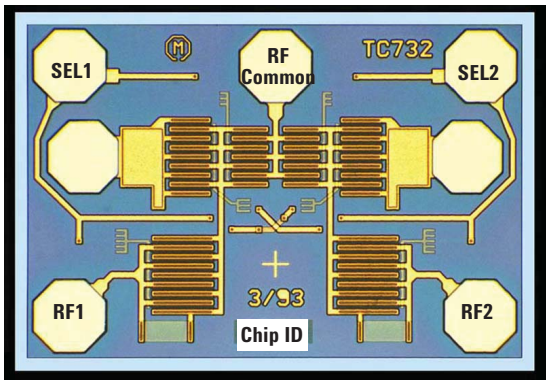
Agilent HMMC-2007
DC–8 GHz Terminated SPDT Switch

1GG7-8004

Data Sheet



Chip size:	660 x 960 µm (25.9 x 37.8 mils)
Chip size tolerance:	±10 µm (±0.4 mils)
Chip thickness:	127 ± 15 µm (5.0 ± 0.6 mils)
Pad dimensions:	120 x 120 µm (4.7 x 4.7 mils)

Features

- **Outputs terminated in 50 Ω 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 µs (10%–90% RF)
- **$P_{-1\ dB}$: 27 dBm**
- **Harmonics (DC coupled):**
  < –80 dBc @ 10 dBm

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[1]

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

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

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DC specifications/physical properties

(T_A = 25°C)

Symbol	Parameters/conditions	Minimum	Typical	Maximum	Units
$I_{SEL\ -10V}$	Leakage current @ –10V			200	µA
$I_{SEL\ +10V}$	Leakage current @ +10V			20	µA
V_p	Pinch-off voltage ($V_{SEL2} = V_p$, V_{RFout2} = +2V, I_{RFout2} = 4 mA, V_{SEL1} = –10 V, V_{RFout1} = open circuit, V_{RFin} = GND)	–6.75		–3.00	Volts
BV	Breakdown voltage (Test FET w/ $V_D = V_S$ = GND, I_G = –50 µA)			–13.0	Volts

RF specifications

(T_A = 25°C, Z_0 = 50 Ω, $V_{sel\text{-}high}$ = +10 V, $V_{sel\text{-}low}$ = –10 V)

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

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[1] (T_A = 25°C, Z_0 = 50 Ω, V_{sel} high = +10 V, V_{sel} low = –10 V)

Frequency	S_{11}			S_{21} (insertion loss)			S31 (isolation)	S_{22} (ON throw)			S_{33} (OFF throw)		
(GHz)	dB	mag	ang	dB	mag	ang	dB	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

1 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).

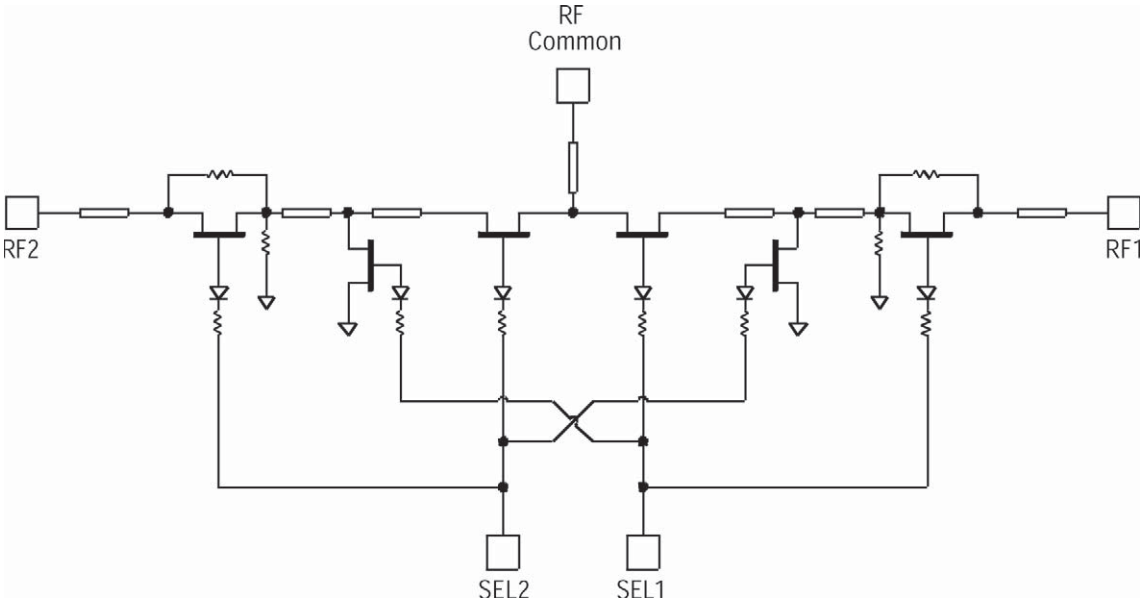


Figure 1. Schematic

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°C)

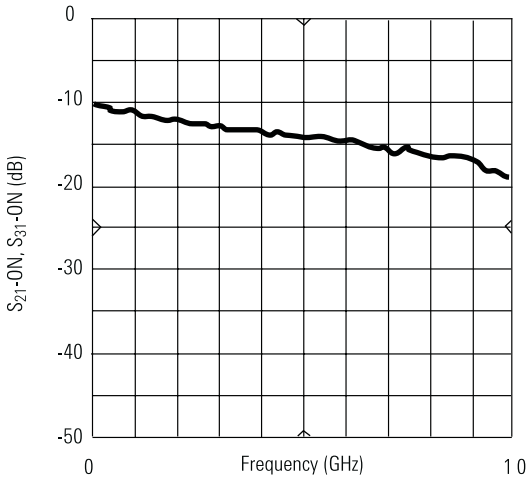


Figure 3. Insertion Loss[1]

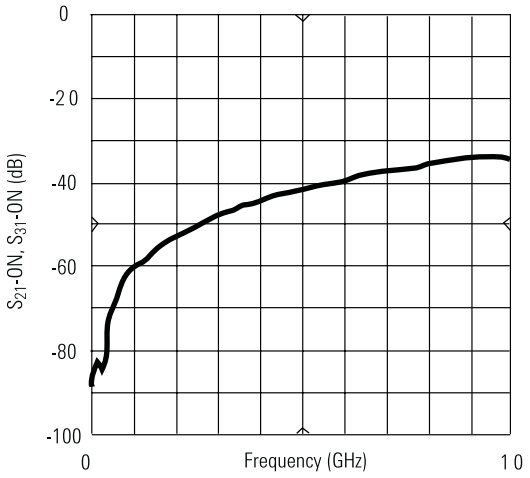


Figure 4. Input-to-output Isolation[1]

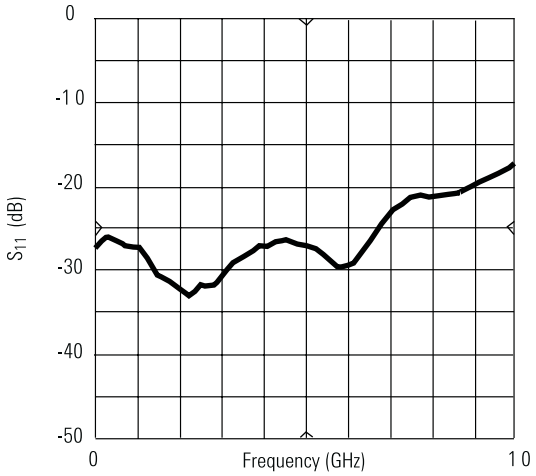


Figure 5. Input return loss[1]

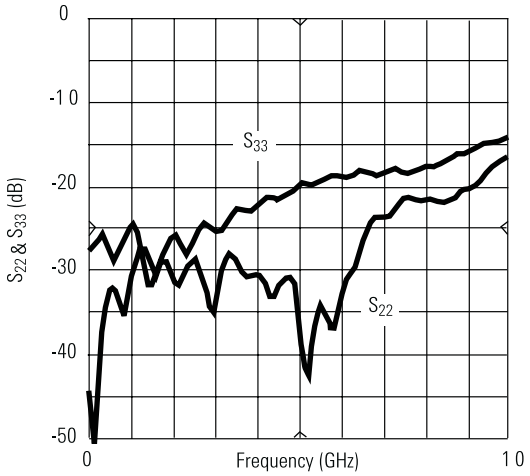


Figure 6. Output return loss[1]

1 Data taken with the device mounted in modular breadboard package

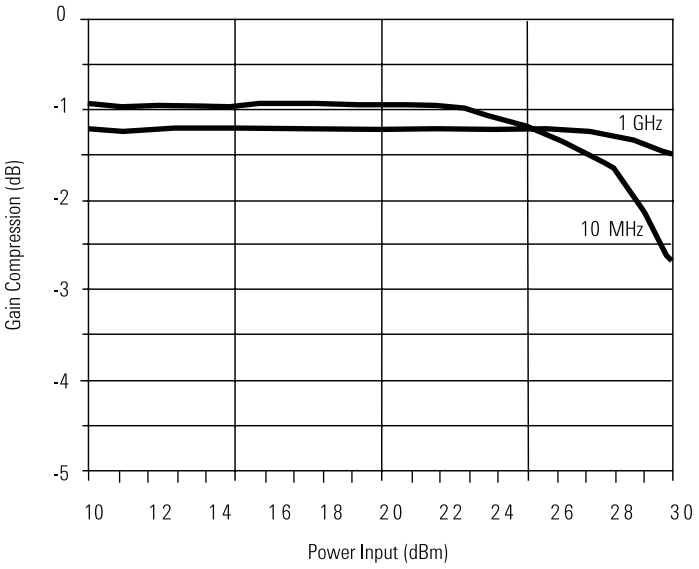
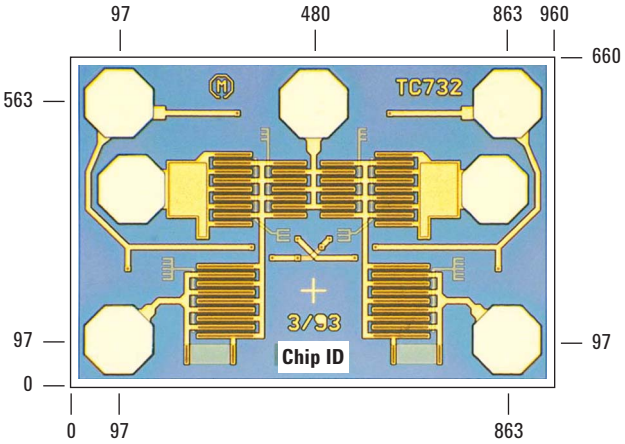


Figure 7. Gain compression



Note: All dimensions in micrometers.

Figure 5. Bonding pad locations

Note:

All compression data measured on individual device mounted in an Agilent 83040 Series Modular Microcircuit Package @ T_{case} = 25°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.

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Other Asia Pacific Countries:
(tel) (65) 6375 8100
(fax) (65) 6755 0042
Email: tm_ap@agilent.com

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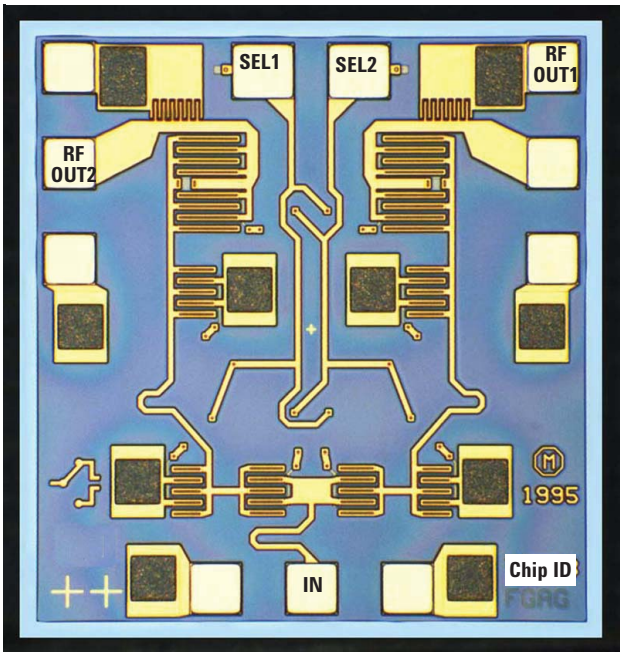
Agilent Technologies

Agilent HMMC-2027
DC–26.5 GHz SPDT GaAs MMIC Switch

1GG7-8005

Data Sheet



Chip size: 900 x 960 µm (35.4 x 37.8 mils)
Chip size tolerance: ±10 µm (±0.4 mils)
Chip thickness: 127 ± 15 µm (5.0 ± 0.6 mils)
Pad dimensions: 80 x 80 µm (3.2 x 3.2 mils) or larger

Features

- **Outputs terminated in 50 Ω 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)
- **$P_{-1\ dB}$: 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

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[1]

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

1 Operation in excess of any one of these ratings may result in permanent damage to this device. T_A = 25°C except for T_{op}, T_{st}, and T_{max}.
2 Operation in excess of these @ $T_{op–max}$ may result in permanent damage.

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DC specifications/physical properties

(T_A = 25°C)

Symbol	Parameters/conditions	Minimum	Typical	Maximum	Units
I_I	Leakage current @ –10 V			200	µA
V_p	Pinch-off voltage ($V_{SEL2} = V_p$, V_{RFout2} = +2V, I_{RFout2} = 2 mA, V_{SEL1} = –10 V, V_{RFout1} = open circuit, V_{RFin} = GND)	–6.75		–3.00	Volts
BV_{gss}	Breakdown voltage (Test FET w/ $V_D = V_S$ = GND, I_G = –50 µA)			–13.0	Volts

RF specifications

(T_A = 25°C, Z_0 = 50 Ω, $V_{sel\text{-}high}$ = 0 V, $V_{sel\text{-}low}$ = –10 V)

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

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

S-Parameters[1] (T_A = 25°C, Z_0 = 50 Ω, V_{sel} high = 0 V, V_{sel} low = –10 V)

Frequency	S_{11}			S_{21} (insertion loss)			S31 (isolation)	S_{22} (ON throw)			S_{33} (OFF throw)		
(GHz)	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

1 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).

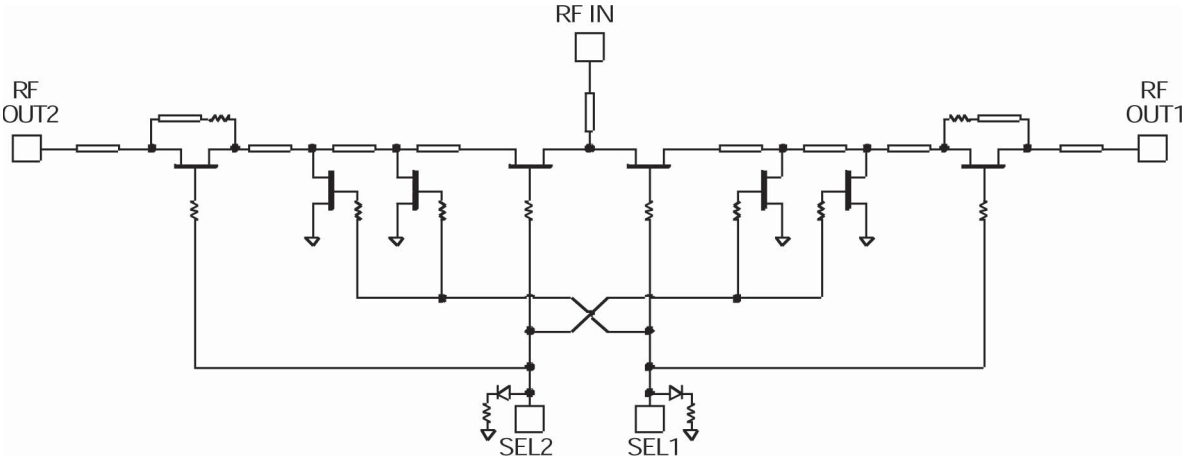


Figure 1. Schematic

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°C)

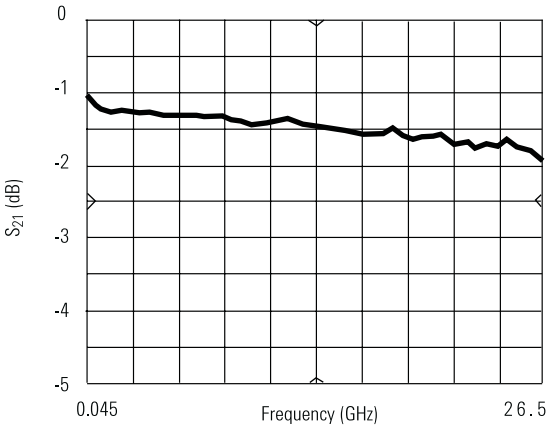


Figure 3. Insertion loss[1]

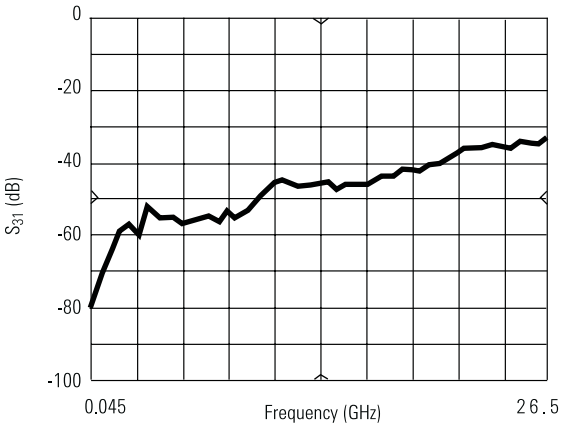


Figure 4. Input-to-output isolation[1]

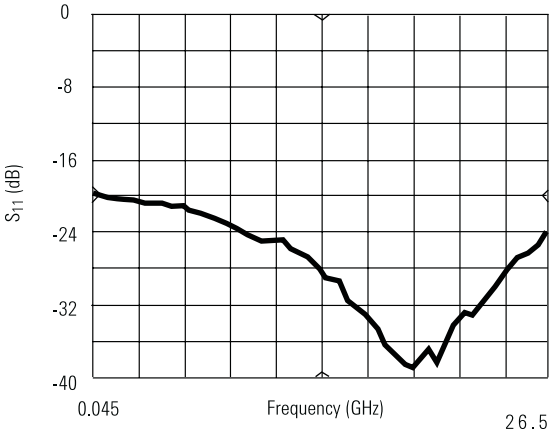


Figure 5. Input return loss[1]

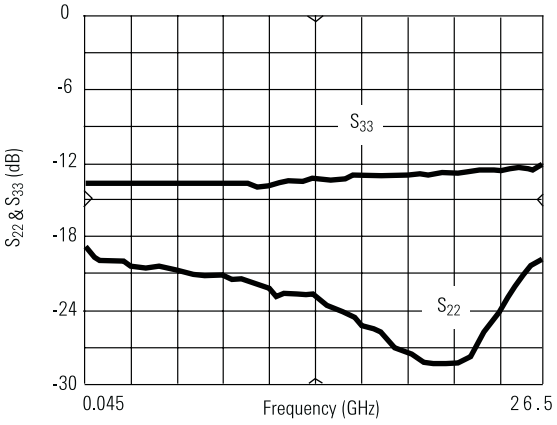


Figure 6. Output return loss[1]

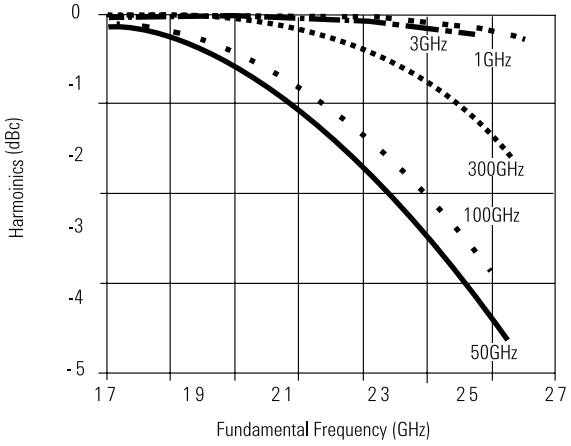


Figure 7. Gain compression[2]

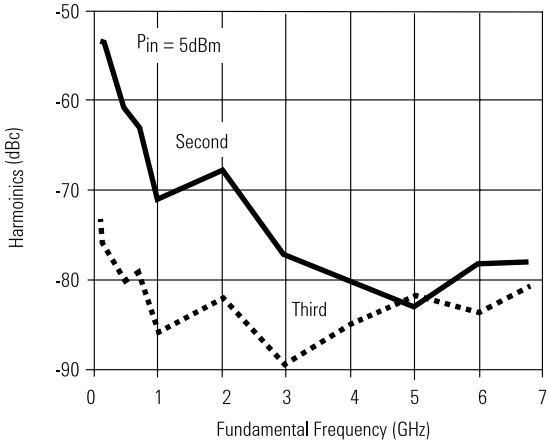
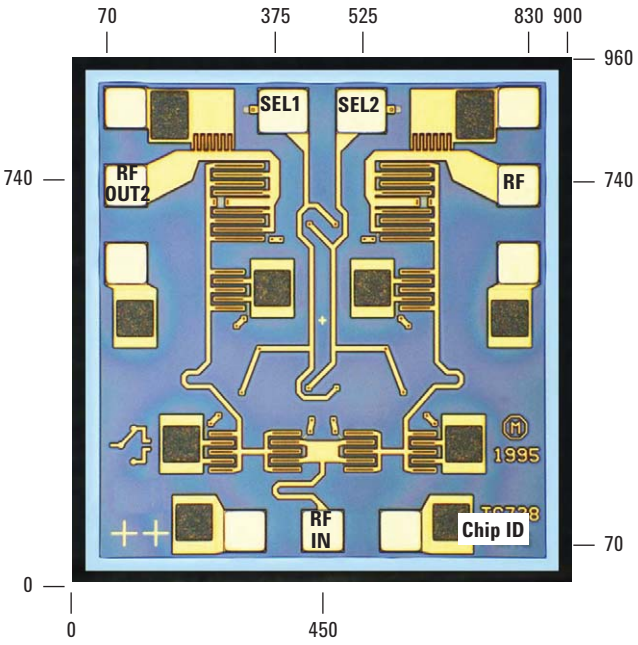


Figure 8. Harmonics[2, 3]

1 Data obtained from wafer-probed measurements.
2 All compression and harmonic data measured on individual device mounted in an Agilent 83040 Series Modular Microcircuit Package @ T_{case} = 25°C.
3 Harmonic data points below –80 dBc are at or near the noise floor of the measurement system.



Note: All dimensions in micrometers.

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.

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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

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