Testing Times Ahead

THE LATEST PROPOSALS FOR TESTING COPPER AND OPTICAL FIBRE CABLING

Prepared and delivered by The Cabling Partnership

BSI, Chiswick, London: 15th October 2001
Wandsworth, London: 19th November 2001

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AGENDA

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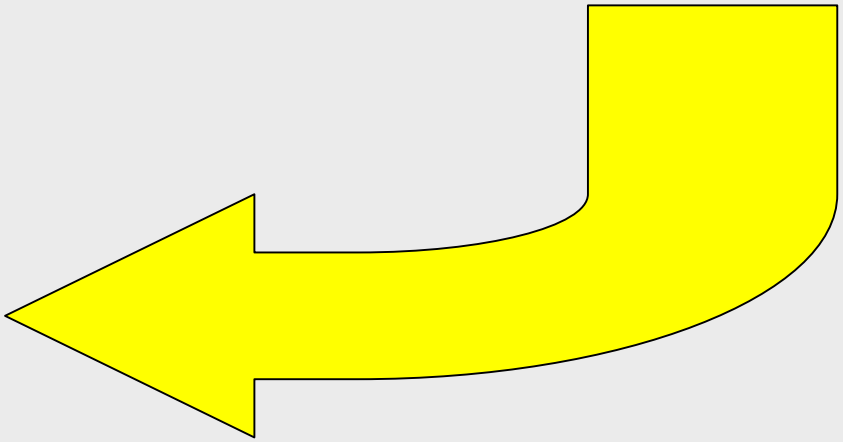
50173 Ed.2 (2002)
Convenor: TC215 WG1: IT Cabling

BSI
Chairman TCT7/-/1: IT Cabling
Chairman TCT7/-/3: IT Cabling

Fibreoptic Industry Association
Standards Director
Technical Director

AGENDA

Agenda



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  - Inter/Cross-connects
  - Cords
  - Interfaces
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  - Contents - ISO/IEC and EN
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The status of the standards

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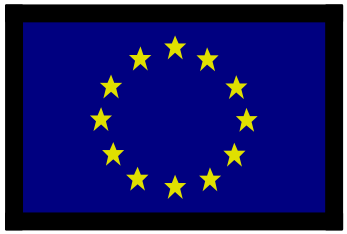
ISO, EN and US



EN 50173 Ed.2 (2002)

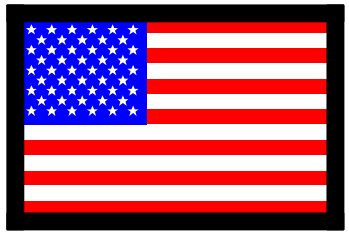
Information technology
-
Generic cabling systems

- SE — Completed
- 6MP begins — July, 2001
- 3MV begins — Q2, 2002
- publication — Q4, 2002

ISO/IEC 11801 Ed.2 (2002)

Information technology
-
Generic cabling for customer premises

- 2nd CD — Completed
- FCD — NOW (N739)
- FDIS — Q2, 2002
- publication — Q4, 2002



ANSI/TIA/EIA 568 B Series

Commercial building telecommunications cabling standard

- B.1 General Requirements
  - published
- B.2 Balanced Twisted-pair Cabling
  - published
  - Addendum 1
    - Category 6
    - Draft 9a (08/01)
- B.3 Optical Fibre Cabling
  - published

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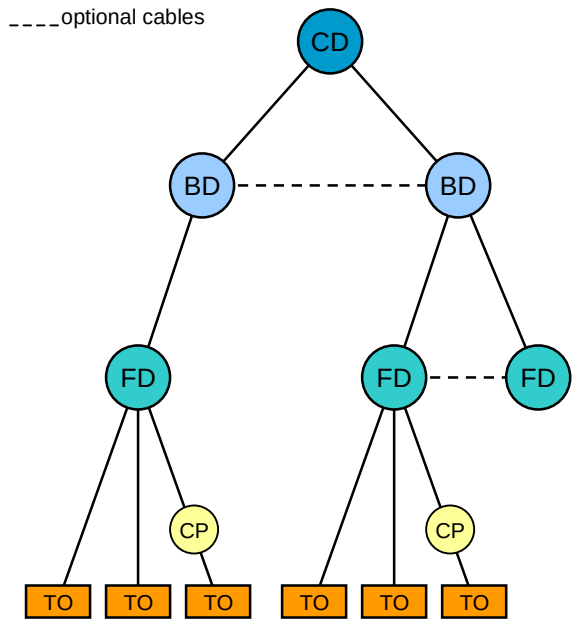
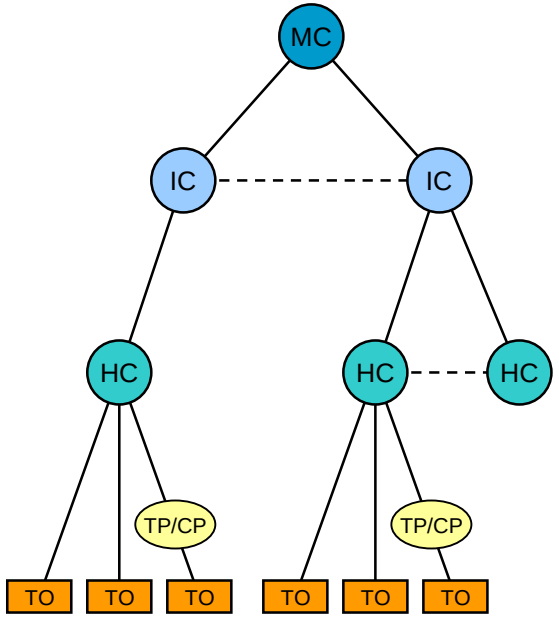
Structure

ISO/IEC and EN



CD	Campus distributor
BD	Building distributor
FD	Floor distributor
CP	Consolidation point
TO	Telecommunications outlet

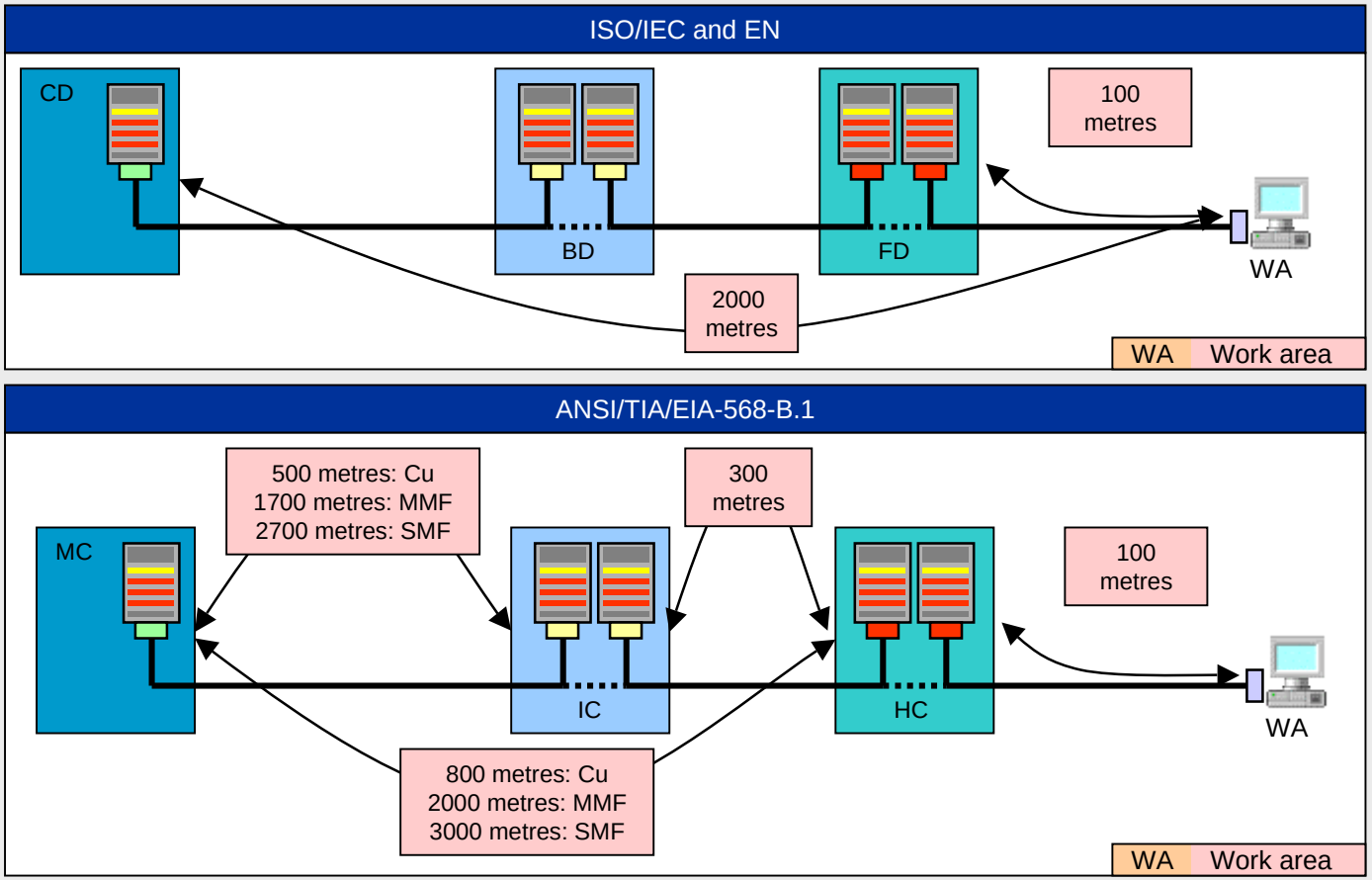
ANSI/TIA/EIA-568-B.1



MC	Main cross-connect
IC	Intermediate cross-connect
HC	Horizontal cross-connect
CP	Consolidation point
TP	Transition point
TO	Telecommunications outlet

AGENDA

Maximum Implementations



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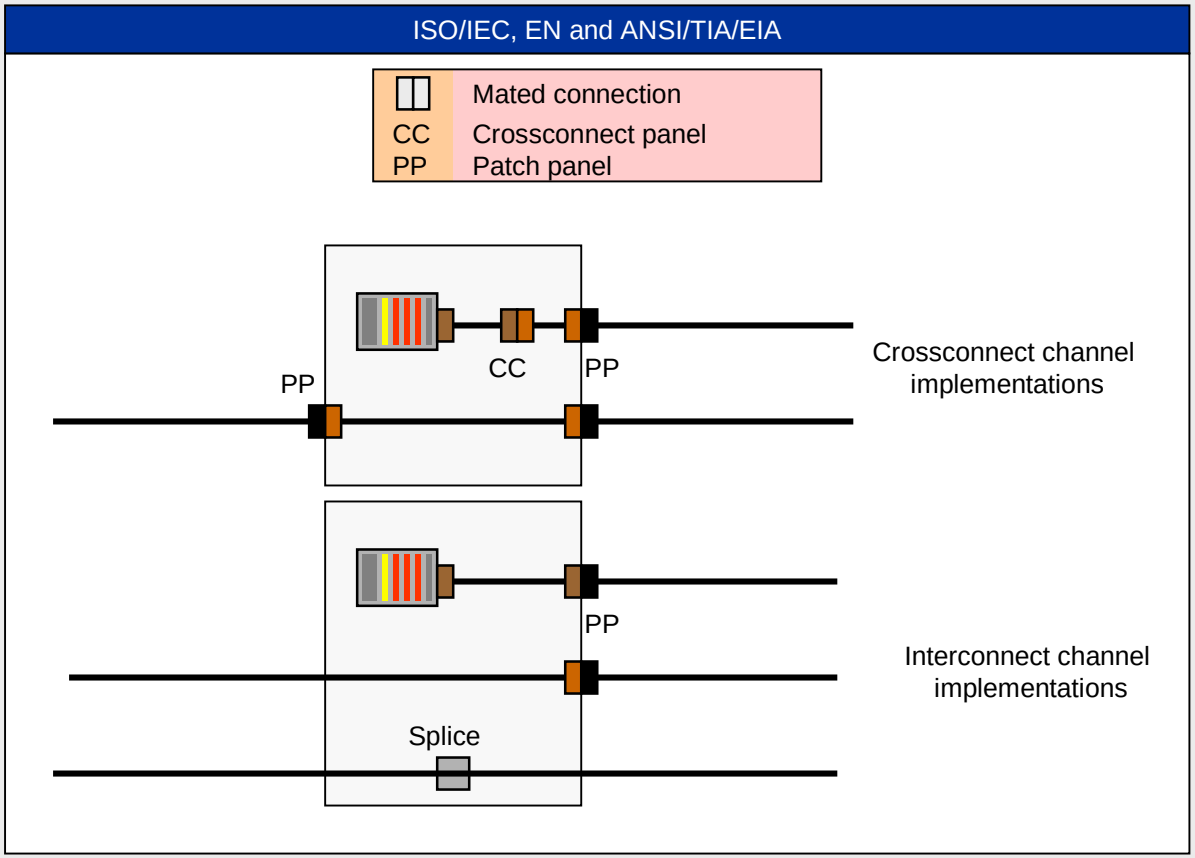
Inter/Cross-connects



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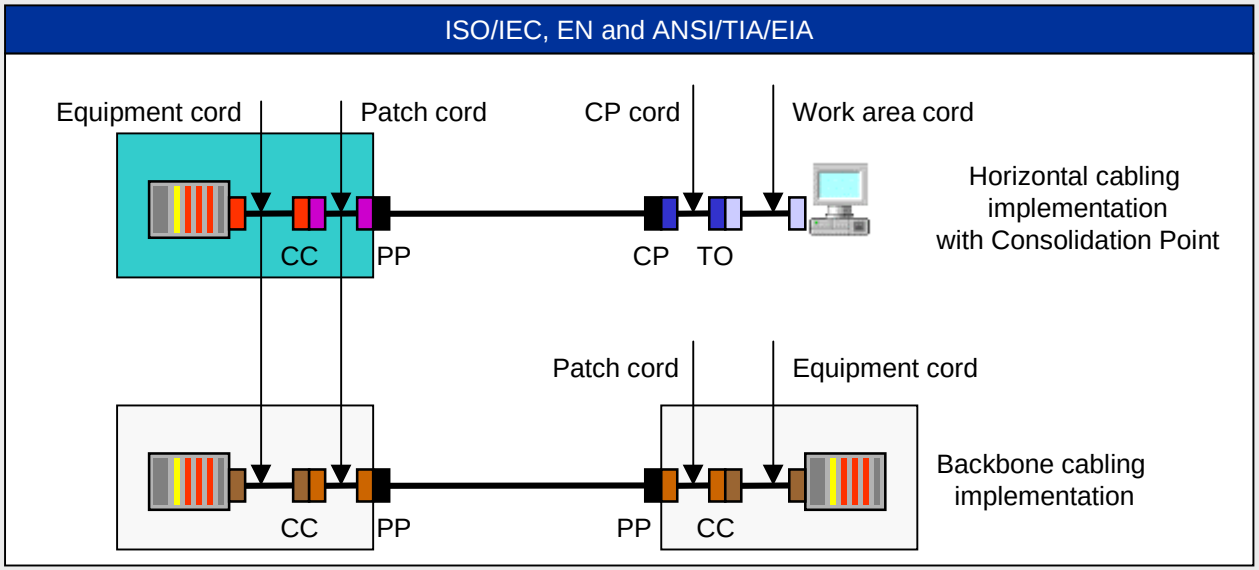
Cords



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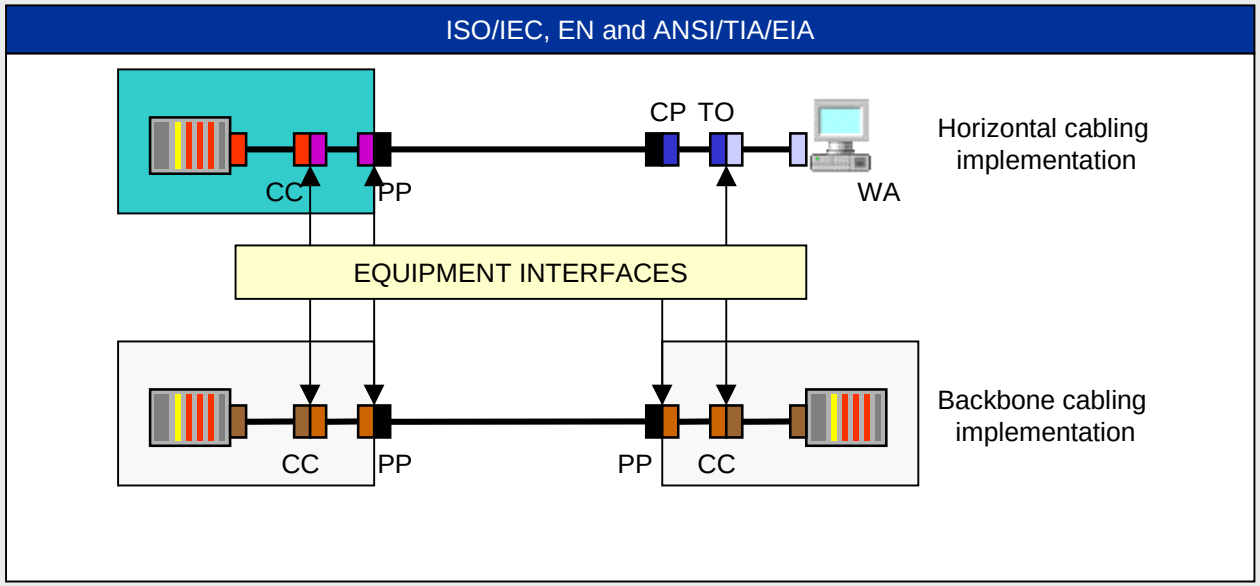
Equipment Interfaces



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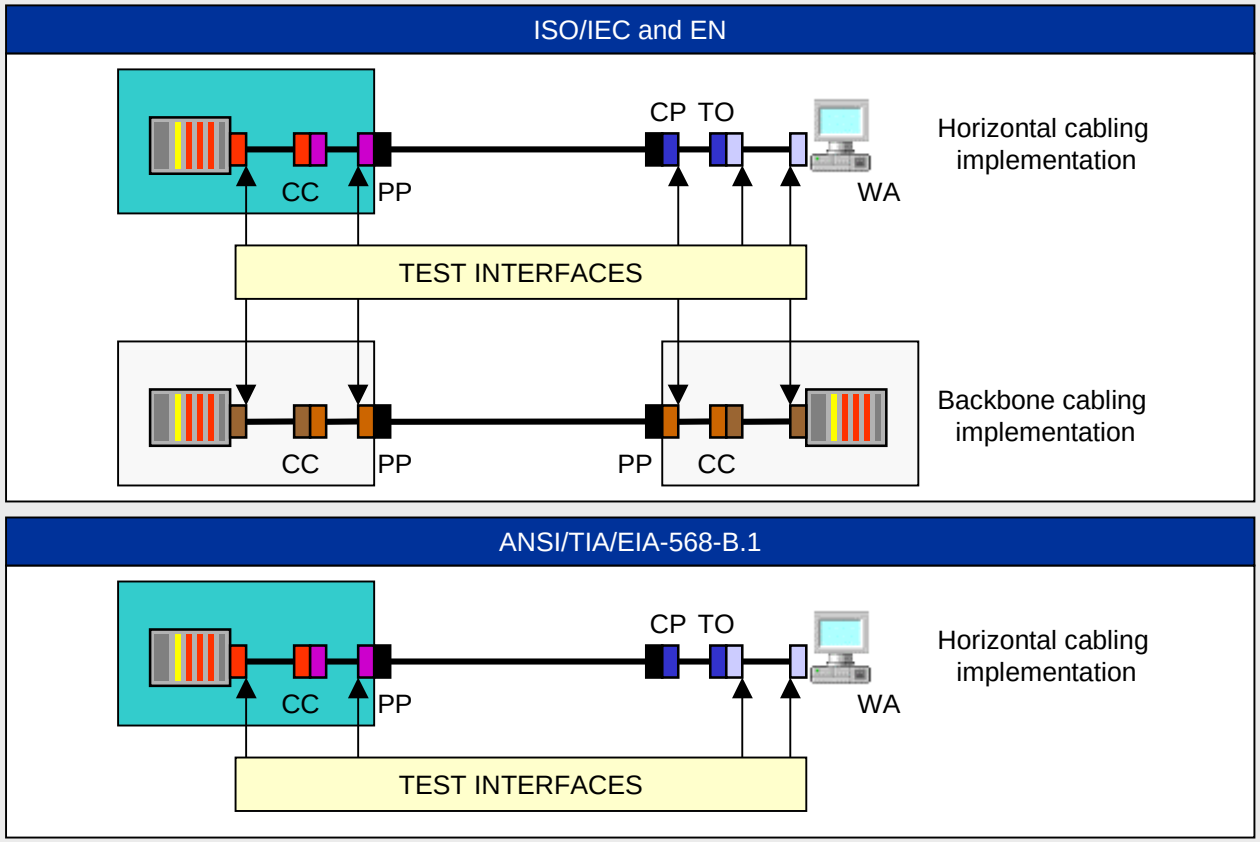
Test Interfaces



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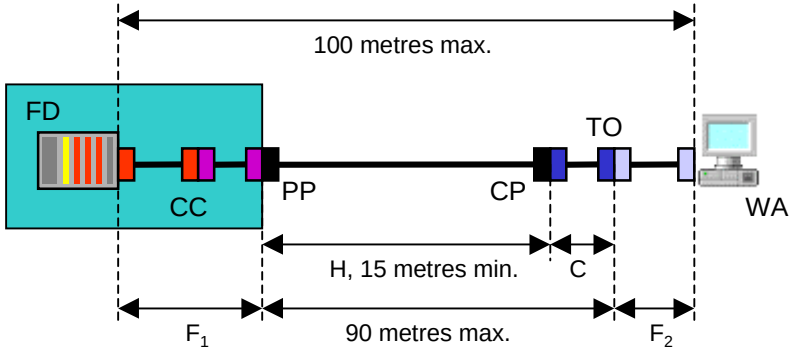
Implementation Rules

ISO/IEC and EN



$F = F_1 + F_2$

X = cord attenuation premium
Y = CP cable attenuation premium (if any)

No. of connections	Class D/Category 5	Class E/Category 6	Class F/Category 7
2	H = (109-FX)/T	H = (107-3^1-FX)/T	H = (107-2^1-FX)/T
3 w/o. CP	H = (107-FX)/T	H = (106-3^1-FX)/T	H = (106-3^1-FX)/T
3 inc. CP	H = (107-FX-CY)/T	H = (106-3^1-FX-CY)/T	H = (106-3^1-FX-CY)/T
4	H = (105-FX-CY)/T	H = (105-3^1-FX-CY)/T	H = (105-4^1-FX-CY)/T

T = 1 + (t-20) x α where t = maximum design temperature within link

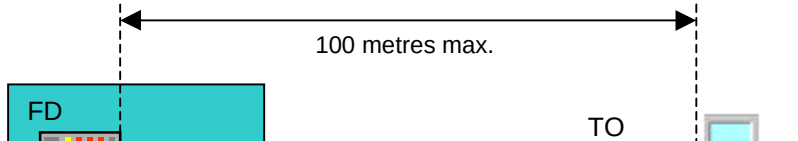
	for screened cables	for unscreened cables
X and Y	1.5 typically	1.2 typically
α	= 0.2 for t>20ºC	= 0.4 for 20ºC<t<40ºC = 0.6 for 40ºC<t<60ºC

Note 1: this length reduction is provides margin for insertion loss deviation.

AGENDA

Implementation Rules

ANSI/TIA/EIA-568-B.1



$F = F_1 + F_2$	X = cord attenuation premium

No. of connections	Class D/Category 5	Class E/Category 6
2,3 or 4	H = (102-FX)	

	for screened cables	for unscreened cables
X	1.5 typically	1.2 typically

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Contents - ISO/IEC and EN

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Contents - ISO/IEC and EN

ISO/IEC FCD 11801 Ed.2 (N739)			EN 50173 Ed.2 (6MP)	
	FOREWORD			
	INTRODUCTION			
1	SCOPE			1.1
2	NORMATIVE REFERENCES			2
3	DE… ABBREVIATIONS			3
4	…NFORMANCE			1.2
5	STRUCTURE			4
6	Copper channels and links*	PERFORMANCE	Copper and OF channels	5
8	OF channels and links		Copper and OF links	Annexes A/B
7	Copper	REFERENCE IMPLEMENTATIONS	Copper and OF	6
8	OF			
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Annex B	Test procedures			
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Annex D	ELECTROMAGNETIC PERFORMANCE			Annex D
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Annex F	SUPPORTED APPLICATIONS			Annex C
Annex G	Calculation of links and channels			
Annex H	LINK AND CHANNEL PERFORMANCE REQUIREMENTS OF PREVIOUS EDITIONS			Annex E
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Worst case

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  - Permanent Link (2002)
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What can we test?

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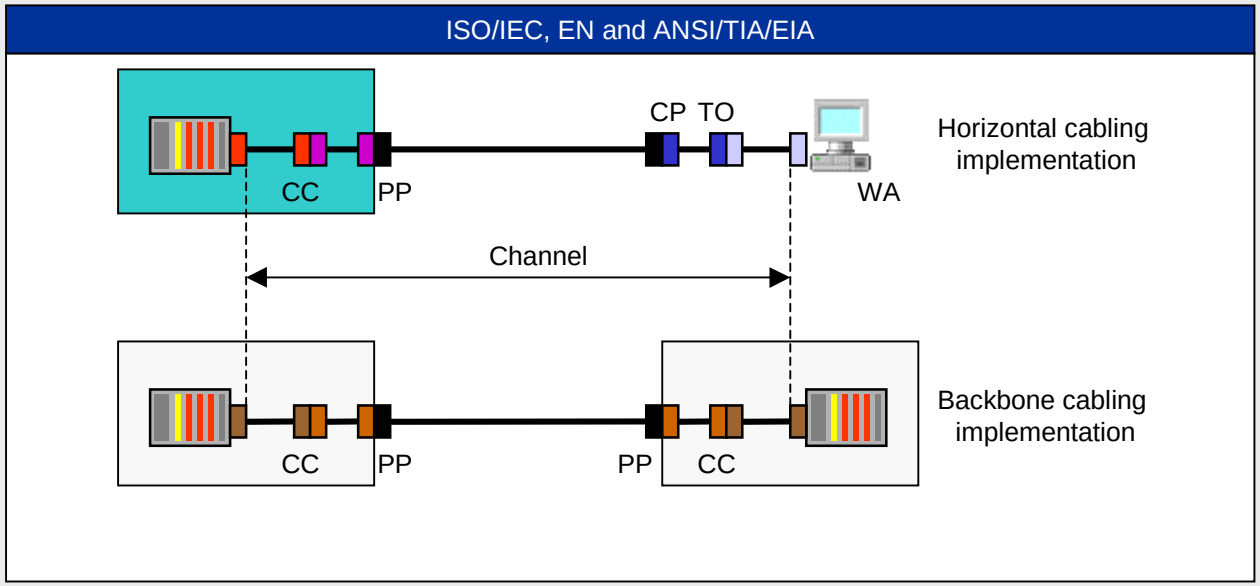
The Channel



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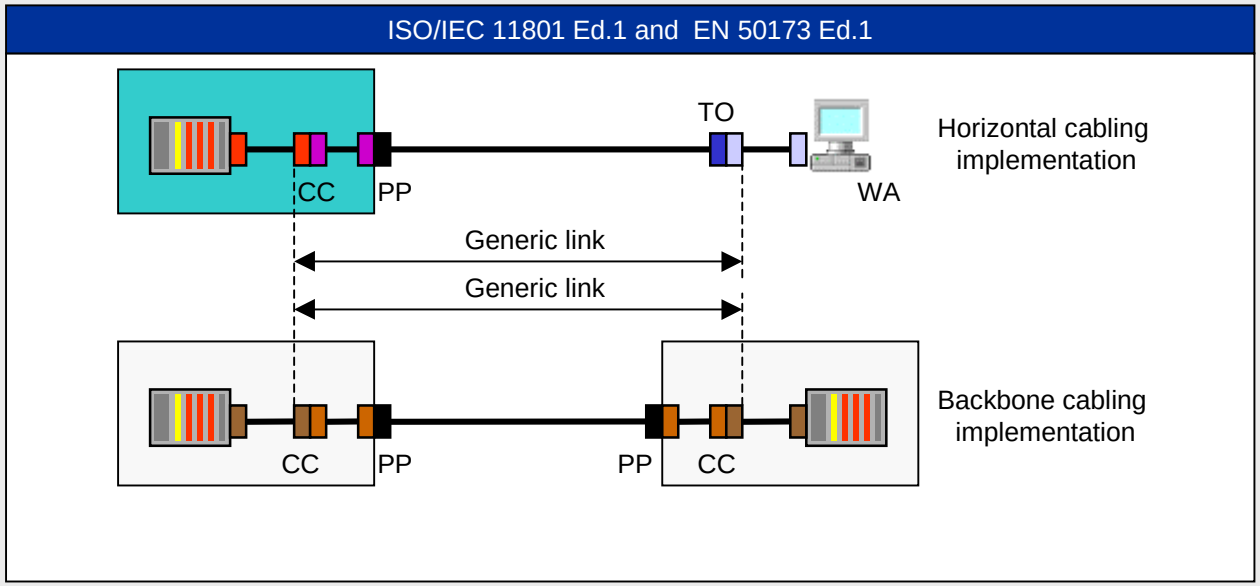
Generic Link (1995)



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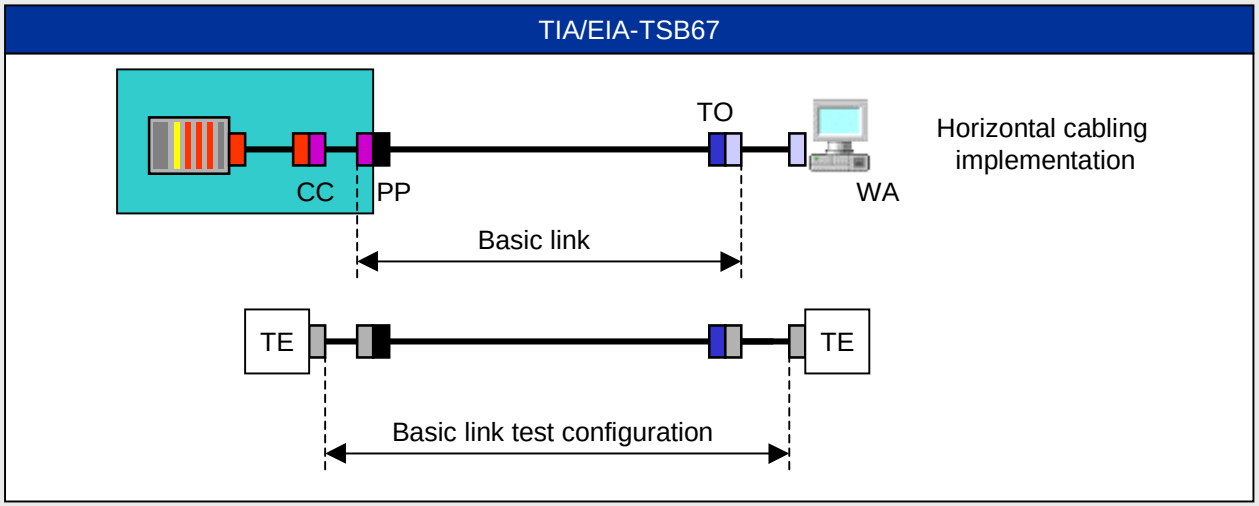
Basic Link (1997)



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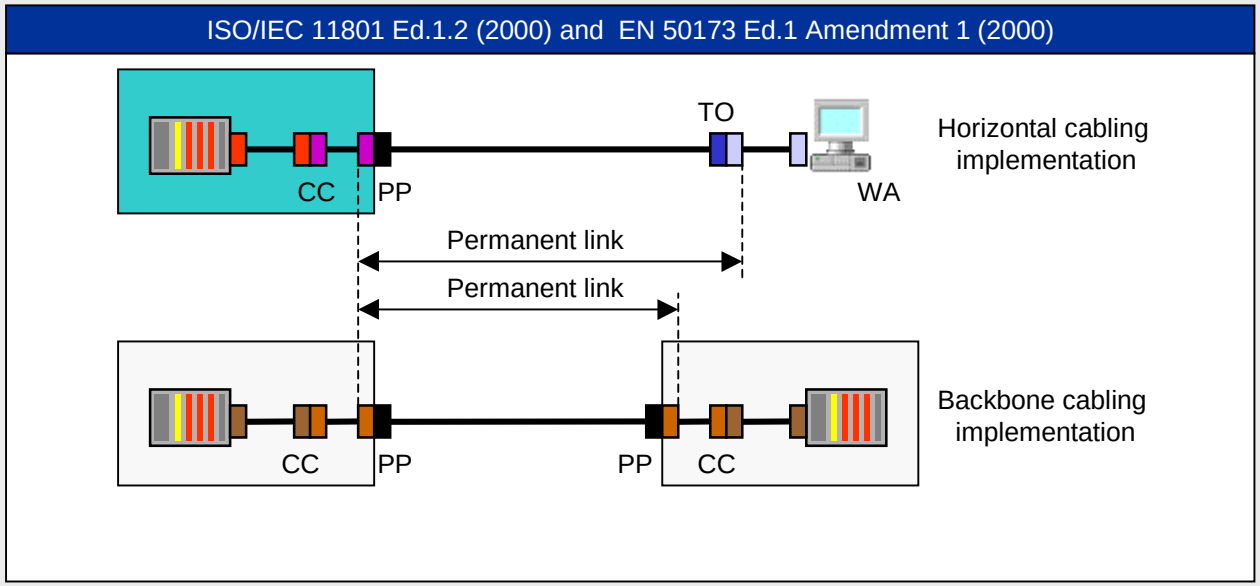
Permanent Link (2000)



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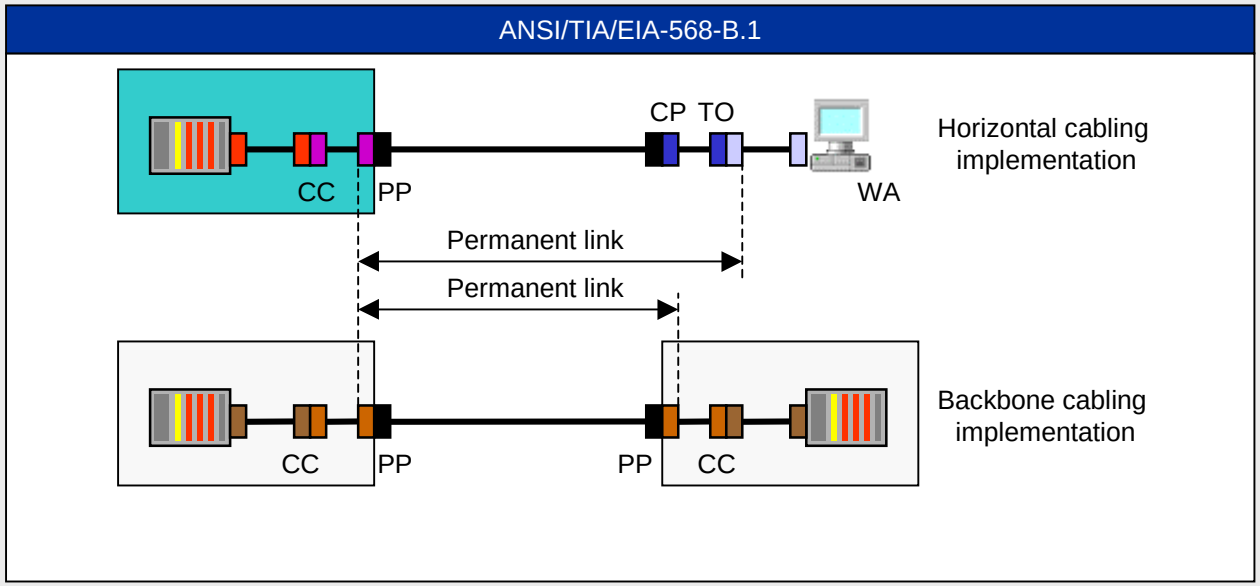
Permanent Link (2001)



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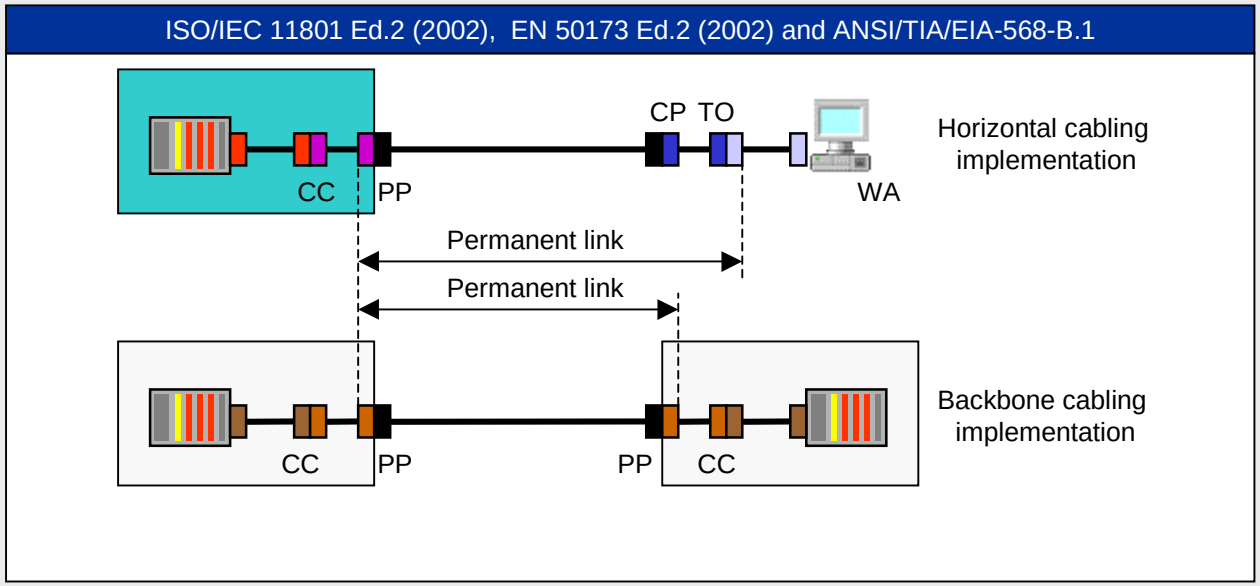
Permanent Link (2002)



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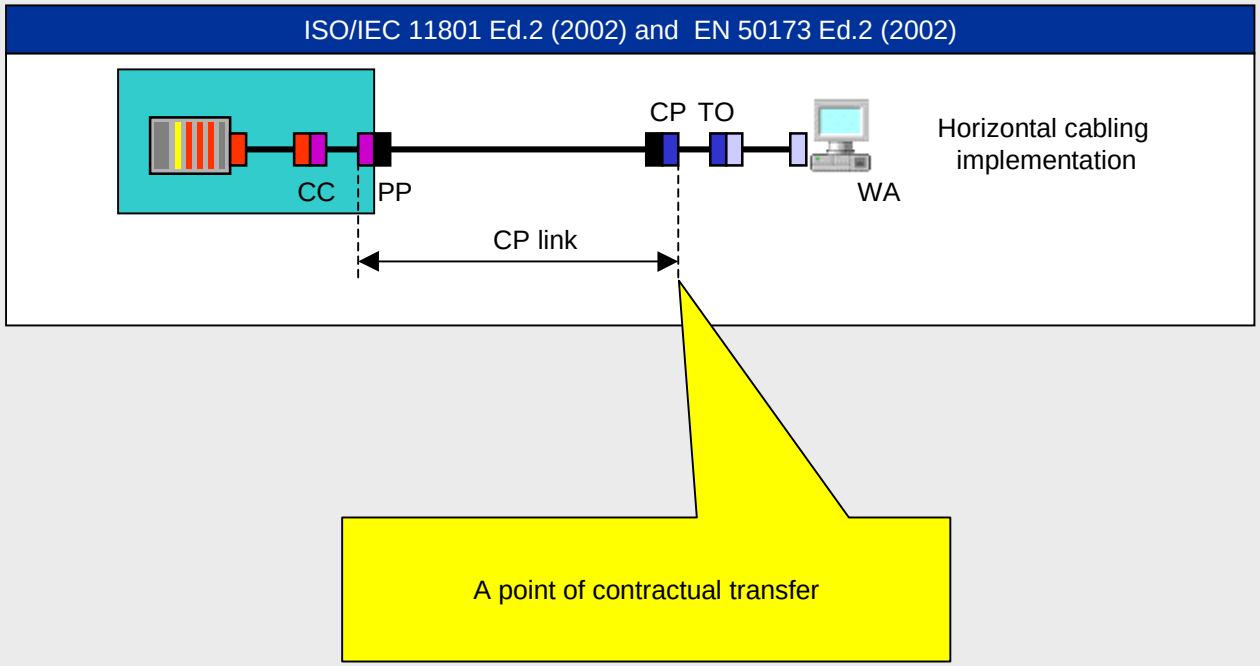
CP Link (2002)

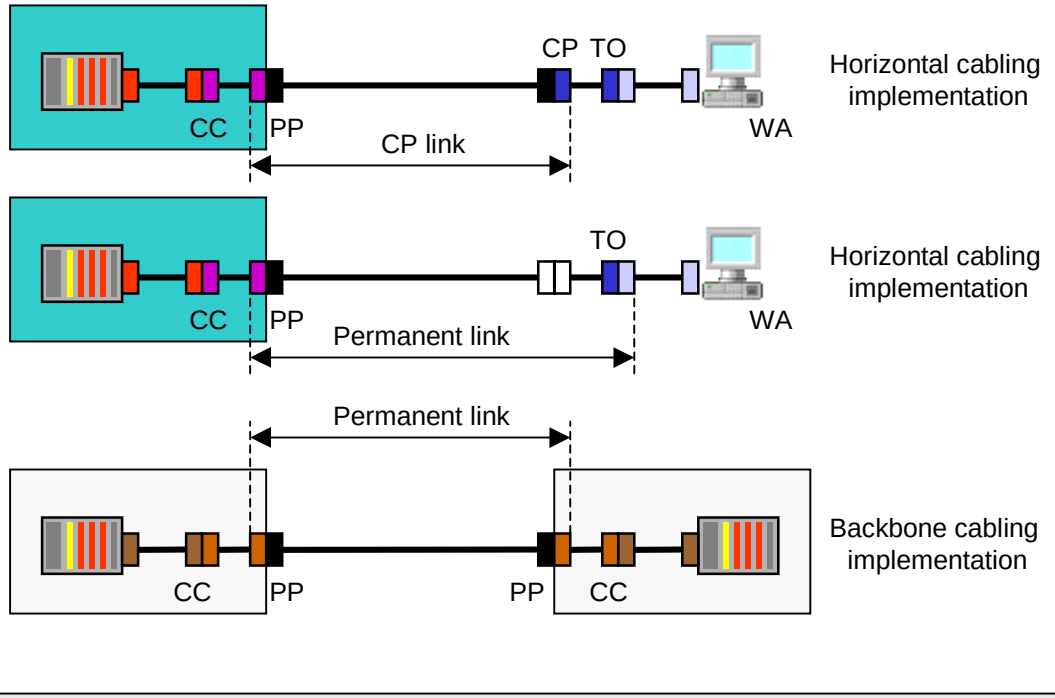


AGENDA

Link Limit Definition

ISO/IEC 11801 Ed.2 (2002), EN 50173 Ed.2 (2002) and ANSI/TIA/EIA-568-B.1

There are no restrictions on the length of:
- equipment and patch cords;
- CP cords/cables;
- work area cords.



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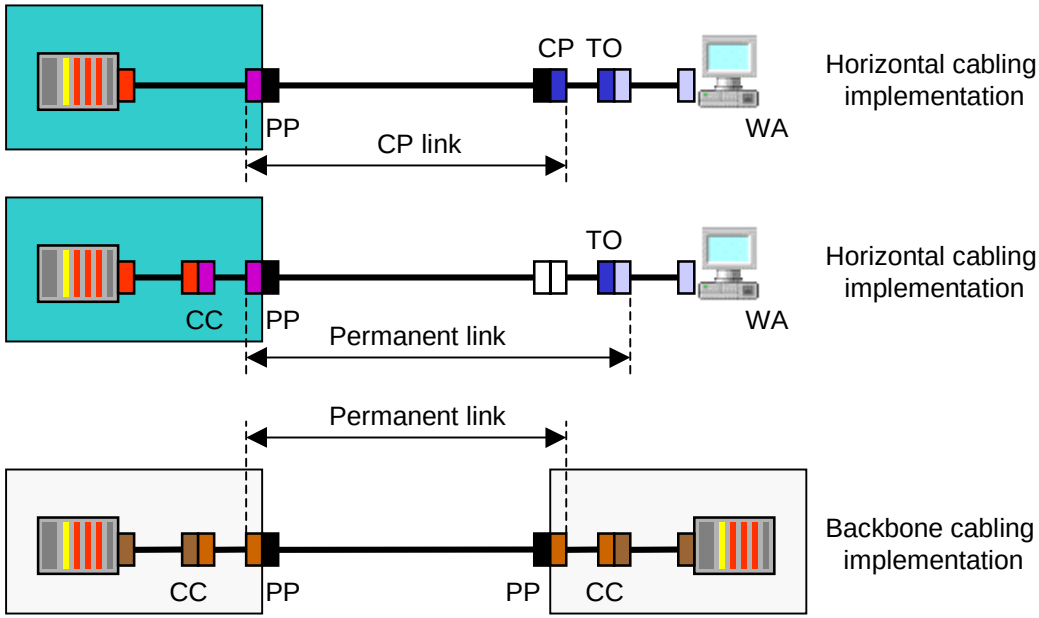
Link Measurement Validity

ISO/IEC 11801 Ed.2 (2002) and EN 50173 Ed.2 (2002)

CONFORMANCE

"Channel performance shall be explicitly verified where a channel is created by adding more than one cord to either end of a link meeting the requirements of Annex A".



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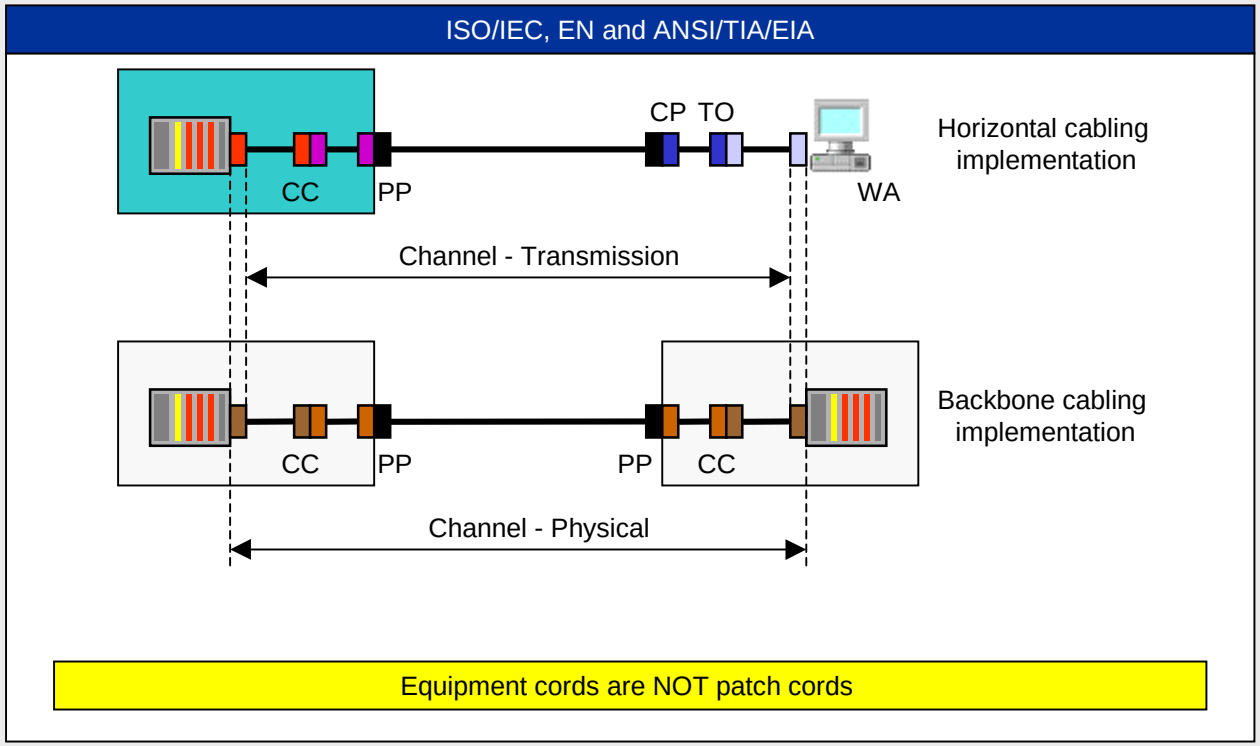
Channel Misconceptions



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Break

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The Differing Requirements

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Channel Requirements Summary

	Parameter	ISO/IEC and EN Class D (2002)	568-B.1 Category 5e	ISO/IEC and EN Class E	568-B.2.1 Category 6
Transmission parameters	Return loss	Harmonized[1]		Harmonized[1]	
	Attenuation/insertion loss	Not harmonized		Not harmonized	
	NEXT	Harmonized		Harmonized	
	PS NEXT	Harmonized		Harmonized	
	ACR	NEXT[2]	Not specified	NEXT[2]	Not specified
	PS ACR	PSNEXT[2]	Not specified	PSNEXT[2]	Not specified
	ELFEXT	Harmonized		Harmonized	
	PS ELFEXT	Harmonized		Harmonized	
Protocol function parameters	Propagation delay	Harmonized		Harmonized	
	Delay skew	Harmonized		Harmonized	
Current carrying parameters	d.c. loop resistance		Not specified		Not specified
	d.c. resistance unbalance		Not specified		Not specified
	d.c. current carrying capacity		Not specified		Not specified
Other parameters	Length	Not specified		Not specified	

NOTE 1: 3dB get-out clause in ISO/IEC and EN
NOTE 2: 4dB get-out clause in ISO/IEC and EN

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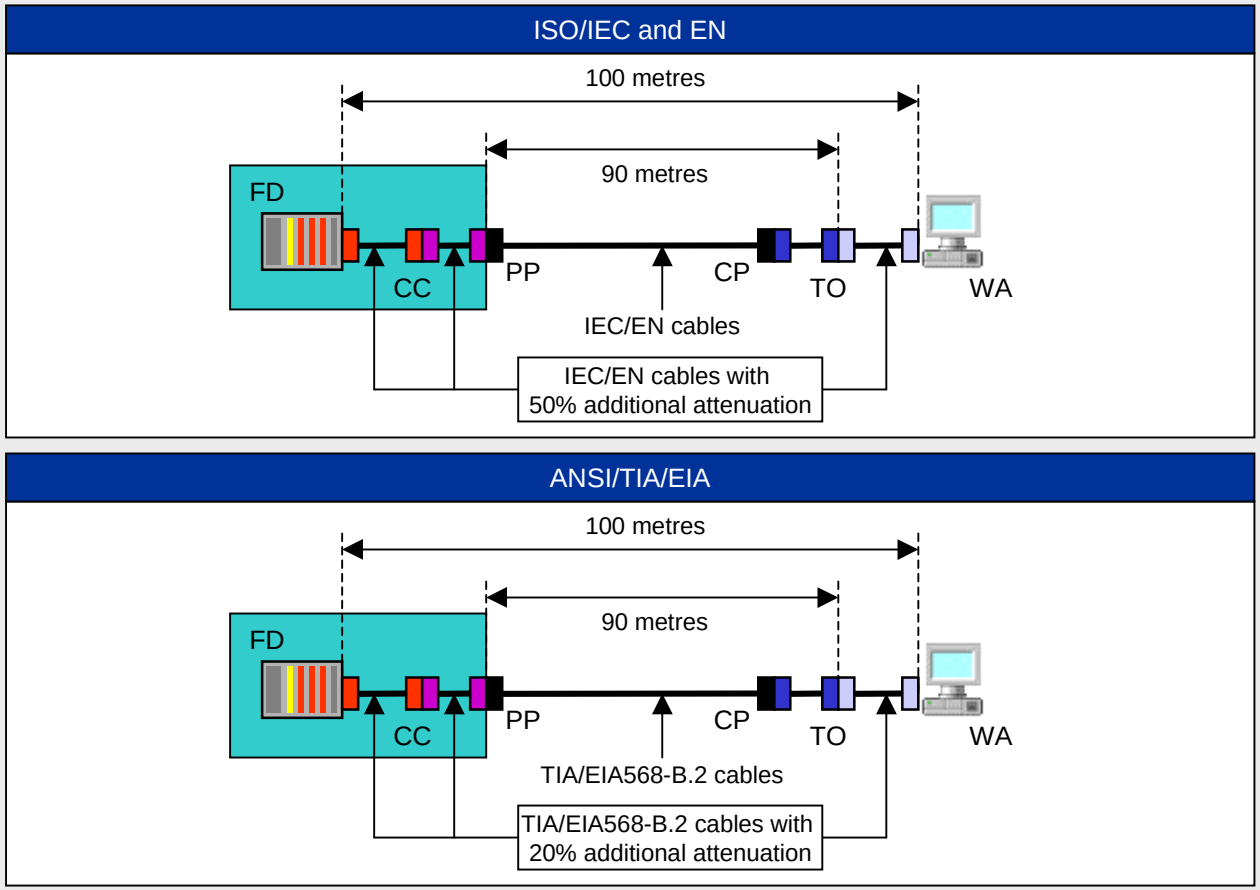
Channel Models



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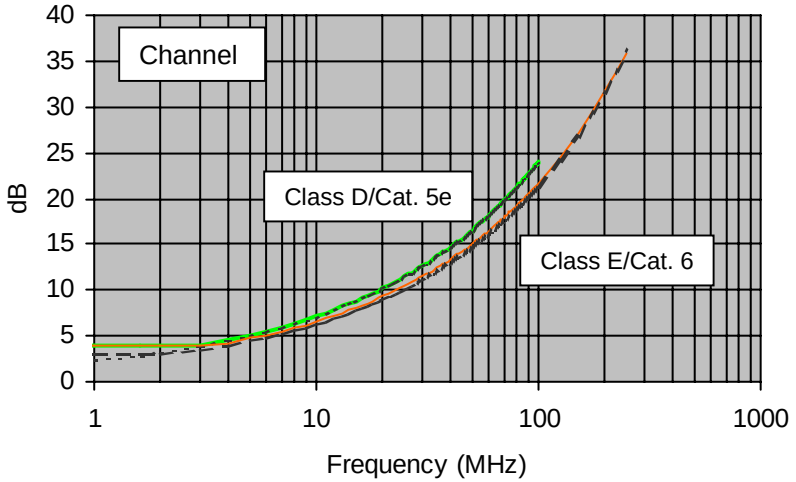
Attenuation/Insertion Loss

ISO/IEC and EN	568-B.1
Class D (2002)	Category 5e
1,05*(1,9108*sqrt(f)+0,0222*f+0,2/sqrt(f))+4*0,04*sqrt(f) 4dB min	1,02*(1,967*sqrt(f)+0,023*f+0,2/sqrt(f))+4*0,04*sqrt(f))
	568-B.2.1
Class E	Category 6
1,05*(1,82*sqrt(f)+0,0169*f+0,25/sqrt(f))+4*0,02*sqrt(f)) 4dB min.	1,02*(1,808*sqrt(f)+0,017*f+0,2/sqrt(f))+4*0,02*sqrt(f)) + 0,0003*$f^{1.5}$ 3dB min.



	Class D	Cat. 5e
f	dB	dB
16	9,1	9,1
100	24,0	24,0

	Class E	Cat. 6
f	dB	dB
16	8,3	8,0
100	21,7	21,3
200	31,7	31,5
250	35,9	36,0

AGENDA

PL Requirements Summary

	Parameter	ISO/IEC and EN Class D (2002)	568-B.1 Category 5e	ISO/IEC and EN Class E	568-B.2.1 Category 6
Transmission parameters	Return loss	Harmonized[1,3]		Harmonized[1,3]	
	Attenuation/insertion loss	Not harmonized		Not harmonized	
	NEXT	Harmonized		Harmonized	
	PS NEXT	Harmonized		Harmonized	
	ACR	NEXT[2,3]	Not specified	NEXT[2,3]	Not specified
	PS ACR	PSNEXT[2,3]	Not specified	PSNEXT[2,3]	Not specified
	ELFEXT	Harmonized		Harmonized	
	PS ELFEXT	Harmonized		Harmonized	
Protocol function parameters	Propagation delay	Harmonized		Harmonized	
	Delay skew	Harmonized		Harmonized	
Current carrying parameters	d.c. loop resistance	Specified	Not specified	Specified	Not specified
	d.c. resistance unbalance	Channel	Not specified	Channel	Not specified
	d.c. current carrying capacity	Channel	Not specified	Channel	Not specified
Other parameters	Length	Not specified		Not specified	

NOTE 1: 3dB get-out clause in ISO/IEC and EN
NOTE 2: 4dB get-out clause in ISO/IEC and EN
NOTE 3: TO-CP get-out clause in EN 50173 6MP

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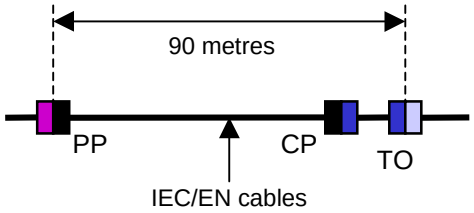
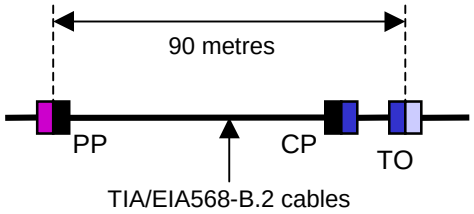
AGENDA

Maximum PL Models

ISO/IEC and EN



ANSI/TIA/EIA



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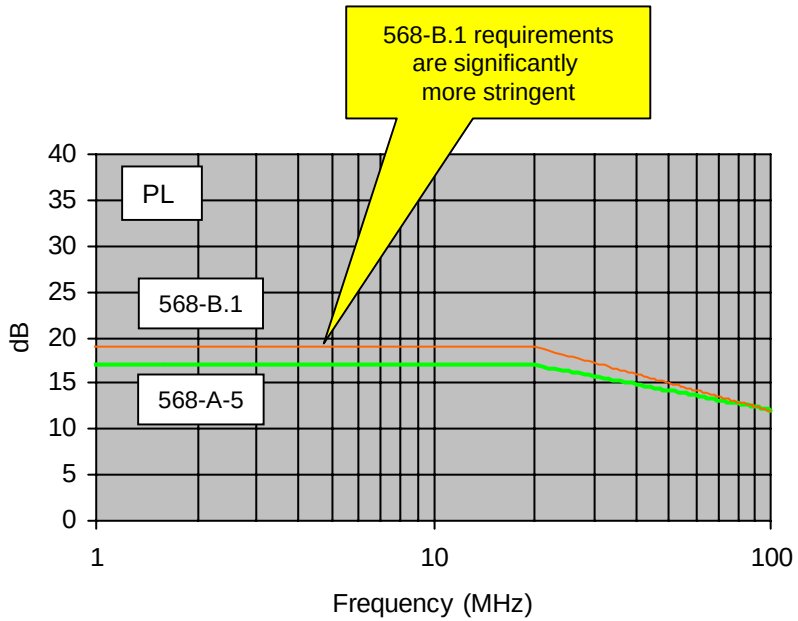
AGENDA

Return Loss

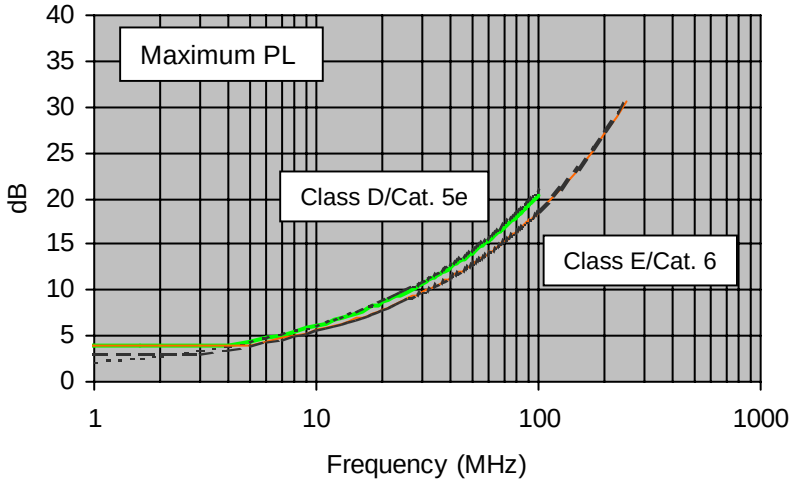
568-A Addendum 5	568-B.1
Category 5e	Category 5e
17-7log(f/20), 17,0 dB max.	19-10log(f/20), 19,0 dB max.



AGENDA

Attenuation/Insertion Loss

ISO/IEC and EN	568-B.1
Class D (2002)	Category 5e
0,9*(1,9108*sqrt(f)+0,0222*f+0,2/sqrt(f))+3*0,04*sqrt(f) 4dB min	0,9*(1,967*sqrt(f)+0,023*f+0,2/sqrt(f))+3*0,04*sqrt(f))
	568-B.2.1
Class E	Category 6
0,9*(1,82*sqrt(f)+0,0169*f+0,25/sqrt(f))+4*0,02*sqrt(f)) 4dB min.	0,9*(1,808*sqrt(f)+0,017*f+0,2/sqrt(f))+3*0,02*sqrt(f)) + 0,00015*$f^{1.5}$ 3dB min.



	Class D	Cat. 5e
f	dB	dB
16	7,7	7,9
100	20,4	21,0

	Class E	Cat. 6
f	dB	dB
16	7,0	7,1
100	18,5	18,6
200	27,1	27,4
250	30,7	31,1

AGENDA

CP Link Requirements Summary

	Parameter	ISO/IEC and EN Class D (2002)	568-B.1 Category 5e	ISO/IEC and EN Class E	568-B.2.1 Category 6
Transmission parameters	Return loss	PL	Not specified	PL	Not specified
	Attenuation/insertion loss	Length dependent		Length dependent	
	NEXT	PL		PL	
	PS NEXT	PL		PL	
	ACR	NEXT[1]		NEXT[1]	
	PS ACR	PSNEXT[1]		PSNEXT[1]	
	ELFEXT	PL++		PL++	
	PS ELFEXT	PL++		PL++	
Protocol function parameters	Propagation delay	Length dependent		Length dependent	
	Delay skew	Length dependent		Length dependent	
Current carrying parameters	d.c. loop resistance	Length dependent		Length dependent	
	d.c. resistance unbalance	Channel		Channel	
	d.c. current carrying capacity	Channel		Channel	

NOTE 1: 4dB get-out clause in ISO/IEC and EN

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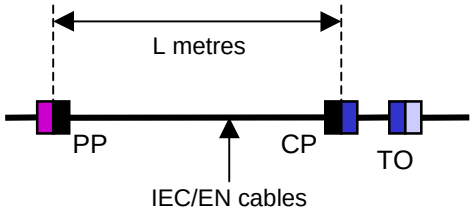
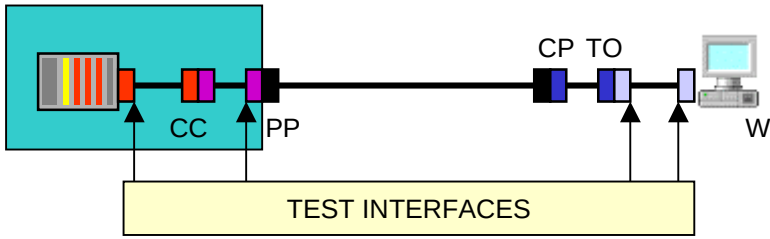
AGENDA

CP Link Model

ISO/IEC and EN



ANSI/TIA/EIA-568-B.1



Horizontal cabling implementation

AGENDA

- Introduction
- The Status of the Standards
- What Can We Test?
- Break
- The Differing Requirements
- Copper: Testing Philosophies
  - Channel and Link Test Limits
  - Test Equipment Limitations
  - ISO/EN Length Dependencies
  - ISO/EN Return Loss
  - ISO/EN NEXT/PSNEXT
  - ISO/EN Outstanding Items
- Copper: The “Real World”
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Copper: Testing Philosophies

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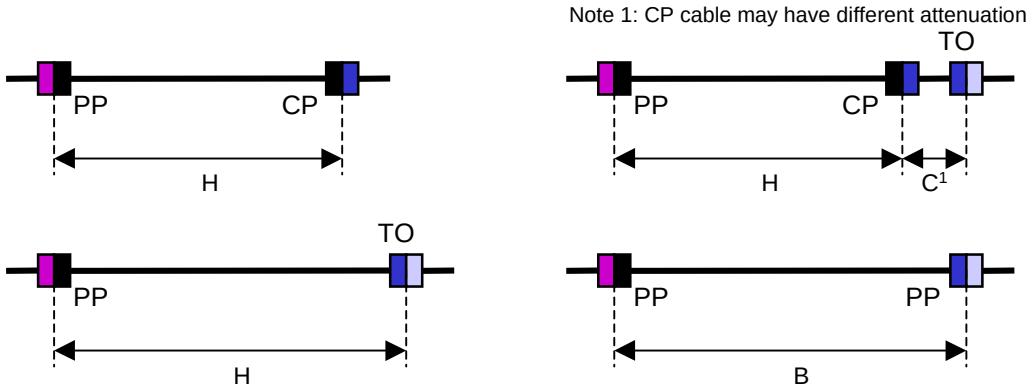
AGENDA

Channel and Link Test Limits

	ISO/IEC and EN	ANSI/TIA/EIA-568-B
Channel	Design independent Fixed limit	Design independent Fixed limit
Permanent Link	Design dependent Fixed maximum implementation limit	Design independent Fixed limit
CP Link	Design dependent Fixed maximum implementation limit	No specified limits

Complex requirement - Difficult to verify

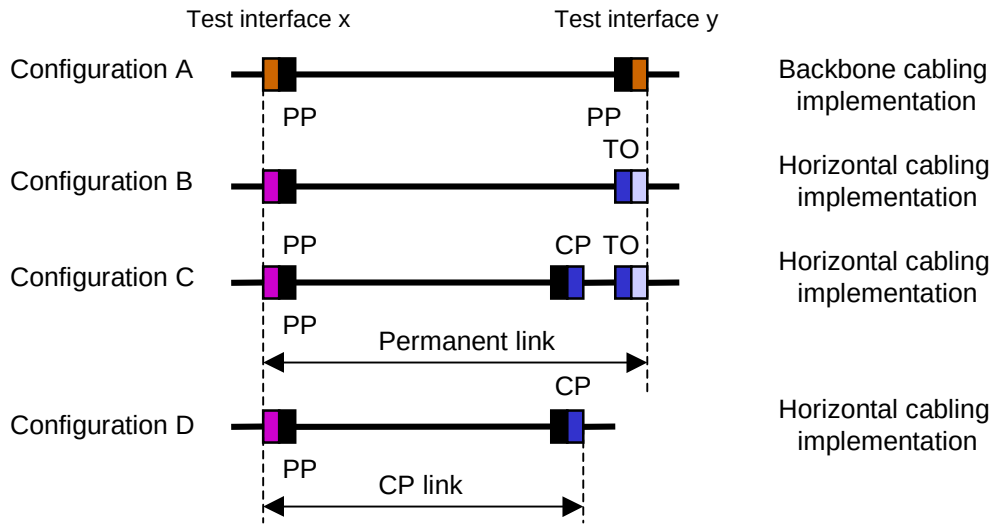
Simple requirement - Inadequate QA



AGENDA

Theoretical Link Limits - I

	Formulae taking the form
Return loss	Channel + 2 dB
NEXT	-20*log(10^(-0,05*(function of log(f))+N*10^(function of log(f)))
PSNEXT	-20*log(10^(-0,05*(function of log(f))+N*10^(function of log(f)))
ELFEXT	-20*log(10^(-0,05*(function of log(f))+n*10^(function of log(f)))
PSELFEXT	-20*log(10^(-0,05*(function of log(f))+n*10^(function of log(f)))
	N = 1 for Configurations A, B and D N = 1 for Configuration C at "Test interface x" and N=2 at "Test interface y"
	n = 2 for Configurations A, B and D, n = 3 for Configuration C



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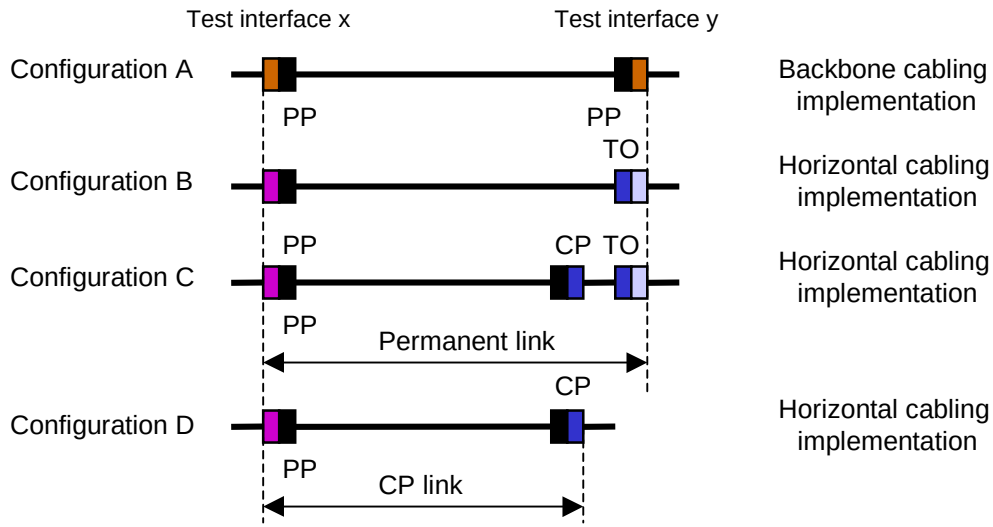
AGENDA

Theoretical Link Limits - II

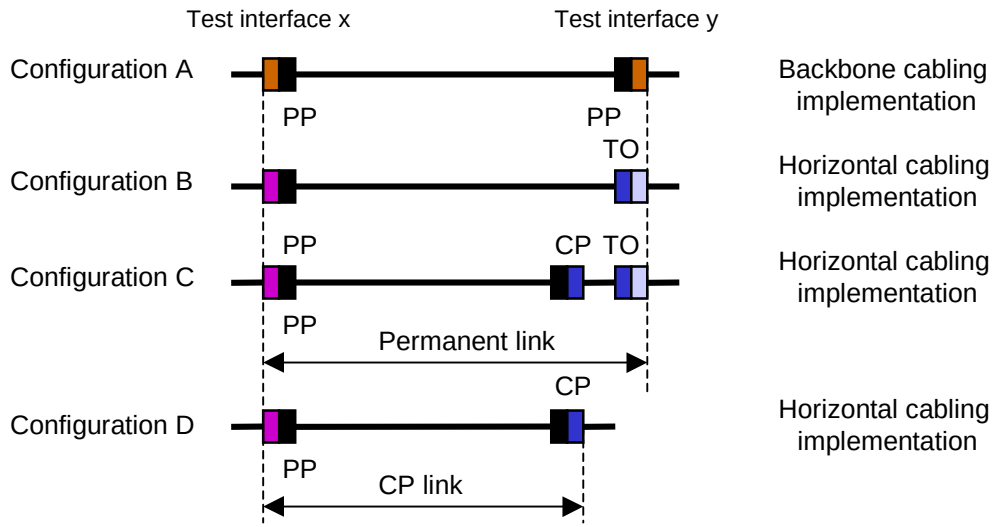
	Formulae taking the form
Propagation delay	(L/100)*(0,534+0,036/sqrt(f)) + n*0,0025
Delay skew	(L/100)*0,045 + n*0,00125
	n = 2 for Configurations A, B and D, n = 3 for Configuration C
	$L = L_{PL} + L_{CP}$ L_{PL} = length of fixed cable (m), L_{CP} = length of CP cord (where present) (m)



AGENDA

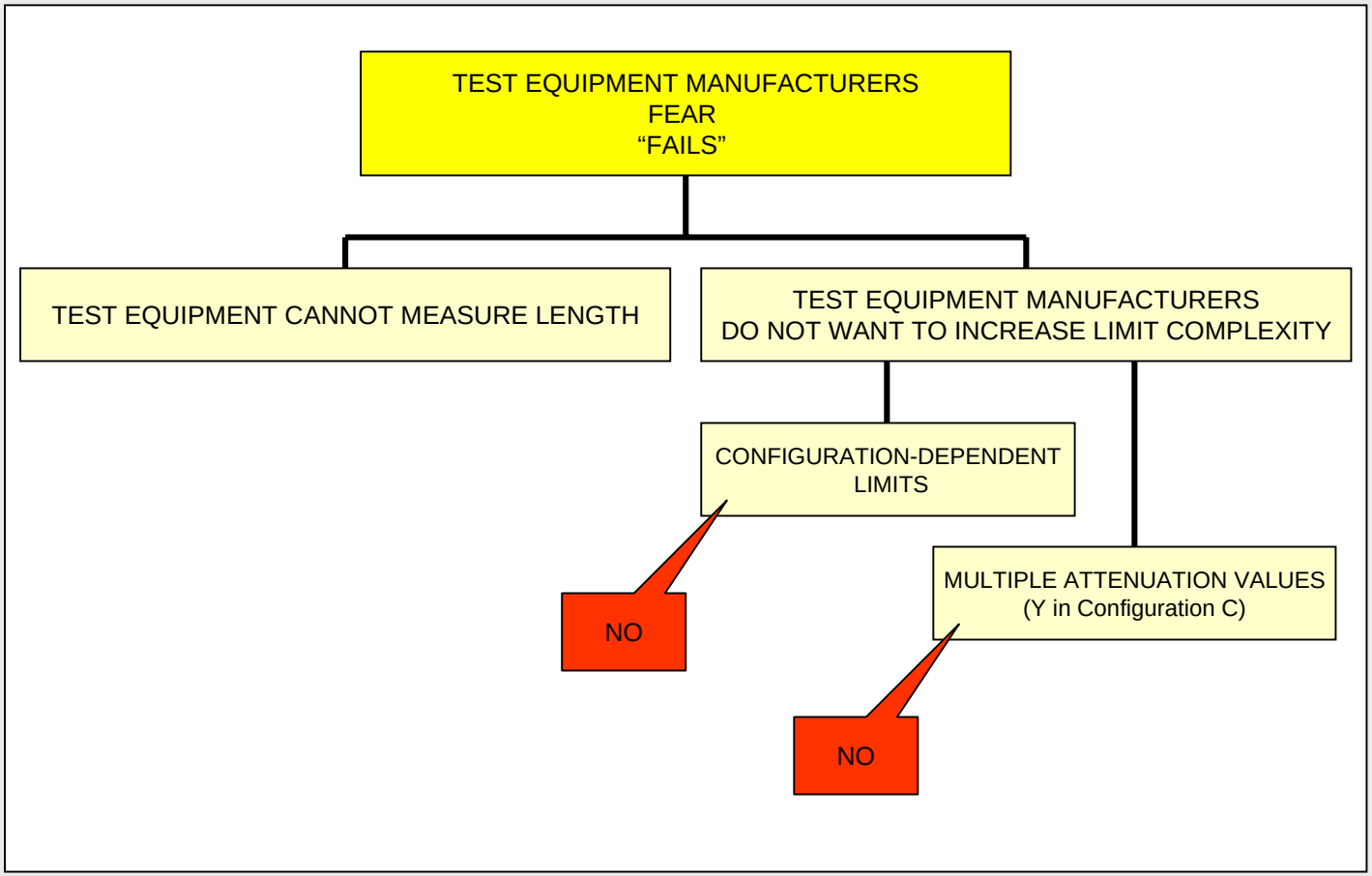
Theoretical Link Limits - III

	Formulae taking the form	
Insertion loss/attenuation	$(L/100)*(A*\sqrt{f}+B*f+C/\sqrt{f}) + n*D*\sqrt{f}$	
d.c. loop resistance	$(L/100)*22 + n*0{,}4$	
d.c. resistance unbalance	Within a pair	3%
	$n = 2$ for Configurations A, B and D, $n = 3$ for Configuration C	
	$L = L_{PL} + L_{CP}*Y$ L_{PL} = length of fixed cable (m), L_{CP} = length of CP cord (where present) (m) Y = the ratio of CP cable attenuation (dB/m) to fixed horizontal cable attenuation (dB/m)	



AGENDA

Test Equipment Limitations



AGENDA

ISO/EN Length Dependencies

	Formulae taking the form	
Propagation delay	$(L/100)*(0{,}534+0{,}036/\sqrt{f}) + n*0{,}0025$	
Delay skew	$(L/100)*0{,}045 + n*0{,}00125$	
	$L = L_{PL} + L_{CP}$ L_{PL} = length of fixed cable (m), L_{CP} = length of CP cord (where present) (m)	
Insertion loss/attenuation	$(L/100)*(A*\sqrt{f}+B*f+C/\sqrt{f}) + n*D*\sqrt{f}$	
d.c. loop resistance	$(L/100)*22 + n*0{,}4$	
d.c. resistance unbalance	Within a pair	3%
	n = 2 for Configurations A, B and D, n = 3 for Configuration C	
	$L = L_{PL} + L_{CP}*Y$ L_{PL} = length of fixed cable (m), L_{CP} = length of CP cord (where present) (m) Y = the ratio of CP cable attenuation (dB/m) to fixed horizontal cable attenuation (dB/m)	

FCD ISO/IEC 11801 (N739) contains a practical alternative

A practical method of meeting this requirement is to demonstrate that the margin between the measured value and the channel limits are adequate to accommodate any additional cabling components used to create the channel.

An improved wording is proposed for EN 50173 3MV

Where the maximum lengths of channel components to be added to the link are known and specified for the cabling, the margin between the measured value of ……. and the channel limits shall exceed the total ……. of:

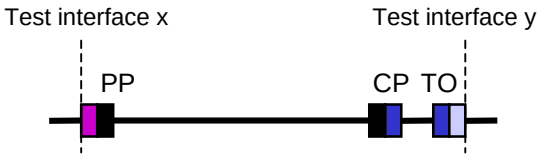
- the specified maximum lengths of cords used to create the channel;
- the specified maximum lengths of additional cables/connections, where appropriate, used to create the channel.

AGENDA

ISO/EN Return Loss

	Formulae taking the form
Return loss	Channel + 2 dB
NEXT	-20*log(10^(-0,05*(function of log(f))+N*10^(function of log(f)))
PSNEXT	-20*log(10^(-0,05*(function of log(f))+N*10^(function of log(f)))
ELFEXT	-20*log(10^(-0,05*(function of log(f))+n*10^(function of log(f)))
PSELFEXT	-20*log(10^(-0,05*(function of log(f))+n*10^(function of log(f)))
	N = 1 for Configurations A, B and D N = 1 for Configuration C at "Test interface x" and N=2 at "Test interface y"
	n = 2 for Configurations A, B and D, n = 3 for Configuration C

EN 50173 6MP contains Configuration C get-out clause



For configuration C ….. close proximity of TO and CP connections can ….FAIL

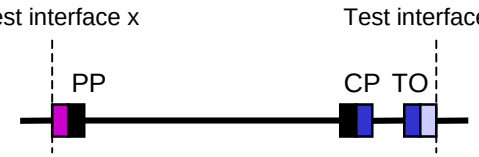
Such results are compliant provided that:
a) the measured link values at test interface "y", and a complete channel, comply with the channel requirements
or
b) a complete channel complies with the channel requirements.

AGENDA

EN NEXT/PSNEXT

	Formulae taking the form
Return loss	Channel + 2 dB
NEXT	-20*log(10^(-0,05*(function of log(f))+10^(function of log(f)))
PSNEXT	-20*log(10^(-0,05*(function of log(f))+10^(function of log(f)))
ELFEXT	-20*log(10^(-0,05*(function of log(f))+n*10^(function of log(f)))
PSELFEXT	-20*log(10^(-0,05*(function of log(f))+n*10^(function of log(f)))
	n = 2 for Configurations A, B and D, n = 3 for Configuration C

EN 50173 6MP contains Configuration C get-out clause



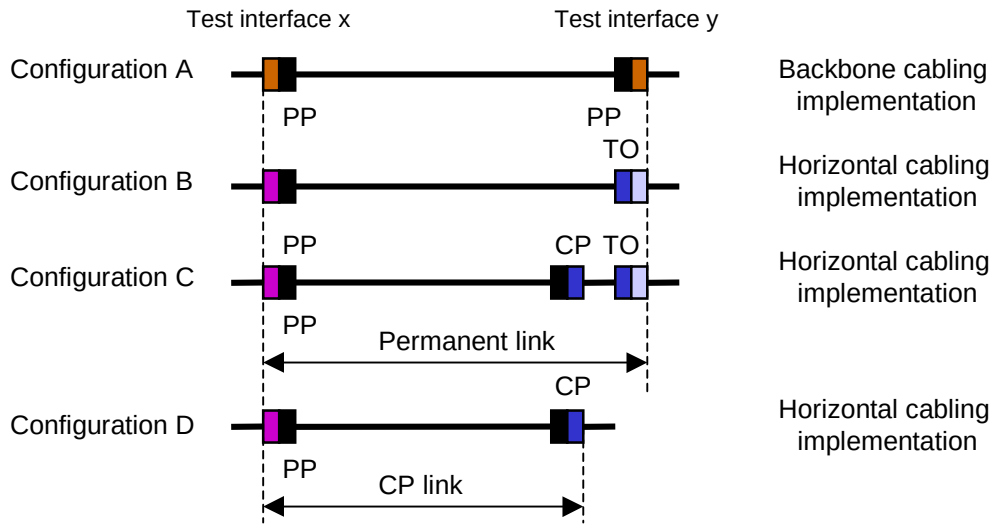
For configuration C ….. close proximity of TO and CP connections can ….FAIL

Such results are compliant provided that the measured link values at test interface "y" comply with the channel requirements.

AGENDA

ISO/EN Outstanding Items

	Formulae taking the form
Return loss	Channel + 2 dB
NEXT	-20*log(10^(-0,05*(function of log(f))+10^(function of log(f)))
PSNEXT	-20*log(10^(-0,05*(function of log(f))+10^(function of log(f)))
ELFEXT	-20*log(10^(-0,05*(function of log(f))+n*10^(function of log(f)))
PSELFEXT	-20*log(10^(-0,05*(function of log(f))+n*10^(function of log(f)))
	n = 2 for Configurations A, B and D, n = 3 for Configuration C



AGENDA

- Introduction
- The Status of the Standards
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- Break
- The Differing Requirements
- Copper: Testing Philosophies
- Copper: The “Real World”
  - Implementation Rules
  - Channel Design
  - Attenuation and Delay Skew
- Question Time
- Lunch
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Copper: the “real world”

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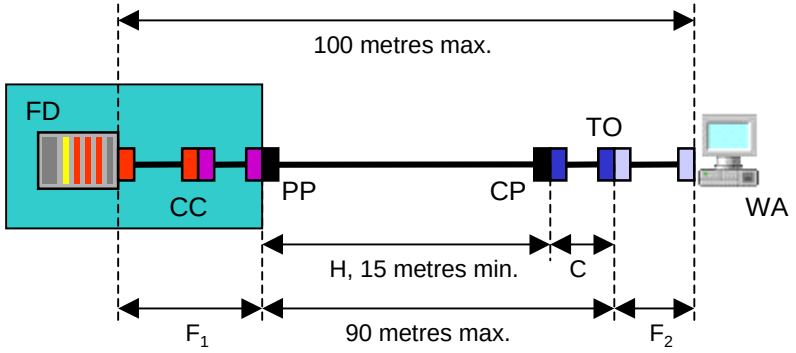
AGENDA

Implementation Rules

ISO/IEC and EN



$F = F_1 + F_2$

X = cord attenuation premium
Y = CP cable attenuation premium (if any)

No. of connections	Class D/Category 5	Class E/Category 6	Class F/Category 7
2	H = (109-FX)/T	H = (107-3[1]-FX)/T	H = (107-2[1]-FX)/T
3 w/o. CP	H = (107-FX)/T	H = (106-3[1]-FX)/T	H = (106-3[1]-FX)/T
3 inc. CP	H = (107-FX-CY)/T	H = (106-3[1]-FX-CY)/T	H = (106-3[1]-FX-CY)/T
4	H = (105-FX-CY)/T	H = (105-3[1]-FX-CY)/T	H = (105-4[1]-FX-CY)/T

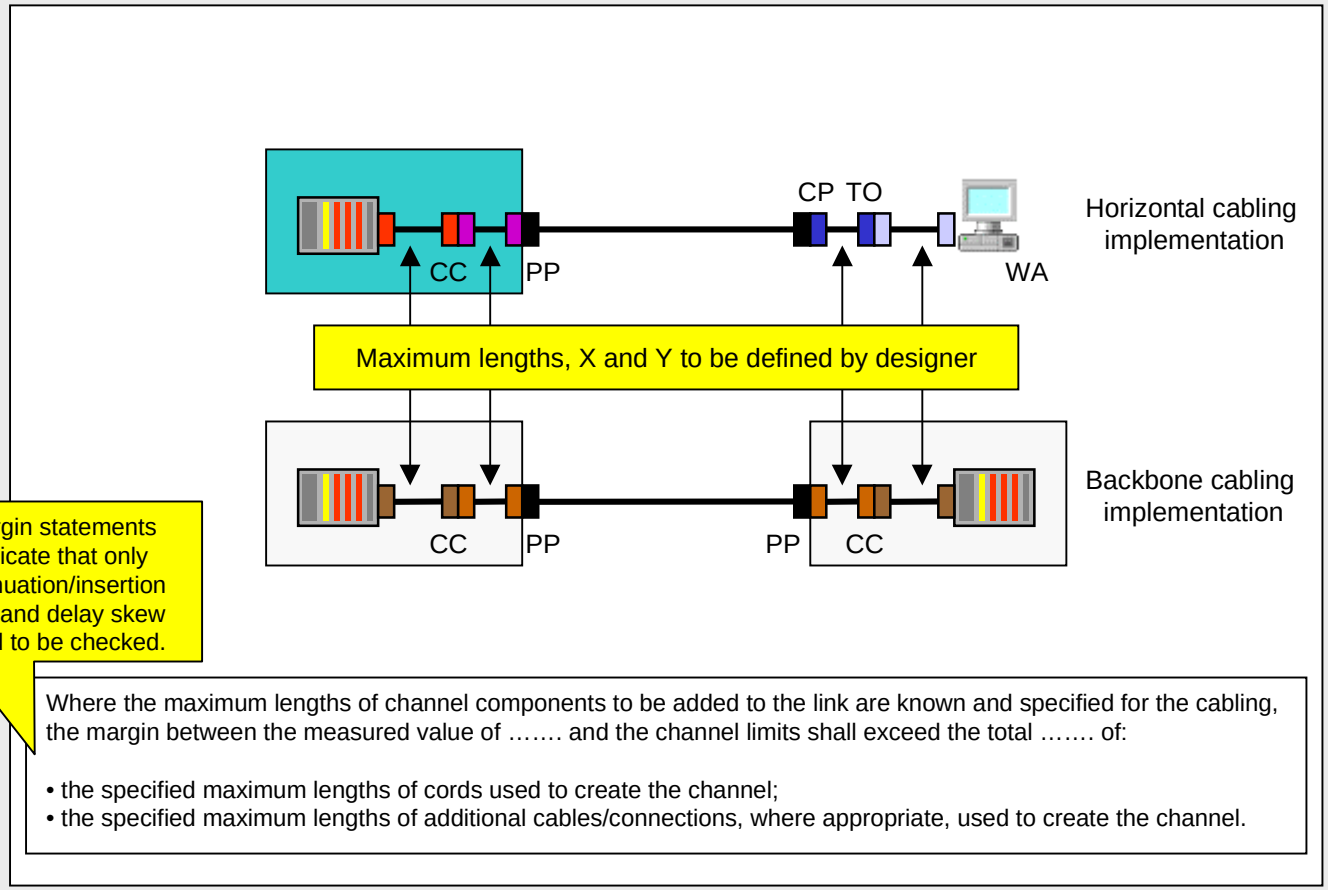
$T = 1 + (t-20) \times \alpha$ where t = maximum design temperature within link

	for screened cables	for unscreened cables
X and Y	1.5 typically	1.2 typically
α	= 0.2 for t>20ºC	= 0.4 for 20ºC<t<40ºC = 0.6 for 40ºC<t<60ºC

Note 1: this length reduction is provides margin for insertion loss deviation.

AGENDA

Channel Design



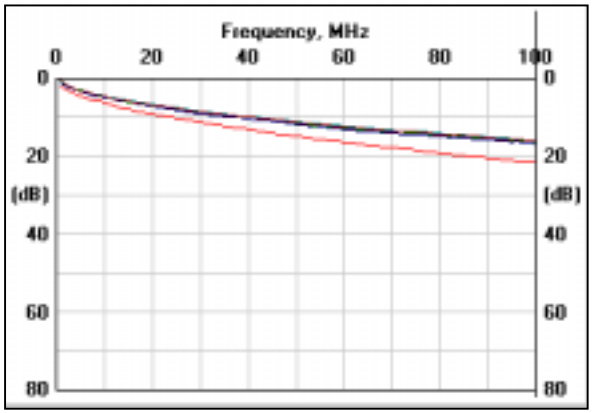
Where the maximum lengths of channel components to be added to the link are known and specified for the cabling, the margin between the measured value of ……. and the channel limits shall exceed the total ……. of:

- the specified maximum lengths of cords used to create the channel;
- the specified maximum lengths of additional cables/connections, where appropriate, used to create the channel.

AGENDA

Attenuation and Delay Skew

ATTENUATION/INSERTION LOSS



The highest measured attenuation/insertion loss occurs at the highest measurement frequency.

The test equipment will have to report the margin between the measured value and the channel limit at:
- 100 MHz for Class D compliance;
- 250 MHz for Class E compliance.

The installer has to check that the margin is acceptable.

	Class D	Class E
Connection	0,2 dB	0,32 dB
Solid cable	0,21 dB/m	0,33 dB/m
Stranded cable		
Unscreened cable	0,25 dB/m	0,40 dB/m
Screened cable	0,32 dB/m	0,50 dB/m

DELAY SKEW

Delay skew is constant with frequency

The installer has to check that the margin is acceptable.

	Class D	Class E
Connection	1,25 ns	
Cable	0,45 ns/m	

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AGENDA

Question Time

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AGENDA

Lunch

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  - Reference Points
  - General Implementations
  - The Alternative Approaches
  - Testing Regimes
  - LSPM Test Methods
  - Glossary
  - Cabling Configurations
  - Test Methods
    - Configuration A
    - Configuration B
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OF - Testing Philosophies

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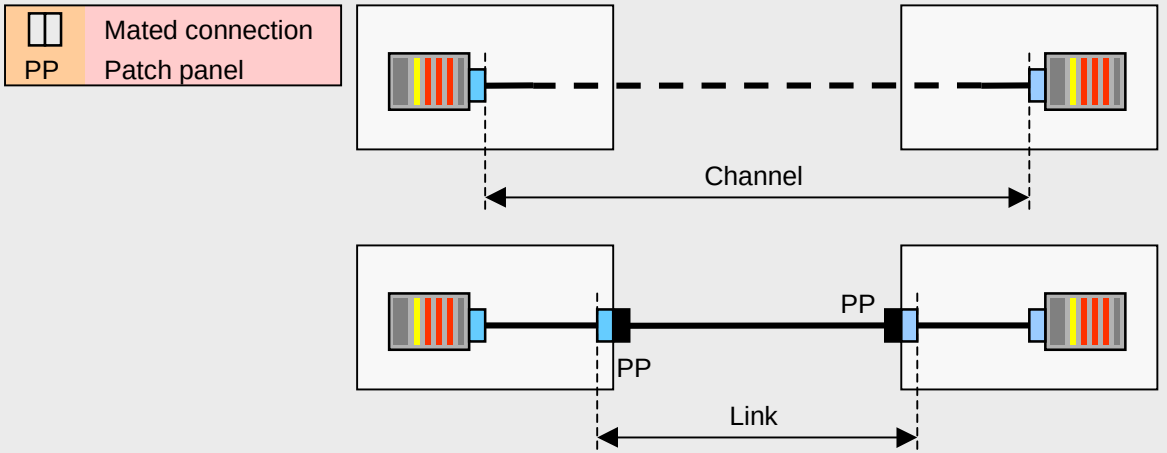
AGENDA

Reference Points



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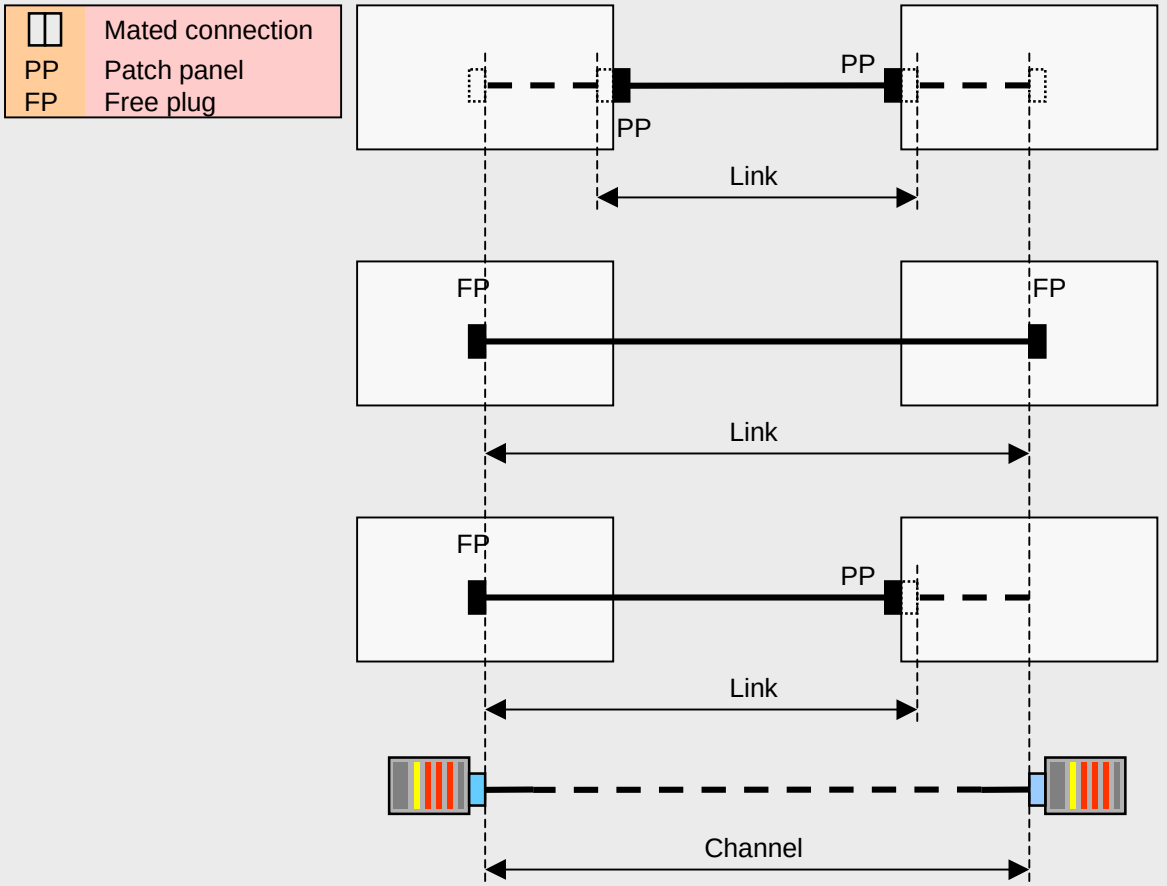
AGENDA

General Implementations



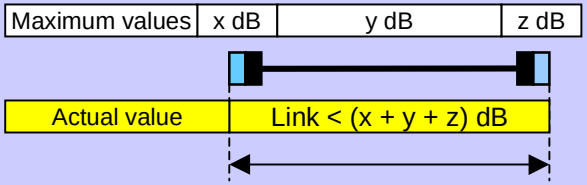
AGENDA

The Alternative Approaches

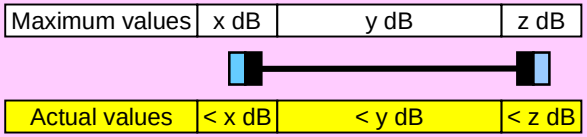
"Channel" approach

APPLICATION	Optical power budget (dB) MMF 850nm	MMF 1300nm	SMF 1310nm
ISO/IEC 8802-3: 10BASE-FL/FB	12,5 (6,8)		
ISO/IEC 8802-5: TR 4/16 Mbit/s	13,0 (8,0)		
ISO/IEC 9314-3 FDDI		11,0 (6,0)	
ISO/IEC DIS 9314-4 FDDI			10,0
ISO/IEC 8802-3: 100BASE-FX		11,0 (6,0)	
TR 100 Mbit/s		11,0 (6,0)	
CD 14165-1: Fibre Channel-1062	4,0		6,0
IEEE 802-3: 1000BASE-SX	2,6 (3,56)		
IEEE 802-3: 1000BASE-LX		2,35	5,0

"Overall loss" approach



"Component loss" approach



AGENDA

Testing Regimes

TEST REGIME	ITEMS UNDER TEST	TESTING APPROACH	TEST TOOL
Component Acceptance	Cables	Component	OTDR
	Cords	Overall loss	LSPM
		Component	LSPM
Legacy Cabling Acceptance	Links and channels	Overall loss	LSPM
		Component	OTDR
Partial Completion Tests	Links	Component	OTDR
Installed Cabling Acceptance	Links and channels	Overall loss	LSPM
		Component	OTDR
Fault Diagnosis	Links and channels	Component	OTDR

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AGENDA

LSPM Test Methods

INTERNATIONAL STANDARDS

ISO/IEC
11801 Ed.2 (2002)

- Multimode: IEC **61280-4-1**
- Singlemode: IEC **61280-4-2**

US STANDARDS

ANSI/TIA/EIA
568B.1 (2001)

- Multimode: ANSI/TIA/EIA **526-14-A**
- Singlemode: ANSI/TIA/EIA **526-7-A**

EUROPEAN STANDARDS

EN (future BS EN)
50173 Ed.2 (2002)

EN (future BS EN)
50346 (2002)

- Multimode
- Singlemode: IEC **61280-4-2**

BRITISH STANDARDS

BS
7718 (1996)

- Multimode
- Singlemode

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AGENDA

LSPM Test Method Glossary

ARENA	REFERENCE	TITLE
IEC	61280-4-1	Fibre optic communication subsystem basic test procedures - Part 4-1: Fibre optic cable plant - Multimode fibre optic cable plant attenuation
IEC	61280-4-2	Fibre optic communication subsystem basic test procedures - Part 4-2: Fibre optic cable plant - Single-mode fibre optic cable plant attenuation
EN	50346	Information Technology - Testing of installed cabling
TIA/EIA	526-14-A	OFSTP-14A Optical Power Loss Measurement of Installed Multimode Fiber Cable Plant (ANSI/TIA/EIA-526-14A-98)
TIA/EIA	526-7	OFSTP-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant (ANSI/TIA/EIA-526-7-98)

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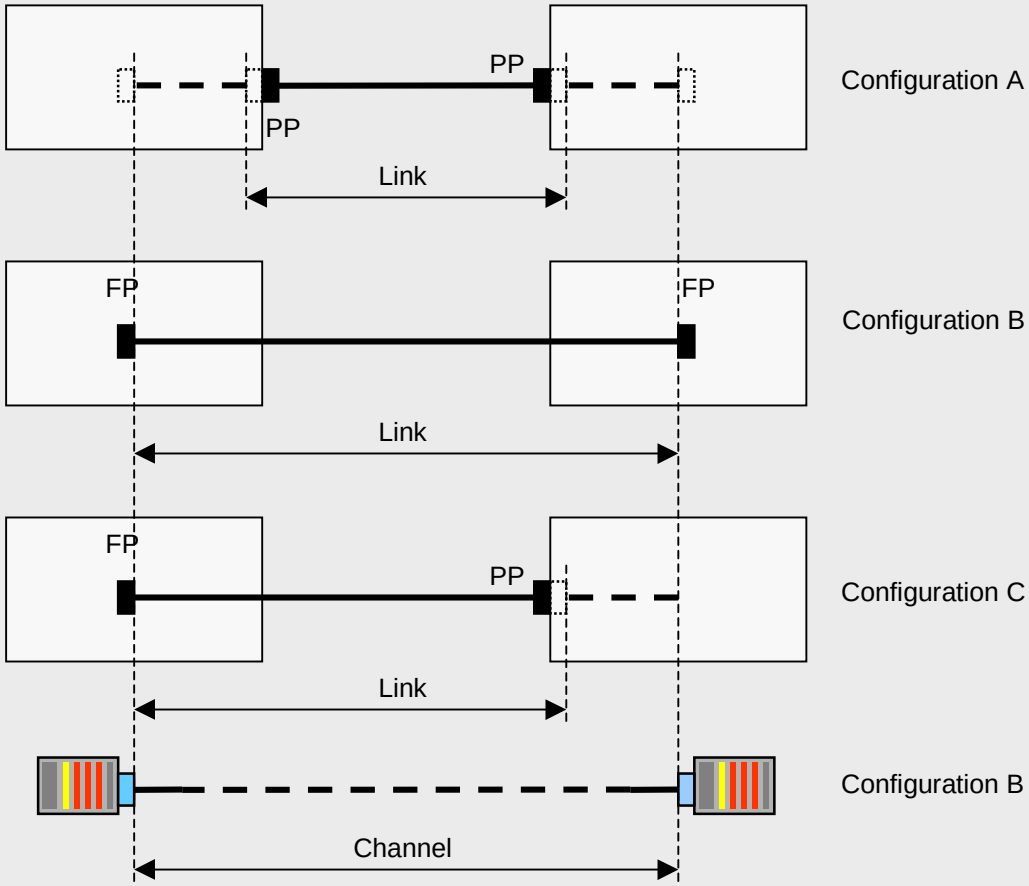
AGENDA

Cabling Configurations



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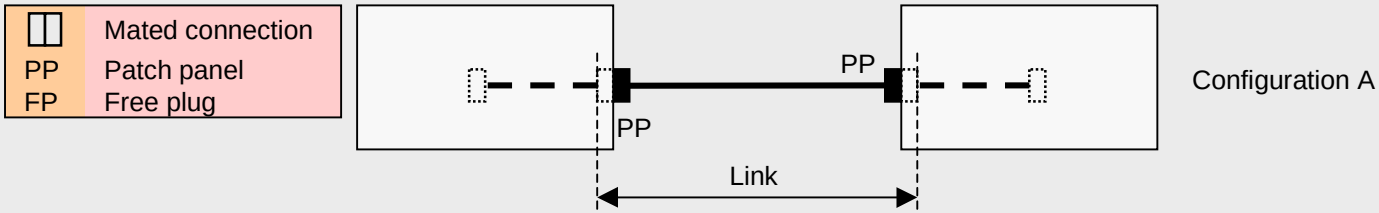
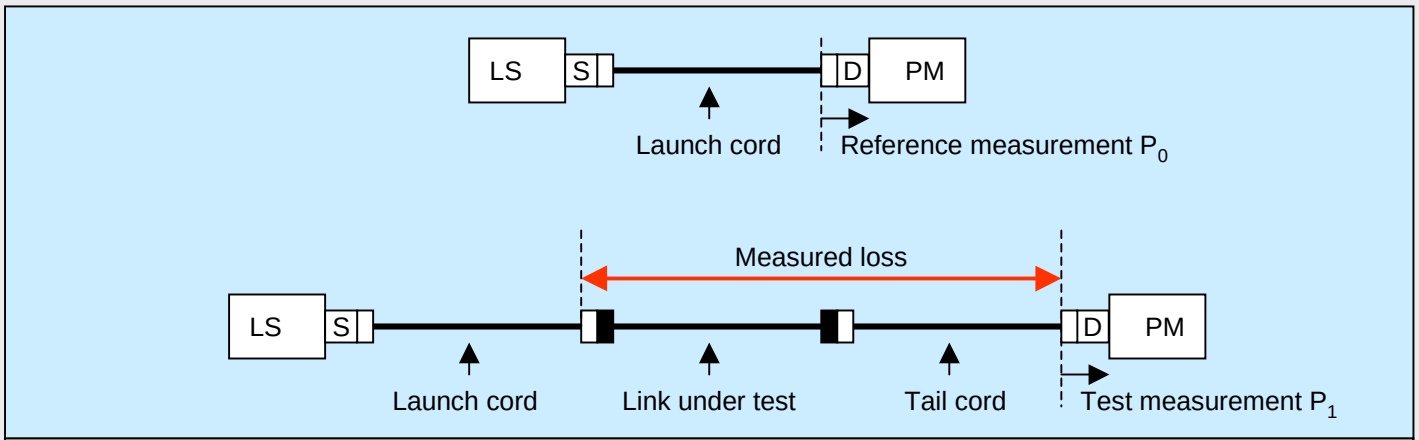
AGENDA

Configuration A Test Method





Loss = P_1 - P_0 (dB)

MMF: not applicable	MMF: EN 50346 Method 1	MMF: ….-526-14-A Method B
SMF: IEC 61280-4-2 Method 1.A	SMF: IEC 61280-4-2 Method 1.A	SMF: ….-526-7 Method A.1
	BS 7718: Configuration A	

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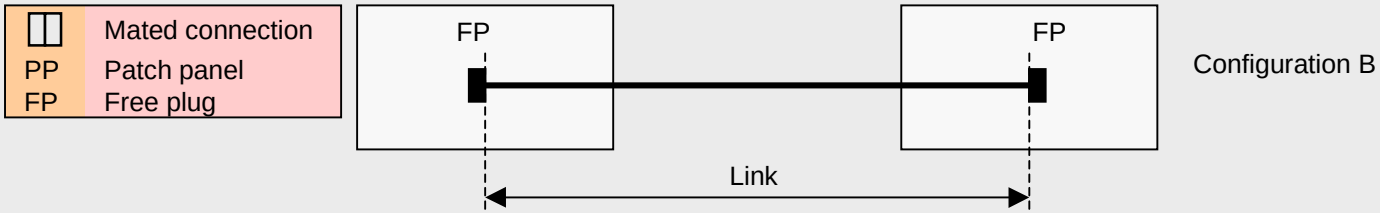
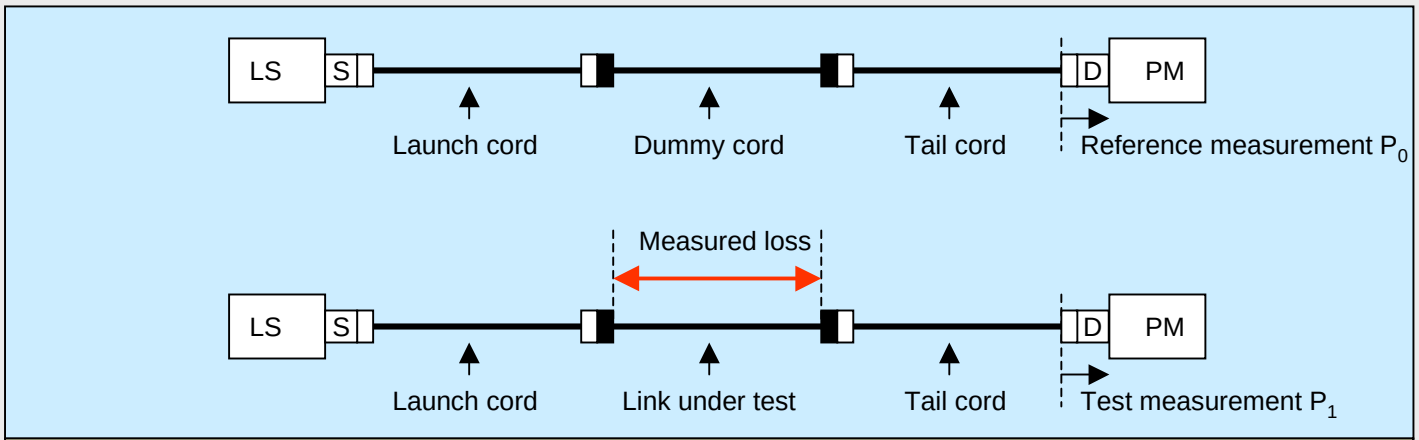
AGENDA

Configuration B Test Method





Loss = P_1 - P_0 (dB)

MMF: not applicable	MMF: EN 50346 Method 2	MMF: ….-526-14-A Method C
SMF: IEC 61280-4-2 Method 1.C	SMF: IEC 61280-4-2 Method 1.C	SMF: ….-526-7
	BS 7718: Configuration B	

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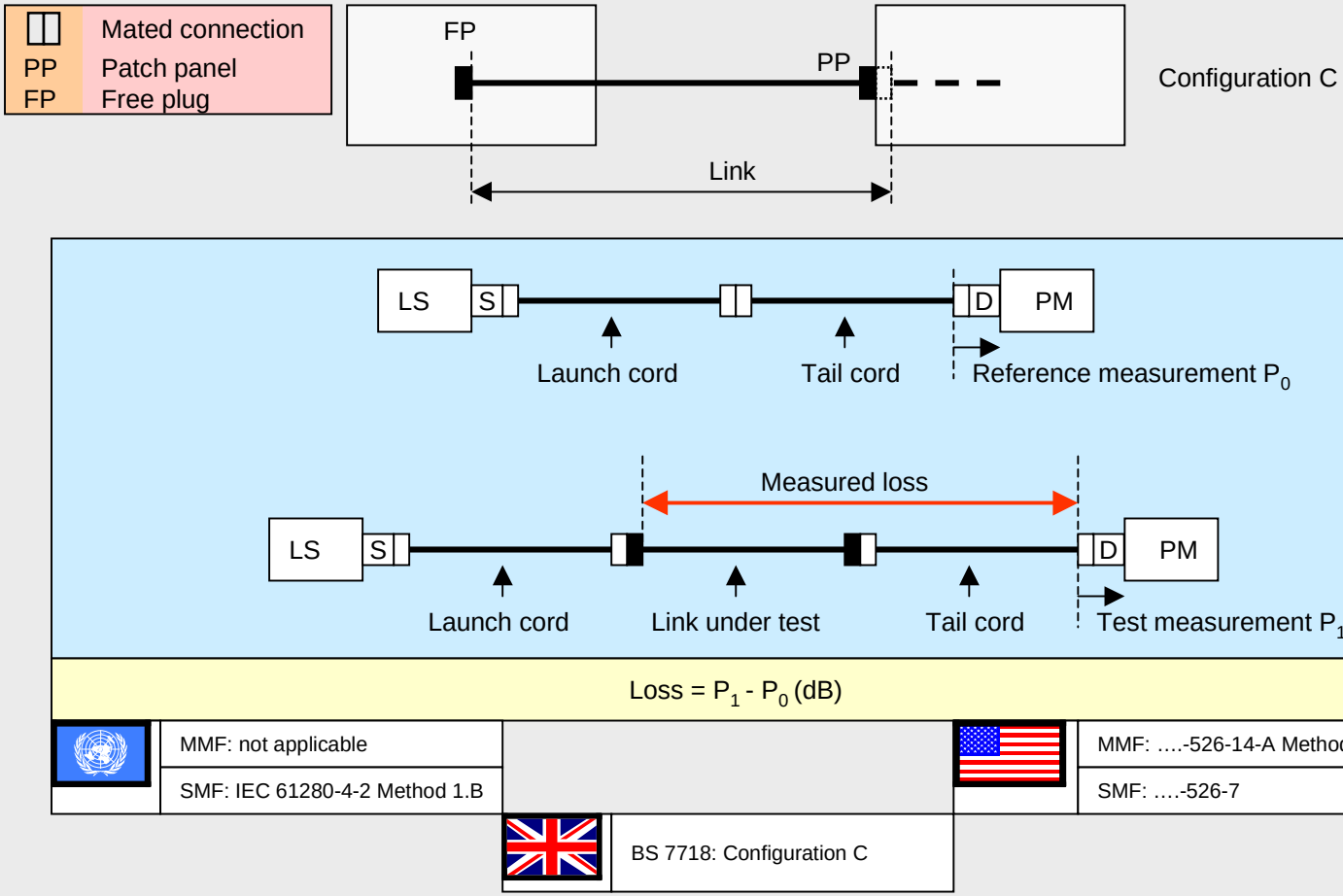
AGENDA

Configuration C Test Method



AGENDA

Impact of Incorrect Methods

INSTALLED LINK	METHOD APPLIED	RESULT
CONFIGURATION A	CONFIGURATION A	CORRECT
	CONFIGURATION B	LOW BY 2 CONNECTIONS
	CONFIGURATION C	LOW BY 1 CONNECTION
CONFIGURATION B	CONFIGURATION A	HIGH BY 2 CONNECTIONS
	CONFIGURATION B	CORRECT
	CONFIGURATION C	HIGH BY 1 CONNECTION
CONFIGURATION C	CONFIGURATION A	HIGH BY 1 CONNECTION
	CONFIGURATION B	LOW BY 1 CONNECTION
	CONFIGURATION C	CORRECT

INSTALLED CHANNEL	METHOD APPLIED	RESULT
CONFIGURATION B	CONFIGURATION A	HIGH BY 2 CONNECTIONS
	CONFIGURATION B	CORRECT
	CONFIGURATION C	HIGH BY 1 CONNECTION

All measurements are subject to the fundamental accuracy of the technique

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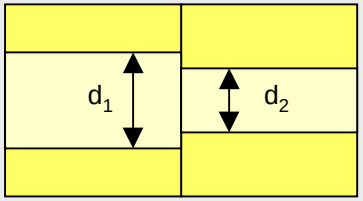
AGENDA

LSPM Measurement Accuracy

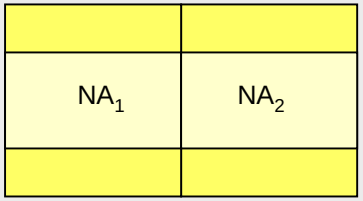
CORE



$$Loss = -10\log_{10}\left[\left(\frac{d_2}{d_1}\right)^2\right]$$

dB from large core to small core
(0 dB from small to large)

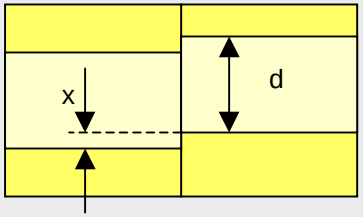
CORE



$$Loss = -10\log_{10}\left[\left(\frac{NA_2}{NA_1}\right)^2\right]$$

dB from large NA to small NA
(0 dB from small to large)

CORE



$$Loss = -10\log_{10}\left[\frac{1}{90}\tan^{-1}\left(\frac{de}{x}\right) - \frac{2xe}{\pi d}\right]$$

dB in both directions

$$e = \left[1 - \left(\frac{x}{d}\right)^2\right]^{0.5}$$

AGENDA

LSPM Measurement Accuracy

CORE	53 / 47	$Loss = -10\log_{10}\left[\left(\frac{47}{53}\right)^2\right]$	= -1.04 dB	Applied statistics and real manufacturing tolerances suggest combined value < -0.35 dB per joint
CORE	NA = 0.215 / NA = 0.185	$Loss = -10\log_{10}\left[\left(\frac{0.185}{0.215}\right)^2\right]$	= -1.30 dB	
CORE	2 µm / 50 µm	$Loss$	= -0.47 dB	

Measurement accuracy of LSPM systems = 0.7 dB plus other mismatches

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Duplex and SFF Testing

AGENDA

- Introduction
- The Status of the Standards
- What Can We Test?
- Break
- The Differing Requirements
- Copper: Testing Philosophies
- Copper: The “Real World”
- Question Time
- Lunch
- OF: Testing Philosophies
- Duplex and SFF Testing
  - Duplex Cabling
  - General Test Methods
    - Configuration A
    - Configuration B
  - Duplex Test Equipment
  - Specific Test Methods
    - Uni-Directional Test Equipment
      - Configuration A
      - Channel
    - Bi-Directional Test Equipment
      - Configuration A
  - SFF Connections
  - Specific Test Methods
    - Configuration A
    - Channel
  - The Importance of Cords
- Break
- Gigabit Ethernet
- Launch Conditions
- OTDR vs. LSPM
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- Conclusions
- Close

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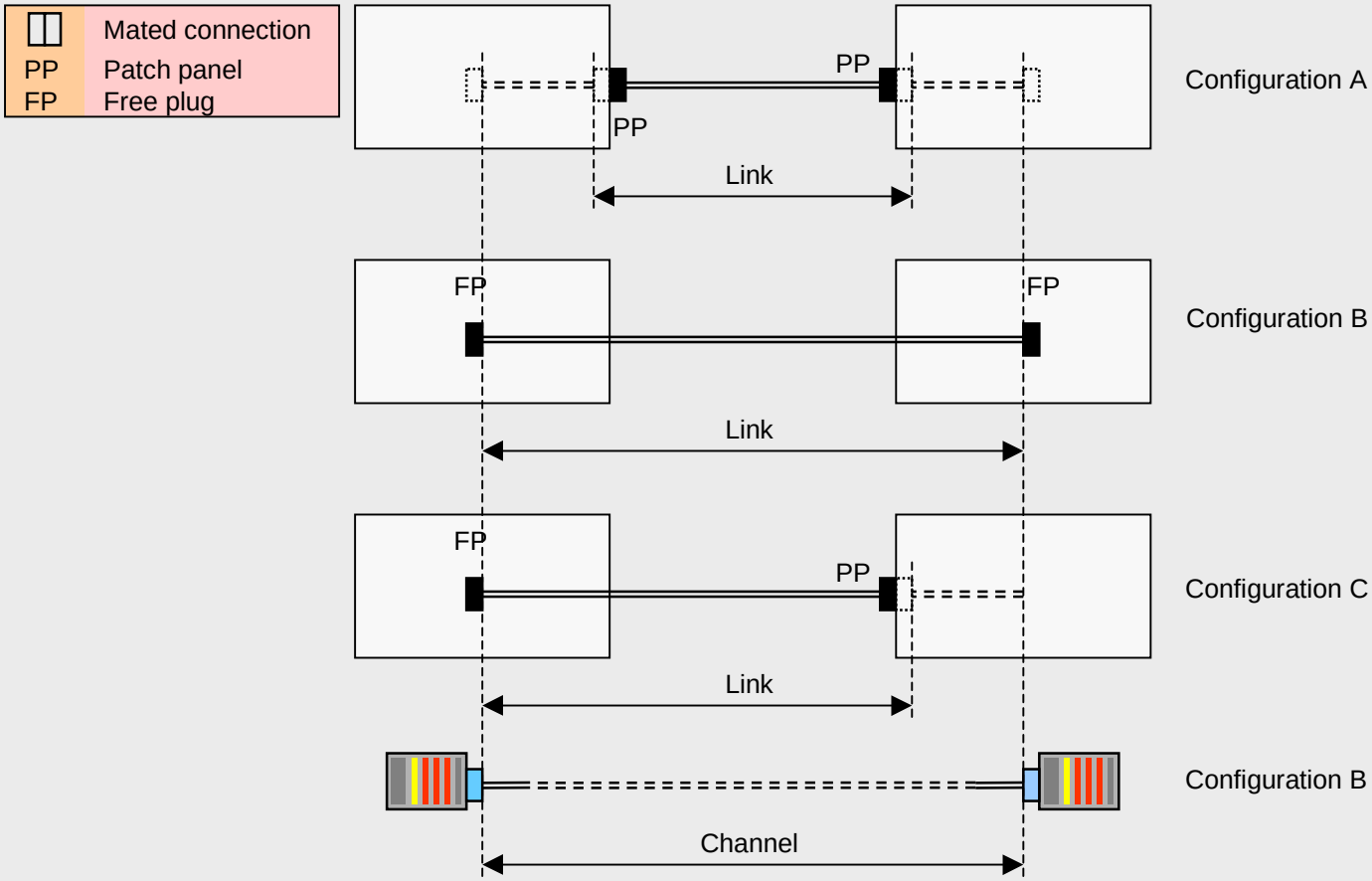
AGENDA

Duplex Cabling



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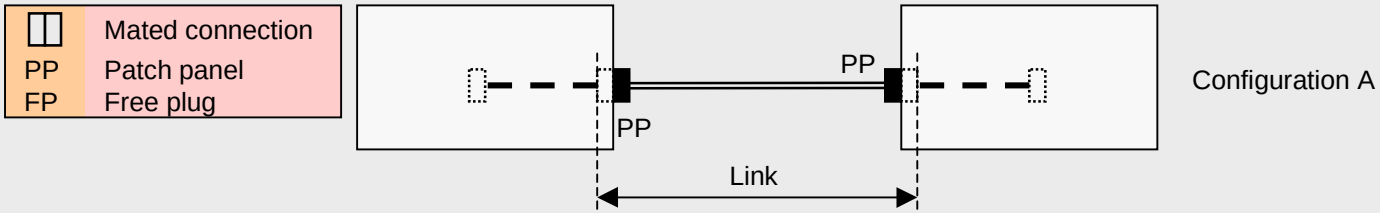
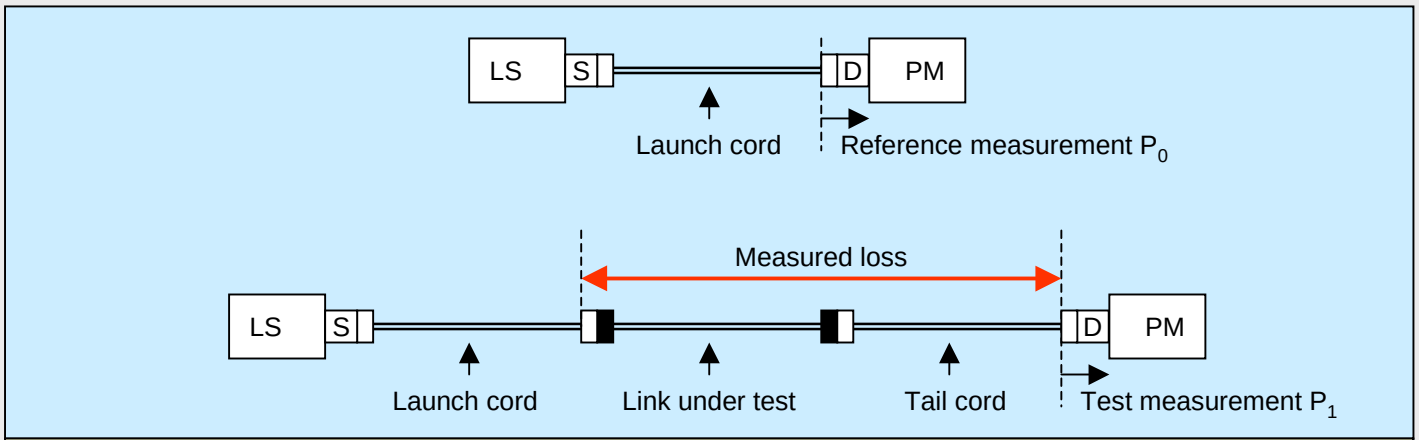
AGENDA

Configuration A Test Method





Loss = P_1 - P_0 (dB)

MMF: not applicable	MMF: EN 50346 Method 1	MMF: ….-526-14-A Method B
SMF: IEC 61280-4-2 Method 1.A	SMF: IEC 61280-4-2 Method 1.A	SMF: ….-526-7 Method A.1
	BS 7718: Configuration A	

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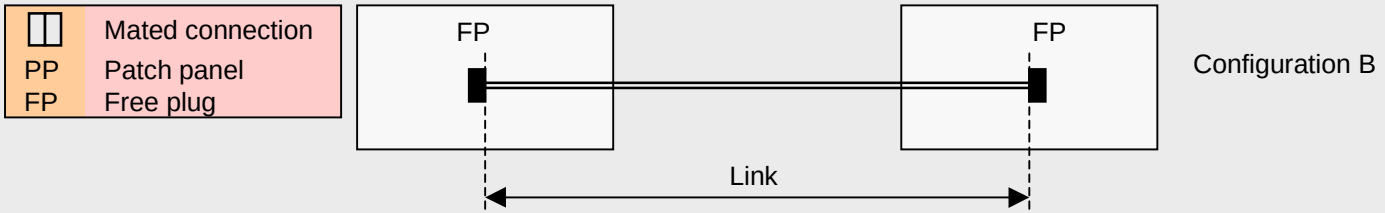
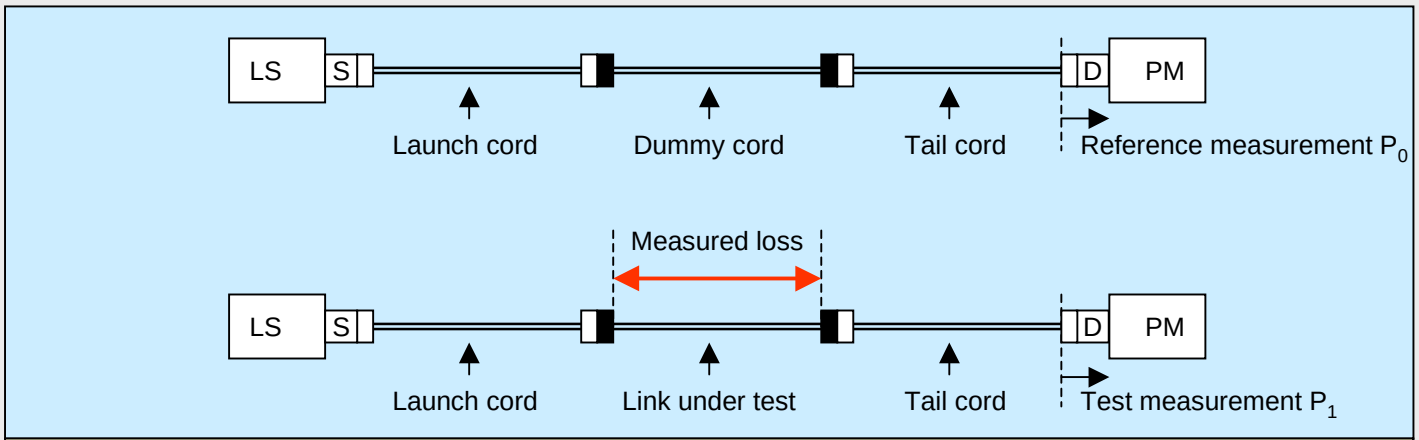
AGENDA

Configuration B Test Method





Loss = P_1 - P_0 (dB)

MMF: not applicable	MMF: EN 50346 Method 2	MMF: ….-526-14-A Method C
SMF: IEC 61280-4-2 Method 1.C	SMF: IEC 61280-4-2 Method 1.C	SMF: ….-526-7
	BS 7718: Configuration B	

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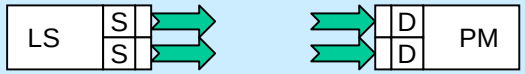
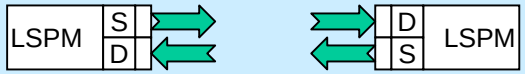
AGENDA

Duplex Test Equipment

EQUIPMENT TYPE	EQUIPMENT TYPE	GENERAL RULES
Uni-directional duplex		Link testing rules Configuration A: OK Configuration B: OK Configuration C: OK Channel tests: OK
Bi-directional duplex		Link testing rules Configuration A: test as channel Configuration B: OK Configuration C: test as channel Channel tests: OK

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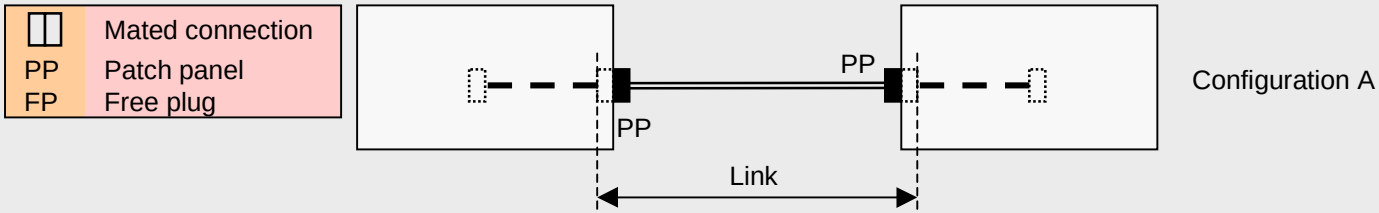
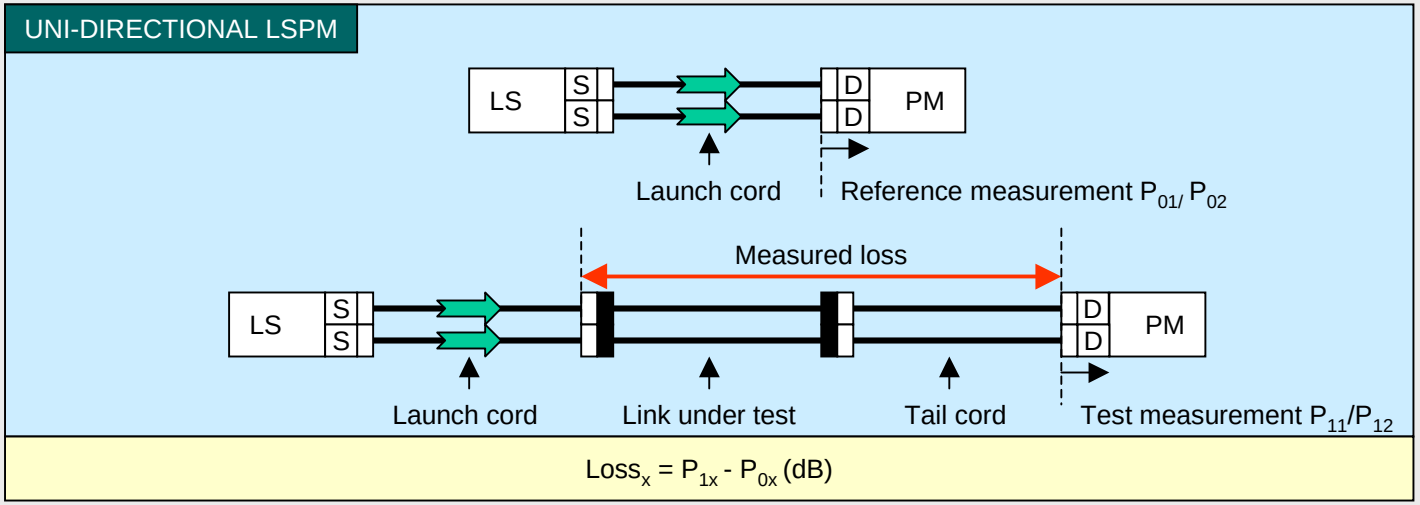
AGENDA

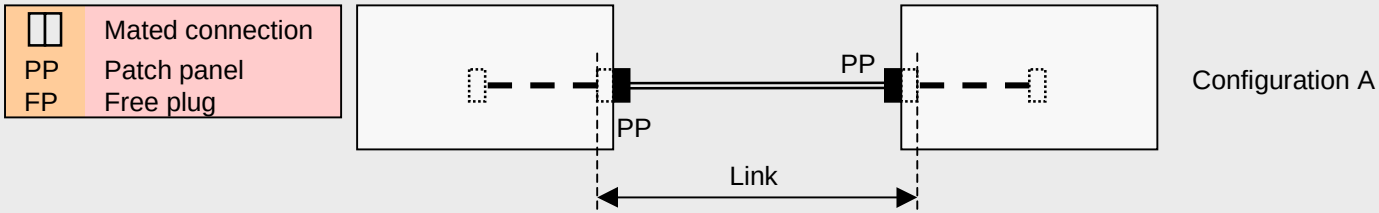
Link Configuration A Test - I

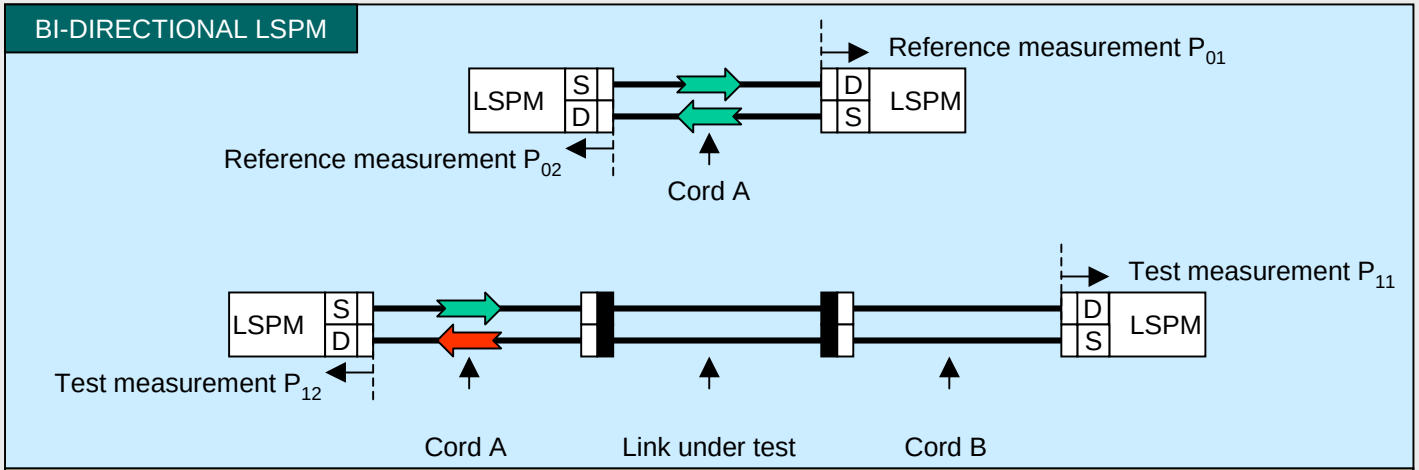




AGENDA

Link Configuration A Test - II



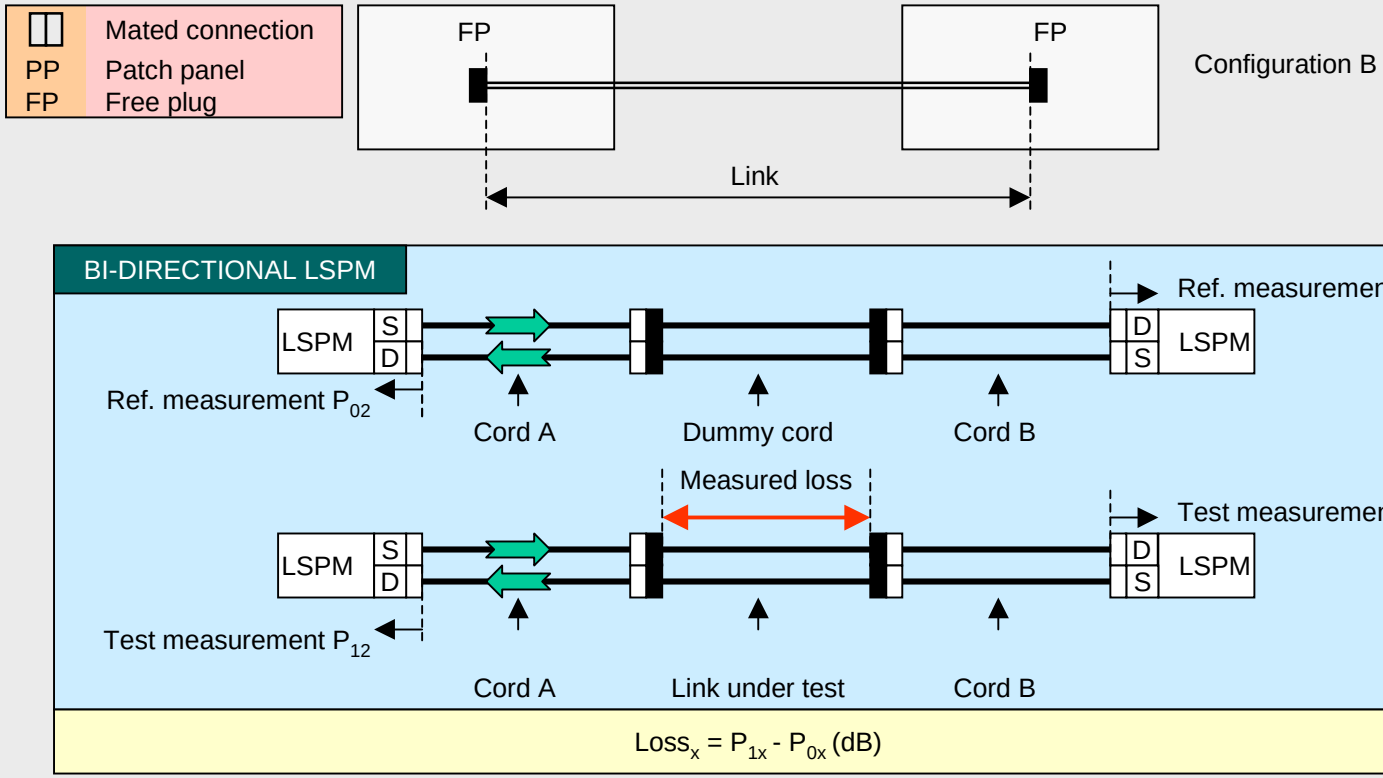


$Loss_1 = P_{11} - P_{01}$ (dB), $Loss_2 <=> P_{12} - P_{02}$ (dB)

Test measurement P_{12} will be influenced by removal of Cord A from RH LSPM
Unless LSPM guarantees that coupled power into Cord B is the same as Cord A, measurement error may occur

AGENDA

Channel Test



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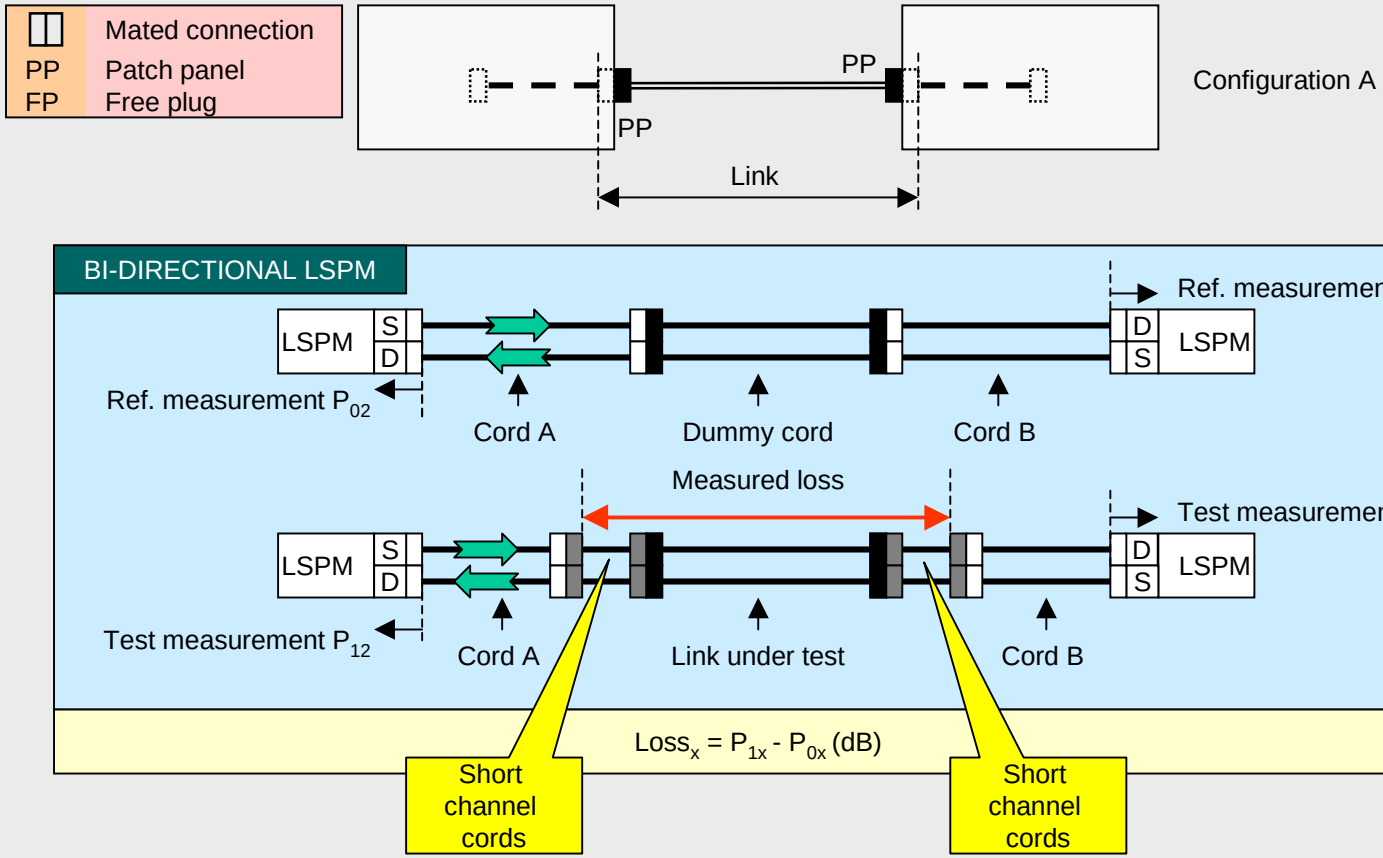
AGENDA

Link Configuration A Test



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AGENDA

SFF Connections

IT CABLING STANDARDS		
ISO/IEC 11801 Ed. 2 (2002)		EN 50173 Ed. 2 (2002)
		6MP Document
2nd CDV: Document N696		BS EN 50173 Ed. 2 (2002)

Mating dimensions and gauging of TO connection	
SC Duplex	IEC 60874-19-1

		Multimode OF		Singlemode OF	
	Wavelength	Connection	Splice	Connection	Splice
Return loss (dB min)	All	20dB	NA	35dB	NA
Attenuation (dB max)	All	95%<0,5 100%<0,75	100%<0,3	95%<0,5 100%<0,75	100%<0,3

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		Multimode OF		Singlemode OF	
	Wavelength	Connection	Splice	Connection	Splice
Return loss (dB min)	All	20dB	NA	35dB	NA
Attenuation (dB max)	All	95%<0,5 100%<0,75	100%<0,3	95%<0,5 100%<0,75	100%<0,3

Requirements for areas other than the telecommunications outlet

The optical fibre connectors used shall meet the requirements ..., with exception of the physical dimensions.... In areas other than the work area, the choice of connecting hardware is open to all types of optical fibre connectors **standardized by IEC**.

When high density is an important consideration …….. **Small Form Factor** connector designs that accommodate at least two fibres within the footprint of an EN 60603-7 connector are recommended.

However, where detail specifications produced by IEC or CENELEC in accordance with requirements of …. do not exist then **assurance should be sought from suppliers that the combinations of components** within connecting hardware are able to meet the optical and mechanical requirements of this clause.

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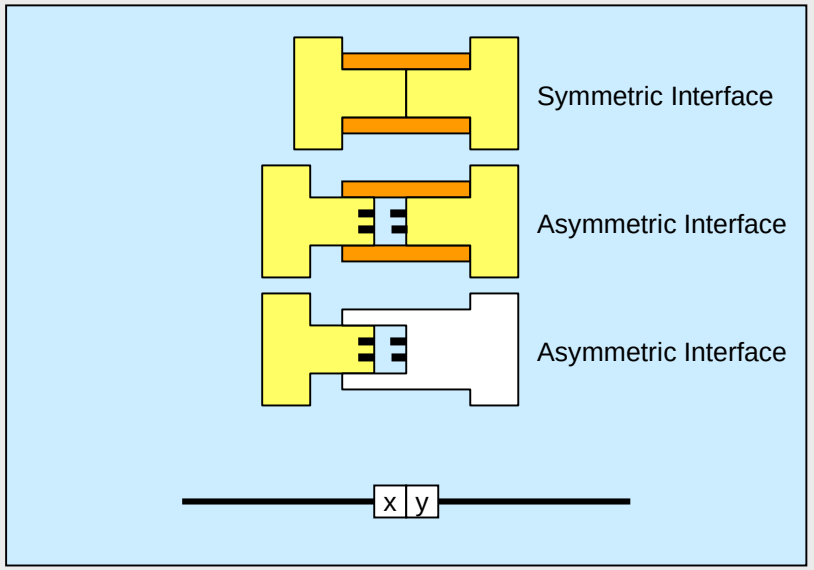
AGENDA

Symmetric and Asymmetric



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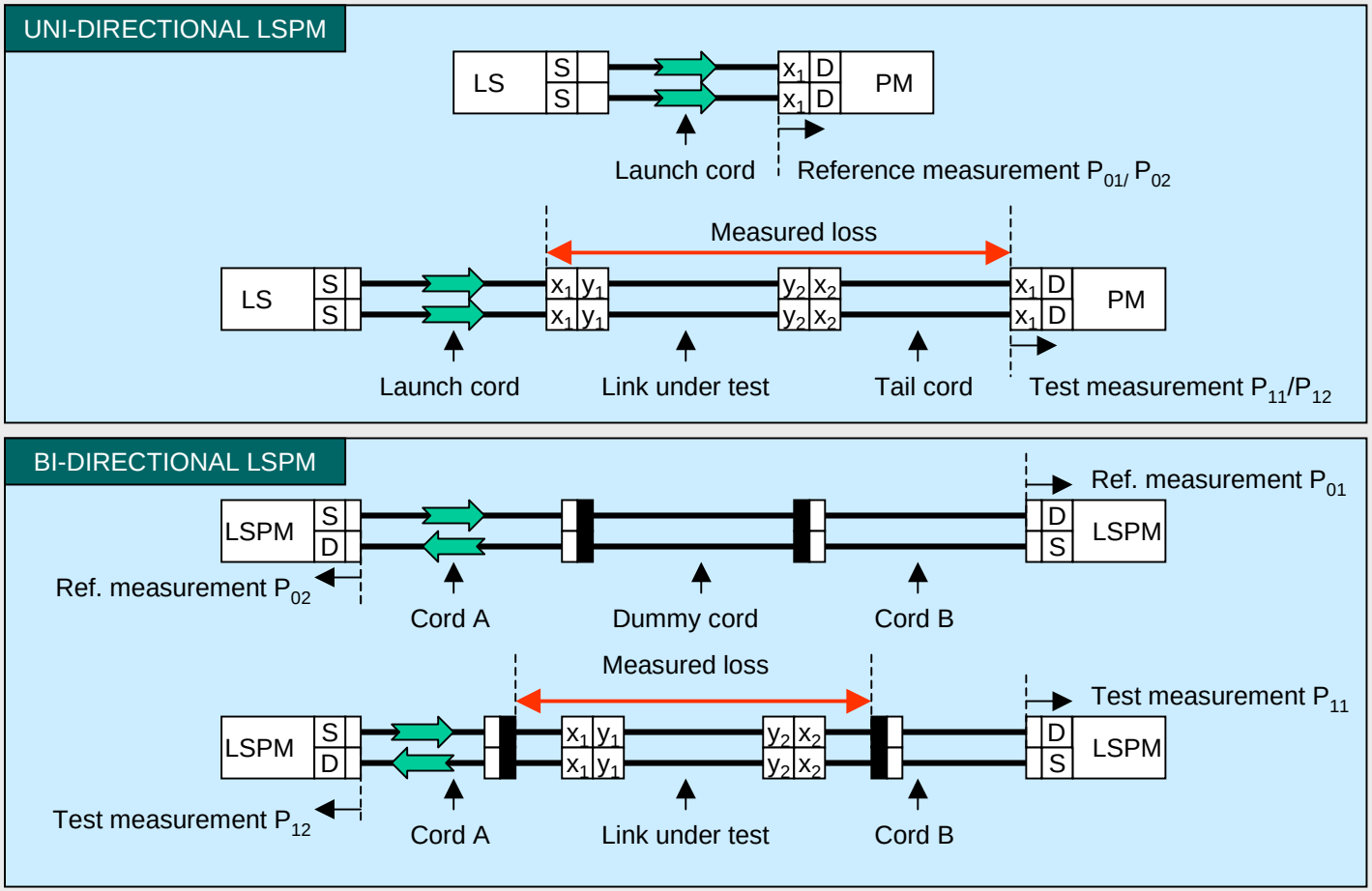
AGENDA

Configuration A Link Testing



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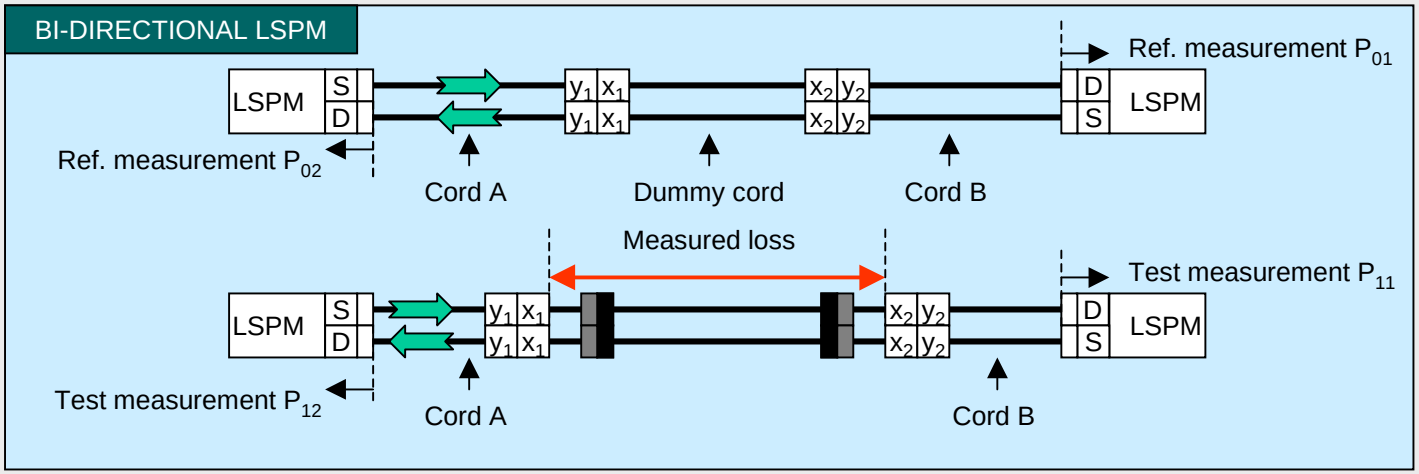
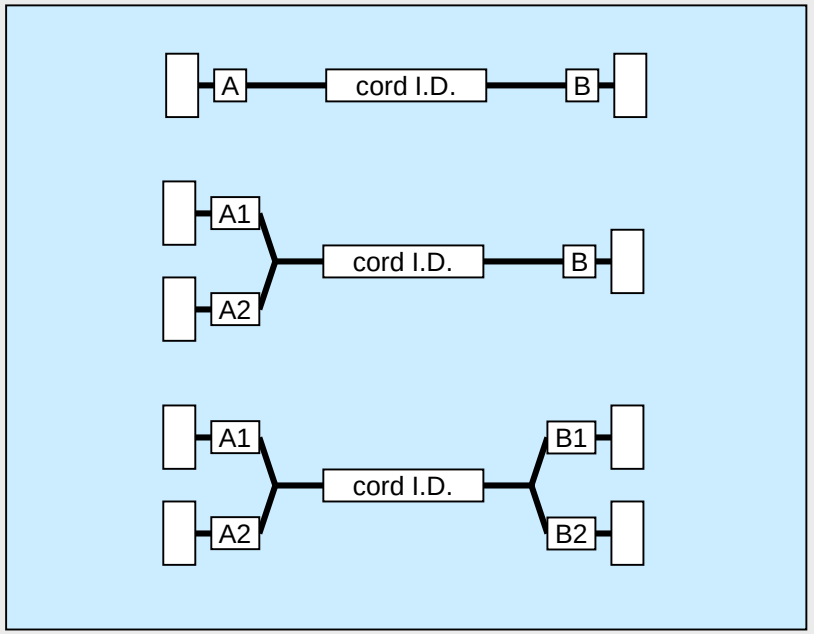
Channel Testing



AGENDA

The Importance of Cords



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AGENDA

Break

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- Duplex and SFF Testing
- Break
- Gigabit Ethernet
  - Optical Fibre Categories
  - Optical Power Budgets
  - Measurement Error
  - Pass/Fail Indicators
- Launch Conditions
- OTDR vs. LSPM
- Question Time
- Conclusions
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Gigabit Ethernet

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AGENDA

Optical Fibre Categories

IT CABLING STANDARDS		
ISO/IEC 11801 Ed. 2 (2002)		EN 50173 Ed. 2 (2002)
		6MP Document
2nd CDV: Document N696		BS EN 50173 Ed. 2 (2002)

		Multimode OF 50/125 or 62.5/125				Singlemode OF	
	Wavelength	OM1	OM2	OM3	Wavelength	OS1	
Attenuation coefficient (dBkm^{-1} max)	850nm	3,5			1310nm	1,0	
	1300nm	1,5			1550nm	1,0	
Modal bandwidth OFL (MHz.km min)	850nm	200	500	500			
	1300nm	500	500	500			
Modal bandwidth LL (MHz.km min)	850nm	ffs	ffs	2000			
	1300nm	ffs	ffs	ffs			
Propagation delay (ns.m^{-1} max)	850nm	5			1310nm	5	
	1300nm				1550nm		

AGENDA

Optical Fibre Categories

IT CABLING STANDARDS		
ISO/IEC 11801 Ed. 2 (2002)		EN 50173 Ed. 2 (2002)
		Next draft (3MV)
FCD: Document N739		BS EN 50173 Ed. 2 (2002)

		Multimode OF				Singlemode OF
		50/125 or 62.5/125		50/125		
	Wavelength	OM1	OM2	OM3	Wavelength	OS1
Attenuation coefficient ($dBkm^{-1}$ max)	850nm	3,5			1310nm	1,0
	1300nm	1,5			1550nm	1,0
Modal bandwidth OFL (MHz.km min)	850nm	200	500	1500		
	1300nm	500	500	500		
Modal bandwidth LL (MHz.km min)	850nm	-	-	2000		
	1300nm	-	-	-		
Propagation delay ($ns.m^{-1}$ max)	850nm	5			1310nm	5
	1300nm				1550nm	

Legacy OF

Legacy OF

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AGENDA

Optical Power Budgets

Application			Optical Fibre			
			50/125 (OM2)		62.5/125 (OM1)	
Mb/s	Network	λ	Max. length (m)	OPB max. (dB)	Max. length (m)	OPB max. (dB)
4	Token Ring	850 nm	1857[1]	8.0	2000	13.0
10	Ethernet		1514[1]	6.8	2000	12.5
16	Token Ring		1857[1]	8.0	2000	13.0
100	Ethernet	1300 nm	2000	6.0	2000	11.0
1000	Ethernet	850 nm	550	3.56	275	2.6
1000	Ethernet	1300 nm	550	2.35	550	2.35
10000	Ethernet	850 nm	82	1.80	33	1.60
10000	Ethernet	CWDM/1300	300	2.46	300	2.46
			50/125 (OM3)			
10000	Ethernet	850 nm	300	2.59		

[1] Calculated values using 1.5dB of connecting hardware losses

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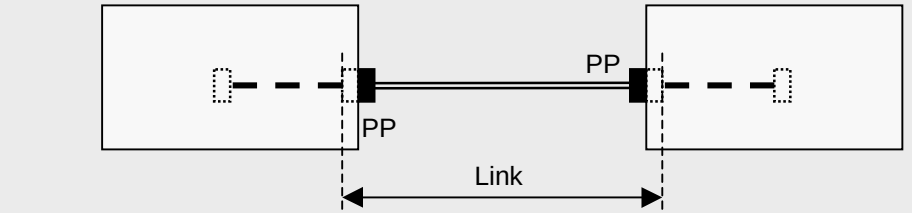
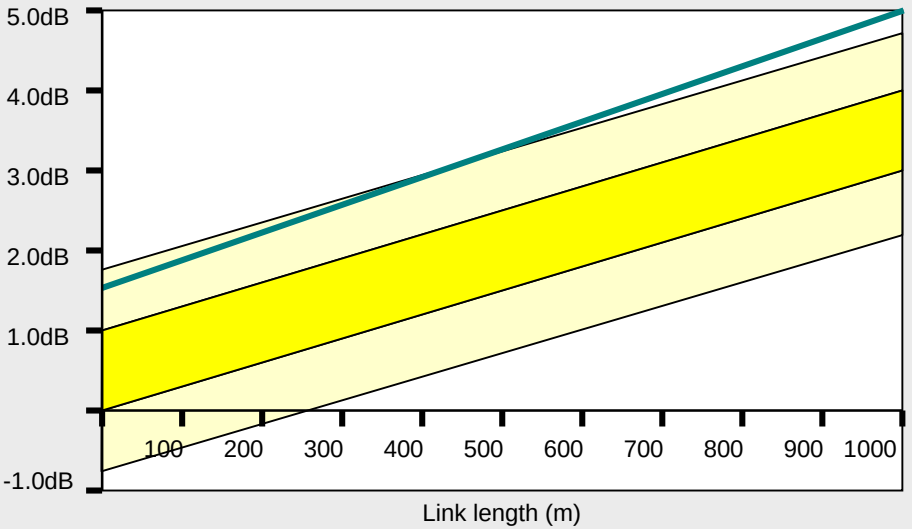
AGENDA

Measurement Error



Configuration A



Optical loss budget

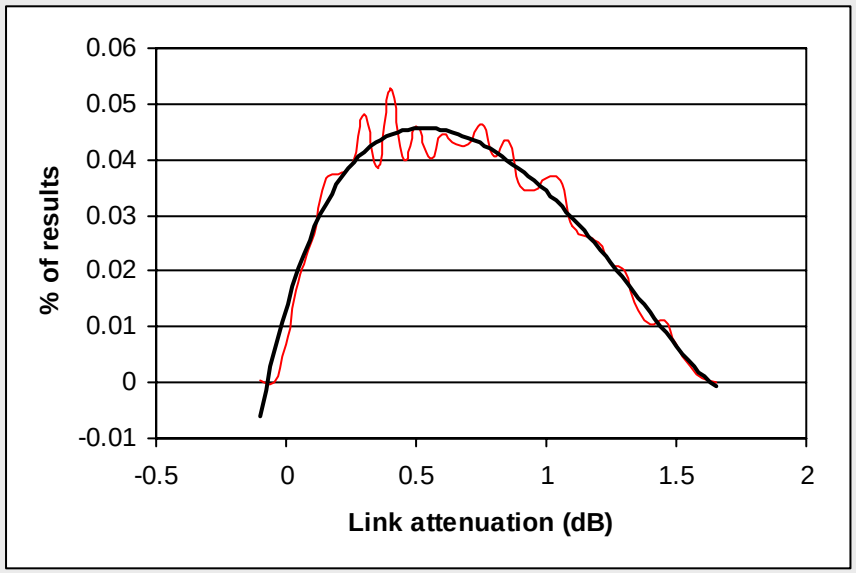
99.75% spread + ME

99.75% spread
(2 x 0.5dB + 3.0dBkm^{-1} x L)

99.75% spread - ME

AGENDA

Typical Results



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AGENDA

Pass/Fail Indicators

Test equipment that
not only
measures
but also
ADJUDICATES

Application support based upon:
- length (requiring the modal bandwidth of the optical fibre to be input);
- measured link/channel loss.

Cabling performance against calculation of optical loss budget based upon:
- number and type of joints
- length;
- measured link/channel loss.

PASS/FAIL INDICATORS ARE VERY SUSCEPTIBLE
TO SHORT LENGTH SYNDROME
(measurement error)

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AGENDA

- Introduction
- The Status of the Standards
- What Can We Test?
- Break
- The Differing Requirements
- Copper: Testing Philosophies
- Copper: The “Real World”
- Question Time
- Lunch
- OF: Testing Philosophies
- Duplex and SFF Testing
- Break
- Gigabit Ethernet
- Launch Conditions
  - Test Cord Launch Conditions
  - MMF Mandrel Wrap
  - Cladding Mode Stripping
  - LASER LSPM Equipment
- OTDR vs. LSPM
- Question Time
- Conclusions
- Close

Launch Conditions

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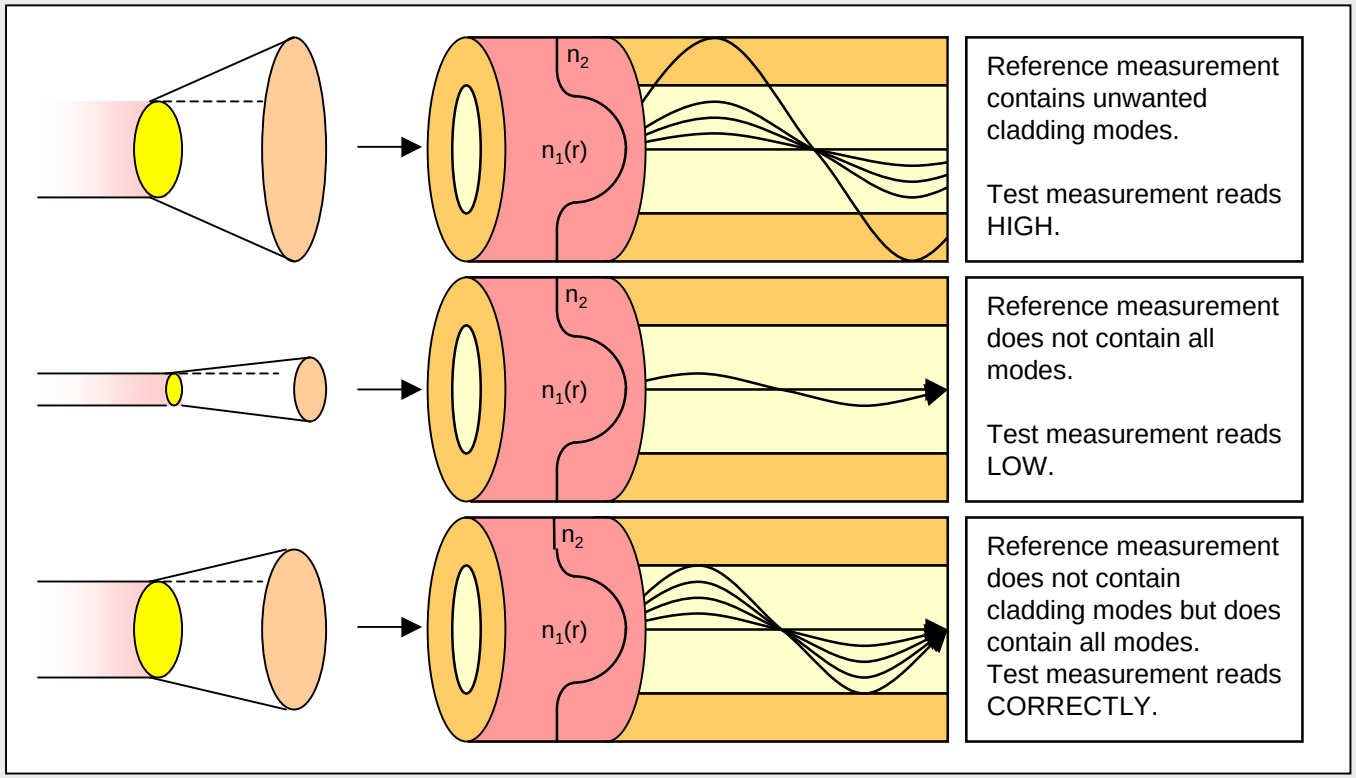
Test Cord Launch Conditions



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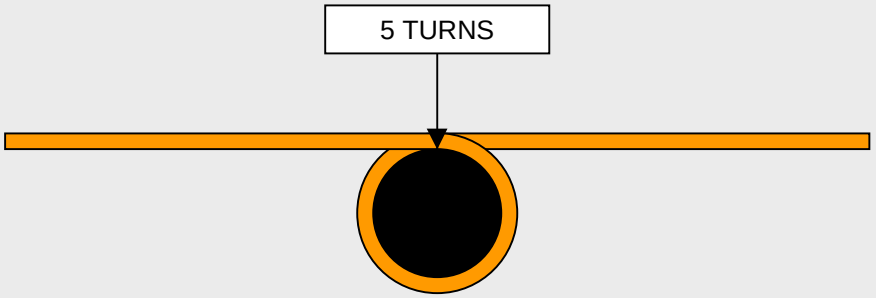
AGENDA

MMF Mandrel Wrap



MMF: not applicable

MMF: EN 50346 6MP

50/125	Cable	18
50/125	SCOF	15
62.5/125	Cable	20
62.5/125	SCOF	17

MMF: ANSI/TIA/EIA B.1

50/125	Cable	25
50/125	SCOF	22
62.5/125	Cable	20
62.5/125	SCOF	17

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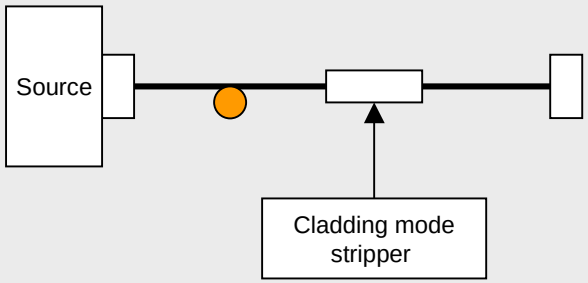
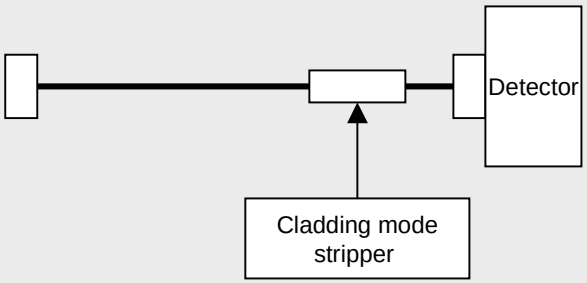
Cladding Mode Stripping



MMF LAUNCH CORD

Mandrel wrap and cladding mode stripper aim to present an equilibrium launch condition



MMF TAIL CORD

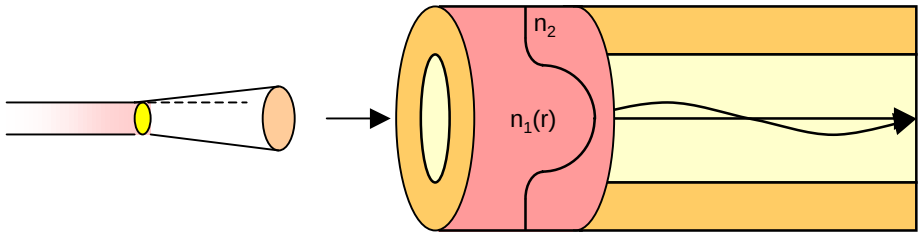
Cladding mode stripper provides “core only” light to detector

Removes requirement for bi-directional test

AGENDA

LASER LSPM Equipment

There is an argument to suggest that MMF cabling to support LASER-based applications should be tested with LASER sources



Reference measurement does not contain all modes.

Test measurement reads LOW.

Test results can vary with test lead handling.

Unless explicitly allowed and documented such equipment should not be used

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OTDR vs. LSPM

SHORT LENGTH SYNDROME
calls LSPM measurements into question

(unless measurement error is “allowed for” in adjudication)

OTDRs can be used to assess and measure individual components
(subject to appropriate techniques)

COMPONENT UP VERIFICATION MAY BECOME MORE COMMON

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AGENDA

FIA Documentation Update

DESIGN		
FIA-TSD-2000-1-1	OPTICAL FIBRE CABLING: LAN APPLICATION SUPPORT GUIDE	JANUARY 2001
	Revision to include mode conditioning cords and 10GBASE-xyz	JANUARY 2002
INSTALLATION		
FIA-TSD-2000-4-2-1	TESTING OF INSTALLED CABLING: ATTENUATION USING LSPM EQUIPMENT	JANUARY 2002
FIA-TSD-2000-4-2-2	TESTING OF INSTALLED CABLING: ATTENUATION USING OTDR EQUIPMENT	mid 2002
SAFETY		
FIA-TSD-2000-5-1	OPTICAL POWER: SAFETY LEVELS	DECEMBER 2001
FIA-TSD-2000-5-2	OPTICAL FIBRE: HANDLING OF PROCESSING CHEMICALS	
FIA-TSD-2000-5-3	OPTICAL FIBRE: DISPOSAL OF WASTE	

MODELLING TOOLS	
CABLING STRUCTURES COST MODEL	DECEMBER 2001

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Question Time

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AGENDA

Conclusions

READ THE CABLING SPECIFICATION

KNOW YOUR LIMITS
- which standard?
- which issue?

UNDERSTAND THE MARGINS
- undertake a channel design review
- make sure the client understands it

PLAN FOR FAILURE
- can "FAIL"s be expected?
- under which conditions?
- what happens next?
- agree process with client

TEST CORDS - TEST CORDS
TEST CORDS - TEST CORDS

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Close

- full colour copy of presentation
  - www.it-cabling.com/gendocs/tta.pdf

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