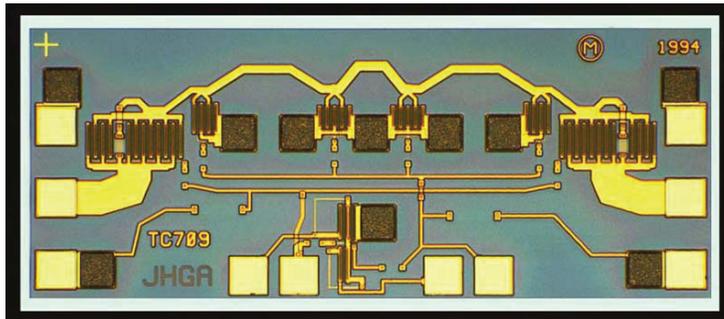


Keysight HMMC-1015

DC–50 GHz Variable Attenuator

1GG7-8008

Data Sheet



Features

- Specified frequency range:
DC to 26.5 GHz
- P_{in} (-1 dB): 27 dBm @ 500 MHz
- Return loss: 10 dB
- Minimum attenuation: 2.0 dB
- Maximum attenuation: 30.0 dB

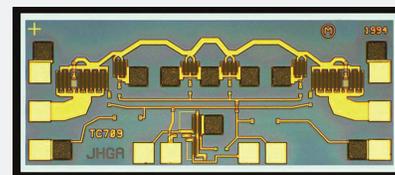
Description

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.

Absolute Maximum Ratings¹

Symbol	Parameters/conditions	Minimum	Maximum	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 temperature (for 60 seconds maximum)		+300	°C

1. Operation in excess of any one of these conditions may result in permanent damage to this device



Chip size:

1470 x 610 μm (57.9 x 24.0 mils)

Chip size tolerance:

$\pm 10 \mu\text{m}$ (± 0.4 mils)

Chip thickness:

$127 \pm 15 \mu\text{m}$ (5.0 ± 0.6 mils)

RF pad dimensions:

60 x 70 μm (2.4 x 2.8 mils) or larger

DC pad dimensions:

75 x 75 μm (3.0 x 3.0 mils) or larger

DC Specifications/Physical Properties

($T_A = 25\text{ }^\circ\text{C}$)

Symbol	Parameters/conditions	Minimum	Typical	Maximum	Units
I_{V1}	V_1 control current, ($V_1 = -10\text{ V}$)	5.0	5.9	7.1	mA
I_{V2}	V_2 control current, ($V_2 = -10\text{ V}$)	5.0	5.9	7.1	mA
V_p	Pinch-off voltage	-6.75	-5.0	-3.75	Volts

Electrical Specifications¹

($T_A = 25\text{ }^\circ\text{C}$, $Z_0 = 50\text{ }\Omega$)

Parameters/conditions	Frequency (GHz)	Minimum	Typical	Maximum	Units
Minimum attenuation, $ S_{21} $ ($V_1 = 0\text{ V}$, $V_2 = -10\text{ V}$)	1.5		1.0	2.4	dB
	8.0		1.4	2.4	dB
	20.00		1.7	2.4	dB
	26.5		2.0	2.4	dB
	50.0		3.9		dB
Input/output return loss @ minimum attenuation setting, ($V_1 = 0\text{ V}$, $V_2 = -10\text{ V}$)	< 26.5	10	16		dB
	< 50.0		8		dB
Maximum attenuation $ S_{21} $ ($V_1 = -10\text{ V}$, $V_2 = 0\text{ V}$)	1.5	27	30		dB
	8.0	27	38		dB
	20.0	27	38		dB
	26.5	27	40		dB
	50.0		35		dB
$P_{-1\text{ dB}}$ @ minimum attenuation	300 kHz		18.5		dBm
	> 500 MHz		27		dBm
Input/output return loss @ maximum attention setting, ($V_1 = -0\text{ V}$, $V_2 = 0\text{ V}$)	< 26.5	8	10		dB
	< 50.0		10		dB
DC power dissipation, ($V_1 = -10.5\text{ V}$, $V_2 = -10.5\text{ V}$) (does not include input signals)				158	mW

1. Attenuation is a positive number; whereas, S_{21} as measured on a network analyzer would be a negative number.

Applications

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 value of the HMMC-1002 is adjusted by applying negative voltage to V_2 . At any attenuation setting, optimum VSWR is obtained by applying negative voltage to V_1 . Applying negative voltage (V_2) to the gates of the shunt FETs sets the source-to-drain resistance and establishes the attenuation level. Applying negative voltage (V_1) to the gates of the series FETs optimizes the input and output match for different attenuation settings. In some applications, a single setting of V_1 may provide sufficient input and output match over the desired attenuation range (V_2). 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 and input/output match 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 WPTC's Application Note, *HMMC-1021 Attenuator: Attenuation Control*, literature number 5991-3555EN. For more S-parameter information, see WPTC's Application Note, *HMMC-1015 Attenuator: S-Parameters*, literature number 5991-3556EN.

Assembly Techniques

GaAs MMICs are ESD sensitive. ESD preventive measures must be employed in all aspects of storage, handling, and assembly.

MMIC ESD precautions, handling considerations, die attach and bonding methods are critical factors in successful GaAs MMIC performance and reliability.

Keysight Technologies, Inc. application note, *GaAs MMIC ESD, Die Attach and Bonding Guidelines*, literature number 5991-3484EN, provides basic information on these subjects.

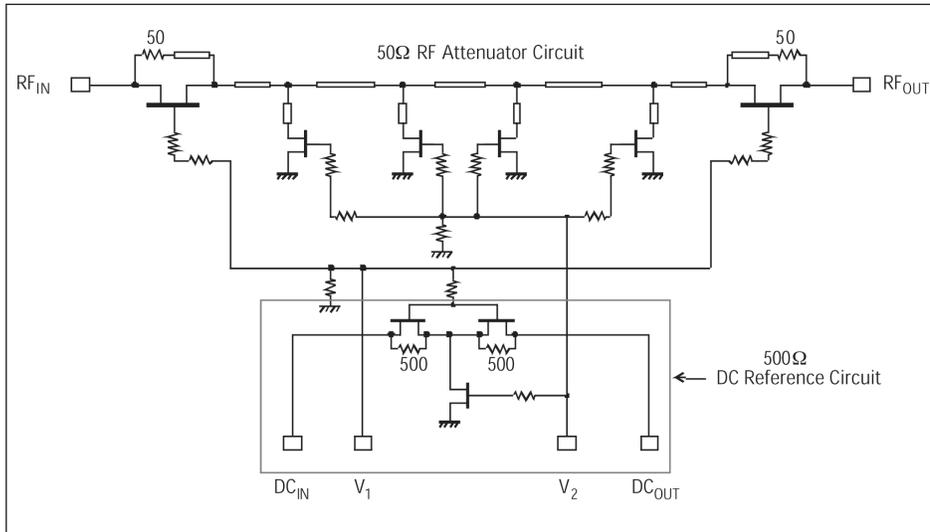


Figure 1. Schematic

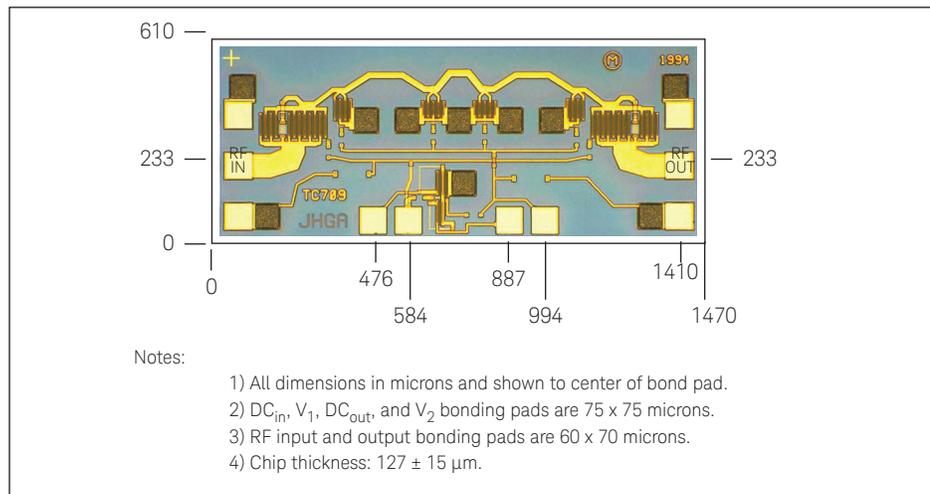


Figure 2. Bonding pad locations

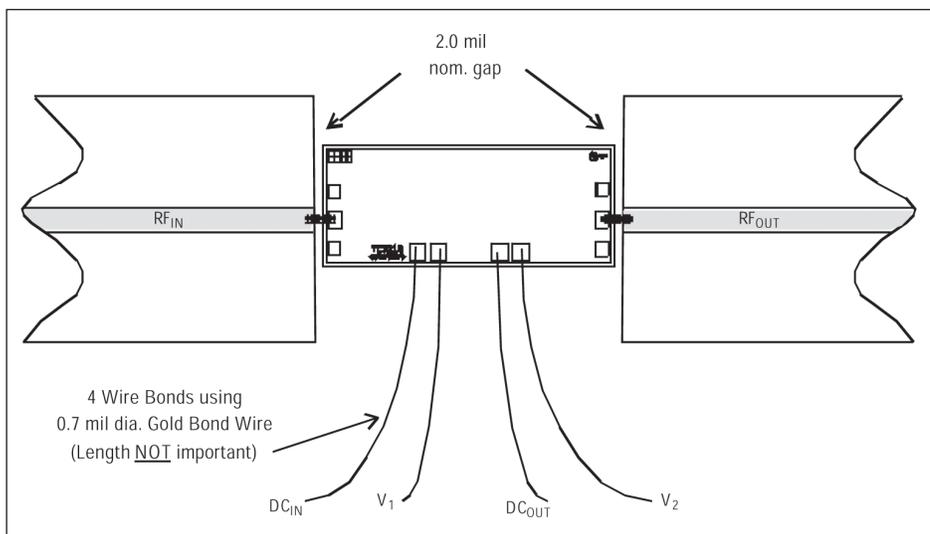
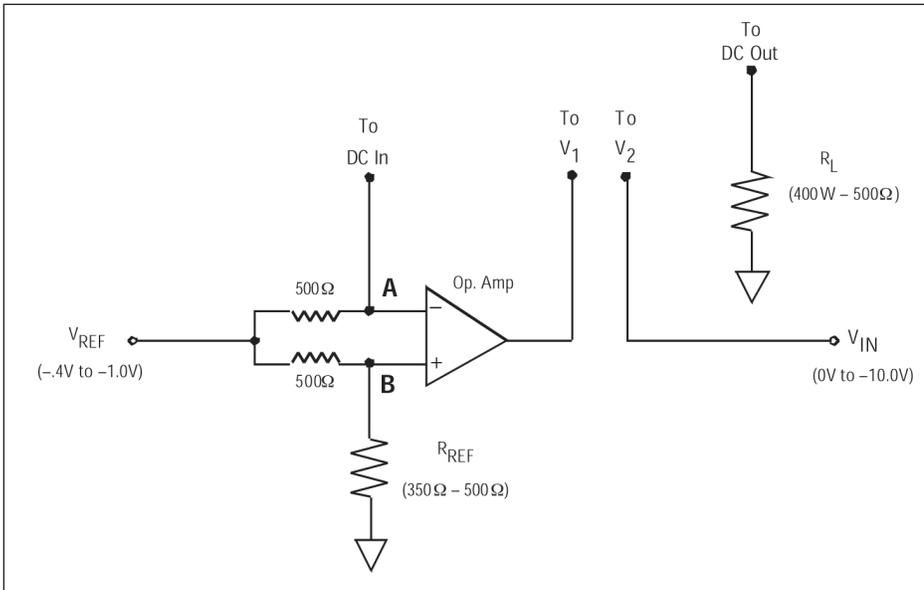


Figure 3. Assembly diagram

Figure 4. Attenuator driver



Typical Performance

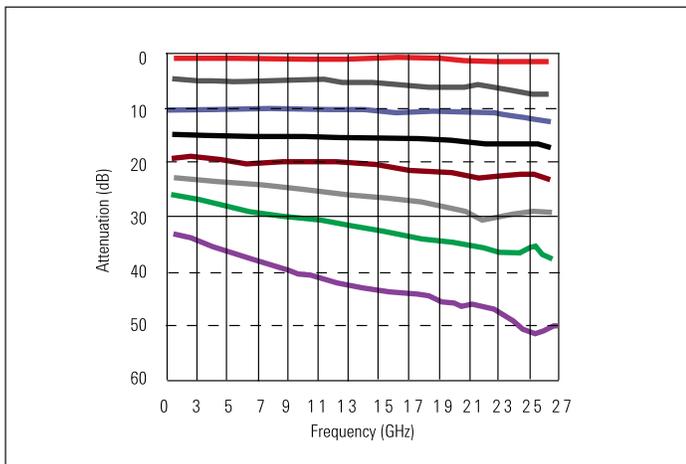


Figure 5. Attenuation vs. frequency¹

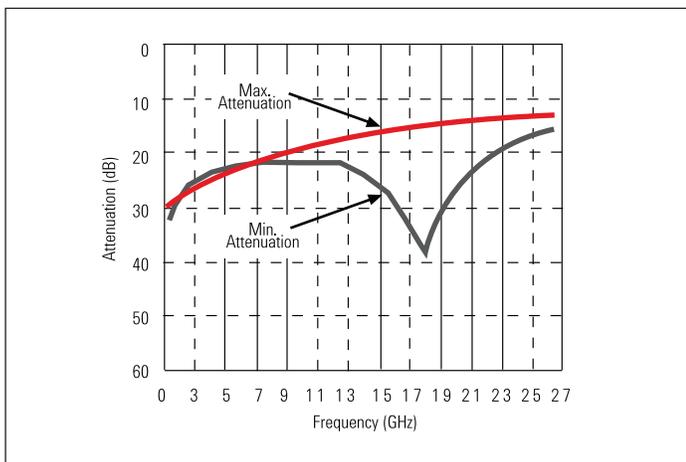


Figure 6. Output return loss vs. frequency¹

1. Data obtained from on-wafer measurements. $T_{\text{chuck}} = 25\text{ }^{\circ}\text{C}$.

Typical Temperature Performance

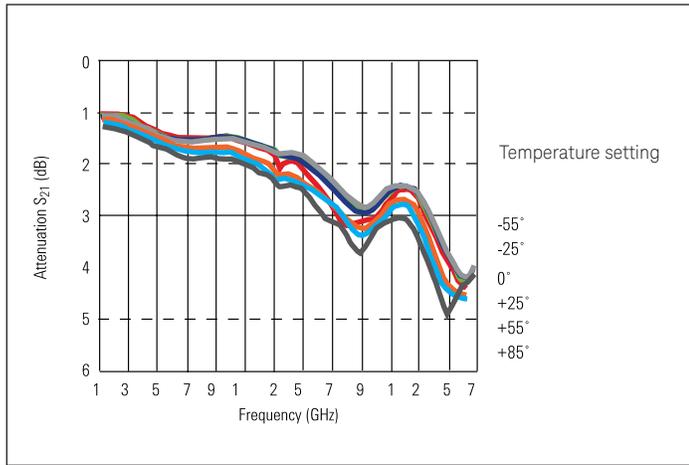


Figure 7. Attenuation vs. temperature @ minimum attenuation¹

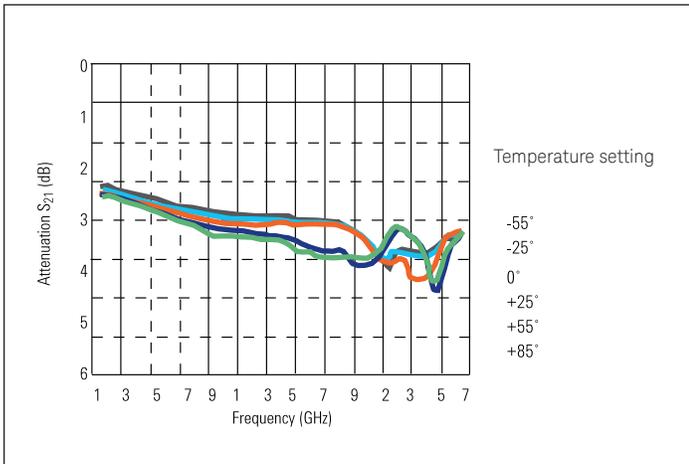


Figure 8. Attenuation vs. temperature @ maximum attenuation¹

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. Customers considering the use of this, or other Keysight GaAs ICs, for their design should obtain the current production specifications from Keysight. In this data sheet the term typical refers to the 50th percentile performance. For additional information contact Keysight MMIC_Helpline@Keysight.com.

1. Data taken with the device mounted in connectorized package

myKeysight

myKeysight

www.keysight.com/find/mykeysight

A personalized view into the information most relevant to you.



www.axistandard.org

AdvancedTCA® Extensions for Instrumentation and Test (AXIe) is an open standard that extends the AdvancedTCA for general purpose and semiconductor test. Keysight is a founding member of the AXIe consortium. ATCA®, AdvancedTCA®, and the ATCA logo are registered US trademarks of the PCI Industrial Computer Manufacturers Group.



www.lxistandard.org

LAN eXtensions for Instruments puts the power of Ethernet and the Web inside your test systems. Keysight is a founding member of the LXI consortium.



www.pxisa.org

PCI eXtensions for Instrumentation (PXI) modular instrumentation delivers a rugged, PC-based high-performance measurement and automation system.



Three-Year Warranty

www.keysight.com/find/ThreeYearWarranty

Keysight's commitment to superior product quality and lower total cost of ownership. The only test and measurement company with three-year warranty standard on all instruments, worldwide.



Keysight Assurance Plans

www.keysight.com/find/AssurancePlans

Up to five years of protection and no budgetary surprises to ensure your instruments are operating to specification so you can rely on accurate measurements.



www.keysight.com/quality

Keysight Technologies, Inc.
DEKRA Certified ISO 9001:2008
Quality Management System

Keysight Channel Partners

www.keysight.com/find/channelpartners

Get the best of both worlds: Keysight's measurement expertise and product breadth, combined with channel partner convenience.

For more information on Keysight Technologies' products, applications or services, please contact your local Keysight office. The complete list is available at: www.keysight.com/find/contactus

Americas

Canada	(877) 894 4414
Brazil	55 11 3351 7010
Mexico	001 800 254 2440
United States	(800) 829 4444

Asia Pacific

Australia	1 800 629 485
China	800 810 0189
Hong Kong	800 938 693
India	1 800 112 929
Japan	0120 (421) 345
Korea	080 769 0800
Malaysia	1 800 888 848
Singapore	1 800 375 8100
Taiwan	0800 047 866
Other AP Countries	(65) 6375 8100

Europe & Middle East

Austria	0800 001122
Belgium	0800 58580
Finland	0800 523252
France	0805 980333
Germany	0800 6270999
Ireland	1800 832700
Israel	1 809 343051
Italy	800 599100
Luxembourg	+32 800 58580
Netherlands	0800 0233200
Russia	8800 5009286
Spain	0800 000154
Sweden	0200 882255
Switzerland	0800 805353
	Opt. 1 (DE)
	Opt. 2 (FR)
	Opt. 3 (IT)
United Kingdom	0800 0260637

For other unlisted countries:
www.keysight.com/find/contactus
(BP-07-01-14)

