



# BIPOLAR DIGITAL INTEGRATED CIRCUIT

# $\mu$ PB1509GV

## 1GHz INPUT DIVIDE BY 2, 4, 8 PRESCALER IC FOR PORTABLE SYSTEMS

$\mu$ PB1509GV is a divide by 2, 4, 8 prescaler IC for portable radio or cellular telephone applications.  $\mu$ PB1509GV is a shrink package version of  $\mu$ PB587G so that this small package contributes to reduce the mounting space.

$\mu$ PB1509GV is manufactured using NEC's high fr NESAT™ IV silicon bipolar process. This process uses silicon nitride passivation film and gold electrodes. These materials can protect chip surface from external pollution and prevent corrosion/migration. Thus, this IC has excellent performance, uniformity and reliability.

### FEATURES

- High toggle frequency :  $f_{in} = 50 \text{ MHz to } 700 \text{ MHz @ } \div 2,$   
50 MHz to 800 MHz @  $\div 4,$   
50 MHz to 1000 MHz @  $\div 8$
- Low current consumption : 5.0 mA @  $V_{CC} = 3.0 \text{ V}$
- High-density surface mounting : 8 pin plastic SSOP (175mil)
- Supply voltage :  $V_{CC} = 2.2 \text{ to } 5.5 \text{ V}$
- Selectable division :  $\div 2, \div 4, \div 8$

### APPLICATION

- Portable radio systems
- Cellular/cordless telephone 2nd Local prescaler and so on.

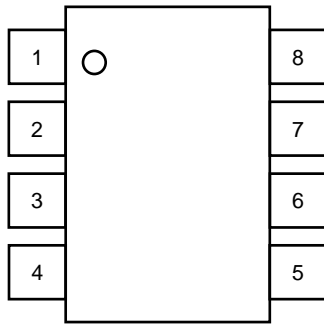
### ORDERING INFORMATION

PART NUMBER	PACKAGE	MARKING	SUPPLYING FORM
$\mu$ PB1509GV-E1-A	8 pin plastic SSOP (175 mil) (Pb-Free)	1509	Embossed tape 8 mm wide. Pin 1 is in tape pull-out direction. 1000p/reel.

**Remarks** : To order evaluation samples, please contact your local NEC sales office. (Part number for sample order:  $\mu$ PB1509GV-A)

**Caution:Electro-static sensitive devices**

**PIN CONNECTION (Top View)**



Pin NO.	Pin Name
1	V <sub>CC1</sub>
2	IN
3	$\overline{\text{IN}}$
4	GND
5	SW1
6	SW2
7	OUT
8	V <sub>CC2</sub>

**PRODUCT LINE-UP**

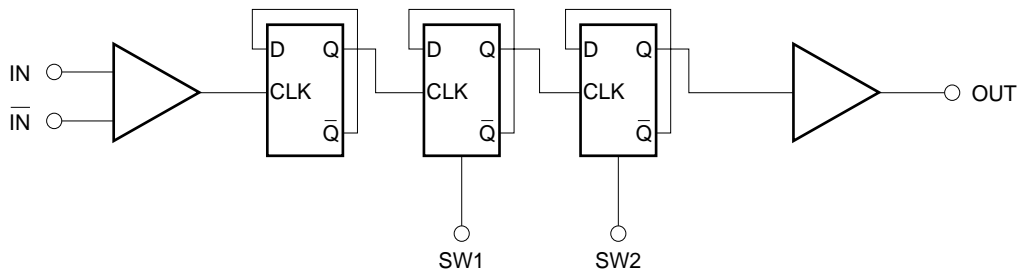
Product No.	I <sub>CC</sub> (mA)	V <sub>CC</sub> (V)	÷ 2 f <sub>in</sub> (MHz)	÷ 4 f <sub>in</sub> (MHz)	÷ 8 f <sub>in</sub> (MHz)	Package	Pin Connection
μPB587 G	5.5	2.2 to 3.5	50 to 300	50 to 600	50 to 1000	8 pin SOP (225 mil)	NEC Original
μPB1509 GV	5.0	2.2 to 5.5	50 to 700	50 to 800	50 to 1000	8 pin SSOP (175 mil)	

**Remarks**

This table shows the TYP values of main parameters. Please refer to ELECTRICAL CHARACTERISTICS.

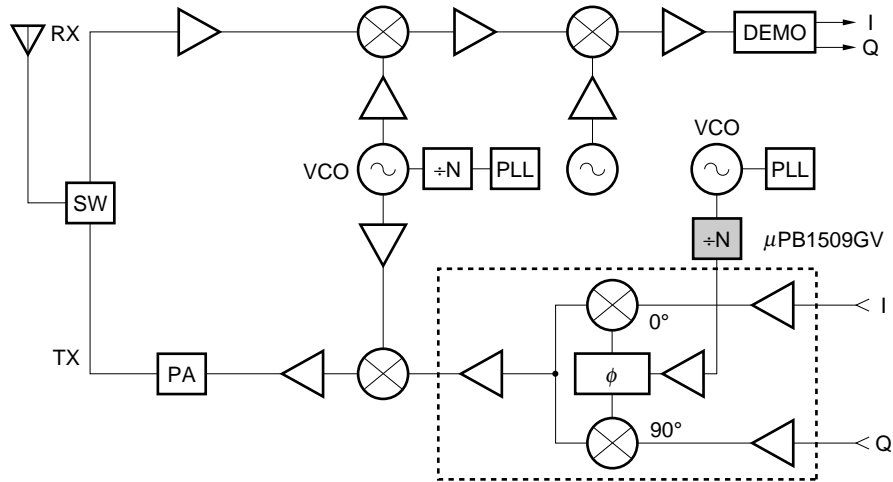
μPB587G is discontinued.

**INTERNAL BLOCK DIAGRAM**



SYSTEM APPLICATION EXAMPLE

One of the example for usage



This block diagram schematically shows the  $\mu$ PB1509GV's location in one of the example application system. The other applications are also acceptable for divider use.

**Pin Explanations**

Pin No.	Symbol	Applied Voltage	Pin Voltage	Functions and Explanation													
1	V <sub>CC1</sub>	2.2 to 5.5	—	Power supply pin of a input amplifier and dividers. This pin must be equipped with bypass capacitor (eg 1000 pF) to minimize ground impedance.													
2	IN	—	1.7 to 4.95	Signal input pin. This pin should be coupled to signal source with capacitor (eg 1000 pF) for DC cut.													
3	IN̄	—	1.7 to 4.95	Signal input bypass pin. This pin must be equipped with bypass capacitor (eg 1000 pF) to minimize ground impedance.													
4	GND	0	—	Ground pin. Ground pattern on the board should be formed as wide as possible to minimize ground impedance.													
5	SW1	H/L	—	Divide ratio control pin. Divide ratio can be determined by following applied level to these pins. <table border="1" style="margin: 10px auto;"> <thead> <tr> <th colspan="2" rowspan="2"></th> <th colspan="2">SW2</th> </tr> <tr> <th>H</th> <th>L</th> </tr> </thead> <tbody> <tr> <th rowspan="2">SW1</th> <th>H</th> <td>1/2</td> <td>1/4</td> </tr> <tr> <th>L</th> <td>1/4</td> <td>1/8</td> </tr> </tbody> </table>			SW2		H	L	SW1	H	1/2	1/4	L	1/4	1/8
		SW2															
		H	L														
SW1	H	1/2	1/4														
	L	1/4	1/8														
6	SW2	H/L	—	These pins must be each equipped with bypass capacitor to minimize their impedance.													
7	OUT	—	1.0 to 4.7	Divided frequency output pin. This pin is designed as emitter follower output. This pin can output 0.1 V <sub>P-P</sub> min with 200 Ω load.  This pin should be coupled to load device with capacitor (eg 1000 pF) for DC cut.													
8	V <sub>CC2</sub>	2.2 to 5.5	—	Power supply pin of output buffer amplifier. This pin must be equipped with bypass capacitor (eg 1000 pF) to minimize ground impedance.													

**ABSOLUTE MAXIMUM RATINGS**

PARAMETER	SYMBOL	CONDITION	RATINGS	UNIT
Supply voltage	V <sub>CC</sub>	T <sub>A</sub> = +25 °C	6.0	V
Input voltage	V <sub>in</sub>	T <sub>A</sub> = +25 °C, SW1, SW2 pins	6.0	V
Total power dissipation	P <sub>D</sub>	Mounted on double sided copper clad 50 × 50 × 1.6 mm epoxy glass PWB (T <sub>A</sub> = +85 °C)	250	mW
Operating ambient temperature	T <sub>A</sub>		-40 to +85	°C
Storage temperature	T <sub>stg</sub>		-55 to +150	°C

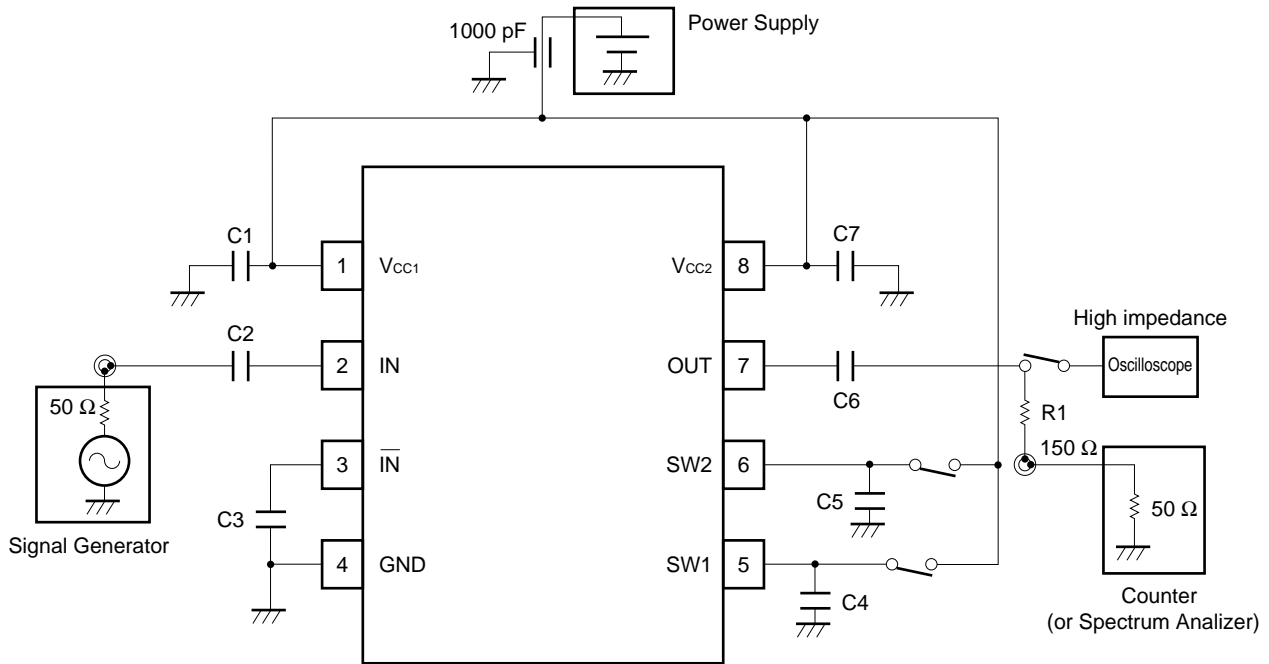
**RECOMMENDED OPERATING CONDITIONS**

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT	NOTICE
Supply voltage	V <sub>CC</sub>	2.2	3.0	5.5	V	
Operating ambient temperature	T <sub>A</sub>	-40	+25	+85	°C	

**ELECTRICAL CHARACTERISTICS (T<sub>A</sub> = -40 to +85 °C, V<sub>CC</sub> = 2.2 to 5.5 V)**

PARAMETERS	SYMBOLS	TEST CONDITIONS	MIN.	TYP.	MAX.	UNIT
Circuit current	I <sub>CC</sub>	No signals, V <sub>CC</sub> = 3.0 V	3.5	5.0	5.9	mA
Upper Limit Operating Frequency 1	f <sub>in(U)1</sub>	P <sub>in</sub> = -20 to 0 dBm	500	—	—	MHz
Upper Limit Operating Frequency 2	f <sub>in(U)2</sub>	P <sub>in</sub> = -20 to -5 dBm @ ÷ 2 @ ÷ 4 @ ÷ 8	700 800 1000	— — —	— — —	MHz
Lower Limit Operating Frequency 1	f <sub>in(L)1</sub>	P <sub>in</sub> = -20 to 0 dBm	—	—	50	MHz
Lower Limit Operating Frequency 2	f <sub>in(L)2</sub>	P <sub>in</sub> = -20 to -5 dBm	—	—	500	MHz
Input Power 1	P <sub>in1</sub>	f <sub>in</sub> = 50 MHz to 1000 MHz	-20	—	-5	dBm
Input Power 2	P <sub>in2</sub>	f <sub>in</sub> = 50 MHz to 500 MHz	-20	—	0	dBm
Output Voltage	V <sub>out</sub>	R <sub>L</sub> = 200 Ω	0.1	0.2	—	V <sub>P-P</sub>
Divide ratio control input high	V <sub>IH1</sub>	Connection in the test circuit	V <sub>CC</sub>	V <sub>CC</sub>	V <sub>CC</sub>	—
Divide ratio control input low	V <sub>IL1</sub>	Connection in the test circuit	OPEN or GND	OPEN or GND	OPEN or GND	—
Divide ratio control input high	V <sub>IH2</sub>	Connection in the test circuit	V <sub>CC</sub>	V <sub>CC</sub>	V <sub>CC</sub>	—
Divide ratio control input low	V <sub>IL2</sub>	Connection in the test circuit	OPEN or GND	OPEN or GND	OPEN or GND	—

**TEST CIRCUIT**



**EQUIPMENTS**

Signal Generator (HP-8665A)

Counter (HP-5350B) for measuring input sensitivity (Spectrum Analyzer for measuring output frequency)

Oscilloscope for measuring output swing (In measuring output power on Spectrum Analyzer, oscilloscope should be turned off.)

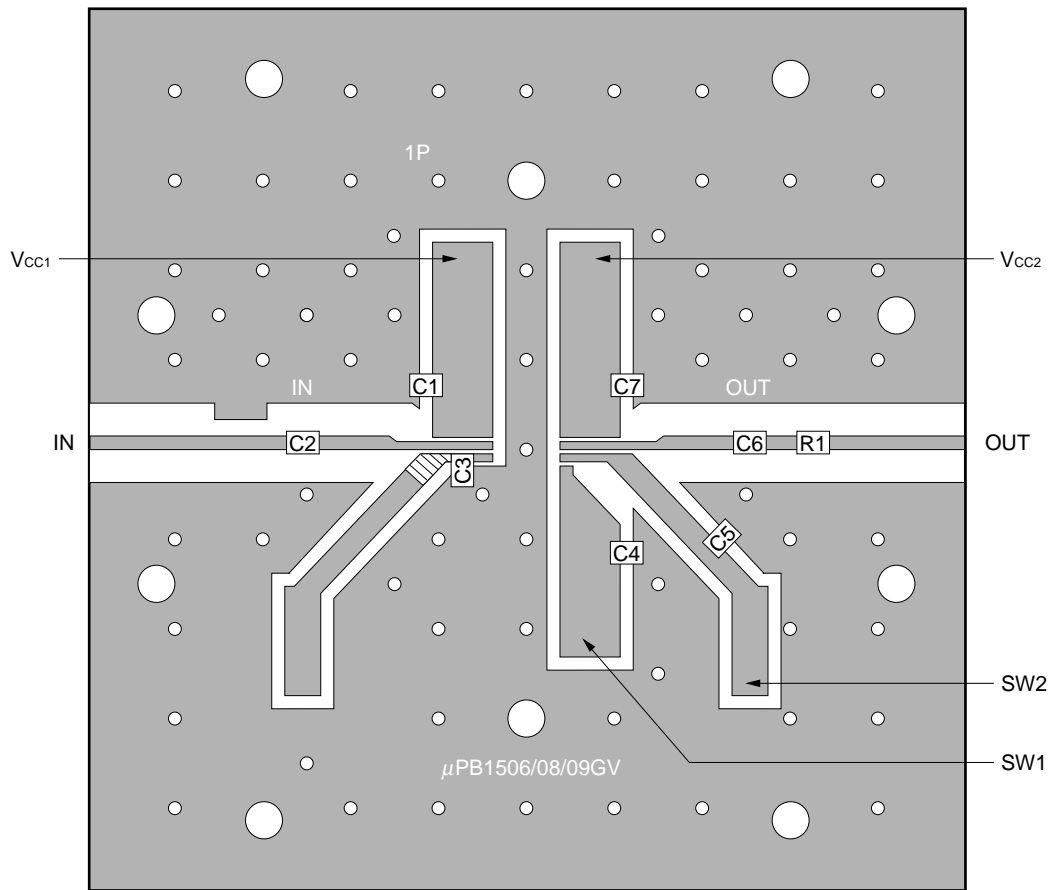
**Divide Ratio Setting**

		SW2	
		H	L
SW1	H	1/2	1/4
	L	1/4	1/8

H: SW pin should be connected to Vcc1 pin.

L: SW pin should be opened or connected to GND.

ILLUSTRATION OF THE TEST CIRCUIT ASSEMBLED ON EVALUATION BOARD



Component List

No.	Value
C1 to C7	1000 pF
R1	150 Ω <sup>Note</sup>

Notes for evaluation board

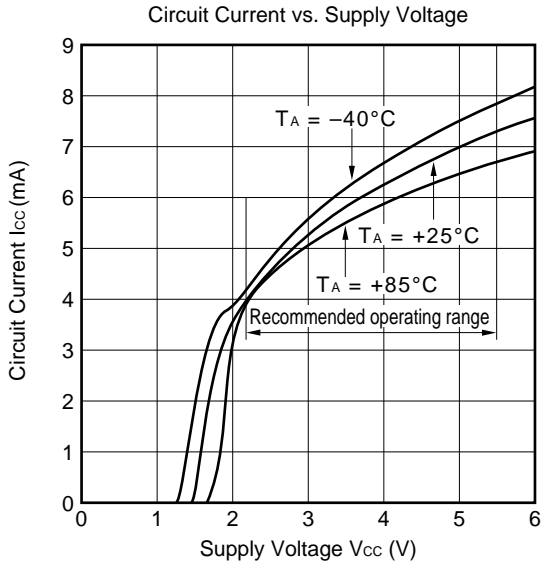
- (1) 35 μm thick double sided copper clad 50 × 50 × 0.4 mm polyimide board
- (2) Back side : GND pattern
- (3) Solder plated on pattern
- (4) ○○ : Through holes
- (5) ▨ : Remove pattern

**Note** For Output load of IC, R1 is determined as follows; R1 + Impedance of measurement equipment = 200 Ω.

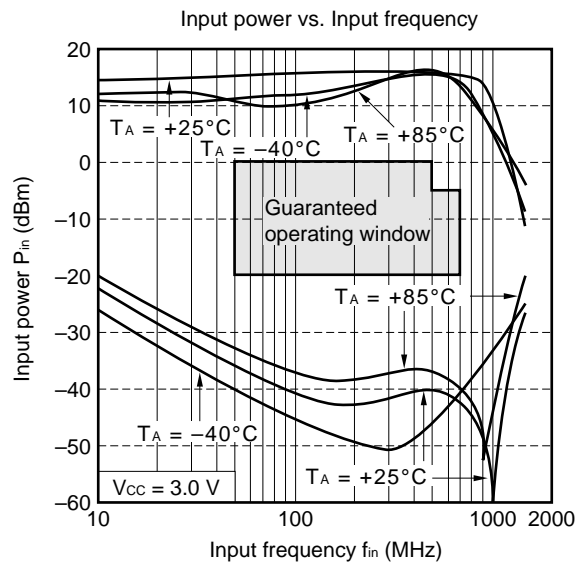
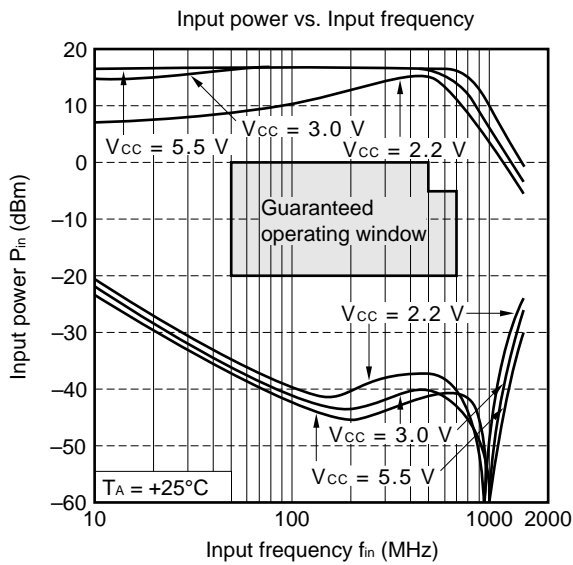
The application circuits and their parameters are for reference only and are not intended for use in actual design-ins.

The usage and applications of μPB1509GV should be referred to the application note (Document No. P12611E).

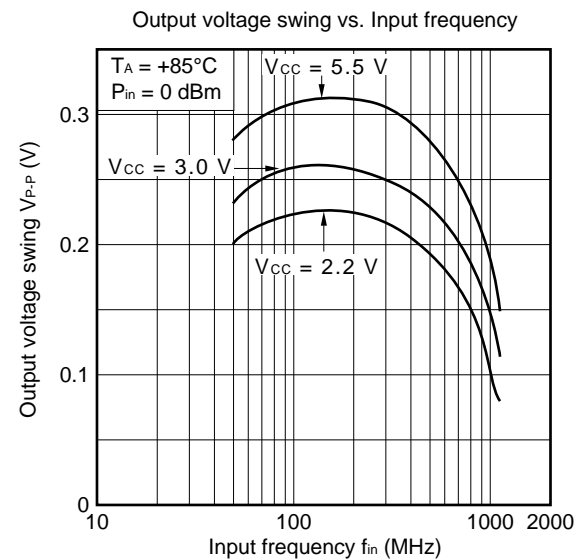
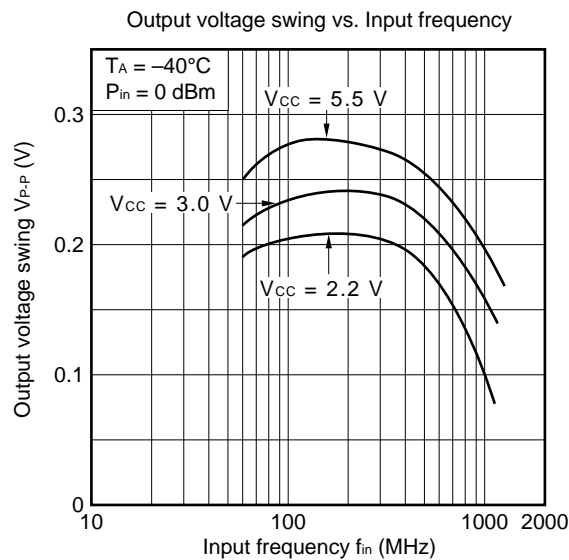
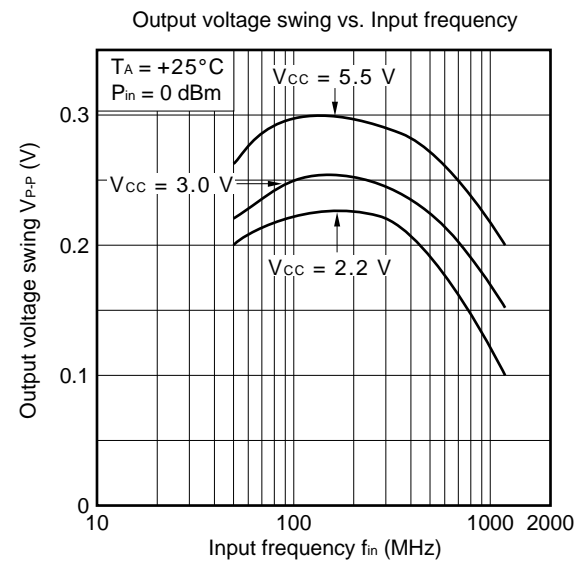
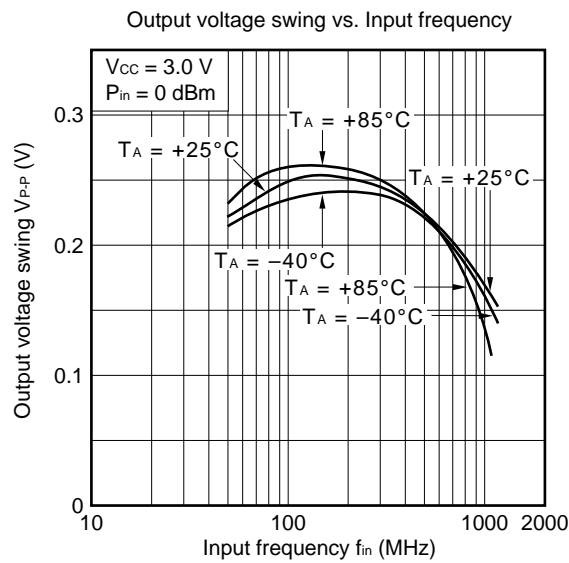
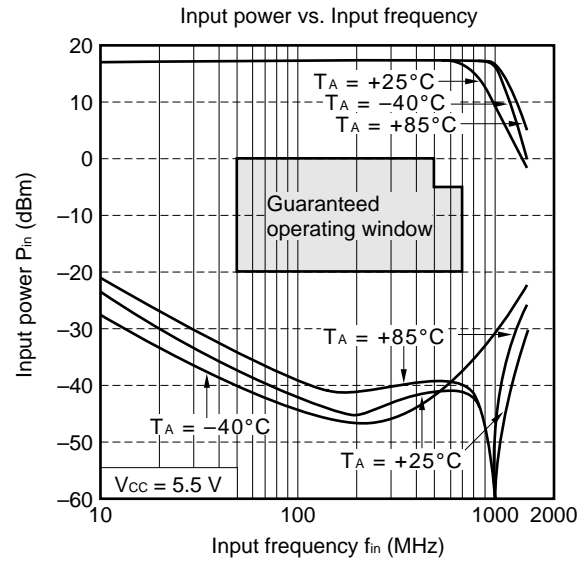
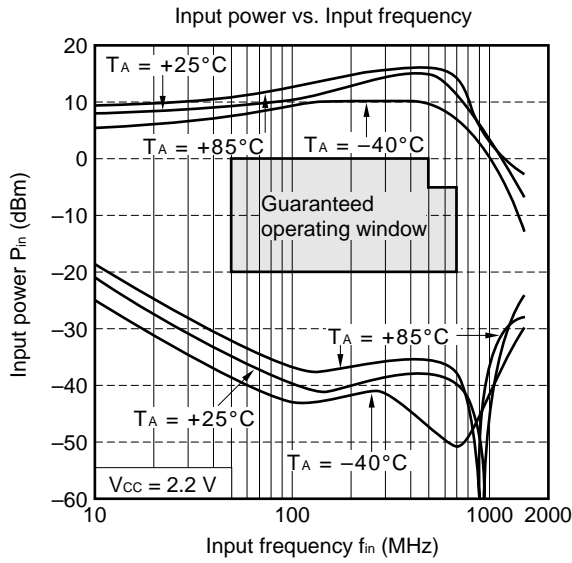
CHARACTERISTIC CURVES



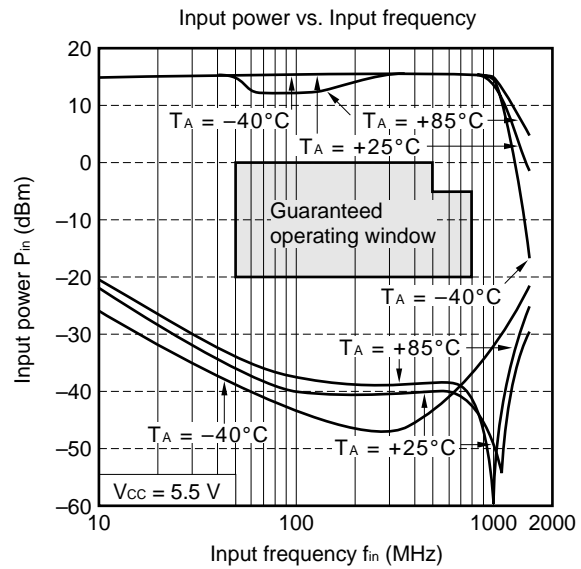
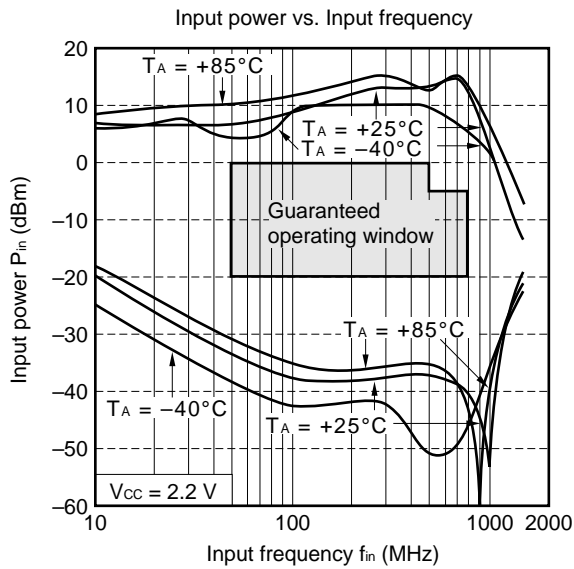
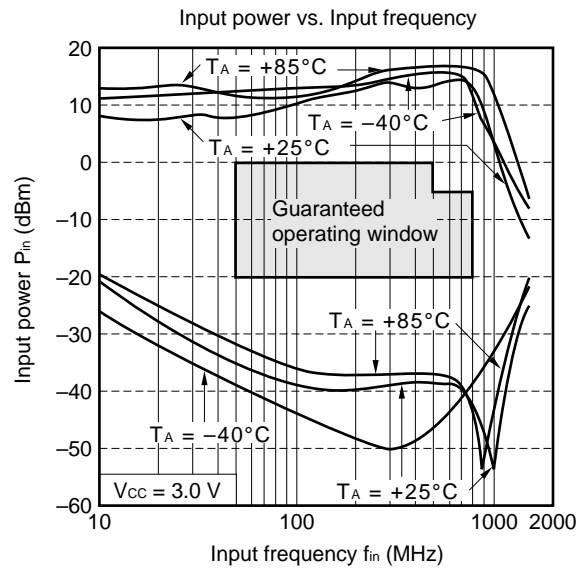
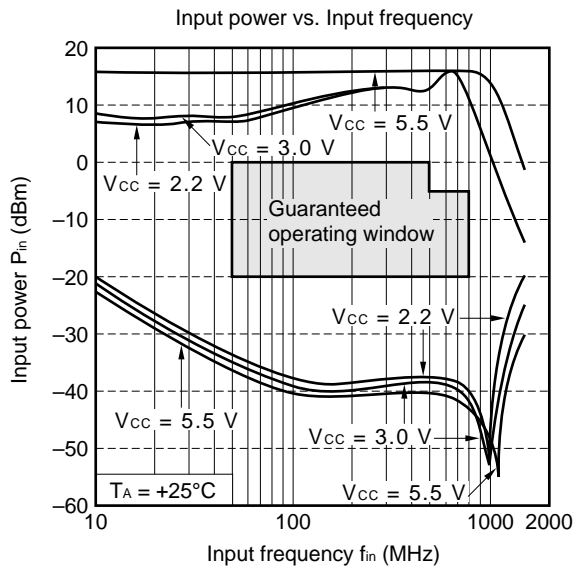
Divide by 2 mode (Guaranteed operating window:  $V_{CC} = 2.2$  to  $5.5$  V,  $T_A = -40$  to  $+85^\circ\text{C}$ )



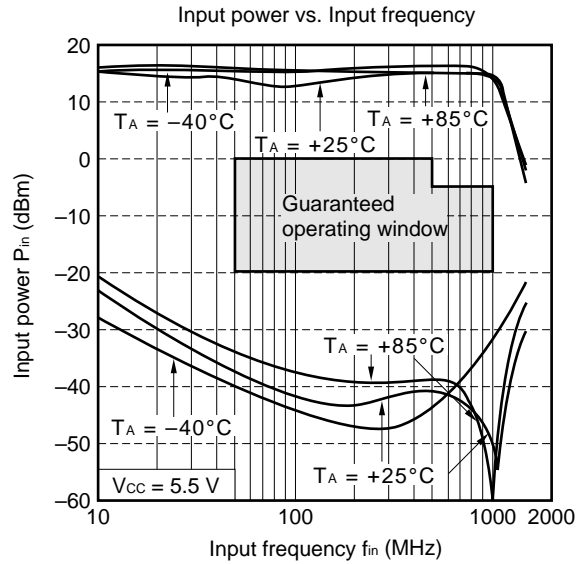
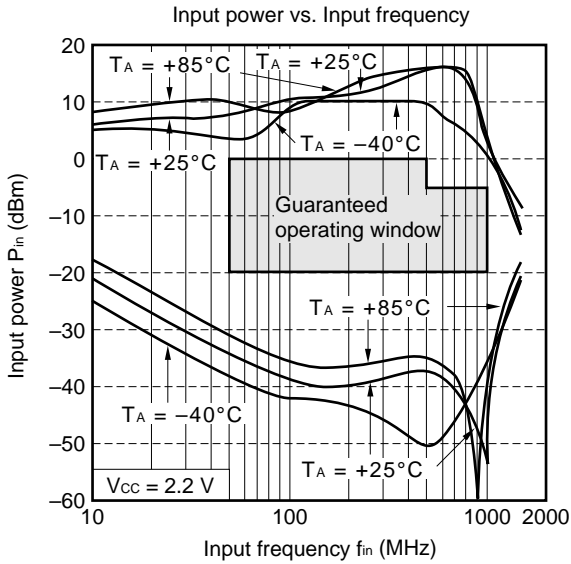
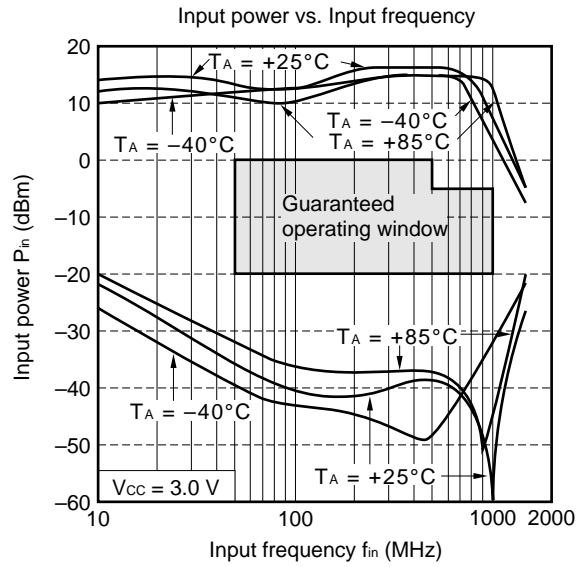
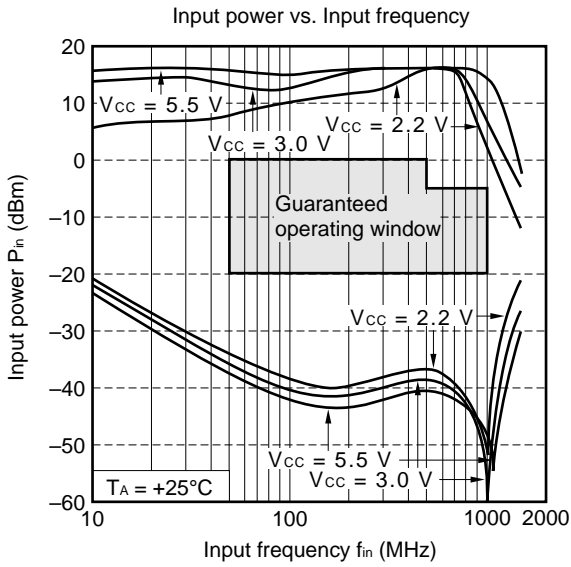




Divide by 4 mode (Guaranteed operating window:  $V_{CC} = 2.2$  to  $5.5$  V,  $T_A = -40$  to  $+85^\circ\text{C}$ )



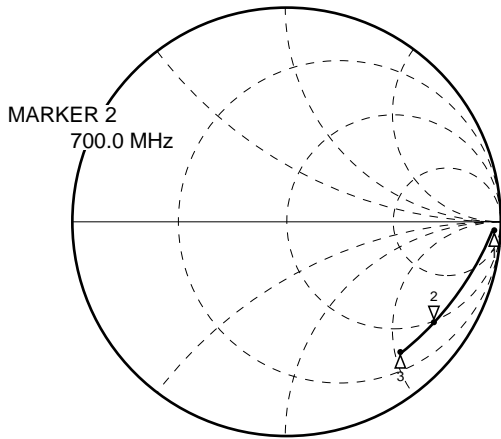
Divide by 8 mode (Guaranteed operating window:  $V_{CC} = 2.2$  to  $5.5$  V,  $T_A = -40$  to  $+85^\circ\text{C}$ )



**S<sub>11</sub> vs. Input Frequency**

S<sub>11</sub>  
 REF 1.0 Units/  
 2 200.0 mUnits/  
 ▽ 55.375 Ω - 142.79 Ω

V<sub>CC1</sub> = V<sub>CC2</sub> = 3.0 V, SW1 = SW2 = 3.0 V



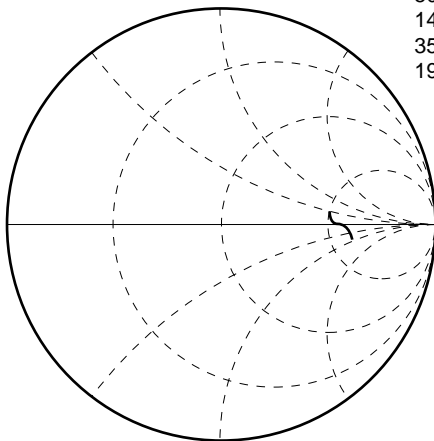
FREQUENCY MHz	MAG	S11 ANG
100.0000	.929	-6.7
200.0000	.898	-10.5
300.0000	.866	-13.6
400.0000	.840	-15.9
500.0000	.834	-19.1
600.0000	.819	-21.9
700.0000	.803	-24.7
800.0000	.792	-27.0
900.0000	.787	-30.0
1000.0000	.771	-32.7

START 0.050000000 GHz  
 STOP 1.000000000 GHz

**S<sub>22</sub> vs. Output Frequency**

S<sub>22</sub>  
 REF 1.0 Units/  
 200.0 mUnits/

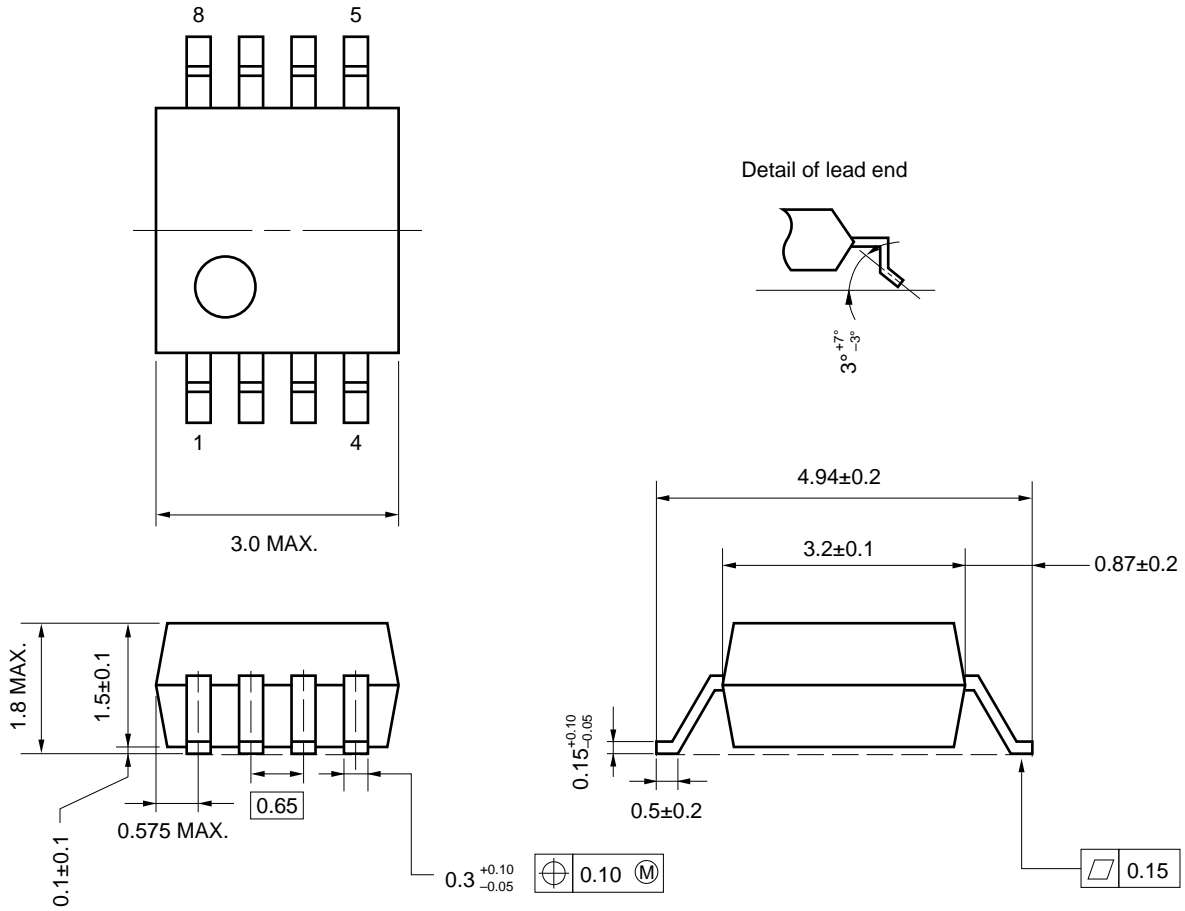
Z  
 50 MHz  
 149.09 Ω + j 14.86 Ω  
 350 MHz  
 194.21 Ω - j 36.64 Ω



START 0.050000000 GHz  
 STOP 0.350000000 GHz

PACKAGE DIMENSIONS (UNIT: mm)

8 PIN PLASTIC SSOP (175 mil)



**NOTE ON CORRECT USE**

- (1) Observe precautions for handling because of electro-static sensitive devices.
- (2) Form a ground pattern as wide as possible to minimize ground impedance (to prevent undesired operation).
- (3) Keep the wiring length of the ground pins as short as possible.
- (4) Connect a bypass capacitor (e.g. 1000 pF) to the V<sub>cc</sub> pin.

**RECOMMENDED SOLDERING CONDITIONS**

This product should be soldered in the following recommended conditions. Other soldering methods and conditions than the recommended conditions are to be consulted with our sales representatives.

**μPB1509GV**

Soldering method	Soldering conditions	Recommended condition symbol
Infrared ray reflow	Package peak temperature: 235°C, Hour: within 30 s. (more than 210°C), Time: 3 times, Limited days: no.*	IR35-00-3
VPS	Package peak temperature: 215°C, Hour: within 40 s. (more than 200°C), Time: 3 times, Limited days: no.*	VP15-00-3
Wave soldering	Soldering tub temperature: less than 260°C, Hour: within 10 s. Time: 1 time, Limited days: no.	WS60-00-1
Pin part heating	Pin area temperature: less than 300°C, Hour: within 3 s./pin Limited days: no.*	

\* It is the storage days after opening a dry pack, the storage conditions are 25°C, less than 65% RH.

**Caution The combined use of soldering method is to be avoided (However, except the pin area heating method).**

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

[MEMO]



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NEC devices are classified into the following three quality grades:

"Standard", "Special", and "Specific". The Specific quality grade applies only to devices developed based on a customer designated "quality assurance program" for a specific application. The recommended applications of a device depend on its quality grade, as indicated below. Customers must check the quality grade of each device 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:** Aircrafts, aerospace equipment, submersible repeaters, nuclear reactor control systems, life support systems or medical equipment for life support, etc.

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Anti-radioactive design is not implemented in this product.