SYSTEMS CHIP CONFERENCE

# Signal Integrity, Bandwidth and Backplane Termination

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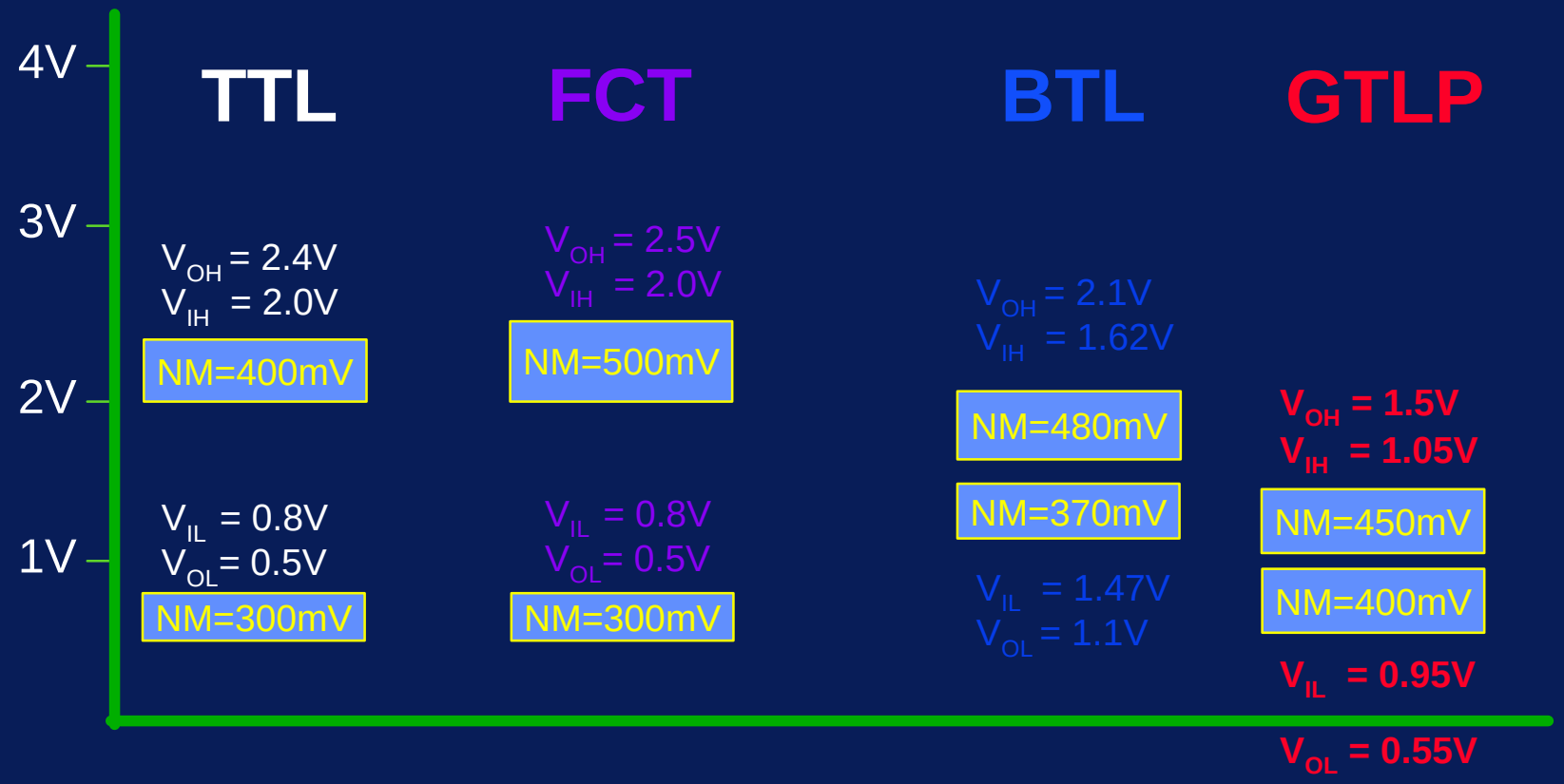
# Introduction

- What You Need To Know To Design for Signal Integrity
- Signal Levels
- Drive Requirements
- Incident Wave Switching and Bandwidth
- Example Application
- Handling Supply Requirements

# What You Need To Know To Design Signal Integrity

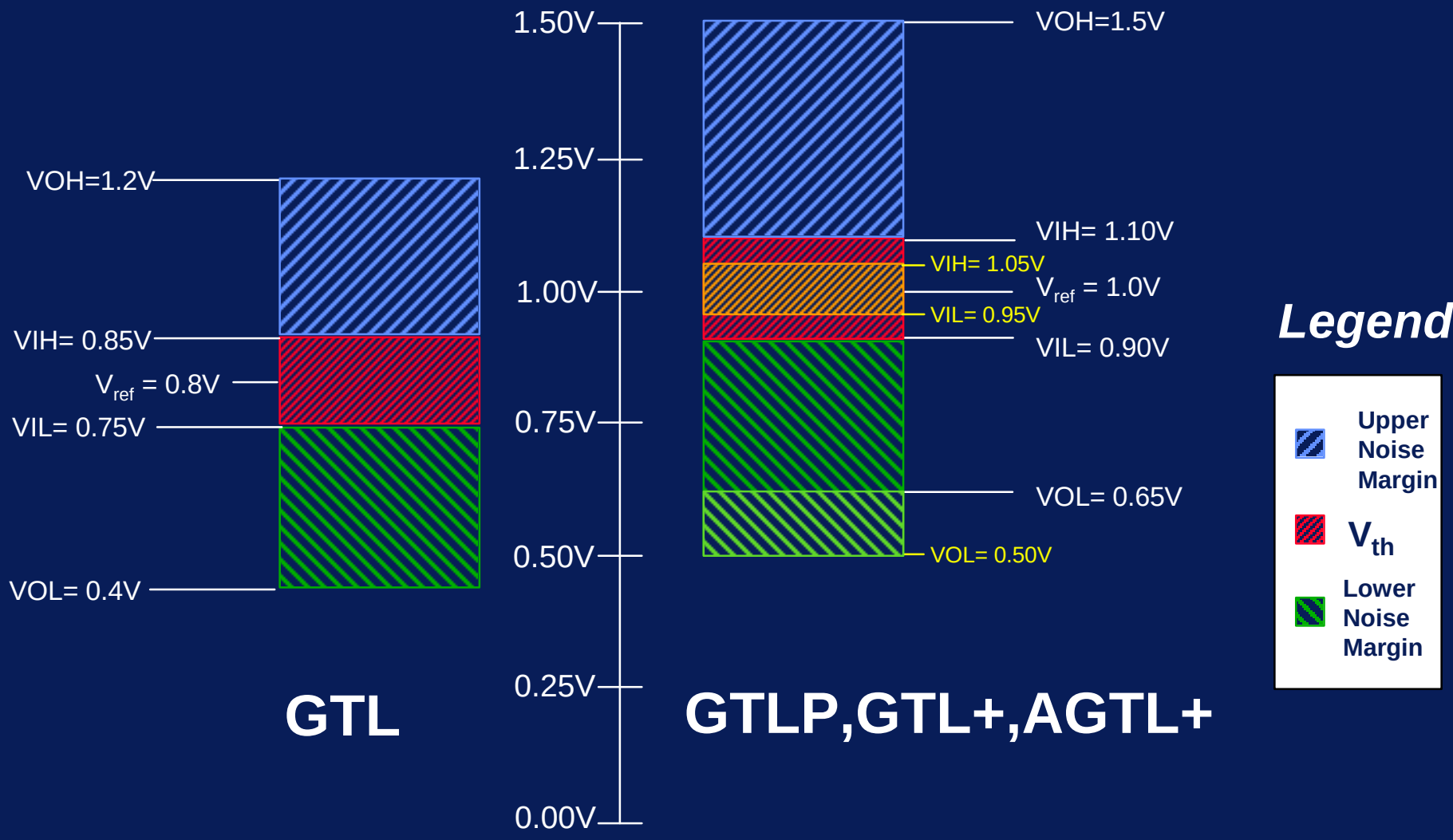
- Signal Levels (why are they different)
- Output Drive Characteristics
  - Static (termination values)
  - Dynamic  (I/O, b/p and trace impedance, double drive advantages)
- Noise Control
  - Edge Rate Control
  - Incident Wave Switching
  - Signal Level / Termination Effects (*example*)

# Voltage Swings and Noise Margins



# Signal Level Comparison

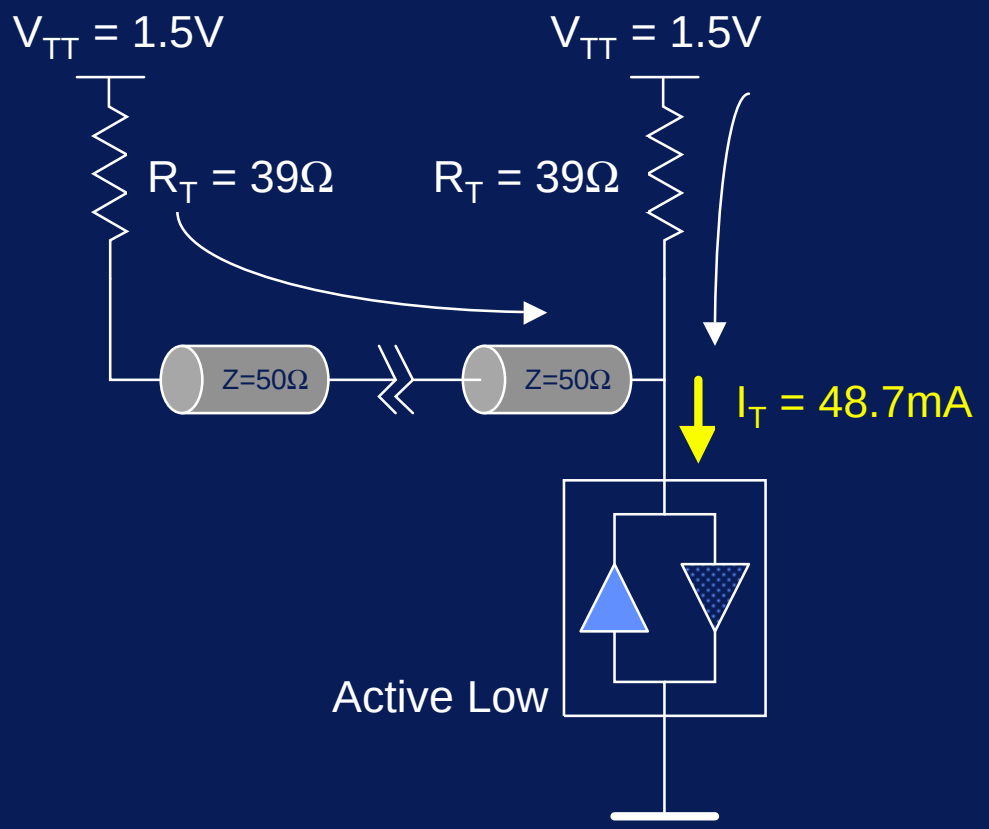
## GTL, GTLP, GTL+, AGTL+



# Output Drive

## Static

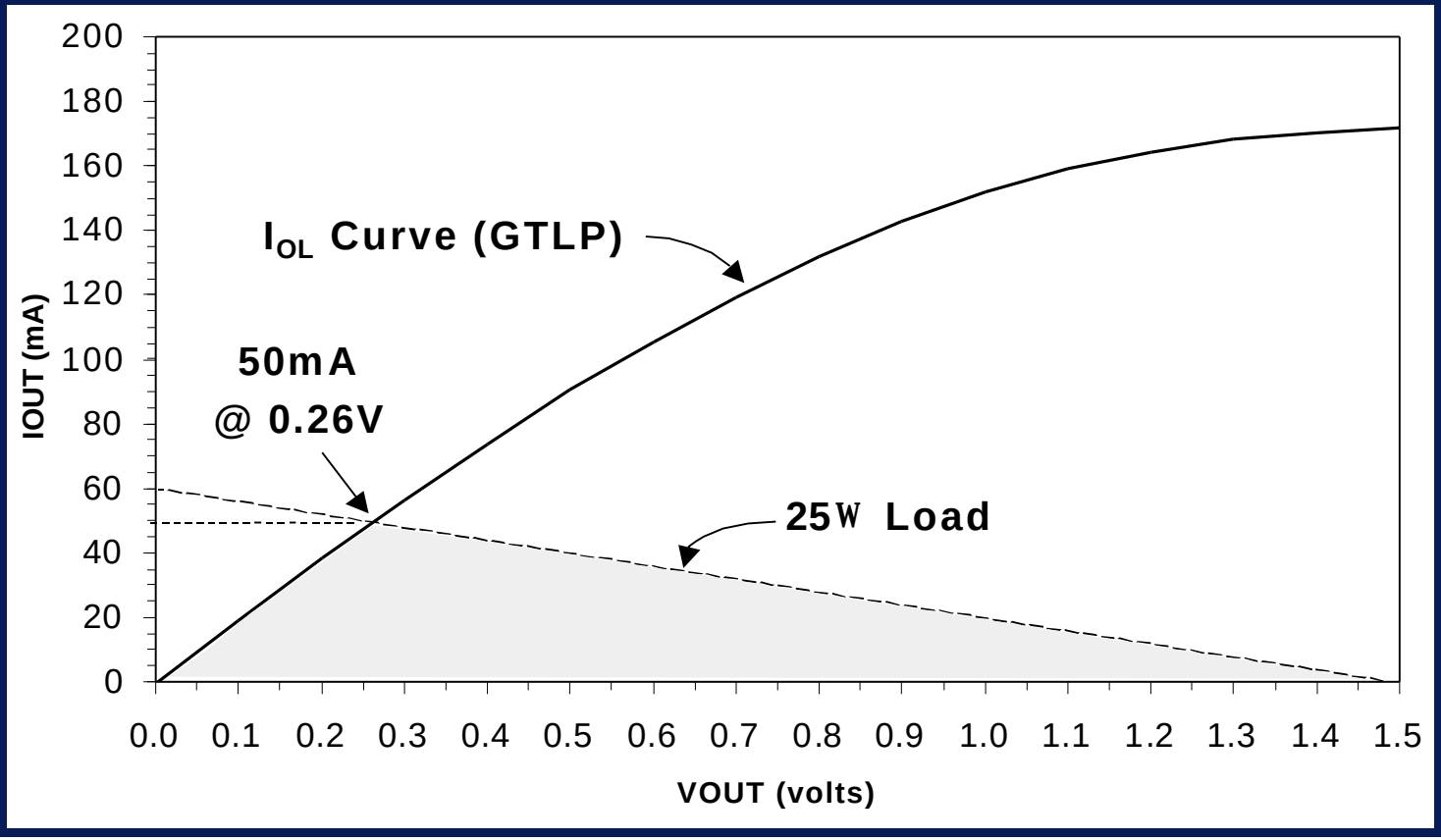
- **Termination Dependent**
- **Example1:**
  - using $V_{TT}$ = 1.5V, $R_T$ = 50Ω, $V_{OL}$ = 0.55V
  - doubly terminated
  - ***$I_T$ = 38.0mA***
- **Example2:**
  - using $V_{TT}$ = 1.5V, $R_T$ = 39Ω, $V_{OL}$ = 0.55V
  - doubly terminated
  - ***$I_T$ = 48.7mA***



# Output Drive

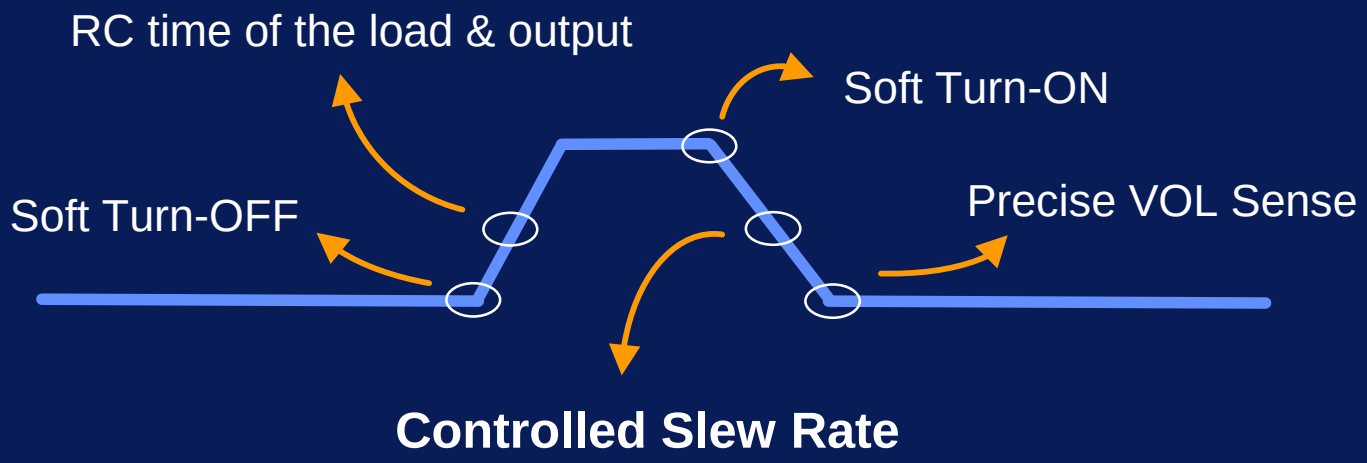
## Dynamic

- Dependent on:
  - Number of Receivers
  - Trace Impedance
  - Stub Capacitance
  - Connector Capacitance (if applicable)
  - I/O Capacitance
  - Termination



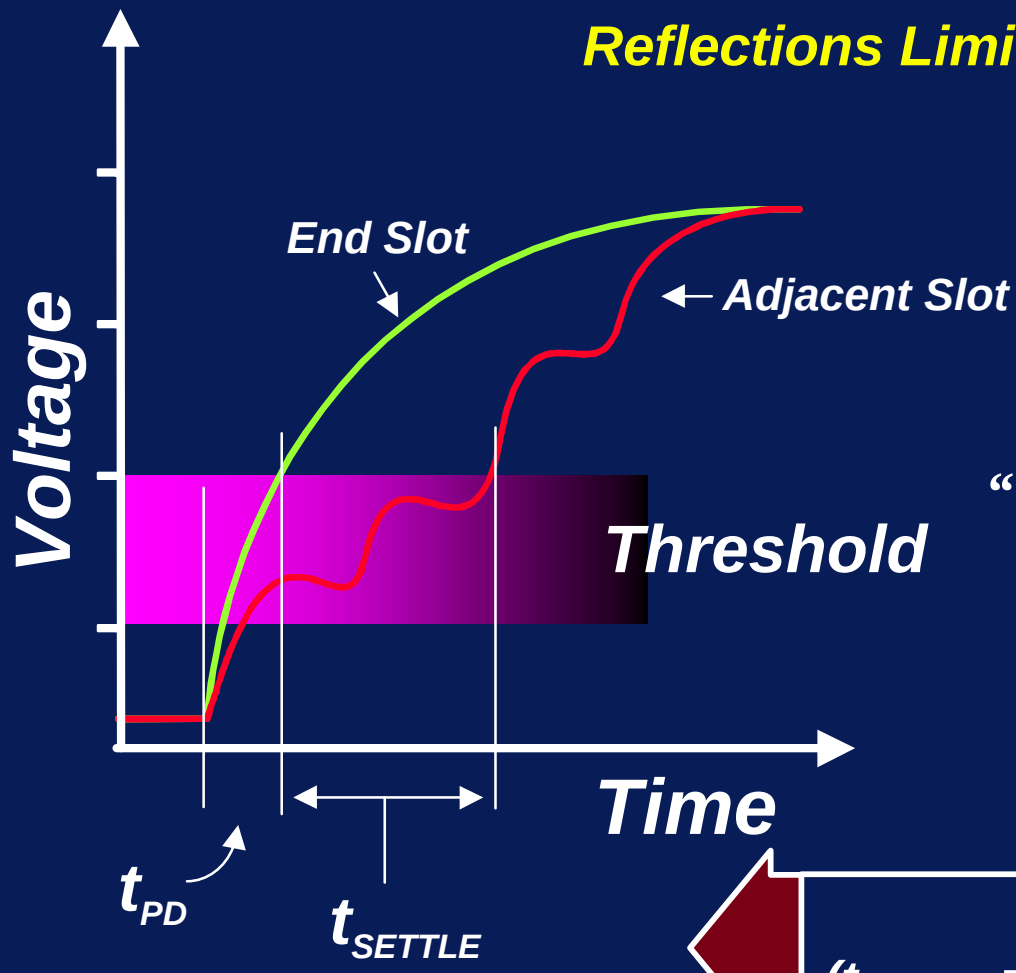
# Edge Rate Control

- **Edge rate control to allow higher throughput and minimize noise on GTLP port.**
- **Ideal for incident wave switching applications.**



# Incident Wave Switching

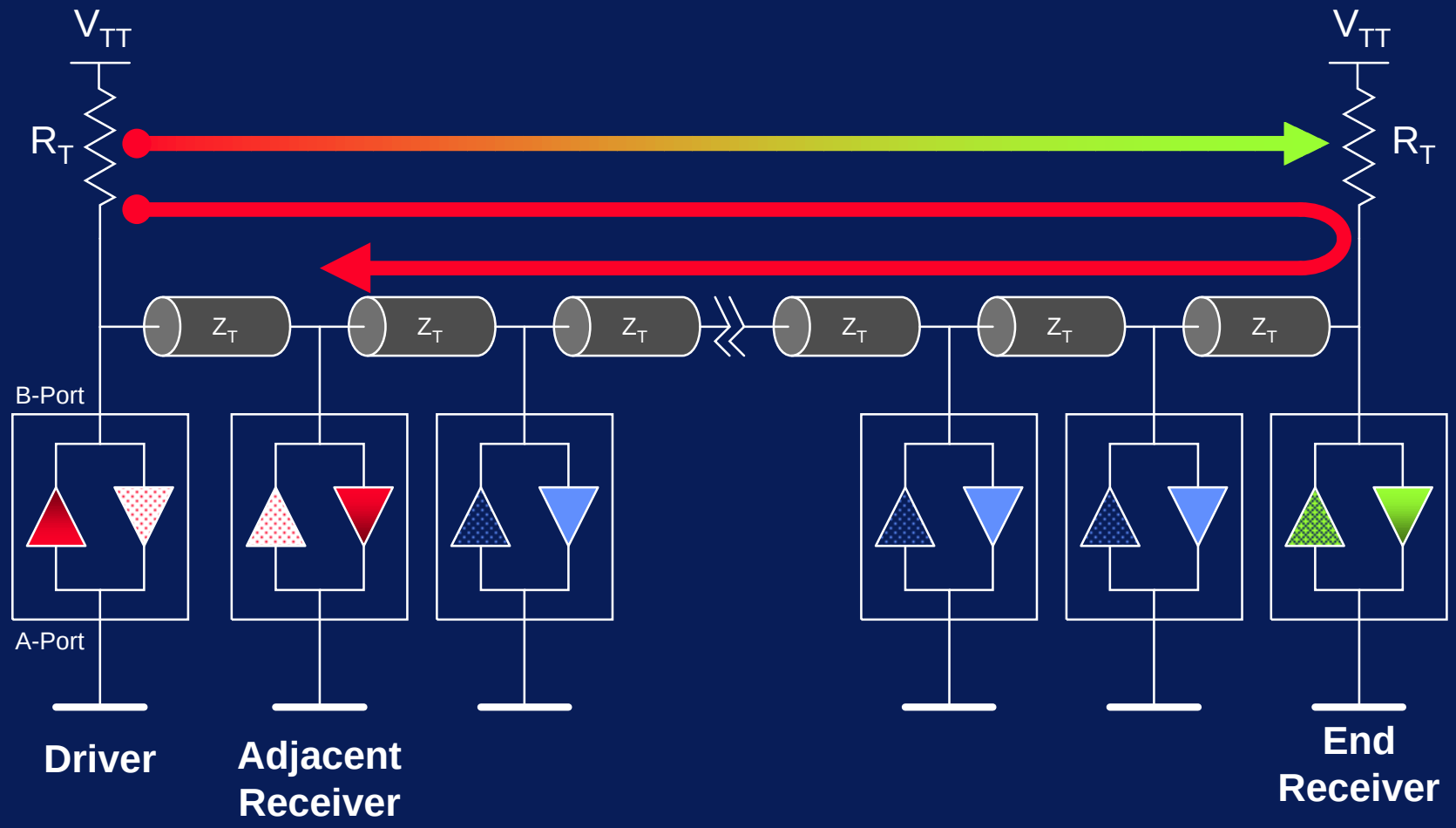
***Reflections Limit Performance***




*"Clean" Incident Wave Signal offers stable, useable data in a shorter (faster) $t_{PD}$.*

*Actual $t_{PD} = t_{PD} + t_{SETTLE}$*
*($t_{SETTLE}$ = multiples of the round trip bus delay)*

# Reflection Path



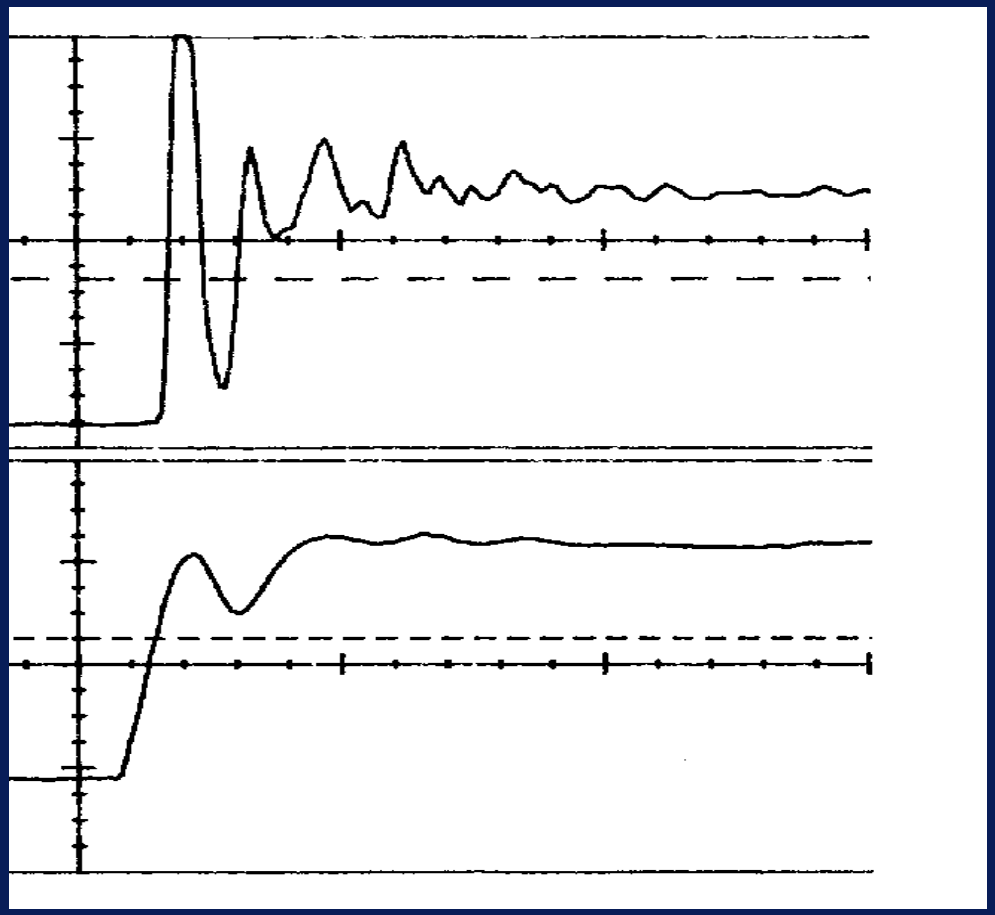
# What to Expect

## *Without* E/R Control

- Fast edge rate
- Ring Back
- Lower Thruput

## *With* E/R Control

- Slower edge rate
- Minimum Ring Back
- Higher Thruput

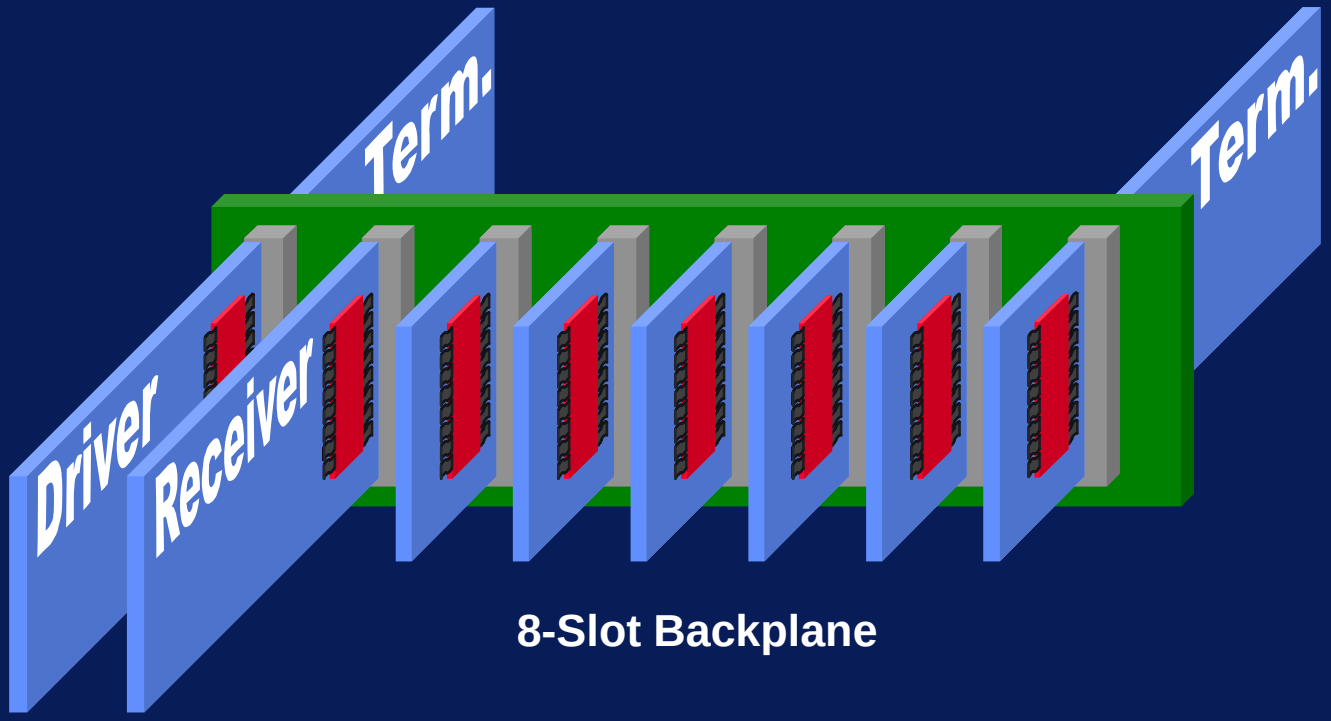


- *B-side output waveforms collected on a 8 slot, 50 ohm backplane with one output switching @1Mhz*
- *Taken on GTL(P)16612 devices at output pin of transceiver*

# GTLP Backplane Application

| | |
|---|---|
| • Number of slots: | 8 |
| • Backplane Impedance: | 65ohms |
| • Stub Impedance: | 50ohms |
| • Connector Pitch: | 0.8in |
| • Backplane Length: | 0.8in * 7 = 5.6in |
| • Location of Boards: | Termination Cards - On the ends and on the back of the backplane |

# Backplane Configuration

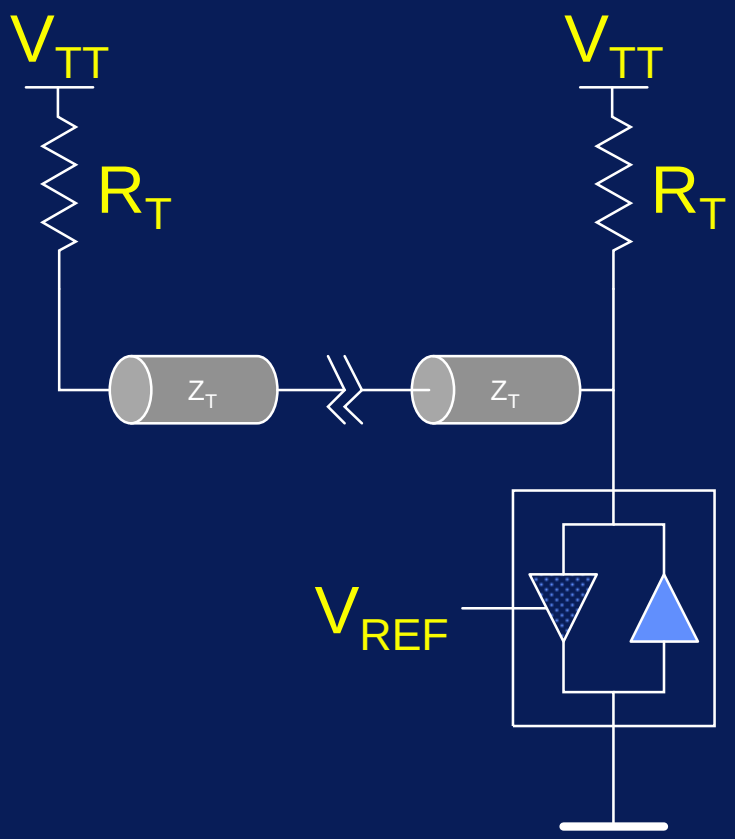



8-Slot Backplane

# Signal Level Effects

## Termination Variations

- $V_{TT}$ Changes
- $R_T$ Changes
- $V_{REF}$ Changes

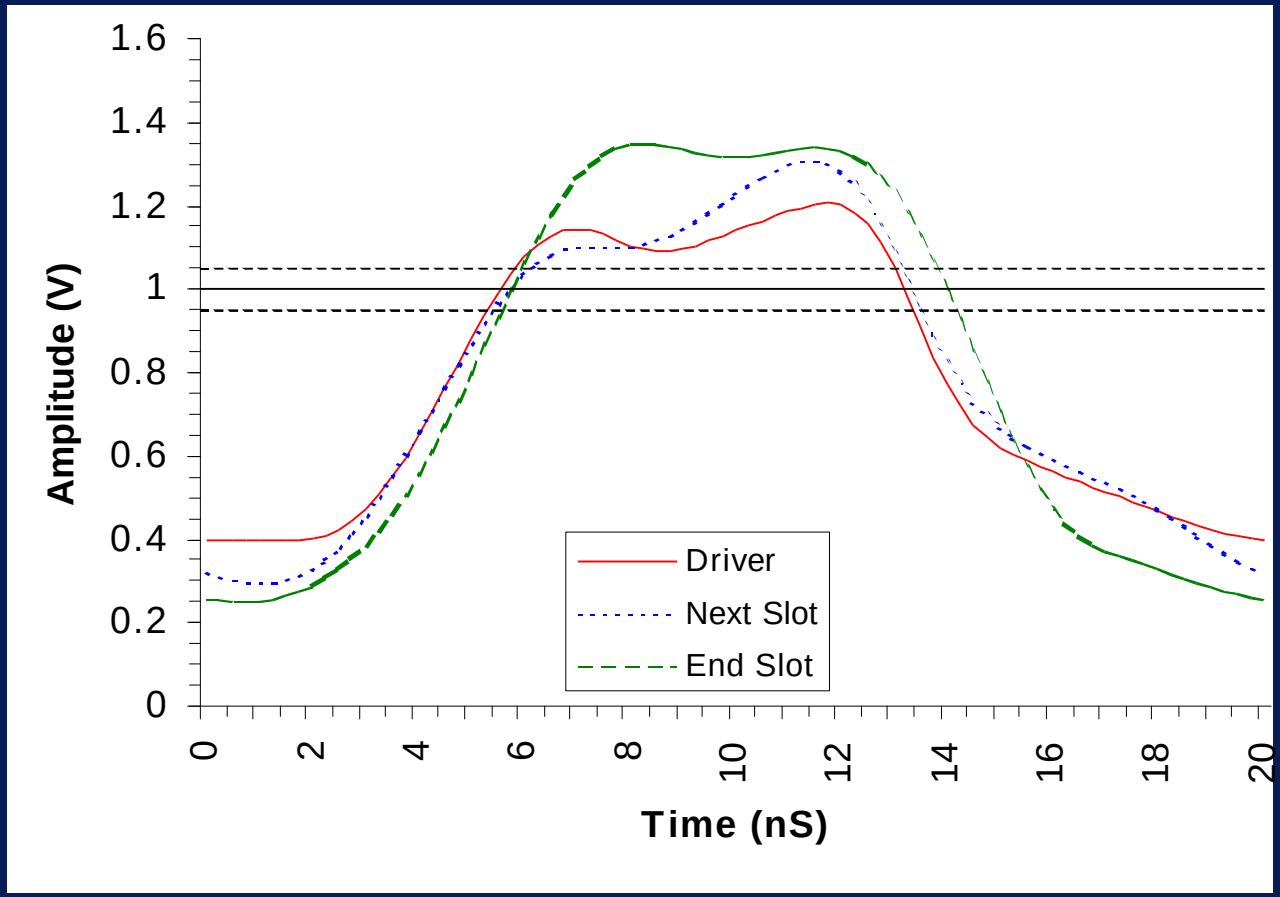


# Starting Point

$R_T = 50\Omega$

- 50MHz
- Single Output
- End Drive

- IWS
- Low $V_{OH}$ Noise Margin

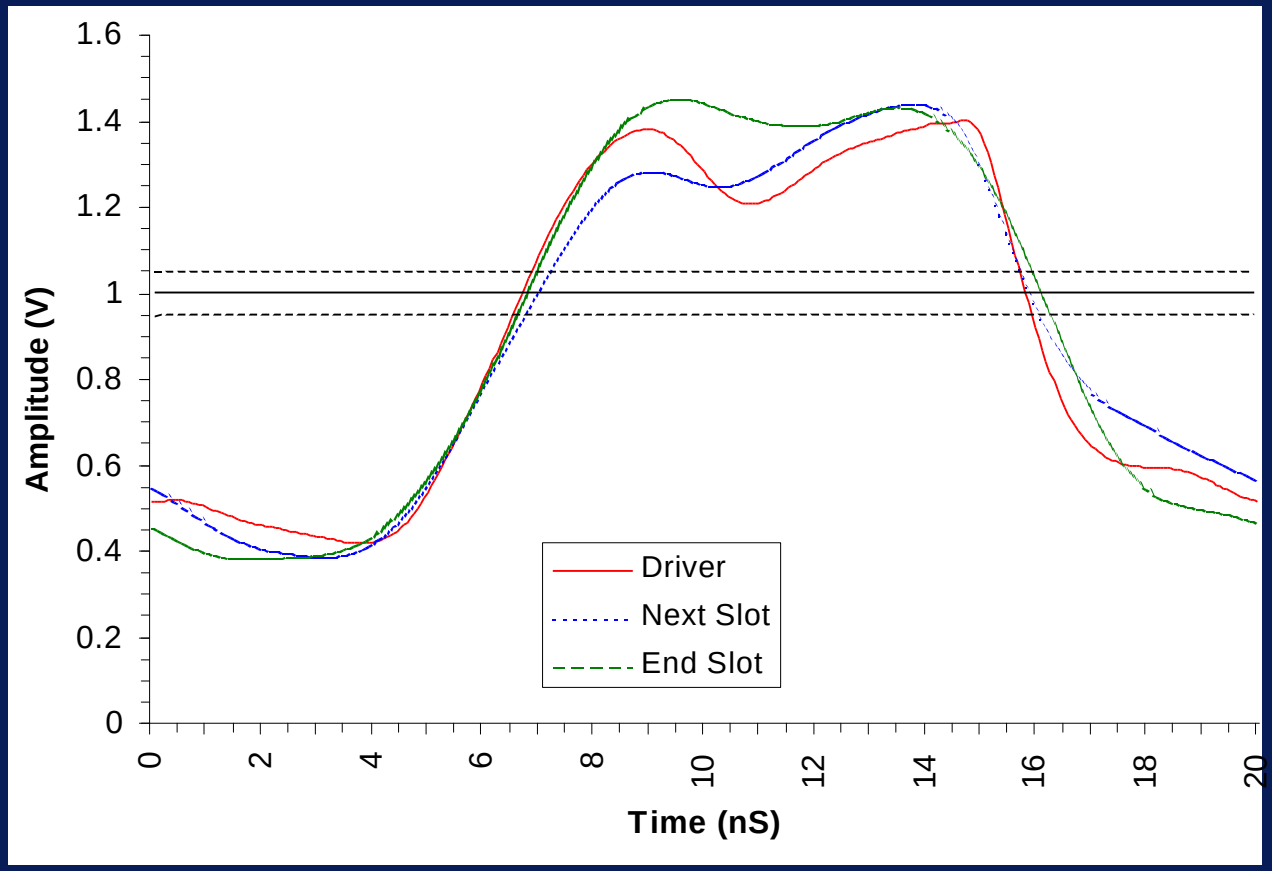


# Effect of Reduced RT

$R_T$ = 39W

- 50MHz
- Single Output
- End Drive

- IWS
- Better $V_{OH}$ Noise Margin
- Some Reflection

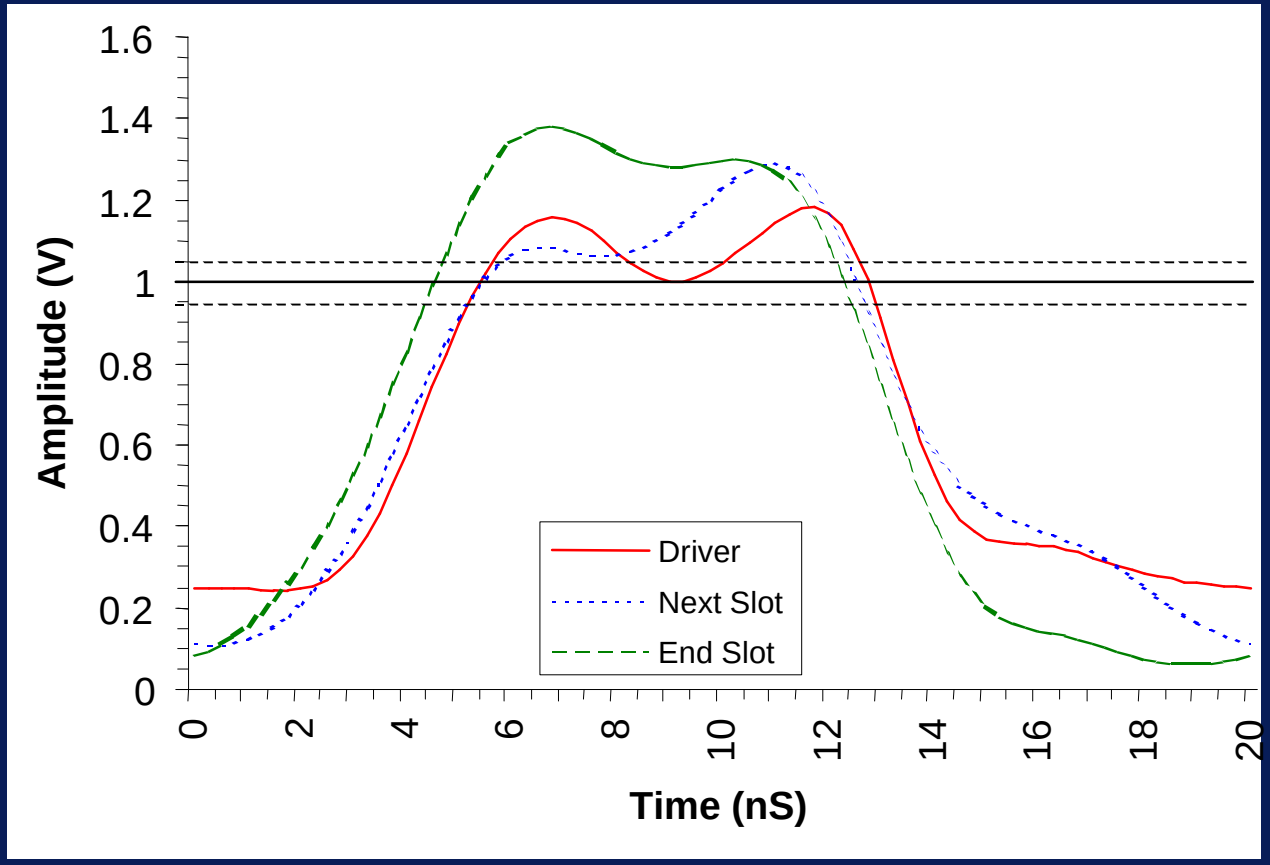


# Effect of Double Drive

$R_T = 50\Omega$

- 50MHz
- Double Output
- End Drive

- Better $V_{OL}$ Margin
- Still IWS
- Some Reflection

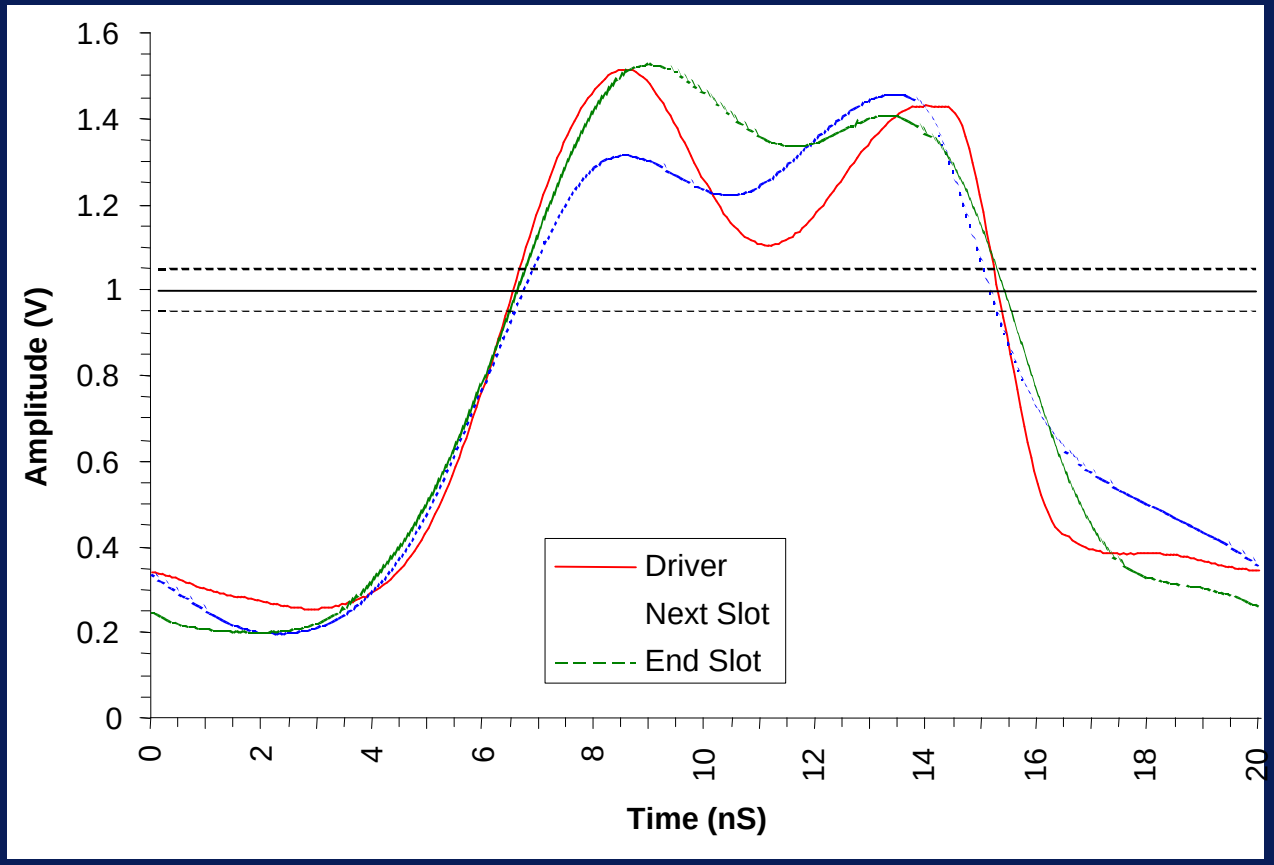


# Effect of Double Drive and Reduced $R_T$

$R_T$ = 39W

- 50MHz
- Double Output
- End Drive

- Improved $V_{OH}$ Margin
- IWS
- Increased Reflection



# Handling Supply Requirements

## Three to Four Supplies

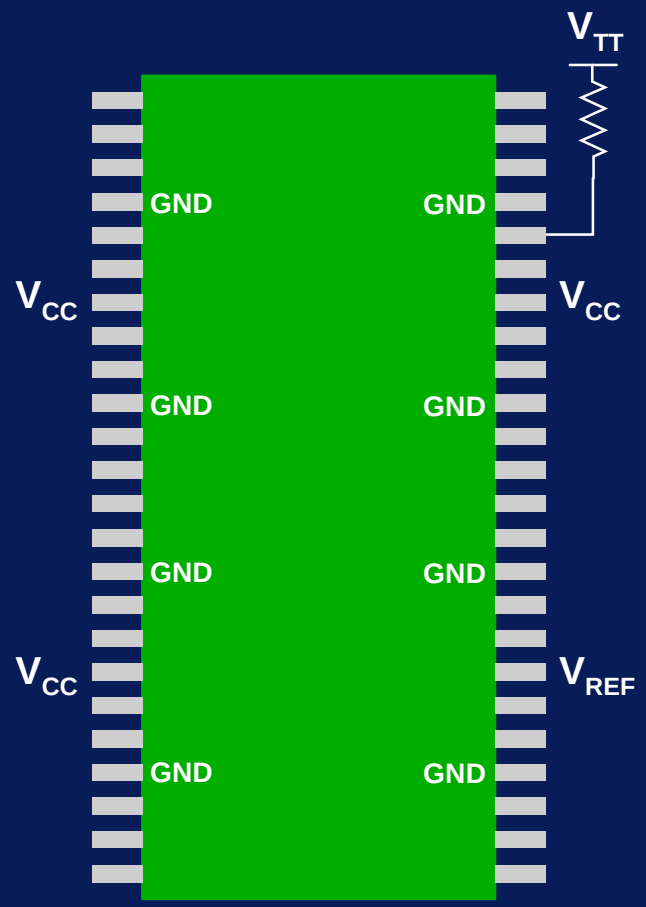
- $V_{CC(s)}$ $V_{TT}$ $V_{REF}$

## Decoupling

- @ Source
- @ Device

## Optimal Location

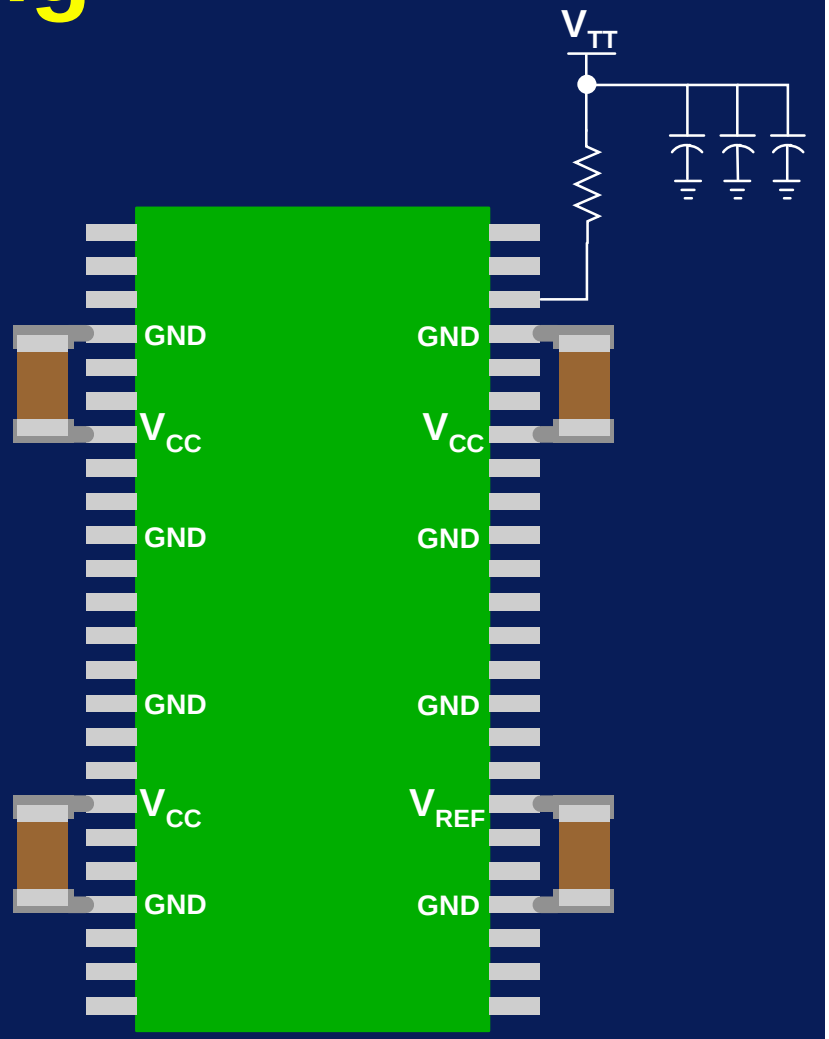
- On-board
- Ends of bus/backplane



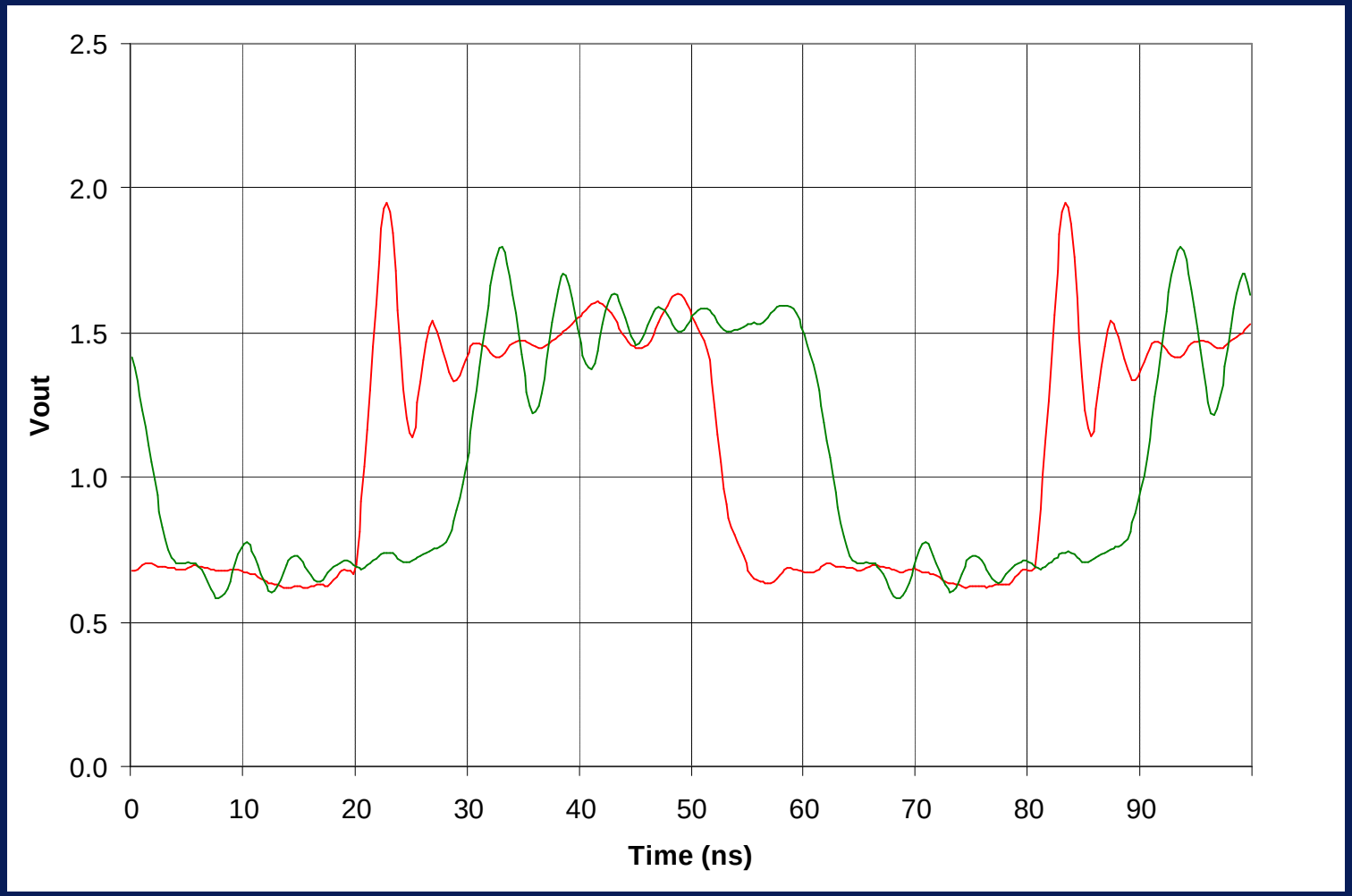
# Decoupling

## Supply

- At source for noise suppression and charge storage
  - 220uF
  - 0.1uF
  - 0.01uF
- At device for noise suppression
  - 0.1uF



# Effect of Improper $V_{TT}$ Decoupling



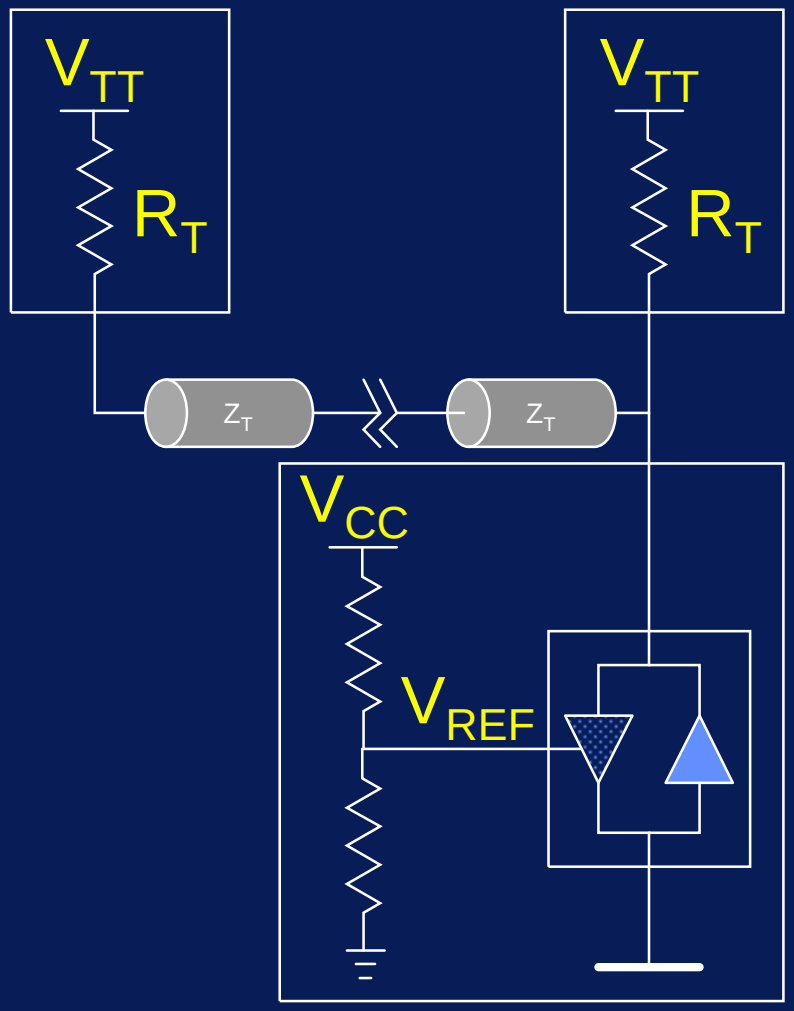
# Supply Location

**$V_{TT}$**

- Located at end(s) of the bus/backplane
- Close to receiver for uni-directional flow

**$V_{REF}$**

- Generated from $V_{CC}$ locally
- Generated from $V_{TT}$ at termination



# Recommendations

- Make use of IWS
  - Improved Signal Integrity
  - Doubling of Data Rate
- Start with standard termination solution
  - Migrate to termination solution that optimizes signal integrity
- Decouple and Isolate