White Paper

Patch Cord Measurement Results

Produced in cooperation with

COMMSCOPE®

Introduction

Occasionally, customers have noticed failing or asterisk marked patch cord field test results when measuring Category 6A patch cords using a cable certifier. In many cases, these patch cords may pass when measured with another certifier or in a laboratory environment. This may result in one unit providing a 'pass' result while another unit reports an asterisk result. In both cases, channels that contain these cords will pass a channel compliance test. This document will explain why these varying results occur and provide steps to take if presented with the condition during field testing.

Channel vs Patch Cord Measurement

A channel appears to be much like a patch cord, as both are terminated with RJ45 plugs with cable between them. However, the measurements for the two are very different, and the first step in understanding the source of variations of patch cord measurements is to compare exactly what is being tested.

A channel test configuration is shown in Figure 1. Per TIA and ISO/IEC standards, a channel is measured between the reference planes shown below which excludes the RJ45 plugs and the mated connection with the test equipment. This is done in laboratory measurements by removing the plugs at the ends of the channel and attaching bare wires from the ends of the cable directly to the test equipment. Field testers cannot use this destructive technique. They remove the effect of the final RJ45 connections from the test mathematically using calibration and signal processing techniques.

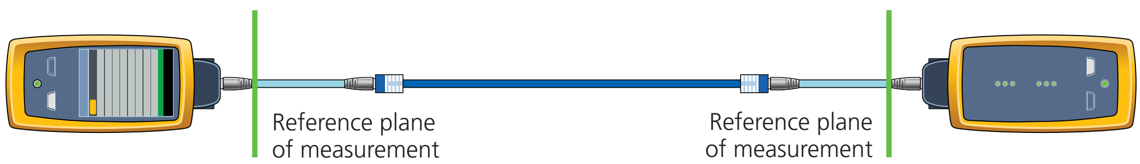

Figure 1: Channel reference planes

A patch cord test configuration is shown in Figure 2. A patch cord is measured between different reference planes (also shown below) which include not only the RJ45 plugs, but also the RJ45 sockets contained in the test adapters (sometimes referred to as a patch cord test heads).

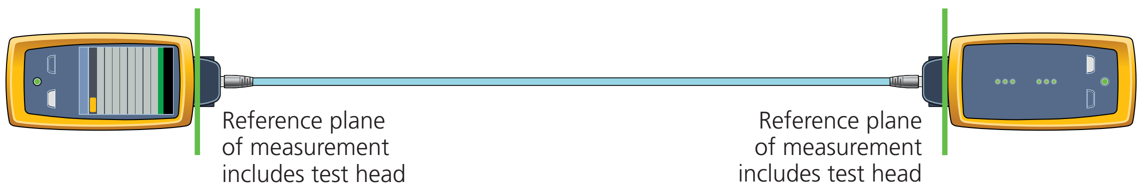

Figure 2: Patch cord reference planes

These test heads are not part of the patch cord, yet they must be included in the measurement, and they have a significant effect on the measurement. For this reason, both the TIA and IEC standards provide special requirements for these test heads. Patch cord test heads are not only required to be Category 6A component compliant, they must also be "*centered*". Centered means that their measured crosstalk level must not vary by more than 2 dB when mated with defined high limit and low limit crosstalk plugs. This technique was highly effective for controlling the measurement variation of Category 5e and Category 6 cords, but has been less effective for Category 6A where the high frequency performance is dominated by the plug/jack interoperability.

Variation of Compliant Test Heads

The patch cord test head requirements set a very tight boundary for the maximum allowable level of crosstalk, but do not provide any guidance as to the minimum allowable level of crosstalk. Now this might seem to be an odd concern, but let's look at a specific example to understand the impact. Take a specific test head that has 52.5 dB of near-end crosstalk (NEXT) at 100 MHz. This would be compliant to the connecting hardware requirement for the 36-45 pair combination, but so would a test head which has 56.5 dB of NEXT at 100 MHz. However, that 4 dB difference will show up as a difference in the patch cord measurements using those two different heads.

It is generally recognized that all measurements have a limited accuracy. The accuracy requirements for permanent link and channel measurements are well documented in the ANSI/TIA 1152-A measurement standard. However, that standard does not provide instructions on how to handle the patch cord measurement variation caused by patch cord test heads. To help reduce that variation on their products, Fluke Networks requires that their patch cord test heads meet a tighter 1 dB centering requirement versus the 2 dB allowed by the standards. This serves to reduce measurement variation even further, but there will always be some differences in measurements made with different test heads.

The use of patch cord test heads of different designs is also a major contributor to the variation seen when testing using different test instruments. It is possible that some patch cords that fail by some small margin with one instrument, may pass when tested with a different instrument, even though both instruments include compliant test heads.

Figure 3 shows the performance ranges of compliant test heads. The range of a test head with the maximum allowed 2 dB crosstalk delta is shown in red, along with the range of a typical Fluke test head, shown in green.

Test head NEXT performance is a significant cause of the variation seen in patch cord testing. Consideration of this variation should be given to patch cords that fail the limit test, as they may easily have passed the test when using a different test head. Figure 4 shows the predicted variation on patch cord test results due to test head variation (as described above). These predictions are based on modeling equations from ANSI/TIA-568-C.2 for a 1 m cord combined with the test head data measured in Figure 3.

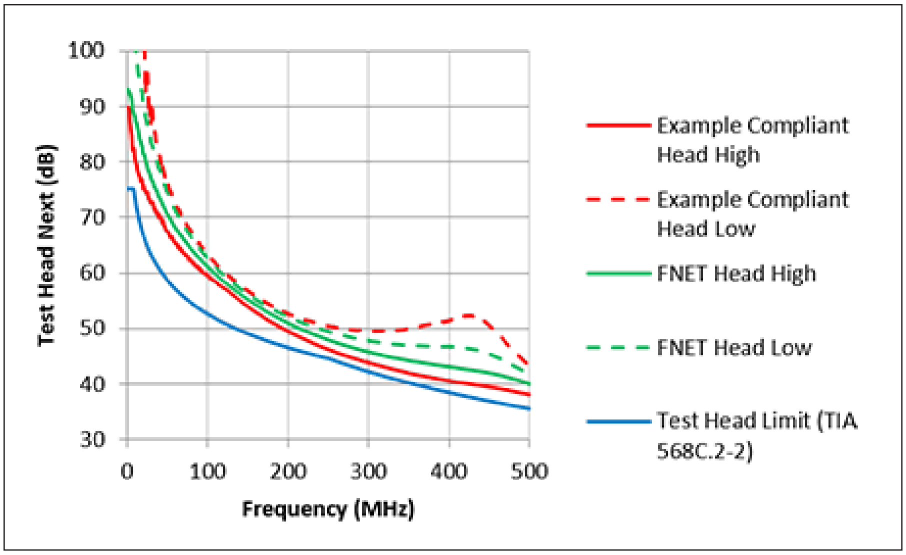

Figure 3: Variation compliant test heads

Variability

A common scenario which highlights variability is when one cord is measured on any two test instruments. In this scenario a comparison is often performed using different heads on the different testers. In this case, variation may arise due to the test instrument itself, as well as the test head. An evaluation can be made of the base unit itself, by using the same test head and measuring patch cords with different instruments. The standards specify the variation requirements of the field tester base units, but not the test heads themselves.

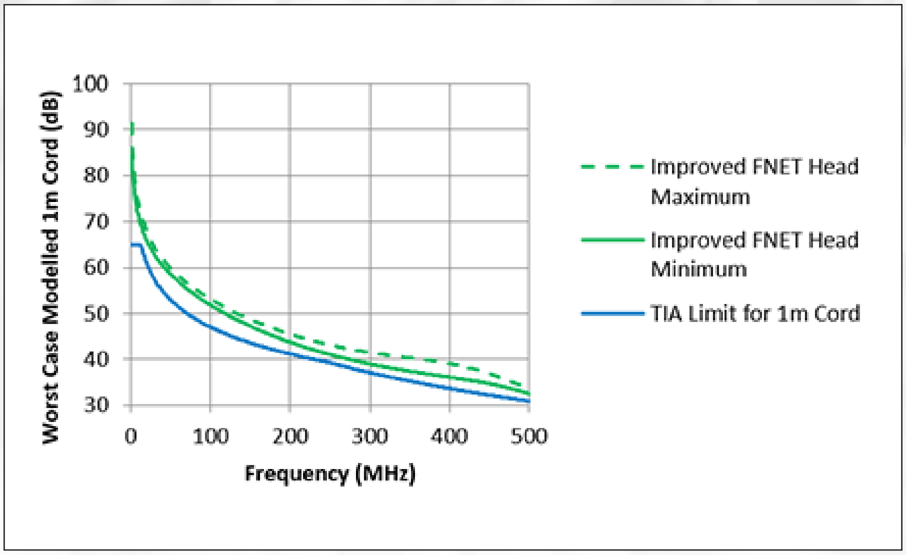

Figure 4: Study of variation seen on 1 m cord results

Head Variation on Cord Results

In order to account for variations between test heads, Fluke Networks has characterized its supply of test heads and found a variation between results taken with those test heads to always be less than that shown in Figure 5.

Cords with test results whose crosstalk margins are within this range may pass if tested with a different test head. As this margin is larger than the baseline accuracy of the tester, it may be considered unreasonable to “fail” cords with results in this region.

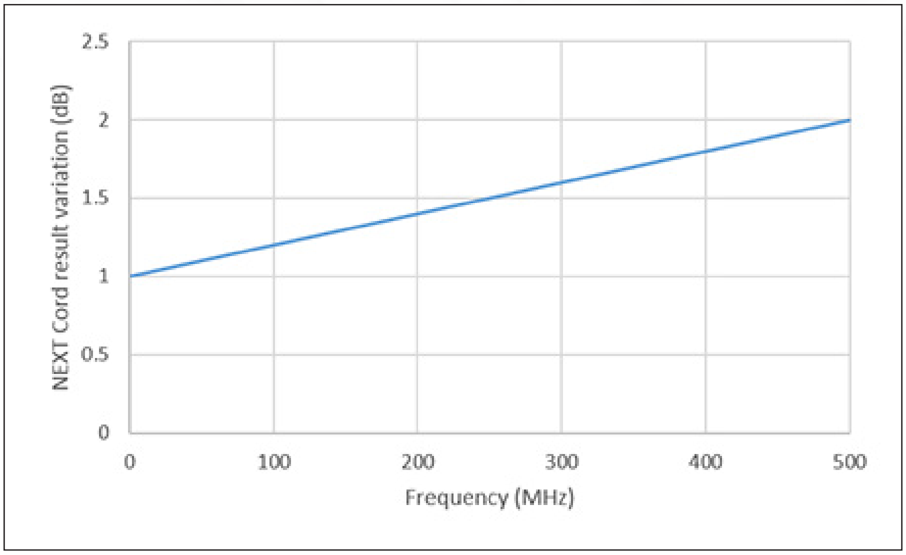

Figure 5: Maximum cord result variation

Effect on Channel Results

What is the effect on channel results of patch cords with test results within this range? It turns out to be negligible. Figure 7 shows the results of seven channels tested by CommScope®, using a Fluke Networks DSX-5000 CableAnalyzer™. These were four-connector channels with segment lengths of 2 m, 1 m, 15 m, 5 m, and 1 m (as shown in Figure 6).

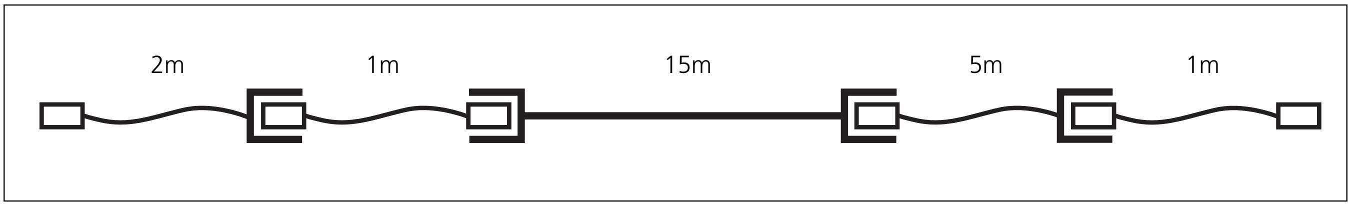

Figure 6: This is one of the reference modeling implementation in ANSI/TIA-568.C-2 Annex J

The fourteen, one meter patch cords used in these seven channels were also measured by CommScope. Figure 8 shows the results.

Figures 7 and 8 show the lowest margin at any frequency point. Note that all the patch cords failed by realtively small margins while all the channels using these same patch cords pass with more than 4 dB of margin, and all the patch cords, tested with these heads, have margins less than -0.5 dB. This same experiment was done with horizontal cable lengths of 5 m and 85 m, with the same result. As can be seen, channels made with these patch cords will comfortably pass the channel requirements, and presumably support applications based on the channel requirements, in spite of the patch cord outcomes when tested with these particular patch cord heads. Please note that these patch cords are very likely to pass when tested with a different set of heads, as explained above.

Figure 9 shows the lowest margin frequency response, of any pair combination, of any of the fourteen patch cords.

Figure 10 shows the lowest margin frequency response, of any pair combination, of any of the seven channels, measured by CommScope.

In conclusion, these measurements provide assurance that patch cords with results in this range can be used with confidence to produce passing channels that will support applications and systems.

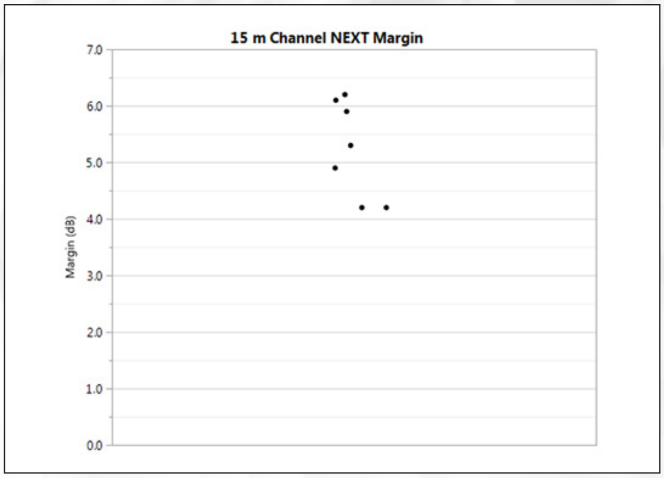

Figure 7: Channel results measured by CommScope

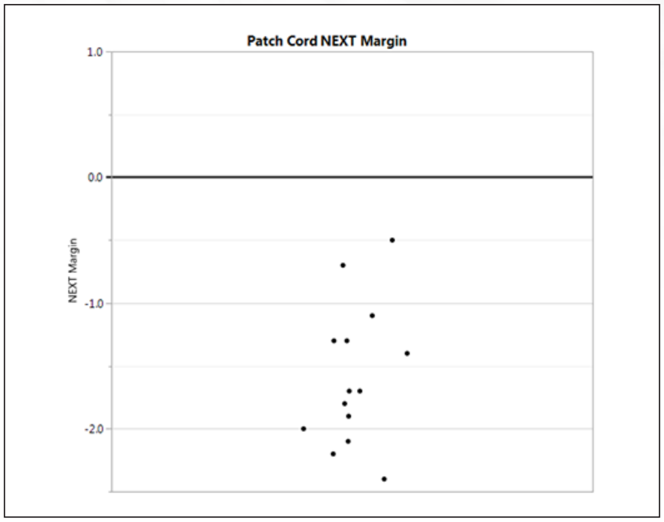

Figure 8: Patch cords from channels in figure 6 measured by CommScope

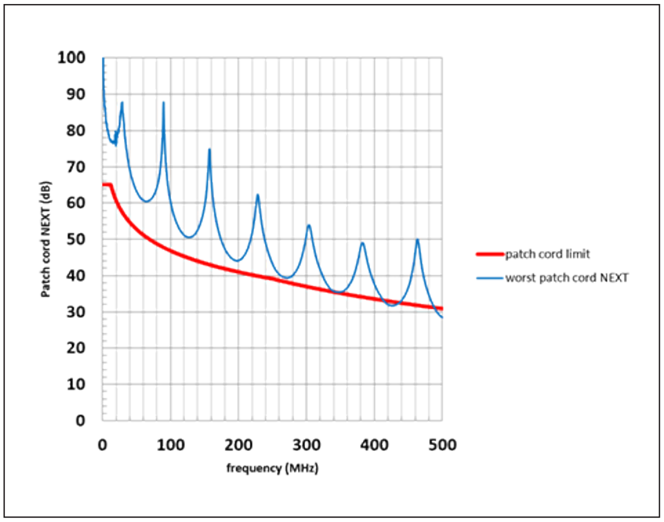

Figure 9: Worst case patch cord NEXT frequency response measured by CommScope

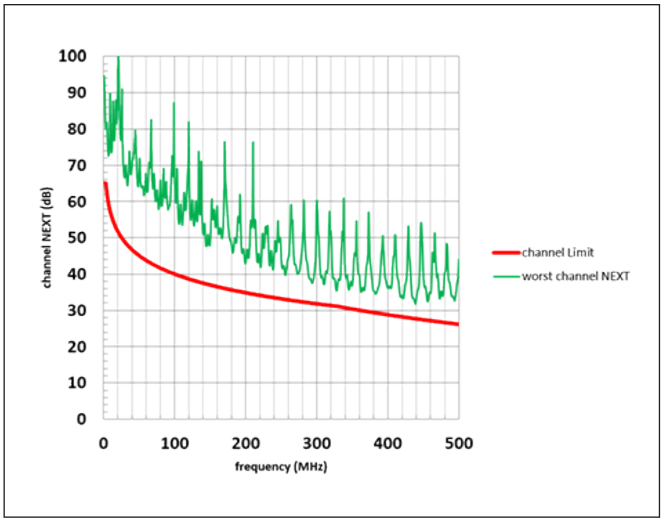

Figure 10: Worst case channel NEXT frequency response measured by CommScope

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