

**DATA SHEET**

# **AA104-73, AA104-73LF: GaAs IC 1-Bit Digital Attenuator, 32 dB 300 kHz–2.5 GHz**

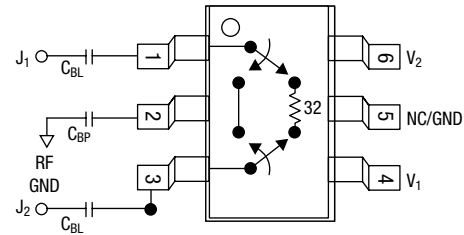
**Features**

- 1-bit attenuation of 32 dB 300 kHz–1 GHz, 27 dB 1–2 GHz, 24 dB 2–2.5 GHz
- Combine with AA260-85 or AA101-80 for 63 dB 6-bit solution
- Tune with one capacitor and/or resistor to desired operating frequency and attenuation
- Ideal for both IF and RF applications including cable, GSM, PCS, EDGE, 3G and ISM
- Available lead (Pb)-free and RoHS-compliant MSL-1 @ 260 °C per JEDEC J-STD-020

**Description**

The AA104-73 is a 1-bit, GaAs IC FET digital attenuator in a low-cost SOT-6 package. This attenuator has up to 32 dB total attenuation. The attenuator requires two lines of voltage control. The AA104-73 is particularly suited where high attenuation accuracy, low insertion loss, and low intermodulation products are required. Typical application is as a sixth bit value for the AA260-85 and AA101-80. A total attenuation of 63 dB in 1 dB steps can be obtained by combining the two attenuators.

**NEW** Skyworks offers lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant packaging.


**Pin Out**
**Positive Voltage**


$C_{BL} = 47$  pF for frequencies >500 MHz. See table on previous page for  $C_{BP}$  value. See application notes APN2013 and APN2014 for 6 bit attenuator requirements.

**Electrical Specifications at -40 °C to +85 °C (0, 3 V), (0, 5 V)**

| Parameter <sup>(1)</sup>                   | Frequency <sup>(2)</sup> | Min.                                            | Typ.  | Max.  | Unit |
|--------------------------------------------|--------------------------|-------------------------------------------------|-------|-------|------|
| Insertion loss                             | 300 kHz–1.0 GHz          |                                                 | 0.8   | 1.0   | dB   |
|                                            | 1.0–2.0 GHz              |                                                 | 0.9   | 1.2   | dB   |
|                                            | 2.0–2.5 GHz              |                                                 | 1.0   | 1.3   | dB   |
| Attenuation range                          | 300 kHz–1.0 GHz          |                                                 | 32    |       | dB   |
|                                            | 1.0–2.0 GHz              |                                                 | 27    |       | dB   |
|                                            | 2.0–2.5 GHz              |                                                 | 24    |       | dB   |
|                                            | 2.3–2.5 GHz              |                                                 | 23    |       | dB   |
| Attenuation accuracy <sup>(3, 4)</sup>     | 300 kHz–0.5 GHz          | $\pm (0.4 + 10\%$ of attenuation setting in dB) |       |       | dB   |
|                                            | 0.85–0.95 GHz            | $\pm (0.4 + 5\%$ of attenuation setting in dB)  |       |       | dB   |
|                                            | 1.7–2.0 GHz              | $\pm (0.5 + 6\%$ of attenuation setting in dB)  |       |       | dB   |
|                                            | 2.0–2.5 GHz              | $\pm (0.6 + 7\%$ of attenuation setting in dB)  |       |       | dB   |
|                                            | 2.3–2.5 GHz              | $\pm (0.7 + 7\%$ of attenuation setting in dB)  |       |       | dB   |
| VSWR (insertion loss state) <sup>(5)</sup> | 300 kHz–2.5 GHz          |                                                 | 1.2:1 | 1.5:1 |      |
| VSWR (attenuation state) <sup>(5)</sup>    | 300 kHz–2.5 GHz          |                                                 | 1.5:1 | 2.0:1 |      |

1. All measurements made in a 50  $\Omega$  system, unless otherwise specified.

2. Operates to 300 kHz when controlled with negative voltage,  $C_{BP}$  not required.

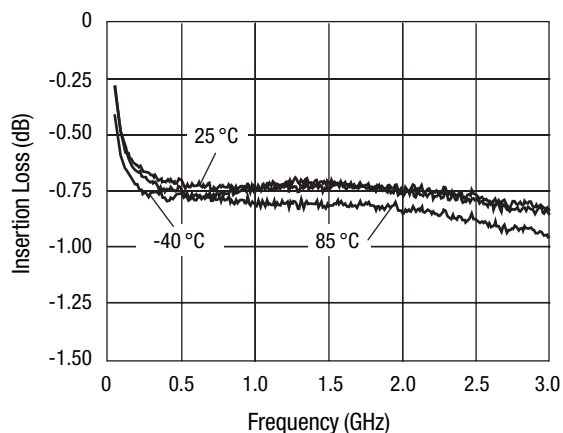
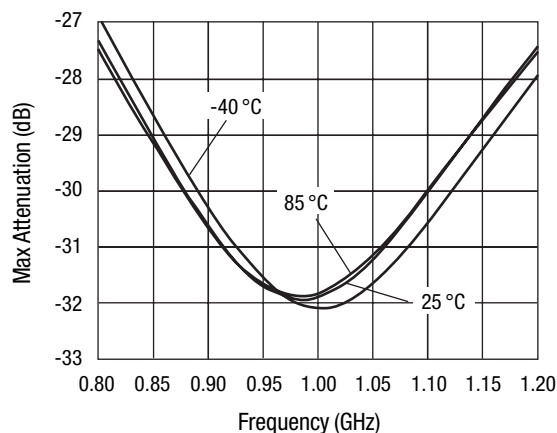
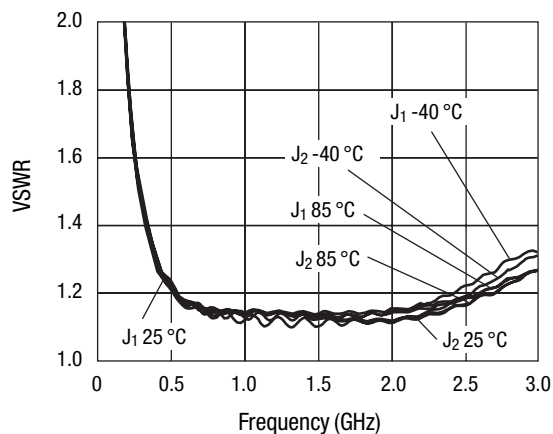
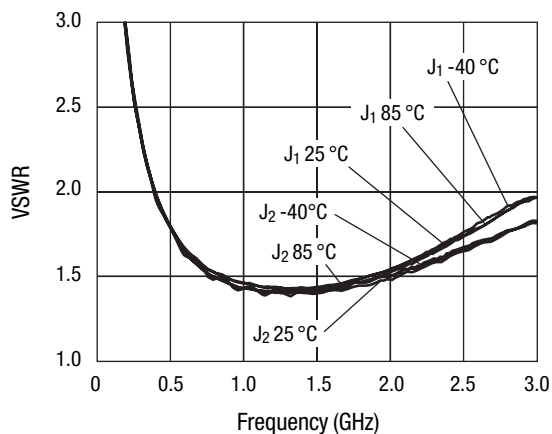
3. Attenuation value set by  $C_{BP}$ .

4. Attenuation referenced to insertion loss.

5. Input/output. In band.

**Electrical Specifications at -40 °C to +85 °C (0, 3 V), (0, 5 V)**

| Parameter                             | Condition                                                                                                 | Frequency   | Min. | Typ. | Max. | Unit |
|---------------------------------------|-----------------------------------------------------------------------------------------------------------|-------------|------|------|------|------|
| Switching characteristics             |                                                                                                           |             |      |      |      |      |
| Rise, fall                            | 10/90% or 90/10% RF                                                                                       |             |      | 50   |      | ns   |
| On, off                               | 50% CTL to 90/10% RF                                                                                      |             |      | 100  |      | ns   |
| Video feedthru                        | $T_{RISE} = 1$ ns, BW = 500 MHz                                                                           |             |      | 25   |      | mV   |
| Input Power for 1 dB compression      | $V_S = 3$ V                                                                                               | 0.5–2.5 GHz | 14   | 21   |      | dBm  |
|                                       | $V_S = 5$ V                                                                                               | 0.5–2.5 GHz | 18   | 23   |      | dBm  |
| Intermodulation intercept point (IP3) | For two-tone input power +10 dBm                                                                          |             |      |      |      |      |
|                                       | $V_S = 3$ V                                                                                               | 0.5–2.5 GHz | 36   | 41   |      | dBm  |
|                                       | $V_S = 5$ V                                                                                               | 0.5–2.5 GHz | 38   | 44   |      | dBm  |
| Control voltages                      | $V_{LOW} = 0$ to 0.2 V @ 20 $\mu$ A max.<br>$V_{HIGH} = 3$ V @ 100 $\mu$ A max. to 5 V @ 200 $\mu$ A max. |             |      |      |      |      |

**Typical Performance Data at -40 °C to +85 °C (0, 5 V)  $C_{BP} = 12$  pF,  $C_{BL} = 47$  pF****Insertion Loss vs. Frequency****32 dB State vs. Frequency****VSWR vs. Frequency  
Insertion Loss State****VSWR vs. Frequency  
32 dB State**

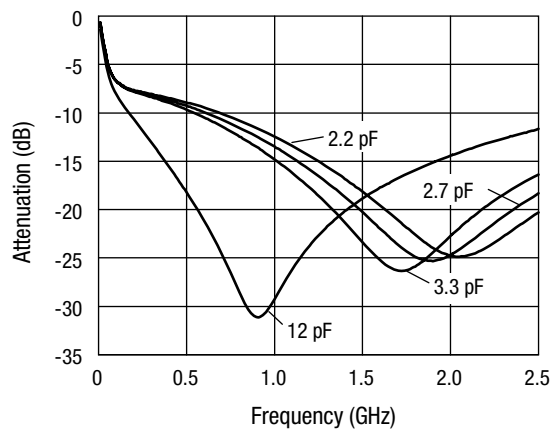
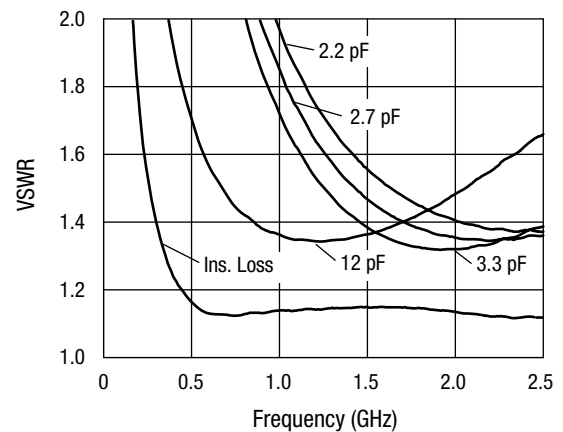
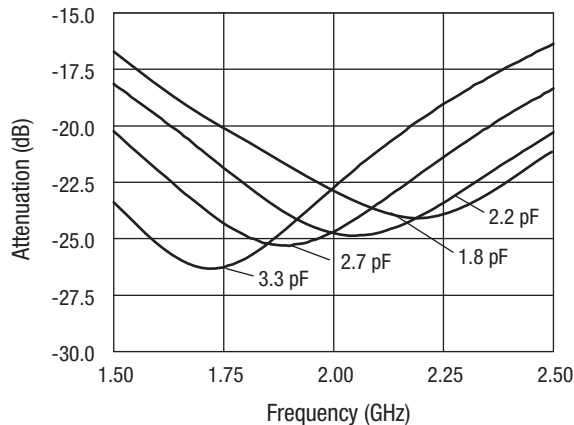
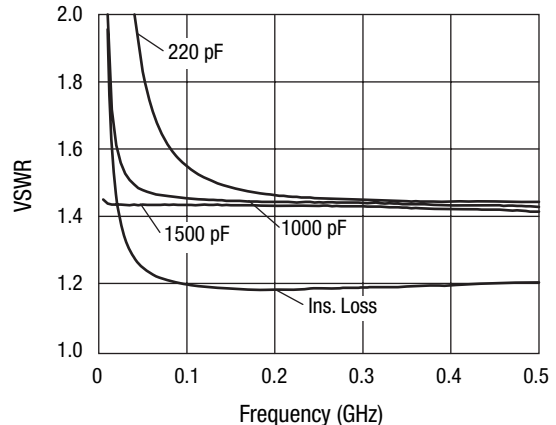
**Compression Point vs. Voltage and Temperature**

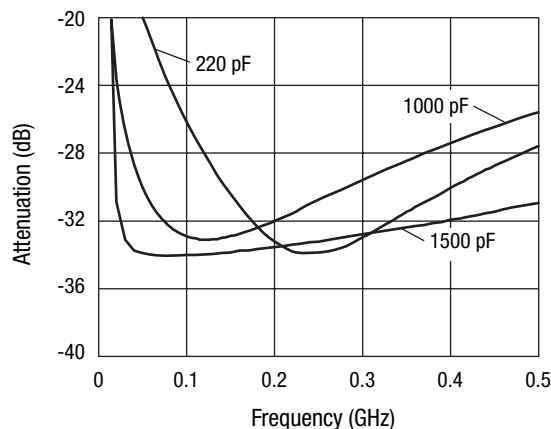
| Control voltage (V) | Temperature (°C) | 1 dB Compression insertion loss state (dBm) | 1 dB Compression 32 dB state (dBm) |
|---------------------|------------------|---------------------------------------------|------------------------------------|
| 3                   | -40              | 21                                          | 16.5                               |
| 3                   | 25               | 21                                          | 15                                 |
| 3                   | 85               | 21                                          | 14                                 |
| 5                   | -40              | 22                                          | 22.5                               |
| 5                   | 25               | 22                                          | 22.5                               |
| 5                   | 85               | 22                                          | 22.5                               |

Frequency: 500 MHz.

**IP3 vs. Voltage and Temperature**

| Control Voltage (V) | Temperature (°C) | IP3 @ 10 dBm each tone (dBm) |
|---------------------|------------------|------------------------------|
| 3                   | -40              | 41                           |
| 3                   | 25               | 42                           |
| 3                   | 85               | 40                           |
| 5                   | -40              | 43                           |
| 5                   | 25               | 44                           |
| 5                   | 85               | 42                           |

Two-tone input power: 10 dBm each tone.  
Tone frequencies: 500 and 501 MHz.**Attenuation vs. Frequency DC–2.5 GHz**  
**C<sub>BP</sub> = 2.2, 2.7, 3.3 and 12 pF****VSWR vs. Frequency DC–2.5 GHz**  
**C<sub>BP</sub> = 2.2, 2.7, 3.3 and 12 pF****Attenuation vs. Frequency 1.5–2.5 GHz**  
**C<sub>BP</sub> = 2.2, 2.7, and 3.3 pF****VSWR vs. Frequency DC–0.5 GHz**  
**C<sub>BP</sub> = 220, 1000, 1500 pF**



**Attenuation vs. Frequency DC–0.5 GHz**  
 **$C_{BP} = 220, 1000, 1500$  pF**

## Truth Table

### Positive Control

| $V_1$      | $V_2$      | Attenuation<br>$J_1-J_2$ |
|------------|------------|--------------------------|
| $V_{HIGH}$ | 0          | Reference I.L.           |
| 0          | $V_{HIGH}$ | 32 dB                    |

All other conditions not recommended.

$V_{HIGH} = 3$  to  $5$  V.

## Recommended Solder Reflow Profiles

Refer to the [“Recommended Solder Reflow Profile”](#)  
 Application Note.

## Tape and Reel Information

Refer to the [“Discrete Devices and IC Switch/Attenuators  
 Tape and Reel Package Orientation”](#) Application Note.

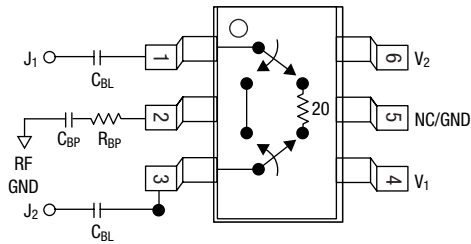
| $C_{BL}$ (pF) | $C_{BP}$ (pF) | Operating Frequency (GHz) |
|---------------|---------------|---------------------------|
| 47            | 1.8           | 2.3–2.5                   |
| 47            | 2.2           | 2–2.3                     |
| 47            | 2.7           | 1.8–2                     |
| 47            | 3.3           | 1.6–1.8                   |
| 47            | 12            | 0.9–1.05                  |
| 47            | 15            | 0.8–0.9                   |
| 330           | 220           | 0.2–0.35                  |
| 1500          | 1000          | 0.07–0.2                  |
| 10000         | 1500          | 0.015–0.25                |

## Absolute Maximum Ratings

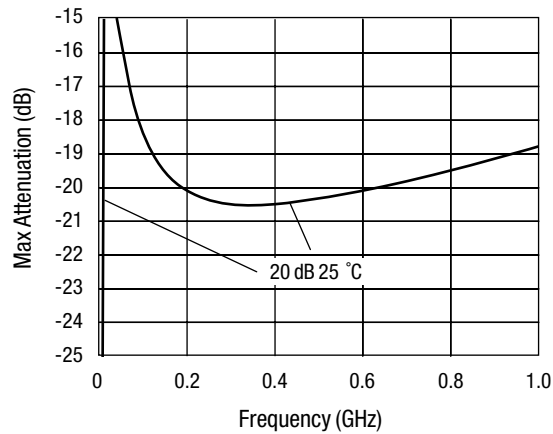
| Characteristic        | Value                                       |
|-----------------------|---------------------------------------------|
| RF input power        | 1 W > 500 MHz 0/8 V<br>0.5 W @ 50 MHz 0/8 V |
| Supply voltage        | 8 V                                         |
| Control voltage       | -0.2 V, +8 V                                |
| Operating temperature | -40 °C to +85 °C                            |
| Storage temperature   | -65 °C to +150 °C                           |

Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

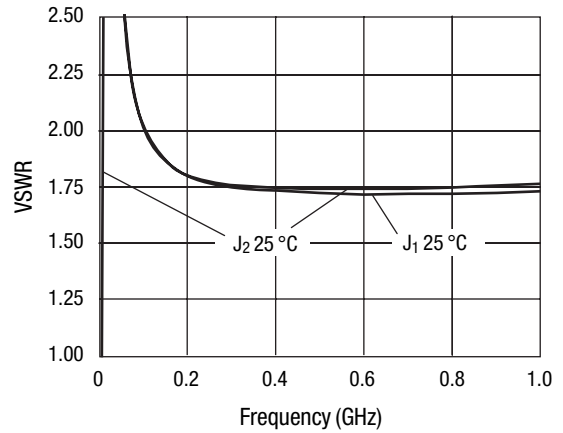
**CAUTION:** Although this device is designed to be as robust as possible, ESD (Electrostatic Discharge) can damage this device. This device must be protected at all times from ESD. Static charges may easily produce potentials of several kilovolts on the human body or equipment, which can discharge without detection. Industry-standard ESD precautions must be employed at all times.

**Application: AA104-73 Used as 1-Bit 20 dB Attenuator 25 °C (0, 5 V)**

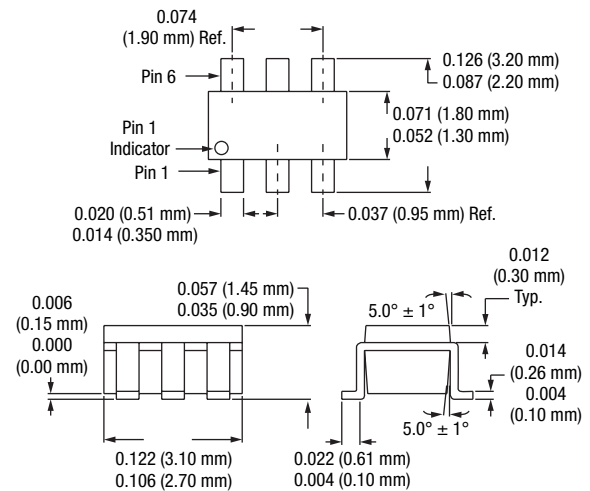
$C_{BL} = 220 \text{ pF}$ ,  $C_{BP} = 100 \text{ pF}$ ,  $R_{BP} = 15 \Omega$ ,  $f_c = 400 \text{ MHz}$  with select values of  $C_{BP}$  and  $R_{BP}$ , center frequency and attenuation value respectively can be varied.



**20 dB State vs. Frequency**  
 $C_{BP} = 100 \text{ pF}$ ,  $C_{BL} = 220 \text{ pF}$ ,  $R_{BP} = 15 \Omega$



**VSWR vs. Frequency**  
**20 dB State**

**SOT-6**

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