ANSYS for Tablet Computer Design

Laila Salman, PhD
Technical Service Specialist
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Tablets in Our Daily Lives

- Tablets are very entertaining, stylish and powerful
  - Shopping, reading, emailing, accessing social network, playing game
  - Schools, operating rooms, sports events

Pictures source: www.istockphoto.com
Virtual System Prototyping

- Layout
- 3D CAD
- Virtual Prototype
- Electromagnetic Extraction
  - Mechanical and Thermal
- Virtual System
  - Virtual Compliance

- Vendor Specific Driver/Receiver Models
- Vendor Specific VRM Models
- Electronics
Tablets Design Challenges

- Designing the impossible
  - Touchscreen
  - Tablet Case
  - Packages
  - Flex circuitry
  - Antenna
  - ESD
  - EMI
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Capacitive Touchscreen

No moving parts present

- Use a thin layer of ITO (indium tin oxide) to sense the presence of a finger by capacitive coupling.
- Capacitive sensors are mounted underneath of hardened glass
- Finger adds a measurable capacitive change in the touch sensor
- Change in sensor capacitance relies on RC time constant change
Touchscreen Design Challenges

Model size, complexity and ....

- Simulate “projected” and/or “mutual-capacitance”
- Include Skin and Proximity Effects
- Build detailed 3D model
Capacitive Touchscreen

Parameterized Example 10x10 electrodes model
Adaptive Mesh Refinement

- Automatically tunes the mesh to the electrical performance of the device. This ensures simulations are correct the first time.

Mesh Convergence

- Real-Time update of performance per adaptive solution
Capacitive Touchscreen

Accuracy of Q3D Capacitance solution

▲ Automated Meshing Refinement
Convergence criteria

- Based on change in Self or Mutual matrix capacitive terms
- Based on specific matrix value or user defined output variable

Solution Time (10x10 electrodes model)

- 2 hrs 45 min
- Supports all available cores
Focus on

- Area of contact
- Glass thickness
Receiver Signal

Electrode scanning change at contacted ITO (Indium Tin Oxide) position

Non-contact

Proximity Effects (0.1mmGap)

Contact!
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Tablets Computer Case

- Perform Drop test of Tablet PC from height of 4 feet onto a concrete floor at an angle of 45 degree using ANSYS Explicit Dynamics
  - The geometry of the Table PC was created from scratch using ANSYS DesignModeler
  - The parts are simplified representations of parts in an actual Tablet PC.
• **Meshing:**
  - ANSYS Workbench meshing with Explicit Dynamics preference is used to create a mesh.
  - Hex dominant mesh is created to reduce the number of elements
  - Total number of elements ~25,000

• **Analysis settings:**
  - Analysis is solved for 4 e-4 seconds.
  - Initial velocity of 4.9 m/sec is assigned to the Tablet
  - The concrete floor is modeled as a rigid shell body with fixed constraints
  - Automatic contact definition is use between all parts.
  - Parts that are in contact but may separate due to the drop test are assigned bonded contacts.
  - Bonded contacts are modeled as breakable based on stress criteria for debonding.
Drop Test Simulation Results

Equivalent Stress Contours Back Cover Off

Equivalent Stress Contours Front
Stress Modeling using ANSYS Mechanical includes:

- Joints to capture the kinematics
- Visco-elastic material
- Contact non-linearity
- Rigid flexible interaction
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Tablet Packages

CPU and Memory Applications

- Flip-chip BGA
- NAND Flash (BGA, FD-BGA SiP, PoP etc.)

Electrical and Thermal simulations

Courtesy of EEMS
Tablet Packages

Design Challenges
- Accurate SYZ and RLGC solution
- Dealing with multiple vendors

Solution
- Automated merging capabilities
- Full-wave and Quasi-static solution

Courtesy of EEMS

TPA

Q3D Extractor and HFSS
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Parameterized Transmission line model

- Accurate Zo analysis
- Trace spacing and offsets
- Solid vs. patterned ground

HFSS Transient
Interconnect Transmission line model

- Trace Thickness and Width
- Trace to Ground Space
- Ground Shape (Solid vs. Meshed)
  - Reduce the Interference with High Speed signal Traces or noisy LCD surface
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Antenna Design Challenges

- Location, Beam Forming
- Antenna type
- Human Body Effect
  - Hand, Body
- Operation Environments
  - Metal Desk
  - Wooden Desk
  - Human lap
Antenna Design Challenges

▲ Location, Beam Forming
▲ Human Body Effect
  – Hand holding tablet at different locations
  – Close to antenna and away from antenna

Radiation Efficiency @2.4Ghz : 0.967907
Radiation Efficiency @2.4Ghz : 0.480466
Antenna Design Challenges

△ Operation Environments
- Human Tissue
- Metal Desk
- Wooden Desk

Radiation Efficiency @2.4Ghz:
- Human Tissue: 0.777207
- Metal Desk: 0.993303
- Wooden Desk: 0.994337
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Circuit and Numerical Modeling of ESD Coupling to Shielded Cables

HFSS Transient solver for numerical Modeling ESD approach

Input Voltage

Curve Info

V(Voltage1)

Setup1 : Transient

Courtesy of: HUWIN
## ESD Gun Simulation Results

<table>
<thead>
<tr>
<th>Applied Voltage (kV)</th>
<th>Peak Current (A) IEC 61000-4-2 (ESD Test)</th>
<th>Peak Current (A) Simulation Results</th>
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<tr>
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</tbody>
</table>

### Graph

Peak Current VS Applied Voltage

- **6kV**
- **5kV**
- **4kV**
- **2kV**

Courtesy of: HUWIN
ESD Animation

ESD Gun and Metal Plate

ESD Gun Simulation Time length: 0 ns ~ 118 ns
ESD Gun on Tablets Touch Electrodes

ESD gun applied on 1 driver and 1 receiver full length electrode
ESD Gun Effect on Tablets Touch Electrodes

ESD Gun Simulation Time length:
0 ns ~ 118 ns
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Tablets EMI

EMI Design Challenges

△ Entire PCB + Case
△ Driver & Receiver
△ Near field, Fairfield
△ Immunity
Tablets EMI

EMI Design Results

Δ Near Field and Far Field Spectrum

Simulation vs. Measurement
Tablet Design Simulations were performed using

- Touchscreen – Q3D Extractor and DesignerSI
- Tablet Case – ANSYS Explicit Dynamic and ANSYS Mechanical
- Packages –
  - Electrical: HFSS in Cadence, Q3D Extractor and TPA
  - Thermal: ANSYS Icepak
- Flex circuitry – HFSS and Q3D Extractor
- Antenna - HFSS
- ESD - HFSS Transient and DesignerSI
- EMI – HFSS, SIwave and DesignerSI
Problem
Meeting numerous tablet design options while meeting strict electrical standards and design specifications

Solution
Automated modeling and optimized analysis using ANSYS Electromagnetics tools allows for system simulation approach

Result
Detailed system simulation enabled tablets to be put on market on time with reduced testing costs