WHITE PAPER

THE COLOURFUL WORLD OF LC DUPLEX CONNECTORS

A broad spectrum of standardised interfaces is available for fibre optic connections in LANs and data centres. This White Paper introduces the various types of LC duplex connectors which are currently in most frequent use, describes the common colours for connectors, adapters and cables, and recommends the connector types best suited to different applications.

Until a few years ago the SC duplex connector (SCD) was the only fibre optic (FO) interface in the workplace described in EN 50173-1. Since then, however, data processing technology has seen a huge drive to miniaturise every component, and this continues to be the case today. In particular the ever-increasing packing density of active devices regularly requires smaller, more compact cabling components.

With the introduction of so-called SFF (Small Form Factor) connectors it became possible to reduce the size of fibre optic duplex connectors to RJ45 dimensions. The most widely known representative of these SFF connectors is the LC duplex (LCD) conforming to IEC 61754-20. In EN 51073-5 the LCD interface is mentioned for data centre cabling and has been widely adopted.

The MU interface conforming to IEC 61754-6 is less well known. Sometimes this connector is also called Mini SC. This interface has the advantage that it is a "true" push-pull connector which can be unlatched without a lock-lever simply by pulling it out.

LCD and mini-LCD

In order to further increase the number of FO ports on certain active devices, especially Brocade switches, fibre channel transceivers were created to allow closer ferrule spacing. The modified LCD connectors needed for this are often referred to as mini-LC duplex or mLCD.

Both versions – LCD and mLCD – are based on simplex connectors conforming to Standard IEC 61754-20:2012. In the IEC standard-compliant "normal" LCD the spacing between two connectors is 6.25 mm. The mini-LCD connector with its reduced ferrule spacing of 5.25 mm is described in the Informative Appendix (NA) of German DIN EN 61754-20:2013-07 only.

If there is no special marking, the difference of as much as one millimetre is detectable only by directly comparing both connectors. But this is important. The IEC standard-compliant LCD connector does not, for example, fit the Brocade 8 Gbit/s SWL mini optical transceiver.

Image 1 (from left): LCD, mini-LCD, push-pull LCD (see page 2) and LCD Uniboot.

The manufacturers of the mini-LCD connector mark the difference from the "normal" LCD by a coloured duplex clip. And this is a good thing, for if an IEC standard-compliant LCD is plugged into a mini optical transceiver, not only is the patch cable ruined as a rule, but the expensive transceiver might possibly be destroyed at the same time. Hybrid patch cables are necessary in this case ("normal" LCD on mLCD). If these are not at hand, the duplex clip on one end must be removed to be able to plug two simplex connectors.

LCD Uniboot

Another important development which reduced cable volume in front of the patch panels was the use of twin-fibre round cables, but the LC duplex connector at this type of patch cable requires a different cable inlet and crimping. It is generally referred to as a LCD Uniboot connector.

Datwyler also offers the option of LCD patch cables with a Uniboot connector. Before use, however it is vital to ensure the correct polarity of the two optical fibres: with traditional LC patch cables you can open the duplex clip and switch polarity; with Datwyler standard duplex patch cords a separate duplex clip is enclosed.

Push-pull LCD

Anyone who has tried to release LCD connectors in patch panels with high packing densities knows how difficult this can be. At high density thumbs and forefingers are not ideally suited to operating the release lever and pulling the connector.

There are a few solutions on the market for releasing the connector using a tool. But some of these tools are really expensive, and the fibre optic connector needs to be handled with the utmost care.

Various fibre optic connector manufacturers therefore offer what are known as push-pull LCD connectors designed to make release somewhat easier. As against traditional LCD connectors, however, the push-pull variants have generally been patented, so they are not widely available and are also considerably more expensive.

The question to ask is therefore always how many ports do you really need on a certain patch area, for example 19 inch / 1 rack unit?

For the reasons mentioned the maximum possible number need not always be the best option. When using "standard" LCD patch cables where the connector is released by pressing the latch down, patch panels with 24 LC quads are practicable, i.e. with adapters of SCD size for contacting four LC connectors or two LCD connectors each. This means that if there are patch panels with 24 LC quad adapters, 48 duplex patch cables can still be easily plugged in and also released.

State of the art

In EN 50173-1 the mechanical and optical characteristics of the FO connectors are described as follows in clause 8.5.1.3: "Optical fibre connecting hardware shall meet the requirements of Table 70. The choice of connecting hardware is open to all types of optical fibre connectors standardised by IEC or CENELEC. When high density is an important consideration then small form factor connector designs that accommodate at least two fibres (…) are recommended. However, where detail specifications produced by IEC or CENELEC in accordance with requirements of Table 70 a) do not exist then assurance should be sought from suppliers that the combinations of components within connecting hardware are able to meet the optical and mechanical requirements of this clause."

Admittedly in FO patch panels the robust SC duplex connector (SCD), which can also be very easily plugged in and released as a push-pull connector, is still in frequent use. Nowadays, though, it is increasingly being replaced by the smaller, equally standardised LCD connector which, as described above, permits higher packing densities but is more difficult to handle.

In keeping with the requirement for increased packing density, the standard for data centre cabling, EN 50173-5, also describes the LCD interface for connectors with a fibre count of 2. For a fibre count >2 it describes the MPO connector. In fact both interfaces have become widely accepted in data centres.

Standard-compliant colours for connectors, adapters and cables

The variety of FO connector types corresponds with an equally bewildering variety of colour codings for connectors, adapters and cable sheaths.

Clause 8.5.1.2 of EN 50173-1:2011 stipulates the colour coding and clear labelling of connectors and adapters for fibre optic connections with quartz glass fibres:

Coding of connectors and adapters, for example by colour, should be used to prevent accidental connection
a) of different types of multimode fibre in the cable;
b) of incompatible single-mode connecting hardware, e.g. blue for connectors with ferrules with physical contact (PC) and green for connectors with ferrules with angled physical contact (APC).

This clause also states that consistent polarisation should be maintained throughout the cabling system by means of physical keying, labelling or both. These are additional identification markings which do not replace other markings conforming to EN 50174-1 or national laws or regulations.

A supplementary note in EN 50173-1 states that the colour codes for SCD connectors (conforming to IEC 60874-19-1) may also be used for other types of connector, i.e. for all LCD connectors:
a) multimode 50 µm and 62.5 µm: beige or black;
b) single-mode PC: blue
c) single-mode APC: green.

EN 50173 thus only specifies a few colours for connecting technology. The colours turquoise and heather violet typical of

Fibre type	Cut	Standardised colour	Market-standard colour
OM1	PC	beige or black	beige
OM2	PC	beige or black	beige
OM3	PC		turquoise
OM4	PC		heather violet
OS2	PC	blue	blue
OS2	APC	green	green

Table 1: Colours of FO connectors. This applies also for LC duplex connector types.

Image 2: LCD adapters in SC simplex size as offered from Datwyler – on the left side in beige for OM1 and OM2, turquoise for OM3, heather violet for OM4; on the right side for single-mode OS2 in blue (PC) and green (APC).

OM3 and OM4 are not even mentioned there, nor are there any requirements for the sheath colours of indoor cables in this standard.

In 2014, a draft of the fourth edition of IEC 60794-2 was published which also describes sheath colours for indoor cables and universal cables.

Cable with fibre type	ISO/IEC 11801 Class	Cable coulor
E09/125 µm	OS1 or OS2	yellow
G50/125 µm	OM1 or OM2	orange
G50/125 µm	OM3	turquoise
G50/125 µm	OM4	magenta
G62,5/125 µm	OM1 or OM2	grey

Table 2: Colours of fibre optic indoor and universal cables confirming to IEC 60794-2.

Datwyler has differentiated between different core diameters (G50/125 µm und G62,5/125 µm) for OM1 and OM2 fibre by using different sheath colours for many years. This avoids improper connections of fibres with different core diameters when using wrong patch cables, for example.

Colour codings used today:

OM1 and OM2

The fibre optic connectors and adapters for OM1 and OM2 cables are often beige. As most local area networks (LANs) in Europe were set up with G50/125µm (OM2), beige has become generally accepted as the adapter colour for OM2 fibres. Beige is thus also the preferred colour of most multimode connectors.

A few firms use beige connectors for fibre type G62.5/125µm (OM1) and black ones for fibre type G50/125µm (OM2).

Many patch cable manufacturers prefer orange-coloured sheaths for OM1 and OM2 patch cables. To distinguish between fibres of different core diameters Datwyler long ago decided to give OM1 patch cables a grey sheath and OM2 patch cables an orange one.

OM3 and OM4

Due to the further increase in transmission speed, initially to 1 Gbit/s and then 10 Gbit/s, new fibres with a core diameter of 50 µm were introduced. These fibres are known as OM3 and OM4.

The colour turquoise (aqua) has become generally accepted for OM3 cable adapters. OM4 adapters are generally supplied in heather violet.

Today the sheath colours of OM3 and OM4 patch and indoor cables are consistent with the relevant adapter colours. They were adopted on a one-to-one basis – though without any precise definition or without conforming, for example, to the RAL chart.

OS2

Single-mode cables (OS2) are generally yellow – conforming to IEC 60794-2. The colour of connectors and adapters for single-mode cables depends – as described above – on the type of cut: blue for PC (physical contact) and green for APC (angled physical contact).

Conclusion

The mini-LCD is only necessary for plugging into certain Brocade transceivers. This means that a hybrid patch cable is needed for connections between the patch panel and these transceivers – with standard LCD on one side and mLCD on the other.

Datwyler recommends the use of LC duplex (LCD) adapters or LC quad (LCQ) adapters in patch panels. Front panels with a staggered arrangement of openings are best suited to LCD. 24 adapters are fitted vertically when LCQ is used, the opening here being the same as for SCD.

LCD Uniboot connectors with relatively thin round cables should be used, as at this port density there is a huge volume of cable. At the same time it is vital to ensure that the polarity of the fibres is correct.

Fibre type	Market-standard cable colour for indoor cables	Patch cable colour used by Datwyler
OM1	orange	grey
OM2	orange	orange
OM3	turquoise	turquoise
OM4	heather violet	heather violet
OS2	yellow	yellow (also green)

Table 3: Colours of fibre optic indoor cables as used today (overview).

