Table 5-1. **296-Pin SPGA Package Signal Names Sorted by Pin Number**

| Pin | Signal | Pin | Signal | Pin | Signal | Pin | Signal | Pin | Signal | Pin | Signal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| A3 | NC | C29 | D21 | J35 | D2 | U35 | Vss | AE35 | NC | AL21 | A20 |
| A5 | D41 | C31 | D17 | J37 | Vcc | U37 | Vcc | AE37 | Vcc | AL23 | A18 |
| A7 | Vcc | C33 | D14 | K2 | Vss | V2 | Vss | AF2 | Vss | AL25 | A16 |
| A9 | Vcc | C35 | D10 | K4 | D59 | V4 | AHOLD | AF4 | PCHK# | AL27 | A14 |
| A11 | Vcc | C37 | D9 | K34 | D0 | V34 | SUSP# | AF34 | A21 | AL29 | A12 |
| A13 | Vcc | D2 | D50 | K36 | Vss | V36 | Vss | AF36 | Vss | AL31 | A11 |
| A15 | Vcc | D4 | D48 | L1 | Vcc | W1 | Vcc | AG1 | Vcc | AL33 | A7 |
| A17 | Vcc | D6 | D44 | L3 | D61 | W3 | EWBE# | AG3 | SMIACT# | AL35 | A3 |
| A19 | Vcc | D8 | D40 | L5 | D60 | W5 | KEN# | AG5 | PCD | AL37 | Vss |
| A21 | Vcc | D10 | D39 | L33 | Vcc | W33 | SUSPA# | AG33 | A27 | AM2 | ADSC# |
| A23 | Vcc | D12 | D37 | L35 | NC | W35 | *Reserved* | AG35 | A24 | AM4 | EADS# |
| A25 | Vcc | D14 | D35 | L37 | Vcc | W37 | Vcc | AG37 | Vcc | AM6 | W/R# |
| A27 | Vcc | D16 | D33 | M2 | Vss | X2 | Vss | AH2 | Vss | AM8 | Vss |
| A29 | Vcc | D18 | DP3 | M4 | D62 | X4 | BRDY# | AH4 | LOCK# | AM10 | Vss |
| A31 | D22 | D20 | D30 | M34 | TCK | X34 | *Reserved* | AH34 | A26 | AM12 | Vss |
| A33 | D18 | D22 | D28 | M36 | Vss | X36 | Vss | AH36 | A22 | AM14 | Vss |
| A35 | D15 | D24 | D26 | N1 | Vcc | Y1 | Vcc | AJ1 | BREQ | AM16 | Vss |
| A37 | NC | D26 | D23 | N3 | D63 | Y3 | BRDYC# | AJ3 | HLDA | AM18 | Vss |
| B2 | NC | D28 | D19 | N5 | DP7 | Y5 | NA# | AJ5 | ADS# | AM20 | Vss |
| B4 | D43 | D30 | DP1 | N33 | TDO | Y33 | CLKMUL | AJ33 | A31 | AM22 | Vss |
| B6 | Vss | D32 | D12 | N35 | TDI | Y35 | *Reserved* | AJ35 | A25 | AM24 | Vss |
| B8 | Vss | D34 | D8 | N37 | Vcc | Y37 | Vcc | AJ37 | Vss | AM26 | Vss |
| B10 | Vss | D36 | DP0 | P2 | Vss | Z2 | Vss | AK2 | AP | AM28 | Vss |
| B12 | Vss | E1 | D54 | P4 | NC | Z4 | BOFF# | AK4 | D/C# | AM30 | Vss |
| B14 | Vss | E3 | D52 | P34 | TMS | Z34 | NC | AK6 | HIT# | AM32 | A8 |
| B16 | Vss | E5 | D49 | P36 | Vss | Z36 | Vss | AK8 | A20M# | AM34 | A4 |
| B18 | Vss | E7 | D46 | Q1 | Vcc | AA1 | Vcc | AK10 | BE1# | AM36 | A30 |
| B20 | Vss | E9 | D42 | Q3 | *Reserved* | AA3 | *Reserved* | AK12 | BE3# | AN1 | NC |
| B22 | Vss | E33 | D7 | Q5 | FERR# | AA5 | WB/WT# | AK14 | BE5# | AN3 | NC |
| B24 | Vss | E35 | D6 | Q33 | TRST# | AA33 | WM_RST | AK16 | BE7# | AN5 | NC |
| B26 | Vss | E37 | Vcc | Q35 | NC | AA35 | IGNNE# | AK18 | CLK | AN7 | FLUSH# |
| B28 | Vss | F2 | DP6 | Q37 | Vcc | AA37 | Vcc | AK20 | RESET | AN9 | Vcc |
| B30 | D20 | F4 | D51 | R2 | Vss | AB2 | Vss | AK22 | A19 | AN11 | Vcc |
| B32 | D16 | F6 | DP5 | R4 | *Reserved* | AB4 | HOLD | AK24 | A17 | AN13 | Vcc |
| B34 | D13 | F34 | D5 | R34 | BHOLD | AB34 | SMI# | AK26 | A15 | AN15 | Vcc |
| B36 | D11 | F36 | D4 | R36 | Vss | AB36 | Vss | AK28 | A13 | AN17 | Vcc |
| C1 | NC | G1 | Vcc | S1 | Vcc | AC1 | Vcc | AK30 | A9 | AN19 | Vcc |
| C3 | D47 | G3 | D55 | S3 | *Reserved* | AC3 | *Reserved* | AK32 | A5 | AN21 | Vcc |
| C5 | D45 | G5 | D53 | S5 | LBA# | AC5 | NC | AK34 | A29 | AN23 | Vcc |
| C7 | DP4 | G33 | D3 | S33 | *Reserved* | AC33 | NMI | AK36 | A28 | AN25 | Vcc |
| C9 | D38 | G35 | D1 | S35 | DHOLD | AC35 | NC | AL1 | NC | AN27 | Vcc |
| C11 | D36 | G37 | Vcc | S37 | Vcc | AC37 | Vcc | AL3 | PWT | AN29 | Vcc |
| C13 | D34 | H2 | Vss | T2 | Vss | AD2 | Vss | AL5 | HITM# | AN31 | A10 |
| C15 | D32 | H4 | D56 | T4 | MI/O# | AD4 | NC | AL7 | QDUMP# | AN33 | A6 |
| C17 | D31 | H34 | NC | T34 | Vcc | AD34 | INTR | AL9 | BE0# | AN35 | *Reserved* |
| C19 | D29 | H36 | Vss | T36 | Vss | AD36 | Vss | AL11 | BE2# | AN37 | Vss |
| C21 | D27 | J1 | Vcc | U1 | Vcc | AE1 | Vcc | AL13 | BE4# | | |
| C23 | D25 | J3 | D57 | U3 | CACHE# | AE3 | NC | AL15 | BE6# | | |
| C25 | DP2 | J5 | D58 | U5 | INV | AE5 | APCHK# | AL17 | SCYC | | |
| C27 | D24 | J33 | *Reserved* | U33 | Vcc | AE33 | A23 | AL19 | *Reserved* | | |

Note: *Reserved* pins are reserved for future use by IBM only. Pins marked NC are not internally connected.

Table 5-2. **296-Pin SPGA Package Pin Numbers Sorted by Signal Name**

| Signal | Pin | Signal | Pin | Signal | Pin | Signal | Pin | Signal | Pin | Signal | Pin |
|---|---|---|---|---|---|---|---|---|---|---|---|
| A3 | AL35 | CLKMUL | Y33 | D48 | D4 | NC | AN3 | Vcc | AA37 | Vss | AM12 |
| A4 | AM34 | D/C# | AK4 | D49 | E5 | NC | AN5 | Vcc | AC1 | Vss | AM14 |
| A5 | AK32 | D0 | K34 | D50 | D2 | NC | B2 | Vcc | AC37 | Vss | AM16 |
| A6 | AN33 | D1 | G35 | D51 | F4 | NC | C1 | Vcc | AE1 | Vss | AM18 |
| A7 | AL33 | D2 | J35 | D52 | E3 | NC | H34 | Vcc | AE37 | Vss | AM20 |
| A8 | AM32 | D3 | G33 | D53 | G5 | NC | L35 | Vcc | AG1 | Vss | AM22 |
| A9 | AK30 | D4 | F36 | D54 | E1 | NC | P4 | Vcc | AG37 | Vss | AM24 |
| A10 | AN31 | D5 | F34 | D55 | G3 | NC | Q35 | Vcc | AN11 | Vss | AM26 |
| A11 | AL31 | D6 | E35 | D56 | H4 | NC | Z34 | Vcc | AN13 | Vss | AM28 |
| A12 | AL29 | D7 | E33 | D57 | J3 | NMI | AC33 | Vcc | AN15 | Vss | AM30 |
| A13 | AK28 | D8 | D34 | D58 | J5 | PCD | AG5 | Vcc | AN17 | Vss | AM8 |
| A14 | AL27 | D9 | C37 | D59 | K4 | PCHK# | AF4 | Vcc | AN19 | Vss | AN37 |
| A15 | AK26 | D10 | C35 | D60 | L5 | PWT | AL3 | Vcc | AN21 | Vss | B6 |
| A16 | AL25 | D11 | B36 | D61 | L3 | QDUMP# | AL7 | Vcc | AN23 | Vss | B8 |
| A17 | AK24 | D12 | D32 | D62 | M4 | RESET | AK20 | Vcc | AN25 | Vss | B10 |
| A18 | AL23 | D13 | B34 | D63 | N3 | SCYC | AL17 | Vcc | AN27 | Vss | B12 |
| A19 | AK22 | D14 | C33 | DHOLD | S35 | *Reserved* | AA3 | Vcc | AN29 | Vss | B14 |
| A20 | AL21 | D15 | A35 | DP0 | D36 | *Reserved* | AC3 | Vcc | AN9 | Vss | B16 |
| A20M# | AK8 | D16 | B32 | DP1 | D30 | *Reserved* | AL19 | Vcc | E37 | Vss | B18 |
| A21 | AF34 | D17 | C31 | DP2 | C25 | *Reserved* | AN35 | Vcc | G1 | Vss | B20 |
| A22 | AH36 | D18 | A33 | DP3 | D18 | *Reserved* | J33 | Vcc | G37 | Vss | B22 |
| A23 | AE33 | D19 | D28 | DP4 | C7 | *Reserved* | Q3 | Vcc | J1 | Vss | B24 |
| A24 | AG35 | D20 | B30 | DP5 | F6 | *Reserved* | R4 | Vcc | J37 | Vss | B26 |
| A25 | AJ35 | D21 | C29 | DP6 | F2 | *Reserved* | S3 | Vcc | L1 | Vss | B28 |
| A26 | AH34 | D22 | A31 | DP7 | N5 | *Reserved* | S33 | Vcc | L33 | Vss | H2 |
| A27 | AG33 | D23 | D26 | EADS# | AM4 | *Reserved* | W35 | Vcc | L37 | Vss | H36 |
| A28 | AK36 | D24 | C27 | EWBE# | W3 | *Reserved* | X34 | Vcc | N1 | Vss | K2 |
| A29 | AK34 | D25 | C23 | FERR# | Q5 | *Reserved* | Y35 | Vcc | N37 | Vss | K36 |
| A30 | AM36 | D26 | D24 | FLUSH# | AN7 | SMI# | AB34 | Vcc | Q1 | Vss | M2 |
| A31 | AJ33 | D27 | C21 | HIT# | AK6 | SMIACT# | AG3 | Vcc | Q37 | Vss | M36 |
| ADS# | AJ5 | D28 | D22 | HITM# | AL5 | SUSP# | V34 | Vcc | S1 | Vss | P2 |
| ADSC# | AM2 | D29 | C19 | HLDA | AJ3 | SUSPA# | W33 | Vcc | S37 | Vss | P36 |
| AHOLD | V4 | D30 | D20 | HOLD | AB4 | TCK | M34 | Vcc | T34 | Vss | R2 |
| AP | AK2 | D31 | C17 | IGNNE# | AA35 | TDI | N35 | Vcc | U1 | Vss | R36 |
| APCHK# | AE5 | D32 | C15 | INTR | AD34 | TDO | N33 | Vcc | U33 | Vss | T2 |
| BE0# | AL9 | D33 | D16 | INV | U5 | TMS | P34 | Vcc | U37 | Vss | T36 |
| BE1# | AK10 | D34 | C13 | KEN# | W5 | TRST# | Q33 | Vcc | W1 | Vss | U35 |
| BE2# | AL11 | D35 | D14 | LBA# | S5 | Vcc | A7 | Vcc | W37 | Vss | V2 |
| BE3# | AK12 | D36 | C11 | LOCK# | AH4 | Vcc | A9 | Vcc | Y1 | Vss | V36 |
| BE4# | AL13 | D37 | D12 | MI/O# | T4 | Vcc | A11 | Vcc | Y37 | Vss | X2 |
| BE5# | AK14 | D38 | C9 | NA# | Y5 | Vcc | A13 | Vss | AB2 | Vss | X36 |
| BE6# | AL15 | D39 | D10 | NC | A3 | Vcc | A15 | Vss | AB36 | Vss | Z2 |
| BE7# | AK16 | D40 | D8 | NC | A37 | Vcc | A17 | Vss | AD2 | Vss | Z36 |
| BHOLD | R34 | D41 | A5 | NC | AC35 | Vcc | A19 | Vss | AD36 | WB/WT# | AA5 |
| BOFF# | Z4 | D42 | E9 | NC | AC5 | Vcc | A21 | Vss | AF2 | W/R# | AM6 |
| BRDY# | X4 | D43 | B4 | NC | AD4 | Vcc | A23 | Vss | AF36 | WM_RST | AA33 |
| BRDYC# | Y3 | D44 | D6 | NC | AE3 | Vcc | A25 | Vss | AH2 | | |
| BREQ | AJ1 | D45 | C5 | NC | AE35 | Vcc | A27 | Vss | AJ37 | | |
| CACHE# | U3 | D46 | E7 | NC | AL1 | Vcc | A29 | Vss | AL37 | | |
| CLK | AK18 | D47 | C3 | NC | AN1 | Vcc | AA1 | Vss | AM10 | | |

Note: *Reserved* pins are reserved for future use by IBM only. Pins marked NC are not internally connected.

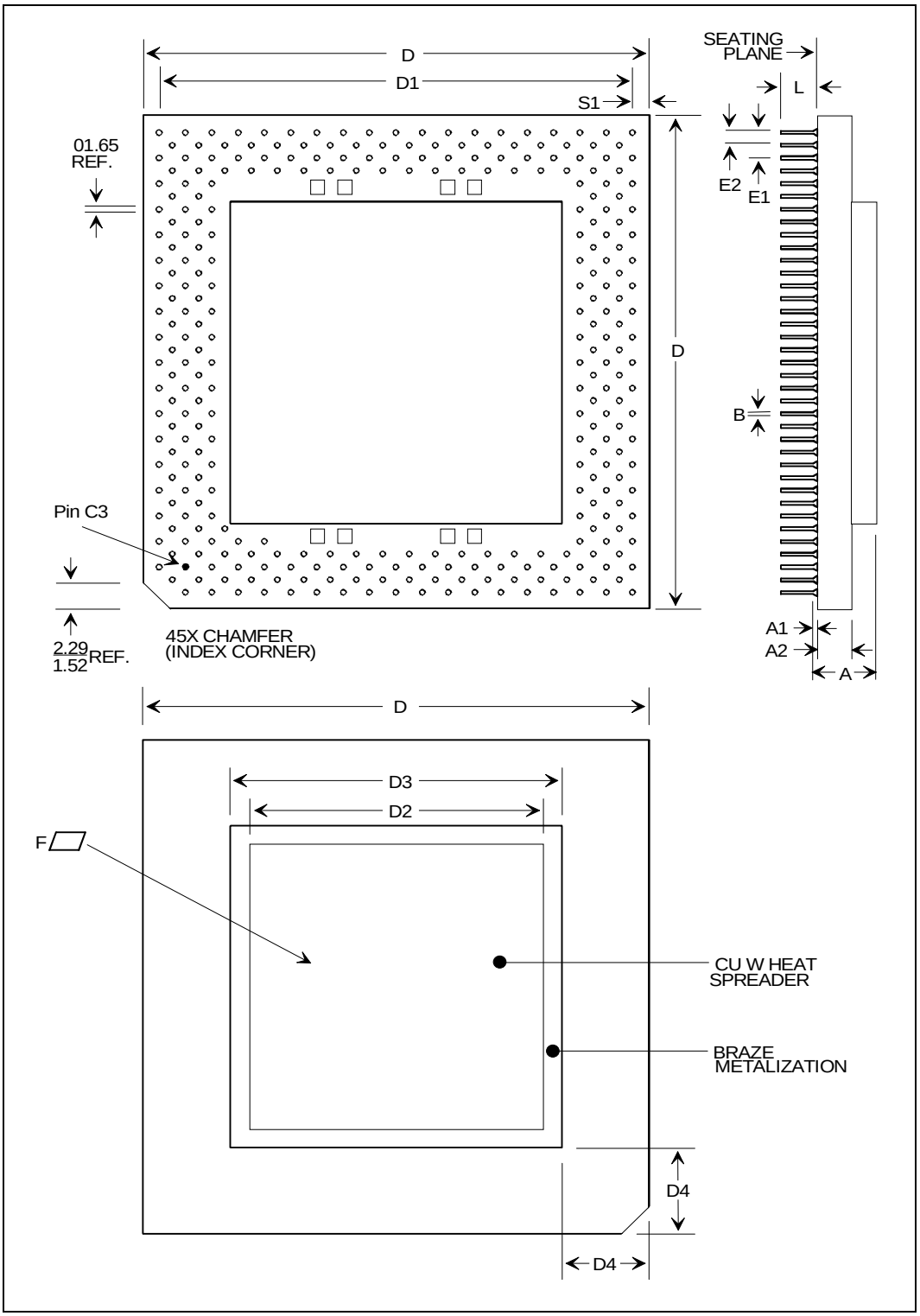


**Figure 5-2. 296-Pin SPGA Package**

**Table 5-3. 296-Pin SPGA Package Dimensions**

| SYMBOL | MILLIMETERS | |
|---|---|---|
| | MIN | MAX |
| A | 3.00 | 4.20 |
| A1 | 0.63 | 1.04 |
| A2 | 2.51 | 3.10 |
| B | 0.43 | 0.51 |
| D | 49.28 | 49.91 |
| D1 | 45.47 | 45.97 |
| D2 | 31.50 Sq. | 32.00 Sq. |
| D3 | 33.91 | 36.49 |
| D4 | 6.39 | 8.00 |
| E1 | 2.41 | 2.67 |
| E2 | 1.14 | 1.40 |
| F | 0.05 Diag. | 0.08 Diag. |
| L | 3.05 | 3.30 |
| N | 296 (Pin Count) | |
| S1 | 1.47 | 2.39 |

## 5.2 Thermal Characteristics

The IBM 6x86 processor is designed to operate when the case temperature at the top center of the package is between 0°C and 70°C. The maximum die (junction) temperature, $T_{J\,MAX}$, and the maximum ambient temperature, $T_{A\,MAX}$, can be calculated by substituting thermal resistance and maximum values for case or junction temperature and power dissipation in the following equations:

$$T_J = T_C + (P * \theta_{JC})$$
$$T_A = T_J - (P * \theta_{JA})$$

where:

- $T_A$ = Ambient temperature (°C)
- $T_J$ = Average junction temperature (°C)
- $T_C$ = Case temperature at top center of package (°C)
- P = Power dissipation (W)
- $\theta_{JC}$ = Junction-to-case thermal resistance (°C/W)
- $\theta_{JA}$ = Junction-to-ambient thermal resistance (°C/W).

Table 5-4 lists the junction-to-case and case-to-ambient thermal resistances for the SPGA package.

**Table 5-4. Thermal Resistances for SPGA Package With and Without Heatsinks**

| Thermal Resistance | $\theta_{JC}$ °C/W | $\theta_{CA}$ °C/W | | | | | |
|---|---|---|---|---|---|---|---|
| Laminar Air Flow (ft/min) | 0 | 0 | 100 | 200 | 400 | 600 | 800 |
| 1.95 x 1.95 x 0.25 Heatsink | 0.9 | 8.4 | 7.4 | 6.0 | 4.0 | 3.1 | 2.6 |
| 1.95 x 1.95 x 0.40 Heatsink | 0.9 | 7.7 | 6.6 | 4.9 | 3.2 | 2.7 | 2.1 |
| 1.95 x 1.95 x 0.65 Heatsink | 0.9 | 5.9 | 4.7 | 3.2 | 2.1 | 1.7 | 1.4 |
| Without Heatsink | 1.4 | 14.7 | 11.5 | 9.1 | 7.3 | 7.0 | 6.2 |

Notes:
For a 6x86 processor with 1.25 x 1.25 x 0.40 inch CuW heat spreader.
Heatsinks are omni-directional pin aluminum alloy.
Features are based on standard extrusion practices for a given height.
Heatsink attachment was made with 0.006 inch of thermal grease applied between heatsink and case.
Maximum air temperature is assumed to be 40 °C

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Printed in the United States of America
2-96



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