



# ETM

# Calculation Algorithm and Limit Line

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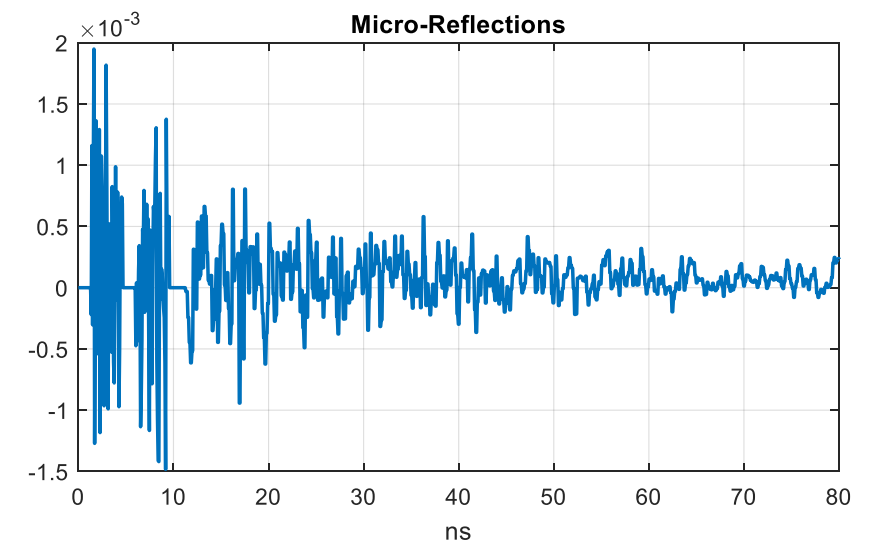
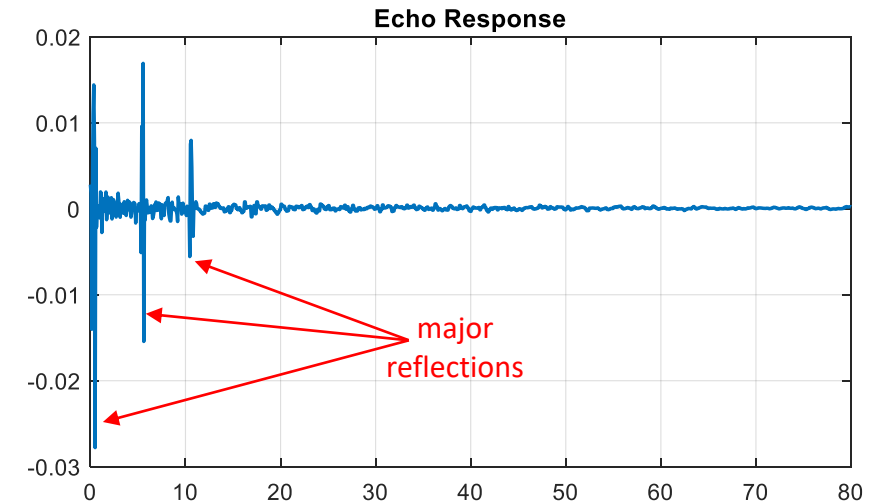
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# Overview

- Drafted 1.2 subclause 165.7.1.3.2 includes adopted text for micro-reflection metrics
- The limit on Echo Tail Metric (ETM) is defined as TBD
- This presentation is to provide context on the [proposed changes](#) in the current text and the associated comments regarding this subclause

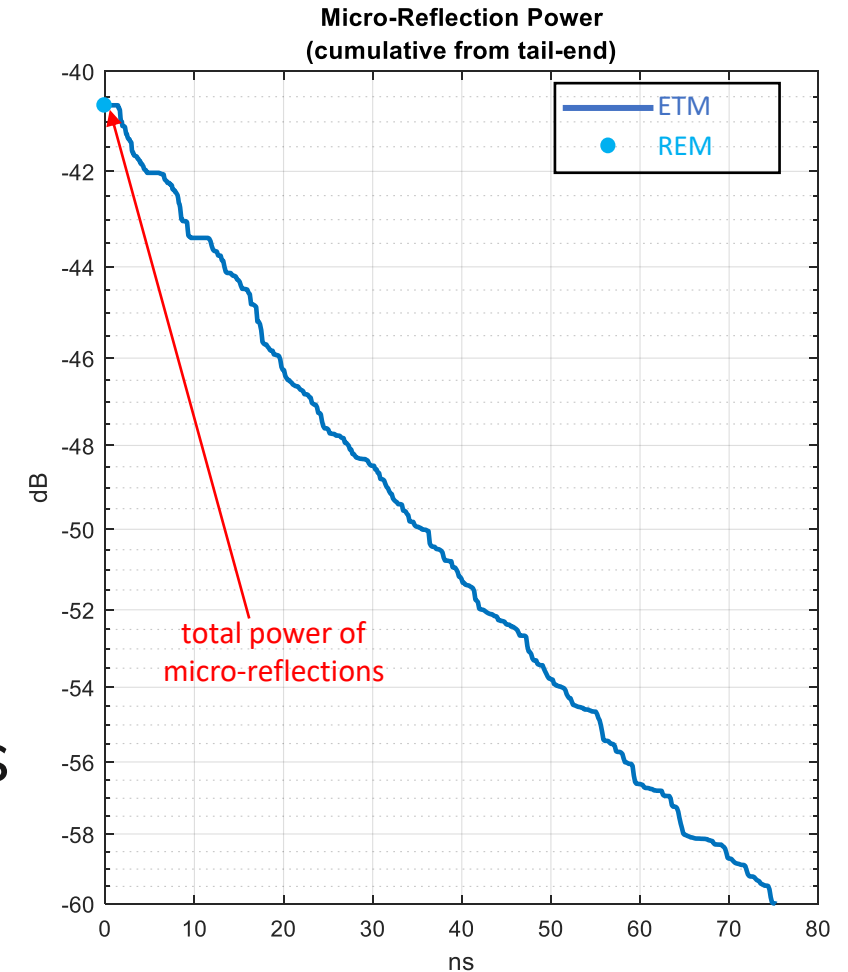
# Echo Pulse Response

- Echo response consists of a few major reflection points (due to connectors) and back-ground micro-reflections (due to inhomogeneity of the cable)
- Significant computational power of PHY is dedicated to cancel micro-reflections
- A limit on the power of micro-reflections can help reduce the complexity of the PHY



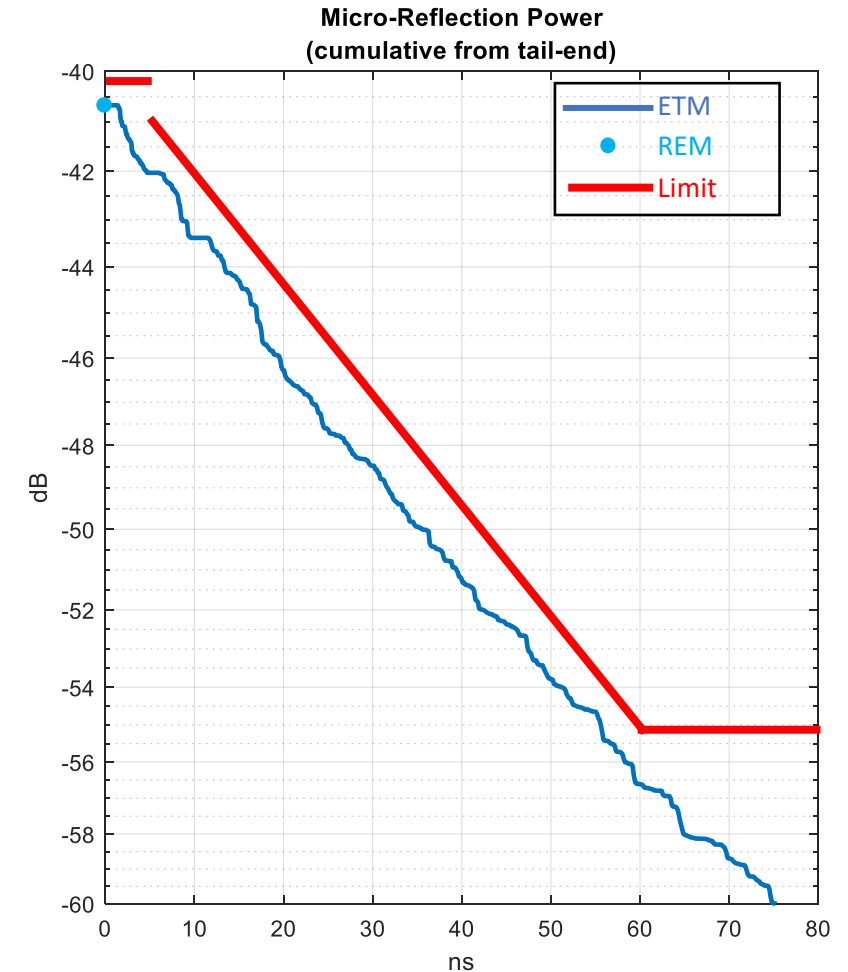
# Micro-Reflection: Cumulative Power

- The power of micro-reflections, if not cancelled, contributes to the overall noise and limits the SNR
- ETM is the cumulative power of the micro-reflection from the tail end of the echo pulse response
- REM is the total power of micro-reflections for the entire span of the echo response
  - $REM = ETM$  at time zero



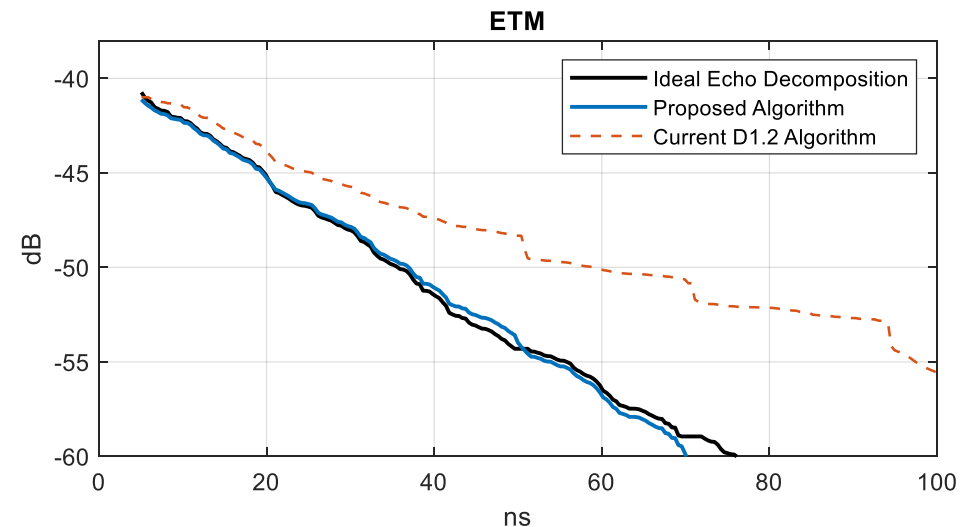
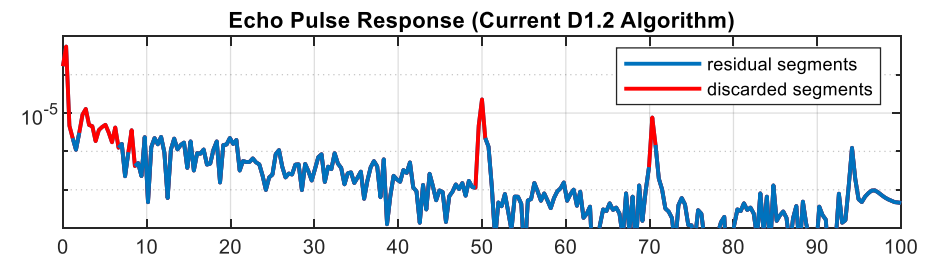
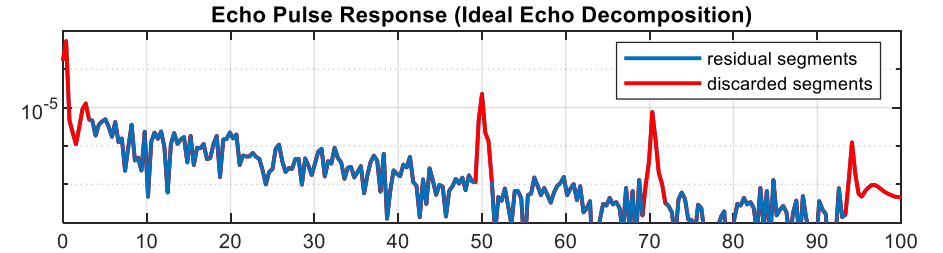
# Limits on Micro-Reflection

- A limit on REM determines the level of cancellation required to meet a target SNR
- A limit on ETM determines the efficient distribution of computational resource for echo cancellation:
  - the span of time beyond which the power of micro-reflections is negligible, hence they can remain uncanceled
  - the rate of reduction in micro-reflection power which provides a bound on the magnitude and the resolution of the echo canceller coefficients



# ETM Calculation

- The current ETM calculation algorithm, specified in D1.2 subclause 165.7.1.3.2, wrongly includes the power of major reflection points in ETM
  - The calculated ETM may be significantly more than the true value
- The new proposed algorithm (based on [sedarat\\_0515](#)) matches an ideal echo decomposition and offers an accurate representation of ETM

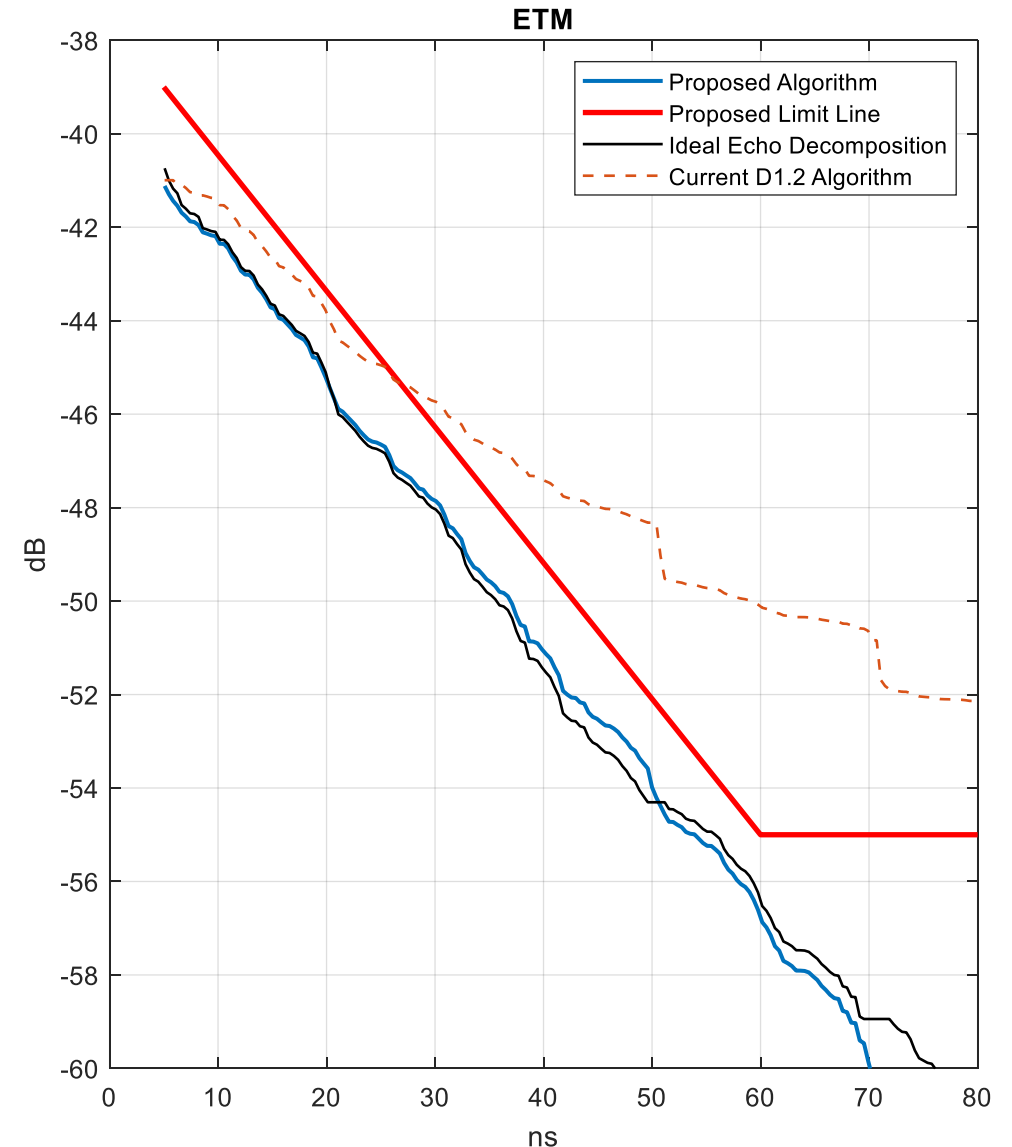


# ETM Limit Line

The proposed limit line:

$$\begin{cases} REM_{Limit} - 16 \times \frac{t - 5}{55} \text{ dB} & 5 \text{ ns} \leq t < 60 \text{ ns} \\ REM_{Limit} - 16 \text{ dB} & 60 \text{ ns} \leq t \end{cases}$$

- The power of micro-reflections beyond 60 ns should be 16 dB lower than the limit for REM
- Cumulative power should stay below the limit line with a slope of 0.29 dB/ns



# Measurements vs Limit Line

- The proposed limit line has shown good margin against measurements from a large set of link-segment configurations
- Publicly share data ([Koeppendoerfer\\_07\\_22](#)):

