FAQ: Thermal Resistance of LFCSP packages used in ADL5370/1/2/3/4/5 Modulators

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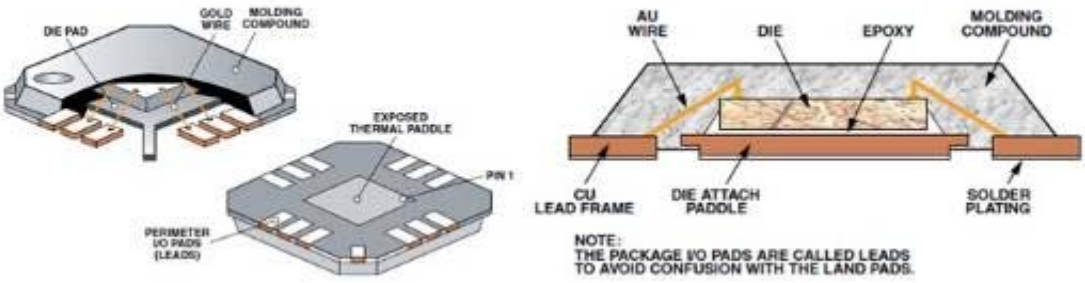
Version 6

Q.

What is the Thermal Resistance of LFCSP packages used in ADL5370/1/2/3/4/5 Modulators?

A.

Thermal Resistance, expressed in °C/Watt, is a measure of a device's resistance to heat transfer. The illustration shows the of 4x4 mm 24 Lead LFCSP package of the ADL5370/1/2/3/4/5 and ADL5385 Modulators.



Definitions :

Rja (ΘJA(Theta-JA)) = Thermal Resistance Junction to Ambient, °C/W

Rjc (ΘJC(Theta-JC)) = Thermal Resistance Junction to Case, °C/W

Rjb (ΘJB(Theta-JB)) = Thermal Resistance Junction to Board, °C/W

Psi_jt (Ψjt) = Junction to Top of Package Characterization Parameter, °C/W

Psi_jb(Ψjb) = Junction to Board Characterization Parameter, °C/W

TJ = Die Junction Temp °C

TA= Ambient Air Temp °C

TC= Package Case Temp °C

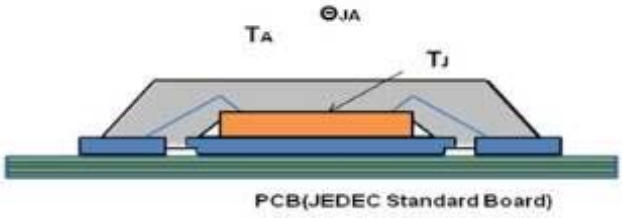
TT= Top of package Temp at Center °C

TB= Board Temp Adjacent to Package °C

P = Power Dissipated by device, Watts

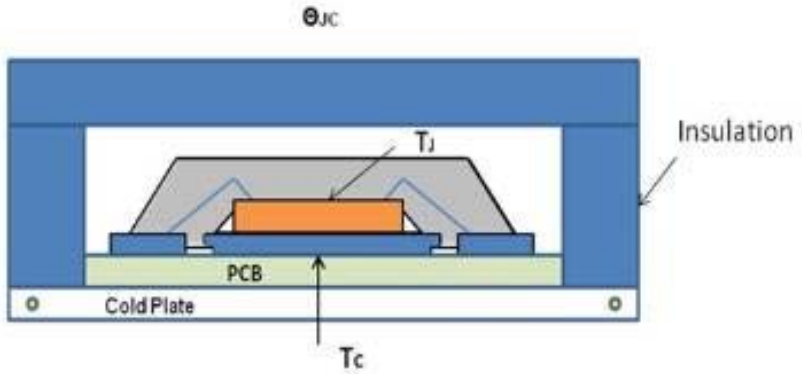
Measurement Method based on JEDEC

ΘJA



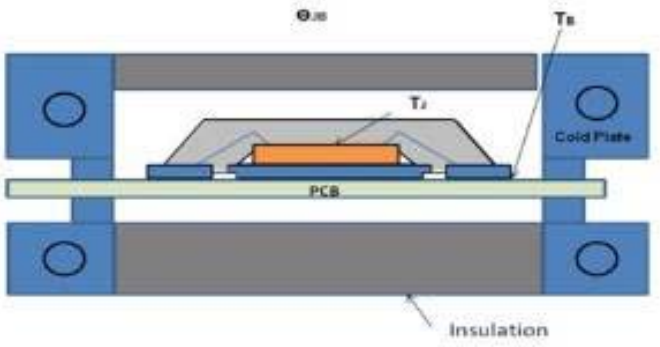
ΘJA = (TJ-TA)/P

ΘJC



ΘJC = (TJ-TC)/P

ΘJB



ΘJB = (TJ-TB)/P

The LFCSP has a metal exposed PAD at the base that is directly connected to the GND of the die. As a result, the majority of the heat is lost through this path. Die-to-top-surface-to-air on the other hand presents a much higher thermal impedance. Because there is so little heat flowing through this path, we make the approximation that the die temperature is close to the temp on the plastic case of the package.
Below are the estimated thermal impedances of this package(with pad soldered to 4 layer JEDEC test board@0 airflow) from the package vendor.

Rja = 54.3 C/W

Rjc = 8.3 C/W

Rjb = 32.9 C/W

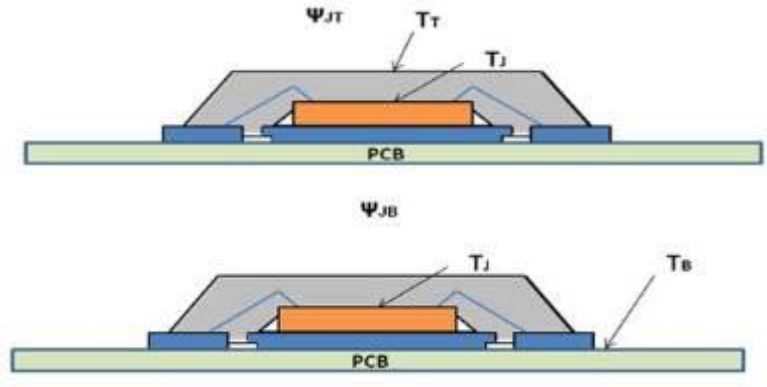
Psi_jt = 0.9 C/W

Psi_jb = 31.6 C/W

We have found that the thermal impedance specs that we get from the package vendors are very conservative. Take a look at the ADL5375 datasheet Abs Max Ratings along with the discussion on page 28. Basically, we have found that the LFCSP-24 package has a more realistic thermal impedance of around 30 degC/watt when properly grounded.

54.3 degC/W is the specified junction to air thermal impedance when the device is soldered down. If the device was not soldered down, the junction to air thermal impedance would go up. As mentioned already, We think that this 54.3 degC/W number is too conservative.

Psi-jt and Psi-jb are not “true” resistance because it does not force all heat flow into the test point(the board like Rjb and the exposed pad(heat sink) like Rjc). They were developed in response of the need to have a relationship between externally known temperatures and the junction temperature. Psi-jt is the relationship between the junction and top case temperatures and Psi-jb is the relationship between the junction and board temperatures.



Tj = TT,b + (Ψjt,b x P)

Since the board temperature may be affected by adjacent IC's and since the case is closer to the junction, Psi-jt is used more often than Psi-jb. Although the board type and package construction can affect Psi-jt the values determined using the JEDEC standards can accurately be used to determine the junction temp in an working PCB. This is because the typical values of Psi-jt are between 0.5 and 1.5 C/W, depending upon the thickness of the package type. So at low power the case temp is essentially the same as the junction temp and even at high power the junction temp would only be a couple of degrees higher than the case. So variations in Psi-jt due to test conditions are usually within the accuracy of the ability to measure the case temp.

So using Θjc instead of Psi-jt to determine the junction temp, can lead to a large error in junction temp after measuring the temperature at the top of package temp(TT). Given that Psi-jt is always much lower than Θjc.

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Last Modified by **AndyR** on Jan 31, 2012 3:36 PM

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