# Thermal Management

# Technical Note

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# Acronyms in This Document

A list of acronyms used in this document.

| Acronym | Definition |
|---|---|
| CPLD | Complex Programmable Logic Device |
| FPGA | Field-Programmable Gate Array |
| GAL | Generic Array Logic |
| JEDEC | JEDEC Solid State Technology Association |
| PCB | Printed Circuit Board |

# 1. Introduction

Thermal Management is recommended as part of any sound Complex Programmable Logic Device (CPLD) and Field-Programmable Gate Array (FPGA) design methodology. To properly assess the thermal characteristics of the system, Lattice Semiconductor specifies a maximum allowable junction temperature in all device data sheets. The system designer should always complete a thermal analysis of the design to ensure that the device and package do not exceed the junction temperature requirements.

The data shown in this Thermal Management document is relative and actual values depend on a variety of factors such as: die size, paddle size, airflow, power applied, printed circuit board design, proximity of other devices and user applications. The Package Thermal Resistance section specifies the generic package thermal resistance for legacy Generic Array Logic (GAL), CPLD, FPGA and Expanded Programmable Logic Device (XPLD) devices. The tables in the Device/Package Thermal Resistance section specify the device/package specific thermal resistance for newer FPGA products. These values are based upon JEDEC standards. If specified, the device/package specific thermal value supersedes the generic package thermal data contained in the Package Thermal Resistance section.

In addition to the device and package, the thermal characteristics of a circuit depend on the operating temperature, device power consumption, and the ability of the system to dissipate heat. The maximum junction temperature of a device can be calculated using the equation below that corresponds to the type of thermal management utilized in the design. Equation 1.1 is for a simple system that dissipates heat directly from the device to the ambient air, as shown in Figure 1.1. Equation 1.2 is for a system that has a heat sink located on the top of the device, as shown in Figure 1.2. Finally, Equation 1.3 is used for a system that dissipates the device heat into the PCB, as shown in Figure 1.2.

$$T_J = T_A + Power * \theta_{JA} \quad \text{(Equation 1.1)}$$

or

$$T_J = T_A + Power * (\theta_{JC} + \theta_{CS} + \theta_{SA}) \quad \text{(Equation 1.2)}$$

or

$$T_J = T_A + Power * (\theta_{JB} + \theta_{BA}) \quad \text{(Equation 1.3)}$$

Where:

| | | |
|---|---|---|
| $T_J$ | = | Junction Temperature of the device. |
| $T_A$ | = | Ambient Temperature |
| $\theta_{BA}$ | = | Thermal resistance of PCB to ambient air; property of user board geometry. |
| $\theta_{CS}$ | = | Thermal resistance of thermal interface material between device case and heat sink; typically thermal pad, grease, or glue as shown in Figure 1.2. |
| $\theta_{SA}$ | = | Thermal resistance of heat sink to ambient air (specified in heat sink data sheet). |
| $\theta_{JA}$ | = | Junction-to-Ambient thermal resistance as shown in Figure 1.1 (see the Package Thermal Resistance and Device/Package Thermal Resistance sections. |
| $\theta_{JB}$ | = | Junction-to-Board Thermal Resistance as shown in Figure 1.2 (see the Package Thermal Resistance and Device/Package Thermal Resistance sections). |
| $\theta_{JC}$ | = | Junction-to-Case thermal resistance as shown in Figure 1.2 (see the Package Thermal Resistance and Device/Package Thermal Resistance sections). |
| Power | = | $I_{CC} * V_{CC}$ (Maximum values for maximum power) |

$I_{CC}$ may be estimated as shown in the Power Consumption section of the DC and Switching Characteristics section of each individual device data sheet. The parameters in the $I_{CC}$ equation may be found in the report file from the Lattice Diamond® compiler. For predicting power, the best resource is to use Lattice Diamond design tools. For additional information on power calculations and considerations, refer to the referenced technical note in the For Further Information section of each individual data sheet.

If the calculated $T_J$ exceeds the maximum specified limits, refer to the following section on how to reduce the overall power dissipation and package temperature.

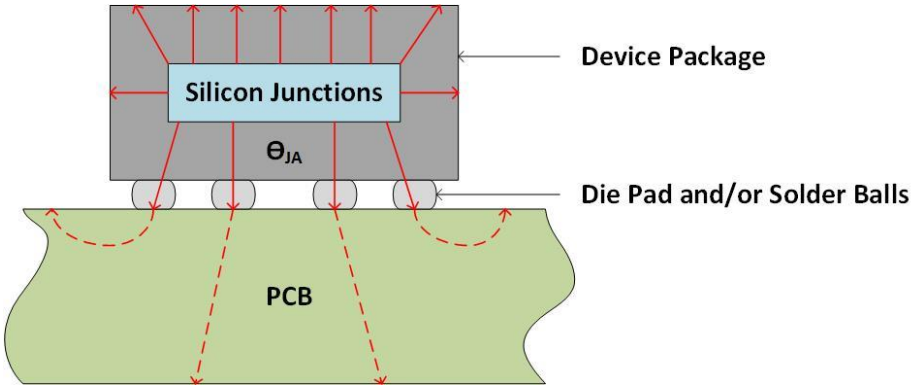


**Figure 1.1. Thermal Resistance Path from Silicon Junctions to Ambient Air**

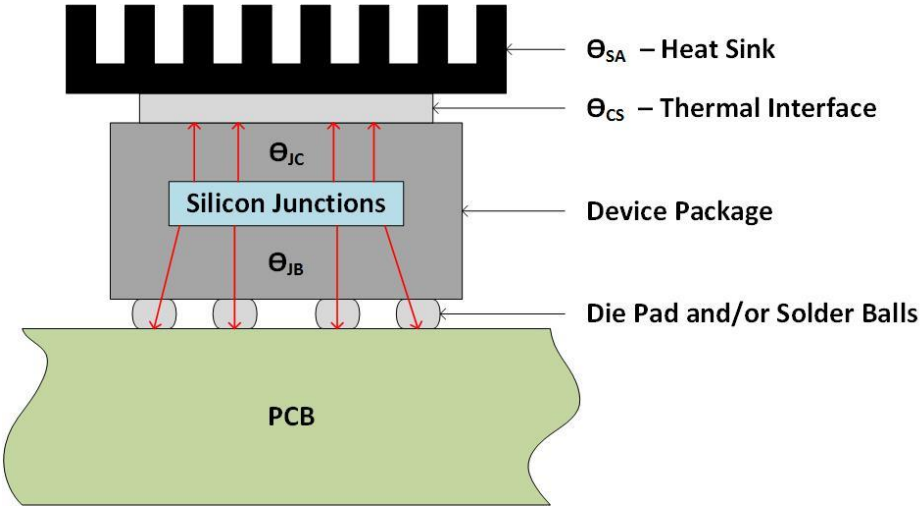


**Figure 1.2. Thermal Resistance Path from Silicon Junctions to Package Top and to PCB**

# 2. Reducing Junction Temperature

The following are the ways to reduce junction temperature:

- Increase airflow in the system to reduce the case or ambient temperature.
- Reduce power in one of the following ways:
  - Reduce overall device utilization by combining common input functions. This is especially true when using wide input CPLD blocks. Even with the narrow FPGA logic blocks, careful partitioning of logic can reduce the overall net utilization.
  - Trade off net utilization with reducing the number of high frequency switching nets. By careful use of different encoding schemes, the high frequency switching nodes can be reduced. For example, using one-hot encoding can reduce the high frequency switching nodes compared to a binary encoding while increasing the logic utilization.
  - Reduce the frequency of operation. High-density architectures provide flexibility to control clock polarity to potentially reduce the overall clock speed.
- Where possible, make use of the output slew rate control to reduce the output switching current of the device.
- Make sure that programmable pull-ups are enabled to drive unused inputs to a proper logic level.
- Select an appropriate heat sink and thermal interface material for the package.

# 3. Package Thermal Resistance

**Table 3.1. Package Thermal Resistance[1]**

| Package | Dimension | Pin Count | $\theta_{JA}$ (0lfm) °C/W | $\theta_{JA}$ (200lfm) °C/W | $\theta_{JC}$ °C/W |
|---|---|---|---|---|---|
| **PDIP** | .300 wide | 20 | 67 | 49 | 30 |
| | .300 wide | 24 | 64 | 35 | 25 |
| | .300 wide | 28 | 56 | 33 | 23 |
| **PLCC** | — | 20 | 64 | 58 | 22 |
| | — | 28 | 56 | 49 | 18 |
| | — | 44 | 35 | 31 | 16 |
| | — | 68 | 34 | 30 | 13 |
| | — | 84 | 33 | 29 | 12 |
| **QFN** | 4 mm x 4 mm | 24 | 42 | 32 | 16 ($\theta_{JB}$) [2] |
| | 5 mm x 5 mm | 32 | 40 | 30 | 15 ($\theta_{JB}$) [2] |
| | 7 mm x 7 mm | 48 | 39 | 29 | 15 ($\theta_{JB}$) [2] |
| | 9 mm x 9 mm | 64 | 38 | 27 | 14 ($\theta_{JB}$ ) [2] |
| **SSOP** | — | 28 | 105 | 80 | 25 |
| **PQFP/MQFP** | 14 mm x 20 mm | 100 | 35 | 34 | 12 |
| | 28 mm x 28 mm | 120 | 32 | 26 | 12 |
| | 28 mm x 28 mm | 128 | 32 | 26 | 11 |
| | 28 mm x 28 mm | 160 | 30 | 24 | 9 |
| | 28 mm x 28 mm | 208 | 25 | 23 | 8 |
| | 32 mm x 32 mm | 240 | 24 | 18 | 5 |
| **TQFP (1.4 mm thick)** | 10 mm x 10 mm | 44 | 42 | 36 | 17 |
| | 7 mm x 7 mm | 48 | 48 | 44 | 19 |
| | 14 mm x 14 mm | 100 | 35 | 29 | 10 |
| | 14 mm x 14 mm | 128 | 35 | 29 | 10 |
| | 20 mm x 20 mm | 144 | 33 | 27 | 9 |
| | 24 mm x 24 mm | 176 | 33 | 27 | 8 |
| **TQFP (1.0 mm thick)** | 7 mm x 7 mm | 48 | 49 | 45 | 19 |
| | 10 mm x 10 mm | 44 | 43 | 37 | 17 |
| **ucBGA** | 4 mm x 4 mm | 64 | 77 | 70 | 20 |
| | 6 mm x 6 mm | 132 | 61 | 53 | 16 |
| **csBGA** | 5 mm x 5 mm | 64 | 90 | 85 | 15 |
| | 6 mm x 6 mm | 56 | 74 | 68 | 15 |
| | 7 mm x 7 mm | 144 | 72 | 66 | 13 |
| | 8 mm x 8 mm | 100 | 70 | 65 | 13 |
| | 8 mm x 8 mm | 132 | 49 | 40 | 13 |
| **caBGA** | 7 mm x 7 mm | 49 | 74 | 68 | 15 |
| | 10 mm x 10 mm | 100 | 48 | 39 | 12 |
| | 14 mm x 14 mm | 256 | 40 | 35 | 10 |

| Package | Dimension | Pin Count | $\theta_{JA}$ (0lfm) °C/W | $\theta_{JA}$ (200lfm) °C/W | $\theta_{JC}$ °C/W |
|---|---|---|---|---|---|
| **fpBGA** | 11 mm x 11 mm | 100 | 40 | 32 | 11 |
| | 13 mm x 13 mm | 144 | 29 | 25 | 11 |
| | 17 mm x 17 mm | 208 | 24 | 20 | 10 |
| | 17 mm x 17 mm | 256 | 20 | 16 | 10 |
| | 23 mm x 23 mm | 388 | 18 | 15 | 6 |
| | 23 mm x 23 mm | 484 | 18 | 15 | 6 |
| | 27 mm x 27 mm | 416 | 17 | 14 | 5 |
| | 27 mm x 27 mm | 672 | 16 | 13 | 5 |
| | 31 mm x 31 mm | 516 | 14 | 12 | 4 |
| | 31 mm x 31 mm | 676 | 14 | 12 | 4 |
| | 31 mm x 31 mm | 900 | 14 | 12 | 4 |
| | 35 mm x 35 mm | 680 | 14 | 12 | 3 |
| | 35 mm x 35 mm | 1156 | 13 | 11 | 3 |
| **PBGA** | 27 mm x 27 mm | 272 | 20 | 17 | 6 |
| | 35 mm x 35 mm | 388 | 16 | 13 | 3 |
| | 35 mm x 35 mm | 492 | 16 | 13 | 3 |
| **fpSBGA** | 40 mm x 40 mm | 680 | 11 | 10 | 0.65 |
| | 45 mm x 45 mm | 1036 | 10 | 9 | 0.65 |
| **SBGA** | 27 mm x 27 mm | 256 | 15 | 12 | 0.65 |
| | 31 mm x 31 mm | 320[3] | 13 | 10 | 0.65 |
| | 35 mm x 35 mm | 352 | 12 | 9 | 0.65 |
| | 40 mm x 40 mm | 432[3] | 11 | 8 | 0.65 |
| | 45 mm x 45 mm | 600 | 10 | 7 | 0.65 |
| **ftBGA** | 17 mm x 17 mm | 256 | 37 | 33 | 6 |
| | 19 mm x 19 mm | 324 | 37 | 31 | 6 |
| **CERDIP** | — | 20 | 62 | 52 | 10 |
| | — | 24 | 60 | 48 | 10 |
| **LCC** | — | 20 | 65 | 60 | 8 |
| | — | 28 | 62 | 49 | 7 |
| **JLCC** | — | 44 | 69 | 38 | 4 |
| | — | 68 | 52 | 30 | 3 |
| **CPGA** | — | 84 | 38 | 21 | 3 |
| | — | 133 | 26 | 21 | 2 |

**Notes:**

1. The data shown in this Thermal Management document is relative and actual values depend on a variety of factors such as: die size, paddle size, airflow, power applied, printed circuit board design, proximity of other devices and user applications. This table specifies the generic package thermal resistance for legacy GAL, CPLD, FPGA and XPLD devices. These values are based upon JEDEC standards. If specified in the Device/Package Thermal Resistance section, the device/package specific thermal value supercedes the generic package thermal data contained in the tables.
2. $\theta_{JB}$ ($\theta_{JB}$ = Junction-to-Board Thermal Resistance). $\theta_{JB}$ value shown is only applicable when the package thermal pad and/or solder balls are soldered directly onto user PCB (see Figure 1.2).
3. The 320-ball BGA and 432-ball BGA packages junction temperature must not exceed 140 °C.

# 4. Device/Package Thermal Resistance

## 4.1. CrossLink™

**Table 4.1. CrossLink Device/Package Thermal Resistance**

| Device | Package | Dimensions (mm) | Pin Count | $\theta_{JA}$ (0 lfm) °C/W | $\theta_{JA}$ (200 lfm) °C/W | $\theta_{JA}$ (500 lfm) °C/W | $\theta_{JB}$ °C/W | $\theta_{JC}$ °C/W |
|---|---|---|---|---|---|---|---|---|
| LIF-MD6000 | WLCSP | 2.46 mm x 2.46 mm | 36 | 56.2 | 51.8 | 49.2 | 38.7 | 2.2 |
| LIF-MD6000 | ucfBGA | 3.5 mm x 3.5 mm | 64 | 53.2 | 47.4 | 44.6 | 40.9 | 23.0 |
| LIF-MD6000 | ctfBGA | 6.5 mm x 6.5 mm | 80 | 47.5 | 42.4 | 39.7 | 26.6 | 16.8 |
| LIF-MD6000 | csfBGA | 4.5 mm x 4.5 mm | 81 | 49.3 | 43.4 | 40.7 | 30.3 | 18.9 |
| LIA-MD6000 | ctfBGA | 6.5 mm x 6.5 mm | 80 | 47.5 | 42.4 | 39.7 | 26.6 | 16.8 |

## 4.2. CrossLinkPlus™

**Table 4.2. CrossLinkPlus Device/Package Thermal Resistance**

| Device | Package | Dimensions (mm) | Pin Count | $\theta_{JA}$ (0 lfm) °C/W | $\theta_{JA}$ (200 lfm) °C/W | $\theta_{JA}$ (500 lfm) °C/W | $\theta_{JB}$ °C/W | $\theta_{JC}$ °C/W |
|---|---|---|---|---|---|---|---|---|
| LIF-MDF6000 | ucfBGA | 3.5 mm x 3.5 mm | 64 | 54.6 | 48.5 | 45.6 | 38.4 | 16.8 |

## 4.3. CrossLink™-NX

**Table 4.3. CrossLink-NX Device/Package Thermal Resistance**

| Device | Package | Dimensions (mm) | Pin Count | $\theta_{JA}$ (0 lfm) °C/W | $\theta_{JA}$ (200 lfm) °C/W | $\theta_{JA}$ (500 lfm) °C/W | $\theta_{JB}$ °C/W | $\theta_{JC}$ °C/W |
|---|---|---|---|---|---|---|---|---|
| LIFCL-40 | CABGA | 17 mm x 17 mm | 400 | 27.5 | 26.9 | 25.9 | 18.4 | 8.9 |
| LIFCL-40 | CSBGA | 9.5 mm x 9.5 mm | 289 | 34.1 | 29.7 | 28.7 | 28.3 | 9.5 |
| LIFCL-40 | CABGA | 14 mm x 14 mm | 256 | 30.4 | 25.6 | 23.6 | 6.9 | 8.1 |
| LIFCL-40 | CSFBGA | 6 mm x 6 mm | 121 | 33.2 | 28.5 | 26.1 | 18.4 | 4.7 |
| LIFCL-40 | QFN | 10 mm x 10 mm | 72 | 26.3 | 19.5 | 17.8 | 8.9 | 8.5 |

## 4.4. Certus™-NX

**Table 4.4. Certus-NX Device/Package Thermal Resistance**

| Device | Package | Dimensions (mm) | Pin Count | $\theta_{JA}$ (0 lfm) °C/W | $\theta_{JA}$ (200 lfm) °C/W | $\theta_{JA}$ (500 lfm) °C/W | $\theta_{JB}$ °C/W | $\theta_{JC}$ °C/W |
|---|---|---|---|---|---|---|---|---|
| LFD2NX-40 | CABGA | 14 mm x 14 mm | 256 | 30.4 | 25.6 | 23.6 | 6.9 | 8.1 |
| LFD2NX-40 | CABGA | 12 mm x 12 mm | 196 | 33.3 | 28.3 | 25.8 | 9.7 | 11.7 |
| LFD2NX-40 | CSFBGA | 6 mm x 6 mm | 121 | 33.2 | 28.5 | 26.1 | 18.4 | 4.7 |
| LFD2NX-17 | CSFBGA | 6 mm x 6 mm | 121 | 35.4 | 30.6 | 28.2 | 20.5 | 6.1 |

## 4.5. LatticeECP™/LatticeEC™

**Table 4.5. LatticeECP/LatticeEC Device/Package Thermal Resistance**

| Device | Package | Dimensions | Pin Count | $\theta_{JA}$ (0 lfm) °C/W | $\theta_{JA}$ (200 lfm) °C/W | $\theta_{JA}$ (500 lfm) °C/W | $\theta_{JB}$ °C/W | $\theta_{JC}$ °C/W |
|---|---|---|---|---|---|---|---|---|
| LFEC1 | TQFP | 14 mm x 14 mm | 100 | 36.9 | 33.0 | 30.4 | 23.6 | 12.4 |
| LFEC1 | TQFP | 20 mm x 20 mm | 144 | 28.8 | 26.1 | 24.0 | 19.1 | 9.4 |
| LFEC1 | PQFP | 28 mm x 28 mm | 208 | 40.2 | 37.0 | 34.2 | 30.5 | 18.5 |
| LFEC3 | TQFP | 14 mm x 14 mm | 100 | 36.9 | 33.0 | 30.4 | 23.6 | 12.4 |
| LFEC3 | TQFP | 20 mm x 20 mm | 144 | 28.8 | 26.1 | 24.0 | 19.1 | 9.4 |
| LFEC3 | PQFP | 28 mm x 28 mm | 208 | 30.2 | 27.8 | 25.7 | 22.9 | 13.9 |
| LFEC3 | FPBGA | 17 mm x 17 mm | 256 | 28.4 | 24.3 | 21.8 | 16.4 | 5.2 |
| LFECP/EC6 | TQFP | 20 mm x 20 mm | 144 | 27.8 | 25.0 | 23.1 | 17.8 | 7.2 |
| LFECP/EC6 | PQFP | 28 mm x 28 mm | 208 | 30.2 | 27.8 | 25.7 | 22.9 | 13.9 |
| LFECP/EC6 | FPBGA | 17 mm x 17 mm | 256 | 25.9 | 22.0 | 19.5 | 14.2 | 4.0 |
| LFECP/EC6 | FPBGA | 23 mm x 23 mm | 484 | 19.6 | 16.9 | 15.3 | 11.3 | 6.5 |
| LFECP/EC10 | PQFP | 28 mm x 28 mm | 208 | 30.2 | 27.8 | 25.7 | 22.9 | 13.9 |
| LFECP/EC10 | FPBGA | 17 mm x 17 mm | 256 | 24.0 | 20.1 | 17.7 | 12.4 | 3.1 |
| LFECP/EC10 | FPBGA | 23 mm x 23 mm | 484 | 18.0 | 15.4 | 13.7 | 9.3 | 5.0 |
| LFECP/EC15 | FPBGA | 17 mm x 17 mm | 256 | 22.7 | 18.9 | 16.5 | 11.3 | 2.6 |
| LFECP/EC15 | FPBGA | 23 mm x 23 mm | 484 | 17.1 | 14.6 | 12.8 | 8.4 | 4.2 |
| LFECP/EC20 | FPBGA | 23 mm x 23 mm | 484 | 16.6 | 14.0 | 12.2 | 7.8 | 3.8 |
| LFECP/EC20 | FPBGA | 27 mm x 27 mm | 672 | 15.2 | 12.8 | 11.0 | 7.0 | 3.2 |
| LFECP/EC33 | FPBGA | 23 mm x 23 mm | 484 | 15.8 | 13.1 | 11.3 | 7.1 | 3.1 |
| LFECP/EC33 | FPBGA | 27 mm x 27 mm | 672 | 14.0 | 11.8 | 10.1 | 6.9 | 2.6 |

## 4.6. LatticeECP2™

**Table 4.6. LatticeECP2 Device/Package Thermal Resistance**

| Device | Package | Dimensions | Pin Count | $\theta_{JA}$ (0 lfm) °C/W | $\theta_{JA}$ (200 lfm) °C/W | $\theta_{JA}$ (500 lfm) °C/W | $\theta_{JB}$ °C/W | $\theta_{JC}$ °C/W |
|---|---|---|---|---|---|---|---|---|
| LFE2-6E | TQFP | 20 mm x 20 mm | 144 | 28.8 | 26.1 | 24.0 | 19.1 | 9.4 |
| LFE2-6E | FPBGA | 17 mm x 17 mm | 256 | 29.1 | 25.0 | 22.5 | 17.1 | 5.7 |
| LFE2-12E | TQFP | 20 mm x 20 mm | 144 | 28.8 | 26.1 | 24.0 | 19.1 | 9.4 |
| LFE2-12E | PQFP | 28 mm x 28 mm | 208 | 30.2 | 27.8 | 25.7 | 22.9 | 13.9 |
| LFE2-12E | FPBGA | 17 mm x 17 mm | 256 | 26.7 | 22.7 | 20.2 | 14.9 | 4.3 |
| LFE2-12E | FPBGA | 23 mm x 23 mm | 484 | 20.0 | 17.4 | 15.8 | 11.7 | 7.0 |
| LFE2-20E | PQFP | 28 mm x 28 mm | 208 | 30.2 | 27.8 | 25.7 | 22.9 | 13.9 |
| LFE2-20E | FPBGA | 17 mm x 17 mm | 256 | 24.9 | 21.0 | 18.5 | 13.2 | 3.5 |
| LFE2-20E | FPBGA | 23 mm x 23 mm | 484 | 18.7 | 16.1 | 14.4 | 10.1 | 5.6 |
| LFE2-20E | FPBGA | 27 mm x 27 mm | 672 | 17.4 | 15.1 | 13.0 | 10.2 | 4.8 |
| LFE2-35E | FPBGA | 23 mm x 23 mm | 484 | 17.7 | 15.2 | 13.4 | 9.0 | 4.7 |
| LFE2-35E | FPBGA | 27 mm x 27 mm | 672 | 16.4 | 14.0 | 12.1 | 8.5 | 4.0 |
| LFE2-50E | FPBGA | 23 mm x 23 mm | 484 | 16.7 | 14.2 | 12.3 | 7.9 | 3.9 |
| LFE2-50E | FPBGA | 27 mm x 27 mm | 672 | 15.3 | 13.0 | 11.2 | 7.2 | 3.3 |
| LFE2-70E | FPBGA | 27 mm x 27 mm | 672 | 14.3 | 12.0 | 10.3 | 6.0 | 2.7 |
| LFE2-70E | FPBGA | 31 mm x 31 mm | 900 | 12.6 | 10.5 | 9.2 | 6.3 | 2.0 |

## 4.7. LatticeECP2M™

**Table 4.7. LatticeECP2M Device/Package Thermal Resistance**

| Device | Package | Dimensions | Pin Count | $\theta_{JA}$ (0 lfm) °C/W | $\theta_{JA}$ (200 lfm) °C/W | $\theta_{JA}$ (500 lfm) °C/W | $\theta_{JB}$ °C/W | $\theta_{JC}$ °C/W |
|---|---|---|---|---|---|---|---|---|
| LFE2M20E | FPBGA | 17 mm x 17 mm | 256 | 24.2 | 20.2 | 17.8 | 12.6 | 3.2 |
| LFE2M20E | FPBGA | 23 mm x 23 mm | 484 | 18.1 | 15.6 | 13.8 | 9.5 | 5.1 |
| LFE2M35E | FPBGA | 17 mm x 17 mm | 256 | 22.4 | 18.5 | 16.2 | 11.0 | 2.5 |
| LFE2M35E | FPBGA | 23 mm x 23 mm | 484 | 16.8 | 14.3 | 12.5 | 8.1 | 4.0 |
| LFE2M35E | FPBGA | 27 mm x 27 mm | 672 | 15.5 | 13.0 | 11.1 | 5.9 | 3.1 |
| LFE2M50E | FPBGA | 23 mm x 23 mm | 484 | 15.6 | 13.1 | 11.3 | 6.9 | 3.1 |
| LFE2M50E | FPBGA | 27 mm x 27 mm | 672 | 14.2 | 11.9 | 10.2 | 5.9 | 2.6 |
| LFE2M50E | FPBGA | 31 mm x 31 mm | 900 | 12.5 | 10.4 | 9.1 | 6.1 | 1.9 |
| LFE2M70E | FPBGA | 31 mm x 31 mm | 900 | 11.7 | 9.5 | 8.1 | 5.3 | 1.5 |
| LFE2M70E | FPBGA | 35 mm x 35 mm | 1152 | 13.7 | 12.0 | 11.0 | 6.5 | 2.0 |
| LFE2M100E | FPBGA | 31 mm x 31 mm | 900 | 10.8 | 8.6 | 7.1 | 4.5 | 1.2 |
| LFE2M100E | FPBGA | 35 mm x 35 mm | 1152 | 13.2 | 11.2 | 9.8 | 5.7 | 1.5 |

## 4.8. LatticeECP3™

**Table 4.8. LatticeECP3 Device/Package Thermal Resistance**

| Device | Package | Dimensions | Pin Count | $\theta_{JA}$ (0 lfm) °C/W | $\theta_{JA}$ (200 lfm) °C/W | $\theta_{JA}$ (500 lfm) °C/W | $\theta_{JB}$ °C/W | $\theta_{JC}$ °C/W |
|---|---|---|---|---|---|---|---|---|
| LFE3-17 | FTBGA | 17 mm x 17 mm | 256 | 24.5 | 20.6 | 18.2 | 12.9 | 3.3 |
| LFE3-17 | CSBGA | 10 mm x 10 mm | 328 | 30.8 | 27.8 | 25.5 | 12.5 | 6.1 |
| LFE3-17 | FPBGA | 23 mm x 23 mm | 484 | 18.4 | 15.8 | 14.1 | 9.8 | 5.4 |
| LFE3-35 | FTBGA | 17 mm x 17 mm | 256 | 24.5 | 20.6 | 18.2 | 12.9 | 3.3 |
| LFE3-35 | FPBGA | 23 mm x 23 mm | 484 | 18.4 | 15.8 | 14.1 | 9.8 | 5.4 |
| LFE3-35 | FPBGA | 27 mm x 27 mm | 672 | 17.1 | 14.7 | 12.7 | 9.5 | 4.5 |
| LFE3-70 | FPBGA | 23 mm x 23 mm | 484 | 15.7 | 13.2 | 11.4 | 7 | 3.2 |
| LFE3-70 | FPBGA | 27 mm x 27 mm | 672 | 14.3 | 12 | 10.3 | 6 | 2.7 |
| LFE3-70 | FPBGA | 35 mm x 35 mm | 1156 | 12.9 | 11.5 | 10.6 | 7.3 | 2.3 |
| LFE3-95 | FPBGA | 23 mm x 23 mm | 484 | 15.7 | 13.2 | 11.4 | 7 | 3.2 |
| LFE3-95 | FPBGA | 27 mm x 27 mm | 672 | 14.3 | 12 | 10.3 | 6 | 2.7 |
| LFE3-95 | FPBGA | 35 mm x 35 mm | 1156 | 12.9 | 11.5 | 10.6 | 7.3 | 2.3 |
| LFE3-150 | FPBGA | 27 mm x 27 mm | 672 | 13.2 | 10.9 | 9.3 | 4.8 | 2.1 |
| LFE3-150 | FPBGA | 35 mm x 35 mm | 1156 | 12.2 | 10.5 | 9.2 | 6 | 1.6 |

## 4.9. LatticeSC™ /LatticeSCM™

**Table 4.9. LatticeSC /LatticeSCM Device/Package Thermal Resistance**

| Device | Package | Dimensions | Pin Count | $\theta_{JA}$ (0 lfm) °C/W | $\theta_{JA}$ (200 lfm) °C/W | $\theta_{JA}$ (500 lfm) °C/W | $\theta_{JB}$ °C/W | $\theta_{JC}$ °C/W |
|---|---|---|---|---|---|---|---|---|
| LFSC/SCM15 | FPBGA | 17 mm x 17 mm | 256 | 21.1 | 17.4 | 15.1 | 10.0 | 2.1 |
| LFSC/SCM15 | FPBGA | 31 mm x 31 mm | 900 | 12.9 | 10.8 | 9.6 | 6.6 | 2.1 |
| LFSC/SCM25 | FPBGA | 31 mm x 31 mm | 900 | 11.5 | 9.3 | 7.9 | 5.1 | 1.5 |
| LFSC/SCM25 | FFBGA | 33 mm x 33 mm | 1020 | 10.1 | 8.1 | 6.7 | 5.1 | 1.1 |
| LFSC/SCM40 | FFBGA | 33 mm x 33 mm | 1020 | 10.1 | 8.1 | 6.7 | 3.7 | 0.4 |
| LFSC/SCM40 | FCBGA | 35 mm x 35 mm | 1152 | 9.5 | 6.8 | 5.1 | 2.7 | 0.6 |
| LFSC/SCM80 | FCBGA | 35 mm x 35 mm | 1152 | 7.9 | 5.7 | 4.2 | 2.2 | 0.5 |
| LFSC/SCM80 | FCBGA | 42.5 mm x 42.5 mm | 1704 | 7.7 | 5.5 | 4.0 | 3.0 | 0.5 |
| LFSC/SCM115 | FCBGA | 35 mm x 35 mm | 1152 | 7.9 | 5.7 | 4.2 | 2.2 | 0.5 |
| LFSC/SCM115 | FCBGA | 42.5 mm x 42.5 mm | 1704 | 7.7 | 5.5 | 4.0 | 3.0 | 0.5 |

## 4.10. ECP5™

**Table 4.10. ECP5 Device/Package Thermal Resistance**

| Device | Package | Dimensions | Pin Count | $\theta_{JA}$ (0 lfm) °C/W | $\theta_{JA}$ (200 lfm) °C/W | $\theta_{JA}$ (500 lfm) °C/W | $\theta_{JB}$ °C/W | $\theta_{JC}$ °C/W |
|---|---|---|---|---|---|---|---|---|
| LFE5U-12F | CSFBGA | 10 mm x 10 mm | 285 | 33.1 | 26.8 | 24.3 | 20.7 | 12.5 |
| LFE5U-12F | CABGA | 17 mm x 17 mm | 381 | 21.5 | 15.8 | 13.9 | 11.7 | 6.8 |
| LAE5U-12F | CABGA | 17 mm x 17 mm | 381 | 21.5 | 15.8 | 13.9 | 11.7 | 6.8 |
| LFE5U-25F | CSFBGA | 10 mm x 10 mm | 285 | 33.1 | 26.8 | 24.3 | 20.7 | 12.5 |
| LFE5U-25F | CABGA | 14 mm x 14 mm | 256 | 35.1 | 31.1 | 29.2 | 24.0 | 13.8 |
| LFE5U-25F | CABGA | 17 mm x 17 mm | 381 | 21.5 | 15.8 | 13.9 | 11.7 | 6.8 |
| LFE5UM-25F | CSFBGA | 10 mm x 10 mm | 285 | 33.1 | 26.8 | 24.3 | 20.7 | 12.5 |
| LFE5UM-25F | CABGA | 17 mm x 17 mm | 381 | 21.5 | 15.8 | 13.9 | 11.7 | 6.8 |
| LAE5UM-25F | CABGA | 17 mm x 17 mm | 381 | 21.5 | 15.8 | 13.9 | 11.7 | 6.8 |
| LFE5UM-45F | CSFBGA | 10 mm x 10 mm | 285 | 29.6 | 23.2 | 20.8 | 17.2 | 9.6 |
| LFE5UM-45F | CABGA | 17 mm x 17 mm | 381 | 20.5 | 14.6 | 12.8 | 10.6 | 5.7 |
| LAE5UM-45F | CABGA | 17 mm x 17 mm | 381 | 20.5 | 14.6 | 12.8 | 10.6 | 5.7 |
| LFE5UM-45F | CABGA | 23 mm x 23 mm | 554 | 20.3 | 15.1 | 13.4 | 9.3 | 2.9 |
| LFE5U-45F | CSFBGA | 10 mm x 10 mm | 285 | 29.6 | 23.2 | 20.8 | 17.2 | 9.6 |
| LFE5U-45F | CABGA | 14 mm x 14 mm | 256 | 30.7 | 24.6 | 22.9 | 17.9 | 9.1 |
| LFE5U-45F | CABGA | 17 mm x 17 mm | 381 | 20.5 | 14.6 | 12.8 | 10.6 | 5.7 |
| LFE5U-45F | CABGA | 23 mm x 23 mm | 554 | 20.3 | 15.1 | 13.4 | 9.3 | 2.9 |
| LFE5U-85F | CSFBGA | 10 mm x 10 mm | 285 | 26.2 | 21.9 | 19.8 | 12.5 | 6.7 |
| LFE5U-85F | CABGA | 17 mm x 17 mm | 381 | 19.0 | 13.5 | 11.7 | 9.4 | 4.1 |
| LFE5U-85F | CABGA | 23 mm x 23 mm | 554 | 18.6 | 13.3 | 11.6 | 8.3 | 3.8 |
| LFE5U-85F | CABGA | 27 mm x 27 mm | 756 | 17.1 | 11.8 | 10.2 | 8.1 | 2.1 |
| LFE5UM-85F | CSFBGA | 10 mm x 10 mm | 285 | 26.2 | 21.9 | 19.8 | 12.5 | 6.7 |
| LFE5UM-85F | CABGA | 17 mm x 17 mm | 381 | 19.0 | 13.5 | 11.7 | 9.4 | 4.1 |
| LFE5UM-85F | CABGA | 23 mm x 23 mm | 554 | 18.6 | 13.3 | 11.6 | 8.3 | 3.8 |
| LFE5UM-85F | CABGA | 27 mm x 27 mm | 756 | 17.1 | 11.8 | 10.2 | 8.1 | 2.1 |

## 4.11. ECP5-5G™

**Table 4.11. ECP5-5G Device/Package Thermal Resistance**

| Device | Package | Dimensions | Pin Count | $\theta_{JA}$ (0 lfm) °C/W | $\theta_{JA}$ (200 lfm) °C/W | $\theta_{JA}$ (500 lfm) °C/W | $\theta_{JB}$ °C/W | $\theta_{JC}$ °C/W |
|---|---|---|---|---|---|---|---|---|
| LFE5UM5G-25F | CSFBGA | 10 mm x 10 mm | 285 | 33.1 | 26.8 | 24.3 | 20.7 | 12.5 |
| LFE5UM5G-25F | CABGA | 17 mm x 17 mm | 381 | 21.5 | 15.8 | 13.9 | 11.7 | 6.8 |
| LFE5UM5G-45F | CSFBGA | 10 mm x 10 mm | 285 | 29.6 | 23.2 | 20.8 | 17.2 | 9.6 |
| LFE5UM5G-45F | CABGA | 17 mm x 17 mm | 381 | 20.5 | 14.6 | 12.8 | 10.6 | 5.7 |
| LFE5UM5G-45F | CABGA | 23 mm x 23 mm | 554 | 20.3 | 15.1 | 13.4 | 9.3 | 2.9 |
| LFE5UM5G-85F | CSFBGA | 10 mm x 10 mm | 285 | 26.2 | 21.9 | 19.8 | 12.5 | 6.7 |
| LFE5UM5G-85F | CABGA | 17 mm x 17 mm | 381 | 19.0 | 13.5 | 11.7 | 9.4 | 4.1 |
| LFE5UM5G-85F | CABGA | 23 mm x 23 mm | 554 | 18.6 | 13.3 | 11.6 | 8.3 | 3.8 |
| LFE5UM5G-85F | CABGA | 27 mm x 27 mm | 756 | 17.1 | 11.8 | 10.2 | 8.1 | 2.1 |

## 4.12. iCE40™ LP/HX/LM

**Table 4.12. iCE40 LP/HX/LM Device/Package Thermal Resistance**

| Device | Package | Dimensions | Pin Count | $\theta_{JA}$ (0 lfm) °C/W | $\theta_{JA}$ (200 lfm) °C/W | $\theta_{JA}$ (500 lfm) °C/W | $\theta_{JB}$ °C/W | $\theta_{JC}$ °C/W |
|---|---|---|---|---|---|---|---|---|
| iCE40-LP384 | QFN | 5 mm x 5 mm | 32 | 67.75 | 64.2 | 62.3 | 29.9 | 18.2 |
| iCE40-LP384 | UCBGA | 2.5 mm x 2.5 mm | 36 | 138.1 | 128.1 | 123.2 | 57.2 | 35.7 |
| iCE40-LP384 | UCBGA | 3 mm x 3 mm | 49 | 121.0 | 110.9 | 106.4 | 53.7 | 33.5 |
| iCE40-LP640 | WLCSP | 1.40 mm x 1.48 mm | 16 | 72.3 | 66.9 | 64.8 | 30.0 | 3.0 |
| iCE40-LP1K | UCBGA | 2.5 mm x 2.5 mm | 36 | 119.3 | 109.7 | 105.2 | 51.9 | 32.5 |
| iCE40-LP1K | UCBGA | 3 mm x 3 mm | 49 | 108.5 | 100.3 | 96.5 | 44.0 | 27.5 |
| iCE40-LP1K | UCBGA | 4 mm x 4 mm | 81 | 83.9 | 72.6 | 69.9 | 33.6 | 24.6 |
| iCE40-LP1K | CSBGA | 5 mm x 5 mm | 81 | 72.7 | 60.1 | 56.3 | 32.5 | 20.3 |
| iCE40-LP1K | QFN | 7 mm x 7 mm | 84 | 46.7 | 43.9 | 42.4 | 15.6 | 14.3 |
| iCE40-LP1K | UCBGA | 5 mm x 5 mm | 121 | 79.6 | 74.3 | 71.9 | 45.2 | 22.0 |
| iCE40-LP1K | CSBGA | 6 mm x 6 mm | 121 | 70.6 | 64.7 | 60.7 | 61.6 | 18.0 |
| iCE40-LP1K | WLCSP | 1.48 mm x 1.40 mm | 16 | 72.3 | 66.9 | 64.8 | 30.0 | 3.0 |
| iCE40-LM1K | WLCSP | 1.71 mm x 1.71 mm | 25 | 57.8 | 52.6 | 50.9 | 29.0 | 4.4 |
| iCE40-LM1K | UCBGA | 2.5 mm x 2.5 mm | 36 | 116.5 | 110.5 | 105.9 | 41.1 | 39.0 |
| iCE40-LM1K | UCBGA | 3 mm x 3 mm | 49 | 104.5 | 98.9 | 94.7 | 33.9 | 27.2 |
| iCE40-HX1K | TQFP | 14 mm x 14 mm | 100 | 44.2 | 40.4 | 37.8 | 26.7 | 14.2 |
| iCE40-HX1K | CSBGA | 8 mm x 8 mm | 132 | 67.7 | 61.2 | 59.2 | 55.5 | 27.3 |
| iCE40-HX1K | TQFP | 20 mm x 20 mm | 144 | 38.5 | 35.4 | 33.3 | 19.8 | 10.0 |
| iCE40-LM2K | WLCSP | 1.71 mm x 1.71 mm | 25 | 57.8 | 52.6 | 50.9 | 29.0 | 4.4 |
| iCE40-LM2K | UCBGA | 2.5 mm x 2.5 mm | 36 | 116.5 | 110.5 | 105.9 | 41.1 | 39.0 |
| iCE40-LM2K | UCBGA | 3 mm x 3 mm | 49 | 104.5 | 98.9 | 94.7 | 33.9 | 27.2 |
| iCE40-LP4K | UCBGA | 4 mm x 4 mm | 81 | 77.0 | 64.3 | 60.6 | 32.8 | 20.5 |
| iCE40-LP4K | UCBGA | 5 mm x 5 mm | 121 | 70.7 | 63.1 | 59.8 | 31.6 | 19.7 |
| iCE40-LP4K | UCBGA | 7 mm x 7 mm | 225 | 66.7 | 61.1 | 57.4 | 58.0 | 16.9 |
| iCE40-HX4K | CABGA | 9 mm x 9 mm | 121 | 53.4 | 49.3 | 46.8 | 31.0 | 20.8 |
| iCE40-HX4K | CSBGA | 8 mm x 8 mm | 132 | 60.2 | 55.2 | 51.8 | 52.3 | 15.3 |
| iCE40-HX4K | TQFP | 20 mm x 20 mm | 144 | 38.3 | 35.2 | 33.1 | 19.7 | 9.9 |
| iCE40-LM4K | WLCSP | 1.71 mm x 1.71 mm | 25 | 57.8 | 52.6 | 50.9 | 29.0 | 4.4 |
| iCE40-LM4K | UCBGA | 2.5 mm x 2.5 mm | 36 | 116.5 | 110.5 | 105.9 | 41.1 | 39.0 |
| iCE40-LM4K | UCBGA | 3 mm x 3 mm | 49 | 104.5 | 98.9 | 94.7 | 33.9 | 27.2 |
| iCE40-LP8K | UCBGA | 4 mm x 4 mm | 81 | 77.0 | 64.3 | 60.6 | 32.8 | 20.5 |
| iCE40-LP8K | UCBGA | 5 mm x 5 mm | 121 | 60.9 | 52.7 | 48.3 | 27.8 | 17.4 |
| iCE40-LP8K | UCBGA | 7 mm x 7 mm | 225 | 55.1 | 49.3 | 47.3 | 46.5 | 16.5 |
| iCE40-HX8K | CABGA | 9 mm x 9 mm | 121 | 53.4 | 49.3 | 46.8 | 31.0 | 20.8 |
| iCE40-HX8K | CSBGA | 8 mm x 8 mm | 132 | 54.3 | 50.1 | 47.4 | 42.8 | 12.5 |
| iCE40-HX8K | UCBGA | 7 mm x 7 mm | 225 | 55.1 | 49.3 | 47.3 | 46.5 | 16.5 |
| iCE40-HX8K | CABGA | 14 mm x 14 mm | 256 | 42.8 | 38.3 | 36.4 | 39.5 | 11.6 |

## 4.13. iCE40 Ultra™

**Table 4.13. iCE40 Ultra Device/Package Thermal Resistance**

| Device | Package | Dimensions | Pin Count | $\theta_{JA}$ (0 lfm) °C/W | $\theta_{JA}$ (200 lfm) °C/W | $\theta_{JA}$ (500 lfm) °C/W | $\theta_{JB}$ °C/W | $\theta_{JC}$ °C/W |
|---|---|---|---|---|---|---|---|---|
| iCE5LP1K | WLCSP | 2.078 mm x 2.078 mm | 36 | 68.2 | 63.1 | 60.4 | 18.4 | 3.3 |
| iCE5LP1K | UCFBGA | 2.5 mm x 2.5 mm | 36 | 117.9 | 105.1 | 100.2 | 42.9 | 24.3 |
| iCE5LP1K | QFN | 7 mm x 7 mm | 48 | 37.1 | 33.0 | 30.7 | 11.5 | 14.3 |
| iCE5LP2K | WLCSP | 2.078 mm x 2.078 mm | 36 | 68.2 | 63.1 | 60.4 | 18.4 | 3.3 |
| iCE5LP2K | UCFBGA | 2.5 mm x 2.5 mm | 36 | 117.9 | 105.1 | 100.2 | 42.9 | 24.3 |
| iCE5LP2K | QFN | 7 mm x 7 mm | 48 | 37.1 | 33.0 | 30.7 | 11.5 | 14.3 |
| iCE5LP4K | WLCSP | 2.078 mm x 2.078 mm | 36 | 68.2 | 63.1 | 60.4 | 18.4 | 3.3 |
| iCE5LP4K | UCFBGA | 2.5 mm x 2.5 mm | 36 | 117.9 | 105.1 | 100.2 | 42.9 | 24.3 |
| iCE5LP4K | QFN | 7 mm x 7 mm | 48 | 37.1 | 33.0 | 30.7 | 11.5 | 14.3 |

## 4.14. iCE40 UltraLite™

**Table 4.14. iCE40 UltraLite Device/Package Thermal Resistance**

| Device | Package | Dimensions | Pin Count | $\theta_{JA}$ (0 lfm) °C/W | $\theta_{JA}$ (200 lfm) °C/W | $\theta_{JA}$ (500 lfm) °C/W | $\theta_{JB}$ °C/W | $\theta_{JC}$ °C/W |
|---|---|---|---|---|---|---|---|---|
| iCE40UL640 | WLCSP | 1.409 mm x 1.409 mm | 16 | 93.1 | 86.7 | 83.7 | 29.7 | 6.7 |
| iCE40UL640 | UCBGA | 2.5 mm x 2.5 mm | 36 | 125.3 | 119.0 | 113.7 | 59.8 | 40.6 |
| iCE40UL1K | WLCSP | 1.409 mm x 1.409 mm | 16 | 93.1 | 86.7 | 83.7 | 29.7 | 6.7 |
| iCE40UL1K | UCBGA | 2.5 mm x 2.5 mm | 36 | 125.3 | 119.0 | 113.7 | 59.8 | 40.6 |

## 4.15. iCE40 UltraPlus™

**Table 4.15. iCE40 UltraPlus Device/Package Thermal Resistance**

| Device | Package | Dimensions | Pin Count | $\theta_{JA}$ (0 lfm) °C/W | $\theta_{JA}$ (200 lfm) °C/W | $\theta_{JA}$ (500 lfm) °C/W | $\theta_{JB}$ °C/W | $\theta_{JC}$ °C/W |
|---|---|---|---|---|---|---|---|---|
| iCE40UP3K | WLCSP | 2.15 mm x 2.55 mm | 30 | 65.25 | 60.57 | 57.75 | 20.57 | 2.03 |
| iCE40UP3K | QFN | 7 mm x 7 mm | 48 | 37.1 | 33 | 30.7 | 11.5 | 14.3 |
| iCE40UP5K | WLCSP | 2.15 mm x 2.55 mm | 30 | 65.25 | 60.57 | 57.75 | 20.57 | 2.03 |
| iCE40UP5K | QFN | 7 mm x 7 mm | 48 | 37.1 | 33 | 30.7 | 11.5 | 14.3 |

## 4.16. MachXO™

**Table 4.16. MachXO Device/Package Thermal Resistance**

| Device | Package | Dimensions | Pin Count | $\theta_{JA}$ (0 lfm) °C/W | $\theta_{JA}$ (200 lfm) °C/W | $\theta_{JA}$ (500 lfm) °C/W | $\theta_{JB}$ °C/W | $\theta_{JC}$ °C/W |
|---|---|---|---|---|---|---|---|---|
| LCMXO256C/E | CSBGA | 8 mm x 8 mm | 100 | 85.4 | 79.4 | 74.4 | 62.8 | 31.9 |
| LCMXO256C/E | TQFP | 14 mm x 14 mm | 100 | 36.9 | 33.0 | 30.4 | 23.6 | 12.4 |
| LCMXO640C/E | CSBGA | 8 mm x 8 mm | 100 | 75.1 | 69.5 | 65.9 | 57.5 | 18.5 |
| LCMXO640C/E | TQFP | 14 mm x 14 mm | 100 | 36.9 | 33.0 | 30.4 | 23.6 | 12.4 |
| LCMXO640C/E | CSBGA | 8 mm x 8 mm | 132 | 67.6 | 62.3 | 58.5 | 50.4 | 16.7 |
| LCMXO640C/E | TQFP | 20 mm x 20 mm | 144 | 28.8 | 26.1 | 24.0 | 19.1 | 9.4 |
| LCMXO640C/E | CABGA | 14 mm x 14 mm | 256 | 47.8 | 43.8 | 41.1 | 46.1 | 15.1 |
| LCMXO640C/E | FTBGA | 17 mm x 17 mm | 256 | 44.9 | 40.3 | 37.8 | 39.0 | 11.4 |
| LCMXO1200C/E | TQFP | 14 mm x 14 mm | 100 | 36.9 | 33.0 | 30.4 | 23.6 | 12.4 |
| LCMXO1200C/E | CSBGA | 8 mm x 8 mm | 132 | 55.7 | 51.0 | 48.0 | 37.1 | 9.7 |
| LCMXO1200C/E | TQFP | 20 mm x 20 mm | 144 | 28.8 | 26.1 | 24.0 | 19.1 | 9.4 |
| LCMXO1200C/E | CABGA | 14 mm x 14 mm | 256 | 43.1 | 39.1 | 36.5 | 35.8 | 9.5 |
| LCMXO1200C/E | FTBGA | 17 mm x 17 mm | 256 | 41.8 | 36.9 | 34.3 | 33.2 | 7.7 |
| LCMXO2280C/E | TQFP | 14 mm x 14 mm | 100 | 36.9 | 33.0 | 30.4 | 23.6 | 12.4 |
| LCMXO2280C/E | CSBGA | 8 mm x 8 mm | 132 | 48.4 | 44.1 | 41.6 | 33.7 | 6.6 |
| LCMXO2280C/E | TQFP | 20 mm x 20 mm | 144 | 28.8 | 26.1 | 24.0 | 19.1 | 9.4 |
| LCMXO2280C/E | CABGA | 14 mm x 14 mm | 256 | 40.9 | 34.9 | 32.3 | 32.5 | 6.5 |
| LCMXO2280C/E | FTBGA | 17 mm x 17 mm | 256 | 40.0 | 34.9 | 32.3 | 28.7 | 5.1 |
| LCMXO2280C/E | FTBGA | 19 mm x 19 mm | 324 | 37.3 | 31.2 | 29.5 | 25.0 | 6.2 |

## 4.17. MachXO2™

**Table 4.17. MachXO2 Device/Package Thermal Resistance**

| Device | Package | Dimensions | Pin Count | $\theta_{JA}$ (0 lfm) °C/W | $\theta_{JA}$ (200 lfm) °C/W | $\theta_{JA}$ (500 lfm) °C/W | $\theta_{JB}$ °C/W | $\theta_{JC}$ °C/W |
|---|---|---|---|---|---|---|---|---|
| LCMXO2-256 | QFN | 5 mm x 5 mm | 32 | 41.3 | 37.3 | 35.1 | 22.2 | 20.4 |
| LCMXO2-256 | QFN | 7 mm x 7 mm | 48 | 36.8 | 31.1 | 28.9 | 20.2 | 16.6 |
| LCMXO2-256 | UCBGA | 4 mm x 4 mm | 64 | 71.6 | 59.2 | 55.5 | 32.0 | 20.0 |
| LCMXO2-256 | TQFP | 14 mm x 14 mm | 100 | 40.8 | 35.5 | 33.3 | 23.6 | 12.4 |
| LCMXO2-256 | CSBGA | 8 mm x 8 mm | 132 | 90.3 | 82.8 | 79.4 | 62.8 | 31.9 |
| LCMXO2-640 | QFN | 7 mm x 7 mm | 48 | 36 | 30.2 | 28.1 | 17.1 | 15.9 |
| LCMXO2-640 | TQFP | 14 mm x 14 mm | 100 | 36.9 | 33.0 | 30.4 | 23.6 | 12.4 |
| LCMXO2-640 | CSBGA | 8 mm x 8 mm | 132 | 79.8 | 72.3 | 68.9 | 62.8 | 31.9 |
| LCMXO2-640U | TQFP | 20 mm x 20 mm | 144 | 34.1 | 29.7 | 27.7 | 19.1 | 9.4 |
| LCMXO2-1200 | WLCSP | 2.5 mm x 2.5 mm | 25 | 42.4 | 36.8 | 33.5 | 30.5 | 5.8 |
| LCMXO2-1200 | QFN | 5 mm x 5 mm | 32 | 39.9 | 36.4 | 34.5 | 32.5 | 17.7 |
| LCMXO2-1200 | TQFP | 14 mm x 14 mm | 100 | 36.9 | 33.0 | 30.4 | 23.6 | 12.4 |
| LCMXO2-1200 | CSBGA | 8 mm x 8 mm | 132 | 69.8 | 62.3 | 59.1 | 62.8 | 31.9 |
| LCMXO2-1200 | TQFP | 20 mm x 20 mm | 144 | 34.1 | 29.7 | 27.7 | 19.1 | 9.4 |
| LCMXO2-1200U | FTBGA | 17 mm x 17 mm | 256 | 43.3 | 38.6 | 36.1 | 36.1 | 9.5 |
| LCMXO2-2000 | WLCSP | 3.2 mm x 3.2 mm | 49 | 31.4 | 27.6 | 25.5 | 24.5 | 4.8 |
| LCMXO2-2000 | TQFP | 14 mm x 14 mm | 100 | 36.9 | 33.0 | 30.4 | 23.6 | 12.4 |
| LCMXO2-2000 | CSBGA | 8 mm x 8 mm | 132 | 60.7 | 55.8 | 52.5 | 57.5 | 18.5 |
| LCMXO2-2000 | TQFP | 20 mm x 20 mm | 144 | 28.8 | 26.1 | 24.0 | 19.1 | 9.4 |
| LCMXO2-2000 | FTBGA | 17 mm x 17 mm | 256 | 43.3 | 38.6 | 36.1 | 36.1 | 9.5 |
| LCMXO2-2000 | CABGA | 14 mm x 14 mm | 256 | 47.7 | 43.7 | 41.0 | 46.1 | 15.1 |
| LCMXO2-2000U | FPBGA | 23 mm x 23 mm | 484 | 25.2 | 21.5 | 19.5 | 19.9 | 10.3 |
| LCMXO2-4000 | QFN | 7 mm x 7 mm | 84 | 37.9 | 33.8 | 31.6 | 22.8 | 14.0 |
| LCMXO2-4000 | CSBGA | 8 mm x 8 mm | 132 | 52.8 | 48.3 | 45.5 | 37.1 | 9.7 |
| LCMXO2-4000 | CSBGA | 8 mm x 8 mm | 184 | 40.0 | 34.7 | 32.4 | 13.7 | 9.8 |
| LCMXO2-4000 | TQFP | 20 mm x 20 mm | 144 | 28.8 | 26.1 | 24.0 | 19.1 | 9.4 |
| LCMXO2-4000 | FTBGA | 17 mm x 17 mm | 256 | 40.9 | 36.0 | 33.4 | 25.1 | 4.4 |
| LCMXO2-4000 | CABGA | 14 mm x 14 mm | 256 | 42.6 | 38.7 | 36.0 | 32.5 | 6.5 |
| LCMXO2-4000 | CABGA | 17 mm x 17 mm | 332 | 35.1 | 31.3 | 29.1 | 30.4 | 6.6 |
| LCMXO2-4000 | FPBGA | 23 mm x 23 mm | 484 | 25.2 | 21.5 | 19.5 | 19.9 | 10.3 |
| LCMXO2-7000 | TQFP | 20 mm x 20 mm | 144 | 28.8 | 26.1 | 24.0 | 19.1 | 9.4 |
| LCMXO2-7000 | FTBGA | 17 mm x 17 mm | 256 | 38.7 | 33.8 | 31.0 | 28.4 | 4.4 |
| LCMXO2-7000 | CABGA | 14 mm x 14 mm | 256 | 40.3 | 36.3 | 33.6 | 30.1 | 6.1 |
| LCMXO2-7000 | CABGA | 17 mm x 17 mm | 332 | 33.3 | 29.5 | 27.3 | 26.9 | 5.5 |
| LCMXO2-7000 | FPBGA | 23 mm x 23 mm | 484 | 23.4 | 19.8 | 17.8 | 18.6 | 7.5 |

## 4.18. MachXO3™

**Table 4.18. MachXO3 Device/Package Thermal Resistance**

| Device | Package | Dimensions | Pin Count | $\theta_{JA}$ (0 lfm) °C/W | $\theta_{JA}$ (200 lfm) °C/W | $\theta_{JA}$ (500 lfm) °C/W | $\theta_{JB}$ °C/W | $\theta_{JC}$ °C/W |
|---|---|---|---|---|---|---|---|---|
| LCMXO3L-640E | CSFBGA | 6 mm x 6 mm | 121 | 52.4 | 49.5 | 46.8 | 35.4 | 18.3 |
| LCMXO3L-1300E | WLCSP | 2.487 mm x 2.541 mm | 36 | 41.7 | 36.3 | 33.0 | 30.2 | 5.8 |
| LCMXO3L-1300E | CSFBGA | 6 mm x 6 mm | 121 | 52.4 | 49.5 | 46.8 | 35.4 | 18.3 |
| LCMXO3L-1300E | CSFBGA | 9 mm x 9 mm | 256 | 36.2 | 33.8 | 31.5 | 23.8 | 11.6 |
| LCMXO3L-1300C | CABGA | 14 mm x 14 mm | 256 | 47.0 | 43.0 | 40.3 | 44.1 | 13.9 |
| LCMXO3L-2100E | WLCSP | 3.106 mm x 3.185 mm | 49 | 31.4 | 27.6 | 25.5 | 24.5 | 4.8 |
| LCMXO3L-2100E | CSFBGA | 6 mm x 6 mm | 121 | 45.1 | 40.4 | 37.7 | 28.2 | 13.7 |
| LCMXO3L-2100E | CSFBGA | 9 mm x 9 mm | 256 | 36.2 | 33.8 | 31.5 | 23.8 | 11.6 |
| LCMXO3L-2100E | CSFBGA | 10 mm x 10 mm | 324 | 31.2 | 28.7 | 26.6 | 19.3 | 8.7 |
| LCMXO3L-2100C | CABGA | 14 mm x 14 mm | 256 | 47.0 | 43.0 | 40.3 | 44.1 | 13.9 |
| LCMXO3L-2100C | CABGA | 15 mm x 15 mm | 324 | 34.8 | 31.0 | 28.8 | 29.9 | 6.4 |
| LCMXO3L-4300E | WLCSP | 3.797 mm x 3.693 mm | 81 | 21.6 | 19.4 | 18.3 | 19.1 | 3.8 |
| LCMXO3L-4300E | CSFBGA | 6 mm x 6 mm | 121 | 39.1 | 34.9 | 32.1 | 22.0 | 10.3 |
| LCMXO3L-4300E | CSFBGA | 9 mm x 9 mm | 256 | 33.2 | 30.9 | 28.5 | 20.9 | 9.5 |
| LCMXO3L-4300E | CSFBGA | 10 mm x 10mm | 324 | 31.2 | 28.7 | 26.6 | 19.3 | 8.7 |
| LCMXO3L-4300C | CABGA | 14 mm x 14 mm | 256 | 42.2 | 38.3 | 35.6 | 32.1 | 6.4 |
| LCMXO3L-4300C | CABGA | 15 mm x 15 mm | 324 | 34.8 | 31.0 | 28.8 | 29.9 | 6.4 |
| LCMXO3L-4300C | CABGA | 17 mm x 17 mm | 400 | 33.0 | 29.2 | 27.0 | 26.3 | 5.3 |
| LCMXO3L-6900E | CSFBGA | 9 mm x 9 mm | 256 | 30.5 | 28.0 | 25.7 | 18.1 | 7.7 |
| LCMXO3L-6900E | CSFBGA | 9 mm x 9 mm | 256 | 30.5 | 28.0 | 25.7 | 18.1 | 7.7 |
| LCMXO3L-6900E | CSFBGA | 10 mm x 10 mm | 324 | 29.1 | 26.7 | 24.4 | 17.1 | 7.3 |
| LCMXO3L-6900C | CABGA | 14 mm x 14 mm | 256 | 39.9 | 35.9 | 33.2 | 29.7 | 6.0 |
| LCMXO3L-6900C | CABGA | 15 mm x 15 mm | 324 | 33.1 | 29.5 | 27.4 | 29.8 | 6.0 |
| LCMXO3L-6900C | CABGA | 17 mm x 17 mm | 400 | 33.0 | 29.2 | 27.0 | 26.3 | 5.3 |
| LCMXO3L-9400E | CSFBGA | 9 mm x 9 mm | 256 | 29.3 | 25.3 | 23.1 | 15.8 | 5.7 |
| LCMXO3L-9400C | CABGA | 14 mm x 14 mm | 256 | 30.6 | 26.6 | 24.7 | 18.9 | 10.5 |
| LCMXO3L-9400C | CABGA | 15 mm x 15 mm | 400 | 29.7 | 26.0 | 24.1 | 19.2 | 8.9 |
| LCMXO3L-9400C | CABGA | 17 mm x 17 mm | 484 | 28.1 | 25.2 | 23.7 | 17.2 | 7.0 |
| LCMXO3L-9400E | CABGA | 14 mm x 14 mm | 256 | 30.6 | 26.6 | 24.7 | 18.9 | 10.5 |
| LCMXO3L-9400E | CABGA | 15 mm x 15 mm | 400 | 29.7 | 26.0 | 24.1 | 19.2 | 8.9 |
| LCMXO3L-9400E | CABGA | 17 mm x 17 mm | 484 | 28.1 | 25.2 | 23.7 | 17.2 | 7.0 |

**Note:** XO3L and XO3LF use physically the same die size. All thermal data for the XO3L also applies to the XO3LF.

## 4.19. MachXO3D™

**Table 4.19. MachXO3D Device/Package Thermal Resistance**

| Device | Package | Dimensions | Pin Count | $\theta_{JA}$ (0 lfm) °C/W | $\theta_{JA}$ (200 lfm) °C/W | $\theta_{JA}$ (500 lfm) °C/W | $\theta_{JB}$ °C/W | $\theta_{JC}$ °C/W |
|---|---|---|---|---|---|---|---|---|
| LCMXO3D-4300 | QFN | 10 mm x 10 mm | 72 | 18.1 | 15.4 | 14.2 | 8.5 | 7.8 |
| LCMXO3D-4300 | CABGA | 14 mm x 14 mm | 256 | 30.7 | 26.4 | 24.5 | 19.7 | 9.3 |
| LCMXO3D-9400 | QFN | 10 mm x 10 mm | 72 | 17.7 | 14.0 | 12.9 | 8.2 | 7.3 |
| LCMXO3D-9400 | CABGA | 19 mm x 19 mm | 484 | 24.7 | 20.9 | 19.1 | 15.3 | 6.2 |
| LCMXO3D-9400 | CABGA | 17 mm x 17 mm | 400 | 25.3 | 21.7 | 19.9 | 15.8 | 6.5 |
| LCMXO3D-9400 | CABGA | 14 mm x 14 mm | 256 | 26.3 | 22.5 | 20.6 | 15.8 | 6.8 |

## 4.20. Mach™-NX

**Table 4.20. Mach-NX Device/Package Thermal Resistance**

| Device | Package | Dimensions | Pin Count | $\theta_{JA}$ (0 lfm) °C/W | $\theta_{JA}$ (200 lfm) °C/W | $\theta_{JA}$ (500 lfm) °C/W | $\theta_{JB}$ °C/W | $\theta_{JC}$ °C/W |
|---|---|---|---|---|---|---|---|---|
| LFMNX-50 | FCBGA | 19 mm x 19 mm | 484 | 23.3 | 12.1 | 10.4 | 17.5 | 0.7 |

## 4.21. LatticeXP™

**Table 4.21. LatticeXP Device/Package Thermal Resistance**

| Device | Package | Dimensions | Pin Count | $\theta_{JA}$ (0 lfm) °C/W | $\theta_{JA}$ (200 lfm) °C/W | $\theta_{JA}$ (500 lfm) °C/W | $\theta_{JB}$ °C/W | $\theta_{JC}$ °C/W |
|---|---|---|---|---|---|---|---|---|
| LFXP3C/E | TQFP | 14 mm x 14 mm | 100 | 31.0 | 27.1 | 24.6 | 16.9 | 8.1 |
| LFXP3C/E | TQFP | 20 mm x 20 mm | 144 | 28.8 | 26.1 | 24.0 | 19.1 | 9.4 |
| LFXP3C/E | PQFP | 28 mm x 28 mm | 208 | 29.5 | 27.0 | 24.7 | 21.5 | 13.2 |
| LFXP6C/E | TQFP | 20 mm x 20 mm | 144 | 27.8 | 25.0 | 23.1 | 17.8 | 7.2 |
| LFXP6C/E | PQFP | 28 mm x 28 mm | 208 | 30.2 | 27.8 | 25.7 | 22.9 | 13.9 |
| LFXP6C/E | FPBGA | 17 mm x 17 mm | 256 | 25.7 | 21.6 | 19.4 | 14.1 | 5.3 |
| LFXP10C/E | FPBGA | 17 mm x 17 mm | 256 | 23.4 | 19.5 | 17.2 | 11.9 | 2.9 |
| LFXP10C/E | FPBGA | 23 mm x 23 mm | 388 | 17.6 | 15.0 | 13.2 | 8.9 | 4.6 |
| LFXP15C/E | FPBGA | 17 mm x 17 mm | 256 | 21.6 | 18.1 | 15.6 | 11.6 | 1.5 |
| LFXP15C/E | FPBGA | 23 mm x 23 mm | 388 | 16.1 | 13.5 | 11.9 | 7.6 | 3.8 |
| LFXP15C/E | FPBGA | 23 mm x 23 mm | 484 | 16.3 | 14.0 | 12.0 | 7.3 | 3.7 |
| LFXP20C/E | FPBGA | 17 mm x 17 mm | 256 | 21.9 | 17.8 | 15.6 | 9.6 | 2.8 |
| LFXP20C/E | FPBGA | 23 mm x 23 mm | 388 | 16.2 | 13.7 | 11.8 | 7.4 | 3.5 |
| LFXP20C/E | FPBGA | 23 mm x 23 mm | 484 | 16.2 | 13.7 | 11.8 | 7.4 | 3.5 |

## 4.22. LatticeXP2™

**Table 4.22. LatticeXP2 Device/Package Thermal Resistance**

| Device | Package | Dimensions | Pin Count | $\theta_{JA}$ (0 lfm) °C/W | $\theta_{JA}$ (200 lfm) °C/W | $\theta_{JA}$ (500 lfm) °C/W | $\theta_{JB}$ °C/W | $\theta_{JC}$ °C/W |
|---|---|---|---|---|---|---|---|---|
| LFXP2-5E | CSBGA | 8 mm x 8 mm | 132 | 47.2 | 43.0 | 40.5 | 32.7 | 6.1 |
| LFXP2-5E | TQFP | 20 mm x 20 mm | 144 | 28.8 | 26.1 | 24.0 | 19.1 | 9.4 |
| LFXP2-5E | PQFP | 28 mm x 28 mm | 208 | 30.2 | 27.8 | 25.7 | 22.9 | 13.9 |
| LFXP2-5E | FTBGA | 17 mm x 17 mm | 256 | 39.1 | 34.1 | 31.4 | 29.4 | 6.1 |
| LFXP2-8E | CSBGA | 8 mm x 8 mm | 132 | 41.9 | 38.0 | 35.8 | 28.4 | 4.4 |
| LFXP2-8E | TQFP | 20 mm x 20 mm | 144 | 28.8 | 26.1 | 24.0 | 19.1 | 9.4 |
| LFXP2-8E | PQFP | 28 mm x 28 mm | 208 | 30.2 | 27.8 | 25.7 | 22.9 | 13.9 |
| LFXP2-8E | FTBGA | 17 mm x 17 mm | 256 | 37.2 | 32.3 | 29.5 | 27.0 | 5.1 |
| LFXP2-17E | PQFP | 28 mm x 28 mm | 208 | 30.2 | 27.8 | 25.7 | 22.9 | 13.9 |
| LFXP2-17E | FTBGA | 17 mm x 17 mm | 256 | 33.9 | 29.1 | 26.2 | 23.7 | 4.3 |
| LFXP2-17E | FPBGA | 23 mm x 23 mm | 484 | 18.6 | 16.0 | 14.3 | 10.0 | 5.5 |
| LFXP2-30E | FTBGA | 17 mm x 17 mm | 256 | 32.0 | 27.1 | 24.2 | 20.7 | 3.0 |
| LFXP2-30E | FPBGA | 23 mm x 23 mm | 484 | 17.3 | 14.8 | 13.0 | 8.6 | 4.4 |
| LFXP2-30E | FPBGA | 27 mm x 27 mm | 672 | 16.0 | 13.6 | 11.7 | 7.9 | 3.7 |
| LFXP2-40E | FPBGA | 23 mm x 23 mm | 484 | 16.5 | 14.0 | 12.1 | 7.7 | 3.7 |
| LFXP2-40E | FPBGA | 27 mm x 27 mm | 672 | 15.1 | 12.7 | 10.9 | 6.8 | 3.1 |

## 4.23. L-ASC10™

**Table 4.23. L-ASC10 Device/Package Thermal Resistance**

| Device | Package | Dimensions | Pin Count | $\theta_{JA}$ (0 lfm) °C/W | $\theta_{JA}$ (200 lfm) °C/W | $\theta_{JA}$ (500 lfm) °C/W | $\theta_{JB}$ °C/W | $\theta_{JC}$ °C/W |
|---|---|---|---|---|---|---|---|---|
| L-ASC10 | QFN | 7 mm x 7 mm | 48 | 35.33 | 31.19 | 28.95 | 11.15 | 12.98 |

## 4.24. Platform Manager™

**Table 4.24. Platform Manager Device/Package Thermal Resistance**

| Device | Package | Dimensions | Pin Count | $\theta_{JA}$ (0 lfm) °C/W | $\theta_{JA}$ (200 lfm) °C/W | $\theta_{JA}$ (500 lfm) °C/W | $\theta_{JB}$ °C/W | $\theta_{JC}$ °C/W |
|---|---|---|---|---|---|---|---|---|
| LPTM10-1247 | TQFP | 14 mm x 14 mm | 128 | 33.7 | 29.5 | 27.0 | 17.7 | 15.5 |
| LPTM10-12107 | FTBGA | 17 mm x 17 mm | 208 | 37.7 | 34.3 | 31.8 | 24.2 | 18.3 |

## 4.25. Platform Manager 2

**Table 4.25. Platform Manager 2 Device/Package Thermal Resistance**

| Device | Package | Dimensions | Pin Count | $\theta_{JA}$ (0 lfm) °C/W | $\theta_{JA}$ (200 lfm) °C/W | $\theta_{JA}$ (500 lfm) °C/W | $\theta_{JB}$ °C/W | $\theta_{JC}$ °C/W |
|---|---|---|---|---|---|---|---|---|
| LPTM21 | FTBGA | 17 mm x 17 mm | 237 | 36 | 33.1 | 30.2 | 24.7 | 15.5 |
| LPTM21L | CABGA | 10 mm x 10 mm | 100 | 48.9 | 45.1 | 41.9 | 38.8 | 19.5 |

**Note:** The data shown in this Thermal Management document is relative and actual values depend on a variety of factors such as: die size, paddle size, airflow, power applied, printed circuit board design, proximity of other devices and user applications. This table specifies the device/package specific thermal resistance for newer FPGA products. These values are based upon JEDEC standards.

# Technical Support Assistance

Submit a technical support case through www.latticesemi.com/techsupport.

# Revision History

**Revision 3.7, February 2021**

| Section | Change Summary |
|---|---|
| Device/Package Thermal Resistance | Added Mach™-NX device package: LFMNX-50 FCBGA484. |

**Revision 3.6, June 2020**

| Section | Change Summary |
|---|---|
| Device/Package Thermal Resistance | • Added Certus-NX device packages: LFD2NX-40-CABGA256, LFD2NX-40-CABGA196, LFD2NX-40-CSFBGA121, and LFD2NX-17-CSFBGA121<br>• Added CrossLink-NX device packages: LIFCL-40-CSBGA121 and LIFCL-40-CSBGA256. |

**Revision 3.5, November 2019**

| Section | Change Summary |
|---|---|
| Device/Package Thermal Resistance | Added CrossLink-NX device packages: LIFCL-40-CABGA400, LIFCL-40-CSBGA289, and LIFCL-40-QFN72. |

**Revision 3.4, September 2019**

| Section | Change Summary |
|---|---|
| Device/Package Thermal Resistance | • Added CrossLinkPlus device.<br>• Added note referring to XO3LF device.<br>• Added new packages to XO2: XO2-2000-WLCSP49, XO2-4000-QFN84, and XO2-4000-CSBGA184.<br>• Added new packages to XO3D: XO3D-4300-QFN72, XO3D-4300-CABGA256, XO3D-9400-QFN72. |

**Revision 3.3, June 2019**

| Section | Change Summary |
|---|---|
| — | Added Disclaimers section. |
| Device/Package Thermal Resistance | Added MachXO3D device. |

**Revision 3.2, March 2019**

| Section | Change Summary |
|---|---|
| Acronyms in This Document | Added PCB. |
| Introduction | • Revised and added context information.<br>• Revised equations.<br>• Added Figure 1.1. Thermal Resistance Path from Silicon Junctions to Ambient Air and Figure 1.2. Thermal Resistance Path from Silicon Junctions to Package Top and to PCB. |
| Reducing Junction Temperature | Revised list format. |
| Device/Package Thermal Resistance | • Added Platform Manager device and moved LPTM10-1247 and LPTM10-12107 to this section.<br>• Added Platform Manager 2 device. |

**Revision 3.1, September 2018**

| Section | Change Summary |
|---|---|
| All | • Changed document ID from “thermal” to FPGA-TN-02044.<br>• Updated document template.<br>  • Added Acronyms in This Document section. |
| Device/Package Thermal Resistance | • Updated CrossLink thermal data based on new silicon design O1E.<br>• Added automotive part LIA-MD6000 80 ctfBGA.<br>• Added LFE5U-12F CSFBGA 285, LFE5U-12F CABGA 381, LFE5U-25F CABGA 256, LFE5U-45F CABGA 256, and LAE5U-12F CABGA 381.<br>• Added automotive part LAE5UM-4F 381 CABGA.<br>• Added iCE40 UltraPlus devices.<br>• Updated LCMXO2-256 QFN 7 mm x 7 mm and LCMXO2-640 QFN 7 mm x 7 mm thermal data.<br>• Added LCMXO2-1200 QFN 5 mm x 5 mm thermal data.<br>• Added LCMXO3L-9400E devices.<br>• Added L-ASC10 device.<br>• Deleted obsolete packages. |

**Revision 3.0, March 2017**

| Section | Change Summary |
|---|---|
| Device/Package Thermal Resistance | Reverted the LCMXO3L-6900C 400 I/O data in Table 4.18. MachXO3 Device/Package Thermal Resistance |

**Revision 2.9, March 2017**

| Section | Change Summary |
|---|---|
| Device/Package Thermal Resistance | • Added CrossLink packages.<br>• Added MachX02 QFN packages.<br>• Added LCMXO3L-9400E and LCMXO3L-9400C values. |

**Revision 2.8, February 2015**

| Section | Change Summary |
|---|---|
| Device/Package Thermal Resistance | Added iCE40 UltraLite packages. |

**Revision 2.7, January 2015**

| Section | Change Summary |
|---|---|
| Device/Package Thermal Resistance | Updated Package Thermal Resistance section.<br>• Added iCE40LP1K and iCE40LM4K WLCSP packages.<br>Updated Device/Package Thermal Resistance section.<br>• Added iCE40 UltraLite packages<br>• Updated iCE40 Ultra 36 WLCSP $\theta_{JB}$ and $\theta_{JC}$ data for all devices<br>• Removed iCE40 Ultra 20 WLCSP product. |

**Revision 2.6, October 2014**

| Section | Change Summary |
|---|---|
| Device/Package Thermal Resistance | Added ECP5 packages. |

**Revision 2.5, September 2014**

| Section | Change Summary |
|---|---|
| Device/Package Thermal Resistance | Added MachXO3L packages. |

**Revision 2.4, June 2014**

| Section | Change Summary |
|---|---|
| Device/Package Thermal Resistance | Added iCE40 Ultra packages. |

**Revision 2.3, May 2014**

| Section | Change Summary |
|---|---|
| Device/Package Thermal Resistance | Changed LCMXO2-1200 TQFP package dimensions to 20 mm x 20 mm. |

**Revision 2.2, May 2014**

| Section | Change Summary |
|---|---|
| Device/Package Thermal Resistance | Added Platform Manager information. |

**Revision 2.1, August 2013**

| Section | Change Summary |
|---|---|
| Device/Package Thermal Resistance | Added iCE40 and MachXO2 information. |

**Revision 2.0, August 2012**

| Section | Change Summary |
|---|---|
| Device/Package Thermal Resistance | Added iCE40 information. |

**Revision 1.9, March 2012**

| Section | Change Summary |
|---|---|
| Device/Package Thermal Resistance | Updated MachXO2 and LatticeECP3 families to reflect current product availability. |

**Revision 1.8, February 2012**

| Section | Change Summary |
|---|---|
| All | Updated document with new corporate logo. |

**Revision 1.7, February 2011**

| Section | Change Summary |
|---|---|
| Device/Package Thermal Resistance | Added MachXO2 information. |

**Revision 1.6, July 2009**

| Section | Change Summary |
|---|---|
| Package Thermal Resistance | Added new caBGA packaging. |
| Device/Package Thermal Resistance | • Added LatticeECP3 information.<br>• Added $\theta_{JB}$ column in tables. |

**Revision 1.5, April 2009**

| Section | Change Summary |
|---|---|
| Package Thermal Resistance | Added new QFNS, ucBGA, csBGA, and caBGA packaging. |

**Revision 1.4, October 2008**

| Section | Change Summary |
|---|---|
| Package Thermal Resistance | Added units (°C/W). |

**Revision 1.3, April 2008**

| Section | Change Summary |
|---|---|
| Package Thermal Resistance | Added 64-ball csBGA and 144-ball csBGA packaging. |

**Revision 1.2, March 2008**

| Section | Change Summary |
|---|---|
| Introduction | Corrected equation on page 1. |

**Revision 1.1, January 2008**

| Section | Change Summary |
|---|---|
| Package Thermal Resistance | Updated this section for ftBGA 256 packaging information. |

**Revision 1.0, September 2007**

| Section | Change Summary |
|---|---|
| Package Thermal Resistance | Updated information |
| Device/Package Thermal Resistance | Added this section. |

**Previous Lattice releases**


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