13. Packaging

The R10000 microprocessor is presently supplied in one standard package configuration:

- a single-chip 599 ceramic LGA (Land Grid Array)

MIPS Licensees are encouraged to develop package solutions with MIPS Semiconductor Partners to meet specific requirements.

13.1 R10000 Single-Chip Package, 599CLGA

The standard single-chip R10000 package is a **599CLGA** (ceramic land grid array), as shown in Figure 13-1.

The 599CLGA package minimizes output switching noise by reducing the inductance of the power and ground paths leading into the package. Much of the decrease in power/ground inductance is accomplished by shortening the wire bonds running from the die pads to the package inner leads. The 599CLGA is designed with its cavity-side down, and the die is connected directly to a thermal slug.

Mechanical Characteristics

The 599CLGA has lands on a straight 1.27mm (.050inch) grid. It is a cavity-down, multi-layer ceramic package with an integral copper-tungsten slug, and is designed for use with a socket. Preliminary information suggests that the 599CLGA can withstand a force of 100 kilograms applied to the CuW slug, without damage, and a PWB assembly should insure that this force is not exceeded. Drawings for a reference LGA-PWB assembly are included in this chapter.

Electrical Characteristics

The 599CLGA uses multilayer construction, incorporating stripline configuration for signals. Multiple planes distribute power and ground throughout the package and provide built-in distributed bypass/coupling capacitance between the primary power supplies: **Vcc**, **VccQSC**, **VccQSys**, and **Vss**.

Pads are present on the package body for attaching chip-capacitors to provide additional bypass capacitance between the primary power supplies and the PLL power supply (**VccPa** and **VssPa**), and to provide an additional PLL loop filter capacitor (**PLLRC**). Chip-capacitors on the R10000 are assembled by the chip manufacturer.

Detailed electrical package characteristics will be provided by the MIPS Semiconductor Partners as they become available. The data in Table 13-1 is provided as an estimate of the package parasitics. These estimates include the effects of bondwires, package traces and vias, but not the sockets.

Table 13-1 R10000 599CLGA Electrical Characteristics

Parameter	Description	Minimum	Typical	Maximum
L_{sig}	Effective signal inductance	4.0nH		8.4nH
M_{sig}	Signal-to-signal mutual inductance			1.3nH
C_{sig}	Signal loading capacitance	3.0pF		5.6pF
C_m	Signal-to-signal mutual capacitance			0.5pF
R_{sig}	Signal resistance	400mΩ		1300mΩ
Z_0	Characteristic impedance		40Ω	
T_{pd}	Propagation delay			200ps

The copper-tungsten slug (provided for thermal performance) is hard-connected to **Vss** to minimize EMI radiation from the package.

Thermal Characteristics

The 599CLGA incorporates a copper-tungsten slug to provide an efficient thermal path from the processor to the heatsink.

The thermal analysis listed in Table 13-2 gives a preliminary indication of heatsink requirements for the 599CLGA.

Table 13-2 R10000 599CLGA Thermal Characteristics - Preliminary

Parameter	Description	Value
T_j	Maximum junction temperature	85° C
T_a	Maximum ambient temperature	40° C
P_{R10000}	Maximum power dissipation	30 watts
T_{ja}	Minimum temperature differential	45° C
Θ_{ja}	Minimum total thermal resistance	1.5° C/W
Θ_{jc}	Estimated junction to case thermal resistance	0.3° C/W
Θ_{ca}	Required case to ambient thermal resistance	1.2° C/W

System designers must take care, especially in desktop applications, to ensure sufficient airflow and heat-dissipation surface area to meet the required case-to-ambient thermal resistance, Θ_{ca}=1.2C/W.

The thermal interface between the package and heatsink is very important. Typically, grease or compliant material is inserted between the package and heatsink to increase the contact area between their surfaces.

Assembly Drawings and Pinout List

The following pages contain a pinout list (Table 13-3), and drawings of an example R10000 LGA-PWB assembly, including details of the PWB, heatsink, and bolster plate. Actual hardware specifications are dependent on the user.

An assembly drawing of the 599LGA is also shown in Figure 13-2. Note that hardware specifications given in this drawing will require modifications to accommodate the actual dimensions of the socket, PWB, heatsink, bolster, etc.

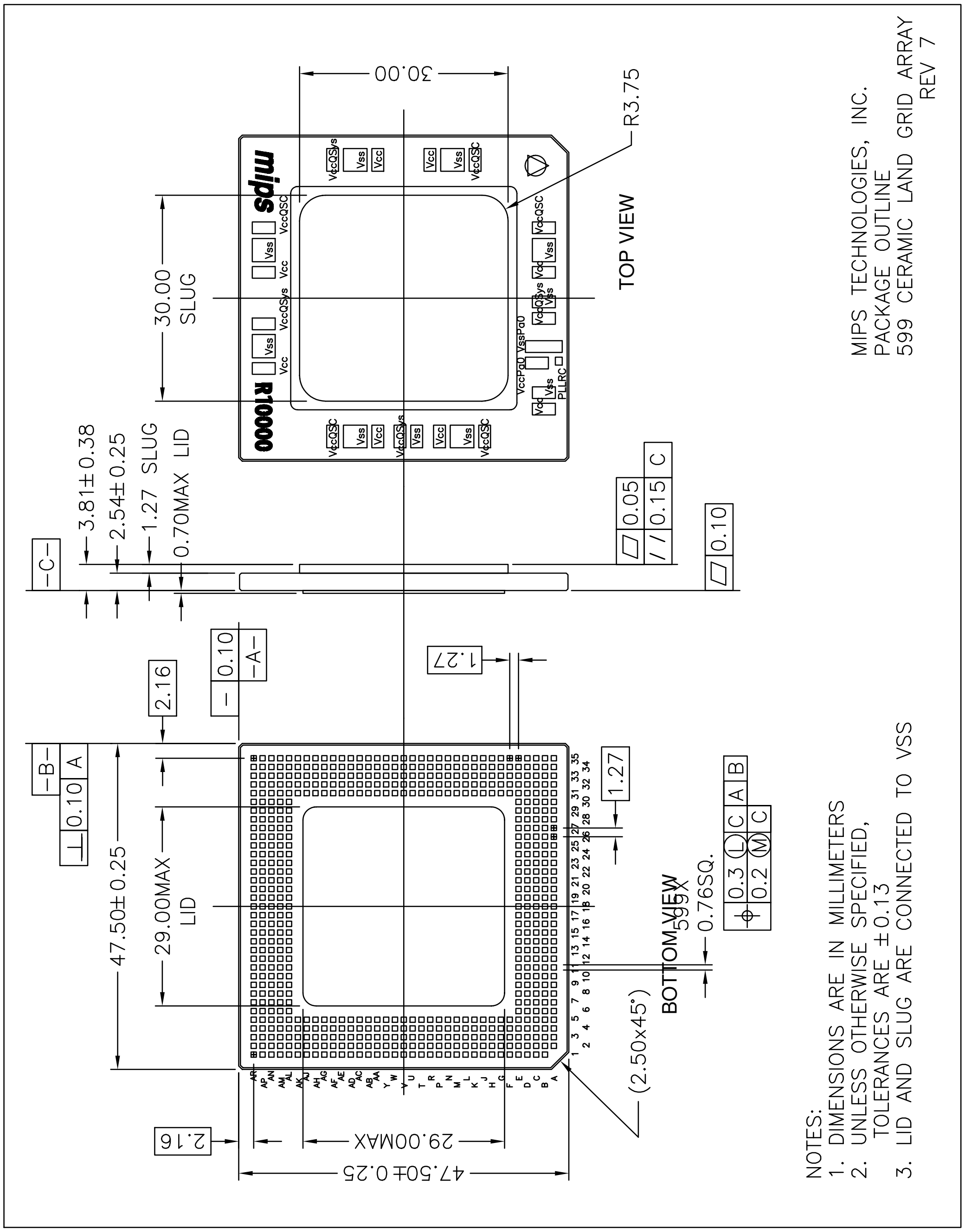

Figure 13-1 R10000 599CLGA Package Outline

599CLGA Pinout

Table 13-3 599CLGA Pinout

Signal	Location	Signal	Location	Signal	Location
DCOk	AF..........2	DCOk	B............22	JTCK	W...........33
JTDI	W...........35	JTDO	Y............31	JTMS	AA.........34
PLLDis	E.............24	PLLRC	A............25	PLLSpare1	C............21
PLLSpare2	A............21	PLLSpare3	D............21	PLLSpare4	B.............21
SCAAddr<0>	E.............13	SCAAddr<1>	A............11	SCAAddr<2>	D............12
SCAAddr<3>	C............11	SCAAddr<4>	E............12	SCAAddr<5>	B.............10
SCAAddr<6>	D............11	SCAAddr<7>	C............10	SCAAddr<8>	A............9
SCAAddr<9>	B.............30	SCAAddr<10>	E............29	SCAAddr<11>	A............31
SCAAddr<12>	D............30	SCAAddr<13>	C............31	SCAAddr<14>	E.............30
SCAAddr<15>	B.............32	SCAAddr<16>	D............31	SCAAddr<17>	B.............33
SCAAddr<18>	C............32	SCADCS*	B............9	SCADOE*	D............9
SCADWay	E.............10	SCADWr*	A............8	SCBAddr<0>	AL..........13
SCBAddr<1>	AP.........12	SCBAddr<2>	AM........12	SCBAddr<3>	AR..........11
SCBAddr<4>	AL.........12	SCBAddr<5>	AN........11	SCBAddr<6>	AM........11
SCBAddr<7>	AP.........10	SCBAddr<8>	AL.........11	SCBAddr<9>	AL..........29
SCBAddr<10>	AP.........30	SCBAddr<11>	AM........30	SCBAddr<12>	AR..........31
SCBAddr<13>	AL.........30	SCBAddr<14>	AN........31	SCBAddr<15>	AM........31
SCBAddr<16>	AP.........32	SCBAddr<17>	AP.........33	SCBAddr<18>	AN.........32
SCBDCS*	AN.........10	SCBDOE*	AL.........10	SCBDWay	AR..........9
SCBDWr*	AP.........9	SCClk<0>	B............13	SCClk<1>	A............26
SCClk<2>	AA.........31	SCClk<3>	AM........15	SCClk<4>	W...........1
SCClk<5>	E.............1	SCClk<0>*	E............15	SCClk<1>*	B.............26
SCClk<2>*	AB.........33	SCClk<3>*	AR.........14	SCClk<4>*	W...........4
SCClk<5>*	F.............4	SCData<0>	R............31	SCData<1>	N............34
SCData<2>	P.............33	SCData<3>	M...........35	SCData<4>	P.............32
SCData<5>	M...........34	SCData<6>	N...........33	SCData<7>	L.............35
SCData<8>	N............31	SCData<9>	L............33	SCData<10>	M............32
SCData<11>	K............34	SCData<12>	M...........31	SCData<13>	J..............35
SCData<14>	L.............32	SCData<15>	J.............34	SCData<16>	K............33
SCData<17>	H............35	SCData<18>	K............31	SCData<19>	G............34
SCData<20>	J..............32	SCData<21>	G............33	SCData<22>	J..............31
SCData<23>	F.............35	SCData<24>	H...........32	SCData<25>	F.............34
SCData<26>	G............31	SCData<27>	E............35	SCData<28>	F.............32
SCData<29>	D............34	SCData<30>	F............31	SCData<31>	E.............32
SCData<32>	AA.........32	SCData<33>	AB.........35	SCData<34>	AC.........34
SCData<35>	AB.........32	SCData<36>	AD........35	SCData<37>	AC.........33
SCData<38>	AD.........34	SCData<39>	AC.........31	SCData<40>	AE..........35

Table 13-3 (cont.)

Signal	Location	Signal	Location	Signal	Location
SCData<41>	AD.........32	SCData<42>	AE.........33	SCData<43>	AD.........31
SCData<44>	AF.........34	SCData<45>	AE.........32	SCData<46>	AG.........35
SCData<47>	AF.........33	SCData<48>	AG.........34	SCData<49>	AF.........31
SCData<50>	AH.........35	SCData<51>	AG.........32	SCData<52>	AJ.........34
SCData<53>	AG.........31	SCData<54>	AJ.........33	SCData<55>	AH.........32
SCData<56>	AK.........35	SCData<57>	AJ.........31	SCData<58>	AK.........34
SCData<59>	AK.........32	SCData<60>	AL.........35	SCData<61>	AK.........31
SCData<62>	AM.........34	SCData<63>	AM.........33	SCData<64>	D.........28
SCData<65>	B.........29	SCData<66>	E.........27	SCData<67>	C.........28
SCData<68>	D.........27	SCData<69>	E.........26	SCData<70>	A.........28
SCData<71>	C.........26	SCData<72>	B.........15	SCData<73>	D.........15
SCData<74>	A.........14	SCData<75>	C.........14	SCData<76>	A.........12
SCData<77>	D.........14	SCData<78>	B.........12	SCData<79>	C.........13
SCData<80>	E.........9	SCData<81>	C.........8	SCData<82>	D.........8
SCData<83>	B.........7	SCData<84>	C.........7	SCData<85>	A.........6
SCData<86>	E.........7	SCData<87>	B.........6	SCData<88>	D.........6
SCData<89>	A.........5	SCData<90>	E.........6	SCData<91>	C.........5
SCData<92>	D.........5	SCData<93>	B.........4	SCData<94>	C.........4
SCData<95>	B.........3	SCData<96>	AN.........29	SCData<97>	AP.........29
SCData<98>	AM.........28	SCData<99>	AN.........28	SCData<100>	AL.........27
SCData<101>	AR.........28	SCData<102>	AM.........27	SCData<103>	AP.........27
SCData<104>	AL.........16	SCData<105>	AP.........15	SCData<106>	AL.........15
SCData<107>	AP.........13	SCData<108>	AN.........14	SCData<109>	AN.........13
SCData<110>	AM.........14	SCData<111>	AR.........12	SCData<112>	AM.........9
SCData<113>	AR.........8	SCData<114>	AL.........9	SCData<115>	AN.........8
SCData<116>	AM.........8	SCData<117>	AP.........7	SCData<118>	AN.........7
SCData<119>	AR.........6	SCData<120>	AL.........7	SCData<121>	AP.........6
SCData<122>	AM.........6	SCData<123>	AR.........5	SCData<124>	AL.........6
SCData<125>	AN.........5	SCData<126>	AM.........5	SCData<127>	AP.........4
SCDataChk<0>	D.........33	SCDataChk<1>	AL.........32	SCDataChk<2>	C.........29
SCDataChk<3>	AR.........30	SCDataChk<4>	A.........30	SCDataChk<5>	AP.........3
SCDataChk<6>	E.........4	SCDataChk<7>	AN.........4	SCDataChk<8>	D.........3
SCDataChk<9>	B.........27	SCTCS*	D.........2	SCTag<0>	R.........1
SCTag<1>	R.........4	SCTag<2>	P.........1	SCTag<3>	R.........5
SCTag<4>	P.........3	SCTag<5>	N.........2	SCTag<6>	P.........4
SCTag<7>	M.........1	SCTag<8>	N.........3	SCTag<9>	M.........2
SCTag<10>	N.........5	SCTag<11>	M.........4	SCTag<12>	L.........1
SCTag<13>	M.........5	SCTag<14>	K.........2	SCTag<15>	L.........4

Table 13-3 (cont.)

Signal	Location	Signal	Location	Signal	Location
SCTag<16>	J............1	SCTag<17>	K...........3	SCTag<18>	J.............2
SCTag<19>	K...........5	SCTag<20>	H..........1	SCTag<21>	J.............4
SCTag<22>	G...........2	SCTag<23>	J............5	SCTag<24>	G...........3
SCTag<25>	H...........4	SCTagChk<0>	V...........4	SCTagChk<1>	W..........3
SCTagChk<2>	V...........2	SCTagChk<3>	V...........5	SCTagChk<4>	V...........1
SCTagChk<5>	U...........3	SCTagChk<6>	U...........1	SCTOE*	G...........5
SCTWay	T............3	SCTWr*	F...........2	SCTagLSBAddr	T............5
SelDVCO	E............21	Spare1	F...........5	Spare3	U...........4
SysAD<0>	Y...........34	SysAD<1>	W..........32	SysAD<2>	V...........35
SysAD<3>	V...........31	SysAD<4>	V...........34	SysAD<5>	U...........33
SysAD<6>	V...........32	SysAD<7>	U...........32	SysAD<8>	U...........35
SysAD<9>	T............33	SysAD<10>	T...........34	SysAD<11>	T............31
SysAD<12>	R...........35	SysAD<13>	R...........32	SysAD<14>	R............34
SysAD<15>	P............35	SysAD<16>	AL.........26	SysAD<17>	AR..........27
SysAD<18>	AN.........26	SysAD<19>	AP.........26	SysAD<20>	AL..........25
SysAD<21>	AN.........25	SysAD<22>	AM........25	SysAD<23>	AR..........25
SysAD<24>	AL.........24	SysAD<25>	AP.........24	SysAD<26>	AM........24
SysAD<27>	AR.........24	SysAD<28>	AL.........23	SysAD<29>	AN.........23
SysAD<30>	AM........22	SysAD<31>	AP.........23	SysAD<32>	C...........20
SysAD<33>	B............20	SysAD<34>	D...........19	SysAD<35>	A...........19
SysAD<36>	C...........19	SysAD<37>	A...........18	SysAD<38>	D...........18
SysAD<39>	E............18	SysAD<40>	B...........18	SysAD<41>	C...........17
SysAD<42>	A...........17	SysAD<43>	D...........17	SysAD<44>	B............16
SysAD<45>	C...........16	SysAD<46>	A...........15	SysAD<47>	E............16
SysAD<48>	AN.........20	SysAD<49>	AR.........19	SysAD<50>	AL..........19
SysAD<51>	AN.........19	SysAD<52>	AM........19	SysAD<53>	AP..........18
SysAD<54>	AM........18	SysAD<55>	AR.........18	SysAD<56>	AL..........18
SysAD<57>	AR.........17	SysAD<58>	AM........17	SysAD<59>	AN.........17
SysAD<60>	AL.........17	SysAD<61>	AP.........16	SysAD<62>	AN.........16
SysAD<63>	AR.........15	SysADChk<0>	AN........22	SysADChk<1>	AR..........22
SysADChk<2>	AL.........21	SysADChk<3>	AP.........21	SysADChk<4>	AM........21
SysADChk<5>	AR.........21	SysADChk<6>	AL.........20	SysADChk<7>	AP..........20
SysClk	A............22	SysClk*	A...........23	SysClkRet*	C...........23
SysClkRet	B............23	SysCmd<0>	Y...........2	SysCmd<1>	Y............3
SysCmd<2>	AA.........1	SysCmd<3>	Y...........5	SysCmd<4>	AA.........2
SysCmd<5>	AA.........4	SysCmd<6>	AB.........1	SysCmd<7>	AA.........5
SysCmd<8>	AB.........3	SysCmd<9>	AC.........2	SysCmd<10>	AB..........4

Table 13-3 (cont.)

Signal	Location	Signal	Location	Signal	Location
SysCmd<11>	AD.........1	SysCmdPar	AC......... 3	SysCorErr*	AK 4
SysCyc*	E............20	SysGblPerf*	AG 4	SysGnt*	AD 4
SysNMI*	AK.........5	SysRdRdy*	AJ 3	SysRel*	AE..........1
SysReq*	AC 5	SysReset*	AD 5	SysResp<0>	AJ...........2
SysResp<1>	AF..........5	SysResp<2>	AH 1	SysResp<3>	AF..........3
SysResp<4>	AG.........2	SysRespPar	AE......... 4	SysRespVal*	AG 1
SysState<0>	AL 1	SysState<1>	AJ 5	SysState<2>	AK 2
SysStatePar	AH.........4	SysStateVal	AK......... 1	SysUncErr*	AM 2
SysVal*	AD.........2	SysWrRdy*	AG 5	TCA	AM 3
TCB	AL 4	TriState	T 2	VccPa	B.............25
VccPa	C 25	VccPd	E 22	VrefByp	C 22
VssPa	A............24	VssPa	B 24	VssPd	D 22
Vcc	A............2	Vcc	A............ 34	Vcc	AB..........2
Vcc	AB 34	Vcc	AE......... 3	Vcc	AF..........32
Vcc	AF..........4	Vcc	AH 2	Vcc	AH.........34
Vcc	AL 3	Vcc	AL......... 31	Vcc	AL..........33
Vcc	AL 5	Vcc	AM........ 10	Vcc	AM 16
Vcc	AM........20	Vcc	AM........ 26	Vcc	AN.........18
Vcc	AN.........2	Vcc	AN 34	Vcc	AP..........1
Vcc	AP 14	Vcc	AP......... 22	Vcc	AP..........28
Vcc	AP 35	Vcc	AP......... 8	Vcc	AR..........2
Vcc	AR 34	Vcc	B 1	Vcc	B.............14
Vcc	B.............28	Vcc	B 35	Vcc	B.............8
Vcc	C 18	Vcc	C............ 2	Vcc	C 34
Vcc	D............10	Vcc	D............ 16	Vcc	D 20
Vcc	D............26	Vcc	E 3	Vcc	E.............31
Vcc	E.............33	Vcc	E 5	Vcc	F.............1
Vcc	H............2	Vcc	H 34	Vcc	K 32
Vcc	K............4	Vcc	L 3	Vcc	P.............2
Vcc	P.............34	Vcc	T 32	Vcc	T.............4
Vcc	V 3	Vcc	V............ 33	Vcc	Y.............32
Vcc	Y 4	VccQSC	A............ 10	VccQSC	A 32
VccQSC	A............4	VccQSC	AB......... 31	VccQSC	AD 33
VccQSC	AF..........35	VccQSC	AH 31	VccQSC	AH.........33
VccQSC	AK.........33	VccQSC	AL......... 14	VccQSC	AL..........28
VccQSC	AL 8	VccQSC	AM........ 35	VccQSC	AN.........12
VccQSC	AN.........3	VccQSC	AN 30	VccQSC	AN.........33

Table 13-3 (cont.)

Signal	Location	Signal	Location	Signal	Location
VccQSC	AN.........6	VccQSC	AR......... 10	VccQSC	AR..........32
VccQSC	AR 4	VccQSC	C............ 12	VccQSC	C 3
VccQSC	C 30	VccQSC	C............ 33	VccQSC	C 6
VccQSC	D............1	VccQSC	D............ 35	VccQSC	E.............14
VccQSC	E.............28	VccQSC	E 8	VccQSC	F 3
VccQSC	F.............33	VccQSC	H 3	VccQSC	H 31
VccQSC	H............33	VccQSC	H 5	VccQSC	K 1
VccQSC	K 35	VccQSC	M........... 3	VccQSC	M............33
VccQSC	P.............31	VccQSC	P 5	VccQSC	R.............2
VccQSC	T.............1	VccQSys	A............ 16	VccQSys	A 20
VccQSys	AB 5	VccQSys	AD 3	VccQSys	AF 1
VccQSys	AH.........3	VccQSys	AH 5	VccQSys	AK 3
VccQSys	AL 22	VccQSys	AM........ 1	VccQSys	AN 24
VccQSys	AR 16	VccQSys	AR......... 20	VccQSys	AR..........26
VccQSys	T.............35	VccQSys	Y............ 1	VccQSys	Y.............35
VrefSC	AA.........35	VrefSys	Y............ 33	Vss	A 13
Vss	A............27	Vss	A............ 29	Vss	A 3
Vss	A............33	Vss	A............ 35	Vss	A 7
Vss	AA.........3	Vss	AA 33	Vss	AC 1
Vss	AC 32	Vss	AC......... 35	Vss	AC 4
Vss	AE 2	Vss	AE 31	Vss	AE..........34
Vss	AE 5	Vss	AG 3	Vss	AG 33
Vss	AJ...........1	Vss	AJ 32	Vss	AJ...........35
Vss	AJ...........4	Vss	AL 2	Vss	AL..........34
Vss	AM 13	Vss	AM........ 23	Vss	AM 29
Vss	AM 32	Vss	AM........ 4	Vss	AM 7
Vss	AN.........1	Vss	AN 15	Vss	AN 21
Vss	AN.........27	Vss	AN 35	Vss	AN 9
Vss	AP 11	Vss	AP 17	Vss	AP..........19
Vss	AP 2	Vss	AP 25	Vss	AP..........31
Vss	AP 34	Vss	AP 5	Vss	AR..........1
Vss	AR 13	Vss	AR......... 23	Vss	AR..........29
Vss	AR 3	Vss	AR......... 33	Vss	AR..........35
Vss	AR 7	Vss	B 11	Vss	B.............17
Vss	B.............19	Vss	B 2	Vss	B.............31
Vss	B.............34	Vss	B 5	Vss	C 1
Vss	C 15	Vss	C............ 24	Vss	C 27
Vss	C 35	Vss	C............ 9	Vss	D 13

Table 13-3 (cont.)

Signal	Location	Signal	Location	Signal	Location
Vss	D...........23	Vss	D........... 24	Vss	D 25
Vss	D...........29	Vss	D........... 32	Vss	D 4
Vss	D...........7	Vss	E 11	Vss	E............17
Vss	E............19	Vss	E 2	Vss	E............23
Vss	E............25	Vss	E 34	Vss	G 1
Vss	G...........32	Vss	G........... 35	Vss	G 4
Vss	J.............3	Vss	J 33	Vss	L............2
Vss	L............31	Vss	L 34	Vss	L............5
Vss	N...........1	Vss	N 32	Vss	N 35
Vss	N...........4	Vss	R........... 3	Vss	R............33
Vss	U...........2	Vss	U........... 31	Vss	U 34
Vss	U...........5	Vss	W.......... 2	Vss	W 31
Vss	W 34	Vss	W.......... 5		

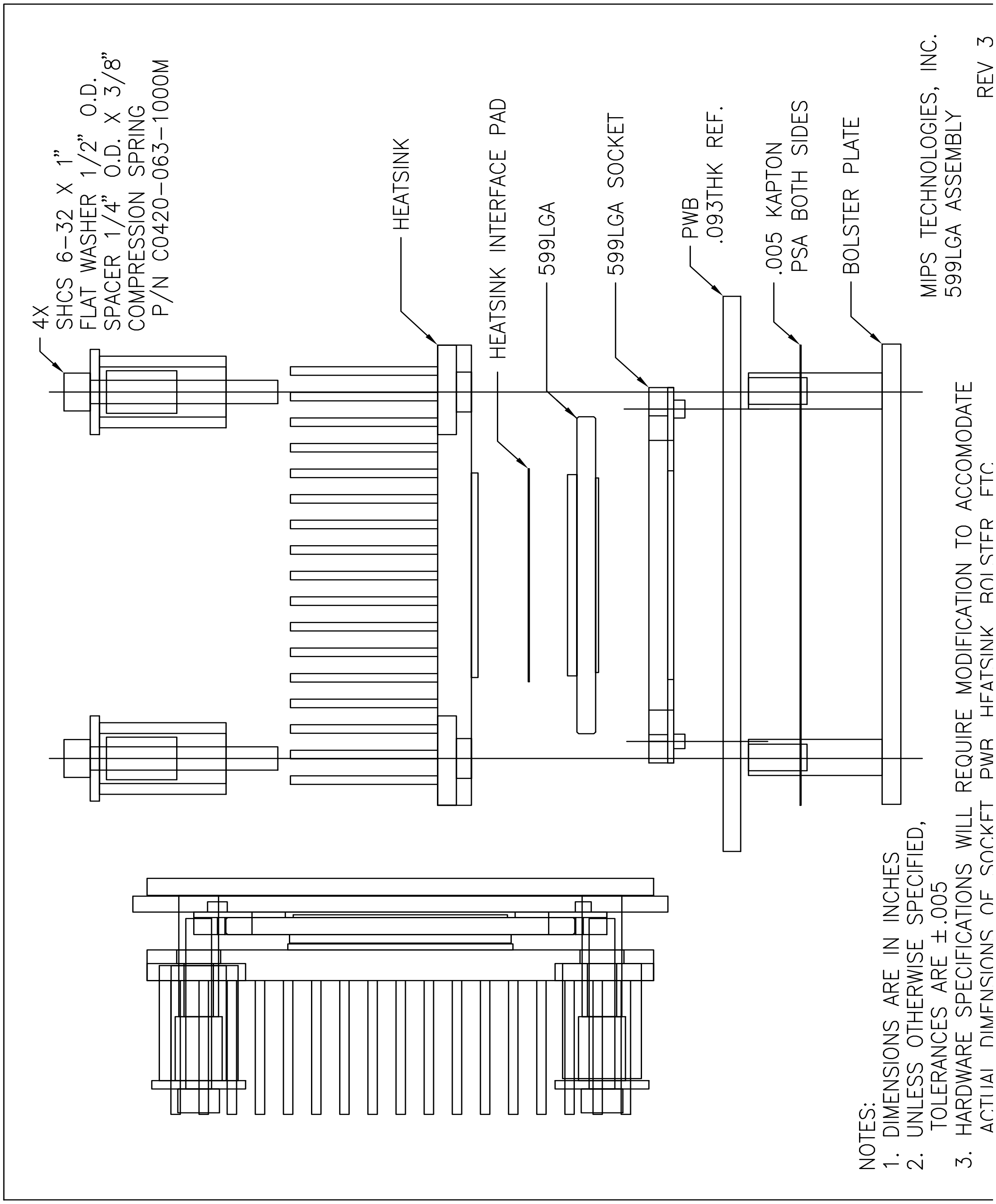

Figure 13-2 599LGA Assembly Drawing

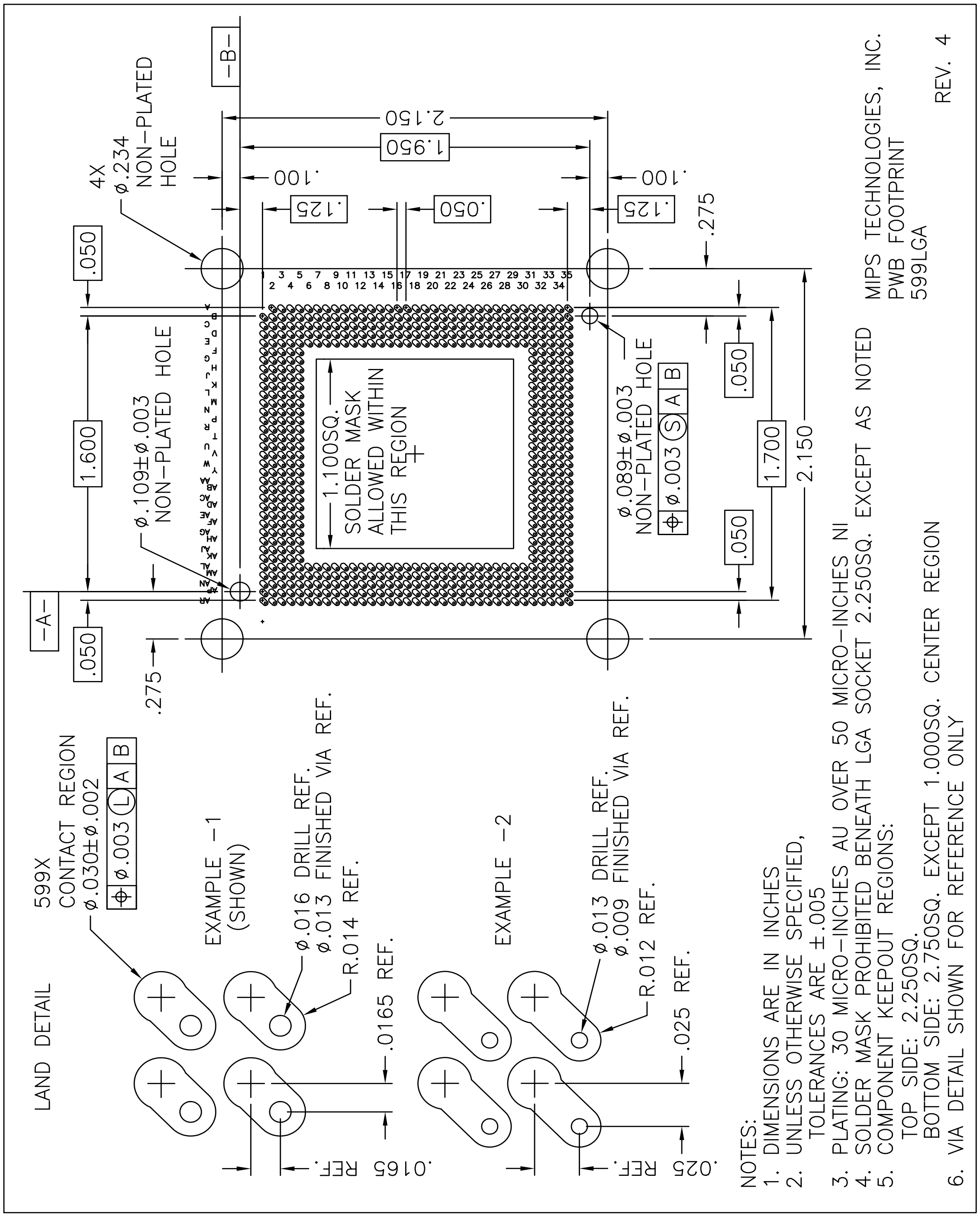

Figure 13-3 599LGA PWB Footprint

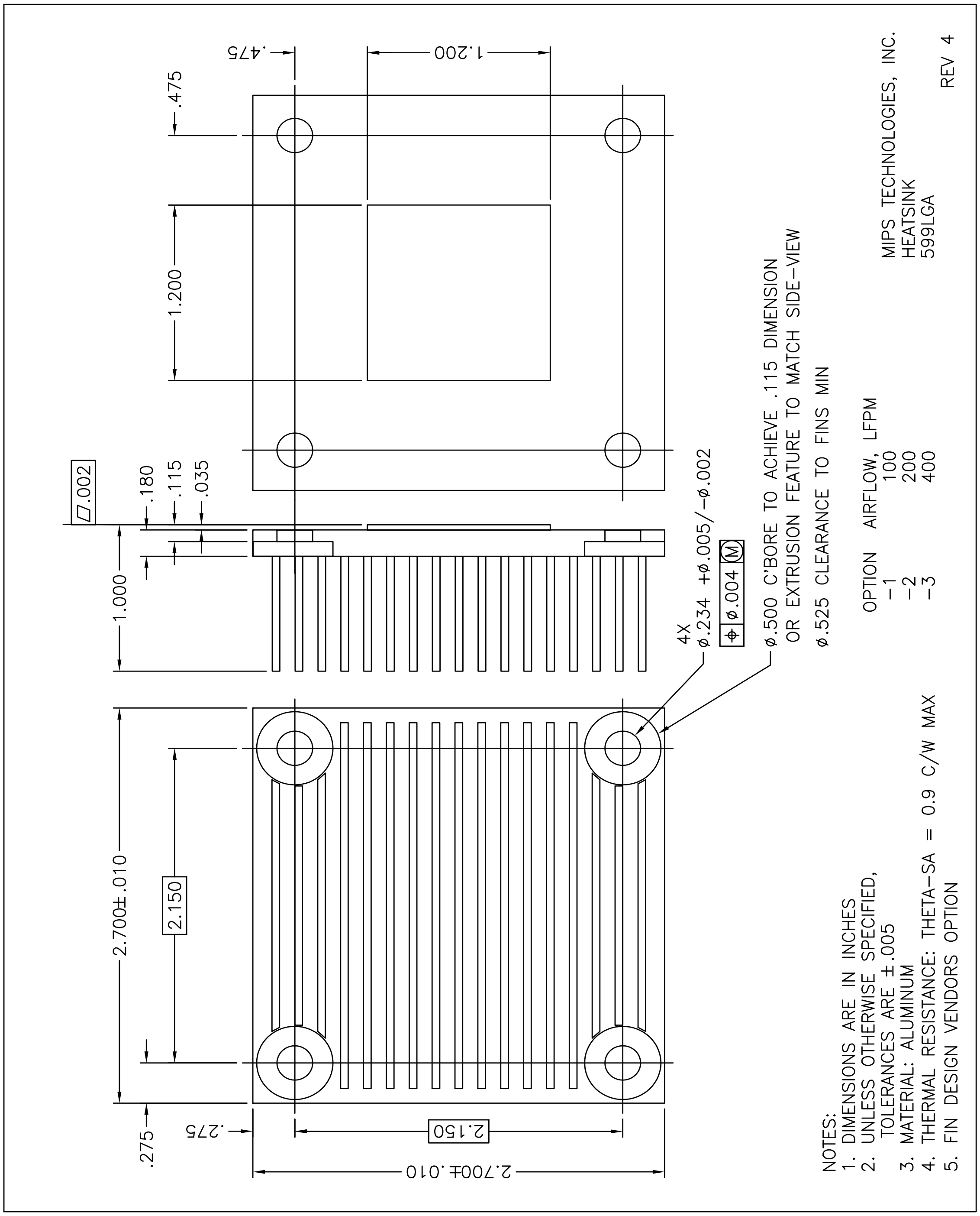

Figure 13-4 599LGA Heatsink

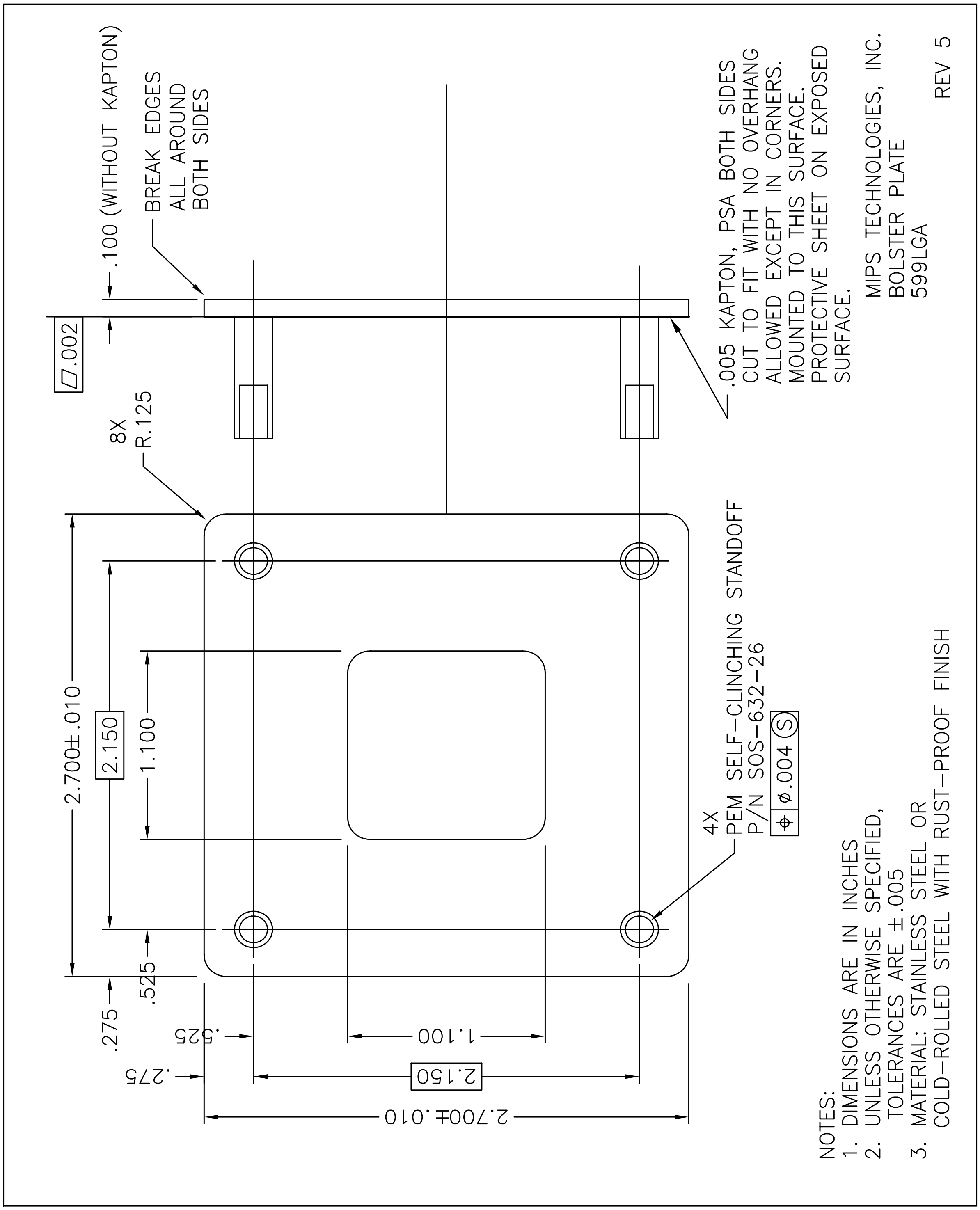

Figure 13-5 599LGA Bolster Plate