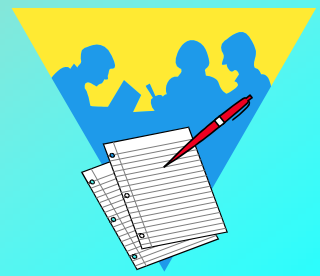


COPPER COMMUNICATION

CABLING SYSTEMS

Jacob Ben Ary

Member IEEE-SA

Member IEEE-EMC

Israel Expert representative in IEC-46C/W7

Editor of IEC cable specification 1200 MHz

Electronic communication

Any transmission of electronic information in analog or digital form.

Copper communication cables are

- **For DATA transmission in LANs.**
- **For broadband transmission (fast internet).**
- **For fast INDUSTRIAL BUS transmission.**
- **For Smart home and SOHO applications.**

Transmission Parameters

SNR = Signal to Noise Ratio
The ratio of the "good" to the "bad"

The "GOOD"

The SIGNAL

The "BAD"

The NOISE

The "confused"

ACR

ACR is defined as:

Attenuation to CrossTalk Ratio in dB

Attenuation

what is Attenuation ?

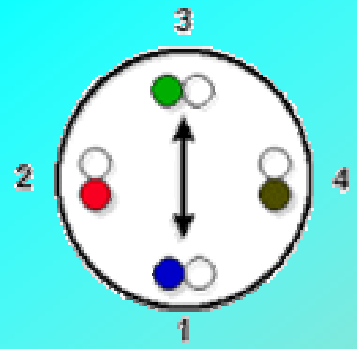
If the input signal is U_r , the output signal is U_s.

Due to attenuation U_s is lower than U_r.

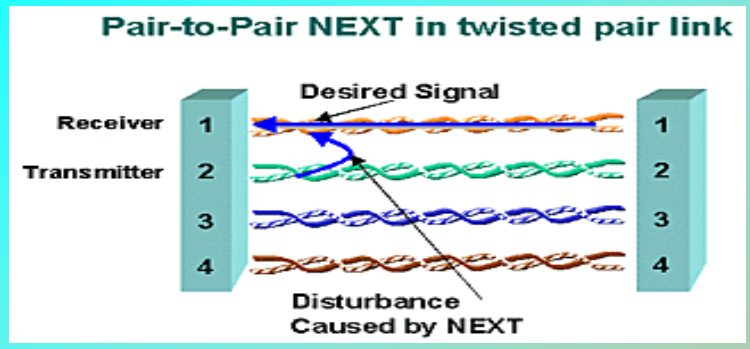
$$A = |20 \log(Us/Ur)| \quad \text{In dB}$$

Near End Cross Talk (NEXT)

Sending a signal U_r through one twisted pair results in a reflected signal (reflected noise) U_{nNE}, in the twisted pair under consideration.



$$NEXT = 20 \log(U_r / U_{nNE})$$



PS NEXT is the sum of the NEXT in one pair generated by all the pairs in the cable.

Definition of ACR

ACR=A(dB) – XT(dB)

ACR=20 log(Us/Ur) – 20log(Ur/Un)

ACR=20 log{(Us/Ur)/(Ur/Un)}

ACR=20 log(Us/Un)

"Remember the bad and the good"

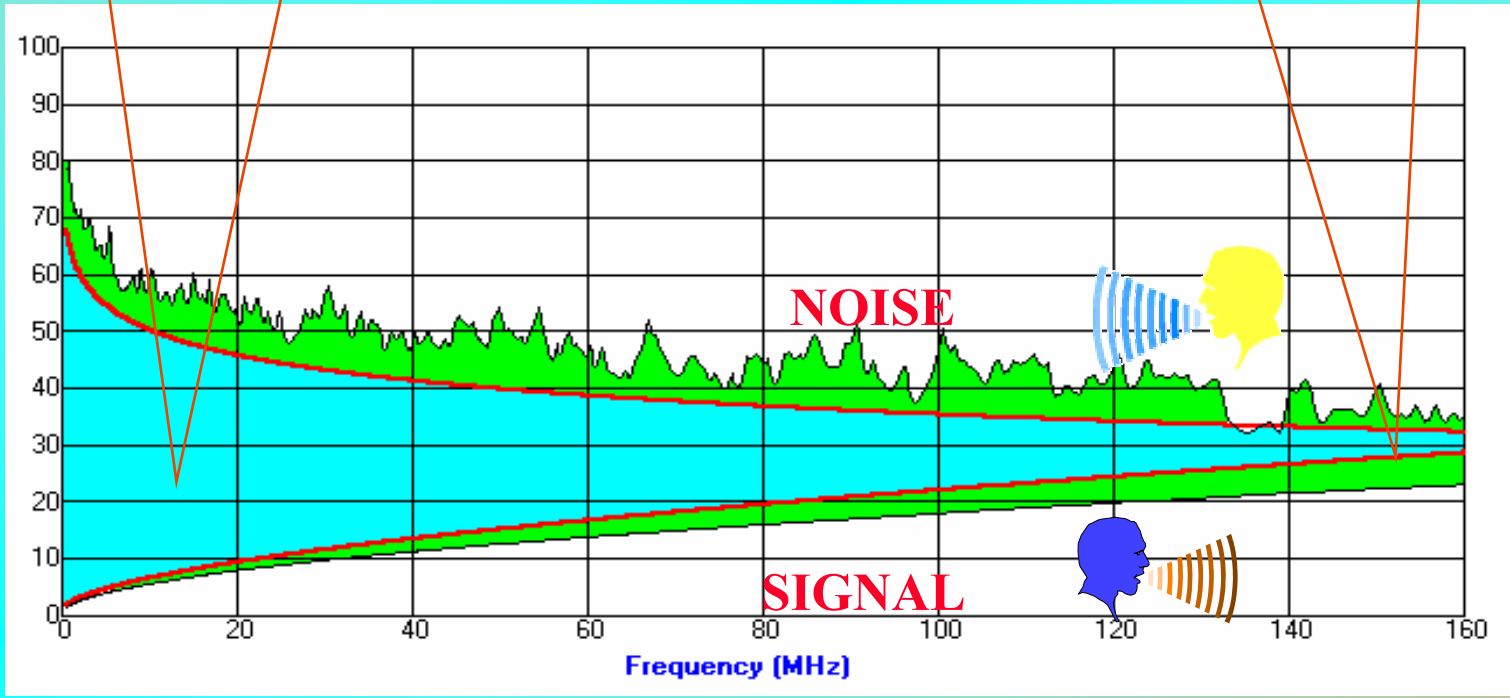
The ACR is SIGNAL "good" to NOISE "bad" ratio.

Higher ACR - better transmission performance (lower BER).

Graphic Presentation of ACR
(or any other SNR)

High ACR = better performance

Low ACR = lower performance



Impedance (Z_0)- Definition

- **In practical cables the characteristic impedance is determined by cable geometry, dielectric material, conductor type and size and by production process.**

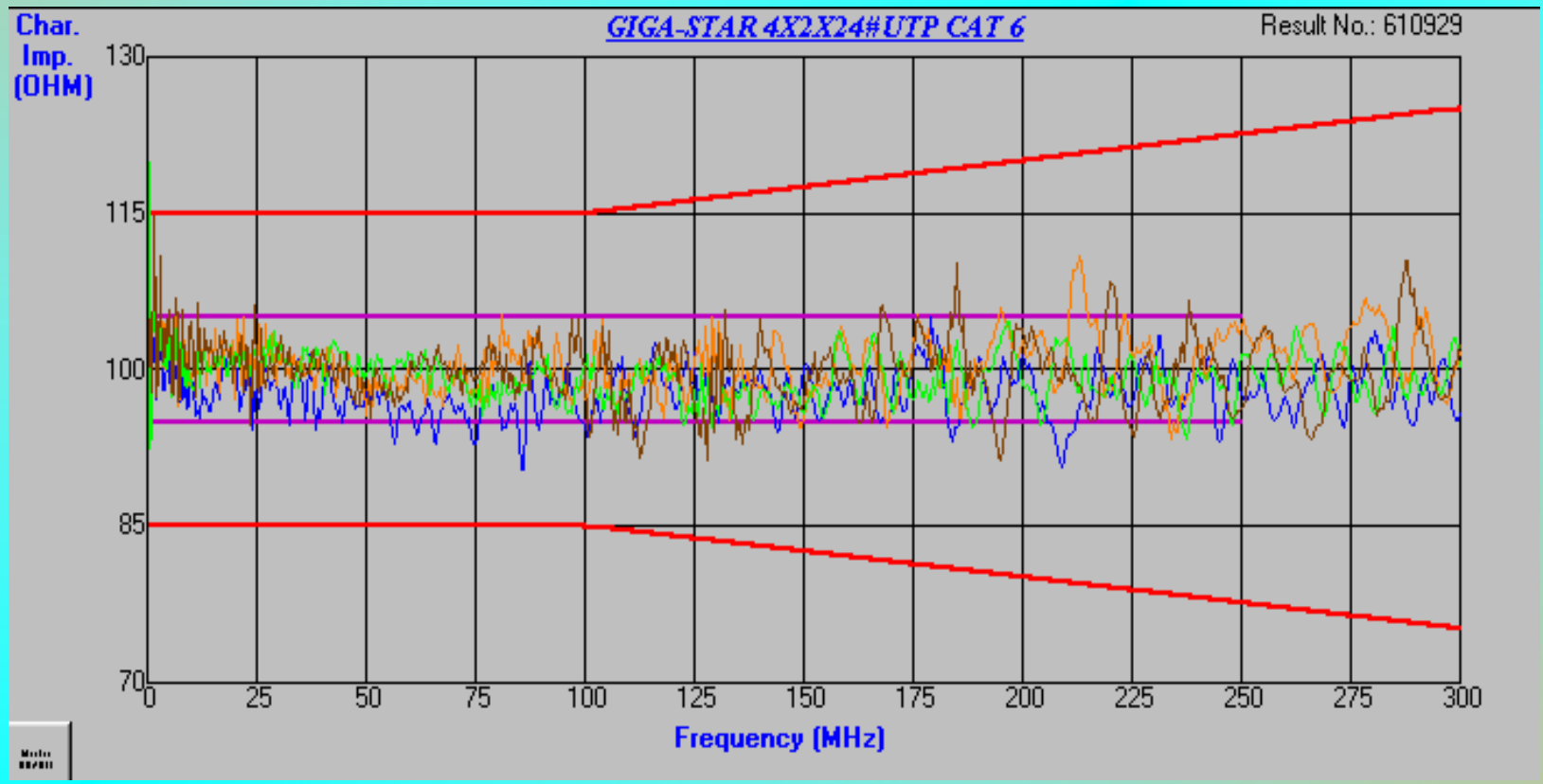
$$Z_0 = \sqrt{\frac{R + jwL}{G + jwC}}$$

Where: R = DC Resistance **G = Conductance**

L = Inductance **C = Capacitance**

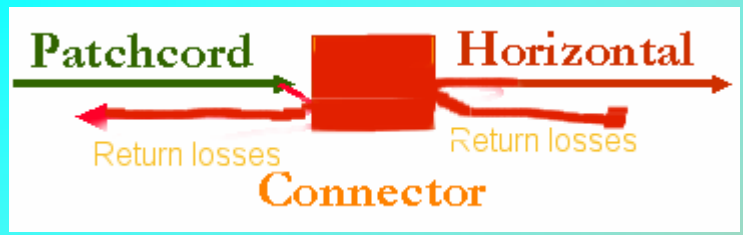
Characteristic Impedance

(Teldor Giga-Star Cat-6 Cable)



Return Losses

- The signal which is reflected from any discontinuity in the media impedance
- Another source of noise
- Any mismatch between cable or connector impedance will cause Return Losses
- Variations in a cable structure lead to impedance changes ---> Return Losses



Return Loss - RL

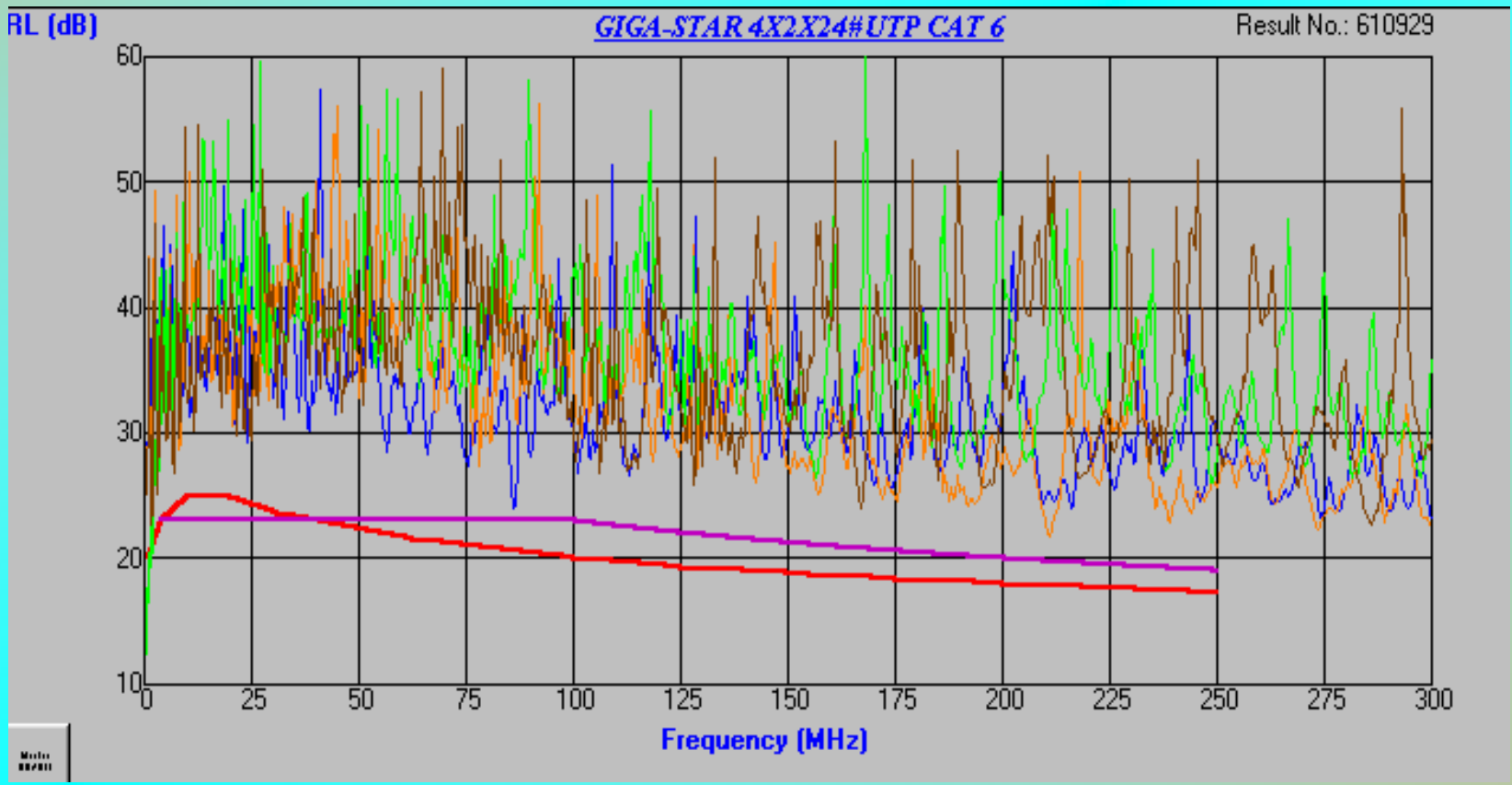
- The quality of the cable performance for 100 Ohm systems is measured by the RL.

$$RL_f = f\left(\frac{Z_{in} - 100}{Z_{in} + 100}\right)$$

- The main difference between Cat 5 and Cat 5e is the requirement for RL rather than SRL

Return Loss

(Teldor Giga-Star Cat-6 Cable)



What we can do

1. **Reduce NOISE**
2. **Use higher BW cables**
3. **Use cables with higher S/N values.**

HOW DO TO…… (wait for the next slide)

Shannon's low

$$C = BW \, LOG_2 (1 + S / N)$$

C maximum data rate
BW bandwidth
S signal power
N noise power

Shannon's low

Ways to increase data rate

Increase bandwidth of channel

Increase the S/N ratio by:

Signal power - UP

Noise power - DOWN

Noise !

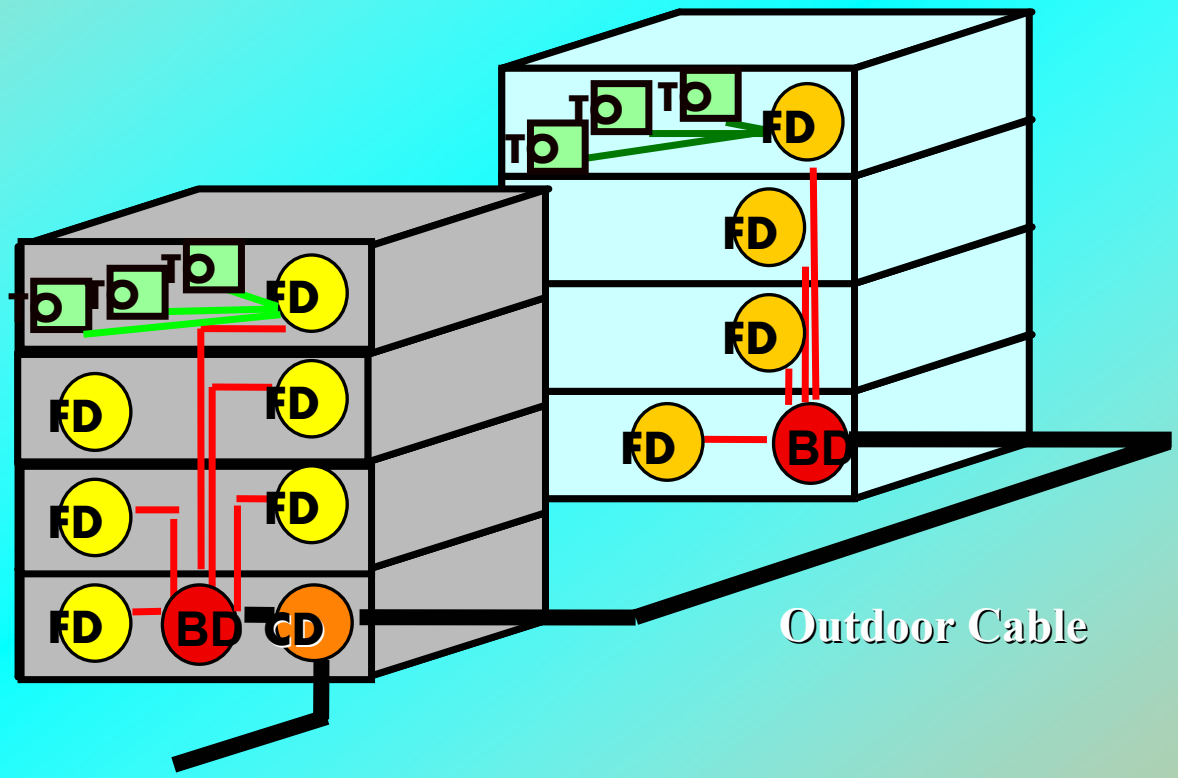
- Other source of noise: EMI
- EMI is a source of noise into the cable and out of the cable
- Best way to reduce EMI is to use shielded cables
- Overall shield would not reduce internal noise but will reduce the noises to and from the cable.
- Individual pair shielding will reduce NEXT, FEXT and EMI-generated noise

Conclusion

1. **Higher BW by higher Cat grade cable.**
2. **Lower NOISE by STP solution.**
3. **And higher S/N by S/STP solutions.**

LAN copper cables

Structured Cabling System

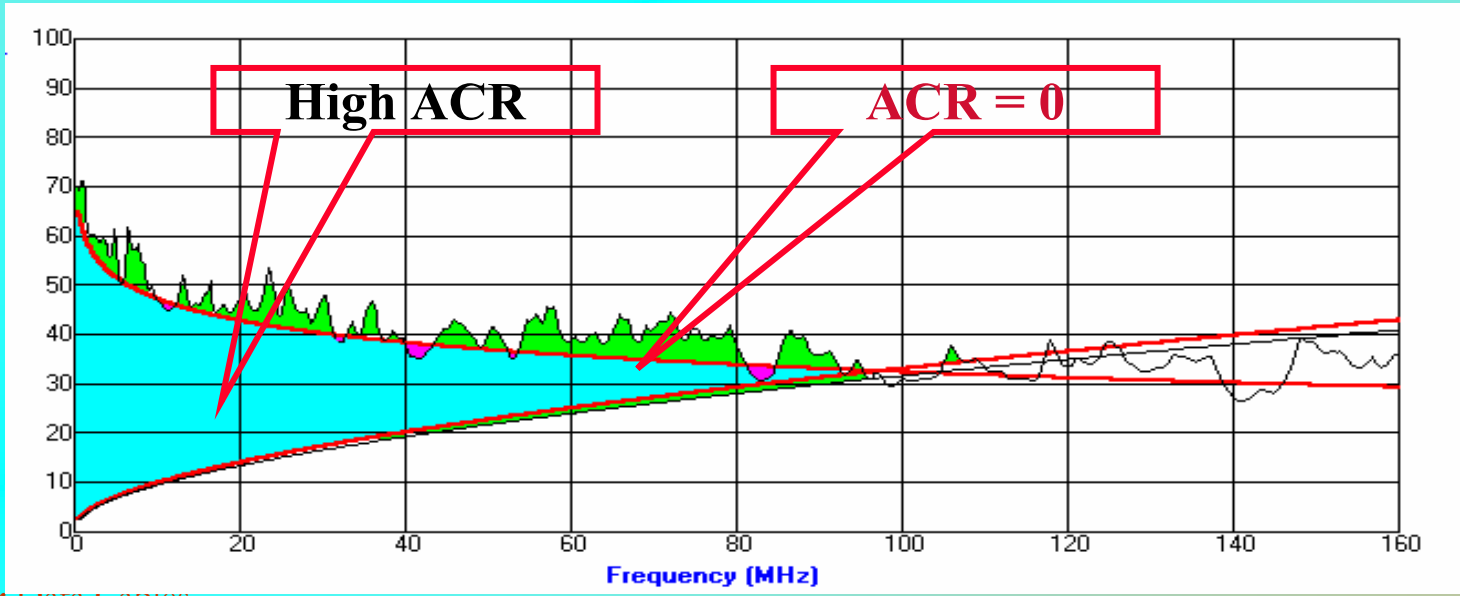


Status of Installed Base Cables

- Most pre - 1998 cables have not been characterized for:
  - FEXT
  - Delay Skew
  - RL
- Most people are still running 10BASE-T systems….
- Most of these installations will not support the new 1000 Mbps applications.

Improperly Installed Cat 5 Cables

Category 5 cables are being dangerously pushed to the limit , and any flaw in the installation or in the link components may have a substantial influence on its performance.

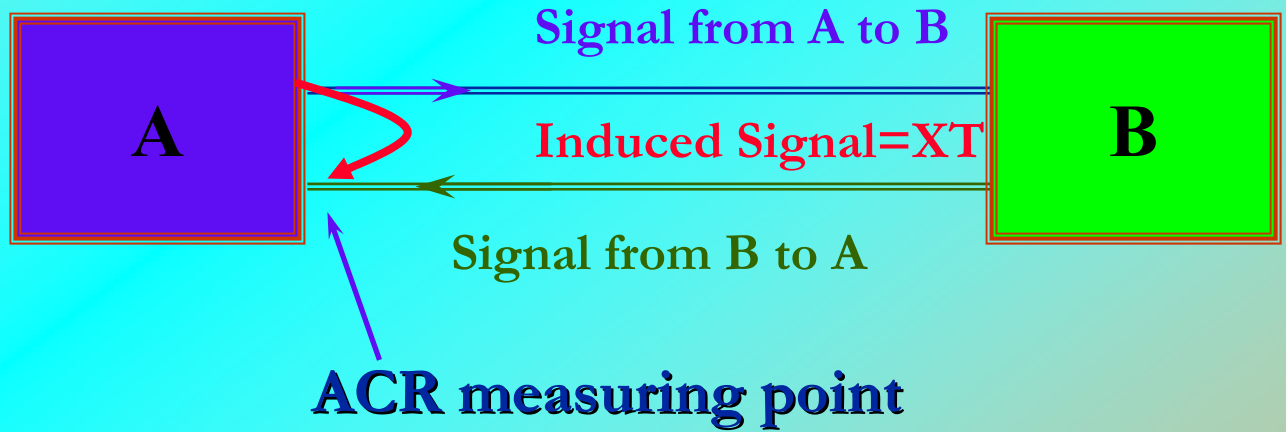


PROTOCOLS

Half-duplex 2-pair Systems

Only 2 pairs active - Other pairs idle

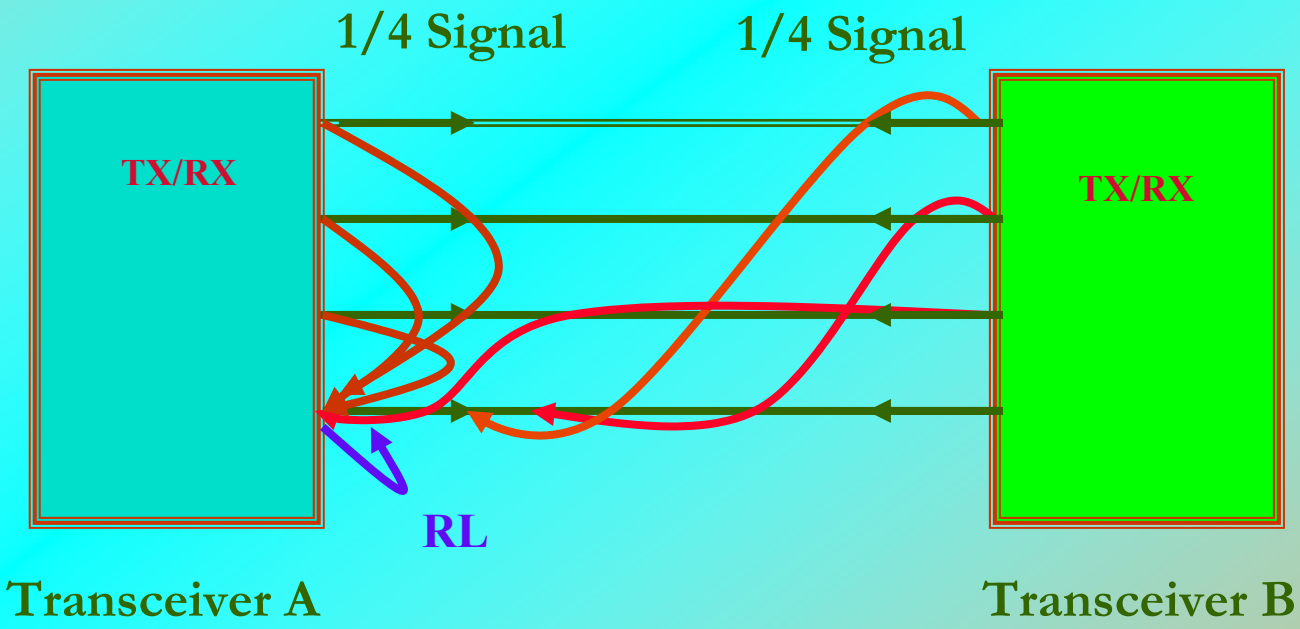
- The crucial parameter in such systems is the ACR



Full-Duplex 4 Pair Systems

Bi-directional simultaneous 4 pair transmission

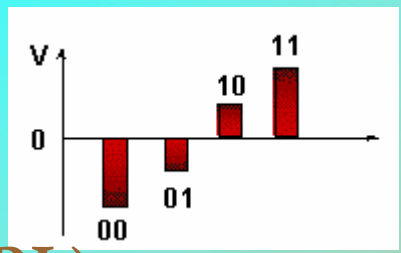
- The crucial parameters in such systems are PS-ELFEXT, PS-ACR, Delay Skew, and Return Loss (RL).



Return-Loss effect on a single pair

Full-Duplex 4 Pair System
Gigabit Ethernet

- For Gigabit Ethernet (IEEE 802.3ab 1000Base-T) on Category 5 cabling systems (f must not be more then 100 MHz!):
  250 Mbps/pair, PAM-5=>~3 bit/Hz, f => ~83 MHz.
- *PAM-5 coding:*
  (Pulse Amplitude Modulation 5 Levels)
  The crucial parameters are PSACR,
  EL-PSFEXT, Delay-Skew and Return-Loss (RL).



- The two major concerns are the high cost of the PHY chip required and the ability of the cabling systems to meet the tight RL requirements.

Cable Categories: What to Choose?

Cable Categories per EIA/TIA-568-B2

Category 3 - to 16 MHz

Category 4 - to 20 MHz

Category 5 - to 100 MHz

Category 5e - to 100 MHz

Category 6 - to 250 MHz (568-B2.1, still a draft)

Cable Categories per IEC 61156

ISO 11801	Category	Bandwidth	Status
Class C	3	16 MHz	Obsolete for DATA IEC 61156-3/4
Class D/Dnew	5/5e	100 MHz	IEC 61156-3/4
Class E	6	250 MHz	Final Draft IEC 61156-5/6
Class F	7	600 MHz	Final Draft IEC 61156-5/6
Class --?	8?	1200 MHz	Proposal

Some guidelines

1. Learn all the customer needs
2. Learn location and end user requirements.
3. Choose the cables that has maximum margins. In other words the highest ACR.
4. Check with your customer the future applications.
5. Use shielded pairs.

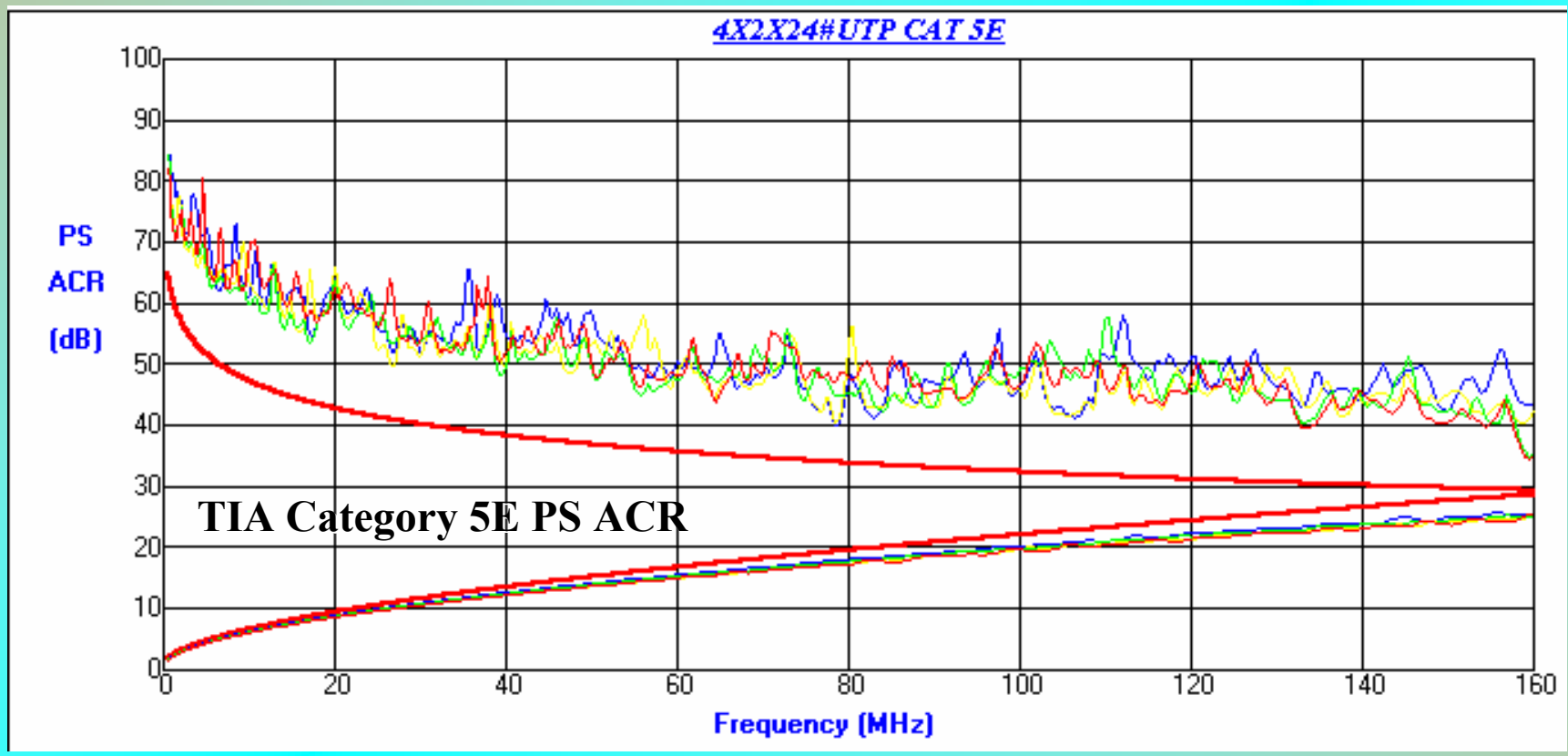
Cable Solutions Provided by Teldor

The BASIC-Solution™

CATEGORY 5E per ANSI/TIA/EIA-568-A-5
"NEW" CATEGORY 5 per ISO/IEC 11801 (2nd Edition)
"NEW" CATEGORY 5 per CENELEC EN 50173 (2nd Edition)

- **Teldor BASIC-Solution cables meet or exceed all the requirements of CATEGORY 5E**
- **Available as UTP, FTP and SFTP**
- **Available in OUTDOOR constructions and Fig. 8**
- **Available in PVC or HFFR**
- ***If properly installed and terminated, cabling system based on BASIC-Solution cables can support GbE with a comfortable margin.***
- ***EL verified, UL CMX listed***

PSACR of Teldor's BASIC-Solution Cables



The BASIC-Solution cables are ETL Verified to ANSI/TIA/EIA-568-A-5 Category 5E

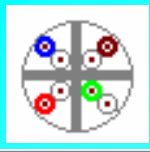
The GIGA-STAR-Solution™

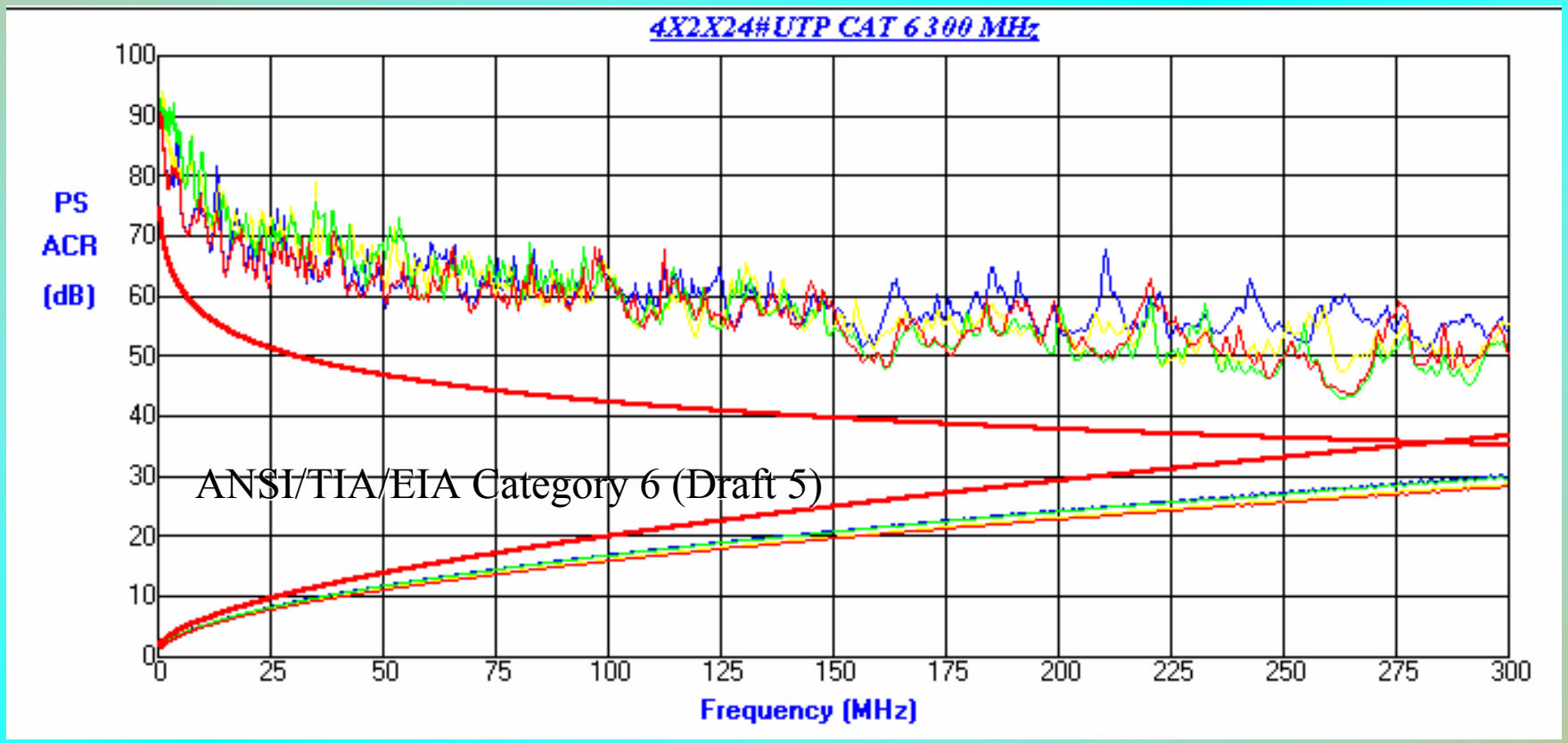
Category 6 Cables tested up to 300 MHz.

- *UTP cables.*
- *Individual screen pair ScTP.*
- *Solid and Patch UTP and ScTP.*
- *PVC or HFFR jacket, single or FIG-8 construction)*
- *Outdoor cables are available*
- *Used for digital data-transmission up to 250 MHz.*

PSACR of The GIGA-STAR-Solution UTP

Teldor P/N 750AZ04129

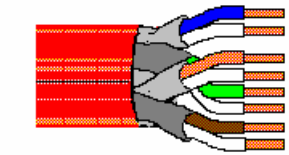


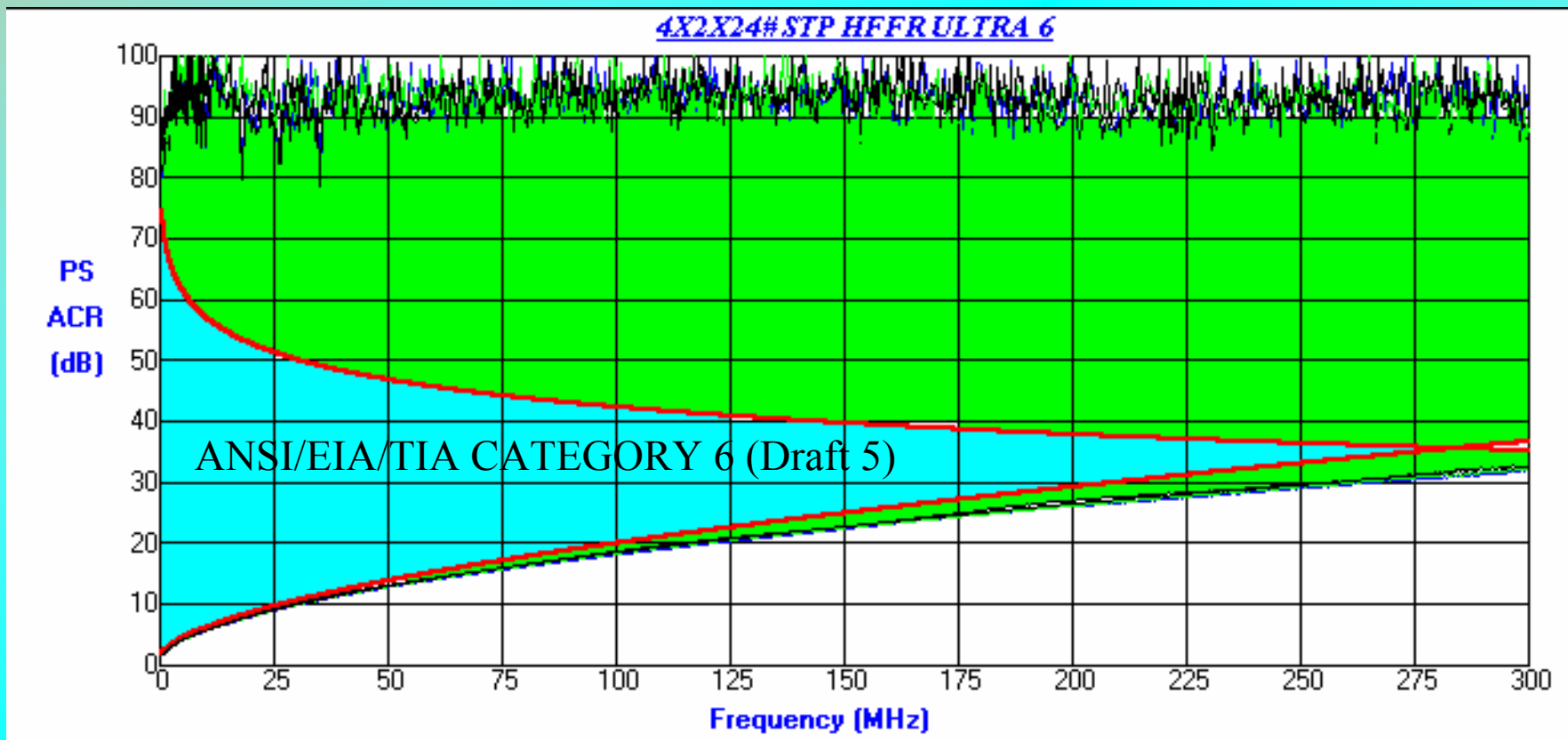


The GIGA-STAR-Solution UTP is ETL Verified to ANSI/TIA/EIA-568-A Category 6 Draft 5

PSACR of GIGA-STAR STP Cables

Teldor P/N 8301204129





Category 7 - S/STP cabling

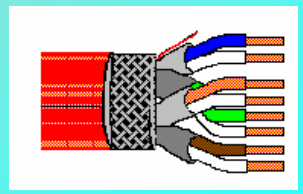
- Category 6 cabling is probably the next generation in cabling systems, mainly because it offers a support of the present "hot" protocol, namely Gigabit-Ethernet, without a dramatic cost increase - but there are better copper cables available: Category 7 S/STP cables.
- These cables are used extensively where users want higher margins and better EMC.
- The S/STP construction provides cabling systems that can support almost any digital application on copper.

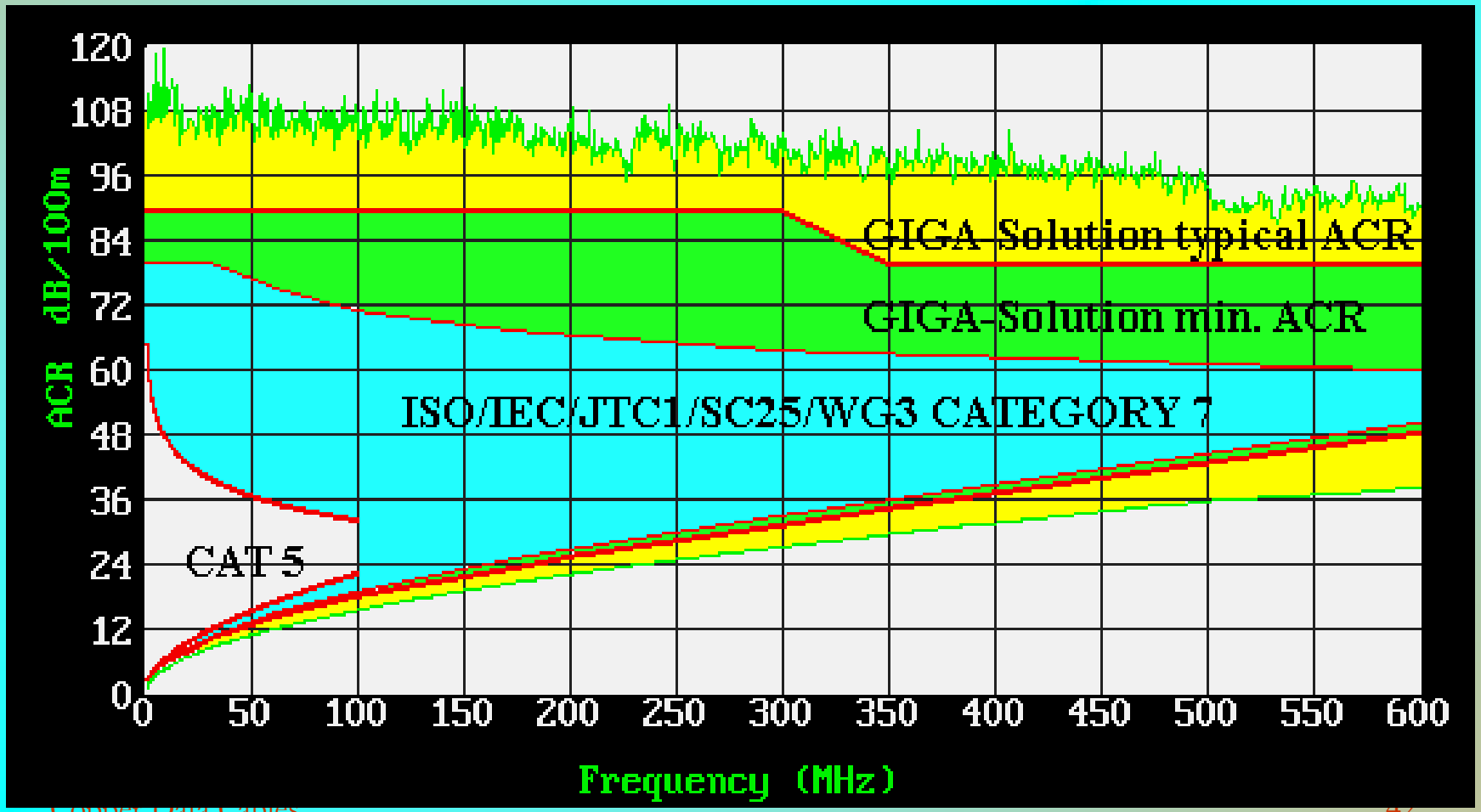
600 MHz Cables "The GIGA-Solution" ™

GIGADOR™ Cables

- Exceed the Class F / CATEGORY 7 requirements of ISO/IEC JTC1 SC25 WG3 proposal (based on DIN-44312-5 draft)
- Features: 100Ω impedance, 4 individually foil shielded twisted pairs, overall braid shielded.
  Horizontal cables: 22 or 23 AWG solid conductors
  Available both with PVC or HFFR jacket.
- Easily meet all the proposed Category 6 requirements up to 300 MHz (including EL-PSFEXT, PS-ACR and delay skew) and in addition, extend the useful bandwidth up to 600 MHz.

ACR of GIGA-Solution Cables





Cat-6 or Cat-7 ???

Cat 6 is good solution for GbE applications.

Cat 6 will be the standard for GbE cabling.

BUT, for installed cables we need some spare for future applications,

AND for the HUB to HUB … we need higher data transmission capacity this force for higher BW the solution CAT 7 or higher.

- **Big margins above the standards requirements will allow lower EBR.**
- **Teldor's LAN cables solutions has big margins. We believe that paying for these margins is cost-benefit to the end-user**

SOHO and Multi-Service

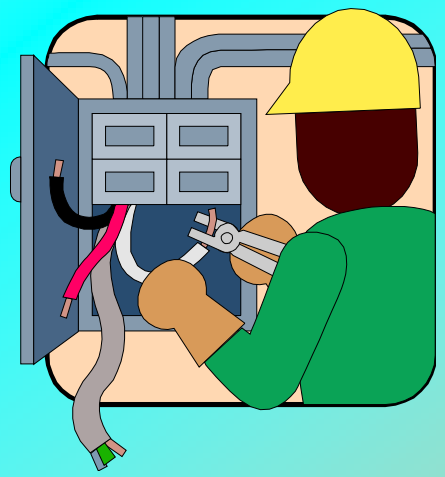
Category 8 Cables

What is SOHO?

- According to ANSI/EIA/TIA-570 it is a premises wiring system intended for connecting exchange access lines to various types of customer premises equipment.
- The system outlined today includes a voice network, data and video. However, the standard appears to be migrating toward the Commercial Building Wiring Standards (568-A, TSB67, 569-A 606, 607).
- ISO/IEC/WG1 is developing another SOHO standard for Small Office / Home Office wiring.

What cables should be selected?

Instead of installing several cables (one for each application) all SOHO applications can be efficiently supported by one S/STP cable, in which every pair can be used for a different service.



Where is the limit?

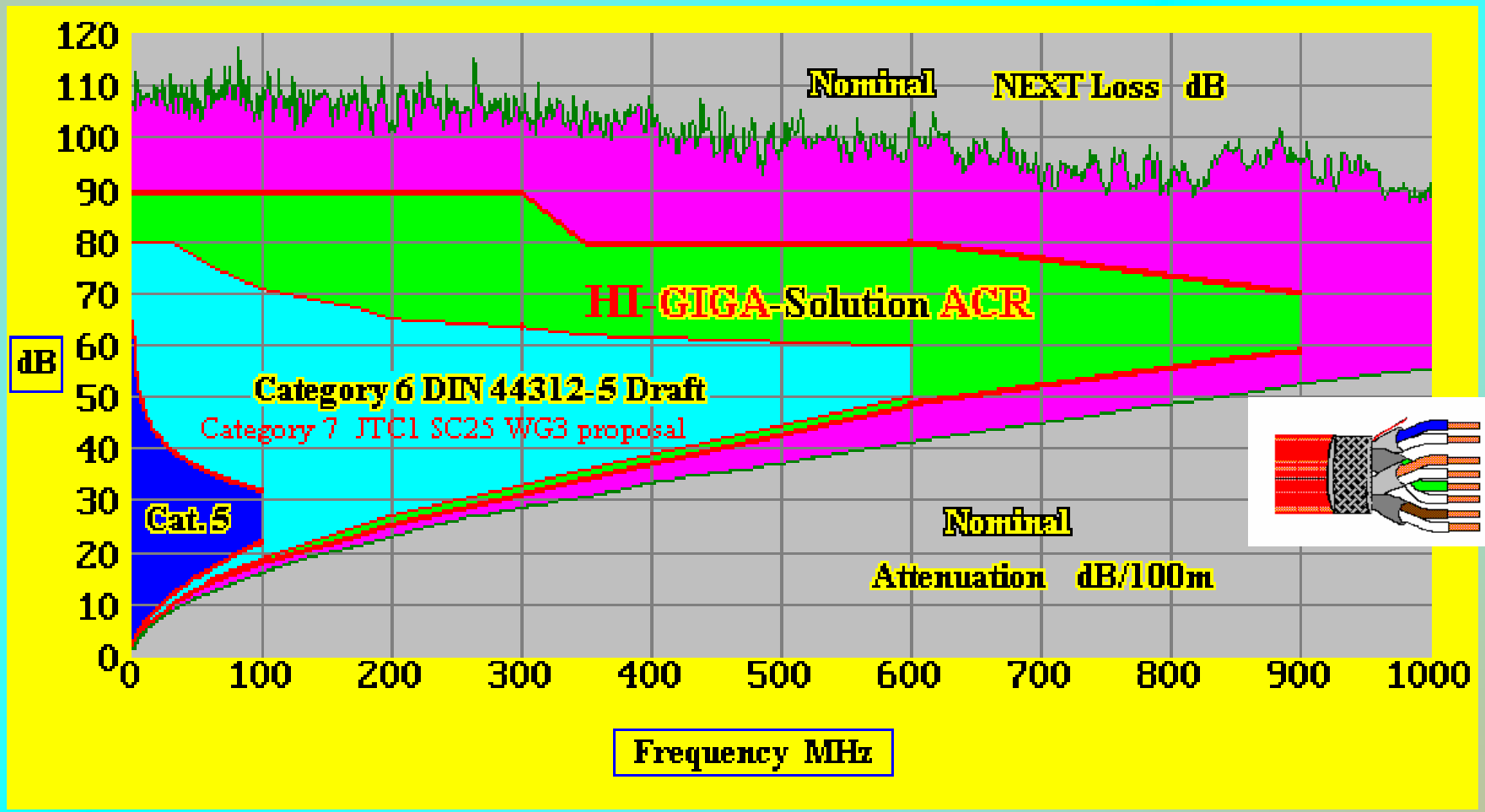
- The IEC proposals for Category 7 class F twisted pair cabling system defines a bandwidth up to 600 MHz. There is new project groupe for 1200 MHz cables.
- Recent developments show, however, that higher bandwidths, up to 900 MHz, are feasible.
- This adds the broadband CATV (860 MHz in Europe) to the multiple services that can be delivered under the same jacket with Teldor Hi-GIGADOR (22#) and Hi-JUNIOR (23#) cables.

The HI-GIGA-Solution ™

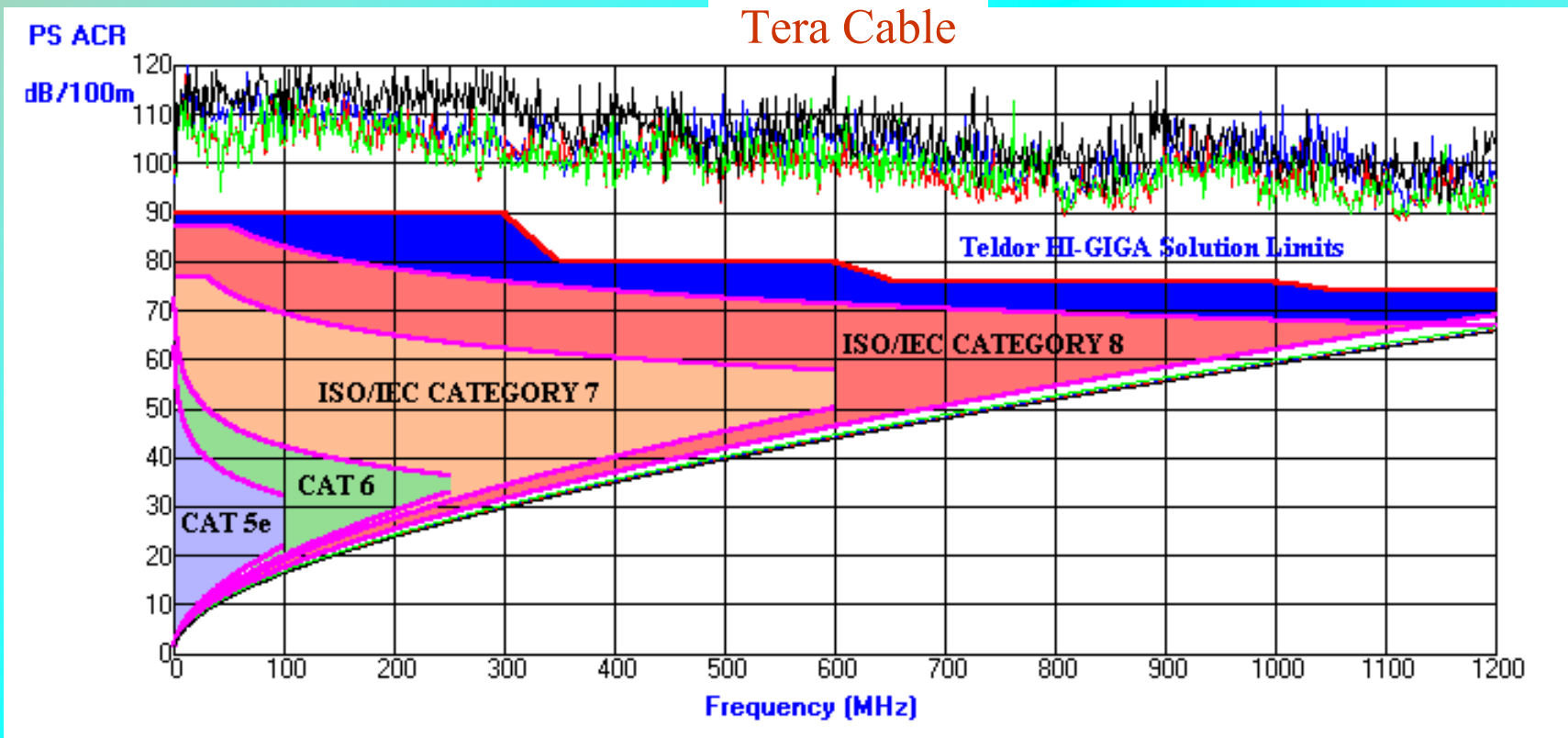
HI-GIGADOR™ 22# Cable, HI-JUNIOR™ 23# Cable

- These cables are sometimes referred to as "CATEGORY 8", although no such draft is discussed yet.
  They are optimized for broadband CATV signals up to 900 MHz.
- Features: 100 (impedance, 4 individually foil shielded twisted pairs, overall braid shielded.
  Horizontal cables: 22 or 23 AWG solid conductors.

ACR of HI-GIGA-Solution Cables



Crossing the 1 GHz Barrier: Teldor's Tera Solution a 1200 MHz Cable



The future of SOHO

- More people work in small offices or at home, requiring a cabling system that can support all services at low-cost.
- New hotels require efficient networks that support telephone, data and TV.
- Industrial complexes (such as off-shore oil-rigs) require compact cabling infrastructure for all IT services.
- All-in-all: The SOHO concept is an important step toward unified cabling system, providing a low-cost and an easy to manage solution.

xDSL solutions

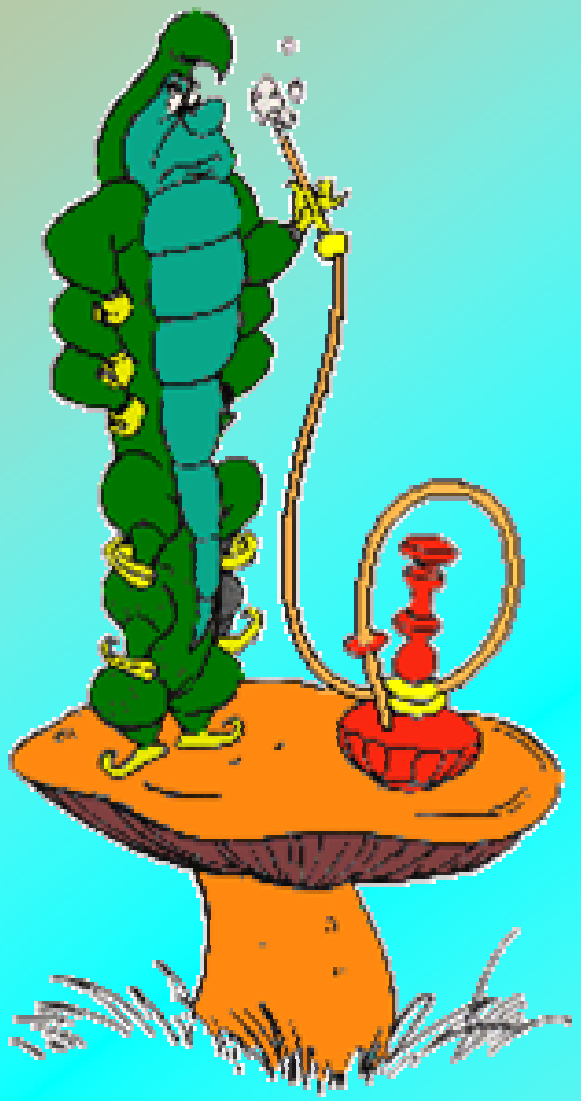
- Multipairs SFTP cables CAT5E performance for switchboard connections
- Multicable UTP cables for in-house connections.
- Teldor suggest to use 4 pair CAT5E, UTP or FTP cables for in-home telephone/xDSL applications.
- Note: the wiring standards request category wiring for the “telephone wiring system” in new buildings.

Hybrid, Composite cables

- Fiber optic and category pairs under one jacket.
- Fiber optic and coax cables under one jacket.
- CAT5E UTP/FTP/ScTP and coax cables under one jacket.
- Almost any structure per request, based on Teldor's basic modules.

Industrial applications - FieldBus

- Profibus cables.
- Multi ProfiBus cables.
- DeviceNet cables.
- Interbus cabling solutions.
- Cables specially design for RS-232, RS-485, RS-422 communication standards
- Large range of industrial automation cables.



Teldor Quality Assurance

Features

- ✓ High precision machines.
- ✓ Constant lay twinners.
- ✓ Automatic fault detectors.
- ✓ Tight QA control during production.
- ✓ Testing of each reel/box/cable before supplying.
- ✓ Installation Simulation.
- ✓ Aging Simulation

The FAIL-SAFE Program

In TELDOR's ambitious QA program, each and every drum or box of BASIC-*Solution* cable shipped from the factory is sweep-tested for compliance with NEXT, Power-Sum NEXT and impedance Category 5E requirements.

Many cable manufacturers can produce good Category 5E cables but only very few can guarantee that 100% of the cables shipped comply with 100% of the transmission parameters required by the standards.

Even fewer can prove it.

TELDOR production methods guarantee continuous and consistent production of high-quality Category 5e BASIC-Solution cables.

The FAIL-SAFE program proves it.

A Short Summary

- Installing standard cabling elements today does not guarantee a “future-proof” cabling system.
- Category 5E cabling systems may be insufficient for some present and future applications.
- Category 6&7 cabling systems give a longer future and support a wider range of applications and frequencies, including Gigabit Ethernet.
- SOHO networks, supporting telephone, data and CATV and Fiber To The Home may provide a low-cost and efficient solution in many cases.

If you're interested in
Technical Discussion
on Data Cabling Systems

Join the

TTCF

Teldor Technical Cabling Forum

Email: teldorcd@teldor.com

Thank You !

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