DATASHEET

BoT-CLE100

Specification

Bluetooth 4.1 SMART (BLE)

CONFIDENTEAL INFORMATION

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List of contents

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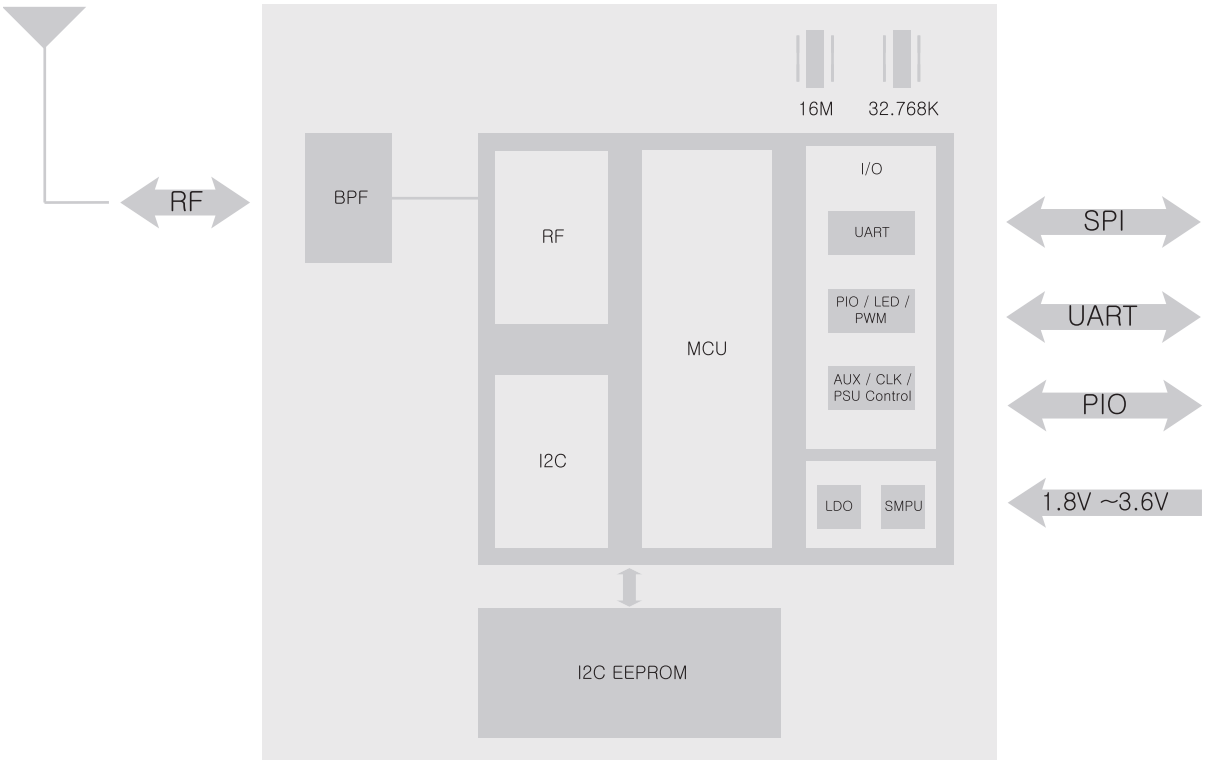
1. General

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.



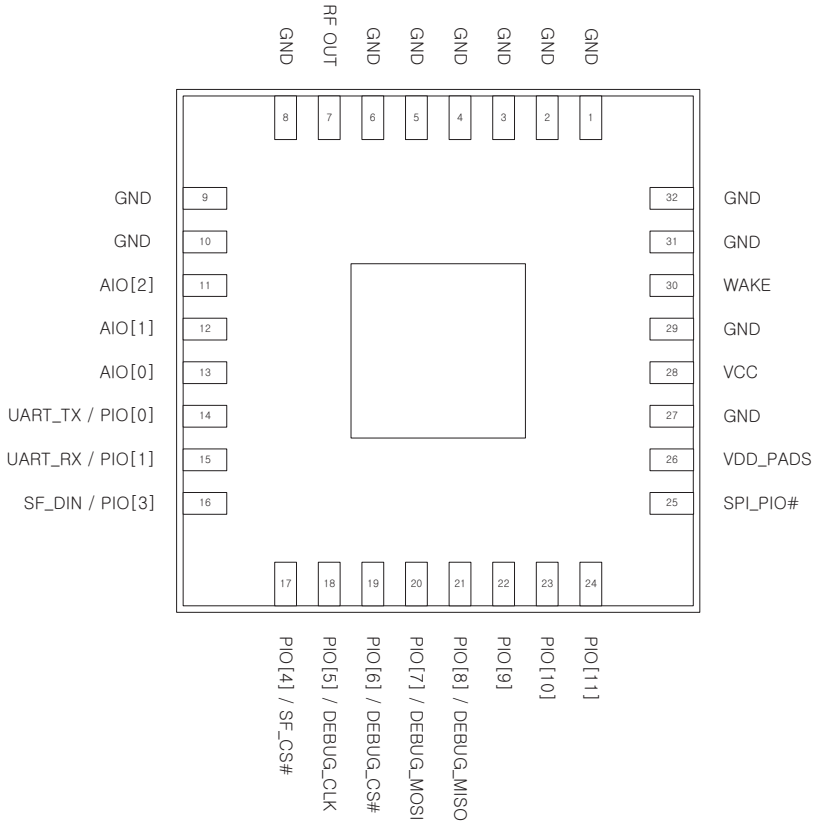
1.2 Features

- 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 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 (12mm x 12mm x 2mm : 32Pin)
- Operating temperature range (MAX -20℃ ~ 70℃)

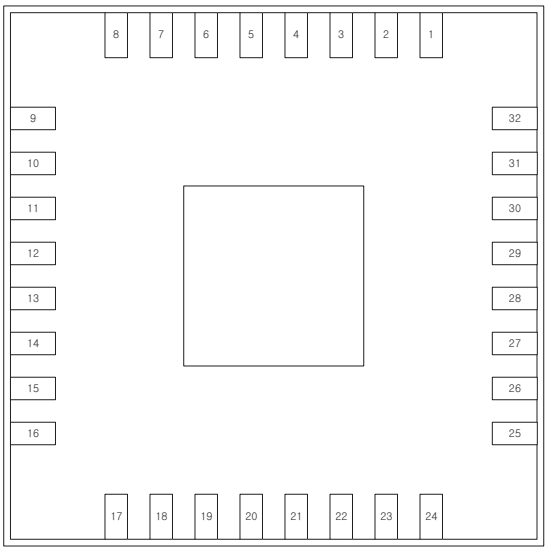
1.3 Application

- 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)



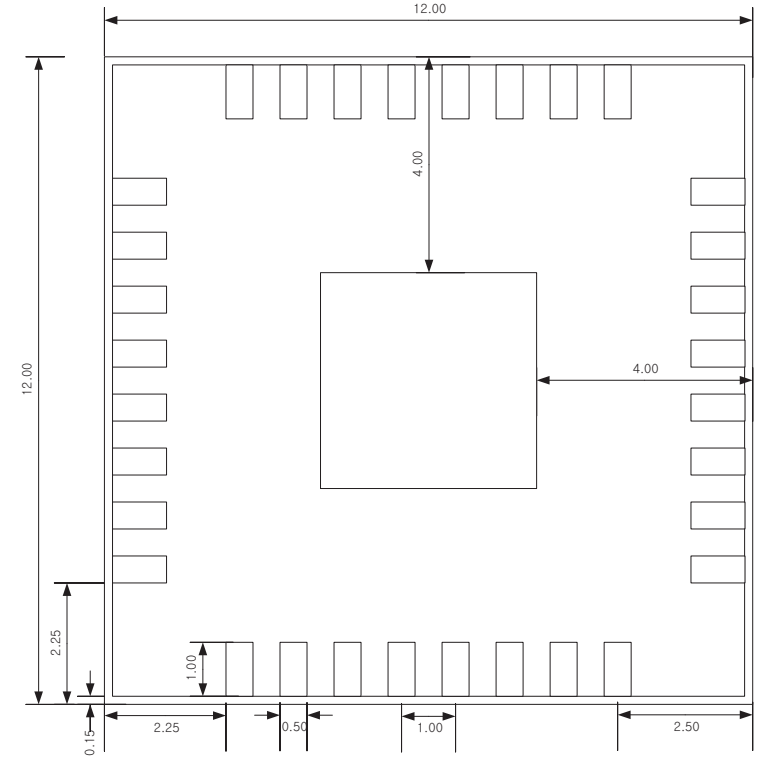
1.5 Device Terminal Functions

Function			Pin Name	Pin No.	Pin Type	Description	Note
AIO	AIO[0]		AIO[0]	13	Bidirectional analogue	Analogue programmable I/O line	
	AIO[1]		AIO[1]	12	Bidirectional analogue	Analogue programmable I/O line	
	AIO[2]		AIO[2]	11	Bidirectional analogue	Analogue programmable I/O line	
PIO	PIO[0]	UART_TX	PIO[0]	14	Bidirectional	Programmable I/O line or UART TX	
	PIO[1]	UART_RX	PIO[1]	15	Bidirectional	Programmable I/O line or UART RX	
	PIO[3]		PIO[3]	16	Bidirectional	Programmable I/O line	
	PIO[4]		PIO[4]	17	Bidirectional	Programmable I/O line	
	PIO[5]	SPI_CLK	PIO[5]	18	Bidirectional	Programmable I/O line or debug SPI_CLK selected by SPI_PIO#	
	PIO[6]	SPI_CS#	PIO[6]	19	Bidirectional	Programmable I/O line or debug SPI_CSB selected by SPI_PIO#	
	PIO[7]	SPI_MOSI	PIO[7]	20	Bidirectional	Programmable I/O line or debug SPI_MOSI selected by SPI_PIO#	
	PIO[8]	SPI_MISO	PIO[8]	21	Bidirectional	Programmable I/O line or debug SPI_MISO selected by SPI_PIO#	
	PIO[9]		PIO[9]	22	Bidirectional	Programmable I/O line	
	PIO[10]		PIO[10]	23	Bidirectional	Programmable I/O line	
	PIO[11]		PIO[11]	24	Bidirectional	Programmable I/O line	
Control	SPI_PIO#		SPI_PIO#	25	Input with strong internal Pull-down	Selects SPI debug on PIO[8:5]	▪High = SPI ▪Low = PIO
	WAKE		WAKE	30	Input has no internal pull-up or Pull-down	Input to wake CSR1010QFN form hibernate or dormant.	
Power	VCC		VCC	28	Power	Battery input and regulator enable (active high)	
	VDD_PADS		VDD_PADS	26	Power	Positive supply for all digital I/O ports PIO[11:0].	
	GND		GND	1,2,3,4,5, 6,8,9,10,27, 29,31,32,33	GND	Ground	33pin BOTTOM PAD
RF	RF OUT		RF OUT	7	RF OUT	Bluetooth transmitter / receiver.	

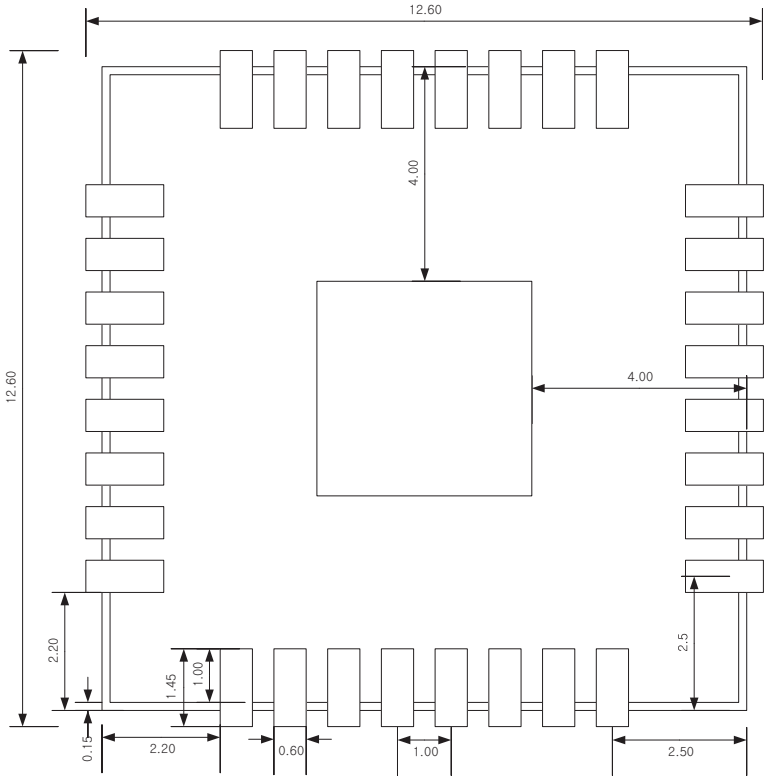
1.5.1 Software pin define

Function			Pin Name	Pin No.	Description
AIO	AIO[0]		AIO[0]	13	Analogue Input (0~1.5v)
	AIO[1]		AIO[1]	12	Analogue Input (0~1.5v)
	AIO[2]		AIO[2]	11	Analogue Input (0~1.5v)
PIO	PIO[0]	UART_TX	PIO[0]	14	Programmable I/O line or UART TX
	PIO[1]	UART_RX	PIO[1]	15	Programmable I/O line or UART RX
	PIO[3]		PIO[3]	16	Connection Detect LED Output (Low=Disconnect, High=Connect)
	PIO[4]		PIO[4]	17	UART select (Low=off, High=on)
	PIO[5]	SPI_CLK	PIO[5]	18	PWM0, PWM Output (0~255)
	PIO[6]	SPI_CS#	PIO[6]	19	PWM1, PWM Output (0~255)
	PIO[7]	SPI_MOSI	PIO[7]	20	PWM2, PWM Output (0~255)
	PIO[8]	SPI_MISO	PIO[8]	21	PWM3, PWM Output (0~255)
	PIO[9]		PIO[9]	22	Factory Reset (active high, 4초이상)
	PIO[10]		PIO[10]	23	Digital Input or Output port
	PIO[11]		PIO[11]	24	Digital Input or Output port
Control	SPI_PIO#		SPI_PIO#	25	Selects SPI debug on PIO [8:5] (Low=PWM, High=firmware SPI)

1.6 Package Dimensions & Land Pattern



Top view



Land Pattern

1.7 Power Consumption

(Server Role)

	UART ON
Discovering	**1.533mA**
Connected	**1.694mA**

* Advertising Interval : 1280ms
* Connection Interval : 500ms

(Clien Role)

	UART ON
Scanning	**20mA**
Connectd	**1.64mA**

* Scan Window Size : 400ms
  Scan Interval : 400ms
* Connection Interval : 500ms

UART OFF (Deep Sleep)
31uA

1.8 Advertising Interval Current

UART ON 단위(mA)

dBm	Adv Interval(ms)				
	160	320	640	1280	2560
-6dBm	1.679	1.602	1.57	1.552	1.541
-2 dBm	1.694	1.622	1.577	1.553	1.547
2 dBm	1.714	1.633	1.583	1.554	1.56
6 dBm	1.775	1.642	1.587	1.557	1.563

UART OFF 단위(μA)

dBm	Adv Interval(ms)				
	160	320	640	1280	2560
-6dBm	180	94	50	28	15
-2 dBm	192	99	51	31	16
2 dBm	210	107	56	33	17
6 dBm	240	123	64	37	21

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

■ 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	-
2nd harmonic content		-	-34	-	-	dBm	(6)
3rd harmonic content		-	-32	-	-	dBm	(6)

Note:
(1) The firmware maintains the transmit power within Bluetooth v4.0, Bluetooth v4.1 specification 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

■ 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.

3. Terminal Description

3.1 UART Interface

BoT-CLE100 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-CLE100 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-CLE100 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-CLE100 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-CLE100 debug SPI interface is available in SPI slave mode to enable an external MCU to program and control the BoT-CLE100, 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-CLE100. 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-CLE100 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-CLE100 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-CLE100 replies to the master on DEBUG_MISO with the data changing 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-CLE100 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-CLE100 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-CLE100 in a multi-slave arrangement by simple parallel connection of slave MISO lines. When BoT-CLE100 is deselected (DEBUG_CS# = 1), the DEBUG_MISO line does not float. Instead, BoT-CLE100 outputs “0” if the processoris running or “1” if it is stopped.

4. Application Schematic