Heat Sink Requirements for LSI53C1030, LSI53C1030T, LSI53C1020, and LSI53C1020A

System Engineering Note

S11027 Version 5.0

1 Revision Record

Revision	Date	Remarks
Version 5.0	4/2004	Updated Section 5, "Example Thermal Calculation," section. Added θ_{JC} data for each package.
Version 4.0	2/2004	Added information concerning the LSI53C1020A.
Version 3.0	7/2003	Updated Vendor information and the package thermal handling characteristics.
Version 2.0	5/2003	Added LSI53C1030T information. Updated information to reflect operating data.
Version 1.0	3/2001	Initial release of document.

2 Introduction

This SEN provides information concerning the requirement for additional heat sinking capability for the LSI Logic LSI53C1030 and LSI53C1030T PCI-X to Dual Channel Ultra320 SCSI Multifunction Controller chips, and the LSI53C1020 and LSI53C1020A PCI-X to Ultra320 SCSI Controller chips.

Section 3, "Thermal and Package Data," provides the thermal and package data. Section 4, "Thermal Resistance Equations and Variable Definitions," provides the equations to calculate the thermal resistance. Section 5, "Example Thermal Calculation," discusses an example heat sink calculations. Lastly, Section 6, "Vendors," provides a list of vendors for customer consideration.[1]

1. LSI Logic can neither recommend nor suggest vendors. LSI Logic provides this list only for customer consideration.

3 Thermal and Package Data

This section provides thermal and package information for the LSI Logic Ultra320 SCSI controllers.

3.1 LSI53C1030, LSI53C1030T, and LSI53C1020 Data

Table 1 provides the thermal characteristics for the 456-EPBGA package under various air flow conditions. It also provides the maximum operating junction temperature and maximum operating ambient temperature for the LSI Logic Ultra320 SCSI controllers that are made using G12® process. If the junction temperature exceeds the 115 °C limit, LSI Logic cannot guarantee the operation or reliability of the part.

The thermal resistance values take into account the dissipation of the heat through the PCB, as well as through the top of the package. The LSI53C1030, LSI53C1030T, and LSI53C1020 use a 456 EPBGA-M package.

Table 1 456-EPBGA-M Package Thermal Handling Characteristics[1]

Parameter	Package Characteristics				
Air Flow[2]	0 m/s (0 lfm)	0.5 m/s (100 lfm)	1.0 m/s (200 lfm)	2.0 m/s (400 lfm)	3.0 m/s (600 lfm)
θ_{JA}	15 °C/W	13.1 °C/W	12.5 °C/W	11.6 °C/W	10.9 °C/W
T_A Max	70 °C				
T_J Max	115 °C				
θ_{JC}	5 °C/W				

1. Refer to Section 4 for the variable definitions.
2. Meters/second (m/s) and linear feet/minute (lfm).

Table 2 provides the power dissipation data for the LSI53C1030 and LSI53C1030T. Table 3 provides the power dissipation data for the LSI53C1020.

Table 2 LSI53C1030 and LSI53C1030T Power Dissipation[1]

Parameter	Voltage	Current	Power
I/O	3.3 V	0.7 A	2.3 W
Core	1.8 V	1.6 A	2.9 W
Total	–	–	5.2 W

1. Operating conditions: 133 MHz PCI-X; Ultra320 SCSI large block transfers on both SCSI channels with four Ultra320 SCSI drives per channel; nominal voltage and nominal temperature.

Table 3 LSI53C1020 Power Dissipation[1]

Parameter	Voltage	Current	Power
I/O	3.3 V	0.5 A	1.7 W
Core	1.8 V	1.6 A	2.9 W
Total	–	–	4.6 W

1. Operating conditions: 133 MHz PCI-X; Ultra320 SCSI large block transfers with four Ultra320 SCSI drives; nominal voltage and nominal temperature.

3.2 LSI53C1020A Data

The LSI53C1020A is packaged in a 448 EPBGA-T or in a 384 EPBGA-T. Table 4 provides the thermal handling characteristics of both packages. Table 5 provides the power dissipation data for the LSI53C1020A.

Table 4 LSI53C1020A Package Thermal Handling Characteristics[1]

Parameter	LSI53C1020A Package Characteristics				
Air Flow[2]	0 m/s (0 lfm)	0.5 m/s (100 lfm)	1.0 m/s (200 lfm)	2.0 m/s (400 lfm)	3.0 m/s (600 lfm)
θ_{JA-384} EPBGA-T	15.9 °C/W	13.9 °C/W	12.8 °C/W	12.1 °C/W	11.4 °C/W
θ_{JA-448} EPBGA-T	15.0 °C/W	13.4 °C/W	12.7 °C/W	12.0 °C/W	10.8 °C/W
T_A Max	70 °C				
T_J Max	115 °C				
θ_{JC-384} EPBGA-T	5.6 °C/W				
θ_{JC-448} EPBGA-T	4.7 °C/W				

1. Refer to Section 4 for the variable definitions.
2. Meters/second (m/s) and linear feet/minute (lfm).

Table 5 LSI53C1020A Power Dissipation[1]

Parameter	Voltage	Current	Power
I/O	3.3 V	0.44 A	1.6 W
Core	1.8 V	0.8 A	1.5 W
Total	–	–	3.1 W

1. Operating conditions: 133 MHz PCI-X; Ultra320 SCSI large block transfers with four Ultra320 SCSI drives; nominal voltage and nominal temperature.

4 Thermal Resistance Equations and Variable Definitions

The thermal resistance calculations employ the following equations:

Equation 1 $\theta_{JA} = (T_J - T_A) / q$

Equation 2 $\theta_{JA} = \theta_{JC} + \theta_{CS} + \theta_{SA}$

where:

θ_{JA} Junction to air thermal resistance (˚C/W).

T_J Junction temperature (˚C).

T_A Air temperature near the package (˚C).

q Power dissipated in the device (W).

θ_{JC} Junction to case thermal resistance (˚C/W).

θ_{CS} Case to heat sink thermal resistance (˚C/W) through the attachment medium.

θ_{SA} Heat sink to ambient air thermal resistance (˚C/W).

5 Example Thermal Calculation

This section discusses the thermal resistance calculation and provides an example calculation for the LSI53C1030 and LSI53C1030T. For the LSI53C1020, perform similar calculations using the data in Table 3. For the LSI53C1020A, use the data from Table 4 and Table 5. An example calculation for the LSI53C1020A is given at the end of this section.

This calculation determines if the thermal resistance of the package is sufficient to meet the maximum operating temperature goal. Assuming the maximum allowed ambient air temperature of 70 ˚C and negligible air flow, Equation 1 returns:

$$\theta_{JA} = (T_J - T_A) / q$$

$$T_J = q\ \theta_{JA} + T_A$$

$$T_J = (5.2\ \text{W} \quad 15\ ^\circ\text{C/W}) + 70\ ^\circ\text{C}$$

$$T_J = 148\ ^\circ\text{C}$$

A value of T_J = 148 ˚C is higher than the maximum allowable T_J of 115 ˚C. Therefore, when air flow is negligible and the ambient air temperature is 70 ˚C, the thermal resistance of the package is not low enough to meet the maximum allowable T_J.

If a 100 lfm air flow is present, the thermal resistance value is 13.1 ˚C/W. If an ambient air temperature of 55 ˚C is assumed, Equation 1 yields:

$$T_J = q\ \theta_{JA} + T_A$$

$$T_J = (5.2\ W\ \ 13.2\ ^\circ C/W) + 55\ ^\circ C$$

$$T_J = 123\ ^\circ C$$

While the junction temperature is closer to the T_J maximum of 115 ˚C, the thermal resistance of the package is not low enough to meet the maximum allowable T_J when the air flow is 100 lfm and the ambient air temperature is 55 ˚C. To realize a lower thermal resistance, the package requires heat sinking assistance.

The following calculations determine the required heat sink capacity.

$$\theta_{JA} = (T_J - T_A) / q$$

$$\theta_{JA} = (115\ ^\circ C - 55\ ^\circ C) / 5.2\ W$$

$$\theta_{JA} = 11.54\ ^\circ C/W$$

Then use Equation 2 to determine the heat sink to ambient air thermal resistance requirement (θ_{SA}). Use θ_{JC} = 5.0 ˚C/W for the junction to case thermal resistance, and θ_{CS} = 1.0 ˚C/W for the heat sink attachment thermal resistance.

$$\theta_{JA} = \theta_{JC} + \theta_{CS} + \theta_{SA}$$

$$11.54\ ^\circ C/W = 5.0\ ^\circ C/W + 1.0\ ^\circ C/W + \theta_{SA}$$

$$\theta_{SA} = 5.54\ ^\circ C/W$$

The thermal resistance of the heat sink must be 5.54 ˚C/W or lower.

For the LSI53C1020A in the 448 EPBGA-T package, with negligible air flow and an ambient air temperature of 70 ˚C, the junction temperature is

$$T_j = 3.1\ W \times 15.0\ ^\circ C/W + 70\ ^\circ C = 116.5\ ^\circ C$$

This is slightly over the maximum allowed junction temperature. For a more typical condition with an ambient air temperature of 55 ˚C or less, the junction temperature is

$$T_j = 3.1\ W \times 15.0\ ^\circ C/W + 55\ ^\circ C = 101.5\ ^\circ C$$

6 Vendors

While LSI Logic can neither recommend nor suggest vendors who supply heat sinks, for customer convenience, LSI Logic does provide a list of vendors for consideration:

1. Cooler Master USA Inc.
   Phone: (510) 770-8566
   Fax (510)770-0855
   Website: www.coolermaster.com
2. Aavid Thermal Products, Inc.
   143 N. Main St., Concord, NH 03301
   Phone: (603) 224-9988
   Website: www.aavidthermalloy.com
3. Wakefield Engineering, Inc.
   100 Cummings Center, Suite 157H, Beverly, MA 01915-6135
   Phone: (781) 406-3000
   Website: www.wakefield.com
4. Intricast Company, Inc.
   2160 Walsh Ave., Santa Clara, CA 95050-2512
   Phone: (408) 988-6200
   Website: www.intricast.com
5. ChipCoolers, Inc.
   333 Strawberry Fields Rd., Warwick, RI 02886
   Phone (800) 227-0254
   Website: www.chipcoolers.com
6. Jaro Components, Inc.
   6600 Park of Commerce Blvd., Boca Raton, FL 33487
   Phone: (561) 241-6700
   Website: www.jaro1.com

Notes

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