Product utilizing with SESUB Technology

[SESUB : Semiconductor Embedded in SUBstrate]

Bluetooth V4.0 Low Energy Module

Type : SESUB-PAN-T2541

NAME OF DRAWING	DRAWING NO	DATE	REV	PAGE
Preliminary Specification	XL-07-95-SES-935	2014.11.1	1	1

Features

- **General**
  - Bluetooth V4.0 Low Energy Module, its size of 4.6mm x 5.6mm x 1.0mm, only possible using TDK proprietary SESUB technology embedding Texas Instruments CC2541 semiconductor and integrating the function required components.
  - Space saving, <26mm^2 total package size compared with 36mm^2 as discrete solution.
  - Module Height of 1.0mm (typ).
  - 36 user pins with center GND pads, 0.5mm pad pitch with solder bumped LGA.
  - Complete module solution allowing just plug and play to the antenna, giving the designers more flexibility in small area solutions
  - All development tools provided from Texas Instruments for discrete CC2541 package IC can be used for this module without any modification.
  - Embedded Bluetooth-Stack from Texas Instruments available.

- **RF**
  - 2.4GHz Bluetooth Low Energy Mode.
  - Programmable Output Power up to 0 dBm.
  - Accurate Digital RSSI Support.

- **Microcontroller**
  - High-Performance and Low-Power 8051 Microcontroller Core with Code Prefetch.
  - 256KB of In-System-Programmable Flash.
  - 8KB RAM.

- **Peripherals**
  - Five-Channel DMA.
  - General-Purpose Timers (One 16-bit, Two 8-bit).
  - I2C Interface.
  - 32kHz Sleep Timer with Capture.
  - Battery Monitor and Temperature Sensor.
  - 12-bit ADC with Eight channels and Configurable Resolution.
  - AES Security Coprocessor.
  - Two UARTs with supporting for Several Serial Protocols.
  - Total 23 General Purpose I/O Pins (21 x 4mA, 2 x 20mA output current capable).
  - Watchdog Timer.
  - Integrated High-Performance Comparator.

- **Applications**
  - Human-Interface Devices (Keyboard, Mouse, Remote Control).
  - Sports and Leisure Equipment.
  - Fitness / Healthcare Products
  - Sensor Monitoring Products
  - Gaming
  - Wearable Products
  - Mobile Phone Accessories
  - Digital Consumer Electronics

Block Diagram

The module block diagram is shown in Figure 1.

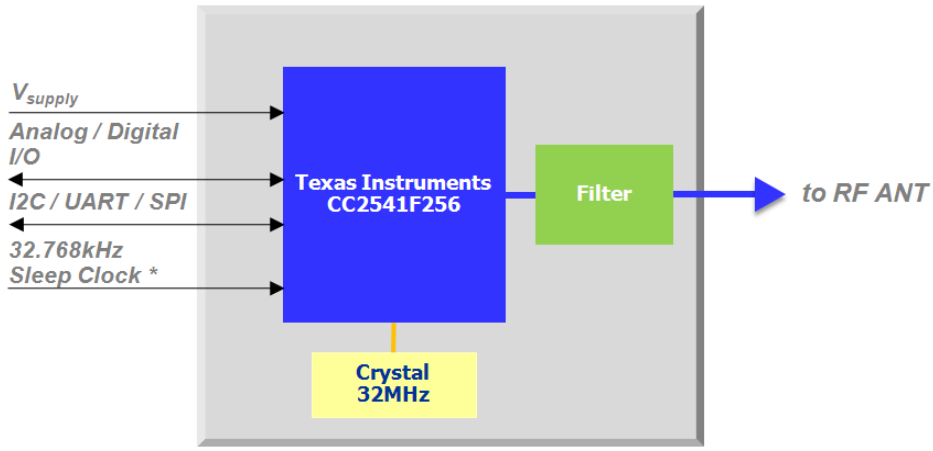


Figure 1 Module Block Diagram

Remark *

External 32.768 kHz crystal or external 32.768 kHz clock input from other device can be used.

Schematic

The module Schematic is shown in Figure 2.

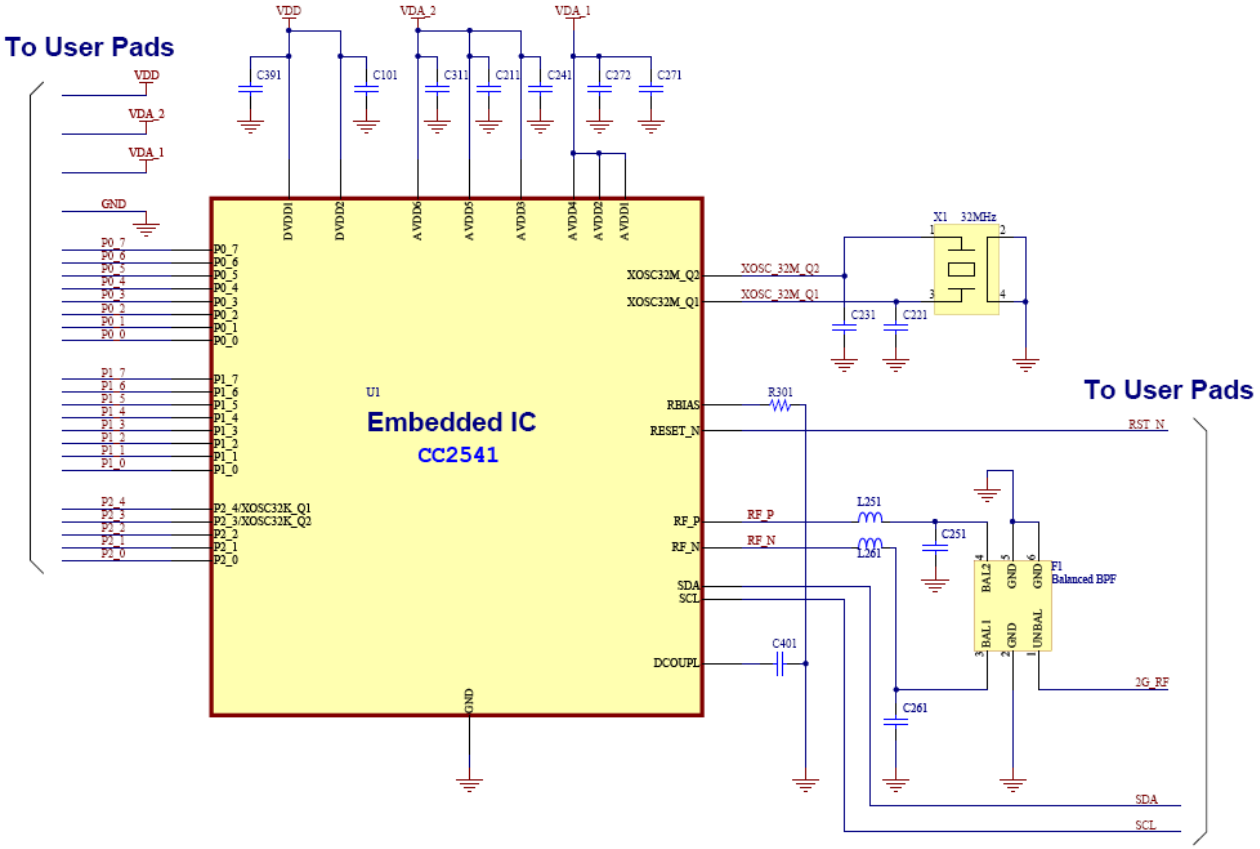


Figure 2 Module Schematic

Absolute Maximum Ratings

Over operating room temperature range (unless otherwise noted)

Item	VALUE	UNIT
Supply voltage range	-0.3 to 3.9	V
Voltage range to any of digital pins	-0.3 to VDD + 0.3, <3.9	V
Storage temperature range	-40 to +85	℃
Radio input power level	+10	dBm
ESD (Charged Device Model)	500	V
ESD (Human Body Model)	1000	V

Operating Conditions

Over operating room temperature range (unless otherwise noted)

Item	Min	Typ	Max	UNIT
Supply voltage range	2.0		3.6	V
Operational temperature range	-20		+70	℃

Electrical Characteristics

Measured on SP13801 EM board with the condition of Ta=25℃+/-10℃ and VDD = 3V

PARAMETER	Conditions	Value			UNIT
		Min	Typ	Max	
Rx mode Current	RF input PWR level: -70dBm Packet type: RF_PHY_TEST Payload Data Pattern: PRBS9 Payload Data Length: 37bytes		19.8		mA
Tx mode Current	RF output PWR level: 0dBm Payload Data Pattern: PRBS9 Payload Data Length: 37bytes		20.6		mA
Standby mode Current	PM2 (Sleep Timer On) *refer IC datasheet in detail*		1.2		μA

General RF Characteristics

Measured on SP13801 EM board with the condition of Ta=25℃+/-10℃ and VDD = 3V

PARAMETER	Conditions	Value			UNIT
		Min	Typ	Max	
Center Frequency		2402		2480	MHz
Channel Spacing			2		MHz
RF Port Impedance			50		Ohm

RF Characteristics

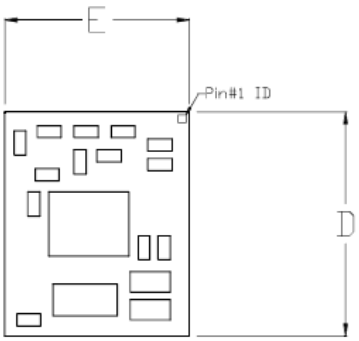
Measured on SP13801 EM board with the condition of Ta=25℃+/-10℃ and VDD = 3V

fc=2440MHz

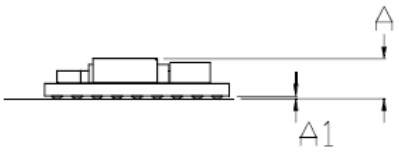
PARAMETER	Conditions	Value			UNIT
		Min	Typ	Max	
Tx Output Power	Maximum output power setting	-6	0	-	dBm
Tx Frequency accuracy	Maximum output power setting XOSC32M_TUNE[3:0]= 0x0F	-150	0	+150	kHz
Tx modulation characteristics					
Delta F1		225		275	kHz
Delta F2/F1		0.8			-
Delta F2 Max		99.9			%
Receiver Sensitivity max input level [measured by Packet Error Rate]	Packet error rate : ≤ 30.8%	-10			dBm
Receiver Sensitivity level [measured by Packet Error Rate]	Packet error rate : ≤ 30.8%			-70	dBm

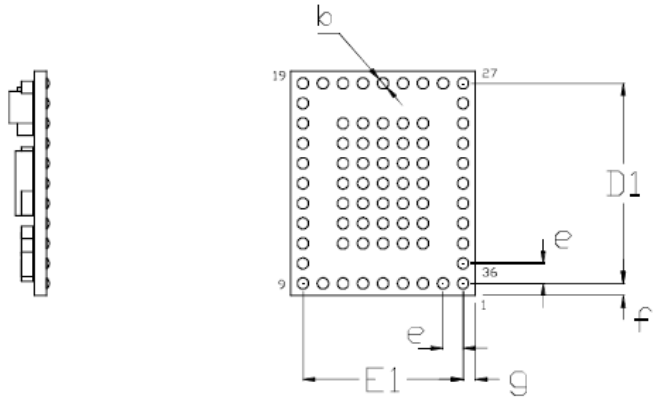
Mechanical Dimensions

The module mechanical dimensions are shown in Figure 3.



TOP VIEW





BTTOM VIEW

Symbol	Dimmension in mm		
	MIN	TYP	MAX
A		1.0	1.2
A1	---	(0.06)	---
b	---	ø0.28	---
D	5.5	5.6	5.7
E	4.5	4.6	4.7
D1		5.0	
E1		4.0	
e		0.5	
f	---	0.3	---
g	---	0.3	---

Figure 3 Module Mechanical Dimensions

Module Pin-Out

The module Pin-Out and names are shown in Figure 4 and Table 1.

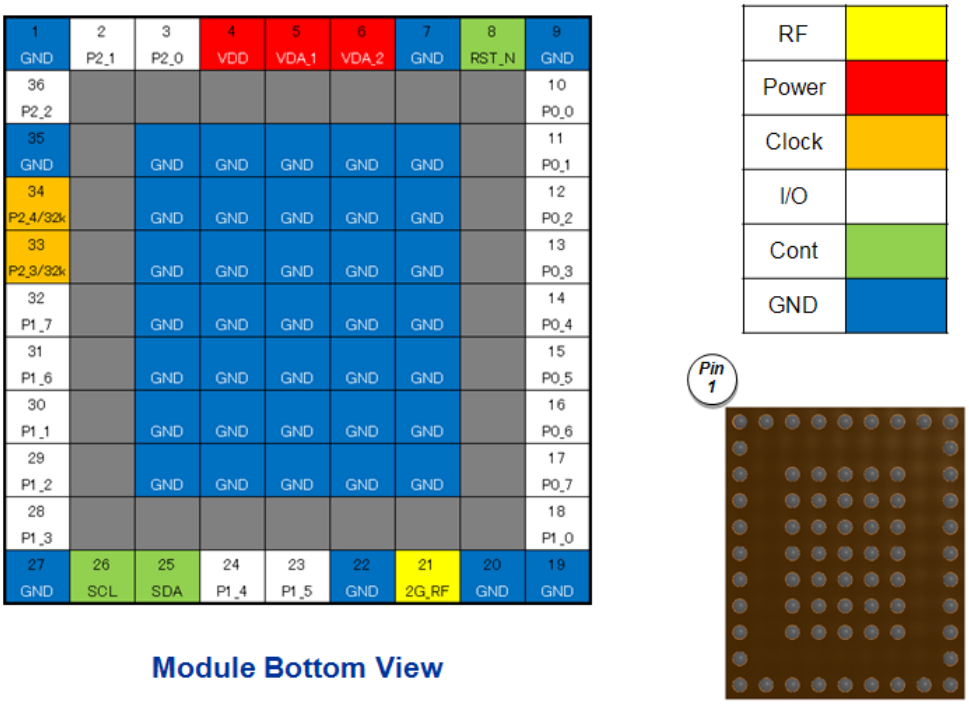


Figure 4 Module Pin-Out & Color Definition

Table 1 PIN Descriptions

Pin Nr	Pin Name	Pin Type	Description
1	GND	Ground	Connect to Ground
2	P2_1/DD	Digital I/O	Port2.1 / Programming I/F DD
3	P2_0	Digital I/O	Port2.0
4	VDD	Power	2V-3.6V digital power supply
5	VDA_1	Power	2V-3.6V analog power supply
6	VDA_2	Power	2V-3.6V analog power supply
7	GND	Ground	Connect to Ground
8	RST_N	Digital I/O	Reset in active low
9	GND	Ground	Connect to Ground
10	P0_0	Digital I/O	Port0.0
11	P0_1	Digital I/O	Port0.1
12	P0_2	Digital I/O	Port0.2 / UART RX / SPI MISO
13	P0_3	Digital I/O	Port0.3 / UART TX / SPI MOSI
14	P0_4	Digital I/O	Port0.4 / UART CTS / SPI CS
15	P0_5	Digital I/O	Port0.5 / UART RTS / SPI CLK
16	P0_6	Digital I/O	Port0.6

Pin Nr	Pin Name	Pin Type	Description
17	P0_7	Digital I/O	Port0.7
18	P1_0	Digital I/O	Port1.0 – 20mA drive capability
19	GND	Ground	Connect to Ground
20	GND	Ground	Connect to Ground
21	2G_RF	RF I/O	Connect to RF antenna
22	GND	Ground	Connect to Ground
23	P1_5	Digital I/O	Port1.5
24	P1_4	Digital I/O	Port1.4
25	SDA	Digital I/O	I2C SDA // Leave floating if not used.
26	SCL	Digital I/O	I2C SCL // Leave floating if not used.
27	GND	Ground	Connect to Ground
28	P1_3	Digital I/O	Port1.3
29	P1_2	Digital I/O	Port1.2
30	P1_1	Digital I/O	Port1.1 – 20mA drive capability
31	P1_6	Digital I/O	Port1.6
32	P1_7	Digital I/O	Port1.7
33	P2_3/32k-1	I/O / Clock	Port2.3 / 32.768kHz crystal1
34	P2_4/32k-2	I/O / Clock	Port2.4 / 32.768kHz crystal2
35	GND	Ground	Connect to Ground
36	P2_2/DC	Digital I/O	Port2.2 / Programming I/F DC

Table 2 Peripheral I/O Pin Mapping

Periphery/ Function	P0								P1								P2				
	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	4	3	2	1	0
ADC	A7	A6	A5	A4	A3	A2	A1	A0													T
Operational amplifier						O	–	+													
Analog comparator			+	–																	
USART 0 SPI			C	SS	MO	MI															
Alt. 2											M0	MI	C	SS							
USART 0 UART			RT	CT	TX	RX															
Alt. 2											TX	RX	RT	CT							
USART 1 SPI			MI	M0	C	SS															
Alt. 2									MI	M0	C	SS									
USART 1 UART			RX	TX	RT	CT															
Alt. 2									RX	TX	RT	CT									
TIMER 1		4	3	2	1	0															
Alt. 2	3	4												0	1	2					
TIMER 3												1	0								
Alt. 2									1	0											
TIMER 4															1	0					
Alt. 2																		1			0
32-kHz XOSC																	Q1	Q2			
DEBUG																			DC	DD	
OBSSEL											5	4	3	2	1	0					

Notes:

This table is referred from the “CC2541 User Guide” (swru191). See description about I/O Pins in section 7. SESUB-PAN-T2541 has same I/O Pin structure with CC2541 SoC.

Module Pick & Place Point

This module can be handled at the area where shown in red colored break during assembling.
The area is 2.0x1.6mm. (Picking up with top of the crystal Unit)

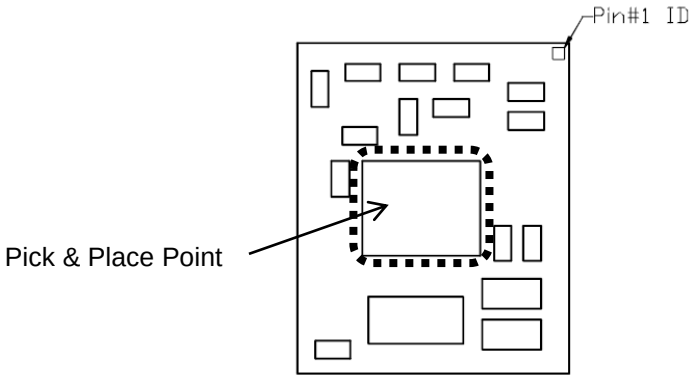


Figure 6 Module Pick & Place Point

Marking

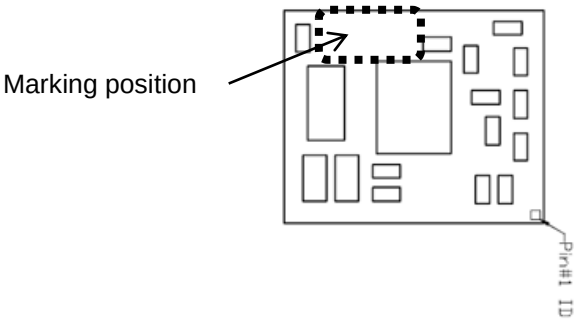


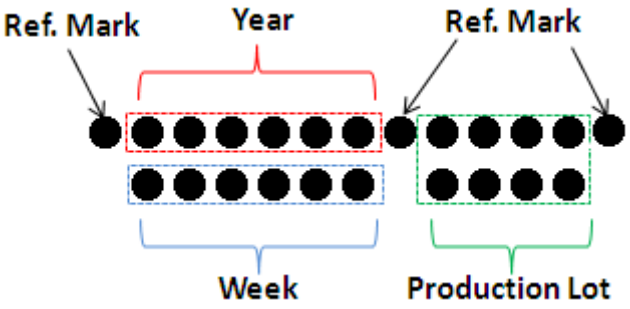
Figure 7 Module Marking Position

	Dot					
Year (Last 2 digits)	● 1	● 2	● 4	● 8	● 16	● 32

	Dot					
Week	● 1	● 2	● 4	● 8	● 16	● 32

	Dot			
Production Lot	● 1	● 2	● 4	● 8
	● 16	● 32	● 64	● 128

(Maximum Production = 225 Lots)



Example

Year : 2013

Week : 45

Production Lot : 25

Figure 8 Module lot code

Recommended PWB Footprint

The recommended PWB foot print for the module is shown in Figure 9.

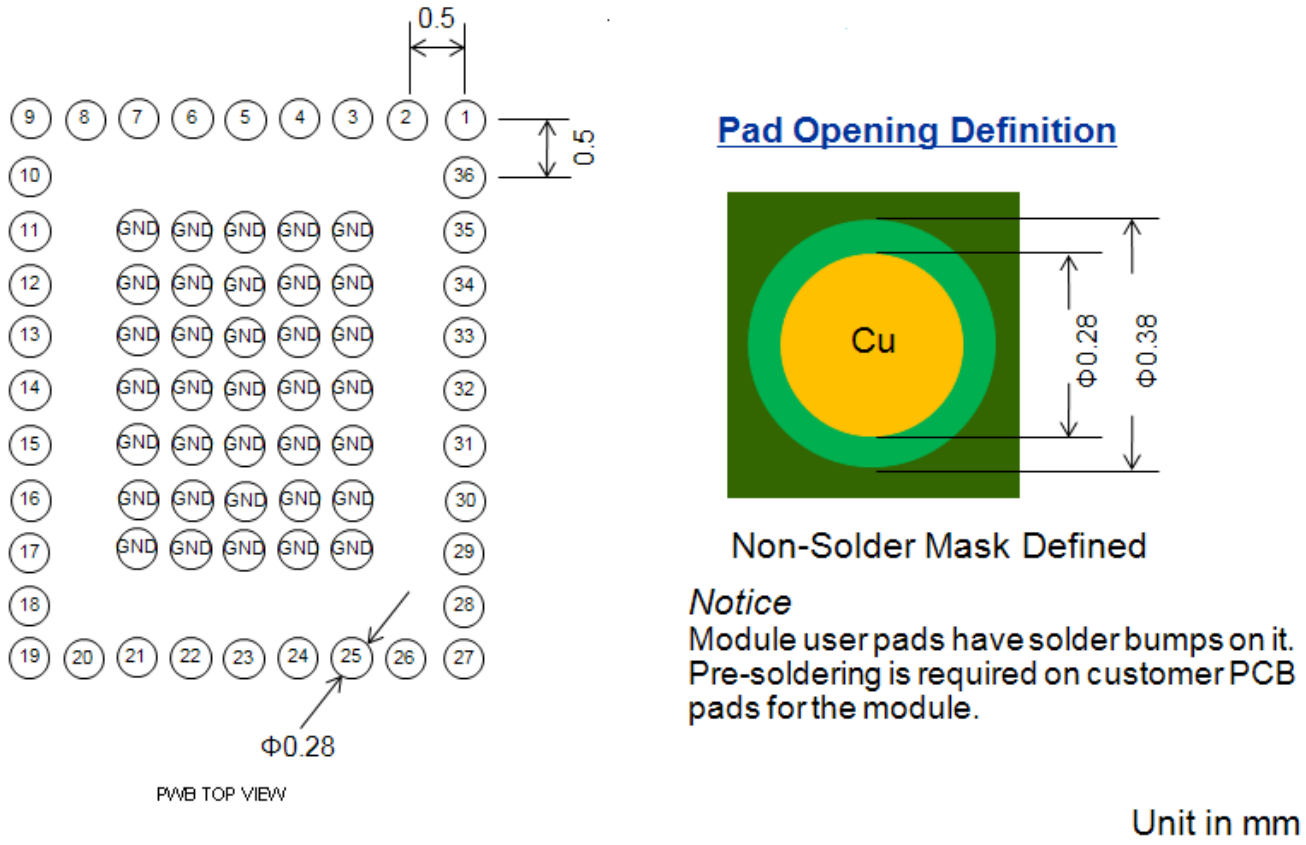


Figure 9 Recommended PWB Footprints

Recommended Metal Mask Design

The recommended metal mask design for the module is shown in Figure 10.

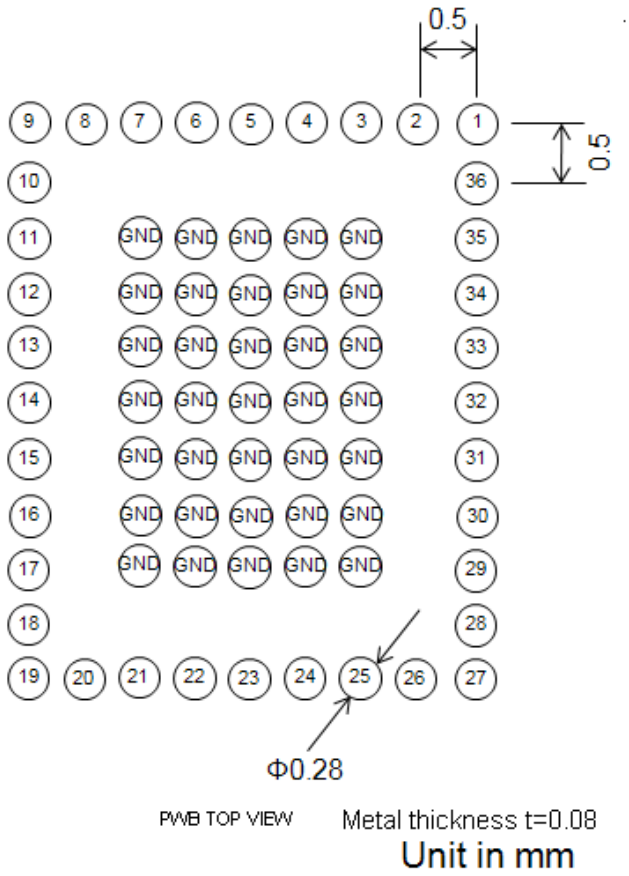


Figure 10 Recommended Metal Mask Design

Recommended Reflow Profile

The recommended reflow profile for the module is shown in Figure 11.

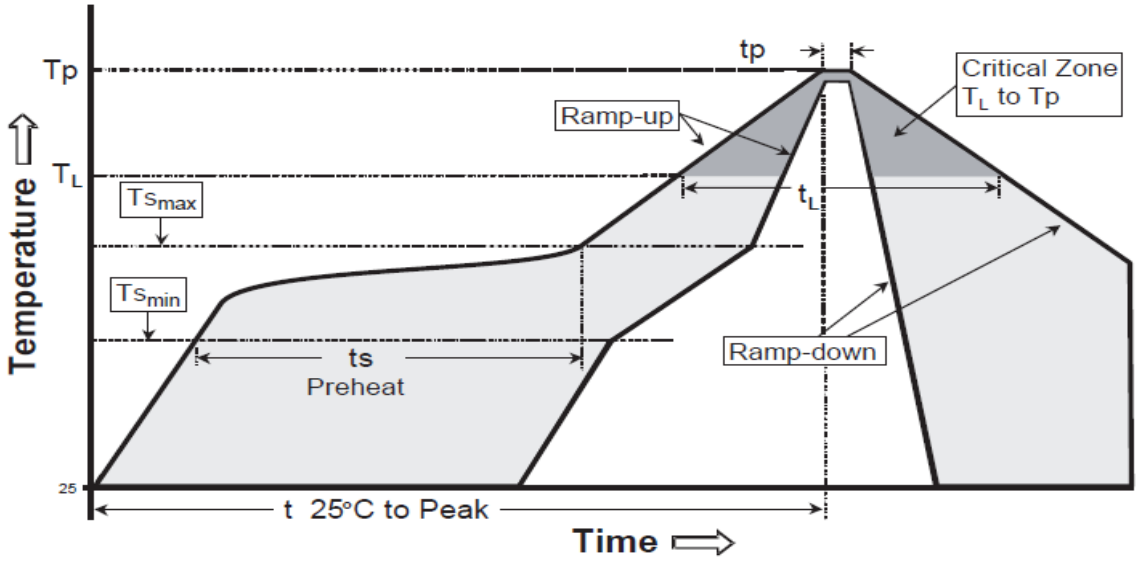


Figure 11 Recommended Reflow Profile

Table 4 Reflow Profile Condition

Profile Feature	Range
Average Ramp-Up Rate (Ts_{max} to Tp)	0.8 °C/seconds
Preheat: -Temperature Min (Ts_{min}) -Temperature Max (Ts_{max}) -Time (ts_{min} to ts_{max})	 150 °C 180 °C 100 +/-10 seconds
Time maintained above: -Temperature (T_L) -Time (t_L)	 220 °C 50 +/-10 seconds
Peak Temperature (Tp)	250 °C
Time within 5°C of actual Peak Temperature (tp)	20-40 seconds
Ramp-Down Rate	6 °C/seconds max.
Time 25°C to Peak Temperature	8 minutes max.

Note:

Solder material used in this product: M705-GRN260K2KJ-V (Senjyu Metal Industry Co., Ltd.)

Permissible maximum reflow cycle: 2

Tape & Reel Specifications

Reel Diameter: 180 mm
Reel Width 13.0mm
Reel Hub Diameter: 21mm
Qty/reel: 1000 pcs

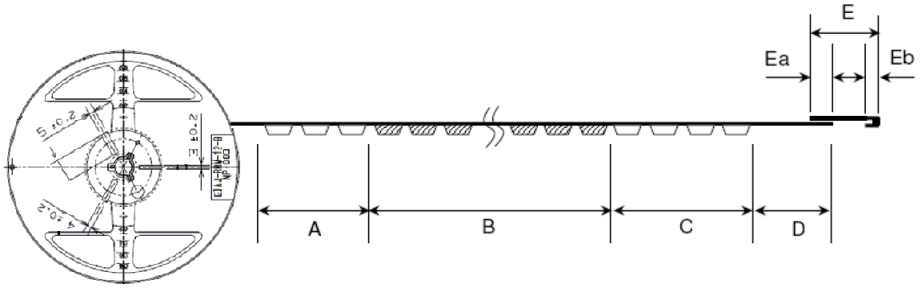


Figure 12 Tape & Reel Definition

Table 5 Taping Length

A	B	C	D	E
Ending pockets	Products pockets	Front pockets	Cover tape	Stop Tape
40mm min	1000pcs	100mm min	250mm min	50mm
		350mm min		70mm

Ea=20mm typ, Eb=10mm typ.

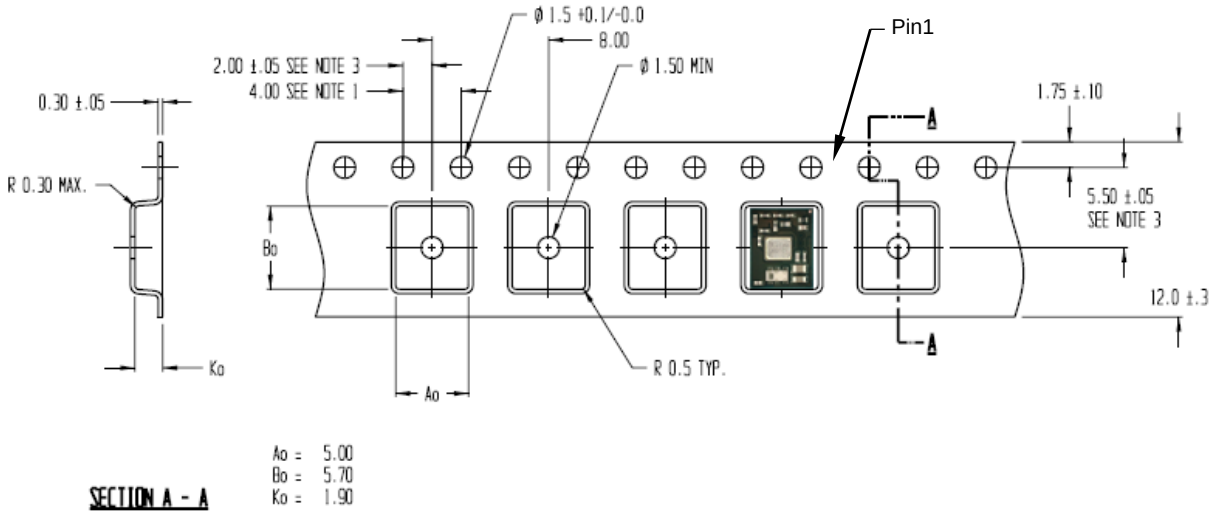


Figure 13 Carrier Tape Dimension

Notes:

1) 10 Sprocket hole pitches cumulative tolerance +/-0.2.
2) Pocket position relative to sprocket hole measured as true position, not pocket hole
3) Ao and Bo are calculated on a plane at a distance “R” above the bottom of the pocket.

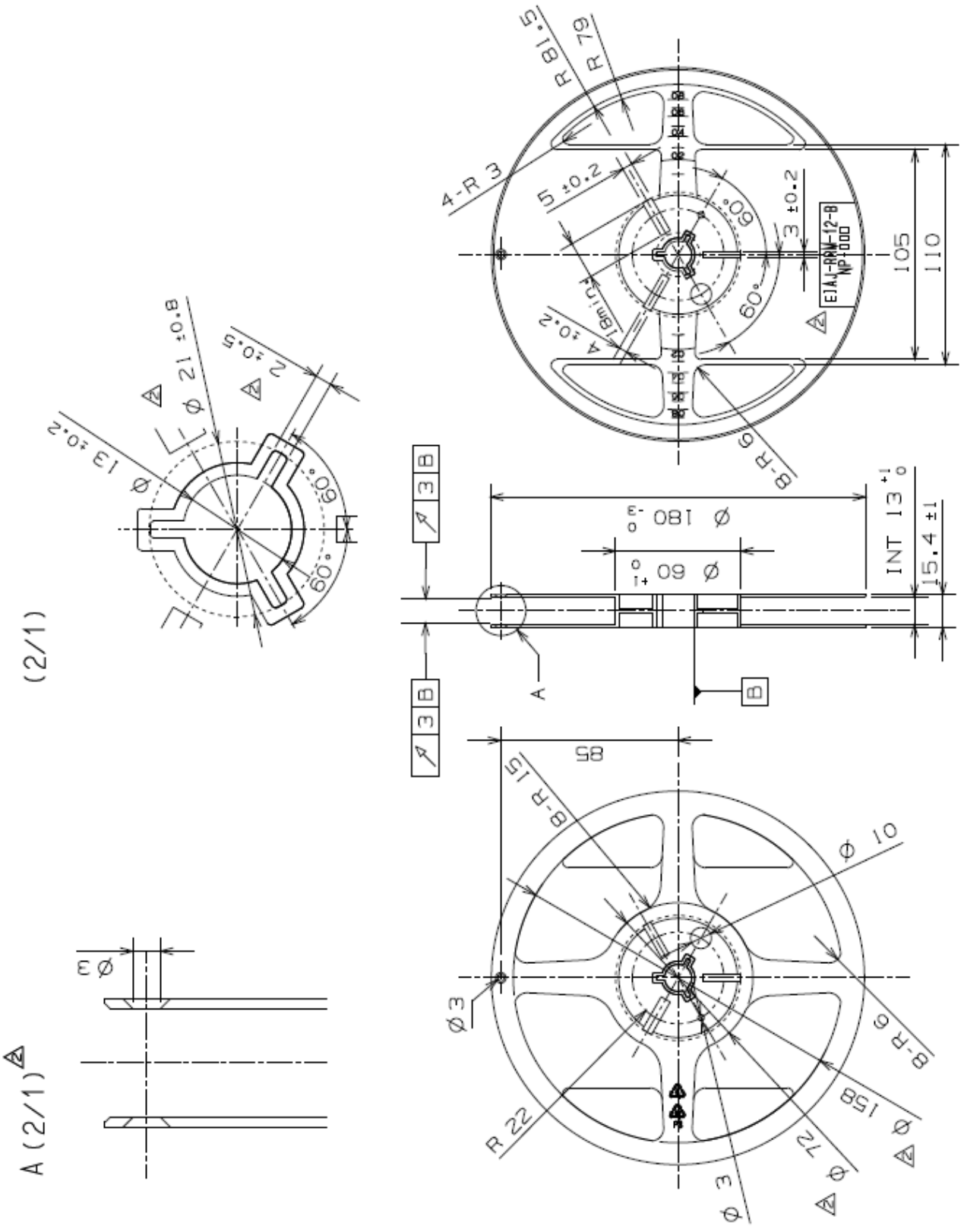


Figure 14 Emboss Definition

Packing Label Specifications

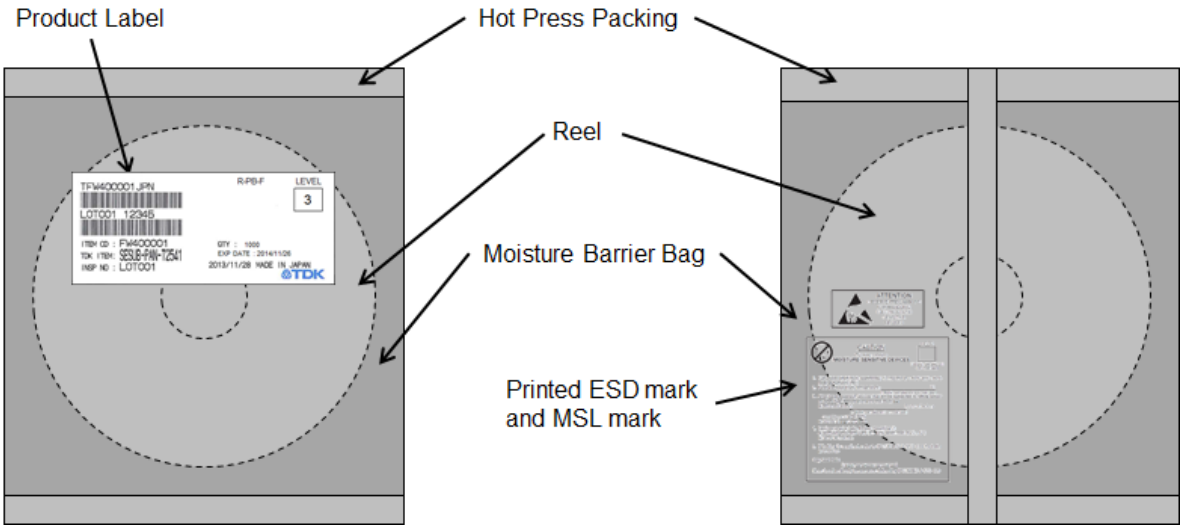
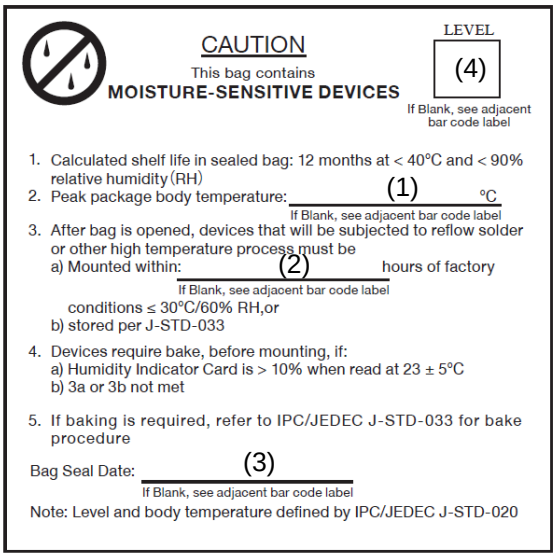


Figure 15 Packing Form

Storage Condition : 5-30℃ / 40-60%RH

The guaranteed term until mounting is 12 months in the above condition.

Figure 16 Product Label (Example)



Items	Example
(1) Max Temperature	260
(2) Guarantee time after opening MBB	168
(3) Processing time	2013/11/27
(4) MSL Level	3

Figure 17 Packing Print (Example)

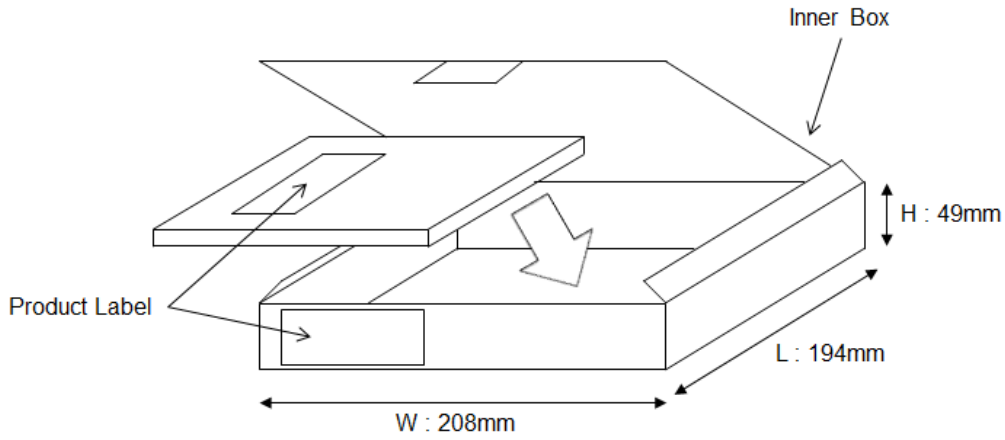


Figure 18 Inner Box

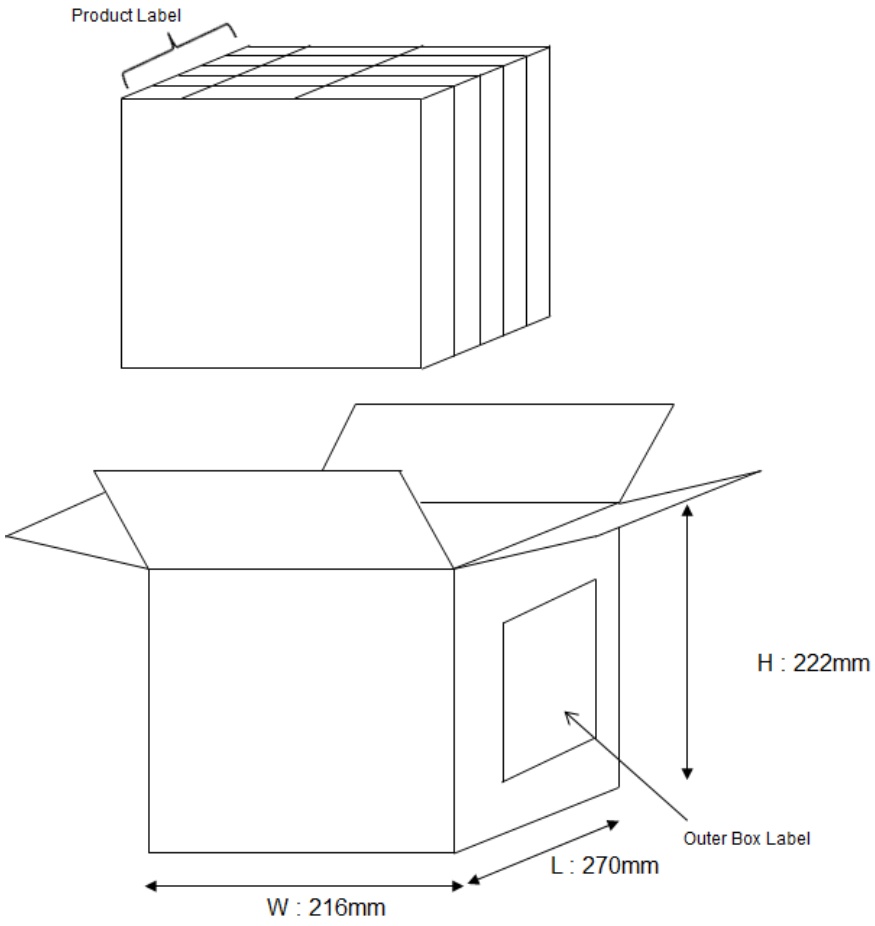


Figure 19 Outer Box

Reference Information

1. Bluetooth Core Technical Specification document, version 4.0
   http://www.bluetooth.com/SiteCollectionDocuments/Core_V40.zip

2. Texas Instruments CC2541 2.4GHz Bluetooth Low Energy System-on-Chip Datasheet (swrs110c)

3. Texas Instruments CC2541 System-on-Chip Solution for 2.4GHz Bluetooth low energy Applications User's Guide (swru191d)

4. Texas Instruments CC2540DK, Development Kit as of evaluation base board for SP13801
   http://www.ti.com/tool/cc2540dk

5. Texas Instruments SmartRF05 Evaluation Board User Guide (swru210a)
   http://www.ti.com/lit/ug/swru210a/swru210a.pdf

6. Texas Instruments CC2541EMK, CC2541 evaluation Module Kit
7. http://www.ti.com/tool/cc2541emk

8. Texas Instruments Bluetooth Low Energy Software Development Kit (SDK)
   http://www.ti.com/tool/ble-stack

9. Texas Instruments SmartRF Studio
   http://focus.ti.com/docs/toolsw/folders/print/smartrftm-studio.html

10. IAR Embedded Workbench for 8051 devices programming
    http://www.iar.com

11. For all other related technical documents, visit Texas Instruments Low-Power RF web site.
    http://www.ti.com/lprf-forum
    http://www.ti.com/lprfnetwork

Lead-free Product Status

Conformity to RoHS Directive: This means that, in conformity with EU Directive 2002/95/EC, lead, cadmium, mercury, hexavalent chromium, and specific bromine-based flame retardants, PBB and PBDE, have not been used except for exempted applications.

Legal Description

For further information please contact your local TDK sales office or visit our webpage at www.tdk.com .
Published by TDK Corporation

For questions on technology, prices and delivery please contact the Sales Offices of TDK Corporation or the international Representatives.

Due to technical requirements components may contain dangerous substances. For information on the type in question please also contact one of our Sales Offices.

The following applies to all products named in this publication:

1) We may modify products or discontinue production of a product listed in this document without prior notification.
2) We provide "Delivery Specification" that explain precautions for the specifications and safety of each product listed in this document. We strongly recommend that you exchange these delivery specifications with customers that use one of these products.
3) If you plan to export a product listed in this document, keep in mind that it may be a restricted item according to the "Foreign Exchange and Foreign Trade Control Law". In such cases, it is necessary to acquire export permission in harmony with this law.
4) Any reproduction or transferring of the contents of this document is prohibited without prior permission from our company.
5) We are not responsible for problems that occur related to the intellectual property rights or other rights of our company or a third party when you use a product listed in this document. We do not grant license of these rights.
6) This document only applies to products purchased through our company or one of our company's official agencies. This document does not apply to products that are purchased through other third parties.
7) The products listed on this document are intended for use in general electronic equipment (AV equipment, telecommunications equipment, home appliances, amusement equipment, computer equipment, personal equipment, office equipment, measurement equipment, industrial robots) under a normal operation and use condition.
   The products are not designed or warranted to meet the requirements of the applications listed below, whose performance and/or quality require a more stringent level of safety or reliability, or whose failure, malfunction or trouble could cause serious damage to society, person or property.
   If you intend to use the products in the applications listed below or if you have special requirements exceeding the range or conditions set forth in the each document, please contact us.
   (1) Aerospace/Aviation equipment
   (2) Transportation equipment (cars, electric trains, ships, etc.)
   (3) Medical equipment
   (4) Power-generation control equipment
   (5) Atomic energy-related equipment
   (6) Seabed equipment
   (7) Transportation control equipment
   (8) Public information-processing equipment

(9) Military equipment

(10) Electric heating apparatus, burning equipment

(11) Disaster prevention/crime prevention equipment

(12) Safety equipment

(13) Other applications that are not considered general-purpose applications

When designing your equipment even for general-purpose applications, you are kindly requested to take into consideration securing protection circuit/device or providing backup circuits in your equipment.

R4E