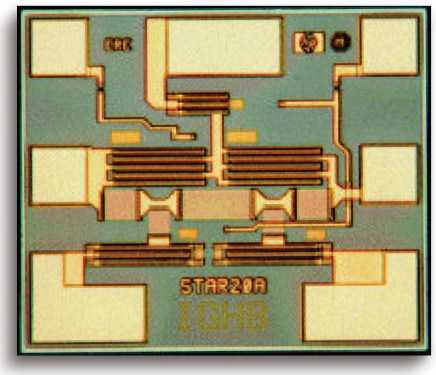
# Keysight 1GG7-4082
# DC-6 GHz 0/20 dB Single Step Attenuator

## Data Sheet




### Features

- Frequency range:
  DC to 6.0 GHz
- Attenuation values:
  Single Bit
  20 dB
- Min. insertion loss:
  < 0.8 @ 3 GHz
  < 1.4 @ 6 GHz
- Step accuracy:
  ±0.7 @ 3 GHz
  ±0.9 @ 6 GHz
- Return loss:
  20 dB through 3 GHz
  15 dB through 6 GHz
- Switching speed:
  < 1 µs (10% to 90% $T_R$)
- $P_{-1\ dB}$:
  25 dBm @ 10 MHz
  30 dBm @ 3 GHz
- Distortion
  SHI: + 95 dBm
  THI: + 65 dBm
  TOI: + 56 dBm

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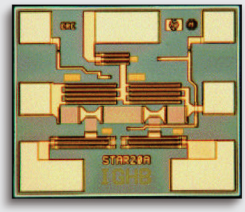
# Description

The 1GG7-4082 is a single bit, 0/20 dB single step attenuator designed for low insertion loss and low distortion from DC to 6 GHz. It is intended for use as a general–purpose solid–state step–attenuator for RF instrumentation or commercial communication systems.

This device incorporates two 10 dB "T" attenuators combined with integral series and shunt MESFET switching elements. The 1GG7-4082 also incorporates a unique diode/resistor bias topology to improve low frequency RF performance and is fabricated with Keysight Technologies, Inc. GaAs FET MMIC process which is specifically designed to eliminate GaAs anomalies common in control circuit components.



- Chip size: 900 x 760 (35.4 x 29.9 mils)
- Chip size tolerance: ±10 µm (±0.4 mils)
- Chip thickness: 127 ±15 µm (5.0 ±0.6 mils)
- Small pad dimensions: 114 x 114 µm (4.5 x 4.5 mils)
- Large pad dimensions: 114 x 228 µm (4.5 x 9.0 mils)

## Absolute maximum ratings[1]

| Symbol | Parameters/conditions | Min. | Max. | Units |
|---|---|---|---|---|
| $V_{C1,2}$ | Control line voltages | –12 | +12 | Volts |
| $V_{RF(in/out)}$ | DC input/output voltage | | | |
| $P_{in(CW)}$ | CW RF input power | | 30 | dBm |
| $T_{op}$ | Operating temperature | –55 | +125 | °C |
| $T_{st}$ | Storage temperature | –65 | +165 | °C |
| $T_{max}$ | Max. assembly temperature | | 300 | °C |

1. Operation in excess of any one of these may result in permanent damage to this device $T_A$ = 25 °C except for $T_{op}$, $T_{st}$, and $T_{max}$.

## DC specifications/physical properties

($T_A$ = 25 °C)

| Symbol | Parameters/conditions | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|
| $V_{C1,2,3,4(+)}$ | Positive control line voltage | 7 | 10 | 10.5 | Volts |
| $V_{C1,2,3,4(-)}$ | Negative control line voltage | –10.5 | –10 | –7 | Volts |
| $I_{L(+)}$ | Positive control line leakage current ($V_{C1,2,3,4}$ = +10 volts) | | | 50 | µA |
| $I_{L(-)}$ | Negative control line leakage current ($V_{C1,2,3,4}$ = –10 volts) | | | 50 | µA |

## Typical attenuation temperature coefficients

| Symbol | Parameters/conditions | | | | | | Units |
|---|---|---|---|---|---|---|---|
| $\alpha_T$ | Frequency | 50 MHz | 1 GHz | 2 GHz | 3 GHz | 4 GHz | dBc/ °C |
| | @ Min. insertion loss state | .0008 | .0008 | .0008 | .0007 | .0006 | |
| | @ –20 dB state | –.0018 | –.0018 | –.0016 | –.0014 | –.0010 | |

## RF specifications

($T_A$ = 25 °C, $Z_0$ = 50 Ω, $V_{C1,2}$ = ±10 volts)

| Symbol | Parameters/conditions | Typ.[1] | Min. | Typ. | Max. | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|---|---|---|
| BW | Guaranteed operating bandwidth | 0.01 | | DC to 30 | | | DC to 6.0 | | GHz |
| $IL_{(min)}$ | Minimum insertion loss ($V_{C1}$ = +10 v, $V_{C2}$ = –10 V) | 0.5 | | 0.7 | 0.8 | | 1.3 | 1.4 | dB |
| $\Delta_{acc.}$ | Attenuation step (@ –20 dB state) | | 19.3 | 20 | 20.3 | 19.1 | 19.8 | 20.4 | dB |
| RL | Return loss | | | | 20 | | | 15 | dB |
| $T_R$ | Rise time switching speed (10% to 90% of RF swing, $f_0$ = 3 GHz) | | | 1 | | | 1 | | µs |
| SHI | Second harmonic intercept point (Referred to $P_{in}$) | | | 95 | | | 65 | 95 | dBm |
| THI | Third harmonic intercept point (Referred to $P_{in}$) | | | 65 | | | 65 | | dBm |
| TOI | Two–tone third order lintercept point (For two–tone power levels <+20 dBm) (Referred to $P_{in}$) | | | 56 | | | | 56 | dBm |
| $P_{-1dB}$ | Input power @ 1 dB increase in insertion loss | 25 | | 30 | | | 30 | | dBm |
| $P_{in}$ (max) | Maximum continuous RF input power | | | | 27 | | | 27 | dBm |

1. Typical performance <10 MHz

# Applications

The 1GG7-4082 is designed for use in instrumentation, communications, radar, ECM, EW, and many other systems requiring fast switching speed, low distortion to input signals, and high cycle lifetimes. It can be used for pulse modulation, port isolation, replacement of mechanical relays, and in any application requiring the advantages of solid–state performance.

This device does not include any on–chip driver circuitry. An external driver circuit is required to convert TTL or ECL logic signals to the ±10 volt switching levels required by this device.

Figure 3 shows the device assembly diagram for operation through 6 GHz. Dual RF input and output bonds are recommended for assemblies where the device to thin film circuit gap exceeds 10 mils.

## Logic table

($V_{C1-2}$ typical values in volts)

| Attenuation setting | $V_{C1}$ | $V_{C2}$ |
|---|---|---|
| Min. insertion loss | +10 | –10 |
| –20 dB state | –10 | +10 |

# Assembly Techniques

This device is compatible with Au–Sn eutectic or conductive epoxy processes. Gold thermosonic ball or wedge bonding is recommended for all bonds. The bond pads are designed to be large enough to facilitate autobonding. The top and bottom metallization is gold.

GaAs MMICs are ESD sensitive. ESD preventive measures must be employed in all aspects of storage, handling, and assembly.

MMIC ESD precautions, handling considerations, die attach and bonding methods are critical factors in successful GaAs MMIC performance and reliability.

# RoHS Compliance

This device is RoHS Compliant. This means the component meets the requirements of the European Parliament and the Council of the European Union Restriction of Hazardous Substances Directive 2011/65/EU, commonly known as RoHS.

The six regulated substances are lead, mercury, cadmium, chromium VI (hexavalent), polybrominated biphenyls (PBB) and polybrominated biphenyl ethers (PBDE). RoHS compliance implies that any residual concentration of these substances is below the RoHS Directive's maximum concentration values (MVC); being less than 1000 ppm by weight for all substances except for cadmium which is less than 100 ppm by weight.

# Additional References

Keysight document, *GaAs MMIC ESD, Die Attach and Bonding Guidelines - Application Note* (5991-3484EN) provides basic information on these subjects.

## Simplified schematic

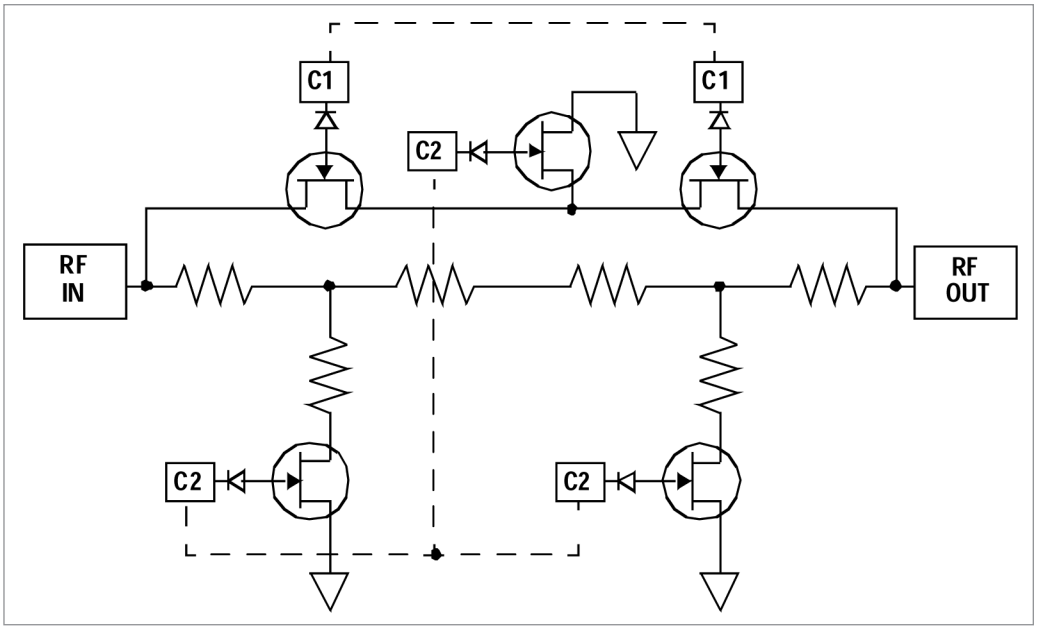



Figure 1. 1GG7-4082 simplified schematic

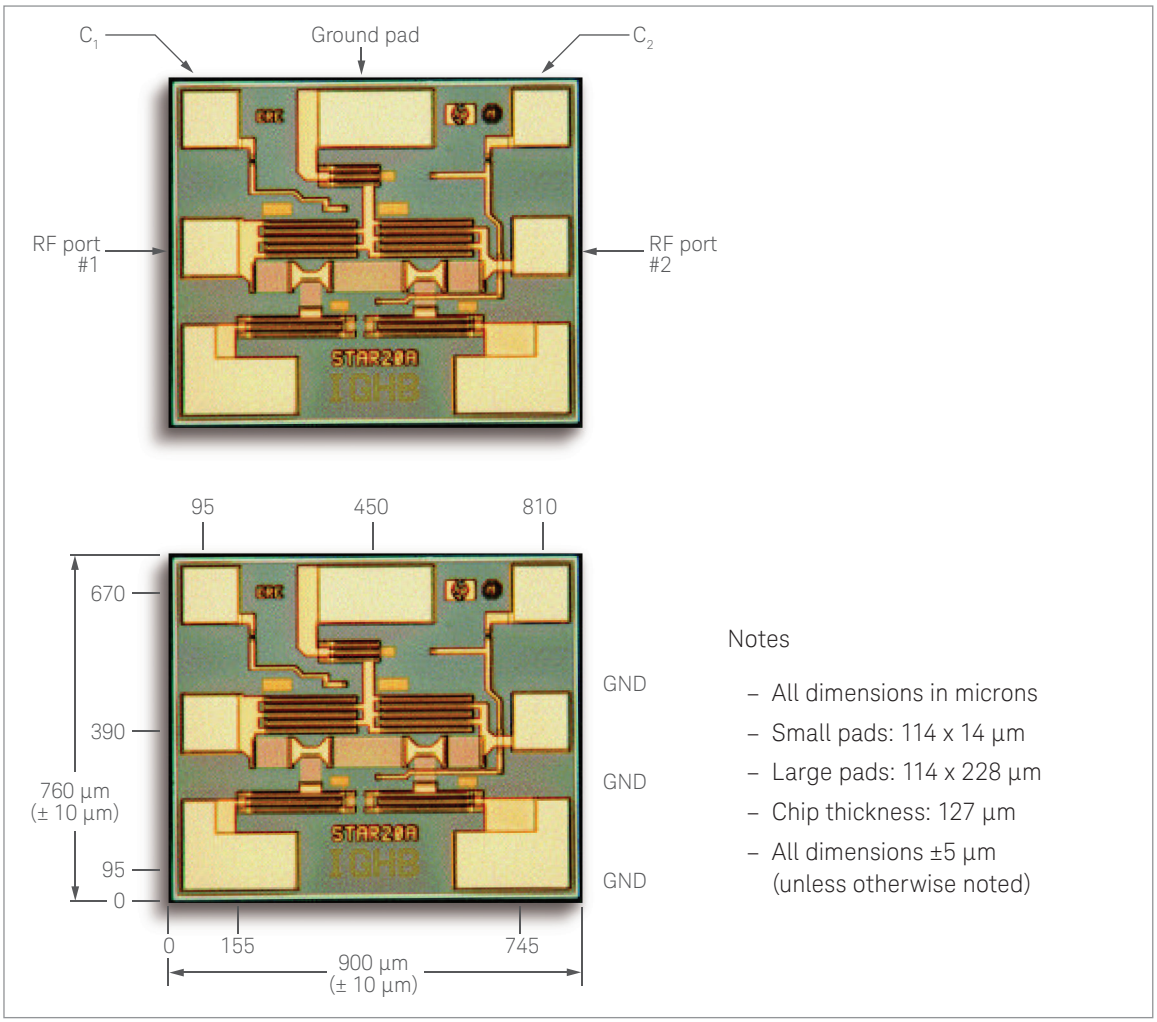



Figure 2. 1GG7-4082 bond pad locations

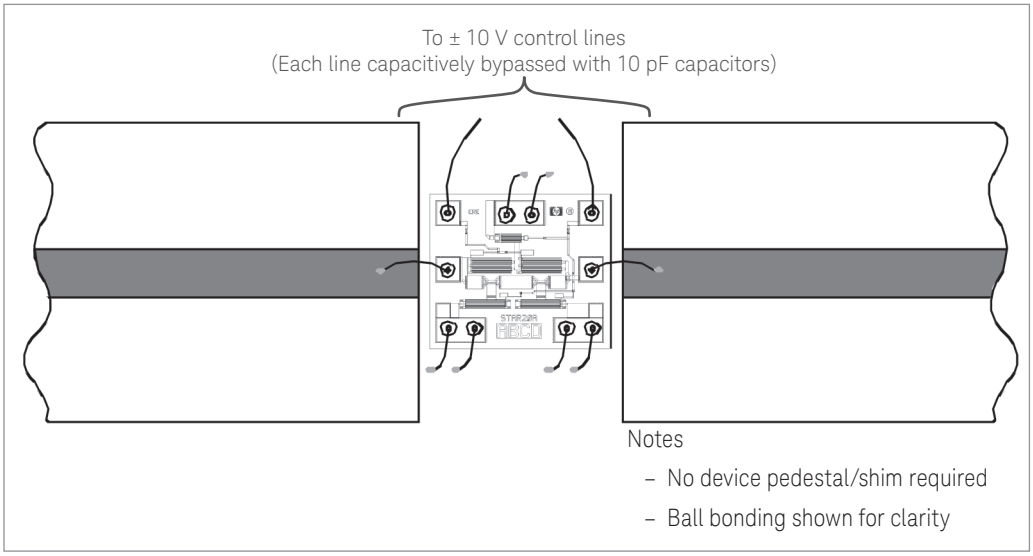



Figure 3. 1GG7-4082 assembly diagram

# Supplemental Data

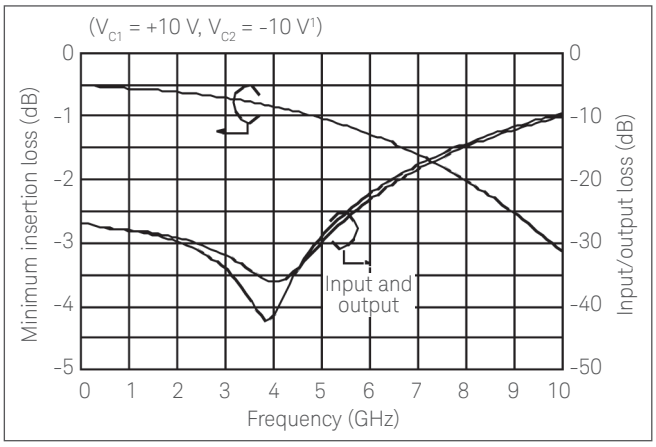



Figure 4. Minimum insertion loss and return loss vs. frequency

1. Data obtained from small–signal linear modeling

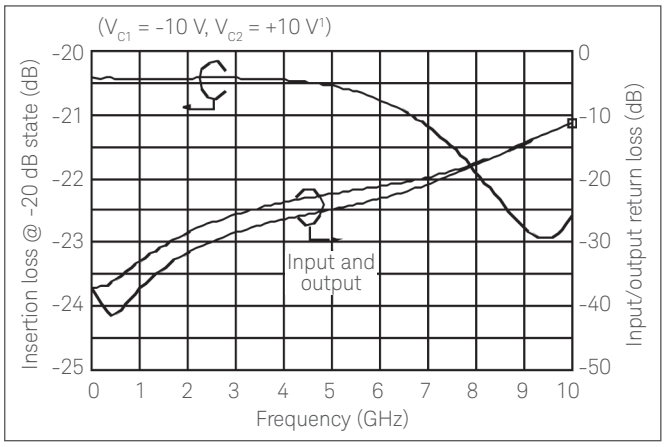



Figure 5. Insertion loss @ –20 dB state and return loss vs. frequency

1. Data obtained from small–signal linear modeling

## Typical S-parameters: minimum insertion loss state[1]

($T_A$ = +25 °C, $V_{C1}$ = +10 V, $V_{C2}$ = –10 V, $Z_{in}$ = $Z_{out}$ = 50 Ω)

| Frequency (GHz) | $S_{11}$ | | | $S_{12}$ | | | $S_{21}$ | | | $S_{22}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | dB | Mag | Ang | dB | Mag | Ang | dB | Mag | Ang | dB | Mag | Ang |
| 0.001 | –25.9 | 0.051 | –0.05 | –0.45 | 0.949 | –0.01 | –0.45 | 0.949 | –0.01 | –25.9 | 0.051 | –0.05 |
| 0.01 | –25.9 | 0.051 | –0.61 | –0.45 | 0.949 | –0.13 | –0.45 | 0.949 | –0.13 | –25.9 | 0.051 | –0.61 |
| 0.1 | –26.3 | 0.049 | –5.1 | –0.48 | 0.947 | –1.2 | –0.48 | 0.947 | –1.2 | –26.3 | 0.049 | –5.1 |
| 0.5 | –27.5 | 0.042 | –5.4 | –0.54 | 0.940 | –5.1 | –0.54 | 0.940 | –5.1 | –27.6 | 0.042 | –5.2 |
| 1.0 | –27.9 | 0.040 | –5.2 | –0.56 | 0.938 | –10.0 | –0.56 | 0.938 | –10.0 | –28.1 | 0.040 | –4.8 |
| 1.5 | –28.4 | 0.038 | –6.9 | –0.58 | 0.935 | –14.9 | –0.58 | 0.935 | –14.9 | –28.7 | 0.037 | –6.1 |
| 2.0 | –29.1 | 0.035 | –10.2 | –0.61 | 0.932 | –19.8 | –0.61 | 0.932 | –19.8 | –29.7 | 0.033 | –8.6 |
| 2.5 | –30.2 | 0.031 | –15.7 | –0.65 | 0.927 | –24.8 | –0.65 | 0.927 | –24.8 | –31.4 | 0.027 | –12.8 |
| 3.0 | –31.8 | 0.026 | –25.0 | –0.71 | 0.922 | –29.8 | –0.71 | 0.922 | –29.8 | –34.0 | 0.020 | –20.7 |
| 3.5 | –34.1 | 0.020 | –42.5 | –0.77 | 0.916 | –34.8 | –0.77 | 0.916 | –34.8 | –38.7 | 0.012 | –41.5 |
| 4.0 | –36.1 | 0.016 | –78.1 | –0.84 | 0.908 | –39.8 | –0.84 | 0.908 | –39.8 | –41.6 | 0.008 | –115.2 |
| 4.5 | –34.1 | 0.020 | –122.9 | –0.92 | 0.899 | –44.9 | –0.92 | 0.899 | –44.9 | –34.3 | 0.019 | –161.7 |
| 5.0 | –29.9 | 0.032 | –149.5 | –1.0 | 0.889 | –50.0 | –1.0 | 0.889 | –50.0 | –29.0 | 0.035 | –175.8 |
| 5.5 | –26.2 | 0.049 | –163.9 | –1.1 | 0.877 | –55.1 | –1.1 | 0.877 | –55.1 | –25.2 | 0.055 | 176.5 |
| 6.0 | –23.2 | 0.069 | –173.5 | –1.3 | 0.864 | –60.2 | –1.3 | 0.864 | –60.2 | –22.3 | 0.077 | 170.6 |
| 7.0 | –18.5 | 0.119 | 172.7 | –1.6 | 0.832 | –70.5 | –1.6 | 0.832 | –70.5 | –17.7 | 0.130 | 160.7 |
| 8.0 | –15.0 | 0.179 | 161.3 | –2.0 | 0.794 | –80.8 | –2.0 | 0.794 | –80.8 | –14.4 | 0.191 | 151.3 |
| 9.0 | –12.2 | 0.245 | 150.8 | –2.5 | 0.749 | –91.0 | –2.5 | 0.749 | –91.0 | –11.7 | 0.259 | 142.2 |
| 10.0 | –10.0 | 0.315 | 140.9 | –3.1 | 0.698 | –100.9 | –3.1 | 0.698 | –100.9 | –9.6 | 0.330 | 133.2 |

## Typical S–parameters: @ –20 dB state[1]

($T_A$ = +25 °C, $V_{C1}$ = –10 V, $V_{C2}$ = +10 V, $Z_{in}$ = $Z_{out}$ = 50 Ω)

| Frequency (GHz) | $S_{11}$ | | | $S_{12}$ | | | $S_{21}$ | | | $S_{22}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | dB | Mag | Ang | dB | Mag | Ang | dB | Mag | Ang | dB | Mag | Ang |
| 0.001 | –37.2 | 0.014 | –0.05 | –20.4 | 0.096 | –0.008 | –20.4 | 0.096 | –0.008 | –37.0 | 0.014 | 0.10 |
| 0.01 | –37.2 | 0.014 | –0.75 | –20.4 | 0.096 | –0.08 | –20.4 | 0.096 | –0.08 | –37.0 | 0.014 | 0.71 |
| 0.1 | –37.9 | 0.013 | –6.3 | –20.4 | 0.096 | –0.76 | –20.4 | 0.096 | –0.76 | –37.0 | 0.014 | 6.4 |
| 0.5 | –41.2 | 0.008 | 28.2 | –20.4 | 0.095 | –3.1 | –20.4 | 0.095 | –3.1 | –35.8 | 0.016 | 32.6 |
| 1.0 | –37.2 | 0.014 | 60.8 | –20.4 | 0.095 | –6.1 | –20.4 | 0.095 | –6.1 | –33.0 | 0.022 | 51.9 |
| 1.5 | –33.9 | 0.020 | 71.8 | –20.4 | 0.095 | –9.1 | –20.4 | 0.095 | –9.1 | –30.5 | 0.030 | 61.8 |
| 2.0 | –31.6 | 0.026 | 77.3 | –20.4 | 0.095 | –12.3 | –20.4 | 0.095 | –12.3 | –28.5 | 0.037 | 67.5 |
| 2.5 | –29.9 | 0.032 | 81.1 | –20.4 | 0.095 | –15.6 | –20.4 | 0.095 | –15.6 | –26.9 | 0.045 | 71.3 |
| 3.0 | –28.5 | 0.038 | 84.2 | –20.4 | 0.095 | –19.2 | –20.4 | 0.095 | –19.2 | –25.7 | 0.052 | 74.1 |
| 3.5 | –27.3 | 0.043 | 87.3 | –20.4 | 0.095 | –22.9 | –20.4 | 0.095 | –22.9 | –24.6 | 0.059 | 76.5 |
| 4.0 | –26.4 | 0.048 | 90.6 | –20.5 | 0.095 | –27.0 | –20.5 | 0.095 | –27.0 | –23.7 | 0.065 | 78.8 |
| 4.5 | –25.6 | 0.053 | 94.4 | –20.5 | 0.095 | –31.5 | –20.5 | 0.095 | –31.5 | –23.0 | 0.071 | 81.3 |
| 5.0 | –24.8 | 0.057 | 98.8 | –20.5 | 0.094 | –36.4 | –20.5 | 0.094 | –36.4 | –22.4 | 0.076 | 84.2 |
| 5.5 | –24.0 | 0.063 | 103.9 | –20.6 | 0.093 | –41.9 | –20.6 | 0.093 | –41.9 | –21.8 | 0.081 | 87.8 |
| 6.0 | –23.2 | 0.069 | 109.7 | –20.8 | 0.092 | –48.1 | –20.8 | 0.092 | –48.1 | –21.2 | 0.087 | 92.0 |
| 7.0 | –20.9 | 0.090 | 121.8 | –21.2 | 0.087 | –63.7 | –21.2 | 0.087 | –63.7 | –19.8 | 0.102 | 102.8 |
| 8.0 | –17.9 | 0.127 | 130.9 | –21.9 | 0.080 | –85.8 | –21.9 | 0.080 | –85.8 | –17.6 | 0.131 | 114.2 |
| 9.0 | –14.5 | 0.188 | 133.7 | –22.8 | 0.073 | –119.5 | –22.8 | 0.073 | –119.5 | –14.6 | 0.186 | 121.0 |
| 10.0 | –11.3 | 0.271 | 129.6 | –22.6 | 0.074 | –168.5 | –22.6 | 0.074 | –168.5 | –11.4 | 0.268 | 120.3 |

1. Data obtained from small–signal linear modeling

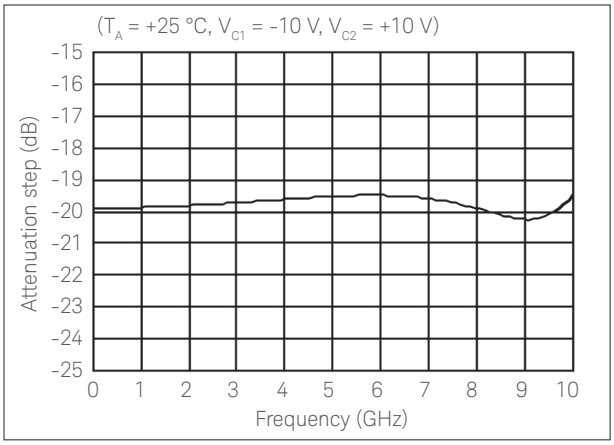



Figure 6. Attenuation step values vs. frequency

## Typical attenuation step values[1]

($T_A$ = +25 °C, $V_{C1}$ = –10 v, $V_{C2}$ = +10 v, $Z_{in}$ = $Z_{out}$ = 50 Ω)

| Frequency (GHz) | –20 dB state (dB) |
|---|---|
| 0.001 | –19.9 |
| 0.01 | –19.9 |
| 0.1 | –19.9 |
| 0.5 | –19.9 |
| 1.0 | –19.9 |
| 1.5 | –19.8 |
| 2.0 | –19.8 |
| 2.5 | –19.8 |
| 3.0 | –19.7 |
| 3.5 | –19.7 |
| 4.0 | –19.6 |
| 4.5 | –19.6 |
| 5.0 | –19.5 |
| 5.5 | –19.5 |
| 6.0 | –19.5 |
| 6.5 | –19.5 |
| 7.0 | –19.6 |
| 7.5 | –19.7 |
| 8.0 | –19.9 |
| 8.5 | –20.1 |
| 9.0 | –20.2 |
| 9.5 | –20.1 |
| 10.0 | –19.4 |

1. Data obtained from small–signal linear modeling

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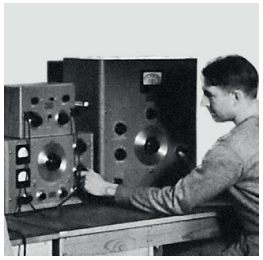

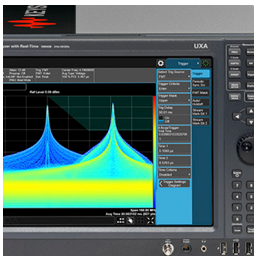

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