Heat dissipation solution for electronics products

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Abstract: heat dissipation causes inefficiency of electronics products which requires thermal analysis. Most of electronics products generate heat on usage, most of which is by switching devices like metal oxide semiconductor FET and transistor circuits. This heat has to be removed from the device for efficient functioning. While thinking of a way to solve these problem heat dissipation needs of today's components are more challenging than ever. So heat sink design is a very important factor in applications generating heat like automobiles, lightning which mostly requires thermal solutions. High performance requirement & smaller feature dimension for today's electronics devices enforced semiconductor industry to face challenges on thermal dissipation.

Keywords: Heat sink, thermal interface, therminator

Efficient Heat sink:

Power usage of today's processor results greater capacity cooling requirements to overcome excess heat. To provide cooling solutions we can use fans, heat sinks or we can increase surface area. Also we can use higher performance interface material between the case and heat sink. Generally heat transfers from hotter surface to colder one. So application tips for heat sink design will be helpful in designing heat sink. Interfaces which are to be used for heat transfer must be smooth & flat. Cabinets & racks must be ventilated at the top & bottom of enclosure. Provide maximum surface area to increase surface emissivity.

What's new in heat Removal?

Generally heat generated & rate of generation are important parameters for the size and design of heat sink. Accordingly we can choose thermal pads on these two factors. Today's designers mostly use radial & grid patterns for heat dissipation. Radial pattern provide ease of design while grid pattern provides higher surface area, for this nowadays aluminum material is the best choice for efficient cooling. Aluminium is well known for light weight, conductivity & low cost. Designers can use high quality alloys for complex designs. Various designers also experimented thermal conductive plastics and graphite, while nonmetallic & noncorrosive materials are already being used in LEDs. Thermal conductive materials are loaded with a conductive material like aluminium nitride is noncorrosive which are ideal for outdoor applications. Thermoplastics are less expensive than aluminium, some of international manufacturer combines copper & extruded aluminium, also did number of experiments on these materials. From graphite a lightweight material called hitherm is developed which is a flexible material. As Carbon is highly conductive it enables this material to be a very good heat sink. Wide structures of graphite sheets can be created even though material presents much lower strength but it enhances structural performance it can be molded with metal casing or perforated with metals. There are various methods of heat spreading; heat spreaders are used in the die level packaging to spread heat from ICs into packaging. On component level heat spreaders like heat pipes are used to move heat & heat sinks themselves can incorporate spreaders such as copper base or heat pipes embedded in aluminum pipes.

Solid & liquid cooling solutions:

While fans & heat sink are not enough for cooling and if rate of heat generation is very high we can go for liquid cooling which provides higher rate of heat transfer. That solution allows coolant to flow in between the plates of heat sink. It absorbs heat from heat sink and tries to maintain efficient environment for smooth operation. Mixture of distilled water & ethylene glycol will be a better coolant, while proportion of these two forms the required temperature. In case of solid solution silicon with ceramic is in higher demand.

Number of layers is used depending on area of usage, to fulfill air gaps thermal pads & compounds are used. Pads should be solid or rubber like material. They are firm at room temperature & become soft as well as having higher ability to fill gaps at higher temperatures. This solution has short life, however thermal pastes moves towards lower end of spectrum as they have tendency to dry out. There is risk of dispersing grease over time & leaves no interface material between the heat source and the sink.
Liquid approaches provide thickness variations with no stress to sensitive components during assembly Epoxy resins from electro lube cater to wide range of automotive applications. Where higher thermal conductivity have prime importance and good thermal performance. Grease solutions can also be designed in range of one watt, two watt, three watt or five watt grease. This gives perfect balance of spread & conductivity. We can use small metal conductors inside the paste which transfer the heat; it leads of smaller sizes of conductors & rate of heat transfer. Among all available solutions the vast majority are the passive heat sinks, where main heat flow path is between the heat sink and the environment.

Thermal interface materials:
Unwanted heat spots of electronics devices can be removed to heat sink with some thermal interface material. Thermal interface materials creates important link between the heat source of active region & heat sink mounted on top. Thermal interface materials are exceeding their limits too fast so innovations are necessary to overcome thermal related challenges for future heat generation. The nanostructured foam like thermal interface materials based on three dimensional carbon & hexagonal boron nitride with high intrinsic thermal conductivities offer solution for both electrical conducting and insulation needs. 3D foam like materials has approximately 25% reduction in temperature increase & thermal resistance by 30 to 40% than any other thermal interface materials. So thermal management remains one of the most critical issues in today's IC technologies especially in high power devices & components. There may be many possible on-chip & off-chip cooling methods available like forced air cooling, internal conduction coupled with forced convection, pure conduction & liquid cooling.

Parameters to be consider while designing Heat sink:
Major challenges to design heat sink are amount of required heat dissipation, maximum allowable heat sink temperature, size of heat sink. By considering all these challenges designers can work on number of fins, thickness of fins, shape of fins & material for designing efficient heat sink. For low to medium power & for effective compact design ambient air will be better option as an fluid. This air can be moved by fan or through natural convection, so design of heat sink must be in such a way that maximum surface area must be contact and will be in direction of flow. Recently most of the designs utilize natural convection for heat sink design and to maintain lower temperature for electronic devices. Sometimes adding chimney effect is also a better option to maintain low heat dissipation. Till now different approaches have been developed to handle heating problems with the help of modeling and simulation at circuit level. One of such approach is for power devices using equivalent electrical networks which models self heating within the devices itself. Number of measurements is being carried out onboard in mass production and packaging of power devices, outcome of this may be negative like it may require redesign and complete fabrication with huge loss of money. For these reasons modeling approach is a big step to improve device performance & to reduce need of redesign. One of such platform is THERMINATOR which is implementation of modeling & simulation framework which fulfills the gap of various aspects of design with various features. Design phase is also enhanced with capacity to simulate through some simulation software's such as SPICE simulator. THERMINATOR platform benefited to modeling, controlling & compensating higher temperature problems in semiconductor devices.

CONCLUSION:

The existing techniques of heat sink production need to be improved in order to face new challenges in electronics. So best solutions needs to be identified and provided for keeping pace with increasing loads of power semiconductors. While cooling electronics products which generates heats there is always heat from other electronics parts in the cabinets so in such cases heat exchanger will be best solution to reduce heat inside the cabinets.

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