Device Features

- Low power 3.3V operation
- Simple serial UART communications
- EasyConnect™ enabled
- 2.4GHz FHSS technology ensures high reliability and is robust 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 250kbps continuous data rate
- Full reference designs available upon request

EmbeddedBlue™ 100-SER

OEM Bluetooth® Serial Module

Production Information Data Sheet for:

eb100-SER v2.1

March 26, 2007

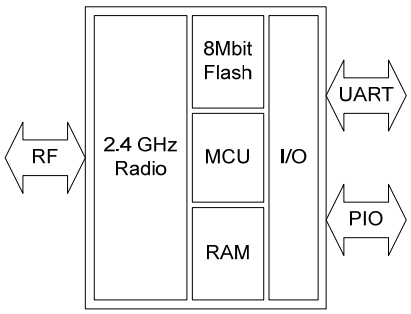
General Description

The A7 Engineering eb100-SER surface mount module is a highly integrated and easy to use Bluetooth solution designed for low cost and reliability.

The eb100-SER 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 eb100-SER radio. This UART interface may be used to discover, connect, and communicate with other Bluetooth devices through simple ASCII commands.

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.



eb100-SER Block Diagram

Applications

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

The EmbeddedBlue eb100-SER OEM Bluetooth serial 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 eb100-SER ideal for use in standalone battery powered devices common to medical and remote data capture applications.

The eb100-SER 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.

Table of Contents

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1 Key Features

Radio

- Based on CSR's BC2-Ext Bluetooth Chip
- +6dBm output power
- -85dBm receiver sensitivity
- Common TX/RX terminal simplifies external matching; eliminates external antenna switch
- Support for Adaptive Frequency Hopping (AFH) and 802.11 coexistence
- 2.4GHz FHSS technology ensures high reliability and is robust to interference
- Full RF 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 (128-bit encryption is available upon request)
- 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
- Break control input line
- Upgradeable via UART
- Bluetooth v1.2 specification compliant

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
- 3.3 V logic levels for Tx and Rx

Power

- 3.0 – 3.6VDC supply voltage
- Low operating power consumption of less than 45mA
- RESET line controls module boot and restart

Device

- Up to 250kbps 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 diagram is oriented from the top of the device. The eb100-SER module has the text “A7 eb100” in the upper right corner of the module as shown and a small number one near pin one.

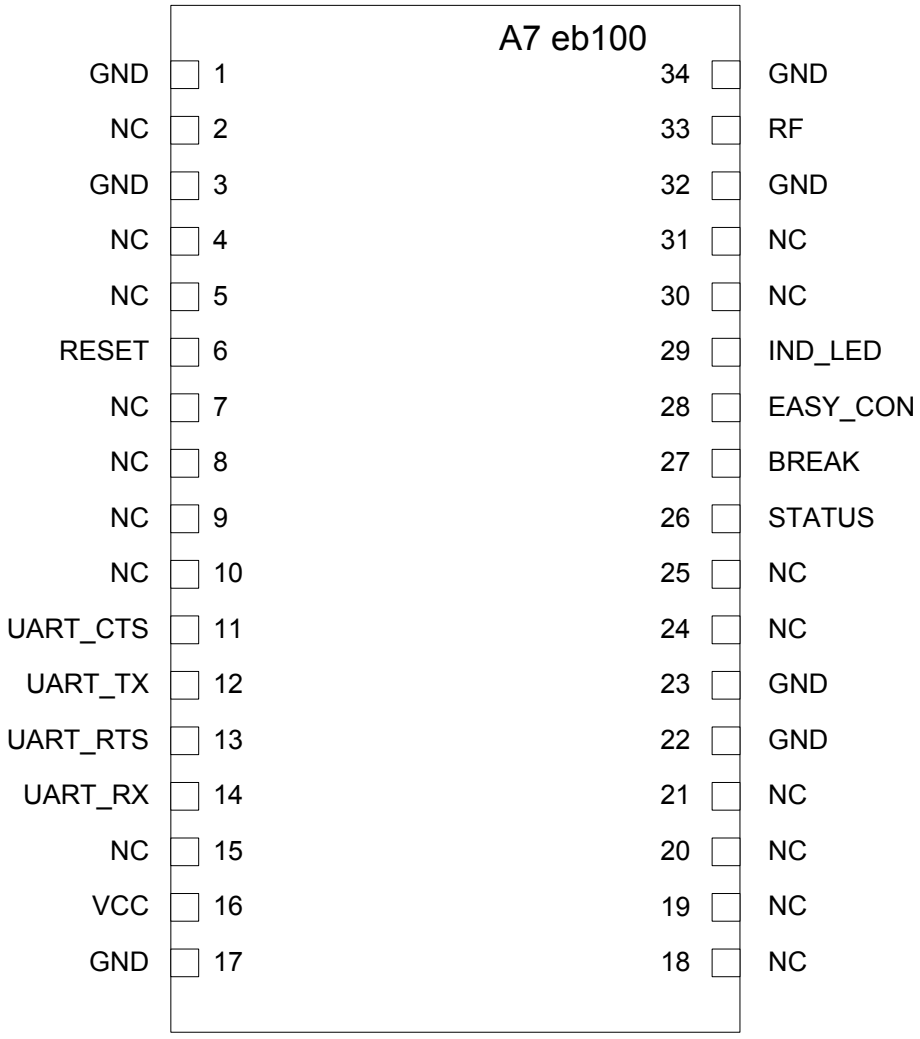

Figure 2.1: eb100-SER Device Pinout Diagram

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3 Device Terminal Functions

Radio and Control	Pin	Type	Description
RESET	6	CMOS input with weak internal pull-down	Reset if high. Input debounced; must be high 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	If low, breaks the flow of data to enable the command set. Input debounced; must be signaled for >10ms
EASY_CON	28	CMOS input with weak internal pull-up	EasyConnect mode if low on power up. Factory Reset if held low for >5 seconds after power up
IND_LED	29	CMOS output	Active low output for connection with an indicator LED. No more than 8mA may be drawn from this line
RF	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	Module supply ground	All ground pins must be connected
VCC	16	Supply voltage	Module supply positive, 3.3V nominal

Unconnected Terminals	Pin	Description
NC	2, 4, 5, 7, 8, 9, 10, 15, 18, 19, 20, 21, 24, 25, 30, 31	Leave unconnected

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4 Electrical Characteristics

Absolute Maximum Ratings		
Rating	**Min**	**Max**
Storage Temperature	-40°C	120°C
Supply Voltage: VCC	-0.4V	3.60V

Recommended Operating Conditions		
Rating	**Min**	**Max**
Operating Temperature Range	-15°C	70°C
Supply Voltage: VCC	3.0V	3.60V

Input/Output Terminal Characteristics				
Digital Terminals	**Min**	**Typ**	**Max**	**Unit**
Input Voltage				
V_{IL} input logic level low	-0.4	-	+0.8	V
V_{IH} input logic level high	0.7VCC	-	VCC+0.4	V
Output Voltage				
V_{OL} output logic level low	-	-	0.2	V
V_{OH} output logic level high	VCC-0.2	-	-	V
Input and Tristate Current with:				
Strong pull-up	-100	-20	-10	µA
Strong pull-down	+10	+20	+100	µA
Weak pull-up	-5	-1	0	µA
Weak pull-down	0.2	+1	+5	µA
I/O pad leakage current	-1	0	+1	µA

Average Current Consumption		
VCC=3.0V Temperature = 20°C		
Mode	**Avg**	**Unit**
115.2kbps data transfer	25	mA
Idle connection	20	mA
No connection	3	mA

Peak Current Consumption			
VCC=3.0V Temperature = 20°C			
Mode	**Typ**	**Max**	**Unit**
Peak RF current during TX burst (+6 dBm)	65.0	80.0	mA
Peak RF current during TX burst (0 dBm)	57.0	70.0	mA
Peak RF current during RX burst (-85 dBm)	47.0	70.0	mA

Notes:

These results are typical for the eb100-SER rev.B running firmware version 2.1. 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 high, the eb100-SER module will enter reset mode and remain there until this line is driven low. This line is debounced so it must be held high for > 5ms to cause a reset.

When power is applied to the eb100-SER module, it must be held in a RESET state until the supply voltage has stabilized. The example application circuit in figure 7.1 shows one method of doing this by adding a capacitor between the RESET line and VCC. There is a built in 1k pull down resistor on this line so adding a capacitor connected to VCC will create an RC circuit. The design shown will pull the RESET line high for approximately 15ms.

Note:

The timing of an RC circuit can be calculated by using the formula T = RC or time equals the resistance (in ohms) multiplied by the capacitance (in farads). This gives T = 1000 * .00001 = .01 = 10ms.

This formula gives the time that it takes for the capacitor to reach 63% of capacity. The RESET line will be signaled until it falls below 0.8V and the capacitor has to charge past 63% for this to occur. The RESET line will typically fall below 0.8V after 1.5 * T. In this example the RC circuit will hold the module in reset for approximately 15ms on power up.

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

When there is an active connection, driving this line low will break the flow of data and allow you to issue commands to the module. When the line is then driven high, the flow of data will be reestablished and directed over the air to the remote device. This line is disabled in EasyConnect mode and its use is optional in command mode.

5.1.4 EASY_CON

When held low on power up, this line puts the module into EasyConnect setup mode. If held low for >5 seconds after power up, the module will perform a factory reset. 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 required when supporting EasyConnect mode.

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 in command mode and can be controlled over the UART using the command set.

blinks twice at power on	The module is in EasyConnect mode and will automatically establish a connection with the remote device that it is paired with. It is operating as a cable replacement solution and will not respond to UART commands.
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	If the module is in command mode then it is idle when the LED is off. If the module is in EasyConnect mode then it is attempting to connect with its paired device.

Table 5.1 IND_LED Display Patterns

5.1.6 RF

The RF pin should be connected to a 50 Ohm Bluetooth ISM Band antenna. There are a number of available antenna options and you will need to weigh various design considerations when making a selection. The following chart illustrates the main factors to consider.

Design Consideration	**Yes**	**No**
eb100-SER mounted in a metal enclosure	Use a U.FL coax connector and external cabled antenna	Use any antenna option
eb100-SER mounted near batteries or other metal	Use a U.FL coax connector and internal cabled antenna	Use any antenna option
Cost sensitive	Use a surface mount antenna	Use any antenna option
Maximize range	Use a U.FL coax connector and cabled antenna	Use any antenna option

Table 5.2 RF Design Considerations

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

5.2 UART Interface

The eb100-SER 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 VCC. Communications with a standard RS232 device would require an external RS232 transceiver IC.

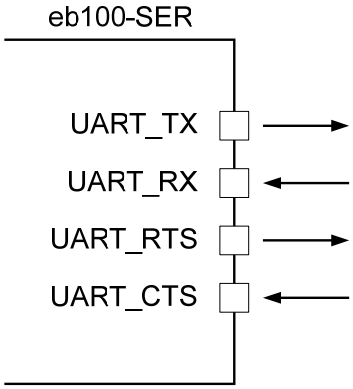

Figure 5.1: Universal Asynchronous Receiver

Figure 5.1 shows four signals used to implement the UART function. When the eb100-SER 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
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 VCC

Supply power for the module.

5.3.3 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 eb100-SER 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 eb100-SER supports two main operating modes: EasyConnect mode and Command Mode. In EasyConnect mode 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 eb100-SER 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 eb100-SER 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 eb100-SER 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 eb100-SER 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 eb100-SER 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 eb100-SER 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 in command mode. 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 eb100-SER begins to parse the parameters. If the syntax of the command is correct the eb100-SER 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 Engineering website.

Note:

In the following examples, text inside of a gray box is used to show data that is sent from the eb100-SER.

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 eb100-SER 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 eb100-SER that supports both EasyConnect and an indicator LED to monitor the modules current mode. These features are optional and only the connections with VCC, GND, UART_TX, UART_RX, RF, and RESET are generally required. For a full reference design, please contact A7 Engineering support.

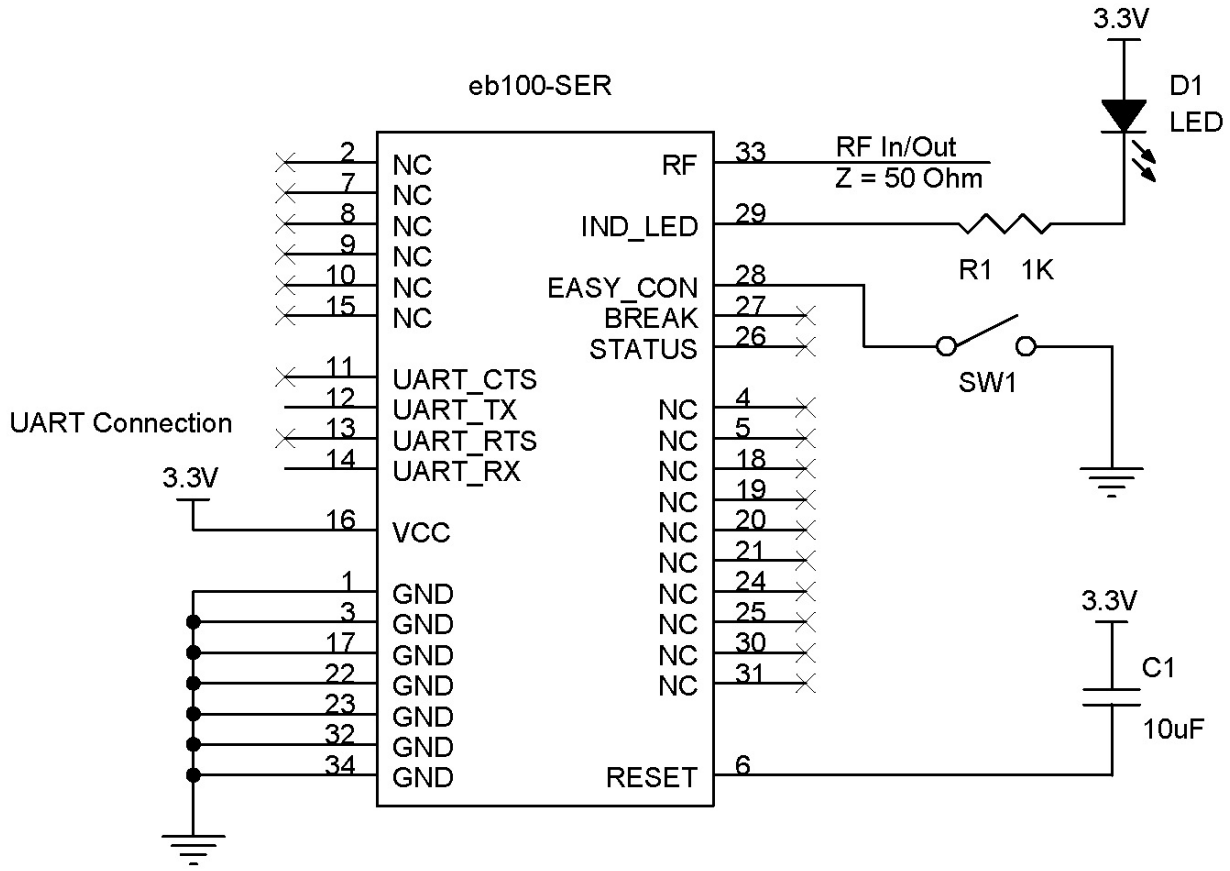

Figure 7.1 Example Application Circuit with EasyConnect

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8 Device Footprint

The following figure is oriented from the top of the device. The eb100-SER module has the text “A7 eb100” in the upper right corner of the module as shown and a small number one near pin one.

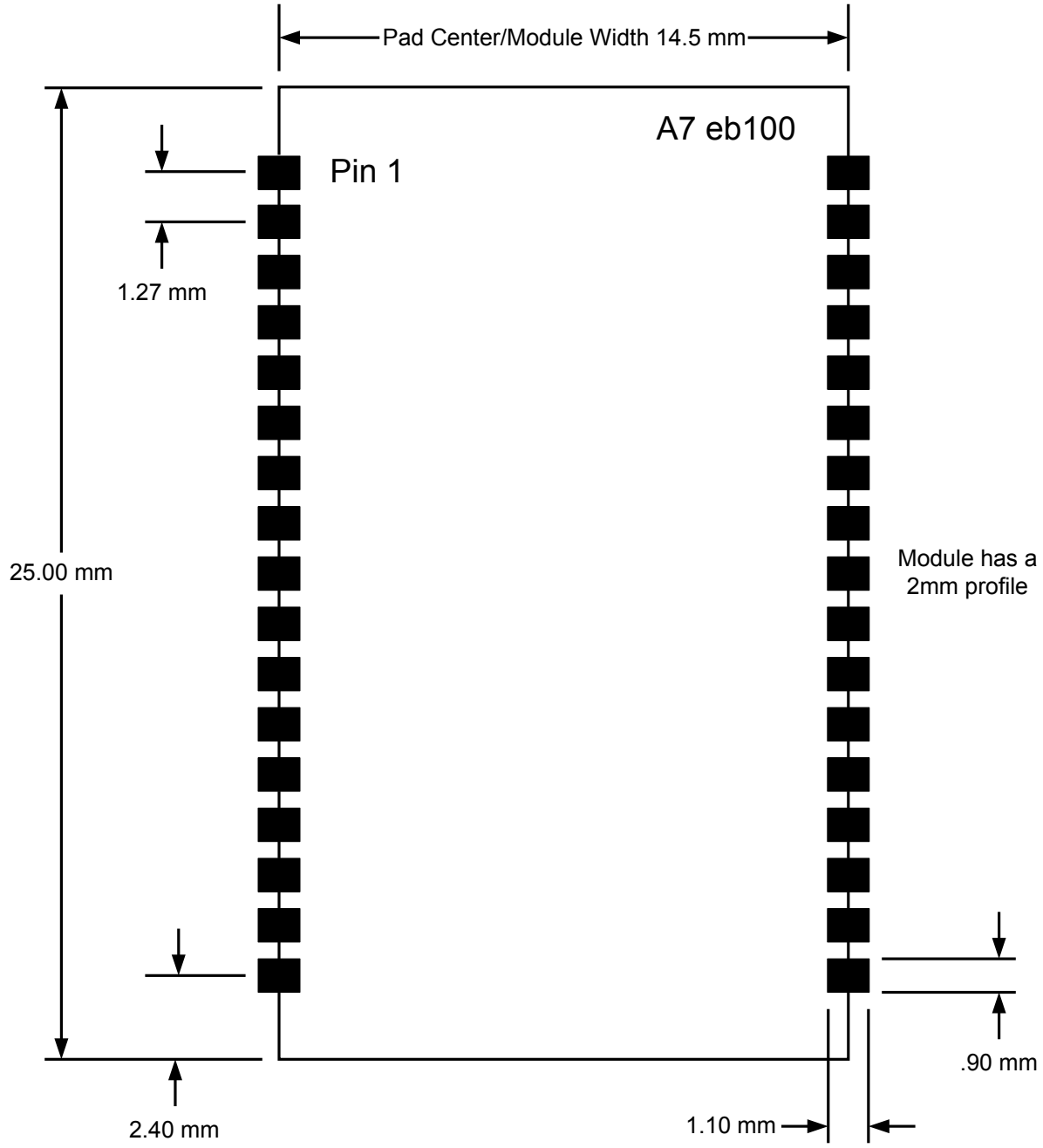

Figure 8.1: eb100-SER Footprint

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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, typically 1-2.5°C/s.
2. Equilibrium Zone: This zone brings the board to a uniform temperature and also activates the flux. The duration in this zone (typically two to three minutes) 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. Typical rates will be 2-5°C/s.

9.1 Solder Reflow Profile for Devices with Lead-Free Solder

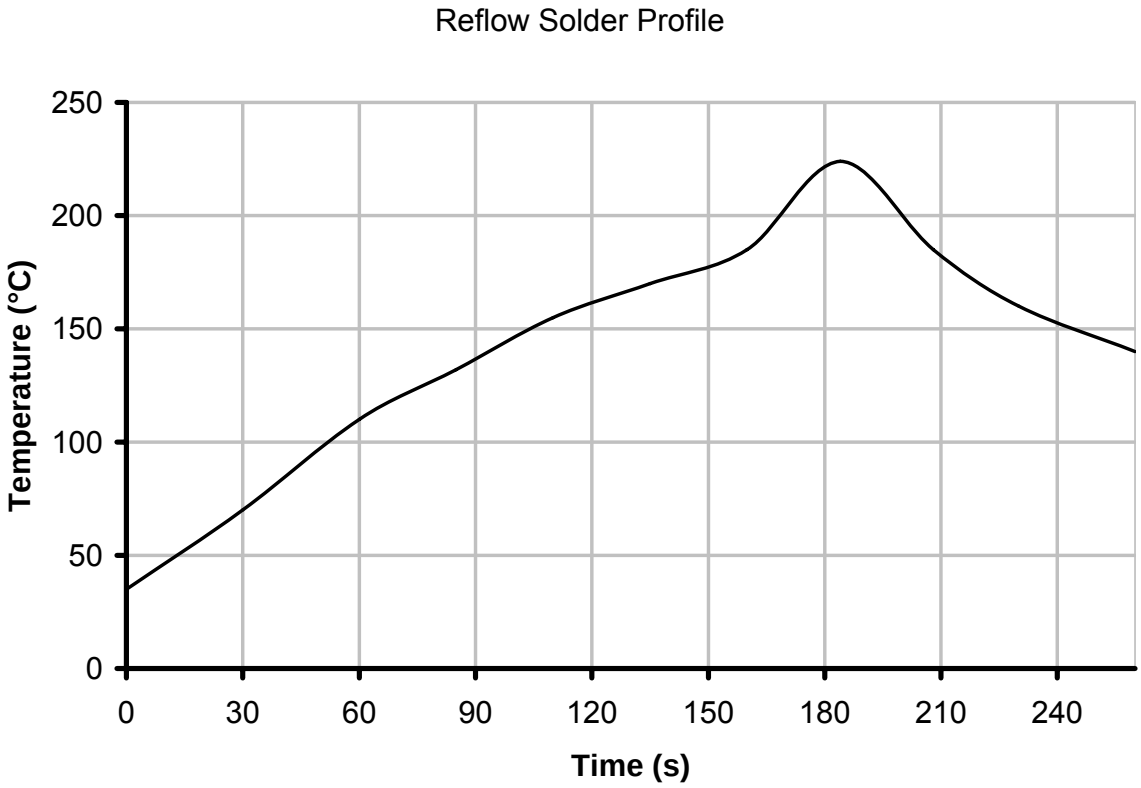

Figure 9.1: Typical Lead-Free Reflow Solder Profile

Key features of the profile

- Initial Ramp = 1-2.5°C/s to 175°C±25°C equilibrium
- Equilibrium time = 60 to 180 seconds
- Ramp to maximum temperature (224°C) = 3°C/s max.
- Time above liquidus temperature (190°C): 40-80 seconds
- Device absolute maximum reflow temperature: 230°C

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10 Contact Information

A7 Engineering 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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11 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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12 Revision History

Date	Description
March 28, 2006	Initial publication of this document
April 25, 2006	Updated receiver sensitivity
March 26, 2007	Updated information for v2.1 firmware changes; added IND_LED and EASY_CON; renamed MODE to BREAK; changed STATUS to active low; Please see the v2.1 firmware release notes for full details.