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Datasheet

BT860

Bluetooth v4.2 Dual-Mode UART HCI Module

Version 1.0

REVISION HISTORY

Version	Date	Notes	Approver
1.0	04 Dec. 2017	Initial Release	Jacky Kuo

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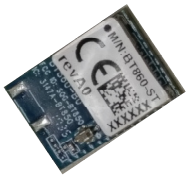
1 SCOPE

This document describes key hardware aspects of the Laird BT860 Bluetooth HCI module. This document is intended to assist device manufacturers and related parties with the integration of this module into their host devices. Data in this document are drawn from a number of sources including data sheets for the CYW20704A2. Because the BT860 is currently in development stage, this document is preliminary and the information in this document is subject to change. Please contact Laird Technologies or visit the Laird website at www.Lairdtech.com to obtain the most recent version of this document.

BT860-SA module



BT860-ST module

2 OPERATIONAL DESCRIPTION

The BT86x series of UART HCI modules leverage the Cypress CYW20704 A2 chipset to provide exceptionally low power consumption with outstanding range for OEMs needing both Classic Bluetooth and Bluetooth Low Energy support. The Bluetooth v4.2 core specification shortens your development time and provides enhanced throughput, security and privacy.

The BT860 modules are ideal when designers need both performance and minimum size. For maximum flexibility in integration, they support a host UART interface, I^2S and PCM audio interfaces, GPIO, and Cypress'GCI coexistence (2-Wire). The modules provide excellent RF performance and identical footprint options for integrated antenna or an external antenna via a trace pin.

These modules present a Bluetooth standard HCI interface with support for Linux / Android and Embedded Bluetooth software stacks for operating system backed devices. Additionally, Laird has partnered with Searan for support of their ultra small, flexible 'dotstack' platform for embedded Cortex M3 and M4 implementations.

Features and Benefits

- Bluetooth v4.2 - Dual mode (Classic Bluetooth and BLE)
- Compact footprint
- 2-wire Cypress Global Coexistence Interface (GCI)
- High antenna radiation gain and efficiency
- Good interference rejection for multi-com system (GSM/WCDMA)
- Class 1 output – 8 dBm
- USB, I^2S, and PCM
- Industrial Temperature Range
- 512 k EEPROM support
- Bluetooth Controller subsystem
- FCC, IC, CE, RCM and Giteki approvals

Application Areas

- Medical devices
- ePOS terminals
- Barcode scanners
- Industrial Cable Replacement
- M2M Connectivity
- Automotive Diagnostic Equipment
- Personal Digital Assistants (PDA)
- Bluetooth HID device (keyboard, mouse, joystick)

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3 Block Diagram and Descriptions

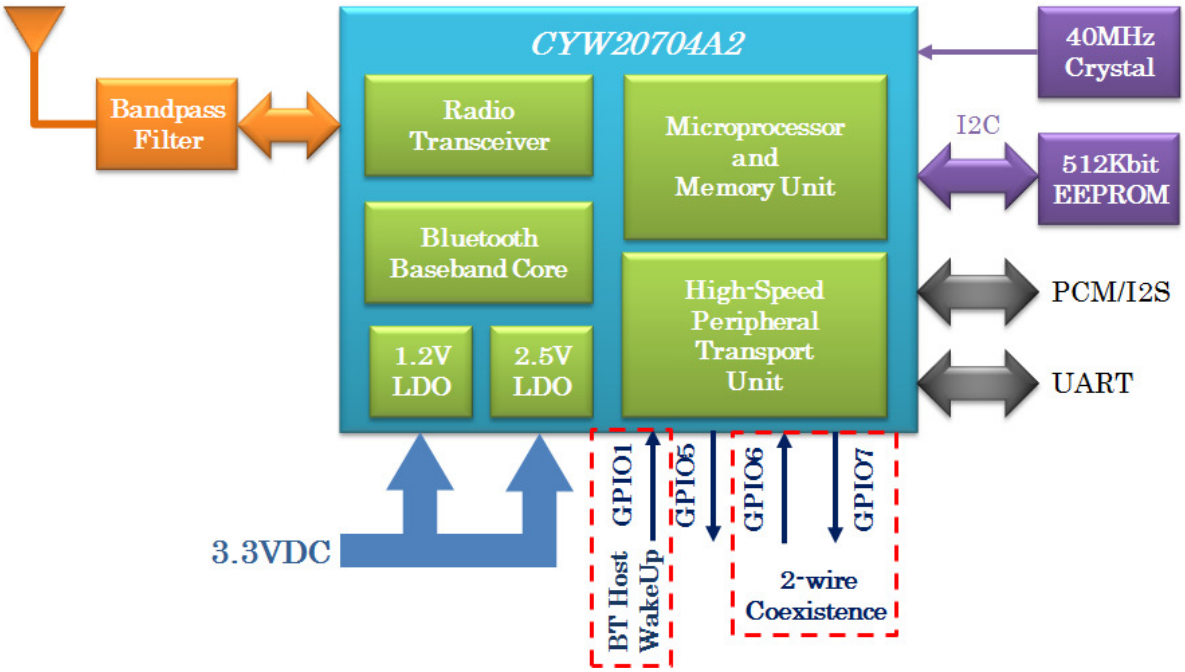

Figure 1: BT860 Module block diagram

CYW20704A2 (Main chip)	The BT860 is based on CYW20704A2 dual mode chip. The chip is a single-chip radio with on-chip LDO regulators and baseband IC for Bluetooth 2.4 GHz systems including EDR to 3 Mbps. Dedicated signal and baseband processing is included for full Bluetooth operation. The chip provides I^2S/PCM and USB interfaces. There are two general purpose I/Os be configured for proprietary of Cypress GCI used and a general purpose I/O can be configured for scan/inquire/paging/data traffic of indicator. There three I/Os pins are controlled by firmware.
Antenna	BT860 – The antenna is a ceramic monopole chip antenna.
Band Pass Filter	The band pass filter filters the out-of-band emissions from the transmitter to meet the specific regulations for type approvals of various countries.
EEPROM	There are 512 k bits EEPROM embedded on the BT860 module which can be used to store parameters, such as BD_ADDR, USB enumeration information, maximum TX power, PCM configuration, USB product ID, USB vendor ID, and USB product description. With that, the BT860 module can support UHE/HCI Proxy mode.
Crystal	The embedded 40 MHz crystal is used for generating the clock for the entire module.

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4 SPECIFICATIONS

Table 1: BT860 specifications

Categories	Feature	Implementation
Wireless Specification	Bluetooth®	V4.2 Dual Mode
	Frequency	2.402 - 2.480 GHz
	Maximum Transmit Power	Class 1 +8 dBm from antenna
	Receive Sensitivity	-94 dBm
	Range	Circa 100 meters
	Data Rates	Up to 3 Mbps (over-the-air)
Host Interface	UART	Up to 4 Mbps
	GPIO	3.3V for all general purpose I/Os
Operational Modes	HCI	Host Controller Interface over USB
	UHE	USB HID Emulation
EEPROM	2-wire	512 K bits
Coexistence	802.11 (Wi-Fi)	2-Wire Cypress Global Coexistence Interface (GCI)
Supply Voltage	Supply	3.3V +/-10%
Power Consumption	Current	Idle Mode ~8 mA File Transfer ~43 mA
Antenna Option	Internal	Multilayer ceramic antenna
Physical	Dimensions	8.5 x 13 x 1.6 mm (BT860 - Module)
Environmental	Operating	-30° C to +85° C
	Storage	-40° C to +85° C
Miscellaneous	Lead Free	Lead-free and RoHS compliant
	Warranty	One-Year Warranty
Approvals	Bluetooth®	Controller Subsystem Approved
	FCC / IC / CE / RCM / Giteki	All BT860 series

5 PIN DEFINITIONS

Table 2: BT860 pin definitions

Pin No.	Pin Name	I/O	Supply Domain	Description	If Unused
1	NC				NC
2	GND	GND		Ground	GND
3	GPIO_5	Bi-directional	3V3	Programmable input/output line	
4	UART_RTS	Bi-directional	3V3	UART request to send output	NC
5	UART_TXD	Bi-directional	3V3	UART transmit data	NC
6	UART_CTS	Bi-directional	3V3	UART clear to send input	NC
7	UART_RXD	Bi-directional	3V3	UART receive data	NC

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Pin No.	Pin Name	I/O	Supply Domain	Description	If Unused
8	RESET	Input	3V3	Active-low reset input	N/A
9	3.3V	Input	3V3	Module main DC power supply, Input to internal 1.2V and 2.5V LDO	N/A
10	NC				NC
11	GND	GND		Ground	GND
12	GND	GND		Ground	GND
13	GND	GND		Ground	GND
14	GND	GND		Ground	GND
15	GND	GND		Ground	GND
16	GND	GND		Ground	GND
17	RF			BT860-ST RF signal output (50Ω) BT860-SA No connection	
18	GND	GND		Ground	GND
19	I2S_WS/PCM_SYNC	Bidirectional	3V3	PCM sync/I2S word select	NC
20	I2S_CLK/PCM_CLK	Bidirectional	3V3	PCM/I2S clock	NC
21	I2S_DI/PCM_IN	Bidirectional	3V3	PCM/I2S data input	NC
22	I2S_OUT/PCM_OUT	Bidirectional	3V3	PCM/I2S data output	NC
23	GND	GND		Ground	GND
24	NC				NC
25	BT_SECI_IN	Input	3V3	Coexistence data input	NC
26	BT_SECI_OUT	Output	3V3	Coexistence data output	NC
27	NC				NC
28	NC				NC
29	BT_HOST_WAKE	Output	3V3	BT device to wake up the Host	NC
30	GND	GND		Ground	NC

Pin Definition Note:

Note 1	For to meet the pin alignment of BT830, there are a number of pins which must be put to NC (No Connection) status.

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6 DC Electrical Characteristics

Table 3: Recommended operating conditions

Rating	Min	Max	Unit
Storage temperature	-40	+150	^{0}C
Operating Temperature	-30	+85	^{0}C
3V3 Input	3.0	3.6	V

Table 4: Digital I/O characteristics

Normal Operation	Min	Typ.	Max	Unit
V_{IL} Input Low Voltage (VDDO = 3.3V)	-	-	0.8	V
V_{IH} Input High Voltage (VDDO = 3.3V)	2.0	-	-	V
V_{OL} Output Low Voltage	-	-	0.4	V
V_{OH} Output High Voltage	VDDO-0.4	-	-	V
I_{IL} Input Low Current	-	-	1.0	µA
I_{IH} Input High Current	-	-	1.0	µA
I_{OL} Output Low Current (VDDO = 3.3V, V_{OL} = 0.4V)	-	-	2.0	mA
I_{OH} Output Low Current (VDDO = 3.3V, V_{OH} = 2.9V)	-	-	2.0	mA
C_{IN} Input Capacitance	-	-	0.4	pF

Table 5: Current consumption

Normal Operation	Peak (8 dBm)	AVG	Unit
Idle	-	8	mA
Inquiry	23	22	mA
File Transfer	43	26	mA
LE Connected (Master)	26	-	mA
LE Scan (Master)	26	-	mA
LE File Transfer	27	26	mA

7 RF Characteristics

Table 6: BDR/EDR/LE transmitter characteristics (Input = 3V3 @ 25° C)

Parameter		Min	Typ.	Max	BT. Spec.	Unit
GFSK Maximum RF Transmit Power		6	8	10	20	dBm
EDR Maximum RF Transmit Power		2	4	6	20	dBm
RF power variation over temperature range		-	2.0	-	-	dB
RF power variation over BT band		-	2	-	-	dB
RF power control step		2	4	8	-	dB
Initial Carrier Frequency Tolerance		-	10	-	±75	kHz
20 dB Bandwidth		-	920	-	1000	kHz
In-Band Spurious Emissions	1.0 MHz < |M-N| < 1.5 MHz	-	-	-39	-26	dBc

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Parameter		Min	Typ.	Max	BT. Spec.	Unit
	1.5 MHz < |M-N| < 2.5 MHz	-	-	-39	-20	dBm
	|M-N| ≧ 2.5 MHz	-	-	-47	-40	dBm
Drift rate		-	10	-	+/-25	kHz
ΔF_{1Avg}		-	152	-	140<>175	kHz
ΔF_{2Max}		100	-	-	99.9	%
$\Delta F_{2Avg} / \Delta F_{1Avg}$		-	1.0	-	≧ 0.8	
LE ΔF_{1Avg}		-	245	-	225<>275	kHz
LE ΔF_{2Max}		100	-	-	99.9	%
LE $\Delta F_{2Avg} / \Delta F_{1Avg}$		-	1.0	-	≧ 0.8	

Table 7: BDR/EDR/LE receiver sensitivity (Input = 3V3 @ 25° C)

Parameter	Conditions	Min	Typ.	Max	BT. Spec.	Unit
Sensitivity	GFSK, 0.1% BER, 1Mbps		-90		-70	dBm
	π/4-DQPSK, 0.01% BER, 2Mbps		-94		-70	dBm
	8-DPSK, 0.01% BER, 3Mbps		-87		-70	dBm
	GFSK, 30.8% PER, 1Mbps		-94		-70	dBm
Sensitivity variation	All Modulations (Over BT band)		2			dB

8 INTERFACE

8.1. Global Coexistence Interface

The BT860 supports the proprietary Cypress Global Coexistence Interface (GCI) which is a 2-wire interface.

The following key features are associated with the interface:

- Enhanced coexistence data can be exchanged over GCI_SECI_IN and GCI_SECI_OUT a two-wire interface, one serial input (GCI_SECI_IN), and one serial output (GCI_SECI_OUT). The both pins are controlled by the configuration file that is stored in EEPROM from the host.
- It supports generic UART communication between WLAN and Bluetooth devices.
- To conserve power, it is disabled when inactive.
- It supports automatic resynchronization upon waking from sleep mode.
- It supports a baud rate of up to 4 Mbps.

Table 8 shows the 2-wire BT coexistence interface assignments.

Table 8: BT GCI Two-Wire Coexistence

Coexistence Signal Name	Signal Assignment	Pin Number
BT_SECI_IN	GPIO_6	B6
BT_SECI_OUT	GPIO_7	C6

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8.2. UART Interface

The BT860 shares a single UART for Bluetooth. The UART is a standard four-wire interface (RX, TX, RTS, and CTS) with adjustable baud rates from 38400 bps to 4.0 Mbps. The interface features an automatic baud rate detection capability that returns a baud rate selection. Alternatively, the baud rate may be selected through a vendor-specific UART HCI command.

UART has a 1040-byte receive FIFO and 1040-byte transmits FIFO to support EDR. Access to the FIFO is conducted through the AHB interface through either DMA or the CPU. The UART supports the Bluetooth 4.2 UART HCI specification: H4, and a custom Extended H4. The default baud rate is 115.2 Kbaud.

The BT860 UART can perform XON/XOFF flow control and includes hardware support for Serial Line Input Protocol (SLIP). It can also perform wake-on activity. For the BT860 is supported BT to wake-up Host.

Normally, the UART baud rate is set by a configuration record downloaded after device reset, or by automatic baud rate detection, and the host does not need to adjust the baud rate. Support for changing the baud rate during normal HCI UART operation is included through a vendor-specific command that allows the host to adjust the contents of the baud rate registers. The BT860 UARTs operate correctly with the host UART if the combined baud rate error of the two devices is within ±2%.

Table 9: Example of common baud rates

Desired Rate	Actual Rate	Error (%)
4000000	4000000	0.00
3000000	3000000	0.00
2000000	2000000	0.00
1500000	1500000	0.00
921600	923077	0.16
460800	461538	0.16
230400	230796	0.17
115200	115385	0.16
57600	57692	0.16
38400	38400	0.00

8.2.1. Simultaneous UART Transport and Bridging

The BT860 supports UART or USB interfaces that can function as the host controller interface (HCI). Typically, a customer application would choose one of the two interfaces and the other would be idle. The BT860 allows the UART transport to operate simultaneously with the USB. To operate this way, the assumption is that the USB would function as the primary host transport, while the UART would function as a secondary communication channel that can operate at the same time. This can enable the following applications -

- Bridging primary HCI transport traffic to another device via the UART
- Generic communication to an external device for a vendor-supported application via the UART

Table 10 and Figure 2 shows UART timing of specifications.

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Table 10: UART timing specifications

Reference	Characteristics	Min.	Typ.	Max.	Unit
1	Delay time UART_CTS_N low to UART TXD valid	-	-	1.50	Bit periods
2	Setup time UART_CTS_N high before midpoint of stop bit	-	-	0.67	Bit periods
3	Delay time Midpoint of stop bit to UART_CTS_N high	-	-	1.33	Bit periods

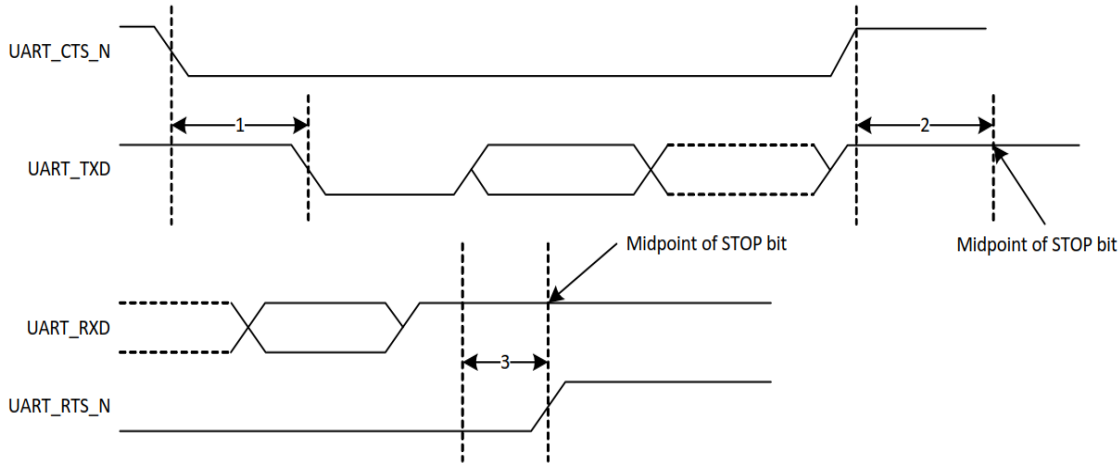

Figure 2: UART timing

8.3. PCM Interface

The BT860 supports two independent PCM interfaces that share the pins with I2S interfaces. The PCM interface on the BT860 can connect to linear PCM Codec devices in master or slave mode. In master mode, the BT860 generates the PCM_CLK and PCM_SYNC signals, and in slave mode, these signals are provided by another master on the PCM interface and are inputs to the BT860.

The configuration of the PCM interface may be adjusted by the host using vendor-specific HCI commands.

8.3.1. Slot Mapping

The BT860 supports up to three simultaneous full-duplex SCO or eSCO channels through the PCM interface. These three channels are time-multiplexed onto the single PCM interface by using a time-slotting scheme where the 8 kHz or 16 kHz audio sample interval is divided into as many as 16 slots. The number of slots is dependent on the selected interface rate of 128 kHz, 512 kHz, or 1024 kHz. The corresponding number of slots for these interface rate is 1, 2, 4, 8 and 16, respectively. Transmit and receive PCM data from an SCO channel is always mapped to the same slot. The PCM data output driver tristates its output on unused slots to allow other devices to share the same PCM interface signals. The data output driver tristates its output after the falling edge of the PCM clock during the last bit of the slot.

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8.3.2. Frame Synchronization

The BT860 supports both short- and long-frame synchronization in both master and slave modes. In short-frame synchronization mode, the frame synchronization signal uses an active-high pulse at the audio frame rate that is a single-bit period in width and is synchronized to the rising edge of the bit clock. The PCM slave looks for a high on the falling edge of the bit clock and expects the first bit of the first slot to start at the next rising edge of the clock.

Figure 3 and Table 11 shows PCM Timing Diagram and Specifications for the master mode of short-frame.

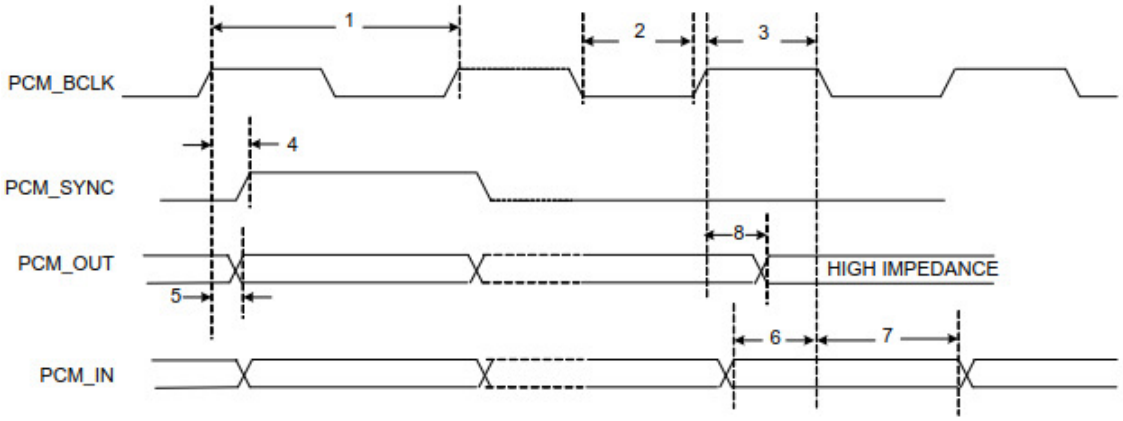

Figure 3: PCM timing diagram (Short-Frame Sync, Master Mode)

Table 11: PCM Interface timing specifications (Short-Frame Sync, Master Mode)

Reference	Characteristics	Min.	Typ.	Max.	Unit
1	PCM bit clock frequency	-	-	12	MHz
2	PCM bit clock LOW	41	-	-	ns
3	PCM bit clock HIGH	41	-	-	ns
4	PCM_SYNC setup	0	-	25	ns
5	PCM_OUT delay	0	-	25	ns
6	PCM_IN setup	8	-	-	ns
7	PCM_IN hold	8	-	-	ns
8	Delay from rising edge of PCM_BCLK during last bit period to PCM_OUT becoming high impedance	0	-	25	ns

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Figure 4 and Table 12 shows PCM Timing Diagram and Specifications for the slave mode of short-frame.

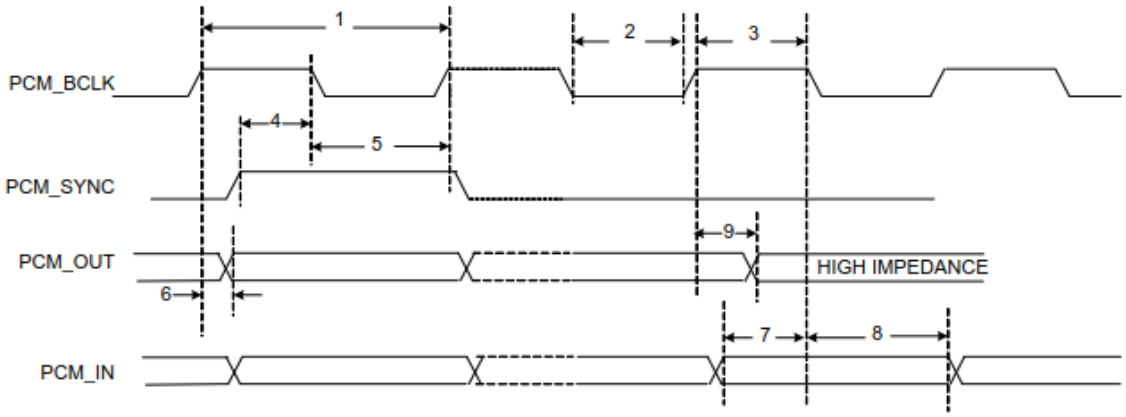

Figure 4: PCM timing diagram (Short-Frame Sync, Slave Mode)

Table 12: PCM Interface timing specifications (Short-Frame Sync, Slave Mode)

Reference	Characteristics	Min.	Typ.	Max.	Unit
1	PCM bit clock frequency	-	-	12	MHz
2	PCM bit clock LOW	41	-	-	ns
3	PCM bit clock HIGH	41	-	-	ns
4	PCM_SYNC setup	8	-	-	ns
5	PCM_SYNC_hold	8	-	-	ns
6	PCM_OUT delay	0	-	25	ns
7	PCM_IN setup	8	-	-	ns
8	PCM_IN hold	8	-	-	ns
9	Delay from rising edge of PCM_BCLK during last bit period to PCM_OUT becoming high impedance	0	-	25	ns

In long-frame synchronization mode, the frame synchronization signal is again an active-high pulse at the audio frame rate; however, the duration is three bit periods and the pulse starts coincident with the first bit of the first slot.

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Figure 5 through Table 13 shows PCM Timing Diagram and Specifications for the master mode of long-frame.

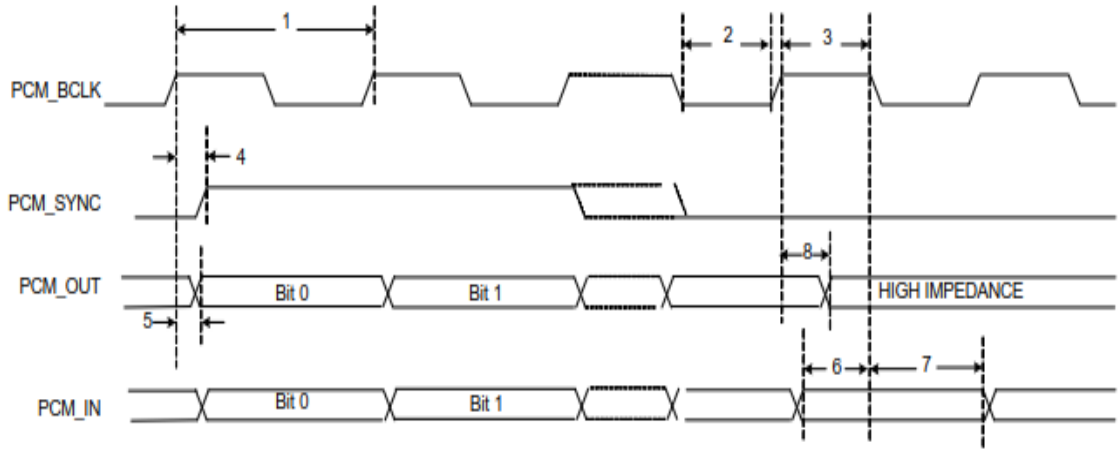

Figure 5: PCM timing diagram (Long-Frame Sync, Master Mode)

Table 13: PCM Interface timing specifications (Long-Frame Sync, Master Mode)

Reference	Characteristics	Min.	Typ.	Max.	Unit
1	PCM bit clock frequency	-	-	12	MHz
2	PCM bit clock LOW	41	-	-	ns
3	PCM bit clock HIGH	41	-	-	ns
4	PCM_SYNC delay	0	-	25	ns
5	PCM_OUT delay	0	-	25	ns
6	PCM_IN setup	8	-	-	ns
7	PCM_IN hold	8	-	-	ns
8	Delay from rising edge of PCM_BCLK during last bit period to PCM_OUT becoming high impedance	0	-	25	ns

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Figure 6 and Table 14 shows PCM Timing Diagram and Specifications for the slave mode of long-frame

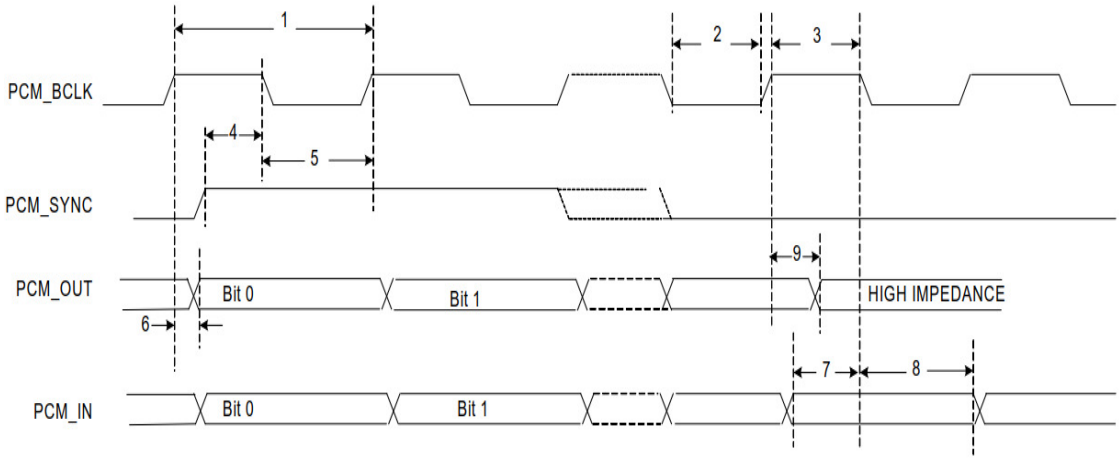

Figure 6: PCM timing diagram (Long-Frame Sync, Slave Mode)

Table 14: PCM Interface timing specifications (Long-Frame Sync, Slave Mode)

Reference	Characteristics	Min.	Typ.	Max.	Unit
1	PCM bit clock frequency	-	-	12	MHz
2	PCM bit clock LOW	41	-	-	ns
3	PCM bit clock HIGH	41	-	-	ns
4	PCM_SYNC setup	8	-	-	ns
5	PCM_SYNC_hold	8	-	-	ns
6	PCM_OUT delay	0	-	25	ns
7	PCM_IN setup	8	-	-	ns
8	PCM_IN hold	8	-	-	ns
9	Delay from rising edge of PCM_BCLK during last bit period to PCM_OUT becoming high impedance	0	-	25	ns

8.3.3. Data Formatting

The BT860 may be configured to generate and accept several different data formats. For conventional narrowband speech mode, the BT860 uses 13 of the 16 bits in each PCM frame. The location and order of these 13 bits can be configured to support various data formats on the PCM interface. The remaining three bits are ignored on the input and may be filled with 0s, 1s, a sign bit, or a programmed value on the output. The default format is 13-bit 2's complement data, left justified, and clocked MSB first.

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8.3.4. Wideband Speech Support

When the host encodes Wideband Speech (WBS) packets in transparent mode, the encoded packets are transferred over the PCM bus for an eSCO voice connection. In this mode, the PCM bus is typically configured in master mode for a 4 kHz sync rate with 16-bit samples, resulting in a 64 Kbps bit rate. The BT860 also supports slave transparent mode using a proprietary rate-matching scheme. In SBC-code mode, linear 16-bit data at 16 kHz (256Kbps rate) is transferred over the PCM bus.

8.3.5. Multiplexed Bluetooth Over PCM

Bluetooth supports multiple audio streams within the Bluetooth channel and both 16 kHz and 8 kHz streams can be multiplexed. This mode of operation is only supported when the Bluetooth host is the master. Figure7 shows the operation of the multiplexed transport with three simultaneous SCO connections. To accommodate additional SCO channels, the transport clock speed is increased. To change between modes of operation, the transport must be halted and restarted in the new configuration.

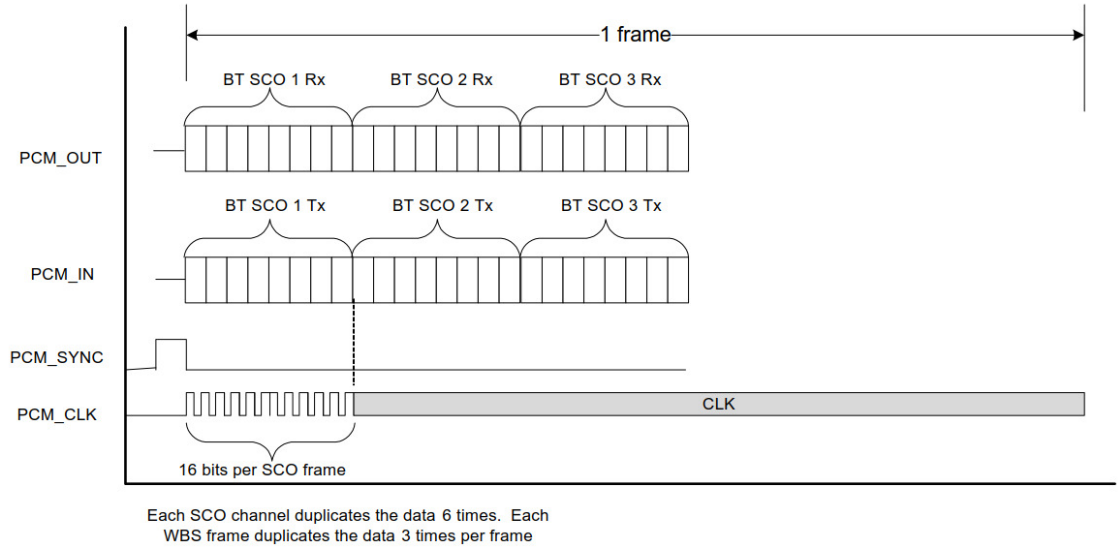

Figure 7: Functional Multiples Data diagram

8.3.6. Burst PCM Mode

In this mode of operation, the PCM bus runs at a significantly higher rate of operation to allow the host to duty cycle its operation and save current. In this mode of operation, the PCM bus can operate at a rate of up to 24 MHz. This mode of operation is initiated with an HCI command from the host.

Figure 8 and Table 15 shows PCM Burst mode timing diagram and specifications for the receive-only mode of short-frame sync.

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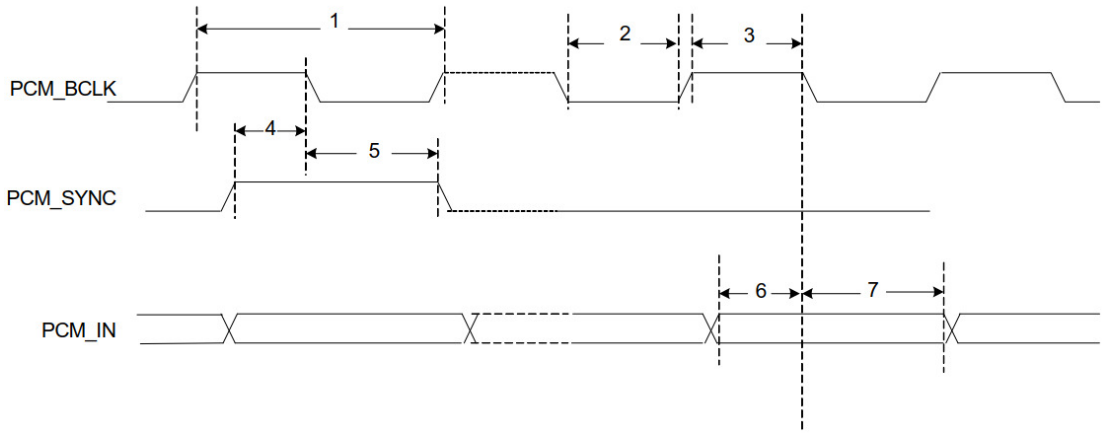

Figure 8: PCM Burst Mode timing (Receive Only, Short Frame Sync)

Table 15: PCM Burst Mode Specifications (Receive Only, Short-Frame Sync)

Reference	Characteristics	Min.	Typ.	Max.	Unit
1	PCM bit clock frequency	-	-	24	MHz
2	PCM bit clock LOW	20.8	-	-	ns
3	PCM bit clock HIGH	20.8	-	-	ns
4	PCM_SYNC setup	8	-	-	ns
5	PCM_SYNC_hold	8	-	-	ns
6	PCM_IN setup	8	-	-	ns
7	PCM_IN hold	8	-	-	ns

Figure 9 and Table 16 shows PCM Burst mode timing diagram and specifications for the receive-only mode of long-frame sync.

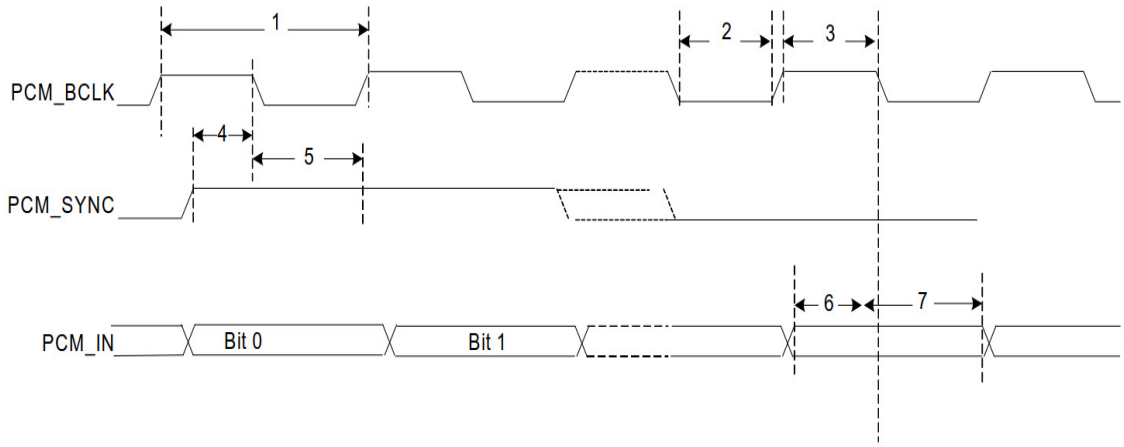

Figure 9: PCM Burst Mode Timing (Receive Only, Long Frame Sync)

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Table 16: PCM Burst Mode Specifications (Receive Only, Long-Frame Sync)

Reference	Characteristics	Min.	Typ.	Max.	Unit
1	PCM bit clock frequency	-	-	24	MHz
2	PCM bit clock LOW	20.8	-	-	ns
3	PCM bit clock HIGH	20.8	-	-	ns
4	PCM_SYNC setup	8	-	-	ns
5	PCM_SYNC_hold	8	-	-	ns
6	PCM_IN setup	8	-	-	ns
7	PCM_IN hold	8	-	-	ns

8.4. I^2S Interface

The BT860 supports two independent I^2S digital audio ports. The I^2S interface supports both master and slave modes. The I^2S signals are:

- I^2S clock: I^2S SCK
- I^2S Word Select: I^2S WS
- I^2S Data Out: I^2S SDO
- I^2S Data In: I^2S SDI

I^2S SCK and I^2S WS become outputs in master mode and inputs in slave mode, while I^2S SDO always stays as an output. The channel word length is 16 bits and the data is justified so that the MSB of the left-channel data is aligned with the MSB of the I^2S bus, per the I^2S specification. The MSB of each data word is transmitted one bit clock cycle after the I^2S WS transition, synchronous with the falling edge of bit clock. Left-channel data is transmitted when I^2S WS is low, and right-channel data is transmitted when I^2S WS is high. Data bits sent by the BT860 are synchronized with the falling edge of I2S_SCK and should be sampled by the receiver on the rising edge of I2S_SSCK.

The clock rate in master mode is either of the following:

48 kHz x 32 bits per frame = 1.536 MHz

48 kHz x 50 bits per frame = 2.400 MHz

The master clock is generated from the input reference clock using a N/M clock divider.

In the slave mode, any clock rate is supported to a maximum of 3.072 MHz.

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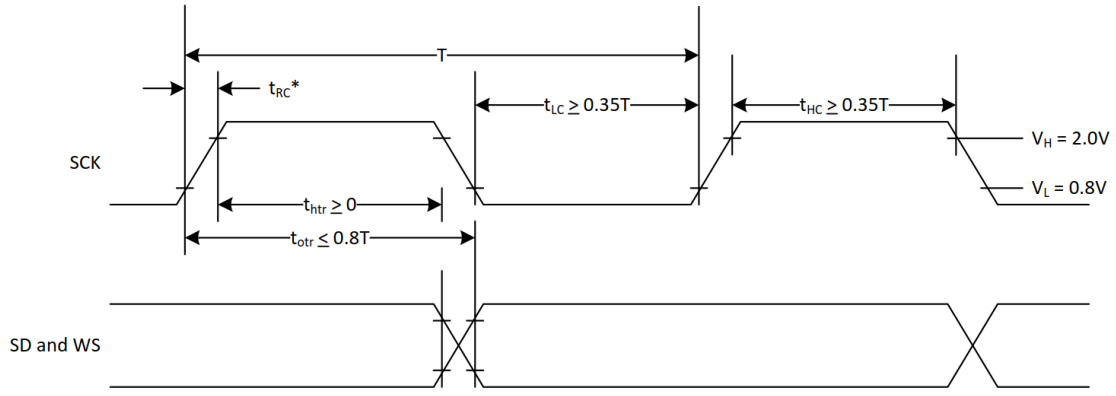
8.4.1. I²S Timing

Timing values specified in Table 17 are relative to high and low threshold levels.

Table 17: Timing for I2S Transmitters and Receivers

	Transmitter				Receiver				Notes
	Lower Limit		Upper Limit		Lower Limit		Upper Limit		
	Min	Max	Min	Max	Min	Max	Min	Max	
Clock Period T	T_{tr}	-	-	-	T_r	-	-	-	
Master Mode: Clock generated by transmitter or receiver									
HIGH t_{HC}	$0.35T_{tr}$	-	-	-	$0.35T_{tr}$	-	-	-	
LOW t_{LC}	$0.35T_{tr}$	-	-	-	$0.35T_{tr}$	-	-	-	
Master Mode: Clock generated by transmitter or receiver									
HIGH t_{HC}	-	$0.35T_{tr}$	-	-	-	$0.35T_{tr}$	-	-	
LOW t_{LC}	-	$0.35T_{tr}$	-	-	-	$0.35T_{tr}$	-	-	
Rise time t_{RC}	-	-	$0.15T_{tr}$	-	-	-	-	-	
Transmitter									
Delay t_{dtr}	-	-	-	0.8T	-	-	-	-	
Hold time t_{htr}	0	-	-	-	-	-	-	-	
Receiver									
Setup time t_{sr}	-	-	-	-	-	$0.2T_r$	-	-	
Hold time t_{hr}	-	-	-	-	-	0	-	-	

The time periods specified in Figure 10 and Figure 11 are defined by the transmitter speed. The receiver specifications must match transmitter performance.



T = Clock period
T_{tr} = Minimum allowed clock period for transmitter
$T = T_{tr}$
* t_{RC} is only relevant for transmitters in slave mode.

Figure 10: I²S Transmitter timing

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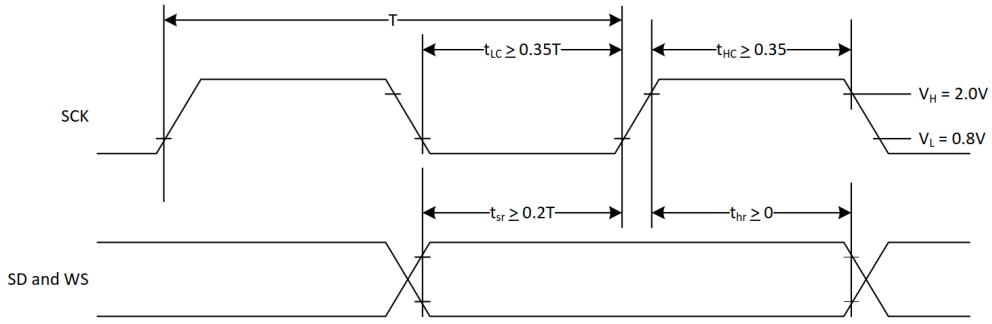

T = Clock period
T_r = Minimum allowed clock period for transmitter
$T > T_r$

Figure 11: I²S Receiver Timing

8.5. BSC (Cypress Serial Control) Master Interface

BT860 includes a Cypress Serial Control (BSC) master interface. The BSC interface supports low-speed and fast mode devices and is compatible with I²C slave devices. Multiple I²C master devices and flexible wait state insertion by the master interface or slave devices are not supported. The BT860 provides 400 kHz, full speed clock support.

The BSC interface is programmed by the CPU to generate the following BSC transfer types on the bus:

- Read-only
- Write-only
- Combined read/write
- Combined write-read

NVRAM may contain configuration information about the customer application, including the following:

- Fractional-N information
- BD_ADDR
- UART baud rate
- USB enumeration information
- SDP service record
- File system information used for code, code patches, or data

Figure 12 and Table 18 define the timing requirements for the BSC interface.

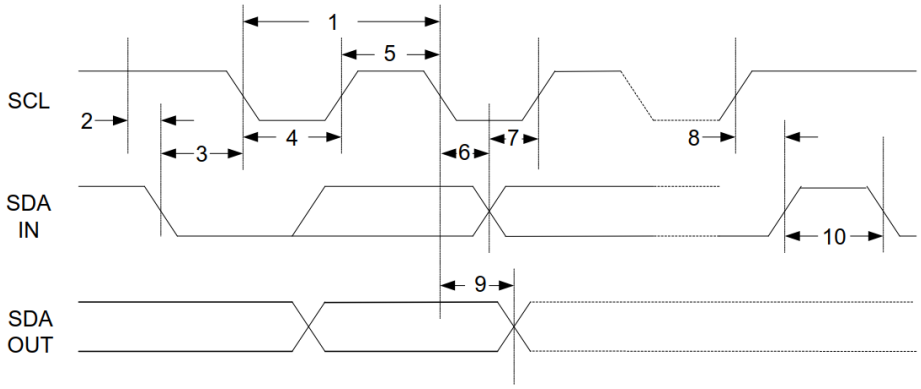

Figure 12: BSC Interface Timing Diagram

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Table 18: BSC Interface Timing Specifications

Reference	Characteristics	Min.	Max.	Unit
1	Clock frequency	-	100 400 800 1000	kHz
2	START condition setup time	650	-	ns
3	START condition hold time	280	-	ns
4	Clock low time	650	-	ns
5	Clock high time	280	-	ns
6	Data input hold time	0	-	ns
7	Data input setup time	100	-	ns
8	STOP condition setup time	280	-	ns
9	Output valid from clock	-	400	ns
10	Bus free time	650	-	ns

9 Antenna Performance

Table 19, Figure 13, and Figure 14 show the antenna gain and performance.

Table 19: Antenna gain

Unit in dBi @ 2440MHz	XY-Plane		XZ-Plane		YZ-Plane		Efficiency
AT3216-B2R7HAA	Peak	Avg.	Peak	Avg.	Peak	Avg.	
	1.7	-2.9	2.3	-2.3	0.2	-5.4	55%

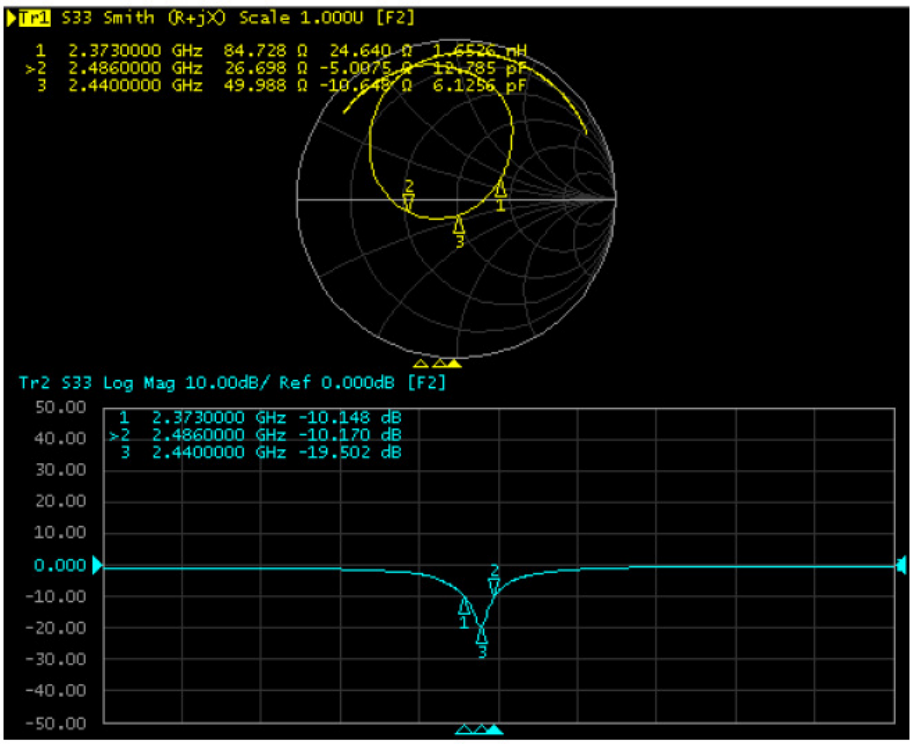

Figure 13: Antenna Return Loss

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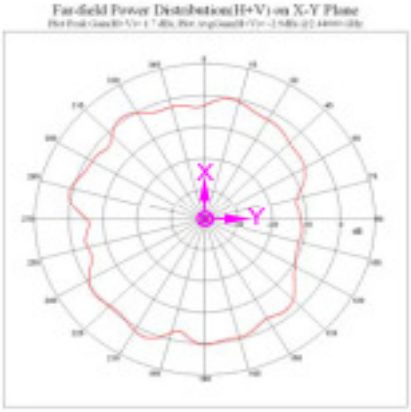
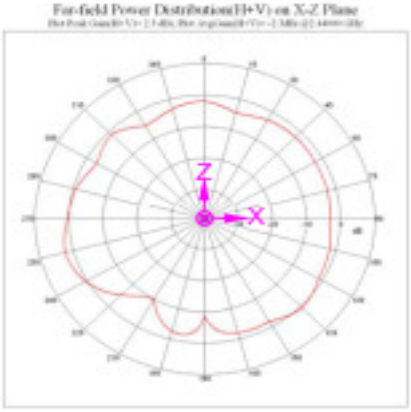
◆XY-plane



Unit : dBi

	Peak gain	Avg. gain
XY-plane	1.7	-2.9

◆XZ-plane



	Peak gain	Avg. gain
XZ-plane	2.3	-2.3

◆YZ-plane

	Peak gain	Avg. gain
YZ-plane	0.2	-5.4

Figure 14: Antenna pattern

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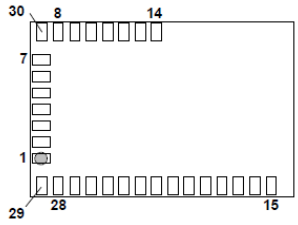
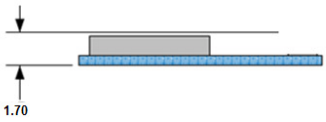
10 Mechanical Dimensions and Land Pattern

10.1. BT860 Mechanical Drawing

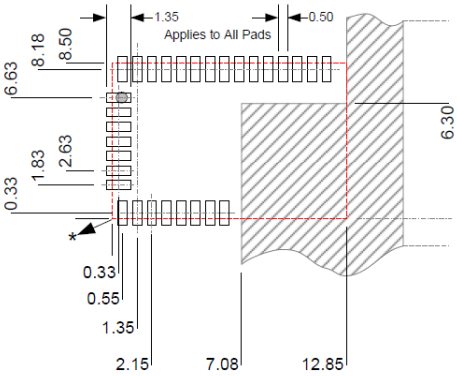
Bottom View Device Pads



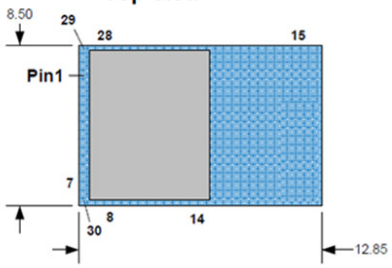
Side View



Top View
Recommended PCB Layout



Top View



* Dimensions from corner of BT860

Pin1

No Copper in this area!

Note: Dimensions are in millimetres.
Tolerances: .xx ±0.03 mm
.x ±1.3 mm

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11 Implementation Note

11.1. PCB Layout on Host PCB

Checklist (for PCB):

- **Must** locate the BT860 module close to the edge of PCB.
- Use solid GND plane on inner layer (for best EMC and RF performance).
- Place GND vias close to module GND pads as possible
- Route traces to avoid noise being picked up on VCC supply.
- Antenna Keep-out area:
  - Ensure there is no copper in the antenna keep-out area on any layers of the host PCB.
  - Keep all mounting hardware and metal clear of the area to allow proper antenna radiation.
  - For best antenna performance, place the BT860 module on the edge of the host PCB, preferably in the corner with the antenna facing the corner.
  - A different host PCB thickness dielectric will have small effect on antenna.

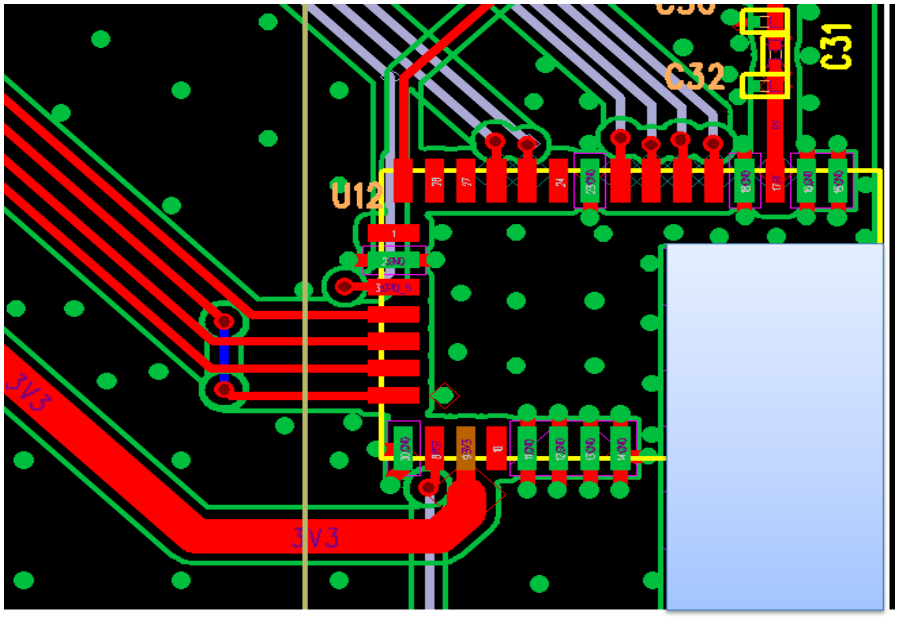

Figure 15: Recommend Antenna keep-out area (in Blue) used on the BT860

11.1.1. Antenna Keep-out and Proximity to Metal or Plastic

Checklist (for metal /plastic enclosure):

- Minimum safe distance for metals without seriously compromising the antenna (tuning) is 40 mm top/bottom and 30 mm left or right.
- Metal close to the BT860 chip monopole antenna (bottom, top, left, right, any direction) will have degradation on the antenna performance. The amount of degradation is entirely system dependent which means some testing by customers is required (in their host application).
- Any metal closer than 20 mm starts to significantly degrade performance (S11, gain, radiation efficiency).
- It is best that the customer tests the range with mock-up (or actual prototype) of the product to assess effects of enclosure height (and material whether metal or plastic).

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12 Application Note for Surface Mount Modules

12.1. Introduction

Laird surface mount modules are designed to conform to all major manufacturing guidelines. This application note is intended to provide additional guidance beyond the information that is presented in the user manual. This application note is considered a living document and is updated as new information is presented.

The modules are designed to meet the needs of a number of commercial and industrial applications. They are easy to manufacture and they conform to current automated manufacturing processes.

12.2. Shipping

12.2.1. Tray Package

Modules are shipped in ESD (Electrostatic Discharge) safe trays that can be loaded into most manufacturers pick and place machines. Layouts of the trays are provided in Figure 16.

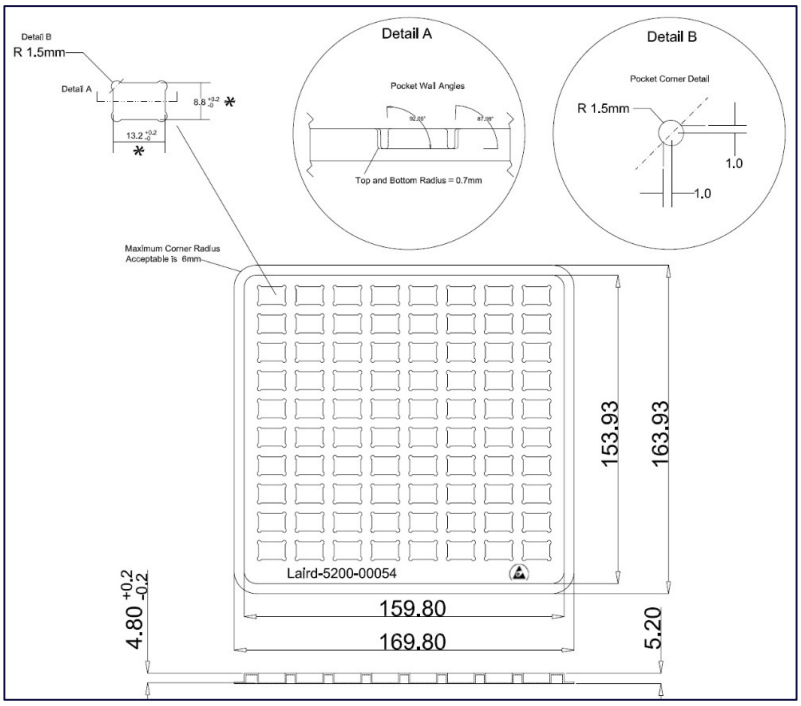

Figure 16: Shipping tray layout

12.2.2. Tape and Reel Package Information

Note: Ordering information for Tape and Reel packaging is an addition of T/R to the end of the full module part number. For example, BT860 becomes BT860-Sx-xx-T/R.

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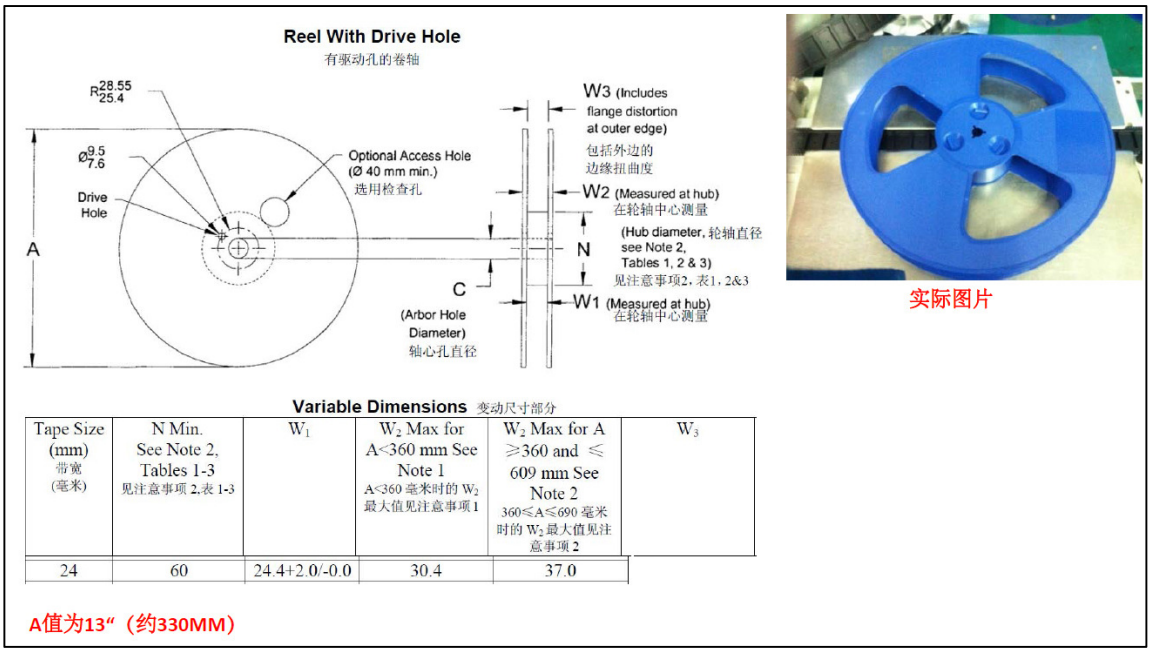

Tape Size (mm) 带宽 (毫米)	N Min. See Note 2, Tables 1-3 见注意事项 2,表 1-3	W_1	W_2 Max for A<360 mm See Note 1 A<360 毫米时的 W_2 最大值见注意事项 1	W_2 Max for A ≥360 and ≤ 609 mm See Note 2 360≤A≤690 毫米时的 W_2 最大值见注意事项 2	W_3
24	60	24.4+2.0/-0.0	30.4	37.0	

Figure 17: Reel specifications

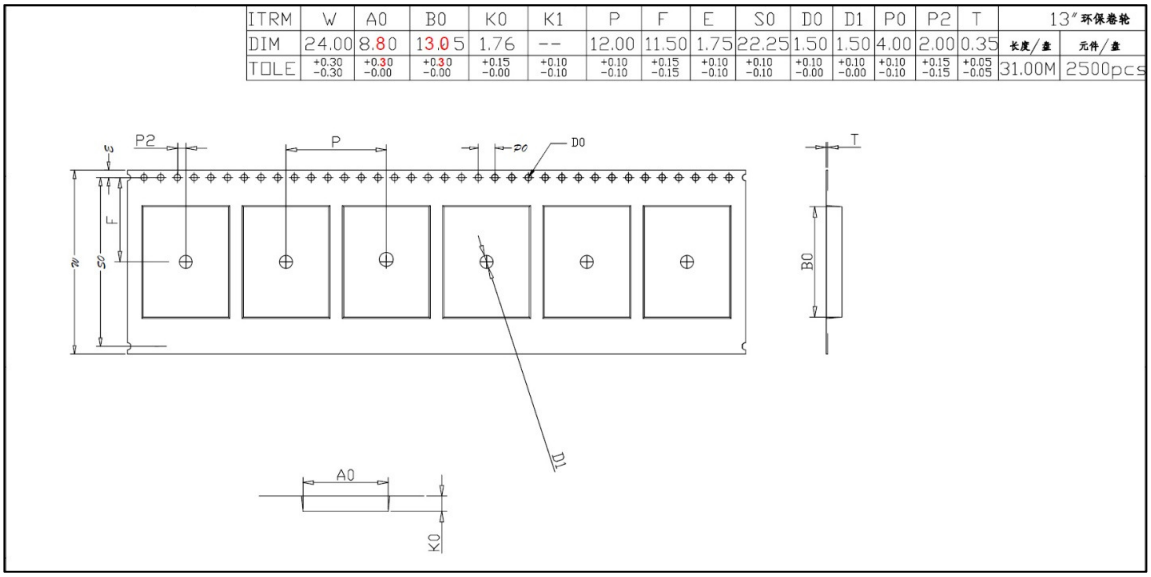

Figure 18: Tape specifications

There are 2500 BT860 modules taped in a reel (and packaged in a pizza box) and five boxes per carton (12,500 modules per carton). Reel, boxes, and carton are labeled with the appropriate labels. See Figure 19.

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12.2.3. Packaging Process

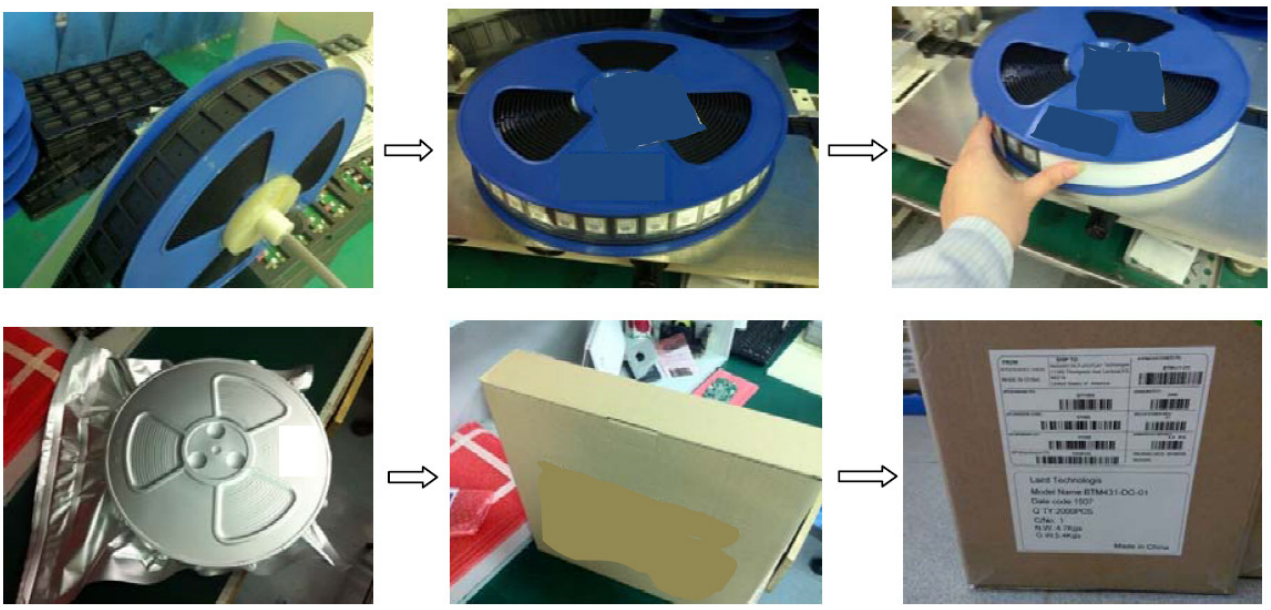

Figure 19: BT860 packaging process

12.3. Reflow Parameters

Laird surface mount modules are designed to be easily manufactured, including reflow soldering to a PCB. Ultimately it is the responsibility of the customer to choose the appropriate solder paste and to ensure oven temperatures during reflow meet the requirements of the solder paste. Laird's surface mount modules conform to J-STD-020D1 standards for reflow temperatures.

Important: During reflow, modules should not be above 260° and not for more than 30 seconds.

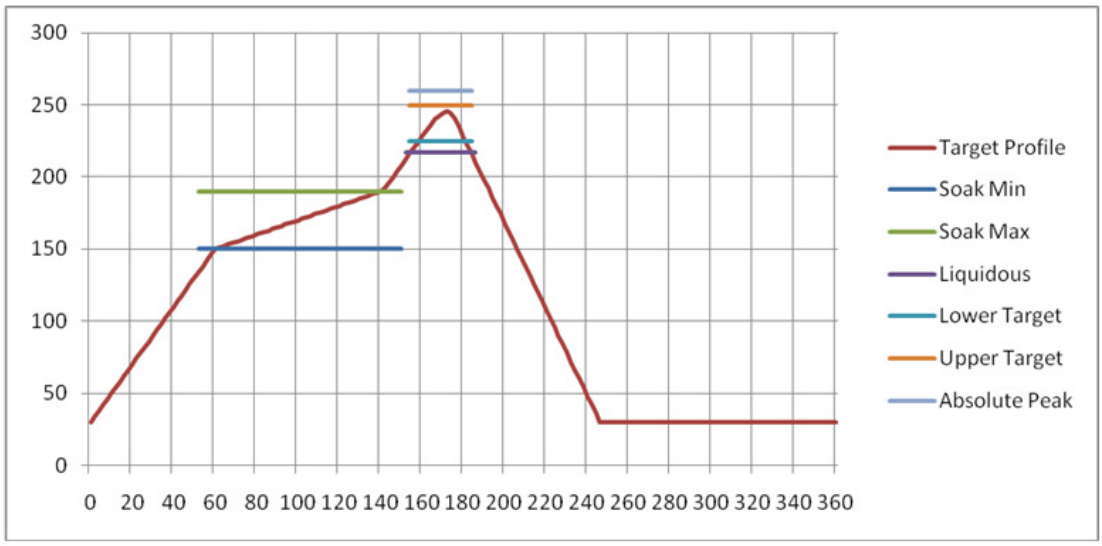

Figure 20: Recommended reflow temperature

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Temperatures should not exceed the minimums or maximums presented in Table 20.

Table 20: Recommended maximum and minimum temperatures

Specification	Value	Unit
Temperature Inc./Dec. Rate (max)	1~3	°C / Sec
Temperature Decrease rate (goal)	2-4	°C / Sec
Soak Temp Increase rate (goal)	.5 - 1	°C / Sec
Flux Soak Period (Min)	70	Sec
Flux Soak Period (Max)	120	Sec
Flux Soak Temp (Min)	150	°C
Flux Soak Temp (max)	190	°C
Time Above Liquidous (max)	70	Sec
Time Above Liquidous (min)	50	Sec
Time In Target Reflow Range (goal)	30	Sec
Time At Absolute Peak (max)	5	Sec
Liquidous Temperature (SAC305)	218	°C
Lower Target Reflow Temperature	240	°C
Upper Target Reflow Temperature	250	°C
Absolute Peak Temperature	260	°C

13 JAPAN (MIC) REGULATORY

The BT800 is approved for use in the Japanese market. The part numbers listed below hold WW type certification. Refer to **ARIB-STD-T66** for further guidance on OEM's responsibilities.

Model	Product Name	Description	Certificate Number
BT860-SA BT860-ST	BT v4.2 Dual Mode UART HCI Module	Mounted with chipset antenna	201-170971

13.1. Antenna Information

The BT800 was tested with antennas listed below. The OEM can choose a different manufacturers antenna but must make sure it is of same type and that the gain is lesser than or equal to the antenna that is approved for use.

Item	Part Number	Mfg.	Type	Gain (dBi)
1	AT3216-B2R7HAA	ACX	Ceramic	0.5
2	001-0030 mFlexPIFA	LAIRD	PIFA	2
3	001-0014 FlexPIFA	LAIRD	PIFA	2
4	0600-00040	LAIRD	Dipole	2
5	NanoBlue MAF94045	LAIRD	PCB Dipole	2

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14 FCC REGULATORY

Model	US/FCC	CANADA/IC
BT860-SA	SQGBT850	
BT860-ST	SQGBT850	
DVK-BT860-SA		
DVK-BT860-ST		

The BT85x family has been designed to operate with the antenna listed below having a maximum gain of 0.5 dBi. The required antenna impedance is 50 ohms.

Item	Part Number	Mfg.	Type	Gain (dBi)	
1	AT3216-B2R7HAA	ACX	Ceramic	0.5	
2	001-0030 mFlexPIFA	LAIRD	PIFA	2	
3	001-0014 FlexPIFA	LAIRD	PIFA	2	
4	0600-00040	LAIRD	Dipole	2	
5	NanoBlue MAF94045	LAIRD	PCB Dipole	2	

14.1. Documentation Requirements

To ensure regulatory compliance, when integrating the BT860 into a host device, it is necessary to meet the documentation requirements set forth by the applicable regulatory agencies. The following sections (FCC, Industry Canada, and European Union) outline the information that may be included in the user's guide and external labels for the host devices into which the BT860 is integrated.

IMPORTANT:

If the conditions above cannot be met (for example certain device configurations or co-location with another transmitter), then the FCC authorization is no longer considered valid and the FCC ID cannot be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC authorization.

When using Laird's FCC grant for the BT860, the integrator must include specific information in the user's guide for the device into which the BT860 is integrated. The integrator must not provide information to the end user regarding how to install or remove this RF module in the user's manual of the device into which the BT860 is integrated. The following FCC statements must be added in their entirety and without modification into a prominent place in the user's guide for the device into which the BT860 is integrated:

IMPORTANT NOTE: To comply with FCC requirements, the BT860 must not be co-located or operating in conjunction with any other antenna or transmitter.

This device is intended only for OEM integrators under the following conditions:

- The transmitter module may not be co-located with any other transmitter or antenna,

If the condition above is met, further transmitter test will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed

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Important Note:

If these conditions cannot be met (for example, certain laptop configurations or co-location with another transmitter), then the FCC authorization is no longer considered valid and the FCC ID cannot be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC authorization.

End Product Labeling

The final end product must be labeled in a visible area with the following: ***Contains FCC ID: SQGBT850.***

Manual Information to the End User

The OEM integrator must be aware to not provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this module.

The end user manual shall include all required regulatory information/warning as show in this manual.

Federal Communication Commission Interference Statement

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

FCC Caution: Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

IMPORTANT NOTE: FCC Radiation Exposure Statement:

This equipment complies with the US portable RF exposure limit set forth for an uncontrolled environment and are safe for intended operation as described in this manual. The further RF exposure reduction can be achieved if the product can be kept as far as possible from the user body or set the device to lower output power if such function is available.

This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

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15 INDUSTRY CANADA REGULATORY

This device complies with Industry Canada's license-exempt RSSs. Operation is subject to the following two conditions:

1. This device may not cause interference; and
2. This device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes:

1. l'appareil ne doit pas produire de brouillage;
2. l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Radiation Exposure Statement:

The product complies with the Canada portable RF exposure limit set forth for an uncontrolled environment and are safe for intended operation as described in this manual. The further RF exposure reduction can be achieved if the product can be kept as far as possible from the user body or set the device to lower output power if such function is available.

Déclaration d'exposition aux radiations:

Le produit est conforme aux limites d'exposition pour les appareils portables RF pour les Etats-Unis et le Canada établies pour un environnement non contrôlé. Le produit est sûr pour un fonctionnement tel que décrit dans ce manuel. La réduction aux expositions RF peut être augmentée si l'appareil peut être conservé aussi loin que possible du corps de l'utilisateur ou que le dispositif est réglé sur la puissance de sortie la plus faible si une telle fonction est disponible.

This device is intended only for OEM integrators under the following conditions:

- The transmitter module may not be co-located with any other transmitter or antenna.

If the condition above is met, further transmitter test will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed.

Cet appareil est conçu uniquement pour les intégrateurs OEM dans les conditions suivantes:

- Le module émetteur peut ne pas être coïmplanté avec un autre émetteur ou antenne.

Tant que les 1 condition ci-dessus sont remplies, des essais supplémentaires sur l'émetteur ne seront pas nécessaires. Toutefois, l'intégrateur OEM est toujours responsable des essais sur son produit final pour toutes exigences de conformité supplémentaires requis pour ce module installé.

IMPORTANT NOTE:

If these conditions cannot be met (for example, certain laptop configurations or co-location with another transmitter), then the Canada authorization is no longer considered valid and the IC ID cannot be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate Canada authorization.

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NOTE IMPORTANTE:

Dans le cas où ces conditions ne peuvent être satisfaites (par exemple pour certaines configurations d'ordinateur **portable** ou de certaines co-localisation avec un autre émetteur), l'autorisation du Canada n'est plus considéré comme valide et l'ID IC ne peut pas être utilisé sur le produit final. Dans ces circonstances, l'intégrateur OEM sera chargé de réévaluer le produit final (y compris l'émetteur) et l'obtention d'une autorisation distincte au Canada.

End Product Labeling

The final end product must be labeled in a visible area with the following: “Contains IC: 3147A-BT850”.

Plaque signalétique du produit final

Le produit final doit être étiqueté dans un endroit visible avec l'inscription suivante: "Contient des IC: 3147A-BT850".

Manual Information to the End User

The OEM integrator must be aware not to provide information to the end user regarding how to install or remove this RF module in the user’s manual of the end product which integrates this module.

The end user manual shall include all required regulatory information/warning as show in this manual.

Manuel d'information à l'utilisateur final

L'intégrateur OEM doit être conscient de ne pas fournir des informations à l'utilisateur final quant à la façon d'installer ou de supprimer ce module RF dans le manuel de l'utilisateur du produit final qui intègre ce module. Le manuel de l'utilisateur final doit inclure toutes les informations réglementaires requises et avertissements comme indiqué dans ce manuel.

This radio transmitter *(IC: 3147A-BT850)* has been approved by *Industry Canada* to operate with the antenna types listed below with the maximum permissible gain indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Le présent émetteur radio *(IC: 3147A-BT850)* a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés cidessous et ayant un gain admissible maximal. Les types d'antenne non inclus dans cette liste, et dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.

16 European Union Regulatory

The BT800 has been tested for compliance with relevant standards for the EU market. BT800 module was tested with a 0.5 dBi chip antenna.

The OEM should consult with a qualified test house before entering their device into an EU member country to make sure all regulatory requirements have been met for their complete device.

Reference the Declaration of Conformities listed below for a full list of the standards that the modules were tested to. Test reports are available upon request.

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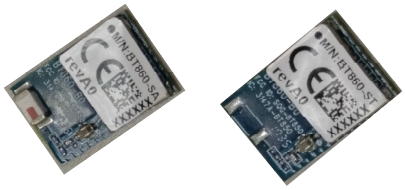
16.1. EU Declarations of Conformity

Manufacturer	Laird
Products	BT860-SA and BT860-ST
Product Description	Bluetooth v4.2 Class 1 UART HCI
EU Directives	2014/53/EU – Radio Equipment Directive (RED)



Reference standards used for presumption of conformity:

Article Number	Requirement	Reference standard(s)
3.1a	Low voltage equipment safety	EN 60950-1:2006 +A11:2009 +A1:2010 +A12:2011 +A2:2013
	RF Exposure	EN 62311:2008
		EN 62479:2010
3.1b	Protection requirements with respect to electromagnetic compatibility	EN 301 489-1 v2.2.0 (2017-03) EN 301 489-17 v3.2.0 (2017-03)
3.2	Means of the efficient use of the radio frequency spectrum	EN 300 328 v2.1.1 (2016-11)

Declaration:
We, Laird, declare under our sole responsibility that the essential radio test suites have been carried out and that the above product to which this declaration relates is in conformity with all the applicable essential requirements of Article 3 of the EU Directive 1999/5/EC, when used for its intended purpose.

Place of Issue:	Laird W66N220 Commerce Court, Cedarburg, WI 53012 USA tel: +1-262-375-4400 fax: +1-262-364-2649
Date of Issue:	May 2017
Name of Authorized Person:	Thomas T Smith, Director of EMC Compliance
Signature of Authorized Person:	

17 Ordering Information

Part Number	Description
BT860-SA	BTv4.2 Dual Mode UART HCI Module with integrated Antenna
BT860-ST	BTv4.2 Dual Mode UART HCI Module – Trace Pin
DVK-BT860	Development Kit for BT860 Module

17.1. General Comments

This is a preliminary datasheet. Please check with Laird for the latest information before commencing a design. If in doubt, ask.

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18 BLUETOOTH SIG APPROVALS

18.1. Application Note: Subsystem Combinations

This application note covers the procedure for generating a new Declaration ID for a Subsystem combination on the Bluetooth SIG website. In the instance of subsystems, a member can combine two or more subsystems to create a complete Bluetooth End Product solution.

Subsystem listings referenced as an example:

Design Name	Owner	Declaration ID	Link to listing on the SIG website
BT860-SA	Laird	B021369	https://www.bluetooth.org/tpg/QLI_viewQDL.cfm?qid=21369
Windows 8 (Host Subsystem)	Microsoft Corporation	B012854	https://www.bluetooth.org/tpg/QLI_viewQDL.cfm?qid=12854

Laird Customer Declaration ID Procedure

This procedure assumes that the member is simply combining two subsystems to create a new design, without any modification to the existing, qualified subsystems. This is achieved by using the Listing interface on the Bluetooth SIG website. **Error! Reference source not found.** shows the basic subsystem combination of a controller and host subsystem. The Controller provides the RF/BB/LM and HCI layers, with the Host providing L2CAP, SDP, GAP, RFCOMM/SPP and any other specific protocols and profiles existing in the Host subsystem listing. The design may also include a Profile Subsystem.

The controller provides the RF/BB/LM and HCI layers, with the Host providing L2CAP, SDP, GAP, RFCOMM/SPP and any other specific protocols and profiles existing in the Host subsystem listing. The design may also include a Profile Subsystem.

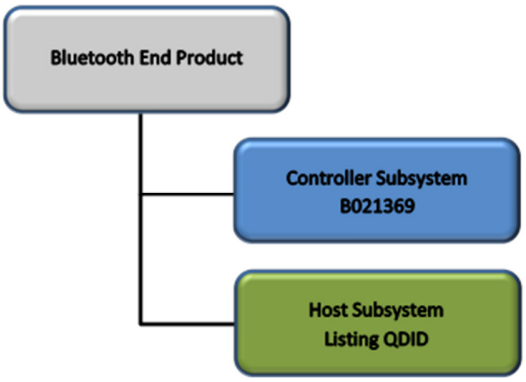

Figure 21: Basic subsystem combination of a controller and host subsystem

The Qualification Process requires each company to registered as a member of the Bluetooth SIG – http://www.bluetooth.org

The following link provides a link to the Bluetooth Registration page: https://www.bluetooth.org/login/register/

For each Bluetooth Design it is necessary to purchase a Declaration ID. This can be done before starting the new qualification, either through invoicing or credit card payment. The fees for the Declaration ID will depend on your membership status, please refer to the following webpage:

https://www.bluetooth.org/en-us/test-qualification/qualification-overview/fees

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For a detailed procedure of how to obtain a new Declaration ID for your design, please refer to the following SIG document:

https://www.bluetooth.org/DocMan/handlers/DownloadDoc.ashx?doc_id=283698&vId=317486

To start the listing, go to: https://www.bluetooth.org/tpg/QLI_SDoc.cfm.

In step 1, select the option, **Reference a Qualified Design** and enter the Declaration IDs of each subsystem used in the End Product design. You can then select your pre-paid Declaration ID from the drop down menu or go to the Purchase Declaration ID page, (please note that unless the Declaration ID is pre-paid or purchased with a credit card, it will not be possible to proceed until the SIG invoice is paid.

Once all the relevant sections of step 1 are finished, complete steps 2, 3, and 4 as described in the help document. Your new Design will be listed on the SIG website and you can print your Certificate and DoC.

For further information please refer to the following training material:

https://www.bluetooth.org/en-us/test-qualification/qualification-overview/listing-process-updates

19 Additional Assistance

Please contact your local sales representative or our support team for further assistance:

Laird Technologies Connectivity Products Business Unit
Support Centre: http://ews-support.lairdtech.com

Email: wireless.support@lairdtech.com

Phone: Americas: +1-800-492-2320
Europe: +44-1628-858-940
Hong Kong: +852 2923 0610

Web: http://www.lairdtech.com/bluetooth

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