

# 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.

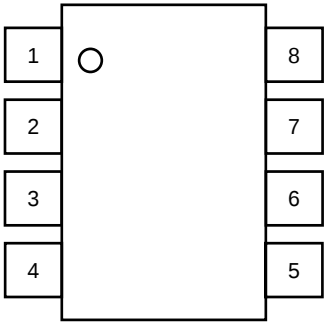
### ORDERING INFORMATION

| PART NUMBER       | PACKAGE                         | MARKING | SUPPLYING FORM                                                            |
|-------------------|---------------------------------|---------|---------------------------------------------------------------------------|
| $\mu$ PB1509GV-E1 | 8 pin plastic SSOP<br>(175 mil) | 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)

**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>       |

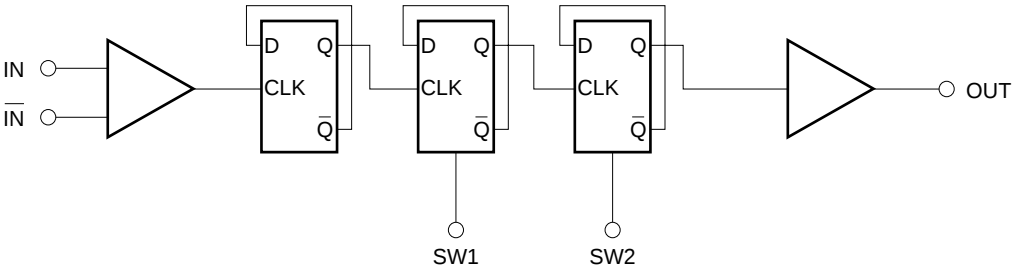
PRODUCT LINE-UP

| Product No. | I <sub>CC</sub><br>(mA) | V <sub>CC</sub><br>(V) | ÷ 2<br>f <sub>in</sub><br>(MHz) | ÷ 4<br>f <sub>in</sub><br>(MHz) | ÷ 8<br>f <sub>in</sub><br>(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

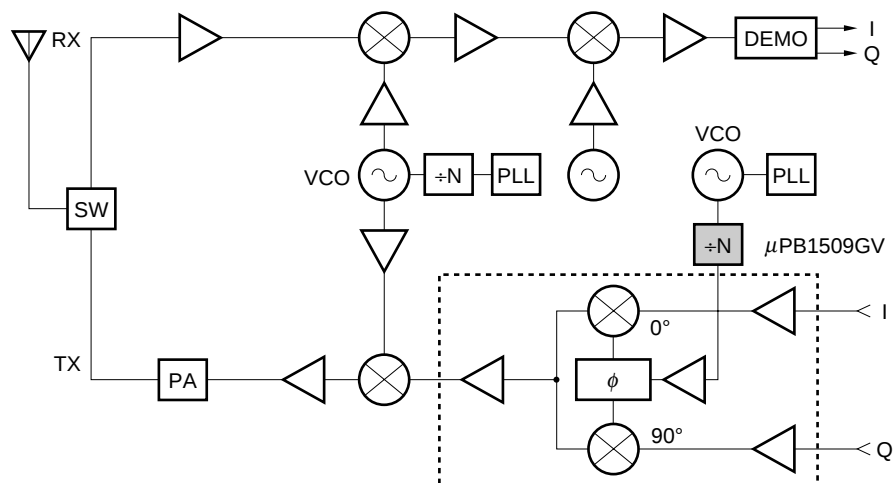
This table shows the TYP values of main parameters. Please refer to ELECTRICAL CHARACTERISTICS.  
μPB587G is discontinued.

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       | $\overline{\text{IN}}$ | —               | 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             | —           | <div>Divide ratio control pin. Divide ratio can be determined by following applied level to these pins.</div> <table border="1"><tr><td colspan="2" rowspan="2"></td><th colspan="2">SW2</th></tr><tr><th>H</th><th>L</th></tr><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></table> <div>These pins must be each equipped with bypass capacitor to minimize their impedance.</div> |  |  | 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             | —           |                                                                                                                                                                                                                                                                                                                                                                                                                                                      |  |  |     |  |   |   |     |   |     |     |   |     |     |
| 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.<br><br>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   |

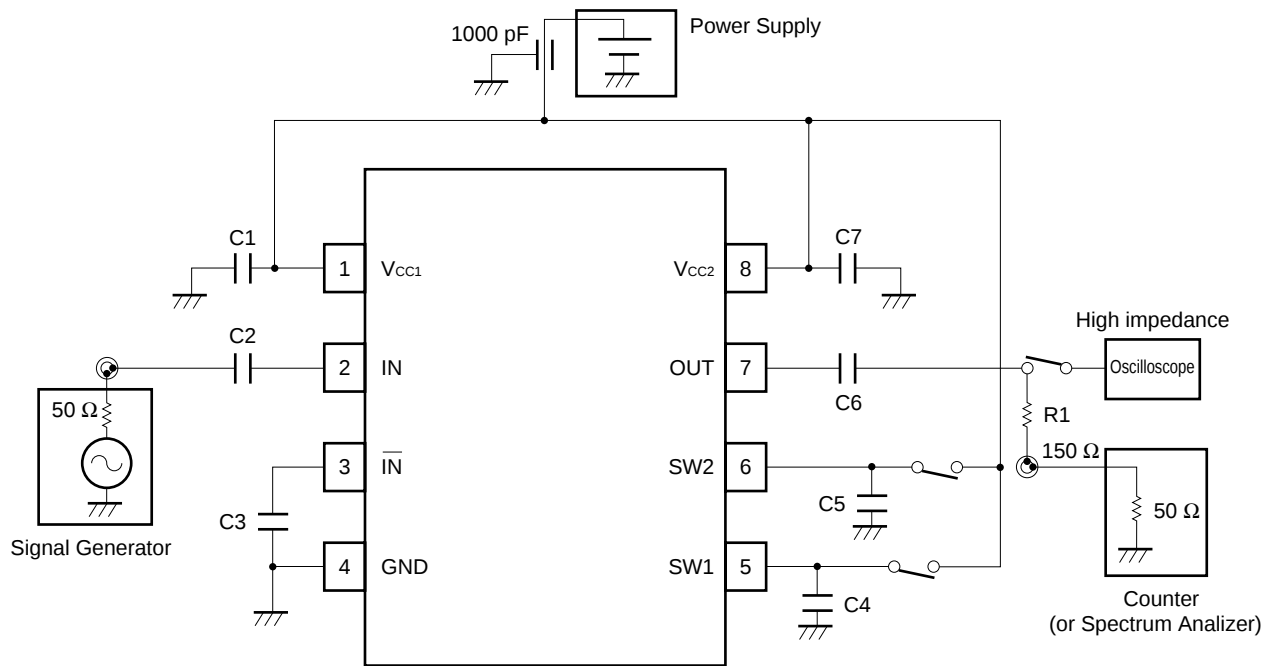
## RECOMMENDED OPERATING CONDITIONS

| 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<br>@ ÷ 4<br>@ ÷ 8 | 700<br>800<br>1000 | —<br>—<br>—       | —<br>—<br>—       | 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<br>or<br>GND  | OPEN<br>or<br>GND | OPEN<br>or<br>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<br>or<br>GND  | OPEN<br>or<br>GND | OPEN<br>or<br>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.)

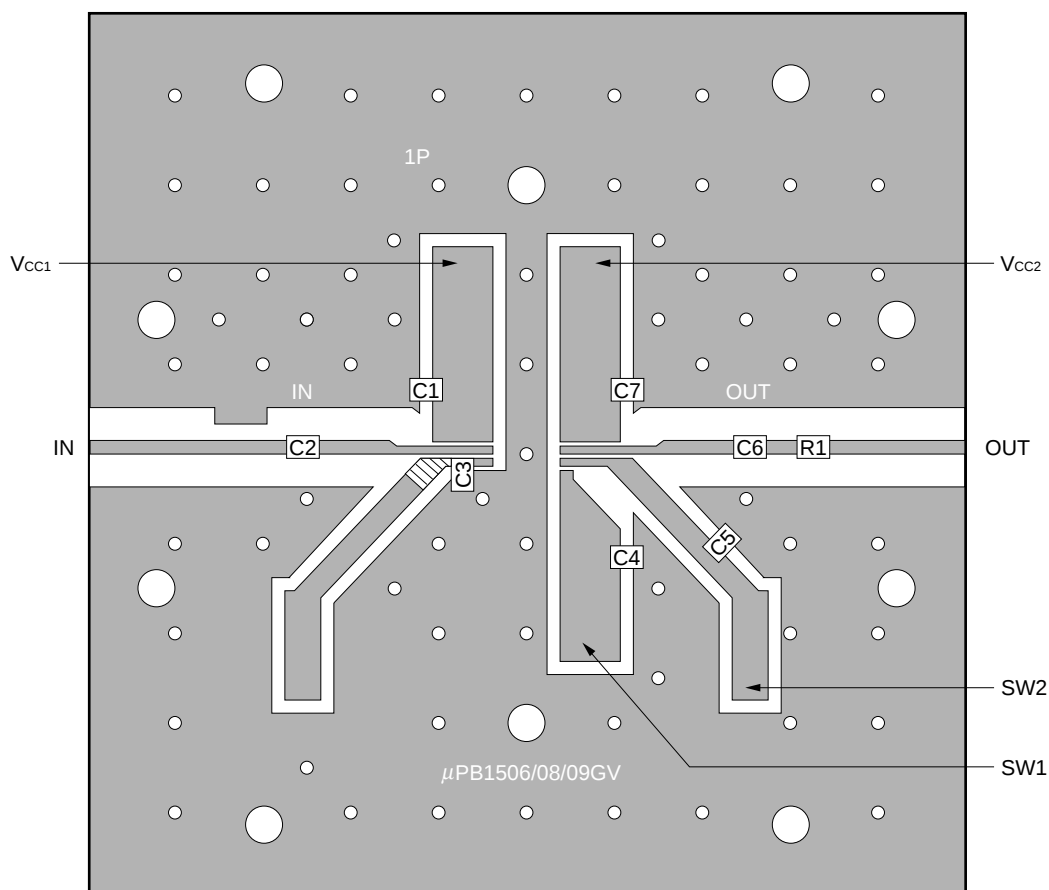
### Divide Ratio Setting

|     |   | 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

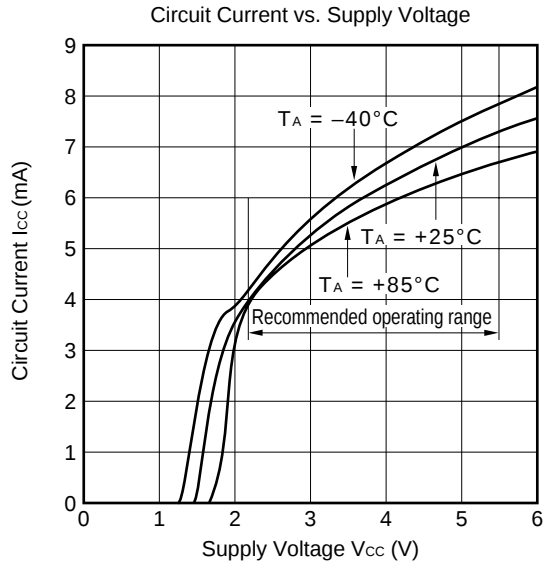
- (1) 35 μm thick double sided copper clad 50 × 50 × 0.4 mm polyimide board
- (2) Back side : GND pattern
- (3) Solder plated on pattern
- (4) ○ : Through holes
- (5) ▨ : Remove pattern

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

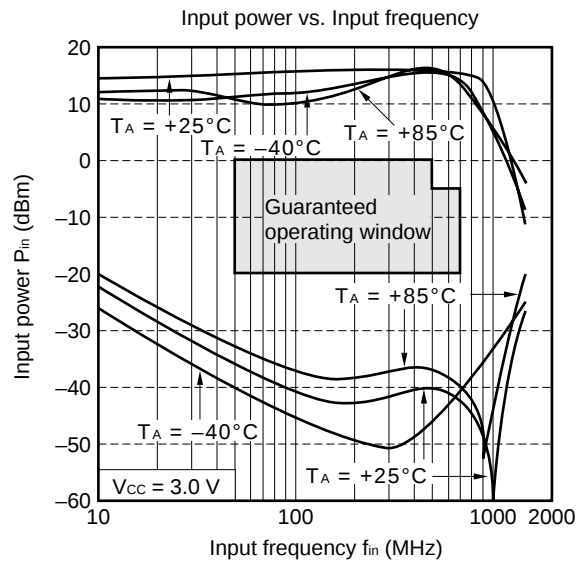
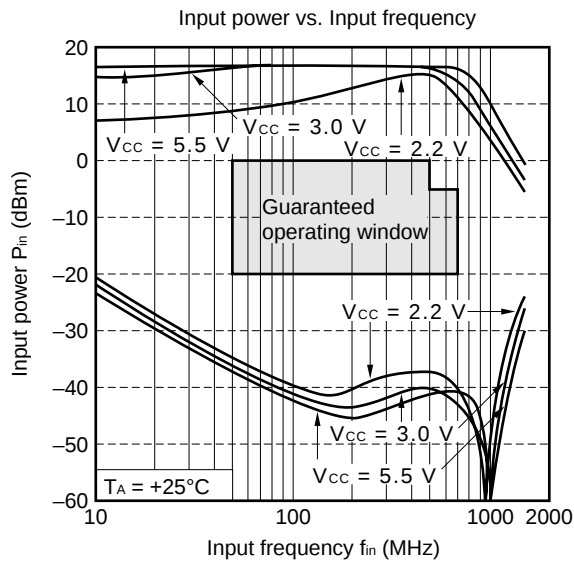
The application circuits and their parameters are for reference only and are not intended for use in actual design-ins.

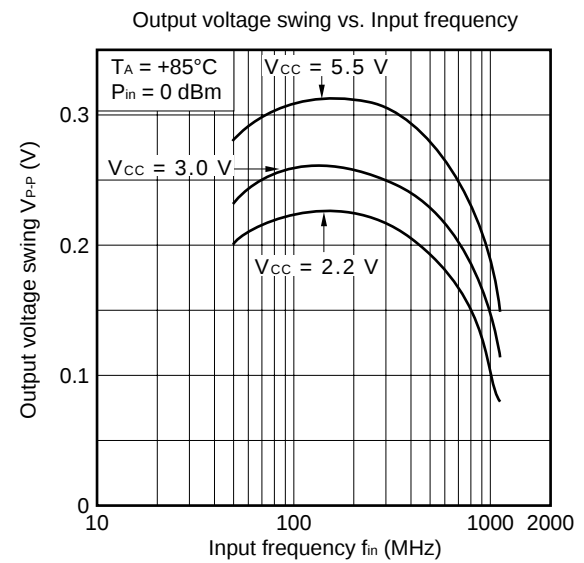
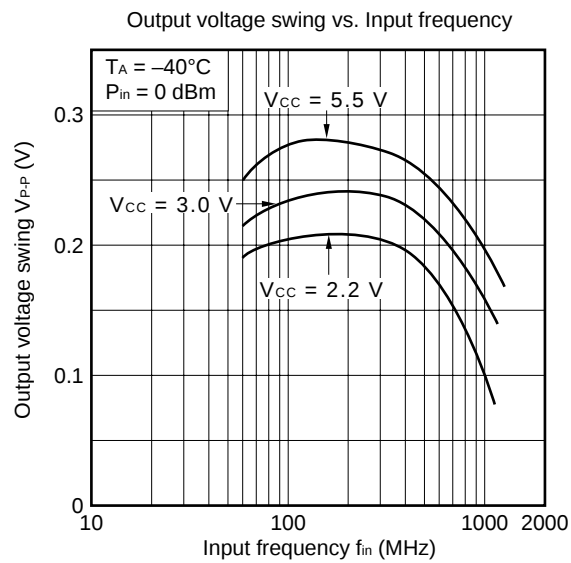
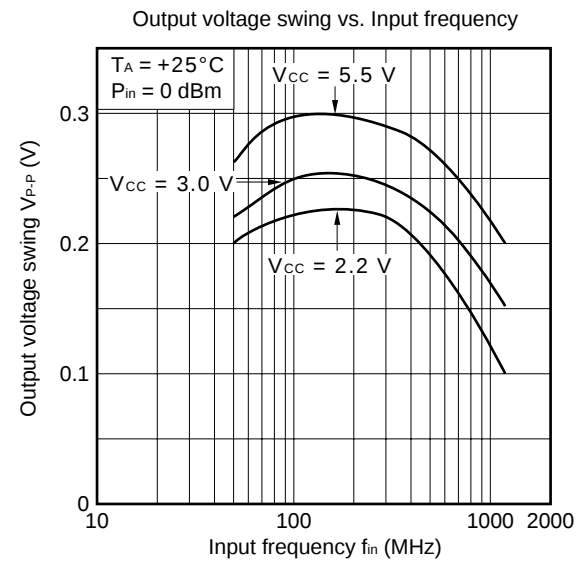
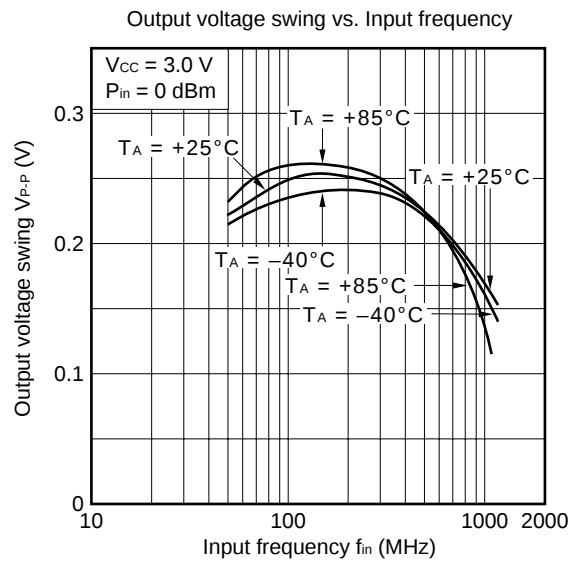
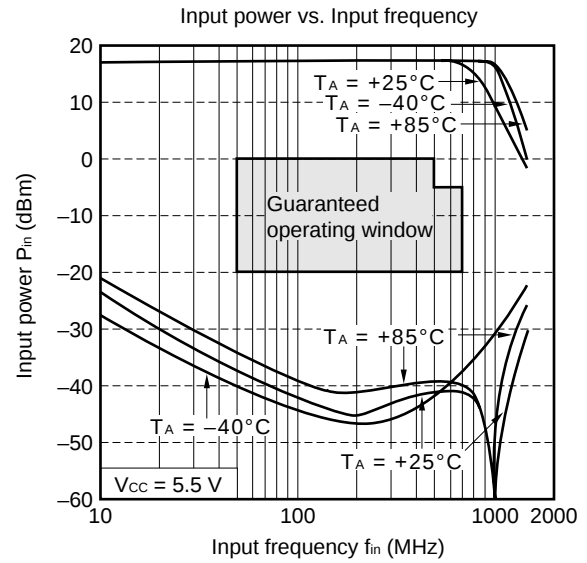
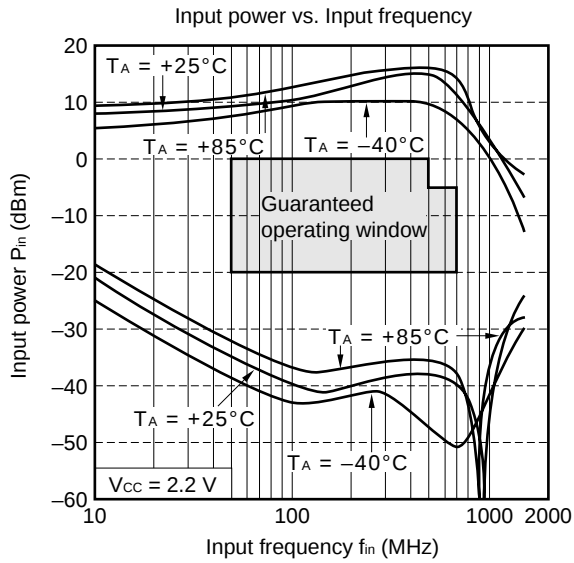
The usage and applications of μPB1509GV should be referred to the application note (Document No. P12611E).

# CHARACTERISTIC CURVES

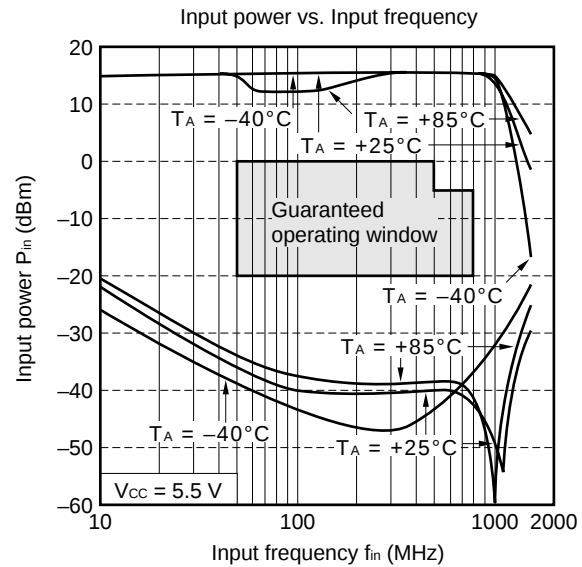
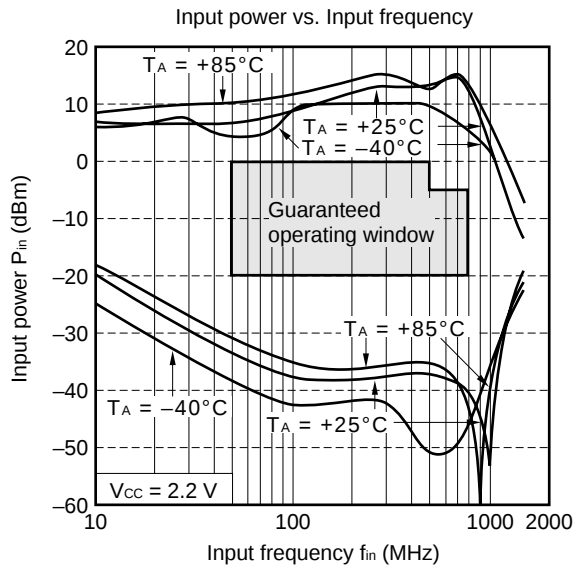
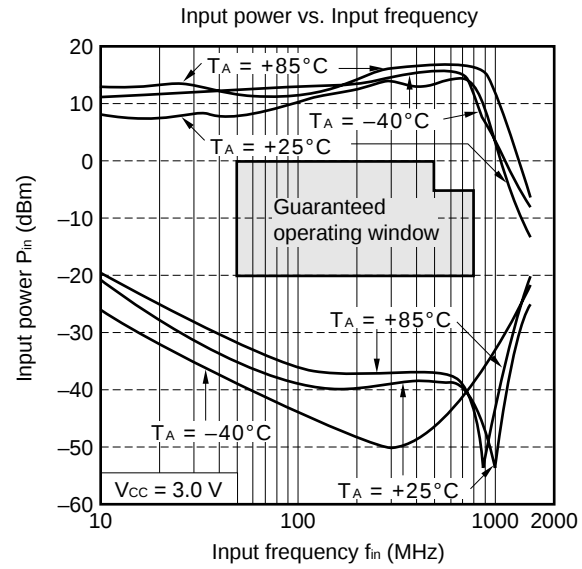
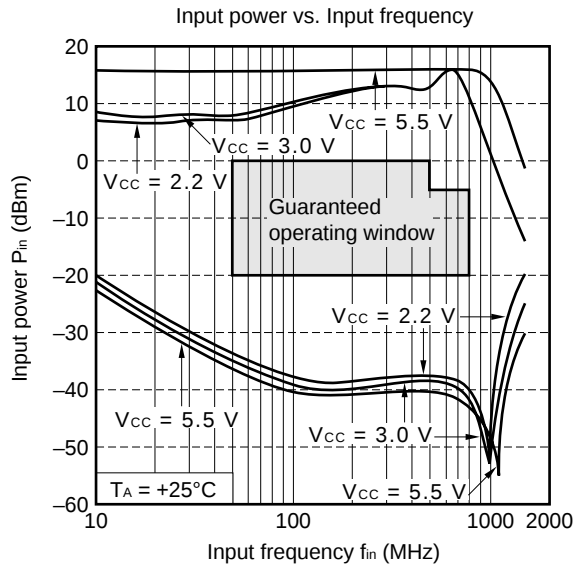


Divide by 2 mode (Guaranteed operating window:  $V_{CC} = 2.2$  to  $5.5$  V,  $T_A = -40$  to  $+85^\circ\text{C}$ )

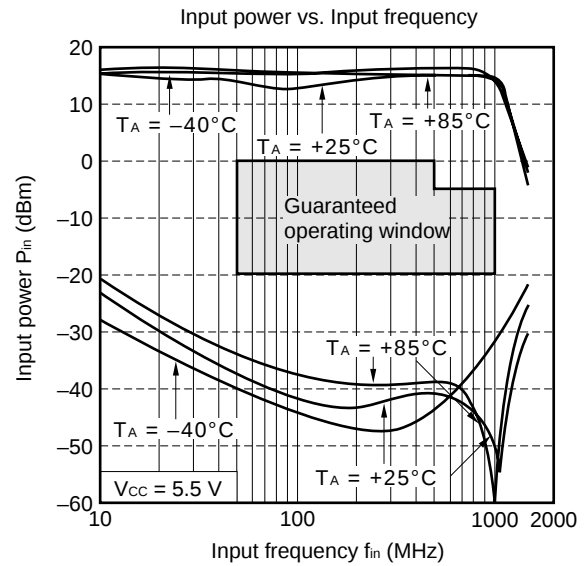
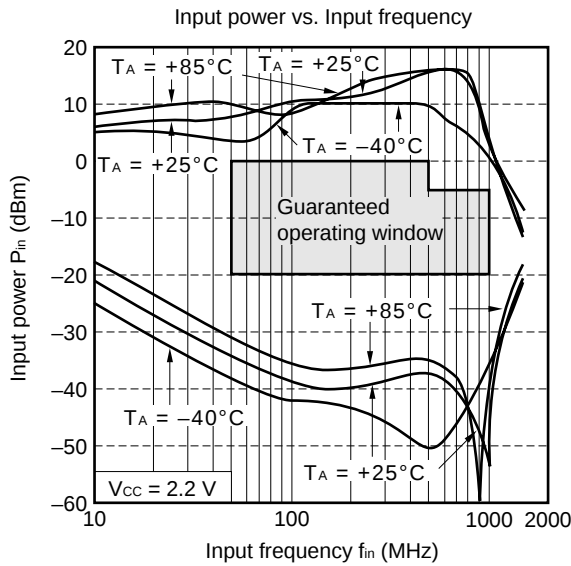
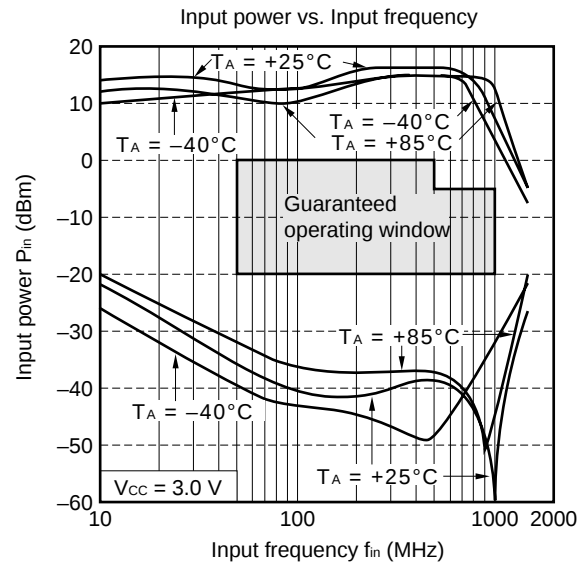
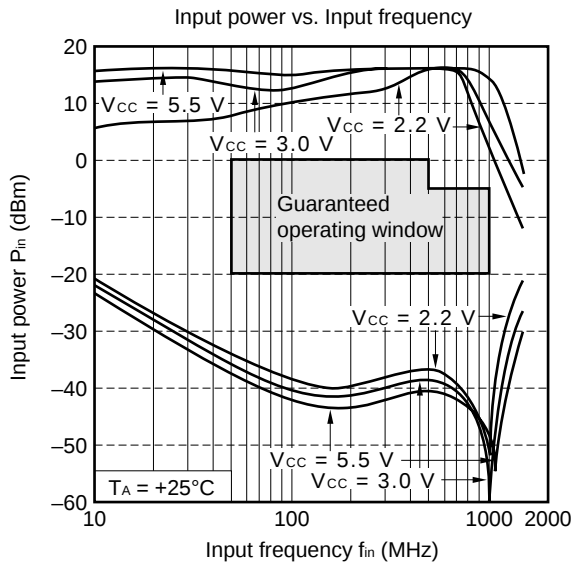




Divide by 4 mode (Guaranteed operating window:  $V_{CC} = 2.2$  to  $5.5$  V,  $T_A = -40$  to  $+85^\circ\text{C}$ )

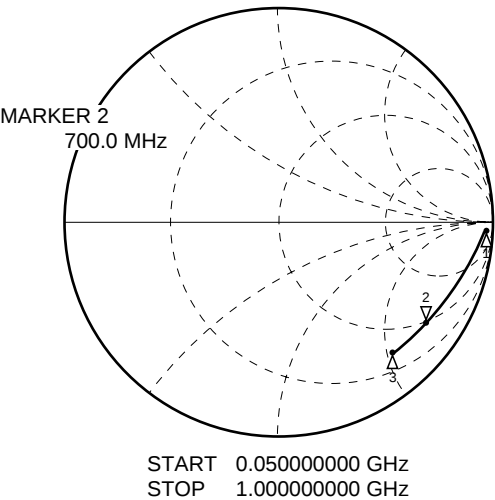


Divide by 8 mode (Guaranteed operating window:  $V_{CC} = 2.2$  to  $5.5$  V,  $T_A = -40$  to  $+85^\circ\text{C}$ )



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

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

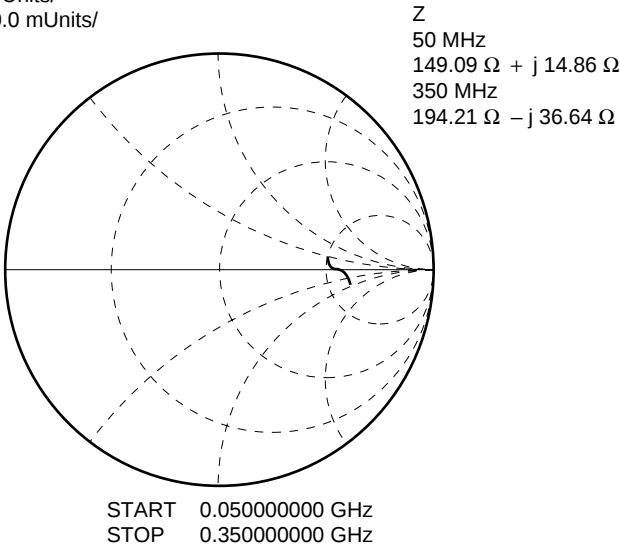


V<sub>CC1</sub> = V<sub>CC2</sub> = 3.0 V, SW1 = SW2 = 3.0 V

| FREQUENCY<br>MHz | S <sub>11</sub><br>MAG | 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 |

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

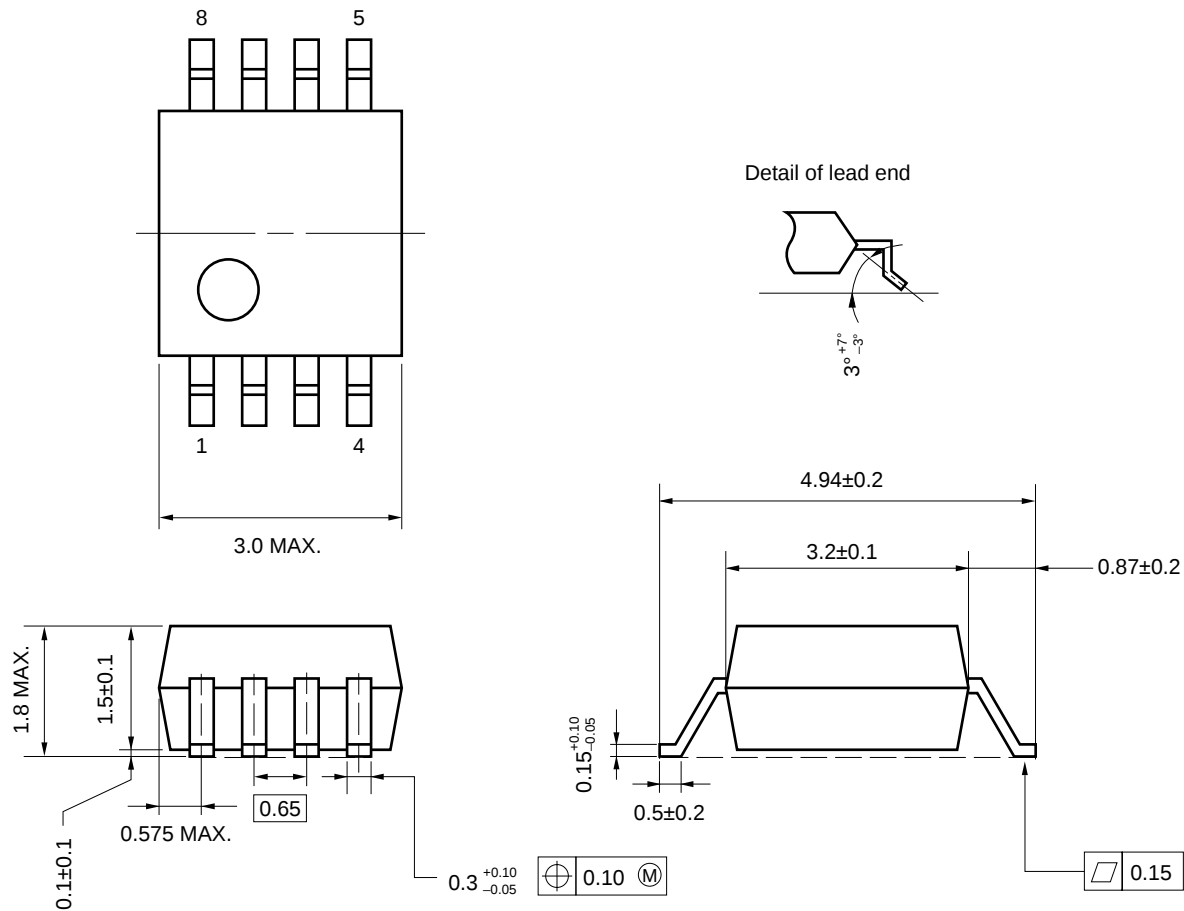
S<sub>22</sub>  
REF 1.0 Units/  
200.0 mUnits/



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

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**

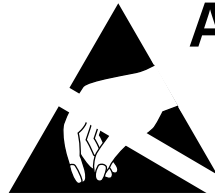
| Soldering method    | Soldering conditions                                                                                           | Recommended condition symbol |
|---------------------|----------------------------------------------------------------------------------------------------------------|------------------------------|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



## ATTENTION

OBSERVE PRECAUTIONS  
FOR HANDLING  
ELECTROSTATIC  
SENSITIVE  
DEVICES

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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)

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.