

# NON-CATALOG

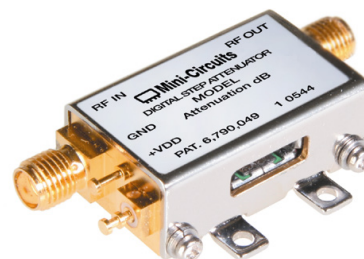
# Digital Step Attenuator

50 $\Omega$  DC-2400 MHz

31.5 dB, 0.5 dB Step, 6 Bit, Serial Control Interface,  
Single Supply Voltage

## Product Features

- Low Insertion Loss
- High IP3, +52 dBm Typ
- Excellent return loss, 20 dB Typ
- Excellent accuracy, 0.1 dB Typ
- Single Supply Voltage: +3V
- Control inputs buffered by Schmitt Triggers
- Rigid unibody case
- Protected by US patent 6,790,049



CASE STYLE: HK1172

## ZX76-31R5-SP-S+

## Typical Applications

- Lab
- Instrumentation
- Test equipment

| Connectors | Order P/N       |
|------------|-----------------|
| SMA        | ZX76-31R5-SP-S+ |

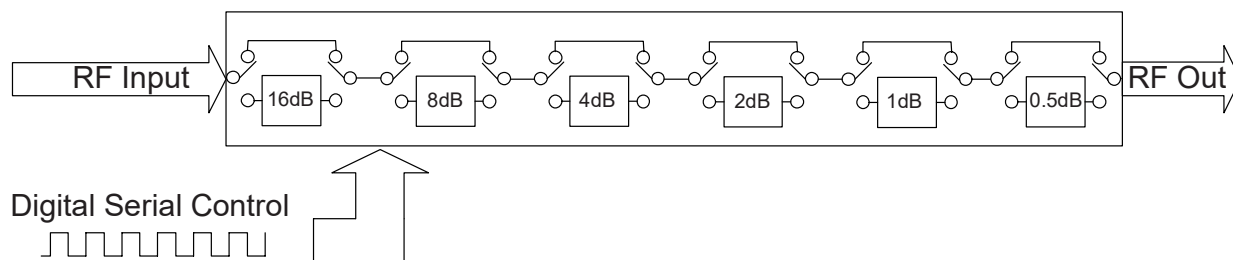
### +RoHS Compliant

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

## General Description

The ZX76-31R5-SP-S+ is a 50 $\Omega$  RF digital step attenuator that offers an attenuation range up to 31.5 dB in 0.5 dB steps. The control is a 6-bit serial interface. The model operates on a single +3 volt supply. See application note AN-70-004 for 5V supply voltage. The ZX76-31R5-SP-S+ is produced using a unique case package for ruggedness and operation in tough environments.

## Simplified Schematic



### RF Electrical Specifications, DC-2400 MHz, $T_{AMB}=25^{\circ}\text{C}$ , $V_{DD}=+3\text{V}$

| Parameter                                                       | Freq. Range (GHz) | Min. | Typ. | Max. | Units |
|-----------------------------------------------------------------|-------------------|------|------|------|-------|
| Accuracy @ 0.5 dB Attenuation Setting                           | DC-1              | —    | 0.03 | 0.1  | dB    |
|                                                                 | 1-2.4             | —    | 0.05 | 0.15 | dB    |
| Accuracy @ 1 dB Attenuation Setting                             | DC-1              | —    | 0.02 | 0.1  | dB    |
|                                                                 | 1-2.4             | —    | 0.05 | 0.15 | dB    |
| Accuracy @ 2 dB Attenuation Setting                             | DC-1              | —    | 0.05 | 0.15 | dB    |
|                                                                 | 1-2.4             | —    | 0.15 | 0.25 | dB    |
| Accuracy @ 4 dB Attenuation Setting                             | DC-1              | —    | 0.07 | 0.2  | dB    |
|                                                                 | 1-2.4             | —    | 0.15 | 0.25 | dB    |
| Accuracy @ 8 dB Attenuation Setting                             | DC-1              | —    | 0.03 | 0.2  | dB    |
|                                                                 | 1-2.4             | —    | 0.15 | 0.3  | dB    |
| Accuracy @ 16 dB Attenuation Setting                            | DC-1              | —    | 0.1  | 0.3  | dB    |
|                                                                 | 1-2.4             | —    | 0.15 | 0.5  | dB    |
| Insertion Loss @ all attenuator set to 0dB                      | DC-1              | —    | 1.5  | 2.2  | dB    |
|                                                                 | 1-2.4             | —    | 2.0  | 3.0  | dB    |
| IP3 Input * (at Min. and Max. Attenuation)                      | DC-2.4            | —    | +52  | —    | dBm   |
| Input Power @ 0.2dB Compression* (at Min. and Max. Attenuation) | DC-2.4            | —    | +24  | —    | dBm   |
| VSWR                                                            | DC-1              | —    | 1.2  | 1.5  | —     |
|                                                                 | 1-2.4             | —    | 1.2  | 1.5  | —     |

\* IP3 and 1dB compression degrade below 1 MHz

### DC Electrical Specifications

| Parameter                  | Min.                | Typ. | Max.                | Units         |
|----------------------------|---------------------|------|---------------------|---------------|
| $V_{DD}$ , Supply Voltage  | 2.7                 | 3    | 3.3                 | V             |
| $I_{DD}$ , Supply Current  | —                   | —    | 1.5                 | mA            |
| Control Input Voltage Low  | 0                   | —    | $0.3 \times V_{DD}$ | V             |
| Control Input Voltage High | $0.7 \times V_{DD}$ | —    | 5V                  | V             |
| Control Current            | —                   | —    | 400                 | $\mu\text{A}$ |

### Switching Specifications

| Parameter                                                  | Min. | Typ. | Max. | Units           |
|------------------------------------------------------------|------|------|------|-----------------|
| Switching Speed, 50% Control to 0.5dB of Attenuation Value | —    | 1.0  | —    | $\mu\text{Sec}$ |
| Switching Control Frequency                                | —    | —    | 25   | KHz             |

### Absolute Maximum Ratings

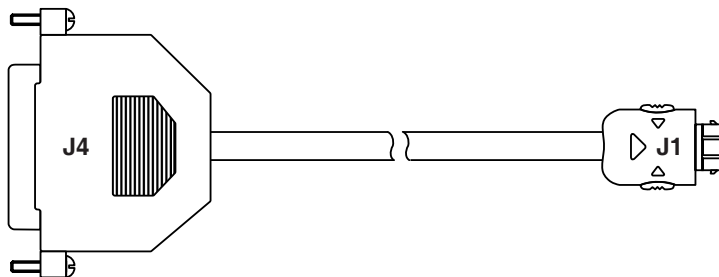
| Parameter                 | Ratings                                       |
|---------------------------|-----------------------------------------------|
| Operating Temperature     | $-40^{\circ}\text{C}$ to $85^{\circ}\text{C}$ |
| Storage Temperature       | $-40^{\circ}\text{C}$ to $85^{\circ}\text{C}$ |
| $V_{DD}$ , Supply Voltage | -0.3V Min., 4V Max.                           |
| Voltage on Control Input  | -0.3V Min., 6V Max.                           |
| ESD, HBM                  | 500V                                          |
| ESD, MM                   | 100V                                          |
| Input Power               | +24dBm                                        |

Permanent damage may occur if any of these limits are exceeded

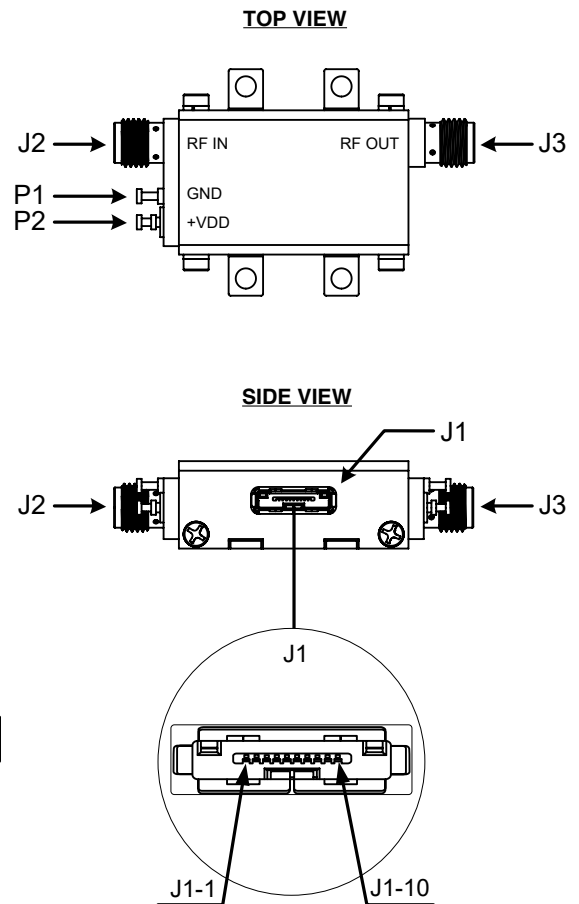
### Pin Description

| Function | Pin Number | Description                  |
|----------|------------|------------------------------|
| N/C      | J1-1       | Not Connected                |
| GND      | J1-2       | Ground connection            |
| LE       | J1-3       | Latch Enable Input           |
| N/C      | J1-4       | Not Connected                |
| GND      | J1-5       | Ground connection            |
| N/C      | J1-6       | Not Connected                |
| Clock    | J1-7       | Serial Interface clock Input |
| GND      | J1-8       | Ground connection            |
| Data     | J1-9       | Serial Interface data Input  |
| N/C      | J1-10      | Not Connected                |
| RF in    | J2         | RF in port (Note 1)          |
| RF out   | J3         | RF out port (Note 1)         |
| GND      | P1         | Ground connection            |
| VDD      | P2         | Positive Supply Voltage      |

Note 1: Both RF ports must be held at 0VDC or DC blocked with an external series capacitor.



### Pin Configuration



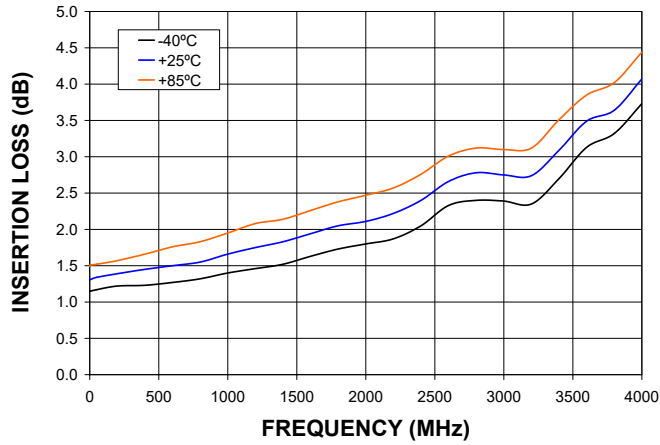
### Cable Pin Description

| J1-Pin Number | J4-Pin Number | Function | Description                  | Wire Color |
|---------------|---------------|----------|------------------------------|------------|
| J1-2          | J4-18         | GND      | Ground connection            | BLACK      |
| J1-3          | J4-4          | LE       | Latch Enable Input           | GREEN      |
| J1-5          | J4-19         | GND      | Ground connection            | BLUE       |
| J1-7          | J4-2          | Clock    | Serial Interface clock Input | RED        |
| J1-8          | J4-20         | GND      | Ground connection            | ORANGE     |
| J1-9          | J4-3          | Data     | Serial Interface data Input  | WHITE      |

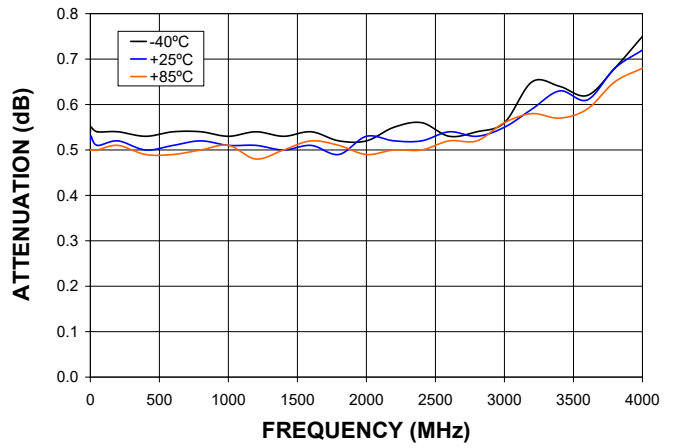
Note: Other pins not connected. Cable shield connected to case ground.

### Typical Performance Curves

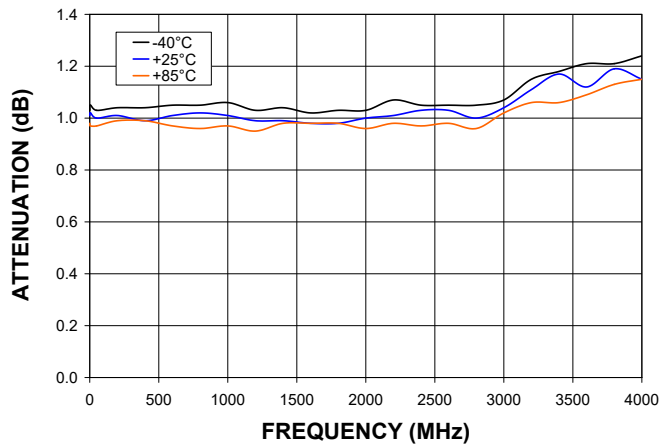
INSERTION LOSS (Ref)



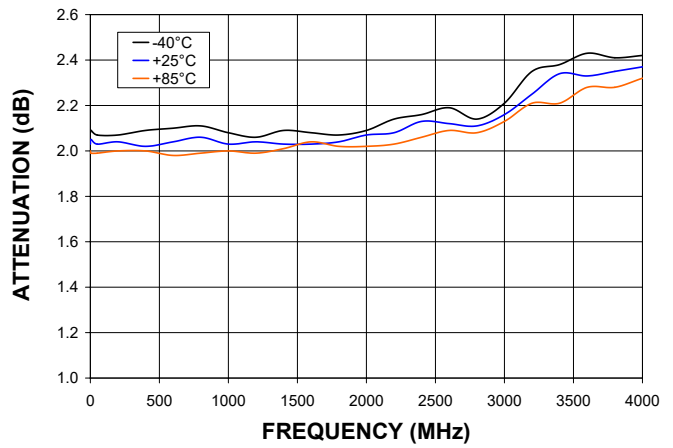
ATTENUATION (0.5 dB)



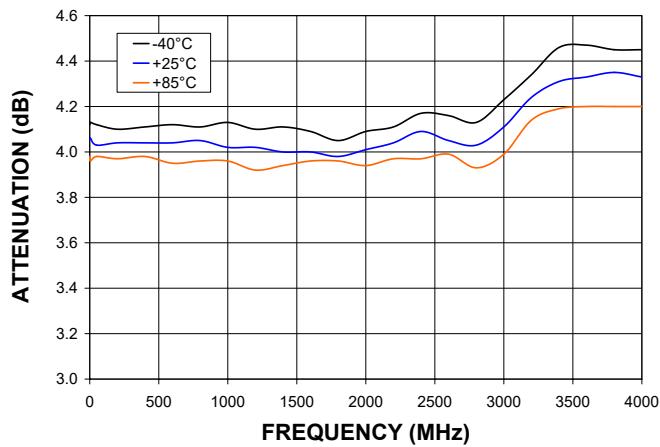
ATTENUATION (1 dB)



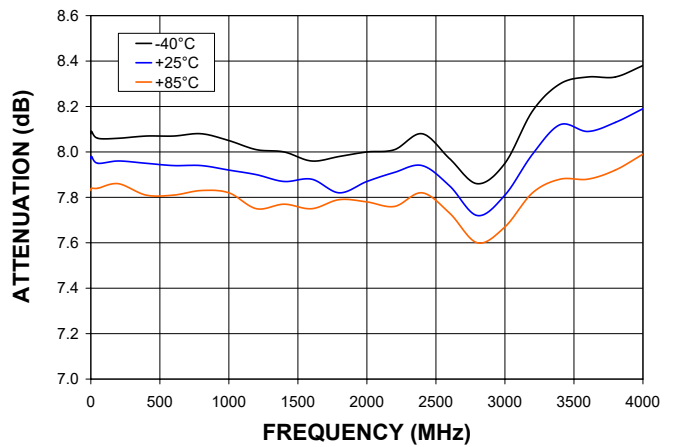
ATTENUATION (2 dB)



ATTENUATION (4 dB)



ATTENUATION (8 dB)



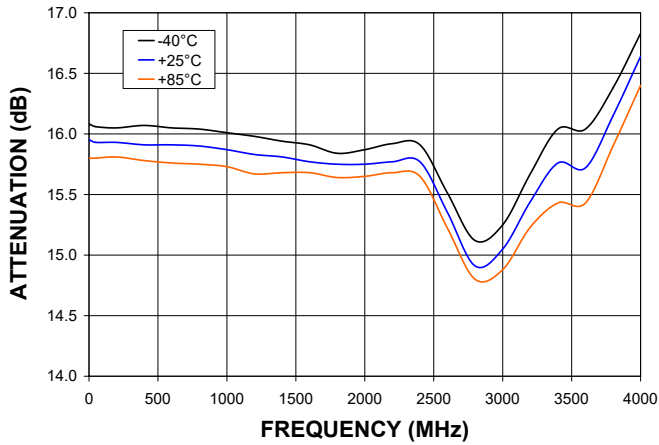
# NON-CATALOG

## Digital Step Attenuator

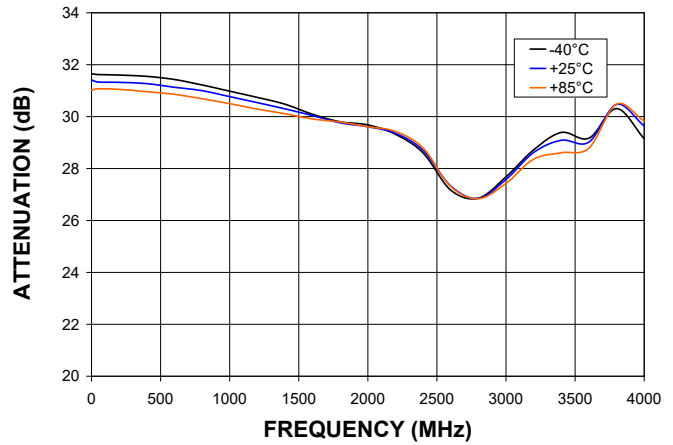
ZX76-31R5-SP-S+

### Typical Performance Curves

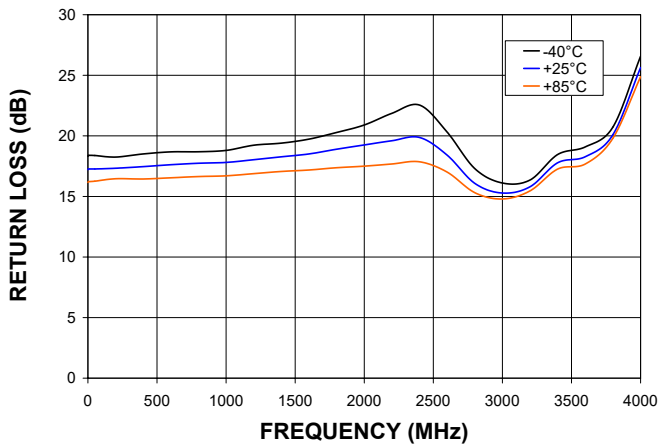
ATTENUATION (16 dB)



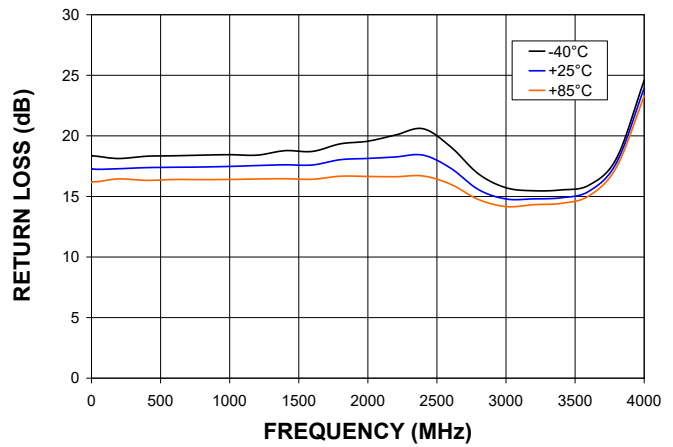
ATTENUATION (31.5 dB)



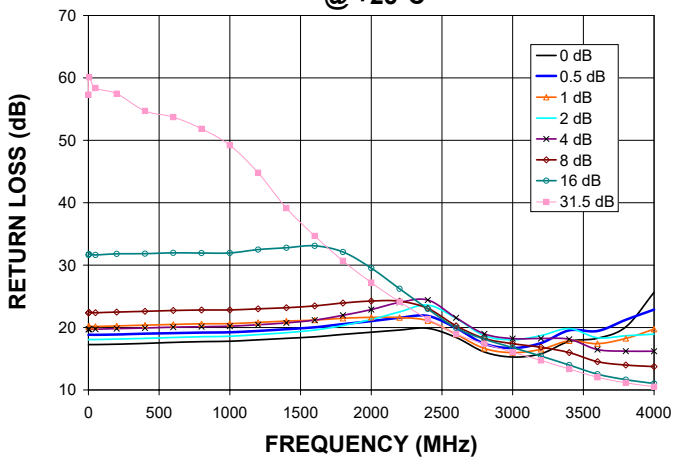
RETURN LOSS IN (Ref)



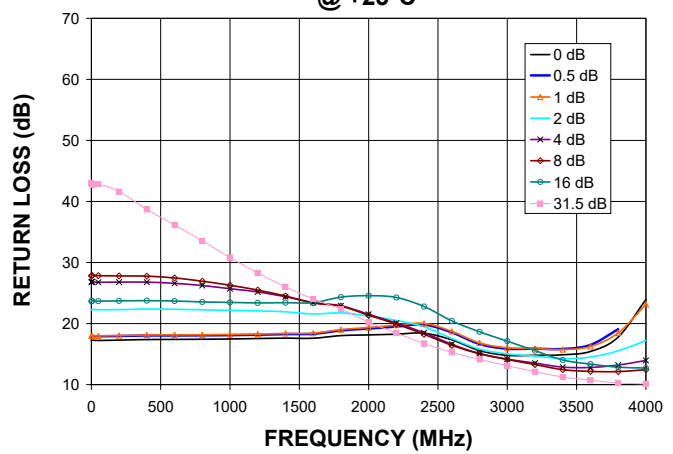
RETURN LOSS OUT (Ref)



RETURN LOSS IN (Major Atten. Steps)  
@ +25°C



RETURN LOSS OUT (Major Atten. Steps)  
@ +25°C



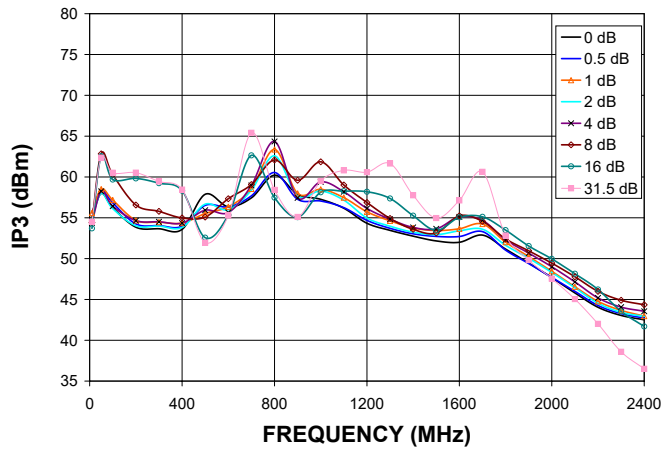
# NON-CATALOG

## Digital Step Attenuator

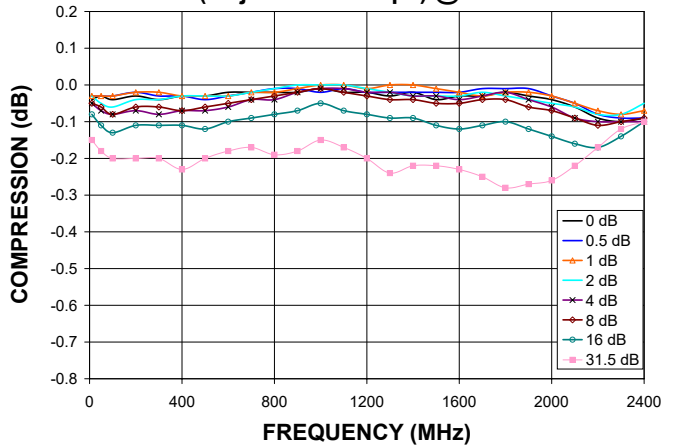
ZX76-31R5-SP-S+

### Typical Performance Curves

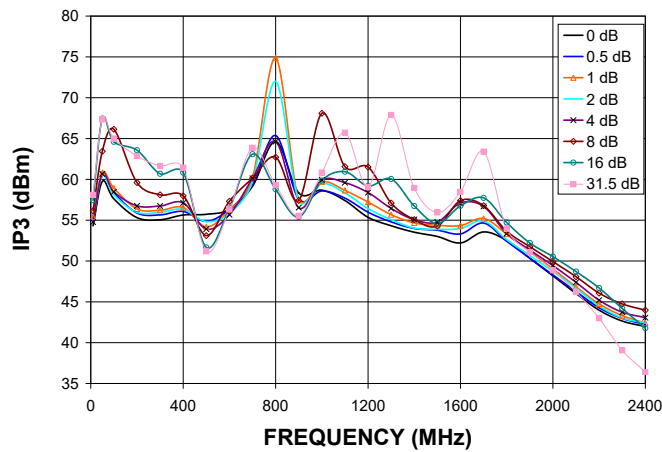
IP3 (Major Atten. Steps) @ +25°C



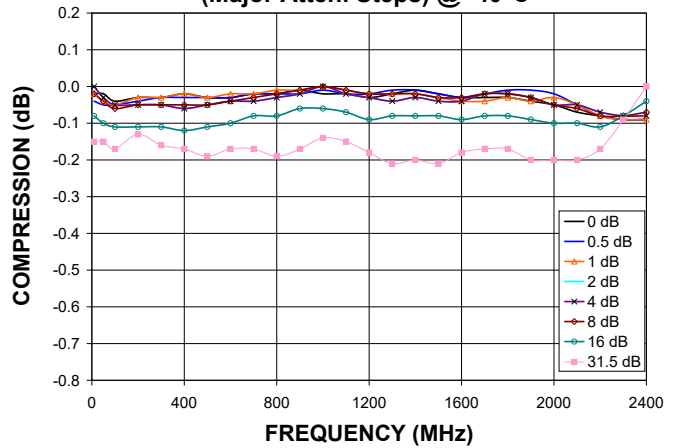
COMPRESSION @ INPUT POWER=+24dBm  
(Major Atten. Steps) @ +25°C



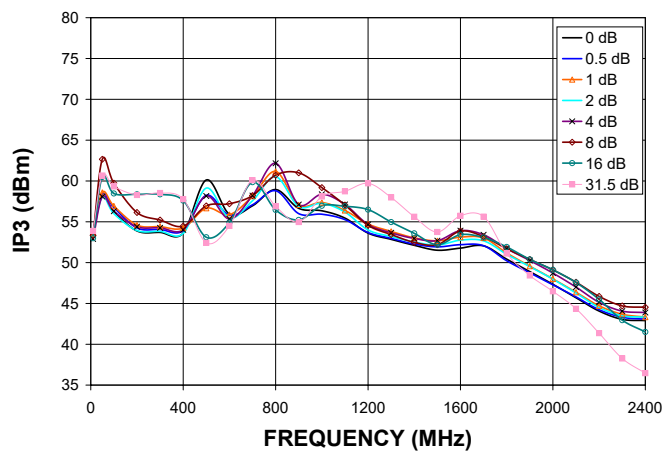
IP3 (Major Atten. Steps) @ -40°C



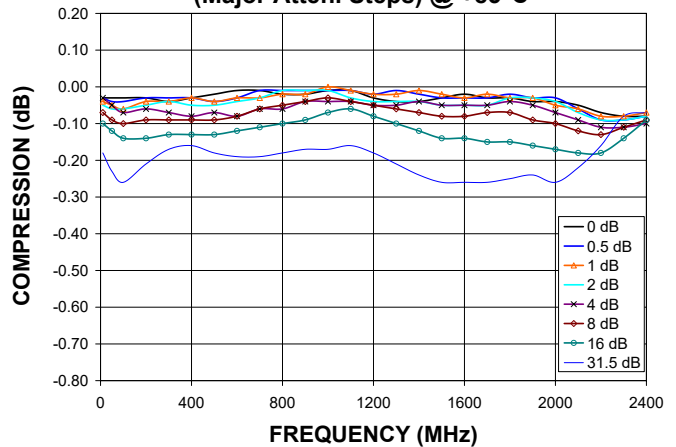
COMPRESSION @ INPUT POWER=+24dBm  
(Major Atten. Steps) @ -40°C



IP3 (Major Atten. Steps) @ +85°C



COMPRESSION @ INPUT POWER=+24dBm  
(Major Atten. Steps) @ +85°C

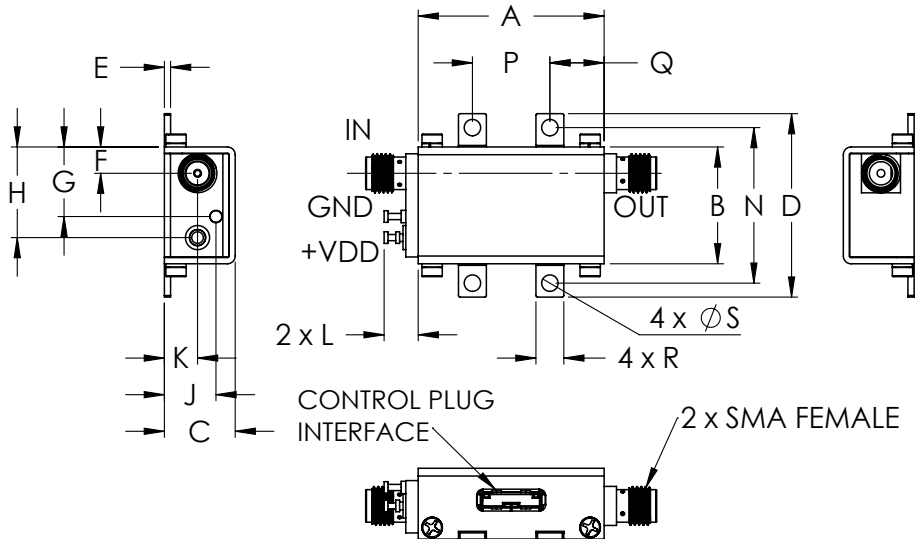


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## Digital Step Attenuator

ZX76-31R5-SP-S+

### Outline Drawing



NOTE: When soldering the DC connections, caution must be used to avoid overheating the DC terminals. See Application Note [AN-40-10](#).

### Outline Dimensions (inch mm)

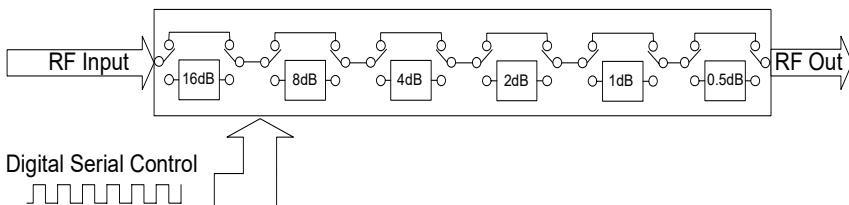
| A     | B     | C     | D     | E    | F    | G     | H     | J    | K    | L    | M | N     | P     | Q    | R    | S    | WT.<br>GRAMS |
|-------|-------|-------|-------|------|------|-------|-------|------|------|------|---|-------|-------|------|------|------|--------------|
| 1.20  | .75   | .46   | 1.18  | .04  | .17  | .45   | .59   | .33  | .21  | .22  | - | 1.00  | .50   | .35  | .18  | .106 | 35           |
| 30.48 | 19.15 | 11.61 | 30.07 | 1.02 | 4.32 | 11.40 | 14.86 | 8.31 | 5.44 | 5.59 | - | 25.40 | 12.70 | 8.89 | 4.57 | 2.69 |              |

### Recommended Mounting Hardware:

Use UNC#2 pan head screws with internal tooth lock washers for unit mounting.



### Simplified Schematic



The ZX76-31R5-SP-S+ Serial 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

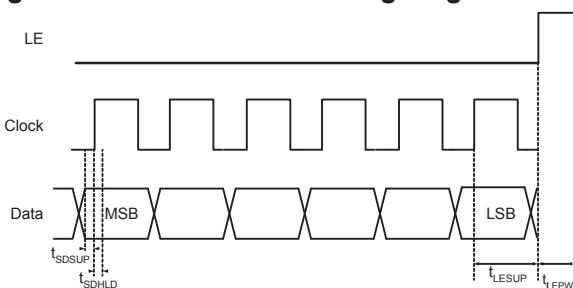
The serial interface is a 6-bit serial in, parallel-out shift register buffered by a transparent latch. It is controlled by three CMOS-compatible signals: Data, Clock, and Latch Enable (LE). The Data and Clock inputs allow data to be serially entered into the shift register, a process that is independent of the state of the LE input.

The LE input controls the latch. When LE is HIGH, the latch is transparent and the contents of the serial shift register control the attenuator. When LE is brought LOW, data in the shift register is latched.

The shift register should be loaded while LE is held LOW to prevent the attenuator value from changing as data is entered. The LE input should then be toggled HIGH and brought LOW again, latching the new data. The timing for this operation is defined by Figure 1 (Serial Interface Timing Diagram) and Table 2 (Serial Interface AC Characteristics).

Control cables for programming can be ordered separately. For details see page 10.

**Figure 1: Serial Interface Timing Diagram**



| Table 2. Serial Interface AC Characteristics |                                                  |      |      |       |
|----------------------------------------------|--------------------------------------------------|------|------|-------|
| Symbol                                       | Parameter                                        | Min. | Max. | Units |
| $f_{clk}$                                    | Serial data clock frequency (Note 1)             |      | 10   | MHz   |
| $t_{clkH}$                                   | Serial clock HIGH time                           | 30   |      | ns    |
| $t_{clkL}$                                   | Serial clock LOW time                            | 30   |      | ns    |
| $t_{LESUP}$                                  | LE set-up time after last clock falling edge     | 10   |      | ns    |
| $t_{LEPW}$                                   | LE minimum pulse width                           | 30   |      | ns    |
| $t_{SDSUP}$                                  | Serial data set-up time before clock rising edge | 10   |      | ns    |
| $t_{SDHLD}$                                  | Serial data hold time after clock falling edge   | 10   |      | ns    |

Note 1.  $f_{clk}$  verified during the functional pattern test. Serial programming sections of the functional pattern are clocked at 10MHz to verify  $f_{clk}$  specification.

The ZX76-31R5-SP-S+, uses a common 6-bit serial word format, as shown in Table 3: 6-Bit attenuator Serial Programming Register Map.

The first bit, the MSB, corresponds to the 16-dB Step and the last bit, the LSB, corresponds to the 0.5dB step.

| Table 3. 6-Bit attenuator Serial Programming Register Map |    |    |    |    |      |
|-----------------------------------------------------------|----|----|----|----|------|
| B5                                                        | B4 | B3 | B2 | B1 | B0   |
| C16                                                       | C8 | C4 | C2 | C1 | C0.5 |

↑  
MSB  
(first in)

↑  
LSB  
(last in)

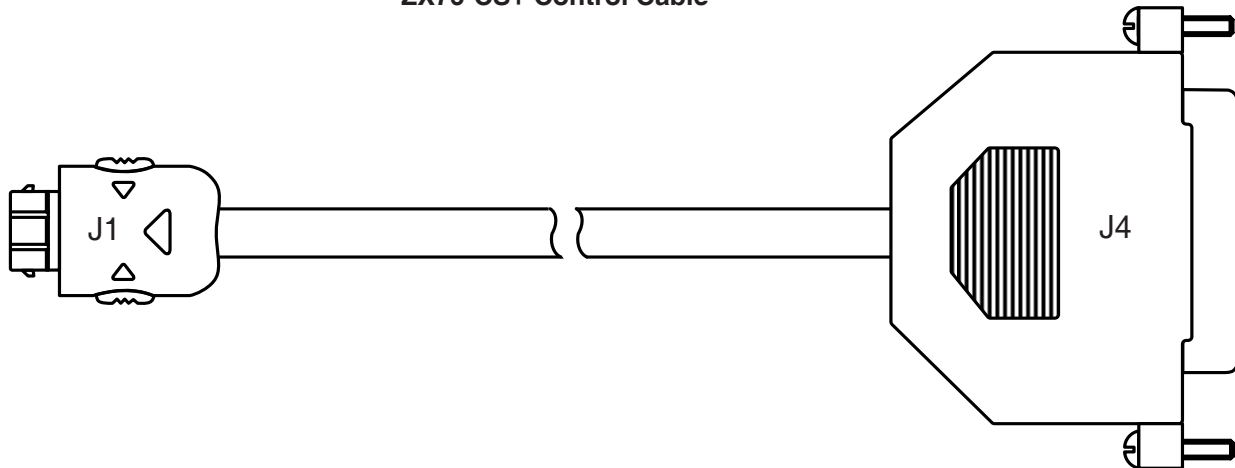
### Recommended Accessories

Two optional cable accessories with and without interface connector are available with ZX76-31R5-SP-S+, the ZX76-CS+ and ZX76-WS+. Cable length is 4.9 feet / 1.5 meters.

ZX76-CS+ shielded cable with interface 25 pin D-type connector J4 and supplied software are used to control the ZX76-31R5-SP-S+ digital attenuator from a computer, using LPT port.

ZX76-WS+ shielded cable without interface 25 pin D-type connector enables customer to use the ZX76-31R5-SP-S+ digital attenuator in his own application.

**ZX76-CS+ Control Cable**



**ZX76-CS+ wiring information**

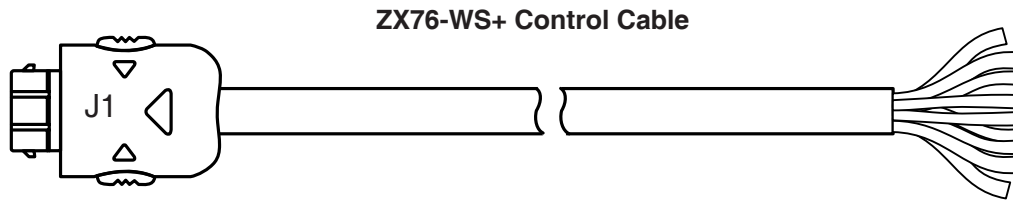
| J1-Pin Number | J4-Pin Number | Function | Description                  | Wire Color |
|---------------|---------------|----------|------------------------------|------------|
| J1-2          | J4-18         | GND      | Ground connection            | BLACK      |
| J1-3          | J4-4          | LE       | Latch Enable Input           | GREEN      |
| J1-5          | J4-19         | GND      | Ground connection            | BLUE       |
| J1-7          | J4-2          | Clock    | Serial Interface clock Input | RED        |
| J1-8          | J4-20         | GND      | Ground connection            | ORANGE     |
| J1-9          | J4-3          | Data     | Serial Interface data Input  | WHITE      |

Note: Other pins not connected. Cable shield connected to case ground.

# NON-CATALOG

## Digital Step Attenuator

**ZX76-31R5-SP-S+**



### ZX76-WS+ wiring information

| J1-Pin Number | Function | Description                  | Wire Color |
|---------------|----------|------------------------------|------------|
| J1-2          | GND      | Ground connection            | BLACK      |
| J1-3          | LE       | Latch Enable Input           | GREEN      |
| J1-5          | GND      | Ground connection            | BLUE       |
| J1-7          | Clock    | Serial Interface clock Input | RED        |
| J1-8          | GND      | Ground connection            | ORANGE     |
| J1-9          | Data     | Serial Interface data Input  | WHITE      |

Note: Other pins not connected. Cable shield connected to case ground.

### Ordering Information

| Model Number    | Description                                                             |
|-----------------|-------------------------------------------------------------------------|
| ZX76-31R5-SP-S+ | Digital attenuator - Serial interface<br>Single Positive Supply Voltage |
| ZX76-CS+        | Cable accessory with interface connector                                |
| ZX76-WS+        | Cable accessory without interface connector                             |

### Additional Notes

- 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.
- Electrical specifications and performance data contained in this specification document are based on Mini-Circuit's applicable established test performance criteria and measurement instructions.
- 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/MCLStore/terms.jsp](http://www.minicircuits.com/MCLStore/terms.jsp)

