
Proposed Details for TP2 and TP3 Tests

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Outline

- **TP2 Compliance Test**
 - **Background**
 - **Proposal**
 - **Follow-Up Work Needed – Define Owners and Working Groups?**
- **TP3 Compliance Test**
 - **Requirements**
 - **Normative Stressed Sensitivity Test**
 - **Normative Adaptation Speed Test**
 - **Simple Informative Sensitivity Test**
 - **Further Work Needed – Define Owners and Working Groups?**

Strategy / Philosophy / Process

- **Make Specific Proposals to Establish Spec Structure and Focus Further Work**
 - Many Details (numbers) Presented Here Should be Seen As ‘Placeholders’
Need for Further Refinement Is Noted.
- **Err on the Side of Test Simplicity**
 - Many More Rigorous Proposals Result in Tests Which are Impractical
 - Change Specs and Methods if Justified by Analysis **AND**
Accompanied by a New SPECIFIC Proposal.
- **Use –LR and Other Existing Test Specifications Where Applicable**
 - Existing Equipment
 - Familiar Methodologies, Familiar Form to 802.3ae Clause 52
- **Test Parameters to Flow From Channel Figure of Merit (IFR, PIE-L or D)**
 - Channel Analysis w/ Proposed Launch Will Justify Required Figure of Merit
 - E.g. With proposed TP2 Test and Accepted Fiber Model, Allocation of 3.5 dB PIE-D Penalty Will Guarantee 220m Operation on 99% of Fiber
 - Link Budget Will Imply ISI and Other Burdens on TP3 test
 - E.g. TP3 Test To Incorporate 3.5 dB PIE-D ISI Penalty as Well as Noise Penalties

Specific Proposal for TP2 – Eye Mask

- **For Eye Mask, Use 10GBASE-LR Eye Mask with same 7.5 GHz RX Receiver**
 - **Good Starting Point**
 - Routinely Achieved Now Because of –LR Developments.
 - Good Understanding of Power / Cost Tradeoffs in Laser, Drive and Packaging
 - **Test Equipment Available (~ 7.5 GHz Test Receivers Common)**
 - **Benefit of More Stringent Eye Mask Not Clear**
 - Certainly More Costly
 - Probably More Power
 - **Benefit of Looser Spec Less Clear**
 - Slower Risetimes Probably Improve Laser Yield and Cost, Probably Lower Power
 - Slower Risetimes Will Eat into EDC Penalty Budget.
Required EDC Penalty Not Yet Clear from Channel Modeling Group
 - Using a Reduced Eyemask to Allow Slower Rise/Fall May Allow Other Unwanted Impairments.
 - **Conclusion: Premature to Loosen Eye Mask, Stick with -LR Mask For Now**

Specific Proposal for TP2 – Conditioned Launch

- **Goals**

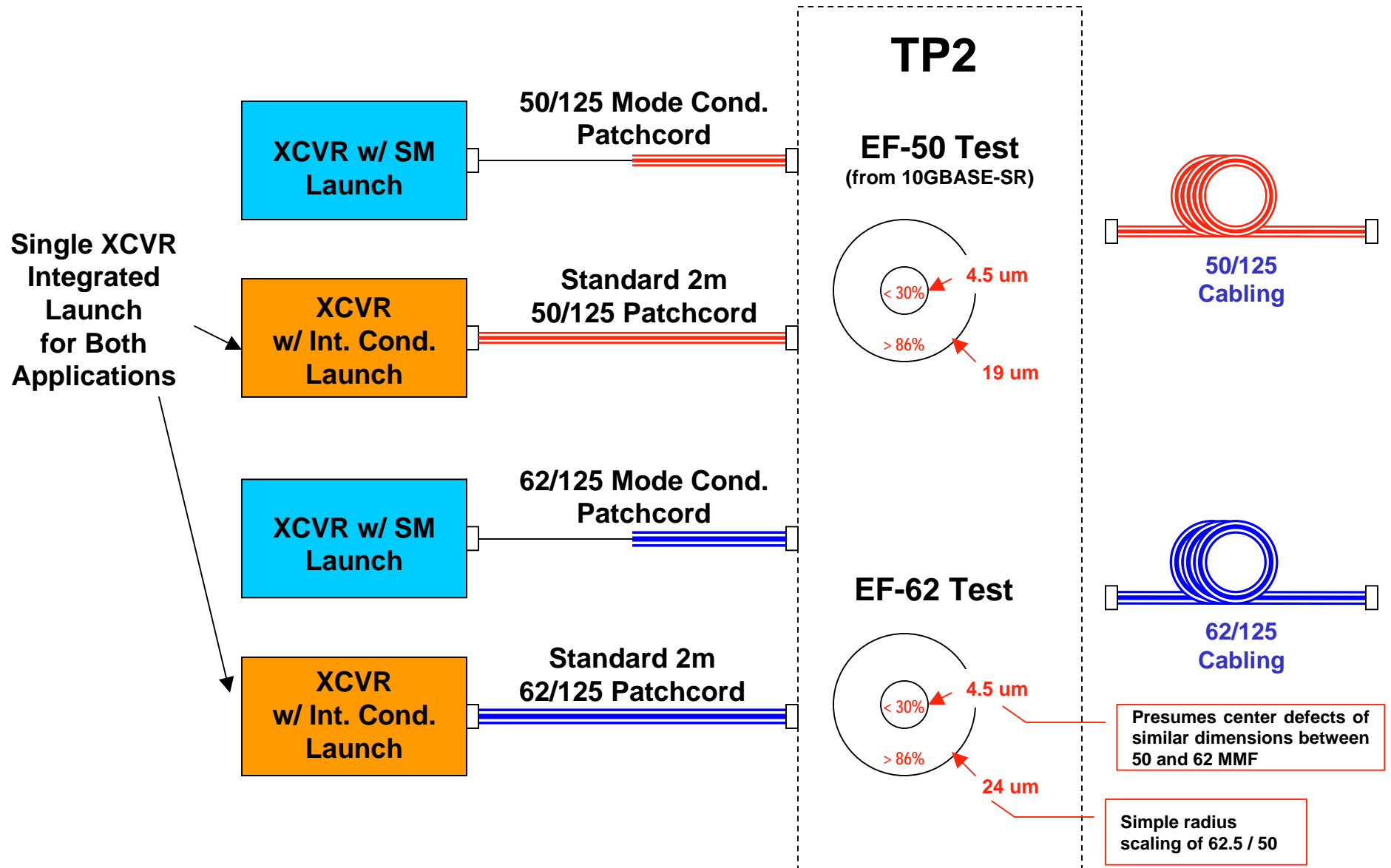
- Allow Use of Current OSL Patchcords For Each Fiber Type (50 , 62)
 - So Much Feasibility Data Based on This Launch
- Allow Use of Integrated Mode Conditioning Solutions
- Achieve Adequate Performance (by Agreed Figure of Merit) In Face of Connector Offsets and Agreed Fiber Model with Required Statistical Coverage.
- Do Not Allow Launches with Poor Figure of Merit

- **For Conditioned Launch, Use Encircled Flux Test**

- 10G-BASE-SR Defined Single Encircled Flux Test for Both Fiber Types
 - Primary Goal Was Similar: Achieving Adequate Eff. Modal Bandwidth (3dB) for 50/125
- Define Different Encircled Flux Tests for 50MMF and 62 MMF launch.
 - Precedent is 50 and 62MMF CPR Tests in 1000-SX and –LX.
 - Probably Needed to Allow Both Existing Offset Single Mode Launch Patchcords
 - Single Integrated Launch to Meet Each Test with 50 or 62 MMF Patchcord to TP2
- As Starting Point, Use 10G-BASE-SR for 50MMF Test and Scale for 62 MMF:

- EFT – 50 MMF: > 86% power in 19 um Radius, < 30% power in 4.5 um Radius
- EFT – 62 MMF: > 86 % power in 24 um Radius, < 30% power in 4.5 um Radius
 - For 62 MMF, Outer Rad. Scaled as 62.5/50, Inner Radius Assumes Same Dip Dimensions For Both Fiber Types

TP2 Cases



Follow-Up Work on TP2

- **Eye Mask / related**
 - **May Require Results From Channel Model Group to Tradeoff with Increased Penalty.**
 - **Should Propose Specific Alternative Which Addresses Measurement Issues of Relaxed Eye.**
 - Potential Savings May Not Justify Much Harder Compliance Test.
 - **Questions Raised on Need for Equivalent to TDP in 10GBASE-LR (I.e. TX penalties which eye mask do not capture)**
 - Probably Increasingly Significant with Looser Eye Masks
- **Conditioned Launch Test – Certainly Deeply Related to Channel Model Group’s Work**
 - **Decide on Single Test For Both Fiber Types**
 - Suggestion that New Compromise OSL Patchcord Allows Single Test (Compromise on Performance)
 - Certainly Desirable For Single Integrated Launch
 - **If 50 and 62/125 Test is Retained:**
 - Verify that 50/125 Offset Launch Patchcord Output Complies with EF-50 Parameters
 - Verify that 62.5/125 Offset Launch Patchcord Output Complies with EF-62 Parameters
 - For Integrated Launch of Interest (say Vortex Launch), Verify Compliance with Each Test Using Associated Patchcord.
 - **In Either Case, Decide If These Are Good Specific Encircled Flux Test Parameters**
 - Is Assumption of Center Defect Size OK (would be easier on single integrated launch) ?
 - Is There a Better Choice That Allows OSL Patchcord Launch, but Results in a Better Performance Metric ? (as tested against a Fiber Model)
 - **Hardest Question: Does This Test Allow Low Metric and/or Low 3 dB Bandwidth Launches?**

TP3 Test Requirements – Stressed RX Sens. (Normative)

- **Key Requirement:**
 - Normative Stressed RX Test to Confirm Performance at Min. Rec. OMA
- **Stressed Receiver Test Challenges to be Reconciled:**
 - Including All Important Interacting Impairments
 - ISI representative of Worst Case Fiber Induced DMD (How Many Cases?)
 - Noise (as it impacts EDC Performance)
 - Sinusoidal Jitter (as it applies to Overall Transceiver as in -LR Stressed Test)
 - Dynamically Changing ISI as it Impacts the EDC Performance
 - Implicit Requirement of Low Mode Dependent Loss in Receiver
 - The Need to Have a Practical Test Which Generates Reproducible Results
 - Ability to Reasonably Build Tester without Major R+D Effort
 - Ability for Two Groups to Generate Same Test
(don't allow too many tradeoff choices)
 - Ability to Perform Test in Reasonable Time

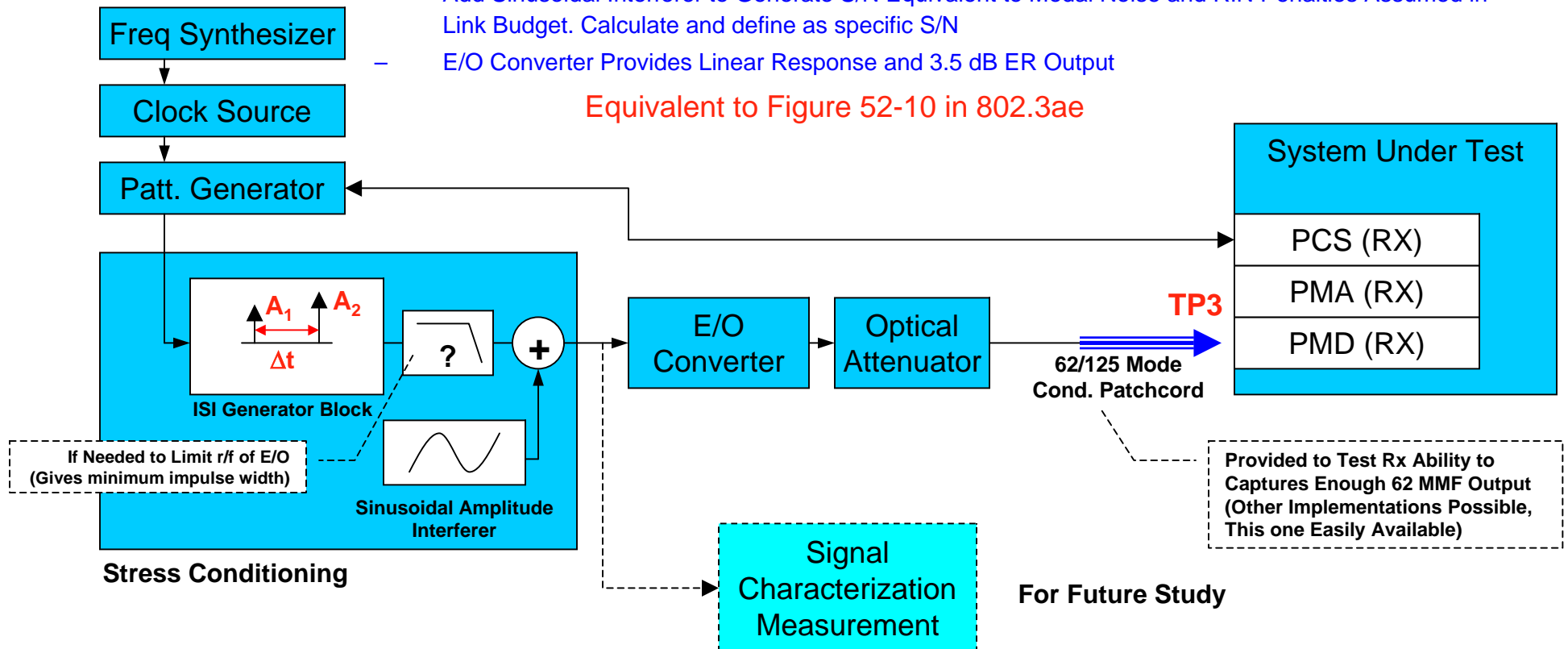
Specific Proposal for Norm. Sensitivity Tests

- **Wherever Possible, Make Specification Look Like 802.3ae**
- Start With Single, Simple ISI Block of Agreed on Performance Metric
 - Different or Multiple ISI Tests Should be Justified
 - Should be Shown As More Challenging at the Same ISI Level.
- Reuse As Much of the –LR Stressed Receiver Test Hardware as Possible
 - Sinusoidal Jitter Generation
 - Sinusoidal Interferer for Noise Addition
 - S/N of Compliance Signal Corresponding to Allocated Modal Noise and RIN Penalties
 - Linear E/O Converter with 3.5 dB ER
- Propose we NOT include Dynamics (too complex) in Normative Sensitivity Test
 - Define Stressed Test Without Dynamics
 - Test EDC Adaptation Rate Capability in Separate Test
 - Allocate a Dynamic Adaptation Penalty (Part of EDC Implementation Penalty)
Build into Link Budget and Required Static Stressed Test Sensitivity
 - **Main Question:** Is Combined Penalty of Dynamic and Static Effects Larger Than Linear Combination of Separate Measurements.

TP3- Normative (Static) Stressed Sensitivity Test

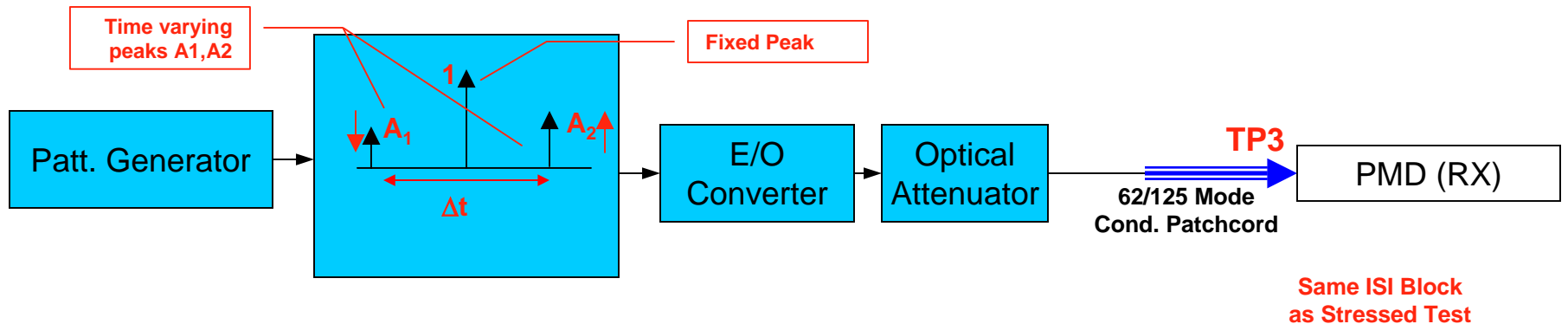
- **Goals:**
 - Simplest Test Which Adequately Stresses EDC – **Start Really Simple!**
 - Reuse as Much 10GBASE-LR Stressed RX Test Hardware As Practical
 - Avoid User Tradeoff Choices Allowed in –LR Stressed Test
- **Proposed Parameters (to be included in 10GBASE-LRM receive characteristics table)**
 - 2 Peak Impulse Response.
 - $A_2/A_1 \sim 1.5$ (?)
 - Δt Chosen to Yield Target Figure or Merit (Based on Allocated EDC Link Penalty) and Representative of DMD span of channel model
 - Choose One Sinusoidal Jitter Frequency and Amplitude from the 10GBASE-LR Mask
 - Add Sinusoidal Interferer to Generate S/N Equivalent to Modal Noise and RIN Penalties Assumed in Link Budget. Calculate and define as specific S/N
 - E/O Converter Provides Linear Response and 3.5 dB ER Output

Equivalent to Figure 52-10 in 802.3ae



TP3- Adaptation Speed Test

- **Goals:**
 - **Simplest Test to Establish Adequate EDC Adaptation Speed**
 - Decouple from Stressed RX Test, Do not Include SJ and Amplitude Noise
 - Likely Used Only in IC Development and XCVR Design Verification, But Still Normative
 - **Choose Minimum OMA and Test for $< 1e-12$ BER Over Minimum ISI Cycle**
- **Is an Initialization Time Spec / Test Needed or is it Implicit in Form Factor MSAs**
 - **Probably needed but outside scope of IEEE specification**



- **Shift Power Sinusoidally and Completely Between A_1 and A_2 But Retain A Larger Fixed Peak**
Specify Adaptation Rate in Receive Characteristics Table
 - **Rate of Oscillation Cycle Between A_1 and A_2**
 - **Chosen using Measurement Experiments on Time Variation of Perturbed Fiber Link**
- **Measure Penalty for Dynamic (At Specified Test Rate) vs Static ISI**
(static case probably being the worst specific ISI case in the dynamic cycle ?)
- **Parameters included in 10GBASE-LRM Receive Characteristics Table.**

TP3 – Need for Simple Informative Sensitivity Test

- We Need an Equivalent of the Informative Sensitivity Spec in -LR
 - Clean Eye, No Impairments-> Traditional Receiver Sensitivity Test
 - Important as Day-to-Day Test for Manufacturing, Incoming Inspection etc.
 - Great Value in Having Agreed on Definition for –LRM
- Traditional Test (no ISI Penalty) may be Poor Choice
 - Just Tests Linear TIA Sensitivity. Important, BUT...
 - Could Either Be Limited by EDC AGC Capability or Force Unnecessarily Wide Range of EDC AGC Performance
 - I.e. Not Meaningful to Require RX to Demonstrate EDC Penalty Assumed in Link Budget, and May Unnecessarily Increase Cost
- Propose Simplest Test with ONLY ISI impairment
 - Use Single, Simple ISI Block (hopefully same as Normative Stressed Test)
 - No Sinusoidal Jitter or Added Noise
 - See 802.3ae 52.9.9 for definition (other than ISI requirement)

TP3- Simple Informative Sensitivity Test

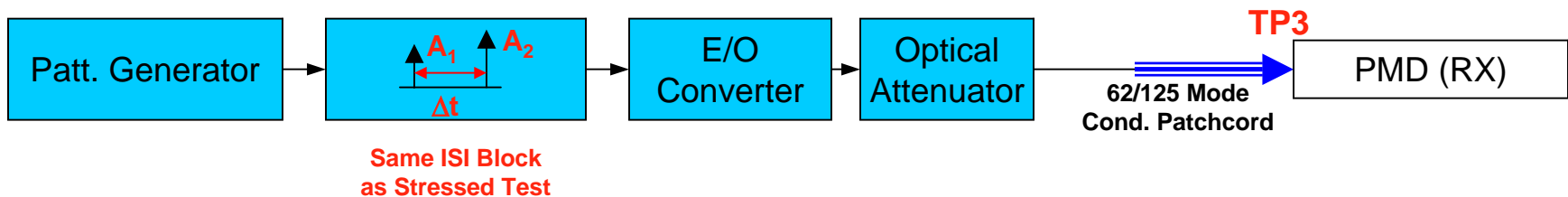
- **Goals:**

- EDC Relevant Test Equivalent to Informative Basic Sensitivity Test in 802.3ae
- Low Noise, No SJ Signal with Simple ISI Block
- Provide Simplest Test For Use in Day-to-Day Measurements Such as Manufacturing

- **Option 1 - Simplest:**



- **Option 2 – If Option 1 is Considered Inadequate:**



- **Need to Calculate Required Informative Sensitivity for Receive Characteristics Table**
- **Not a Clear Way to Do So, Requires Further Study**

TP3- Key Elements of RX and Link Budget Tables

Description	Value	Unit
Signaling speed (nominal)	10.3125	GBd
Signaling speed variation from nominal (max)	±100	ppm
Center wavelength (range)	1260 to 1355	nm
Average receive power ^a (max)	0.5	dBm
Received OMA (max)	+1.5	dBm
RX Sensitivity w/ ISI only (max) in OMA ^b	Xxx	dBm
Receiver dynamic adaptation penalty (max) per 1.8...	0.5 (TBC)	dB
Adaptation rate (min) ^c	Xxx	Hz
Stressed receiver sensitivity (max) in OMA per 1.8.	-7.6 (TBC)	dBm
ISI Generator Impulse Response Relative Peak Height (A_2/A_1) ^d	1.5 (TBC)	
ISI Generator Impulse Response Peak Spacing (Δt) (min) ^d	220	ps
Stressed test signal Sinusoidal Jitter (min) ^d	0.07	UI
Stressed test signal Sinusoidal Jitter Frequency ^d	40	MHz
Receiver Reflectance (max)	-12 dB	dB

Our Simple Informative Sensitivity Test (but does include Some ISI)

Example Placeholder Value

Dynamic Effects NOT Included in Stressed Test.
 Modal and RIN Noise Penalties ARE Included by Added Amplitude Noise in Stressed Test
 -4.5dBm – Loss – Dyn. Pen. – Cons Pen = -7.6dBm

Single Sinusoidal Jitter Number rather than Mask

^a The receiver shall be able to tolerate, without damage, continuous exposure to an optical input signal having a power level equal to the Average Receive Power (max) plus at least 1 dB.

^b RX Sensitivity with only ISI stress is informative.

^c Adaptation rate is a test condition of the Receiver adaptation penalty test. It is not a characteristic of the Receiver

^d ISI response and sinusoidal jitter parameters are test conditions for measuring the stressed receiver sensitivity.

Parameter	Value (dB)
Fiber attenuation	0.4
Connector losses	2.0
Modal noise	0.5
RIN	0.4
RX dynamic adaptation penalty	0.5
Consequent penalty	0.2
Total	4.0

Modal Noise and RIN Built into Stressed RX test

Dynamic Adaptation Penalty Tested and Bounded by Independent Test

Follow-Up Work on TP3 – Normative Stressed Sensitivity Test

- **Resolve Best Choice of ISI Generator Characteristics :**
- **Is a Two Pulse ISI Generator Adequate? (Certainly Simple to Implement)**
 - **Do More Complex Impulse Responses of Same Metric Stress EDC Further in Important Ways**
 - **Is it Too Easy to Design the Receiver to the Test. – Yes But Is That A Worthwhile/Practical Concern?**
- **What is the Best Choice for Relative Peak Height and Spacing?**
 - **For Choice of Relative Peak Height, Spacing Determined by Figure of Merit Target, but probably as much by DMD spans from Channel Model**
 - **Total Span or 3 dB Consideration Needed to Distinguish PIE Infinite Tap Performance from Real Finite Equalizer.**
 - **Debate on Use of Equal Peak Heights**
 - **Equal Peak Heights are an Unfair Burden – (Yes, But Mostly When Spacing Very Near Multiple of Bit Period)**
 - **2 Equal Peaks Do Occur in Fiber, particularly as Fiber is Manipulated**
 - **Suggestion: 2 Equal Peaks is Valid Test, But Choose Spacing to be Sufficiently Away from Multiple of Bit Period.**
 - **Is a Single ISI Test Adequate? (Multiple Tests Will Be Large Test Time/Cost Burden)**
 - **What is the Real Justification for Multiple Tests?**
- **Is a Certain Maximum Bandwidth (minimum peak width) Important?**
 - **If So What is Good Choice.**

Follow-Up Work on TP3 – Normative Stressed Sensitivity Test (cont)

- **Define Measurement Technique for OMA - Questions Raised on Meas. of OMA with 'Closed' Eye**
 - 52.9.5 of 802.3ae Defines OMA test With 4 – 11 Bit Square Pattern
(Defines Measurement Window for Clear 0,1 level)
 - Retain Wording But Use Square Pattern 2 – 3 x Longer Than Compliance Impulse Response Pulse Spacing.
This Should Provide Similar Clear Measurement Window For OMA Measurement Even with ISI.
(We Could Add A Good Representative Illustration as in Figure 52-6 in 802.3ae for Our Chosen Level of ISI)
- **Determine S/N Requirement of Compliance Signal**
 - Calculate S/N level to Represent Modal Noise and RIN penalties Allocated in Link Budget
 - S/N Set and Verified on Square OMA Test Pattern in the Same Portion of Pattern Where OMA is Measured
 - Add Noise at Specific Frequency (not harmonic of bitrate, Propose 1 GHz)
Rather Than Allow Wide Range of Choices
- **Define Test Procedure for Calibrating Conformance Test Signal as in 52.9.10.2 of 802.3ae**
 - Approach 1: Bypass ISI Generator, Describe Required Eye Characteristics
(Based on nominal 10G-BASE-LR Eye to allow use of typical –LR TOSA biased for linear response?)
Also implies independent electrical test of ISI block
 - Approach 2: Set Generator to Pattern with Isolated 1, Measure Signal Characteristics on Scope
(perhaps without sinusoidal interferer and jitter first)

Follow-Up Work on TP3 – Dynamic Adaptation Test

- **Determine Required Adaptation Rate for Test**
 - Previous Proposal on Measuring Speed of Peak Height variation with Perturbation
 - Need to Reach Closure on Agreed Worst Case Fiber Perturbation Parameters
- **Determine Best ISI Pattern and Time Varying Component**
 - Is A Certain 2 Pulse Test Adequate
 - Is the 3 pulse (2 varying) Shown in Diagram Overall Simpler and Safer
- **Define Exact Test Method**
 - Define Penalty Relative to Specific Worst Static ISI within Time Varying Range?
 - Probably Other Details
- **Choose Appropriate Allocation For Dynamic Adaptation Penalty**
 - When Required Rate is Determined, Probably Easy to Gather Modeling and Experimental Data on EDC Designs to Support Target.

Follow-Up Work on TP3 – Informative Sensitivity Test

- **Agree on Informative Sensitivity Test Goal**
 - Tradeoff Between Simple Test with No ISI (Unfair EDC Burden Because of Low Required OMA)
 - Complexity of Adding ISI
- **Can We Use Simple Gaussian ISI for Adequate Informative Test?**
 - Certainly Can Be Used to Burden EDC block and Shift Required Sensitivity closer to Normal Link Operating Range
 - Good Test for Performance to 3 dB Point of Fiber Spec
 - 2.3 GHz (500 MHz km/ 220m) may Be Too Difficult?
Actually has High PIE Metric (PIE-L = 8.69 dB, PIE-D = 4.93 dB) Use Higher Bandwidth Gaussian?
- **Is an Equal Height, Non-Bit Period Spacing Easy Enough to Generate and Representative?**