UNIVERSITÉ DE SHERBROOKE

PPMPMPPMPMPPMPPPMPPPMPPPMP05

Comment se déplace un signal?

Pascal-Emmanuel Lachance &
Maxime Grenier-Castillo

PPMPMPPMPMPPMPPPMPPPMPPPMP05

Comment se déplace un signal?

Par: Pascal-Emmanuel Lachance &
Maxime Grenier-Castillo

- Où l'impédance est la plus faible?
- Retour de courant
- Vitesse de déplacement d'un signal
- Tout est une ligne de transmission

Level 1: Surface Ripple [20min]

- Surface Ripple [20min]
  - EM Fields I
  - Superposition I
  - Charge Movement
  - Passive Components I
- Current Paths [30min-50min]

Level 1: Surface Ripple [20min] – Introduction

Introduction des mathematiques et équation fondamentales à l'electromagnetisme

[10min - Max] Level 1: EM Fields I – Plan

- ✔ Champ Vectoriel
- ✘ Divergente, Rotationnelle
- ✘ Regle de la main droite
- ✘ Equation de Maxwell

[1min - Max] Level 1: Superposition I – Plan

- ✖ Équation Linéaire
- ✖ Addition de Signaux

[4min - Max] Level 1: Charge Movement – Plan

- ✖ Comment les Electrons bougent
- ✖ Propriété materiaux

[3min - Max] Level 1: Passive Components I – Plan

- ✖ Resistance
- ✖ Condensateur
- ✖ Inducteur

Level 2: Current Paths [30min-50min]

- Surface Ripple [20min]
- Current Paths [30min-50min]
  - Signal Source I
  - Harmonics I
  - Propagation Speed I
  - Ground planes
  - Induction
  - Current loops
  - Radiation I
  - Fil d'une année lumière de long
- Impedance & Reflection [20min - 1h10]

[2min-Pascal] Level 2: Signal Source I – Plan

- ✖ Source de tension
- ✖ Source de courant

[3min - Max] Level 2: Harmonics I – Plan

- ✗ Transformé de fourier
- ✗ Addition de Signaux
- ✗ Taylor
- ✗ Harmonique paires/impaires

[5min-Pascal] Level 2: Propagation Speed I – Plan

- ✖ Vitesse de propagation
- ✖ Speed of light

[5min-Pascal] Level 2: Ground planes – Plan

- Item 1
- Item 2
- GND IS NOT A SINK, IT'S A REFERENCE

[5min-Pascal/Max] Level 2: Induction – Plan

- ✖ Comment les courants sont induits
- ✖ Regle de la main droite
- ✖ Item 3

[5min-Pascal] Level 2: Current loops – Plan

- ✗ GND Loop avec cable(Ou on place ca apres la section noise?)
- ✗ Frequency dependant loop
- ✗ Item 3

[3min-Max] Level 2: Radiation I – Plan

- ✗ Simple Travelling wave
- ✗ Wavelength
- ✗ Induction is actually radiation
- ✗ Stripline radiation Pattern

- Item 1
- Item 2
- Item 3

Level 3: Impedance & Reflection [20min - 1h10]

- Current Paths [30min-50min]
- Impedance & Reflection [20min - 1h10]
  - Signal Source II
  - Impédances I
  - Réflection
  - Transmission Line I
- Noise [27min - 1h37]

[5min-Pascal] Level 3: Signal Source II – Plan

- ✗ Type of source
- ✗ High/Low Impedance
- ✗ GPIO output circuit

- PPPPP2
- Impedance dans le plan complexe
- Rappel qu'on ignore la conductance G.

[5min-Pascal] Level 3: Réflection – Plan

- ✖ Bounce Diagram
- ✖ Impedance Mismatch
- ✖ Item 3

[5min-Pascal] Level 3: Transmission Line I – Plan

- ✖ Equation de base
- ✖ Pertes en dB (exponential decay)

Level 4: Noise [27min - 1h37]

- Impedance & Reflection [20min - 1h10]
- Noise [27min - 1h37]
  - Decibel Review
  - Signal Source III
  - Noise Spectrum
  - Harmonics II
  - Signal to Noise Ratio (SNR)
  - Jitter
  - Eye diagram
- Crosstalk & Coupling [18min - 1h55]

[5min-Max] Level 4: Decibel Review – Plan

- Pourquoi c'est important
- Analogie des dB avec le stock market
- Item 3

[4min-Max] Level 4: Signal Source III – Plan

- ✖ Random Noise Source
- ✖ Noise Power
- ✖ Source of noise in a circuit

[2min-Max] Level 4: Noise Spectrum – Plan

- ✖ Frequency dependant noise power
- ✖ Demo avec type de bruit (red, white, brown, etc..)

[3min-Max] Level 4: Harmonics II – Plan

- ✖ Gauss representation in frequency domain of a sine wave
- ✖ Sinc function
- ✖ Item 3

[5min-Max] Level 4: Signal to Noise Ratio (SNR) – Plan

- ✗ Why it matters
- ✗ How can you tell the SNR you need
- ✗ Shannon-Hartley Theorem
- ✗ Application: DAC,ADC
- ✗ Application: Example for Voyager 1 Detection Link

[5min-Pascal] Level 4: Jitter – Plan

- Item 1
- Item 2
- Item 3

[5min-Pascal] Level 4: Eye diagram – Plan

- Item 1
- Item 2
- Item 3

Level 5: Crosstalk & Coupling [18min - 1h55]

- Noise [27min - 1h37]
- Crosstalk & Coupling [18min - 1h55]
  - Impedances II
  - Radiation II
  - Differential Pairs
  - Far crosstalk
  - Near crosstalk
- Basic Building Blocks [12min-2h07]

Level 5: Crosstalk & Coupling [18min - 1h55] – Introduction

- Item 1
- Item 2
- Item 3

[5min-Pascal] Level 5: Impedances II – Plan

- ✖ Impedance du vide
- ✖ How its related to radiation

[3min-Max] Level 5: Radiation II – Plan

- ✗ Twisted Pairs
- ✗ Radiation Pattern
- ✗ Radiation Lense

[5min-Pascal] Level 5: Differential Pairs – Plan

- ✖ Item 1
- ✖ Item 2
- ✖ Do Differential Pairs need GND?

[5min-Pascal] Level 5: Far crosstalk – Plan

- Item 1
- Item 2
- Item 3

[5min-Pascal] Level 5: Near crosstalk – Plan

- Item 1
- Item 2
- Item 3

Level 6: Basic Building Blocks [12min-2h07]

- Crosstalk & Coupling [18min - 1h55]
- Basic Building Blocks [12min-2h07]
  - Signal Source IV
  - Filters
  - Transmission Line II
  - Waveguide I
- Field lines and Fringes [20min-2h27]

[5min-Max] Level 6: Signal Source IV – Plan

- ✗ Crystals
- ✗ Oscillators
- ✗ Item 3

[2min-Max] Level 6: Filters – Plan

- ✗ Transfer fonction
- ✗ Item 2
- ✗ Item 3

[5min-Pascal] Level 6: Transmission Line II – Plan

- ✗
- ✗
- ✗ Transmission/Frequency plot

[5min-Pascal] Level 6: Waveguide I – Plan

- ✖ Explain Strip line
- ✖ Show other structures
- ✖ CPWG, Microstrip, GCPWG

Level 7: Field lines and Fringes [20min-2h27]

- Basic Building Blocks [12min-2h07]
- Field lines and Fringes [20min-2h27]
  - Waveguide II
  - Skew, loss
  - Skin effect
  - EMI
- Dielectric Depths [26min-2h49]

[5min-Pascal] Level 7: Waveguide II – Plan

- ✖ stripline Field
- ✖ Microstrip Field
- ✖ CPWG, GCPWG field
- ✖ Item 3

[5min-Pascal] Level 7: Skew, loss – Plan

- Item 1
- Item 2
- Item 3

[5min-Pascal] Level 7: Skin effect – Plan

- Item 1
- Item 2
- Item 3

[5min-Pascal] Level 7: EMI – Plan

- Item 1
- Item 2
- Item 3

Level 8: Dielectric Depths [26min-2h49]

- Field lines and Fringes [20min-2h27]
- Dielectric Depths [26min-2h49]
  - Conduction
  - Loss tangent
  - Passive Component II
  - Current Bunching
  - Stackup I
  - Dispersion
  - Fin premiere Partie
- Advanced Building Blocks [17min-3h06]

[3min-Max] Level 8: Conduction – Plan

- ✗ Conduction G
- ✗ Substrate vibration
- ✗ Item 3

[3min-Max/Pascal] Level 8: Loss tangent – Plan

- ✗ Item 1
- ✗ Item 2
- ✗ Item 3

[5min-Pascal] Level 8: Passive Component II – Plan

- ✖ Frequency-dependant passives
- ✖ Item 3

[3min-Max/Pascal] Level 8: Current Bunching – Plan

- ✗ Item 1
- ✗ Item 2
- ✗ Item 3

[10min-Pascal] Level 8: Stackup I – Plan

- ✖ Conversion
- ✖ Lecture datasheet diélectrique
- ✖ Optimisation Stackup
- ✖ Propriété FR4, copper, or, plomb

[2min-Max] Level 8: Dispersion – Plan

- Ou trouver dans une data sheet de cable
- Item 2
- Item 3

Fin officiel du PPMPMPPPMPMPPMPPPMPPPMPPPMP05. Le reste c'est pour les crinqué

Bonus Level 9: Advanced Building Blocks [17min-3h06]

- Dielectric Depths [26min-2h49]
- Advanced Building Blocks [17min-3h06]
  - Signal Source V
  - Stackup II
  - Stubs
  - Coupler
  - Resonator
  - Antennes
- Waveform Abyss [12min-3h18]

[2min-Max] Bonus Level 9: Signal Source V – Plan

- ✗ PLL
- ✗ n-Synth
- ✗ Item 3

[10min-Pascal] Bonus Level 9: Stackup II – Plan

- ✖ Rogers
- ✖ Substrate weave pattern
- ✖ Avantages / désavantages de certains matériaux

[2min-Max] Bonus Level 9: Stubs – Plan

- ✗ Item 1
- ✗ Item 2
- ✗ Item 3

[2min-Max] Bonus Level 9: Coupler – Plan

- ✗ Item 1
- ✗ Item 2
- ✗ Item 3

[2min-Max] Bonus Level 9: Resonator – Plan

- ✗ Item 1
- ✗ Item 2
- ✗ Item 3

[4min-Max] Bonus Level 9: Antennes – Plan

- ✖ Item 1
- ✖ Item 2
- ✖ Item 3

Bonus Level 10: Waveform Abyss [12min-3h18]

- Advanced Building Blocks [17min-3h06]
- Waveform Abyss [12min-3h18]
  - Impedances III
  - Modulation
  - Mixing
  - Superposition II
- S-Parameters and Smith Charts [17min-3h35]

[2min-Pascal/Max] Bonus Level 10: Impedances III – Plan

- ✖ Impedance Negative

[3min-Max] Bonus Level 10: Modulation – Plan

- ✖ Item 1
- ✖ Item 2
- ✖ Item 3

[2min-Max] Bonus Level 10: Mixing – Plan

- ✗ Item 1
- ✗ Item 2
- ✗ Item 3

[5min-Max] Bonus Level 10: Superposition II – Plan

- ✗ I/Q - Wave Complex Conjugate
- ✗ negative frequency
- ✗ Item 3

Bonus Level 11: S-Parameters and Smith Charts [17min-3h35]

- Waveform Abyss [12min-3h18]
- S-Parameters and Smith Charts [17min-3h35]
  - S-Parameters
  - Smith Charts
  - Impedance Matching Network
  - Standing Waves
- Non-linearity Valley [14min-3h49]

[5min-Pascal/Max] Bonus Level 11: S-Parameters – Plan

- ✗ Item 1
- ✗ Item 2
- ✗ Item 3

[5min-Pascal/Max] Bonus Level 11: Smith Charts – Plan

- ✖ Item 1
- ✖ Item 2
- ✖ Item 3

- ✗ Item 1
- ✗ Item 2
- ✗ Item 3

[2min-Max] Bonus Level 11: Standing Waves – Plan

- ✗ Item 1
- ✗ Item 2
- ✗ Item 3

Bonus Level 12: Non-linearity Valley [14min-3h49]

- S-Parameters and Smith Charts [17min-3h35]
- Non-linearity Valley [14min-3h49]
  - Passive Component III
  - Superposition III
  - Harmonics III
  - Intermodulation
  - Crossmodulation
- Infrared Chasm [10min-3h59]

[5min-Pascal] Bonus Level 12: Passive Component III – Plan

- ✗ Nonlinear passive component models
- ✗

[3min-Max] Bonus Level 12: Superposition III – Plan

- ✗ Superposition breaks
- ✗ Item 2
- ✗ Item 3

[5min-Max] Bonus Level 12: Harmonics III – Plan

- ✗ How non-linearity create harmonics
- ✗ Item 2
- ✗ Item 3

[3min-Max] Bonus Level 12: Intermodulation – Plan

- ✗ Item 1
- ✗ Item 2
- ✗ Item 3

[3min-Max] Bonus Level 12: Crossmodulation – Plan

- ✗ Item 1
- ✗ Item 2
- ✗ Item 3

Bonus Level 13: Infrared Chasm [10min-3h59]

- Non-linearity Valley [14min-3h49]
- Infrared Chasm [10min-3h59]
  - When the equations fails
  - Electron vibration frequency
  - Blackbody Radiation
- Integrated Photonics [18min-4h17]

[5min-Max] Bonus Level 13: When the equations fails – Plan

- ✗ Item 1
- ✗ Item 2
- ✗ Item 3

- ✗ Item 1
- ✗ Item 2
- ✗ Item 3

[3min-Max] Bonus Level 13: Blackbody Radiation – Plan

- ✗ Item 1
- ✗ Item 2
- ✗ Item 3

Final Boss: Integrated Photonics [18min-4h17]

- Infrared Chasm [10min-3h59]
- Integrated Photonics [18min-4h17]
  - RF Blocks can also be used to guide light
  - We can make circuits with light
  - We can manipulate light using Electrical Signals
  - We can use photonics to generate and manipulate Microwave Signals

[5min - Max] Final Boss: RF Blocks can also be used to guide light – Plan

- ✗ Item 1
- ✗ Item 2
- ✗ Item 3

[3min - Max] Final Boss: We can make circuits with light – Plan

- ✗ Item 1
- ✗ Item 2
- ✗ Item 3

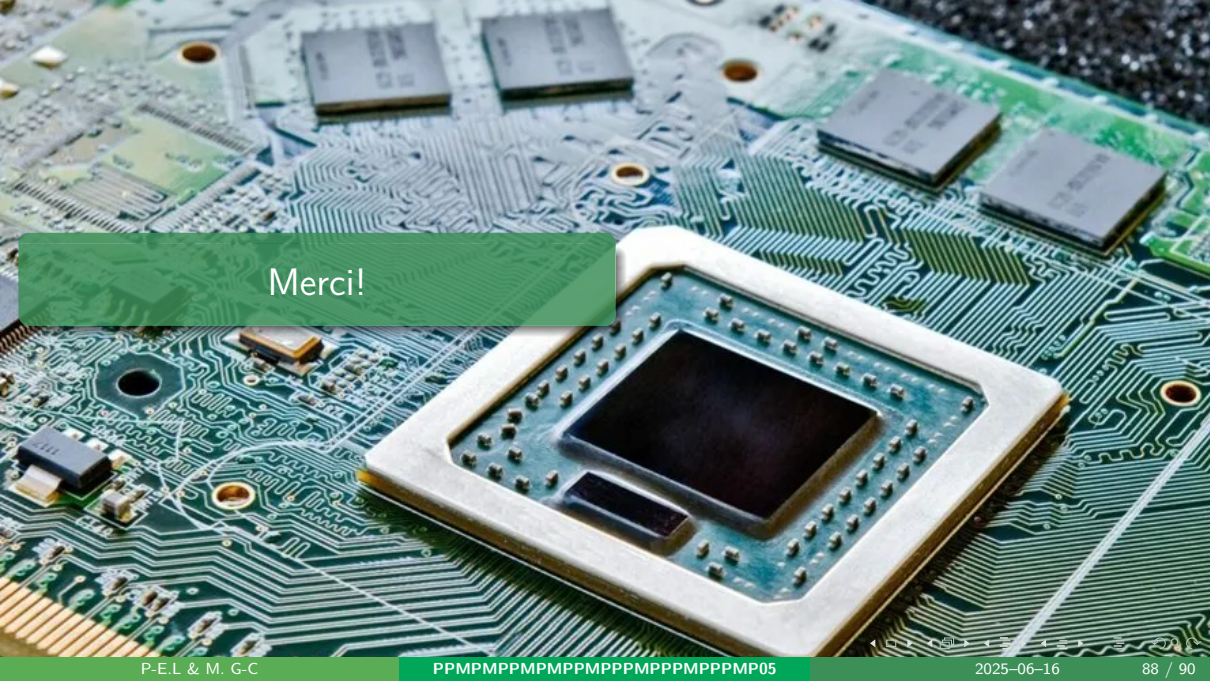
[5min - Max] Final Boss: We can manipulate light using Electrical Signals

- ✗ Item 1
- ✗ Item 2
- ✗ Item 3

[5min - Max] Final Boss: We can use photonics to generate and manipulate Microwa

Plan

- Item 1
- Item 2
- Item 3


Merci!

Prochain PPPPP

Bonnes pratiques de design

- Comment choisir ses composantes et optimiser son BOM?
- Comment bien concevoir un symbole et un footprint?
- Bonnes pratiques de schémas
- Bonnes pratiques de layout
- Communication avec fabricants, assembleurs et programmeurs

[5min - Max] Final Boss: We can use photonics to generate and manipulate Microwa

Références