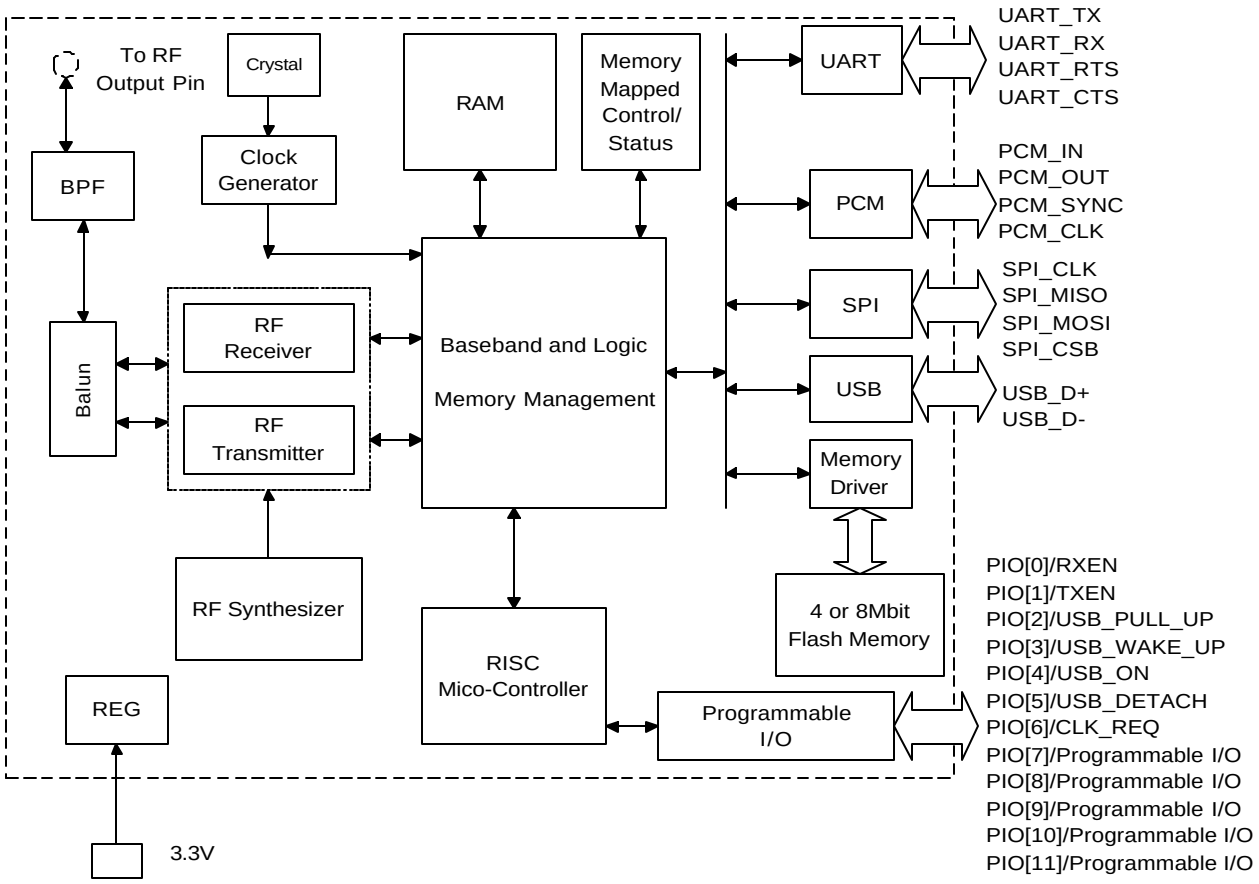

Figure 2. Bluetooth Mini Module Block Diagram

9. Electrical Characteristics

Absolute maximum Ratings

- Storage Temperature ---------- -40°C to 150°C (ambient)
- Supply Voltage ---------- -0.4V to 3.6V (MAX)

Operating Conditions

- Temperature Range ---------- -20°C< T_A<95°C
- Supply Voltage Range --------- 3.3V±10%

Table 3. Radio Characteristics(Note: 3)

VDD = 1.8V Temperature = -20°C						
Receiver	**Frequency (GHz)**	**Min**	**Typ**	**Max**	**Bluetooth Specification**	**Unit**
Sensitivity at 0.1% BER	2.402	-	-83	-80	≤-70	dBm
	2.441	-	-85	-80		dBm
	2.480	-	-85	-80		dBm
Maximum received signal at 0.1% BER		0	-	-	[3] -20	dBm
Transmitter	**Frequency (GHz)**	**Min**	**Typ**	**Max**	**Bluetooth Specification**	**Unit**
RF transmit power	2.402	0	3	4	-6 to +4	dBm
	2.441	0	3	4		dBm
	2.480	0	3	4		dBm
RF power control range		-	35	-	≥16	dB
RF power range control resolution		-	1.8	-	-	dB
20 dB bandwidth for modulated carrier		-	800	-	1000	KHz
Initial carrier frequency tolerance		-	±25	-	≤ ±75	KHz
Drift		-	±15	-	≤ ±25	KHz
Drift Rate		-	±20	-	400	Hz/µs
$\Delta f1_{avg}$ "Maximum Modulation"		-	165	-	$140<\Delta f1_{avg}<175$	KHz
$\Delta f2_{avg}$ "Minimum Modulation"		-	150	-	115	KHz
VDD = 1.8V Temperature = +20°C						
Receiver	**Frequency (GHz)**	**Min**	**Typ**	**Max**	**Bluetooth Specification**	**Unit**
Sensitivity at 0.1% BER	2.402	-	-82	-80	≤-70	dBm
	2.441	-	-84	-80		dBm
	2.480	-	-84	-80		dBm

Maximum received signal at 0.1% BER		0	-	-	[3] -20	dBm
Transmitter	**Frequency (GHz)**	**Min**	**Typ**	**Max**	**Bluetooth Specification**	**Unit**
RF transmit power	2.402	0	2.5	4	-6 to +4	dBm
	2.441	0	2.5	4		dBm
	2.480	0	2.5	4		dBm
RF power control range		-	35	-	≥16	dB
RF power range control resolution		-	1.8	-	-	dB
20 dB bandwidth for modulated carrier		-	800	-	1000	kHz
Initial carrier frequency tolerance		-	±25	-	≤ ±75	kHz
Drift		-	±15	-	≤ ±25	kHz
Drift Rate		-	±20	-	400	Hz/µs
$\Delta f1_{avg}$ "Maximum Modulation"		-	165	-	$140<\Delta f1_{avg}<175$	kHz
$\Delta f2_{avg}$ "Minimum Modulation"		-	150	-	115	kHz
C/I co-channel		-	10	11	≤ 11	dB
Adjacent channel selectivity C/I $f=f_0 \pm 1$MHz		-	-4	0	≤ 0	dB
Adjacent channel selectivity C/I $f=f_0 \pm 2$MHz		-	-35	-30	≤ -30	dB
Adjacent channel selectivity C/I $f \geq f_0+3$MHz		-	-45	-	≤ -40	dB
Adjacent channel selectivity C/I $f \leq f_0-3$MHz		-	-45	-	≤ -40	dB
Adjacent channel selectivity C/I $f=f_{image}$		-	-18	-9	≤ -9	dB
Adjacent channel Transmit power $f=f_0 \pm 2$MHz		-	-35	-20	≤ -20	dBc
Adjacent channel Transmit power $f=f_0 \pm 3$MHz		-	-45	-40	≤ -40	dBc
VDD = 1.8V Temperature = +95°C						
Receiver	**Frequency (GHz)**	**Min**	**Typ**	**Max**	**Bluetooth Specification**	**Unit**
Sensitivity at 0.1% BER	2.402	-	-81	-80	≤-70	dBm
	2.441	-	-82	-80		dBm
	2.480	-	-82	-80		dBm
Maximum received signal at 0.1% BER		0	-	-	[3] -20	dBm
Transmitter	**Frequency (GHz)**	**Min**	**Typ**	**Max**	**Bluetooth Specification**	**Unit**
RF transmit power	2.402	0	1	4	-6 to +4	dBm
	2.441	0	1	4		dBm
	2.480	0	1	4		dBm
RF power control range		-	35	-	≥16	dB

RF power range control resolution	-	1.8	-	-	dB
20 dB bandwidth for modulated carrier	-	800	-	1000	kHz
Initial carrier frequency tolerance	-	±25	-	≤ ±75	kHz
Drift	-	±15	-	≤ ±25	kHz
Drift Rate	-	±20	-	400	Hz/µs
$\Delta f1_{avg}$ "Maximum Modulation"	-	165	-	$140<\Delta f1_{avg}<175$	kHz
$\Delta f2_{avg}$ "Minimum Modulation"	-	150	-	115	kHz

Note 1. Power at antenna port.
Note 2. Measured according to the Bluetooth specification v1.1 and Bluetooth RF test specification 0.91.
Note3. Some of the data is based on the Bluetooth chip, Module data may differs.

Table 4. Module Current Consumption

Average Current Consumption			
VDD = 1.8V Temperature = +20°C			
Mode	**Avg**	**Peak**	**Unit**
SCO connection HV3 (40 ms interval Sniff Mode) (Slave)	26.0	-	mA
SCO connection HV3 (40 ms interval Sniff Mode) (Master)	26.0	-	mA
SCO connection HV1 (Slave)	53.0	-	mA
SCO connection HV1 (Master)	53.0	-	mA
ACL data transfer 115.2kbps UART (Master)	15.0	-	mA
ACL connection, Sniff Mode 40ms interval, 38.4kpbs UART	4	-	mA
ACL connection, Sniff Mode 1.28s interval, 38.4kpbs UART	8	-	mA
Parked Slave, 1.28s beacon interval, 38.4kpbs UART	.6	-	mA
ACL data transfer 720kbps USB (Slave)	53.0	-	mA
ACL data transfer 720kbps USB (Master)	53.0	-	mA
Standby mode (Connected to host, no RF activity)	7	-	mA
Peak Current Consumption			
VDD = 1.8V Temperature = +20°C			
Mode	**Typ**	**Max**	Unit
Deep Sleep Mode	300	500	µA
Peak current during TX burst (+4 dBm)	70.0	80	mA
Peak current during TX burst (0dBm)	60.0	70	mA
Peak current during RX burst (-85 dBm)	50.0	70	mA

Notes: Current consumption is based on BC0212015A and includes current supplied to external 3V Flash.

10. UART Interface

The Universal Asynchronous Receiver Transmitter (UART) interface provides a mechanism for communicating with other serial devices using the RS232 standard. When the module is connected to another digital device, UART_RX and UART_TX transfer data between the two devices. The other two signals, UART_CTS and UART_RTS, can be used to implement RS232 hardware flow control where both are active low indicators.

Table 5. Possible UART Settings

Parameter		**Possible Values**
Baud Rate	Minimum	1200 Baud (≤2% Error)
		9600 Baud (≤1% Error)
	Maximum	1.5MBaud (≤1% Error)
Flow Control		RTS/CTS or None
Parity		None, Odd or Even
Number of Stop Bits		1 or 2
Bits per channel		8

11. USB Interface

The Universal Serial Bus (USB) interface on the module provides a full-speed (12Mbits/s) data throughput, capable of driving a USB cable directly. No external USB transceiver is required. The device operates as a USB peripheral, responding to requests from a master host controller such as a PC. Both the OHCI and the UHCI standards are supported. Only the USB slave operation is supported.

Table 6. USB Data Connections

USB Connections	**Function**
D-	“Differential” 0
D+	“Differential” 1

12. PCM

Pulse Code Modulation (PCM) is the standard method used to digitize human voice patterns for transmission over digital communication channels. The module has hardware

support for continual transmission and reception of PCM data, thus reducing processor overhead for wireless headset applications. The module offers a bi-directional digital audio interface routes directly into the baseband layer of the on-chip firmware. Up to three SCO connections can be supported by the PCM interface at any one time.

The PCM interface can be configured as Master or Slave. When it operates as the PCM interface Master, it generates an output clock of 128, 256 or 521kHz. When configured as PCM interface Slave, it can operate with an input clock up to 2048kHz. It is compatible with a variety of clock formats, including Long Frame Sync, Short Frame Sync and GCI timing.

The module supports 13 or 16-bit linear, 8-bit µ-law or A-law sample formats at 8ksamples/s and can receive and transmit on any selection of the three of the first four slots following PCM_SYNC.

The PCM interface on the module can interfaces directly to PCM audio devices includes the following:

- Qualcomm MSM 3000 series and MSM 5000 series CDMA baseband devices.
- OKI MSM7705 four-channel A-lay and µ-law CODEC.
- Motorola MC145481 8-bit A-law and µ-law CODEC.
- Motorola MC145483 13-bit linear CODEC.

13. The Parallel Input Output (PIO) Port

The PIO is a general-purpose I/O interface to the module. The module has ports with twelve programmable, bi-directional I/O lines, PIO[11:0]. Programmable I/O lines can be accessed either via an embedded application running on the module or via private channel or manufacture-specific HCI commands. Six PIO ports, PIO[5:0], are implemented on the module.

PIO[0]/RXEN
This is a multifunction terminal. Its function is selected by setting the Persistent Store Key PSKEY_TX/RX_PIO_CONTROL (0x209). It can be used as a programmable I/O, however it will normally be used to control the radio front-end receive switch.
PIO[1]/TXEN
This is a multifunction terminal. Its function is selected by setting the Persistent Store Key PSKEY_TX/RX_PIO_CONTROL (0x209). It can be used as a programmable I/O, however it will normally be used to control the radio front-end transmit switch.

PIO[2]/USB_PULL_UP
This is a multifunction terminal. For UART versions, it is a programmable I/O. On USB versions, it can drive a pull-up resistor on USB_D+. For application using external RAM this terminal may be programmed for chip select.

PIO[3]/USB_WAKE_UP
This is a multifunction terminal. For UART versions, it is a programmable I/O. On USB versions, its function is selected by setting the Persistent Store Key PSKEY_USB_PIO_WAKEUP (0x2cf) either as a programmable I/O or as a USB_WAKE_UP function.

PIO[4]/USN_ON
This is a multifunction terminal. For UART versions, it is a programmable I/O. On USB versions, the USB_ON function is also selectable.

PIO[5]/USB_DETACH
This is a multifunction terminal. For UART versions, it is a programmable I/O. On USB versions, the USB_DETACH function is also selectable.

PIO[6]/CLK_REQ
This is a multifunction terminal, its function is determined by Persistent Store Keys. Using PSKEY_CLOCK_REQUEST_ENABLE (0x246), it can be configured to be low when the module is in deep sleep and high when a clock is required. The clock must be supplied within 4ms of the rising edge of PIO[6] to avoid losing timing accuracy in certain Bluetooth operation modes.

PIO[7]
Programmable I/O terminal.

PIO[8]
Programmable I/O terminal.

PIO[9]
Programmable I/O terminal.

PIO[10]
Programmable I/O terminal.

PIO[11]
Programmable I/O terminal.

Note: USB functions can be software mapped to any PIO terminal, the present module support PIOs [0 - 5].

14. Key Features of HCI Stack

- Bluetooth components: Baseband (including LC), LM and HCI.
- Standard USB v1.1 and UART (H4) HCI Transport Layers.
- All standard radio packet types.
- Full Bluetooth data rate, up to 721kbps asymmetric.
- Operation with up to seven slaves.
- Maximum number of simultaneous active ACL connections: 7
- Maximum number of simultaneous active SCO connections: 3
- Operation with up to 3 SCO links, routed to one or more slaves.
- Role switch: can reverse Maser/Slave relationship.
- All standard SCO voice codings, plus "transparent SCO".
- Standard operating modes: page, inquiry, page-scan and inquiry-scan.
- All standard pairing, authentication, link key and encryption operations.
- Standard Bluetooth power saving mechanisms: Hold, Sniff and Park modes, including "Forced Hold".
- Dynamic control of peers' transmit power via LMP.
- Master/Slave switch.
- Broadcast.
- Channel quality driven data rate.
- All standard Bluetooth Test Modes.
- Standard firmware upgrade via UART interface.
- Standard firmware upgrade via USB interface.
- Provides manufacture-specific HCI extension commands with the following features:
  - Access to the chip's general-purpose PIO port.
  - Access to the chip's Bluetooth clock.
  - The negotiated effective encryption length on established Bluetooth links.
  - Access to the firmware's random number generator.
  - Controls to set the default and maximum transmit powers.
  - Dynamic UART configuration.
  - Radio transmitter enable/disable.
- A UART "break" condition can be used in two ways:
  - Presenting a UART break condition on the module can force the chip to perform a hardware reboot.
  - Presenting a break condition at boot time can hold the chip in a low power state, thus preventing normal initialization while the condition exists.
- Hardware low power modes: Shallow Sleep and Deep Sleep.

- SCO channels are normally routed over HCI. However, up to three SCO channels can be routed over the chip's single PCM port (at the same time as routing other SCO channels over HCI).

15. Qualification

15.1 Bluetooth Qualification Tests.
15.2 USB Qualification Tests.

16. Agency and Regulatory Body Approvals

16.1 Safety Compliance

- IEC 60 950:1999 (3rd Edition) "Safety of Information Technology" including all CB scheme country deviations.
- EN 60950:2000 "Safety of Information Technology", European Union.
- UL 60950:2000 (3rd Edition) "Safety of Information Technology", USA, Canada.

16.2 Electromagnetic Compatibility (EMC)

- FCC Part 15, Class B "Radio Frequency Devices", USA.
- ICES-003, Issue 3 "Interference-causing equipment standard - digital apparatus", Canada.
- EN 301 489-17:2000 "Electromagnetic Compatibility for Radio Equipment and Services", European Union.
- VCCI, "Interference By Information Technology Equipment", Japan.

16.3 Radio Compliance

- FCC Part 15 "Radio Frequency Devices", USA.
- ICAN RSS-210, Issue 5 "Low Power License-Exempt Radio Communication Devices", Canada.
- EN 300 328-2:2001 "Data Transmission Equipment Operating in 2.4GHz ISM Band Using Spread Spectrum Modulation Technique", European Union.
- ARIB STD-T66 "Second Generation Low Power Data Communication System and Wireless LAN System", ARIB STD-33, "Low Power data Communication System of Wireless Equipment", Japan.

16.4 CE Marking

- EN 60950:2000 "Safety of Information Technology", European Union.
- EN 301 489-17:2000: "Electromagnetic Compatibility for Radio Equipment and Services", European Union.
- EN 300 328-2:2001 "Data Transmission Equipment Operating in 2.4GHz ISM Band Using Spread Spectrum Modulation Technique", European Union.

17. Manufacture Procedure and Production Test

17.1 Manufacture Process Flow
- Process and X-ray

17.2 Manufacture Test
- F/T

18. Product Design and Related Documentations

- Hardware & SW Functional Test Reports
- Hardware Compatibility Test Report
- Hardware/SW performance Test Report
- Hardware EMI Test Report
- Hardware Reliability Test Report
- Hardware Environmental Test Report
- Product Specifications
- Chipsets Specifications
- Schematics
- BOM
- Layout
- Drawings
- PCB artwork
- SW Process Control / Release process document