# Altera Device Package Information Data Sheet

DS-PKG-15.7

## Introduction

This data sheet provides package information about Altera® devices, and includes the following sections:

- Device and Package Cross Reference
- Thermal Resistance (starting on page 19)
- Package Outlines (starting on page 45)

In this data sheet, packages are listed in order of ascending pin count.

## Device and Package Cross Reference

Table 2 through Table 25 show the devices available in Ball-Grid Array (BGA), FineLine BGA (FBGA), Ultra FineLine BGA (UBGA), Micro FineLine BGA (MBGA), Pin-Grid Array (PGA), Plastic J-Lead Chip Carrier (PLCC), Thin Quad Flat Pack (TQFP), Plastic Quad Flat Pack (PQFP), Ceramic Dual In-Line Package (CerDIP), and Hybrid FineLine BGA (HBGA):

- Arria® series FPGAs
- Stratix® series FPGAs
- Cyclone® series FPGAs
- MAX® series CPLDs
- HardCopy® series ASICs
- APEX™ series FPGAs
- ACEX® 1K FPGAs
- Mercury™ FPGAs
- FLEX® series FPGAs
- Excalibur™ FPGA
- Enhanced configuration devices

**Table 1.** Arria II GX Devices

| Device | Package | Pins |
|---|---|---|
| EP2AGX20 | FBGA, Flip Chip | 358 |
| | FBGA, Flip Chip | 572 |
| EP2AGX30 | FBGA, Flip Chip | 358 |
| | FBGA, Flip Chip | 572 |
| EP2AGX45 | FBGA, Flip Chip | 358 |
| | FBGA, Flip Chip | 572 |
| | FBGA, Flip Chip | 780 |
| EP2AGX65 | FBGA, Flip Chip | 358 |
| | FBGA, Flip Chip | 572 |
| | FBGA, Flip Chip | 780 |
| EP2AGX95 | FBGA, Flip Chip | 572 |
| | FBGA, Flip Chip | 780 |
| | FBGA, Flip Chip | 1152 |
| EP2AGX125 | FBGA, Flip Chip | 572 |
| | FBGA, Flip Chip | 780 |
| | FBGA, Flip Chip | 1152 |
| EP2AGX190 | FBGA, Flip Chip | 780 |
| | FBGA, Flip Chip | 1152 |
| EP2AGX260 | FBGA, Flip Chip | 780 |
| | FBGA, Flip Chip | 1152 |

**Table 2.** Arria GX Devices

| Device | Package | Pins |
|---|---|---|
| EP1AGX20 | FBGA, Flip Chip | 484 |
| | FBGA, Flip Chip | 780 |
| EP1AGX35 | FBGA, Flip Chip | 484 |
| | FBGA, Flip Chip | 780 |
| EP1AGX50 | FBGA, Flip Chip | 484 |
| | FBGA, Flip Chip | 780 |
| | FBGA, Flip Chip | 1,152 |
| EP1AGX60 | FBGA, Flip Chip | 484 |
| | FBGA, Flip Chip | 780 |
| | FBGA, Flip Chip | 1,152 |
| EP1AGX90 | FBGA, Flip Chip | 1,152 |

**Table 3.** Stratix IV Devices (Part 1 of 2)

| Device | Package | Pins |
|---|---|---|
| EP4SGX70 | FBGA, Flip Chip | 780 |
| | FBGA, Flip Chip | 1,152 |
| EP4SGX110 | FBGA, Flip Chip | 780 |
| | FBGA, Flip Chip | 1,152 |
| EP4SGX180 | FBGA, Flip Chip | 780 |
| | FBGA, Flip Chip | 1,152 |
| | FBGA, Flip Chip | 1,517 |
| EP4SGX230 | FBGA, Flip Chip | 780 |
| | FBGA, Flip Chip | 1,152 |
| | FBGA, Flip Chip | 1,517 |
| EP4SGX290 | 33 MM SQ HBGA, Flip Chip | 780 |
| | FBGA, Flip Chip | 1,152 |
| | FBGA, Flip Chip | 1,517 |
| EP4SGX360 | 33 MM SQ HBGA, Flip Chip | 780 |
| | FBGA, Flip Chip | 1,152 |
| | FBGA, Flip Chip | 1,517 |
| EP4SGX530 | 42.5 MM SQ HBGA, Flip Chip | 1,152 |
| | 42.5 MM SQ HBGA, Flip Chip | 1,517 |
| | FBGA, Flip Chip | 1,932 |
| EP4SE110 | FBGA, Flip Chip | 780 |
| EP4SE230 | FBGA, Flip Chip | 780 |
| EP4SE290 | 33 MM SQ HBGA, Flip Chip | 780 |
| | FBGA, Flip Chip | 1,152 |
| | FBGA, Flip Chip | 1,517 |

**Table 3.** Stratix IV Devices (Part 2 of 2)

| Device | Package | Pins |
|---|---|---|
| EP4SE360 | 33 MM SQ HBGA, Flip Chip | 780 |
| | FBGA, Flip Chip | 1,152 |
| | FBGA, Flip Chip | 1,517 |
| EP4SE530 | 42.5 MM SQ HBGA, Flip Chip | 1,152 |
| | 42.5 MM SQ HBGA, Flip Chip | 1,517 |
| | FBGA, Flip Chip | 1,760 |
| EP4SE680 | 40 MM SQ HBGA, Flip Chip | 1,152 |
| | FBGA, Flip Chip | 1,517 |
| | FBGA, Flip Chip | 1,760 |

**Table 4.** Stratix III Devices

| Device | Package | Pins |
|---|---|---|
| EP3SL50 | FBGA, Flip Chip | 484 |
| | FBGA, Flip Chip | 780 |
| EP3SL70 | FBGA, Flip Chip | 484 |
| | FBGA, Flip Chip | 780 |
| EP3SL110 | FBGA, Flip Chip | 780 |
| | FBGA, Flip Chip | 1,152 |
| EP3SL150 | FBGA, Flip Chip | 780 |
| | FBGA, Flip Chip | 1,152 |
| EP3SL200 | HBGA, Flip Chip | 780 |
| | FBGA, Flip Chip | 1,152 |
| | FBGA, Flip Chip | 1,517 |
| EP3SL340 | HBGA, Flip Chip | 1,152 |
| | FBGA, Flip Chip | 1,517 |
| | FBGA, Flip Chip | 1,760 |
| EP3SE50 | FBGA, Flip Chip | 484 |
| | FBGA, Flip Chip | 780 |
| EP3SE80 | FBGA, Flip Chip | 780 |
| | FBGA, Flip Chip | 1,152 |
| EP3SE110 | FBGA, Flip Chip | 780 |
| | FBGA, Flip Chip | 1,152 |
| EP3SE260 | HBGA, Flip Chip | 780 |
| | FBGA, Flip Chip | 1,152 |
| | FBGA, Flip Chip | 1,517 |

**Table 5.** Stratix II Devices

| Device | Package | Pins |
|---|---|---|
| EP2S15 | FBGA, Flip Chip | 484 |
| | FBGA, Flip Chip | 672 |
| EP2S30 | FBGA, Flip Chip | 484 |
| | FBGA, Flip Chip | 672 |
| EP2S60 | FBGA, Flip Chip | 484 |
| | FBGA, Flip Chip | 672 |
| | FBGA, Flip Chip | 1,020 |
| EP2S90 | HBGA, Flip Chip | 484 |
| | FBGA, Flip Chip | 780 |
| | FBGA, Flip Chip | 1,020 |
| | FBGA, Flip Chip | 1,508 |
| EP2S130 | FBGA, Flip Chip | 780 |
| | FBGA, Flip Chip | 1,020 |
| | FBGA, Flip Chip | 1,508 |
| EP2S180 | FBGA, Flip Chip | 1,020 |
| | FBGA, Flip Chip | 1,508 |

**Table 6.** Stratix II GX Devices

| Device | Package | Pins |
|---|---|---|
| EP2SGX30 | FBGA, Flip Chip | 780 |
| EP2SGX60 | FBGA, Flip Chip | 780 |
| | FBGA, Flip Chip | 1,152 |
| EP2SGX90 | FBGA, Flip Chip | 1,152 |
| | FBGA, Flip Chip | 1,508 |
| EP2SGX130 | FBGA, Flip Chip | 1,508 |

**Table 7.** Stratix GX Devices

| Device | Package | Pins |
|---|---|---|
| EP1SGX10 | FBGA, Flip Chip | 672 |
| EP1SGX25 | FBGA, Flip Chip | 672 |
| | FBGA, Flip Chip | 1,020 |
| EP1SGX40 | FBGA, Flip Chip | 1,020 |

**Table 8.** Stratix Devices

| Device | Package | Pins |
|---|---|---|
| EP1S10 | FBGA, Flip Chip | 484 |
| | BGA, Wire Bond | 672 |
| | FBGA, Wire Bond (Option 2) | 672 |
| | FBGA, Flip Chip | 780 |
| EP1S20 | FBGA, Flip Chip | 484 |
| | BGA, Wire Bond | 672 |
| | FBGA, Wire Bond (Option 2) | 672 |
| | FBGA, Flip Chip | 780 |
| EP1S25 | BGA, Wire Bond | 672 |
| | FBGA, Wire Bond (Option 2) | 672 |
| | FBGA, Flip Chip | 780 |
| | FBGA, Flip Chip | 1,020 |
| EP1S30 | FBGA, Flip Chip | 780 |
| | BGA, Flip Chip | 956 |
| | FBGA, Flip Chip | 1,020 |
| EP1S40 | BGA, Flip Chip | 956 |
| | FBGA, Flip Chip | 780 |
| | FBGA, Flip Chip | 1,020 |
| | FBGA, Flip Chip | 1,508 |
| EP1S60 | BGA, Flip Chip | 956 |
| | FBGA, Flip Chip | 1,020 |
| | FBGA, Flip Chip | 1,508 |
| EP1S80 | BGA, Flip Chip | 956 |
| | FBGA, Flip Chip | 1,020 |
| | FBGA, Flip Chip | 1,508 |

**Table 9.** Cyclone III LS Devices

| Device | Package | Pins |
|---|---|---|
| EP3CLS70 | FBGA, Wire Bond (Option 2) | 484 |
| | UBGA, Wire Bond | 484 |
| | FBGA, Wire Bond (Option 2) | 780 |
| EP3CLS100 | FBGA, Wire Bond (Option 2) | 484 |
| | UBGA, Wire Bond | 484 |
| | FBGA, Wire Bond (Option2) | 780 |
| EP3CLS150 | FBGA, Wire Bond (Option 2) | 484 |
| | FBGA, Wire Bond (Option 2) | 780 |
| EP3CLS200 | FBGA, Wire Bond (Option 2) | 484 |
| | FBGA, Wire Bond (Option 2) | 780 |

**Table 10.** Cyclone III Devices

| Device | Package *(2)* | Pins |
|---|---|---|
| EP3C5 | EQFP, Wire Bond | 144 *(1)* |
| | MBGA, Wire Bond | 164 |
| | FBGA, Wire Bond (Option 2) | 256 |
| | UBGA, Wire Bond | 256 |
| EP3C10 | EQFP, Wire Bond | 144 *(1)* |
| | MBGA, Wire Bond | 164 |
| | FBGA, Wire Bond (Option2) | 256 |
| | UBGA, Wire Bond | 256 |
| EP3C16 | EQFP, Wire Bond | 144 *(1)* |
| | MBGA, Wire Bond | 164 |
| | PQFP, Wire Bond | 240 |
| | FBGA, Wire Bond (Option 2) | 256 |
| | UBGA, Wire Bond | 256 |
| | FBGA, Wire Bond (Option 3) | 484 |
| | UBGA, Wire Bond | 484 |
| EP3C25 | EQFP, Wire Bond | 144 *(1)* |
| | PQFP, Wire Bond | 240 |
| | FBGA, Wire Bond (Option 2) | 256 |
| | UBGA, Wire Bond | 256 |
| | FBGA, Wire Bond | 324 |
| EP3C40 | PQFP, Wire Bond | 240 |
| | FBGA, Wire Bond | 324 |
| | FBGA, Wire Bond (Option 3) | 484 |
| | UBGA, Wire Bond | 484 |
| | FBGA, Wire Bond (Option 2) | 780 |
| EP3C55 | FBGA, Wire Bond (Option 3) | 484 |
| | UBGA, Wire Bond | 484 |
| | FBGA, Wire Bond (Option 2) | 780 |
| EP3C80 | FBGA, Wire Bond (Option 3) | 484 |
| | UBGA, Wire Bond | 484 |
| | FBGA, Wire Bond (Option 2) | 780 |
| EP3C120 | FBGA, Wire Bond (Option 3) | 484 |
| | FBGA, Wire Bond (Option 2) | 780 |

**Notes to Table 10:**

(1) The E144 package has an exposed pad at the bottom of the package. This exposed ground pad must be connected to the ground plane on your PCB. This exposed pad is used for electrical connectivity and not for thermal purposes.

(2) The package type entries with "Option #" refer to instances where multiple package options exist for a given package type and pin count. The Option number identifies the specific type used by the corresponding device density.

**Table 11.** Cyclone II Devices

| Device | Package | Pins |
|---|---|---|
| EP2C5 | TQFP, Wire Bond | 144 |
| | PQFP, Wire Bond | 208 |
| | FBGA, Wire Bond (Option 2) | 256 |
| EP2C8 | TQFP, Wire Bond | 144 |
| | PQFP, Wire Bond | 208 |
| | FBGA, Wire Bond (Option 2) | 256 |
| EP2C15 | FBGA, Wire Bond (Option 2) | 256 |
| | FBGA, Wire Bond (Option 3) | 484 |
| EP2C20 | PQFP, Wire Bond | 240 |
| | FBGA, Wire Bond (Option 2) | 256 |
| | FBGA, Wire Bond (Option 3) | 484 |
| EP2C35 | FBGA, Wire Bond (Option 3) | 484 |
| | UBGA, Wire Bond | 484 |
| | FBGA, Wire Bond (Option 3) | 672 |
| EP2C50 | FBGA, Wire Bond (Option 3) | 484 |
| | UBGA, Wire Bond | 484 |
| | FBGA, Wire Bond (Option 3) | 672 |
| EP2C70 | FBGA, Wire Bond (Option 3) | 672 |
| | FBGA, Wire Bond | 896 |

**Table 12.** Cyclone Devices

| Device | Package | Pins |
|---|---|---|
| EP1C3 | TQFP, Wire Bond | 100 |
| | TQFP, Wire Bond | 144 |
| EP1C4 | FBGA, Wire Bond | 324 |
| | FBGA, Wire Bond | 400 |
| EP1C6 | TQFP, Wire Bond | 144 |
| | PQFP, Wire Bond | 240 |
| | FBGA, Wire Bond (Option 1) | 256 |
| EP1C12 | PQFP, Wire Bond | 240 |
| | FBGA, Wire Bond (Option 1) | 256 |
| | FBGA, Wire Bond | 324 |
| EP1C20 | FBGA, Wire Bond | 324 |
| | FBGA, Wire Bond | 400 |

**Table 13.** MAX Series Devices (Part 1 of 3)

| Device | Package | Pins |
|---|---|---|
| **MAX II Devices** | | |
| EPM240 | TQFP, Wire Bond | 100 |
| | FBGA, Wire Bond (Option 2) | 100 |
| | MBGA, Wire Bond | 100 |
| EPM570 | TQFP, Wire Bond | 100 |
| | MBGA, Wire Bond | 100 |
| | FBGA, Wire Bond (Option 2) | 100 |
| | TQFP, Wire Bond | 144 |
| | FBGA, Wire Bond (Option 1) | 256 |
| | MBGA, Wire Bond | 256 |
| EPM1270 | TQFP, Wire Bond | 144 |
| | FBGA, Wire Bond (Option 1) | 256 |
| | MBGA, Wire Bond | 256 |
| EPM2210 | FBGA, Wire Bond (Option 1) | 256 |
| | FBGA, Wire Bond | 324 |
| **MAX 9000 Devices** | | |
| EPM9320 | BGA, Wire Bond | 356 |
| EPM9320A | BGA, Wire Bond | 356 |
| EPM9560 | BGA, Wire Bond | 356 |
| **MAX 7000B Devices** | | |
| EPM7032B | PLCC, Wire Bond | 44 |
| | TQFP, Wire Bond | 44 |
| | UBGA, Wire Bond | 49 |
| EPM7064B | TQFP, Wire Bond | 44 |
| | UBGA, Wire Bond | 49 |
| | FBGA, Wire Bond | 100 |
| | TQFP, Wire Bond | 100 |
| EPM7128B | UBGA, Wire Bond | 49 |
| | TQFP, Wire Bond | 100 |
| | FBGA, Wire Bond | 100 |
| | TQFP, Wire Bond | 144 |
| | UBGA, Wire Bond | 169 |
| | FBGA, Wire Bond (Option 1) | 256 |
| EPM7256B | TQFP, Wire Bond | 100 |
| | TQFP, Wire Bond | 144 |
| | UBGA, Wire Bond | 169 |
| | PQFP, Wire Bond | 208 |
| | FBGA, Wire Bond (Option 1) | 256 |

**Table 13.** MAX Series Devices (Part 2 of 3)

| Device | Package | Pins |
|---|---|---|
| EPM7512B | TQFP, Wire Bond | 144 |
| | UBGA, Wire Bond | 169 |
| | PQFP, Wire Bond | 208 |
| | FBGA, Wire Bond (Option 1) | 256 |
| | BGA, Wire Bond (Option 1) | 256 |
| **MAX 7000AE Devices** | | |
| EPM7032AE | PLCC, Wire Bond | 44 |
| | TQFP, Wire Bond | 44 |
| EPM7064AE | PLCC, Wire Bond | 44 |
| | TQFP, Wire Bond | 100 |
| | TQFP, Wire Bond | 144 |
| | UBGA, Wire Bond | 49 |
| | FBGA, Wire Bond | 100 |
| | FBGA, Wire Bond (Option 1) | 256 |
| EPM7128AE | PLCC, Wire Bond | 84 |
| | TQFP, Wire Bond | 100 |
| | FBGA, Wire Bond | 100 |
| | UBGA, Wire Bond | 169 |
| | TQFP, Wire Bond | 144 |
| | FBGA, Wire Bond (Option 1) | 256 |
| EPM7256AE | TQFP, Wire Bond | 100 |
| | FBGA, Wire Bond | 100 |
| | TQFP, Wire Bond | 144 |
| | PQFP, Wire Bond | 208 |
| | FBGA, Wire Bond (Option 1) | 256 |
| EPM7512AE | TQFP, Wire Bond | 144 |
| | PQFP, Wire Bond | 208 |
| | BGA, Wire Bond (Option 1) | 256 |
| | FBGA, Wire Bond (Option 1) | 256 |
| **MAX 7000A Devices** | | |
| EPM7032A | PLCC, Wire Bond | 44 |
| | TQFP, Wire Bond | 44 |
| EPM7128A | PLCC, Wire Bond | 84 |
| | TQFP, Wire Bond | 100 |
| | FBGA, Wire Bond | 100 |
| | TQFP, Wire Bond | 144 |
| | FBGA, Wire Bond (Option 1) | 256 |

**Table 13.** MAX Series Devices (Part 3 of 3)

| Device | Package | Pins |
|---|---|---|
| EPM7256A | TQFP, Wire Bond | 100 |
| | TQFP, Wire Bond | 144 |
| | PQFP, Wire Bond | 208 |
| | FBGA, Wire Bond (Option 1) | 256 |

**Table 14.** HardCopy IV E Devices

| Device | Package | Pins |
|---|---|---|
| HC4E25WF484 | FBGA, Wire Bond | 484 |
| HC4E25FF484 | FBGA, Flip Chip | 484 |
| HC4E25WF780 | FBGA, Wire Bond | 780 |
| HC4E25FF780 | FBGA, Flip Chip | 780 |
| HC4E35LF1152 | FBGA, Flip Chip | 1,152 |
| HC4E35FF1152 | FBGA, Flip Chip | 1,152 |
| HC4E35LF1517 | FBGA, Flip Chip | 1,517 |
| HC4E35FF1517 | FBGA, Flip Chip | 1,517 |

**Table 15.** HardCopy IV GX Devices

| Device | Package | Pins |
|---|---|---|
| HC4GX15LF780 | FBGA, Flip Chip | 780 |
| HC4GX15LAF780X | FBGA, Flip Chip | 780 |
| HC4GX25LF780 | FBGA, Flip Chip | 780 |
| HC4GX25LF1152 | FBGA, Flip Chip | 1,152 |
| HC4GX25FF1152 | FBGA, Flip Chip | 1,152 |
| HC4GX35FF1152 | FBGA, Flip Chip | 1,152 |
| HC4GX35FF1517 | FBGA, Flip Chip | 1,517 |

**Table 16.** HardCopy III Devices

| Device | Package | Pins |
|---|---|---|
| HC315WF484 | FBGA, Wire Bond | 484 |
| HC325WF484 | FBGA, Wire Bond | 484 |
| HC325FF484 | FBGA, Flip Chip | 484 |
| HC325WF780 | FBGA, Wire Bond | 780 |
| HC325FF780 | FBGA, Flip Chip | 780 |
| HC335LF1152 | FBGA, Flip Chip | 1, 152 |
| HC335FF1152 | FBGA, Flip Chip | 1,152 |
| HC335LF1517 | FBGA, Flip Chip | 1,157 |
| HC335FF1517 | FBGA, Flip Chip | 1,157 |

**Table 17.** HardCopy II Devices

| Device | Package | Pins |
|---|---|---|
| HC210 | FBGA, Flip Chip | 484 |
| HC210W | FBGA, Wire Bond (Option 3) | 484 |
| HC220 | FBGA, Flip Chip | 672 |
| | FBGA, Flip Chip | 780 |
| HC230 | FBGA, Flip Chip | 1,020 |
| HC240 | FBGA, Flip Chip | 1,020 |
| | FBGA, Flip Chip | 1,508 |

**Table 18.** HardCopy Devices

| Device | Package | Pins |
|---|---|---|
| HC1S25 | FBGA, Wire Bond (Option 3) | 672 |
| | BGA, Wire Bond | 672 |
| HC1S30 | FBGA, Flip Chip | 780 |
| HC1S40 | FBGA, Flip Chip | 780 |
| HC1S60 | FBGA, Flip Chip | 1,020 |
| HC1S80 | FBGA, Flip Chip | 1,020 |

**Table 19.** HardCopy APEX Devices

| Device | Package | Pins |
|---|---|---|
| HC20K400 | BGA, Wire Bond (Option 3) | 652 |
| HC20K600 | BGA, Wire Bond (Option 3) | 652 |
| | FBGA, Flip Chip | 672 |

**Table 20.** APEX Series Devices (Part 1 of 3)

| Device | Package | Pins |
|---|---|---|
| **APEX II Devices** | | |
| EP2A15 | FBGA, Flip Chip | 672 |
| | BGA, Flip Chip | 724 |
| EP2A25 | FBGA, Flip Chip | 672 |
| | BGA, Flip Chip | 724 |
| | FBGA, Flip Chip | 1,020 |
| EP2A40 | FBGA, Flip Chip | 672 |
| | BGA, Flip Chip | 724 |
| | FBGA, Flip Chip | 1,020 |
| EP2A70 | BGA, Flip Chip | 724 |
| | FBGA, Flip Chip | 1,508 |

**Table 20.** APEX Series Devices (Part 2 of 3)

| Device | Package | Pins |
|---|---|---|
| **APEX 20KE Devices** | | |
| EP20K30E | TQFP, Wire Bond | 144 |
| | FBGA, Wire Bond | 144 |
| | PQFP, Wire Bond | 208 |
| | FBGA, Wire Bond | 324 |
| EP20K60E | TQFP, Wire Bond | 144 |
| | FBGA, Wire Bond | 144 |
| | PQFP, Wire Bond | 208 |
| | PQFP, Wire Bond | 240 |
| | FBGA, Wire Bond | 324 |
| | BGA, Wire Bond | 356 |
| EP20K100E | TQFP, Wire Bond | 144 |
| | FBGA, Wire Bond | 144 |
| | PQFP, Wire Bond | 208 |
| | PQFP, Wire Bond | 240 |
| | FBGA, Wire Bond | 324 |
| | BGA, Wire Bond | 356 |
| EP20K160E | TQFP, Wire Bond | 144 |
| | PQFP, Wire Bond | 208 |
| | PQFP, Wire Bond | 240 |
| | BGA, Wire Bond | 356 |
| | FBGA, Wire Bond (Option 2) | 484 |
| EP20K200E | PQFP, Wire Bond | 208 |
| | PQFP, Wire Bond | 240 |
| | BGA, Wire Bond | 356 |
| | FBGA, Wire Bond (Option 2) | 484 |
| | BGA, Wire Bond (Option 2) | 652 |
| | FBGA, Wire Bond (Option 2) | 672 |
| EP20K300E | PQFP, Wire Bond | 240 |
| | BGA, Wire Bond (Option 2) | 652 |
| | FBGA, Wire Bond (Option 2) | 672 |
| EP20K400E | BGA, Wire Bond (Option 3) | 652 |
| | FBGA, Flip Chip | 672 |
| EP20K600E | BGA, Wire Bond (Option 3) | 652 |
| | FBGA, Flip Chip | 672 |
| | FBGA, Flip Chip | 1,020 |
| EP20K1000E | BGA, Flip Chip | 652 |
| | FBGA, Flip Chip | 672 |
| | FBGA, Flip Chip | 1,020 |

**Table 20.** APEX Series Devices (Part 3 of 3)

| Device | Package | Pins |
|---|---|---|
| EP20K1500E | BGA, Flip Chip | 652 |
| | FBGA, Flip Chip | 1,020 |
| **APEX 20KC Devices** | | |
| EP20K200C | PQFP, Wire Bond | 208 |
| | PQFP, Wire Bond | 240 |
| | BGA, Wire Bond | 356 |
| | FBGA, Wire Bond (Option 2) | 484 |
| EP20K400C | BGA, Wire Bond (Option 3) | 652 |
| | FBGA, Flip Chip | 672 |
| EP20K600C | BGA, Wire Bond (Option 3) | 652 |
| | FBGA, Flip Chip | 672 |
| | FBGA, Flip Chip | 1,020 |
| EP20K1000C | BGA, Flip Chip | 652 |
| | FBGA, Flip Chip | 672 |
| | FBGA, Flip Chip | 1,020 |
| **APEX 20K Devices** | | |
| EP20K100 | TQFP, Wire Bond | 144 |
| | PQFP, Wire Bond | 208 |
| | PQFP, Wire Bond | 240 |
| | FBGA, Wire Bond | 324 |
| | BGA, Wire Bond | 356 |
| EP20K160 | PQFP, Wire Bond | 240 |
| | TQFP, Wire Bond | 144 |
| EP20K200 | PQFP, Wire Bond | 208 |
| | PQFP, Wire Bond | 240 |
| | BGA, Wire Bond | 356 |
| | FBGA, Wire Bond (Option 2) | 484 |
| EP20K300 | FBGA, Wire Bond (Option 2) | 672 |
| EP20K400 | BGA, Wire Bond (Option 3) | 652 |
| | PGA, Wire Bond | 655 |
| | FBGA, Flip Chip | 672 |

**Table 21.** ACEX 1K Devices (Part 1 of 2)

| Device | Package | Pins |
|---|---|---|
| EP1K10 | TQFP, Wire Bond | 100 |
| | TQFP, Wire Bond | 144 |
| | PQFP, Wire Bond | 208 |
| | FBGA, Wire Bond (Option 1) | 256 |

**Table 21.** ACEX 1K Devices (Part 2 of 2)

| Device | Package | Pins |
|---|---|---|
| EP1K30 | TQFP, Wire Bond | 144 |
| | PQFP, Wire Bond | 208 |
| | FBGA, Wire Bond (Option 1) | 256 |
| EP1K50 | TQFP, Wire Bond | 144 |
| | PQFP, Wire Bond | 208 |
| | FBGA, Wire Bond (Option 1) | 256 |
| | FBGA, Wire Bond (Option 2) | 484 |
| EP1K100 | PQFP, Wire Bond | 208 |
| | FBGA, Wire Bond (Option 1) | 256 |
| | FBGA, Wire Bond (Option 2) | 484 |

**Table 22.** Mercury Devices

| Device | Package | Pins |
|---|---|---|
| EP1M120 | FBGA, Flip Chip | 484 |
| EP1M350 | FBGA, Flip Chip | 780 |

**Table 23.** FLEX Series Devices (Part 1 of 4)

| Device | Package | Pins |
|---|---|---|
| **FLEX 10KA Devices** | | |
| EPF10K10A | TQFP, Wire Bond | 100 |
| | TQFP, Wire Bond | 144 |
| | PQFP, Wire Bond | 208 |
| | FBGA, Wire Bond (Option 1) | 256 |
| EPF10K30A | TQFP, Wire Bond | 144 |
| | PQFP, Wire Bond | 208 |
| | PQFP, Wire Bond | 240 |
| | FBGA, Wire Bond (Option 1) | 256 |
| | BGA, Wire Bond | 356 |
| | FBGA, Wire Bond (Option 2) | 484 |
| EPF10K100A | RQFP, Wire Bond | 240 |
| | BGA, Wire Bond | 356 |
| | FBGA, Wire Bond (Option 2) | 484 |
| | BGA, Wire Bond | 600 |
| EPF10K250A | PGA, Wire Bond | 599 |
| | BGA, Wire Bond | 600 |

**Table 23.** FLEX Series Devices (Part 2 of 4)

| Device | Package | Pins |
|---|---|---|
| **FLEX 10KS Devices** | | |
| EPF10K50S | TQFP, Wire Bond | 144 |
| | PQFP, Wire Bond | 208 |
| | PQFP, Wire Bond | 240 |
| | FBGA, Wire Bond (Option 1) | 256 |
| | BGA, Wire Bond | 356 |
| | FBGA, Wire Bond (Option 2) | 484 |
| EPF10K200S | RQFP, Wire Bond | 240 |
| | BGA, Wire Bond | 356 |
| | FBGA, Wire Bond (Option 2) | 484 |
| | BGA, Wire Bond | 600 |
| | FBGA, Wire Bond (Option 2) | 672 |
| **FLEX 10KE Devices** | | |
| EPF10K30E | TQFP, Wire Bond | 144 |
| | PQFP, Wire Bond | 208 |
| | FBGA, Wire Bond (Option 1) | 256 |
| | FBGA, Wire Bond (Option 2) | 484 |
| EPF10K50E | TQFP, Wire Bond | 144 |
| | PQFP, Wire Bond | 208 |
| | PQFP, Wire Bond | 240 |
| | FBGA, Wire Bond (Option 1) | 256 |
| | BGA, Wire Bond | 356 |
| | FBGA, Wire Bond (Option 2) | 484 |
| EPF10K100E | PQFP, Wire Bond | 208 |
| | PQFP, Wire Bond | 240 |
| | FBGA, Wire Bond (Option 1) | 256 |
| | BGA, Wire Bond | 356 |
| | FBGA, Wire Bond (Option 2) | 484 |
| EPF10K130E | PQFP, Wire Bond | 240 |
| | BGA, Wire Bond | 356 |
| | FBGA, Wire Bond (Option 2) | 484 |
| | BGA, Wire Bond | 600 |
| | FBGA, Wire Bond (Option 2) | 672 |
| EPF10K200E | PGA, Wire Bond | 599 |
| | BGA, Wire Bond | 600 |
| | FBGA, Wire Bond (Option 2) | 672 |
| EPF10K10 | PLCC, Wire Bond | 84 |
| | TQFP, Wire Bond | 144 |
| | PQFP, Wire Bond | 208 |

**Table 23.** FLEX Series Devices (Part 3 of 4)

| Device | Package | Pins |
|---|---|---|
| EPF10K20 | TQFP, Wire Bond | 144 |
| | RQFP, Wire Bond | 208 |
| | RQFP, Wire Bond | 240 |
| EPF10K30 | RQFP, Wire Bond | 208 |
| | RQFP, Wire Bond | 240 |
| | BGA, Wire Bond | 356 |
| EPF10K40 | RQFP, Wire Bond | 208 |
| | RQFP, Wire Bond | 240 |
| EPF10K50 | RQFP, Wire Bond | 240 |
| | BGA, Wire Bond | 356 |
| | PGA, Wire Bond | 403 |
| EPF10K50V | RQFP, Wire Bond | 240 |
| | PQFP, Wire Bond | 240 |
| | BGA, Wire Bond | 356 |
| | FBGA, Wire Bond | 484 |
| EPF10K70 | RQFP, Wire Bond | 240 |
| | PGA, Wire Bond | 503 |
| EPF10K100 | PGA, Wire Bond | 503 |
| EPF10K130V | PGA, Wire Bond | 599 |
| | BGA, Wire Bond | 600 |
| EPF6010A | TQFP, Wire Bond | 100 |
| | TQFP, Wire Bond | 144 |
| | PQFP, Wire Bond | 208 |
| EPF6016 | TQFP, Wire Bond | 144 |
| | PQFP, Wire Bond | 208 |
| | PQFP, Wire Bond | 240 |
| | BGA, Wire Bond (Option 2) | 256 |
| EPF6016A | TQFP, Wire Bond | 100 |
| | FBGA, Wire Bond | 100 |
| | TQFP, Wire Bond | 144 |
| | PQFP, Wire Bond | 208 |
| | FBGA, Wire Bond (Option 1) | 256 |
| EPF6024A | TQFP, Wire Bond | 144 |
| | PQFP, Wire Bond | 208 |
| | PQFP, Wire Bond | 240 |
| | BGA, Wire Bond (Option 2) | 256 |
| | FBGA, Wire Bond (Option 1) | 256 |
| EPF8282A | PLCC, Wire Bond | 84 |
| | TQFP, Wire Bond | 100 |

**Table 23.** FLEX Series Devices (Part 4 of 4)

| Device | Package | Pins |
|---|---|---|
| EPF8452A | TQFP, Wire Bond | 100 |
| | PQFP, Wire Bond | 160 |

**Table 24.** Excalibur Devices

| Device | Package | Pins |
|---|---|---|
| EPXA1 | FBGA, Wire Bond (Option 2) | 484 |
| | FBGA, Flip Chip | 672 |
| EPXA4 | FBGA, Flip Chip | 672 |
| | FBGA, Flip Chip | 1,020 |
| EPXA10 | FBGA, Flip Chip | 1,020 |

**Table 25.** Enhanced Configuration Devices

| Device | Package | Pins |
|---|---|---|
| EPC1 | PDIP, Wire Bond | 8 |
| | PLCC, Wire Bond | 20 |
| EPC2 | PLCC, Wire Bond | 20 |
| | TQFP, Wire Bond | 32 |
| EPC4 | PLCC, Wire Bond | 44 |
| | TQFP, Wire Bond | 44 |
| | PQFP, Wire Bond | 100 |
| | FPGA, Wire Bond | 144 |
| EPC8 | PQFP, Wire Bond (Option 2) | 100 |
| EPC16 | UBGA, Wire Bond | 88 |
| | PQFP, Wire Bond (Option 2) | 100 |
| EPC32 | FPGA, Wire Bond | 88 |
| EPC1441 | PDIP, Wire Bond | 8 |
| | PLCC, Wire Bond | 20 |
| | TQFP, Wire Bond | 32 |

# Thermal Resistance

Table 26 through Table 54 provide $\theta_{JA}$ (junction-to-ambient thermal resistance) and $\theta_{JC}$ (junction-to-case thermal resistance) values for the following Altera device families:

- Arria series FPGAs
- Stratix series FPGAs
- Cyclone series FPGAs
- MAX series CPLDs
- HardCopy series ASICs
- APEX series FPGAs
- ACEX 1K FPGAs
- Mercury FPGAs
- FLEX series FPGAs
- Excalibur FPGA
- Classic devices

Altera is transitioning to an industry-standard copper lid for its thermally enhanced BGA and thermally enhanced Flip Chip FBGA package offerings (as mentioned in the *Process Change Notice PCN0214* available on Altera's website: http://www.altera.com/literature/pcn/pcn0214.pdf). This change affects the APEX 20KE, APEX 20KC, APEX II, Mercury, and Excalibur device families. Therefore, two thermal resistance specifications are provided for devices affected by this change. The older packages are identified as using the aluminum silicon carbide (AlSiC) lid, while the newer packages are identified as using the copper (Cu) lid.

Thermally enhanced BGA and thermally enhanced Flip Chip FBGA packages offered in the newer Altera families, including Stratix and Stratix GX, were introduced using an industry-standard Cu lid. Therefore, these device specifications include only a single thermal resistance specification.

Contact Altera if you need typical +/– values of A dimensions for thermal analysis. The max numbers are provided for physical layout.

## Arria Series Devices Thermal Resistance

Table 26 and Table 27 provide thermal resistance values for Arria series devices.

**Table 26.** Thermal Resistance of Arria II GX Devices

| Device | Pin Count | Package | $\theta_{JA}$ (° C/W) Still Air | $\theta_{JA}$ (° C/W) 100 ft./min. | $\theta_{JA}$ (° C/W) 200 ft./min. | $\theta_{JA}$ (° C/W) 400 ft./min. | $\theta_{JC}$ (° C/W) | $\theta_{JB}$ (° C/W) |
|---|---|---|---|---|---|---|---|---|
| EP2AGX20 | 358 | FBGA | 20.5 | 17.2 | 15.5 | 14.0 | 3.5 | 8.2 |
| | 572 | FBGA | 13.4 | 10.5 | 8.9 | 7.7 | 1.1 | 3.5 |
| EP2AGX30 | 358 | FBGA | 20.5 | 17.2 | 15.5 | 14.0 | 3.5 | 8.2 |
| | 572 | FBGA | 13.4 | 10.5 | 8.9 | 7.7 | 1.1 | 3.5 |
| EP2AGX45 | 358 | FBGA | 17.7 | 15.4 | 13.7 | 12.3 | 2.2 | 6.5 |
| | 572 | FBGA | 11.9 | 10.0 | 8.5 | 7.2 | 0.8 | 3.0 |
| | 780 | FBGA | 10.9 | 9.1 | 7.7 | 6.5 | 0.8 | 2.8 |
| EP2AGX65 | 358 | FBGA | 17.7 | 15.4 | 13.7 | 12.3 | 2.2 | 6.5 |
| | 572 | FBGA | 11.9 | 10.0 | 8.5 | 7.2 | 0.8 | 3.0 |
| | 780 | FBGA | 10.9 | 9.1 | 7.7 | 6.5 | 0.8 | 2.8 |
| EP2AGX95 | 572 | FBGA | 10.9 | 9.6 | 8.1 | 6.8 | 0.4 | 2.6 |
| | 780 | FBGA | 9.9 | 8.8 | 7.3 | 6.1 | 0.5 | 2.4 |
| | 1152 | FBGA | 9.0 | 8.0 | 6.6 | 5.5 | 0.5 | 2.4 |
| EP2AGX125 | 572 | FBGA | 10.9 | 9.6 | 8.1 | 6.8 | 0.4 | 2.6 |
| | 780 | FBGA | 9.9 | 8.8 | 7.3 | 6.1 | 0.5 | 2.4 |
| | 1152 | FBGA | 9.0 | 8.0 | 6.6 | 5.5 | 0.5 | 2.4 |
| EP2AGX190 | 780 | FBGA | 9.1 | 8.5 | 7.0 | 5.9 | 0.3 | 2.1 |
| | 1152 | FBGA | 8.1 | 7.7 | 6.3 | 5.2 | 0.4 | 2.1 |
| EP2AGX260 | 780 | FBGA | 9.1 | 8.5 | 7.0 | 5.9 | 0.3 | 2.1 |
| | 1152 | FBGA | 8.1 | 7.7 | 6.3 | 5.2 | 0.4 | 2.1 |

**Table 27.** Thermal Resistance of Arria GX Devices

| Device | Pin Count | Package | $\theta_{JA}$ (° C/W) Still Air | $\theta_{JA}$ (° C/W) 100 ft./min. | $\theta_{JA}$ (° C/W) 200 ft./min. | $\theta_{JA}$ (° C/W) 400 ft./min. | $\theta_{JC}$ (° C/W) | $\theta_{JB}$ (° C/W) |
|---|---|---|---|---|---|---|---|---|
| EP1AGX20 | 484 | FBGA | 12.8 | 10.3 | 8.7 | 7.5 | 0.3 | 3.1 |
| | 780 | FBGA | 11.1 | 8.6 | 7.2 | 6.0 | 0.2 | 3.1 |
| EP1AGX35 | 484 | FBGA | 12.8 | 10.3 | 8.7 | 7.5 | 0.3 | 3.1 |
| | 780 | FBGA | 11.1 | 8.6 | 7.2 | 6.0 | 0.2 | 3.1 |
| EP1AGX50 | 484 | FBGA | 12.7 | 10.2 | 8.6 | 7.3 | 0.2 | 2.9 |
| | 780 | FBGA | 10.9 | 8.4 | 6.9 | 5.8 | 0.2 | 2.9 |
| | 1152 | FBGA | 9.9 | 7.5 | 6.1 | 5.0 | 0.2 | 2.5 |
| EP1AGX60 | 484 | FBGA | 12.7 | 10.2 | 8.6 | 7.3 | 0.2 | 2.9 |
| | 780 | FBGA | 10.9 | 8.4 | 6.9 | 5.8 | 0.2 | 2.8 |
| | 1152 | FBGA | 9.9 | 7.5 | 6.1 | 5.0 | 0.2 | 2.5 |
| EP1AGX90 | 1152 | FBGA | 9.6 | 7.3 | 5.9 | 4.9 | 0.1 | 2.3 |

## Stratix Series Devices Thermal Resistance

Table 28 through Table 33 provide thermal resistance values for Stratix series devices.

**Table 28.** Thermal Resistance of Stratix IV Devices (Part 1 of 3)

| Device | Pin Count | Package | $\theta_{JA}$ (° C/W) Still Air | $\theta_{JA}$ (° C/W) 100 ft./min. | $\theta_{JA}$ (° C/W) 200 ft./min. | $\theta_{JA}$ (° C/W) 400 ft./min. | $\theta_{JC}$ (° C/W) | $\theta_{JB}$ (° C/W) |
|---|---|---|---|---|---|---|---|---|
| **JEDEC 2S2P Board without OPD and 8-Layer Substrates** | | | | | | | | |
| EP4SE110 | 780 | FBGA | 10.7 | 8.6 | 7.2 | 6.0 | 0.3 | 2.3 |
| EP4SE230 | 780 | FBGA | 9.7 | 8.4 | 7.0 | 5.8 | 0.2 | 2.0 |
| EP4SE290 | 780 | HBGA | 9.0 | 8.2 | 6.7 | 5.6 | 0.2 | 2.6 |
| EP4SE360 | 780 | HBGA | 9.0 | 8.2 | 6.7 | 5.6 | 0.2 | 2.6 |
| EP4SGX70 | 780 | FBGA | 10.7 | 8.6 | 7.2 | 6.0 | 0.3 | 2.3 |
| EP4SGX110 | 780 | FBGA | 10.7 | 8.6 | 7.2 | 6.0 | 0.3 | 2.3 |
| | 1152 | FBGA | 9.8 | 7.7 | 6.3 | 5.2 | 0.3 | 2.0 |
| EP4SGX180 | 780 | FBGA | 9.7 | 8.4 | 7.0 | 5.8 | 0.2 | 2.0 |
| | 1152 | FBGA | 8.8 | 7.5 | 6.1 | 5.0 | 0.2 | 1.7 |
| EP4SGX230 | 780 | FBGA | 9.7 | 8.4 | 7.0 | 5.8 | 0.2 | 2.0 |
| | 1152 | FBGA | 8.8 | 7.5 | 6.1 | 5.0 | 0.2 | 1.7 |
| EP4SGX290 | 780 | HBGA | 9.0 | 8.2 | 6.7 | 5.6 | 0.2 | 2.6 |
| | 1152 | FBGA | 8.3 | 7.4 | 6.0 | 4.9 | 0.2 | 1.6 |
| EP4SGX360 | 780 | HBGA | 9.0 | 8.2 | 6.7 | 5.6 | 0.2 | 2.6 |
| | 1152 | FBGA | 8.3 | 7.4 | 6.0 | 4.9 | 0.2 | 1.6 |
| **JEDEC 2S2P Board with OPD and 14-Layer (GX Devices) and 10-Layer (E Devices) Substrates** | | | | | | | | |
| EP4SE290 | 1152 | FBGA | 8.3 | 7.4 | 6.0 | 4.9 | 0.2 | 1.6 |
| | 1517 | FBGA | 7.7 | 6.8 | 5.4 | 4.4 | 0.2 | 1.7 |
| EP4SE360 | 1152 | FBGA | 8.3 | 7.4 | 6.0 | 4.9 | 0.2 | 1.6 |
| | 1517 | FBGA | 7.7 | 6.8 | 5.4 | 4.4 | 0.2 | 1.7 |
| EP4SE530 | 1152 | HBGA | 7.6 | 6.9 | 5.7 | 4.7 | 0.1 | 2.8 |
| | 1517 | HBGA | 7.2 | 6.4 | 5.2 | 4.3 | 0.1 | 1.8 |
| | 1760 | FBGA | 7.0 | 6.1 | 5.0 | 4.1 | 0.1 | 1.4 |
| EP4SE680 | 1152 | HBGA | 8.0 | 7.2 | 5.8 | 4.7 | 0.1 | 2.3 |
| | 1517 | FBGA | 7.7 | 6.7 | 5.4 | 4.3 | 0.1 | 1.4 |
| | 1760 | FBGA | 7.0 | 6.1 | 5.0 | 4.1 | 0.1 | 1.4 |
| EP4SGX70 | 1152 | FBGA | 9.8 | 7.7 | 6.3 | 5.2 | 0.3 | 2.0 |
| EP4SGX110 | 1152 | FBGA | 9.8 | 7.7 | 6.3 | 5.2 | 0.3 | 2.0 |
| EP4SGX180 | 1152 | FBGA | 8.8 | 7.5 | 6.1 | 5.0 | 0.2 | 1.7 |
| | 1517 | FBGA | 8.2 | 6.9 | 5.5 | 4.5 | 0.2 | 1.8 |
| EP4SGX230 | 1152 | FBGA | 8.8 | 7.5 | 6.1 | 5.0 | 0.2 | 1.7 |
| | 1517 | FBGA | 8.2 | 6.9 | 5.5 | 4.5 | 0.2 | 1.8 |

**Table 28.** Thermal Resistance of Stratix IV Devices (Part 2 of 3)

| Device | Pin Count | Package | $\theta_{JA}$ (° C/W) Still Air | $\theta_{JA}$ (° C/W) 100 ft./min. | $\theta_{JA}$ (° C/W) 200 ft./min. | $\theta_{JA}$ (° C/W) 400 ft./min. | $\theta_{JC}$ (° C/W) | $\theta_{JB}$ (° C/W) |
|---|---|---|---|---|---|---|---|---|
| EP4SGX290 | 1152 | FBGA | 8.3 | 7.4 | 6.0 | 4.9 | 0.2 | 1.6 |
| | 1517 | FBGA | 7.7 | 6.8 | 5.4 | 4.4 | 0.2 | 1.7 |
| | 1760 | FBGA | 7.0 | 6.2 | 5.1 | 4.2 | 0.2 | 1.5 |
| | 1932 | FBGA | 6.8 | 5.9 | 4.8 | 3.9 | 0.1 | 1.5 |
| EP4SGX360 | 1152 | FBGA | 8.3 | 7.4 | 6.0 | 4.9 | 0.2 | 1.6 |
| | 1517 | FBGA | 7.7 | 6.8 | 5.4 | 4.4 | 0.2 | 1.7 |
| | 1760 | FBGA | 7.0 | 6.2 | 5.1 | 4.2 | 0.2 | 1.5 |
| | 1932 | FBGA | 6.8 | 5.9 | 4.8 | 3.9 | 0.1 | 1.5 |
| EP4SGX530 | 1152 | HBGA | 7.6 | 6.9 | 5.7 | 4.7 | 0.1 | 2.8 |
| | 1517 | HBGA | 7.2 | 6.4 | 5.2 | 4.3 | 0.1 | 1.8 |
| | 1760 | FBGA | 7.0 | 6.1 | 5.0 | 4.1 | 0.1 | 1.4 |
| | 1932 | FBGA | 6.8 | 5.9 | 4.8 | 3.9 | 0.1 | 1.5 |
| EP4S40G2 | 1517 | FBGA | 8.2 | 6.9 | 5.5 | 4.5 | 0.2 | 1.8 |
| EP4S100G2 | 1517 | FBGA | 8.2 | 6.9 | 5.5 | 4.5 | 0.2 | 1.8 |
| EP4S40G5 | 1517 | HBGA | 7.2 | 6.4 | 5.2 | 4.3 | 0.1 | 1.8 |
| EP4S100G5 | 1517 | HBGA | 7.2 | 6.4 | 5.2 | 4.3 | 0.1 | 1.8 |
| EP4S100G5 | 1932 | FBGA | 6.8 | 5.9 | 4.8 | 3.9 | 0.1 | 1.5 |
| **Typical Board without OPD and 8-Layer Substrates** | | | | | | | | |
| EP4SE110 | 780 | FBGA | 10.3 | 8.1 | 6.5 | 5.3 | — | 1.7 |
| EP4SE230 | 780 | FBGA | 9.1 | 7.8 | 6.3 | 5.1 | — | 1.5 |
| EP4SE290 | 780 | HBGA | 8.3 | 7.4 | 5.9 | 4.8 | — | 1.7 |
| EP4SE360 | 780 | HBGA | 8.3 | 7.4 | 5.9 | 4.8 | — | 1.7 |
| EP4SGX70 | 780 | FBGA | 10.3 | 8.1 | 6.5 | 5.3 | — | 1.7 |
| EP4SGX110 | 780 | FBGA | 10.3 | 8.1 | 6.5 | 5.3 | — | 1.7 |
| | 1152 | FBGA | 9.3 | 7.2 | 5.7 | 4.6 | — | 1.4 |
| EP4SGX180 | 780 | FBGA | 9.1 | 7.8 | 6.3 | 5.1 | — | 1.5 |
| | 1152 | FBGA | 8.1 | 6.9 | 5.5 | 4.4 | — | 1.2 |
| EP4SGX230 | 780 | FBGA | 9.1 | 7.8 | 6.3 | 5.1 | — | 1.5 |
| | 1152 | FBGA | 8.1 | 6.9 | 5.5 | 4.4 | — | 1.2 |
| EP4SGX290 | 780 | HBGA | 8.3 | 7.4 | 5.9 | 4.8 | — | 1.7 |
| | 1152 | FBGA | 7.7 | 6.7 | 5.3 | 4.3 | — | 1.1 |
| EP4SGX360 | 780 | HBGA | 8.3 | 7.4 | 5.9 | 4.8 | — | 1.7 |
| | 1152 | FBGA | 7.7 | 6.7 | 5.3 | 4.3 | — | 1.1 |
| **Typical Board with OPD and 14-Layer (GX Devices) and 10-Layer (E Devices) Substrates** | | | | | | | | |
| EP4SE290 | 1152 | FBGA | 7.7 | 6.8 | 5.4 | 4.3 | — | 1.1 |
| | 1517 | FBGA | 7.0 | 6.1 | 4.8 | 3.8 | — | 1.1 |
| EP4SE360 | 1152 | FBGA | 7.7 | 6.8 | 5.4 | 4.3 | — | 1.1 |
| | 1517 | FBGA | 7.0 | 6.1 | 4.8 | 3.8 | — | 1.1 |

**Table 28.** Thermal Resistance of Stratix IV Devices (Part 3 of 3)

| Device | Pin Count | Package | $\theta_{JA}$ (° C/W) Still Air | $\theta_{JA}$ (° C/W) 100 ft./min. | $\theta_{JA}$ (° C/W) 200 ft./min. | $\theta_{JA}$ (° C/W) 400 ft./min. | $\theta_{JC}$ (° C/W) | $\theta_{JB}$ (° C/W) |
|---|---|---|---|---|---|---|---|---|
| EP4SE530 | 1152 | HBGA | 7.1 | 6.2 | 4.9 | 3.9 | — | 1.5 |
| | 1517 | HBGA | 6.8 | 5.9 | 4.6 | 3.6 | — | 1.0 |
| | 1760 | FBGA | 6.7 | 5.8 | 4.5 | 3.5 | — | 0.9 |
| EP4SE680 | 1152 | HBGA | 7.2 | 6.3 | 5.0 | 4.0 | — | 1.4 |
| | 1517 | FBGA | 7.0 | 6.0 | 4.7 | 3.7 | — | 1.0 |
| | 1760 | FBGA | 6.7 | 5.8 | 4.5 | 3.6 | — | 0.9 |
| EP4SGX70 | 1152 | FBGA | 9.3 | 7.2 | 5.7 | 4.6 | — | 1.5 |
| EP4SGX110 | 1152 | FBGA | 9.3 | 7.2 | 5.7 | 4.6 | — | 1.5 |
| EP4SGX180 | 1152 | FBGA | 8.1 | 6.9 | 5.5 | 4.4 | — | 1.2 |
| | 1517 | FBGA | 7.4 | 6.2 | 4.9 | 3.9 | — | 1.2 |
| EP4SGX230 | 1152 | FBGA | 8.1 | 6.9 | 5.5 | 4.4 | — | 1.2 |
| | 1517 | FBGA | 7.4 | 6.2 | 4.9 | 3.9 | — | 1.2 |
| EP4SGX290 | 1152 | FBGA | 7.7 | 6.8 | 5.4 | 4.3 | — | 1.1 |
| | 1517 | FBGA | 7.0 | 6.1 | 4.8 | 3.8 | — | 1.1 |
| | 1760 | FBGA | 6.8 | 5.8 | 4.6 | 3.6 | — | 1.0 |
| | 1932 | FBGA | 6.5 | 5.6 | 4.4 | 3.4 | — | 0.9 |
| EP4SGX360 | 1152 | FBGA | 7.7 | 6.8 | 5.4 | 4.3 | — | 1.1 |
| | 1517 | FBGA | 7.0 | 6.1 | 4.8 | 3.8 | — | 1.1 |
| | 1760 | FBGA | 6.8 | 5.8 | 4.6 | 3.6 | — | 1.0 |
| | 1932 | FBGA | 6.5 | 5.6 | 4.4 | 3.4 | — | 0.9 |
| EP4SGX530 | 1152 | SHBGA | 7.1 | 6.2 | 4.9 | 3.9 | — | 1.5 |
| | 1517 | HBGA | 6.8 | 5.9 | 4.6 | 3.6 | — | 1.0 |
| | 1760 | FBGA | 6.7 | 5.8 | 4.5 | 3.5 | — | 0.9 |
| | 1932 | FBGA | 6.5 | 5.6 | 4.4 | 3.4 | — | 0.9 |
| EP4S40G2 | 1517 | FBGA | 7.4 | 6.2 | 4.9 | 3.9 | — | 1.2 |
| EP4S100G2 | 1517 | FBGA | 7.4 | 6.2 | 4.9 | 3.9 | — | 1.2 |
| EP4S40G5 | 1517 | HBGA | 6.8 | 5.9 | 4.6 | 3.6 | — | 1.0 |
| EP4S100G5 | 1517 | HBGA | 6.8 | 5.9 | 4.6 | 3.6 | — | 1.0 |
| EP4S100G5 | 1932 | FBGA | 6.5 | 5.6 | 4.4 | 3.4 | — | 0.9 |

**Table 29.** Thermal Resistance of Stratix III Devices (Part 1 of 2)

| Device | Pin Count | Package | $\theta_{JA}$ (° C/W) Still Air | $\theta_{JA}$ (° C/W) 100 ft./min. | $\theta_{JA}$ (° C/W) 200 ft./min. | $\theta_{JA}$ (° C/W) 400 ft./min. | $\theta_{JC}$ (° C/W) | $\theta_{JB}$ (° C/W) |
|---|---|---|---|---|---|---|---|---|
| EP3SE50 | 484 | FBGA | 12.7 | 10.1 | 8.6 | 7.3 | 0.3 | 2.8 |
| | 780 | FBGA | 11.3 | 8.7 | 7.2 | 6.1 | 0.3 | 2.4 |
| EP3SL50 | 484 | FBGA | 12.7 | 10.1 | 8.6 | 7.3 | 0.3 | 2.8 |
| | 780 | FBGA | 11.3 | 8.7 | 7.3 | 6.1 | 0.3 | 2.4 |
| EP3SL70 | 484 | FBGA | 12.7 | 10.1 | 8.6 | 7.3 | 0.3 | 2.8 |
| | 780 | FBGA | 11.3 | 8.7 | 7.3 | 6.1 | 0.3 | 2.4 |

**Table 29.** Thermal Resistance of Stratix III Devices (Part 2 of 2)

| Device | Pin Count | Package | $\theta_{JA}$ (° C/W) Still Air | $\theta_{JA}$ (° C/W) 100 ft./min. | $\theta_{JA}$ (° C/W) 200 ft./min. | $\theta_{JA}$ (° C/W) 400 ft./min. | $\theta_{JC}$ (° C/W) | $\theta_{JB}$ (° C/W) |
|---|---|---|---|---|---|---|---|---|
| EP3SE80 | 780 | FBGA, Flip Chip | 10.2 | 8.5 | 7.0 | 5.8 | 0.2 | 2.0 |
| | 1152 | FBGA, Flip Chip | 9.4 | 7.6 | 6.2 | 5.1 | 0.2 | 2.0 |
| EP3SE110 | 780 | FBGA, Flip Chip | 10.2 | 8.5 | 7.0 | 5.8 | 0.2 | 2.0 |
| | 1152 | FBGA, Flip Chip | 9.4 | 7.6 | 6.2 | 5.1 | 0.2 | 2.0 |
| EP3SL110 | 780 | FBGA, Flip Chip | 10.2 | 8.5 | 7.0 | 5.8 | 0.2 | 2.0 |
| | 1152 | FBGA, Flip Chip | 9.4 | 7.6 | 6.2 | 5.1 | 0.2 | 2.0 |
| EP3SL150 | 780 | FBGA, Flip Chip | 10.2 | 8.5 | 7.0 | 5.8 | 0.2 | 2.0 |
| | 1152 | FBGA, Flip Chip | 9.4 | 7.6 | 6.2 | 5.1 | 0.2 | 2.0 |
| EP3SL200 | 780 | HBGA, Flip Chip | 9.0 | 8.1 | 6.7 | 5.5 | 0.1 | 2.5 |
| | 1152 | FBGA, Flip Chip | 8.4 | 7.4 | 6.0 | 4.9 | 0.1 | 1.8 |
| | 1517 | FBGA, Flip Chip | 7.8 | 6.8 | 5.5 | 4.4 | 0.1 | 1.7 |
| EP3SE260 | 780 | HBGA, Flip Chip | 9.0 | 8.1 | 6.7 | 5.5 | 0.1 | 2.5 |
| | 1152 | FBGA, Flip Chip | 8.4 | 7.4 | 6.0 | 4.9 | 0.1 | 1.8 |
| | 1517 | FBGA, Flip Chip | 7.8 | 6.8 | 5.5 | 4.4 | 0.1 | 1.7 |
| EP3SL340 | 1152 | HBGA, Flip Chip | 8.1 | 7.2 | 5.8 | 4.7 | 0.1 | 2.3 |
| | 1517 | FBGA, Flip Chip | 7.7 | 6.8 | 5.4 | 4.4 | 0.1 | 1.4 |
| | 1760 | FBGA, Flip Chip | 7.5 | 6.5 | 5.2 | 4.2 | 0.1 | 1.3 |

**Table 30.** Thermal Resistance of Stratix II Devices (Part 1 of 2)

| Device | Pin Count | Package | $\theta_{JC}$ (° C/W) | $\theta_{JA}$ (° C/W) Still Air | $\theta_{JA}$ (° C/W) 100 ft./min. | $\theta_{JA}$ (° C/W) 200 ft./min. | $\theta_{JA}$ (° C/W) 400 ft./min. | $\theta_{JB}$ (° C/W) |
|---|---|---|---|---|---|---|---|---|
| EP2S15 | 484 | FBGA, Flip Chip | 0.4 | 13.1 | 11.1 | 9.6 | 8.3 | 4.2 |
| | 672 | FBGA, Flip Chip | 0.4 | 12.2 | 10.2 | 8.8 | 7.6 | 4.1 |
| EP2S30 | 484 | FBGA, Flip Chip | 0.2 | 12.6 | 10.6 | 9.1 | 7.9 | 3.7 |
| | 672 | FBGA, Flip Chip | 0.2 | 11.7 | 9.7 | 8.3 | 7.1 | 3.4 |

**Table 30.** Thermal Resistance of Stratix II Devices (Part 2 of 2)

| Device | Pin Count | Package | $\theta_{JC}$ (° C/W) | $\theta_{JA}$ (° C/W) Still Air | $\theta_{JA}$ (° C/W) 100 ft./min. | $\theta_{JA}$ (° C/W) 200 ft./min. | $\theta_{JA}$ (° C/W) 400 ft./min. | $\theta_{JB}$ (° C/W) |
|---|---|---|---|---|---|---|---|---|
| EP2S60 | 484 | FBGA, Flip Chip | 0.1 | 12.3 | 10.3 | 8.8 | 7.5 | 3.4 |
| | 672 | FBGA, Flip Chip | 0.1 | 11.4 | 9.4 | 7.8 | 6.7 | 3.0 |
| | 1,020 | FBGA, Flip Chip | 0.1 | 10.4 | 8.4 | 7.0 | 5.9 | 2.7 |
| EP2S90 | 484 | HBGA, Flip Chip | 0.1 | 12.0 | 9.9 | 8.3 | 7.1 | 3.7 |
| | 780 | FBGA, Flip Chip | 0.1 | 10.8 | 8.8 | 7.3 | 6.1 | 2.6 |
| | 1,020 | FBGA, Flip Chip | 0.1 | 10.2 | 8.2 | 6.8 | 5.7 | 2.4 |
| | 1,508 | FBGA, Flip Chip | 0.1 | 9.3 | 7.4 | 6.1 | 5.0 | 2.2 |
| EP2S130 | 780 | FBGA, Flip Chip | 0.1 | 10.1 | 8.7 | 7.2 | 6.0 | 2.4 |
| | 1,020 | FBGA, Flip Chip | 0.1 | 9.5 | 8.1 | 6.7 | 5.5 | 2.2 |
| | 1,508 | FBGA, Flip Chip | 0.1 | 8.6 | 7.3 | 6.0 | 4.8 | 2.1 |
| EP2S180 | 1,020 | FBGA, Flip Chip | 0.1 | 9.0 | 7.9 | 6.5 | 5.4 | 2.1 |
| | 1,508 | FBGA, Flip Chip | 0.1 | 8.1 | 7.1 | 5.8 | 4.7 | 1.9 |

**Table 31.** Thermal Resistance of Stratix II GX Devices

| Device | Pin Count | Package | $\theta_{JC}$ (° C/W) | $\theta_{JA}$ (° C/W) Still Air | $\theta_{JA}$ (° C/W) 100 ft./min. | $\theta_{JA}$ (° C/W) 200 ft./min. | $\theta_{JA}$ (° C/W) 400 ft./min. | $\theta_{JB}$ (°C/W) |
|---|---|---|---|---|---|---|---|---|
| EP2SGX30 | 780 | FBGA, Flip Chip | 0.2 | 11.1 | 8.6 | 7.2 | 6.0 | 3.1 |
| EP2SGX60 | 780 | FBGA, Flip Chip | 0.2 | 10.9 | 8.4 | 6.9 | 5.8 | 2.8 |
| | 1152 | FBGA, Flip Chip | 0.2 | 9.9 | 7.5 | 6.1 | 5.0 | 2.5 |
| EP2SGX90 | 1152 | FBGA, Flip Chip | 0.1 | 9.6 | 7.3 | 5.9 | 4.9 | 2.3 |
| | 1508 | FBGA, Flip Chip | 0.1 | 9.0 | 6.7 | 5.4 | 4.4 | 1.9 |
| EP2SGX130 | 1508 | FBGA, Flip Chip | 0.1 | 8.3 | 6.6 | 5.3 | 4.3 | 1.8 |

**Table 32.** Thermal Resistance of Stratix GX Devices

| Device | Pin Count | Package | $\theta_{JC}$ (° C/W) | $\theta_{JA}$ (° C/W) Still Air | $\theta_{JA}$ (° C/W) 100 ft./min. | $\theta_{JA}$ (° C/W) 200 ft./min. | $\theta_{JA}$ (° C/W) 400 ft./min. |
|---|---|---|---|---|---|---|---|
| EP1SGX10C EP1SGX10D | 672 | FBGA, Flip Chip | 0.4 | 11.1 | 9.1 | 7.7 | 6.5 |
| EP1SGX25C EP1SGX25D | 672 | FBGA, Flip Chip | 0.2 | 10.8 | 8.8 | 7.4 | 6.2 |
| EP1SGX25D EP1SGX25F | 1020 | FBGA, Flip Chip | 0.2 | 9.9 | 7.9 | 6.5 | 5.4 |
| EP1SGX40D EP1SGX40G | 1020 | FBGA, Flip Chip | 0.2 | 9.8 | 7.7 | 6.4 | 5.3 |

**Table 33.** Thermal Resistance of Stratix Devices

| Device | Pin Count | Package | $\theta_{JC}$ (° C/W) | $\theta_{JA}$ (° C/W) Still Air | $\theta_{JA}$ (° C/W) 100 ft./min. | $\theta_{JA}$ (° C/W) 200 ft./min. | $\theta_{JA}$ (° C/W) 400 ft./min. |
|---|---|---|---|---|---|---|---|
| EP1S10 | 484 | FBGA, Flip Chip | 0.4 | 11.9 | 9.8 | 8.4 | 7.2 |
| | 672 | BGA | 3.2 | 16.8 | 13.7 | 11.9 | 10.5 |
| | 672 | FBGA | 3.4 | 17.2 | 14.0 | 12.2 | 10.8 |
| | 780 | FBGA, Flip Chip | 0.4 | 10.9 | 8.8 | 7.4 | 6.3 |
| EP1S20 | 484 | FBGA, Flip Chip | 0.3 | 11.8 | 9.7 | 8.3 | 7.1 |
| | 672 | BGA | 2.5 | 15.5 | 12.4 | 10.7 | 9.3 |
| | 672 | FBGA | 2.7 | 16.0 | 12.8 | 11.0 | 9.6 |
| | 780 | FBGA, Flip Chip | 0.3 | 10.7 | 8.6 | 7.2 | 6.1 |
| EP1S25 | 672 | BGA | 2.2 | 14.8 | 11.7 | 10.0 | 8.7 |
| | 672 | FBGA | 2.3 | 15.3 | 12 | 10.4 | 9.0 |
| | 780 | FBGA, Flip Chip | 0.3 | 10.5 | 8.5 | 7.1 | 6.0 |
| | 1020 | FBGA, Flip Chip | 0.3 | 10.0 | 8.0 | 6.6 | 5.5 |
| EP1S30 | 780 | FBGA, Flip Chip | 0.2 | 10.4 | 8.4 | 7.0 | 5.9 |
| | 956 | BGA, Flip Chip | 0.2 | 9.1 | 7.1 | 5.8 | 4.8 |
| | 1020 | FBGA, Flip Chip | 0.2 | 9.9 | 7.9 | 6.5 | 5.4 |
| EP1S40 | 780 | FBGA, Flip Chip | 0.2 | 10.4 | 8.3 | 6.9 | 5.8 |
| | 956 | BGA, Flip Chip | 0.2 | 9.0 | 7.0 | 5.7 | 4.7 |
| | 1020 | FBGA, Flip Chip | 0.2 | 9.8 | 7.8 | 6.4 | 5.3 |
| | 1508 | FBGA, Flip Chip | 0.2 | 9.1 | 7.1 | 5.8 | 4.7 |
| EP1S60 | 956 | BGA, Flip Chip | 0.1 | 8.9 | 6.9 | 5.6 | 4.6 |
| | 1020 | FBGA, Flip Chip | 0.1 | 9.7 | 7.7 | 6.3 | 5.2 |
| | 1508 | FBGA, Flip Chip | 0.1 | 8.9 | 7.0 | 5.6 | 4.6 |
| EP1S80 | 956 | BGA, Flip Chip | 0.1 | 8.8 | 6.8 | 5.5 | 4.5 |
| | 1020 | FBGA, Flip Chip | 0.1 | 9.6 | 7.6 | 6.2 | 5.1 |
| | 1508 | FBGA, Flip Chip | 0.1 | 8.8 | 6.9 | 5.5 | 4.5 |

## Cyclone Series Devices Thermal Resistance

Table 34 through Table 37 provide thermal resistance values for Cyclone series devices.

**Table 34.** Thermal Resistance of Cyclone III LS Devices

| Device | Package | $\theta_{JA}$ (° C/W) Still Air | $\theta_{JA}$ (° C/W) 100 ft./min. | $\theta_{JA}$ (° C/W) 200 ft./min. | $\theta_{JA}$ (° C/W) 400 ft./min. | $\theta_{JC}$ (° C/W) | $\theta_{JB}$ (° C/W) |
|---|---|---|---|---|---|---|---|
| EP3CLS70 | F484 Wire Bond (Option 2) | 17.5 | 12.7 | 11.1 | 9.8 | 3.4 | 5.5 |
| | U484 Wire Bond | 18.7 | 13.8 | 12.2 | 10.8 | 3.2 | 6.4 |
| | F780 Wire Bond (Option 2) | 16.6 | 11.8 | 10.3 | 9.0 | 3.0 | 5.2 |
| EP3CLS100 | F484 Wire Bond (Option 2) | 17.5 | 12.7 | 11.1 | 9.8 | 3.4 | 5.5 |
| | U484 Wire Bond | 18.7 | 13.8 | 12.2 | 10.8 | 3.2 | 6.4 |
| | F780 Wire Bond (Option 2) | 16.6 | 11.8 | 10.3 | 9.0 | 3.0 | 5.2 |
| EP3CLS150 | F484 Wire Bond (Option 2) | 14.5 | 11.5 | 9.9 | 8.6 | 2.6 | 4.4 |
| | F780 Wire Bond (Option 2) | 13.5 | 10.5 | 9.0 | 7.8 | 2.2 | 4.1 |
| EP3CLS200 | F484 Wire Bond (Option 2) | 14.5 | 11.5 | 9.9 | 8.6 | 2.6 | 4.4 |
| | F780 Wire Bond (Option 2) | 13.5 | 10.5 | 9.0 | 7.8 | 2.2 | 4.1 |

**Table 35.** Thermal Resistance of Cyclone III Devices (Part 1 of 3)

| Device | Package | $\theta_{JA}$ (° C/W) Still Air | $\theta_{JA}$ (° C/W) 100 ft./min. | $\theta_{JA}$ (° C/W) 200 ft./min. | $\theta_{JA}$ (° C/W) 400 ft./min. | $\theta_{JC}$ (° C/W) | $\theta_{JB}$ (° C/W) |
|---|---|---|---|---|---|---|---|
| EP3C5 | E144 Wire Bond | 20.0 | 17.5 | 15.4 | 14.0 | 8.4 | — |
| EP3C5 | F256 Wire Bond (Option 2) | 32.4 | 28.9 | 27.0 | 25.5 | 11.7 | 15.6 |
| EP3C5 | U256 Wire Bond | 32.5 | 29.1 | 27.2 | 25.6 | 12.2 | 17.3 |
| EP3C10 | E144 Wire Bond | 20.0 | 17.5 | 15.4 | 14.0 | 8.4 | — |
| EP3C10 | M164 Wire Bond | 39.0 | 32.3 | 30.4 | 28.7 | 9.9 | 20.0 |
| EP3C10 | F256 Wire Bond (Option 2) | 32.4 | 28.9 | 27.0 | 25.5 | 11.7 | 15.6 |
| EP3C10 | U256 Wire Bond | 32.5 | 29.1 | 27.2 | 25.6 | 12.2 | 17.3 |
| EP3C16 | E144 Wire Bond | 20.0 | 17.5 | 15.4 | 14.0 | 8.4 | — |

**Table 35.** Thermal Resistance of Cyclone III Devices (Part 2 of 3)

| Device | Package | $\theta_{JA}$ (° C/W) Still Air | $\theta_{JA}$ (° C/W) 100 ft./min. | $\theta_{JA}$ (° C/W) 200 ft./min. | $\theta_{JA}$ (° C/W) 400 ft./min. | $\theta_{JC}$ (° C/W) | $\theta_{JB}$ (° C/W) |
|---|---|---|---|---|---|---|---|
| EP3C16 | M164 Wire Bond | 35.0 | 28.4 | 26.4 | 24.7 | 7.6 | 15.8 |
| EP3C16 | Q240 Wire Bond | 27.2 | 24.7 | 22.1 | 17.8 | 4.3 | — |
| EP3C16 | F256 Wire Bond (Option 2) | 28.5 | 25.1 | 23.2 | 21.7 | 9.1 | 13.2 |
| EP3C16 | U256 Wire Bond | 28.8 | 25.4 | 23.5 | 22.0 | 9.7 | 14.1 |
| EP3C16 | U484 Wire Bond | 26.1 | 23.5 | 21.6 | 20.1 | 8.5 | 11.4 |
| EP3C16 | F484 Wire Bond (Option 3) | 22.9 | 19.4 | 17.7 | 16.2 | 6.9 | 10.2 |
| EP3C25 | E144 Wire Bond | 29.0 | 27.5 | 26.3 | 24.4 | 7.8 | —-- |
| EP3C25 | Q240 Wire Bond | 27.0 | 24.5 | 21.8 | 17.6 | 4.2 | — |
| EP3C25 | F256 Wire Bond (Option 2) | 27.5 | 24.1 | 22.2 | 20.7 | 8.5 | 12.5 |
| EP3C25 | U256 Wire Bond | 27.9 | 24.5 | 22.6 | 21.1 | 9.1 | 13.6 |
| EP3C25 | F324 Wire Bond | 26.6 | 23.1 | 21.3 | 19.8 | 8.0 | 11.5 |
| EP3C40 | Q240 Wire Bond | 25.8 | 23.2 | 20.6 | 17.0 | 4.0 | — |
| EP3C40 | F324 Wire Bond | 23.2 | 19.7 | 18.0 | 16.5 | 5.9 | 8.9 |
| EP3C40 | U484 Wire Bond | 22.8 | 19.3 | 17.6 | 16.1 | 5.9 | 8.5 |
| EP3C40 | F484 Wire Bond (Option 3) | 19.8 | 16.3 | 14.6 | 13.2 | 4.8 | 7.6 |
| EP3C40 | F780 Wire Bond (Option 2) | 18.7 | 15.2 | 13.5 | 12.2 | 4.5 | 7.0 |
| EP3C55 | U484 Wire Bond | 21.6 | 18.2 | 16.4 | 15.0 | 5.1 | 8.2 |
| EP3C55 | F484 Wire Bond (Option 3) | 18.9 | 15.4 | 13.8 | 12.2 | 4.2 | 6.9 |
| EP3C55 | F780 Wire Bond (Option 2) | 17.8 | 14.4 | 12.7 | 11.4 | 3.9 | 6.7 |
| EP3C80 | U484 Wire Bond | 20.4 | 16.9 | 15.2 | 13.8 | 4.4 | 7.2 |
| EP3C80 | F484 Wire Bond (Option 3) | 18.0 | 14.5 | 12.9 | 11.5 | 3.6 | 6.1 |
| EP3C80 | F780 Wire Bond (Option 2) | 16.9 | 13.5 | 11.8 | 10.5 | 3.3 | 5.9 |

**Table 35.** Thermal Resistance of Cyclone III Devices (Part 3 of 3)

| Device | Package | $\theta_{JA}$ (° C/W) Still Air | $\theta_{JA}$ (° C/W) 100 ft./min. | $\theta_{JA}$ (° C/W) 200 ft./min. | $\theta_{JA}$ (° C/W) 400 ft./min. | $\theta_{JC}$ (° C/W) | $\theta_{JB}$ (° C/W) |
|---|---|---|---|---|---|---|---|
| EP3C120 | F484 Wire Bond (Option 3) | 17.1 | 13.7 | 12.0 | 10.7 | 3.1 | 5.4 |
| EP3C120 | F780 Wire Bond (Option 2) | 16.0 | 12.6 | 11.0 | 9.7 | 2.8 | 5.1 |

**Table 36.** Thermal Resistance of Cyclone II Devices

| Device | Pin Count | Package | $\theta_{JC}$ (° C/W) | $\theta_{JA}$ (° C/W) Still Air | $\theta_{JA}$ (° C/W) 100 ft./min. | $\theta_{JA}$ (° C/W) 200 ft./min. | $\theta_{JA}$ (° C/W) 400 ft./min. |
|---|---|---|---|---|---|---|---|
| EP2C5 | 144 | TQFP, Wire Bond | 10.0 | 31.0 | 29.3 | 27.9 | 25.5 |
| | 208 | PQFP, Wire Bond | 5.5 | 30.4 | 29.2 | 27.3 | 22.3 |
| | 256 | FBGA, Wire Bond | 8.7 | 30.2 | 26.1 | 23.6 | 21.7 |
| EP2C8 | 144 | TQFP, Wire Bond | 9.9 | 29.8 | 28.3 | 26.9 | 24.9 |
| | 208 | PQFP, Wire Bond | 5.4 | 30.2 | 28.8 | 26.9 | 21.7 |
| | 256 | FBGA, Wire Bond | 7.1 | 27.0 | 23.0 | 20.5 | 18.5 |
| EP2C15 | 256 | FBGA, Wire Bond | 5.5 | 24.2 | 20.0 | 17.8 | 16.0 |
| | 484 | FBGA, Wire Bond | 4.2 | 21.0 | 17.0 | 14.8 | 13.1 |
| EP2C20 | 240 | PQFP, Wire Bond | 4.2 | 26.6 | 24.0 | 21.4 | 17.4 |
| | 256 | FBGA, Wire Bond | 5.5 | 24.2 | 20.0 | 17.8 | 16.0 |
| | 484 | FBGA, Wire Bond | 4.2 | 21.0 | 17.0 | 14.8 | 13.1 |
| EP2C35 | 484 | FBGA, Wire Bond | 3.3 | 19.4 | 15.4 | 13.3 | 11.7 |
| | 484 | UBGA, Wire Bond | 5.0 | 20.6 | 16.6 | 14.5 | 12.8 |
| | 672 | FBGA, Wire Bond | 3.1 | 18.6 | 14.6 | 12.6 | 11.1 |
| EP2C50 | 484 | FBGA, Wire Bond | 2.8 | 18.4 | 14.4 | 12.4 | 10.9 |
| | 484 | UBGA, Wire Bond | 4.4 | 19.6 | 15.6 | 13.6 | 11.9 |
| | 672 | FBGA, Wire Bond | 2.6 | 17.7 | 13.7 | 11.8 | 10.2 |
| EP2C70 | 672 | FBGA, Wire Bond | 2.2 | 16.9 | 13.0 | 11.1 | 9.7 |
| | 896 | FBGA, Wire Bond | 2.1 | 16.3 | 11.9 | 10.5 | 9.1 |

**Table 37.** Thermal Resistance of Cyclone Devices

| Device | Pin Count | Package | $\theta_{JC}$ (° C/W) | $\theta_{JA}$ (° C/W) Still Air | $\theta_{JA}$ (° C/W) 100 ft./min. | $\theta_{JA}$ (° C/W) 200 ft./min. | $\theta_{JA}$ (° C/W) 400 ft./min. |
|---|---|---|---|---|---|---|---|
| EP1C3 | 100 | TQFP | 11.0 | 37.5 | 35.4 | 33.4 | 29.8 |
| | 144 | TQFP | 10.0 | 31.1 | 29.4 | 27.9 | 25.5 |
| EP1C6 | 144 | TQFP | 9.8 | 29.4 | 28.0 | 26.7 | 24.7 |
| | 240 | PQFP | 4.3 | 27.2 | 24.7 | 22.1 | 17.8 |
| | 256 | FBGA | 8.8 | 28.7 | 24.5 | 22.3 | 20.5 |
| EP1C12 | 240 | PQFP | 4.0 | 26.0 | 23.4 | 20.8 | 17.1 |
| | 256 | FBGA | 6.6 | 24.3 | 20.2 | 18.1 | 16.4 |
| | 324 | FBGA | 6.1 | 23.0 | 19.8 | 17.7 | 16.1 |
| EP1C20 | 324 | FBGA | 5.0 | 21.0 | 17.7 | 15.6 | 14.1 |
| | 400 | FBGA | 4.7 | 20.7 | 17.5 | 15.5 | 13.9 |

## MAX Series Devices Thermal Resistance

Table 38 through Table 41 provide thermal resistance values for MAX series devices.

**Table 38.** Thermal Resistance of MAX II Devices

| Device | Pin Count | Package | $\theta_{JC}$ (° C/W) | $\theta_{JA}$ (° C/W) Still Air | $\theta_{JA}$ (° C/W) 100 ft./min. | $\theta_{JA}$ (° C/W) 200 ft./min. | $\theta_{JA}$ (° C/W) 400 ft./min. |
|---|---|---|---|---|---|---|---|
| EPM240 | 100 | TQFP | 12.0 | 39.5 | 37.5 | 35.5 | 31.6 |
| | 100 | MBGA | 32.1 | 53.8 | 47.7 | 45.7 | 44.0 |
| | 100 | FBGA | 20.8 | 51.2 | 45.2 | 43.2 | 41.5 |
| EPM570 | 100 | TQFP | 11.2 | 38.7 | 36.6 | 34.6 | 30.8 |
| | 100 | MBGA | 25.0 | 46.5 | 40.4 | 38.4 | 36.8 |
| | 100 | FBGA | 14.8 | 42.8 | 36.8 | 34.9 | 33.3 |
| | 144 | TQFP | 10.5 | 32.1 | 30.3 | 28.7 | 26.1 |
| | 256 | FBGA | 13.0 | 37.4 | 33.1 | 30.5 | 28.4 |
| | 256 | MBGA | 12.9 | 39.5 | 33.6 | 31.6 | 30.1 |
| EPM1270 | 144 | TQFP | 10.5 | 31.4 | 29.7 | 28.2 | 25.8 |
| | 256 | FBGA | 10.4 | 33.5 | 29.3 | 26.8 | 24.7 |
| | 256 | MBGA | 10.6 | 36.1 | 30.2 | 28.3 | 26.8 |
| EPM2210 | 256 | FBGA | 8.7 | 30.2 | 26.1 | 23.6 | 21.7 |
| | 324 | FBGA | 8.2 | 29.8 | 25.7 | 23.3 | 21.3 |

**Table 39.** Thermal Resistance of MAX 9000 Devices (Part 1 of 2)

| Device | Pin Count | Package | $\theta_{JC}$ (° C/W) | $\theta_{JA}$ (° C/W) Still Air | $\theta_{JA}$ (° C/W) 100 ft./min. | $\theta_{JA}$ (° C/W) 200 ft./min. | $\theta_{JA}$ (° C/W) 400 ft./min. |
|---|---|---|---|---|---|---|---|
| EPM9320 | 84 | PLCC | 9.0 | 29.0 | 27.0 | 25.0 | 23.0 |
| | 208 | RQFP | 1.0 | 17.0 | 16.0 | 15.0 | 13.0 |
| | 280 | PGA | 2.0 | 14.0 | 10.0 | 7.0 | 5.0 |
| | 356 | BGA | 2.0 | 14.0 | 12.0 | 11.0 | 10.0 |
| EPM9320A | 84 | PLCC | 9.0 | 29.0 | 27.0 | 26.0 | 23.0 |
| | 208 | RQFP | 2.0 | 17.0 | 16.0 | 15.0 | 13.0 |
| | 356 | BGA | 1.0 | 12.0 | 11.0 | 10.0 | 9.0 |
| EPM9400 | 84 | PLCC | 9.0 | 29.0 | 27.0 | 25.0 | 23.0 |
| | 208 | RQFP | 1.0 | 17.0 | 16.0 | 15.0 | 13.0 |
| | 240 | RQFP | 1.0 | 14.0 | 12.0 | 11.0 | 10.0 |
| EPM9480 | 208 | RQFP | 1.0 | 17.0 | 16.0 | 15.0 | 12.0 |
| | 240 | RQFP | 1.0 | 12.0 | 11.0 | 10.0 | 9.0 |
| EPM9560 | 208 | RQFP | 1.0 | 17.0 | 16.0 | 15.0 | 12.0 |
| | 240 | RQFP | 1.0 | 12.0 | 11.0 | 10.0 | 9.0 |
| | 280 | PGA | 2.0 | 14.0 | 10.0 | 7.0 | 5.0 |
| | 304 | RQFP | 1.0 | 12.0 | 11.0 | 10.0 | 9.0 |
| | 356 | BGA | 1.0 | 12.0 | 11.0 | 10.0 | 9.0 |

**Table 39.** Thermal Resistance of MAX 9000 Devices (Part 2 of 2)

| Device | Pin Count | Package | $\theta_{JC}$ (° C/W) | $\theta_{JA}$ (° C/W) Still Air | $\theta_{JA}$ (° C/W) 100 ft./min. | $\theta_{JA}$ (° C/W) 200 ft./min. | $\theta_{JA}$ (° C/W) 400 ft./min. |
|---|---|---|---|---|---|---|---|
| EPM9560A | 208 | RQFP | 1.0 | 17.0 | 16.0 | 15.0 | 12.0 |
| | 240 | RQFP | 1.0 | 11.0 | 10.0 | 9.0 | 8.0 |
| | 356 | BGA | 1.0 | 12.0 | 11.0 | 10.0 | 9.0 |

**Table 40.** Thermal Resistance of MAX 7000 Devices (Part 1 of 3)

| Device | Pin Count | Package | $\theta_{JC}$ (° C/W) | $\theta_{JA}$ (° C/W) Still Air | $\theta_{JA}$ (° C/W) 100 ft./min. | $\theta_{JA}$ (° C/W) 200 ft./min. | $\theta_{JA}$ (° C/W) 400 ft./min. |
|---|---|---|---|---|---|---|---|
| EPM7032 | 44 | PLCC | 10.0 | 33.0 | 31.0 | 30.0 | 27.0 |
| | | PQFP | 15.0 | 48.0 | 46.0 | 45.0 | 42.0 |
| | | TQFP | 14.0 | 46.0 | 44.0 | 43.0 | 40.0 |
| EPM7032B | 44 | PLCC | 10.0 | 33.0 | 31.0 | 30.0 | 27.0 |
| | | TQFP | 14.0 | 46.0 | 44.0 | 43.0 | 40.0 |
| | 49 | UBGA | 23.0 | 69.0 | 67.0 | 66.0 | 62.0 |
| EPM7032S | 44 | PLCC | 10.0 | 33.0 | 31.0 | 30.0 | 27.0 |
| | | TQFP | 14.0 | 46.0 | 44.0 | 43.0 | 40.0 |
| EPM7032V | 44 | PLCC | 9.0 | 31.0 | 30.0 | 28.0 | 25.0 |
| | | TQFP | 14.0 | 45.0 | 44.0 | 42.0 | 39.0 |
| EPM7032AE | 44 | PLCC | 9.0 | 31.0 | 30.0 | 28.0 | 25.0 |
| | | TQFP | 14.0 | 46.0 | 45.0 | 43.0 | 40.0 |
| EPM7064S | 44 | PLCC | 9.0 | 31.0 | 30.0 | 28.0 | 25.0 |
| | | TQFP | 14.0 | 46.0 | 44.0 | 43.0 | 40.0 |
| | 84 | PLCC | 9.0 | 28.0 | 26.0 | 25.0 | 23.0 |
| | 100 | TQFP | 11.0 | 39.0 | 37.0 | 35.0 | 32.0 |
| EPM7064 | 44 | PLCC | 9.0 | 31.0 | 30.0 | 28.0 | 25.0 |
| | | TQFP | 13.0 | 44.0 | 43.0 | 41.0 | 38.0 |
| | 68 | PLCC | 9.0 | 29.0 | 28.0 | 26.0 | 23.0 |
| | 84 | PLCC | 9.0 | 28.0 | 26.0 | 25.0 | 22.0 |
| | 100 | PQFP | 6.0 | 33.0 | 32.0 | 31.0 | 30.0 |
| EPM7064AE EPM7064B | 44 | PLCC | 9.0 | 31.0 | 30.0 | 28.0 | 25.0 |
| | | TQFP | 14.0 | 46.0 | 45.0 | 43.0 | 40.0 |
| | 49 | UBGA | 23.0 | 56.0 | 53.0 | 51.0 | 47.0 |
| | 100 | TQFP | 12.0 | 39.0 | 37.0 | 35.0 | 31.0 |
| | | FBGA | 21.0 | 49.0 | 47.0 | 44.0 | 40.0 |
| EPM7096 | 68 | PLCC | 9.0 | 29.0 | 27.0 | 26.0 | 23.0 |
| | 84 | PLCC | 9.0 | 28.0 | 26.0 | 24.0 | 22.0 |
| | 100 | PQFP | 6.0 | 32.0 | 31.0 | 30.0 | 29.0 |

**Table 40.** Thermal Resistance of MAX 7000 Devices (Part 2 of 3)

| Device | Pin Count | Package | $\theta_{JC}$ (° C/W) | $\theta_{JA}$ (° C/W) Still Air | $\theta_{JA}$ (° C/W) 100 ft./min. | $\theta_{JA}$ (° C/W) 200 ft./min. | $\theta_{JA}$ (° C/W) 400 ft./min. |
|---|---|---|---|---|---|---|---|
| EPM7128A | 84 | PLCC | 9.0 | 28.0 | 26.0 | 25.0 | 22.0 |
| | 100 | TQFP | 11.0 | 37.0 | 35.0 | 33.0 | 30.0 |
| | | FBGA | 18.0 | 44.0 | 42.0 | 39.0 | 35.0 |
| | 144 | TQFP | 9.0 | 31.0 | 29.0 | 28.0 | 25.0 |
| | 256 | FBGA | 12.0 | 38.0 | 36.0 | 34.0 | 31.0 |
| EPM7128B | 49 | UBGA | 22.0 | 53.0 | 50.0 | 48.0 | 44.0 |
| | 100 | TQFP | 11.0 | 38.0 | 36.0 | 34.0 | 31.0 |
| | | FBGA | 19.0 | 46.0 | 44.0 | 41.0 | 37.0 |
| | 144 | TQFP | 9.0 | 32.0 | 30.0 | 29.0 | 26.0 |
| | 169 | UBGA | 16.0 | 44.0 | 42.0 | 39.0 | 35.0 |
| | 256 | FBGA | 13.0 | 40.0 | 38.0 | 36.0 | 33.0 |
| EPM7128E | 84 | PLCC | 10.0 | 29.0 | 28.0 | 26.0 | 23.0 |
| | 100 | PQFP | 6.0 | 32.0 | 31.0 | 30.0 | 29.0 |
| | 160 | PQFP | 6.0 | 32.0 | 31.0 | 30.0 | 28.0 |
| EPM7128S | 84 | PLCC | 10.0 | 30.0 | 28.0 | 26.0 | 23.0 |
| | 100 | TQFP | 12.0 | 38.0 | 36.0 | 34.0 | 30.0 |
| | | PQFP | 10.0 | 35.0 | 34.0 | 33.0 | 32.0 |
| | 160 | PQFP | 7.0 | 33.0 | 32.0 | 31.0 | 30.0 |
| EPM7128AE | 84 | PLCC | 11.0 | 30.0 | 28.0 | 26.0 | 23.0 |
| | 100 | TQFP | 12.0 | 38.0 | 36.0 | 34.0 | 30.0 |
| | | FBGA | 14.0 | 43.0 | 40.0 | 38.0 | 37.0 |
| | 144 | TQFP | 11.0 | 33.0 | 30.0 | 28.0 | 26.0 |
| | 169 | UBGA | 14.0 | 42.0 | 40.0 | 38.0 | 36.0 |
| | 256 | FBGA | 12.0 | 39.0 | 37.0 | 35.0 | 31.0 |
| EPM7160E | 84 | PLCC | 10.0 | 29.0 | 28.0 | 26.0 | 23.0 |
| | 100 | PQFP | 6.0 | 32.0 | 31.0 | 30.0 | 29.0 |
| | 160 | PQFP | 6.0 | 33.0 | 32.0 | 31.0 | 30.0 |
| EPM7160S | 84 | PLCC | 10.0 | 35.0 | 28.0 | 26.0 | 23.0 |
| | 100 | TQFP | 12.0 | 37.0 | 35.0 | 33.0 | 30.0 |
| | 160 | PQFP | 6.0 | 33.0 | 32.0 | 31.0 | 30.0 |
| EPM7192S | 160 | PQFP | 6.0 | 32.0 | 31.0 | 30.0 | 29.0 |
| EPM7192E | 160 | PGA | 6.0 | 20.0 | 13.0 | 10.0 | 8.0 |
| | | PQFP | 6.0 | 32.0 | 31.0 | 30.0 | 26.0 |
| EPM7256A | 100 | TQFP | 9.0 | 36.0 | 34.0 | 32.0 | 30.0 |
| | 144 | TQFP | 8.0 | 32.0 | 27.0 | 25.0 | 24.0 |
| | 208 | PQFP | 5.0 | 30.0 | 28.0 | 26.0 | 21.0 |
| | 256 | FBGA | 12.0 | 34.0 | 32.0 | 29.0 | 28.0 |

**Table 40.** Thermal Resistance of MAX 7000 Devices (Part 3 of 3)

| Device | Pin Count | Package | $\theta_{JC}$ (° C/W) | $\theta_{JA}$ (° C/W) Still Air | $\theta_{JA}$ (° C/W) 100 ft./min. | $\theta_{JA}$ (° C/W) 200 ft./min. | $\theta_{JA}$ (° C/W) 400 ft./min. |
|---|---|---|---|---|---|---|---|
| EPM7256B | 100 | TQFP | 12.0 | 37.0 | 35.0 | 33.0 | 30.0 |
| | 144 | TQFP | 9.0 | 33.0 | 29.0 | 27.0 | 25.0 |
| | 169 | UBGA | 13.0 | 40.0 | 38.0 | 36.0 | 34.0 |
| | 208 | PQFP | 5.0 | 31.0 | 29.0 | 27.0 | 22.0 |
| | 256 | FBGA | 9.0 | 34.0 | 32.0 | 30.0 | 28.0 |
| EPM7256E | 192 | PGA | 6.0 | 20.0 | 13.0 | 10.0 | 8.0 |
| | 160 | PQFP | 6.0 | 31.0 | 30.0 | 29.0 | 25.0 |
| | 208 | RQFP | 1.0 | 17.0 | 16.0 | 15.0 | 13.0 |
| EPM7256S | 208 | PQFP | 5.0 | 30.0 | 29.0 | 26.0 | 21.0 |
| | | RQFP | 1.0 | 18.0 | 17.0 | 16.0 | 15.0 |
| EPM7256AE | 100 | FBGA | 13.0 | 42.0 | 39.0 | 37.0 | 36.0 |
| | 100 | TQFP | 12.0 | 37.0 | 35.0 | 33.0 | 30.0 |
| | 144 | TQFP | 9.0 | 33.0 | 29.0 | 27.0 | 25.0 |
| | 208 | PQFP | 5.0 | 31.0 | 29.0 | 27.0 | 22.0 |
| | 256 | FBGA | 9.0 | 34.0 | 32.0 | 30.0 | 28.0 |
| EPM7512AE | 144 | TQFP | 10.0 | 32.0 | 27.0 | 25.0 | 23.0 |
| | 208 | PQFP | 5.0 | 30.0 | 28.0 | 25.0 | 21.0 |
| | 256 | BGA | 1.2 | 14.0 | 12.0 | 11.0 | 10.0 |
| | | FBGA | 11.0 | 32.0 | 30.0 | 28.0 | 22.0 |
| EPM7512B | 144 | TQFP | 10.0 | 32.0 | 27.0 | 25.0 | 24.0 |
| | 169 | UBGA | 12.0 | 35.0 | 33.0 | 31.0 | 30.0 |
| | 208 | PQFP | 5.0 | 30.0 | 28.0 | 25.0 | 21.0 |
| | 256 | BGA | 1.2 | 14.0 | 12.0 | 11.0 | 10.0 |
| | 256 | FBGA | 11.0 | 32.0 | 30.0 | 28.0 | 27.0 |

**Table 41.** Thermal Resistance of MAX 3000A Devices

| Device | Pin Count | Package | $\theta_{JC}$ (° C/W) | $\theta_{JA}$ (° C/W) Still Air | $\theta_{JA}$ (° C/W) 100 ft./min. | $\theta_{JA}$ (° C/W) 200 ft./min. | $\theta_{JA}$ (° C/W) 400 ft./min. |
|---|---|---|---|---|---|---|---|
| EPM3032A | 44 | TQFP | 14.0 | 46.0 | 45.0 | 43.0 | 40.0 |
| | | PLCC | 9.0 | 31.0 | 30.0 | 28.0 | 25.0 |
| EPM3064A | 44 | TQFP | 14.0 | 46.0 | 45.0 | 43.0 | 40.0 |
| | | PLCC | 9.0 | 31.0 | 30.0 | 28.0 | 25.0 |
| | 100 | TQFP | 12.0 | 39.0 | 37.0 | 35.0 | 31.0 |
| EPM3128A | 100 | TQFP | 12.0 | 38.0 | 36.0 | 34.0 | 30.0 |
| EPM3256A | 144 | TQFP | 9.0 | 33.0 | 29.0 | 27.0 | 25.0 |
| | 208 | PQFP | 5.0 | 31.0 | 29.0 | 27.0 | 22.0 |
| EPM3512A | 208 | PQFP | 5.0 | 30.0 | 28.0 | 25.0 | 21.0 |
| | 256 | FBGA | 11.0 | 32.0 | 30.0 | 28.0 | 22.0 |

## HardCopy Series Devices Thermal Resistance

Table 42 through Table 45 provide thermal resistance values for HardCopy series devices.

**Table 42.** Thermal Resistance of HardCopy IV Devices

| Device | Pin Count | Package | Theta JA for Without Heat Sink | | | | $\theta_{JC}$ (° C/W) | $\theta_{JB}$ (° C/W) |
|---|---|---|---|---|---|---|---|---|
| | | | $\theta_{JA}$ (° C/W) Still Air | $\theta_{JA}$ (° C/W) 100 ft./min. | $\theta_{JA}$ (° C/W) 200 ft./min. | $\theta_{JA}$ (° C/W) 400 ft./min. | | |
| **HardCopy IV E Devices** | | | | | | | | |
| HC4E25WF484 | 484 | FBGA, Wire Bond | 15.8 | 13.2 | 11.7 | 10.4 | 3.9 | 5.6 |
| HC4E25FF484 | 484 | FBGA, Flip Chip | 13.1 | 10.4 | 8.8 | 7.6 | 0.5 | 3.2 |
| HC4E25WF780 | 780 | FBGA, Wire Bond | 14.5 | 12.3 | 10.8 | 9.6 | 3.5 | 5.8 |
| HC4E25FF780 | 780 | FBGA, Flip Chip | 11.3 | 9.0 | 7.6 | 6.4 | 0.5 | 2.8 |
| HC4E35LF1152 | 1152 | FBGA, Flip Chip | 9.6 | 8.0 | 6.5 | 5.4 | 0.3 | 2.4 |
| HC4E35FF1152 | 1152 | FBGA, Flip Chip | 9.6 | 8.0 | 6.5 | 5.4 | 0.3 | 2.4 |
| HC4E35LF1517 | 1517 | FBGA, Flip Chip | 8.7 | 7.3 | 6.0 | 4.9 | 0.3 | 2.4 |
| HC4E35FF1517 | 1517 | FBGA, Flip Chip | 8.7 | 7.3 | 6.0 | 4.9 | 0.3 | 2.4 |
| **HardCopy IV GX Devices** | | | | | | | | |
| HC4GX15LF780 | 780 | FBGA, Flip Chip | 11.1 | 9.4 | 7.9 | 6.7 | 0.7 | 3.0 |
| HC4GX15LAF780 | 780 | FBGA, Flip Chip | 11.1 | 9.4 | 7.9 | 6.7 | 0.7 | 3.0 |
| HC4GX25LF780 | 780 | FBGA, Flip Chip | 10.2 | 8.7 | 7.3 | 6.1 | 0.4 | 2.3 |
| HC4GX25LF1152 | 1152 | FBGA, Flip Chip | 9.4 | 7.9 | 6.5 | 5.4 | 0.4 | 2.3 |
| HC4GX25FF1152 | 1152 | FBGA, Flip Chip | 9.3 | 7.8 | 6.4 | 5.3 | 0.4 | 2.3 |
| HC4GX35FF1152 | 1152 | FBGA, Flip Chip | 8.7 | 7.7 | 6.3 | 5.2 | 0.3 | 2.0 |
| HC4GX35FF1517 | 1517 | FBGA, Flip Chip | 8.2 | 7.1 | 5.8 | 4.7 | 0.3 | 2.0 |

**Table 43.** Thermal Resistance of HardCopy III Devices

| Device | Pin Count | Package | Theta JA for Without Heat Sink | | | | $\theta_{JC}$ (° C/W) | $\theta_{JB}$ (° C/W) |
|---|---|---|---|---|---|---|---|---|
| | | | $\theta_{JA}$ (° C/W) Still Air | $\theta_{JA}$ (° C/W) 100 ft./min. | $\theta_{JA}$ (° C/W) 200 ft./min. | $\theta_{JA}$ (° C/W) 400 ft./min. | | |
| HC315WF484 | 484 | FBGA, Wire Bond | 18.4 | 15.6 | 14.0 | 12.7 | 5.7 | 7.9 |
| HC325WF484 | 484 | FBGA, Wire Bond | 15.8 | 13.2 | 11.7 | 10.4 | 3.9 | 5.6 |
| HC325FF484 | 484 | FBGA, Flip Chip | 13.1 | 10.4 | 8.8 | 7.6 | 0.5 | 3.2 |
| HC325WF780 | 780 | FBGA, Wire Bond | 14.5 | 12.3 | 10.8 | 9.6 | 3.5 | 5.8 |
| HC325FF780 | 780 | FBGA, Flip Chip | 11.3 | 9.0 | 7.6 | 6.4 | 0.5 | 2.8 |
| HC335LF1152 | 1152 | FBGA, Flip Chip | 9.6 | 8.0 | 6.5 | 5.4 | 0.3 | 2.4 |
| HC335FF1152 | 1152 | FBGA, Flip Chip | 9.6 | 8.0 | 6.5 | 5.4 | 0.3 | 2.4 |
| HC335LF1517 | 1517 | FBGA, Flip Chip | 8.7 | 7.3 | 6.0 | 4.9 | 0.3 | 2.4 |
| HC335FF1517 | 1517 | FBGA, Flip Chip | 8.7 | 7.3 | 6.0 | 4.9 | 0.3 | 2.4 |

**Table 44.** Thermal Resistance of HardCopy II Devices

| Device | Pin Count | Package | $\theta_{JC}$ (° C/W) | $\theta_{JA}$ (° C/W) Still Air | $\theta_{JA}$ (° C/W) 100 ft./min. | $\theta_{JA}$ (° C/W) 200 ft./min. | $\theta_{JA}$ (° C/W) 400 ft./min. | $\theta_{JB}$ (° C/W) |
|---|---|---|---|---|---|---|---|---|
| HC210 | 484 | FBGA, Flip Chip | 0.8 | 13.4 | 11.2 | 9.6 | 8.3 | 4.6 |
| | 484 | FBGA, Wire Bond | 5.5 | 21.3 | 17.4 | 15.3 | 13.8 | 9.6 |
| HC220 | 672 | FBGA, Flip Chip | 0.5 | 12.1 | 9.9 | 8.3 | 7.1 | 3.6 |
| | 780 | FBGA, Flip Chip | 0.5 | 11.7 | 9.5 | 8.0 | 6.8 | 3.5 |
| HC230 | 1020 | FBGA, Flip Chip | 0.3 | 10.8 | 8.6 | 7.1 | 6.0 | 2.9 |
| HC240 | 1020 | FBGA, Flip Chip | 0.2 | 10.6 | 8.4 | 6.9 | 5.8 | 2.7 |
| | 1508 | FBGA, Flip Chip | 0.2 | 9.7 | 7.5 | 6.1 | 5.0 | 2.6 |

**Table 45.** Thermal Resistance of HardCopy Devices (Part 1 of 2)

| Device | Pin Count | Package | $\theta_{JC}$ (° C/W) | $\theta_{JA}$ (° C/W) Still Air | $\theta_{JA}$ (° C/W) 100 ft./min. | $\theta_{JA}$ (° C/W) 200 ft./min. | $\theta_{JA}$ (° C/W) 400 ft./min. |
|---|---|---|---|---|---|---|---|
| HC20K400 | 652 | BGA, Flip Chip | 0.5 | 9.1 | 7.9 | 6.4 | 5.3 |
| HC20K600 | 672 | FBGA, Flip Chip | 1.0 | 13.0 | 10.2 | 8.6 | 7.3 |
| HC1S25 | 672 | FBGA, Wire Bond | 3.7 | 19.7 | 15.8 | 13.9 | 12.4 |
| | | BGA, Wire Bond | 3.4 | 19.3 | 15.6 | 13.8 | 12.3 |
| HC1S30 | 780 | FBGA, Flip Chip | 0.4 | 10.9 | 8.8 | 7.4 | 6.3 |
| HC1S40 | 780 | FBGA, Flip Chip | 0.4 | 10.9 | 8.8 | 7.4 | 6.3 |

**Table 45.** Thermal Resistance of HardCopy Devices (Part 2 of 2)

| Device | Pin Count | Package | $\theta_{JC}$ (° C/W) | $\theta_{JA}$ (° C/W) Still Air | $\theta_{JA}$ (° C/W) 100 ft./min. | $\theta_{JA}$ (° C/W) 200 ft./min. | $\theta_{JA}$ (° C/W) 400 ft./min. |
|---|---|---|---|---|---|---|---|
| HC1S60 | 1020 | FBGA, Flip Chip | 0.3 | 10.3 | 8.54 | 7.0 | 5.8 |
| HC1S80 | 1020 | FBGA, Flip Chip | 0.3 | 10.3 | 8.54 | 7.0 | 5.8 |

## APEX Series Devices Thermal Resistance

Table 46 and Table 47 provide thermal resistance values for APEX series devices.

**Table 46.** Thermal Resistance of APEX II Devices

| Device | Pin Count | Package | $\theta_{JC}$ (° C/W) | $\theta_{JA}$ (° C/W) Still Air | $\theta_{JA}$ (° C/W) 100 ft./min. | $\theta_{JA}$ (° C/W) 200 ft./min. | $\theta_{JA}$ (° C/W) 400 ft./min. |
|---|---|---|---|---|---|---|---|
| EP2A15 | 672 | FBGA, Flip Chip (Cu lid) | 0.2 | 10.8 | 8.8 | 7.4 | 6.2 |
| | | FBGA, Flip Chip (AlSiC lid) | 0.3 | 11.6 | 9.6 | 8.0 | 6.6 |
| | 724 | BGA, Flip Chip (Cu lid) | 0.2 | 9.7 | 7.7 | 6.4 | 5.3 |
| | | BGA, Flip Chip (AlSiC lid) | 0.4 | 10.0 | 8.2 | 6.6 | 5.4 |
| EP2A25 | 672 | FBGA (Cu lid) | 0.2 | 10.7 | 8.7 | 7.2 | 6.1 |
| | | FBGA, Flip Chip (AlSiC lid) | 0.3 | 11.5 | 9.6 | 8.0 | 6.6 |
| | 724 | BGA, Flip Chip (Cu lid) | 0.2 | 9.6 | 7.6 | 6.2 | 5.2 |
| | | BGA, Flip Chip (AlSiC lid) | 0.3 | 10.0 | 8.2 | 6.6 | 5.4 |
| | 1020 | FBGA, Flip Chip (Cu lid) | 0.2 | 9.8 | 7.8 | 6.4 | 5.3 |
| | | FBGA, Flip Chip (AlSiC lid) | 0.3 | 10.4 | 8.5 | 6.9 | 5.7 |
| EP2A40 | 672 | FBGA, Flip Chip (Cu lid) | 0.2 | 10.0 | 8.2 | 6.9 | 5.9 |
| | | FBGA, Flip Chip (AlSiC lid) | 0.2 | 10.0 | 8.2 | 6.9 | 5.9 |
| | 724 | BGA, Flip Chip (Cu lid) | 0.2 | 9.5 | 7.5 | 6.1 | 5.1 |
| | | BGA, Flip Chip (AlSiC lid) | 0.2 | 9.5 | 7.5 | 6.1 | 5.1 |
| | 1,020 | FBGA, Flip Chip (Cu lid) | 0.2 | 9.7 | 7.7 | 6.3 | 5.2 |
| | | FBGA, Flip Chip (AlSiC lid) | 0.2 | 9.7 | 7.7 | 6.3 | 5.2 |
| EP2A70 | 724 | BGA, Flip Chip (Cu lid) | 0.1 | 9.3 | 7.3 | 6.0 | 4.9 |
| | | BGA, Flip Chip (AlSiC lid) | 0.1 | 10.0 | 7.9 | 6.4 | 5.3 |
| | 1,508 | FBGA, Flip Chip (Cu lid) | 0.1 | 8.8 | 6.8 | 5.5 | 4.5 |
| | | FBGA, Flip Chip (AlSiC lid) | 0.1 | 9.3 | 7.3 | 5.8 | 4.7 |

**Table 47.** Thermal Resistance of APEX 20K and APEX 20KE Devices (Part 1 of 3)

| Device | Pin Count | Package | $\theta_{JC}$ (° C/W) | $\theta_{JA}$ (° C/W) Still Air | $\theta_{JA}$ (° C/W) 100 ft./min. | $\theta_{JA}$ (° C/W) 200 ft./min. | $\theta_{JA}$ (° C/W) 400 ft./min. |
|---|---|---|---|---|---|---|---|
| EP20K30E | 144 | TQFP | 8.0 | 29.0 | 28.0 | 26.0 | 25.0 |
| | 208 | PQFP | 5.0 | 30.0 | 29.0 | 27.0 | 22.0 |
| | 144 | FBGA | 14.0 | 36.0 | 34.0 | 32.0 | 29.0 |
| | 324 | FBGA | 9.0 | 31.0 | 29.0 | 28.0 | 25.0 |

**Table 47.** Thermal Resistance of APEX 20K and APEX 20KE Devices (Part 2 of 3)

| Device | Pin Count | Package | $\theta_{JC}$ (° C/W) | $\theta_{JA}$ (° C/W) Still Air | $\theta_{JA}$ (° C/W) 100 ft./min. | $\theta_{JA}$ (° C/W) 200 ft./min. | $\theta_{JA}$ (° C/W) 400 ft./min. |
|---|---|---|---|---|---|---|---|
| EP20K60E | 144 | TQFP | 7.0 | 28.0 | 26.0 | 25.0 | 24.0 |
| | 144 | FBGA | 11.0 | 33.0 | 32.0 | 30.0 | 27.0 |
| | 208 | PQFP | 5.0 | 30.0 | 28.0 | 26.0 | 21.0 |
| | 240 | PQFP | 4.0 | 26.0 | 24.0 | 21.0 | 17.0 |
| | 324 | FBGA | 7.0 | 29.0 | 28.0 | 26.0 | 24.0 |
| | 356 | BGA | 1.0 | 12.0 | 11.0 | 10.0 | 9.0 |
| EP20K100 | 144 | TQFP | 7.0 | 26.0 | 25.0 | 24.0 | 23.0 |
| | 208 | PQFP | 5.0 | 29.0 | 27.0 | 25.0 | 20.0 |
| | 240 | PQFP | 4.0 | 25.0 | 23.0 | 20.0 | 17.0 |
| | 324 | FBGA | 6.0 | 28.0 | 26.0 | 25.0 | 23.0 |
| | 356 | BGA | 1.0 | 12.0 | 11.0 | 10.0 | 9.0 |
| EP20K100E | 144 | TQFP | 7.0 | 26.0 | 25.0 | 24.0 | 23.0 |
| | 144 | FBGA | 9.0 | 32.0 | 30.0 | 29.0 | 26.0 |
| | 208 | PQFP | 5.0 | 29.0 | 27.0 | 25.0 | 20.0 |
| | 240 | PQFP | 4.0 | 25.0 | 23.0 | 20.0 | 17.0 |
| | 324 | FBGA | 6.0 | 28.0 | 26.0 | 25.0 | 23.0 |
| | 356 | BGA | 1.0 | 12.0 | 11.0 | 10.0 | 9.0 |
| EP20K160E | 144 | TQFP | 6.0 | 25.0 | 24.0 | 23.0 | 22.0 |
| | 208 | PQFP | 5.0 | 28.0 | 26.0 | 23.0 | 19.0 |
| | 240 | PQFP | 4.0 | 24.0 | 21.0 | 19.0 | 16.0 |
| | 356 | BGA | 1.0 | 12.0 | 11.0 | 10.0 | 9.0 |
| | 484 | FBGA | 5.0 | 24.0 | 23.0 | 22.0 | 21.0 |
| EP20K200 | 208 | PQFP | 4.0 | 25.0 | 23.0 | 20.0 | 17.0 |
| | 240 | PQFP | 3.0 | 21.0 | 19.0 | 17.0 | 15.0 |
| | 356 | BGA | 1.0 | 12.0 | 11.0 | 10.0 | 9.0 |
| | 484 | FBGA | 5.0 | 22.0 | 21.0 | 20.0 | 19.0 |
| EP20K200E | 208 | PQFP | 4.0 | 25.0 | 23.0 | 20.0 | 17.0 |
| | 240 | PQFP | 3.0 | 22.0 | 19.0 | 18.0 | 16.0 |
| | 356 | BGA | 2.0 | 12.0 | 11.0 | 10.0 | 9.0 |
| | 484 | FBGA | 5.0 | 23.0 | 22.0 | 21.0 | 20.0 |
| | 652 | BGA | 1.0 | 12.0 | 11.0 | 10.0 | 9.0 |
| | 672 | FBGA | 5.0 | 21.0 | 20.0 | 19.0 | 18.0 |
| EP20K200C | 208 | PQFP | 4.0 | 25.0 | 23.0 | 20.0 | 17.0 |
| | 240 | PQFP | 3.0 | 22.0 | 19.0 | 18.0 | 16.0 |
| | 356 | BGA | 2.0 | 12.0 | 11.0 | 10.0 | 9.0 |
| | 484 | FBGA | 5.0 | 23.0 | 22.0 | 21.0 | 20.0 |
| EP20K300E | 240 | PQFP | 3.0 | 19.0 | 18.0 | 16.0 | 15.0 |
| | 652 | BGA | 1.0 | 12.0 | 11.0 | 10.0 | 9.0 |
| | 672 | FBGA | 5.0 | 20.0 | 19.0 | 18.0 | 17.0 |

**Table 47.** Thermal Resistance of APEX 20K and APEX 20KE Devices (Part 3 of 3)

| Device | Pin Count | Package | $\theta_{JC}$ (° C/W) | $\theta_{JA}$ (° C/W) Still Air | $\theta_{JA}$ (° C/W) 100 ft./min. | $\theta_{JA}$ (° C/W) 200 ft./min. | $\theta_{JA}$ (° C/W) 400 ft./min. |
|---|---|---|---|---|---|---|---|
| EP20K400 | 652 | BGA | 0.5 | 9.0 | 8.0 | 7.0 | 6.0 |
| | 655 | PGA | 1.0 | 8.0 | 7.0 | 6.0 | 4.0 |
| | 672 | FBGA | 0.4 | 11.6 | 9.6 | 7.9 | 6.5 |
| | 672 | FBGA w/ fin *(1)* | 0.5 | 7.0 | 4.0 | 3.0 | 2.6 |
| EP20K400E | 652 | BGA | 0.5 | 9.0 | 8.0 | 7.0 | 6.0 |
| EP20K400C | 672 | FBGA (Cu lid) | 0.3 | 10.9 | 8.8 | 7.4 | 6.3 |
| | | FBGA (AlSiC lid) | 0.4 | 11.7 | 9.7 | 8.0 | 6.7 |
| | 672 | FBGA w/ fin *(1)* | 0.5 | 7.0 | 4.0 | 3.0 | 2.6 |
| EP20K600E | 652 | BGA | 0.5 | 9.0 | 8.0 | 7.0 | 6.0 |
| EP20K600C | 672 | FBGA (Cu lid) | 0.2 | 10.8 | 8.7 | 7.3 | 6.1 |
| | | FBGA (AlSiC lid) | 0.3 | 11.6 | 9.6 | 7.9 | 6.5 |
| | 672 | FBGA w/ fin *(1)* | 0.5 | 5.0 | 3.0 | 3.0 | 2.0 |
| | 1,020 | FBGA (Cu lid) | 0.2 | 9.9 | 7.8 | 6.5 | 5.4 |
| | | FBGA (AlSiC lid) | 0.3 | 10.4 | 8.4 | 6.8 | 5.6 |
| | 1,020 | FBGA w/ fin *(1)* | 0.5 | 5.0 | 3.0 | 3.0 | 2.0 |
| EP20K1000E | 652 | BGA (Cu lid) | 0.1 | 8.3 | 7.0 | 5.6 | 4.5 |
| EP20K1000C | | BGA (AlSiC lid) | 0.2 | 9.3 | 7.4 | 6.0 | 4.9 |
| | 652 | FBGA w/ fin *(1)* | 0.5 | 4.0 | 3.0 | 3.0 | 2.0 |
| | 672 | FBGA (Cu lid) | 0.1 | 10.6 | 8.6 | 7.2 | 6.0 |
| | | FBGA (AlSiC lid) | 0.2 | 11.4 | 9.4 | 7.7 | 6.3 |
| | 672 | FBGA w/ fin *(1)* | 0.5 | 6.0 | 4.0 | 3.0 | 2.0 |
| | 1,020 | FBGA (Cu lid) | 0.1 | 9.7 | 7.7 | 6.3 | 5.2 |
| | | FBGA (AlSiC lid) | 0.2 | 10.2 | 8.2 | 6.6 | 5.4 |
| | 1,020 | FBGA w/ fin *(1)* | 0.5 | 5.0 | 3.0 | 2.0 | 2.0 |
| EP20K1500E | 652 | BGA (Cu lid) | 0.1 | 8.2 | 6.9 | 5.5 | 4.4 |
| | | BGA (AlSiC lid) | 0.2 | 9.2 | 7.3 | 5.8 | 4.8 |
| | 652 | FBGA | 0.1 | 9.2 | 7.3 | 5.8 | 4.8 |
| | 652 | FBGA w/ fin *(1)* | 0.5 | 4.0 | 3.0 | 2.5 | 2.0 |
| | 1,020 | FBGA (Cu lid) | 0.1 | 9.6 | 7.6 | 6.2 | 5.1 |
| | | FBGA (AlSiC lid) | 0.2 | 10.1 | 8.1 | 6.4 | 5.3 |
| | 1,020 | FBGA w/ fin *(1)* | 0.5 | 5.0 | 3.0 | 2.5 | 2.0 |

**Note to Table 47:**

(1) "fin" is an extra heat sink that customers can add to the device. Several vendors make heat sinks, and they all have different sizes. Altera performed the thermal calculations in Table 47 using the following fin specifications: width: 0.25 mm; height: 7.0 mm; pitch: 1.5 mm; base thickness: 0.5 mm.

## ACEX 1K Devices Thermal Resistance

Table 48 provides thermal resistance values for ACEX 1K devices.

**Table 48.** Thermal Resistance of ACEX 1K Devices

| Device | Pin Count | Package | $\theta_{JC}$ (° C/W) | $\theta_{JA}$ (° C/W) Still Air | $\theta_{JA}$ (° C/W) 100 ft./min. | $\theta_{JA}$ (° C/W) 200 ft./min. | $\theta_{JA}$ (° C/W) 400 ft./min. |
|---|---|---|---|---|---|---|---|
| EP1K10 | 100 | TQFP | 11.0 | 37.0 | 35.0 | 33.0 | 29.0 |
| | 144 | TQFP | 8.0 | 31.0 | 29.0 | 28.0 | 25.0 |
| | 208 | PQFP | 6.0 | 30.0 | 29.0 | 27.0 | 22.0 |
| | 256 | FBGA | 12.0 | 37.0 | 35.0 | 33.0 | 30.0 |
| EP1K30 | 144 | TQFP | 8.0 | 28.0 | 27.0 | 26.0 | 24.0 |
| | 208 | PQFP | 5.0 | 30.0 | 28.0 | 26.0 | 21.0 |
| | 256 | FBGA | 9.0 | 31.0 | 29.0 | 28.0 | 25.0 |
| EP1K50 | 144 | TQFP | 7.0 | 26.0 | 25.0 | 24.0 | 23.0 |
| | 208 | PQFP | 5.0 | 29.0 | 28.0 | 25.0 | 20.0 |
| | 256 | FBGA | 7.0 | 30.0 | 28.0 | 27.0 | 24.0 |
| | 484 | FBGA | 5.0 | 25.0 | 24.0 | 23.0 | 22.0 |
| EP1K100 | 208 | PQFP | 5.0 | 28.0 | 26.0 | 23.0 | 18.0 |
| | 256 | FBGA | 6.0 | 28.0 | 26.0 | 25.0 | 23.0 |
| | 484 | FBGA | 5.0 | 24.0 | 23.0 | 22.0 | 21.0 |

## Mercury Devices Thermal Resistance

Table 49 provides thermal resistance values for Mercury devices.

**Table 49.** Thermal Resistance of Mercury Devices

| Device | Pin Count | Package | $\theta_{JC}$ (° C/W) | $\theta_{JA}$ (° C/W) Still Air | $\theta_{JA}$ (° C/W) 100 ft./min. | $\theta_{JA}$ (° C/W) 200 ft./min. | $\theta_{JA}$ (° C/W) 400 ft./min. |
|---|---|---|---|---|---|---|---|
| EP1M120 | 484 | FBGA (Cu lid) | 0.6 | 12.2 | 10.1 | 8.7 | 7.5 |
| | 484 | FBGA (AlSiC lid) | 0.9 | 13.0 | 11.1 | 9.3 | 7.9 |
| EP1M350 | 780 | FBGA (Cu lid) | 0.2 | 10.5 | 8.5 | 7.1 | 5.9 |
| | 780 | FBGA (AlSiC lid) | 0.3 | 11.0 | 9.2 | 7.6 | 6.3 |

## FLEX Series Devices Thermal Resistance

Table 50 through Table 52 provide thermal resistance values for FLEX series devices.

**Table 50.** Thermal Resistance of FLEX 10K Devices (Part 1 of 3)

| Device | Pin Count | Package | $\theta_{JC}$ (° C/W) | $\theta_{JA}$ (° C/W) Still Air | $\theta_{JA}$ (° C/W) 100 ft./min. | $\theta_{JA}$ (° C/W) 200 ft./min. | $\theta_{JA}$ (° C/W) 400 ft./min. |
|---|---|---|---|---|---|---|---|
| EPF10K10 | 84 | PLCC | 9.0 | 28.0 | 26.0 | 24.0 | 22.0 |
| | 144 | TQFP | 7.0 | 26.0 | 25.0 | 24.0 | 23.0 |
| | 208 | PQFP | 5.0 | 29.0 | 27.0 | 25.0 | 20.0 |
| EPF10K10A | 100 | TQFP | 10.0 | 35.0 | 33.0 | 31.0 | 28.0 |
| | 144 | TQFP | 7.0 | 29.0 | 28.0 | 26.0 | 25.0 |
| | 208 | PQFP | 5.0 | 30.0 | 29.0 | 27.0 | 21.0 |
| | 256 | FBGA | 7.0 | 33.0 | 30.0 | 28.0 | 26.0 |
| EPF10K20 | 144 | TQFP | 6.0 | 24.0 | 23.0 | 22.0 | 21.0 |
| | 208 | RQFP | 1.0 | 17.0 | 16.0 | 15.0 | 13.0 |
| | 240 | RQFP | 1.0 | 14.0 | 12.0 | 11.0 | 10.0 |
| EPF10K30 | 208 | RQFP | 1.0 | 17.0 | 16.0 | 15.0 | 12.0 |
| | 240 | RQFP | 1.0 | 13.0 | 12.0 | 11.0 | 10.0 |
| | 356 | BGA | 1.0 | 12.0 | 11.0 | 10.0 | 9.0 |
| EPF10K30A | 144 | TQFP | 7.0 | 25.0 | 24.0 | 23.0 | 22.0 |
| | 208 | PQFP | 5.0 | 29.0 | 27.0 | 24.0 | 19.0 |
| | 240 | PQFP | 4.0 | 25.0 | 22.0 | 20.0 | 17.0 |
| | 256 | FBGA | 6.0 | 28.0 | 26.0 | 24.0 | 23.0 |
| | 356 | BGA | 1.0 | 12.0 | 11.0 | 10.0 | 9.0 |
| | 484 | FBGA | 5.0 | 24.0 | 22.0 | 21.0 | 20.0 |
| EPF10K30E | 144 | TQFP | 9.0 | 28.0 | 27.0 | 26.0 | 24.0 |
| | 208 | PQFP | 5.0 | 30.0 | 28.0 | 26.0 | 21.0 |
| | 256 | FBGA | 9.0 | 31.0 | 29.0 | 28.0 | 25.0 |
| | 484 | FBGA | 6.0 | 26.0 | 25.0 | 24.0 | 22.0 |
| EPF10K40 | 208 | RQFP | 1.0 | 17.0 | 16.0 | 15.0 | 12.0 |
| | 240 | RQFP | 1.0 | 13.0 | 12.0 | 11.0 | 10.0 |
| EPF10K50 | 240 | RQFP | 1.0 | 12.0 | 11.0 | 10.0 | 9.0 |
| | 356 | BGA | 1.0 | 12.0 | 11.0 | 10.0 | 9.0 |
| | 403 | PGA | 3.0 | 12.0 | 10.0 | 9.0 | 8.0 |
| | | PGA *(1)* | 3.0 | 10.0 | 8.0 | 7.0 | 6.0 |
| EPF10K50V | 240 | PQFP | 4.0 | 25.0 | 22.0 | 20.0 | 17.0 |
| | 240 | RQFP | 1.0 | 13.0 | 12.0 | 11.0 | 10.0 |
| | 356 | BGA | 1.0 | 12.0 | 11.0 | 10.0 | 9.0 |
| | 484 | FBGA | 5.0 | 23.0 | 22.0 | 21.0 | 20.0 |

**Table 50.** Thermal Resistance of FLEX 10K Devices (Part 2 of 3)

| Device | Pin Count | Package | $\theta_{JC}$ (° C/W) | $\theta_{JA}$ (° C/W) Still Air | $\theta_{JA}$ (° C/W) 100 ft./min. | $\theta_{JA}$ (° C/W) 200 ft./min. | $\theta_{JA}$ (° C/W) 400 ft./min. |
|---|---|---|---|---|---|---|---|
| EPF10K50E | 144 | TQFP | 9.0 | 26.0 | 25.0 | 24.0 | 23.0 |
| | 208 | PQFP | 5.0 | 29.0 | 27.0 | 24.0 | 19.0 |
| | 240 | PQFP | 4.0 | 25.0 | 22.0 | 20.0 | 17.0 |
| | 256 | FBGA | 6.0 | 29.0 | 27.0 | 26.0 | 24.0 |
| | 484 | FBGA | 5.0 | 25.0 | 24.0 | 23.0 | 21.0 |
| EPF10K50S | 144 | TQFP | 9.0 | 26.0 | 25.0 | 24.0 | 23.0 |
| | 208 | PQFP | 5.0 | 29.0 | 28.0 | 25.0 | 20.0 |
| | 240 | PQFP | 4.0 | 26.0 | 23.0 | 20.0 | 17.0 |
| | 256 | FBGA | 7.0 | 30.0 | 28.0 | 27.0 | 24.0 |
| | 356 | BGA | 1.0 | 12.0 | 11.0 | 10.0 | 9.0 |
| | 484 | FBGA | 5.0 | 25.0 | 24.0 | 23.0 | 22.0 |
| EPF10K70 | 240 | RQFP | 1.0 | 12.0 | 11.0 | 10.0 | 9.0 |
| | 503 | PGA | 1.0 | 8.0 | 7.0 | 6.0 | 4.0 |
| EPF10K100 | 503 | PGA | 1.0 | 8.0 | 7.0 | 6.0 | 4.0 |
| | | PGA *(1)* | 1.0 | 6.0 | 5.0 | 4.0 | 3.0 |
| | | PGA *(2)* | — | 2.0 | — | — | — |
| EPF10K100A | 240 | RQFP | 1.0 | 13.0 | 11.0 | 10.0 | 9.0 |
| | 356 | BGA | 1.0 | 12.0 | 11.0 | 10.0 | 9.0 |
| | 484 | FBGA | 5.0 | 22.0 | 21.0 | 20.0 | 18.0 |
| | 600 | BGA | 0.5 | 10.0 | 9.0 | 8.0 | 7.0 |
| EPF10K100E | 208 | PQFP | 5.0 | 28.0 | 26.0 | 23.0 | 18.0 |
| | 240 | PQFP | 4.0 | 23.0 | 21.0 | 19.0 | 16.0 |
| | 256 | FBGA | 6.0 | 28.0 | 26.0 | 25.0 | 23.0 |
| | 356 | BGA | 1.0 | 12.0 | 11.0 | 10.0 | 9.0 |
| | 484 | FBGA | 5.0 | 24.0 | 23.0 | 22.0 | 21.0 |
| EPF10K130V | 599 | PGA | 1.0 | 8.0 | 7.0 | 6.0 | 4.0 |
| | 600 | BGA | 0.5 | 10.0 | 9.0 | 8.0 | 7.0 |
| EPF10K130E | 240 | PQFP | 4.0 | 21.0 | 19.0 | 17.0 | 15.0 |
| | 356 | BGA | 1.0 | 12.0 | 11.0 | 10.0 | 9.0 |
| | 484 | FBGA | 5.0 | 23.0 | 22.0 | 21.0 | 20.0 |
| | 600 | BGA | 0.5 | 10.0 | 9.0 | 8.0 | 7.0 |
| | 672 | FBGA | 5.0 | 21.0 | 20.0 | 19.0 | 18.0 |
| EPF10K200E | 599 | PGA | 1.0 | 8.0 | 7.0 | 6.0 | 4.0 |
| | 600 | BGA | 0.5 | 10.0 | 9.0 | 8.0 | 7.0 |
| | 672 | FBGA | 5.0 | 20.0 | 19.0 | 18.0 | 17.0 |

**Table 50.** Thermal Resistance of FLEX 10K Devices (Part 3 of 3)

| Device | Pin Count | Package | $\theta_{JC}$ (° C/W) | $\theta_{JA}$ (° C/W) Still Air | $\theta_{JA}$ (° C/W) 100 ft./min. | $\theta_{JA}$ (° C/W) 200 ft./min. | $\theta_{JA}$ (° C/W) 400 ft./min. |
|---|---|---|---|---|---|---|---|
| EPF10K200S | 240 | RQFP | 1.0 | 13.0 | 11.0 | 10.0 | 9.0 |
| | 356 | BGA | 1.0 | 12.0 | 11.0 | 10.0 | 9.0 |
| | 484 | FBGA | 5.0 | 22.0 | 21.0 | 20.0 | 19.0 |
| | 600 | BGA | 0.5 | 10.0 | 9.0 | 8.0 | 7.0 |
| | 672 | FBGA | 5.0 | 21.0 | 20.0 | 19.0 | 18.0 |
| EPF10K250A | 599 | PGA | 1.0 | 8.0 | 7.0 | 6.0 | 4.0 |
| | 600 | BGA | 0.5 | 10.0 | 9.0 | 8.0 | 7.0 |

**Notes to Table 50:**

(1) With attached pin-fin heat sink.

(2) With attached motor-driven fan heat sink.

**Table 51.** Thermal Resistance of FLEX 8000 Devices

| Device | Pin Count | Package | $\theta_{JC}$ (° C/W) | $\theta_{JA}$ (° C/W) Still Air | $\theta_{JA}$ (° C/W) 100 ft./min. | $\theta_{JA}$ (° C/W) 200 ft./min. | $\theta_{JA}$ (° C/W) 400 ft./min. |
|---|---|---|---|---|---|---|---|
| EPF8282A | 84 | PLCC | 10.0 | 30.0 | 28.0 | 26.0 | 23.0 |
| | 100 | TQFP | 11.0 | 36.0 | 34.0 | 32.0 | 29.0 |
| EPF8452A | 84 | PLCC | 10.0 | 30.0 | 28.0 | 26.0 | 23.0 |
| | 100 | TQFP | 11.0 | 35.0 | 33.0 | 31.0 | 28.0 |
| | 160 | PQFP | 6.0 | 32.0 | 31.0 | 30.0 | 28.0 |
| | 160 | PGA | 6.0 | 20.0 | 13.0 | 10.0 | 8.0 |
| EPF8636A | 84 | PLCC | 10.0 | 29.0 | 28.0 | 26.0 | 23.0 |
| | 160 | PQFP | 6.0 | 32.0 | 31.0 | 30.0 | 27.0 |
| | 192 | PGA | 6.0 | 16.0 | 11.0 | 8.0 | 6.0 |
| | 208 | PQFP | 5.0 | 30.0 | 38.0 | 26.0 | 20.0 |
| | 208 | RQFP | 1.0 | 17.0 | 16.0 | 15.0 | 14.0 |
| EPF8820A | 144 | TQFP | 9.0 | 26.0 | 25.0 | 24.0 | 23.0 |
| | 160 | PQFP | 6.0 | 32.0 | 31.0 | 30.0 | 27.0 |
| | 192 | PGA | 6.0 | 16.0 | 11.0 | 8.0 | 6.0 |
| | 208 | PQFP | 5.0 | 29.0 | 27.0 | 25.0 | 20.0 |
| | 208 | RQFP | 1.0 | 17.0 | 16.0 | 15.0 | 14.0 |
| | 225 | BGA | 6.0 | 28.0 | 19.0 | 14.0 | 11.0 |
| EPF81188A | 208 | PQFP | 5.0 | 28.0 | 26.0 | 24.0 | 19.0 |
| | 232 | PGA | 2.0 | 14.0 | 10.0 | 7.0 | 5.0 |
| | 240 | PQFP | 4.0 | 24.0 | 21.0 | 19.0 | 16.0 |
| | 240 | RQFP | 1.0 | 14.0 | 12.0 | 11.0 | 10.0 |
| EPF81500A | 240 | PQFP | 4.0 | 22.0 | 20.0 | 19.0 | 16.0 |
| | 240 | RQFP | 1.0 | 13.0 | 12.0 | 11.0 | 10.0 |
| | 280 | PGA | 2.0 | 14.0 | 10.0 | 7.0 | 5.0 |
| | 304 | RQFP | 1.0 | 11.0 | 10.0 | 9.0 | 8.0 |

**Table 52.** Thermal Resistance of FLEX 6000 Devices

| Device | Pin Count | Package | $\theta_{JC}$ (° C/W) | $\theta_{JA}$ (° C/W) Still Air | $\theta_{JA}$ (° C/W) 100 ft./min. | $\theta_{JA}$ (° C/W) 200 ft./min. | $\theta_{JA}$ (° C/W) 400 ft./min. |
|---|---|---|---|---|---|---|---|
| EPF6010A | 100 | TQFP | 11.0 | 35.0 | 33.0 | 31.0 | 28.0 |
| | 144 | TQFP | 10.0 | 28.0 | 26.0 | 25.0 | 24.0 |
| EPF6016 | 144 | TQFP | 10.0 | 28.0 | 26.0 | 25.0 | 24.0 |
| | 208 | PQFP | 5.0 | 30.0 | 28.0 | 26.0 | 21.0 |
| | 240 | PQFP | 4.0 | 26.0 | 24.0 | 21.0 | 17.0 |
| | 256 | BGA | 6.0 | 28.0 | 22.0 | 20.0 | 19.0 |
| EPF6016A | 100 | TQFP | 11.0 | 35.0 | 33.0 | 31.0 | 28.0 |
| | | FBGA | 14.0 | 36.0 | 34.0 | 32.0 | 29.0 |
| | 144 | TQFP | 10.0 | 29.0 | 28.0 | 26.0 | 24.0 |
| | 208 | PQFP | 5.0 | 30.0 | 29.0 | 26.0 | 21.0 |
| | 256 | FBGA | 10.0 | 32.0 | 30.0 | 29.0 | 26.0 |
| EPF6024A | 144 | TQFP | 10.0 | 27.0 | 26.0 | 25.0 | 24.0 |
| | 208 | PQFP | 5.0 | 29.0 | 28.0 | 26.0 | 20.0 |
| | 240 | PQFP | 4.0 | 26.0 | 23.0 | 21.0 | 17.0 |
| | 256 | BGA | 6.0 | 28.0 | 22.0 | 20.0 | 19.0 |
| | | FBGA | 8.0 | 30.0 | 29.0 | 27.0 | 25.0 |

## Excalibur Embedded Processor Solutions Thermal Resistance

Table 53 provides thermal resistance values for Excalibur Embedded Processor Solutions.

**Table 53.** Thermal Resistance of Excalibur Embedded Processor Solutions

| Device | Pin Count | Package | $\theta_{JC}$ (° C/W) | $\theta_{JA}$ (° C/W) Still Air | $\theta_{JA}$ (° C/W) 100 ft./min. | $\theta_{JA}$ (° C/W) 200 ft./min. | $\theta_{JA}$ (° C/W) 400 ft./min. |
|---|---|---|---|---|---|---|---|
| EPXA1 | 484 | FBGA | 4.0 | 20.0 | 18.3 | 15.8 | 13.9 |
| | 672 | FBGA, Flip Chip (Cu lid) | 0.5 | 11.3 | 9.3 | 7.9 | 6.7 |
| | 672 | FBGA, Flip Chip (AlSiC lid) | 0.8 | 12.2 | 10.2 | 8.6 | 7.2 |
| EPXA4 | 672 | FBGA, Flip Chip (Cu lid) | 0.2 | 10.8 | 8.8 | 7.3 | 6.2 |
| | 672 | FBGA, Flip Chip (AlSiC lid) | 0.3 | 11.6 | 9.6 | 7.9 | 6.6 |
| | 1,020 | FBGA, Flip Chip (Cu lid) | 0.2 | 9.9 | 7.9 | 6.5 | 5.4 |
| | 1,020 | FBGA, Flip Chip (AlSiC lid) | 0.3 | 10.4 | 8.5 | 6.9 | 5.7 |
| EPXA10 | 1,020 | FBGA, Flip Chip (Cu lid) | 0.1 | 9.6 | 7.6 | 6.2 | 5.1 |
| | 1,020 | FBGA, Flip Chip (AlSiC lid) | 0.2 | 10.0 | 8.0 | 6.4 | 5.7 |

## Classic Devices Thermal Resistance

Table 54 provides thermal resistance values for Classic devices.

**Table 54.** Thermal Resistance of Classic Devices

| Device | Pin Count | Package | $\theta_{JC}$ (° C/W) | $\theta_{JA}$ (° C/W) |
|---|---|---|---|---|
| EP600I | 24 | PDIP | 22.0 | 67.0 |
| | | CerDIP | 18.0 | 60.0 |
| | 28 | PLCC | 16.0 | 64.0 |
| EP610 | 24 | CerDIP | 10.0 | 60.0 |
| | | PDIP | 18.0 | 55.0 |
| | | SOIC | 17.0 | 77.0 |
| | 28 | PLCC | 13.0 | 74.0 |
| EP610I | 24 | CerDIP | 18.0 | 60.0 |
| | | PDIP | 22.0 | 67.0 |
| | 28 | PLCC | 16.0 | 64.0 |
| EP900I | 40 | PDIP | 23.0 | 49.0 |
| | 44 | PLCC | 10.0 | 58.0 |
| EP910 | 40 | CerDIP | 12.0 | 40.0 |
| | | PDIP | 23.0 | 49.0 |
| | 44 | PLCC | 10.0 | 58.0 |
| EP910I | 40 | CerDIP | 17.0 | 44.0 |
| | | PDIP | 29.0 | 51.0 |
| | 44 | PLCC | 16.0 | 55.0 |
| EP1800I | 68 | PLCC | 13.0 | 44.0 |
| EP1810 | 68 | JLCC | 12.0 | 47.0 |
| | | PLCC | 13.0 | 44.0 |
| | | PGA | 6.0 | 38.0 |

# Package Outlines

The package outlines on the following pages are listed in order of ascending pin count. Altera package outlines meet the requirements of **JEDEC Publication No. 95**.

All flip chip packages are vented packages and all wire bond packages are non-vented packages.

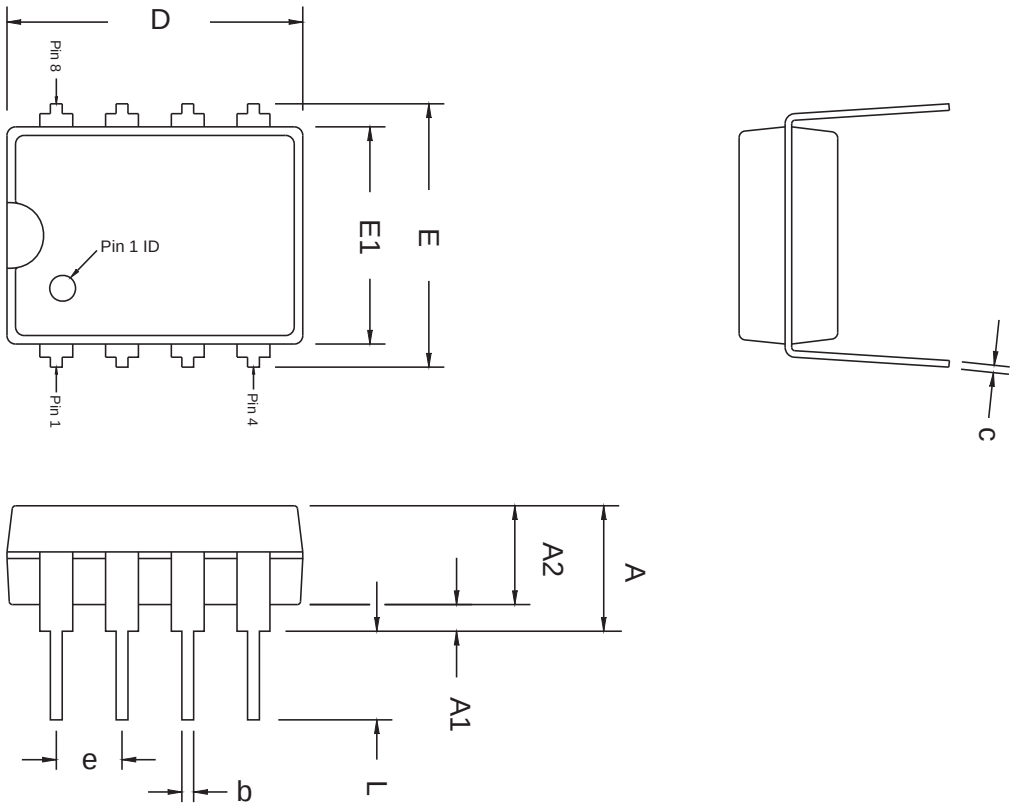
## 8-Pin Plastic Dual In-Line Package (PDIP) — Wire Bond

- All dimensions and tolerances conform to ASME Y14.5M - 1994.
- Controlling dimension is in inches.
- Pin 1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | P |
| Package Acronym | PDIP |
| Leadframe Material | Copper |
| Lead Finish (Plating) | Regular: 85Sn:15Pb (Typ.)<br>Pb-free: Matte Sn |
| JEDEC Outline Reference | MS-001 Variation: BA |
| Lead Coplanarity | NA |
| Weight | 0.6 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Inches** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 0.170 |
| A1 | 0.015 | – | – |
| A2 | 0.130 TYP | | |
| D | 0.360 | – | 0.380 |
| E | 0.300 | 0.310 | 0.325 |
| E1 | 0.240 | 0.250 | 0.260 |
| L | 0.125 | – | 0.135 |
| b | 0.016 | 0.018 | 0.020 |
| c | 0.008 | 0.010 | 0.014 |
| e | 0.100 BSC | | |

## Package Outline



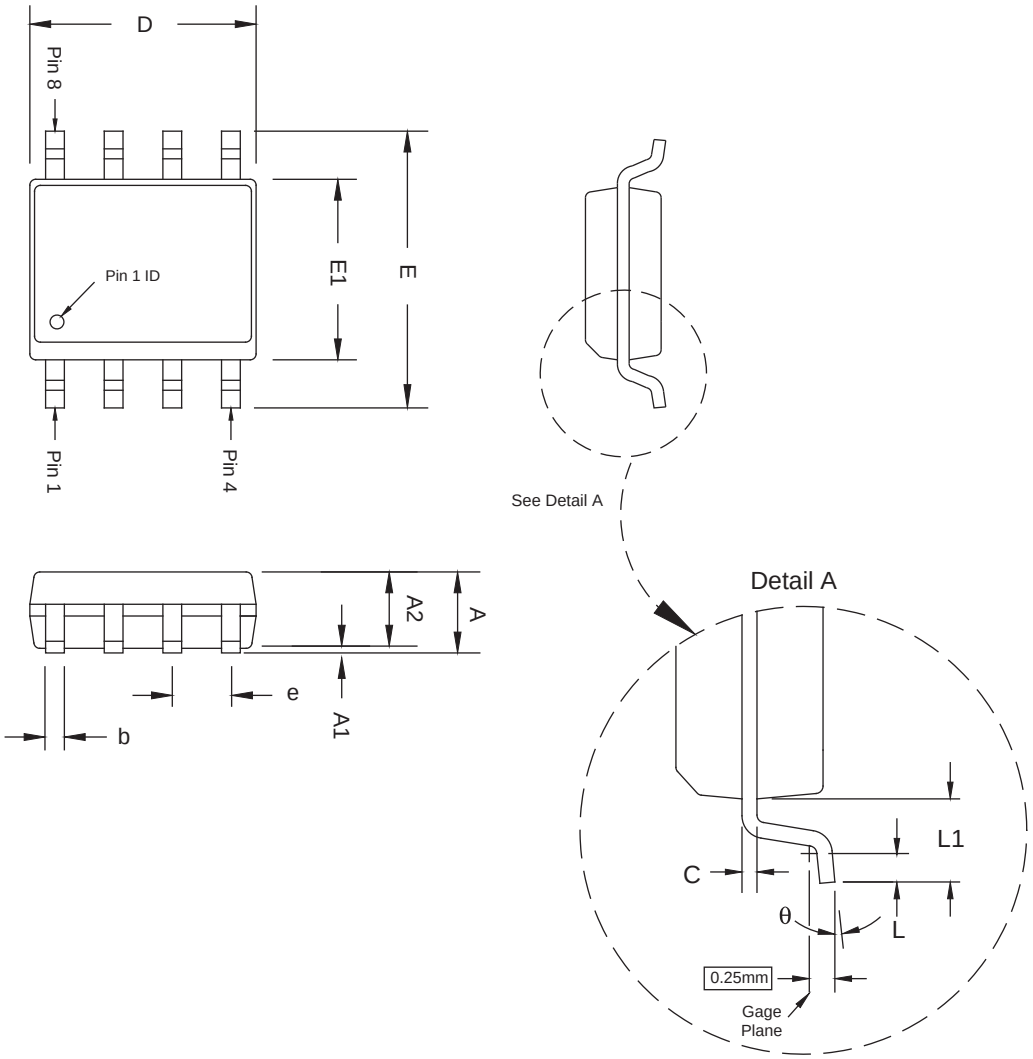
## 8-Pin Small Outline Integrated Circuit Package (SOIC) — Wire Bond

- All dimensions and tolerances conform to ASME Y14.5M - 1994.
- Controlling dimension is in millimeters.
- Pin 1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | S |
| Package Acronym | SOIC |
| Leadframe Material | Copper |
| Lead Finish (Plating) | Regular: 85Sn:15Pb (Typ)<br>Pb-free: NiPdAu (Preplated) |
| JEDEC Outline Reference | MS-012 Variation. AA |
| Lead Coplanarity | 0.1 mm |
| Weight | 0.1 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | 1.35 | – | 1.75 |
| A1 | 0.10 | – | 0.25 |
| A2 | 1.25 | – | 1.65 |
| D | 4.90 BSC | | |
| E | 6.00 BSC | | |
| E1 | 3.90 BSC | | |
| L | 0.40 | – | 1.27 |
| L1 | 1.04 REF | | |
| b | 0.31 | – | 0.51 |
| c | 0.17 | – | 0.25 |
| e | 1.27 BSC | | |
| θ | 0° | – | 8° |

## Package Outline



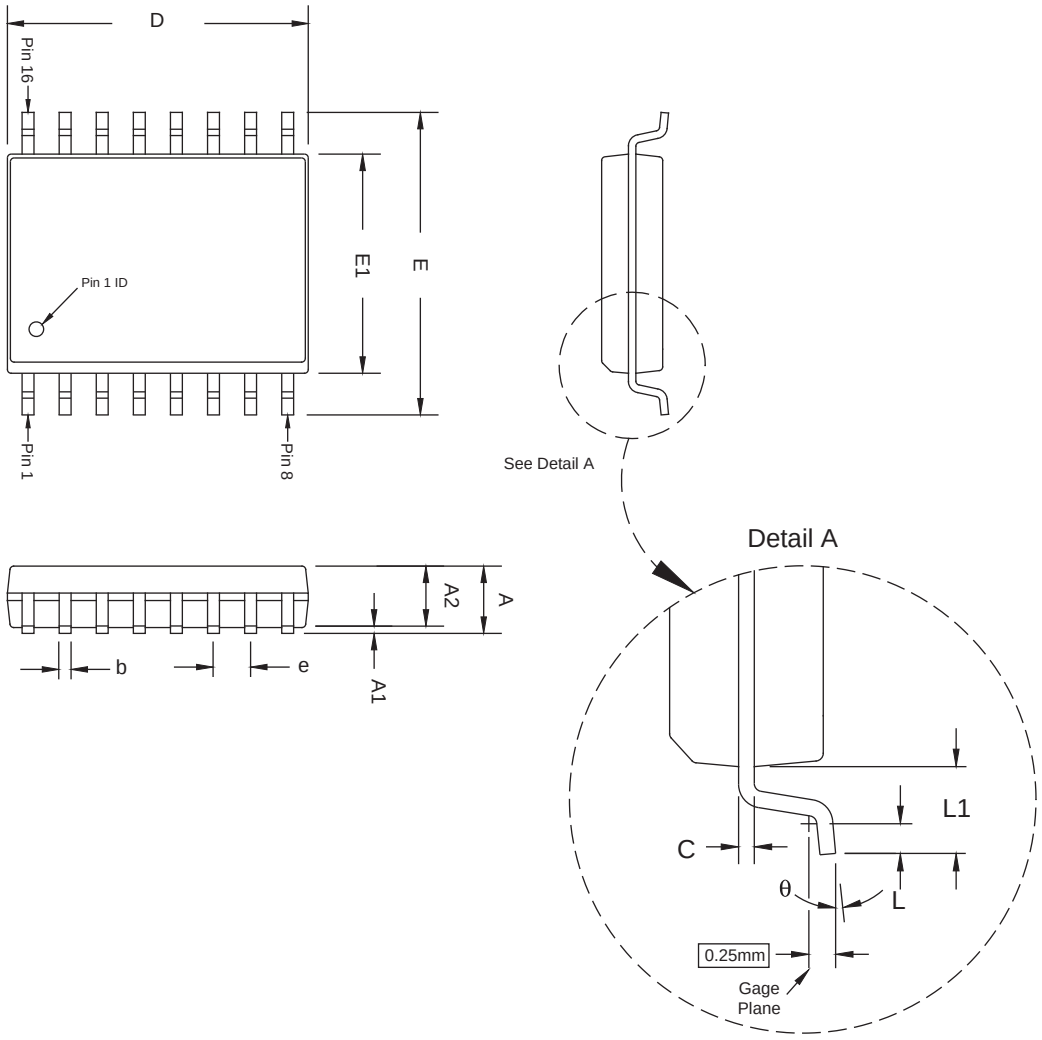
## 16-Pin Small Outline Integrated Circuit Package (SOIC) — Wire Bond

- All dimensions and tolerances conform to ASME Y14.5M - 1994.
- Controlling dimension is in millimeters.
- Pin 1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | S |
| Package Acronym | SOIC |
| Leadframe Material | Copper |
| Lead Finish (Plating) | Pb-free: NiPdAu (Preplated) |
| JEDEC Outline Reference | MS-013 Var. AA |
| Lead Coplanarity | 0.1 mm |
| Weight | 0.5 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | 2.35 | – | 2.65 |
| A1 | 0.10 | – | 0.30 |
| A2 | 2.05 | – | 2.55 |
| D | 10.30 BSC | | |
| E | 10.30 BSC | | |
| E1 | 7.50 BSC | | |
| L | 0.40 | – | 1.27 |
| L1 | 1.40 REF | | |
| b | 0.31 | – | 0.51 |
| c | 0.20 | – | 0.33 |
| e | 1.27 BSC | | |
| θ | 0° | – | 8° |

## Package Outline



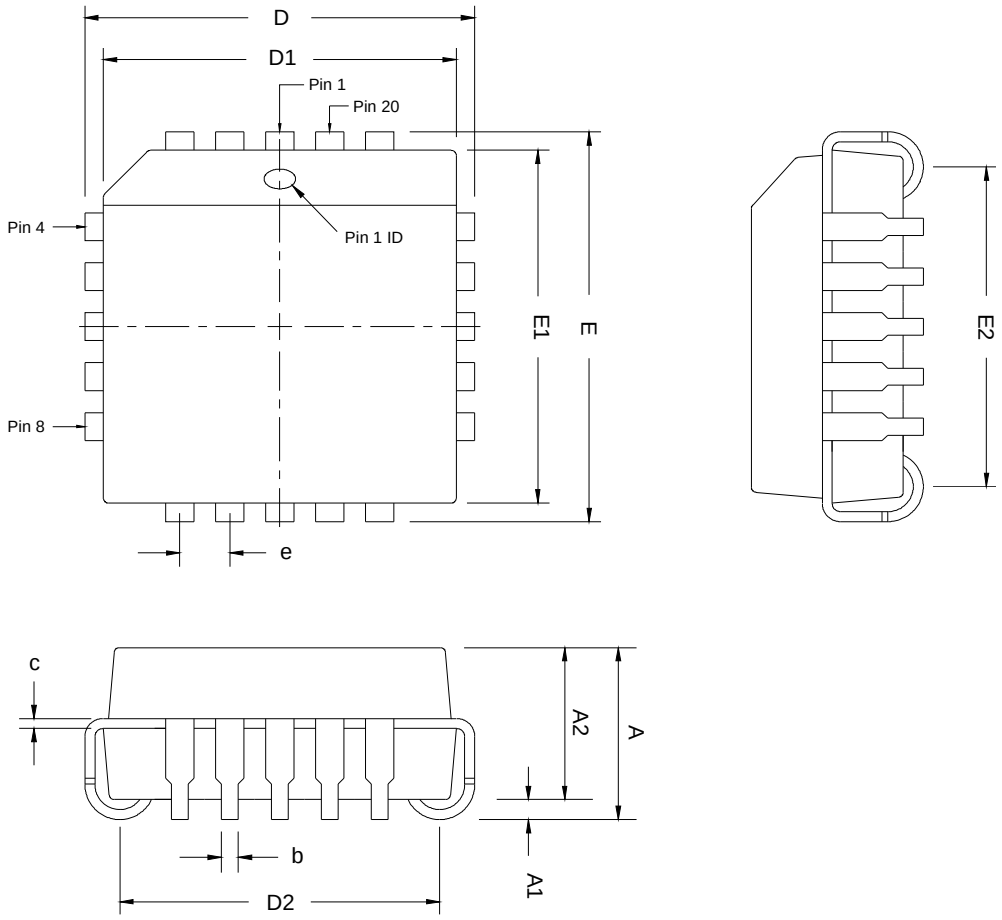
## 20-Pin Plastic J-Lead Chip Carrier (PLCC) Wire Bond

- All dimensions and tolerances conform to ASME Y14.5M – 1994.
- Controlling dimension is in inches.
- Pin 1 is generally indicated by an indentation in the plastic body, in Pin 1's proximity, on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | L |
| Package Acronym | PLCC |
| Leadframe Material | Copper |
| Lead Finish (Plating) | Regular: 85Sn:15Pb (Typ.)<br>Pb-free: Matte Sn |
| JEDEC Outline Reference | MS-018 Variation: AA |
| Lead Coplanarity | 0.004 inches (0.10mm) |
| Weight | 0.8 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Inches** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | 0.165 | 0.172 | 0.180 |
| A1 | 0.020 | – | – |
| A2 | 0.150 TYP | | |
| D | 0.385 | 0.390 | 0.395 |
| D1 | 0.350 | 0.353 | 0.356 |
| D2 | 0.290 | 0.310 | 0.330 |
| E | 0.385 | 0.390 | 0.395 |
| E1 | 0.350 | 0.353 | 0.356 |
| E2 | 0.290 | 0.310 | 0.330 |
| b | 0.013 | – | 0.021 |
| c | 0.010 TYP | | |
| e | 0.050 TYP | | |

## Package Outline



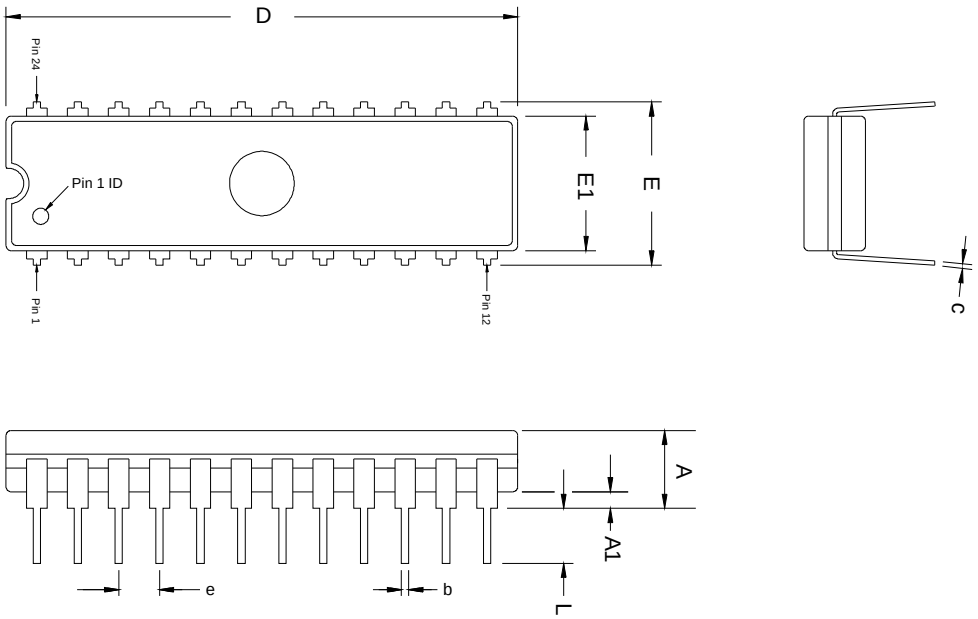
## 24-Pin Ceramic Dual In-Line Package (CerDIP) —Wire Bond

- All dimensions and tolerances conform to ASME Y14.5M – 1994.
- Controlling dimension is in inches.
- Pin 1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | D |
| Package Acronym | CerDIP |
| Leadframe Material | Alloy 42 |
| Lead Finish | Regular: 63Sn:37Pb (Typ.) |
| JEDEC Outline Reference | MS-030 Variation: AF |
| Lead Coplanarity | NA |
| Weight | 4.1 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Inches** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 0.200 |
| A1 | 0.015 | 0.028 | 0.041 |
| D | 1.240 | 1.260 | 1.280 |
| E | 0.290 | 0.305 | 0.320 |
| E1 | 0.280 | 0.295 | 0.310 |
| L | 0.125 | – | – |
| b | 0.015 | 0.018 | 0.021 |
| e | 0.100 BSC | | |

## Package Outline



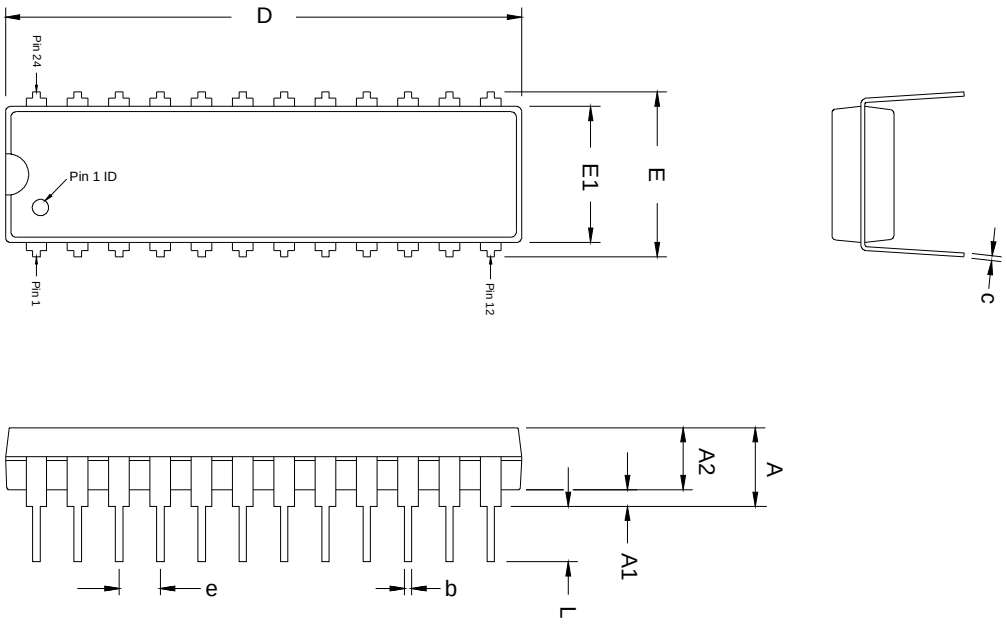
## 24-Pin Plastic Dual In-Line Package (PDIP) — Wire Bond

- All dimensions and tolerances conform to ASME Y14.5M – 1994.
- Controlling dimension is in inches.
- Pin 1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | P |
| Package Acronym | PDIP |
| Leadframe Material | Copper |
| Lead Finish (Plating) | Regular: 85Sn:15Pb (Typ.)<br>Pb-free: Matte Sn |
| JEDEC Outline Reference | MS-001 Variation: AF |
| Lead Coplanarity | NA |
| Weight | 1.9 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Inches** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 0.170 |
| A1 | 0.015 | – | – |
| A2 | 0.130 TYP | | |
| D | 1.245 | 1.250 | 1.255 |
| E | 0.300 | 0.310 | 0.325 |
| E1 | 0.245 | – | 0.270 |
| L | 0.125 | – | 0.135 |
| b | 0.014 | 0.018 | 0.022 |
| c | 0.008 | 0.010 | 0.014 |
| e | 0.100 BSC | | |

## Package Outline



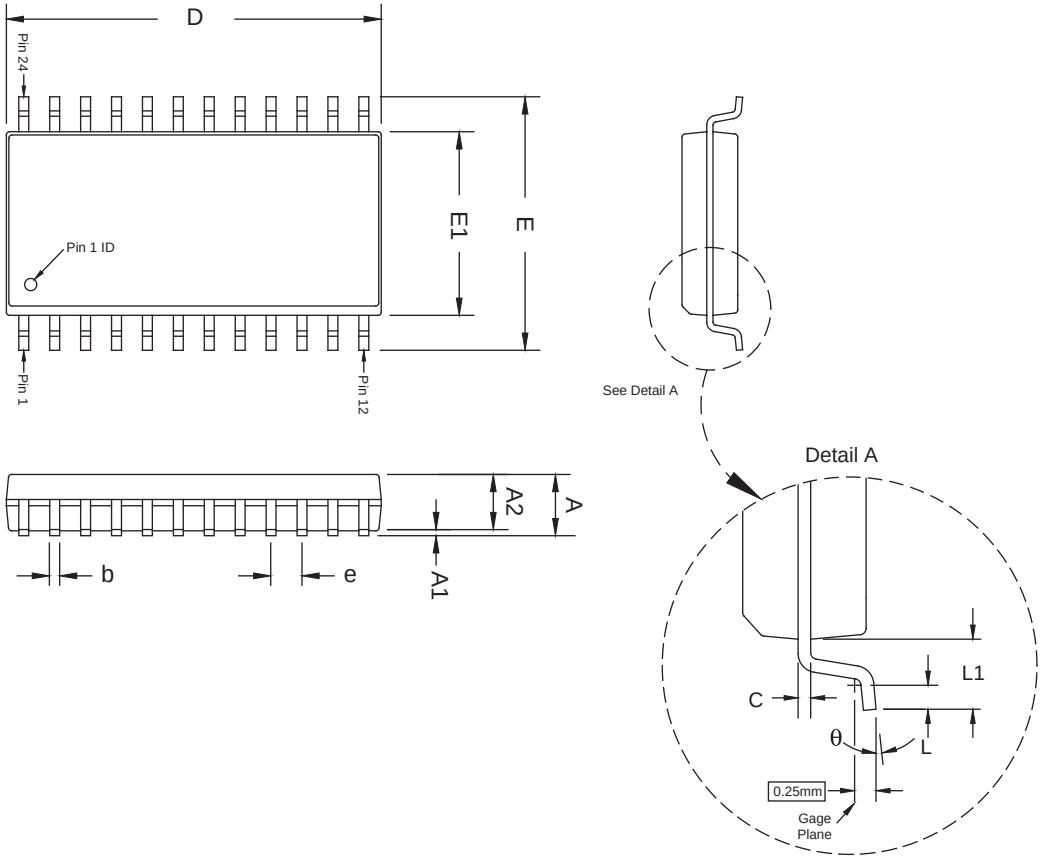
## 24-Pin Small Outline Integrated Circuit Package (SOIC) — Wire Bond

- All dimensions and tolerances conform to ASME Y14.5M - 1994.
- Controlling dimension is in millimeters.
- Pin 1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | S |
| Package Acronym | SOIC |
| Leadframe Material | Copper |
| Lead Finish (Plating) | Regular 85Sn:15Pb (Typ) |
| JEDEC Outline Reference | MS-013 Variation: AD |
| Lead Coplanarity | 0.1 mm |
| Weight | 0.7 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | 2.35 | – | 2.65 |
| A1 | 0.10 | – | 0.30 |
| A2 | 2.05 | – | 2.55 |
| D | 15.40 BSC | | |
| E | 10.30 BSC | | |
| E1 | 7.50 BSC | | |
| L | 0.40 | – | 1.27 |
| L1 | 1.40 REF | | |
| b | 0.31 | – | 0.51 |
| c | 0.20 | – | 0.33 |
| e | 1.27 BSC | | |
| θ | 0° | – | 8° |

## Package Outline



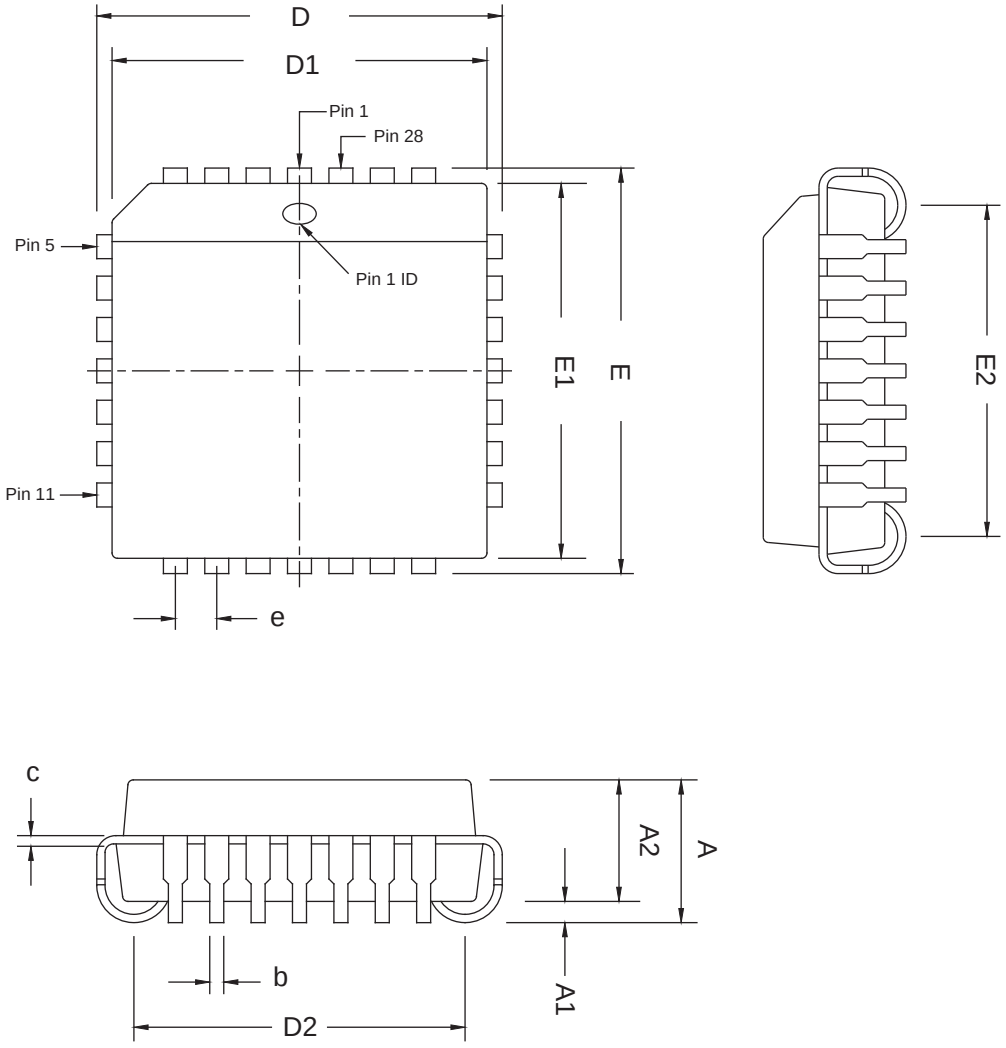
## 28-Pin Plastic J-Lead Chip Carrier (PLCC) — Wire Bond

- All dimensions and tolerances conform to ASME Y14.5M - 1994.
- Controlling dimension is in inches.
- Pin 1 is generally indicated by an indentation in the plastic body, in Pin 1's proximity, on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | L |
| Package Acronym | PLCC |
| Leadframe Material | Copper |
| Lead Finish (Plating) | Regular: 85Sn:15Pb (Typ.)<br>Pb-free: Matte Sn |
| JEDEC Outline Reference | MS-018 Variation: AB |
| Lead Coplanarity | 0.004 inches (0.10 mm) |
| Weight | 1.3 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Inches** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | 0.165 | 0.172 | 0.180 |
| A1 | 0.020 | – | – |
| A2 | 0.150 TYP | | |
| D | 0.485 | 0.490 | 0.495 |
| D1 | 0.450 | 0.453 | 0.456 |
| D2 | 0.382 | 0.410 | 0.438 |
| E | 0.485 | 0.490 | 0.495 |
| E1 | 0.450 | 0.453 | 0.456 |
| E2 | 0.382 | 0.410 | 0.438 |
| b | 0.013 | – | 0.021 |
| c | 0.010 TYP | | |
| e | 0.050 TYP | | |

## Package Outline



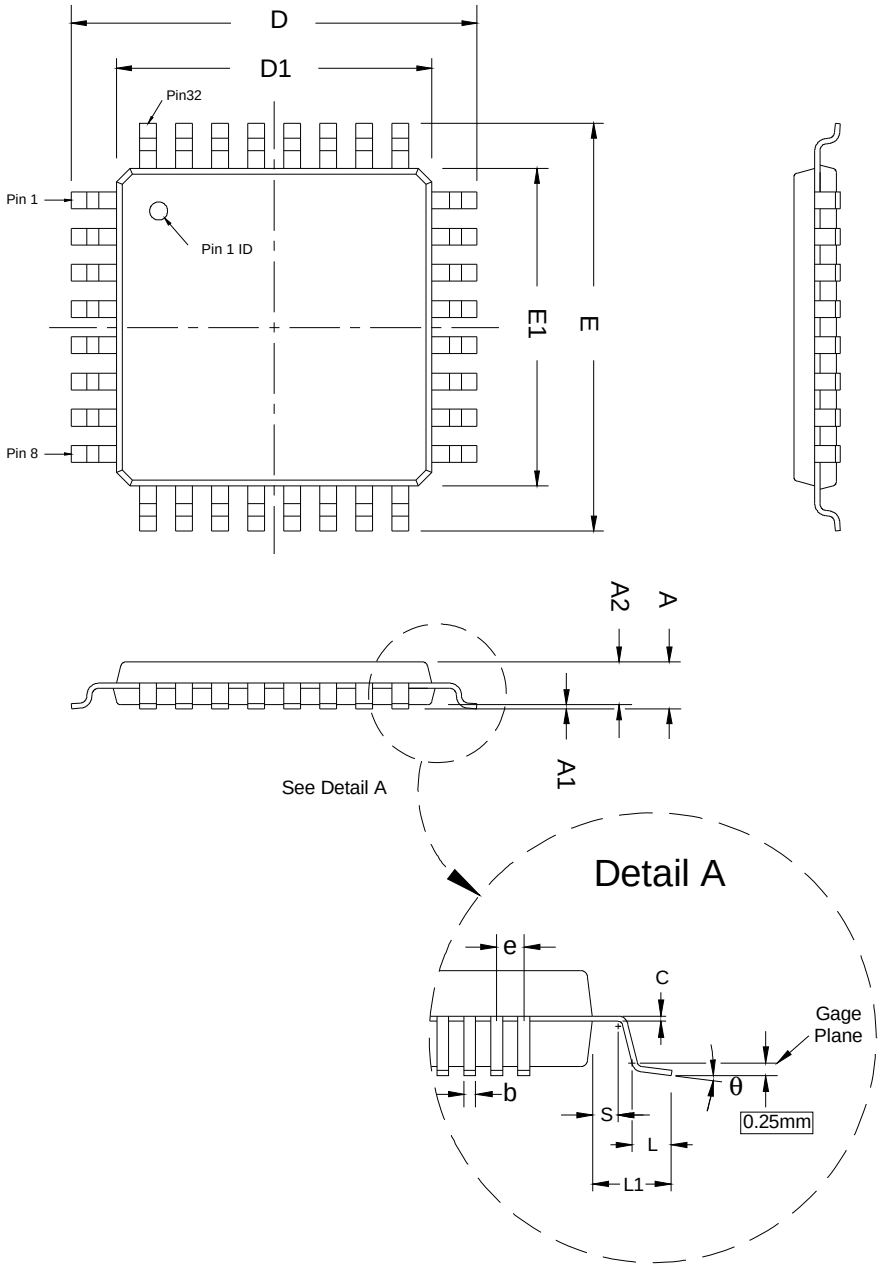
## 32-Pin Plastic Thin Quad Flat Pack (TQFP) — Wire Bond

- All dimensions and tolerances conform to ASME Y14.5M – 1994.
- Controlling dimension is in millimeters.
- Pin 1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | T |
| Package Acronym | TQFP |
| Leadframe Material | Copper |
| Lead Finish (Plating) | Regular: 85Sn:15Pb (Typ.)<br>Pb-free: Matte Sn |
| JEDEC Outline Reference | MS-026 Variation: ABA |
| Lead Coplanarity | 0.004 inches (0.1mm) |
| Weight | 0.2 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 1.20 |
| A1 | 0.05 | – | 0.15 |
| A2 | 0.95 | 1.00 | 1.05 |
| D | 9.00 BSC | | |
| D1 | 7.00 BSC | | |
| E | 9.00 BSC | | |
| E1 | 7.00 BSC | | |
| L | 0.45 | 0.60 | 0.75 |
| L1 | 1.00 REF | | |
| S | 0.20 | – | – |
| b | 0.30 | 0.37 | 0.45 |
| c | 0.09 | – | 0.20 |
| e | 0.80 BSC | | |
| θ | 0° | 3.5° | 7° |

## Package Outline



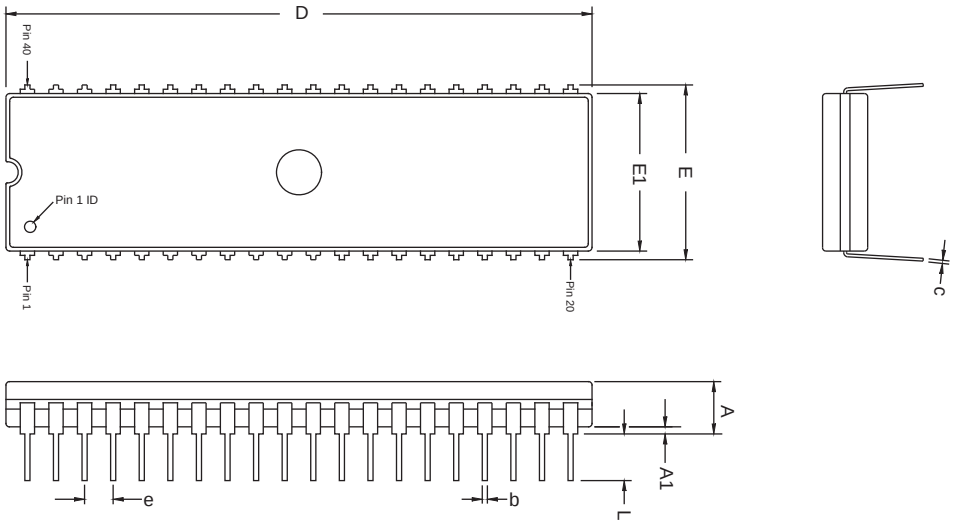
## 40-Pin Ceramic Dual In-Line Package (CerDIP) — Wire Bond

- All dimensions and tolerances conform to ASME Y14.5M - 1994.
- Controlling dimension is in inches.
- Pin 1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | D |
| Package Acronym | CerDIP |
| Leadframe Material | Alloy 42 |
| Lead Finish | Regular: 63Sn:37Pb (Typ.) |
| JEDEC Outline Reference | MS-032 Variation: AD |
| Lead Coplanarity | N/A |
| Weight | 12.8 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Inches** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 0.225 |
| A1 | 0.015 | 0.025 | 0.035 |
| D | 2.030 | 2.050 | 2.070 |
| E | 0.600 | 0.610 | 0.620 |
| E1 | 0.510 | 0.550 | 0.590 |
| L | 0.125 | – | – |
| b | 0.016 | 0.018 | 0.020 |
| c | 0.008 | 0.010 | 0.012 |
| e | 0.100 BSC | | |

## Package Outline



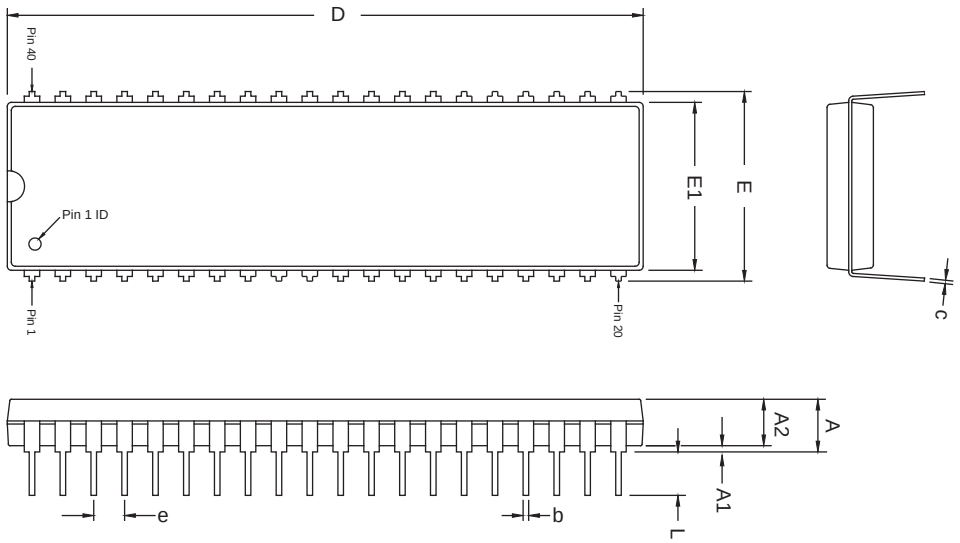
## 40-Pin Plastic Dual In-Line Package (PDIP) — Wire Bond

- All dimensions and tolerances conform to ASME Y14.5M - 1994.
- Controlling dimension is in inches.
- Pin 1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | P |
| Package Acronym | PDIP |
| Leadframe Material | Copper |
| Lead Finish (Plating) | Regular: 85Sn:15Pb (Typ.) |
| JEDEC Outline Reference | MS-011 Variation: AC |
| Lead Coplanarity | N/A |
| Weight | 7.0 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Inches** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 0.190 |
| A1 | 0.015 | – | – |
| A2 | 0.150 BSC | | |
| D | 2.030 | 2.050 | 2.070 |
| E | 0.600 | – | 0.625 |
| E1 | 0.520 | 0.540 | 0.560 |
| L | 0.125 | – | 0.135 |
| b | 0.015 | 0.018 | 0.022 |
| c | 0.008 | – | 0.012 |
| e | 0.100 BSC | | |

## Package Outline



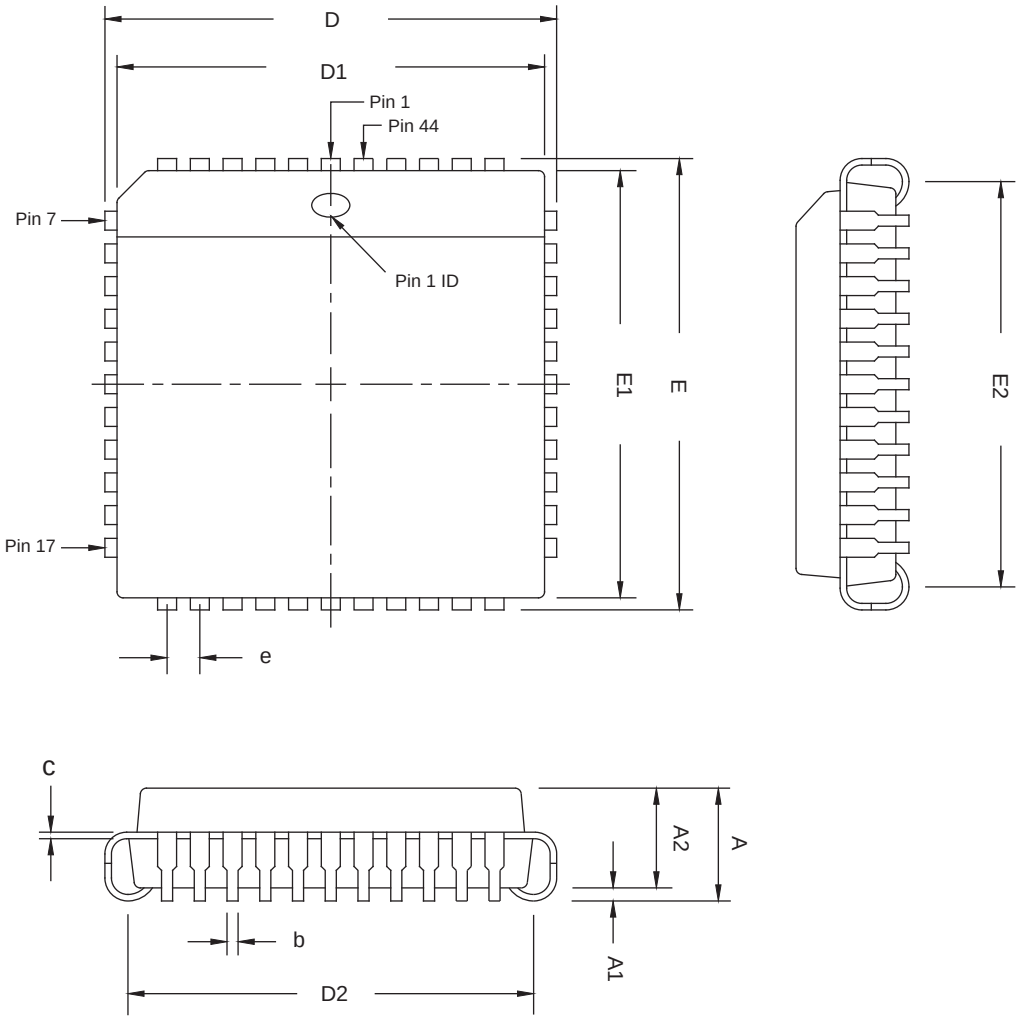
## 44-Pin Plastic J-Lead Chip Carrier (PLCC) — Wire Bond

- All dimensions and tolerances conform to ASME Y14.5M - 1994.
- Controlling dimension is in inches.
- Pin 1 is generally indicated by an indentation in the plastic body, in Pin 1's proximity, on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | L |
| Package Acronym | PLCC |
| Leadframe Material | Copper |
| Lead Finish (Plating) | Regular: 85Sn:15Pb (Typ.)<br>Pb-free: Matte Sn |
| JEDEC Outline Reference | MS-018 Variation: AC |
| Lead Coplanarity | 0.004 inches (0.10 mm) |
| Weight | 2.6 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Inches** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | 0.165 | 0.172 | 0.180 |
| A1 | 0.020 | – | – |
| A2 | 0.150 TYP | | |
| D | 0.685 | 0.690 | 0.695 |
| D1 | 0.650 | 0.653 | 0.656 |
| D2 | 0.582 | 0.610 | 0.638 |
| E | 0.685 | 0.690 | 0.695 |
| E1 | 0.650 | 0.653 | 0.656 |
| E2 | 0.582 | 0.610 | 0.638 |
| b | 0.013 | – | 0.021 |
| c | 0.010 TYP | | |
| e | 0.050 TYP | | |

## Package Outline



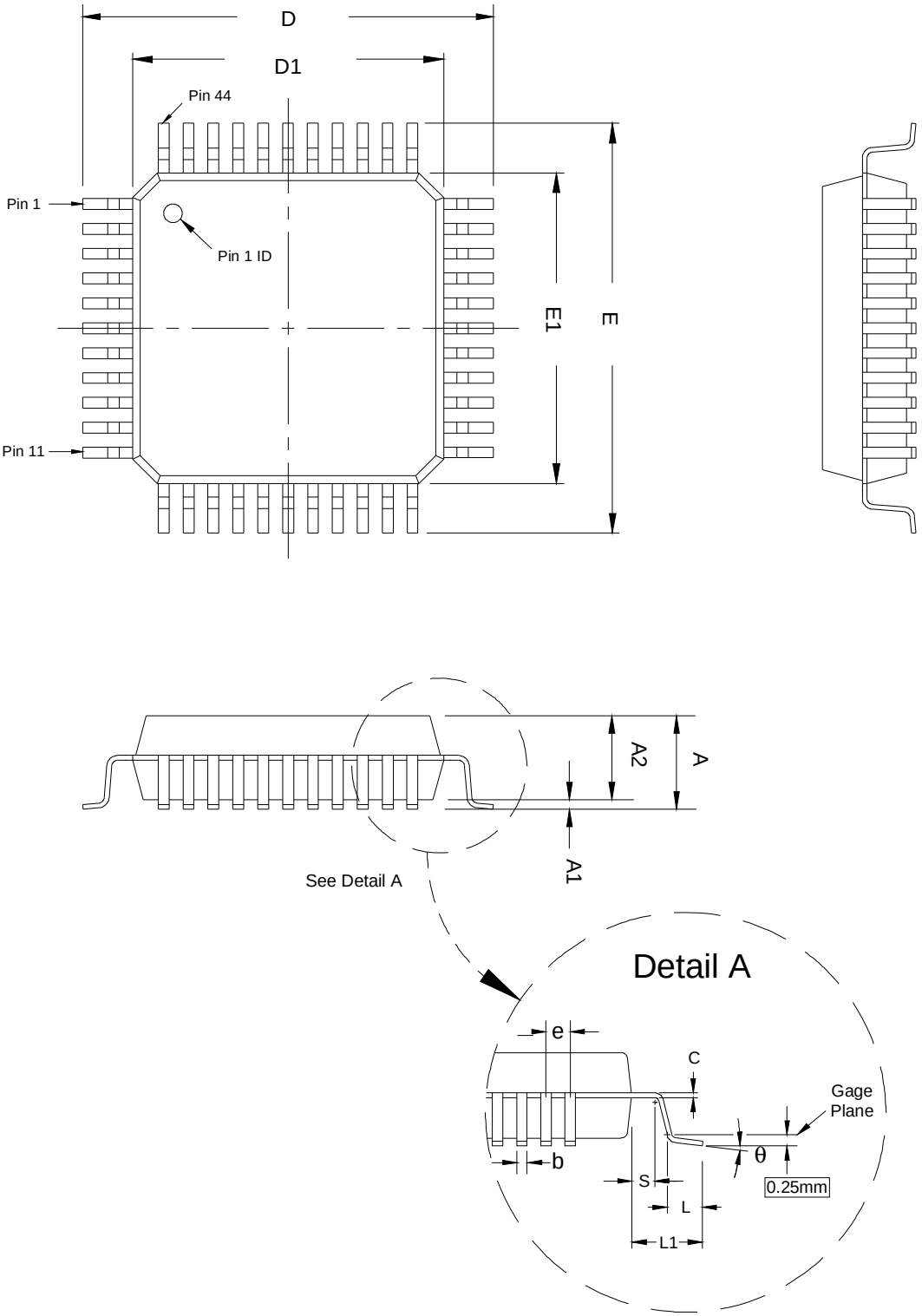
## 44-Pin Plastic Quad Flat Pack (PQFP) — Wire Bond

- All dimensions and tolerances conform to ASME Y14.5M – 1994.
- Controlling dimension is in millimeters.
- Pin 1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | Q |
| Package Acronym | PQFP |
| Leadframe Material | Copper |
| Lead Finish (Plating) | Regular: 85Sn:15Pb (Typ.)<br>Pb-free: Matte Sn |
| JEDEC Outline Reference | MS-022 Variation: AB |
| Lead Coplanarity | 0.004 inches (0.10 mm) |
| Weight | 0.5 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 2.45 |
| A1 | – | – | 0.25 |
| A2 | 1.80 | 2.00 | 2.20 |
| D | 13.20 BSC | | |
| D1 | 10.00 BSC | | |
| E | 13.20 BSC | | |
| E1 | 10.00 BSC | | |
| L | 0.73 | 0.88 | 1.03 |
| L1 | 1.60 REF | | |
| S | 0.20 | – | – |
| b | 0.29 | – | 0.45 |
| c | 0.11 | – | 0.23 |
| e | 0.80 BSC | | |
| θ | 0° | – | 7° |

## Package Outline



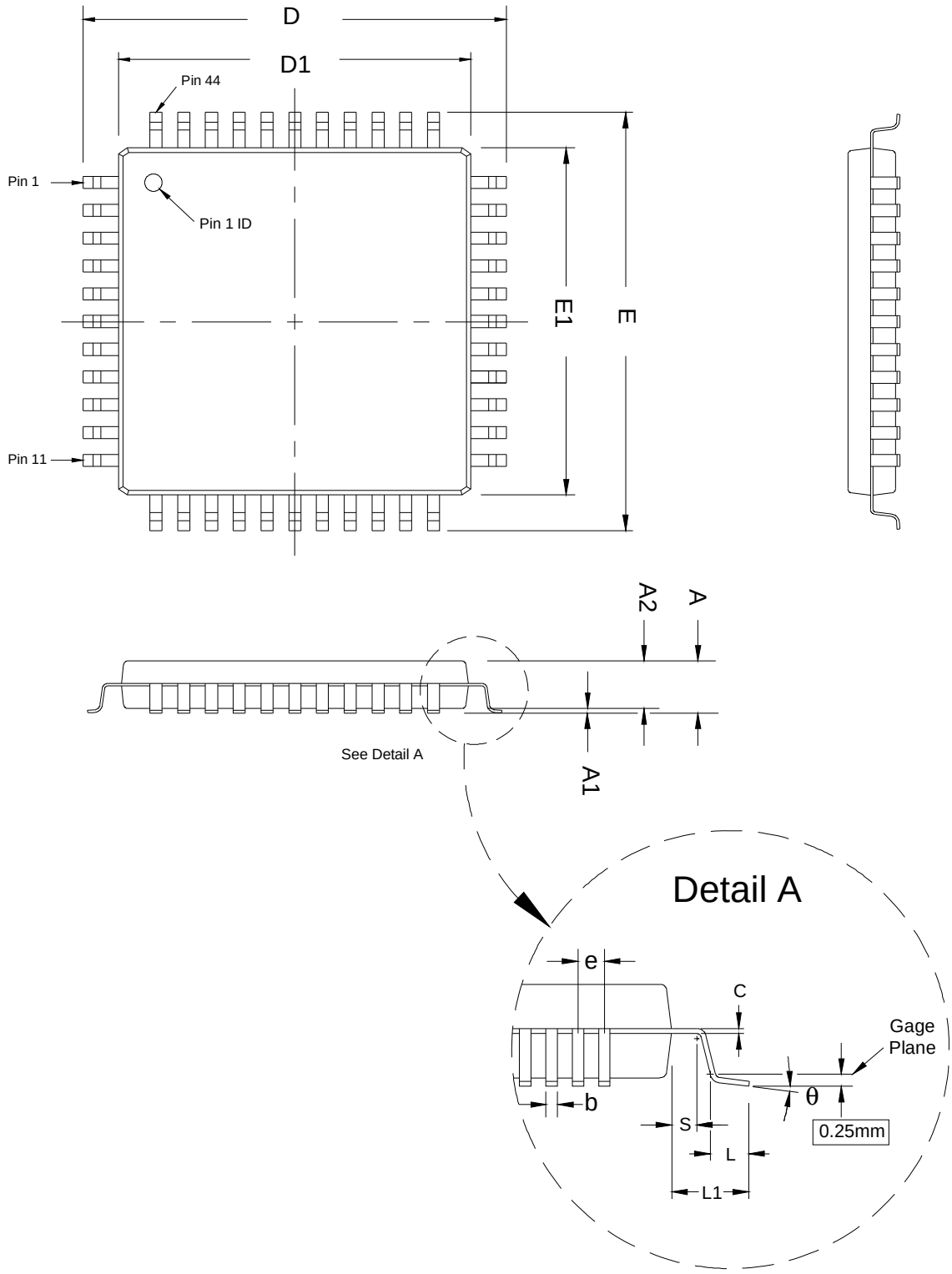
## 44-Pin Plastic Thin Quad Flat Pack (TQFP) — Wire Bond

- All dimensions and tolerances conform to ASME Y14.5M – 1994.
- Controlling dimension is in millimeters.
- Pin 1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | T |
| Package Acronym | TQFP |
| Leadframe Material | Copper |
| Lead Finish (Plating) | Regular: 85Sn:15Pb (Typ.)<br>Pb-free: Matte Sn |
| JEDEC Outline Reference | MS-026 Variation: ACB |
| Lead Coplanarity | 0.004 inches (0.1mm) |
| Weight | 0.3 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 1.20 |
| A1 | 0.05 | – | 0.15 |
| A2 | 0.95 | – | – |
| D | 12.00 BSC | | |
| D1 | 10.00 BSC | | |
| E | 12.00 BSC | | |
| E1 | 10.00 BSC | | |
| L | 0.45 | 0.60 | 0.75 |
| L1 | 1.00 REF | | |
| S | 0.20 | – | – |
| b | 0.30 | 0.37 | 0.45 |
| c | 0.09 | – | 0.20 |
| e | 0.80 BSC | | |
| θ | 0° | 3.5° | 7° |

## Package Outline



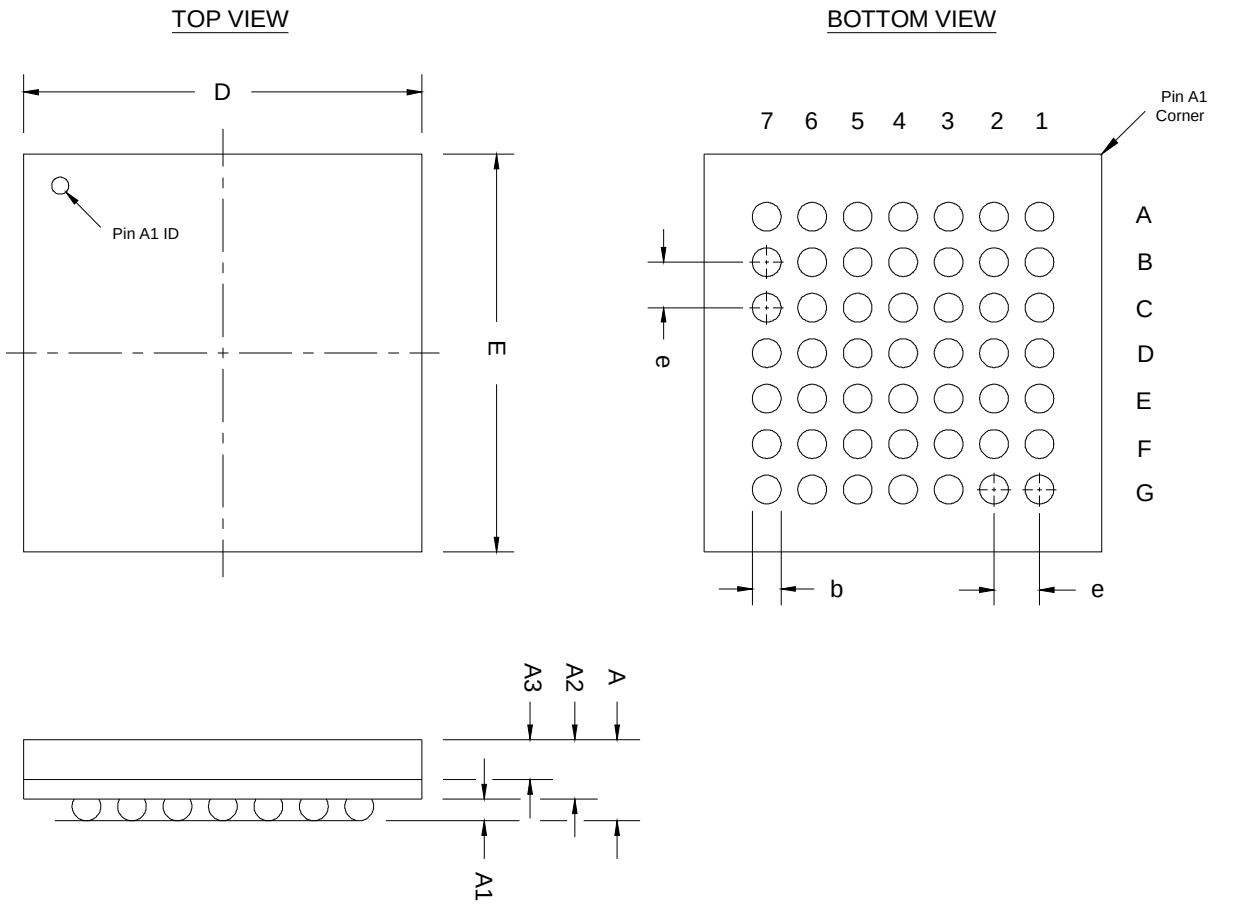
## 49-Pin Ultra FineLine Ball-Grid Array (UBGA) — Wire Bond

- All dimensions and tolerances conform to ASME Y14.5M – 1994.
- Controlling dimension is in millimeters.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | U |
| Package Acronym | UBGA |
| Substrate Material | BT |
| Solder Ball Composition | Regular: 63Sn:37Pb (Typ.)<br>Pb-free: Sn:3Ag:0.5Cu (Typ.) |
| JEDEC Outline Reference | MO-216 Variation: BAB-2 |
| Lead Coplanarity | 0.005 inches (0.12mm) |
| Weight | 0.2 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 1.55 |
| A1 | 0.20 | – | – |
| A2 | – | – | 1.35 |
| A3 | 0.70 TYP | | |
| D | 7.00 BSC | | |
| E | 7.00 BSC | | |
| b | 0.40 | 0.50 | 0.60 |
| e | 0.80 BSC | | |

## Package Outline



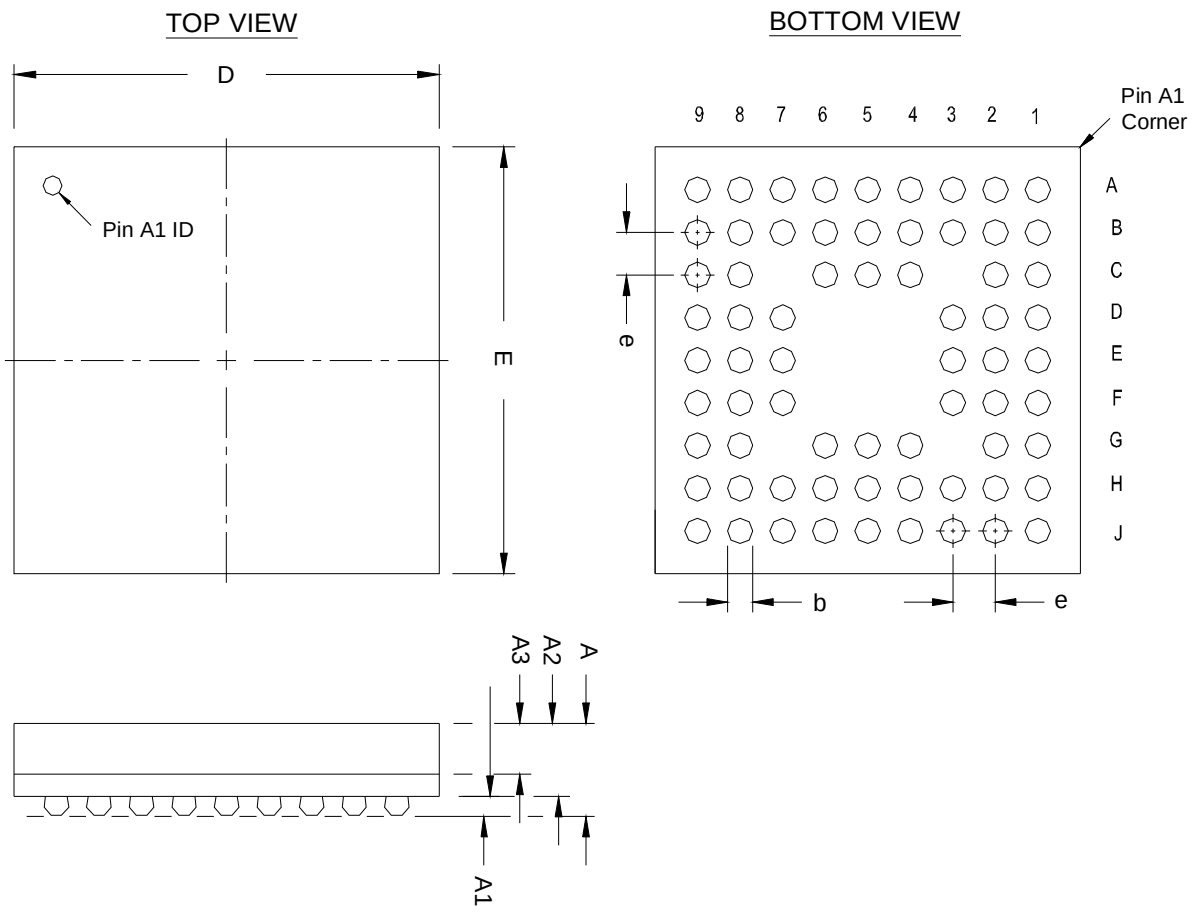
## 68-Pin Micro FineLine Ball-Grid Array (MBGA) — Wire Bond

- All dimensions and tolerances conform to ASME Y14.5M – 1994.
- Controlling dimension is in millimeters.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | M |
| Package Acronym | MBGA |
| Substrate Material | BT |
| Solder Ball Composition | Pb-free: Sn:3Ag:0.5Cu (Typ.) |
| JEDEC Outline Reference | MO-195 Variation: AB |
| Lead Coplanarity | 0.003 inch (0.08 mm) |
| Weight | 0.1 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | — | — | 1.20 |
| A1 | 0.15 | — | — |
| A2 | — | — | 1.00 |
| A3 | 0.60 REF | | |
| D | 5.00 BSC | | |
| E | 5.00 BSC | | |
| b | 0.25 | 0.30 | 0.35 |
| e | 0.50 BSC | | |

## Package Outline



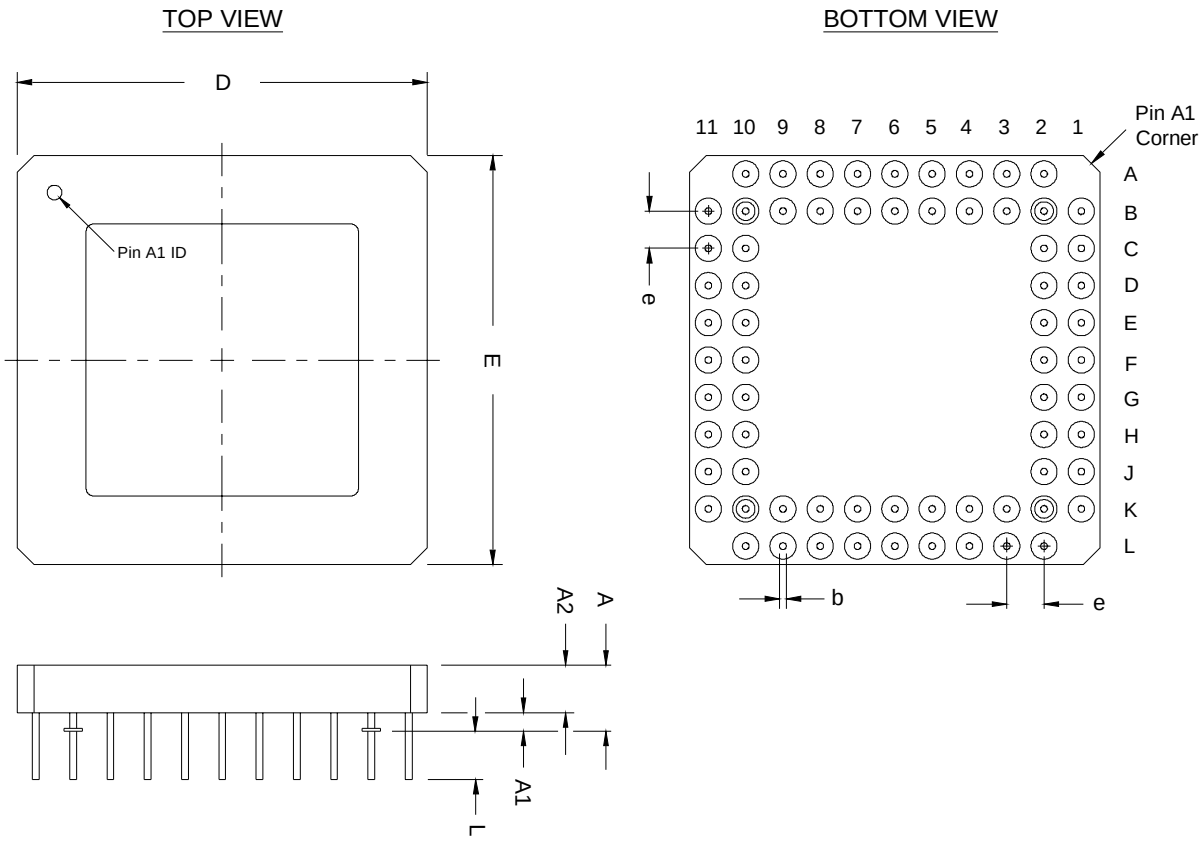
## 68-Pin Ceramic Pin-Grid Array (PGA) — Wire Bond

- All dimensions and tolerances conform to ASME Y14.5M – 1994.
- Controlling dimension is in inches.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | G |
| Package Acronym | PGA |
| Leadframe Material | Alloy 42 |
| Lead Finish | Gold Over Nickel Plate |
| JEDEC Outline Reference | MO-066 Variation: AC |
| Lead Coplanarity | N/A |
| Weight | 10.4 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Inches** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | 0.154 | 0.177 | 0.200 |
| A1 | | 0.050 TYP | |
| A2 | 0.114 | 0.127 | 0.140 |
| D | 1.100 | 1.120 | 1.140 |
| E | 1.100 | 1.120 | 1.140 |
| L | | 0.130 TYP | |
| b | 0.016 | 0.018 | 0.020 |
| e | | 0.100 BSC | |

## Package Outline



## 68-Pin Plastic J-Lead Chip Carrier (PLCC) — Wire Bond

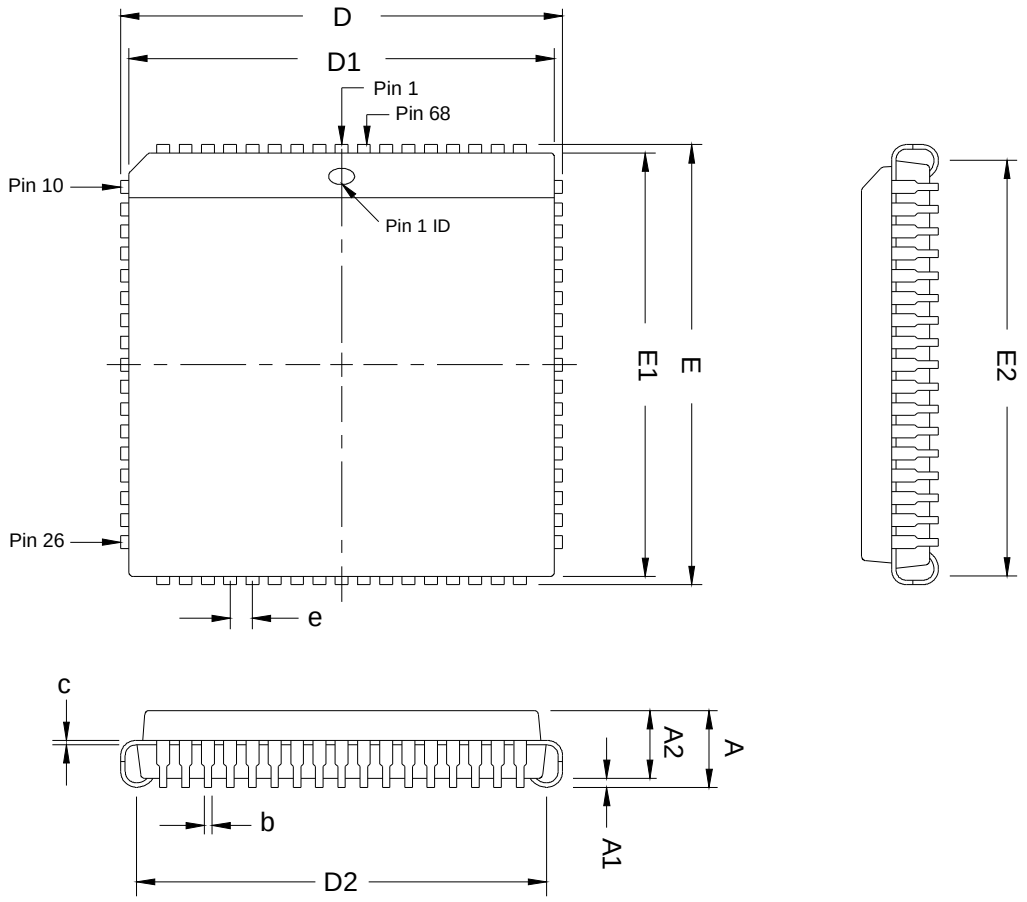
- All dimensions and tolerances conform to ASME Y14.5M - 1994.
- Controlling dimension is in inches.
- Pin 1 is generally indicated by an indentation in the plastic body, in Pin 1's proximity, on package surface.

**Figure 19–1.**

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | L |
| Package Acronym | PLCC |
| Lead Material | Copper |
| Lead Finish (Plating) | Regular: 85Sn:15Pb (Typ.)<br>Pb-free: Matte Sn |
| JEDEC Outline Reference | MS-018 Variation: AE |
| Lead Coplanarity | 0.004 inches (0.10 mm) |
| Weight | 5.5 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Inches** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | 0.165 | 0.172 | 0.180 |
| A1 | 0.020 | – | – |
| A2 | 0.150 TYP | | |
| D | 0.985 | 0.990 | 0.995 |
| D1 | 0.950 | 0.954 | 0.958 |
| D2 | 0.882 | 0.910 | 0.938 |
| E | 0.985 | 0.990 | 0.995 |
| E1 | 0.950 | 0.954 | 0.958 |
| E2 | 0.882 | 0.910 | 0.938 |
| b | 0.013 | – | 0.021 |
| c | 0.008 TYP | | |
| e | 0.050 TYP | | |

## Package Outline



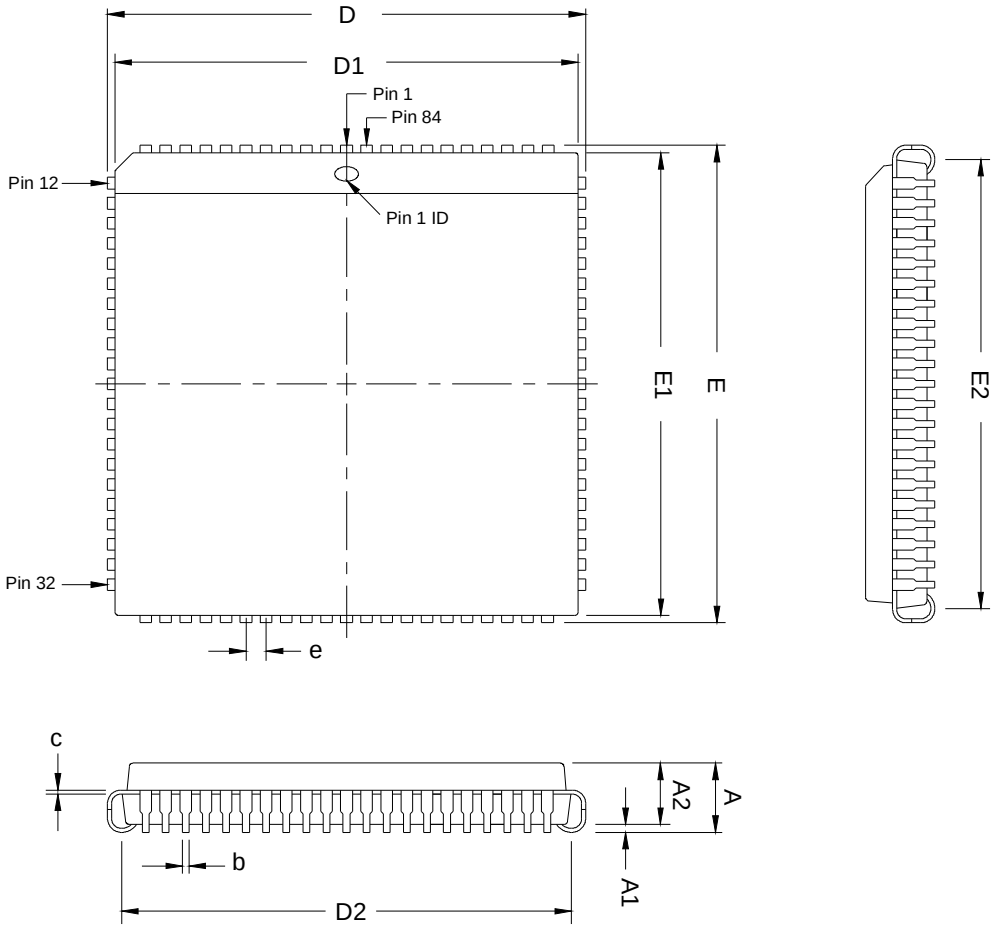
## 84-Pin Plastic J-Lead Chip Carrier (PLCC) — Wire Bond

- All dimensions and tolerances conform to ASME Y14.5M – 1994.
- Controlling dimension is in inches.
- Pin 1 is generally indicated by an indentation in the plastic body, in Pin 1's proximity, on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | L |
| Package Acronym | PLCC |
| Leadframe Material | Copper |
| Lead Finish (Plating) | Regular: 85Sn:15Pb (Typ.)<br>Pb-free: Matte Sn |
| JEDEC Outline Reference | MS-018 Variation: AF |
| Lead Coplanarity | 0.004 inches (0.10mm) |
| Weight | 7.9 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Inches** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | 0.165 | 0.172 | 0.180 |
| A1 | 0.020 | – | – |
| A2 | 0.150 TYP | | |
| D | 1.185 | 1.190 | 1.195 |
| D1 | 1.150 | 1.154 | 1.158 |
| D2 | 1.082 | 1.110 | 1.138 |
| E | 1.185 | 1.190 | 1.195 |
| E1 | 1.150 | 1.154 | 1.158 |
| E2 | 1.082 | 1.110 | 1.138 |
| b | 0.013 | – | 0.021 |
| c | 0.008 TYP | | |
| e | 0.050 TYP | | |

## Package Outline



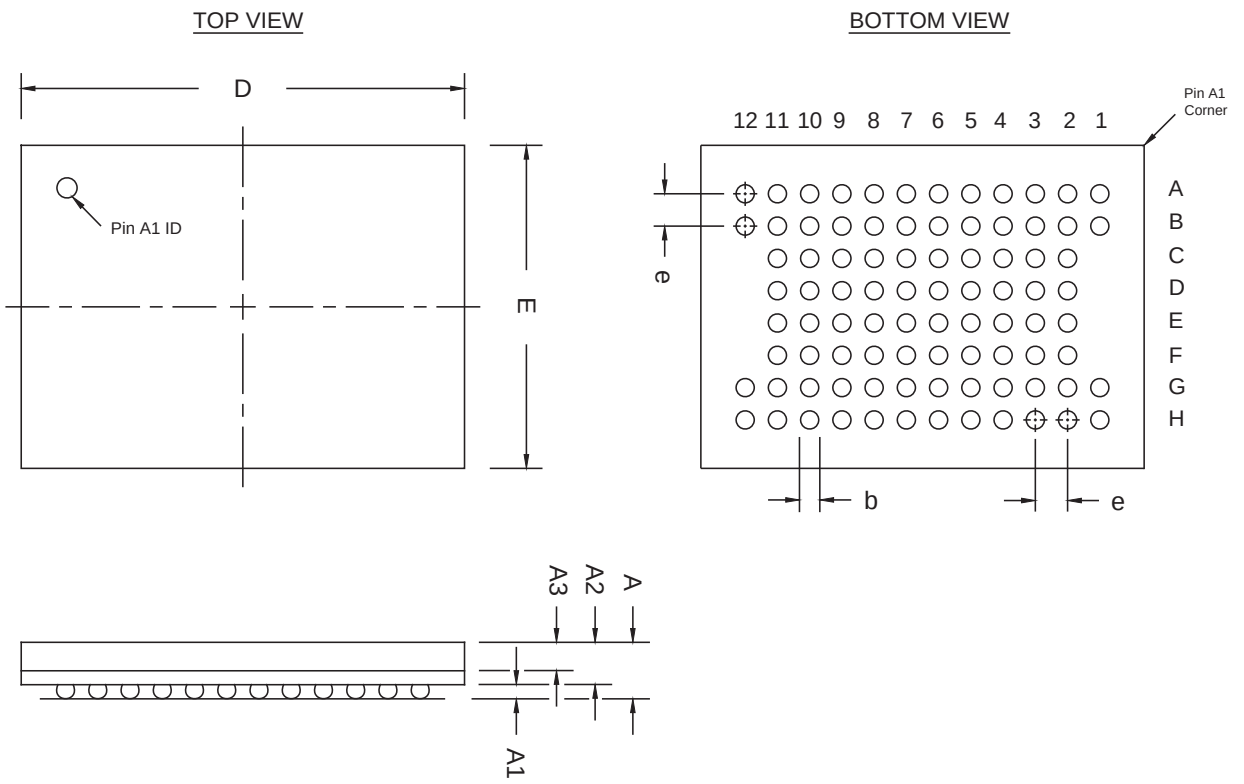
## 88-Pin Ultra FineLine Ball-Grid Array (UBGA) — Wire Bond

- All dimensions and tolerances conform to ASME Y14.5M - 1994.
- Controlling dimension is in millimeters.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | U |
| Package Acronym | UBGA |
| Substrate Material | BT |
| Solder Ball Composition | Regular: 63Sn:37Pb (Typ.)<br>Pb-free: Sn:3Ag:0.5Cu (Typ.) |
| JEDEC Outline | MO-219 |
| Lead Coplanarity | 0.005 inches (0.12 mm) |
| Weight | 0.4 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 1.40 |
| A1 | 0.25 | – | – |
| A2 | 0.80 | – | – |
| A3 | 0.70 REF | | |
| D | 11.00 BSC | | |
| E | 8.00 BSC | | |
| b | 0.40 | 0.45 | 0.50 |
| e | 0.80 BSC | | |

## Package Outline



## 100-Pin FineLine Ball-Grid Array (FBGA), Option 1 — Wire Bond

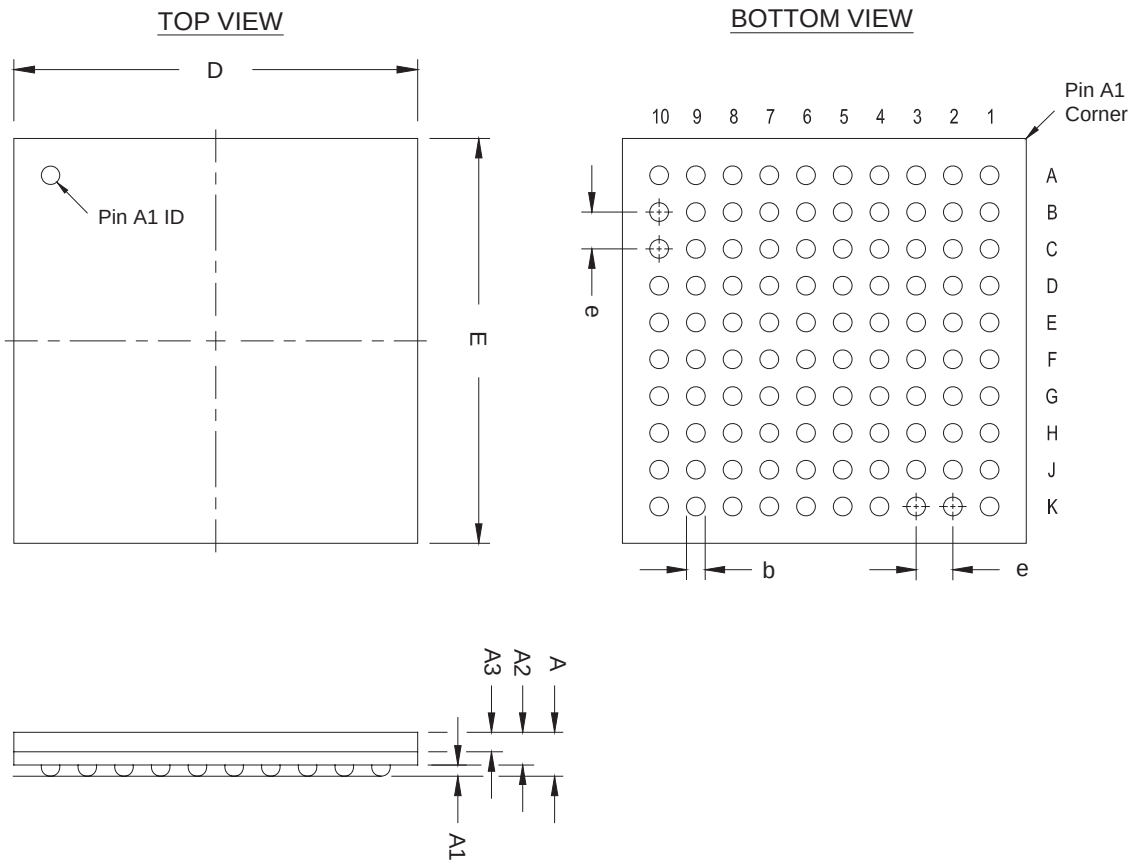
- All dimensions and tolerances conform to ASME Y14.5M – 1994.
- Controlling dimension is in millimeters.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on the package surface.

This POD is applicable to F100 packages of all products except MAX II, which is assembled in Option 2 package outlines.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | F |
| Package Acronym | FBGA |
| Substrate Material | BT |
| Solder ball composition | Regular: 63Sn:37Pb (Typ.)<br>Pb-free: Sn:3Ag:0.5Cu (Typ.) |
| JEDEC Outline Reference | MO-192 Variation: AAC-1 |
| Lead Coplanarity | 0.008 inches (0.20mm) |
| Weight | 0.6 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 1.70 |
| A1 | 0.30 | – | – |
| A2 | 0.25 | – | 1.10 |
| A3 | – | – | 0.80 |
| D | 11.00 BSC | | |
| E | 11.00 BSC | | |
| b | 0.50 | 0.60 | 0.70 |
| e | 1.00 BSC | | |

## Package Outline



## 100-Pin FineLine Ball-Grid Array (FBGA), Option 2 — Wire Bond

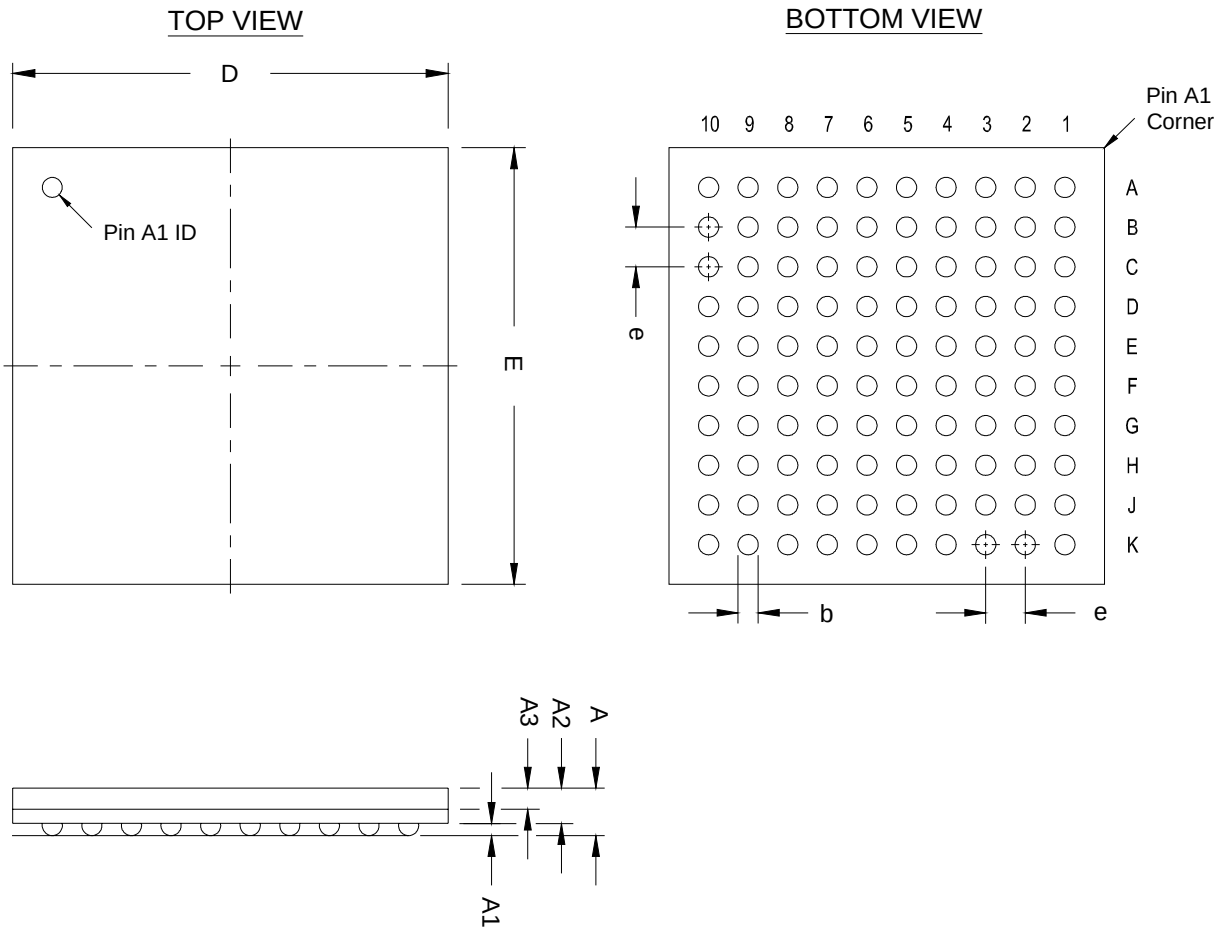
- All dimensions and tolerances conform to ASME Y14.5M – 1994.
- Controlling dimension is in millimeters.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

This POD is applicable to F100 packages of the MAX II device only.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | F |
| Package Acronym | FBGA |
| Substrate Material | BT |
| Solder ball composition | Regular: 63Sn:37Pb (Typ.)<br>Pb-free: Sn:3Ag:0.5Cu (Typ.) |
| JEDEC Outline Reference | MO-192 Variation: DAC-1 |
| Lead Coplanarity | 0.008 inches (0.20mm) |
| Weight | 0.6 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 1.55 |
| A1 | 0.25 | – | – |
| A2 | | 1.05 REF | |
| A3 | – | – | 0.80 |
| D | | 11.00 BSC | |
| E | | 11.00 BSC | |
| b | 0.45 | 0.50 | 0.55 |
| e | | 1.00 BSC | |

## Package Outline



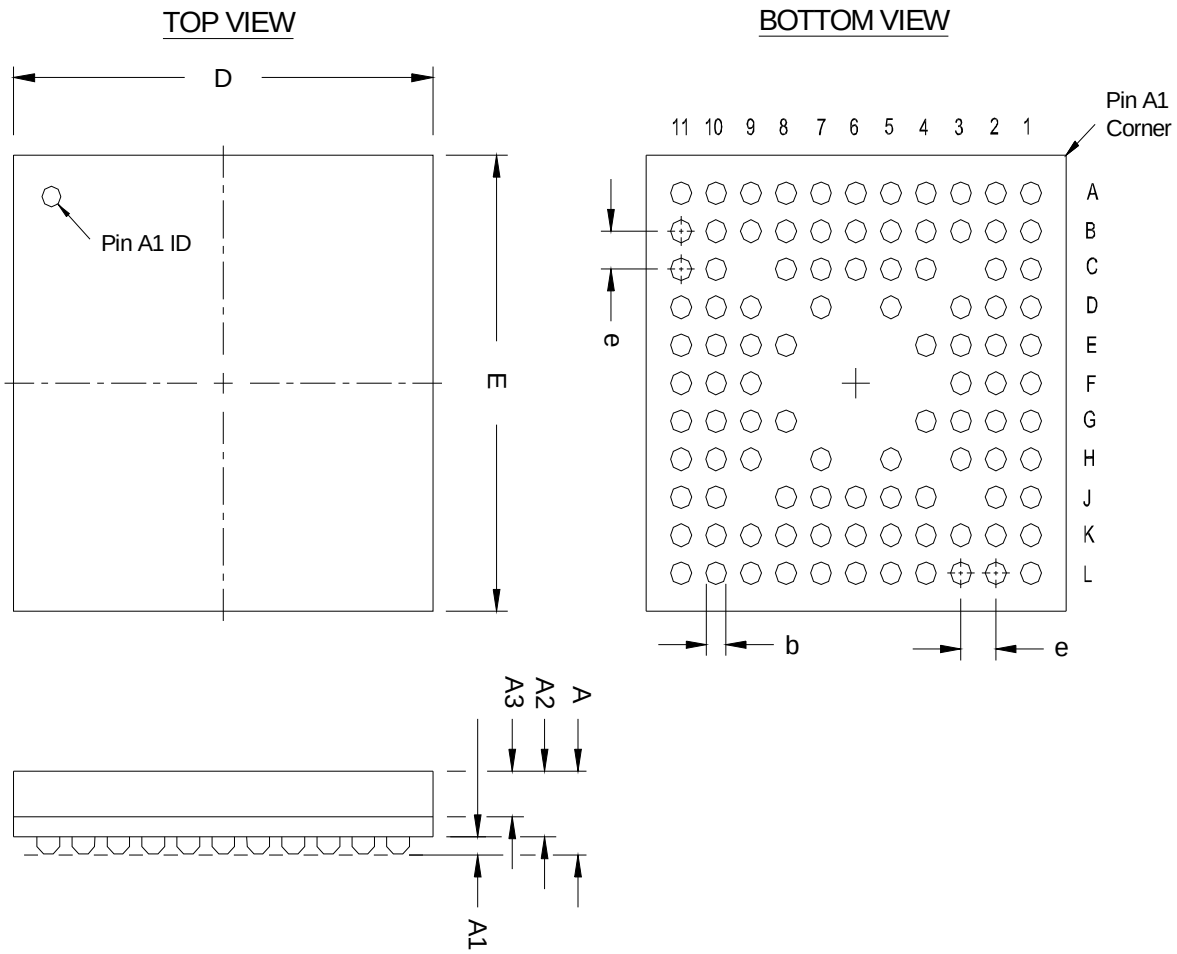
## 100-Pin Micro FineLine Ball-Grid Array (MBGA) — Wire Bond

- All dimensions and tolerances conform to ASME Y14.5M – 1994.
- Controlling dimension is in millimeters.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | M |
| Package Acronym | MBGA |
| Substrate Material | BT |
| Solder Ball Composition | Pb-free: Sn:3Ag:0.5Cu (Typ.) |
| JEDEC Outline Reference | MO-195 Variation: AC |
| Lead Coplanarity | 0.003 inch (0.08mm) |
| Weight | 0.1 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 1.20 |
| A1 | 0.15 | – | – |
| A2 | – | – | 1.00 |
| A3 | 0.60 REF | | |
| D | 6.00 BSC | | |
| E | 6.00 BSC | | |
| b | 0.25 | 0.30 | 0.35 |
| e | 0.50 BSC | | |

## Package Outline



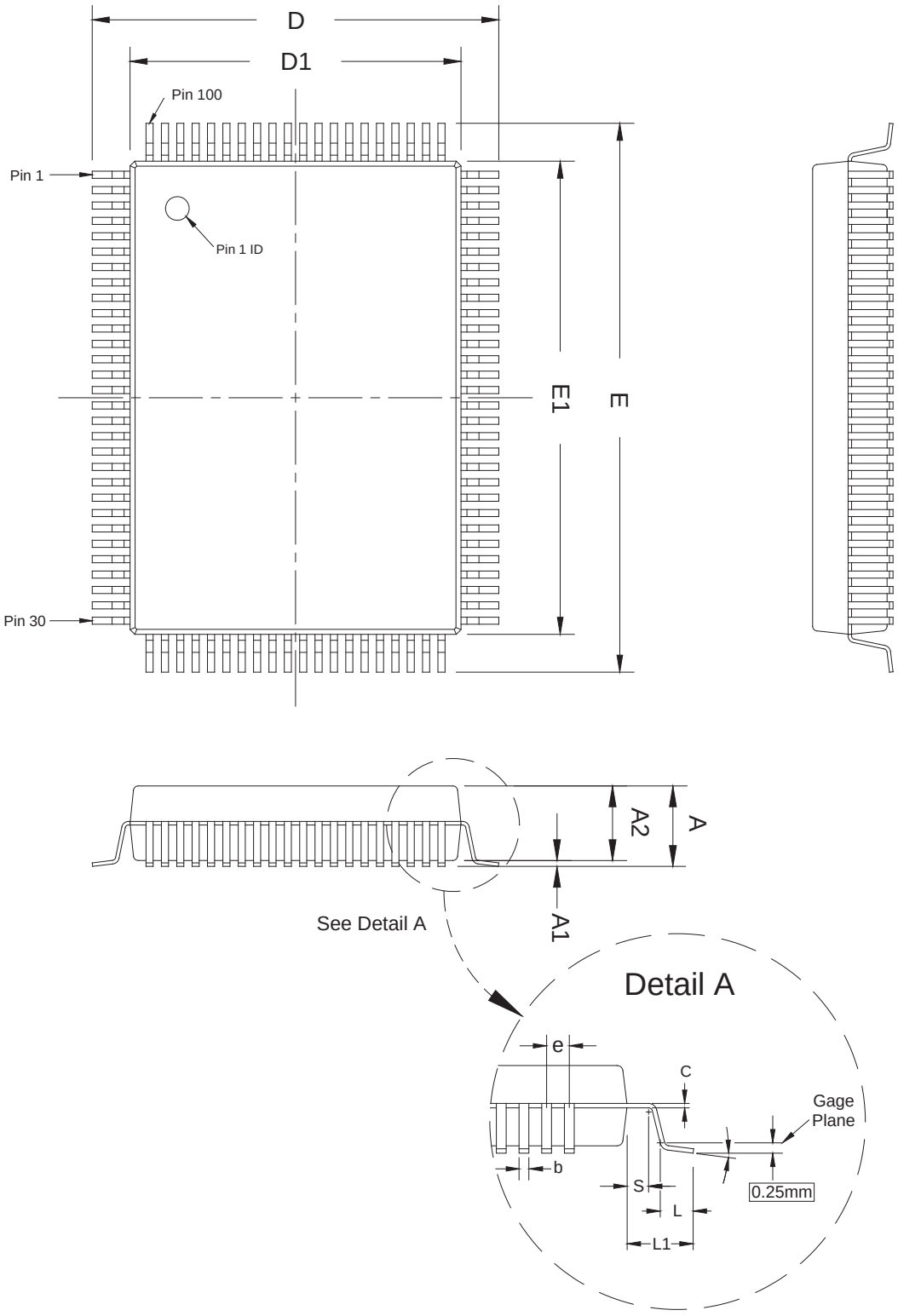
## 100-Pin Plastic Quad Flat Pack (PQFP) — Wire Bond

- All dimensions and tolerances conform to ASME Y14.5M – 1994.
- Controlling dimension is in millimeters.
- Pin 1 may be indicated by an ID dot, or a special feature, in its proximity on the package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | Q |
| Package Acronym | PQFP |
| Leadframe Material | Copper |
| Lead Finish (Plating) | Regular: 85Sn:15Pb (Typ.)<br>Pb-free: Matte Sn |
| JEDEC Outline Reference | MS-022 Variation: GC-1 |
| Lead Coplanarity | 0.004 inches (0.10mm) |
| Weight | 1.9 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 3.40 |
| A1 | 0.25 | – | 0.50 |
| A2 | 2.50 | 2.70 | 2.90 |
| D | 17.20 BSC | | |
| D1 | 14.00 BSC | | |
| E | 23.20 BSC | | |
| E1 | 20.00 BSC | | |
| L | 0.73 | 0.88 | 1.03 |
| L1 | 1.60 REF | | |
| S | 0.20 | – | – |
| b | 0.22 | – | 0.40 |
| c | 0.11 | – | 0.23 |
| e | 0.65 BSC | | |
| θ | 0° | – | 7° |

## Package Outline



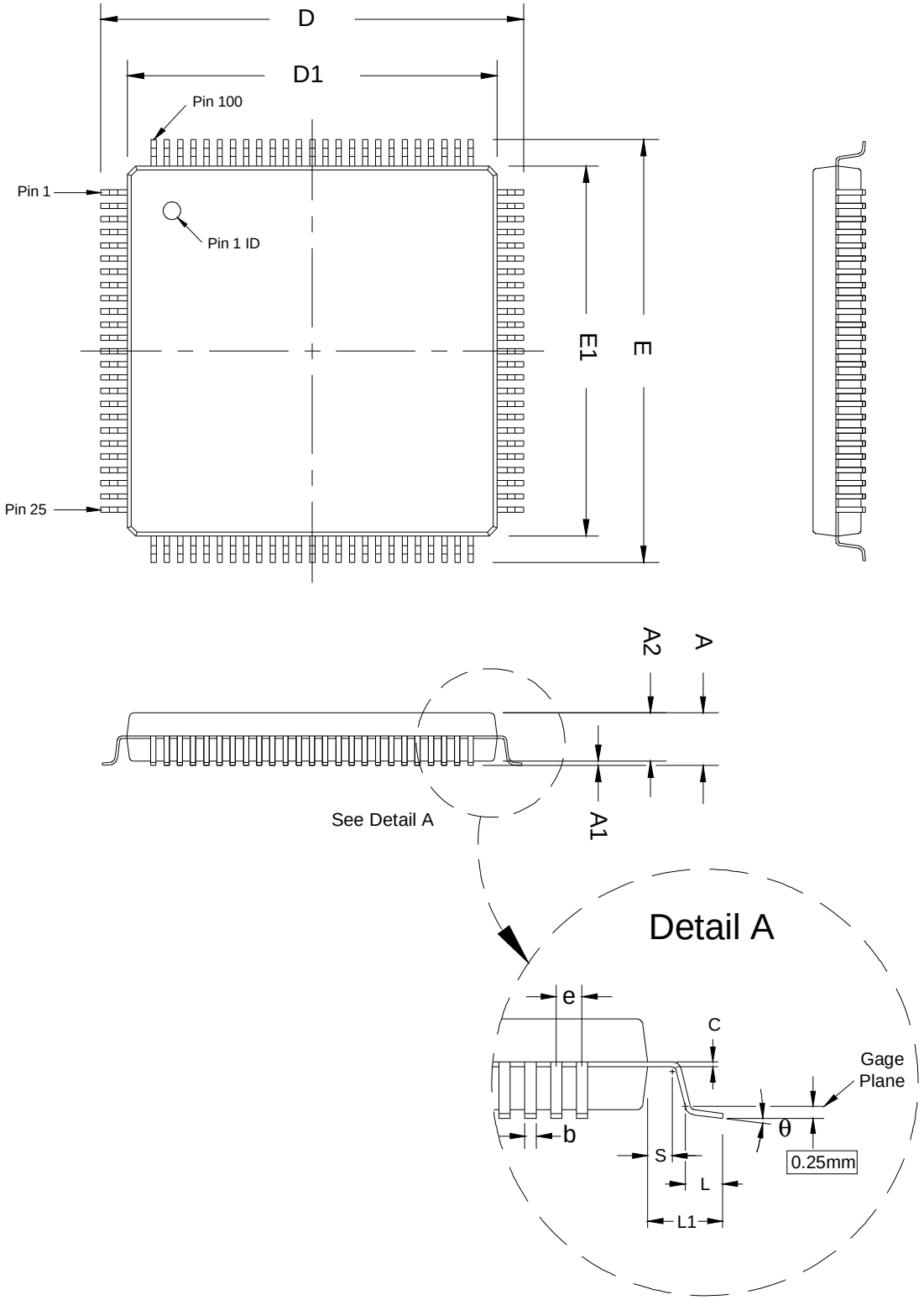
## 100-Pin Plastic Thin Quad Flat Pack (TQFP) — Wire Bond

- All dimensions and tolerances conform to ASME Y14.5M – 1994.
- Controlling dimension is in millimeters.
- Pin 1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | T |
| Package Acronym | TQFP |
| Leadframe Material | Copper |
| Lead Finish (Plating) | Regular: 85Sn:15Pb (Typ.)<br>Pb-free: Matte Sn |
| JEDEC Outline Reference | MS-026 Variation: AED |
| Lead Coplanarity | 0.003 inches (0.08mm) |
| Weight | 0.6 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 1.20 |
| A1 | 0.05 | – | 0.15 |
| A2 | 0.95 | 1.00 | 1.05 |
| D | 16.00 BSC | | |
| D1 | 14.00 BSC | | |
| E | 16.00 BSC | | |
| E1 | 14.00 BSC | | |
| L | 0.45 | 0.60 | 0.75 |
| L1 | 1.00 REF | | |
| S | 0.20 | – | – |
| b | 0.17 | 0.22 | 0.27 |
| c | 0.09 | – | 0.20 |
| e | 0.50 BSC | | |
| θ | 0° | 3.5° | 7° |

## Package Outline



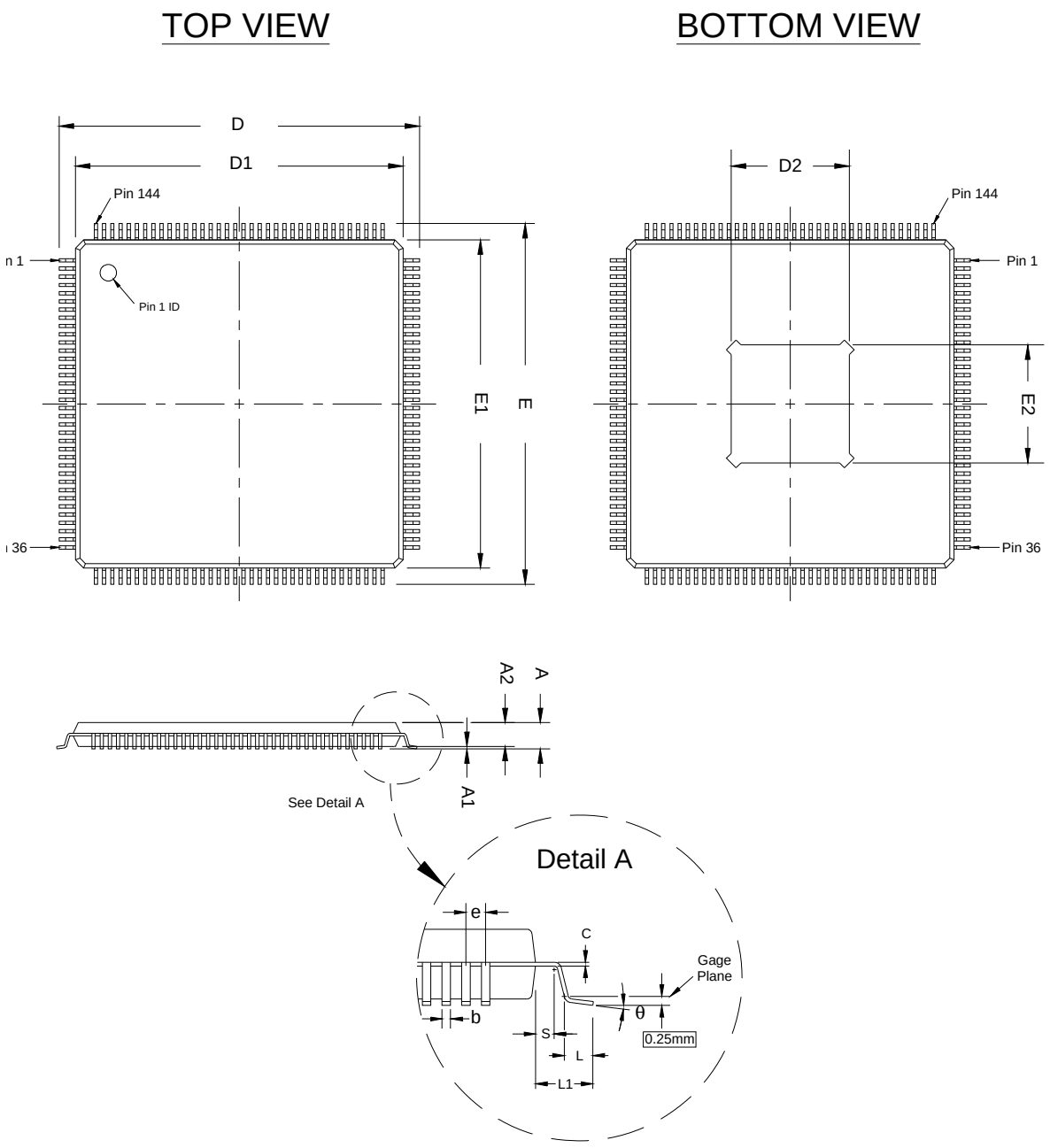
## 144-Pin Plastic Enhanced Quad Flat Pack (EQFP) — Wire Bond

- All dimensions and tolerances conform to ASME Y14.5M – 1994.
- Controlling dimension is in millimeters.
- Pin 1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | E |
| Package Acronym | EQFP |
| Leadframe Material | Copper |
| Lead Finish (Plating) | Regular: 85Sn:15Pb (Typ.)<br>Pb-free: Matte Sn |
| JEDEC Outline Reference | MS-026 Variation: BFB |
| Lead Coplanarity | 0.003 inches (0.08mm) |
| Weight | 1.1 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 1.60 |
| A1 | 0.05 | – | 0.15 |
| A2 | 1.35 | 1.40 | 1.45 |
| D | | 22.00 BSC | |
| D1 | | 20.00 BSC | |
| D2 | 4.00 | – | – |
| E | | 22.00 BSC | |
| E1 | | 20.00 BSC | |
| E2 | 4.00 | – | – |
| L | 0.45 | 0.60 | 0.75 |
| L1 | | 1.00 REF | |
| S | 0.20 | – | – |
| b | 0.17 | 0.22 | 0.27 |
| c | 0.09 | – | 0.20 |
| e | | 0.50 BSC | |
| θ | 0° | 3.5° | 7° |

## Package Outline



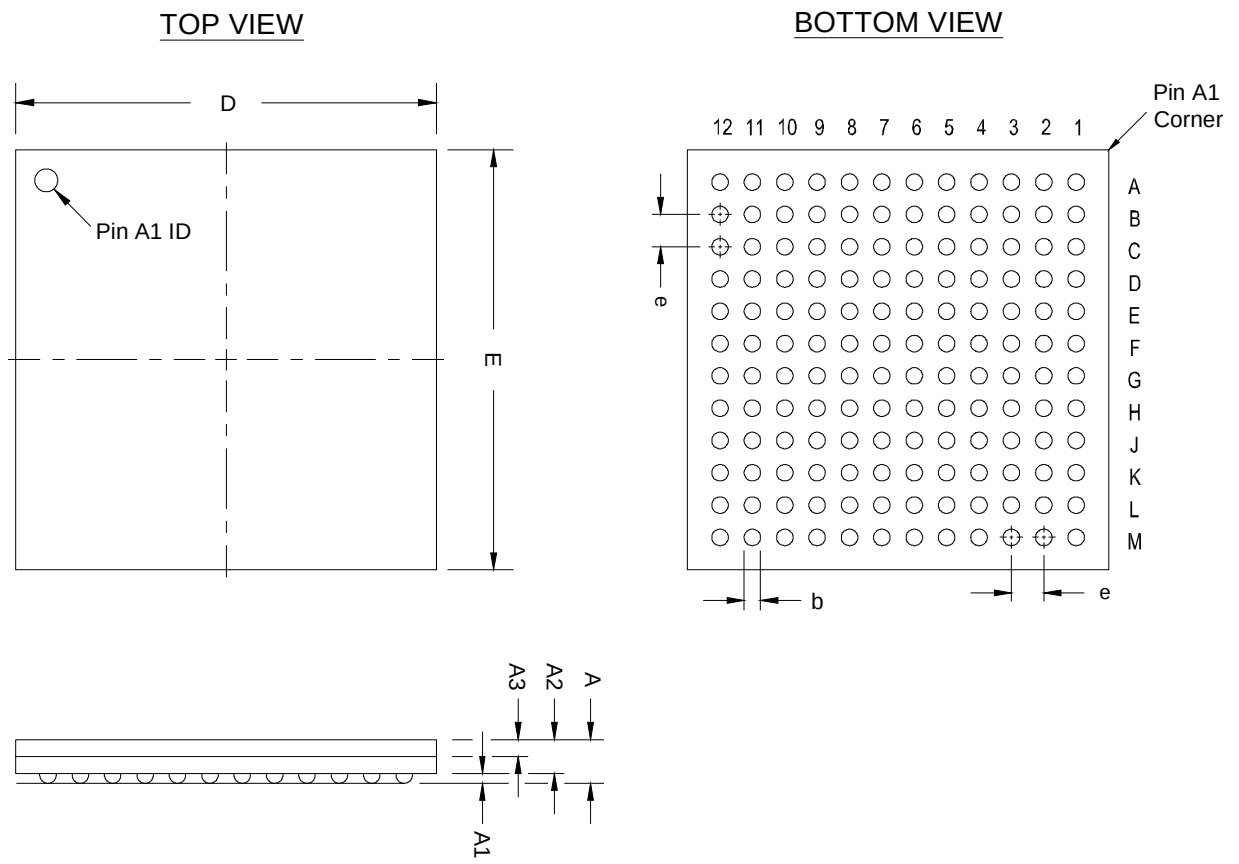
## 144-Pin FineLine Ball-Grid Array (FBGA) — Wire Bond

- All dimensions and tolerances conform to ASME Y14.5M – 1994.
- Controlling dimension is in millimeters.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | F |
| Package Acronym | FBGA |
| Substrate Material | BT |
| Solder Ball Composition | Regular: 63Sn:37Pb (Typ.)<br>Pb-free: Sn:3Ag:0.5Cu (Typ.) |
| JEDEC Outline Reference | MO-192 Variation: AAD-1 |
| Lead Coplanarity | 0.008 inches (0.20mm) |
| Weight | 0.8 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 2.20 |
| A1 | 0.30 | – | – |
| A2 | 0.25 | – | 1.80 |
| A3 | 0.70 REF | | |
| D | 13.00 BSC | | |
| E | 13.00 BSC | | |
| b | 0.50 | 0.60 | 0.70 |
| e | 1.00 BSC | | |

## Package Outline



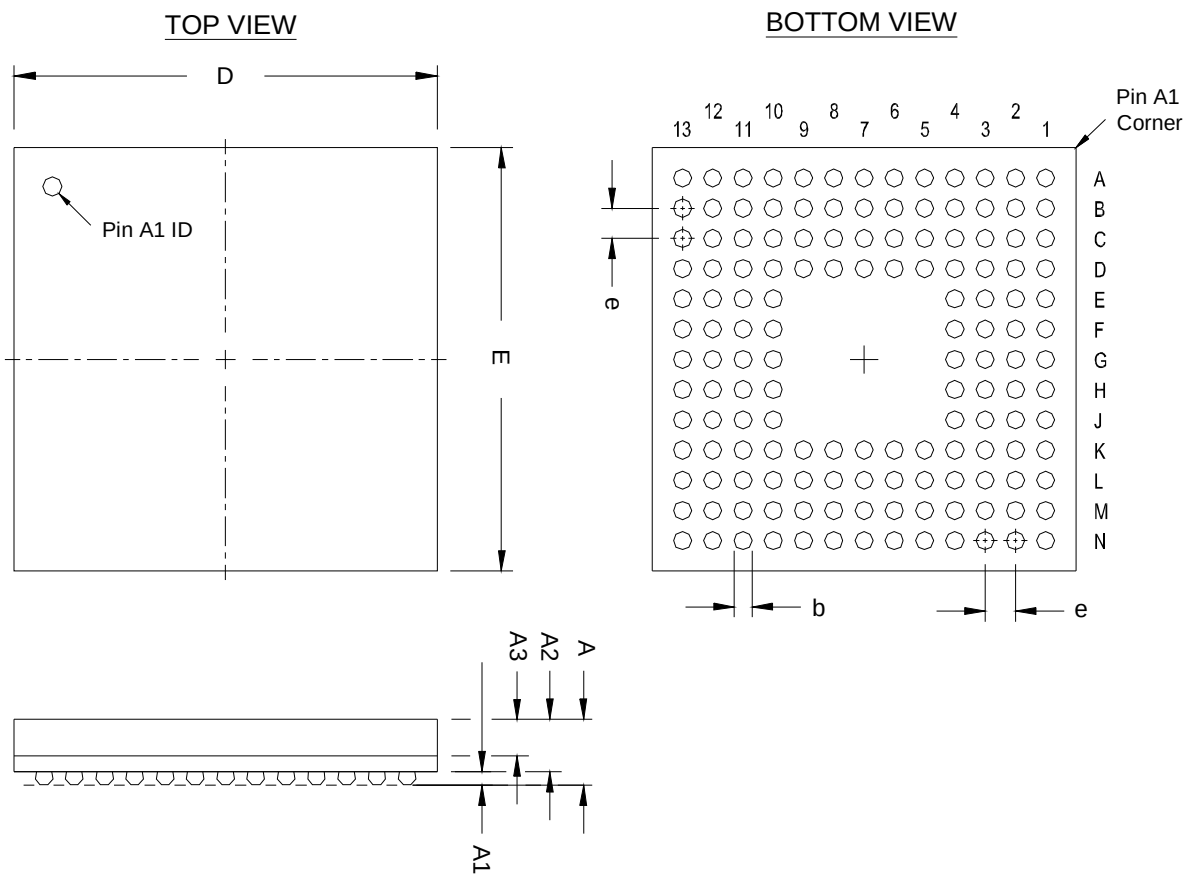
## 144-Pin Micro FineLine Ball-Grid Array (MBGA) — Wire Bond

- All dimensions and tolerances conform to ASME Y14.5M – 1994.
- Controlling dimension is in millimeters.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | M |
| Package Acronym | MBGA |
| Substrate Material | BT |
| Solder Ball Composition | Pb-free: Sn:3Ag:0.5Cu (Typ.) |
| JEDEC Outline Reference | MO-195 Variation: AD |
| Lead Coplanarity | 0.003 inch (0.08mm) |
| Weight | 0.1 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 1.20 |
| A1 | 0.15 | – | – |
| A2 | – | – | 1.00 |
| A3 | 0.60 REF | | |
| D | 7.00 BSC | | |
| E | 7.00 BSC | | |
| b | 0.25 | 0.30 | 0.35 |
| e | 0.50 BSC | | |

## Package Outline



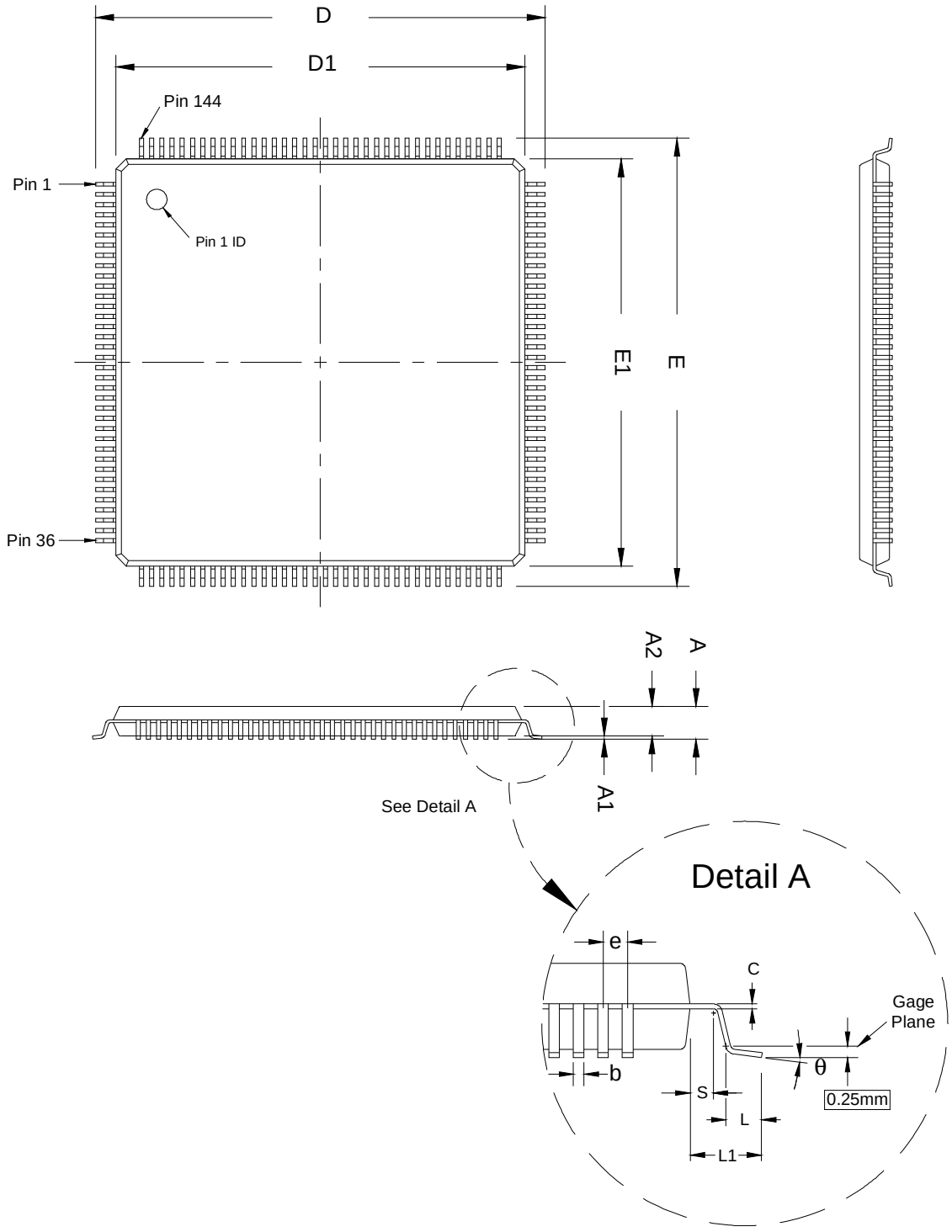
## 144-Pin Plastic Thin Quad Flat Pack (TQFP) — Wire Bond

- All dimensions and tolerances conform to ASME Y14.5M – 1994.
- Controlling dimension is in millimeters.
- Pin 1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | T |
| Package Acronym | TQFP |
| Leadframe Material | Copper |
| Lead Finish (Plating) | Regular: 85Sn:15Pb (Typ.)<br>Pb-free: Matte Sn |
| JEDEC Outline Reference | MS-026 Variation: BFB |
| Lead Coplanarity | 0.003 inches (0.08mm) |
| Weight | 1.1 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 1.60 |
| A1 | 0.05 | – | 0.15 |
| A2 | 1.35 | 1.40 | 1.45 |
| D | 22.00 BSC | | |
| D1 | 20.00 BSC | | |
| E | 22.00 BSC | | |
| E1 | 20.00 BSC | | |
| L | 0.45 | 0.60 | 0.75 |
| L1 | 1.00 REF | | |
| S | 0.20 | – | – |
| b | 0.17 | 0.22 | 0.27 |
| c | 0.09 | – | 0.20 |
| e | 0.50 BSC | | |
| θ | 0° | 3.5° | 7° |

## Package Outline



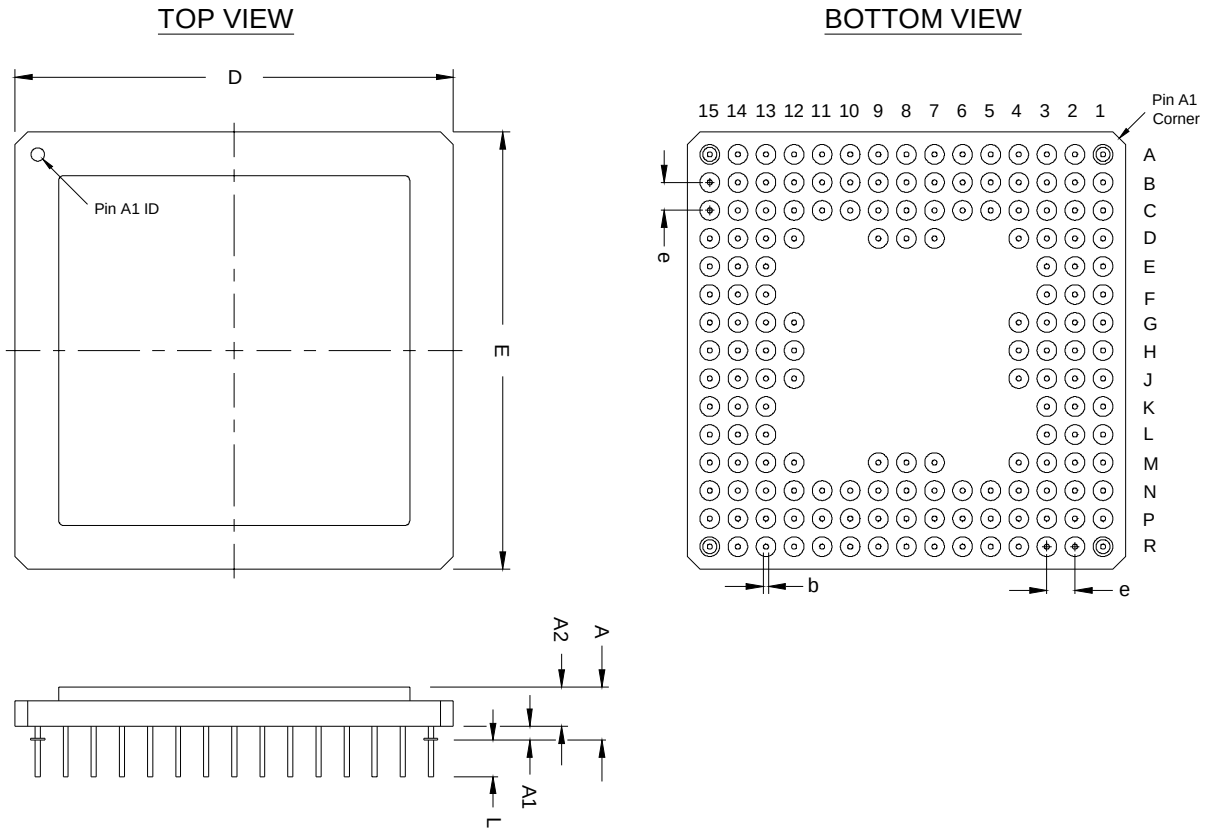
## 160-Pin Ceramic Pin-Grid Array (PGA) — Wire Bond

- All dimensions and tolerances conform to ASME Y14.5M – 1994.
- Controlling dimension is in inches.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | G |
| Package Acronym | PGA |
| Leadframe Material | Alloy 42 |
| Lead Finish | Gold Over Nickel Plate |
| JEDEC Outline Reference | MO-067 Variation: AG |
| Lead Coplanarity | N/A |
| Weight | 19.9 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Inches** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | 0.160 | 0.190 | 0.220 |
| A1 | | 0.050 TYP | |
| A2 | 0.120 | 0.140 | 0.160 |
| D | 1.540 | 1.560 | 1.580 |
| E | 1.540 | 1.560 | 1.580 |
| L | | 0.130 TYP | |
| b | 0.016 | 0.018 | 0.020 |
| e | | 0.100 BSC | |

## Package Outline



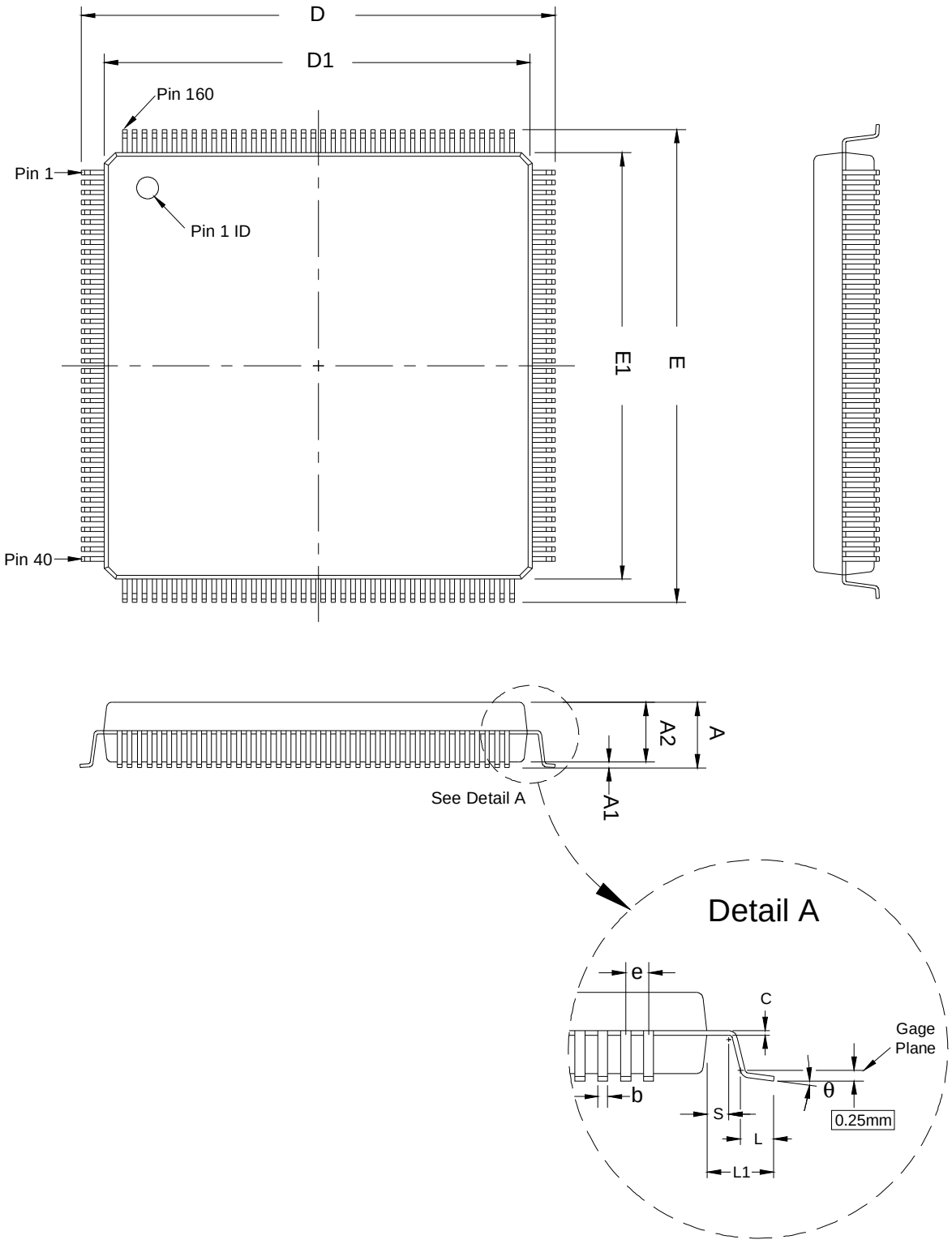
## 160-Pin Plastic Quad Flat Pack (PQFP) — Wire Bond

- All dimensions and tolerances conform to ASME Y14.5M – 1994.
- Controlling dimension is in millimeters.
- Pin 1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | Q |
| Package Acronym | PQFP |
| Leadframe Material | Copper |
| Lead Finish (Plating) | Regular: 85Sn:15Pb (Typ.)<br>Pb-free: Matte Sn |
| JEDEC Outline Reference | MS-022 Variation: DD-1 |
| Lead Coplanarity | 0.004 inches (0.10mm) |
| Weight | 6.2 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 4.10 |
| A1 | 0.25 | – | 0.50 |
| A2 | 3.20 | 3.40 | 3.60 |
| D | 31.20 BSC | | |
| D1 | 28.00 BSC | | |
| E | 31.20 BSC | | |
| E1 | 28.00 BSC | | |
| L | 0.50 | – | 1.03 |
| L1 | 1.60 REF | | |
| S | 0.20 | – | – |
| b | 0.22 | – | 0.40 |
| c | 0.09 | – | 0.23 |
| e | 0.65 BSC | | |
| θ | 0° | – | 7° |

## Package Outline



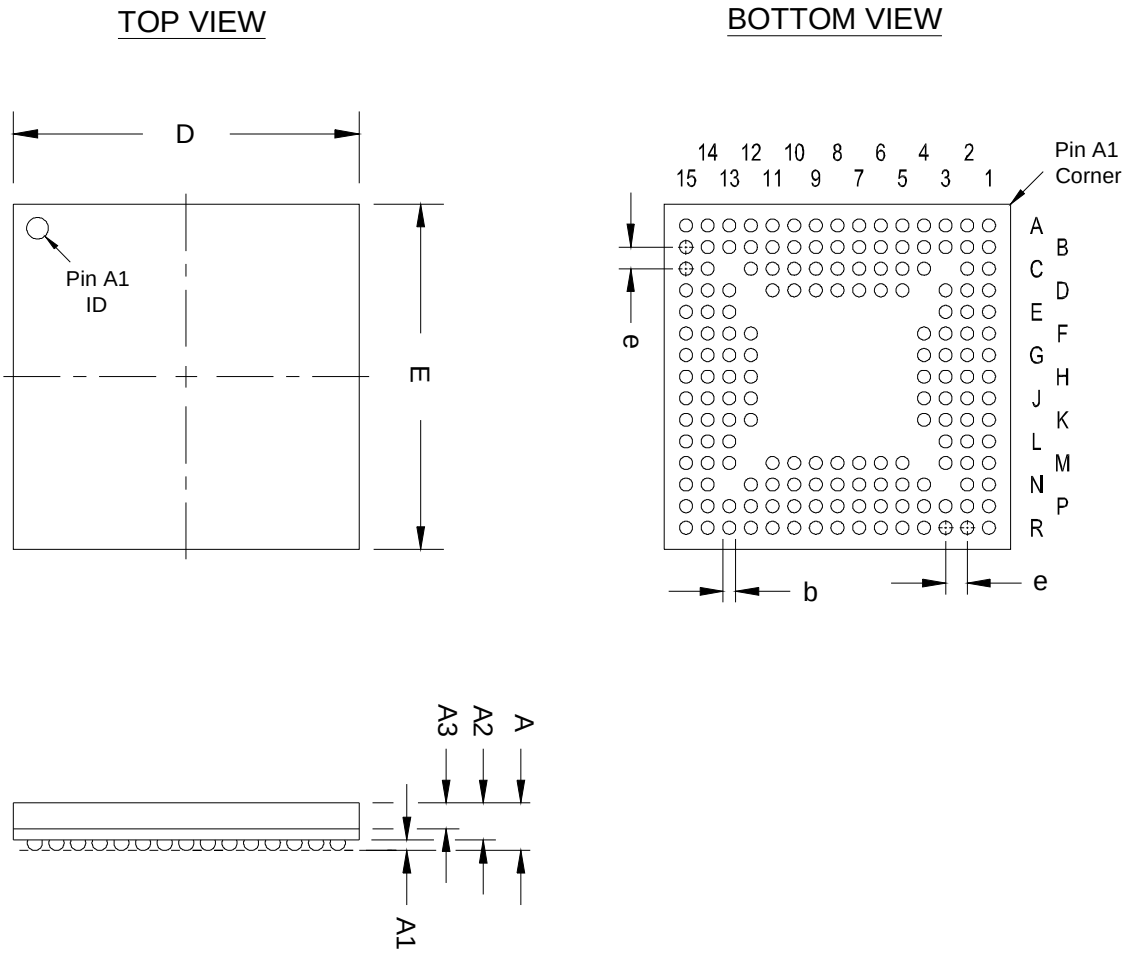
## 164-Pin Micro FineLine Ball-Grid Array (MBGA) — Wire Bond

- All dimensions and tolerances conform to ASME Y14.5M – 1994.
- Controlling dimension is in millimeters.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | M |
| Package Acronym | MBGA |
| Substrate Material | BT |
| Solder Ball Composition | Pb-free: Sn:3Ag:0.5Cu (Typ.) |
| JEDEC Outline Reference | MO-195 Variation: AE |
| Lead Coplanarity | 0.003 inch (0.08mm) |
| Weight | 0.2 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 1.20 |
| A1 | 0.15 | – | – |
| A2 | – | – | 1.00 |
| A3 | 0.60 REF | | |
| D | 8.00 BSC | | |
| E | 8.00 BSC | | |
| b | 0.25 | 0.30 | 0.35 |
| e | 0.50 BSC | | |

## Package Outline



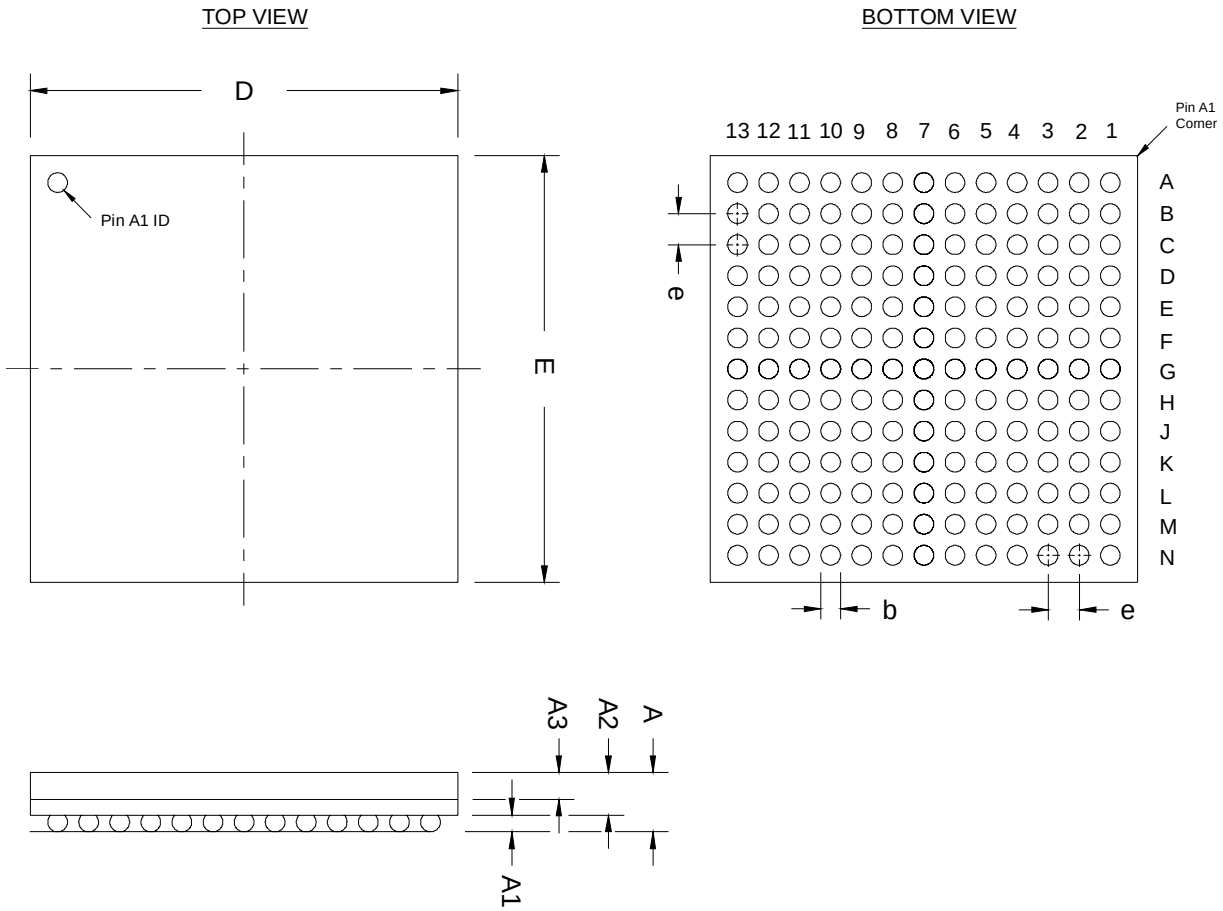
## 169-Pin Ultra FineLine Ball-Grid Array (UBGA) — Wire Bond

- All dimensions and tolerances conform to ASME Y14.5M – 1994.
- Controlling dimension is in millimeters.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | U |
| Package Acronym | UBGA |
| Substrate Material | BT |
| Solder Ball Composition | Regular: 63Sn:37Pb (Typ.)<br>Pb-free: Sn:3Ag:0.5Cu (Typ.) |
| JEDEC Outline Reference | MO-216 Variation: BAF-1 |
| Lead Coplanarity | 0.005 inches (0.12mm) |
| Weight | 0.6 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 1.70 |
| A1 | 0.20 | – | – |
| A2 | 0.65 | – | – |
| A3 | 0.70 TYP | | |
| D | 11.00 BSC | | |
| E | 11.00 BSC | | |
| b | 0.40 | 0.50 | 0.60 |
| e | 0.80 BSC | | |

## Package Outline



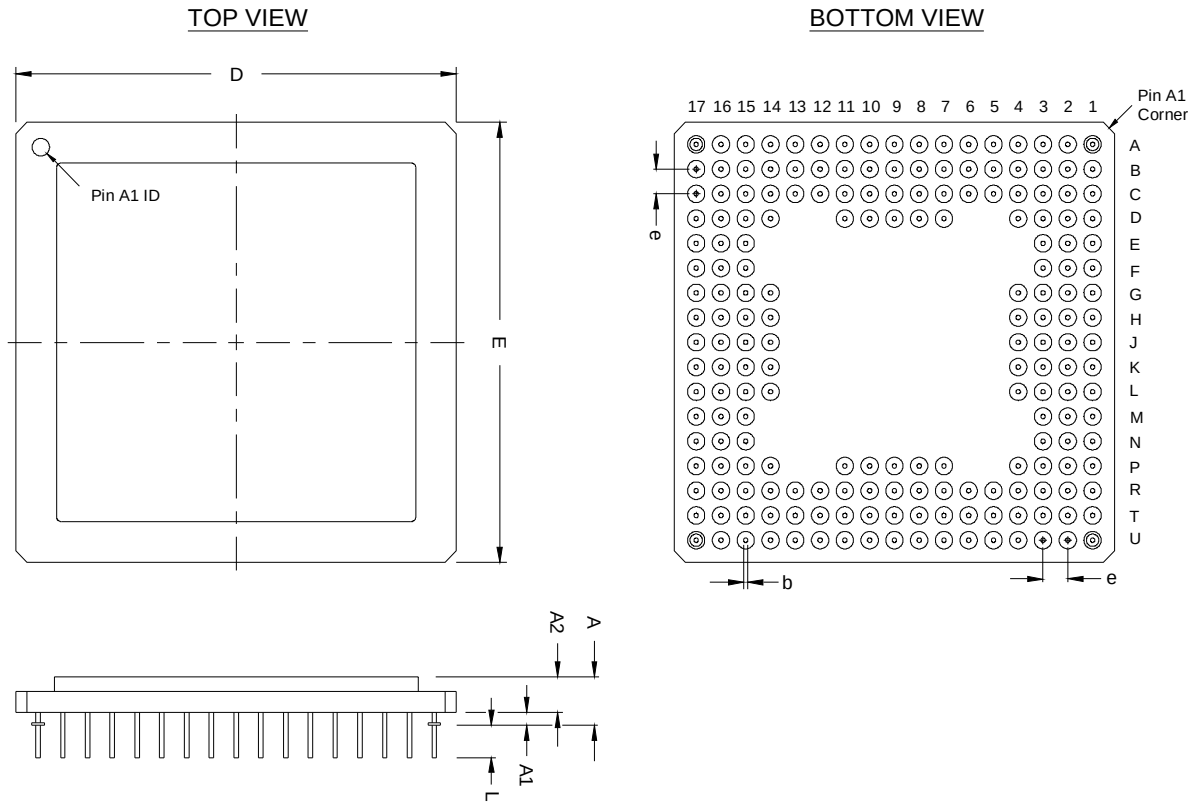
## 192-Pin Ceramic Pin-Grid Array (PGA) — Wire Bond

- All dimensions and tolerances conform to ASME Y14.5M – 1994.
- Controlling dimension is in inches.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | G |
| Package Acronym | PGA |
| Leadframe Material | Alloy 42 |
| Lead Finish | Gold Over Nickel Plate |
| JEDEC Outline Reference | MO-067 Variation: AJ |
| Lead Coplanarity | N/A |
| Weight | 21.0 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Inches** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | 0.167 | 0.192 | 0.217 |
| A1 | | 0.050 TYP | |
| A2 | 0.127 | 0.142 | 0.157 |
| D | 1.740 | 1.760 | 1.780 |
| E | 1.740 | 1.760 | 1.780 |
| L | | 0.130 TYP | |
| b | 0.016 | 0.018 | 0.020 |
| e | | 0.100 BSC | |

## Package Outline



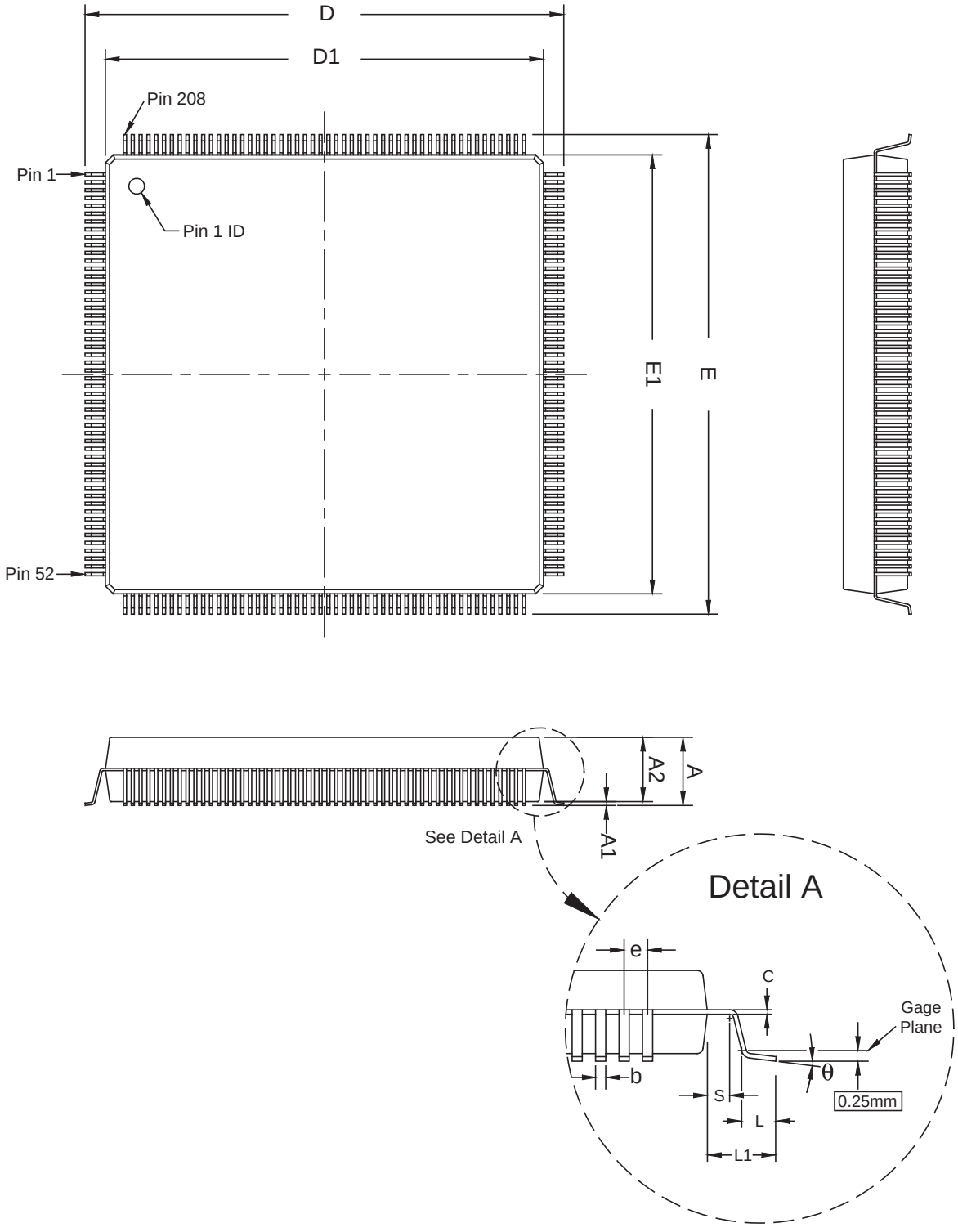
## 208-Pin Plastic Quad Flat Pack (PQFP) — Wire Bond

- All dimensions and tolerances conform to ASME Y14.5M - 1994.
- Controlling dimension is in millimeters.
- Pin 1 may be indicated by an ID dot in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | Q |
| Package Acronym | PQFP |
| Lead Material | Copper |
| Lead Finish (Plating) | Regular: 85Sn:15Pb (Typ.)<br>Pb-free: Matte Sn |
| JEDEC Outline Reference | MS-029 Variation: FA-1 |
| Lead Coplanarity | 0.003 inches (0.08 mm) |
| Weight | 6.3 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 4.10 |
| A1 | 0.25 | – | 0.50 |
| A2 | 3.20 | 3.40 | 3.60 |
| D | 30.60 BSC | | |
| D1 | 28.00 BSC | | |
| E | 30.60 BSC | | |
| E1 | 28.00 BSC | | |
| L | 0.50 | 0.60 | 0.75 |
| L1 | 1.30 REF | | |
| S | 0.20 | – | – |
| b | 0.17 | – | 0.27 |
| c | 0.09 | – | 0.20 |
| e | 0.50 BSC | | |
| θ | 0° | 3.5° | 8° |

## Package Outline



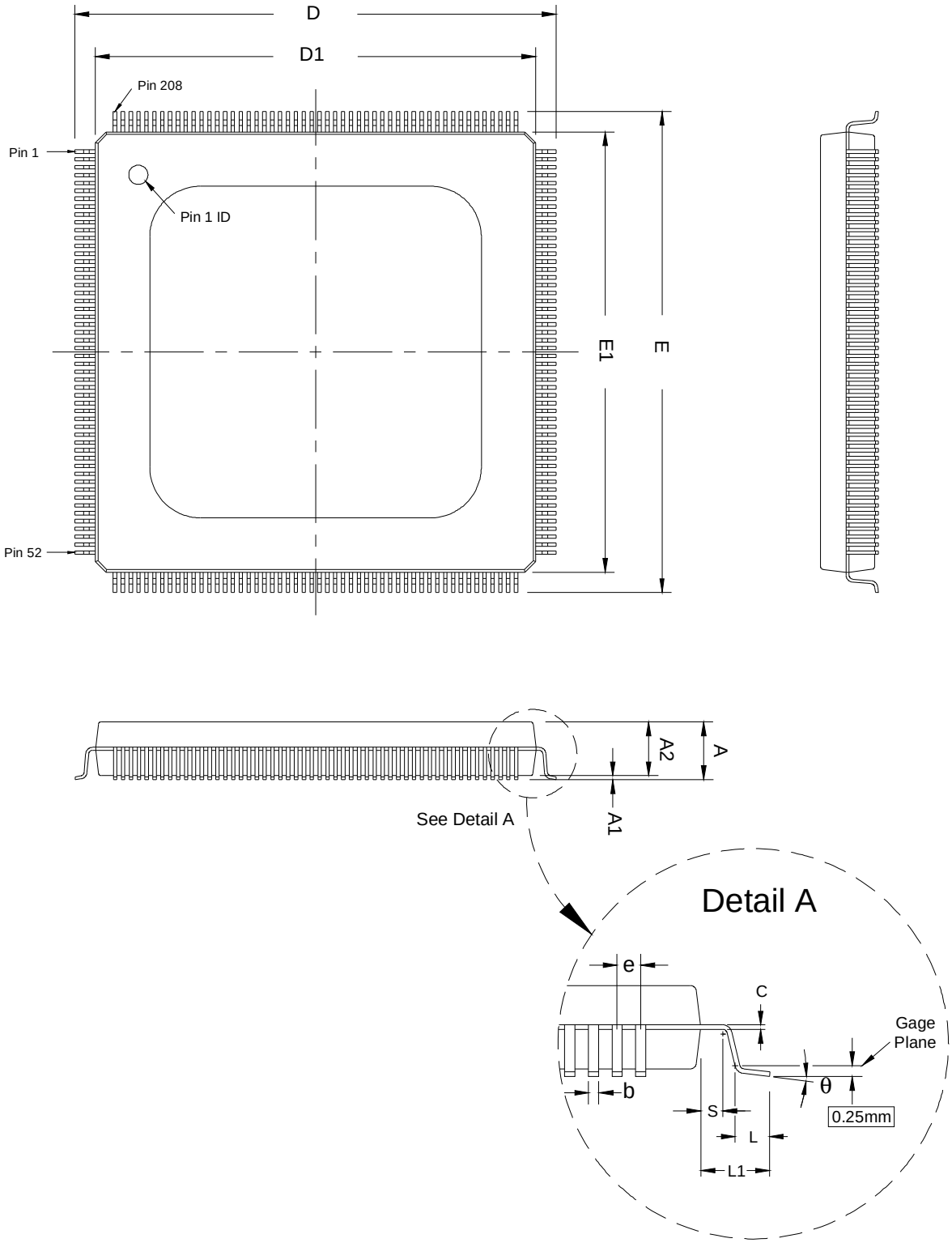
## 208-Pin Power Quad Flat Pack (RQFP) — Wire Bond

- All dimensions and tolerances conform to ASME Y14.5M – 1994.
- Controlling dimension is in millimeters.
- Pin 1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | R |
| Package Acronym | RQFP |
| Leadframe Material | Copper |
| Lead Finish (Plating) | Regular: 85Sn:15Pb (Typ.)<br>Pb-free: Matte Sn |
| JEDEC Outline Reference | MS-029 Variation: FA-1 |
| Lead Coplanarity | 0.003 inches (0.08mm) |
| Weight | 11.0 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 4.10 |
| A1 | 0.25 | – | 0.50 |
| A2 | 3.20 | 3.40 | 3.60 |
| D | | 30.60 BSC | |
| D1 | | 28.00 BSC | |
| E | | 30.60 BSC | |
| E1 | | 28.00 BSC | |
| L | 0.45 | 0.60 | 0.75 |
| L1 | | 1.30 REF | |
| S | 0.20 | – | – |
| b | 0.17 | – | 0.27 |
| c | 0.09 | – | 0.20 |
| e | | 0.50 BSC | |
| θ | 0° | 3.5° | 8° |

## Package Outline



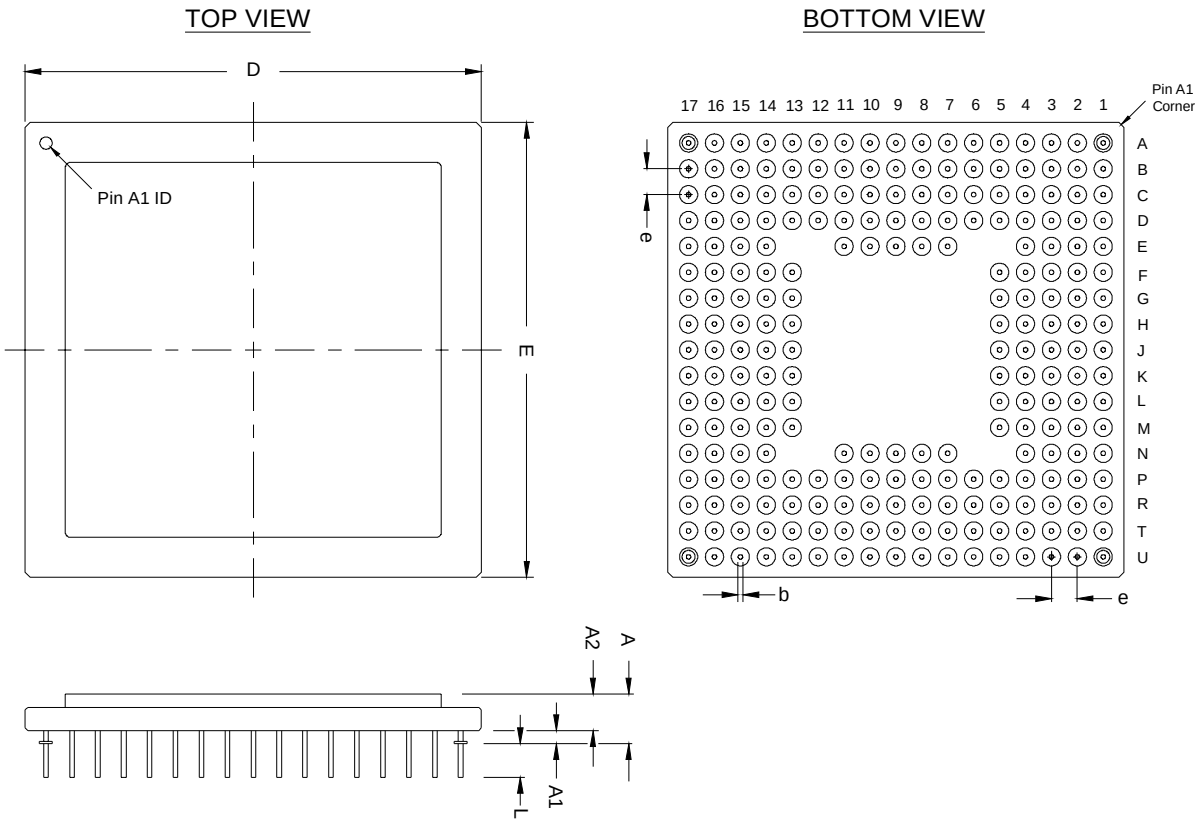
## 232-Pin Ceramic Pin-Grid Array (PGA) — Wire Bond

- All dimensions and tolerances conform to ASME Y14.5M – 1994.
- Controlling dimension is in inches.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | G |
| Package Acronym | PGA |
| Leadframe Material | Alloy 42 |
| Lead Finish | Gold Over Nickel Plate |
| JEDEC Outline Reference | MO-067 Variation: AJ |
| Lead Coplanarity | N/A |
| Weight | 25.5 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Inches** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | 0.174 | 0.192 | 0.210 |
| A1 | | 0.050 TYP | |
| A2 | 0.134 | 0.142 | 0.150 |
| D | 1.740 | 1.760 | 1.780 |
| E | 1.740 | 1.760 | 1.780 |
| L | | 0.130 TYP | |
| b | 0.016 | 0.018 | 0.020 |
| e | | 0.100 BSC | |

## Package Outline



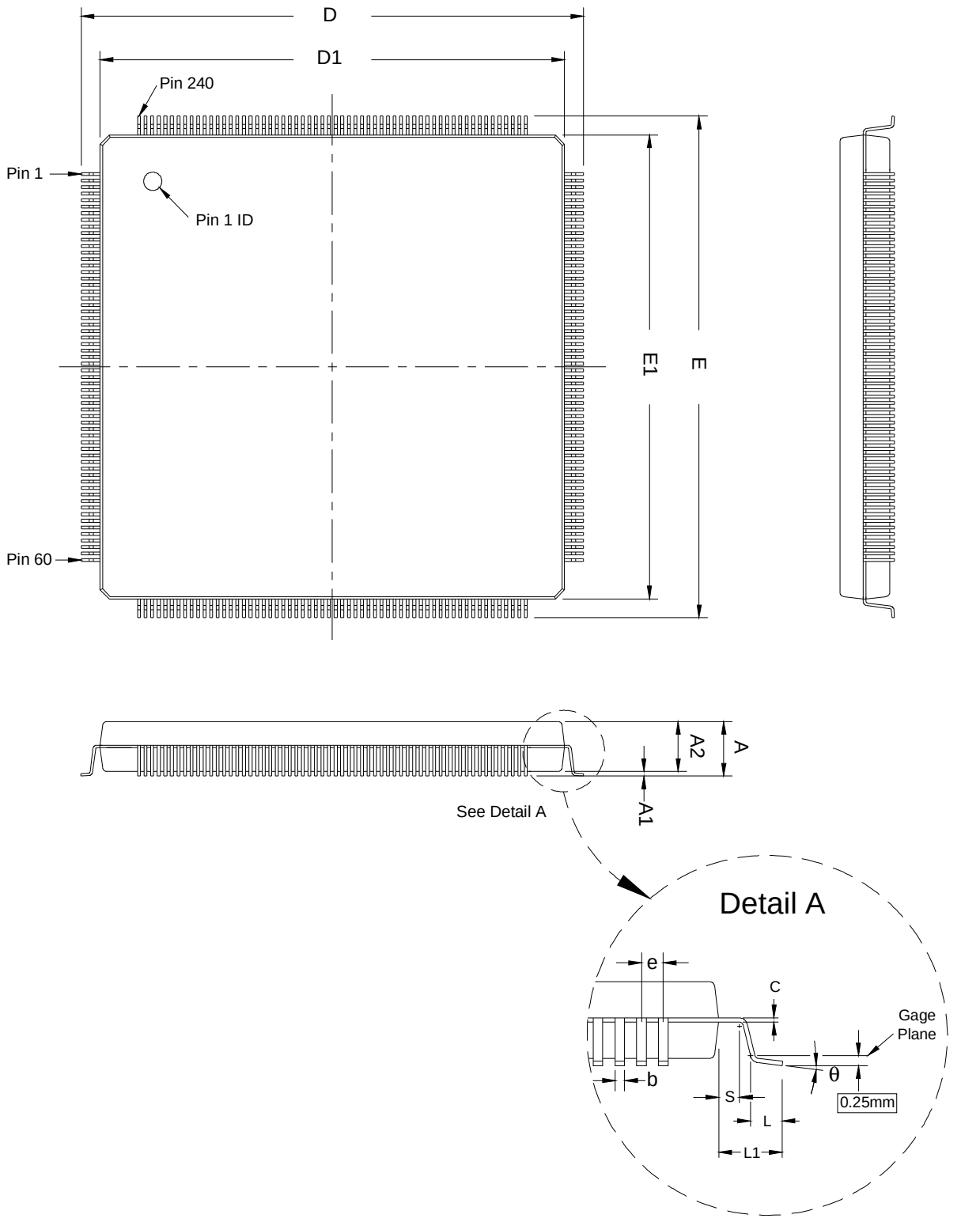
## 240-Pin Plastic Quad Flat Pack (PQFP) — Wire Bond

- All dimensions and tolerances conform to ASME Y14.5M – 1994.
- Controlling dimension is in millimeters.
- Pin 1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | Q |
| Package Acronym | PQFP |
| Leadframe Material | Copper |
| Lead Finish (Plating) | Regular: 85Sn:15Pb (Typ.)<br>Pb-free: Matte Sn |
| JEDEC Outline Reference | MS-029 Variation: GA |
| Lead Coplanarity | 0.003 inches (0.08mm) |
| Weight | 8.0 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 4.10 |
| A1 | 0.25 | – | 0.50 |
| A2 | 3.20 | 3.40 | 3.60 |
| D | | 34.60 BSC | |
| D1 | | 32.00 BSC | |
| E | | 34.60 BSC | |
| E1 | | 32.00 BSC | |
| L | 0.45 | 0.60 | 0.75 |
| L1 | | 1.30 REF | |
| S | 0.20 | – | – |
| b | 0.17 | – | 0.27 |
| c | 0.09 | – | 0.20 |
| e | | 0.50 BSC | |
| θ | 0° | 3.5° | 8° |

## Package Outline



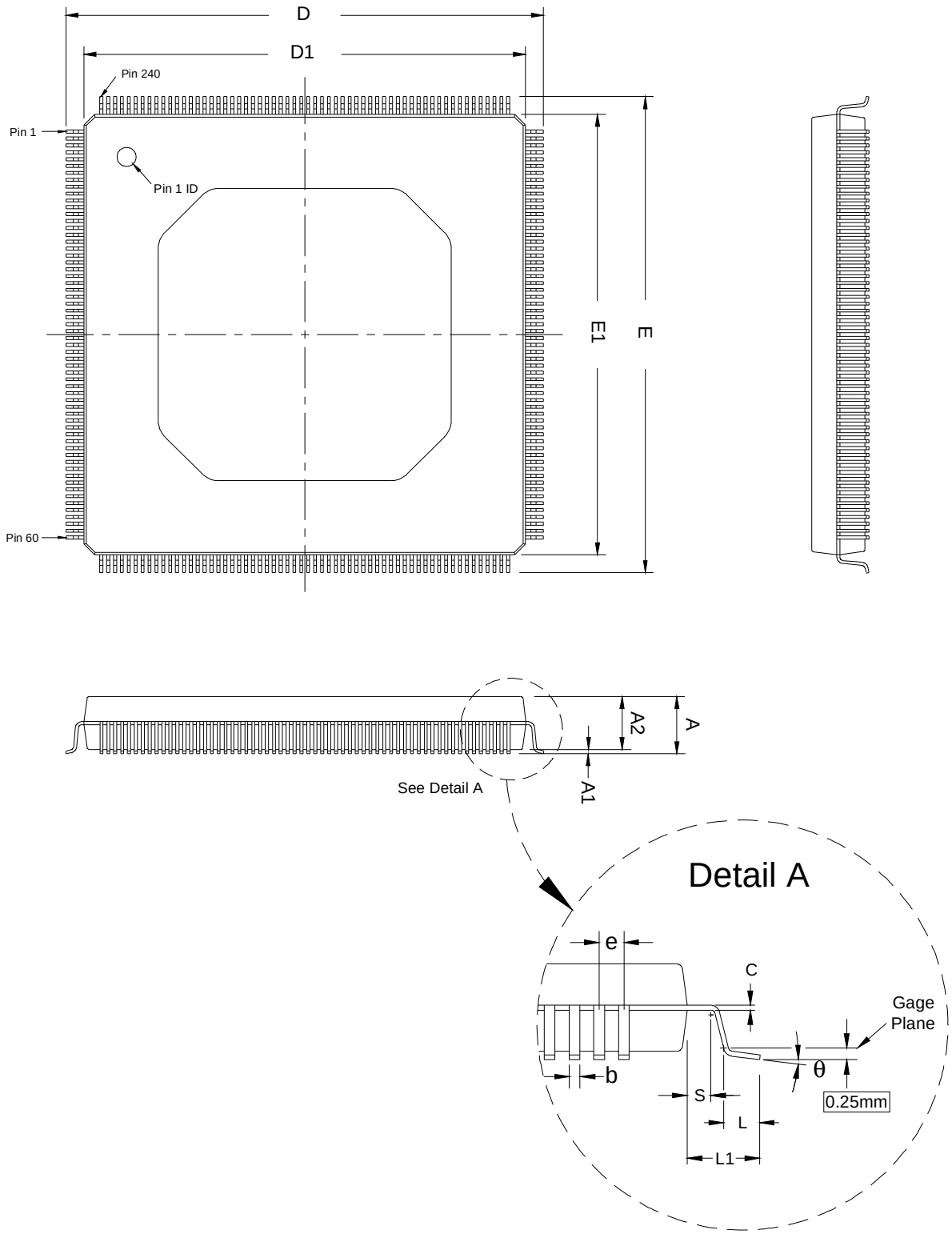
## 240-Pin Power Quad Flat Pack (RQFP) — Wire Bond

- All dimensions and tolerances conform to ASME Y14.5M – 1994.
- Controlling dimension is in millimeters.
- Pin 1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | R |
| Package Acronym | RQFP |
| Leadframe Material | Copper |
| Lead Finish (Plating) | Regular: 85Sn:15Pb (Typ.)<br>Pb-free: Matte Sn |
| JEDEC Outline Reference | MS-029 Variation: GA |
| Lead Coplanarity | 0.003 inches (0.08mm) |
| Weight | 15.4 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 4.10 |
| A1 | 0.25 | – | 0.50 |
| A2 | 3.20 | 3.40 | 3.60 |
| D | 34.60 BSC | | |
| D1 | 32.00 BSC | | |
| E | 34.60 BSC | | |
| E1 | 32.00 BSC | | |
| L | 0.45 | 0.60 | 0.75 |
| L1 | 1.30 REF | | |
| S | 0.20 | – | – |
| b | 0.17 | – | 0.27 |
| c | 0.09 | – | 0.20 |
| e | 0.50 BSC | | |
| θ | 0° | 3.5° | 8° |

## Package Outline



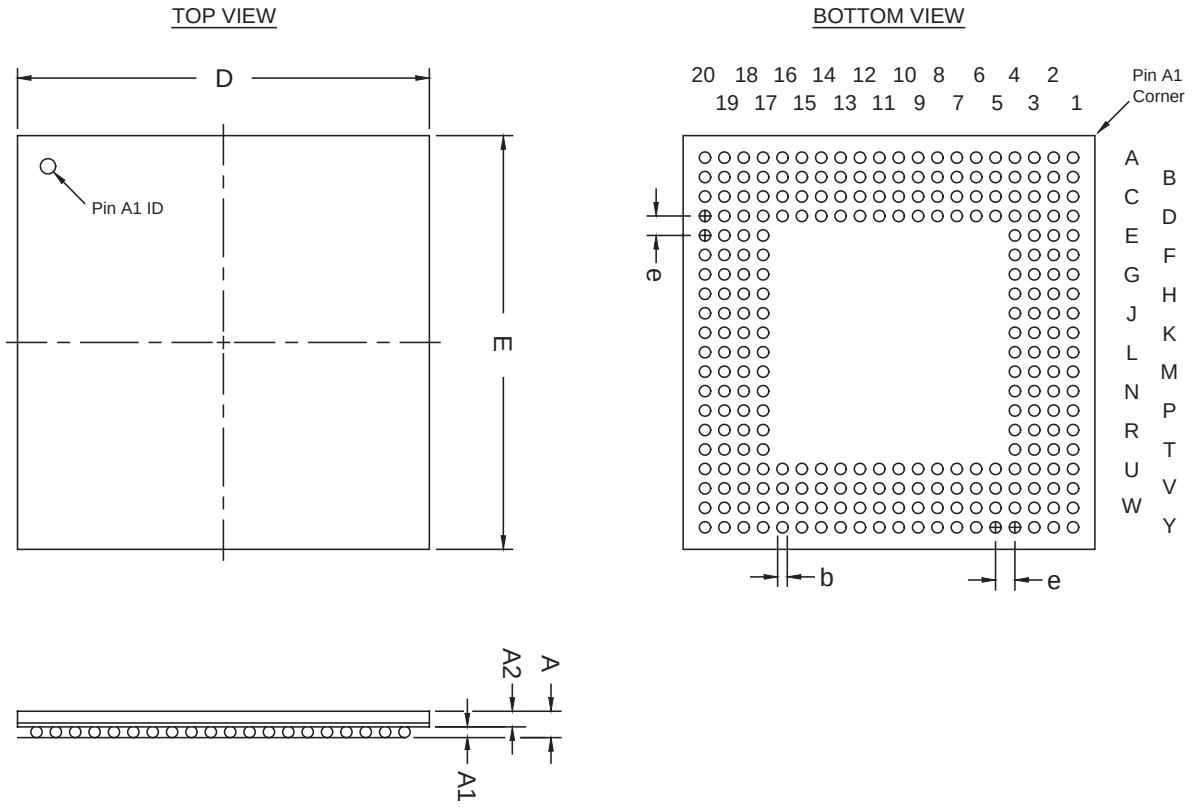
## 256-Pin Ball-Grid Array (BGA), Option 1 — Wire Bond

- All dimensions and tolerances conform to ASME Y14.5M - 1994.
- Controlling dimension is in millimeters.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | B |
| Package Acronym | BGA |
| Substrate Material | BT or tape |
| Solder Ball Composition | Regular: 63Sn:37Pb (Typ.)<br>Pb-free: Sn:3Ag:0.5Cu (Typ.) |
| JEDEC Outline Reference | MO-192 Variation: BAL-2 |
| Lead Coplanarity | 0.008 inches (0.20 mm) |
| Weight | 4.8 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 1.70 |
| A1 | 0.35 | – | – |
| A2 | 0.25 | – | 1.10 |
| D | 27.00 BSC | | |
| E | 27.00 BSC | | |
| b | 0.60 | 0.75 | 0.90 |
| e | 1.27 BSC | | |

## Package Outline



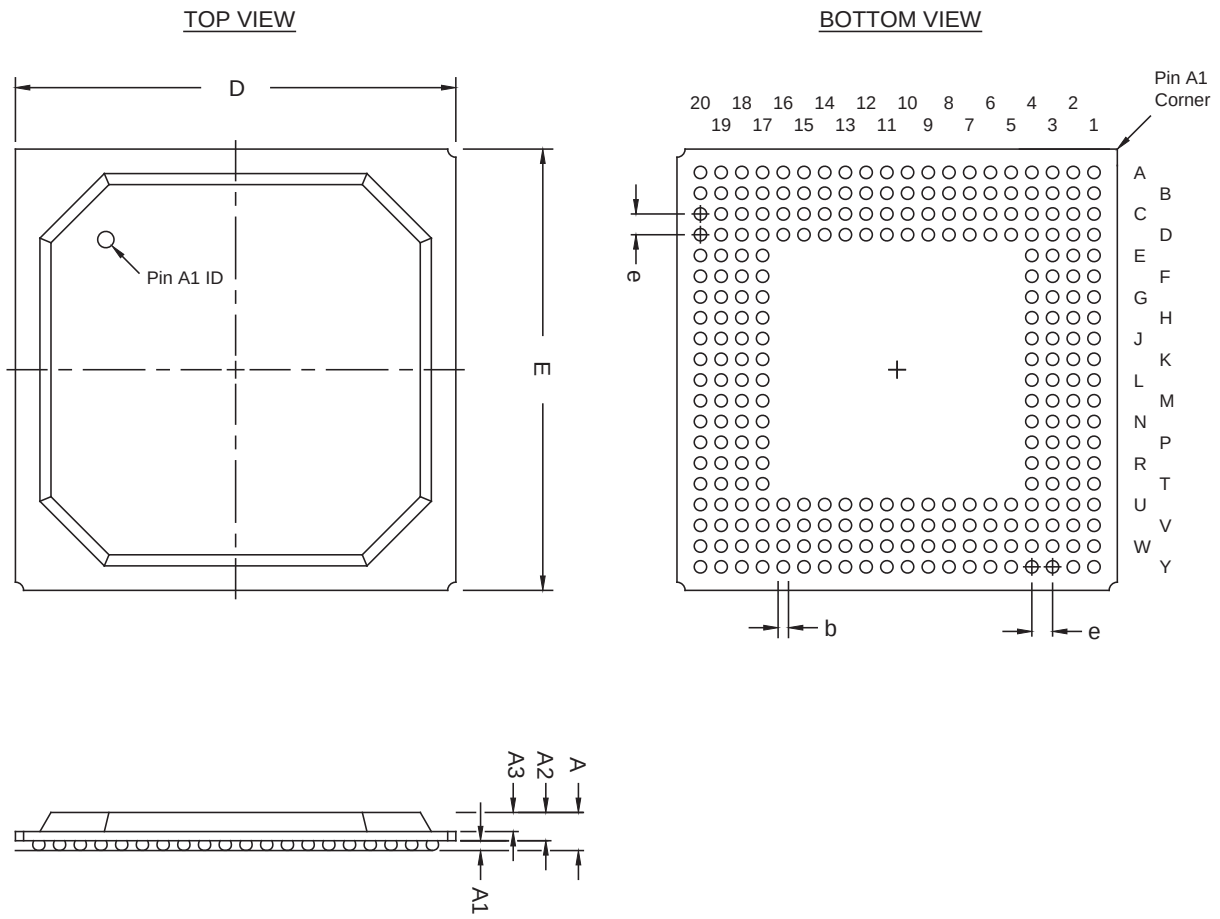
## 256-Pin Plastic Ball-Grid Array (BGA), Option 2 — Wire Bond

- All dimensions and tolerances conform to ASME Y14.5M - 1994.
- Controlling dimension is in millimeters.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | B |
| Package Acronym | BGA |
| Substrate Material | BT |
| Solder Ball Composition | Regular: 63Sn:37Pb (Typ.)<br>Pb-free: Sn:3Ag:0.5Cu (Typ.) |
| JEDEC Outline Reference | MS-034 Variation: BAL-2 |
| Lead Coplanarity | 0.008 inches (0.20 mm) |
| Weight | 2.2 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 2.60 |
| A1 | 0.35 | – | – |
| A2 | – | – | 2.20 |
| A3 | – | – | 1.80 |
| D | 27.00 BSC | | |
| E | 27.00 BSC | | |
| b | 0.60 | 0.75 | 0.90 |
| e | 1.27 BSC | | |

## Package Outline



## 256-Pin FineLine Ball-Grid Array (FBGA), Option 1 — Wire Bond

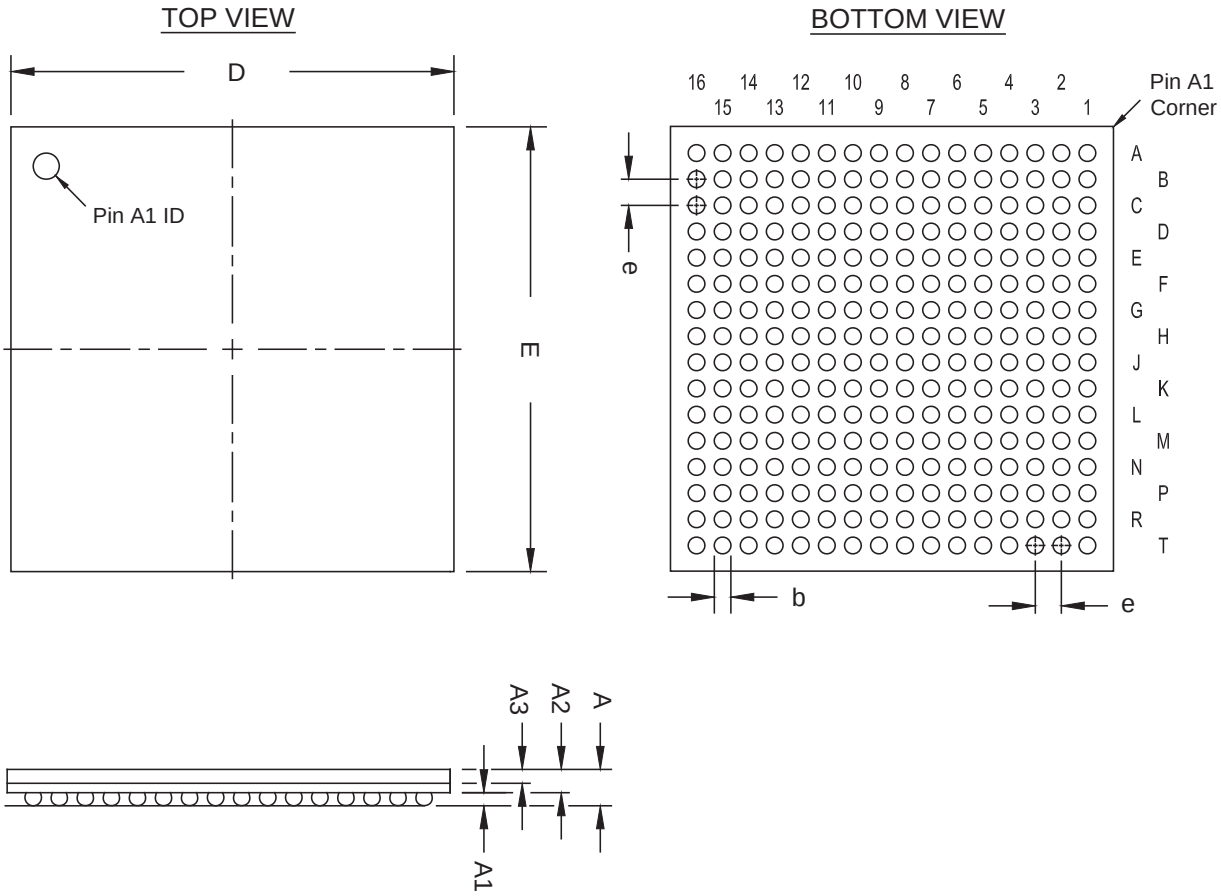
- All dimensions and tolerances conform to ASME Y14.5M - 1994.
- Controlling dimension is in millimeters.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

This POD is applicable to F256 packages of all products except Cyclone II and III, which is assembled in Option 2 package outlines.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | F |
| Package Acronym | FBGA |
| Substrate Material | BT |
| Solder Ball Composition | Regular: 63Sn:37Pb (Typ.)<br>Pb-free: Sn:3Ag:0.5Cu (Typ.) |
| JEDEC Outline Reference | MS-034 Variation: AAF-1 |
| Lead Coplanarity | 0.008 inches (0.20 mm) |
| Weight | 1.5 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 2.20 |
| A1 | 0.30 | – | – |
| A2 | – | – | 1.80 |
| A3 | | 0.70 REF | |
| D | | 17.00 BSC | |
| E | | 17.00 BSC | |
| b | 0.50 | 0.60 | 0.70 |
| e | | 1.00 BSC | |

## Package Outline



## 256-Pin FineLine Ball-Grid Array (FBGA), Option 2 — Wire Bond

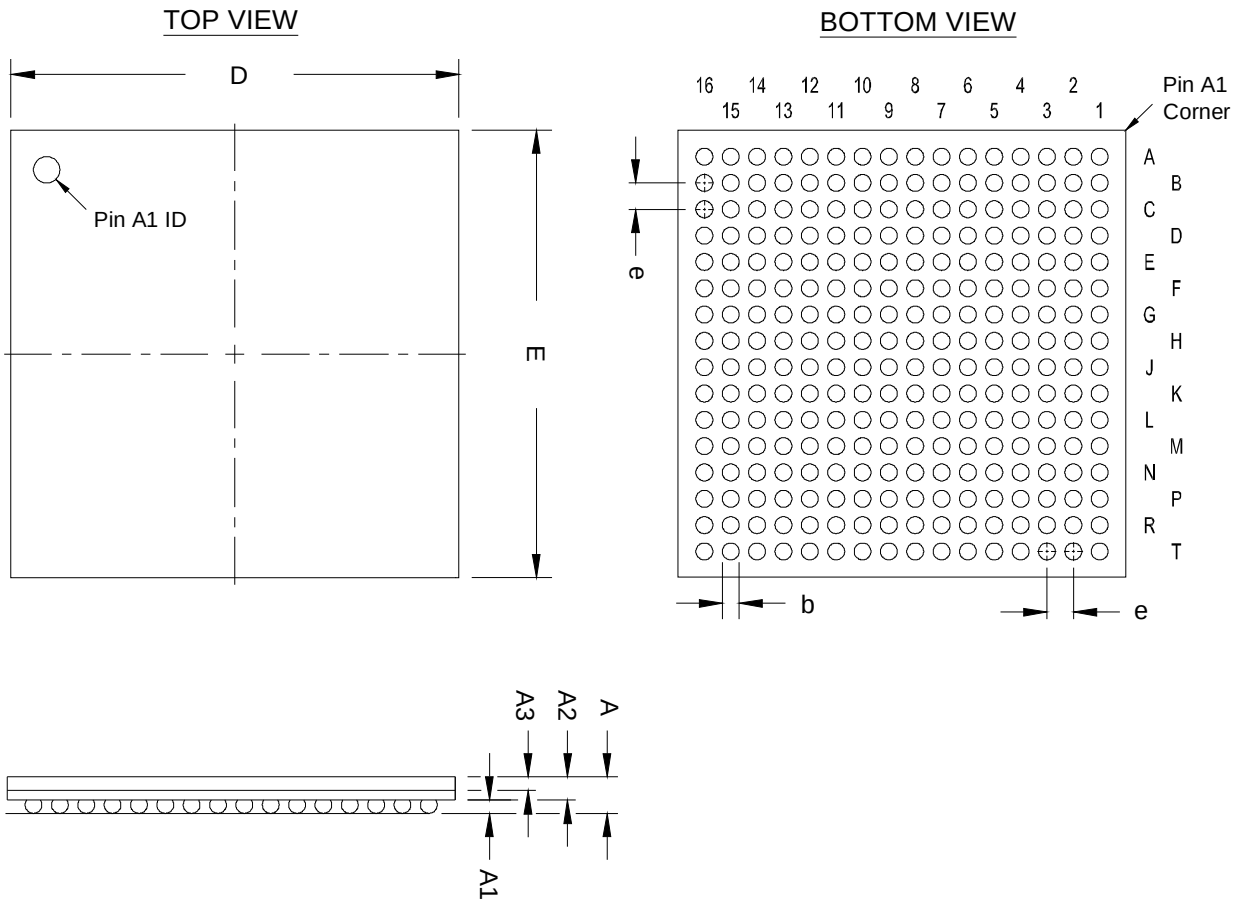
- All dimensions and tolerances conform to ASME Y14.5M - 1994.
- Controlling dimension is in millimeters.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on the package surface.

This POD is applicable to F256 packages of the Cyclone II and III products only.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | F |
| Package Acronym | FBGA |
| Substrate Material | BT |
| Solder Ball Composition | Regular: 63Sn:37Pb (Typ.)<br>Pb-free: Sn:3Ag:0.5Cu (Typ.) |
| JEDEC Outline Reference | MO-192 Variation: DAF-1 |
| Lead Coplanarity | 0.008 inches (0.20 mm) |
| Weight | 1.5 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 1.55 |
| A1 | 0.25 | – | – |
| A2 | | 1.05 REF | |
| A3 | – | – | 0.80 |
| D | | 17.00 BSC | |
| E | | 17.00 BSC | |
| b | 0.45 | 0.50 | 0.55 |
| e | | 1.00 BSC | |

## Package Outline



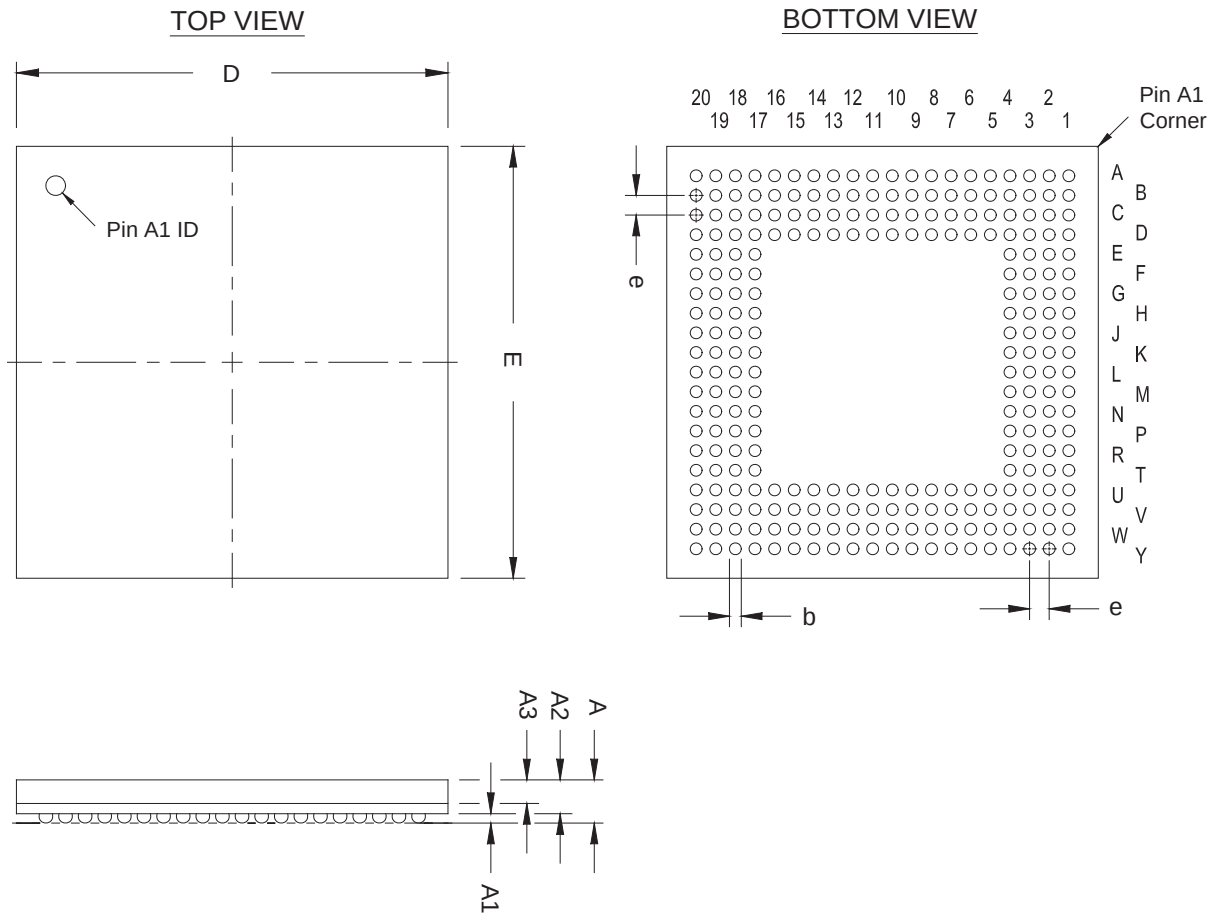
## 256-Pin Micro FineLine Ball-Grid Array (MBGA) — Wire Bond

- All dimensions and tolerances conform to ASME Y14.5M - 1994.
- Controlling dimension is in millimeters.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | M |
| Package Acronym | MBGA |
| Substrate Material | BT |
| Solder Ball Composition | Pb-free: Sn:3Ag:0.5Cu (Typ.) |
| JEDEC Outline Reference | MO-195 Variation: BH |
| Lead Coplanarity | 0.003 inch (0.08mm) |
| Weight | 0.3 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 1.20 |
| A1 | 0.15 | – | – |
| A2 | – | – | 1.00 |
| A3 | 0.60 REF | | |
| D | 11.00 BSC | | |
| E | 11.00 BSC | | |
| b | 0.25 | 0.30 | 0.35 |
| e | 0.50 BSC | | |

## Package Outline



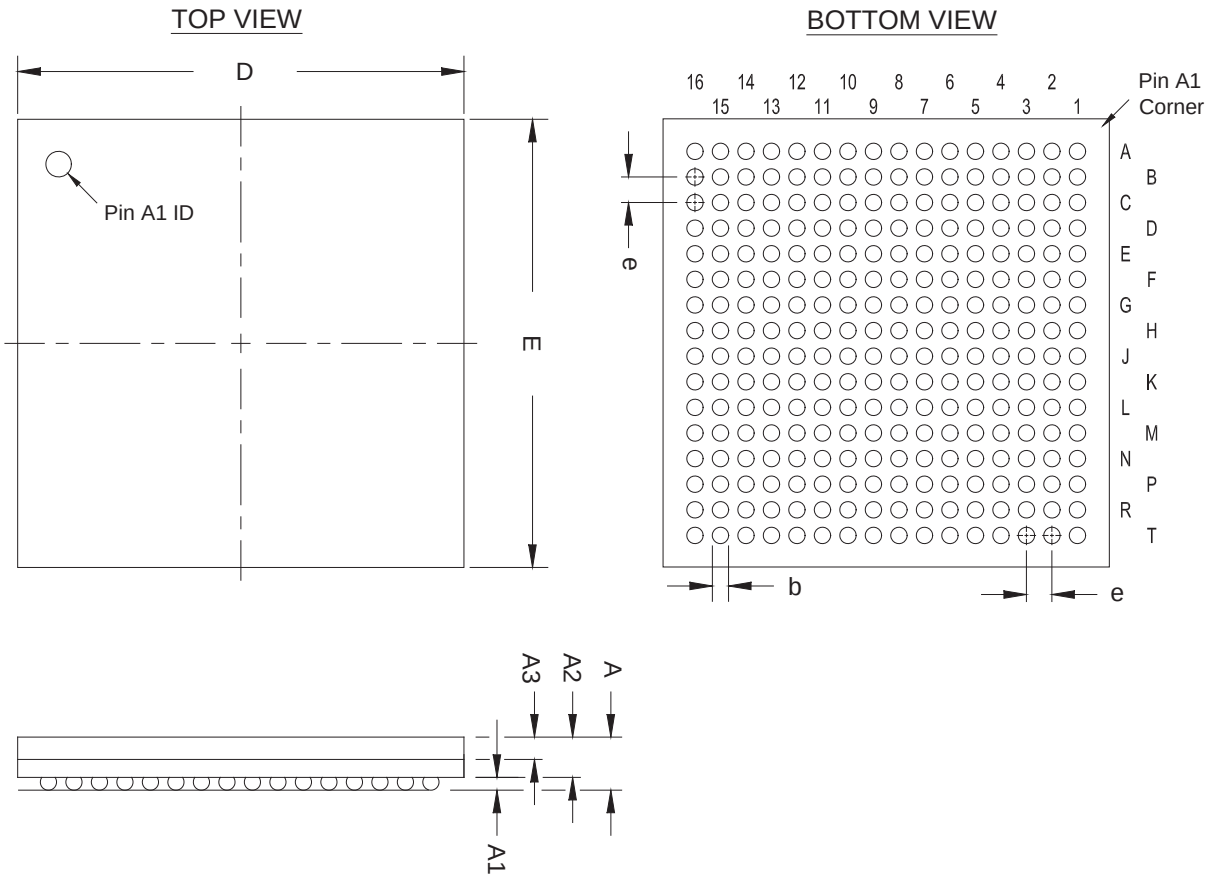
## 256-Pin Ultra FineLine Ball-Grid Array (UBGA) — Wire Bond

- All dimensions and tolerances conform to ASME Y14.5M - 1994.
- Controlling dimension is in millimeters.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | U |
| Package Acronym | UBGA |
| Substrate Material | BT |
| Solder Ball Composition | Regular: 63Sn:37Pb (Typ.)<br>Pb-free: Sn:3Ag:0.5Cu (Typ.) |
| JEDEC Outline Reference | MO-216 Variation: BAJ-2 |
| Lead Coplanarity | 0.005 inches (0.12mm) |
| Weight | 0.8 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 1.55 |
| A1 | 0.20 | – | – |
| A2 | 0.65 | _ | _ |
| A3 | 0.80 TYP | | |
| D | 14.00 BSC | | |
| E | 14.00 BSC | | |
| b | 0.40 | 0.50 | 0.60 |
| e | 0.80 BSC | | |

## Package Outline



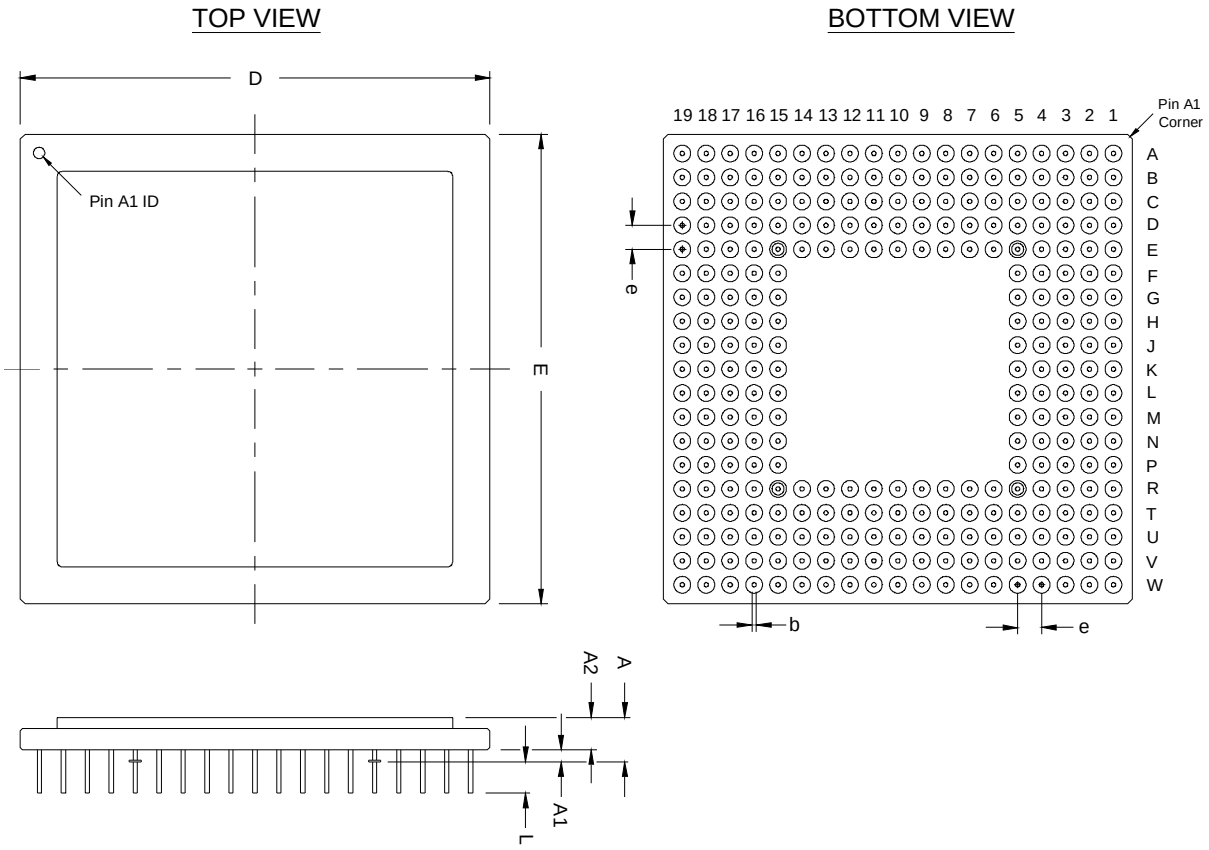
## 280-Pin Ceramic Pin-Grid Array (PGA) — Wire Bond

- All dimensions and tolerances conform to ASME Y14.5M – 1994.
- Controlling dimension is in inches.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | G |
| Package Acronym | PGA |
| Leadframe Material | Alloy 42 |
| Lead Finish | Gold Over Nickel Plate |
| JEDEC Outline Reference | MO-067 Variation: AL |
| Lead Coplanarity | N/A |
| Weight | 29.5 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Inches** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | 0.165 | 0.185 | 0.205 |
| A1 | | 0.050 TYP | |
| A2 | 0.125 | 0.135 | 0.145 |
| D | 1.940 | 1.960 | 1.980 |
| E | 1.940 | 1.960 | 1.980 |
| L | | 0.130 TYP | |
| b | 0.016 | 0.018 | 0.020 |
| e | | 0.100 BSC | |

## Package Outline



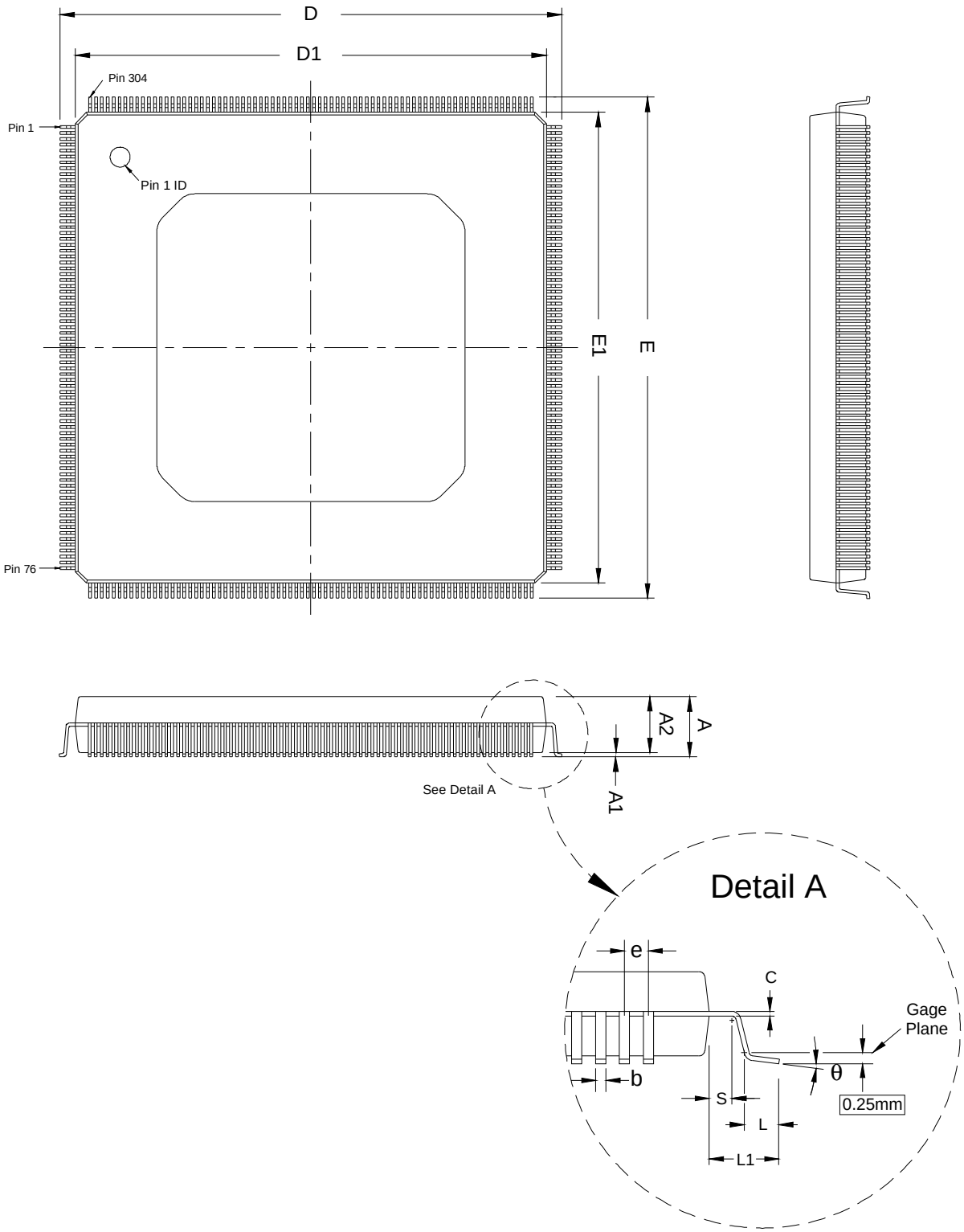
## 304-Pin Power Quad Flat Pack (RQFP) — Wire Bond

- All dimensions and tolerances conform to ASME Y14.5M – 1994.
- Controlling dimension is in millimeters.
- Pin 1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | R |
| Package Acronym | RQFP |
| Leadframe Material | Copper |
| Lead Finish (Plating) | Regular: 85Sn:15Pb (Typ.)<br>Pb-free: Matte Sn |
| JEDEC Outline Reference | MS-029 Variation: JA |
| Lead Coplanarity | 0.003 inches (0.08mm) |
| Weight | 26.1 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 4.50 |
| A1 | 0.25 | – | 0.50 |
| A2 | 3.55 | 3.80 | 4.05 |
| D | | 42.60 BSC | |
| D1 | | 40.00 BSC | |
| E | | 42.60 BSC | |
| E1 | | 40.00 BSC | |
| L | 0.45 | 0.60 | 0.75 |
| L1 | | 1.30 REF | |
| S | 0.20 | – | – |
| b | 0.17 | – | 0.27 |
| c | 0.09 | – | 0.20 |
| e | | 0.50 BSC | |
| θ | 0° | 3.5° | 8° |

## Package Outline



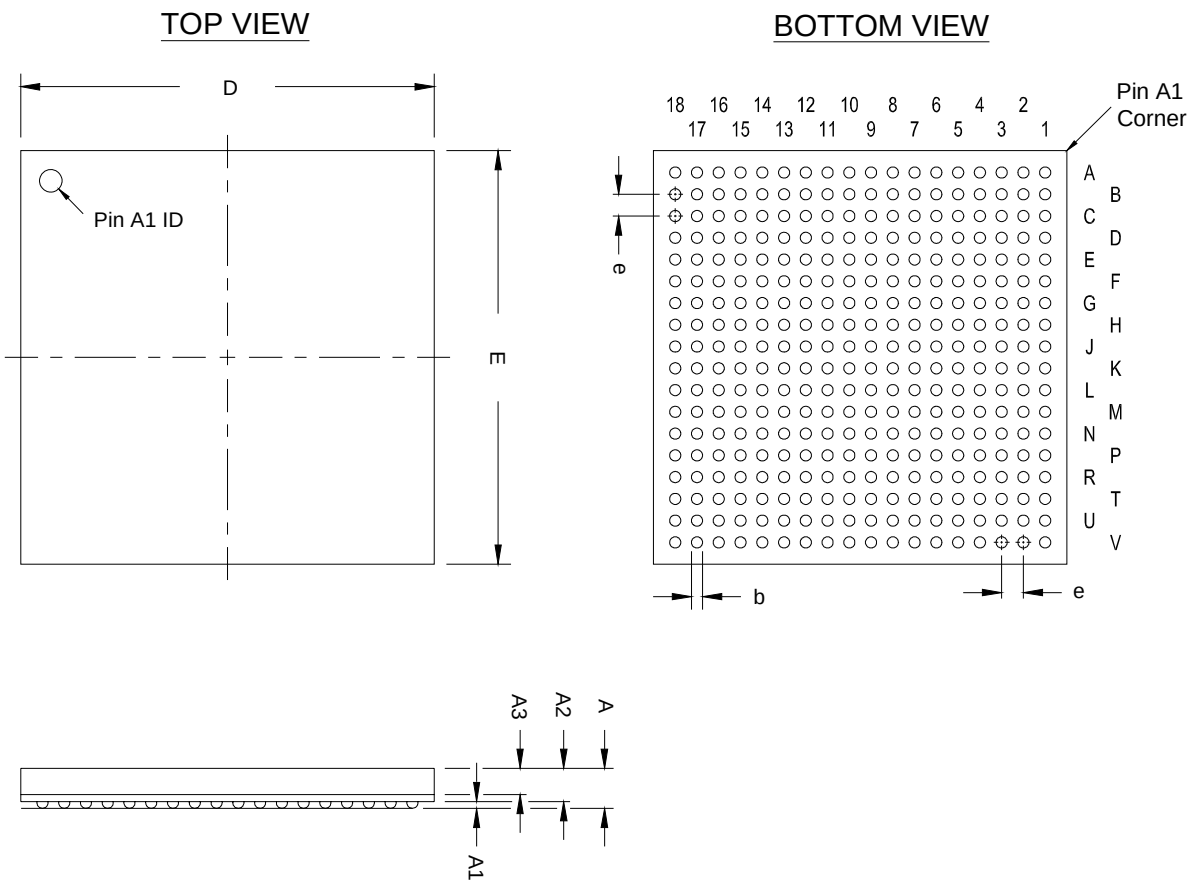
## 324-Pin FineLine Ball-Grid Array (FBGA) — Wire Bond

- All dimensions and tolerances conform to ASME Y14.5M – 1994.
- Controlling dimension is in millimeters.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | F |
| Package Acronym | FBGA |
| Substrate Material | BT |
| Solder Ball Composition | Regular: 63Sn:37Pb (Typ.)<br>Pb-free: Sn:3Ag:0.5Cu (Typ.) |
| JEDEC Outline Reference | MS-034 Variation: AAG-1 |
| Lead Coplanarity | 0.008 inches (0.20mm) |
| Weight | 1.6 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 2.20 |
| A1 | 0.30 | – | – |
| A2 | – | – | 1.80 |
| A3 | 0.70 REF | | |
| D | 19.00 BSC | | |
| E | 19.00 BSC | | |
| b | 0.50 | 0.60 | 0.70 |
| e | 1.00 BSC | | |

## Package Outline



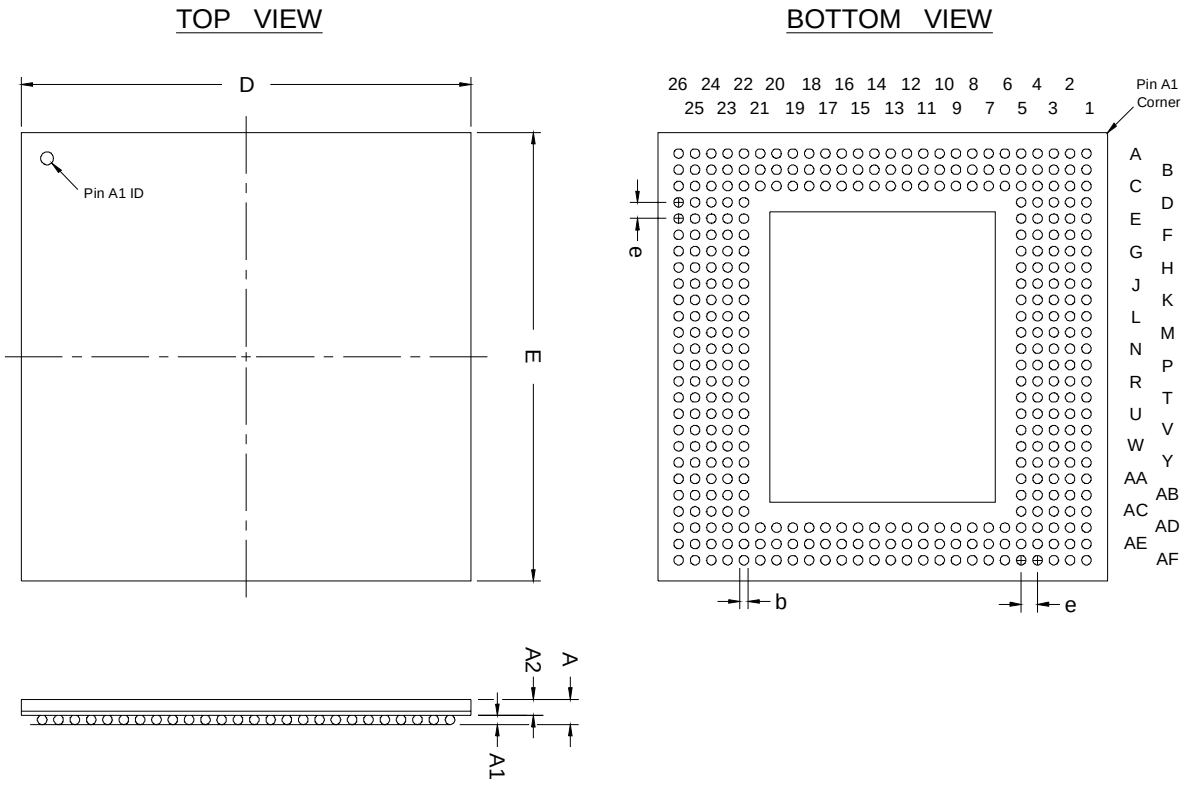
## 356-Pin Ball-Grid Array (BGA) — Wire Bond

- All dimensions and tolerances conform to ASME Y14.5M – 1994.
- Controlling dimension is in millimeters.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | B |
| Package Acronym | BGA |
| Substrate Material | BT or tape |
| Solder Ball Composition | Regular: 63Sn:37Pb (Typ.)<br>Pb-free: Sn:3Ag:0.5Cu (Typ.) |
| JEDEC Outline Reference | MO-192 Variation: BAR-2 |
| Lead Coplanarity | 0.008 inches (0.20mm) |
| Weight | 7.7 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 1.70 |
| A1 | 0.35 | – | – |
| A2 | 0.25 | - | 1.10 |
| D | 35.00 BSC | | |
| E | 35.00 BSC | | |
| b | 0.60 | 0.75 | 0.90 |
| e | 1.27 BSC | | |

## Package Outline



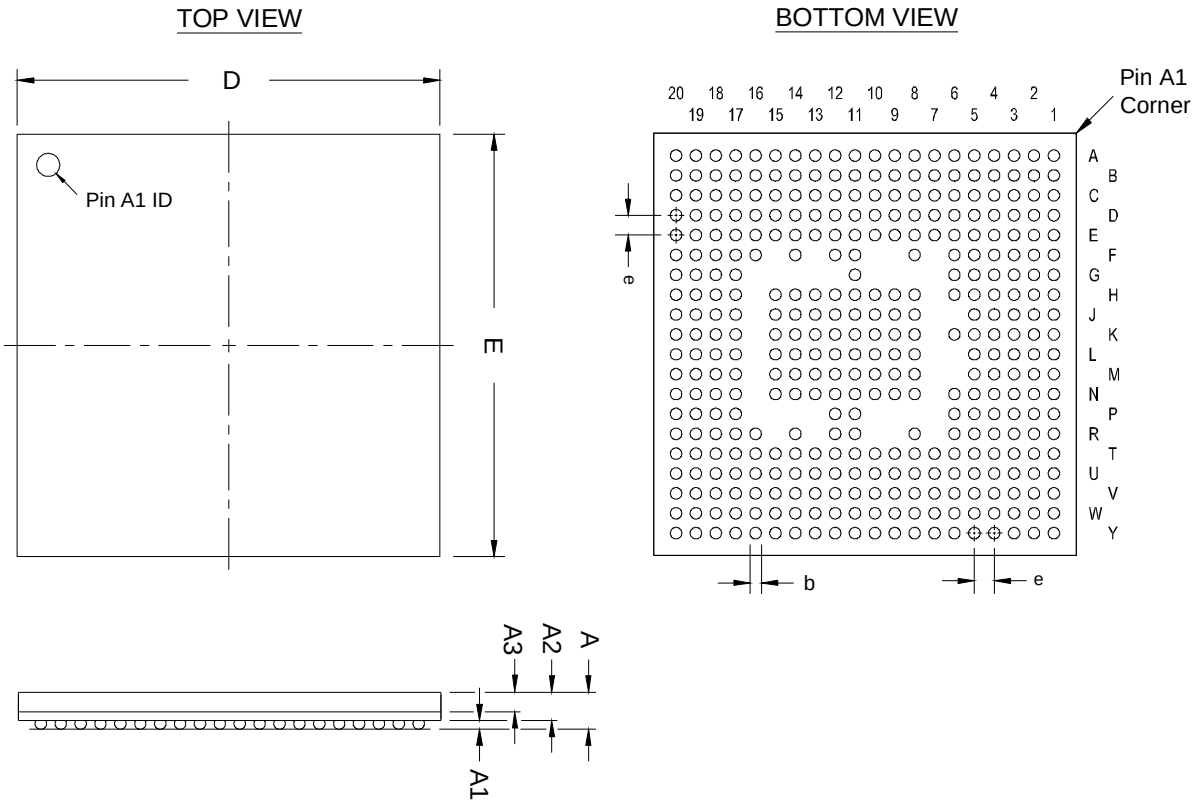
## 358-Pin Ultra FineLine Ball-Grid Array (UBGA) — Flip Chip

- All dimensions and tolerances conform to ASME Y14.5M – 1994.
- Controlling dimension is in millimeters.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | U |
| Package Acronym | UBGA |
| Substrate Material | BT |
| Solder Ball Composition | Regular: 63Sn:37Pb (Typ.)<br>Pb-free: Sn:3Ag:0.5Cu (Typ.) |
| JEDEC Outline Reference | MO-216 Variation: BAM-1 |
| Lead Coplanarity | 0.008 inches (0.20mm) |
| Weight | 1.3 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 1.70 |
| A1 | 0.25 | – | – |
| A2 | 0.80 | - | 1.10 |
| A3 | 0.80 TYP | | |
| D | 17.00 BSC | | |
| E | 17.00 BSC | | |
| b | 0.40 | 0.50 | 0.60 |
| e | 0.80 BSC | | |

## Package Outline



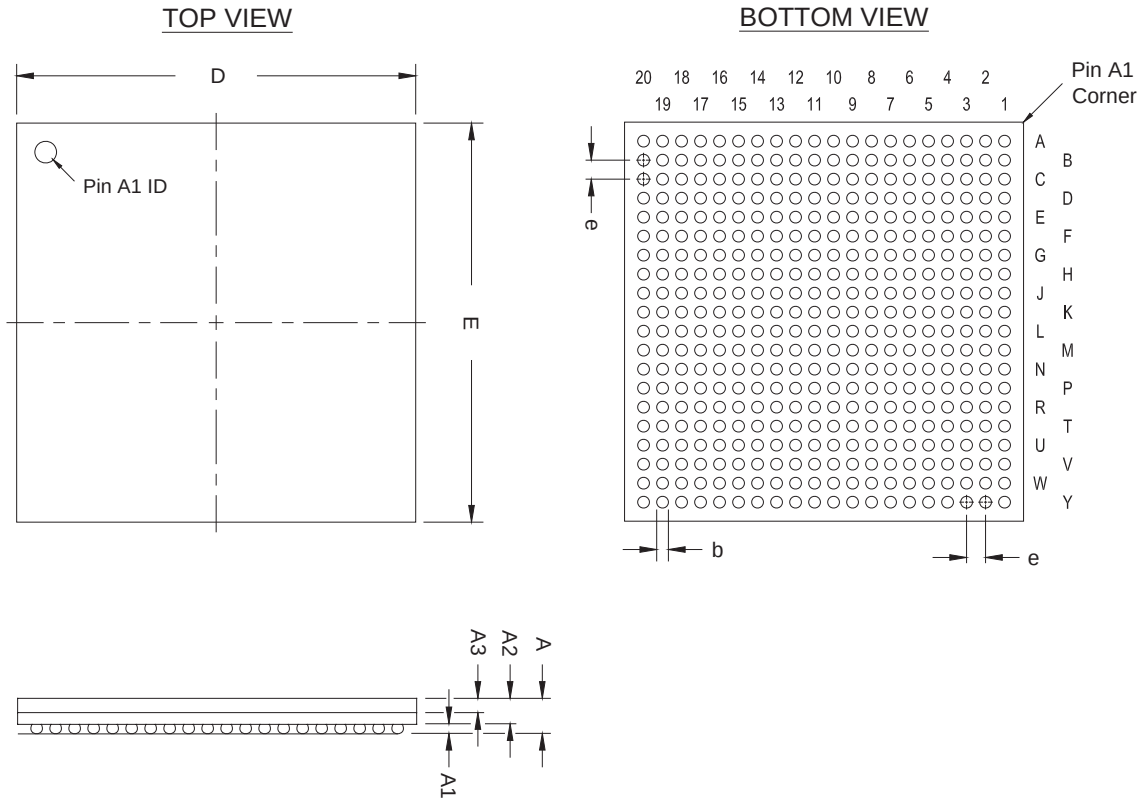
## 400-Pin FineLine Ball-Grid Array (FBGA) — Wire Bond

- All dimensions and tolerances conform to ASME Y14.5M – 1994.
- Controlling dimension is in millimeters.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | F |
| Package Acronym | FBGA |
| Substrate Material | BT |
| Solder Ball Composition | Regular: 63Sn:37Pb (Typ.)<br>Pb-free: Sn:3Ag:0.5Cu (Typ.) |
| JEDEC Outline Reference | MS-034 Variation: AAH-1 |
| Lead Coplanarity | 0.008 inches (0.20mm) |
| Weight | 2.3 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeteres** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 2.20 |
| A1 | 0.30 | – | – |
| A2 | – | – | 1.80 |
| A3 | 0.80 REF | | |
| D | 21.00 BSC | | |
| E | 21.00 BSC | | |
| b | 0.50 | 0.60 | 0.70 |
| e | 1.00 BSC | | |

## Package Outline



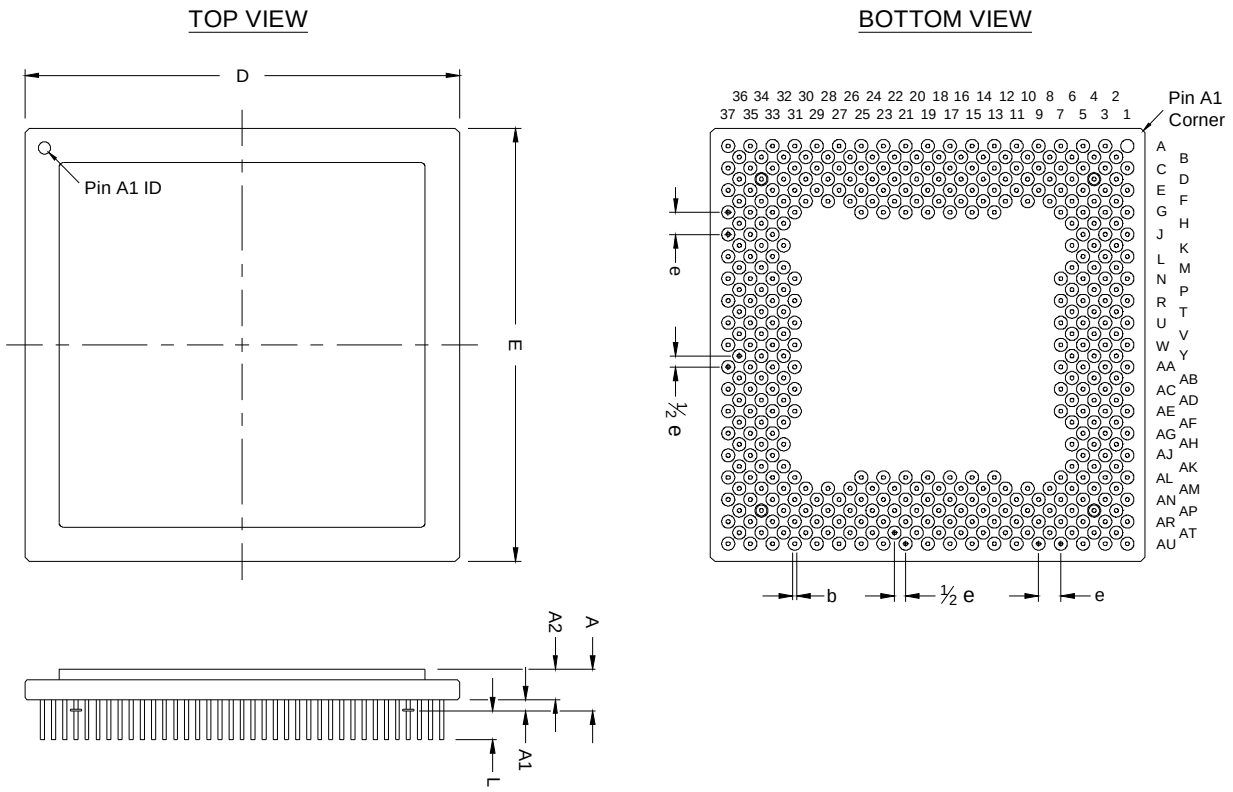
## 403-Pin Ceramic Pin-Grid Array (PGA) — Wire Bond

- All dimensions and tolerances conform to ASME Y14.5M – 1994.
- Controlling dimension is in inches.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | G |
| Package Acronym | PGA |
| Leadframe Material | Alloy 42 |
| Lead Finish | Gold Over Nickel Plate |
| JEDEC Outline Reference | MO-128 Variation: AL |
| Lead Coplanarity | N/A |
| Weight | 47.7 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Inches** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | 0.157 | 0.180 | 0.203 |
| A1 | | 0.050 TYP | |
| A2 | 0.117 | 0.130 | 0.143 |
| D | 1.940 | 1.960 | 1.980 |
| E | 1.940 | 1.960 | 1.980 |
| L | | 0.130 TYP | |
| b | 0.016 | 0.018 | 0.020 |
| e | | 0.100 BSC | |

## Package Outline



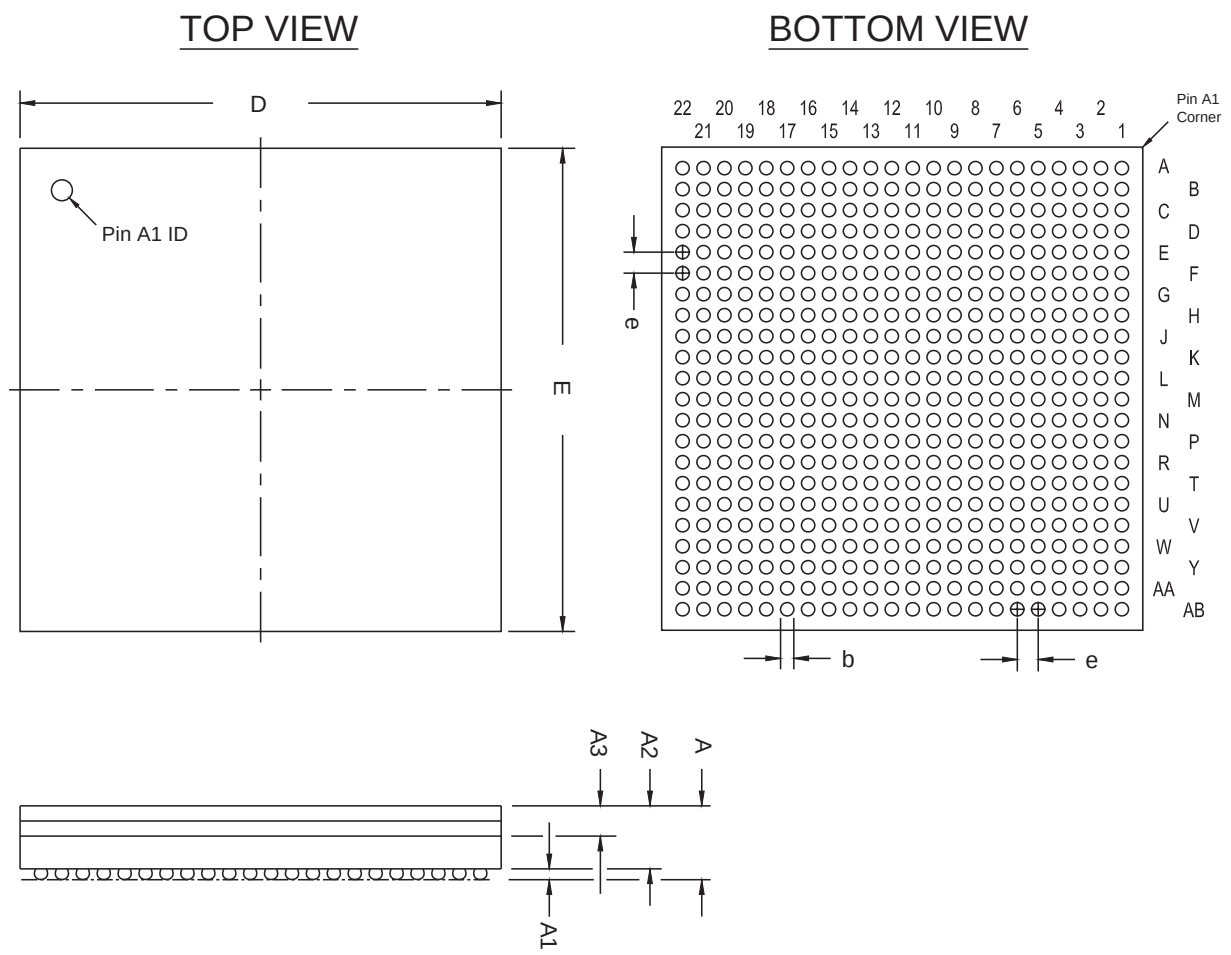
## 484-Pin FineLine Ball-Grid Array (FBGA), Option 1 — Flip Chip

- All dimensions and tolerances conform to ASME Y14.5M – 1994.
- Controlling dimension is in millimeters.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on the package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | F |
| Package Acronym | FBGA |
| Substrate Material | BT |
| Solder Ball Composition | Regular: 63Sn:37Pb (Typ.)<br>Pb-free: Sn:3Ag:0.5Cu (Typ.) |
| JEDEC Outline Reference | MS-034 Variation: AAJ-1 |
| Lead Coplanarity | 0.008 inches (0.20 mm) |
| Weight | 7.1 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 3.50 |
| A1 | 0.30 | – | – |
| A2 | 0.25 | – | 3.00 |
| A3 | – | – | 2.50 |
| D | 23.00 BSC | | |
| E | 23.00 BSC | | |
| b | 0.50 | 0.60 | 0.70 |
| e | 1.00 BSC | | |

## Package Outline



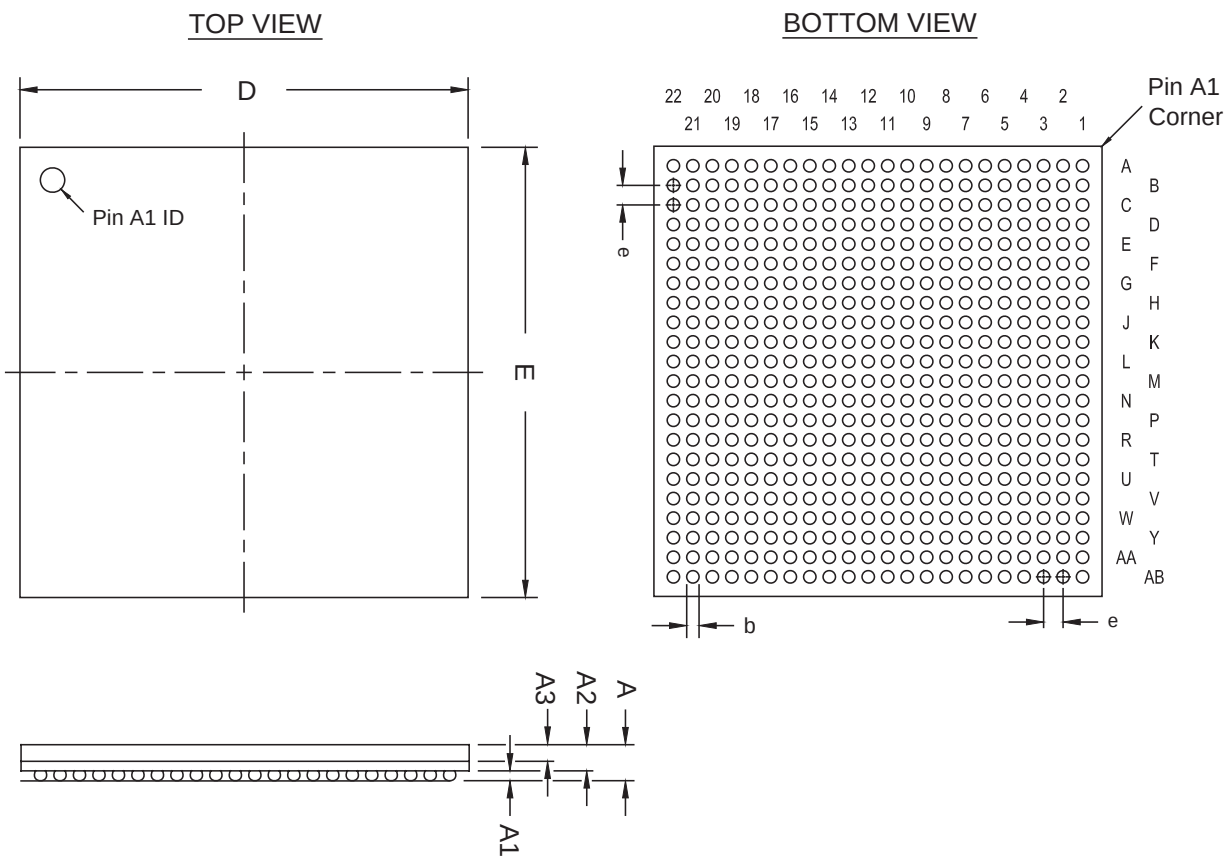
## 484-Pin FineLine Ball-Grid Array (FBGA), Option 2 — Wire Bond

- All dimensions and tolerances conform to ASME Y14.5M – 1994.
- Controlling dimension is in millimeters.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | F |
| Package Acronym | FBGA |
| Substrate Material | BT |
| Solder Ball Composition | Regular: 63Sn:37Pb (Typ.)<br>Pb-free: Sn:3Ag:0.5Cu (Typ.) |
| JEDEC Outline Reference | MS-034 Variation: AAJ-1 |
| Lead Coplanarity | 0.008 inches (0.20 mm) |
| Weight | 2.6 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 2.60 |
| A1 | 0.30 | – | – |
| A2 | – | – | 2.20 |
| A3 | – | – | 1.80 |
| D | 23.00 BSC | | |
| E | 23.00 BSC | | |
| b | 0.50 | 0.60 | 0.70 |
| e | 1.00 BSC | | |

## Package Outline



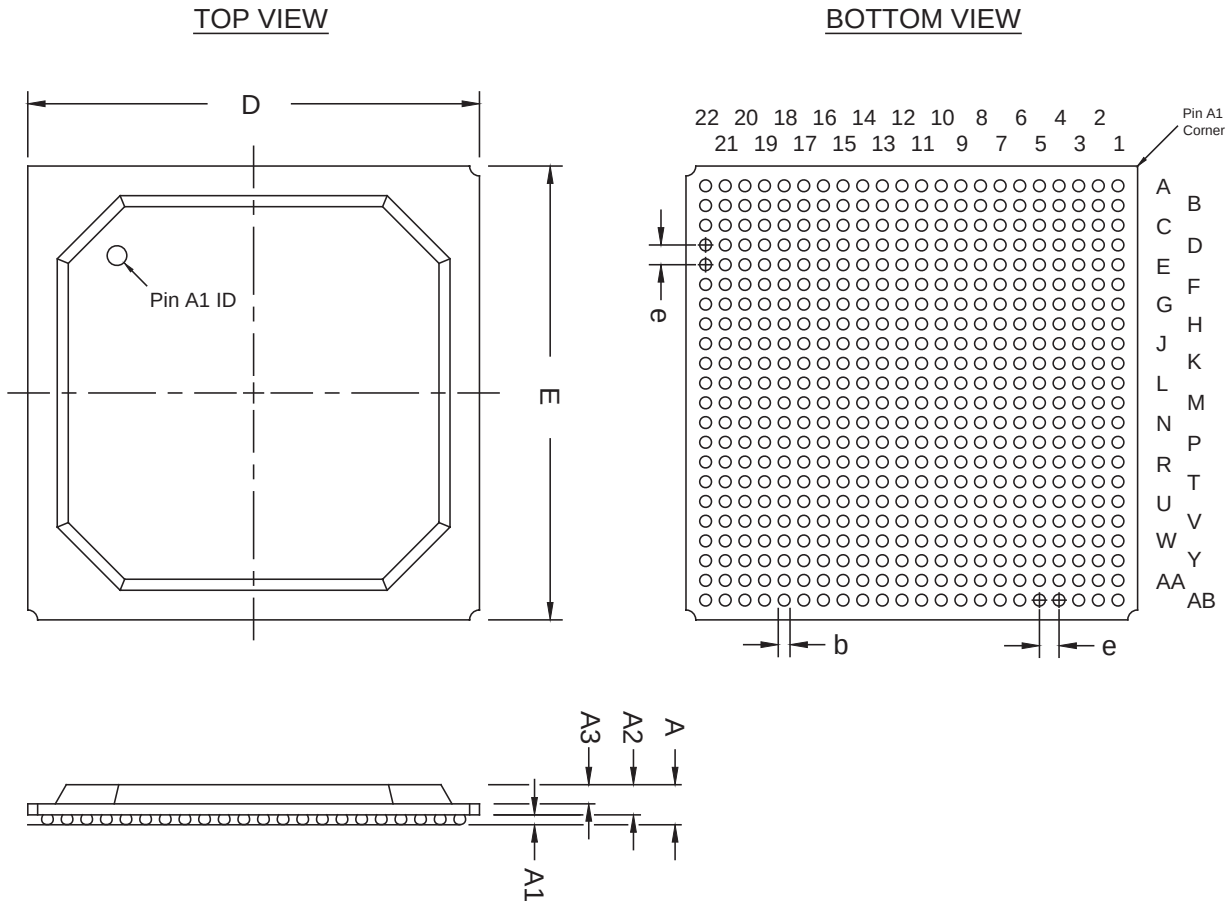
## 484-Pin FineLine Ball-Grid Array (FBGA), Option 3 — Wire Bond

- All dimensions and tolerances conform to ASME Y14.5M – 1994.
- Controlling dimension is in millimeters.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | F |
| Package Acronym | FBGA |
| Substrate Material | BT |
| Solder Ball Composition | Regular: 63Sn:37Pb (Typ.)<br>Pb-free: Sn:3Ag:0.5Cu (Typ.) |
| JEDEC Outline Reference | MS-034 Variation: AAJ-1 |
| Lead Coplanarity | 0.008 inches (0.20 mm) |
| Weight | 2.6 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 2.60 |
| A1 | 0.30 | – | – |
| A2 | – | – | 2.20 |
| A3 | – | – | 1.80 |
| D | 23.00 BSC | | |
| E | 23.00 BSC | | |
| b | 0.50 | 0.60 | 0.70 |
| e | 1.00 BSC | | |

## Package Outline



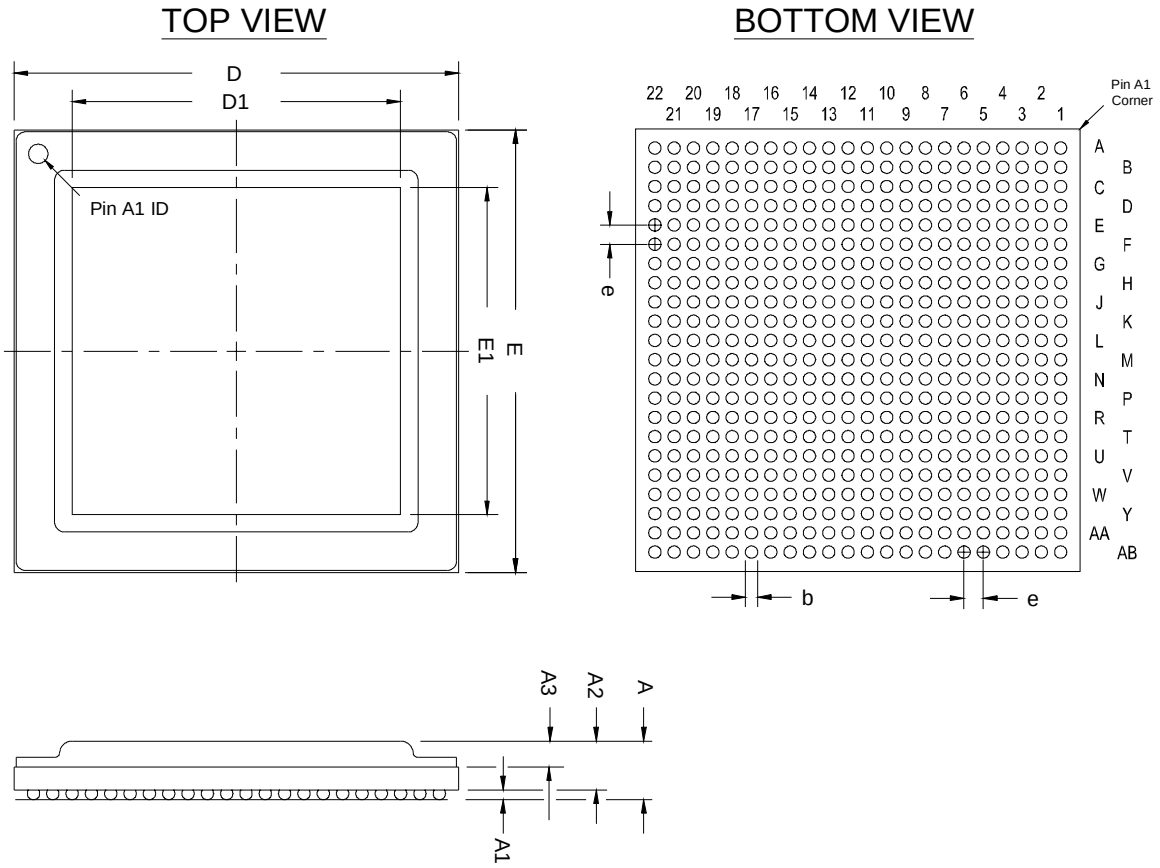
## 484-Pin FineLine Ball-Grid Array (FBGA), Option 4 — Flip Chip

- All dimensions and tolerances conform to ASME Y14.5M – 1994.
- Controlling dimension is in millimeters.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | F |
| Package Acronym | FBGA |
| Substrate Material | BT |
| Solder Ball Composition | Regular: 63Sn:37Pb (Typ.)<br>Pb-free: Sn:3Ag:0.5Cu (Typ.) |
| JEDEC Outline Reference | MS-034 Variation: AAJ-1 |
| Lead Coplanarity | 0.008 inches (0.20 mm) |
| Weight | 5.8 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 3.50 |
| A1 | 0.30 | – | – |
| A2 | 0.25 | – | 3.00 |
| A3 | – | – | 2.50 |
| D | 23.00 BSC | | |
| D1 | 17.00 BSC | | |
| E | 23.00 BSC | | |
| E1 | 17.00 BSC | | |
| b | 0.50 | 0.60 | 0.70 |
| e | 1.00 BSC | | |

## Package Outline



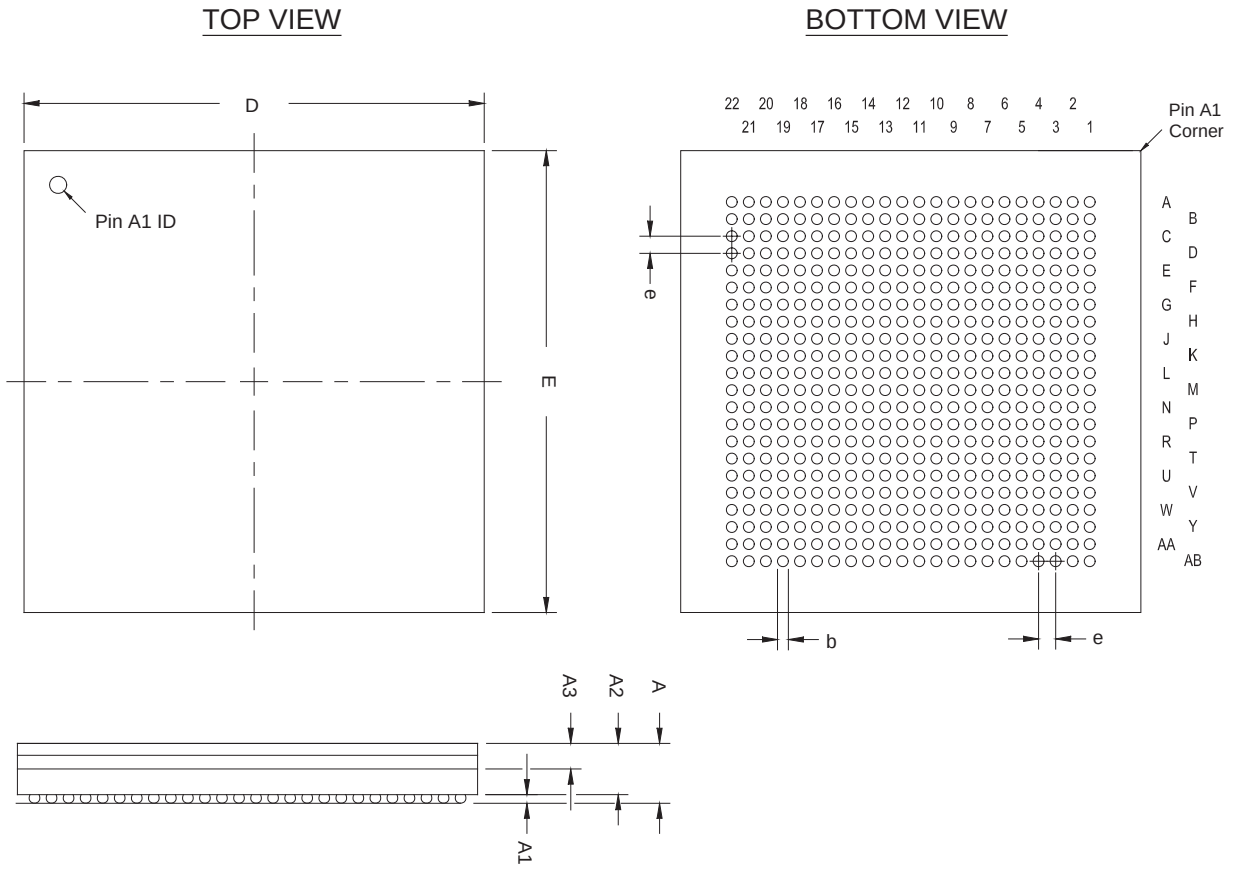
## 484-Pin Hybrid FineLine Ball-Grid Array (HBGA) — Flip Chip

- All dimensions and tolerances conform to ASME Y14.5M - 1994.
- Controlling dimension is in millimeters.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | H |
| Package Acronym | HBGA |
| Substrate Material | BT |
| Solder Ball Composition | Regular: 63Sn:37Pb (Typ.)<br>Pb-free: Sn:3Ag:0.5Cu (Typ.) |
| JEDEC Outline Reference | MS-034 Variation: AAL-1 |
| Lead Coplanarity | 0.008 inches (0.20mm) |
| Weight | 10.0 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 3.50 |
| A1 | 0.30 | – | – |
| A2 | 0.25 | – | 3.00 |
| A3 | – | – | 2.50 |
| D | 27.00 BSC | | |
| E | 27.00 BSC | | |
| b | 0.50 | 0.60 | 0.70 |
| e | 1.00 BSC | | |

## Package Outline



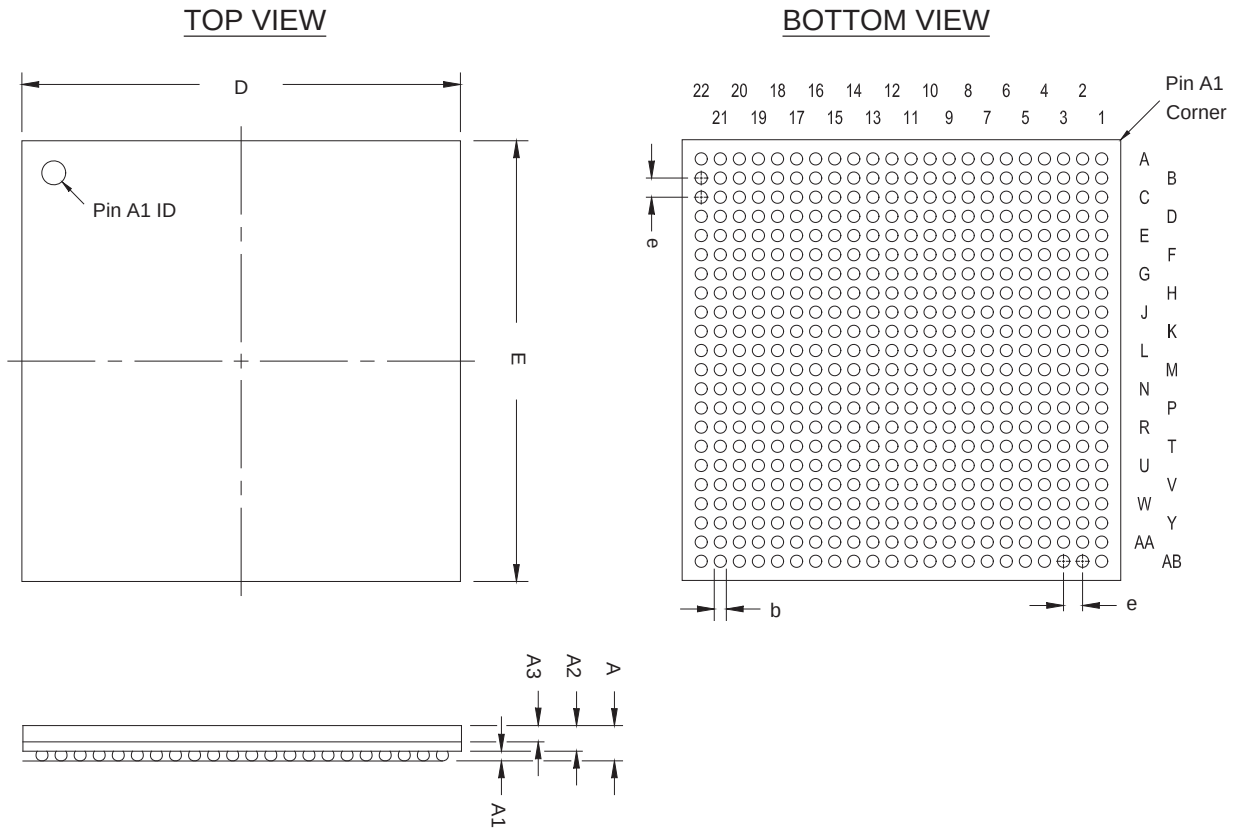
## 484-Pin Ultra FineLine Ball-Grid Array (UBGA) — Wire Bond

- All dimensions and tolerances conform to ASME Y14.5M - 1994.
- Controlling dimension is in millimeters.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | U |
| Package Acronym | UBGA |
| Substrate Material | BT |
| Solder Ball Composition | Regular: 63Sn:37Pb (Typ.)<br>Pb-free: Sn:3Ag:0.5Cu (Typ.) |
| JEDEC Outline Reference | MO-216 Variation: BAP-2 |
| Lead Coplanarity | 0.005 inches (0.12mm) |
| Weight | 1.6 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 2.20 |
| A1 | 0.20 | – | – |
| A2 | 0.65 | – | – |
| A3 | 0.95 TYP | | |
| D | 19.00 BSC | | |
| E | 19.00 BSC | | |
| b | 0.40 | 0.50 | 0.60 |
| e | 0.80 BSC | | |

## Package Outline



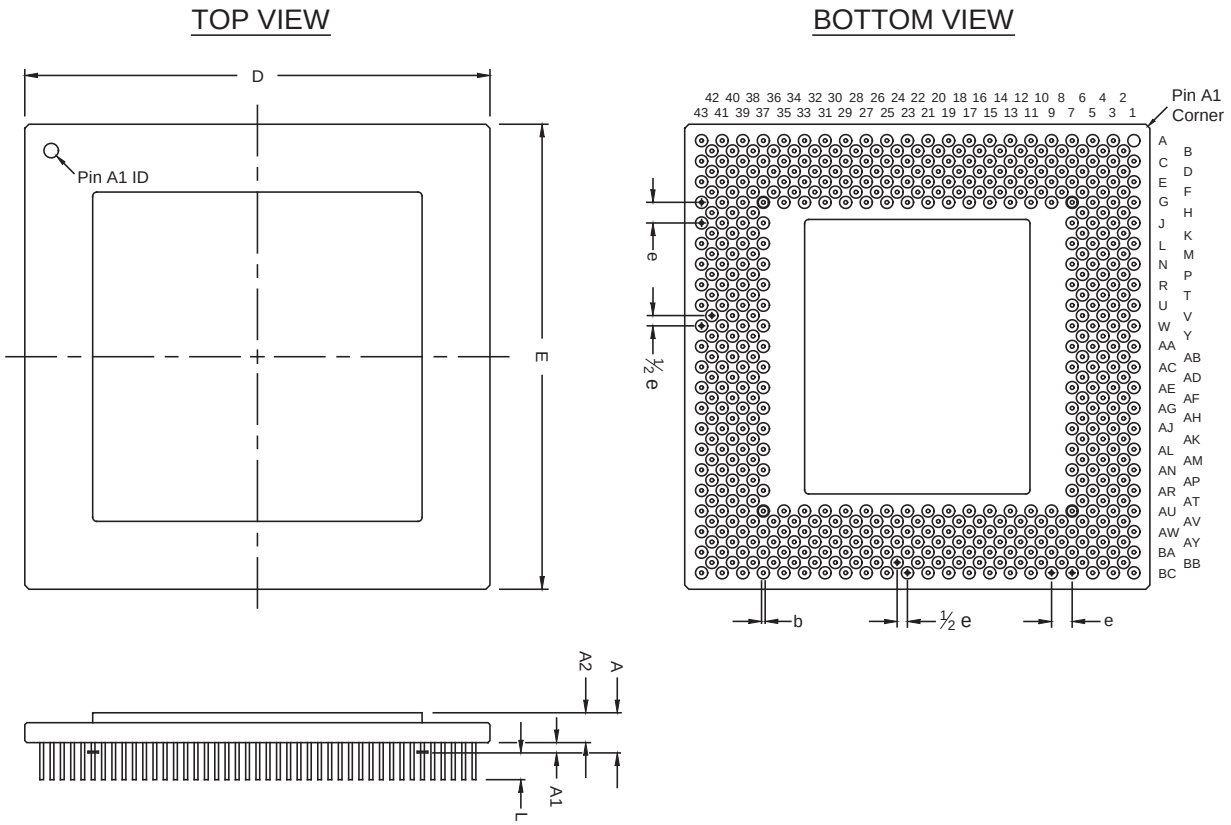
## 503-Pin Ceramic Pin-Grid Array (PGA) — Wire Bond

- All dimensions and tolerances conform to ASME Y14.5M - 1994.
- Controlling dimension is in inches.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | G |
| Package Acronym | PGA |
| Leadframe Material | Alloy 42 |
| Lead Finish | Gold Over Nickel Plate |
| JEDEC Outline Reference | MO-128 Variation: AN |
| Lead Coplanarity | N/A |
| Weight | 59.0 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Inches** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 0.205 |
| A1 | | 0.050 TYP | |
| A2 | – | – | 0.145 |
| D | 2.245 | 2.260 | 2.275 |
| E | 2.245 | 2.260 | 2.275 |
| L | | 0.130 TYP | |
| b | 0.016 | 0.018 | 0.020 |
| e | | 0.100 BSC | |

## Package Outline



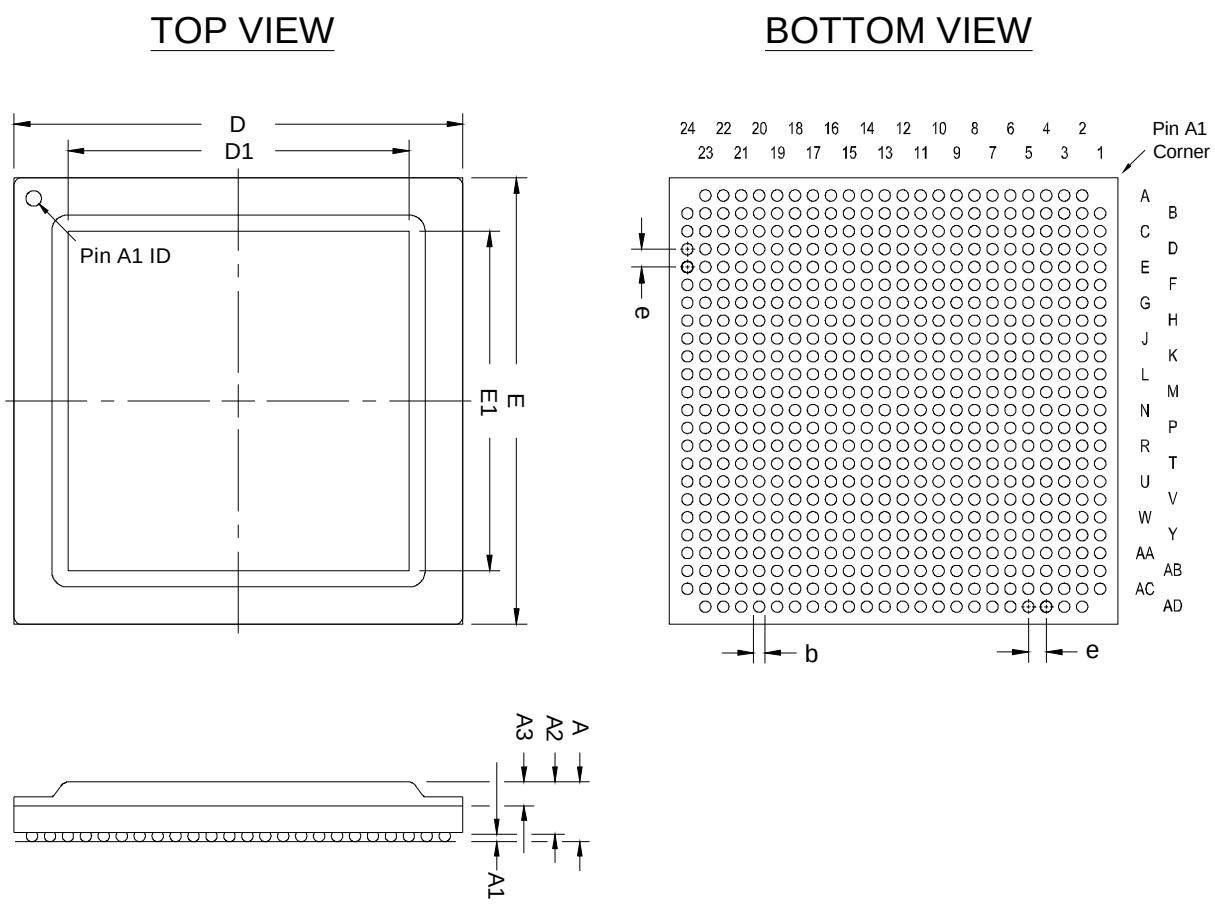
## 572-Pin FineLine Ball-Grid Array (FBGA) — Flip Chip

- All dimensions and tolerances conform to ASME Y14.5M – 1994.
- Controlling dimension is in millimeters.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on the package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | F |
| Package Acronym | FBGA |
| Substrate Material | BT |
| Solder Ball Composition | Regular: 63Sn:37Pb (Typ.)<br>Pb-free: Sn:3Ag:0.5Cu (Typ.) |
| JEDEC Outline Reference | MS-034 Variation: AAK-1 |
| Lead Coplanarity | 0.008 inches (0.20 mm) |
| Weight | 6.2 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 3.50 |
| A1 | 0.30 | – | – |
| A2 | 0.25 | – | 3.00 |
| A3 | – | – | 2.50 |
| D | 25.00 BSC | | |
| D1 | 19.00 BSC | | |
| E | 25.00 BSC | | |
| E1 | 19.00 BSC | | |
| b | 0.50 | 0.60 | 0.70 |
| e | 1.00 BSC | | |

## Package Outline



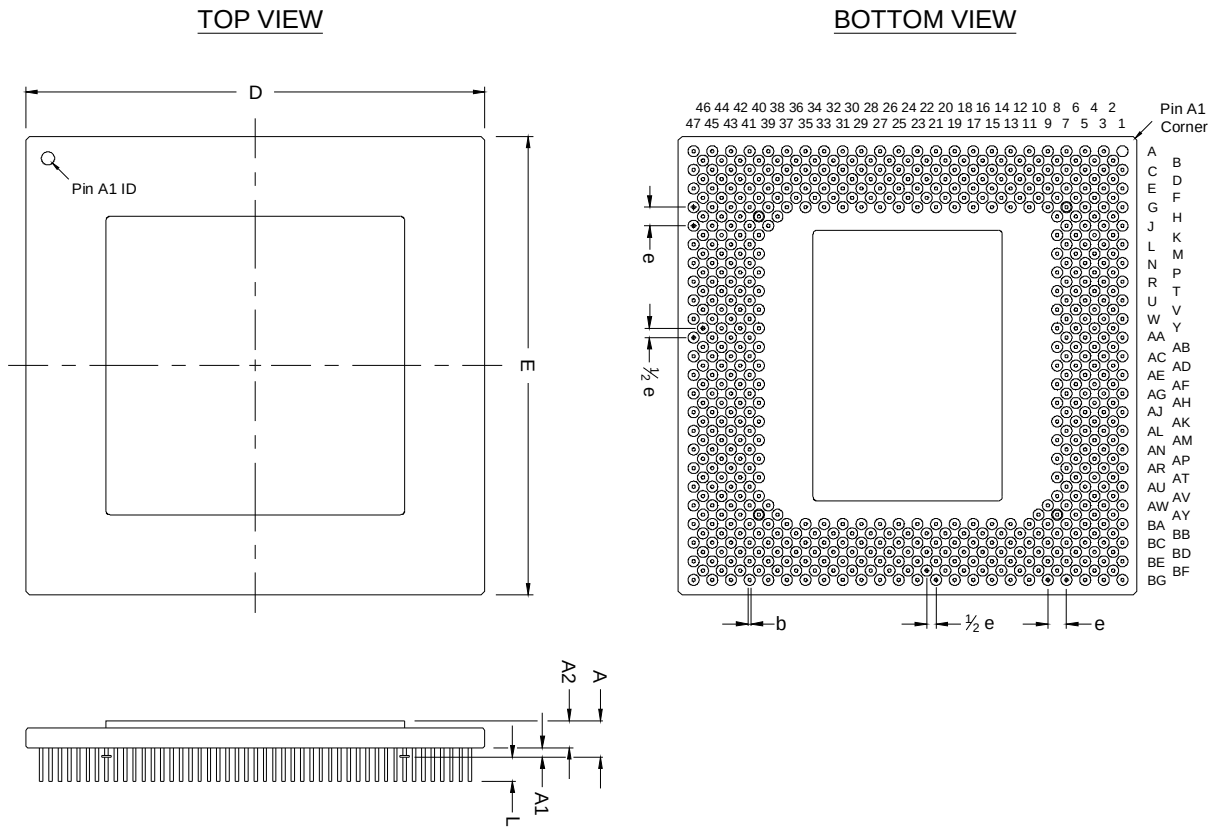
## 599-Pin Ceramic Pin-Grid Array (PGA) — Wire Bond

- All dimensions and tolerances conform to ASME Y14.5M – 1994.
- Controlling dimension is in inches.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | G |
| Package Acronym | PGA |
| Leadframe Material | Alloy 42 |
| Lead Finish | Gold over Nickel Plate |
| JEDEC Outline Reference | MO-128 Variation: AP |
| Lead Coplanarity | N/A |
| Weight | 69.0 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Inches** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 0.205 |
| A1 | | 0.050 TYP | |
| A2 | – | – | 0.145 |
| D | 2.445 | 2.460 | 2.475 |
| E | 2.445 | 2.460 | 2.475 |
| L | | 0.130 TYP | |
| b | 0.016 | 0.018 | 0.020 |
| e | | 0.100 BSC | |

## Package Outline



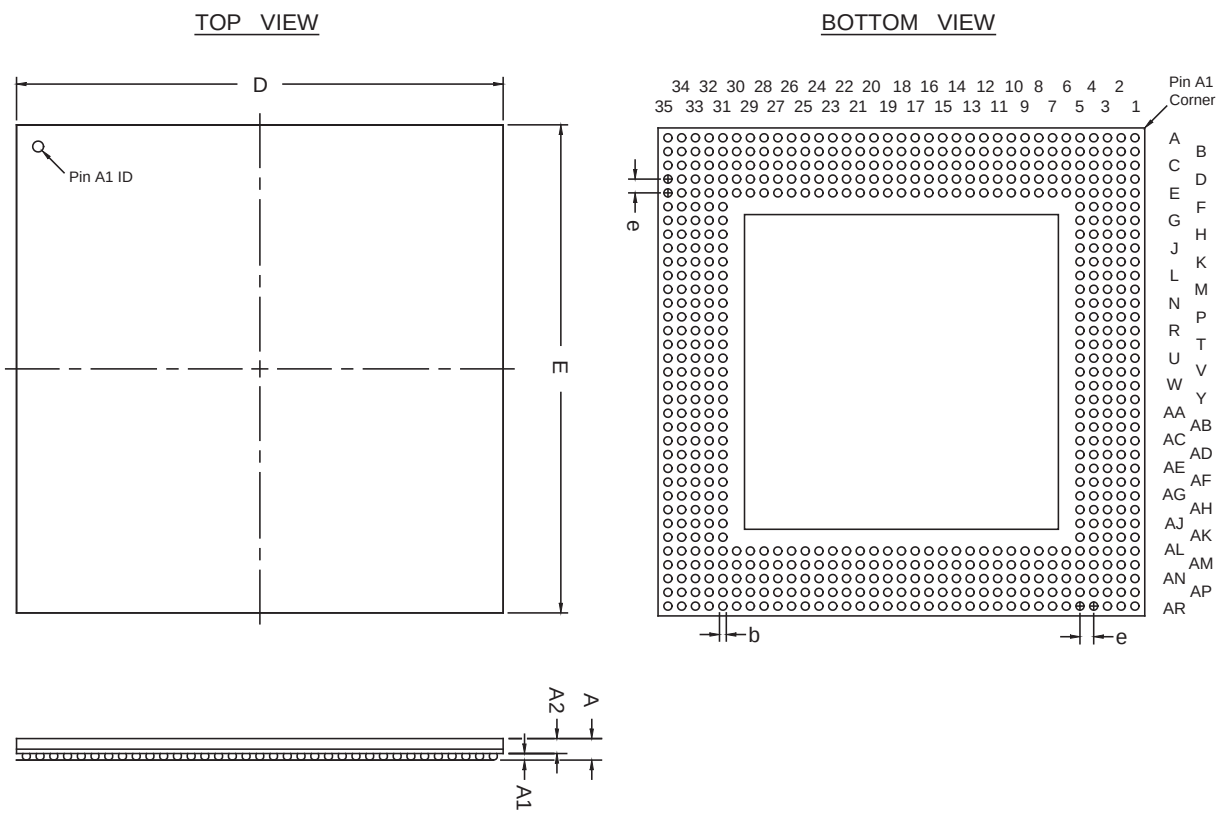
## 600-Pin Ball-Grid Array (BGA) — Wire Bond

- All dimensions and tolerances conform to ASME Y14.5M - 1994.
- Controlling dimension is in millimeters.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | B |
| Package Acronym | BGA |
| Substrate Material | BT or tape |
| Solder Ball Composition | Regular: 63Sn:37Pb (Typ.)<br>Pb-free: Sn:3Ag:0.5Cu (Typ.) |
| JEDEC Outline Reference | MO-192 Variation: BAW-1 |
| Lead Coplanarity | 0.008 inches (0.20mm) |
| Weight | 12.0 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 2.00 |
| A1 | 0.35 | – | – |
| A2 | 0.25 | – | 1.10 |
| D | 45.00 BSC | | |
| E | 45.00 BSC | | |
| b | 0.60 | 0.75 | 0.90 |
| e | 1.27 BSC | | |

## Package Outline



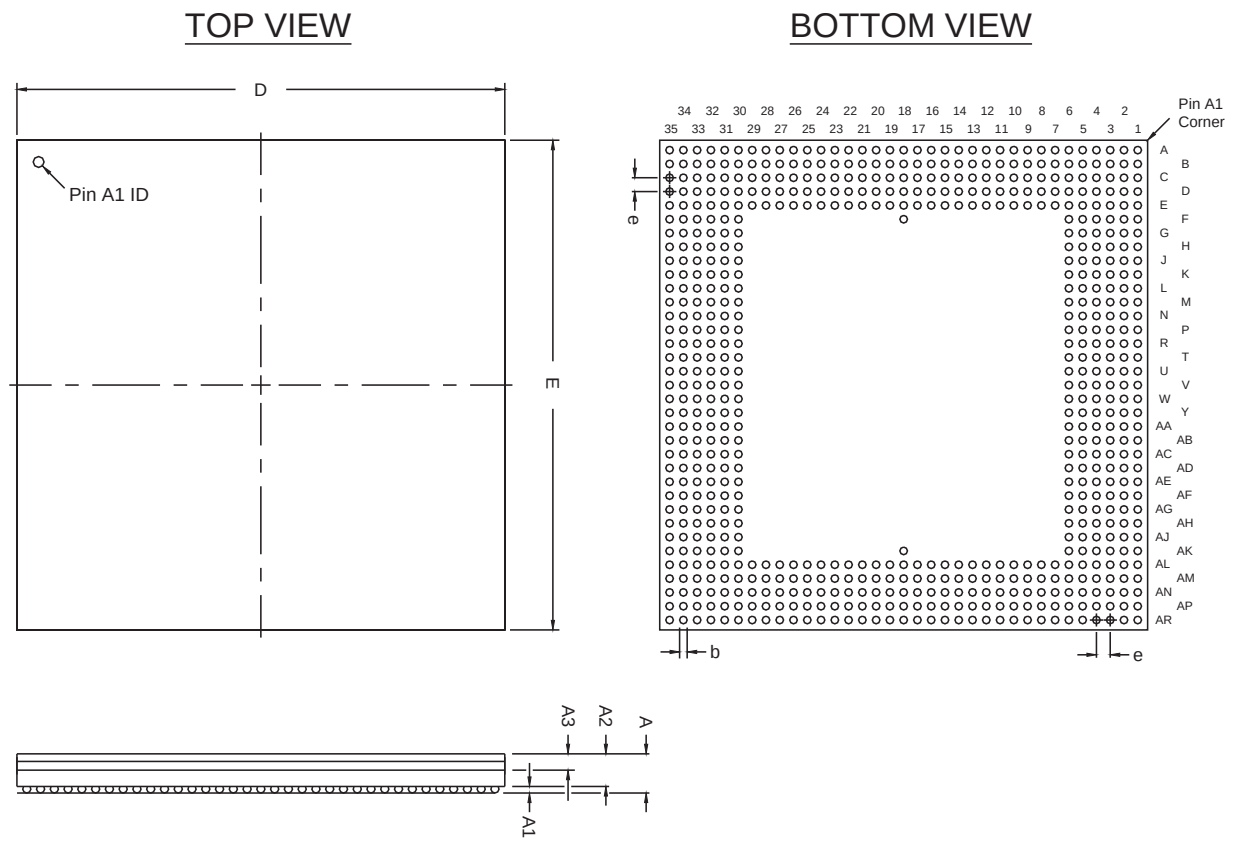
## 652-Pin Ball-Grid Array (BGA), Option 1 — Flip Chip

- All dimensions and tolerances conform to ASME Y14.5M - 1994.
- Controlling dimension is in millimeters.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | B |
| Package Acronym | BGA |
| Substrate Material | BT |
| Solder Ball Composition | Regular: 63Sn:37Pb (Typ.)<br>Pb-free: Sn:3Ag:0.5Cu (Typ.) |
| JEDEC Outline Reference | MS-034 Variation: BAW-1 |
| Lead Coplanarity | 0.008 inches (0.20 mm) |
| Weight | 23.8 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 3.50 |
| A1 | 0.30 | – | – |
| A2 | 0.25 | – | 3.00 |
| A3 | – | – | 2.50 |
| D | 45.00 BSC | | |
| E | 45.00 BSC | | |
| b | 0.60 | 0.75 | 0.90 |
| e | 1.27 BSC | | |

## Package Outline



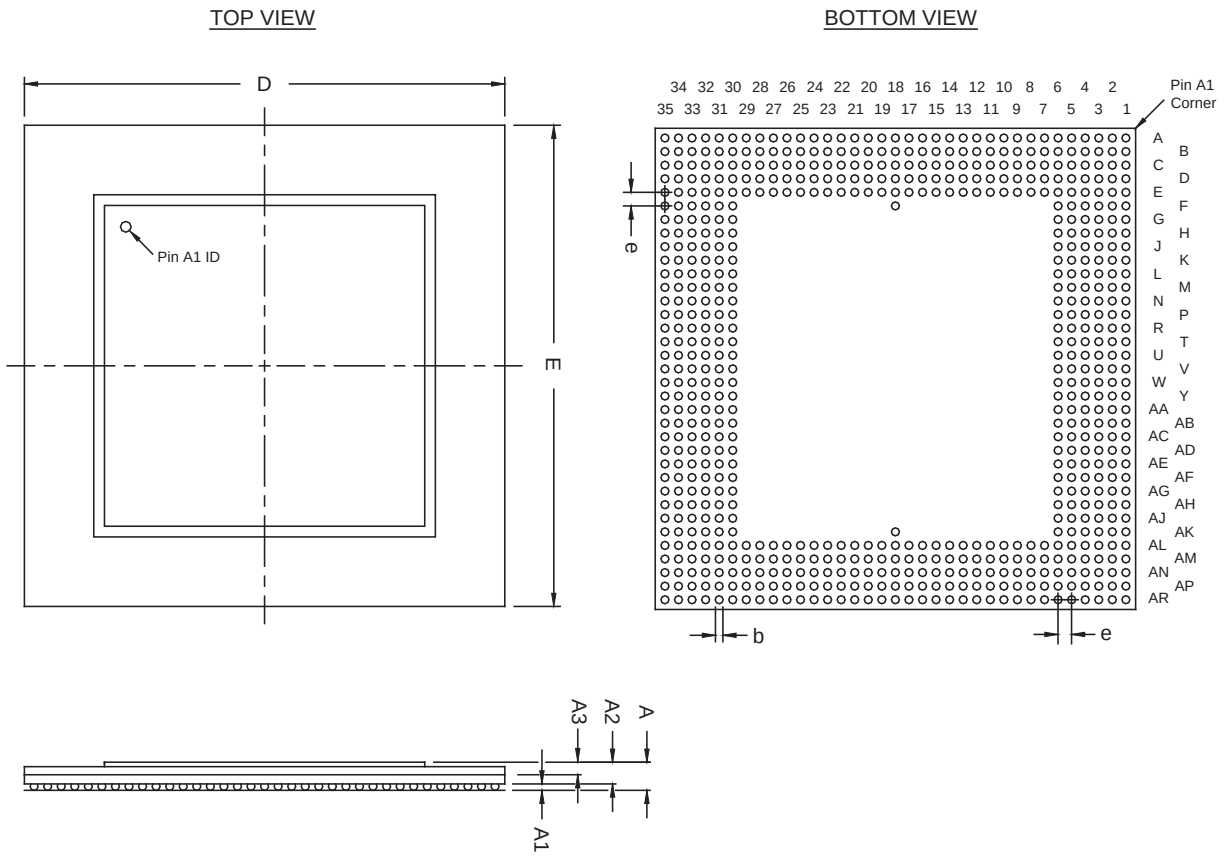
## 652-Pin Plastic Ball-Grid Array (BGA), Option 2 — Wire Bond

- All dimensions and tolerances conform to ASME Y14.5M - 1994.
- Controlling dimension is in millimeters.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | B |
| Package Acronym | BGA |
| Substrate Material | BT |
| Solder Ball Composition | Regular: 63Sn:37Pb (Typ.)<br>Pb-free: Sn:3Ag:0.5Cu (Typ.) |
| JEDEC Outline Reference | MS-034 Variation: BAW-1 |
| Lead Coplanarity | 0.008 inches (0.20 mm) |
| Weight | 15.9 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 3.20 |
| A1 | 0.35 | – | – |
| A2 | – | – | 2.80 |
| A3 | – | – | 2.40 |
| D | 45.00 BSC | | |
| E | 45.00 BSC | | |
| b | 0.60 | 0.75 | 0.90 |
| e | 1.27 BSC | | |

## Package Outline



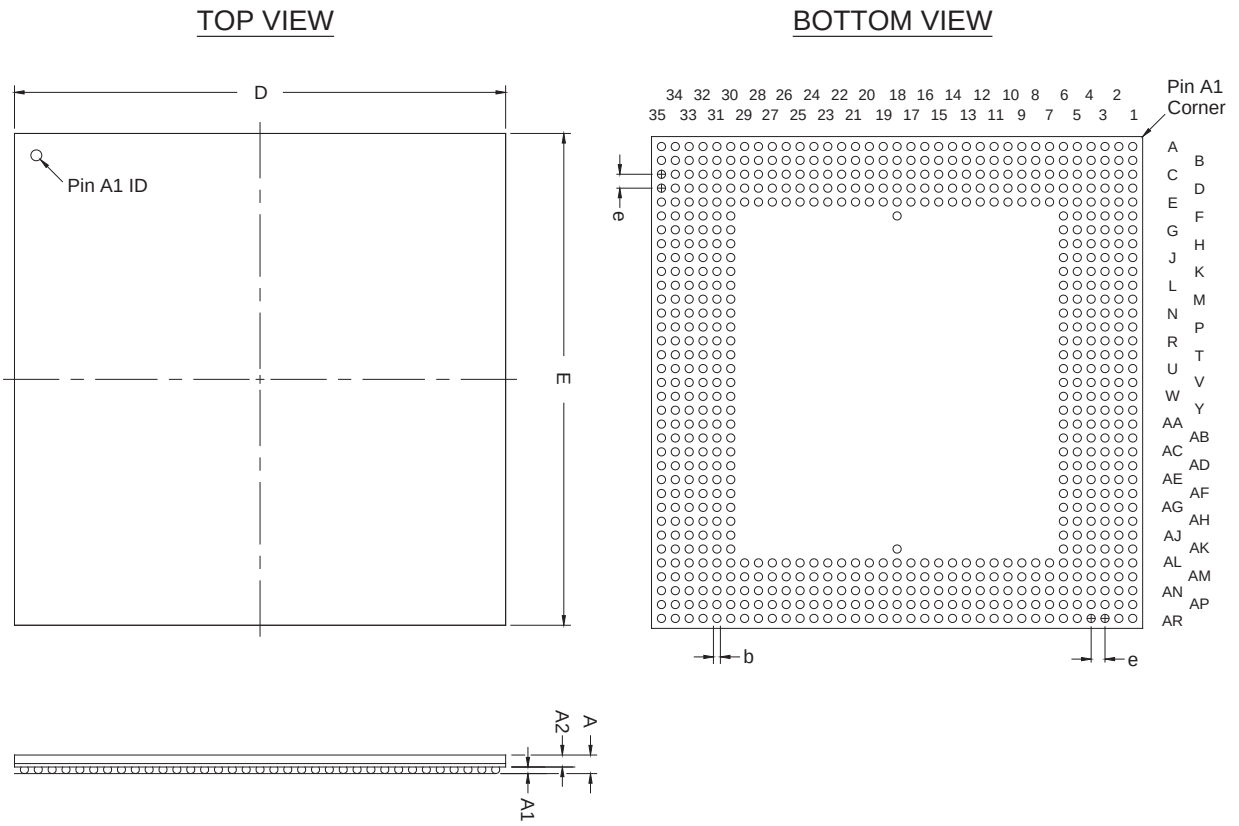
## 652-Pin Plastic Ball-Grid Array (BGA), Option 3 — Wire Bond

- All dimensions and tolerances conform to ASME Y14.5M - 1994.
- Controlling dimension is in millimeters.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | B |
| Package Acronym | BGA |
| Substrate Material | BT or tape |
| Solder Ball Composition | Regular: 63Sn:37Pb (Typ.)<br>Pb-free: Sn:3Ag:0.5Cu (Typ.) |
| JEDEC Outline Reference | MO-192 Variation: BAW-1 |
| Lead Coplanarity | 0.008 inches (0.20 mm) |
| Weight | 15.1 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 2.00 |
| A1 | 0.35 | – | – |
| A2 | 0.25 | – | 1.10 |
| D | 45.00 BSC | | |
| E | 45.00 BSC | | |
| b | 0.60 | 0.75 | 0.90 |
| e | 1.27 BSC | | |

## Package Outline



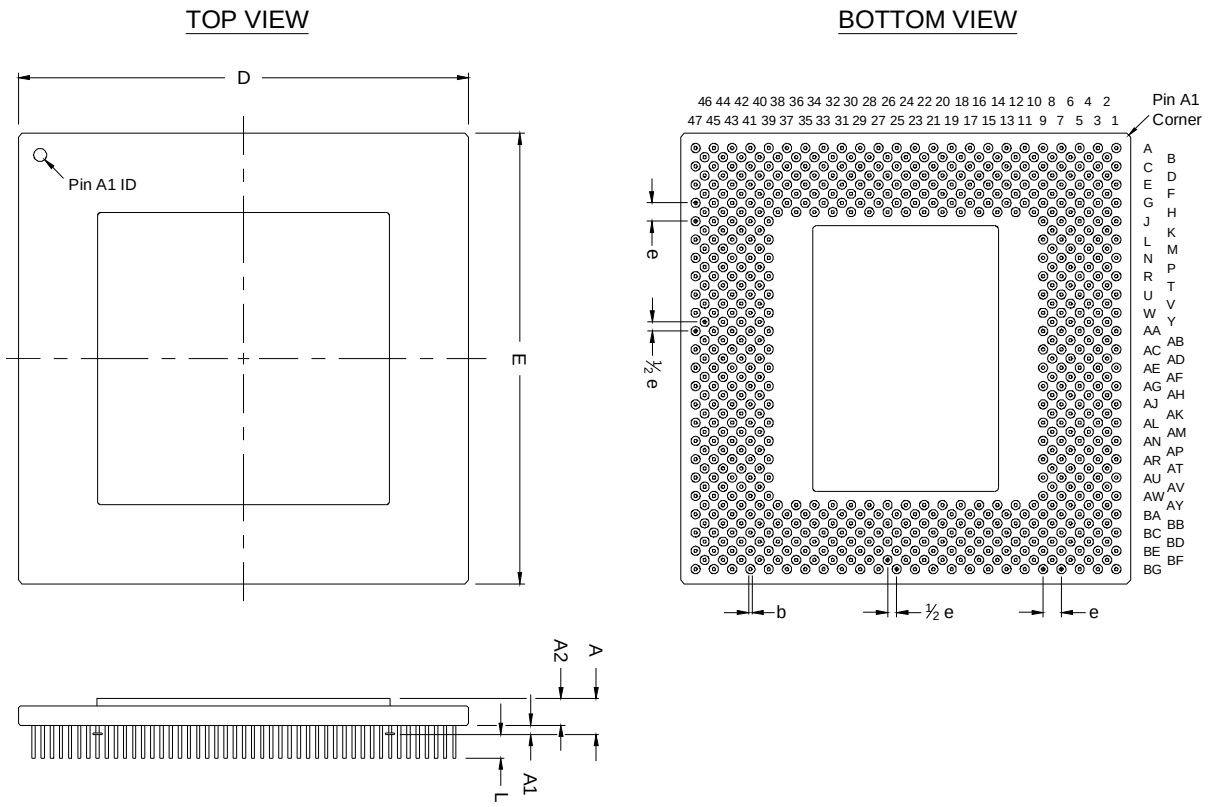
## 655-Pin Ceramic Pin-Grid Array (PGA) — Wire Bond

- All dimensions and tolerances conform to ASME Y14.5M – 1994.
- Controlling dimension is in inches.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | G |
| Package Acronym | PGA |
| Leadframe Material | Alloy 42 |
| Lead Finish | Gold over Nickel Plate |
| JEDEC Outline Reference | MO-128 Variation: AP |
| Lead Coplanarity | N/A |
| Weight | 74.9 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Inches** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 0.205 |
| A1 | | 0.050 TYP | |
| A2 | – | – | 0.145 |
| D | 2.445 | 2.460 | 2.475 |
| E | 2.445 | 2.460 | 2.475 |
| L | | 0.130 TYP | |
| b | 0.016 | 0.018 | 0.020 |
| e | | 0.100 BSC | |

## Package Outline



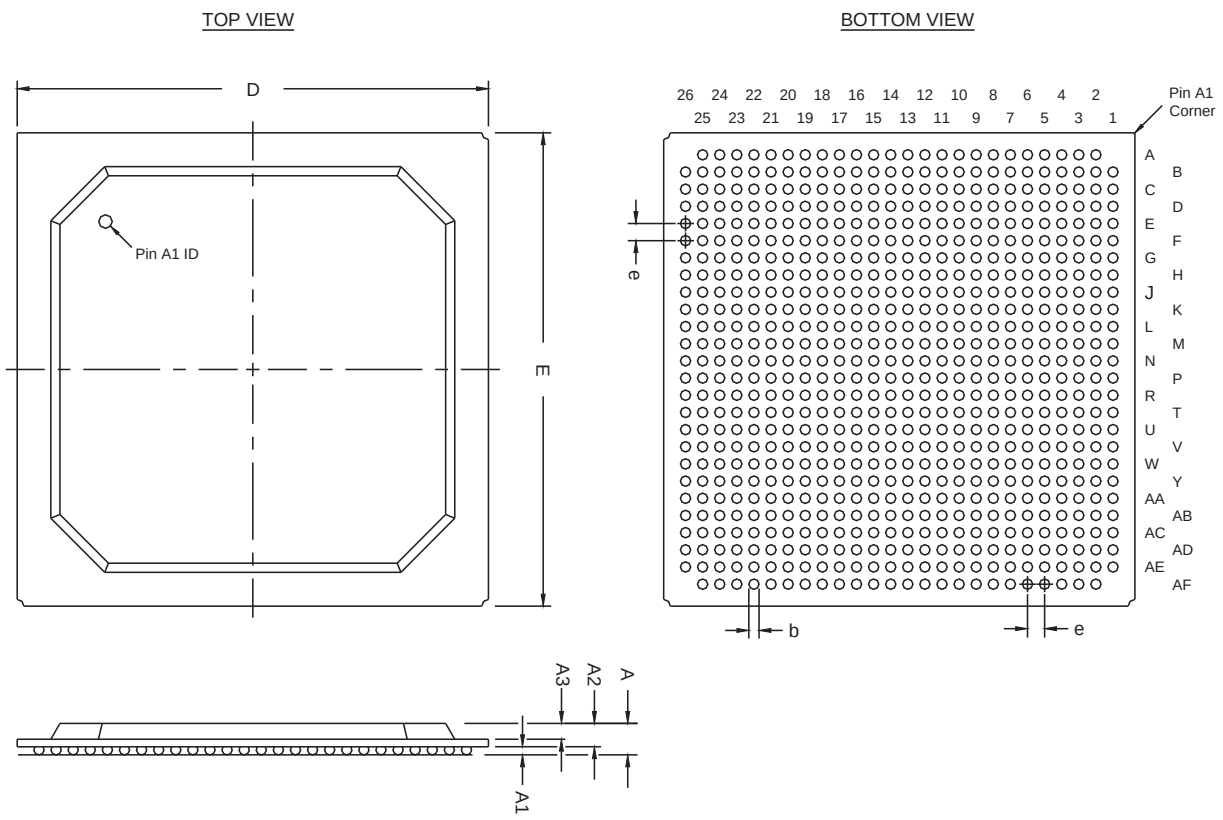
## 672-Pin Plastic Ball-Grid Array (BGA) — Wire Bond

- All dimensions and tolerances conform to ASME Y14.5M - 1994.
- Controlling dimension is in millimeters.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | B |
| Package Acronym | BGA |
| Substrate Material | BT |
| Solder Ball Composition | Regular: 63Sn:37Pb (Typ.)<br>Pb-free: Sn:3Ag:0.5Cu (Typ.) |
| JEDEC Outline Reference | MS-034 Variation: BAR-2 |
| Lead Coplanarity | 0.008 inches (0.20 mm) |
| Weight | 5.8 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 2.60 |
| A1 | 0.35 | – | – |
| A2 | – | – | 2.20 |
| A3 | – | – | 1.80 |
| D | 35.00 BSC | | |
| E | 35.00 BSC | | |
| b | 0.60 | 0.75 | 0.90 |
| e | 1.27 BSC | | |

## Package Outline



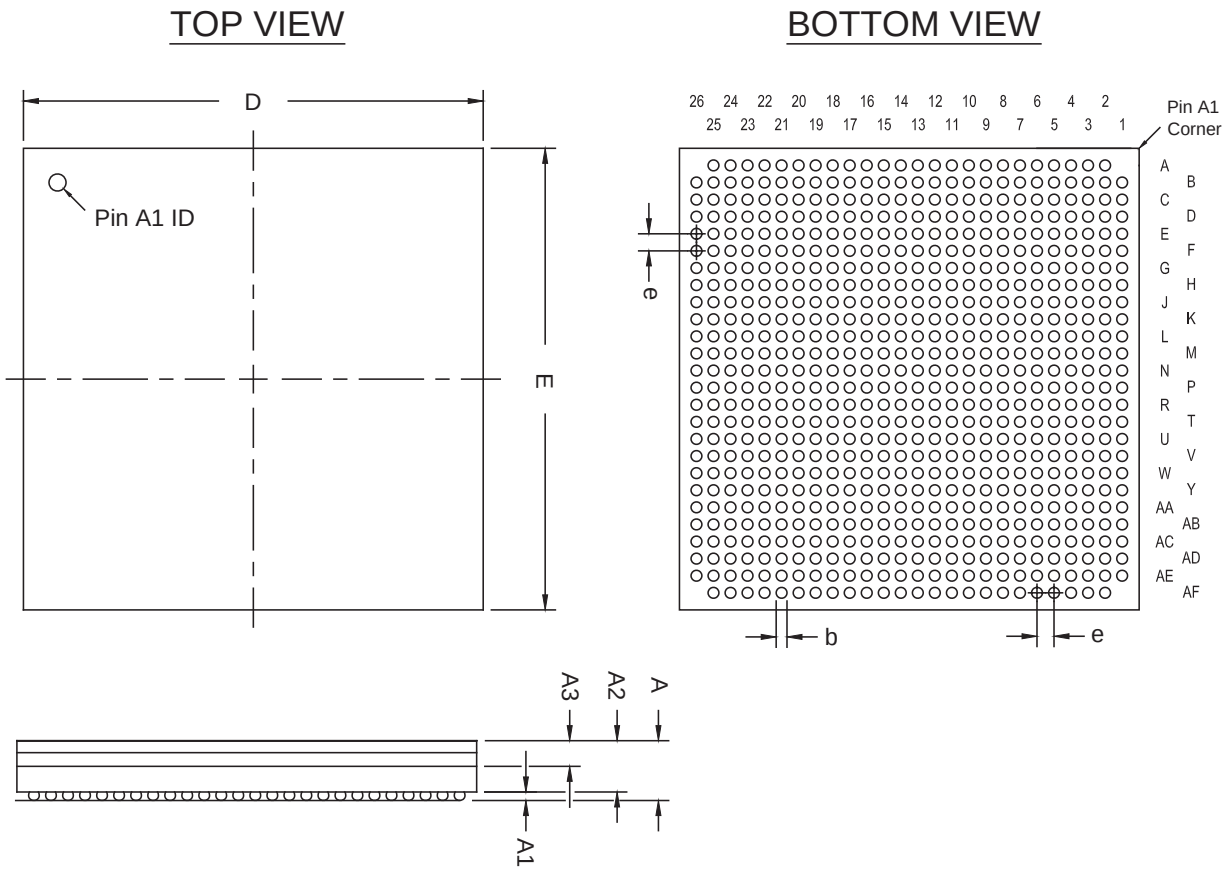
## 672-Pin FineLine Ball-Grid Array (FBGA), Option 1 — Flip Chip

- All dimensions and tolerances conform to ASME Y14.5M - 1994.
- Controlling dimension is in millimeters.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | F |
| Package Acronym | FBGA |
| Substrate Material | BT |
| Solder Ball Composition | Regular: 63Sn:37Pb (Typ.)<br>Pb-free: Sn:3Ag:0.5Cu (Typ.) |
| JEDEC Outline Reference | MS-034 Variation: AAL-1 |
| Lead Coplanarity | 0.008 inches (0.20 mm) |
| Weight | 10.2 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 3.50 |
| A1 | 0.30 | – | – |
| A2 | 0.25 | – | 3.00 |
| A3 | – | – | 2.50 |
| D | 27.00 BSC | | |
| E | 27.00 BSC | | |
| b | 0.50 | 0.60 | 0.70 |
| e | 1.00 BSC | | |

## Package Outline



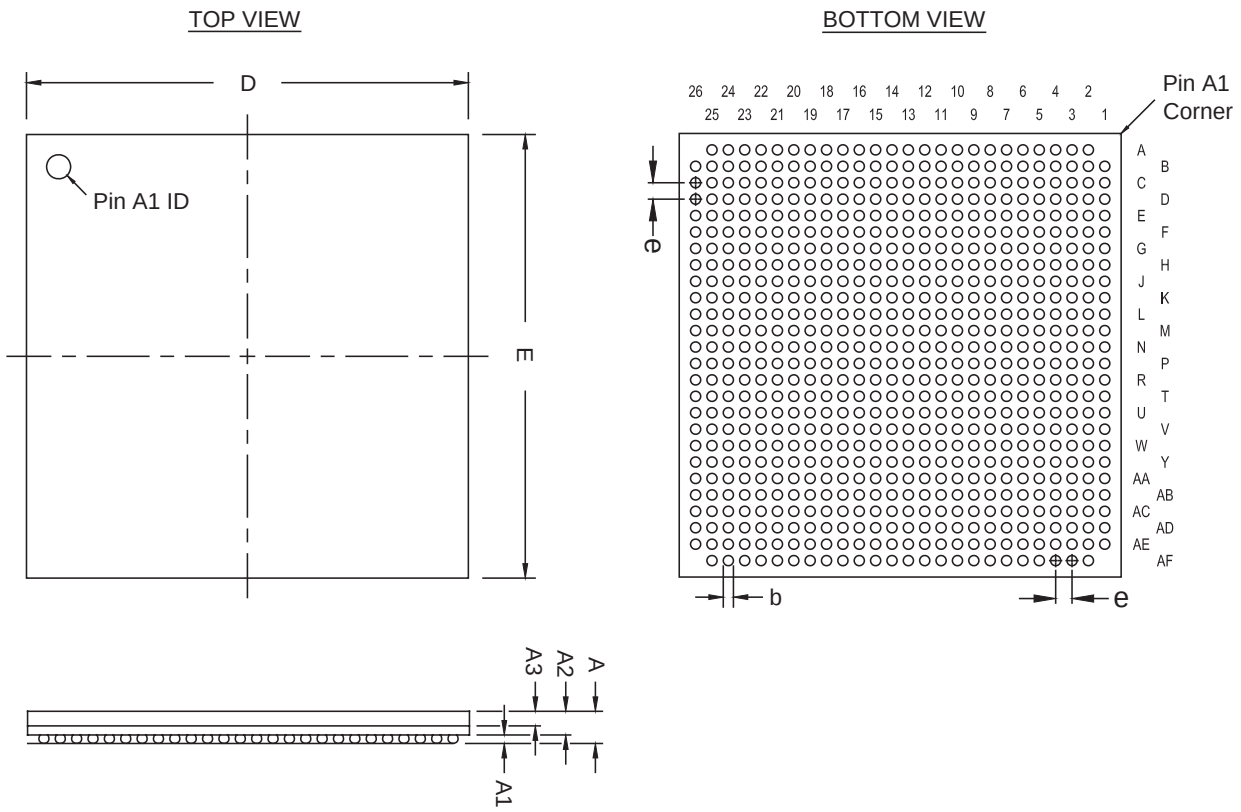
## 672-Pin FineLine Ball-Grid Array (FBGA), Option 2 — Wire Bond

- All dimensions and tolerances conform to ASME Y14.5M - 1994.
- Controlling dimension is in millimeters.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | F |
| Package Acronym | FBGA |
| Substrate Material | BT |
| Solder Ball Composition | Regular: 63Sn:37Pb (Typ.)<br>Pb-free: Sn:3Ag:0.5Cu (Typ.) |
| JEDEC Outline Reference | MS-034 Variation: AAL-1 |
| Lead Coplanarity | 0.008 inches (0.20 mm) |
| Weight | 3.8 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 2.60 |
| A1 | 0.30 | – | – |
| A2 | – | – | 2.20 |
| A3 | – | – | 1.80 |
| D | 27.00 BSC | | |
| E | 27.00 BSC | | |
| b | 0.50 | 0.60 | 0.70 |
| e | 1.00 BSC | | |

## Package Outline



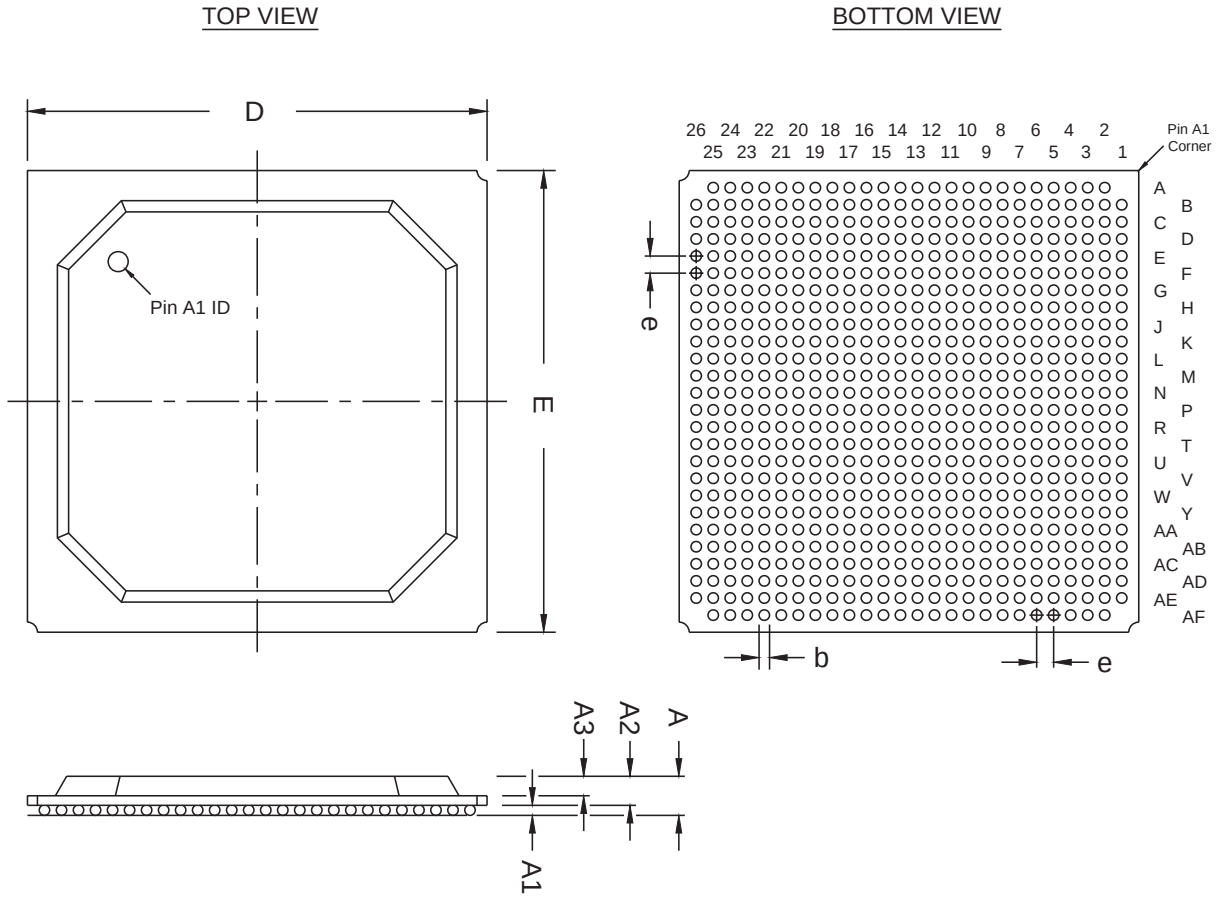
## 672-Pin FineLine Ball-Grid Array (FBGA), Option 3 — Wire Bond

- All dimensions and tolerances conform to ASME Y14.5M - 1994.
- Controlling dimension is in millimeters.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | F |
| Package Acronym | FBGA |
| Substrate Material | BT |
| Solder Ball Composition | Regular: 63Sn:37Pb (Typ.)<br>Pb-free: Sn:3Ag:0.5Cu (Typ.) |
| JEDEC Outline Reference | MS-034 Variation: AAL-1 |
| Lead Coplanarity | 0.008 inches (0.20 mm) |
| Weight | 3.9 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 2.60 |
| A1 | 0.30 | – | – |
| A2 | – | – | 2.20 |
| A3 | – | – | 1.80 |
| D | 27.00 BSC | | |
| E | 27.00 BSC | | |
| b | 0.50 | 0.60 | 0.70 |
| e | 1.00 BSC | | |

## Package Outline



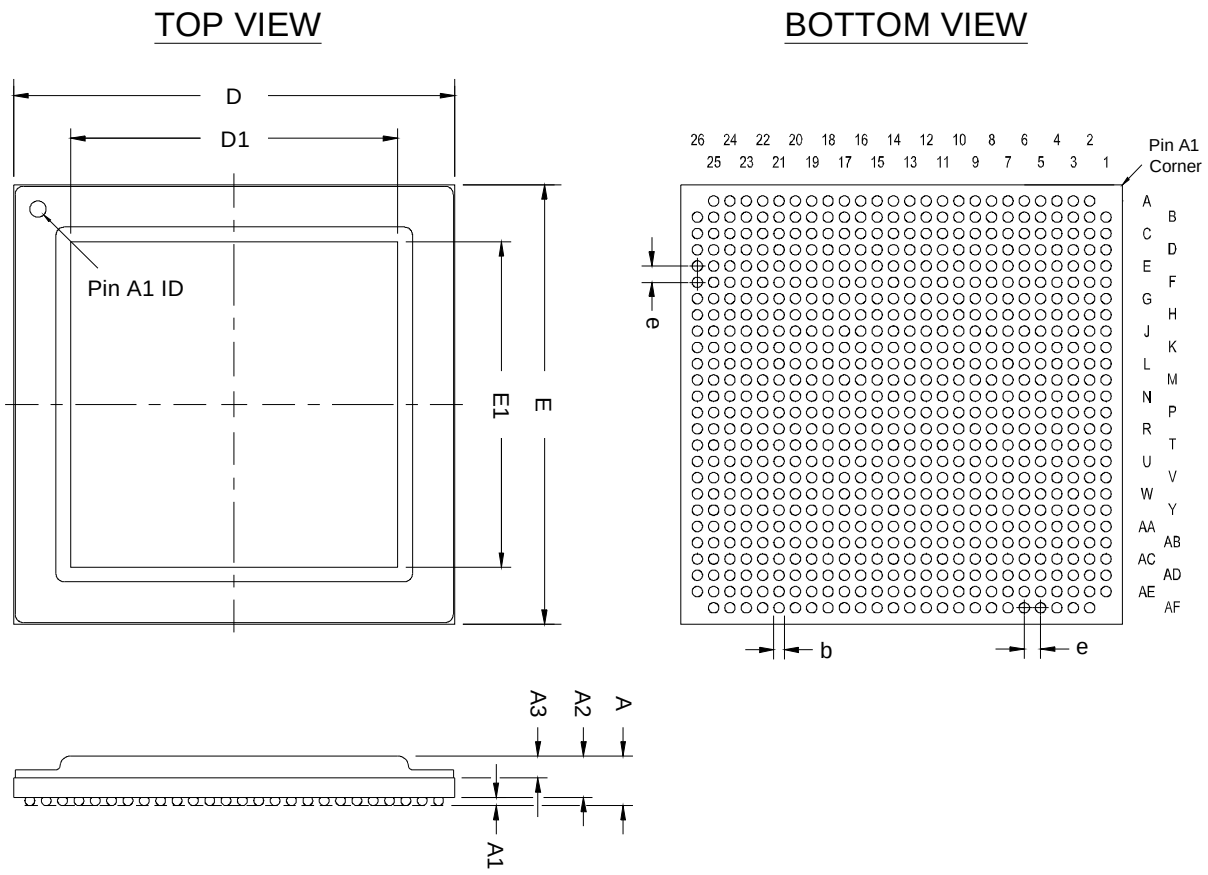
## 672-Pin FineLine Ball-Grid Array (FBGA), Option 4 — Flip Chip

- All dimensions and tolerances conform to ASME Y14.5M - 1994.
- Controlling dimension is in millimeters.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | F |
| Package Acronym | FBGA |
| Substrate Material | BT |
| Solder Ball Composition | Regular: 63Sn:37Pb (Typ.)<br>Pb-free: Sn:3Ag:0.5Cu (Typ.) |
| JEDEC Outline Reference | MS-034 Variation: AAL-1 |
| Lead Coplanarity | 0.008 inches (0.20 mm) |
| Weight | 8.3 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 3.50 |
| A1 | 0.30 | – | – |
| A2 | 0.25 | – | 3.00 |
| A3 | – | – | 2.50 |
| D | 27.00 BSC | | |
| D1 | 20.00 BSC | | |
| E | 27.00 BSC | | |
| E1 | 20.00 BSC | | |
| b | 0.50 | 0.60 | 0.70 |
| e | 1.00 BSC | | |

## Package Outline



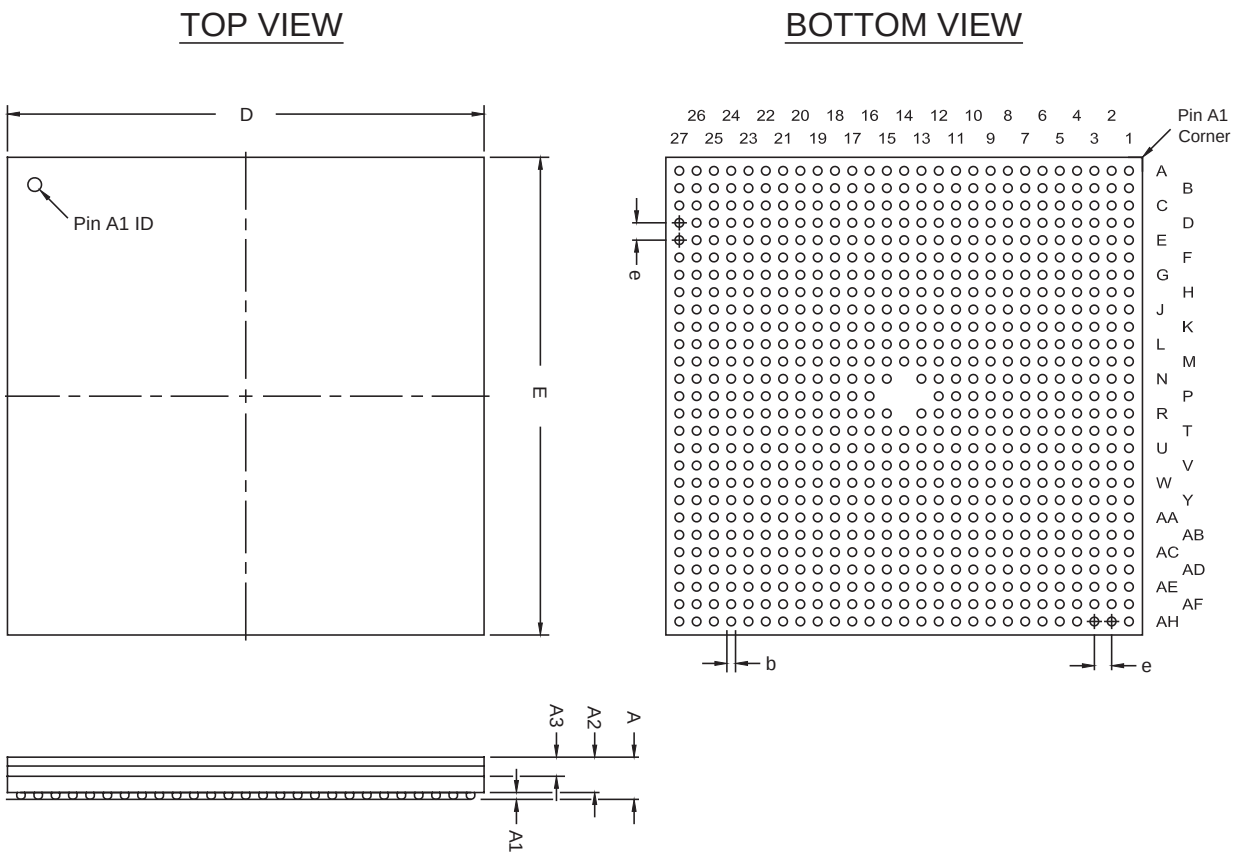
## 724-Pin Ball-Grid Array (BGA) — Flip Chip

- All dimensions and tolerances conform to ASME Y14.5M - 1994.
- Controlling dimension is in millimeters.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | B |
| Package Acronym | BGA |
| Substrate Material | BT |
| Solder Ball Composition | Regular: 63Sn:37Pb (Typ.)<br>Pb-free: Sn:3Ag:0.5Cu (Typ.) |
| JEDEC Outline Reference | MS-034 Variation: BAR-1 |
| Lead Coplanarity | 0.008 inches (0.20 mm) |
| Weight | 13.6 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 3.50 |
| A1 | 0.30 | – | – |
| A2 | 0.25 | – | 3.00 |
| A3 | – | – | 2.50 |
| D | 35.00 BSC | | |
| E | 35.00 BSC | | |
| b | 0.60 | 0.75 | 0.90 |
| e | 1.27 BSC | | |

## Package Outline



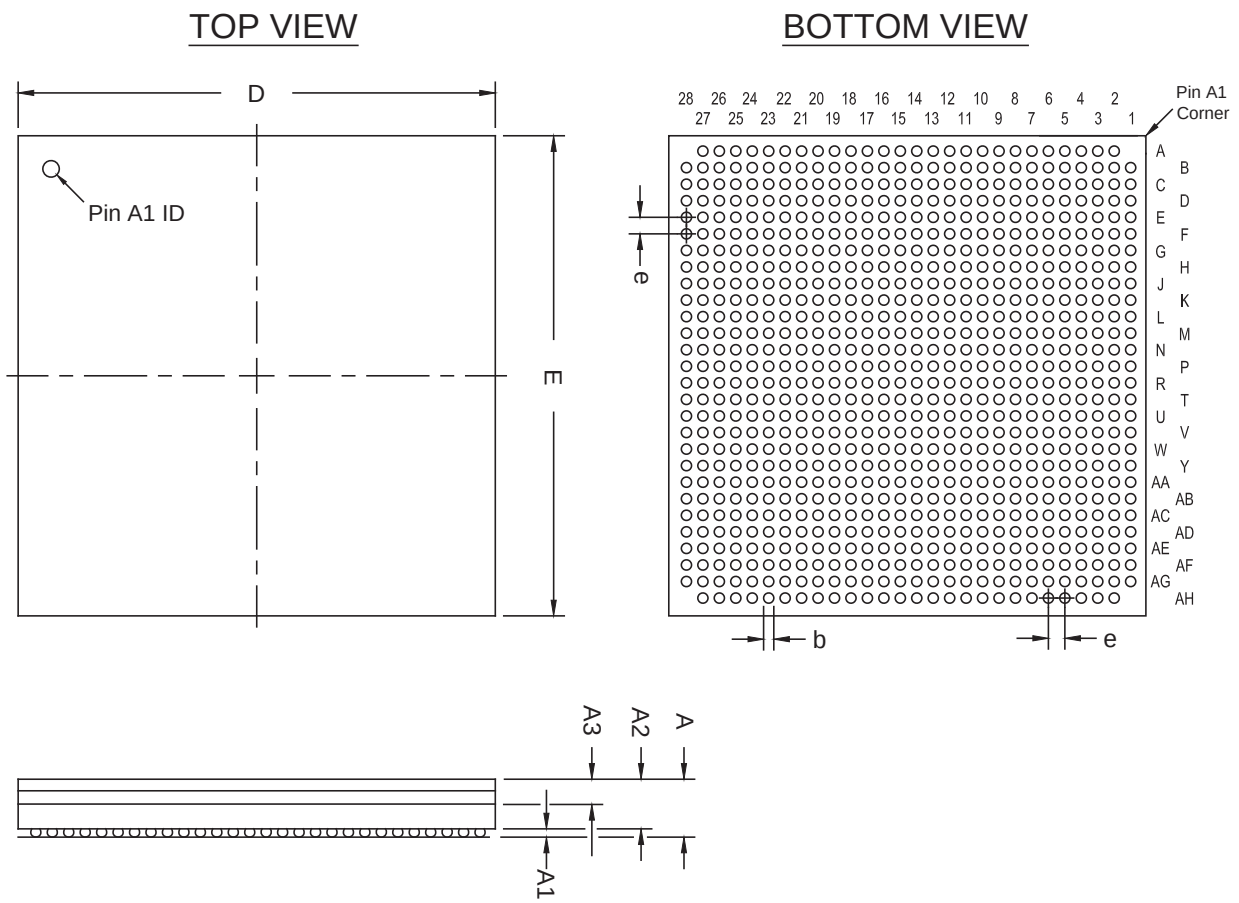
## 780-Pin FineLine Ball-Grid Array (FBGA), Option 1 — Flip Chip

- All dimensions and tolerances conform to ASME Y14.5M - 1994.
- Controlling dimension is in millimeters.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | F |
| Package Acronym | FBGA |
| Substrate Material | BT |
| Solder Ball Composition | Regular: 63Sn:37Pb (Typ.)<br>Pb-free: Sn:3Ag:0.5Cu (Typ.) |
| JEDEC Outline Reference | MS-034 Variation: AAM-1 |
| Lead Coplanarity | 0.008 inches (0.20 mm) |
| Weight | 11.9 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 3.50 |
| A1 | 0.30 | – | – |
| A2 | 0.25 | – | 3.00 |
| A3 | – | – | 2.50 |
| D | 29.00 BSC | | |
| E | 29.00 BSC | | |
| b | 0.50 | 0.60 | 0.70 |
| e | 1.00 BSC | | |

## Package Outline



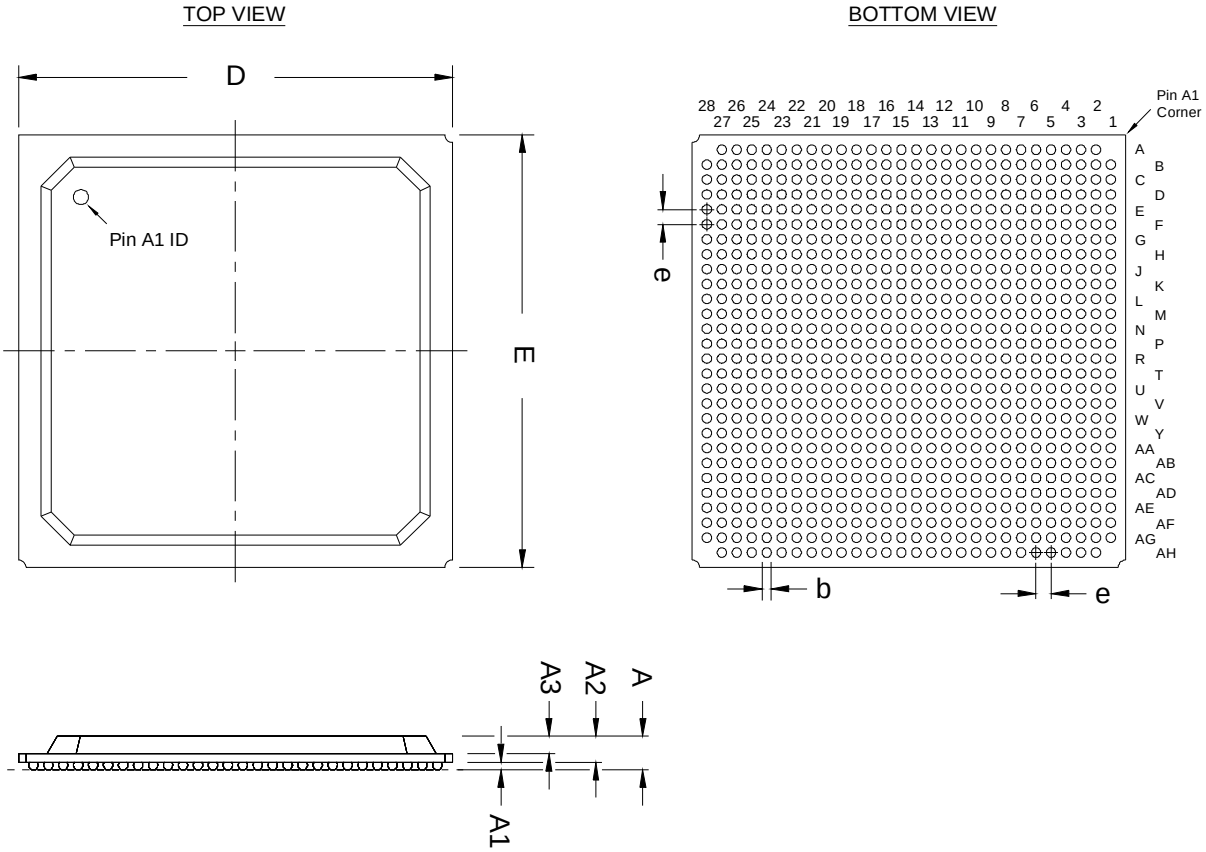
## 780-Pin FineLine Ball-Grid Array (FBGA), Option 2 — Wire Bond

- All dimensions and tolerances conform to ASME Y14.5M - 1994.
- Controlling dimension is in millimeters.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | F |
| Package Acronym | FBGA |
| Substrate Material | BT |
| Solder Ball Composition | Regular: 63Sn:37Pb (Typ.)<br>Pb-free: Sn:3Ag:0.5Cu (Typ.) |
| JEDEC Outline Reference | MS-034 Variation: AAM-1 |
| Lead Coplanarity | 0.008 inches (0.20 mm) |
| Weight | 4.0 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 2.60 |
| A1 | 0.30 | – | – |
| A2 | – | – | 2.20 |
| A3 | – | – | 1.80 |
| D | 29.00 BSC | | |
| E | 29.00 BSC | | |
| b | 0.50 | 0.60 | 0.70 |
| e | 1.00 BSC | | |

## Package Outline



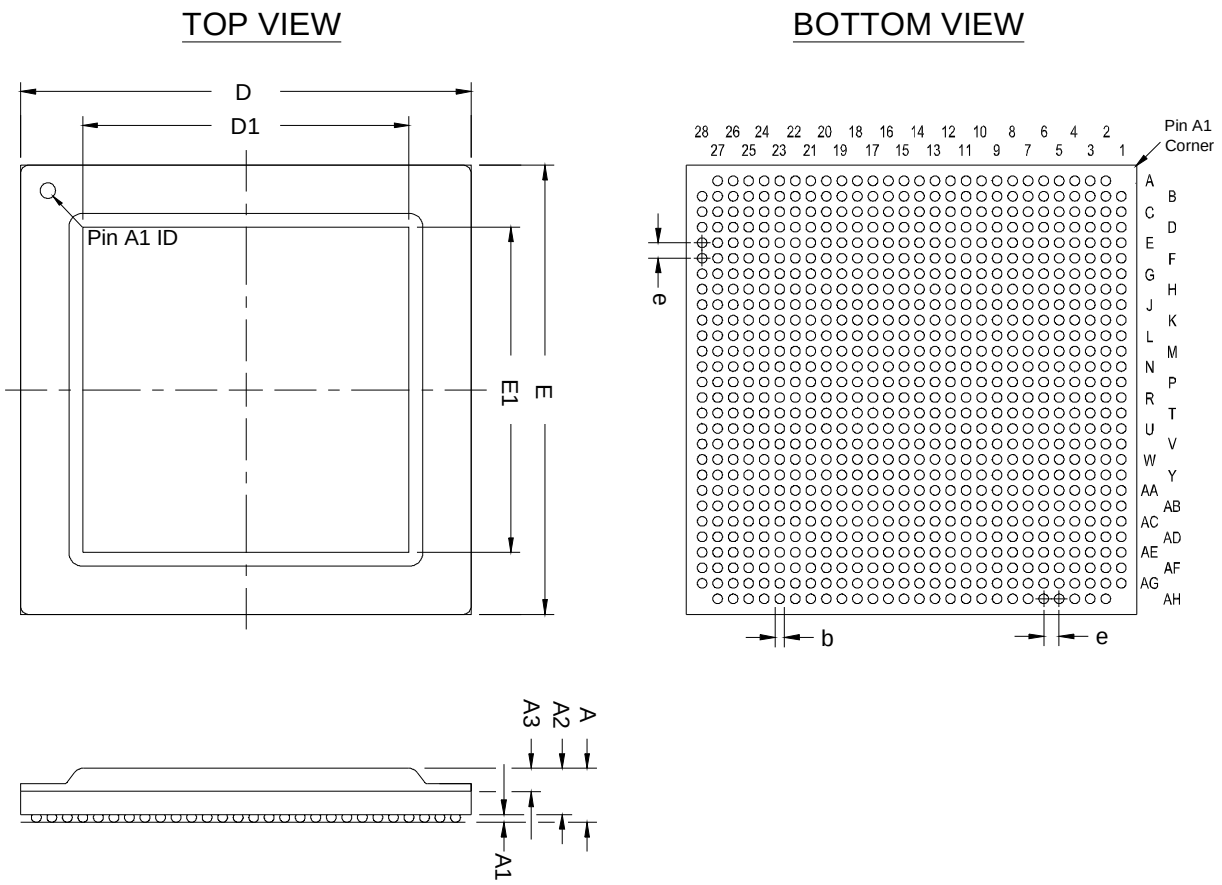
## 780-Pin FineLine Ball-Grid Array (FBGA), Option 3 — Flip Chip

- All dimensions and tolerances conform to ASME Y14.5M - 1994.
- Controlling dimension is in millimeters.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | F |
| Package Acronym | FBGA |
| Substrate Material | BT |
| Solder Ball Composition | Regular: 63Sn:37Pb (Typ.)<br>Pb-free: Sn:3Ag:0.5Cu (Typ.) |
| JEDEC Outline Reference | MS-034 Variation: AAM-1 |
| Lead Coplanarity | 0.008 inches (0.20 mm) |
| Weight | 8.5 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 3.50 |
| A1 | 0.30 | – | – |
| A2 | 0.25 | – | 3.00 |
| A3 | – | – | 2.50 |
| D | 29.00 BSC | | |
| D1 | 21.00 BSC | | |
| E | 29.00 BSC | | |
| E1 | 21.00 BSC | | |
| b | 0.50 | 0.60 | 0.70 |
| e | 1.00 BSC | | |

## Package Outline



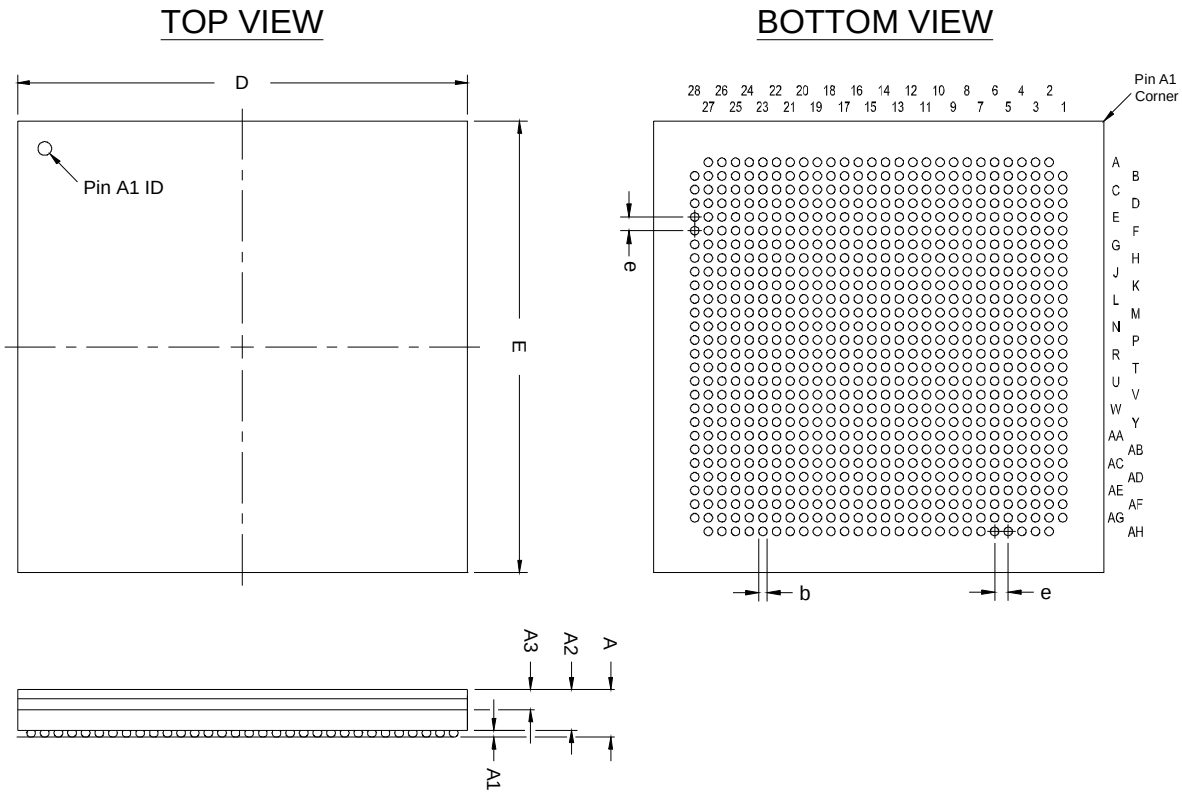
## 780-Pin Hybrid FineLine Ball-Grid Array (HBGA) — Flip Chip

- All dimensions and tolerances conform to ASME Y14.5M - 1994.
- Controlling dimension is in millimeters.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | H |
| Package Acronym | HBGA |
| Substrate Material | BT |
| Solder Ball Composition | Regular: 63Sn:37Pb (Typ.)<br>Pb-free: Sn:3Ag:0.5Cu (Typ.) |
| JEDEC Outline Reference | MS-034 Variation: AAP-1 |
| Lead Coplanarity | 0.008 inches (0.20 mm) |
| Weight | 14.1 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 3.50 |
| A1 | 0.30 | – | – |
| A2 | 0.25 | – | 3.00 |
| A3 | – | – | 2.50 |
| D | 33.00 BSC | | |
| E | 33.00 BSC | | |
| b | 0.50 | 0.60 | 0.70 |
| e | 1.00 BSC | | |

## Package Outline



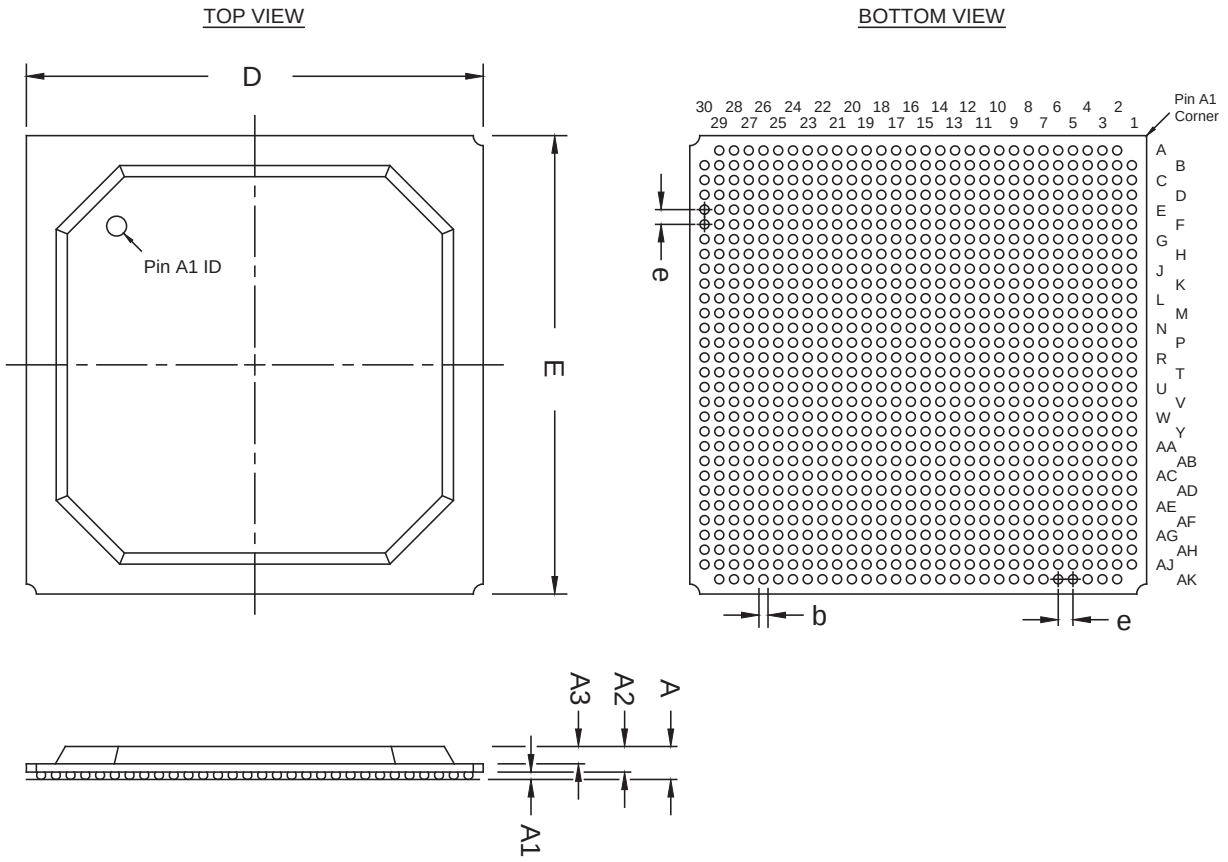
## 896-Pin FineLine Ball-Grid Array (FBGA) — Wire Bond

- All dimensions and tolerances conform to ASME Y14.5M - 1994.
- Controlling dimension is in millimeters.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | F |
| Package Acronym | FBGA |
| Substrate Material | BT |
| Solder Ball Composition | Regular: 63Sn:37Pb (Typ.)<br>Pb-free: Sn:3Ag:0.5Cu (Typ.) |
| JEDEC Outline Reference | MS-034 Variation: AAN-1 |
| Lead Coplanarity | 0.008 inches (0.20 mm) |
| Weight | 4.7 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 2.60 |
| A1 | 0.30 | – | – |
| A2 | – | – | 2.20 |
| A3 | – | – | 1.80 |
| D | 31.00 BSC | | |
| E | 31.00 BSC | | |
| b | 0.50 | 0.60 | 0.70 |
| e | 1.00 BSC | | |

## Package Outline



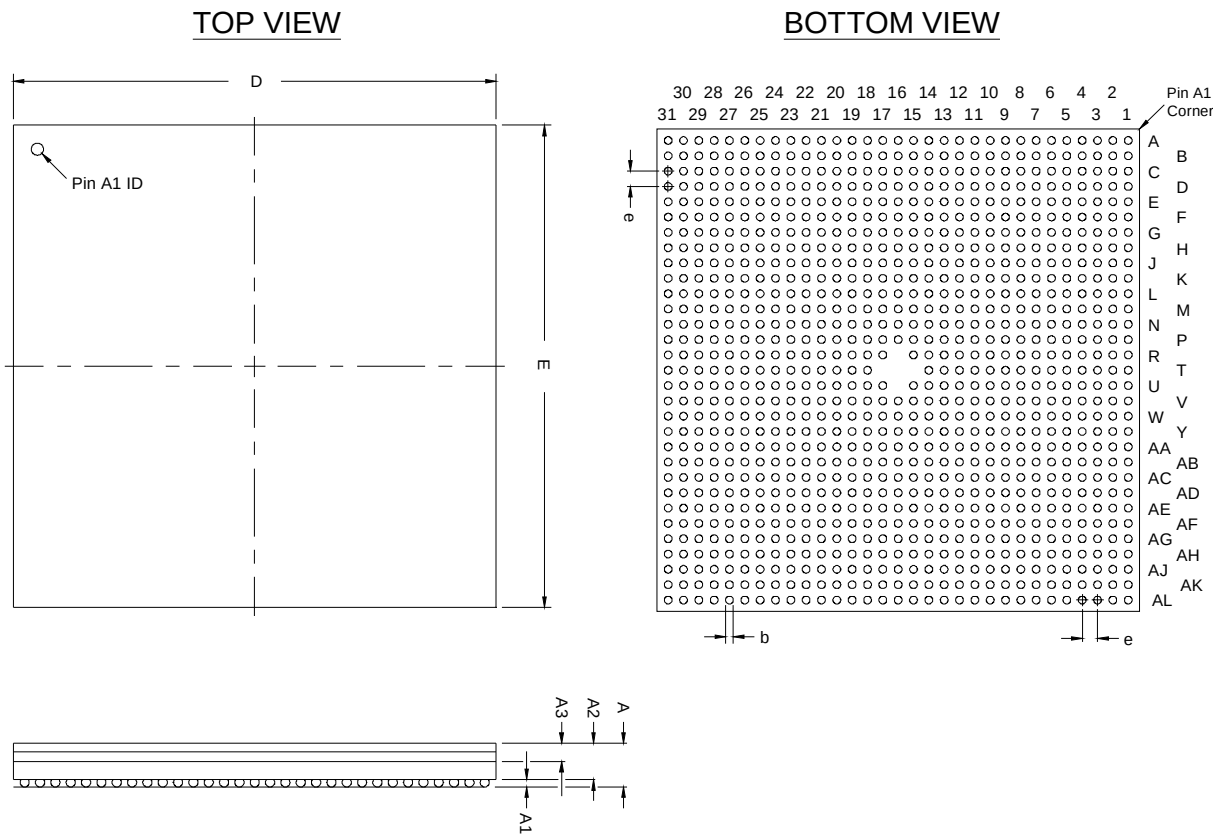
## 956-Pin Ball-Grid Array (BGA), Option 1 — Flip Chip

- All dimensions and tolerances conform to ASME Y14.5M - 1994.
- Controlling dimension is in millimeters.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | B |
| Package Acronym | BGA |
| Substrate Material | BT |
| Solder Ball Composition | Regular: 63Sn:37Pb (Typ.)<br>Pb-free: Sn:3Ag:0.5Cu (Typ.) |
| JEDEC Outline Reference | MS-034 Variation: BAU-1 |
| Lead Coplanarity | 0.008 inches (0.20 mm) |
| Weight | 19.6 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 3.50 |
| A1 | 0.30 | – | – |
| A2 | 0.25 | – | 3.00 |
| A3 | – | – | 2.50 |
| D | 40.00 BSC | | |
| E | 40.00 BSC | | |
| b | 0.60 | 0.75 | 0.90 |
| e | 1.27 BSC | | |

## Package Outline



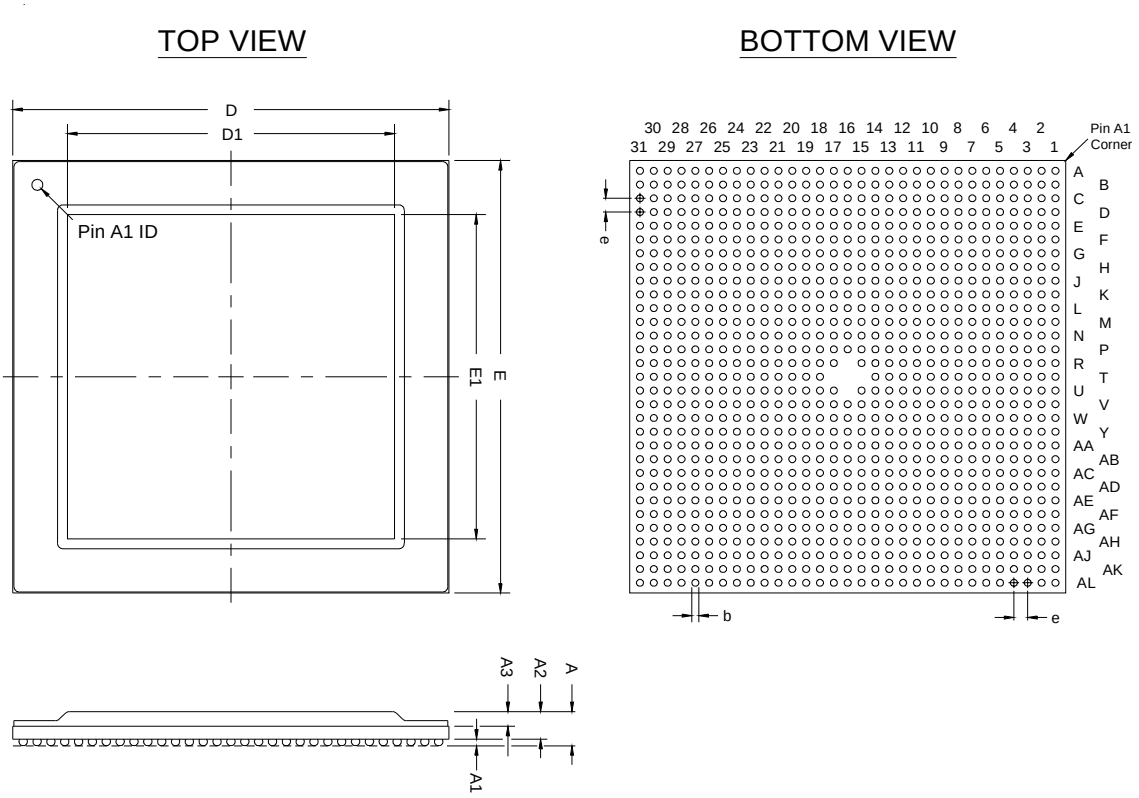
## 956-Pin Ball-Grid Array (BGA), Option 2 — Flip Chip

- All dimensions and tolerances conform to ASME Y14.5M - 1994.
- Controlling dimension is in millimeters.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | B |
| Package Acronym | BGA |
| Substrate Material | BT |
| Solder Ball Composition | Regular: 63Sn:37Pb (Typ.)<br>Pb-free: Sn:3Ag:0.5Cu (Typ.) |
| JEDEC Outline Reference | MS-034 Variation: BAU-1 |
| Lead Coplanarity | 0.008 inches (0.20 mm) |
| Weight | 17.0 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 3.50 |
| A1 | 0.30 | – | – |
| A2 | 0.25 | – | 3.00 |
| A3 | – | – | 2.50 |
| D | 40.00 BSC | | |
| D1 | 30.00 BSC | | |
| E | 40.00 BSC | | |
| E1 | 30.00 BSC | | |
| b | 0.60 | 0.75 | 0.90 |
| e | 1.27 BSC | | |

## Package Outline



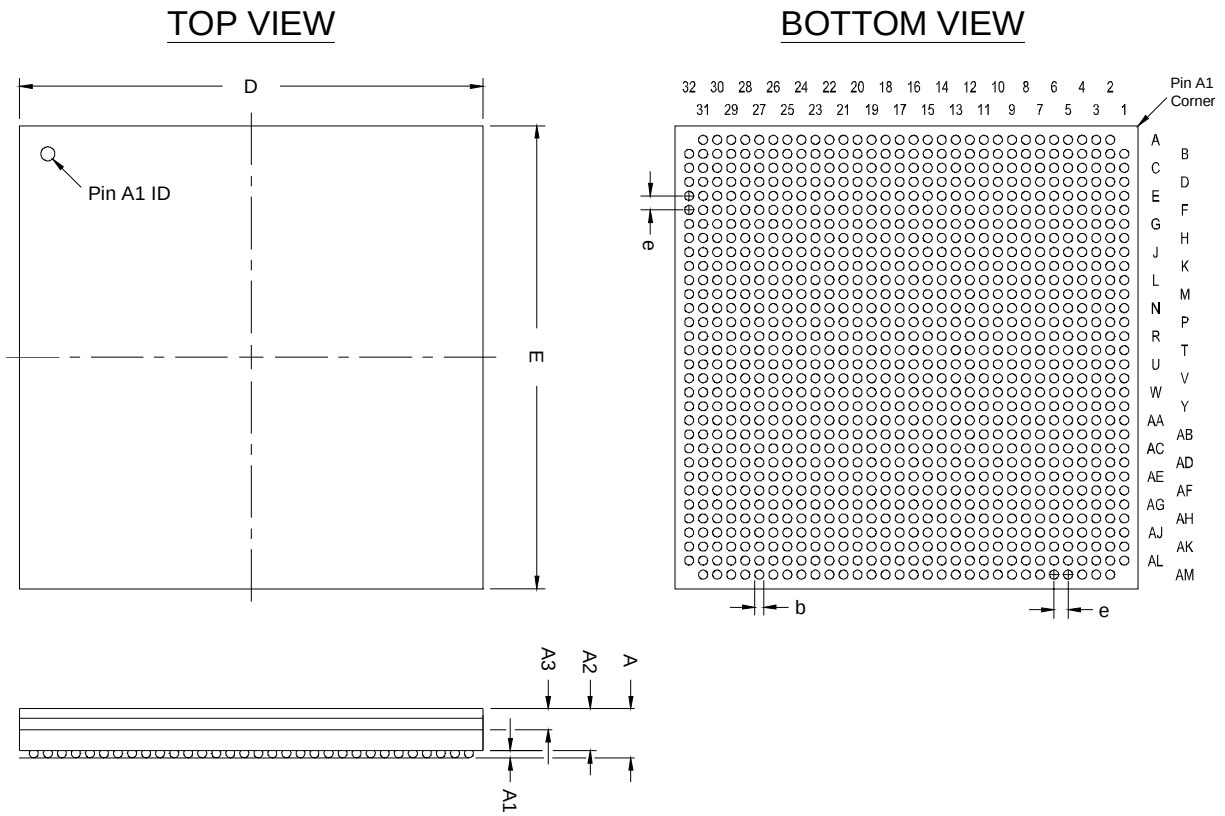
## 1020-Pin FineLine Ball-Grid Array (FBGA), Option 1 — Flip Chip

- All dimensions and tolerances conform to ASME Y14.5M - 1994.
- Controlling dimension is in millimeters.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | F |
| Package Acronym | FBGA |
| Substrate Material | BT |
| Solder Ball Composition | Regular: 63Sn:37Pb (Typ.)<br>Pb-free: Sn:3Ag:0.5Cu (Typ.) |
| JEDEC Outline Reference | MS-034 Variation: AAP-1 |
| Lead Coplanarity | 0.008 inches (0.20 mm) |
| Weight | 14.1 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 3.50 |
| A1 | 0.30 | – | – |
| A2 | 0.25 | – | 3.00 |
| A3 | – | – | 2.50 |
| D | 33.00 BSC | | |
| E | 33.00 BSC | | |
| b | 0.50 | 0.60 | 0.70 |
| e | 1.00 BSC | | |

## Package Outline



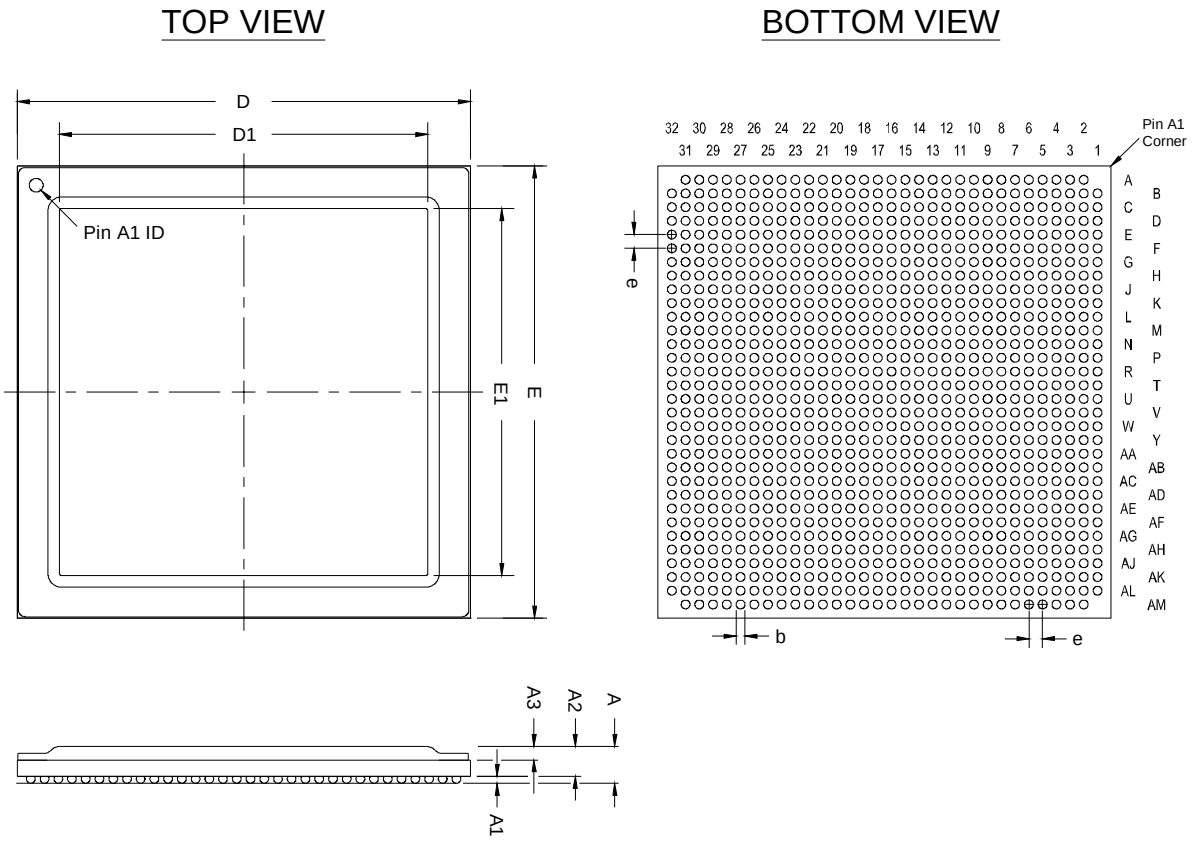
## 1020-Pin FineLine Ball-Grid Array (FBGA), Option 2 — Flip Chip

- All dimensions and tolerances conform to ASME Y14.5M - 1994.
- Controlling dimension is in millimeters.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | F |
| Package Acronym | FBGA |
| Substrate Material | BT |
| Solder Ball Composition | Regular: 63Sn:37Pb (Typ.)<br>Pb-free: Sn:3Ag:0.5Cu (Typ.) |
| JEDEC Outline Reference | MS-034 Variation: AAP-1 |
| Lead Coplanarity | 0.008 inches (0.20 mm) |
| Weight | 12.4 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 3.50 |
| A1 | 0.30 | – | – |
| A2 | 0.25 | – | 3.00 |
| A3 | – | – | 2.50 |
| D | 33.00 BSC | | |
| D1 | 26.80 BSC | | |
| E | 33.00 BSC | | |
| E1 | 26.80 BSC | | |
| b | 0.50 | 0.60 | 0.70 |
| e | 1.00 BSC | | |

## Package Outline



## 1152-Pin FineLine Ball-Grid Array (FBGA), Option 1 — Flip Chip

- All dimensions and tolerances conform to ASME Y14.5M - 1994.
- Controlling dimension is in millimeters.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | F |
| Package Acronym | FBGA |
| Substrate Material | BT |
| Solder Ball Composition | Regular: 63Sn:37Pb (Typ.)<br>Pb-free: Sn:3Ag:0.5Cu (Typ.) |
| JEDEC Outline Reference | MS-034 Variation: AAR-1 |
| Lead Coplanarity | 0.008 inches (0.20 mm) |
| Weight | 15.8 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 3.50 *(1)* |
| A1 | 0.30 | – | – |
| A2 | 0.25 | – | 3.00 *(2)* |
| A3 | – | – | 2.50 |
| D | 35.00 BSC | | |
| E | 35.00 BSC | | |
| b | 0.50 | 0.60 | 0.70 |
| e | 1.00 BSC | | |

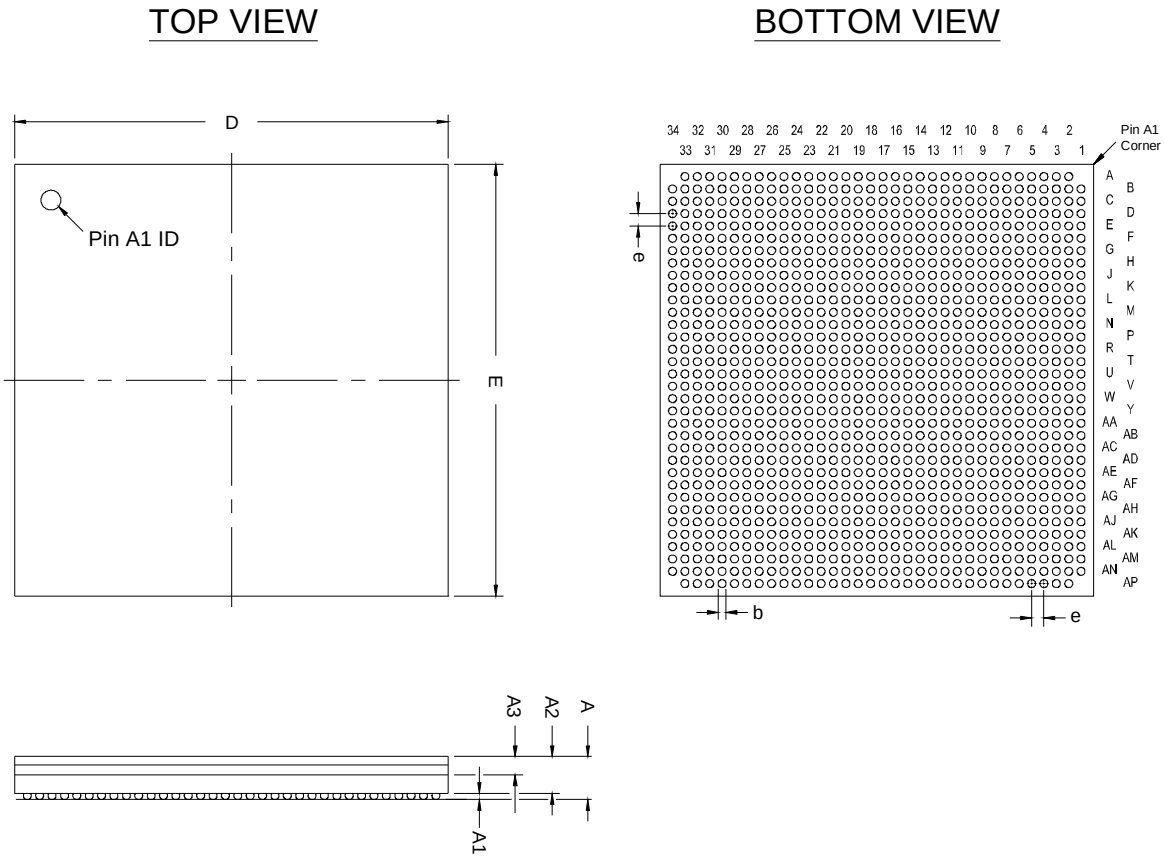
**Notes:**

For Stratix IV GX products:

(1) Overall package thickness (Dimension “A”) is 3.90 mm maximum.

(2) Package body thickness (Dimension “A2”) is 3.30 mm maximum.

## Package Outline



## 1152-Pin FineLine Ball-Grid Array (FBGA), Option 2 — Flip Chip

- All dimensions and tolerances conform to ASME Y14.5M - 1994.
- Controlling dimension is in millimeters.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | F |
| Package Acronym | FBGA |
| Substrate Material | BT |
| Solder Ball Composition | Regular: 63Sn:37Pb (Typ.)<br>Pb-free: Sn:3Ag:0.5Cu (Typ.) |
| JEDEC Outline Reference | MS-034 Variation: AAR-1 |
| Lead Coplanarity | 0.008 inches (0.20 mm) |
| Weight | 12.1 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 3.50 *(1)* |
| A1 | 0.30 | – | – |
| A2 | 0.25 | – | 3.00 *(2)* |
| A3 | – | – | 2.50 |
| D | 35.00 BSC | | |
| D1 | 27.00 BSC | | |
| E | 35.00 BSC | | |
| E1 | 27.00 BSC | | |
| b | 0.50 | 0.60 | 0.70 |
| e | 1.00 BSC | | |

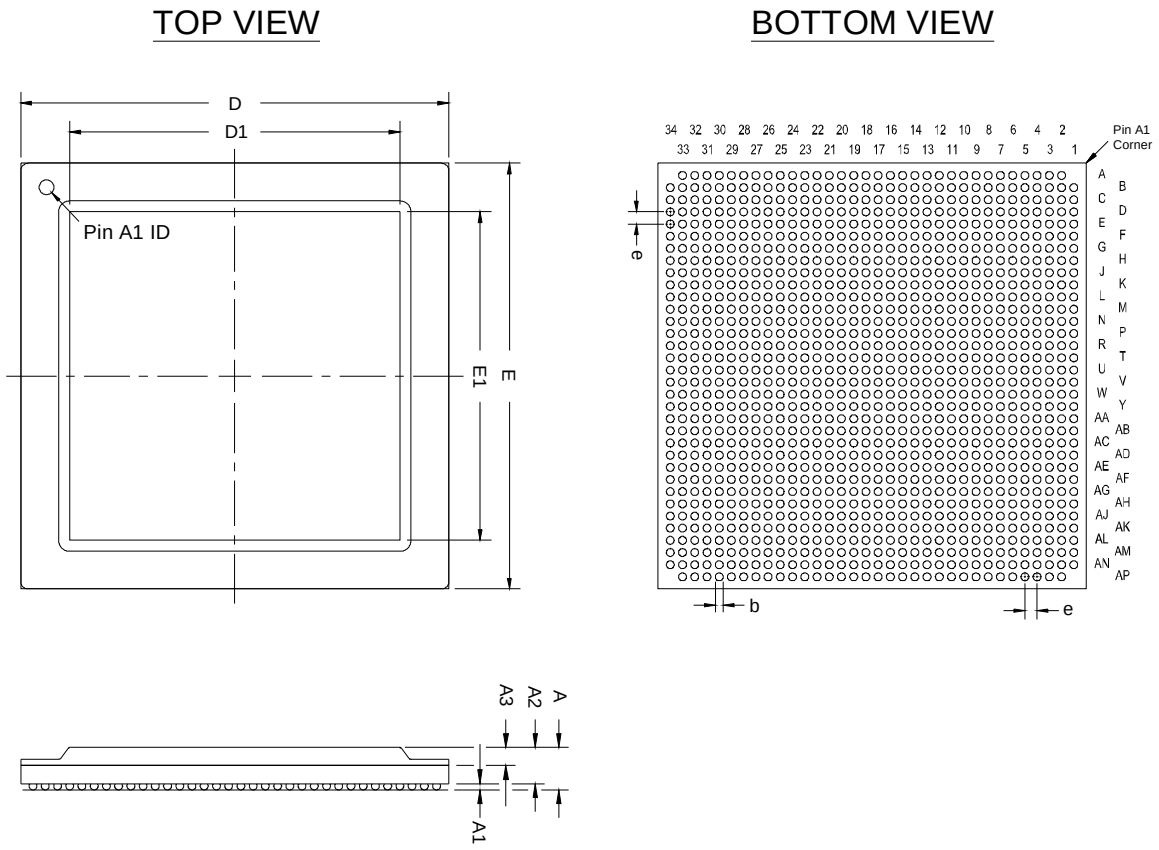
**Notes:**

For Stratix IV GX products:

(1) Overall package thickness (Dimension “A”) is 3.90 mm maximum.

(2) Package body thickness (Dimension “A2”) is 3.30 mm maximum.

## Package Outline



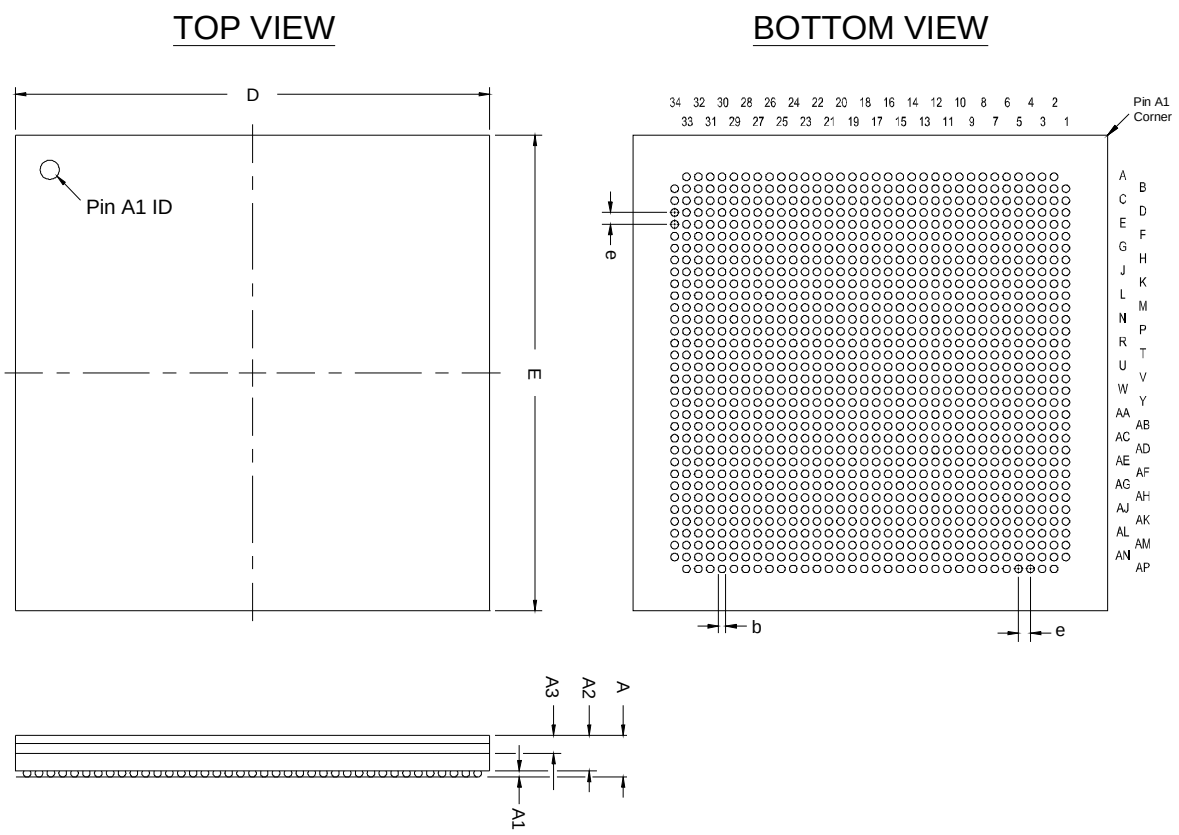
## 1152-Pin Hybrid FineLine Ball-Grid Array (HBGA), Option 1 — Flip Chip

- All dimensions and tolerances conform to ASME Y14.5M - 1994.
- Controlling dimension is in millimeters.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | H |
| Package Acronym | HBGA |
| Substrate Material | BT |
| Solder Ball Composition | Regular: 63Sn:37Pb (Typ.)<br>Pb-free: Sn:3Ag:0.5Cu (Typ.) |
| JEDEC Outline Reference | MS-034 Variation: AAU-1 |
| Lead Coplanarity | 0.008 inches (0.20 mm) |
| Weight | 20.4 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 3.50 |
| A1 | 0.30 | – | – |
| A2 | 0.25 | – | 3.00 |
| A3 | – | – | 2.50 |
| D | 40.00 BSC | | |
| E | 40.00 BSC | | |
| b | 0.50 | 0.60 | 0.70 |
| e | 1.00 BSC | | |

## Package Outline



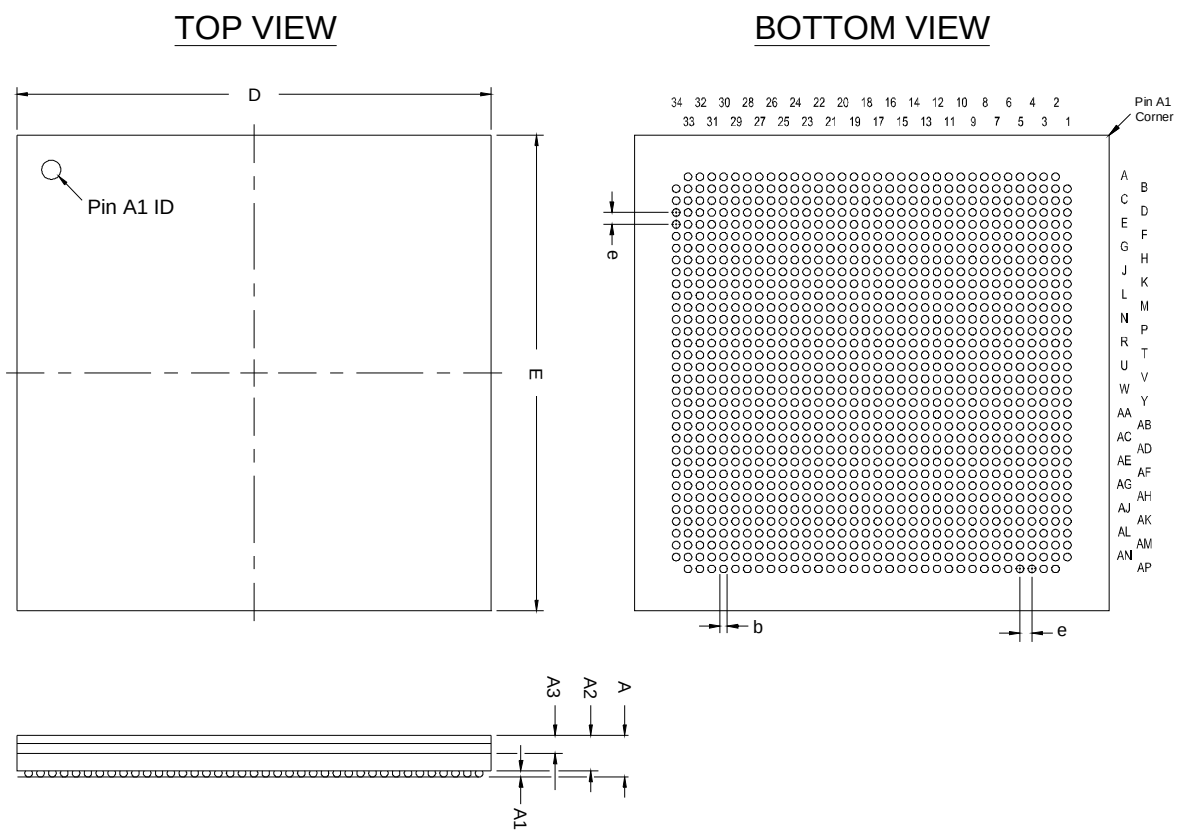
## 1152-Pin Hybrid FineLine Ball-Grid Array (HBGA), Option 2 — Flip Chip

- All dimensions and tolerances conform to ASME Y14.5M - 1994.
- Controlling dimension is in millimeters.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | H |
| Package Acronym | HBGA |
| Substrate Material | BT |
| Solder Ball Composition | Regular: 63Sn:37Pb (Typ.)<br>Pb-free: Sn:3Ag:0.5Cu (Typ.) |
| JEDEC Outline Reference | MS-034 Variation: AAU-1 |
| Lead Coplanarity | 0.010 inches (0.25 mm) |
| Weight | 22.5 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 3.50 |
| A1 | 0.30 | – | – |
| A2 | 0.25 | – | 3.00 |
| A3 | – | – | 2.50 |
| D | 42.50 BSC | | |
| E | 42.50 BSC | | |
| b | 0.50 | 0.60 | 0.70 |
| e | 1.00 BSC | | |

## Package Outline



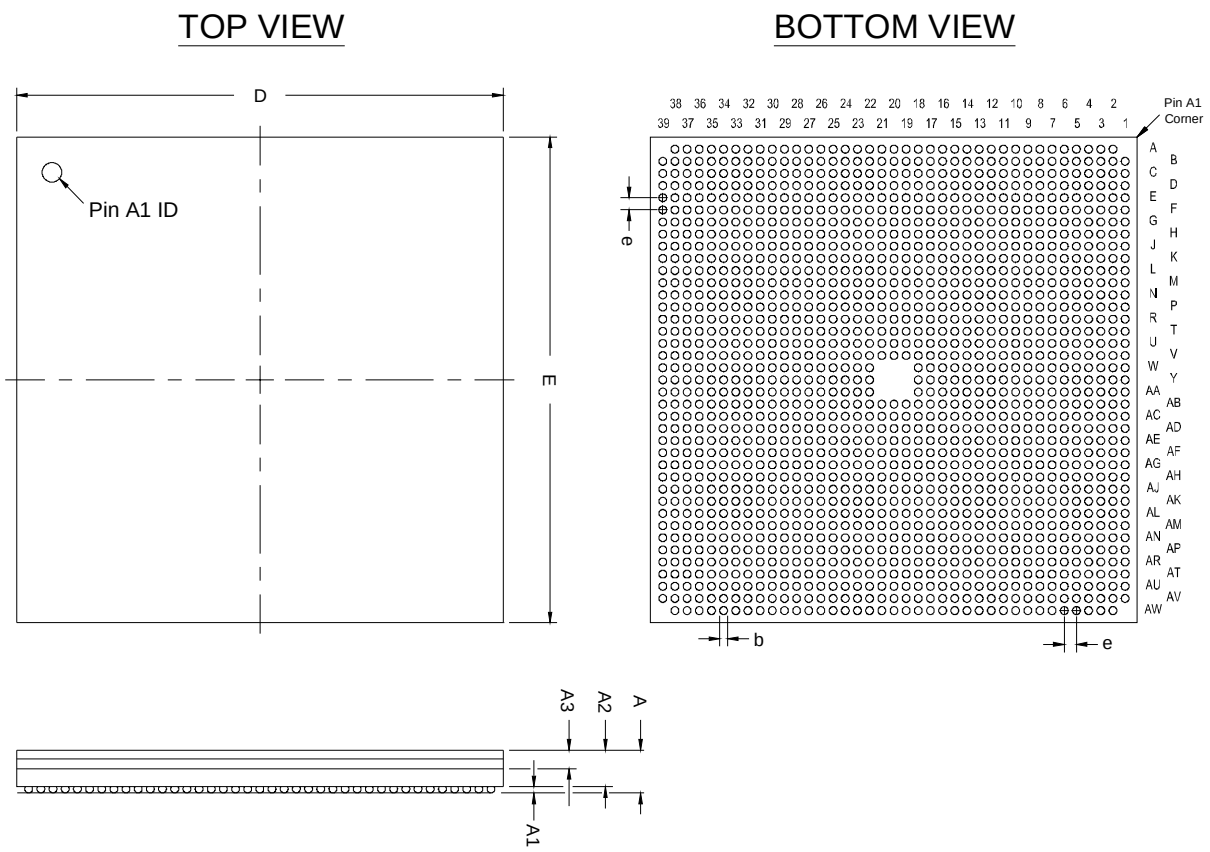
## 1508-Pin FineLine Ball-Grid Array (FBGA), Option 1 — Flip Chip

- All dimensions and tolerances conform to ASME Y14.5M - 1994.
- Controlling dimension is in millimeters.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | F |
| Package Acronym | FBGA |
| Substrate Material | BT |
| Solder Ball Composition | Regular: 63Sn:37Pb (Typ.)<br>Pb-free: Sn:3Ag:0.5Cu (Typ.) |
| JEDEC Outline Reference | MS-034 Variation: AAU-1 |
| Lead Coplanarity | 0.008 inches (0.20 mm) |
| Weight | 20.4 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 3.50 |
| A1 | 0.30 | – | – |
| A2 | 0.25 | – | 3.00 |
| A3 | – | – | 2.50 |
| D | 40.00 BSC | | |
| E | 40.00 BSC | | |
| b | 0.50 | 0.60 | 0.70 |
| e | 1.00 BSC | | |

## Package Outline



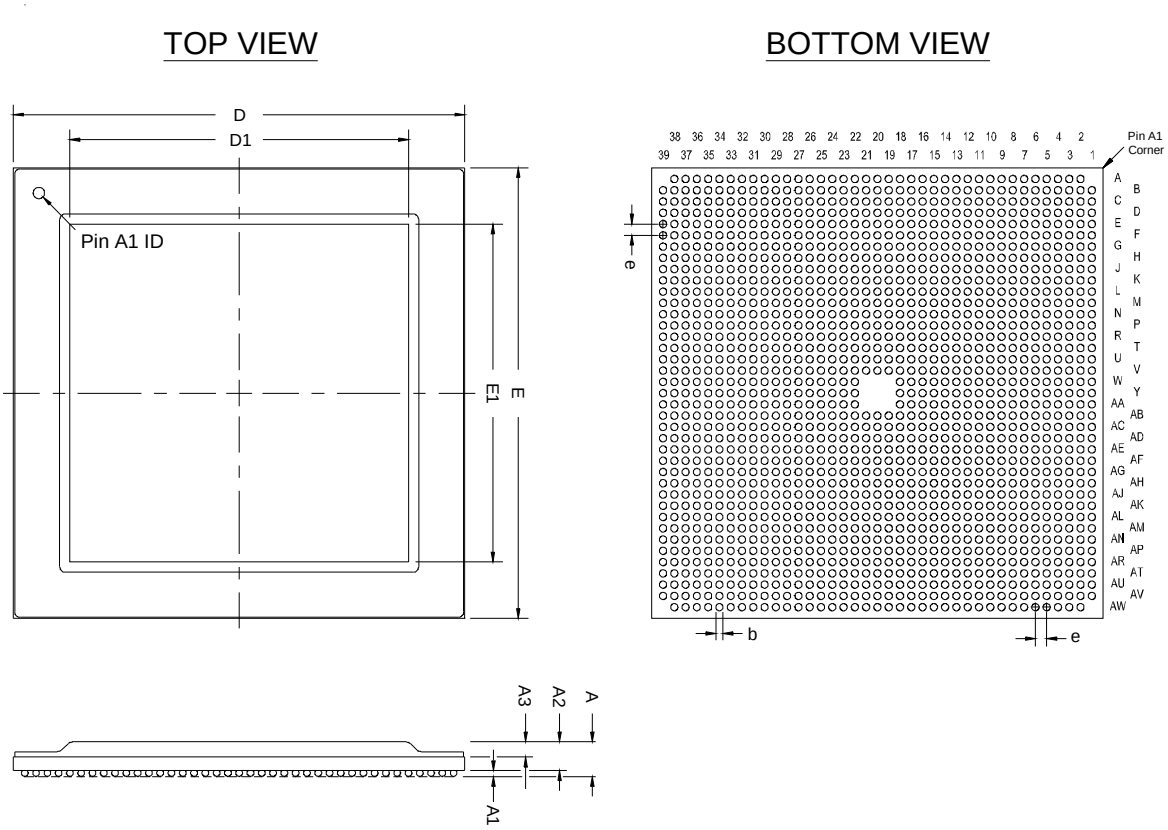
## 1508-Pin FineLine Ball-Grid Array (FBGA), Option 2 — Flip Chip

- All dimensions and tolerances conform to ASME Y14.5M - 1994.
- Controlling dimension is in millimeters.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | F |
| Package Acronym | FBGA |
| Substrate Material | BT |
| Solder Ball Composition | Regular: 63Sn:37Pb (Typ.)<br>Pb-free: Sn:3Ag:0.5Cu (Typ.) |
| JEDEC Outline Reference | MS-034 Variation: AAU-1 |
| Lead Coplanarity | 0.008 inches (0.20 mm) |
| Weight | 17.8 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 3.50 |
| A1 | 0.30 | – | – |
| A2 | 0.25 | – | 3.00 |
| A3 | – | – | 2.50 |
| D | 40.00 BSC | | |
| D1 | 30.00 BSC | | |
| E | 40.00 BSC | | |
| E1 | 30.00 BSC | | |
| b | 0.50 | 0.60 | 0.70 |
| e | 1.00 BSC | | |

## Package Outline



## 1517-Pin FineLine Ball-Grid Array (FBGA), Option 1 — Flip Chip

- All dimensions and tolerances conform to ASME Y14.5M - 1994.
- Controlling dimension is in millimeters.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | F |
| Package Acronym | FBGA |
| Substrate Material | BT |
| Solder Ball Composition | Regular: 63Sn:37Pb (Typ.)<br>Pb-free: Sn:3Ag:0.5Cu (Typ.) |
| JEDEC Outline Reference | MS-034 Variation: AAU-1 |
| Lead Coplanarity | 0.010 inches (0.25 mm) |
| Weight | 20.4 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 3.50 *(1)* |
| A1 | 0.30 | – | – |
| A2 | 0.25 | – | 3.00 *(2)* |
| A3 | – | – | 2.50 |
| D | 40.00 BSC | | |
| E | 40.00 BSC | | |
| b | 0.50 | 0.60 | 0.70 |
| e | 1.00 BSC | | |

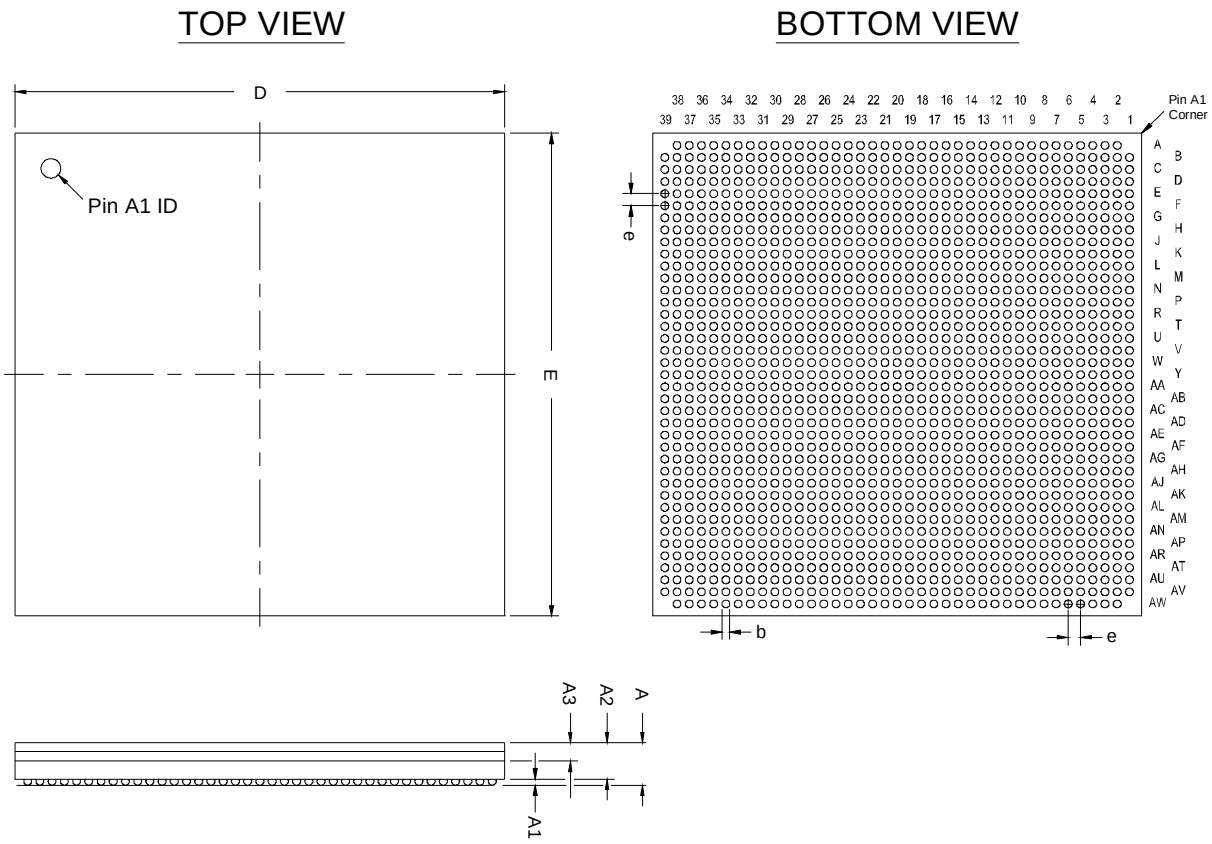
**Notes:**

For Stratix IV GX products:

(1) Overall package thickness (Dimension “A”) is 3.90 mm maximum.

(2) Package body thickness (Dimension “A2”) is 3.30 mm maximum.

## Package Outline



## 1517-Pin FineLine Ball-Grid Array (FBGA), Option 2 — Flip Chip

- All dimensions and tolerances conform to ASME Y14.5M - 1994.
- Controlling dimension is in millimeters.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | F |
| Package Acronym | FBGA |
| Substrate Material | BT |
| Solder Ball Composition | Regular: 63Sn:37Pb (Typ.)<br>Pb-free: Sn:3Ag:0.5Cu (Typ.) |
| JEDEC Outline Reference | MS-034 Variation: AAU-1 |
| Lead Coplanarity | 0.010 inches (0.25 mm) |
| Weight | 17.8 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 3.50 *(1)* |
| A1 | 0.30 | – | – |
| A2 | 0.25 | – | 3.00 *(2)* |
| A3 | – | – | 2.50 |
| D | 40.00 BSC | | |
| D1 | 30.00 BSC | | |
| E | 40.00 BSC | | |
| E1 | 30.00 BSC | | |
| b | 0.50 | 0.60 | 0.70 |
| e | 1.00 BSC | | |

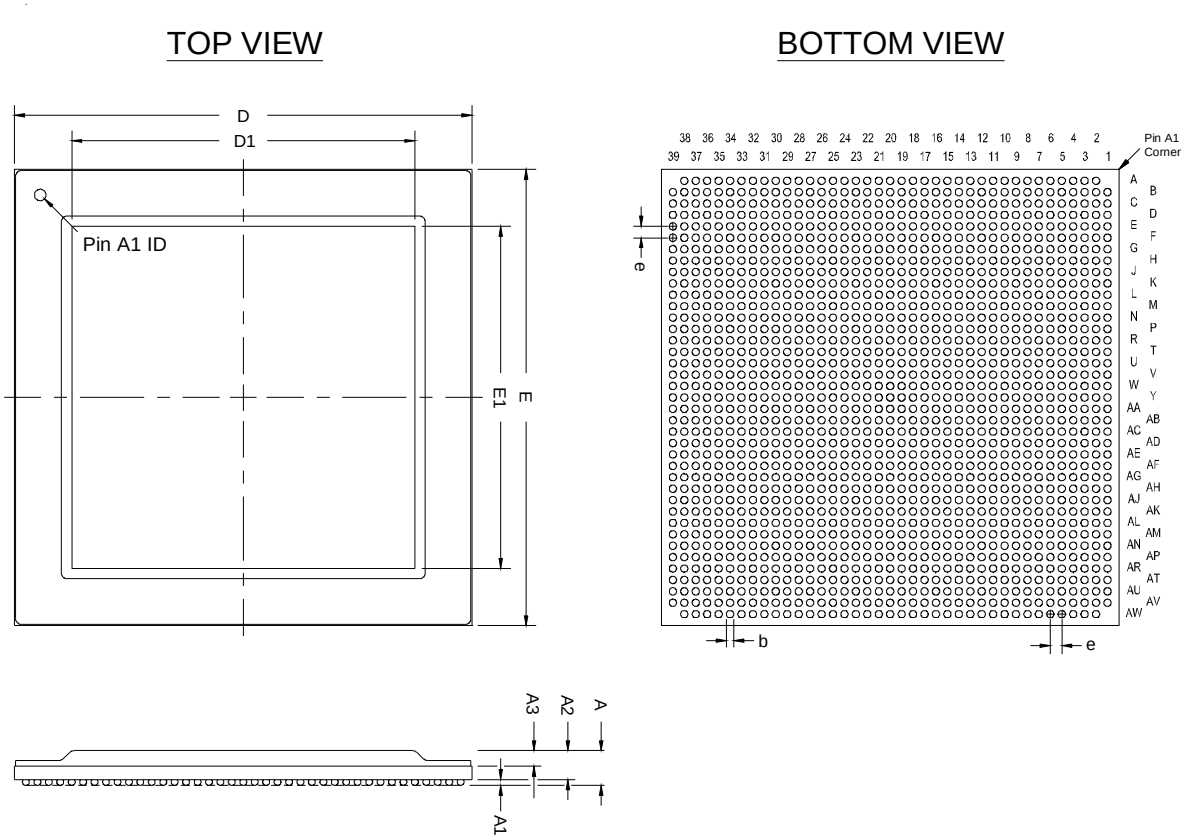
**Notes:**

For Stratix IV GX products:

(1) Overall package thickness (Dimension “A”) is 3.90 mm maximum.

(2) Package body thickness (Dimension “A2”) is 3.30 mm maximum.

## Package Outline



## 1517-Pin Hybrid FineLine Ball-Grid Array (HBGA) — Flip Chip

- All dimensions and tolerances conform to ASME Y14.5M - 1994.
- Controlling dimension is in millimeters.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | H |
| Package Acronym | HBGA |
| Substrate Material | BT |
| Solder Ball Composition | Regular: 63Sn:37Pb (Typ.)<br>Pb-free: Sn:3Ag:0.5Cu (Typ.) |
| JEDEC Outline Reference | MS-034 Variation: AAV -1 |
| Lead Coplanarity | 0.010 inches (0.25 mm) |
| Weight | 22.5 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 3.50 *(1)* |
| A1 | 0.30 | – | – |
| A2 | 0.25 | – | 3.00 *(2)* |
| A3 | – | – | 2.50 |
| D | 42.50 BSC | | |
| E | 42.50 BSC | | |
| b | 0.50 | 0.60 | 0.70 |
| e | 1.00 BSC | | |

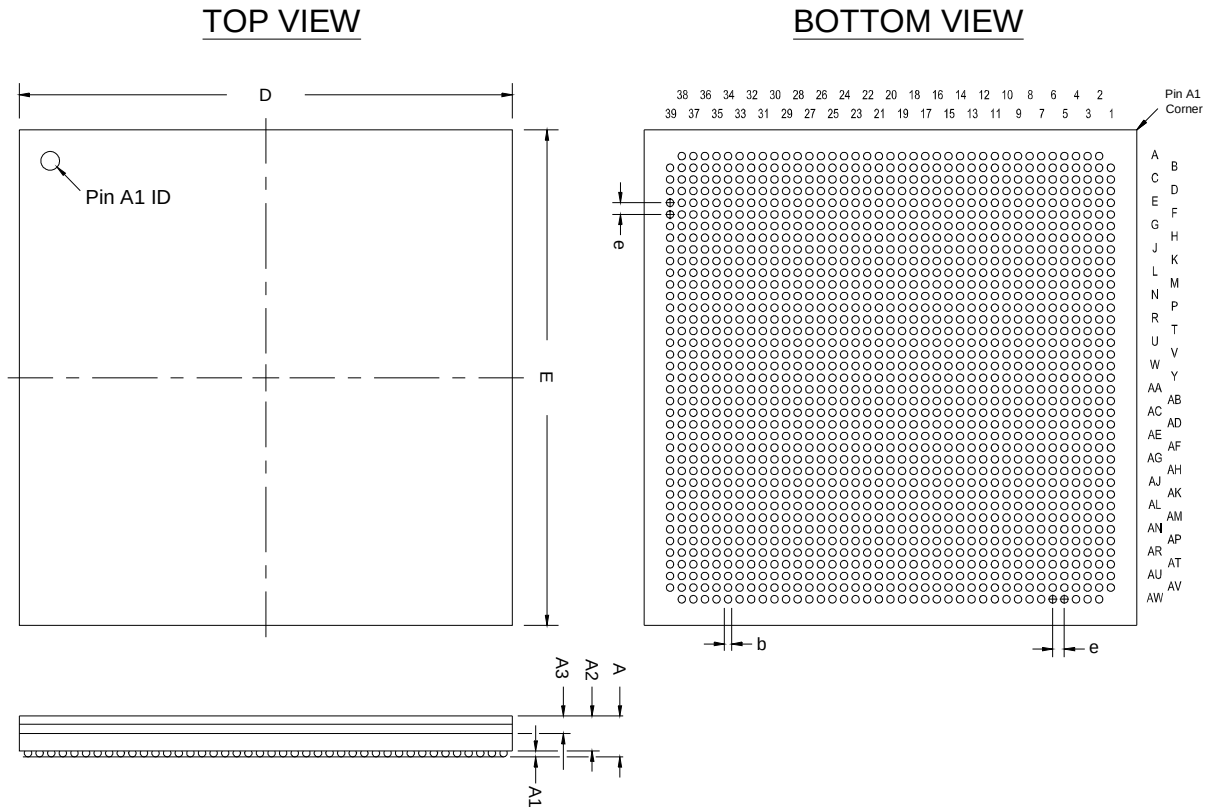
**Notes:**

For Stratix IV GX products:

(1) Overall package thickness (Dimension “A”) is 3.90 mm maximum.

(2) Package body thickness (Dimension “A2”) is 3.30 mm maximum.

## Package Outline



## 1760-Pin FineLine Ball-Grid Array (FBGA) — Flip Chip

- All dimensions and tolerances conform to ASME Y14.5M - 1994.
- Controlling dimension is in millimeters.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | F |
| Package Acronym | FBGA |
| Substrate Material | BT |
| Solder Ball Composition | Regular: 63Sn:37Pb (Typ.)<br>Pb-free: Sn:3Ag:0.5Cu (Typ.) |
| JEDEC Outline Reference | MS-034 Variation: AAV-1 |
| Lead Coplanarity | 0.010 inches (0.25 mm) |
| Weight | 22.5 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 3.50 *(1)* |
| A1 | 0.30 | – | – |
| A2 | 0.25 | – | 3.00 *(2)* |
| A3 | – | – | 2.50 |
| D | 42.50 BSC | | |
| E | 42.50 BSC | | |
| b | 0.50 | 0.60 | 0.70 |
| e | 1.00 BSC | | |

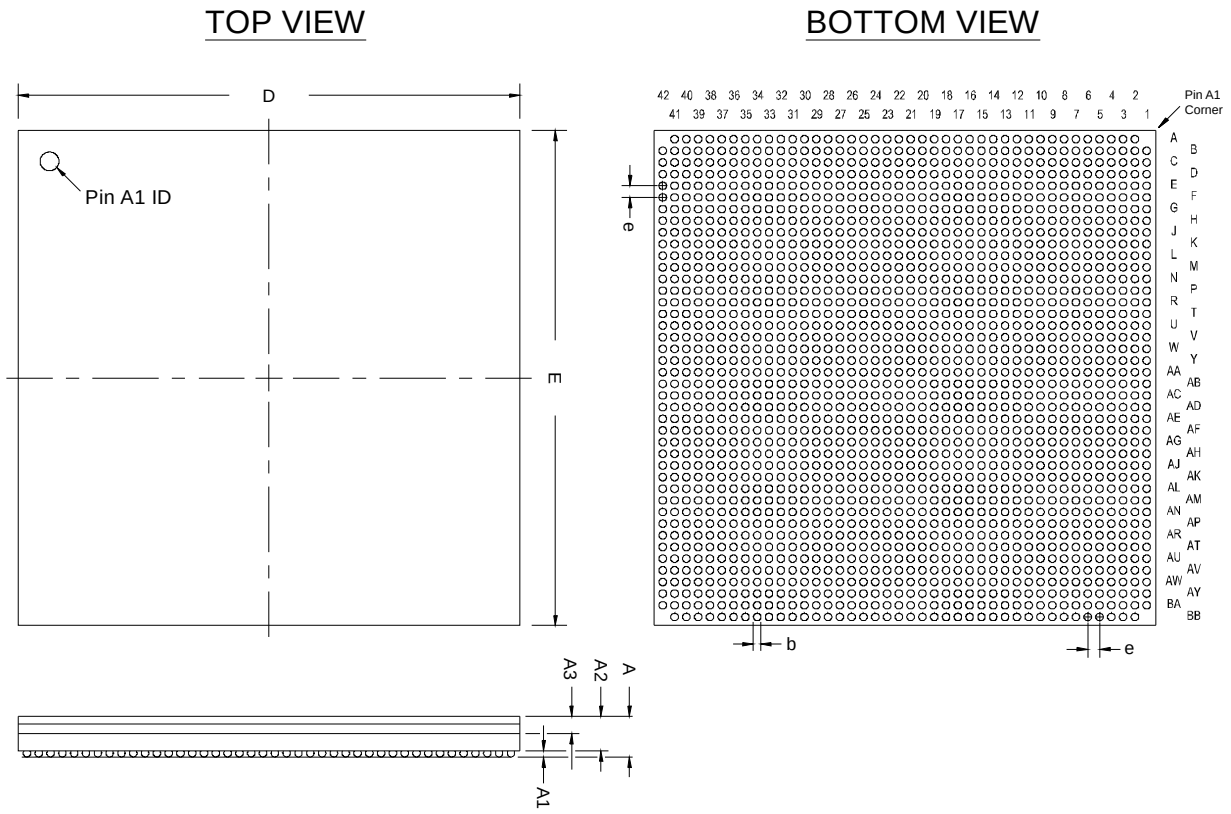
**Notes:**

For Stratix IV GX products:

(1) Overall package thickness (Dimension “A”) is 3.90 mm maximum.

(2) Package body thickness (Dimension “A2”) is 3.30 mm maximum.

## Package Outline



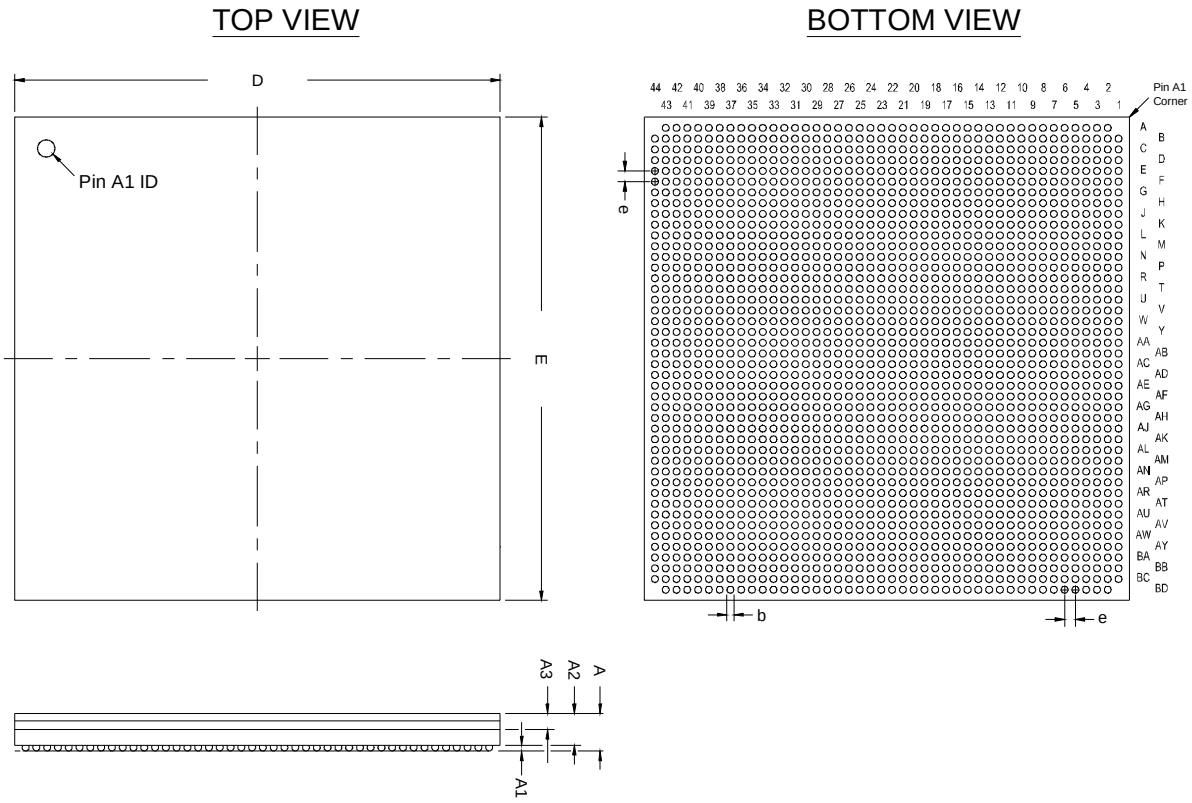
## 1932-Pin FineLine Ball-Grid Array (FBGA) — Flip Chip

- All dimensions and tolerances conform to ASME Y14.5M - 1994.
- Controlling dimension is in millimeters.
- Pin A1 may be indicated by an ID dot, or a special feature, in its proximity on package surface.

| Package Information | |
|---|---|
| **Description** | **Specification** |
| Ordering Code Reference | F |
| Package Acronym | FBGA |
| Substrate Material | BT |
| Solder Ball Composition | Regular: 63Sn:37Pb (Typ.)<br>Pb-free: Sn:3Ag:0.5Cu (Typ.) |
| JEDEC Outline Reference | MS-034 Variation: AAW-1 |
| Lead Coplanarity | 0.010 inches (0.25 mm) |
| Weight | 24.7 g (Typ.) |
| Moisture Sensitivity Level | Printed on moisture barrier bag |

| Package Outline Dimension Table | | | |
|---|---|---|---|
| **Symbol** | **Millimeters** | | |
| | **Min.** | **Nom.** | **Max.** |
| A | – | – | 3.90 |
| A1 | 0.30 | – | – |
| A2 | 0.25 | – | 3.30 |
| A3 | – | – | 2.50 |
| D | 45.00 BSC | | |
| E | 45.00 BSC | | |
| b | 0.50 | 0.60 | 0.70 |
| e | 1.00 BSC | | |

## Package Outline



# Additional Information

This section contains revision history and contact information.

## Revision History

Table 55 shows the revision history for this document.

**Table 55.** Document Revision History *(1)* (Part 1 of 3)

| Date and Document Version | Changes Made | Summary of Changes |
|---|---|---|
| June 2009 | ■ Made three corrections to Stratix III thermal resistance table<br>■ Added Cyclone III LS information<br>■ Added Stratix IV GT thermal resistance values<br>■ Added and/or HardCopy III and IV cross-reference and thermal resistance tables<br>■ Updated HardCopy III and IV part numbers<br>■ Added Cyclone III M164 package information<br>■ Added 484-Pin FBGA Option 4, 672-Pin FBGA Option 4, 1020-Pin FBGA Option 2, 1508-Pin FBGA Option 2, and 1517-Pin Option 2 FBGA Data Sheets<br>■ Revised 1508-Pin FBGA Option 1, 1020-Pin FBGA Option 1, 1517-Pin FBGA Option 1, 572-Pin FBGA, and 1152-Pin FBGA Option 2 Data Sheets<br>■ Added 956-Pin BGA Option 2 Data Sheet | Updated for version 15.7 |
| March 2009 | ■ Corrected “b Nom.” value in 358-Pin UBGA Data Sheet<br>■ Corrected “A Max.” value and replaced package drawing in 780-Pin FBGA - Option 3 Data Sheet<br>■ Corrected “A Max.” value in 256-Pin UBGA Data Sheet<br>■ Modified thermal resistance values for EP3SL200 device in Stratix III thermal resistance table | Updated for version 15.6 |
| March 2009 | ■ Fixed theta symbols in several data sheet Dimension Tables<br>■ Updated dimensions in 256-Pin UBGA Data Sheet<br>■ Added 358-Pin UBGA Data Sheet, 572-Pin, 780-Pin Option 3, and 1152-Pin Option 2 FBGA Data Sheets<br>■ Added Arria II GX thermal resistance table<br>■ Added Arria II GX device and package cross-reference table<br>■ Added EP3SL50, EP3SE80, and EP3SL110 devices to Stratix III thermal resistance table<br>■ Added EP4SGX70, EP4SGX180, and EP4SGX290 devices and updated Stratix IV GX thermal resistance table<br>■ Added HardCopy III and HardCopy IV thermal resistance table<br>■ Miscellaneous formatting changes | Updated for version 15.5 |

**Table 55.** Document Revision History *(1)* (Part 2 of 3)

| Date and Document Version | Changes Made | Summary of Changes |
|---|---|---|
| December 2008 | ■ Changed dimension "A" Max. value in 1932-Pin FBGA Data Sheet | Updated for version 15.4 |
| November 2008 | ■ Moved Revision History to the end and added "How to Contact Altera" section<br>■ Added subheadings in Thermal Resistance section<br>■ Converted to 8-1/2 x 11 page size<br>■ Changed "Maximum Lead Coplanarity" to "Lead Coplanarity" and added "(Typ.)" to weights for all packages<br>■ Added EP2C15 information to Cyclone II tables | Updated for version 15.3 |
| September 2008 | ■ Added thermal resistance values for Stratix IV<br>■ Added new 1152-Pin HBGA Option 2 (42.5 MM SQ.) Data Sheet<br>■ Added new 1517-Pin HBGA (42.5 MM SQ.) Data Sheet<br>■ Added theta-JB thermal resistance values for Stratix II<br>■ Added HardCopy II thermal resistance values<br>■ Revised weights for 256-Pin BGA Option 2, 652-Pin BGA Option 2, 652-Pin BGA Option 3, 208-Pin RQFP, 240-Pin RQFP, and 304-Pin RQFP Data Sheets<br>■ Added notes to 1152-Pin FBGA, 1517-Pin FBGA, 1760-Pin FBGA; changed dimension "A" thickness and "A2" thickness in 1932-Pin FBGA Data Sheet | Updated for version 15.2 |
| May 2008 | ■ Added 1932-Pin FBGA Data Sheet<br>■ Added Device and Package Cross Reference table for Stratix IV | Updated for version 15.1 |
| April 2008 | ■ Revised Maximum Lead Coplanarity values for 1517-Pin FBGA and 1760-Pin FBGA Data Sheets<br>■ Added three entries to Table 3<br>■ Corrected minor typos in Table 4 and Table 10<br>■ Corrected HC210W package in Table 12<br>■ Many tables updated for formatting consistency | Updated for version 15.0 |
| February 2008 | ■ Added 164-Pin MBGA information in Table 8<br>■ Added HardCopy II device information in Table 12<br>■ Updated Stratix III thermal resistance values in Table 22<br>■ Added 164-Pin MBGA Data Sheet<br>■ Corrected 8-Pin SOIC Data Sheet (changed "B" to "b" in Package Outline Dimension Table)<br>■ Corrected 68-Pin MBGA Data Sheet (changed "Inches" to "Millimeters" in Package Outline Dimension Table) | Updated for version 14.9 |

**Table 55.** Document Revision History *(1)* (Part 3 of 3)

| Date and Document Version | Changes Made | Summary of Changes |
|---|---|---|
| October 2007 | ■ Removed note from 100-Pin PQFP Option 1 Data Sheet<br>■ Removed 100-Pin PQFP Option 2 Data Sheet<br>■ Updated 88-Pin UBGA, 144-Pin EQFP, 256-Pin FBGA Option 1, 256-Pin FBGA Option 2, 256-Pin UBGA, 1517-Pin FBGA, and 1760-Pin FBGA Data Sheets<br>■ Added 780-Pin HBGA and 1152-Pin HBGA Data Sheets | Updated for version 14.8 |
| May 2007 v14.7 | ■ Added Arria™ GX information<br>■ Added Cyclone III tables<br>■ Revised D2 and E2 dimensions for 144-Pin EQFP<br>■ Revised 100-Pin MBGA - Wire Bond and 256-Pin MBGA - Wire Bond<br>■ Added 780-Pin FBGA option 2 - Wire Bond, 256-Pin UBGA - Wire Bond, 68-Pin MBGA - Wire Bond, and 144-Pin MBGA - Wire Bond | Changes and additions as described in “Changes Made” section |
| February 2007 v14.6 | ■ Updated 144-Pin Plastic Thin Quad Flat Pack (TQFP) Data Sheet to correct title and ordering code reference<br>■ Added revision history | Revised one data sheet (144-Pin Plastic Thin Quad Flat Pack (TQFP) Data Sheet), added revision history |
| December 2006 v14.5 | ■ Table 2 was added for Stratix III Device and Package Cross-Reference<br>■ Tables 16, 17, and 18 were added for Stratix III Thermal Resistance information<br>■ 1517-Pin FineLine Ball-Grid Array (FBGA) - Flip Chip data sheet was added<br>■ 1760-Pin FineLine Ball-Grid Array (FBGA) - Flip Chip data sheet was added<br>■ "Wire Bond" and "Flip Chip" was added to title of each data sheet, as appropriate<br>■ "BGA" was spelled out as "Ball-Grid Array" in all titles<br>■ Some package outline drawings were reformatted<br>■ Weights were updated for many packages | Added Tables for Stratix III, updated other data sheets |

**Note to Table 49:**

(1) Formal revision history for this document began with version 14.5.

## How to Contact Altera

For the most up-to-date information about Altera® products, see the following table.

| Contact *(Note 1)* | Contact Method | Address |
|---|---|---|
| Technical support | Website | www.altera.com/support |
| Technical training | Website | www.altera.com/training |
| | Email | custrain@altera.com |
| Altera literature services | Email | literature@altera.com |

| Contact *(Note 1)* | Contact Method | Address |
|---|---|---|
| Non-technical support (General) | Email | nacomp@altera.com |
| (Software Licensing) | Email | authorization@altera.com |

**Note:**

(1) You can also contact your local Altera sales office or sales representative.

101 Innovation Drive
San Jose, CA 95134
www.altera.com
Technical Support
www.altera.com/support