



BlueSoleil EcoSystem

BlueSoleil EcoSystem



i410e-S Datasheet

February 19, 2013

Version 1.0

BlueSoleil EcoSystem

BlueSoleil EcoSystem

VERSION HISTORY

REVISION	AMENDMENT	DATE	AUTHOR
1.0	Initial version	2014-2-19	Wan Zhifu Li Li

BlueSoleil EcoSystem

BlueSoleil EcoSystem

BlueSoleil EcoSystem

BlueSoleil EcoSystem

Contents

1	Block Diagram	6
2	Electrical Characteristics	7
2.1	Absolute Maximum Ratings	7
2.2	Recommended Operating Conditions.....	8
2.3	Input/output Terminal Characteristics.....	8
2.3.1	Switch-mode Regulator	8
2.3.2	Low-voltage Linear Regulator	9
2.3.3	Digital Terminals	9
2.3.4	AIO.....	9
2.3.5	ESD Protection.....	10
2.4	Current Consumption.....	10
2.5	Radio Characteristics.....	10
2.5.1	RF Ports	10
2.5.2	RF Receiver	11
2.5.3	RF Transmitter	11
2.5.4	Bluetooth Radio Synthesizer.....	11
2.5.5	Baseband.....	11
3	Pin Description	12
4	Physical Interfaces.....	14
4.1	UART Interface	14
4.2	SPI Interface	15
5	Software Stacks	15
5.1	BlueSoleil Stack	16
6	Re-flow Temperature-time Profile.....	17
7	Reliability and Environmental Specification.....	18
7.1	Temperature test	18
7.2	Vibration Test.....	18
7.3	Desquamation Test	18
7.4	Drop Test.....	18
7.5	Packaging Information	18
8	Layout and Soldering Considerations.....	19
8.1	Soldering Recommendations	19
8.2	Layout Guidelines.....	19
9	Physical Dimensions	20
10	Package.....	21
11	Certification.....	21
11.1	Bluetooth	21
11.2	CE 0700.....	22

11.3	FCC	22
11.4	IC	22
12	<i>Bluetooth</i> Technology Best Developed Corporation	22
13	Contact Information	23
14	Copyright	23

BlueSoleil EcoSystem

BlueSoleil EcoSystem

BlueSoleil EcoSystem

BlueSoleil EcoSystem


DESCRIPTION

BlueSoleil i410e-S is a *Bluetooth* 4.0 single-mode module. It provides a *Bluetooth* Low Energy fully compliant system for data communication with IVT BlueSoleil stack. It allows your target devices to send and receive data via *Bluetooth* 4.0 without connecting a serial cable to your computer.

By default, i410e-S module is equipped with powerful and easy-to-use BlueSoleil firmware. It's easy-to-use and completely encapsulated. BlueSoleil enables users to access *Bluetooth* functionality with simple ASCII commands delivered to the module over serial interface - it's just like a *Bluetooth* modem.

Therefore, BlueSoleil i410e-S provides an ideal solution for developers who want to integrate *Bluetooth* wireless technology into their design.

FEATURES

- Fully Qualified *Bluetooth* system v4.0
- Low energy
- Support Master or Slave roles
- Integrated layout antenna
- Industrial temperature range from -40°C to +85°C
- RoHS Compliant

APPLICATIONS

- Cable replacement
- Sports and fitness
- Healthcare
- Home entertainment
- Office and mobile accessories
- Automotive
- Commercial
- Watches
- Human interface devices

TBD

Figure 1 BlueSoleil i410e-S

1 Block Diagram

BlueSoleil i410e-S's block diagram is illustrated in Figure 2 below.

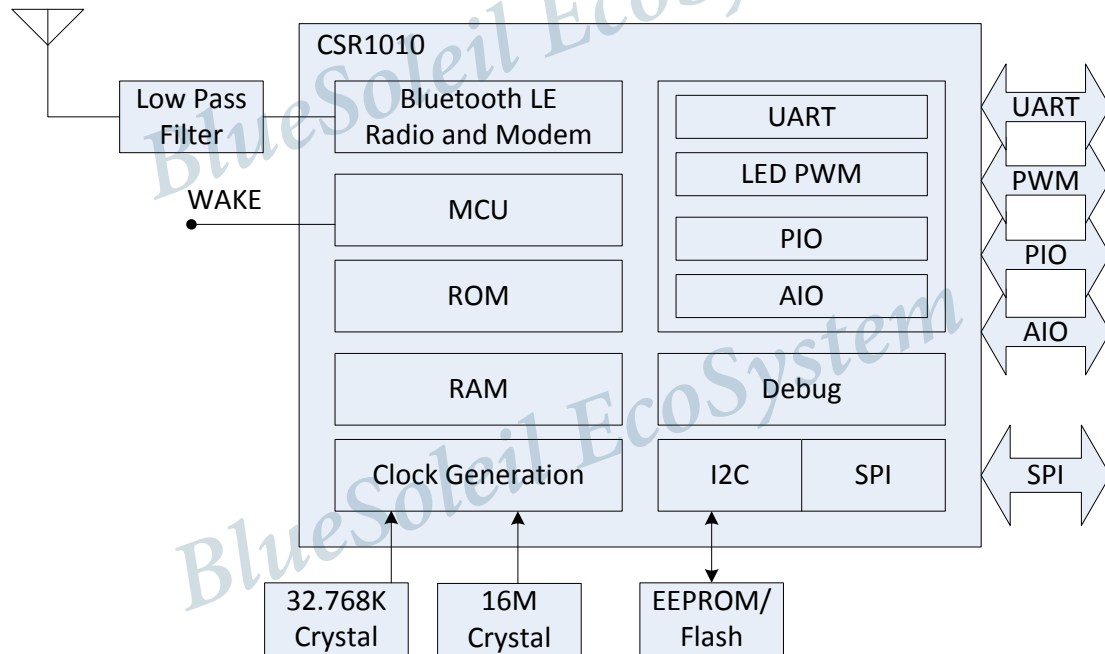


Figure 2 i410e-S Block Diagram

CSR1010

CSR1010 is a single chip *Bluetooth* 4.0 solution which implements the *Bluetooth* radio transceiver and also an on chip microcontroller. CSR1010 implements *Bluetooth* 4.0 and it can deliver data rates up to 3 Mbps.

The microcontroller (MCU) on CSR1010 acts as interrupt controller and event timer run the BlueSoleil stack and control the radio and host interfaces. A 16-bit RISC microcontroller is used for low power consumption and efficient use of memory.

CSR1010 has 64Kbytes of on-chip RAM. It supports the RISC MCU and is shared between the ring buffers used to hold data for each active connection and the general-purpose memory required by the BlueSoleil stack.

Crystal

The crystal oscillates include 16MHz and 32.768 KHz. 16MHz is external reference clock source. 32.768 KHz is used during deep sleep and in other low-power modes.

EEPROM/Flash

Flash /EEPROM is used for storing the *Bluetooth* protocol stack, profile and applications.

Low Pass Filter

The filter is a band pass filter (ISM band).

Antenna

The antenna is meander PCB antenna.

Synchronous Serial Interface

This is a synchronous serial port interface (SPI) for interfacing with other digital devices. The SPI port can be used for system debugging. It can also be used for programming the Flash memory.

UART

This is a standard Universal Asynchronous Receiver Transmitter (UART) interface for communicating with other serial devices.

Programmable I/O

i410e-S has five digital programmable I/O terminals controlled by firmware running on the device.

AIO

i410e-S has three general-purpose analogue interface pins, AIO[2:0].

PWM

i410e-S contains a PWM module that works in sleep modes.

WAKE

Wake up input. It wakes i410e-S from sleep mode.

2 Electrical Characteristics

2.1 Absolute Maximum Ratings

The module should not continuously run under extreme conditions. The absolute maximum ratings are summarized in Table 1 below. Exposure to absolute maximum rating conditions for extended periods of time may affect reliability and cause permanent damage to the device.

Table 1 Absolute Maximum Ratings

Rating	Min	Max	Unit
Storage temperature	-40	85	°C
Battery (VDD_BAT) operation	1.8	3.6	V
I/O supply voltage	-0.4	3.6	V
Other terminal voltages	VSS-0.4	VDD+0.4	V

2.2 Recommended Operating Conditions

Recommended operating conditions are summarized in Table 2 below.

Table 2 Recommended Operating Conditions

	Min	Typ	Max	Unit
Operating temperature	-30	20	85	°C
Battery(VDD_BAT) Operation	1.8	-	3.6	V
I/O supply voltage(VDD_PADS)	1.2	-	3.6	V

2.3 Input/output Terminal Characteristics

2.3.1 Switch-mode Regulator

Table 3 Switch-mode Regulator

	Min	Typ.	Max	Unit
Switch-mode Regulator				
input voltage	1.8	-	3.6	V
Output voltage	0.65	1.35	1.35	V
Temperature coefficient	-200	-	200	ppm/°C
Normal Operation				
Output noise, Frequency range 100Hz to 100KHz	-	-	0.4	mV rms
Setting time, setting to within 10% of final value	-	-	30	μs
Output current(I_{max})	-	-	50	mA
Quiescent current(excluding load, $I_{load} < 1mA$)	-	-	20	μA
Ultra Low-power Mode				

Output current(I_{max})	-	-	100	μ A
Quiescend current	-	-	1	μ A

2.3.2 Low-voltage Linear Regulator

Table 4 Switch-mode Regulator

Normal Operation	Min	Typ.	Max	Unit
Input voltage	0.65	-	1.35	V
Output voltage	0.65	-	1.20	V

2.3.3 Digital Terminals

Table 5 Digital Terminals

	Min	Typ.	Max	Unit
Input Voltage Levels				
V_{IL} input Logic level low	-0.4	-	0.4	V
V_{IH} input logic level high	$0.7 \cdot V_{DD}$	-	$V_{DD} + 0.4$	V
T_r/T_f	-	-	25	ns
Output Voltage Levels				
V_{OL} output logic level low, $I_{OL} = 4.0\text{mA}$	-	-	0.4	V
V_{OH} output logic level high, $I_{OH} = -4.0\text{mA}$	$0.75 \cdot V_{DD}$	-	-	V
T_r/T_f	-	-	5	ns
Input and Tristate Currents				
With strong pull-up	-150	-40	-10	μ A
I^2C with strong pull-up	-250	-	-	μ A
With strong pull-down	10	40	150	μ A
With weak pull-up	-5.0	-1.0	-0.33	μ A
With weak pull-down	0.33	1.0	5.0	μ A
C_i input capacitance	1.0	-	5.0	pF

2.3.4 AIO

Table 6 AIO

Input Voltage Levels	Min	Typ.	Max	Unit
Input voltage	0	-	1.3	V

2.3.5 ESD Protection

Apply ESD static handling precautions during manufacturing. ESD handling maximum ratings are summarized in Table 7 below.

Table 7 ESD Handling Maximum Ratings

Condition	Max	Unit
Human body model contact discharge per JEDEC EIA/JESD22-A114	2	2000V(all pins)
Machine model contact Discharge per JEDEC EIA/JESD22-A115	200V	200V(all pins)
Charged Device Model Contact Discharge per JEDEC EIA/JESD22-C101	III	500V(all pins)

2.4 Current Consumption

Table 8 Current Consumption, Power supply 3.0v

Operation Mode	Description	Average
Dormant	All functions are shutdown. To wake up toggle the wake pin.	5~6 μ A
Hibernate	VDD_PADS=ON, REFCLK=OFF, SLEEPCLK+ON, VDD_BAT=ON	5~6 μ A
Deep Sleep	VDD_PADS=ON, REFCLK=OFF, SLEEPCLK=ON, VDD_BAT=ON, RAM=ON, digital circuits=ON, SMPs=ON(low-power mode), 1ms wake-up time	7~8 μ A
Connected Standby	-	~1.2mA
RX/TX active	-	~ 4mA

2.5 Radio Characteristics

2.5.1 RF Ports

BlueSoleil i410e-S contains an integrated balun which provides a single-ended RF TX / RX port pin. No matching components are needed as the receive mode impedance is 50 Ω and the transmitter has been optimized to deliver power in to a 50 Ω load.

2.5.2 RF Receiver

The receiver features a near-zero IF architecture that allows the channel filters to be integrated onto the die. Sufficient out-of-band blocking specification at the LNA input allows the receiver to be used in close proximity to GSM and W-CDMA cellular phone transmitters without being significantly desensitized.

An ADC digitizes the IF received signal.

Low Noise Amplifier

The LNA operates in differential mode and takes its input from the balanced port of the integrated balun.

RSSI Analogue to Digital Converter

The ADC samples the RSSI voltage on a packet-by-packet basis and implements a fast AGC. The front-end LNA gain is changed according to the measured RSSI value, keeping the first mixer input signal within a limited range. This improves the dynamic range of the receiver, improving performance in interference-limited environments.

2.5.3 RF Transmitter

IQ Modulator

The transmitter features a direct IQ modulator to minimize frequency drift during a transmit packet, which results in a controlled modulation index. Digital baseband transmit circuitry provides the required spectral shaping.

Power Amplifier

The internal PA has a maximum 7.5dBm output power without needing an external RF PA.

2.5.4 Bluetooth Radio Synthesizer

The *Bluetooth* radio synthesizer is fully integrated onto the die with no requirement for an external VCO screening, varactor tuning diodes, LC resonators or loop filter. The synthesizer is guaranteed to lock in sufficient time across the guaranteed temperature range to meet *Bluetooth* v4.0 specification.

2.5.5 Baseband

Physical Layer Hardware Engine

The hardware supports all optional and mandatory features of *Bluetooth v4.0* specification. It performs the following features:

- Cyclic redundancy check
- Encryption
- Data whitening
- Access code correlation

3 Pin Description

BlueSoleil i410e-S's PIN descriptions are summarized in Figure 3 and Table 9 below.

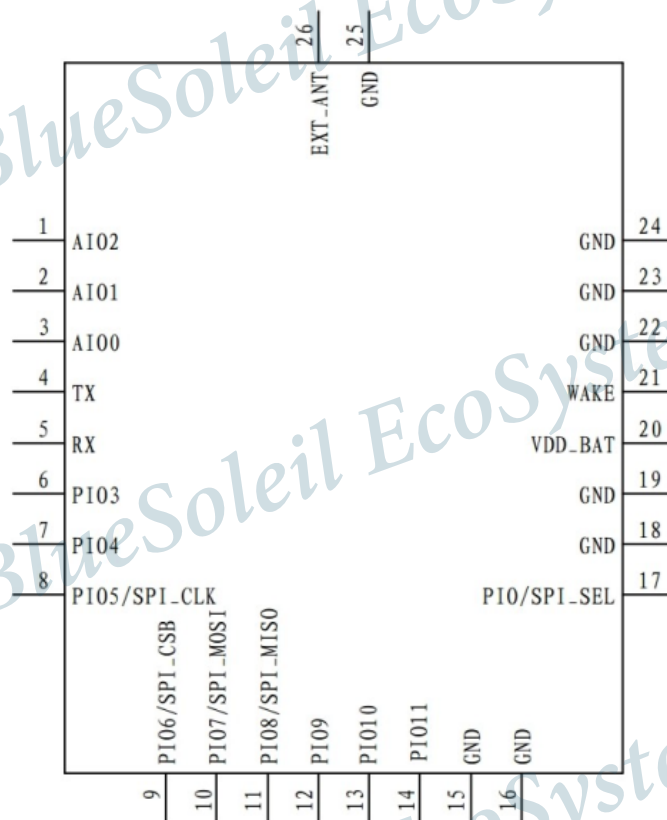


Figure 3 i410e-S PIN diagram

Table 9 PIN Description

PIN NO.	Name	Type	Function
1	AI02		
2	AI01		
3	AI00		
4	TX		
5	RX		
6	PI03		
7	PI04		
8	PI05/SPI_CLK		
9	PI06/SPI_CSB		
10	PI07/SPI_MOSI		
11	PI08/SPI_MISO		
12	PI09		
13	PI010		
14	PI011		
15	GND		
16	GND		
17	PI0/SPI_SEL		
18	GND		
19	GND		
20	VDD_BAT		
21	WAKE		
22	GND		
23	GND		
24	GND		
25	GND		
26	EXT_ANT		

1	AIO[2]	Bidirectional analogue	Analogue programmable I/O line. General-purpose analogue interface pins.
2	AIO[1]	Bidirectional analogue	Analogue programmable I/O line. General-purpose analogue interface pins.
3	AIO[0]	Bidirectional analogue	Analogue programmable I/O line. General-purpose analogue interface pins.
4	TX	CMOS Output	CMOS output with weak internal pull-up. TXD is used to implement UART data transfer from i410e-S to another device.
5	RX	CMOS Input	CMOS input with weak internal pull-down. RXD is used to implement UART data transfer from another device to i410e-S.
6	PIO3	Bidirectional with programmable strength internal pull-up/down	Programmable I/O line
7	PIO4	Bidirectional with programmable strength internal pull-up/down	Programmable I/O line
8	PIO5 / SPI_CLK	Bidirectional with programmable strength internal pull-up/down	Programmable I/O line or debug SPI CLK selected by SPI_EN#. CMOS input for the SPI clock signal with weak internal pull-down.
9	PIO6 / SPI_CSB	Bidirectional with programmable strength internal pull-up/down	Programmable I/O line or debug SPI CSB selected by SPI_EN#. CMOS input with weak internal pull-up. Active low chip select for SPI
10	PIO7 / SPI_MOSI	Bidirectional with programmable strength internal pull-up/down	Programmable I/O line or debug SPI MOSI selected by SPI_EN#. SPI data input with weak internal pull-down.
11	PIO8 / SPI_MISO	Bidirectional with programmable strength internal pull-up/down	Programmable I/O line or debug SPI MISO selected by SPI_EN#. SPI data output with weak internal pull-down.
12	PIO9	Bidirectional with programmable strength internal pull-up/down	Programmable I/O line
13	PIO10	Bidirectional with programmable	Programmable I/O line

		strength internal pull-up/down	
14	PIO11	Bidirectional with programmable strength internal pull-up/down	Programmable I/O line
15	GND	GND	Ground
16	GND	GND	Ground
17	PIO0/SPI_SEL	Input with strong internal pull-down	This pin foot pulls high to SPI mode, pulled low for programmable I/O port mode.
18	GND	GND	Ground
19	GND	GND	Ground
20	VDD_BAT	POWER	+3.3V supply voltage connection. Battery input and regulator enables (active high).
21	WAKE	WAKE	External wake-up function. When WAKE Pin pulls low (To Ground), it wakes up module.
22	GND	GND	Ground
23	GND	GND	Ground
24	GND	GND	Ground
25	EXT_ANT	External antenna	If use the external antenna interface, the on-board antenna needs to be removed.
26	GND	GND	Ground

4 Physical Interfaces

4.1 UART Interface

BlueSoleil i410e-S Universal Asynchronous Receiver Transmitter (UART) interface provides a simple mechanism for communicating with other serial devices using the RS232 standard. The UART interface of i410e-S uses voltage levels of 0 to VDD and thus external transceiver IC is required to meet the voltage level specifications of UART.

In order to communicate with the UART at its maximum data rate using a standard PC, an accelerated serial port adapter card is required for the PC.

Table 10 Possible UART Settings

Parameters		Possible Values
Baud rate	Minimum	1200 baud ($\leq 2\%$ Error)

		9600 baud ($\leq 1\%$ Error)
	Maximum	2Mbaud ($\leq 1\%$ Error)
Flow control		RTS/CTS, none
Parity		None, Odd, Even
Number of stop bits		1 or 2
Bits per channel		8

NOTE: The maximum baud rate is 9600bps during deep sleep.

4.2 SPI Interface

The synchronous serial port interface (SPI) is for interfacing with other digital devices. The SPI port can be used for system debugging. SPI interface is connected using the MOSI, MISO, CSB and CLK pins. It uses a 16-bit data and 16-bit address programming and debug interface. Transaction occurs when the internal processor is running or is stopped.

The module operates as a slave and receives commands on MOSI and outputs data on MISO. Table 11 shows the instruction cycle for a SPI transaction.

Table 11 Instruction Cycle for a SPI Transaction

Step	Operation	Description
1	Reset the SPI interface	Hold CSB high for 2 CLK cycles
2	Write the command word	Take CSB low and clock in the 8-bit command
3	Write the address	Clock in the 16-bit address word
4	Write or read data words	Clock in or out 16-bit data words
5	Termination	Take CSB high

With the exception of reset, CSB must be held low during the transaction. Data on MOSI is clocked on the rising edge of the clock line CLK. When reading, i410e-S replies to the master on MISO with the data changing on the falling edge of the CLK. The master provides the clock on CLK. The transaction is terminated by taking CSB high.

The auto increment operation on the i410e-S cuts down on the overhead of sending a command word and the address of a register for each read or write, especially when large amounts of data are to be transferred. The auto increment offers increased data transfer efficiency on the i410e-S. To invoke auto increment, CSB is kept low, which auto increments the address, while providing an extra 16 clock cycles for each extra word written or read.

5 Software Stacks

BlueSoleil i410e-S is supplied with *Bluetooth* v4.0 compliant stack firmware, which runs on

the internal RISC microcontroller. The i410e-S software architecture allows *Bluetooth* processing and the application program to be shared in different ways between the internal RISC microcontroller and an external host processor (if any).

5.1 BlueSoleil Stack

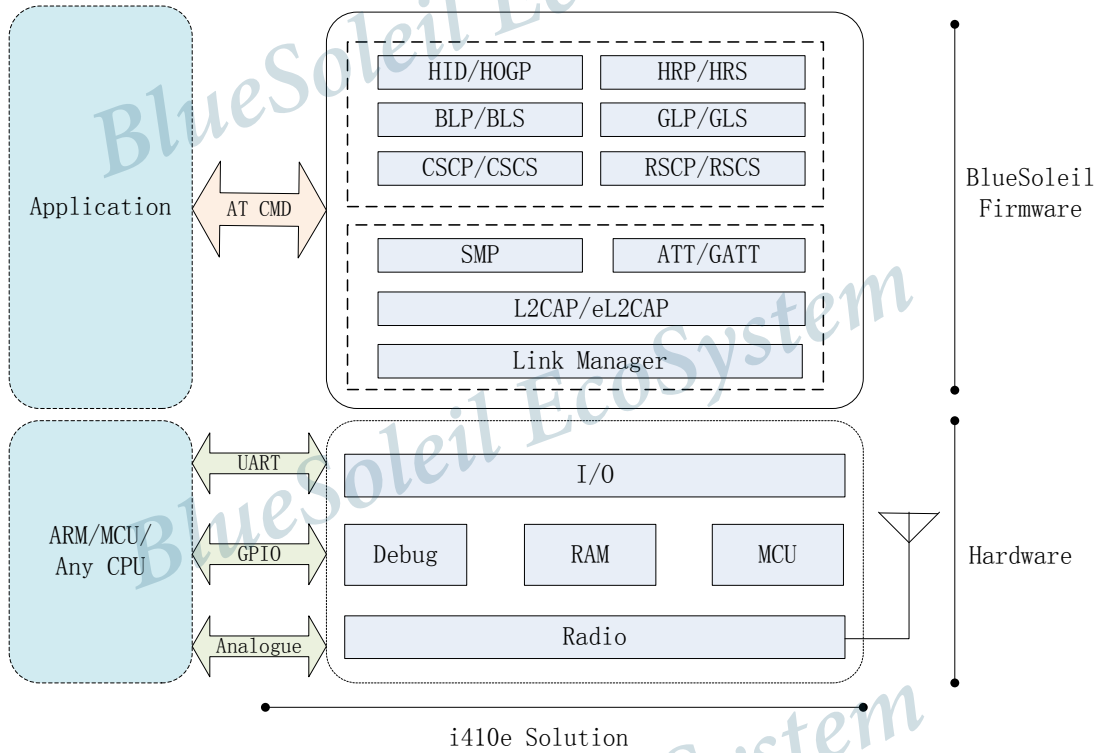


Figure 4 BlueSoleil Stack

As illustrated in Figure 4 above, no host processor is required to run the *Bluetooth* protocol stack. All BlueSoleil stack layers, including application software, run on the internal RISC processor.

The MCU interfaces to BlueSoleil i410e-S via one or more of the physical interfaces, which are also shown in the figure 4. The most common interfacing is done via UART interface using the ASCII commands supported by the BlueSoleil stack. With these ASCII commands the user can access *Bluetooth* functionality without paying any attention to the complexity, which lies in the *Bluetooth* protocol stack.

The user may write applications code to run on the MCU to control BlueSoleil stack with ASCII commands and to develop *Bluetooth* powered applications. Please refer to BlueSoleil_i410e_Programming_Manual.pdf.

6 Re-flow Temperature-time Profile

The re-flow profiles are illustrated in Figure 5 and Figure 6 below.

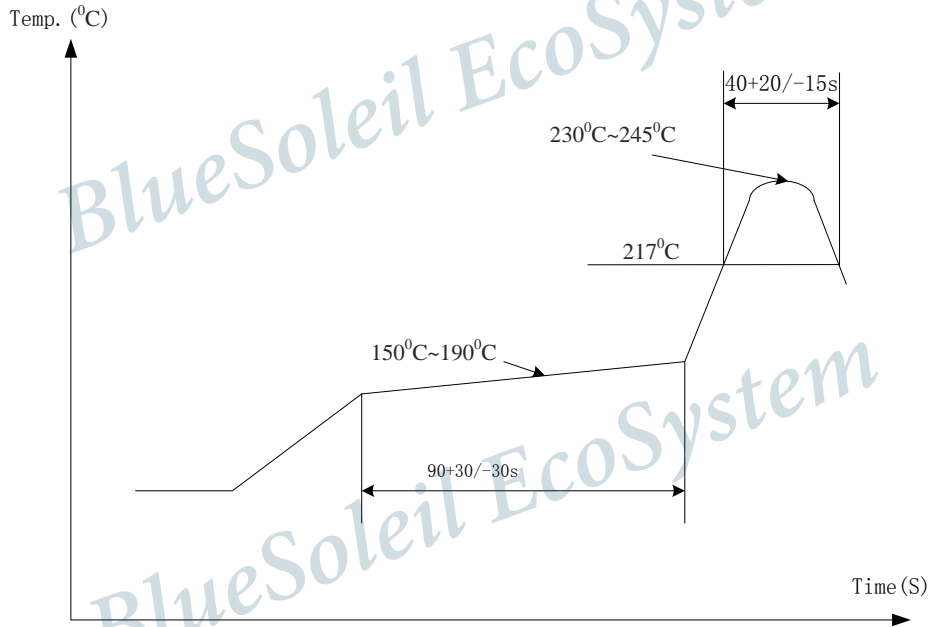


Figure 5 Typical Lead-Free Re-flow Solder Profile

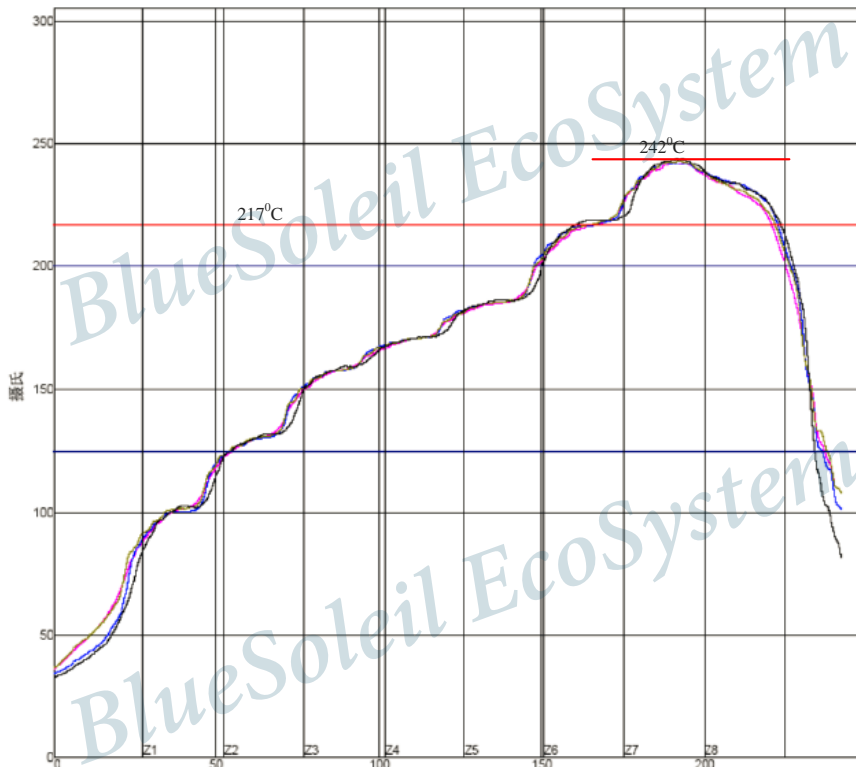


Figure 6 Typical Lead-free Re-flow

The soldering profile depends on various parameters according to the use of different solder and material. The data here is given only for guidance on solder re-flow.

i410e-S will withstand up to two re-flows to a maximum temperature of 245°C.

7 Reliability and Environmental Specification

7.1 Temperature test

Put the module in demo board which uses exit power supply, power on the module and connect to mobile. Then put the demo in the -40°C space for 1 hour and then move to +85°C space within 1 minute, after 1 hour move back to -40°C space within 1 minute. This is 1 cycle. The cycles are 32 times and the units have to pass the testing.

7.2 Vibration Test

The module is being tested without package. The displacement requests 1.5mm and sample is vibrated in three directions(X,Y,Z). Vibration frequency set as 0.5G, a sweep rate of 0.1 octave/min from 5Hz to 100Hz last for 90 minutes each direction. Vibration frequency set as 1.5G, a sweep rate of 0.25 octave/min from 100Hz to 500Hz last for 20 minutes each direction.

7.3 Desquamation Test

Use clamp to fix the module, measure the pull of the component in the module, make sure the module's soldering is good.

7.4 Drop Test

Free fall the module (condition built in a wrapper which can defend ESD) from 150cm height to cement ground, each side twice, total twelve times. The appearance will not be damaged and all functions OK.

7.5 Packaging Information

After unpacking, the module should be stored in environment as follows:

- Temperature: 25°C ± 2°C
- Humidity: <60%
- No acidity, sulfur or chlorine environment

The module must be used in four days after unpacking.

8 Layout and Soldering Considerations

8.1 Soldering Recommendations

BlueSoleil i410e-S is compatible with industrial standard reflow profile for Pb-free solders. The reflow profile used is dependent on the thermal mass of the entire populated PCB, heat transfer efficiency of the oven and particular type of solder paste used. Consult the datasheet of particular solder paste for profile configurations.

IVT Corporation will give following recommendations for soldering the module to ensure reliable solder joint and operation of the module after soldering. Since the profile used is process and layout dependent, the optimum profile should be studied case by case. Thus following recommendation should be taken as a starting point guide.

8.2 Layout Guidelines

It is strongly recommended to use good layout practices to ensure proper operation of the module. Placing copper or any metal near antenna deteriorates its operation by having effect on the matching properties. Metal shield around the antenna will prevent the radiation and thus metal case should not be used with the module. Use grounding via separated max 3 mm apart at the edge of grounding areas to prevent RF penetrating inside the PCB and causing an unintentional resonator. Use GND via all around the PCB edges.

The mother board should have no bare conductors or via in this restricted area, because it is not covered by stop mask print. Also no copper (planes, traces or via) are allowed in this area, because of mismatching the on-board antenna.

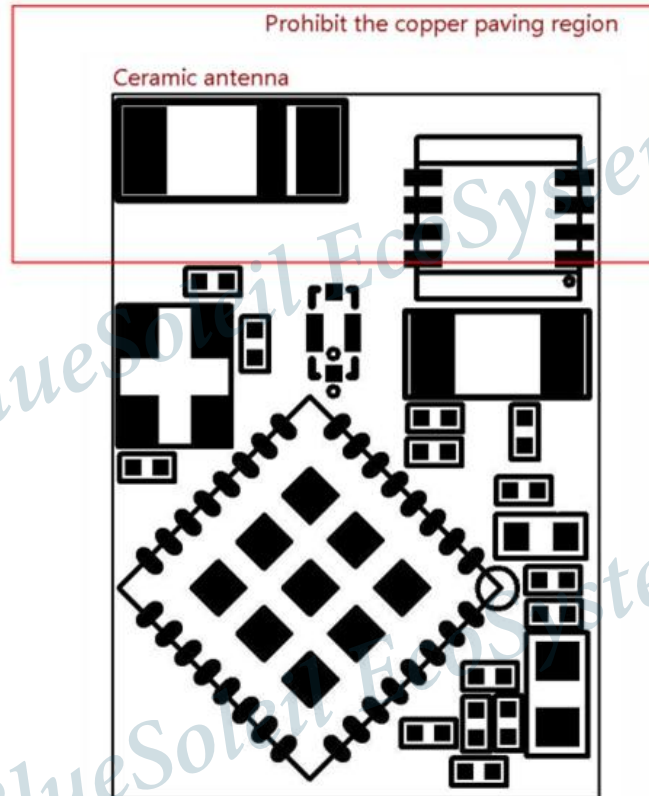


Figure 7 i410e-S Restricted Area

Following recommendations helps to avoid EMC problems arising in the design. Note that each design is unique and the following list do not consider all basic design rules such as avoiding capacitive coupling between signal lines. Following list is aimed to avoid EMC problems caused by RF part of the module. Use good consideration to avoid problems arising from digital signals in the design.

Ensure that signal lines have return paths as short as possible. For example if a signal goes to an inner layer through a via, always use ground via around it. Locate them tightly and symmetrically around the signal via. Routing of any sensitive signals should be done in the inner layers of the PCB. Sensitive traces should have a ground area above and under the line. If this is not possible, make sure that the return path is short by other means (for example using a ground line next to the signal line).

9 Physical Dimensions

BlueSoleil i410e-S's dimension is 13mm (L) *9mm (W).

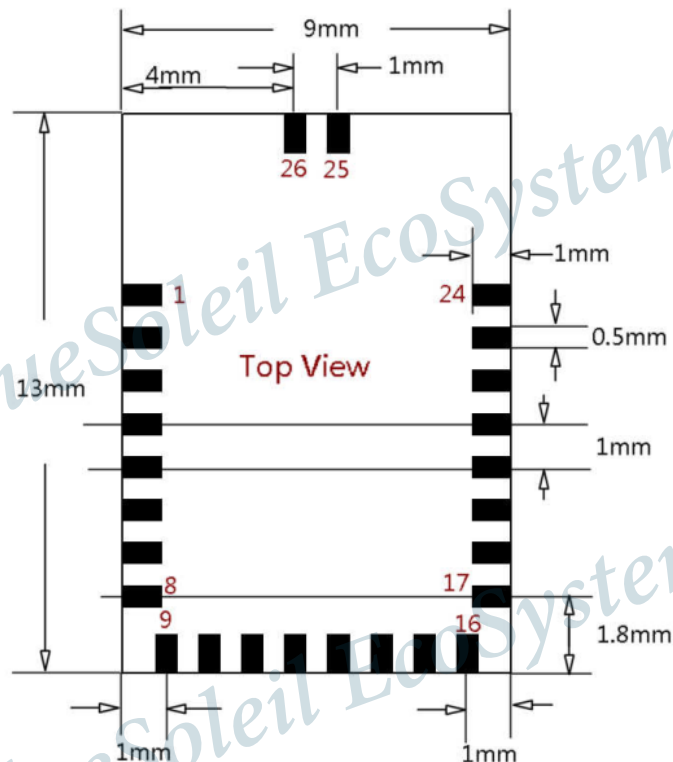


Figure 8 i410e-S Footprint

10 Package

TBD

11 Certification

11.1 Bluetooth

BlueSoleil i410e module is qualified as a *Bluetooth* controller subsystem and it fulfills all the mandatory requirements of Bluetooth 4.0 core specification. If not modified in any way, it is a complete Bluetooth entity, containing software and hardware functionality as well as the whole RF-part including the antenna. This practically translates to that if the module is used without modification of any kind, it does not need any Bluetooth approval work for evaluation on what needs to be tested.

i410e Qualified Design ID (QDID): B020729

11.2 CE 0700

Hereby, IVT Corporation declares that this device is in compliance with the essential requirements and other relevant provisions of Directive 1999/5/EC.

CE 0700

11.3 FCC

FCC IDENTIFIER: S78-IVTI410E
Name of Grantee: IVT Corporation
Equipment Class: Digital Transmission System
Notes: Bluetooth module 4.0 LE
Modular Type: Single Modular

11.4 IC

CERTIFICATION NUMBER: IC: 11004A-IVTI410E

Issued to/Déjà livré a:	IVT Corporation	Date Issued:	7/8/2013
Address:	5/F, Zhongguancun Fazhan Building No. 12, Shangdi Xinx Road, Haidian District, Beijing		
Nature of Application/Nature d'Application:	Original		
Equipment Description/Genre de Matériel:	BT module 4.0 LE		
Type of Radio Equipment:	Low Power Device (2400-2483.5 MHz), Modular Approval		
Equipment Category/Catégorie de Matériel:	Category I		
<u>Model Number(s)/Modele</u>	i410e		

12 Bluetooth Technology Best Developed Corporation

IVT Corporation is one of Bluetooth technology BEST developed together which is authenticated by The Bluetooth SIG. See Figure 9 below.



Figure 9 IVT is one of *Bluetooth* technology BEST developed together

13 Contact Information

Contacts: Mr. Zhu Yong

Mobile: +86 18910255873

Tel: +86 10 82898219

Fax: +86 10 62963059

Email: embedded@ivtcorporation.com

Address: IVT Corporation 5/F, Fa Zhan Building No.12, Shang Di Xin Xi Road, Beijing, 100085 P.R. China

Company Site: www.ivtcorporation.com

Support: support@ivtcorporation.com

14 Copyright

Copyright ©1999-2013 IVT Corporation

All rights reserved.

IVT Corporation assumes no responsibility for any errors which may appear in the specification.

Furthermore, IVT Corporation reserves the right to alter the hardware, software, and/or specification detailed here at any time without notice and does not make any commitment to update the information contained here.

BlueSoleil is a registered trademark of IVT Corporation for *Bluetooth* production.

The *Bluetooth* trademark is owned by The Bluetooth SIG Inc., USA and is licensed to IVT Corporation.

All other trademarks listed herein are owned by their respective owners.

BlueSoleil EcoSystem

BlueSoleil EcoSystem

BlueSoleil EcoSystem

BlueSoleil EcoSystem