PCB Workshop

From Napkin to PCB

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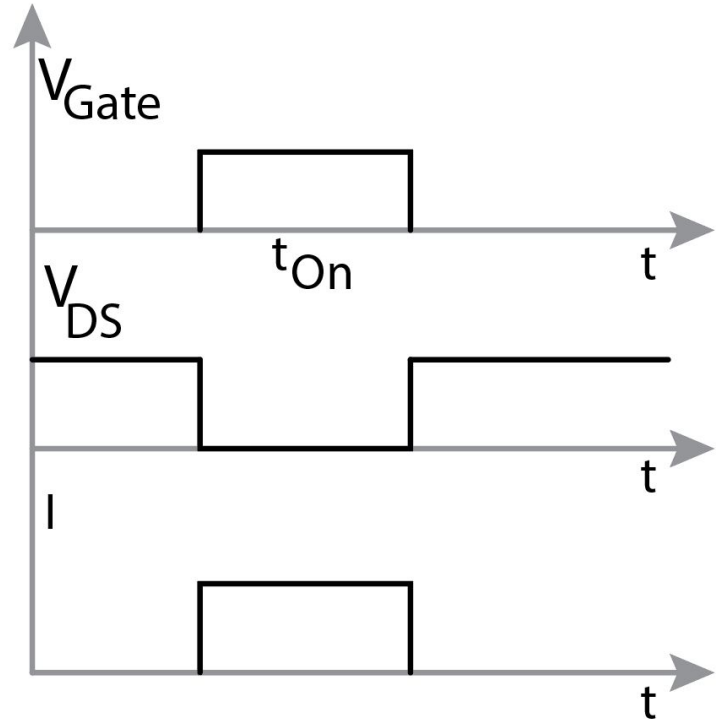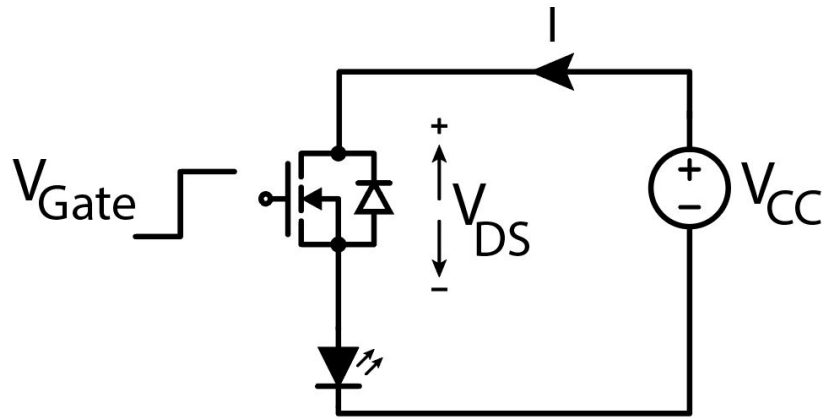
Outline

- Circuit Simulation using Altium + SPICE
- Schematic Capture
- PCB Design
- Generating Manufacturing Outputs

Circuit Simulation

- Altium + SPICE Engine
  - Basics with example circuit
- Transient circuit simulation
  - Ideal components
  - Parameter
- Refining Circuit-Model
  - Constraints
  - Real components

The Circuit - PWM Dimmer

Requirements & Constraints

- 12V/12W supply
- Dimming through MCU with current control

- Components for this workshop are pre-selected
  - Component selection out of scope for this workshop

Hands on

Components

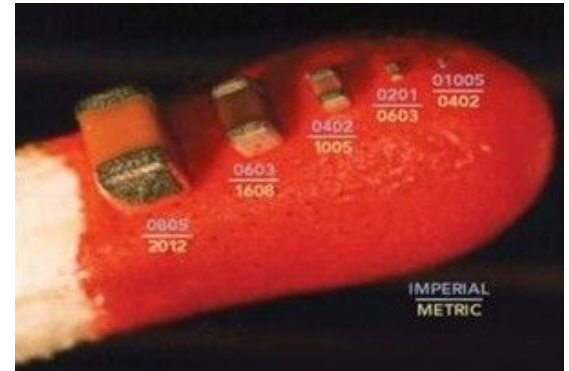- MosFET (NTMS4939NR2G)
- OpAmp (OP113)

Recap Circuit Simulation

- Using SPICE within Altium
- Transient analysis
- Parameters
- Modelling constraints
- Real components and models

- Learnings

Schematic capture

- Circuit Description and Documentation
  - Components
  - Nets and Net classes
- Auxiliary Circuit add-ons / Considerations
  - Prototyping
  - Mass production

Component considerations

- Unify as much as possible
    - Cost reduction
    - Easy assembly
    - Alternative suppliers
- Component sizes
    - Size vs. Cost vs. Effort
    - 1206 or 0805 recommended
- Environment
    - RoHS compliance

Picture credit http://www.surfacemountprocess.com   11

Hands on

Components

- MosFET (NTMS4939NR2G)
- OpAmp (OP133)
- Driver (MIC4416YM4-TR)
- MCU (Atmega328P)
- 5V Regulator (7805)
- 3V3 Regulator (LD1117S33TR)
- Connector (282836-2)
- LED (XPGWHT-L1-0000-00G51)

Common troubleshooting problems

- Failing sub-circuits
- Noisy signals
- Measurement of unaccounted signals

Mitigation

- Jumper in supply lines
- Extra unpopulated footprints
- Testpoints, Testpoints, Testpoints

Hands on

Recap Schematic capture

- Proper Documentation (digital/analog)
- Component selection considerations
- Manufacturing part search
- Auxiliary components for prototyping

PCB Design

- Design rules
- Manufacturing considerations
- Floor planning
- Routing / Polygons
- Labeling
- Mechanical design considerations

Design rules (DR)

- CAD support / Error reduction
  - Safes cost and time
- Most important rules (for designers)
  - Clearances
  - Trace widths
  - Min. Hole size
- Sources of constraints for DR
  - Manufacturing limits
  - Material limits
  - Standard compliance

Manufacturing considerations

- Min. Clearance & Trace width
  - Etching limits
- Hole sizes
  - Tool swap & Drill wear (especially < 0.3mm)
- Select Manufacturing candidates early! (pcbshopper.com)

PCB Anatomy primer

- **PCB Stackup (simplified)**
  - Core (FR4 - Fiberglass compound)
  - Layers (Copper)
  - Prepreg (Multilayer)

- **Manufacturing**
  - Drilling
  - Etching
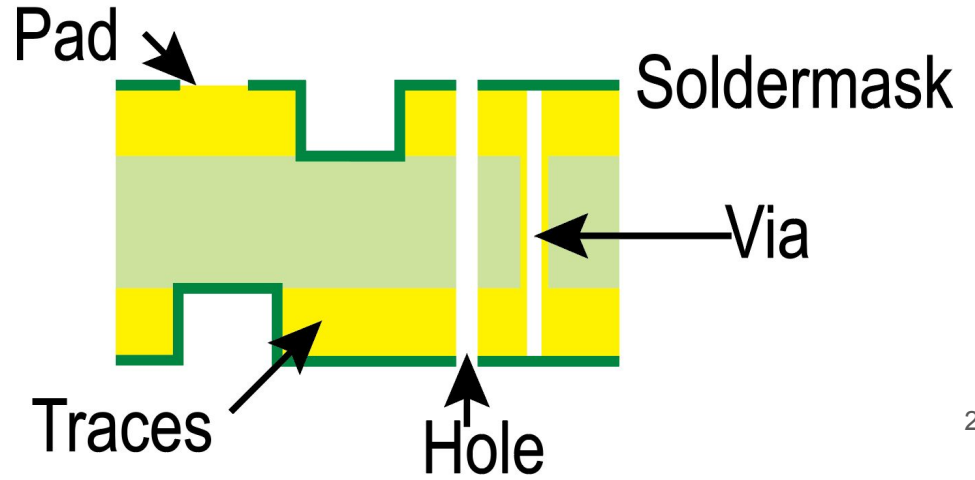
PCB Anatomy cont.

- ## Copper thickness
  - 0.5-4 oz/ft^2 | 12.5-140 µm (Imperial vs. metric)
  - Ampacity (Online Calculators)
- ## Cost implications (Multipliers)
  - Design Area
  - Design Complexity (Layer Count)
  - Copper Thickness

Hands-on

PCB Recap

- Design rules
- Manufacturing considerations
- Floor planning
- Routing / Polygons
- Labelling
- Mechanical design considerations

Manufacturing Outputs

- Gerber Files
- Drill Files
- Pick and Place files
- Bill of Materials (BOM)

Gerber files

- Industry standard files
- Outlines
  - Etching
  - Solder mask
  - Labels
  - Mechanical aspects

Drill & Pick and Place

- ## Drill Files
  - ○ Location and size of holes
  - ○ Type of holes (Shape, Plating)

- ## Pick and Place Files
  - ○ Location and orientation of components
  - ○ Automated assembly

Bill of Materials (BOM)

- List of Components & Parameter
- Important Parameter
  - Manufacturer Part Number
  - Quantity
  - Designator
  - Description/Comment
- Eases purchase and Assembly

Hands-on

Workshop conclusion

- Circuit Simulation using Altium + SPICE
- Schematic Capture
- PCB Design
- Generating Manufacturing Outputs