



## COAXIAL WIDEBAND

# Digital Step Attenuator **ZX76-44G-30-K+**

50Ω 0 to 31.5 dB, 0.5 dB Step 100 MHz to 43.5 GHz  
6 Bit, Parallel Control Interface, Dual or Single Supply Voltage

### THE BIG DEAL

- Wideband, Operates Up to 43.5 GHz
- Immune to Latch-Up
- High IIP3, +50 dBm
- Low Insertion Loss
- Good VSWR, 1.5:1 Typ.
- Glitch-Less Attenuation Transitions
- Dual +3.3, -3 V or Single Supply Voltage +3.3 V



Generic photo used for illustration purposes only

|            |                |
|------------|----------------|
| Model No.  | ZX76-44G-30-K+ |
| Case Style | MS3009         |
| Connectors | 2.92 mm female |

### +RoHS Compliant

The +Suffix identifies RoHS Compliance.  
See our website for methodologies and qualifications

### APPLICATIONS

- Test Setup
- 5G
- Satellite Communications
- X Band, S Band, C Band, KU Band, and K Band Radars
- EW Test Sets

### PRODUCT OVERVIEW

The ZX76-44G-30-K+ is a 50Ω Digital Step Attenuator that provides adjustable attenuation from 0 to 31.5 dB in 0.5 dB steps. The control is a 6-bit parallel interface, with a single positive supply voltage. The model is produced using a unique unibody case package for ruggedness and operation in tough environments.

### KEY FEATURES

| Feature                                                                 | Advantages                                                                                                                                                                                                                                                                                                                                                                           |
|-------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Wideband Operation, Specified from 100 MHz to 43.5 GHz                  | Can be used in multiple applications such as communications, satellite and defense, reducing part count. Able to work up to 43.5 GHz.                                                                                                                                                                                                                                                |
| Parallel Control Interface with Wide Control Voltage Range              | Uses a simple parallel control interface with no clock required.                                                                                                                                                                                                                                                                                                                     |
| Good VSWR, 1.5:1 Typ.                                                   | Eases interfacing with adjacent components and results in low amplitude ripple.                                                                                                                                                                                                                                                                                                      |
| Glitch-Less Attenuation Transitions                                     | The ZX76-44G-30-K+ employs novel architecture to reduce the RF output power spikes during attenuation transition to 0.3 dB (typ.) thus reducing noise in the system and eliminating the risk of a transient spike damaging sensitive components in the system.                                                                                                                       |
| Positive and Negative Power Supply, Single Positive Supply Is Available | The use of a single positive supply simplifies power supply design. An internal negative voltage generator supplies the desired negative voltage. Single positive supply results in excellent spurious performance. For applications that require the lowest possible spur performance negative voltage can be applied externally to bypass the internal negative voltage generator. |
| Power Supply +2.3 V to +5.5 V                                           | Model suitable for both +5 V and +3.3 V systems applications with no voltage dividers or multipliers needed.                                                                                                                                                                                                                                                                         |





## COAXIAL WIDEBAND

# Digital Step Attenuator **ZX76-44G-30-K+**

50Ω 0 to 31.5 dB, 0.5 dB Step 100 MHz to 43.5 GHz  
6 Bit, Parallel Control Interface, Dual or Single Supply Voltage

### RF ELECTRICAL SPECIFICATIONS, 100 MHz - 43.5 GHz, $T_{AMB} = +25^{\circ}\text{C}$ , $V_{DD} = +3.3\text{ V}$

| Parameter                                  | Frequency (GHz) | Min. | Typ. | Max. | Units |
|--------------------------------------------|-----------------|------|------|------|-------|
| Insertion Loss at 0 dB Attenuation Setting | 0.1-13          |      | 3.0  | 7.0  | dB    |
|                                            | 13- 26.5        |      | 5.5  | 8.5  |       |
|                                            | 26.5-43.5       |      | 7.5  | 11.5 |       |
| Input IP3 <sup>1</sup>                     | 2-16            |      | +50  |      | dBm   |
| Input Power at 1 dB Compression            | 0.1-43.5        | +22  |      |      | dBm   |
| VSWR                                       | 0.1-26.5        |      | 1.3  |      | :1    |
|                                            | 26.5-43.5       |      | 1.5  |      |       |

1. Tested with 1 MHz offset between signals.

### ATTENUATION ACCURACY AT +25 °C

| Attenuation Setting | Nominal Attenuation (Typ.) |          |          | Typical Attenuation Accuracy |          |          |
|---------------------|----------------------------|----------|----------|------------------------------|----------|----------|
|                     | 13 GHz                     | 26.5 GHz | 43.5 GHz | 13 GHz                       | 26.5 GHz | 43.5 GHz |
| 0.5 dB              | 0.45                       | 0.28     | 0.33     | ±0.04                        | ±0.22    | ±0.17    |
| 1 dB                | 0.85                       | 0.70     | 0.45     | ±0.13                        | ±0.30    | ±0.55    |
| 2 dB                | 2.2                        | 2.5      | 2.8      | ±0.16                        | ±0.49    | ±0.75    |
| 4 dB                | 4.2                        | 4.1      | 4.0      | ±0.16                        | ±0.11    | ±0.05    |
| 8 dB                | 8.2                        | 8.5      | 8.4      | ±0.17                        | ±0.46    | ±0.35    |
| 16 dB               | 16.4                       | 16.5     | 17.1     | ±0.41                        | ±0.49    | ±1.06    |
| 31.5 dB             | 32.0                       | 32.0     | 31.8     | ±0.54                        | ±0.54    | ±0.26    |

### DC ELECTRICAL SPECIFICATIONS

| Parameter                         | Min.  | Typ. | Max. | Units |
|-----------------------------------|-------|------|------|-------|
| Positive Supply Voltage, $V_{DD}$ | +2.3  | +3.3 | +5.5 | V     |
| Positive Supply Current, $I_{DD}$ |       | 170  | 250  | μA    |
| Negative Supply Voltage, $V_{SS}$ | -3.3  | -3.0 | -2.7 | V     |
| Negative Supply Current, $I_{SS}$ | -40   | -16  |      | μA    |
| Control Input Low                 | -0.3  |      | +0.6 | V     |
| Control Input High                | +1.17 |      | +3.5 | V     |
| Control Current                   |       | 10   | 20   | μA    |

### SWITCHING SPECIFICATIONS

| Parameter                                                   | Min. | Typ. | Max. | Units |
|-------------------------------------------------------------|------|------|------|-------|
| Switching Speed, 50% Control to 0.5 dB of Attenuation Value |      | 330  | 400  | nsec  |

### ABSOLUTE MAXIMUM RATINGS

| Parameter                        | Ratings                  |
|----------------------------------|--------------------------|
| Operating Temperature            | 0 °C to +50 °C           |
| Storage Temperature              | -20 °C to +85 °C         |
| $V_{DD}$                         | -0.3 V Min., +6 V Max.   |
| $V_{SS}$                         | -3.6 V Min., +0.3 V Max. |
| Voltage On Any Control Input     | -0.3 V Min., +3.6 V Max. |
| ESD, HBM                         | 1000 V                   |
| Maximum Input Power <sup>2</sup> | +28 dBm                  |

Permanent damage may occur if any of these limits are exceeded. Operating in the range between operating power limits and absolute maximum ratings for extended periods of time may result in reduced life and reliability.

2.  $T_{AMBIENT} = +25^{\circ}\text{C}$ , derate to +26 dBm at +50 °C





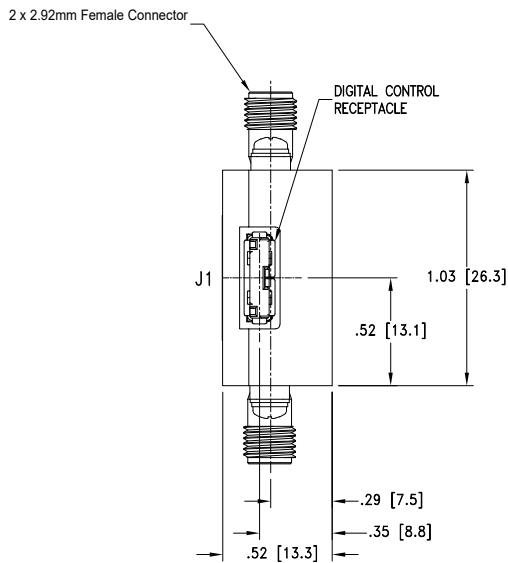
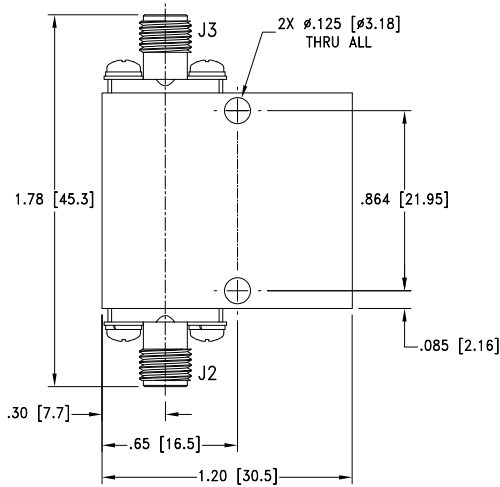
Mini-Circuits

COAXIAL WIDEBAND

# Digital Step Attenuator **ZX76-44G-30-K+**

50Ω 0 to 31.5 dB, 0.5 dB Step 100 MHz to 43.5 GHz  
6 Bit, Parallel Control Interface, Dual or Single Supply Voltage

## PIN CONFIGURATION (TOP VIEW)



## PIN DESCRIPTION

| Function        | Pin Number | Description                                         |
|-----------------|------------|-----------------------------------------------------|
| LE              | J1-1       | Latch Enable Input                                  |
| P/S             | J1-2       | Logic Low (0 V) <sup>3</sup>                        |
| C0.5            | J1-3       | Control for attenuation bit, 0.5 dB                 |
| C1              | J1-4       | Control for attenuation bit, 1.0 dB                 |
| C4              | J1-5       | Control for attenuation bit, 4.0 dB                 |
| C2              | J1-6       | Control for attenuation bit, 2 dB                   |
| C8              | J1-7       | Control for attenuation bit, 8 dB                   |
| C16             | J1-8       | Control for attenuation bit, 16 dB                  |
| V <sub>DD</sub> | J1-9       | Positive Supply Voltage                             |
| V <sub>SS</sub> | J1-10      | Negative Supply Voltage <sup>4</sup> (or ext. gnd.) |
| IN              | J2         | RF in port <sup>5</sup>                             |
| OUT             | J3         | RF out port <sup>5</sup>                            |

3. J1-2 Must be tied low before applying any control bit.

4. If Pin J1-10 is grounded the internal negative voltage will be generated.

5. Both RF ports are DC blocked with an internal series capacitors.

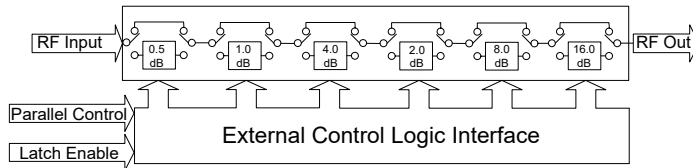


## COAXIAL WIDEBAND

# Digital Step Attenuator **ZX76-44G-30-K+**

50Ω 0 to 31.5 dB, 0.5 dB Step 100 MHz to 43.5 GHz  
6 Bit, Parallel Control Interface, Dual or Single Supply Voltage

### SIMPLIFIED SCHEMATIC



The ZX76-44G-30-K+ parallel interface consists of 6 control bits that select the desired attenuation state, as shown in Table 1: Truth Table.

**TABLE 1. TRUTH TABLE**

| Attenuation State | C16 | C8 | C4 | C2 | C1 | C0.5 |
|-------------------|-----|----|----|----|----|------|
| Reference         | 0   | 0  | 0  | 0  | 0  | 0    |
| 0.5 (dB)          | 0   | 0  | 0  | 0  | 0  | 1    |
| 1 (dB)            | 0   | 0  | 0  | 0  | 1  | 0    |
| 2 (dB)            | 0   | 0  | 0  | 1  | 0  | 0    |
| 4 (dB)            | 0   | 0  | 1  | 0  | 0  | 0    |
| 8 (dB)            | 0   | 1  | 0  | 0  | 0  | 0    |
| 16 (dB)           | 1   | 0  | 0  | 0  | 0  | 0    |
| 31.5 (dB)         | 1   | 1  | 1  | 1  | 1  | 1    |

Note: Not all 64 possible combinations of C0.5 - C16 are shown in table.

The parallel interface timing requirements are defined by Figure 1 (Parallel Interface Timing Diagram) and Table 2 (Parallel Interface AC Characteristics), and the switching speed.

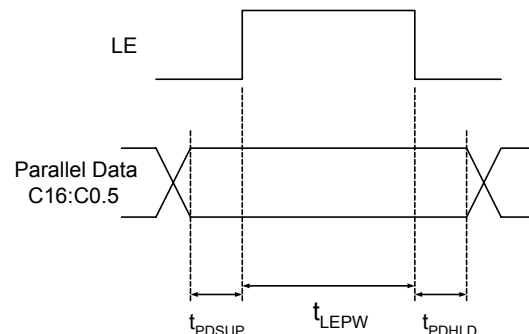
For latched parallel programming the Latch Enable (LE) should be held LOW while changing attenuation state control values, then pulse LE HIGH to LOW (per Figure 1) to latch new attenuation state into the device.

For direct parallel programming, the Latch Enable (LE) line should be pulled HIGH. Changing the attenuation state control values will immediately change the device's state to a new attenuation value. Direct mode is ideal for manual control of the device (using hardware, switches, or jumpers).

**TABLE 2. PARALLEL INTERFACE AC CHARACTERISTICS**

| Symbol      | Parameter                                       | Min. | Units |
|-------------|-------------------------------------------------|------|-------|
| $t_{LEPW}$  | LE minimum pulse width                          | 30   | ns    |
| $t_{PDSUP}$ | Data set-up time before clock rising edge of LE | 100  | ns    |
| $t_{PDHLD}$ | Data hold time after clock falling edge of LE   | 100  | ns    |

**FIGURE 1: PARALLEL INTERFACE TIMING DIAGRAM**



### POWER-UP STATE

When the attenuator powers up and LE is logic low, the maximum attenuation is set to 31.5 dB. When LE is logic high, the nominal attenuation selected upon control logics (see Table 1 ). When LE is logic HIGH upon turn on, the start-up attenuation value will be set based on the control logic in Table 1.



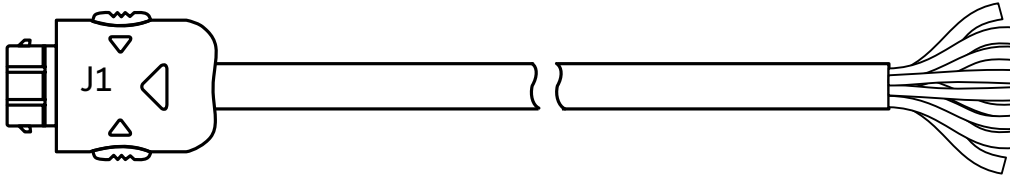
Mini-Circuits

## COAXIAL WIDEBAND

# Digital Step Attenuator **ZX76-44G-30-K+**

50Ω 0 to 31.5 dB, 0.5 dB Step 100 MHz to 43.5 GHz  
6 Bit, Parallel Control Interface, Dual or Single Supply Voltage

### CBL-5FT-MPD+ CONTROL CABLE



### INCLUDED ACCESSORIES

CBL-5FT-MPD+ is a "Pigtail" connector included with every purchase of ZX76-44G-30-K+. CBL-5FT-MPD+ is a shielded cable with stripped wires (#32 AWG) on one end and a connector on the other end designed to mate to the ZX76-44G-30-K+. These bare wires enable the customer to assemble their own cable as required to interface with the ZX76-44G-30-K+ (cable length is 4.9 ft/ 1.5 meters).

### CBL-5FT-MPD+ WIRING INFORMATION

| J1 Pin Number | Function        | Description                              | Wire Color   |
|---------------|-----------------|------------------------------------------|--------------|
| 1             | LE              | Latch Enable Input                       | Green        |
| 2             | $\bar{P}/S$     | Logic Low (0 V)                          | Green/Black  |
| 3             | C0.5            | Control for attenuation bit, 0.5 dB      | Red          |
| 4             | C1              | Control for attenuation bit, 1.0 dB      | Orange       |
| 5             | C4              | Control for attenuation bit, 4.0 dB      | Orange/Black |
| 6             | C2              | Control for attenuation bit, 2.0 dB      | Black        |
| 7             | C8              | Control for attenuation bit, 8.0 dB      | Red/Black    |
| 8             | C16             | Control for attenuation bit, 16.0 dB     | Blue         |
| 9             | V <sub>DD</sub> | Positive Supply Voltage                  | White        |
| 10            | V <sub>SS</sub> | Negative Supply Voltage (or ext. ground) | White/Black  |
| Shield        | -               | Shield Braid/Drain                       | -            |

Note: Cable shield connected to case ground.





## COAXIAL WIDEBAND

# Digital Step Attenuator **ZX76-44G-30-K+**

50Ω 0 to 31.5 dB, 0.5 dB Step 100 MHz to 43.5 GHz  
6 Bit, Parallel Control Interface, Dual or Single Supply Voltage

### TYPICAL PERFORMANCE DATA

| Frequency (MHz) | Insertion loss (dB) | Attenuation Relative to Insertion Loss @ Attenuation Settings |      |      |      |      |       |       |
|-----------------|---------------------|---------------------------------------------------------------|------|------|------|------|-------|-------|
|                 |                     | 0.5 dB                                                        | 1 dB | 2 dB | 4 dB | 8 dB | 16 dB | 32 dB |
| 100             | 1.41                | 0.49                                                          | 0.90 | 2.20 | 4.21 | 8.13 | 16.23 | 32.10 |
| 500             | 1.51                | 0.49                                                          | 0.91 | 2.18 | 4.22 | 8.15 | 16.25 | 32.12 |
| 1000            | 1.61                | 0.49                                                          | 0.92 | 2.17 | 4.22 | 8.15 | 16.26 | 32.13 |
| 5000            | 2.32                | 0.44                                                          | 0.84 | 2.26 | 4.15 | 8.06 | 16.15 | 32.00 |
| 10000           | 3.43                | 0.45                                                          | 0.85 | 2.23 | 4.11 | 8.10 | 16.25 | 31.96 |
| 13000           | 3.67                | 0.46                                                          | 0.87 | 2.16 | 4.16 | 8.17 | 16.41 | 32.04 |
| 15000           | 3.92                | 0.41                                                          | 0.80 | 2.21 | 4.09 | 8.11 | 16.34 | 31.95 |
| 20000           | 4.64                | 0.37                                                          | 0.74 | 2.23 | 4.02 | 8.14 | 16.39 | 31.91 |
| 25000           | 5.65                | 0.30                                                          | 0.68 | 2.34 | 4.00 | 8.25 | 16.37 | 31.92 |
| 26000           | 5.78                | 0.28                                                          | 0.70 | 2.43 | 4.07 | 8.38 | 16.44 | 32.00 |
| 30000           | 6.09                | 0.30                                                          | 0.65 | 2.48 | 3.95 | 8.26 | 16.44 | 31.77 |
| 35000           | 6.17                | 0.29                                                          | 0.71 | 2.46 | 4.06 | 8.59 | 16.83 | 32.12 |
| 40000           | 7.65                | 0.27                                                          | 0.50 | 2.48 | 3.79 | 8.01 | 16.39 | 31.46 |
| 43500           | 7.82                | 0.33                                                          | 0.45 | 2.75 | 3.95 | 8.35 | 17.06 | 31.76 |

| Frequency (MHz) | VSWR In (:1) @ Attenuation Settings |        |      |      |      |      |       |       | VSWR Out (:1) @ Attenuation Settings |        |      |      |      |      |       |       |
|-----------------|-------------------------------------|--------|------|------|------|------|-------|-------|--------------------------------------|--------|------|------|------|------|-------|-------|
|                 | 0 dB                                | 0.5 dB | 1 dB | 2 dB | 4 dB | 8 dB | 16 dB | 32 dB | 0 dB                                 | 0.5 dB | 1 dB | 2 dB | 4 dB | 8 dB | 16 dB | 32 dB |
| 100             | 1.33                                | 1.21   | 1.10 | 1.69 | 1.24 | 1.01 | 1.03  | 1.03  | 1.31                                 | 1.21   | 1.13 | 1.57 | 1.05 | 1.18 | 1.03  | 1.05  |
| 500             | 1.35                                | 1.23   | 1.12 | 1.70 | 1.25 | 1.02 | 1.03  | 1.03  | 1.33                                 | 1.23   | 1.16 | 1.59 | 1.06 | 1.19 | 1.04  | 1.05  |
| 1000            | 1.35                                | 1.23   | 1.12 | 1.70 | 1.25 | 1.03 | 1.04  | 1.04  | 1.34                                 | 1.23   | 1.17 | 1.59 | 1.07 | 1.20 | 1.05  | 1.05  |
| 5000            | 1.22                                | 1.13   | 1.05 | 1.54 | 1.19 | 1.03 | 1.04  | 1.04  | 1.23                                 | 1.15   | 1.12 | 1.46 | 1.06 | 1.20 | 1.06  | 1.03  |
| 10000           | 1.14                                | 1.12   | 1.12 | 1.35 | 1.12 | 1.20 | 1.22  | 1.22  | 1.17                                 | 1.17   | 1.22 | 1.21 | 1.10 | 1.16 | 1.19  | 1.18  |
| 13000           | 1.20                                | 1.16   | 1.22 | 1.29 | 1.10 | 1.21 | 1.21  | 1.22  | 1.21                                 | 1.14   | 1.11 | 1.36 | 1.17 | 1.13 | 1.08  | 1.17  |
| 15000           | 1.22                                | 1.16   | 1.17 | 1.41 | 1.14 | 1.08 | 1.07  | 1.07  | 1.25                                 | 1.20   | 1.21 | 1.39 | 1.17 | 1.27 | 1.07  | 1.09  |
| 20000           | 1.18                                | 1.23   | 1.30 | 1.12 | 1.16 | 1.29 | 1.28  | 1.29  | 1.06                                 | 1.09   | 1.13 | 1.08 | 1.09 | 1.12 | 1.24  | 1.15  |
| 25000           | 1.83                                | 1.87   | 1.99 | 1.40 | 1.61 | 1.77 | 1.72  | 1.70  | 1.54                                 | 1.48   | 1.41 | 1.67 | 1.58 | 1.42 | 1.43  | 1.54  |
| 26000           | 1.78                                | 1.81   | 1.93 | 1.48 | 1.65 | 1.82 | 1.78  | 1.76  | 1.53                                 | 1.47   | 1.45 | 1.72 | 1.67 | 1.58 | 1.44  | 1.62  |
| 30000           | 1.39                                | 1.34   | 1.28 | 1.70 | 1.41 | 1.34 | 1.36  | 1.35  | 1.65                                 | 1.68   | 1.74 | 1.43 | 1.53 | 1.57 | 1.43  | 1.45  |
| 35000           | 1.08                                | 1.09   | 1.13 | 1.24 | 1.10 | 1.20 | 1.21  | 1.19  | 1.22                                 | 1.25   | 1.25 | 1.08 | 1.17 | 1.16 | 1.18  | 1.15  |
| 40000           | 1.71                                | 1.66   | 1.54 | 1.92 | 1.55 | 1.38 | 1.36  | 1.37  | 1.78                                 | 1.81   | 1.77 | 1.54 | 1.62 | 1.47 | 1.55  | 1.47  |
| 43500           | 1.31                                | 1.33   | 1.26 | 1.49 | 1.35 | 1.23 | 1.23  | 1.25  | 1.35                                 | 1.38   | 1.32 | 1.52 | 1.43 | 1.53 | 1.76  | 1.54  |

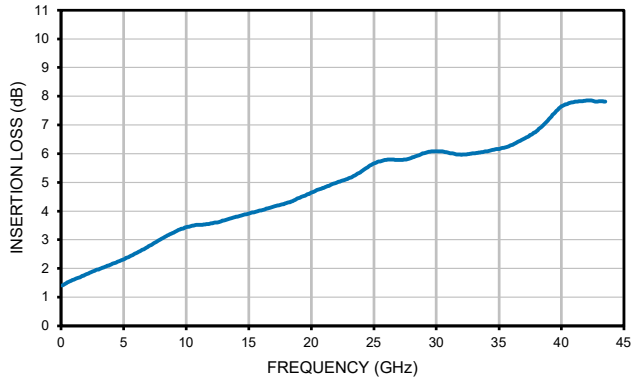


COAXIAL WIDEBAND

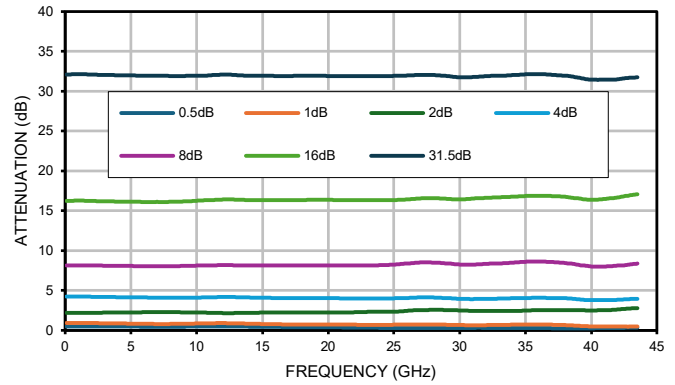
# Digital Step Attenuator **ZX76-44G-30-K+**

50Ω 0 to 31.5 dB, 0.5 dB Step 100 MHz to 43.5 GHz  
6 Bit, Parallel Control Interface, Dual or Single Supply Voltage

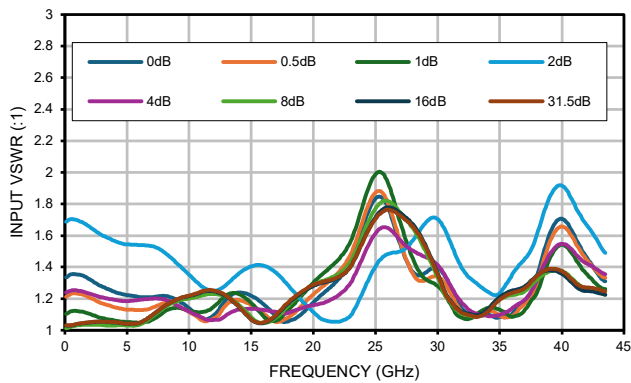
Insertion Loss



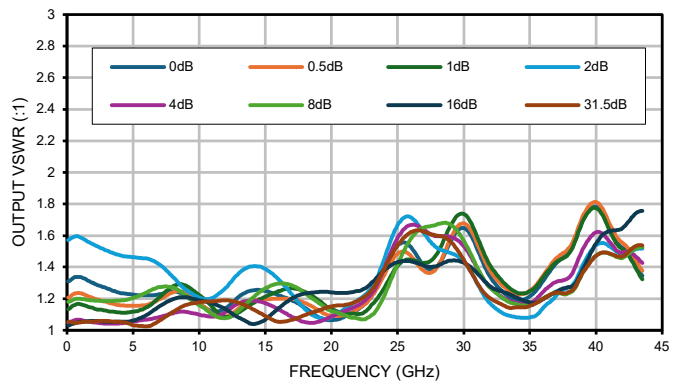
Attenuation relative to Insertion Loss over Attenuation Settings



Input VSWR over Attenuation Settings



Output VSWR over Attenuation Settings





Mini-Circuits

COAXIAL WIDEBAND

# Digital Step Attenuator **ZX76-44G-30-K+**

50Ω 0 to 31.5 dB, 0.5 dB Step 100 MHz to 43.5 GHz  
6 Bit, Parallel Control Interface, Dual or Single Supply Voltage

ADDITIONAL DETAILED INFORMATION IS AVAILABLE ON OUR DASHBOARD

[CLICK HERE](#)

|                           |                                              |
|---------------------------|----------------------------------------------|
| Performance Data & Graphs | Data                                         |
|                           | Graphs                                       |
|                           | S-Parameter (S2P Files) Data Set (.zip file) |
| Case Style                | MS3009                                       |
| RoHS Status               | Compliant                                    |
| Environmental Ratings     | ENV28T14                                     |
| Export Info               | EAR99                                        |

## INCLUDED ACCESSORY

|             |                                                                                     |
|-------------|-------------------------------------------------------------------------------------|
| Photo       |  |
| Part No.    | CBL-5FT-MPD+                                                                        |
| Description | 5 ft. (1.5 m) Control Cable                                                         |
| Quantity    | 1                                                                                   |

### NOTES

- A. Performance and quality attributes and conditions not expressly stated in this specification document are intended to be excluded and do not form a part of this specification document.
- B. Electrical specifications and performance data contained in this specification document are based on Mini-Circuit's applicable established test performance criteria and measurement instructions.
- C. The parts covered by this specification document are subject to Mini-Circuits standard limited warranty and terms and conditions (collectively, "Standard Terms"); Purchasers of this part are entitled to the rights and benefits contained therein. For a full statement of the standard. Terms and the exclusive rights and remedies thereunder, please visit Mini-Circuits' website at [www.minicircuits.com/terms/viewterm.html](http://www.minicircuits.com/terms/viewterm.html)





# Wide Band Digital Step Attenuation

**ZX76-44G-30-K+**

## Typical Performance Data

| Frequency<br>(GHz) | Insertion<br>Loss<br>(dB) | Attenuation relative to Insertion Loss |        |        |        |        |       |         |
|--------------------|---------------------------|----------------------------------------|--------|--------|--------|--------|-------|---------|
|                    |                           | (dB)                                   |        |        |        |        |       |         |
|                    |                           | @ Attenuation Setting                  |        |        |        |        |       |         |
|                    | 0 dB                      | .5 dB                                  | 1.0 dB | 2.0 dB | 4.0 dB | 8.0 dB | 16 dB | 31.5 dB |
| 0.1                | 1.33                      | 0.48                                   | 0.90   | 2.16   | 4.20   | 8.13   | 16.23 | 32.09   |
| 0.2                | 1.39                      | 0.48                                   | 0.91   | 2.16   | 4.21   | 8.14   | 16.24 | 32.11   |
| 0.3                | 1.43                      | 0.48                                   | 0.91   | 2.15   | 4.21   | 8.15   | 16.25 | 32.12   |
| 0.4                | 1.46                      | 0.48                                   | 0.92   | 2.14   | 4.22   | 8.15   | 16.26 | 32.13   |
| 0.5                | 1.48                      | 0.49                                   | 0.92   | 2.14   | 4.22   | 8.16   | 16.27 | 32.14   |
| 0.6                | 1.50                      | 0.49                                   | 0.92   | 2.14   | 4.22   | 8.16   | 16.27 | 32.15   |
| 0.7                | 1.52                      | 0.49                                   | 0.93   | 2.14   | 4.22   | 8.17   | 16.28 | 32.15   |
| 0.8                | 1.54                      | 0.49                                   | 0.93   | 2.13   | 4.23   | 8.17   | 16.28 | 32.16   |
| 0.9                | 1.56                      | 0.49                                   | 0.93   | 2.13   | 4.23   | 8.17   | 16.29 | 32.16   |
| 1.0                | 1.57                      | 0.49                                   | 0.93   | 2.13   | 4.23   | 8.17   | 16.29 | 32.16   |
| 2.0                | 1.76                      | 0.48                                   | 0.91   | 2.15   | 4.21   | 8.14   | 16.25 | 32.13   |
| 3.0                | 1.95                      | 0.45                                   | 0.86   | 2.21   | 4.16   | 8.09   | 16.18 | 32.05   |
| 4.0                | 2.13                      | 0.44                                   | 0.85   | 2.23   | 4.15   | 8.07   | 16.16 | 32.02   |
| 5.0                | 2.25                      | 0.45                                   | 0.86   | 2.21   | 4.16   | 8.08   | 16.20 | 32.06   |
| 6.0                | 2.45                      | 0.43                                   | 0.83   | 2.24   | 4.14   | 8.06   | 16.17 | 32.04   |
| 7.0                | 2.70                      | 0.42                                   | 0.80   | 2.28   | 4.12   | 8.04   | 16.14 | 31.98   |
| 8.0                | 2.97                      | 0.43                                   | 0.82   | 2.25   | 4.11   | 8.05   | 16.17 | 31.94   |
| 9.0                | 3.17                      | 0.44                                   | 0.85   | 2.21   | 4.12   | 8.09   | 16.24 | 31.99   |
| 10.0               | 3.34                      | 0.46                                   | 0.88   | 2.17   | 4.12   | 8.13   | 16.31 | 32.03   |
| 11.0               | 3.41                      | 0.48                                   | 0.92   | 2.12   | 4.15   | 8.19   | 16.42 | 32.10   |
| 12.0               | 3.41                      | 0.49                                   | 0.94   | 2.08   | 4.18   | 8.25   | 16.52 | 32.20   |
| 13.0               | 3.50                      | 0.46                                   | 0.90   | 2.10   | 4.15   | 8.20   | 16.50 | 32.17   |
| 14.0               | 3.61                      | 0.43                                   | 0.85   | 2.14   | 4.10   | 8.15   | 16.43 | 32.13   |
| 15.0               | 3.69                      | 0.42                                   | 0.83   | 2.17   | 4.09   | 8.14   | 16.44 | 32.13   |
| 16.0               | 3.77                      | 0.42                                   | 0.81   | 2.17   | 4.09   | 8.14   | 16.47 | 32.16   |
| 17.0               | 3.88                      | 0.40                                   | 0.79   | 2.19   | 4.08   | 8.14   | 16.48 | 32.19   |
| 18.0               | 4.04                      | 0.39                                   | 0.78   | 2.20   | 4.06   | 8.15   | 16.48 | 32.19   |
| 19.0               | 4.20                      | 0.40                                   | 0.78   | 2.19   | 4.07   | 8.16   | 16.55 | 32.24   |
| 20.0               | 4.41                      | 0.41                                   | 0.78   | 2.15   | 4.08   | 8.19   | 16.65 | 32.36   |
| 21.0               | 4.64                      | 0.38                                   | 0.75   | 2.12   | 4.03   | 8.16   | 16.60 | 32.36   |
| 22.0               | 4.75                      | 0.34                                   | 0.72   | 2.19   | 4.01   | 8.16   | 16.51 | 32.30   |
| 23.0               | 4.78                      | 0.32                                   | 0.71   | 2.26   | 4.04   | 8.23   | 16.51 | 32.29   |
| 24.0               | 5.06                      | 0.32                                   | 0.72   | 2.23   | 4.02   | 8.26   | 16.54 | 32.29   |
| 25.0               | 5.49                      | 0.29                                   | 0.72   | 2.25   | 4.04   | 8.33   | 16.54 | 32.32   |
| 26.0               | 5.53                      | 0.27                                   | 0.75   | 2.43   | 4.20   | 8.56   | 16.67 | 32.44   |
| 27.0               | 5.44                      | 0.27                                   | 0.74   | 2.53   | 4.24   | 8.62   | 16.69 | 32.35   |
| 28.0               | 5.54                      | 0.27                                   | 0.71   | 2.53   | 4.17   | 8.53   | 16.60 | 32.10   |
| 29.0               | 5.84                      | 0.27                                   | 0.68   | 2.52   | 4.11   | 8.42   | 16.47 | 31.82   |
| 30.0               | 6.18                      | 0.28                                   | 0.61   | 2.45   | 3.93   | 8.14   | 16.22 | 31.37   |
| 31.0               | 6.06                      | 0.31                                   | 0.59   | 2.40   | 3.87   | 8.07   | 16.26 | 31.23   |
| 32.0               | 5.84                      | 0.32                                   | 0.64   | 2.36   | 3.91   | 8.20   | 16.41 | 31.33   |
| 33.0               | 5.95                      | 0.31                                   | 0.66   | 2.35   | 3.94   | 8.28   | 16.46 | 31.34   |
| 34.0               | 6.13                      | 0.31                                   | 0.63   | 2.37   | 3.91   | 8.24   | 16.47 | 31.29   |
| 35.0               | 6.09                      | 0.31                                   | 0.63   | 2.36   | 3.91   | 8.30   | 16.59 | 31.41   |
| 36.0               | 6.04                      | 0.30                                   | 0.68   | 2.33   | 3.97   | 8.44   | 16.71 | 31.68   |
| 37.0               | 6.10                      | 0.29                                   | 0.70   | 2.36   | 4.03   | 8.52   | 16.76 | 31.96   |
| 38.0               | 6.50                      | 0.28                                   | 0.63   | 2.36   | 3.94   | 8.35   | 16.62 | 32.01   |
| 39.0               | 7.00                      | 0.29                                   | 0.56   | 2.35   | 3.82   | 8.14   | 16.50 | 31.88   |
| 40.0               | 7.17                      | 0.31                                   | 0.52   | 2.40   | 3.81   | 8.13   | 16.61 | 31.90   |
| 41.0               | 7.05                      | 0.32                                   | 0.53   | 2.44   | 3.85   | 8.26   | 16.82 | 31.88   |
| 42.0               | 7.06                      | 0.31                                   | 0.52   | 2.45   | 3.86   | 8.29   | 16.85 | 31.68   |
| 43.0               | 7.26                      | 0.32                                   | 0.48   | 2.53   | 3.87   | 8.27   | 16.86 | 31.34   |
| 43.5               | 7.36                      | 0.34                                   | 0.46   | 2.59   | 3.90   | 8.32   | 16.95 | 31.24   |

# Wide Band Digital Step Attenuation

**ZX76-44G-30-K+**

## Typical Performance Data

| Frequency<br>(GHz) | Input VSWR<br>(:1)<br>@ Attenuation Setting |        |        |        |        |        |       |         |
|--------------------|---------------------------------------------|--------|--------|--------|--------|--------|-------|---------|
|                    | 0 dB                                        | 0.5 dB | 1.0 dB | 2.0 dB | 4.0 dB | 8.0 dB | 16 dB | 31.5 dB |
|                    |                                             |        |        |        |        |        |       |         |
| 0.1                | 1.31                                        | 1.20   | 1.13   | 1.56   | 1.03   | 1.16   | 1.01  | 1.08    |
| 0.2                | 1.33                                        | 1.22   | 1.14   | 1.57   | 1.04   | 1.17   | 1.02  | 1.08    |
| 0.3                | 1.34                                        | 1.23   | 1.15   | 1.58   | 1.05   | 1.17   | 1.03  | 1.08    |
| 0.4                | 1.34                                        | 1.23   | 1.16   | 1.58   | 1.06   | 1.18   | 1.03  | 1.08    |
| 0.5                | 1.34                                        | 1.23   | 1.16   | 1.58   | 1.06   | 1.18   | 1.04  | 1.08    |
| 0.6                | 1.35                                        | 1.24   | 1.17   | 1.58   | 1.06   | 1.18   | 1.04  | 1.08    |
| 0.7                | 1.35                                        | 1.24   | 1.17   | 1.58   | 1.06   | 1.18   | 1.05  | 1.09    |
| 0.8                | 1.35                                        | 1.24   | 1.17   | 1.58   | 1.06   | 1.18   | 1.05  | 1.09    |
| 0.9                | 1.35                                        | 1.24   | 1.17   | 1.58   | 1.06   | 1.18   | 1.06  | 1.09    |
| 1.0                | 1.34                                        | 1.24   | 1.17   | 1.57   | 1.06   | 1.18   | 1.06  | 1.09    |
| 2.0                | 1.32                                        | 1.22   | 1.15   | 1.55   | 1.05   | 1.19   | 1.05  | 1.07    |
| 3.0                | 1.30                                        | 1.21   | 1.16   | 1.56   | 1.08   | 1.24   | 1.08  | 1.03    |
| 4.0                | 1.28                                        | 1.21   | 1.19   | 1.50   | 1.07   | 1.26   | 1.12  | 1.06    |
| 5.0                | 1.22                                        | 1.16   | 1.15   | 1.42   | 1.02   | 1.21   | 1.10  | 1.08    |
| 6.0                | 1.18                                        | 1.12   | 1.13   | 1.39   | 1.02   | 1.20   | 1.07  | 1.06    |
| 7.0                | 1.23                                        | 1.21   | 1.24   | 1.38   | 1.06   | 1.28   | 1.14  | 1.07    |
| 8.0                | 1.29                                        | 1.30   | 1.35   | 1.31   | 1.13   | 1.30   | 1.23  | 1.16    |
| 9.0                | 1.23                                        | 1.24   | 1.30   | 1.23   | 1.11   | 1.23   | 1.22  | 1.20    |
| 10.0               | 1.20                                        | 1.20   | 1.25   | 1.23   | 1.07   | 1.19   | 1.19  | 1.18    |
| 11.0               | 1.18                                        | 1.16   | 1.20   | 1.23   | 1.06   | 1.16   | 1.17  | 1.18    |
| 12.0               | 1.16                                        | 1.10   | 1.12   | 1.27   | 1.11   | 1.12   | 1.15  | 1.20    |
| 13.0               | 1.22                                        | 1.15   | 1.13   | 1.36   | 1.19   | 1.15   | 1.08  | 1.19    |
| 14.0               | 1.26                                        | 1.20   | 1.22   | 1.39   | 1.19   | 1.29   | 1.04  | 1.12    |
| 15.0               | 1.27                                        | 1.25   | 1.31   | 1.34   | 1.13   | 1.36   | 1.15  | 1.04    |
| 16.0               | 1.24                                        | 1.25   | 1.32   | 1.25   | 1.08   | 1.35   | 1.20  | 1.04    |
| 17.0               | 1.22                                        | 1.24   | 1.32   | 1.20   | 1.07   | 1.34   | 1.23  | 1.05    |
| 18.0               | 1.28                                        | 1.32   | 1.40   | 1.20   | 1.12   | 1.40   | 1.32  | 1.13    |
| 19.0               | 1.31                                        | 1.38   | 1.45   | 1.17   | 1.19   | 1.40   | 1.45  | 1.26    |
| 20.0               | 1.21                                        | 1.28   | 1.32   | 1.13   | 1.23   | 1.30   | 1.51  | 1.36    |
| 21.0               | 1.23                                        | 1.24   | 1.20   | 1.27   | 1.31   | 1.16   | 1.47  | 1.40    |
| 22.0               | 1.29                                        | 1.27   | 1.18   | 1.34   | 1.34   | 1.10   | 1.37  | 1.37    |
| 23.0               | 1.22                                        | 1.21   | 1.14   | 1.29   | 1.29   | 1.07   | 1.32  | 1.31    |
| 24.0               | 1.38                                        | 1.35   | 1.26   | 1.45   | 1.43   | 1.20   | 1.45  | 1.45    |
| 25.0               | 1.66                                        | 1.60   | 1.50   | 1.77   | 1.73   | 1.48   | 1.56  | 1.69    |
| 26.0               | 1.50                                        | 1.44   | 1.42   | 1.68   | 1.73   | 1.61   | 1.48  | 1.72    |
| 27.0               | 1.26                                        | 1.24   | 1.31   | 1.45   | 1.56   | 1.59   | 1.34  | 1.60    |
| 28.0               | 1.31                                        | 1.31   | 1.40   | 1.40   | 1.52   | 1.59   | 1.31  | 1.55    |
| 29.0               | 1.59                                        | 1.61   | 1.70   | 1.53   | 1.67   | 1.75   | 1.43  | 1.66    |
| 30.0               | 1.99                                        | 2.02   | 2.08   | 1.68   | 1.77   | 1.80   | 1.53  | 1.63    |
| 31.0               | 1.81                                        | 1.84   | 1.88   | 1.50   | 1.55   | 1.54   | 1.43  | 1.38    |
| 32.0               | 1.46                                        | 1.49   | 1.53   | 1.25   | 1.33   | 1.32   | 1.26  | 1.20    |
| 33.0               | 1.52                                        | 1.56   | 1.59   | 1.31   | 1.42   | 1.39   | 1.30  | 1.30    |
| 34.0               | 1.66                                        | 1.71   | 1.71   | 1.44   | 1.49   | 1.45   | 1.49  | 1.37    |
| 35.0               | 1.41                                        | 1.46   | 1.43   | 1.33   | 1.29   | 1.31   | 1.50  | 1.28    |
| 36.0               | 1.15                                        | 1.18   | 1.14   | 1.17   | 1.05   | 1.08   | 1.30  | 1.08    |
| 37.0               | 1.21                                        | 1.24   | 1.25   | 1.05   | 1.21   | 1.12   | 1.09  | 1.13    |
| 38.0               | 1.55                                        | 1.58   | 1.57   | 1.31   | 1.45   | 1.31   | 1.26  | 1.31    |
| 39.0               | 1.71                                        | 1.74   | 1.71   | 1.49   | 1.58   | 1.43   | 1.48  | 1.41    |
| 40.0               | 1.60                                        | 1.63   | 1.58   | 1.53   | 1.53   | 1.47   | 1.64  | 1.45    |
| 41.0               | 1.31                                        | 1.34   | 1.29   | 1.40   | 1.30   | 1.37   | 1.60  | 1.35    |
| 42.0               | 1.19                                        | 1.22   | 1.19   | 1.23   | 1.19   | 1.19   | 1.38  | 1.18    |
| 43.0               | 1.29                                        | 1.32   | 1.28   | 1.32   | 1.33   | 1.31   | 1.48  | 1.31    |
| 43.5               | 1.27                                        | 1.30   | 1.25   | 1.39   | 1.35   | 1.40   | 1.61  | 1.40    |

# Wide Band Digital Step Attenuation

**ZX76-44G-30-K+**

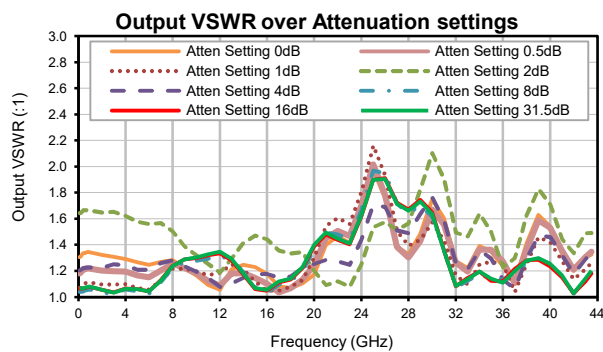
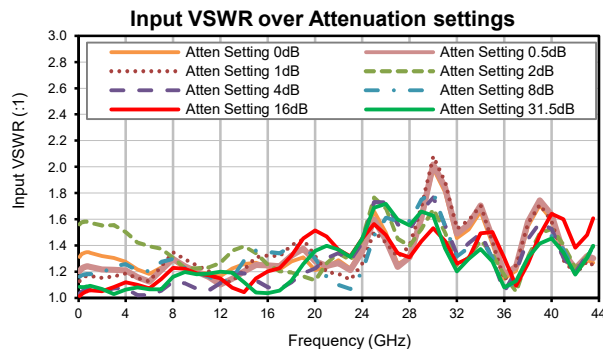
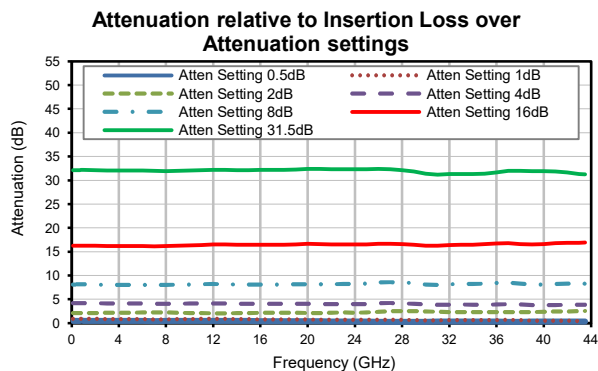
## Typical Performance Data

| Frequency<br>(GHz) | Output VSWR<br>(:1)<br>@ Attenuation Setting |        |        |        |        |        |       |         |
|--------------------|----------------------------------------------|--------|--------|--------|--------|--------|-------|---------|
|                    | 0 dB                                         | 0.5 dB | 1.0 dB | 2.0 dB | 4.0 dB | 8.0 dB | 16 dB | 31.5 dB |
|                    |                                              |        |        |        |        |        |       |         |
| 0.1                | 1.31                                         | 1.18   | 1.07   | 1.64   | 1.20   | 1.04   | 1.07  | 1.07    |
| 0.2                | 1.31                                         | 1.19   | 1.08   | 1.65   | 1.21   | 1.04   | 1.06  | 1.07    |
| 0.3                | 1.32                                         | 1.20   | 1.09   | 1.65   | 1.21   | 1.04   | 1.07  | 1.07    |
| 0.4                | 1.34                                         | 1.21   | 1.10   | 1.67   | 1.22   | 1.04   | 1.06  | 1.07    |
| 0.5                | 1.34                                         | 1.21   | 1.11   | 1.67   | 1.22   | 1.05   | 1.07  | 1.07    |
| 0.6                | 1.34                                         | 1.21   | 1.11   | 1.67   | 1.22   | 1.05   | 1.07  | 1.07    |
| 0.7                | 1.34                                         | 1.22   | 1.11   | 1.67   | 1.23   | 1.05   | 1.07  | 1.07    |
| 0.8                | 1.34                                         | 1.22   | 1.11   | 1.67   | 1.23   | 1.06   | 1.07  | 1.08    |
| 0.9                | 1.34                                         | 1.22   | 1.11   | 1.67   | 1.23   | 1.06   | 1.08  | 1.08    |
| 1.0                | 1.34                                         | 1.22   | 1.11   | 1.66   | 1.23   | 1.06   | 1.08  | 1.08    |
| 2.0                | 1.32                                         | 1.20   | 1.10   | 1.65   | 1.22   | 1.03   | 1.05  | 1.06    |
| 3.0                | 1.31                                         | 1.20   | 1.10   | 1.65   | 1.25   | 1.03   | 1.03  | 1.03    |
| 4.0                | 1.29                                         | 1.19   | 1.10   | 1.62   | 1.25   | 1.06   | 1.07  | 1.06    |
| 5.0                | 1.27                                         | 1.17   | 1.07   | 1.58   | 1.21   | 1.04   | 1.06  | 1.06    |
| 6.0                | 1.25                                         | 1.15   | 1.06   | 1.56   | 1.21   | 1.03   | 1.04  | 1.04    |
| 7.0                | 1.27                                         | 1.20   | 1.13   | 1.57   | 1.26   | 1.12   | 1.13  | 1.12    |
| 8.0                | 1.28                                         | 1.26   | 1.22   | 1.50   | 1.28   | 1.23   | 1.24  | 1.24    |
| 9.0                | 1.22                                         | 1.22   | 1.22   | 1.39   | 1.24   | 1.27   | 1.29  | 1.29    |
| 10.0               | 1.17                                         | 1.18   | 1.20   | 1.32   | 1.19   | 1.28   | 1.30  | 1.30    |
| 11.0               | 1.09                                         | 1.12   | 1.17   | 1.25   | 1.15   | 1.29   | 1.32  | 1.33    |
| 12.0               | 1.06                                         | 1.09   | 1.19   | 1.19   | 1.08   | 1.32   | 1.34  | 1.35    |
| 13.0               | 1.21                                         | 1.18   | 1.25   | 1.30   | 1.10   | 1.28   | 1.28  | 1.29    |
| 14.0               | 1.25                                         | 1.18   | 1.21   | 1.42   | 1.15   | 1.19   | 1.17  | 1.18    |
| 15.0               | 1.23                                         | 1.15   | 1.12   | 1.47   | 1.18   | 1.08   | 1.06  | 1.07    |
| 16.0               | 1.18                                         | 1.10   | 1.05   | 1.44   | 1.18   | 1.04   | 1.05  | 1.05    |
| 17.0               | 1.08                                         | 1.04   | 1.05   | 1.36   | 1.15   | 1.10   | 1.11  | 1.12    |
| 18.0               | 1.07                                         | 1.07   | 1.08   | 1.34   | 1.16   | 1.12   | 1.13  | 1.14    |
| 19.0               | 1.10                                         | 1.13   | 1.13   | 1.34   | 1.22   | 1.20   | 1.22  | 1.23    |
| 20.0               | 1.17                                         | 1.24   | 1.30   | 1.20   | 1.25   | 1.37   | 1.39  | 1.40    |
| 21.0               | 1.40                                         | 1.45   | 1.55   | 1.09   | 1.29   | 1.50   | 1.48  | 1.49    |
| 22.0               | 1.46                                         | 1.51   | 1.61   | 1.12   | 1.27   | 1.48   | 1.44  | 1.45    |
| 23.0               | 1.42                                         | 1.47   | 1.56   | 1.08   | 1.25   | 1.44   | 1.40  | 1.41    |
| 24.0               | 1.65                                         | 1.70   | 1.81   | 1.25   | 1.44   | 1.67   | 1.62  | 1.63    |
| 25.0               | 1.98                                         | 2.02   | 2.16   | 1.54   | 1.71   | 1.97   | 1.90  | 1.90    |
| 26.0               | 1.76                                         | 1.78   | 1.93   | 1.58   | 1.69   | 1.95   | 1.91  | 1.90    |
| 27.0               | 1.39                                         | 1.38   | 1.51   | 1.51   | 1.51   | 1.71   | 1.72  | 1.71    |
| 28.0               | 1.33                                         | 1.30   | 1.39   | 1.57   | 1.49   | 1.65   | 1.67  | 1.66    |
| 29.0               | 1.48                                         | 1.43   | 1.44   | 1.83   | 1.64   | 1.70   | 1.74  | 1.73    |
| 30.0               | 1.75                                         | 1.67   | 1.57   | 2.10   | 1.76   | 1.62   | 1.65  | 1.64    |
| 31.0               | 1.60                                         | 1.55   | 1.43   | 1.90   | 1.59   | 1.35   | 1.36  | 1.36    |
| 32.0               | 1.27                                         | 1.26   | 1.17   | 1.49   | 1.26   | 1.07   | 1.08  | 1.08    |
| 33.0               | 1.22                                         | 1.19   | 1.10   | 1.47   | 1.22   | 1.13   | 1.15  | 1.14    |
| 34.0               | 1.39                                         | 1.36   | 1.25   | 1.64   | 1.36   | 1.19   | 1.19  | 1.20    |
| 35.0               | 1.35                                         | 1.36   | 1.27   | 1.50   | 1.30   | 1.13   | 1.13  | 1.14    |
| 36.0               | 1.24                                         | 1.27   | 1.25   | 1.23   | 1.13   | 1.13   | 1.12  | 1.11    |
| 37.0               | 1.11                                         | 1.11   | 1.04   | 1.30   | 1.06   | 1.19   | 1.21  | 1.20    |
| 38.0               | 1.41                                         | 1.37   | 1.26   | 1.63   | 1.30   | 1.26   | 1.28  | 1.28    |
| 39.0               | 1.63                                         | 1.59   | 1.46   | 1.83   | 1.47   | 1.30   | 1.28  | 1.30    |
| 40.0               | 1.54                                         | 1.53   | 1.42   | 1.71   | 1.46   | 1.26   | 1.23  | 1.25    |
| 41.0               | 1.33                                         | 1.35   | 1.28   | 1.44   | 1.32   | 1.16   | 1.15  | 1.16    |
| 42.0               | 1.20                                         | 1.21   | 1.14   | 1.34   | 1.18   | 1.03   | 1.03  | 1.03    |
| 43.0               | 1.30                                         | 1.30   | 1.21   | 1.49   | 1.29   | 1.13   | 1.12  | 1.14    |
| 43.5               | 1.33                                         | 1.35   | 1.26   | 1.49   | 1.36   | 1.19   | 1.18  | 1.20    |

# Wide Band Digital Step Attenuation

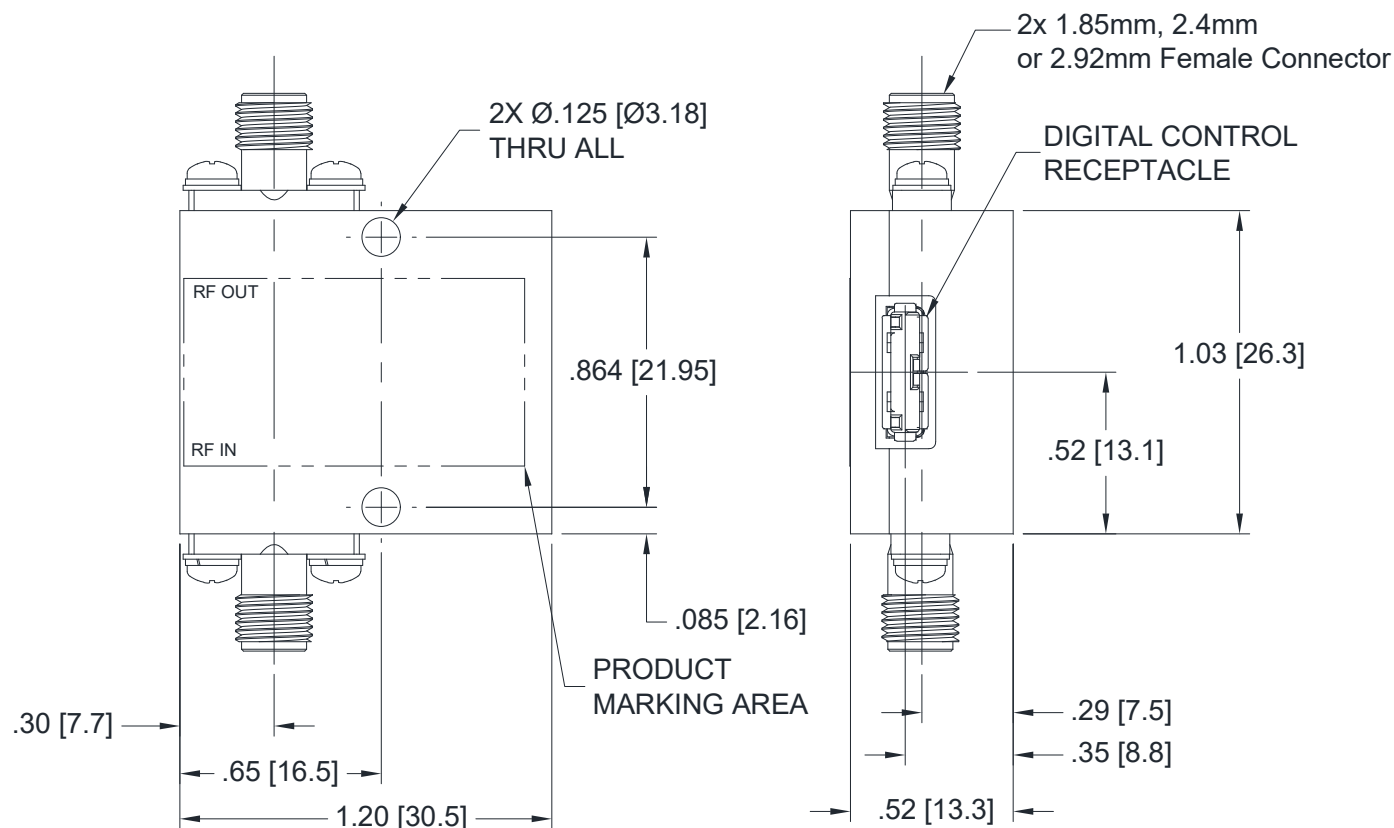
## Typical Performance Data

**ZX76-44G-30-K+**



## Outline Dimensions

MS3009



Weight: 45.36 grams

Dimensions are in inches (mm). Tolerances: 2Pl.  $\pm .03$ ; 3Pl.  $\pm .015$

### Notes:

1. Case material: Brass Alloy.
2. Case finish: Gold plate.

**Mini-Circuits®**  
ISO 9001 ISO 14001 CERTIFIED

ALL NEW  
minicircuits.com

P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718) 332-4661 For detailed performance specs & shopping online see Mini-Circuits web site



The Design Engineers Search Engine Provides ACTUAL Data Instantly From MINI-CIRCUITS At: [www.minicircuits.com](http://www.minicircuits.com)

RF/IF MICROWAVE COMPONENTS



All Mini-Circuits products are manufactured under exacting quality assurance and control standards, and are capable of meeting published specifications after being subjected to any or all of the following physical and environmental test.

| Specification              | Test/Inspection Condition                                                              | Reference/Spec                       |
|----------------------------|----------------------------------------------------------------------------------------|--------------------------------------|
| Operating Temperature      | -40° to 85° C<br>Ambient Environment                                                   | Individual Model Data Sheet          |
| Storage Temperature        | -40° to 85° C<br>Ambient Environment                                                   | Individual Model Data Sheet          |
| Barometric Pressure        | 100,000 Feet                                                                           | MIL-STD-202, Method 105, Condition D |
| Humidity                   | 90% RH, 65°C<br>Units may require bake-out after humidity to restore full performance. | MIL-STD-202, Method 103              |
| Thermal Shock              | -65° to 125°C, 5 cycles                                                                | MIL-STD-202, Method 107, Condition B |
| Vibration (High Frequency) | 20g peak, 10-2000 Hz, 12 times in each of three perpendicular directions (total 36)    | MIL-STD-202, Method 204, Condition D |
| Mechanical Shock           | 100g, 6ms sawtooth, 3 shocks each direction 3 axes (total 18)                          | MIL-STD-202, Method 213, Condition I |