Keywords: Package Thermal Analysis, thermal properties of integrated circuit packages

APPLICATION NOTE 5873

PACKAGE THERMAL ANALYSIS CALCULATOR TUTORIAL

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Abstract: The Package Thermal Analysis Calculator (PTA) aids in the analysis of the thermal properties of integrated circuit packages. These include thermal resistance, power dissipation, and die, package, and ambient temperatures. The program is for use with an HP® 50g calculator or free PC emulator.

Introduction

Steve Edwards*, an experienced analog design engineer, has written several calculators to automate repetitive tasks. These tools are being shared to help other analog design engineers who select, specify, and characterize analog circuits. We will summarize the functionality of one such tool, the Package Thermal Analysis Calculator.

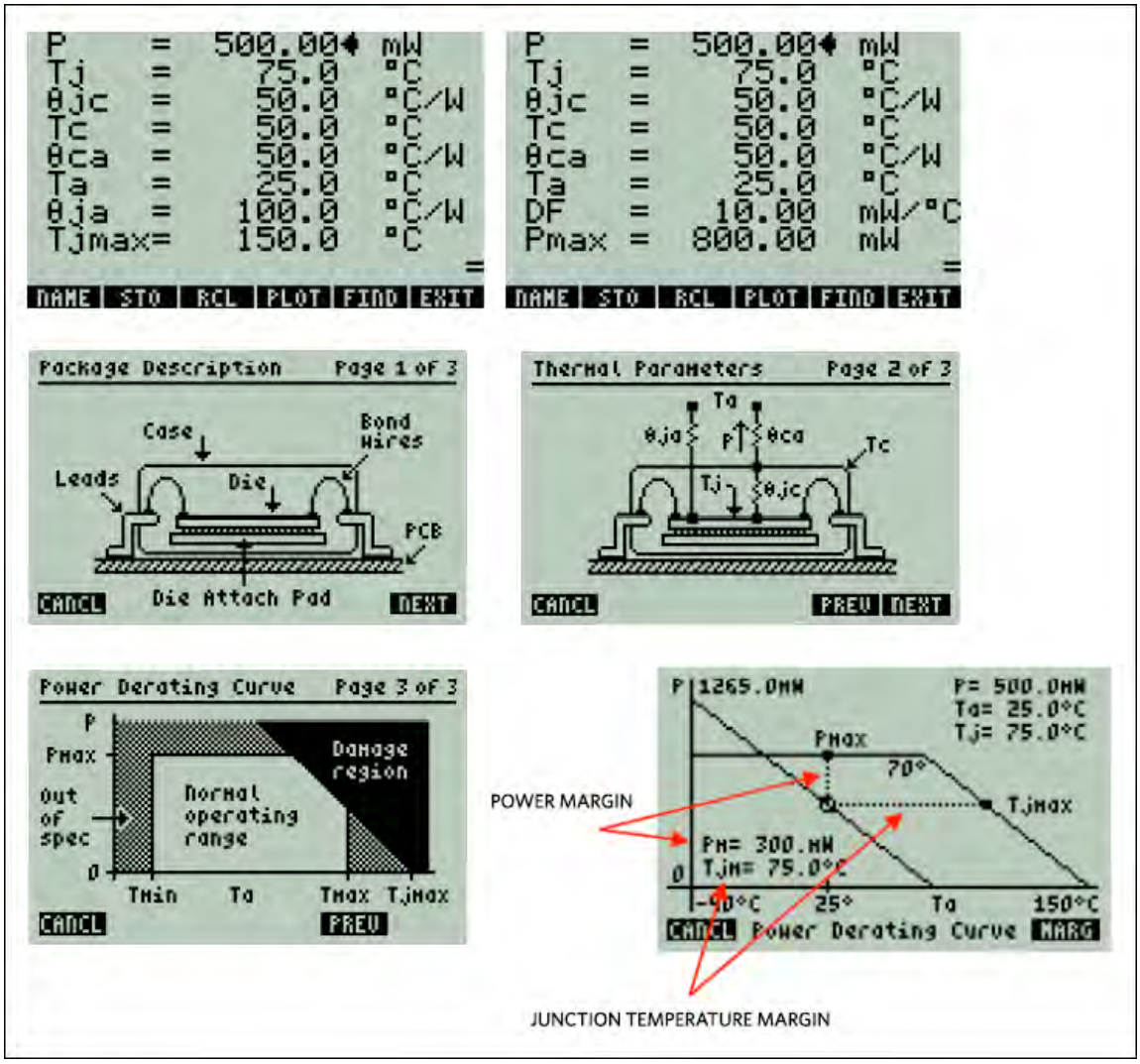
The Package Thermal Analysis (PTA) is a program written for the HP50g calculator that aids in the analysis of the thermal properties of integrated circuit packages. These include thermal resistance, power dissipation and derating, and die, package, and ambient temperatures. PTA can find any of these parameters given the others. PTA can be run on a PC using the free program HPUserEdit 5.4, found at www.hpcalc.org, or our calculator page.

Ten parameters are used.

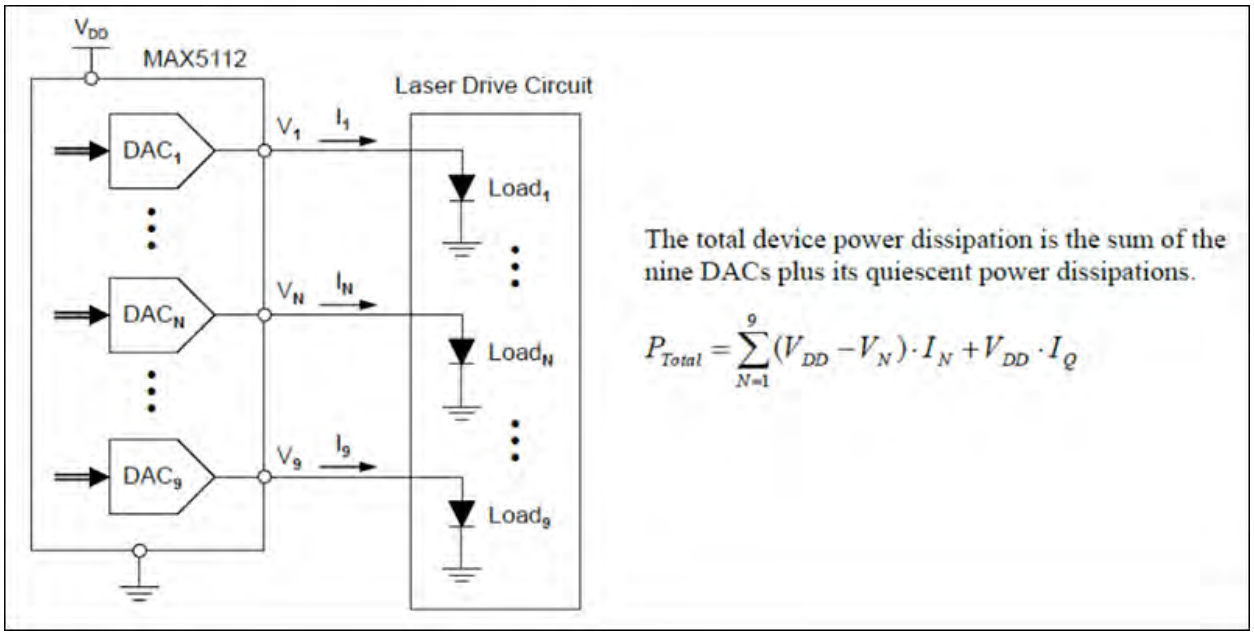
1. Power Dissipation, P, in mW
2. Junction Temperature, Tj, in °C
3. Junction-Case Thermal Resistance, θjc, in °C/W
4. Case Temperature, Tc, in °C
5. Case-Ambient Thermal Resistance, θca, in °C/W
6. Ambient Temperature, Ta, in °C
7. Junction-Ambient Thermal Resistance, θja, in°C/W
8. Power Derating Factor, DF, in mW/°C
9. Maximum Junction Temperature, Tjmax, in °C
10. Maximum Power Dissipation, Pmax, in mW

PTA allows ten parameters to be entered (P, Tj, θjc, Tc, θca, Ta, θja, DF, Tjmax, and Pmax), and nine found (P, Tj, θjc, Tc, θca, Ta, θja, DF, and Pmax) as a function of the other parameters.

These parameters appear in PTA as shown below:

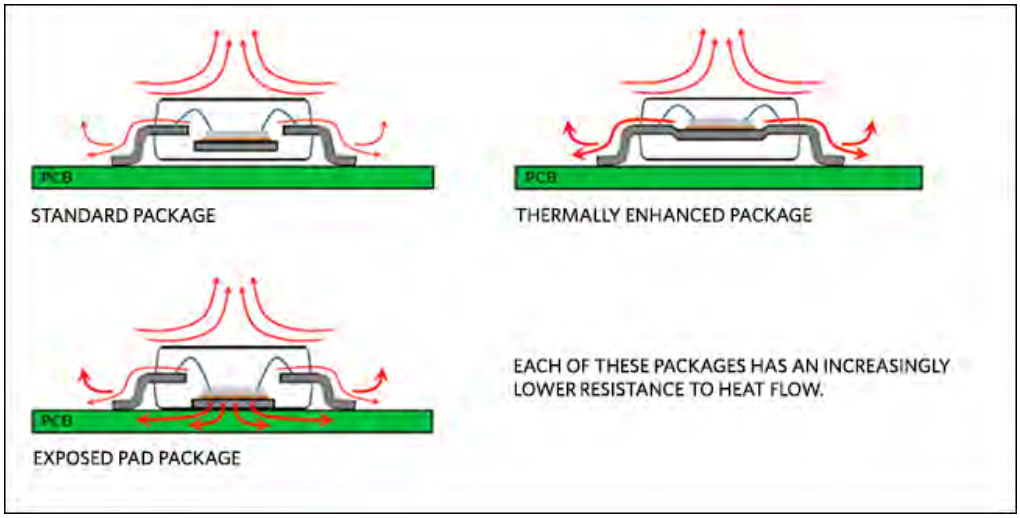

P = 500.00 mW
Tj = 75.0 °C
θjc = 50.0 °C/W
Tc = 50.0 °C
θca = 50.0 °C/W
Ta = 25.0 °C
θja = 100.0 °C/W
Tjmax= 150.0 °C
NAME STO RCL PLOT FIND EXIT
P = 500.00 mW
Tj = 75.0 °C
θjc = 50.0 °C/W
Tc = 50.0 °C
θca = 50.0 °C/W
Ta = 25.0 °C
DF = 10.00 mW/°C
Pmax = 800.00 mW
NAME STO RCL PLOT FIND EXIT
Package Description Page 1 of 3
Case
Bond Wires
Leads
Die
PCB
Die Attach Pad
CANCL NEXT
Thermal Parameters Page 2 of 3
Ta
θja
P
θca
Tc
Tj
θjc
CANCL PREV NEXT
Power Derating Curve Page 3 of 3
P
Pmax
Out of spec
Normal operating range
Damage region
0
Tmin Ta Tmax Tjmax
CANCL PREV
P 1265.0mW
P= 500.0mW
Ta= 25.0°C
Tj= 75.0°C
Pmax
70°
Tjmax
POWER MARGIN
PM= 300.mW
TjM= 75.0°C
0
-40°C 25° Ta 150°C
CANCL Power Derating Curve MARG
JUNCTION TEMPERATURE MARGIN

Example



Heat Flow

When power is generated within a die, heat is produced that flows toward the lower temperature of the surrounding air. The heat must travel via the molding compound, bond wires, leads, and (in some devices) an exposed leadframe pad. The inability of the package to immediately dissipate the heat results in a rise in die (Tj) and package (Tc) temperatures. The thermal resistance (θjc + θca), and therefore the path taken by the heat, varies with the package construction, and PCB mounting. For example,



The calculator user's guide tutorial details the types of integrated circuit packages thermals and how it is calculated. The practical example uses PTA to estimate the package thermals of the MAX5112, 9-channel DAC in a laser optical driver. The example takes us from entering the data, through solving and finding package power vs. temperature.

*Steve Edwards is no longer with Maxim

Related Parts		
MAX5112	9-Channel, 14-Bit, Current DAC with I²C Interface	Free Samples

More Information
For Technical Support: http://www.maximintegrated.com/en/support
For Samples: http://www.maximintegrated.com/en/samples
Other Questions and Comments: http://www.maximintegrated.com/en/contact

Application Note 5873: http://www.maximintegrated.com/en/an5873
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