

### FEATURES

- 1.0 dB LSB steps to 31 dB
- Single positive control line per bit
- ±1.0 dB typical bit error
- Input IP3: 43 dBm
- CMOS-compatible control
- Hermetically sealed module
- Field replaceable K-type connectors
- Operating temperature: -55°C to +85°C

### APPLICATIONS

- Fiber optics and broadband telecommunications
- Microwave radios and VSATs
- Military radios, radars, and electronic counter measures (ECM)
- Space systems
- Test instrumentation

### GENERAL DESCRIPTION

The HMC-C584 is a 0.1 GHz to 40 GHz, 5-bit, gallium arsenide (GaAs) IC digital attenuator housed in a miniature hermetic module. This wideband attenuator features 7 dB typical insertion loss, 43 dBm input IP3, and bit values of 1 dB (LSB), 2 dB, 4 dB, 8 dB, and 16 dB for a total attenuation range of 31 dB. The attenuation accuracy of the device has a ±1.0 dB typical step error. Five control voltage inputs, toggled between 0 V and 5 V, are used to select each attenuation state. Removable K-type connectors can be detached to allow direct connection of the input/output pins of the module to a microstrip or coplanar circuit.

### FUNCTIONAL BLOCK DIAGRAM

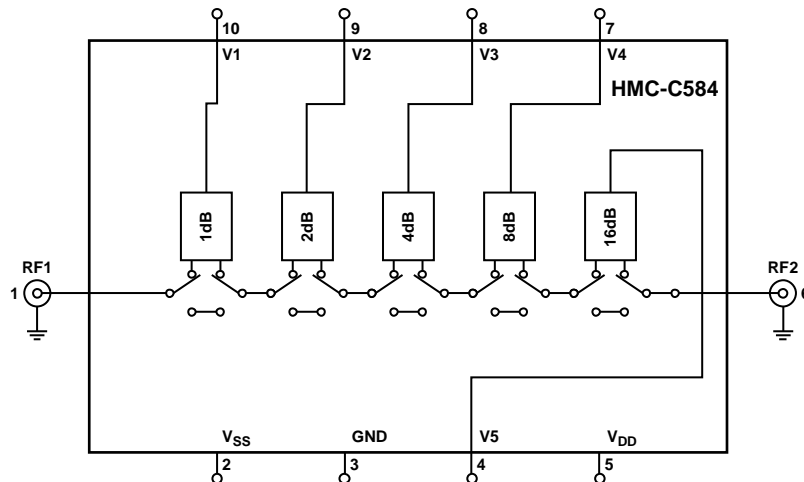


Figure 1.

Rev. 0

#### Document Feedback

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**REVISION HISTORY**

9/2016—Revision 0: Initial Version

## SPECIFICATIONS

$V_{DD} = 5\text{ V}$ ,  $V_{SS} = -5\text{ V}$ ,  $V_{CTL} = 0\text{ V}/5\text{ V}$ ,  $T_A = 25^\circ\text{C}$ , unless otherwise noted.

Table 1.

Parameter	Min	Typ	Max	Unit	Test Conditions/Comments
INSERTION LOSS					
0.1 GHz to 30 GHz		7	9.5	dB	
30 GHz to 40 GHz	4	8	10.5	dB	
ATTENUATION RANGE					Normalized to insertion loss
0.1 GHz to 40 GHz	24	31	35	dB	
ATTENUATION ACCURACY					
0.1 GHz to 30 GHz					
1 dB to 8 dB States		$\pm 0.5 + 5\%$ of maximum attenuation setting		dB	
16 dB to 31 dB States		$\pm 0.6 + 6\%$ of maximum attenuation setting		dB	
30 GHz to 40 GHz					
1 dB to 8 dB States		$\pm 0.8 + 8\%$ of maximum attenuation setting		dB	
16 dB to 31 dB States		$\pm 1.0 + 10\%$ of maximum attenuation setting		dB	
INPUT POWER FOR 0.1 dB COMPRESSION					
0.1 GHz to 0.5 GHz		20		dB	
0.5 GHz to 40 GHz		25		dB	
INPUT IP3					
0.1 GHz to 0.5 GHz		40		dB	
0.5 GHz to 40 GHz		43		dB	
RETURN LOSS					RF1 and RF2
0.1 GHz to 40 GHz		10		dB	
SUPPLY INPUTS					
$V_{DD}$	4.5	5	5.5	V	
$V_{SS}$	-5.5	-5	-4.5	V	
CONTROL INPUTS					
Input Voltage					
High ( $V_{INH}$ )		3.5 to 5		V	
Low ( $V_{INL}$ )		0 to 1.5		V	
Input Current ( $I_{IN}$ )		$\pm 5$		$\mu\text{A}$	$V_{IN} = 0\text{ V or }V_{CC}$
SWITCHING CHARACTERISTICS					
Rise Time ( $t_{RISE}$ )/Fall Time ( $t_{FALL}$ )		60		ns	10%/90 % RF
On Time ( $t_{ON}$ )/Off Time ( $t_{OFF}$ )		90		ns	50% CTL to 10%/90 % RF

## ABSOLUTE MAXIMUM RATINGS

Table 2.

Parameter	Rating
V <sub>DD</sub>	7 V
V <sub>SS</sub>	-7 V
Control Voltage (V1 to V5)	V <sub>DD</sub> + 0.5 V
RF Input Power	25 dBm
Operating Temperature Range	-55°C to +85°C
Storage Temperature Range	-65°C to +150°C
ESD Rating (HBM)	Class 1A (>250 V)

Stresses at or above those listed under Absolute Maximum Ratings may cause permanent damage to the product. This is a stress rating only; functional operation of the product at these or any other conditions above those indicated in the operational section of this specification is not implied. Operation beyond the maximum operating conditions for extended periods may affect product reliability.

### ESD CAUTION



**ESD (electrostatic discharge) sensitive device.** Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

## PIN CONFIGURATION AND FUNCTION DESCRIPTIONS

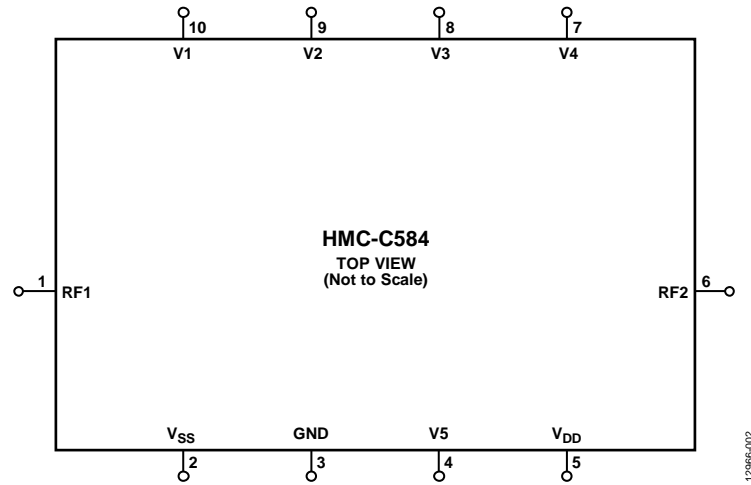


Figure 2. Pin Configuration

Table 3. Pin Function Descriptions

Pin No.	Mnemonic	Description
1	RF1	RF Input/Output 1. This pin is dc-coupled and matched to 50 Ω. Blocking capacitors are required if the RF line potential is not equal to 0 V dc.
2	V <sub>SS</sub>	Negative Supply Voltage, 5 V DC.
3	GND	Power Supply Ground.
4	V <sub>5</sub>	Control Pin for the 16 dB Attenuation State.
5	V <sub>DD</sub>	Positive Supply Voltage, 5 V DC.
6	RF2	RF Input/Output 2. This pin is dc-coupled and matched to 50 Ω. Blocking capacitors are required if the RF line potential is not equal to 0 V dc.
7	V <sub>4</sub>	Control Pin for the 8 dB Attenuation State.
8	V <sub>3</sub>	Control Pin for the 4 dB Attenuation State.
9	V <sub>2</sub>	Control Pin for the 2 dB Attenuation State.
10	V <sub>1</sub>	Control Pin for the 1 dB Attenuation State.

TYPICAL PERFORMANCE CHARACTERISTICS

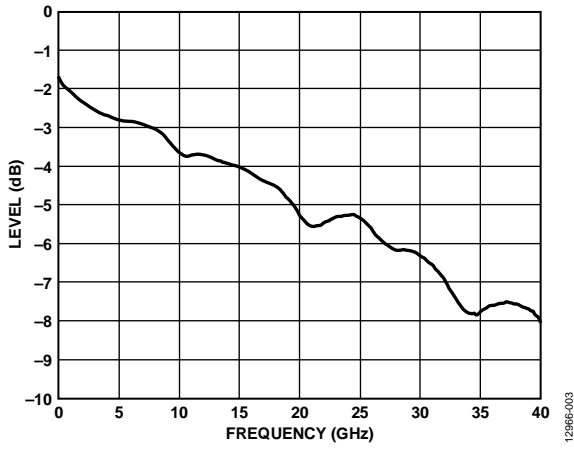


Figure 3. Insertion Loss

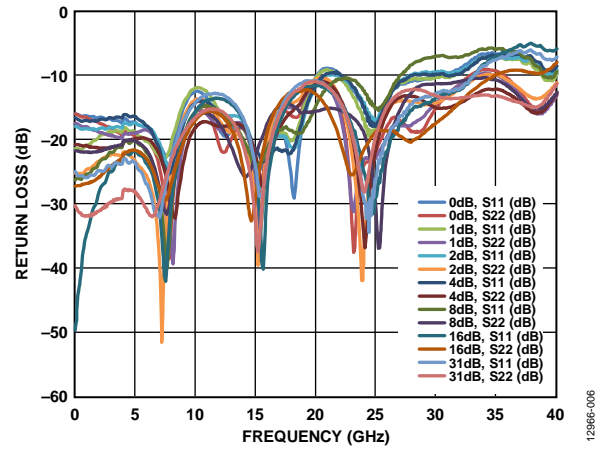


Figure 6. Return Loss for RF1, RF2

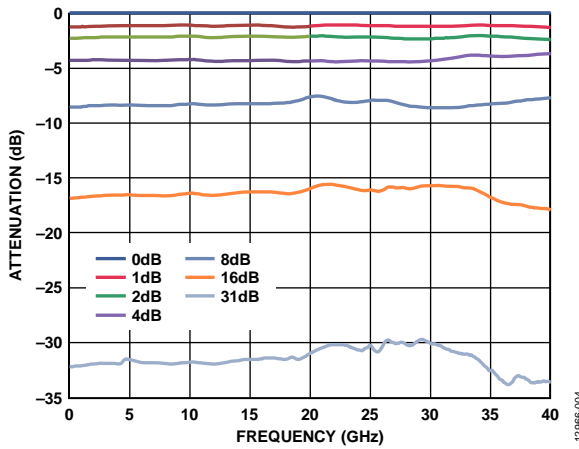


Figure 4. Normalized Attenuation

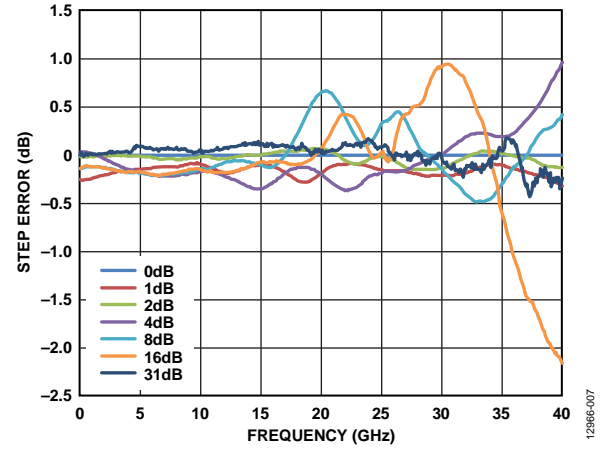


Figure 7. Step Error vs. Frequency

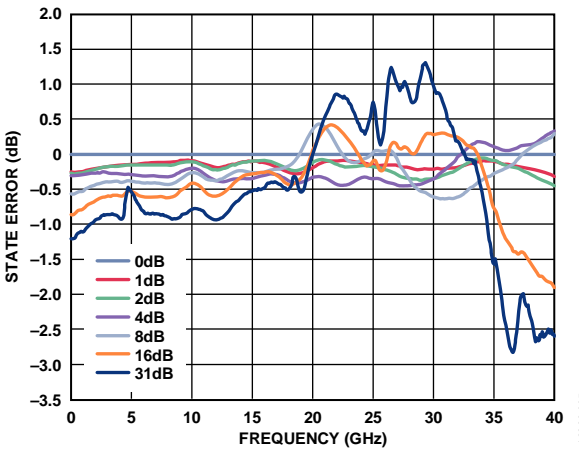


Figure 5. State Error vs. Frequency

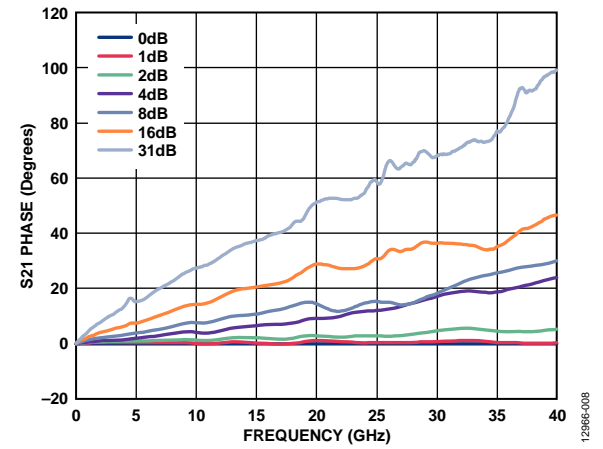


Figure 8. Relative (S21) Phase vs. Frequency

## THEORY OF OPERATION

Any combination of the states listed in Table 4 provides an attenuation level approximately equal to the sum of the bits selected from 0 dB to 31 dB.

A low state level is a voltage between 0 V and 1.5 V. A high state level is a voltage between 3.5 V and 5.0 V.

**Table 4. Attenuation Level Truth Table**

Control Voltage Input State Level					Attenuation State, RF1 to RF2
V1, 1 dB	V2, 2 dB	V3, 4 dB	V4, 8 dB	V5, 16 dB	
Low	Low	Low	Low	Low	Reference insertion loss
High	Low	Low	Low	Low	1 dB
Low	High	Low	Low	Low	2 dB
Low	Low	High	Low	Low	4 dB
Low	Low	Low	High	Low	8 dB
Low	Low	Low	Low	High	16 dB
High	High	High	High	High	31 dB

### APPLICATIONS INFORMATION

In Figure 9, the HMC-C584 is used to make a variable gain amplifier. In this application circuit, the HMC-C584 is used to vary the amplitude of the signal feeding the amplifier over a

31 dB dynamic range. This type of circuit can be used to adjust the overall gain for temperature or frequency. This is only one of the many applications of the HMC-C584.

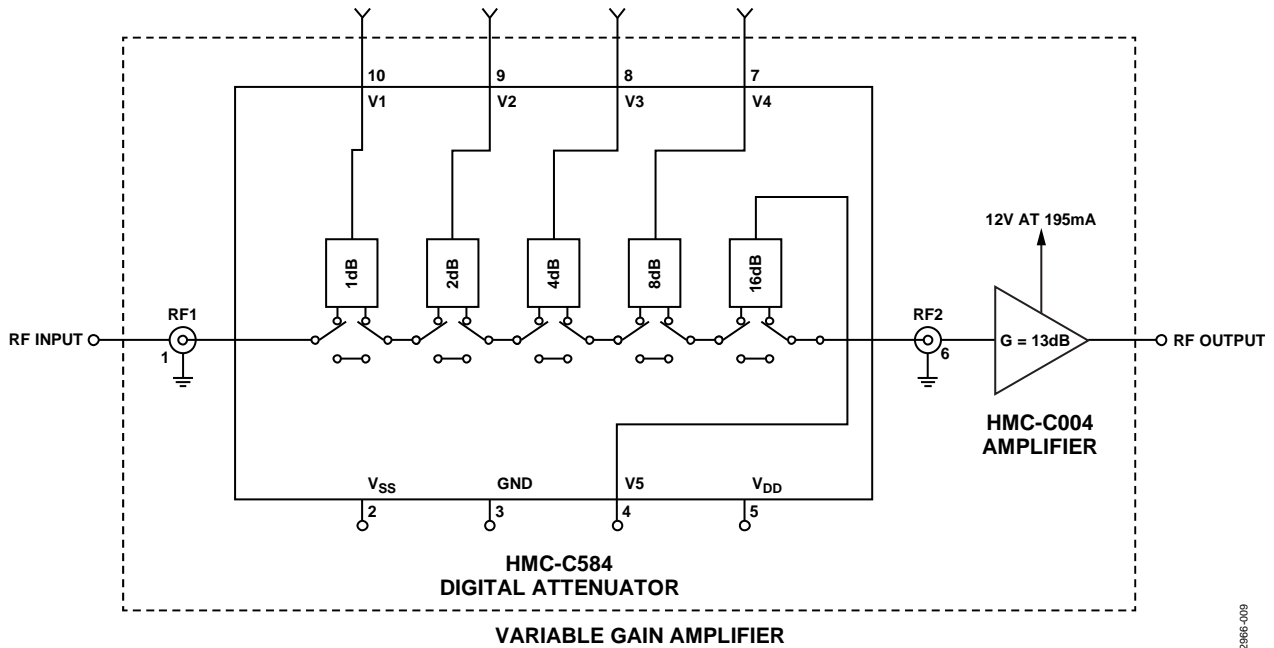
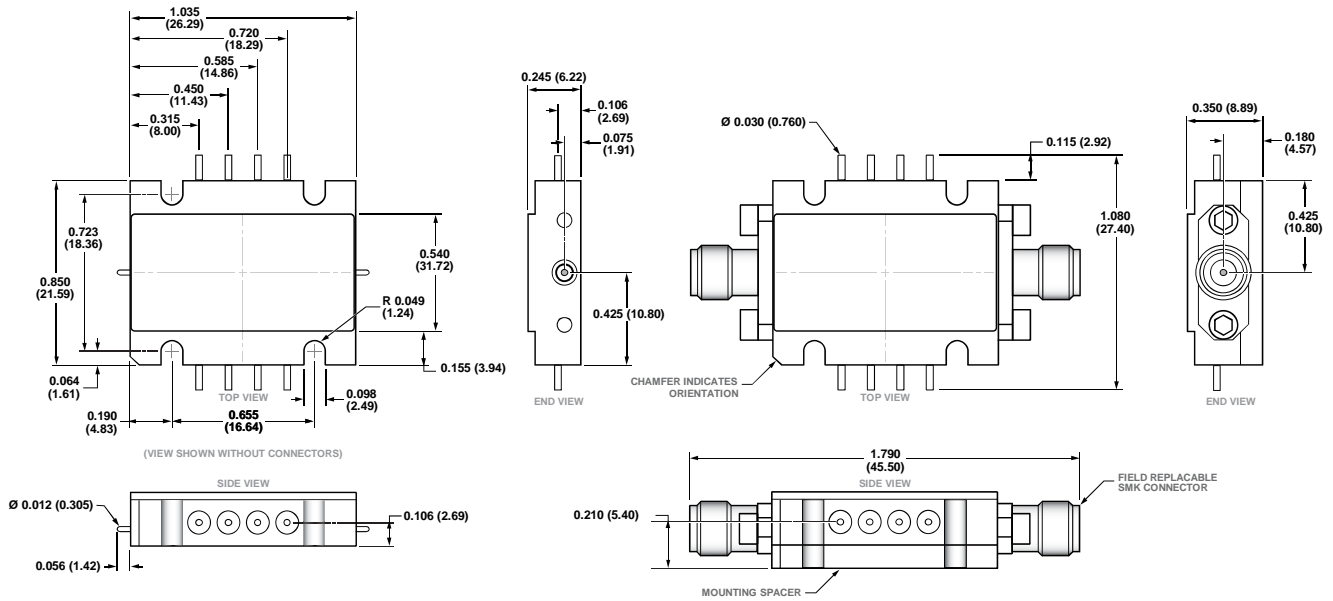


Figure 9. Typical Application Circuit

12986-009



# OUTLINE DIMENSIONS



CONTROLLING DIMENSIONS ARE IN INCHES; MILLIMETER DIMENSIONS (IN PARENTHESES) ARE ROUNDED-OFF INCH EQUIVALENTS FOR REFERENCE ONLY AND ARE NOT APPROPRIATE FOR USE IN DESIGN.

Figure 10. 10-Lead Module with Connector Interface [MODULE] (HML-10-1)  
 Dimensions shown in inches and (millimeters)

## ORDERING GUIDE

Model <sup>1</sup>	Temperature Range	Package Description	Package Option
HMC-C584	-55°C to +85°C	10-Lead Module with Connector Interface [MODULE]	HML-10-1

<sup>1</sup> Z = RoHS Compliant Part.

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