Frequency range limits for 2½, 5, and 10GBASE-T1

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Introduction

- Current draft specifies different freq limits for IL and RL
  - IL: 5MHz-3GHz
  - RL: 5MHz-5.5GHz
- Using different limits is inconsistent (discussion Spokane)
  - Smooth RL behavior up to 5.5GHz will implicitly disallow IL suck-outs between 3-5.5GHz
- Reason for larger RL freq range is to bound echo due to unavoidable signal content beyond Nyquist
  - also mentioned by: Farjadrad_3ch_01b_1117.pdf
- Currently no differentiated frequency limits for 2.5/5/10Gbps
  - Although everybody probably assumes they will scale

Current situation

			Insertion Loss (IL)		Return Loss (RL)		IL-ratios		RL-ratios
	BaudRate	fnyq	fmin	fmax	fmin	fmax	fnyq/fmin	fmax/fnyq	fmax/fnyq
	[MBd]	[MHz]	[MHz]	[MHz]	[MHz]	[MHz]	[1]	[1]	[1]
2.5GBASE-T1	1406.25	703.125	5	3000	5	5500	140.63	4.27	7.82
5GBASE-T1	2812.5	1406.25	5	3000	5	5500	281.25	2.13	3.91
10GBASE-T1	5625	2812.5	5	3000	5	5500	562.50	1.07	1.96

- Fmax for IL & RL are different
- Fmax/Fnyq ratio almost unity for 10Gbps
- Fmax/Fnyq ratio >2 for 2.5Gbps and 5Gbps
- Fmin at 5MHz

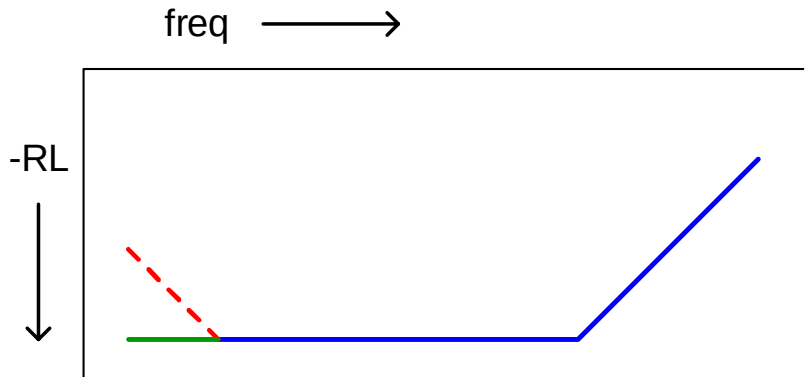
Legacy BASE-T standards

			Insertion Loss (IL)		Return Loss (RL)		IL-ratios		RL-ratios
	BaudRate	fnyq	fmin	fmax	fmin	fmax	fnyq/fmin	fmax/fnyq	fmax/fnyq
	[MBd]	[MHz]	[MHz]	[MHz]	[MHz]	[MHz]			
100BASE-T1	66.67	33.33	1	66	1	66	33.33	1.98	1.98
1000BASE-T1	750	375	1	600	1	600	375	1.60	1.60
100BASE-TX	125	62.5	1	100	1	100	62.5	1.60	1.60
1000BASE-T	125	62.5	1	100	1	100	62.5	1.60	1.60
10GBASE-T	800	400	1	500	1	500	400	1.25	1.25

- IL and RL are always specified with same freq limits
  - Also makes sense from characterization perspective
- Fmin is always at 1MHz
- Fmax/Fnyq ratio significantly larger than unity

Clarification on 1MHz

- Constrained channel characteristics down to 1MHz beneficial for transceiver
  - Prevent design for weird characteristics that should not exist
- No reason to increase lower frequency limit as a practical link segment should be smooth downto DC
  - At DC just a galvanic thru connection with some resistance
- Note that DC resistance really matters for PoDL
  - 1 MHz limit constrains DC resistance better then 5MHz limit
- MDI specification can be done downto 1MHz too
  - Limit may include a corner above 1MHz for PoDL



Conclusions (underpinned by legacy)

- It makes sense to specify IL and RL limits for the same frequency ranges
- In order to achieve sufficient excess BW, the frequency range for IL needs to be extended
  - Doesn’t imply tighter specs, but extended specified frequency range
  - Sufficient tolerant limit line for excess range
  - Possible options listed in separate presentation
- Beneficial to choose Fmin at 1MHz
  - Consistency with other BASE-T1 specs
  - Limit for lowest frequency range can be quite ‘relaxed’
  - Useful to keep IL and RL behavior bounded down to a low, still easilly measurable, frequency

Most viable frequency range options

			Insertion Loss (IL)		Return Loss (RL)		IL-ratios		RL-ratios
	BaudRate	fnyq	fmin	fmax	fmin	fmax	fnyq/fmin	fmax/fnyq	fmax/fnyq
	[MBd]	[MHz]	[MHz]	[MHz]	[MHz]	[MHz]			
2.5GBASE-T1	1406.25	703.125	1	1000	1	1000	703.13	1.42	1.42
5GBASE-T1	2812.5	1406.25	1	2000	1	2000	1406.25	1.42	1.42
10GBASE-T1	5625	2812.5	1	4000	1	4000	2812.50	1.42	1.42
2.5GBASE-T1	1406.25	703.125	1	900	1	900	703.13	1.28	1.28
5GBASE-T1	2812.5	1406.25	1	1800	1	1800	1406.25	1.28	1.28
10GBASE-T1	5625	2812.5	1	3600	1	3600	2812.50	1.28	1.28

- Fmax is scaling with data rate
- Fmin down to 1MHz for all rates
- Fmax/Fnyq ratio >25%
  - If 1/2/4GHz doesn't impose a practical problem is might be best to take that extra margin

Frequency range proposal

- Easy frequency limits preferable
  - 1GHz limit exist already for other cable types
- No killer argument brought forward to squeeze BW
  - Preferred to keep the higher excess BW
  - Avoid unnecessary complications in the PHY

			Insertion Loss (IL)		Return Loss (RL)		IL-ratios		RL-ratios
	BaudRate	fnyq	fmin	fmax	fmin	fmax	fnyq/fmin	fmax/fnyq	fmax/fnyq
	[MBd]	[MHz]	[MHz]	[MHz]	[MHz]	[MHz]			
2.5GBASE-T1	1406.25	703.125	1	1000	1	1000	703.13	1.42	1.42
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Motion

- Move to adopt link segment frequency range limits from 1MHz to baudrate/2½ for both IL and RL (=1,2,4GHz for 2½,5,10 Gbps)
- M:
- S:
- Technical >= 75%)
- Y: N: A:
- Motion …