Modern Design and Simulation for Automotive Electronics Using Keysight EEsof EDA Tools
先進汽車電子設計及模擬之EEsof EDA解決方案

March, 2016
Agenda

1. Power Electronics
   • Challenges in power supply circuit simulation
   • Simulation Example
   • Collaboration with Automotive Companies Examples

2. Automotive Radar
   • Overview
   • System Simulation
1. Power Electronics
   • Challenges in power supply circuit simulation
     • Simulation Example
     • Collaboration with Automotive Companies Examples

2. Automotive Radar
   • Overview
   • System Simulation
Challenge in Power Supply Circuit Simulation
Downsizing/Higher frequency

- Downsizing/Higher frequency
  - Difficult to reduce noise
    - Tend to noisy at higher frequency
  - Power loss at components and PCB

Production prototyping is not efficient

Using Simulation is much effective
(No electric shock!)
Design Challenges: Circuit Designers
Designers are not high speed savvy

Challenges:
• Designers come from a power supply background – no HS experience
• Switched edges contain frequency content into the GHz range
• Layout parasitics degrade efficiency and cause EMI issues
• Spikes and ringing exceed ratings of devices and destroy them!
• Switch mode circuits generate EMI
• Thermal issues are not well modeled

- High frequency, RF experts
- Experts in HSD design for a decade
- Multi-domain simulator technologies
- Expertise in physical design
To Simulate Power Supply Circuit
Simulation model is required

ADS supports various models to simulate Power Supply Circuit

1. Power Transistors
   - Switch Model → Lower accuracy
   - SPICE Model → High accuracy

2. PCB
   - EM Simulation → S-parameters

3. Transformer/Inductor/Capacitor
   - Vendor component models
   - Measurement results
   - Generate equivalent circuit from datasheet (DIY)
Power Device Modeling

Variation of Power Device

Power Device

LDMOS, HVMOS
IGBT
SiC MOS/Diode
GaN HEMT
GaN MOS

HiSIM-HV

No standard model

Can’t simulate
Accurate Modeling Service

BSIM4

Id-Vd

HiSIM_HV

Angelov-GaN (Revised)

Cgd

Cds

Simulation for Automotive Electronics
Generate simple power device model from….

1.Measurement data
or
2. Device data sheet
with one click!
Accurate Power Supply Noise Analysis
Taking PCB characteristics into account is the key

How much is PCB characteristics important?
• You can see the answer from this plot!

How can I tell the PCB characteristics?
• Using “Electro Magnetic (EM)” Simulator

Is simulation accurate?
• If you use simulator with proper way by using accurate model, you can gain good correlation with the measurements.
Full-wave EM Simulation

Prediction of layout, packaging, non-ideal parts, PCB physical effects

Schematic/Layout/EM tied together for faster workflow
Advanced Design System (ADS)
All in One Environment for RFuW/HSD/Power Supply Circuit

Time Domain/Mod-Demod/Spara/AC/DC/HB

Moment FEM
SIPro/ PIPro

HSD PHY/EQ analysis

Advanced Post Processing

Optimization/Statistical Analysis

PHY standard compliance
Tx/Rx and sample circuits

Advanced Design System
Premier High-Frequency and High Speed Design Platform
Agenda

1. Power Electronics
   • Challenges in power supply circuit simulation
   • Simulation Example
   • Collaboration with Automotive Companies Examples

2. Automotive Radar
   • Overview
   • System Simulation
Example-1
Synchronous Buck Converter and output

1st

2nd

Schematic

Layout

Simulation for Automotive Electronics
Page 14
Current Density Changes by Frequency
Current Density \( \equiv \) Near Magnetic Field

You can observe current flow with IC working state
Example-2
Correlation with Measurement Results

By using accurate model and taking PCB into account, you can gain similar high frequency noise with measurement.
Agenda

1. Power Electronics
   • Challenges in power supply circuit simulation
   • Simulation Example
   • Collaboration with Automotive Companies Examples

2. Automotive Radar
   • Overview
   • System Simulation
Collaboration with Device Vendors recently

Joint Seminar

Joint presentation at ICEP

Case Study introduction with TDK

Importance of Switched-Mode Power Supply IC Model for Conductive EMI Noise Simulation

Asuma Imamura¹, Mitsuharu Umekawa², ¹ROHM, ²Keysight Technologies Japan / Japan
Agenda

1. Power Electronics
   • Challenges in power supply circuit simulation
   • Simulation Example
   • Collaboration with Automotive Companies Examples

2. Automotive Radar
   • Overview
   • System Simulation
Why we need automotive radar?

Comfort->Passive safety->Active safety->Autonomous Car

– The trend from “comfort only” functions to autonomous systems with radar sensing technologies that serve both the comfort and the safety domain.
SystemVue Platform Brief Introduction

Transition naturally from Design ➔ Test with a single “cockpit”

- Quickly capture “system level” design concepts
- Model implementation-level impairments
- Connect BB, RF, and T&M for rapid validation
- Rapid prototyping with integrated measurement

SystemVue enables system architects and algorithm developers to innovate the physical layer (PHY) of wireless and aerospace/defense communications systems and provides unique value to RF, DSP, and FPGA/ASIC implementers.

IP Reference Libraries
- **4G** LTE-Advanced, LTE
- **3G** HSPA+, WCDMA, EDGE, GSM
- **WLAN** 802.11ac/n/a/b/g
- **WPAN** 802.11ad, 802.15.3c
- **Radar, 5G, GNSS, DOCSIS, DVB**

BB Algorithm Modeling
- MATLAB .m
- FixedPoint, HDL/FPGA
- Embedded C++
- Filtering, EQ, Modem

RF / Analog Channel Modeling
- MIMO Channel (OTA)
- Digital Pre-Distortion (DPD)
- RF System Design
- RF EDA platforms

Test Software
- I/O Lib, ComExpert
- 89600 VSA
- Signal Studio
- 3rd Party

Test Equipment
- RF Sources & Analyzers
- AWG & Digitizers
- Scopes, Logic, Modular

Simulation for Automotive Electronics
Agenda

1. Power Electronics
   - Challenges in power supply circuit simulation
   - Simulation Example
   - Collaboration with Automotive Companies Examples

2. Automotive Radar
   - Overview
   - System Simulation
Automotive Radar Simulation with EEsof solutions

Design Tools
- System/DSP: SystemVue
- uW/mmW: ADS
- Antenna: ADS/EMPro

Simulation for Automotive Electronics
<table>
<thead>
<tr>
<th>Source</th>
<th>Basic</th>
<th>Advanced</th>
</tr>
</thead>
<tbody>
<tr>
<td>CW Pulse, LFM, NLFM, Binary phase coded (Barker), Poly phase coded (ZCCode, Frank), PolyTime, FSK HP, Arbitrary PRN, FMCW</td>
<td>DDS, UWB, SFR, SAR, Phased Array, MIMO, PBR</td>
<td></td>
</tr>
<tr>
<td>RF Behavior</td>
<td>Tx and Rx Front-end, PA, LNA, Filters</td>
<td>DUC, DDC, ADC, DAC, DAC, T/R Modules</td>
</tr>
<tr>
<td>Antenna</td>
<td>Antenna Tx &amp; Rx</td>
<td>Phased Array Antenna, Tx &amp; Rx, Array-Couple</td>
</tr>
<tr>
<td>Environments</td>
<td>Clutters, Jamming, Deceptive Jamming, Interference</td>
<td>Moving target, Multi Scattering RCS, STK-Link</td>
</tr>
<tr>
<td>EW</td>
<td>Detection, EP, ES, EA</td>
<td>Dynamic Signal generation, Receiver, DOA, DRFM</td>
</tr>
<tr>
<td>Signal Processing</td>
<td>Pulse Compression, Detection &amp; Tracking, CFAR, MTI, MTD</td>
<td>Beamforming, Adaptive Phased Array Receiving, STAP, SF Processing, Beam forming, Passive Radar SP</td>
</tr>
<tr>
<td>Measurements</td>
<td>Waveform, Spectrum, Group Delay</td>
<td>Antenna Pattern 2D&amp;3D, Imaging Display, Detection Rate, False Alarm Rate, Range &amp; Velocity Estimation, Un-Ambiguity Range &amp; Velocity</td>
</tr>
<tr>
<td>Moving Platform</td>
<td></td>
<td>Moving Platform Tx &amp; Rx</td>
</tr>
<tr>
<td>Systems</td>
<td>CW Pulse, Pulse Doppler, UWB FMCW, SFR, SAR</td>
<td>AESA, MIMO, PBR</td>
</tr>
<tr>
<td>Templates</td>
<td>Almost 100 design templates for reference</td>
<td></td>
</tr>
</tbody>
</table>
Automotive Radar Transceiver Chipset

FRDxX1050x 77GHz Radar Transceiver Chipset

Differentiating Points
- Highly integrated 77GHz automotive radar chipset supports up to 4Tx and 16 Rx channel configurations for 2D, 3D, DBF, and SAR automotive radar applications
- Supports slow and fast modulation to 10 MHz / 100 ns
- Fully integrated PLL and chirp generator programmed via SPI along with Tx power level, channel activation, & state machine control
- Designed for integration with a multitude of microprocessors including the Freescale MPC567xK

Cited from Freescale

Design Tools
- System/DSP: SystemVue
- uW/mmW: ADS
- Antenna: ADS/EMPro

Simulation for Automotive Electronics
Planar Antenna Array Simulation
Momentum/FEM/FDTD

Design Tools
- System/DSP: SystemVue
- uW/mmW: ADS
- Antenna: ADS/EMPro

77GHz Antenna array
64mm x 55mm (HxW)

Phased Array Radar Modeling

Antenna Pattern can be exported to UAN file and imported to SystemVue for System Co-Simulation
What is required for the transmitter and receiver chain?

Spectrasys

Cited from Freescale

Simulation for Automotive Electronics
Summary

1. Power Electronic ➞ ADS
   - Power Supply Circuit: ADS
   - Device model extraction: IC-CAP

2. Automotive Radar ➞ SystemVue
   - System/DSP: SystemVue
   - uW/mmW: ADS
   - Antenna: ADS/EMPro
Thank You
Question?