Cat 6 Alien Crosstalk Testing in WAP Deployment Configurations

Ron Nordin, Bob Wagner, Ron Tellas – Panduit

Chris DiMinico – MC Communications / Panduit

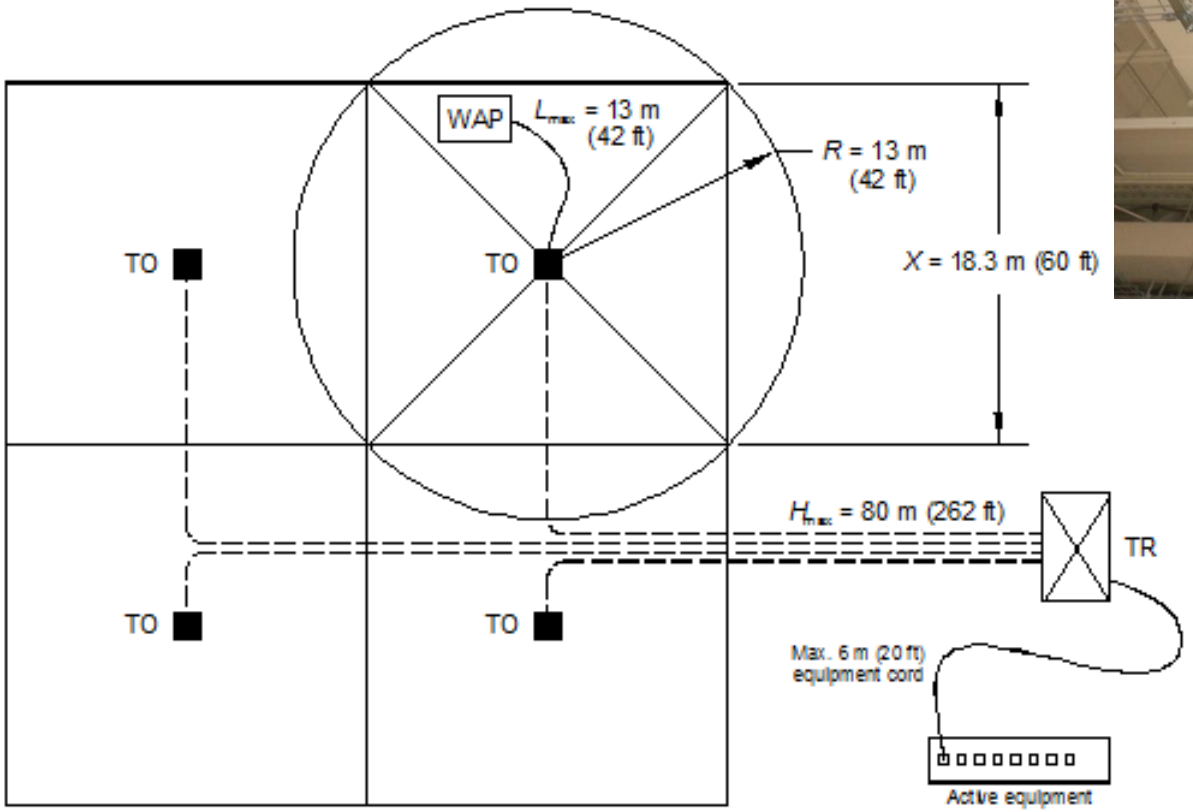
Berlin, Germany
March 2015

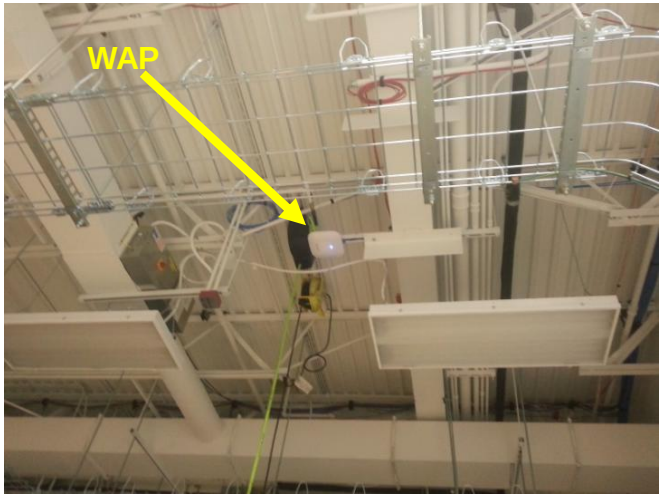
PANDUIT LABORATORIES

Purpose

- Create cabling test configurations based on TIA-162 “use cases” (deployment configurations)
- To measure Alien crosstalk using COTS (Commercial off the Shelf) Cat6 cabling in TIA-162 WAP cell configurations, referenced to 10GBT/TIA-TSB-155 crosstalk limits (Alien crosstalk adjusted for insertion loss)

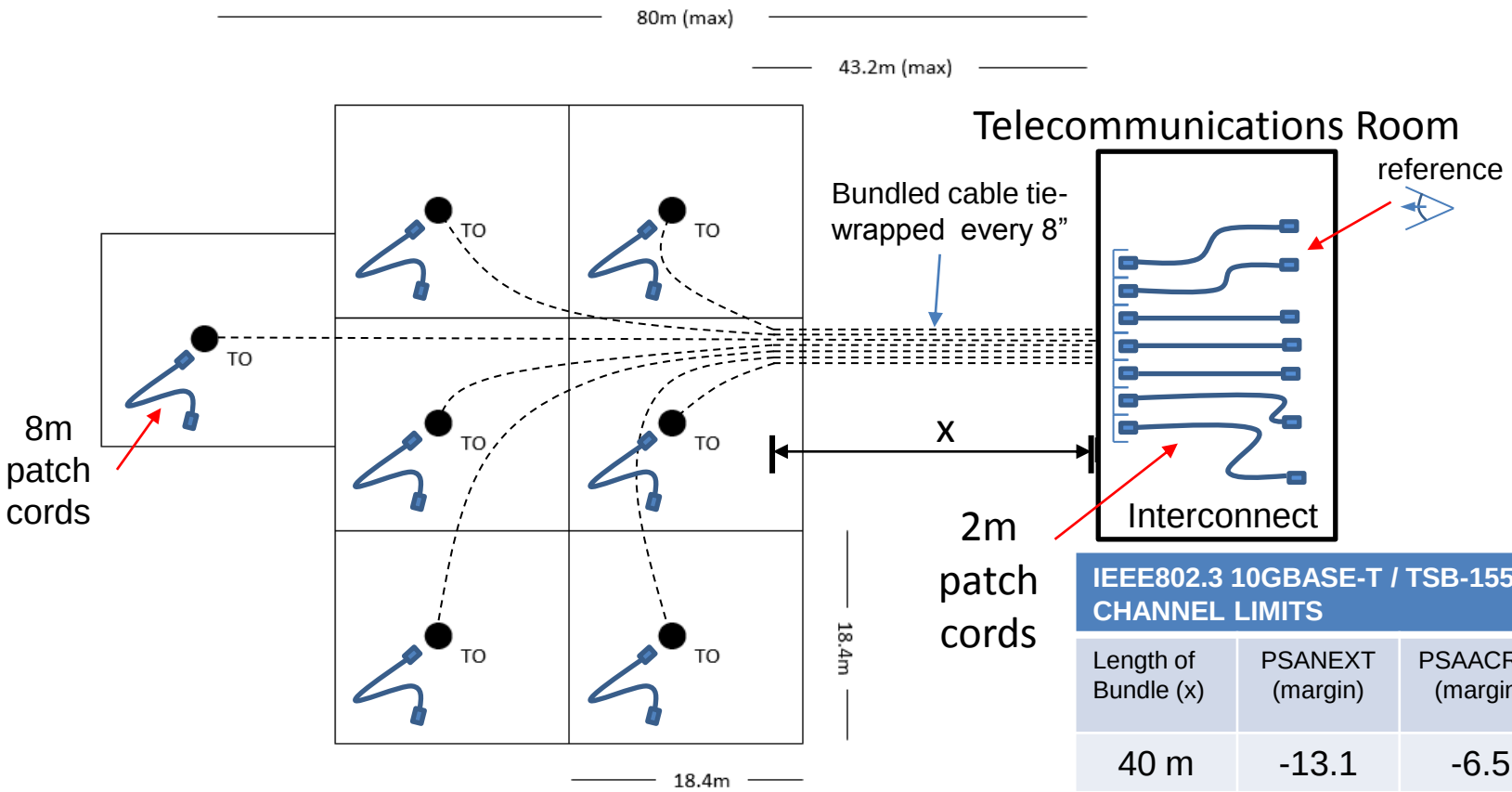
TSB-162 WAP Typical Uniform Cell Size





Cell sizing (wireless access point placed anywhere inside the cell)

TSB-162 WAP Cell ALIEN testing
2-Connector Channel Method used:
For a 90m Channel, let x = 40, 30, 20, 10 and measure Alien Crosstalk



IEEE802.3 10GBASE-T / TSB-155 CHANNEL LIMITS			
Length of Bundle (x)	PSANEXT (margin)	PSAACR-F (margin)	PS AxTalk Margin Computation
40 m	-13.1	-6.5	-8.6
30 m	-9.6	-3.2	-5.6
20 m	-3.6	0.8	-1.4
10 m	0.2	4.6	3.5

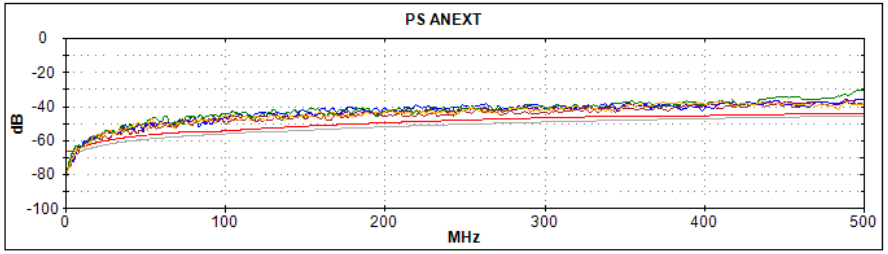
IEEE802.3 10GBASE-T / TSB-155 CHANNEL LIMITS

Bundle Length (x=40m) with Interconnect (2 connector) Off the shelf Cat 6 Cable & Connectors

PS ANEXT

Pair	Frequency	Value	Limit	Margin	Status
12	54.0 MHz	47.77 dB	57.10 dB	-9.33 dB	FAIL
36	497.0 MHz	30.87 dB	43.98 dB	-13.11 dB	FAIL
45	161.0 MHz	41.29 dB	51.32 dB	-10.04 dB	FAIL
78	73.8 MHz	47.93 dB	55.75 dB	-7.82 dB	FAIL
Average	105.0 MHz	45.54 dB	56.36 dB	-10.81 dB	FAIL

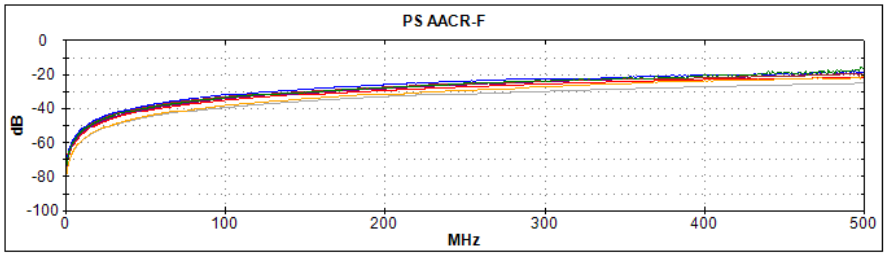
Disturber List
80M 2-CONN 1111
80M 2-CONN 1112
80M 2-CONN 1113
80M 2-CONN 1114
80M 2-CONN 1115
80M 2-CONN 1116



PS AACR-F

Pair	Frequency	Value	Limit	Margin	Status
12	470.0 MHz	21.91 dB	22.11 dB	-0.20 dB	FAIL
36	498.0 MHz	16.47 dB	21.61 dB	-5.14 dB	FAIL
45	481.0 MHz	18.53 dB	21.91 dB	-3.39 dB	FAIL
78	3.4 MHz	62.59 dB	64.99 dB	-2.40 dB	FAIL
Average	499.0 MHz	19.10 dB	25.59 dB	-6.49 dB	FAIL

Disturber List
80M 2-CONN 1111
80M 2-CONN 1112
80M 2-CONN 1113
80M 2-CONN 1114
80M 2-CONN 1115
80M 2-CONN 1116



PS AxTalk Margin Computation

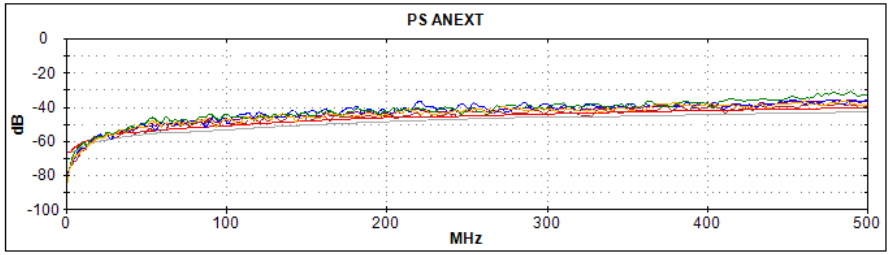
Pair	Margin	Status
12	-5.71 dB	FAIL
36	-7.51 dB	FAIL
45	-7.54 dB	FAIL
78	-5.38 dB	FAIL
Average	-8.58 dB	FAIL

Bundle Length (x=30m) with Interconnect (2 connector) Off the shelf Cat 6 Cable & Connectors

PS ANEXT

Pair	Frequency	Value	Limit	Margin	Status
12	121.5 MHz	44.46 dB	49.91 dB	-5.45 dB	FAIL
36	490.0 MHz	31.16 dB	40.82 dB	-9.66 dB	FAIL
45	220.5 MHz	36.89 dB	46.03 dB	-9.13 dB	FAIL
78	147.0 MHz	44.74 dB	48.67 dB	-3.93 dB	FAIL
Average	219.0 MHz	41.16 dB	48.32 dB	-7.16 dB	FAIL

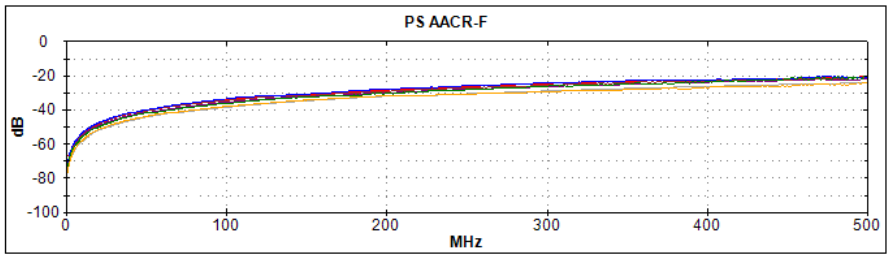
Disturber List
70M 2-CONN 1111
70M 2-CONN 1112
70M 2-CONN 1113
70M 2-CONN 1114
70M 2-CONN 1115
70M 2-CONN 1116



PS AACR-F

Pair	Frequency	Value	Limit	Margin	Status
12	24.6 MHz	50.09 dB	46.81 dB	3.28 dB	PASS
36	499.0 MHz	20.12 dB	20.68 dB	-0.56 dB	FAIL
45	2.9 MHz	64.52 dB	65.47 dB	-0.94 dB	FAIL
78	3.1 MHz	64.17 dB	64.74 dB	-0.57 dB	FAIL
Average	470.0 MHz	21.99 dB	25.20 dB	-3.21 dB	FAIL

Disturber List
70M 2-CONN 1111
70M 2-CONN 1112
70M 2-CONN 1113
70M 2-CONN 1114
70M 2-CONN 1115
70M 2-CONN 1116



PS AxTalk Margin Computation

Pair	Margin	Status
12	-2.68 dB	FAIL
36	-4.28 dB	FAIL
45	-4.64 dB	FAIL
78	-2.26 dB	FAIL
Average	-5.55 dB	FAIL

IEEE802.3 10GBASE-T / TSB-155 CHANNEL LIMITS

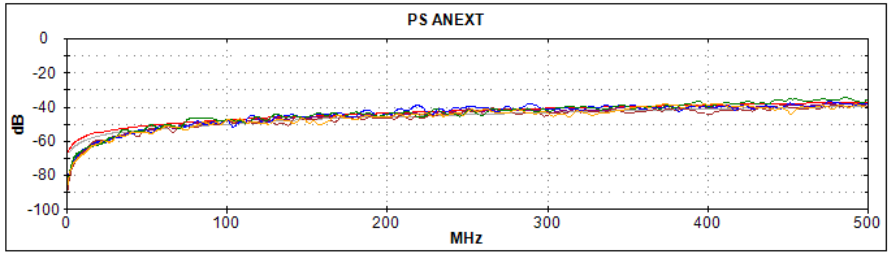
PANDUIT LABORATORIES

Bundle Length (x=20m) with Interconnect (2 connector) Off the shelf Cat 6 Cable & Connectors

PS ANEXT

Pair	Frequency	Value	Limit	Margin	Status
12	375.0 MHz	38.43 dB	39.61 dB	-1.18 dB	FAIL
36	486.0 MHz	34.56 dB	37.92 dB	-3.36 dB	FAIL
45	219.0 MHz	39.50 dB	43.11 dB	-3.61 dB	FAIL
78	266.0 MHz	40.95 dB	41.85 dB	-0.90 dB	FAIL
Average	252.0 MHz	41.66 dB	44.45 dB	-2.79 dB	FAIL

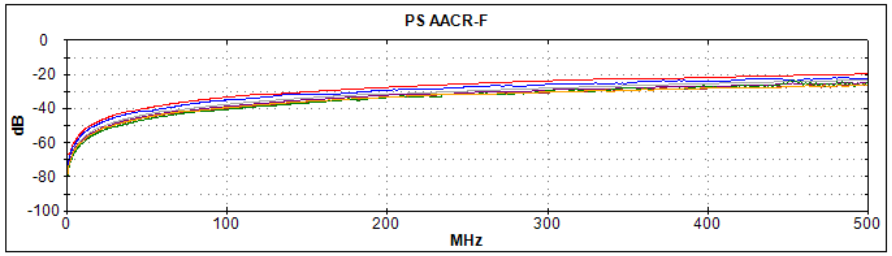
Disturber List
60M 2-CONN 1111
60M 2-CONN 1112
60M 2-CONN 1113
60M 2-CONN 1114
60M 2-CONN 1115
60M 2-CONN 1116



PS AACR-F

Pair	Frequency	Value	Limit	Margin	Status
12	7.9 MHz	61.21 dB	55.95 dB	5.27 dB	PASS
36	452.0 MHz	24.00 dB	20.77 dB	3.23 dB	PASS
45	28.1 MHz	46.15 dB	44.89 dB	1.26 dB	PASS
78	27.1 MHz	50.86 dB	45.21 dB	5.65 dB	PASS
Average	6.6 MHz	62.20 dB	61.45 dB	0.75 dB	PASS

Disturber List
60M 2-CONN 1111
60M 2-CONN 1112
60M 2-CONN 1113
60M 2-CONN 1114
60M 2-CONN 1115
60M 2-CONN 1116



PS AxTalk Margin Computation

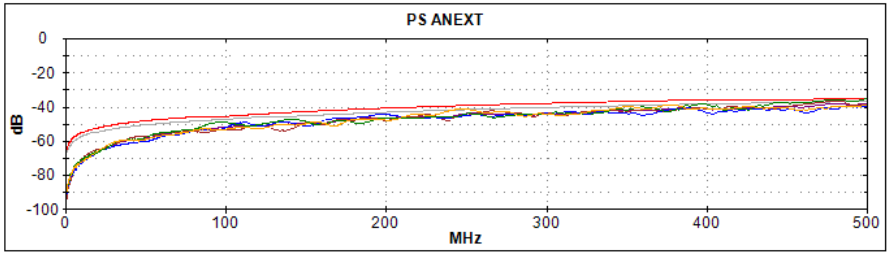
Pair	Margin	Status
12	1.53 dB	FAIL
36	0.40 dB	FAIL
45	-0.84 dB	FAIL
78	1.86 dB	FAIL
Average	-1.38 dB	FAIL

Bundle Length (x=10m) with Interconnect (2 connector) Off the shelf Cat 6 Cable & Connectors

PS ANEXT

Pair	Frequency	Value	Limit	Margin	Status
12	246.0 MHz	41.47 dB	39.62 dB	1.86 dB	PASS
36	500.0 MHz	35.18 dB	35.00 dB	0.18 dB	PASS
45	196.0 MHz	44.33 dB	41.10 dB	3.24 dB	PASS
78	481.0 MHz	36.90 dB	35.25 dB	1.65 dB	PASS
Average	485.0 MHz	38.23 dB	37.44 dB	0.78 dB	PASS

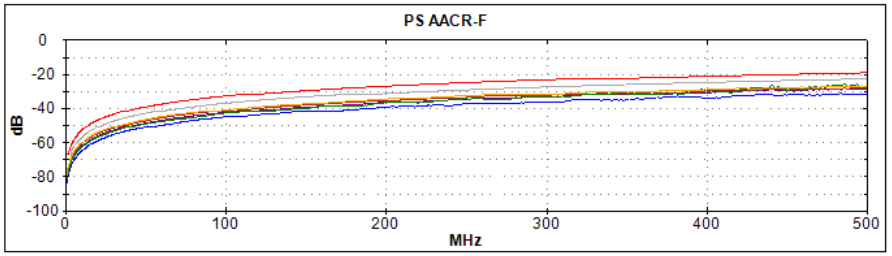
Disturber List
50M 2-CONN 1111
50M 2-CONN 1112
50M 2-CONN 1113
50M 2-CONN 1114
50M 2-CONN 1115



PS AACR-F

Pair	Frequency	Value	Limit	Margin	Status
12	7.8 MHz	62.65 dB	55.46 dB	7.19 dB	PASS
36	441.0 MHz	26.45 dB	20.35 dB	6.10 dB	PASS
45	433.0 MHz	32.09 dB	20.51 dB	11.57 dB	PASS
78	7.3 MHz	63.58 dB	56.04 dB	7.54 dB	PASS
Average	441.0 MHz	28.91 dB	24.35 dB	4.56 dB	PASS

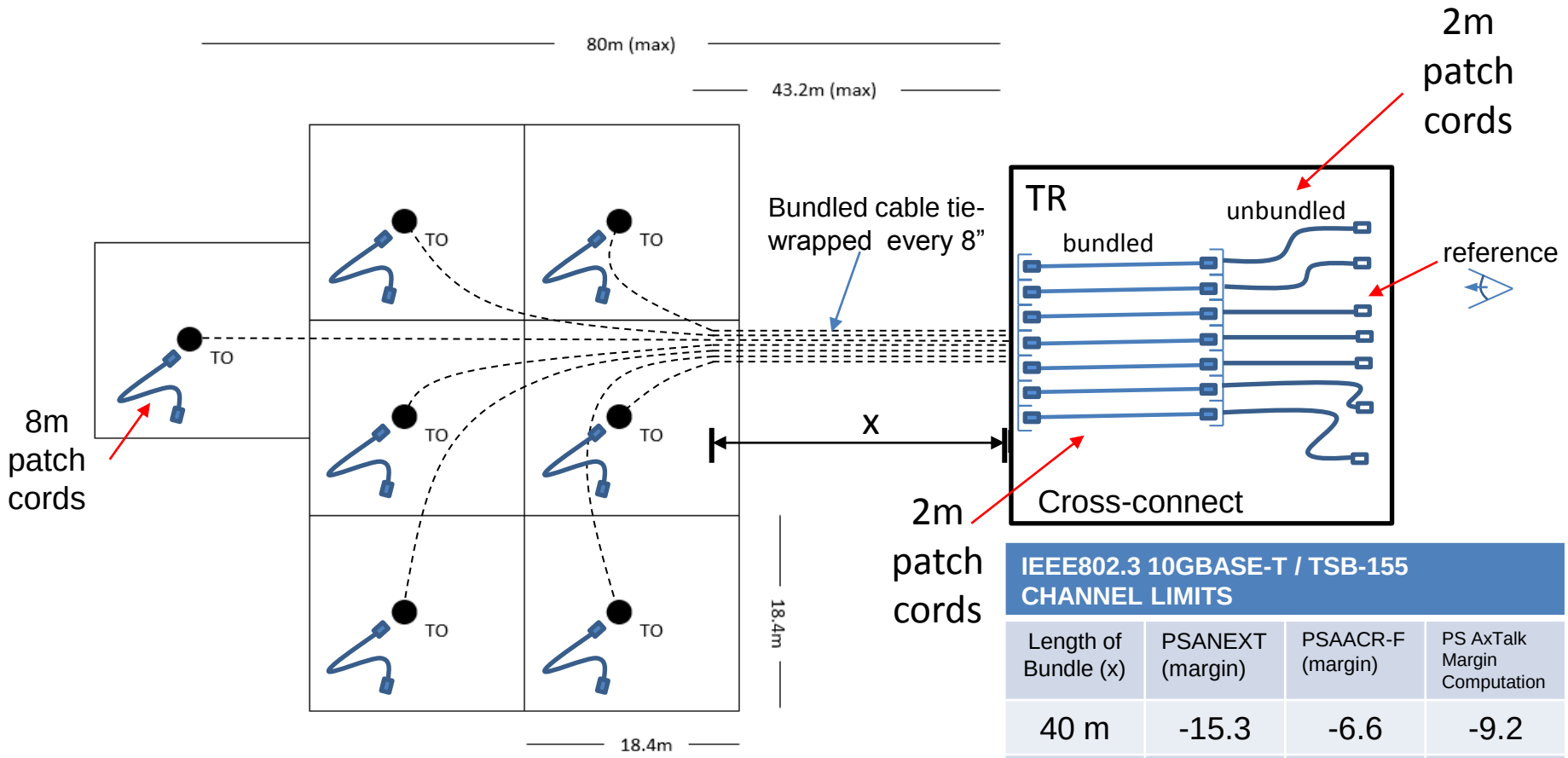
Disturber List
50M 2-CONN 1111
50M 2-CONN 1112
50M 2-CONN 1113
50M 2-CONN 1114
50M 2-CONN 1115
50M 2-CONN 1116



PS AxTalk Margin Computation

Pair	Margin	Status
12	4.94 dB	PASS
36	5.65 dB	PASS
45	6.47 dB	PASS
78	5.52 dB	PASS
Average	3.50 dB	PASS

TSB-162 WAP Cell ALIEN testing
3-Connector Channel Method used:
For a 92m Channel, let x = 40, 30, 20, 10 and measure Alien Crosstalk



IEEE802.3 10GBASE-T / TSB-155 CHANNEL LIMITS			
Length of Bundle (x)	PSANEXT (margin)	PSAACR-F (margin)	PS AxTalk Margin Computation
40 m	-15.3	-6.6	-9.2
30 m	-11.9	-3.7	-6.4
20 m	-7.2	-0.1	-2.3
10 m	-3.4	3.7	1.2

IEEE802.3 10GBASE-T / TSB-155 CHANNEL LIMITS

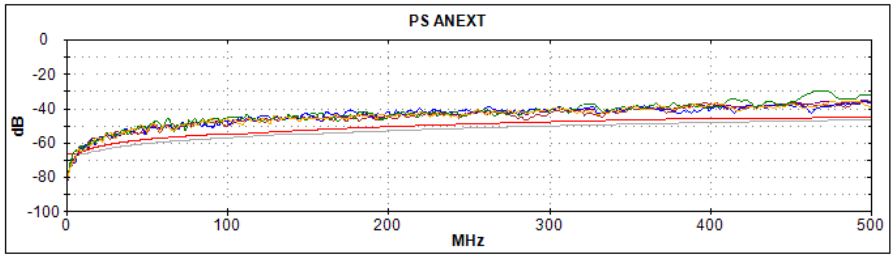
PANDUIT LABORATORIES

Bundle Length (x=40m) with Cross-Connect (3 connector) Off the shelf Cat 6 Cable & Connectors

PS ANEXT

Pair	Frequency	Value	Limit	Margin	Status
12	90.5 MHz	46.16 dB	55.75 dB	-9.58 dB	FAIL
36	471.0 MHz	29.91 dB	45.22 dB	-15.30 dB	FAIL
45	176.5 MHz	41.05 dB	51.61 dB	-10.56 dB	FAIL
78	496.0 MHz	35.09 dB	44.88 dB	-9.79 dB	FAIL
Average	495.0 MHz	35.15 dB	47.14 dB	-11.99 dB	FAIL

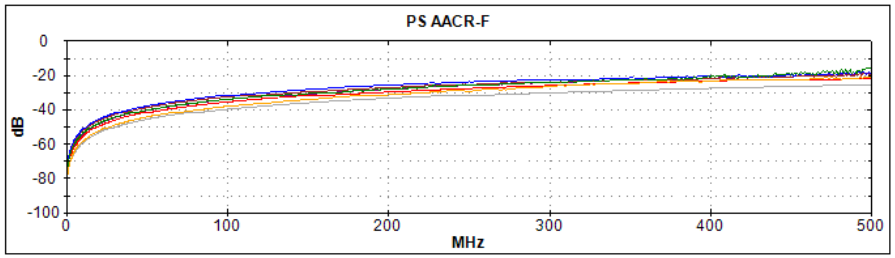
Disturber List
80M 3-CONN 1111
80M 3-CONN 1112
80M 3-CONN 1113
80M 3-CONN 1114
80M 3-CONN 1115
80M 3-CONN 1116



PS AACR-F

Pair	Frequency	Value	Limit	Margin	Status
12	425.0 MHz	22.51 dB	23.25 dB	-0.74 dB	FAIL
36	500.0 MHz	15.37 dB	21.84 dB	-6.47 dB	FAIL
45	3.0 MHz	62.17 dB	66.28 dB	-4.11 dB	FAIL
78	3.1 MHz	62.57 dB	65.92 dB	-3.35 dB	FAIL
Average	481.0 MHz	19.57 dB	26.17 dB	-6.60 dB	FAIL

Disturber List
80M 3-CONN 1111
80M 3-CONN 1112
80M 3-CONN 1113
80M 3-CONN 1114
80M 3-CONN 1115
80M 3-CONN 1116



PS AxTalk Margin Computation

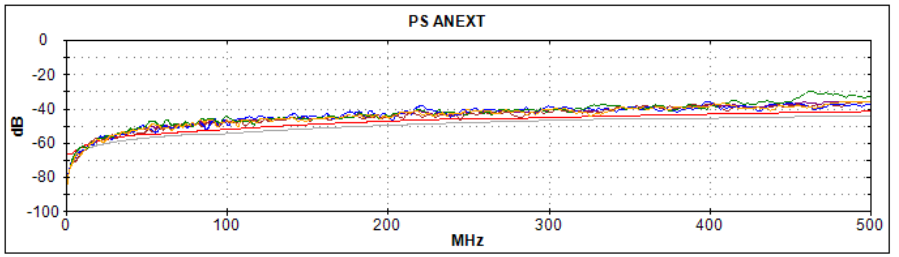
Pair	Margin	Status
12	-6.50 dB	FAIL
36	-7.59 dB	FAIL
45	-7.88 dB	FAIL
78	-6.65 dB	FAIL
Average	-9.19 dB	FAIL

Bundle Length (x=30m) with Cross-Connect (3 connector) Off the shelf Cat 6 Cable & Connectors

PS ANEXT

Pair	Frequency	Value	Limit	Margin	Status
12	487.0 MHz	35.76 dB	41.90 dB	-6.14 dB	FAIL
36	463.0 MHz	30.31 dB	42.23 dB	-11.92 dB	FAIL
45	221.0 MHz	38.28 dB	47.05 dB	-8.76 dB	FAIL
78	498.0 MHz	35.98 dB	41.75 dB	-5.77 dB	FAIL
Average	488.0 MHz	35.78 dB	44.14 dB	-8.35 dB	FAIL

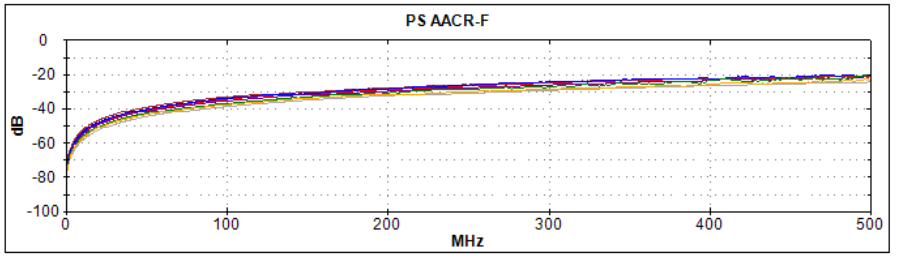
Disturber List
70M 3-CONN 1111
70M 3-CONN 1112
70M 3-CONN 1113
70M 3-CONN 1114
70M 3-CONN 1115
70M 3-CONN 1116



PS AACR-F

Pair	Frequency	Value	Limit	Margin	Status
12	497.0 MHz	23.16 dB	20.99 dB	2.17 dB	PASS
36	496.0 MHz	20.33 dB	21.01 dB	-0.68 dB	FAIL
45	421.0 MHz	21.11 dB	22.44 dB	-1.32 dB	FAIL
78	2.6 MHz	64.45 dB	66.54 dB	-2.09 dB	FAIL
Average	497.0 MHz	21.33 dB	24.99 dB	-3.66 dB	FAIL

Disturber List
70M 3-CONN 1111
70M 3-CONN 1112
70M 3-CONN 1113
70M 3-CONN 1114
70M 3-CONN 1115
70M 3-CONN 1116



PS AxTalk Margin Computation

Pair	Margin	Status
12	-3.71 dB	FAIL
36	-4.43 dB	FAIL
45	-4.85 dB	FAIL
78	-4.22 dB	FAIL
Average	-6.37 dB	FAIL

IEEE802.3 10GBASE-T / TSB-155 CHANNEL LIMITS

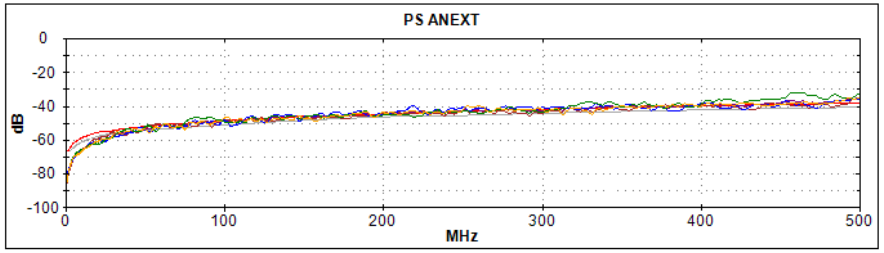
PANDUIT LABORATORIES

Bundle Length (x=20m) with Cross-Connect (3 connector) Off the shelf Cat 6 Cable & Connectors

PS ANEXT

Pair	Frequency	Value	Limit	Margin	Status
12	494.0 MHz	35.30 dB	38.73 dB	-3.43 dB	FAIL
36	458.0 MHz	32.04 dB	39.22 dB	-7.18 dB	FAIL
45	218.5 MHz	39.88 dB	44.04 dB	-4.16 dB	FAIL
78	498.0 MHz	35.65 dB	38.68 dB	-3.02 dB	FAIL
Average	499.0 MHz	35.21 dB	40.91 dB	-5.70 dB	FAIL

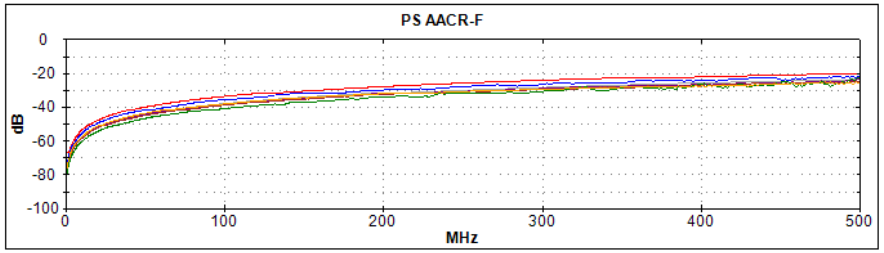
Disturber List
60M 3-CONN 1111
60M 3-CONN 1112
60M 3-CONN 1113
60M 3-CONN 1114
60M 3-CONN 1115
60M 3-CONN 1116



PS AACR-F

Pair	Frequency	Value	Limit	Margin	Status
12	6.3 MHz	61.64 dB	58.18 dB	3.45 dB	PASS
36	500.0 MHz	22.83 dB	20.12 dB	2.71 dB	PASS
45	485.0 MHz	21.79 dB	20.39 dB	1.40 dB	PASS
78	6.3 MHz	62.76 dB	58.18 dB	4.57 dB	PASS
Average	500.0 MHz	24.07 dB	24.12 dB	-0.05 dB	FAIL

Disturber List
60M 3-CONN 1111
60M 3-CONN 1112
60M 3-CONN 1113
60M 3-CONN 1114
60M 3-CONN 1115
60M 3-CONN 1116



PS AxTalk Margin Computation

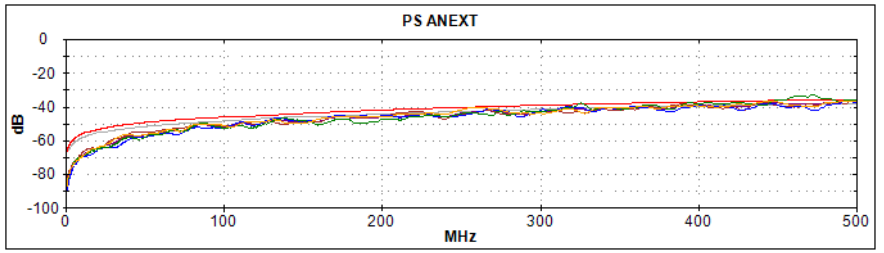
Pair	Margin	Status
12	-0.16 dB	FAIL
36	-0.02 dB	FAIL
45	-1.07 dB	FAIL
78	0.35 dB	FAIL
Average	-2.33 dB	FAIL

Bundle Length (x=10m) with Cross-Connect (3 connector) Off the shelf Cat 6 Cable & Connectors

PS ANEXT

Pair	Frequency	Value	Limit	Margin	Status
12	445.0 MHz	36.84 dB	36.84 dB	0.01 dB	PASS
36	473.0 MHz	33.05 dB	36.44 dB	-3.39 dB	FAIL
45	492.0 MHz	37.14 dB	36.18 dB	0.96 dB	PASS
78	497.0 MHz	36.16 dB	36.12 dB	0.04 dB	PASS
Average	496.0 MHz	36.59 dB	38.38 dB	-1.79 dB	FAIL

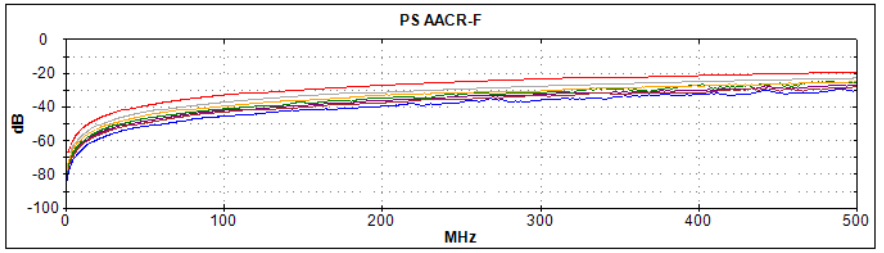
Disturber List
50M 3-CONN 1111
50M 3-CONN 1112
50M 3-CONN 1113
50M 3-CONN 1114
50M 3-CONN 1115
50M 3-CONN 1116



PS AACR-F

Pair	Frequency	Value	Limit	Margin	Status
12	5.6 MHz	64.13 dB	58.48 dB	5.65 dB	PASS
36	482.0 MHz	25.09 dB	19.82 dB	5.27 dB	PASS
45	443.0 MHz	30.08 dB	20.55 dB	9.53 dB	PASS
78	500.0 MHz	27.84 dB	19.50 dB	8.34 dB	PASS
Average	441.0 MHz	28.32 dB	24.59 dB	3.73 dB	PASS

Disturber List
50M 3-CONN 1111
50M 3-CONN 1112
50M 3-CONN 1113
50M 3-CONN 1114
50M 3-CONN 1115
50M 3-CONN 1116



PS AxTalk Margin Computation

Pair	Margin	Status
12	2.46 dB	PASS
36	3.56 dB	PASS
45	3.84 dB	PASS
78	3.40 dB	PASS
Average	1.18 dB	PASS

Summary

- TIA-162 WAP cabling configurations used where the length of bundling was varied from 40m to 10m towards the TR.
- Both Cross connect (3-connector)and interconnect (2-connector) TR configurations used.
- Alien Cross talk (ANEXT and AACRF) channel measurements were made using commercial off the shelf Cat 6 cabling
- Alien crosstalk adjusted for insertion loss limits applied (10GBT/TIA-TSB-155)

Comparison of Alien Performance IEEE802.3 10GBASE-T / TSB-155 Channel Limits						
	Cross connect			Interconnect		
Length of Bundle (x)	PSANEXT (margin)	PSAACR-F (margin)	PS AxTalk Margin Computation	PSANEXT (margin)	PSAACR-F (margin)	PS AxTalk Margin Computation
40 m	-15.3	-6.6	-9.2	-13.1	-6.5	-8.6
30 m	-11.9	-3.7	-6.4	-9.6	-3.2	-5.6
20 m	-7.2	-0.1	-2.3	-3.6	0.8	-1.4
10 m	-3.4	3.7	1.2	0.2	4.6	3.5

Appendix A

- IEEE802.3 10GBASE-T / TSB-155 CHANNEL LIMITS
- In cable Performance to Cat6 Limits

PANDUIT LABORATORIES

- The 10GBASE-T standard includes equations to determine the amount of PSANEXT loss and PSAELFEXT that a receiver can tolerate based on the link segment insertion loss and an alien crosstalk margin computation.
- Adjusted limits: the derived PSANEXT loss and PSAELFEXT noise tolerances and the insertion loss are applied as limits in qualifying installed cabling as well as specifying new cabling.
- Alien crosstalk margin computation: Link segments that can support 10GBASE-T operation (i.e., have sufficient SNR margin) can still fail the individual pair limit lines.
- 10GBASE-T specifies an alien crosstalk margin computation to assess whether the cabling can support 10GBASE-T operation in the event that the individual pair limits are not met.
- Similar alien crosstalk margin allowances may be warranted for 2.5 and 5 GBASET.

IN CABLE PERFORMANCE TO TIA CAT6 CHANNEL LIMITS

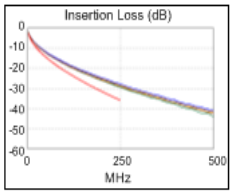
PANDUIT LABORATORIES

Bundle Length (x=40m) with Interconnect (2 connector) Off the shelf Cat 6 Cable & Connectors

Length (m), Limit 100.0	[Pair 45]	89.6
Prop. Delay (ns), Limit 555	[Pair 78]	460
Delay Skew (ns), Limit 50	[Pair 78]	22
Resistance (ohms)	[Pair 78]	14.1
Insertion Loss Margin (dB)	[Pair 36]	6.5
Frequency (MHz)	[Pair 36]	250.0
Limit (dB)	[Pair 36]	35.9

89.6 m

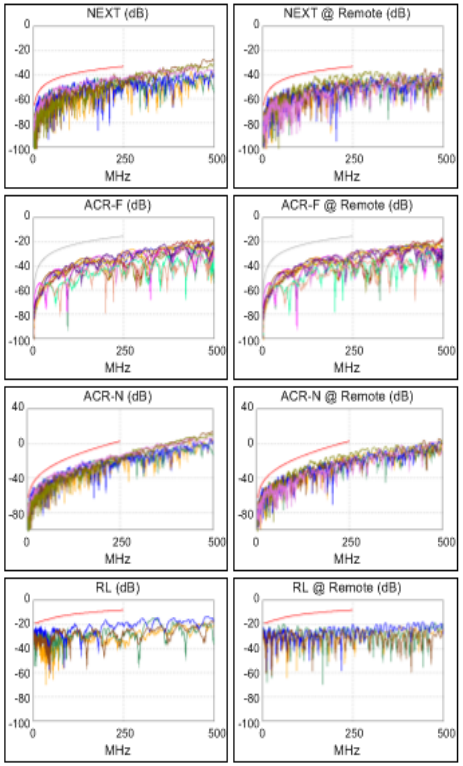
Wire Map (T568B) PASS



	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	12-78	36-78	36-45	36-78
NEXT (dB)	4.6	4.1	5.5	5.3
Freq. (MHz)	14.6	145.0	223.0	221.0
Limit (dB)	53.9	37.2	34.0	34.0
Worst Pair	12	78	45	36
PS NEXT (dB)	5.7	6.4	5.8	6.7
Freq. (MHz)	7.5	143.5	223.0	221.0
Limit (dB)	56.1	34.4	31.0	31.1
PASS	MAIN	SR	MAIN	SR
Worst Pair	12-36	45-12	12-36	36-12
ACR-F (dB)	12.4	12.5	12.4	13.1
Freq. (MHz)	247.0	3.8	247.0	247.0
Limit (dB)	15.4	51.8	15.4	15.4
Worst Pair	36	36	36	12
PS ACR-F (dB)	12.7	12.9	13.0	13.6
Freq. (MHz)	143.0	144.5	250.0	246.5
Limit (dB)	17.2	17.1	12.3	12.4
N/A	MAIN	SR	MAIN	SR
Worst Pair	12-78	12-78	36-45	36-78
ACR-N (dB)	5.7	6.1	12.8	11.6
Freq. (MHz)	14.6	14.6	223.0	221.0
Limit (dB)	46.2	46.2	0.4	0.6
Worst Pair	12	36	78	36
PS ACR-N (dB)	6.6	7.9	14.5	13.5
Freq. (MHz)	7.5	2.9	239.0	232.0
Limit (dB)	50.6	58.6	-4.5	-3.7
PASS	MAIN	SR	MAIN	SR
Worst Pair	45	36	45	36
RL (dB)	4.5	5.0	7.3	5.1
Freq. (MHz)	19.9	17.4	200.0	57.0
Limit (dB)	17.5	17.8	9.0	14.4

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	ATM-25	ATM-51
ATM-155	100VG-AnyLan	TR-4
TR-16 Active	TR-16 Passive	

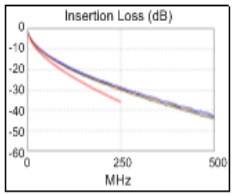


Bundle Length (x=40m) with Cross-Connect (3 connector) Off the shelf Cat 6 Cable & Connectors

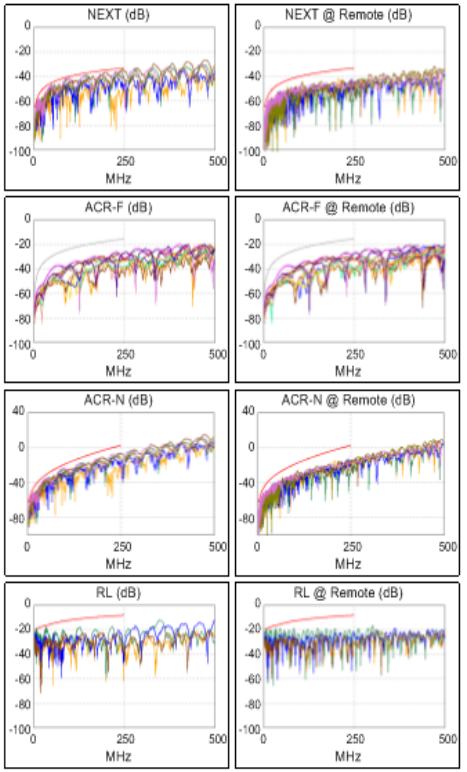
Length (m), Limit 100.0	[Pair 45]	92.0
Prop. Delay (ns), Limit 555	[Pair 78]	470
Delay Skew (ns), Limit 50	[Pair 78]	20
Resistance (ohms)	[Pair 78]	14.5
Insertion Loss Margin (dB)	[Pair 78]	5.9
Frequency (MHz)	[Pair 78]	250.0
Limit (dB)	[Pair 78]	35.9

92.0 m

Wire Map (T568B) PASS



	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	45-78	45-78	36-45	12-36
NEXT (dB)	1.0	4.2	1.1	7.2
Freq. (MHz)	88.0	3.5	242.5	206.0
Limit (dB)	40.9	64.0	33.3	34.6
Worst Pair	45	45	45	36
PS NEXT (dB)	0.4*	4.0	1.3	7.8
Freq. (MHz)	95.8	3.6	242.5	218.5
Limit (dB)	37.4	61.2	30.4	31.2
PASS	MAIN	SR	MAIN	SR
Worst Pair	45-12	12-45	45-12	12-45
ACR-F (dB)	9.5	9.6	9.9	10.2
Freq. (MHz)	56.3	56.8	227.5	227.5
Limit (dB)	28.3	28.2	16.1	16.1
Worst Pair	45	45	12	45
PS ACR-F (dB)	11.8	10.6	12.1	10.6
Freq. (MHz)	56.8	228.5	227.5	228.5
Limit (dB)	25.2	13.1	13.1	13.1
N/A	MAIN	SR	MAIN	SR
Worst Pair	45-78	45-78	36-45	12-78
ACR-N (dB)	2.5	4.8	8.1	14.7
Freq. (MHz)	6.1	3.5	242.5	242.5
Limit (dB)	55.1	60.2	-2.0	-2.0
Worst Pair	45	45	45	78
PS ACR-N (dB)	2.8	4.6	8.3	14.7
Freq. (MHz)	7.4	3.6	242.5	242.5
Limit (dB)	50.7	57.4	-4.9	-4.9
PASS	MAIN	SR	MAIN	SR
Worst Pair	36	36	36	36
RL (dB)	1.9	1.2*	8.5	8.5
Freq. (MHz)	6.9	5.9	216.0	148.5
Limit (dB)	19.0	19.0	8.7	10.3

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	ATM-25	ATM-51
ATM-155	100VG-AnyLan	TR-4
TR-16 Active	TR-16 Passive