Thermal Characteristics of Atmel Standard Packages

Thermal Specifications

The thermal performance of the semiconductor package is a very important consideration for the board designer. The reliability and functional life of the device is directly related to its junction operating temperature. As the temperature of the device increases, the stability of its junctions decline, as does its reliable life. The thermal performance is also important to the board design because it may limit the board density, or dictate the board location of high power-dissipating devices, or require expensive cooling methods for the system. As devices have become more complex and boards have become denser, the need to account for the thermal characteristics of packages has shifted from being a minor consideration to being a necessary consideration.

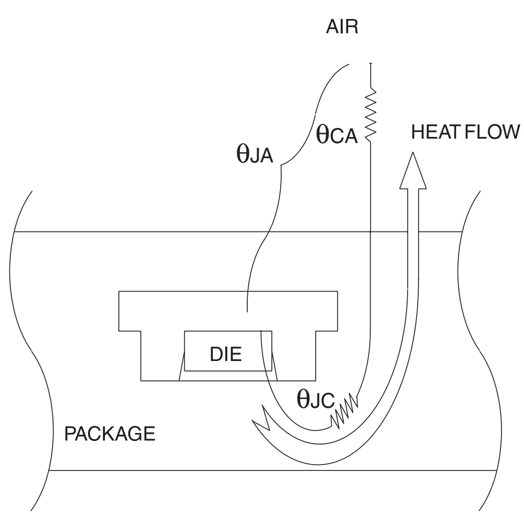
The thermal performance of a package is measured by its ability to dissipate the power required by the device into its surroundings. The electrical power drawn by the device generates heat on the top surface of the die. This heat is conducted through the package to the surface and then transferred to the surrounding air by convection. Each heat transfer step has a corresponding resistance to the heat flow, which is given the value θ, the thermal resistance coefficient. Subscripts are added to the coefficient to specify the two points that the heat is transferred between. Commonly used coefficients are θ_{JA} (junction to ambient air), θ_{JC} (junction to package case), and θ_{CA} (case to ambient air).

An electrical analogy can be made, as shown in the figure below, to illustrate the heat flow of a package. The heat transfer can be characterized mathematically by the following equation:

$$Tj - Ta = P \times \theta_{JA}$$

where,

P	=	*Device operating power [watts]*
Tj	=	*Temperature of a junction on the device [°C]*
Ta	=	*Temperature of the surrounding ambient air [°C]*



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Two conclusions can be made after examining this analogy. First, the lower the value of θ_{JA}, the better the heat dissipation of the package. Secondly, the value of θ_{JA} is directly dependent upon both the conductive (θ_{JC}) and convective (θ_{CA}) properties of the package. θ_{JC} is a function of the package material, the adhesion between the package materials, and device size. θ_{CA} is a function of the package size and configuration, package mounting method, and air flow across the package. Lower θ_{JA} values can be achieved by specifying ceramic packages instead of plastic packages, choosing larger packages, or improving air flow across the package.

The thermal resistance values of Atmel standard packages are listed on the following table. The figures shown are maximum values for θ, typical values are lower dependent upon the device type.

Thermal Resistance Coefficients

		θ_{JC} [°CW]	θ_{JA} [°CW] Airflow = 0 ft/min
Ceramic DIP	24D3/DW3	9	65
	24D6/DW6	10-15	45
	28D6/DW6	10-15	45
	32D6/DW6	10	45
	40D6/DW6	7	40
Plastic DIP	20P3	19	65
	24P3	22	60
	24P6	39	60
	28P6	36	55
	32P6	34	50
	40P6	30	45
Leadless Chip Carrier (LCC)	28L/LW	12	68
	32L/LW	10	65
	44L/LW	8-10	60
	68L/LW	6-8	50 - 60
Plastic Leaded Chip Carrier (PLCC)	20J	35	42
	28J	16	38
	32J	16	36
	44J	14	30
	68J	13	25
	84J	13	22
J-leaded Chip Carrier (JLCC)	28K/KW	16	72
	32K/KW	16	72
	44K/KW	16	68
	44K/KW	10-14	47
Cerpack	24C/CW	15	81

Thermal Resistance Coefficients (Continued)

		θ_{JC} [°CW]	θ_{JA} [°CW] Airflow = 0 ft/min
Flatpack	28F	10	65
	32F	8-10	60
PGA	28U	10	65
	30U	10	65
Sidebraze	32S	8-10	40-50
SOIC	20S	17	56
	24S	17	46
PQFP	44Q	15	38
	100Q	12	32
	160Q	8	30
TQFP	44A	17	41
	100A	10	34
TSOP	28T	66	55
	32T	45	53
	40T	35	50
	40(V)	55	53
	48T	30	47
TSSOP	20X	64	72
	24X	60	67
	28X		65
MLF	32M	39	32
	44M	23	25
	64M	12	20