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DATA SHEET

Part No.	AN26218A
Package Code No.	XLGA011-W-1216AKA

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Contents

AN26218A

UMTS triple band LNA-IC

■ Overview
- AN26218A is LNA-IC for 800 MHz / 1.7 GHz / 2.1 GHz Band Applications.
- Realizing high performance by using 0.18 μm SiGeC Bi-CMOS process(fT = 90 GHz, fmax = 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.

■ Features
• Low voltage operation	+2.8 V typ.		
• Low current consumption	3.3 mA typ.		(High-Gain mode)
	11 μA typ.	2.1 GHz	(Low-Gain mode)
	25 μA typ.	800 MHz / 1.7 GHz	(Low-Gain mode)
• High gain(Gain)	16.7 dB typ.	fRX = 2140 MHz	(High-Gain mode)
	16.7 dB typ.	fRX = 884.5 MHz	(High-Gain mode)
	16.5 dB typ.	fRX = 1862.5 MHz	(High-Gain mode)
• Low noise figure(NF)	1.75 dB typ.	fRX = 2140 MHz	(High-Gain mode)
	1.80 dB typ.	fRX = 884.5 MHz	(High-Gain mode)
	1.65 dB typ.	fRX = 1862.5 MHz	(High-Gain mode)
• Low distortion	0.0 dBm typ.	fRX = 2140 MHz	(High-Gain mode)
(IIP3 +10 MHz offset)	−5.0 dBm typ.	fRX = 884.5 MHz	(High-Gain mode)
	−3.0 dBm typ.	fRX = 1862.5 MHz	(High-Gain mode)

- Small package(WLCSP)

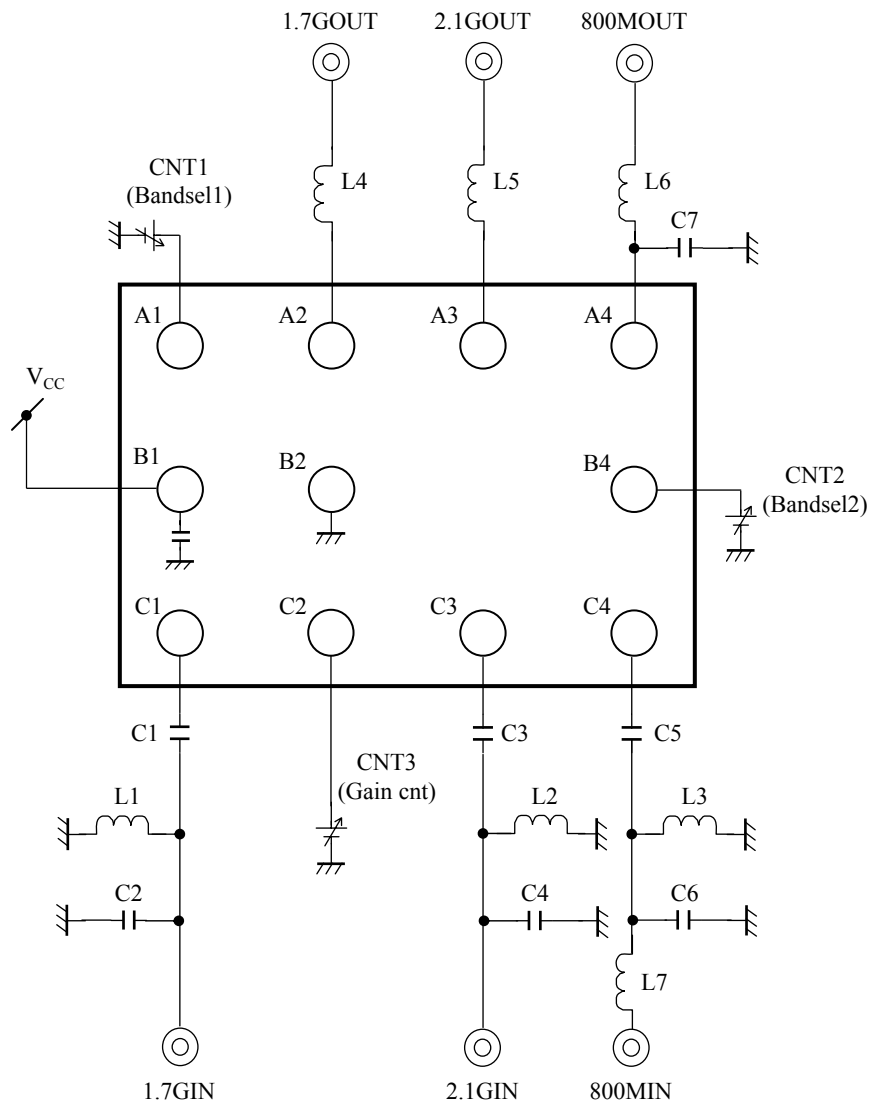### ■ Applications
- UMTS triple-band handset

■ Package
- 11 pin Wafer level chip size package (WLCSP)
  Size : 1.16 mm × 1.56 mm (0.4 mm pitch)

■ Type
- Bi-CMOS IC

■ Application Circuit Example (Block Diagram)

(Top View)

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.
• This block diagram is for explaining functions. Part of the block diagram may be omitted, or it may be simplified.
• External components : See page 29.

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■ Pin Descriptions

Pin No.	Pin name	Type	Description
A1	CNT1	Input	Band Selective SW1
A2	OUT1	Output	1.7 GHz RF Output
A3	OUT2	Output	2.1 GHz RF Output
A4	OUT3	Output	800 MHz RF Output
B1	V_{CC}	Power Supply	V_{CC}
B2	GND	Ground	GND
B4	CNT2	Input	Band Selective SW2
C1	IN1	Input	1.7 GHz RF Input
C2	CNT3	Input	High-Gain / Low-Gain Selective SW
C3	IN2	Input	2.1 GHz RF Input
C4	IN3	Input	800 MHz RF Input

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■ Absolute Maximum Ratings

Note) Absolute maximum ratings are limit values which do not result in damages to this IC, and IC operation is not guaranteed at these limit values.

A No.	Parameter	Symbol	Rating	Unit	Notes
1	Supply voltage	V_{CC}	3.6	V	*1
2	Supply current	I_{CC}	20	mA	—
3	Power dissipation	P_D	50.8	mW	*2
4	Operating ambient temperature	T_{opr}	−30 to +85	°C	*3
5	Storage temperature	T_{stg}	−55 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 in the ■ Technical Data 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}	2.7 to 2.875	V	*1

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

■ Allowable Current and Voltage Range

Notes) • Allowable current and voltage ranges are limit ranges which do not result in damages to this IC, and IC operation is not guaranteed within
these limit ranges.
• Voltage values, unless otherwise specified, are with respect to GND.
• Do not apply external currents or voltages to any pin not specifically mentioned.

Pin No.	Pin name	Rating	Unit	Notes
A1	CNT1	-0.3 to $(V_{CC} + 0.3)$	V	*2
A2	OUT1	-0.3 to $(V_{CC} + 0.3)$	V	*2
A3	OUT2	-0.3 to $(V_{CC} + 0.3)$	V	*2
A4	OUT3	-0.3 to $(V_{CC} + 0.3)$	V	*2
B4	CNT2	-0.3 to $(V_{CC} + 0.3)$	V	*2
C1	IN1	—	V	*1
C2	CNT3	-0.3 to $(V_{CC} + 0.3)$	V	*2
C3	IN2	—	V	*1
C4	IN3	—	V	*1

Notes) *1 : Do not apply more than 0 dBm at high gain mode (5 dBm at low gain mode) to RF input.
This is a RF signal input pin. Do not apply DC.

*2 : $(V_{CC} + 0.3)$ V must not be exceeded 3.6 V.

■ Electrical Characteristics at V_{CC} = 2.80 V

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

B No.	Parameter	Symbol	Conditions	Limits			Unit	Notes
				Min	Typ	Max		
DC electrical characteristics								
DC-1	Circuit current HG (2.1 GHz)	IccHSa	V_{CC} current at 2.1 GHz , High-Gain mode. No input signal.	—	3.3	4.25	mA	—
DC-2	Circuit current HG (800 MHz)	IccHSb	V_{CC} current at 800 MHz , High-Gain mode. No input signal.	—	3.3	4.25	mA	—
DC-3	Circuit current HG (1.7 GHz)	IccHSc	V_{CC} current at 1.7 GHz , High-Gain mode. No input signal.	—	3.3	4.25	mA	—
DC-4	Circuit current LG (2.1 GHz)	IccLSa	V_{CC} current at 2.1 GHz , Low-Gain mode. No input signal.	—	11	35	µA	—
DC-5	Circuit current LG (800 MHz)	IccLSb	V_{CC} current at 800 MHz , Low-Gain mode. No input signal.	—	25	50	µA	—
DC-6	Circuit current LG (1.7 GHz)	IccLSc	V_{CC} current at 1.7 GHz , Low-Gain mode. No input signal.	—	25	50	µA	—
DC-7	SW voltage (High)	VIHS	—	2.16	—	2.875	V	—
DC-8	SW voltage (Low)	VILS	—	0	—	0.6	V	—
DC-9	SW Current (High)	IIHS	Current at SW pin VIHS = 2.9 V	—	10	20	µA	—
DC-10	SW Current (Low)	IILS	Current at SW pin VILS = 0 V	—	10	20	µA	—

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■ Electrical Characteristics (continued) V_{CC} = 2.80 V

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

B No.	Parameter	Symbol	Conditions	Limits			Unit	Notes
				Min	Typ	Max		
2.1 GHz : LNA AC characteristics (High-gain mode / Low-gain mode)								
A-1	Gain Step	GΔSa	GΔSa = GHSa – GLSa	18.2	21.7	23.5	dB	—
2.1 GHz : LNA AC characteristics (High-gain mode)								
A-2	Power gain	GHSa	f1 = fRXa f2 = fRXa – 190 MHz PRX1 = –30 dBm PRX2 = –24 dBm Input 2 signals (f1, f2)	15.3	16.7	18.0	dB	—
A-3	IIP3	IIP3H1Sa	f1 = fRXa + 10 MHz f2 = fRXa + 20 MHz Input 2 signals (f1, f2)	–10	0	—	dBm	—
2.1 GHz : LNA AC characteristics (Low-gain mode)								
A-4	Power gain	GLSa	f1 = fRXa f2 = fRXa – 190 MHz PRX1 = –24 dBm PRX2 = –24 dBm Input 2 signals (f1, f2)	–6.1	–5.0	–4.0	dB	—

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■ Electrical Characteristics (continued) V_{CC} = 2.80 V

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

B No.	Parameter	Symbol	Conditions	Limits			Unit	Notes
				Min	Typ	Max		
800 MHz : LNA AC characteristics (High-gain mode / Low-gain mode)								
B-1	Gain Step	GΔSb	GΔSb = GHSb – GLSb	18.2	22.2	23.8	dB	—
800 MHz : LNA AC characteristics (High-gain mode)								
B-2	Power gain	GHSb	f1 = fRXb f2 = fRXb – 45 MHz PRX1 = –30 dBm PRX2 = –24 dBm Input 2 signals (f1, f2)	15.5	16.7	18.0	dB	—
B-3	IIP3	IIP3H1Sb	f1 = fRXb + 10 MHz f2 = fRXb + 20 MHz Input 2 signals (f1, f2)	–10	–5	—	dBm	—
800 MHz : LNA AC characteristics (Low-gain mode)								
B-4	Power gain	GLSb	f1 = fRXb f2 = fRXb – 45 MHz PRX1 = –24 dBm PRX2 = –24 dBm Input 2 signals (f1, f2)	–5.9	–5.5	–4.0	dB	—

■ Electrical Characteristics (continued) V_{CC} = 2.80 V

Note) All parameters are specified under T_a = 25°C±2°C, fRXc = 1862.5 MHz, PRXc = –30 dBm, CW unless otherwise specified.

B No.	Parameter	Symbol	Conditions	Limits			Unit	Notes
				Min	Typ	Max		
1.7 GHz : LNA AC characteristics (High-gain mode / Low-gain mode)								
C-1	Gain Step	GΔSc	GΔSc = GHSc – GLSc	17.9	21.5	23.7	dB	—
1.7 GHz : LNA AC characteristics (High-gain mode)								
C-2	Power gain	GHSc	f1 = fRXc f2 = fRXc – 95 MHz PRX1 = –30 dBm PRX2 = –24 dBm Input 2 signals (f1, f2)	15.0	16.5	17.8	dB	—
C-3	IIP3	IIP3H1Sc	f1 = fRXc + 10 MHz f2 = fRXc + 20 MHz Input 2 signals (f1, f2)	–7.5	–3	—	dBm	—
1.7 GHz : LNA AC characteristics (Low-gain mode)								
C-4	Power gain	GLSc	f1 = fRXc f2 = fRXc – 95 MHz PRX1 = –24 dBm PRX2 = –24 dBm Input 2 signals (f1, f2)	–6.0	–5.0	–4.0	dB	—

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■ Electrical Characteristics (Reference values for design) at V_{CC} = 2.8 V

Notes) • All characteristics are specified under T_a = 25°C±2°C, fRXa = 2110 MHz to 2170 MHz, PRXa = –30 dBm, CW
     • The characteristics listed below are reference values derived from the design of the IC and are not guaranteed by inspection.
      If a problem does occur related to these characteristics, we will respond in good faith to user concerns.

B No.	Parameter	Symbol	Conditions	Reference values			Unit	Notes
				Min	Typ	Max		
2.1 GHz : LNA AC characteristics (High-gain mode / Low-gain mode)								
D-1	Gain Step	G∆a	G∆a = GHa – GLa	18.2	21.7	23.5	dB	—
D-2	In - band gain deviation	Gch∆a	—	—	—	1.8	dB	—
2.1 GHz : LNA AC characteristics (High-gain mode)								
D-3	Input VSWR	Vswr_inHa	—	—	—	2.1	—	—
D-4	Output VSWR	Vswr_outHa	—	—	—	2.3	—	—
D-5	Power gain	GHa	f1 = fRXa f2 = fRXa – 190 MHz PRX1 = –30 dBm PRX2 = –24 dBm Input 2 signals (f1, f2)	15.3	16.7	18.0	dB	—
D-6	Noise figure	NFHa	f1 = fRXa f2 = fRXa – 190 MHz PRX2 = –24 dBm Input 2 signals (f1, f2)	—	1.75	1.95	dB	—
D-7	IIP3	IIP3H1a	f1 = fRXa + 10 MHz f2 = fRXa + 20 MHz Input 2 signals (f1, f2)	–10	0	—	dBm	—
D-8	Reverse isolation	Ris_H1a	2 .1GHz band Output → 2 .1GHz band input f = 1920 to 2170 MHz	—	–34	–30	dB	—

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■ Electrical Characteristics (Reference values for design) (continued) at V_{CC} = 2.8 V

Notes) ● All characteristics are specified under T_a = 25°C±2°C, fRXa = 2110 MHz to 2170 MHz, PRXa = –30 dBm, CW
  ● The characteristics listed below are reference values derived from the design of the IC and are not guaranteed by inspection.
    If a problem does occur related to these characteristics, we will respond in good faith to user concerns.

B No.	Parameter	Symbol	Conditions	Reference values			Unit	Notes
				Min	Typ	Max		
2.1 GHz : LNA AC characteristics (Low-gain mode)								
D-9	Input VSWR	Vswr_inLa	—	—	—	2.1	—	—
D-10	Output VSWR	Vswr_outLa	—	—	—	2.5	—	—
D-11	Power gain	GLa	f1 = fRXa f2 = fRXa – 190 MHz PRX1 = –24 dBm PRX2 = –24 dBm Input 2 signals (f1, f2)	–6.1	–5.0	–4.0	dB	—
D-12	Noise figure	NFLa	f1 = fRXa f2 = fRXa – 190 MHz PRX2 = –24 dBm Input 2 signals (f1, f2)	—	5	6.8	dB	—
D-13	IIP3	IIP3_LGa	f1 = fRXa + 3.5 MHz f2 = fRXa + 6.5 MHz PRX1 = –15 dBm PRX2 = –15 dBm Input 2 signals (f1, f2)	2	20	—	dBm	—
D-14	Reverse isolation	Ris_L1a	2 .1GHz band Output → 2.1 GHz band input	–6.1	–5.0	–4.0	dB	—

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■ Electrical Characteristics (Reference values for design) (continued) at V_CC = 2.8 V

Notes) ● All characteristics are specified under T_a = 25°C±2°C, fRXb = 869 MHz to 895 MHz, PRXb = –30 dBm, CW
　　　　● The characteristics listed below are reference values derived from the design of the IC and are not guaranteed by inspection.
　　　　　If a problem does occur related to these characteristics, we will respond in good faith to user concerns.

B No.	Parameter	Symbol	Conditions	Min	Typ	Max	Unit	Notes
800 MHz : LNA AC characteristics (High-gain mode / Low-gain mode)								
E-1	Gain Step	GΔb	GΔb = GHb – GLb	18.2	22.2	23.8	dB	—
E-2	In - band gain deviation	GchΔb	—	—	—	1.8	dB	—
800 MHz : LNA AC characteristics (High-gain mode)								
E-3	Input VSWR	Vswr_inHb	—	—	—	1.8	—	—
E-4	Output VSWR	Vswr_outHb	—	—	—	2.0	—	—
E-5	Power gain	GHb	f1 = fRXb f2 = fRXb – 45 MHz PRX1 = –30 dBm PRX2 = –24 dBm Input 2 signals (f1, f2)	15.5	16.7	18.0	dB	—
E-6	Noise figure	NFHb	f1 = fRXb f2 = fRXb – 45 MHz PRX2 = –24 dBm Input 2 signals (f1, f2)	—	1.8	2.0	dB	—
E-7	IIP3	IIP3H1b	f1 = fRXb + 10 MHz f2 = fRXb + 20 MHz Input 2 signals (f1, f2)	–10	–5	—	dBm	—
E-8	Reverse isolation	Ris_H2b	800 MHz band Output → 　　　　800 MHz band input f = 830 to 885 MHz	—	–26	–21.5	dB	—

■ Electrical Characteristics (Reference values for design) (continued) at V_{CC} = 2.8 V

Notes) • All characteristics are specified under T_a = 25°C±2°C, fRXb = 869 MHz to 895 MHz, PRXb = –30 dBm, CW
   • The characteristics listed below are reference values derived from the design of the IC and are not guaranteed by inspection.
     If a problem does occur related to these characteristics, we will respond in good faith to user concerns.

B No.	Parameter	Symbol	Conditions	Reference values			Unit	Notes
				Min	Typ	Max		
800 MHz : LNA AC characteristics (Low-gain mode)								
E-9	Input VSWR	Vswr_inLb	—	—	—	1.8	—	—
E-10	Output VSWR	Vswr_outLb	—	—	—	1.8	—	—
E-11	Power gain	GLb	f1 = fRXb f2 = fRXb – 45 MHz PRX1 = –24 dBm PRX2 = –24 dBm Input 2 signals (f1, f2)	–5.9	–5.5	–4.2	dB	—
E-12	Noise figure	NFLb	f1 = fRXb f2 = fRXb – 45 MHz PRX2 = –24 dBm Input 2 signals (f1, f2)	—	5.5	7	dB	—
E-13	IIP3	IIP3_LGb	f1 = fRXb + 3.5 MHz f2 = fRXb + 6.5 MHz PRX1 = –15 dBm PRX2 = –15 dBm Input 2 signals (f1, f2)	2	20	—	dBm	—
E-14	Reverse isolation	Ris_L2b	800 MHz band Output → 800 MHz band input	–5.9	–5.5	–4.2	dB	—

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■ Electrical Characteristics (Reference values for design) (continued) at V_{CC} = 2.8 V

Notes) • All characteristics are specified under T_a = 25°C±2°C, fRXc = 1844.9 MHz to1879.9 MHz, PRXc = –30 dBm, CW
   • The characteristics listed below are reference values derived from the design of the IC and are not guaranteed by inspection.
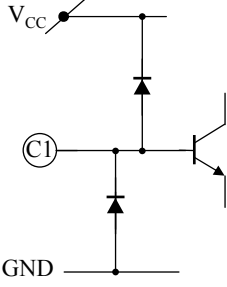   If a problem does occur related to these characteristics, we will respond in good faith to user concerns.

B No.	Parameter	Symbol	Conditions	Reference values			Unit	Notes
				Min	Typ	Max		
1.7 GHz : LNA AC characteristics (High-gain mode / Low-gain mode)								
F-1	Gain Step	GΔc	GΔc = GHc – GLc	17.9	21.5	23.7	dB	—
F-2	In - band gain deviation	GchΔc	—	—	—	1.8	dB	—
1.7 GHz : LNA AC characteristics (High-gain mode)								
F-3	Input VSWR	Vswr_inHc	—	—	—	2.0	—	—
F-4	Output VSWR	Vswr_outHc	—	—	—	2.1	—	—
F-5	Power gain	GHc	f1 = fRXc f2 = fRXc – 95 MHz PRX1 = –30 dBm PRX2 = –24 dBm Input 2 signals (f1, f2)	15.0	16.5	17.8	dB	—
F-6	Noise figure	NFHc	f1 = fRXc f2 = fRXc – 95 MHz PRX2 = –24 dBm Input 2 signals (f1, f2)	—	1.65	1.85	dB	—
F-7	IIP3	IIP3H1c	f1 = fRXc + 10 MHz f2 = fRXc + 20 MHz Input 2 signals (f1, f2)	–7.5	–3	—	dBm	—
F-8	Reverse isolation	Ris_H3c	1.7 GHz band Output → 1.7 GHz band input f = 1745 to 1880 MHz	—	–37	–32	dB	—

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■ Electrical Characteristics (Reference values for design) (continued) at V_{CC} = 2.8 V

Notes) • All characteristics are specified under T_a = 25°C±2°C, fRXc = 1844.9 MHz to 1879.9 MHz, PRXc = −30 dBm, CW
          • The characteristics listed below are reference values derived from the design of the IC and are not guaranteed by inspection.
           If a problem does occur related to these characteristics, we will respond in good faith to user concerns.

B No.	Parameter	Symbol	Conditions	Reference values			Unit	Notes
				Min	Typ	Max		
1.7 GHz : LNA AC characteristics (Low-gain mode)								
F-9	Input VSWR	Vswr_inLc	—	—	—	1.8	—	—
F-10	Output VSWR	Vswr_outLc	—	—	—	2.4	—	—
F-11	Power gain	GLc	f1 = fRXc f2 = fRXc − 95 MHz PRX1 = −24 dBm PRX2 = −24 dBm Input 2 signals (f1, f2)	−6.0	−5.0	−4.0	dB	—
F-12	Noise figure	NFLc	f1 = fRXc f2 = fRXc − 95 MHz PRX2 = −24 dBm Input 2 signals (f1, f2)	—	5.0	6.8	dB	—
F-13	IIP3	IIP3_LGc	f1 = fRXc + 3.5 MHz f2 = fRXc + 6.5 MHz PRX1 = −15 dBm PRX2 = −15 dBm Input 2 signals (f1, f2)	2.0	20	—	dBm	—
F-14	Reverse isolation	Ris_L3c	1.7 GHz band Output → 1.7 GHz band input	−6.0	−5.0	−4.0	dB	—

■ Control Pins Mode Table
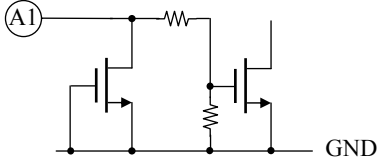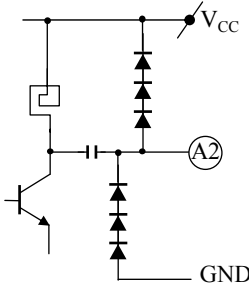
Note) Control voltage range : See B No. DC-7 / B No. DC-8 at page 8.

CNT1 (Band Select1) (A1)	CNT2 (Band Select2) (B4)	CNT3 (Gain Control) (C2)	Band1 (2.1 GHz)	Band2 (800 MHz)	Band3 (1.7 GHz)	Mode
Low	Low	High	High-Gain	Off	Off	2.1 GHz High-Gain
		Low	Low-Gain	Off	Off	2.1 GHz Low-Gain
High	Low	High	Off	High-Gain	Off	800 MHz High-Gain
		Low	Off	Low-Gain	Off	800 MHz Low-Gain
Low	High	High	Off	Off	High-Gain	1.7 GHz High-Gain
		Low	Off	Off	Low-Gain	1.7 GHz Low-Gain
High	High	—	—	—	—	—

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■ Technical Data

• I/O block circuit diagrams and pin function descriptions

Note) The characteristics listed below are reference values derived from the design of the IC and are not guaranteed.

Pin No.	Voltage	Internal Circuit	Description
A1	—		2.1 GHz / 800 MHz / 1.7 GHz Band selective SW 1 0.60 V or less : Low 2.16 V or more : High
A2	—		1.7 GHz LNA RF Output
A3	—	Refer to A2	2.1 GHz LNA RF Output
A4	—	Refer to A2	800 MHz LNA RF Output
B1	2.8 V	—	Voltage supply (V_{CC})
B2	0.0 V	—	GND
B4	—	Refer to A1	2.1 GHz / 800 MHz / 1.7 GHz Band selective SW 2 0.60 V or less : Low 2.16 V or more : High

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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 derived from the design of the IC and are not guaranteed.

Pin No.	Voltage	Internal Circuit	Description
C1	0.75 V	V_{CC} ... (C1) ... GND	1.7 GHz LNA RF Input
C2	—	Refer to A1	High-Gain / Low-Gain selective SW 0.60 V or less : Low 2.16 V or more : High
C3	0.75 V	Refer to C1	2.1 GHz LNA RF Input
C4	0.75 V	Refer to C1	800 MHz LNA RF Input

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■ Technical Data

• P_D — T_a diagram

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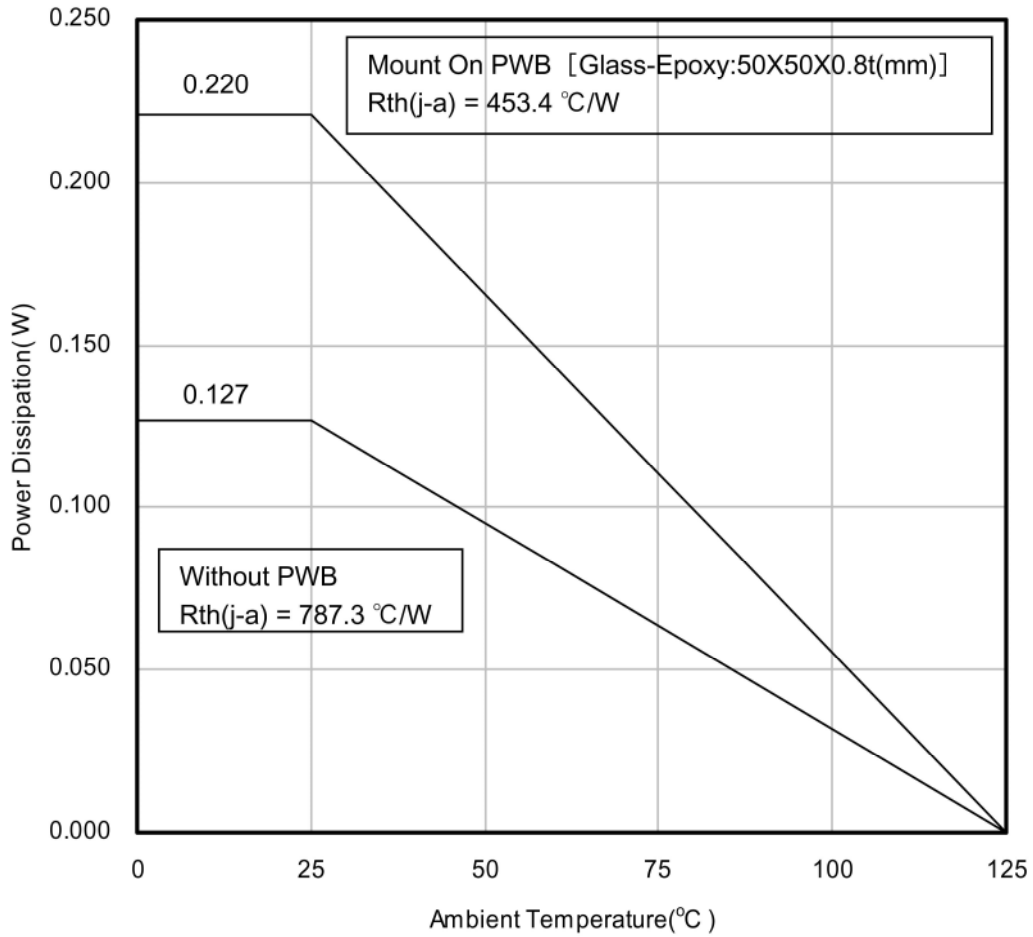
■ Usage Notes

● Special attention and precaution in using

1. This IC is intended to be used for general electronic equipment [UMTS Triple – Band 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
   It is to be understood that our company shall not be held responsible for any damage incurred as a result of or in connection with your using the IC described in this book for any special application, unless our company agrees to your using the IC in this book for any special application.

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 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 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.

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

8. 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.

9. Due to unshielded structure of this IC, under exposure of light, function and characteristic of the product cannot be guaranteed. During normal operation or even under testing condition, please ensure that IC is not exposed to light.

10. Basically, chip surface is ground potential. Please design to ensure no contact between chip surface and metal shielding.