From Module to Market

Trustworthy Advice for Designing Custom COM Carrier Boards

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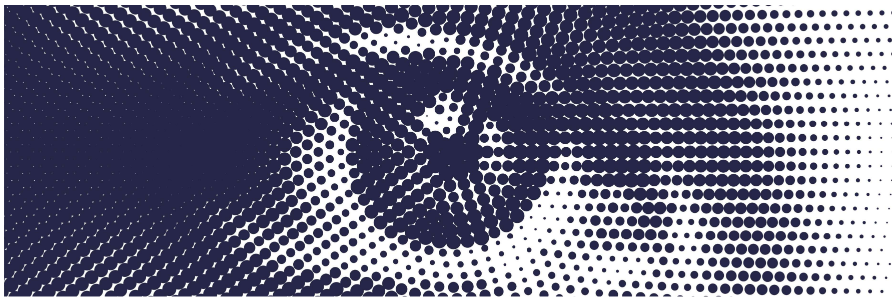
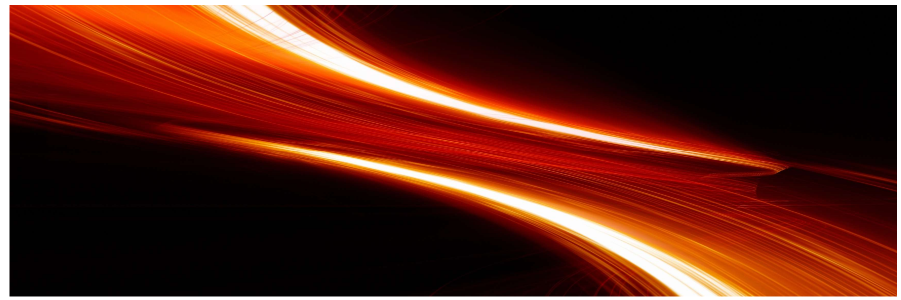
Product Sales Manager

From Module to Market

Agenda

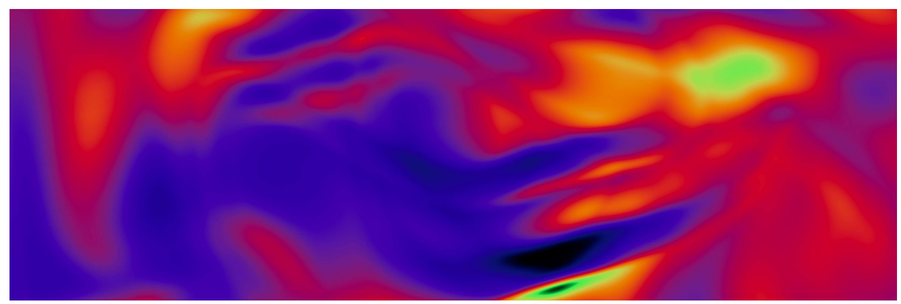


Requirements Capture



Electrical Design

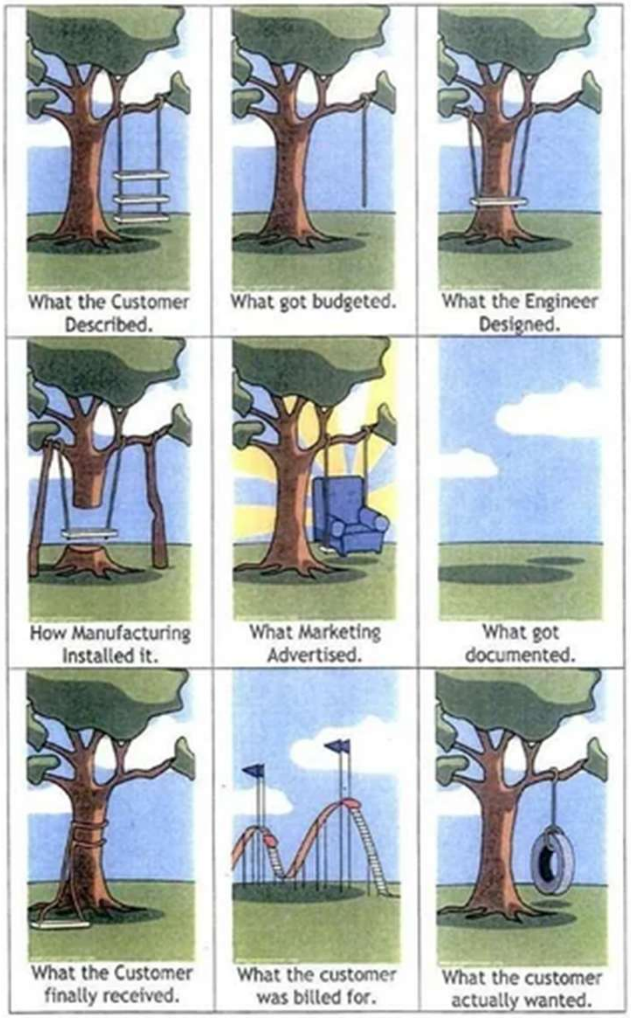
Mechanical Design



Thermal Design

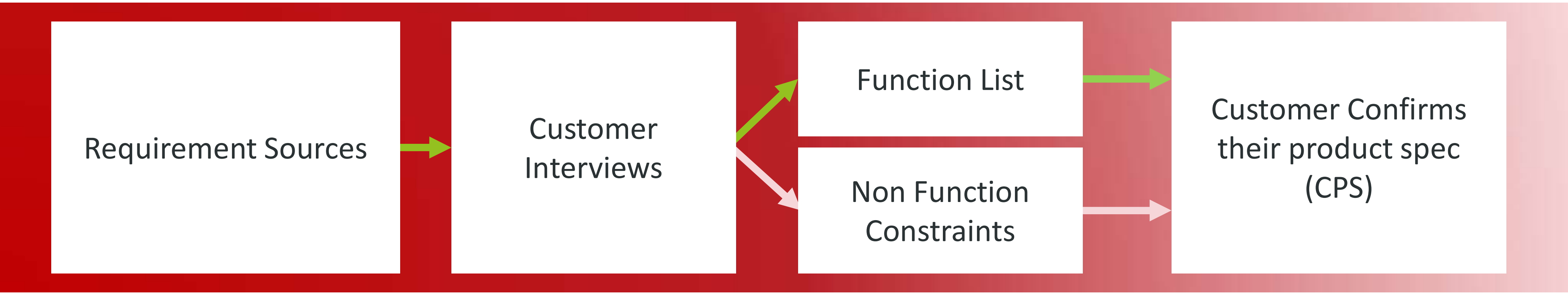
Why Requirements Matter

Most of design failures trace back to unclear requirements.



Functional/Non-Functional Requirements

- Functional Requirements
  - CPU/GPU performance targets
  - Supported I/O (USB, Ethernet, PCIe, CAN, GPIO)
  - Specific tasks to accomplish (AI inference, image processing, control logic)



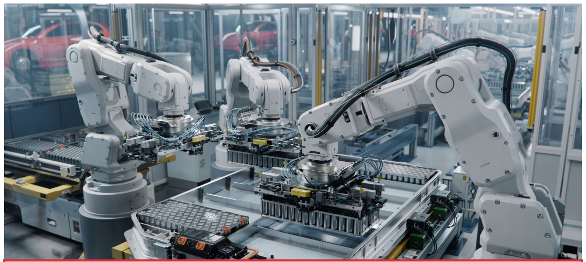
Why Requirements Matter

Non Functional Requirements |Market Positioning & Use Cases

IoT

Medical

Defense



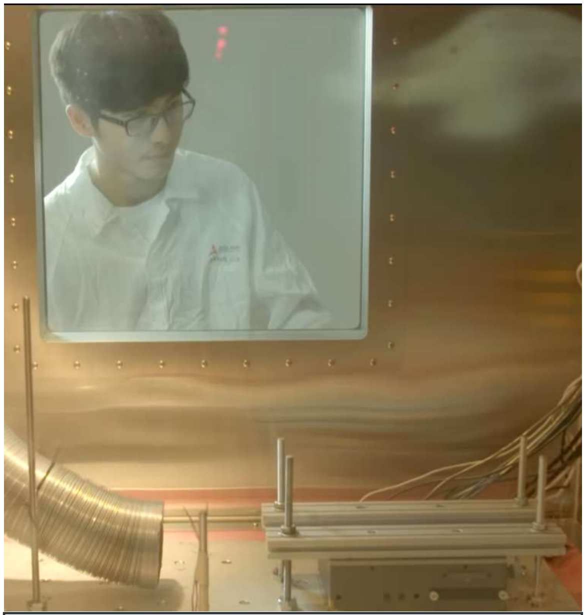
Commercial

Why Requirements Matter

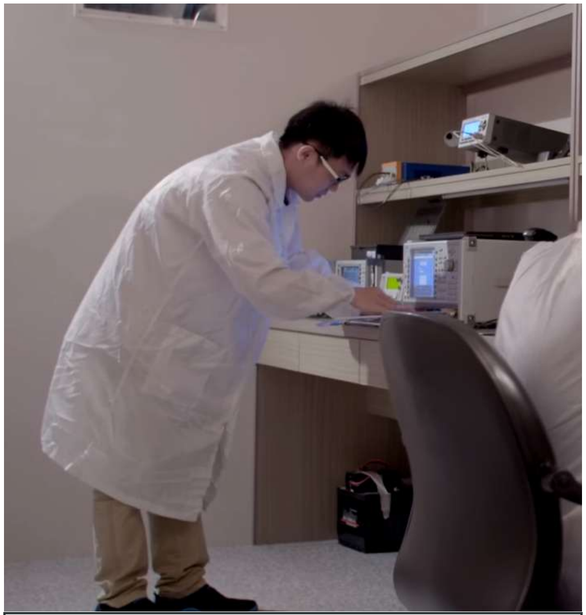
Which 3 part of the requirements are most likely to be missed?

Need to understand customer application.

Longevity

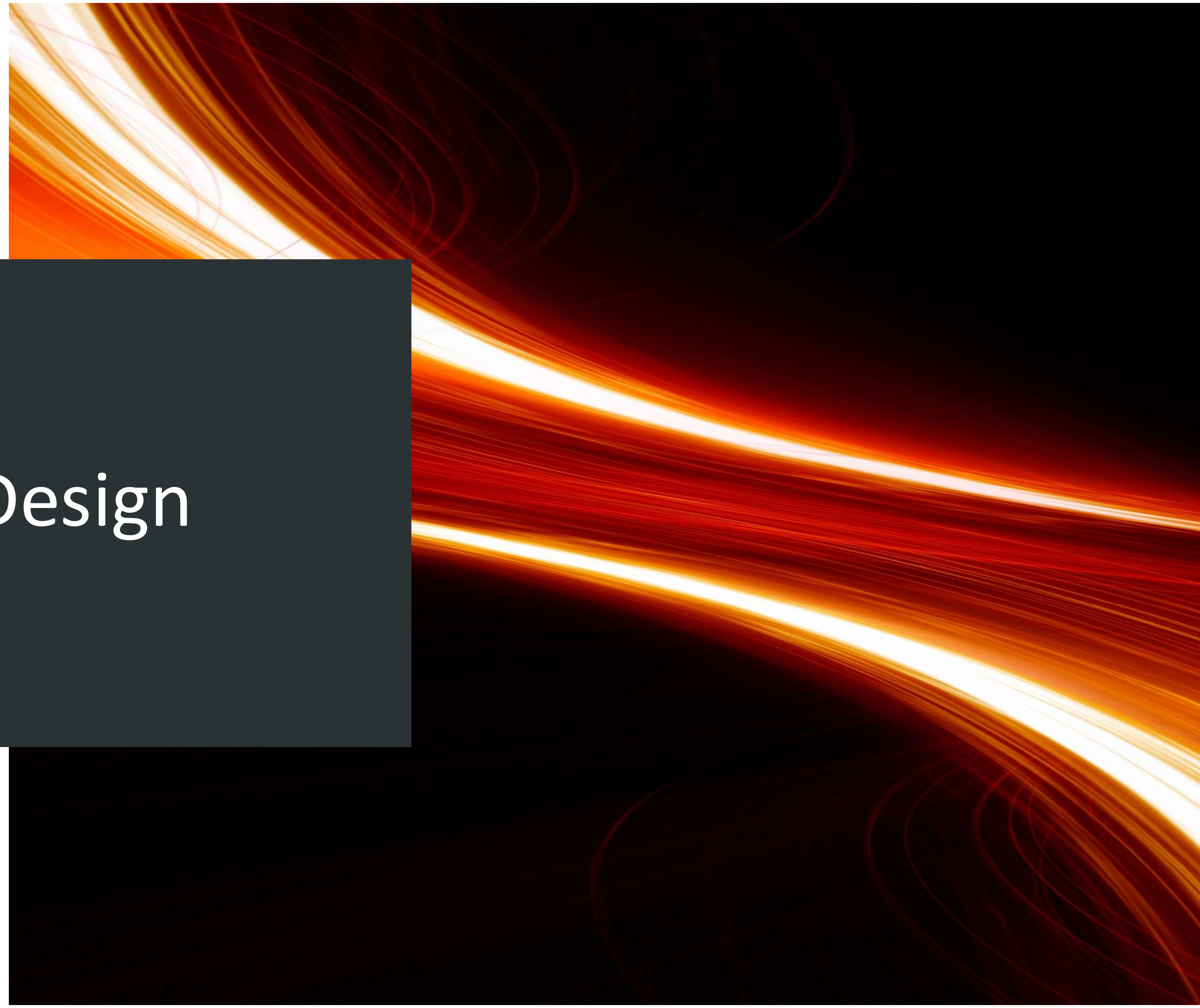


Thermal



Signal Integrity (SI)

Electrical Design



Electrical Design

Electric Requirements and PI

- System input voltages: 12V / 19V / 24V…
- Module rails: 1.8V / 3.3V / 5V / 12V
- Number and distribution of power rails
    - Analog, high speed, hibernate.
    - Current? Standby/Steady/inrush?
- Power noise and suppression
- Decoupling capacitor placement
- PDN (Power Distribution Network) simulation
- PI is as critical as SI.

Apollo Lake SoC	Max=12W	#557555 V1.0 P.97
VCC_VCGI	IccTDC= 18A	0~1.45V 21A
VNN_SVID		0~1.45V 3.3A
VCCIOA		0~1.45V 1.5A
VCCRAM_V1P05		1.05V 2.7A
VCC_V1P24_1P35_A		1.24V or 1.35V 1.8A
VCC_V1P24_A		1.24V 0.13A
VCC_V1P8V_A		1.8V 0.4A
VDDQ		1.35V 2.8A
VCC_3P3V_A		3.3V 0.15A
VCC_RTC_3P3V		2-3.47V TBD

DDR3L SDRAMx9	3.141W	P.20-21
VDDQ	1.350V	0.20911A* 8= 1.673A
VTT	0.675V	0.1634A* 8= 1.307A

LPC to UART (NCT5104D)	0.66W	P.26
VDD	3.3V 0.2A	

GbE LAN (intel i210LM)	0.58W	P.28
VDD	3.3V 0.175A	

LPC to UART (LM73)	1.63mW	P.32
VDD	3.3V 0.495mA	

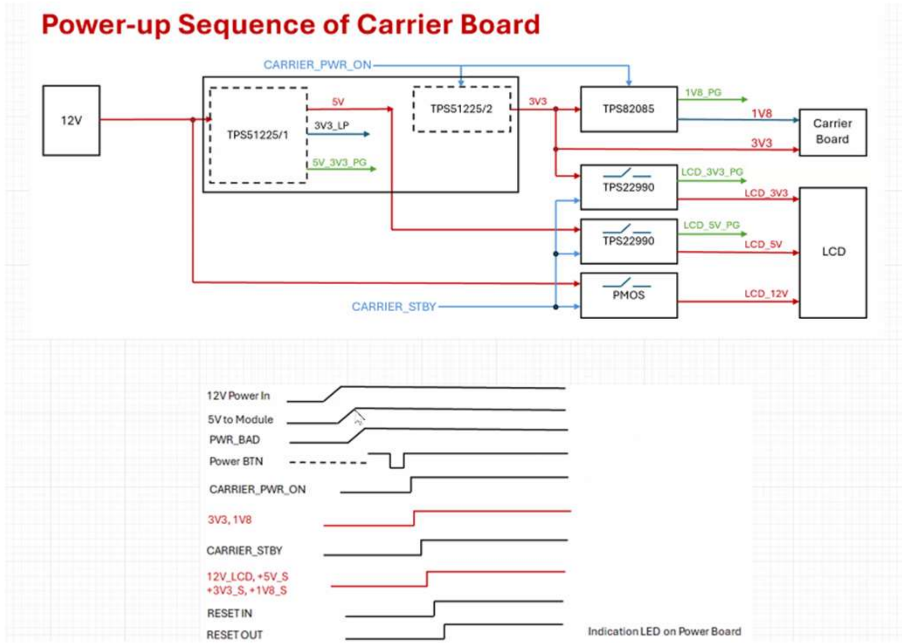
eDP to LVDS (PTN3460)	0.57W	P.33
VDD	3.3V 0.172A	

eMMC (THGBMFG8C4L)	0.92W	P.34
VCC	3.3V 0.12A	
VCCQ	1.8V 0.29A	

Electrical Design

Power Sequence

- Startup order of different rails
- Reset & Power Good coordination
- Use of embedded controller IC
- Wrong power sequence = module fails to boot.



Unreliable Root Cause!!

Electrical Design

PCB Stack-up & Routing Strategy

- 4/6/8 layer board differences
- Power plane & ground plane distribution
- High-speed return path planning

Routing determines signal integrity

Electrical Design

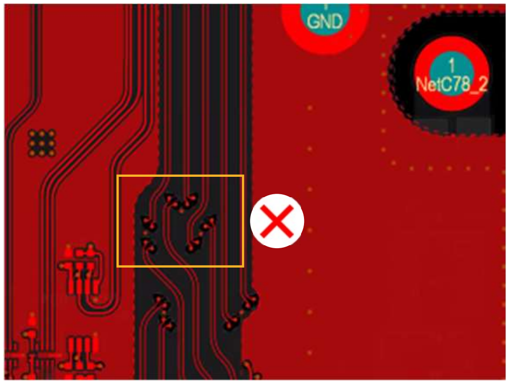
High-Speed Signal Routing

- DDR: Length matching, fly-by topology
- PCIe / USB3.0: Differential pair routing, impedance control
- MIPI / HDMI: Crosstalk and eye diagram analysis
- Routing directly impacts performance & stability.

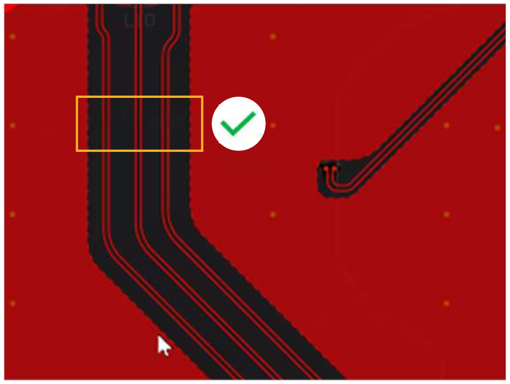
Electrical Design

PCIe / USB3.0 / MIPI High-Speed Interfaces

- Lane allocation and length constraints
- Use of re-drivers / re-timers
- Connector selection impact
- High-speed I/O is often the bottleneck.



Not Acceptable

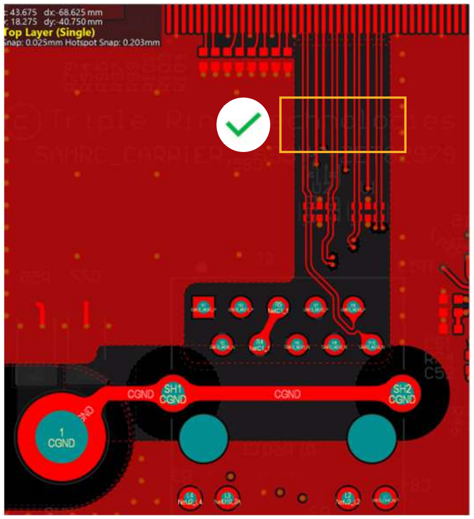


Acceptable

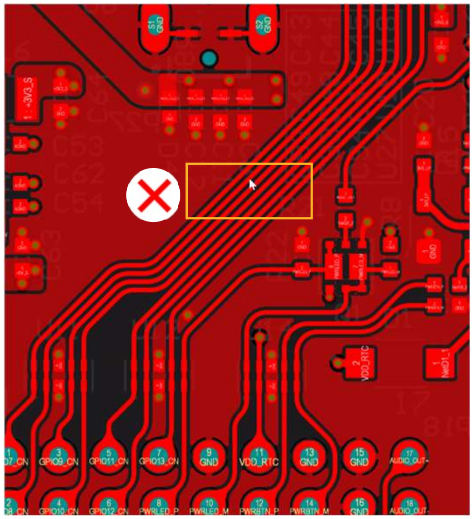
Electrical Design

I/O Requirements

- Interface selection: Ethernet, CAN, UART, GPIO, USB, PCIe
- Solation needs (RS-485/422 in industrial)
- Protection: ESD, surge
- Bandwidth vs latency tradeoffs
- I/O defines who and how long the product can connect.



Acceptable



Not Acceptable

Electrical Design

EMI / EMC / ESD Design

- Ground split & via design
- EMI filters, ferrite beads, shielding
- Preventing PCB layout hot spots

EMC determines certification success

Electrical Design

BOM source (COO)& Lifecycle Management

- Component lifecycle tracking
- Alternate parts & multi-vendor strategy
- Longevity programs
- BOM is the shared language of engineering & procurement.

Mechanical Design

Mechanical Constraints

- PCB size and placement limitations
- Height restrictions (enclosure thickness / slot interference)
- Weight and structural strength requirements

Mechanical constraints often define the product form earlier than circuits

Mechanical Design

Carrier Board Size & Mounting Mechanism

- Standardized holes
    - SMARC
    - COM Express
    - COM-HPC carrier
- Mated connector pairs vs Slot
- Attaching the thermal solution

Wrong hole placement leads to installation failure or EMC issues.

Mechanical Design

Connector Layout & Robustness

- Board-to-board connector alignment precision
- High-frequency connectors (M.2, PCIe)
    - Insertion force/life rating

Connector durability directly impacts system reliability.

Mechanical Design

Industrial vs Commercial Grade Mechanical Design

- Different environments = different priorities
- Industrial and commercial designs follow very different mindsets.

Industrial	Commercial
❑ anti-vibration	❑ Aesthetics
❑ long life	❑ Cost
❑ easy maintenance outdoor	❑ Mass Production
❑ IP rating	❑ Plastic
❑ Conformal coating	

Mechanical Design

Vibration & Shock Resistance

- MIL-STD-810G testing standards
- Number and placement of PCB mounting points
- Rubber pads / damping structures/shock mounting
- Anti-shock design determines entry into transportation/defense markets.

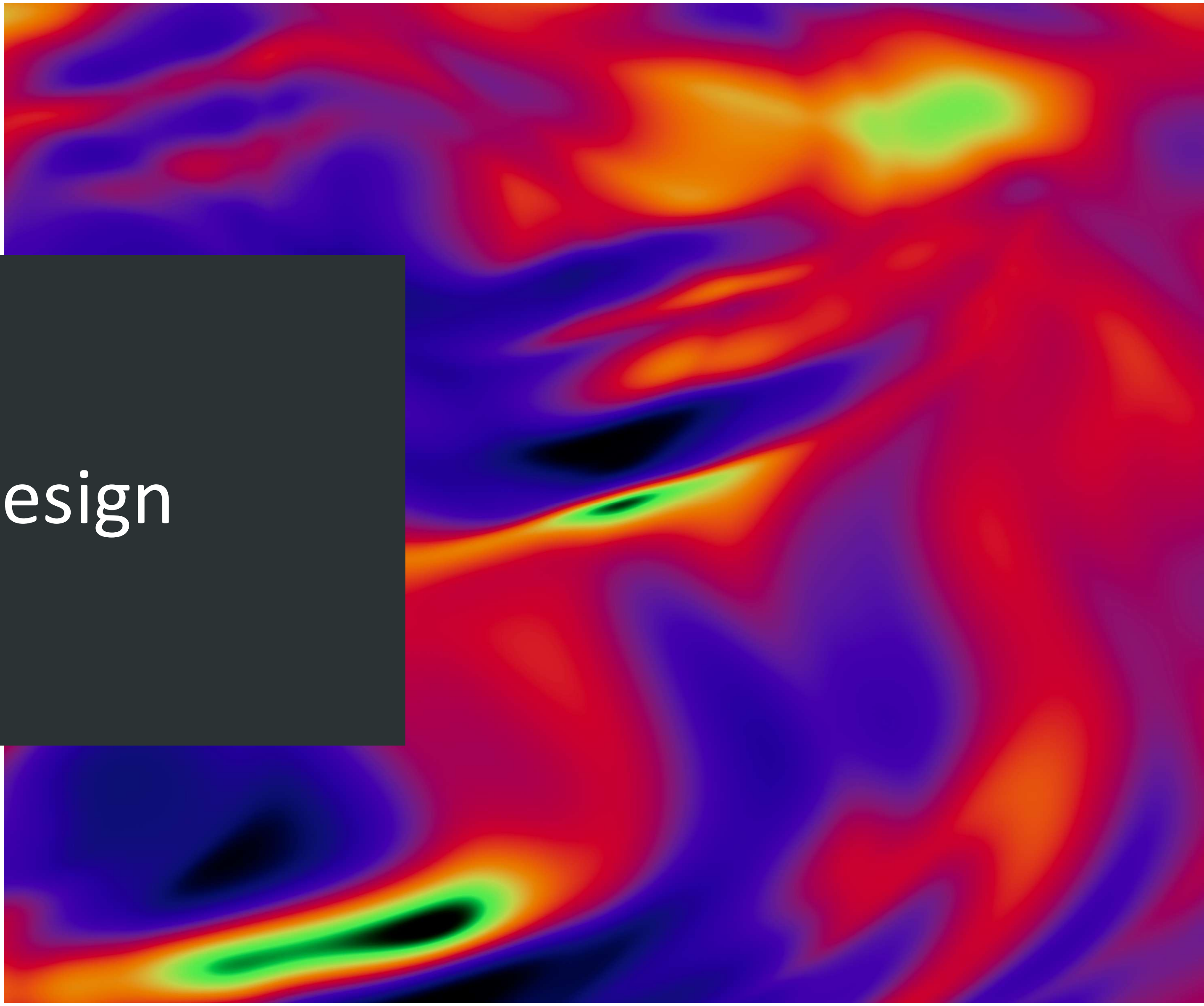
Mechanical Design

IP Rating (Ingress Protection)

- IP40/IP54 / IP65 / IP67 levels
- Seal gaskets, screw design
- Use of waterproof breathable membranes
- Medical wipe-down
- IP design defines outdoor/harsh environment readiness.

Medical Grade HMI

Thermal Design



Thermal Design

Power & TDP/TGP Estimation

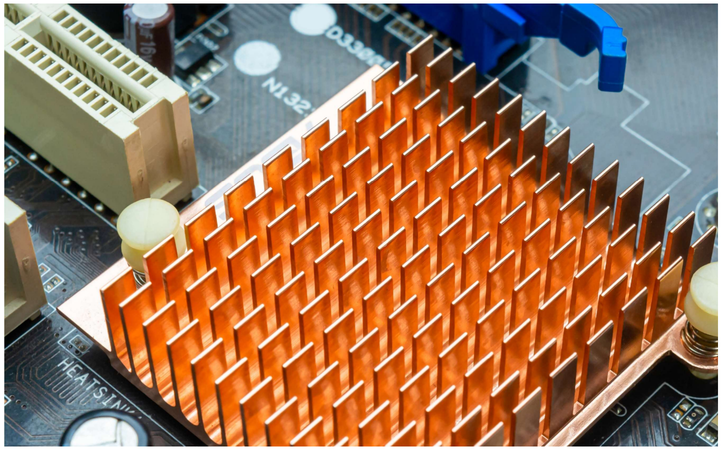
- Estimate system maximum power consumption
- Thermal Design Power (TDP) calculation
- Thermal Graphic Power/TGP

Thermal Design

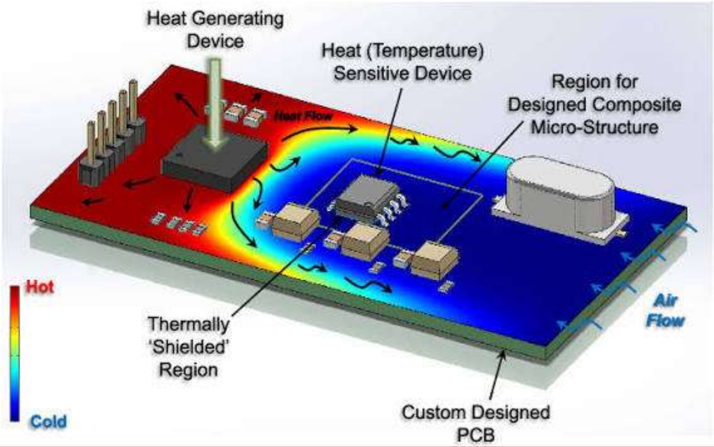
Heat Source Distribution & Thermal Path

- CPU / GPU / PCH / PMIC hotspots/Voltage Regulator (VR)
- Thermal path (chip → package → PCB → heatsink → Enclosure)
- Thermal stacking effect in multilayer boards

Passive Cooling Design



Heatsink



Heatspread

Thermal Design

Active Cooling Design

- Fan / blower selection
- Heatsink Fin direction affects COM orientation
- Airflow path design
- Trade-off between noise and performance

Thermal Design

Liquid Cooling Feasibility

- Limitations in industrial applications
- Pump lifetime, maintenance challenges
- Not recommended for high-reliability environments

Common Thermal Failure Cases

- Heat accumulation → local overheating
- Poor heatsink contact(or air gaps) → high thermal resistance
- Wrong airflow design → hot air recirculation
- Identifying or tracking fan failure to trigger alarm or warning → Fan Replacement
- Failure cases are the best lessons to avoid problems.

Q&A

Bonus: Share Your Feedback

Get a $20 Amazon Gift Card

THE END

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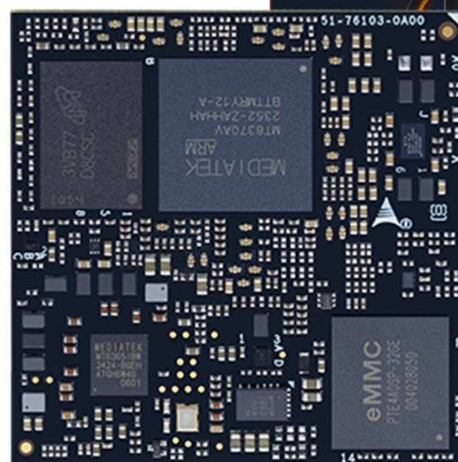
Requirements Capture

Failure Case

- Application
- Indoor, Outdoor, Vehicle, Medical
- Regulations and standards
- Lifetime and longevity



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