Ecliptek Thermal Resistance - Frequently Asked Questions

Rev A

1. **What is the definition of 'thermal resistance' of an oscillator package?**
Thermal resistance is defined as the temperature difference that occurs between the semiconductor element within the package and the package's surface or ambient atmosphere when the device consumes 1 watt [W] of power. Thermal resistance is the measure of the package's heat dissipation capability from a die's active surface (junction) to a specified reference point (package, board, ambient, etc.). The most commonly documented thermal relationship for packages that contain integrated circuits are the junction-to-air thermal resistance and the junction-to-case thermal resistance.

2. **Why is the thermal resistance of an oscillator important to system designers?**
Board and system level designers need to design their printed circuit boards to handle the heat generated due to power consumption of the integrated circuit within the oscillator. Knowledge of thermal resistance and its implication on power dissipation and heat generation is essential to prevent board overheating and device failure.

3. **What are the units used to measure thermal resistance?**
Thermal resistance is an indication of the heat transfer from the semiconductor device through all of the package materials out to the open environment. This parameter is often measured in terms of temperature per unit of power, or degrees Celsius per Watt (°C/W).

4. **What is the definition of power dissipation?**
Power dissipation is the transference of heat generated by the device during normal operation.

5. **What is the junction-to-ambient air thermal resistance?**
Junction-to-ambient thermal resistance (θ_{JA}) is defined as the thermal resistance from the semiconductor junction to the ambient air (junction-to-ambient). θ_{JA} is a measure of the ability of a device to dissipate heat from the surface of the die to the ambient air via all paths.

6. **What is the junction-to-case thermal resistance?**
Junction-to-case thermal resistance (θ_{JC}) is defined as the thermal resistance from the semiconductor junction to the case of the oscillator (junction-to-case). A low value of θ_{JC} corresponds to increased heat conduction and a high value corresponds with decreased heat conduction.

7. **What is the case-to-ambient air thermal resistance?**
Case-to-ambient thermal resistance (θ_{CA}) is defined as the thermal resistance between package surface and ambient air.

8. What is the formula for the junction to ambient thermal resistance?

Junction-to-air thermal resistance (θ_{JA}) is defined by the following formula:

$$\theta_{JA} = \theta_{JC} + \theta_{CA} = (T_J - T_A) / P_D$$

Where T_J is the junction temperature of the semiconductor device mounted inside the oscillator (measured in °C), T_A is the ambient temperature outside the oscillator (measured in °C), and P_D is the power dissipation of the oscillator (measured in Watts). Given the above equation, the θ_{JA} parameter is measured in units of degrees Celsius per Watt (°C/W).

9. What is the formula for the junction to case thermal resistance?

Junction-to-case thermal resistance (θ_{JC}) is defined by the following formula:

$$\theta_{JC} = (T_J - T_C) / P_D$$

Where T_J is the junction temperature of the semiconductor device mounted inside the oscillator (measured in °C), T_C is the external case or package temperature of the oscillator (measured in °C), and P_D is the power dissipation of the oscillator (measured in Watts). Given the above equation, the θ_{JC} parameter is measured in units of degrees Celsius per Watt (°C/W).

10. How does one calculate the junction temperature of the semiconductor device inside an oscillator package?

The above formulas can be rearranged to calculate the device junction temperature (T_J):

$$T_J = (\theta_{JA} * P_D) + T_A \text{ or } T_J = (\theta_{JC} * P_D) + T_C$$

11. How does one calculate the power dissipation of an oscillator?

The above formulas can be rearranged to calculate the power dissipation (P_D):

$$P_D = (T_J - T_A) / \theta_{JA} \text{ or } P_D = (T_J - T_C) / \theta_{JC}$$

12. Is thermal resistance data available for Ecliptek oscillator product series?

Typical thermal resistance values (θ_{JA} and θ_{JC}) can be found on the Environmental / Mechanical section of the series home page.

13. What is the airflow used for the thermal resistance values presented by Ecliptek?

The amount of airflow around a package can have a significant impact upon the θ_{JA} thermal resistance value. The amount of airflow is typically listed in feet per minute (fpm). The Ecliptek thermal resistance values for its oscillator product series is provided using an airflow rate of zero feet per minute in free, uncontrolled air.

14. What is the mounting scheme used for the thermal resistance measurements?

The typical thermal resistance values published by Ecliptek represent oscillator devices that have the pads or pins solder mounted onto traces of a two layer FR-4 printed circuit board (PCB) with copper V_{DD} and ground planes.

15. How are the θ_{JA} and θ_{JC} measurements presented by Ecliptek determined?

The θ_{JA} and θ_{JC} values are determined through the use of empirical data, supplier data, and thermal simulation results. In some cases, the actual temperature rise and/or the actual junction temperature of a semiconductor device is known from testing. At other times, these parameters can be determined from certain factors that are known about the device or from information supplied by the vendor of the device. In cases where limited thermal information is known about a device, a standardized temperature rise for that device type may have been used.

16. How does one calculate the maximum power dissipation for an Ecliptek oscillator series?

The Ecliptek oscillator specification sheet provides two parameters that can be used to determine the maximum power dissipation. The specification sheet lists the maximum input current and the nominal supply voltage. Power dissipation can be calculated using the following formula:

$$P_D = V_{DD} * I_{CC}$$

V_{DD} is the supply voltage (measured in DC volts) and I_{CC} is the maximum input current (measured in amps). The resultant power dissipation term is measured in watts.

17. What is the definition of maximum junction temperature for a semiconductor device?

The maximum junction temperature (T_{JMAX}) is defined as the maximum temperature on the surface of the integrated circuit (IC).

18. What is the recommended maximum junction temperature?

Ecliptek does not specify a maximum junction temperature (T_{JMAX}) for its oscillator series. Ecliptek recommends that the maximum junction temperature (T_{JMAX}) not exceed 125°C.

Note: Functional operation beyond the specified operating temperature range is not implied. Extended exposure to stresses above the specified operating conditions may affect device reliability.

19. Who do I contact if I have additional technical questions about the thermal resistances of Ecliptek oscillator products?

Please contact the Ecliptek Global Customer Support team for additional support or questions regarding your oscillator thermal resistance requirements.