Qualified Partner Programme QPP

Cat.6 Channel Meassurement Issues

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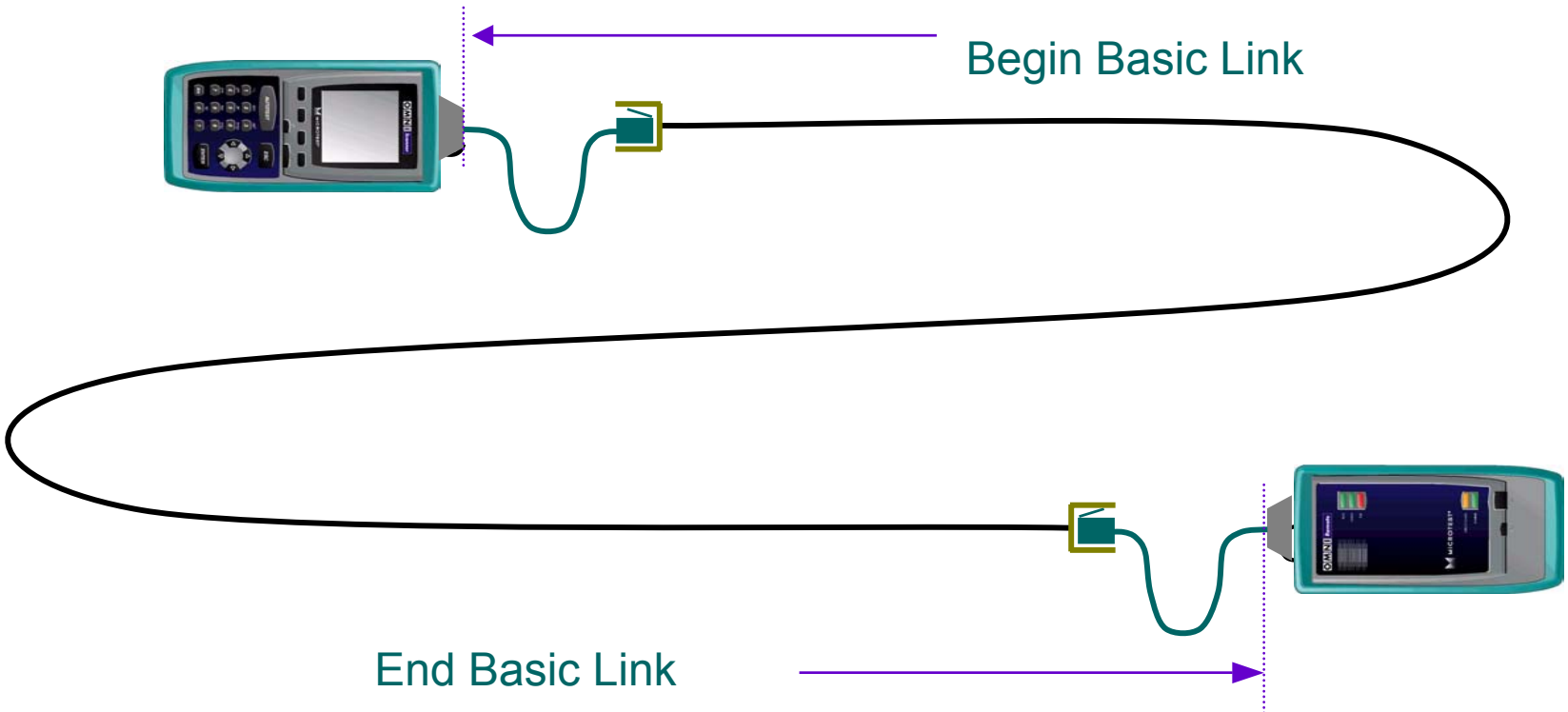
Agenda

- Channel and link definitions
- Why measure a channel?
- Patch cord affects on link performance
- The challenge of channel measurements
- Category 6 connector issues
- Methods of channel testing
- Conclusions

Channels and links

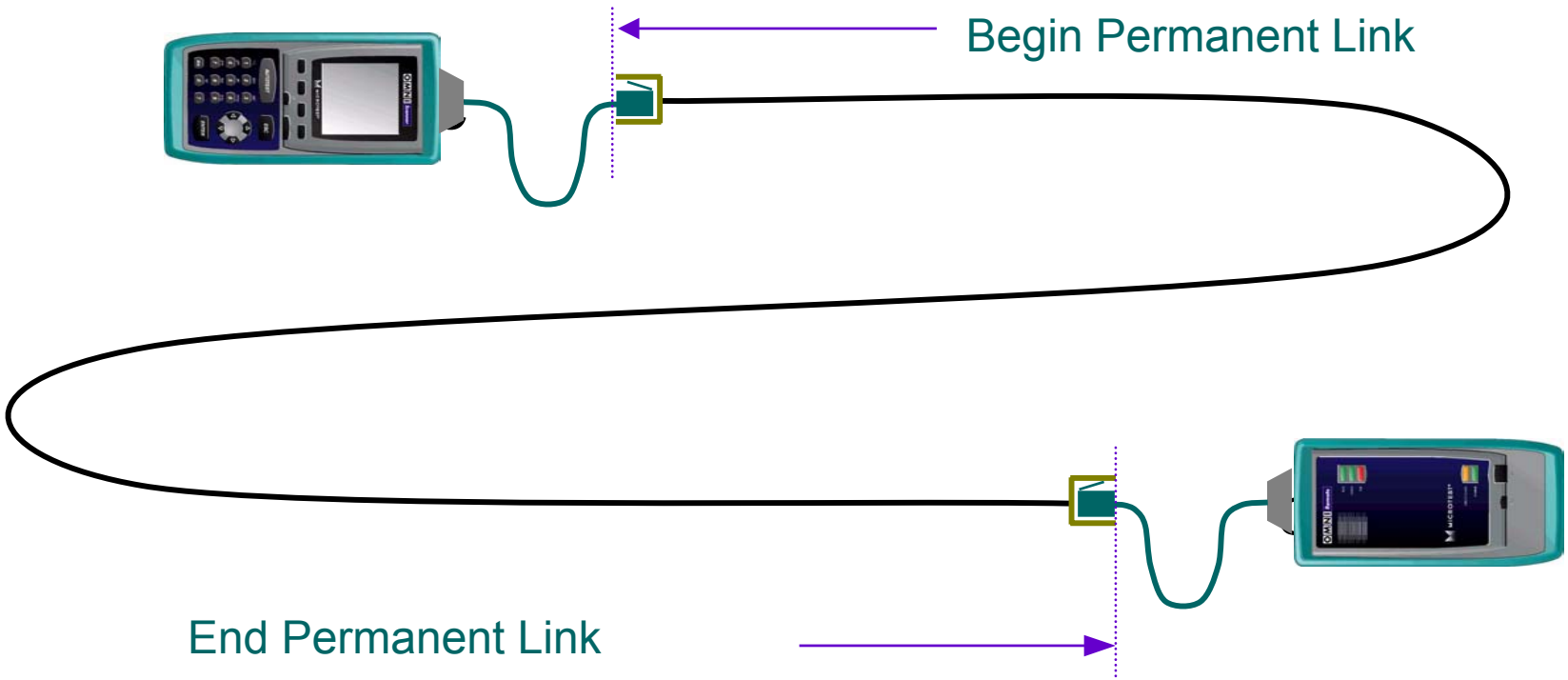
- Installers typically test a basic link (permanent cabling)
- Basic link does not include the users patch cord and equipment cord in the telecommunications closet
- Network equipment uses the full channel
- The performance of patch cord and its mated connection will directly affect channel performance
- The channel is rarely tested before system start up

The Basic Link



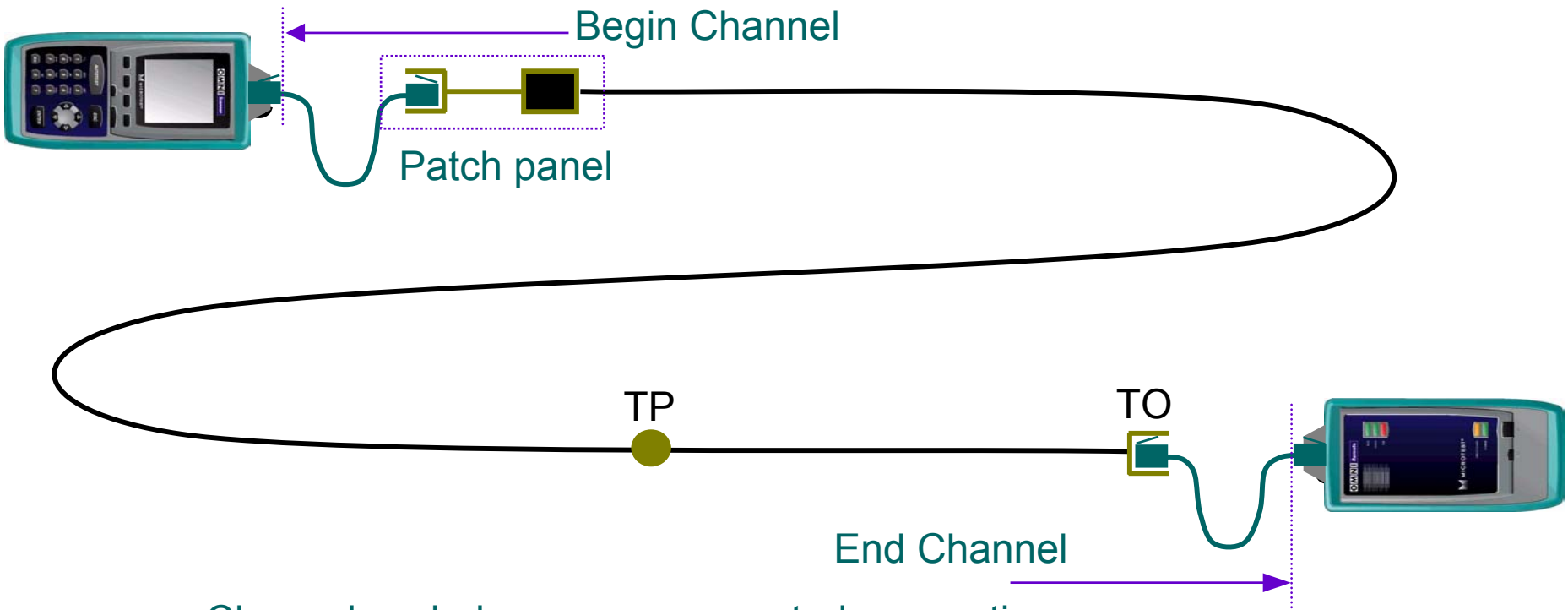
Basic link includes necessary test cables
Measurement starts at field tester interface

The Permanent Link



Permanent link excludes necessary test cables
Measurement “starts” at far end of test cord

The Channel



Channel excludes necessary mated connection
Channel includes all of user patch cord
Measurement “starts” after channel adapter

Basic Link testing misses...

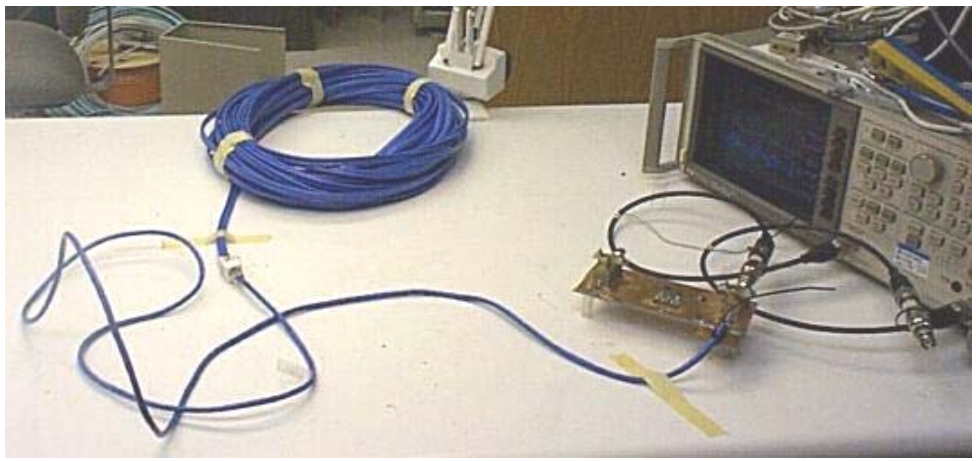
- The user patch cord!
- Why is this important?
- Basic link testing is usually more practical than channel testing
- Don’t suppliers warranty channel performance?
- Is there really a difference in cord quality?
- Aren’t patch cords all basically the same?

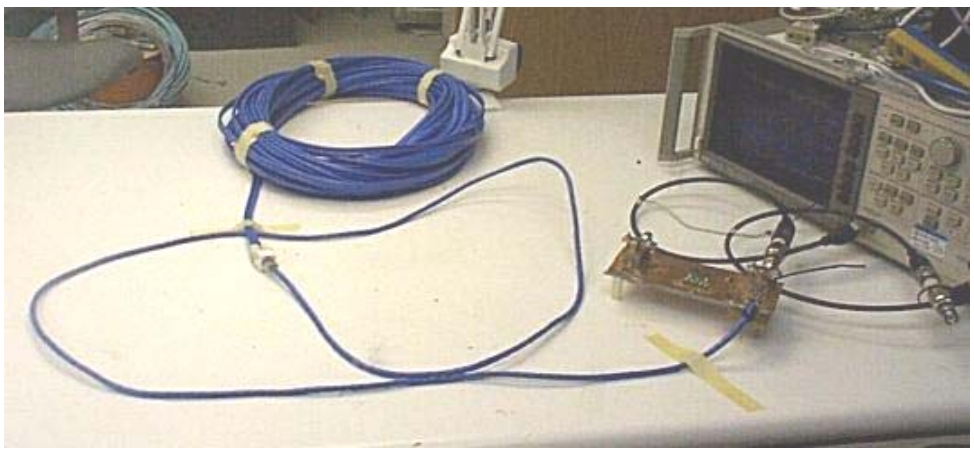
Patch cord Return Loss issues

- 1998 starting finding: Physical positioning of the cable significantly changes the return loss of many patch cords
- Patch cord material was not being tested in short segments
- The orientation of the cord position can have a major impact on link return loss performance
- Whether the cable is straight, looped, or randomly positioned can make a difference between passing and failing the test

Return Loss experiment

- Measure the same patch cord in two different positions. No kinking, sharp bends, or cable abuse - just a simple re-positioning of the patch cord





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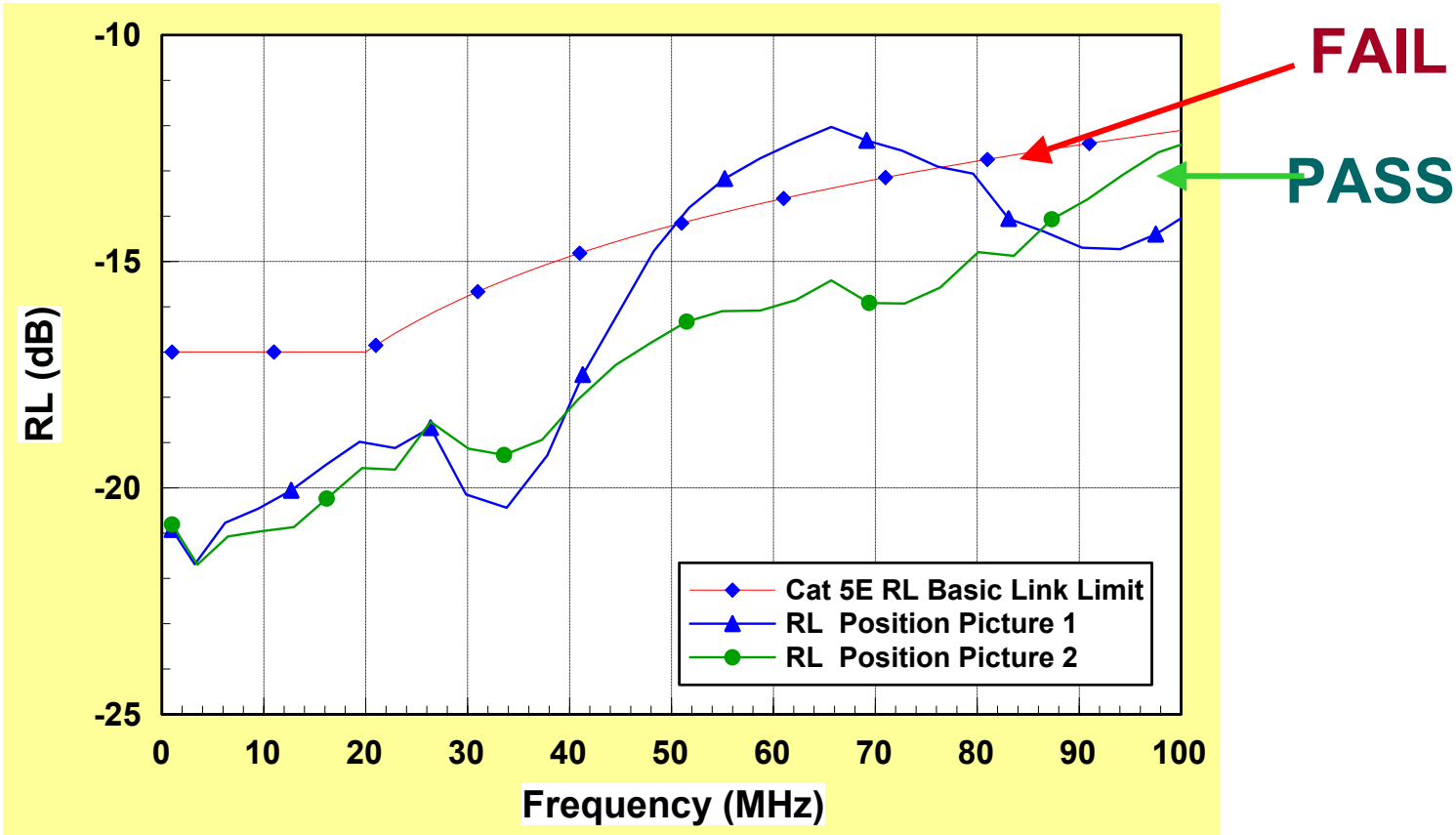
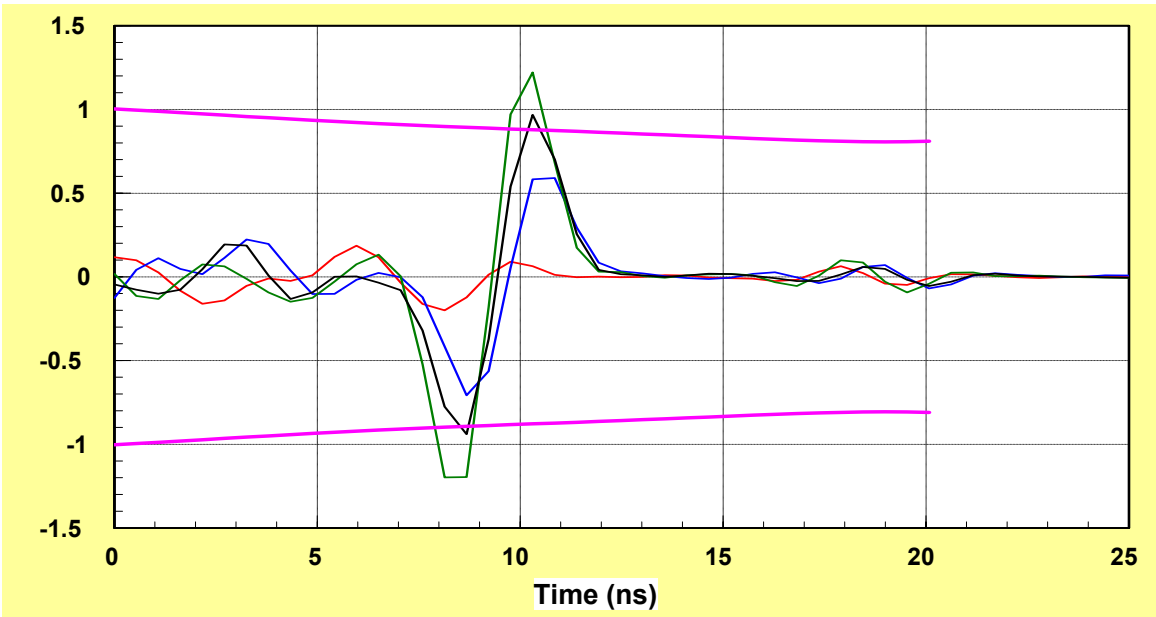
Return Loss measurement results



What about NEXT performance?

- One supplier
- Four consecutive patch cords tested into same jack
- Same pair combination tested for NEXT



S-Band Results

One great cord
One OK cord
One marginally failing cord
One really bad cord

Patch cord conclusions

- No prior return loss performance specifications existed for patch cords
- TIA 568A-A4 includes NEXT performance requirements for patch cords
- TIA 568A-A5 includes new return loss performance requirements for patch cord material
- Patch cord performance is critical: ask your supplier what tests they perform to ensure cord quality
- In the event of field failures of Cat. 5e or 6 return loss, try cord re-positioning to see if results change.

Can't category 5 handle the future?

- Category 5 was originally designed to last 15-20 years; it lasted 6
- Category 5 has been exhausted by Gigabit Ethernet (GBE)
- Many existing Cat. 5 channels will not support GBE
- Many legacy Category 5 links were never designed or tested for new, important transmission parameters (return loss, delay, skew, PSNEXT, ELFEXT, PSELFEXT)
- Category 5 is no longer good enough
- TIA 568B will eliminate Category 5 this year

Category 6 / Class E

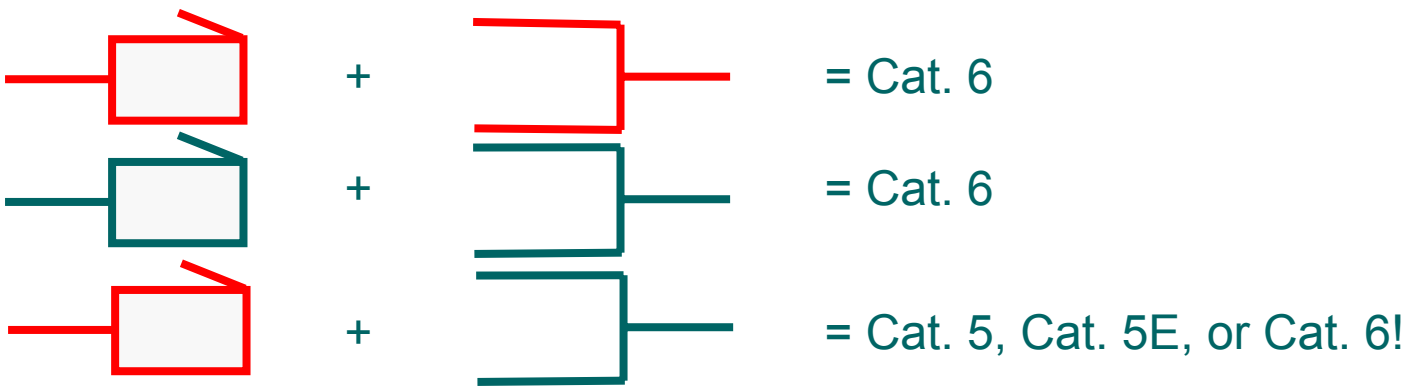
- All parameters specified to 250 MHz, with positive link PSACR at 200 MHz
- UTP
- Advanced RJ45 (mechanically/electrically compatible but higher performance)
- Designed for very uniform impedance (excellent return loss performance)
- But: Intermatability is not interoperability

Category 6 interoperability issue

Plugs and jacks from different suppliers connect but may not support Category 6 link performance

Each supplier may use a proprietary, incompatible technique for NEXT cancellation

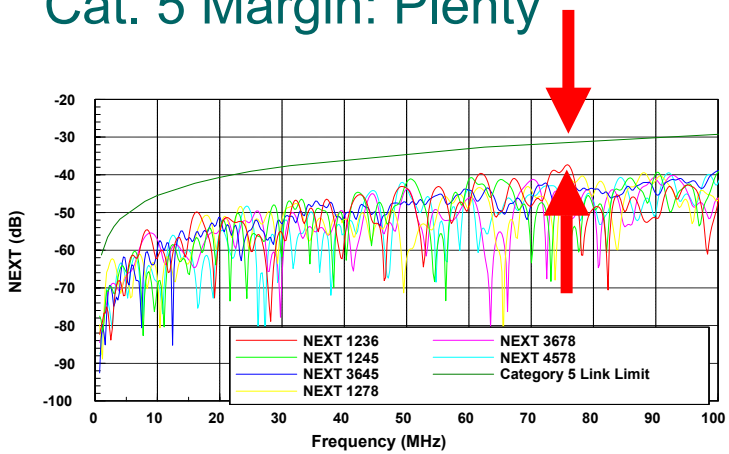
Efforts are focused on a connector performance standard, should be set by Q1 2000



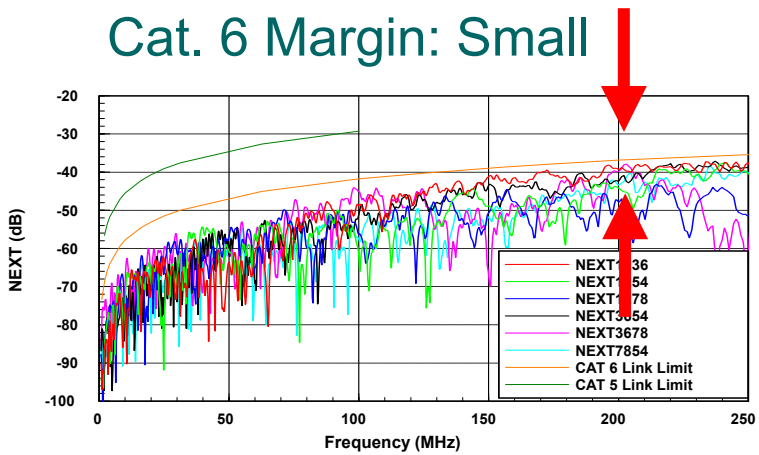
Narrower margins

- Category 6 and Category 5E have narrow margins relative to Category 5 links
- Higher number of link failures are assured
- Much more difficult to troubleshoot

Cat. 5 Margin: Plenty



Cat. 6 Margin: Small



Narrower margins can mean more link failures

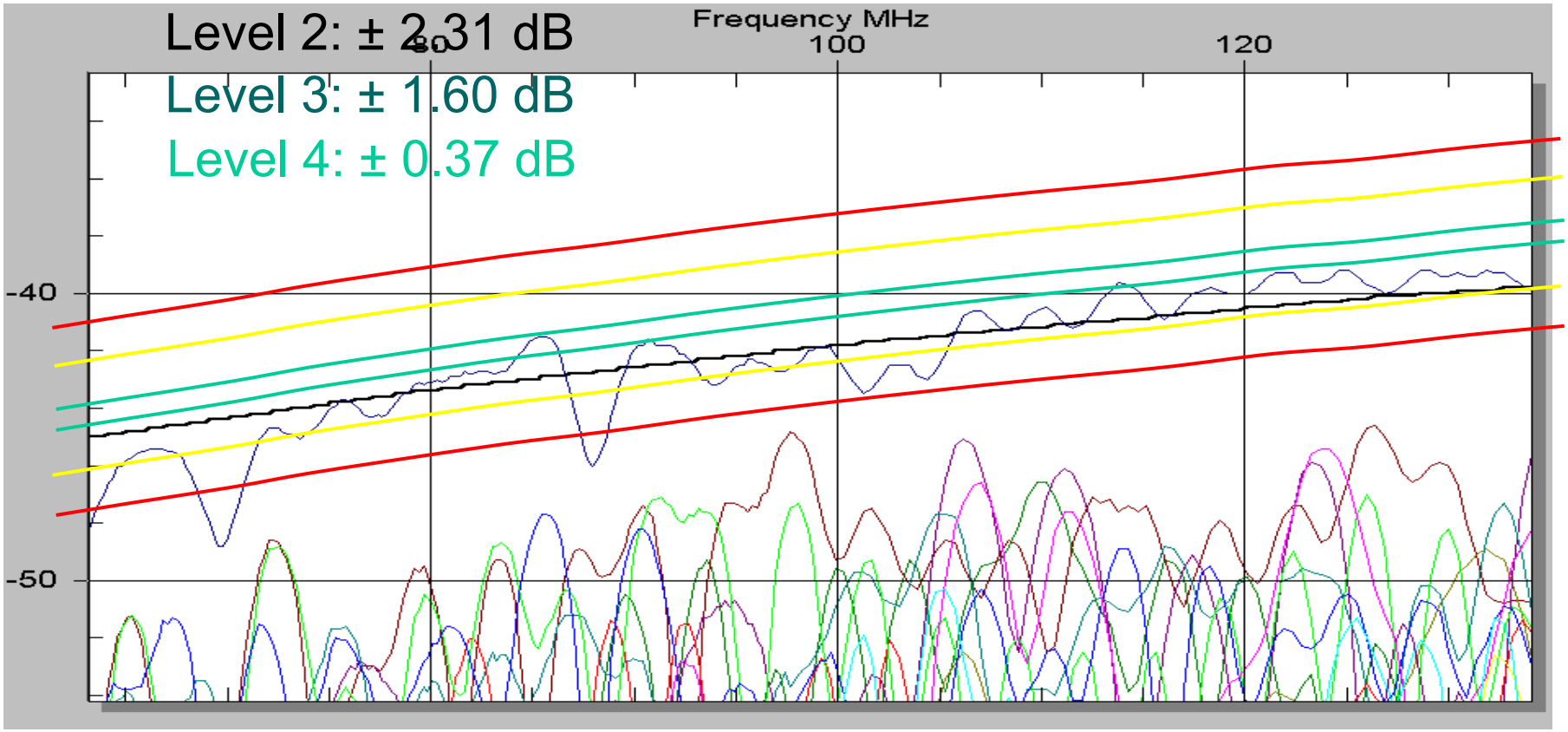
- Lower Productivity
- Need for multiple return trips on site
- Higher costs
- Customer frustration, missed deadlines, delay in payment

Consequences of narrower margins

Need very high accuracy

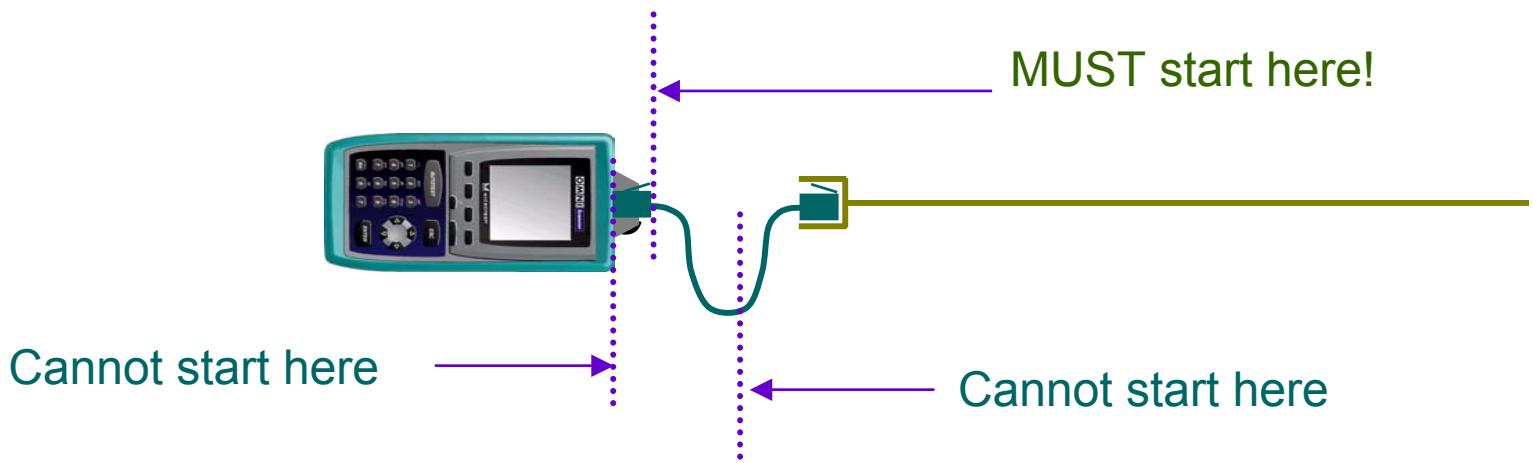
- Accuracy is largely dependent on dynamic range
- This determines how accurately you can measure a weak signal
- High frequency does not mean high accuracy
- Better accuracy translates to lower uncertainty
- Better accuracy means fewer indeterminate results
- Indeterminate results waste a great deal of time
- Channel measurements can add additional uncertainty

Higher Accuracy = less uncertainty



Channel field testing issues

- Cord can make or break channel performance
- Need to verify cord performance
- Need accurate measurements
- Must measure ONLY the channel; not the channel adapter



Field testing challenge

- Need to measure ALL of the channel
- Need to measure NONE of the channel adapter
- Need to measure THROUGH the channel adapter!
- User patch cord with unknown plug is required; no guarantee that plug and jack will be interoperable
- Channel adapter can add significant error

- Affect of the connection at 100 MHz channel limit:

Cat. 5	Cat. 5e
Adds up to 1.8 dB NEXT Adds up to 2.5 dB return loss	Adds up to 1.8 dB NEXT Adds up to 2 dB return loss

Channel testing options

1) Measure through the adapter without cancelling it

2) Use supplier-specific test cords

3) Cut off the plug and directly connect the pairs without an adapter

4) Use time gating to electronically eliminate the channel adapter

5) Use vector cancellation to electronically eliminate the channel adapter

Option #1: measure without compensating

- Assumes the adapter does not materially affect performance
- OK: if lots of margin available or
  if pass/fail limits adjusted to compensate for extra connection
- Can add significantly to uncertainty
- Done in most older Cat. 5 field testers
- Not a big issue **except** when the link is marginal
- For TSB-67, this is not generally a problem (lots of NEXT margin)
- Cat. 5e, this can be a problem on some links
- For Cat. 6, you need a Cat. 6 jack, and there's no standard yet. Plus there's no margin, so for Cat. 6 this method is not a good alternative

Option #2: use supplier-specific test cords

- If the test cord is made from approved, matching patch cord material, it matches the channel definition
- The challenge is this requires supplier-specific test cords. A unique cord must be used for every different supplier's cabling system
- Shows true channel performance but is not user's actual cord

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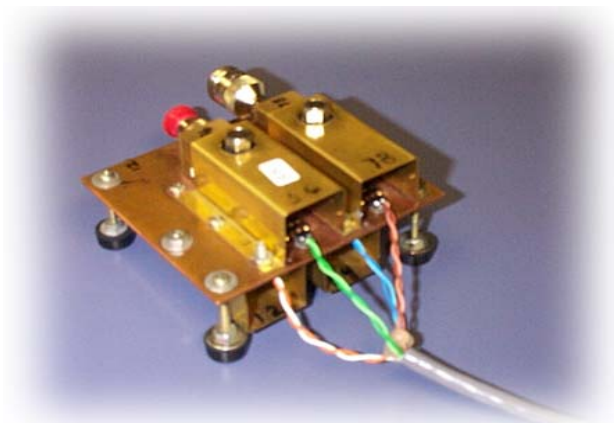
Option Nr. 3: cut off the plug!

- This is standard laboratory practice
- Advantage: you can measure the true channel performance by directly connecting the pairs to a test instrument
- Challenge: takes expert knowledge, expensive equipment, custom software to analyse results, and a great deal of time
- Minor problem: it destroys the cord you are testing!
- Obviously not a practical field solution, though can be done in special circumstances by experts



Option Nr. 4: use time gating

1) Measure the link in the time domain

2) Mathematically ignore the first part of the link, including the channel adapter and part of the patch cord

3) Convert the leftover link segment to the frequency domain

4) Compare performance against frequency domain standards

Advantages: Non-destructive to user cord, easy to do

Disadvantages: Not compliant with channel definition, inaccuracy

Time domain resolution challenge

- Objective: subtract connector without subtracting patch cable
- Connector length: 3 cm = 0.03 meters
- What frequency is needed to resolve a 3 cm length?
- For a simple approximation: $V = f \lambda$
- 3×10^8 (0.7 NVP) = f (0.03)
- frequency = 7 GHz
- Real requirement is closer to 15 GHz!
- Well beyond the range of today's test tools - field or lab

Time gating resolution

- The lower the frequency, the longer the gap subtracted
- 300 MHz bandwidth can only resolve 1 meter
- Not compliant with channel requirement to measure all of the patch cord

Method Nr. 5: adaptive vector cancellation

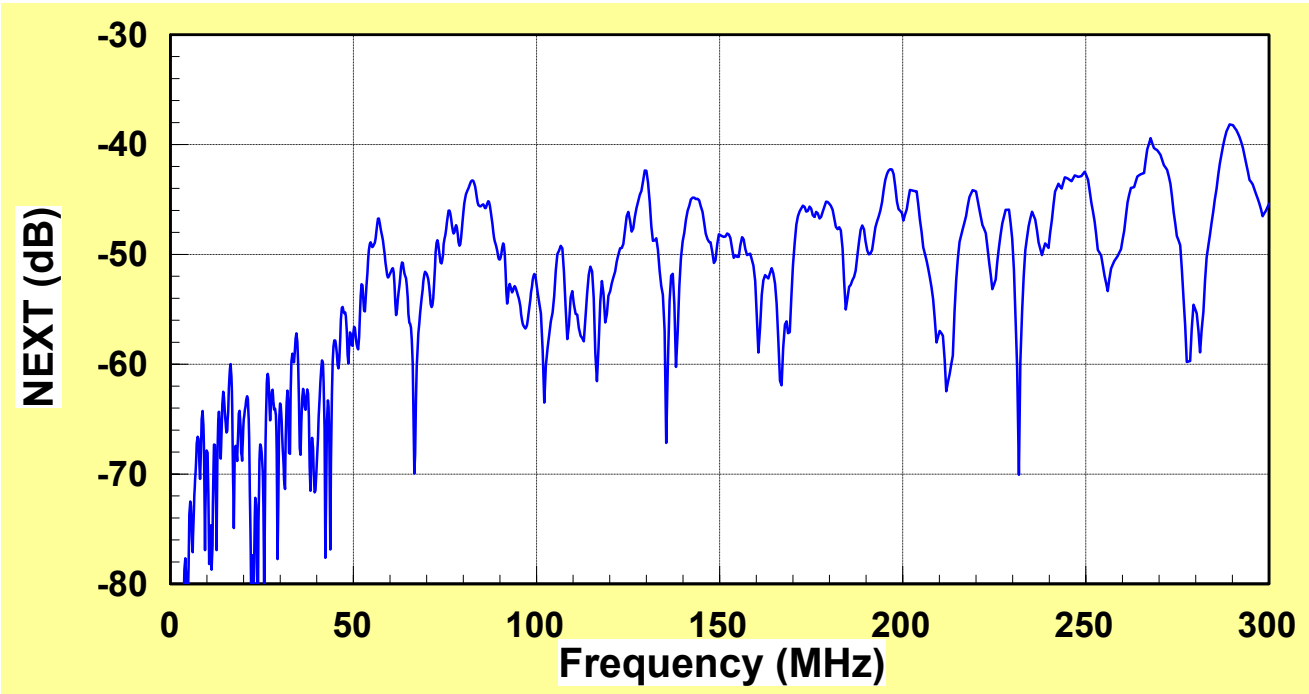
- Measure NEXT or return loss in the frequency domain
- Convert to time domain, look at NEXT/RL at time = 0
- Fit an idealized vector NEXT/RL point source at time = 0
- Convert this fitted curve back to frequency domain, and vector subtract it from the original measurement
- Result: a frequency domain response of channel including **all** of the patch cord but **none** of the channel adapter
- Method can be applied iteratively to achieve almost perfect cancellation

Advantages: Non-destructive to user cord, complies with channel definition, provides accurate result, simple for user

Disadvantage: Complex measurement technology required

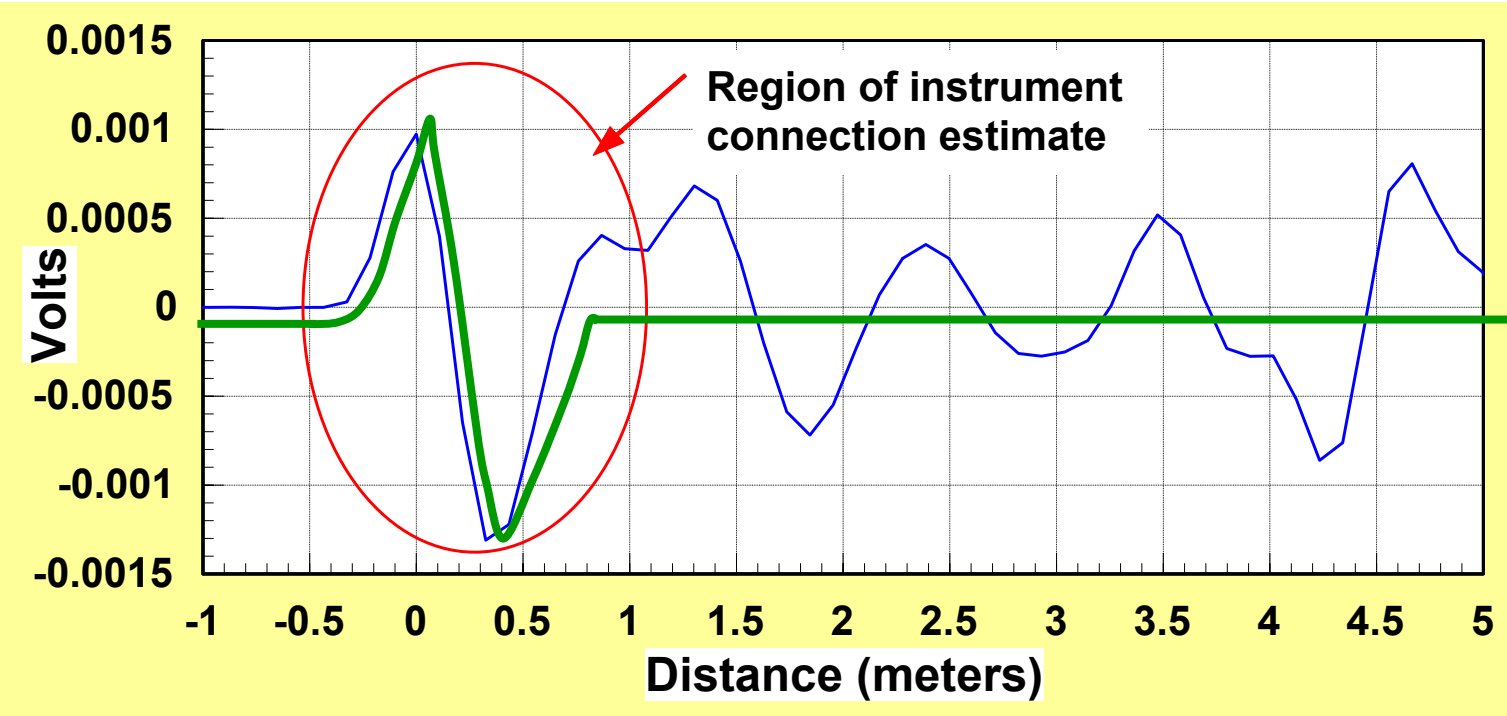
AVC Step 1: measure in frequency domain

- NEXT measured of entire link including channel adapter
- No correction applied yet

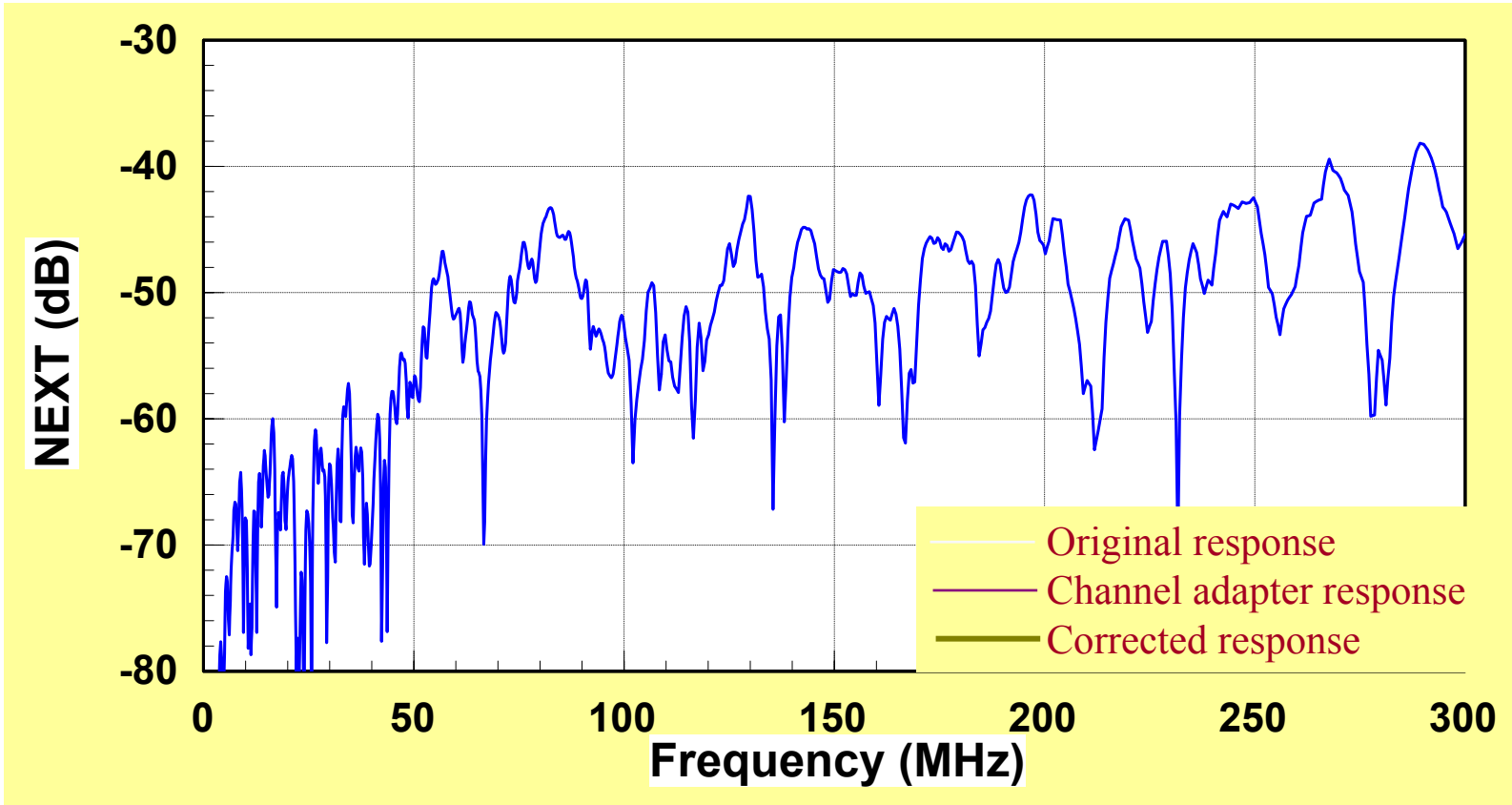


AVC Step 2: convert to time domain and estimate

Ideal Connector Response

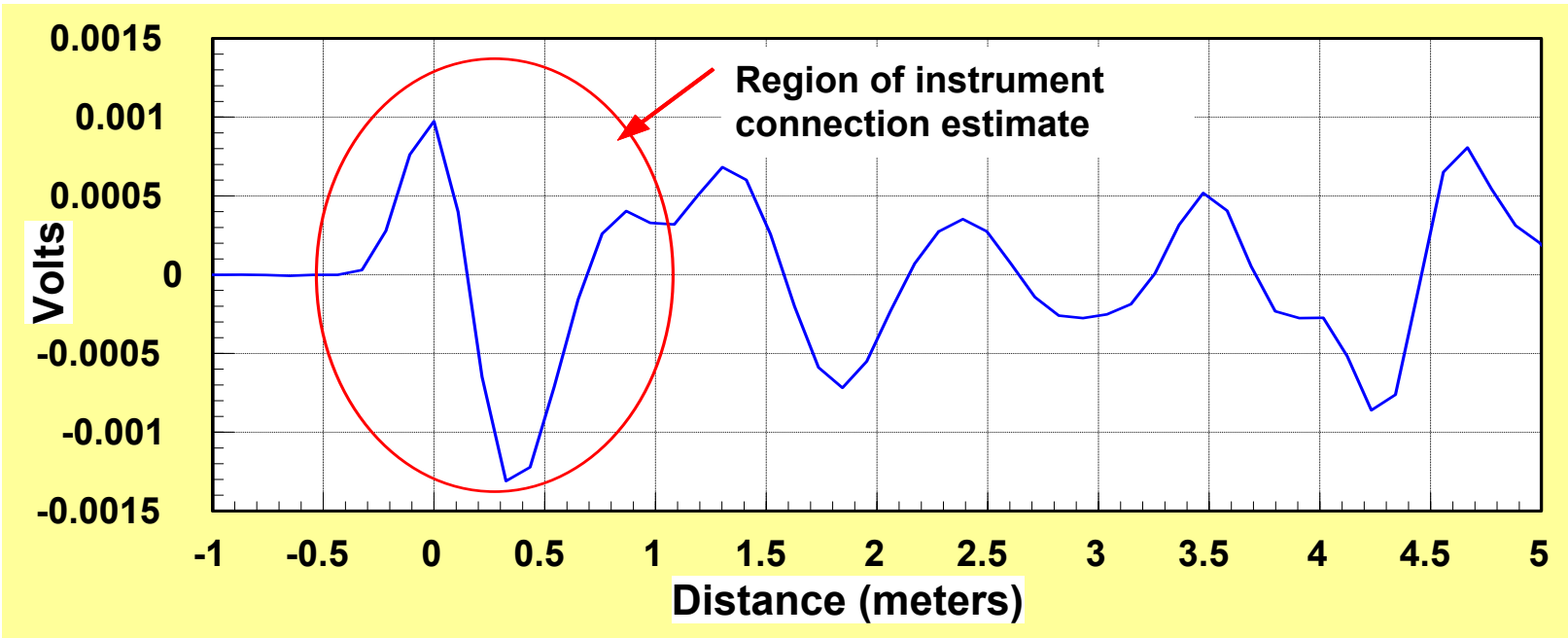


AVC Step 3: Convert channel connection back to frequency domain; vector subtract It



Final check: convert result back to time domain

- If channel connector properly subtracted, connector NEXT response should be flat at Time = 0
- Patch cord response should be unaffected



AVC advantages

- Complies with Channel definition
- One channel adapter works for any plug design
- All of patch cord and link seen and measured
- Lowers the channel connector contribution 40 dB (100X) below specified connector performance

Conclusions

- Many different channel test methods; your mileage will vary
  Understand which method you have and its pros & cons
- Patch cord performance is crucial
- Watch for Category 6 interoperability issues - connection standards should be in place soon
- Narrower margins for Category 5e and 6 increases need for higher accuracy (lower uncertainty zone)
- Good news: technology is now being developed for true channel measurements
- For current information on measurements, standards, and cabling technology visit www.cabletesting.com