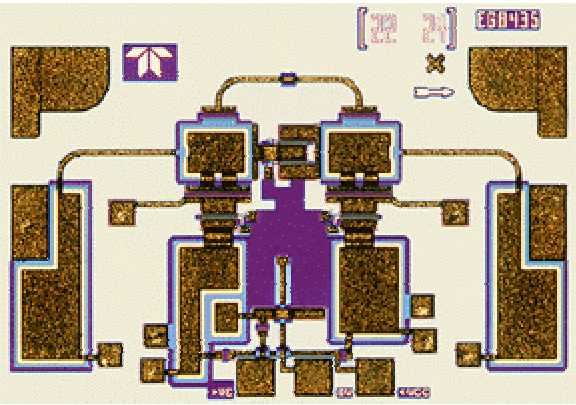
TriQuint SEMICONDUCTOR

Product Data Sheet

January 5, 2005

2 - 20 GHz Analog Attenuator TGL8784-SCC



Key Features and Performance

- 2 to 20 GHz Frequency Range
- 2-dB Insertion Loss at Midband
- 10-dB Input/Output Return Loss
- 13-dB Variable Attenuation Range
- Single Polarity Power Supply Required
- 1.702 x 1.219 x 0.152 mm (0.067 x 0.048 x 0.006 in.)

Description

The TriQuint TGL8784-SCC is a monolithic variable attenuator which operates from 2 to 20-GHz. This analog attenuator can operate from a single +2.5 volt power supply if used with an external variable voltage divider circuit. Typical RF performance at 10-GHz is: Insertion Loss 2-dB, Maximum attenuation: 15-dB at 10-GHz, input and output return loss: better than 10-dB. DC blocking capacitors are provided on-chip.

TGL8784-SCC is an absorptive attenuator designed using MESFET technology employing a “PI” configuration which reduces bias currents and simplifies bias networks. The broadband capabilities of this device are versatile in many applications such as telecommunications, military and space. This device has a space heritage.

Bond pad and backside metallization is gold plated for compatibility with eutectic attachment methods as well as thermocompression and thermosonic wire-bonding processes. The TGL8784-SCC is supplied in chip form and is readily assembled using automated equipment. Ground is provided to the circuitry through vias the backside metallization.

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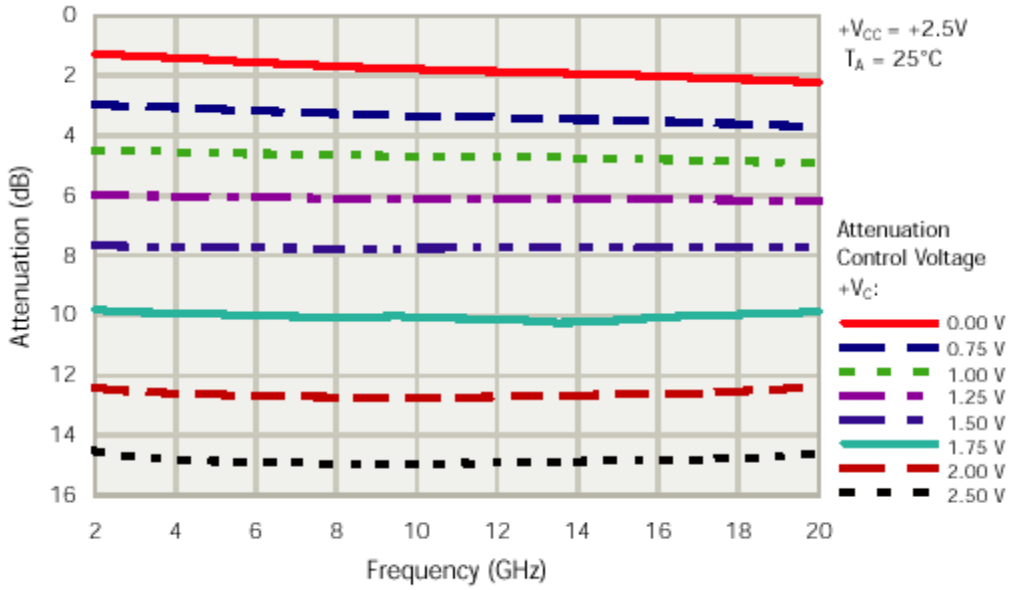
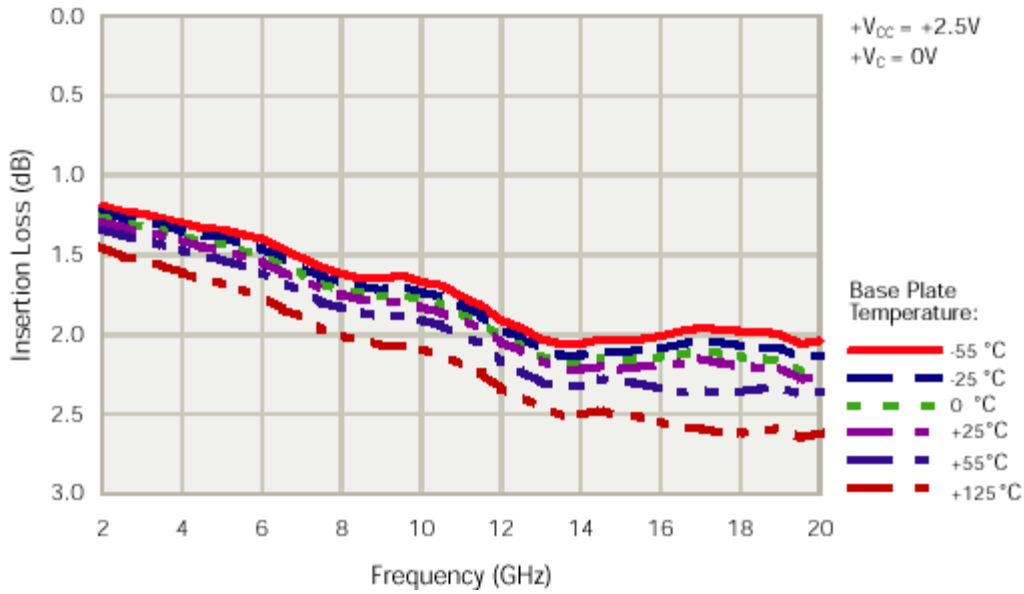
TYPICAL ATTENUATION VS CONTROL VOLTAGE +Vc



TYPICAL INSERSION LOSS VS TEMPERATURE



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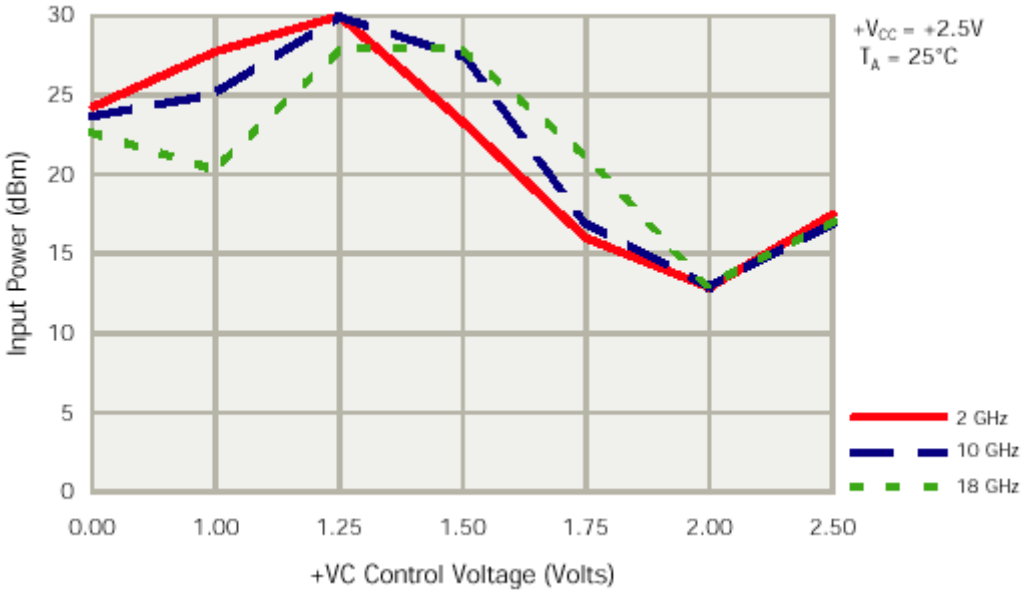
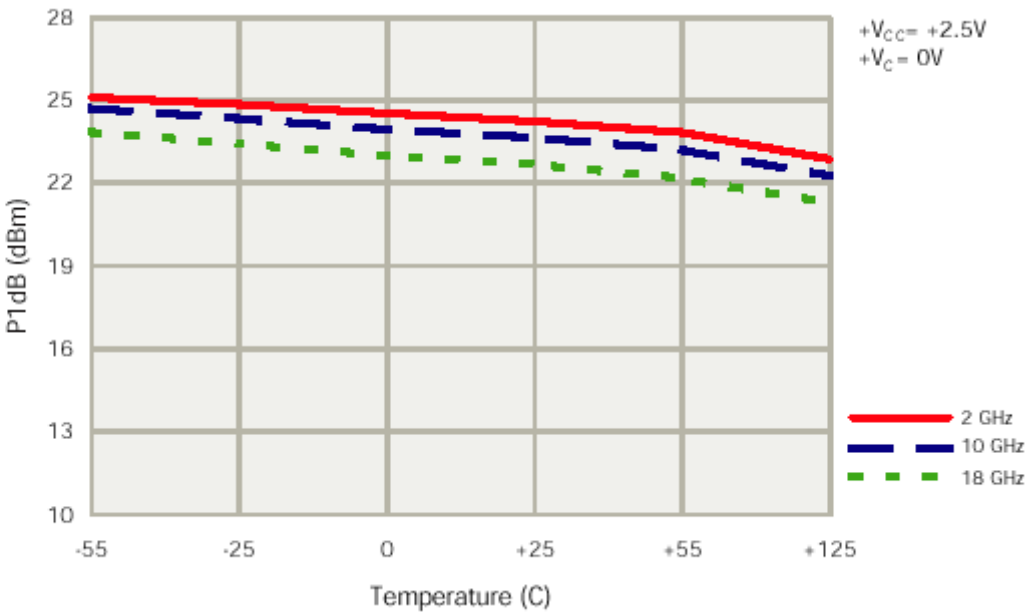
TYPICAL INPUT POWER AT 1dB ATTENUATION CHANGE VS +Vc P1dB



Recommended Maximum P_{IN} is 24 dBm.
P1dB data taken at control voltages ($+V_C$) listed at major division points on graph only

TYPICAL INPUT POWER AT 1dB ATTENUATION CHANGE VS TEMPERATURE



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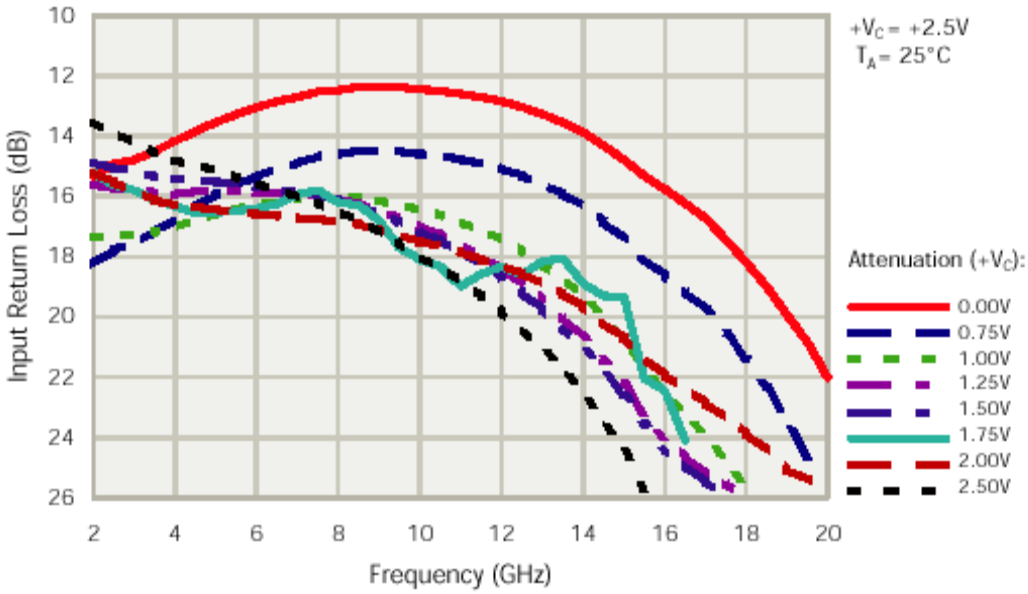
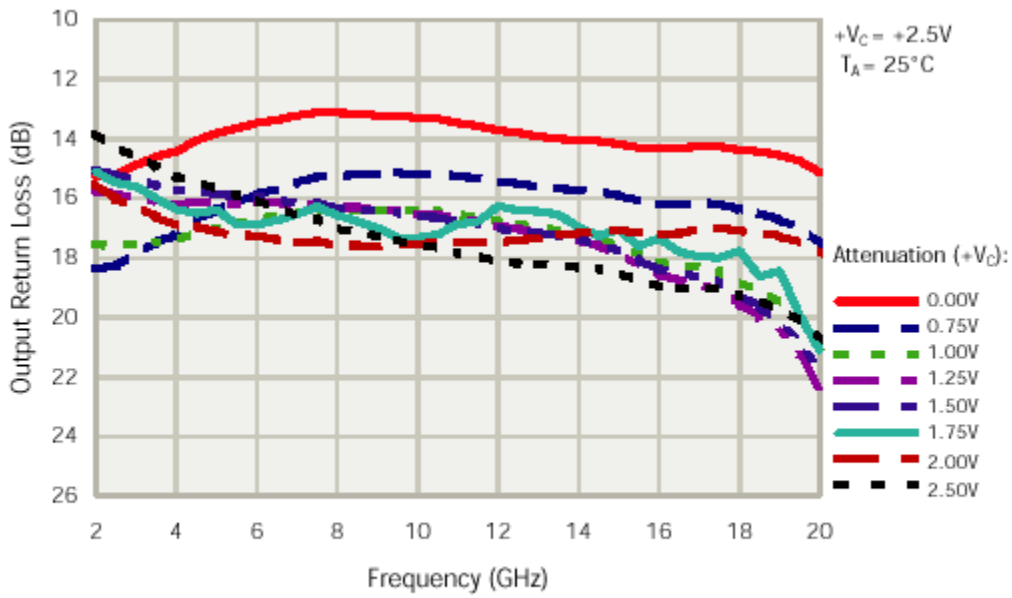
TYPICAL
INPUT RETURN LOSS



TYPICAL
OUTPUT RETURN LOSS



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TYPICAL INSERTION PHASE VS +Vc

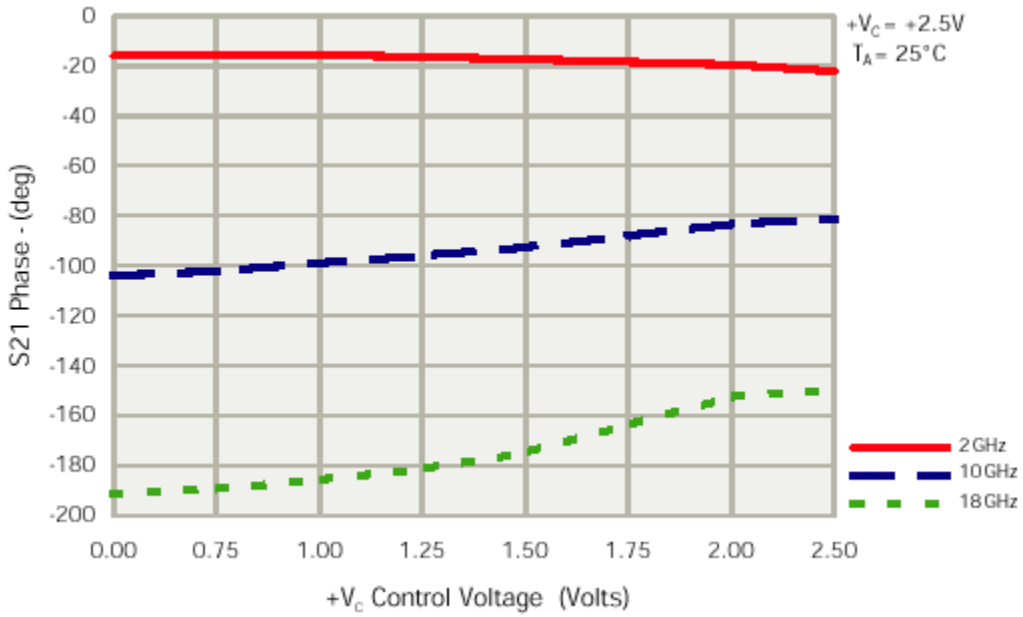

TABLE I
MAXIMUM RATINGS

SYMBOL	PARAMETER	VALUE
$+V_{CC}$	POSITIVE SUPPLY VOLTAGE	10V
$+V_C$, ($+V_{CC} > +V_C$)	ATTENUATION CONTROL VOLTAGE	0V to 10V
P_{IN}	INPUT CONTINUOUS WAVE POWER	24 dBm
T_{CH} *	OPERATING CHANNEL TEMPERATURE	150 ^{0}C
T_M	MOUNTING TEMPERATURE (30 SECONDS)	320 ^{0}C
T_{STG}	STORAGE TEMPERATURE	-65 to 150 ^{0}C

Ratings over channel temperature range, T_{CH} (unless otherwise noted)

Stresses beyond those listed under “Maximum Ratings” may cause permanent damage to the device.

These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated under “RF Specifications” is not implied. Exposure to maximum rated conditions for extended periods may affect device reliability.

* Operating channel temperature, T_{CH}, directly affects the device MTTF. For maximum life, it is recommended that channel temperature be maintained at the lowest possible level.

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TABLE II
DC PROBE TESTS (100%)
(T_A = 25 °C ± 5 °C)

NOTES	SYMBOL	TEST CONDITIONS	LIMITS		UNITS
			MIN	MAX	
4/	I_{DSS1}	STD	12.8	36.6	mA
4/	G_{M1}	STD	11.9	19.8	mS
1/,4/	$\|V_{P1}\|$	STD	1.1	3.5	V
1/,4/	$\|V_{P2}\|$	STD	1.1	3.5	V
1/	$\|V_{P3}\|$	2/	15200	102000	uA
1/,4/	$\|V_{BRGD1}\|$	STD	8	30	V
1/,4/	$\|V_{BRGS1,2}\|$	STD	8	30	V
	$R_{1,2}$	3/	83.8	113.4	Ω

1/ V_P, V_{BRGD}, and V_{BRGS} are negative.

2/ FET with resistors parallel across source-drain, V_P current measured with –4.5V applied to gate, +2V applied to drain, source at ground.

3/ Applied –4.5V to gate pin for resistance measurement.

4/ STD refers to Standard Test Conditions (see Table IV for definitions).

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TABLE III
RF WAFER CHARACTERIZATION TEST
(T_A = 25°C ± 5°C)

NOTE	TEST	MEASUREMENT CONDITIONS	VALUE			UNITS
			MIN	TYP	MAX	
1/	INSERTION LOSS	F = 2 – 20 GHz $+V_C$ = 0V, $+V_{CC}$ = +2.5V			3.5	dB
		F = 2 GHz		1.5		dB
		F = 10 GHz		2.0		dB
		F = 20 GHz		2.5		dB
1/	MAXIMUM ATTENUATION	F = 2 – 20 GHz $+V_C$ = 2.5,$+V_{CC}$ = +2.5V	12	15		dB
1/	FLATNESS	F = 2 – 20 GHz $+V_C$ = 0V, $+V_{CC}$ = +2.5V AND $+V_C$ = 2.5V, $+V_{CC}$ = 2.5V			2.0	dB P-P
1/	INPUT RETURN LOSS MAGNITUDE	F = 2 – 20 GHz $+V_C$ = 0V, $+V_{CC}$ = +2.5V	9	10		dB
1/	OUTPUT RETURN LOSS MAGNITUDE	F = 2 – 20 GHz $+V_C$ = 0V, $+V_{CC}$ = +2.5V	9	10		dB
2/	INPUT POWER AT 1dB ATTENUATION CHANGE	F = 2, 10, 18 GHz				dBm

1/ All devices are tested only in the frequency range of 2 – 18 GHz, but performance is guaranteed as specified from 2 – 20 GHz.

2/ P_{1dB} varies depending on $+V_C$ setting and frequency. See graph on page 3 for details.

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TABLE IV
AUTOPROBE FET PARAMETER MEASUREMENT CONDITONS

FET Parameters	Test Conditions
I_{DSS} : Maximum drain current (I_{DS}) with gate voltage (V_{GS}) at zero volts.	V_{GS} = 0.0 V, drain voltage (V_{DS}) is swept from 0.5 V up to a maximum of 3.5 V in search of the maximum value of I_{DS}; voltage for I_{DSS} is recorded as VDSP.
G_m : Transconductance; $\frac{(I_{DSS} - IDS1)}{VG1}$	For all material types, V_{DS} is swept between 0.5 V and VDSP in search of the maximum value of I_{ds}. This maximum I_{DS} is recorded as IDS1. For Intermediate and Power material, IDS1 is measured at V_{GS} = VG1 = -0.5 V. For Low Noise, HFET and pHEMT material, V_{GS} = VG1 = -0.25 V. For LNBECOLC, use V_{GS} = VG1 = -0.10 V.
V_P : Pinch-Off Voltage; V_{GS} for I_{DS} = 0.5 mA/mm of gate width.	V_{DS} fixed at 2.0 V, V_{GS} is swept to bring I_{DS} to 0.5 mA/mm.
V_{BVGD} : Breakdown Voltage, Gate-to-Drain; gate-to-drain breakdown current (I_{BD}) = 1.0 mA/mm of gate width.	Drain fixed at ground, source not connected (floating), 1.0 mA/mm forced into gate, gate-to-drain voltage (V_{GD}) measured is V_{BVGD} and recorded as BVGD; this cannot be measured if there are other DC connections between gate-drain, gate-source or drain-source.
V_{BVGS} : Breakdown Voltage, Gate-to-Source; gate-to-source breakdown current (I_{BS}) = 1.0 mA/mm of gate width.	Source fixed at ground, drain not connected (floating), 1.0 mA/mm forced into gate, gate-to-source voltage (V_{GS}) measured is V_{BVGS} and recorded as BVGS; this cannot be measured if there are other DC connections between gate-drain, gate-source or drain-source.

THERMAL INFORMATION

	PARAMETER	TEST CONDITIONS	NON	UNIT
R_{JC}	Thermal resistance, channel to backside.	70°C Base, $+V_{CC}$ = +2.5V, $+V_C$ = +2.5V	300	°C/W

* Thermal Resistance analysis based on Max Pin = 24 dBm and +Vc set for maximum attenuation. Power dissipation in Q1 is 135mW which represents a worst-case condition.

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TYPICAL S-PARAMETERS

Insertion Loss

Frequency (GHz)	S11		S21		S12		S22	
	dB	ANG(°)	dB	ANG(°)	dB	ANG(°)	dB	ANG(°)
2.0	-15.34	-70.1	-1.29	-18.0	-1.29	-18.0	-15.26	-70.5
2.5	-14.92	-75.4	-1.31	-23.1	-1.31	-23.1	-15.22	-77.4
3.0	-14.78	-81.8	-1.34	-28.1	-1.35	-28.1	-14.88	-83.1
3.5	-14.50	-87.0	-1.37	-32.8	-1.37	-32.8	-14.59	-88.8
4.0	-14.16	-92.0	-1.41	-37.5	-1.41	-37.5	-14.43	-94.7
4.5	-13.84	82.1	-1.44	-42.1	-1.45	-42.1	-14.05	79.3
5.0	-13.53	77.2	-1.48	-46.7	-1.48	-46.7	-13.80	73.9
5.5	-13.28	72.6	-1.52	-51.2	-1.52	-51.2	-13.65	68.3
6.0	-13.05	68.1	-1.55	-55.6	-1.55	-55.6	-13.47	62.8
6.5	-12.84	63.8	-1.59	-60.1	-1.59	-60.1	-13.36	57.6
7.0	-12.70	59.5	-1.63	-64.5	-1.63	-64.5	-13.22	53.1
7.5	-12.52	55.4	-1.66	-68.9	-1.66	-68.9	-13.11	47.7
8.0	-12.47	51.8	-1.69	-73.2	-1.69	-73.2	-13.13	43.4
8.5	-12.37	48.2	-1.72	-77.6	-1.72	-77.6	-13.15	38.3
9.0	-12.35	45.1	-1.74	-82.0	-1.74	-82.0	-13.22	33.6
9.5	-12.37	41.2	-1.77	-86.4	-1.77	-86.4	-13.22	29.2
10.0	-12.44	37.9	-1.79	-90.8	-1.79	-90.8	-13.30	25.2
10.5	-12.49	34.2	-1.81	-95.2	-1.82	-95.2	-13.32	20.9
11.0	-12.60	31.1	-1.83	-99.7	-1.83	-99.7	-13.46	16.8
11.5	-12.70	27.8	-1.85	-104.1	-1.85	-104.1	-13.57	12.5
12.0	-12.84	24.6	-1.86	-108.6	-1.86	-108.6	-13.71	8.7
12.5	-13.03	21.2	-1.88	-113.0	-1.88	-113.0	-13.79	4.9
13.0	-13.26	17.7	-1.90	-117.6	-1.90	-117.6	-13.92	1.0
13.5	-13.54	14.1	-1.92	-122.1	-1.93	-122.1	-14.00	-2.3
14.0	-13.87	-169.7	-1.94	-126.6	-1.94	-126.6	-14.05	174.4
14.5	-14.31	-173.8	-1.96	-131.1	-1.96	-131.1	-14.08	171.5
15.0	-14.78	-177.7	-1.97	-135.8	-1.97	-135.8	-14.18	169.0
15.5	-15.32	178.8	-1.99	-140.4	-1.99	-140.4	-14.29	166.4
16.0	-15.75	174.6	-2.02	-145.1	-2.02	-145.1	-14.33	163.5
16.5	-16.23	169.7	-2.05	-149.7	-2.05	-149.7	-14.31	160.2
17.0	-16.73	164.4	-2.07	-154.4	-2.07	-154.4	-14.25	156.6
17.5	-17.44	158.9	-2.09	-159.1	-2.10	-159.1	-14.26	153.2
18.0	-18.18	154.2	-2.12	-163.9	-2.12	-163.9	-14.37	149.9
18.5	-19.00	149.2	-2.14	-168.7	-2.14	-168.7	-14.42	146.8
19.0	-19.94	144.8	-2.16	-173.6	-2.17	-173.6	-14.55	143.8
19.5	-20.86	141.8	-2.20	-178.4	-2.20	-178.4	-14.73	140.8
20.0	-22.03	138.4	-2.21	-176.7	-2.22	-176.7	-15.13	138.4
20.5	-23.40	136.5	-2.24	-171.7	-2.24	-171.7	-15.52	136.0
21.0	-25.21	135.6	-2.27	-166.6	-2.25	-166.6	-15.87	133.3
21.5	-27.33	136.2	-2.29	-161.4	-2.30	-161.4	-16.28	131.1
22.0	-29.25	143.4	-2.33	-156.2	-2.33	-156.2	-16.73	128.7

T_A = 25°C, +Vcc = 2.5 V, +Vc = 0 V

The reference planes for S-parameter data include bond wires as specified in the “Recommended Assembly Diagram.

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TYPICAL S-PARAMETERS
Maximum Attenuation

Frequency (GHz)	S11		S21		S12		S22	
	dB	ANG(°)	dB	ANG(°)	dB	ANG(°)	dB	ANG(°)
2.0	-13.53	-140	-14.51	-24.0	-14.51	-24.0	-13.82	-143.7
2.5	-13.90	-146.6	-14.64	-26.0	-14.64	-26.0	-14.30	-152.4
3.0	-14.20	-153.5	-14.72	-28.4	-14.72	-28.4	-14.59	-158.5
3.5	-14.55	-157.9	-14.76	-31.0	-14.77	-31.0	-14.94	-163.2
4.0	-14.81	-161.5	-14.81	-33.8	-14.81	-33.7	-15.28	-167.9
4.5	-14.94	14.8	-14.84	-36.6	-14.84	-36.6	-15.42	8.5
5.0	-15.16	12.4	-14.86	-39.6	-14.86	-39.6	-15.70	5.5
5.5	-15.36	9.8	-14.89	-42.7	-14.88	-42.7	-15.91	2.0
6.0	-15.57	7.3	-14.89	-45.8	-14.90	-45.8	-16.07	-1.0
6.5	-15.77	5.5	-14.91	-48.9	-14.92	-49.0	-16.30	-3.9
7.0	-16.02	3.7	-14.93	-52.2	-14.93	-52.2	-16.58	-5.8
7.5	-16.23	2.1	-14.94	-55.5	-14.94	-55.4	-16.58	-8.3
8.0	-16.51	0.7	-14.94	-58.7	-14.94	-58.7	-17.01	-10.4
8.5	-16.77	-0.8	-14.95	-62.1	-14.95	-62.1	-17.13	-13.3
9.0	-17.20	-2.0	-14.95	-65.4	-14.95	-65.4	-17.29	-16.0
9.5	-17.55	-3.7	-14.95	-68.9	-14.96	-68.9	-17.40	-17.7
10.0	-18.00	-5.3	-14.95	-72.2	-14.95	-72.3	-17.60	-20.1
10.5	-18.37	-7.1	-14.95	-75.7	-14.94	-75.7	-17.66	-22.1
11.0	-18.82	-8.4	-14.93	-79.3	-14.94	-79.2	-17.84	-24.7
11.5	-19.32	-9.5	-14.94	-82.7	-14.93	-82.7	-17.93	-27.1
12.0	-19.81	-10.7	-14.92	-86.3	-14.92	-86.3	-18.12	-29.5
12.5	-20.40	-12.2	-14.91	-89.9	-14.91	-89.9	-18.19	-31.9
13.0	-21.04	-13.5	-14.90	-93.4	-14.91	-93.4	-18.22	-34.3
13.5	-21.75	-15.4	-14.90	-97.0	-14.90	-97.1	-18.26	-36.7
14.0	-22.53	162.7	-14.87	-100.6	-14.87	-100.5	-18.33	141.2
14.5	-23.52	160.3	-14.85	-104.2	-14.86	-104.3	-18.37	139.6
15.0	-24.44	157.4	-14.84	-107.9	-14.83	-107.9	-18.52	137.6
15.5	-25.71	155.1	-14.82	-111.7	-14.82	-111.7	-18.75	135.3
16.0	-26.92	151.0	-14.84	-115.4	-14.83	-115.5	-18.96	132.9
16.5	-27.98	148.4	-14.84	-118.9	-14.85	-118.9	-19.02	131.0
17.0	-29.13	144.4	-14.82	-122.4	-14.82	-122.5	-19.00	128.9
17.5	-30.24	140.6	-14.78	-126.0	-14.79	-126.0	-19.03	127.1
18.0	-31.56	135.1	-14.75	-129.8	-14.75	-129.8	-19.27	124.7
18.5	-32.76	129.4	-14.73	-133.5	-14.72	-133.5	-19.44	123.0
19.0	-34.78	124.1	-14.69	-137.3	-14.68	-137.3	-19.73	121.5
19.5	-36.56	125.8	-14.66	-141.0	-14.65	-141.1	-20.11	120.3
20.0	-38.64	119.2	-14.58	-144.8	-14.59	-144.8	-20.73	119.2
20.5	-45.80	100.5	-14.56	-148.7	-14.57	-148.8	-21.31	117.4
21.0	-53.20	6.6	-14.53	-152.9	-14.50	-152.9	-22.01	114.7
21.5	-43.52	-44.2	-14.47	-157.0	-14.50	-157.0	-22.83	114.2
22.0	-39.20	-62.3	-14.48	-161.1	-14.47	-161.1	-23.56	113.7

T_A = 25°C, +Vcc = 2.5 V, +Vc = 2.5V

The reference planes for S-parameter data include bond wires as specified in the “Recommended Assembly Diagram.

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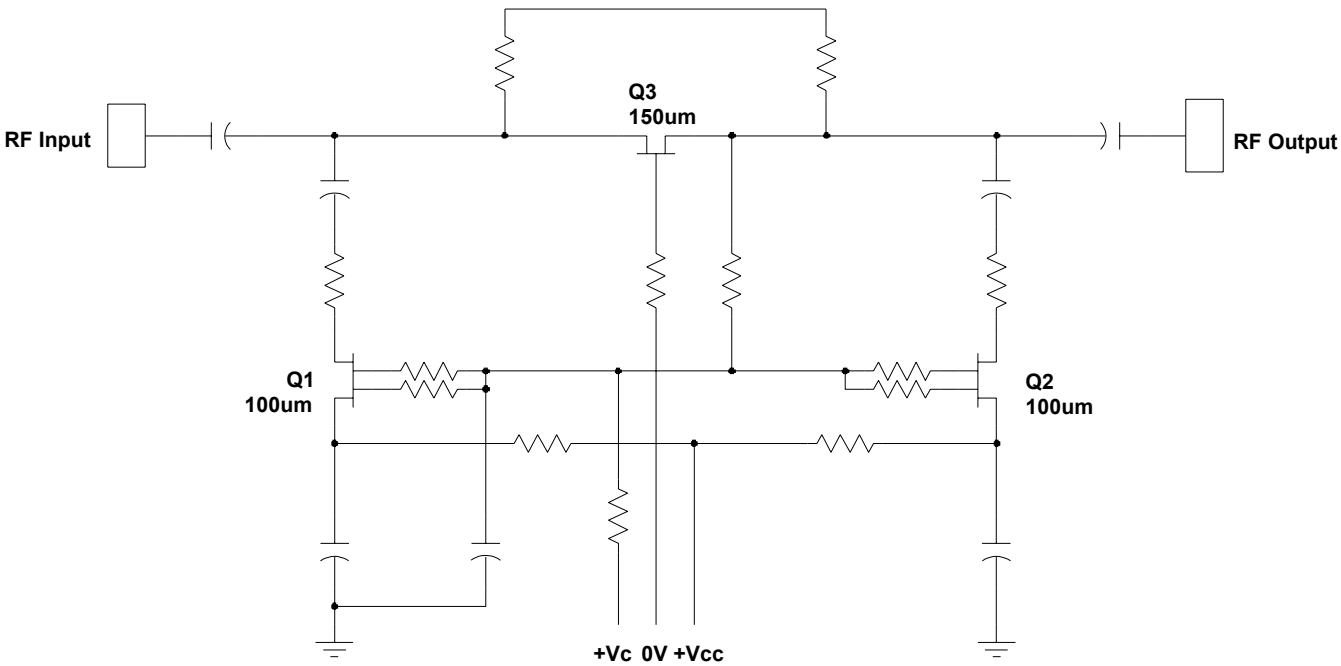
EQUIVALENT SCHEMATIC



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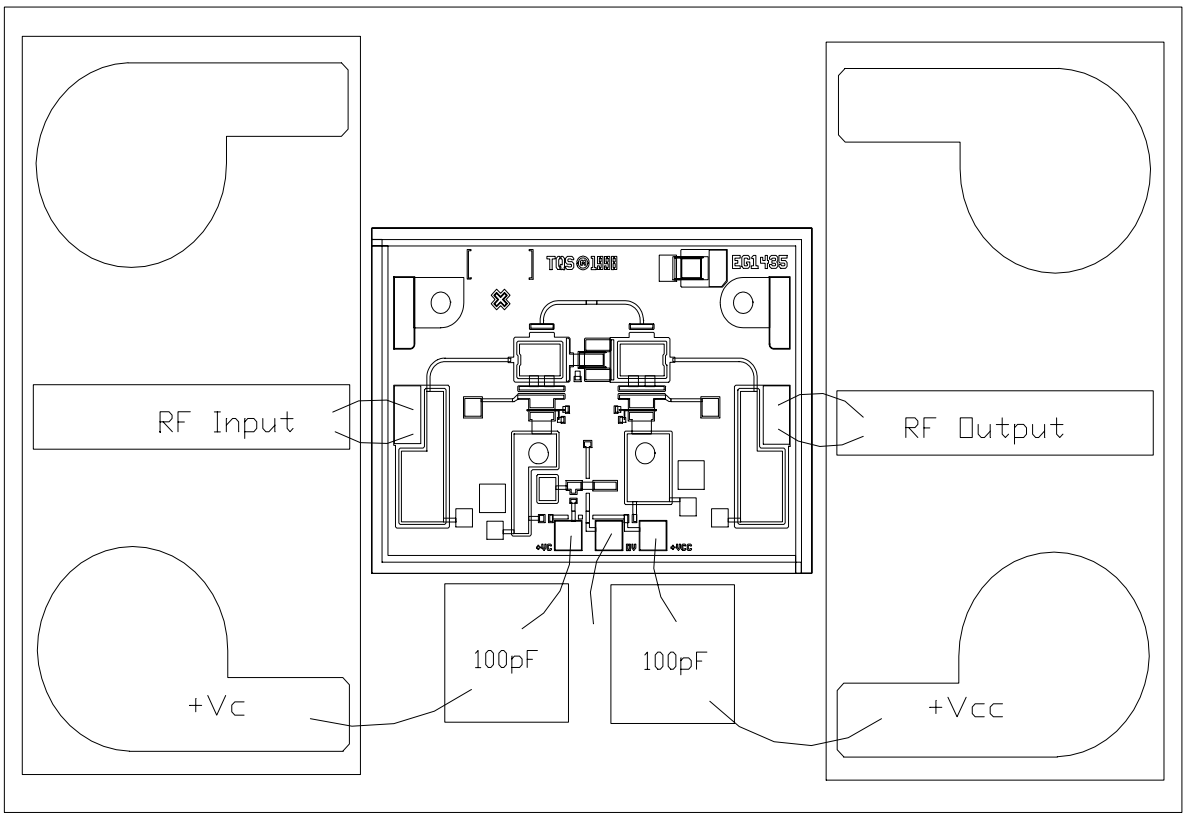
RECOMMENDED ASSEMBLY DRAWING



Bond using two 1.0-mil diameter, 25 to 30-mil length gold bond wires at both RF Input and RF output for optimum performance.

Close placement of external components is essential.

Refer to TriQuint Semiconductor *Gallium Arsenide Products Designer's Information, MMIC Assembly Procedures,* on TriQuint's website for details.

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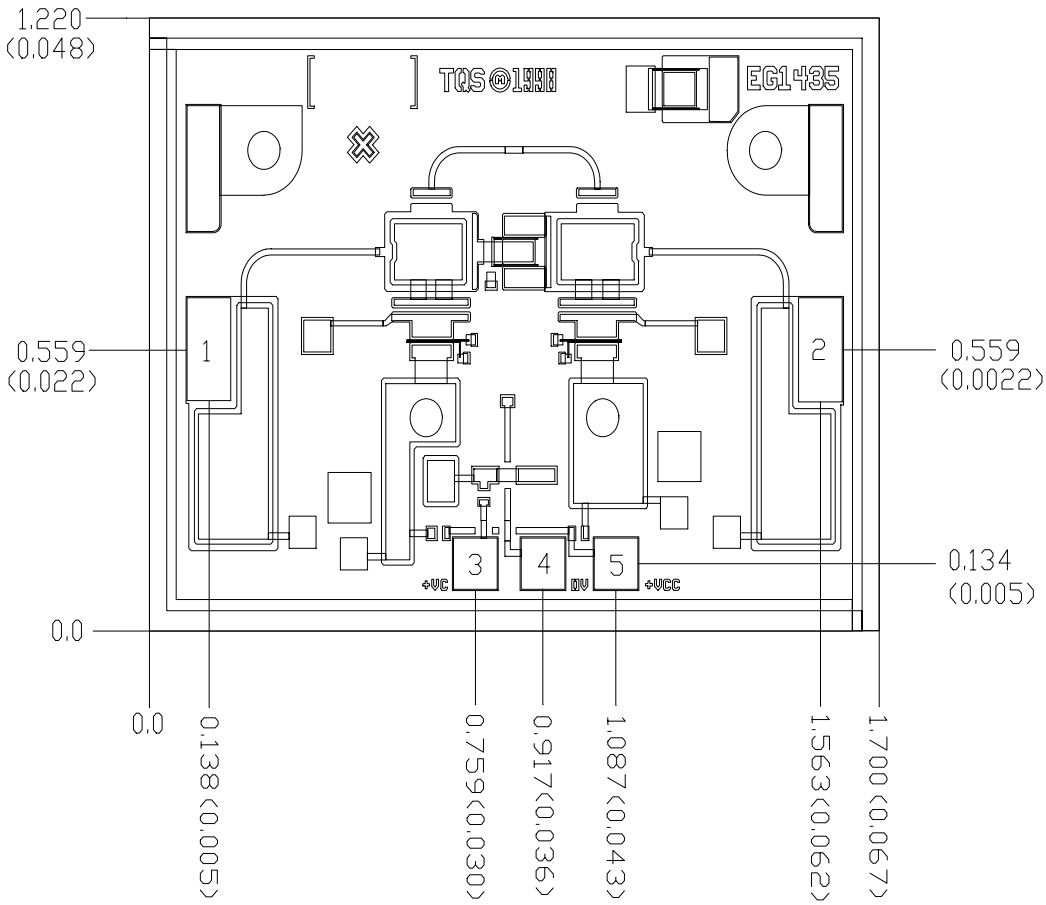
MECHANICAL DRAWING



Units: millimeters (inches)
Thickness: 0.1524 (0.006)
Chip edge to bond pad dimensions are shown to center of bond pad
Chip size tolerance: +/- 0.051 (0.002)

Bond pad #1 (RF Input)	0.102 x 0.204 (0.004 x 0.008)
Bond pad #2 (RF Output)	0.102 x 0.204 (0.004 x 0.008)
Bond pad #3 (+Vc)	0.102 x 0.102 (0.004 x 0.004)
Bond pad #4 (GND)	0.102 x 0.102 (0.004 x 0.004)
Bond pad #5 (+Vcc)	0.102 x 0.102 (0.004 x 0.004)

GaAs MMIC devices are susceptible to damage from Electrostatic Discharge. Proper precautions should be observed during handling, assembly and test.

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Assembly and Process Notes

Reflow process assembly notes:

- AuSn (80/20) solder with limited exposure to temperatures at or above 300□C
- alloy station or conveyor furnace with reducing atmosphere
- no fluxes should be utilized
- coefficient of thermal expansion matching is critical for long-term reliability
- storage in dry nitrogen atmosphere

Component placement and adhesive attachment assembly notes:

- vacuum pencils and/or vacuum collets preferred method of pick up
- avoidance of air bridges during placement
- force impact critical during auto placement
- organic attachment can be used in low-power applications
- curing should be done in a convection oven; proper exhaust is a safety concern
- microwave or radiant curing should not be used because of differential heating
- coefficient of thermal expansion matching is critical

Interconnect process assembly notes:

- thermosonic ball bonding is the preferred interconnect technique
- force, time, and ultrasonics are critical parameters
- aluminum wire should not be used
- discrete FET devices with small pad sizes should be bonded with 0.0007-inch wire
- maximum stage temperature: 200□C

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