

# Channel Operating Margin Program Usage, Review, and Plans

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Inclusion of comment resolutions from,  
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IEEE802.3bj Geneva Interim

# Operation

- Running com2l
  - Interactive file input (Q/A)
    - Spreadsheet selection windows
    - File selection windows
  - Scriptable single line entry
- Spreadsheet (XLS file) configures parameters
  - Values in most sheet slides are syntax examples unless noted
- Versions
  - 1.05 (com2L\_r105) on Geneva, 09-2012 meeting site
  - 1.06 will be updated to Draft 1.2
  - 1.07 proposed changes
- Output
  - Display to MatLab® window
  - Frequency plots to floating window
  - Floating progress windows
- The COM2L runs in MatLab® version 7
- First step – check/edit configuration spreadsheet
- Next step – run com2l in MatLab®

# Configuration Spreadsheet: Select Port Type, r1.06

	A	B	C	D	E	F	G
1	Parameter	Setting		Coding/Port Type	Operational Control		
2	Coding/Port Type	NRZ Clause 93 d1.2		NRZ Clause 93 d1.2	INCLUDE_CTL	1	
3	Signal Rate (fb)	25.78125	GHz	NRZ/FEC Clause 93 d1.2	INCLUDE_TX_RX_FILTER	1	
4	[c(-1) c(1)]	[-.1 -.4]		PAM4 Clause 94 d.1.2	DEBUG	1	
5	Nb	14	UI	NRZ Clause 93 alt	DISPLAY_WINDOW	1	
6	Gdc, for CTF	-12	dB	NRZ/FEC Clause 93 alt	CSV_REPORT	1	
7	Av	0.4	V	PAM4 Clause 94 alt	SAVE_RESP	0	
8	Af	0.4	V		GET_FD	1	
9	An	0.6	V		INC_PACKAGE_RL	1	
10	L	2			USE_EXTERNAL_PARAM	0	
11	SERO	1.00E-12			RESULT_DIR	est_results\	
12	CC1	3			INC_PACKAGE_H	1	
13	sigma_rj	0.01					
14	Add	0.1					
15	sigma_r						
16	Samples Per UI						
17	Port Order						
18	Gamma_01						
19	Gamma_02						
20	f1						
21	f2						
22	CTF_step						
23	TXFFE_step						
24	bmax						
25	f_v	0.55	*fb				
26	f_f	0.55	*fb				
27	f_n	1	*fb				
28	f_r	0.75	*fb				
29	PKG_a1	2.91E+00	ers/m/GHz^1/2				
30	PKG_a2	4.84E-01	epers/m/GH				
31	PKG_a4	5.87E-02	pers/m/GH				
32	PKG_L_tl	7.07E-03	m				
33	PKG_C_d	2.50E-04	nF				
34	PKG_C_b	2.20E-04	nF				
35	PKG_vp	0.182	m/ns				
36	PKG_RO	50	ohm				
	PKG_Ed	11.9	%				

Grey areas are new

Coding and port type selection roller

Data can be directly entered or defaults can be set in the lookup data table tab when using the selection roller.

r1.06

	A	B	C	D	E	F	G
1	Parameter	Setting		Coding/Port Type	Operational Control		
2	Coding/Port Type	NRZ Clause 93 d1.2		NRZ Clause 93 d1.2	INCLUDE_CTL	1	
3	Signal Rate (fb)	25.78125	GHz	NRZ/FEC Clause 93 d1.2	INCLUDE_TX_RX_FILTER	1	
4	[c(-1) c(1)]	[-1 -.4]		PAM4 Clause 94 d.1.2	DEBUG	1	
5	Nb	14	UI	NRZ Clause 93 alt	DISPLAY_WINDOW	1	
6	Gdc, for CTF	-12	dB	NRZ/FEC Clause 93 alt	CSV_REPORT	1	
7	Av	0.4	V	PAM4 Clause 94 alt	SAVE_RESP	0	
8	Af	0.4	V		GET_FD	1	
9	An	0.6	V		INC_PACKAGE_RL	1	
10	L	2			USE_EXTERNAL_PARAM	0	
11	SERO	1.00E-12			RESULT_DIR	est_results\	
12	CC1	3			INC_PACKAGE_IL	1	
13	sigma_rj	0.01	UI				
14	Add	0.1	UI				
15	sigma_r	0.001	V				
16	Samples Per UI	32					
17	Port Order	[1 3 2 4]					
18	Gamma_01	0.315	V/V				
19	Gamma_02	0.315	V/V				
20	f1	20.625	GHz				
21	f2	20.625	GHz				
22	CTF_step	1	dB				
23	TXFFE_step	0.02					
24	bmax	1					
25	f_v	0.55	*fb				
26	f_f	0.55	*fb				
27	f_n	1	*fb				
28	f_r	0.75	*fb				
29	PKG_a1	2.91E+00	ers/m/GHz^1/2				
30	PKG_a2	4.84E-01	epers/m/GH				
31	PKG_a4	5.87E-02	ers/m/GHz^2				
32	PKG_L_tl	7.07E-03	m				
33	PKG_C_d	2.50E-04	nF				
34	PKG_C_b	2.20E-04	nF				
35	PKG_vp	0.182	m/ns				
36	PKG_R0	50	ohm				
37	PKG_Ed	11.9	%				

# D1.2 Sheet: KR4 for r1.06

	A	B	C	D	E	F	G
1	Parameter	Setting		Coding/Port Type	Operational Control		
2	Coding/Port Type	NRZ/FEC Clause 93 d1.2		NRZ Clause 93 d1.2	INCLUDE_CTL	1	
3	Signal Rate (fb)	25.78125	GHz	NRZ/FEC Clause 93 d1.2	INCLUDE_TX_RX_FILTER	1	
4	[c(-1) c(1)]	[-.1 -.4]		PAM4 Clause 94 d.1.2	DEBUG	1	
5	Nb	14	UI	NRZ Clause 93 alt	DISPLAY_WINDOW	1	
6	Gdc, for CTF	-12	dB	NRZ/FEC Clause 93 alt	CSV_REPORT	1	
7	Av	0.4	V	PAM4 Clause 94 alt	SAVE_RESP	0	
8	Af	0.4	V		GET_FD	1	
9	An	0.6	V		INC_PACKAGE_RL	1	
10	L	2			USE_EXTERNAL_PARAM	0	
11	SERO	1.00E-05			RESULT_DIR	est_results\	
12	CC1	3			INC_PACKAGE_IL	1	
13	sigma_rj	0.01	UI				
14	Add	0.1	UI				
15	sigma_r	0.001	V				
16	Samples Per UI	32					
17	Port Order	[1 3 2 4]					
18	Gamma_01	0.315	V/V				
19	Gamma_02	0.315	V/V				
20	f1	20.625	GHz				
21	f2	20.625	GHz				
22	CTF_step	1	dB				
23	TXFFE_step	0.02					
24	bmax	1					
25	f_v	0.55	*fb				
26	f_f	0.55	*fb				
27	f_n	1	*fb				
28	f_r	0.75	*fb				
29	PKG_a1	2.91E+00	ers/m/GHz^1/2				
30	PKG_a2	4.84E-01	apers/m/GH				
31	PKG_a4	5.87E-02	ers/m/GHz^2				
32	PKG_L_tl	7.07E-03	m				
33	PKG_C_d	2.50E-04	nF				
34	PKG_C_b	2.20E-04	nF				
35	PKG_vp	0.182	m/ns				
36	PKG_R0	50	ohm				
37	PKG_Ed	11.9	%				

## D1.2 Sheet: KR4/FEC for r1.06

	A	B	C	D	E	F	G
1	Parameter	Setting		Coding/Port Type	Operational Control		
2	Coding/Port Type	PAM4 Clause 94 d.1.2		NRZ Clause 93 d1.2	INCLUDE_CTL	1	
3	Signal Rate (fb)	13.59375	GHz	NRZ/FEC Clause 93 d1.2	INCLUDE_TX_RX_FILTER	1	
4	[c(-1) c(1)]	[-.1 -.4]		PAM4 Clause 94 d.1.2	DEBUG	1	
5	Nb	16	UI	NRZ Clause 93 alt	DISPLAY_WINDOW	1	
6	Gdc, for CTF	-12	dB	NRZ/FEC Clause 93 alt	CSV_REPORT	1	
7	Av	0.4	V	PAM4 Clause 94 alt	SAVE_RESP	0	
8	Af	0.4	V		GET_FD	1	
9	An	0.6	V		INC_PACKAGE_RL	1	
10	L	4			USE_EXTERNAL_PARAM	0	
11	SER0	1.00E-05			RESULT_DIR	est_results\	
12	CC1	3			INC_PACKAGE_IL	1	
13	sigma_rj	0.005	UI				
14	Add	0.05	UI				
15	sigma_r	0.001	V				
16	Samples Per UI	32					
17	Port Order	[1 3 2 4]					
18	Gamma_01	0.315	V/V				
19	Gamma_02	0.315	V/V				
20	f1	20.625	GHz				
21	f2	20.625	GHz				
22	CTF_step	1	dB				
23	TXFFE_step	0.02					
24	bmax	0.2					
25	f_v	0.55	*fb				
26	f_f	0.55	*fb				
27	f_n	1	*fb				
28	f_r	0.75	*fb				
29	PKG_a1	2.91E+00	ers/m/GHz^1/2				
30	PKG_a2	4.84E-01	epers/m/GH				
31	PKG_a4	5.87E-02	ers/m/GHz^2				
32	PKG_L_tl	7.07E-03	m				
33	PKG_C_d	2.50E-04	nF				
34	PKG_C_b	2.20E-04	nF				
35	PKG_vp	0.182	m/ns				
36	PKG_RO	50	ohm				
37	PKG_Ed	11.9	%				

## D1.2 Sheet: KP4 for r1.06

# Parameter list (1.06)

Example Setting		
Coding/Port Type	NRZ Clause 93 D1.1	selector for port type name
Signal Rate (fb)	25.78125	Signal. Used to calculate unit interval
[c(-1) c(1)]	[-.1 -.4]	Transmitter equalizer, max pre and post cursor coefficient
Nb	14	Victim single bit response exception window (in UI). Decision feedback equalizer (DFE) length
Gdc, for CTF	-12	Continuous time filter, max DC gain
Av	0.4	
Af	0.4	Transmitter differential peak output voltage for Far-end aggressor
An	0.6	Transmitter differential peak output voltage for Near-end aggressor
L	2	related to number of levels, L (symbol gain)
SER0	1.00E-12	Target uncorrected symbol error ratio
CC1	3	Minimum channel operating margin
sigma_rj	0.01	Normalized RMS Gaussian noise
Add	0.1	Normalized peak dual-Dirac noise
sigma_r	0.001	voltage sensitivy RMS Gaussian noise
Samples Per UI	32	
Port Order	[1 3 2 4]	for the 4 ports the first two listed are inputs and respective last two are outputs (RX)
Gamma_01	0.315	Transmitter reflection coefficient DC value. Values < .01 disables
Gamma_02	0.315	Receiver reflection coefficient DC value. Values < .01 disables
f1	20.625	Transmitter reflection coefficient reference frequency scale. Value > 2 disables
f2	20.625	Receiver reflection coefficient reference frequency scale. Value > 2 disables
CTF_step	1	Continuous time filter step size dB
TXFFE_step	0.02	Transmitter equalizer, pre/post cursor coefficient step size
bmax	1	max in W region
f_v	0.55	Transmitter 3 dB bandwidth for victim. Set to > 2 to deactivate
f_f	0.55	Transmitter 3 dB bandwidth for Far-end aggressor. Set to > 2 to deactivate
f_n	1	Transmitter 3 dB bandwidth for Near-end aggressor. Set to > 2 to deactivate
f_r	0.75	Receiver 3dB bandwidth
PKG_a1	2.91E+00	package loss fit a1
PKG_a2	4.84E-01	package loss fit a2
PKG_a4	5.87E-02	package loss fit a3
PKG_L_tl	7.07E-03	package lenght (m)
PKG_C_d	2.50E-04	die capacitance load (nF)
PKG_C_b	2.20E-04	BGA/interconnect capacitance load (nF)
PKG_vp	0.182	propation velocity
PKG_R0	50	ref impedance
PKG_Ed	11.9	possibe % impedance variation

# Operational Control

INCLUDE_CTLE	0 = do not include CTLE 1 = include CTLE. Will eventually be removed
INCLUDE_FILTER	0 = do not include TX/RX filters 1 = include TX/RX filters. Will eventually be removed
DEBUG	0 = do not print internal data; 1 = prints and graphs internal data. Shows equalization settings
DISPLAY_WINDOW	0 - do not display FD graphs 1 - display FD graphs (IL, ILD, ICR, RL, MDPST)
CSV_REPORT	0 - do not create CSV report file 1- create CSV report file in .\results directory
SAVE_RESP	0 - do no save channel time domian data 1 - save channel time domian data in mat file
GET_FD	0 - do not report frequency domain metrics 1 - report some frequency domain metrics
INC_PACKAGE	0 - do not use package models <b>1 – use proposal 1 for h21(f) (d1.1), benartsi_3bj_02_0912, p 9</b> 2 – use proposal 2 for h21(f), benartsi_3bj_02_0912, p 9 3 – use proposal 3 for h21(f), benartsi_3bj_02_0912, p 9 4 – use proposal 4 for h21(f), benartsi_3bj_02_0912, p 9
USE_EXTERNAL_PARAM	set to 0 . Will eventually be removed
RESULT_DIR	Point to the results directory. Full directory path ending in “\ ” or “/ ” is recommended
PKG_LOSS	0 – do not include package insertion loss <b>1- include package insertion loss</b>



# CSV and display outputs

Output Parameters	
channel_operating_margin_dB: (COM)	Figure of merit. Adjusted so that above zero passes and below fails
peak_interference_mV:	Peak interference on channel include chip and system noise. For a test type of channel, this would be the value for additive rx tolerance injected noise. Since this is peak value of interference, dividing by 7 may be the amount of rms noise from an AWGN generator. Peak interference is measure at the spec BER.
peak_channel_interference_mV:	The peak interference. contribution for residual ISI and crosstalk.
peak_ISI_mV:	The peak interference. contribution for residual ISI.
peak_MDXTK_interference_mV:	The peak interference. contribution for all crosstalk.
icn_mV:	If FD is selected this is the integrated crosstalk noise. Information about channel design may discerned from $7 \times \text{ICN} - \text{peak\_MDXTK\_interference}$
peak_MDNEXT_interference_mV:	The peak interference contribution for all NEXT crosstalk.
peak_MDFEXT_interference_mV:	The peak interference contribution for all FEXT crosstalk.
available_signal_after_eq_mV:	Essentially the “zero-first-precursor” signal height after filtering and reference equalization
fit_loss_dB_at_Fnq:	If FD is selected this is the value of the fitted IL loss at Nyquist. Same as SCAT, IL_fit_atNq
IL_dB_at_Fnq:	If FD is selected this is the value of the IL loss at Nyquist.
ILD_RMS:	This may be useful for a quick evaluation of a channel. It is the RMS of the Insertion Loss Deviation in dB
file_names:	List of channel files

# Syntax 1.06 example

```
function [ output_args ] =com21(coding, num_fext,  
num_next, varargin)
```

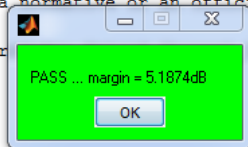
- output\_args is a structure with results
- coding is string containing the full path name of the configuration spreadsheet
- num\_fext is the number for fext s4p files
- num\_next is the number for next s4p files
- All the reset of the arguments are strings containing the respective full path names of through, fext, and next files

## Result screen

This is not a normative or an official IEEE  
Files set is:  
TEC\_STRADAWhisper  
co6\_THRU\_C8C9

ans =

```
channel_operating_margin_dB: 5.1874  
peak_interference_mV: 6.7000  
peak_channel_interference_mV: 4.6000  
peak_ISI_mV: 3.1000  
peak_MDXTK_interference_mV: 2.9000  
icn_mV: 1.5335  
peak_MDNEXT_interference_mV: 2.4000  
peak_MDFEXT_interference_mV: 1.1000  
available_signal_after_eq_mV: 12.1744  
fit_loss_dB_at_Fnq: 20.1695  
IL_dB_at_Fnq: 19.8332  
baud_rate_GHz: 13.5938  
ILD_RMS: 0.1216  
file_names: [8x101 char]
```



```
>> com21_r106('config_COM2L_106.xls', 3,  
4, 'J:\2012_TEMP\IEEE802.3bj\channels\models\shanbhag_02_0411\TEC_STRADAWhisper29p8in_Nel  
co6_Channel_IEEE802_3_100GbCu_04282011\TEC_Whisper29p8in_Nelco6_THRU_C8C9.s4p',  
'J:\2012_TEMP\IEEE802.3bj\channels\models\shanbhag_02_0411\TEC_STRADAWhisper29p8in_Nelco  
6_Channel_IEEE802_3_100GbCu_04282011\TEC_Whisper29p8in_Nelco6_FEXT_B8B9_C8C9.s4p',  
'J:\2012_TEMP\IEEE802.3bj\channels\models\shanbhag_02_0411\TEC_STRADAWhisper29p8in_Nelco  
6_Channel_IEEE802_3_100GbCu_04282011\TEC_Whisper29p8in_Nelco6_FEXT_C11C12_C8C9.s4p',  
'J:\2012_TEMP\IEEE802.3bj\channels\models\shanbhag_02_0411\TEC_STRADAWhisper29p8in_Nelco  
6_Channel_IEEE802_3_100GbCu_04282011\TEC_Whisper29p8in_Nelco6_FEXT_D8D9_C8C9.s4p',  
'J:\2012_TEMP\IEEE802.3bj\channels\models\shanbhag_02_0411\TEC_STRADAWhisper29p8in_Nelco  
6_Channel_IEEE802_3_100GbCu_04282011\TEC_Whisper29p8in_Nelco6_NEXT_B8B9_C8C9.s4p',  
'J:\2012_TEMP\IEEE802.3bj\channels\models\shanbhag_02_0411\TEC_STRADAWhisper29p8in_Nelco  
6_Channel_IEEE802_3_100GbCu_04282011\TEC_Whisper29p8in_Nelco6_NEXT_C11C12_C8C9.s4p',  
'J:\2012_TEMP\IEEE802.3bj\channels\models\shanbhag_02_0411\TEC_STRADAWhisper29p8in_Nelco  
6_Channel_IEEE802_3_100GbCu_04282011\TEC_Whisper29p8in_Nelco6_NEXT_C5C6_C8C9.s4p',  
'J:\2012_TEMP\IEEE802.3bj\channels\models\shanbhag_02_0411\TEC_STRADAWhisper29p8in_Nelco  
6_Channel_IEEE802_3_100GbCu_04282011\TEC_Whisper29p8in_Nelco6_NEXT_D8D9_C8C9.s4p')
```

# Interactive file input example

INPUT CONFIG FILE.xls

Look in: COM2L\_100

Name Date modified

NRZ\_result  
old  
PAM4\_resu  
result  
results  
test\_results  
config\_COM2L\_105.xls  
config\_COM2L\_105a.xls  
config\_COM2L\_106.xls  
config\_COM2L\_106\_liav.xls  
config\_COM2L\_mod1.xls  
config\_COM2L\_new\_pkg\_clte75.xls  
confia COM2L new pka halfitter.xls

File name: config\_COM2L\_106.xls  
Files of type: (\*.xls)

input thru channel response.s4p

Look in: 20db\_Loss\_Channel

Name Date modified Type Size

FEXT1.s4p 5/18/2011 10:28 AM S4P File 1,610 KB  
FEXT2.s4p 5/18/2011 10:29 AM S4P File 1,610 KB  
FEXT3.s4p 5/18/2011 10:29 AM S4P File 1,610 KB  
FEXT4.s4p 5/18/2011 10:29 AM S4P File 1,610 KB  
FEXT5.s4p 5/18/2011 10:29 AM S4P File 1,610 KB  
FEXT6.s4p 5/18/2011 10:29 AM S4P File 1,610 KB  
FEXT7.s4p 5/18/2011 10:29 AM S4P File 1,610 KB  
FEXT8.s4p 5/18/2011 10:29 AM S4P File 1,610 KB

File name: THRU.s4p  
Files of type: (\*.s4p)

Indicates type of file requested

Enter spreadsheet

Then enter s4p files

```
>> com2l_r106
COM2L version 1.06
This code is expected to change as the IEEE802.3bj document evolves.
This is not a normative or an official IEEE document.
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 is means no FEXT]
How many NEXT channels are to be entered? [return is means no NEXT]
```

# Example for single line entry

Command Window

New to MATLAB? Watch this [Video](#), see [Demos](#), or read [Getting Started](#).

```
6_Channel_IEEE802_3_100GbCu_04282011\TEC_Whisper29p8in_Nelco6_FEXT_B8B9_0
'J:\2012_TEMP\IEEE802.3bj\channels\models\shanhbag_02_0411\TEC_STRADAWhi
6_Channel_IEEE802_3_100GbCu_04282011\TEC_Whisper29p8in_Nelco6_FEXT_C11C1
'J:\2012_TEMP\IEEE802.3bj\channels\models\shanhbag_02_0411\TEC_STRADAWhi
6_Channel_IEEE802_3_100GbCu_04282011\TEC_Whisper29p8in_Nelco6_FEXT_D8D9_0
'J:\2012_TEMP\IEEE802.3bj\channels\models\shanhbag_02_0411\TEC_STRADAWhi
6_Channel_IEEE802_3_100GbCu_04282011\TEC_Whisper29p8in_Nelco6_NEXT_B8B9_0
'J:\2012_TEMP\IEEE802.3bj\channels\models\shanhbag_02_0411\TEC_STRADAWhi
6_Channel_IEEE802_3_100GbCu_04282011\TEC_Whisper29p8in_Nelco6_NEXT_C11C1
'J:\2012_TEMP\IEEE802.3bj\channels\models\shanhbag_02_0411\TEC_STRADAWhi
6_Channel_IEEE802_3_100GbCu_04282011\TEC_Whisper29p8in_Nelco6_NEXT_C5C6_0
'J:\2012_TEMP\IEEE802.3bj\channels\models\shanhbag_02_0411\TEC_STRADAWhi
6_Channel_IEEE802_3_100GbCu_04282011\TEC_Whisper29p8in_Nelco6_NEXT_D8D9_0
COM2L version 1.06
```

This code is expected to change as the IEEE802.3bj document evolves.

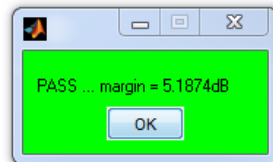
This is not a normative or an official IEEE document.

Files set is:

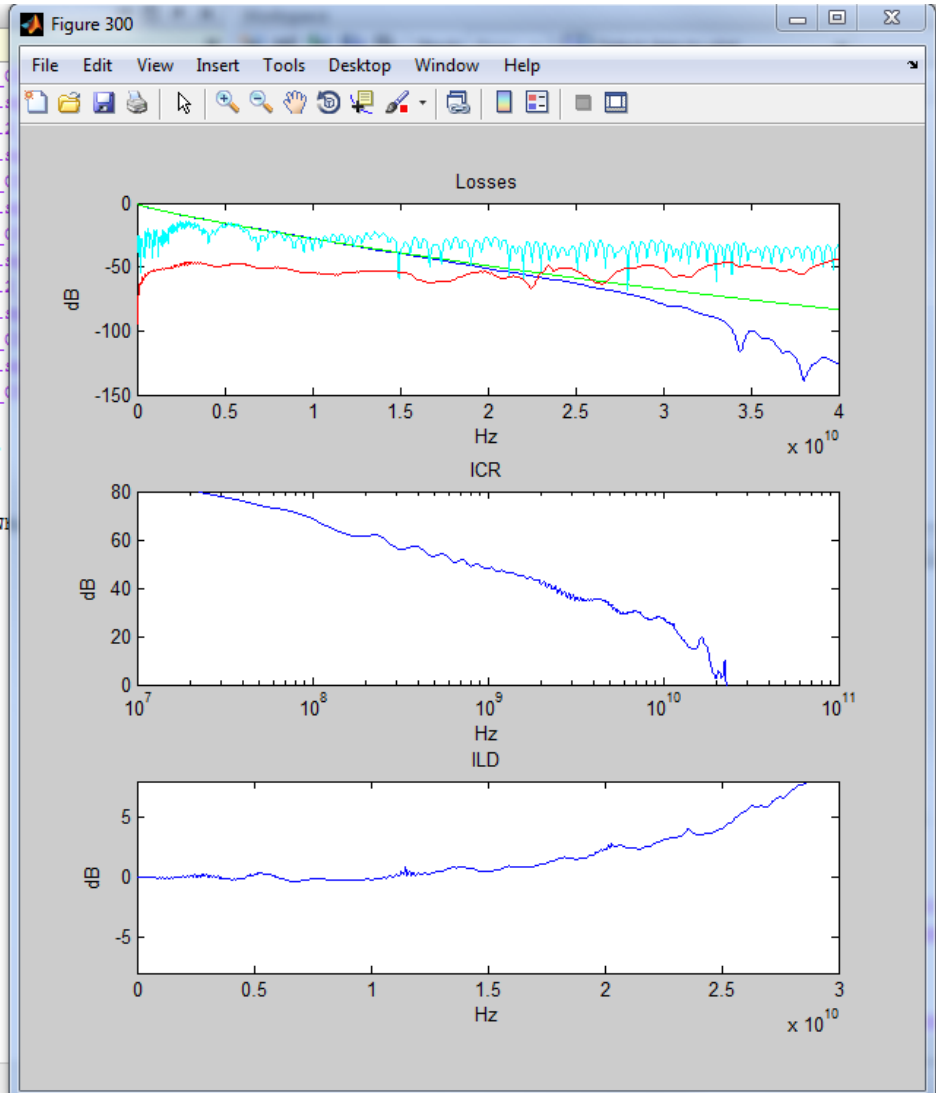
```
TEC_STRADAWhisper29p8in_Nelco6_Channel_IEEE802_3_100GbCu_04282011--TEC_W
co6_THRU_C8C9
```

ans =

```
channel_operating_margin_dB: 5.1874
peak_interference_mV: 6.7000
peak_channel_interference_mV: 4.6000
peak_ISI_mV: 3.1000
peak_MDXTK_interference_mV: 2.9000
icn_mV: 1.5335
peak_MDNEXT_interference_mV: 2.4000
peak_MDFEXT_interference_mV: 1.1000
available_signal_after_eq_mV: 12.1744
fit_loss_dB_at_Fnq: 20.1695
IL_dB_at_Fnq: 19.8332
baud_rate_GHz: 13.5938
ILD_RMS: 0.1216
file_names: [8x101 char]
```



f >>



# Results are written to csv file (data is example only)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	File set	COM_dB	peak_inte	peak_char	peak_ISI	peak_MD	ICN	peak_MD	peak_MD	fit_loss_d	IL_loss_dE	ILD RMS	available_coding	Fnq (GHz)					
2	TEC_STRA	5.18743	6.7	4.6	3.1	2.9	1.533494	2.4	1.1	20.1695	19.83322	0.121609	12.17436	PAM4	6.796875	TEC_Whis	TEC_Whis	TEC_Whis	TEC_V
3																			

TEC\_STRADAWhisper29p8in\_Nelco6\_