DATASHEET

BoT-CLE110

Specification

Bluetooth 4.1 SMART (BLE)

CONFIDENTEAL INFORMATION

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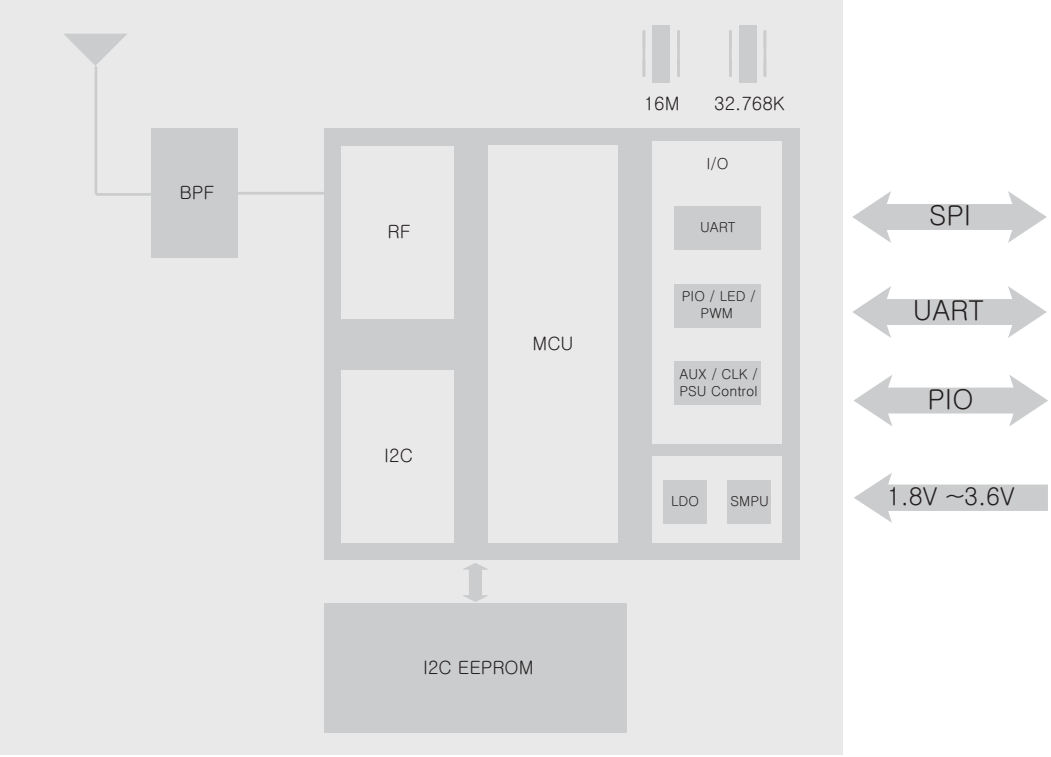
1. General

1.1 Overview

This specification covers Bluetooth module (class-2) which single IC Bluetooth Low Energy solution; this module provides everything required to create a Bluetooth low energy product with RF, baseband, MCU, qualified Bluetooth v4.0, Bluetooth v4.1 stack and customer application running.

This Module has deployed CSR μEnergy® CSR1010™ chipset.

All detailed specification including pin outs and electrical specification may be changed without notice.



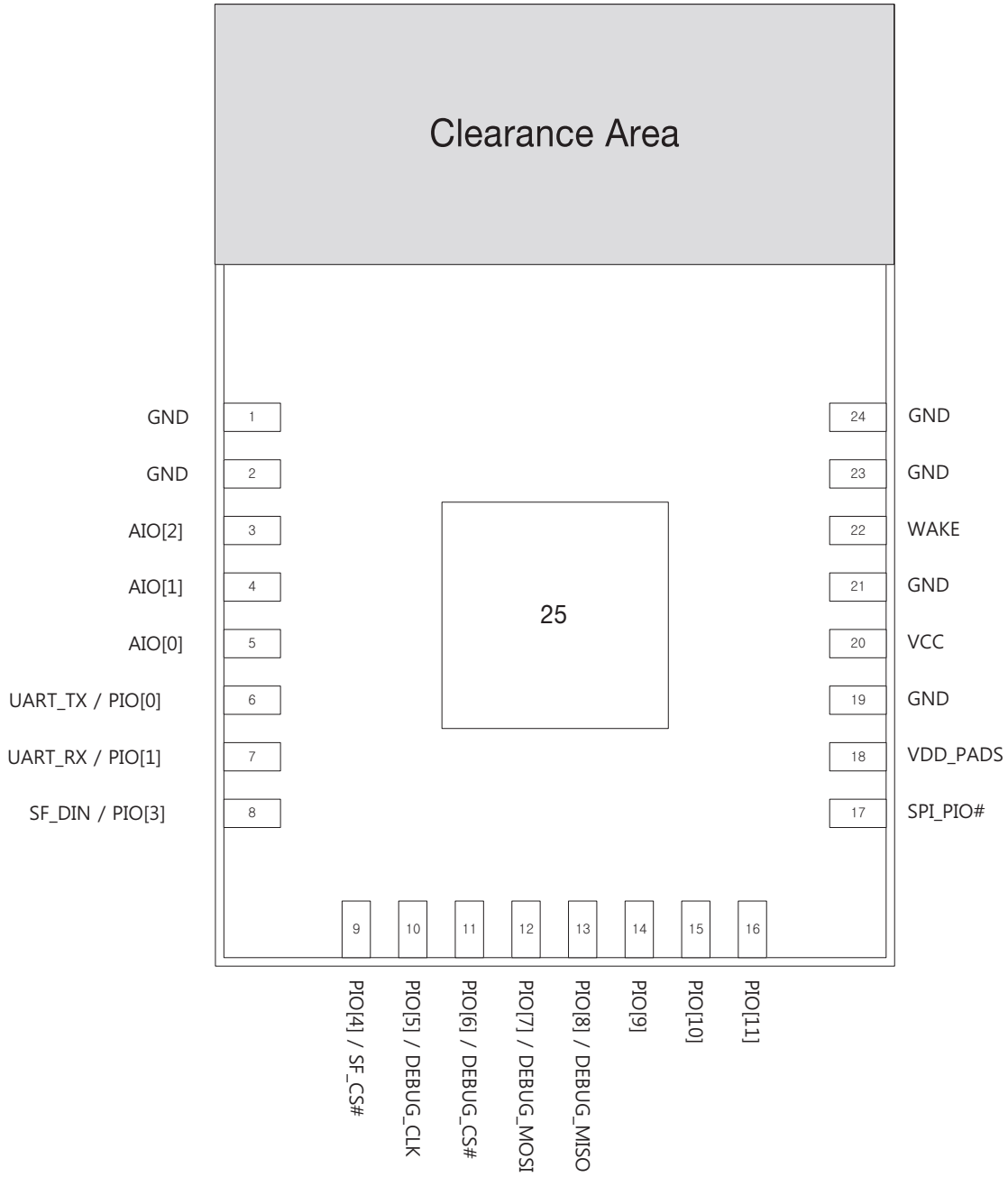
1.2 Features

- 128KB memory: 64KB RAM and 64KB ROM
- Bluetooth® v4.0, Bluetooth® v4.1 specification
- 7.5dBm Bluetooth low energy maximum transmit output power
- -92.5dBm Bluetooth low energy receive sensitivity
- Support for Bluetooth v4.0, Bluetooth v4.1 specification host stack including ATT, GATT, SMP, L2CAP, GAP
- RSSI monitoring for proximity applications
- Programmable general purpose PIO controller
- 10-bit ADC
- 11 digital PIOs
- 3 analogue AIOs
- UART
- Debug SPI
- 4 PWM modules
- Wake-up interrupt and watchdog timer
- Competitive Size (17mm x 12mm x 2mm : 32Pin)
- Operating temperature range (MAX -20℃ ~ 70℃)

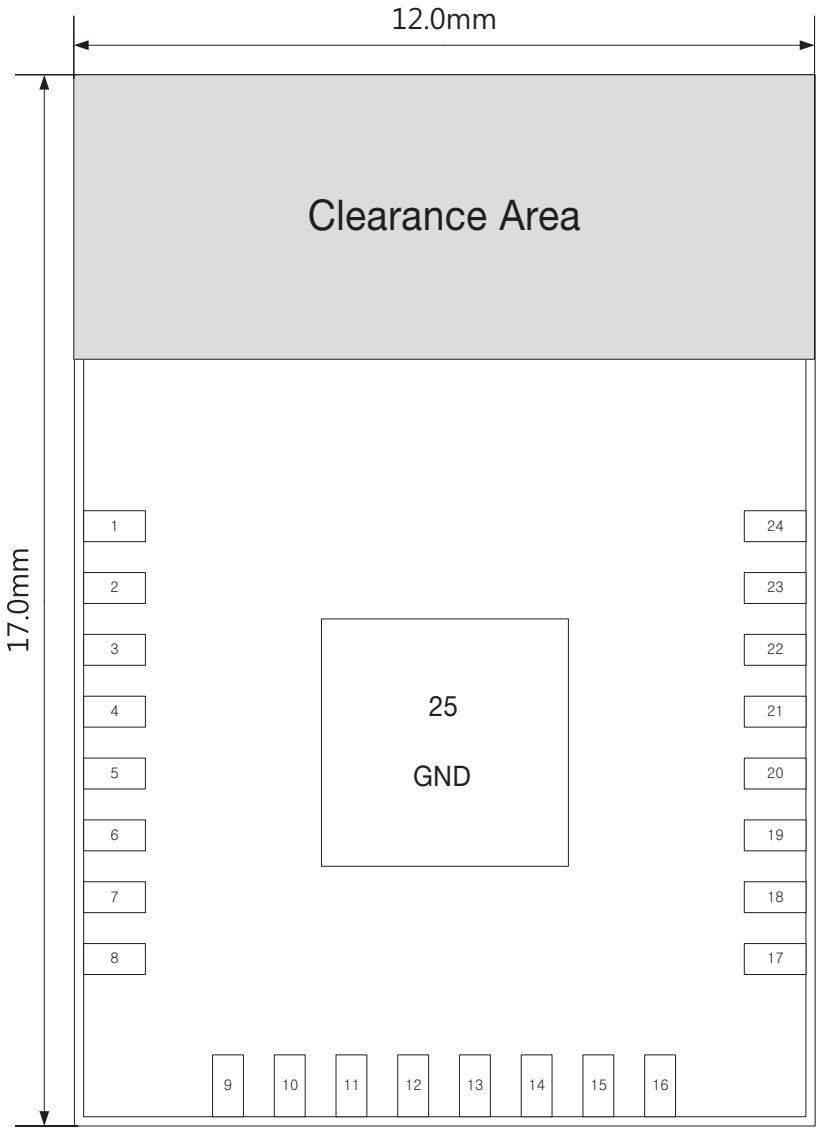
1.3 Application

- 2.4-GHz Bluetooth low energy Systems
- Watch, Keyboard, Mouse, Remote Control
- Sport and Fitness sensors
- Health sensors
- Smart Home
- Mobile Phone Accessories

1.4 Pin Configuration & Outline Size



Pin Configuration (TOP VIEW)



Outline Size (TOP VIEW)

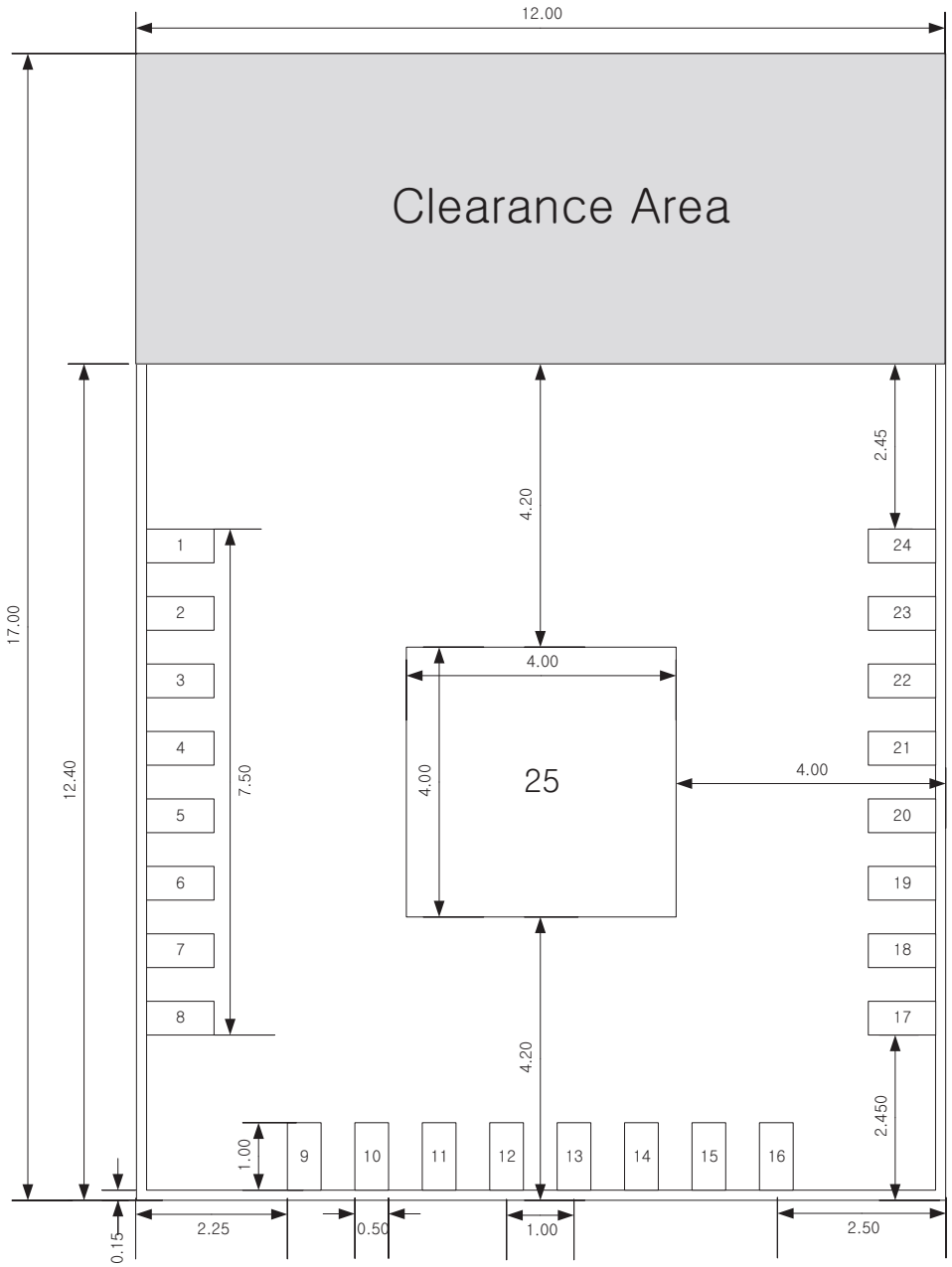
1.5 Device Terminal Functions

Function			Pin Name	Pin No.	Pin Type	Description	Note
AIO	AIO[0]		AIO[0]	5	Bidirectional analogue	Analogue programmable I/O line	
	AIO[1]		AIO[1]	4	Bidirectional analogue	Analogue programmable I/O line	
	AIO[2]		AIO[2]	3	Bidirectional analogue	Analogue programmable I/O line	
PIO	PIO[0]	UART_TX	PIO[0]	6	Bidirectional	Programmable I/O line or UART TX	
	PIO[1]	UART_RX	PIO[1]	7	Bidirectional	Programmable I/O line or UART RX	
	PIO[3]		PIO[3]	8	Bidirectional	Programmable I/O line	
	PIO[4]		PIO[4]	9	Bidirectional	Programmable I/O line	
	PIO[5]	SPI_CLK	PIO[5]	10	Bidirectional	Programmable I/O line or debug SPI_CLK selected by SPI_PIO#	
	PIO[6]	SPI_CS#	PIO[6]	11	Bidirectional	Programmable I/O line or debug SPI_CSB selected by SPI_PIO#	
	PIO[7]	SPI_MOSI	PIO[7]	12	Bidirectional	Programmable I/O line or debug SPI_MOSI selected by SPI_PIO#	
	PIO[8]	SPI_MISO	PIO[8]	13	Bidirectional	Programmable I/O line or debug SPI_MISO selected by SPI_PIO#	
	PIO[9]		PIO[9]	14	Bidirectional	Programmable I/O line	
	PIO[10]		PIO[10]	15	Bidirectional	Programmable I/O line	
	PIO[11]		PIO[11]	16	Bidirectional	Programmable I/O line	
Control	SPI_PIO#		SPI_PIO#	17	Input with strong internal Pull-down	Selects SPI debug on PIO[8:5]	▪High = SPI ▪Low = PIO
	WAKE		WAKE	22	Input has no internal pull-up or Pull-down	Input to wake CSR1010QFN form hibernate or dormant.	
Power	VCC		VCC	20	Power	Battery input and regulator enable (active high)	
	VDD_PADS		VDD_PADS	18	Power	Positive supply for all digital I/O ports PIO[11:0].	
	GND		GND	1, 2,19,21,23, 24,25	GND	Ground	25pin BOTTOM PAD

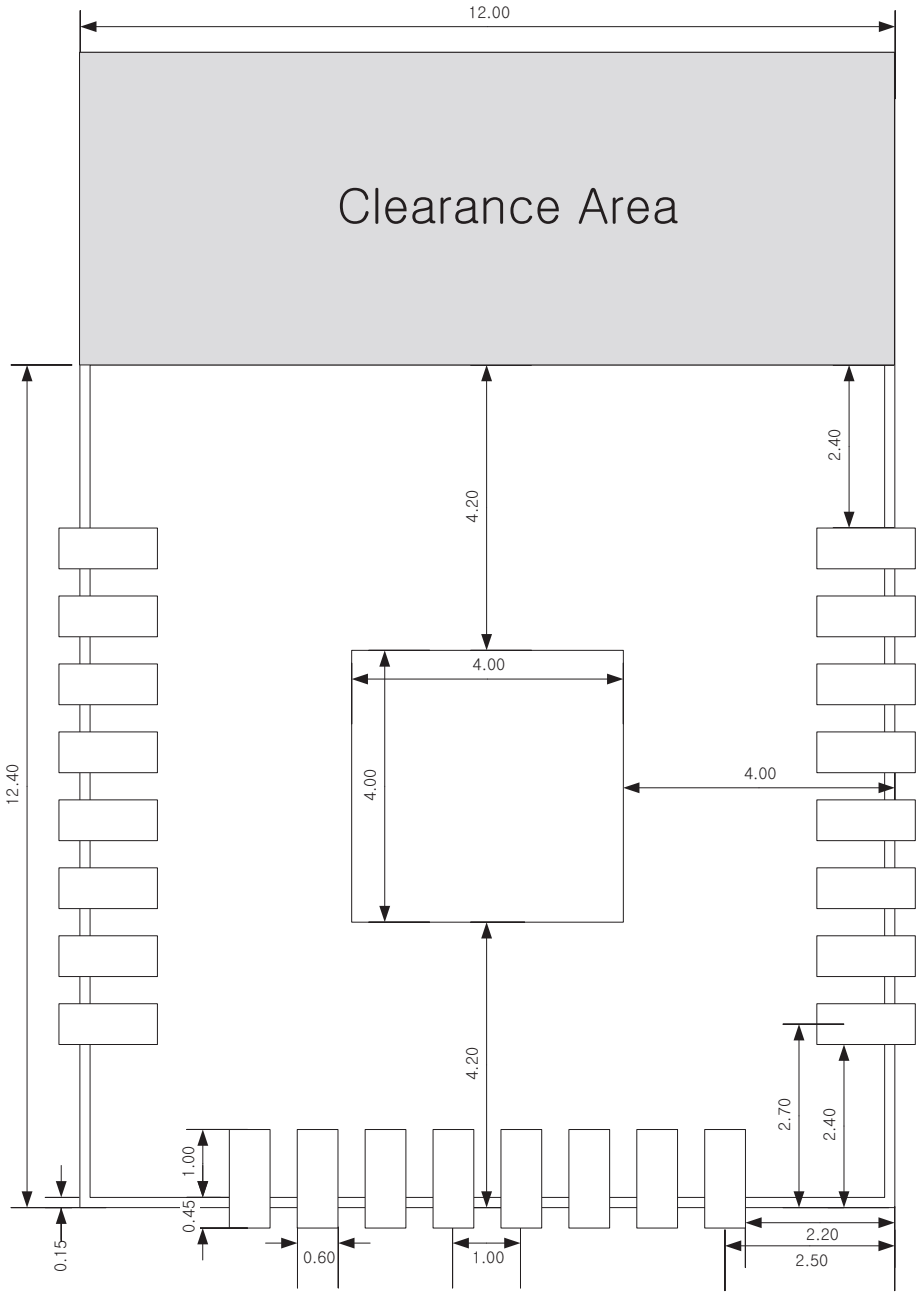
1.5.1 Software pin define

Function			Pin Name	Pin No.	Description
AIO	AIO[0]		AIO[0]	5	Analogue Input (0~1.5v)
	AIO[1]		AIO[1]	4	Analogue Input (0~1.5v)
	AIO[2]		AIO[2]	3	Analogue Input (0~1.5v)
PIO	PIO[0]	UART_TX	PIO[0]	6	Programmable I/O line or UART TX
	PIO[1]	UART_RX	PIO[1]	7	Programmable I/O line or UART RX
	PIO[3]		PIO[3]	8	Connection Detect LED Output (Low=Disconnect, High=Connect)
	PIO[4]		PIO[4]	9	UART select (Low=off, High=on)
	PIO[5]	SPI_CLK	PIO[5]	10	PWM0, PWM Output (0~255)
	PIO[6]	SPI_CS#	PIO[6]	11	PWM1, PWM Output (0~255)
	PIO[7]	SPI_MOSI	PIO[7]	12	PWM2, PWM Output (0~255)
	PIO[8]	SPI_MISO	PIO[8]	13	PWM3, PWM Output (0~255)
	PIO[9]		PIO[9]	14	Factory Reset (active high, 4초이상)
	PIO[10]		PIO[10]	15	Digital Input or Output port
	PIO[11]		PIO[11]	16	Digital Input or Output port
Control	SPI_PIO#		SPI_PIO#	17	Selects SPI debug on PIO [8:5] (Low=PWM, High=firmware SPI)

1.6 Package Dimensions & Land Pattern



Package Dimensions (TOP VIEW)



Land Pattern (TOP VIEW)

2. Characteristics

2.1 Electrical Characteristics

■ Absolute Maximum Ratings

Rating	Min	Max	Unit
Storage Temperature range	-40	85	℃
Supply (VCC) voltage	1.8	3.6	V
Other terminal voltages	VSS-0.4	VDD+0.4	V

■ Recommended Operating Conditions

Operating Condition	Min	TYP	Max	Unit
Operating temperature range	-20	-	70	℃
Supply (VCC) voltage	1.8	-	3.6	V

■ DigitalInput/ Output Terminal Characteristics

Input Voltage Levels	Min	TYP	Max	Unit
VIL input logic level low	-0.4	-	0.3 x VCC	V
VIH input logic level high	0.7 x VCC	-	VCC + 0.4	V
Tr/Tf	-	-	25	ns

Output Voltage Levels	Min	TYP	Max	Unit
VOL output logic level low, IOL = 4.0mA	-	-	0.4	V
VOH output logic level high, IOH = -4.0mA	0.75 x VCC	-	-	V
Tr/Tf	-	-	5	ns

■ PIO & AIO Recommended Operating Conditions

Output Voltage Levels	Min	TYP	Max	Unit
Input voltage	-	-	1.35	V
Output voltage	-	-	1.35	V

2.2 RF Characteristics

2.2.1 Transmitter

RF Characteristics		MIN	TYP	Max	Bluetooth Specification	Unit	Note
Maximum RF transmit power		3.5 @ -30℃ 3.5 @ 20℃ 2 @ 85℃	7.5 @ -30℃ 7.5 @ 20℃ 6 @ 85℃	-	-20 to 10	dBm	(1) (2)
ACP	F = F_0± 2MHz	-	-28 @ -30℃ -28 @ 20℃ -29 @ 85℃	-20	≤-20	dBm	(3) (4)
	F = F0± 3MHz	-	-32 @ -30℃ -32 @ 20℃ -35 @ 85℃	-22 @ -30℃ -22 @ 20℃ -23 @ 85℃	≤-30	dBm	(3) (4)
	F = F0± > 3MHz	-	<-55	-24 @ -30℃ -27 @ 20℃ -40 @ 85℃	≤-30	dBm	(3) (4)
Δf_{1avg} maximum modulation		225	258	275	225 < f_{1avg}< 275	kHz	-
Δ_{f2max} minimum modulation		185	197	-	≥185	kHz	-
Δf_{2avg} / Δf_{1avg}		0.8	0.86	-	≥0.80	-	-
ICFT		-35	10 @ -30℃ 5 @ 20℃ 10 @ 85℃	35	±150	kHz	(5)
Carrier drift rate		-	11 @ -30℃ 8 @ 20℃	20	≤20	kHz/50μs	-
Carrier drift		-	6 @ -30℃ 7 @ 20℃ 8 @ 85℃	50	≤50	kHz	-
2^{nd} harmonic content		-	-34	-	-	dBm	(6)
3^{rd} harmonic content		-	-32	-	-	dBm	(6)

Note:

(1) The firmware maintains the transmit power within Bluetooth v4.0, Bluetooth v4.1specification limits
(2) Illustrative: Can be varied under firmware control on an application-dependent basis down to approximately -20dbm
(3) Measured at F0= 2440MHz
(4) CSR1010A04 QFN guaranteed to meet ACP performance in Bluetooth v4.0, Bluetooth v4.1 specification
(5) Ignores any frequency error in the reference
(6) Addition of a filter attenuates the harmonics

2.22 Receiver

RF Characteristics	Frequency (GHz)	MIN	TYP	Max	Bluetooth Specification	Unit	Note
Sensitivity at 30.8% PER for all basic rate packet types	2.402	@ -30℃ @ 20℃ @ 85℃	-92.5 @ -30℃ -92 @ 20℃ -89 @ 85℃	-88.5 @ -30℃ -88 @ 20℃ -85 @ 85℃	≤-70	dBm	-
	2.44	-	-93 @ -30℃ -92.5 @ 20℃ -89.5 @ 85℃	-89 @ -30℃ -88.5 @ 20℃ -85.5 @ 85℃			-
	2.48	-	-93 @ -30℃ -92.5 @ 20℃ -89.5 @ 85℃	-89 @ -30℃ -88.5 @ 20℃ -85.5 @ 85℃			-
Reported PER during PER report integrity test	2.426	50	50	65.4	50 < PER < 65.4	%	(1)
Maximum received signal at 30.8% PER		-10	> -10	-	≥-10	dBm	-
Continuous power required to block Bluetooth reception (for input power of -67dBm with 30.8% PER) measured at the single-ended RF port of CSR1010A04 QFN	0.030 - 2.000	-35	> 3	-	-30	dBm	(2)
	2.000 - 2.400	-35	-3	-	-35		(2)
	2.500 - 3.000	-35	-3	-	-35		(2)
	3.000 - 12.75	-30	>3	-	-30		(2)
C/I co-channel		-	6	21	≤21	dBm	(3) (4) (5)
Adjacent channel selectivity C/I	$F = F_0 + 1MHz$	-	2	15	≤15	dB	(3) (4) (5)
	$F = F_0 - 1MHz$	-	1	15	≤15		(3) (4) (5)
	$F = F_0 + 2MHz$	-	-28	17	≤-17		(3) (4) (5)
	$F = F_0 - 2MHz$	-	-21	15	≤-15		(3) (4) (5)
	$F = F_0 + 3MHz$	-	-31	27	≤-27		(3) (4) (5)
	$F = F_0 - 5MHz$	-	-30	27	≤-27		(3) (4) (5)
	$F = F_{image}$	-	-24	-9	≤-9		(3) (4) (5)
Maximum level of intermodulation interferers		-50	-33	-	≥-50	dBm	(6)
Spurious output level		-	154	-	-	dBm / Hz	(7)

Note:

(1) Measured in accordance with the RCV-LE/CA/07/C test. Random number of packets transmitted by tester of which 50% have corrupted CRCs. Wanted signal level is -30dBm.

(2) CSR1010A04 QFN is guaranteed to meet the blocking performance as specified by the Bluetooth v4.0, Bluetooth v4.1 specification

(3) CSR1010A04 QFN is guaranteed to meet the C/I performance as specified by the Bluetooth v4.0 Bluetooth v4.1 specification.

(4) Measured at F_0= 2440MHz.

(5) F_{Image}= F_0- 3MHz. However, depending on crystal frequency and channel number, the image may switch to the opposite side of the carrier. When this occurs, FImage= F_0+ 3MHz and the offsets in the table equations associated with C/I are also reversed.

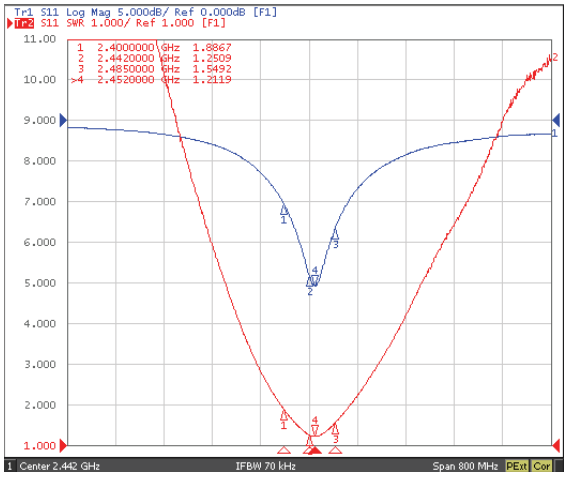
(6) Measured at f_1- f_2= ±3, 4 and 5MHz. Measurement is performed in accordance with Bluetooth RF test RCV-LE/CA/05/C, i.e. wanted signal at -64dBm.

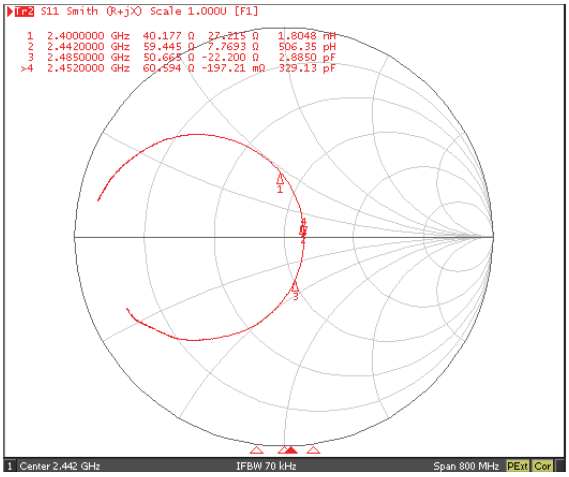
(7) Integrated in 100kHz bandwidth and normalised to 1Hz. Actual figure is typically -154dBm/Hz except for peaks of -82dBm at 1600MHz and -82dBm in-band at 2.4GHz.

2.2.3 Antenna Characteristics

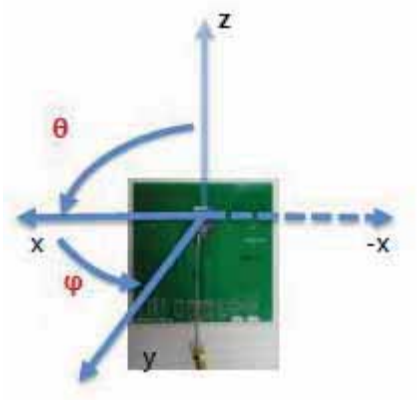
The antenna is monopole type of chip antenna. The antenna impedance matching is optimized for 1 mm ~ 2 mm mother board PCB thickness. The radiation pattern is impacted by the layout of the mother board. Typically the highest gain is towards GND plane and weakest gain away from the GND plane.

■ S-Parameter





■ Radiation Gain



Freq (GHz)	Efficiency (%)	Avg. Gain (dBi)	Peak Gain (dBi)
2400 MHz	46.3	-3.3	1.0
2440 MHz	51.4	-2.9	1.6
2485 MHz	50.2	-3.0	2.0

3. Terminal Description

3.1 UART Interface

BoT-CLE110 UART interface provides a simple mechanism for communicating with other serial devices using the RS232 protocol.

The 2 signals implement the UART function, UART_TX and UART_RX. When BoT-CLE110 is connected to another digital device, UART_RX and UART_TX transfer data between the 2 devices. UART configuration parameters, e.g. baud rate and data format, are set using BoT-CLE110 firmware.
When selected in firmware PIO[0] is assigned to a UART_TX output and PIO[1] is assigned to a UART_RX input. The UART CTS and RTS signals can be assigned to any PIO pin by the BoT-CLE110 firmware

3.1.1 UART Setting

To communicate with the UART at its maximum data rate using a standard PC, the PC requires an accelerated serial port adapter card.
However, The maximum baud rate is 9600 baud during deep sleep.

Parameter		Possible values
Baud rate	Minimum	1200 baud(≤2% Error)
		9600 baud(≤1% Error)
	Maximum	2M baud(≤1% Error)
Flow control		RTS/CTS
Parity		None, Odd or Even
Number of stop bits		1 or 2
Bits per byte		8

3.2 Programming and Debug Interface

Important Note:

The BoT-CLE110 debug SPI interface is available in SPI slave mode to enable an external MCU to program and control the BoT-CLE110 , generally via libraries or tools supplied by CSR. The protocol of this interface is proprietary. The 4 SPI debug lines directly support this function.

The SPI programs, configures and debugs the BoT-CLE110 . It is required in production. Ensure the 4 SPI signals are brought out to either test points or a header.

Take SPI_PIO#_SEL high to enable the SPI debug feature on PIO[8:5].

BoT-CLE110 uses a 16-bit data and 16-bit address programming and debug interface. Transactions occur when the internal processor is running or is stopped. Data is written or read one word at a time, or the auto-increment feature is available for block access.

3.2.1 Instruction Cycle

The BoT-CLE110 is the slave and receives commands on DEBUG_MOSI and outputs data on DEBUG_MISO.

1	Reset the SPI interface	Hold DEBUG_CS# high for 2 DEBUG_CLK cycles
2	Write the command word	Take DEBUG_CS# 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 word(s)
5	Termination	Take DEBUG_CS# high

With the exception of reset, DEBUG_CS# must be held low during the transaction. Data on DEBUG_MOSI is clocked into the CSR1010 QFN on the rising edge of the clock line DEBUG_CLK. When reading, BoT-CLE110 replies to the master on DEBUG_MISO with the data cha nging on the falling edge of the DEBUG_CLK. The master provides the clock on DEBUG_CLK. The transaction is terminated by taking DEBUG_CS# high.

The auto increment operation on the BoT-CLE110 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 BoT-CLE110 QFN. To invoke auto increment, DEBUG_CS# is kept low, which auto increments the address, while providing an extra 16 clock cycles for each extra word written or read.

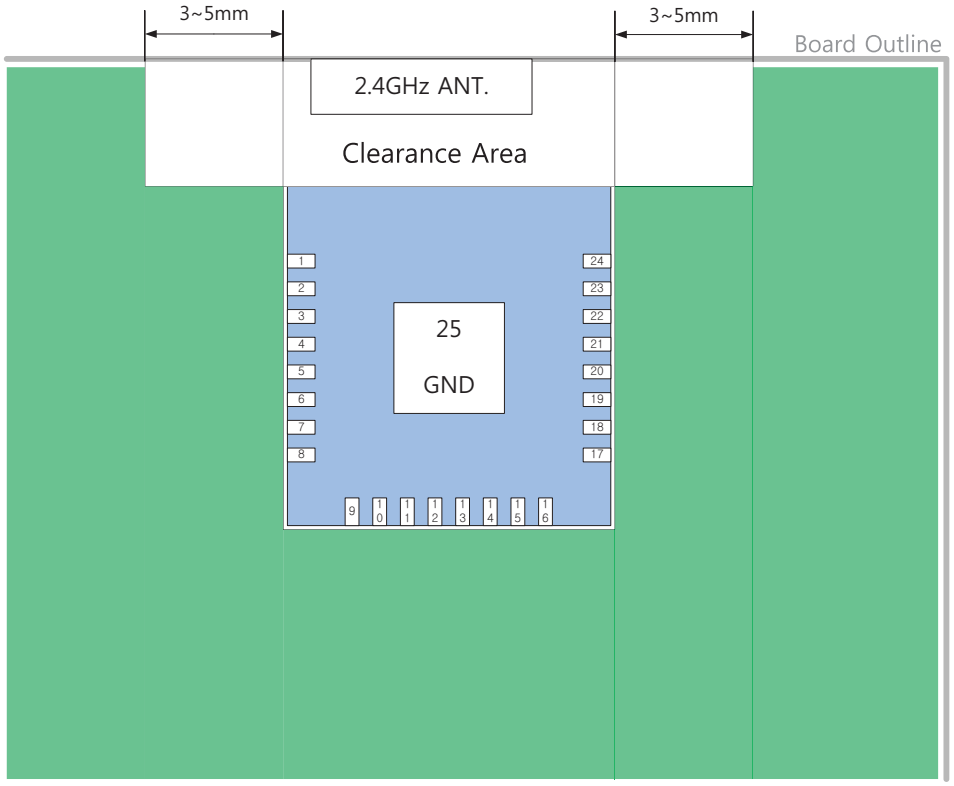
3.2.2 Multi-slave Operation

Do not connect the BoT-CLE110 in a multi-slave arrangement by simple parallel connection of slave MISO lines. When BoT-CLE110 is deselected (DEBUG_CS# = 1), the DEBUG_MISO line does not float. Instead, BoT-CLE110 outputs "0" if the processor is running or "1" if it is stopped.

4. Layout Guide

4.1 Layout Guide

For optimal performance of the antenna place the module at the outside of the PCB
Do not place any metal (traces, components, battery etc.) within the clearance area of the antenna. Connect all the GND pins directly to a solid GND plane. Place the GND vias as close to the GND pins as possible. Use good layout practices to avoid any excessive noise coupling to signal lines or supply voltage lines. Avoid placing plastic or any other dielectric material closer than 5 mm from the antenna. Any dielectric closer than 5 mm from the antenna will detune the antenna to lower frequencies.



5. Application Schematic