IEEE 802.3af Power via MDI
Spare Pair Feeding Performance Test

Presented by PowerDsine:

Nadav Barnea- nadavb@powerdsine.com

David Pincu - davidp@powerdsine.com

PowerDsine

Objectives

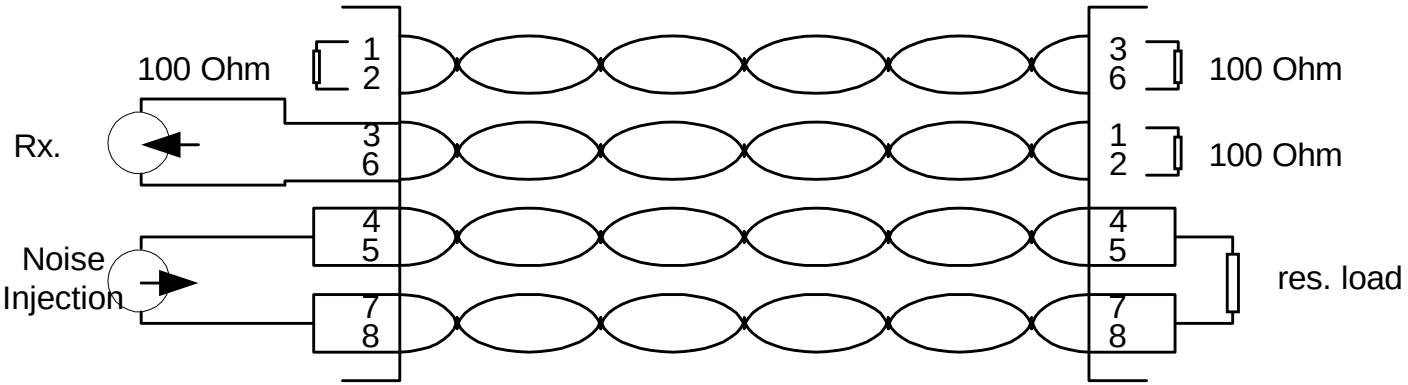
- To present 100Base-Tx BER test results using 90-140 meter Cat 5 UTP cable while injecting noise on “Spare Pairs”
- To present 100Base-Tx BER test results using Mid-Span device featuring spare wires power feeding
- Demonstrating that spare pair power feeding is a robust solution

PowerDsine

Demonstrating Methods

- Measurements of cable characteristics
  (cross-talk between spare to data pairs)
- BER test of typical standard LINK using 100Base-T data with noise injection over the spare pairs
- BER test of typical standard LINK + Mid-Span device using 100Base-T data with noise injection over the spare wires

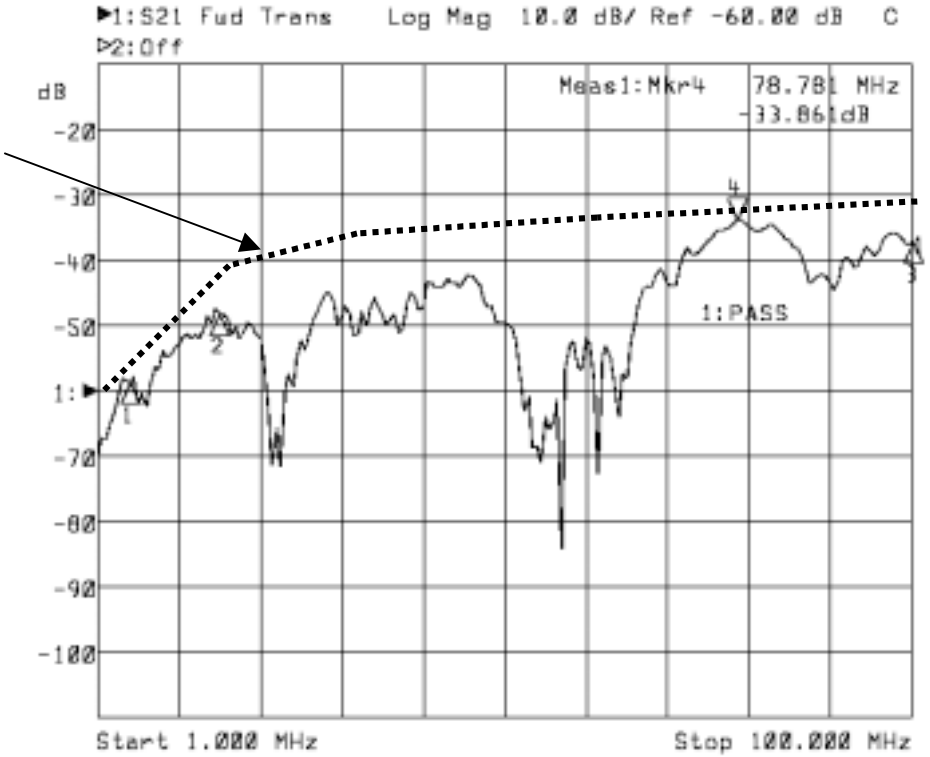
Near-End-Cross-Talk (NEXT) Test Setup



Worst case NEXT was observed on pair 3/6 while noise is injected between pairs 4/5 to 7/8

NEXT Between Spare and 1/2 Data Pair

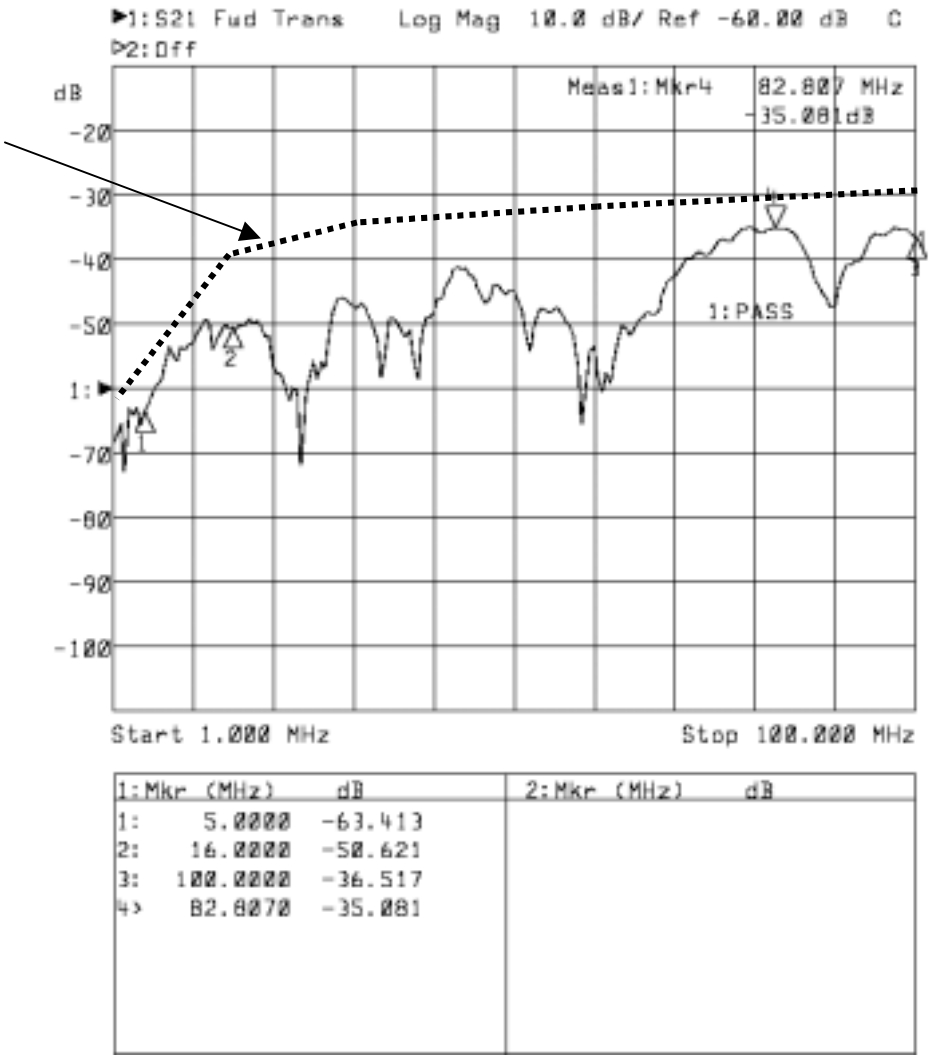
Worst Pair Combination
NEXT limits level between pairs
(From ANSI/TIA.EIA-568-A sec. 10.2.4.7)



1:Mkr (MHz)	dB	2:Mkr (MHz)	dB
1: 5.0000	-58.723		
2: 16.0000	-48.145		
3: 100.0000	-37.372		
4> 78.7810	-33.861		

NEXT Between Spare Pair to 3/6 Data Pair

Worst Pair Combination
NEXT limits level between pairs
(From ANSI/TIA.EIA-568-A sec. 10.2.4.7)

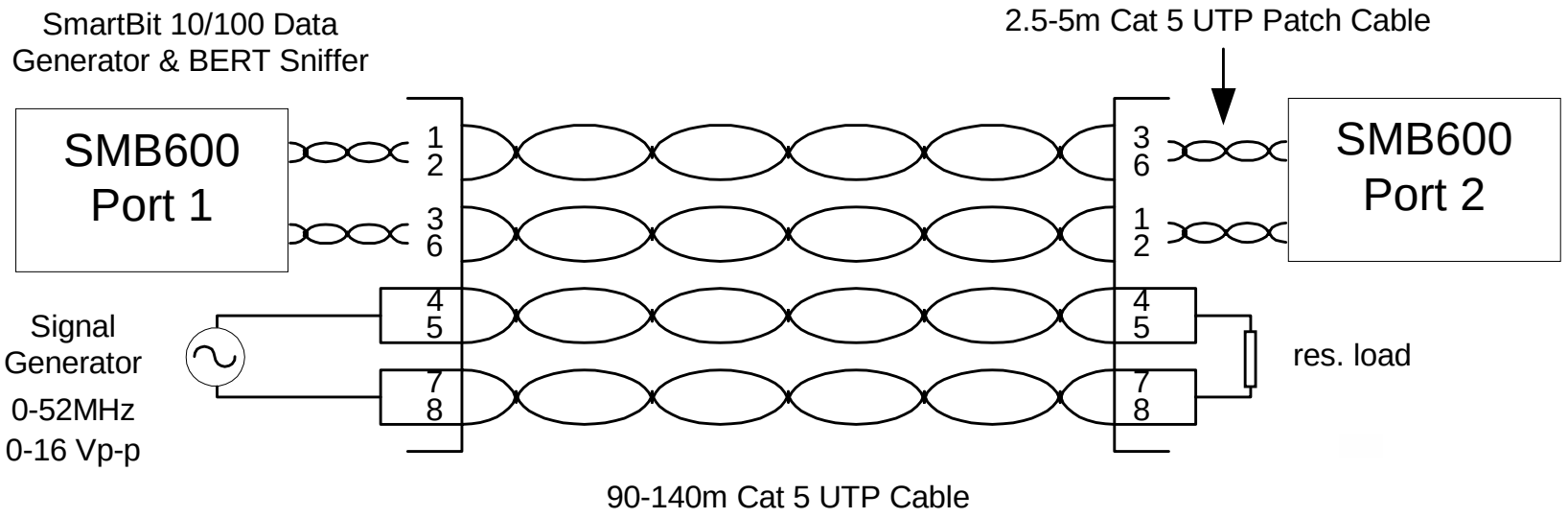


PowerDsine

Test Conclusions

NEXT between spare wires to any of the data pairs is safely within the standard specifications

BER Test Setup with Noise Injection on Spare Pairs



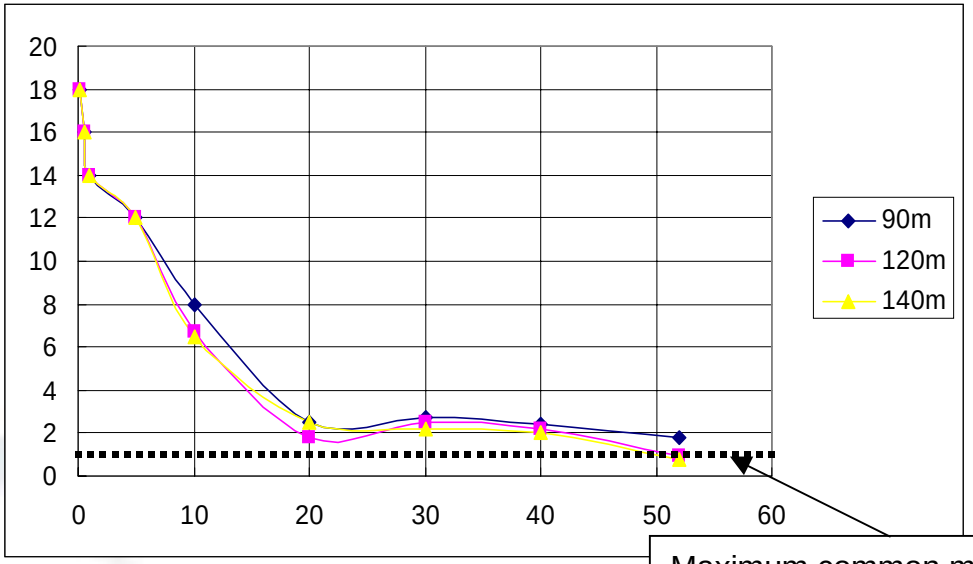
PowerDsine

Tests Description

- 90-140m of Cat 5 UTP was used @ 100Mbps data rate
- 100KHz to 52MHz sine wave was injected into spare pair
- Injected voltage level was increased until data was corrupted (BER reaches 10E-12)
- 1Vp-p to 16Vp-p was measured at the cable far end

Tests Results - Max. Noise Level with BERT=0

- 100KHz to 52MHz Sine wave injected on spare wires (4/5 and 7/8)
- Maximum voltage level before data is corrupted (BER less than 10E-12) was measured at far end side
- 90 - 140 meter (Cat 5 UTP cable



Maximum common mode noise immunity level as defined in TP-PMD standards

Cabel Length (m) UTP	Injected Voltage Sine (vp-p)	Freq. MHz
90	1.8	52
90	2.4	30
90	2.5	20
90	8	10
90	16	0.5
90	18	0.1
120	0.9	52
120	2.2	40
120	2.5	30
120	1.8	20
120	6.7	10
120	12	5
120	14	1
120	16	0.5
120	18	0.1
140	0.8	52
140	2	40
140	2.2	30
140	2.5	20
140	6.5	10
140	12	5
140	14	1
140	16	0.5
140	18	0.1

Tests Results - Typical Zero BERT Report

- **Both channels at 100Base-Tx data generation**
- **Full duplex mode**
- **Noise injection over spare wires (100KHz to 52MHz)**
- **Sniffing for: CRC errors, Alignment errors and Frame size errors**

SmartCounters,25,5,0,0,0,(	Events	Rates	Events	Rates
	1-01 LN-3100A	1-01 LN-3100A	1-02 LN-3100A	1-02 LN-3100A
Tx Frames	10,497,410	0	10,599,590	0
Rx Frames	10,599,624	0	10,497,376	0
Rx Bytes	678,375,915	0	671,832,037	0
Rx Triggers	0	0	0	0
Tx Latency	0		0	
Rx Latency	0		0	
Collisions	0	0	0	0
CRC Errors	0	0	0	0
Alignment Errors	0	0	0	0
OverSize	0	0	0	0
Frag/UnderSize	0	0	0	0
ARP Replies Sent	0		0	
ARP Requests Sent	0		0	
ARP Replies Received	0		0	
ARP Requests Received	0		0	
PING Replies Sent	0		0	
PING Requests Sent	0		0	
PING Replies Received	0		0	
PING Requests Received	0		0	
VLAN Frames	0		0	
IP Frames Received	0		0	
IP Checksum Errors	0		0	

Tests Results - Typical Packet Loss Report

120m Cat 5 UTP with Noise injection

Results - Untitled

File Edit Setup Run Help

Connected IP 192.1.1.10 Port 16385

Packet Loss Test

Test duration (sec): 1
Minimum frame size (byte): 64
Maximum frame size (byte): 1518
Step frame size (byte): 256

Number of pairs: 1
Initial rate (%): 10.00
Step rate (%): 10.00
Resolution rate (%): None
Mode: Bi-direction

Bi-directional test

Frame Size	Rate Tested(%)	(01,01,01) to (01,01,02) (%)	(01,01,02) to (01,01,01) (%)	Average
		100M-100M	100M-100M	
64	10.00	0.000	0.000	0.000
64	20.00	0.000	0.000	0.000
64	30.00	0.000	0.000	0.000
64	40.00	0.000	0.000	0.000
64	50.00	0.000	0.000	0.000
64	60.00	0.000	0.000	0.000
64	70.00	0.000	0.000	0.000
64	80.00	0.000	0.000	0.000
64	90.00	0.000	0.000	0.000
64	100.00	0.000	0.000	0.000
320	10.00	0.000	0.000	0.000
320	20.00	0.000	0.000	0.000
320	30.00	0.000	0.000	0.000
320	40.00	0.000	0.000	0.000
320	50.00	0.000	0.000	0.000
320	60.00	0.000	0.000	0.000
320	70.00	0.000	0.000	0.000
320	80.00	0.000	0.000	0.000
320	90.00	0.000	0.000	0.000
320	100.00	0.000	0.000	0.000
576	10.00	0.000	0.000	0.000
576	20.00	0.000	0.000	0.000
576	30.00	0.000	0.000	0.000
576	40.00	0.000	0.000	0.000
576	50.00	0.000	0.000	0.000

Throughput | Latency | Packet Loss | Back-to-back | Reports | Log

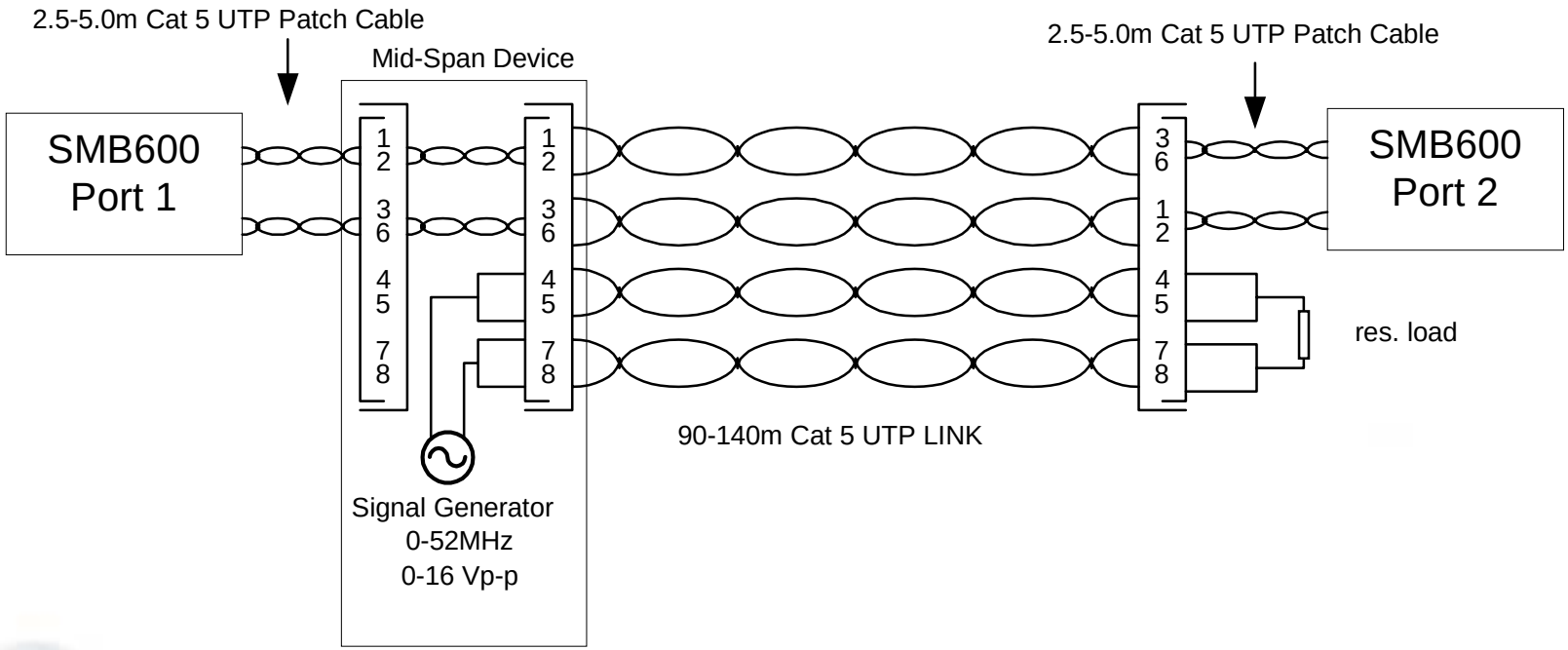
Ready | Frame size: 1344 | Trial: 1 of 1 Rep: 0 | Passed: | Current: | Failed:

PowerDsine

First Set up Conclusions

- Experiments show that the noise susceptibility of spare pair power feeding is extremely high while using a 90m Cat 5 UTP link
- It has been demonstrated that the high noise susceptibility is maintained over 50% longer cable lengths

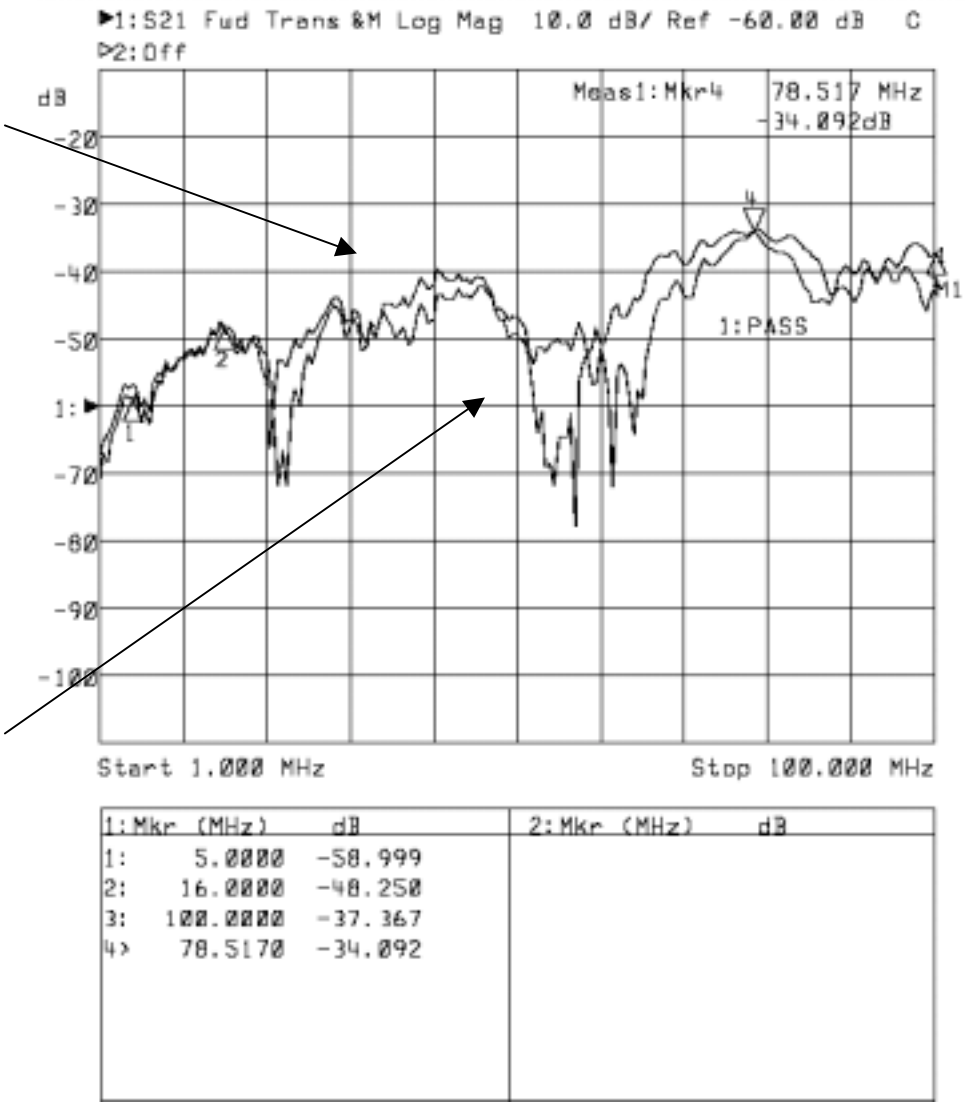
BER including Mid-Span device Connection with Noise Source - Test Setup



NEXT between direct LINK to CHANNEL including a Mid-Span Device

CHANNEL of 90m data cable
+ 10m patch cords + Mid Span device

LINK of 90m data cable
+ 10m patch cords



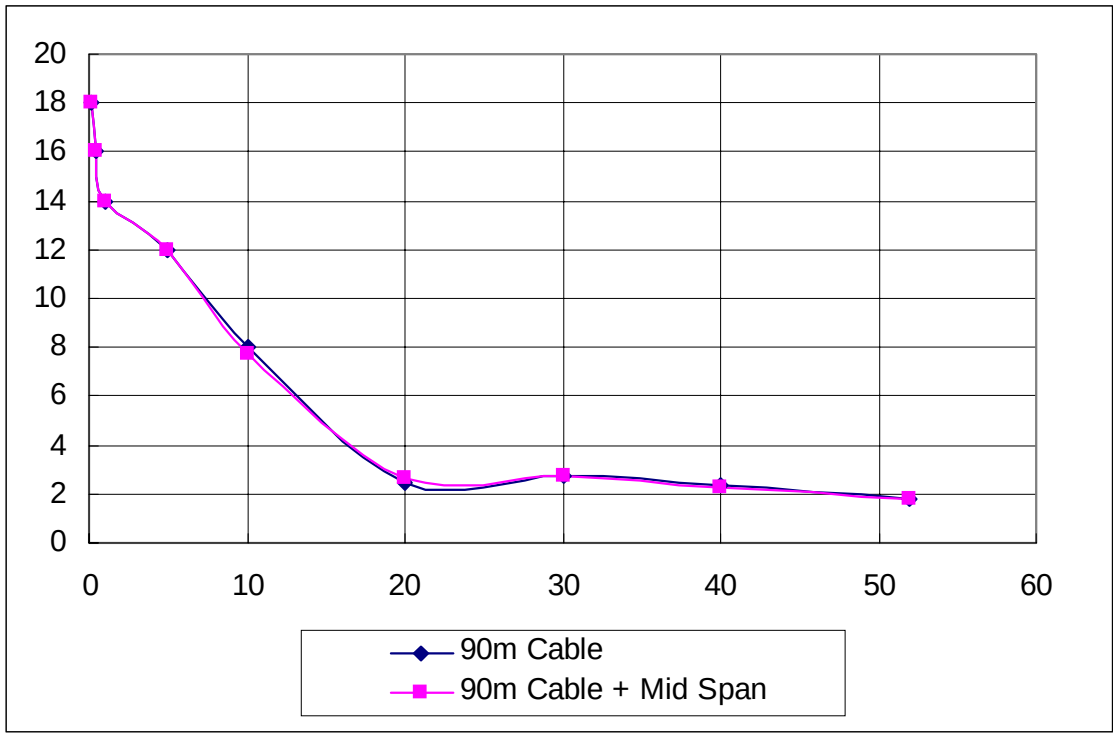
Tests Results - Typical Zero BERT Report

- Both data channels are at 100Base-Tx data generation
- Full duplex mode
- Noise injection over spare wires (100KHz to 52MHz)
- Sniffing for: CRC errors, Alignment errors and Frame size errors

SmartCounters,25,5,0,0,0,(	Events	Rates	Events	Rates
	1-01 LN-3100A	1-01 LN-3100A	1-02 LN-3100A	1-02 LN-3100A
Tx Frames	10,618,640	0	10,704,172	0
Rx Frames	10,704,206	0	10,618,607	0
Rx Bytes	685,069,133	0	679,590,796	0
Rx Triggers	0	0	0	0
Tx Latency	0		0	
Rx Latency	0		0	
Collisions	0	0	0	0
CRC Errors	0	0	0	0
Alignment Errors	0	0	0	0
OverSize	0	0	0	0
Frag/UnderSize	0	0	0	0
ARP Replies Sent	0		0	
ARP Requests Sent	0		0	
ARP Replies Received	0		0	
ARP Requests Received	0		0	
PING Replies Sent	0		0	
PING Requests Sent	0		0	
PING Replies Received	0		0	
PING Requests Received	0		0	
VLAN Frames	0		0	
IP Frames Received	0		0	
IP Checksum Errors	0		0	

Tests Results - Maximum noise level with Zero BERT

- As seen - Noise immunity of both LINK and CHANNEL with Mid-Span device are typically the same



PowerDsine

Summary

- Cable characteristics shows low NEXT levels between spare and data pairs
- Spare Pair power feeding is a highly robust solution
- Data noise immunity of power feeding over spare pair is typically 500% higher than defined in the PHY standards (@ 0-10MHz)
- Data at 100Mbps @ full duplex mode was clear of BERT up to 140m UTP, including noise injection over spare pairs
- Data at 10Mbps @ full duplex mode was clear of BERT up to 220m UTP, including noise injection over spare pairs