



Cyclone Series Device Thermal Resistance

May 2008, version 3.0

Data Sheet

Revision History

The following table shows the revision history for this data sheet.

Date	Document Version	Changes Made
May 2008	3.0	Updated Tables 2, 4, and 5 .
July 2007	2.2	Updated values for EP3C25 (E144) device in Table 2.
May 2007	2.1	Updated values for EP3C10 (E144) device in Table 2 and added Revision History.
March 2007	2.0	Added Cyclone III information.
April 2006	1.0	Initial release.

[Tables 1](#) through [6](#) in this data sheet provide θ_{JA} (junction-to-ambient thermal resistance) and θ_{JC} (junction-to-case thermal resistance) values for Altera® Cyclone® series devices available in Ball-Grid Array (BGA), FineLine® BGA (FBGA), Micro FineLine BGA® (MBGA), Ultra FineLine BGA (UBGA), Pin-Grid Array (PGA), Plastic J-Lead Chip Carrier (PLCC), Plastic Enhanced Quad Flat Pack (EQFP), Thin Quad Flat Pack (TQFP), Plastic Quad Flat Pack (PQFP), and Power Quad Flat Pack (RQFP).



For additional packaging information, refer to the [Altera Device Packaging Data Sheet](#).

Cyclone III Devices

Thermal resistance values for Cyclone III devices are provided for a board meeting JEDEC specifications and for a typical board. The JEDEC board specifications require two signals and two power/ground planes and are available at www.jedec.org. The values are described in [Tables 1 through 4](#).

Table 1. Thermal Resistance Values for Cyclone III Devices

Value	Description
θ_{JA} (C/W) Still Air	Junction-to-ambient thermal resistance (θ_{JA}) with no airflow when a heat sink is not being used.
θ_{JA} (C/W) 100 ft./minute	Junction-to-ambient thermal resistance with 100 ft./minute airflow when a heat sink is not being used.
θ_{JA} (C/W) 200 ft./minute	Junction-to-ambient thermal resistance with 200 ft./minute airflow when a heat sink is not being used.
θ_{JA} (C/W) 400 ft./minute	Junction-to-ambient thermal resistance with 400 ft./minute airflow when a heat sink is not being used.
θ_{JC} (C/W)	Junction-to-case thermal resistance (θ_{JC}) for device.
θ_{JB} (C/W)	Junction-to-board thermal resistance (θ_{JB}) for specific board being used.

[Table 2](#) provides θ_{JA} (junction-to-ambient thermal resistance) values and θ_{JC} (junction-to-case thermal resistance) values for Cyclone III devices on a board meeting JEDEC specifications for thermal resistance calculation.

Table 2. Thermal Resistance of Cyclone III Devices for Board Meeting JEDEC Specifications (Part 1 of 2)

Device	Package	θ_{JA} (°C/W) Still Air	θ_{JA} (°C/W) 100 ft./min.	θ_{JA} (°C/W) 200 ft./min.	θ_{JA} (°C/W) 400 ft./min.	θ_{JC} (°C/W)
EP3C5	E144	20	17.5	15.4	14	8.4
	F256	32.4	28.9	27	25.5	11.7
	U256	32.5	29.1	27.2	25.6	12.2
	M164	38.2	31.5	29.6	27.9	11.6
EP3C10	E144	20	17.5	15.4	14	8.4
	F256	32.4	28.9	27	25.5	11.7
	U256	32.5	29.1	27.2	25.6	12.2
	M164	38.2	31.5	29.6	27.9	11.6

Table 2. Thermal Resistance of Cyclone III Devices for Board Meeting JEDEC Specifications (Part 2 of 2)

Device	Package	θ_{JA} (°C/W) Still Air	θ_{JA} (°C/W) 100 ft./min.	θ_{JA} (°C/W) 200 ft./min.	θ_{JA} (°C/W) 400 ft./min.	θ_{JC} (°C/W)
EP3C16	E144	20	17.5	15.4	14	8
	Q240	27.2	24.7	22.1	17.8	4.3
	F256	28.5	25.1	23.2	21.7	9.1
	U256	28.8	25.4	23.5	22	9.7
	U484	26.9	23.5	21.6	20.1	8.5
	F484	22.9	19.4	17.7	16.2	6.9
	M164	34.7	28	26.1	24.4	9.2
EP3C25	E144	20	17.5	15.4	14	7.8
	Q240	27	24.5	21.8	17.6	4.2
	F256	27.5	24.1	22.2	20.7	8.5
	U256	27.9	24.5	22.6	21.1	9.1
	F324	26.6	23.1	21.3	19.8	8
EP3C40	Q240	25.8	23.2	20.6	17	4
	F324	23.2	19.7	18	16.5	5.9
	U484	22.8	19.3	17.6	16.1	5.9
	F484	19.8	16.3	14.6	13.2	4.8
	F780	18.7	15.2	13.5	12.2	4.5
EP3C55	F484	21.6	18.2	16.4	15	5.1
	U484	18.9	15.4	13.8	12.2	4.2
	F780	17.8	14.4	12.7	11.4	3.9
EP3C80	U484	20.4	16.9	15.2	13.8	4.4
	F484	18	14.5	12.9	11.5	3.6
	F780	16.9	13.5	11.8	10.5	3.3
EP3C120	F484	17.1	13.7	12	10.7	3.1
	F780	16	12.6	11	9.7	2.8

Table 3 provides board dimension information for each package.

Table 3. PCB Dimensions Notes (1), (2) (Part 1 of 2)

2.5 mm Thick	Signal Layers	Power/Ground Layers	Package Dimensions (mm)	Board Dimensions (mm)
F780	9	9	29	89
F484	7	7	23	83

Table 3. PCB Dimensions <i>Notes (1), (2)</i> (Part 2 of 2)				
2.5 mm Thick	Signal Layers	Power/Ground Layers	Package Dimensions (mm)	Board Dimensions (mm)
U484	7	7	19	79
F324	6	6	19	79
F256	6	6	17	77
U256	6	6	14	74

Notes to Table 3:

- (1) Power layer Cu thickness 35 μm , Cu 90%
- (2) Signal layer Cu thickness 17 μm , Cu 15%

Table 4 provides θ_{JA} values and θ_{JB} (junction-to-board thermal resistance) values for Cyclone III devices on a typical board.

Table 4. Thermal Resistance of Cyclone III Devices for Typical Board (Part 1 of 2)						
Device	Package	θ_{JA} ($^{\circ}\text{C/W}$) Still Air	θ_{JA} ($^{\circ}\text{C/W}$) 100 ft./min.	θ_{JA} ($^{\circ}\text{C/W}$) 200 ft./min.	θ_{JA} ($^{\circ}\text{C/W}$) 400 ft./min.	θ_{JB} ($^{\circ}\text{C/W}$)
EP3C5	F256	32.2	27.9	25.5	23.6	17.3
	U256	32.7	28.2	25.7	23.7	16.3
EP3C10	F256	32.2	27.9	25.5	23.6	17.3
	U256	32.7	28.2	25.7	23.7	16.3
EP3C16	F256	28.4	24.2	21.8	20	13.5
	U256	29	24.6	22.2	20.2	12.7
	U484	26.3	22.1	19.9	18.1	12.4
	F484	22.5	18.5	16.4	14.8	9.8
EP3C25	F256	27.5	23.2	20.9	19.1	12.6
	U256	28.1	23.7	21.3	19.4	11.8
	F324	26.4	22.3	20.1	18.3	12.4
EP3C40	F324	23.1	19	16.9	15.1	9.2
	F484	22.3	18.2	16	14.3	8.5
	U484	19.4	15.4	13.5	11.9	6.8
	F780	17.6	13.9	12.1	10.7	6.7
EP3C55	U484	21.2	17.1	15	13.3	7.5
	F484	18.6	14.6	12.6	11.1	6
	F780	16.8	13.1	11.3	9.9	5.9

Table 4. Thermal Resistance of Cyclone III Devices for Typical Board (Part 2 of 2)

Device	Package	θ_{JA} (°C/W) Still Air	θ_{JA} (°C/W) 100 ft./min.	θ_{JA} (°C/W) 200 ft./min.	θ_{JA} (°C/W) 400 ft./min.	θ_{JB} (°C/W)
EP3C80	U484	20	15.9	13.8	12.1	6.3
	F484	17.7	13.7	11.8	10.3	5.2
	F780	15.9	12.2	10.5	9.1	5.1
EP3C120	F484	16.8	12.9	11	9.4	4.4
	F780	15.1	11.4	9.6	8.3	4.2

Cyclone II Devices

Table 5 provides θ_{JA} (junction-to-ambient thermal resistance) and θ_{JC} (junction-to-case thermal resistance) values for Cyclone II devices.

Table 5. Thermal Resistance of Cyclone II Devices

Device	Package	θ_{JA} (°C/W) 0 ft./min.	θ_{JA} (°C/W) 100 ft./min.	θ_{JA} (°C/W) 200 ft./min.	θ_{JA} (°C/W) 400 ft./min.	θ_{JC} (°C/W)
EP2C5	F256	30.2	26.1	23.6	21.7	8.7
	T144	31	29.3	27.9	25.5	10
	Q208	30.4	29.2	27.3	22.3	5.5
EP2C8	F256	27.0	23.0	20.5	18.5	7.1
	T144	29.8	28.3	26.9	24.9	9.9
	Q208	30.2	28.2	26.9	21.7	5.4
EP2C20	Q240	26.6	24.0	21.4	17.4	4.2
	F256	24.2	20.0	17.8	16.0	5.5
	F484	21.0	17.0	14.8	13.1	4.2
	T144	27.6	26.4	25.4	23.8	9.6
EP2C35	F484	19.4	15.4	13.3	11.7	3.3
	U484	20.6	16.6	14.5	12.8	5.0
	F672	18.6	14.6	12.6	11.1	3.1
EP2C50	F484	18.4	14.4	12.4	10.9	2.8
	U484	19.6	15.6	13.6	11.9	4.4
	F672	17.7	13.7	11.8	10.2	2.6
EP2C70	F672	16.9	13.0	11.1	9.7	2.2
	F896	16.3	11.9	10.5	9.1	2.1

Table 6 provides θ_{JA} and θ_{JB} (junction-to-board thermal resistance) values for Cyclone II devices on a typical board.

Table 6. Thermal Resistance of Cyclone II Devices						
Device	Package	θ_{JA} (°C/W) Still Air	θ_{JA} (°C/W) 100 ft./min.	θ_{JA} (°C/W) 200 ft./min.	θ_{JA} (°C/W) 400 ft./min.	θ_{JB} (°C/W)
EP2C5	F256	30.2	25.8	22.9	20.6	14.8
EP2C8	F256	27.9	23.2	20.5	18.4	12.3
EP2C20	F256	24.7	20.1	17.5	15.3	9.1
	F484	20.5	16.2	13.9	12.2	7.2
EP2C35	F484	18.8	14.5	12.3	10.6	5.7
	U484	20.0	15.5	13.2	11.3	5.3
EP2C50	F484	17.7	13.5	11.4	9.8	4.5
	U484	19.0	14.6	12.3	10.6	4.4
EP2C35	F672	17.4	13.3	11.3	9.8	5.5
EP2C50	F672	16.5	12.4	10.5	9.0	4.6
	F672	15.7	11.7	9.8	8.3	3.8
EP2C70	F896	14.6	10.7	8.9	7.6	3.7

Cyclone Devices

Table 7 provides θ_{JA} (junction-to-ambient thermal resistance) and θ_{JC} (junction-to-case thermal resistance) values for Cyclone devices.

Table 7. Thermal Resistance of Cyclone Devices (Part 1 of 2)							
Device	Pin Count	Package	θ_{JC} (°C/W)	θ_{JA} (°C/W) Still Air	θ_{JA} (°C/W) 100 ft./min.	θ_{JA} (°C/W) 200 ft./min.	θ_{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

Table 7. Thermal Resistance of Cyclone Devices (Part 2 of 2)

Device	Pin Count	Package	θ_{JC} (°C/W)	θ_{JA} (°C/W) Still Air	θ_{JA} (°C/W) 100 ft./min.	θ_{JA} (°C/W) 200 ft./min.	θ_{JA} (°C/W) 400 ft./min.
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



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