

**REFERENCE FREQUENCY 16.368 MHz, 2ND IF FREQUENCY 4.092 MHz
RF/IF FREQUENCY DOWN-CONVERTER +
PLL FREQUENCY SYNTHESIZER IC FOR GPS RECEIVER**

★ **DESCRIPTION**

The μ PB1005K is a silicon monolithic integrated circuit for GPS receiver. This IC is designed as double conversion RF block integrated RF/IF down-converter + PLL frequency synthesizer on 1 chip.

The incorporation of a chip identical to the conventional 30-pin SSOP ($9.85 \times 6.1 \times 2.0$ mm) μ PB1005GS in a 36-pin QFN package ($6.0 \times 6.0 \times 0.95$ mm) has enabled a reduction in mounting area of 45%.

The μ PB1005K features 36-pin plastic QFN, fixed prescaler and supply voltage. The 36-pin plastic QFN package is suitable for high density surface mounting. The fixed division internal prescaler is needless to input serial counter data. Supply voltage is 3 V. Thus, the μ PB1005K can make RF block fewer components and lower power consumption.

This IC is manufactured using NEC's 20 GHz fr NESAT™III silicon bipolar process. This process uses direct silicon nitride passivation film and gold electrodes. These materials can protect the chip surface from pollution and prevent corrosion/migration. Thus, this IC realizes excellent performance, uniformity and reliability.

FEATURES

- Double conversion : $f_{REFin} = 16.368$ MHz, $f_{2ndIFout} = 4.092$ MHz
- Integrated RF block : RF/IF frequency down-converter + PLL frequency synthesizer
- High-density surface mountable : 36-pin plastic QFN ($6.0 \times 6.0 \times 0.95$ mm)
- Needless to input counter data : fixed division internal prescaler
 - VCO side division : $\div 200$ ($\div 25$, $\div 8$ serial prescaler)
 - Reference division : $\div 2$
- Supply voltage : $V_{CC} = 2.7$ to 3.3 V
- Low current consumption : $I_{CC} = 45.0$ mA TYP. @ $V_{CC} = 3.0$ V
- Gain adjustable externally : Gain control voltage pin (control voltage up vs. gain down)

APPLICATION

- Consumer use GPS receiver of reference frequency 16.368 MHz, 2nd IF frequency 4.092 MHz (for general use)

ORDERING INFORMATION

Part Number	Package	Supplying Form
μ PB1005K-E1	36-pin plastic QFN	Embossed tape 12 mm wide. Pin 1 is in pull-out direction. Qty 2.5 kpcs/reel.

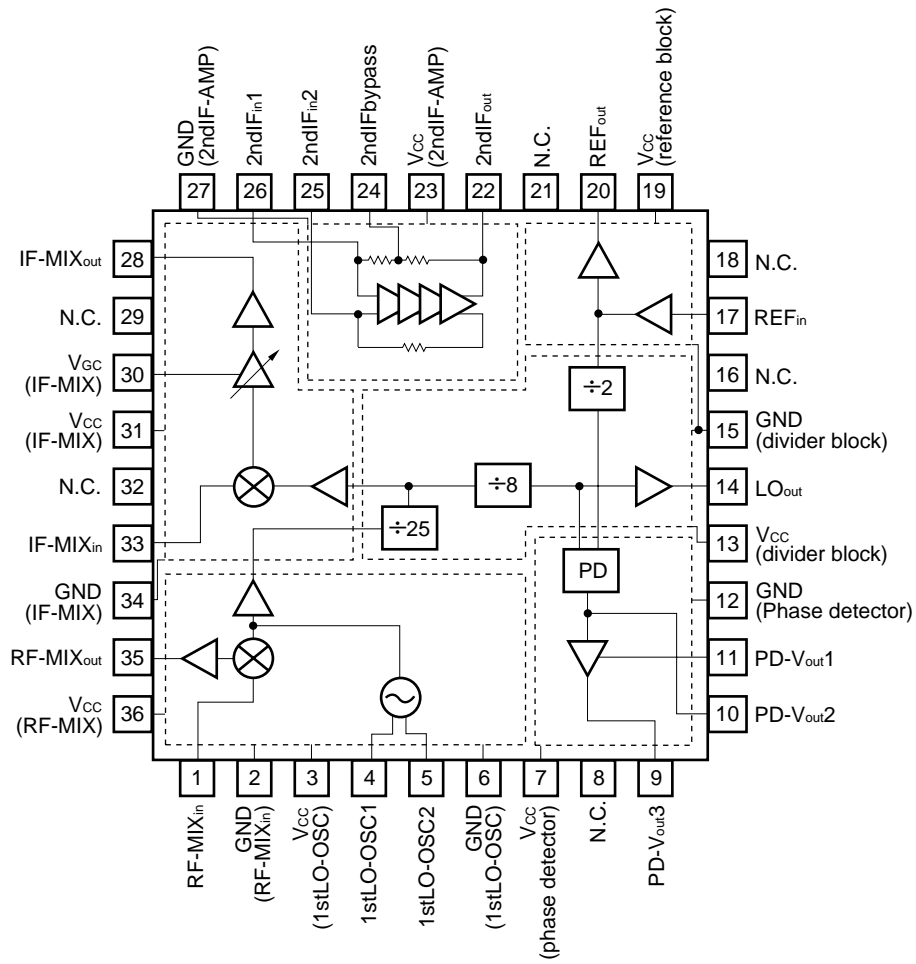
Remark To order evaluation samples, please contact your local NEC sales office. (Part number for sample order: μ PB1005K)

Caution Electro-static sensitive devices

The information in this document is subject to change without notice. Before using this document, please confirm that this is the latest version.

Not all devices/types available in every country. Please check with local NEC representative for availability and additional information.

PIN CONNECTION AND INTERNAL BLOCK DIAGRAM



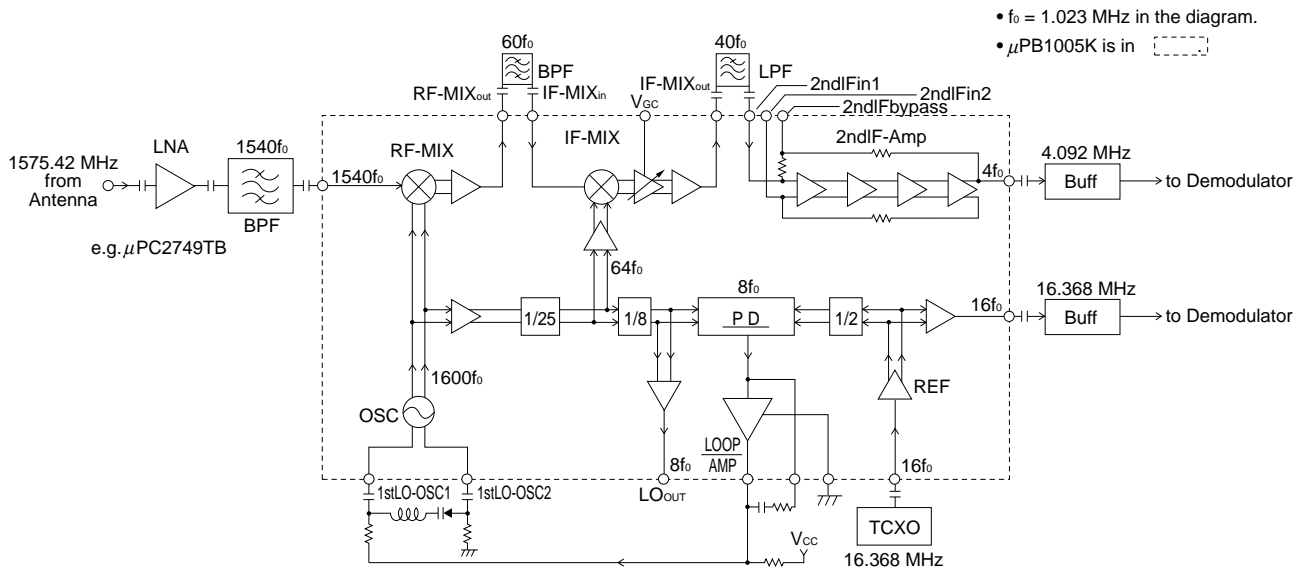
PRODUCT LINE-UP (T_A = +25°C, V_{CC} = 3.0 V)

Type	Part Number	Functions (Frequency unit: MHz)	V _{CC} (V)	I _{CC} (mA)	CG (dB)	Package	Status
General Purpose Wideband Separate IC	μPC2756T	RF down-converter with osc. Tr	2.7 to 3.3	6.0	14	6-pin minimold	Available
	μPC2756TB					6-pin super minimold	
	μPC2753GR	IF down-converter with gain control amplifier	2.7 to 3.3	6.5	60 to 79	20-pin plastic SSOP	
Clock Frequency Specific 1 chip IC	μPB1003GS	RF/IF down-converter + PLL synthesizer REF = 18.414 1stIF = 28.644/2ndIF = 1.023	2.7 to 3.3	37.5	72 to 92	30-pin plastic SSOP	Discontinued
	μPB1004GS	RF/IF down-converter + PLL synthesizer REF = 16.368	2.7 to 3.3	37.5	72 to 92	30-pin plastic SSOP	
	μPB1005GS	RF/IF down-converter + PLL synthesizer REF = 16.368	2.7 to 3.3	45.0	72 to 92	30-pin plastic SSOP	Available
	μPB1005K	RF/IF down-converter + PLL synthesizer REF = 16.368 1stIF = 61.380/2ndIF = 4.092	2.7 to 3.3	45.0	72 to 92	36-pin plastic QFN	

Notice Typical performance. Please refer to ELECTRICAL CHARACTERISTICS in detail.
To know the associated products, please refer to their latest data sheets.

SYSTEM APPLICATION EXAMPLE

GPS receiver RF block diagram



Caution This diagram schematically shows only the μPB1005K's internal functions on the system.
This diagram does not present the actual application circuits.

★ ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Conditions	Rating	Unit
Supply Voltage	V _{CC}	T _A = +25°C	3.6	V
Total Circuit Current	I _{CC}	T _A = +25°C	100	mA
Power Dissipation	P _D	Mounted on double-sided copper clad 50 × 50 × 1.6 mm epoxy glass PWB (T _A = +85°C)	361	mW
Operating Ambient Temperature	T _A		-40 to +85	°C
Storage Temperature	T _{stg}		-55 to +150	°C

RECOMMENDED OPERATING RANGE

Parameter	Symbol	MIN.	TYP.	MAX.	Unit
Supply Voltage	V _{CC}	2.7	3.0	3.3	V
Operating Ambient Temperature	T _A	-40	+25	+85	°C
RF Input Frequency	f _{RFIn}	—	1575.42	—	MHz
1st LO Oscillating Frequency	f _{1stLOin}	1616.80	1636.80	1656.80	MHz
1st IF Input Frequency	f _{1stIFin}	—	61.380	—	MHz
2nd LO Input Frequency	f _{2ndLOin}	—	65.472	—	MHz
2nd IF Input/output Frequency	f _{2ndIFin} f _{2ndIFout}	—	4.092	—	MHz
Reference Input/output Frequency	f _{REFin} f _{REFout}	—	16.368	—	MHz
LO Output Frequency	f _{LOout}	—	8.184	—	MHz

ELECTRICAL CHARACTERISTICS (Unless otherwise specified TA = +25°C, VCC = 3.0 V)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Total Circuit Current	I _{ccTotal}	I _{cc1} + I _{cc2} + I _{cc3} + I _{cc4}	32.0	45.0	60.0	mA
RF Down-converter Block (f _{RFIn} = 1575.42 MHz, f _{1stLOIn} = 1636.80 MHz, P _{LOIn} = -10 dBm, Z _S = Z _L = 50 Ω)						
Circuit Current 1	I _{cc1}	No Signals	6.0	10.0	14.0	mA
RF Conversion Gain	CG _{RF}	P _{RFIn} = -40 dBm	12.5	15.5	18.5	dB
RF-SSB Noise Figure	NF _{RF}	P _{RFIn} = -40 dBm	7.0	10.0	13.0	dB
Maximum IF Output	P _{O(sat)RF}	P _{RFIn} = -10 dBm	-5.5	-2.5	+0.5	dBm
IF Down-converter Block (f _{1stIFIn} = 61.38 MHz, f _{2ndLOIn} = 65.472 MHz, Z _S = 50 Ω, Z _L = 2 kΩ)						
Circuit Current 2	I _{cc2}	No Signals	3.4	5.3	7.2	mA
IF Conversion Voltage Gain	CG _{(GV)IF}	at Maximum Gain, P _{1stIFIn} = -50 dBm	38	41	44	dB
IF-SSB Noise Figure	NF _{IF}	at Maximum Gain, P _{1stIFIn} = -50 dBm	8.5	11.5	14.5	dB
Maximum 2ndIF Output	P _{O(sat)IF}	at Maximum Gain, P _{1stIFIn} = -20 dBm	-9.5	-6.5	-3.5	dBm
Gain Control Voltage	V _{GC}	Voltage at Maximum Gain CG _{IF}	—	—	1.0	V
Gain Control Range	D _{GC}	P _{1stIFIn} = -50 dBm	20	—	—	dB
2nd IF Amplifier (f _{2ndIFIn} = 4.092 MHz, Z _S = 50 Ω, Z _L = 2 kΩ)						
Circuit Current 3	I _{cc3}	No Signals	1.55	2.40	3.25	mA
Voltage Gain	G _V	P _{2ndIFIn} = -60 dBm	37	40	43	dB
Output Power	P _{2ndIFout}	P _{2ndIFIn} = -30 dBm	-14.5	-11.5	-8.5	dBm
PLL Synthesizer Block						
Circuit Current 4	I _{cc4}	PLL All Block Operating	18.5	28.5	38.5	mA
Phase Comparing Frequency	f _{PD}	PLL Loop	8.0	8.184	8.4	MHz
Reference Input Minimum Level	V _{REFIn}	Z _L = 10 kΩ//20 pF Impedance of measurement equipment	200	—	—	mV _{P-P}
Loop Filter Output Level (H)	V _{LP(H)}		2.8	—	—	V
Loop Filter Output Level (L)	V _{LP(L)}		—	—	0.4	V
Reference Output Swing	V _{REFout}	Z _L = 10 kΩ//2 pF Impedance of measurement equipment	1.0	—	—	V _{P-P}

STANDARD CHARACTERISTICS (Unless otherwise specified $T_A = +25^{\circ}\text{C}$, $V_{CC} = 3.0\text{ V}$)

Parameter	Symbol	Conditions	Reference	Unit
RF Down-converter Block ($P_{1stLOin} = -10\text{ dBm}$, $Z_s = Z_L = 50\ \Omega$)				
LO Leakage to IF Pin	LO _{if}	$f_{1stLOin} = 1\ 636.80\text{ MHz}$	-30	dBm
LO Leakage to RF Pin	LO _{rf}	$f_{1stLOin} = 1\ 636.80\text{ MHz}$	-30	dBm
Input 3rd Order Intercept Point	IIP _{3RF}	$f_{RFin1} = 1\ 600\text{ MHz}$, $f_{RFin2} = 1605\text{ MHz}$ $f_{1stLOin} = 1\ 660\text{ MHz}$	-13	dBm
IF Down-converter Block (1st LO oscillating, $Z_s = 50\ \Omega$, $Z_L = 2\text{ k}\Omega$)				
LO Leakage to 2nd IF	LO _{2ndif}	$f_{2ndLOin} = 65.472\text{ MHz}$	-20	dBm
LO Leakage to 1st IF	LO _{1stif}	$f_{2ndLOin} = 65.472\text{ MHz}$	-40	dBm
Input 3rd Order Intercept Point	IIP _{3IF}	$f_{1stIFin1} = 61.38\text{ MHz}$, $f_{1stIFin2} = 61.48\text{ MHz}$ $f_{2ndLOin} = 65.472\text{ MHz}$	-34	dBm
VCO Block				
Phase Noise	C/N	PLL Loop, $\Delta 1\text{kHz}$ of VCO wave	-78	dBc/Hz

★ PIN EXPLANATION

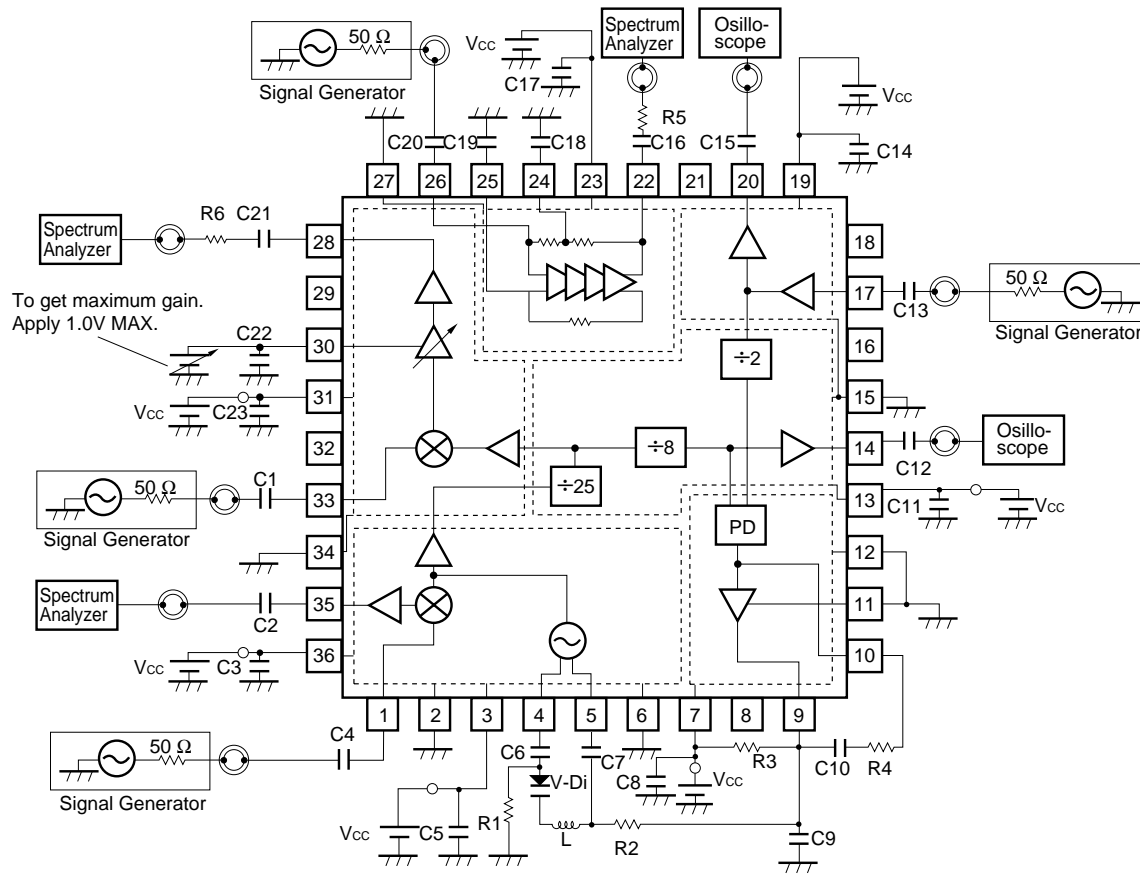
Pin No.	Pin Name	Applied Voltage (V)	Pin Voltage (V)	Function and Application	Internal Equivalent Circuit
35	RX-MIX _{out}	—	1.67	Output pin of RF mixer. 1st IF filter must be inserted between pin 33 & 35.	
36	V _{cc} (RF-MIX)	2.7 to 3.3	—	Supply voltage pin of RF mixer block. This pin must be decoupled with capacitor (example: 1 000 pF).	
1	RF-MIX _{in}	—	1.18	Input pin of RF mixer. 1 575.42 MHz band pass filter can be inserted between pin 1 and external LNA.	
2	GND (RF-MIX _{in})	0	—	Ground pin RF mixer.	
3	V _{cc} (1stLO-OSC)	2.7 to 3.3	—	Supply voltage pin of differential amplifier for 1st LO oscillator circuit.	
4	1stLO-OSC1	—	1.88	Pin 4 & 5 are each base pin of differential amplifier for 1st LO oscillator. These pins should be equipped with LC and varactor to oscillate on 1 636.80 MHz as VCO.	
5	1stLO-OSC2	—	1.88		
6	GND (1stLO-OSC)	0	—	Ground pin of differential amplifier for 1st LO oscillator circuit.	
7	V _{cc} (phase detector)	2.7 to 3.3	—	Supply voltage pin of phase detector and active loop filter.	
8	N.C.	—	—	Non connection	
9	PD-V _{out3}	Pull-up with resistor	—	Pins of active loop filter for tuning voltage output. The active transistors configured with darlington pair are built on chip. Pin 11 should be pulled down with external resistor. Pin 9 to 10 should be equipped with external RC in order to adjust dumping factor and cutoff frequency. This tuning voltage output must be connected to varactor diode of 1st LO-OSC.	
10	PD-V _{out2}	—	Output in accordance with phase difference		
11	PD-V _{out1}	Pull-up with resistor	—		
12	GND (phase detector)	0	—	Ground pin of phase detector + active loop filter.	

Pin No.	Pin Name	Applied Voltage (V)	Pin Voltage (V)	Function and Application	Internal Equivalent Circuit
13	V _{cc} (divider block)	2.7 to 3.3	—	Supply voltage pin of prescalers.	
14	LO _{out}	—	2.10	Monitor pin of comparison frequency at phase detector.	
15	GND (divider block)	0	—	Ground pin of prescalers + LO _{out} amplifier	
16	N.C.	—	—	Non connection	—
17	REF _{in}	—	1.97	Input pin of reference frequency. This pin should be equipped with external 16.368 MHz oscillator (example: TCXO).	
18	N.C.	—	—	Non connection	
19	V _{cc} (reference block)	2.7 to 3.3	—	Supply voltage pin of input/output amplifiers in reference block.	
20	REF _{out}	—	1.65	Output pin of reference frequency. The frequency from pin 17 can be took out as 1 V _{P-P} swing.	—
21	N.C.	—	—	Non connection	—
22	2ndIF _{out}	—	1.55	Output pin of 2nd IF amplifier. This pin output 4.092 MHz clipped sinewave. This pin should be equipped with external inverter to adjust level to next stage on user's system.	
23	V _{cc} (2ndIF-AMP)	2.7 to 3.3	—	Supply voltage pin of 2nd IF amplifier.	
24	2ndIF _{bypass}	—	2.20	Bypass pin of 2nd IF amplifier input 1. This pin should be grounded through capacitor.	
25	2ndIF _{in2}	—	2.30	Pin of 2nd IF amplifier input 2. This pin should be grounded through capacitor.	
26	2ndIF _{in1}	—	2.30	Pin of 2nd IF amplifier input 1. 2nd IF filter can be inserted between pin 26 & 28.	
27	GND (2ndIF-AMP)	0	—	Ground pin of 2nd IF amplifier.	

Pin No.	Pin Name	Applied Voltage (V)	Pin Voltage (V)	Function and Application	Internal Equivalent Circuit
28	IF-MIX _{out}	—	1.14	Output pin from IF mixer. IF mixer output signal goes through gain control amplifier before this emitter follower output port.	<p>The diagram shows an internal equivalent circuit. It includes a gain control amplifier with a VCC supply (pin 31), a 2nd LO input (pin 33), and an output (pin 28). This amplifier is connected to an emitter follower transistor. The transistor's VCC supply is also pin 31, its emitter is pin 28, and its base is pin 30. A resistor is connected between the emitter (pin 28) and ground (pin 34).</p>
29	N.C.	—	—	Non connection	
30	V _{GC} (IF-MIX)	0 to 3.3	—	Gain control voltage pin of IF mixer output amplifier. This voltage performs forward control (V _{GC} up → Gain down).	
31	V _{CC} (IF-MIX)	2.7 to 3.3	—	Supply voltage pin of IF mixer, gain control amplifier and emitter follower transistor.	
32	N.C.	—	—	Non connection	
33	IF-MIX _{in}	—	2.03	Input pin of IF mixer.	
34	GND (IF-MIX)	0	—	Ground pin of IF mixer.	

Caution Ground pattern on the board must be formed as wide as possible to minimize ground impedance.

TEST CIRCUIT



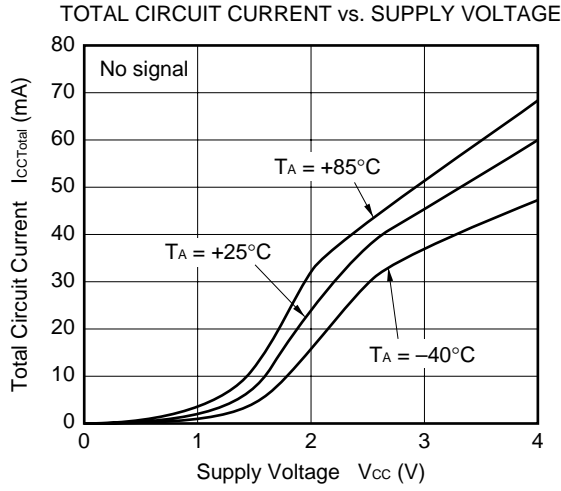
Spectrum Analyzer : measure frequency
 Oscilloscope : measure output voltage swing

COMPONENT LIST

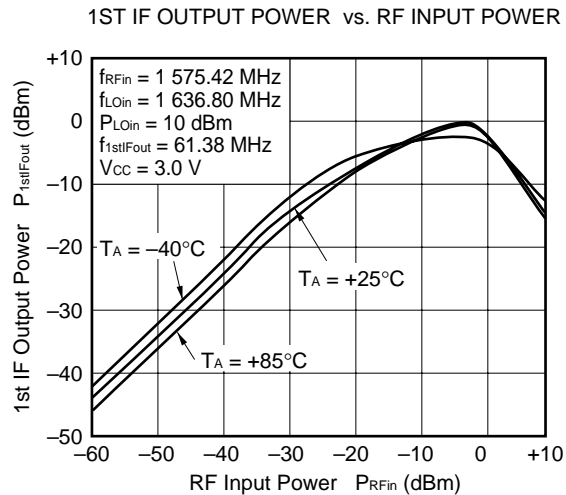
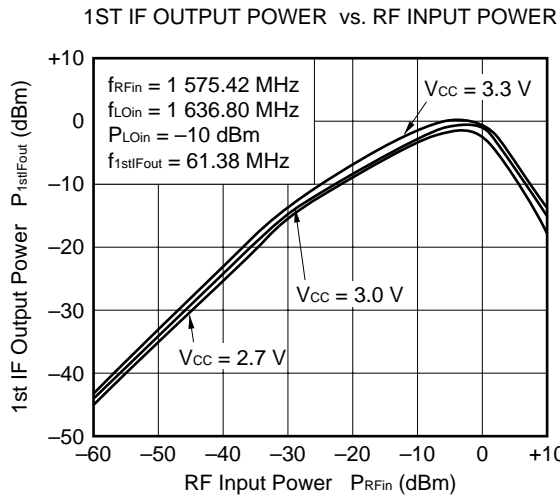
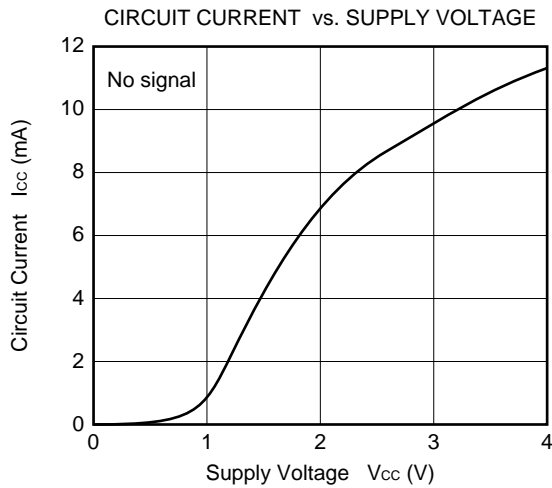
Form	Symbol	Value
Chip capacitor	C1 to C5, C8, C11 to C15, C17, C18, C22	1 000 pF
	C6, C7	24 pF (UJ)
	C9	1800 pF
	C10	33 nF
	C19	10 000 pF
	C23	1 μF
	C16, C20	0.1 μF
	C21	0.01 μF
Chip resistor	R1, R2	4.7 kΩ
	R3	6.2 kΩ
	R4	1.2 kΩ
	R5, R6	1.95 kΩ
Varactor Diode	V-Di	1SV285
Chip Inductor	L	3.9 nH

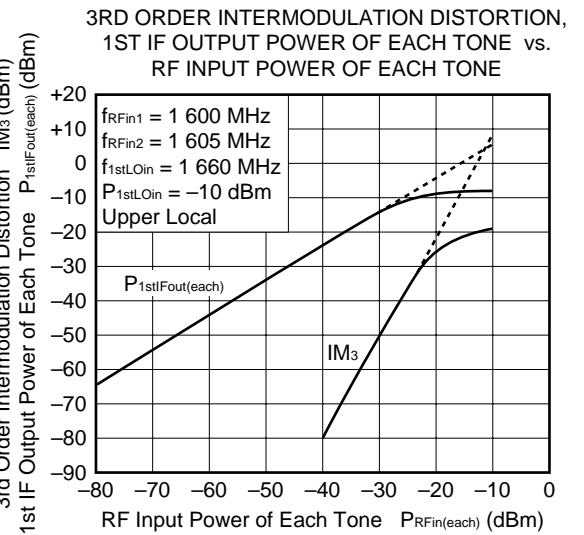
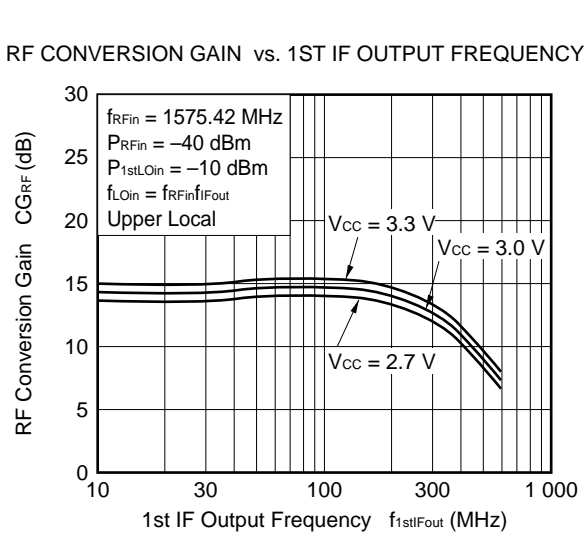
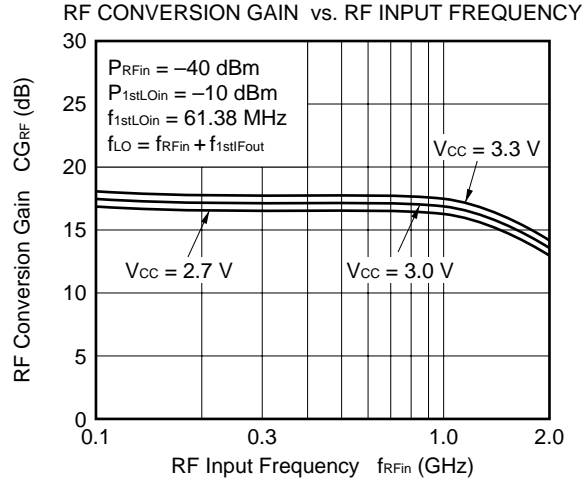
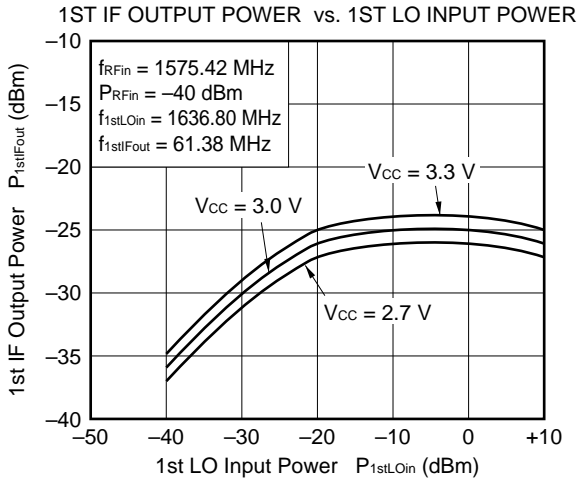
★ TYPICAL CHARACTERISTICS (Unless otherwise specified, $T_A = +25^\circ\text{C}$, $V_{CC} = 3.0\text{ V}$)

– IC TOTAL –

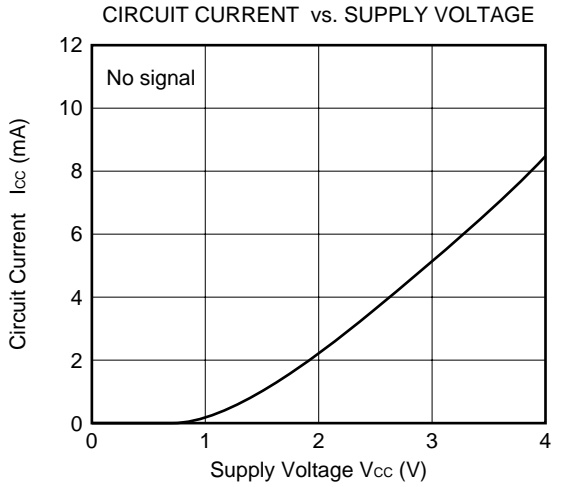


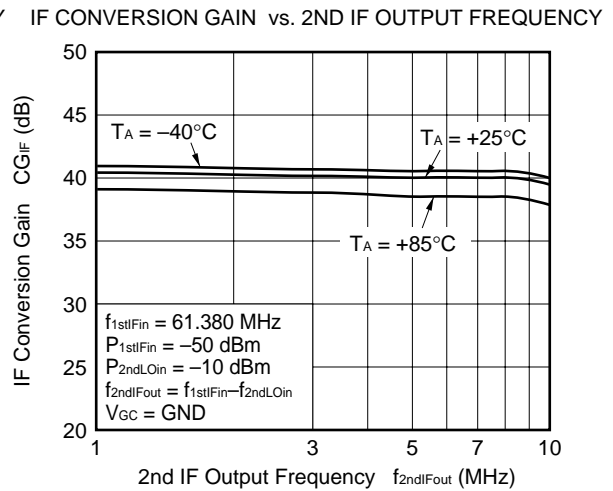
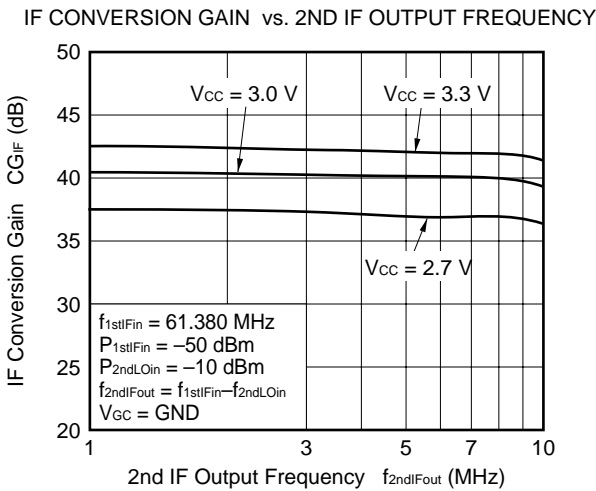
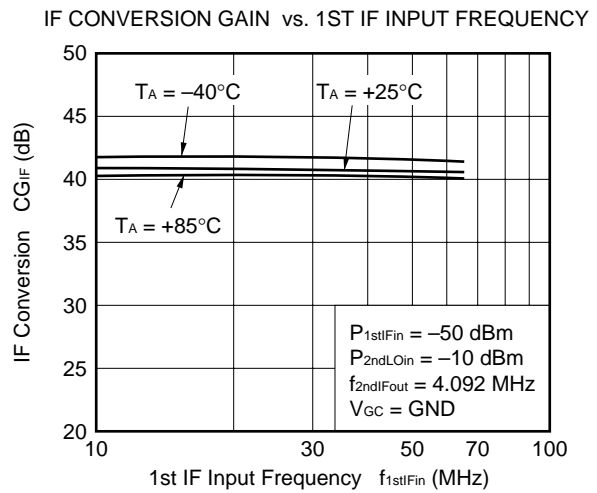
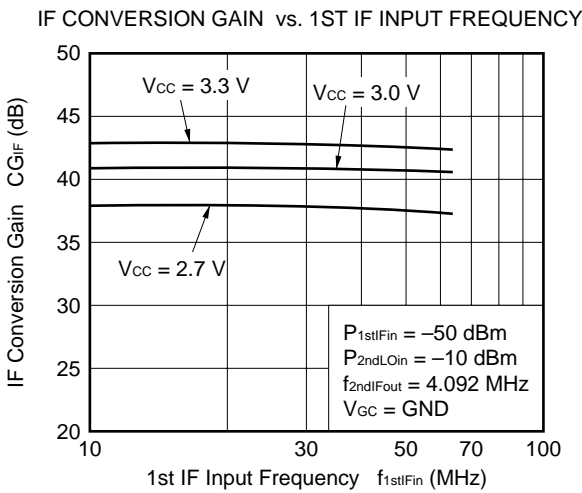
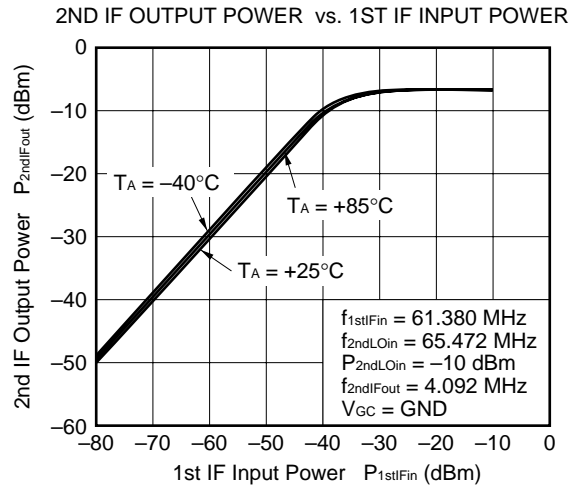
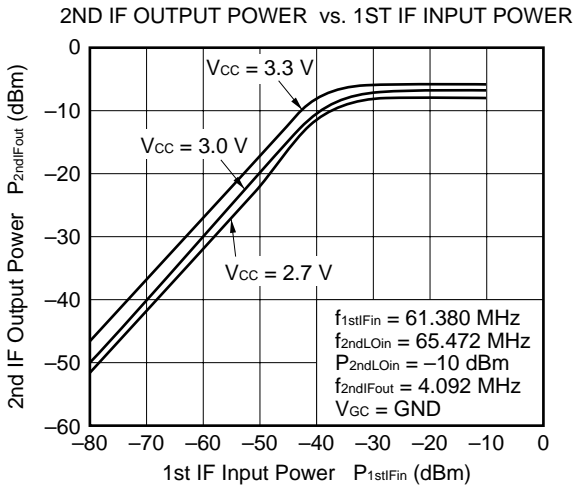
– RF DOWN-CONVERTER BLOCK –



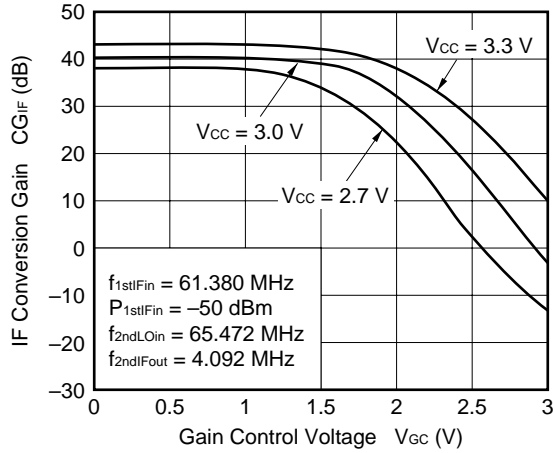


– IF DOWN-CONVERTER BLOCK –

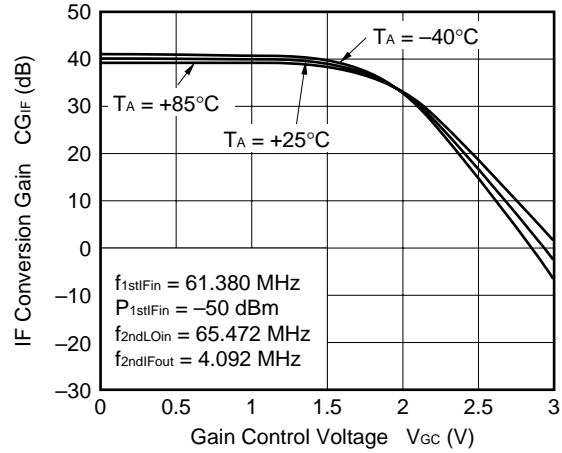




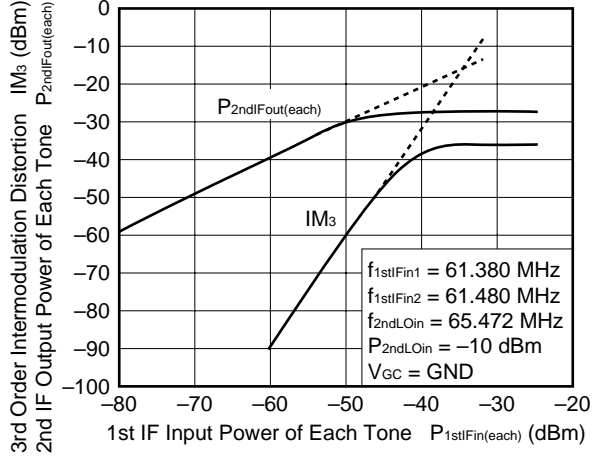
IF CONVERSION GAIN vs. GAIN CONTROL VOLTAGE



IF CONVERSION GAIN vs. GAIN CONTROL VOLTAGE

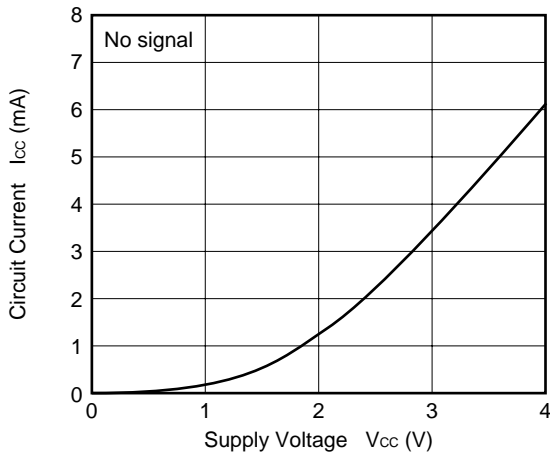


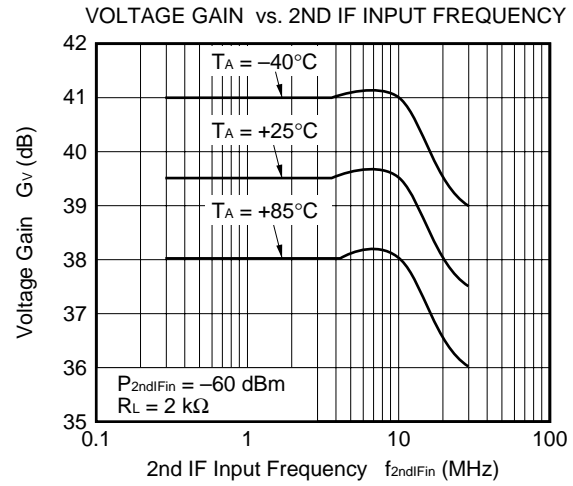
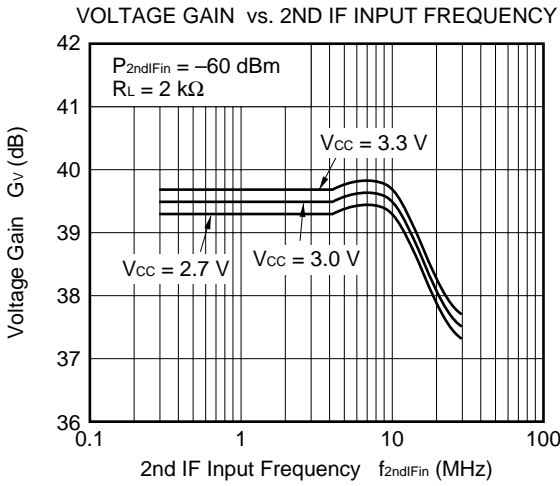
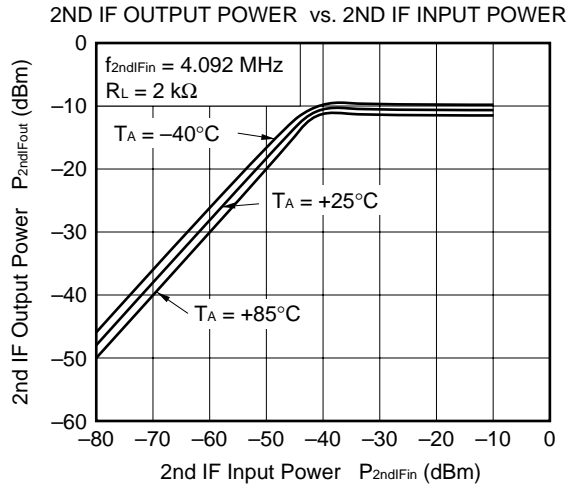
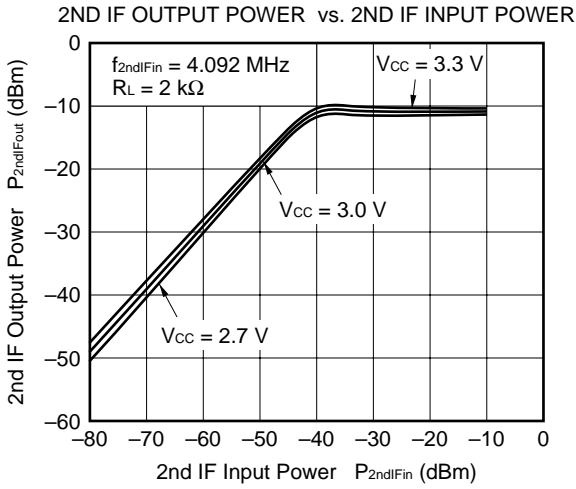
3RD ORDER INTERMODULATION DISTORTION, 2ND IF OUTPUT POWER OF EACH TONE vs. 1ST IF INPUT POWER OF EACH TONE



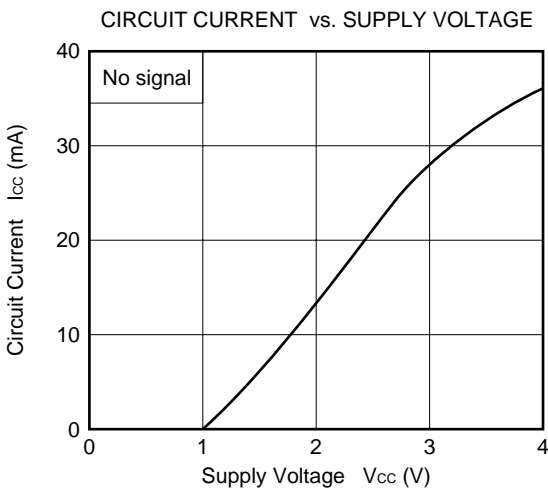
– IF AMPLIFIER BLOCK –

CIRCUIT CURRENT vs. SUPPLY VOLTAGE

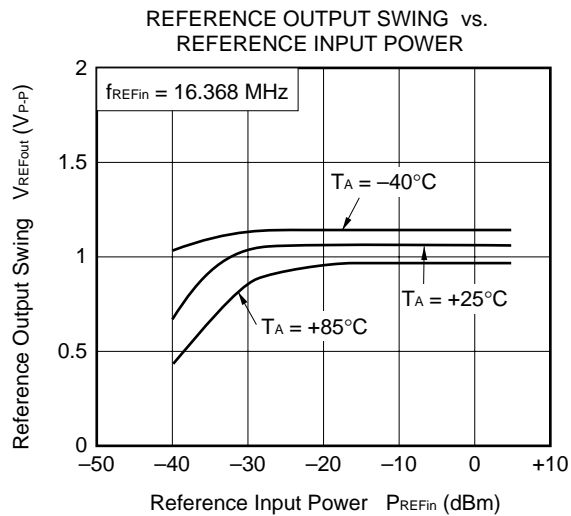
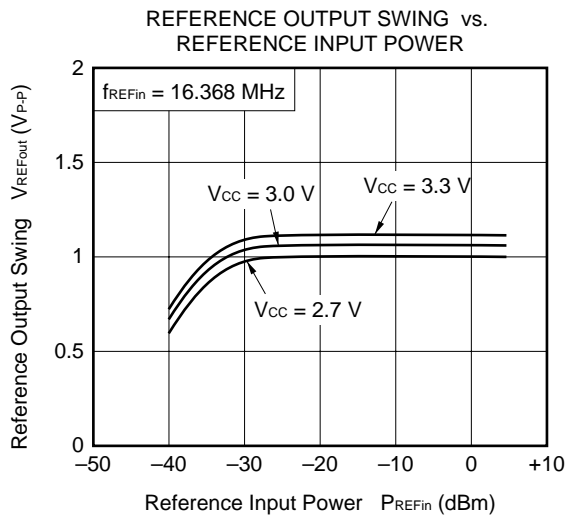
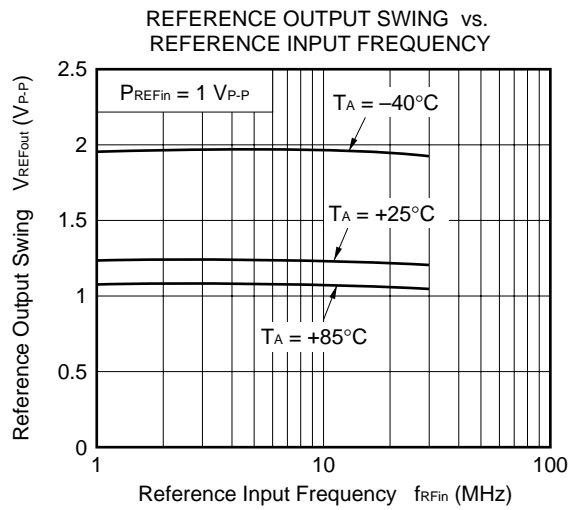
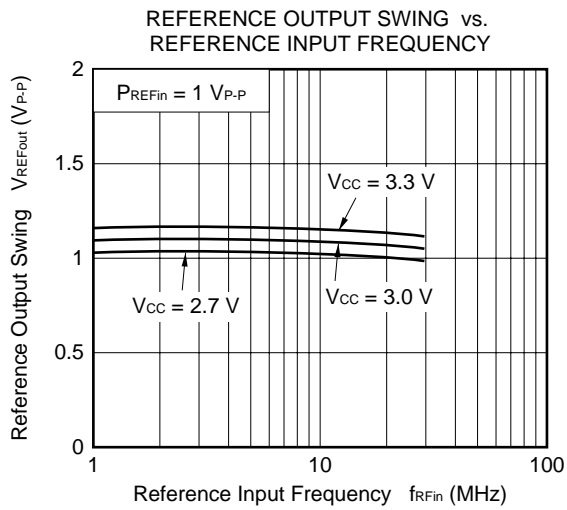




- PLL SYNTHESIZER BLOCK -



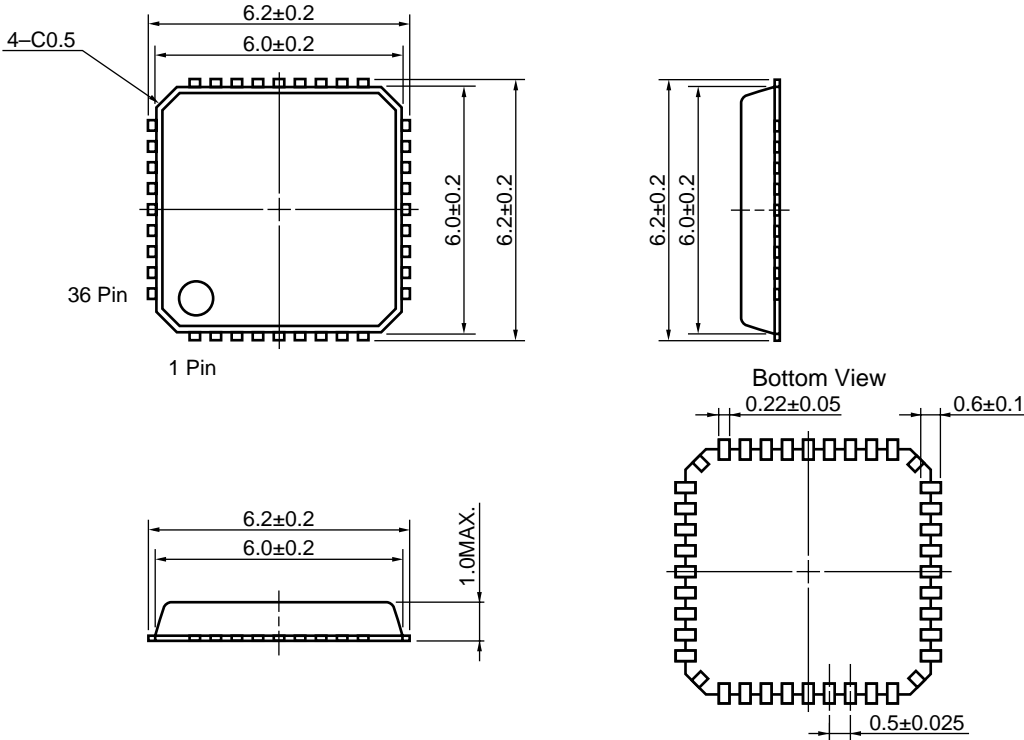
– REFERENCE BLOCK –



Remark The graphs indicate nominal characteristics.

★ PACKAGE DIMENSIONS

36-PIN PLASTIC QFN (UNIT: mm)



NOTE ON CORRECT USE

- (1) Observe precautions for handling because of electro-static sensitive devices.
- (2) Form a ground pattern as widely as possible to minimize ground impedance (to prevent abnormal oscillation).
- (3) Keep the track length of the ground pins as short as possible.
- (4) Connect a bypass capacitor (example: 1 000 pF) to the V_{CC} pin.
- (5) Frequency signal input/output pins must be each coupled with external capacitor for DC cut.

RECOMMENDED SOLDERING CONDITIONS

This product should be soldered under the following recommended conditions. For soldering methods and conditions other than those recommended below, contact your NEC sales representative.

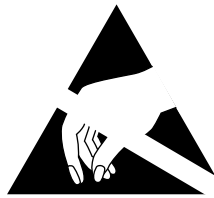
Soldering Method	Soldering Conditions	Recommended Condition Symbol
Infrared Reflow	Package peak temperature: 235°C or below Time: 30 seconds or less (at 210°C) Count: 2, Exposure limit: None ^{Note}	IR35-00-2
Partial Heating	Pin temperature: 300°C Time: 3 seconds or less (per side of device) Exposure limit: None ^{Note}	-

Note After opening the dry pack, keep it in a place below 25°C and 65% RH for the allowable storage period.

Caution Do not use different soldering methods together (except for partial heating).

For details of recommended soldering conditions for surface mounting, refer to information document **SEMICONDUCTOR DEVICE MOUNTING TECHNOLOGY MANUAL (C10535E)**.

[MEMO]



ATTENTION

OBSERVE PRECAUTIONS
FOR HANDLING
ELECTROSTATIC
SENSITIVE
DEVICES

NESAT (NEC Silicon Advanced Technology) is a trademark of NEC Corporation.

- **The information in this document is current as of August, 2000. The information is subject to change without notice. For actual design-in, refer to the latest publications of NEC's data sheets or data books, etc., for the most up-to-date specifications of NEC semiconductor products. Not all products and/or types are available in every country. Please check with an NEC sales representative for availability and additional information.**
- No part of this document may be copied or reproduced in any form or by any means without prior written consent of NEC. NEC assumes no responsibility for any errors that may appear in this document.
- NEC does not assume any liability for infringement of patents, copyrights or other intellectual property rights of third parties by or arising from the use of NEC semiconductor products listed in this document or any other liability arising from the use of such products. No license, express, implied or otherwise, is granted under any patents, copyrights or other intellectual property rights of NEC or others.
- Descriptions of circuits, software and other related information in this document are provided for illustrative purposes in semiconductor product operation and application examples. The incorporation of these circuits, software and information in the design of customer's equipment shall be done under the full responsibility of customer. NEC assumes no responsibility for any losses incurred by customers or third parties arising from the use of these circuits, software and information.
- While NEC endeavours to enhance the quality, reliability and safety of NEC semiconductor products, customers agree and acknowledge that the possibility of defects thereof cannot be eliminated entirely. To minimize risks of damage to property or injury (including death) to persons arising from defects in NEC semiconductor products, customers must incorporate sufficient safety measures in their design, such as redundancy, fire-containment, and anti-failure features.
- NEC semiconductor products are classified into the following three quality grades:
 "Standard", "Special" and "Specific". The "Specific" quality grade applies only to semiconductor products developed based on a customer-designated "quality assurance program" for a specific application. The recommended applications of a semiconductor product depend on its quality grade, as indicated below. Customers must check the quality grade of each semiconductor product before using it in a particular application.
 - "Standard": Computers, office equipment, communications equipment, test and measurement equipment, audio and visual equipment, home electronic appliances, machine tools, personal electronic equipment and industrial robots
 - "Special": Transportation equipment (automobiles, trains, ships, etc.), traffic control systems, anti-disaster systems, anti-crime systems, safety equipment and medical equipment (not specifically designed for life support)
 - "Specific": Aircraft, aerospace equipment, submersible repeaters, nuclear reactor control systems, life support systems and medical equipment for life support, etc.

The quality grade of NEC semiconductor products is "Standard" unless otherwise expressly specified in NEC's data sheets or data books, etc. If customers wish to use NEC semiconductor products in applications not intended by NEC, they must contact an NEC sales representative in advance to determine NEC's willingness to support a given application.

(Note)

- (1) "NEC" as used in this statement means NEC Corporation and also includes its majority-owned subsidiaries.
- (2) "NEC semiconductor products" means any semiconductor product developed or manufactured by or for NEC (as defined above).