Power Dissipation and Thermal Considerations

AN-809

APPLICATION NOTE

Introduction

The 8T49N282I is a multi-functional, high speed device that targets a wide variety of clock applications. The numerous innovative features contained in the device each consume incremental power. If all outputs are enabled in the maximum frequency and mode that have the highest power, the safe thermal operating conditions of the device may be exceeded. Careful analysis and consideration of power dissipation and thermal management are critical elements in the successful application of the 8T49N282I device.

The 8T49N282I device is specified to operate within the industrial temperature range of -40°C to +85°C. This specification is conditional, however, such that the absolute maximum junction temperature is not exceeded. At high operating temperatures, extreme care must be taken when operating the device to avoid exceeding the junction temperature and potentially damaging the device.

A maximum junction temperature is listed in the 8T49N282I datasheet with the ambient operating range. The ambient range and maximum junction temperature specifications ensure the performance of the device, as guaranteed in the Specifications section.

Many variables contribute to the operating junction temperature within the device, including

- Selected driver mode of operation
- Output clock speed
- Supply voltage
- Ambient temperature

The combination of these variables determines the junction temperature within the 8T49N282I device for a given set of operating conditions.

The 8T49N282I is specified for an ambient temperature (T_A). To ensure that T_A is not exceeded, an airflow source can be used.

Use the following equation to determine the junction temperature on the application PCB:

$$T_J = T_{CASE} + (\Psi_{JT} \text{ x } PD)$$

where:

T_J is the junction temperature (°C).
T_{CASE} is the case temperature (°C) measured by the user at the top center of the package.
Ψ_{JT} is the value from Table **?**.
PD is the power dissipation of the 8T49N282I.

Values of Θ_{JA} are provided for package comparison and PCB design considerations. Θ_{JA} can be used for a first-order approximation of T_J by the equation:

$$T_J = T_A + (\Theta_{JA} \text{ x } PD)$$

where T_A is the ambient temperature (°C).

Values of Θ_{JC} are provided for package comparison and PCB design considerations when an external heat sink is required.

Values of Ψ_{JB} are provided for package comparison and PCB design considerations.

Clock Speed and Driver Mode

Clock speed directly and linearly influences the total power dissipation of the device and, therefore, the junction temperature. Two operating frequencies are listed under the incremental power dissipation parameter in Table 3. Using linear interpretation is a sufficient approximation for frequency not listed in the table. When calculating power dissipation for thermal consideration, the amount of power dissipated in the 100Ω resistor should be removed. If using the data in Table **?**, this power is already removed. If using the current vs. frequency graphs provided in the Typical Performance Characteristics section, the power into the load must be subtracted, using the following equation:

$$\frac{\text{Differential Output Voltage Swing}^2}{100\Omega}$$

Evaluation of Operating Conditions

The first step in evaluating the operating conditions is to determine the maximum power consumption (PD) internal to the 8T49N282I. The maximum PD excludes power dissipated in the load resistors of the drivers because such power is external to the device. Use the power dissipation specifications listed in Table 3 to calculate the total power dissipated for the desired configuration. The base typical configuration parameter in Table **?** lists a power of 428mW, which includes one LVPECL output at 122.88MHz. If the frequency of operation is not listed in Table **?**, see the Typical Performance Characteristics section, current vs. frequency and driver mode to calculate the power dissipation; then add 20% for maximum current draw. Remove the power dissipated in the load resistor to achieve the most accurate power dissipation internal to the 8T49N282I. See the following table for a summary of the incremental power dissipation from the base power configuration for two different examples.

Table 1. Temperature Gradient Examples

Description	Mode	Frequency (MHz)	Maximum Power (mW)
Example 1			
Base Typical Configuration			
Output Driver	6 x LVPECL		
Output Driver	6 x LVDS		
Total Power			
Example 2			
Base Typical Configuration			
Output Driver			
Total Power			

The second step is to multiply the power dissipated by the thermal impedance to determine the maximum power gradient. For this example, a thermal impedance of Θ_{JA} = 20.1°C/W was used.

Example 1

(868 mW x 20.1°C/W) = 17.4°C

With an ambient temperature of 85°C, the junction temperature is

T_J = 85°C + 17.4°C = 102°C

This junction temperature is below the maximum allowable.

Example 2

(2500 mW x 20.1°C/W) = 50.2°C

With an ambient temperature of 85°C, the junction temperature is

T_J = 85°C + 50°C = 135°C

This junction temperature is above the maximum allowable. To operate in the condition of Example 2, the ambient temperature must be lowered to 65°C.

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