Considerations for the minimum COM limit

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Specification method review

- Channel is required to have Channel Operating Margin (COM) no less than COM_{min}
- COM is relative to a target Detector Error Ratio (DER_0) which in turn is related to the target Frame Loss Ratio (FLR) after error correction
- Receivers are tested with an input noise whose amplitude is calibrated so that the COM of the test channel is COM_{min}
- In effect, COM_{min} is a the receiver “implementation allowance”
- It leaves room for impairments not explicitly included in the calculation of COM
- It is a “lumped sum” enabling trade-offs in the receiver implementation
- Let’s take a closer look at the impairments that consume this allowance

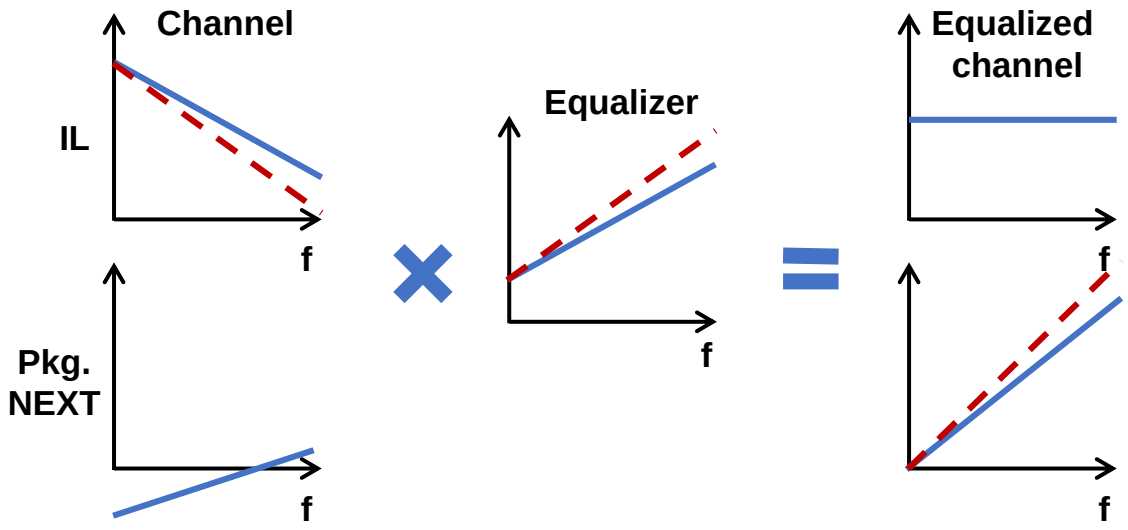
Implementation allowance “bucket” (don’t let it overflow!)

- Difference between reference receiver and implementation
- Difference between reference receiver package (loss) and implementation
- Receiver package crosstalk
- Receiver analog front-end distortion
- Receiver analog front-end noise
- Sampling clock jitter
- Analog-to-digital converter (ADC) quantization noise
  — OR —
  Slicer noise and offset
- Equalizer coefficient quantization effects
- Approximation errors (e.g., no EOJ model, simplified phase-to-amplitude noise conversion, nominal termination resistors)

Observations about the implementation allowance

- The reference receiver should represent the minimum capability needed to achieve the project objectives
  - Implementations may trade “superset” capabilities against other impairments
  - “Superset” becomes elusive as the reference receiver becomes more capable
- The implementation allowance includes channel-dependent impairments
- Some impairments are a function of the channel insertion loss

Examples of impairments related to channel insertion loss	
Receiver package crosstalk	Receive equalizer enhances noise. Transmit equalizer reduces receiver input signal relative to noise.
ADC quantization noise	Enhanced by digital equalizer. More loss implies more equalization which implies higher noise enhancement.
Receiver analog front-end noise	The noise added by an amplifier tends to increase with higher gain and/or gain peaking.

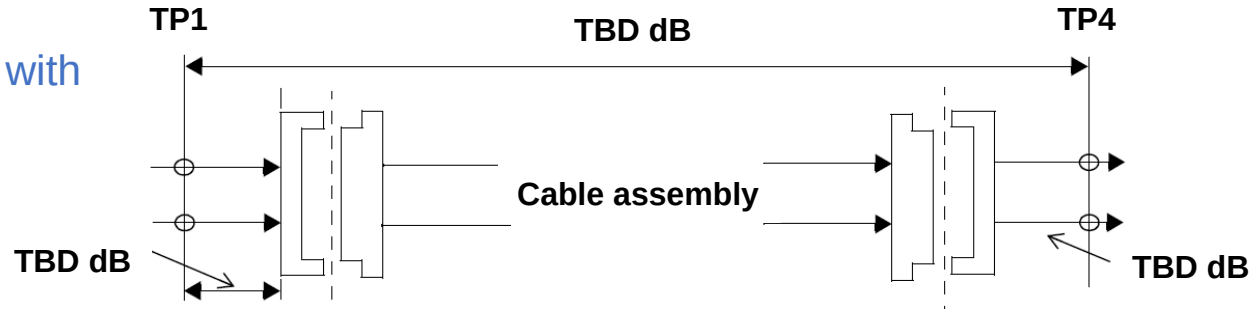


Relationship between COM and insertion loss limits

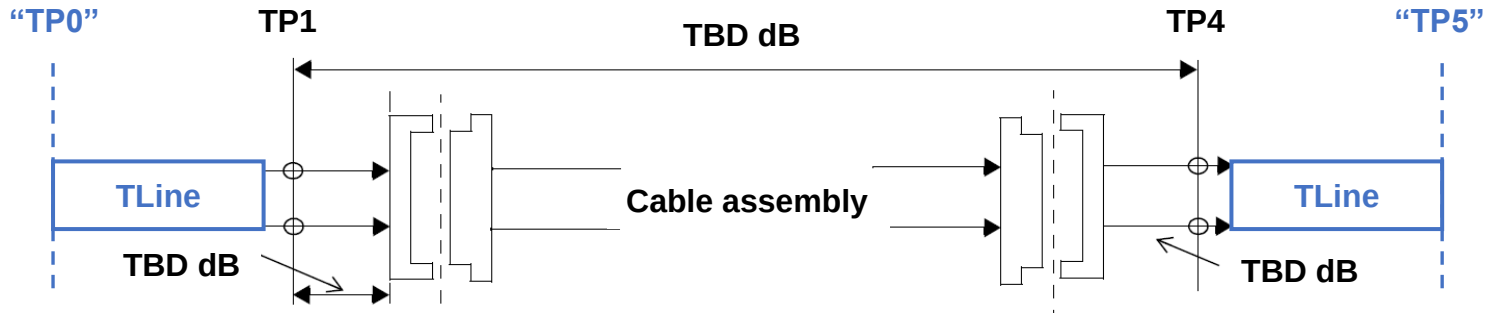
- COM is the best available method for channel specification
- A channel insertion loss limit is a complementary specification
- It provides useful guidance to channel and receiver implementers
- It suggests an upper bound on some impairments that consume the implementation allowance COM_{min}

Cable assembly specification method review

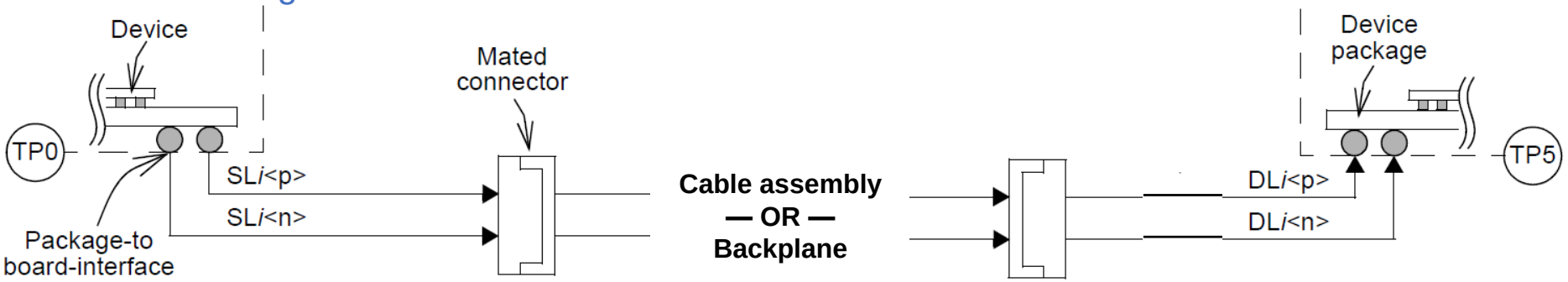
Measure the cable assembly with controlled test fixtures



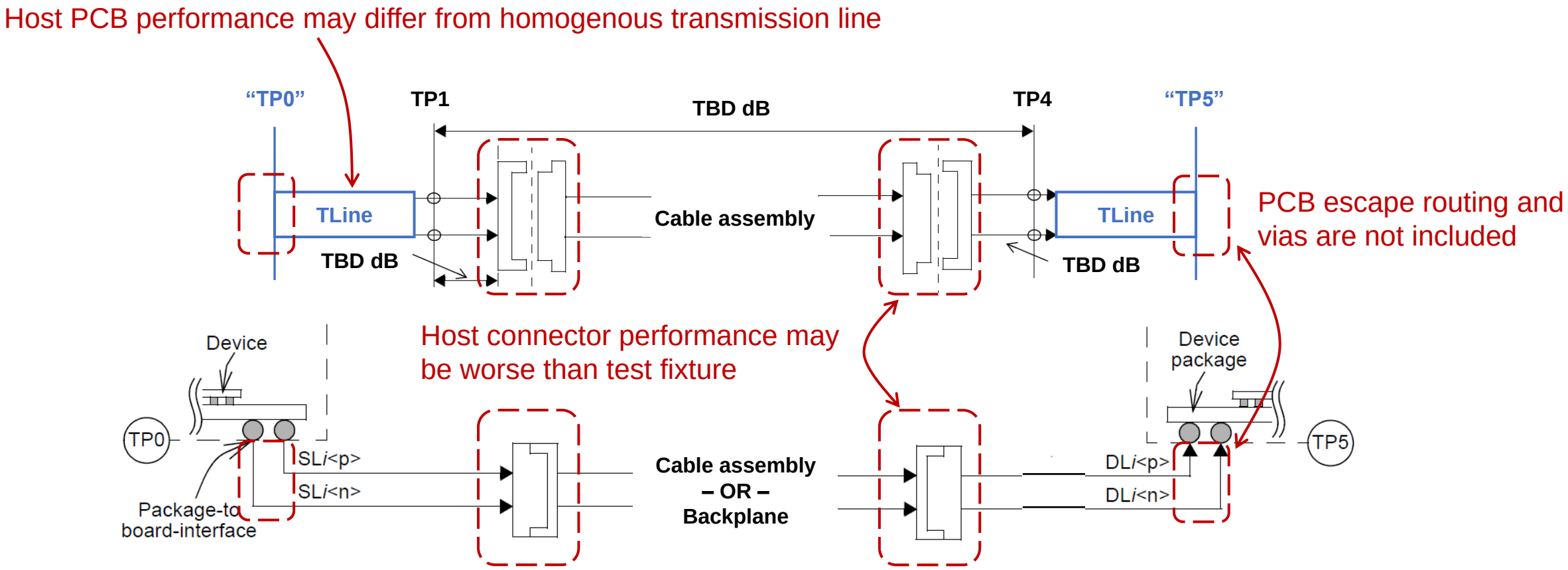
Concatenate ideal transmission line models to each end of the cable assembly measurement to yield a TP0 to TP5 channel.



COM for the calculated TP0 to TP5 channel must be no less than COM_{min}. This implies backplane and cable assembly TP0 to TP5 channels are inter-changeable.



Cable assembly TP0 to TP5 channel is incomplete



- Backplane and cable assembly TP0 to TP5 channels are **not** completely inter-changeable

Is the implementation allowance bucket overflowing?

What if the implementation allowance was fully consumed by approximation errors and receiver impairments?

Difference between reference host loss and implementation

Difference between test fixture and host connector crosstalk *

Crosstalk from escape routing/vias *

Difference between reference receiver and implementation

Difference between reference receiver package (loss) and implementation

Receiver package crosstalk

Receiver analog front-end distortion

Receiver analog front-end noise

Sampling clock jitter

Analog-to-digital converter (ADC) quantization noise
— OR —
Slicer noise and offset

Equalizer coefficient quantization effects

Approximation errors (e.g., no EOJ model, simplified phase-to-amplitude noise conversion, nominal termination resistors)

* Host impairment magnitude related to channel insertion loss

Food for thought…

- The concern is not about interoperability but about budgeting
- The host is tested (at TP3) to ensure that the combined host channel and receiver can meet the requirements with an allowance of COM_{min}
- However, if COM_{min}(cable assembly) = COM_{min}(backplane) …
- … a receiver for the cable assembly case must have more margin than a receiver for the backplane case or …
- … the host channel loss must be reduced to offset the discontinuities and crosstalk not included in the cable assembly COM
- There is value in having common requirements at TP0 and TP5 for cable assembly and backplane applications
- The host channel is already loss-constrained so trade-offs may be difficult
- There is an argument for COM_{min}(cable assembly) > COM_{min}(backplane)

Summary

- There is merit in continuing to define an insertion loss limit
- For a given reference receiver, the accompanying COM_{min} value should be “audited” to ensure that it is a sufficient implementation allowance
- Such an audit should consider the maximum insertion loss expected
- The TP0 to TP5 channel estimate calculated for cable assembly COM should be compared to TP0 to TP5 channels based on the same cable assembly and realistic host implementations
- This would inform any difference between COM_{min}(cable assembly) and COM_{min}(backplane)
- Until this work has been completed, the statement “if it passes COM, it must be a good channel” may not be accurate