



## COAXIAL WIDEBAND

# Digital Step Attenuator **ZX76-15R5A-SPS+**

50Ω 15.5 dB, 0.5 dB Step DC to 4 GHz

### THE BIG DEAL

- 5-bit digital step attenuator
- Serial 3-wire control interface
- Low insertion loss
- Fast attenuation transitions
- No control software or PC required



Generic photo used for illustration purposes only

Model No.	ZX76-15R5A-SPS+
Case Style	HK1172
Connectors	SMA

### APPLICATIONS

- Test Setup
- Lab
- Instrumentation

### RoHS Compliant

See our website for RoHS Compliance methodologies and qualifications

### PRODUCT OVERVIEW

ZX76-15R5A-SPS+ is a 5-bit digital step attenuator with serial control and single positive supply voltage input. Attenuation can be set from 0 to 15 dB in 0.5 dB steps, with 0.1 dB typical accuracy. The attenuator is housed in a compact unibody package, with SMA RF connections and a snap-fit control input.

The serial 3-wire serial control interface supports simple integration with a wide range of microcontroller and custom I/O (input / output) control systems. Data is clocked into the internal shift register using 5V logic levels and then latched to set the attenuation.

For applications requiring Ethernet / USB control and software support, please review Mini-Circuits' R\_DAT series of programmable attenuators at <https://www.minicircuits.com/WebStore/RF-Programmable-Step-Attenuators.html>

### KEY FEATURES

Feature	Advantages
Wideband operation, from DC to 4 GHz	Supports a range of applications in communications, satellite and defense.
Excellent RF performance	Low insertion loss and 18 dB typical return loss minimize the impact on overall system performance.
Single voltage supply input	Use of 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, -140 dBm typical
Serial 3-wire control	Designed for integration with generic control systems at 5V logic levels, no PC or control software required.



RF ELECTRICAL SPECIFICATIONS, DC - 4 GHz,  $T_{AMB}=25^{\circ}\text{C}$ ,  $V_{DD}=+3\text{V}$ 

Parameter	Frequency (MHz)	Min.	Typ.	Max.	Units
Insertion Loss @ 0dB Attenuation Setting	DC - 1000	—	1.4	2.0	dB
	1000 - 2400	—	1.9	2.7	
	2400 - 4000	—	2.5	3.3	
Accuracy @ 0.5 dB Attenuation Setting	DC - 1000	—	$\pm 0.03$	$\pm 0.10$	dB
	1000 - 2400	—	$\pm 0.05$	$\pm 0.15$	
	2400 - 4000	—	$\pm 0.07$	$\pm 0.20$	
Accuracy @ 1 dB Attenuation Setting	DC - 1000	—	$\pm 0.02$	$\pm 0.10$	dB
	1000 - 2400	—	$\pm 0.05$	$\pm 0.15$	
	2400 - 4000	—	$\pm 0.10$	$\pm 0.25$	
Accuracy @ 2 dB Attenuation Setting	DC - 1000	—	$\pm 0.05$	$\pm 0.15$	dB
	1000 - 2400	—	$\pm 0.15$	$\pm 0.25$	
	2400 - 4000	—	$\pm 0.15$	$\pm 0.35$	
Accuracy @ 4 dB Attenuation Setting	DC - 1000	—	$\pm 0.07$	$\pm 0.20$	dB
	1000 - 2400	—	$\pm 0.15$	$\pm 0.25$	
	2400 - 4000	—	$\pm 0.23$	$\pm 0.50$	
Accuracy @ 8 dB Attenuation Setting	DC - 1000	—	$\pm 0.03$	$\pm 0.25$	dB
	1000 - 2400	—	$\pm 0.15$	$\pm 0.50$	
	2400 - 4000	—	$\pm 0.60$	$\pm 0.80$	
Input IP3 (at Min. and Max. Attenuation) <sup>1</sup>	DC - 4000	—	+52	—	dBm
Input Power @ 0.2dB Compression (at Min. and Max. Attenuation) <sup>1</sup>	DC - 4000	—	+24	—	
Input Operating Power	0.010 - 50	—	—	See figure 1	dBm
	50 - 4000	—	—	+24	
Return Loss	DC - 1000	12.5	21	—	dB
	1000 - 2400	11.5	18	—	
	2400 - 4000	10.0	15	—	

1. Input IP3 and 1dB compression degrade below 1 MHz. Input power not to exceed max operating specification for continuous operation.

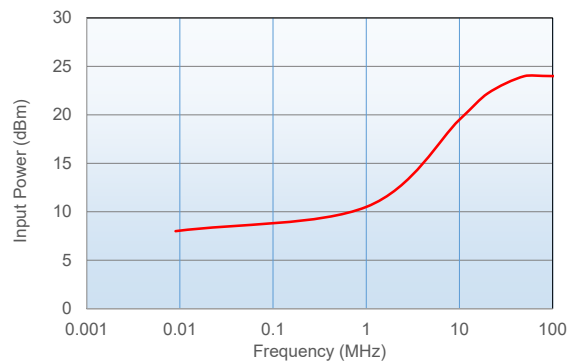
## DC ELECTRICAL SPECIFICATIONS

Parameter	Min.	Typ.	Max.	Units
Positive Supply Voltage, $V_{DD}$	+2.7	+3	+3.6	V
Positive Supply Current, $I_{DD}$	—	—	200	$\mu\text{A}$
Control Input Low	-0.3	—	+0.3x $V_{DD}$	V
Control Input High	+0.7x $V_{DD}$	—	+5	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	—	$\mu\text{sec}$
Switching Control Frequency	—	25	—	kHz

FIGURE 1: Max Input Operating Power vs Frequency



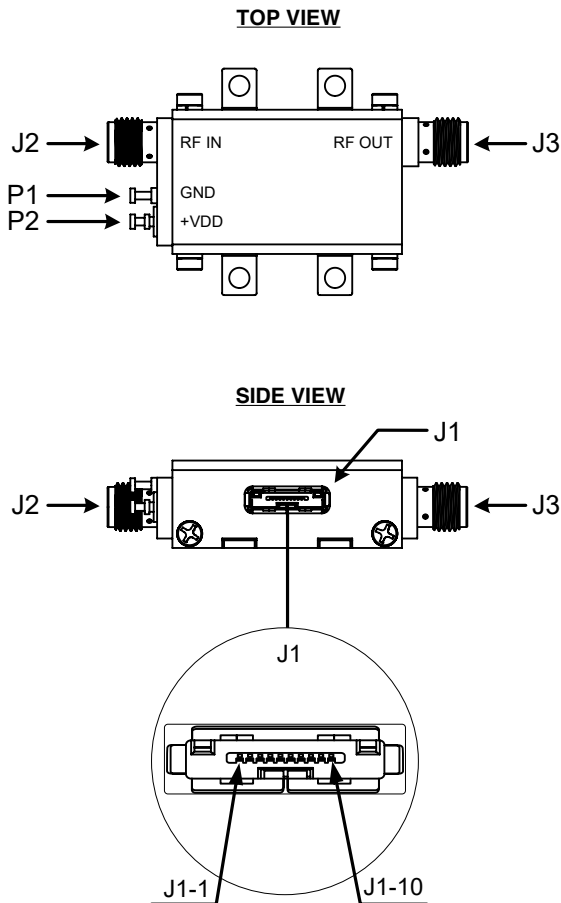


### ABSOLUTE MAXIMUM RATINGS

Parameter	Ratings
Operating Temperature	-40°C to 85°C
Storage Temperature	-40°C to 85°C
V <sub>DD</sub>	-0.3V Min., +5.5V Max.
V <sub>SS</sub>	-3.6V Min., +0.3V Max.
Voltage on any control input	-0.3V Min., +6V Max.
ESD, HBM	500V
ESD, MM	100V
Input Power	+30dBm

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.

### PIN CONFIGURATION



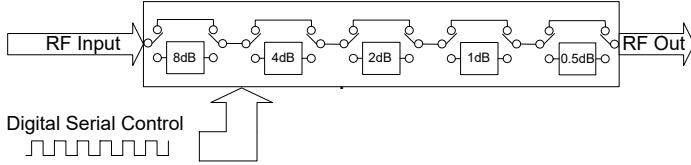
### PIN DESCRIPTION

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 <sup>2</sup>
RF out	J3	RF out port <sup>2</sup>
GND	P1	Ground Connection
V <sub>DD</sub>	P2	Positive Supply Voltage

<sup>2</sup> Both RF ports must be held at 0VDC or DC blocked with an external series capacitor.



### SIMPLIFIED SCHEMATIC



The ZX76-15R5A-SPS+ serial 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 serial interface is a 6-bit serial in, parallel-out shift register buffered by a transparent latch with the first bit being '0' and the last five bits being the control bits.

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 shift register triggers on the rising edge of the clock signal.

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.

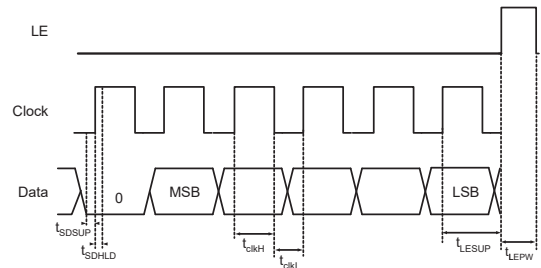
The timing for this operation is defined by Figure 2 (Serial Interface Timing Diagram) and Table 2 (Serial Interface AC Characteristics).

TABLE 2. SERIAL INTERFACE AC CHARACTERISTICS

Symbol	Parameter	Min.	Max.	Units
$f_{clk}$	Serial data clock frequency <sup>3</sup>		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 rising edge	10		ns
$t_{LEPW}$	LE minimum pulse width	30		ns
$t_{SDSUP}$	Serial data set-up rising edge	10		ns
$t_{SDHLD}$	Serial data hold time after clock rising edge	10		ns

<sup>3</sup>  $f_{clk}$  verified during the functional pattern test. Serial programming sections of the functional pattern are clocked at 10MHz to verify  $f_{clk}$  specification.

FIGURE 2: SERIAL INTERFACE TIMING DIAGRAM

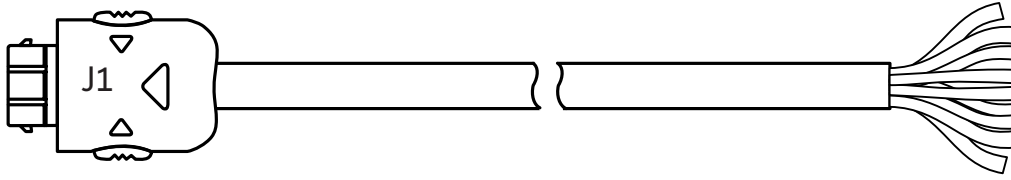


### POWER-UP STATE

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 ).



## ZX76-WS+ CONTROL CABLE



## RECOMMENDED ACCESSORIES

An optional ZX76-WS+ is a shielded cable on one end and a connector on the other end designed to mate to the ZX76-15R5A-SPS+. These bare wires enable the customer to assemble their own cable as required to interface with the ZX76-15R5A-SPS+ (cable length is 4.9ft/ 1.5meters).

## 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.



TYPICAL PERFORMANCE DATA (AT 25°C)

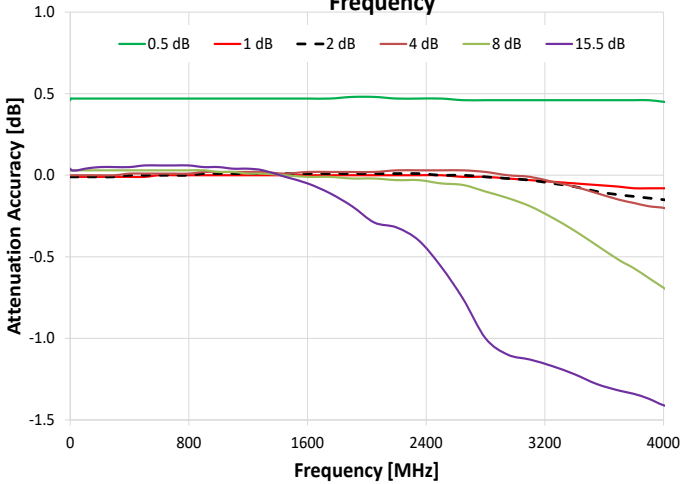
Freq. [MHz]	I.Loss [dB]	Attenuation relative to Insertion Loss [dB]					
		@ Attenuation setting [dB]					
		0.5	1	2	4	8	15.5
0.1	-1.21	0.46	-0.01	-0.01	0.00	0.03	0.04
1	-1.23	0.47	-0.01	-0.01	0.00	0.03	0.04
10	-1.24	0.47	-0.01	-0.01	0.00	0.03	0.03
100	-1.27	0.47	-0.01	-0.01	0.00	0.03	0.04
200	-1.31	0.47	-0.01	-0.01	0.00	0.03	0.05
400	-1.38	0.47	-0.01	0.00	0.01	0.03	0.05
500	-1.42	0.47	-0.01	0.00	0.01	0.03	0.06
700	-1.49	0.47	0.00	0.00	0.01	0.03	0.06
800	-1.54	0.47	0.00	0.00	0.01	0.03	0.06
1000	-1.61	0.47	0.00	0.01	0.02	0.02	0.05
1100	-1.65	0.47	0.00	0.01	0.02	0.02	0.04
1300	-1.73	0.47	0.00	0.01	0.02	0.01	0.03
1450	-1.79	0.47	0.00	0.01	0.01	0.00	-0.01
1750	-1.92	0.47	0.00	0.01	0.02	-0.01	-0.11
1900	-1.98	0.48	0.00	0.01	0.02	-0.02	-0.19
2200	-2.11	0.47	0.00	0.01	0.03	-0.03	-0.32
2350	-2.18	0.47	0.00	0.01	0.03	-0.03	-0.40
2650	-2.29	0.46	-0.01	0.00	0.03	-0.06	-0.76
2800	-2.32	0.46	-0.01	-0.01	0.02	-0.10	-1.00
3100	-2.39	0.46	-0.03	-0.03	-0.01	-0.19	-1.13
3250	-2.41	0.46	-0.04	-0.05	-0.04	-0.26	-1.17
3550	-2.44	0.46	-0.06	-0.10	-0.11	-0.43	-1.28
3700	-2.45	0.46	-0.07	-0.12	-0.15	-0.52	-1.32
3900	-2.48	0.46	-0.08	-0.14	-0.19	-0.63	-1.37
4000	-2.52	0.45	-0.08	-0.15	-0.20	-0.69	-1.41

Freq. [MHz]	Return Loss In [dB]							Return Loss Out [dB]						
	@ Attenuation setting [dB]							@ Attenuation setting [dB]						
	0	0.5	1	2	4	8	15.5	0	0.5	1	2	4	8	15.5
0.1	-18.79	-20.34	-21.87	-19.97	-21.00	-24.11	-28.22	-18.63	-19.24	-19.43	-24.48	-28.24	-32.18	-52.48
1	-18.66	-20.23	-21.75	-19.81	-20.79	-23.77	-28.28	-18.51	-19.13	-19.30	-24.34	-27.99	-31.68	-52.93
10	-18.54	-20.10	-21.62	-19.72	-20.73	-23.73	-28.44	-18.39	-19.02	-19.21	-24.20	-27.86	-31.61	-54.08
100	-18.57	-20.12	-21.63	-19.74	-20.74	-23.72	-28.45	-18.52	-19.15	-19.33	-24.35	-28.02	-31.76	-53.68
200	-18.59	-20.15	-21.66	-19.77	-20.78	-23.77	-28.48	-18.49	-19.12	-19.30	-24.30	-27.94	-31.64	-53.34
400	-18.58	-20.12	-21.61	-19.73	-20.70	-23.60	-28.44	-18.42	-19.03	-19.22	-24.10	-27.58	-30.96	-50.27
500	-18.59	-20.12	-21.60	-19.72	-20.68	-23.53	-28.34	-18.53	-19.14	-19.32	-24.22	-27.69	-30.98	-63.15
700	-18.54	-20.05	-21.51	-19.64	-20.58	-23.35	-27.90	-18.51	-19.11	-19.28	-24.10	-27.46	-30.44	-50.38
800	-18.53	-20.03	-21.49	-19.63	-20.56	-23.28	-27.46	-18.50	-19.10	-19.27	-24.06	-27.37	-30.24	-44.39
1000	-18.60	-20.08	-21.51	-19.63	-20.49	-23.06	-25.71	-18.49	-19.07	-19.23	-23.92	-27.04	-29.56	-35.53
1100	-18.45	-19.92	-21.32	-19.48	-20.32	-22.83	-25.00	-18.47	-19.06	-19.21	-23.87	-26.96	-29.35	-32.36
1300	-18.21	-19.58	-20.87	-19.05	-19.74	-21.82	-23.14	-18.43	-18.96	-19.05	-23.40	-25.97	-27.52	-27.38
1450	-18.16	-19.44	-20.63	-18.72	-19.19	-20.87	-21.89	-18.39	-18.82	-18.82	-22.80	-24.76	-25.59	-24.62
1750	-18.02	-19.10	-20.04	-17.94	-18.07	-19.27	-19.99	-18.59	-18.74	-18.53	-21.92	-22.78	-23.15	-20.30
1900	-18.03	-18.96	-19.75	-17.70	-17.77	-19.05	-19.36	-18.33	-18.34	-18.09	-21.00	-21.52	-22.19	-18.57
2200	-16.33	-16.85	-17.27	-16.23	-16.59	-18.37	-17.35	-17.11	-16.99	-16.87	-18.66	-19.11	-21.03	-16.04
2350	-15.74	-16.13	-16.45	-15.95	-16.61	-18.97	-15.59	-16.08	-16.01	-16.02	-17.33	-17.92	-20.53	-15.23
2650	-14.58	-14.86	-15.07	-15.20	-16.20	-19.23	-13.43	-14.64	-14.69	-14.85	-15.74	-16.50	-19.69	-14.54
2800	-14.41	-14.63	-14.78	-15.16	-16.30	-19.58	-12.82	-14.20	-14.29	-14.49	-15.28	-16.08	-19.41	-14.17
3100	-14.14	-14.30	-14.36	-15.11	-16.45	-19.79	-12.53	-13.82	-13.96	-14.21	-14.75	-15.51	-18.80	-13.23
3250	-14.11	-14.22	-14.22	-15.13	-16.46	-19.38	-12.66	-13.91	-14.08	-14.34	-14.75	-15.46	-18.62	-12.90
3550	-14.01	-13.95	-13.79	-14.86	-15.83	-17.18	-12.52	-14.85	-15.02	-15.28	-15.26	-15.68	-18.10	-12.58
3700	-13.95	-13.81	-13.59	-14.62	-15.33	-15.99	-12.47	-15.81	-15.95	-16.20	-15.76	-15.94	-17.75	-12.43
3900	-13.72	-13.53	-13.24	-14.13	-14.52	-14.60	-12.24	-17.04	-17.14	-17.36	-16.18	-15.99	-16.83	-12.33
4000	-13.77	-13.60	-13.30	-14.15	-14.51	-14.49	-12.26	-17.39	-17.45	-17.64	-16.09	-15.76	-16.18	-12.34

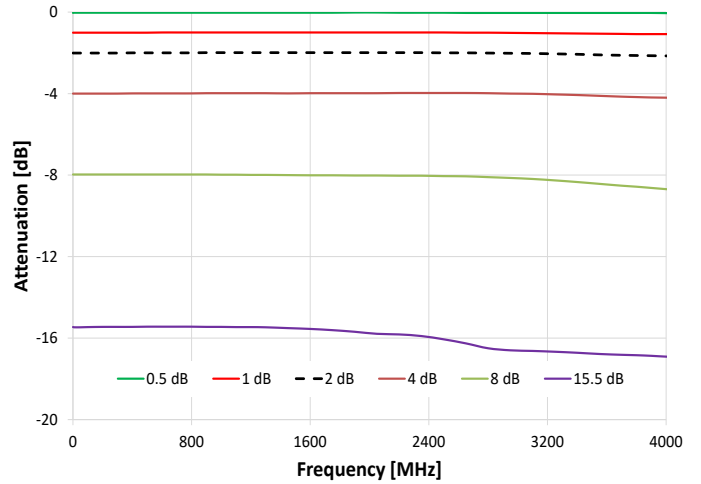


### TYPICAL PERFORMANCE CURVES (AT 25°C)

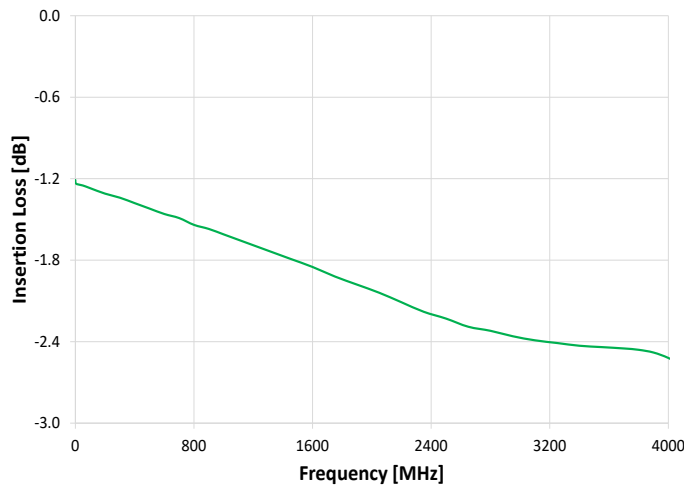
Attenuation Accuracy relative to Insertion Loss vs. Frequency



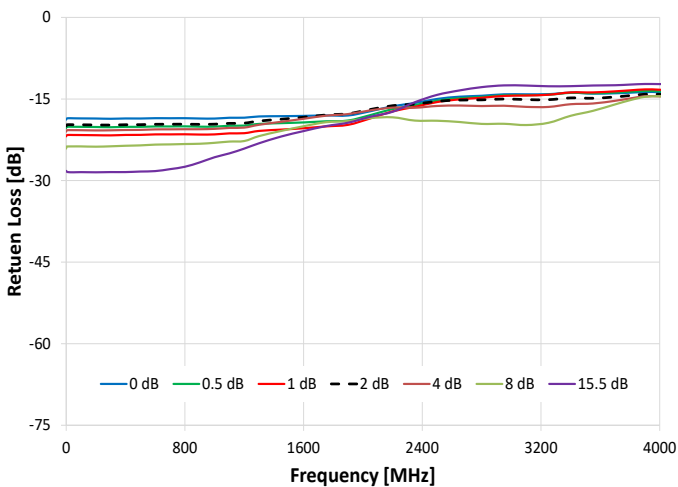
Attenuation relative to Insertion Loss vs. Frequency



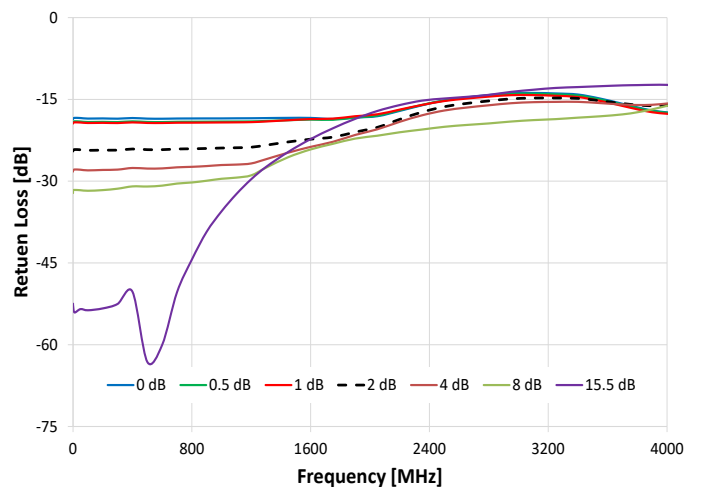
Insertion Loss vs. Frequency



R. Loss In vs. Frequency over Attenuation settings




R. Loss Out vs. Frequency over Attenuation settings





### ORDERING INFORMATION

Model	Description
ZX76-15R5A-SPS+	Digital attenuator - Serial interface, Dual Voltage (Positive & Negative)

Recommended Accessories	Part No.	Description
	ZX76-WS+	4.9 ft. (1.5M) Control Cable

### ADDITIONAL DETAILED TECHNICAL INFORMATION

Performance Data	Data Table
	Swept Graphs
	S-Parameter (S2P Files) Data Set (.zip.file)
Case Style	HK1172
Environmental Rating	ENV28T14

Additional information is available on our dash board. To access this information [click here](#)

- 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/MCLStore/terms.jsp](http://www.minicircuits.com/MCLStore/terms.jsp)