Considering all Noise Sources over a single data and power pair
IEEE802.3bp Task Force
Channel Definition ad-hoc

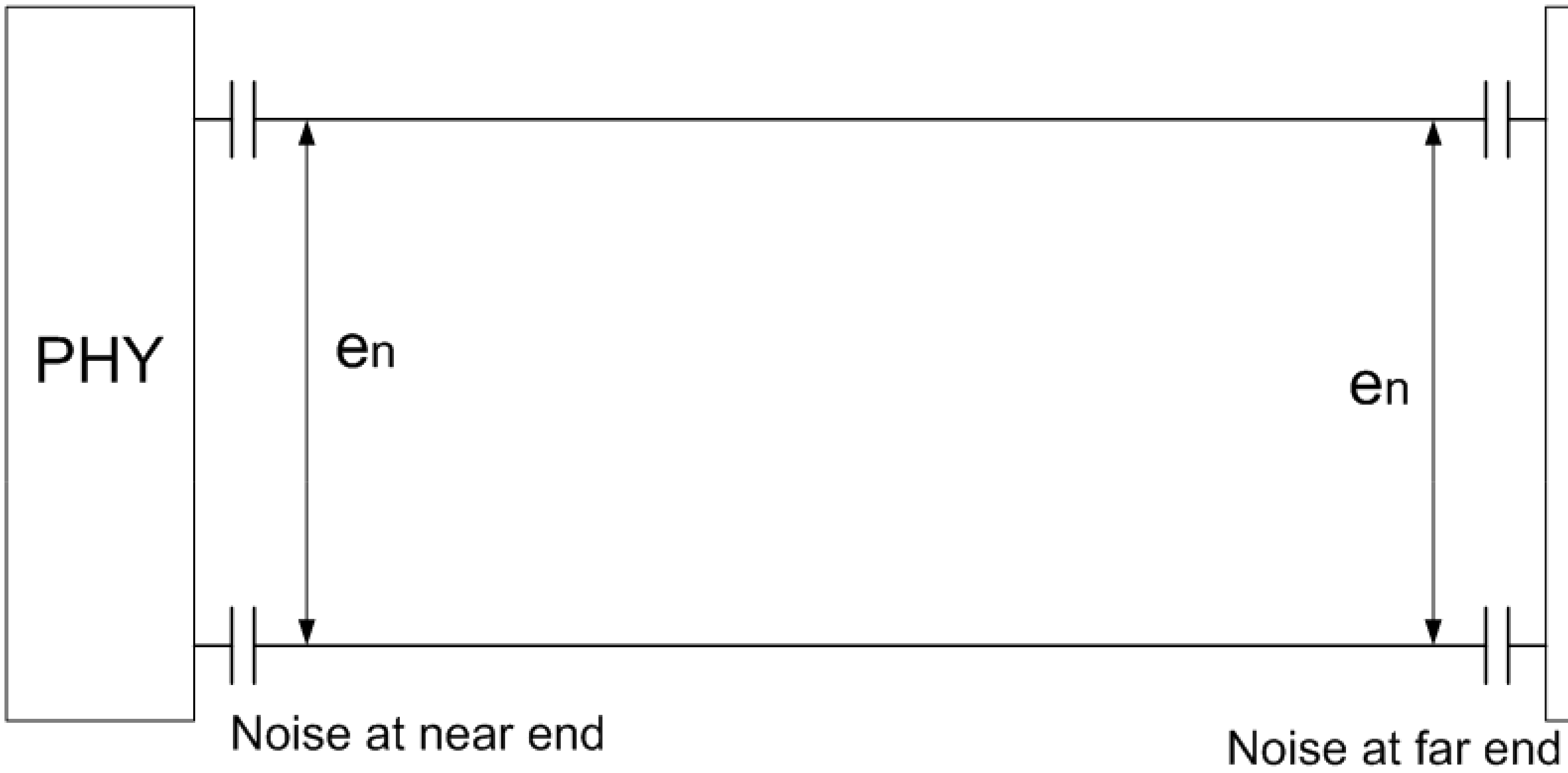
May 2013 .

Yair Darshan, Microsemi
ydarshan@microsemi.com

Objectives

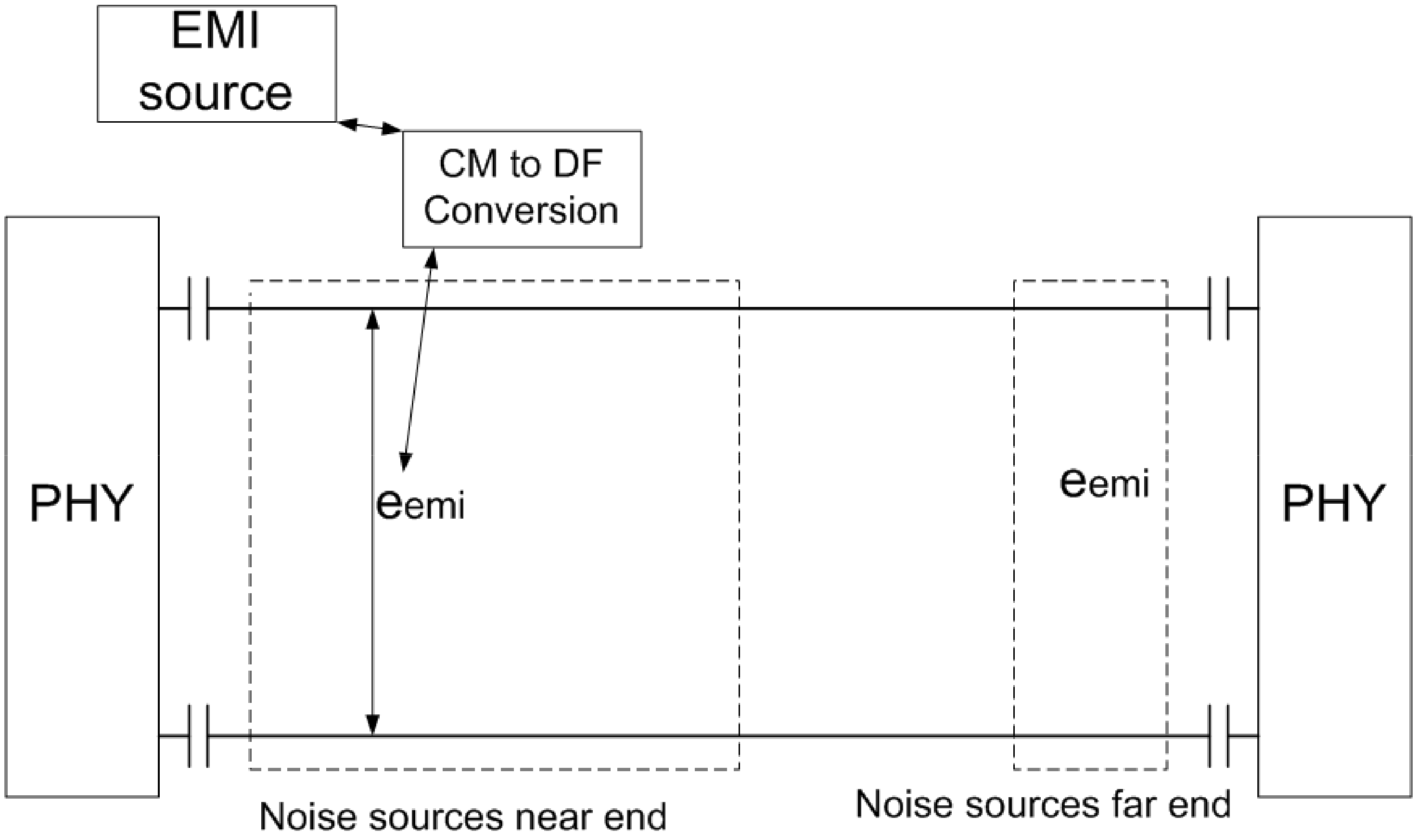
- To ensure that we cover all potential noise sources over the data pair for specifying the total differential maximum noise over the data pair.

$e_n(f)$ = Maximum Noise Vs Frequency Requirement



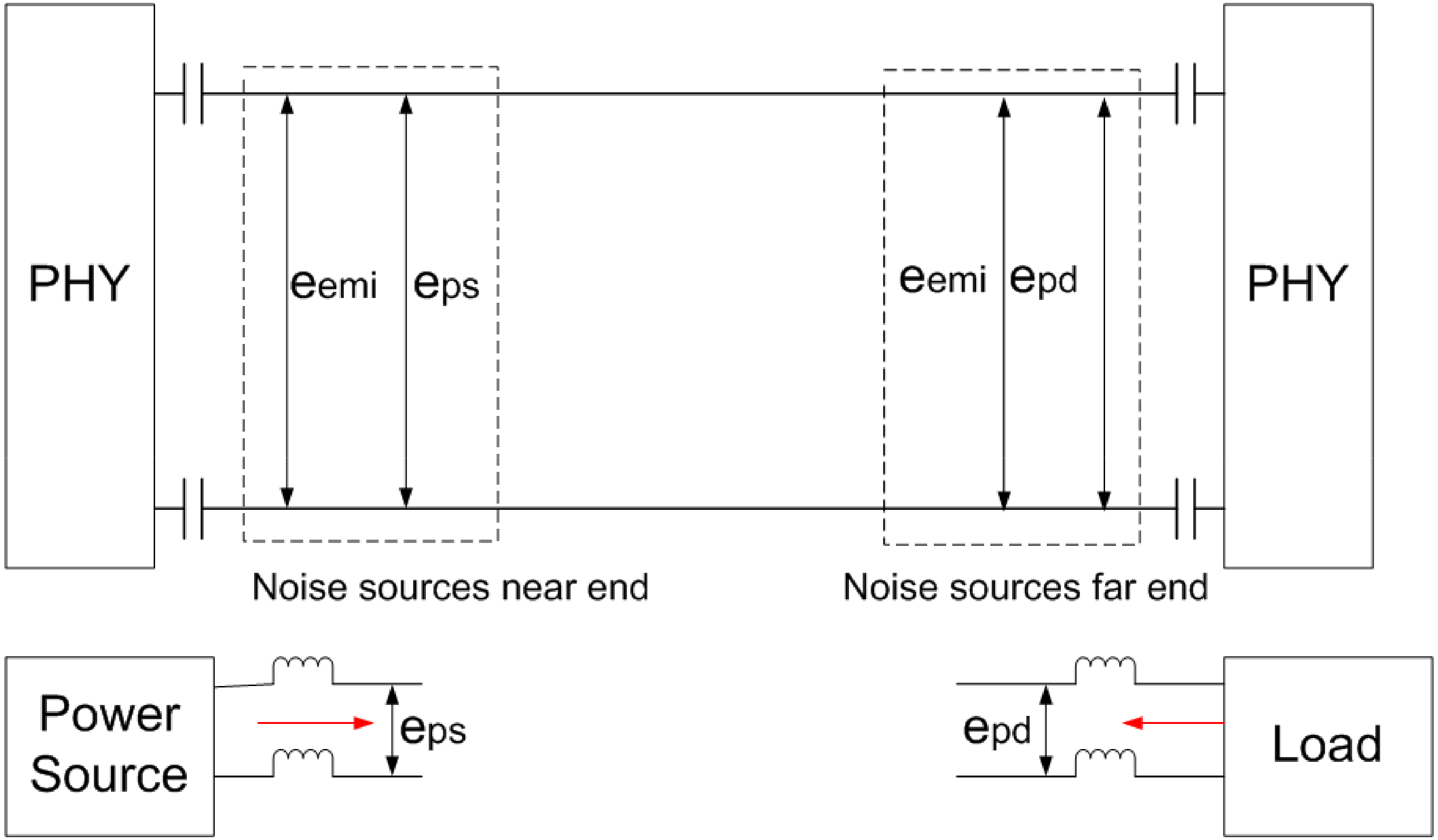
- *We need to know the maximum rms noise. e_n as function of freuency in which data specificatiion is met.*

EMI noise source



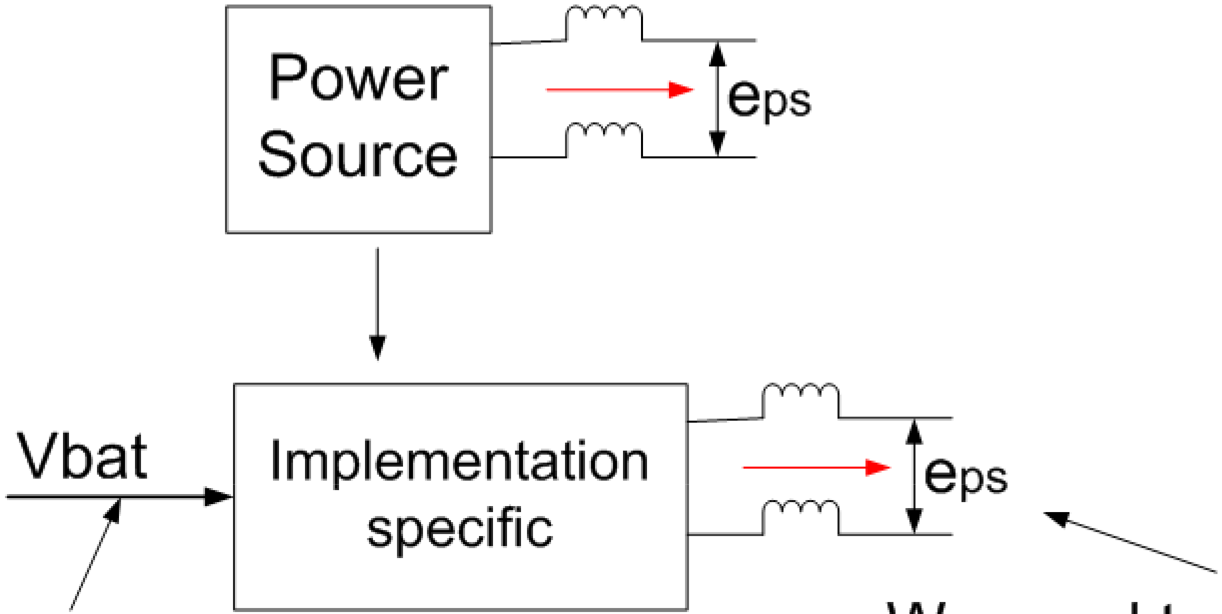
- EMI is one of the noise sources that generate DM noise

Power source and load noise sources



- If power is delivered over the same data pair, we have additional noise sources at near end (power supply noise) and far end (load noise e.g. DC/DC converter noise)

More about Power Source Noise

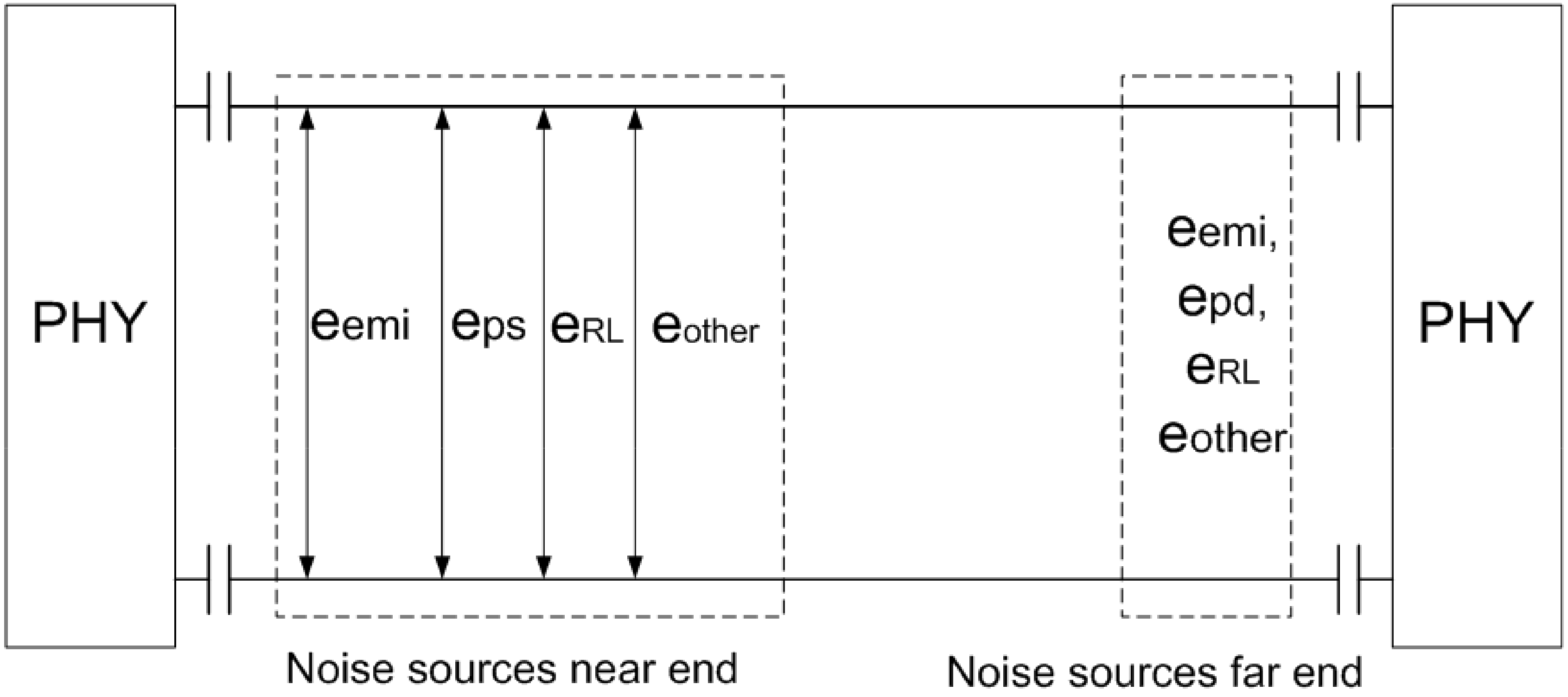


- Ripple
- Noise
- Transients

per automotive standards (ISO7637 etc.)

We need to define e_{ps} for any frequency at Vbat and the data range operating frequencies.

Proposed general case for noise sources



$$e_n^2 = e_{emi}^2 + e_{ps}^2 + e_{RL}^2 + e_{other}^2$$

$$e_n^2 = e_{emi}^2 + e_{pd}^2 + e_{RL}^2 + e_{other}^2$$

- e_{RL} is the noise gnerated by the return loss during transmision.
- e_{other} is other noise sources that we may add to the list including design margin

Working assumption

- e_{emi} on both ends is the same quantity
- e_{other} is unknow noise source or a design margin
- e_{ps} and e_{pd} are independent noise sources
- e_{RL} on both sides is the same quantity
- As a result:
- Total Worst Case Noise on each end is(*): $e_n^2 \geq e_{emi}^2 + e_{ps}^2 + e_{pd}^2 + e_{RL}^2 + 2 \cdot e_{other}^2$
- Assuming all sources have the same weight: $e_n^2 \geq= 6 \cdot e^2$
- The upper limit spec. for each noise source as function of frequency:

$$e_{rms}(f) \leq \frac{e_n(f)}{\sqrt{6}} = 0.4 \cdot e_n(f)$$

- Which is ~7.8dB below e_n.

(*) If there are more noise sources the model above can be extended accordingly)

More about the evaluation of spec limits

- There are other ways to plug in the design margin. Probably different ways will generate a bit different results.
- <u>Without design margin</u>, due to 4 known noise sources, the total noise with the same working assumptions shown previously will be:

$$e_n^{\ 2} \geq e_{emi}^{\ \ 2} + e_{ps}^{\ \ 2} + e_{pd}^{\ \ 2} + e_{RL}^{\ \ 2} = 4 \cdot e^2$$

- The upper limit spec. for each noise source as function of frequency:

$$e_{rms}(f) \leq \frac{e_n(f)}{\sqrt{4}} = 0.5 \cdot e_n(f)$$

- Which is ~6dB below en. (not including design margin)

- <u>The negeral case for the upper limit of a noise source of a list of S noise sources:</u>

- $$e_{rms}(f) \leq \frac{e_n(f)}{\sqrt{S}}$$

Summary

- There are additional noise sources that are needed to be taken when noise limits are defined for $e_{emi}(f)$ or any other noise source.

- When total $e_n(f)$ is known, any noise source e_i need to meet: $e_i(f) < e_n(f)$ by at least -10*log(S)[dB] for any noise source i from a list of i=1 to S noise sources.

Proposed next steps

- To get en test data that ensures meeting data requirements over the specified channel.
- To generate a list of all known noise sources
- To derive the spec values for each noise source.
- It is highly practical from power source and load point of view, to define a detailed table of differential noise per frequency over the frequency range of interest.
- It is important to define the noise also for low frequencies outside the transmiting range e.g. from 1-2Hz to 1-10MHz. It will allow more flexibility and cost effective power source when power over data will be implemented.

Discussion

Thank You