

400GBASE-ZR EVM Characterization

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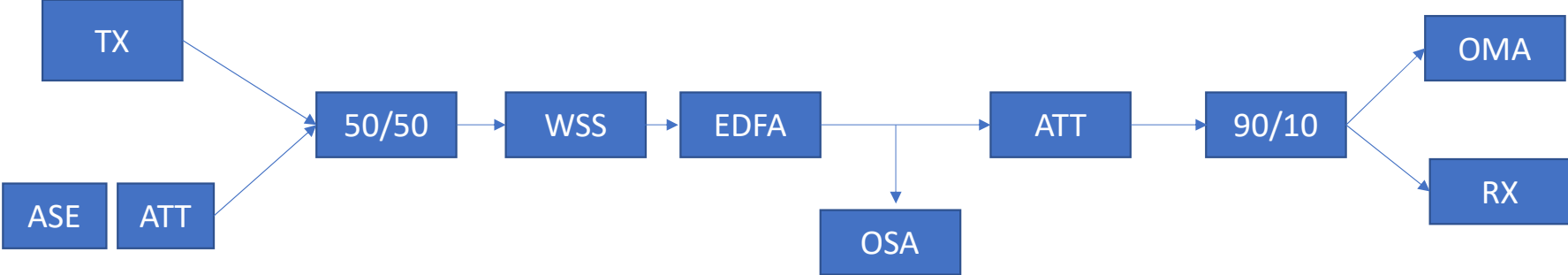
Mike Sluyski, Cisco

Mark Nowell, Cisco

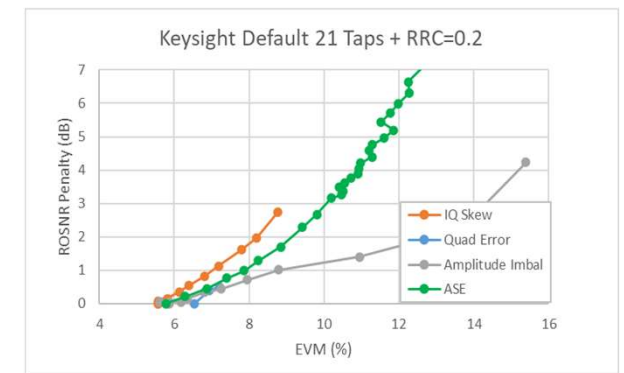
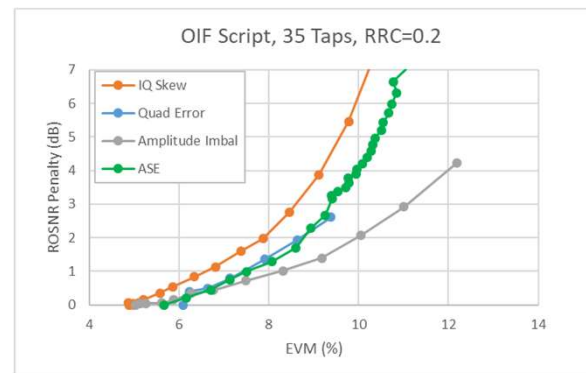
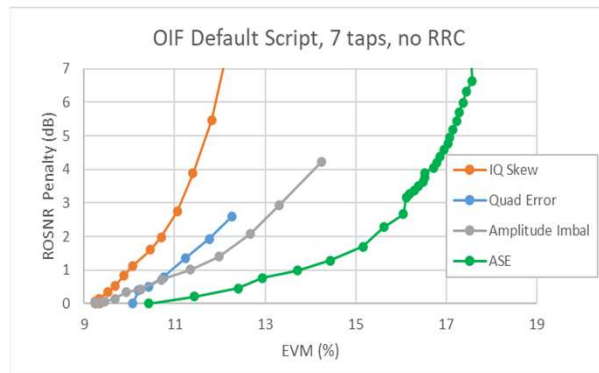
Overview

- Error Vector Magnitude (EVM) has been identified as a potential Transmitter Quality Metric (TQM)
 - Data validating the usefulness of EVM as a TQM has been requested
- EVM characterization performed using calibrated Keysight OMA
- Waveforms were captured and processed using Matlab script
- Impact on ROSNR was evaluated independently for each impairment
 - I/Q Skew
 - Quadrature Error
 - I/Q Imbalance
 - ASE
- Except as noted, Rx compensation circuitry was disabled for ROSNR correlation
- Consistent offset in absolute EVM values was observed relative to data presented previously by Eric Maniloff
 - Needs further investigation?

Test Setup

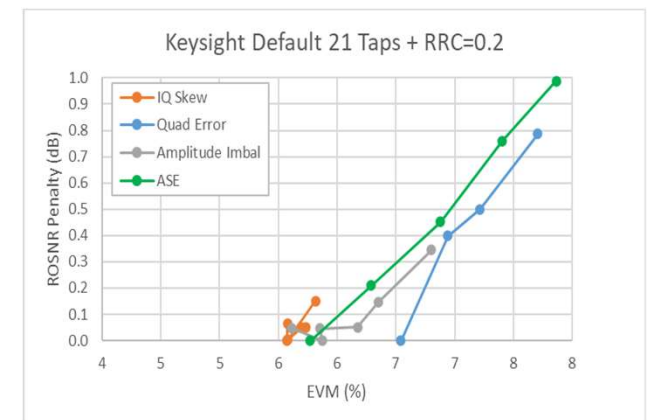
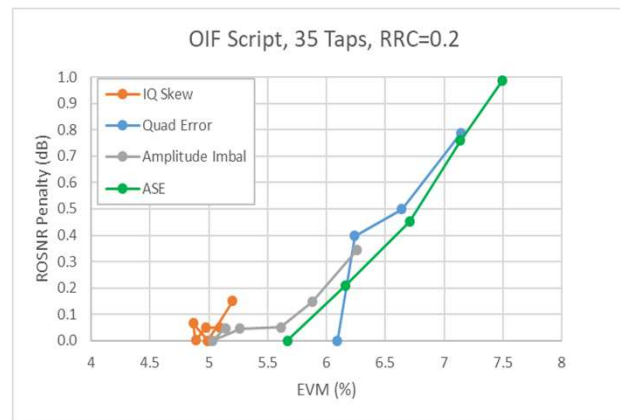
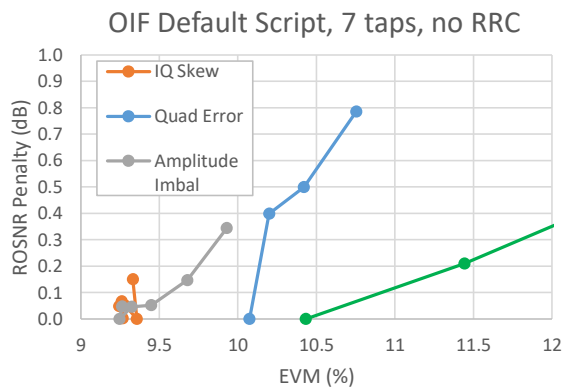


Dependency on Reference Receiver Settings



- Strong dependency on reference receiver configuration
- 7 taps, yields poor correlation between parameters, reduced penalty from ASE
- Correlation with 35 taps is much stronger
- IQ Skew penalty tends to exceed ASE, IQ-Imbalance less impact

Impairments When Limited to Specs adopted in D1.5



- Spec limit on I/Q Skew mitigates ROSNR penalty and EVM contribution.
- Quadrature Error and I/Q Imbalance show reasonable correlation with EVM
- Quadrature Error shows highest penalty based on spec limit, but can be compensated by DSP

Max Impairments
 I/Q Skew = 0.75ps
 I/Q Imbalance = 1.0dB
 Quadrature Error = 5°

Total Tx Impairment Penalty

Compare ROSNR penalty of nominal transmitter to all impairments set to max proposed specification

Max Impairments
I/Q Skew = 0.75ps
I/Q Imbalance = 1.0dB
Quadrature Error = 5°

Receiver Correction Circuit	ROSNR Penalty
Off	1.5dB
On	0.4dB

Parametric spec limits constrain max penalty 1.5dB with Rx correction circuit disabled, but practical penalty significantly lower when compensation Rx correction circuit is enabled

Summary

- EVM test results show strong dependence on reference receiver
- ROSNR impact of I/Q impairments do not correlate well with ASE
 - Supports inclusion of separate parameter specs adopted in Draft 1.5
 - When enabled, receive compensation affect on I/Q impairments varies by parameter
 - Limiting I/Q impairments constrains contribution to EVM to range undetectable from ASE
- More work needs to be done to make EVM useful pass/fail criteria
 - Potential to capture other impairments that may not be fully specified in a parameterized specification
- Currently defined TX parametric specs appear sufficient to progress specification
 - Evidenced by interoperability testing completed to date across multi-vendor implementations
 - EVM should proceed as offline exercise as an enhanced quality check

Potential Paths Forward

- Given the proposed parametric specifications sufficiently constrain transmitter impairment penalty, recommend moving EVM to informative
 - Continue TF review and investigations to understand observations presented here
- Based on fu_3cw_01_211115, propose an maximum EVM of 12% given demonstrated interoperability between modules from multiple vendors