

# Agilent HMMC-2007

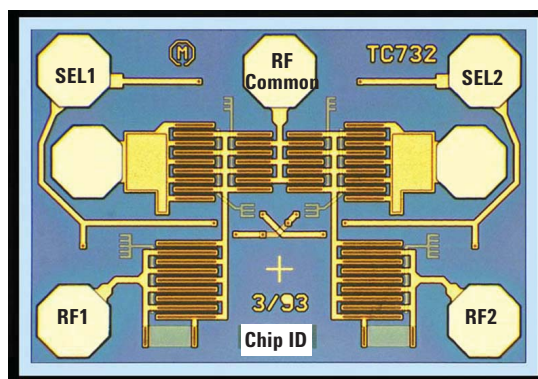
## DC–8 GHz Terminated SPDT Switch

1GG7-8004

### Data Sheet

#### Features

- **Outputs terminated in 50  $\Omega$  when off**
- **Frequency range: DC to 8 GHz**
- **Insertion loss: 1.2 dB @ 8 GHz**
- **Isolation:**
  - > 70 dB @ 45 MHz
  - > 35 dB @ 8 GHz
- **Return loss: 25 dB (both input and selected output)**  
**18 dB unselected output**
- **Switching speed:**  
< 20  $\mu$ s (10%–90% RF)
- **$P_{-1\text{ dB}}$ : 27 dBm**
- **Harmonics (DC coupled):**  
< –80 dBc @ 10 dBm



Chip size: 660 x 960  $\mu$ m (25.9 x 37.8 mils)  
 Chip size tolerance:  $\pm 10$   $\mu$ m ( $\pm 0.4$  mils)  
 Chip thickness: 127  $\pm$  15  $\mu$ m (5.0  $\pm$  0.6 mils)  
 Pad dimensions: 120 x 120  $\mu$ m (4.7 x 4.7 mils)

#### Description

The HMMC-2007 is a GaAs monolithic microwave integrated circuit (MMIC) designed for low insertion loss and high isolation from DC to 8 GHz. It is intended for use as a general-purpose, single-pole, double-throw (SP-DT), absorptive switch. Two series and two shunt MESFETs per throw provide 1.4 dB maximum insertion loss and 38 dB typical isolation at 6 GHz. HMMC-2007 chips use through-substrate vias to provide ground connections to the chip backside and minimize the number of wire bonds required.

#### Absolute maximum ratings<sup>1</sup>

Symbol	Parameters/conditions	Minimum	Maximum	Units
$V_{\text{sel}}$	Select voltages 1 & 2	–10.5	+10.5	Volts
$P_{\text{in}}$	RF input power		27	dBm
$T_{\text{op}}$	Operating temperature	–55	+125	°C
$T_{\text{st}}$	Storage temperature	–65	+165	°C
$T_{\text{max}}$	Maximum assembly temperature		+200	°C
$P_{\text{unsel}}$	Power into unselected output		27	dBm

<sup>1</sup> Operation in excess of any one of these ratings may result in permanent damage to this device.  $T_A$  = 25°C except for  $T_{\text{op}}$ ,  $T_{\text{st}}$ , and  $T_{\text{max}}$ .



Agilent Technologies

## DC specifications/physical properties

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

Symbol	Parameters/conditions	Minimum	Typical	Maximum	Units
$I_{\text{SEL}-10\text{V}}$	Leakage current @ $-10\text{V}$			200	$\mu\text{A}$
$I_{\text{SEL}+10\text{V}}$	Leakage current @ $+10\text{V}$			20	$\mu\text{A}$
$V_p$	Pinch-off voltage ( $V_{\text{SEL}2} = V_p$ , $V_{\text{RFout}2} = +2\text{V}$ , $I_{\text{RFout}2} = 4\text{ mA}$ , $V_{\text{SEL}1} = -10\text{ V}$ , $V_{\text{RFout}1} = \text{open circuit}$ , $V_{\text{RFin}} = \text{GND}$ )	$-6.75$		$-3.00$	Volts
BV	Breakdown voltage (Test FET w/ $V_D = V_S = \text{GND}$ , $I_G = -50\text{ }\mu\text{A}$ )			$-13.0$	Volts

## RF specifications

( $T_A = 25^\circ\text{C}$ ,  $Z_0 = 50\text{ }\Omega$ ,  $V_{\text{sel-high}} = +10\text{ V}$ ,  $V_{\text{sel-low}} = -10\text{ V}$ )

Symbol	Parameters/conditions	Minimum	Typical	Maximum	Units
BW	Guaranteed operating bandwidth	DC		8.0	GHz
IL	Insertion loss, $\text{RF}_{\text{in}}$ to selected $\text{RF}_{\text{out}}$ (ON throw), 6 GHz		1.1	1.4	dB
ISO	Isolation, $\text{RF}_{\text{in}}$ to unselected $\text{RF}_{\text{out}}$ (OFF throw), 6 GHz		38		dB
$\text{RL}_{\text{in}}$	Input return loss @ 6 GHz		25		dB
$\text{RL}_{\text{out-ON}}$	Output return loss, ON throw @ 6 GHz		25		dB
$\text{RL}_{\text{out-OFF}}$	Output return loss, OFF throw @ 6 GHz		18		dB
$P_{-1\text{ dB}}$	Input power where IL increases by 1 dB, $f_{\text{in}} = 2\text{ GHz}$		27		dBm
$t_s$	Switching speed, 10%-90% RF envelope, $f_{\text{in}} = 2\text{ GHz}$		20		$\mu\text{s}$

### Applications

The HMMC-2007 can be used in instrumentation, communications, radar, ECM, EW, and many other systems requiring SPDT switching. It can be used for pulse modulation, port isolation, transfer switching, high-speed switching, replacement of mechanical switches, and so on.

### 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.

Agilent application note #54, "GaAs MMIC ESD, Die Attach and Bonding Guidelines" provides basic information on these subjects.

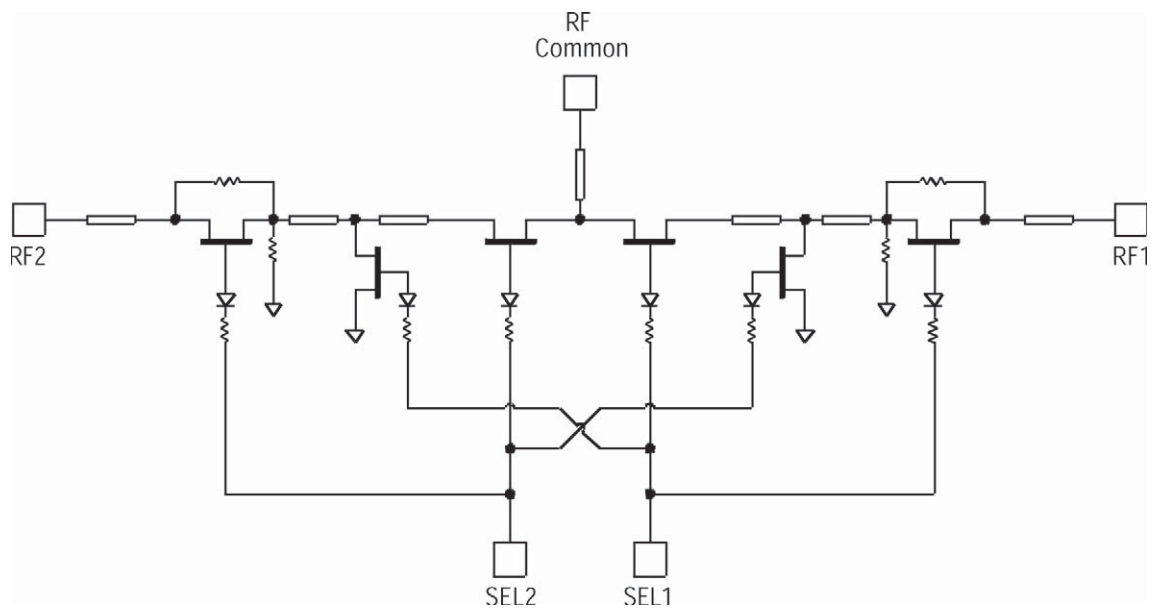
### Additional references

AN #57, "FET Switch Speed and Settling Time."

### S-Parameters<sup>1</sup> ( $T_A = 25^\circ\text{C}$ , $Z_0 = 50\ \Omega$ , $V_{\text{sel high}} = +10\ \text{V}$ , $V_{\text{sel low}} = -10\ \text{V}$ )

Frequency (GHz)	S <sub>11</sub>			S <sub>21</sub> (insertion loss)			S <sub>31</sub> (isolation) dB	S <sub>22</sub> (ON throw)			S <sub>33</sub> (OFF throw)		
	dB	mag	ang	dB	mag	ang		dB	mag	ang	dB	mag	ang
0.5	-26.41	0.048	-57.11	-1.08	0.88	-49.06	-67.74	-28.40	0.03	-47.94	-32.26	0.024	47.18
1.0	-27.53	0.042	-113.83	-1.13	0.88	-93.69	-60.55	-24.74	0.05	-117.54	-30.79	0.029	-38.11
1.5	-30.69	0.029	-176.73	-1.18	0.87	-138.08	-56.17	-31.91	0.02	168.76	-30.35	0.030	-64.68
2.0	-32.37	0.024	115.57	-1.21	0.87	177.39	-53.18	-31.31	0.02	119.22	-26.21	0.049	-134.70
2.5	-31.79	0.026	61.35	-1.25	0.87	133.00	-50.38	-28.90	0.03	68.41	-26.38	0.048	151.66
3.0	-30.60	0.030	4.27	-1.30	0.86	88.53	-47.63	-32.95	0.02	-11.68	-25.66	0.052	103.24
3.5	-28.53	0.037	-58.32	-1.33	0.86	44.08	-45.67	-29.26	0.03	-44.21	-22.99	0.071	38.61
4.0	-27.14	0.044	-124.01	-1.34	0.86	-0.53	-44.12	-30.61	0.02	-113.40	-22.41	0.076	-21.25
4.5	-26.46	0.048	172.69	-1.37	0.85	-45.16	-42.68	-32.21	0.02	165.53	-21.68	0.082	-75.25
5.0	-27.03	0.045	107.19	-1.40	0.85	-89.79	-41.45	-36.49	0.01	141.98	-19.88	0.101	-133.81
5.5	-28.64	0.037	32.44	-1.42	0.85	-134.56	-40.28	-34.51	0.01	4.26	19.89	0.101	167.02
6.0	-29.55	0.033	-59.18	-1.45	0.85	-179.46	-39.16	-32.44	0.02	-100.27	-19.03	0.112	115.49
6.5	-26.88	0.045	-156.32	-1.51	0.84	135.54	-38.12	-27.18	0.04	176.54	-18.28	0.122	56.80
7.0	-23.24	0.069	130.95	-1.56	0.84	90.76	-37.13	-23.83	0.06	122.00	-18.67	0.117	-2.63
7.5	-21.53	0.084	70.91	-1.52	0.84	46.04	-36.36	-21.48	0.08	51.31	-18.61	0.117	-60.32
8.0	-21.21	0.087	15.06	-1.62	0.83	0.47	-35.64	-21.73	0.08	-15.06	-17.65	0.131	-124.25
8.5	-20.92	0.090	-41.26	-1.64	0.83	-44.44	-34.83	-22.22	0.07	-81.88	-16.95	0.142	172.46
9.0	-19.88	0.101	-104.30	-1.66	0.83	-90.23	-34.13	-20.42	0.09	-145.01	-16.07	0.157	115.03
9.5	-18.65	0.117	-175.05	-1.84	0.81	-135.81	-33.62	-18.17	0.12	145.14	-14.94	0.179	59.82
10.0	-17.04	0.141	116.96	-1.90	0.80	179.24	-34.14	-16.31	0.15	85.15	-14.31	0.193	3.39

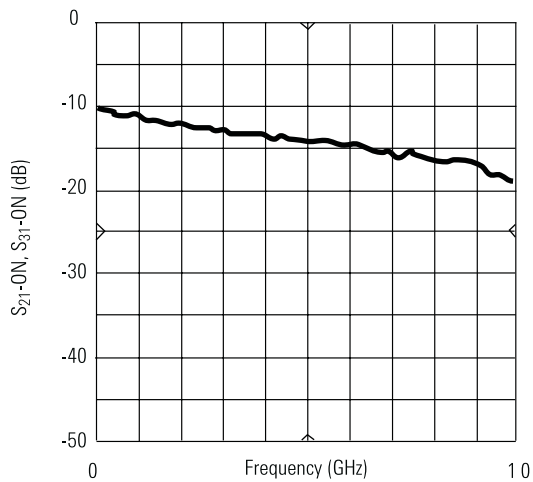
<sup>1</sup> Three-port wafer-probed data: Port 1 = RF input, Port 2 = selected RF output (i.e., ON throw), and Port 3 = unselected RF output (i.e., OFF throw).



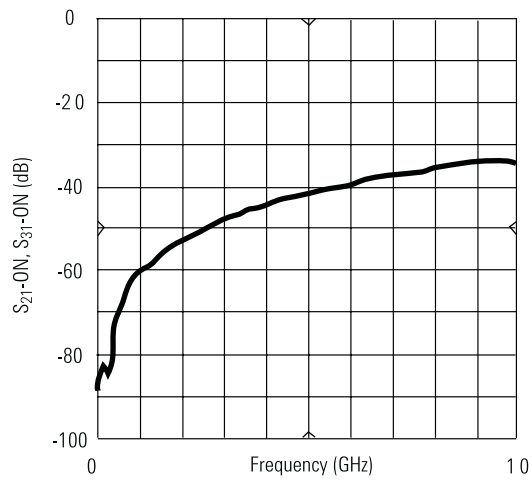
**Figure 1. Schematic**

Select line		RF path	
SEL1	SEL2	RF IN to RF OUT2	RF IN to RF OUT1
+10 V	−10 V	Isolated	Low loss
−10 V	+10 V	Low loss	Isolated

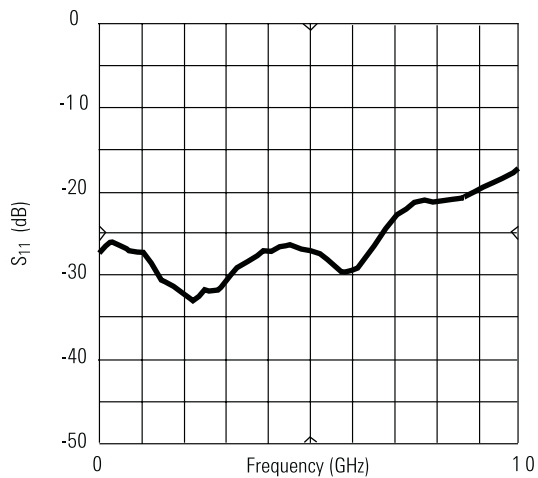
**Figure 2. Recommended operating conditions ( $T_A = 25^\circ\text{C}$ )**



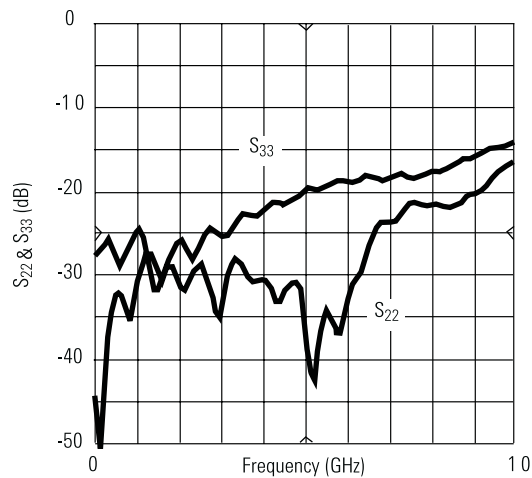
**Figure 3. Insertion Loss<sup>1</sup>**



**Figure 4. Input-to-output Isolation<sup>1</sup>**

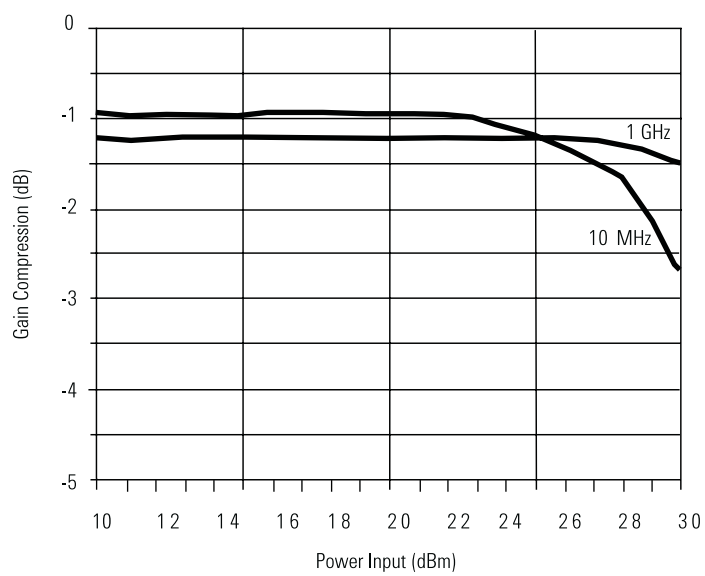


**Figure 5. Input return loss<sup>1</sup>**

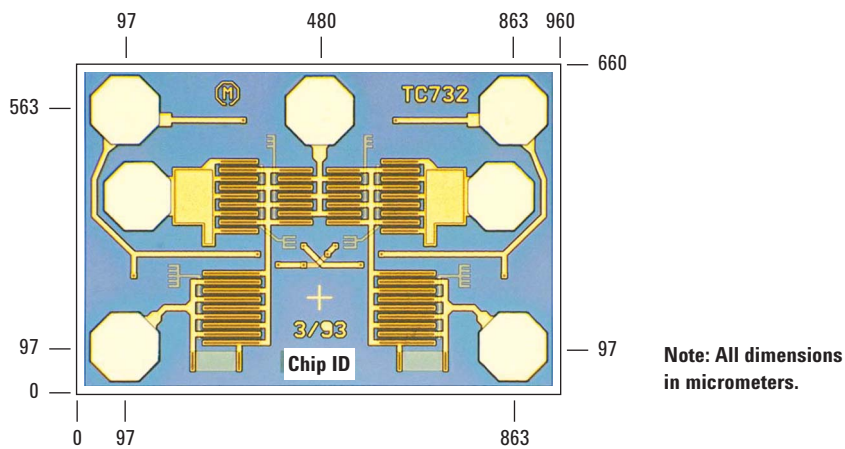


**Figure 6. Output return loss<sup>1</sup>**

<sup>1</sup> Data taken with the device mounted in modular breadboard package



**Figure 7. Gain compression**



**Figure 5. Bonding pad locations**

**Note:**

**All compression data measured on individual device mounted in an Agilent 83040 Series Modular Microcircuit Package @  $T_{\text{case}} = 25^{\circ}\text{C}$ .**

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 Agilent GaAs ICs, for their design should obtain the current production specifications from Agilent. In this data sheet the term typical refers to

the 50th percentile performance. For additional information contact Agilent [MMIC\\_Helpline@agilent.com](mailto:MMIC_Helpline@agilent.com).



### Agilent Email Updates

**[www.agilent.com/find/emailupdates](http://www.agilent.com/find/emailupdates)**

Get the latest information on the products and applications you select.



### Agilent Direct

**[www.agilent.com/find/agilentdirect](http://www.agilent.com/find/agilentdirect)**

Quickly choose and use your test equipment solutions with confidence.



**[www.agilent.com/find/open](http://www.agilent.com/find/open)**

Agilent Open simplifies the process of connecting and programming test systems to help engineers design, validate and manufacture electronic products. Agilent offers open connectivity for a broad range of system-ready instruments, open industry software, PC-standard I/O and global support, which are combined to more easily integrate test system development.

## **[www.agilent.com](http://www.agilent.com)**

For more information on Agilent Technologies' products, applications or services, please contact your local Agilent office. The complete list is available at:

**[www.agilent.com/find/contactus](http://www.agilent.com/find/contactus)**

### Phone or Fax

#### **United States:**

(tel) 800 829 4444  
(fax) 800 829 4433

#### **Canada:**

(tel) 877 894 4414  
(fax) 800 746 4866

#### **China:**

(tel) 800 810 0189  
(fax) 800 820 2816

#### **Europe:**

(tel) 31 20 547 2111

#### **Japan:**

(tel) (81) 426 56 7832  
(fax) (81) 426 56 7840

#### **Korea:**

(tel) (080) 769 0800  
(fax) (080) 769 0900

#### **Latin America:**

(tel) (305) 269 7500

#### **Taiwan:**

(tel) 0800 047 866  
(fax) 0800 286 331

#### **Other Asia Pacific Countries:**

(tel) (65) 6375 8100  
(fax) (65) 6755 0042  
Email: [tm\\_ap@agilent.com](mailto:tm_ap@agilent.com)

Revised: February 5, 2007

Product specifications and descriptions in this document subject to change without notice.

© Agilent Technologies, Inc. 2007

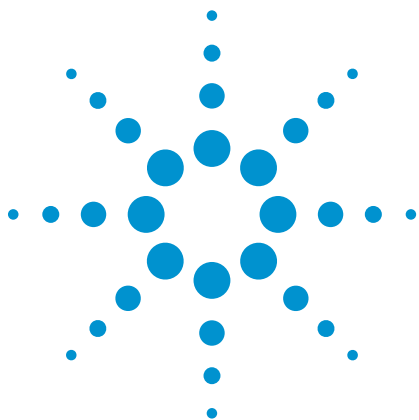
Printed in USA, June 8, 2007

5989-6203EN



**Agilent Technologies**





# Agilent HMMC-2027

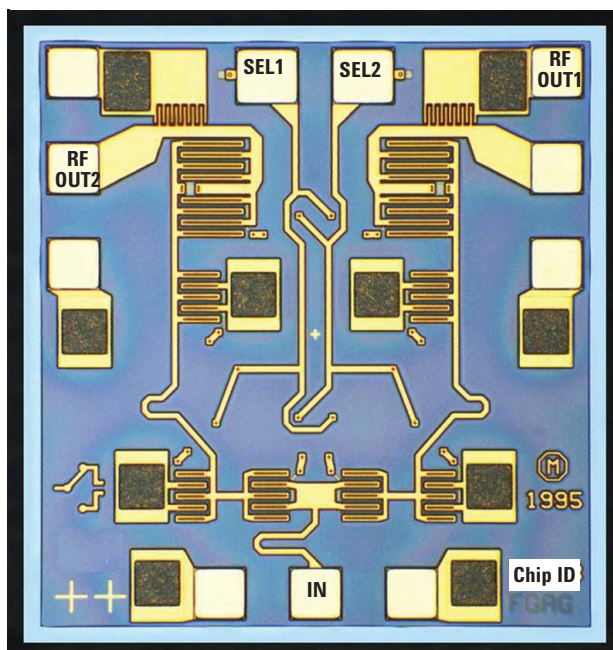
## DC–26.5 GHz SPDT GaAs MMIC Switch

### 1GG7-8005

#### Data Sheet

#### Features

- **Outputs terminated in 50  $\Omega$  when off**
- **Frequency range: DC to 26.5 GHz**
- **Insertion loss: 2.5 dB @ 26.5 GHz**
- **Isolation: > 70 dB @ 45 MHz  
30 dB @ 26.5 GHz**
- **Return loss: 15 dB (both input and selected output)  
12 dB unselected output**
- **Switching speed:  
< 1 ns (10%–90% RF)**
- **$P_{-1\text{ dB}}$ : 18 dBm @ 10 MHz  
27 dBm @ 2 GHz**
- **Harmonics (DC coupled):  
< –45 dBc @ 10 MHz and 5 dBm  
< –65 dBc @ 2 GHz and 5 dBm**



Chip size: 900 x 960  $\mu\text{m}$  (35.4 x 37.8 mils)  
 Chip size tolerance:  $\pm 10\text{ }\mu\text{m}$  ( $\pm 0.4$  mils)  
 Chip thickness:  $127 \pm 15\text{ }\mu\text{m}$  ( $5.0 \pm 0.6$  mils)  
 Pad dimensions: 80 x 80  $\mu\text{m}$  (3.2 x 3.2 mils) or larger

#### Description

The HMMC-2027 is a GaAs monolithic microwave integrated circuit (MMIC) designed for low insertion loss and high isolation from DC to 26.5 GHz. It is intended for use as a general-purpose, single-pole, double-throw (SP-DT), absorptive switch. Two series and two shunt MESFETs per throw provide 3 dB maximum insertion loss and 30 dB minimum isolation at 26.5 GHz. HMMC-2027 chips use through-substrate vias to provide ground connections to the chip backside and minimize the number of wire bonds required.

#### Absolute maximum ratings<sup>1</sup>

Symbol	Parameters/conditions	Minimum	Maximum	Units
$V_{\text{sel}}$	Select voltages 1 & 2	–10.5	+3	Volts
$P_{\text{in}}$	RF input power		25	dBm
$T_{\text{op}}$	Operating temperature	–55	+125	°C
$T_{\text{st}}$	Storage temperature	–65	+165	°C
$T_{\text{max}}$	Maximum assembly temperature		+200	°C
$P_{\text{unsel}}^2$	Power into unselected output		15	dBm

<sup>1</sup> Operation in excess of any one of these ratings may result in permanent damage to this device.  $T_A = 25^\circ\text{C}$  except for  $T_{\text{op}}$ ,  $T_{\text{st}}$ , and  $T_{\text{max}}$ .

<sup>2</sup> Operation in excess of these @  $T_{\text{op-max}}$  may result in permanent damage.



Agilent Technologies

**DC specifications/physical properties** $(T_A = 25^\circ\text{C})$ 

Symbol	Parameters/conditions	Minimum	Typical	Maximum	Units
$I_l$	Leakage current @ $-10\text{ V}$			200	$\mu\text{A}$
$V_p$	Pinch-off voltage ( $V_{\text{SEL}2} = V_p$ , $V_{\text{RFout}2} = +2\text{V}$ , $I_{\text{RFout}2} = 2\text{ mA}$ , $V_{\text{SEL}1} = -10\text{ V}$ , $V_{\text{RFout}1} = \text{open circuit}$ , $V_{\text{RFin}} = \text{GND}$ )	$-6.75$		$-3.00$	Volts
$BV_{\text{gss}}$	Breakdown voltage (Test FET w/ $V_D = V_S = \text{GND}$ , $I_G = -50\text{ }\mu\text{A}$ )			$-13.0$	Volts

**RF specifications** $(T_A = 25^\circ\text{C}, Z_0 = 50\text{ }\Omega, V_{\text{sel-high}} = 0\text{ V}, V_{\text{sel-low}} = -10\text{ V})$ 

Symbol	Parameters/conditions	Minimum	Typical	Maximum	Units
BW	Guaranteed operating bandwidth	DC		26.5	GHz
IL	Insertion loss, $\text{RF}_{\text{in}}$ to selected $\text{RF}_{\text{out}}$ (ON throw), 26.5 GHz		2.5	3.0	dB
ISO	Isolation, $\text{RF}_{\text{in}}$ to unselected $\text{RF}_{\text{out}}$ (OFF throw), 26.5 GHz	27	30		dB
ISO	Isolation, $\text{RF}_{\text{in}}$ to unselected $\text{RF}_{\text{out}}$ (OFF throw), 18 GHz	40	43		dB
$\text{RL}_{\text{in}}$	Input return loss	12	15		dB
$\text{RL}_{\text{out-ON}}$	Output return loss, ON throw	13	16		dB
$\text{RL}_{\text{out-OFF}}$	Output return loss, OFF throw	9	12		dB
$P_{-1\text{ dB}}$	Input power where IL increases by 1 dB, $f_{\text{in}} = 2\text{ GHz}$		27		dBm
$t_s$	Switching speed, 10%-90% RF envelope, $f_{\text{in}} = 2\text{ GHz}$		1		ns

**Applications**

The HMMC-2027 can be used in instrumentation, communications, radar, ECM, EW, and many other systems requiring SPDT switching. It can be used for pulse modulation, port isolation, transfer switching, high-speed switching, replacement of mechanical switches, and so on.

**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.

Application note #54, "GaAs MMIC ESD, Die Attach and Bonding Guidelines" provides basic information on these subjects.

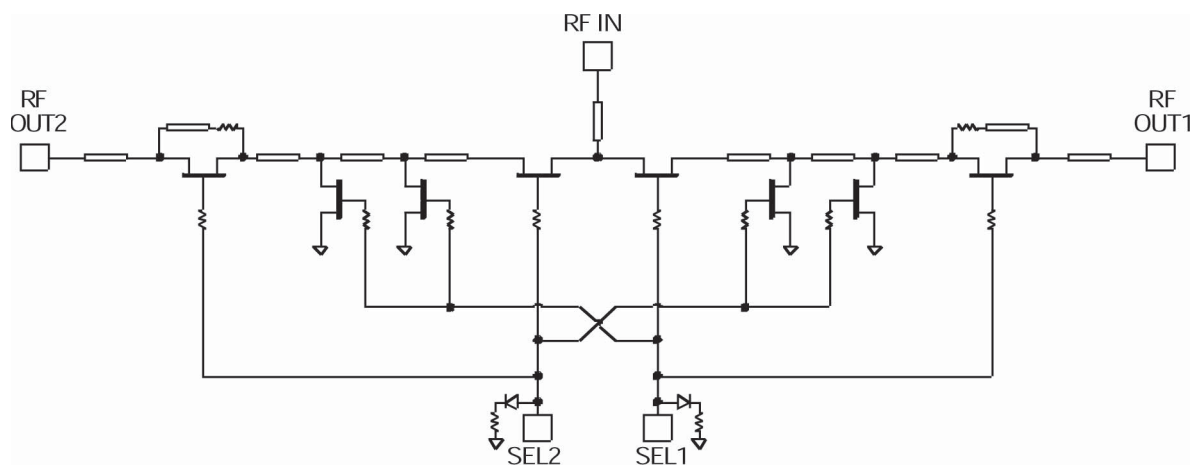
**Additional references**

AN #57, "FET Switch Speed and Settling Time."

**S-Parameters<sup>1</sup> ( $T_A = 25^\circ\text{C}$ ,  $Z_0 = 50\ \Omega$ ,  $V_{\text{sel high}} = 0\ \text{V}$ ,  $V_{\text{sel low}} = -10\ \text{V}$ )**

Frequency (GHz)	<b>S<sub>11</sub></b>			<b>S<sub>21</sub> (insertion loss)</b>			<b>S<sub>31</sub> (isolation)</b>	<b>S<sub>22</sub> (ON throw)</b>			<b>S<sub>33</sub> (OFF throw)</b>		
	dB	M	ang	dB	M	ang	dB	dB	M	ang	dB	M	ang
0.5	-18.28	0.12	-7.04	-1.33	0.86	-8.52	-71.40	-18.44	0.12	-9.89	-16.79	0.14	173.87
1.5	-18.53	0.12	-13.70	-1.35	0.86	-14.62	-61.02	-18.46	0.12	-19.75	-16.47	0.15	171.75
4.0	-18.92	0.11	-27.64	-1.41	0.85	-24.53	-51.67	-18.75	0.12	-38.78	-15.36	0.17	168.03
6.5	-19.43	0.11	-45.02	-1.47	0.84	-39.56	-49.50	-19.10	0.11	-63.22	-14.55	0.19	152.55
9.0	-20.57	0.09	-64.07	-1.56	0.84	-55.13	-46.87	-19.72	0.10	15.79	-14.28	0.19	136.68
11.5	-21.85	0.08	-2.59	-1.62	0.83	-71.03	-44.71	-20.91	0.09	243.63	-13.84	0.20	121.81
14.0	-23.10	0.07	258.44	-1.74	0.82	-29.63	-42.30	-22.41	0.08	217.48	-13.53	0.21	106.44
16.5	-24.05	0.06	235.82	-1.88	0.81	258.60	-41.74	-24.17	0.06	179.74	-12.95	0.23	92.94
19.0	-24.59	0.06	224.56	-1.99	0.80	242.13	-37.07	-27.09	0.04	133.20	-12.76	0.23	74.01
21.5	-25.42	0.05	206.39	-2.10	0.79	227.84	-40.39	-28.85	0.04	68.10	-13.12	0.22	68.84
24.0	-24.66	0.06	209.77	-2.10	0.78	209.72	-34.46	-24.31	0.06	6.26	-12.11	0.25	54.32
26.5	-21.90	0.08	223.86	-2.39	0.76	191.82	-31.38	-19.43	0.11	-33.31	-12.03	0.25	3

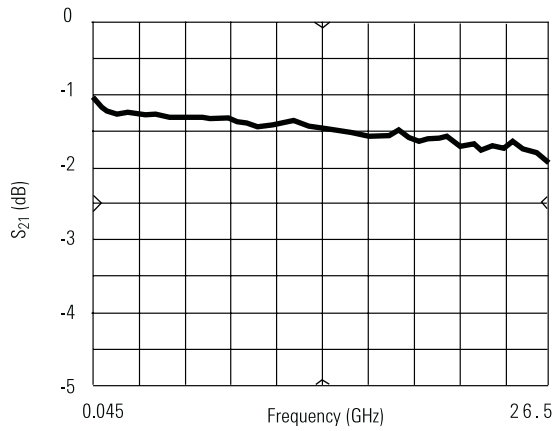
<sup>1</sup> Three-port wafer-probed data: Port 1 = RF input, Port 2 = selected RF output (i.e., ON throw), and Port 3 = unselected RF output (i.e., OFF throw).



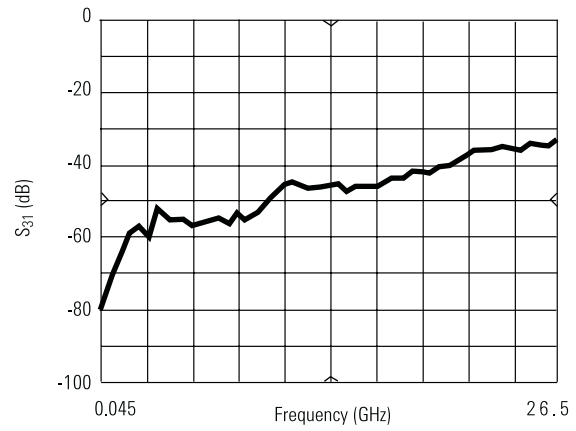
**Figure 1. Schematic**

Select line		RF path	
SEL1	SEL2	RF IN to RF OUT1	RF IN to RF OUT2
-10 V	0 V	Isolated	Low loss
0 V	-10 V	Low loss	Isolated

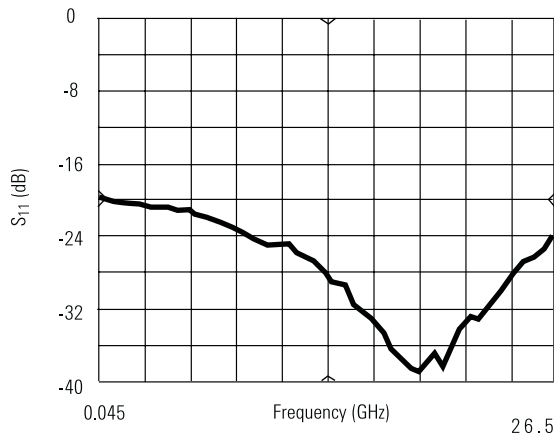
**Figure 2. Recommended operating conditions ( $T_A = 25^\circ\text{C}$ )**



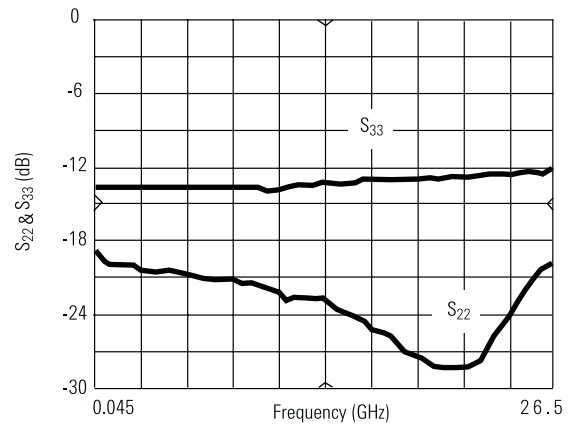
**Figure 3. Insertion loss<sup>1</sup>**



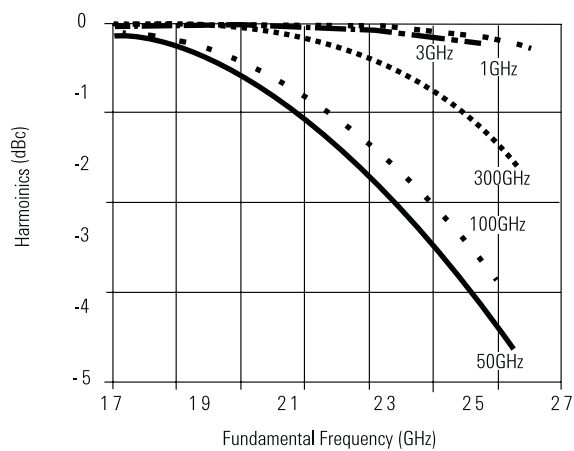
**Figure 4. Input-to-output isolation<sup>1</sup>**



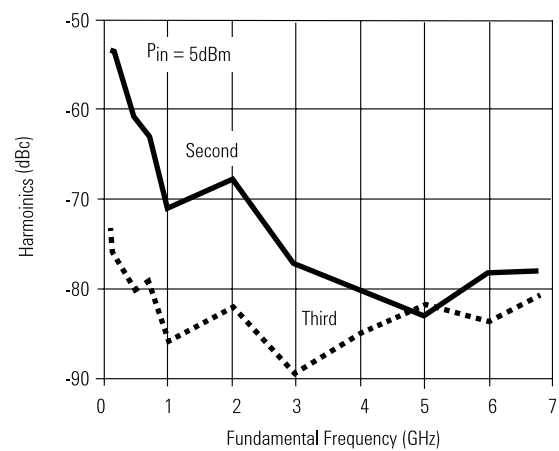
**Figure 5. Input return loss<sup>1</sup>**



**Figure 6. Output return loss<sup>1</sup>**



**Figure 7. Gain compression<sup>2</sup>**

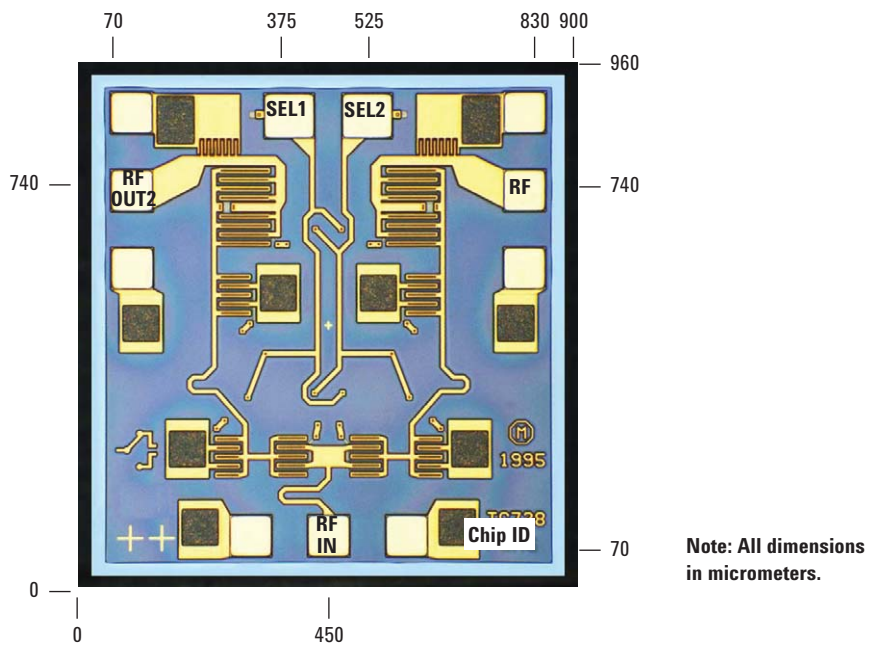


**Figure 8. Harmonics<sup>2, 3</sup>**

<sup>1</sup> Data obtained from wafer-probed measurements.

<sup>2</sup> All compression and harmonic data measured on individual device mounted in an Agilent 83040 Series Modular Microcircuit Package @  $T_{case} = 25^{\circ}C$ .

<sup>3</sup> Harmonic data points below -80 dBc are at or near the noise floor of the measurement system.



**Figure 9. Bonding pad positions**

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 Agilent GaAs ICs, for their design should obtain the current production specifications from Agilent. In this data sheet the term typical refers to

the 50th percentile performance. For additional information contact Agilent [MMIC\\_Helpline@agilent.com](mailto:MMIC_Helpline@agilent.com).



### Agilent Email Updates

**[www.agilent.com/find/emailupdates](http://www.agilent.com/find/emailupdates)**

Get the latest information on the products and applications you select.



### Agilent Direct

**[www.agilent.com/find/agilentdirect](http://www.agilent.com/find/agilentdirect)**

Quickly choose and use your test equipment solutions with confidence.



**[www.agilent.com/find/open](http://www.agilent.com/find/open)**

Agilent Open simplifies the process of connecting and programming test systems to help engineers design, validate and manufacture electronic products. Agilent offers open connectivity for a broad range of system-ready instruments, open industry software, PC-standard I/O and global support, which are combined to more easily integrate test system development.

## **[www.agilent.com](http://www.agilent.com)**

For more information on Agilent Technologies' products, applications or services, please contact your local Agilent office. The complete list is available at:

**[www.agilent.com/find/contactus](http://www.agilent.com/find/contactus)**

### Phone or Fax

#### **United States:**

(tel) 800 829 4444  
(fax) 800 829 4433

#### **Canada:**

(tel) 877 894 4414  
(fax) 800 746 4866

#### **China:**

(tel) 800 810 0189  
(fax) 800 820 2816

#### **Europe:**

(tel) 31 20 547 2111

#### **Japan:**

(tel) (81) 426 56 7832  
(fax) (81) 426 56 7840

#### **Korea:**

(tel) (080) 769 0800  
(fax) (080) 769 0900

#### **Latin America:**

(tel) (305) 269 7500

#### **Taiwan:**

(tel) 0800 047 866  
(fax) 0800 286 331

#### **Other Asia Pacific Countries:**

(tel) (65) 6375 8100  
(fax) (65) 6755 0042  
Email: [tm\\_ap@agilent.com](mailto:tm_ap@agilent.com)

Revised: February 5, 2007

Product specifications and descriptions in this document subject to change without notice.

© Agilent Technologies, Inc. 2007

Printed in USA, June 8, 2007

5989-6204EN



**Agilent Technologies**