

COM Implementation example of receiver interference tolerance specified in 178A.1.7.5 (RiTol) Commit Request 4p9_5

Richard Mellitz, Samtec

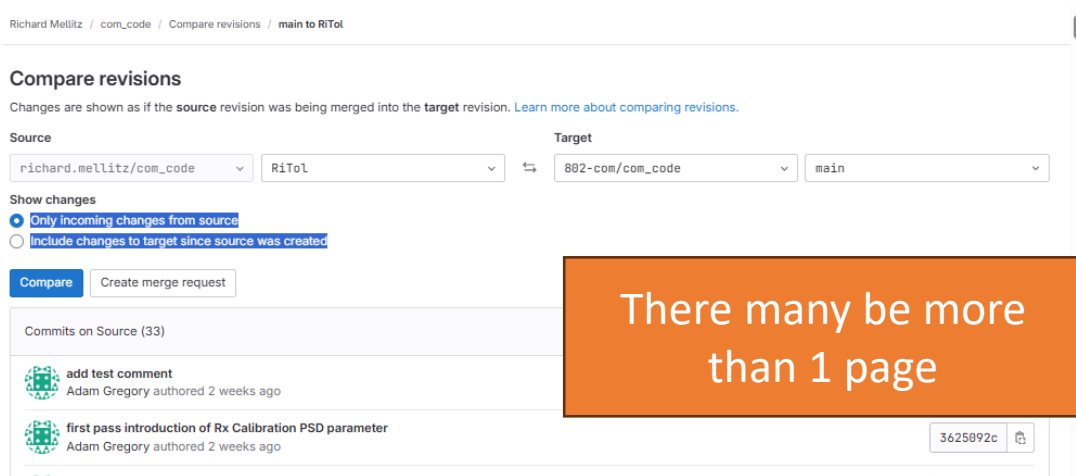
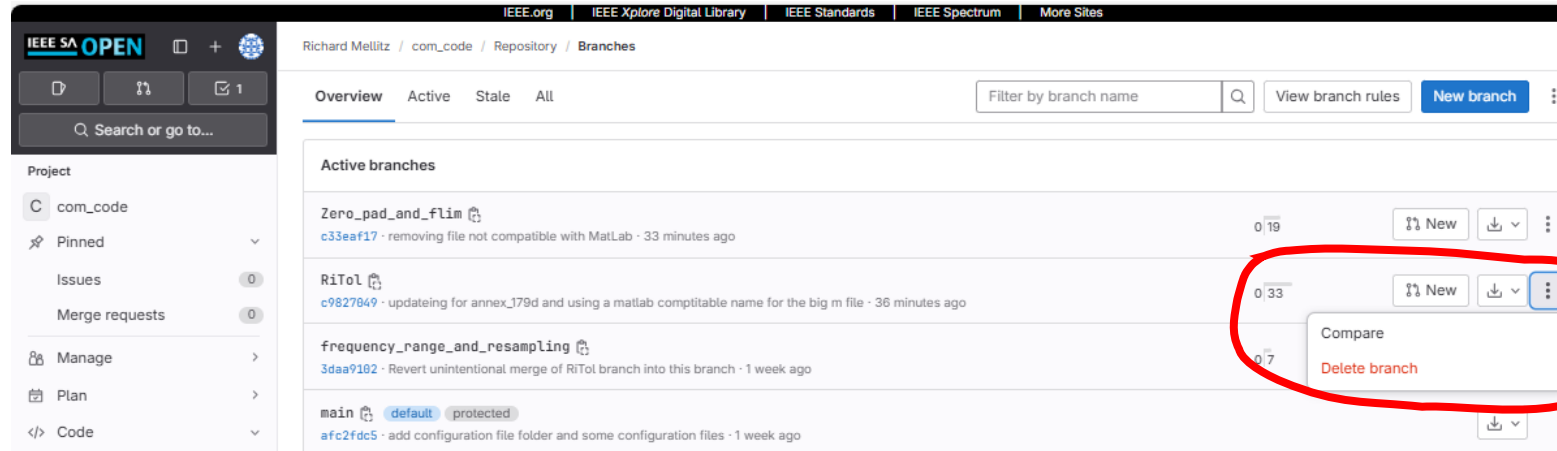
Adam Gregory, Samtec

IEEE 802.3 Channel Operating Margin (COM) Open Source Project Ad Hoc,
New Orleans, LA May 2025 Interim

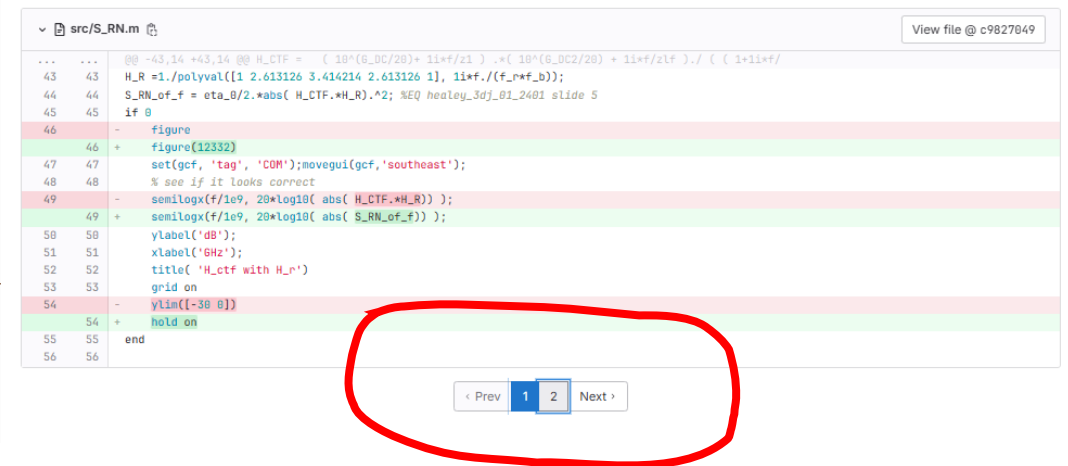
Purpose for Commit Request

- ❑ COM Implementation example of receiver interference tolerance specified in 178A.1.7.5 (RiTol)
- ❑ Limit configuration templates provided
 - Values and settings in the spread sheet may not be aligned with a standard or ongoing work. Please check before using.
- ❑ Branch: RiTOL
- ❑ Branch test code (will disappear after merge)
 - https://opensource.ieee.org/richard.mellitz/com_code/-/raw/RiTol/release/com_ieee8023_4p9p1_RiTOL.m?ref_type=heads&inline=false

Checking changes of a branch to the last release



There may be more than 1 page



Operation

- ❑ The keyword RX_calibration and usages with RxFFE turns on the calibration operations.
 - Prior version without RxFFE operate as in pervious versions
- ❑ Injected noise power spectral density included in get_PDSs
- ❑ 2 new functions
 - S_in
 - Create injected noise PSD
 - N_s
 - Creates noise source
- ❑ Changes to 17 other functions to modify dialog, CLI, and looping..
- ❑ Operation is similar to prior versions.
 - i.e. looping until 3 dB COM is reached.
- ❑ The noise sigma BBN step is a starting step size as before
- ❑ The change is that crosstalk channels can be consider and entered and an added channel may be cascaded for running CR COM

N_s.m

- ❑ Creates noise source to be used in S_in

src/N_s.m 0 → 100644 View file @ c9827049

```
25 + % HOLDER OR CONTRIBUTORS BE LIABLE FOR ANY DIRECT, INDIRECT, INCIDENTAL,
26 + % SPECIAL, EXEMPLARY, OR CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT
27 + % LIMITED TO, PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES; LOSS OF USE,
28 + % DATA, OR PROFITS; OR BUSINESS INTERRUPTION) HOWEVER CAUSED AND ON ANY
29 + % THEORY OF LIABILITY, WHETHER IN CONTRACT, STRICT LIABILITY, OR TORT
30 + % (INCLUDING NEGLIGENCE OR OTHERWISE) ARISING IN ANY WAY OUT OF THE USE
31 + % OF THIS SOFTWARE, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGE.
32 + %
33 + % SPDX-License-Identifier: BSD-3-Clause
34 + %%
35 + % computes Ns(f) PSD on rx compliance injected noise base on sigma_ns
36 + % Ns_of_f the single-sided power spectral density at the noise generator output in V^2/Hz
37 + % hence the incoming f is > 0
38 + f_b=param.fb; %align variable with standard variable usage
39 + f_hp=param.f_hp; %align variable with standard variable usage
40 +
41 + inq=find( f<=f_b/2,1,'last');
42 + RIT_REF_PTR=lower(OP.RIT_REF_PTR);
43 + Ns_of_f=zeros(1,length(f));
44 + switch RIT_REF_PTR
45 +     case 'clause_178'
46 +         Ns_of_f(1:inq)=ones(1,inq)*2*sigma_ns^2/f_b;% described in 178.9.3.4.2 d1.5
47 +     case 'clause_179'
48 +         if f_hp <= 0
49 +             error('Parameter f_hp must be greater than 0 when using Clause 179');
50 +         end
51 +         beta=1-(2*f_hp/f_b)*atan(f_b/(2*f_hp));
52 +         Ns_of_f(1:inq)=(2*sigma_ns^2)/(beta*f_b)* (f(1:inq)./f_hp).^2 ./ (1+(f(1:inq)/f_hp).^2);% equation 179-23 d1.5
53 +     case 'annex_176d'
54 +         if f_hp <= 0
55 +             error('Parameter f_hp must be greater than 0 when using Clause 179');
56 +         end
57 +         beta=1-(2*f_hp/f_b)*atan(f_b/(2*f_hp));
58 +         Ns_of_f(1:inq)=(2*sigma_ns^2)/(beta*f_b)* (f(1:inq)./f_hp).^2 ./ (1+(f(1:inq)/f_hp).^2);% equation 179-23 d1.5
59 +     otherwise
60 +         error('unsuported RIT Reference Pointer "%s" ', RIT_REF_PTR);
61 + end
62 + if 0
63 +     figure(99)
64 +     set(gcf, 'tag', 'COM');movegui(gcf,'southeast');
65 +     % see if it looks correct
66 +     plot(f/1e9, Ns_of_f);
67 +     ylabel('pwr');
68 +     xlabel('GHz');
69 +     title('N_s')
70 +     grid on
71 +     hold on
72 + end
```

S_IN

- ❑ Created interference noise PSD

```
src/S_IN.m 0 → 100644 View file @ c9827049

28 + % DATA, OR PROFITS; OR BUSINESS INTERRUPTION) HOWEVER CAUSED AND ON ANY
29 + % THEORY OF LIABILITY, WHETHER IN CONTRACT, STRICT LIABILITY, OR TORT
30 + % (INCLUDING NEGLIGENCE OR OTHERWISE) ARISING IN ANY WAY OUT OF THE USE
31 + % OF THIS SOFTWARE, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGE.
32 + %
33 + % SPDX-License-Identifier: BSD-3-Clause
34 + %%
35 + % computes PSD on rx compliance injected noise
36 + Hn21=noise_path;% as function of f. the VTF of the passed noise channel with rx package added.
37 + p1=param.CTLE_fp1(1);
38 + z1=param.CTLE_fz(1);
39 + p2=param.CTLE_fp2(1);
40 + zlf=param.f_HP(1);
41 + plf=param.f_HP(1);
42 + f_b=param.fb;
43 + f_r=param.f_r;
44 + sigma_ns=param.sigma_ns+eps(0);
45 + H_CTF = ( 10^(G_DC/20)+ 1i*f/z1 ).*( 10^(G_DC2/20) + 1i*f/zlf )./ ( ( 1+1i*f/p1 ).*( 1+1i*f/p2 ).*( 1+1i*f/plf));
46 + H_R =1./polyval([1 2.613126 3.414214 2.613126 1], 1i*f./(f_r*f_b));
47 + Ns_of_f = N_s(f,param, sigma_ns,OP);
48 + S_IN_of_f = Ns_of_f./2.*abs( Hn21.*H_CTF.*H_R).^2; %
49 + if 0
50 +     delta_f=f(2)-f(1);
51 +     S_IN_of_f_rms=sqrt(sum(S_IN_of_f)* delta_f);
52 +     figure(12332)
53 +     set(gcf, 'tag', 'COM');movegui(gcf,'southeast');
54 +     % see if it looks correct
55 +     semilogx(f/1e9, 20*log10( abs( S_IN_of_f) ) );
56 +     ylabel('dB');
57 +     xlabel('GHz');
58 +     title( 'S_IN_of_f including H_ctf with H_r')
59 +     grid on
60 +     hold off
61 +
62 + end
63 +
```

- ❑ Adding S_IN to noise PSD
- ❑ When not performing an Rx Calibration S_IN is zero.

- ❑ Adding S_IN to noise PSD
- ❑ When not performing an Rx Calibration S_IN is zero.

```

src/get_PSDs.m
View file at c9827649

... @@ -78,9 +78,33 @@ if OP_PSDRXCAL % to speed up loop find an only first time ctile is case
78 78 S_rn=[real(S_rn(1)), S_rn(2:end-1), real(S_rn(end)), conj(S_rn(end-1:-1:2))];
79 79 result.S_rn=S_rn;
80 80 result.S_rn_rms = sqrt(sum(result.S_rn)* delta_f);

81 +
82 + %% compute S_in ( eq 178A-24 dB.2 )
83 + % S_in = 0 when Rx Calibration is not performed
84 + if OP_PSDRXCAL
85 + % interpolate to fvec
86 + result.H_noise=M_interp(chdata(end).sdd2ip,chdata(1).faxis,fvec,f_b);
87 + % Units are V^2/Hz
88 + S_IN_of_f=S_IN(fvec,result.H_noise,G_DC,G_DC2,param,OP);
89 + % Convert single-sided frequency response to conjugate-symmetric
90 + inn_psd=[real(S_IN_of_f(1)), S_IN_of_f(2:end-1), real(S_IN_of_f(end)), conj(S_IN_of_f(end-1:-1:2))];
91 + inn_rms = sqrt(sum(inn_psd)* delta_f);
92 + S_in = sum(reshape(inn_psd, num_ui, M, '));
93 + S_in=S_in/(num_ui*2+1);
94 + S_in=[real(S_in(1)), S_in(2:end-1), real(S_in(end)), conj(S_in(end-1:-1:2))];
95 + result.S_in=S_in;
96 + result.S_in_rms = sqrt(sum(result.S_in)* delta_f);
97 +
98 + else
99 + result.S_in=0;
100 + result.S_in_rms =0;
101 + end

81 101 else
82 - result.S_rn=result.S_rn.*H_rxffe_2;
83 - result.S_rn_rms = sqrt(sum(result.S_rn)* delta_f);

102 +
103 + result.S_rn=result.S_rn.*H_rxffe_2;
104 + result.S_rn_rms = sqrt(sum(result.S_rn)* delta_f);
105 +
106 + %% compute S_in
107 + result.S_in=result.S_in.*H_rxffe_2;
108 + result.S_in_rms = sqrt(sum(result.S_in)* delta_f);

84 108 end
85 109
86 110 else % find noise for item that set have tx ffe for each loop
... @@ -88,8 +112,13 @@ else % find noise for item that set have tx ffe for each loop
88 112 %% Crosstalk power spectral density
89 113 if ~OP_COMPUTE_COP % result.S_xn and result.S_xn_rms were found in optimizes_fom and passed in with the variable result
90 114 result.S_xn=0;
91 - if length(chdata)==1
92 - for xchan=2:length(chdata)
115 + if OP_PSDRXCAL
116 + num_channel_files = length(chdata) - 1;
117 + else
118 + num_channel_files = length(chdata);
119 + end
120 + if num_channel_files==1
121 + for xchan=2:num_channel_files
93 122 pulse_ctile=filter(ones(1,M),1,chdata(xchan).ctile_imp_response(:).');
94 123 pulse_ctile=[ pulse_ctile(1:floor(length(pulse_ctile)/M)*M) ];
95 124 hk(xchan).k=chdata(xchan).pulse_response_w_CFI_TXFFE_noRXFFE.';
... @@ -193,7 +222,7 @@ else % find noise for item that set have tx ffe for each loop
193 222 hext_txffe=filter(txffe,1,hext);
194 223 sig_after_ctile_pdf = get_pdf_from_sampled_signal(hext_txffe,param.levels,OP.BinSize);
195 224 noise_after_ctile_pdf = sig_after_ctile_pdf;

196 - sigma_noise = sqrt(result.S_rn_rms^2+result.S_xn_rms^2+result.S_tn_rms^2+result.S_rj_rms^2);
225 + sigma_noise = sqrt(result.S_in_rms^2+result.S_rn_rms^2+result.S_xn_rms^2+result.S_tn_rms^2+result.S_rj_rms^2);
197 226 noise_after_ctile_pdf.y = 1/(sqrt(2*pi)*sigma_noise)*exp(-noise_after_ctile_pdf.x.^2/(2*sigma_noise^2))*OP.BinSize;
198 227 sig_noise_after_ctile_pdf= conv_fct(sig_after_ctile_pdf,noise_after_ctile_pdf);
199 228 sig_noise_after_ctile_cdf = cumsum(sig_noise_after_ctile_pdf.y);
... @@ -225,7 +254,7 @@ else % find noise for item that set have tx ffe for each loop
225 254 result.S_qn_rms = 0;
226 255 % result.S_n
227 256 end

228 - result.S_n=result.S_rn+ result.S_tn+ result.S_xn+ result.S_jn+ result.S_qn;
257 + result.S_n=result.S_rn+ result.S_tn+ result.S_xn+ result.S_jn+ result.S_qn+result.S_in;
229 258 result.S_n_rms = sqrt(sum(result.S_n)* delta_f);
230 259
231 260 %%
... @@ -265,7 +294,7 @@ else % find noise for item that set have tx ffe for each loop
265 294 result.S_isi=sigma_X2*(abs(fftf(hisi))).^2/param.fb;
266 295 result.S_isi_rms = sqrt(sum(result.S_isi)* delta_f);
267 296 %%

268 - result.S_6=result.S_tn+ result.S_rj_jn + result.S_rn; % eq 178A-30
297 + result.S_6=result.S_tn+ result.S_rj_jn + result.S_rn+ result.S_in; % eq 178A-30
298 298 result.S_6_rms = sqrt(sum(result.S_6)* delta_f);
299 299 result.Sn_rho=result.S_isi +result.S_n; % need to include xtalk and isi
300 300 result.Sn_rho_rms = sqrt(sum(result.Sn_rho)* delta_f);

```

com_ieee8023_

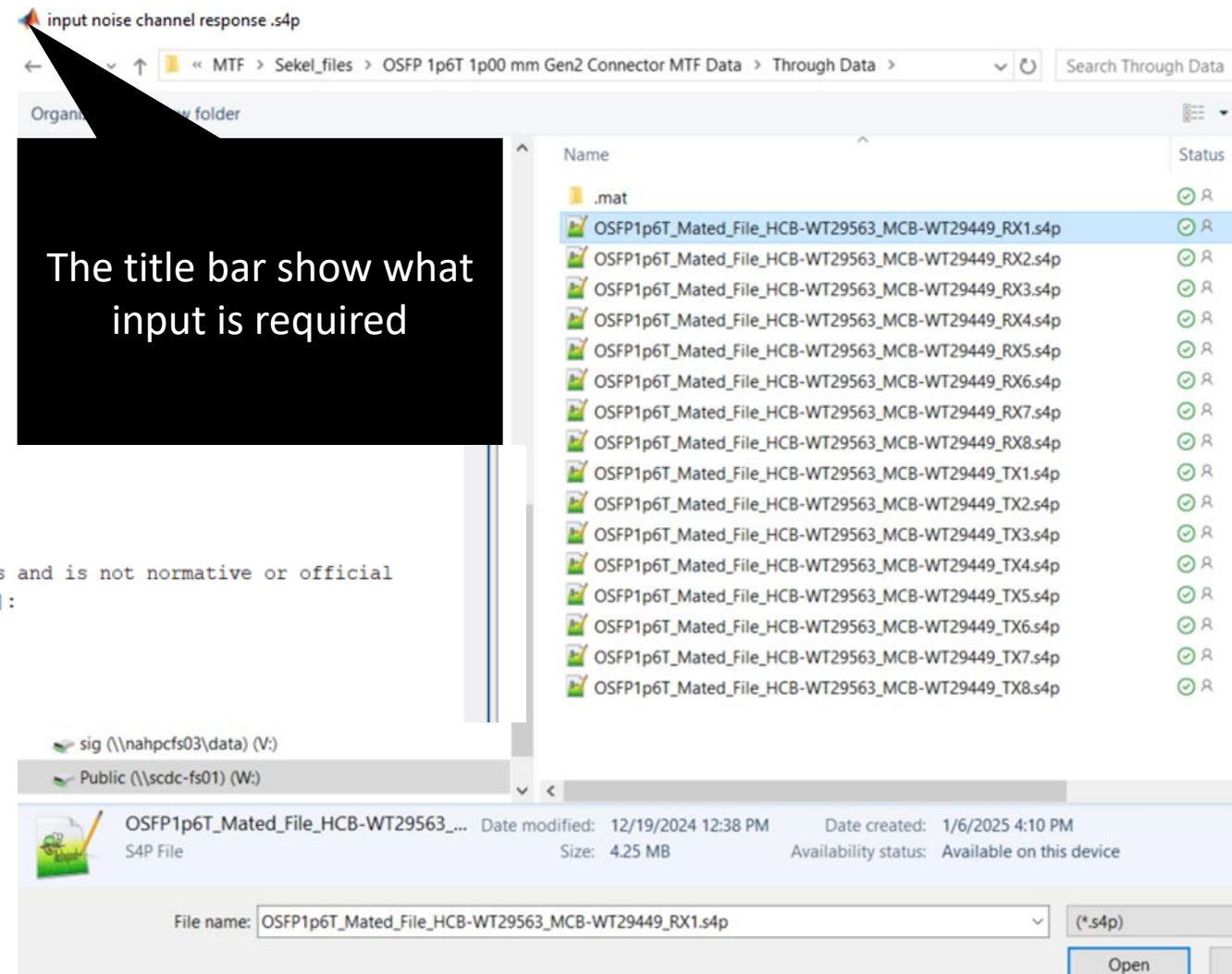
- ❑ 39 changed files
 - [Review in GIT](#)
- ❑ Code complete and initially test
- ❑ Configuration sheet need contributions.
- ❑ An example provided
- ❑ New keywords and interactive dialog and command line syntax

CONTRIBUTING.md	+1 -1	release/com_ieee8023_4p9p0_beta_SNR_MD...	+0 -10663
CONTRIBUTING.md		release/com_ieee8023_4p9p0_beta_SNR_MDFEXT_01.m	
config_templates/C2M/200G/README.md	+0 -0	src/+Management/make_release.m	+2 -1
config_templates/C2M/200G/README.md		src/+Management/make_release.m	
config_templates/C2M/200G/config_com_3dj_200...	+0 -0	src/COM_FD_to_TD.m	+10 -1
...2M/200G/config_com_3dj_200G_176D_C2M_host_05_21...		src/COM_FD_to_TD.m	
config_templates/CR/200G/CA/README.md	+0 -0	src/Create_Noise_PDF.m	+6 -1
config_templates/CR/200G/CA/README.md		src/Create_Noise_PDF.m	
config_templates/CR/200G/CR_Host/README.md	+0 -0	src/FD_Processing.m	+5 -0
config_templates/CR/200G/CR_Host/README.md		src/FD_Processing.m	
config_templates/CR/200G/CR_Module/README.md	+0 -0	src/H_interp.m	+51 -0
config_templates/CR/200G/CR_Module/README.md		src/H_interp.m	
config_templates/KR/200G/README.md	+0 -0	src/N_s.m	+69 -0
config_templates/KR/200G/README.md		src/N_s.m	
config_templates/KR/200G/config_com_dj_200G...	+0 -0	src/Output_Arg_Fill.m	+1 -1
.../KR/200G/config_com_dj_200G_CAKR_178_PKGA_05_21...		src/Output_Arg_Fill.m	
config_templates/KR/200G/config_com_dj_200G...	+0 -0	src/S_IN.m	+63 -0
.../KR/200G/config_com_dj_200G_CAKR_178_PKGB_05_21...		src/S_IN.m	
config_templates/README.md	+0 -0	src/S_RN.m	+3 -3
config_templates/README.md		src/S_RN.m	
config_templates/RiToL_Calitbration/200G/178/REA...	+2 -0	src/add_brd.m	+1 -1
config_templates/RiToL_Calitbration/200G/178/REA...		src/add_brd.m	
config_templates/RiToL_Calitbration/200G/178/con...	+0 -0	src/com_ieee8023_.m	+65 -16
...78/config_com_dj_200G_RxToL_CAKR_178_PKGA_05_23_2...		src/com_ieee8023_.m	
config_templates/RiToL_Calitbration/200G/178/con...	+0 -0	src/get_PSDs.m	+36 -7
...78/config_com_dj_200G_RxToL_CAKR_178_PKGB_05_23_2...		src/get_PSDs.m	
config_templates/RiToL_Calitbration/200G/178/tem...	+0 -0	src/get_s4p_files.m	+22 -0
config_templates/RiToL_Calitbration/200G/178/temp.xlsx		src/get_s4p_files.m	
config_templates/RiToL_Calitbration/200G/179/HH/...	+2 -0	src/get_xtlk_noise.m	+2 -0
config_templates/RiToL_Calitbration/200G/179/HH/REA...		src/get_xtlk_noise.m	
config_templates/RiToL_Calitbration/200G/179/HL/...	+2 -0	src/make_full_pkg.m	+4 -0
config_templates/RiToL_Calitbration/200G/179/HL/REA...		src/make_full_pkg.m	
config_templates/RiToL_Calitbration/200G/179/HN/...	+2 -0	src/read_ParamConfigFile.m	+27 -1
config_templates/RiToL_Calitbration/200G/179/HN/REA...		src/read_ParamConfigFile.m	
config_templates/RiToL_Calitbration/README.md	+3 -0	src/s21_pkg.m	+8 -1
config_templates/RiToL_Calitbration/README.md		src/s21_pkg.m	
release/com_ieee8023_490beta1.m	+0 -14482	src/save_cmd_line.m	+4 -8
release/com_ieee8023_490beta1.m		src/save_cmd_line.m	
release/com_ieee8023_4p9p0_beta_SNDR_Re...	+0 -10691		
release/com_ieee8023_4p9p0_beta_SNDR_Ref_01.m			

New Dialog

- ❑ Question added as to whether want to proceed with a Rx calibration.
- ❑ The file request window is the entry for the noise channel

```
>> com_ieee8023_  
This is NOT an official IEEE document.  
Revision: This is a computation example for exploring COM and ERL  
for projects like IEEE P802.3bj/b/bs/cd/ck/dj with some exploratory extensions and is not normative or official  
Enter config XLS file or return will just pop a window to ask for the XLS file]:  
How many FEXT channels are to be entered? [return means no FEXT] 1  
How many NEXT channels are to be entered? [return means no NEXT] 1  
Do you want to continue with Rx calibration (Y/N) ? [return means yes]
```



COM CLI call adds a noise path

```
com_ieee8023_('C:\Users\richardm\OneDrive - Samtec\COM\802-  
COM\Richard_Mellitz_com_code\com_code\config_templates\RiTol_Calitbration\200G\178\config_com_dj_200G_RxTol_CAKR_178_PKGB_05_23_2025.xlsx'...  
,1,1,...  
'W:\userdata\channels\IEEE802.3df\sekel_3dj_02_2503\OSFP1p6T_Mated_File_HCB-WT29563_MCB-WT29449_RX1.s4p',...  
'W:\userdata\channels\IEEE802.3df\mammenga_3dj_02_2501\FEXT\HCB_vic_TX1_HCB_aggr_RX1_FEXT.s4p', ...  
'W:\userdata\channels\IEEE802.3df\mammenga_3dj_02_2501\NEXT\HCB_vic_TX1_HCB_aggr_RX1_NEXT.s4p',...  
'W:\userdata\channels\IEEE802.3df\sekel_3dj_02_2503\OSFP1p6T_Mated_File_HCB-WT29563_MCB-WT29449_RX1.s4p');
```

↑
Noise Path

New Keywords

- ❑ RIT_REF_PTR – controls noise filter in N_in
 - [clause_179](#) (default)
 - [clause_178](#)
 - [annex_176d](#)

Output indicates what RMS voltage to set noise source too

```
WC All cases FAIL ... COM = 2.993 dB
WC All cases DER = 1.208e-04 at COM threshold
WC All cases: PASS ... ERL = 11.079 dB (12.642 dB, 11.079 dB)
  LOOP with [sigma_bn] = [0.015234] performed with COM = 2.9929
  Set Tx calibration noise (sigma_hp) rms voltage to 15.2344 mV.
  redo string is: eval(['My_var_0 = ' getappdata(0,'cmd_str')])
```

fx >>

<

Spreadsheet snippets

Receiver testing		
RX_CALIBRATION	1	logical
Sigma BBN step	0.05	V
RIT_REF_PTR	clause_178	select
f_hp	clause_178	Hz
Parameter	clause_179	
board_tl_gamma0_a1_a2	annex_176D	1.4 db/in @ 53.125G
board_tl_tau	5.790E-03	ns/mm
board_Z_c	92.5	Ohm
z_bp (TX)	0	mm
z_bp (NEXT)	60	mm
z_bp (FEXT)	0	mm
z_bp (RX)	60	mm
C_0	[0 0]	nF
C_1	[0 0]	nF
include PCB	0	logical

Switch for Rx calibration

Starting noise step size

If Rx FFE is used there are 3 Annex choices. 179 is the default. Only used when RxFFE is enabled

This section needs to be filled in from the referring section

f_hp must be set if using Clause 176 or 179.
Default value of 0 will result in errors

Thank You!