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Renesas Electronics website: <http://www.renesas.com>

April 1st, 2010
Renesas Electronics Corporation

Issued by: Renesas Electronics Corporation (<http://www.renesas.com>)

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BIPOLAR DIGITAL INTEGRATED CIRCUITS

μ PB1506GV, μ PB1507GV

3GHz INPUT DIVIDE BY 256, 128, 64 PRESCALER IC FOR ANALOG DBS TUNERS

The μ PB1506GV and μ PB1507GV are 3.0 GHz input, high division silicon prescaler ICs for analog DBS tuner applications. These ICs divide-by-256, 128 and 64 contribute to produce analog DBS tuners with kit-use of 17 K series DTS controller or standard CMOS PLL synthesizer IC. The μ PB1506GV/ μ PB1507GV are shrink package versions of the μ PB586G/588G or μ PB1505GR so that these smaller packages contribute to reduce the mounting space replacing from conventional ICs.

The μ PB1506GV and μ PB1507GV are 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, these ICs have excellent performance, uniformity and reliability.

FEATURES

- High toggle frequency : $f_{in} = 0.5 \text{ GHz to } 3.0 \text{ GHz}$
- High-density surface mounting : 8-pin plastic SSOP (175 mil)
- Low current consumption : 5 V, 19 mA
- Selectable high division : $\div 256, \div 128, \div 64$
- Pin connection variation : μ PB1506GV and μ PB1507GV

APPLICATION

These ICs can use as a prescaler between local oscillator and PLL frequency synthesizer included modulus prescaler. For example, following application can be chosen;

- Analog DBS tuner's synthesizer
- Analog CATV converter synthesizer

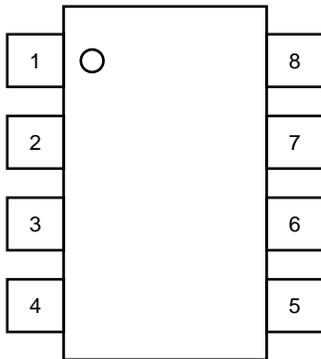
ORDERING INFORMATION

| PART NUMBER | PACKAGE | MARKING | SUPPLYING FORM |
|-------------------|----------------|---------|---|
| μ PB1506GV-E1 | 8-pin plastic | 1506 | Embossed tape 8 mm wide. Pin 1 is in tape pull-out direction. 1 000 p/reel. |
| μ PB1507GV-E1 | SSOP (175 mil) | 1507 | |

Remarks To order evaluation samples, please contact your local NEC sales office.
(Part number for sample order: μ PB1506GV, μ PB1507GV)

Caution: Electro-static sensitive devices

PIN CONNECTION (Top View)



| Pin NO. | μ PB1506GV | μ PB1507GV |
|---------|------------------------|------------------------|
| 1 | SW1 | IN |
| 2 | IN | V _{CC} |
| 3 | $\overline{\text{IN}}$ | SW1 |
| 4 | GND | OUT |
| 5 | NC | GND |
| 6 | SW2 | SW2 |
| 7 | OUT | NC |
| 8 | V _{CC} | $\overline{\text{IN}}$ |

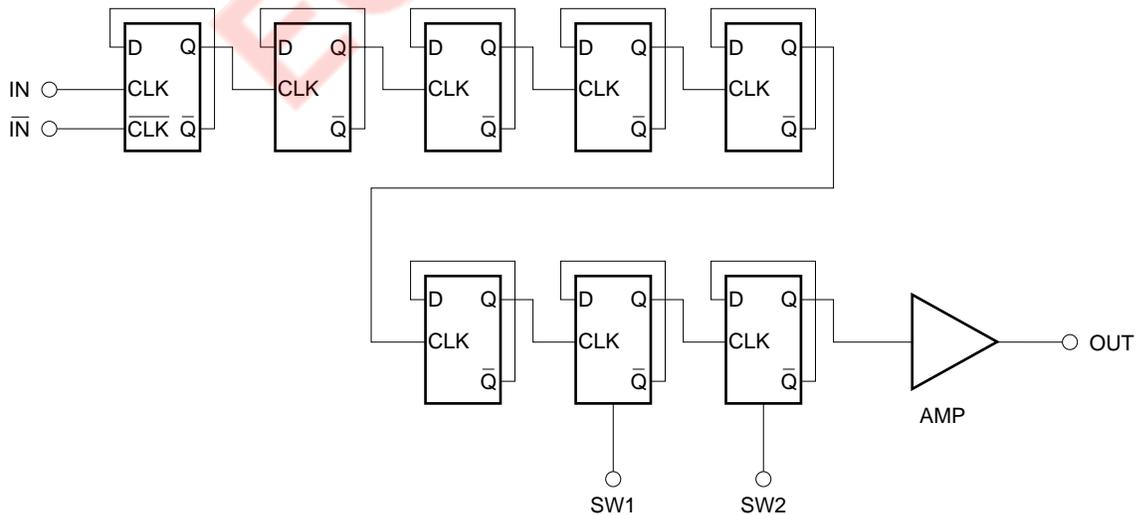
PRODUCT LINE-UP

| Features (division, Freq.) | Part No. | I _{CC} (mA) | f _{in} (GHz) | V _{CC} (V) | Package | Pin connection |
|--|----------------|-------------------------|--------------------------|------------------------|-------------------|--------------------|
| $\div 512, \div 256, 2.5$ GHz | μ PB586G | 28 | 0.5 to 2.5 | 4.5 to 5.5 | 8 pin SOP 225 mil | NEC original |
| $\div 128, \div 64, 2.5$ GHz | μ PB588G | 26 | 0.5 to 2.5 | 4.5 to 5.5 | | Standard |
| $\div 256, \div 128, \div 64$ 3.0 GHz | μ PB1505GR | 14 | 0.5 to 3.0 | 4.5 to 5.5 | | 8 pin SSOP 175 mil |
| | μ PB1506GV | 19 | 0.5 to 3.0 | 4.5 to 5.5 | Standard | |
| | μ PB1507GV | 19 | 0.5 to 3.0 | 4.5 to 5.5 | | |

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

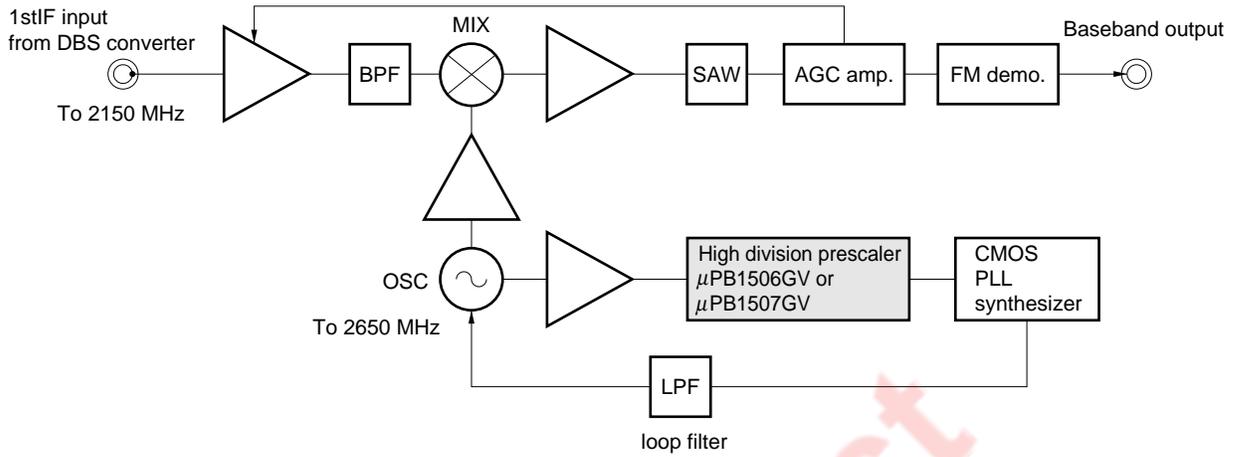
- μ PB586G and μ PB588G are discontinued.

INTERNAL BLOCK DIAGRAM

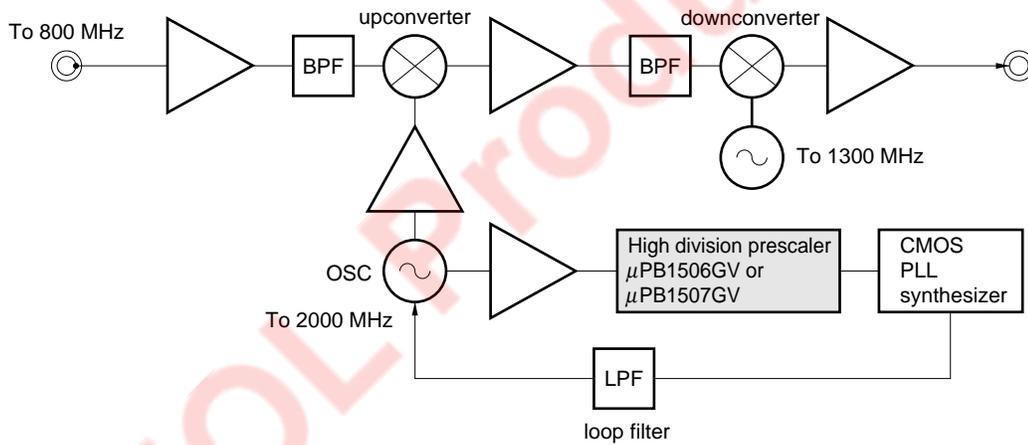


SYSTEM APPLICATION EXAMPLE

RF unit block of Analog DBS tuners



RF unit block of Analog CATV converter



PIN EXPLANATION

| Pin name | Applied voltage V | Pin voltage V | Functions and explanation | Pin no. | | | | | | | | | | | | | | |
|------------------------|-------------------|---------------|--|-----------|-----------|-----|--|---|---|-----|---|-----|------|---|------|------|---|---|
| | | | | μPB1506GV | μPB1507GV | | | | | | | | | | | | | |
| IN | — | 2.9 | Signal input pin. This pin should be coupled to signal source with capacitor (e.g. 1 000 pF) for DC cut. | 2 | 1 | | | | | | | | | | | | | |
| $\overline{\text{IN}}$ | — | 2.9 | Signal input bypass pin. This pin must be equipped with bypass capacitor (e.g. 1 000 pF) to minimize ground impedance. | 3 | 8 | | | | | | | | | | | | | |
| GND | 0 | — | Ground pin. Ground pattern on the board should be formed as wide as possible to minimize ground impedance. | 4 | 5 | | | | | | | | | | | | | |
| SW1 | H/L | — | Divide ratio input pin. The ratio can be determined by following applied level to these pins. | 1 | 3 | | | | | | | | | | | | | |
| SW2 | | | <table border="1" style="margin-left: auto; margin-right: 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>÷64</td> <td>÷128</td> </tr> <tr> <th>L</th> <td>÷128</td> <td>÷256</td> </tr> </tbody> </table> <p>These pins should be equipped with bypass capacitor (e.g. 1 000 pF) to minimize ground impedance.</p> | | | SW2 | | H | L | SW1 | H | ÷64 | ÷128 | L | ÷128 | ÷256 | 6 | 6 |
| | | SW2 | | | | | | | | | | | | | | | | |
| | | H | L | | | | | | | | | | | | | | | |
| SW1 | H | ÷64 | ÷128 | | | | | | | | | | | | | | | |
| | L | ÷128 | ÷256 | | | | | | | | | | | | | | | |
| Vcc | 4.5 to 5.5 | — | Power supply pin. This pin must be equipped with bypass capacitor (e.g. 10 000 pF) to minimize ground impedance. | 8 | 2 | | | | | | | | | | | | | |
| OUT | — | 2.6 to 4.7 | Divided frequency output pin. This pin is designed as emitter follower output. This pin can be connected to CMOS input due to 1.2 V _{P-P} MIN output. | 7 | 4 | | | | | | | | | | | | | |
| NC | — | — | Non connection pin. This pin must be opened. | 5 | 7 | | | | | | | | | | | | | |

ABSOLUTE MAXIMUM RATINGS

| PARAMETER | SYMBOL | CONDITION | RATINGS | UNIT |
|-------------------------------|------------------|--|-------------------------------|------|
| Supply voltage | V _{CC} | T _A = +25 °C | -0.5 to +6.0 | V |
| Input voltage | V _{in} | T _A = +25 °C | -0.5 to V _{CC} + 0.5 | V |
| Total power dissipation | P _D | Mounted on double sided copper clad 50 × 50 × 1.6 mm epoxy glass PWB (T _A = +85 °C) | 250 | mW |
| Operating ambient temperature | T _A | | -40 to +85 | °C |
| Storage temperature | T _{stg} | | -55 to +150 | °C |

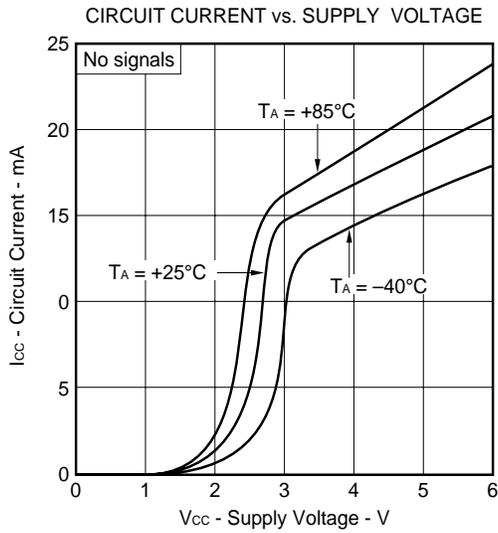
RECOMMENDED OPERATING CONDITIONS

| PARAMETER | SYMBOL | MIN. | TYP. | MAX. | UNIT | NOTICE |
|-------------------------------|-----------------|------|------|------|------|--------|
| Supply voltage | V _{CC} | 4.5 | 5.0 | 5.5 | V | |
| Operating ambient temperature | T _A | -40 | +25 | +85 | °C | |

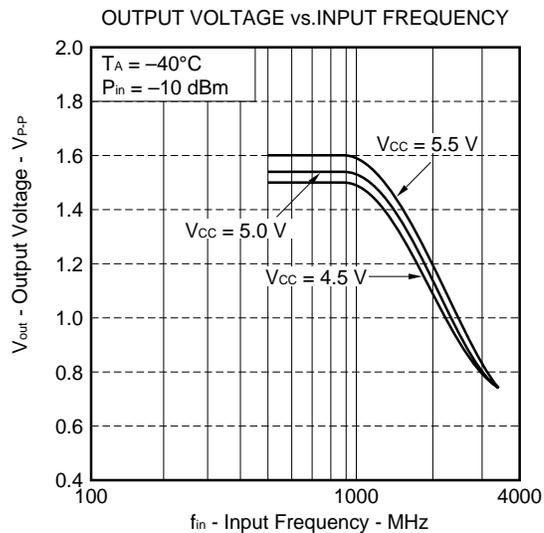
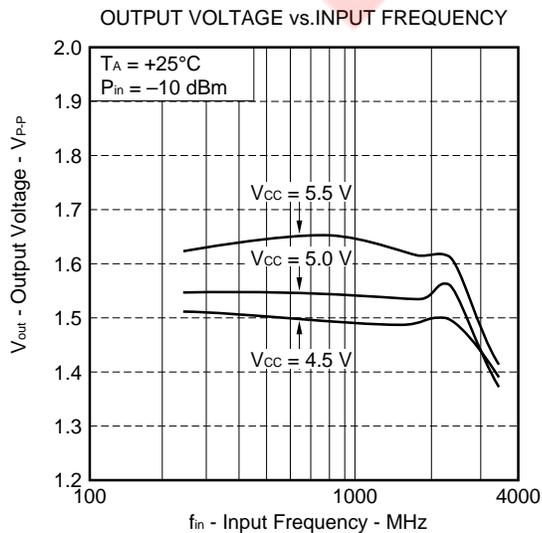
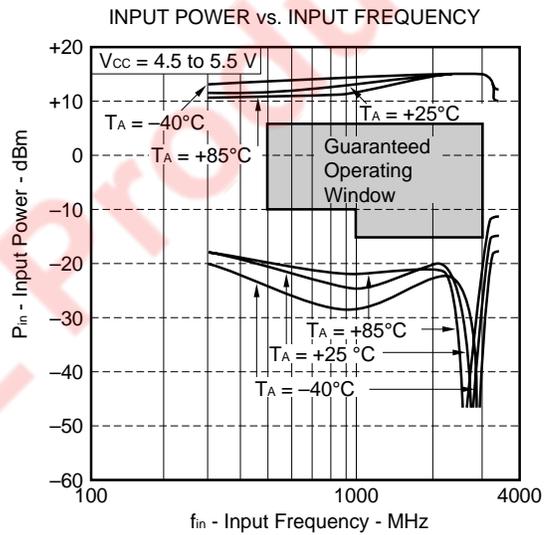
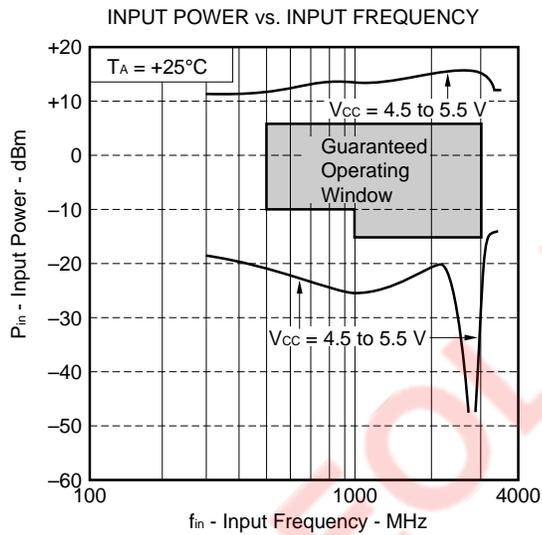
ELECTRICAL CHARACTERISTICS (T_A = -40 to +85 °C, V_{CC} = 4.5 to 5.5 V, Z_s = 50 Ω)

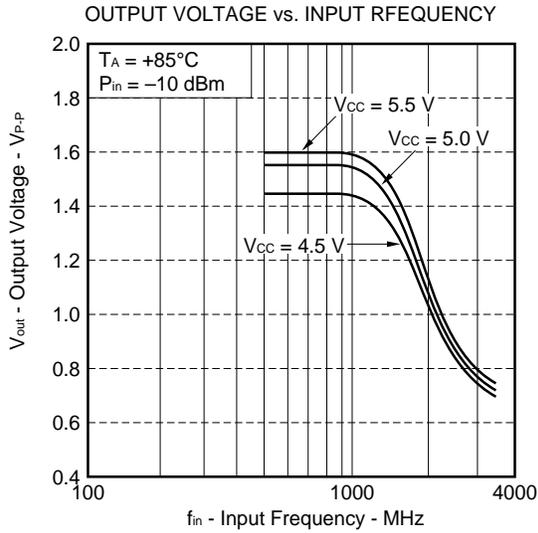
| PARAMETER | SYMBOL | TEST CONDITION | MIN. | TYP. | MAX. | UNIT |
|-----------------------------------|---------------------|----------------------------------|-----------------|-----------------|-----------------|------------------|
| Circuit current | I _{CC} | No signals | 12.5 | 19 | 26.5 | mA |
| Upper limit operating frequency | f _{in(u)} | P _{in} = -15 to +6 dBm | 3.0 | — | — | GHz |
| Lower limit operating frequency 1 | f _{in(L)1} | P _{in} = -10 to +6 dBm | — | — | 0.5 | GHz |
| Lower limit operating frequency 2 | f _{in(L)2} | P _{in} = -15 to +6 dBm | — | — | 1.0 | GHz |
| Input power 1 | P _{in1} | f _{in} = 1.0 to 3.0 GHz | -15 | — | +6 | dBm |
| Input power 2 | P _{in2} | f _{in} = 0.5 to 1.0 GHz | -10 | — | +6 | dBm |
| Output Voltage | V _{out} | C _L = 8 pF | 1.2 | 1.6 | — | V _{P-P} |
| Divide ratio control input high | V _{IH1} | Connection in the test circuit | V _{CC} | V _{CC} | V _{CC} | |
| Divide ratio control input low | V _{IL1} | Connection in the test circuit | OPEN or GND | OPEN or GND | OPEN or GND | |
| Divide ratio control input high | V _{IH2} | Connection in the test circuit | V _{CC} | V _{CC} | V _{CC} | |
| Divide ratio control input low | V _{IL2} | Connection in the test circuit | OPEN or GND | OPEN or GND | OPEN or GND | |

TYPICAL CHARACTERISTICS (Unless otherwise specified $T_A = +25^\circ\text{C}$)

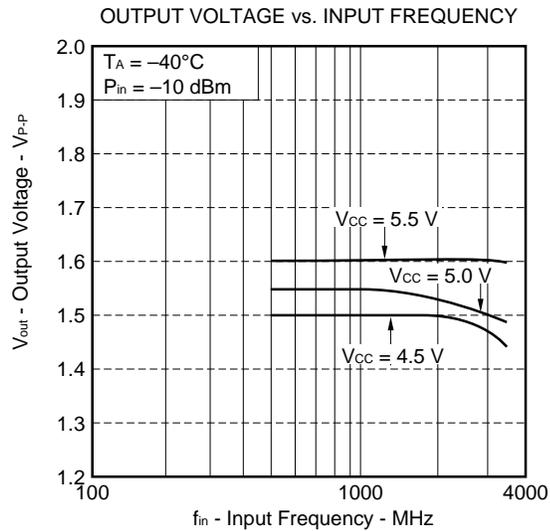
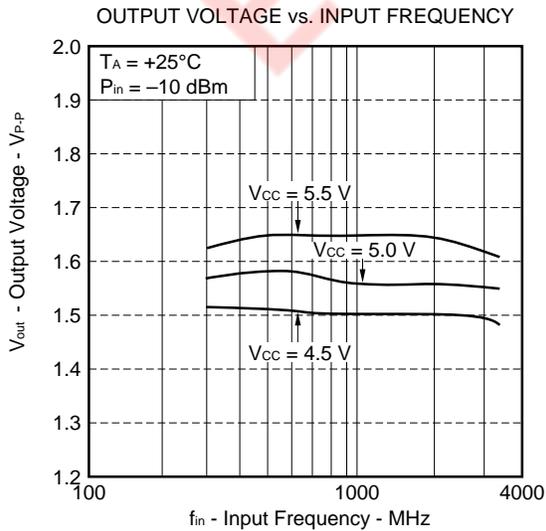
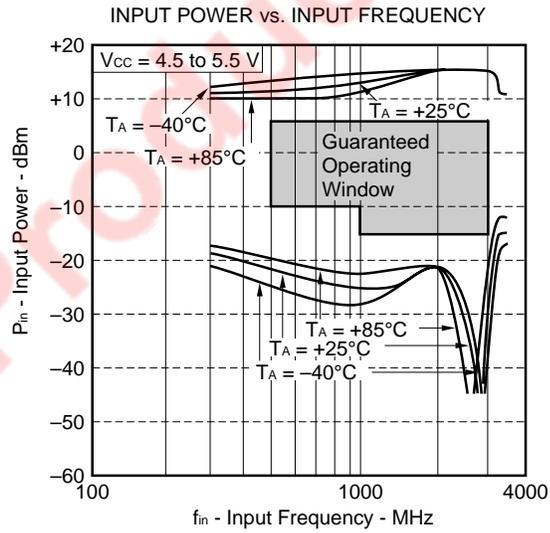
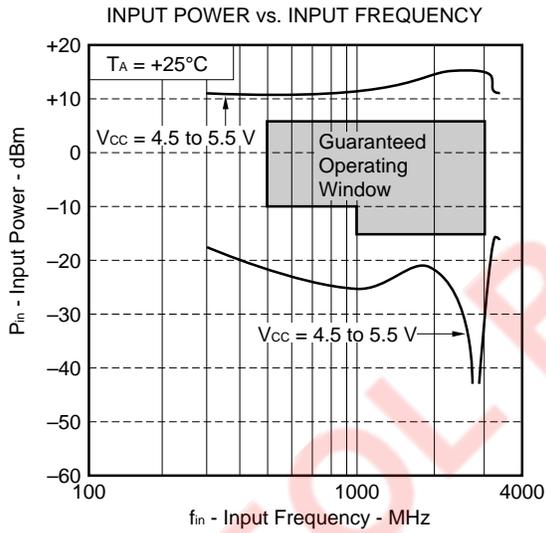


Divide by 64 mode

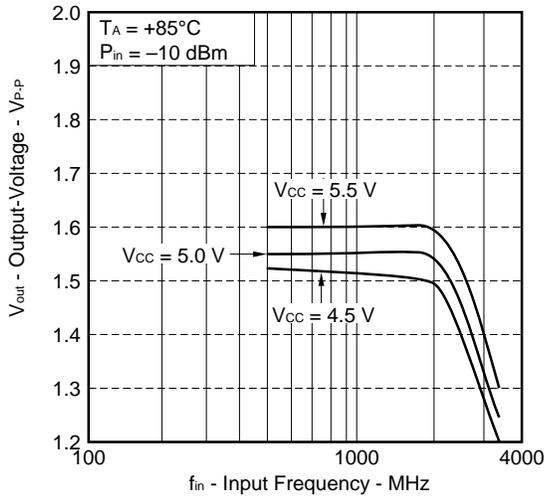




Divide by 128 mode

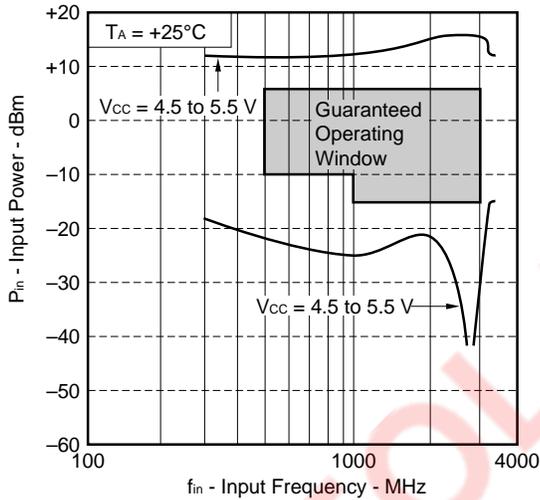


OUTPUT VOLTAGE vs. INPUT FREQUENCY

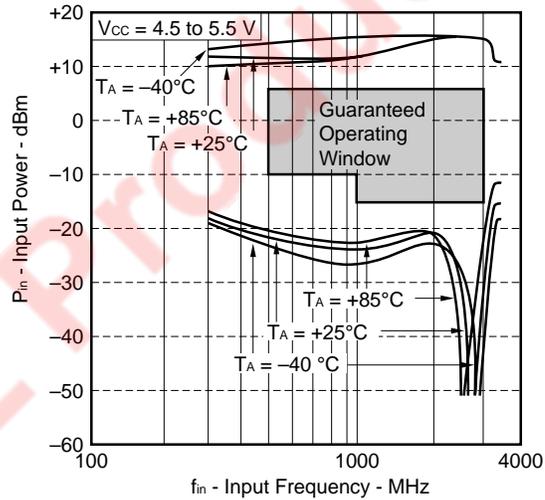


Divide by 256 mode

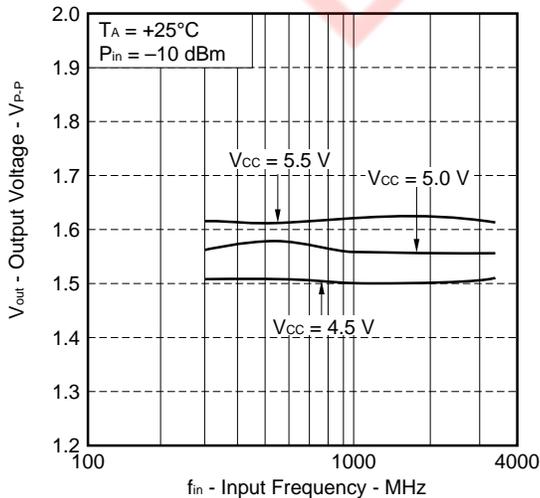
INPUT POWER vs. INPUT FREQUENCY



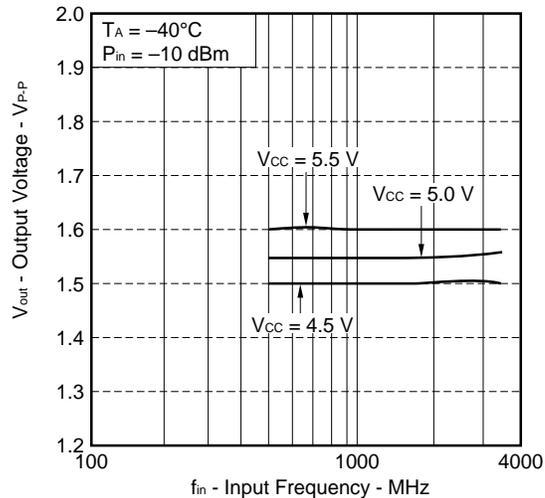
INPUT POWER vs. INPUT FREQUENCY

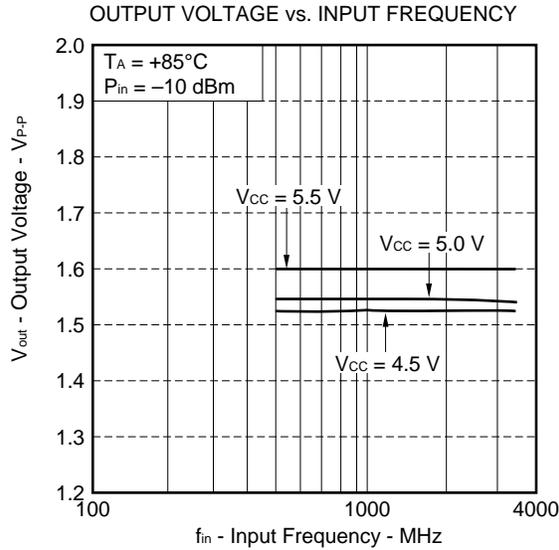


OUTPUT VOLTAGE vs. INPUT FREQUENCY



OUTPUT VOLTAGE vs. INPUT FREQUENCY



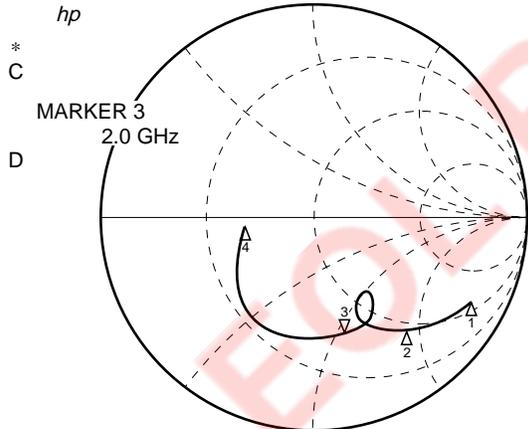


μ PB1506GV

S₁₁ vs. INPUT FREQUENCY

V_{CC} = 5.0 V

S_{11} Z
 REF 1.0 Units
 3 200.0 mUnits/
 V 33.881 Ω -52.875 Ω



START 0.500000000 GHz
 STOP 3.000000000 GHz

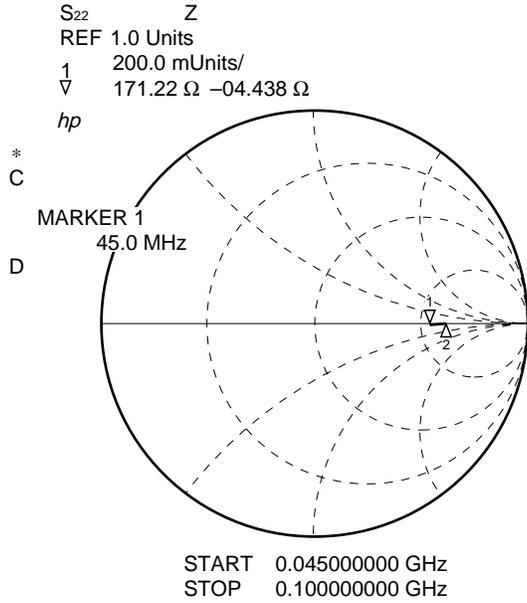
Δ_1 : 500 MHz
 Δ_2 : 1000 MHz
 Δ_3 : 2000 MHz
 Δ_4 : 3000 MHz

| FREQUENCY | S ₁₁ | |
|-----------|-----------------|--------|
| MHz | MAG | ANG |
| 500.0000 | .868 | -26.6 |
| 600.0000 | .828 | -32.6 |
| 700.0000 | .794 | -37.4 |
| 800.0000 | .761 | -41.9 |
| 900.0000 | .721 | -46.5 |
| 1000.0000 | .706 | -49.3 |
| 1100.0000 | .662 | -54.0 |
| 1200.0000 | .629 | -57.2 |
| 1300.0000 | .595 | -60.2 |
| 1400.0000 | .554 | -62.9 |
| 1500.0000 | .516 | -64.8 |
| 1600.0000 | .440 | -61.9 |
| 1700.0000 | .428 | -51.0 |
| 1800.0000 | .543 | -61.5 |
| 1900.0000 | .555 | -68.4 |
| 2000.0000 | .560 | -74.7 |
| 2100.0000 | .558 | -79.5 |
| 2200.0000 | .564 | -84.9 |
| 2300.0000 | .570 | -90.9 |
| 2400.0000 | .574 | -98.3 |
| 2500.0000 | .574 | -107.9 |
| 2600.0000 | .564 | -118.3 |
| 2700.0000 | .530 | -131.4 |
| 2800.0000 | .476 | -144.6 |
| 2900.0000 | .411 | -159.1 |
| 3000.0000 | .331 | -175.8 |

μ PB1506GV

S₂₂ vs. OUTPUT FREQUENCY

Divide by 64 mode, V_{CC} = 5.0 V



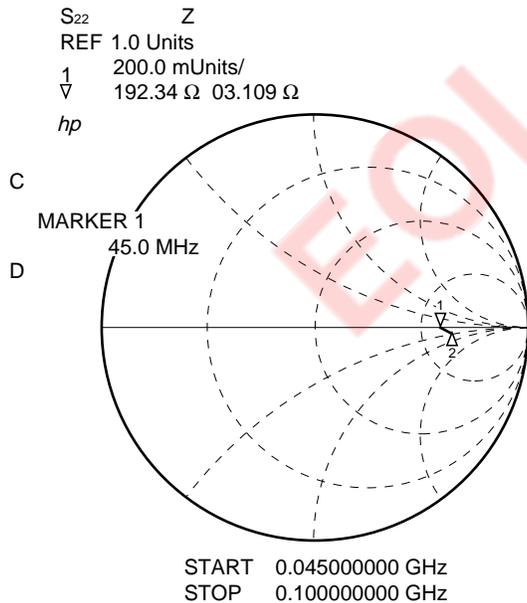
| FREQUENCY MHz | S ₂₂ | |
|------------------|-----------------|------|
| | MAG | ANG |
| 45.000 | .542 | -1.4 |
| 50.000 | .602 | -3 |
| 55.000 | .616 | 0.0 |
| 60.000 | .605 | 1.1 |
| 65.000 | .609 | .7 |
| 70.000 | .616 | .3 |
| 75.000 | .620 | .1 |
| 80.000 | .622 | 0.0 |
| 85.000 | .619 | .6 |
| 90.000 | .610 | .9 |
| 95.000 | .626 | -7 |
| 100.000 | .623 | -1.7 |

Δ₁: 45 MHz
Δ₂: 100 MHz

μ PB1506GV

S₂₂ vs. OUTPUT FREQUENCY

Divide by 128 mode, V_{CC} = 5.0 V



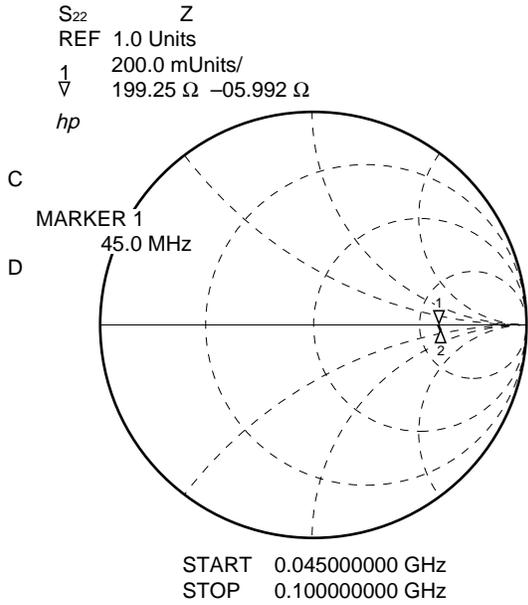
| FREQUENCY MHz | S ₂₂ | |
|------------------|-----------------|------|
| | MAG | ANG |
| 45.000 | .590 | .4 |
| 50.000 | .604 | -1.0 |
| 55.000 | .610 | -1.1 |
| 60.000 | .607 | -8 |
| 65.000 | .548 | -5.9 |
| 70.000 | .630 | -0.0 |
| 75.000 | .615 | -1.0 |
| 80.000 | .618 | -1.4 |
| 85.000 | .617 | -1.2 |
| 90.000 | .616 | -2.2 |
| 95.000 | .623 | -2.4 |
| 100.000 | .624 | -2.3 |

Δ₁: 45 MHz
Δ₂: 100 MHz

μPB1506GV

S₂₂ vs. OUTPUT FREQUENCY

Divide by 256 mode, V_{cc} = 5.0 V

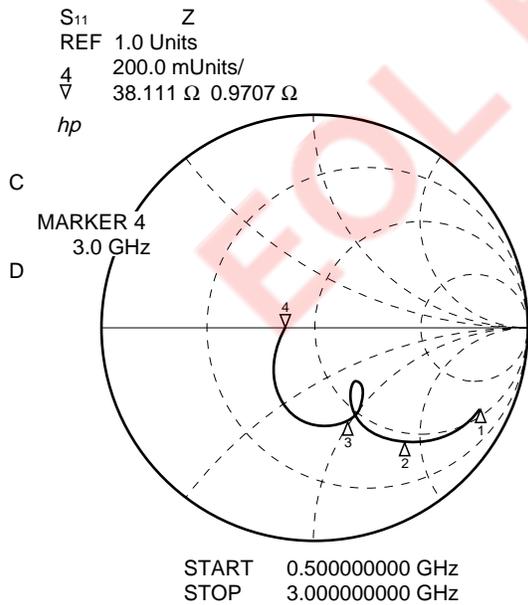


| FREQUENCY MHz | S ₂₂ | |
|------------------|-----------------|------|
| | MAG | ANG |
| 45.000 | .601 | -9 |
| 50.000 | .609 | -1.6 |
| 55.000 | .611 | -1.5 |
| 60.000 | .620 | -1.4 |
| 65.000 | .607 | -2.1 |
| 70.000 | .615 | -1.9 |
| 75.000 | .613 | -3.2 |
| 80.000 | .611 | -2.8 |
| 85.000 | .607 | -2.5 |
| 90.000 | .605 | -2.4 |
| 95.000 | .610 | -3.0 |
| 100.000 | .608 | -2.8 |

μPB1507GV

S₁₁ vs. INPUT FREQUENCY

V_{cc} = 5.0 V

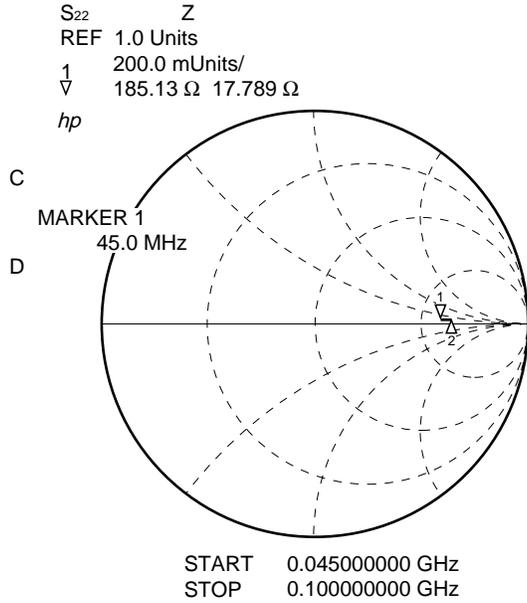


| FREQUENCY MHz | S ₁₁ | |
|------------------|-----------------|--------|
| | MAG | ANG |
| 500.0000 | .857 | -27.5 |
| 600.0000 | .849 | -32.0 |
| 700.0000 | .800 | -38.9 |
| 800.0000 | .764 | -43.8 |
| 900.0000 | .725 | -49.0 |
| 1000.0000 | .665 | -50.9 |
| 1100.0000 | .619 | -55.3 |
| 1200.0000 | .573 | -59.3 |
| 1300.0000 | .531 | -61.3 |
| 1400.0000 | .484 | -62.8 |
| 1500.0000 | .439 | -63.0 |
| 1600.0000 | .377 | -59.1 |
| 1700.0000 | .340 | -54.1 |
| 1800.0000 | .377 | -54.7 |
| 1900.0000 | .441 | -59.5 |
| 2000.0000 | .464 | -67.2 |
| 2100.0000 | .443 | -67.4 |
| 2200.0000 | .466 | -74.5 |
| 2300.0000 | .465 | -81.3 |
| 2400.0000 | .454 | -89.4 |
| 2500.0000 | .433 | -99.2 |
| 2600.0000 | .383 | -109.6 |
| 2700.0000 | .350 | -114.0 |
| 2800.0000 | .332 | -124.2 |
| 2900.0000 | .271 | -141.2 |
| 3000.0000 | .185 | -163.6 |

μ PB1507GV

S₂₂ vs. OUTPUT FREQUENCY

Divide by 64 mode, V_{CC} = 5.0 V



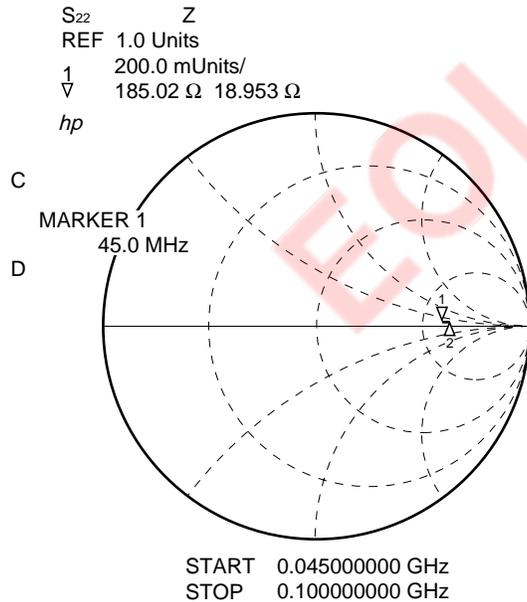
| FREQUENCY MHz | S ₂₂ | |
|------------------|-----------------|-----|
| | MAG | ANG |
| 45.000 | .580 | 3.4 |
| 50.000 | .572 | 2.5 |
| 55.000 | .574 | 3.0 |
| 60.000 | .574 | 2.7 |
| 65.000 | .584 | 3.0 |
| 70.000 | .587 | 2.6 |
| 75.000 | .592 | 2.4 |
| 80.000 | .587 | 2.6 |
| 85.000 | .589 | 2.9 |
| 90.000 | .591 | 2.9 |
| 95.000 | .573 | 1.7 |
| 100.000 | .604 | 2.9 |

Δ₁: 45 MHz
Δ₂: 100 MHz

μ PB1507GV

S₂₂ vs. OUTPUT FREQUENCY

Divide by 128 mode, V_{CC} = 5.0 V



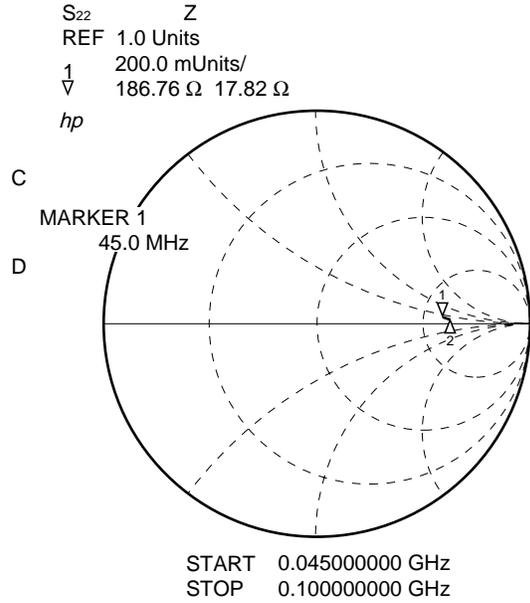
| FREQUENCY MHz | S ₂₂ | |
|------------------|-----------------|-----|
| | MAG | ANG |
| 45.000 | .578 | 3.2 |
| 50.000 | .571 | 2.8 |
| 55.000 | .572 | 3.3 |
| 60.000 | .576 | 3.0 |
| 65.000 | .584 | 3.1 |
| 70.000 | .587 | 2.8 |
| 75.000 | .589 | 2.4 |
| 80.000 | .589 | 2.8 |
| 85.000 | .588 | 3.0 |
| 90.000 | .593 | 2.8 |
| 95.000 | .598 | 3.0 |
| 100.000 | .602 | 2.9 |

Δ₁: 45 MHz
Δ₂: 100 MHz

μ PB1507GV

S₂₂ vs. OUTPUT FREQUENCY

Divide by 256 mode, V_{cc} = 5.0 V



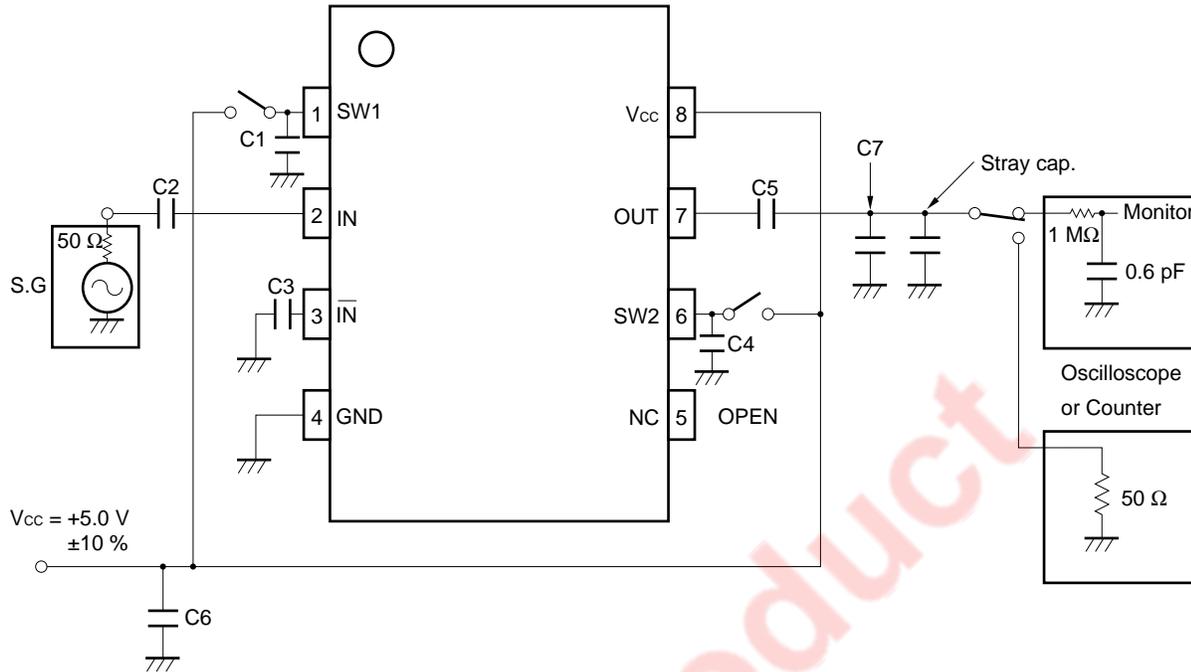
Δ_1 : 45 MHz
 Δ_2 : 100 MHz

| FREQUENCY MHz | S ₂₂ | |
|------------------|-----------------|-----|
| | MAG | ANG |
| 45.000 | .580 | 3.0 |
| 50.000 | .572 | 2.8 |
| 55.000 | .571 | 2.9 |
| 60.000 | .576 | 2.9 |
| 65.000 | .585 | 3.2 |
| 70.000 | .590 | 2.8 |
| 75.000 | .589 | 2.5 |
| 80.000 | .590 | 2.6 |
| 85.000 | .588 | 2.9 |
| 90.000 | .597 | 2.9 |
| 95.000 | .600 | 3.1 |
| 100.000 | .601 | 3.1 |

EOL Product

TEST CIRCUIT

μ PB1506GV



- SG (HP-8665A)
- Counter (HP5350B) : To measure input sensitivity
or
Oscilloscope : To measure output voltage swing

Divide ratio setting

| | | SW2 | |
|-----|---|-------|-------|
| | | H | L |
| SW1 | H | 1/64 | 1/128 |
| | L | 1/128 | 1/256 |

H: Connect to Vcc

L: Connect to GND or OPEN

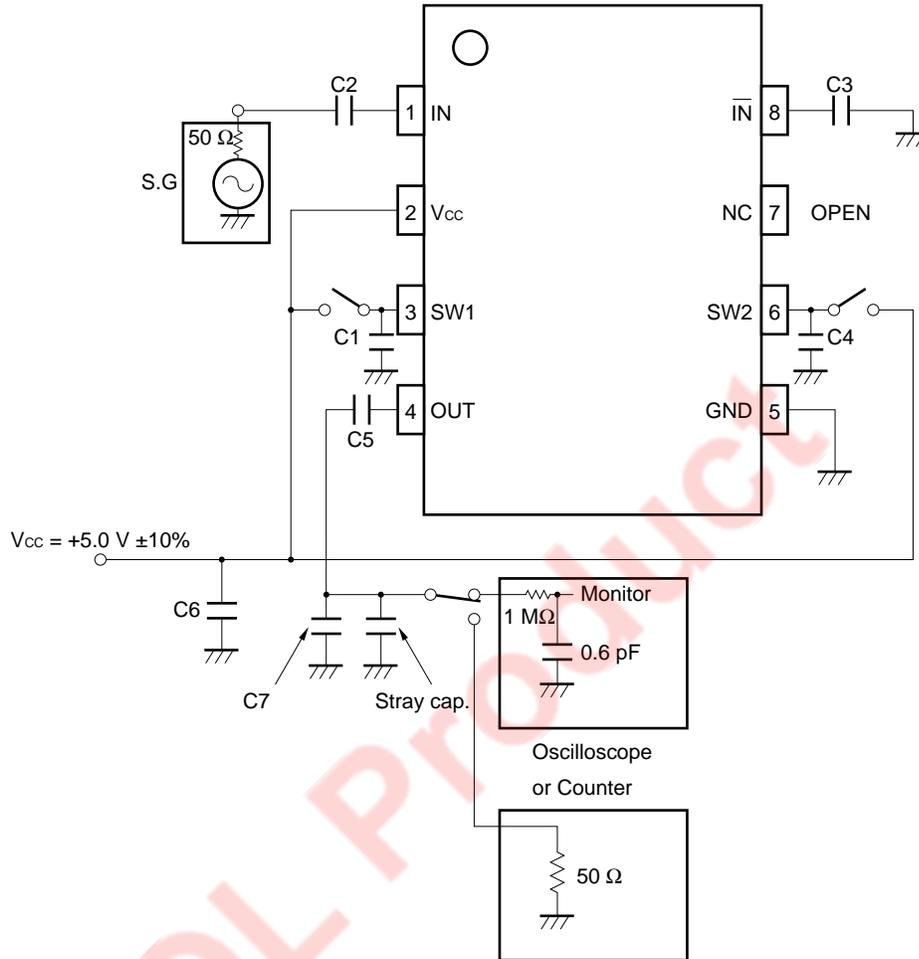
COMPONENT LIST

| | μ PB1506GV | μ PB1507GV |
|------------|----------------|----------------|
| C1 to C5 | 1 000 pF | 1 000 pF |
| C6 | 10 000 pF | 10 000 pF |
| Stray cap. | Aprox 4 pF | Aprox 5 pF |
| C7 | 3.5 pF* | 2.5 pF* |

* Capacitance $C_L = 8$ pF for DUT includes C7 value + stray capacitance on the board and measurement equipment.

TEST CIRCUIT

μ PB1507GV



- SG (HP-8665A)
- Counter (HP5350B) : To measure input sensitivity
or
Oscilloscope : To measure output voltage swing

Divide ratio setting

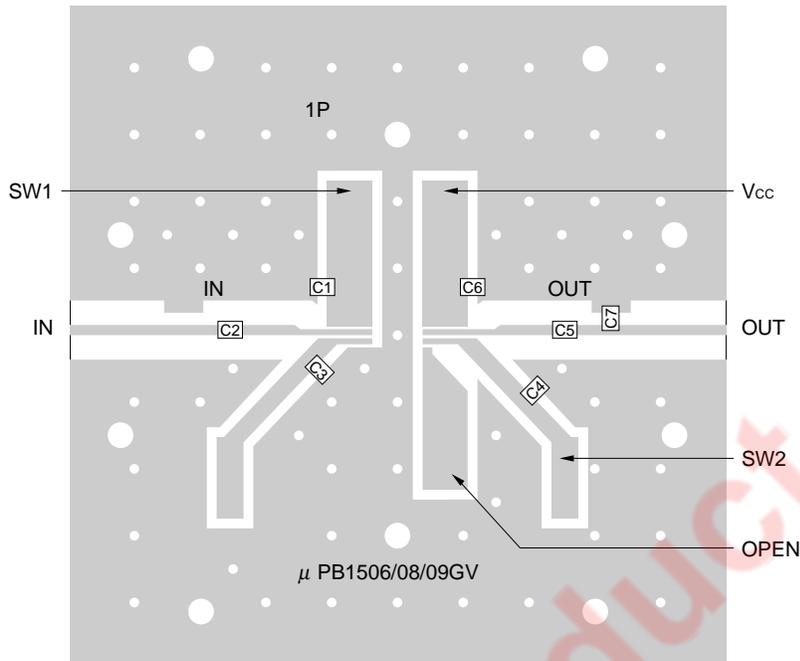
| | | SW2 | |
|-----|---|-------|-------|
| | | H | L |
| SW1 | H | 1/64 | 1/128 |
| | L | 1/128 | 1/256 |

H: Connect to Vcc

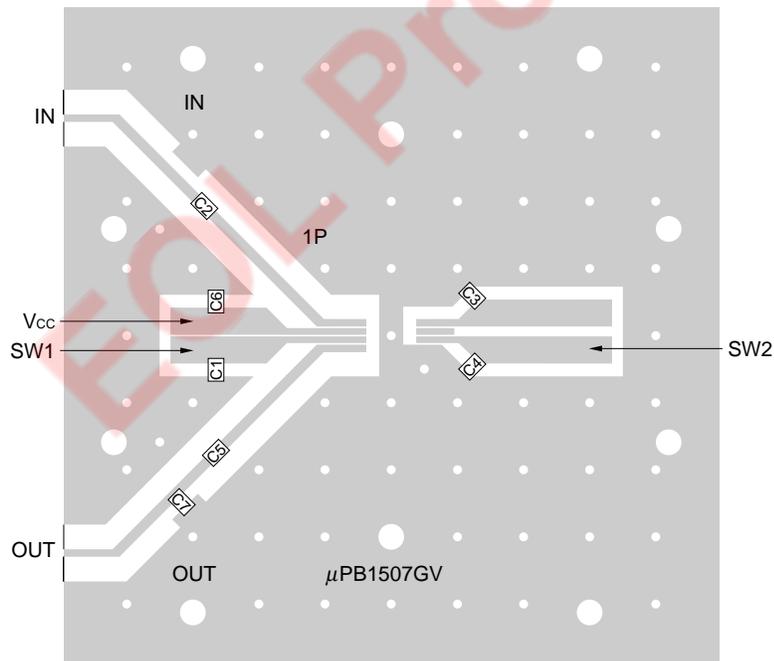
L: Connect to GND or OPEN

ILLUSTRATION OF THE TEST CIRCUIT ASSEMBLED ON EVALUATION BOARD

μPB1506GV



μPB1507GV

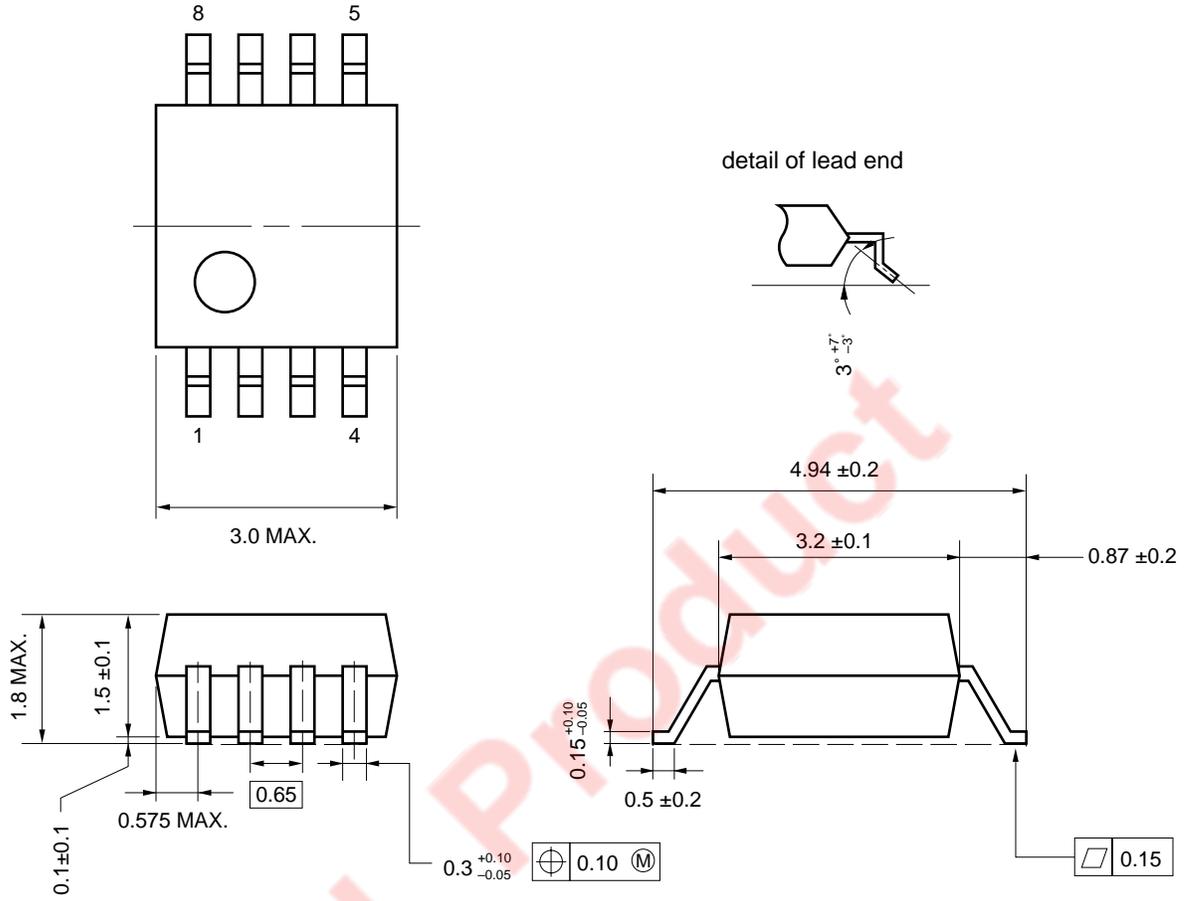


EVALUATION BOARD CHARACTERS

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

PACKAGE DIMENSIONS

8 PIN PLASTIC SSOP (UNIT: mm) (175 mil)



NOTE 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. 10 000 pF) to the Vcc 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.

μPB1506GV, μPB1507GV

| 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.* | |

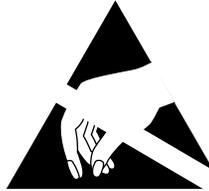
* It is the storage days after opening a dry pack, the storage conditions are 25 °C, less than 65 % RH.

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]

EOL Product



ATTENTION

OBSERVE PRECAUTIONS
FOR HANDLING
ELECTROSTATIC
SENSITIVE
DEVICES

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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.