A receiver-agnostic approach to ETCC
Supporting contribution for Draft 2.2 comment #251

IEEE 802.3 November 2025 plenary

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Acknowledgement to

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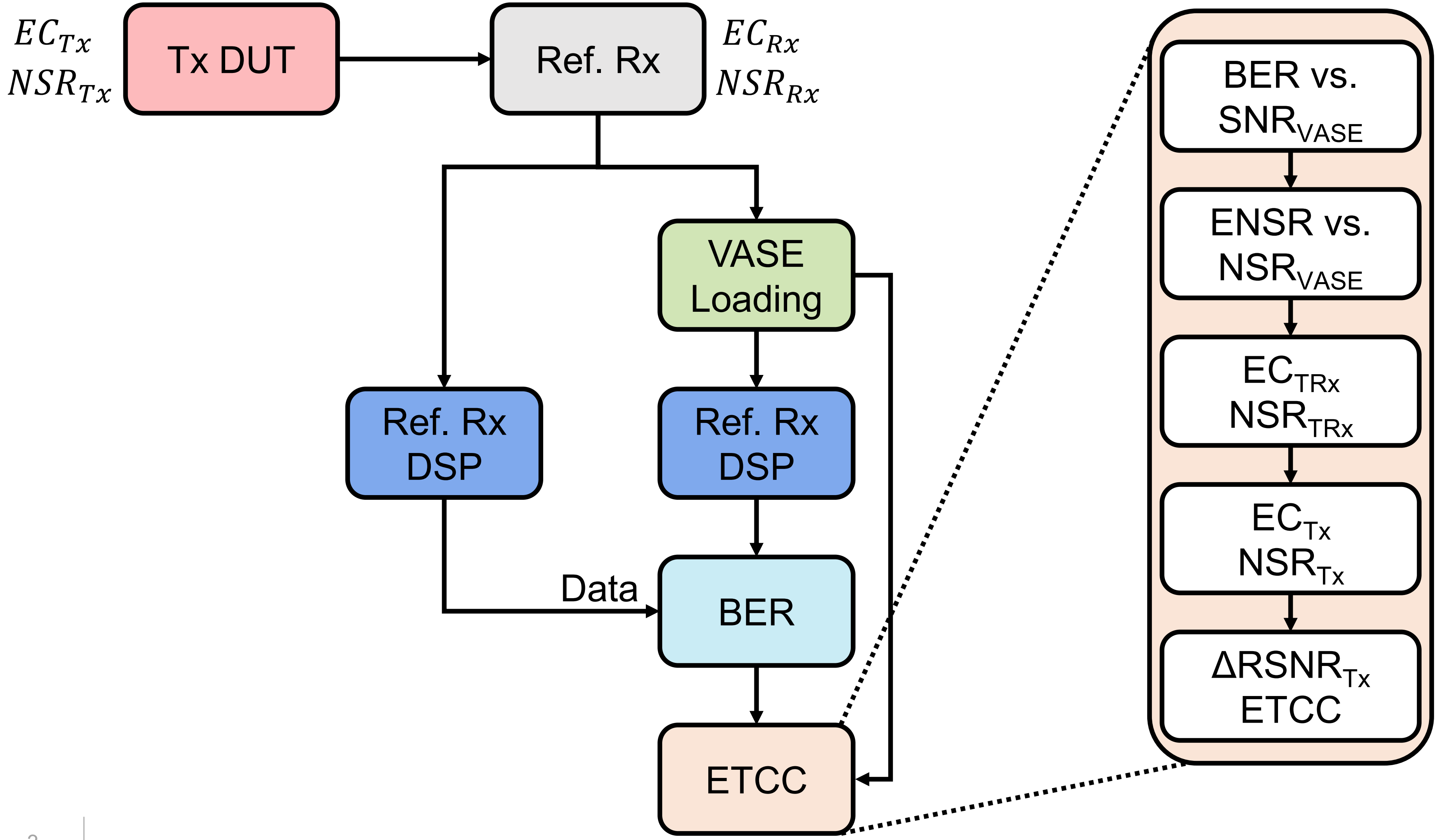
Outline

1. Review of current ETCC methodology
2. Simulation showing inconsistent results with different Rx/Tx DUTs
3. ETCC with receiver compensation
4. Simulation of new approach
5. Experimental demonstration of new approach
6. Proposal summary and suggested editorial changes

Current ETCC Methodology



Error counting

Estimation of ENSR from BER

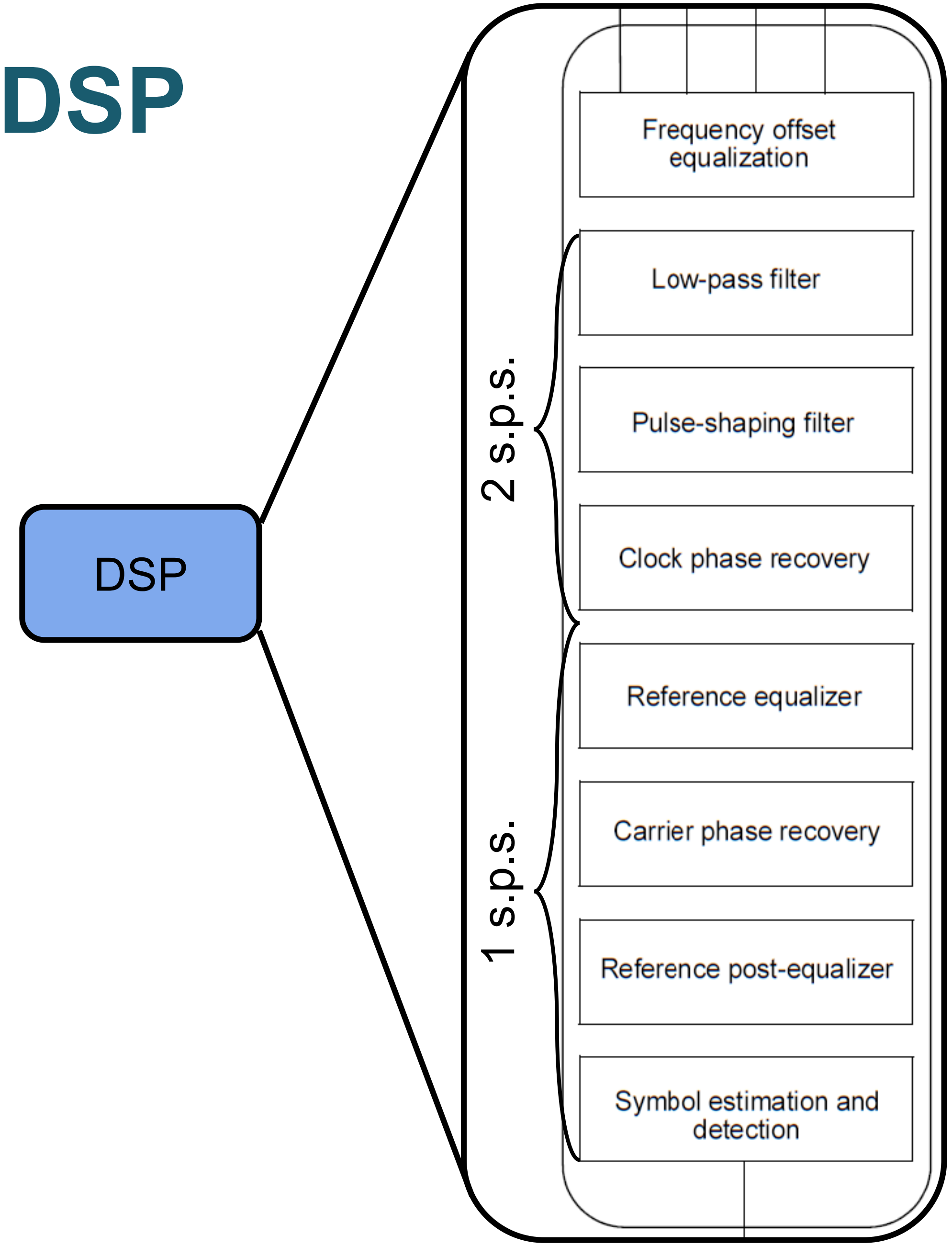
Linear fit to ENSR vs. NSR_{VASE} curve

Deembed using known EC_{Rx}, NSR_{Rx}

$$RSNR_{ase,tx} = ((EC_{tx} \cdot ESNR_{ref})^{-1} - NSR_{tx})^{-1}$$

$$ETCC = \Delta RSNR_{tx} = 10\log 10\left(\frac{RSNR_{ase,tx}}{ESNR_{ref}}\right)$$

Ref. Rx DSP



4th-power FFT

Bessel Thomson w/ 0.55*BR BW

Root-raised cosine w/ 0.1 roll-off

Power clock tone per polarization

31-tap T-spaced 2x2 CMA/RDE/LMS

4th-power w/ inner & outer symbols

5-tap T-spaced 2x2 real MIMO per pol.

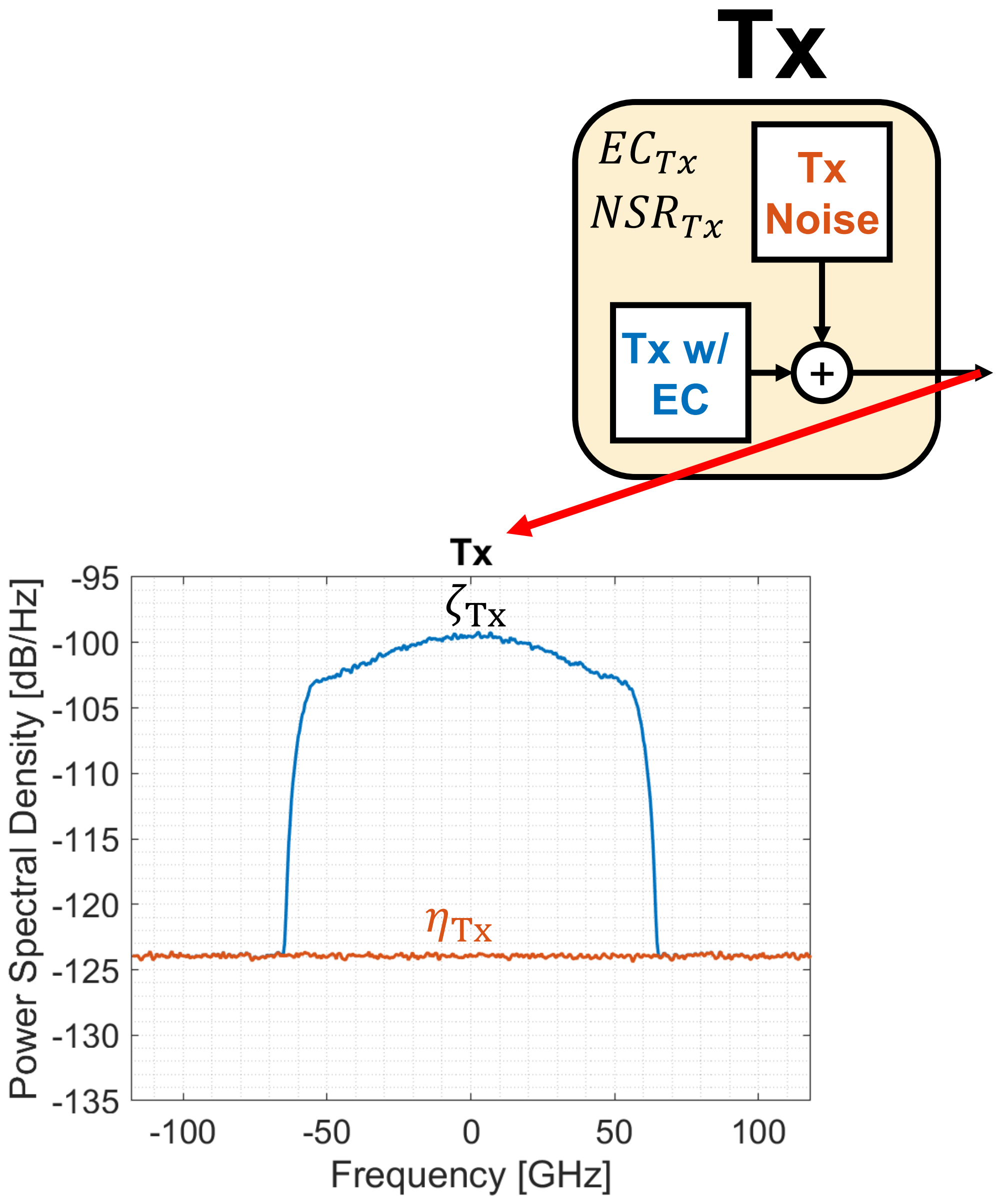
Optimized thresholds

Validating ETCC methodology in simulation

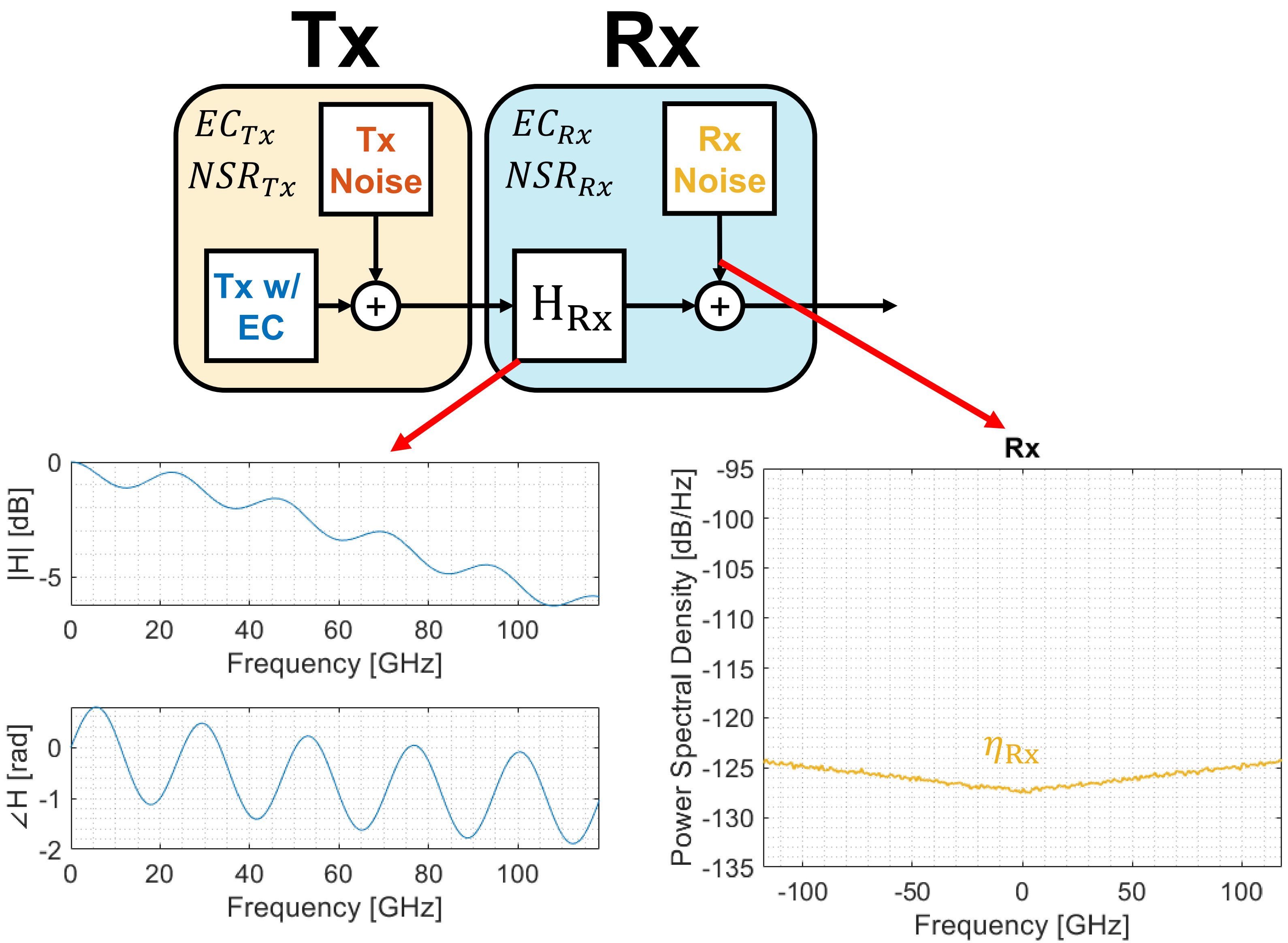
1. DUT Tx (EC_{Tx}, NSR_{Tx}) → Ideal Rx = $\Delta RSNR_{Tx}$
2. Ideal Tx → DUT Rx (EC_{Rx}, NSR_{Rx}) = $\Delta RSNR_{Rx}$
3. DUT Tx (EC_{Tx}, NSR_{Tx}) → DUT Rx (EC_{Rx}, NSR_{Rx}) = $\Delta RSNR_{TRx}$
4. Deembed DUT Rx from (EC_{TRx}, NSR_{TRx}) to find $\Delta RSNR_{Tx\ (Rx\ deembed)}$

Analytically $\Delta RSNR_{Tx\ (Rx\ deembed)} = \Delta RSNR_{Tx}$, but what happens in practice?

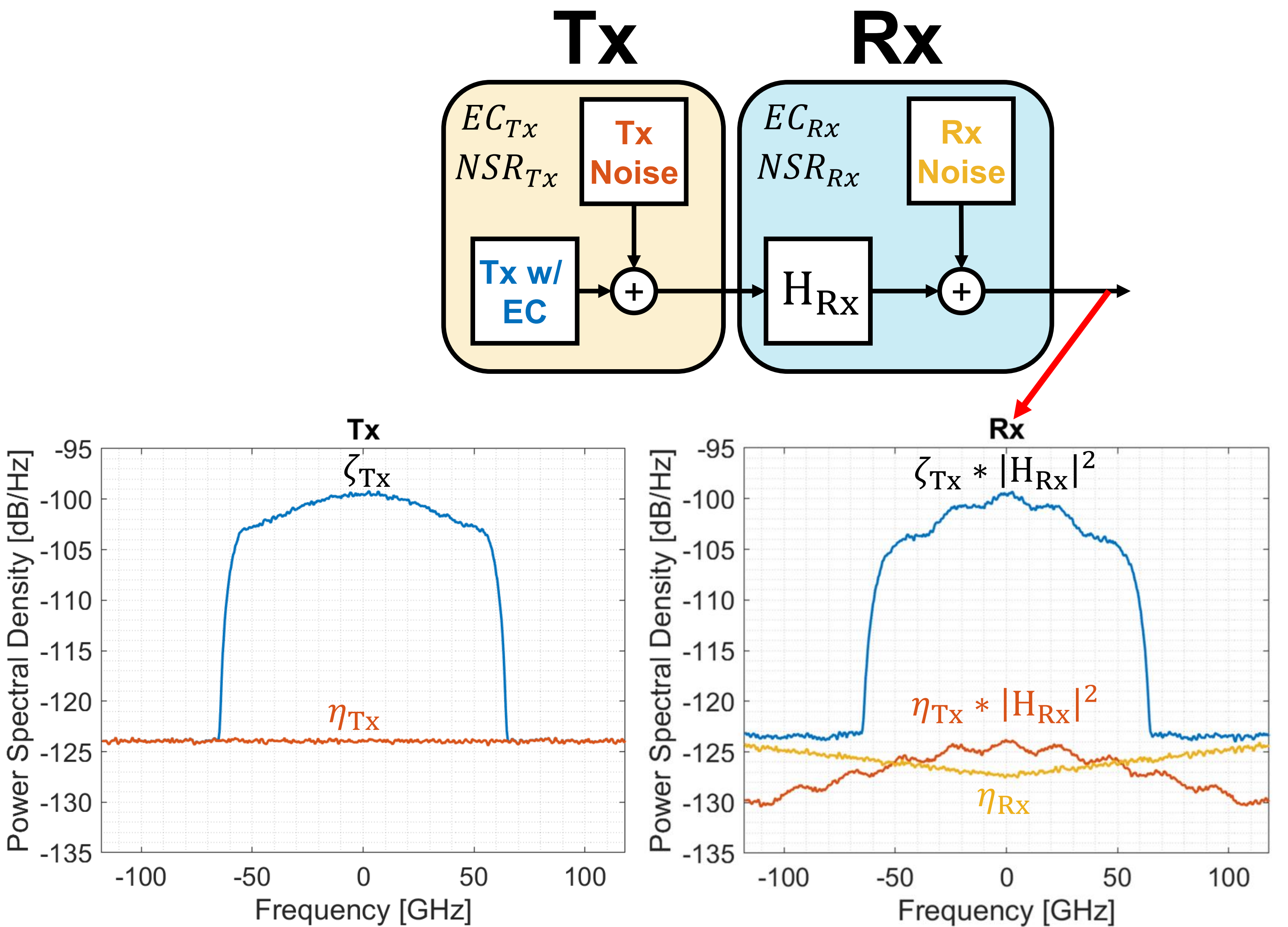
ETCC Simulation



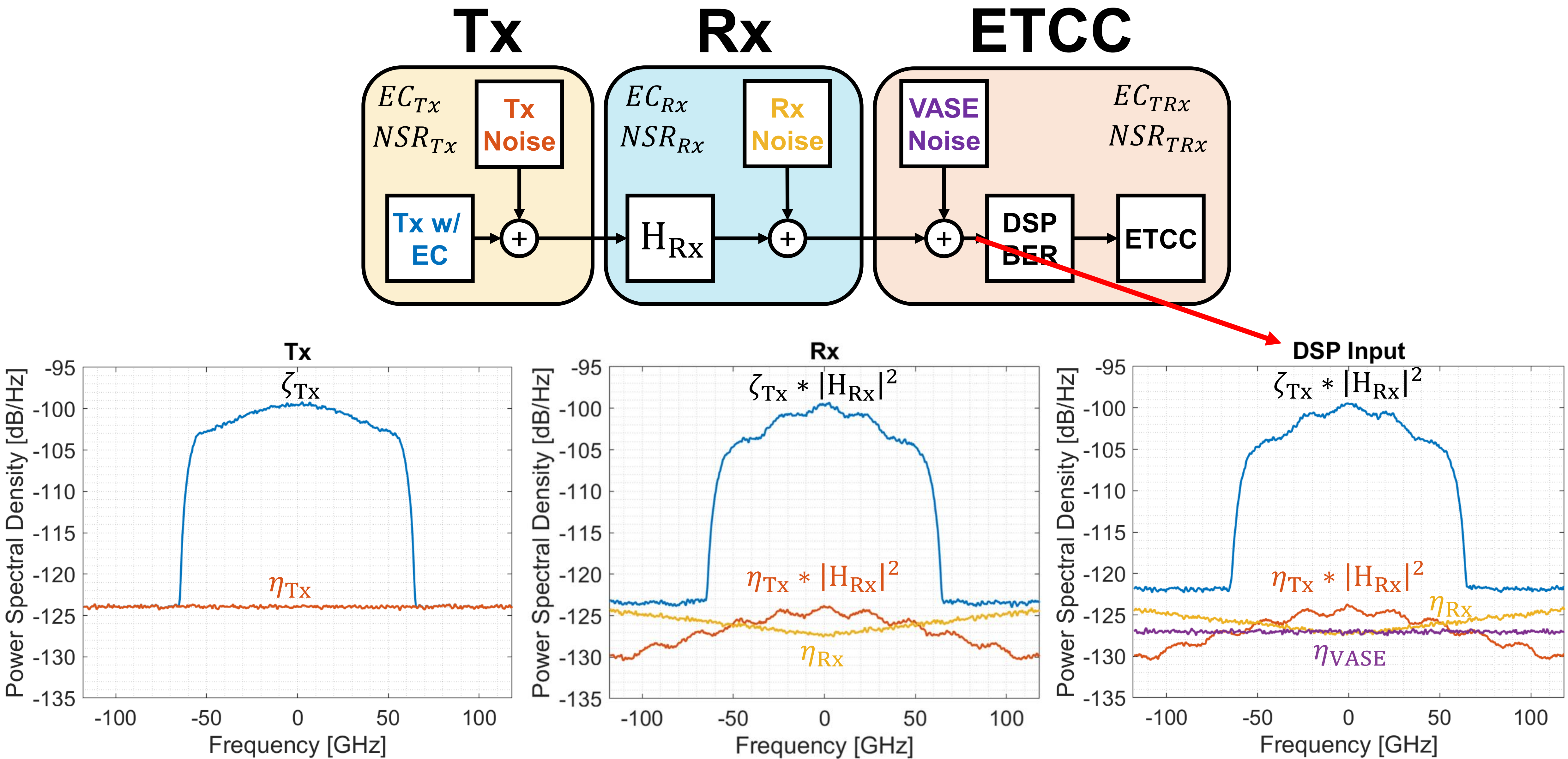
ETCC Simulation



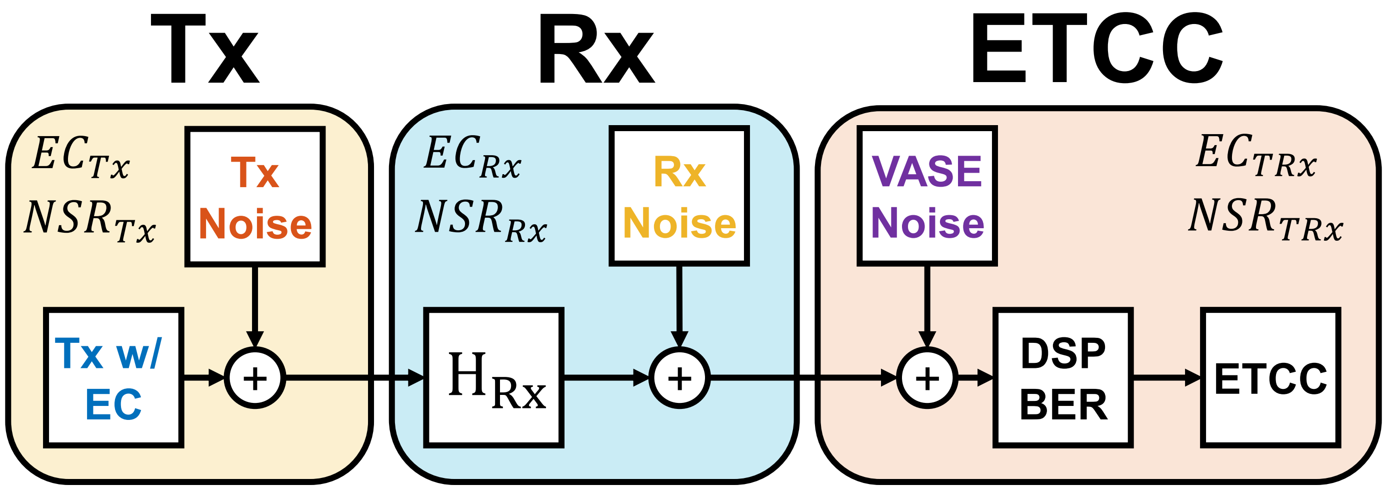
ETCC Simulation



ETCC Simulation



ETCC Simulation



	TRx			Tx after deembed		
	EC [dB]	SNR [dB]	ΔRSNRTRx [dB]	EC [dB]	SNR [dB]	ΔRSNRTx [dB]
DUT Tx → Ideal Rx	0.5	23.03	0.98			
Ideal Tx → DUT Rx	0.31	24.48	0.63			
DUT Tx → DUT Rx	1.04	20.84	1.98	0.73	23.3	1.2

ETCC Simulation (Different Tx/Rx)

Tx1/Rx1

	TRx			Tx after deembed		
	EC [dB]	SNR [dB]	ΔRSNRTRx [dB]	EC [dB]	SNR [dB]	ΔRSNRTx [dB]
DUT Tx1 → Ideal Rx	0.5	23.03	0.98			
Ideal Tx → DUT Rx1	0.31	24.48	0.63			
DUT Tx1 → DUT Rx1	1.04	20.84	1.98	0.73	23.3	1.2

Tx1/Rx2

	TRx			Tx after deembed		
	EC [dB]	SNR [dB]	ΔRSNRTRx [dB]	EC [dB]	SNR [dB]	ΔRSNRTx [dB]
DUT Tx1 → Ideal Rx	0.5	23.03	0.98			
Ideal Tx → DUT Rx2	0.51	23.79	0.9			
DUT Tx1 → DUT Rx2	1.48	20.84	2.54	0.98	23.9	1.41

Tx2/Rx1

	TRx			Tx after deembed		
	EC [dB]	SNR [dB]	ΔRSNRTRx [dB]	EC [dB]	SNR [dB]	ΔRSNRTx [dB]
DUT Tx2 → Ideal Rx	0.86	22.96	1.39			
Ideal Tx → DUT Rx1	0.31	24.48	0.63			
DUT Tx2 → DUT Rx1	1.24	20.88	2.61	1.24	23.37	1.77

Tx2/ Rx2

	TRx			Tx after deembed		
	EC [dB]	SNR [dB]	ΔRSNRTRx [dB]	EC [dB]	SNR [dB]	ΔRSNRTx [dB]
DUT Tx2 → Ideal Rx	0.86	22.96	1.39			
Ideal Tx → DUT Rx2	0.51	23.79	0.9			
DUT Tx2 → DUT Rx2	2.08	20.92	3.29	1.57	24.06	2.05

Issues with current approach

- **Issue #1:** NSR_{Rx} & EC_{Rx} parameters aren't directly measurable
  - In practice there is no "Ideal Tx"
  - CW laser method (Keysight) does not capture Rx burden on equalizer (underestimates EC_{Rx} & NSR_{Rx})

- **Issue #2:** Deembedding NSR_{Rx} & EC_{Rx} from NSR_{TRx} & EC_{TRx} does not yield consistent $\Delta RSNR_{Tx}$ results
  - Tx DUT and Rx DUT share equalizer resources

$$EC_{TRx} > EC_{Tx} \cdot EC_{Rx}$$

  - Equalizer enhances noise differently depending on its state

$$NSR_{TRx} \neq NSR_{Tx} + NSR_{Rx}$$

Proposed ETCC modification

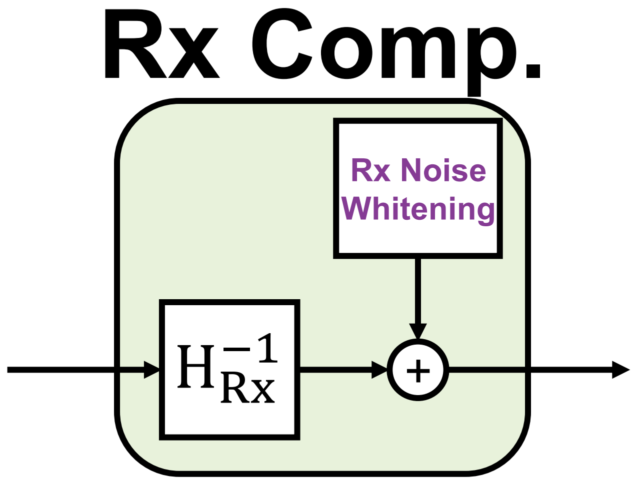
Same

- Measurement procedure (single capture using reference receiver)
- Digital signal processing pipeline
- EC & NSR estimation methodology (VASE Noise loading → BER vs. SNR_{VASE} → ENSR vs NSR_{VASE} → linear fit)

Proposed change: "Receiver Compensation"

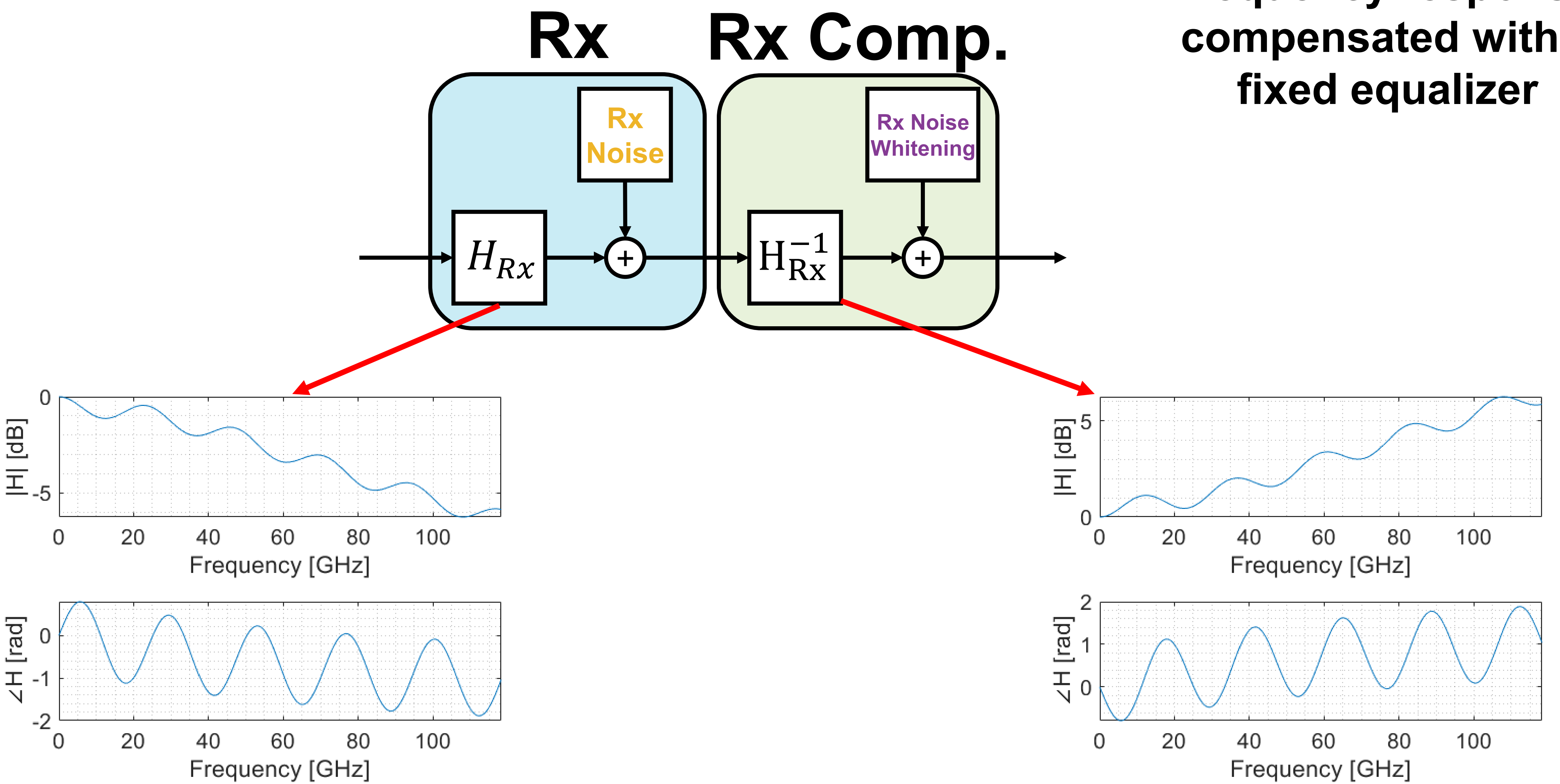
A) Receiver Response Equalization: Fixed equalizer to compensate receiver frequency response (H_{Rx}^{-1})

B) Receiver Noise Whitening: Addition of spectrally-shaped noise to whiten receiver noise



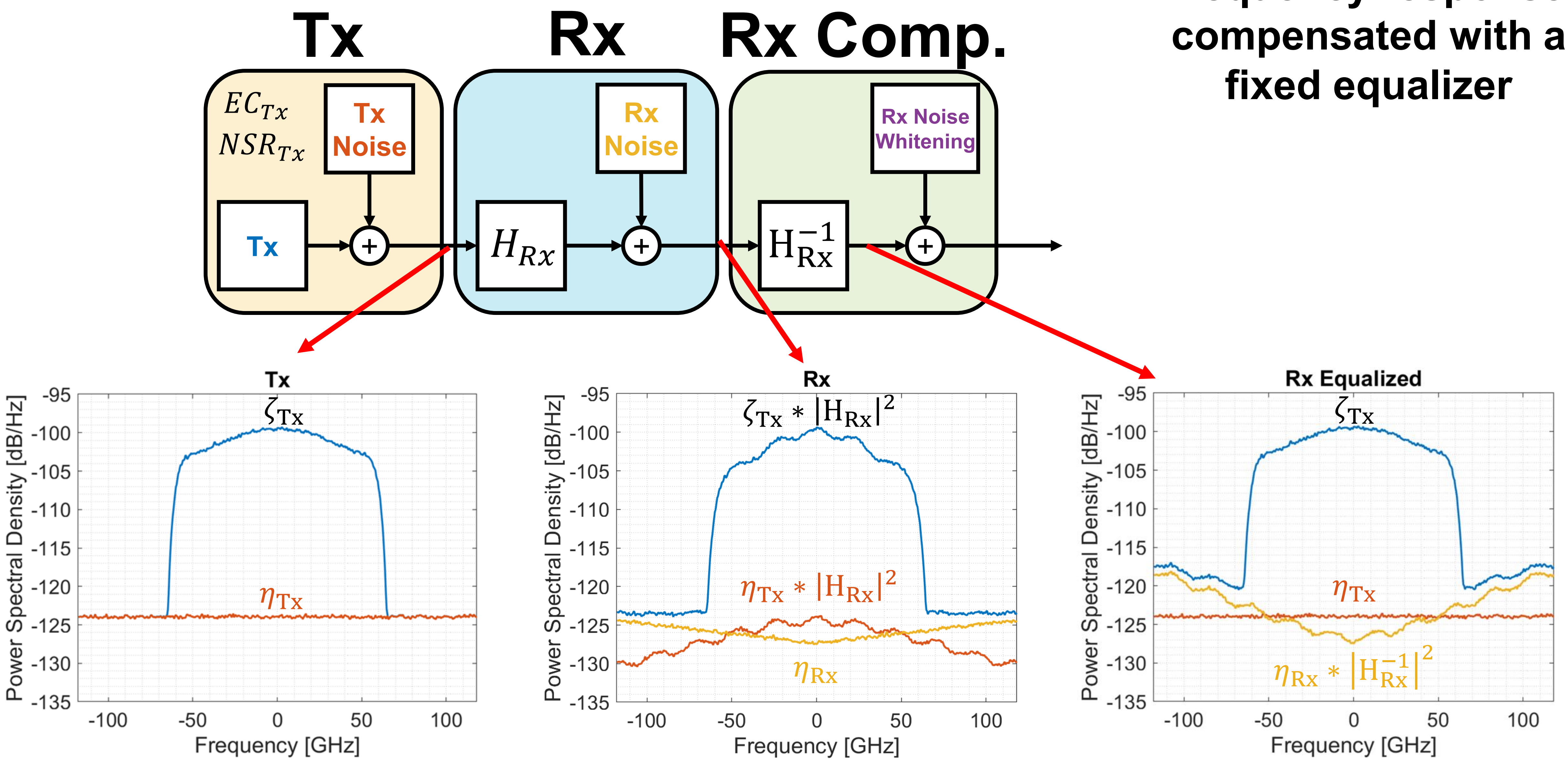
A) Receiver Response Equalization

Rx analog front end frequency response compensated with a fixed equalizer



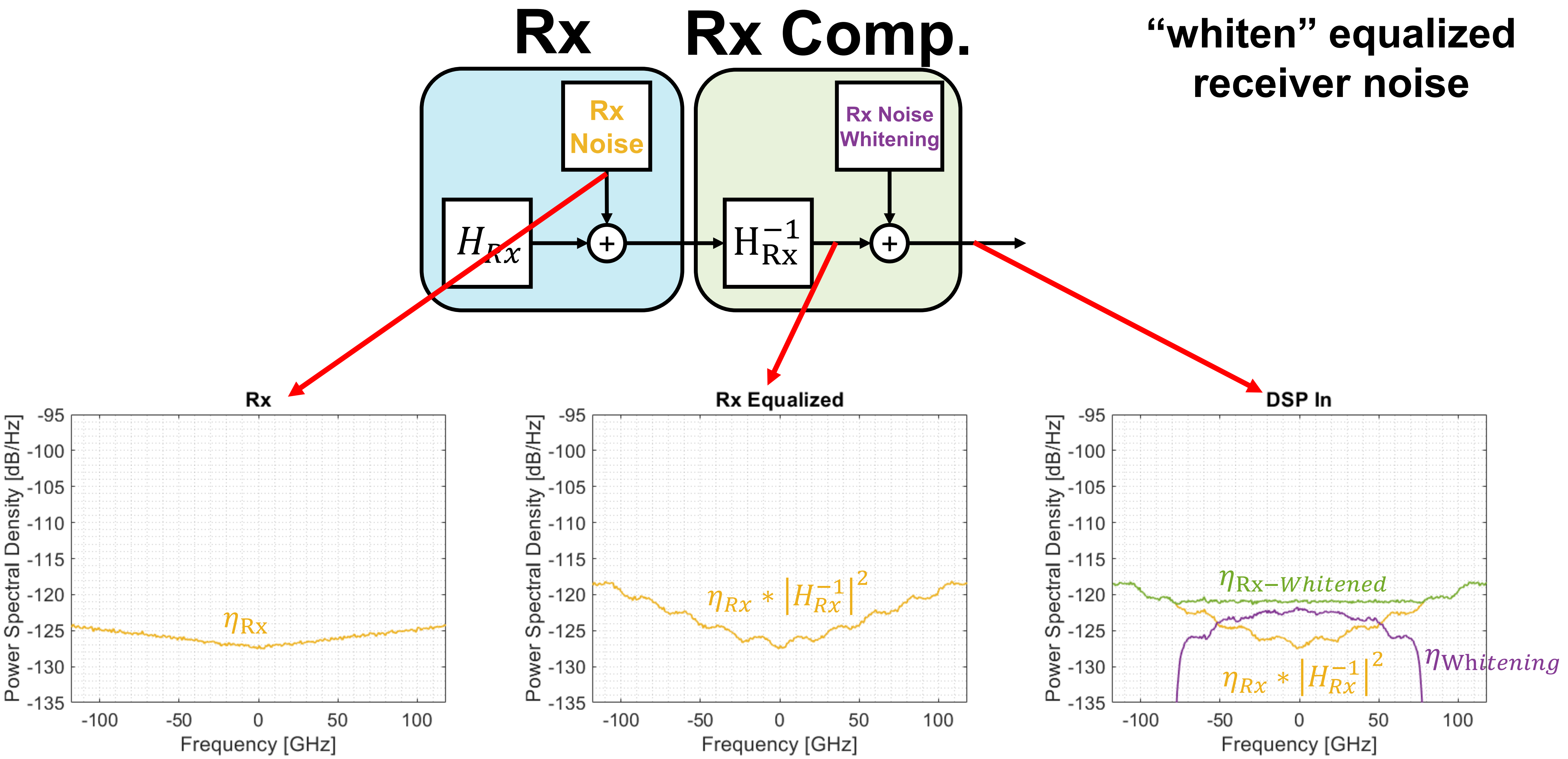
A) Receiver Response Equalization

Rx analog front end frequency response compensated with a fixed equalizer



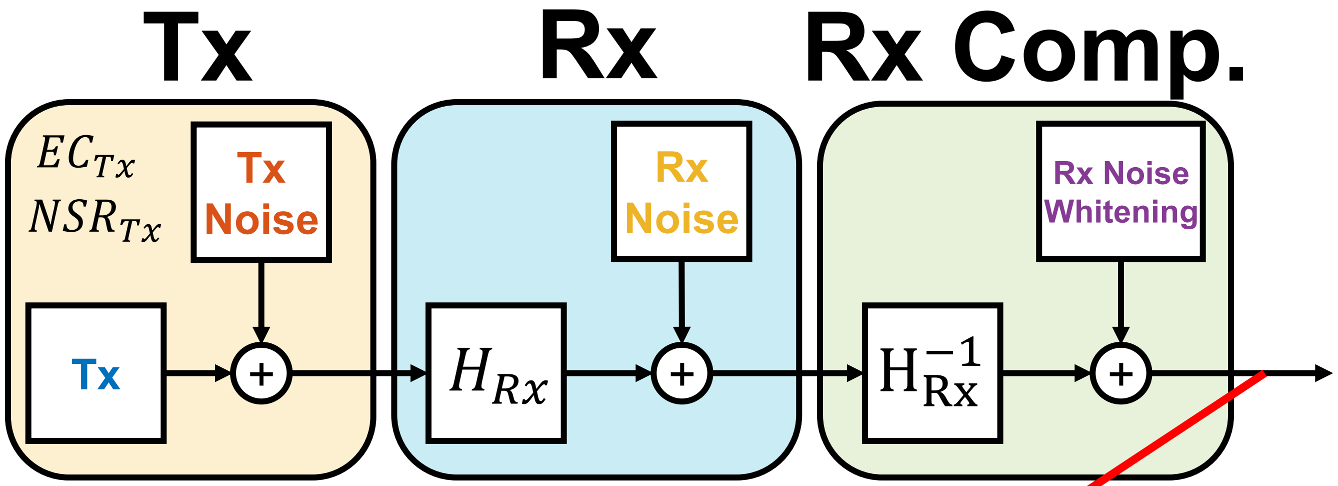
B) Receiver Noise Whitening

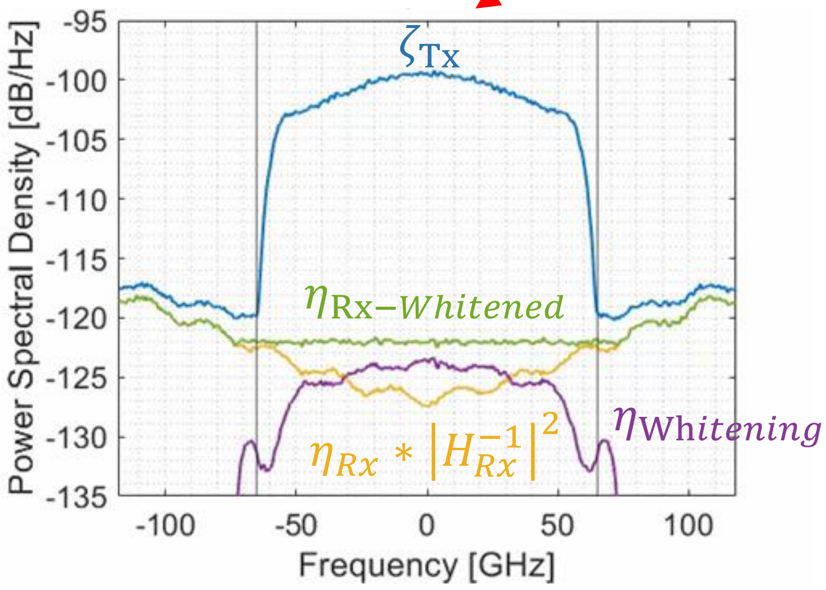
Spectrally-shaped noise added to “whiten” equalized receiver noise



B) Receiver Noise Whitening

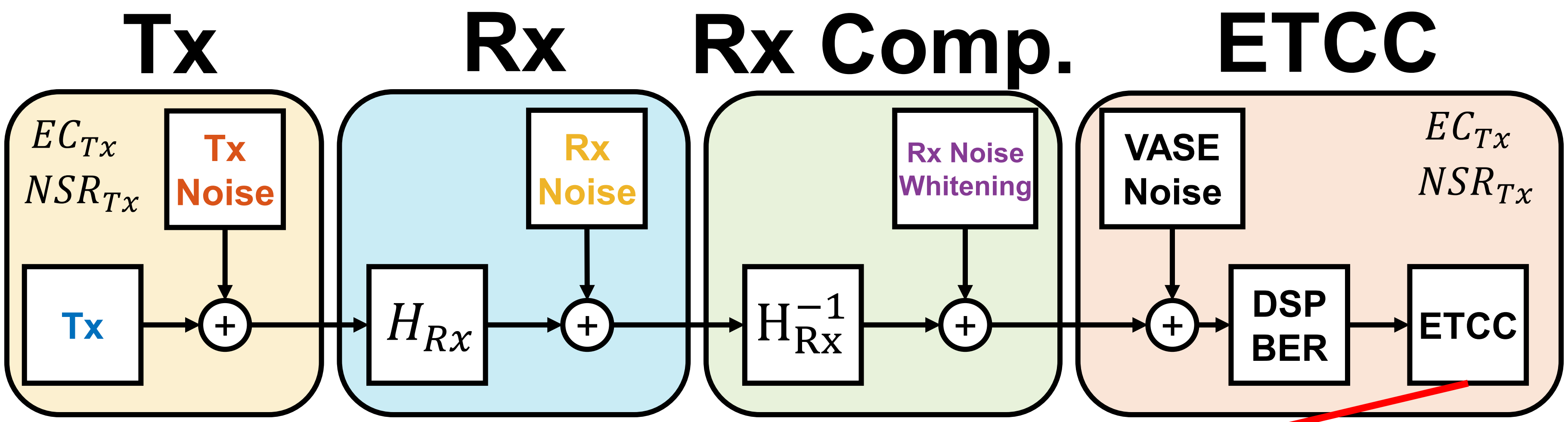
Spectrally-shaped noise added to "whiten" equalized receiver noise





$$\left.\begin{array}{l}\eta_{\mathrm{Rx}} * \left|\mathrm{H}_{\mathrm{Rx}}^{-1}\right|^2 \\ + \eta_{\mathrm{Whitening}}\end{array}\right\} \eta_{\mathrm{Rx}-Whitened} \sim \mathrm{AWGN}$$

ETCC with Rx Compensation

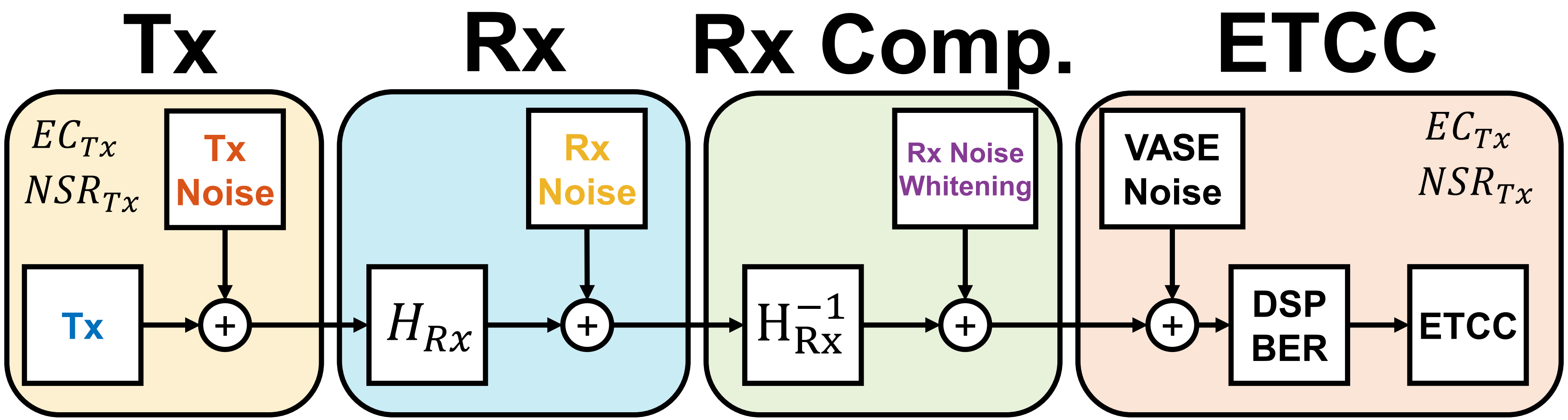


NSR calculation accounts for whitened receiver noise power

$$NSR_{ETCC,i} = \frac{N_{VASE,i} + N_{Rx-Whitened}}{S}$$

Receiver is inherently deembedded in ETCC calculation!

ETCC Simulation with Rx Compensation



	Tx 1		
	EC [dB]	SNR [dB]	ΔRSNRTx [dB]
DUT Tx → Ideal Rx	0.5	23.03	0.98
DUT Tx → DUT Rx	0.52	23.01	1

ETCC Simulation with Rx Compensation (Different Tx/Rx)

Tx1/Rx1

	Tx 1		
	EC [dB]	SNR [dB]	ΔRSNRTx [dB]
DUT Tx1 → Ideal Rx	0.5	23.03	0.98
DUT Tx1 → DUT Rx1	0.52	23.01	1

Tx1/Rx2

	Tx 1		
	EC [dB]	SNR [dB]	ΔRSNRTx [dB]
DUT Tx1 → Ideal Rx	0.5	23.03	0.98
DUT Tx1 → DUT Rx2	0.52	23.04	1

Tx2/Rx1

	Tx 2		
	EC [dB]	SNR [dB]	ΔRSNRTx [dB]
DUT Tx2 → Ideal Rx	0.86	22.96	1.39
DUT Tx2 → DUT Rx1	0.88	22.96	1.41

Tx2/Rx2

	Tx 2		
	EC [dB]	SNR [dB]	ΔRSNRTx [dB]
DUT Tx2 → Ideal Rx	0.86	22.96	1.39
DUT Tx2 → DUT Rx2	0.88	22.95	1.41

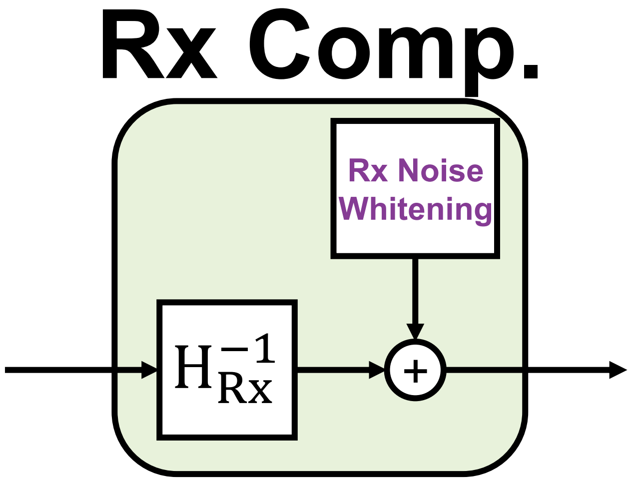
Experimental Demonstration

Keysight Dataset October 2025

- Anonymous vendor → Keysight N4391C OMA
- 800 ZR sampled @ 256 GS/s

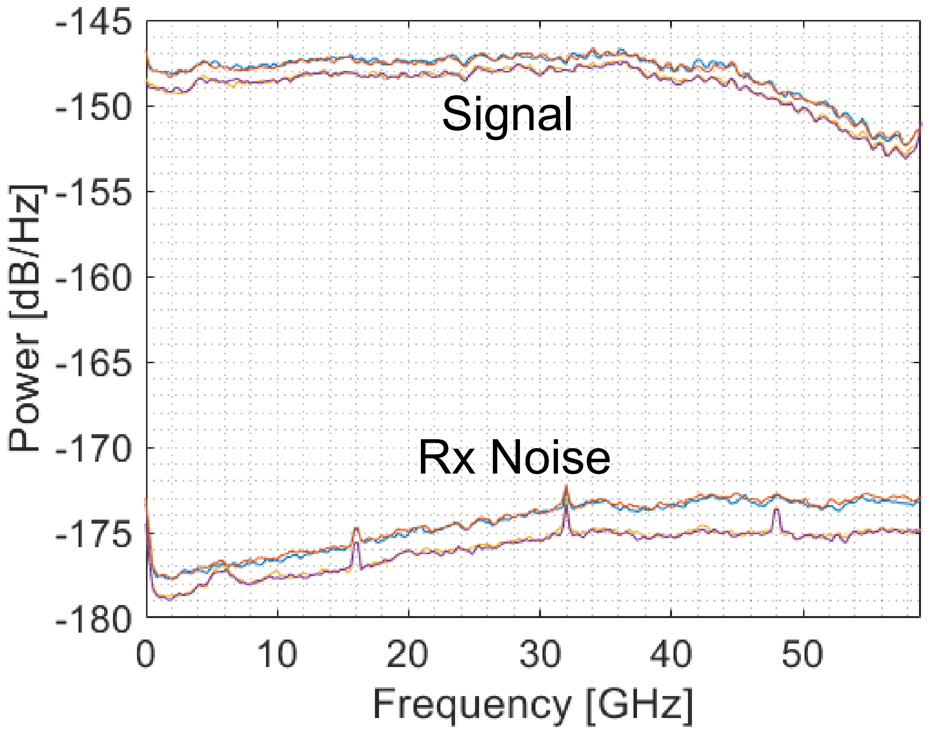
- Three oscilloscope voltage range settings: 80, 120 & 160 [mV]
- Signal power sweep: -10:2:0 (80 mV) | -10:2:2 (120/160 mV) [dBm]

- **N4391C OMA includes equalizer**
- **Noise whitening applied per previous slides**

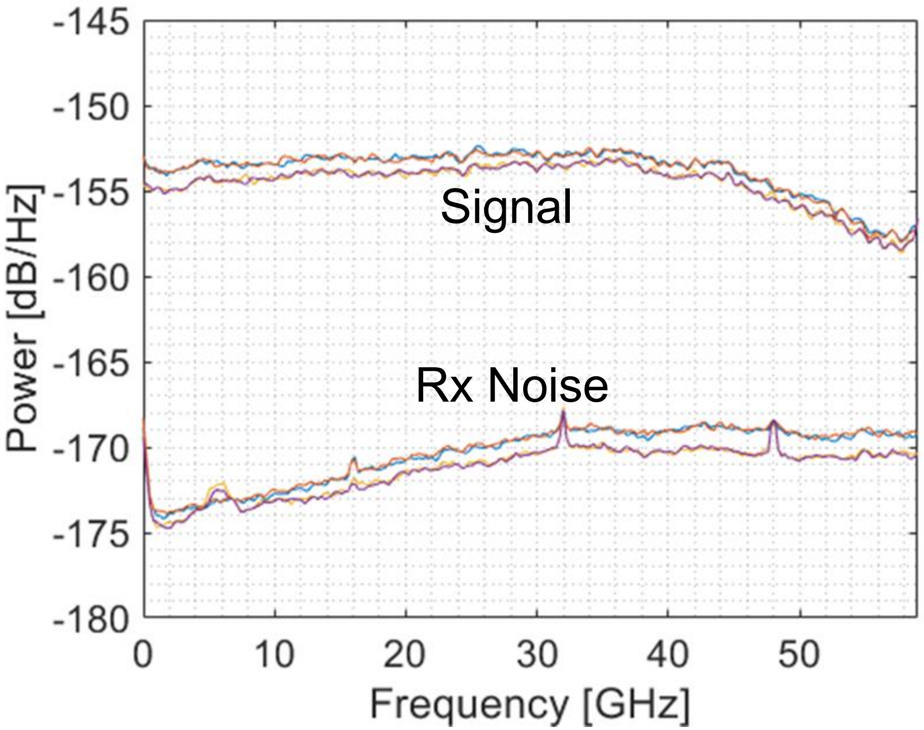


Signal and Rx Noise PSD before whitening

80 mV range
0 dBm signal power

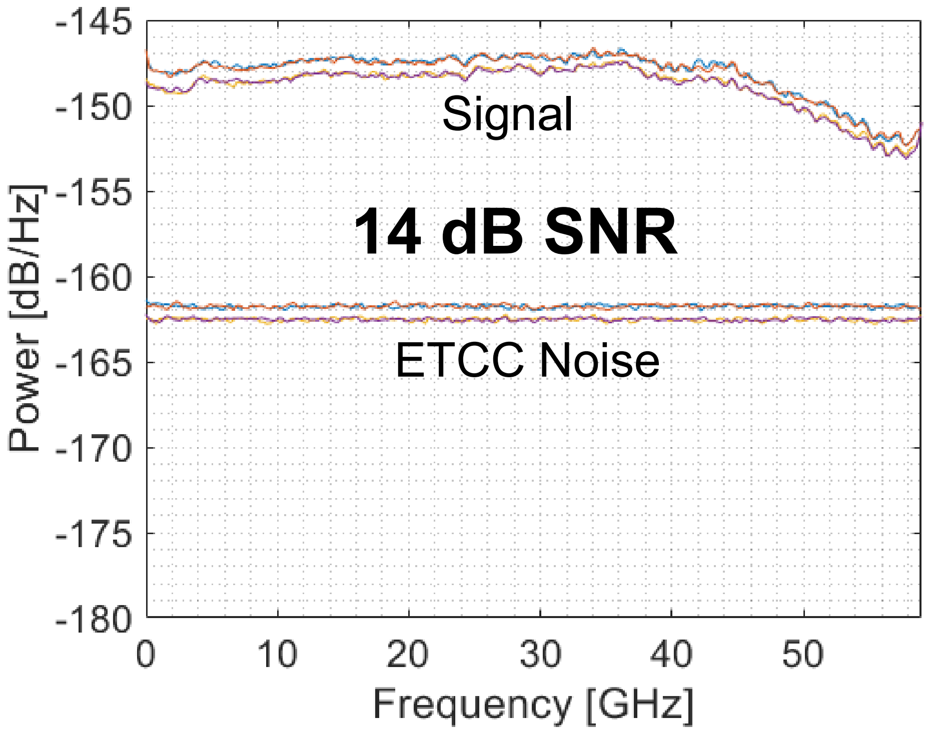


160 mV range
-6 dBm signal power

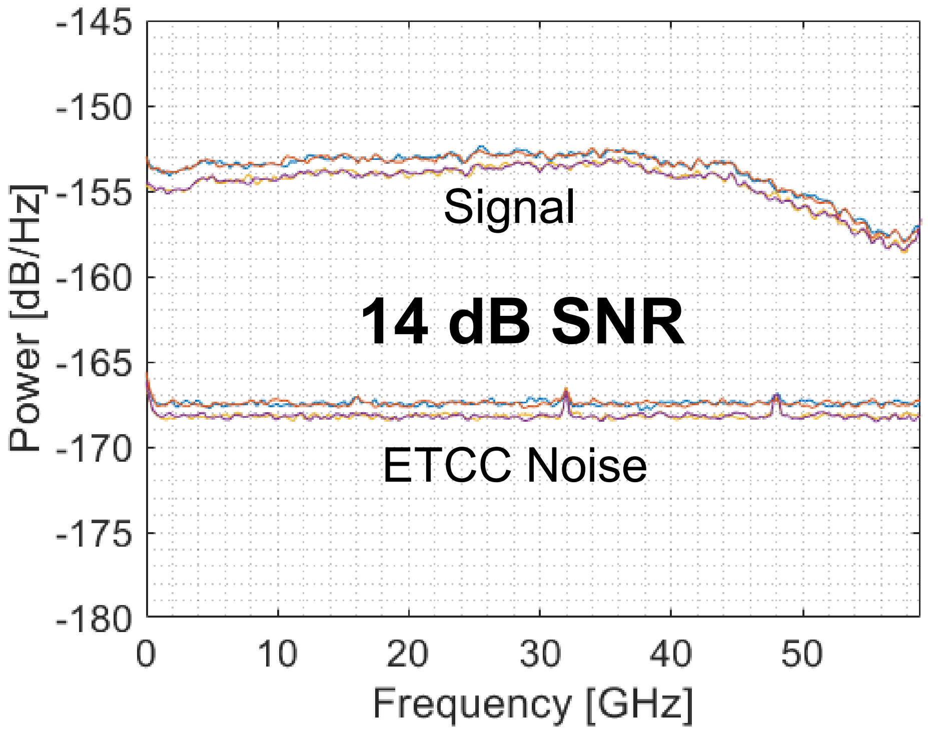


Signal and Rx Noise PSD after whitening

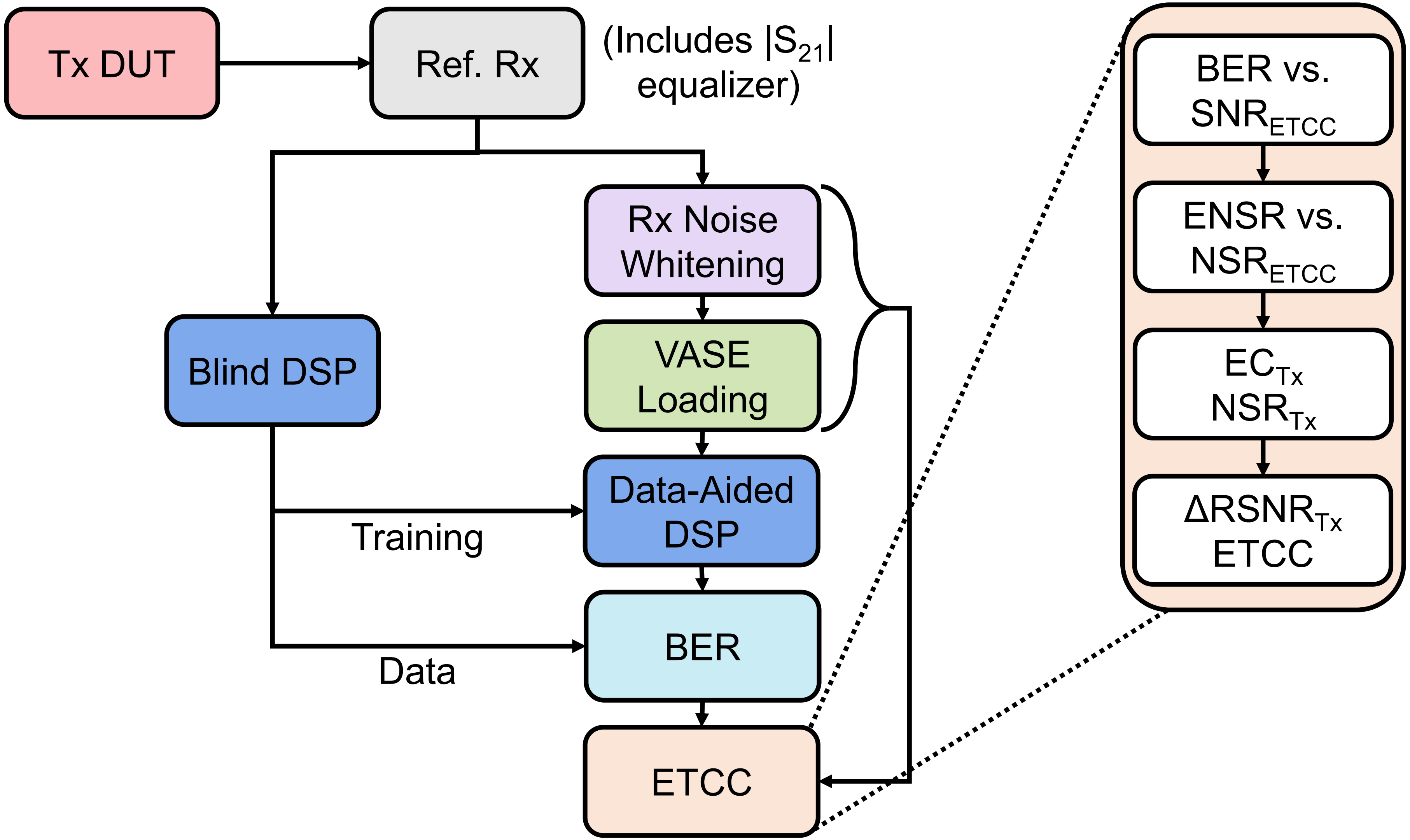
80 mV range
0 dBm signal power



160 mV range
-6 dBm signal power



New ETCC Methodology



Error counting

Estimation of ENSR from BER

Linear fit to ENSR vs. NSR_{ETCC} curve

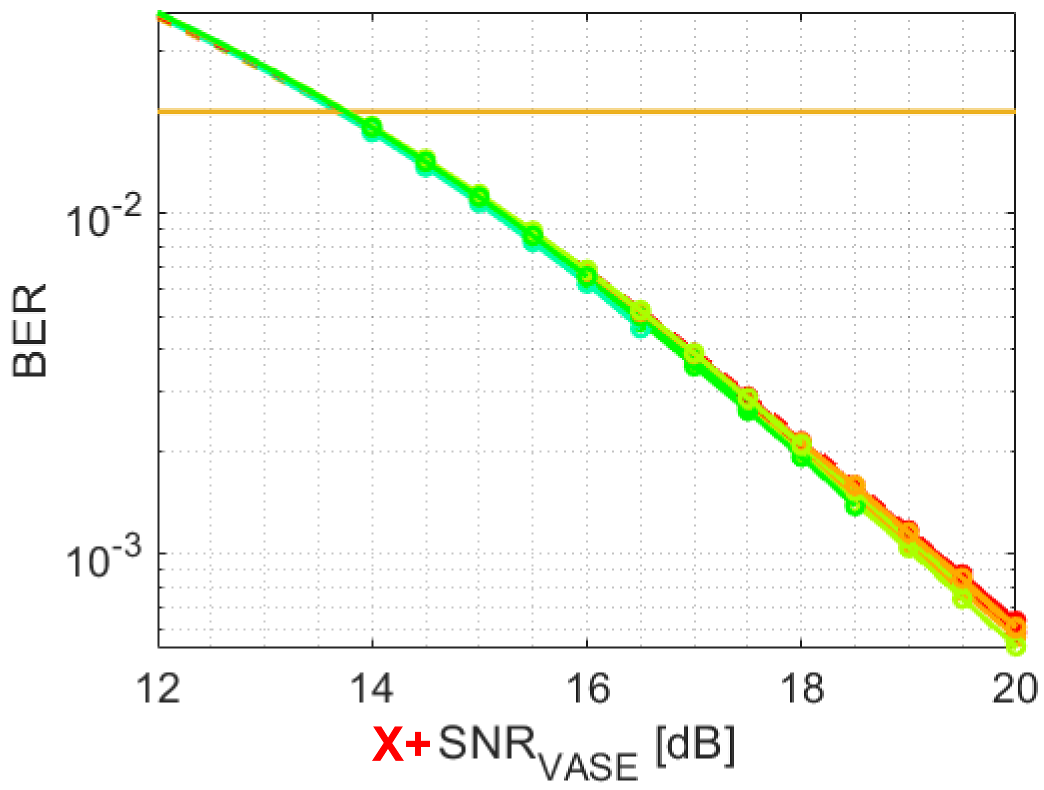
$$RSNR_{ase,tx} = ((EC_{tx} \cdot ESNR_{ref})^{-1} - NSR_{tx})^{-1}$$

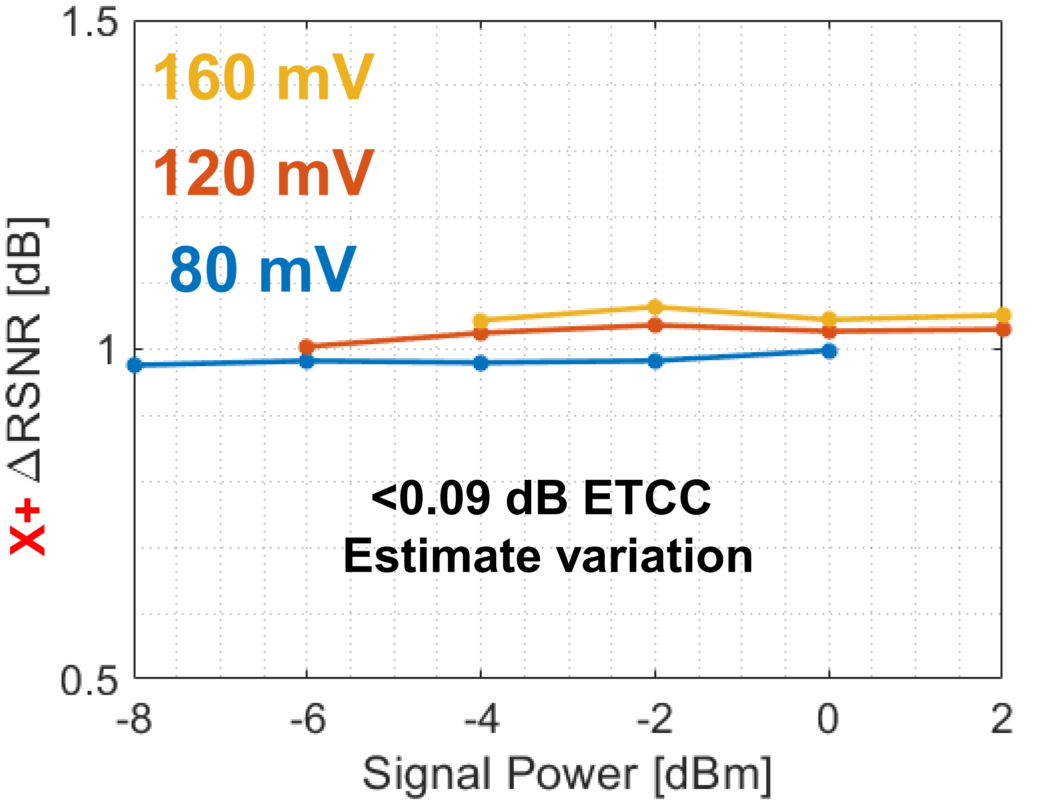
$$ETCC = \Delta RSNR_{tx} = 10\log 10\left(\frac{RSNR_{ase,tx}}{ESNR_{ref}}\right)$$

Experimental Results

Note: SNR values shifted to maintain vendor confidentiality

All signal powers and ranges overlaid





ETCC change proposal summary

- Include “Receiver Compensation”
  - A) Receiver Response Equalization: Fixed equalizer to compensate receiver frequency response
    - Requires Rx S_{21} (PD/TIA/ADC)
  - B) Receiver Noise Whitening: Addition of spectrally-shaped noise to whiten receiver noise
    - Requires Rx noise spectral shape
- Receiver is inherently deembedded (equalizers are burdened by Tx only, noise loading accounts for Rx noise)
- Estimated $\Delta RSNR$ is attributed to the transmitter (ETCC)

- Ancillary changes:
  - Remove EC_{Rx}, NSR_{Rx}, EC_{TRx}, NSR_{TRx}
  - Add compensated Rx requirements (frequency response maximum variation, noise power spectral density maximum variation, minimum signal-to-receiver-noise)

Editorial changes: Pg 943 - Calibrated front-end sampling

Current

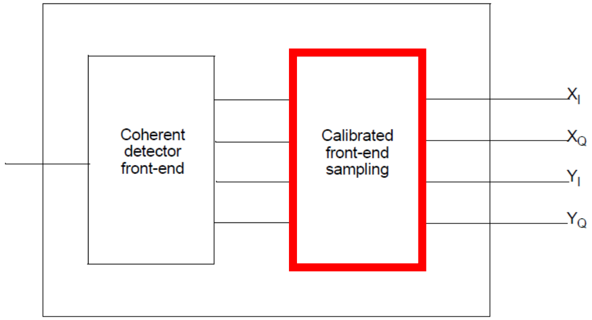


Figure 185A–2—Calibrated coherent detector front-end

185A.2.2.1.2 Calibrated front-end sampling

The coherent calibrated sampling performs analog-to-digital conversion of the four electric signals obtained by the coherent detector front-end and mitigates the imperfections of the front-end as listed in Table 185A–2. The values assigned to these parameters are defined by the Physical Layer specification that invokes the method.

Table 185A–2—Coherent front-end post calibration residuals

Description	Unit
X-Y gain error (max)	dB
Skew between X-Y polarizations (max)	ps
I-Q phase error for X (max)	degree
I-Q gain error for X (max)	dB
I-Q skew for X (max)	dB
I-Q phase error for Y (max)	degree
I-Q gain error for Y (max)	dB
I-Q skew for Y (max)	dB
Carrier frequency offset (max)	GHz

Proposed

185A.2.2.1.2 Calibrated front-end sampling

The calibrated front-end sampling function performs the analog-to-digital conversion of the four electrical signals obtained from the coherent detector front-end and compensates for the front-end imperfections listed in Table 185A–2.

The calibrated coherent detector front-end shall exhibit a flat frequency response, with magnitude and phase variations within the limits specified in Table 185A–2. Compliance with these limits may be achieved through the implementation of a digital equalizer applied prior to the ETCC noise-loading and calculation process.

The receiver noise impairing the digitized signal shall exhibit a flat power spectral density across the occupied signal bandwidth, with variations within the limits specified in Table 185A–2. If the intrinsic receiver noise does not meet this requirement, additive colored noise shall be synthesized and applied to the sampled waveform such that the aggregate receiver noise presented to the ETCC processing is effectively white. The calibrated receiver-noise power spectral density shall be known and shall be used in the ETCC computation as specified in 185A.2.5. The signal-to-receiver-noise ratio of the sampled waveform after noise whitening shall comply with the minimum value defined in Table 185A–2.

The parameters in Table 185A–2 and their associated limits are defined by the invoking Physical Layer specification, which assigns values consistent with the requirements of this method.

Table 185A–2—Coherent front-end post calibration residuals

Description	Unit
X-Y gain error (max)	dB
Skew between X-Y polarizations (max)	ps
I-Q phase error (max)	degree
I-Q skew (max)	ps
I-Q gain error (max)	dB
Carrier frequency offset (max)	GHz
Frequency response magnitude variation (max)	dB
Frequency response phase variation (max)	rad
White noise power spectral density variation (max)	dB
Signal-to-Receiver-Noise Ratio (min)	dB

Values defined in Clause 185, 187

Table 185–15 & Table 187-13 —Coherent front-end frequency response and noise post calibration residuals

Description	Value	Unit
Frequency response magnitude variation (max)	1	dB
Frequency response phase variation (max)	0.3	rad
White noise power spectral density variation (max)	0.1	dB
Signal-to-Receiver-Noise Ratio (min)	20	dB

Editorial changes: Pg 947 – Parameter definitions

Current

185A.2.5.1 Parameter definitions

The following parameters are used in the equations for ETCC derivation and ETCC calculation:

a	is the slope of the derived linear equation
b	is the y-intercept of the derived linear equation
~~EC_{rx}~~	~~is the eye-closure term representing signal loss due to receiver imperfections~~
EC_{tx}	is the eye-closure term representing signal loss due to transmitter imperfections
~~EC_{trx}~~	~~is the eye-closure term representing signal loss due to transmitter and receiver imperfections~~
$ENSR_{ref}$	is the theoretical noise-to-signal ratio at BER_{ref} for the modulation format being used
$ESNR$	is the signal-to-noise ratio for the modulation format used at the FEC input
$ESNR_{ref}$	is the theoretical signal-to-noise ratio at the BER_{ref} for the modulation format and FEC being used
N_{ase}	is the amplified spontaneous emission (ASE) noise power or the non-transmitter related noise power in the signal Nyquist bandwidth
~~N_{trx}~~	~~is the noise including contributions from the transmitter and receiver impairments and physical noise sources~~
$N_{vase,i}$	is the virtual ASE noise power of each increment
NSR_{ase}	is the ASE noise-to-signal ratio
~~NSR_{rx}~~	~~is the intrinsic front-end noise power~~
NSR_{tx}	is the transmitter noise-to-signal ratio including contributions from the transmitter imperfections and physical noise sources
~~NSR_{trx}~~	~~is the transmitter and receiver noise-to-signal ratio including contributions from impairments and physical noise sources~~
~~$RSNR_{ase}$~~	~~is the required SNR to meet a specific BER of a device in the presence of virtual ASE~~

Proposed

185A.2.5.1 Parameter definitions

The following parameters are used in the equations for ETCC derivation and ETCC calculation:

a	*Slope of the derived linear equation*
b	*Y-intercept of the derived linear equation*
BER_{ref}	*Reference bit-error-ratio for the modulation format and FEC under test*
EC_{tx}	*Eye-closure term representing signal loss due to transmitter imperfections*
$ENSR_{ref}$	*Theoretical noise-to-signal ratio corresponding to BER_{ref} for the modulation format and FEC under test*
$ESNR$	*Estimated signal-to-noise ratio for the modulation format under test, measured at the FEC input*
$ESNR_{ref}$	*Theoretical signal-to-noise ratio corresponding to BER_{ref} for the modulation format and FEC under test*
N_{ASE}	*Power (within the signal Nyquist bandwidth) of amplified spontaneous emission (ASE) noise*
$N_{VASE,i}$	*Power (within the signal Nyquist bandwidth) of the i-th increment of virtual ASE noise*
N_{rx}	*Power (within the signal Nyquist bandwidth) of the receiver white noise*
N_{tx}	*Transmitter noise power (within the signal Nyquist bandwidth)*
NSR_{ASE}	*ASE noise-to-signal ratio*
NSR_{VASE}	*Virtual ASE noise-to-signal ratio*
NSR_{tx}	*Transmitter noise-to-signal ratio, including contributions from transmitter imperfections and physical noise sources*
$RSNR_{ASE,tx}$	*Required signal-to-noise ratio to achieve a specified BER for the transmitter-under-test in the presence of ASE noise*
$\Delta RSNR_{tx}$	*Required signal-to-noise ratio penalty due to transmitter impairments (ETCC)*
S	*Signal power of the captured dual-polarization waveform*

Editorial changes: Pg 948 – ETCC derivation

Current

185A.2.5.2 ETCC derivation

ETCC calculation is based on BER and digital noise loading and the process is described in the following steps.

The estimated signal to noise ratio (ESNR) for a signal is related to its eye-closure and noise terms according to Equation (185A–1).

$$ESNR = \frac{EC_{trx}^{-1} S}{N_{ase} + N_{trx}} = \frac{EC_{trx}^{-1}}{NSR_{ase} + NSR_{trx}} \quad (185A–1)$$

The required signal to noise ratio (RSNR) in the presence of virtual ASE ($RSNR_{ase}$) is related to $ESNR_{ref}$ according to Equation (185A–2).

$$RSNR_{ase} = ((EC_{trx} \cdot ESNR_{ref})^{-1} - NSR_{trx})^{-1} \quad (185A–2)$$

For an ideal device where $NSR_{trx} = 0$ and $EC_{trx} = 1$, the theoretical RSNR is equal to the reference ESNR, $ESNR_{ref}$.

$\Delta RSNR_{trx}$ is related to the eye closure, $RSNR_{ase}$, and NSR_{trx} by Equation (185A–3) expressed in dB.

$$\Delta RSNR_{trx} = 10 \times \log 10\left(\frac{RSNR_{ase}(EC_{trx}, NSR_{trx})}{ESNR_{ref}}\right) \quad (185A–3)$$

$\Delta RSNR_{trx}$ includes contributions from both the transmitter and receiver. ETCC is defined by the transmitter contribution $\Delta RSNR_{tx}$. The contributions from only the transmitter are defined in Equation (185A–4) and Equation (185A–5) expressed in dB.

$$RSNR_{ase,tx} = ((EC_{tx} \cdot ESNR_{ref})^{-1} - NSR_{tx})^{-1} \quad (185A–4)$$

$$ETCC = \Delta RSNR_{tx} = 10 \log 10\left(\frac{RSNR_{ase,tx}}{ESNR_{ref}}\right) \quad (185A–5)$$

EC_{trx} and NSR_{trx} are measured using a noise loading procedure based on captured waveforms as described in Figure 185A–5.

A set of data relating $ESNR$ to NSR_{ase} is created and used to derive a linear fit with parameters a and b according to Equation (185A–6). From the derived linear fit parameters, $EC_{trx} = a$ and $NSR_{trx} = b / a$.

$$ENSR = EC_{trx}\, NSR_{ase} + EC_{trx}\, NSR_{trx} = a\, NSR_{ase} + b \quad (185A–6)$$

Proposed

185A.2.5.2 ETCC derivation

The estimated signal-to-noise ratio (ESNR) of a transmitter is related to its eye-closure (EC_{tx}), its intrinsic noise term (N_{tx}), and ASE noise term (N_{ASE}) according to Equation (185A-1).

$$ESNR = \frac{EC_{tx}^{-1} S}{N_{ASE} + N_{tx}} = \frac{EC_{tx}^{-1}}{NSR_{ASE} + NSR_{tx}} \quad (185A–1)$$

The required signal-to-noise ratio (RSNR) is related to the reference ESNR by Equation (185A-2):

$$RSNR_{ASE,tx} = \left(\left(EC_{tx} \cdot ESNR_{ref}\right)^{-1} - NSR_{tx}\right)^{-1} \quad (185A–2)$$

For an ideal transmitter with $NSR_{tx} = 0$ and $EC_{tx} = 1$, the theoretical value of $RSNR_{ASE,tx}$ is equal to $ESNR_{ref}$.

The ETCC parameter represents the penalty in RSNR attributed to the transmitter at given BER_{ref}. Denoted $\Delta RSNR_{tx}$, it is related to $RSNR_{ASE,tx}$ by Equation (185A-3), expressed in decibels.

$$ETCC = \Delta RSNR_{tx} = 10 \log_{10}\left(\frac{RSNR_{ASE,tx}}{ESNR_{ref}}\right) \quad (185A–3)$$

The parameters EC_{tx}, NSR_{tx} and the resulting $\Delta RSNR_{tx}$ shall be determined using the digital noise loading procedure applied to captured waveforms, as described in Figure 185A–5 and detailed in 185A.2.5.3.

Editorial changes: Pg 949 – ETCC calculation

Current

185A.2.5.3 ETCC calculation

ETCC is calculated using the following steps.

A reference receiver and a real-time sampling oscilloscope are used to acquire X_i, X_q, Y_i and Y_q digital waveforms as detailed in 185A.2.2.

The sampled waveforms are processed using the reference receiver DSP algorithm described in 185A.2.3 to estimate the BER with no added noise power, BER_0, of the preconditioned test waveform from a given transmitter under test.

Add incremental, controlled amounts of additive white Gaussian noise (AWGN) with virtual amplified spontaneous emission noise power of each increment, $N_{vase,i}$, to the transmitter under test waveform and repeat the processing to the estimate BER_i of each increment. Repeat the increments a minimum of 10 times with small enough noise increments such that BER_i is less than BER_{ref}.

For each BER_i calculate $NSR_{vase,i}$ and $ENSR_i$ using Equation (185A–7) and Equation (185A–8).

$$NSR_{vase,i} = \frac{N_{vase,i}}{S} \quad (185A–7)$$

A set of data relating $ENSR_i$ to $NSR_{vase,i}$ is created and used to derive a linear fit with parameters a and b according to Equation (185A–8).

$$ENSR_i = a \times NSR_{vase,i} + b \quad (185A–8)$$

As a result of the fit $EC_{trx} = a$ and $NSR_{trx} = b / EC_{trx}$.

Determine the intrinsic receiver noise power NSR_{rx} and EC_{rx} of the calibrated coherent detector front-end via a measurement or calibration process using a known transmitter.

Determine the NSR_{tx} using Equation (185A–9) and the EC_{tx} using Equation (185A–10).

$$NSR_{tx} = NSR_{trx} - NSR_{rx} \quad (185A–9)$$

$$EC_{tx} = \frac{EC_{trx}}{EC_{rx}} \quad (185A–10)$$

Calculate the $RSNR_{ase,tx}$ using Equation (185A–4).

Calculate ETCC using Equation (185A–5).

Proposed

185A.2.5.3 ETCC calculation

The ETCC calculation is based on digital noise loading and BER measurements, following the steps described below. The overall processing flow is illustrated in Figure 185A–5.

A reference receiver and a real-time sampling oscilloscope are used to acquire Xi, Xq, Yi and Yq digital waveforms as detailed in 185A.2.2.

The transmitted data patterns are determined by processing the raw digitized waveforms and are used to measure BER on the noise-loaded signals in the subsequent steps.

Controlled amounts of virtual ASE (additive complex white Gaussian noise) with power $N_{VASE,i}$ are incrementally added to the transmitter-under-test waveform, and the corresponding BER_i values are measured.

The procedure shall begin at zero added noise and proceed with small increments in noise power, acquiring a minimum of ten measurement points such that all measured BER_i values remain below the reference BER_{ref}.

$$\{N_{VASE,1} = 0, N_{VASE,2}, \dots, N_{VASE,10}\} \rightarrow \{BER_1, BER_2, \dots, BER_{10}\}$$

For each BER_i, the corresponding $ENSR_i$ is computed using the theoretical BER-ESNR relationship specific to the modulation format under test.

$$\{BER_1, BER_2, \dots, BER_{10}\} \rightarrow \{ENSR_1, ENSR_2, \dots, ENSR_{10}\}$$

For each noise increment $N_{VASE,i}$, the $NSR_{ETCC,i}$ is calculated using Equation (185A–4), incorporating the calibrated and whitened receiver noise power N_{rx}.

$$NSR_{ETCC,i} = \frac{N_{VASE,i} + N_{rx}}{S} \quad (185A–4)$$

$$\{N_{VASE,1}, N_{VASE,2}, \dots, N_{VASE,10}\} \rightarrow \{NSR_{ETCC,1}, NSR_{ETCC,2}, \dots, NSR_{ETCC,10}\}$$

A set of data relating $ENSR_i$ to $NSR_{ETCC,i}$ is then used to derive a linear fit with parameters a and b according to Equation (185A–5).

$$\{ENSR_1, ENSR_2, \dots, ENSR_{10}\} \leftrightarrow \{NSR_{ETCC,1}, NSR_{ETCC,2}, \dots, NSR_{ETCC,10}\}$$

$$ENSR_i = a \cdot NSR_{ETCC,i} + b \quad (185A–5)$$

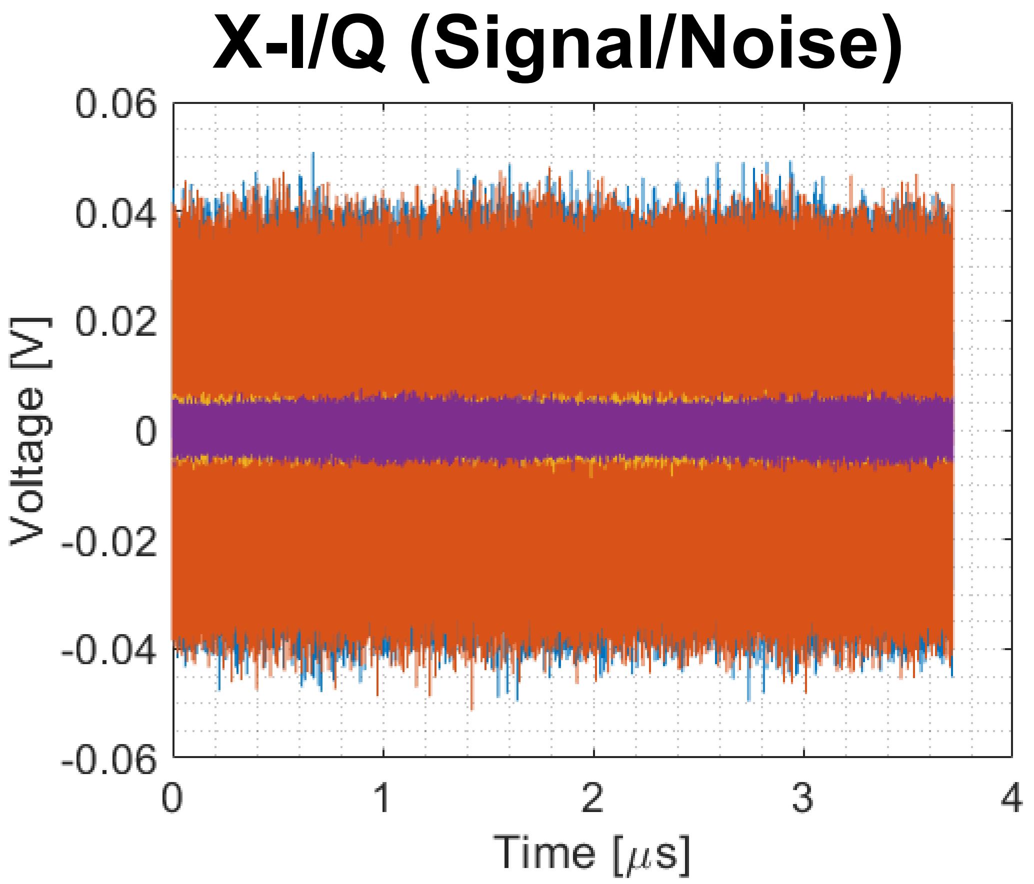
The transmitter parameters EC_{tx} and NSR_{tx} are obtained from the linear fit according to Equation (185A-6)

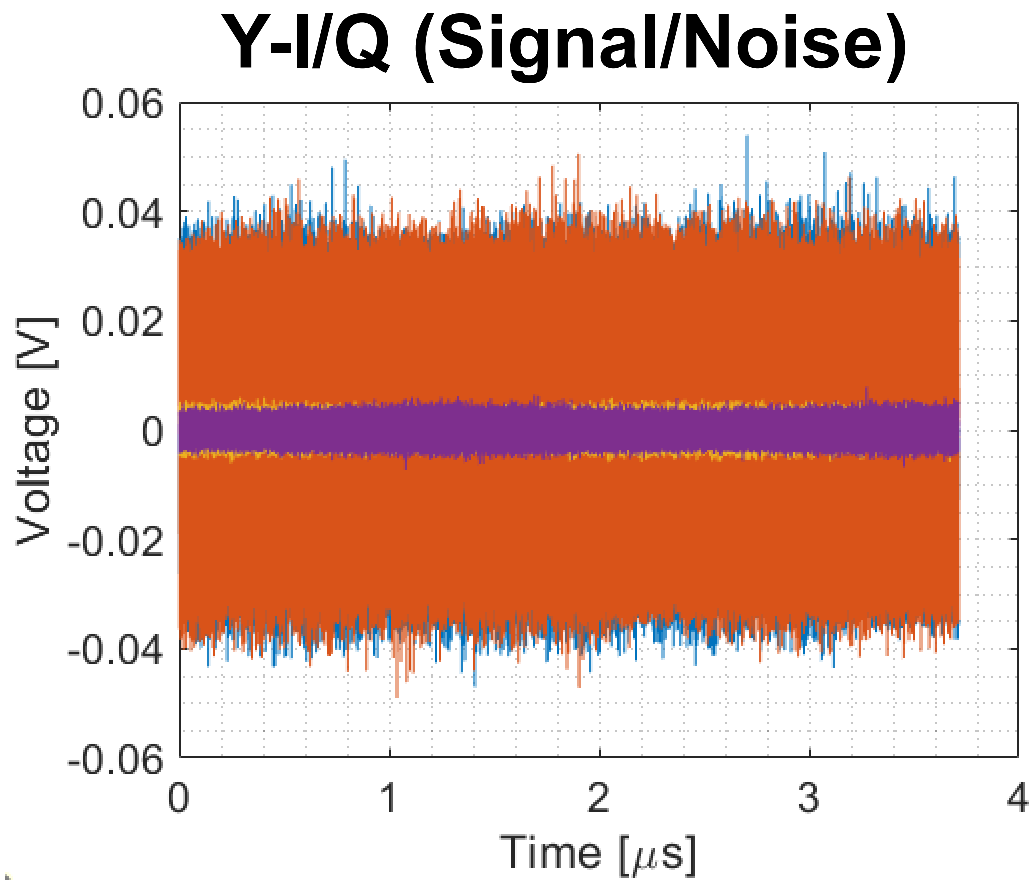
$$EC_{tx} = a, NSR_{tx} = b/a \quad (185A–6)$$

Finally, $RSNR_{ASE}$ is calculated using Equation (185A–2), and the ETCC is calculated using Equation (185A-3).

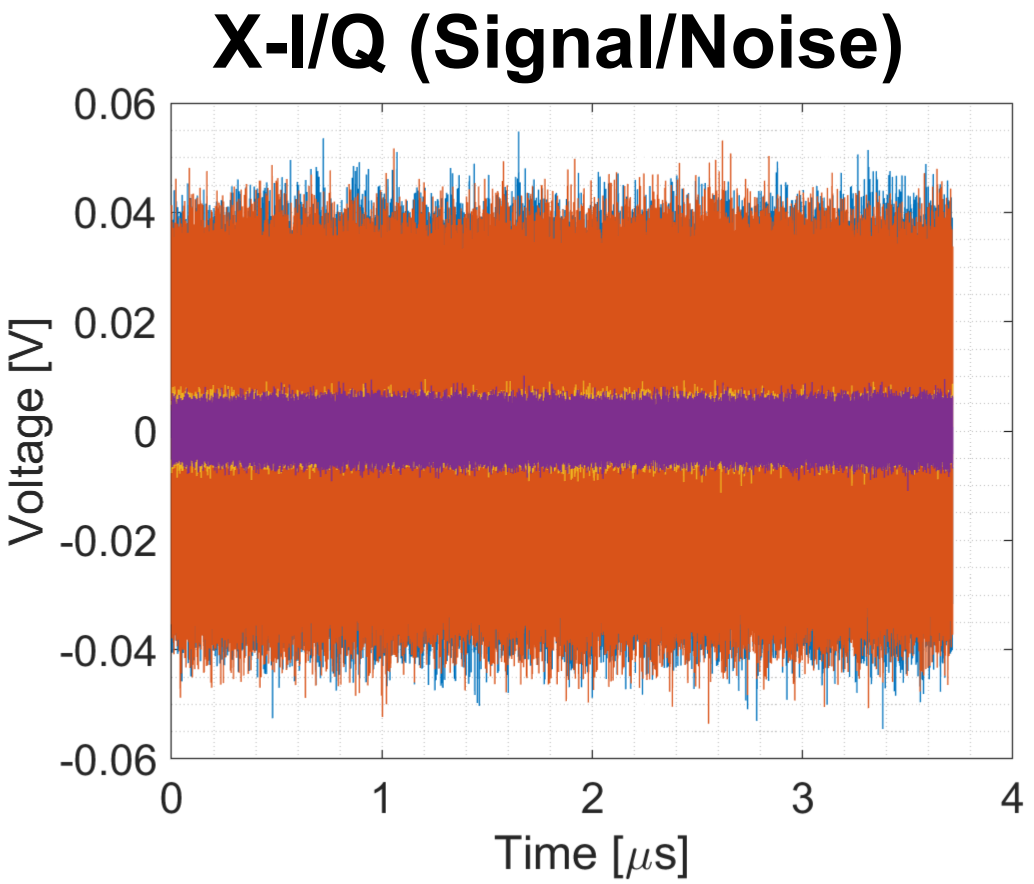
Backup

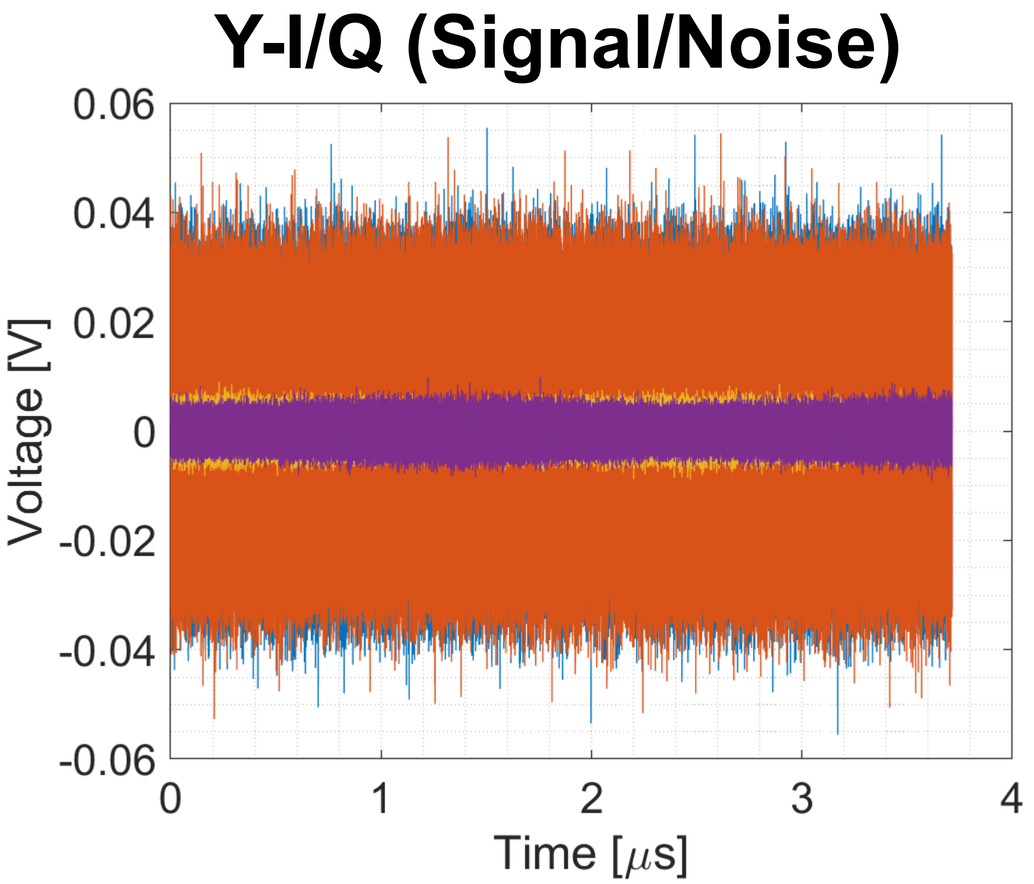
Scope Range Setting = 80 mV
Signal Power = 0 dBm



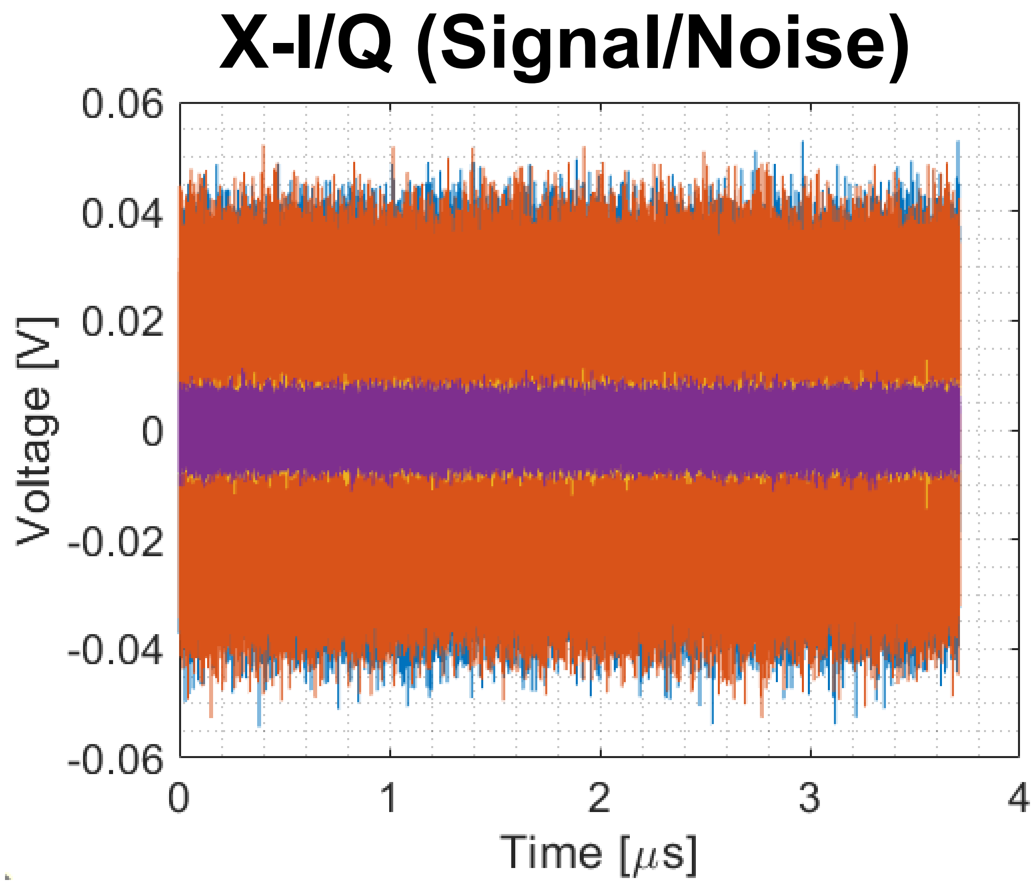


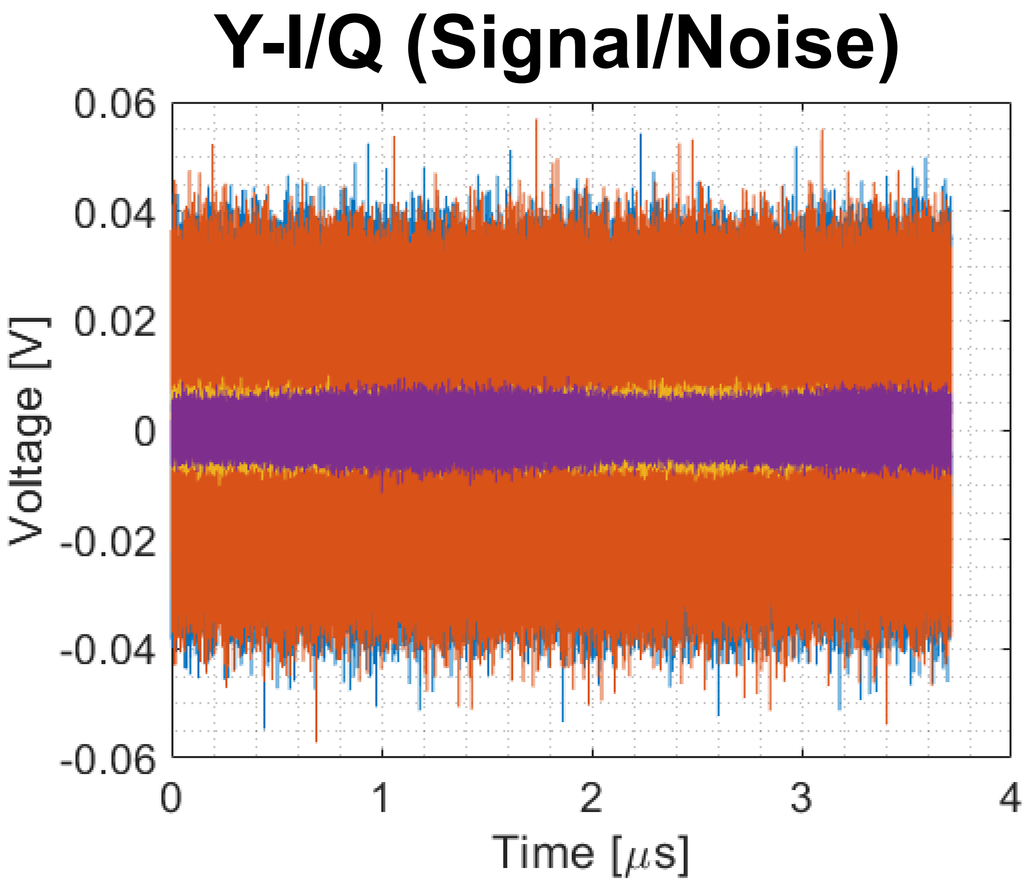
Scope Range Setting = 120 mV
Signal Power = 0 dBm





Scope Range Setting = 160 mV
Signal Power = 0 dBm





Noise Whitening