

# **Module ERL: Process to determine $ERL_{min}$** **Relating to comments 66, 101, 191**

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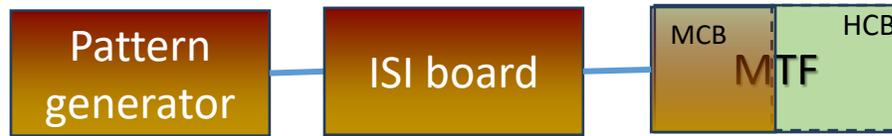
- ❑ Rx Module Compliance Review
- ❑ COM and ERL Experiment
- ❑ DOE (Design of Experiments) Variables
- ❑ Results and Recommendations

# Rx Module Compliance: Steps

- ❑ Calibrate at TP1a using mated test fixture and frequency dependent attenuator (AKA ISI board). (Figure 176E–8a)
  - COM simulation at 3dB is used as a proxy until Rx compliance module data is better defined.
- ❑ Verify ERL of the Module is greater than  $ERL_{min}$
- ❑ Remove the host Compliance board and plug in the module. (Figure 176E–8a)
- ❑ Verify the Module PMA has measured block error ratio better than  $1.45e-11$ 
  - In simulations this equates to 3 dB of COM at the specified DER0

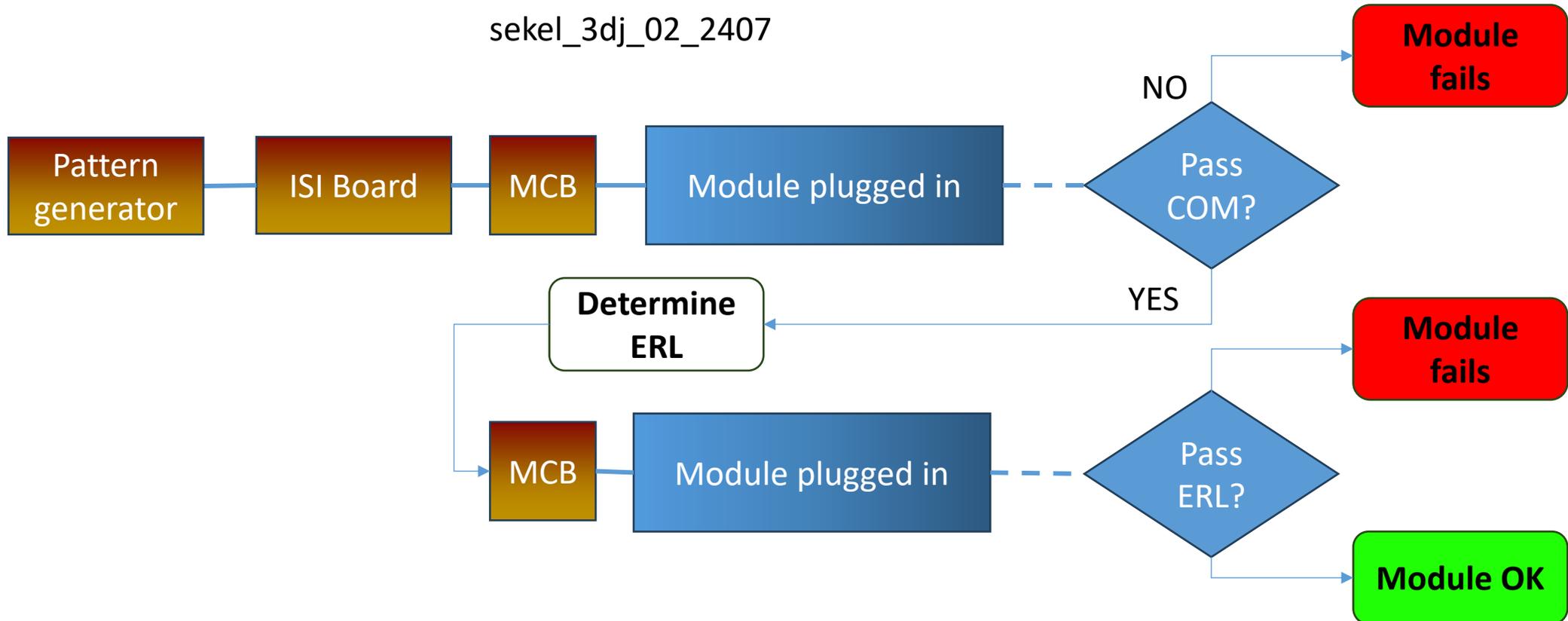
# Rx Module Compliance Experiment

TO DETERMINE COM AND ERL



Use ISI board that has ~3 dB COM, adjust SNDR to tune

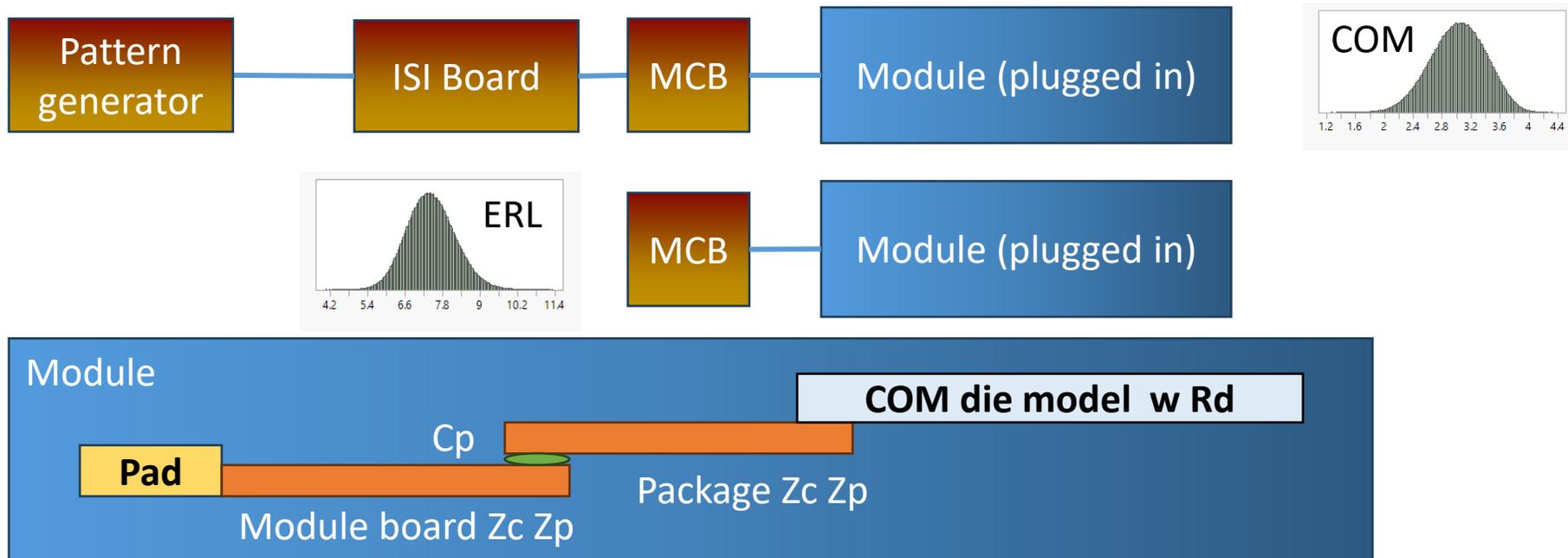
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# Experiment: Compare COM to ERL for a Distribution of Modules

ONE COM SCRIPT RUN FOR ERL AND ONE FOR ERL

- ❑ Adjust physical module parameters to yield a COM distribution centered on 3 dB
- ❑ “Impactful” COM parameters are chosen for DOE

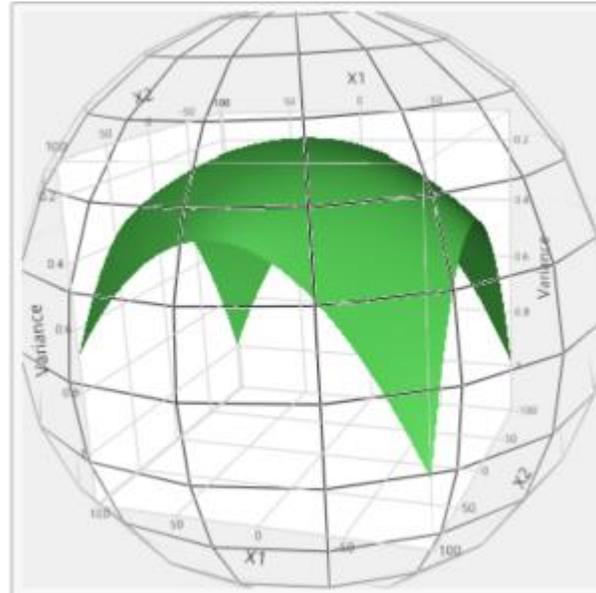


# DOE parameters that cause noticeable reflections

- ❑ Other parameters were considered but these were the most impactful on COM
- ❑ Impactful variables sensitized for reflection are required for a good experiment fit

DOE parameter	Min	Max
Module Zp (mm)	10	20
Module Zc (Ohms)	70	130
package Zp (mm)	2	10
package Zc (Ohms)	70	130
Cp (fF)	20	100
Rd (Ohms)	40	50
Nbx (UI)	0	28

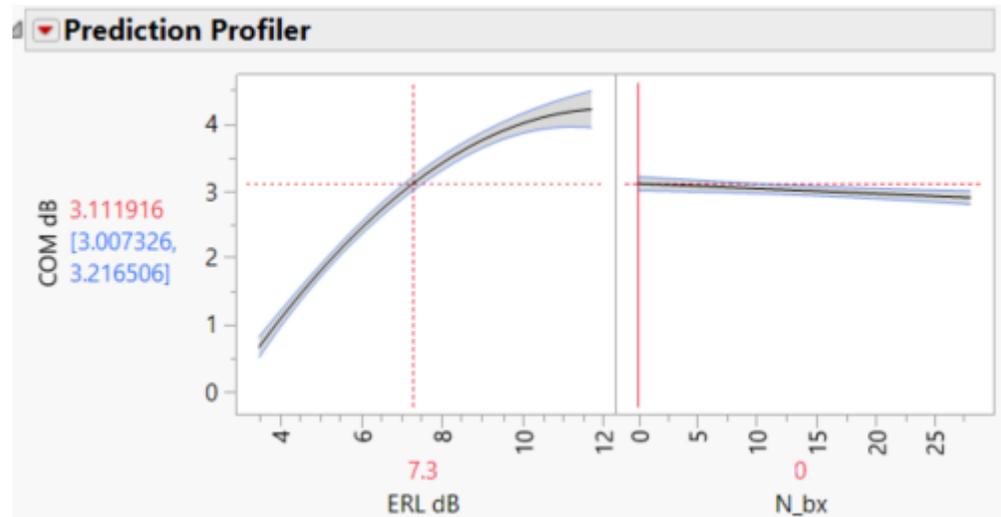
# A large range yields a better fit prediction even though it may not be actual



A large range is like using a tablecloth to determine the contour and outline of a table rather than using a single napkin.

# Find $ERL_{min}$

- ❑ Determine what value of ERL corresponds to  $COM = 3$  dB plus experiment uncertainty
- ❑ Set  $N_{bx} = 0$  for ERL computation
  - RxFFE seems to be more effective at reducing far reflections DFE.
- ❑ Recommend setting  $ERL_{min}$  to 7.3 dB for a C2M module



$R^2$  0.98

$R^2$  0.96

# Recommendations

- ❑ Set  $N_{bx} = 0$  for ERL computations
  - Apply to comment 192 and 101
- ❑ Recommend setting  $ERL_{min}$  to 7.3 dB for a C2M module in 120G.3.2 and in 120G.3.4
  - Update respective value in comment 66
- ❑ Base ERL determinations on compliance testing

# Thank You!

# COM spreadsheet – Main Body

Green cells were altered in experiment

Table 93A-1 parameters			
Parameter	Setting	Units	Information
f_b	106.25	GBd	
f_min	0.05	GHz	
Delta_f	0.01	GHz	
R_0	50	Ohm	[TX RX]
PKG_NAME	PKG_TST_EQUIP	PKG_Module	TX RX
z_pselect	[ 1 ]		
L	4		
M	32		
filter and Eq			
f_r	0.565	*fb	
c(0)	0.54		min
c(-1)	0		[min:step:max]
c(-2)	0		[min:step:max]
c(-3)	0		[min:step:max]
c(-4)	0		[min:step:max]
c(1)	0		[min:step:max]
N_b	1	UI	
b_max(1)	0.85		As/dffe1
b_max(2..N_b)	0		As/dfe2..N_b
b_min(1)	0		As/dffe1
b_min(2..N_b)	-0.15	UI	NA if Nb=1
g_DC	[-20:1:0]	dB	[-20:1:0]
f_z	42.50	GHz	
f_p1	42.50	GHz	
f_p2	106.25	GHz	
g_DC_HP	[-6:1:0]		[min:step:max]
f_HP_PZ	1.328125	GHz	

I/O control		
DIAGNOSTICS	1	logical
DISPLAY_WINDOW	1	logical
CSV_REPORT	0	logical
RESULT_DIR	.\results\C2M_{date}\	
SAVE_FIGURES	0	logical
Port Order	[ 2 4 1 3 ]	input fi
RUNTAG	C2M_	
COM_CONTRIBUTION	0	logical
TDR and ERL options		
TDR	1	logical
ERL	1	logical
ERL_ONLY	0	logical
TR_TDR	1	ns
N	1600	UI
TDR_Butterworth	1	
beta_x	1	
rho_x	1	
TDR_W_TXPKG	0	UI
N_bx	0	UI
fixture delay time	[ 0 1.7e-9 ]	S
Tukey_Window	1	
Noise, jitter		
sigma_RJ	0.01	UI
A_DD	0.02	UI
eta_0	1.00E-08	V^2/GHz
SNR_TX	33	dB
R_LM	0.95	
Host chip to Module (AUI)		

Operational		
ERL Pass threshold	10	dB
COM Pass threshold	3	db
DER_0	2.00E-05	
T_r	0.00400	ns
FORCE_TR	1	logical
PMD_type	C2M	
samples_for_C2M	100	
T_0	50	
EW	1	
MLSE	0	logical
ts_anchor	1	
sample_adjustment	[-12 12]	
Local Search	0	
Filter: Rx FFE		
ffe_pre_tap_len	5	UI
ffe_post_tap_len	14	UI
ffe_pre_tap1_max	0.7	interpreted as +/-
ffe_post_tap1_max	0.7	interpreted as +/-
ffe_tapn_max	0.7	interpreted as +/-
FFE_OPT_METHOD	MMSE	
num_ui_RXFF_noise	1024	
Floating Tap Control		
N_bg	2	0 1 2 or 3 groups
N_bf	4	taps per group
N_f	50	UI span for floating taps
bmaxg	0.05	max DFE value for floating taps
B_float_RSS_MAX	1	rss tail tap limit
N_tail_start	15	(UI) start of tail taps limit

SAVE_CONFIG2MAT	0	
Receiver testing		
RX_CALIBRATION	0	logical
Sigma BBN step	5.00E-03	V
ICN parameters		
f_v	0.278	Fb
f_f	0.278	Fb
f_n	0.278	Fb
f_2	60.000	GHz
A_ft	0.450	V
A_nt	0.450	V
Parameter Setting		
board_tl_gamma0_a1_a2	[0 2.7784e-04 4.7955e-05]	1.0 db/in @ 53.125G
board_tl_tau	5.790E-03	ns/mm
board_Z_c	100	Ohm
z_bp (TX)	0	mm
z_bp (NEXT)	0	mm
z_bp (FEXT)	0	mm
z_bp (RX)	0	mm
C_0	[ 0 0 ]	nF
C_1	[0 0.2e-4]	nF
Include PCB	1	logical
Seletions (rectangle, gaussian,dual_rayleigh,triangle		
Histogram_Window_Weight	gaussian	selection
Qr	0.02	UI

# COM spreadsheet – Package section

.START	PKG_TST_EQUIP	only Tx used	
Parameter	Setting	Units	Information
C_d	[0.4e-4 0.9e-4 1.1e-4; 0.4e-4 0.9e-4 1.1e-4]	nF	[TX RX]
L_s	[0.13 0.15 0.14; 0.13 0.15 0.14]	nH	[TX RX]
C_b	[0.3e-4 0.3e-4]	nF	[TX RX]
package_tl_gamma0_a1_a2	[ 0.0005 0.00065 0.000293 ]		
package_tl_tau	0.006141	ns/mm	
package_Z_c	[87.5 87.5 ; 95 95 ; 100 100; 78 78]	Ohm	
R_d	[ 46.25 46.25 ]	Ohm	[TX RX]
z_p (TX)	[ 0 0 0 ; 0 0 0 ; 0 0 0 ; 0 0 0 ]	mm	[test cases]
z_p (NEXT)	[ 0 0 0 ; 0 0 0 ; 0 0 0 ; 0 0 0 ]	mm	[test cases]
z_p (FEXT)	[ 0 0 0 ; 0 0 0 ; 0 0 0 ; 0 0 0 ]	mm	[test cases]
z_p (RX)	[ 0 0 0 ; 0 0 0 ; 0 0 0 ; 0 0 0 ]	mm	[test cases]
C_p	[ 0 0 ]	nF	[TX RX]
A_v	0.413	V	Vf=0.400
A_fe	0.413	V	Vf=0.399
A_ne	0.45	V	Vf=0.400
.END			
.START	PKG_Module	only Rx used	
Parameter	Setting	Units	Information
C_d	[0.4e-4 0.9e-4 1.1e-4; 0.4e-4 0.9e-4 1.1e-4]	nF	[TX RX]
L_s	[0.13 0.15 0.14; 0.13 0.15 0.14]	nH	[TX RX]
C_b	[0.3e-4 0.3e-4]	nF	[TX RX]
Parameter	Setting	Units	Information
package_tl_gamma0_a1_a2	[ 0.0005 0.00089 0.0002 ]		
package_tl_tau	0.006141	ns/mm	
package_Z_c	[87.5 87.5 ; 95 95 ; 100 100; 100 100]	Ohm	
C_b	[0.3e-4 0.6e-4]	nF	[TX RX]
R_d	[ 50 50 ]	Ohm	[TX RX]
z_p (TX)	[ 0 0 0 ; 0 0 0 ; 0 0 0 ; 0 0 0 ]	mm	[test cases]
z_p (NEXT)	[ 0 0 0 ; 0 0 0 ; 0 0 0 ; 0 0 0 ]	mm	[test cases]
z_p (FEXT)	[ 0 0 0 ; 0 0 0 ; 0 0 0 ; 0 0 0 ]	mm	[test cases]
z_p (RX)	[ 0 0 0 ; 0 0 0 ; 0 0 0 ; 0 0 0 ]	mm	[test cases]
C_p	[ 0 0 ]	nF	[TX RX]
A_v	0.413	V	Vf=0.400
A_fe	0.413	V	Vf=0.399
A_ne	0.45	V	Vf=0.400
.END			

Green cells were altered in experiment