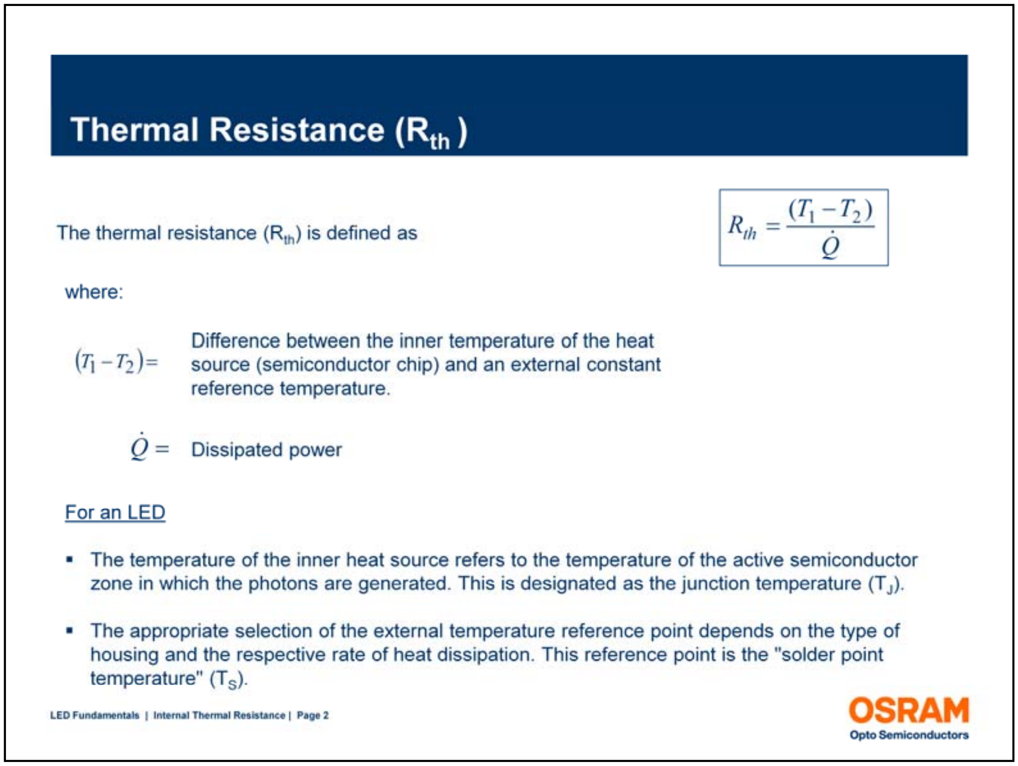
Welcome to this presentation on Internal Thermal Resistance of LEDs, part of OSRAM Opto Semiconductors‘ LED Fundamentals series.

In this presentation we will look at:

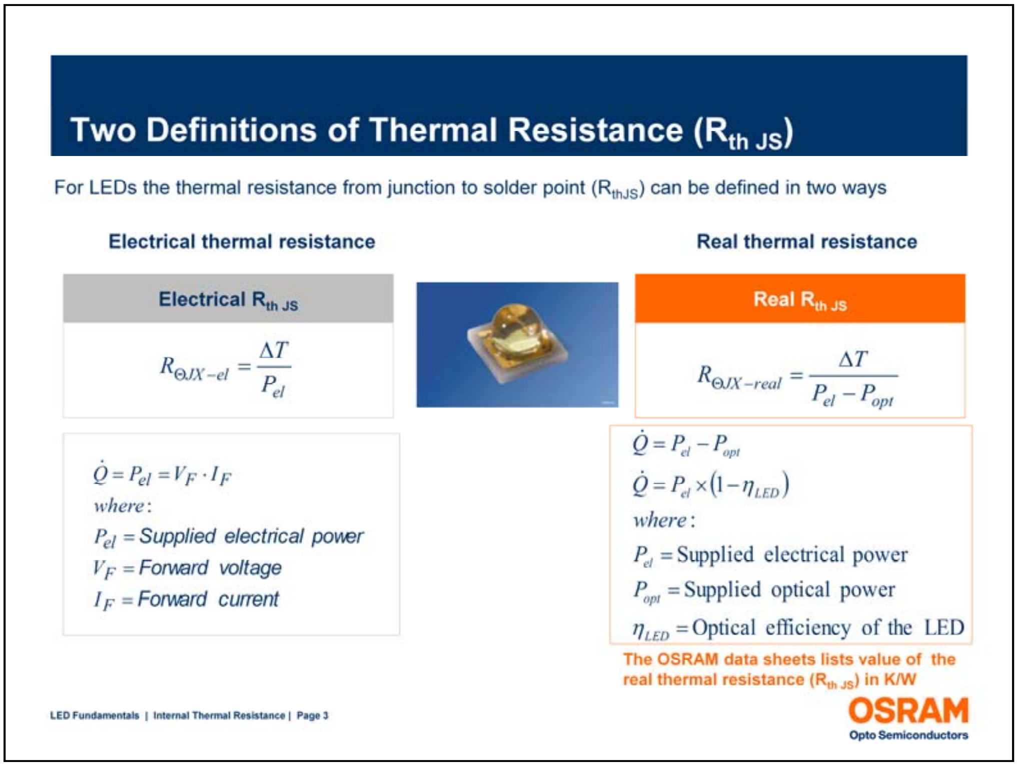
- the definition and significance of internal thermal resistance in LED packages.
- the path of heat transfer in some OSRAM LED packages.
- the calculation of the junction temp in LEDs.



The thermal resistance (Rth) is defined as the rate of temperature increase for the dissipated power. It is a measure of the capability of the material to dissipate heat.

The temperature increase of light emitting diodes (LEDs) is caused by the portion of the dissipated power that is not transformed into light. The temperature difference in an LED is defined as the difference of the inner temperature of the semiconductor chip; designated as the junction temperature of the LED and an external constant reference temperature which is the solder point temperature.

Since the temperature increase is proportional to the power dissipation, the thermal resistance (Rth) can be seen as the proportionality factor that contains the physical heat dissipation characteristics of the LED.



With classical silicon-based semiconductor components such as integrated circuits and transistors, the entire electrical energy is converted into heat. The heat flow can therefore be equated to the electrical power loss and leads to a clear interpretation of the thermal resistance.

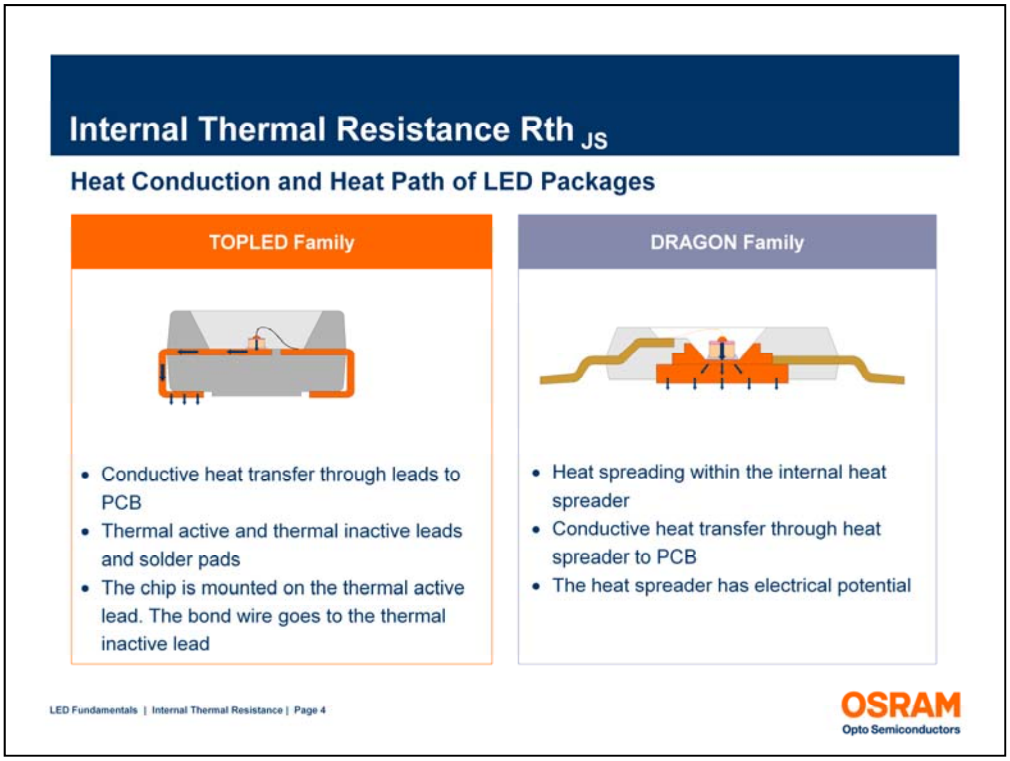
With LEDs however, the supplied electrical energy is only partially converted to heat. Depending on the optical efficiency, a portion of the electrical energy is emitted as light/radiation (optical energy). This leads to two different definitions of thermal resistance for LEDs.

In one definition the thermal resistance is defined in the same manner as classic semiconductor components. The energy coupled out (light/radiation) is not taken into consideration. This is also referred to as the electrical thermal resistance.

The other definition of thermal resistance considers the actual flow of heat that is dissipated through the housing. The optical power of the LED that is coupled out is taken into consideration. Therefore it is defined as the real thermal resistance of the LED.

The OSRAM datasheet lists the real value of thermal resistance from junction to solder point of the LED. This value for thermal resistance (Rth) is listed in Kelvin/Watt (K/W).

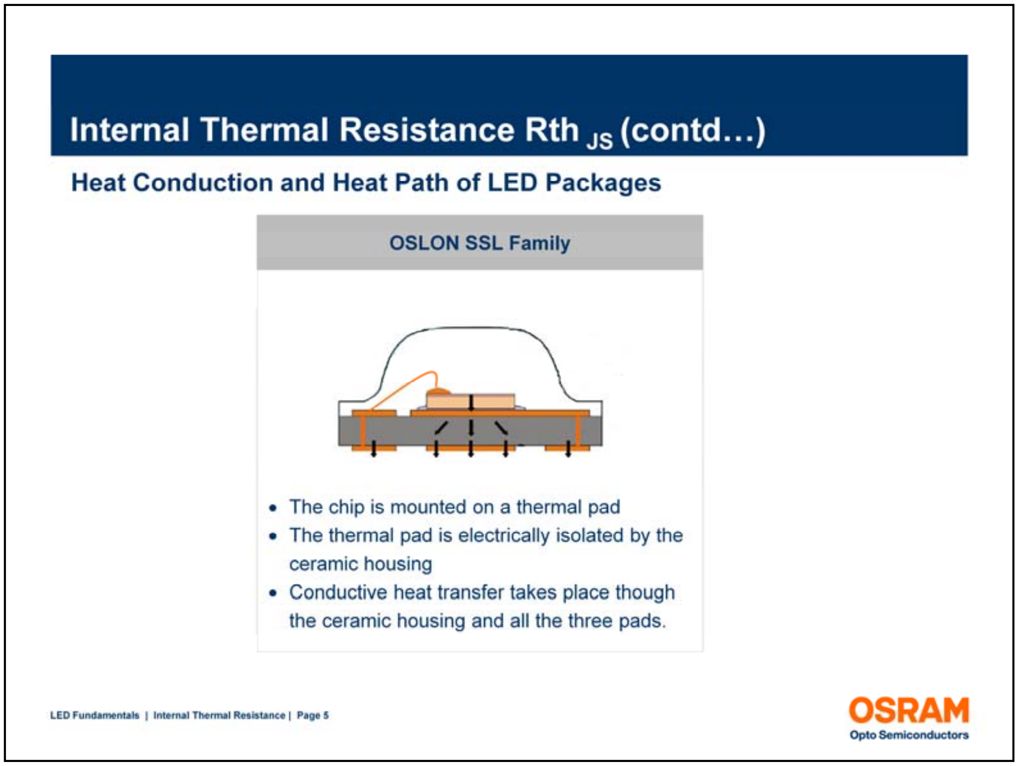
Please refer to the application note “**Package-Related Thermal Resistance of LEDs”** for information on definition and specification of the internal thermal resistance value for LED packages.



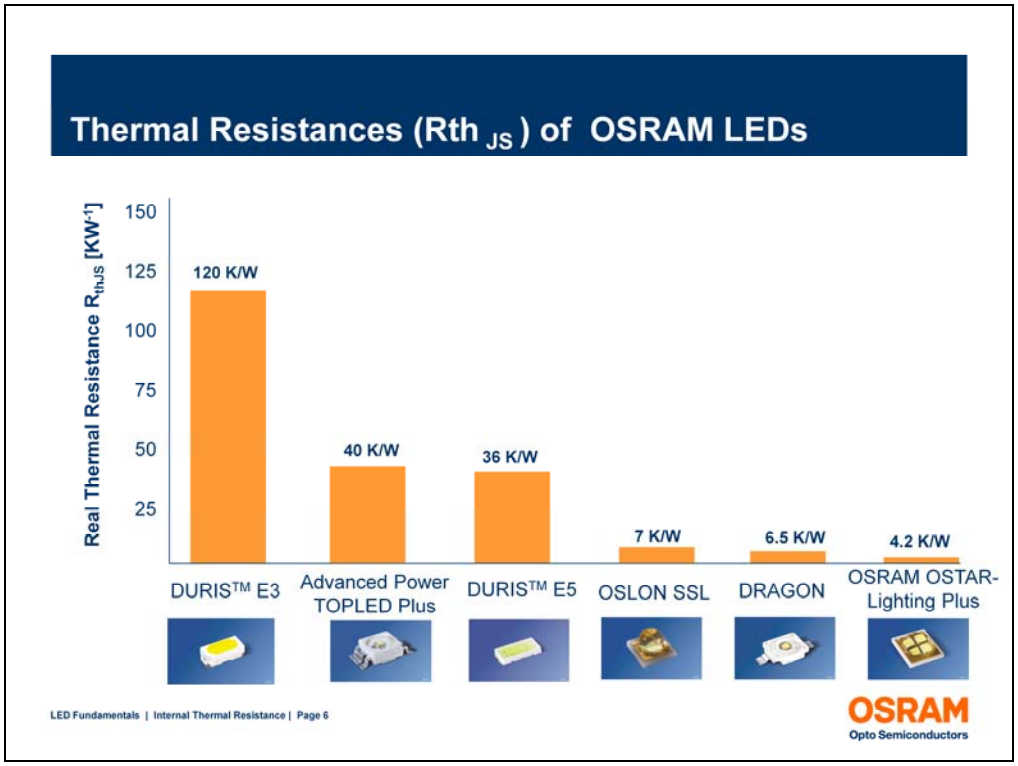
This slide captures the path of heat flow in two OSRAM LED packages.

The primary path of flow of heat for TOPLED packages occurs by the transfer of heat from the chip and leadframe to the ends of the thermally active leads. It should be noted here that depending on the design of the semiconductor housing, a differentiation can be made between thermally active and inactive leads. Thermally inactive leads are those which are only connected to the chip by bond wires.

In the case of the DRAGON product family, the internal dissipation of heat from the chip occurs primarily via the integrated heat sink to the solder pads.



Differing from lead frame packaged LEDs, the semiconductor die in the OSLON SSL package is in a ceramic housing on a thermal pad, which is electrically-isolated from the anode and cathode pads. The ceramic housing, along with the three pads, form an effective channel for heat dissipation.



This slide lists the value of the internal thermal resistance in some OSRAM LED packages.

The value of the thermal resistance of the LED package varies with the package design and die size.

Significance of Thermal Resistance Rth_{JS}

Knowledge of the thermal resistance (Rth_{JS}) of an LED serves to:

- Determine the junction temperature that arises in the LED under operating conditions.
- Determine the maximum allowable external reference temperature for a given internal temperature and power dissipation.
- Evaluate measures for dissipation of heat in the LED system (thermal management).

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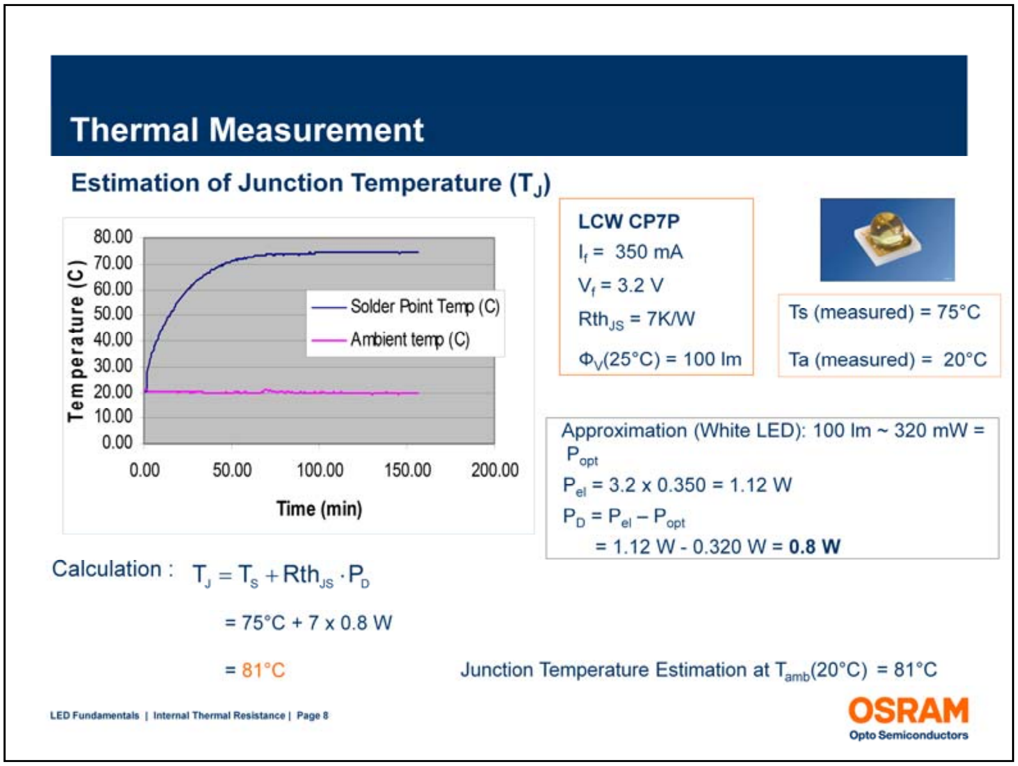
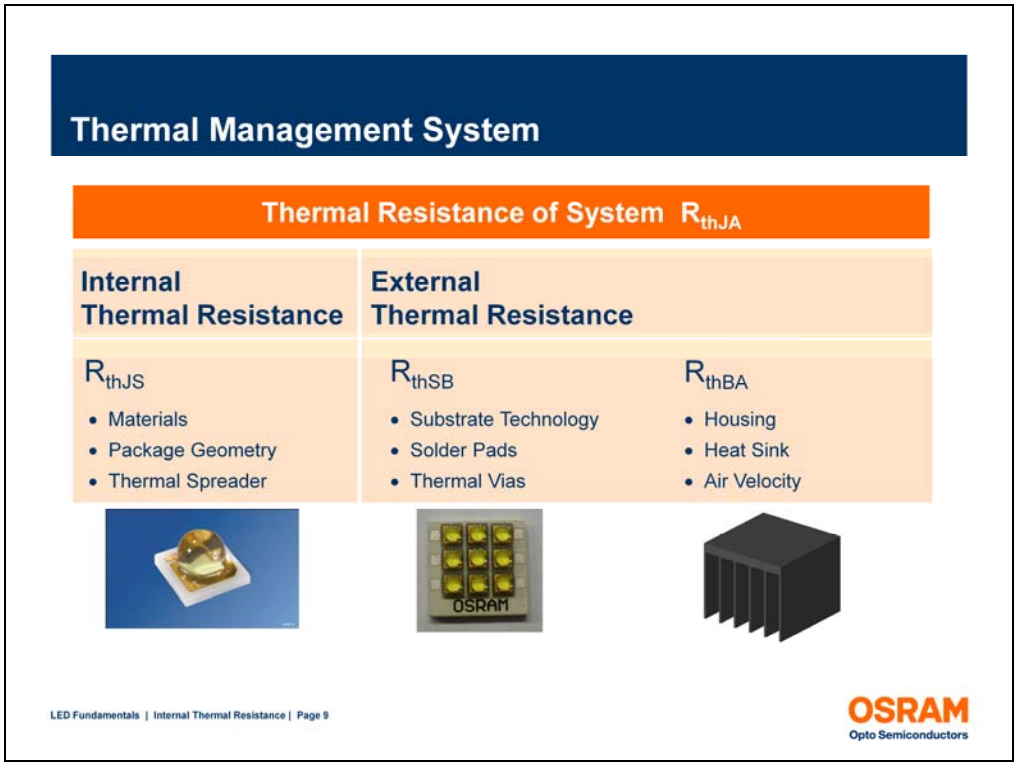
Finally, knowledge of the thermal resistance of an LED package serves as an important tool in LED system design.



The value of the thermal resistance for an LED package is used to calculate the junction temperature of the LED. This slide shows an example of the calculation of junction temperature of the LED under the listed operating conditions.

Please refer to the application note **"Thermal Measurement Guidelines for SSL LEDs"** for information on how to measure solder point temperature for various LED packages.



The overall thermal resistance of an LED system (junction- ambient) can be divided into internal and external thermal resistances.

This presentation covered the internal thermal resistance of the LED package. The next two thermal presentations will cover the aspects of external thermal resistance in an LED system.

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Please refer to the application note **“Thermal Measurement Guidelines for SSL LEDs”** on this website for additional information.

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