Regulations No.:

Product Standards

Part No.	AN26065A
Package Code No.	ALGA011-W-0912ANA

Semiconductor Company
Matsushita Electric Industrial Co., Ltd.

Established by	Applied by	Checked by	Prepared by
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Contents

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AN26065A

UMTS Triple Band LNA-IC (Band I, II, IV, IX / V, XIII)

■ Overview
- AN26065A is LNA-IC for triple band (Band I, II, IV, IX / V, XIII) UMTS.
- Realizing high performance by using 0.18 μm SiGeC Bi-CMOS process (f_T = 90 GHz, f_{max} = 140 GHz).
- Each Band is selectable and High/Low Gain-mode is changeable, controlled by integrated CMOS logic circuit.
- Achieving miniaturization by using small size package.

[Unit: MHz]

Band	TX	RX
I	1920 to 1980	2110 to 2170
II	1850 to 1910	1930 to 1990
III	1710 to 1785	1805 to 1880
IV	1710 to 1755	2110 to 2155
V	824 to 849	869 to 894
VI	830 to 840	875 to 885
VII	2500 to 2570	2620 to 2690
VIII	880 to 915	925 to 960
IX	1750 to 1785	1845 to 1880

■ Features
- Low voltage operation   +2.85 V typ.
- Low current consumption   4.7 mA typ.   (High-Gain mode)
  25 μA typ.   (Low-Gain mode)
- High gain(Gain)   16.5 dB typ.   fRX = 2140 MHz   (High-Gain mode)
  16.5 dB typ.   fRX = 881.5 MHz   (High-Gain mode)
  16.3 dB typ.   fRX = 1960 MHz   (High-Gain mode)
- Low noise figure(NF)   1.40 dB typ.   fRX = 2140 MHz   (High-Gain mode)
  1.10 dB typ.   fRX = 881.5 MHz   (High-Gain mode)
  1.40 dB typ.   fRX = 1960 MHz   (High-Gain mode)
- Low distortion   2.0 dBm typ.   fRX = 2140 MHz   (High-Gain mode)
  (IIP3 +10 MHz offset)   4.0 dBm typ.   fRX = 881.5 MHz   (High-Gain mode)
  2.5 dBm typ.   fRX = 1960 MHz   (High-Gain mode)
- Small package(WLCSP)

■ Applications
- Triple-band UMTS handset.

■ Package
- 11 pin Wafer level chip size package (WLCSP)
  Size : 0.86 mm × 1.16 mm (0.3 mm pitch)

### ■ Type
- Bi-CMOS IC

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■ Application Circuit Example (Block Diagram)

Note) See "External parts" on Page16.

(Top View)
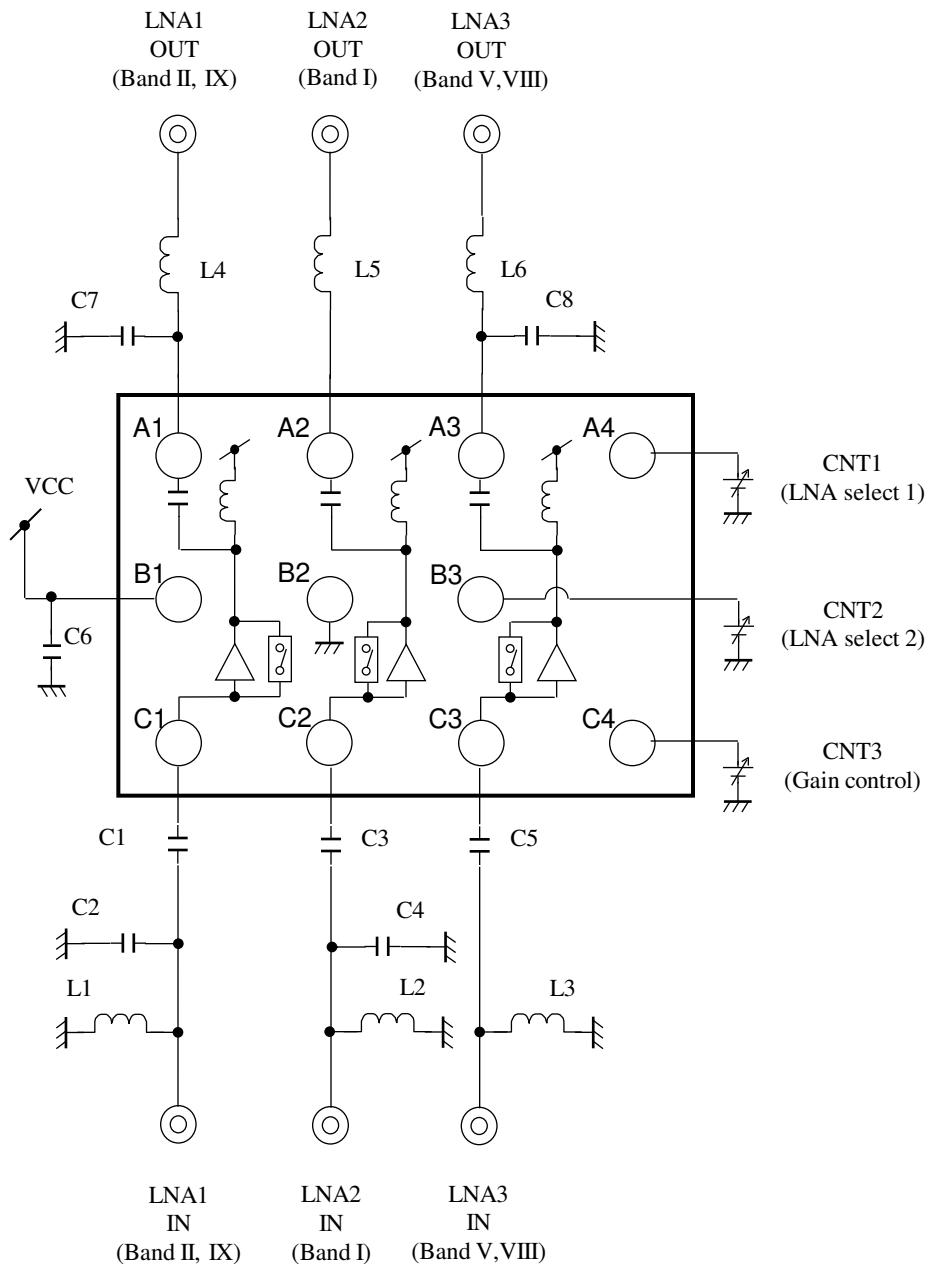
Notes) • This application circuit is shown as an example but does not guarantee the design for mass production set.

• This block diagram is for explaining functions. The part of the block diagram may be omitted, or it may be simplified.

■ Pin Descriptions

Pin No.	Pin name	Type	Description
A1	OUT1	Output	LNA1 RF Output (Band I, II, IV, IX)
A2	OUT2	Output	LNA2 RF Output (Band I)
A3	OUT3	Output	LNA3 RF Output (Band V, VIII)
A4	CNT1	Input	LNA select SW input 1
B1	VCC	Power Supply	V_{CC}
B2	GND	Ground	GND
B3	CNT2	Input	LNA select SW input 2
B4	N.C.	—	N.C.
C1	IN1	Input	LNA1 RF Input (Band I, II, IV, IX)
C2	IN2	Input	LNA2 RF Input (Band I)
C3	IN3	Input	LNA3 RF Input (Band V, VIII)
C4	CNT3	Input	High-Gain / Low-Gain SW input

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■ Current and Voltage Ranges for Pins

Note)
- The ranges on the list are the voltages of respective pins in relation to GND.
- Do not apply the voltages or the currents from external into the pins which are not on the list.
- The values shows voltage to the GND unless otherwise specified. (+) is inlet current and (–) is outlet current in the circuit.
- Voltage applying exceeding below ratings leads to the malfunction and the damage of the device.
- Below ratings are specified regarding malfunction and stress, not for operation guaranty.

Pin No.	Pin name	Range	Unit	Note
A1	OUT1	-0.3 to (V_{CC})	V	—
A2	OUT2	-0.3 to (V_{CC})	V	—
A3	OUT3	-0.3 to (V_{CC})	V	—
A4	CNT1	-0.3 to (V_{CC})	V	—
B1	VCC	0 to 3.0	V	—
B2	GND	0	V	*1
B3	CNT2	-0.3 to (V_{CC})	V	—
B4	N.C.	—	V	—
C1	IN1	—	V	*2
C2	IN2	—	V	*2
C3	IN3	—	V	*2
C4	CNT3	-0.3 to (V_{CC})	V	—

Notes) *1 : Same as GND pin.

*2 : RF signal input pin. (Maximum input power is 0dBm.) Do not apply DC voltages.

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■ Absolute Maximum Ratings

Note) Absolute maximum ratings are limit values which are not destructed, and are not the values to which operation is guaranteed.

A No.	Parameter	Symbol	Rating	Unit	Notes
1	Supply voltage	V_{CC}	3.6	V	*1
2	Supply current	I_{CC}	10	mA	—
3	Power dissipation	P_D	31	mW	*2
4	Operating ambient temperature	T_{opr}	−30 to +85	°C	*3
5	Storage temperature	T_{stg}	−40 to +125	°C	*3

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

*2 : The power dissipation shown is the value at $T_a = 85$°C for the independent (unmounted) IC package without a heat sink. When using this IC, refer to the P_D-T_a diagram of the package standard and design the heat radiation with sufficient margin so that the allowable value might not be exceeded based on the conditions of power supply voltage, load, and ambient temperature.

*3 : Except for the power dissipation, operating ambient temperature, and storage temperature, all ratings are for $T_a = 25$°C.

■ Operating Supply Voltage Range

Parameter	Symbol	Range	Unit	Notes
Supply voltage range	V_{CC}	2.65 to 3.00	V	*1

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

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■ Electrical Characteristics at V_{CC} = 2.85 V

Notes) • All parameters are specified under $T_a = 25°C \pm 2°C$ unless otherwise specified.

B No.	Parameter	Symbol	Test circuits	Conditions	Limits			Unit	Notes
					Min	Typ	Max		
DC electrical characteristics									
DC-1	Circuit current HG (LNA2)	IccHa	1	V_{CC} current at LNA2 High-Gain mode. No input signal	—	4.7	6.3	mA	—
DC-2	Circuit current HG (LNA3)	IccHb	1	V_{CC} current at LNA3 High-Gain mode. No input signal	—	4.1	5.5	mA	—
DC-3	Circuit current HG (LNA1)	IccHc	1	V_{CC} current at LNA1 High-Gain mode. No input signal	—	4.7	6.3	mA	—
DC-4	Circuit current LG (LNA2)	IccLa	1	V_{CC} current at LNA2 Low-Gain mode. No input signal	—	11	60	μA	—
DC-5	Circuit current LG (LNA3)	IccLb	1	V_{CC} current at LNA3 Low-Gain mode. No input signal	—	25	80	μA	—
DC-6	Circuit current LG (LNA1)	IccLc	1	V_{CC} current at LNA1 Low-Gain mode. No input signal	—	25	80	μA	—
DC-7	SW voltage (High)	VIH	1	—	1.60	—	—	V	—
DC-8	SW voltage (Low)	VIL	1	$VIL = V_{CC} \times 0.20$	0.0	—	0.6	V	—
DC-9	SW current (High)	IIH	1	Current at CNT pin $VIH = V_{CC}$	—	10	20	μA	—

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■ Electrical Characteristics (continued) at V_{CC} = 2.85 V

Notes) • All parameters are specified under T_a = 25°C±2°C, fRXa = 2 140 MHz, PRX = –30 dBm, CW unless otherwise specified.

• Input/output connector & substrate loss (0.34 dB/0.34 dB) included.

B No.	Parameter	Symbol	Test circuits	Conditions	Limits			Unit	Notes
					Min	Typ	Max		
LNA2 : AC electrical characteristics (BAND I)									
A-1	Power Gain HG	GHSa	1	High-Gain mode f = fRXa	15.0	16.5	18.0	dB	—
A-2	Power Gain LG	GLSa	1	Low-Gain mode f = fRXa	–8.5	–7.0	–5.0	dB	—
A-3	IIP3 +10 MHz detuning HG	IIP3H1Sa	1	High-Gain mode f1 = fRXa + 10 MHz f2 = fRXa + 20 MHz Input 2 signals (f1, f2)	–2.5	2.0	—	dBm	—
A-4	IIP3 –10 MHz detuning HG	IIP3H2Sa	1	High-Gain mode f1 = fRXa – 10 MHz f2 = fRXa – 20 MHz Input 2 signals (f1, f2)	–1.5	3.0	—	dBm	—

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■ Electrical Characteristics (continued) at V_{CC} = 2.85 V

Notes) • All parameters are specified under T_a = 25°C±2°C, fRXb = 881.5 MHz, PRX = –30 dBm, CW unless otherwise specified.

• Input/output connector & substrate loss (0.15 dB/0.15 dB) included.

B No.	Parameter	Symbol	Test circuits	Conditions	Limits			Unit	Notes
					Min	Typ	Max		
LNA3 : AC electrical characteristics (BAND V)									
B-1	Power Gain HG	GHSb	2	High-Gain mode f = fRXb	15.0	16.5	17.7	dB	—
B-2	Power Gain LG	GLSb	2	Low-Gain mode f = fRXb	–7.5	–5.5	–3.5	dB	—
B-3	IIP3 +10 MHz detuning HG	IIP3H1Sb	2	High-Gain mode f1 = fRXb + 10 MHz f2 = fRXb + 20 MHz Input 2 signals (f1, f2)	– 0.5	4.0	—	dBm	—
B-4	IIP3 –10 MHz detuning HG	IIP3H2Sb	2	High-Gain mode f1 = fRXb – 10 MHz f2 = fRXb – 20 MHz Input 2 signals (f1, f2)	– 0.5	3.0	—	dBm	—

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■ Electrical Characteristics (continued) at $V_{CC} = 2.85$ V

Notes) • All parameters are specified under $T_a = 25°C\pm2°C$, fRXc = 1 960 MHz, PRX = –30 dBm, CW unless otherwise specified.
• Input/output connector & substrate loss (0.32 dB/0.32 dB) included.

B No.	Parameter	Symbol	Test circuits	Conditions	Limits			Unit	Notes
					Min	Typ	Max		
LNA1 : AC electrical characteristics (BAND II)									
C-1	Power Gain HG	GHSc	3	High-Gain mode f = fRXc	14.8	16.3	17.8	dB	—
C-2	Power Gain LG	GLSc	3	Low-Gain mode f = fRXc	–8.5	–7.0	–5.0	dB	—
C-3	IIP3 +10 MHz detuning HG	IIP3H1Sc	3	High-Gain mode f1 = fRXc + 10 MHz f2 = fRXc + 20 MHz Input 2 signals (f1, f2)	–1.5	2.5	—	dBm	—
C-4	IIP3 –10 MHz detuning HG	IIP3H2Sc	3	High-Gain mode f1 = fRXc – 10 MHz f2 = fRXc – 20 MHz Input 2 signals (f1, f2)	0.0	2.5	—	dBm	—

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■ Control Pin Mode Table

Note) See parameters B No.DC-7 to B No.DC-8 in the Electrical Characteristics for control voltage retention ranges.

CNT1 (LNA select 1)	CNT2 (LNA select 2)	CNT3 (Gain control)	LNA1 (Band I,II,IV,IX)	LNA2 (Band I)	LNA3 (Band V,VIII)	Mode
High	High	High	—	—	—	—
		Low	—	—	—	—
High	Low	High	Off	Off	On	LNA3 High-Gain
		Low	Off	Off	On	LNA3 Low-Gain
Low	High	High	On	Off	Off	LNA1 High-Gain
		Low	On	Off	Off	LNA1 Low-Gain
Low	Low	High	Off	On	Off	LNA2 High-Gain
		Low	Off	On	Off	LNA2 Low-Gain

■ Test Circuit Diagram

Note) See "External parts" on Page16.

1. Test Circuit Diagram 1

(Top View)
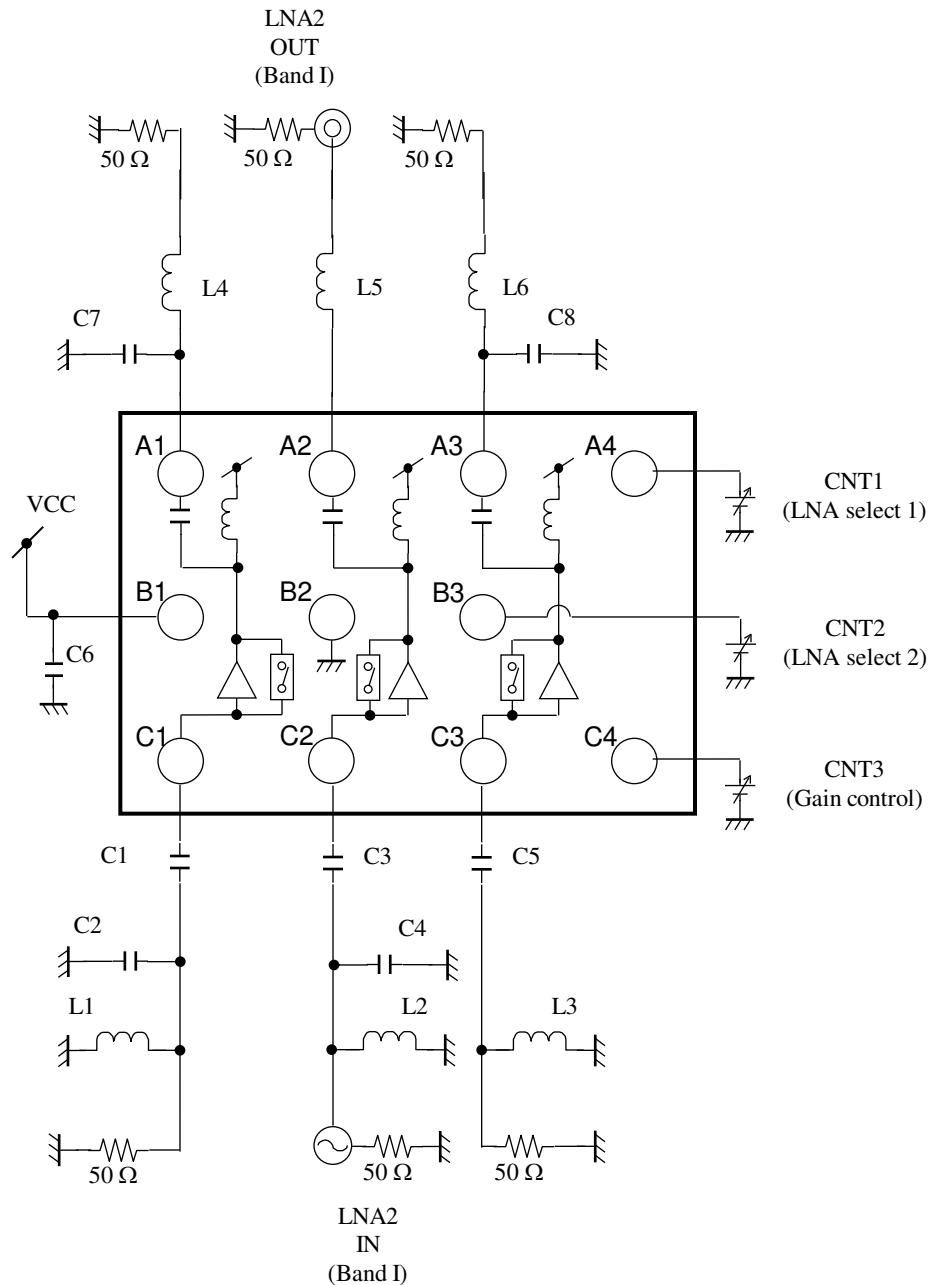
LNA2
OUT
(Band I)

50 Ω   50 Ω   50 Ω

L4   L5   L6

C7   C8

A1   A2   A3   A4   CNT1 (LNA select 1)

VCC

B1   B2   B3   CNT2 (LNA select 2)

C6

C1   C2   C3   C4   CNT3 (Gain control)

C1   C3   C5

C2   C4

L1   L2   L3

50 Ω   50 Ω   50 Ω

LNA2
IN
(Band I)

■ Test Circuit Diagram (continued)

Note) See "External parts" on Page16.

2. Test Circuit Diagram 2

(Top View)
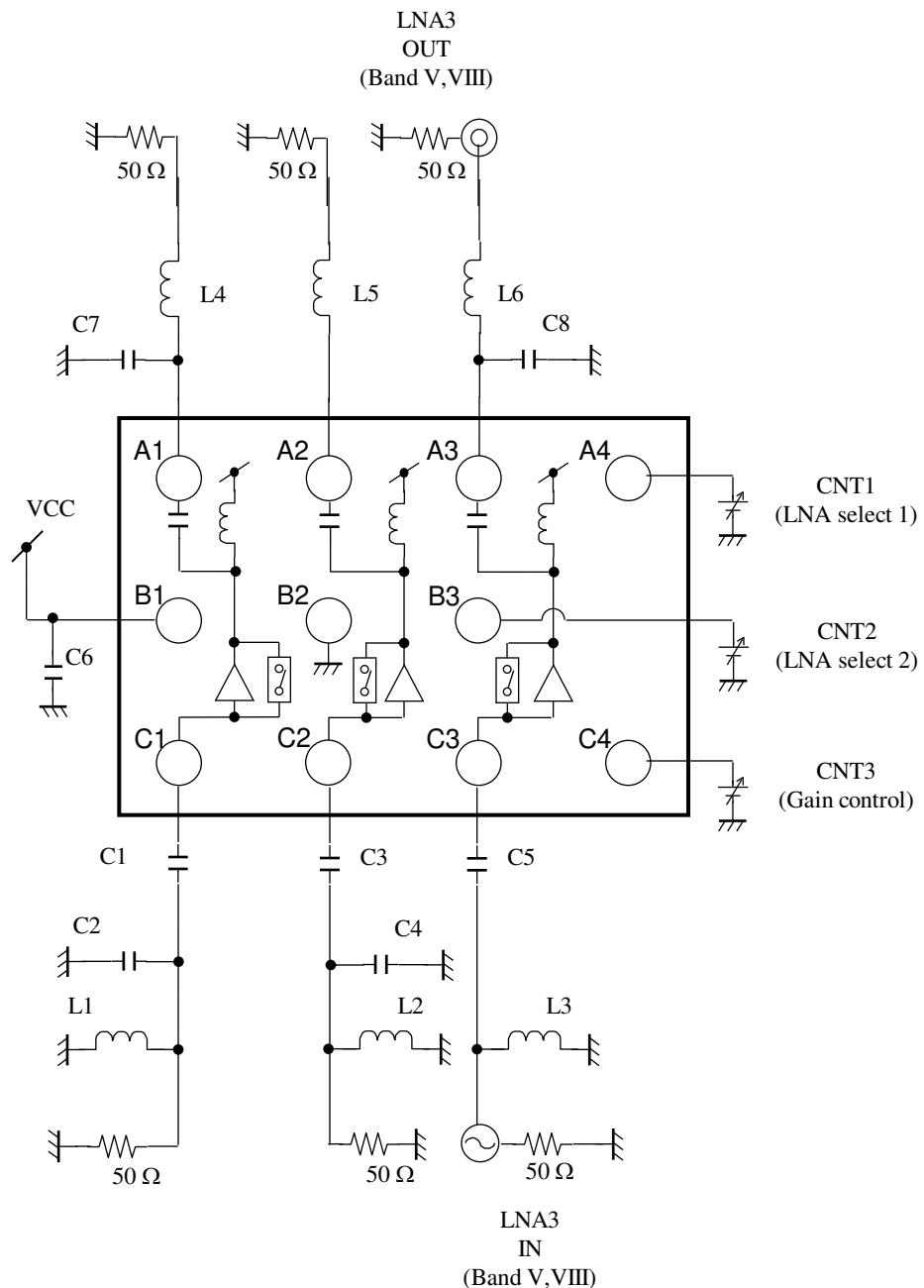
LNA3
OUT
(Band V,VIII)

LNA3
IN
(Band V,VIII)

■ Test Circuit Diagram (continued)

Note) See "External parts" on Page16.

3. Test Circuit Diagram 3

(Top View)
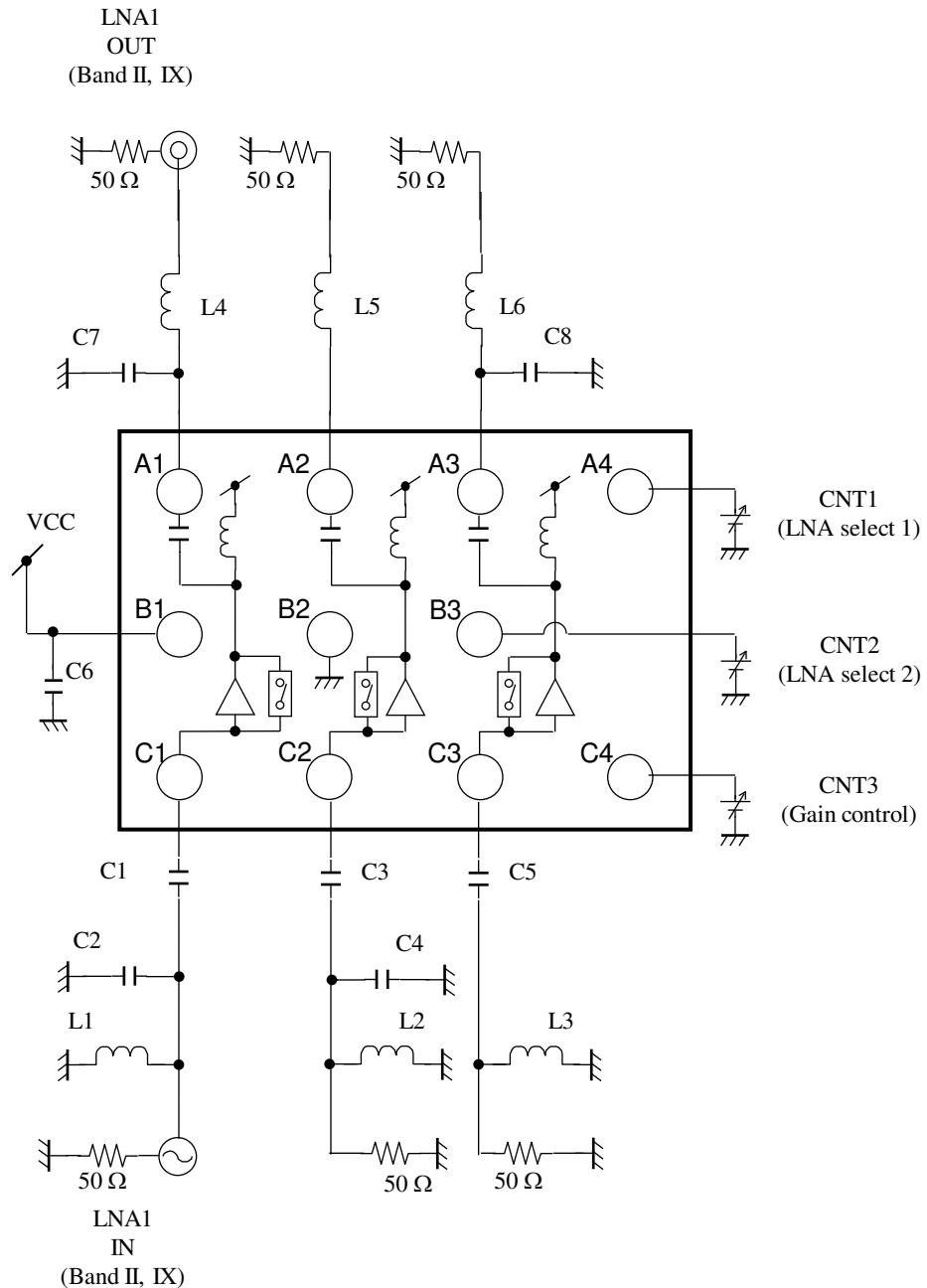
LNA1
OUT
(Band II, IX)

LNA1
IN
(Band II, IX)

■ Test Circuit Diagram
• External parts

| Part name	Chip size	Value	Model	Manufacturer
L1	0603	1.8 nH	LQP03T1N8B04	Murata
L2	0603	2.2 nH	LQP03T2N2B04	Murata
L3	0603	8.2 nH	LQP03T8N2H04	Murata
L4	0603	5.1 nH	LQP03T5N1H04	Murata
L5	0603	5.6 nH	LQP03T5N6H04	Murata
L6	0603	12 nH	LQP03T12NH04	Murata
C1	0603	1000 pF	GRM033B11C102KD01	Murata
C2	0603	2.0 pF	GJM0334C1E2R0BB01	Murata
C3	0603	1000 pF	GRM033B11C102KD01	Murata
C4	0603	2.0 pF	GJM0334C1E2R0BB01	Murata
C5	0603	1000 pF	GRM033B11C102KD01	Murata
C6	0603	0.1 μF	GRM033B30J104KE18	Murata
C7	0603	0.5 pF	GJM0334C1ER50BB01	Murata
C8	0603	1.5 pF	GJM0334C1E1R6BB01	Murata

■ Technical Data

• I/O block circuit diagrams and pin function descriptions

Note) The characteristics listed below are reference values based on the IC design and are not guaranteed.

Pin No.	Voltage	Internal Circuit	Description
A1	—		LNA1 RF Output (Band II)
A2	—	Refer to A1	LNA2 RF Output (Band I)
A3	—	Refer to A1	LNA3 RF Output (Band V)
A4	—		CNT1 ; LNA select SW input 1
B1	2.85 V	—	Voltage supply (V_{CC})
B2	0.0 V	—	GND
B3	—	Refer to A4	CNT2 ; LNA select SW input 2
B4	—	—	N.C.
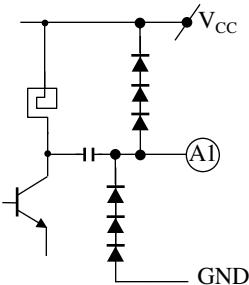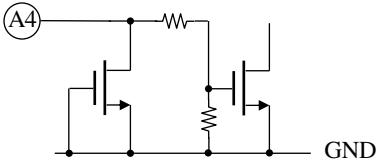
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■ Technical Data (continued)
• I/O block circuit diagrams and pin function descriptions (continued)

Note) The characteristics listed below are reference values based on the IC design and are not guaranteed.

Pin No.	Voltage	Internal Circuit	Description
C1	0.75 V		LNA1 RF Input (Band II)
C2	0.75 V	Refer to C1	LNA2 RF Input (Band I)
C3	0.75 V	Refer to C1	LNA3 RF Input (Band V)
C4	—	Refer to A4	CNT3 ; High-Gain / Low-Gain SW input
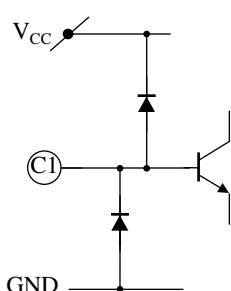
■ Usage Notes

● Special attention and precaution in using

1. This IC is intended to be used for general electronic equipment [Triple-band UMTS handset].

   Consult our sales staff in advance for information on the following applications:

   ・Special applications in which exceptional quality and reliability are required, or if the failure or malfunction of this IC may directly jeopardize life or harm the human body.

   ・Any applications other than the standard applications intended.

       (1) Space appliance (such as artificial satellite, and rocket)

       (2) Traffic control equipment (such as for automobile, airplane, train, and ship)

       (3) Medical equipment for life support

       (4) Submarine transponder

       (5) Control equipment for power plant

       (6) Disaster prevention and security device

       (7) Weapon

       (8) Others : Applications of which reliability equivalent to (1) to (7) is required

2. 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.

3. 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 (Page 5 and Page 6) for the pin configuration.

4. 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.

5. Take notice in the use of this product that it might break or occasionally smoke when an abnormal state occurs such as output pin-V_{CC} 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.

6. When using the LSI for new models, verify the safety including the long-term reliability for each product.

7. When the application system is designed by using this LSI, be sure to confirm notes in this book.

   Be sure to read the notes to descriptions and the usage notes in the book.

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