



T e c h n o l o g y   t o   t h e   C o r e

**Revisiting CX4 Transition Time Definition  
and Measurement  
Ze'ev Roth**

# Overview

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- Goal
- Transition Time
- Model
- Results
- Conclusions & Recommendations

# Objective

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- Demonstrate that current rise/fall time measurement results depend on the pre-emphasis value
  - Phenomena that does not occur for established 20%-80% measurement procedure

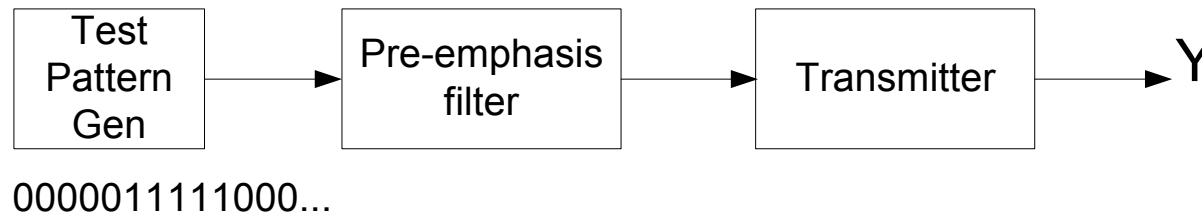
# Transition Time

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- Defined in Clause 54.7.3.7 (P802.3ak D5.0)
  - “The rising edge transition time shall be between 60 and 130 ps as measured between the -0.35 to the 0.66 normalized levels as specified in 54.7.3.6. The falling edge transition time shall be between 60 and 130 ps as measured between the 0.35 to the -0.66 normalized levels as specified in 54.7.3.6.”
- In most applications it's defined as the time between the 20%-80% of the transition swing

# Model & Procedure

## Simplified model for assessing rise time



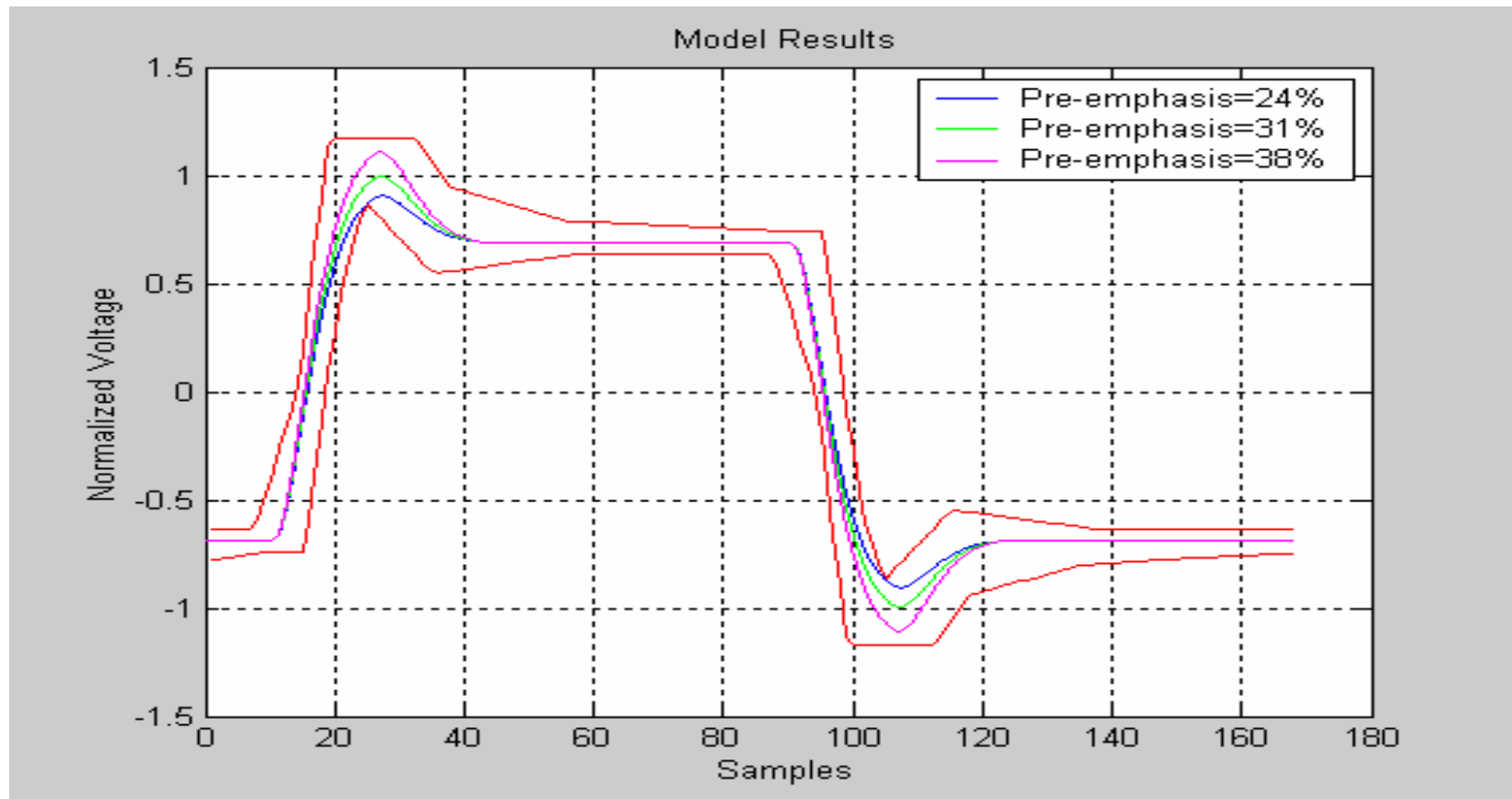
- Procedure
  - Calculate Y
  - Perform Template Normalization
  - Measure Rise Time
    - According to standard
    - 20%-80% of normalized template

# Results

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- By nominal rise we refer to the transition time as measured according to 20%-80% of the transition swing
  - Note that normalization process does not change the 20%-80% transition times

# Nominal Rise Time = 128psec



- All three templates are within the limits

## Rise-Time “measurements”

	Nominal Rise Time [psec]		
Pre-emphasis [%]	64	102	128
24	66	110	142
31	60	98	128
38	54	88	114

- Pre-emphasis effects the rise time measurement
- About 10% difference from nominal value at low and high pre-emphasis values
- Problematic cases are shaded



# Conclusions & Recommendations

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- Current CX4 definition causes unnecessary coupling between rise/fall time and pre-emphasis.
- Propose to revert to 20%-80% rise time definition
  - Basic idea is that for the normalized template we know that the starting point of the positive transition is at normalized voltage level of -0.69 to define the 20%-80% thresholds all that remains is to find the peak
  - Similarly for negative transition the starting point is 0.69

# Rising Edge transition time - proposed definition

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- The rising edge transition time shall be between 60 and 130 ps.
- The rising edge transition time will be measured by using the following procedure:
  1. Measure the peak normalized template between 0.5UI and 2.5UI - called  $V_p$
  2. Compute the lower threshold of the positive transition
$$th\_low\_p = -0.69 + 0.2 \cdot (V_p + 0.69)$$
  3. Compute the upper threshold of the positive transition
$$th\_up\_p = -0.69 + 0.8 \cdot (V_p + 0.69)$$
  4. measure the rising time of the normalized template transition from the lower to upper thresholds defined above.

# Falling Edge transition time – proposed definition

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- The falling edge transition time shall be between 60 and 130 ps.
- The falling edge transition time will be measured by using the following procedure:
  1. Measure the peak of the absolute of the normalized template between 5.5UI and 7.5UI - called  $V_n$
  2. Compute the upper threshold of the negative transition  
 $th\_up\_n = 0.69 - 0.2 * (V_n + 0.69)$
  2. Compute the lower threshold of the negative transition  
 $th\_low\_n = 0.69 - 0.8 * (V_n + 0.69)$
  4. measure the falling time of the normalized template transition from the upper to lower thresholds defined above.