

# Digital Step Attenuator

50Ω DC-4000 MHz

15.5 dB, 0.5 dB Step, 5 Bit, Parallel Control Interface  
Dual Supply Voltage

## Product Features

- Low Insertion Loss
- High IP3, +52 dBm Typ
- Excellent return loss, 20 dB Typ
- Excellent accuracy, 0.1 dB Typ
- Fast switching control frequency, 1 MHz typ.
- Dual Supply Voltage:  $V_{DD}=+3V$ ,  $V_{SS}=-3V$
- Control inputs buffered by Schmitt Triggers
- Rigid unibody case
- Protected by US patent 6,790,049



**ZX76-15R5-PN+**  
**ZX76-15R5-PN**

CASE STYLE: HK1149

## Typical Applications

- Lab
- Instrumentation
- Test equipment

| Connectors | Order P/N       | Price       | Qty.  |
|------------|-----------------|-------------|-------|
| SMA        | ZX76-15R5-PN-S+ | \$73.95 ea. | (1-9) |
| SMA        | ZX76-15R5-PN-S  | \$73.95 ea. | (1-9) |

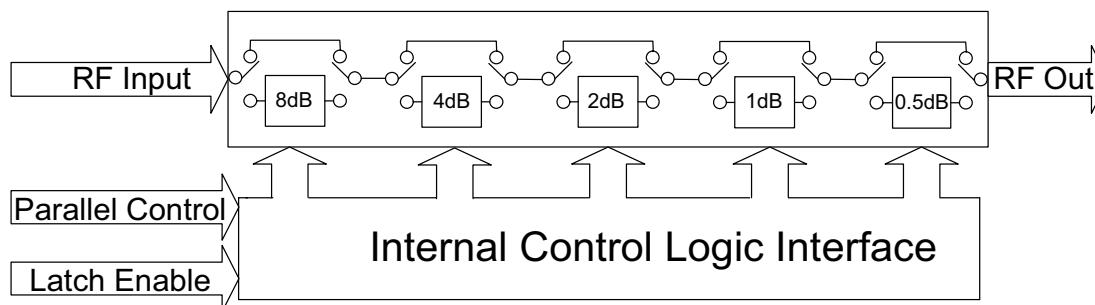
*+ RoHS compliant in accordance  
with EU Directive (2002/95/EC)*

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

## General Description

The ZX76-15R5-PN(+) is a 50Ω RF digital step attenuator that offers an attenuation range up to 15.5 dB in 0.5 dB steps. The control is a 5-bit parallel interface. The model operates on a dual supply voltage:  $V_{DD}=+3V$ ,  $V_{SS}=-3V$ . See application note AN-70-004 for 5V supply voltage. The ZX76-15R5-PN(+) is produced using a unique case package for ruggedness and operation in tough environments.

## Simplified Schematic



# Digital Step Attenuator

**ZX76-15R5-PN+**  
**ZX76-15R5-PN**

## RF Electrical Specifications, DC-4000 MHz, $T_{AMB}=25^{\circ}\text{C}$ , $V_{DD}=+3\text{V}$ , $V_{SS}=-3\text{V}$

| Parameter   | Freq. Range (GHz) | Min. | Typ. | Max. | Units |
|---|-------------------|------|------|------|-------|
| Accuracy @ 0.5 dB Attenuation Setting                           | DC-1              | —    | 0.03 | 0.1  | dB    |
|   | 1-2.2             | —    | 0.05 | 0.15 | dB    |
|   | 2.2-4.0           | —    | 0.1  | 0.35 | dB    |
| Accuracy @ 1 dB Attenuation Setting                             | DC-1              | —    | 0.02 | 0.1  | dB    |
|   | 1-2.2             | —    | 0.05 | 0.15 | dB    |
|   | 2.2-4.0           | —    | 0.1  | 0.35 | dB    |
| Accuracy @ 2 dB Attenuation Setting                             | DC-1              | —    | 0.05 | 0.15 | dB    |
|   | 1-2.2             | —    | 0.15 | 0.25 | dB    |
|   | 2.2-4.0           | —    | 0.2  | 0.6  | dB    |
| Accuracy @ 4 dB Attenuation Setting                             | DC-1              | —    | 0.07 | 0.2  | dB    |
|   | 1-2.2             | —    | 0.15 | 0.25 | dB    |
|   | 2.2-4.0           | —    | 0.18 | 0.6  | dB    |
| Accuracy @ 8 dB Attenuation Setting                             | DC-1              | —    | 0.03 | 0.2  | dB    |
|   | 1-2.2             | —    | 0.15 | 0.3  | dB    |
|   | 2.2-4.0           | —    | 0.5  | 0.6  | dB    |
| Insertion Loss @ all attenuator set to 0dB                      | DC-1              | —    | 1.5  | 2.0  | dB    |
|   | 1-2.2             | —    | 1.8  | 2.5  | dB    |
|   | 2.2-4.0           | —    | 3.0  | 4.5  | dB    |
| IP3 Input * (at Min. and Max. Attenuation)                      | DC-2.2            | —    | +52  | —    | dBm   |
|   | 2.2-4.0           | —    | +42  | —    | dBm   |
| Input Power @ 0.2dB Compression* (at Min. and Max. Attenuation) | DC-4.0            | —    | +24  | —    | dBm   |
| VSWR  | DC-1              | —    | 1.2  | 1.5  | —     |
|   | 1-2.2             | —    | 1.2  | 1.5  | —     |
|   | 2.2-4.0           | —    | 1.8  | 2.1  | —     |

\* 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             |
| $V_{SS}$ , Supply Voltage  | -3.3                | -3   | -2.7                | V             |
| $I_{DD}$ , Supply Current  | —                   | —    | 3                   | mA            |
| $I_{SS}$ , Supply Current  | —                   | —    | 100                 | $\mu\text{A}$ |
| 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                                | —    | 1.0  | —    | MHz             |

## Absolute Maximum Ratings

| Parameter                | Ratings             |
|--------------------------|---------------------|
| Operating Temperature    | -40°C to 85°C       |
| Storage Temperature      | -55°C to 100°C      |
| $V_{DD}$                 | -0.3V Min., 4V Max. |
| $V_{SS}$                 | -4V Min., 0.3V Max. |
| Voltage on Control Input | -0.3V Min., 6V Max. |
| ESD, HBM                 | 500V                |
| ESD, MM                  | 100V                |
| Input Power              | +24dBm              |



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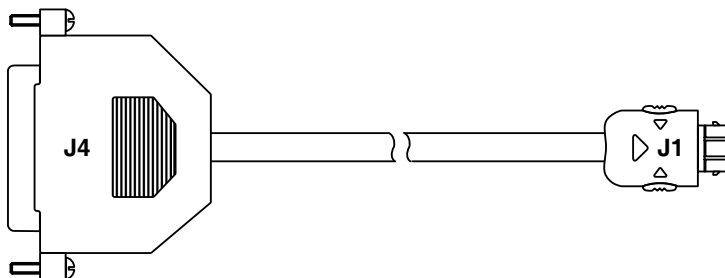
# Digital Step Attenuator

**ZX76-15R5-PN+**  
**ZX76-15R5-PN**

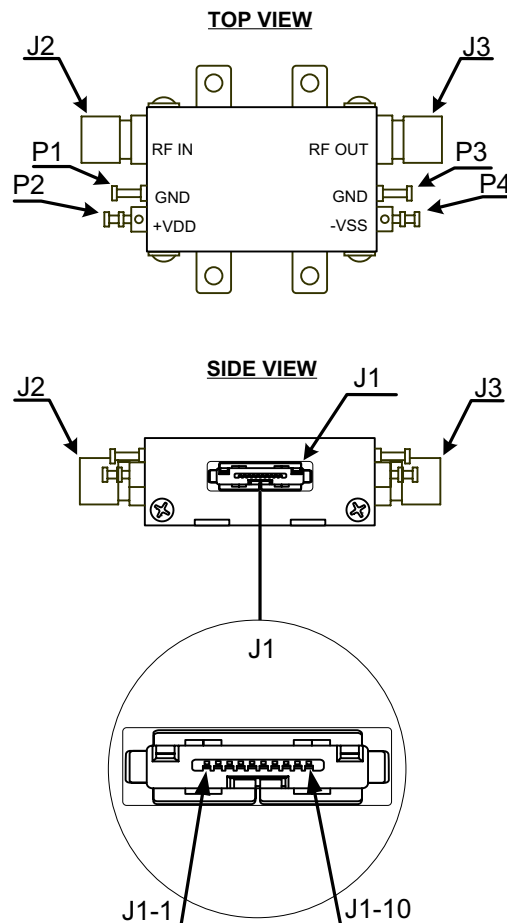
## Pin Description

| Function        | Pin Number | Description                         |
|-----------------|------------|-------------------------------------|
| LE              | J1-1       | Latch Enable Input                  |
| C1              | J1-2       | Control for attenuation bit, 1 dB   |
| C0.5            | J1-3       | Control for attenuation bit, 0.5 dB |
| N/C             | J1-4       | Not Connected                       |
| -               | J1-5       | Not used                            |
| GND             | J1-6       | Ground connection                   |
| GND             | J1-7       | Ground connection                   |
| C4              | J1-8       | Control for attenuation bit, 4 dB   |
| C8              | J1-9       | Control for attenuation bit, 8 dB   |
| C2              | J1-10      | Control for attenuation bit, 2 dB   |
| RF in           | J2         | RF in port (Note 1)                 |
| RF out          | J3         | RF out port (Note 1)                |
| GND             | P1         | Ground connection                   |
| V <sub>DD</sub> | P2         | Positive Supply Voltage             |
| GND             | P3         | Ground connection                   |
| V <sub>SS</sub> | P4         | Negative 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 |
|---------------|---------------|----------|-------------------------------------|------------|
| J1-1          | J4-8          | LE       | Latch Enable Input                  | WHITE      |
| J1-2          | J4-3          | C1       | Control for attenuation bit, 1 dB   | YELLOW     |
| J1-3          | J4-2          | C0.5     | Control for attenuation bit, 0.5 dB | GREEN      |
| J1-5          | J4-7          | -        | Not used                            | BLUE       |
| J1-6          | J4-20         | GND      | Ground connection                   | BLACK      |
| J1-8          | J4-5          | C4       | Control for attenuation bit, 4 dB   | ORANGE     |
| J1-9          | J4-6          | C8       | Control for attenuation bit, 8 dB   | BROWN      |
| J1-10         | J4-4          | C2       | Control for attenuation bit, 2 dB   | RED        |

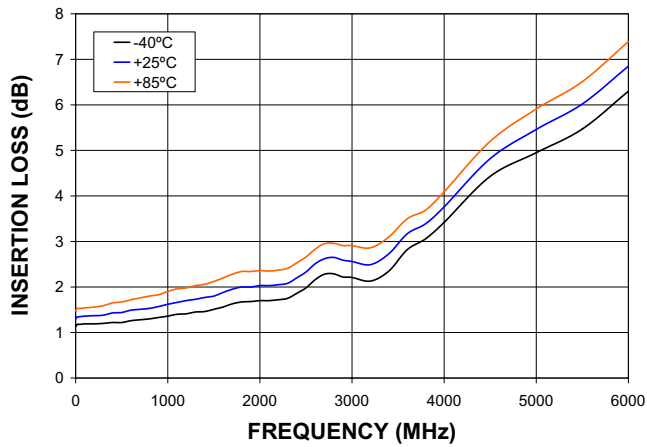
Note: Other pins not connected. Cable shield connected to case ground.

# Digital Step Attenuator

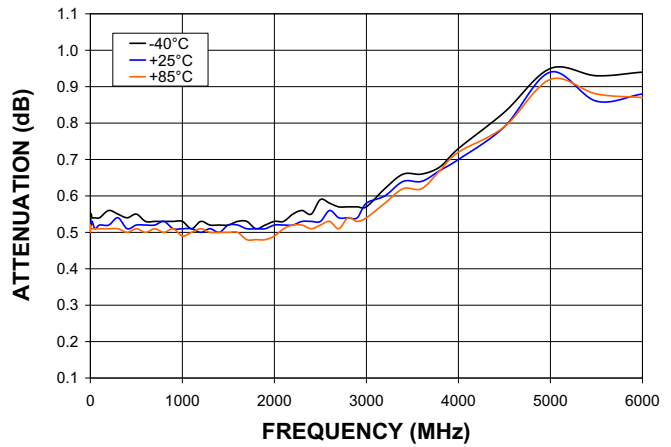
**ZX76-15R5-PN+**  
**ZX76-15R5-PN**

## Typical Performance Curves

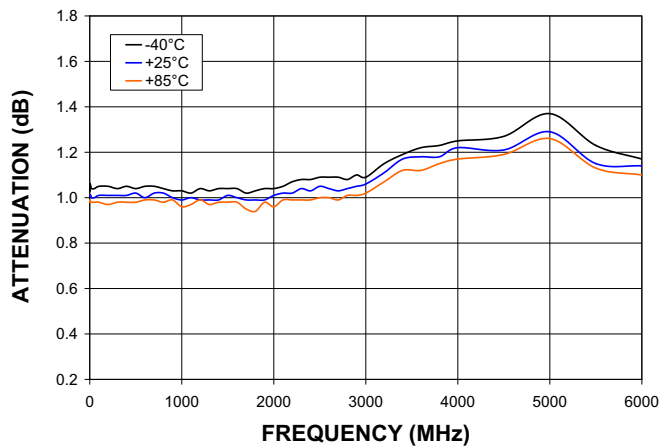
INSERTION LOSS (Ref)



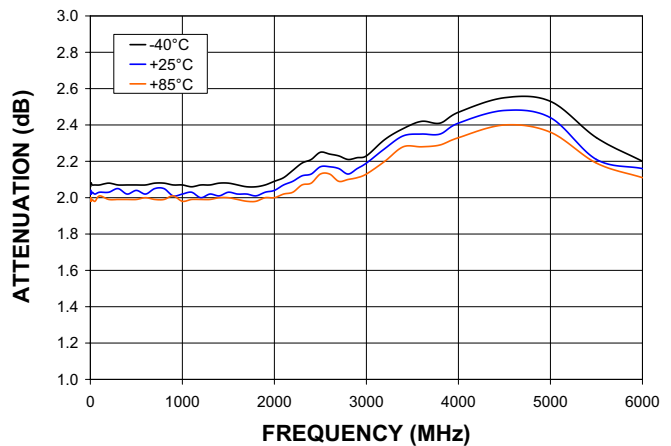
ATTENUATION (0.5 dB)



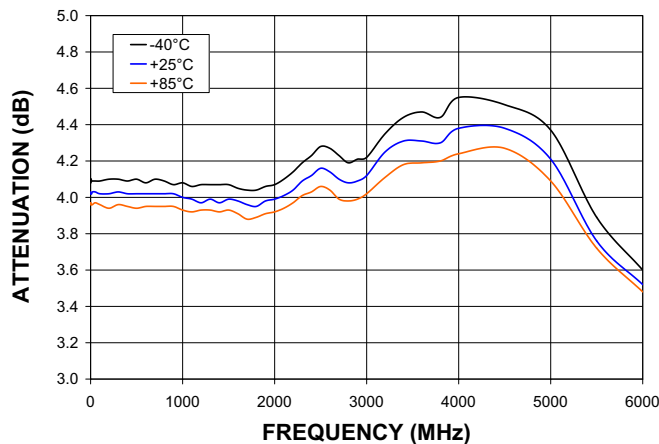
ATTENUATION (1 dB)



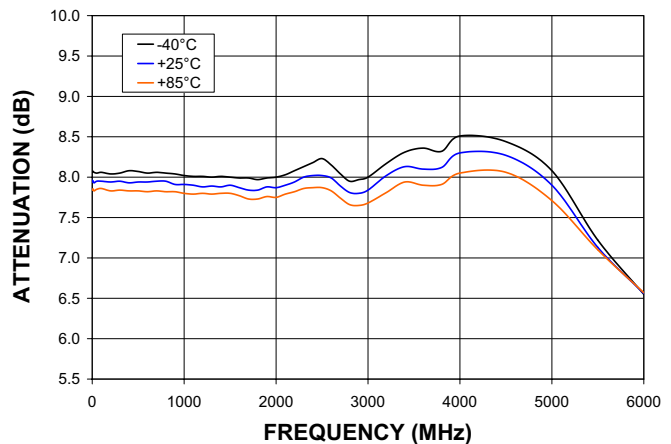
ATTENUATION (2 dB)



ATTENUATION (4 dB)



ATTENUATION (8 dB)

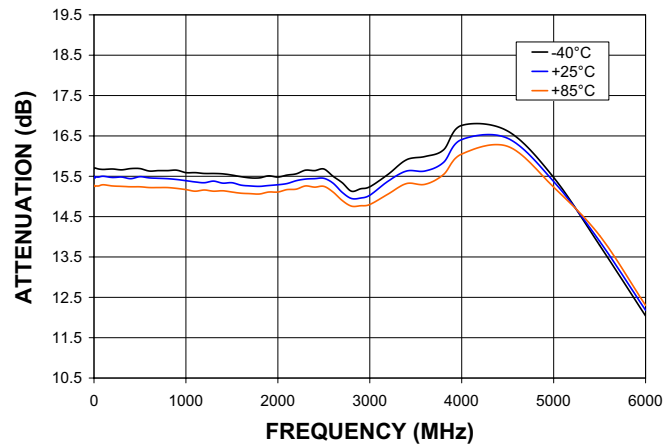


# Digital Step Attenuator

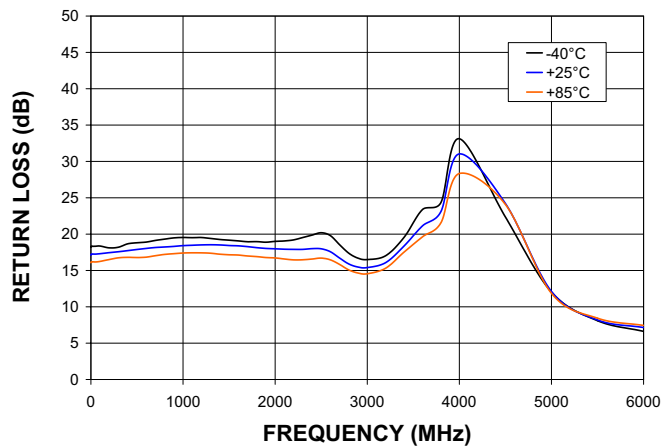
**ZX76-15R5-PN+**  
**ZX76-15R5-PN**

## Typical Performance Curves

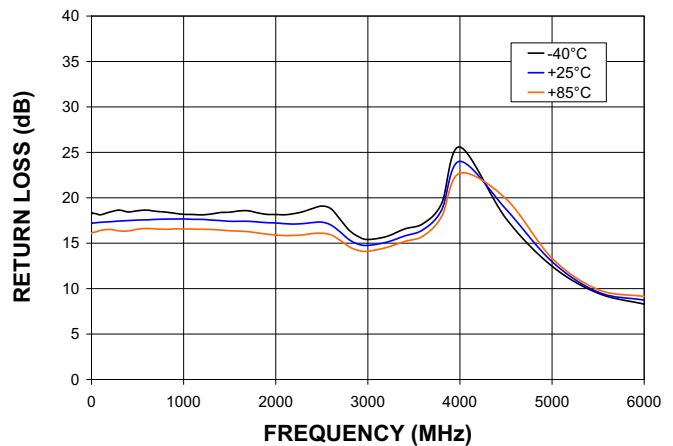
**ATTENUATION (15.5 dB)**



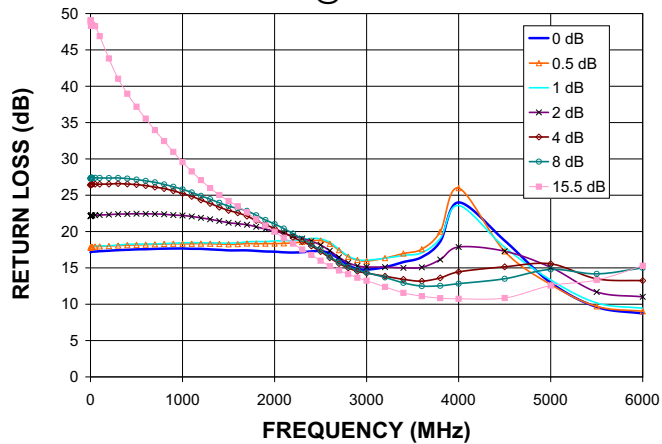
**RETURN LOSS IN (Ref)**



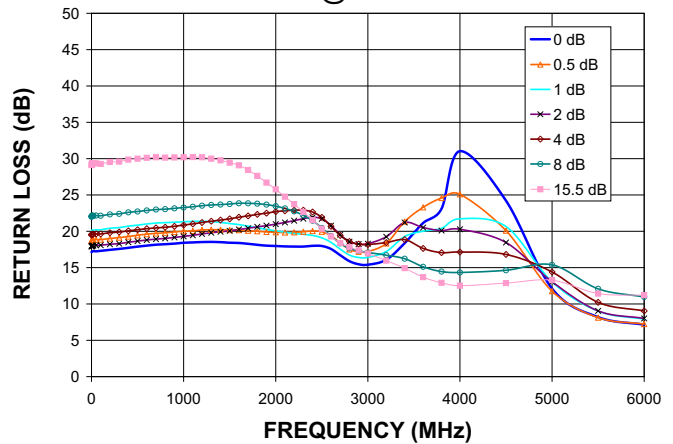
**RETURN LOSS OUT (Ref)**



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



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

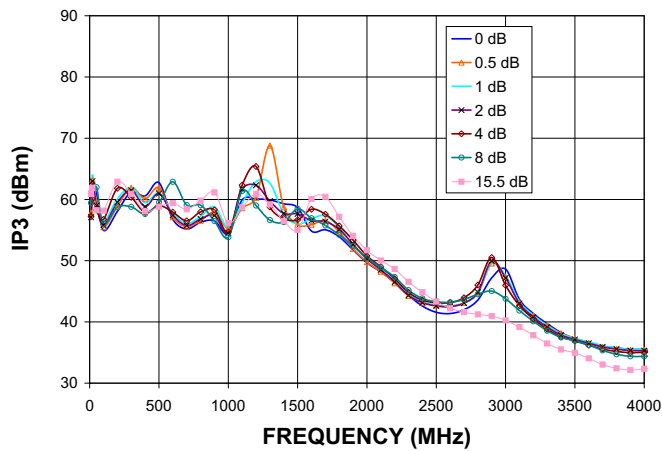


# Digital Step Attenuator

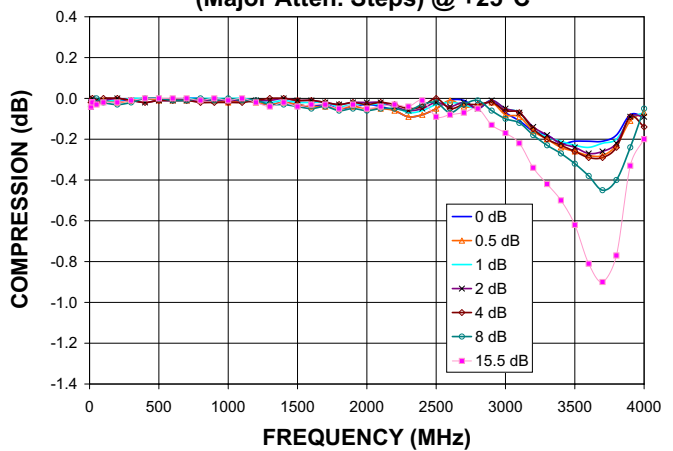
**ZX76-15R5-PN+**  
**ZX76-15R5-PN**

## Typical Performance Curves

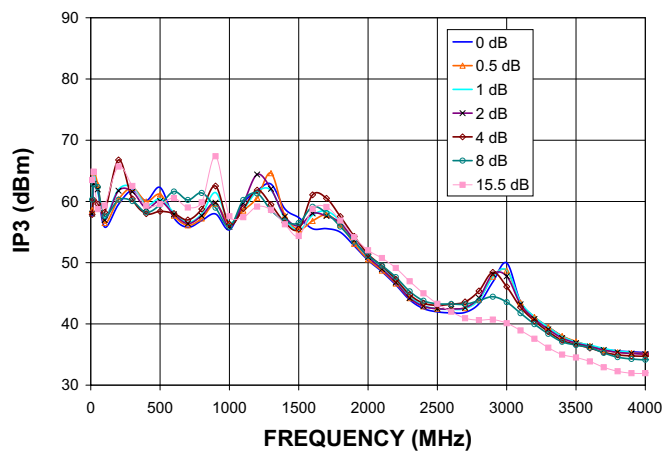
**IP3 (Major Atten. Steps) @ +25°C**



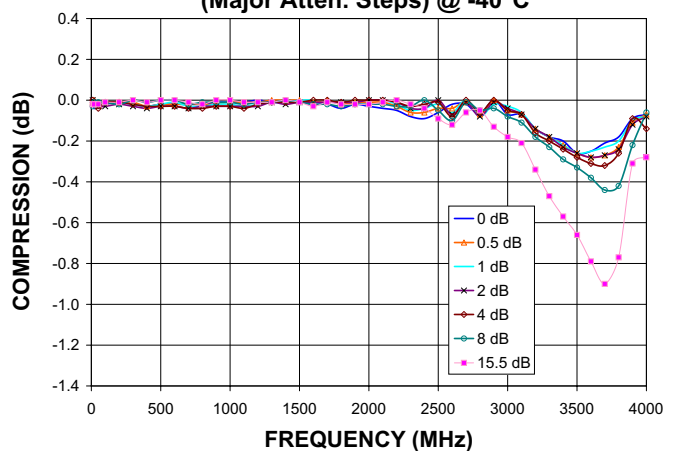
**COMPRESSION @ INPUT POWER=+24dBm  
(Major Atten. Steps) @ +25°C**



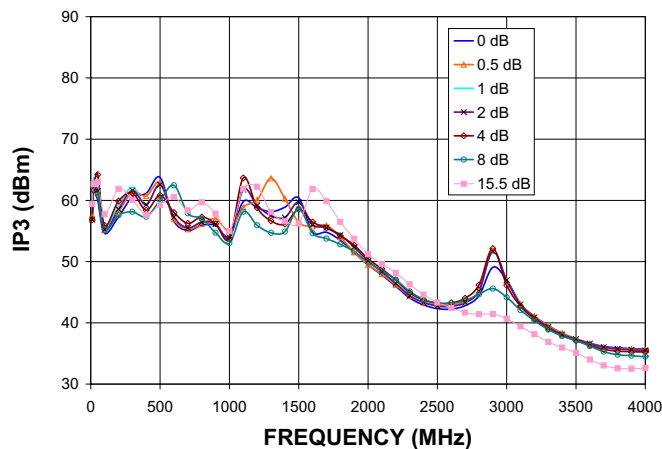
**IP3 (Major Atten. Steps) @ -40°C**



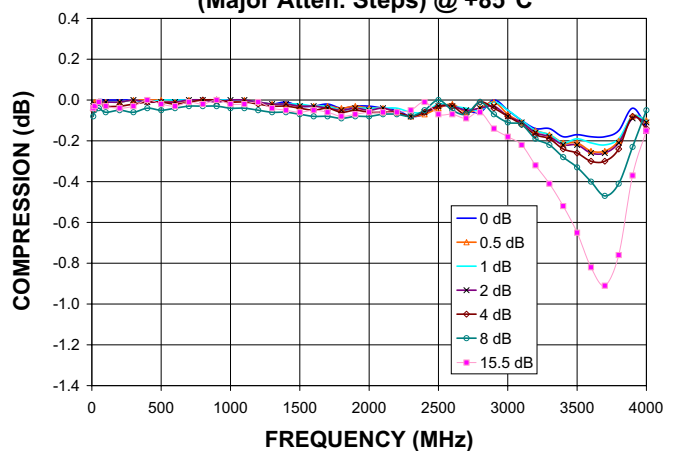
**COMPRESSION @ INPUT POWER=+24dBm  
(Major Atten. Steps) @ -40°C**



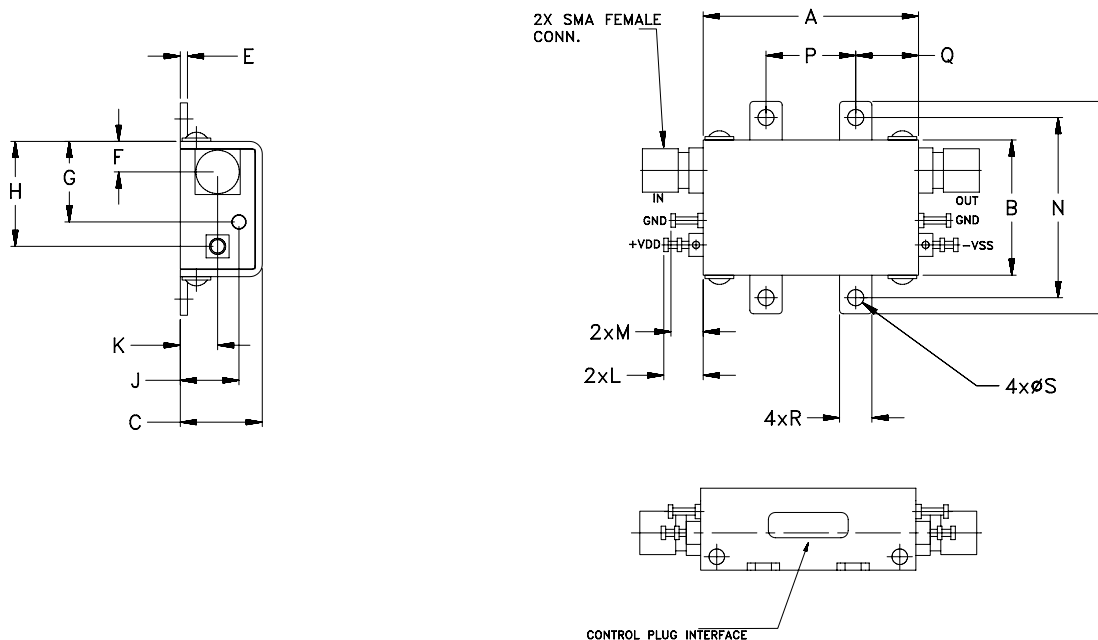
**IP3 (Major Atten. Steps) @ +85°C**



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



### Outline Drawing



### Outline Dimensions (inch mm)

| A    | B    | C    | D    | E   | F   | G    | H    | J   | K   | L   | M   | N    | P    | Q   | R   | S   | WT.<br>GRAMS |
|------|------|------|------|-----|-----|------|------|-----|-----|-----|-----|------|------|-----|-----|-----|--------------|
| .120 | .75  | .46  | 1.18 | .04 | .17 | .45  | .59  | .33 | .21 | .22 | .18 | 1.00 | .50  | .35 | .18 | .09 | 35.0         |
| 30.5 | 19.1 | 11.6 | 30.0 | 1.0 | 4.3 | 11.4 | 14.9 | 8.3 | 5.3 | 5.6 | 4.6 | 25.4 | 12.7 | 8.9 | 4.6 | 2.3 |              |

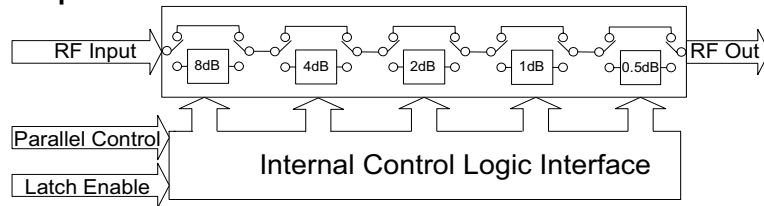
### Recommended Mounting Hardware:

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

# Digital Step Attenuator

**ZX76-15R5-PN+**  
**ZX76-15R5-PN**

## Simplified Schematic



The ZX76-15R5-PN(+) parallel interface consists of 5 control bits that select the desired attenuation state, as shown in Table 1: Truth Table

| Table 1. Truth Table   |    |    |    |    |      |
|--|----|----|----|----|------|
| Attenuation State  | C8 | C4 | C2 | C1 | C0.5 |
| Reference  | 0  | 0  | 0  | 0  | 0    |
| 0.5 (dB)   | 0  | 0  | 0  | 0  | 1    |
| 1 (dB)   | 0  | 0  | 0  | 1  | 0    |
| 2 (dB)   | 0  | 0  | 1  | 0  | 0    |
| 4 (dB)   | 0  | 1  | 0  | 0  | 0    |
| 8 (dB)   | 1  | 0  | 0  | 0  | 0    |
| 15.5 (dB)  | 1  | 1  | 1  | 1  | 1    |
| Note: Not all 32 possible combinations of C0.5 - C8 are shown in table |    |    |    |    |      |

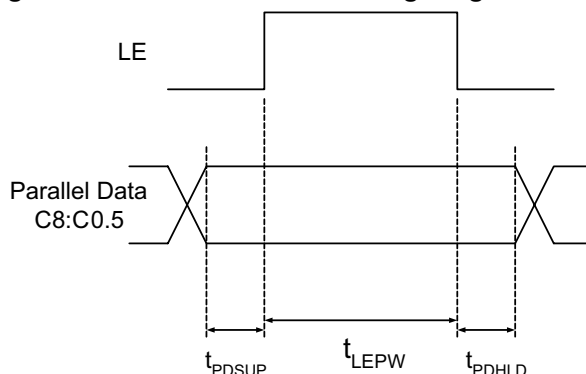
The parallel interface timing requirements are defined by Figure 1 (Parallel Interface Timing Diagram) and Table 2 (Parallel Interface AC Characteristics), and switching speed.

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 device.

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

Control cables for programming and CD with software can be ordered separately. For details see page 9.

**Figure 1: Parallel Interface Timing Diagram**



| Table 2. Parallel Interface AC Characteristics |   |      |       |
|--|---|------|-------|
| Symbol   | Parameter                                       | Min. | Units |
| $t_{LEPW}$                                     | LE minimum pulse width                          | 10   | ns    |
| $t_{PDSUP}$                                    | Data set-up time before clock rising edge of LE | 10   | ns    |
| $t_{PDHL}$                                     | Data hold time after clock falling edge of LE   | 10   | ns    |

## Power-up State

When the attenuator powers up and LE is logic low, the nominal attenuation is set on 0 dB. When LE is logic high, the nominal attenuation selected upon control logics ( see Table 1 ).

# Digital Step Attenuator

**ZX76-15R5-PN+**  
**ZX76-15R5-PN**

## Recommended Accessories

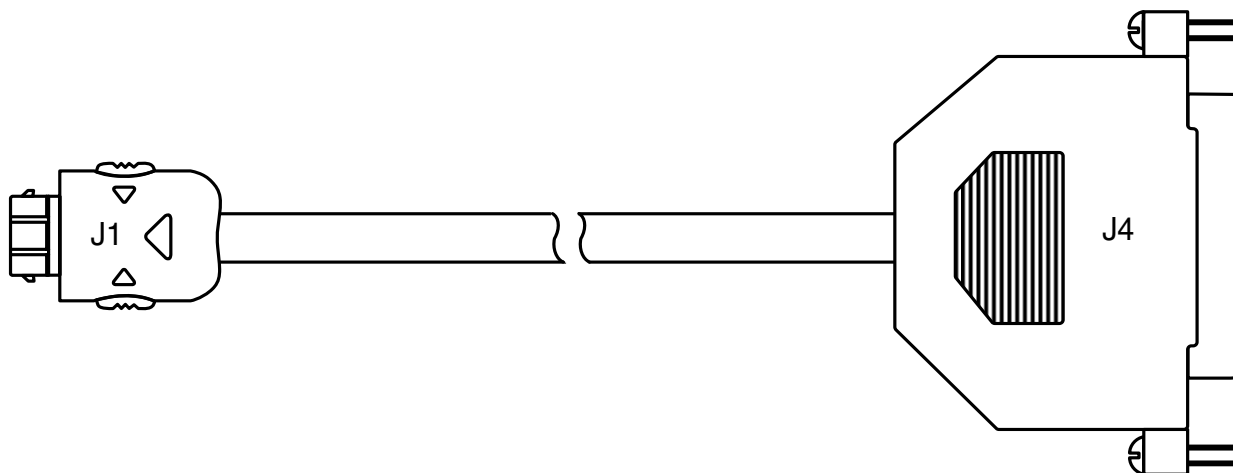
Two optional cable accessories with and without interface connector are available with ZX76-15R5-PN(+), the ZX76-CP+ and ZX76-WP+.

ZX76-CP+ shielded cable with interface 25 pin D-type connector and supplied software are used to control the ZX76-15R5-PN(+) digital attenuator from a computer, using LPT port.

ZX76-WP+ shielded cable without interface 25 pin D-type connector enables customer to use the ZX76-15R5-PN(+) digital attenuator in his own application. Cable length is 4.9 feet / 1.5 meters.

**Note:** Mini-Circuits can supply control cables with other options for the J4 connector and/or different cable lengths. Consult factory with your specific requirements.

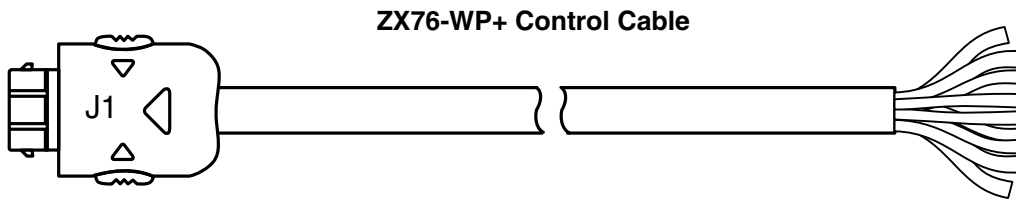
## ZX76-CP+ Control Cable



## ZX76-CP+ wiring information

| J1-Pin Number | J4-Pin Number | Function | Description                         | Wire Color |
|---------------|---------------|----------|-------------------------------------|------------|
| J1-1          | J4-8          | LE       | Latch Enable Input                  | WHITE      |
| J1-2          | J4-3          | C1       | Control for attenuation bit, 1 dB   | YELLOW     |
| J1-3          | J4-2          | C0.5     | Control for attenuation bit, 0.5 dB | GREEN      |
| J1-5          | J4-7          | -        | Not used                            | BLUE       |
| J1-6          | J4-20         | GND      | Ground connection                   | BLACK      |
| J1-8          | J4-5          | C4       | Control for attenuation bit, 4 dB   | ORANGE     |
| J1-9          | J4-6          | C8       | Control for attenuation bit, 8 dB   | BROWN      |
| J1-10         | J4-4          | C2       | Control for attenuation bit, 2 dB   | RED        |

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



### ZX76-WP+ wiring information

| Pin Number | Function | Description                         | Wire Color |
|------------|----------|-------------------------------------|------------|
| J1-1       | LE       | Latch Enable Input                  | WHITE      |
| J1-2       | C1       | Control for attenuation bit, 1 dB   | YELLOW     |
| J1-3       | C0.5     | Control for attenuation bit, 0.5 dB | GREEN      |
| J1-5       | -        | Not used                            | BLUE       |
| J1-6       | GND      | Ground connection                   | BLACK      |
| J1-8       | C4       | Control for attenuation bit, 4 dB   | ORANGE     |
| J1-9       | C8       | Control for attenuation bit, 8 dB   | BROWN      |
| J1-10      | C2       | Control for attenuation bit, 2 dB   | RED        |

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

### Ordering Information

| Model Number       | Description  | Quantity Min. No. of Units | Price \$ Ea. |
|--------------------|--|----------------------------|--------------|
| ZX76-15R5-PN-S (+) | Digital attenuator - Parallel interface Dual Voltage (Negative and Positive) | 1-9                        | 73.95        |
| ZX76-CP+           | Cable accessory with interface connector                                     | 1                          | 19.95        |
| ZX76-WP+           | Cable accessory without interface connector                                  | 1                          | 15.95        |
| ZX76-CD*           | CD ROM ZX76 programming software   | 1                          | No Charge    |

\*Note: To receive the CD, request when placing order.