



Application Hint 81

MIC2169 Thermal Consideration

General Description

Ensuring that the MIC2169A junction temperature operating is below its maximum specification is important for the system's long term reliability. This application note provides a quick and approach for estimating the junction temperature of MIC2169A product family. The junction temperature of MIC2169A can be calculated via the following:

$$T_J = T_A + \Delta T = T_A + P_D \theta_{JA}$$

Where T_A is the ambient temperature and θ_{JA} is the thermal resistance from junction-to-ambient of the part. For MSOP package, θ_{JA} is about 180 °C/W and for ePAD MSOP it is about 58 °C/W.

1. Power dissipation consists of three parts:

Quiescent power dissipation – minimum power used for the operation of the chip.

$$P_{\text{QUIESCENT}} = V_{\text{IN}} I_{\text{QUIESCENT}}$$

Where V_{in} is the input voltage and $I_{\text{Quiescent}}$ is the quiescent current of the chip provided in the datasheet. It is about 1.5mA typical.

2. FET gate drive power dissipation – power loss due to charge and discharge of external FET gate capacitance. It is heavily dependent upon the choice of external FET. Gate charge loss for each FET can be calculated as:

$$P_{\text{GATE}} = f_s Q_G V_G$$

Where f_s is switching frequency which is 500 kHz in this case, Q_G is total gate charge at V_G and V_G is the gate drive voltage (5V for MIC2169A).

3. LDO power dissipation – dissipation associated with the internal LDO regulator. LDO loss is calculated by voltage drop multiplied by average current. Average current is estimated by the following charge balance equation:

$$I_{\text{LDO}} = f_s Q_G$$

So the loss associated with each FET is,

$$P_{\text{LDO}} = f_s Q_G (V_{\text{IN}} - V_G)$$

Where V_{IN} is the input voltage. And in summary, total dissipation of MIC2169A is:

$$P_D = P_{\text{QUIESCENT}} + P_{\text{GATE1}} + P_{\text{GATE2}} + P_{\text{LDO1}} + P_{\text{LDO2}}$$

OR,

$$P_D = V_{\text{IN}} (I_{\text{QUIESCENT}} + f_s Q_{G1} + F_s Q_{G2})$$

Another way of looking at the above equation is that the power dissipation is input voltage times input current. The is because what goes into the chip is eventually dissipated. This also provides an easy way of actually measuring the dissipation by measuring input current through a shunt resistor in series with the V_{in} pin.

Example

Given

$$V_{\text{IN}} = 12 \text{ V}$$

$$Q_{G1} = Q_{G2} = 11 \text{ nC (Si4390DY)}$$

$$f_s = 500 \text{ kHz}$$

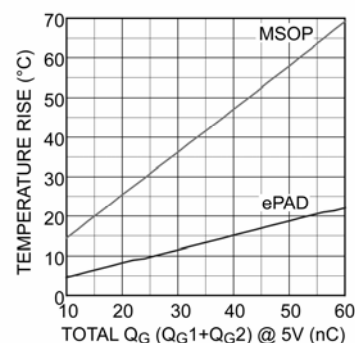
Applying the above equations,

$$P_D = 150 \text{ mW}$$

$$\Delta T = 27.0 \text{ }^\circ\text{C for MSOP}$$

$$\Delta T = 8.7 \text{ }^\circ\text{C for ePAD MSOP}$$

The following chart shows the relationship between total Q_g and ΔT when V_{in} is at 12V.



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