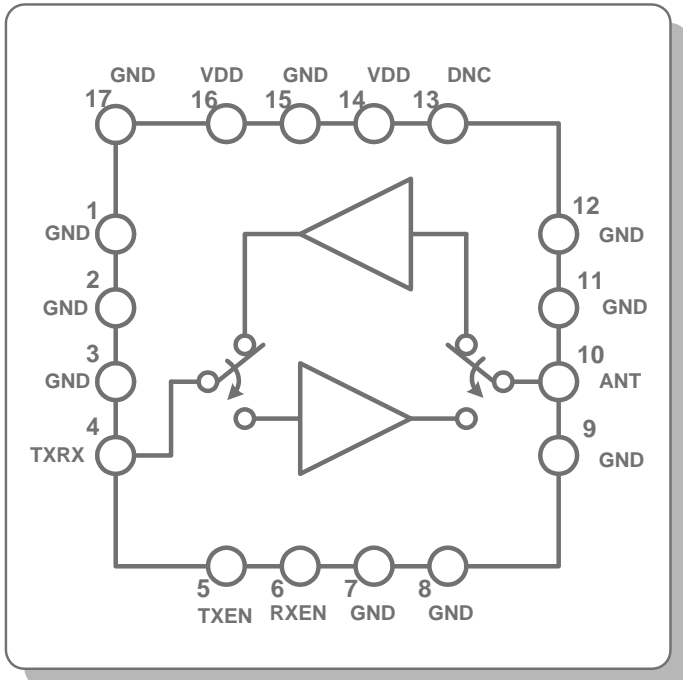# CMOS 2.4GHZ ZIGBEE/ISM TRANSMIT/RECEIVE RFeIC

Description

The RFX2401C is a fully integrated, single-chip, single-die RFeIC (RF Front-end Integrated Circuit) which incorporates all the RF functionality needed for IEEE 802.15.4/ZigBee, wireless sensor network, and any other wireless systems in the 2.4GHz ISM band. The RFX2401C architecture integrates the PA, LNA, Transmit and Receive switching circuitry, the associated matching network, and the harmonic filter all in a CMOS single-chip device.

Typical high power applications include home and industrial automation, smart power, and RF4CE among others. Combining superior performance, high sensitivity and efficiency, low noise, small form factor, and low cost, RFX2401C is the perfect solution for applications requiring extended range and bandwidth. RFX2401C has simple and low-voltage CMOS control logic, and requires minimal external components for system implementation.

Applications

- ZigBee Extended Range Devices
- ZigBee Smart Power
- Wireless Sound and Audio Systems
- Home and Industrial Automation
- Wireless Sensor Networks
- Custom 2.4GHz Radio Systems

## FEATURES

- 2.4GHz ZigBee High Power Single-Chip, Single-Die RF Front-End IC
- Combined TX / RX Transceiver Port and Single Antenna Port
- 2.4GHz Transmit High Power Amplifier with Low-Pass Harmonic Filter
- Low Noise Amplifier
- Transmit / Receive Switch Circuitry
- High Transmit Signal Linearity Meeting Standards for OQPSK Modulation
- Integrated Power Detector for Transmit Power Monitor and Control
- Low Voltage (1.2V) CMOS Control Logic

- ESD Protection Circuitry on All Ports
- DC Decoupled RF Ports
- Internal RF Decoupling on All VDD Bias Pins
- Low Noise Figure for the Receive Channel
- Very Low DC Power Consumption
- Full On-chip Matching and Decoupling Circuitry
- Minimal External Components Required
- 50-Ohm Input / Output Matching
- Market Proven CMOS Technology
- 3 x 3 x 0.55mm Small Outline QFN-16 Package with Exposed Ground Pad

PIN ASSIGNMENTS:

Pin Number	Pin Name	Description
4	TXRX	RF signal to / from the Transceiver: DC shorted to GND
5	TXEN	CMOS Input to Control TX Enable
6	RXEN	CMOS Input to Control RX Enable
10	ANT	RF Signal from the PA or RF Signal Applied to the LNA; DC Shorted to GND
1, 2, 3, 7, 8, 9, 11, 12, 15, 17	GND	Ground – Must be connected to Ground in the Application Circuit
13	DNC	Reserved – Do Not Connect in the Application Circuit
14	VDD	Alternative Voltage Supply Pin, internally connected to Pin 16, no connection needed
16	VDD	Voltage Supply Connection

PIN-OUT DIAGRAM:
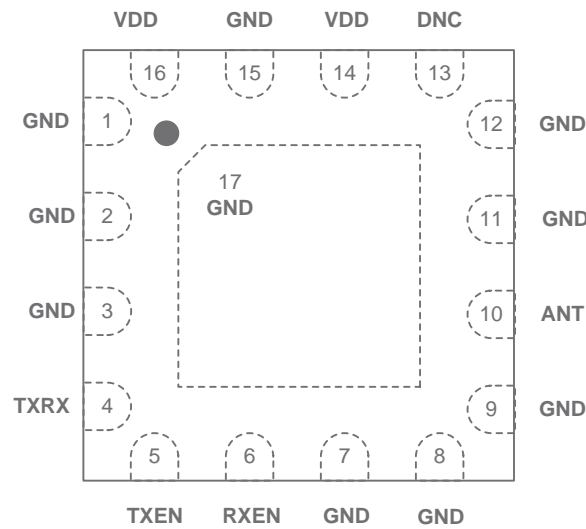
(Top View)

ABSOLUTE MAXIMUM RATINGS:

Parameters	Units	Min	Max	Conditions
DC VDD Voltage Supply	V	0	4.0	
DC Control Pin Voltage	V	0	3.6	Through 1Kohm resistor
DC VDD Current Consumption	mA		350	Through VDD Pins when TX is "ON"
DC Control Pin Current Consumption	µA		1	
TX RF Input Power	dBm		+5	All Operating Modes
ANT RF Input Power	dBm		+5	When RX is "ON"
Storage Ambient Temperature	^{o}C	-50	+125	No RF and DC Voltages Applied Appropriate care required according to JEDEC Standards

Note: Sustained operation at or above the Absolute Maximum Ratings for any one or combinations of the above parameters may result in permanent damage to the device and is not recommended. All Maximum RF Input Power Ratings assume 50-Ohm terminal impedance.

RECOMENDED OPERATING CONDITIONS:

Parameters	Units	Min	Typ	Max	Conditions
DC VDD Voltage Supply	V	2.0	3.3	3.6	All VDD Pins
Control Voltage "High"	V	1.2		VDD	Through 1Kohm resistor
Control Voltage "Low"	V	0		0.3	
Operating Ambient Temperature	^{o}C	-40		+85	

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TRANSMIT TECHNICAL PARAMETERS (VDD=3.3V; T=+25 ^{o}C)

Parameters	Units	Min	Typ	Max	Conditions
Operating Frequency Band	GHz	2.4		2.525	All RF Pins Terminated by 50 Ohm
Saturated Output Power	dBm		+22		
Small-Signal Gain	dB		25		
Second Harmonic	dBm/MHz		-15		P_{OUT} = +20dBm, IEEE 802.15.4 OQPSK modulation signal
Third Harmonic	dBm/MHz		-20		P_{OUT} = +20dBm, IEEE 802.15.4 OQPSK modulation signal
Input Return Loss	dB		-10		
Output Return Loss	dB		-8		
Input / Output Impedance Single-Ended	Ohm		50		
TX Quiescent Current	mA		17		No RF Applied
TX High Power Current	mA		100		P_{OUT} = +20dBm
Load VSWR for Stability (Pout=+20dBm)	N/A		6:1		All Non-Harmonically Related Spurs Less than -43dBm/MHz
Load VSWR for Ruggedness (Pout=+20dBm)	N/A		10:1		No Damage

RECEIVE TECHNICAL PARAMETERS (VDD=3.3V; T=+25 ^{o}C)

Parameters	Units	Min	Typ	Max	Conditions
Operating Frequency Band	GHz	2.4		2.525	All RF Pins Terminated by 50 Ohm
Gain	dB		12		
Noise Figure	dB		2.5		
Input Return Loss	dB		-12		
Output Return Loss	dB		-15		
RF Port Impedance	Ohm		50		
RX Quiescent Current	mA		10		No RF Applied
Input P_{1dB}	dBm		-8		At ANT Pin

STANDBY MODE TECHNICAL PARAMTERS:

Parameters	Units	Min	Typ	Max	Conditions
DC Shutdown Current	µA			1	
TXRX-ANT Insertion Loss (S21)	dB		-50		Pin < -20dBm
ANT-TXRX Insertion Loss (S21)	dB		-50		
Return Loss (S11)	dB		-1.5		From TXRX Port
Transmit-Receive Switching Time	nsec		800		
Shut-Down and "ON" State Switching Time	nsec		800		

CONTROL LOGIC TRUTH TABLE

TXEN	RXEN	Operating Conditions
1	X	TX Active
0	1	RX Active
0	0	Chip is Shut-down

Note: "1" denotes high voltage state (> 1.2V)
"0" denotes low voltage stage (<0.3V) at Control Pins
"X" denotes do not care: either "1" or "0" can be applied
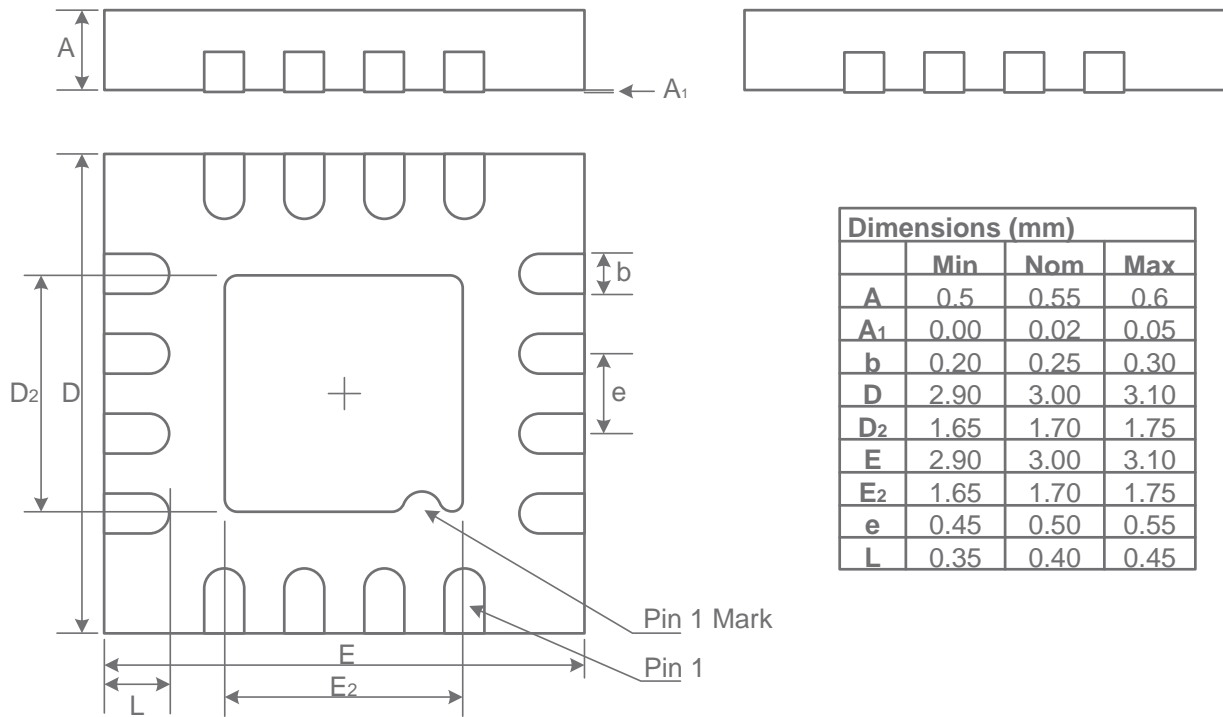
APPLICATION CIRCUIT GUIDELINES
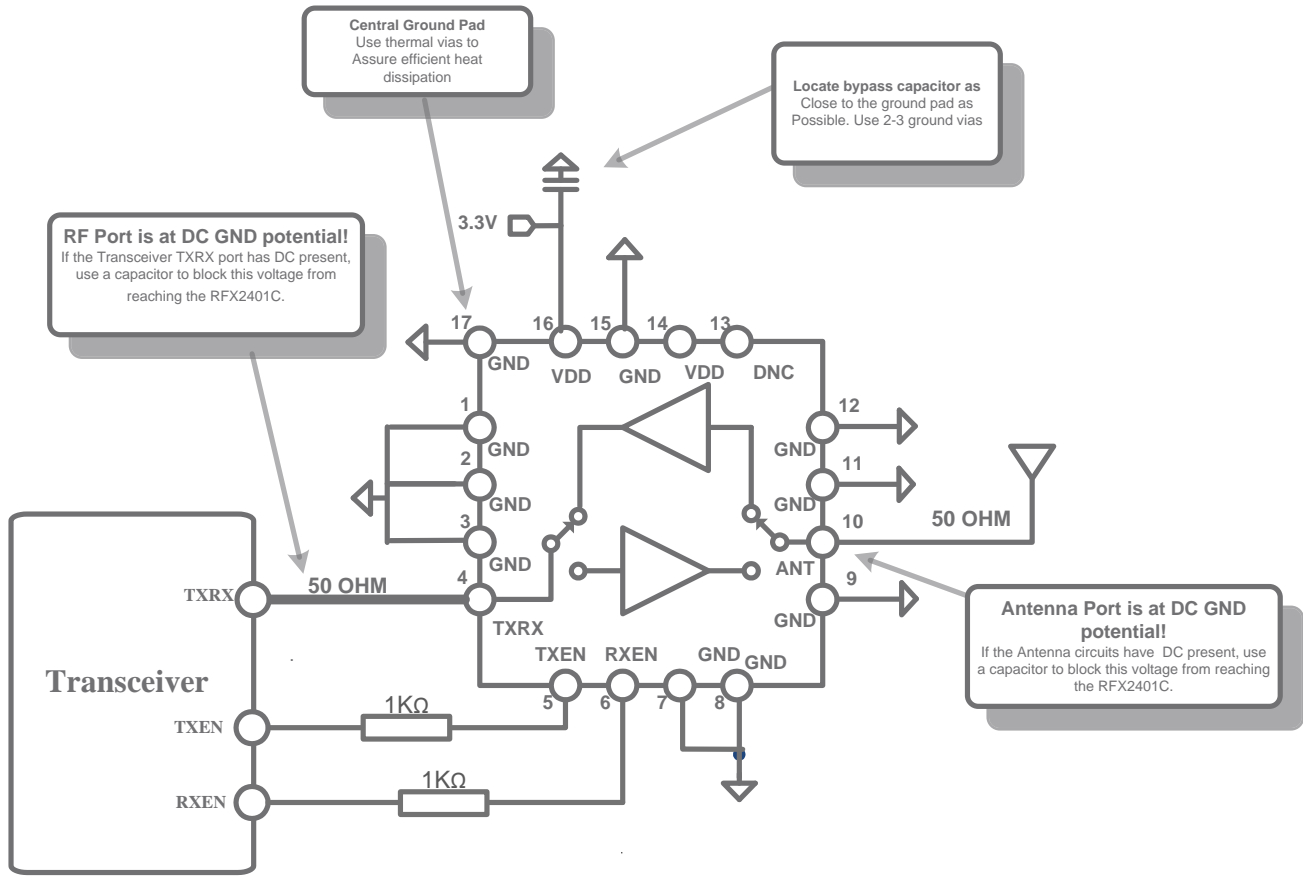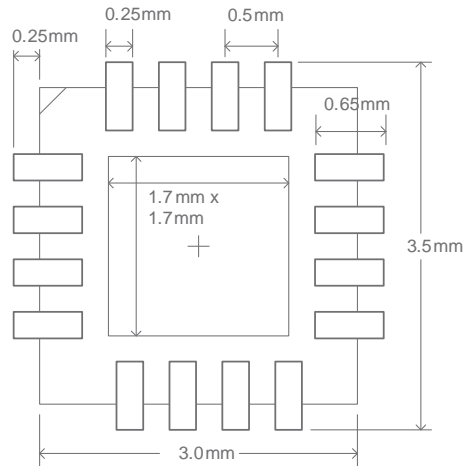
Central Ground Pad
Use thermal vias to
Assure efficient heat
dissipation

Locate bypass capacitor as
Close to the ground pad as
Possible. Use 2-3 ground vias

3.3V

RF Port is at DC GND potential!
If the Transceiver TXRX port has DC present,
use a capacitor to block this voltage from
reaching the RFX2401C.

| 17 | 16 | 15 | 14 | 13 |
| GND | VDD | GND | VDD | DNC |

1 GND
2 GND
3 GND
4 GND

12 GND
11 GND
10 ANT
9 GND

50 OHM

Transceiver

TXRX   50 OHM   TXRX

TXEN   1KΩ   TXEN   RXEN   GND GND
5   6   7   8

RXEN   1KΩ

Antenna Port is at DC GND potential!
If the Antenna circuits have DC present, use
a capacitor to block this voltage from reaching
the RFX2401C.

PCB LAND PATTERN

0.25mm   0.25mm   0.5mm   0.65mm

1.7 mm x 1.7mm

3.5mm

3.0mm

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PACKAGE DIMENSIONS:

Dimensions (mm)			
	Min	Nom	Max
A	0.5	0.55	0.6
A_1	0.00	0.02	0.05
b	0.20	0.25	0.30
D	2.90	3.00	3.10
D_2	1.65	1.70	1.75
E	2.90	3.00	3.10
E_2	1.65	1.70	1.75
e	0.45	0.50	0.55
L	0.35	0.40	0.45

Pin 1 Mark
Pin 1
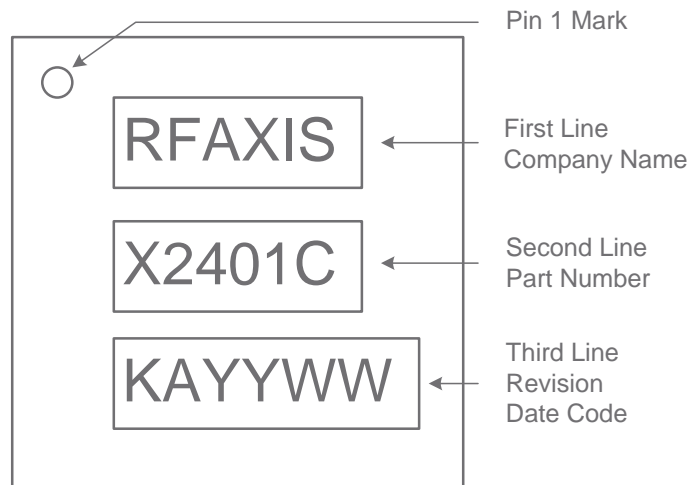
PACKAGE MARKING:

Pin 1 Mark

RFAXIS — First Line Company Name

X2401C — Second Line Part Number

KAYYWW — Third Line Revision Date Code

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TAPE AND REEL INFORMATION:
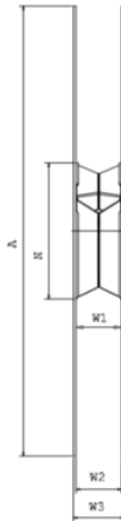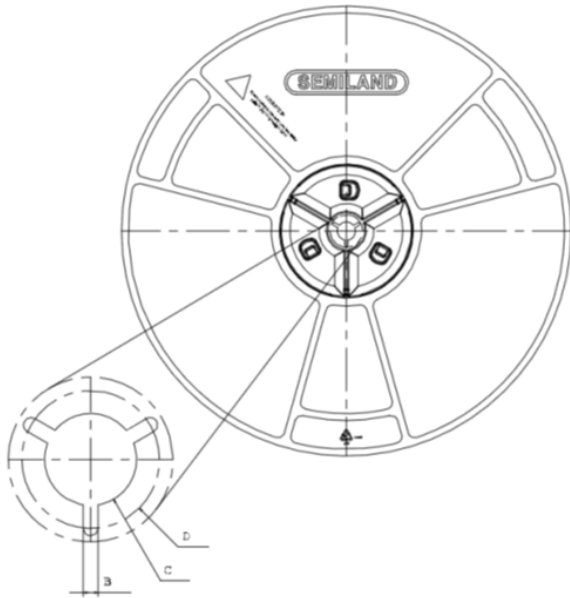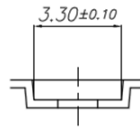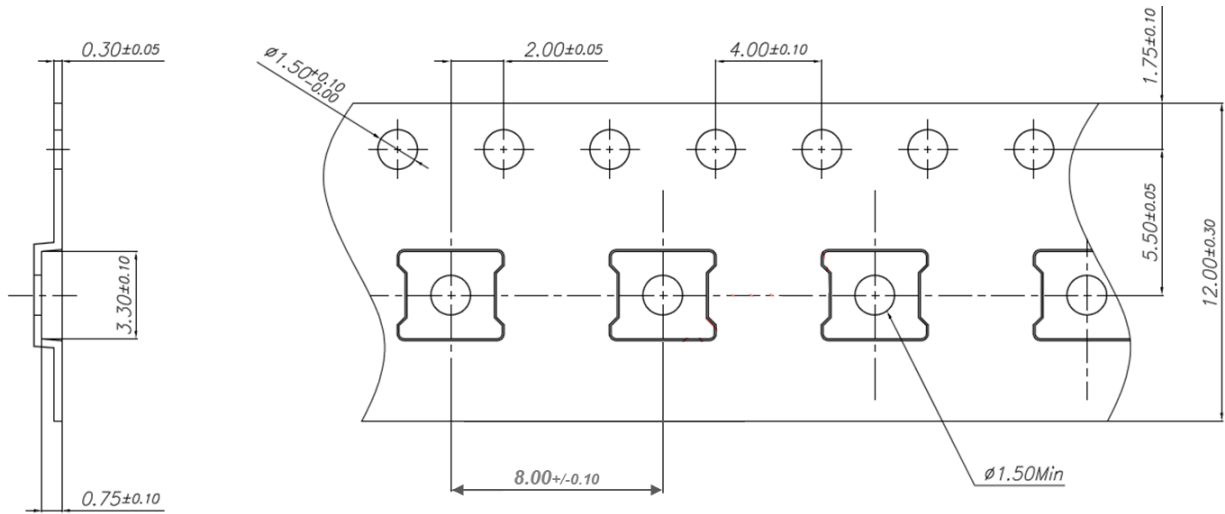
Size	12mm
A	$330^{+0.2}_{-2.0}$
B	1.5min
C	$13.0^{+0.5}_{-0.2}$
D	20.2min
N	$100^{+2.0}_{-0.0}$
W1	$12.4^{+3.0}_{-0.0}$
W2	$12.4^{+3.0}_{-0.0}$
W3	$16.4^{+2.0}_{-2.0}$
PART#	SRL-12134H

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RECOMMENDED SOLDER REFLOW PROFILE:
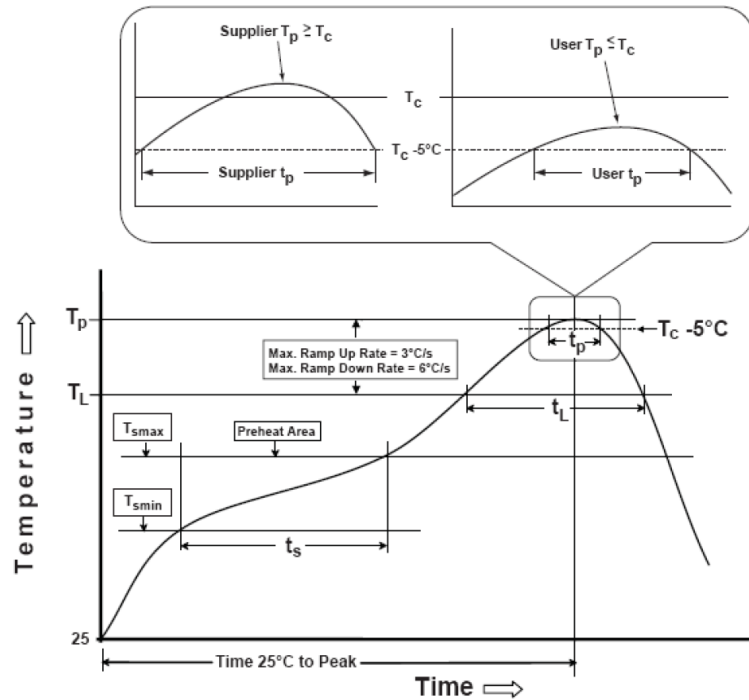
Profile Feature	Sn-Pb Eutectic Assembly	Pb-Free Assembly
Preheat/Soak Temperature Min (T_{smin}) Temperature Max (T_{smax}) Time (t_s) from (T_{smin} to T_{smax})	100 °C 150 °C 60-120 seconds	150 °C 200 °C 60-120 seconds
Ramp-up rate (T_L to T_p)	3 °C/second max.	3 °C/second max.
Liquidous temperature (T_L) Time (t_L) maintained above T_L	183 °C 60-150 seconds	217 °C 60-150 seconds
Peak package body temperature (T_p)	For users T_p must not exceed the Classification temp in Table 4-1. For suppliers T_p must equal or exceed the Classification temp in Table 4-1.	For users T_p must not exceed the Classification temp in Table 4-2. For suppliers T_p must equal or exceed the Classification temp in Table 4-2.
Time (t_p)* within 5 °C of the specified classification temperature (T_c), see Figure 5-1.	20* seconds	30* seconds
Ramp-down rate (T_p to T_L)	6 °C/second max.	6 °C/second max.
Time 25 °C to peak temperature	6 minutes max.	8 minutes max.
* Tolerance for peak profile temperature (T_p) is defined as a supplier minimum and a user maximum.		

SnPb Eutectic Process - Classification Temperatures (T_c)

Package Thickness	Volume mm³ <350	Volume mm³ ≥350
<2.5 mm	235 °C	220 °C
≥2.5 mm	220 °C	220 °C

Pb-Free Process - Classification Temperatures (T_c)

Package Thickness	Volume mm³ <350	Volume mm³ 350 - 2000	Volume mm³ >2000
<1.6 mm	260 °C	260 °C	260 °C
1.6 mm - 2.5 mm	260 °C	250 °C	245 °C
>2.5 mm	250 °C	245 °C	245 °C

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