ELECTRONICS & APPLICATIONS
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EMI – the undesirable Effect of modern Power Electronics

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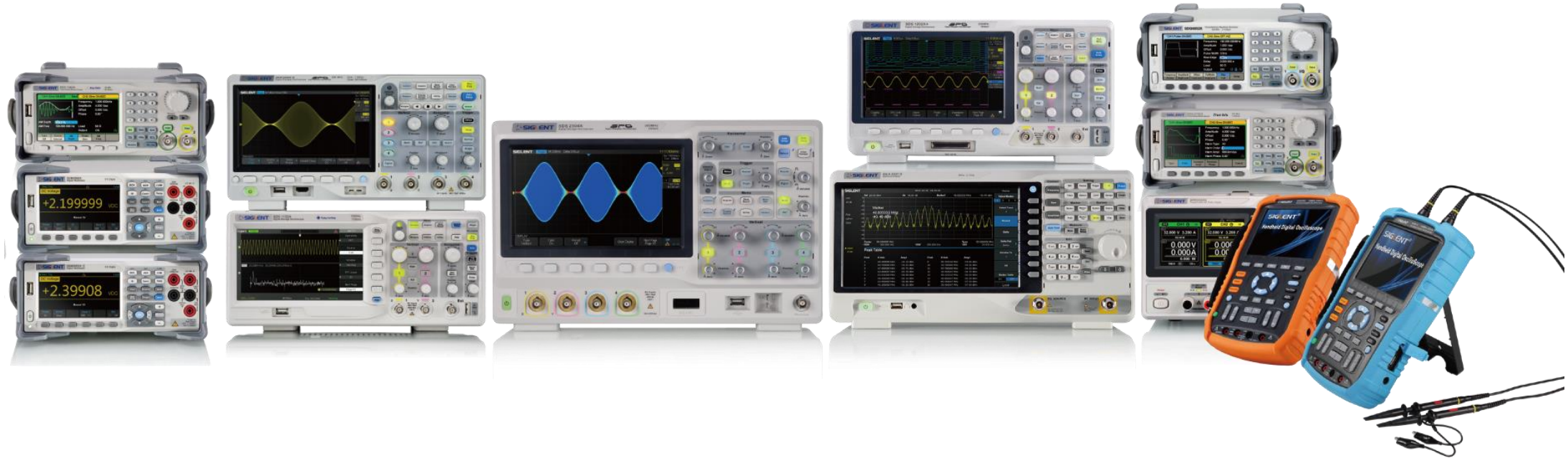
Sales & Marketing Manager Europe



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- Introduction – Trends & Markets
- Power Electronics Basic Intro
- EMI from Power Electronics
- How modern Semiconductors change EMI behavior
- Who we are and What we offer

Trends & Markets

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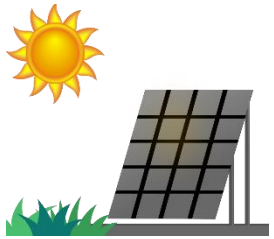
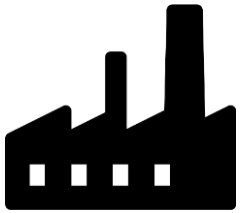
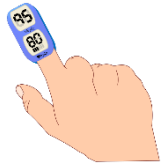
- Digitization – Smart X
- Renewable Energy
- Electrification of Transportation
- Autonomous Driving







Why Power Electronics is now popular?

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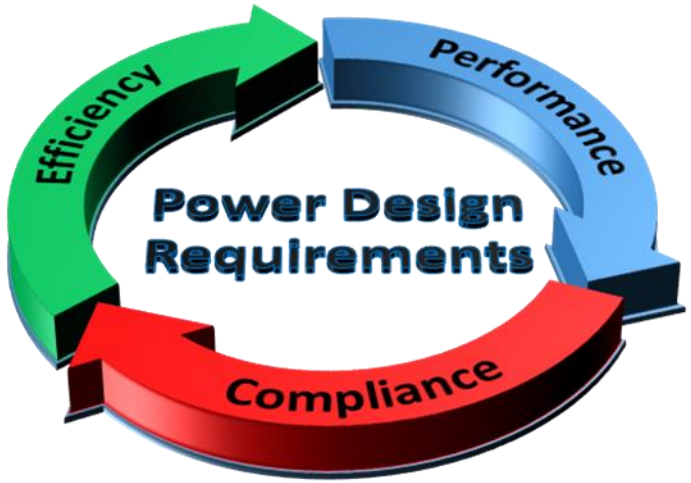
- **Digitization**
  - Continuously growing Number of Battery Powered Devices
  - IoT & **Autonomous Driving** → More Data → Growing # of Data Centers
  - Growing need for electric Power
- **Electrification**
  - Fast increasing number of Power Converters
  - Growing need for electric Power
  - Push extension of **Renewable Power** Generation

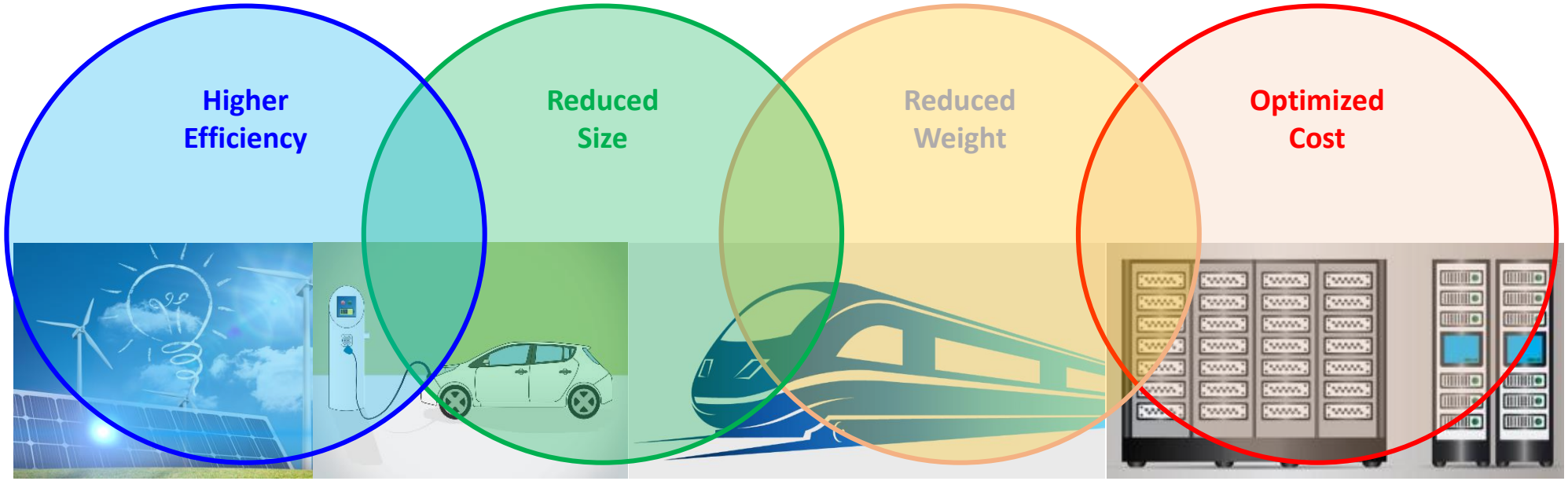


This all create the requirements for Efficient, High-Performance and Compliant Power Supplies

How achieve higher Efficiency?

WBG Semiconductors (SiC / GaN) can help to achieve the targets, because

- **Enable higher Switching Frequencies -> smaller periphere components**
- **Have 3x lower Switching Losses -> more efficent -> smaller heat sinks**
- **Provide 4x higher Power Density -> lower space requirement**



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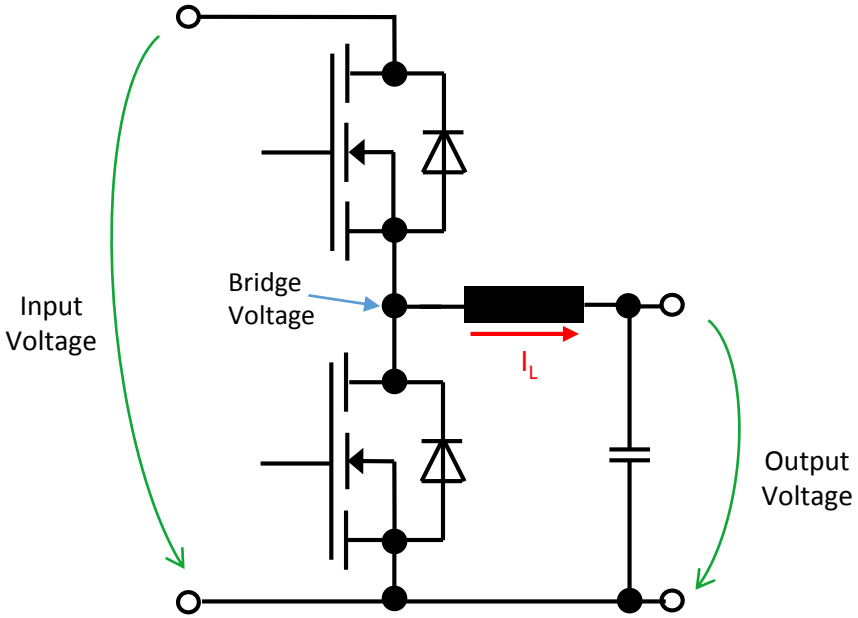
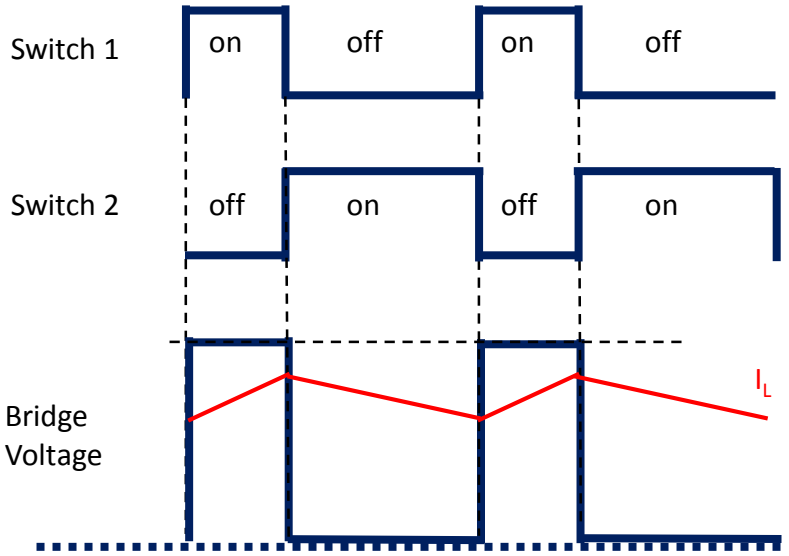
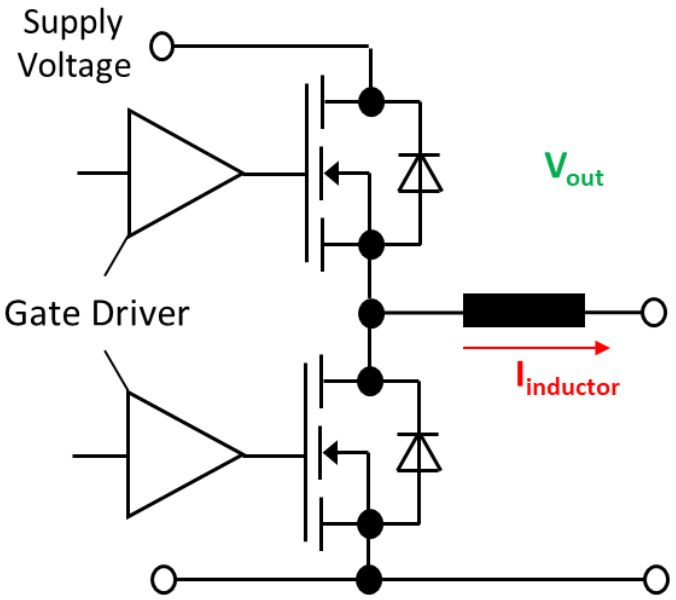
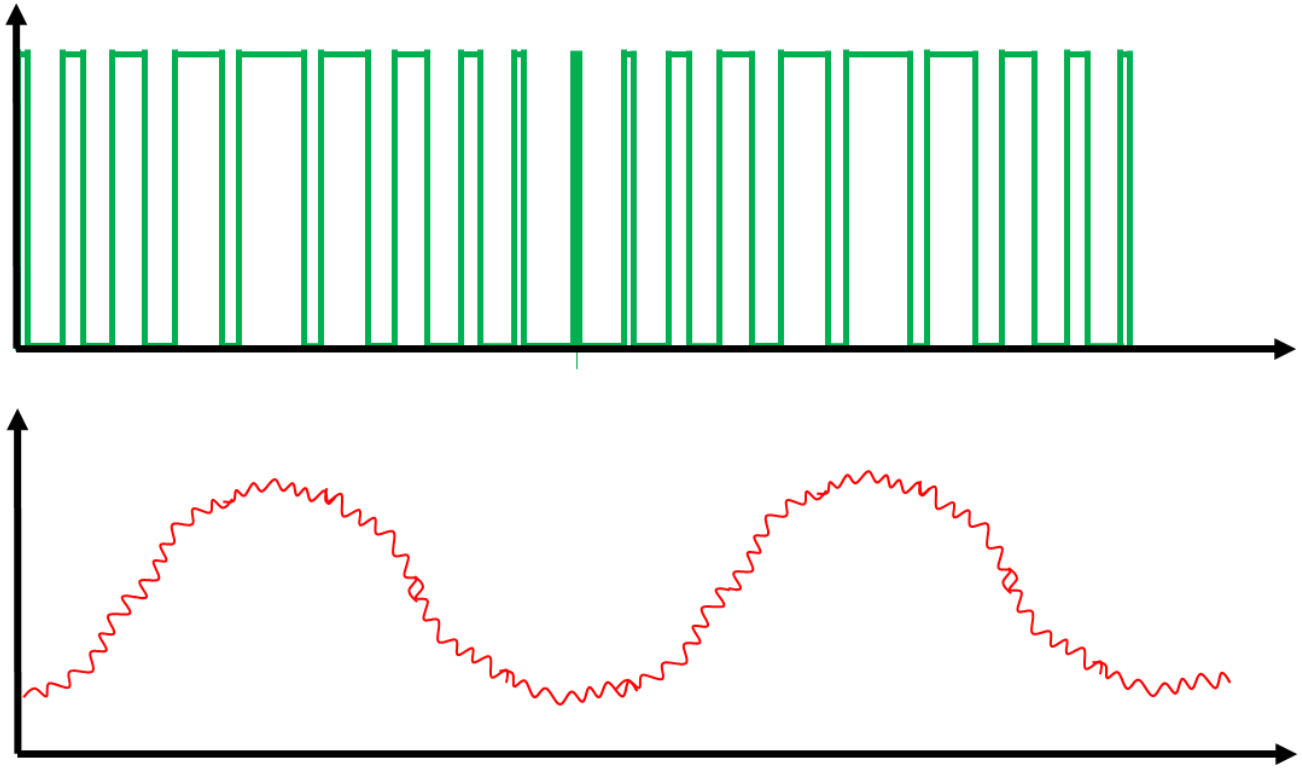
Power Electronics Basics Intro





PWM Controlled Motor Drive





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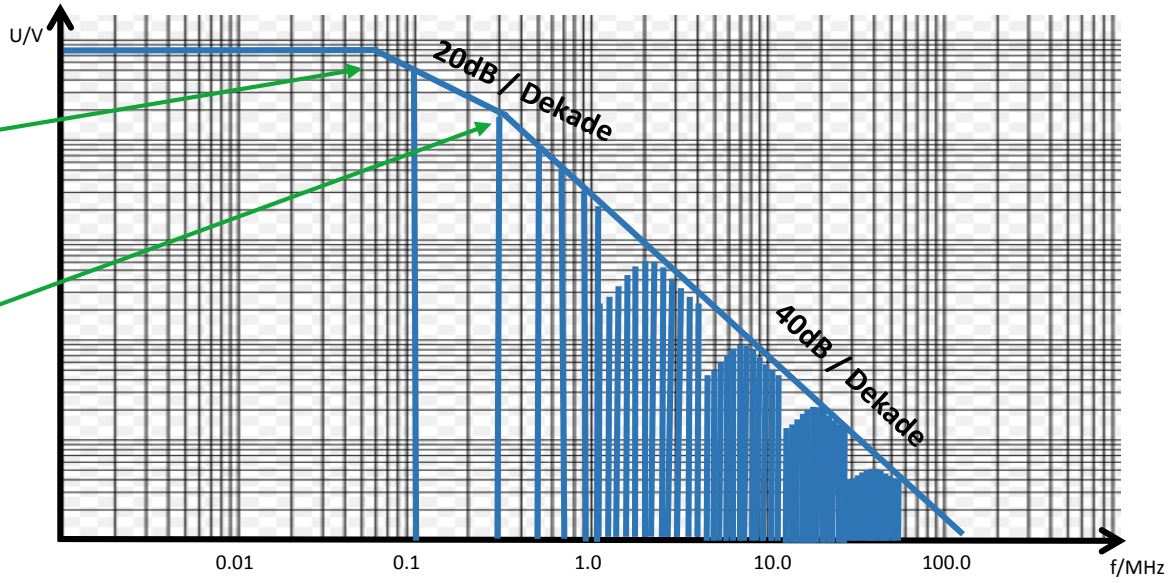
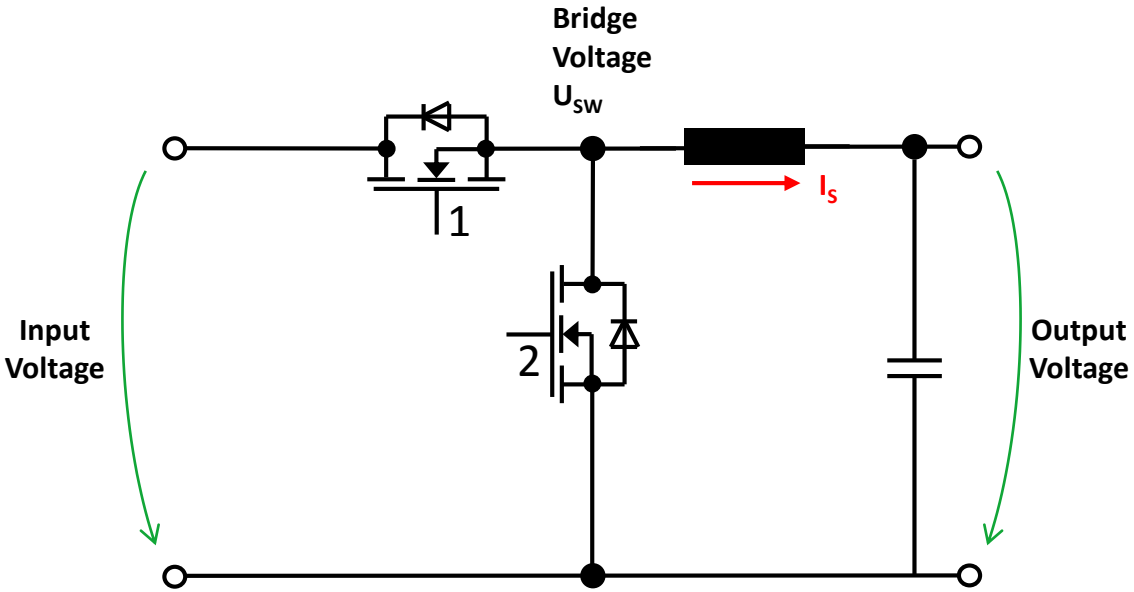
Frequency Consideration

- **1st Frequency point =** $\frac{2*fsw}{\Pi}$ **(here = 63.7kHz)**
- **2nd Frequency point =** $\frac{1}{\Pi*RiseTime}$

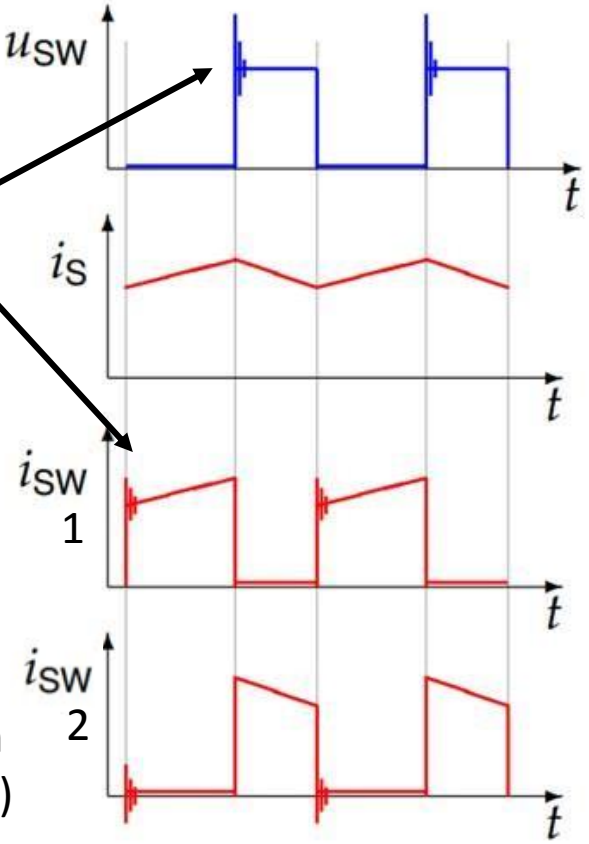
1µs Rise Time => 318,3kHz



Frequency Consideration

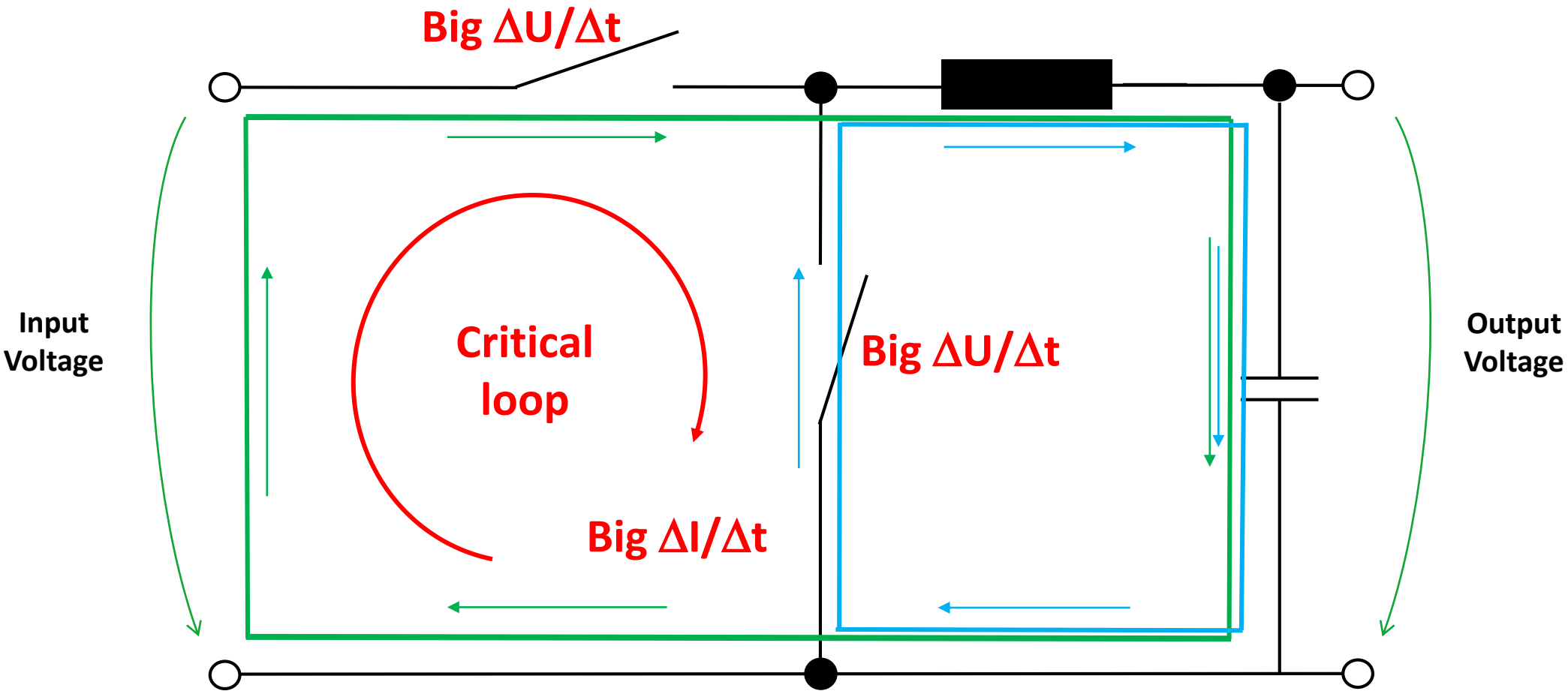


Source of Ringing:
LC resonance circuit
e.g. C_{DS} / L_{trace}

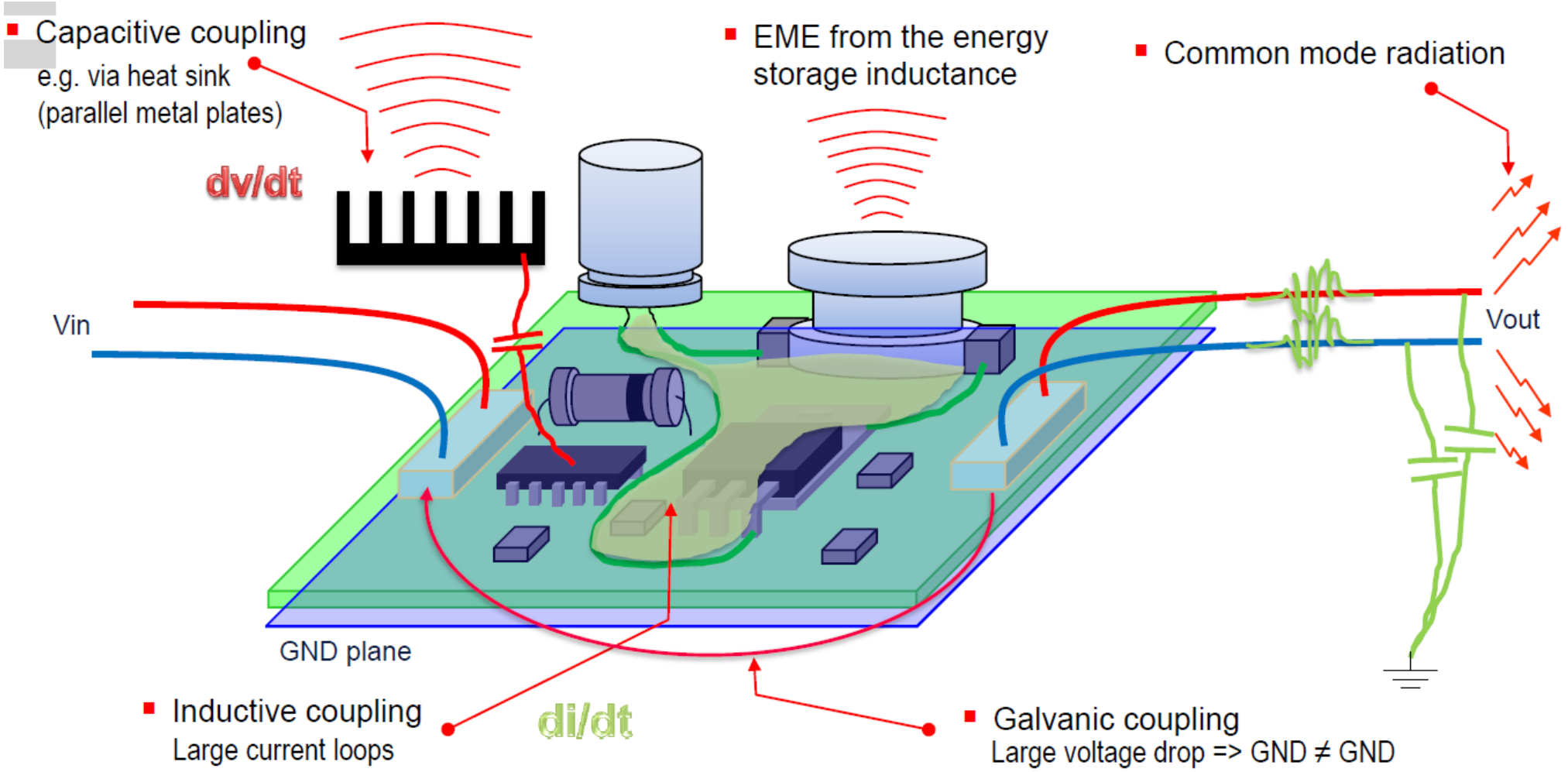


Ringing Frequencies can be fairly high (>200MHz)

Voltage / Current Consideration

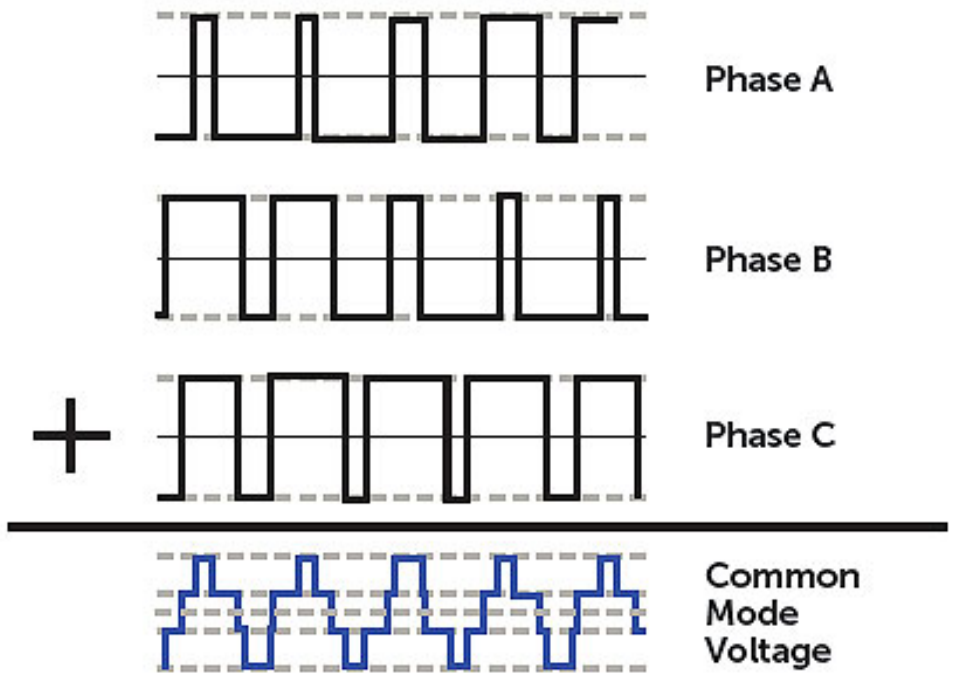


EM Emission Sources



Common Mode voltage

- Existing stray Capacities between Load And earth may result in common mode Currents
- Higher Switching Frequencies tend to produce more common mode voltage and current



This diagram shows the three-phase voltage waveforms in a typical PWM drive.

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“Classical” vs. “Modern” Semiconductors

- **Higher Breakdown voltages -> higher switched voltage**

➔Higher $\Delta U/\Delta t$ → critical Capacitive coupling

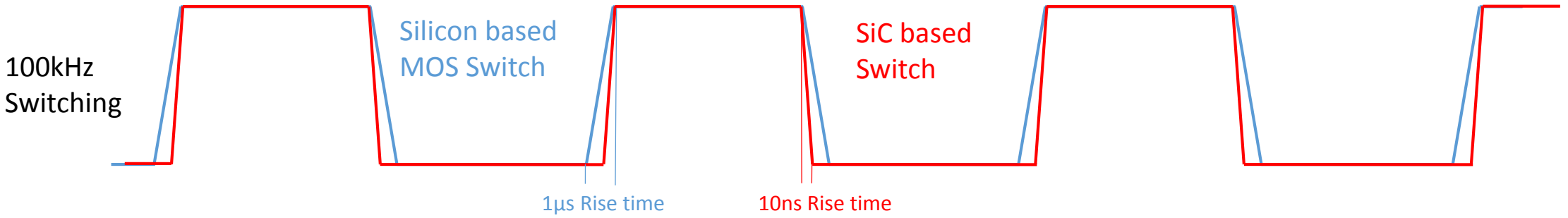
- **Lower ON-Resistance -> higher currents possilbe**

➔Higher $\Delta I/\Delta t$ → critical Inductive Coupling

- **Faster Switching**

- **Steeper Edges**

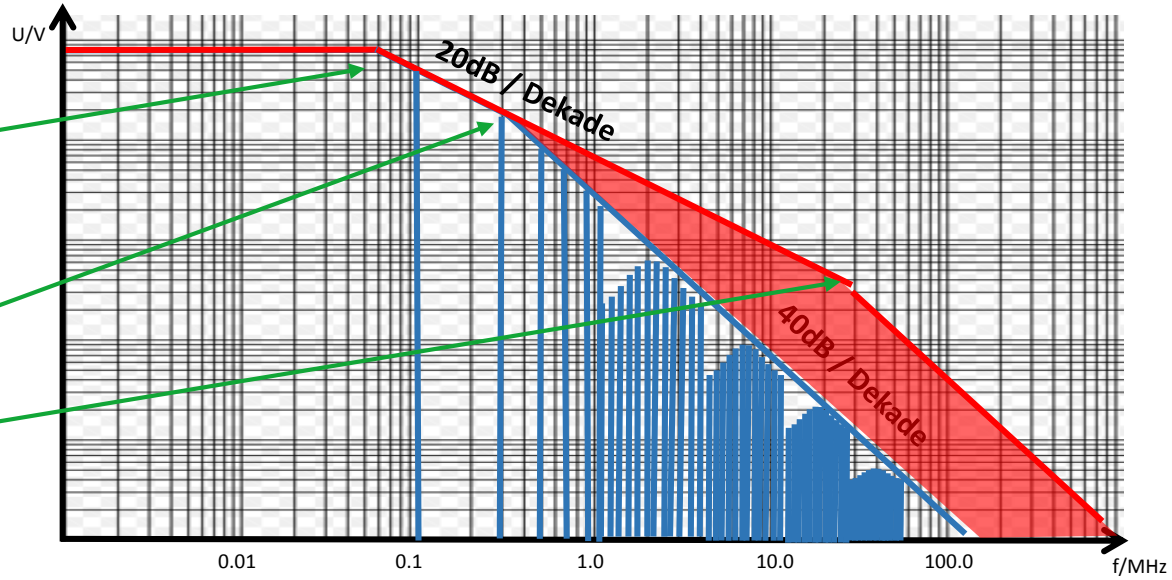
Effect of steeper Edges



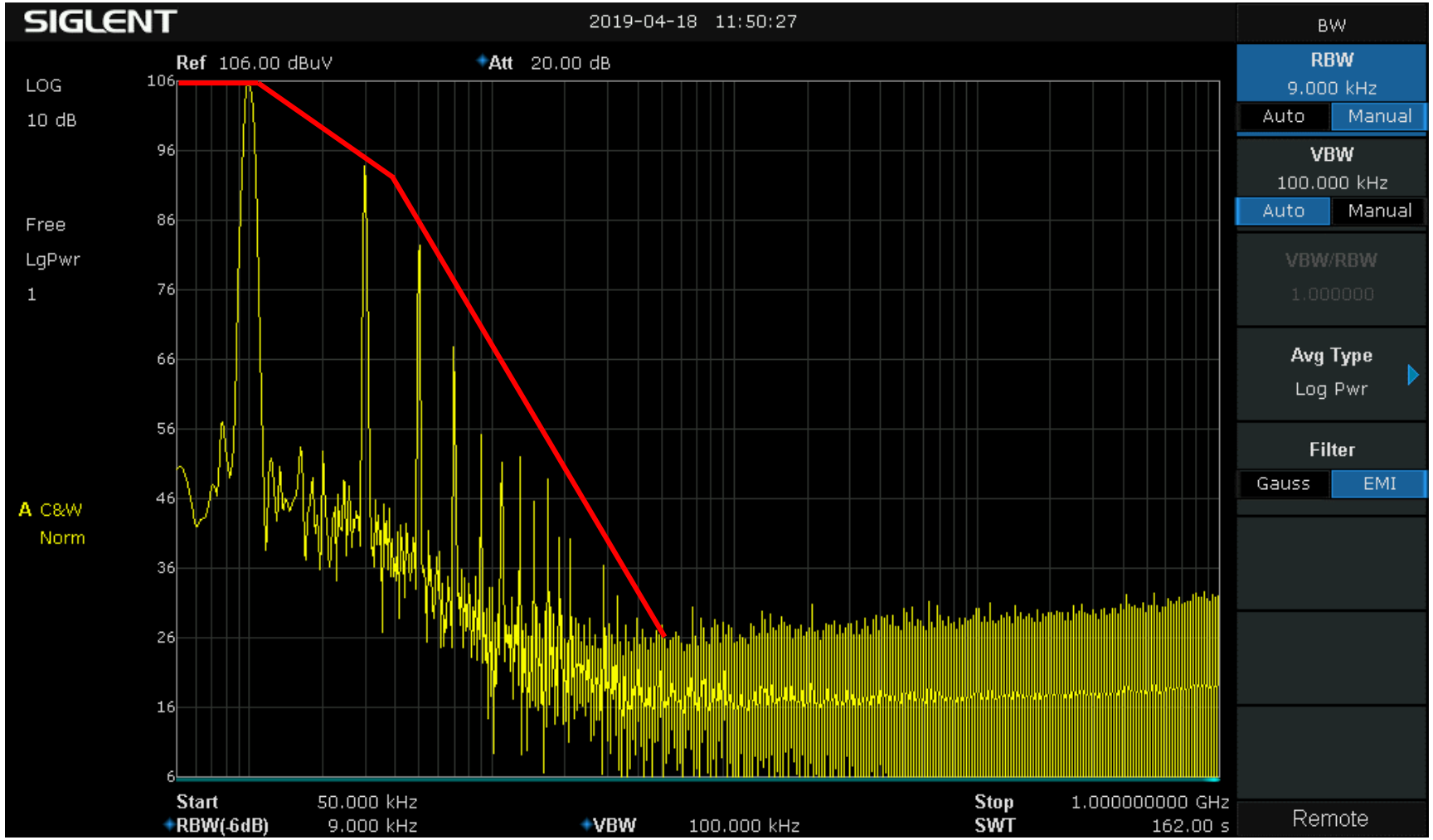
- **1st Frequency point = $\frac{2*fsw}{\Pi}$ (here = 63.7kHz)**
- **2nd Frequency point = $\frac{1}{\Pi*RiseTime}$**

1µs Rise Time => 318,3kHz

10ns Rise Time => 31,83MHz



Faster Switching + steeper Edges



Faster Switching + steeper Edges

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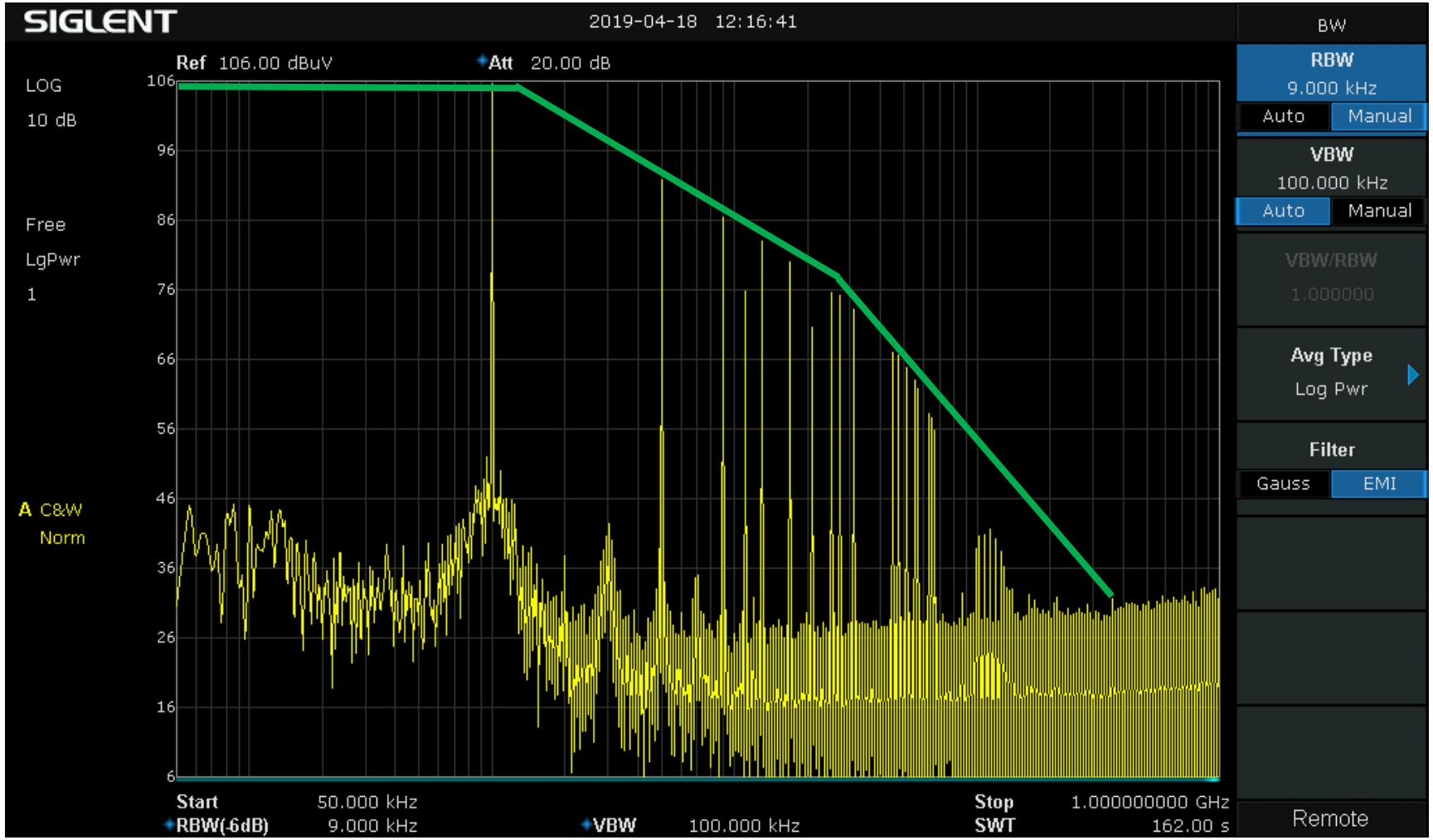

Faster Switching + steeper Edges

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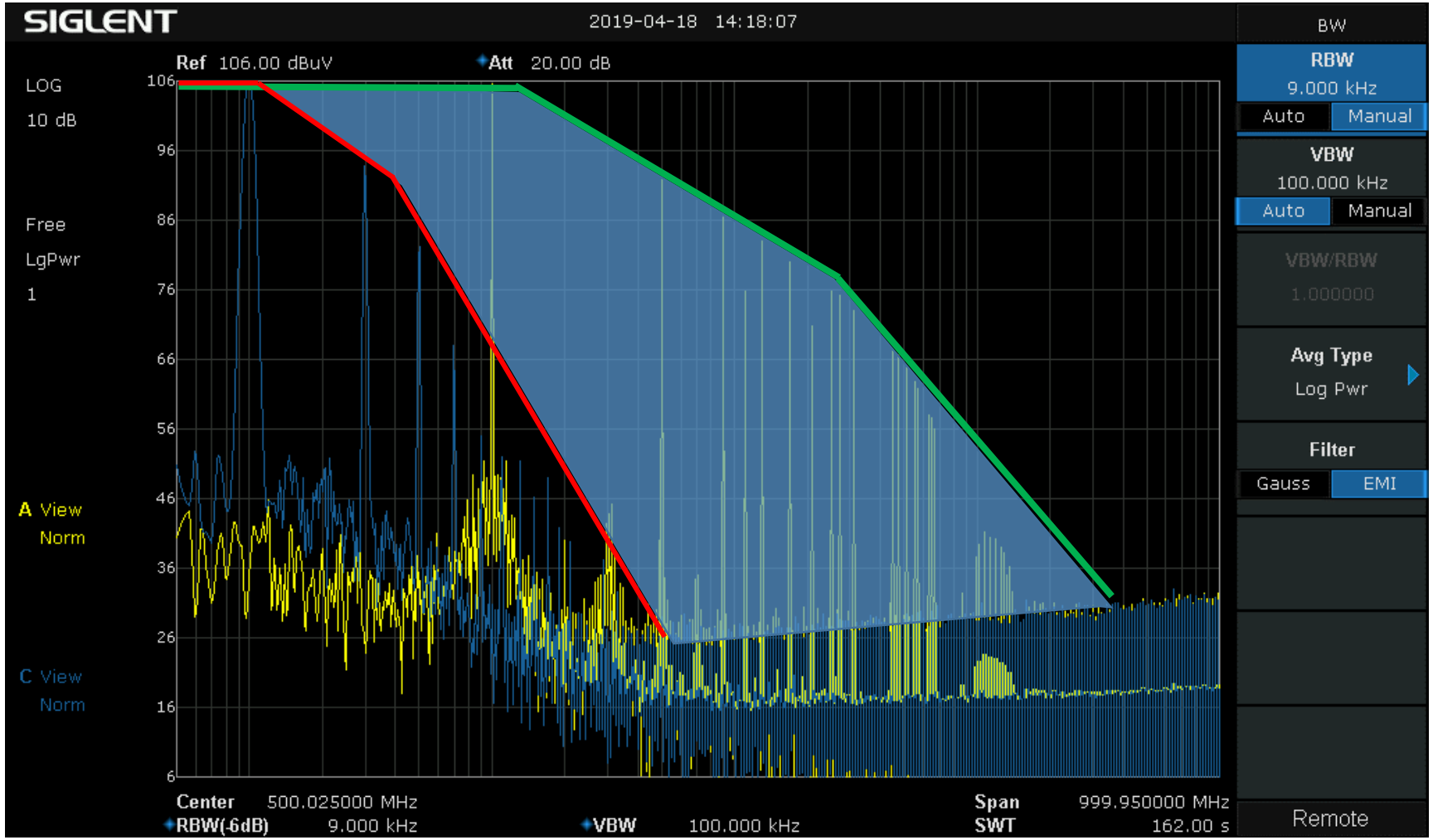

Design Considerations

- Critical loop as small as possible
- Grounding concept around Critical Loop
- Proper Grounding of Heat Sinks
- Uses Shielded Storage Inductivities
- Re-think the Filter concept (input / output)

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Who we are and What we offer?

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- Established in 2002
- Headquarter - Shenzhen, China
- Employees - over 300 incl. big R&D team
- ISO9001:2000 and ISO14001:2004
- CE certification on all products
- Professional integrated supply chain & production system
- Export to 70+ countries & regions

Time Domain Analysis

Signal Generation

Frequency Domain Analysis

General Purpose

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