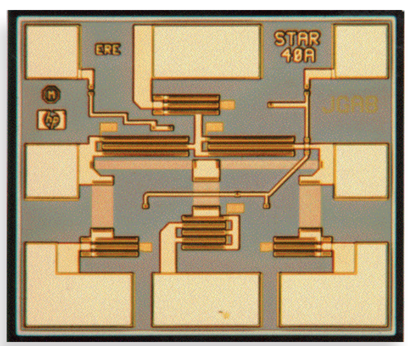
Keysight 1GG7-4088
DC - 6 GHz 0/40 dB Single Step Attenuator

Data Sheet



Features

- Frequency range: DC to 6 GHz
- Attenuation values:
  Single bit 40 dB
- Min. Insertion Loss:
  < 1.3 @ 3 GHz
  < 1.8 @ 6 GHz
- Step accuracy:
  ± 1.2 @ 3 GHz
  ± 1.2 @ 6 GHz
- Return loss:
  17 dB through 3 GHz
  13 dB through 6 GHz
- Switching speed:
  < 1.5 ms (10 to 90% TR)
- P_{-1dB}:
  25 dBm @ 10 MHz
  30 dBm @ 3 GHz
- Distortion
  SHI: + 90 dBm
  THI: + 60 dBm
  TOI: + 55 dBm

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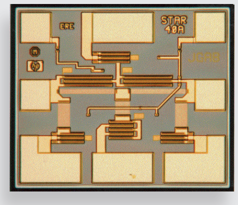
Description

The 1GG7-4088 is a single bit, 0/ 40 dB single step attenuator designed for low insertion loss and low distortion from DC to 6 GHz. It is intended for use as a general–purpose solid–state step attenuator for RF instrumentation or commercial communication systems. This device incorporates two 20 dB “p” attenuators combined with integral series and shunt MESFET switching elements. The 1GG7-4088 also incorporates a unique diode/resistor bias topology to improve low frequency RF performance and is fabricated with Keysight’s GaAs FET MMIC process, which is specifically designed to eliminate GaAs anomalies common in control circuit components.



- Chip size:
  900 x 760 (35.4 x 29.9 mils)
- Chip size tolerance:
  ± 10 µm (± 0.4 Mils)
- Chip thickness:
  127 ± 15 µm (5.0 ± 0.6 mils)
- Small pad dimensions:
  114 x 114 µm (4.5 x 4.5 mils)
- Large pad dimensions:
  114 x 228 µm (4.5 x 9.0 mils)

Absolute maximum ratings[1]

Symbol	Parameters/conditions	Min	Max	Units
$V_{C1,2}$	Control line voltages	-12	+12	Volts
$P_{in (CW)}$	CW RF input power		30	dBm
T_{op}	Operating temperature	-55	+125	° C
T_{st}	Storage temperature	-65	+165	° C
T_{max}	Max. assembly temperature	300	+300	° 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

(T_A = 25 °C)

Symbol	Parameters/conditions	Min	Typ	Max	Units
$V_{C1,2,3,4(+)}$	Positive control line voltage	7	10	10.5	Volts
$V_{C1,2,3,4(-)}$	Negative control line voltage	-10.5	-10	-7	Volts
$I_{L(+)}$	Positive control line leakage current ($V_{C1,2,3,4}$ = +10 volts)			50	µA
$I_{L(+)}$	Positive control line leakage current ($V_{C1,2,3,4}$ = +10 volts)			50	µA

Attenuation temperature coefficient

	Frequency	50 MHz	1 GHz	2 GHz	3 GHz	4 GHz	
α_T	@ Min. insertion loss state	.0014	.0013	.0013	.0013	.0013	dB/°C
	@ –40 dB State	–.0043	–.0037	–.0034	–.0027	–.0023	

RF specifications

(T_A = 25° C, V_{CC} = + 5V, R_{out} = 64 Ω, 50 Ω system)

Symbol	Parameters/conditions	Min	Typ	Max	Min	Typ	Max	Units
BW	Guaranteed operating bandwidth		DC–3.0					GHz
$IL_{(min)}$	Minimum insertion loss (V_{C1}= +10 V, VC2= –10 V)		1.25[1]					dB
D_{acc}	Attenuation step (@ –40 dB State)	39	40	41.2	38.8	40	41.2	dB
RL	Return loss			17			13	dB
T_R	Rise time switching speed (10 to 90% of RF swing, f_0=3 GHz)		1.5			1.5		µs
SHI	Second harmonic intercept point (Referred to P_{in})		90			90		dBm
THI	Third harmonicintercept point (Referred to P_{in})		60			60		dBm
TOI	Two-tone third order intercept point (For two–tone power levels <+17 dBm) (Referred to P_{in})		55			55		dBm
P_{-1dB}	Input Power @ 1 dB increase in insertion loss		30[2]			30		dBm
P_{in}(max)	Maximum continuous RF input power			27			27	dBm

1. Typical $IL_{(min)}$ @<10 MHz = 1.0 dB
2. Typical P_{-1dB} @<10 MHz = 25 dB

Applications

The 1GG7-4088 is designed for use in instrumentation, communications, radar, ECM, EW, and many other systems requiring fast switching speed, low distortion to input signals, and high cycle lifetimes. It can be used for pulse modulation, port isolation, replacement of mechanical relays, and in any application requiring the advantages of solid–state performance.

This device does not include any on-chip driver circuitry. An external driver circuit is required to convert TTL or ECL logic signals to the ±10 volt switching levels required by this device.

Figure 3 shows the device assembly diagram for operation through 6 GHz. Dual RF input and output bonds are recommended for assemblies where the device to thinfilm circuit gap exceeds 10 mils.

RoHS Compliance

This device is RoHS Compliant. This means the component meets the requirements of the European Parliament and the Council of the European Union Restriction of Hazardous Substances Directive 2011/65/EU, commonly known as RoHS. The six regulated substances are lead, mercury, cadmium, chromium VI (hexavalent), polybrominated biphenyls (PBB) and polybrominated biphenyl ethers (PBDE). RoHS compliance implies that any residual concentration of these substances is below the RoHS Directive's maximum concentration values (MVC); being less than 1000 ppm by weight for all substances except for cadmium which is less than 100 ppm by weight.

Assembly Techniques

This device is compatible with Au–Sn eutectic or conductive epoxy processes Gold thermosonic ball or wedge bonding is recommended for all bonds. The bond pads are designed to be large enough to facilitate autobonding. The top and bottom metallization is gold.

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. document, *GaAs MMIC ESD, Die Attach and Bonding Guidelines - Application Note* (5991-3484EN) provides basic information on these subjects.

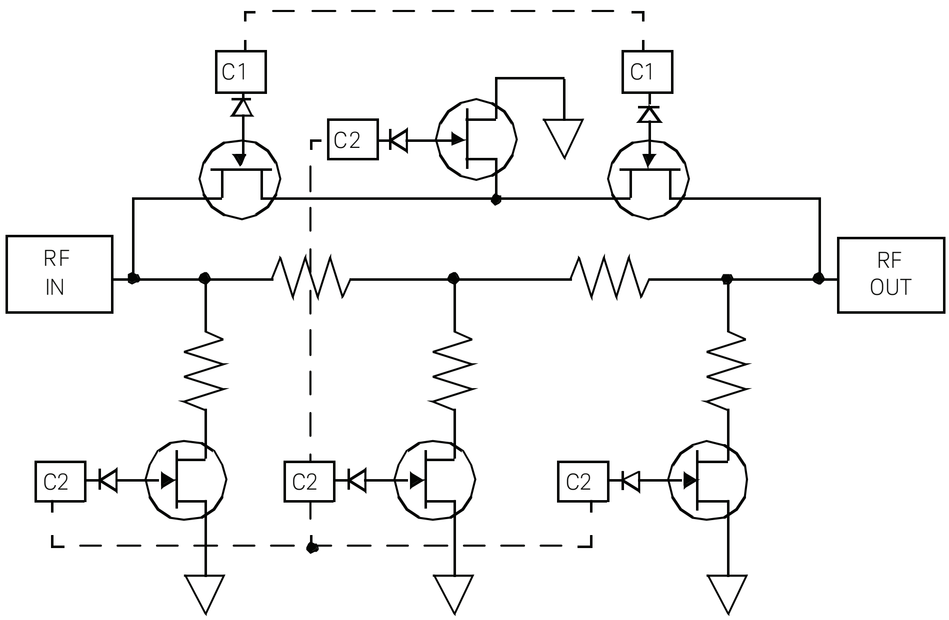
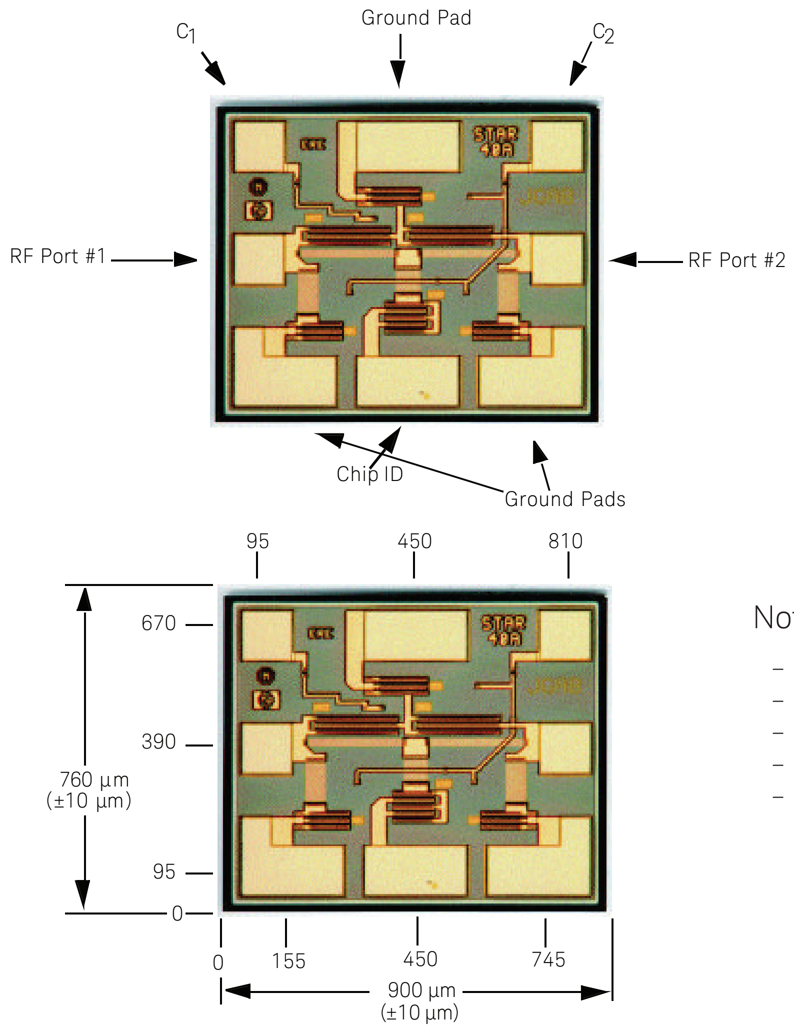


Figure 1. 1GG7-4088 Schematic

Logic table

(V_{C1-2} typical values in volts)

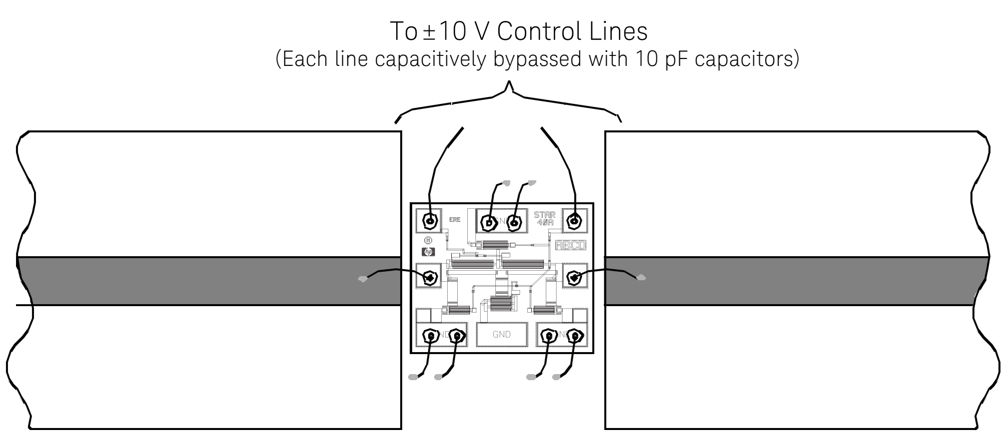
Attenuation setting	V_{C1}	V_{C2}
Min. insertion loss	+10	–10
–40 dB state	-10	+10



Notes

- All dimensions in microns
- Small pads: 114 x 114 µm
- Large pads: 114 x 228 µm
- Chip thickness: 127 µm
- All dimensions ± 5 µm (unless otherwise noted)

Figure 2. 1GG7-4088 Bond pad locations



Notes

- No device pedestal/shim required
- Ball bonding shown for clarity

Figure 3. 1GG7-4088 assembly diagram

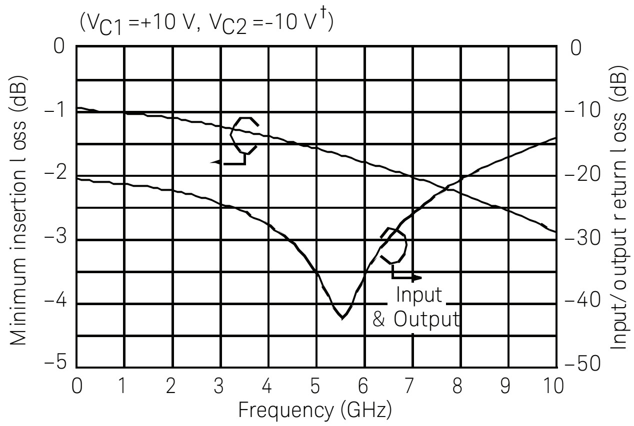


Figure 4. 1GG7-4088 Min. insertion loss and return loss vs. frequency

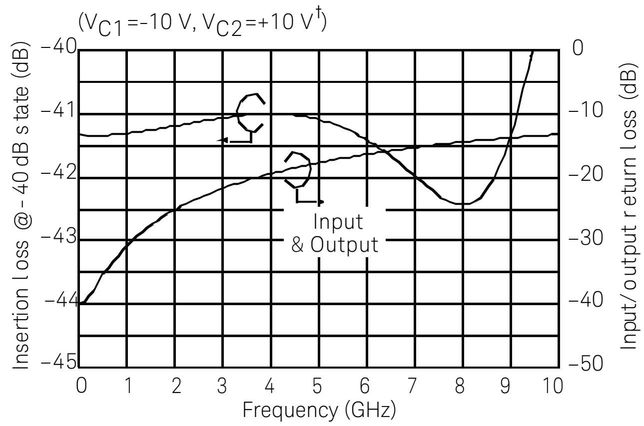


Figure 5. 1GG7-4088 Insertion loss @ -40 dB state and return loss vs. frequency

Typical S–parameters: minimum insertion loss state[1]

(T_A=+25 °C, V_{C1}=+10 V, V_{C2}= -10 V, Z_{in}=Z_{out}=50 Ω)

Freq. (GHz)	S_{11}			S_{12}			S_{21}			S_{22}		
	dB	Mag	Ang	dB	Mag	Ang	dB	Mag	Ang	dB	Mag	Ang
0.001	–20.1	0.098	–0.04	–1.0	0.902	–0.02	–1.0	0.902	–0.02	–20.1	0.098	–0.04
0.01	–20.1	0.098	–0.40	–1.0	0.902	–0.15	–1.0	0.902	–0.15	–20.1	0.098	–0.40
0.1	–20.4	0.096	–3.2	–1.0	0.899	–1.3	–1.0	0.899	–1.3	–20.4	0.096	–3.2
0.5	–21.1	0.088	–4.0	–1.0	0.891	–5.3	–1.0	0.891	–5.3	–21.1	0.088	–4.0
1.0	–21.4	0.085	–5.1	–1.0	0.888	–10.2	–1.0	0.888	–10.2	–21.4	0.085	–5.2
1.5	–21.8	0.081	–6.7	–1.1	0.885	–15.3	–1.1	0.885	–15.3	–21.8	0.081	–6.8
2.0	–22.4	0.076	–8.3	–1.1	0.880	–20.3	–1.1	0.880	–20.3	–22.4	0.075	–8.5
2.5	–23.2	0.069	–9.6	–1.2	0.874	–25.2	–1.2	0.874	–25.2	–23.3	0.069	–9.9
3.0	–24.3	0.061	–10.7	–1.2	0.868	–30.2	–1.2	0.868	–30.2	–24.4	0.060	–11.0
3.5	–25.8	0.051	–11.2	–1.3	0.860	–35.1	–1.3	0.860	–35.1	–25.9	0.051	–11.6
4.0	–27.7	0.041	–10.8	–1.4	0.852	–40.0	–1.4	0.852	–40.0	–27.9	0.040	–11.2
4.5	–30.6	0.030	–8.2	–1.5	0.843	–44.8	–1.5	0.843	–44.8	–30.8	0.029	–8.6
5.0	–35.2	0.017	1.1	–1.6	0.834	–49.7	–1.6	0.834	–49.7	–35.7	0.016	1.3
5.5	–42.2	0.007	52.0	–1.7	0.824	–54.5	–1.7	0.824	–54.5	–42.7	0.007	59.5
6.0	–36.0	0.016	123.3	–1.8	0.814	–59.3	–1.8	0.814	–59.3	–35.5	0.017	126.0
7.0	–26.1	0.049	139.8	–2.0	0.792	–68.9	–2.0	0.792	–68.9	–25.8	0.051	140.0
8.0	–20.9	0.091	139.9	–2.3	0.769	–78.5	–2.3	0.769	–78.5	–20.7	0.092	139.8
9.0	–17.2	0.139	137.2	–2.6	0.745	–88.1	–2.6	0.745	–88.1	–17.0	0.141	136.9
10.0	–14.3	0.193	133.1	–2.9	0.718	–97.8	–2.9	0.718	–97.8	–14.2	0.195	132.8

1. Data obtained from small–signal linear modeling

Typical S–Parameters: @ −40 dB state[1]

(T_A=+25 °C, V_{C1}=+10 V, V_{C2}= -10 V, Z_{in}=Z_{out}=50 Ω)

Freq. (GHz)	S_{11}			S_{12}			S_{21}			S_{22}		
	dB	Mag	Ang	dB	Mag	Ang	dB	Mag	Ang	dB	Mag	Ang
0.001	−40.0	0.009	180.0	−41.3	0.009	0.00	−41.3	0.009	0.00	−40.0	0.009	179.8
0.01	−40.0	0.010	180.0	−41.3	0.009	−0.01	−41.3	0.009	−0.01	−40.0	0.010	178.3
0.1	−39.1	0.011	177.2	−41.3	0.009	−0.09	−41.3	0.009	−0.09	−39.7	0.010	164.2
0.5	−35.0	0.018	141.3	−41.3	0.009	0.01	−41.3	0.009	0.01	−35.4	0.017	124.5
1.0	−31.1	0.028	119.2	−41.3	0.009	0.04	−41.3	0.009	0.04	−30.7	0.029	107.4
1.5	−28.2	0.039	108.8	−41.2	0.009	−0.12	−41.2	0.009	−0.12	−27.5	0.042	100.0
2.0	−25.9	0.051	102.8	−41.2	0.009	−0.52	−41.2	0.009	−0.52	−25.1	0.055	95.6
2.5	−24.1	0.062	98.7	−41.1	0.009	−1.2	−41.1	0.009	−1.2	−23.3	0.068	92.5
3.0	−22.7	0.073	95.7	−41.0	0.009	−2.3	−41.0	0.009	−2.3	−21.8	0.081	90.1
3.5	−21.4	0.085	93.3	−41.0	0.009	−3.9	−41.0	0.009	−3.9	−20.5	0.094	88.1
4.0	−20.4	0.096	91.4	−41.0	0.009	−5.9	−41.0	0.009	−5.9	−19.5	0.106	86.3
4.5	−19.5	0.106	89.8	−41.0	0.009	−8.6	−41.0	0.009	−8.6	−18.5	0.118	84.8
5.0	−18.7	0.117	88.5	−41.1	0.009	−11.9	−41.1	0.009	−11.9	−17.7	0.130	83.4
5.5	−18.0	0.126	87.3	−41.2	0.009	−16.1	−41.2	0.009	−16.1	−17.0	0.141	82.2
6.0	−17.3	0.136	86.4	−41.4	0.009	−21.4	−41.4	0.009	−21.4	−16.4	0.152	81.1
7.0	−16.3	0.154	85.0	−42.0	0.008	−36.6	−42.0	0.008	−36.6	−15.3	0.172	79.3
8.0	−15.4	0.170	84.4	−42.4	0.008	−61.5	−42.4	0.008	−61.5	−14.5	0.189	78.1
9.0	−14.7	0.185	84.7	−41.4	0.009	−97.4	−41.4	0.009	−97.4	−13.8	0.205	77.5
10.0	−14.0	0.200	86.2	−37.9	0.013	−132.1	−37.9	0.013	−132.1	−3.2	0.218	77.9

1. Data obtained from small–signal linear modeling

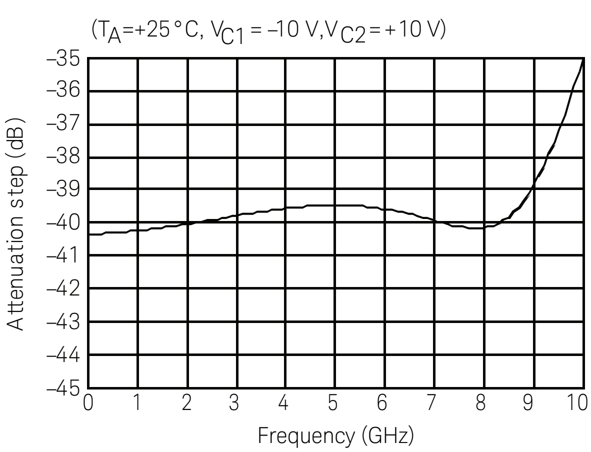


Figure 6. 1GG7-4088 attenuation step values vs. frequency

Typical attenuation step values

(T_A=+25 °C, V_{C1}=+10 V, V_{C2}= -10 V, Z_{in}=Z_{out}=50 Ω)

Freq. (GHz)	-40 dB State (dB)	Freq. (GHz)	-40 dB State (dB)
0.001	−40.4	5.0	−39.5
0.01	−40.4	5.5	−39.5
0.1	−40.4	6.0	−39.6
0.5	−40.3	6.5	−39.7
1.0	−40.3	7.0	−39.9
1.5	−40.2	7.5	−40.1
2.0	−40.1	8.0	−40.2
2.5	−39.9	8.5	−39.8
3.0	−39.8	9.0	−38.8
3.5	−39.7	9.5	−37.2
4.0	−39.6	10.0	−35.0

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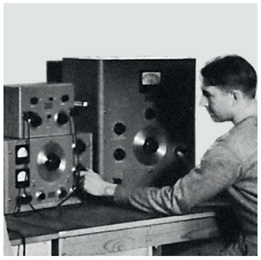
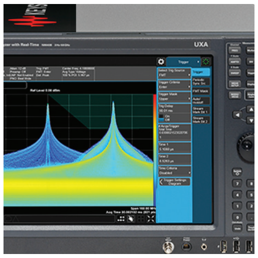


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The product described in this data sheet is RoHS Compliant. See RoHS Compliance section for more details.

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