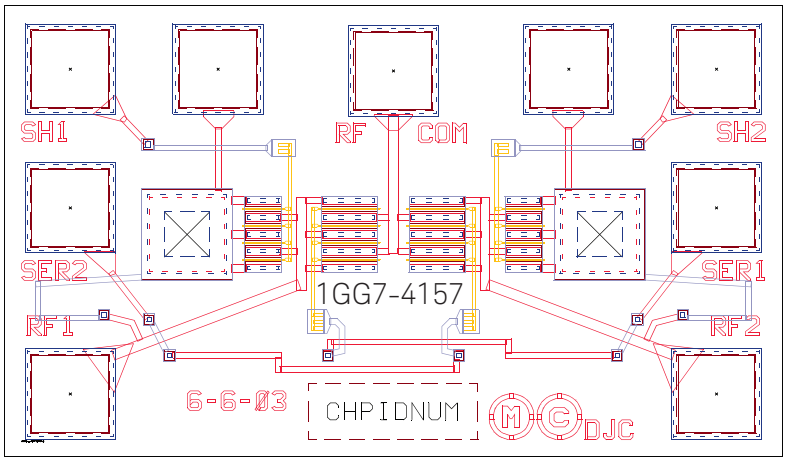
Keysight 1GG7-4157
DC – 20 GHz SPDT GaAs MMIC Switch

Data Sheet



Features

- Frequency range:
  DC–20 GHz, usable to 26.5 GHz
- Insertion loss:
  1.4 dB typ @ 20 GHz
- Isolation:
  > 70 dB @ 45 MHz
  20 dB @ 20 GHz
- Return loss:
  15 dB typ
- Switching speed:
  < 1 ns (10%–90% RF)
- P_{-1dB}:
  25 dBm @ 10 MHz
  26 dBm @ 2 GHz
- Harmonics (DC coupled):
  SHI > 75 dBm typ
  THI > 50 dBm typ

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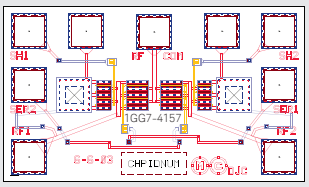
Description

The 1GG7-4157 is a GaAs monolithic microwave integrated circuit (MMIC) designed for low insertion loss and high isolation from DC to 20 GHz. It is intended for use as a general-purpose, single-pole, double–throw (SPDT), non-terminated switch. One series and one shunt MESFET per throw provide 2 dB maximum insertion loss and 20 dB typical isolation at 20 GHz. 1GG7-4157 chips use through-substrate vias to provide ground connections to the chip backside and minimize the number of wire bonds required.



- Chip size: 690 × 400 µm (27.2 × 15.7 mils)
- Chip size tolerance: ±10 µm (±0.4 mils)
- Chip thickness: 127 ±15 µm (5.0 ±0.6 mils)
- Pad dimensions: 80 × 80 µm (3.2 × 3.2 mils), or larger

Absolute maximum ratings[1]

Symbol	Parameters/conditions	Min	Max	Units
V_{ser}	Series select voltages 1 & 2	–10.5	+10.5	volts
V_{sh}	Shunt select voltages 1 & 2	–10.5	+10.5	volts
P_{in}	RF input power		27	dBm
V_{in}	RF input DC voltage	–2.5	+2.5	volts
I_{source}	Current sourcing (sinking not allowed) at RF1 or RF2		60	mA
ESD	ESD level at any pad		300	volts
T_{op}	Operating temperature	–55	+125	°C
T_{st}	Storage temperature	–65	+165	°C
T_{max}	Maximum assembly temperature		+200	°C

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

DC specifications/physical properties

Symbol	Parameters/conditions	Min	Typ	Max	Units
R1/2ON	Series FET "ON" resistance RFCOM to RF1/2	9	11.5	14	ohms
R1/2ON	Shunt FET "ON" resistance at RF1/2	14	17.5	20.5	ohms
R1/2OFF	Resistance at RF1/2 with all FETs "OFF"	9	11.9	15	Kohms
Isel1/2	Current with SER1/2 connected to SH2/1 at –10V		–16.6		µA
IG1/2	Current with SER1/2 connected to SH2/1 at +10V			21	µA
V_p	Pinchoff voltage ($V_{SEL2} = V_p, V_{RFout2}$ = +2 V, I_{RFout2} = 2 mA, V_{SEL1} = –10 V, V_{RFout1} = open circuit, V_{RFin} = GND)	–7	-5	-3	volts

RF specifications

(T_A = 25 °C, Z0 = 50 Ω, V_{SEL-H} = +10 V, V_{SEL-L} = –10 V)

Symbol	Parameters/conditions	Min	Typ	Max	Units
BW	Guaranteed operating bandwidth	DC		20	GHz
IL	Insertion loss, RF_{COM} to selected RF_{out} (ON throw), 20 GHz		1.4	2.0	dB
ISO	Isolation, RF_{COM} to unselected RF_{out} (OFF throw), 20 GHz		20		dB
RL_{in}	Input return loss		15		dB
RL_{out-ON}	Output return loss, ON throw		15		dB
P_{-1dB}	Input power where IL Increases by 1 dB, f_{in} = 2 GHz		25		dBm
t_s	Switching speed, 10%–90% RF envelope, f_{in} = 2 GHz		10		ns
IL_t	Insertion loss temperature coefficient		–2.9		mdB/C

Applications

The 1GG7-4157 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.

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

Additional References

Keysight Technologies FET Switch Speed and Settling Time - Application Note, literature number 5991-3516EN

S–Parameters[1]

(T_A = 25 °C, Z_0 = 50 Ω, V_{ser} high = 0 V, V_{ser} low = –10 V)

Freq	S11			S21 (Insertion loss)			S31 (Isolation)	S22 (ON throw)			S33 (OFF throw)		
GHz	dB	Mag	Ang	dB	Mag	Ang		dB	Mag	Ang	dB	Mag	Ang
0.5	–18.85	0.11	8.14	–0.94	0.90	–2.46	–60.65	–18.87	0.11	4.91	–6.16	0.49	174.50
1.0	–19.39	0.11	12.17	–0.95	0.90	–4.59	–56.50	–18.87	0.11	5.40	–6.15	0.49	169.89
2.0	–20.46	0.09	17.08	–1.01	0.89	–8.85	–51.08	–19.50	0.11	9.93	–6.20	0.49	161.99
3.0	–19.15	0.11	22.32	–1.06	0.89	–12.73	–43.19	–18.74	0.12	20.94	–6.19	0.49	156.11
4.0	–16.68	0.15	21.56	–1.10	0.88	–16.68	–38.51	–17.52	0.13	25.80	–6.11	0.49	150.15
5.0	–15.29	0.17	24.96	–1.09	0.88	–20.58	–35.53	–15.88	0.16	25.28	–5.89	0.51	141.36
6.0	–15.72	0.16	32.66	–1.08	0.88	–24.46	–32.30	–15.20	0.17	19.63	–5.61	0.52	133.42
7.0	–17.98	0.13	24.18	–1.06	0.88	–28.73	–30.08	–16.92	0.14	11.64	–5.51	0.53	128.59
8.0	–16.64	0.15	10.40	–1.17	0.87	–33.37	–28.25	–16.67	0.15	11.70	–5.70	0.52	122.02
9.0	–13.33	0.22	16.88	–1.26	0.87	–37.24	–26.85	–13.94	0.20	19.60	–5.46	0.53	114.21
10.0	–13.24	0.22	18.95	–1.22	0.87	–40.59	–25.55	–13.56	0.21	22.10	–4.90	0.57	111.42
11.0	–15.07	0.18	10.39	–1.17	0.87	–44.37	–24.05	–15.41	0.17	14.89	–4.74	0.58	109.12
12.0	–16.63	0.15	9.21	–1.14	0.88	–48.83	–22.42	–16.80	0.14	5.89	–4.70	0.58	104.37
13.0	–18.84	0.11	–1.76	–1.18	0.87	–53.17	–21.31	–18.88	0.11	–3.66	–4.68	0.58	99.38
14.0	–17.93	0.13	–22.18	–1.27	0.86	–57.92	–21.08	–20.77	0.09	–4.83	–4.69	0.58	93.69
15.0	–15.44	0.17	–12.10	–1.47	0.84	–62.34	–20.55	–17.34	0.14	–0.66	–4.62	0.59	86.40
16.0	–16.48	0.15	–2.23	–1.31	0.86	–65.94	–19.96	–16.88	0.14	–9.92	–4.27	0.61	83.02
17.0	–24.58	0.06	–33.01	–1.21	0.87	–69.91	–19.50	–23.41	0.07	–6.10	–3.85	0.64	84.80
18.0	–21.77	0.08	–142.50	–1.19	0.87	–74.09	–19.11	–29.39	0.03	–170.97	–3.61	0.66	87.39
19.0	–17.73	0.13	–162.11	–1.25	0.87	–78.64	–18.69	–19.92	0.10	167.36	–3.65	0.66	80.53
20.0	–22.05	0.08	–138.47	–1.33	0.86	–85.95	–18.58	–29.75	0.03	86.53	–3.95	0.63	61.99
21.0	–28.92	0.04	–139.75	–1.55	0.84	–92.42	–18.36	–29.20	0.03	23.77	–3.75	0.65	55.73
22.0	–15.32	0.17	162.12	–1.79	0.81	–97.64	–18.85	–19.16	0.11	124.29	–3.37	0.68	64.63
23.0	–9.27	0.34	160.49	–2.23	0.77	–100.31	–18.89	–11.44	0.27	132.43	–3.00	0.71	75.57
24.0	–7.38	0.43	157.26	–2.59	0.74	–100.53	–19.47	–8.59	0.37	134.74	–3.04	0.70	80.66
25.0	–8.32	0.38	151.57	–2.18	0.78	–104.00	–19.24	–9.23	0.35	123.94	–3.71	0.65	64.91
26.0	–12.63	0.23	121.18	–1.90	0.80	–119.17	–19.20	–12.61	0.23	76.47	–3.56	0.66	31.36

1. Data from device mounted in modular breadboard. Bond wires on RF ports are approximately 15 mils long.
Port 1 = RF Input, Port 2 = Selected RF Output (i.e., ON throw), and Port 3 = Unselected RF Output (i.e., OFF throw).

RoHS Compliance

This part is RoHS compliant, meeting the requirements of the EU *Restriction of Hazardous Substances* Directive 2011/65/EU, commonly known as *RoHS*. Six substances are regulated: lead, mercury, cadmium, chromium VI (hexavalent chromium), polybrominated biphenyls (PBB), and polybrominated biphenyl ethers (PBDE). RoHS compliance requires that any residual concentration of these substances is below the Directive's maximum concentration values (MCV): cadmium 100 ppm by weight and all others 1000 ppm by weight.

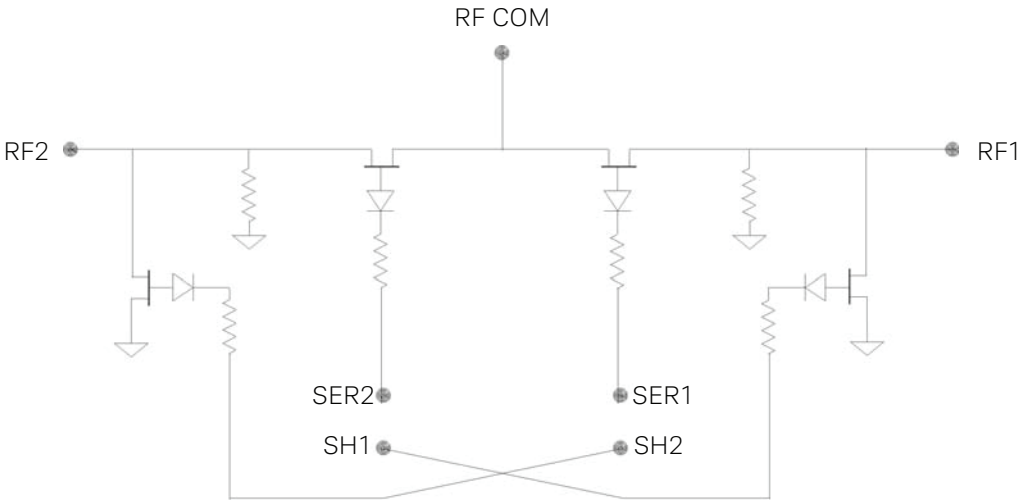


Figure 1. 1GG7-4157 Schematic

Recommended Operating Conditions

(Note: Isolating an RF port from DC ground with a blocking capacitor will result in non-zero DC potential at that port in its off-state, which can cause undesirable slow settling phenomenon in the reflection characteristic of that port in its off state. In this case, a DC path to ground should be provided on either the RFcom port and/or on both RF1/2 ports to accommodate leakage current from the FETs.)

Select line				RF path	
SER1	SH2	SER2	SH1	RF COM to RF1	RF COM to RF2
–10 V	–10 V	+10 V	+10 V	Isolated	Low loss
+10 V	+10 V	–10 V	–10 V	Low loss	Isolated

Figure 2. 1GG7-4157 Switch Conditions (T_A = 25 °C)

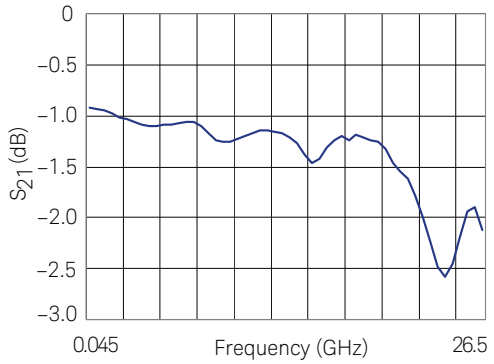


Figure 3. 1GG7-4157 insertion loss[1]

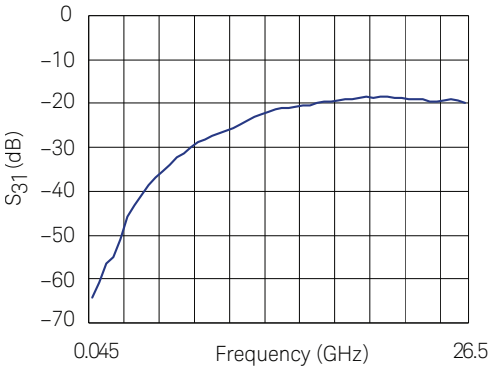


Figure 4. 1GG7-4157 input–to–output isolation[1]

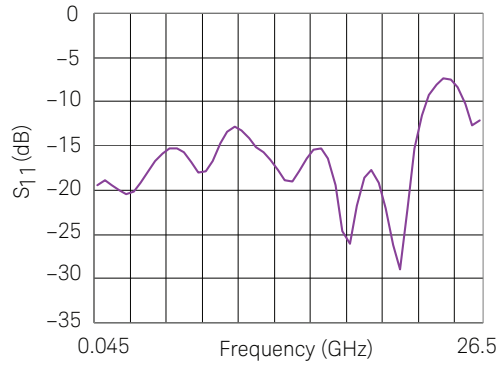


Figure 5. 1GG7-4157 input return loss[1]

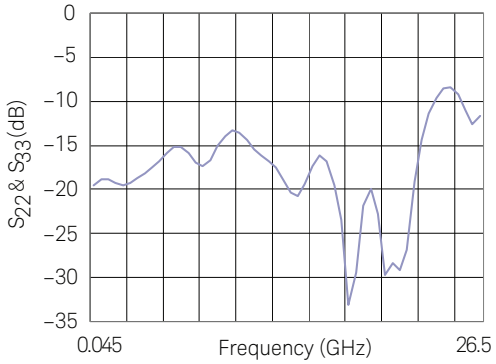


Figure 6. 1GG7-4157 output return loss[1]

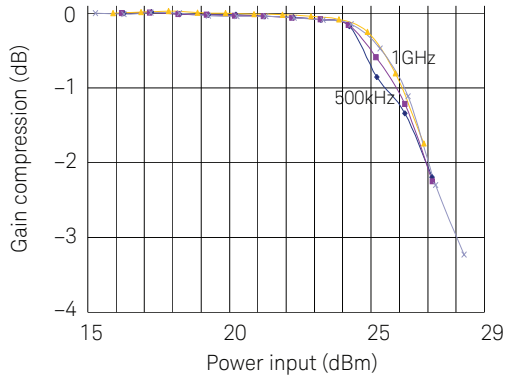


Figure 7. 1GG7-4157 gain compression[2]

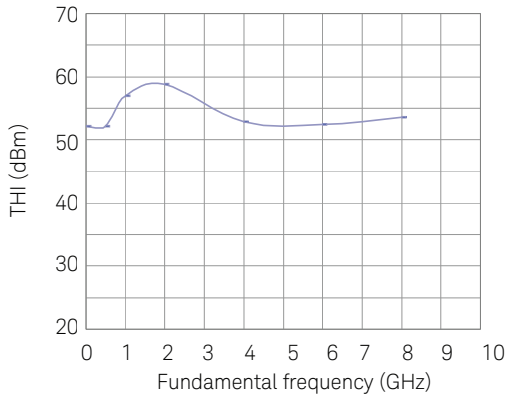


Figure 8. 1GG7-4157 harmonics[2,3]

1. Data obtained from device in modular breadboard wire bonds are 15 mils on all RF ports.
2. All compression and harmonic data measured on individual device mounted in an Keysight 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.

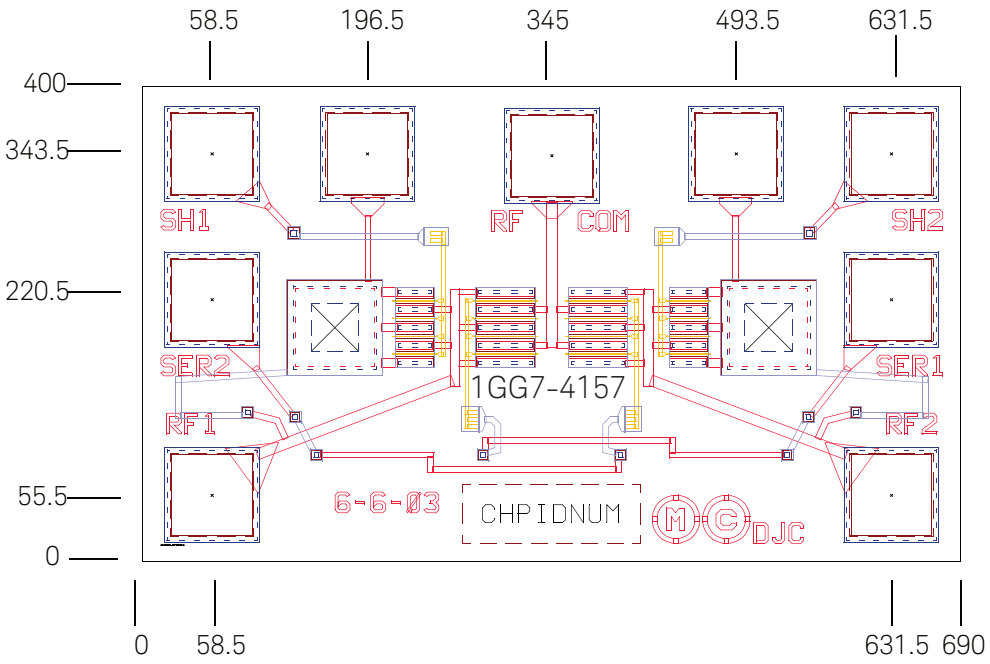


Figure 9. 1GG7-4157 bonding pad positions (shown in micrometers)

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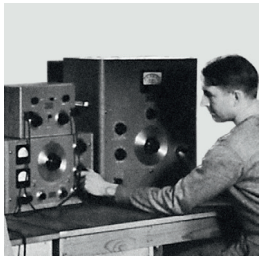

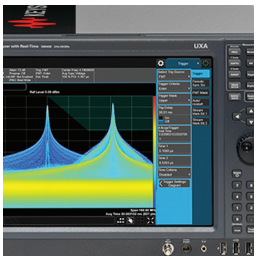

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The product described in this data sheet is RoHS Compliant. See *RoHS Compliance* section for more details.

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