Qualified Partner Programme QPP

Standards Cat. 6

Felice Guarna

R&M
Convincing cabling solutions

New Standards, status and "challenges"

Cat. 6 class E impacts

- new limits
- new testing methodologies
- new cabling

... New problems...

New limits - channel

Are these correct: how do we know? No application driving the design

Frequency	Return loss	Attenuation	NEXT	PS-NEXT	EL-FEXT	PS-EL-FEXT	ACR	PS-ACR
[MHz]	[dB]	[dB]	[dB]	[dB]	[dB]	[dB]	[dB]	[dB]
1.0	19.0	2.2	72.7	70.3	63.2	60.2	70.4	68.1
4.0		4.2	63.0	60.5	51.2	48.2	58.9	56.4
10.0		6.5	56.6	54.0	43.2	40.2	50.0	47.5
16.0		8.3	53.2	50.6	39.1	36.1	44.9	42.3
20.0		9.3	51.6	49.0	37.2	34.2	42.3	39.7
31.25	19- 10*LOG(f/20)	11.7	48.4	45.7	33.3	30.3	36.7	34.0
62.5		16.9	43.4	40.6	27.3	24.3	26.5	23.7
100.0		21.7	39.9	37.1	23.2	20.2	18.2	15.4
155.52		27.6	36.7	33.8	19.4	16.4	9.0	6.1
200.0		31.7	34.8	31.9	17.2	14.2	3.0	0.1
250.0		36.0	33.1	30.2	15.3	12.3	-2.8	-5.8

DC Loop Resistance [Ohm]: <40

Propagation Delay: Frequency [MHz]: $1 \leq f \leq 100$ Value [μs]: < 0.544+0.036/ sqrt (f)

Delay Skew: Frequency [MHz]: $1 \leq f \leq 100$ Value [μs]: < 0.05

R&M
Convincing cabling solutions

New limits - cables EN 50288-5-x

5.1.2.3 Attenuation

1	4	10	16	20	31,25	62,5	100	155	200	250	MHz
2.1	3.8	6.0	7.6	8.5	10.7	15.5	19.9	25.3	29.2	33.0	dB/100m

5.1.2.5 Near-end crosstalk (NEXT)

1	4	10	16	20	31,25	62,5	100	155	200	250	MHz
66.0	65.3	59.3	56.2	54.8	51.9	47.4	44.3	41.4	39.8	38.3	dB

5.1.2.7.1 Power sum Near-end Crosstalk (PSNEXT)

1	4	10	16	20	31,25	62,5	100	155	200	250	MHz
64.0	63.3	57.3	54.2	52.8	49.9	45.4	42.3	39.4	37.8	36.3	dB

5.1.2.6 Equal Level Far-end crosstalk (ELFEXT)

1	4	10	16	20	31,25	62,5	100	155	200	250	MHz
66.0	55.8	47.8	43.7	41.8	37.9	31.9	27.8	24.0	21.8	19.8	dB

5.1.2.7.2 Power Sum Equal Level Far-end crosstalk (PSELFEXT)

1	4	10	16	20	31,25	62,5	100	155	200	250	MHz
63.0	52.8	44.8	40.7	38.8	34.9	28.9	24.8	21.0	18.8	16.8	dB

5.1.2.8 Characteristic impedance[1)]

Input impedance, 100, 120 $\pm$ 15 Ω, 1 $\leq$ f $\leq$ 100 MHz;
100, 120 $\pm$ 18 Ω, 100 < f $\leq$ 250 MHz;
Mean impedance, 100, 120 $\pm$ 10 Ω, 10 $\leq$ f $\leq$ 250 MHz

5.1.2.9 Return loss[1)]

1	4	10	16	20	31,25	62,5	100	155	200	250	MHz
-	-	23.0	23.0	23.0	23.0	23.0	23.0	21.1	20.0	19.0	dB

R&M
Convincing cabling solutions

New limits - cables

The easiest part……

tighter twisting better manufacturing processes

The not so easy part….

Installation techniques

Cable stability

The dilemma: easy to install but not so stable or
stable but not so flexible?

Status: good and reliable cables available in different solutions
just tighter twisting, with pair separator, with stability agents

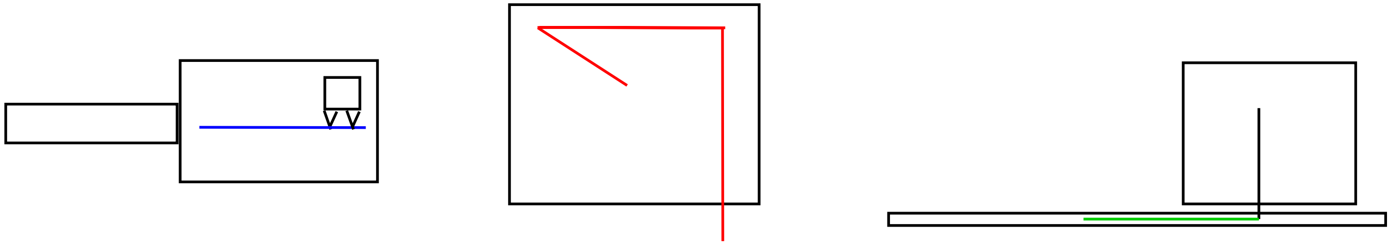
News limits - connectors

Frequency	Attenuation	NEXT	PS-NEXT	FEXT	PS-FEXT	RL
1	-0.02	-94.0	-90.0	-83.1	-80.1	-63.0
4	-0.04	-82.0	-78.0	-71.1	-68.1	-51.0
10	-0.06	-74.0	-70.0	-63.1	-60.1	-43.0
20	-0.09	-68.0	-64.0	-57.1	-54.1	-37.0
31.25	-0.11	-64.1	-60.1	-53.2	-50.2	-33.1
62.5	-0.16	-58.1	-54.1	-47.2	-44.2	-27.1
100	-0.20	-54.0	-50.0	-43.1	-40.1	-23.0
125	-0.22	-52.1	-48.1	-41.2	-38.2	-21.1
155.52	-0.25	-50.2	-46.2	-39.3	-36.3	-19.2
175	-0.26	-49.1	-45.1	-38.2	-35.2	-18.1
200	-0.28	-48.0	-44.0	-37.1	-34.1	-17.0
250	-0.32	-46.0	-42.0	-35.1	-32.1	-15.0

The connecting hardware challenge

- The compensation effects
- The measurement technique
- The mate-ability problem
- The backward compatibility

Background of the simulation

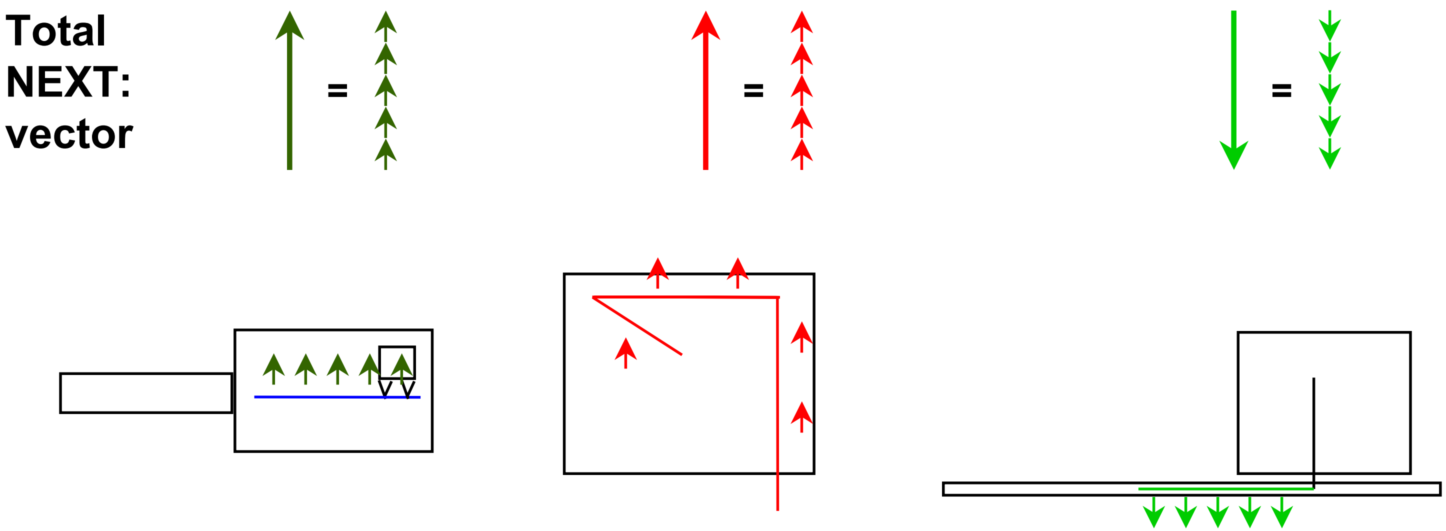


Each zone consists of:

- A certain NEXT contribution: X_P, X_J, X_C [dB] @ Y_P, Y_J, Y_C [°Degree]
- A certain length: l_P, l_J, L_C [mm]
- A certain NVP: z

R&M
Convincing cabling solutions

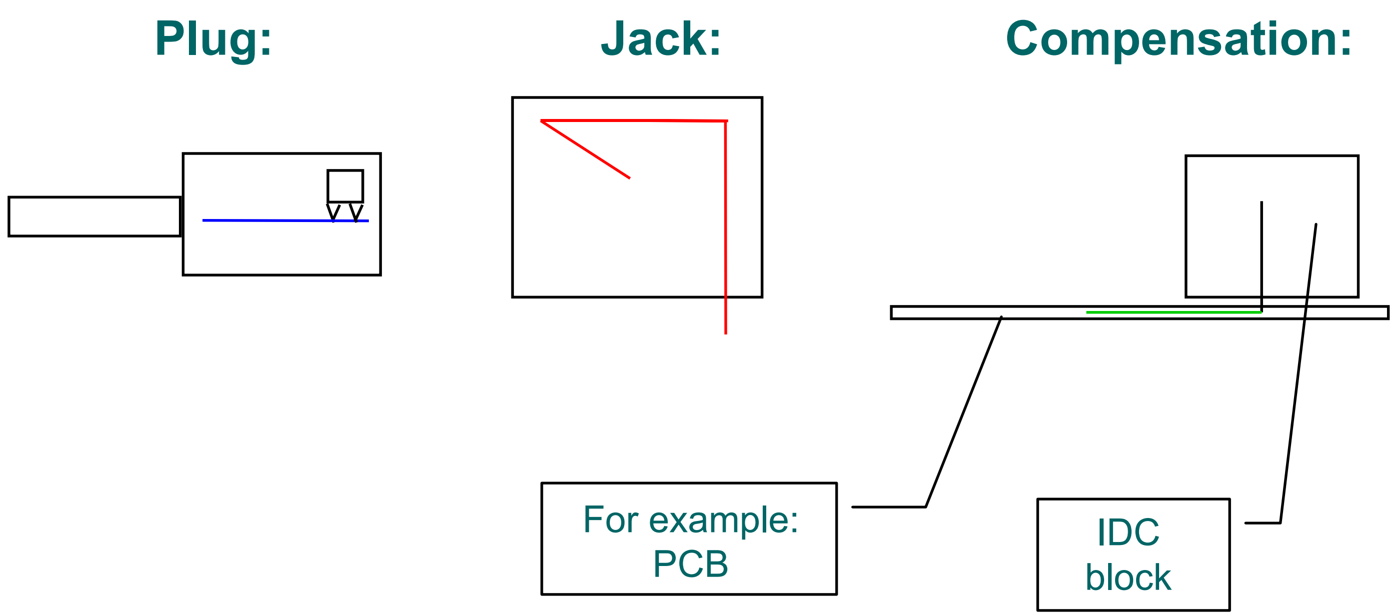
Background of the simulation



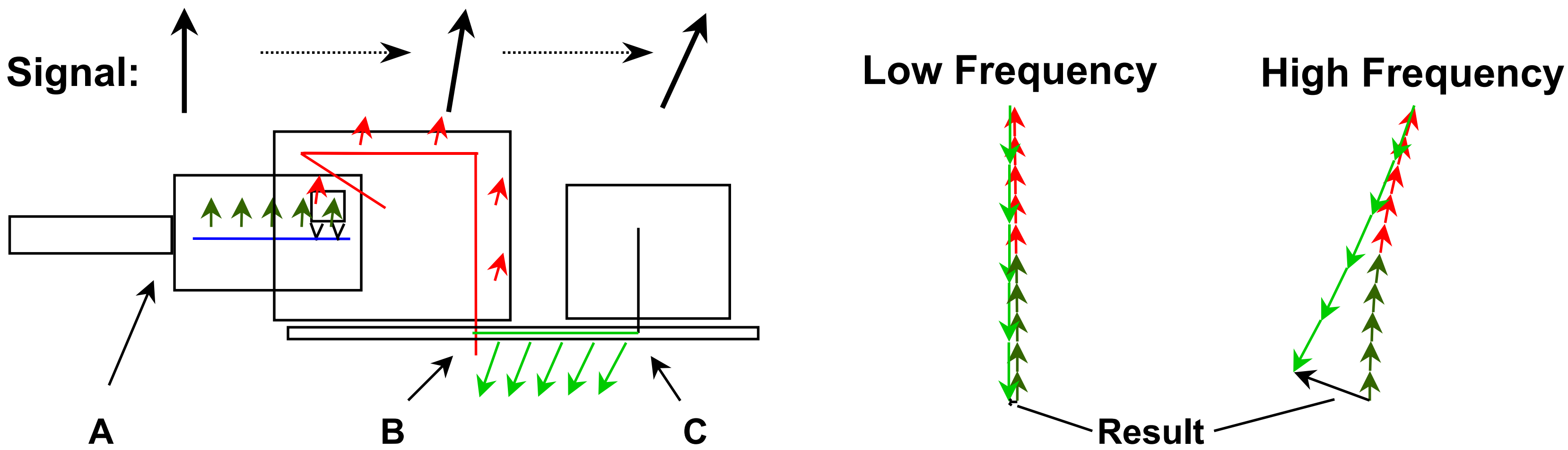
Because of the high frequency involved, the total NEXT contribution of each component has to be looked at as distributed contributions over the length of the component.

Background of the simulation

3 distinct zones within a connector



Background of the simulation

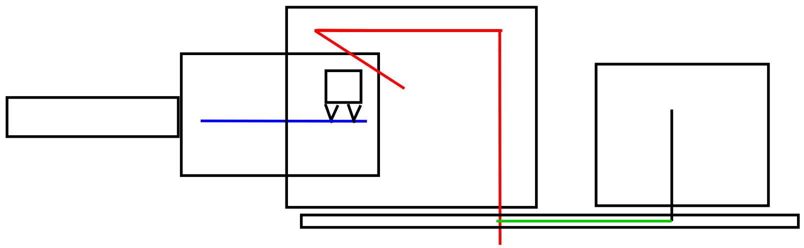


- An exciting signal that enters the connector at **A** will undergo a frequency dependent phase shift while it travels along the conductors to **B** and **C**. The phase shift will be the higher the higher the frequency is.
- The resulting crosstalk at the distributed locations within the 3 zones will therefore also have these phase shifts in regard to the original signal at **A**.
- In order to vector add up the different contributions at **A**, these NEXT contributions have to travel back from the place of origin to **A**, which produces again the same level of phase shift.

R&M
Convincing cabling solutions

Verification of simulation

Simulation of a PCB Cat. 5 Version:



	Plug	Jack	Compensation
Length [mm] =	20	30	10
Total X-Talk [dB] =	-34	-34	-28.7 @ 100 MHz
NVP =	0.8	0.8	0.8

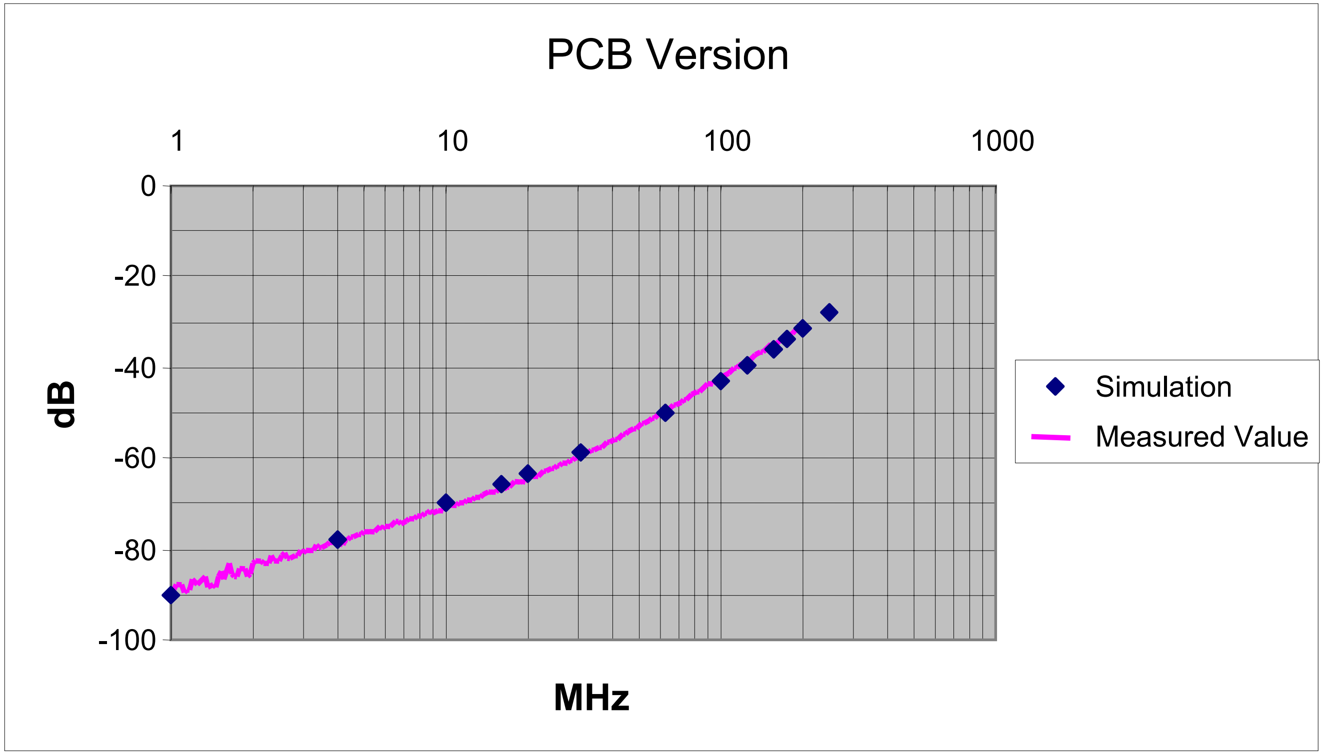
Results

Frequency [MHz] =	100
NEXT [dB] =	-42.9
Phase Shift [°] =	13.5

R&M

Convincing cabling solutions

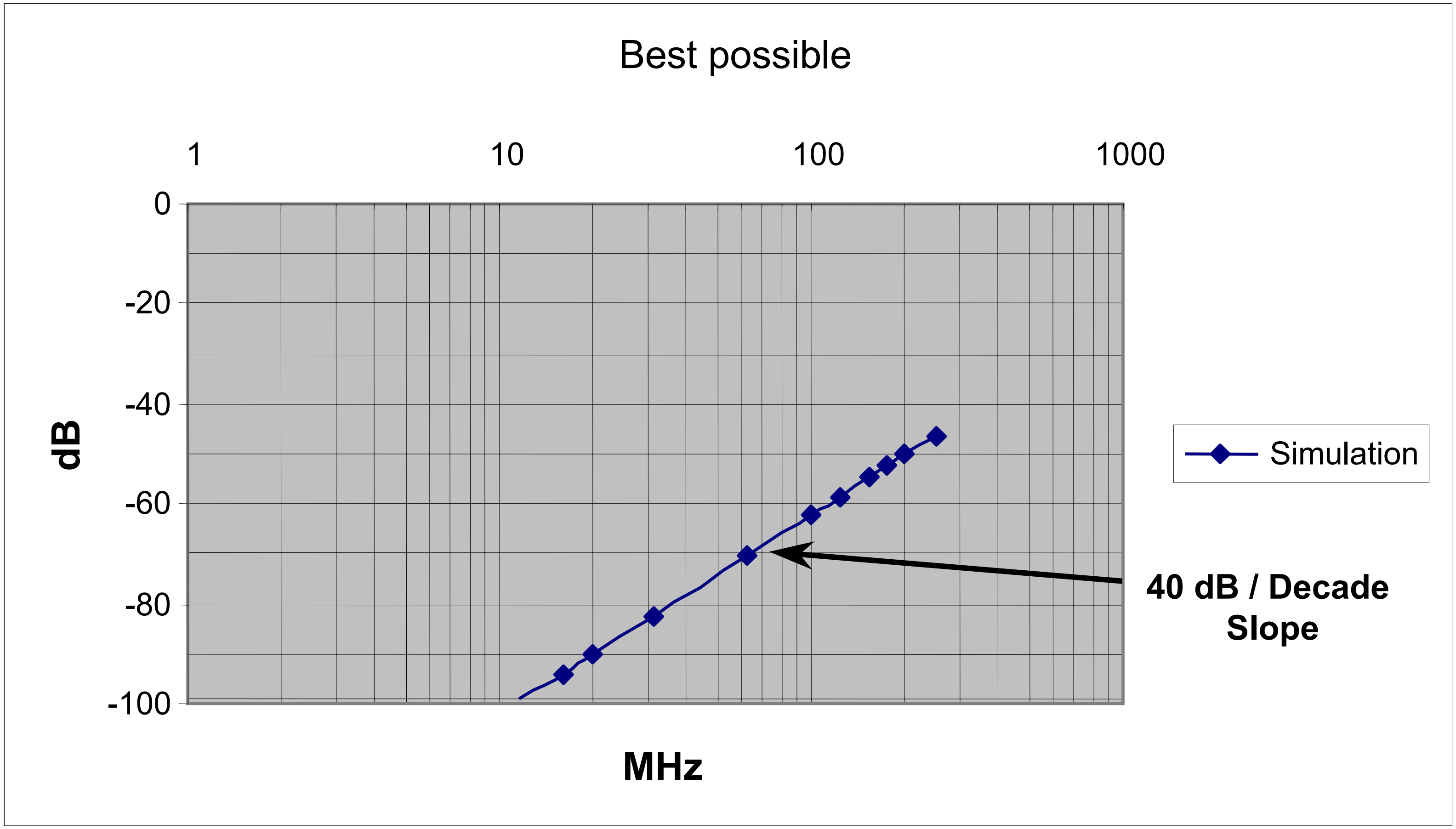
Verification of simulation



By changing the values of the frequency, a chart similar to a network analyser measurement can be produced -> Very good fit between measurement and simulation

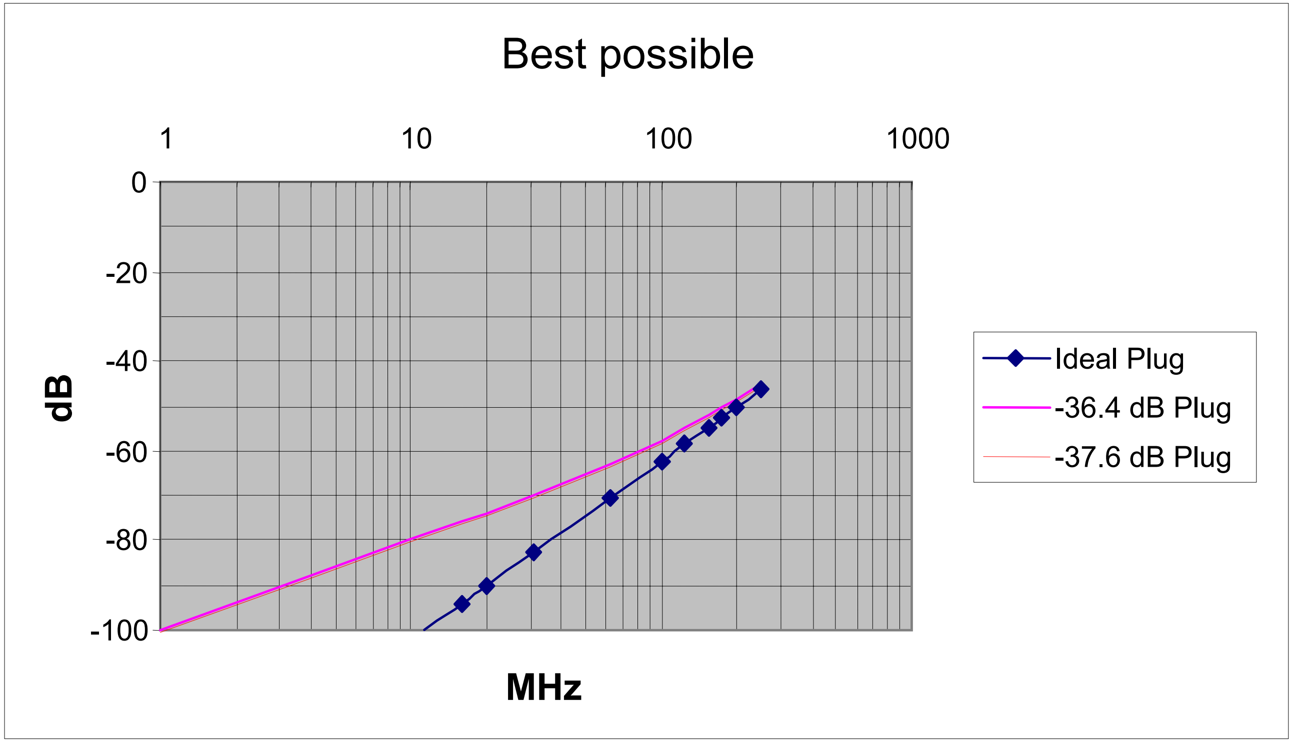
R&M
Convincing cabling solutions

Best possible result 3/6-4/5



Convincing cabling solutions

Cat. 6 NEXT range for plug



The slope for the plugs at the low and high end of the specified NEXT range for Cat. 6 change from a 20 dB / decade at lower frequencies to 40 dB / decade at frequencies above 200 MHz.

R&M
Convincing cabling solutions

Best possible result

By reducing the mechanical dimensions of the 3 parts of the connector to the minimum possible length for an RJ45 and by adjusting the value of the compensation to the exact low frequency level of plug and jack, the best theoretical achievable result for this kind of design can be found:

	Plug	Jack	Compensation	
Length [mm] =	5	5	5	
Total X-Talk [dB] =	-37	-60	-36.4	@ 100 MHz
NVP =	0.8	0.8	0.8	

Results

Frequency [MHz] =	100
NEXT [dB] =	-62.3
Phase Shift [°] =	3

R&M

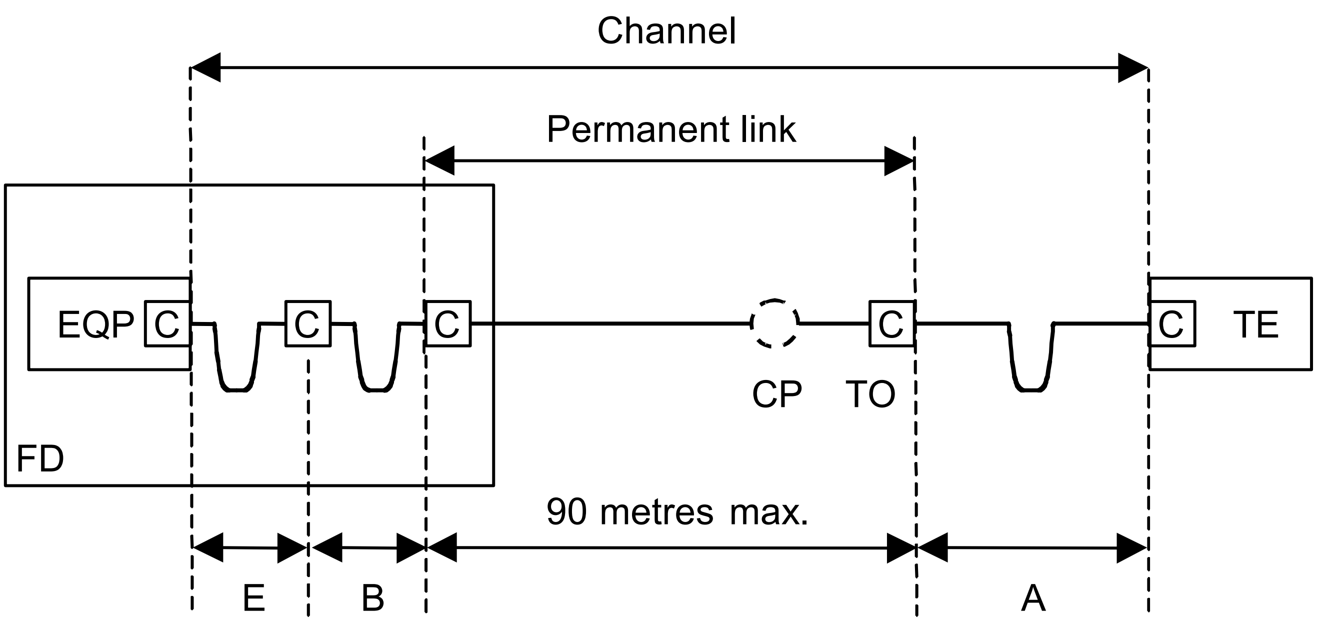
Convincing cabling solutions

Conclusions

- The natural NEXT behaviour of a classic RJ45 connector for data applications at frequencies above 200 MHz is a 40 dB / decade slope.
- The difference between the NEXT value @ 250 MHz for a 40 dB / decade slope instead a 20 dB / decade slope between 200 and 250 MHz is 2 dB (i.e. 44dB instead 46 dB).
- The difference of 2 dB, even considered it sounds rather small, can make the big difference in design options for connector manufacturers.

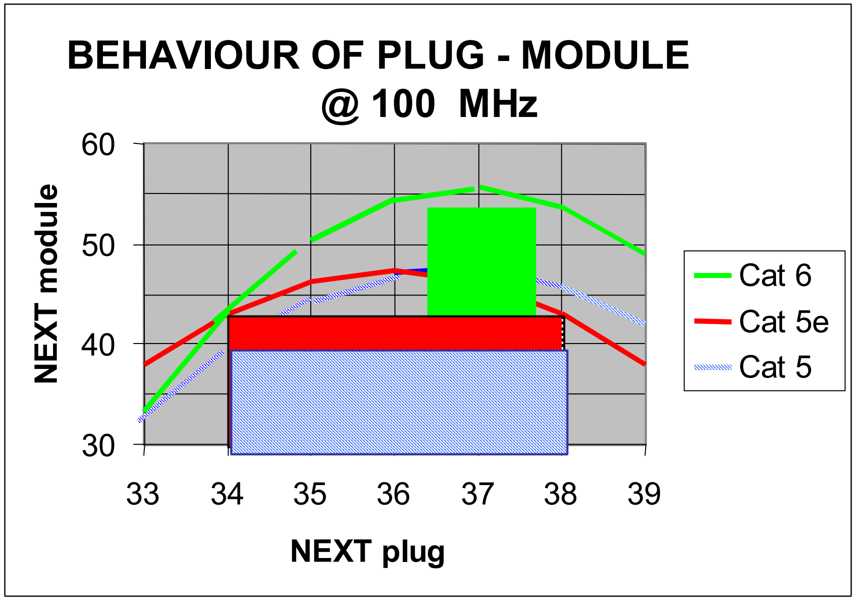
The new cabling topologies challenges

- The flexible distribution and the 4 connectors model
- The central point of administration



Mating plugs and jacks

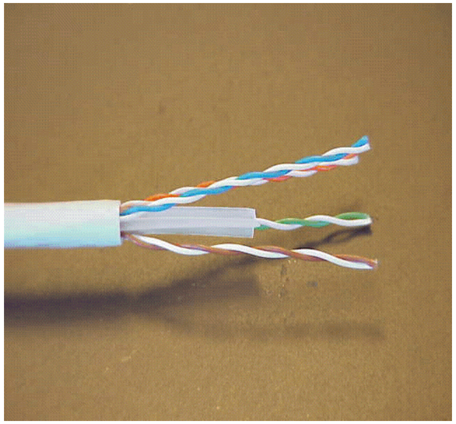
Backward compatibility and interoperability

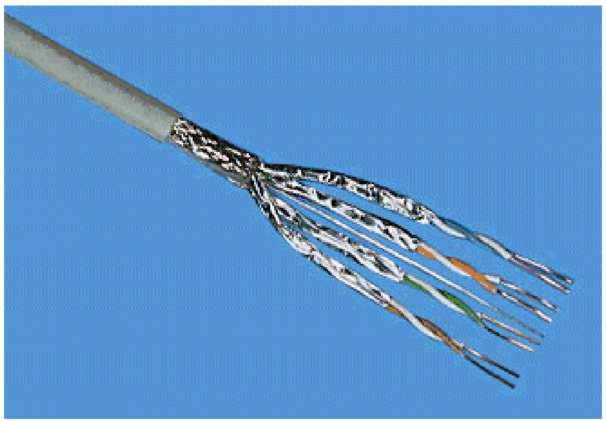


- Pair 4/5-3/6
- each pair combinations has different NEXT values
- Most critical
- Shows the interoperability between plug and jacks
- shows the backward compatibility
- between Cat. 6, 5e and 5

Convincing cabling solutions

Our solutions, cables





- Unshielded, 100 Ohm installation cable
- 4 pairs
- 0.57 mm conductor diameter
- Spacer for better NEXT values
- Better measurements values up to 250 MHz also after installation
- PVC and LS0H outer sheath

- S-STP Cat. 7 cables

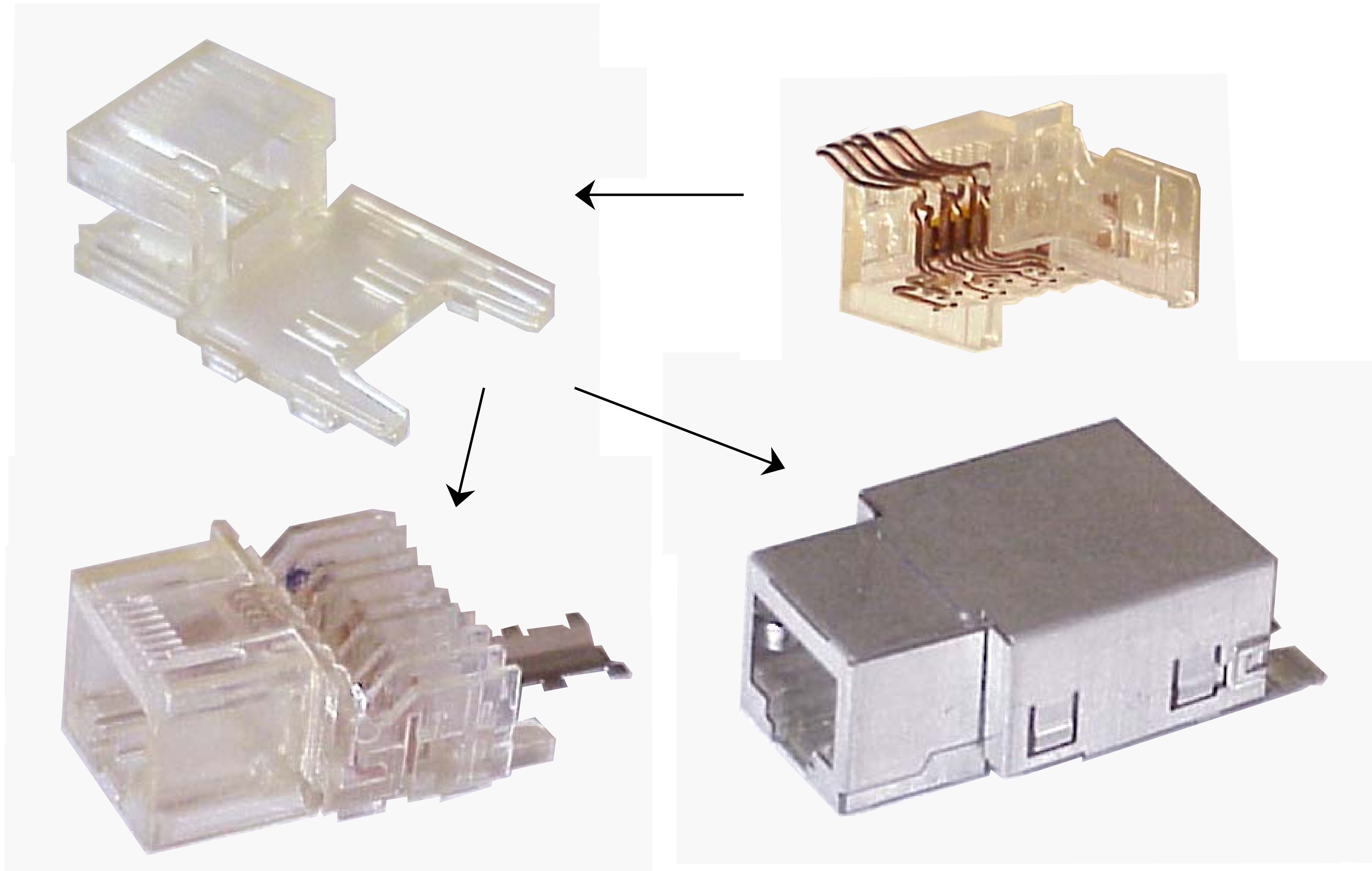
New product, Cat. 6

R&M offers actual Cat. 6 components according to ISO 11801, EN 50173, EIA TIA 568A (plug, patch cords and connection module).

Outstanding features

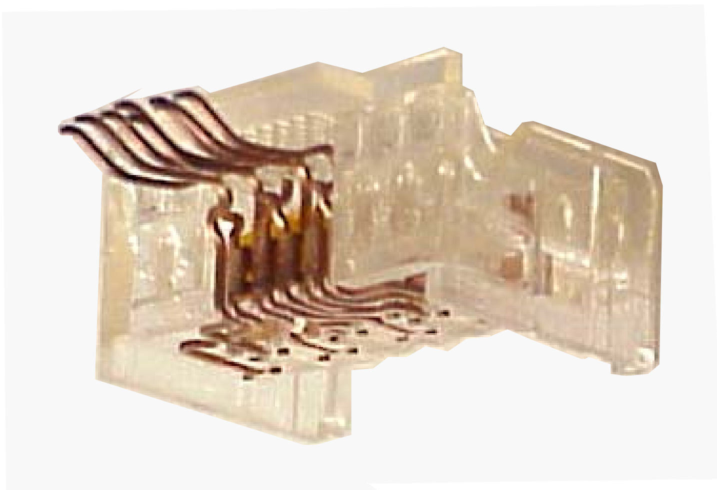
- Real Cat. 6 module (improved electrical values)
- Backwards compatible (with 5, 5e) and inter-operable (mix and match)
- Backwards compatible with all R&M platforms
- Colour blue to differentiate from the R&M Cat. 5 products
- Tool-free termination

Cat. 6 connection module



R&M
Convincing cabling solutions

Cat. 6 interior

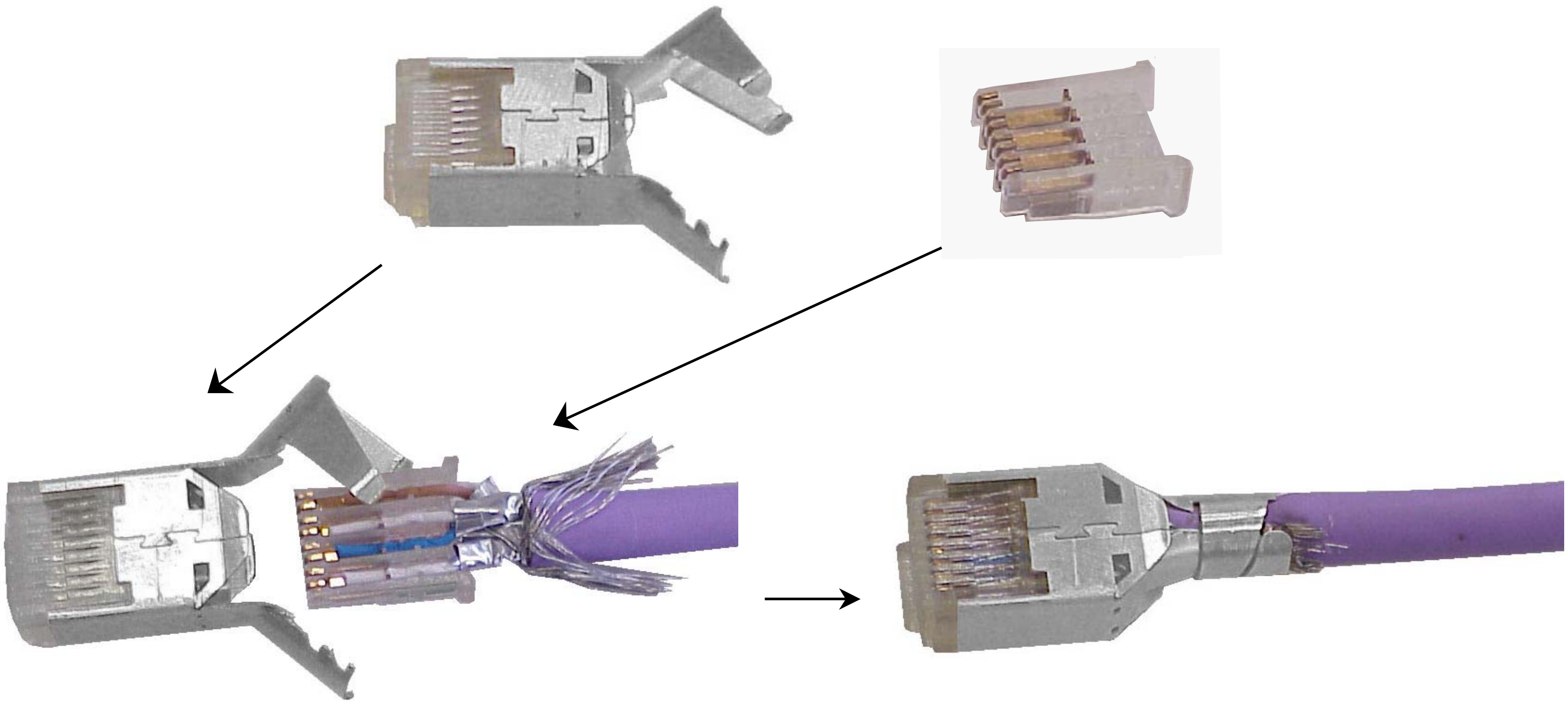


R&M
Convincing cabling solutions

Cat. 6 jack

- Completely without PCB board
- Compensation is done with special designed contacts.
- Solderless connections
- Shielded and unshielded versions
- Same features as the Cat. 5 module
- Availability: Mid July 2000

Cat. 6 plug



Cat. 6 plug

- Parallel wiring of the pairs
- Shortened distance to improve next values
- Termination for flexible or solid wire
- Best screen contact, strain relief on the plug
- Patch cord available in UTP and STP versions
- Colour coding and marking possible

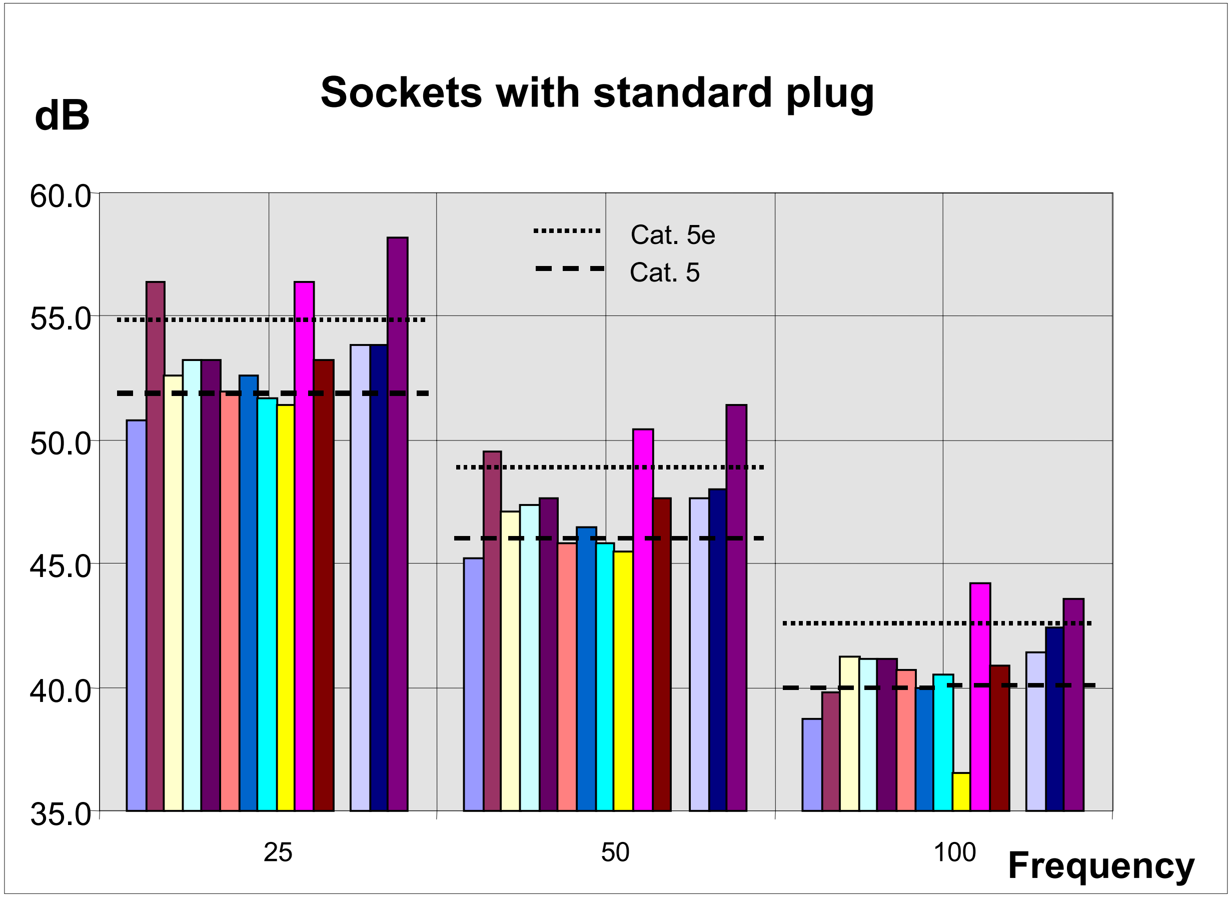
Why such delay from R&M?

- Do not confuse delay with responsible market strategy
- Cat. 6 (Components) standards are not yet available
- Interoperability between system is major issue
- Changes, production process, investments may still happen
- Technology improvements slower than marketing strategies

- All above dictate responsible and correct behaviour in order to prevent:
  - flooding market with not standard components
  - confuse end user or worse cheating him

Some example………………………………..

Comparison between Cat. 5e jacks



- Only two reach Cat. 5e values with a standard plug
- Some don't even reach Cat. 5 limits

Convincing cabling solutions

Responsible answers to market

Make available timely improved systems publishing their limits clearly and correctly

- Class E and not Cat. 6 systems
- Proprietary and not interoperable system
- Wait for ratified standards
- Make sure new products will conform to market expectation
- Avoid non-justified product/process changes that will reflect in additional cost for end user

Convincing cabling solutions