

# PPMPMPPMPPMPPPMPPPMP05 Comment se déplace un signal?

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- 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



- X 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 I
  - 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



- X 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 I – Plan



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

#### [5min-Pascal/Max] <u>Level 2: Induction</u> – Plan



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

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



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

#### [3min-Max] <u>Level 2: Radiation I</u> – Plan



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

## [5min-Pascal] Level 2: Fil d'une année lumière de long – Plan



- X Item 1
- X Item 2
- X 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



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

## [5min-Pascal] Level 3: Impédances I – Plan



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

## [5min-Pascal] <u>Level 3: Réflection</u> – Plan



- ✗ Bounce Diagram
- Impedance Mismatch
- X Item 3

#### [5min-Pascal] <u>Level 3: Transmission Line I</u> – Plan



- **X** 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] <u>Level 4: Decibel Review</u> – Plan



- × Pourquoi c'est important
- ★ Analogie des dB avec le stock market
- X 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



- X Gauss representation in frequency domain of a sine wave
- ✗ Sinc function
- X 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] <u>Level 4: Jitter</u> – Plan



- X Item 1
- X Item 2
- X Item 3

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



- X Item 1
- X Item 2
- X 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



- X Item 1
- X Item 2
- X Item 3

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



- X Impedance du vide
- × How its related to radiation

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



- X Twisted Pairs
- × Radiation Pattern
- × Radiation Lense

#### [5min-Pascal] <u>Level 5: Differential Pairs</u> – Plan



- X Item 1
- X Item 2
- ✗ Do Differential Pairs need GND?

## [5min-Pascal] <u>Level 5: Far crosstalk</u> – Plan



- X Item 1
- X Item 2
- X Item 3

## [5min-Pascal] <u>Level 5: Near crosstalk</u> – Plan



- X Item 1
- X Item 2
- X 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
- X Item 3

# [2min-Max] <u>Level 6: Filters</u> – Plan



- X Transfer fonction
- X Item 2
- X 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]
  - Ground Planes II
  - Waveguide II
  - Skew, loss
  - Skin effect
  - EMI
- Dielectric Depths [26min-2h49]



# [5min-Pascal] Level 7: Ground Planes II – Plan



- × item 1
- × item 2
- × item 3

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



- × stripline Field
- × Microstrip Field
- × CPWG, GCPWG field
- X Item 3

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



- X Item 1
- X Item 2
- X Item 3

## [5min-Pascal] <u>Level 7: Skin effect</u> – Plan



- X Item 1
- X Item 2
- × Item 3

# [5min-Pascal] <u>Level 7: EMI</u> – Plan



- X Item 1
- X Item 2
- X 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] <u>Level 8: Conduction</u> – Plan



- Conduction G
- Substrate vibration
- X Item 3

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



- X Item 1
- X Item 2
- X Item 3

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



- ★ Frequency-dependant passives
- X Item 3



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



- X Item 1
- X 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
- X Item 2
- X Item 3

# [Fin premiere Partie] Level 8: Fin premiere Partie – fin



Fin officiel du PPMPMPPMPPMPPPMPPPMPPPMP05. 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
- S-Parameters and Smith Charts [17min-3h35]

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



- × PLL
- × n-Synth
- X 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



- X Item 1
- X Item 2
- X Item 3

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



- Item 1
- Item 2
- Item 3

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



- X Item 1
- X Item 2
- X Item 3

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



- X Item 1
- X Item 2
- X Item 3

## Bonus Level 10: S-Parameters and Smith Charts [17min-3h35]

- Advanced Building Blocks [17min-3h06]
- S-Parameters and Smith Charts [17min-3h35]
  - S-Parameters
  - Smith Charts
  - Impedance Matching Network
  - Standing Waves
- Waveform Abyss [12min-3h18]

# [5min-Pascal/Max] Bonus Level 10: S-Parameters – Plan



- X Item 1
- X Item 2
- X Item 3

# [5min-Pascal/Max] Bonus Level 10: Smith Charts – Plan



- X Item 1
- X Item 2
- X Item 3

# [5min-Pascal] Bonus Level 10: Impedance Matching Network – Plant

- X Item 1
- X Item 2
- X Item 3

# [2min-Max] Bonus Level 10: Standing Waves – Plan



- X Item 1
- X Item 2
- X Item 3

## Bonus Level 11: Waveform Abyss [12min-3h18]

- S-Parameters and Smith Charts [17min-3h35]
- Waveform Abyss [12min-3h18]
  - Impedances III
  - Modulation
  - Mixing
  - Superposition II
- Non-linearity Valley [14min-3h49]

# [2min-Pascal/Max] Bonus Level 11: Impedances III – Plan



× Impedance Negative



# [3min-Max] Bonus Level 11: Modulation – Plan



- X Item 1
- X Item 2
- X Item 3

# [2min-Max] Bonus Level 11: Mixing – Plan



- X Item 1
- X Item 2
- X Item 3

## [5min-Max] Bonus Level 11: Superposition II – Plan



- X I/Q Wave Complex Conjugate
- negative frequency
- × Item 3

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

- Waveform Abyss [12min-3h18]
- 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
- X Item 2
- X Item 3

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



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

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



- X Item 1
- X Item 2
- X Item 3

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



- X Item 1
- X Item 2
- X 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



- X Item 1
- X Item 2
- × Item 3

# [2min-Max] Bonus Level 13: Electron vibration frequency – Plan



- X Item 1
- X Item 2
- X Item 3

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



- X Item 1
- X Item 2
- X 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

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



- X Item 1
- X Item 2
- X Item 3

Max Final Boss: We can manipulate light using Electrical Signals



- Item 1
- Item 2
- Item 3

Max Final Boss: We can use photonics to generate and manipulate Microw Plan



- Item 1
- Item 2
- Item 3



## **Prochain PPPPP**

# Bonnes pratiques de design

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

Max] Final Boss: We can use photonics to generate and manipulate Microw

Références

