Residual intersymbol interference

(comment R1-28)

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Introduction

- Residual intersymbol interference (ISI) in the transmitter output waveform is constrained by the ISI_RES specification
- Per 163.9.2.6, ISI_RES related to the linear fit error computed for a linear fit pulse length $N_p = 11$
- Signal-to-noise-and-distortion ratio (SNDR) includes a linear fit error term computed using $N_p = 200$
- This term is primarily associated with distortion ($N_p = 200$ was chosen to reduce the influence of residual ISI on SNDR)
- ISI_RES therefore combines residual ISI and distortion
- The model used determine the ISI_RES limit (see dudek_3ck_01_0721) was linear hence the SNDR linear fit error term was likely close to 0

Problem statement #1

- ISI_RES combines residual ISI and distortion
- Since SNDR controls distortion, this is double-counting
- ISI_RES limit was derived for transmitters whose SNDR was dominated by uncorrelated noise

Parameter	Case 1	Case 2	Case 3
RMS uncorrelated noise	2.37%	1.5%	0%
RMS linear fit error for N_p = 200	0%	1.84%	2.37%
RMS residual ISI	2.82%	2.82%	2.82%
RMS linear fit error for N_p = 11	2.82%	3.37%	3.68%
SNDR, dB	32.5	32.5	32.5
ISI_RES, dB	−31	−29.5	−28.7

ISI_RES limit violated despite having an “acceptable” level of residual ISI

Problem statement #2

- ISI_RES is measured with N_p = 11 and D_p = 4 so it includes all errors after post-cursor 6
- A dispersive channel (package, host, test fixture) can generate an ISI tail that extends beyond post-cursor 6
- A receiver can generally be expected to deal with such a tail – reflections are the primary concern
- ISI_RES degraded by inconsequential ISI
- Transmitter equalization has been suggested as a means to reduce the impact of the tail (see ran_3ck_adhoc_01_032322)
- A low-frequency pole/zero pair is a more efficient tool for tail reduction

Inconsistency

- Effective return loss (ERL) considers the alignment of reflections at the sampling point
- ERL uses the sampling phase that maximizes the error
- In contrast, ISI_RES combines all residual errors irrespective of phase
- It would be better for reflections to be treated consistently between ERL and ISI_RES

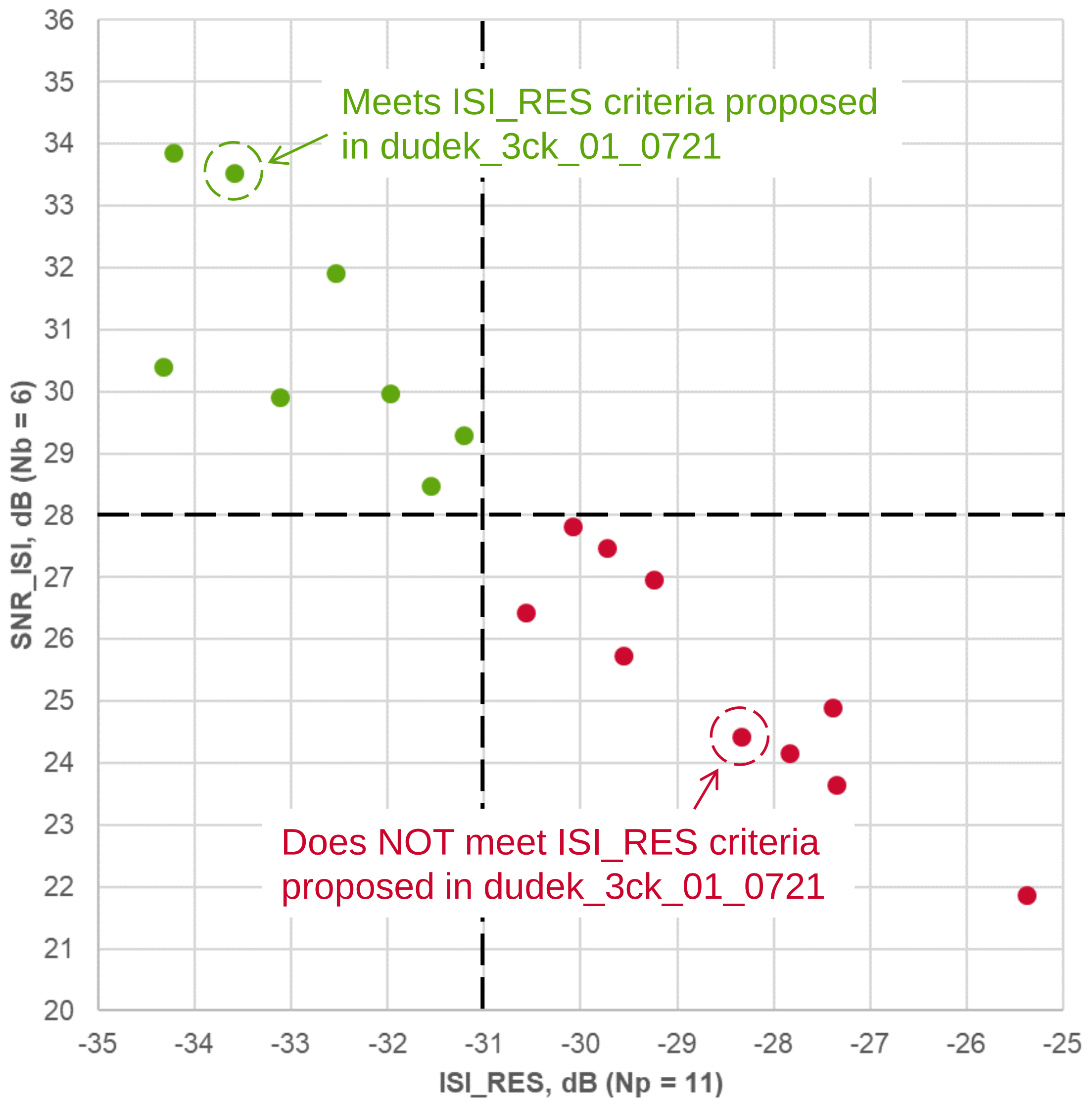
Proposed solution

- Replace ISI_RES with SNR_ISI as defined in 120D.3.1.7 except ...
- ... use the continuous time filter parameters in Table 163−11 and ...
- ... for calculation of $ISI_{cursors}$, sweep phase ±0.5 UI around t_p and choose the phase that minimizes SNR_ISI

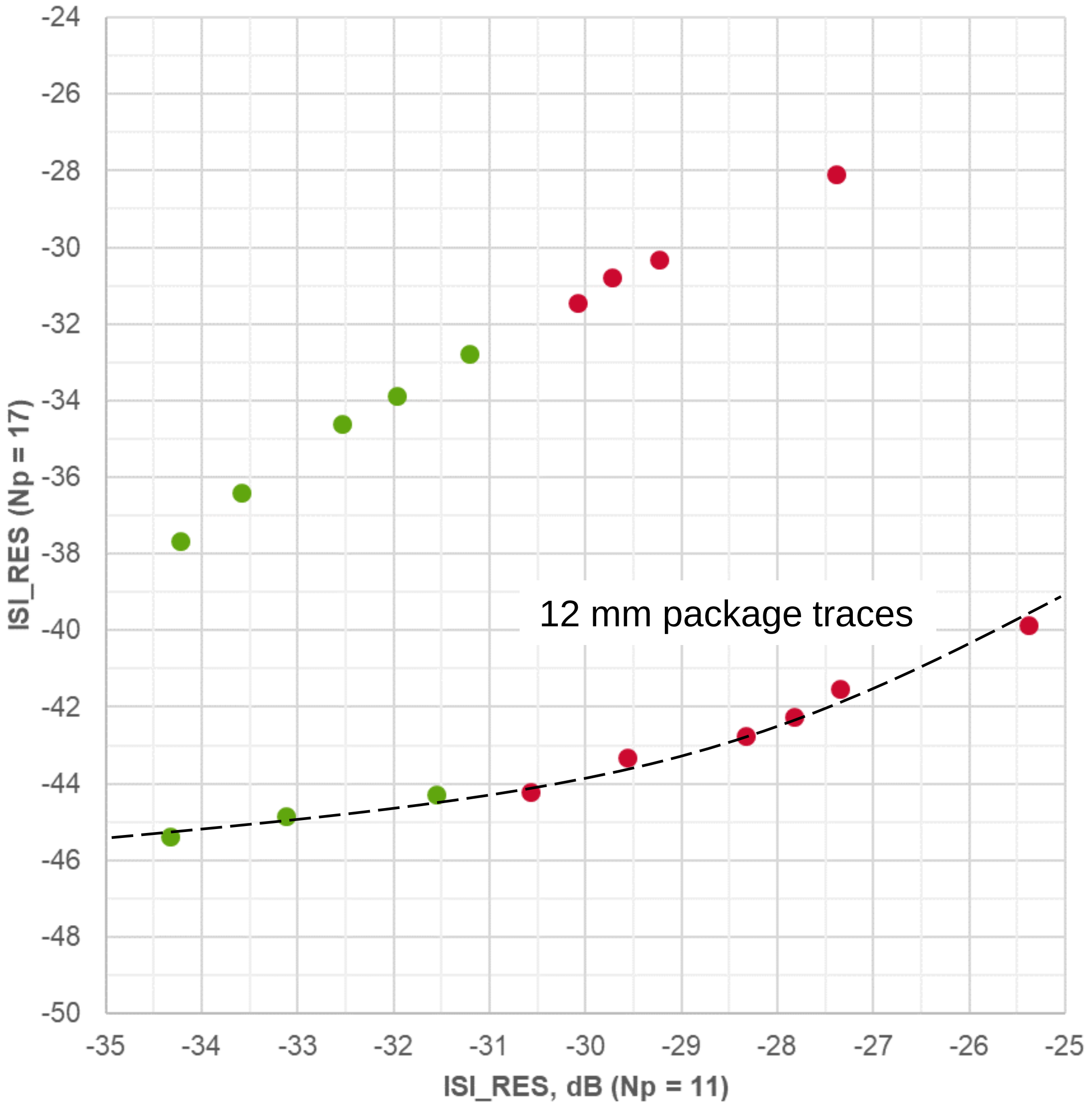
- SNR_ISI does not include SNDR linear fit error
- SNR_ISI includes a reference equalizer to reduce the dispersive tail and focus on reflections
- SNR_ISI accounts for the alignment of reflections at the sampling point (similar to ERL)
- SNR_ISI is already part of the base standard – there is no need to add a new residual ISI metric

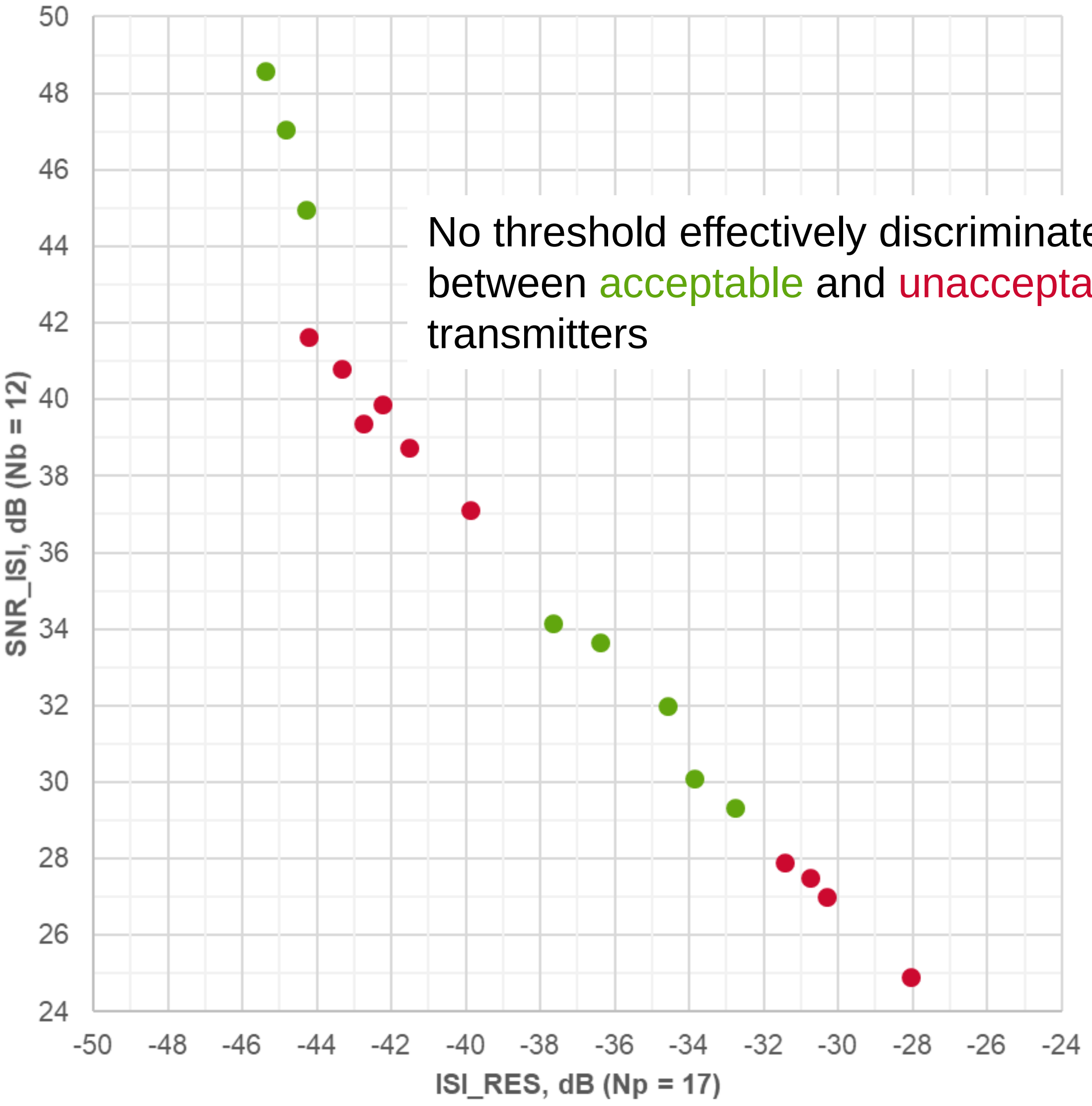
Correlation of SNR_ISI to ISI_RES at TP0v

- 18 transmitter models from slide 9 of [dudek_3ck_01_0721]
- 4 dB test fixture
- N_b = 6 (agrees with N_p = 11)
- Assume transmitters that meet the ISI_RES requirement also yield acceptable COM (and vice versa)



What if N_b = 12? (TP0v results)

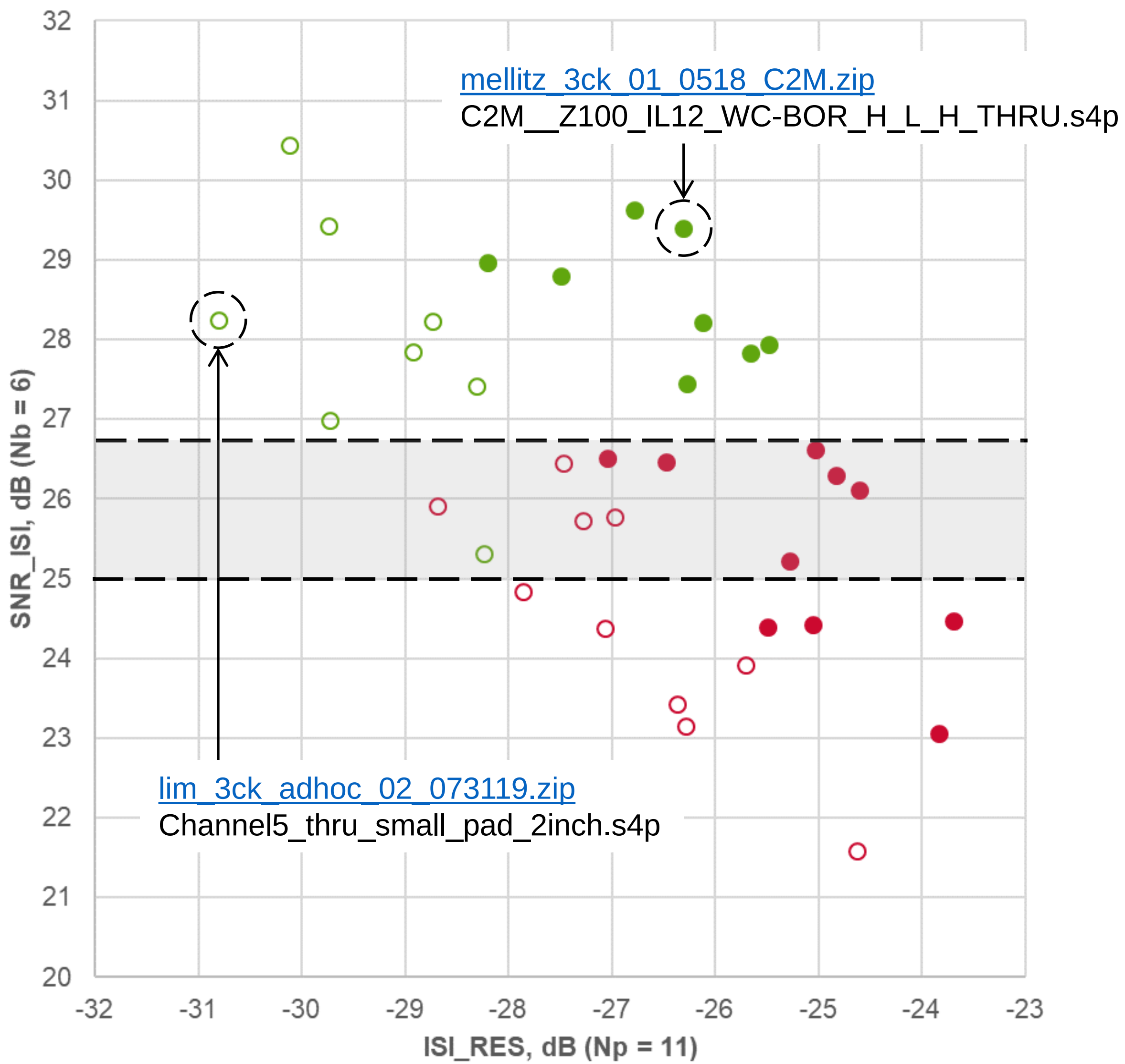




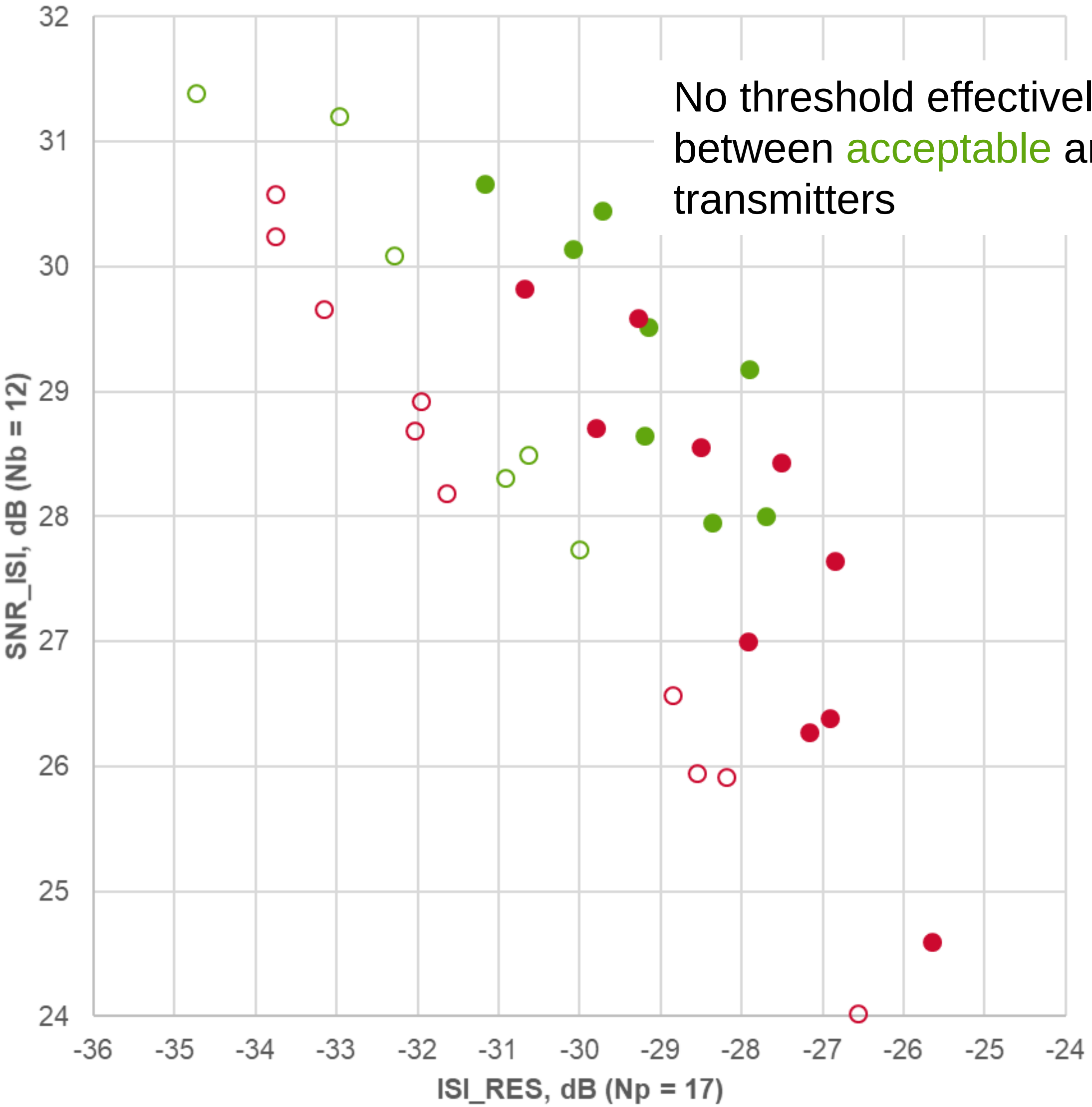
No threshold effectively discriminates between acceptable and unacceptable transmitters

Correlation of SNR_ISI to ISI_RES at TP2

- 18 transmitter models from slide 9 of [dudek_3ck_01_0721]
- Different host models
- N_b = 6 (agrees with N_p = 11)



What if N_b = 12? (TP2 results)



No threshold effectively discriminates between acceptable and unacceptable transmitters

Proposed limits

- Set N_b to 6
- For Clause 163 and Annex 120F, set SNR_ISI (min.) to 28 dB
- For Clause 162, set SNR_ISI (min.) to 26.7 dB
- Requirements need only be met for one transmitter equalizer setting e.g., the one that maximizes SNR_ISI