

Application Note - Heatsink Design

Version 20120529

Background

Thermal management is a crucial ingredient in the design of a luminaire used in solid state lighting (SSL). Light output, reliability, and lifetime increase as LED junction temperature (T_j) decreases. Module case temperature (T_c) has been correlated to T_j , and therefore, it is very important to keep T_c of the Xicato module below 90°C. To assist with thermal management, Xicato has designed several reference heatsinks (HS) that customers can integrate into their design. See the Thermal Class Matrices on the 'Members Lounge' at www.xicato.com for more information on pairing different Thermal Classes with various standard HS.

It is also possible, however, to design the luminaire such that the luminaire itself acts as the HS. When designing a luminaire that also acts as HS, several factors must be taken into consideration, including:

1. Natural convection flow patterns
2. Luminaire orientation
3. Operating environment
4. Material selection

In order to assist in the thermal design, Xicato can run thermal simulations on the luminaire and provide feedback and recommendations for improvement, if necessary. See "Thermal Simulation Request Form" on the 'Members Lounge' or contact your Xicato representative for more information.

Modes of Heat Transfer

The three modes of heat transfer are conduction, convection, and radiation. All three modes play an important role in the thermal management of LEDs.

Conduction is the transfer of heat between adjacent molecules, usually within a solid. Conduction through a solid is described by the following.

$$\text{Equation 1: } q = k \cdot A \cdot \Delta T_{\text{cond}} / L$$

Where:

q is the rate of heat transfer [W]

k is the thermal conductivity of the solid [W/m-K]

A is the cross sectional surface area [m^2]

ΔT_{cond} is the temperature delta across the solid [K]

L is the distance heat is traveling through the material [m]

The higher the thermal conductivity (k), the more heat is transferred across the solid.

Application Note Heatsink Design

Kraig Mitzner



Application Note Heatsink Design:

Circuit Design: Know It All Darren Ashby, Bonnie Baker, Ian Hickman, Walt Kester, Robert Pease, Tim Williams, Bob Zeidman, 2011-04-19 The Newnes Know It All Series takes the best of what our authors have written to create hard working desk references that will be an engineer's first port of call for key information design techniques and rules of thumb. Guaranteed not to gather dust on a shelf. Electronics Engineers need to master a wide area of topics to excel. The Circuit Design Know It All covers every angle including semiconductors IC Design and Fabrication Computer Aided Design as well as Programmable Logic Design. A 360 degree view from our best selling authors. Topics include fundamentals Analog Linear and Digital circuits. The ultimate hard working desk reference all the essential information techniques and tricks of the trade in one volume.

Complete PCB Design Using OrCAD Capture and PCB Editor Kraig Mitzner, Bob Doe, Alexander Akulin, Anton Suponin, Dirk Müller, 2019-06-20 Complete PCB Design Using OrCAD Capture and PCB Editor Second Edition provides practical instruction on how to use the OrCAD design suite to design and manufacture printed circuit boards. Chapters cover how to Design a PCB using OrCAD Capture and OrCAD PCB Editor adding PSpice simulation capabilities to a design how to develop custom schematic parts how to create footprints and PSpice models and how to perform documentation simulation and board fabrication from the same schematic design. This book is suitable for both beginners and experienced designers providing basic principles and the program's full capabilities for optimizing designs. Companion site <https://www.elsevier.com/books-and-journals/book-companion/9780128176849> Presents a fully updated edition on OrCAD Capture Version 17.2. Combines the theoretical and practical parts of PCB design. Includes real life design examples that show how and why designs work providing a comprehensive toolset for understanding OrCAD software. Provides the exact order in which a circuit and PCB are designed. Introduces the IPC JEDEC and IEEE standards relating to PCB design.

Complete PCB Design Using OrCad Capture and Layout Kraig Mitzner, 2011-04-01 Complete PCB Design Using OrCad Capture and Layout provides instruction on how to use the OrCAD design suite to design and manufacture printed circuit boards. The book is written for both students and practicing engineers who need a quick tutorial on how to use the software and who need in depth knowledge of the capabilities and limitations of the software package. There are two goals the book aims to reach. The primary goal is to show the reader how to design a PCB using OrCAD Capture and OrCAD Layout. Capture is used to build the schematic diagram of the circuit and Layout is used to design the circuit board so that it can be manufactured. The secondary goal is to show the reader how to add PSpice simulation capabilities to the design and how to develop custom schematic parts footprints and PSpice models. Often times separate designs are produced for documentation simulation and board fabrication. This book shows how to perform all three functions from the same schematic design. This approach saves time and money and ensures continuity between the design and the manufactured product. Information is presented in the exact order a circuit and PCB are designed. Straightforward realistic examples present the how and why the

designs work providing a comprehensive toolset for understanding the OrCAD software Introduction to the IPC JEDEC and IEEE standards relating to PCB design Full color interior and extensive illustrations allow readers to learn features of the product in the most realistic manner possible *The Circuit Designer's Companion* Peter Wilson, 2012-01-12 Grounding and Wiring Printed Circuits Passive Components Active Components Analog Integrated Circuits Digital Circuits Power Supplies Electromagnetic Compatibility General Product Design Appendices **GaN Power Devices for Efficient Power Conversion** Alex Lidow, Michael de Rooij, John Glaser, Alejandro Pozo Arribas, Shengke Zhang, Marco Palma, David Reusch, 2024-12-31 An up to date and concise review of GaN transistor design and applications In the newly revised fourth edition of GaN Power Devices for Efficient Power Conversion a team of distinguished researchers and practicing engineers deliver a concise and effective new guide to designing small energy efficient and inexpensive products with GaN transistors This new edition covers all relevant new GaN technology advancements allowing students and practicing engineers to get and stay ahead of the curve with GaN device and circuit technology You ll explore applications including DC to DC converters solar inverters motor drive controllers satellite electronics and LiDAR devices The 4th edition offers critical updates for space applications vertical GaN and driving transistors and integrated circuits New chapters on reliability testing advancements device wear out mechanisms thermal management and the latest developments in monolithic integration round out the book Readers will also find The latest updates on significant technology improvements like integrated circuits reliability studies and new applications Comprehensive explorations of integrated circuit construction characteristics reliability results and applications Practical discussions of specific circuit designs layout and thermal dissipation when designing power conversion systems Chapters written by practicing expert leaders in the power semiconductor field and industry pioneers Perfect for practicing power conversion engineers GaN Power Devices for Efficient Power Conversion will also benefit electrical engineering students and device scientists in the field of power electronics *Analog Circuit Design* Bob Dobkin, Jim Williams, 2011-09-26 Analog circuit and system design today is more essential than ever before With the growth of digital systems wireless communications complex industrial and automotive systems designers are challenged to develop sophisticated analog solutions This comprehensive source book of circuit design solutions will aid systems designers with elegant and practical design techniques that focus on common circuit design challenges The book s in depth application examples provide insight into circuit design and application solutions that you can apply in today s demanding designs Covers the fundamentals of linear analog circuit and system design to guide engineers with their design challenges Based on the Application Notes of Linear Technology the foremost designer of high performance analog products readers will gain practical insights into design techniques and practice Broad range of topics including power management tutorials switching regulator design linear regulator design data conversion signal conditioning and high frequency RF design Contributors include the leading lights in analog design Robert Dobkin Jim Williams and Carl Nelson among others *A Comprehensive*

Guide to Cooling Industrial Lighting Charles Nehme, In the vast and ever evolving world of industrial engineering few technologies have been as transformative as the transition from traditional lighting to Solid State Lighting SSL or LED technology This shift has not been merely about replacing one light source with another it is a fundamental paradigm change that has redefined our understanding of efficiency longevity and sustainability As a global MEP Mechanical Electrical and Plumbing Consultant with over 30 years of experience I have had a front row seat to this revolution witnessing its profound impact on everything from the operational costs of a facility to the very well being of its occupants The promise of the LED is seductive dramatically lower energy consumption a life expectancy measured in decades and a versatility that was once unimaginable Yet this promise comes with a silent unseen and often underestimated challenge heat The energy efficiency of an LED is not absolute a significant portion of the electrical power it consumes is still converted into heat but in a way that is profoundly different from its predecessors This heat if left unchecked is the single greatest threat to an LED s performance and longevity This book is born from a simple but critical observation while the industry has embraced the immense potential of the LED it has not always fully grappled with its thermal consequences The result is a market saturated with fixtures that fail to deliver on their advertised lifespan creating a hidden cost in maintenance energy and lost productivity Through this book we will embark on a journey to demystify the science of thermal management We will explore the physics of heat generation in LEDs dissect the catastrophic effects of inadequate cooling and reveal the sophisticated engineering strategies from passive heat sinks to advanced active cooling systems that are essential for a fixture to not only perform but to truly endure This is not a theoretical exercise it is a practical guide rooted in real world applications and professional experience This book is intended for anyone who designs specifies installs or maintains industrial lighting fellow engineers architects facility managers and project leaders My hope is that it will serve as an indispensable resource transforming the perception of thermal management from a technical afterthought into a strategic priority For in the end the true brilliance of an LED is not just in the light it produces but in how effectively it manages the heat it generates

[Designing Electronics That Work](#)
Hunter Scott, 2025-09-16 How real engineers build electronics one working piece at a time If you ve ever had a board fail on power up spent hours debugging a layout that should work or run into a supplier problem just before a deadline you already know this isn t just about theory It s about judgment decisions and real world constraints *Designing Electronics That Work* is a guide to all the practical things you won t find in a typical electronics textbook It s written for people who already know a little maybe a lot about circuits but want to move faster make fewer mistakes and ship working hardware with more confidence You ll learn how to Define and prioritize requirements so you re building the right thing not just the clever thing Design schematics and layouts to make debugging easier Plan for manufacturability compliance and cost from day one Build a lab that helps you work faster without spending a fortune Troubleshoot problems methodically even when nothing s making sense Hunter Scott has designed electronics for medical devices RF systems startups and art installations This book reflects

what he s learned not as theory but as practice You won t find chapter length explanations of what a capacitor is You will find answers to questions like Which capacitor should I actually buy What if the one I spec d is out of stock How do I avoid wasting time and money Whether you re a hobbyist moving beyond Arduino a new grad learning on the job or an experienced engineer looking to streamline your process this book will help you build smarter and avoid problems before they start

Thermal Management for LED Applications Clemens J.M. Lasance,András Poppe,2013-09-17 Thermal Management for LED Applications provides state of the art information on recent developments in thermal management as it relates to LEDs and LED based systems and their applications Coverage begins with an overview of the basics of thermal management including thermal design for LEDs thermal characterization and testing of LEDs and issues related to failure mechanisms and reliability and performance in harsh environments Advances and recent developments in thermal management round out the book with discussions on advances in TIMs thermal interface materials for LED applications advances in forced convection cooling of LEDs and advances in heat sinks for LED assemblies New and Renewable Technologies for Sustainable Development Naim Hamdia Afgan,Maria Cristina Ramos de Carvalho,2012-12-06 Sustainable development encompasses economic social and ecological perspectives of conservation and change in natural resources It is generally defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs This definition is based on the ethical imperative of equity within and between generations Moreover apart from meeting the basic needs of all sustainable development implies sustaining the natural life support systems on Earth and extending to all the opportunity to satisfy their aspirations for a better life Hence sustainable development is more precisely defined as a process of change in which the exploitation of resources the direction of investments the orientation of technological development and institutional change are all in harmony and enhance both current and future potential to meet human needs and aspiration To date various definitions and stationary state criteria of sustainability have been proposed Many authors have been concerned with only part of the problem such as the technological assumptions the ability to substitute natural resources in economic transformation processes and the resilience and importance of ecological processes But the social dimension did not receive the same attention and has not been adequately integrated into formal analysis The engineering community has to play an important role in sustainable development with appropriate evaluation of the engineering systems In this respect energy water and environment systems require multi criteria evaluation methods for the assessment of the economic environmental and social aspect of the systems *National Symposium on Advances in Microwaves and Lightwaves* ,1998 GaN Transistors for Efficient Power Conversion Alex Lidow,Michael de Rooij,Johan Strydom,David Reusch,John Glaser,2019-08-23 An up to date practical guide on upgrading from silicon to GaN and how to use GaN transistors in power conversion systems design This updated third edition of a popular book on GaN transistors for efficient power conversion has been substantially expanded to keep students and practicing power conversion engineers

ahead of the learning curve in GaN technology advancements Acknowledging that GaN transistors are not one to one replacements for the current MOSFET technology this book serves as a practical guide for understanding basic GaN transistor construction characteristics and applications Included are discussions on the fundamental physics of these power semiconductors layout and other circuit design considerations as well as specific application examples demonstrating design techniques when employing GaN devices GaN Transistors for Efficient Power Conversion 3rd Edition brings key updates to the chapters of Driving GaN Transistors Modeling Simulation and Measurement of GaN Transistors DC DC Power Conversion Envelope Tracking and Highly Resonant Wireless Energy Transfer It also offers new chapters on Thermal Management Multilevel Converters and Lidar and revises many others throughout Written by leaders in the power semiconductor field and industry pioneers in GaN power transistor technology and applications Updated with 35% new material including three new chapters on Thermal Management Multilevel Converters Wireless Power and Lidar Features practical guidance on formulating specific circuit designs when constructing power conversion systems using GaN transistors A valuable resource for professional engineers systems designers and electrical engineering students who need to fully understand the state of the art GaN Transistors for Efficient Power Conversion 3rd Edition is an essential learning tool and reference guide that enables power conversion engineers to design energy efficient smaller and more cost effective products using GaN transistors

CRC Handbook of Thermal Engineering Raj P. Chhabra, 2017-11-08 The CRC Handbook of Thermal Engineering Second Edition is a fully updated version of this respected reference work with chapters written by leading experts Its first part covers basic concepts equations and principles of thermodynamics heat transfer and fluid dynamics Following that is detailed coverage of major application areas such as bioengineering energy efficient building systems traditional and renewable energy sources food processing and aerospace heat transfer topics The latest numerical and computational tools microscale and nanoscale engineering and new complex structured materials are also presented Designed for easy reference this new edition is a must have volume for engineers and researchers around the globe

Analysis and Application of Analog Electronic Circuits to Biomedical Instrumentation Robert B. Northrop, 2012-03-02 Analysis and Application of Analog Electronic Circuits to Biomedical Instrumentation Second Edition helps biomedical engineers understand the basic analog electronic circuits used for signal conditioning in biomedical instruments It explains the function and design of signal conditioning systems using analog ICs the circuits that enable ECG EEG

Modules, Systems, and Applications in Thermoelectrics David Michael Rowe, 2012-04-25 Comprising two volumes Thermoelectrics and Its Energy Harvesting reviews the dramatic improvements in technology and application of thermoelectric energy with a specific intention to reduce and reuse waste heat and improve novel techniques for the efficient acquisition and use of energy This volume Modules Systems and Applications in Thermoelec

Thyristor Theory and Application Clay Laster, 1986

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Encyclopedia comes in 3 sets To check out Set 1 and Set 3 please visit Set 1 Thermal Packaging Techniques and Set 3 Thermal Packaging Applications remove Thermal and mechanical packaging the enabling technologies for the physical implementation of electronic systems are responsible for much of the progress in miniaturization reliability and functional density achieved by electronic microelectronic and nanoelectronic products during the past 50 years The inherent inefficiency of electronic devices and their sensitivity to heat have placed thermal packaging on the critical path of nearly every product development effort in traditional as well as emerging electronic product categories Successful thermal packaging is the key differentiator in electronic products as diverse as supercomputers and cell phones and continues to be of pivotal importance in the refinement of traditional products and in the development of products for new applications The Encyclopedia of Thermal Packaging compiled in four multi volume sets Set 1 Thermal Packaging Techniques Set 2 Thermal Packaging Tools Set 3 Thermal Packaging Applications and Set 4 Thermal Packaging Configurations will provide a comprehensive one stop treatment of the techniques tools applications and configurations of electronic thermal packaging Each of the author written sets presents the accumulated wisdom and shared perspectives of a few luminaries in the thermal management of electronics Set 2 Thermal Packaging Tools The second set in the encyclopedia Thermal Packaging Tools includes volumes dedicated to thermal design of data centers techniques and models for the design and optimization of heat sinks the development and use of reduced order compact thermal models of electronic components a database of critical material thermal properties and a comprehensive exploration of thermally informed electronic design The numerical and analytical techniques described in these volumes are among the primary tools used by thermal packaging practitioners and researchers to accelerate product and system development and achieve correct by design thermal packaging solutions The four sets in the Encyclopedia of Thermal Packaging will provide the novice and student with a complete reference for a quick ascent on the thermal packaging learning curve the practitioner with a validated set of techniques and tools to face every challenge and researchers with a clear definition of the state of the art and emerging needs to guide their future efforts This encyclopedia will thus be of great interest to packaging engineers electronic product development engineers and product managers as well as to researchers in thermal management of electronic and photonic components and systems and most beneficial to undergraduate and graduate students studying mechanical electrical and electronic engineering

Recent Advances in Power Electronics and Drives Om Hari Gupta, Simanta Kumar Samal, Ranjit Mahanty, Bhim Singh, Ilhami Colak, 2025-01-02 This book entitled Recent Advances in Power Electronics and Drives select proceedings of EPREC 2024 provides the rigorous discussions case studies and recent developments in the emerging areas of power electronics especially power inverter and converter electrical drives regulated power supplies electric vehicle and its charging infrastructure etc There are two main problems with the electric vehicle EVs technology which are associated with the range anxiety charging spot and time These problems can be taken care of with having a good charging infrastructure which

provides ways to improve the environmental conditions and make sure to mitigate these issues The same issues would be addressed via this book The readers would be benefited in enhancing their knowledge and skills in the domain areas Also this book may help the readers in developing new and innovative ideas The book can be a valuable reference for beginners researchers and professionals interested in advancements in power electronics and drives *Проектирование печатных плат в OrCAD® CAPTURE и OrCAD® PCB EDITOR* Д. Мюллер, А. Супонин, А. Акулин, Б. Доу, К. Митцнер, 2024-11-20 OrCAD PSpice **Advances in Silicon Carbide Processing and Applications** Stephen E. Saddow, Anant K. Agarwal, 2004 Learn the latest advances in SiC Silicon Carbide technology from the leading experts in the field with this new cutting edge resource The book is your single source for in depth information on both SiC device fabrication and system level applications This comprehensive reference begins with an examination of how SiC is grown and how defects in SiC growth can affect working devices Key issues in selective doping of SiC via ion implantation are covered with special focus on implant conditions and electrical activation of implants SiC applications discussed include chemical sensors motor control components high temperature gas sensors and high temperature electronics By cutting through the arcane data and jargon surrounding the hype on SiC this book gives an honest assessment of today s SiC technology and shows you how SiC can be adopted in developing tomorrow s applications

Adopting the Beat of Expression: An Psychological Symphony within **Application Note Heatsink Design**

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