

## SPDT Switch GaAs MMIC

### ■ GENERAL DESCRIPTION

The NJG1612HA8 is a SPDT switch IC featured extremely high speed switching.

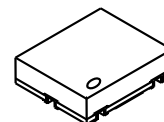
This device is suitable for high speed switching of Tx/Rx signals at sub-microwave applications.

This switch exhibits wide frequency range from 100MHz to 5.0GHz at low operating voltage of 2.5V, and is operated up to 20dBm at 3.0V operating voltage.

An ultra-small and ultra-thin package of USB6-A8 is adopted.

This product is RoHS directive compliant.

### ■ PACKAGE OUTLINE



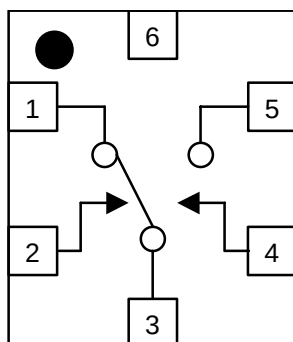
NJG1612HA8

### ■ FEATURES

- Low control voltage +2.5~+6.5V
- High speed switching 3ns typ.
- Low insertion loss 0.45dB typ. @f=2.5GHz  
0.8dB typ. @f=5.0GHz
- High isolation 21dB typ. @f=2.5GHz  
14dB typ. @f=5.0GHz
- P-0.2dB 25dBm typ. @f=2.5GHz,  $V_{CTL}=3.0V$
- Ultra-small & ultra-thin package USB6-A8 (Package Size: 1.0x1.2x0.38mm typ.)

### ■ PIN CONFIGURATION

Top view



Pin connection

- 1.P2
- 2.VCTL2
- 3.PC
- 4.VCTL1
- 5.P1
- 6.GND

### ■ TRUTH TABLE

|       |     |     |
|-------|-----|-----|
| VCTL1 | H   | L   |
| VCTL2 | L   | H   |
| PC-P1 | ON  | OFF |
| PC-P2 | OFF | ON  |

# NJG1612HA8

## ■ ABSOLUTE MAXIMUM RATINGS

( $T_a=25^{\circ}\text{C}$ ,  $Z_s=Z_l=50\Omega$ )

| PARAMETER         | SYMBOL    | CONDITIONS                                        | CONDITIONS | UNITS              |
|-------------------|-----------|---------------------------------------------------|------------|--------------------|
| RF Input Power    | $P_{IN}$  | $V_{CTL(L)}=0V$ , $V_{CTL(H)}=3V$                 | 29         | dBm                |
| Control Voltage   | $V_{CTL}$ | $V_{CTL(H)}-V_{CTL(L)}$                           | 7.5        | V                  |
| Power dissipation | $P_D$     | At on PCB board<br>$T_{jmax}=150^{\circ}\text{C}$ | 150        | mW                 |
| Operating Temp.   | $T_{opr}$ |                                                   | -40~+85    | $^{\circ}\text{C}$ |
| Storage Temp.     | $T_{stg}$ |                                                   | -55~+150   | $^{\circ}\text{C}$ |

## ■ ELECTRICAL CHARACTERISTICS

(General conditions:  $V_{CTL(L)}=0V$ ,  $V_{CTL(H)}=3V$ ,  $Z_s=Z_l=50\Omega$ ,  $T_a=25^{\circ}\text{C}$ , with application circuit)

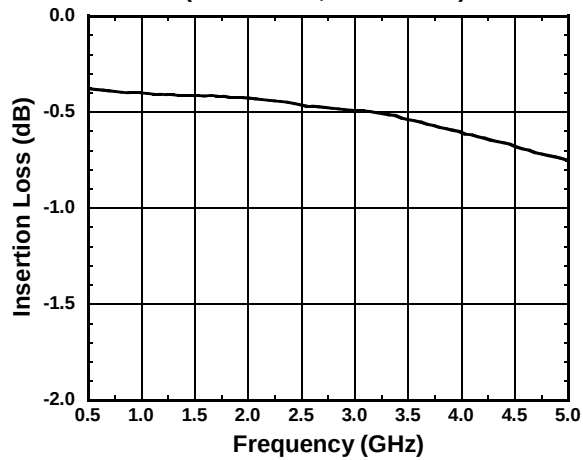
| PARAMETERS                               | SYMBOL       | CONDITIONS                                       | MIN  | TYP  | MAX  | UNITS         |
|------------------------------------------|--------------|--------------------------------------------------|------|------|------|---------------|
| Control Current                          | $I_{CTL}$    | $f=2.5\text{GHz}$ , $P_{IN}=10\text{dBm}$        | -    | 5    | 10   | $\mu\text{A}$ |
| Control Voltage (LOW)                    | $V_{CTL(L)}$ |                                                  | -0.2 | -    | 0.2  | V             |
| Control Voltage (HIGH)                   | $V_{CTL(H)}$ |                                                  | 2.5  | 3.0  | 6.5  | V             |
| Insertion Loss 1                         | Loss1        | $f=1\text{GHz}$                                  | -    | 0.35 | 0.55 | dB            |
| Insertion Loss 2                         | Loss2        | $f=2\text{GHz}$                                  | -    | 0.40 | 0.60 | dB            |
| Insertion Loss 3                         | Loss3        | $f=2.5\text{GHz}$                                | -    | 0.45 | 0.65 | dB            |
| Insertion Loss 4                         | Loss4        | $f=5\text{GHz}$                                  | -    | 0.8  | 1.2  | dB            |
| Isolation 1                              | ISL1         | $f=1\text{GHz}$                                  | 25   | 28   | -    | dB            |
| Isolation 2                              | ISL2         | $f=2\text{GHz}$                                  | 20   | 23   | -    | dB            |
| Isolation 3                              | ISL3         | $f=2.5\text{GHz}$                                | 18   | 21   | -    | dB            |
| Isolation 4                              | ISL4         | $f=5\text{GHz}$                                  | 11   | 14   | -    | dB            |
| Input Power at 0.2dB Compression Point 1 | P-0.2dB(1)   | $f=2.5\text{GHz}$                                | 22   | 25   | -    | dBm           |
| Input Power at 0.2dB Compression Point 2 | P-0.2dB(2)   | $f=5\text{GHz}$                                  | 21   | 24   | -    | dBm           |
| VSWR1                                    | VSWR1        | $f=0.1\sim 3\text{GHz}$ , ON state               | -    | 1.2  | 1.4  |               |
| VSWR2                                    | VSWR2        | $f=3\sim 5\text{GHz}$ , ON state                 | -    | 1.5  | 1.7  |               |
| Switching time                           | $T_{sw}$     | $f=0.1\sim 5\text{GHz}$<br>50% VCTL to 10/90% RF | -    | 3    | 6    | ns            |

## ■TERMINAL INFORMATION

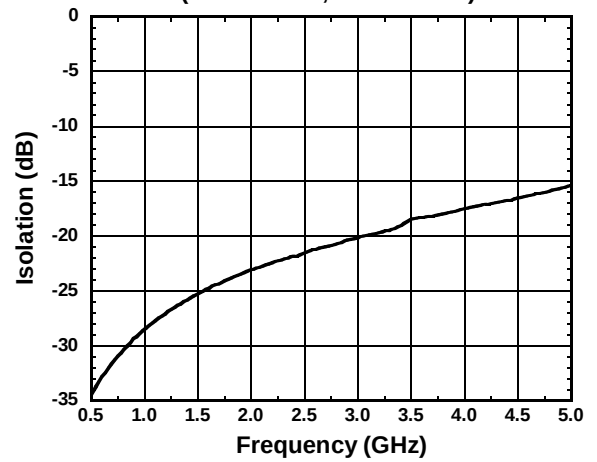
| No. | SYMBOL | DESCRIPTION                                                                                                                                                                                                                                                                                                                                                             |
|-----|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1   | P2     | RF port. This port is connected with PC port by controlling 2 <sup>nd</sup> pin ( $V_{CTL(H)}$ ) to 2.5~6.5V and 4 <sup>th</sup> pin ( $V_{CTL(L)}$ ) to -0.2~+0.2V. An external capacitor is required to block the DC bias voltage of internal circuit. (0.1~0.5GHz: 1000pF, 0.5~3GHz: 56pF, 3~5GHz: 27pF)                                                             |
| 2   | VCTL2  | Control port 2. The voltage of this port controls PC to P2 state. The 'ON' and 'OFF' state is toggled by controlling voltage of this terminal such as high-state (2.5~6.5V) or low-state (-0.2~+0.2V). The voltage of 4 <sup>th</sup> pin has to be set to opposite state. The bypass capacitor has to be chosen to reduce switching time delay from 10pF~1000pF range. |
| 3   | PC     | Common RF port. In order to block the DC bias voltage of internal circuit, an external capacitor is required. (0.1~0.5GHz: 1000pF, 0.5~3GHz: 56pF, 3~5GHz: 27pF)                                                                                                                                                                                                        |
| 4   | VCTL1  | Control port 1. The voltage of this port controls PC to P1 state. The 'ON' and 'OFF' state is toggled by controlling voltage of this terminal such as high-state (2.5~6.5V) or low-state (-0.2~+0.2V). The voltage of 2 <sup>nd</sup> pin has to be set to opposite state. The bypass capacitor has to be chosen to reduce switching time delay from 10pF~1000pF range. |
| 5   | P1     | RF port. This port is connected with PC port by controlling 4 <sup>th</sup> pin ( $V_{CTL(H)}$ ) to 2.5~6.5V and 2 <sup>nd</sup> pin ( $V_{CTL(L)}$ ) to -0.2~+0.2V. An external capacitor is required to block the DC bias voltage of internal circuit(0.1~0.5GHz: 1000pF, 0.5~3GHz: 56pF, 3~5GHz: 27pF)                                                               |
| 6   | GND    | Ground terminal. Please connect this terminal with ground plane as close as possible for excellent RF performance.                                                                                                                                                                                                                                                      |

## ■ELECTRICAL CHARACTERISTICS (with Application circuit, Loss of external circuit are excluded)

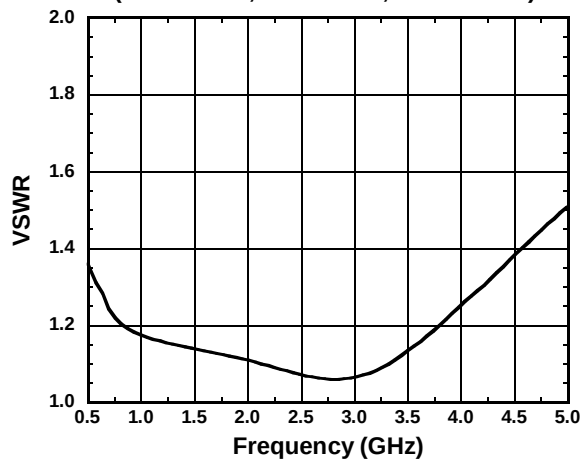
**PC-P1 Insertion Loss vs. Frequency**  
( VCTL1=3V, VCTL2=0V )



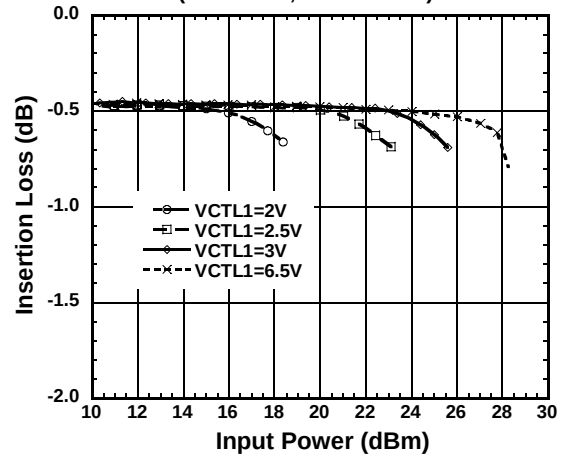
**PC-P1 Isolation vs. Frequency**  
( VCTL1=0V, VCTL2=3V )



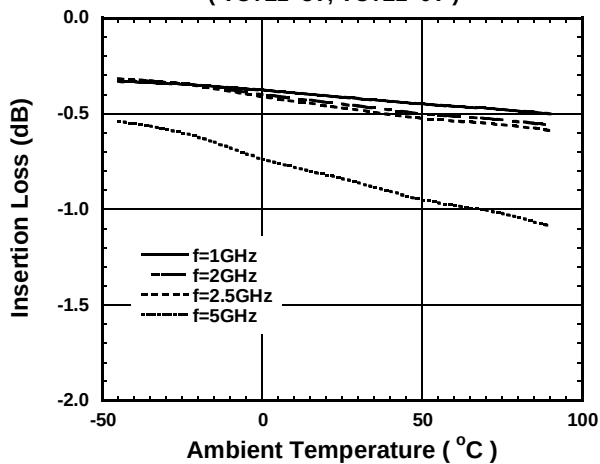
**P1 VSWR vs. Frequency**  
( PC-P1 ON, VCTL1=3V, VCTL2=0V )



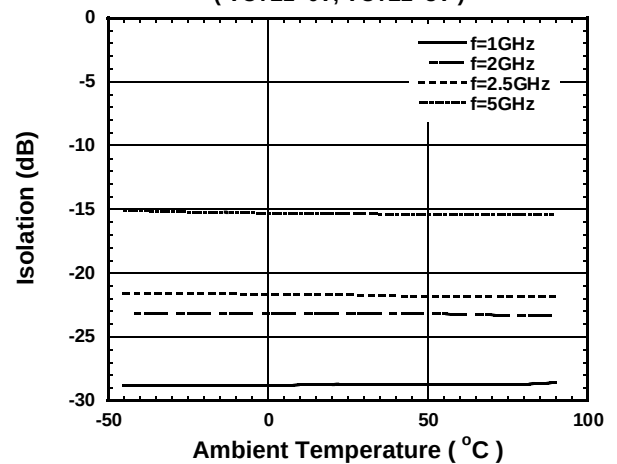
**PC-P1 Insertion Loss vs. Input Power**  
( f=2.5GHz, VCTL2=0V )



**PC-P1 Loss vs. Ambient Temperature**  
( VCTL1=3V, VCTL2=0V )

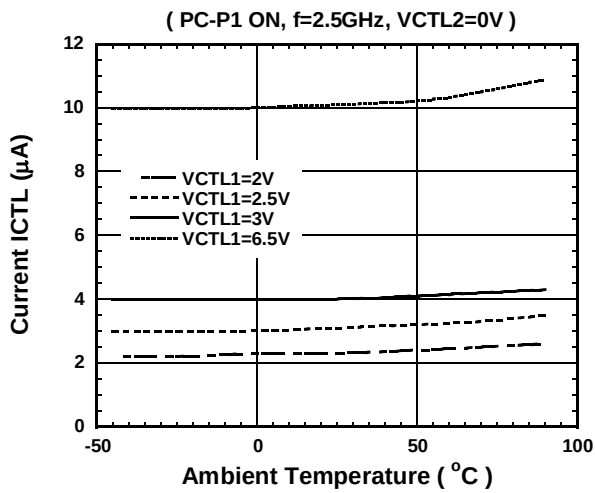


**PC-P1 Isolation vs. Ambient Temperature**  
( VCTL1=0V, VCTL2=3V )

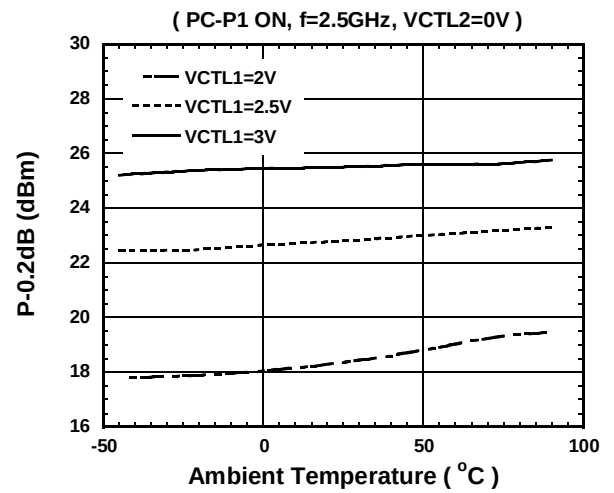


## ■ELECTRICAL CHARACTERISTICS (with Application circuit, Loss of external circuit are excluded)

**Current ICTL vs. Ambient Temperature**

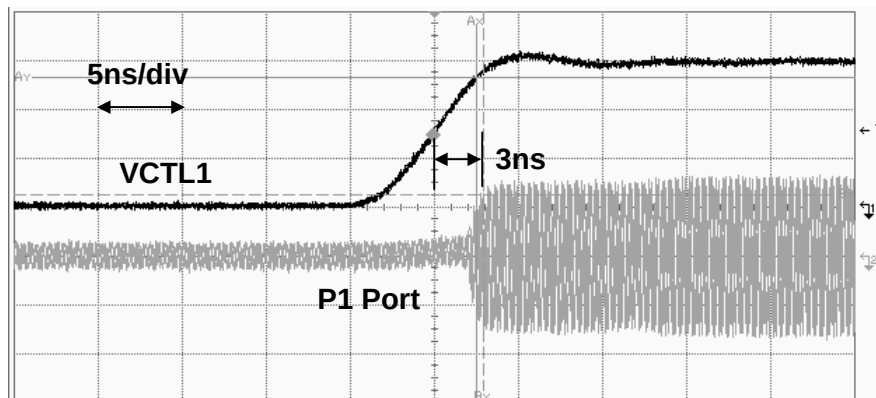


**PC-P1 P-0.2dB vs. Ambient Temperature**



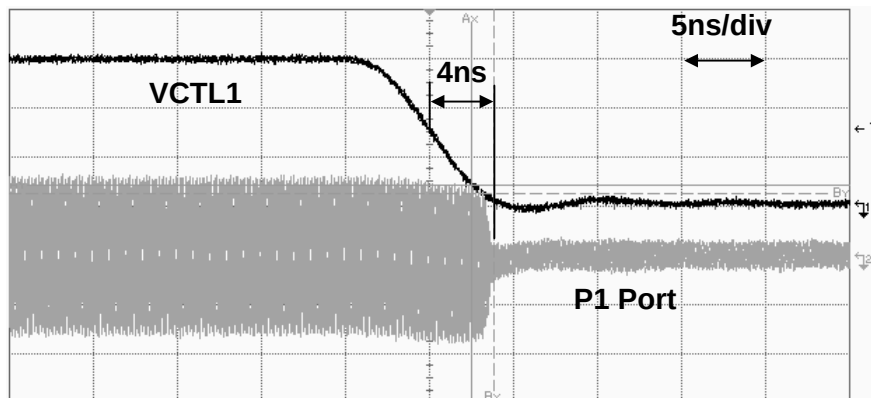
**Switching Speed 1**

(PC-P1 ON, 50%  $V_{CTL1}$  to 90% RF)



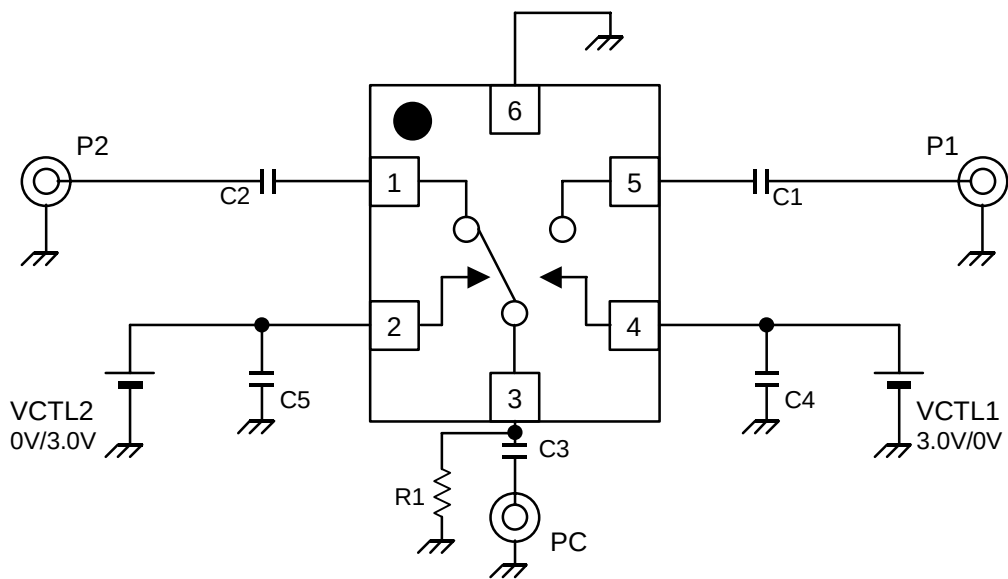
**Switching Speed 2**

(PC-P1 OFF, 50%  $V_{CTL1}$  to 10% RF)



# NJG1612HA8

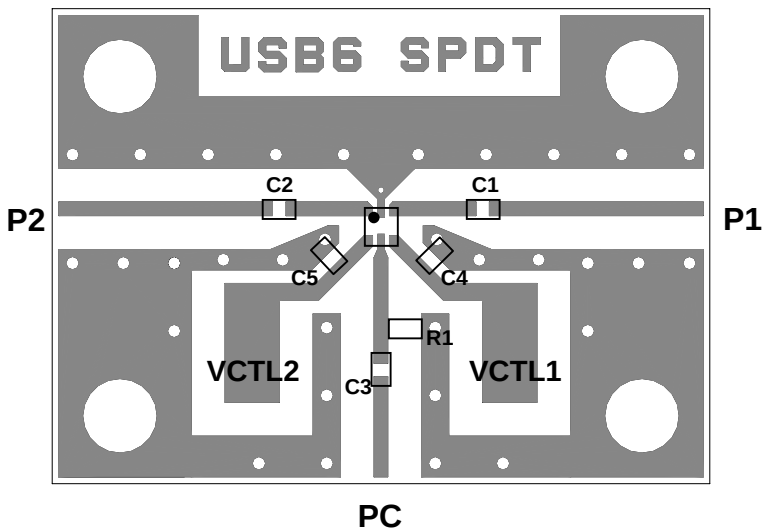
## APPLICATION CIRCUIT



Parts List

| Parts number | List 1         | List 2       | List 3     | Notes        |
|--------------|----------------|--------------|------------|--------------|
|              | fin=0.1~0.5GHz | fin=0.5~3GHz | fin=3~5GHz |              |
| C1~C3        | 1000pF         | 56pF         | 27pF       | GRM15 MURATA |
| C4, C5       | 10pF           | 10pF         | 10pF       | GRM15 MURATA |
| R1           | 560kΩ          | 560kΩ        | 560kΩ      |              |

## TEST PCB LAYOUT



Circuit losses including losses of capacitor and connector.

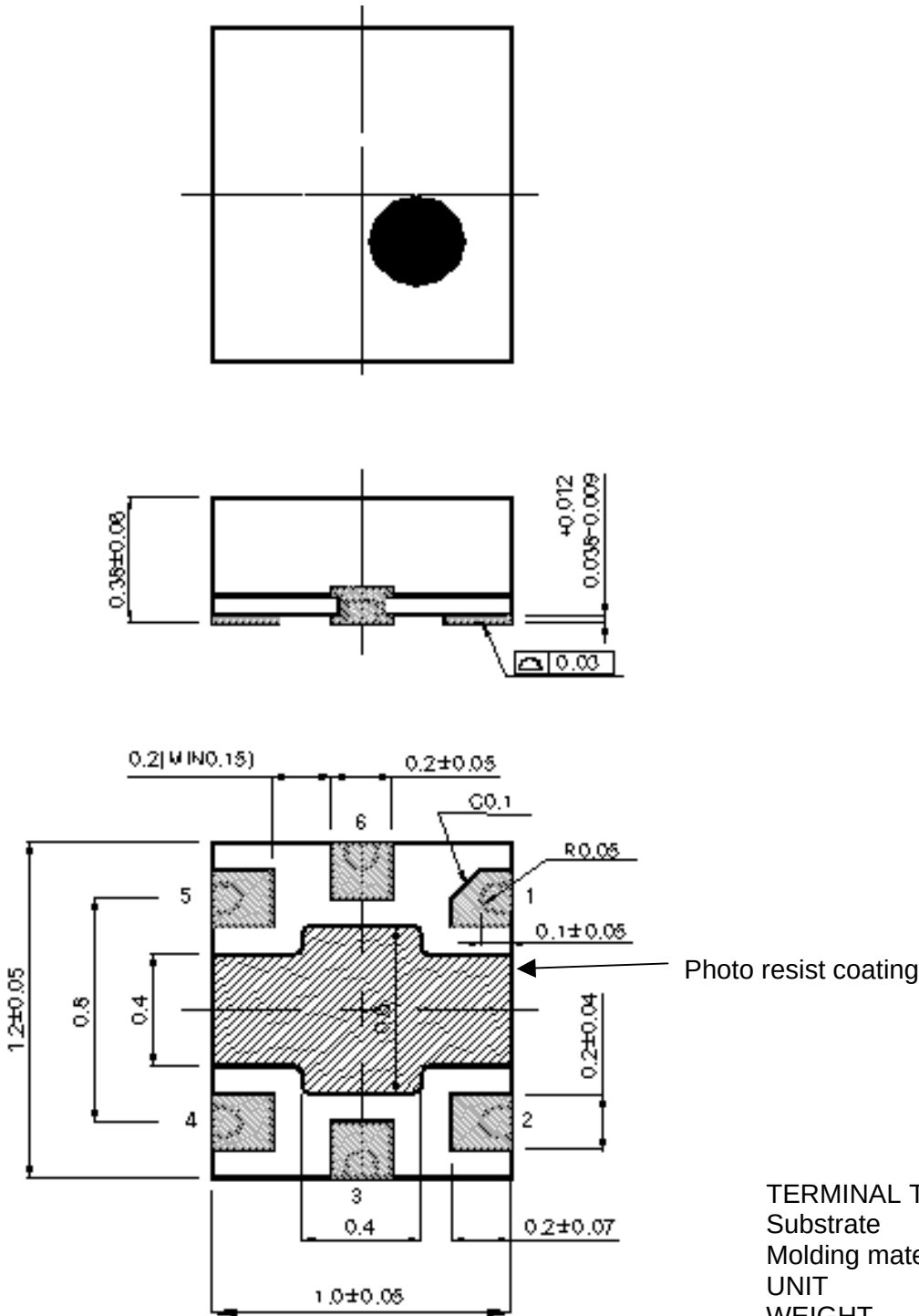
(DC blocking capacitor: 56pF)

| freq   | Loss   |
|--------|--------|
| 1GHz   | 0.22dB |
| 2GHz   | 0.34dB |
| 2.5GHz | 0.42dB |
| 5GHz   | 0.78dB |

## PRECAUTIONS

- [1] The DC blocking capacitors have to be placed at RF terminal of P1, P2 and PC.
- [2] To reduce stripline influence on RF characteristics, please locate bypass capacitors (C4, C5) close to each terminal.

## ■ PACKAGE OUTLINE (USB6-A8)



TERMINAL TREAT : Au  
 Substrate : FR5  
 Molding material : Epoxy resin  
 UNIT : mm  
 WEIGHT : 1.1mg

## Cautions on using this product

This product contains Gallium-Arsenide (GaAs) which is a harmful material.

- Do NOT eat or put into mouth.
- Do NOT dispose in fire or break up this product.
- Do NOT chemically make gas or powder with this product.
- To waste this product, please obey the relating law of your country.

[CAUTION]

The specifications on this databook are only given for information, without any guarantee as regards either mistakes or omissions. The application circuits in this databook are described only to show representative usages of the product and not intended for the guarantee or permission of any right including the industrial rights.

This product may be damaged with electric static discharge (ESD) or spike voltage. Please handle with care to avoid these damages.