

**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 PB1007K is a silicon monolithic integrated circuit for GPS receiver. This IC is designed as double conversion RF block integrated Pre-Amplifier + RF/IF down-converter + PLL frequency synthesizer on 1 chip.

This IC is lower current than the μ PB1005K and packaged in a 36-pin QFN package.

This IC is manufactured using our 30 GHz $f_{\max}$ UHS0 (Ultra High Speed Process) silicon bipolar process.

FEATURES

- Double conversion : $f_{\text{REFin}} = 16.368 \text{ MHz}$, $f_{1\text{stIFin}} = 61.380 \text{ MHz}$, $f_{2\text{ndIFin}} = 4.092 \text{ MHz}$
- Integrated RF block : Pre-Amplifier + RF/IF frequency down-converter + PLL frequency synthesizer
- 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 : $V_{\text{CC}} = 2.7 \text{ to } 3.3 \text{ V}$
- Low current consumption : $I_{\text{CC}} = 25.0 \text{ mA TYP. @ } V_{\text{CC}} = 3.0 \text{ V}$
- Gain adjustable externally : Gain control voltage pin (control voltage up vs. gain down)
- On-chip pre-amplifier : $G_{\text{P}} = 15.5 \text{ dB TYP. @ } f = 1.57542 \text{ GHz}$
 $NF = 3.2 \text{ dB TYP. @ } f = 1.57542 \text{ GHz}$
- Power-save function : Power-save dark current $I_{\text{CC}}(\text{PD}) = 5 \mu\text{A MAX.}$
- High-density surface mountable : 36-pin plastic QFN

APPLICATIONS

- 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 PB1007K-E1-A	36-pin plastic QFN	• 12 mm wide embossed taping • Pin 1 indicates pull-out direction of tape • Qty 2.5 kpcs/reel

Remark To order evaluation samples, contact your nearby sales office.

Part number for sample order: μ PB1007K-A

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.

PRODUCT LINE-UP ($T_A = +25^\circ\text{C}$, $V_{CC} = 3.0\text{ V}$)

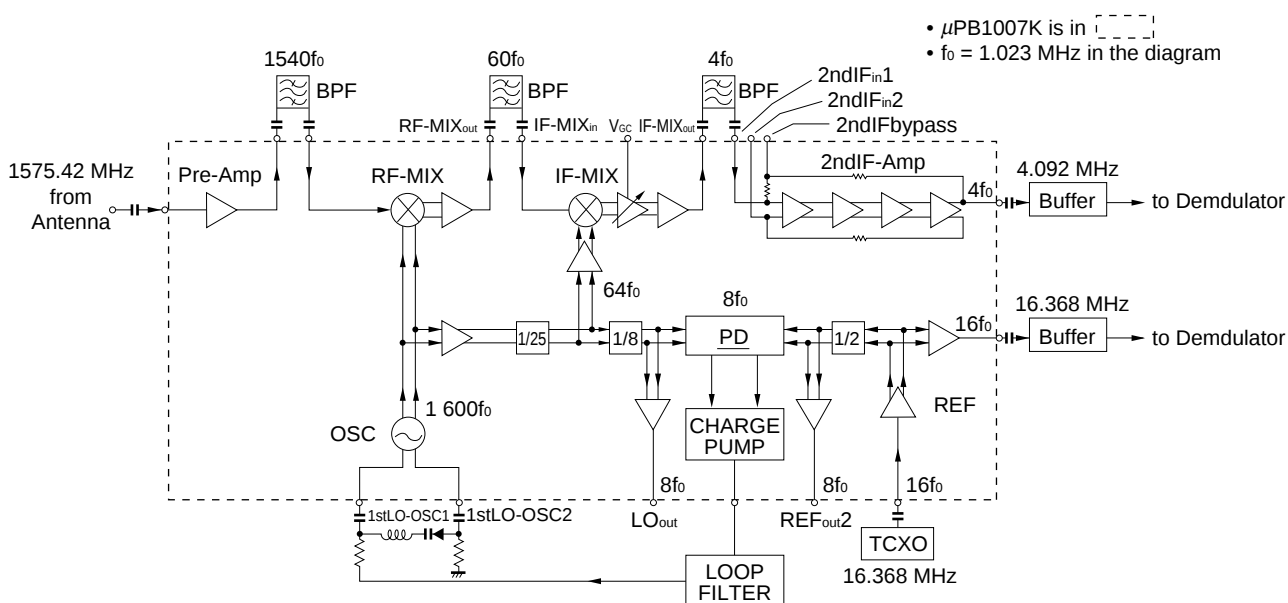
Type	Part Number	Functions (Frequency unit: MHz)	V_{CC} (V)	I_{CC} (mA)	CG (dB)	Package	Status
Clock Frequency Specific 1 chip IC	μPB1007K	Pre-amplifier + RF/IF down-converter + PLL synthesizer REF = 16.368 1stIF = 61.380/2ndIF = 4.092	2.7 to 3.3	25.0	100 to 120	36-pin plastic QFN	New Device
	μPB1005GS	RF/IF down-converter + PLL synthesizer	2.7 to 3.3	45.0	76 to 96	30-pin plastic SSOP	Available
	μPB1005K	REF = 16.368 1stIF = 61.380/2ndIF = 4.092				36-pin plastic QFN	

Remark Typical performance. Please refer to ELECTRICAL CHARACTERISTICS in detail.

To know the associated products, please refer to their latest data sheets.

SYSTEM APPLICATION EXAMPLE

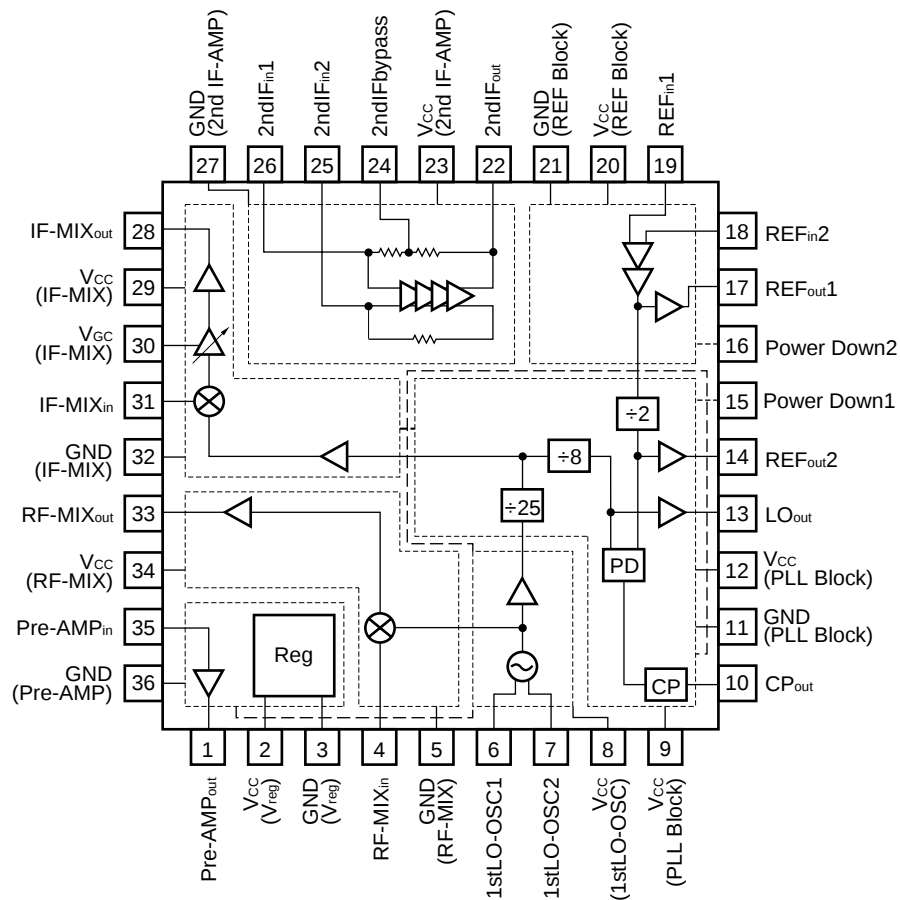
GPS receiver RF block diagram



Caution This diagram schematically shows only the μPB1007K's internal functions on the system.
This diagram does not present the actual application circuits.

PIN CONNECTION AND INTERNAL BLOCK DIAGRAM

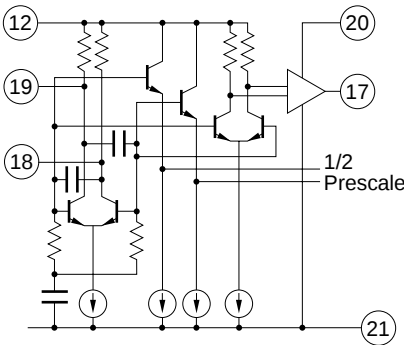
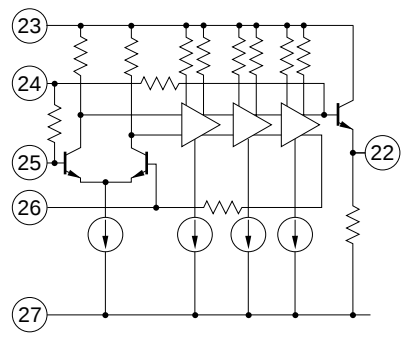
Top View



PIN EXPLANATION

Pin No.	Pin Name	Applied Voltage (V)	Pin Voltage (V)	Function and Application	Internal Equivalent Circuit
1	Pre-AMP _{out}	–	voltage as same as V _{CC}	Output pin of Pre-amplifier. Output biasing and matching required as it is a open collector output.	
2	V _{CC} (V _{reg})	2.7 to 3.3	–	Supply voltage pin of voltage regulator. This pin should be externally equipped with bypass capacitor to minimize ground impedance.	
3	GND(V _{reg})	0	–	Ground pin of voltage regulator.	
35	Pre-AMP _{in}	–	0.79	Input pin of Pre-amplifier. LC matching circuit must be connected to this pin.	
36	GND(Pre-AMP)	0	–	Ground pin of Pre-amplifier.	
4	RF-MIX _{in}	–	1.00	Input pin of RF mixer. 1 575.42 MHz band pass filter can be inserted between pin 1 and 4.	
5	GND(RF-MIX)	0	–	Ground pin of RF mixer.	
33	RF-MIX _{out}	–	1.30	Output pin of RF mixer. 1st IF filter must be inserted between pin 31 and 33.	
34	V _{CC} (RF-MIX)	2.7 to 3.3	–	Supply voltage pin of RF mixer. This pin should be externally equipped with bypass capacitor to minimize ground impedance.	
6	1stLO-OSC1	–	1.80	Pin 6 and 7 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.	
7	1stLO-OSC2	–	1.80		
8	V _{CC} (1stLO-OSC)	2.7 to 3.3	–	Supply voltage pin of differential amplifier for 1st LO oscillator circuit.	

Data Sheet PU10014EJ02V0DS

Pin No.	Pin Name	Applied Voltage (V)	Pin Voltage (V)	Function and Application	Internal Equivalent Circuit				
16	Power Down2	0 or V _{cc}	–	Stand-by mode control pin of reference block. <table><tr><td>Low</td><td>OFF</td></tr><tr><td>High</td><td>ON</td></tr></table>	Low	OFF	High	ON	
Low	OFF								
High	ON								
17	REF _{out} 1	–	–	Output pin of reference frequency. The frequency from pin 19 can be taken out as 3 V _{P-P} swing.					
18	REF _{in} 2	–	2.45	Input pin of reference frequency. This pin should be grounded through capacitor.					
19	REF _{in} 1	–	2.45	Input pin of reference frequency. This pin can use as an input pin of reference frequency buffer. This pin should be equipped with external 16.368 MHz oscillator (example: TCXO).					
20	V _{cc} (REF Block)	2.7 to 3.3	–	Supply voltage pin of reference block. This pin should be externally equipped with bypass capacitor to minimize ground impedance.					
21	GND(REF Block)	0	–	Ground pin of reference block.					
22	2ndIF _{out}	–	1.80	Output pin of 2nd IF amplifier. This pin output 4.092 MHz. This pin should be equipped with external buffer amplifier to adjust level to next stage on user's system.					
23	V _{cc} (2nd IF-AMP)	2.7 to 3.3	–	Supply voltage pin of 2nd IF amplifier. This pin should be externally equipped with bypass capacitor to minimize ground impedance.					
24	2ndIF _{bypass}	–	2.10	Bypass pin of 2nd IF amplifier. This pin should be grounded through capacitor.					
25	2ndIF _{in} 2	–	2.10	Pin of 2nd IF amplifier input 2. This pin should be grounded through capacitor.					
26	2ndIF _{in} 1	–	2.10	Pin of 2nd IF amplifier input 1. 2nd IF filter can be inserted between 26 and 28.					
27	GND(2nd IF-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}	–	1.0	Output pin of IF mixer. IF mixer output signal goes through gain control amplifier before this emitter follower output port.	
29	V _{cc} (IF-MIX)	2.7 to 3.3	–	Supply voltage pin of IF mixer. This pin should be externally equipped with bypass capacitor to minimize ground impedance.	
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	IF-MIX _{in}	–	1.97	Input pin of IF mixer.	
32	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.

ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Test Conditions	Ratings	Unit
Supply Voltage	V_{CC}	$T_A = +25^{\circ}\text{C}$	3.6	V
Total Circuit Current	$I_{CC\text{Total}}$	$T_A = +25^{\circ}\text{C}$	100	mA
Power Dissipation	P_D	$T_A = +85^{\circ}\text{C}$ Note	360	mW
Operating Ambient Temperature	T_A		-40 to +85	$^{\circ}\text{C}$
Storage Temperature	T_{stg}		-55 to +150	$^{\circ}\text{C}$

Note Mounted on double-sided copper-clad 50 × 50 × 1.6 mm epoxy glass PWB

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	$^{\circ}\text{C}$
RF Input Frequency	f_{RFIn}	–	1 575.42	–	MHz
1st LO Oscillating Frequency	$f_{1\text{stLOIn}}$	–	1 636.80	–	MHz
1st IF Input Frequency	$f_{1\text{stIFIn}}$	–	61.380	–	MHz
2nd LO Input Frequency	$f_{2\text{ndLOIn}}$	–	65.472	–	MHz
2nd IF Input Frequency	$f_{2\text{ndIFIn}}$	–	4.092	–	MHz
Reference Input/Output Frequency	f_{REFIn} f_{REFOut}	–	16.368	–	MHz
LO Output Frequency	f_{LOOut}	–	8.184	–	MHz

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

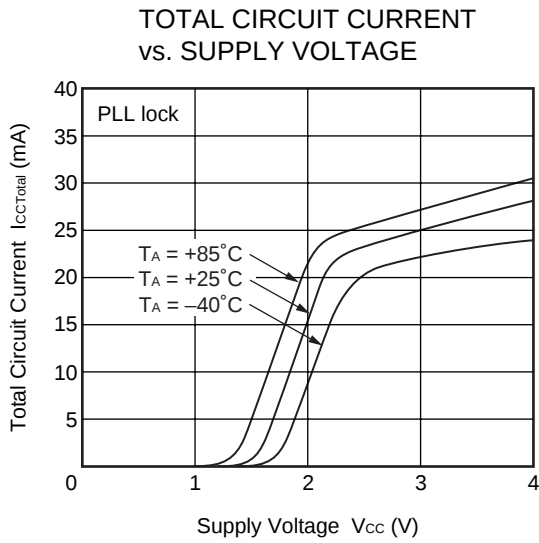
Parameter	Symbol	Test Conditions	MIN.	TYP.	MAX.	Unit
Total Circuit Current	$I_{CC\text{Total}}$	All block operating @ PLL lock	19.0	25.0	35.0	mA
Power-save Dark Current	$I_{CC}(\text{PD})$	Pin 15 = Pin 16 = 0 V	–	–	5	μA
Reference Block Circuit Current	$I_{CC\text{REF}}$	Pin 15 = 0 V, Pin 16 = 3 V	–	3	4	mA
Pre-amplifier Block ($f_{\text{RFin}} = 1\,575.42\text{ MHz}$, $Z_S = Z_L = 50\,\Omega$)						
Circuit Current 1	I_{CC1}	No Signals	1.65	2.50	3.50	mA
Power Gain	G_P	Input/Output matching, $P_{\text{RFin}} = -40\text{ dBm}$	12.5	15.5	18.5	dB
Noise Figure	NF	Input/Output matching	–	3.2	4.0	dB
RF Down-converter Block ($f_{\text{RFin}} = 1\,575.42\text{ MHz}$, $f_{1\text{stLOin}} = 1\,636.80\text{ MHz}$, $P_{\text{LOin}} = -10\text{ dBm}$, $Z_S = Z_L = 50\,\Omega$)						
Circuit Current 2	I_{CC2}	No Signals	5.2	7.0	9.9	mA
RF Conversion Gain	CG_{RF}	$P_{\text{RFin}} = -40\text{ dBm}$	15.5	18.5	21.5	dB
RF-SSB Noise Figure	NF_{RF}		–	10.5	13.5	dB
RF Saturated Output Power	$P_{O(\text{sat})\text{RF}}$	$P_{\text{RFin}} = -10\text{ dBm}$	–4	–1	–	dBm
IF Down-converter Block ($f_{1\text{stIFin}} = 61.38\text{ MHz}$, $f_{2\text{ndLOin}} = 65.472\text{ MHz}$, $Z_S = 50\,\Omega$, $Z_L = 2\text{ k}\Omega$)						
Circuit Current 3	I_{CC3}	No Signals	2.7	3.5	5.0	mA
IF Conversion Voltage Gain	$CG_{(\text{GV})\text{IF}}$	at Maximum Gain, $P_{1\text{stIFin}} = -50\text{ dBm}$	40	43	46	dB
IF-SSB Noise Figure	NF_{IF}	at Maximum Gain	–	11.5	14.5	dB
2nd IF Saturated Output Power	$P_{O(\text{sat})2\text{ndIF}}$	at Maximum Gain, $P_{1\text{stIFin}} = -20\text{ dBm}$	–9.0	–6.0	–	dBm
Gain Control Voltage	V_{GC}	Voltage at Maximum Gain CG_{IF}	–	–	1.0	V
Gain Control Range	D_{GC}	$P_{1\text{stIFin}} = -50\text{ dBm}$	20	–	–	dB
2nd IF Amplifier ($f_{2\text{ndIFin}} = 4.092\text{ MHz}$, $Z_S = 50\,\Omega$, $Z_L = 2\text{ k}\Omega$)						
Circuit Current 4	I_{CC4}	No Signals	0.8	1.0	1.6	mA
Voltage Gain	G_V	$P_{2\text{ndIFin}} = -60\text{ dBm}$	40	43	46	dB
2nd IF Saturated Output Power	$P_{O(\text{sat})2\text{ndIF}}$	$P_{2\text{ndIFin}} = -30\text{ dBm}$	–14.0	–11.0	–	dBm
PLL Synthesizer Block						
Circuit Current 5	I_{CC5}	PLL All Block Operating	8.7	11.0	14.4	mA
Loop Filter Output (High)	V_{OH}		2.8	–	–	V
Loop Filter Output (Low)	V_{OL}		–	–	0.4	V
Reference Minimum Input Level	V_{REFin}	$Z_L = 100\text{ k}\Omega//0.6\text{ pF}$ Impedance of measurement equipment	200	–	–	mV _{P-P}
Reference Output Swing	V_{REFout}	$Z_L = 100\text{ k}\Omega//0.6\text{ pF}$ Impedance of measurement equipment	2.9	3.0	–	V _{P-P}

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

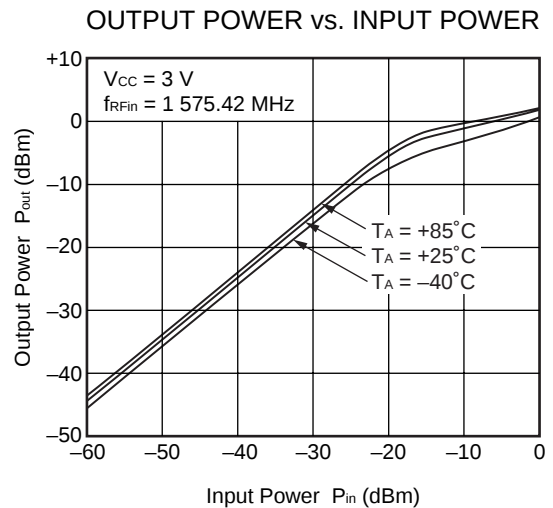
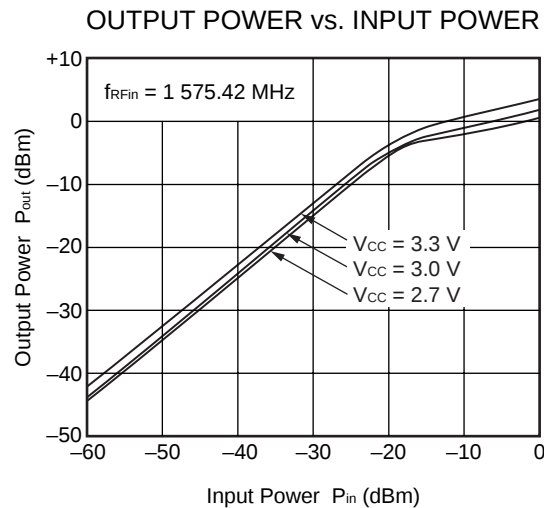
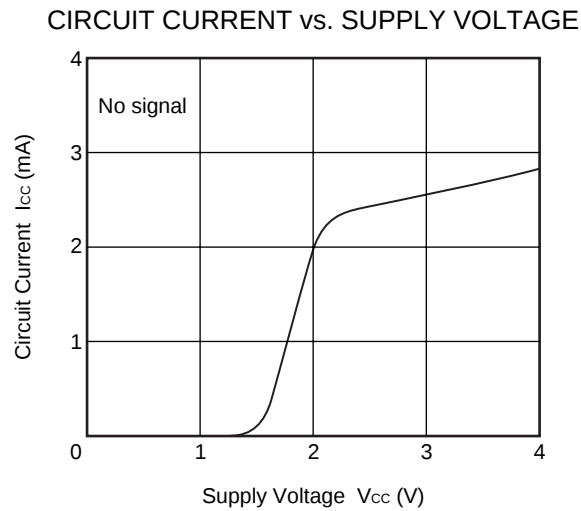
Parameter	Symbol	Test Conditions	Reference	Unit
Pre-amplifier Block ($f_{\text{RFIn}} = 1\,575.42\text{ MHz}$, $Z_S = Z_L = 50\ \Omega$)				
Input 1dB Compression Level	$P_{\text{in}(1\text{dB})}$	Input/Output matching	-20	dBm
RF Down-converter Block ($P_{1\text{stLOin}} = -10\text{ dBm}$, $Z_S = Z_L = 50\ \Omega$)				
LO Leakage to IF Pin	LO_{if}	$f_{1\text{stLOin}} = 1\,636.80\text{ MHz}$	-37	dBm
LO Leakage to RF Pin	LO_{rf}	$f_{1\text{stLOin}} = 1\,636.80\text{ MHz}$	-36	dBm
Input 3rd Order Intercept Point	$\text{IIP}_{3(\text{RF})}$	$f_{\text{RFIn}1} = 1\,600\text{ MHz}$, $f_{\text{RFIn}2} = 1\,605\text{ MHz}$, $f_{1\text{stLOin}} = 1\,660\text{ MHz}$	-15	dBm
IF Down-converter Block (1st LO oscillating, $Z_S = 50\ \Omega$, $Z_L = 2\text{ k}\Omega$)				
LO Leakage to 1st IF Pin	$\text{LO}_{1\text{stif}}$	$f_{2\text{ndLOin}} = 65.472\text{ MHz}$	-90	dBm
LO Leakage to 2nd IF Pin	$\text{LO}_{2\text{ndif}}$	$f_{2\text{ndLOin}} = 65.472\text{ MHz}$	-63	dBm
Input 3rd Order Intercept Point	$\text{IIP}_{3(\text{IF})}$	$f_{1\text{stIFin}1} = 61.38\text{ MHz}$, $f_{1\text{stIFin}2} = 61.48\text{ MHz}$, $f_{2\text{ndLOin}} = 65.472\text{ MHz}$	-27.5	dBm
PLL Synthesizer Block				
Phase Comparing Frequency	f_{PD}	PLL loop	8.184	MHz
VCO Block				
Phase Noise	C/N	PLL Loop, $\Delta 1\text{ kHz}$ of VCO wave	83	dBc/Hz

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

— IC TOTAL —

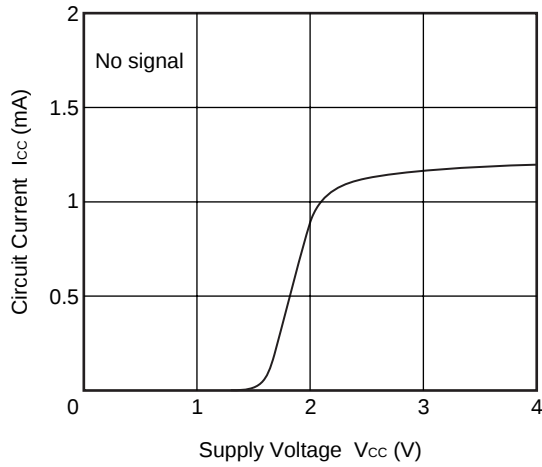


— PRE-AMPLIFIER BLOCK —

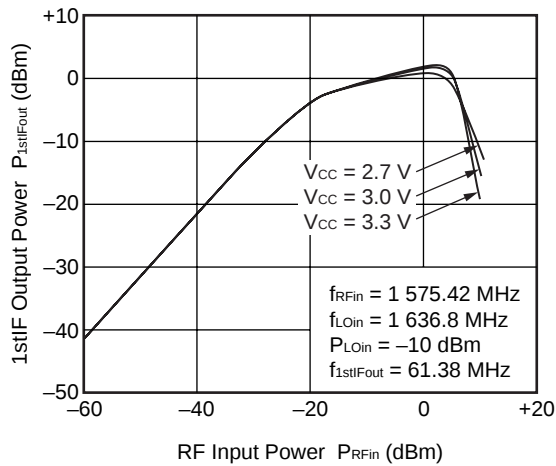


— RF DOWN-CONVERTER BLOCK —

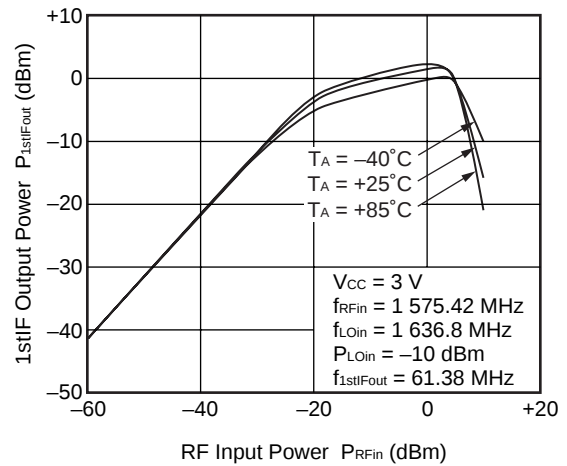
CIRCUIT CURRENT vs. SUPPLY VOLTAGE



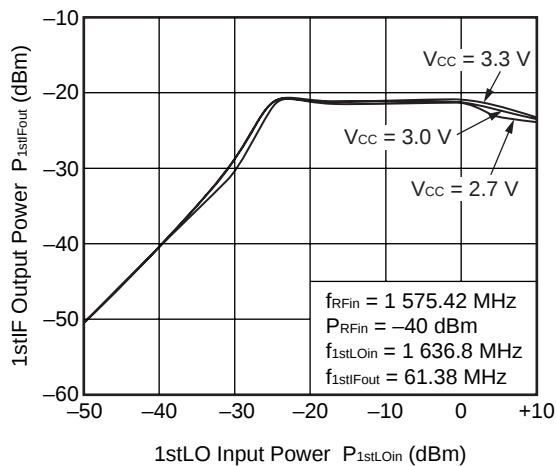
1stIF OUTPUT POWER vs. RF INPUT POWER



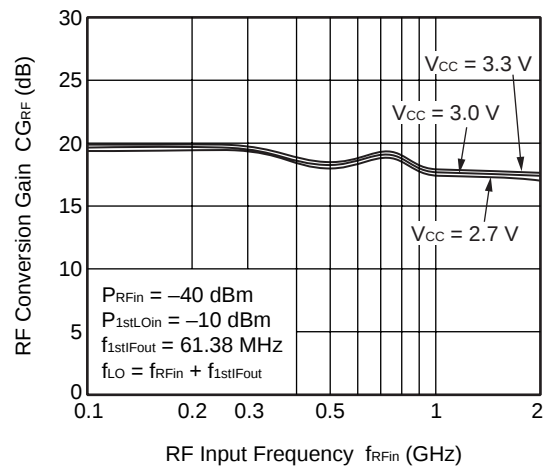
1stIF OUTPUT POWER vs. RF INPUT POWER

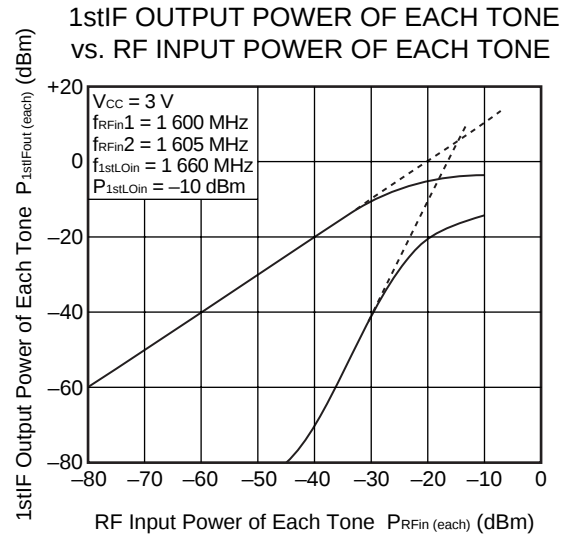
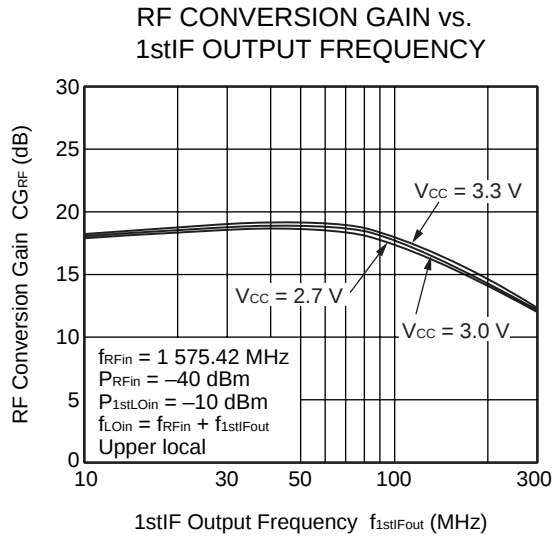


1stIF OUTPUT POWER vs. 1stLO INPUT POWER

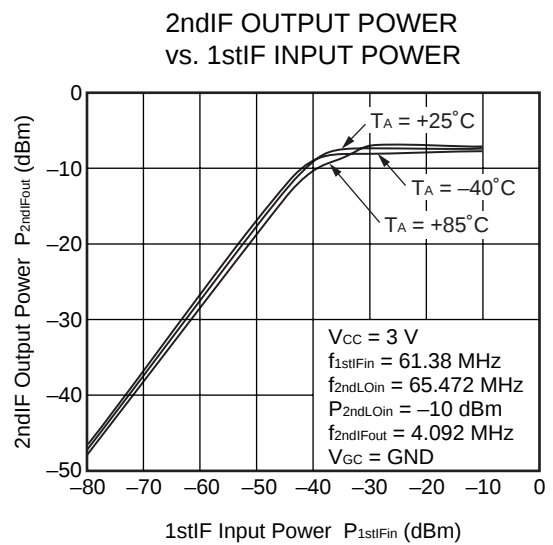
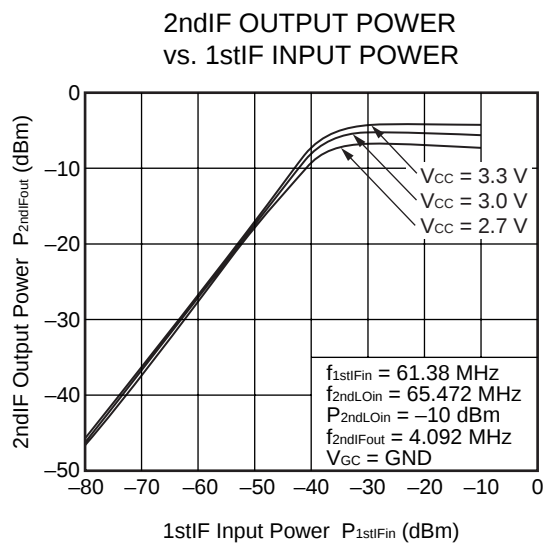
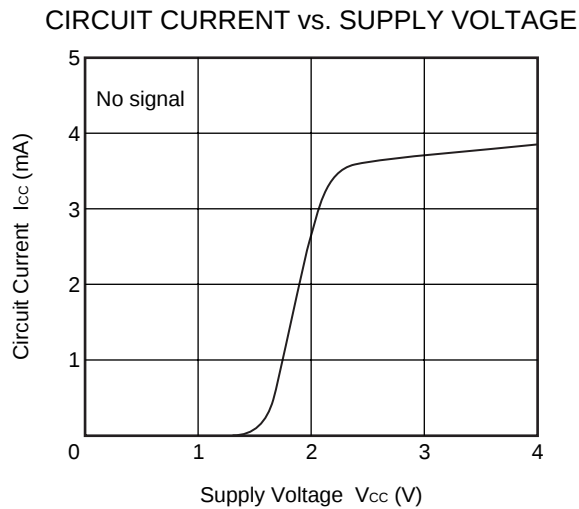


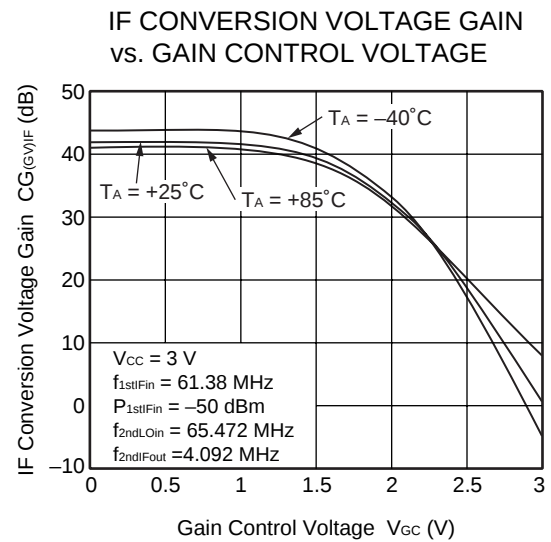
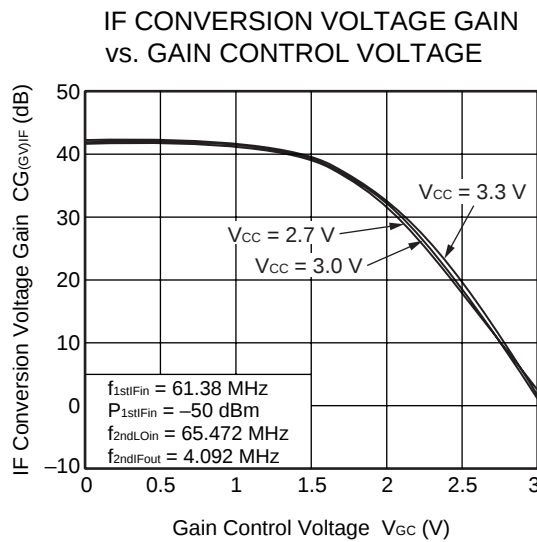
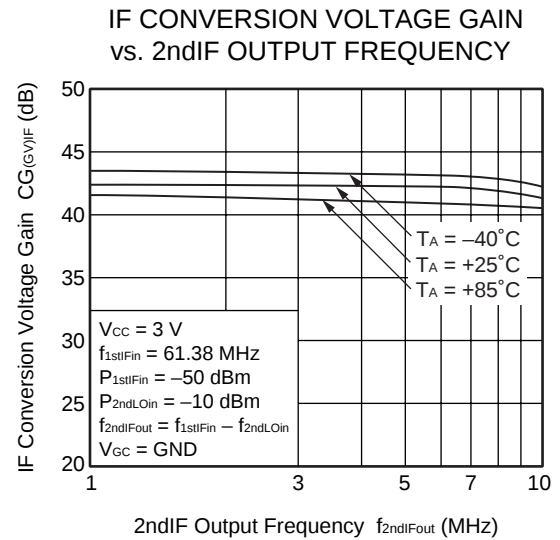
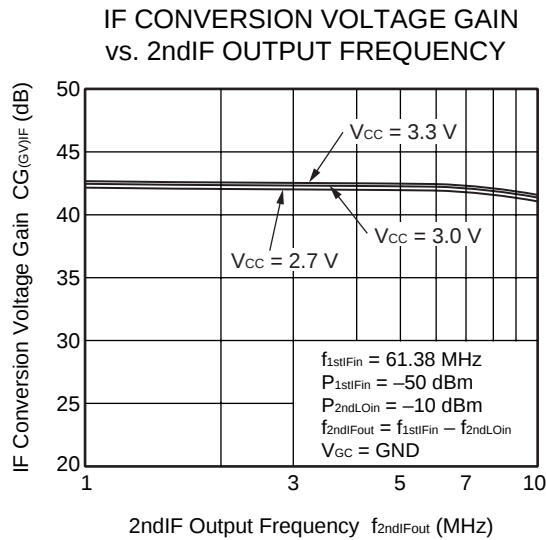
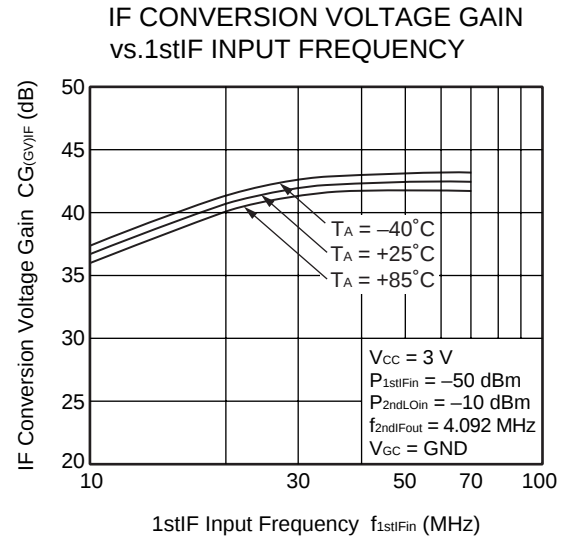
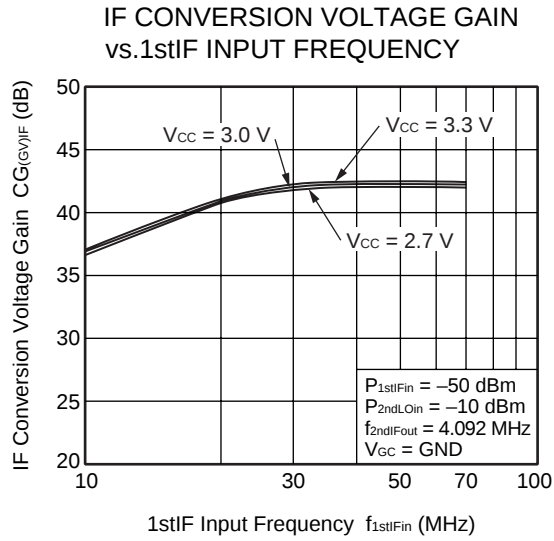
RF CONVERSION GAIN vs. RF INPUT FREQUENCY



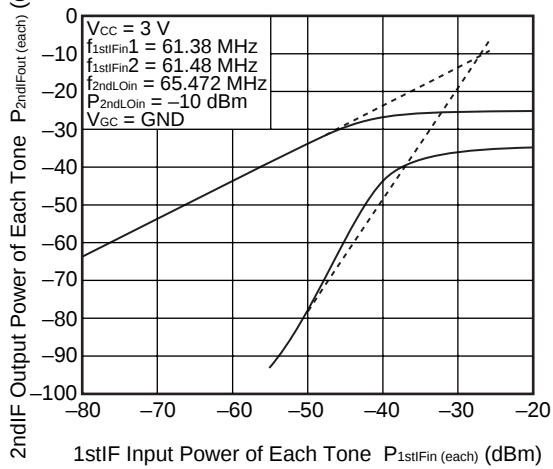


— IF DOWN-CONVERTER BLOCK —



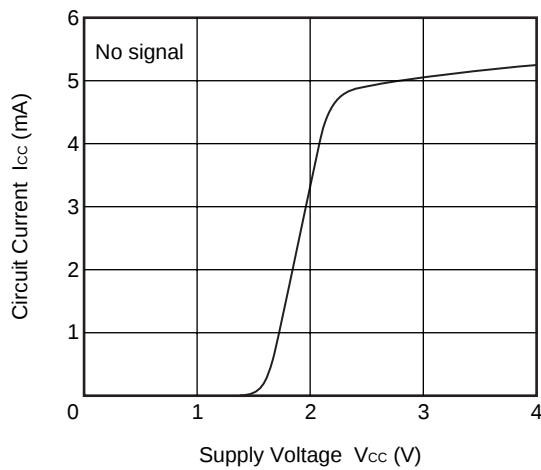


2ndIF OUTPUT POWER OF EACH TONE
vs. 1stIF INPUT POWER OF EACH TONE

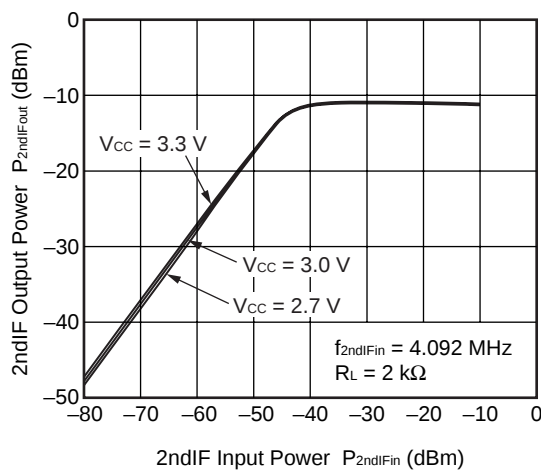


— IF AMPLIFIER BLOCK —

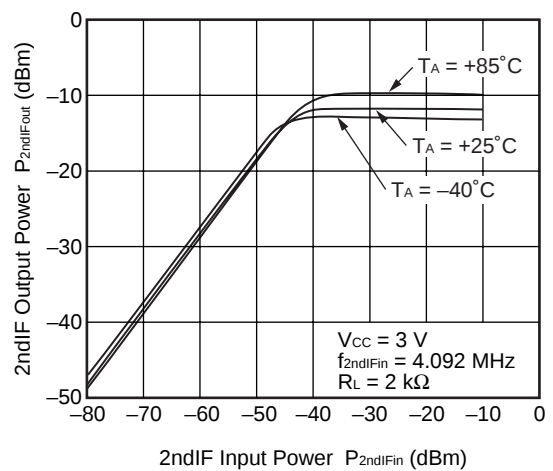
CIRCUIT CURRENT vs. SUPPLY VOLTAGE

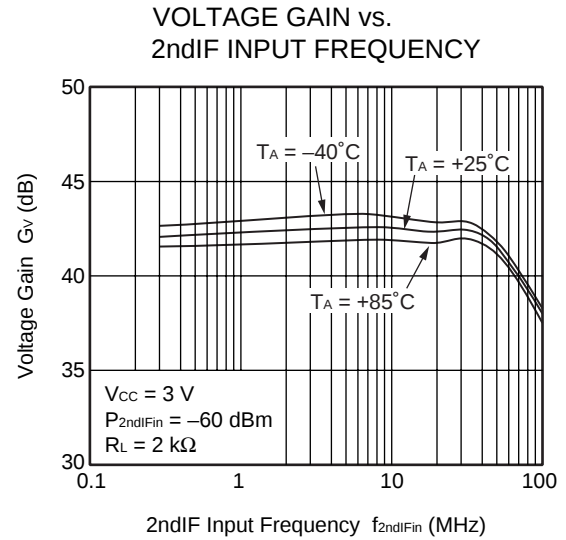
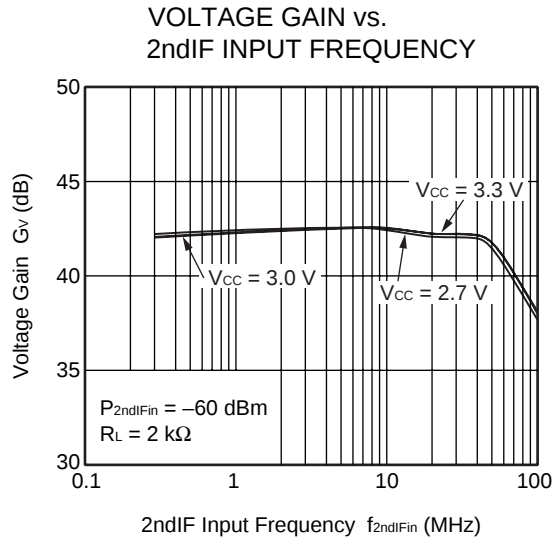


2ndIF OUTPUT POWER
vs. 2ndIF INPUT POWER

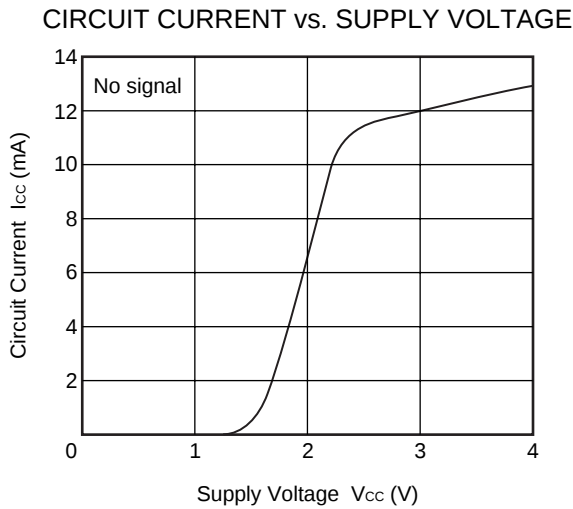


2ndIF OUTPUT POWER
vs. 2ndIF INPUT POWER

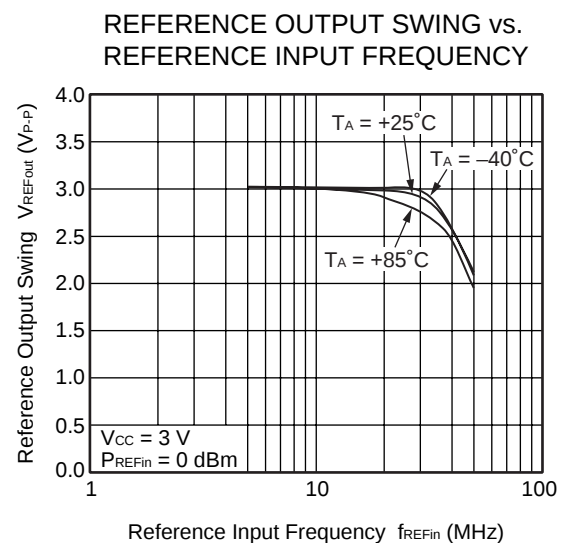
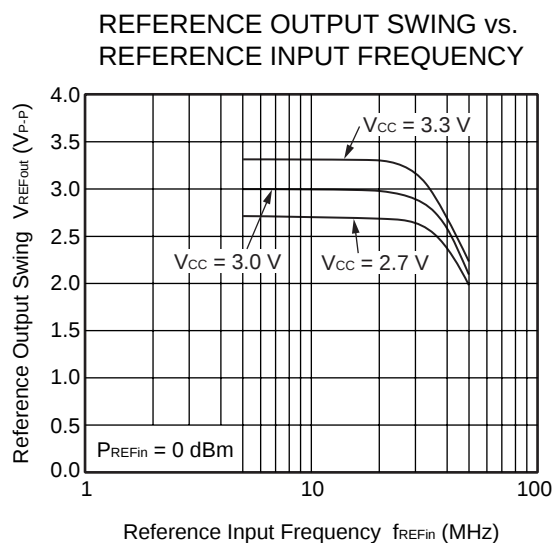




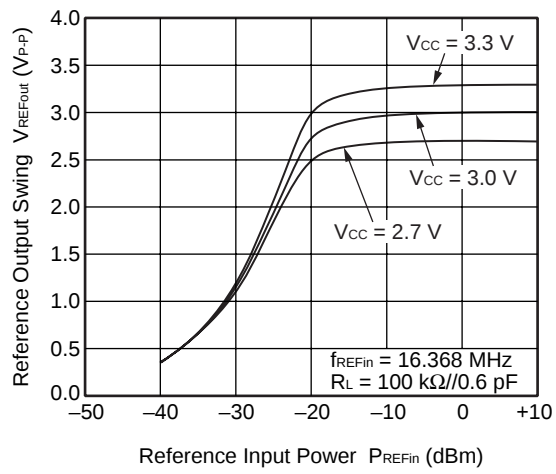
— PLL SYNTHESIZER BLOCK —



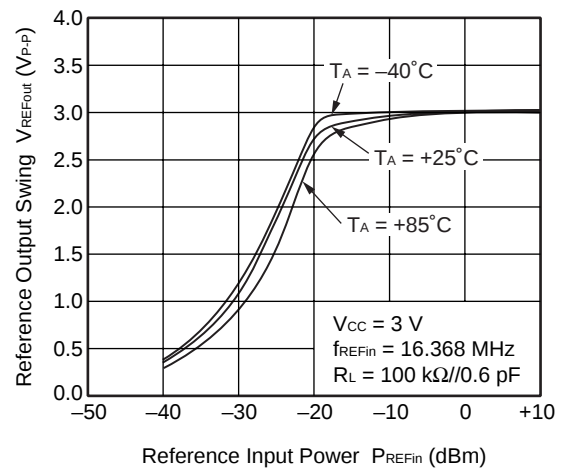
— REFERENCE BLOCK —



REFERENCE OUTPUT SWING vs.
REFERENCE INPUT POWER



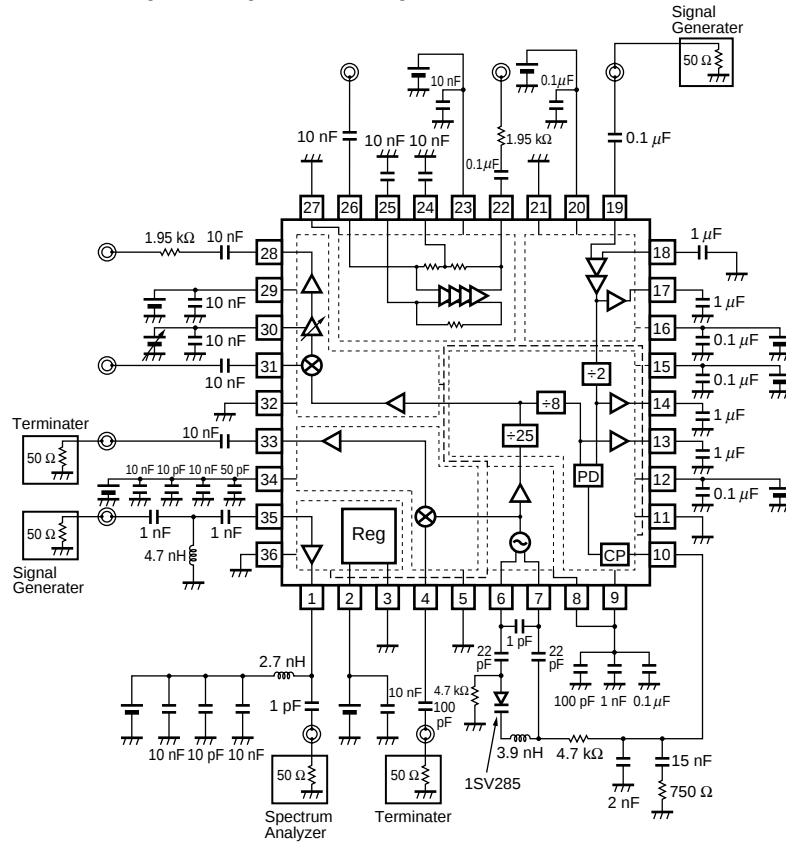
REFERENCE OUTPUT SWING vs.
REFERENCE INPUT POWER



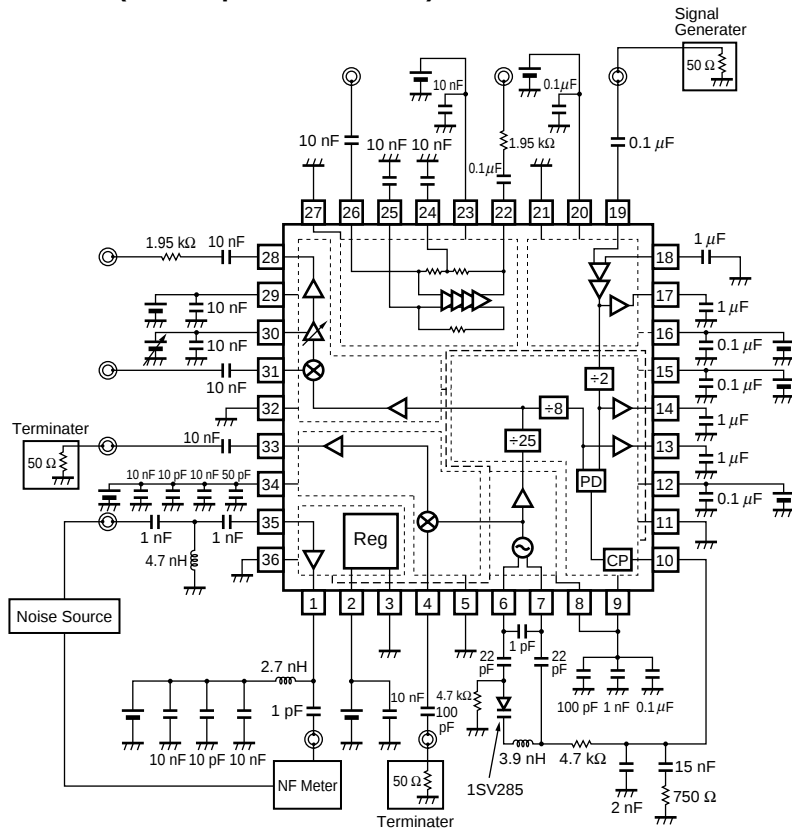
Remark The graphs indicate nominal characteristics.

★ MEASUREMENT CIRCUIT

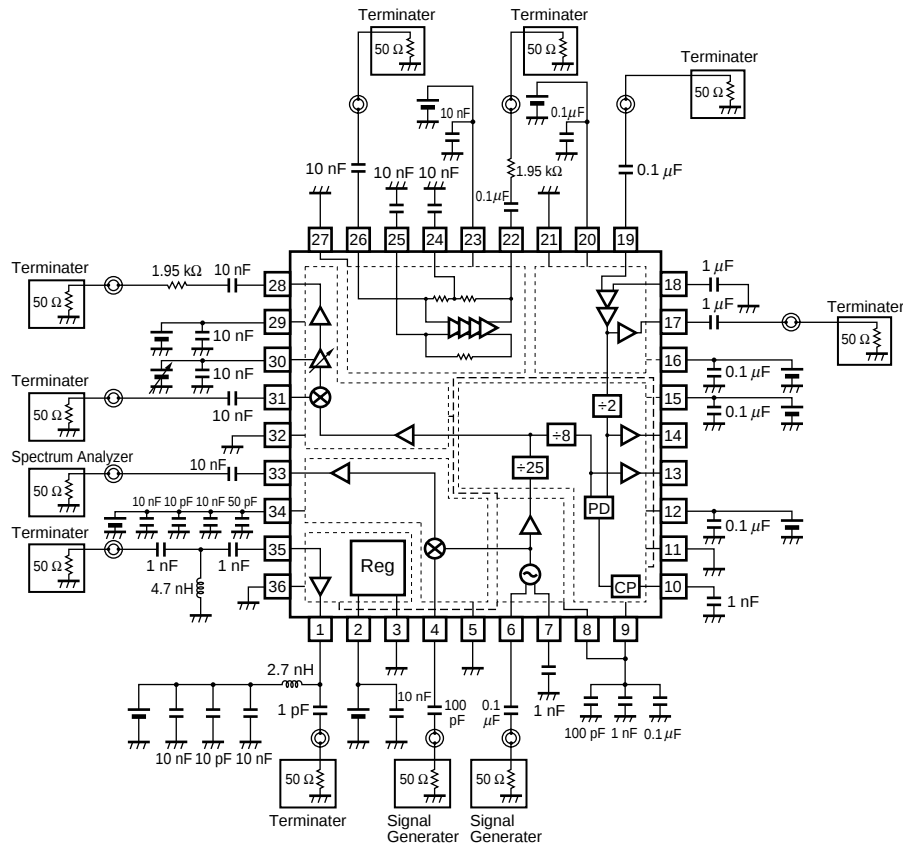
MEASUREMENT CIRCUIT 1 (Pre-Amplifier Block)



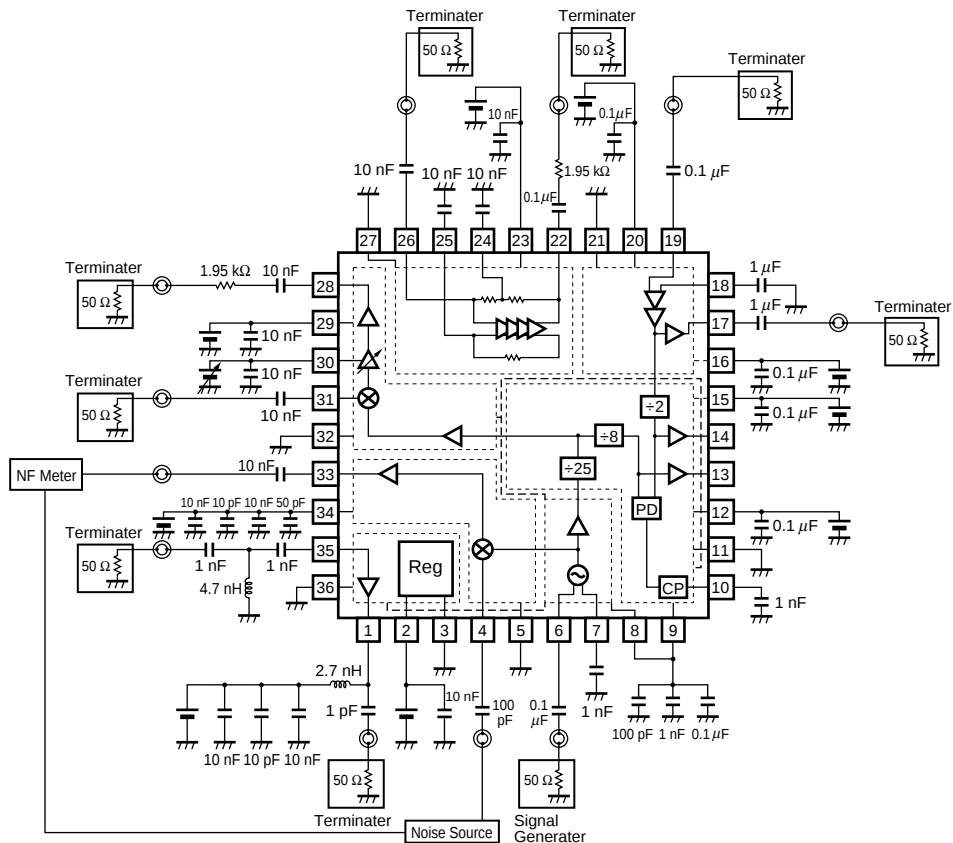
MEASUREMENT CIRCUIT 2 (Pre-Amplifier Block: NF)



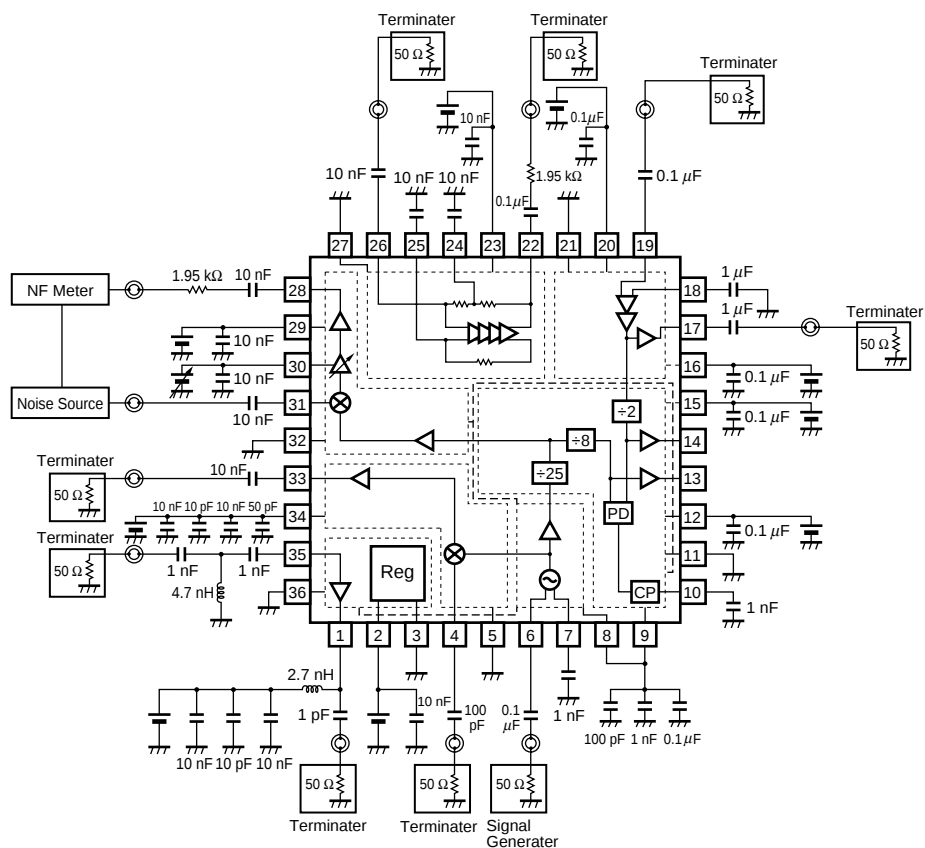
MEASUREMENT CIRCUIT 3 (RF-MIX Block)



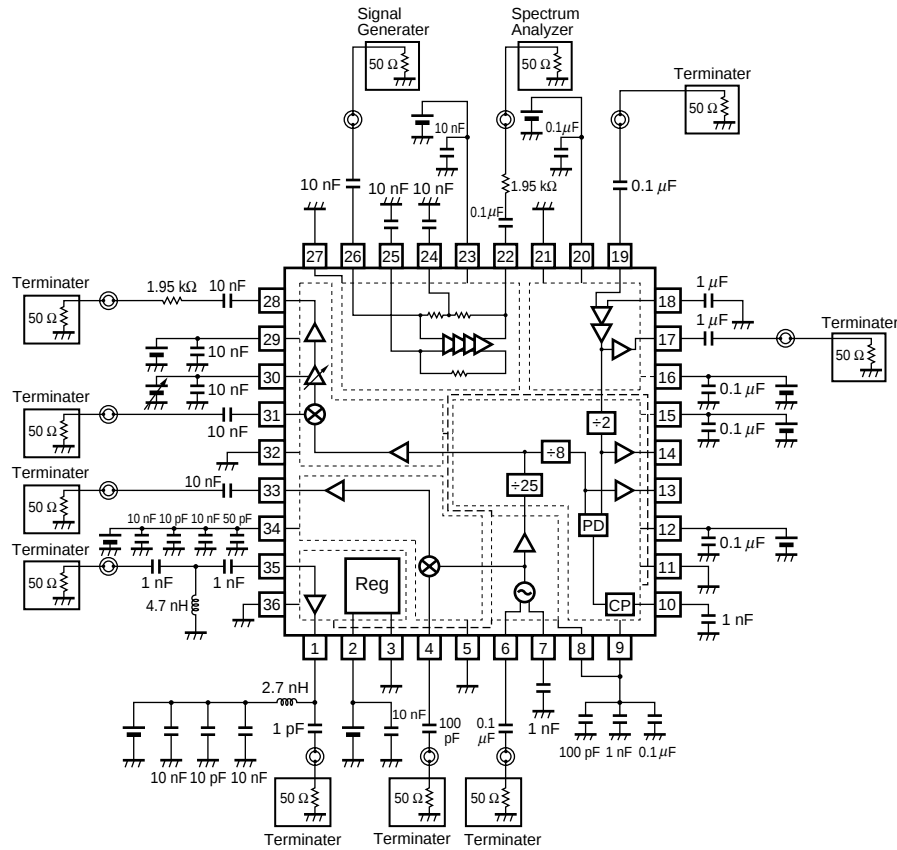
MEASUREMENT CIRCUIT 4 (RF-MIX Block: NF)



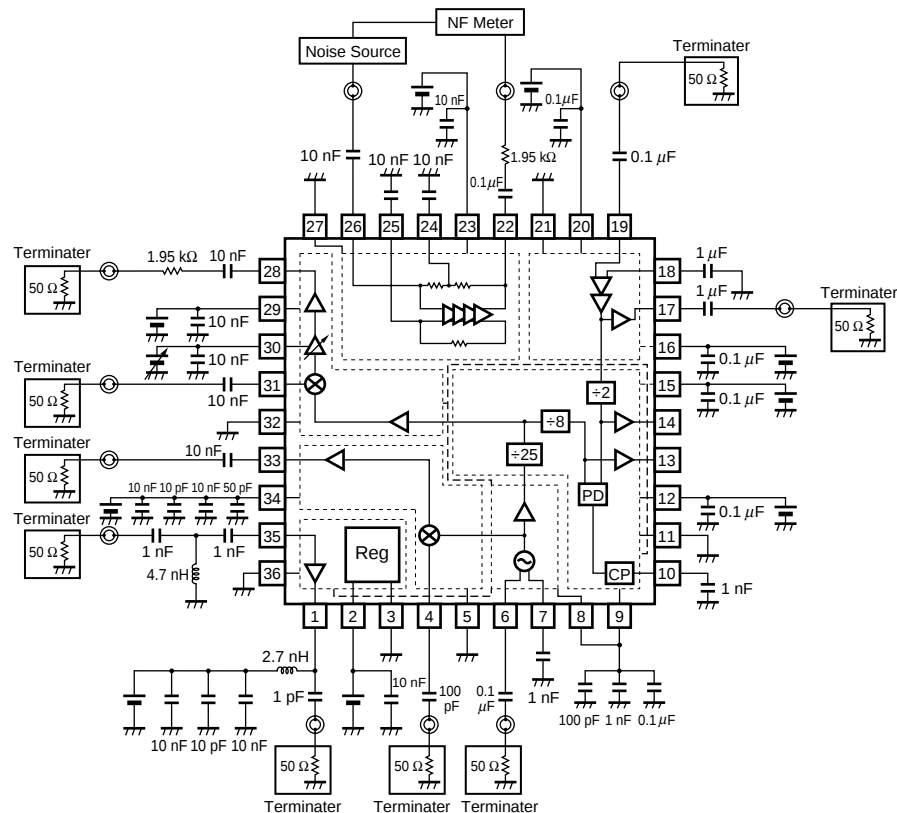
MEASUREMENT CIRCUIT 6 (IF Down-Converter Block: NF)



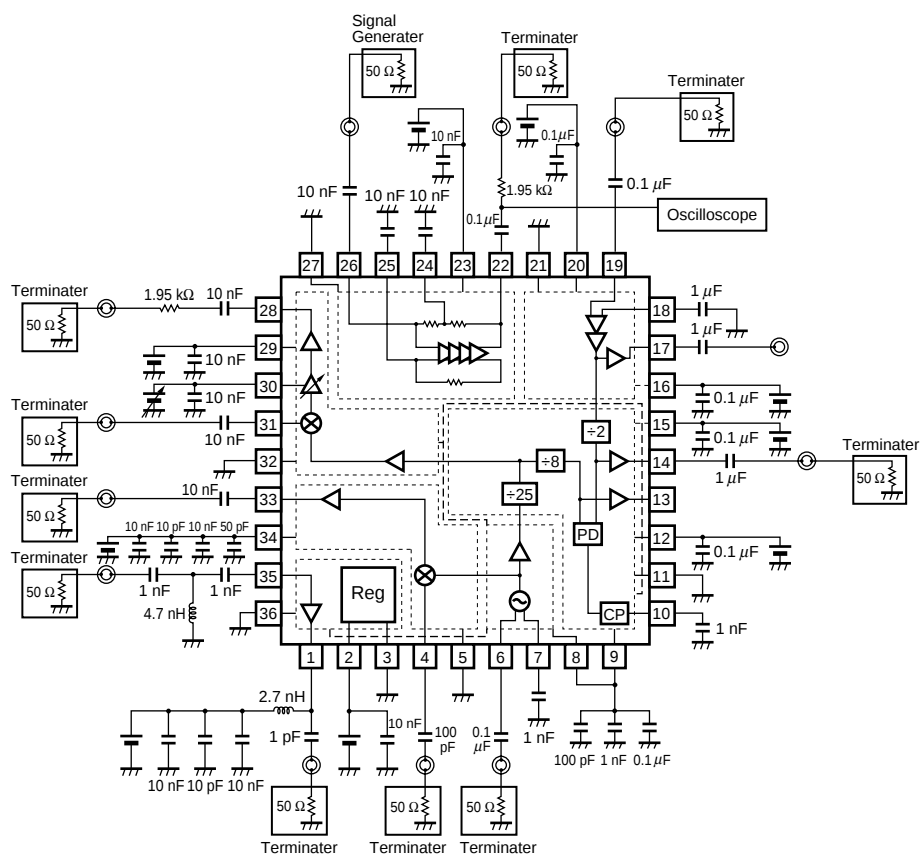
MEASUREMENT CIRCUIT 7 (IF Amplifier Block)



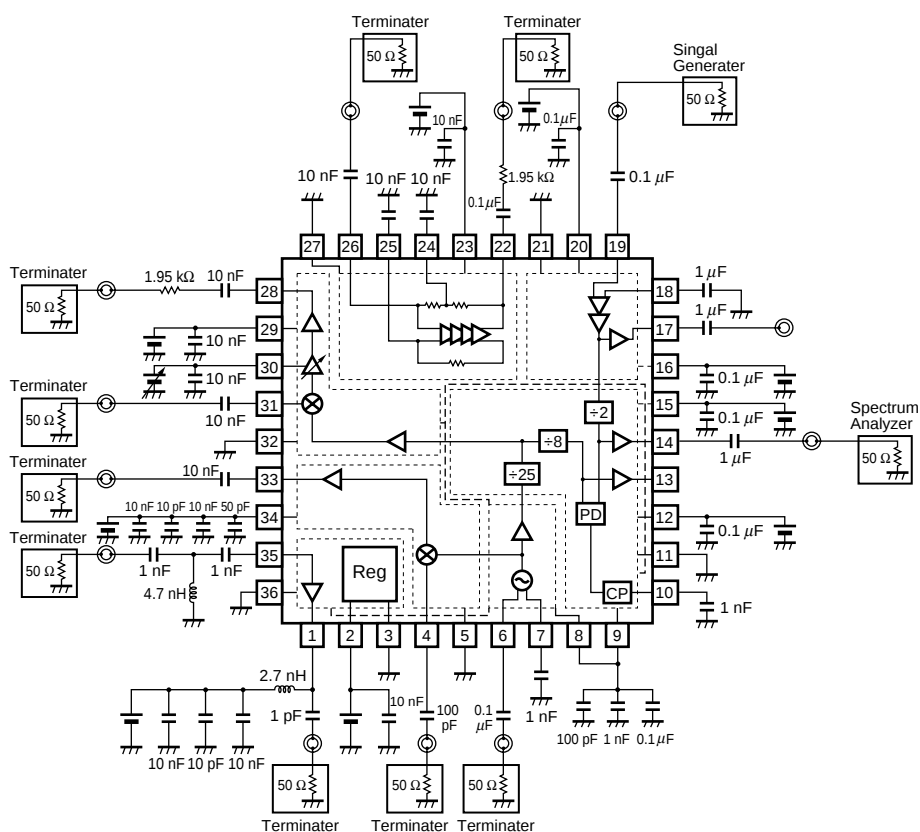
MEASUREMENT CIRCUIT 8 (IF Amplifier Block: NF)



MEASUREMENT CIRCUIT 9 (IF Amplifier Block: Output Swing)



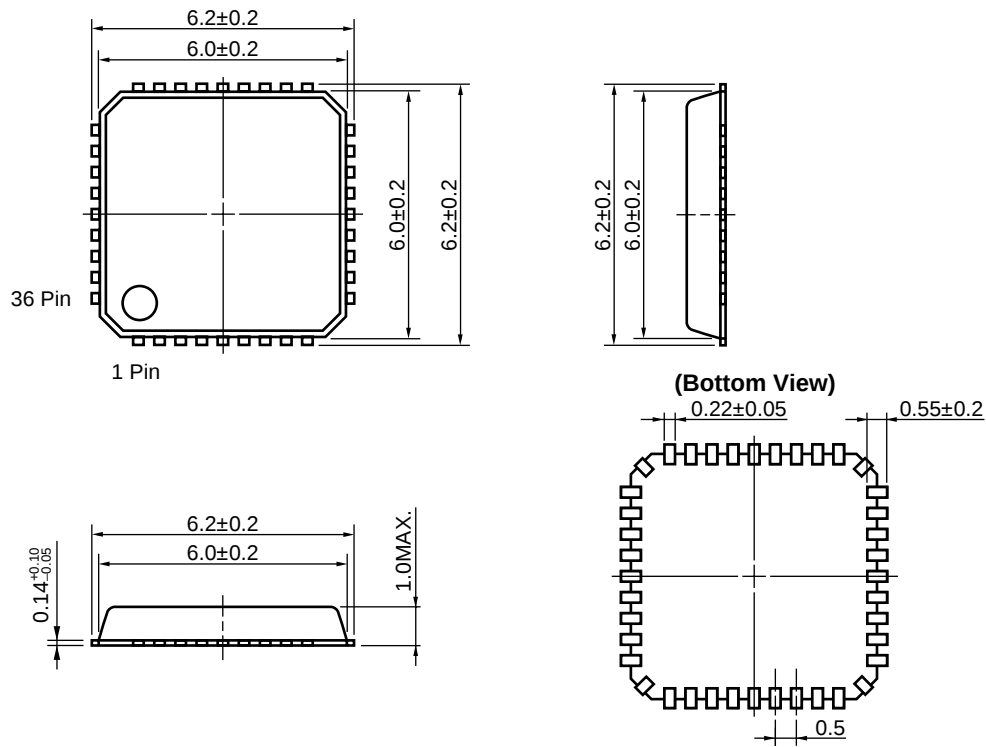
MEASUREMENT CIRCUIT 10 (1/2 Prescaler)



[illegible]

★ **PACKAGE DIMENSIONS**

36-PIN PLASTIC QFN (UNIT: mm)



NOTES 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 wiring length of the ground pins as short as possible.
- (4) Connect a bypass capacitor (example: 1 000 pF) to the V_{CC} pin.
- (5) High-frequency signal I/O pins must be coupled with the external circuit using a coupling capacitor.

★ **RECOMMENDED SOLDERING CONDITIONS**

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

Soldering Method	Soldering Conditions	Condition Symbol
Infrared Reflow	Peak temperature (package surface temperature) : 260°C or below Time at peak temperature : 10 seconds or less Time at temperature of 220°C or higher : 60 seconds or less Preheating time at 120 to 180°C : 120±30 seconds Maximum number of reflow processes : 3 times Maximum chlorine content of rosin flux (% mass) : 0.2%(Wt.) or below	IR260
VPS	Peak temperature (package surface temperature) : 215°C or below Time at temperature of 200°C or higher : 25 to 40 seconds Preheating time at 120 to 150°C : 30 to 60 seconds Maximum number of reflow processes : 3 times Maximum chlorine content of rosin flux (% mass) : 0.2%(Wt.) or below	VP215
Wave Soldering	Peak temperature (molten solder temperature) : 260°C or below Time at peak temperature : 10 seconds or less Preheating temperature (package surface temperature) : 120°C or below Maximum number of flow processes : 1 time Maximum chlorine content of rosin flux (% mass) : 0.2%(Wt.) or below	WS260
Partial Heating	Peak temperature (pin temperature) : 350°C or below Soldering time (per side of device) : 3 seconds or less Maximum chlorine content of rosin flux (% mass) : 0.2%(Wt.) or below	HS350

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

- **The information in this document is current as of February, 2002. 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.**
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"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)
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Subject: Compliance with EU Directives

CEL certifies, to its knowledge, that semiconductor and laser products detailed below are compliant with the requirements of European Union (EU) Directive 2002/95/EC Restriction on Use of Hazardous Substances in electrical and electronic equipment (RoHS) and the requirements of EU Directive 2003/11/EC Restriction on Penta and Octa BDE.

CEL Pb-free products have the same base part number with a suffix added. The suffix –A indicates that the device is Pb-free. The –AZ suffix is used to designate devices containing Pb which are exempted from the requirement of RoHS directive (*). In all cases the devices have Pb-free terminals. All devices with these suffixes meet the requirements of the RoHS directive.

This status is based on CEL's understanding of the EU Directives and knowledge of the materials that go into its products as of the date of disclosure of this information.

Restricted Substance per RoHS	Concentration Limit per RoHS (values are not yet fixed)	Concentration contained in CEL devices	
		-A	-AZ
Lead (Pb)	< 1000 PPM	Not Detected	(*)
Mercury	< 1000 PPM	Not Detected	
Cadmium	< 100 PPM	Not Detected	
Hexavalent Chromium	< 1000 PPM	Not Detected	
PBB	< 1000 PPM	Not Detected	
PBDE	< 1000 PPM	Not Detected	

If you should have any additional questions regarding our devices and compliance to environmental standards, please do not hesitate to contact your local representative.

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