Loss Compensation using Analog Pre-emphasis

by
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Analog Pre-Emphasis

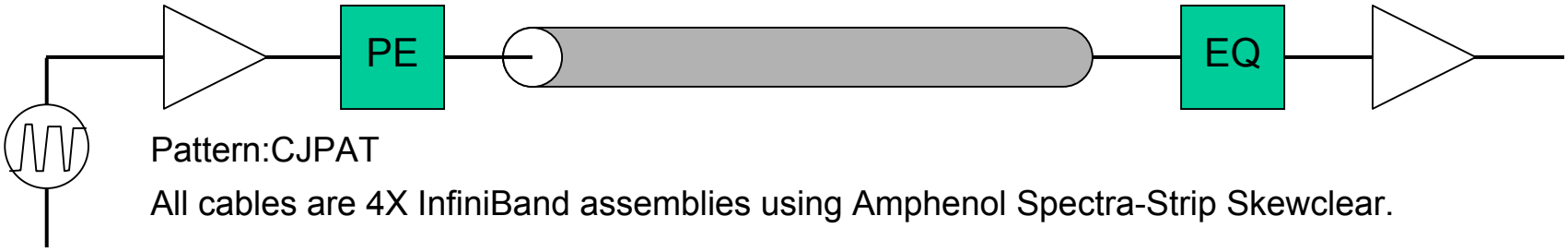
Agenda

- Lab Results of Analog filter for PE
- Comparison of Tx output to Tx template
- Recommendation

Generating Pre-Emphasis

- 1-bit wide FIR
  - easy to implement
  - crude approximation
- Fractional or Sub-bit interval/multi-bit FIR
  - better approximation
  - more complex
- Analog Filter
  - accurate transfer function
  - not an approximation
  - simple

Experiments



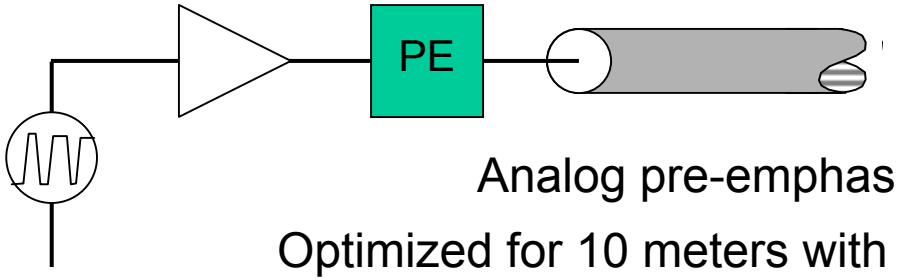
Pattern:CJPAT

All cables are 4X InfiniBand assemblies using Amphenol Spectra-Strip Skewclear.

Experiments:

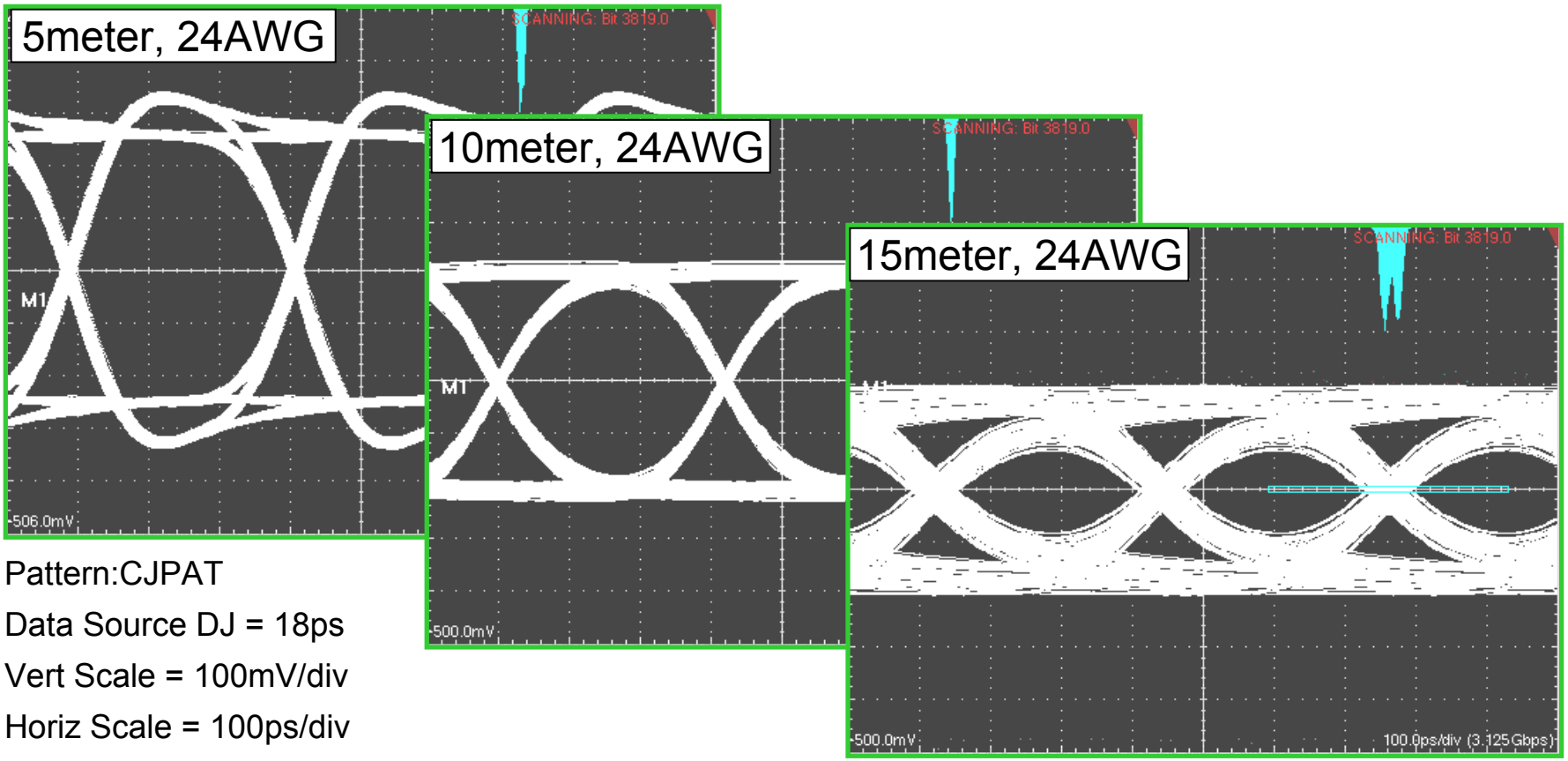
- Evaluate effectiveness of Analog PE **without** a receiver and with an ideal data source. Scope acquires output of the cable.
- Evaluate effectiveness of Analog PE **with** a receiver and with an ideal data source. Scope acquires output of the receiver.
- Evaluate effectiveness of Analog PE **with** a receiver and **with** a jittered data source. Scope acquires output of the receiver.
- Compare Analog PE with the transmitter template.

Mid-Span Compensation



Analog pre-emphasis without receiver.

Optimized for 10 meters with no penalty for short lengths.



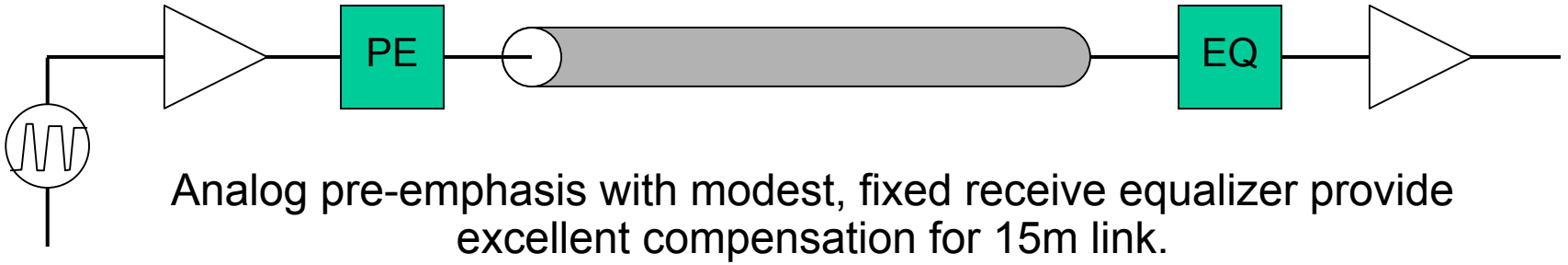
Pattern:CJPAT

Data Source DJ = 18ps

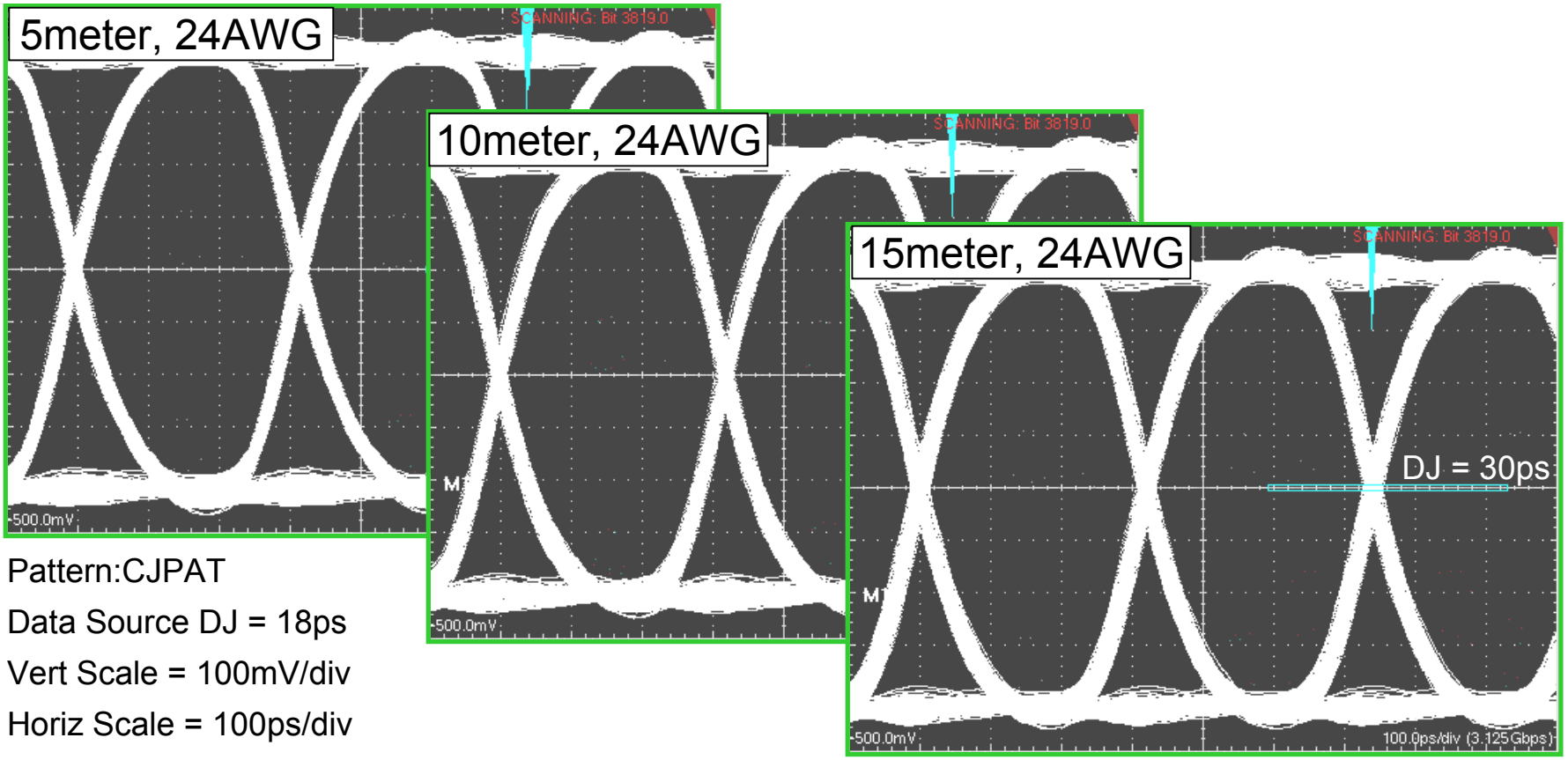
Vert Scale = 100mV/div

Horiz Scale = 100ps/div

End-to-End Compensation



Analog pre-emphasis with modest, fixed receive equalizer provide excellent compensation for 15m link.



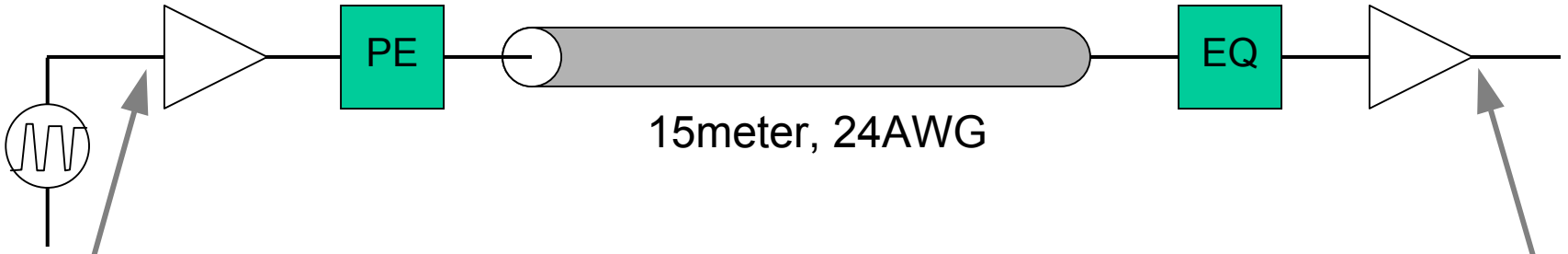
Pattern:CJPAT

Data Source DJ = 18ps

Vert Scale = 100mV/div

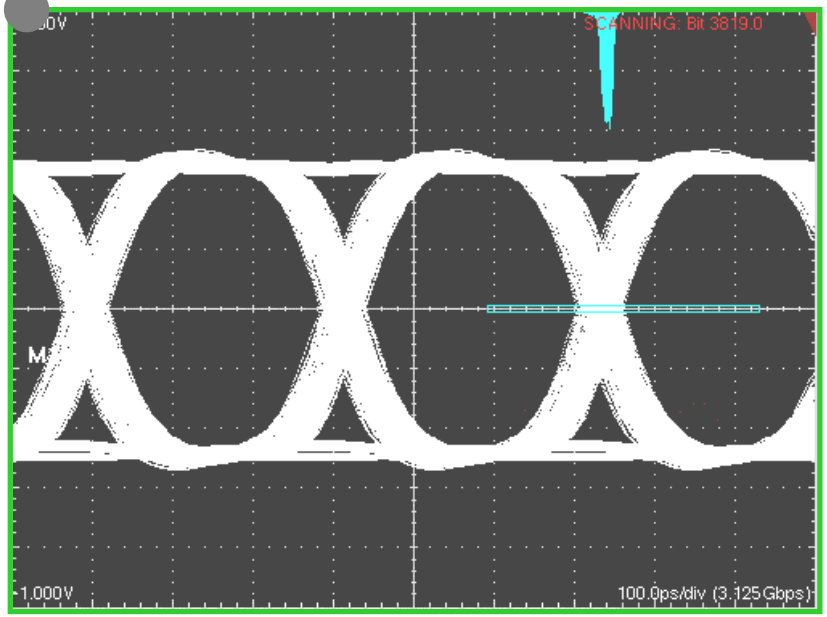
Horiz Scale = 100ps/div

End-to-End Compensation + Source Jitter

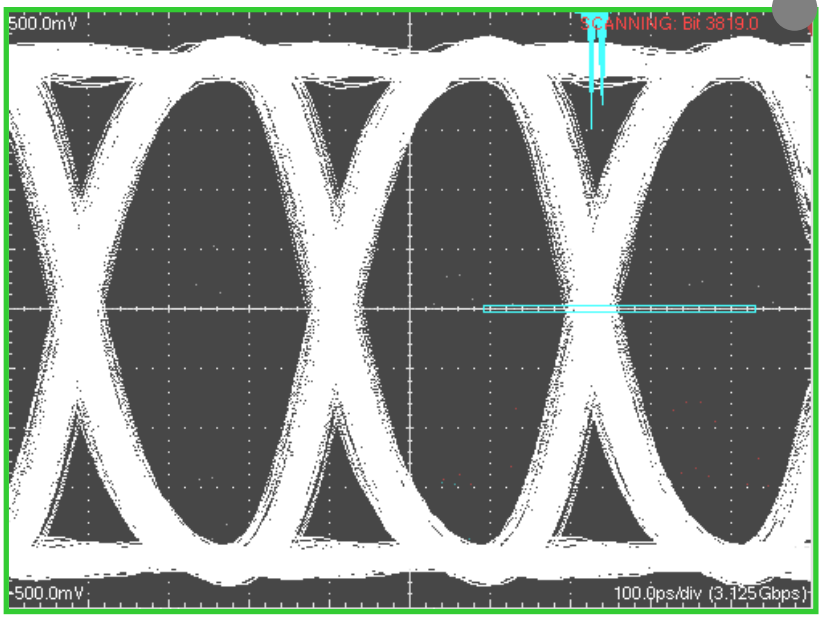


Combined analog pre-emphasis with modest, fixed receive equalizer compensates the 15m span and adds only 10ps additional DJ.

Data Source DJ = 60ps (0.19UI)



Receiver output DJ = 70ps (0.22UI)



Pattern:CJPAT

Data Source DJ = 60ps

Tx Template Concerns

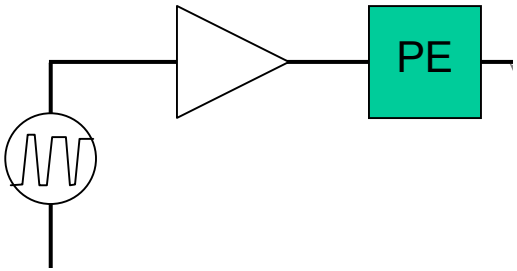
Existing Tx Template is crafted for 1-bit wide pre-emphasis and it is implementation specific.

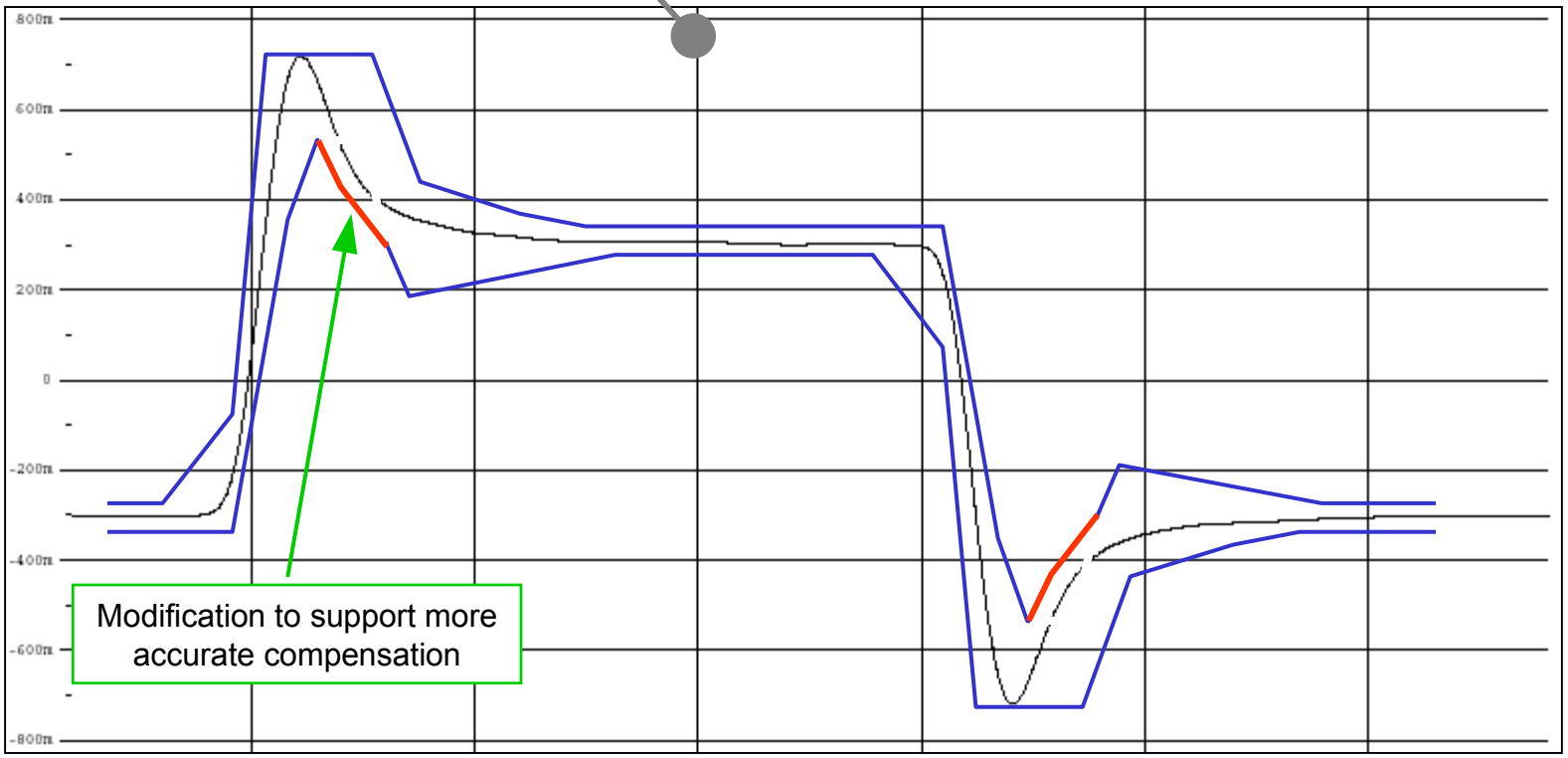
This excludes more accurate solutions:

Fractional delay/sub-bit timing

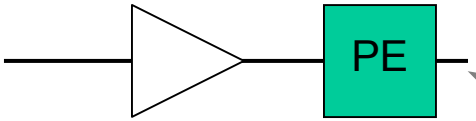
Analog filter

Transmit Pre-Emphasis

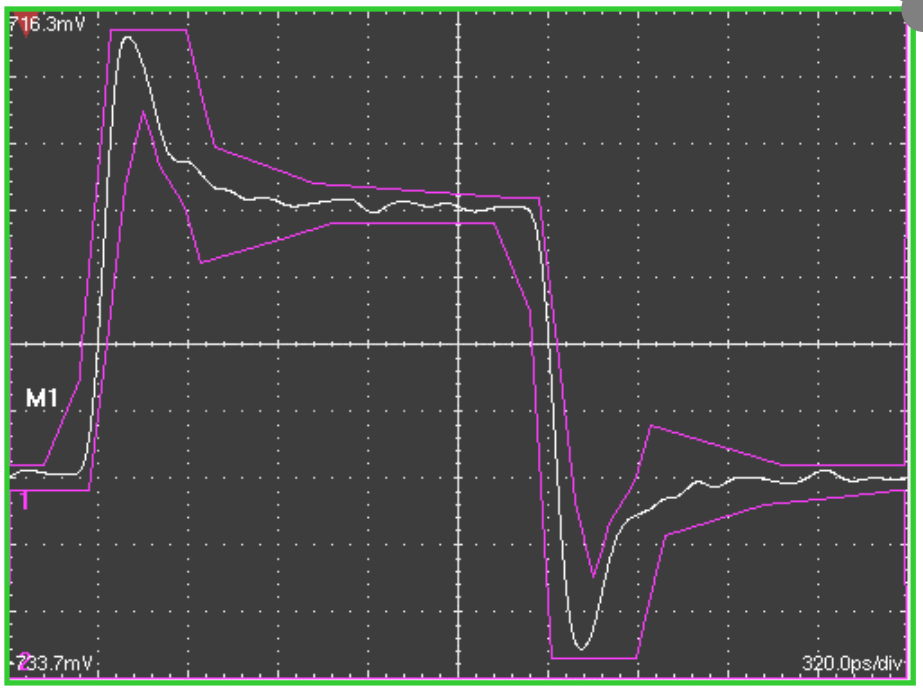




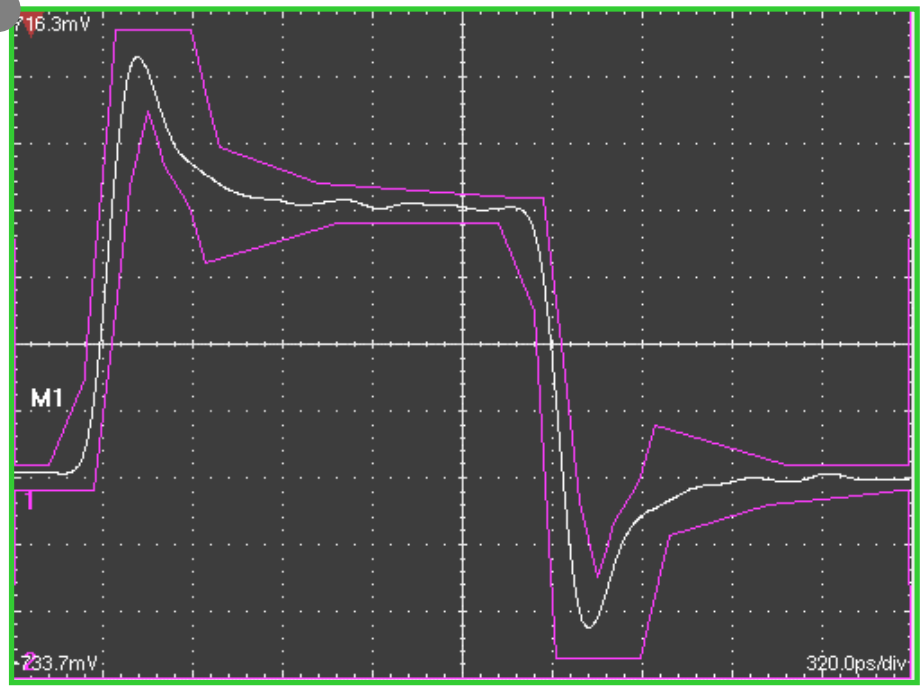
Transmitter Template



20GHz Scope Bandwidth



3.5GHz Scope Bandwidth



Scope bandwidth should be included in the template test requirements.

- Too high of a bandwidth might show more meaningless aberrations that cause violations.
- Too low of a bandwidth might hide meaningful violations.

The “Steve+Ze’ev+Clark” template is shown above. This is a consolidation of proposed modifications complied by Ze’ev Roth.

Conclusion:

Experiments demonstrate that analog pre-emphasis will deliver excellent compensation.

Recommendation:

Modify the Tx Template to accommodate analog pre-emphasis.

Do not exclude a viable and simple technical solution.