Channel Performance Formulation Proposal

April 15, 2013

TC3 Contribution for Consideration

equations for insertion loss of 1-pair ethernet channel

For 20 degrees C and AWG 23

$$IL := \left(1.2 \cdot \frac{L}{100}\right) \cdot \left(1.82 \cdot \sqrt{f} + .0091 \cdot f + \frac{.25}{\sqrt{f}}\right) + B \cdot .02 \cdot \sqrt{f}$$

where

B := number of connectors

f := frequency_MHz

L.. length_m

For any temperature above 20 degrees C and for any conductor size

$$IL := [1 + .004 \cdot (T - 20)] \cdot \left(1.2 \cdot \frac{L}{100}\right) \cdot \left[\frac{1.82}{92^{\frac{(23-n)}{39}}} \cdot \sqrt{f} + .0091 \cdot f + \frac{.25}{\sqrt{f}}\right] + B \cdot .02 \cdot \sqrt{f}$$

where

T := Temperature in degrees_C

n := conductor_size_in_AWG

For conductor size in cross-sectional area, mm^2

$$IL := [1 + .004 \cdot (T - 20)] \cdot \left(1.2 \cdot \frac{L}{100}\right) \cdot \left[1.82 \cdot \left(\frac{.508}{\sqrt{A}}\right) \cdot \sqrt{f} + .0091 \cdot f + \frac{.25}{\sqrt{f}}\right] + B \cdot .02 \cdot \sqrt{f}$$

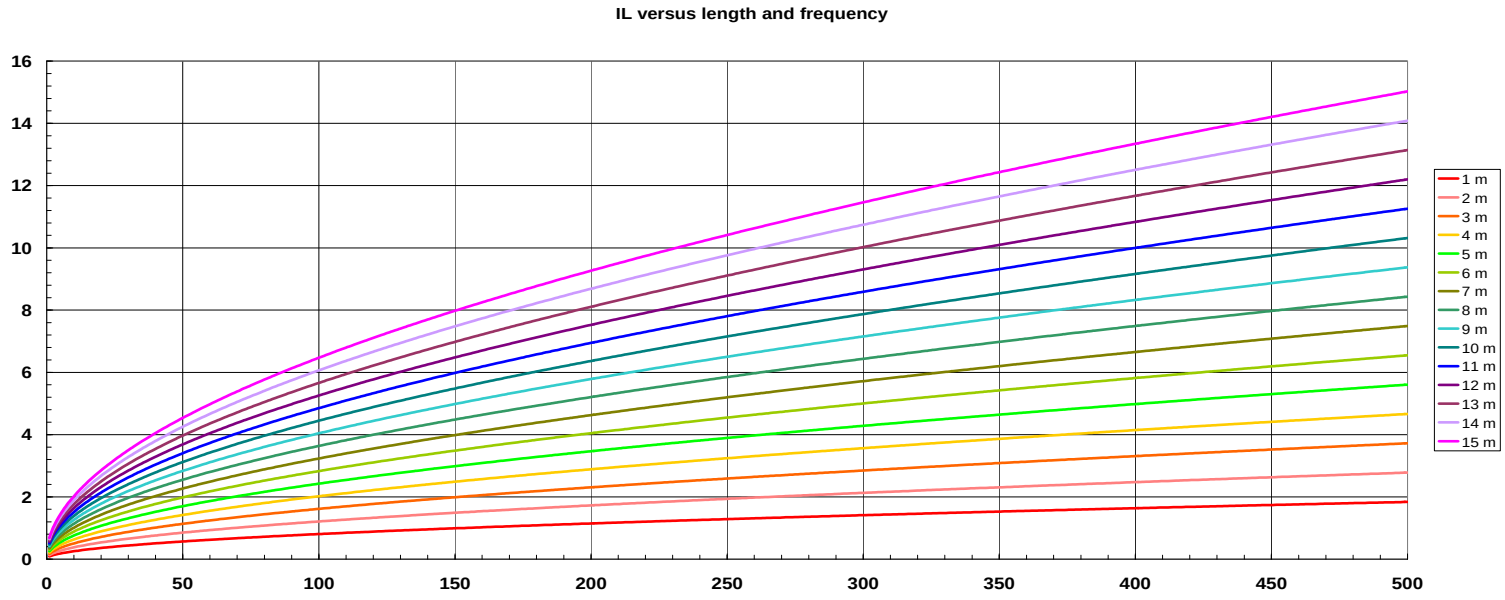
where

$A := conductor\_cross - sectional\_area\_mm^2$

Example calculation for AWG 26 at 125 degrees C

AWG	**26**
temperature (degrees C)	**125**
number of connectors	**2**

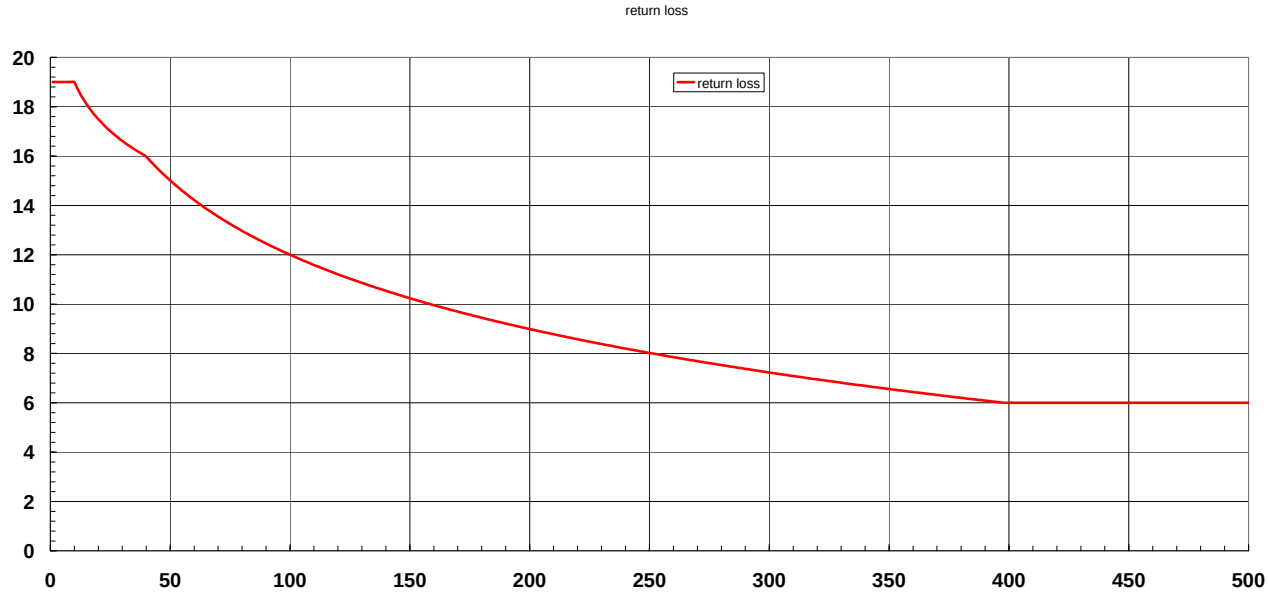
	Length														
	1 m	**2 m**	**3 m**	**4 m**	**5 m**	**6 m**	**7 m**	**8 m**	**9 m**	**10 m**	**11 m**	**12 m**	**13 m**	**14 m**	**15 m**
frequency MHz															
1	0.08	0.13	0.17	0.21	0.25	0.30	0.34	0.38	0.43	0.47	0.51	0.56	0.60	0.64	0.68
50	0.57	0.85	1.13	1.42	1.70	1.98	2.27	2.55	2.83	3.12	3.40	3.68	3.97	4.25	4.54
100	0.80	1.21	1.61	2.02	2.42	2.83	3.23	3.64	4.04	4.45	4.85	5.26	5.66	6.06	6.47
150	0.99	1.49	1.99	2.49	2.99	3.48	3.98	4.48	4.98	5.48	5.98	6.48	6.98	7.48	7.98
200	1.15	1.73	2.31	2.89	3.47	4.05	4.63	5.21	5.79	6.37	6.95	7.53	8.11	8.69	9.27
250	1.28	1.94	2.59	3.24	3.89	4.54	5.20	5.85	6.50	7.15	7.80	8.46	9.11	9.76	10.41
300	1.41	2.13	2.85	3.56	4.28	5.00	5.72	6.44	7.15	7.87	8.59	9.31	10.02	10.74	11.46
350	1.53	2.31	3.08	3.86	4.64	5.42	6.20	6.98	7.76	8.54	9.32	10.09	10.87	11.65	12.43
400	1.64	2.47	3.31	4.14	4.98	5.82	6.65	7.49	8.33	9.16	10.00	10.83	11.67	12.51	13.34
450	1.74	2.63	3.52	4.41	5.30	6.19	7.08	7.97	8.86	9.75	10.64	11.53	12.42	13.31	14.21
500	1.84	2.78	3.72	4.66	5.61	6.55	7.49	8.43	9.37	10.32	11.26	12.20	13.14	14.08	15.03



Return Loss

Frequency MHz	Requirement (dB)
1-10	19
10-40	24-5*log(f)
40-398.1	32-10*log(f)
398.1-500	6

return loss	
frequency MHz	**return loss requirement**
1	19.00
50	15.01
100	12.00
150	10.24
200	8.99
250	8.02
300	7.23
350	6.56
400	6.00
450	6.00
500	6.00



PSANEXT

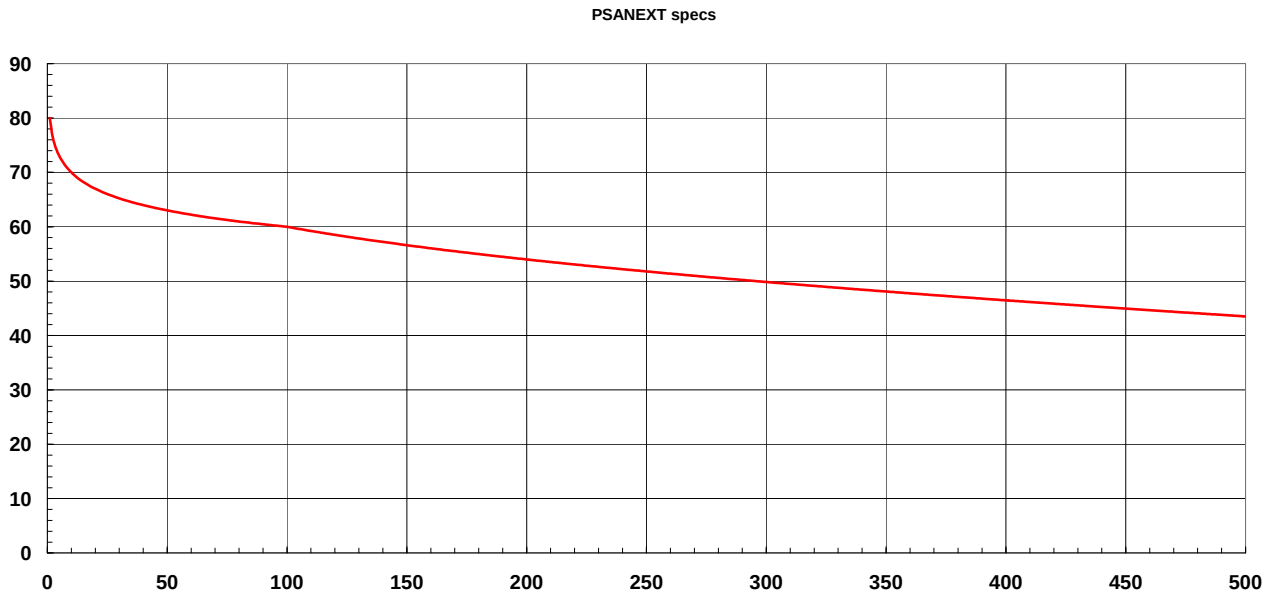
from 1 to 100 MHz

$$PSANEXT := 60 - 10 \cdot \log\left(\frac{f}{100}\right)$$

from 100 to 500 MHz

$$PSANEXT := 60 - 15 \cdot \log\left(\frac{f}{100}\right) + 6 \cdot \frac{(f - 100)}{400}$$

PSANEXT loss	
frequency MHz	**PSNEXT requirement**
1	80.00
50	63.01
100	60.00
150	56.61
200	53.98
250	51.78
300	49.84
350	48.09
400	46.47
450	44.95
500	43.52



PSAACRF

$$PSAACRF := -20\cdot\log\left[10^{\left[\frac{\left(-10\cdot\log\left(\frac{L}{100}\right)+38.2-20\cdot\log\left(\frac{f}{100}\right)\right)}{-20}\right]}+B\cdot10^{\left[\frac{\left(67-20\cdot\log\left(\frac{f}{100}\right)\right)}{-20}\right]}\right]$$

where

L := length_in_meters

f := frequency_in_MHz

B := number_of_connectors

Example calculation for a 2-connector channel:

	Length														
	1 m	**2 m**	**3 m**	**4 m**	**5 m**	**6 m**	**7 m**	**8 m**	**9 m**	**10m**	**11m**	**12m**	**13m**	**14m**	**15m**
Frequency MHz															
1	93.5	91.6	90.4	89.5	88.8	88.2	87.6	87.2	86.8	86.4	86.1	85.8	85.5	85.2	84.9
50	59.5	57.6	56.4	55.5	54.8	54.2	53.7	53.2	52.8	52.4	52.1	51.8	51.5	51.2	51.0
100	53.5	51.6	50.4	49.5	48.8	48.2	47.6	47.2	46.8	46.4	46.1	45.8	45.5	45.2	44.9
150	49.9	48.1	46.9	46.0	45.2	44.6	44.1	43.7	43.3	42.9	42.5	42.2	41.9	41.7	41.4
200	47.4	45.6	44.4	43.5	42.7	42.1	41.6	41.2	40.8	40.4	40.0	39.7	39.4	39.2	38.9
250	45.5	43.6	42.4	41.5	40.8	40.2	39.7	39.2	38.8	38.4	38.1	37.8	37.5	37.2	37.0
300	43.9	42.0	40.8	39.9	39.2	38.6	38.1	37.6	37.2	36.9	36.5	36.2	35.9	35.7	35.4
350	42.6	40.7	39.5	38.6	37.9	37.3	36.8	36.3	35.9	35.5	35.2	34.9	34.6	34.3	34.1
400	41.4	39.5	38.3	37.4	36.7	36.1	35.6	35.1	34.7	34.4	34.0	33.7	33.4	33.2	32.9
450	40.4	38.5	37.3	36.4	35.7	35.1	34.6	34.1	33.7	33.3	33.0	32.7	32.4	32.1	31.9
500	39.5	37.6	36.4	35.5	34.8	34.2	33.7	33.2	32.8	32.4	32.1	31.8	31.5	31.2	31.0

PSAACRF versus length and frequency