apm1010 BT4.0 Single Mode Module

DESCRIPTION

apm1010 module is a full integrated single-mode Bluetooth low energy module for the Bluetooth Smart market. It integrated CSR1010, RF matching circuit, crystal and EEPROM into a surface mount module with a compact size of 15 × 15 × 2.45 mm. It supports all Bluetooth low Energy profiles. A customized or default profiles can pre-loaded into the built-in memory of apm1010 base on customer's request. The module is also well tested and calibrated before shipping to customer. These advantages not only reduce the complication at customer's production line, but also reduce the customer development risk and cost greatly.

GENERAL FEATURES

- Bluetooth® v4.0 specification
- 7dBm Bluetooth low energy maximum transmit output power
- -92dBm Bluetooth low energy receive
- Support for Bluetooth v4.0 specification host stack including ATT, GATT, SMP, L2CAP, GAP
- <600nA current consumption in dormant mode
- 32kHz and 16MHz crystal or system clock
- Programmable general purpose PIO controller
- 10-bit ADC & 12 digital PIOs & 3 analogue AIOs & UART
- Build-in 512Kbit EEPROM
- Debug SPI & 4 PWM modules
- Wake-up interrupt and watchdog timer
- footprint: 15×15×2.45 mm

APPLICATIONS

Bluetooth Smart enables connectivity and data transfer to smartphone, tablet and personal computing devices including Apple iPhone, iPad, iPod and Mac products and Android devices.

Bluetooth low energy consume approximately 1/20th of the power of Bluetooth Basic Rate. With profiles for health and fitness sensors, watches, keyboards, mice and remote controls, the typical Bluetooth Smart applications includes:

■ HID: keyboards, mice, touchpads, remote controls

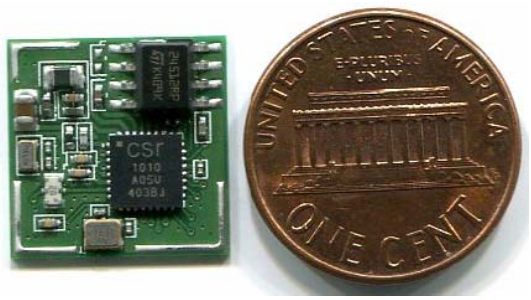
■ Sports and fitness sensors: heart rate, runner speed and cadence, cycle speed and cadence

■ Health sensors: blood pressure, thermometer and glucose meters

■ Mobile accessories: watches, proximity tags, alert tags and camera controls

■ Smart home: heating control and lighting control

APPEARANCE



REVISION HISTORY

Date	Release	Author	Description
2014-Mar-28	1.0	Tu	Initial release
2015-Apr-20	1.1	Pol	Remove flash description in general features Update section 5.2 baking condition

TABLE OF CONTENTS

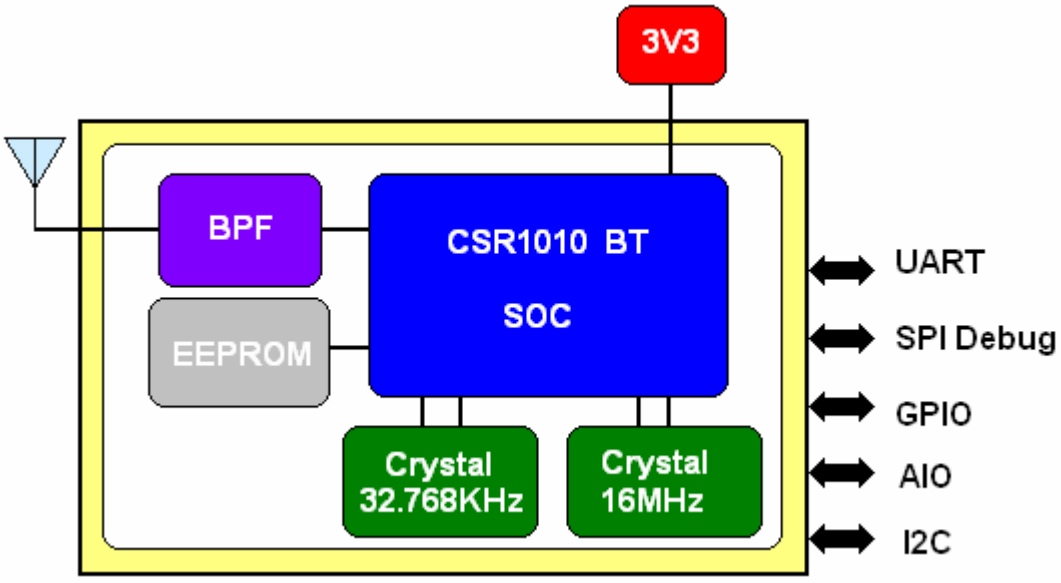
1 Hardware Specification

1.1 General Specification

Bluetooth part:

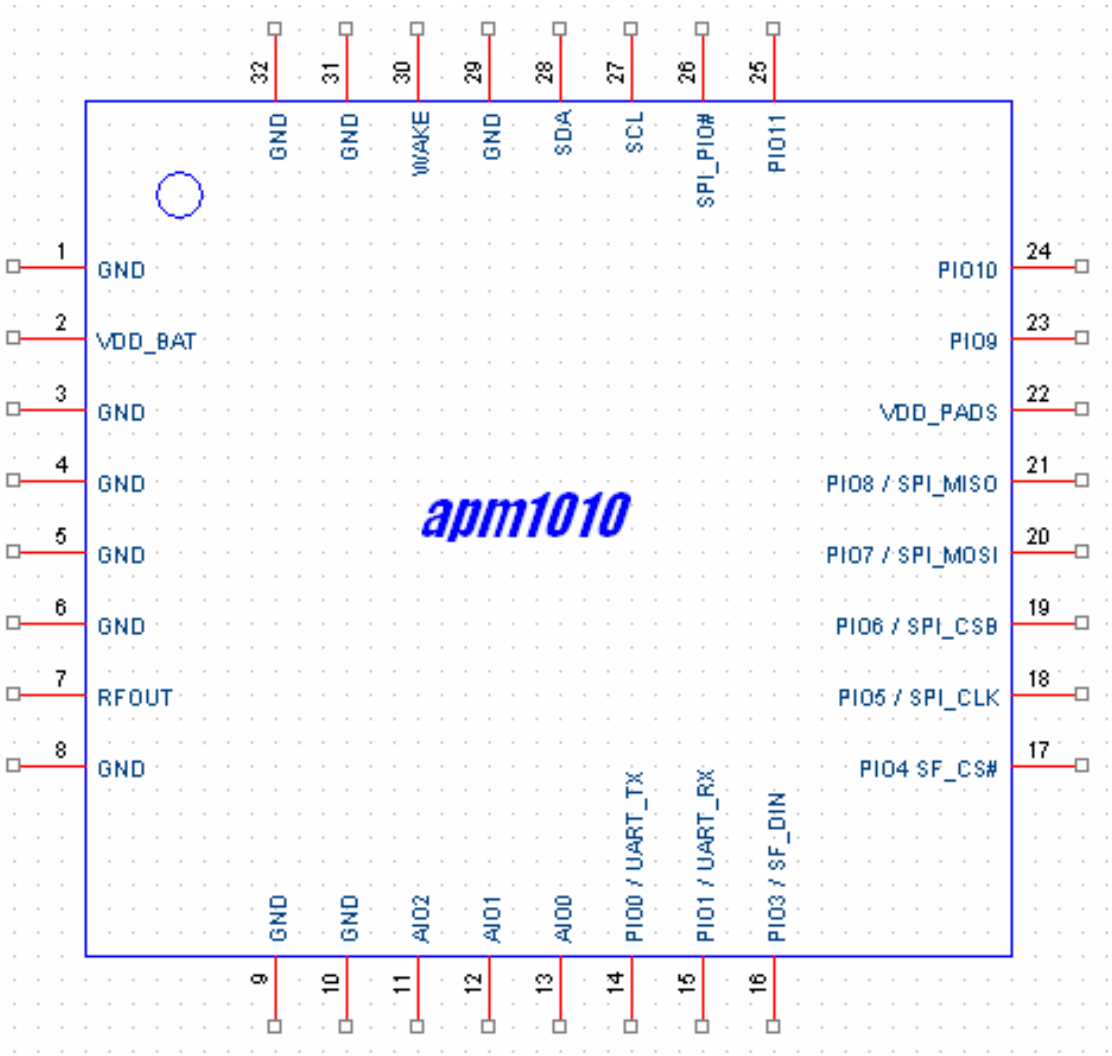
Network Standard	Single Mode BTLe
Host Interface	UART, SPI, I2C, AIO
Frequency Band	2400 to 2480MHz (40 channel)
Modulation	GFSK
Antenna	External single antenna support. The output impedance is 50Ω.

1.2 Block Diagram



1.3 Pinout

1.3.1 Pin Assignment (Top View)



1.3.2 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	GND	GND	-	Ground
2	VDD_BAT	Power	-	3.3V power input

#	Name	I/O	Internal Resistor	Description
3	GND	GND	-	Ground
4	GND	GND	-	Ground
5	GND	GND	-	Ground
6	GND	GND	-	Ground
7	RFOUT	A	-	RF I/O
8	GND	GND	-	Ground
9	GND	GND	-	Ground
10	GND	GND	-	Ground
11	AIO2	I/O	-	Analogue programmable I/O line.
12	AIO1	I/O	-	Analogue programmable I/O line.
13	AIO0	I/O	-	Analogue programmable I/O line.
14	PIO0/UART_TX	O	PU	Programmable I/O line or UART data output active high
15	PIO1/UART_RX	I	PD	Programmable I/O line or UART data input active high
16	PIO3/SF_DIN	I/O	-	Programmable I/O line
17	PIO4 SF_CS#	I/O	-	Programmable I/O line
18	PIO5/SPI_CLK	I/O	PD	Programmable I/O line or debug SPI CLK
19	PIO6/SPI_CSB	I/O	PD	Programmable I/O line or debug SPI CSB
20	PIO7/SPI_MOSI	I/O	PD	Programmable I/O line or debug SPI MOSI
21	PIO8/SPI_MISO	I/O	PD	Programmable I/O line or debug SPI MISO
22	VDD_PADS	Power	-	3.3V power input
23	PIO9	I/O	-	Programmable I/O line
24	PIO10	I/O	-	Programmable I/O line
25	PIO11	I/O	-	Programmable I/O line
26	SPIPION	I	-	Selects SPI debug(pull high) on PIO[5:8](pull low)
27	SCL	O	-	I^2C clock
28	SDA	I/O	-	I^2C data I/O
29	GND	GND	-	Ground
30	WAKE	I	-	Input to wake apm1010 from hibernate or dormant.
31	GND	GND	-	Ground
32	GND	GND	-	Ground

2 Absolute Maximum Rating

Symbol	Description	Min.	Max.	Units
T_{ST}	Storage temperature	-40	+85	°C
VDD_BAT	Battery input	+1.8	+3.6	V
VDD_PAD	I/O Supply voltage	-0.4	+3.6	V

*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
VDD_BAT	Battery input	+1.8	+3.3	+3.6	V
VDD_PAD	I/O Supply voltage	+1.2	+3.3	+3.6	V

3 RF Specification

3.1 Condition: VDD_BAT=VDD_PAD=+3.3V, T_{OP}=+25°C

3.1.1 Channel 0 (2402MHz)

Parameter		Min	Typ	Max	Bluetooth Spec.	Unit
Low Energy - Transmitter Test						
Maximum RF transmit power *(a)		4	5.5	7	Class1: 0 to +20 Class2: -6 to +4	dBm
Modulation Characteristic	Modulation index: Δf1avg	225	253.5	275	225 ≤ Δf1avg ≤ 275	kHz
	Modulation index: Δf2 avg	185	225.8	-	≥ 185	kHz
	Modulation index: Δf2avg / Δf1avg	0.8	0.89	-	≥ 0.8	NA
Initial carrier frequency tolerance		-40	1.7	+40	± 40	kHz
Carrier frequency drift rate		-20	-7	+20	± 20	kHz/50us
Carrier frequency drift: Max Drift		-	-5	50	≤50	kHz
Low Energy – Receiver Test						
Receiver sensitivity		-	-92	-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	%

3.1.2 Channel 18 (2442MHz)

Parameter	Min	Typ	Max	Bluetooth Spec.	Unit
Low Energy - Transmitter Test					
Maximum RF transmit power *(a)	4.5	6	7.5	Class1: 0 to +20 Class2: -6 to +4	dBm

Parameter		Min	Typ	Max	Bluetooth Spec.	Unit
Modulation Characteristic	Modulation index: Δf1avg	225	259	275	225 ≤ Δf1avg ≤ 275	kHz
	Modulation index: Δf2 avg	185	227	-	≥ 185	kHz
	Modulation index: Δf2avg / Δf1avg	0.8	0.87	-	≥ 0.8	NA
Initial carrier frequency tolerance		-40	1.7	+40	± 40	kHz
Carrier frequency drift rate		-20	-8	+20	± 20	kHz/50us
Carrier frequency drift: Max Drift		-	0	50	≤50	kHz
Low Energy – Receiver Test						
Receiver sensitivity		-	-92	-	≤-70	dBm
Receiver sensitivity - Frame Error Rate		-	0	-	≤30.8	%
PER Report Integrity - Frame Error Rate			50		50.0 ≤ PER ≤ 65.4	%

3.1.3 Channel 39 (2480MHz)

Parameter		Min	Typ	Max	Bluetooth Spec.	Unit
Low Energy - Transmitter Test						
Maximum RF transmit power *(a)		4.5	6	7.5	Class1: 0 to +20 Class2: -6 to +4	dBm
Modulation Characteristic	Modulation index: Δf1avg	225	256	275	225 ≤ Δf1avg ≤ 275	kHz
	Modulation index: Δf2 avg	185	226	-	≥ 185	kHz
	Modulation index: Δf2avg / Δf1avg	0.8	0.88	-	≥ 0.8	NA
Initial carrier frequency tolerance		-40	1.7	+40	± 40	kHz
Carrier frequency drift rate		-20	-10	20	± 20	kHz/50us
Carrier frequency drift: Max Drift		-	-6	50	≤50	kHz
Low Energy – Receiver Test						

Parameter	Min	Typ	Max	Bluetooth Spec.	Unit
Receiver sensitivity	-	-92	-	≤-70	dBm
Receiver sensitivity - Frame Error Rate	-	0	-	≤30.8	%
PER Report Integrity - Frame Error Rate		50		50.0 ≤ PER ≤ 65.4	%

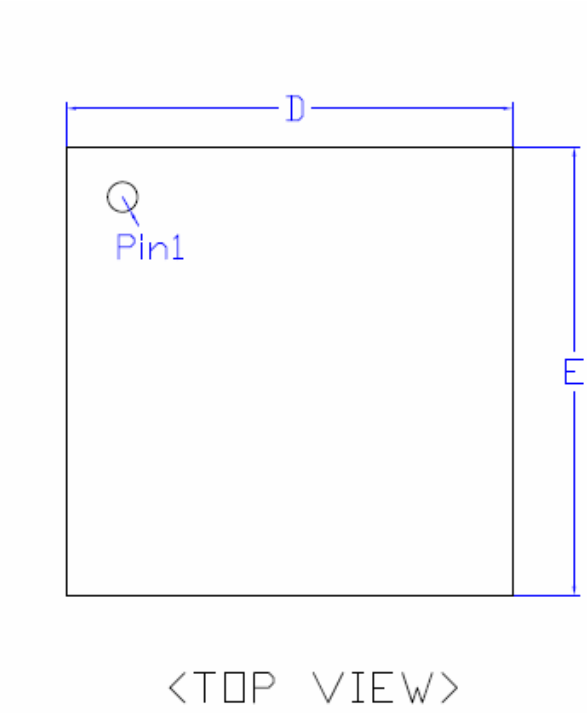
3.2 Bluetooth Current Consumption

Mode	Current Consumption (uA)
Fast advert 60ms	412
Slow advert 1.2s	24
Connected 10 16 100	14.6
Deep sleep	5

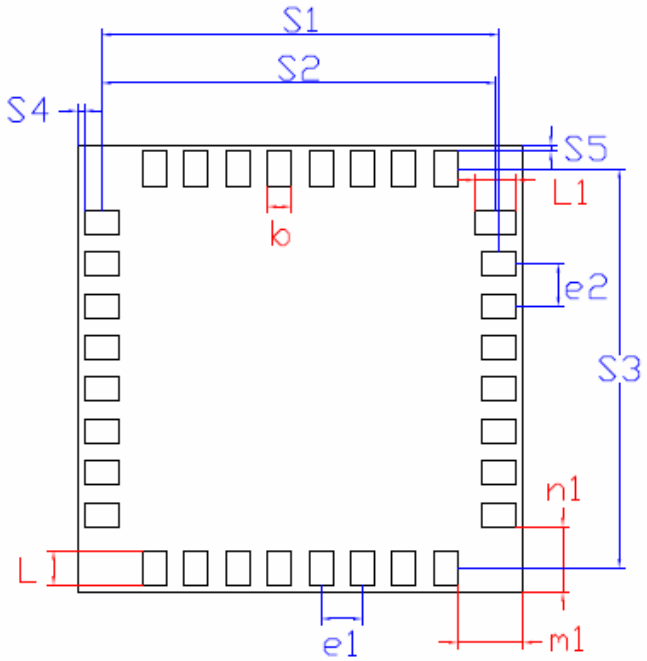
4 Mechanical Specification

Dimension	15×15×2.45 mm
Weight	0.6259 gram
Pinout	32
Antenna	External antenna support (Pin 2)

4.1 Package Outline



<TOP VIEW>



<BOTTOM VIEW>

<SIDE VIEW>

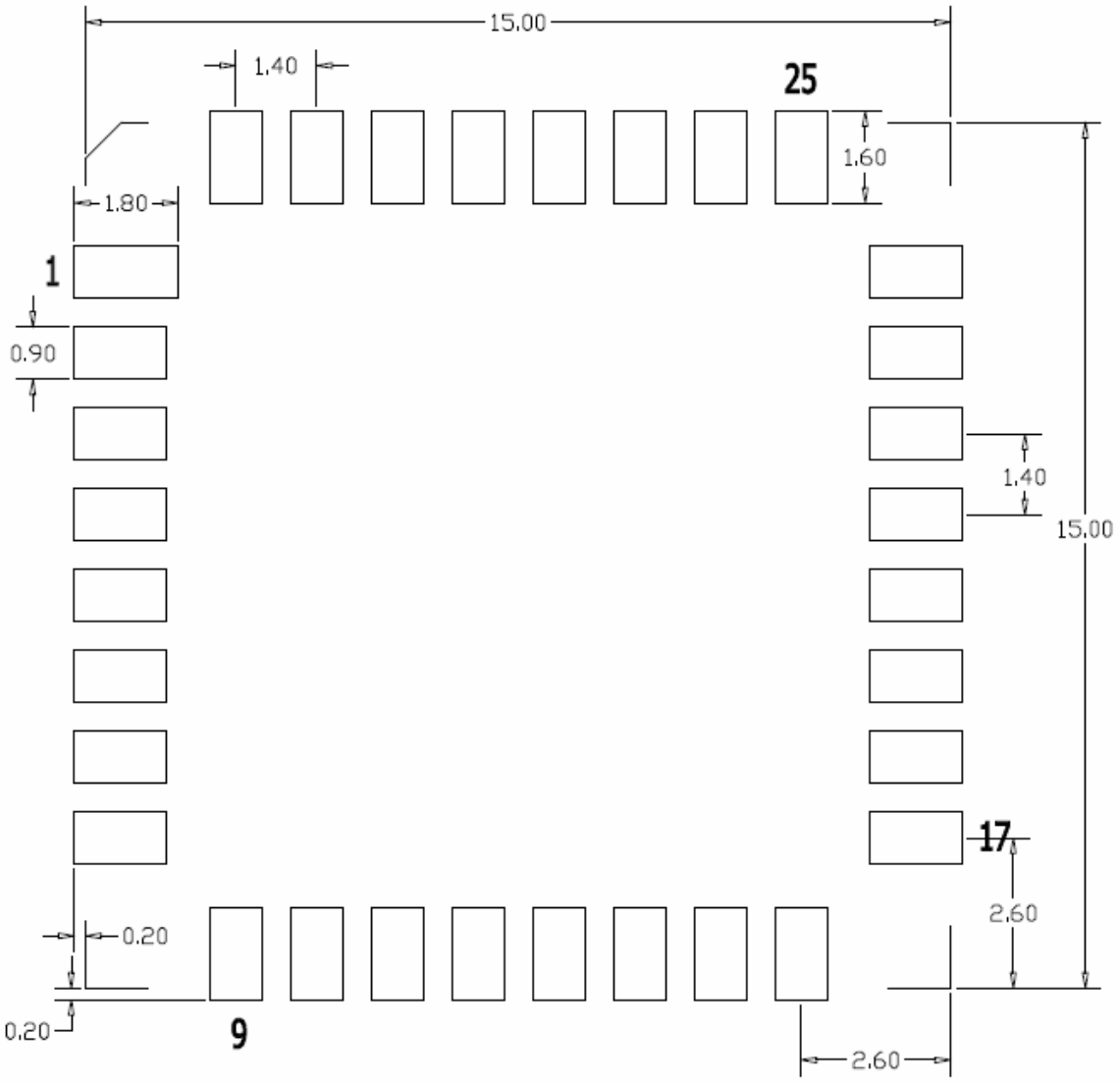
Unit:mm

Symbol	Min	Nor	Max
D	14.9	15.0	15.1
E	14.9	15.0	15.1
A	-	2.35	2.45
A1	-	0.6	0.7
m1	2.1	2.2	2.3
n1	2.1	2.2	2.3
e1	-	1.4	-
e2	-	1.4	-

Symbol	Min	Nor	Max
L	0.99	1.17	1.35
L1	1.16	1.37	1.60
b	0.68	0.80	0.92
S1	13.27	13.37	13.47
S2	13.17	13.27	13.37
S3	13.27	13.37	13.47
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)



Lead Pad

Unit: mm

PCB METAL LAND (TOP VIEW)

5.2 Baking condition recommendation before IR reflow

Baking condition for apm1010 module:

I: 125°C /4 hrs baking is necessary for apm1010 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.

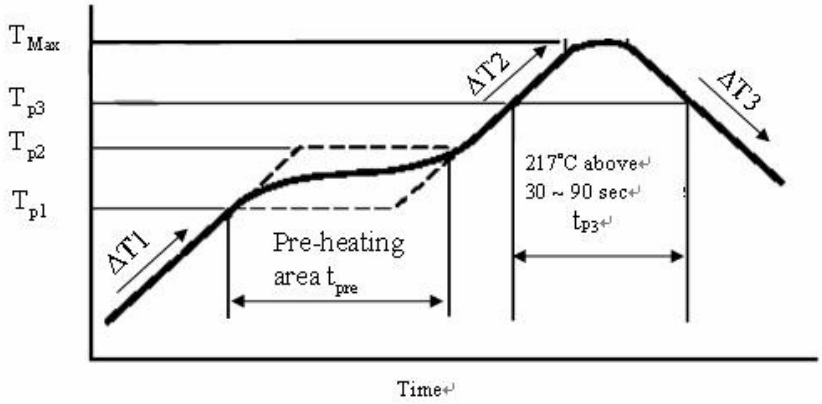
II: In the event that the sealed bag is damaged on receipt of the modules, the baking condition should be changed to 125°C /8 hrs.

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.