The author

Mike Gilmore, Senior Partner of The Cabling Partnership, is involved at the highest level in UK and European cabling standardisation. Mike is Chairman of the BSI Premises Cabling Experts Panels (TCT7/-/1 and TCT7/-/3) and Convenor of CENELEC TC215 Working Group 1 (its European partner). The two groups control the development of UK and European standards for the design and installation of telecommunications cabling. Mike also acts as the Technical Director of the UK Fibreoptic Industry Association. He can be contacted at mike.gilmore@btinternet.com.

The Cabling Partnership

The IT cabling infrastructure division of e-Ready Building Limited

The IT cabling consultants

e-Ready Building Limited
Next generation IT infrastructures

IS 11801 and EN 50173-1: The Proof of the Pudding

Introduction

Proving that an installer has met the requirements of the existing editions of ISO/IEC 11801, EN 50173 and the ANSI/TIA/EIA-568 standards has become an increasingly complex affair over the last five years. As discussed in the previous two articles in this series published by Network Cabling News, the requirements of the three standards do differ. However, most installers perceive, wrongly, that conformance to these standards is achieved by the attainment of a "pass" indication on the field tester. The more detailed requirements of "conformance to the standard" are regularly ignored, largely because neither the client, or consultant, producing the installation specification or the installer claiming conformance has ever actually read the standards. This is a serious issue since, if subsequent litigation was initiated, a court of law would look in detail at the true conformance requirements and would adjudicate against the unwitting party on the basis of those requirements and not simply on a set of test results.

The second edition of ISO/IEC 11801 and EN 50173-1 (the second edition of EN 50173) will, by the time this article pops into your in-tray, be available to the general public as final draft standards. This is an important stage in the development of any standard since the designation as a "final draft" indicates that no further technical changes are possible prior to final publication. As such FDIS 11801 Ed.2 and EN 50173-1 can be quoted in installation specifications and called up in contract documentation.

It is therefore appropriate to review what conformance to these standards actually means. This article summarises the requirements of the new standards as they relate to balanced (copper) cabling and explains the measures that designers and installers alike will have to implement to ensure water-tight compliance. The final article, in next months NCN, covers the same topic for those involved in optical fibre cabling.

What does "conformance" really mean?

What does it actually mean when a tender specifies that cabling "shall be in accordance with IS11801 (or EN 50173)"? The exact meaning is given in the Conformance clauses of the relevant standards (clause 4 in IS11801 and clause 1.2 in EN 50173-1). Table 1 shows the relevant information from each standard.

The requirements may look complex and full of cross-references but when "push come to shove" as it normally does in a court of law these two hundred words in each standards are more important than the remaining 100-plus pages. The CLC document has a slightly more concise statement of conformance. There are two main reasons for this - firstly, the structure of the CLC document is somewhat simpler and secondly the recommendations for screening, system administration, safety and EMC are referenced out to the EN 50174 series of standards. In all other respects the conformance requirements of the two standards are the same.

For balanced cabling, there are, in effect, eight separate elements demanding conformance within FDIS 11801 Ed.2 and six in EN 50173-1. Two elements, common to both standards and marked d) and e) in Table 1, relate to the selection of connecting hardware at the Telecommunications Outlet and at other locations throughout the cabling infrastructure. In FDIS 11801, three other elements relate to screening, system administration and applicable regulations.

This leaves the one element that most people falsely perceive to be the only real requirement - performance - and the last two elements covering the structure and configuration of the cabling together with the treatment of measured results.

FDIS 11801 Ed.2 (2002)	EN 50173-1 (2002)
a) The configuration and structure shall conform to the requirements outlined in clause 5	- the structure and configuration shall conform to the requirements of Clause 4;
b) The performance of balanced channels shall meet the requirements specified in clause 6. This shall be achieved by one of the following: 1 a channel design and implementation ensuring that the prescribed channel is met; 2 attachment of appropriate components to a permanent link or CP link design meeting the prescribed performance class of clause 6 and Annex A. Channel performance shall be assured where a channel is created by adding more than one cord to either end of a link meeting the requirements of clause 6 and Annex A. 3 using the reference implementations of clause 7 and compatible cabling components conforming to the requirements of clauses 9, 10 and 13, based upon a statistical approach of performance modelling.	- the performance of channels shall conform to the requirements of Clause 5; This shall be achieved by one of the following: - a channel design and implementation ensuring that the prescribed channel is met; - attachment of appropriate components to a permanent link or CP link design meeting the prescribed performance class of Annex A. Channel performance shall be assured where a channel is created by adding more than one cord to either end of a link meeting the requirements of Annex A. - using the reference implementations of clause 6 and compatible cabling components conforming to the requirements of clauses 7, 8 and 9, based upon a statistical approach of performance modelling.
c) The implementation and performance of optical fibre cabling channels shall meet the requirements specified in clause 8.	
d) The interfaces to the cabling at the TO shall conform to the requirements of clause 10 with respect to mating interfaces and performance.	- the interfaces to the cabling at the telecommunications outlet shall conform to the requirements of Clause 8 with respect to mating interfaces and performance;
e) Connecting hardware at other places in the cabling structure shall meet the performance requirements specified in clause 10.	- connecting hardware at other places in the cabling structure shall meet the performance requirements specified in Clause 8;
f) If present, screens shall be handled as specified in clause 11.	
g) System administration shall meet the requirements of clause 12.	
h) Regulations on safety and EMC applicable at the location of the installation shall be met. In the absence of the channel the conformance of the link shall be used to verify conformance with the standard.	- local regulations concerning safety shall be met.
The treatment of measured results that fail to meet the requirements of this clause, or lie within the relevant measurement accuracy, shall be clearly documented within a quality plan as described in ISO/IEC TR 14763-2.	The treatment of measured results that fail to meet the requirements of this clause, or lie within the relevant measurement accuracy, shall be clearly documented within a quality plan as described in EN 50174-1.

Table 1: Conformance to FDIS 11801 Ed.2 and EN 50173-1

Proving performance

If an installer is requested to prove conformance of his/her cabling to the international or European standard then the more “picky” customers would expect to see a statement of conformance against all eight/six of the elements of conformance listed above.

Conformance to performance requirements demand that the cabling channels (see Figure 1) meet a specified Class. The standards provide three possible routes as in indicated in item b) of Table 1. The route one is termed “by design” and allows a system supplier to simply state that their cabling channels are conformant with the transmission performance Class specified by the client. The second and third are just different ways of obtaining the desired channel performance by the attachment of appropriate components to links that meet the meeting the transmission performance Class specified by the client.

In practice, the second or third routes the one normally adopted by installers and, in general, the client will want to see the proof of link performance in the form of test results. It should also be remembered that all the new standards adopt the “permanent link” test reference points and even the US standards have dropped the “basic link” configuration. So testing to basic link limits immediately voids the resulting measurements.

What most designers and installers fail to realize is that simple “PASS” results are not necessarily enough to prove conformance with the requirements of the standards. The reasons for this are two-fold. Firstly, as mentioned in previous articles, a “PASS” result obtained for a link does not guarantee that the channel will be conformant if more than one cord is added to either end of the link in order to create the channel.

Secondly, the requirements of the performance clause and the means of proving compliance have been reviewed and revised during the development of the 2nd editions of the standards.

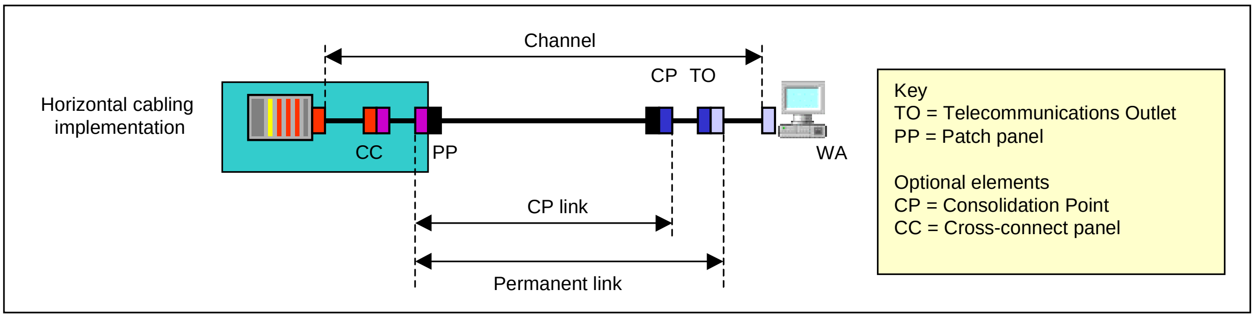


Figure 1: Channels, permanent links and CP links

Which parameters are included in the testing regime?

Table 2 shows the list of parameters that define channel performance in the international, European and US standards. They are broken down into three groups. The top group contains "BY DESIGN" parameters are not required to be measured during the commissioning phase and a design statement has to be made regarding their conformance. The other two groups contain parameters that are required to be measured if testing is to be undertaken to prove conformance. The middle group contains "CONFIGURATION-DEPENDENT" parameters for which the limits defined by formulae that do not take any account of link length. The lower group contains "LENGTH-DEPENDENT" parameters for which the limits defined by formulae that depend upon length and the number of connections.

As discussed in my first article in this series, the US standards do not yet include requirements for d.c. power feeding or ACR/PSACR. For the remainder of the parameters, the US standards define fixed limits independent of length or configuration. In comparison the requirements of the international and European standards are more rigorous, particularly with regard to length-dependent parameters. The international and European standards have always included the requirement that link performance shall not only meet the maximum or minimum limits as appropriate but also that it shall be consistent with the design of the link under test. Put simply, the attenuation of a short link should be consistent with its length and not simply pass the limit (based upon a 90 metre length). In the first editions of IS 11801 and EN 50173 the requirement for measured values to be design consistent for was applied to all parameters. However, the requirement was neither understood or implemented by the manufacturers of field test equipment who continued to use fixed limits.

Balanced	ISO/IEC 11801	EN 50173-1	ANSI/TIA/EIA 568-B series
"BY DESIGN" PARAMETERS			
Loop resistance unbalance	Not tested		Not included
Voltage capacity			
Power capacity			
CONFIGURATION-DEPENDENT PARAMETERS			
Return loss	Fixed limit		Fixed limit
NEXT			
PSNEXT			
ELFEXT			
PSELFEXT			
LENGTH-DEPENDENT PARAMETERS			
Attenuation	Consistent with design with a maximum limit		Fixed limit
Delay			
Delay skew			
Loop resistance			Not included
ACR	Consistent with design with a minimum limit		
PSACR			

Table 2: Balanced cabling link performance parameters

The Cabling Partnership
P. O. Box MT 65, LEEDS, West Yorkshire, LS17 8YD, England
Telephone: +44 (0) 113 232 3721 Fax: +44 (0) 113 293 2632

Immovable objects and irresistible forces

During the development phase of the 2nd editions of the standards, the international and European groups spent countless hours debating the value of the design consistency requirement and decided that it should remain. In parallel with this debate, the field test equipment manufacturers invested equal resources in trying to convince the cabling groups that they could not accurately measure length and therefore other parameters should not be judged on a per unit length basis.

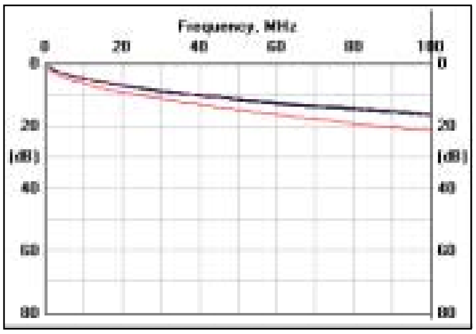
The outcome has been a triumph of common sense. A twin track approach has been developed. The first track is the inclusion of detailed formulae for the length-dependent parameters that accurately define the requirements for a link. The second is an alternative method of proving conformance that focuses on the channel components to be added to the link under test rather than the link itself - shifting the responsibility from the installer to the designer

A competent designer will specify, on a site-wide basis, the maximum lengths of CP cables, equipment and patch cords that are able to be connected to the installed CP or permanent links. This sort of information forms part of the User Guide for the installation and would essentially define a type of channel guarantee for the client. If this design statement exists then conformance for length-dependent parameters simply requires that there be enough margin between the measured result and the channel limit to support the addition of the maximum length channel components.

If, on the other hand, no channel design work has been undertaken then the installation will have to conform to the length-dependent formulae - a task that is not for the faint-hearted.

Once again the new standards are forcing a more channel-oriented approach into the link environment.

ATTENUATION/INSERTION LOSS



The highest measured attenuation/insertion loss occurs at the highest measurement frequency.

The test equipment will have to report the margin between the measured value and the channel limit at:
- 100 MHz for Class D compliance;
- 250 MHz for Class E compliance.

The installer has to check that the margin is acceptable.

	Class D	Class E
Connection	0,2 dB	0,32 dB
Solid cable	0,21 dB/m	0,33 dB/m
Stranded cable		
Unscreened cable	0,25 dB/m	0,40 dB/m
Screened cable	0,32 dB/m	0,50 dB/m

DELAY SKEW

Delay skew is constant with frequency

The installer has to check that the margin is acceptable.

	Class D	Class E
Connection	1,25 ns	
Cable	0,45 ns/m	

Figure 2: Proving channel margin is adequate

How does it work in practice?

The good news is that we only have to prove that adequate channel margin exists for attenuation and delay skew - if so, the other requirements for length-dependent parameters are met.   The good news gets better when we consider that attenuation and delay skew are well-behaved parameters. The highest attenuation values occur at the highest frequency and the requirements for delay skew are frequency independent. Thankfully, we do not have to consider thousands of values and compare them with thousands of others. We have a very simply calculation to do.

The Cabling Partnership
P. O. Box MT 65, LEEDS, West Yorkshire, LS17 8YD, England
Telephone: +44 (0) 113 232 3721   Fax: +44 (0) 113 293 2632

The Cabling Partnership is a division of e-Ready Building Limited
Company Registration No. 4432595 Registered Office - Emery House, 192 Heaton Moor Road, Stockport, Cheshire, SK4 4DU.

All that needs to be known is:

i. how many connections are to be added to the link under test - is the client going to add a crossconnect panel to the permanent link or are we only testing a CP link and therefore there will be an additional TO and possibly a crossconnect panel as well.
ii. what is to the total length of cordage that we are going to allow to be added to he link under test.

Figure 2 contains all the relevant information to allow the calculation of the required channel margin for Class D and E cabling. All the test equipment has to do is report the measured value and provide the margin between that and the channel. Provided that the channel margins for all the links exceed the calculated value from Figure 2 for both attenuation and delay skew then the links are conformant against the requirements of the length-dependent parameters.

Conclusion

There is more to meeting the requirements of the new international and European cabling design standards than getting a "PASS" on your test equipment. A significant responsibility is laid at the door of the designer. The designer may be the client, a consultant or may work for the installer. In any case, installers should be wary of accepting any compliance requests unless they are in control of, or have fully checked, the design of the cabling infrastructure.

Even when it comes to performance testing there is more to do than before and if your test equipment does not report margin against channel requirements it will be necessary to do some of the comparisons by hand (or with the help of a spreadsheet).

Finally be aware that some configurations of cabling may produce "FAIL" or "MARGINAL" results for return loss and/or NEXT parameters even if compliant components are used. Note the conformance requirement that "the treatment of measured results that fail to meet the requirements of this clause, or lie within the relevant measurement accuracy, shall be clearly documented within a quality plan". This text is included to protect installers and clients alike.