

Ultra small, Single Band LNA-IC for 2.5 GHz Band Applications

FEATURES

- Low voltage operation           +3.0 V typ.
- Low current consumption
  - 7.5 mA typ.   (High-Gain mode)
  - 7.5  $\mu$ A typ.   (Low-Gain mode)
- High gain           18.5 dB typ.   (High-Gain mode)
- Low noise figure   0.8 dB typ.   (High-Gain mode)
- Low distortion    +2.5 dBm typ. (High-Gain mode)
- 5 pin Wafer level chip size package (WLCSP)

DESCRIPTION

AN26031A is a single band LNA (Low Noise Amplifier)-IC for 2.5 GHz Band applications.

Realizing high performance by using 0.18  $\mu$ m SiGeC Bi-CMOS process ( $f_T = 90$  GHz,  $f_{max} = 140$  GHz).

High/Low Gain-mode is changeable, controlled by integrated CMOS logic circuit.

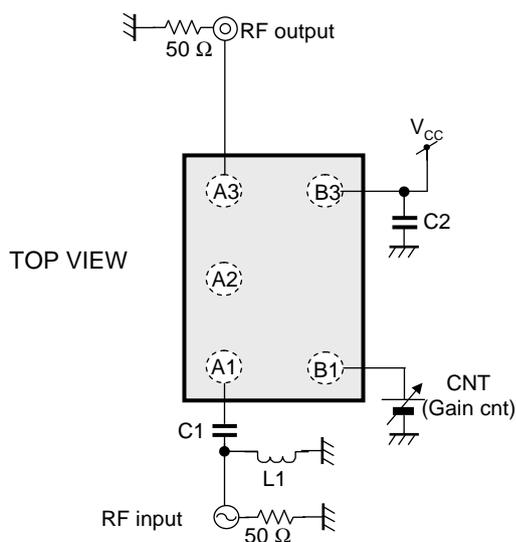
Achieving miniaturization by using small size Wafer Level Chip Size Package (WLCSP).

APPLICATIONS

- WLAN
- WiMAX

SIMPLIFIED APPLICATION

[ SIMPLIFIED APPLICATION for 2.5GHz Band ]



Components	Size	Value	Part Number	Vendor
L1	0603	3.9 nH	LQP03TN3N9H04	Murata
C1	0603	1 000 pF	GRM033B11C102KD01	Murata
C2	0603	100 000 pF	GRM33B30J104KE18	Murata

Notes) This application circuit is an example. The operation of mass production set is not guaranteed. You should perform enough evaluation and verification on the design of mass production set. You are fully responsible for the incorporation of the above application circuit and information in the design of your equipment.

**ABSOLUTE MAXIMUM RATINGS**

Parameter	Symbol	Rating	Unit	Notes
Supply voltage	$V_{CC}$	3.7	V	*1
Supply current	$I_{CC}$	18	mA	—
Operating free-air temperature	$T_{opr}$	-40 to +85	°C	*2
Operating junction temperature	$T_j$	-40 to +125	°C	*2
Storage temperature	$T_{stg}$	-55 to +125	°C	*2
Output Voltage Range	IN (Pin No.A1)	—	V	*3
	CNT (Pin No.B1)	-0.3 to $V_{CC}$	V	—
	OUT (Pin No.A3)	-0.3 to $V_{CC}$	V	—
ESD	HBM (Human Body Model)	2	kV	—

Notes). \*1:The values under the condition not exceeding the above absolute maximum ratings and the power dissipation.

\* 2:Except for the operating ambient temperature, operating junction temperature and storage temperature, all ratings are for  $T_a = 25^{\circ}C$ .

\*3:RF signal input pin. Do not apply DC. Do not apply more than 0 dBm to RF input.

**POWER DISSIPATION RATING**

PACKAGE	$\theta_{JA}$	PD ( $T_a=25^{\circ}C$ )	PD ( $T_a=85^{\circ}C$ )
WLCSP	1391°C/W	0.072W	0.029W

Note). For the actual usage, please refer to the PD-Ta characteristics diagram in the package specification, supply voltage, load and ambient temperature conditions to ensure that there is enough margin follow the power and the thermal design does not exceed the allowable value.



**CAUTION**

Although this has limited built-in ESD protection circuit, but permanent damage may occur on it. Therefore, proper ESD precautions are recommended to avoid electrostatic damage to the MOS gates

**RECOMMENDED OPERATING CONDITIONS**

Parameter	Symbol	Min.	Typ.	Max.	Unit	Notes
Supply voltage range	$V_{CC}$	2.7	3.0	3.6	V	*1

Note) \*1 : The values under the condition not exceeding the above absolute maximum ratings and the power dissipation.

**ELECTRICAL CHARACTERISTICS**

Note) Vcc = 3.0 V, Ta = 25°C±2°C unless otherwise specified.

Performance based on application circuit 1 on page 9

Parameter	Symbol	Condition	Limits			Unit	Note
			Min	Typ	Max		
<b>DC electrical characteristics</b>							
Supply current HG	IccH	Vcc current at High-Gain mode, No input signal	—	7.5	10	mA	—
Supply current LG	IccL	Vcc current at Low-Gain mode, No input signal	—	7.5	15	μA	—
Input voltage (High-Gain mode)	VIH	—	1.48	—	3.6	V	—
Input voltage (Low-Gain mode)	VIL	—	0	—	0.6	V	—
SW current (High)	IiH	Current at CNT pin VIH = Vcc	—	19	30	μA	—

**ELECTRICAL CHARACTERISTICS (continued)**

Note) Vcc = 3.0 V,

Ta = 25°C±2°C, fRX = 2.5GHz, PRX = -30 dBm, CW unless otherwise specified.

Performance based on application circuit 1 on page 9

Parameter	Symbol	Condition	Limits			Unit	Note
			Min	Typ	Max		
<b>AC electrical characteristics</b>							
Power Gain HG	GHS	High-Gain mode	16.6	18.5	20	dB	—
Power Gain LG	GLS	Low-Gain mode PRX = -20 dBm	-8.8	-7	-5.2	dB	—
IIP3 -10 MHz offset HG	IIP3H1S	High-Gain mode f1 = fRX - 10 MHz f2 = fRX - 20 MHz Input 2 signals (f1, f2)	-2	2.5	—	dBm	—

**APPLICATION INFORMATION**  
**REFERENCE VALUES FOR DESIGN**

Notes) Vcc= 3.0 V

Ta = 25 °C ± 2 °C, fRXa= 2.3 GHz, 2.5 GHz, 2.7 GHz, PRX = -30 dBm, CW unless otherwise specified.

Performance based on application circuit 1 on page 9

Parameter	Symbol	Condition	Reference values			Unit	Note
			Min	Typ	Max		
<b>AC electrical characteristics</b>							
Power Gain HG	GHa	High-Gain mode	16.1	18.5	20.5	dB	*1
Power Gain LG	GLa	Low-Gain mode PRX = -20 dBm	-9	-7	-5	dB	*1
Noise Figure HG	NFHa	High-Gain mode	—	0.95	1.45	dB	*1,*2
Noise Figure LG	NFLa	Low-Gain mode	—	7	9.5	dB	*1,*2
IIP3 -10 MHz offset HG	IIP3H1a	High-Gain mode f1 = fRXa - 10 MHz f2 = fRXa - 20 MHz Input 2 signals (f1, f2)	-2.5	2.5	—	dBm	*1
IIP3 +10 MHz offset HG	IIP3H2a	High-Gain mode f1 = fRXa + 10 MHz f2 = fRXa + 20 MHz Input 2 signals (f1, f2)	-2.5	2.0	—	dBm	*1
Input P1dB HG	IP1dBHa	High-Gain mode	-12	-8.5	—	dBm	*1
IIP3 +100 kHz offset LG	IIP3La	Low-Gain mode f1 = fRXa f2 = fRXa + 100 kHz Input 2 signals (f1, f2)	10	24.5	—	dBm	*1
Input P1dB LG	IP1dBLa	Low-Gain mode	0	8	—	dBm	*1
Reverse Isolation HG	ISOHa	High-Gain mode	26	31	—	dB	*1
Reverse Isolation LG	ISOLa	Low-Gain mode	4.5	7	—	dB	*1
Input Return Loss HG	S11Ha	High-Gain mode	10	16	—	dB	*1
Input Return Loss LG	S11La	Low-Gain mode	7	8.5	—	dB	*1
Output Return Loss HG	S22Ha	High-Gain mode	10	19	—	dB	*1
Output Return Loss LG	S22La	Low-Gain mode	9.5	14.5	—	dB	*1

Note) \*1 : Checked by design, not production tested.

\*2 : RF input Connector & substrate loss (0.14 dB) included.

**APPLICATION INFORMATION (Continued)**

**REFERENCE VALUES FOR DESIGN (Continued)**

Notes)  $V_{cc} = 2.7V$  to  $3.6 V$ ,  $T_a = -40\text{ }^\circ\text{C}$  to  $85\text{ }^\circ\text{C}$  unless otherwise specified.

Performance based on application circuit 1 on page 9

Parameter	Symbol	Condition	Reference values			Unit	Note
			Min	Typ	Max		
<b>DC electrical characteristics</b>							
Supply current HG	I <sub>ccHT</sub>	V <sub>cc</sub> current at High-Gain mode No input signal	—	7.5	11.5	mA	*1
Supply current LG	I <sub>ccLT</sub>	V <sub>cc</sub> current at Low-Gain mode No input signal	—	7.5	18	μA	*1
SW current (High)	I <sub>IHT</sub>	Current at CNT pin V <sub>IH</sub> = V <sub>cc</sub>	—	19	35	μA	*1

Note) \*1 : Checked by design, not production tested.

**APPLICATION INFORMATION (Continued)**

**REFERENCE VALUES FOR DESIGN (Continued)**

Notes)  $V_{CC} = 2.7\text{ V to }3.6\text{ V}$

$T_a = -40\text{ }^\circ\text{C to }85\text{ }^\circ\text{C}$ ,  $f_{RXa} = 2.3\text{ GHz, }2.5\text{ GHz, }2.7\text{ GHz}$ ,  $PRX = -30\text{ dBm}$ , CW unless otherwise specified.

Performance based on application circuit 1 on page 9

Parameter	Symbol	Condition	Reference values			Unit	Note
			Min	Typ	Max		
<b>AC electrical characteristics</b>							
Power Gain HG	GHTa	High-Gain mode	14.6	18.5	22	dB	*1
Power Gain LG	GLTa	Low-Gain mode PRX = -20 dBm	-10	-7	-4	dB	*1
Noise Figure HG	NFHTa	High-Gain mode	—	0.95	1.9	dB	*1,*2
Noise Figure LG	NFLTa	Low-Gain mode	—	7	10.5	dB	*1,*2
IIP3 -10 MHz offset HG	IIP3H1Ta	High-Gain mode f1 = $f_{RXa} - 10\text{ MHz}$ f2 = $f_{RXa} - 20\text{ MHz}$ Input 2 signals (f1, f2)	-5	2.5	—	dBm	*1
IIP3 +10 MHz offset HG	IIP3H2Ta	High-Gain mode f1 = $f_{RXa} + 10\text{ MHz}$ f2 = $f_{RXa} + 20\text{ MHz}$ Input 2 signals (f1, f2)	-5	2	—	dBm	*1
Input P1dB HG	P1dBHTa	High-Gain mode	-14.5	-8.5	—	dBm	*1

Note) \*1 : Checked by design, not production tested.

\*2 : RF input Connector & substrate loss (0.14 dB) included.

**APPLICATION INFORMATION (Continued)**

**REFERENCE VALUES FOR DESIGN (continued)**

Notes)  $V_{cc} = 3.0\text{ V}$

$T_a = 25^\circ\text{C} \pm 2^\circ\text{C}$ ,  $f_{RXb} = 3.3\text{ GHz}, 3.5\text{ GHz}, 3.6\text{ GHz}$ ,  $PRX = -30\text{ dBm}$ , CW unless otherwise specified.

Performance based on application circuit 2 on page 9

Parameter	Symbol	Condition	Reference values			Unit	Note
			Min	Typ	Max		
<b>AC electrical characteristics</b>							
Power Gain HG	GHb	High-Gain mode	13	15.5	18	dB	*1
Power Gain LG	GLb	Low-Gain mode PRX = -20 dBm	-9.2	-7.2	-5.2	dB	*1
Noise Figure HG	NFHb	High-Gain mode	—	1.4	1.95	dB	*1,*2
Noise Figure LG	NFLb	Low-Gain mode	—	7.2	9.7	dB	*1,*2
IIP3 -10 MHz offset HG	IIP3H1b	High-Gain mode f1 = fRXb - 10 MHz f2 = fRXb - 20 MHz Input 2 signals (f1, f2)	-2.5	3.5	—	dBm	*1
IIP3 +10 MHz offset HG	IIP3H2b	High-Gain mode f1 = fRXb + 10 MHz f2 = fRXb + 20 MHz Input 2 signals (f1, f2)	-3	1.5	—	dBm	*1
Input P1dB HG	IP1dBHb	High-Gain mode	-14	-7.5	—	dBm	*1
IIP3 +100 kHz offset LG	IIP3Lb	Low-Gain mode f1 = fRXb f2 = fRXb + 100 kHz Input 2 signals (f1, f2)	10	22.5	—	dBm	*1
Input P1dB LG	IP1dBLb	Low-Gain mode	0	6.5	—	dBm	*1
Reverse Isolation HG	ISOHb	High-Gain mode	24	29	—	dB	*1
Reverse Isolation LG	ISOLb	Low-Gain mode	4.7	7.2	—	dB	*1
Input Return Loss HG	S11Hb	High-Gain mode	10	15	—	dB	*1
Input Return Loss LG	S11Lb	Low-Gain mode	7.5	10	—	dB	*1
Output Return Loss HG	S22Hb	High-Gain mode	10	25	—	dB	*1
Output Return Loss LG	S22Lb	Low-Gain mode	8.5	13	—	dB	*1

Note) \*1 : Checked by design, not production tested.

\*2 : RF input Connector & substrate loss (0.18 dB) included.

**APPLICATION INFORMATION (Continued)**

**REFERENCE VALUES FOR DESIGN (continued)**

Notes)  $V_{CC} = 2.7\text{ V to }3.6\text{ V}$

$T_a = -40\text{ }^\circ\text{C to }85\text{ }^\circ\text{C}$ ,  $f_{RXb} = 3.3\text{ GHz, }3.5\text{ GHz, }3.6\text{ GHz}$ ,  $PRX = -30\text{ dBm}$ , CW unless otherwise specified.

Performance based on application circuit 2 on page 9

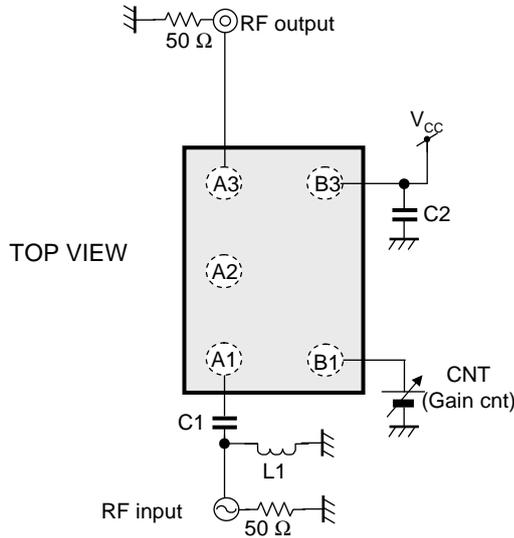
Parameter	Symbol	Condition	Reference values			Unit	Note
			Min	Typ	Max		
<b>AC electrical characteristics</b>							
Power Gain HG	GHTb	High-Gain mode	11.5	15.5	19.5	dB	*1
Power Gain LG	GLTb	Low-Gain mode PRX = -20 dBm	-10.2	-7.2	-4.2	dB	*1
Noise Figure HG	NFHTb	High-Gain mode	—	1.4	2.45	dB	*1,*2
Noise Figure LG	NFLTb	Low-Gain mode	—	7.2	9.7	dB	*1,*2
IIP3 -10 MHz offset HG	IIP3H1Tb	High-Gain mode $f_1 = f_{RXb} - 10\text{ MHz}$ $f_2 = f_{RXb} - 20\text{ MHz}$ Input 2 signals ( $f_1, f_2$ )	-5.5	3.5	—	dBm	*1
IIP3 +10 MHz offset HG	IIP3H2Tb	High-Gain mode $f_1 = f_{RXb} + 10\text{ MHz}$ $f_2 = f_{RXb} + 20\text{ MHz}$ Input 2 signals ( $f_1, f_2$ )	-6	1.5	—	dBm	*1
Input P1dB HG	P1dBHTb	High-Gain mode	-18	-7.5	—	dBm	*1

Note) \*1 : Checked by design, not production tested.

\*2 : RF input Connector & substrate loss (0.18 dB) included.

APPLICATION INFORMATION (Continued)  
APPLICATION CIRCUIT

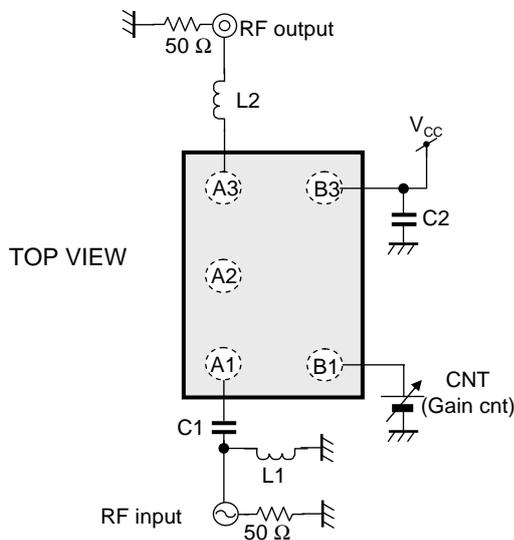
[ Application Circuit 1 for 2.5 GHz Band ]



Components	Size	Value	Part Number	Vendor
L1	0603	3.9 nH	LQP03TN3N9H04	Murata
C1	0603	1 000 pF	GRM033B11C102KD01	Murata
C2	0603	100 000 pF	GRM33B30J104KE18	Murata

Notes) This application circuit is an example. The operation of mass production set is not guaranteed. You should perform enough evaluation and verification on the design of mass production set. You are fully responsible for the incorporation of the above application circuit and information in the design of your equipment.

[ Application Circuit 2 for 3.5 GHz Band ]

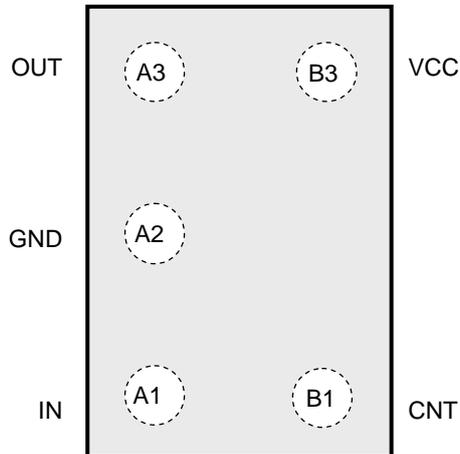


Components	Size	Value	Part Number	Vendor
L1	0603	2.2 nH	LQP03TN2N2H04	Murata
L2	0603	3.1 nH	LQP03TN3N1H04	Murata
C1	0603	1 000 pF	GRM033B11C102KD01	Murata
C2	0603	100 000 pF	GRM33B30J104KE18	Murata

Notes) This application circuit is an example. The operation of mass production set is not guaranteed. You should perform enough evaluation and verification on the design of mass production set. You are fully responsible for the incorporation of the above application circuit and information in the design of your equipment.

PIN CONFIGURATION

Top View

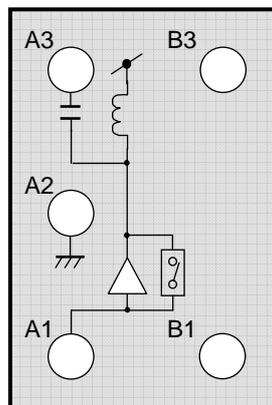


PIN FUNCTIONS

Pin No.	Pin name	Type	Description
A1	IN	Input	RF Input
A2	GND	Ground	GND
A3	OUT	Output	RF Output
B1	CNT	Input	High-Gain / Low-Gain switch L: Low-Gain Mode H: High-Gain Mode
B3	VCC	Power Supply	V <sub>CC</sub>

FUNCTIONAL BLOCK DIAGRAM

Top View

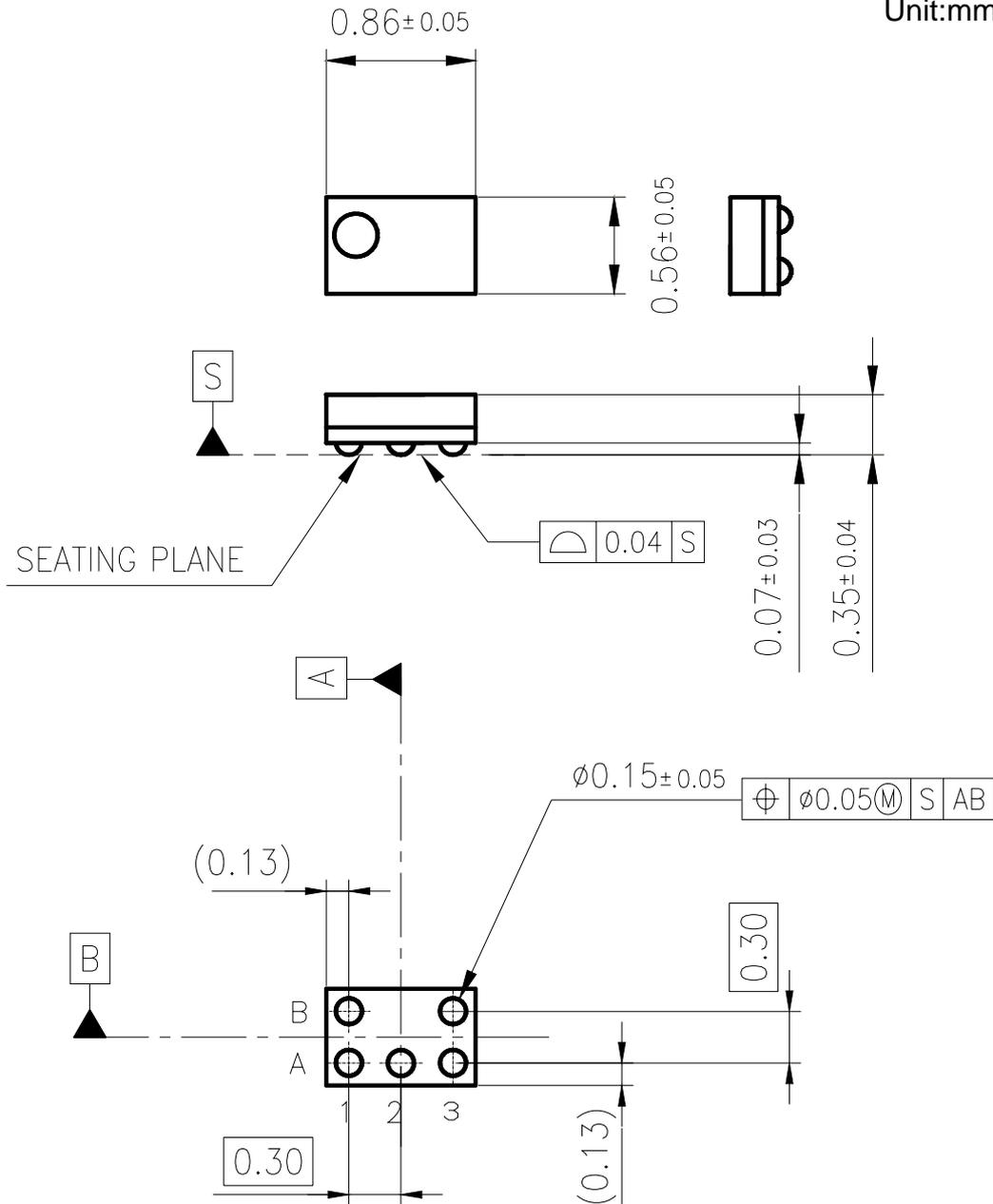


Notes) This circuit and these circuit constants show an example and do not guarantee the design as a mass-production set. This block diagram is for explaining functions. The part of the block diagram may be omitted, or it may be simplified.

PACKAGE INFORMATION ( Reference Data )

Package Code:ALGA005-W-0609ANA

Unit:mm



Body Material : Br/Sb Free Epoxy Resin
Reroute Material : Cu
Bump : SnAgCu

**IMPORTANT NOTICE**

1. The products and product specifications described in this book are subject to change without notice for modification and/or improvement. At the final stage of your design, purchasing, or use of the products, therefore, ask for the most up-to-date Product Standards in advance to make sure that the latest specifications satisfy your requirements.
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  - (4) Submarine transponder
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1. When designing your equipment, comply with the range of absolute maximum rating and the guaranteed operating conditions (operating power supply voltage and operating environment etc.). Especially, please be careful not to exceed the range of absolute maximum rating on the transient state, such as power-on, power-off and mode-switching. Otherwise, we will not be liable for any defect which may arise later in your equipment.

Even when the products are used within the guaranteed values, take into the consideration of incidence of break down and failure mode, possible to occur to semiconductor products. Measures on the systems such as redundant design, arresting the spread of fire or preventing glitch are recommended in order to prevent physical injury, fire, social damages, for example, by using the products.

2. Comply with the instructions for use in order to prevent breakdown and characteristics change due to external factors (ESD, EOS, thermal stress and mechanical stress) at the time of handling, mounting or at customer's process. When using products for which damp-proof packing is required, satisfy the conditions, such as shelf life and the elapsed time since first opening the packages.
3. Pay attention to the direction of LSI. When mounting it in the wrong direction onto the PCB (printed-circuit-board), it might smoke or ignite.
4. Pay attention in the PCB (printed-circuit-board) pattern layout in order to prevent damage due to short circuit between pins. In addition, refer to the Pin Description for the pin configuration.
5. Perform a visual inspection on the PCB before applying power, otherwise damage might happen due to problems such as a solder-bridge between the pins of the semiconductor device. Also, perform a full technical verification on the assembly quality, because the same damage possibly can happen due to conductive substances, such as solder ball, that adhere to the LSI during transportation.
6. Take notice in the use of this product that it might break or occasionally smoke when an abnormal state occurs such as output pin-VCC short (Power supply fault), output pin-GND short (Ground fault), or output-to-output-pin short (load short) .

And, safety measures such as an installation of fuses are recommended because the extent of the above-mentioned damage and smoke emission will depend on the current capability of the power supply.

7. Due to unshielded structure of this LSI, under exposure of light, function and characteristic of the product cannot be guaranteed. During normal operation or even under testing condition, please ensure that LSI is not exposed to light.
8. Basically, chip surface is ground potential. Please design to ensure no contact between chip surface and metal shielding.

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