BESTE VERBINDUNGEN FÜR IHREN ERFOLG

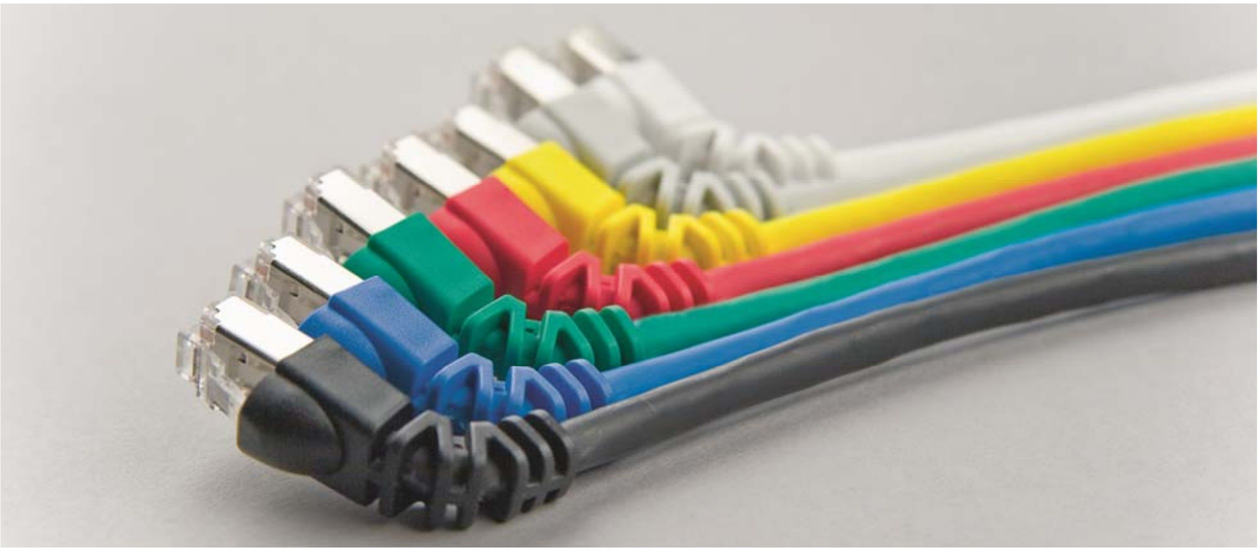
Telegärtner
KARL GÄRTNER GMBH

NETZWERK-KOMPONENTEN
KOAXIALE STECKVERBINDER
KABEL-KONFEKTIONIERUNG
PRÄZISIONS-DREHTEILE
KUNSTSTOFF-SPRITZGUSSTEILE
INDUSTRIE-ELEKTRONIK

Telegärtner Point of View

Category 6_A Patch Cords

10 Gigabit per second is the highest data rate that can be transmitted over copper cables in structured cabling over a distance of 100 metres. At this speed, it takes about half a second to transmit the content of an entire CD ROM. High performance switches and servers in blade centres will be the first ones using this leading technology.
It's no surprise that high quality cables and connecting hardware are needed for this high speed network. But it really surprises that in such highly sophisticated cabling very often cheap patch cords are used which degrade the performance of the whole channel. Patch cords are responsible for more problems in the network than one would guess, and it often is difficult and takes a lot of time to find out that the problems are caused by a simple patch cord.



Cabling infrastructures for 10 or 100 megabits per second are rather robust, but high performance networks like Gigabit Ethernet and 10 Gigabit Ethernet won't tolerate low quality. Component performance classifications defined by the standards are not sufficient, especially not for patch cords. Far too often it's printed in the data sheets or the products themselves that the cords were standards compliant. However, one has to bear in mind that standards allow for tolerances. A link consisting of cheap components, which just meet the standard's requirements, will not reach its full performance when the components are not matched and when they do not have sufficient headroom. Precise, reliable testing to verify these components are a must, but testing individual components, especially patch cords, is not easy at all.

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De-embedded and re-embedded testing

Connections are the most critical parts of any IT channel, and the higher the data rate and the frequency, the more complicated it gets. With the old 100 Mbps Ethernet for example, it was sufficient to roughly set the crosstalk limits of the two twisted pairs. Specifications for the connectors were defined, and the jack had to compensate them. With Gigabit Ethernet, this was not sufficient anymore. Specifications for near end and far end crosstalk (NEXT/FEXT) and return loss (RL) for all four pairs of the combination of plug and jack had to be introduced. In order to test accordingly, the de-embedded testing methode for category 5e and category 6 components was developed between 1998 and 2001. Now, reliable testing was possible in the frequency range from 1 to 250 MHz and for data rates up to 1 Gbps. Beeing backwards compatible with the existing category 5 was a very important point to cover a large spectrum of existing connectors. As the connectors did not differ too much, a spec range was defined, represented by a set of twelve test plugs.

That sounds easy, but it makes testing extensive and complex. With de-embedded testing, a reference plug is tested using a simplified testing method similar to the old category 5, accepting a relatively large test error. The plug is connected to the test equipment with twisted pairs, using a special, in most cases pyramidal test adapter. Then plug and jack are connected to this adapter. The test results of the plug tested before are then subtracted from the results of the plug and the jack (de-embedded). What's left are the results for the jack alone, and this jack becomes the reference jack. With this reference jack, the set of twelve test plugs is „created standards compliantly": The future test plugs are tested against the reference jack, the results of the jacks are subtracted from the combination of jack and plug (de-embedded) and the results are then compared to the specifications in the standard. Only after the set of the twelve test plugs is complete after this extensive procedure, the actual testing can begin: testing a jack against all of the twelve test plugs. Only when all of the test results with all of the test plugs are within the specifications defined by the standard, the device under test (the new jack) is standard compliant. And it's only such a tested jack that may be used to evaluate other components like patch cords.

Image: De-embedded pyramid

De-embedded testing can be used for category 6_A components according to EN 50173 (and the global standard ISO/IEC 11801) with a frequency range from 1 to 500 MHz and data rates up to 10 Gbps, but it leads to a very big effort when precise and reliable test results are required.

Because of this, the re-embedded test method was developed, which can be used for frequencies even beyond 500 MHz. As opposed to the de-embedded method, re-embedded testing is very straight-forward: First, a reference plug is tested in a special adapter called "direct probe fixture". Magnitude and phase of the plug are tested directly with minimum tolerance.

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To give an example: When the NEXT results of the reference plug are known, the combination of the reference plug and the jack to be tested can be tested directly. This is a major simplification, which led to the name of this new testing method: As the results of the reference plug are known with minimum tolerance, they can be subtracted from the combination of plug and jack like before (de-embedding). Then, the results of abstract test plugs specified in the standard can just be added (re-embedding). Thus one gets the results for all the border cases with just one test and the subsequent calculations (in reality, it's a bit more complicated, of course). The new test procedure is much easier and much more straight forward because the new test adapter was developed without a pyramidal fixture and without additional cabling. It leads to more precise testing of the reference plug and of the combination of plug and jack. The specs for the test plugs (re-embedded testing uses fourteen instead of twelve test plugs) are more precise as well.

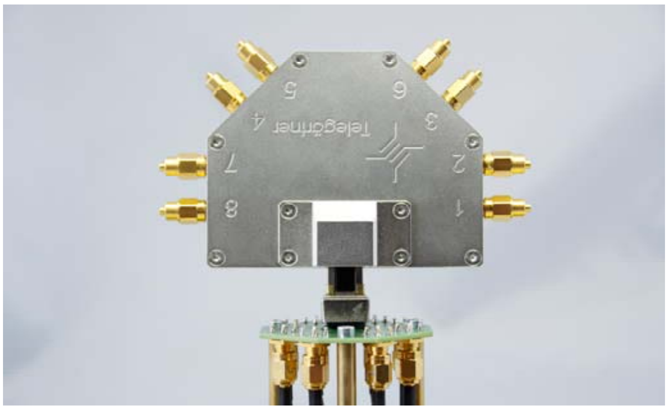

Image: Qualifying of test jack with Salsa Plug (MFP8)

A possible reference plug is the commercially available Salsa plug. This printed circuit board based plug can be connected directly to the re-embedded test adapter without the need for additional wiring. However, IEC 60512-27-100 and ISO/IEC 11801 do not dictate the use of this very connector. Telegärtner's precise, printed circuit board based cat. 6_A connector MFP8 has the same electrical characteristics and can therefore be used as a reference plug as well. This offers an economical solution at the same high quality.

Standard-compliant test configuration and minimum requirements

The international standard ISO/IEC 11801 Ed. 2.0 Adm 2 was already published in April 2010 and specifies cat. 6 A components, but it wasn't until July 2010 that the corresponding standard for testing – ISO/IEC 61935-2 Ed. 3 – was extended from 250 MHz (Category 6) to 500 MHz (Category 6A). Physics made reliable, precise testing of Cat.6_A patch cords very difficult.

The standard defines specifications, test configuration and test adapters for cat.6_A patch cords. It demands a network analyzer as the high-precision test device, and it specifies the test adapter and the test terminator. This test configuration is a so called two port configuration, i.e. a configuration with one port in and one port out.

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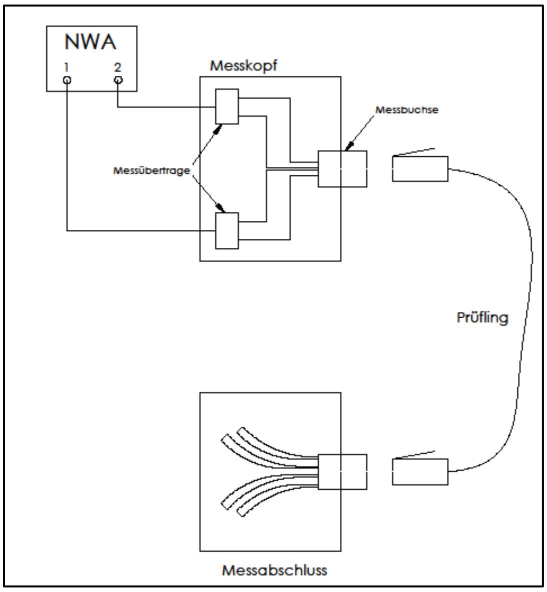

With a two port configuration, NEXT can only be tested between two pairs. To test all four pairs simultaneously (!), an eight port network analyzer like the one in the Telegärtner lab (see picture) has to be used,, transforming a simple two port configuration into an advanced eight port one.

Illustration: Standard-compliant test configuration

With or without baluns?

Being very precise test devices used for frequencies up to several GHz, network analyzers have to have coaxial connectors. The patch cord under test and the RJ45 jacks of the test adapter and the test terminator, into which the cord is plugged in, use twisted pairs. To connect the different cable types correctly, baluns are used in the standard test configuration. They connect twisted pair cables (balanced cable) with coaxial cables (unbalanced cable) and adapt them mechanically and electrically, as the two cable types do have different electrical parameters. But like all electrical components, baluns are frequency dependent and so have an influence on the test results.

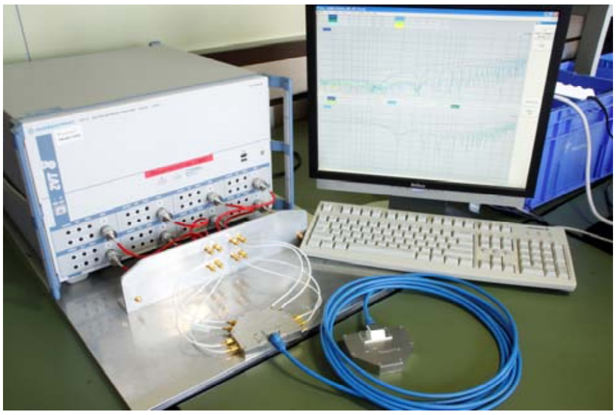

Illustration: TG test configuration with an 8 port network analyzer

With a self-designed test adapter that exceeds the specifications of ISO/IEC 61935-2 Ed. 3, Telegärtner was the first company worldwide who could test cat. 6_A patch cords reliably and repeatably. The test engineers could benefit from decades of experience in both, high frequency technology and coaxial components. Using multiport network analyzers, the Telegärtner lab has been able to abandon baluns for 15 years, which is allowed by the standards.

The cat.6_A jack used in the Telegärtner test adapter is fully compensated and has more than enough headroom over the specifications of IEC 61935-2. As jacks like all parts in a connection are wearing parts, they can be replaced very easily.

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Real-Time Re-Embedding

The test procedures of the Telegärtner lab go far beyond the standards and use the eight port network analyzer even for qualifying the jacks. This is the only way to test the interaction of all four pairs of a jack at the same time. The re-embedding calculations are done directly and in real time. With this Real-Time Re-Embedding Telegärtner has set the new international test standard.

3D field simulation for optimal solutions

The better the transitions between components and wiring are, the lower loss and transmission problems at higher frequencies occur. With test adapters, this means that the better the transitions, the more precise the test results are. Because of this, the electromagnetic fields and waves on all the transitions were evaluated and calculated using the finite elements method. The results and knowledge gained went into the design of the test adapters in an early design phase, leading to adapters that are more precise than the standards demand. Telegärtner developed the adapters and spare jacks with leading test labs along with the standard. They are manufactured in a small series and are commercially available to other companies as test references.

Image: Adapter and qualifiying jacks with Salsa Plug / MFP8

Trend-setting innovations through synergy

These outstanding results have only been possible, because research, development, design and manufacturing have been linked together very closely. The concentration of all these divisions at one location in Germany is the driver for the synergy effects necessary for trend-setting innovations. These synergy effects have already led to such innovative product details like the patented, integrated protection against overbending the contacts of the RJ45 jack. Eight position RJ45 plugs and six position RJ11 or RJ12 plugs can be plugged into the same jack by turns without damaging the outer contacts of the jack. The consistent high quality level is documented by the PVP certification of the highly regarded, independent test lab GHMT.

Image: Test adapter and device under test

Only high quality components, tested and certified, warrant the reliability that high performance IT infrastructures need.
This is true especially for patch cords.

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