

**Single Chip GPS LSI**

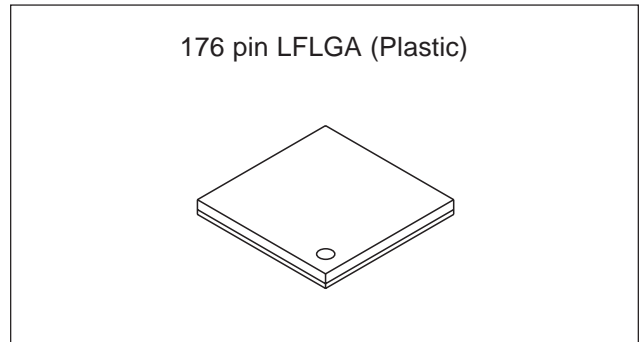
**Description**

The CXD2951GA-2 is a dedicated single chip LSI for the GPS (Global Positioning System), satellite-based location measurement system. This LSI enables the configuration of a single chip system providing a cost-effective, low-power solution.

Compared with conventional methods, position detection time and sensitivity are substantially improved with the use of an advanced signal processing scheme. With the integration of both the Radio and baseband blocks into a single CMOS IC, the CXD2951GA-2 is ideal for use in automotive, cellular handset, handheld navigation, mobile computing and other location-based applications.

**Features**

- 12-channel GPS receiver capable of simultaneously receiving 12 satellites
- Reception frequency: 1575.42MHz (L1 band, CA code)
- Reference clock (TCXO) frequency: 18.414MHz (GPS, Sony standard),  
The unique frequency of major applications is available, such as GSM and W-CDMA. (optional)
  - 13.000MHz (GSM),
  - 14.400MHz (CDMA),
  - 16.368MHz (GPS),
  - 19.800MHz (PDC/CDMA),
  - 26.000MHz (GSM)
- 32 bits RISC CPU (ARM7TDMI)
- 288K-bytes Program ROM
- 72K-bytes Data RAM  
Power is supplied only to 8K-byte Data RAM while in backup mode.
- System power management
- 1-channel UART
- Internal RTC (Real Time Clock)
- 10-bit successive approximation system A/D converter, A/D data available on NMEA messages
- All-in-view positioning
- Communication format: Supports NMEA-0183
- 1 PPS output
- Supports assisted-GPS for cellular (optional)



**Radio**

- Image Rejection Mixer
- VCO Tank
- IF Filters

**Structure**

Silicon gate CMOS IC

**Absolute Maximum Ratings**

• Supply voltage I/O	IOV <sub>DD</sub>	-0.5 to +4.6	V
• Supply voltage core	CV <sub>DD</sub>	-0.5 to +2.5	V
• Supply voltage radio	V <sub>DD</sub>	-0.5 to +2.5	V
• Input voltage	V <sub>I</sub>	-0.5 to +6	V
• Output voltage	V <sub>O</sub>	-0.5 to +6	V
• Operating temperature	Topr	-40 to +85	°C
• Storage temperature	Tstg	-50 to +150	°C

**Recommended Operating Conditions**

• Supply voltage I/O	IOV <sub>DD</sub>	3.0 to 3.6	V
* Under operation with internal ROM, using no external expansion bus:			
	IOV <sub>DD</sub>	2.6 to 3.6	V
* Under operation in backup mode:			
	BKUPIOV <sub>DD</sub>	2.5 (Min.)	V
• Supply voltage core	CV <sub>DD</sub>	1.62 to 1.98	V
• Supply voltage radio	V <sub>DD</sub>	1.62 to 1.98	V
• Operating temperature	Topr	-40 to +85	°C

**Input/Output Pin Capacitance (Baseband)**

• Input capacitance	C <sub>IN</sub>	9 (Max.)	pF
• Output capacitance	C <sub>OUT</sub>	11 (Max.)	pF
• I/O capacitance	C <sub>I/O</sub>	11 (Max.)	pF

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## Performance

### Baseband

- Tracking sensitivity: -152dBm (average) or less
- Acquisition sensitivity: -139dBm (average) or less in Normal mode  
-150dBm (average) or less in High sensitivity mode
  - \* Reference data using the Sony's reference board when using both an antenna of 0dBi and a RF amplifier with  $NF \leq 2\text{dB}$ , 25dB gain.
- TTFF (Time to First Fix):  
Time until initial position measurement after power-on with the following conditions:
  - Cold Start (without both ephemeris and almanac time): 50s (average) / 60s (95% possibility)
  - Warm Start (without ephemeris but with almanac time): 35s (average) / 40s (95% possibility)
  - Hot Start (with both ephemeris and almanac time): 2s (minimum) / 6s (95% possibility)
  - \* Reference data with elevation angle of 5° or more and no interception environment with satellite powers  $\geq -130\text{dBm}$ . (Not in High sensitivity mode)

**Note)** "95% possibility" means "position time with 95% possibility".
- Positioning accuracy:  
2DRMS: approx. 5m
  - \* Reference data with elevation angle of 5° or more and no interception environment with satellite powers  $\geq -130\text{dBm}$ .
- Measurement data update time: 1s
- Power consumption:
  - 50mW (average) while position calculating with tracking satellites in low power mode
  - 120mW (average) while position calculating with acquiring and tracking satellites
  - \* Reference data using the Sony's reference board when the reference clock input is 18.414MHz, and its amplitude is 3.3V swing.
- 1PPS output  
1 $\mu\text{s}$  or less precision, 1PPS outputs from ECLKOUT (Pin 97).

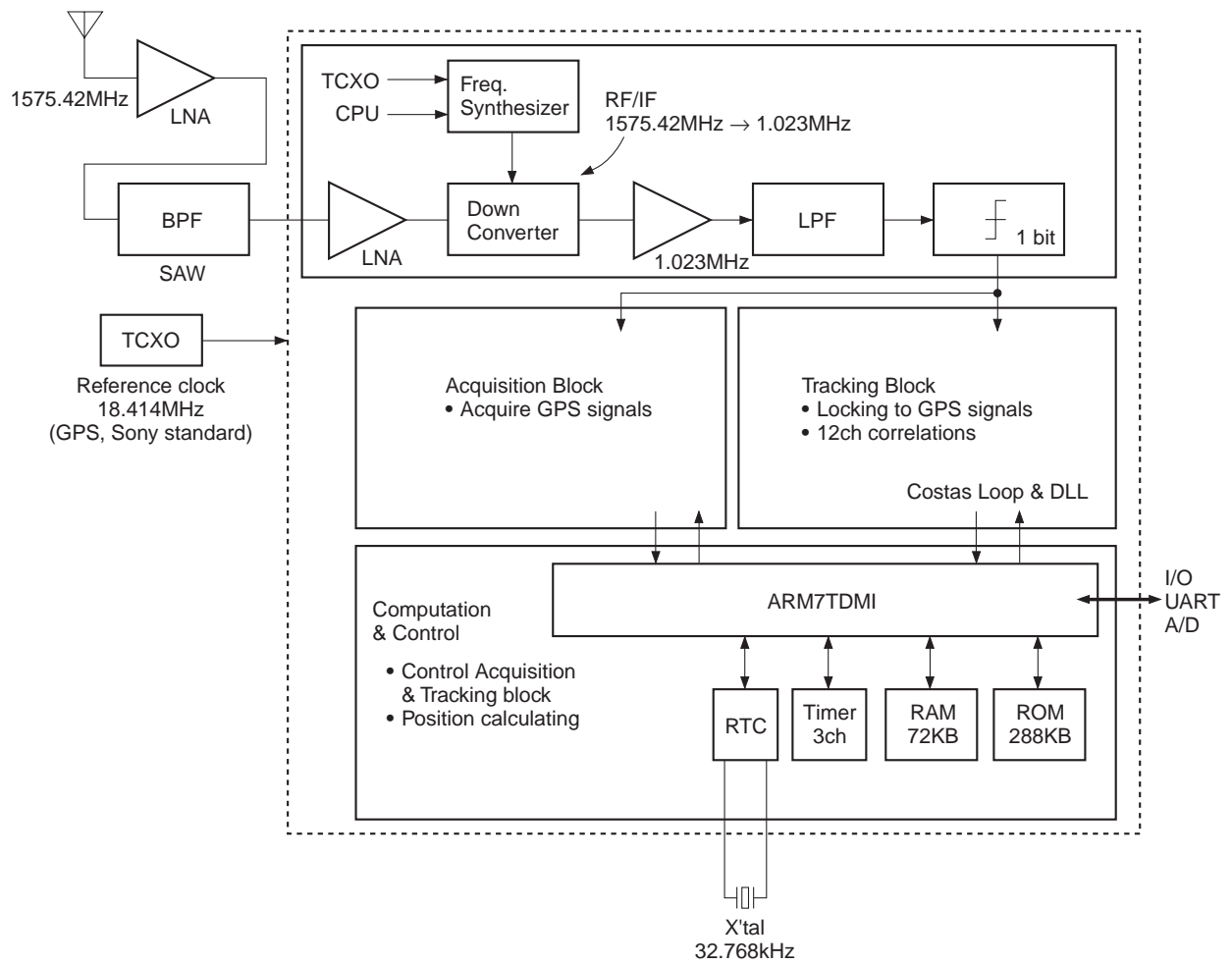
**Note)** These values are not guaranteed, depending on the conditions.

### Radio

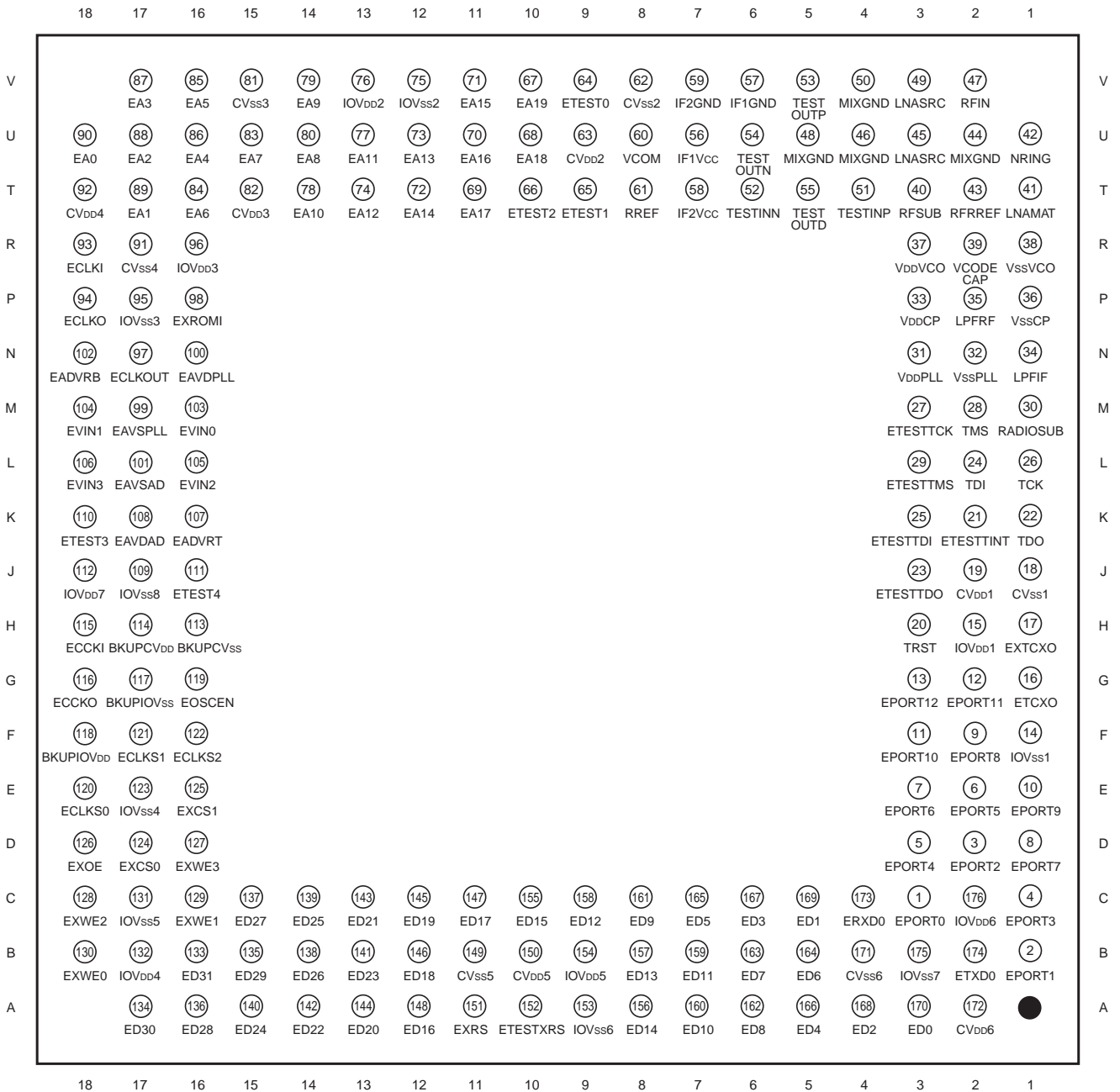
- Total Gain (typ.):  
100dB
- Noise figure (typ.):  
8dB
- Synthesizer phase noise (typ.):  
-70dBc/Hz (10kHz)  
-80dBc/Hz (100kHz)
- PLL spurious (typ.):  
-45dBc (inside fosc  $\pm 1.023\text{MHz}$ )  
-55dBc (outside fosc  $\pm 1.023\text{MHz}$ )

**Note)** These values are not guaranteed.

System Block Diagram



Pin Configuration (Top View)



● : Pin 1 index.

## Pin Description

Pin No.	Symbol	I/O	Description
1	EPOR0	I/O/Z	I/O port 0 (with a software controllable pull-down resistor, Connected to GND with a resistor.)
2	EPOR1	I/O/Z	I/O port 1 (with a software controllable pull-down resistor, See software application note.)
3	EPOR2	I/O/Z	I/O port 2 (with a software controllable pull-down resistor, See software application note.)
4	EPOR3	I/O/Z	I/O port 3 (with a software controllable pull-down resistor, See software application note.)
5	EPOR4	I/O/Z	I/O port 4 (with a software controllable pull-down resistor, See software application note.)
6	EPOR5	I/O/Z	I/O port 5 (with a software controllable pull-down resistor, See software application note.)
7	EPOR6	I/O/Z	I/O port 6 (with a software controllable pull-down resistor, See software application note.)
8	EPOR7	I/O/Z	I/O port 7 (with a software controllable pull-down resistor, See software application note.)
9	EPOR8	I/O/Z	I/O port 8 (with a software controllable pull-down resistor, See software application note.)
10	EPOR9	I/O/Z	I/O port 9 (with a software controllable pull-down resistor, See software application note.)
11	EPOR10	I/O/Z	I/O port 10 (with a software controllable pull-down resistor, See software application note.)
12	EPOR11	I/O/Z	I/O port 11 (with a software controllable pull-down resistor, See software application note.)
13	EPOR12	I/O/Z	I/O port 12 (with a software controllable pull-down resistor, See software application note.)
14	IOVss1		GND
15	IOVDD1		3.3V
16	ETCXO	I	TCXO oscillator (Frequency selectable, See software application note.)
17	EXTCXO	O	
18	CVss1		GND
19	CVDD1		1.8V
20	TRST	I	Test (Open, with a pull-down resistor)
21	ETESTTINT	O	Test
22	TDO	O	Test
23	ETESTTDO	O	Test
24	TDI	I	Test (Open, with a pull-up resistor)
25	ETESTTDI	I	Test (Open, with a pull-up resistor)
26	TCK	I	Test (Open, with a pull-down resistor)
27	ETESTTCK	I	Test (Open, with a pull-down resistor)
28	TMS	I	Test (Open, with a pull-up resistor)

Pin No.	Symbol	I/O	Description
29	ETESTTMS	I	Test (Open, with a pull-up resistor)
30	RADIOSUB	*	Radio GND
31	V <sub>DD</sub> PLL	*	PLL 1.8V
32	V <sub>SS</sub> PLL	*	PLL GND
33	V <sub>DD</sub> CP	*	Charge pump 1.8V
34	LPFIF	*	Loop filter for IF PLL
35	LPFRF	*	Loop filter for RF PLL
36	V <sub>SS</sub> CP	*	Charge pump GND
37	V <sub>DD</sub> VCO	*	VCO 1.8V
38	V <sub>SS</sub> VCO	*	VCO GND
39	VCODECAP	*	VCO decap pin
40	RFSUB	*	RF GND
41	LNAMAT	*	LNA 1.8V
42	NRING	*	LNA 1.8V
43	RFRREF	*	External resistor pin
44	MIXGND	*	Mixer GND
45	LNASRC	*	LNA GND
46	MIXGND	*	Mixer GND
47	RFIN	*	RF input
48	MIXGND	*	Mixer GND
49	LNASRC	*	LNA GND
50	MIXGND	*	Mixer GND
51	TESTINP	*	Radio test (Open)
52	TESTINN	*	Radio test (Open)
53	TESTOUTP	*	Radio test
54	TESTOUTN	*	Radio test
55	TESTOUTD	*	Radio test (Open)
56	IF1V <sub>CC</sub>	*	1st IF 1.8V
57	IF1GND	*	1st IF GND
58	IF2V <sub>CC</sub>	*	2nd IF 1.8V
59	IF2GND	*	2nd IF GND
60	VCOM	*	IF common voltage
61	RREF	*	External resistor pin
62	CV <sub>SS</sub> 2		GND
63	CV <sub>DD</sub> 2		1.8V

\* Radio analog pins: See page 10 to 12 for details.

Pin No.	Symbol	I/O	Description
64	ETEST0	I	Test (Connect to GND.)
65	ETSET1	I	
66	ETEST2	I	
67	EA19	O/Z	External expansion address 19
68	EA18	O/Z	External expansion address 18
69	EA17	O/Z	External expansion address 17
70	EA16	O/Z	External expansion address 16
71	EA15	O/Z	External expansion address 15
72	EA14	O/Z	External expansion address 14
73	EA13	O/Z	External expansion address 13
74	EA12	O/Z	External expansion address 12
75	IOVss2		GND
76	IOVDD2		3.3V
77	EA11	O/Z	External expansion address 11
78	EA10	O/Z	External expansion address 10
79	EA9	O/Z	External expansion address 9
80	EA8	O/Z	External expansion address 8
81	CVss3		GND
82	CVDD3		1.8V
83	EA7	O/Z	External expansion address 7
84	EA6	O/Z	External expansion address 6
85	EA5	O/Z	External expansion address 5
86	EA4	O/Z	External expansion address 4
87	EA3	O/Z	External expansion address 3
88	EA2	O/Z	External expansion address 2
89	EA1	O/Z	External expansion address 1
90	EA0	O/Z	External expansion address 0
91	CVss4		GND
92	CVDD4		1.8V
93	ECLKI	I	CPU clock oscillator
94	ECLKO	O	
95	IOVss3		GND
96	IOVDD3		3.3V
97	ECLKOUT	O/Z	1PPS output (Effective 1s late after reset release)
98	EXROMI	I	Boot selection (Low: Internal ROM, High: External Memory/EXCS0)
99	EAVSPLL		PLL GND
100	EAVDPLL		PLL 3.3V

Pin No.	Symbol	I/O	Description
101	EAVSAD		A/D converter GND
102	EADVRB	I	A/D converter Reference input Bottom
103	EVIN0	I	A/D converter Analog input 0
104	EVIN1	I	A/D converter Analog input 1
105	EVIN2	I	A/D converter Analog input 2
106	EVIN3	I	A/D converter Analog input 3
107	EADVRT	I	A/D converter Reference input Top
108	EAVDAD		A/D converter 3.3V
109	IOV <sub>ss8</sub>		GND
110	ETEST3	I/O/Z	(Connect to GND with a resistor.)
111	ETEST4	I/O/Z	(Connect to GND with a resistor.)
112	IOV <sub>DD7</sub>		3.3V
113	BKUPCV <sub>ss</sub>		Backup core power supply GND
114	BKUPCV <sub>DD</sub>		Backup core power supply 1.8V
115	ECCKI	I	RTC oscillator (32.768kHz)
116	ECCKO	O	
117	BKUPIOV <sub>ss</sub>		Backup I/O power supply GND
118	BKUPIOV <sub>DD</sub>		Backup I/O power supply 3.3V
119	EOSCEN	I	Oscillator enable (H-Active), See backup mode section.
120	ECLKS0	I	Test (Connect to GND.)
121	ECLKS1	I	Test (Connect to GND.)
122	ECLKS2	I	Test (Connect to GND.)
123	IOV <sub>ss4</sub>		GND
124	EXCS0	O/Z	External expansion chip selection 0 (Program boot is enable if EXROMI is high.)
125	EXCS1	O/Z	External expansion chip selection 1
126	EXOE	O/Z	External expansion read signal
127	EXWE3	O/Z	External expansion write signal
128	EXWE2	O/Z	External expansion write signal
129	EXWE1	O/Z	External expansion write signal
130	EXWE0	O/Z	External expansion write signal
131	IOV <sub>ss5</sub>		GND
132	IOV <sub>DD4</sub>		3.3V
133	ED31	I/O	External expansion data 31 (with a pull-down resistor)
134	ED30	I/O	External expansion data 30 (with a pull-down resistor)
135	ED29	I/O	External expansion data 29 (with a pull-down resistor)
136	ED28	I/O	External expansion data 28 (with a pull-down resistor)
137	ED27	I/O	External expansion data 27 (with a pull-down resistor)
138	ED26	I/O	External expansion data 26 (with a pull-down resistor)



Pin No.	Symbol	I/O	Description
139	ED25	I/O	External expansion data 25 (with a pull-down resistor)
140	ED24	I/O	External expansion data 24 (with a pull-down resistor)
141	ED23	I/O	External expansion data 23 (with a pull-down resistor)
142	ED22	I/O	External expansion data 22 (with a pull-down resistor)
143	ED21	I/O	External expansion data 21 (with a pull-down resistor)
144	ED20	I/O	External expansion data 20 (with a pull-down resistor)
145	ED19	I/O	External expansion data 19 (with a pull-down resistor)
146	ED18	I/O	External expansion data 18 (with a pull-down resistor)
147	ED17	I/O	External expansion data 17 (with a pull-down resistor)
148	ED16	I/O	External expansion data 16 (with a pull-down resistor)
149	CV <sub>ss5</sub>		GND
150	CV <sub>DD5</sub>		1.8V
151	EXRS	I	Reset (L-Active)
152	E <sub>TESTXRS</sub>	I	Test (Open, with a pull-up resistor)
153	IOV <sub>ss6</sub>		GND
154	IOV <sub>DD5</sub>		3.3V
155	ED15	I/O	External expansion data 15 (with a pull-down resistor)
156	ED14	I/O	External expansion data 14 (with a pull-down resistor)
157	ED13	I/O	External expansion data 13 (with a pull-down resistor)
158	ED12	I/O	External expansion data 12 (with a pull-down resistor)
159	ED11	I/O	External expansion data 11 (with a pull-down resistor)
160	ED10	I/O	External expansion data 10 (with a pull-down resistor)
161	ED9	I/O	External expansion data 9 (with a pull-down resistor)
162	ED8	I/O	External expansion data 8 (with a pull-down resistor)
163	ED7	I/O	External expansion data 7 (with a pull-down resistor)
164	ED6	I/O	External expansion data 6 (with a pull-down resistor)
165	ED5	I/O	External expansion data 5 (with a pull-down resistor)
166	ED4	I/O	External expansion data 4 (with a pull-down resistor)
167	ED3	I/O	External expansion data 3 (with a pull-down resistor)
168	ED2	I/O	External expansion data 2 (with a pull-down resistor)
169	ED1	I/O	External expansion data 1 (with a pull-down resistor)
170	ED0	I/O	External expansion data 0 (with a pull-down resistor)
171	CV <sub>ss6</sub>		GND
172	CV <sub>DD6</sub>		1.8V
173	ERXD0	I	UART (CH0) reception data (with a pull-down resistor during reset interval)
174	ETXD0	O/Z	UART (CH0) transmission data (with Hi-Z during reset interval)
175	IOV <sub>ss7</sub>		GND
176	IOV <sub>DD6</sub>		3.3V

Radio Pin Description

Pin No.	Symbol	Standard pin voltage [V]	Equivalent circuit	Description
30	RADIOSUB	0		Radio GND
31	V <sub>DD</sub> PLL	1.8		PLL 1.8V
32	V <sub>SS</sub> PLL	0		PLL GND
33	V <sub>DD</sub> CP	1.8		Charge pump 1.8V
34	LPFIF	0.8		IF PLL loop filter connection
35	LPFRF	0.9		RF PLL loop filter connection
39	VCODECAP	0.65		Capacitor connection for decoupling the VCO bias circuit
36	V <sub>SS</sub> CP	0		Charge pump GND
37	V <sub>DD</sub> VCO	1.8		VCO 1.8V
38	V <sub>SS</sub> VCO	0		VCO GND
40	RFSUB	0		RF GND
42	NRING	1.8		LNA 1.8V
43	RFRREF	0.1		External resistor connection (LNA, RF mixer bias)

Pin No.	Symbol	Standard pin voltage [V]	Equivalent circuit	Description
44	MIXGND	0		Mixer GND
45	LNASRC	0		LNA GND
46	V <sub>DDCP</sub>	1.8		Charge pump 1.8V
41	LNAMAT	1.8		LNA 1.8V
47	RFIN	—		RF input
48	MIXGND	0		Mixer GND
49	LNASRC	0		LNA GND
50	MIXGND	0		Mixer GND
51	TESTINP	—		Radio test input pin Normally leave open.
52	TESTINN	—		Radio test input pin Normally leave open.
53	TESTOUTP	—		Radio test output pin Capacitor and resistor connection
54	TESTOUTN	—		Radio test output pin Capacitor and resistor connection

Pin No.	Symbol	Standard pin voltage [V]	Equivalent circuit	Description
55	TESTOUTD	—		Radio digital test output pin Normally leave open.
56	IF1Vcc	1.8		1st IF 1.8V
57	IF1GND	0		1st IF GND
58	IF2Vcc	1.8		2nd IF 1.8V
59	IF2GND	0		2nd IF GND
60	VCOM	1.0		IF common voltage
61	RREF	1.1		External resistor connection (VCO, PLL, IF block bias)

**A/D Converter Operating Conditions**

Item	Symbol	Pin name	Min.	Typ.	Max.	Unit
Supply voltage	V <sub>AD</sub>	EAVDAD*1	3.0	3.3	3.6	V
Operating temperature	T <sub>a</sub>	—	−40.0		+85.0	°C

**A/D Converter Characteristics**(V<sub>AD</sub> = 3.0 to 3.6V, T<sub>a</sub> = −40 to +85°C)

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Resolution					10	Bit
Channel					4	Ch
Differential linearity error (DLE)		V <sub>AD</sub> = 3.0V, V <sub>RT</sub> = 3.0V, V <sub>RB</sub> = 0.3V	−1.0		+1.0	LSB
Integral linearity error (ILE)			−2.0		+2.0	LSB
Sampling time		TCXO = 18.414MHz	3			μs
Conversion time					11	μs
Reference input voltage (Top)	V <sub>RT</sub> *2		2.0		V <sub>AD</sub>	V
Reference input voltage (Bottom)	V <sub>RB</sub> *3		0		0.7	V
Analog input voltage	V <sub>IN</sub> *4		V <sub>RB</sub>		V <sub>RT</sub>	V
Current consumption		V <sub>AD</sub> = 3.0V		1.6		mA

**Applicable pins**

\*1 EAVDAD (Pin 108)

\*2 EADVRT (Pin 107)

\*3 EADVRB (Pin 102)

\*4 EVIN[0:3] (Pins 103 to 106)

**DC Characteristics**

(IOV<sub>DD</sub> = 3.0 to 3.6V, CV<sub>DD</sub> = 1.62 to 1.98V, Ta = -40 to +85°C)

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Input voltage*1	High level	V <sub>IH</sub>	2.0		5.5	V
	Low level	V <sub>IL</sub>	-0.3		0.8	V
Output voltage*2	High level	V <sub>OH1</sub>	I <sub>OH</sub> = 4mA	2.4		V
	Low level	V <sub>OL1</sub>	I <sub>OL</sub> = 4mA		0.4	V
Output voltage*3	High level	V <sub>OH2</sub>	I <sub>OH</sub> = 8mA	2.4		V
	Low level	V <sub>OL2</sub>	I <sub>OL</sub> = 8mA		0.4	V
Pull-up resistor*4	R <sub>U</sub>		48		110	kΩ
Pull-down resistor*5	R <sub>D</sub>		40		100	kΩ
Current consumption during normal operation (via IOV <sub>DD</sub> , CV <sub>DD</sub> and V <sub>DD</sub> )*6	I <sub>OPE</sub>	TCXO = 18.414MHz, Ta = 25°C		60		mA
Current consumption during backup operation (via BKUPIOV <sub>DD</sub> )*7	I <sub>STB1</sub>	BKUPIOV <sub>DD</sub> = 3.6V, Ta = 25°C		0.2	1.0	μA
		BKUPIOV <sub>DD</sub> = 3.6V, Ta = 85°C		0.2	1.0	μA
Current consumption during backup operation (via BKUPCV <sub>DD</sub> )*8	I <sub>STB2</sub>	BKUPCV <sub>DD</sub> = 1.98V, Ta = 25°C		7.5	15	μA
		BKUPCV <sub>DD</sub> = 1.98V, Ta = 85°C		50	120	μA

**Applicable pins**

\*1 Pins 1 to 13, 20, 24 to 29, 64 to 66, 98, 119, 120 to 122, 133 to 148, 151, 152, 155 to 170, 173

\*2 Pins 1 to 13, 21 to 23, 97, 174

\*3 Pins 67 to 74, 77 to 80, 83 to 90, 124 to 130, 133 to 148, 155 to 170

\*4 Pins 24, 25, 28, 29, 152

\*5 Pins 1 to 13, 20, 26, 27, 133 to 148, 155 to 170, 173

\*6 Pins 15, 76, 96, 100, 108, 112, 118, 132, 154, 176 (3.3V)

Pins 19, 31, 33, 37, 41, 42, 56, 58, 63, 82, 92, 114, 150, 172 (1.8V)

\*7 Pin 118

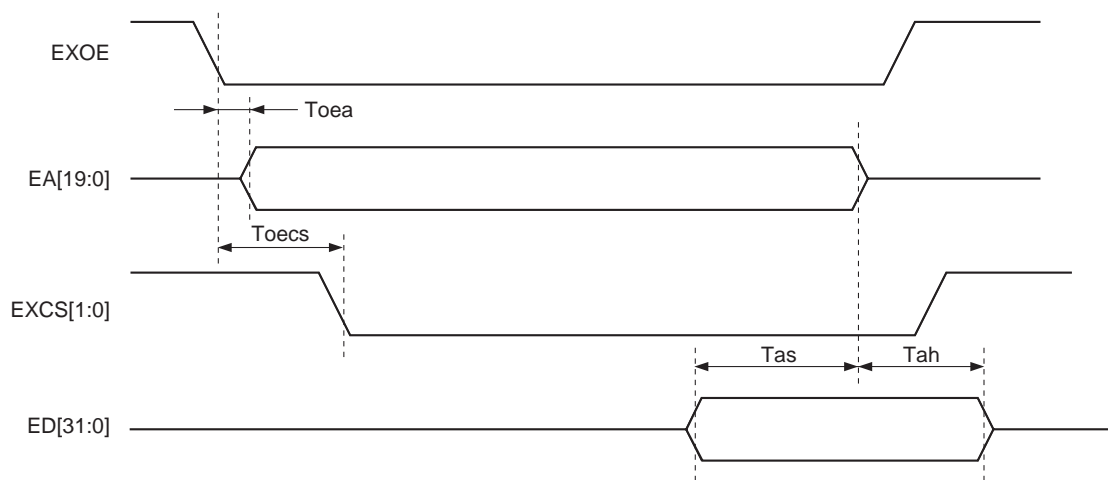
\*8 Pin 114

AC Characteristics

• External Expansion Bus (Read/32-bit mode)

( $C_{VDD} = 1.62$  to  $1.98V$ ,  $IOV_{DD} = 3.0$  to  $3.6V$ ,  $C_L = 25pF$ ,  $T_{opr} = -40$  to  $+85^{\circ}C$ )

Item	Symbol	Min.	Max.	Unit
EXOE ↓ to address valid	Toea		3	ns
EXOE ↓ to EXCS ↓	Toecs		1	ns
Data setup	Tas		15	ns
Data hold	Tah		0	ns

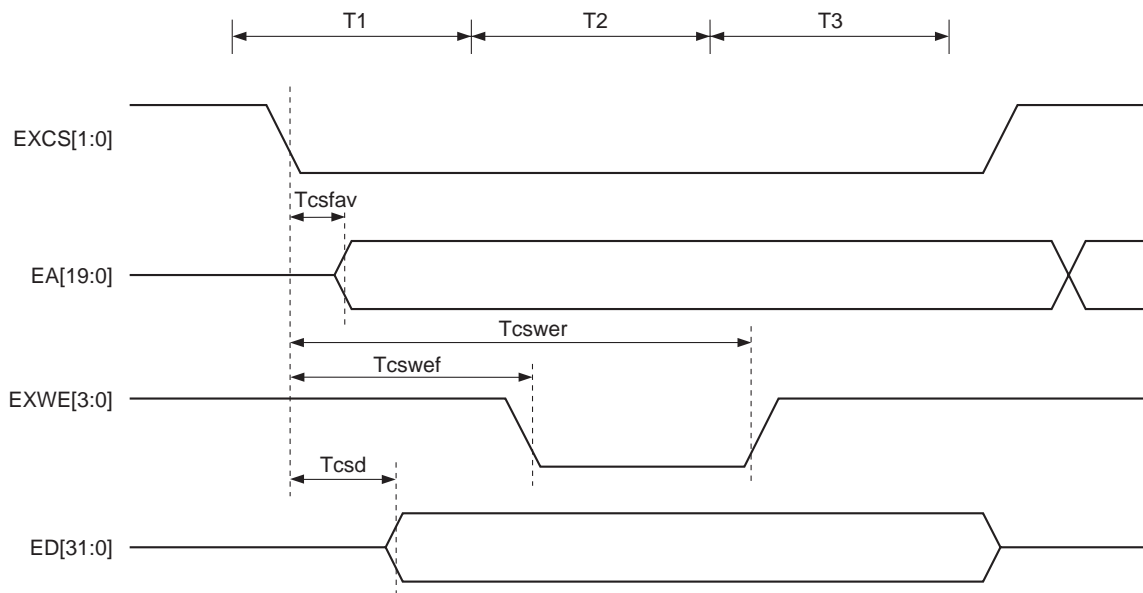


• External Expansion Bus (Write/32-bit mode (1-wait))

( $CV_{DD} = 1.62$  to  $1.98V$ ,  $IOV_{DD} = 3.0$  to  $3.6V$ ,  $C_L = 25pF$ ,  $Topr = -40$  to  $+85^{\circ}C$ )

Item	Symbol	Min.	Max.	Unit
EXCS ↓ to address valid	Tcsfav		2	ns
EXCS ↓ to EXWE ↓	Tcswef		$T_{sys} - 1$	ns
EXCS ↓ to EXWE ↑	Tcswer		$T_{sys} \times 3 - 2$	ns
EXCS ↓ to data valid	Tcsd		15	ns

\* Tsys: ARM clock cycle



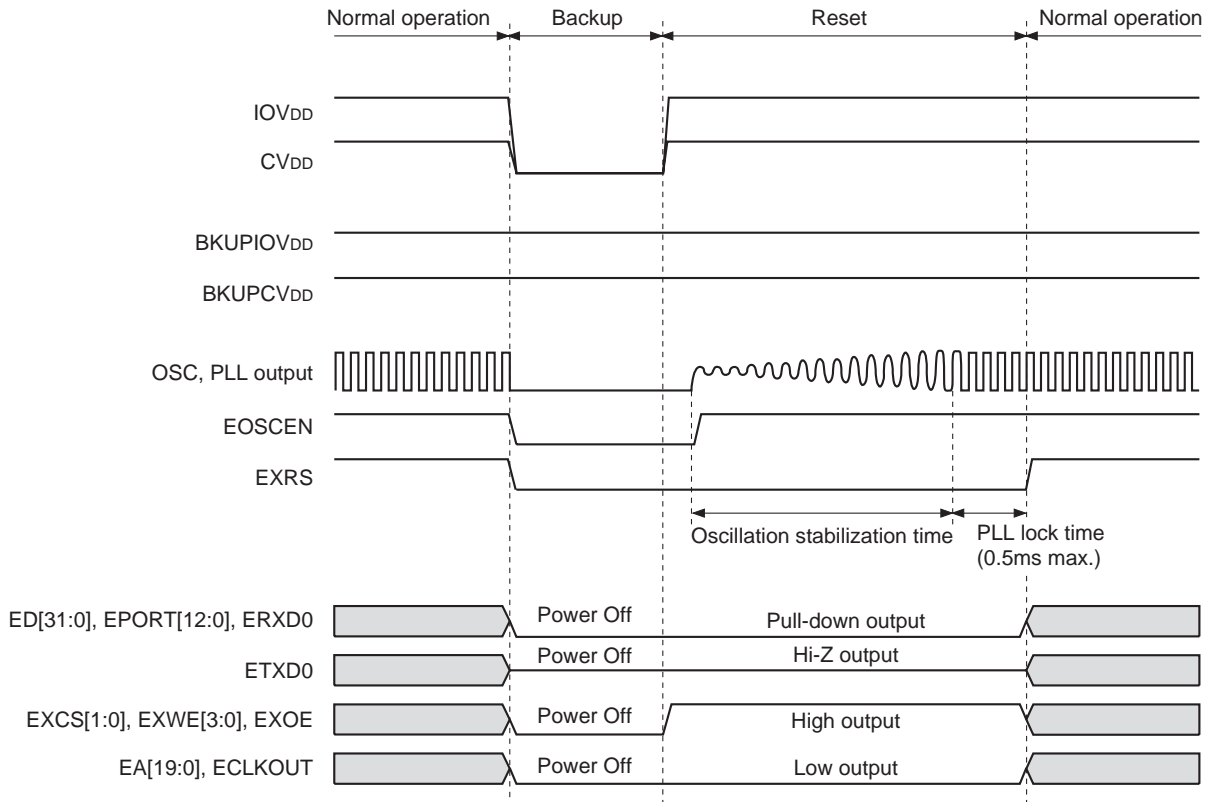


### Backup Mode

The backup mode is established by setting both EOSCEN and EXRS low. In this mode, the low power consumption can be achieved by stopping all oscillators except for RTC oscillator during the reset interval. Although all registers are initialized, the SRAM contents in backup area are held.

In order to cancel this mode (reset cancellation), set EOSCEN high at first and then set EXRS high after the oscillation stabilization time and PLL lock time have passed. It needs 100ms or more.

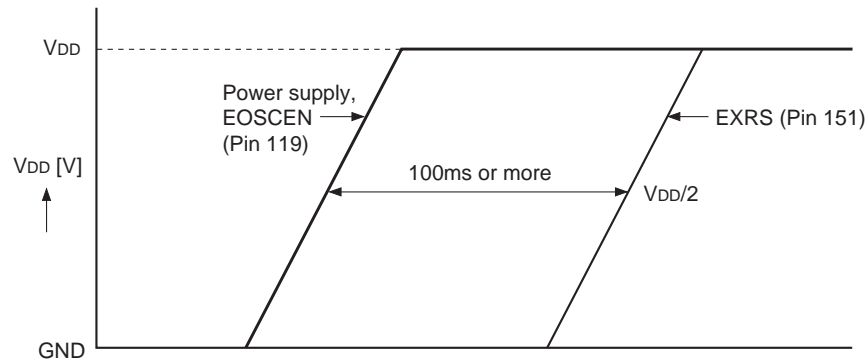
See Initialization section.



**Initialization**

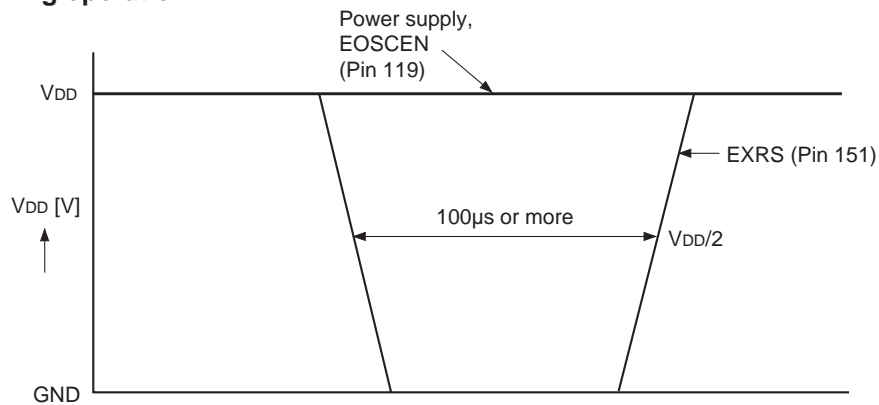
The CXD2951GA-2 is initialized by setting the reset signal EXRS (Pin 151) to the low level. Note that internal RAM is not initialized by the operation. Satisfy the conditions shown below for the timing and others.

**1. When turning the power on (Power-on reset)**



The power supply both 3.3V and 1.8V should turn on simultaneously, and EOSCEN (Pin 119) should also rise simultaneously with the power supply turning on. EXRS (Pin 151) should rise 100ms or more after the power supply and EOSCEN rise.

**2. Initialization during operation**



For initialization during operation, the interior circuit except internal RAM is initialized by setting the EXRS (Pin 151) signal to the low level for 100µs or more. Note that internal RAM is not also initialized by the operation. At this time, the EOSCEN (Pin 119) signal should keep the high level.

## RTC crystal and TCXO

In order to operate CXD2951GA-2 appropriately, the recommended characteristics of RTC crystal and TCXO is shown below.

### Recommended characteristics of RTC crystal

Operating temperature	-40 to +85°C
Nominal frequency	32.768kHz
Frequency tolerance	±20ppm
Frequency temperature coefficient	-0.04ppm/°C <sup>2</sup> (Max.)
Frequency peak temperature	+25 ± 5°C
Frequency aging	±3ppm/year

### Recommended characteristics of TCXO

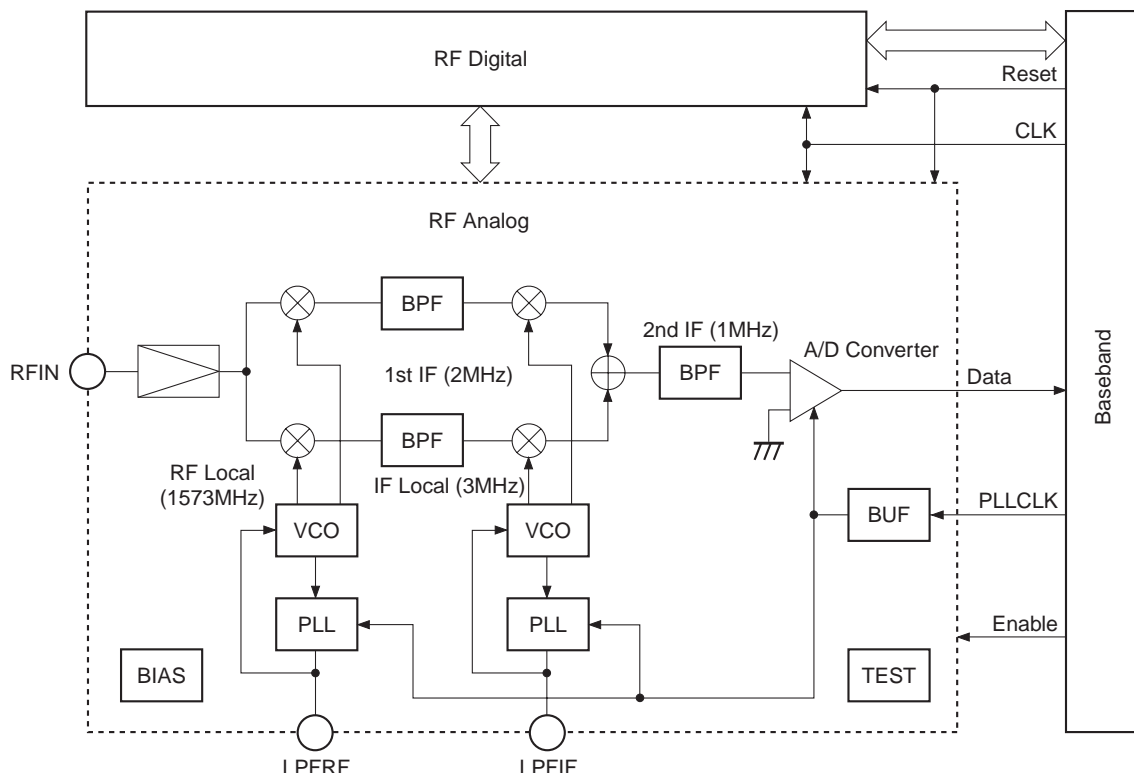
Operating temperature	-40 to +85°C
Frequency tolerance	±2.0ppm
Frequency vs. temperature	±2.5ppm
Frequency vs. supply voltage	±0.2ppm
Frequency vs. load	±0.2ppm
Frequency aging	±1ppm/year

### Recommended parts

RTC crystal	EPSON FC-255
TCXO	NDK SNA3088B (NT5032 series)

**Radio Block Operation**

Radio block diagram shows RF section of the chip. The signal flow starts from the RFIN port (Pin 47). The signal is amplified and mixed down to the first Intermediate Frequency (IF) of 2MHz with cosine and sine wave quadrature mixers. Out of band images are filtered out and the signal is again mixed down to the 2nd IF of 1MHz with another set of quadrature mixers. The complex signal becomes real with the addition of real and imaginary components. The image of the 2nd IF mixing is removed with the last Band Pass Filter (BPF). The real signal is then amplified one last time and transferred to digital baseband processing unit.



**Radio Block Diagram**

To have constant internal frequencies for mixing and other purposes, the supplied TCXO frequency is counted by a Real Time Clock (RTC), and the internal PLL divider is automatically set to provide correct frequency for RF mixing and baseband operation.

The loop filters (RF and IF) are externally connected. Use parts that satisfy the required tolerance.

**Radio Characteristics**

**DC Characteristics**

(V<sub>DD</sub> = 1.8V, Ta = 25°C)

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Supply current 1	I <sub>DD</sub>	Active mode*1	13.5	17	20.5	mA
Supply current 2	I <sub>PS</sub>	Power save mode*1	—	0.1	1.5	μA

\*1 Applicable pins 31, 33, 37, 41, 42, 56, 58

**AC Characteristics**

(V<sub>DD</sub> = 1.8V, Ta = 25°C)

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Total gain	G	Before the A/D converter	90	100	—	dB
Image rejection ratio	IMRR	Image frequency = 1571.328MHz	—	-35	-15	dB
2nd IF filter 2.5MHz	F <sub>c</sub>	@2.5MHz Normalized at 1.023MHz	-6	0	4	dB
2nd IF filter 4MHz	F <sub>a</sub>	@4MHz Normalized at 1.023MHz	—	-25	-15	dB

\* Including the 50Ω matching circuit

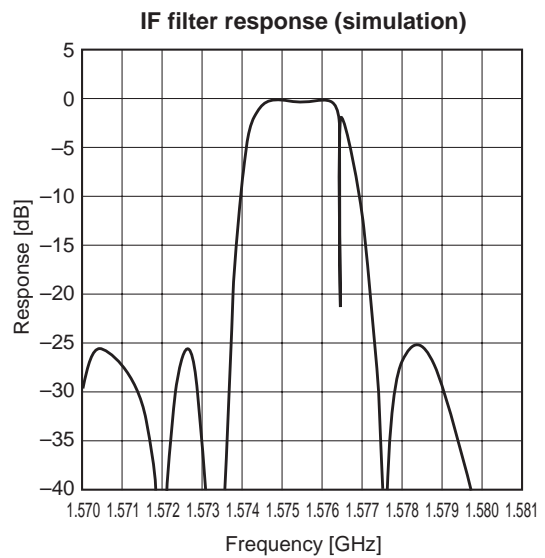
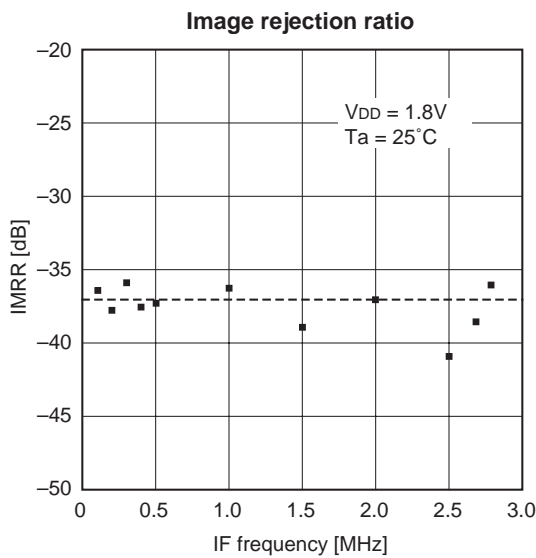
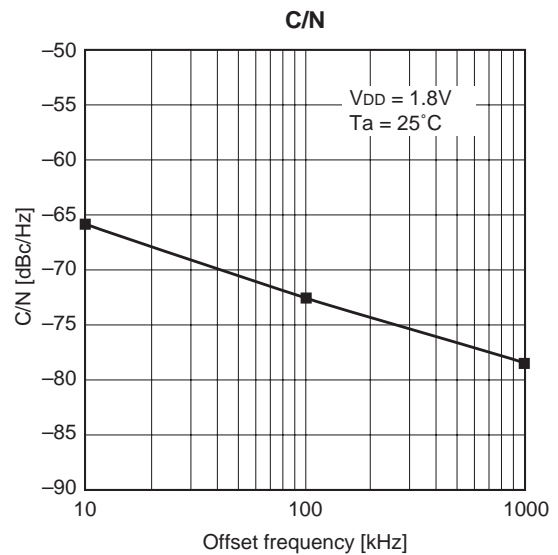
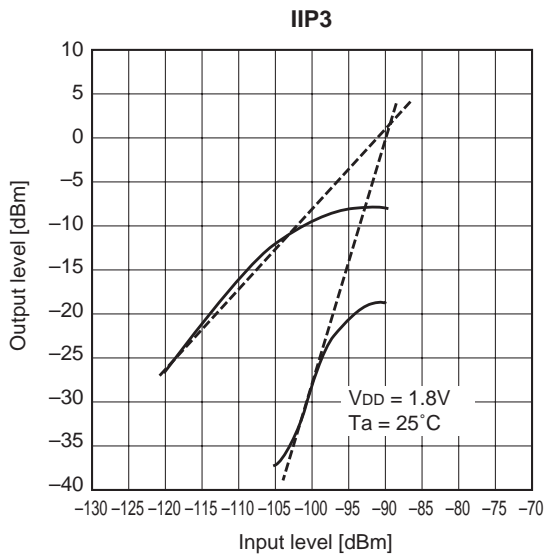
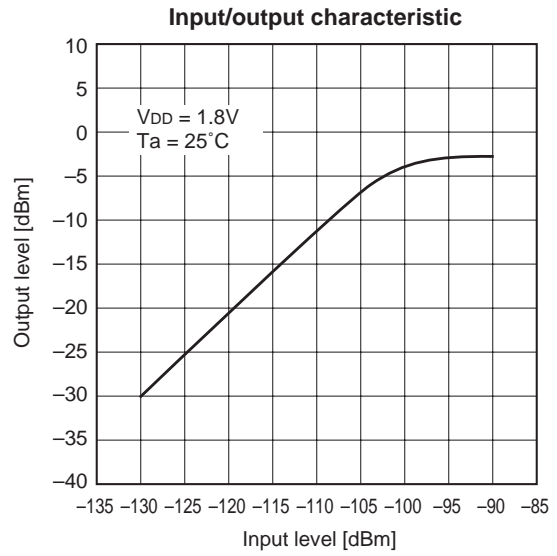
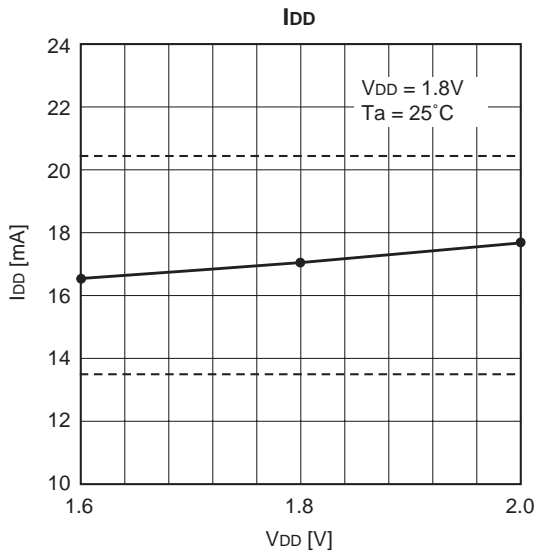
**Design Measurement Results**

(V<sub>DD</sub> = 1.8V, Ta = 25°C)

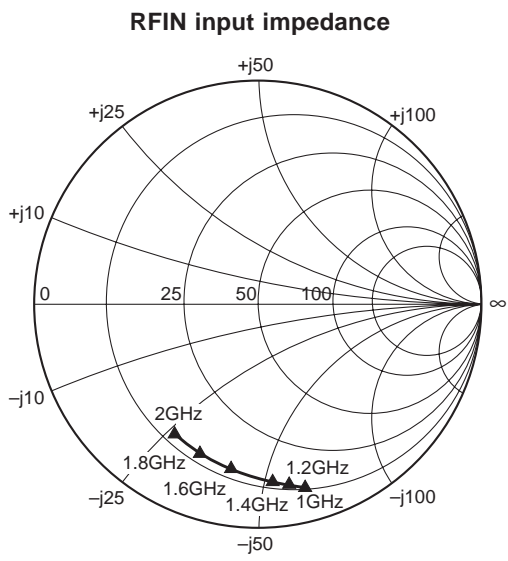
Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Total NF	NF	Before the 2nd IF mixer	—	8	—	dB
IIP3	IIP3	Before the A/D converter	—	-90	—	dBm
P-1dB input	P1dB	Before the A/D converter	—	-100	—	dBm
S11	S11		—	-15	—	dB
Lock up time	LUT	Measure the interval between reset input and IF output.	—	2.5	—	ms
C/N 100K	C/N	TCXO = 18.414MHz	—	-70	—	dBc/Hz
Local leak	Leak	Measure at RF input.	—	-65	—	dBm

\* Including the 50Ω matching circuit

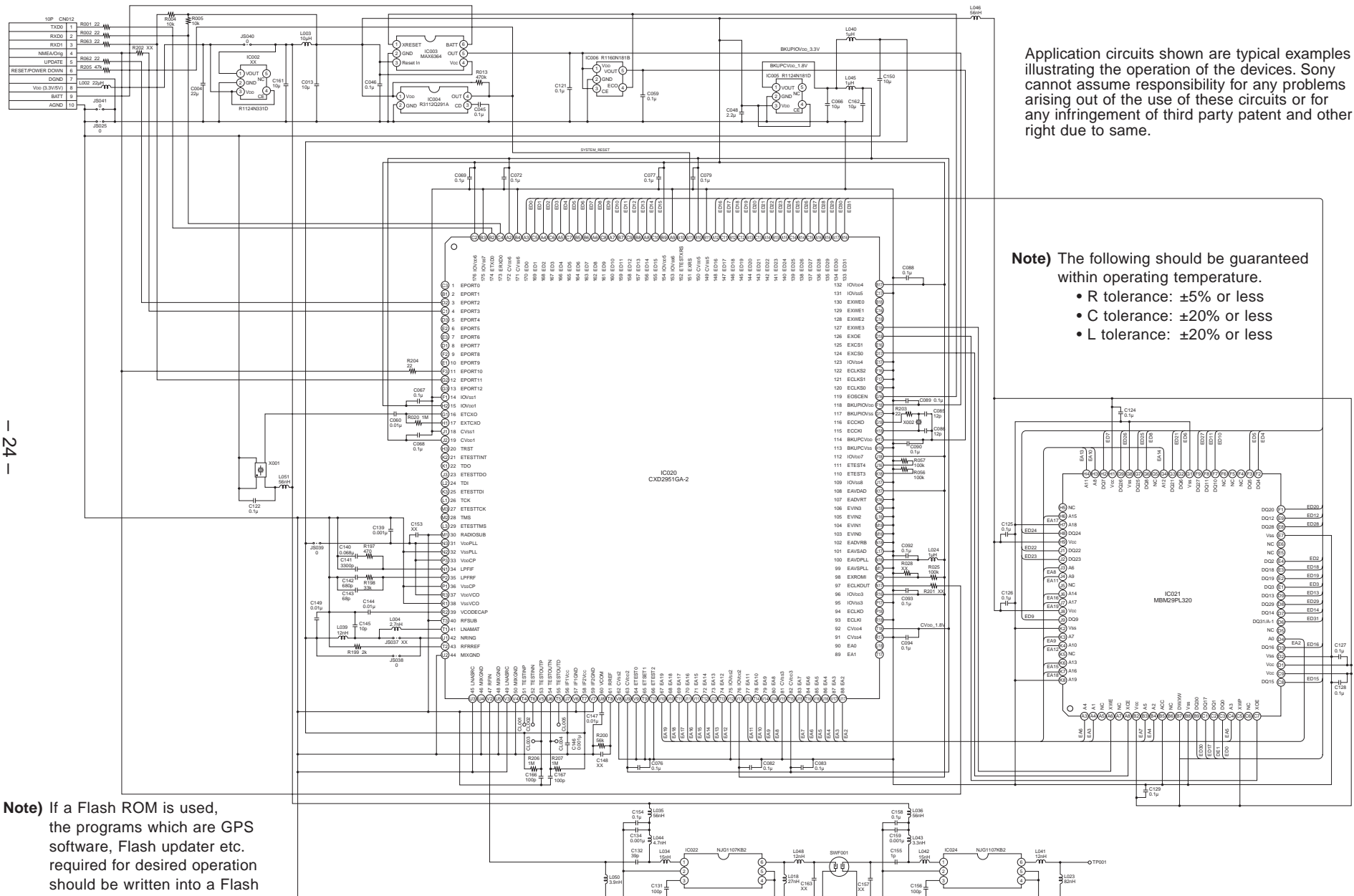
Radio Supplement Materials (Example of Representative Characteristics)



Filter characteristic represented by RF frequency as x-axis  
(Normalized at 1.023MHz)



Application Circuit



Application circuits shown are typical examples illustrating the operation of the devices. Sony cannot assume responsibility for any problems arising out of the use of these circuits or for any infringement of third party patent and other right due to same.

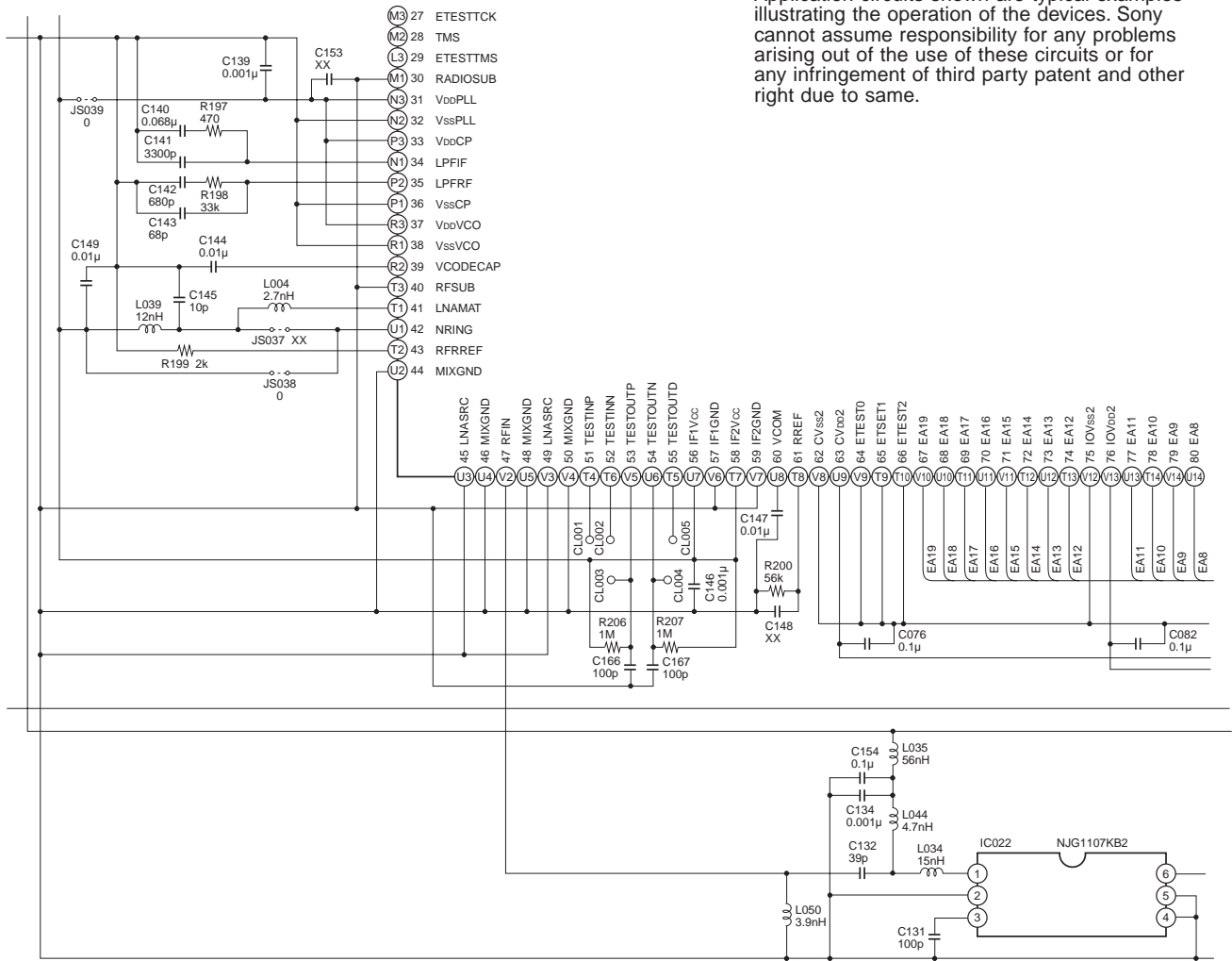
**Note)** The following should be guaranteed within operating temperature.

- R tolerance:  $\pm 5\%$  or less
- C tolerance:  $\pm 20\%$  or less
- L tolerance:  $\pm 20\%$  or less

**Note)** If a Flash ROM is used, the programs which are GPS software, Flash updater etc. required for desired operation should be written into a Flash ROM in advance.



Radio Block Application Circuit



Application circuits shown are typical examples illustrating the operation of the devices. Sony cannot assume responsibility for any problems arising out of the use of these circuits or for any infringement of third party patent and other right due to same.

Enlarged view of the previous page

Parts ID	Parts name	Remarks
C139 to C147, C149, C166, C167	MURATA GRM36CH series	Tolerance: ±5% C145: Self-resonant frequency 2.0GHz or more
L004, L039, L050	TAIYO YUDEN HK1005 series	Tolerance: ±5% L050: Self-resonant frequency 2.0GHz or more
R197 to R200	KOA RK73H series	Tolerance: ±1%
R206, R207	KOA RK73B series	Tolerance: ±5%

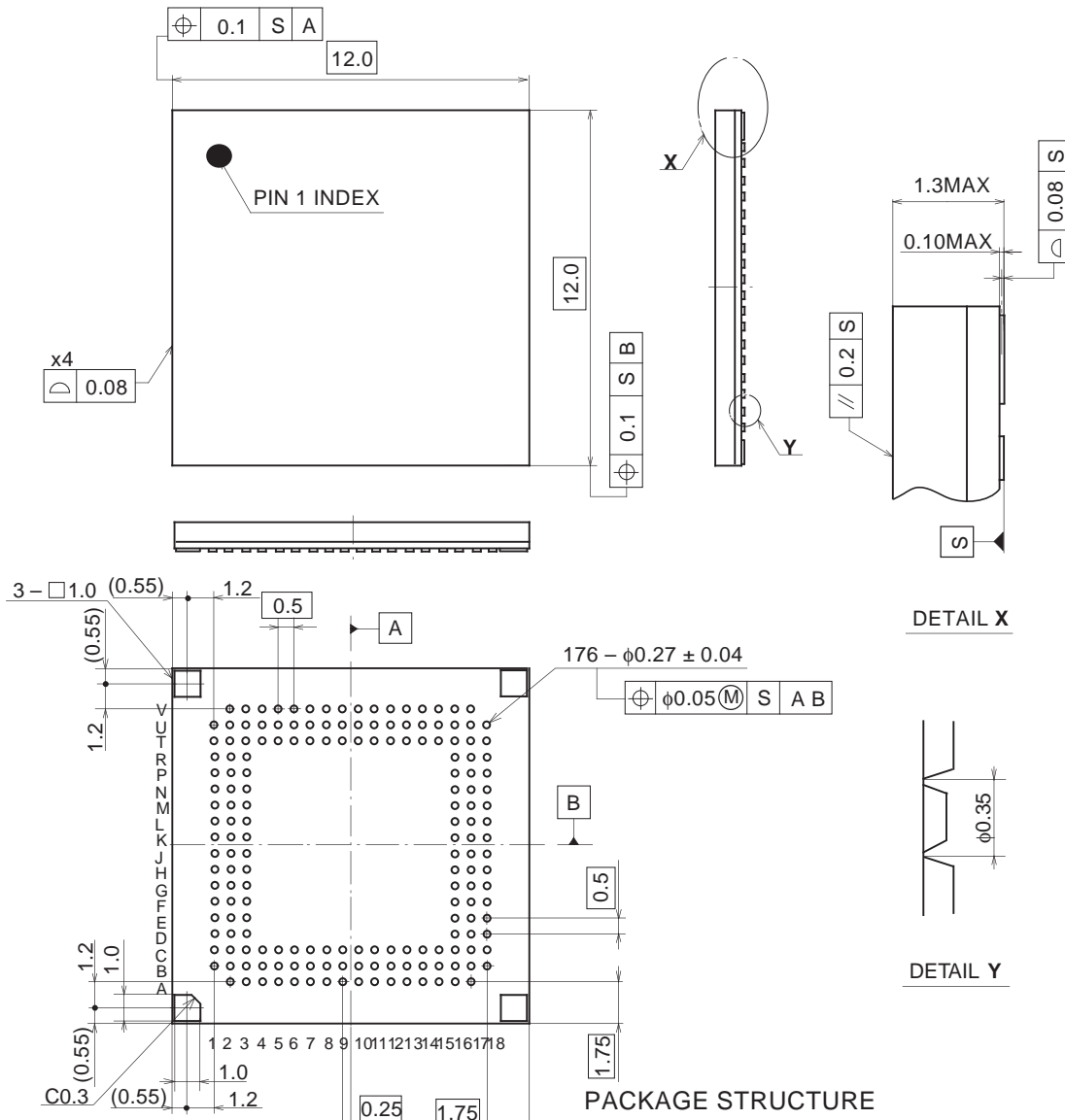
\* Always use matching circuit for the RF amplifier input pin (Pin 47), and match at 1.57542GHz.

\* The external elements should be placed as close to the chip as possible.

Package Outline

Unit: mm

176PIN LFLGA



SONY CODE	LFLGA-176P-052
EIAJ CODE	P-LFLGA176-12x12-0.5
JEDEC CODE	_____

PACKAGE MATERIAL	ORGANIC SUBSTRATE
TERMINAL TREATMENT	NICKEL&GOLD PLATING
TERMINAL MATERIAL	COPPER
PACKAGE MASS	0.4g