apm8811 BT4.0 Dual Mode Module

DESCRIPTION

apm8811 Bluetooth Module is a HCI ROM Dual Mode BT module. It needs a host processor is capable of running the Bluetooth software stack. This means when there is a host processor in the system; apm8811 will be more cost effective compare to BT modules who can work standalone. Besides this, the dual mode radio enable apm8811 not only can act as traditional BT, but also can be act as a Bluetooth Low Energy Device. This provides flexibility and enriches the feature of the product integrated with apm8811 module.

The module was well designed and full tested during development stage. Its design is reliable, with good performance and complies with regulations. Each module is also well tested and calibrated before shipping to customer. With these advantages, customer can reduce the complexity at customer's production line, reduce development risk, time and cost greatly.

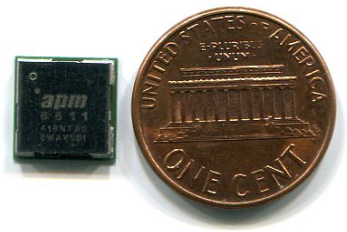
GENERAL FEATURES

- Dual-mode Bluetooth®/Bluetooth low energy radio
- Fully qualifiable Bluetooth v4.0 IC
- Can be used as part of a Bluetooth v4.0 + HS system
- Class 1 or Class 2 Bluetooth power levels
- High-sensitivity Bluetooth receiver
- High-speed UART port (up to 4Mbps)
- Support for IEEE 802.11 coexistence
- Small footprint: 9.6×9.6×1.6 mm

APPLICATIONS

- Wearable Device, design with Cortex M serial micro controller
- Industrial device, such as PDA, POS, Barcode reader/Printer
- BTLe bridge to WiFi
- Low-cost phones
- Feature phones
- Smartphones

APPEARANCE



REVISION HISTORY

Date	Release	Author	Description
2014-Mar-28	1.0	Tu	Initial release
2014-Sep-09	1.1	Tu	Modify Pin Description Number22 & 23
2015-Sep-15	1.2	Pol	Update baking condition

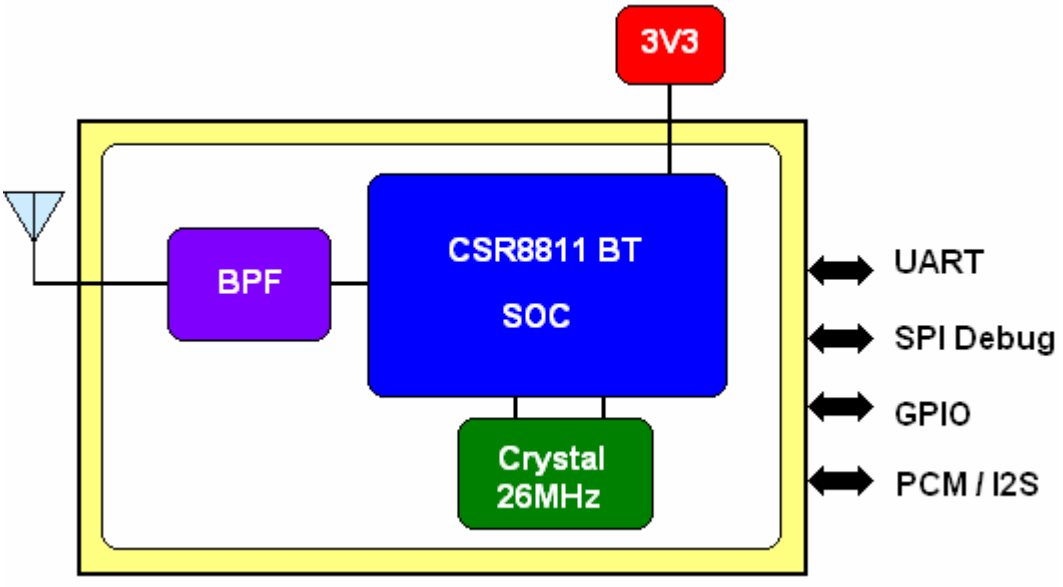
TABLE OF CONTENTS

1 Hardware Specification

1-1 General Specification

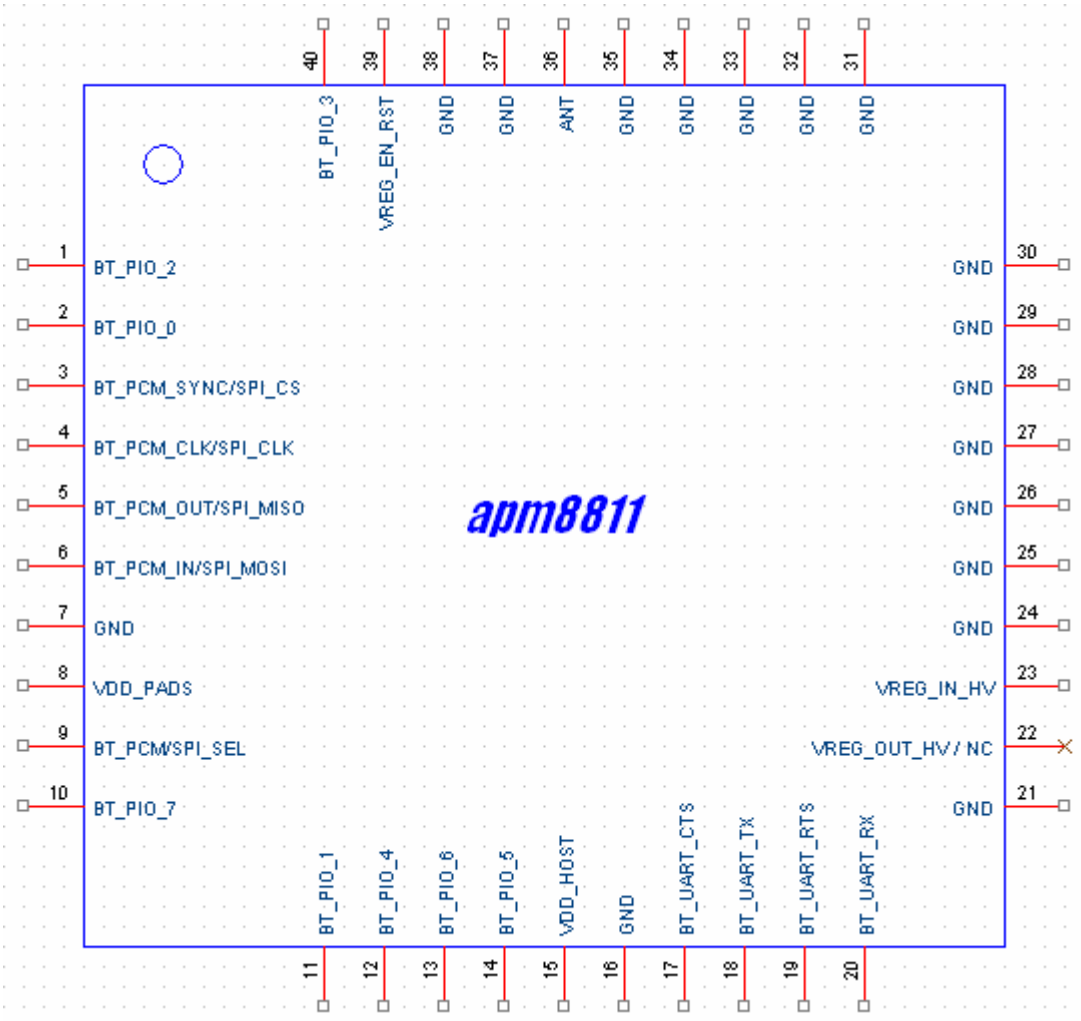
Bluetooth part:	
Network Standard	Dual-mode Bluetooth / Bluetooth low energy radio
Host Interface	UART(up to 4Mbps), SPI, PCM/I2S
Frequency Band	2400 to 2480MHz (79 channel) for basic rate & EDR 2400 to 2480MHz (40 channel) for BLE
Modulation	GFSK & π/4 DPSK & 8DPSK for basic rate & EDR GFSK for BLE
Antenna	External single antenna support. The output impedance is 50Ω.

1-2 Block Diagram



1-3 Pinout

1-3-1 Pin Assignment (Top View)



Pin Description

* I/O: Digital Input/Output, I: Digital Input, O: Digital Output, A: Analog, PU: Pull-up, PD: Pull-down

#	Name	I/O	Internal Resistor	Description
1	BT_PIO_2	I/O	-	Programmable input/output
2	BT_PIO_0	I/O	-	Programmable input/output
3	BT_PCM_SYNC/SPI_CS	I/O	PD	Synchronous data sync
4	BT_PCM_CLK/SPI_CLK	I/O	PD	Synchronous data clock

#	Name	I/O	Internal Resistor	Description
5	BT_PCM_OUT/SPI_MISO	I/O	PD	Synchronous data output
6	BT_PCM_IN/SPI_MOSI	I/O	PD	Synchronous data input
7	GND	GND	-	Ground
8	VDD_PADS	Power	-	3.3V power input
9	BT_PCM/SPI_SEL	I/O	PD	High switches SPI/PCM lines to SPI, low switches SPI/ PCM lines to PCM/PIO use.
10	BT_PIO_7	I/O	-	Programmable input/output
11	BT_PIO_1	I/O	-	Programmable input/output
12	BT_PIO_4	I/O	-	Programmable input/output
13	BT_PIO_6	I/O	-	Programmable input/output
14	BT_PIO_5	I/O	-	Programmable input/output
15	VDD_HOST	Power	-	3.3V Regulator input
16	BT_PIO_8/GND	I/O	-	Programmable input/output/Ground
17	BT_UART_CTS	O	PD	UART clear to send ,active low
18	BT_UART_TX	O	PU	UART data output active high
19	BT_UART_RTS	I	PD	UART request to send ,active low
20	BT_UART_RX	I	PD	UART data input active high
21	GND	GND	-	Ground
22	VREG_OUT_HV / NC	-	-	Floating
23	VREG_IN_HV	Power	-	3.3V LDO input
24	GND	GND	-	Ground
25	BT_PIO_9/GND	I/O	-	Programmable input/output/Ground
26	GND	GND	-	Ground
27	GND	GND	-	Ground
28	GND	GND	-	Ground
29	GND	GND	-	Ground
30	GND	GND	-	Ground
31	GND	GND	-	Ground
32	GND	GND	-	Ground
33	GND	GND	-	Ground
34	GND	GND	-	Ground
35	GND	GND	-	Ground

#	Name	I/O	Internal Resistor	Description
36	ANT	A	-	RF input/output
37	GND	GND	-	Ground
38	GND	GND	-	Ground
39	VREG_EN_RST	I	-	Module enable
40	BT_PIO_3	I/O	-	Programmable input/output

2 Absolute Maximum Rating

Symbol	Description	Min.	Max.	Units
T_{ST}	Storage temperature	-40	+85	°C
VBAT	Input to internal high-voltage regulator	+3.1	+3.6	V
VDD_HOST	I/O supply voltage	+3.1	+3.6	V
VDD_PAD				

*Absolute maximum ratings indicate limits beyond which damage to the device may occur.

2-1 Recommended Operating Condition

Symbol	Description	Min.	Typ.	Max.	Units
T_{OP}	Operating temperature	-20	+25	+70	°C
VBAT	Input to internal high-voltage regulator	+3.1	+3.3	+3.6	V
VDD_HOST	I/O supply voltage	+3.1	+3.3	+3.6	V
VDD_PAD					V

3 RF Specification

3-1 Channel 0 (2402MHz)

Condition: VBAT = VDD_HOST = VDD_PAD =+3.3V, T_{OP}=+25°C

Parameter		Min	Typ	Max	Bluetooth Spec.	Unit
Basic Data Rate - Transmitter Test						
Maximum RF transmit power *(a)		4	5.5	7	Class1: 0 to +20 Class2: -6 to +4	dBm
Power Control Step		-	-	7	2 to 8	dB
Modulation Characteristic	Modulation index: Δf1avg	145	164	175	140 ≤ Δf1avg ≤ 175	kHz
	Modulation index: Δf2 avg	115	142	-	≥ 115	kHz
	Modulation index: Δf2avg / Δf1avg	0.8	0.93	-	≥ 0.8	NA
Initial carrier frequency tolerance		-35	+8.2	35	± 35	kHz
Carrier frequency drift rate		-20	+10	20	± 20	kHz/50us
Carrier frequency drift: one slot packet		-25	-8	25	± 25	kHz
Carrier frequency drift: three slot packet		-40	-7	40	± 40	kHz
Carrier frequency drift: five slot packet		-40	-9	40	± 40	kHz
Basic Data Rate - Receiver Test						
Sensitivity – single slot packets		-	-82.5	-70	≤ -70	dBm
Sensitivity – multi slot packets		-	-82.5	-70	≤ -70	dBm
Enhanced Data Rate – Transmitter Test						
Relative transmit power		-	-1.03	-	-4 to +1	dB
π/4 DQPSK Max carrier frequency stability ω_i		-75	2.7	75	≤ ±75 for all packets	kHz
π/4 DQPSK Max carrier frequency stability ω_o		-10	-1.9	10	≤ ±10 for all blocks	kHz
π/4 DQPSK Max carrier frequency stability $\lvert \omega_o+\omega_i \rvert$		-75	3.7	75	≤ ±75 for all blocks	kHz
8 DPSK Max carrier frequency stability ω_i		-75	3.1	75	≤ ±75 for all packets	kHz
8 DPSK Max carrier frequency stability ω_o		-10	-1.7	10	≤ ±10	kHz

Parameter		Min	Typ	Max	Bluetooth Spec.	Unit
					for all blocks	
8 DPSK Max carrier frequency stability | $\omega_o+\omega_i$ |		-75	3.6	75	≤ ±75 for all blocks	kHz
π/4 DQPSK Modulation Accuracy	rms DEVM	-	7.7	20	≤20	%
	99% DEVM	-	0	0.3	≤0.3	-
	Peak DEVM	-	21	35	≤35	%
8 DPSK Modulation Accuracy	rms DEVM	-	7.2	13	≤13	%
	99% DEVM	-	0	0.2	≤0.2	-
	Peak DEVM	-	18.1	25	≤25	%
EDR Differential Phase Encoding		-	100	-	99	%
Enhanced Data Rate – Receiver Test						
Sensitivity at 0.01% BER	π/4 DQPSK	-	-85.5	-70	≤-70	dBm
	8 DPSK	-	-75.5	-70	≤-70	
EDR Floor Performance		-	0	-	7.00E-006 1.00E-005	
EDR MAX input power			0		1.00E-003	
*(a) RF TX Power can be set by PSR setting.						
Low Energy - Transmitter Test (Channel 0_2402MHz)						
Maximum RF transmit power *(a)		4	5.5	7	< 10	dBm
Modulation Characteristic	Modulation index: Δf1avg	225	264	-275	225 ≤ Δf1avg ≤ 275	kHz
	Modulation index: Δf2 avg	185	229	-	≥ 185	kHz
	Modulation index: Δf2avg / Δf1avg	0.8	0.85	-	≥ 0.8	NA
Initial carrier frequency tolerance		-40	+2.4	40	± 40	kHz
Carrier frequency drift rate		-20	+7.3	20	± 20	kHz/50us
Carrier frequency drift: Max Drift		50	7	-	≤50	kHz
Low Energy – Receiver Test (Channel 0_2402MHz)						
Receiver sensitivity		-	-85	-70	≤-70	dBm
Receiver sensitivity - Frame Error Rate		-	0	30.8	≤30.8	%
PER Report Integrity - Frame Error Rate		50	50	65.4	50.0 ≤ PER ≤ 65.4	%

3-2 Channel 39 (2441MHz)

Condition: VBAT = VDD_HOST = VDD_PAD =+3.3V, T_{OP}=+25°C

Parameter		Min	Typ	Max	Bluetooth Spec.	Unit
Basic Data Rate - Transmitter Test						
Maximum RF transmit power *(a)		4.5	6	7.5	Class1: 0 to +20 Class2: -6 to +4	dBm
Power Control Step		-	-	7	2 to 8	dB
Modulation Characteristic	Modulation index: Δf1avg	145	164.9	175	140 ≤ Δf1avg ≤ 175	kHz
	Modulation index: Δf2 avg	115	146.7	-	≥ 115	kHz
	Modulation index: Δf2avg / Δf1avg	0.8	0.88	-	≥ 0.8	NA
Initial carrier frequency tolerance		-35	+9.1	35	± 35	kHz
Carrier frequency drift rate		-20	-9.	20	± 20	kHz/50us
Carrier frequency drift: one slot packet		-25	-4.3	25	± 25	kHz
Carrier frequency drift: three slot packet		-40	+6.6	40	± 40	kHz
Carrier frequency drift: five slot packet		-40	-8.4	40	± 40	kHz
Basic Data Rate - Receiver Test						
Sensitivity – single slot packets		-	-82.5	-70	≤ -70	dBm
Sensitivity – multi slot packets		-	-82.5	-70	≤ -70	dBm
Enhanced Data Rate – Transmitter Test						
Relative transmit power		-	-1.01	-	-4 to +1	dB
π/4 DQPSK Max carrier frequency stability ω_i		-75	+4.2	75	≤ ±75 for all packets	kHz
π/4 DQPSK Max carrier frequency stability ω_o		-10	+1.6	10	≤ ±10 for all blocks	kHz
π/4 DQPSK Max carrier frequency stability $\lvert \omega_o+\omega_i \rvert$		-75	+4.7	75	≤ ±75 for all blocks	kHz
8 DPSK Max carrier frequency stability ω_i		-75	+4.1	75	≤ ±75 for all packets	kHz
8 DPSK Max carrier frequency stability ω_o		-10	+1.3	10	≤ ±10 for all blocks	kHz
8 DPSK		-75	+4.8	75	≤ ±75	kHz

Parameter		Min	Typ	Max	Bluetooth Spec.	Unit
Max carrier frequency stability | $\omega_o+\omega_i$ |					for all blocks	
π/4 DQPSK Modulation Accuracy	rms DEVM	-	7.1	20	≤20	%
	99% DEVM	-	0	0.3	≤0.3	-
	Peak DEVM	-	19.5	35	≤35	%
8 DPSK Modulation Accuracy	rms DEVM	-	6.9	13	≤13	%
	99% DEVM	-	0	0.2	≤0.2	-
	Peak DEVM	-	18.5	25	≤25	%
EDR Differential Phase Encoding		-	100	-	99	%
Enhanced Data Rate – Receiver Test						
Sensitivity at 0.01% BER	π/4 DQPSK	-	-85.5	-70	≤-70	dBm
	8 DPSK	-	-75.5	-70	≤-70	
EDR Floor Performance		-	0	-	7.00E-006 1.00E-005	
EDR MAX input power			0		1.00E-003	
*(a) RF TX Power can be set by PSR setting.						
Low Energy - Transmitter Test (Channel 18_2442MHz)						
Maximum RF transmit power *(a)		4.5	6	7.5	< 10	dBm
Modulation Characteristic	Modulation index: Δf1avg	225	265.2	-275	225 ≤ Δf1avg ≤ 275	kHz
	Modulation index: Δf2 avg	185	224.2	-	≥ 185	kHz
	Modulation index: Δf2avg / Δf1avg	0.8	0.84	-	≥ 0.8	NA
Initial carrier frequency tolerance		-40	+3.9	40	± 40	kHz
Carrier frequency drift rate		-20	-4.3	20	± 20	kHz/50us
Carrier frequency drift: Max Drift		50	7	-	≤50	kHz
Low Energy – Receiver Test (Channel 18_2442MHz)						
Receiver sensitivity		-	-85	-70	≤-70	dBm
Receiver sensitivity - Frame Error Rate		-	0	30.8	≤30.8	%
PER Report Integrity - Frame Error Rate		50	50	65.4	50.0 ≤ PER ≤ 65.4	%

3-3 Channel 79 (2480MHz)

Condition: VBAT = VDD_HOST = VDD_PAD =+3.3V, T_{OP}=+25°C

Parameter		Min	Typ	Max	Bluetooth Spec.	Unit
Basic Data Rate - Transmitter Test						
Maximum RF transmit power *(a)		4.5	6	7.5	Class1: 0 to +20 Class2: -6 to +4	dBm
Power Control Step		-	-	7	2 to 8	dB
Modulation Characteristic	Modulation index: Δf1avg	145	165.5	175	140 ≤ Δf1avg ≤ 175	kHz
	Modulation index: Δf2 avg	115	146	-	≥ 115	kHz
	Modulation index: Δf2avg / Δf1avg	0.8	0.88	-	≥ 0.8	NA
Initial carrier frequency tolerance		-35	+7.8	35	± 35	kHz
Carrier frequency drift rate		-20	-10	20	± 20	kHz/50us
Carrier frequency drift: one slot packet		-25	-6.8	25	± 25	kHz
Carrier frequency drift: three slot packet		-40	-6.7	40	± 40	kHz
Carrier frequency drift: five slot packet		-40	-6.8	40	± 40	kHz
Basic Data Rate - Receiver Test						
Sensitivity – single slot packets		-	-82.5	-70	≤ -70	dBm
Sensitivity – multi slot packets		-	-82.5	-70	≤ -70	dBm
Enhanced Data Rate – Transmitter Test						
Relative transmit power		-	-0.99	-	-4 to +1	dB
π/4 DQPSK Max carrier frequency stability ω_i		-75	+3.7	75	≤ ±75 for all packets	kHz
π/4 DQPSK Max carrier frequency stability ω_o		-10	+2	10	≤ ±10 for all blocks	kHz
π/4 DQPSK Max carrier frequency stability $\lvert \omega_o+\omega_i \rvert$		-75	+4.8	75	≤ ±75 for all blocks	kHz
8 DPSK Max carrier frequency stability ω_i		-75	+4.4	75	≤ ±75 for all packets	kHz
8 DPSK Max carrier frequency stability ω_o		-10	-1.7	10	≤ ±10 for all blocks	kHz
8 DPSK		-75	+4.8	75	≤ ±75	kHz

Parameter		Min	Typ	Max	Bluetooth Spec.	Unit
Max carrier frequency stability | $\omega_o+\omega_i$ |					for all blocks	
π/4 DQPSK Modulation Accuracy	rms DEVM	-	8.1	20	≤20	%
	99% DEVM	-	0	0.3	≤0.3	-
	Peak DEVM	-	22.8	35	≤35	%
8 DPSK Modulation Accuracy	rms DEVM	-	7.8	13	≤13	%
	99% DEVM	-	0	0.2	≤0.2	-
	Peak DEVM	-	20.5	25	≤25	%
EDR Differential Phase Encoding		-	100	-	99	%
Enhanced Data Rate – Receiver Test						
Sensitivity at 0.01% BER	π/4 DQPSK	-	-85.5	-70	≤-70	dBm
	8 DPSK	-	-75.5	-70	≤-70	
EDR Floor Performance		-	0	-	7.00E-006 1.00E-005	
EDR MAX input power			0		1.00E-003	
*(a) RF TX Power can be set by PSR setting.						
Low Energy - Transmitter Test (Channel 39_2480MHz)						
Maximum RF transmit power *(a)		4.5	6	7.5	< 10	dBm
Modulation Characteristic	Modulation index: Δf1avg	225	264.5	-275	225 ≤ Δf1avg ≤ 275	kHz
	Modulation index: Δf2 avg	185	222	-	≥ 185	kHz
	Modulation index: Δf2avg / Δf1avg	0.8	0.83	-	≥ 0.8	NA
Initial carrier frequency tolerance		-40	+3.7	40	± 40	kHz
Carrier frequency drift rate		-20	+7.1	20	± 20	kHz/50us
Carrier frequency drift: Max Drift		50	8	-	≤50	kHz
Low Energy – Receiver Test (Channel 39_2480MHz)						
Receiver sensitivity		-	-85	-70	≤-70	dBm
Receiver sensitivity - Frame Error Rate		-	0	30.8	≤30.8	%
PER Report Integrity - Frame Error Rate		50	50	65.4	50.0 ≤ PER ≤ 65.4	%

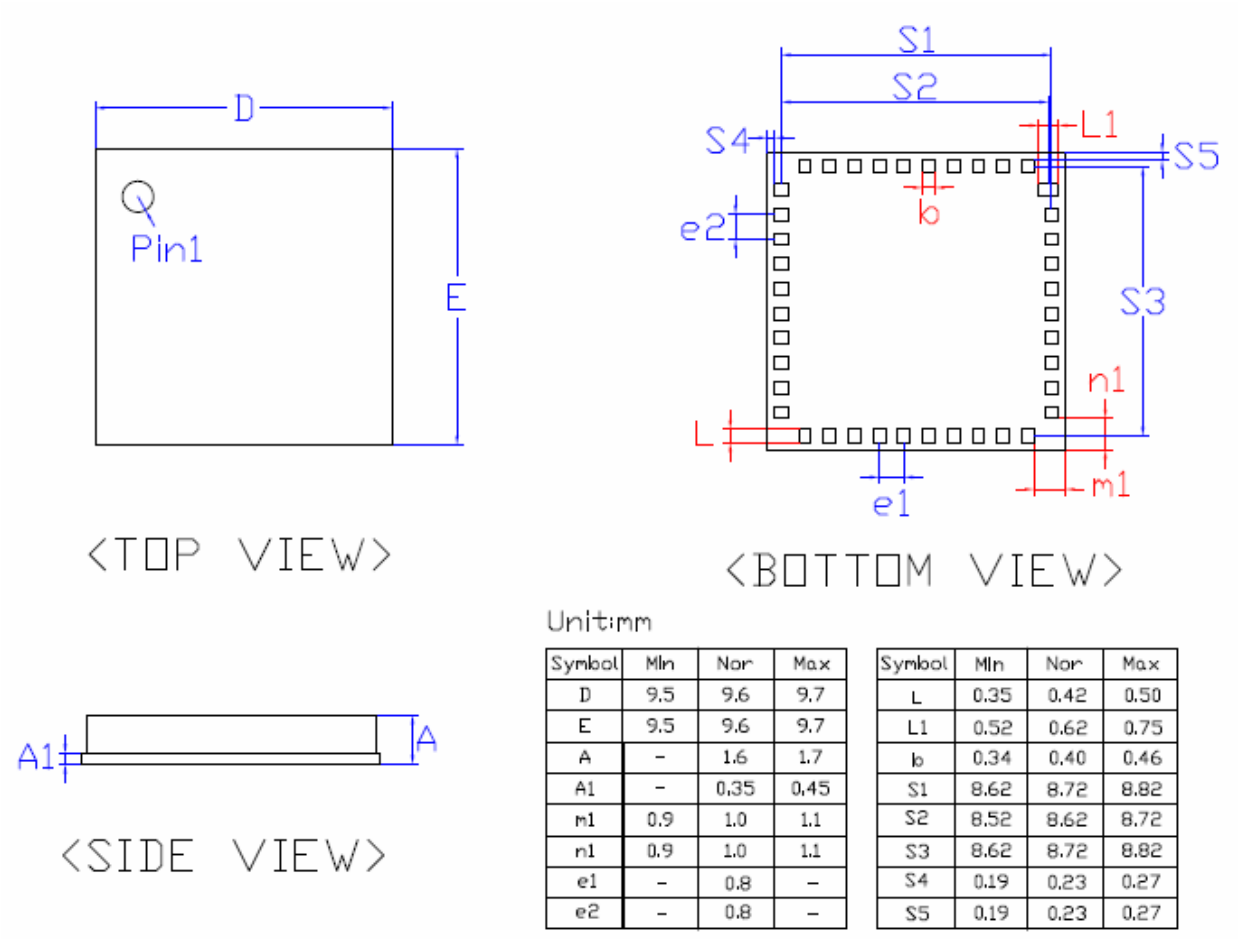
3-4 Bluetooth Current consumption

Parameter	Test conditions	Units	Min	Typ	Max
Current Consumption					
ACL no traffic	Master	mA	-	4.3	-
ACL with file transfer	Master	mA	-	6.7	-
ACL no traffic	Slave	mA	-	9.6	-
ACL with file transfer	Slave	mA	-	20.8	-
SCO HV1	Master	mA	-	34	-
SCO HV3	Master	mA	-	13.1	-
SCO HV1	Slave	mA	-	35.4	-
SCO HV3	Slave	mA	-	16.1	-
Inquire mode	Master	mA	-	24.4	-
Standby with host connection	Master	uA	-	45	-
Deep sleep with host connection	Master	uA	-	175	-

4 Mechanical Specification

Dimension	9.6×9.6×1.6 mm
Weight	0.285 gram
Pinout	40
Antenna	External antenna support (Pin 36)

4-1 Package Outline



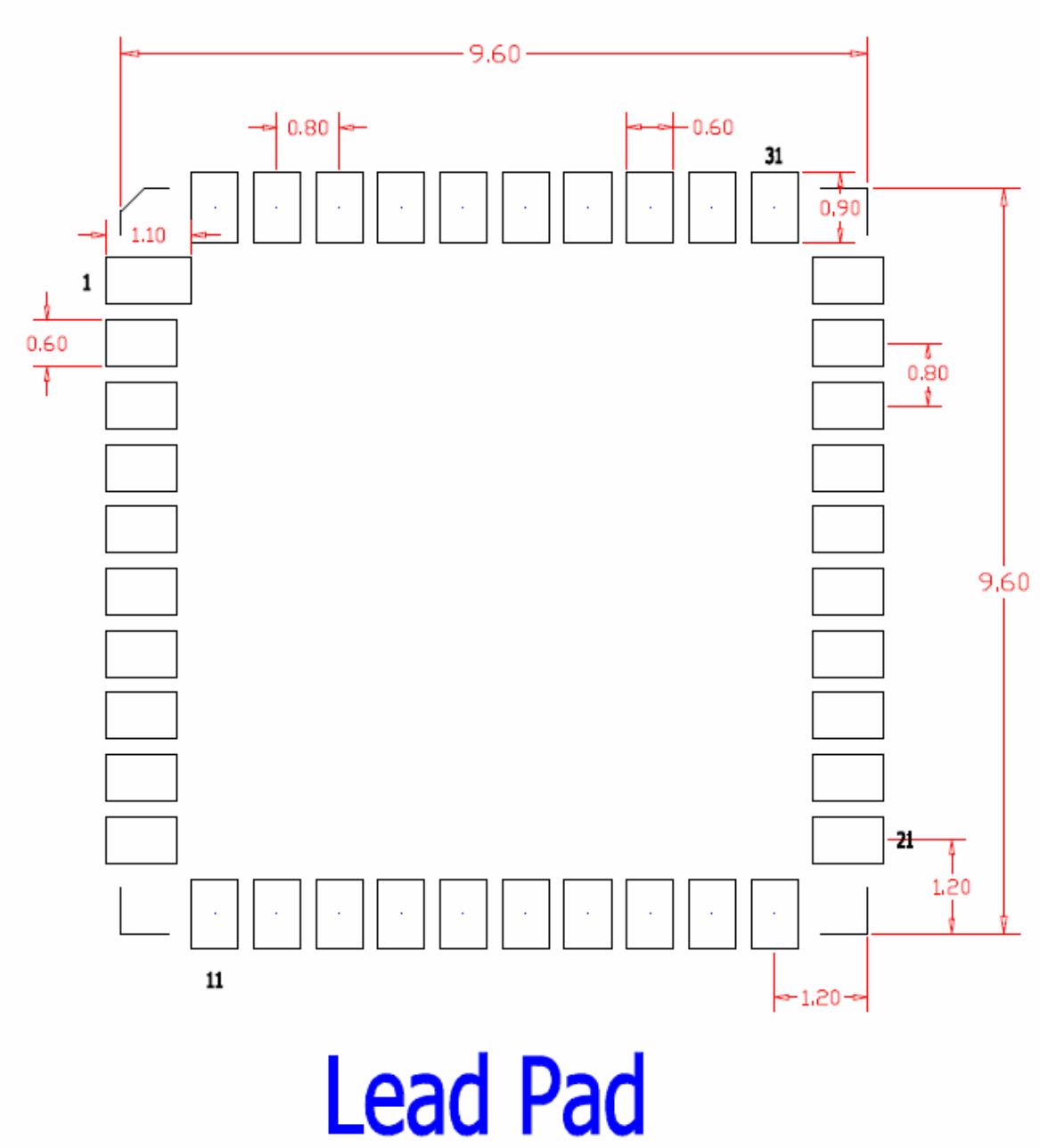
Unit:mm

Symbol	Min	Nor	Max
D	9.5	9.6	9.7
E	9.5	9.6	9.7
A	-	1.6	1.7
A1	-	0.35	0.45
m1	0.9	1.0	1.1
n1	0.9	1.0	1.1
e1	-	0.8	-
e2	-	0.8	-

Symbol	Min	Nor	Max
L	0.35	0.42	0.50
L1	0.52	0.62	0.75
b	0.34	0.40	0.46
S1	8.62	8.72	8.82
S2	8.52	8.62	8.72
S3	8.62	8.72	8.82
S4	0.19	0.23	0.27
S5	0.19	0.23	0.27

5 Assembly Guideline

5-1 Recommended Mounting Pad Design (Top View)



Unit: mm

PCB METAL LAND (TOP VIEW)

5-2 Baking condition recommendation before IR reflow

Baking condition for apm8811 module:

I: 125°C /4 hrs baking is necessary for apm8811 module before SMT process. After baking treatment the modules can be stored in the environment under 30°C and 60% RH for 168 hrs. If the storage time is over 168 hrs, the modules need to be re-baked using the same condition again.

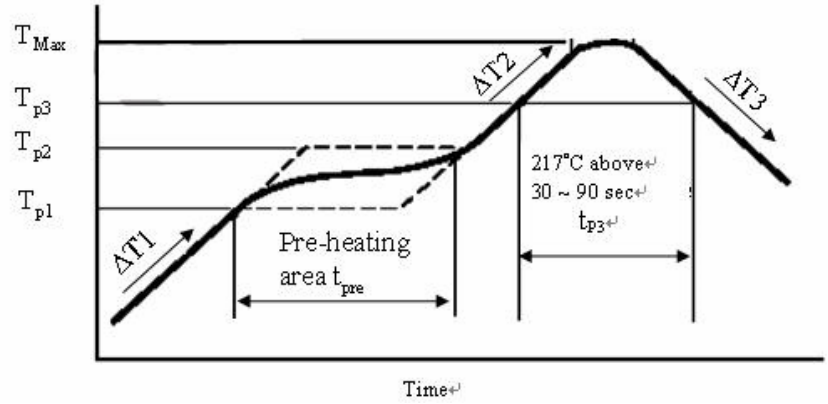
II: In the event that the sealed bag is damaged on receipt of the modules, the baking condition should be changed to 125°C /8 hrs.

5-3 Recommended Temperature Reflow Profile

The solder profile depends on various parameters necessitating a set up for each application. The data here is given only for guidance on solder re-flow.

Maximum reflow temperature is 250°C

Preheat ramp-up rate	125°C to 180°C 1 to 3°C / sec.
Peak temperature	250°C, Max.
Temperature maintained above 217°C	30 ~ 90 sec.
Cooling ramp-down rate	<2°C / sec.
Maximum number of reflow cycles	≤3



Typical Lead-Free Re-flow Solder Profile

Heating/Cooling Speed			Pre-Heating		Heating	
ΔT1	ΔT2	ΔT3	T_{p1}–T_{p2}	t_{pre}	T_{Max}	t_{P3}
1 to 3°C / sec	1 to 3°C / sec	< 2°C / sec	125 ~ 180°C	30 ~ 90 sec.	250°C max.	30 ~ 90 sec.