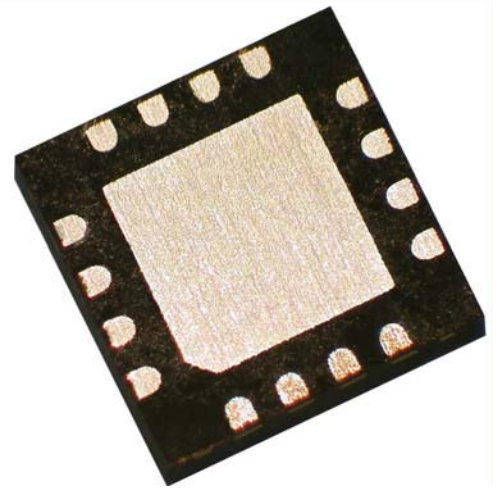


# HRF-AT4521

## 31.0 dB, DC - 2.5GHz, 5 Bit Serial Digital Attenuator

The Honeywell HRF-AT4521 is a 5-bit digital attenuator that is ideal for use in broadband communication system applications that require accuracy, speed and low power consumption. The HRF-AT4521 is manufactured with Honeywell's patented Silicon On Insulator (SOI) CMOS manufacturing technology, which provides the performance of GaAs with the economy and integration capabilities of conventional CMOS. These attenuators are DC coupled to improve lower operating frequency, frequency response and reduce the number of DC bias points required.



*HRF-AT4521 in VQFN Package*

### FEATURES

- Very Low DC Power Consumption
- Attenuation In Steps From 1 dB To 31 dB
- Single Positive Power Supply Voltage
- Serial Data Interface
- 50 Ohm Impedance
- DC-coupled, bi-directional RF path
- Space Saving VQFN Surface Mount Packaging
- Lead-free, RoHS compliant and Green

### RF ELECTRICAL SPECIFICATIONS @ + 25°C

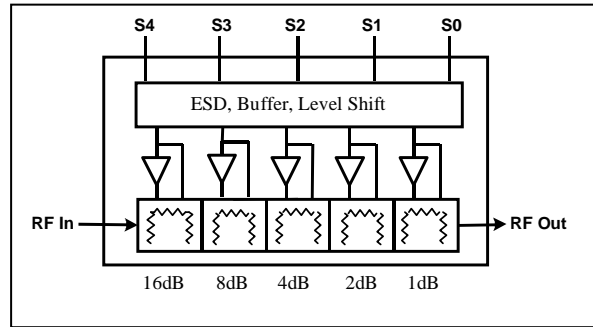
Results @  $V_{DD} = 5.0 \pm 10\%$ ,  $V_{SS} = 0$  unless otherwise stated,  $Z_0 = 50$  Ohms  
Contact Honeywell for relative performance at other supply configurations

Parameter	Test Condition	Frequency	Minimum	Typical	Maximum	Units
Insertion Loss		1.0 GHz		2.0	2.6	dB
		2.0 GHz		2.2	2.8	dB
		2.5 GHz		2.8	3.4	dB
1dB Compression	$V_{SS} = 0V$ , Input Power	2.0 GHz		22		dBm
	$V_{SS} = -3V$ , Input Power	2.0 GHz		28		dBm
Input IP3	$V_{SS} = 0V$ Two-tone inputs, up to +5 dBm @ 0 dBm attenuation	2.0 GHz		36		dBm
Input IP3	$V_{SS} = -3V$ Two-tone inputs, up to +5 dBm @ 0 dBm attenuation	2.0 GHz		>36		dBm
Return Loss	Any Combination of Bits		-11	-13		dB
Attenuation Accuracy	All attenuation states	1.0 GHz	+ (0.25 + 2.5 %), - (0.10 + 5.0 %)			dB
	All attenuation states	2.0 GHz	+ 0.45, - (0.20 + 8.0 %)			dB
	All attenuation states	2.5 GHz	+ 0.35, - (-0.40 + 10.5%)			dB
Trise, Tfall	10% To 90%			10		nS
Ton, Toff (Tpd)	50% Cntl To 90%/10%RF			15		nS
T clock Period (Tprd)	T high / T low = 1/2 minimum clock period		50			nS
T data set up (Tsup)	Set up to rising edge of clock		5			nS
T data hold (Thld)	Data hold after rising edge of clock		2			nS
T latch set up (Tlsup)	Data set up to rising edge of OE		5			nS

Note 1 - For higher accuracy designs, please consider HRF-AT4610/HRF-AT4611

# HRF-AT4521

## FUNCTIONAL SCHEMATIC



## DC ELECTRICAL SPECIFICATIONS @ + 25°C

Parameter	Minimum	Typical	Maximum	Units
V <sub>DD</sub>	3.3 <sup>1</sup>	5.0	5.5	V
V <sub>SS</sub>	-5.0			V
I <sub>DD</sub>		<5.0	50	uA
CMOS Logic level (0)	0		0.8	V
CMOS Logic level (1)	V <sub>DD</sub> - 0.8		V <sub>DD</sub>	V
Input Leakage Current			10	uA

Note 1, the performance curves are for V<sub>DD</sub> = +5.0 +/- 10%

## ABSOLUTE MAXIMUM RATINGS<sup>1</sup>

Parameter	Absolute Maximum	Units
Input Power	+ 35	dBm
V <sub>DD</sub>	+6.0	V
V <sub>SS</sub>	-5.5	V
ESD Voltage <sup>2</sup>	400	V
Operating Temperature	-40 To +85	°C
Storage Temperature	-65 To +125	°C
Moisture Sensitivity Level	Level 3 @ 260°C	
Digital Inputs	V <sub>DD</sub> +0.6 max to -0.6 min	V

Note 1 - Operation of this device beyond any of these parameters may cause permanent damage.

Note 2 - Although the HRF-AT4521 contains ESD protection circuitry on all digital inputs, precautions should be taken to ensure that the Absolute Maximum Ratings are not exceeded.

**Latch-Up:** Unlike conventional CMOS digital attenuators, Honeywell's HRF-AT4521 is immune to latch-up.

# HRF- AT4521

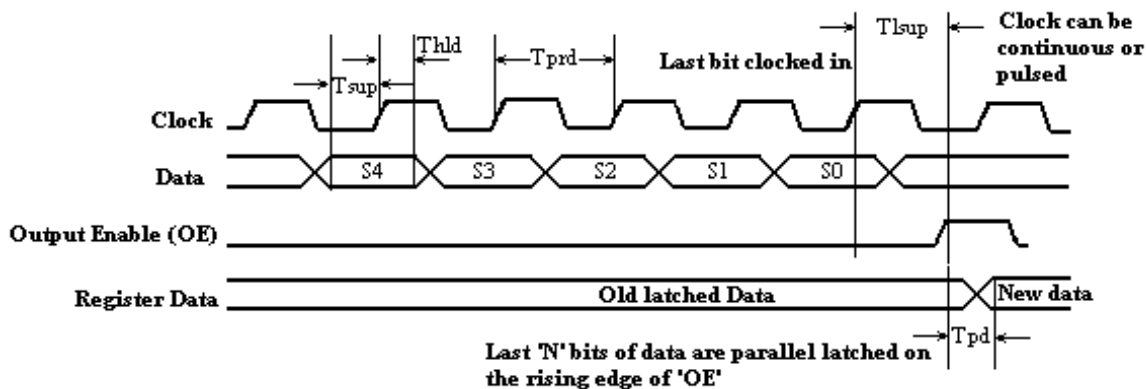
## PIN CONFIGURATIONS

Pin	Function	Pin	Function
1	VDD	9	GROUND
2	GROUND	10	RF OUTPUT
3	RF INPUT	11	GROUND
4	GROUND	12	VSS
5	GROUND	13	GROUND
6	GROUND	14	OE
7	GROUND	15	CLK
8	GROUND	16	DATA

**Note:** Bottom ground plate must be grounded for proper RF performance.

## SERIAL DATA LOAD

Serial data is shifted into the register on the rising edge of clock, MSB first. The state of "OE" will not affect the shifting of data. The rising edge of the "OE" signal will be the clock for the transfer of shifted data. Latched new data occurs one prop delay after the rising edge of "OE". See the Electrical Spec Table for AC parameters.



## TRUTH TABLE

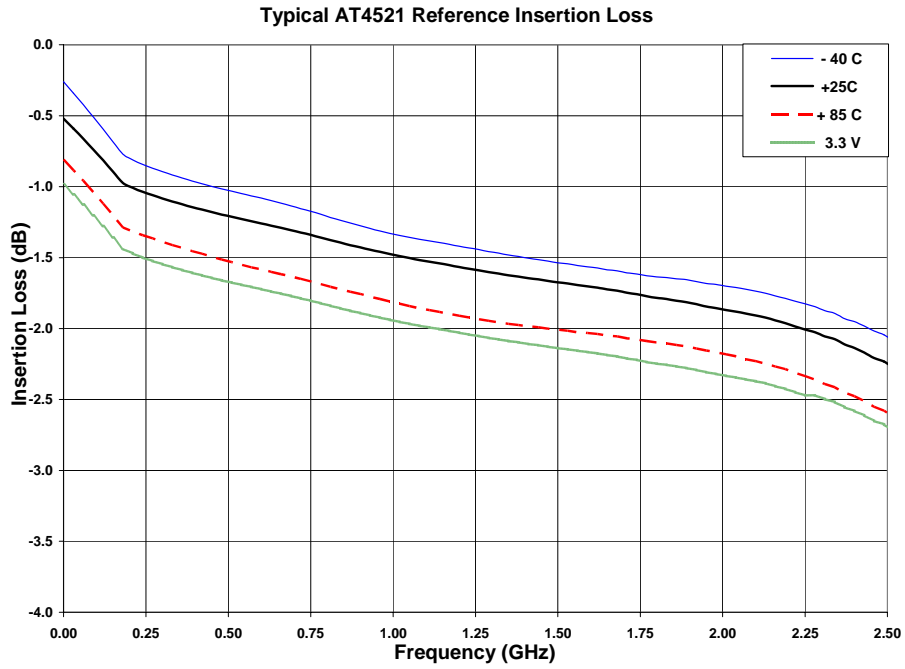
S4	S3	S2	S1	S0	Output
0	0	0	0	0	Reference Input
0	0	0	0	1	1 dB
0	0	0	1	0	2 dB
0	0	1	0	0	4 dB
0	1	0	0	0	8 dB
1	0	0	0	0	16 dB
1	1	1	1	1	31 dB

Operation: Data on serial input D is clocked into internal registers on the low to high transition of the Clock signal (CK). The register output is enabled when Output Enable (OE) is in the low state. "0" = CMOS Low, "1" = CMOS High.

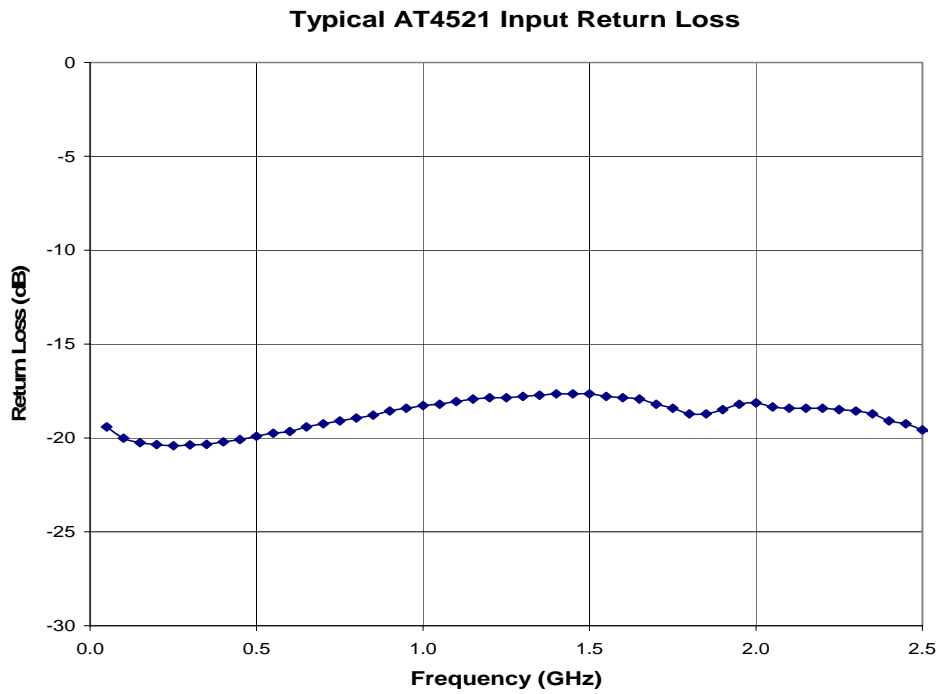
# HRF-AT4521

## PERFORMANCE CURVES

### Insertion Loss

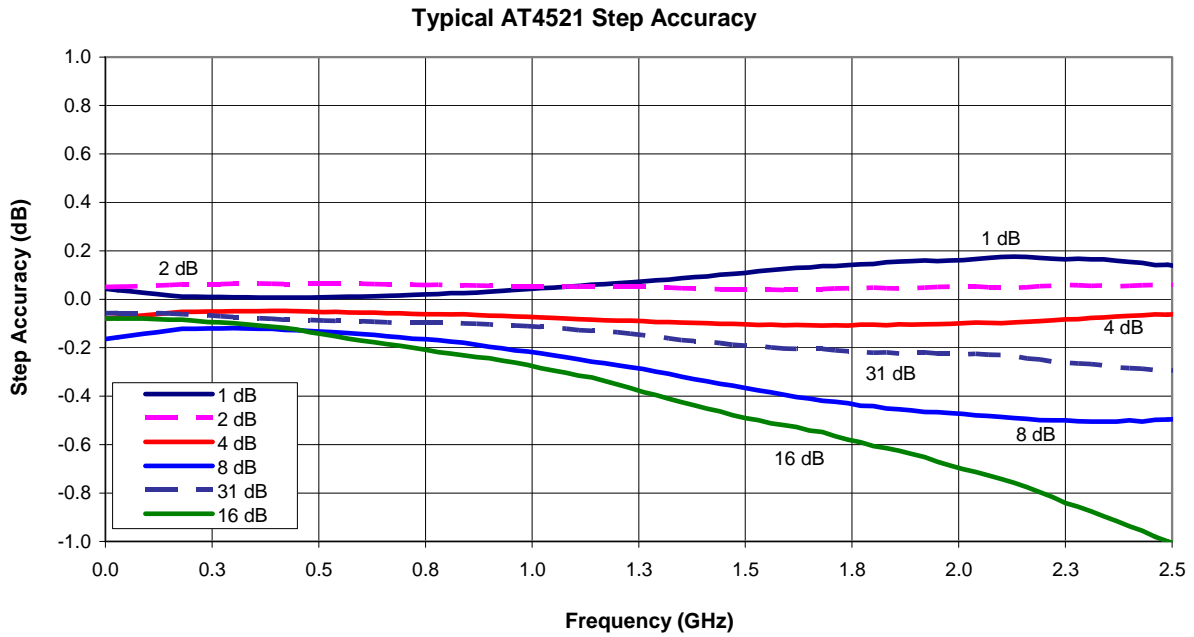


### Return Loss

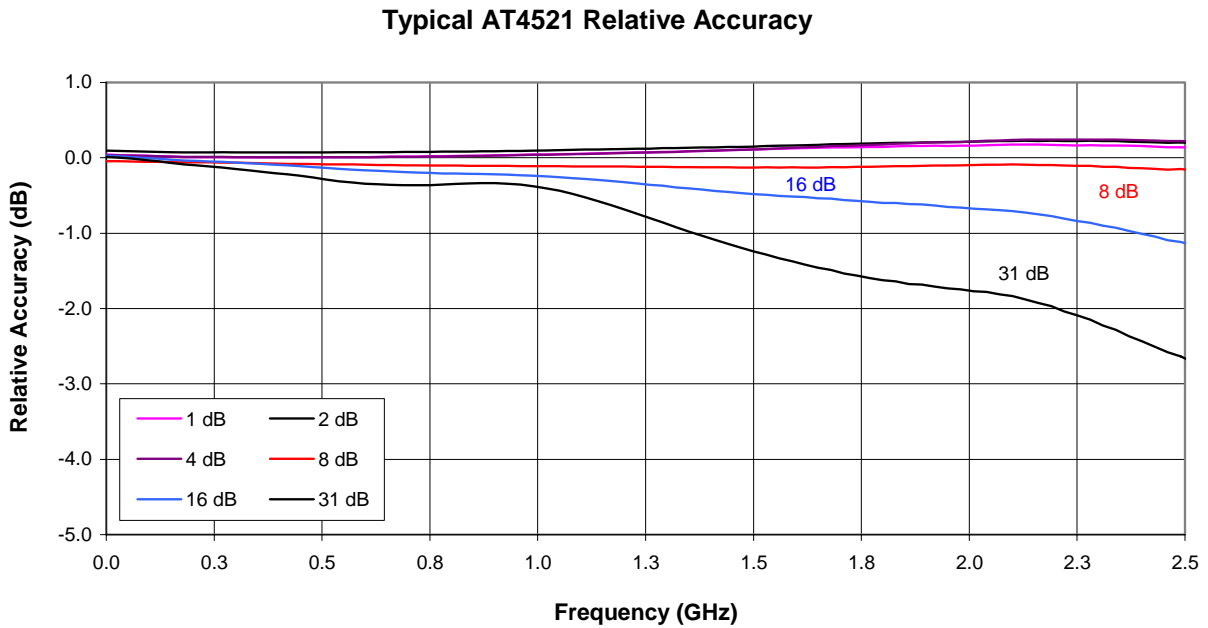


# HRF- AT4521

## Step Accuracy

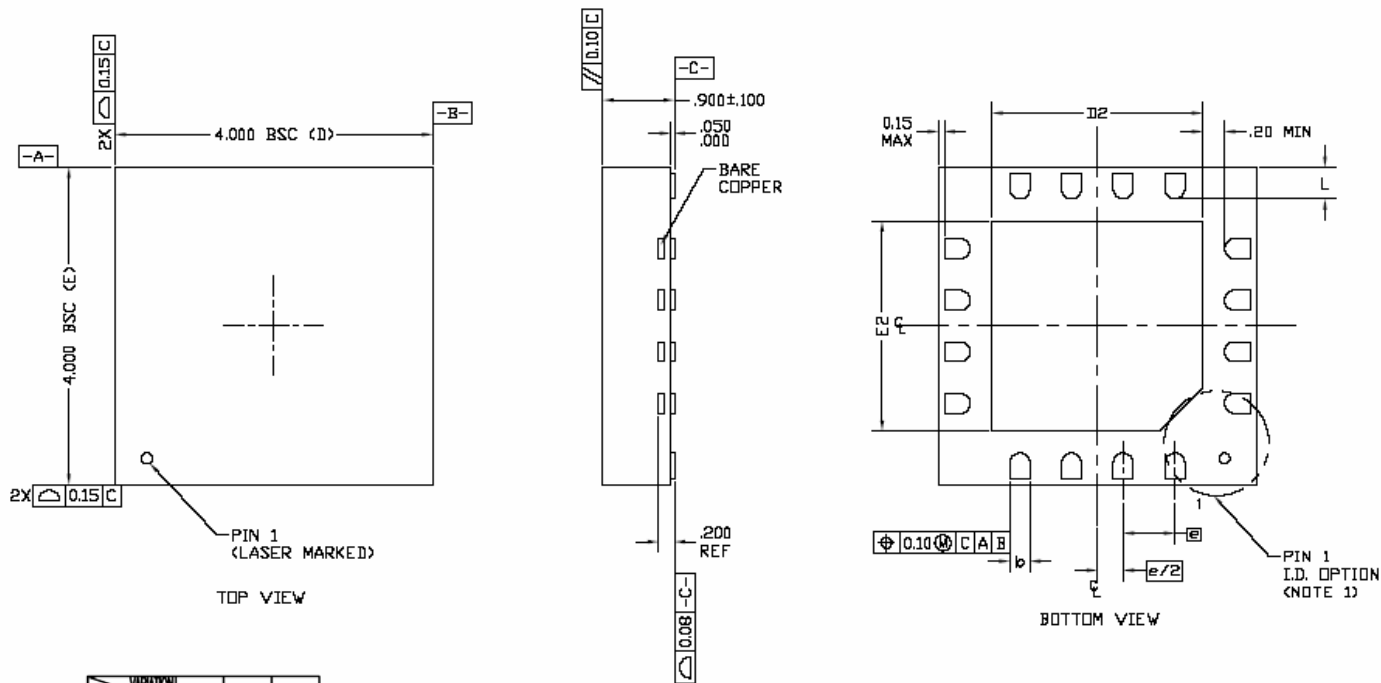


## Relative Accuracy



# HRF-AT4521

## PACKAGE OUTLINE DRAWING



SYMBOL	MIN	NOM	MAX
e	0.65 BSC		
b	0.25	0.30	0.35
E2	2.40	2.50	2.60
D2	2.40	2.50	2.60
L	0.30	0.40	0.50
INTERNAL FEATURE	FUSE LEAD		

### Notes

1. Pin 1 identifier can be a combination of a dot and/or chamfer.
2. Dimensions are in millimeters.

## GREEN MATERIAL SET

The -GR attenuators have a Green material set that can withstand a maximum soldering temperature of 260°C.

## LEAD FINISH

The package leads are Nickel Palladium Gold (NiPdAu). The configuration being manufactured and delivered today is lead-free RoHS compliant. Compliant packages have half-etch leadframes and have date codes of 0300 or greater.

## LEAD FREE QFN SURFACE MOUNT APPLICATION

Please see Application Note AN310 for assembly process recommendations. The maximum soldering temperature of the -GR is 260°C (-AU attenuators are 250°C). Application Notes can be found at our website: [www.honeywell.com/microwave](http://www.honeywell.com/microwave)

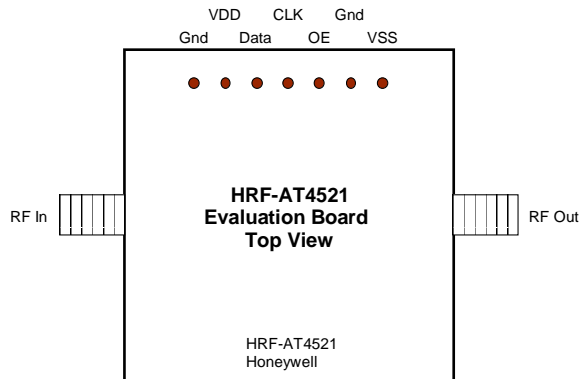
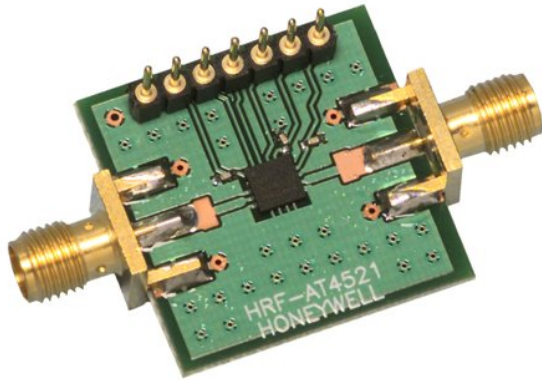
## CIRCUIT APPLICATION INFORMATION

These attenuators require a DC reference to ground. They may not operate properly when AC coupled on both the RF input and output without a DC ground reference provided as part of the circuit. See Application Note AN311.

# HRF- AT4521

## EVALUATION CIRCUIT BOARD

Honeywell's evaluation board provides an easy to use method of evaluating the RF performance of our attenuator. Simply connect power, DC and RF signals to be measuring attenuator performance in less than 10 minutes.



HRF-AT4521 Evaluation Board

## EVALUATION CIRCUIT BOARD LAYOUT DESIGN DETAILS

Item	Description
PCB	Impedance Matched Multi-Layer FR4
Attenuator	HRF-AT4521 Digital Attenuator
Chip Capacitor	Panasonic Model ECU-E1C103KBQ Capacitor, .01uf 0402 10% 16V
RF Connector	Johnson Connectors Model 142-0701-801 SMA RF Coaxial Connector
DC Pin	Mil-Max Model 800-10-064-10-001 Header Pins

## ORDERING INFORMATION

Ordering Number	Delivery Method	Units Per Shipment
HRF-AT4521-GR-TR	Tape and Reel	2500 Units per Reel
HRF-AT4521-GR-T	Tape	<2500
HRF-AT4521-E	Evaluation Board	One Board Per Box

The new –GR attenuators will replace and are fully back-compatible with the –AU attenuators.

## FIND OUT MORE

For more information on Honeywell's Microwave Products visit us online at [www.honeywell.com/microwave](http://www.honeywell.com/microwave) or contact us at 800-323-8295 (763-954-2474 internationally).

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