Device Features

- No external components required
- Simple serial UART communications
- EasyConnect™ enabled
- 2.4GHz FHSS technology ensures high reliability and robustness to interference
- Unique surface mount pad design that can be flow soldered or hand soldered
- Low current consumption
- Small footprint 14.5mm x 25mm x 2.1mm
- Up to 320kbps continuous throughput
- Fully Qualified Bluetooth v2.0+EDR
- FCC Part 15 Modular Approval
- RoHS certified
- Supports 2.2 - 4.2V supply voltage
- Supports 1.8 to 3.6V I/O

EmbeddedBlue™ eb101

OEM Bluetooth® Serial Module

Production Information Data Sheet for:

eb101

February 10, 2009

General Description

The EmbeddedBlue eb101 surface mount module is a highly integrated and easy to use Bluetooth solution designed for low cost and reliability.

The eb101 implements all components of the Bluetooth stack on board so that additional host processor code is not required. Once a connection to another Bluetooth device has been established, the link has the appearance of a cabled serial connection eliminating the need for special wireless protocol knowledge.

Simple UART communication facilitates the interface between the host processor and the eb101 radio. This UART interface may be used to discover, connect, and communicate with other Bluetooth devices through a simple ASCII command set.

EasyConnect provides the option for a drop-in cable replacement solution without having to issue commands. A simple push button and LED provide all the control necessary to establish and maintain a wireless connection.

Applications

- Medical Equipment
- POS Systems
- Telemetry Systems
- Industrial Automation
- Barcode and RFID scanners
- Lighting Control
- Robotics

The EmbeddedBlue eb101 surface mount module is ideal for enabling cost sensitive designs with a widely supported industry standard wireless protocol. Monitoring and control applications will benefit from an integrated implementation of the serial port profile for seamless connectivity with desktop computers, PDAs, and cellular phones. A focus on low current consumption makes the eb101 ideal for use in standalone battery powered devices common to medical and remote data capture applications.

The eb101 has been designed to simplify both hardware and software integration of Bluetooth to reduce development costs. The highly integrated design and surface mount package streamlines production in both low and high volume applications.

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1 Key Features

Radio

- Based on CSR's BC4-Ext Bluetooth Chip
- +6dBm RF transmit power w/level control
- Bluetooth v2.0+EDR compliant
- Integrated Antenna, U.FL connector, and RF pad versions available.
- Support for Adaptive Frequency Hopping (AFH) and 802.11 coexistence
- 2.4GHz FHSS technology ensures high reliability and is robust to interference
- Full reference designs are available

Firmware

- Simple ASCII interface for command and control of Bluetooth technology
- EasyConnect enabled for simple cable replacement solution
- Secure point to point communications
- 56-bit encryption
- Fully embedded Bluetooth stack including the Generic Access Profile (GAP), Service Discovery Profile (SDP), Dial Up Networking Profile (DUN) and Serial Port Profile (SPP)
- Wireless connection status output line
- Output line for visual indicator LED
- Host wakeup output line (future firmware function)
- Break control input line

UART Interface

- Baud rates from 1.2kbps to 460.8kbps are supported
- Optional hardware flow control
- Standard 8 bit, no parity, one stop bit (8N1) communications
- 1.8 – 3.6V logic levels for Tx, Rx, and I/O lines

Power

- 2.2 – 4.2VDC supply voltage
- Low operating power consumption
- RESET line controls module boot and restart

Device

- Up to 320kbps continuous data transfer rate
- Unique surface mount pad design that can be flow soldered or hand soldered
- Small footprint 14.5mm x 25mm x 2.1mm
- All devices have a globally unique ID

Data Integrity

- CQDDR increases the effective data rate in noisy environments.
- RSSI used to minimize interference to other radio devices using the ISM band.

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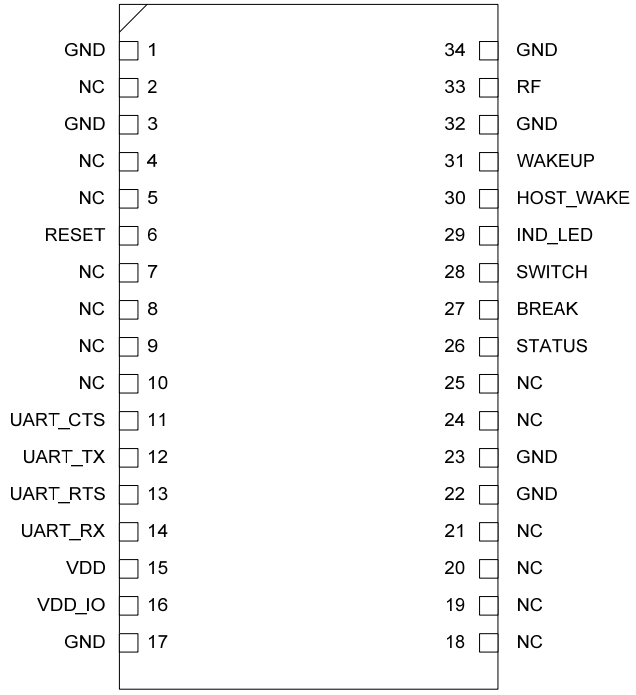
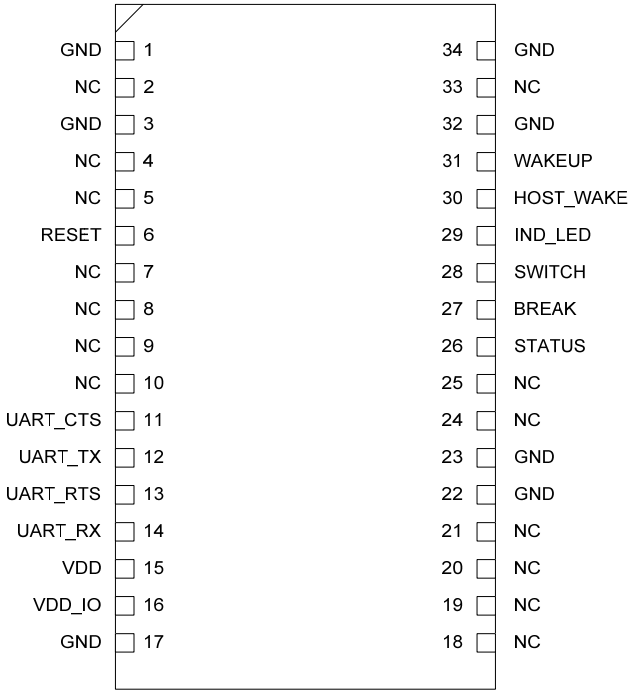
2 Device Pinout Diagram

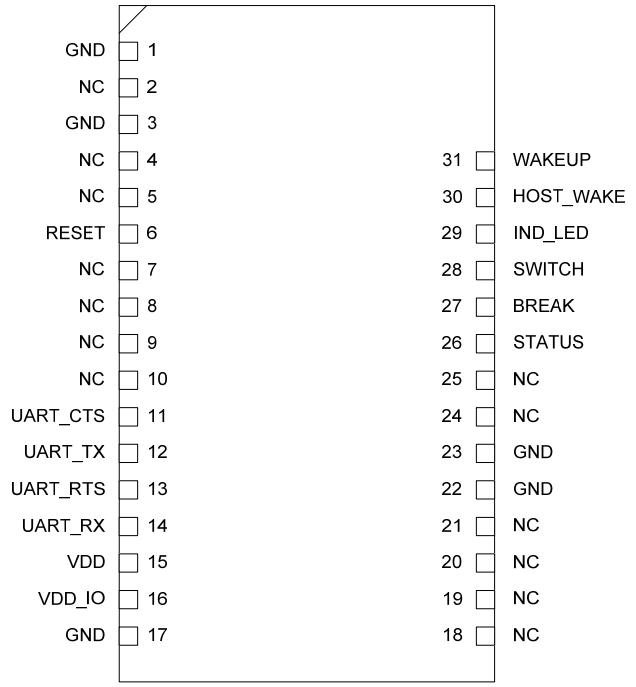
The following diagrams are oriented from the top of the device. The eb101 module has a white triangle in the upper left corner near pin 1.



eb101 with RF Pad Pinout



eb101 with U.FL Antenna Connector Pinout



eb101 with Internal Antenna Pinout

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3 Device Terminal Functions

Radio and Control	Pin	Type	Description
RESET	6	CMOS input with weak internal pull-up	Reset if low. Input debounced; must be low for >5ms to cause a reset
STATUS	26	CMOS output	Low when there is an active connection; otherwise high
BREAK	27	CMOS input with weak internal pull-up	Break if low, Input debounced; must be signaled for >5ms to cause a break
SWITCH	28	CMOS input with weak internal pull-up	Signaled if low. Can be used to initiate EasyConnect or factory reset
IND_LED	29	CMOS output	For connection to an indicator LED. A maximum of 8mA may be drawn from this line
HOST_WAKE (future firmware function)	30	CMOS output	Active low wake signal. Indicates UART communication to host is imminent
WAKEUP (future firmware function)	31	CMOS input with weak internal pull-up	Awake if low. Input debounced; must be low for >5ms to cause a wake
RF (RF Pad Version Only)	33	Bi-directional analog	Connect to a 50Ω Bluetooth ISM Band antenna

UART	Pin	Type	Description
UART_CTS	11	CMOS input with weak internal pull-down	UART clear to send, active low
UART_TX	12	CMOS output	UART data output, active high
UART_RTS	13	CMOS output, tristate with internal pull-up	UART request to send, active low
UART_RX	14	CMOS input with weak internal pull-down	UART data input, active high

Power Supply	Pin	Type	Description
GND	1 3 17 22 23 32 34	Ground connection	All ground pins must be connected
VDD	15	Supply voltage	Positive supply. Usage is optional if supplying 3.3V to VDD_IO
VDD_IO	16	Supply voltage	Positive supply for UART and I/O ports

Unconnected Terminals	Pin	Description
NC	2, 4, 5, 7, 8, 9, 10, 18, 19, 20, 21, 24, 25	Leave unconnected

4 Electrical Characteristics

Absolute Maximum Ratings		
Rating	**Min**	**Max**
Storage Temperature	-40°C	120°C
Supply Voltage: VDD	-0.4V	5.6V
Supply Voltage: VDD_IO	-0.4V	3.7V

Recommended Operating Conditions		
Rating	**Min**	**Max**
Operating Temperature Range	-40°C	+85°C
Supply Voltage: VDD	2.2V	4.2V
Supply Voltage: VDD_IO (VDD is powered)	1.7V	3.6V
Supply Voltage: VDD_IO (VDD is not powered)	3.0V	3.6V

Input/Output Terminal Characteristics				
Digital Terminals	**Min**	**Typ**	**Max**	**Unit**
Input Voltage				
V_{IL} input logic level low	-0.4	-	+0.4	V
V_{IH} input logic level high	0.7VDD_IO	-	VDD_IO+0.4	V
Output Voltage				
V_{OL} output logic level low	-	-	0.2	V
V_{OH} output logic level high	VDD_IO-0.2	-	-	V
Input and Tristate Current with:				
Strong pull-up	-100	-40	-10	µA
Strong pull-down	+10	+40	+100	µA
Weak pull-up	-5	-1	-0.2	µA
Weak pull-down	0.2	+1	+5	µA
I/O pad leakage current	-1	0	+1	µA

Average Current Consumption				
VDD=3.0V Temperature = 20°C				
Mode	**Type**	**Baud Rate**	**Avg**	**Unit**
Data transfer	Master	115.2kbps	14	mA
Data transfer	Slave	115.2kbps	27	mA
Idle connection 40ms sniff	-	38.4kbps	3	mA
Idle connection 1.28s sniff	-	38.4kbps	470	µA
No connection in sleep	-	38.4kbps	110	µA

Peak Current Consumption			
VDD=3.0V Temperature = 20°C			
Mode	**Type**	**Value**	**Unit**
Peak current during cold boot	-	62	mA
Peak current during TX burst	Master	55	mA
Peak current during RX burst	Master	43	mA
Peak current during TX burst	Slave	57	mA
Peak current during RX burst	Slave	50	mA

Notes:

These results are typical for the eb101 Revision A running firmware version 2.2. Different values may be experienced when using other hardware or firmware versions.

5 Device Terminal Descriptions

5.1 Radio and Control

5.1.1 RESET

When this line is driven low, the eb101 module will enter reset mode and remain there until this line is driven high. This line is debounced so it must be held low for > 5ms to cause a reset. Use of this line is optional.

5.1.2 STATUS

This is an output line that can be used to monitor the status of a Bluetooth connection in both command mode and EasyConnect mode. This line will be low when there is an active connection and high when there is no connection. A maximum of 8mA of current may be drawn from this line. Use of this line is optional.

5.1.3 BREAK

Drive this line low for >5ms to switch to the command channel so that commands can be issued by the host over the UART connection. This line is equivalent to the soft break command. Use of this line is optional.

5.1.4 SWITCH

Drive this line low for >10 seconds on power up to initiate a reset to the factory default settings. Drive the line low for >5 seconds at any time after power up to initiate EasyConnect. The application circuit in figure 7.1 shows proper usage of this line with a momentary switch that pulls the line to ground when pressed. Use of this line is optional.

5.1.5 IND_LED

This is an output line that is designed to be connected to a small LED for a visual indication of the current operating mode. Use of this line is standard when supporting EasyConnect but it is useful in command mode as well. The example application circuit in figure 7.1 shows proper usage. A maximum of 8mA of current may be drawn from this line to drive an LED. Use of this line is optional.

IND_LED display pattern	**Description**
blinks once at power on	The module is powered on and ready.
on with no blinking	The module is in EasyConnect setup mode and is actively searching for another EasyConnect device to pair with. When pairing is complete and the devices are connected, the LED will turn off and begin to blink slowly.
slow continuous blink	The module is currently connected with a remote device.
off	The module is not currently connected.

Table 5.1 IND_LED Display Patterns

5.1.6 WAKEUP (Future Firmware Function)

Drive this line low to keep the module awake when sleep mode is enabled. The module will be awake within 5ms after this line is driven low. Use of this line is optional.

5.1.7 HOST_WAKEUP (Future Firmware Function)

When enabled, this line will be signaled low 10ms before data is sent to the host over the UART. Use of this line is optional.

5.1.8 RF (RF Pad Version Only)

The RF pin should be connected to a 50 Ohm Bluetooth ISM Band antenna.

Full reference designs for both surface mount and coax connector solutions are available; please contact A7 support for more information.

5.2 UART Interface

The eb101 Universal Asynchronous Receiver Transmitter (UART) interface provides a simple mechanism for communicating with other serial devices using the RS232 protocol. While the standard RS232 protocol is used, the voltage levels are 0V to VDD_IO. Communications with a standard RS232 device would require an external RS232 transceiver IC.

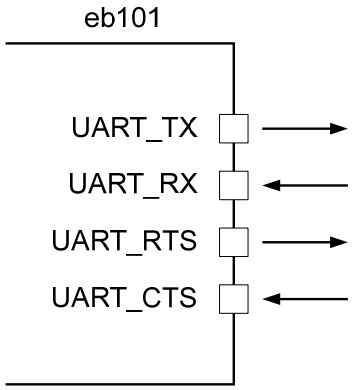

Figure 5.1: Universal Asynchronous Receiver

Figure 5.1 shows four signals used to implement the UART function. When the eb101 is connected to another digital device, UART_RX and UART_TX transfer data between the two devices. The remaining two signals, UART_CTS and UART_RTS, can be used to implement RS232 hardware flow control where both are active low indicators. All UART connections are implemented using CMOS technology and have signaling levels of 0V and VCC.

UART configuration parameters, such as baud rate and flow control, are set using the EmbeddedBlue serial firmware command set.

Parameter		**Value**
Baud Rate	Minimum	1200 baud (≤2% error)
		9600 baud (≤1% error)
	Maximum	460.8k baud (≤1% error)
Flow Control		RTS/CTS or None
Parity		None, Even, Odd
Stop Bits		1
Bits per channel		8

Table 5.3 Possible UART Settings

5.3 Power Supply

5.3.1 GND

All ground lines should be connected in parallel.

5.3.2 VDD

Positive supply for the module. Use of this line is optional if VDD_IO is supplied with 3.0V – 3.6V.

5.3.3 VDD_IO

Positive supply for I/O and UART lines. If this line is supplied with 3.0V – 3.6V then used of VDD is optional.

5.3.4 NC

For proper operation, all pins marked with NC should not be connected externally. All terminals should be placed on pads to ensure mechanical robustness.

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6 Bluetooth Software Stack

6.1 Overview

The eb101 module encapsulates the complexity of working with Bluetooth technology in order to make it simple to use and minimize the time required to add it to a product. The primary application profile that is supported is SPP, or the Serial Port Profile. This is the most popular and convenient protocol for many embedded applications of Bluetooth since it emulates a simple serial port link between devices. Once the connection is established, communications between the endpoints is the same as for a wired serial port.

The eb101 supports two main operating modes: EasyConnect and Commanded. When EasyConnect is used the device operates as a simple cable replacement solution. In Command Mode there is a rich set of functions that allow the host to have programmatic control over the module. In both modes the factory default communication parameters are 9600 Baud, 8 Data Bits, 1 Stop Bit, No Parity, and No Flow Control.

6.2 EasyConnect

EasyConnect mode provides a simple cable replacement solution that can be used without sending any commands to the device. A common implementation of this feature is to connect a momentary switch and LED to the eb101 for initiating pairing and monitoring the status of the module. Once the onetime pairing procedure is complete, data is transmitted between the devices automatically without the need for additional configuration or control. The wireless cable connection will be established and maintained whenever the eb101 is powered. This usage is most common when you want to enable a device with wireless technology, but do not want to make any modifications to it other than connecting it to an ebSerial device.

Pairing two EasyConnect devices that use the common implementation is quite simple. Put each device into pairing mode by holding the EasyConnect button while applying power to the units and then releasing it when the LED turns on. The devices will locate and pair with each other automatically forming a reliable and secure wireless connection. When this process is complete and the devices are ready for use, the indicator LED will begin to blink slowly. The paired devices will automatically establish and maintain a secure wireless connection whenever they are powered on.

6.3 Command Mode

Command mode provides the host with programmatic control over the module and its configuration. There are a number of commands that can be sent to change the baud rate, locate other devices that are in range, check the firmware version, etc. All commands are sent using visible ASCII characters (123 is 3 bytes “123”). Upon the successful transmission of a command, the ACK string will be returned. If there is a problem in the syntax of the transmission then a NAK string is returned. After either the ACK or NAK, a carriage-return <CR> character is returned. When a prompt (<CR> followed by a ‘>’) is returned, it means that the eb101 radio is in the idle state and is waiting for another command. White space is used to separate arguments of the command and a carriage-return <CR> (ASCII 0x0D) is used to mark the end of the command.

Once the eb101 radio is connected to another Bluetooth device, all data written to the UART will be transmitted wirelessly to the remote device. Therefore, NO further commands can be issued until the eb101 radio is disconnected or switched back to command mode by use of the BREAK control line or the soft break command. The connection status line of the eb101 module can be monitored to determine if there is currently an active connection.

6.4 Command Set

The EmbeddedBlue command set is comprised of visible ASCII characters. Therefore, a command can be issued from a terminal application, such as HyperTerminal, or directly from a custom application program, written in a programming language such as assembly, C, Java, or Basic. From a microcontroller application, these commands can be issued directly to the asynchronous UART on the device.

6.5 Command Basics

Commands may only be sent to the module when it is on the command channel. White spaces are used to separate parameters of the command and a carriage-return (ASCII 0x0D) is used to mark the end of the command. Upon receipt of a command the eb101 begins to parse the parameters. If the syntax of the command is correct the eb101 returns an ACK string, specifically the three bytes 'A', 'C', 'K'; otherwise, a NAK string is returned. Following the ACK or NAK string is a carriage-return character. If an error occurs while processing the acknowledged command, an error string is returned followed by a carriage-return followed by the prompt (>) character. If the command executed successfully the module will issue the prompt (>) character.

The full details of the command set are available in the EmbeddedBlue Serial Command Set Reference Manual. This document is available for download from the A7 website.

Note:

In the following examples, text inside of a gray box is used to show data that is sent from the eb101.

The following example shows the basic structure of a command. A prompt (>) is issued by the EmbeddedBlue module. A command followed by a carriage-return is sent to the module. The module responds with either an ACK or NAK string followed by a carriage-return. If an error occurs, the module responds with an Err string followed by a space followed by an ASCII string numeric value followed by a carriage-return. A prompt (>) is then issued by the module.

```
>command<CR>
ACK | NAK<CR>
Err number<CR>
>
```

Here is an example of getting the address of the eb101 module with the GET command.

```
>get address
ACK<CR>
00:0C:84:00:05:29
>
```

Here is an example of locating all of the Bluetooth devices that are currently available with the LIST command.

```
>lst visible<CR>
ACK<CR>
00:0C:84:00:05:29<CR>
00:80:C8:35:2C:B8<CR>
>
```

Here is an example of establishing a connection to another Bluetooth device with the CONNECT command.

```
>con 00:0C:84:00:05:29<CR>
ACK<CR>
>
```

7 Schematics

The schematic below shows a sample application circuit for the eb101 that supports both EasyConnect and an indicator LED to monitor the modules current mode. These features are optional and only the connections with VDD, VDD_IO, GND, UART_TX, UART_RX are generally required. For a full reference design, please contact A7 support.

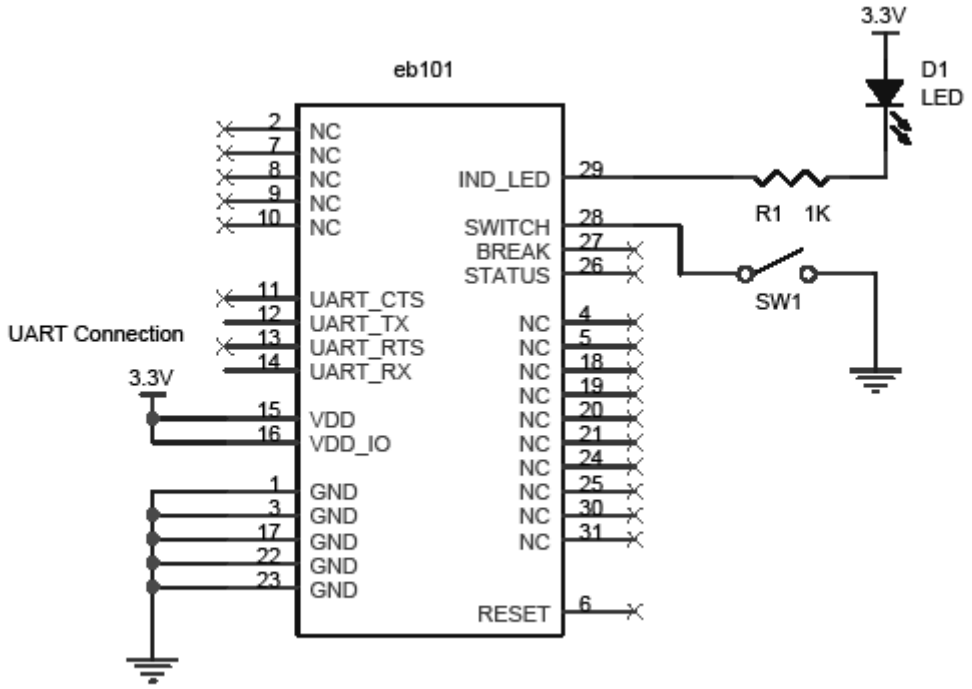

Figure 7.1 Example Circuit 3.3V with EasyConnect

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8 Device Footprint

The following figure is oriented from the top of the device. The eb101 module has a white triangle in the upper left corner near pin 1.

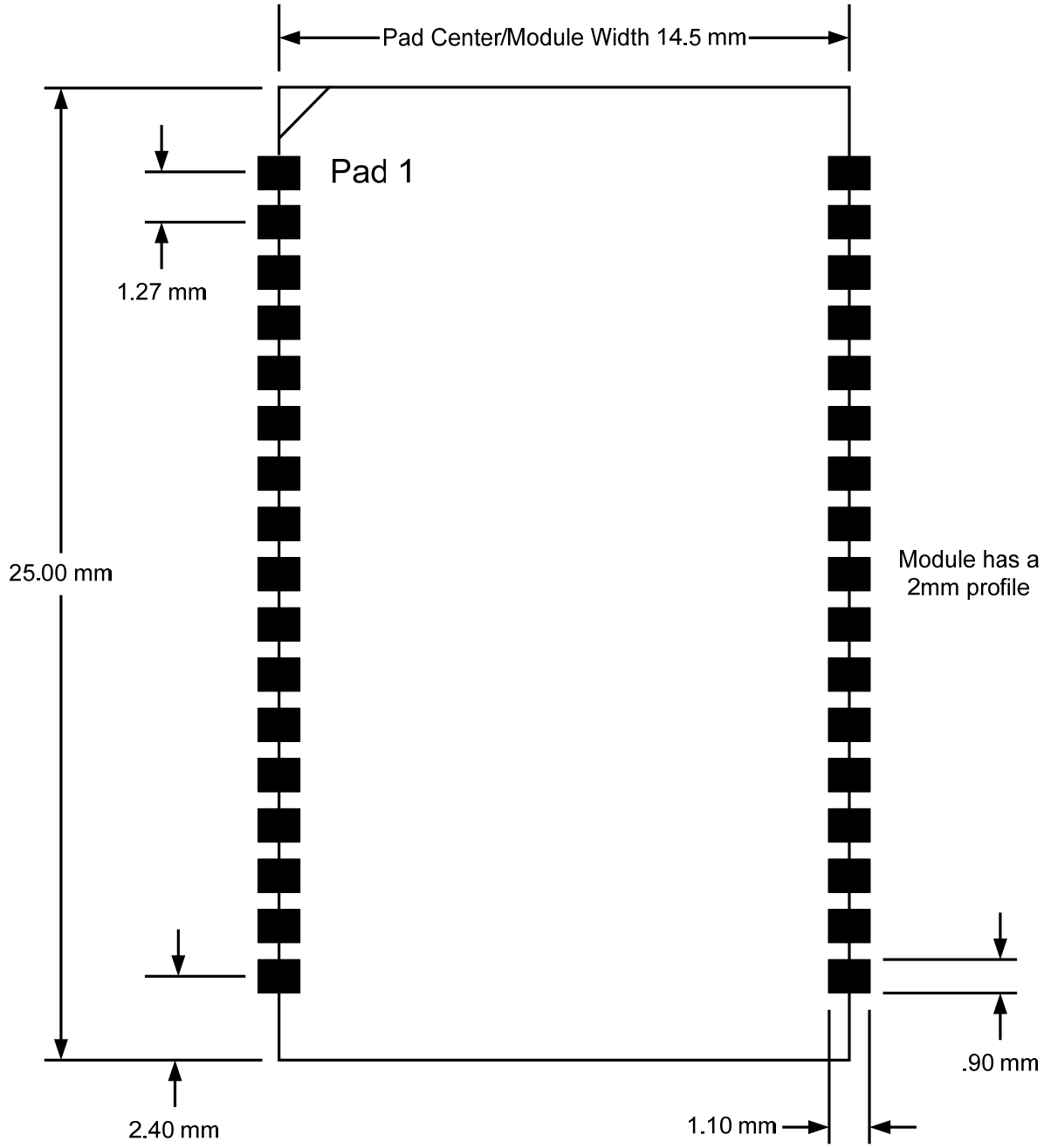

Figure 8.1: eb101 with U.FL / RF Pad Footprint

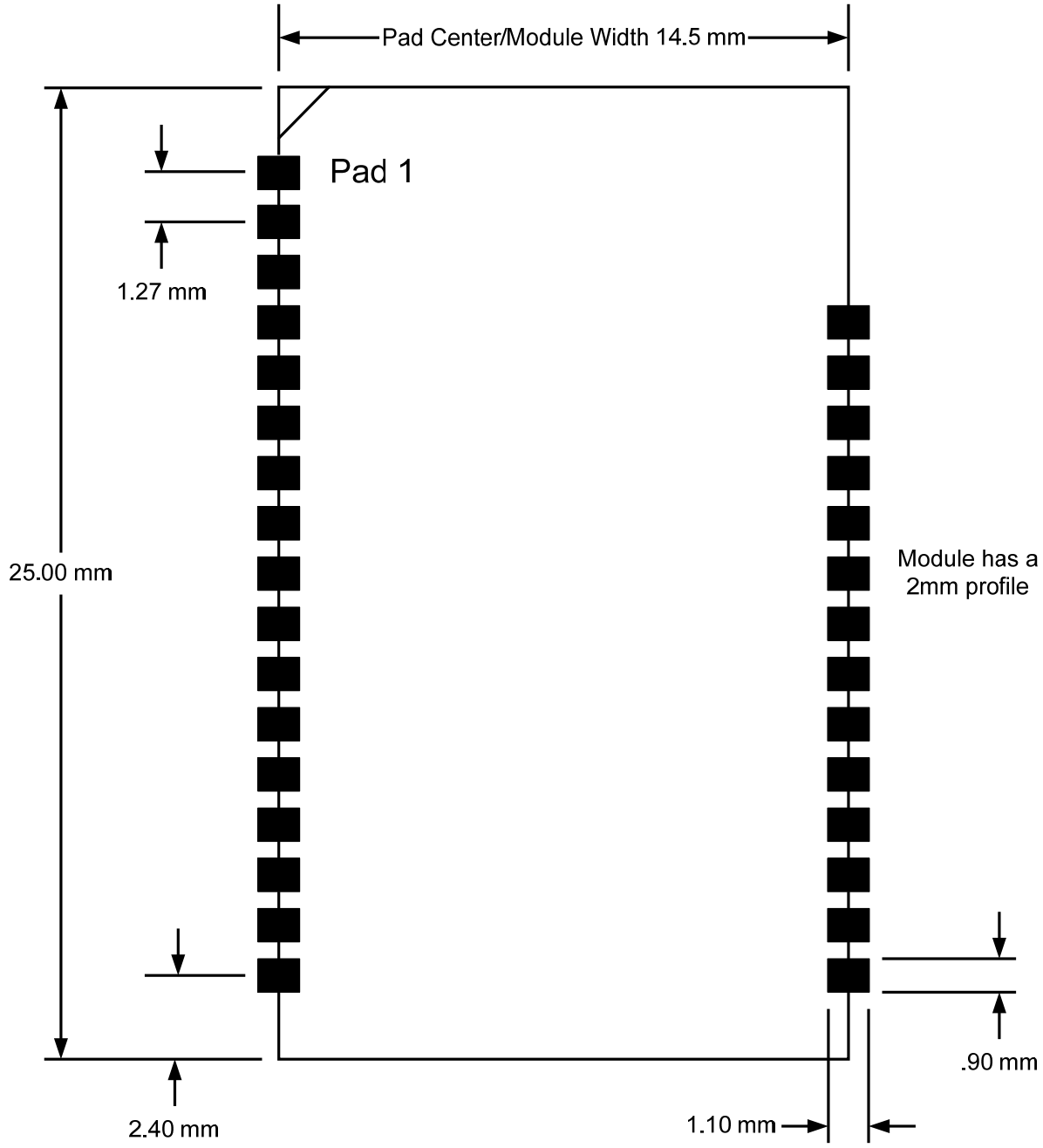

Figure 8.2: eb101 with Internal Antenna Footprint

9 Solder Profile

The solder profile depends on various design specific parameters and thus necessitates a set up for each application. The data here is provided for guidance on solder re-flow only. There typically are four zones:

1. Preheat Zone: This zone raises the temperature at a controlled rate.
2. Equilibrium Zone: This zone brings the board to a uniform temperature and also activates the flux. The duration in this zone will need to be adjusted to optimize the out gassing of the flux.
3. Reflow Zone: The peak temperature should be high enough to achieve good wetting but not so high as to cause component damage.
4. Cooling Zone: The cooling rate should be fast, to keep the solder grains small which will give a longer lasting joint.

9.1 Solder Reflow Profile for Devices with Lead-Free Solder

The following is given as a typical reflow profile for manufacturing with the e101 module. This profile is used in the manufacturing of adapters by A7 Engineering. Solder paste used is Alpha Metals, Part # OM310 whose composition is 96.5%Sn / 3% Ag / 0.5% Cu.

Profile Parameters Specification		
Pre-heat	40 - 170°C	135 – 180 Seconds
Soak Time	170 - 220°C	30 – 75 Seconds
Reflow	Above 220°C	40 – 70 Seconds
Peak Temperature	230 - 240°C	

Calculated specifications are as follows:

- Pre-heat ramp = <2°C/s to 165°C ±10°C
- Equilibrium time = 60 to 180 seconds
- Ramp to maximum temperature (240°C) = 3°C/s max.
- Time above liquidus: 40-70 seconds
- Device absolute maximum reflow temperature: 250°C

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10 Qualifications

This chapter provides details for various qualifications and approvals.

10.1 Bluetooth Approval

The eb101 module is listed as a Bluetooth end product in terms of the Bluetooth SIG PRD (program reference document). If integrated into end products without modification, further testing for approval listing is not necessary; although usage of the Bluetooth trademarks must be done so in accordance with the Bluetooth SIG rules.

QID: B014985

Bluetooth Version 2.0

10.2 EU Declaration of Conformity

The eb101 meets the requirements of Directive 2002/95/EC, the European Union Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment ("RoHS Directive").

10.3 FCC

This device complies with part 15 of the FCC Rules for modular approval. Operation is subject to the following two conditions:

a) This device may not cause harmful interference
b) This device must accept any interference, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Co-location with other radio transmitting devices operating concurrently in the same band will require additional testing and certification.

To satisfy FCC RF exposure requirements for mobile transmitting devices, a separation distance of 20 cm or more should be maintained between antenna of this device and persons during device operation.

10.3.1 FCC ID

FCC ID: WND-1000160

10.3.2 FCC Labeling Requirement

In order to be in compliance with FCC rules the FCC ID must be visible from the outside of any product which incorporates the eb101. This is most often accomplished using a label which contains the FCC ID.

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11 Contact Information

A7 has created the EmbeddedBlue product line of easy to use wireless solutions for embedded systems. In addition, A7 provides several levels of support for OEM product integration, certification, and even custom solutions.

Website: www.a7eng.com

Support Email: support@a7eng.com

Online Forum: http://www.a7eng.com/support/forum/forum.htm

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12 Acronyms and Definitions

Term:	Definition:
ADC	Analog to Digital Converter
API	Application Programming Interface
Bluetooth®	Short range radio technology for both audio and data transfer
CMOS	Complementary Metal Oxide Semiconductor
CPU	Central Processing Unit
CSR	Cambridge Silicon Radio
dBm	Decibels relative to 1mW
DC	Direct Current
DFU	Device Firmware Upgrade
EasyConnect™	Simple pairing, security and connection scheme for Bluetooth devices
FHSS	Frequency Hopping Spread Spectrum
Host	Application's microcontroller
L2CAP	Logical Link Control and Adaptation Protocol
PCM	Pulse Code Modulation. Refers to digital voice data
PIO	Parallel Input Output
RAM	Random Access Memory
RF	Radio Frequency
RFCOMM	Protocol layer providing serial port emulation over L2CAP
RX	Receive
SDP	Service Discovery Protocol
SIG	Special Interest Group
SPP	Serial Port Profile
TX	Transmit
UART	Universal Asynchronous Receiver Transmitter

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13 Revision History

Date	Description
February 10, 2009	Corrected reflow profile & updated Bluetooth QDID
November 12, 2008	Added FCC exposure statement
November 11, 2008	Added section on approvals
July 30, 2008	Release
March 24, 2008	Preliminary release publication of this document