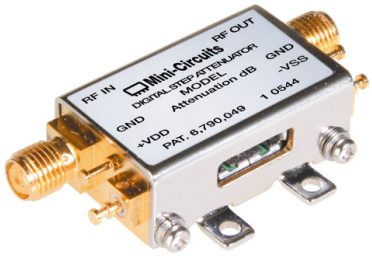
NON-CATALOG

Digital Step Attenuator

50Ω DC-2400 MHz

31 dB, 1 dB Step, 5 Bit, Serial Control Interface
Dual Supply Voltage



CASE STYLE: HK1149

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

ZX76-31-SN-S+

Connectors	Order P/N
SMA	ZX76-31-SN-S+

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

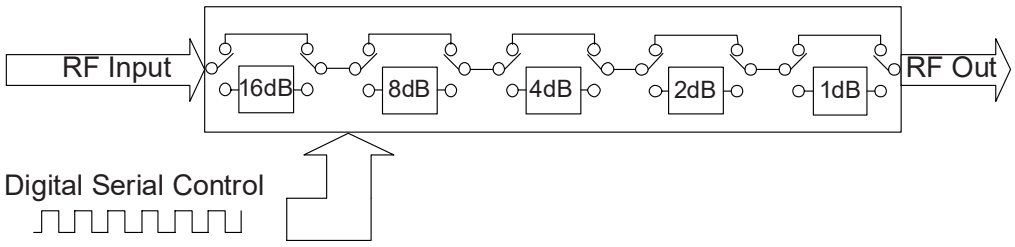
Typical Applications

- Lab
- Instrumentation
- Test equipment

General Description

The ZX76-31R5-SN-S+ is a 50Ω RF digital step attenuator that offers an attenuation range up to 31 dB in 1.0 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 ZX76-31R5-SN-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°C, V_{DD}=+3V, V_{SS}=-3V

Parameter	Freq. Range (GHz)	Min.	Typ.	Max.	Units
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
V_{SS}, Supply Voltage	-3.3	-3	-2.7	V
I_{DD}, Supply Current	—	—	1.5	mA
I_{SS}, Supply Current	—	—	100	µA
Control Input Voltage Low	0	—	0.3xV_{DD}	V
Control Input Voltage High	0.7xV_{DD}	—	5V	V
Control Current	—	—	400	µA

Switching Specifications

Parameter	Min.	Typ.	Max.	Units
Switching Speed, 50% Control to 0.5dB of Attenuation Value	—	1.0	—	µSec
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}, Supply Voltage	-0.3V Min., 4V Max.
V_{SS}, Supply Voltage	-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

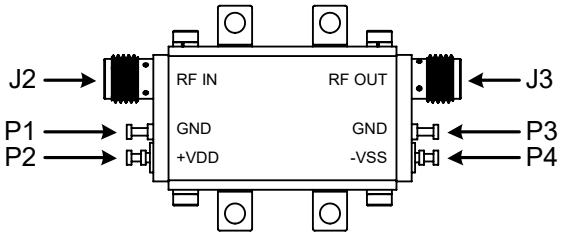
Pin Description

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_{DD}	P2	Positive Supply Voltage
GND	P3	Ground connection
V_{SS}	P4	Negative Supply Voltage

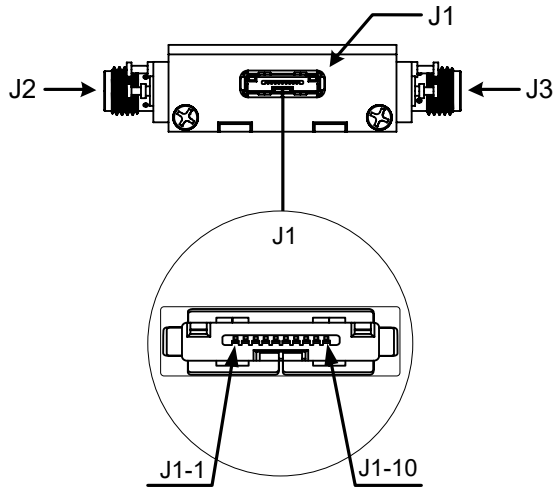
Note 1: Both RF ports must be held at 0VDC or DC blocked with an external series capacitor.

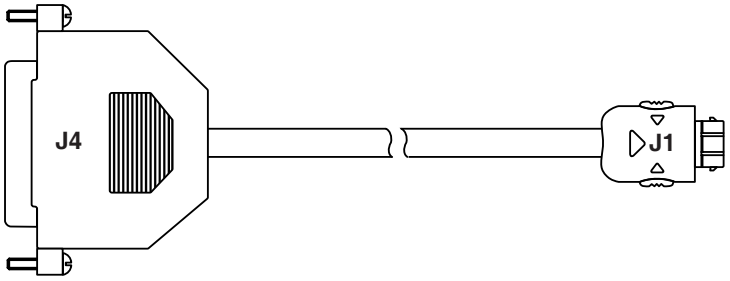
Pin Configuration

TOP VIEW



SIDE VIEW





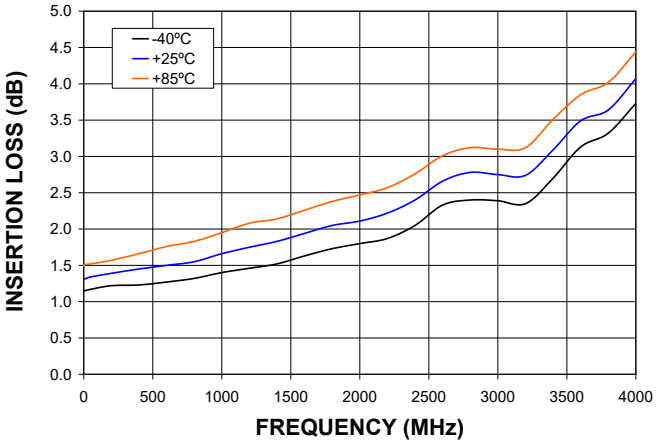
Cable Pin Description

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

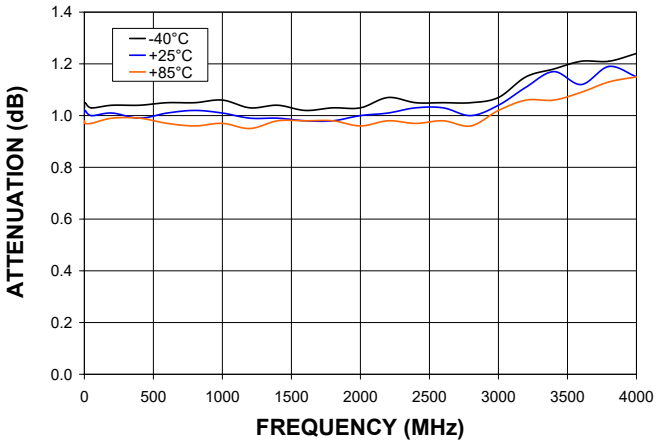
Note: Other pins not connected. Cable shield connected to case ground.

Typical Performance Curves

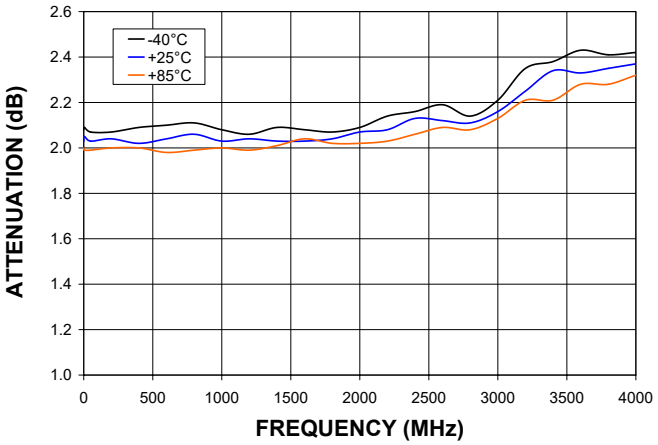
INSERTION LOSS (Ref)



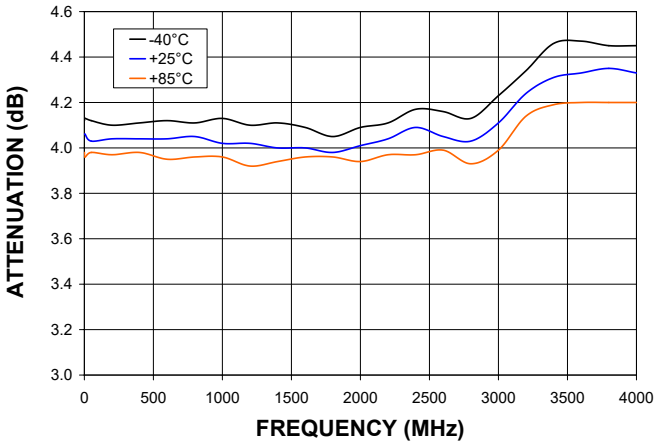
ATTENUATION (1 dB)



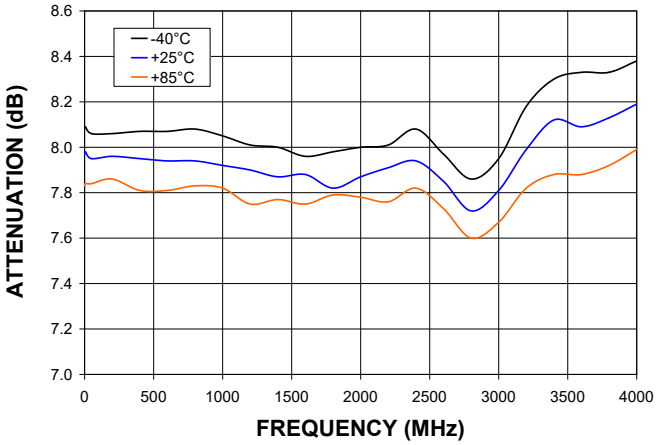
ATTENUATION (2 dB)



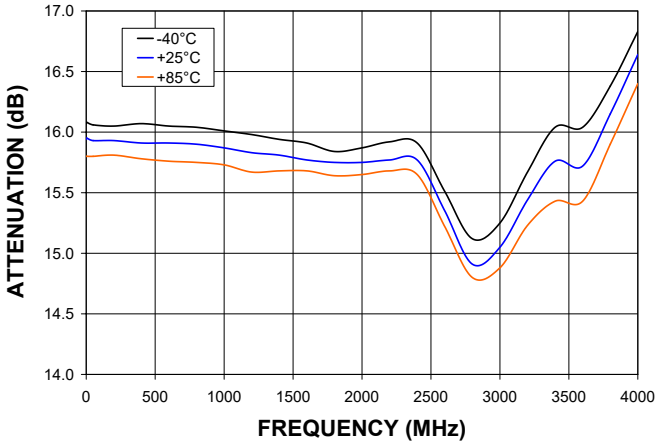
ATTENUATION (4 dB)



ATTENUATION (8 dB)

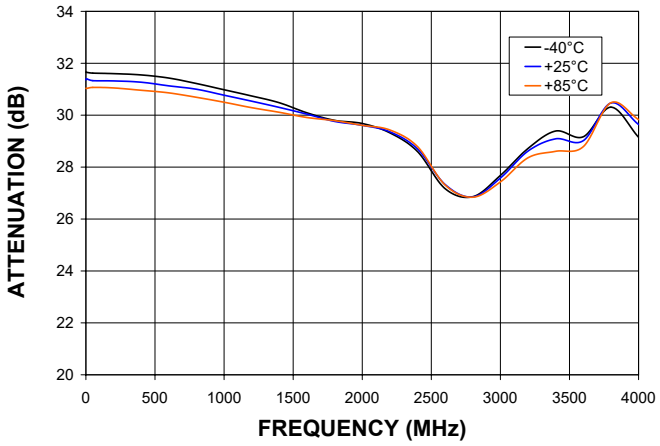


ATTENUATION (16 dB)

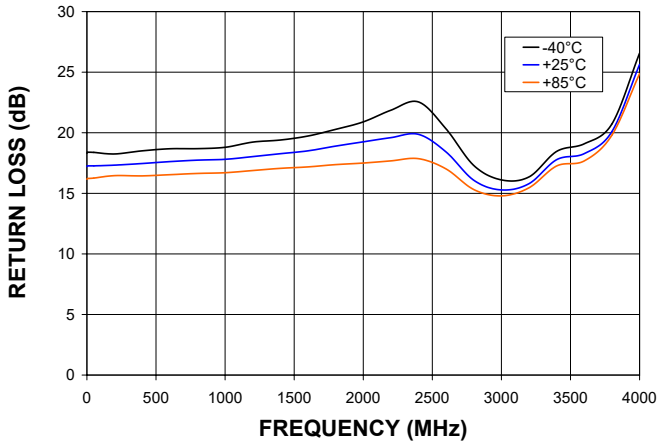


Typical Performance Curves

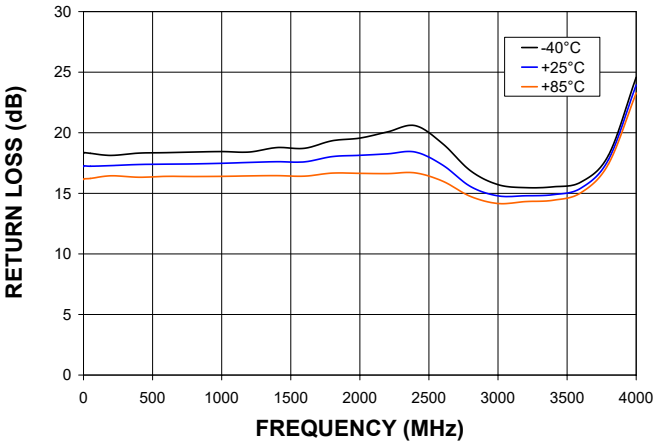
ATTENUATION (31 dB)



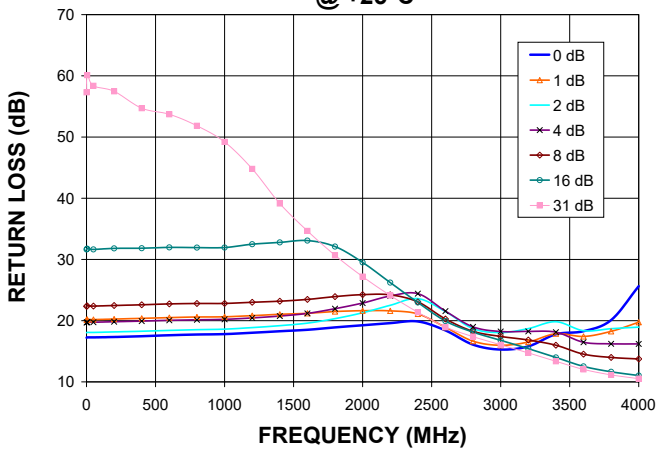
RETURN LOSS IN (Ref)



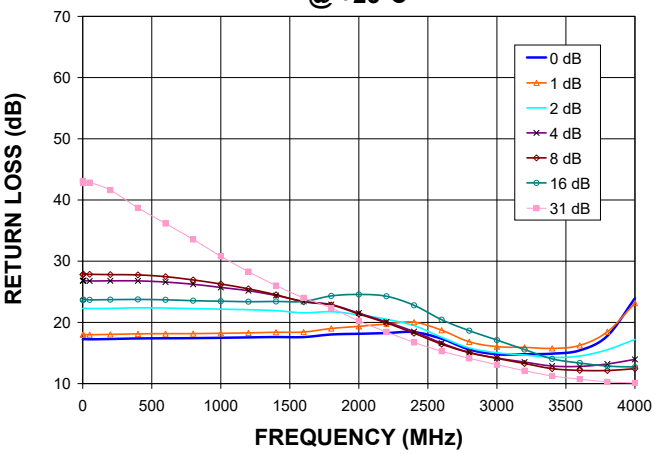
RETURN LOSS OUT (Ref)



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

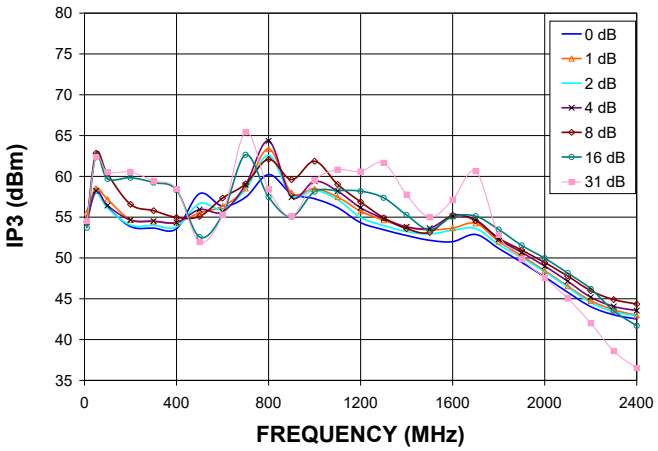


RETURN LOSS OUT (Major Atten. Steps) @ +25°C

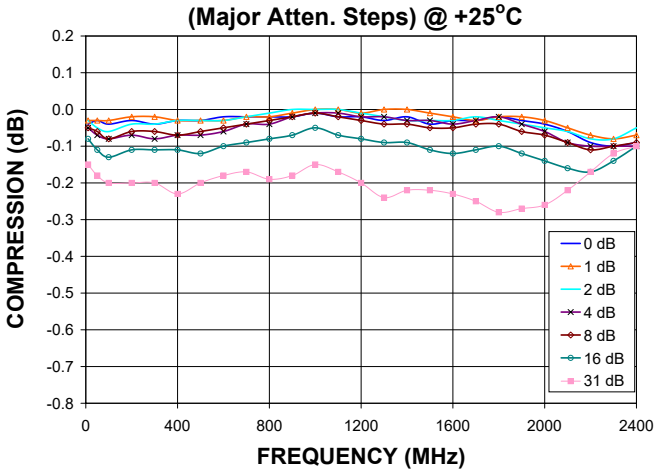


Typical Performance Curves

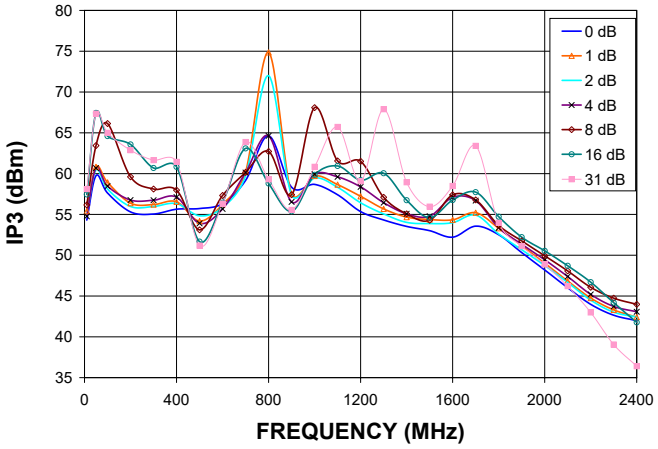
IP3 (Major Atten. Steps) @ +25°C



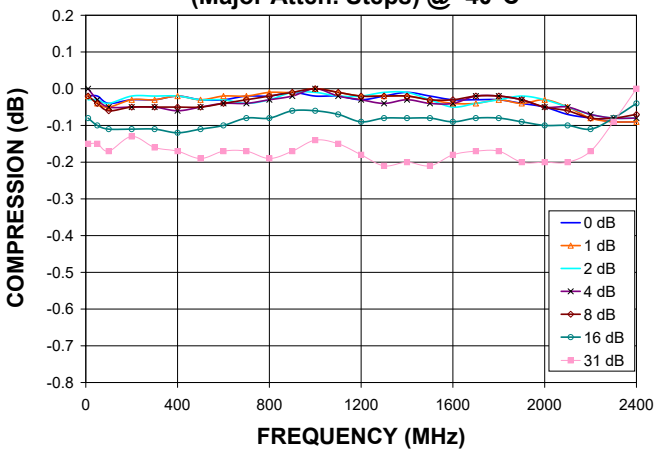
COMPRESSION @ INPUT POWER=+24dBm (Major Atten. Steps) @ +25°C



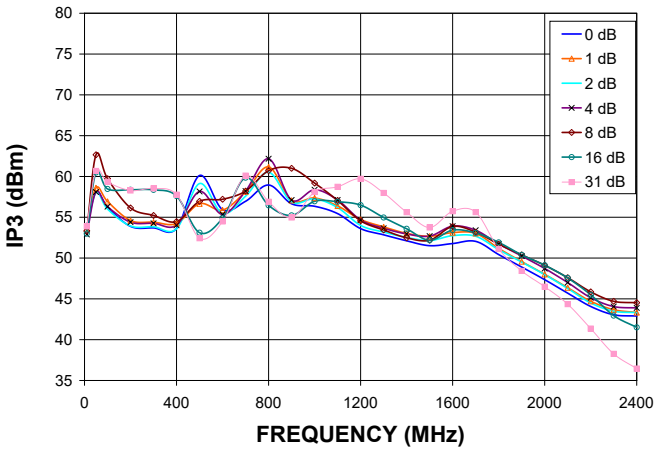
IP3 (Major Atten. Steps) @ -40°C



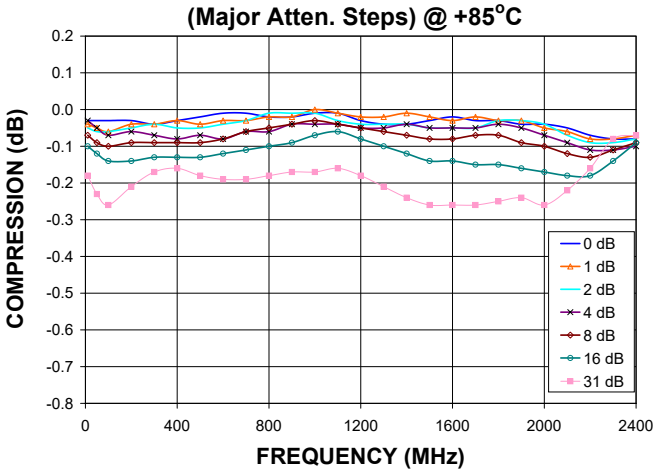
COMPRESSION @ INPUT POWER=+24dBm (Major Atten. Steps) @ -40°C



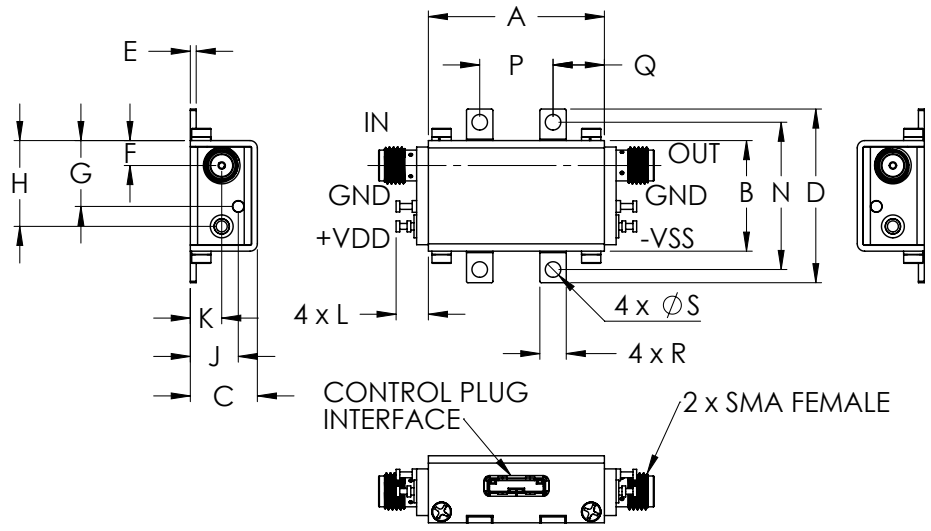
IP3 (Major Atten. Steps) @ +85°C



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



Outline Drawing



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

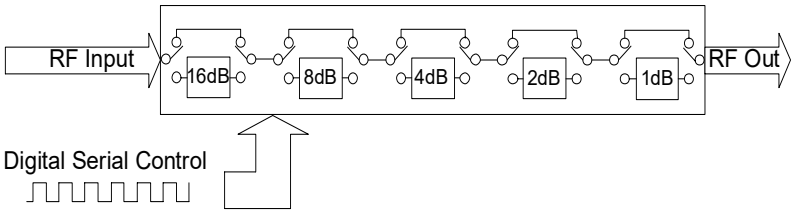
Outline Dimensions (inch/mm)

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**	**-**	**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-SN-S+ 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	C16	C8	C4	C2	C1
Reference	0	0	0	0	0
1 (dB)	0	0	0	0	1
2 (dB)	0	0	0	1	0
4 (dB)	0	0	1	0	0
8 (dB)	0	1	0	0	0
16 (dB)	1	0	0	0	0
31 (dB)	1	1	1	1	1

Note: Not all 32 possible combinations of C1 - C16 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 can be ordered separately. For details see page 10.

Figure 1: Serial Interface Timing Diagram

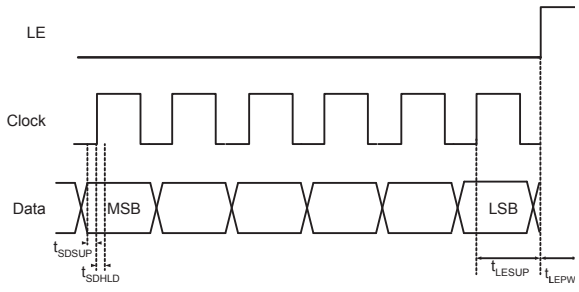


Table 2. Serial Interface AC Characteristics

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

The ZX76-31-SN+, uses a common 5-bit serial word format, as shown in Table 3: 5-Bit attenuator Serial Programming Register Map.

The first bit, the MSB, corresponds to the 16-dB Step and the B1 bit corresponds to the 1 dB step.

Table 3. 5-Bit attenuator Serial Programming Register Map

B5	B4	B3	B2	B1	B0
C16	C8	C4	C2	C1	0

MSB (first in) LSB (last in)

Note: The stop bit (B0) must always be low to prevent the attenuator from entering an unknown state.

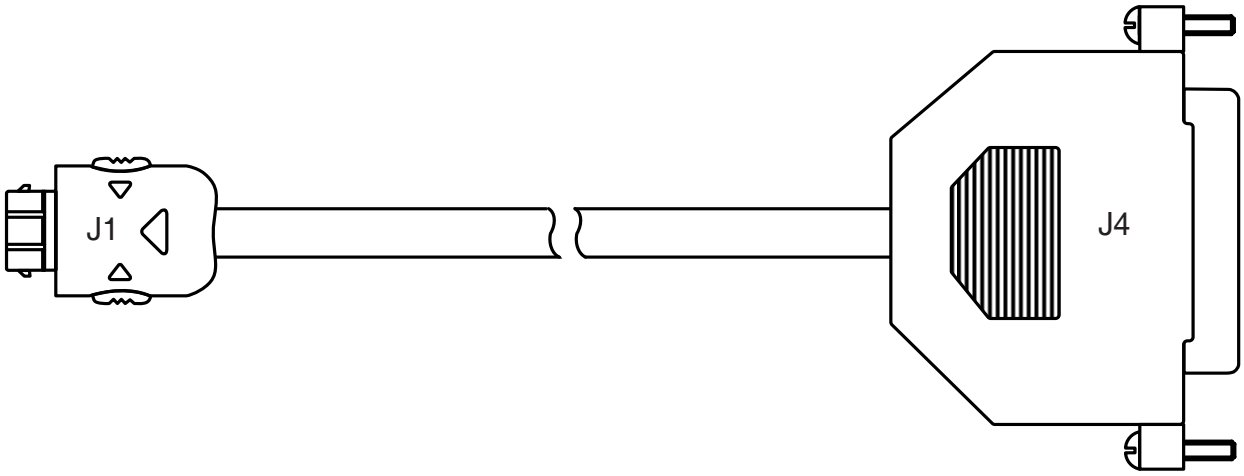
Recommended Accessories

Two optional cable accessories with and without interface connector are available with ZX76-31R5-SN-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-SN-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-SN-S+ digital attenuator in his own application.

ZX76-CS+ Control Cable

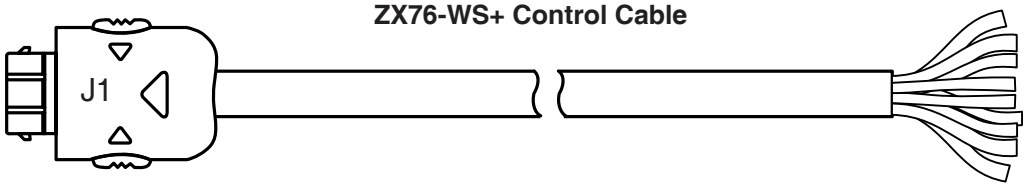


ZX76-CS+ wiring information

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.

ZX76-WS+ Control Cable



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
ZX76-31-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

Additional 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

Digital Step Attenuator ZX76-31-SN+

Typical Performance Data

FREQUENCY (MHz)	STEP ATTENUATION* AT TTL CONTROL STATE (dB)						
	00000 THRU LOSS	00001 1 dB	00010 2 dB	00100 4 dB	01000 8 dB	10000 16 dB	11111 31 dB
10	1.36	1.00	2.02	4.03	7.92	15.89	30.73
50	1.37	1.00	2.02	4.03	7.93	15.87	30.76
100	1.38	1.01	2.03	4.03	7.93	15.89	30.72
200	1.39	1.01	2.04	4.03	7.93	15.88	30.74
500	1.49	1.01	2.03	4.02	7.91	15.85	30.60
800	1.55	1.00	2.04	4.03	7.93	15.85	30.44
1000	1.59	1.01	2.08	4.06	7.95	15.83	30.36
1200	1.72	1.00	2.04	4.00	7.89	15.80	30.09
1400	1.84	1.00	2.01	3.96	7.83	15.72	29.83
1600	1.82	1.01	2.07	4.02	7.90	15.77	29.73
1800	1.91	1.00	2.06	4.02	7.88	15.78	29.50
2000	2.02	1.02	2.06	4.03	7.87	15.74	29.25
2200	2.25	1.00	2.07	4.03	7.88	15.66	28.97
2400	2.41	1.00	2.04	3.98	7.81	15.62	28.41
2600	2.38	1.05	2.12	4.04	7.88	15.68	28.31
3000	2.94	1.04	2.15	4.10	7.91	15.58	28.16

* Step Attenuation above Thru Loss (TTL Logic 00000).

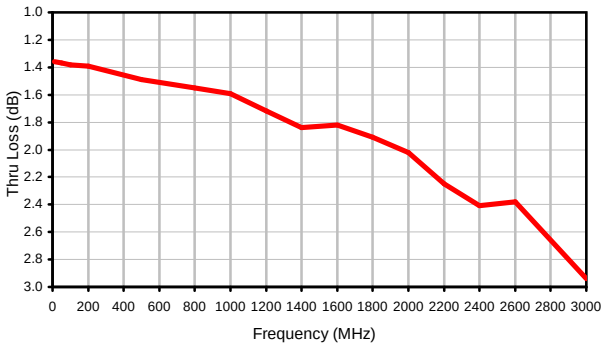
FREQUENCY (MHz)	INPUT RETURN LOSS AT TTL CONTROL STATE (dB)						
	00000 0 dB	00001 1 dB	00010 2 dB	00100 4 dB	01000 8 dB	10000 16 dB	11111 31 dB
10	17.10	20.08	17.99	19.66	22.37	32.02	43.63
50	17.14	20.14	18.03	19.72	22.43	32.16	43.88
100	17.15	20.13	18.05	19.73	22.39	31.99	43.09
200	17.23	20.20	18.11	19.77	22.44	32.02	43.10
500	17.58	20.55	18.44	20.10	22.77	32.58	43.97
800	17.94	20.93	18.81	20.47	23.17	33.46	43.93
1000	18.13	21.13	19.07	20.79	23.56	34.67	42.26
1200	18.41	21.43	19.51	21.24	24.06	36.01	38.55
1400	18.65	21.64	19.96	21.77	24.63	37.01	34.99
1600	18.84	21.77	20.49	22.43	25.29	35.91	31.74
1800	19.04	21.90	21.20	23.32	26.03	32.71	28.73
2000	19.12	21.81	21.93	24.23	26.42	29.17	26.07
2200	19.19	21.70	22.78	25.23	26.46	26.24	23.80
2400	19.80	22.30	24.53	27.00	26.28	23.66	21.72
2600	21.50	23.56	28.00	28.57	24.66	21.11	19.70
3000	22.65	22.45	26.32	23.43	20.26	17.28	16.48

FREQUENCY (MHz)	OUTPUT RETURN LOSS AT TTL CONTROL STATE (dB)						
	00000 0 dB	00001 1 dB	00010 2 dB	00100 4 dB	01000 8 dB	10000 16 dB	11111 31 dB
10	17.08	17.84	22.31	26.97	27.98	23.56	39.26
50	17.11	17.88	22.35	27.02	28.04	23.60	39.03
100	17.15	17.91	22.36	26.99	27.99	23.56	39.10
200	17.22	17.96	22.43	27.04	27.97	23.58	38.39
500	17.47	18.23	22.70	27.12	27.91	23.75	34.61
800	17.72	18.48	22.86	26.86	27.41	23.90	31.22
1000	18.18	18.97	23.47	27.29	27.70	24.70	29.02
1200	18.22	19.10	23.31	26.34	26.63	24.95	26.80
1400	18.37	19.32	23.23	25.46	25.69	25.55	24.90
1600	18.41	19.56	22.92	24.32	24.52	26.23	23.14
1800	18.49	19.83	22.58	23.24	23.38	27.13	21.59
2000	18.55	20.14	22.01	21.93	22.04	27.66	20.00
2200	18.48	20.29	21.15	20.60	20.64	26.95	18.63
2400	18.22	20.19	20.59	19.60	19.65	25.84	17.78
2600	19.33	22.03	21.85	20.57	20.28	27.42	17.49
3000	20.89	22.42	18.95	16.77	16.25	18.78	14.23

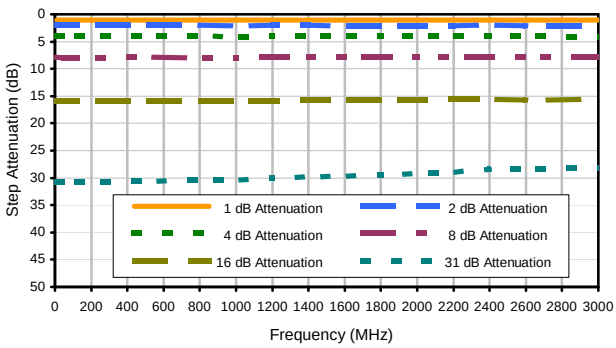
Digital Step Attenuator ZX76-31-SN+

Typical Performance Curves

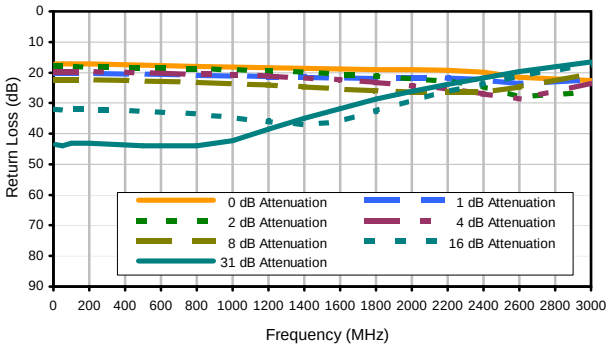
Thru Loss



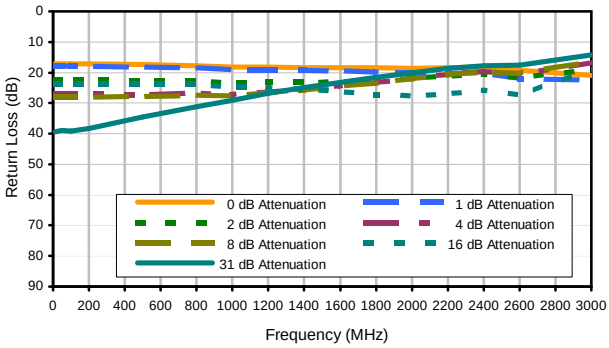
Step Attenuation



Input Return Loss



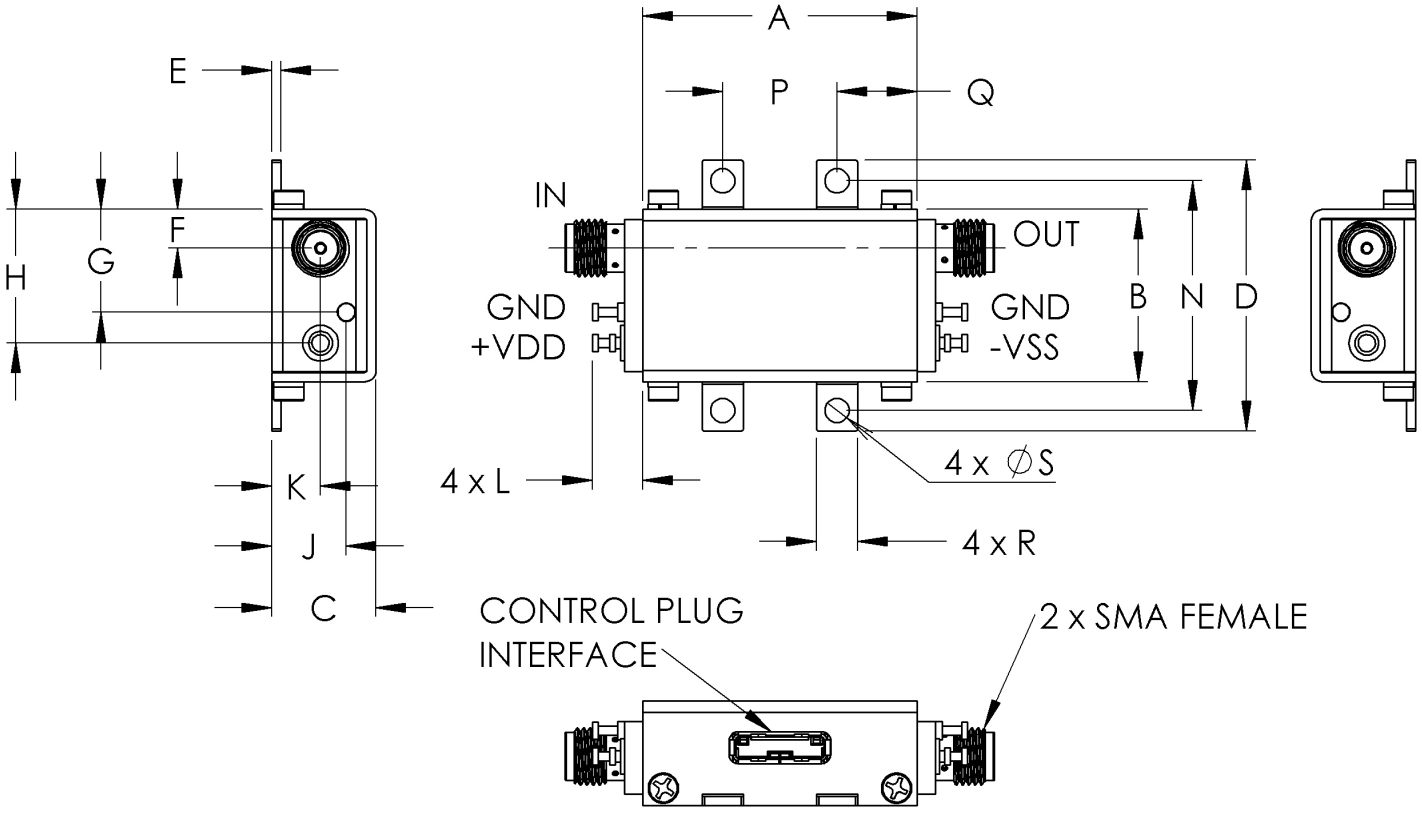
Output Return Loss



Case Style HK

Outline Dimensions

HK1149



CASE #.	A	B	C	D	E	F	G	H	J	K	L	M	N
HK1149	1.20 (30.48)	.75 (19.15)	.46 (11.61)	1.18 (30.07)	.04 (1.02)	.17 (4.32)	.45 (11.40)	.59 (14.86)	.33 (8.31)	.21 (5.44)	.22 (5.59)	-	1.00 (25.4)

CASE #.	P	Q	R	S	WT GRAMS
HK1149	.50 (12.70)	.35 (8.89)	.18 (4.57)	.106 (2.69)	35

Dimensions are in inches (mm). Tolerances: 2Pl. ± .03; 3Pl. ± .015
Tolerance on hole size and interaxes dimensions to be ± .005.

Note:

1. Case material: Brass
2. Case finish: Nickel plate

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Environmental Specifications **ENV28T14**

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 Ambient Environment	Individual Model Data Sheet
Storage Temperature	-40° to 85° C Ambient Environment	Individual Model Data Sheet
Barometric Pressure	100,000 Feet	MIL-STD-202, Method 105, Condition D
Humidity	90% RH, 65°C 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