

## FEATURES

**Wide bandwidth: dc to 20 GHz**  
**Low phase shift vs. attenuation**  
**30 dB attenuation range up to 12 GHz**  
**Hermetically sealed module**  
**Field replaceable SMA connectors**  
**Operating temperature:  $-55^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$**

## APPLICATIONS

**Telecom infrastructure**  
**Military radio, radar, and ECM**  
**Space systems**  
**Test instrumentation**

## GENERAL DESCRIPTION

The [HMC-C053](#) is an absorptive voltage variable attenuator (VVA) operating from dc to 20 GHz. The [HMC-C053](#) features a simple single voltage attenuation control, 0 V to  $-3$  V. The device is ideal in designs where an analog dc control signal must control radio frequency (RF) signal levels over a 30 dB amplitude range. Its broad frequency range makes it an attractive choice for many applications, particularly those involved with automatic gain control (AGC) or temperature compensation of multiple gain stages, typically found in microwave radio or test instrumentation architecture. Removable SMA connectors can be detached to allow direct connection of the module input/output pins to a microstrip or coplanar circuit.

## FUNCTIONAL BLOCK DIAGRAM

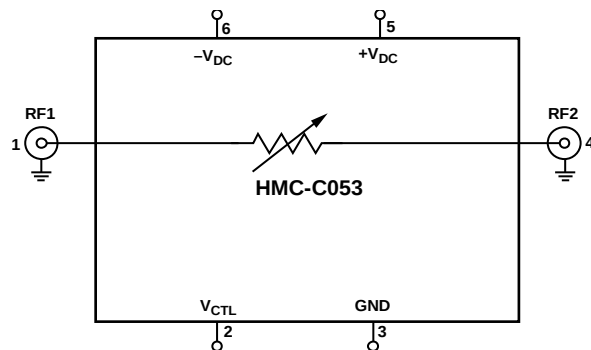


Figure 1.

1344B2-002

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REVISION HISTORY

This Hittite Microwave Products data sheet has been reformatted to meet the styles and standards of Analog Devices, Inc.

10/15—Rev. D to Rev. E

|                                                            |           |
|------------------------------------------------------------|-----------|
| Updated Layout.....                                        | Universal |
| Changes to Table 1 .....                                   | 3         |
| Added Figure 2.....                                        | 5         |
| Changes to Table 3.....                                    | 5         |
| Changes to Figure 7.....                                   | 6         |
| Added Applications Information Section and Figure 14 ..... | 8         |
| Updated Outline Dimensions .....                           | 9         |
| Changes to Ordering Guide .....                            | 9         |

## SPECIFICATIONS

### ELECTRICAL SPECIFICATIONS

$T_A = +25^\circ\text{C}$ ,  $+V_{DC} = 5\text{ V}$ ,  $-V_{DC} = -5\text{ V}$ , and  $V_{CTL} = 0\text{ V}$  to  $-3\text{ V}$ , unless otherwise noted.

Table 1.

| Parameter                                       | Min | Typ  | Max  | Unit | Test Conditions/Comments                                               |
|-------------------------------------------------|-----|------|------|------|------------------------------------------------------------------------|
| INSERTION LOSS ( $V_{CTL} = 0\text{ V}$ )       |     |      |      |      |                                                                        |
| DC to 5 GHz                                     |     | 1.5  |      | dB   |                                                                        |
| 5 GHz to 10 GHz                                 |     | 1.9  |      | dB   |                                                                        |
| 10 GHz to 14 GHz                                |     | 2.4  |      | dB   |                                                                        |
| 14 GHz to 20 GHz                                |     | 4.0  |      | dB   |                                                                        |
| ATTENUATION RANGE ( $V_{CTL} = -2.9\text{ V}$ ) |     |      |      |      |                                                                        |
| DC to 5 GHz                                     | 25  | 32   |      | dB   |                                                                        |
| 5 GHz to 10 GHz                                 | 27  | 33   |      | dB   |                                                                        |
| 10 GHz to 14 GHz                                | 25  | 30   |      | dB   |                                                                        |
| 14 GHz to 20 GHz                                | 21  | 26   |      | dB   |                                                                        |
| RETURN LOSS AT RF1                              |     |      |      |      |                                                                        |
| DC to 14 GHz                                    |     | 15   |      | dB   |                                                                        |
| DC to 20 GHz                                    |     | 8    |      | dB   |                                                                        |
| INPUT POWER FOR 0.25 dB COMPRESSION             |     |      |      |      | Frequency = 0.5 GHz to 8.0 GHz                                         |
| Minimum Attenuation                             |     | 7    |      | dBm  |                                                                        |
| Attenuation > 5 dB                              |     | -4   |      | dBm  |                                                                        |
| INPUT THIRD-ORDER INTERCEPT POINT               |     |      |      |      | Two-tone input power = 10 dBm each tone, frequency = 0.5 GHz to 16 GHz |
| Minimum Attenuation                             |     | 22   |      | dBm  |                                                                        |
| Attenuation > 10 dB                             |     | 25   |      | dBm  |                                                                        |
| SWITCHING CHARACTERISTICS                       |     |      |      |      |                                                                        |
| $t_{RISE}$                                      |     | 111  |      | ns   | 90% RF                                                                 |
| $t_{FALL}$                                      |     | 83   |      | ns   | 10% RF                                                                 |
| $t_{ON}$                                        |     | 125  |      | ns   | 50% $V_{CTL}$ to 90% RF                                                |
| $t_{OFF}$                                       |     | 103  |      | ns   | 50% $V_{CTL}$ to 10% RF                                                |
| SUPPLY VOLTAGE AND CURRENT                      |     |      |      |      | $\pm V_{DC}$ range = $\pm 10\%$                                        |
| Supply Voltage                                  |     |      |      |      |                                                                        |
| $+V_{DC}$                                       |     | 5.0  |      | V    |                                                                        |
| $-V_{DC}$                                       |     | -5.0 |      | V    |                                                                        |
| Supply Current                                  |     |      |      |      |                                                                        |
| +5.0 V dc                                       |     | 3.3  | 3.7  | mA   |                                                                        |
| -5.0 V dc                                       |     | -6.9 | -8.8 | mA   |                                                                        |
| CONTROL VOLTAGE                                 |     |      |      |      |                                                                        |
| Minimum Attenuation                             |     | 0    |      | V    |                                                                        |
| Maximum Attenuation                             |     | -2.9 |      | V    |                                                                        |

## ABSOLUTE MAXIMUM RATINGS

Table 2.

| Parameter                          | Rating             |
|------------------------------------|--------------------|
| Control Voltage ( $V_{CTL}$ )      | –5 V dc to +1 V dc |
| Supply Voltage                     |                    |
| + $V_{DC}$                         | 16 V dc            |
| – $V_{DC}$                         | –16 V dc           |
| RF Input Power (0.5 GHz to 20 GHz) | 18 dBm             |
| Storage Temperature Range          | –65°C to +150°C    |
| Operating Temperature Range        | –55°C to +85°C     |

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

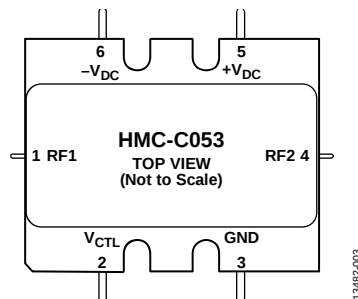


Figure 2. Pin Configuration

Table 3. Pin Function Descriptions

| Pin No. | Mnemonic  | Description                                                                                                                                    |
|---------|-----------|------------------------------------------------------------------------------------------------------------------------------------------------|
| 1       | RF1       | RF Input 1. This pin is dc-coupled and matched to 50 $\Omega$ . Blocking capacitors are required if the RF line potential is not equal to 0 V. |
| 2       | $V_{CTL}$ | Control Input (Master).                                                                                                                        |
| 3       | GND       | Ground. Package bottom has an exposed metal paddle that must also be connected to the printed circuit board (PCB) RF ground.                   |
| 4       | RF2       | RF Input 2. This pin is dc-coupled and matched to 50 $\Omega$ . Blocking capacitors are required if the RF line potential is not equal to 0 V. |
| 5       | $+V_{DC}$ | Positive Supply Voltage.                                                                                                                       |
| 6       | $-V_{DC}$ | Negative Supply Voltage.                                                                                                                       |

## INTERFACE SCHEMATICS

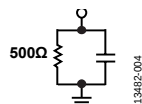


Figure 3.  $V_{CTL}$  Interface Schematic



Figure 4. GND Interface Schematic

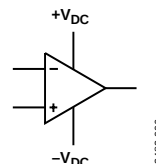


Figure 5.  $+V_{DC}$  and  $-V_{DC}$  Interface Schematic

## TYPICAL PERFORMANCE CHARACTERISTICS

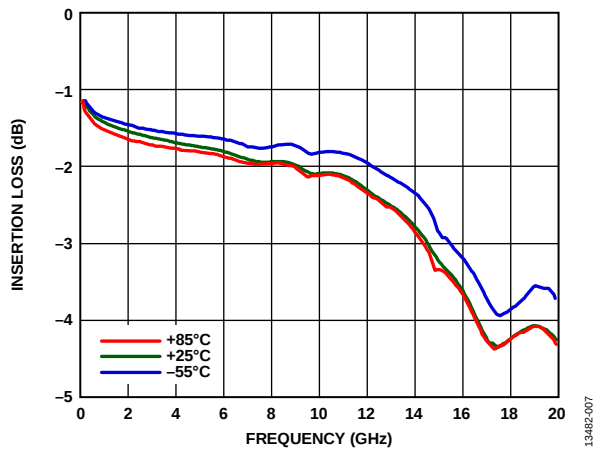


Figure 6. Insertion Loss vs. Frequency over Temperature

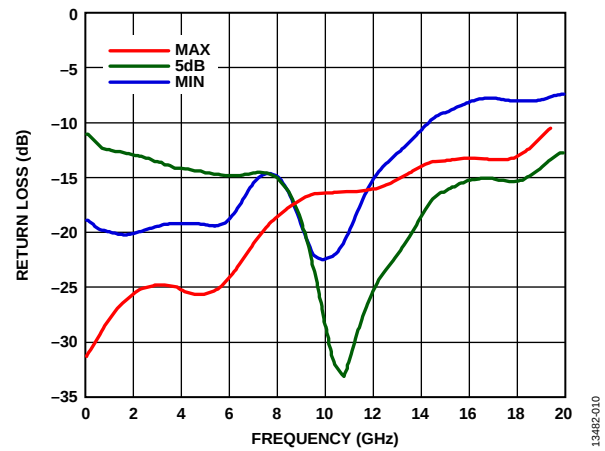


Figure 9. Return Loss RF1 vs. Frequency over Attenuation

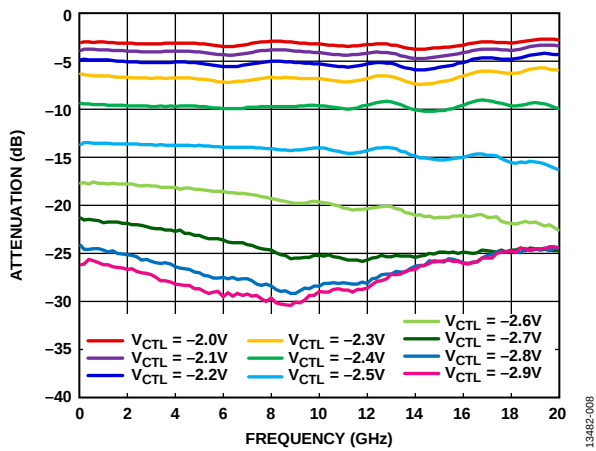


Figure 7. Relative Attenuation vs. Frequency

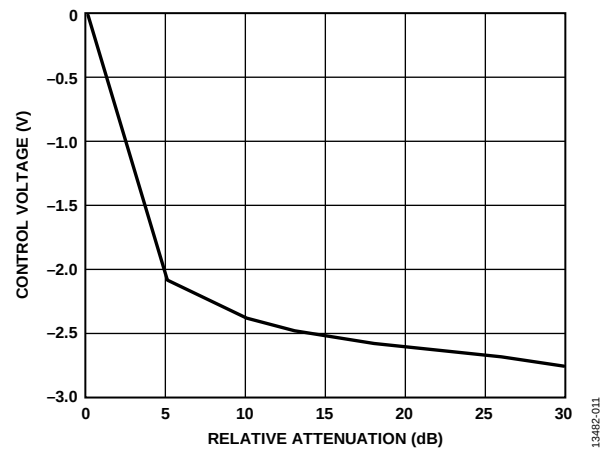


Figure 10. Relative Attenuation vs. Control Voltage at 10 GHz

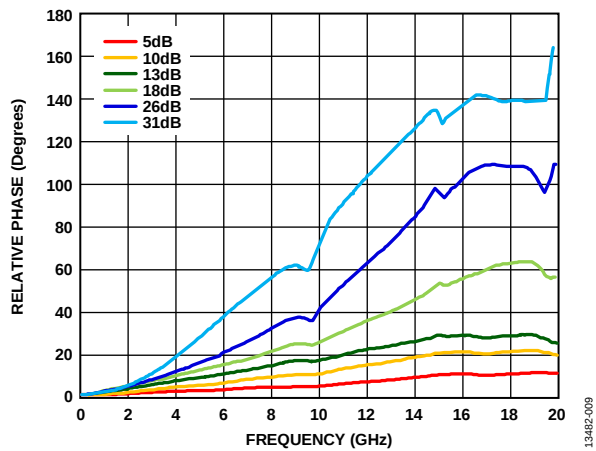


Figure 8. Relative Phase vs. Frequency

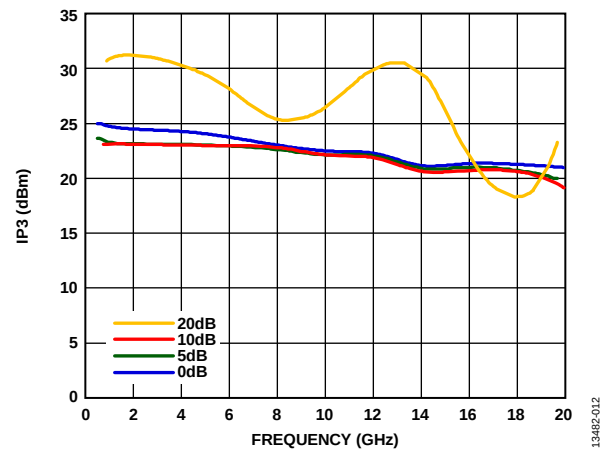


Figure 11. Input IP3 vs. Frequency over Attenuation

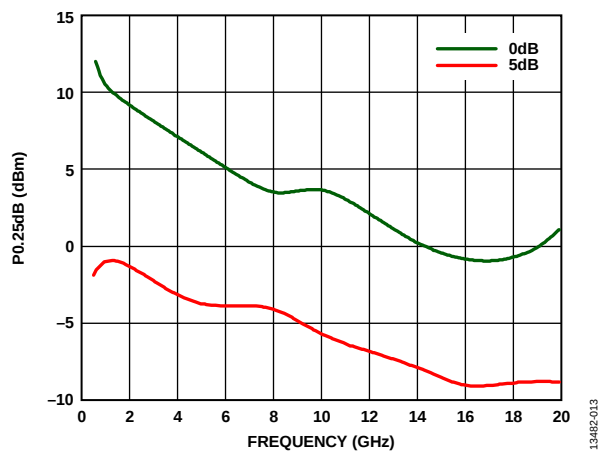


Figure 12. 0.25 dB Compression vs. Frequency over Attenuation

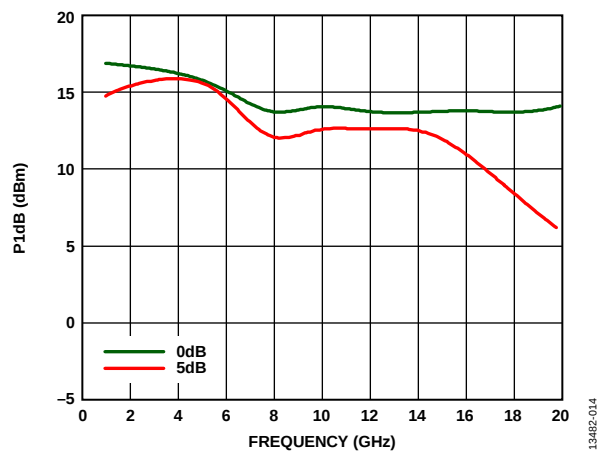


Figure 13. 1 dB Compression vs. Frequency over Attenuation

## APPLICATIONS INFORMATION

In Figure 14, the [HMC-C053](#) is used to make a variable gain amplifier. In this application circuit, the [HMC-C053](#) varies the amplitude of the signal feeding the amplifier over a 30 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-C053](#).

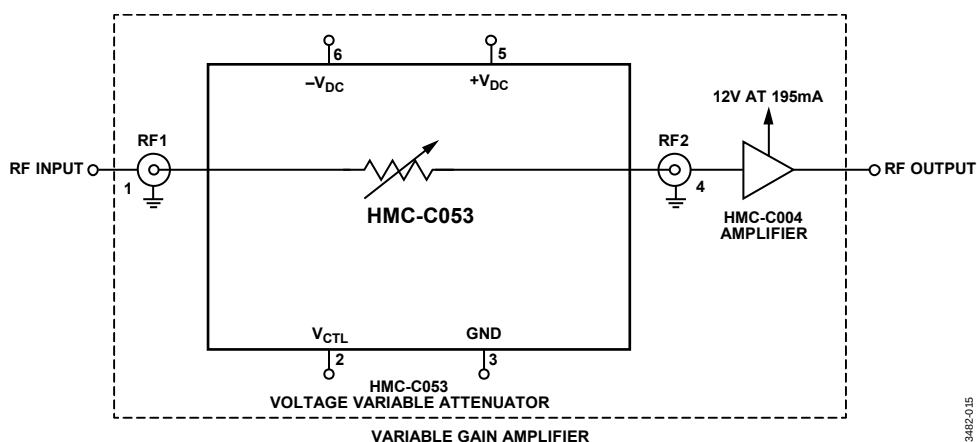
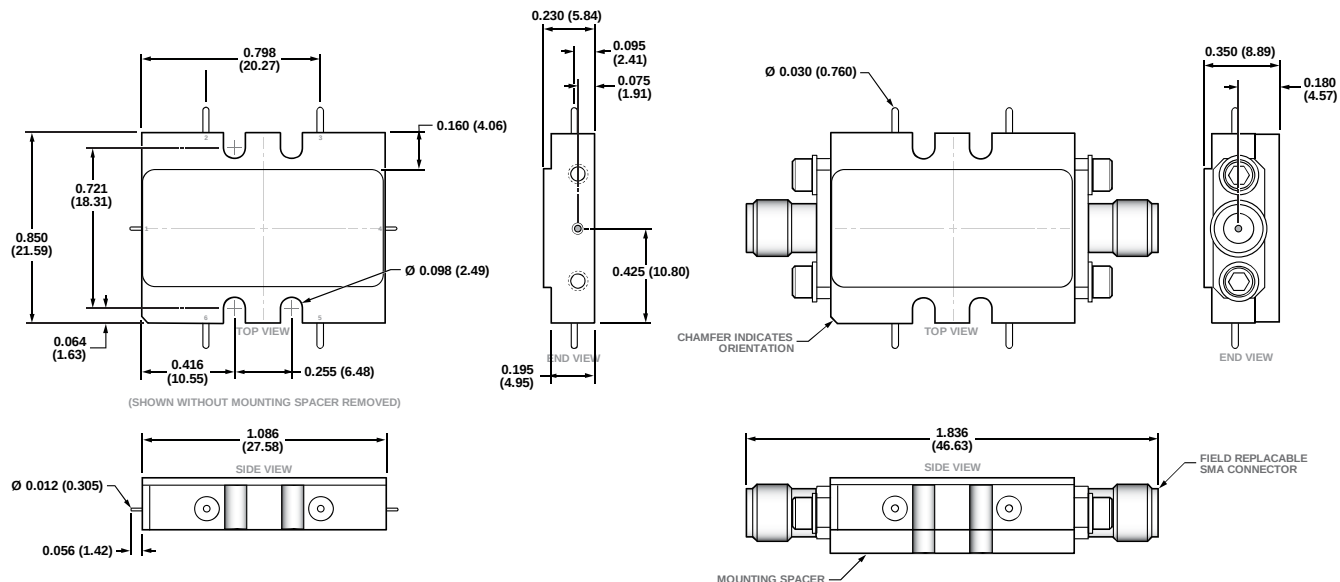


Figure 14. Variable Gain Amplifier

13482-015

## 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 15. 6-Lead Module with Connector Interface [MODULE]  
(HML-6-2)

Dimensions shown in inches (and millimeters)

## ORDERING GUIDE

| Model <sup>1</sup> | Temperature Range | Package Description                             | Package Option |
|--------------------|-------------------|-------------------------------------------------|----------------|
| HMC-C053           | -55°C to +85°C    | 6-Lead Module with Connector Interface [MODULE] | HML-6-2        |

<sup>1</sup> The HMC-C053 is a RoHS compliant part.