Continuous Time Linear Equalizer

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Paper preview

A 0.18-μm CMOS 3.5-Gb/s Continuous-Time Adaptive Cable Equalizer Using Enhanced Low-Frequency Gain Control Method

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- Title of the paper
  - ✓ A 0.18-um CMOS 3.5-Gb/s Continuous-Time Adaptive Cable Equalizer Using Enhanced Low-Frequency Gain Control Method
- Author
  - ✓ Jong-Sang Choi, Moon-Sang Hwang, Deog-Kyoon Jeong
- Publication Journal
  - ✓ IEEE Journal of Solid-State Circuits

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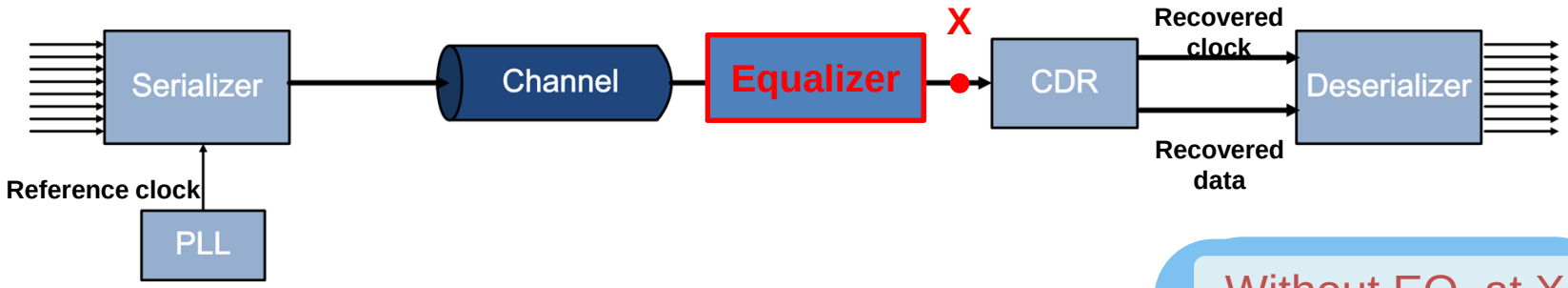
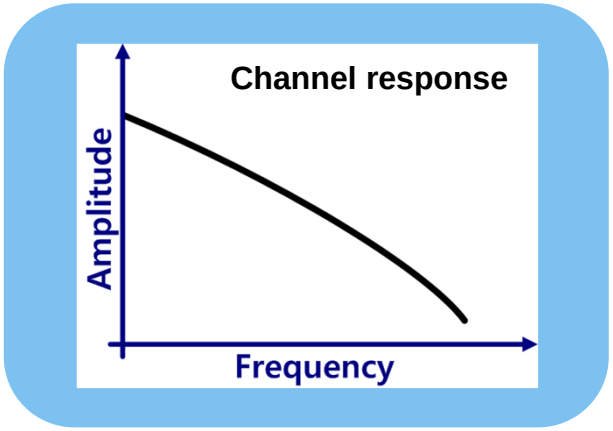
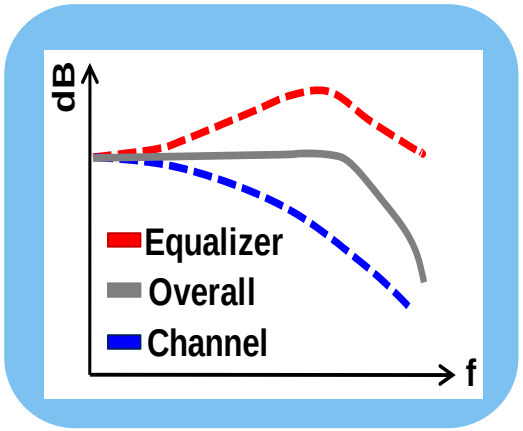
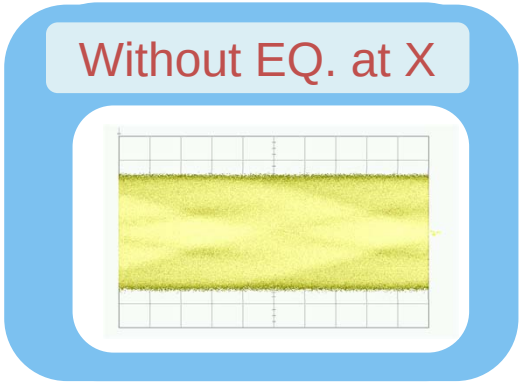
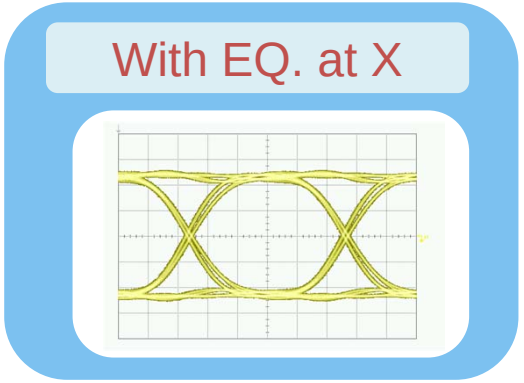










- Disadvantages
  - ✓ Wideband frequency gain control ➔ inadequate
  - ✓ Low frequency gain ⇔ High frequency gain

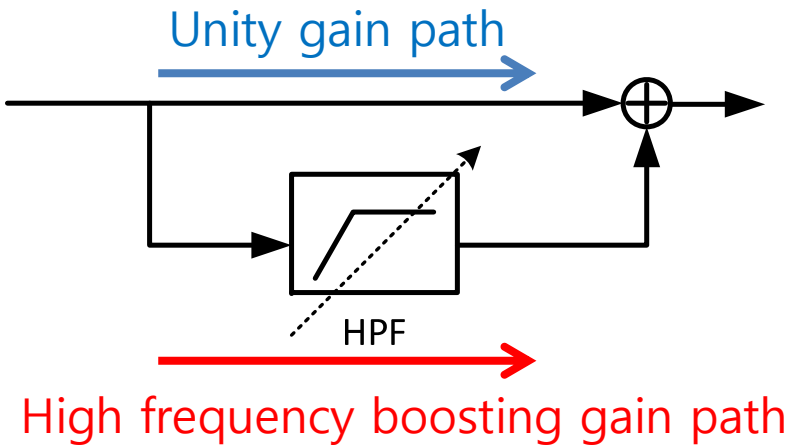
Continuous Time Linear Equalizer

- Split Path Amplifier

✓ The characteristics of channel → Low frequency pass well!
→ High frequency cut → ***Inter-Symbol Interference***

✓ Dividing the signal path into two
: Low frequency signal path + High frequency signal path

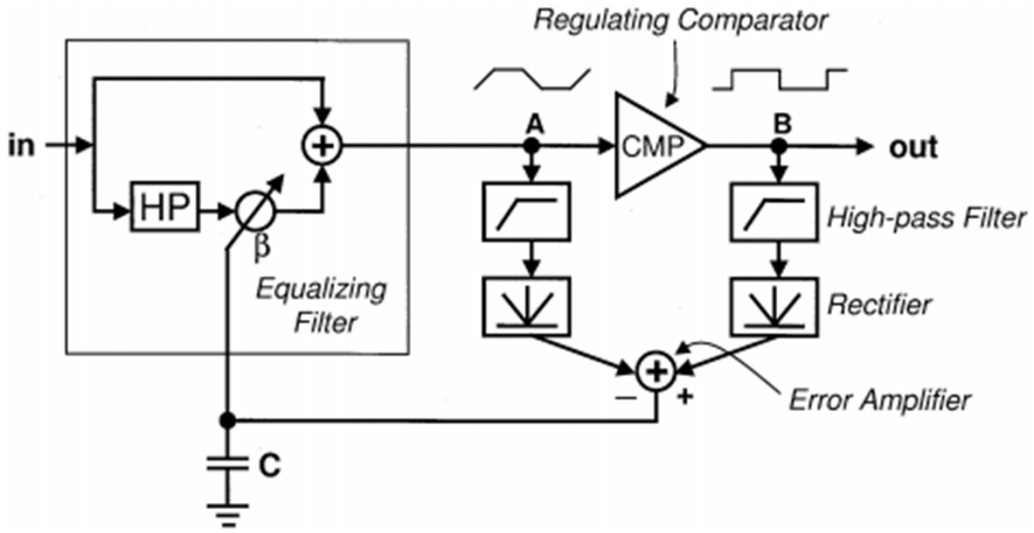
✓ High frequency gain boosting → control!!



✓ Attentions
- Unity gain path
  → Gain stable for PVT
- High frequency boosting
  → Adaptive loop

High Frequency Boosting Adaptive Loop

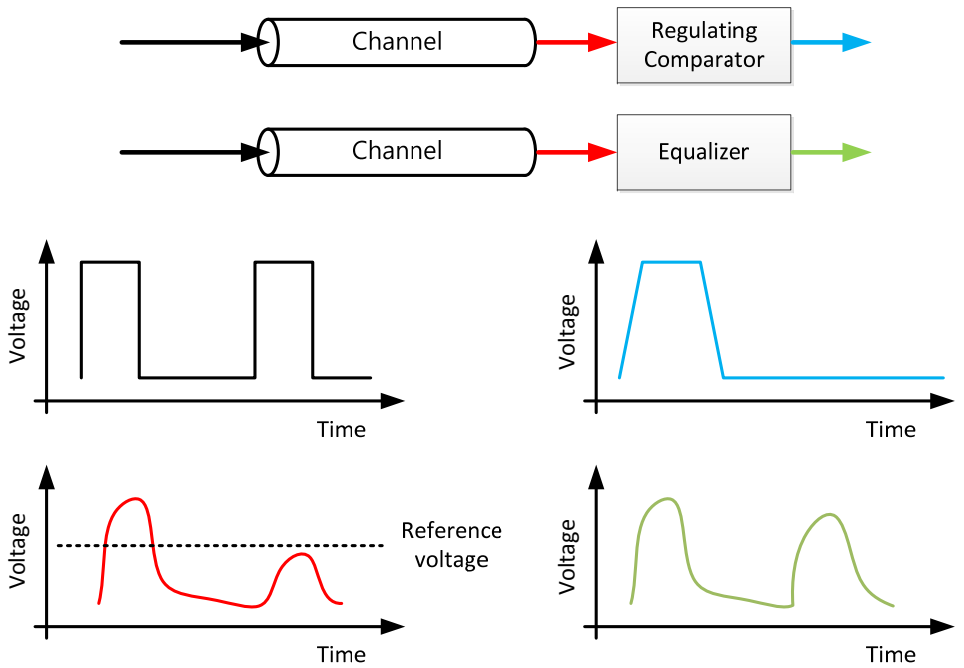
- Adaptive method for high frequency boosting gain
  - ✓ Power comparing :
    - High frequency boosting vs. Regulating Comparator



  - ✓ Using high pass filter & rectifier, power can be detected.

  - ✓ Difference between these two factor, boosting gain can be controlled

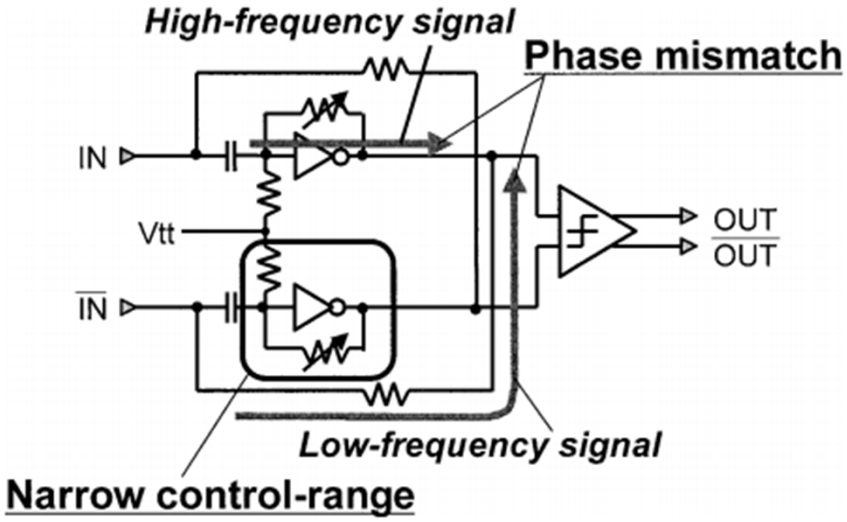
Regulating Comparator



- ✓ Regulating comparator → Limiting amp.
  - ➔ High gain & Large BW → not high frequency boosting
  - ➔ Making signal saturation (Logic level: 1,0)
- ✓ Regulating comparator output
  - ➔ cannot be same with equalized output
- ✓ Equalizing → High frequency boosting
- ✓ By comparing power , adequate boosting gain !!

Stable Unity Gain Path

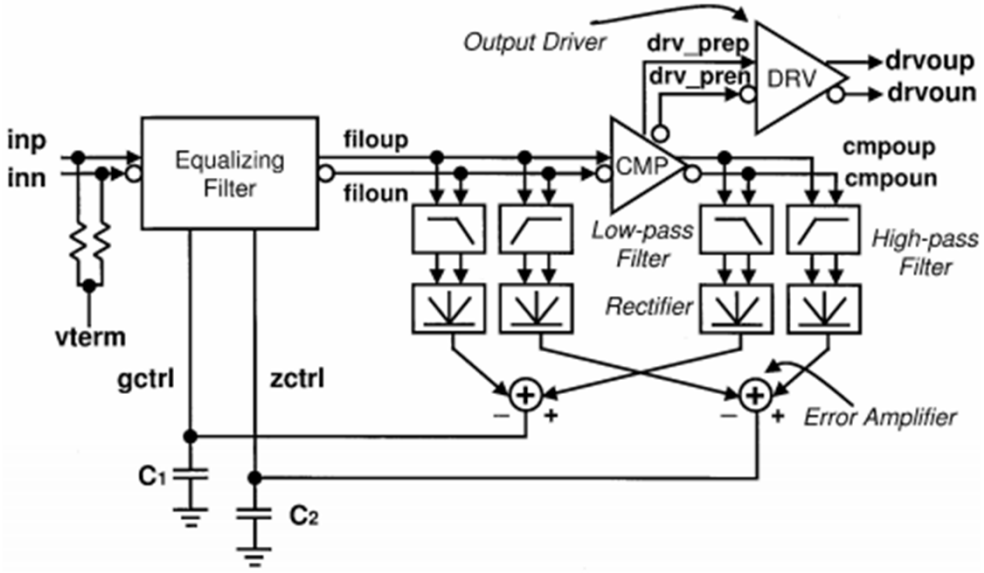
- Stable unity gain path
  - ✓ Negative resistive feedback



  - ✓ Phase mismatch
  - ✓ Input signal distortion

    Feedback resistor ↑ ➔ Effective feedback , RC delay ↑ ➔ Input distortion

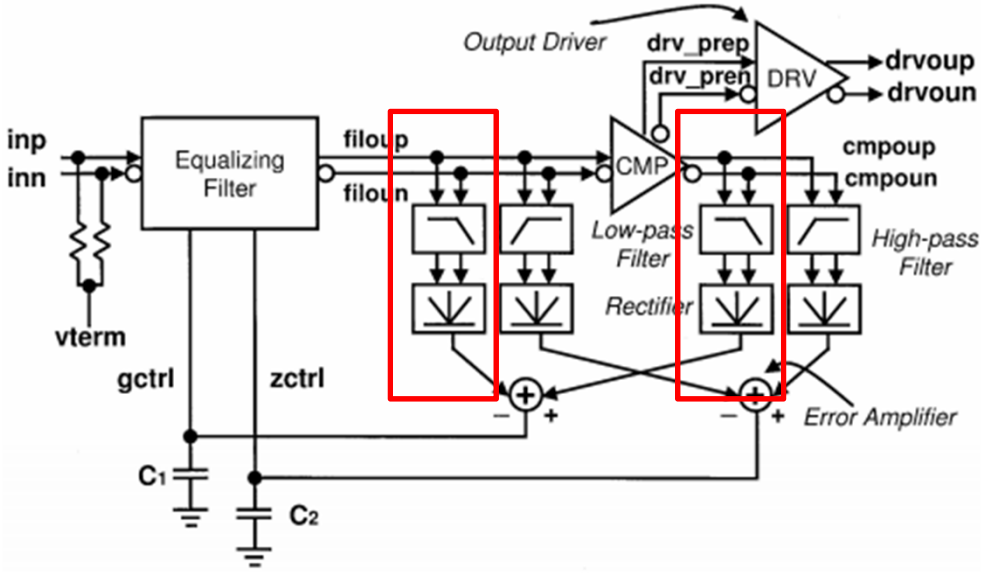
Modified CTLE



- The points of the thesis
  - ✓ High speed amplifier
  - ✓ Stable fixed gain low frequency

- Modifying conventional CTLE
  - ✓ Equalizing filter
  - ✓ Low frequency gain control

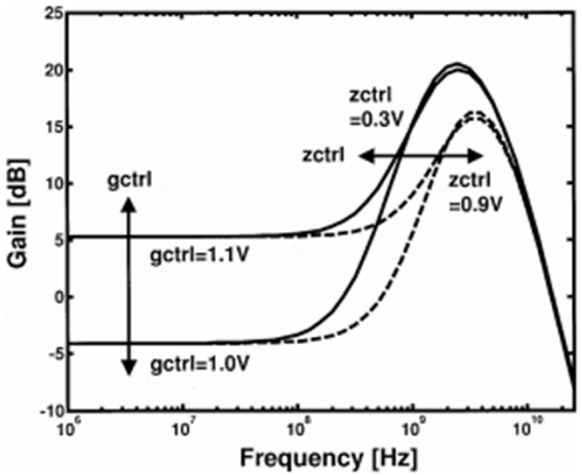
Modified CTLE

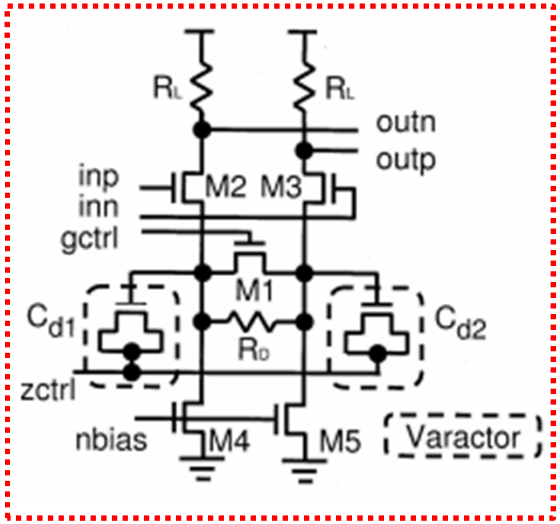


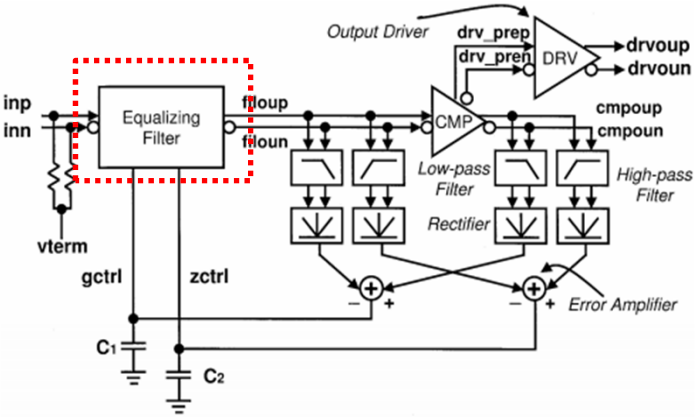
- Low frequency gain control

  - ✓ Power of output, equalizer filter vs. Power of output, regulating comparator
  - ✓ Stable in unity gain path
  - ✓ Still fast operation

Modified CTLE





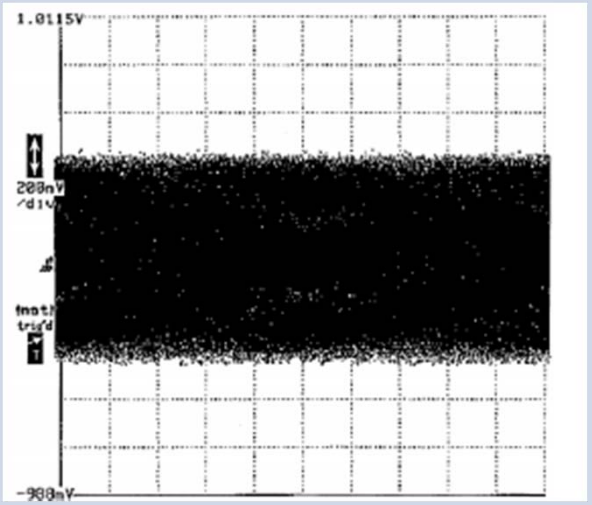
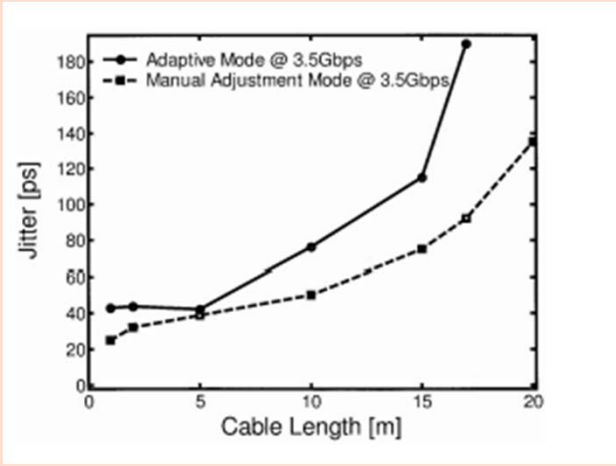
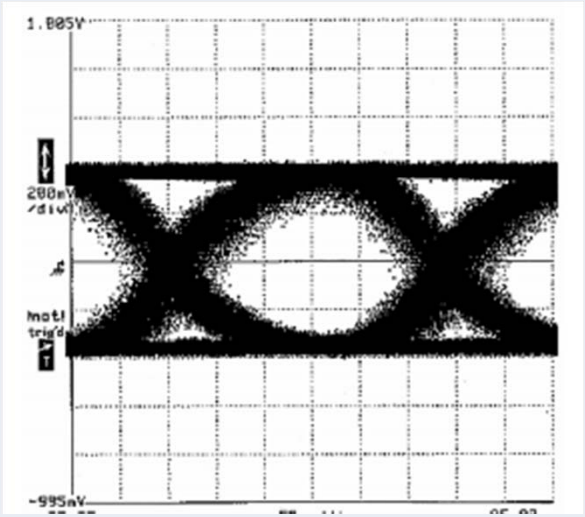
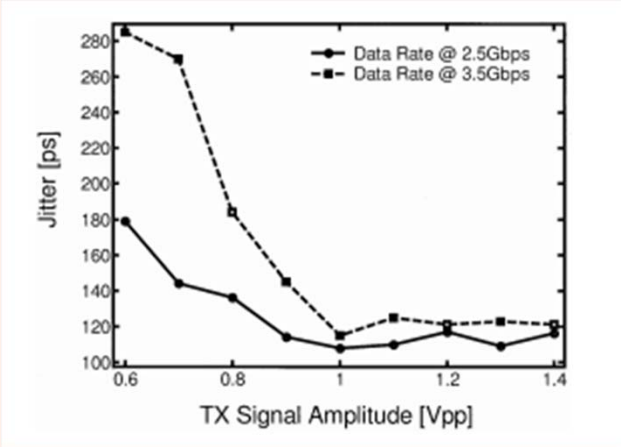


- Equalizing filter

  - ✓ Conventional filter → Split topology , unity gain path & High frequency boosting path

  - ✓ Modified filter → Merged-path topology
    - Need not summation circuit
    - Need not delay matching

Results

	Eye-diagram		Jitter performance
Before Equalizing		Cable length	
After Equalizing		Input signal Amplitude	

Conclusion

- High-speed equalizer filter is designed
- Joint adaptation method ➔ Power comparing
  - ✓ High frequency loss & low-frequency gain variation → Compensated!!
- Merged equalizing filter is used
- 3.5Gb/s @ 15-m RG-58 coaxial cable

Thank you for Listening!