UT63M1XX Series Transceiver: Thermal Considerations

Introduction

To operate UT63M1XX Series Transceivers over the upper end of the data sheet temperature range, thermal protection is recommended. The following discussion will define an electrical analog model used to analyze thermal systems consisting of a packaged integrated circuit, thermally conductive mounting material, and heat sink.

Thermal Resistance
The heat generated within a packaged integrated circuit will conduct away from its sources (transistor junctions and resistors) to the case. Heat conduction results in a temperature gradient between the case and junction proportional to the power dissipated by the device. The proportionality factor is a term that represents the resistance to heat transfer and is defined as thermal resistance, Q_{JC}.

Eq. 1 $\Theta_{JC} = (T_J - T_C)/P_D$ (°C/W)

Where:
T_J = device maximum junction temperature (°C)
T_C = maximum case temperature (°C)
P_D = device power dissipation (W)

The thermal resistance of the heat sink and mounting material also represents heat transfer resistance in degrees Celsius per watt. Thermal conductivity or K-factor for the heat sink or mounting material is specified, by the manufacturer, in watts per centimeter-Celsius or (W)/(cm-°C). Thermal resistance of a material is defined as:

Eq. 2 $\Theta_M = W/(A \times K)$ (°C/W)

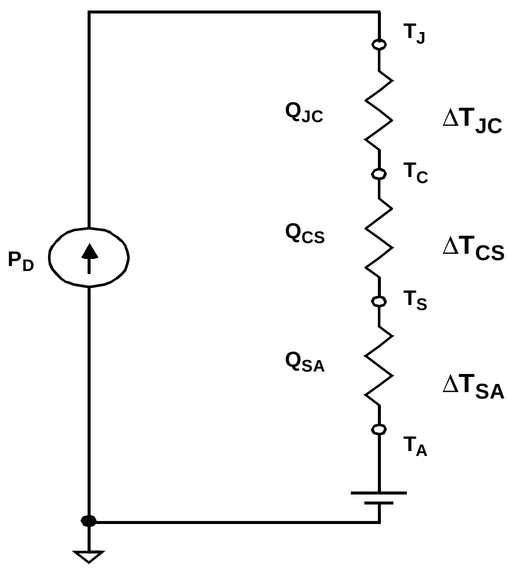
Where:
W = material thickness (cm)
A = heat transfer area (normal to heat flow)
K = thermal conductivity (K-factor)

Electrical Analog

Since thermal resistance is defined as a temperature gradient proportional to power dissipation (i.e., °C/W), it is useful to say:

Eq. 3 $\Delta T_{JC} = P_D \times \Theta_{JC}$

The electrical analog is derived from the above equation since the heat generated at the junction flows through the package, the mounting material and into the heat sink. Each material's thermal resistance results in a temperature rise starting at ambient temperature (T_A). Figure 1 shows the



Where: **Θ_{JC} is the thermal resistance junction to case;**
Θ_{CS} is the thermal resistance case to heat sink;
Θ_{SA} is the thermal resistance of heat sink to ambient.

Figure 1. Electrical Analog of Thermal System

From the electrical model an equation is written as follows:

Eq. 4 $T_J = \Delta T_{JC} + \Delta T_{CS} + \Delta T_{SA} + T_A$

Where:
$\Delta T_{JC} = P_D \times \Theta_{JC}$
$\Delta T_{CS} = P_D \times \Theta_{CS}$
$\Delta T_{SA} = P_D \times \Theta_{SA}$

Eq. 5 $T_J = P_D(\Theta_{JC} + \Theta_{CS} + \Theta_{SA}) + T_A$

To perform a worst-case analysis of this system, enter the transceiver's maximum junction temperature along with the maximum system ambient temperature, Θ_{JC}, and the maximum power dissipation (P_D).

Conclusion

The thermal impedance of the mounting compound and heat sink is calculated from equation 2. Size the mounting material and heat sink (i.e., thickness and surface area) to solve equation 5 for T_J. Refer to UTMC's UT63M1XX Bus Transceiver data sheet for the maximum limits used in equation 5.