COM r3.2 Update for d2.0 and Follow-on Work

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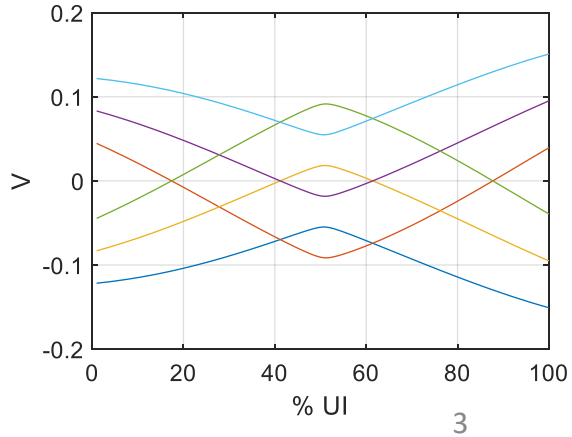
June 30, 2021

New Key Words

Keyword	default	Units		Status
TDMODE	0	logical		Experimental
Histogram_Window_Weight	'Rectangular'	string	'rectangle', 'Gaussian', 'triangle', 'Dual_Rayleigh'	Experimental
QL	2.5	value	Q factor at +/- T_O for Gaussian HISTOGRAM_WINDOW	
Bessel_Thomson	0	Logical	Explicit filter instantiation	No change for normal COM operation
Butterworth	1	logical	Explicit filter instantiation	No change for normal COM operation
SAVE_TD	0	logical	updated saved data	No change for normal COM operation
TDECQ	0	string	Does not report TDECQ. Reports an estimate for VMA string is set to VMA	Experimental

TDMODE, RX_CALIBRATION, VEC/VEO(EH)

- TDMODE is an experimental feature in which pulse responses are used to compute COM. The input is csv channel files instead of s4p files.
  - No package concatenation
  - Does not support RX_CALIBRATION
  - CSV file as 2 columns of time and voltage
    - Units are seconds and volts
  - Some instruments may produce fitted pulse response data which may be used once modified to a simple csv file
- Fixed problem with COM 3.1 when using RX_CALIBRATION
- If min_VEO_test fails to find an passing eye height (EH) optimization is restarted so the any VEC is reported for the best EH > 0 V
- VEC and VEO(EH) are computed for three eyes.
  - Even though the EH at each eye at T_s are the same
  - Added adjustments for “tilted’ eyes.
  - VEC reported higher and EH are reported lower compared to COM 3.1
  - Plot at left is for an output field call eye_contour

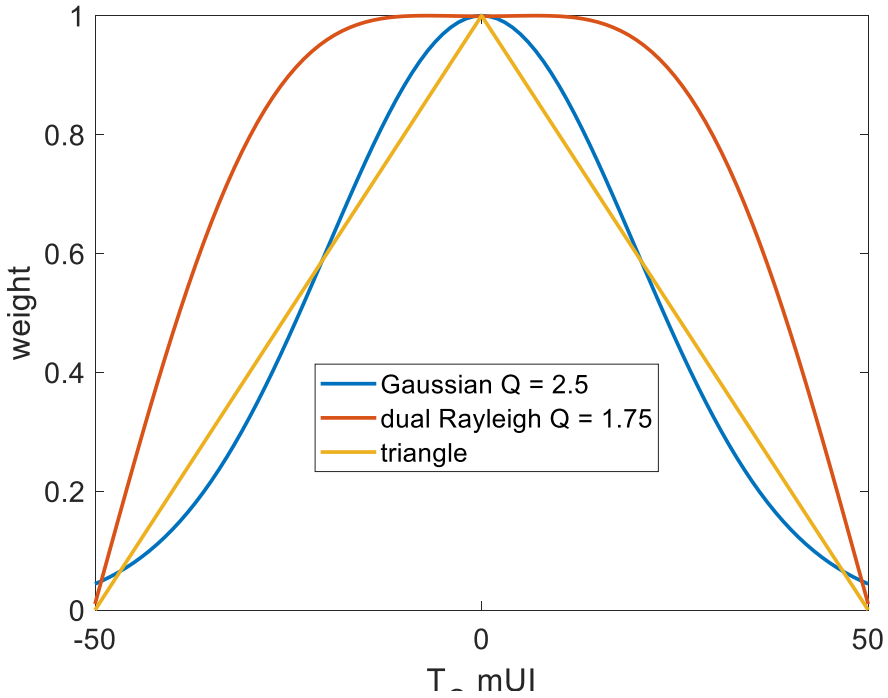


Other modifications for standards exploration

- Bessel_Thomson is defaulted to false (0) if not specified
  - If true a 4th order Bessel Thomson filter is added to all responses before processing with a 3 dB point specified by f_r. (ref. clause 38.6.5)
  - If false the filter is not cascaded.
- Butterworth is defaulted to true (1) if not specified.
  - If true 4th order Butterworth filter is added to all responses before processing with a cutoff frequency specified by f_r.

Histogram_Window_Weight for VEC/VEH

- This is experimental
  - Direction for COM implementation from Adee Ran (Cisco)
- Histogram_Window_Weight
  - Gaussian
    - QL keyword for “Gaussian”
      - Q factor at +/- T_O
      - Default is 2.5
  - Dual Rayleigh
    - Emulates limit based failure statistics
    - Uses QL as for Gaussian
  - Triangle
  - Rectangle (default)
  - More expected in other presentations



- Emulates the effect of Rx jitter without specifying actual Rx jitter designs

Example Comparing Results

One case: Data for Lim Channel5_thru_small_pad_9inch

3.1 COM does not align to measurements (slanted eye not considered)

- ❑ WC All cases PASS ... VEC = 11.062 dB
- ❑ WC All cases PASS ... EH = 10.423 mV

3.2 COM more closely aligns to measurements

- ❑ WC All cases PASS ... VEC = 11.562 dB
- ❑ WC All cases PASS ... EH = 9.84 mV

Other

- SAVE_TD set to 1 saves both the equalized and un-equalized time domain pulse responses and FIRs
  - Save in the results mat file if BREAD_CRUMBS is 1
- Added FD experimental output
  - Reflective Insertion Loss Noise (RILN), Hansel Dsilva, Achronix
    - H. Dsilva, Sasikala J, A Jain, A Kumar, R Mellitz, A Gregory, B. Lee; "Finding Reflective Insertion Loss Noise and Reflectionless Insertion Loss", DesignCon 2020, Santa Clara, CA
- TDECQ is exploratory. The default is false (0)
  - Only the string "VMA" the value 0 is supported right now
  - If set to "VMA"
  - An estimate of VMA is reported in a field is added to the COM output called VMA.
  - The computation uses full PRBS13Q bit stream convolution and computes the mean valve between longest sequence of S3 and S0.
- For ERL the parameter N is corrected to start after t_fx as indicated in Annex 93A.5

Additional information

Matlab Code for Computing Histogram Weights

```
switch lower(OP.Histogram_Window_Weight)
        case {'gaussian' 'norm' 'normal' 'guassian’}
            QL_sigma=T_O/param.QL;
            weights=exp(-1/2 * ([-T_O:T_O]/QL_sigma).^2);
        case 'triangle’
            t_slope=1/(T_O);
            weights=[0:t_slope:1 1-t_slope:-t_slope:0];
        case 'rectangle‘
            weights(1:2*T_O+1)=1;
        case 'dual_rayleigh'
            QL_sigma=T_O/param.QL;
            X=-T_O:T_O;
            weights=(X+T_O)/QL_sigma^2.*exp(-1/2 * ((X+T_O)/QL_sigma).^2)...
                -(X-T_O)/QL_sigma^2.*exp(-1/2 * ((X-T_O)/QL_sigma).^2);
            weights=weights/max(weights);
```

KR CLAUSE 163.10

Table 93A-1 parameters			
Parameter	**Setting**	**Units**	**Information**
f_b	53.125	GBd	
f_min	0.05	GHz	
Delta_f	0.01	GHz	
C_d	[1.2e-4 1.2e-4]	nF	[TX RX]
L_s	[0.12, 0.12]	nH	[TX RX]
C_b	[0.3e-4 0.3e-4]	nF	[TX RX]
z_p select	[1 2]		[test cases to run]
z_p (TX)	[12 31; 1.8 1.8]	mm	[test cases]
z_p (NEXT)	[12 29; 1.8 1.8]	mm	[test cases]
z_p (FEXT)	[12 31; 1.8 1.8]	mm	[test cases]
z_p (RX)	[12 29; 1.8 1.8]	mm	[test cases]
C_p	[0.87e-4 0.87e-4]	nF	[TX RX]
R_0	50	Ohm	
R_d	[50 50]	Ohm	[TX RX]
A_v	0.413	V	
A_fe	0.413	V	
A_ne	0.608	V	
AC_CM_RMS	0	V	[test cases]
L	4		
M	32		
filter and Eq			
f_r	0.75	*fb	
c(0)	0.54		min
c(-1)	[-0.34:0.02:0]		[min:step:max]
c(-2)	[0:0.02:0.12]		[min:step:max]
c(-3)	[-0.06:0.02: 0]		[min:step:max]
c(1)	[-0.2:0.02:0]		[min:step:max]
N_b	12	UI	
b_max(1)	0.85		
b_max(2..N_b)	[0.3 0.2*ones(1,5) 0.1*ones(1,5)]		
b_min(1)	0.3		
b_min(2..N_b)	[0.05 -0.03*ones(1,10)]		
g_DC	[-20:1:0]	dB	[min:step:max]
f_z	21.25	GHz	
f_p1	21.25	GHz	
f_p2	53.125	GHz	
g_DC_HP	[-6:1:0]		[min:step:max]
f_HP_PZ	0.6640625	GHz	

[0.0235 0.0256]

I/O control		
DIAGNOSTICS	1	logical
DISPLAY_WINDOW	1	logical
CSV_REPORT	1	logical
RESULT_DIR	.\results\100GEL_KR_{date}\	
SAVE_FIGURES	0	logical
Port Order	[1 3 2 4]	
RUNTAG	KR_eval_	
COM_CONTRIBUTION	0	logical
Operational		
COM Pass threshold	3	dB
ERL Pass threshold	9.7	dB
DER_0	0.0001	
T_r	0.0075	ns
FORCE_TR	1	logical
Local Search	2	
BREAD_CRUMBS	1	logical
SAVE_CONFIG2MAT	1	logical
PLOT_CM	0	
TDR and ERL options		
TDR	1	logical
ERL	1	logical
ERL_ONLY	0	logical
TR_TDR	0.01	ns
N	3500	
beta_x	0	
rho_x	0.618	
fixture delay time	[0 0]	[port1 port2]
TDR_W_TXPKG	0	
N_bx	21	UI
Tukey_Window	1	logical
Noise, jitter		
sigma_RJ	0.01	UI
A_DD	0.02	UI
eta_0	8.20E-09	V^2/GHz
SNR_TX	33	dB
R_LM	0.95	

Table 93A–3 parameters		
Parameter	**Setting**	**Units**
package_tl_gamma0_a1_a2	[0 0.0009909 0.0002772]	
package_tl_tau	0.006141	ns/mm
package_Z_c	[87.5 87.5 ; 92.5 92.5]	Ohm
Table 92–12 parameters		
Parameter	**Setting**	
board_tl_gamma0_a1_a2	*[0 3.8206e-04 9.5909e-05]*	
board_tl_tau	*5.790E-03*	ns/mm
board_Z_c	100	Ohm
z_bp (TX)	*110.3*	mm
z_bp (NEXT)	*110.3*	mm
z_bp (FEXT)	*110.3*	mm
z_bp (RX)	*110.3*	mm
C_0	[0.29e-4]	nF
C_1	[0.19e-4]	nF
Include PCB	**0**	**logical**
Floating Tap Control		
N_bg	3	0 1 2 or 3 groups
N_bf	3	taps per group
N_f	40	UI span for floating taps
bmaxg	0.05	max DFE value for floating taps
B_float_RSS_MAX	0.02	rss tail tap limit
N_tail_start	25	(UI) start of tail taps limit
ICN & FOM_ILD parameters		
f_v	0.594	*Fb
f_f	0.594	*Fb
f_n	0.594	*Fb
f_2	40.000	GHz
A_ft	0.600	V
A_nt	**0.600**	V
Receiver testing		
RX_CALIBRATION	0	logical
Sigma BBN step	5.00E-03	V

CR CLAUSE 162.11.7

Table 93A-1 parameters				
Parameter	**Setting**	**Units**	**Information**	
f_b	53.125	GBd		
f_min	0.05	GHz		
Delta_f	0.01	GHz		
C_d	[1.2e-4 1.2e-4]	nF	[TX RX]	
L_s	[0.12, 0.12]	nH	[TX RX]	
C_b	[0.3e-4 0.3e-4]	nF	[TX RX]	
z_p select	[1 2]		[test cases to run]	
z_p (TX)	[12 31; 1.8 1.8]	mm	[test cases]	
z_p (NEXT)	[12 29; 1.8 1.8]	mm	[test cases]	
z_p (FEXT)	[12 31; 1.8 1.8]	mm	[test cases]	
z_p (RX)	[12 29; 1.8 1.8]	mm	[test cases]	
C_p	[0.87e-4 0.87e-4]	nF	[TX RX]	
R_0	50	Ohm		
R_d	[50 50]	Ohm	[TX RX]	
A_v	0.413	V		
A_fe	0.413	V		
A_ne	0.608	V		
AC_CM_RMS	0	V	[test cases]	[0.0235 0.0256]
L	4			
M	32			
filter and Eq				
f_r	0.75	*fb		
c(0)	0.54		min	
c(-1)	[-0.34:0.02:0]		[min:step:max]	
c(-2)	[0:0.02:0.12]		[min:step:max]	
c(-3)	[-0.06:0.02: 0]		[min:step:max]	
c(1)	[-0.2:0.02:0]		[min:step:max]	
N_b	12	UI		
b_max(1)	0.85			
b_max(2..N_b)	[0.3 0.2*ones(1,5) 0.1*ones(1,5)]			
b_min(1)	0.3			
b_min(2..N_b)	[0.05 -0.03*ones(1,10)]			
g_DC	[-20:1:0]	dB	[min:step:max]	
f_z	21.25	GHz		
f_p1	21.25	GHz		
f_p2	53.125	GHz		
g_DC_HP	[-6:1:0]		[min:step:max]	
f_HP_PZ	0.6640625	GHz		

I/O control		
DIAGNOSTICS	1	logical
DISPLAY_WINDOW	1	logical
CSV_REPORT	1	logical
RESULT_DIR	.\results\100GEL_CR_CA_{date}\	
SAVE_FIGURES	0	logical
Port Order	[1 3 2 4]	
RUNTAG	CA_eval_	
COM_CONTRIBUTION	0	logical
Operational		
COM Pass threshold	3	dB
ERL Pass threshold	8.25	dB
DER_0	0.0001	
T_r	0.0075	ns
FORCE_TR	1	logical
Local Search	2	
BREAD_CRUMBS	0	logical
SAVE_CONFIG2MAT	1	logical
PLOT_CM	0	
TDR and ERL options		
TDR	1	logical
ERL	1	logical
ERL_ONLY	0	logical
TR_TDR	0.01	ns
N	4500	
beta_x	0	
rho_x	0.618	
fixture delay time	[.3e-9 .3e-9]	[port1 port2]
TDR_W_TXPKG	0	
N_bx	0	UI
Tukey_Window	1	logical
Noise, jitter		
sigma_RJ	0.01	UI
A_DD	0.02	UI
eta_0	9.00E-09	V^2/GHz
SNR_TX	32.5	dB
R_LM	0.95	

Table 93A–3 parameters		
Parameter	**Setting**	**Units**
package_tl_gamma0_a1_a2	[0 0.0009909 0.0002772]	
package_tl_tau	0.006141	ns/mm
package_Z_c	[87.5 87.5 ; 92.5 92.5]	Ohm
Table 92–12 parameters		
Parameter	**Setting**	
board_tl_gamma0_a1_a2	*[0 3.8206e-04 9.5909e-05]*	
board_tl_tau	*5.790E-03*	ns/mm
board_Z_c	100	Ohm
z_bp (TX)	*110.3*	mm
z_bp (NEXT)	*110.3*	mm
z_bp (FEXT)	*110.3*	mm
z_bp (RX)	*110.3*	mm
C_0	[0.29e-4]	nF
C_1	[0.19e-4]	nF
Include PCB	**1**	**logical**
Floating Tap Control		
N_bg	3	0 1 2 or 3 groups
N_bf	3	taps per group
N_f	40	UI span for floating taps
bmaxg	0.05	max DFE value for floating taps
B_float_RSS_MAX	0.02	rss tail tap limit
N_tail_start	25	(UI) start of tail taps limit
ICN parameters		
f_v	0.594	*Fb
f_f	0.594	*Fb
f_n	0.594	*Fb
f_2	40.000	GHz
A_ft	0.600	V
A_nt	**0.600**	V
Receiver testing		
RX_CALIBRATION	0	logical
Sigma BBN step	5.00E-03	V

C2C ANNEX 120F.4.1

Table 93A-1 parameters					I/O control			Table 93A–3 parameters		
Parameter	**Setting**	**Units**	**Information**		DIAGNOSTICS	1	logical	**Parameter**	**Setting**	**Units**
f_b	53.125	GBd			DISPLAY_WINDOW	1	logical	package_tl_gamma0_a1_a2	[0 0.0009909 0.0002772]	
f_min	0.05	GHz			CSV_REPORT	1	logical	package_tl_tau	0.006141	ns/mm
Delta_f	0.01	GHz			RESULT_DIR	.\results\100GEL_KR_{date}\		package_Z_c	[87.5 87.5 ; 92.5 92.5]	Ohm
C_d	[1.2e-4 1.2e-4]	nF	[TX RX]		SAVE_FIGURES	0	logical			
L_s	[0.12, 0.12]	nH	[TX RX]		Port Order	[1 3 2 4]		Table 92–12 parameters		
C_b	[0.3e-4 0.3e-4]	nF	[TX RX]		RUNTAG	KR_eval_		**Parameter**	**Setting**	
z_p select	[1 2]		[test cases to run]		COM_CONTRIBUTION	0	logical	*board_tl_gamma0_a1_a2*	*[0 3.8206e-04 9.5909e-05]*	
z_p (TX)	[13 31; 1.8 1.8]	mm	[test cases]		**Operational**			*board_tl_tau*	*5.790E-03*	ns/mm
z_p (NEXT)	[11 29; 1.8 1.8]	mm	[test cases]		COM Pass threshold	3	dB	*board_Z_c*	100	Ohm
z_p (FEXT)	[13 31; 1.8 1.8]	mm	[test cases]		ERL Pass threshold	9.7	dB	*z_bp (TX)*	*110.3*	mm
z_p (RX)	[11 29; 1.8 1.8]	mm	[test cases]		DER_0	1.00E-05		*z_bp (NEXT)*	*110.3*	mm
C_p	[0.87e-4 0.87e-4]	nF	[TX RX]		T_r	0.0075	ns	*z_bp (FEXT)*	*110.3*	mm
R_0	50	Ohm			FORCE_TR	1	logical	*z_bp (RX)*	*110.3*	mm
R_d	[50 50]	Ohm	[TX RX]		Local Search	2		*C_0*	[0.29e-4]	nF
A_v	0.413	V			BREAD_CRUMBS	1	logical	*C_1*	[0.19e-4]	nF
A_fe	0.413	V			SAVE_CONFIG2MAT	1	logical	**Include PCB**	**0**	**logical**
A_ne	0.608	V			PLOT_CM	0		**Floating Tap Control**		
AC_CM_RMS	0	V	[test cases]	[0.0235 0.0256]	**TDR and ERL options**			N_bg	0	0 1 2 or 3 groups
L	4				TDR	1	logical	N_bf	3	taps per group
M	32				ERL	1	logical	N_f	40	UI span for floating taps
filter and Eq					ERL_ONLY	0	logical	bmaxg	0.05	max DFE value for floating taps
f_r	0.75	*fb			TR_TDR	0.01	ns	B_float_RSS_MAX	0.02	rss tail tap limit
c(0)	0.54		min		N	2000		N_tail_start	25	(UI) start of tail taps limit
c(-1)	[-0.28:0.02:0]		[min:step:max]		beta_x	0		**ICN parameters**		
c(-2)	[0:0.02:0.1]		[min:step:max]		rho_x	0.618		f_v	0.594	*Fb
c(-3)	[-0.04:0.02: 0]		[min:step:max]		fixture delay time	[0 0]	[port1 port2]	f_f	0.594	*Fb
c(1)	[-0.1:0.02:0]		[min:step:max]		TDR_W_TXPKG	0		f_n	0.594	*Fb
N_b	6	UI			N_bx	6	UI	f_2	40.000	GHz
b_max(1)	0.65				Tukey_Window	1	logical	A_ft	0.600	V
b_max(2..N_b)	[0.15 0.1*ones(1,4)]				**Noise, jitter**			**A_nt**	**0.600**	V
b_min(1)	0.3				sigma_RJ	0.01	UI			
b_min(2..N_b)	[0.05 -0.04*ones(1,4)]				A_DD	0.02	UI	**Receiver testing**		
g_DC	[-20:1:0]	dB	[min:step:max]		eta_0	2.00E-08	V^2/GHz	RX_CALIBRATION	0	logical
f_z	21.25	GHz			SNR_TX	33	dB	Sigma BBN step	5.00E-03	V
f_p1	21.25	GHz			R_LM	0.95				
f_p2	53.125	GHz								
g_DC_HP	[-4:1:0]		[min:step:max]							
f_HP_PZ	0.6640625	GHz								

Suggestion for estimating host design VEC/EH (120G.3.2.1) at tp1a

Table 93A-1 parameters				
Parameter	**Setting**	**Units**	**Information**	
f_b	53.125	GBd		
f_min	0.05	GHz		
Delta_f	0.01	GHz		
C_d	[1.2e-4 0]	nF	[TX RX]	
L_s	[0.12 0]	nH	[TX RX]	
C_b	[0.3e-4 0]	nF	[TX RX]	
z_p select	[1 2]		[test cases to run]	
z_p (TX)	[15 30; 1.8 1.8]	mm	[test cases]	
z_p (NEXT)	[0 0 ; 0 0]	mm	[test cases]	
z_p (FEXT)	[15 30; 1.8 1.8]	mm	[test cases]	
z_p (RX)	[0 0 ; 0 0]	mm	[test cases]	
C_p	[0.87e-4 0]	nF	[TX RX]	
R_0	50	Ohm		
R_d	[50 50]	Ohm	[TX RX]	
A_v	0.415	V		
A_fe	0.415	V		
A_ne	0.450	V		
L	4			
M	32	Samp/UI		
samples_for_C2M	100	Samp/UI		
T_O	50	mUI		
AC_CM_RMS	0	V	[test cases]	[0.0235 0.0256]
filter and Eq				
f_r	0.75	*fb		
c(0)	0.54		min	
c(-1)	[-0.2:0.02:0]		[min:step:max]	
c(-2)	[0:0.02:0.1]		[min:step:max]	
c(-3)	[0]		[min:step:max]	
c(1)	[-0.1:0.02:0]		[min:step:max]	
N_b	4	UI		
b_max(1)	**0.4**		**As/dffe1**	
b_max(2..N_b)	**[0.15 0.15 0.1]**		**As/dfe2..N_b**	
b_min(1)	**0.1**		**As/dffe1**	
b_min(2..N_b)	**[-0.15 - 0.15 - 0.05]**		**As/dfe2..N_b**	
g_DC	[-13:1:-0]	dB	[min:step:max]	
f_z	12.58	GHz		
f_p1	20	GHz		
f_p2	28	GHz		
g_DC_HP	[-3:0.5:0]		[min:step:max]	
f_HP_PZ	1.328125	GHz		
G2_Qual	[0 -1 -2 -3]	dB	ranges	

I/O control		
DIAGNOSTICS	1	logical
DISPLAY_WINDOW	1	logical
CSV_REPORT	1	logical
RESULT_DIR	.\results\100GEL_C2M_host_{date}	
SAVE_FIGURES	0	logical
Port Order	[1 3 2 4]	
RUNTAG	C2M_eval_	
COM_CONTRIBUTION	0	logical
Local Search	2	
Operational		
VEC Pass threshold	12	db
EH_min	10	mV
ERL Pass threshold	7.3	dB
Min_VEO_Test	10	mV
DER_0	0.00001	
T_r	0.0075	ns
FORCE_TR	1	logical
PMD_type	C2M	
BREAD_CRUMBS	0	logical
SAVE_CONFIG2MAT	1	logical
PLOT_CM	0	logical
TDR and ERL options		
TDR	1	logical
ERL	1	logical
ERL_ONLY	0	logical
TR_TDR	0.01	ns
N	800	
beta_x	0	
rho_x	0.618	
fixture delay time	[0 0.3e-9]	[port1 port2]
TDR_W_TXPKG	1	
N_bx	0	UI
Tukey_Window	1	
Receiver testing		
RX_CALIBRATION	0	logical
Sigma BBN step	5.00E-03	V
Noise, jitter		
sigma_RJ	0.01	UI
A_DD	0.02	UI
eta_0	4.10E-08	V^2/GHz
SNR_TX	32.5	dB

Table 93A–3 parameters		
Parameter	**Setting**	**Units**
package_tl_gamma0_a1_a2	[0 0.0009909 0.0002772]	
package_tl_tau	6.141E-03	ns/mm
package_Z_c	[87.5 87.5 ; 92.5 92.5]	Ohm
ICN & FOM_ILD parameters		
f_v	0.594	*Fb
f_f	0.594	GHz f_r specified in first column
f_n	0.594	GHz
f_2	40	GHz
A_ft	0.600	V
A_nt	0.600	V

Histogram_Window_Weight	rectangle	Seletions (rectangle, gaussian,dual_rayleigh,triangle

Review of COM 3.1 update

New Key Words for 3.1

KeywordC	default	Uiits	Status	
T_O	0	mUI	Use for C2M	If 0, find VEC an EH at T_s
samples_for_C2M	100	samples/UI	Use for C2M	timing resampled step
Min_VEO_Test	0		experimental	
AC_CM_RMS	0	Volts	experimental	
ACCM_MAX_Freq	fb	Hz	experimental	

Change determining VEC and EH for 3.1

- Requirements
  - PMD_type is C2M
  - T_O is not 0
- T_0 the +/- window around the sample point (t_s) where EH and VEC are estimated
  - IEEE Draft P802.3ck/D1.4 120G p 246
- T_O should be set to 50 mUI as per D1.4
- samples_for_C2M is set to 100 samples/UI to increase timing resolution from M (32) samples/UI
- Min_VEO_Test set to a non-zero value breaks the optimization loop for values EH less that Min_VEO_Test volts.
  - If 0, the EH in not considered for in the optimization loop.
  - Since we really don't know what EH and VEC spec needs to be, set to 0 for now

Experimental for CM investigation in 3.1

- AC_CM_RMS is the CM BBN AWGN RMS at COM source point
  - Default is zero
  - Adds common mode noise source to the COM signal path for the through channel

- ACCM_MAX_Freq
  - Max frequency to integrate noise over a the Rx
  - Defaults is f_b