



The Fibreoptic Industry Association

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# NEWSLETTER

## Testing installed optical fibre cabling

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## TESTING MULTIMODE OPTICAL FIBRE CABLING

### Background

During 2003, the FIA Technical Directorate identified some disturbing issues relating to the attenuation measurement of multimode optical fibre cabling. International standardisation bodies took up the case and a number of important standards developments have resulted which have serious impact on the market for test equipment, the definition of test cords and the methods of testing.

### What were the problems?

Attenuation measurement of multimode optical fibre cabling with different light sources - either light-source/power-meter (LSPM) or OTDR equipment - was found to produce significant variations in results. This plus a failure to use test cord mandrel wraps (or the wrong mandrels) produced result swings in excess of 1,0 dB. Different test cords were found to produce further variations.

LSPM testing provided a further opportunity to undermine the validity of a result if the person doing the testing used the wrong referencing procedure (there were three to choose from in the US, international and European standards that were current in 2003). As a result, the chance of obtaining a valid result was quite small. This may not have mattered if only one test was ever carried out but, unfortunately, a "pass" under one test regime could be a "fail" under another - undermining customer-confidence and leading to requests for re-testing (for which no one wants to pay) - disastrous in the low-profit margin environment that FIA members inhabit.

### Something had to be done!

In 2002, the FIA Technical Support Document TSD-2000-4-2-1, summarised the then-current test methods and provided alternative "referencing" methods of testing for the latest generation power meters that had fixed detector interfaces rather than the older types with interchangeable adaptors. In 2003, the FIA TSD-2000-4-2-1 was submitted to the ISO/IEC structured cabling committee as an input to the revision of their "testing cookbook" ISO/IEC TR 14763-3 - a Technical Report which primarily referred to the test methods of other IEC standards. It was realised those IEC standards were in danger of being undermined and it was decided to revise ISO/IEC 14763-3 as a "full standard". The ISO/IEC experts felt that the FIA document introduced too many complexities and that a dramatic simplification of test methods was required. At the same time the impact of the light source variations mentioned above began to be understood - but it was soon recognised that fixing this problem would require substantial standardisation work.

The first outcome of this work was ISO/IEC 14763-3:2006 but this standard was considered by many, including the FIA, as a stepping stone which, although addressing many of the problems, really acted as a catalyst for other standards committees to undertake further work on its behalf. The culmination of this work has been the publication of IEC 61280-4-1:2009 which has modified some of the content of ISO/IEC 14763-3. In September 2009, Amendment 1 of ISO/IEC 14763-3 was approved which aligns ISO/IEC 14763-3 with specific testing solutions in IEC 61280-4-1:2009. This leads to a situation in which two separate standards exist to cover the same topic - this Newsletter explains their content and how they should be used.

**This Newsletter/White Paper begins by explaining the demands of IEC 61280-4-1:2009 and identifies where the requirements of ISO/IEC 14763-3 and its Amendment 1 make selections from it. These standards have significant impacts and Newsletter describes these impacts from three perspectives: installers, suppliers of test equipment and suppliers of test cords.**

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**The standards and how to purchase them**

IEC 61280-4-1:2009 was automatically ratified as EN 61280-4-1 and published in the UK as BS EN 61280-4-1 and can be purchased via [www.fia-online.co.uk](http://www.fia-online.co.uk). ISO/IEC 14763-3:2006 in combination with its Amendment 1:2009, which duplicates some of the content of BS EN 61280-4-1:2009 is available at [www.iec.ch](http://www.iec.ch).

**FIA recommendations and actions**

The FIA:

- recommends that FIA members follow the requirements of BS EN 61280-4-1:2009 whilst noting that ISO/IEC 14763-3 inc A1 specifies a sub-set of methods of BS EN 61280-4-1 when cabling is being tested against the performance limits of the generic cabling standards such as ISO/IEC 11801, ISO/IEC 24702 and ISO/IEC 24764 and many of the BS EN 50173 series of standards;
- is now amending and dramatically simplifying both TSD-2000-4-2-1 and its sister OTDR publication TSD-2000-4-2-2 in relation to multimode optical fibre cabling.

**THE IMPORTANCE OF LAUNCH CONDITIONS**

The principle reason for variation between results obtained using different light sources lies in the distribution of power among the modes within the optical fibre within the launch test cord at the point were it connects into the cabling under test.

While it was well documented that LASER and VCSEL sources tended to produce lower attenuation results than LEDS, most people failed to recognise that that, although many LED-based light sources provided well filled modal distributions, some equipment generated predominantly high order modes, producing higher results, whereas others mimicked low order modal distributions seen in VCSELS.

The use of mandrels was an attempt to control how much of the available power was concentrated in which mode groups. Both ISO/IEC 14763-3:2006 and BS EN 61280-4-1:2009 have moved away from dowels and curly bits of plastic and taken a technical view of the requirement.

Because there had been no standard to define launch conditions, a great deal of work went into the development of an agreed metric - following which a further substantial debate took place with regard to the actual modal power distribution. ISO/IEC 14763-3:2006 adopted a metric called "modal power distribution" but this has been superseded in BS EN 61280-4-1:2009 by "encircled flux" (EF) - also now applied in ISO/IEC 14763-3 Amendment 1. The required EF profile differs with core diameter and wavelength.

BS EN 61280-4-1:2009 only defines the EF boundaries for 50/125um and 62,5/125 optical fibre types (at 850 nm and 1300nm).

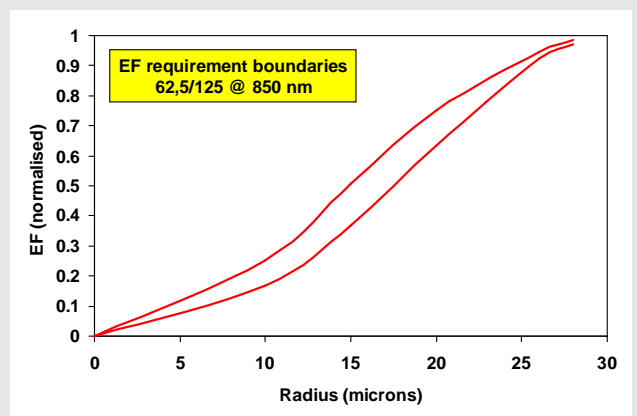
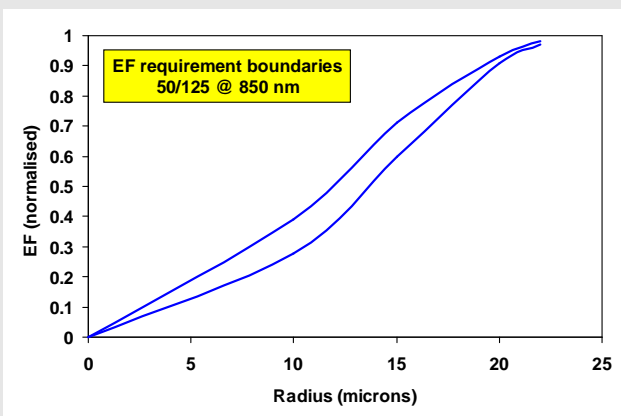
**How to obtain the correct launch conditions?**

Now that the standards have defined the correct launch conditions, how do installers know that they have achieved them? The good news is that two approaches exist.

The first is to purchase LSPM or OTDR equipment that is known to deliver the correct EF profiles, possibly using existing or modified mandrels and tightly-specified test cords. A small number of test equipment suppliers have confirmed the EF performance of their light sources. The FIA is developing a list of equipment that is claimed to be conformant together with the associated test cord hardware necessary to maintain compliance (go to [www.fia-online.co.uk/etest-equipment.htm](http://www.fia-online.co.uk/etest-equipment.htm)).

However, not all installers will want to purchase new test equipment – even when more manufacturers catch up and start taking the matter of EF seriously – so the second approach of a "mode controller cord" which may be used with a wide range of test equipment may be an attractive alternative.

Indeed, it was the work by the FIA in supporting the development of such cords that identified the original launch condition problems. The FIA sponsored the development of such cords and are now able to provide FIA members with discounted commercial terms for these cords (for a limited time only). More information is to be found at [www.fia-online.co.uk/etest-mcc.htm](http://www.fia-online.co.uk/etest-mcc.htm).



**How to obtain test cords conformant to BS EN 61280-4-1 and ISO/IEC 14763-3?**

The FIA has been working on procurement specifications and routes to allow FIA members to obtain test cords featuring the “reference grade terminations” recommended by BS EN 61280-4-1 and mandated by ISO/IEC 14763-3.

Once this process is complete a new FIA publication, TSD-200-4-2-3, will be issued to cover all the important aspects for test cords including operation, administration and performance assessment. A listing of FIA members capable of supplying test cords will be made available at [www.fia-online.co.uk/etest-cords.htm](http://www.fia-online.co.uk/etest-cords.htm).

**THE IMPORTANCE OF TEST CORDS**

The launch test cord is clearly very important for the test system because it acts as the generator of the correct EF profile at the point of connection to the cabling under test.

However, in order to further reduce measurement error BS EN 61280-4-1:2009 recommends, and ISO/IEC requires, all launch and tail test cords to feature reference grade terminations at the points where they connect to the cabling under test. Where the test method requires the use of a dummy, or substitution cord, it shall also feature reference grade terminations.

Before the recent standardisation work, the best that could be said about any multimode cabling attenuation measurements was that “they were good guidance - indicative of installed performance”. This was particularly true of short links, where the attenuation of long lengths of cable had little influence. In order to make use of the measured value, any subsequent measurement would have to use the same test equipment and test cords (in the same configuration as the original test). However, even then the result would be indicative since the launch conditions were not standardised. There was, in effect, no “right” result.

The situation now is considerably improved and installers who fail to implement the correct approaches risk contractual disputes if problems are found to exist.

**However, one aspect that has not changed for LSPM testing is the need for the correct referencing procedure before testing. NO EXCUSE EXISTS FOR SUCH MALPRACTICE.**

**HOW IMPORTANT ARE THE REQUIREMENTS OF BS EN 61280-4-1 AND ISO/IEC 14763-3 inc A1?**

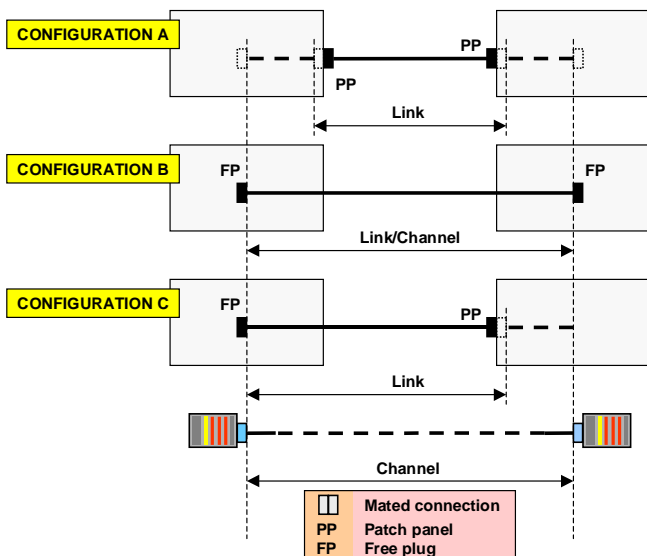
**THE REFERENCE PROCEDURES IN LSPM TESTING**

The three possible configurations of installed cabling are shown on the left. Since BS 7718: 1995 they have been known as Configurations A, B and C and this terminology is retained in BS EN 61280-4-1.

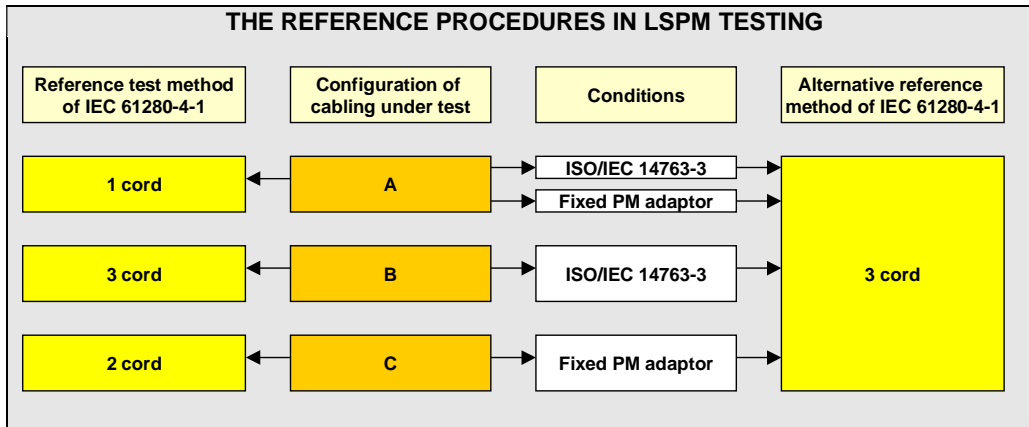
Configuration A is panel-to-panel, the most common arrangement for premises cabling. Configuration B is plug-to-plug and Configuration C is panel-to-plug (a comparatively rare configuration).

The reference procedure to be applied before testing depends upon the cabling Configuration. If the cabling is of Configuration B, then three cords are used to reference the test system. This is true for both BS EN 61280-4-1 and ISO/IEC 14763-3.

To simplify matters ISO/IEC 14763-3 also chose to apply three cord referencing for Configuration A (ISO/IEC 14763-3 does not recognise Configuration C at all). This allows all types of power meters to be used - even those with fixed detector interfaces - and supports all connector types. However, this simplification does come at the cost of measurement accuracy. For this reason, the FIA recommends the use of BS EN 61280-4-1 reference procedures, wherever possible.



The reference test methods of BS EN 61280-4-1 invoke a one cord reference procedure for Configuration A and a two cord reference procedure for Configuration C. BS EN 61280-4-1 recognises the alternative, three cord, reference procedure of ISO/IEC 14763 for Configuration A and also recognises that if the power meter has a fixed detector interfaces then a three cord approach may be necessary for Configurations A and C. This is clearly the most complex aspect of testing and is outlined in the flow-chart overleaf.



Failure to observe the correct referencing procedures prior to testing renders any results null and void - because the subsequent tests will include the wrong number of connections (too few or too many).

**NOTE:** The common practice of using a two cord reference procedure for cabling of Configuration A produces lower results i.e. it “under-measures” the attenuation of the cabling. If this is done without reducing the acceptance limits it misrepresents installed performance.

**In the case of LSPM testing, the three aspects of launch conditions, test cords and referencing methods are equally important and deviation in any one area undermines confidence in the complete testing process.**

**OTDR testing in accordance with BS EN 61280-4-1 and ISO/IEC 14763-3**

The topic of OTDR testing of installed multimode optical fibre cabling is also covered in detail in both standards. The aspects of launch conditions and the criteria for test cords described above for LSPM testing also apply to OTDR testing. Indeed, by meeting the encircled flux boundaries at the point of connection to the cabling under test, the overall attenuation measurement of a link using an OTDR can be directly compared to that obtained by LSPM test equipment.

Both standards provide graphical illustrations of what measurements can be taken from an OTDR characterisation and how to make them. The FIA has made significant amendments to its Technical Support Document TSD-2000-4-2-2 in order to directly refer to both BS EN 61280-4-1 (for multimode cabling) and ISO/IEC 14763-3 in general.

**TESTING SINGLEMODE OPTICAL FIBRE CABLING**

ISO/IEC 14763-3 covers the testing of installed singlemode optical fibre cabling using both LSPM and OTDR equipment. A long-standing standard IEC 61280-4-2: 1999 contains similar but less detailed information. Fortunately, in the case of singlemode transmission, the distribution of power among the modes is irrelevant but the issue of reference grade terminations and the need to apply the correct referencing procedure before testing still apply.

IEC 61280-4-2 is now being revised as has been done for IEC 61280-4-1 and this process should be completed in 2012. In the interim, ISO/IEC 14763-3 and its Amendment 1 provide a source of requirements and recommendations. The vacuum created by the delay to the revised version of IEC 61280-4-2 will be filled by the amendment of the FIA TSD-2000-4-2-1 and TSD-2000-4-2-2 documents in relation to singlemode technology.

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