

# 2.5G/5.0G Transmit Linearity Test with Link-Partner Signal as Disturber

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# Background

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- 1000BASE-T defined Transmit Linearity test with far-end signal superimposed to stress Tx driver as in real link
- 10GBASE-T defined Transmit Linearity 2-Tone test without a signal superimposed to emulate far-side PHY
  - The far-side signal is either heavily attenuated in long cables or has high PBO levels (~10dB) used in short links
- Similar argument can be used for 5GBASE-T given PBO requirement for short cables is 8-10dB
- 2500BASE-T has a maximum PBO of 2dB, so proper to consider similar Transmit test condition to 1000BASE-T
  - However, to simplify the test compared to 1000BASE-T, we propose to use tones as test signal and not random data

# Worst Case for Tx Linearity in 2500BASE-T

- Goal: Ensure far-end Tx non-linearity contribution to total PHY SNR budget stays the same at all lengths
  - At ~45m length, PBO switches from 0dB to 2dB
- Worst case scenarios for link partner (LP) receiver:
  - ~45m: DUT Tx at 2dB PBO, LP Tx at 0dB PBO
    - LP signal on DUT MDI pads is 4.3dB attenuated over 45m cable
  - ~1m: Both DUT & LP are at 2dB PBO → Linearity too relax

Cable Length	PBO	Received Power	Required PHY SNR (Alien xtalk SNR: 30dB)	Far-end Tx Linearity Offset
100m	0dB	-8.8dBm	35.2dB	0
45m	0dB	-4.3dBm	32.4dB	-11dB
<b>45m</b>	<b>2dB</b>	<b>-6.3dBm</b>	<b>34.4dB</b>	<b>-8dB ←</b>
1m	2dB	0.0dBm	30.5dB	-22dB

# Tx Linearity Test for 2500BASE-T

- Consider two conditions for Test mode 4 in 2.5G with same 2-tones as in Table 126-14
  1. Original test as defined in standard text
    - **$SFDR \geq 2.5 + \min \{ 52, 58 - 20 \log_{10}(f/25) \}$**
  2. 2dB PBO on 2-tone amplitudes plus a tone to represent far-end signal stress, but relaxed specs
    - **$SFDR \geq (2.5 - 8) + \min \{ 52, 58 - 20 \log_{10}(f/25) \}$**

$$S \times (400/1024) \times 47, S \times (400/1024) \times 53$$

$$S \times (400/1024) \times 101, S \times (400/1024) \times 103$$

$$S \times (400/1024) \times 179, S \times (400/1024) \times 181$$

$$S \times (400/1024) \times 277, S \times (400/1024) \times 281$$

$$S \times (400/1024) \times 397, S \times (400/1024) \times 401$$

# Test Setup for 1000BASE-T

- UNH used the following setup for 1000BASE-T to ensure reliable & consistent results

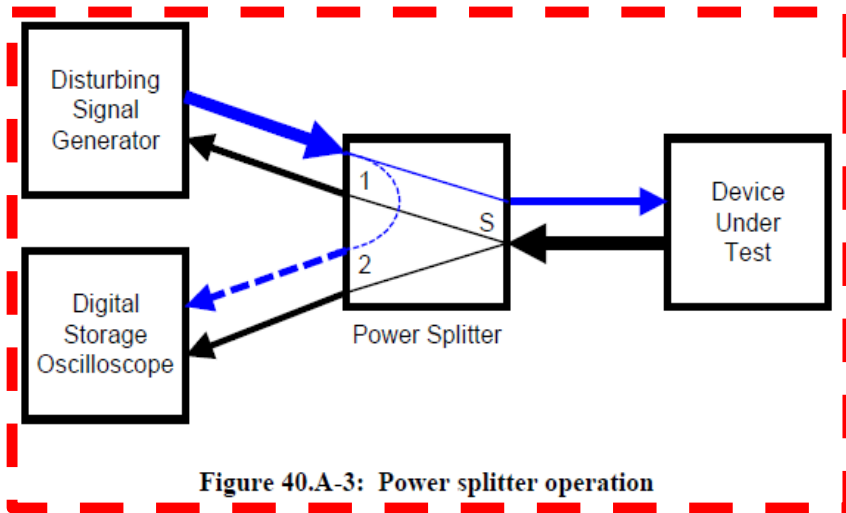


Figure 40.A-3: Power splitter operation

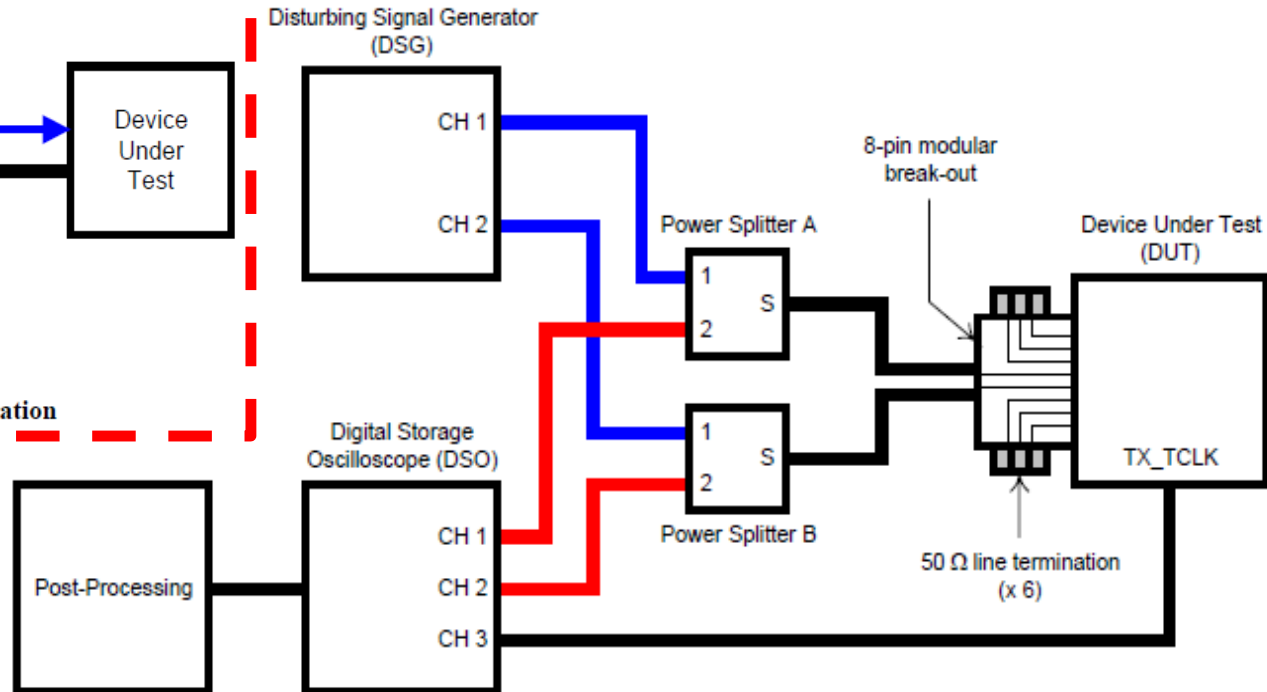
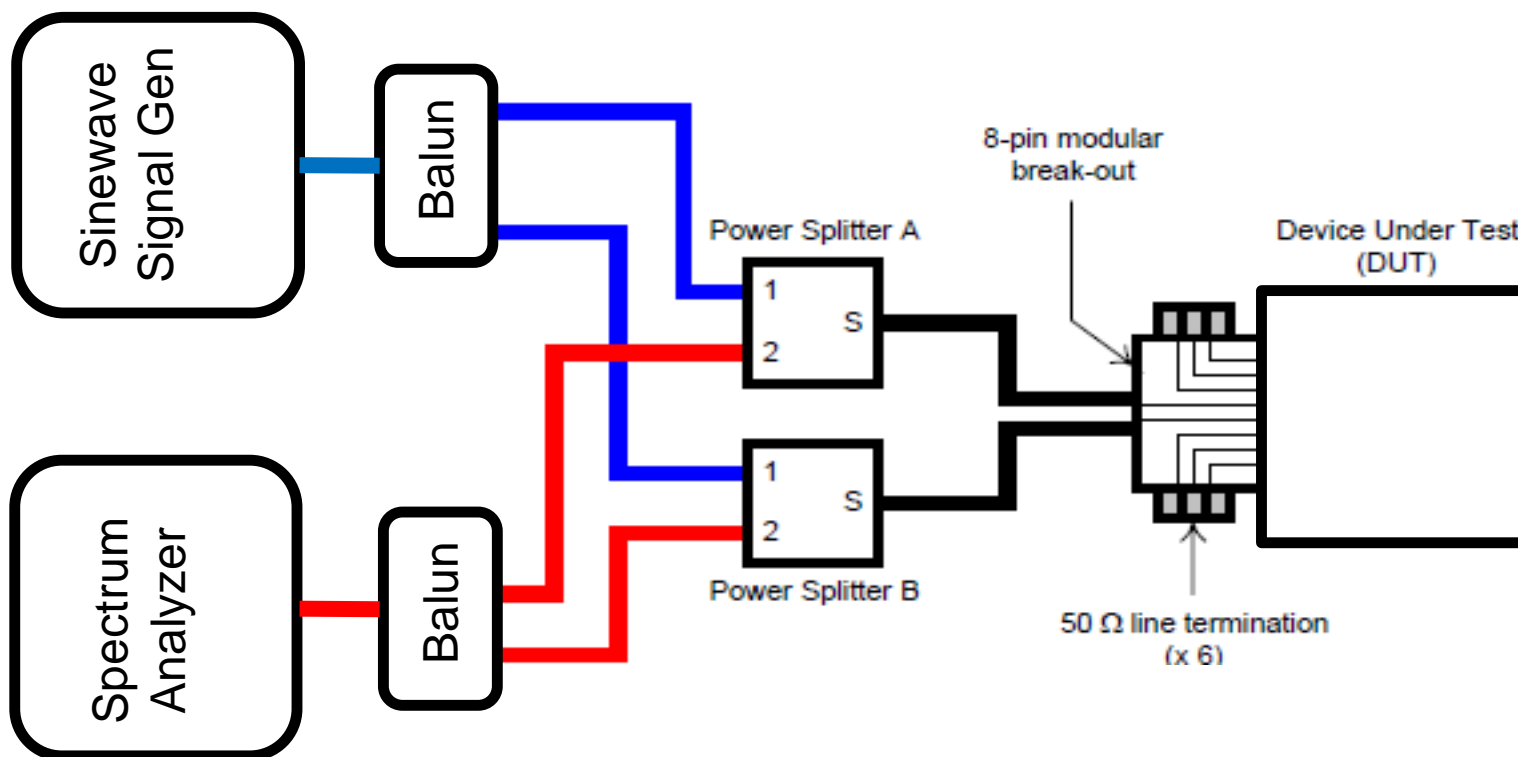


Figure 40.A-1: Test setup block diagram

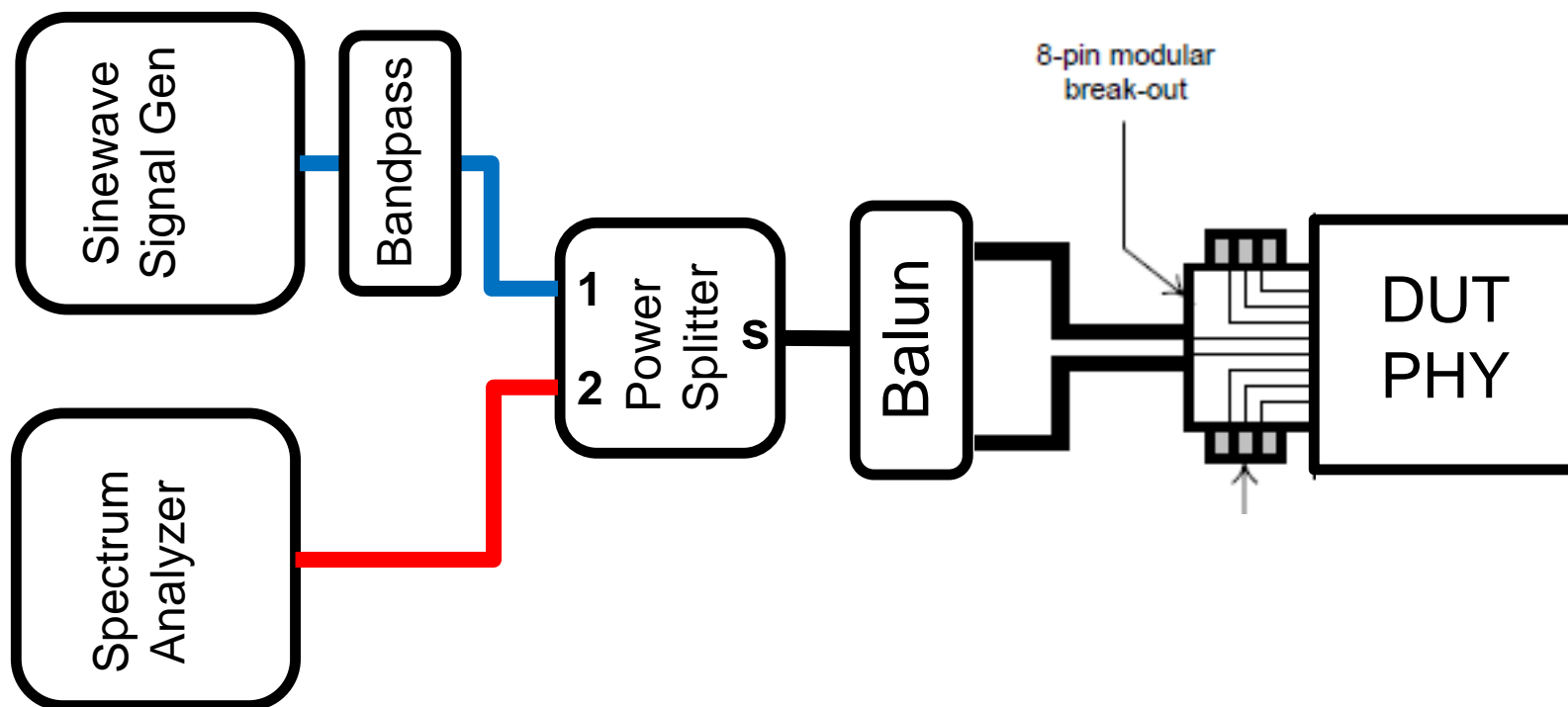
# Setup for New Proposed Test Mode 4

- A similar setup to UNH but using tones and Spectrum Analyzer instead of random data & Digital Scope
  - No complex timing synchronization & post processing
  - Adjust Disturber peak amplitude after Splitter to be same as PHY



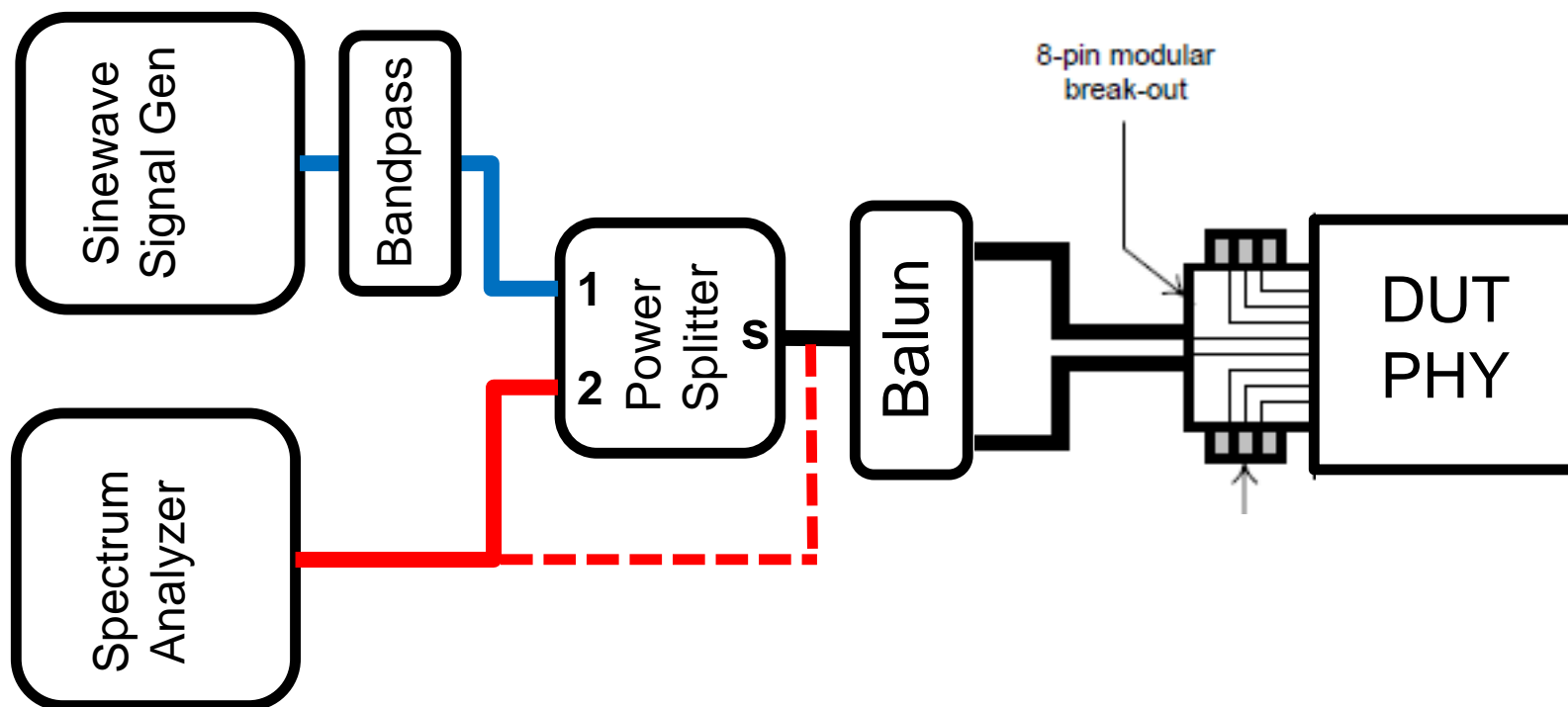
# Setup for New Proposed Test Mode 4

- A simpler test setup with one Balun & one Power Splitter
- Add a bandpass filter to eliminate Signal Generator spurs
- Disturber amplitude at DUT pads to be **4.3dB** below peak
  - 4.3dB is the effective power loss over 45m cable



# Setup for New Proposed Test Mode 4

- Same test setup can be used to perform original linearity test by turning off the Signal Generator (or bypassing the Splitter)





# Conclusion

- 5.0G: No Change to the Linearity Test
- 2.5G: Same 2-tones as in Table 126-14, with 2 modes
  1. No Disturber: Original test as defined in standard text
    - **Linearity Spec: SFDR  $\geq 2.5 + \min \{ 52, 58-20\log_{10}(f/25) \}$**
  2. With Disturber: DUT 2-tones at 2dB PBO plus a 45MHz disturber tone at 4dB below transmit peak amplitude
    - **Linearity Spec: SFDR  $\geq -5.5 + \min \{ 52, 58-20\log_{10}(f/25) \}$**

$$S \times (400/1024) \times 47, S \times (400/1024) \times 53$$

Table 126-14

$$S \times (400/1024) \times 101, S \times (400/1024) \times 103$$

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# Sample Plots

