

# Digital Step Attenuator

50Ω DC-4000 MHz

15.5 dB, 0.5 dB Step, 5 Bit, Serial 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

## Typical Applications

- Lab
- Instrumentation
- Test equipment



**ZX76-15R5-SN+**  
**ZX76-15R5-SN**

CASE STYLE: HK1149

Connectors	Order P/N
SMA	ZX76-15R5-SN-S+
SMA	ZX76-15R5-SN-S

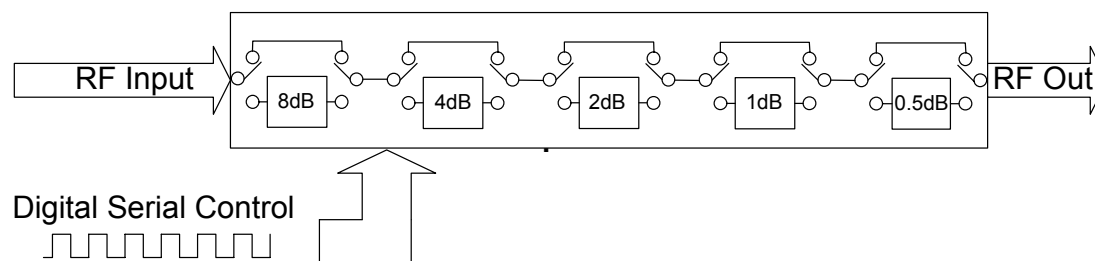
**+RoHS Compliant**

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

## General Description

The ZX76-15R5-SN(+) 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 serial 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 ZX15-15R5-SN(+) is produced using a unique case package for ruggedness and operation in tough environments.

## Simplified Schematic



# Digital Step Attenuator

ZX76-15R5-SN+  
ZX76-15R5-SN

## 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	0.3	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	0.3	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	0.5	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	0.5	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	0.5	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	4.0	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	—	—	1.5	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	-40°C to 85°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

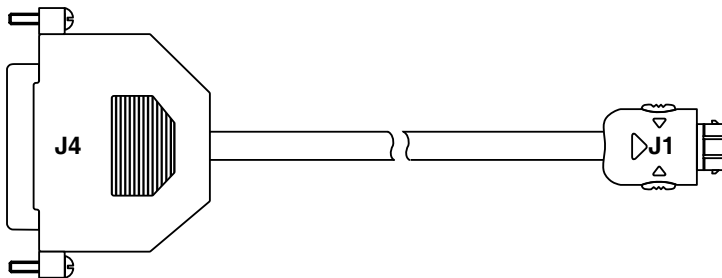
Permanent damage may occur if any of these limits are exceeded



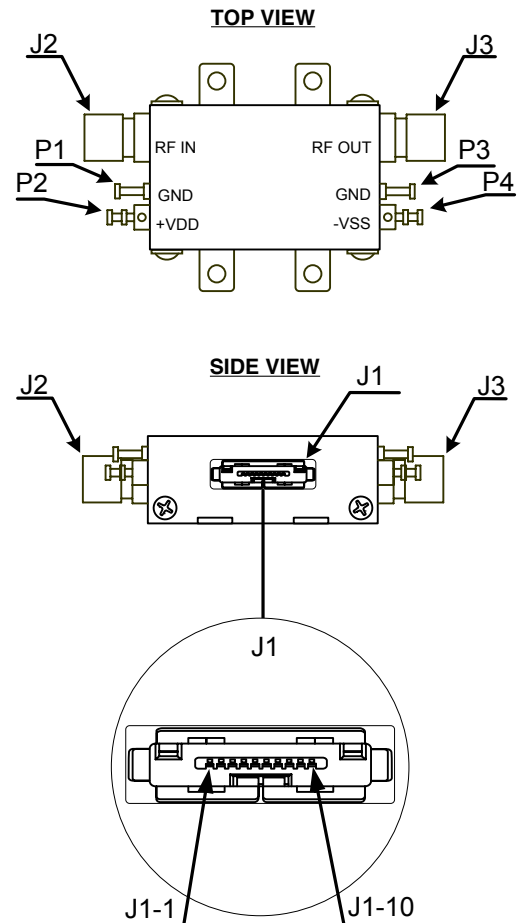
## Pin Description

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
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
J1-2	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

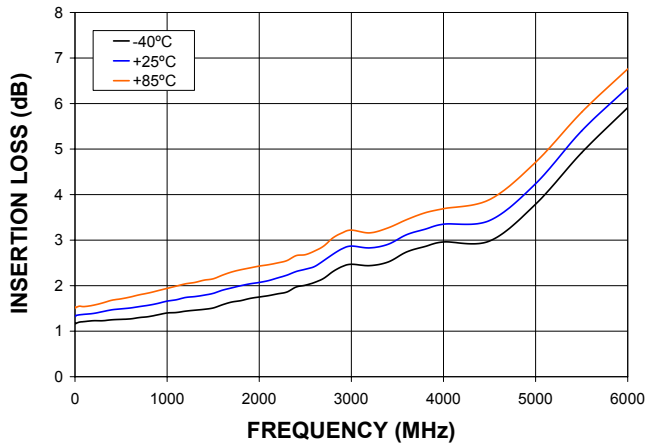
Note: Other pins not connected. Cable shield connected to case ground.

# Digital Step Attenuator

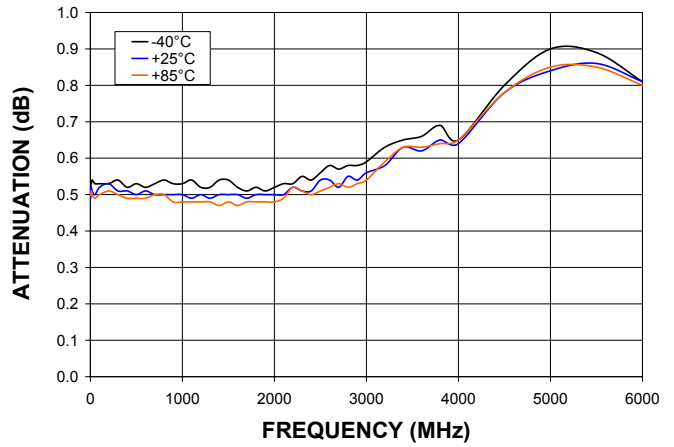
ZX76-15R5-SN+  
ZX76-15R5-SN

## Typical Performance Curves

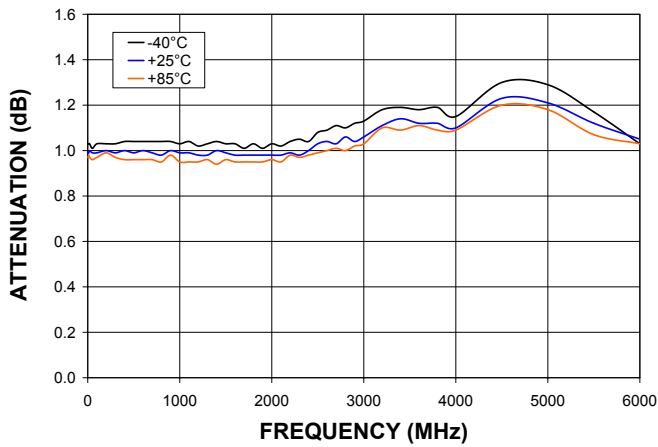
INSERTION LOSS (Ref)



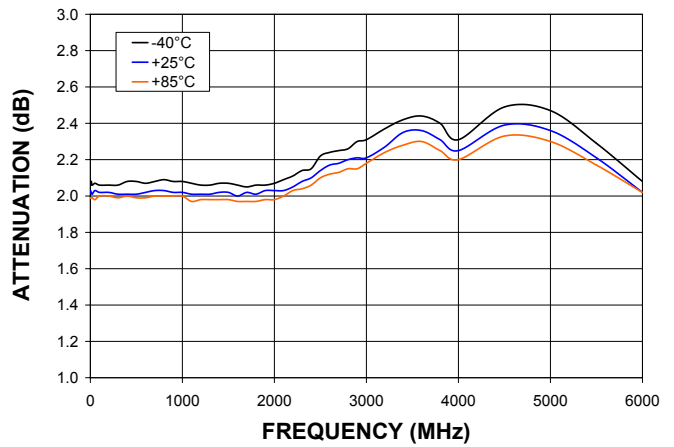
ATTENUATION (0.5 dB)



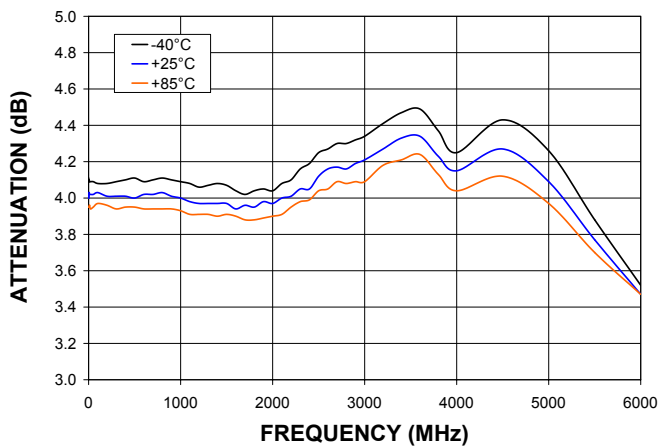
ATTENUATION (1 dB)



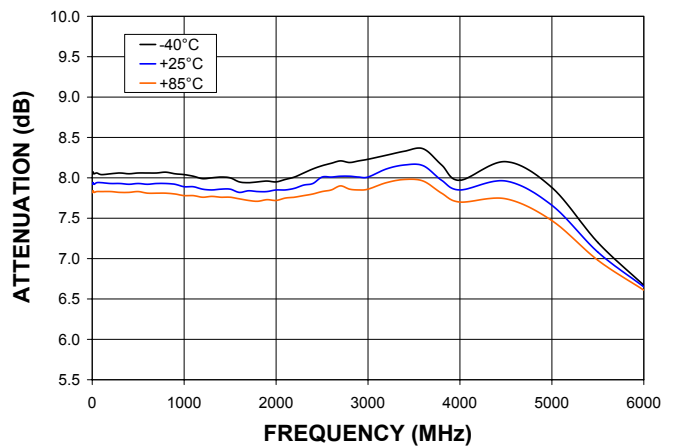
ATTENUATION (2 dB)



ATTENUATION (4 dB)

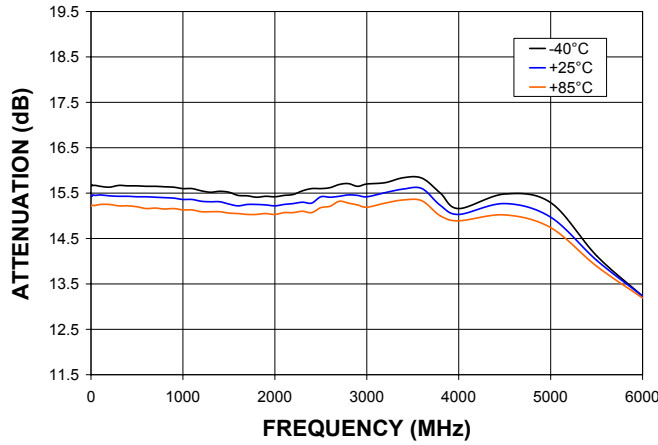


ATTENUATION (8 dB)

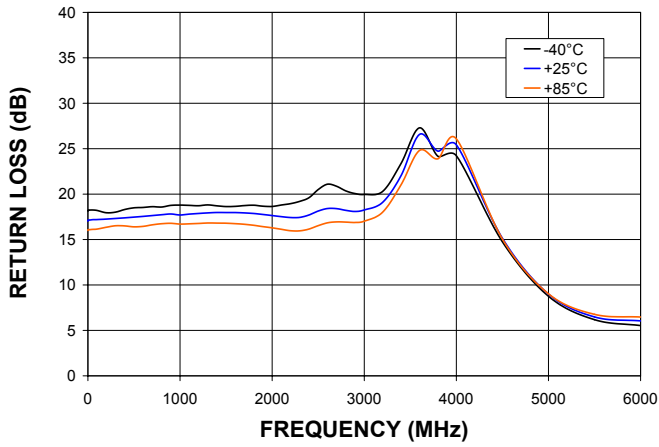


## Typical Performance Curves

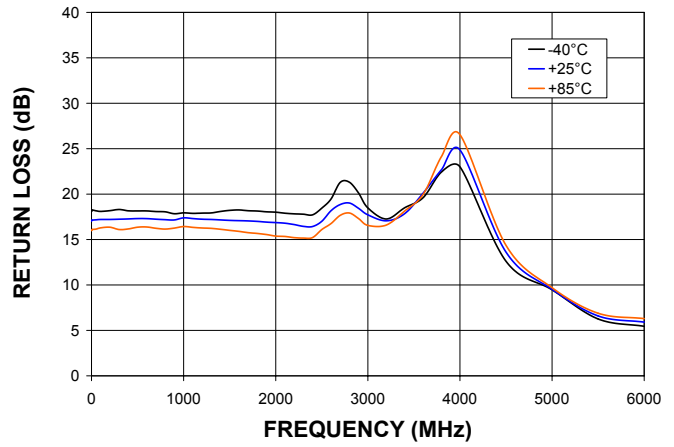
ATTENUATION (15.5 dB)



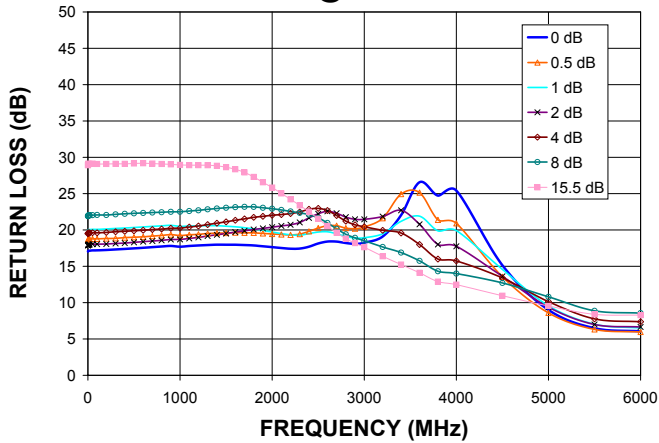
RETURN LOSS IN (Ref)



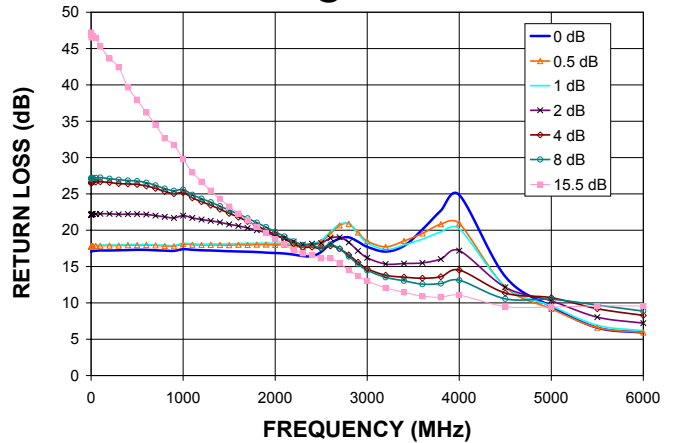
RETURN LOSS OUT (Ref)



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



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

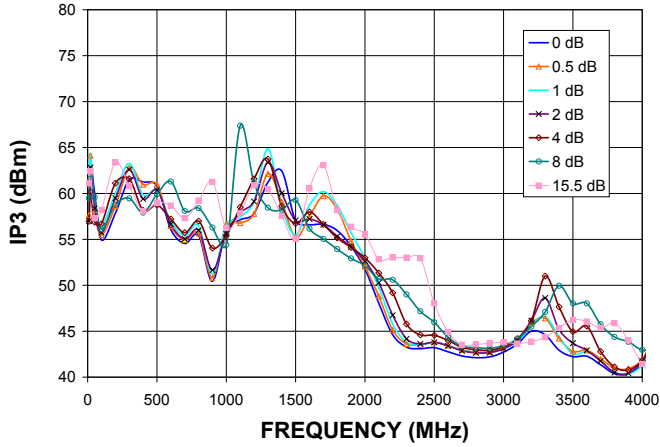


# Digital Step Attenuator

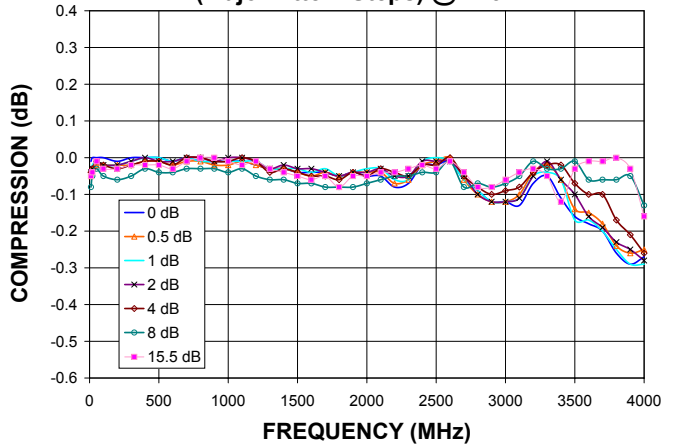
ZX76-15R5-SN+  
ZX76-15R5-SN

## Typical Performance Curves

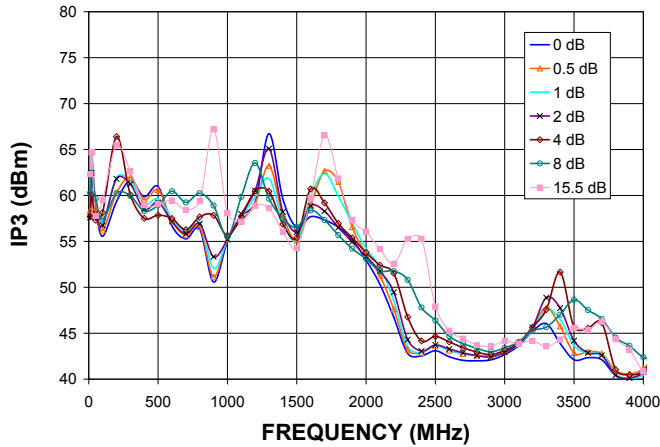
IP3 (Major Atten. Steps) @ +85°C



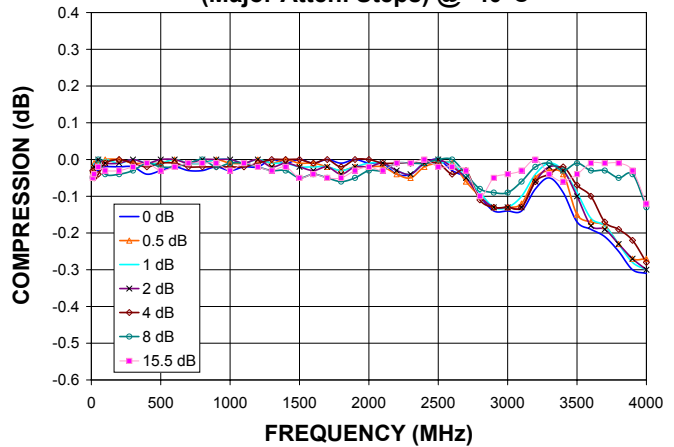
COMPRESSION @ INPUT POWER=+24dBm  
(Major Atten. Steps) @ +25°C



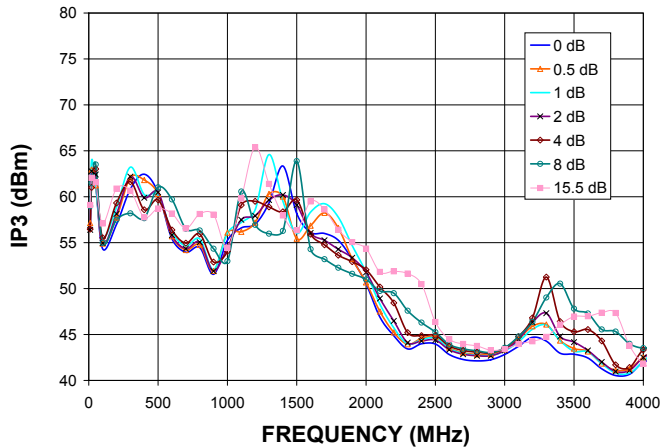
IP3 (Major Atten. Steps) @ -40°C



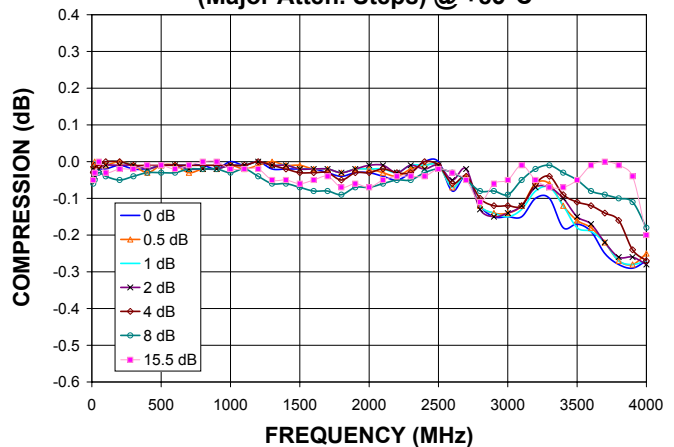
COMPRESSION @ INPUT POWER=+24dBm  
(Major Atten. Steps) @ -40°C



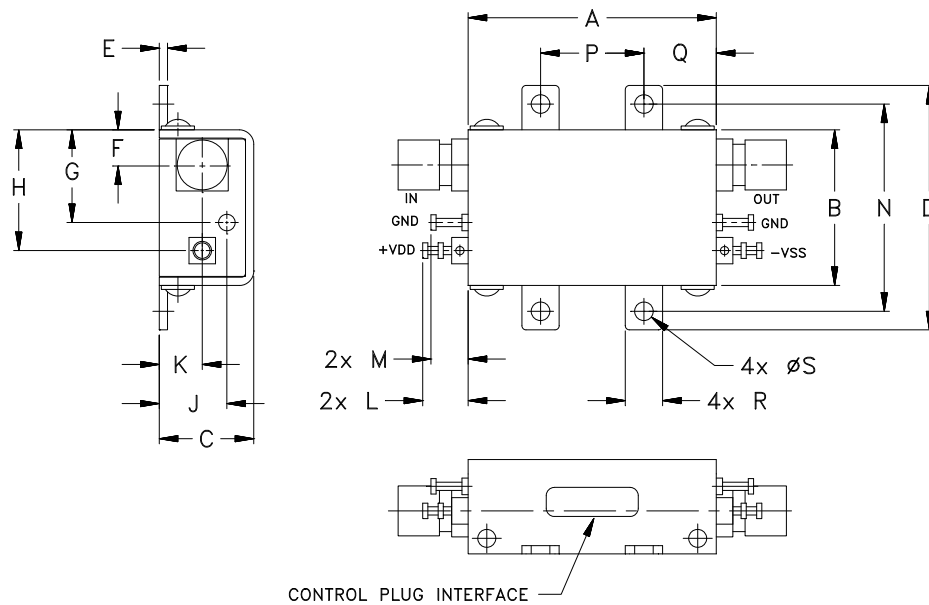
IP3 (Major Atten. Steps) @ +85°C



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



## Outline Drawing



**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)

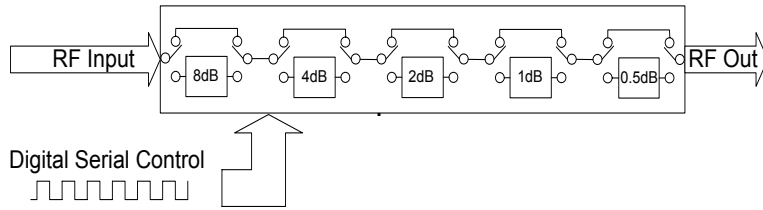
A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R	S	WT. GRAMS
1.20	.75	.46	1.18	.04	.17	.45	.59	.33	.21	.22	.18	1.00	.50	.35	.18	.106	35
30.5	19.1	11.6	30.0	1.0	4.3	11.4	14.9	8.3	5.3	5.6	4.6	25.4	12.7	8.9	4.6	2.69	

## Recommended Mounting Hardware:

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

# Digital Step Attenuator

## Simplified Schematic



The ZX76-15R5-SN(+) Serial interface consists of 5 control bits that select the desired attenuation state, as shown in 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

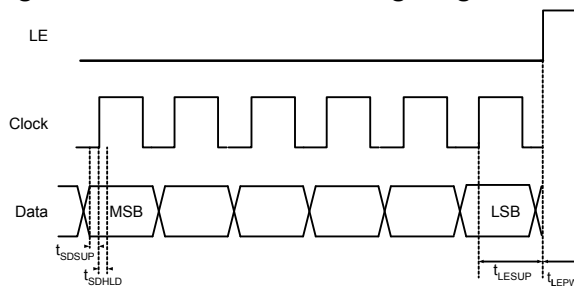
The serial interface is a 5-bit serial in, parallel-out shift register buffered by a transparent latch. It is controlled by three CMOS-compatible signals: Data, Clock, and Latch Enable (LE). The Data and Clock inputs allow data to be serially entered into the shift register, a process that is independent 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 and CD with software can be ordered separately. For details see page 10.

Figure 1: Serial Interface Timing Diagram



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. fclk verified during the functional pattern test. Serial programming sections of the functional pattern are clocked at 10MHz to verify fclk specification.



# Digital Step Attenuator

ZX76-15R5-SN+  
ZX76-15R5-SN

The ZX76-15R5-SN(+), uses a common 5-bit serial word format, as shown in Table 3: 5-Bit attenuator Serial Programming Register Map.

The B4 bit corresponds to the 8 dB Step and the last bit, the LSB, corresponds to the 0.5 dB step.

**Table 3. 5-Bit attenuator Serial Programming Register Map**

B5	B4	B3	B2	B1	B0
0	C8	C4	C2	C1	C0.5

↑  
MSB  
(first in)

↑  
LSB  
(last in)

**Note:** The start bit (B5) must always be low to prevent the attenuator from entering an unknown state.

# Digital Step Attenuator

ZX76-15R5-SN+  
ZX76-15R5-SN

## Recommended Accessories

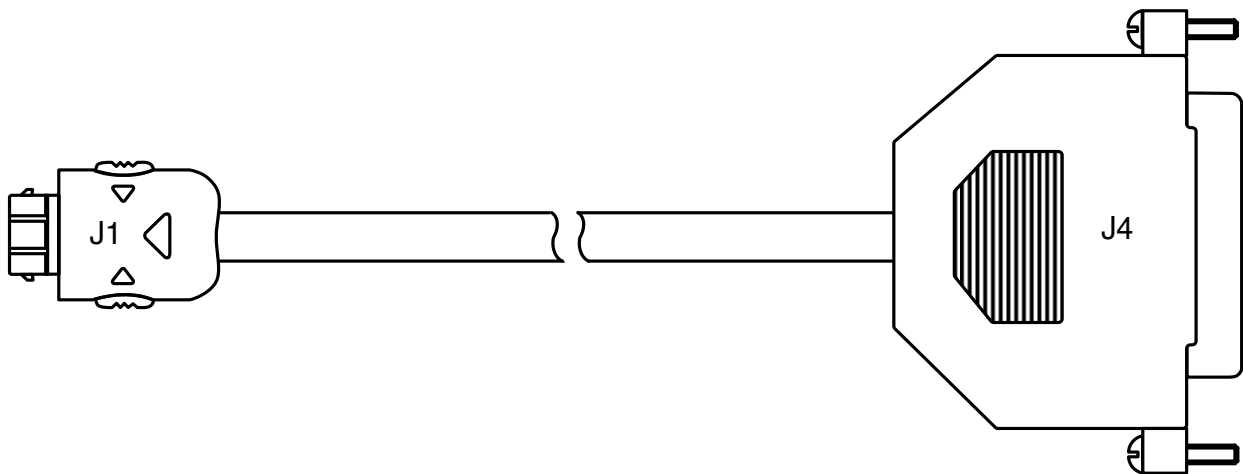
Two optional cable accessories with and without interface connector are available with ZX76-15R5-SN(+), the ZX76-CS+ and ZX76-WS+. Cable length is 4.9 feet / 1.5 meters.

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

ZX76-WS+ shielded cable without interface 25 pin D-type connector enables customer to use the ZX76-15R5-SN(+) digital attenuator in his own application.

**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.

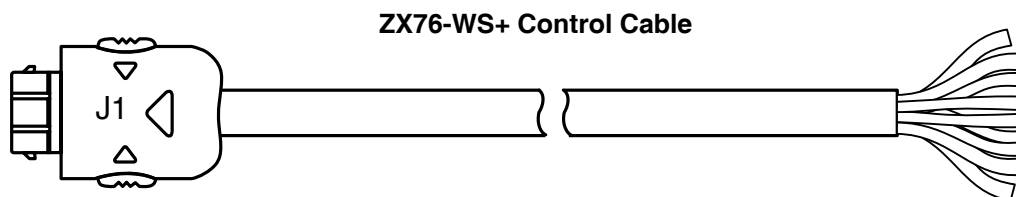
## ZX76-CS+ Control Cable



## 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.



### 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
ZX76-15R5-SN-S (+)	Digital attenuator - Serial interface Dual Voltage (Negative and Positive)
ZX76-CS+	Cable accessory with interface connector
ZX76-WS+	Cable accessory without interface connector
ZX76-CD*	CD ROM ZX76 programming software

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

### 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)