DC-50 GHz Variable Attenuator

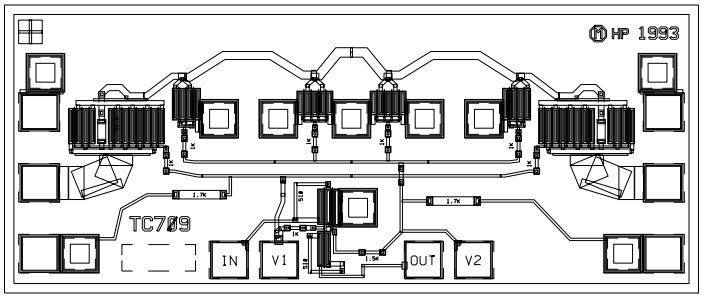
HMMC-1015

Features

- Specified Frequency Range: DC-26.5 GHz
- P_{in} (-1dB): 27 dBm @ 500 MHz
- Return Loss: 10 dB
- Minimum Attenuation: 2.0 dB
- Maximum Attenuation: 30.0 dB

Description

The HMMC-1015 is a monolithic, voltage variable, GaAs IC attenuator that operates from DC to 50 GHz. The distributed topology of the HMMC-1015 minimizes the parasitic effects of its series and shunt FETs, allowing the HMMC-1015 to exhibit a wide dynamic range across its full bandwidth. An on-chip DC reference circuit may be used to maintain optimum VSWR for any attenuation setting or to improve the attenuation versus voltage linearity of the attenuator circuit.



Chip Size: 1470 × 610 µm (57.9 × 24.0 mils)
Chip Size Tolerance: ± 10 µm (± 0.4 mils)
Chip Thickness: 127 ± 15 µm (5.0 ± 0.6 mils)

Absolute Maximum Ratings†

Symbol	Parameters/Conditions	Min.	Max.	Units
V_{DC-RF}	DC Voltage to RF Ports	-0.6	+1.6	volts
V_1	V_1 Control Voltage	-10.5	+0.5	volts
V_2	V_2 Control Voltage	-10.5	+0.5	volts
V_{DC}	DC In/DC Out	-0.6	+1.0	volts
P_{IN}	RF Input Power		17	dBm
T_{mina}	Minimum Ambient Operating Temperature	-55		°C
T_{maxa}	Maximum Ambient Operating Temperature		+125	°C
T_{stg}	Storage Temperature	-65	+165	°C
T_{max}	Maximum Assembly Temp. (for 60 seconds maximum)		+300	°C

†Operation in excess of any one of theses conditions may result in permanent damage to this device.

DC Specifications/Physical Properties

(T_A=25°C)

Symbol	Parameters/Conditions	Min.	Typ.	Max.	Units
I_{V1}	V_1 Control Current, (V_1 = -10V)	5.0	5.9	7.1	mA
I_{V2}	V_2 Control Current, (V_2 = -10V)	5.0	5.9	7.1	mA
V_p	Pinch-Off Voltage	-6.75	-5.0	-3.75	volts

Electrical Specifications††

(T_A= 25°C, Z_o = 50Ω)

Parameters/Conditions	Freq. (GHz)	Min.	Typ.	Max.	Units
Minimum Attenuation, |S_{21}|(V_1 = 0 V, V_2 = -10 V)	1.5		1.0	2.4	dB
	8.0		1.4	2.4	
	20.00		1.7	2.4	
	26.5		2.0	2.4	
	50.0		3.9		
Input/Output Return Loss @ Min. Attenuation Setting, (V_1 = 0 V,V_2 = -10 V)	<26.5	10	16		dB
	<50.0		8		
Maximum Attenuation |S_{21}|(V_1 = -10 V, V_2 = 0 V)	1.5	27	30		dB
	8.0	27	38		
	20.0	27	38		
	26.5	27	40		
	50.0		35		
P_{-1dB} @ Minimum Attenuation	300 kHz		18.5		dBm
	>500 MHz		27		dBm
Input/Output Return Loss @ Max Attention Setting, (V_1 = -10 V, V_2 = 0 V)	<26.5	8	10		dB
	<50.0		10		
DC Power Dissipation, (V_1 = - 10.5, V_2 = -10.5) (does not include input signals)				158	mW

††Attenuation is a positive number; whereas, S_{21} as measured on a Network Analyzer would be a negative number.

Application

The HMMC-1015 is designed to be used as a gain control block in an ALC assembly. Because of its wide dynamic range and return loss performance, the HMMC-1015 may also be used as a broadband pulse modulator or single-pole single-throw, non-reflective switch.

Operation

The attenuation of the HMMC-1015 is adjusted by applying negative voltages to V_1 and V_2. V_1 controls the drain-to-source resistances of the series FETs while V_2 controls the drain-to-source resistances of the shunt FETs. For any HMMC-1015 the values of V_1 may be adjusted so that the device attenuation versus voltage is monotonic for both V_1 and V_2; however, this will slightly degrade the input and output return loss.

The attenuation of the HMMC-1015 may also be controlled using only a single input voltage by utilizing the on-chip DC reference circuit and the driver circuit shown in Figure 4. This circuit optimizes VSWR for any attenuation setting. Because of process variations, the values of V_{REF}, R_{REF}, and R_L are different for each wafer if optimum performance is required. Typical values for these elements are given. The ratio of the resistors R_1 and R_2 determines the sensitivity of the attenuation versus voltage performance of the attenuator. For more information on the performance of the HMMC-1015 and the driver circuits previously mentioned see MWTC's Application Note #37, "HMMC-1015 Attenuator: Attenuation Control." For more S-parameter information, see MWTC's Application Note #44, "HMMC-1015 Attenuator: S-Parameters."

Assembly Techniques

Electrical and thermal conductive epoxy die attach is the preferred assembly method. Solder die attach using a fluxless gold-tin solder preform can also be used. The device should be attached to an electrically conductive surface to complete the DC and RF ground paths. The backside metallization on the device is gold.

Gold thermosonic wedge bonding with 0.7 mil wire is the recommended method for bonding to the device. Tool force should be 22 grams ± 1 gram, stage temperature is 150 ± 2°C, and ultrasonic power and duration of 64 ± 1dB and 76 ± 8msec, respectively. The top and bottom metallization is gold.

For more detailed information see HP application note #999 "GaAs MMIC Assembly and Handling Guidelines."

GaAs MMICs are ESD sensitive. Proper precautions should be used when handling these devices.

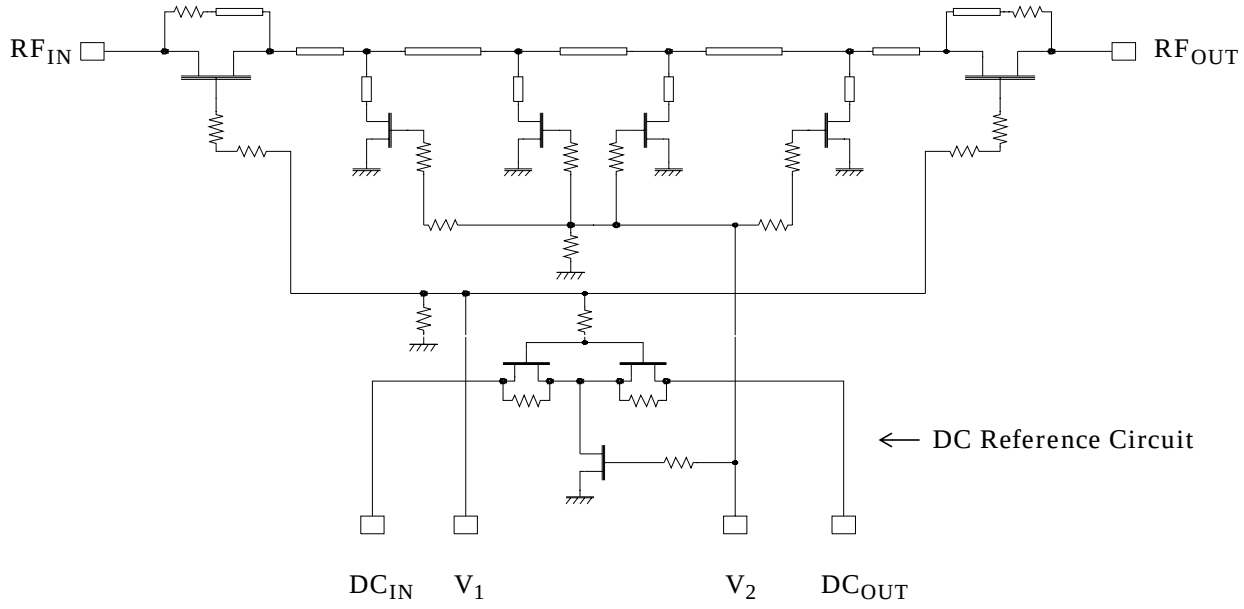
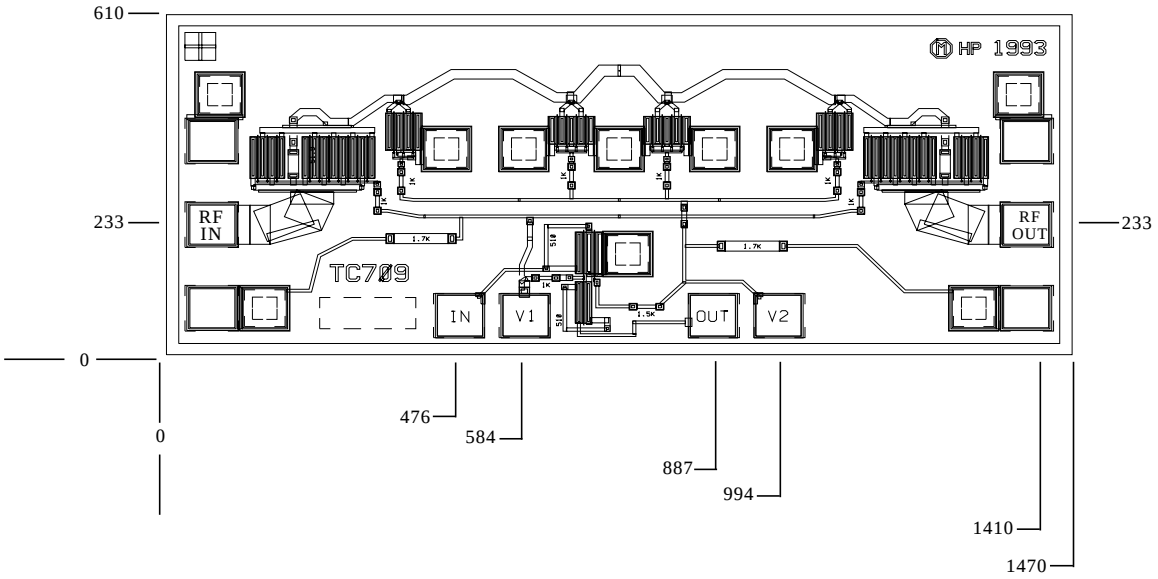


Figure 1.
HMMC-1015 Schematic



Notes: 1) All dimensions in microns and shown to center of bond pad.

2) DC_{in}, V_1, DC_{out}, and V_2 bonding pads are 75×75 microns.

3) RF input and output bonding pads are 60×70 microns.

4) Chip thickness: 127 ± 15 µm.

Figure 2.
HMMC-1015 Bonding Pad Locations

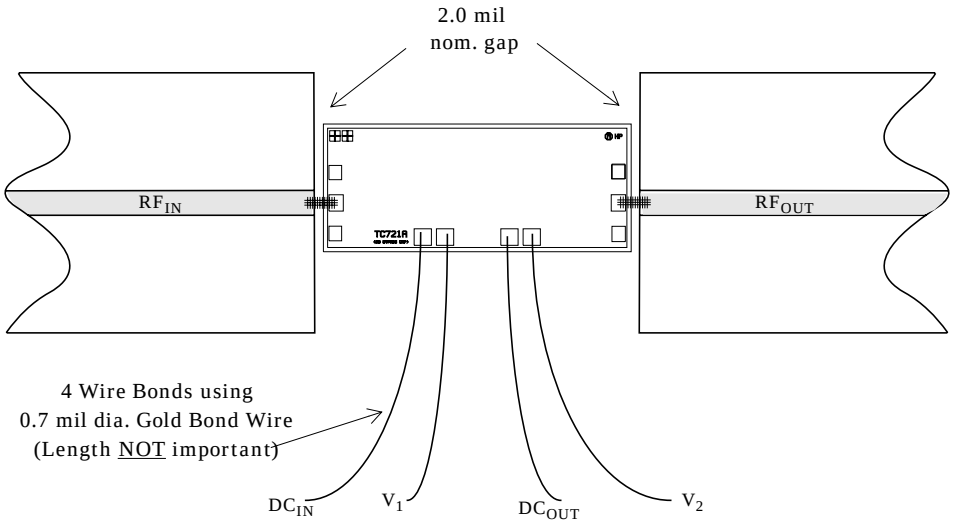


Figure 3.
HMMC-1015 Assembly Diagram

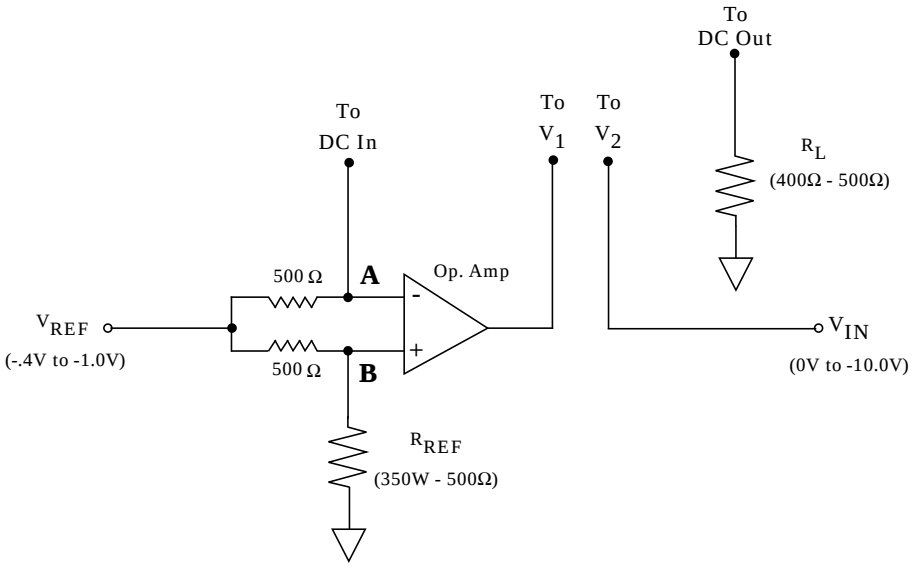


Figure 4.
Attenuator Driver

Typical HMMC-1015 Performance

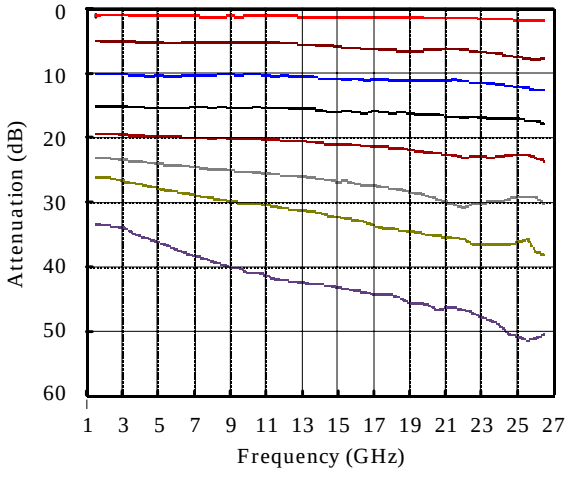


Figure 5.
Attenuation vs. Frequency‡

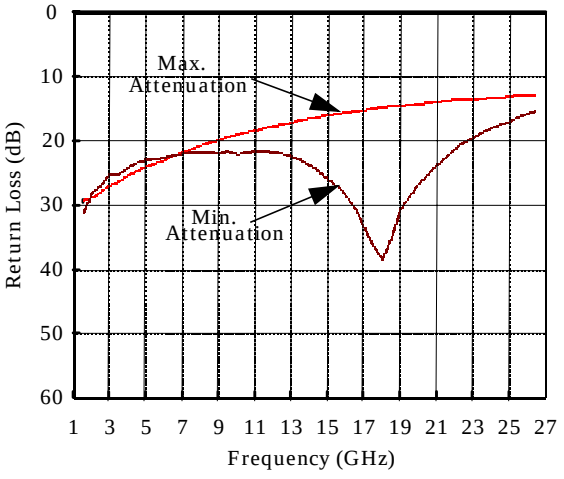


Figure 6.
Output Return Loss vs. Frequency‡

‡Data obtained from on-wafer measurements. T_{chuck} = 25°C.

Typical HMMC-1015 Temperature Performance

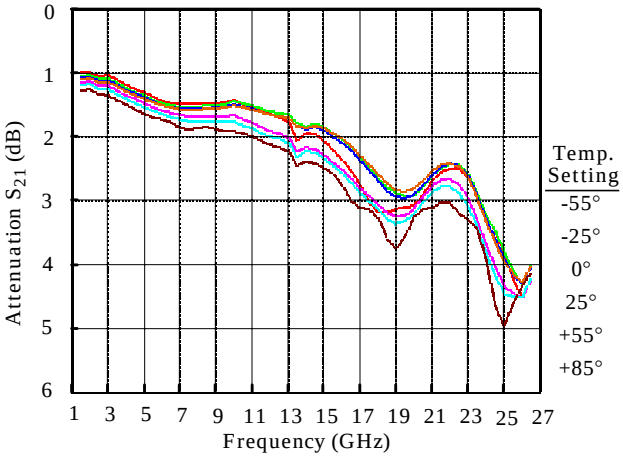


Figure 7.
Attenuation vs. Temperature
@ Minimum Attenuation⌗

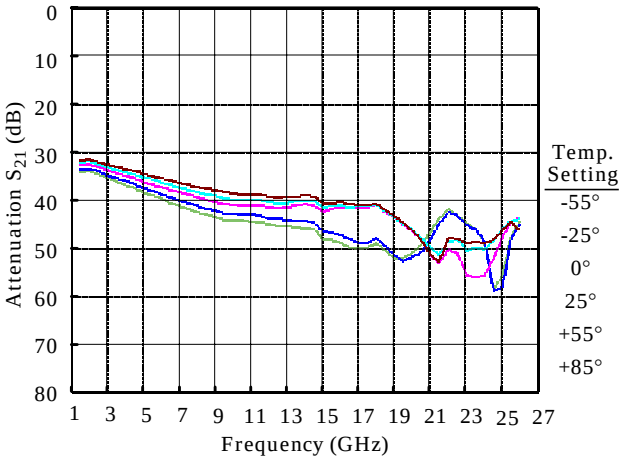


Figure 8.
Attenuation vs. Temperature
@ Maximum Attenuation⌗

⌗Data taken with the device mounted in connectorized package.

This data sheet contains a variety of typical and guaranteed performance data. The information supplied should not be interpreted as a complete list of circuit specifications. In this data sheet the term *typical* refers to the 50th percentile performance. For additional information contact your local HP sales representative.