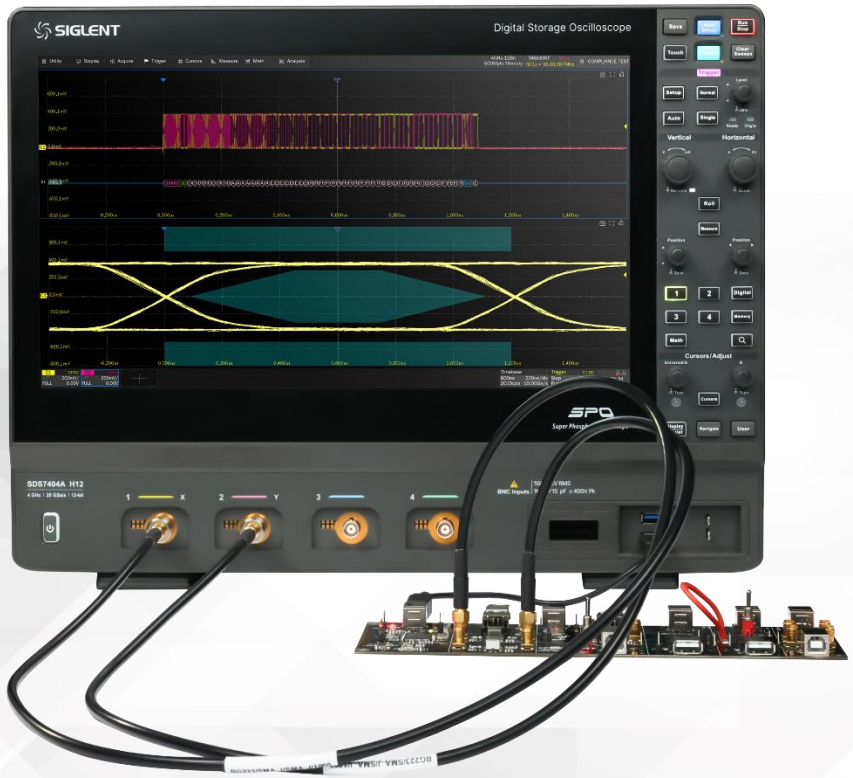
Hardware Integration testing at Embedded Electronics Challenges,Tasks, and Solutions



Agenda

- Challenges
  - Interoperability
  - Power Management / Power & Signal Integrity
  - Thermal & Mechanical Integration
- Testing Tasks & Solutions
  - Core Testing & Verification
  - Timing & Synchronisation
  - Fault injection tests

Challenges

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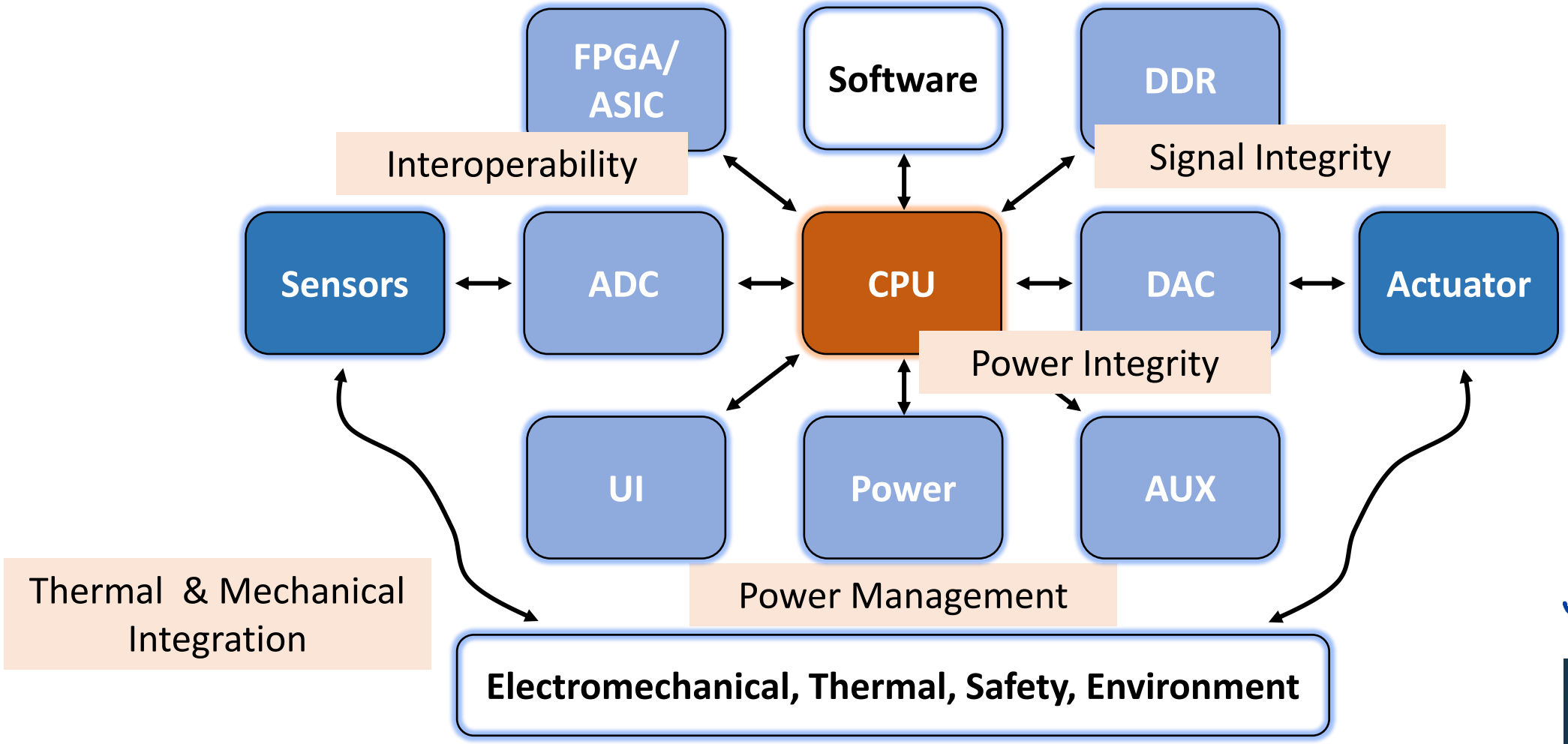
Het ontwerpen van innovatieve elektronica

Woensdag 20 maart 2024

1931 Congrescentrum 's-Hertogenbosch

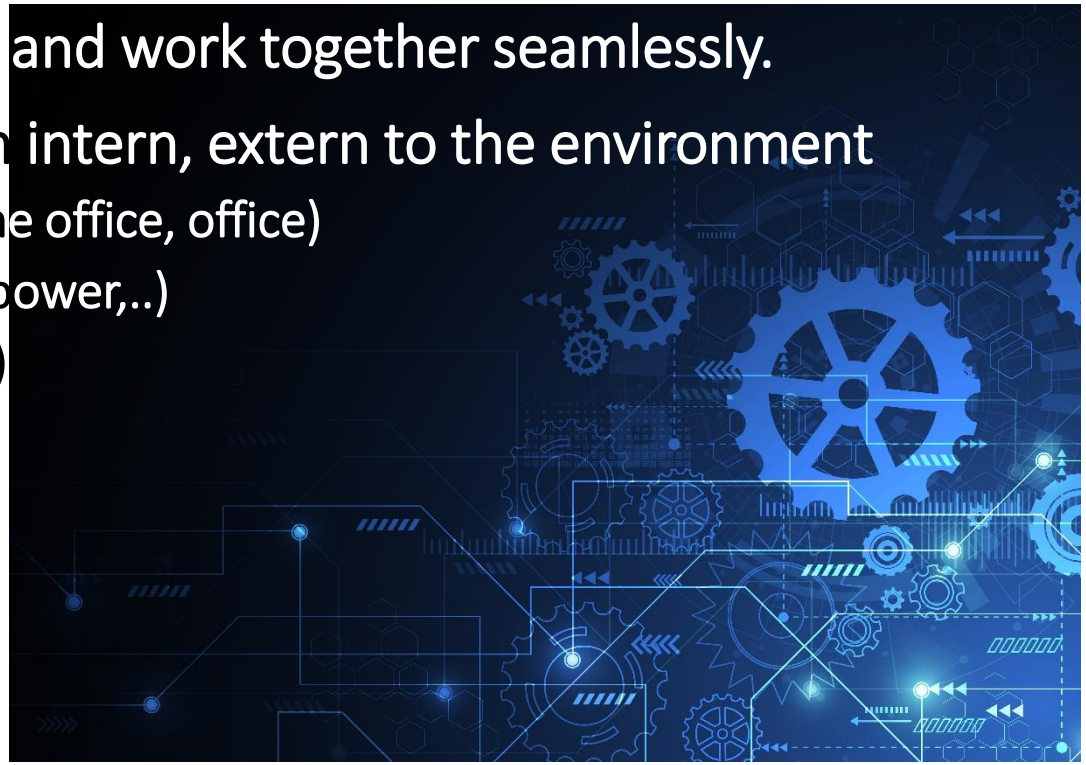
Functional Blocks of an Embedded System



Challenge: Interoperability

Target: Communicate, exchange data, and work together seamlessly.

- Between engineering teams, system intern, extern to the environment
  - Locally separated teams (globally, home office, office)
  - Specialized teams (RF, digital, analog, power,..)
  - Interface definition (intern and extern)

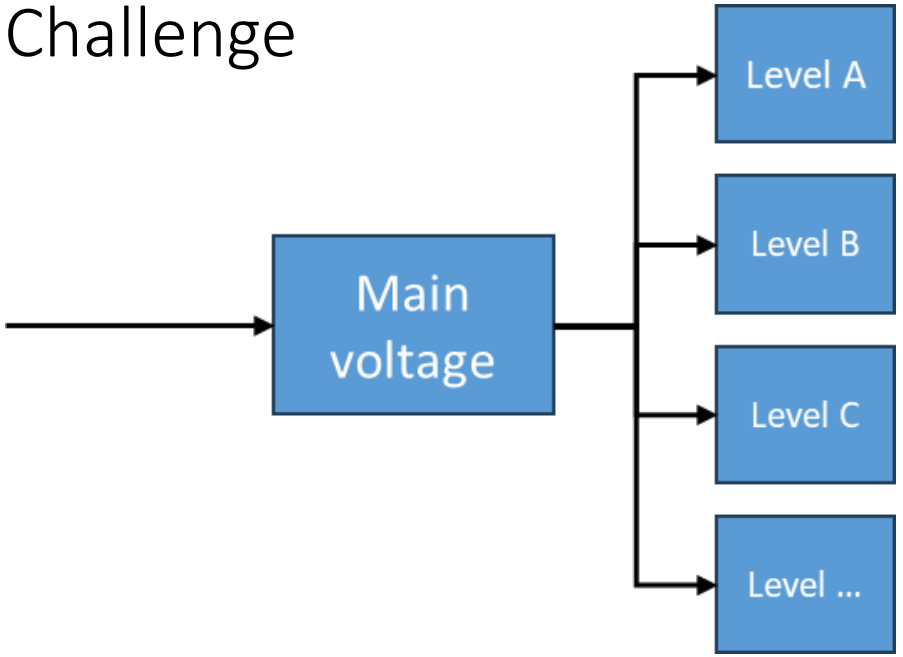


- Communication Protocols
- Voltage Levels

Challenge: Power Management

Target: stable, efficient and sufficient power supply

- Many different voltage levels are needed. The requirements are quite different (low volt, high current, high dynamic, low ripple, …)
- Different building blocks require separate PSU
- Grounding Challenge



Challenge: Power & Signal Integrity

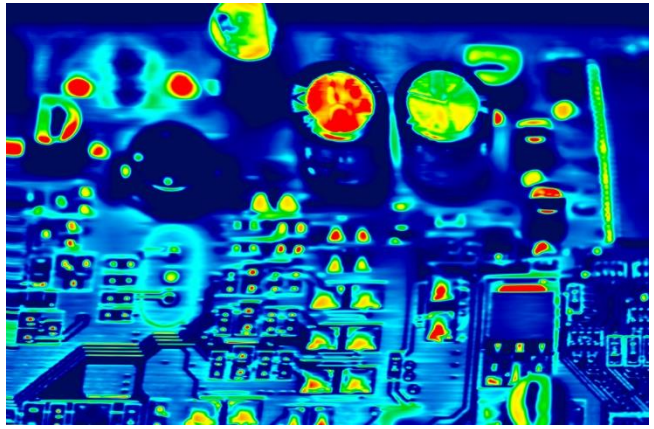
Target: high quality power supply & clean signal transmission

- Power supply quality is crucial for functionality and reliability
- To maintain proper digital communication and wireless communication requires focusing on Signal integrity
- Power integrity impacts Signal Integrity and vice versa

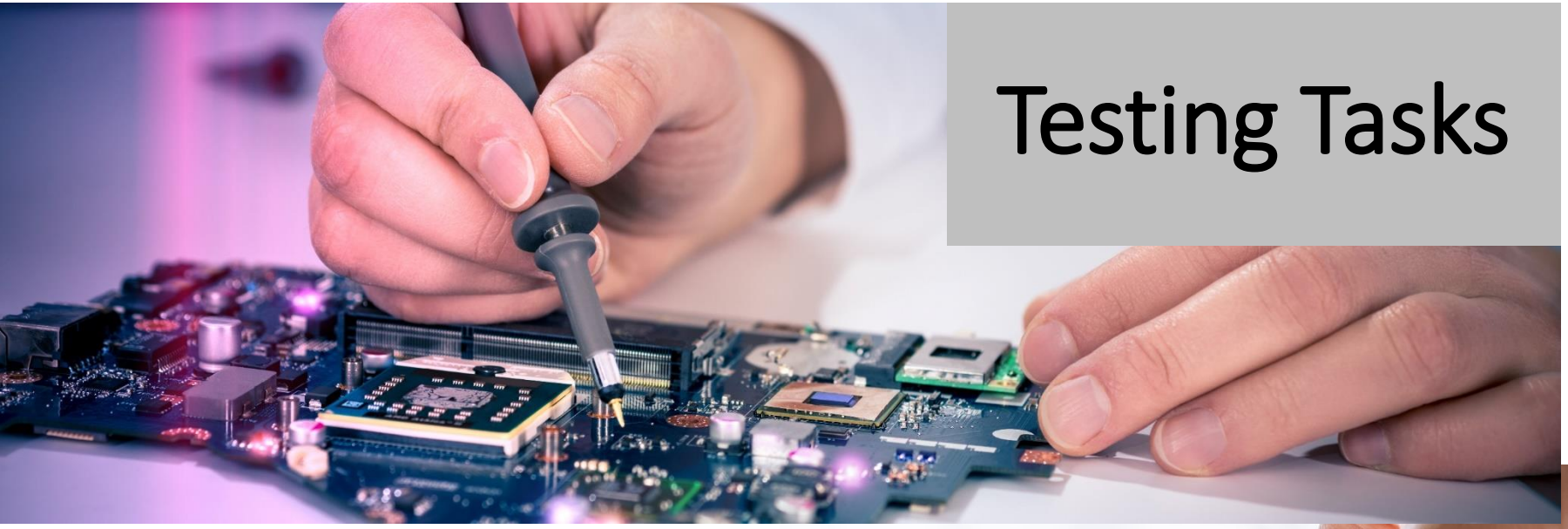
Challenge: Thermal & Mechanical Integration

Target: the optimum packaging solution

- Right thermal concept (air flow, space, head dissipation,…)
- Mechanical integration for water, dust, mechanical protection
- The use-case often defines the limits (wearable vs. industrial)
- Cost!



IPxx rating



Testing Tasks

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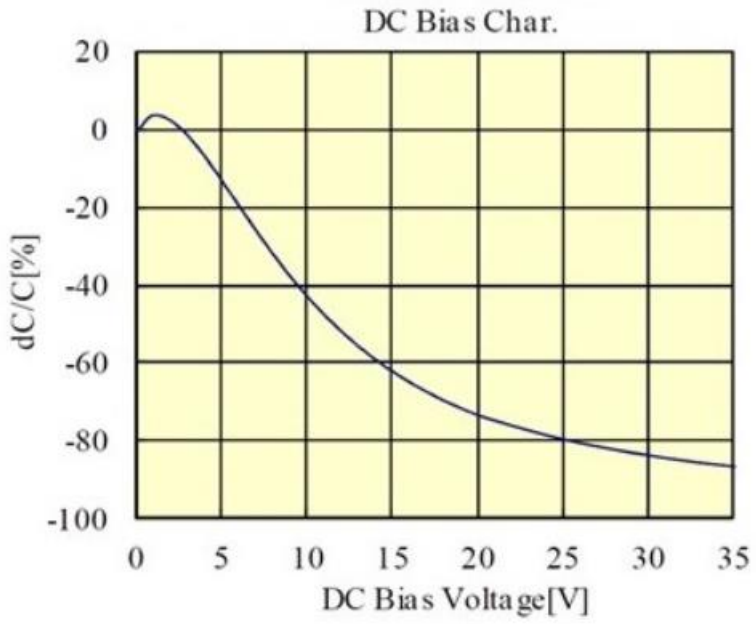
Core Testing & Verification

- Simulation Optimization & Verification
  - Component testing (connectors, transmission lines,)
- Tools: VNA / Component tester / LCR-Meter

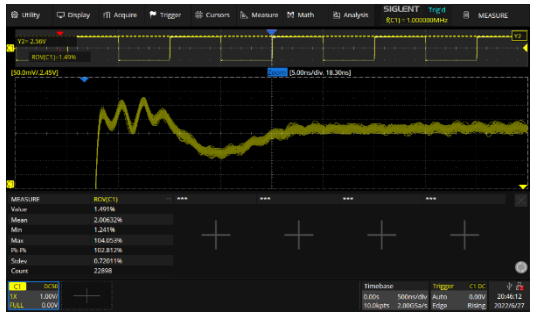
Example: MLCC

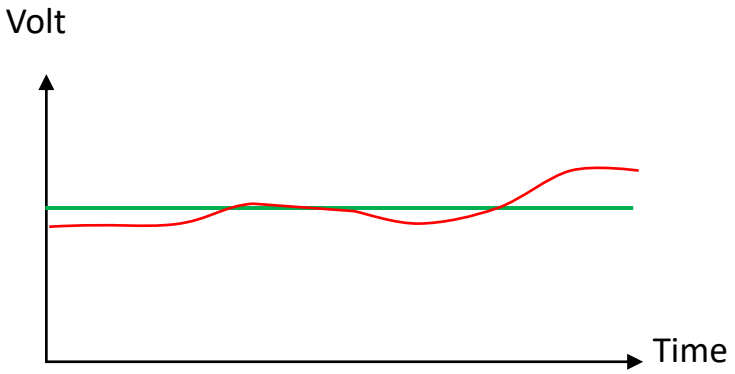
Data sheet values don’t cover every use case



Core Testing & Verification

- Power stability
  - No Oscillation
  - Right power levels
  - Stability over time





- Tools: Oscilloscope / Bode Plot / Data logger / Multimeter

- Functional Testing
  - Input check, output check, Sensor emulation, …
- Tools: Multimeter / Oscilloscope / Arb. Function Generator

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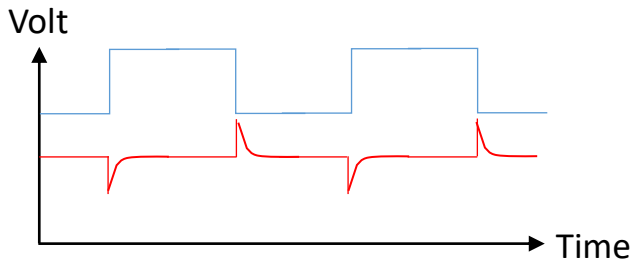
Core Testing & Verification

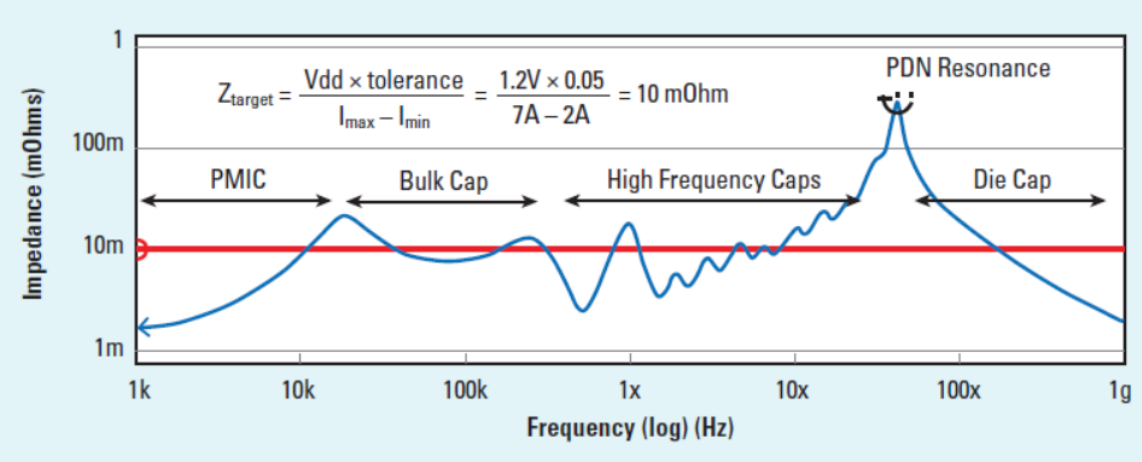
- Power Integrity testing
  - Quality of Supply (static & dynamic)
- Tools: Oscilloscope & Probes / Load / VNA

Ripple



Load Step Response

Concept of design for Target Impedance



[Target Impedance Is Not Enough | 2019-01-16 | Signal Integrity Journal]

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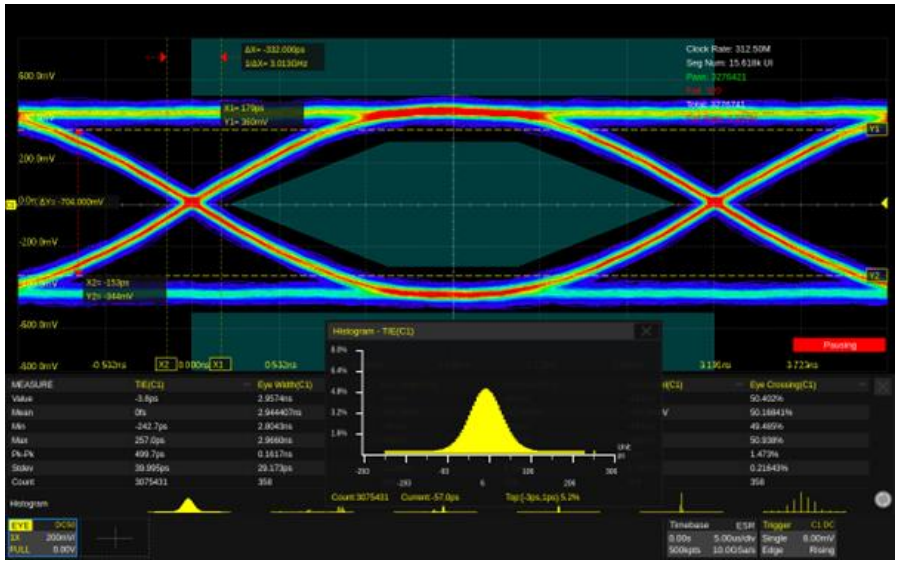
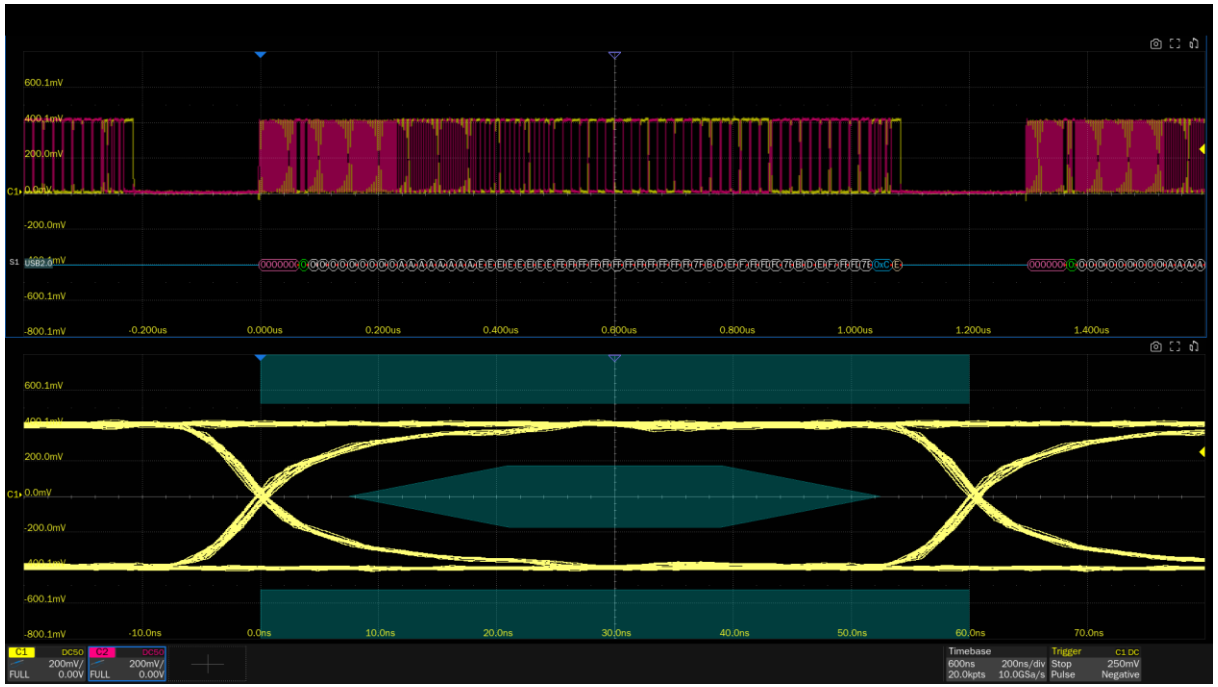
Core Testing & Verification

- Signal Integrity testing
  - Digital communication lines / RF communication
- Tools: VNA / Oscilloscope / Signal Analyzer / Spectrum Analyzer
- Compliance testing (DDR, USB, Ethernet)



Core Testing & Verification

- Compliance testing (DDR, USB, Ethernet)
  - Are communications within Standards
- Tools: Oscilloscope, Arb. Func. Generators / VNA



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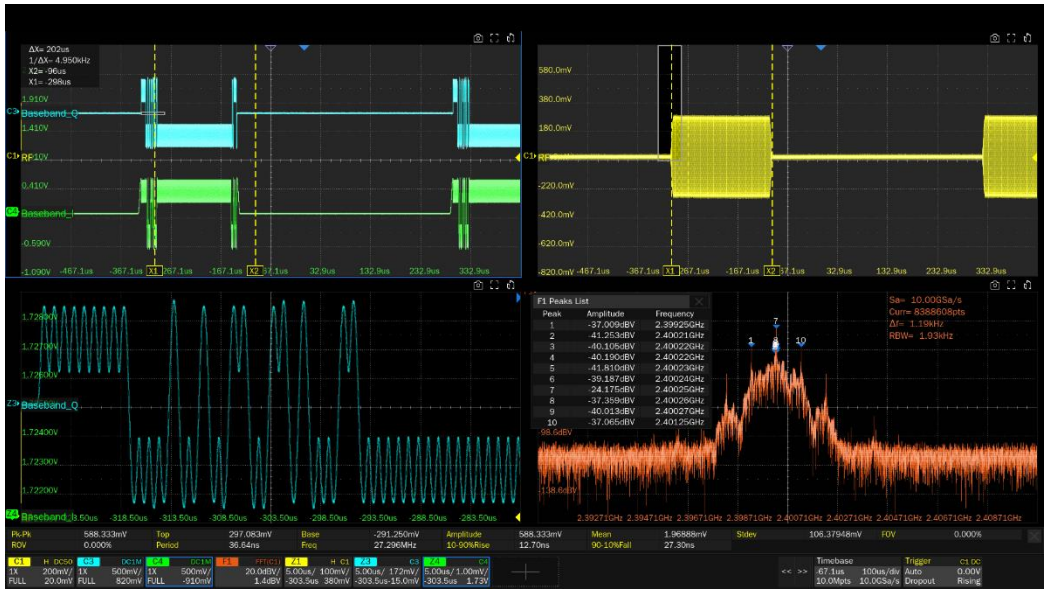
Timing & Synchronization

- Clock verification (Jitter)
- Digital communication -> actors
- Sensor -> data processing -> reaction
- RF output
  - Make sure the different parts work seamlessly together
- Tools: Oscilloscopes / Logic Analyzer / RF-Analyzer



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Fault Injection Test

- Overlay input signals with noise and disturbances
- Worsen internal communication lines
- Voltage level change (up / down)

  ➔Evaluate working boundaries, limits, reliability
- Tools: Noise- & Signal Generators / Analyzers

Don’t miss to visit our booth – number 22.

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