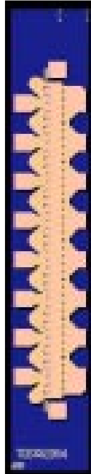
TriQuint SEMICONDUCTOR®

Advance Product Information
September 19, 2005

DC - 20 GHz Discrete power pHEMT TGF2022-60



Key Features and Performance

- Frequency Range: DC - 20 GHz
- > 38 dBm Nominal Psat
- 57% Maximum PAE
- 12 dB Nominal Power Gain
- Suitable for high reliability applications
- 6.0mm x 0.35um Power pHEMT
- Nominal Bias Vd = 8-12V, Idq = 448-752mA
  (Under RF Drive, Id rises from 448mA to 1480mA)
- Chip Dimensions: 0.57 x 2.93 x 0.10 mm
  (0.022 x 0.115 x 0.004 in)

Product Description

The TriQuint TGF2022-60 is a discrete 6.0 mm pHEMT which operates from DC-20 GHz. The TGF2022-60 is designed using TriQuint's proven standard 0.35um power pHEMT production process.

The TGF2022-60 typically provides > 38 dBm of saturated output power with power gain of 12 dB. The The maximum power added efficiency is 57% which makes the TGF2022-60 appropriate for high efficiency applications.

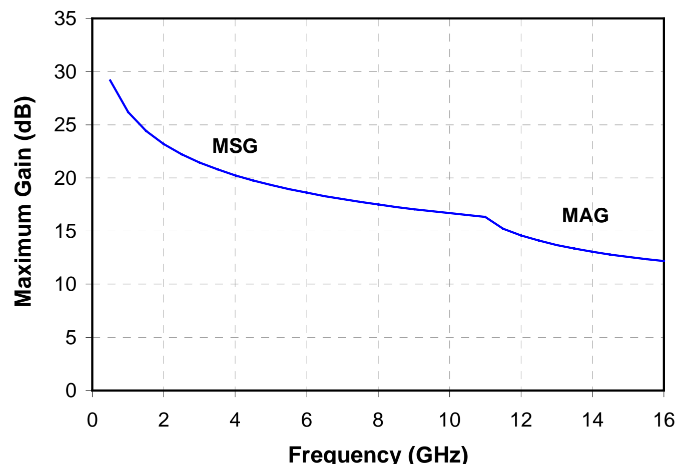
The TGF2022-60 is also ideally suited for Point-to-point Radio, High-reliability space, and Military applications.

The TGF2022-60 has a protective surface passivation layer providing environmental robustness.

Lead-free and RoHS compliant

Primary Applications

- Point-to-point Radio
- High-reliability space
- Military
- Base Stations
- Broadband Wireless Applications



Note: This device is early in the characterization process prior to finalizing all electrical specifications. Specifications are subject to change without notice.

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TABLE I
MAXIMUM RATINGS

Symbol	Parameter 1/	Value	Notes
V^+	Positive Supply Voltage	12.5 V	2/
V^-	Negative Supply Voltage Range	-5V to 0V	
I^+	Positive Supply Current (Quiescent)	2820 mA	2/
$\| I_G \|$	Gate Supply Current	70 mA	
P_{IN}	Input Continuous Wave Power	33 dBm	2/
P_D	Power Dissipation	See note 3	2/ 3/
T_{CH}	Operating Channel Temperature	150 °C	4/
T_M	Mounting Temperature (30 Seconds)	320 °C	
T_{STG}	Storage Temperature	-65 to 150 °C	

1/ These ratings represent the maximum operable values for this device.

2/ Combinations of supply voltage, supply current, input power, and output power shall not exceed P_D.

3/ For a median life time of 1E+6 hrs, Power dissipation is limited to:
$P_D(max) = (150\ °C – TBASE\ °C) / 14.2\ (°C/W)$

4/ Junction operating temperature will directly affect the device median time to failure (T_M). For maximum life, it is recommended that junction temperatures be maintained at the lowest possible levels.

TABLE II
DC PROBE CHARACTERISTICS
(T_A = 25 °C, Nominal)

Symbol	Parameter	Minimum	Typical	Maximum	Unit
Idss	Saturated Drain Current	-	1800	-	mA
Gm	Transconductance	-	2250	-	mS
V_P	Pinch-off Voltage	-1.5	-1	-0.5	V
V_{BGS}	Breakdown Voltage Gate-Source	-30	-	-14	V
V_{BGD}	Breakdown Voltage Gate-Drain	-30	-	-14	V

Note: For TriQuint's 0.35um power pHEMT devices, RF breakdown >> DC breakdown

TABLE III
RF CHARACTERIZATION TABLE 1/
(T_A = 25 °C, Nominal)

SYMBOL	PARAMETER	f = 10 GHz		f = 18 GHz		UNITS
Power Tuned:		**Vd = 10V Idq = 448 mA**	**Vd = 12V Idq = 448 mA**	**Vd = 10V Idq = 448 mA**	**Vd = 12V Idq = 448 mA**	
Psat	Saturated Output Power	38.8	39.4	37.6	38.1	dBm
PAE	Power Added Efficiency	51.6	50	42	38	%
Gain	Power Gain	12.3	7.8	12.1	7.6	dB
Rp 2/	Parallel Resistance	3.34	4.13	3.41	4.00	Ω
Cp 2/	Parallel Capacitance	3.812	3.607	3.151	3.473	pF
Γ_L 3/, 4/	Load Reflection coefficient	0.922 ∠ 176.3	0.916 ∠140.4	0.952 ∠176.2	0.955 ∠175.9	-
Efficiency Tuned:						
Psat	Saturated Output Power	37.6	39.0	37.2	37.9	dBm
PAE	Power Added Efficiency	57.0	53.8	44.0	41.0	%
Gain	Power Gain	12.4	12.4	7.9	7.6	dB
Rp 2/	Parallel Resistance	6.68	6.49	4.01	4.49	Ω
Cp 2/	Parallel Capacitance	4.425	3.947	3.566	3.736	pF
Γ_L 3/, 4/	Load Reflection coefficient	0.942 ∠173.6	0.931 ∠173.3	0.957 ∠175.9	0.962 ∠175.8	-

1/ Values in this table are from measurements taken from a 0.75mm unit pHEMT cell at 10 and 18 GHz

2/ Large signal equivalent pHEMT output network

3/ Optimum load impedance for maximum power or maximum PAE at 10 and 18 GHz

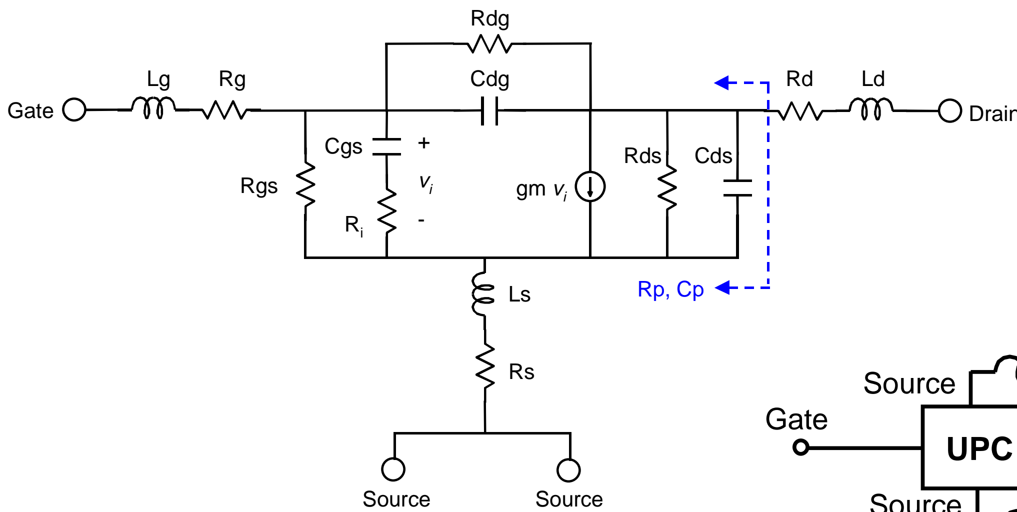
4 The reflection coefficients for this device have been calculated from the scaled large signal Rp & Cp. The series resistance and inductance (Rd and Ld) shown in the Figure on page 4 is excluded

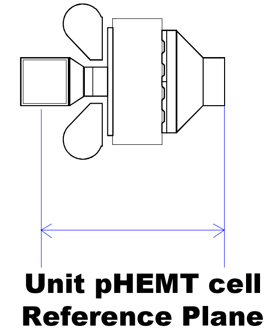
TABLE IV
THERMAL INFORMATION

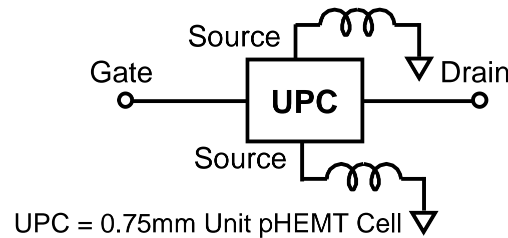
Parameter	Test Conditions	T_{CH} (°C)	θ_{JC} (°C/W)	T_M (HRS)
θ_{JC} Thermal Resistance (channel to backside of carrier)	Vd = 12 V Idq = 448 mA Pdiss = 8.96 W	146	14.2	1.4E+6

Note: Assumes eutectic attach using 1.5 mil 80/20 AuSn mounted to a 20 mil CuMo Carrier at 70°C baseplate temperature.

Linear Model for 0.75 mm Unit pHEMT cell

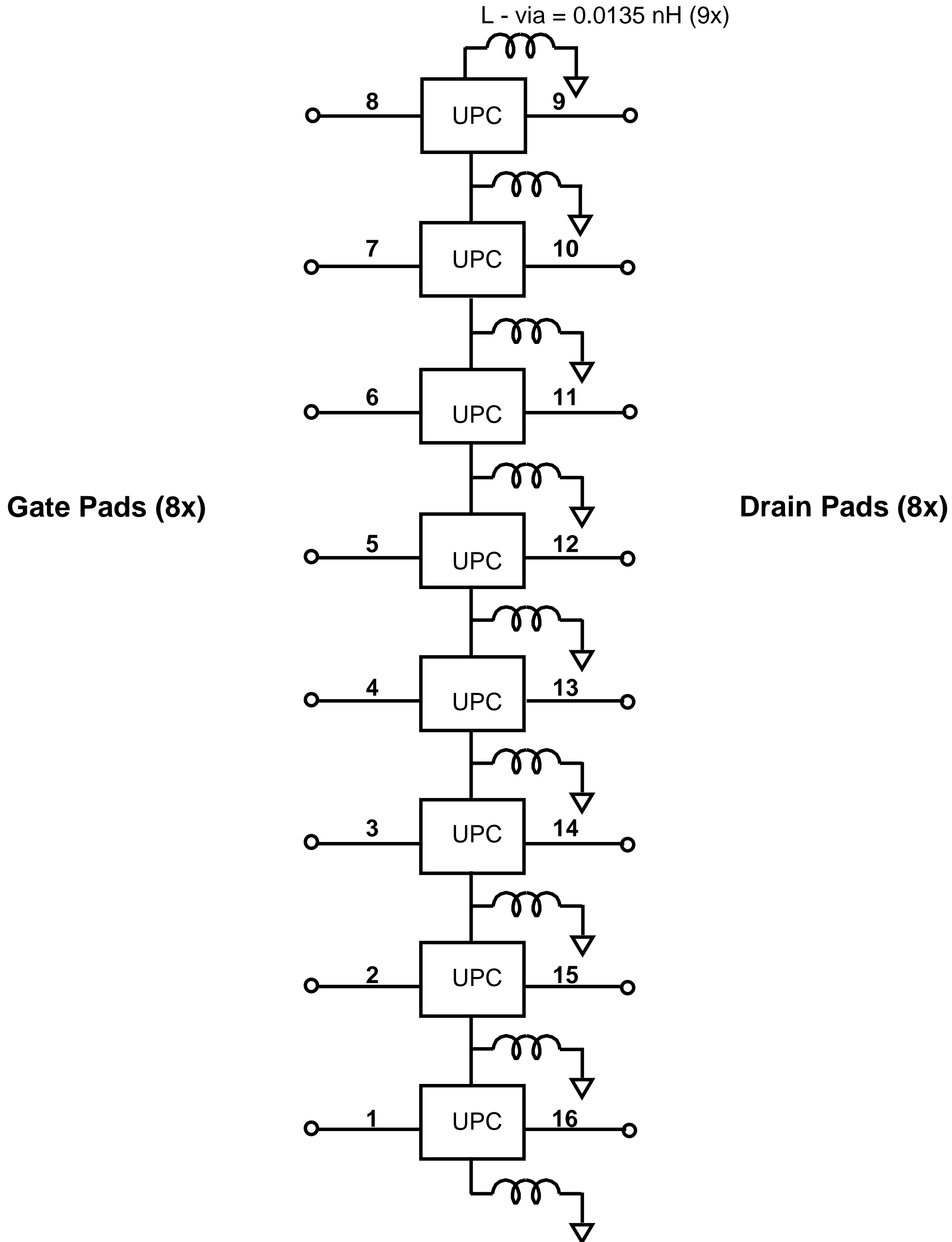






MODEL PARAMETER	Vd = 8V Id = 56mA	Vd = 8V Id = 75mA	Vd = 8V Id = 94mA	Vd = 10V Id = 56mA	Vd = 10V Id = 75mA	Vd = 12V Id = 56mA	UNITS
Rg	0.18	0.19	0.19	0.20	0.20	0.21	Ω
Rs	0.31	0.31	0.31	0.36	0.35	0.40	Ω
Rd	0.41	0.43	0.44	0.41	0.42	0.40	Ω
gm	0.242	0.25	0.25	0.23	0.24	0.227	S
Cgs	1.86	2.019	2.12	2.04	2.15	2.13	pF
Ri	1.33	1.28	1.28	1.36	1.32	1.38	Ω
Cds	0.143	0.144	0.144	0.142	0.143	0.142	pF
Rds	195.83	199.07	206.30	224.73	225.77	244.05	Ω
Cgd	0.090	0.084	0.079	0.080	0.077	0.076	pF
Tau	5.94	6.24	6.55	6.82	6.99	7.37	pS
Ls	0.002	0.002	0.002	0.002	0.002	0.002	nH
Lg	0.103	0.103	0.103	0.102	0.103	0.102	nH
Ld	0.110	0.109	0.108	0.108	0.108	0.108	nH
Rgs	3920	5200	7250	5940	5700	6180	Ω
Rgd	54900	61900	76900	64100	78100	77000	Ω

Linear Model for 6mm pHEMT



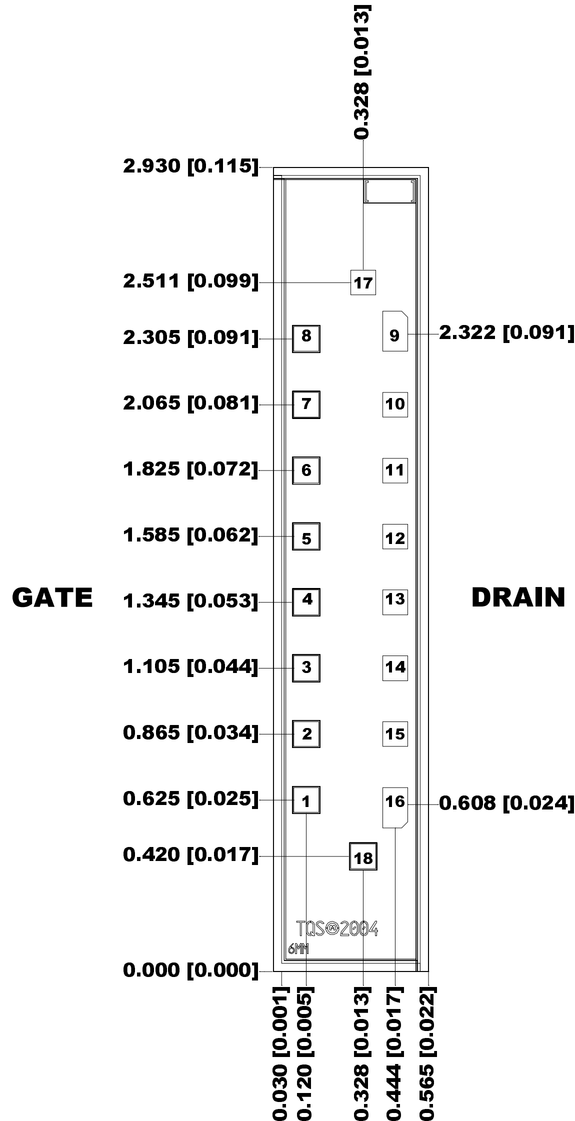
Unmatched S-parameters for 6 mm pHEMT

Bias Conditions: Vd = 12V, Idq = 448mA

Frequency (GHz)	s11 dB	s11 ang deg	s21 dB	s21 ang deg	s12 dB	s12 ang deg	s22 dB	s22 ang deg
0.5	-0.267	-160.66	20.810	96.96	-37.554	9.36	-3.758	-171.94
1	-0.248	-170.31	14.876	88.74	-37.477	3.63	-3.641	-174.40
1.5	-0.244	-173.59	11.346	83.87	-37.501	1.23	-3.583	-174.60
2	-0.241	-175.26	8.817	79.86	-37.554	-0.29	-3.522	-174.25
2.5	-0.238	-176.27	6.834	76.22	-37.626	-1.44	-3.451	-173.72
3	-0.236	-176.97	5.195	72.78	-37.716	-2.37	-3.370	-173.14
3.5	-0.233	-177.47	3.790	69.48	-37.821	-3.15	-3.280	-172.57
4	-0.230	-177.87	2.556	66.28	-37.941	-3.80	-3.183	-172.02
4.5	-0.227	-178.19	1.451	63.17	-38.074	-4.34	-3.079	-171.53
5	-0.223	-178.45	0.445	60.13	-38.220	-4.77	-2.972	-171.10
5.5	-0.220	-178.68	-0.479	57.17	-38.377	-5.09	-2.862	-170.73
6	-0.216	-178.88	-1.338	54.28	-38.545	-5.31	-2.751	-170.42
6.5	-0.212	-179.06	-2.142	51.45	-38.722	-5.43	-2.640	-170.17
7	-0.208	-179.23	-2.899	48.69	-38.906	-5.43	-2.530	-169.99
7.5	-0.204	-179.38	-3.615	46.00	-39.098	-5.32	-2.422	-169.85
8	-0.201	-179.52	-4.297	43.38	-39.294	-5.09	-2.316	-169.77
8.5	-0.197	-179.66	-4.947	40.82	-39.495	-4.74	-2.214	-169.73
9	-0.193	-179.79	-5.570	38.32	-39.699	-4.28	-2.114	-169.74
9.5	-0.189	-179.91	-6.168	35.88	-39.904	-3.70	-2.019	-169.78
10	-0.185	179.97	-6.744	33.50	-40.109	-2.99	-1.927	-169.85
10.5	-0.182	179.85	-7.299	31.19	-40.313	-2.16	-1.839	-169.95
11	-0.178	179.74	-7.835	28.93	-40.513	-1.22	-1.756	-170.08
11.5	-0.175	179.63	-8.354	26.73	-40.709	-0.15	-1.676	-170.23
12	-0.172	179.52	-8.857	24.58	-40.898	1.04	-1.600	-170.40
12.5	-0.169	179.41	-9.344	22.48	-41.079	2.34	-1.527	-170.58
13	-0.166	179.31	-9.818	20.44	-41.251	3.75	-1.459	-170.78
13.5	-0.163	179.21	-10.278	18.44	-41.412	5.26	-1.394	-170.98
14	-0.160	179.10	-10.726	16.49	-41.560	6.87	-1.332	-171.20
14.5	-0.157	179.00	-11.162	14.59	-41.694	8.58	-1.273	-171.43
15	-0.154	178.90	-11.586	12.73	-41.813	10.36	-1.218	-171.66
15.5	-0.152	178.81	-12.001	10.92	-41.916	12.21	-1.165	-171.90
16	-0.150	178.71	-12.405	9.15	-42.001	14.12	-1.115	-172.14
16.5	-0.147	178.61	-12.800	7.41	-42.068	16.07	-1.068	-172.38
17	-0.145	178.51	-13.186	5.71	-42.117	18.06	-1.023	-172.63
17.5	-0.143	178.42	-13.564	4.05	-42.148	20.07	-0.981	-172.88
18	-0.141	178.32	-13.934	2.43	-42.159	22.09	-0.940	-173.13
18.5	-0.139	178.23	-14.296	0.84	-42.153	24.11	-0.902	-173.38
19	-0.137	178.14	-14.650	-0.72	-42.129	26.11	-0.866	-173.63
19.5	-0.135	178.04	-14.998	-2.25	-42.088	28.09	-0.831	-173.87
20	-0.134	177.95	-15.340	-3.75	-42.031	30.03	-0.799	-174.12
20.5	-0.132	177.86	-15.675	-5.22	-41.959	31.93	-0.767	-174.37
21	-0.131	177.77	-16.004	-6.67	-41.874	33.78	-0.738	-174.61
21.5	-0.129	177.68	-16.328	-8.09	-41.776	35.57	-0.709	-174.86
22	-0.128	177.59	-16.647	-9.48	-41.666	37.30	-0.683	-175.10
22.5	-0.126	177.50	-16.961	-10.85	-41.547	38.97	-0.657	-175.34
23	-0.125	177.41	-17.270	-12.20	-41.418	40.57	-0.632	-175.58
23.5	-0.124	177.32	-17.575	-13.53	-41.282	42.11	-0.609	-175.81
24	-0.123	177.23	-17.875	-14.84	-41.139	43.58	-0.587	-176.05
24.5	-0.122	177.14	-18.172	-16.12	-40.991	44.98	-0.565	-176.28
25	-0.120	177.06	-18.466	-17.39	-40.838	46.32	-0.545	-176.51
25.5	-0.119	176.97	-18.756	-18.64	-40.681	47.59	-0.526	-176.74
26	-0.118	176.88	-19.043	-19.88	-40.521	48.80	-0.507	-176.96

Note: The s-parameters are calculated by connecting nodes 1-8 together, and nodes 9-16 together to form a 2-port network.

Mechanical Drawing



Units: millimeters (inches)
Thickness: 0.100 (0.004)
Chip edge to bond pad dimensions are shown to center of b
Chip size tolerance: +/- 0.051 (0.002)

GND IS BACKSIDE OF MMIC

Bond pads #1-8:	**(Gate)**	**0.090 x 0.090 (0.004 x 0.004)**
Bond pads #9-16:	**(Drain)**	**0.090 x 0.090 (0.004 x 0.004)**
Bond pad #17:	**(Vg*)**	**0.090 x 0.090 (0.004 x 0.004)**
Bond pad #18:	**(Vg*)**	**0.090 x 0.090 (0.004 x 0.004)**

***Note: Bond pads #17 & 18 are alternate gate pads**
that can be used for paralleling FETs.

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

Assembly Process Notes

Reflow process assembly notes:

- Use AuSn (80/20) solder with limited exposure to temperatures at or above 300 °C for 30 sec
- An alloy station or conveyor furnace with reducing atmosphere should be used.
- No fluxes should be utilized.
- Coefficient of thermal expansion matching is critical for long-term reliability.
- Devices must be stored in a dry nitrogen atmosphere.

Component placement and adhesive attachment assembly notes:

- Vacuum pencils and/or vacuum collets are the preferred method of pick up.
- Air bridges must be avoided during placement.
- The force impact is 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.
- Devices with small pad sizes should be bonded with 0.0007-inch wire.
- Maximum stage temperature is 200 °C.