

# Application Note

## For the P-to-P Application (DDR SDRAM)

Oct. 2003

Memory Division  
Samsung Electronics Co., Inc.

## 1. No Termination Case

- . Simulation Model
- . Frequency Domain Analysis
- . Frequency vs. trace length vs. Ron

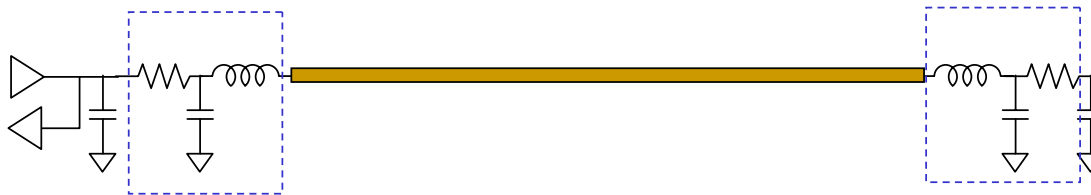
## 2. Series Termination Case

- . Simulation Model
- . Series termination vs. trace length

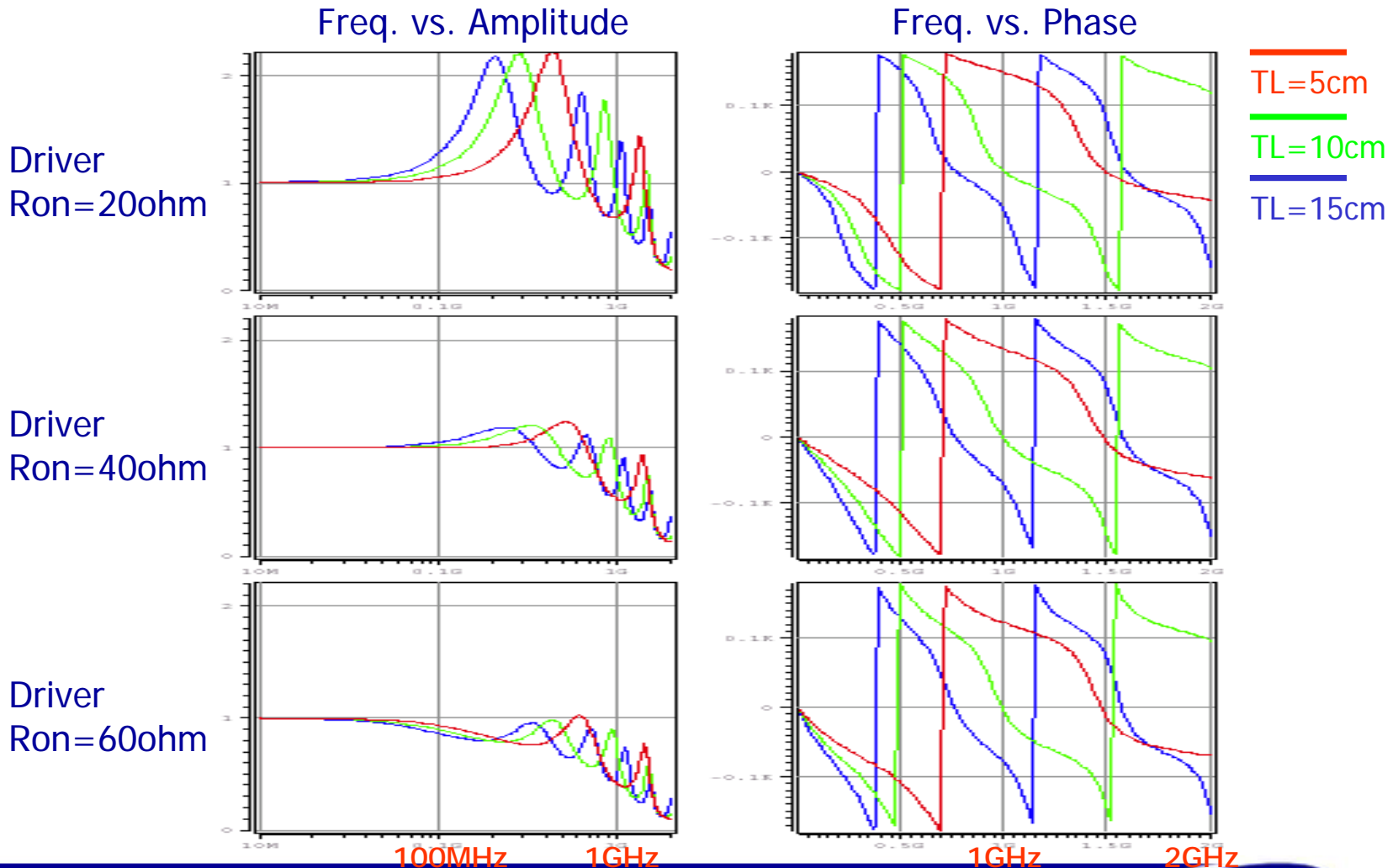
## 3. Summary

# Simulation Model ( for no termination)

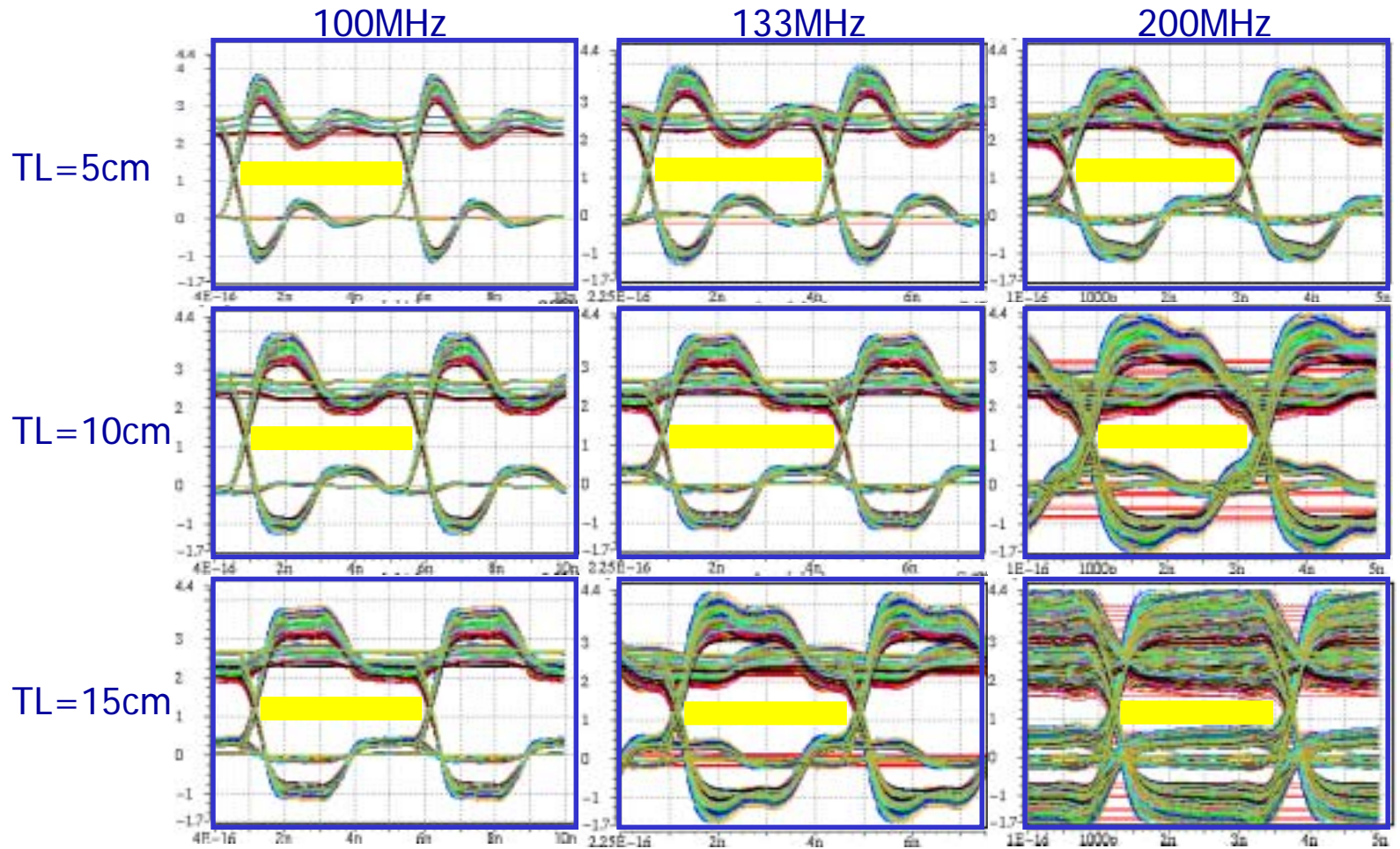
- Driver : Ron=20/40/60ohm
- PKG : DRAM=TSOP, Controller = FBGA PKG
- Freq. : 100/133/200MHz(200/266/400MT/s)
- Vddq : 2.5V
- Trace Length : 5/10/15cm
- Z0 of trace : 60ohm +/-10%
- Termination : No Rs, No Rtt
- Data Pattern : 32-bit stream for ISI simulation
- All signals were probed at the receiver input node



# Frequency Domain Analysis

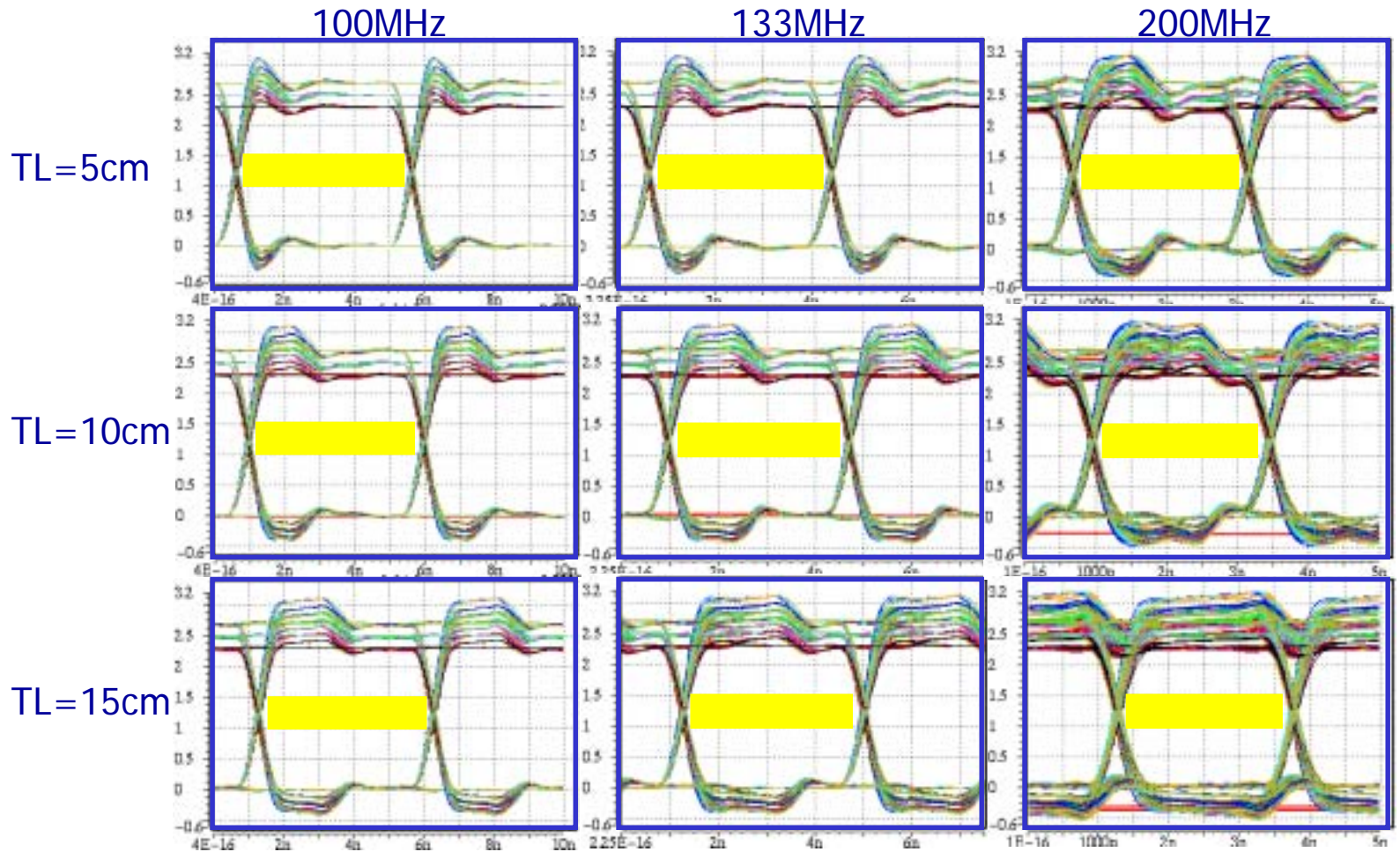


# Frequency vs. Trace Length (@ Ron=20ohm)

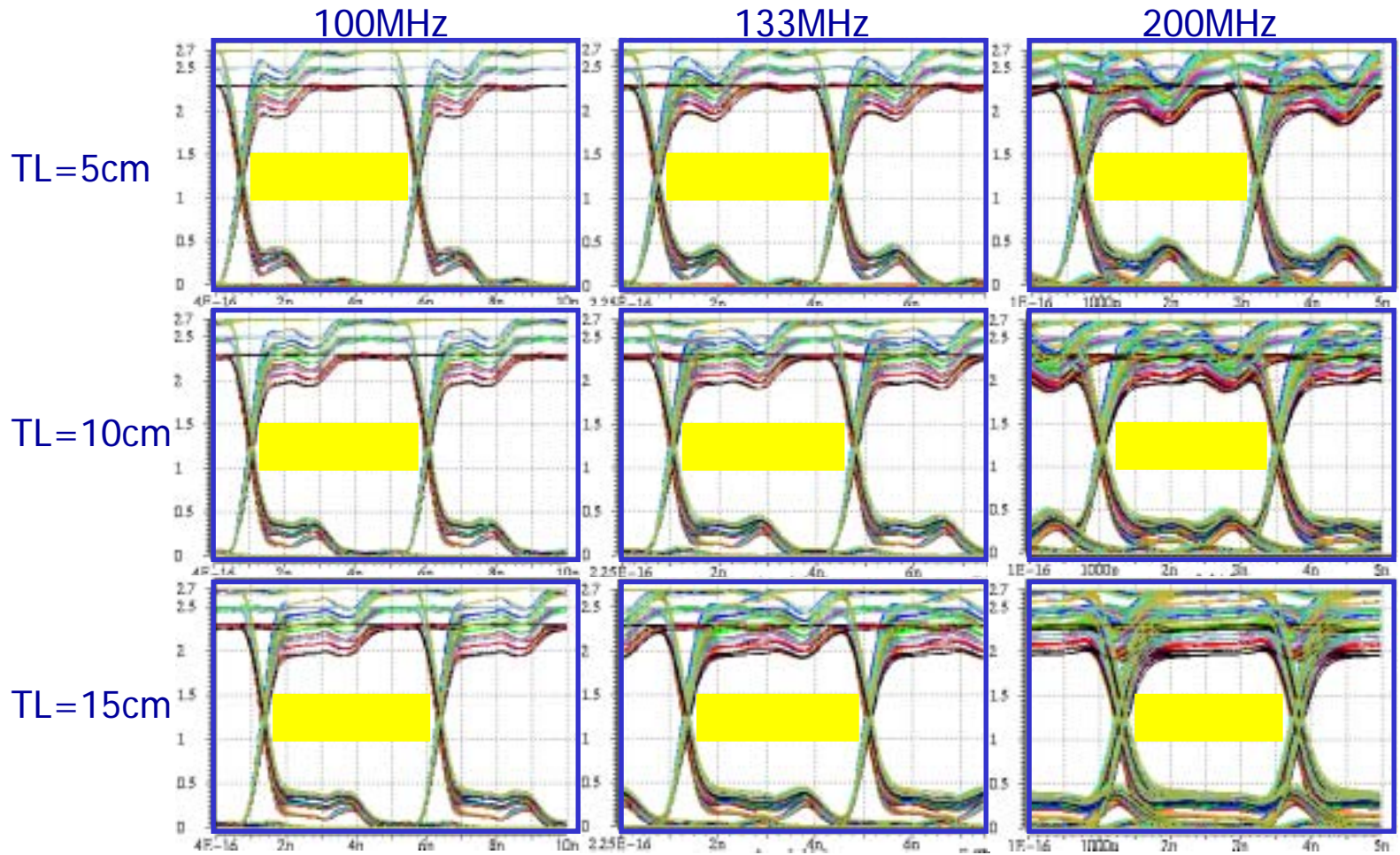


Large over/undershoot is shown.

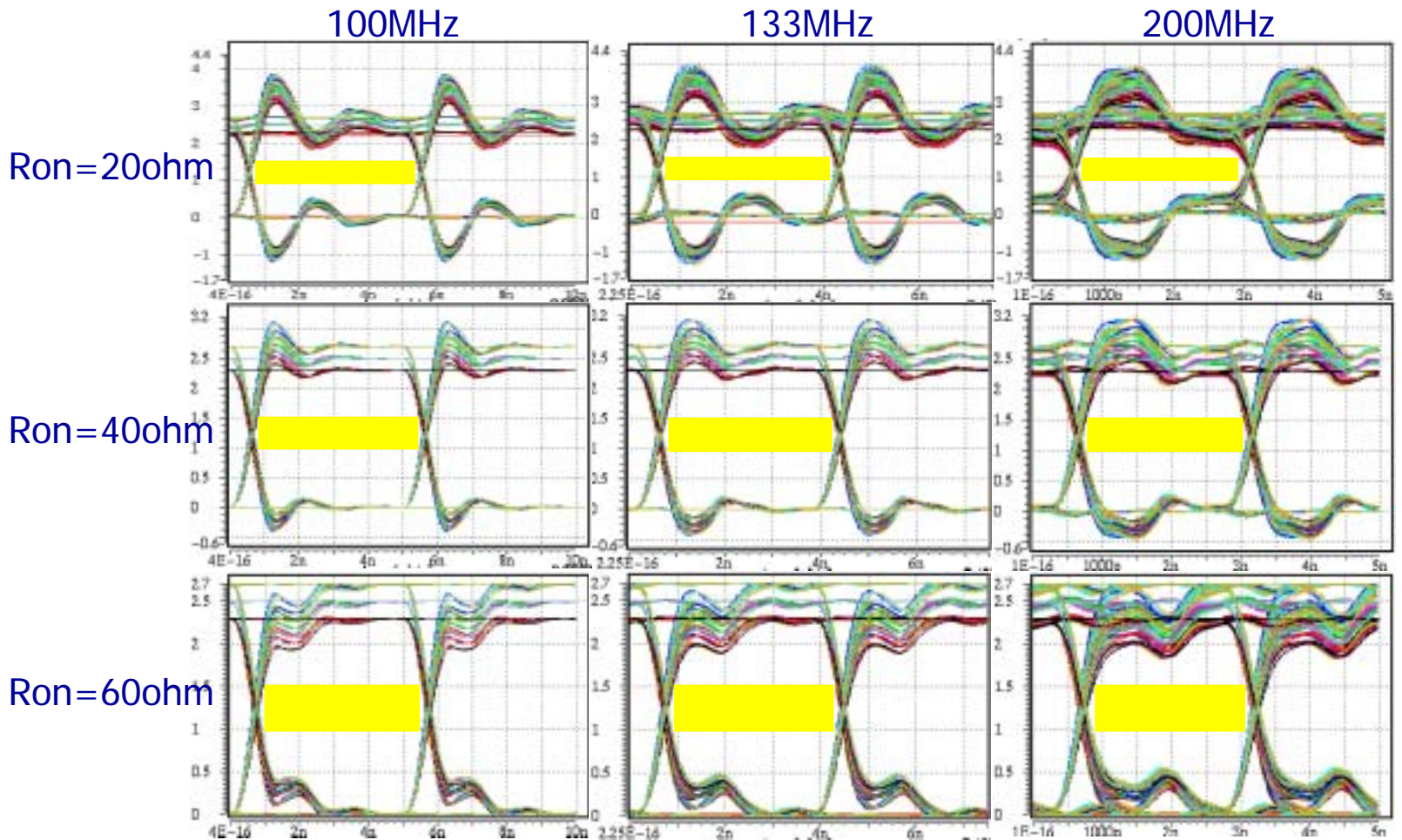
# Frequency vs. Trace Length (@ Ron=40ohm)



# Frequency vs. Trace Length (@ Ron=60ohm)



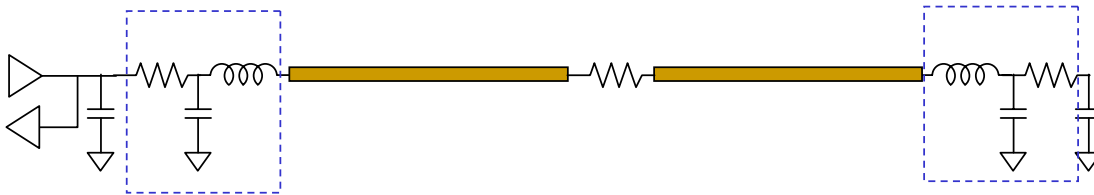
# Frequency vs. Ron (@ Trace Length=5cm)



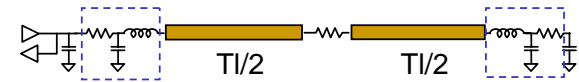
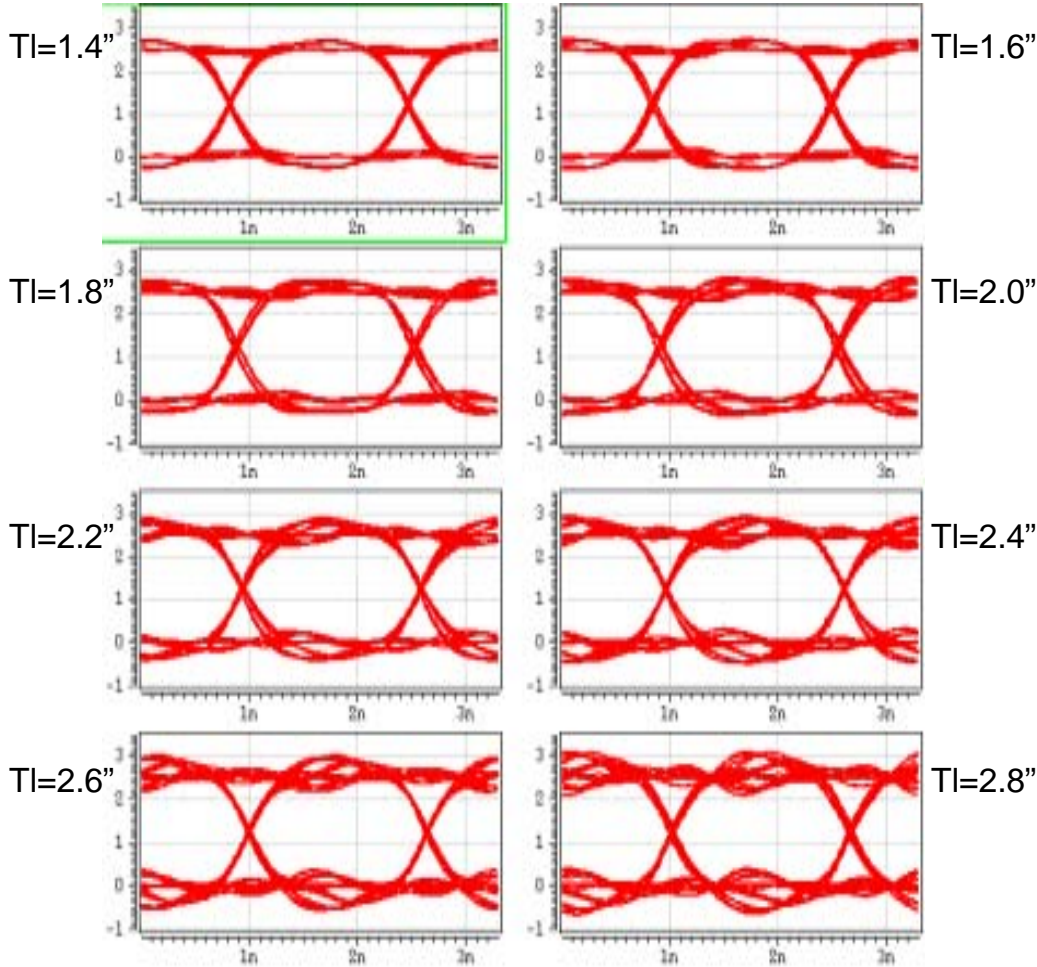
Note) Each scale is different.

# Simulation Model ( for Rs termination)

- PKG : DRAM=TSOP, Controller = FBGA PKG
- Freq. : 100/133/200MHz(200/266/400MT/s)
- Vddq : 2.5V
- Trace Length : 5/10/15cm
- Z0 of trace : 60ohm +/-10%
- Termination : Rs=10ohm
- Data Pattern : 32-bit stream for ISI simulation
- All signals were probed at the receiver input node



# Series Termination vs. Trace Length



Good signal integrity and aperture time.

# Summary

1. Implementing one or two stub resistor between driver and receiver helps to get the optimal terminology in P-to-P Application.
2. In case of no termination , trace between driver and receiver should be shorter than 1.5inch to avoid over/undershoot problem.
3. Parallel termination is not necessary to P-to-P Application , thanks to the enough small signal swing.  
It helps to save the board space and its cost.