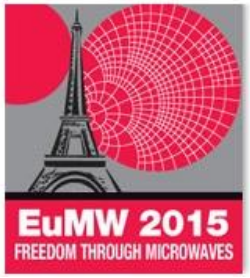

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Exhibition Opening Hours:
• Tuesday 8th September: 9.30 – 18.00
• Wednesday 9th September: 9:30 – 17.30
• Thursday 10th September: 9:30 – 16.30

Application challenges and potential solutions for robust radar sensors

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WS12: EuMIC - *SiGe for mm-Wave and THz*

Content

- System Level Challenges
- Component Level Challenges
  - Detailed Discussion
  - Potential Measures
- Conclusion

System Level Challenges

New Technical Challenges for Next Generation Radar Sensors

SYSTEM LEVEL

- Highly Automated Driving
  - Increased ASIL Classifications
  - Low Cycle Time
  - Azimuth and Elevation Information
  - High Angular, Lateral and Velocity Resolution
- Self Alignment
- Size Reduction
- Cost Reduction

Power Supply Challenges

New Technical Challenges for Next Generation Radar Sensors

COMPONENT LEVEL

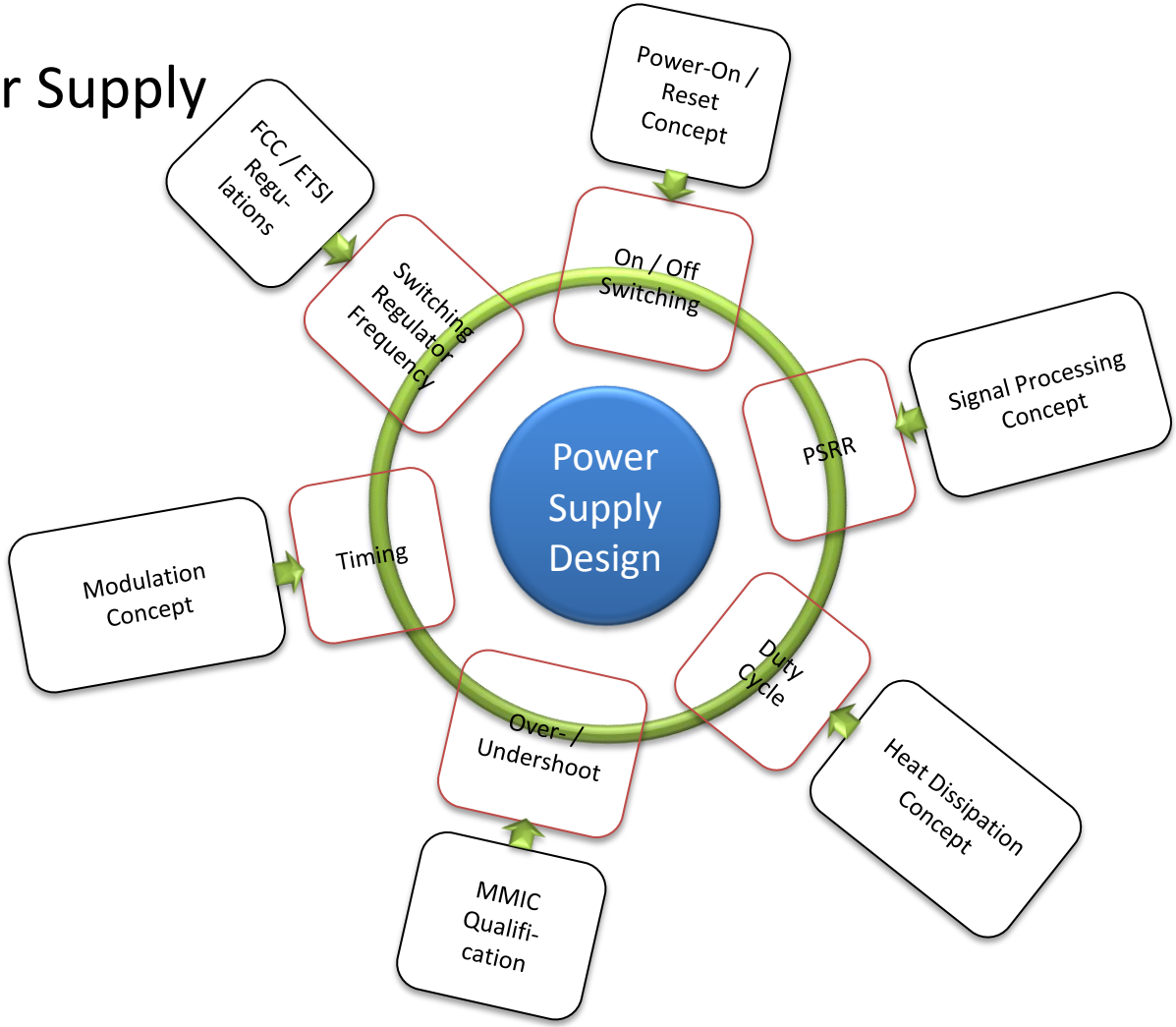
- Power Supply
- Heat Dissipation
- Reliability
- Signal-to-Noise Performance
- Monitoring Functionality

Power Supply Challenges

Design a Clean Power Supply

Challenges

- Multitude of oppositional design aspects and requirements
- Compromises in performance inevitable
- „perfect solution“ not realizable

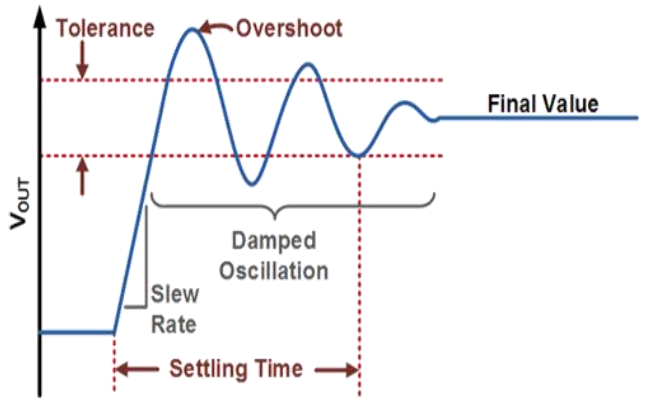


Power Supply Challenges

Design a Clean Power Supply

Design Considerations

- Harmonics of the switching regulator frequency appear in baseband masking relevant objects
- Linear regulators help at lower frequencies but provide limited suppression in the MHz-frequency range along with significant power losses
- Omitting linear regulators will potentially result in over- and undershoots lowering the MMIC life time and incurring unwanted recovery times
- Effective PSRR as an additional design target has to be optimized not only on component, but especially on board level to respect cross coupling



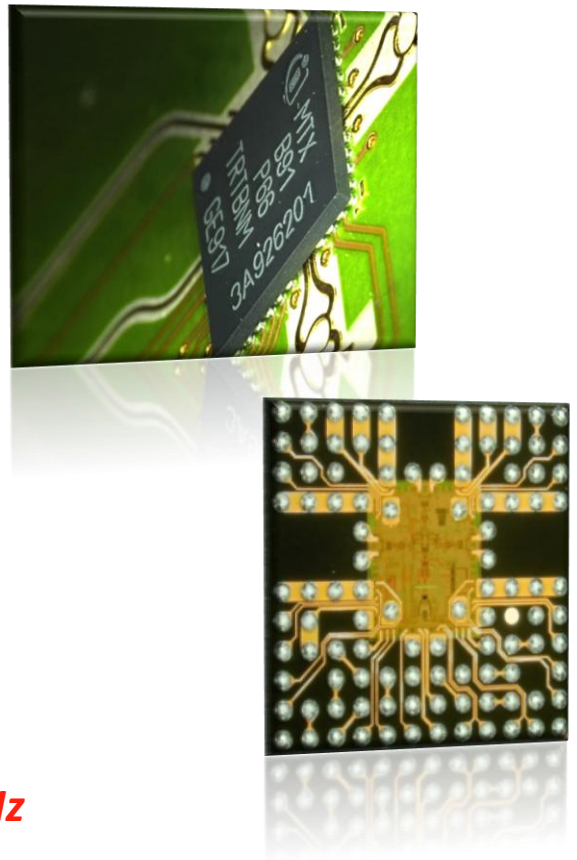
Heat Dissipation Challenges

Transfer Heat from the Silicon Junction to the Sensor Housing

Challenges with eWLB MMICs

- High integration produces heat within confined area
- Heat needs to be transfered to sensor housing
  - Via PCB
  - Via MMIC back side
- Different aspects have to be considered
  - maintain board level realiability
  - obey PCB layout rules
  - account for potential duty cycle

eWLB MMIC

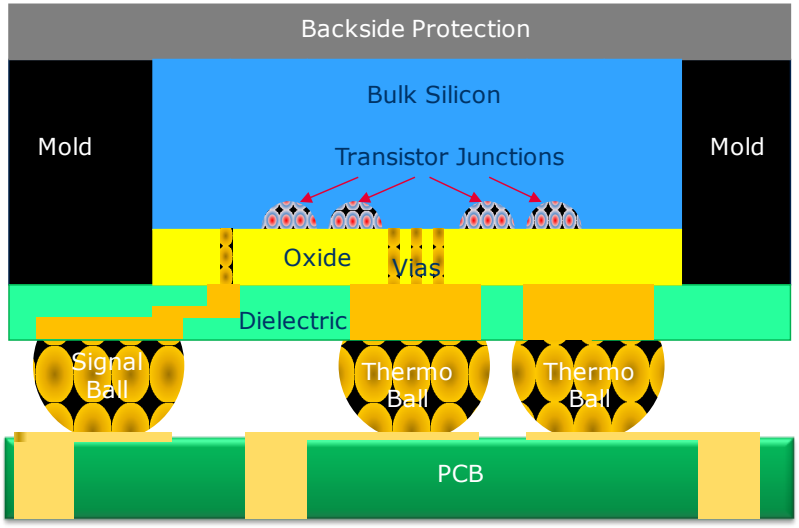


Heat Dissipation Challenges

Transfer Heat from the Silicon Junction to the Sensor Housing

Design Measures

- Realization of thermal balls under via stack in silicon
  - Different efficiency of thermal balls
- Allow for placement of thermal vias on PCB
  - Spare balls where required
- Ensure proper connection of PCB to housing
  - Design heat flow accordingly



Courtesy of Infineon

Reliability Challenges

Meet required life time requirement

Challenges

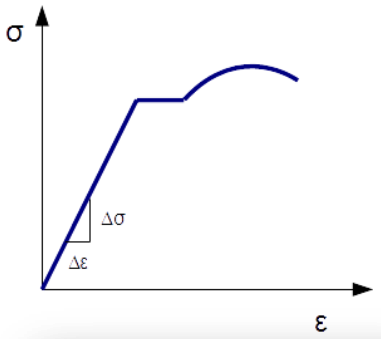
- Higher integration leads to larger packages which are more susceptable for ball breaks
- Limited possibilities to taylor RF PCB for optimum temperature cycling performance
- RF material acts as stress relief layer between MMIC and stiff FR4 carrier board, needs to be optimized for best RF- vs reliability performance vs cost vs manufacturability

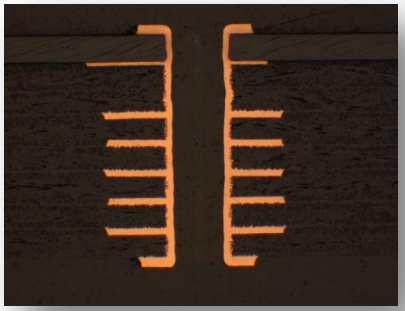
Reliability Challenges

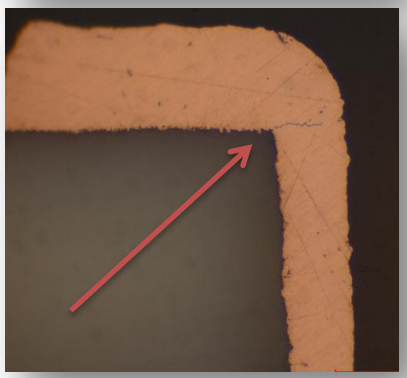
Meet required life time requirement

Design Measures

- Choose low Young's Modulus RF PCB material as a buffer layer
- Make sure at the same time that the PCB exhibits a sufficiently low thermal expansion coefficient CTE, especially in z-direction, to prevent copper via cracks
- Be aware of the difference between a „loose" PCB and a PCB mounted in the sensor housing when evaluating mechanical stress
- Check the potentially positive impact of underfill material

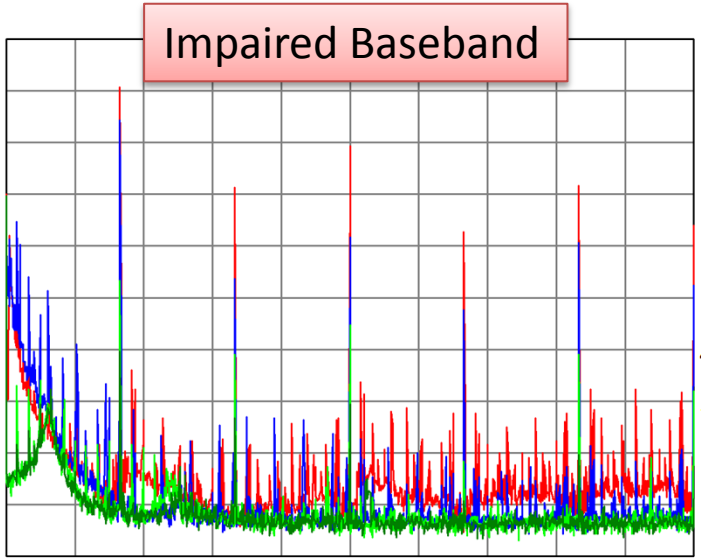






Signal-to-Noise Ratio Challenges

Keeping the Baseband Clean

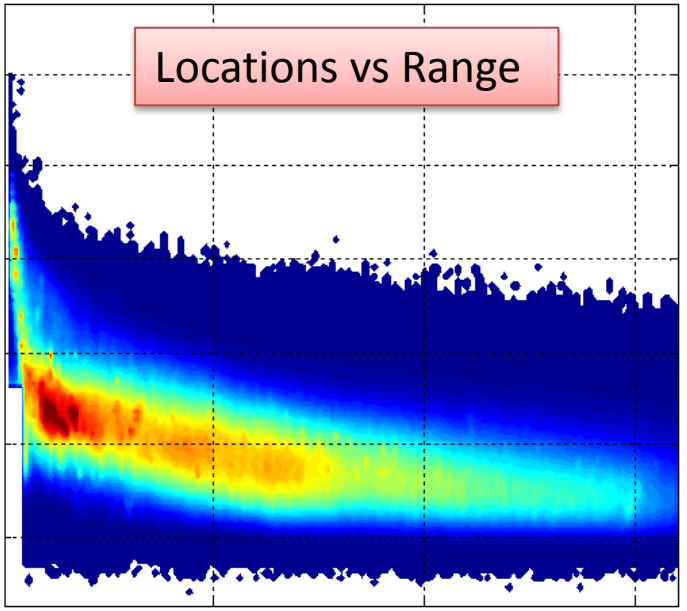


Challenges

- Highly integrated MMICs with different internally generated clocks will produce mixing products with FMCW beat frequencies appearing in the baseband
- Limited PSRR will convey vehicle supply spurs along with various mixing products into baseband
- High object dynamics (60 dB RCS + 60 dB range) could create intermodulation resulting in (potentially closer) ghost objects at baseband
- Voltage regulator switching frequency will arise in the baseband spectrum

Signal-to-Noise Ratio Challenges

Keeping the Baseband Clean



Measures

- Thorough development of a frequency plan as a basis for spur analysis
- Develop HW and DSP counter measures to deal with inevitable switching supply spurs up front
- Create deep understanding of PSRR limiting factors in MMIC such as power supply and especially PCB layout and sensor integration to leverage design measures in early development phase
- Use road data to gain awareness of absolute receive power levels in functionally relevant environment scenarios. Translate to receive design in terms of large signal robustness of RF and baseband.

Conclusion

- Next generation driver assistance functions demand powerful next generation Radar sensors
- Four key enablers for increased performance
  - MMIC technology
  - Micro controller processing power
  - Intelligent algorithms
  - Proper application
- Application challenges will rise significantly with increased sensor complexity
- Solutions require substantiated experience in the technical field of high frequency application