



TECHNICAL BULLETIN

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Date: 13th Apr 05 (rev 6 Sept 19)

No: 101

Raised by: T C

Distributed to: As required

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OPTICAL CONNECTION SYSTEM SPECIFICATION NOTES

For Optocore® system in DiGiCo consoles and AES-10 Optical Madi

The following notes are intended as a guide to system engineers planning external optical systems for permanent building installation, external patch systems etc. Most of this information relates to the Optocore system built into Digico products. See notes below referring to Optical Madi (AES-10 standard) which is not the same specification.

Standard touring systems and cables are supplied by DiGiCo supplied with the standard HMA or Fibrecast expanded beam military connector.

Digico mixer systems can be supplied as a special option built with ST sockets or Neutrik OpticalCON (a type of ruggedized LC) connections. See notes below regarding choice of connectors. HMA is extremely robust and easy to use whilst ST or LC connections have lower losses but are less robust.

In addition, there are now 2 versions of the Digico/Optocore system in use. 1G as used on the original D series mixers and DigiRack systems and 2G as used on SD mixers and SD Rack.

The 2G system can carry more data (e.g. 96KHz audio) whilst the older 1G system has reduced capacity (e.g. 48KHz audio only) but has greater range.

The use of D-series (1G) equipment has declined significantly since 2013 as D-series products have ceased production.

Important Note regarding the Digico Solutions line (e.g. Purple Box) and DigiGrid Studio systems use a different data signal system being AES-10 standard (Optical Madi) and is not Optocore. In terms of optical transmission performance these can be considered similar to or slightly better than the older 1G (D-series).

The notes regarding connections and cables given here for 1G systems apply to these, except that the operating wavelength for optical madi is different. (See note at end)

It should be noted Solutions and DigiGrid systems are NOT compatible with mixer Optocore systems and cannot be directly connected to any Digico mixer optical port and are a “stand alone” system.

Understanding losses

The limit of the range of the optical communications or the length of cable possible between equipment in the system is dependent on 2 main factors being connector losses and cable losses. These can be considered separately for most systems.

This means that even very short runs with low cable losses will not operate if there are many intermediate connectors present and conversely too long a cable with no intermediate connections will also not operate.

Cable losses

In a 2G system the maximum cable run node to node is approximately 350m.

In the older 1G system (and Digico Solutions series) this is approximately 700m, due to reduced dispersion loss of signal within the cable.

Note a "node" is the connector internal to the Digico unit. At each unit the signal is repeated (re-amplified) and the distance can start over again. A passive intermediate connection is not referred to as a node.

Each "leg" in the system is considered separately. i.e. the cable loss from FOH mixer to a rack can be up to 350m, the loss from the Monitor mixer to the other connection on the same rack may also be up to another 350m.

These distances are the maximum possible, irrespective of the connectors present using standard multimode systems. See below regarding long range single mode options.

Connector losses

The typical losses in a HMA connected cable is 0.75-1.25dB per connection. As noted elsewhere the cable and panel connectors are effectively identical and therefore the same loss is found in cable to panel and cable to cable connections.

The loss across a butted (face to face) SC, ST or LC connection is typically 0.25-0.75 dB (this increases with use as the connector gets worn).

Note the panel connector themselves have no loss, as these are "barrels" for the SC, ST & LC cables, however each cable consists of 2 connections.

In the above, each connector to connector junction between cables counts as 1 loss. It is important to include EVERY junction when calculating losses in a system design, including those hidden in wall boxes etc.

Using standard cables:

In a typical mixer system using the older 1G (as in the Digico D series) the maximum length of cables used is normally limited by the number of connections present. The loss in connectors usually exceeds the cable loss.

In 2 G system the maximum length of cables used may become significant.

The maximum typical acceptable connector loss is about 6dB between mixer and mixer or mixer and rack.

The typical losses in a HMA connected cable is 2dB to 2.5dB.

Therefore in a 1G system 2x 150m cables can be connected in series (to make 300m) and be expected to work. 3 x 150m in series (making 450m) will normally work, but is at the limit of the system performance due to connector losses.

In the 1G example above the maximum length allowed due to cable losses exceeds the maximum due to connector losses. The limit on a 2 G system for reliable operation 2 x 150m cables (300m) being towards the maximum cable limit, whilst 3 cables would be considerably over the limit.

Note the cable is 2 core with twin lens connectors (send and return) but losses are equal in both directions, so this does not need to be factored in.

Using installed custom cabling

The external cables used for Optocore are 50um multimode, using 50/125 cable.

Installation cables are available in several "OM" categories. OM2 is standard 50 micron glass is suitable for Optocore. OM3 is enhanced 50 micron glass (primarily for providing an improvement at 10 gigabit only) and therefore acceptable but not required, but may provide a small reduction in cable loss at 2 gigabit. OM4 is even higher performance and also acceptable but not a requirement.

OM1 is used for standard 62.5 micron multimode glass and should not be used.

"Plenum" rated cables are specifically a US fire rating standard for installed cables. Questions regarding choice of cable in these circumstances should be addressed to the relevant local authority.

The maximum length of cable node to node (i.e. mixer or rack) as noted above is 350m for Optocore 2G (as used on SD series consoles). This limit is due to dispersion losses in the cable and does not change by using fewer connections.

The worst case maximum connector loss allowable due to limits of the optical transceivers (the so called power budget), node to node is 7.5dB. System designers should work to this figure. This assumes all tolerances in optical transceiver performance add up together, along with component aging, to form the worst case.

Designers may wish to know that the best case, where all tolerances in the send and receive electronics cause least loss, the power budget (allowable loss) is 16dB, therefore typical performance can accept a loss of 10dB. All normal designs should be for the worst case and allow 7.5 dB as above.

The above figures allow for the losses associated with expected ageing of the optical transceivers over 10 years. Brand new systems will out-perform the above by this margin.

Note a "node" is the SC or LC connector internal to the Digico unit on the interface PCB itself, NOT the panel connector. The internal cables to the rear panel with add typically 0.5 - 1dB per end.

Therefore external systems around 6dB overall loss should be acceptable.

"Looping out" an unused node (mixer or rack) to maintain the Optocore redundant operation introduces 2 extra connections in the optical circuit and therefore adds the associated losses. In general systems reliant of this "looping out" should be avoided.

The use of an optical patch bay also adds 4 connections per patch (more if there are local internal terminations in the panel) and therefore adds to the associated losses.

Please note that the HMA connector is hermaphrodite but SC, LC and ST connectors used in installed systems are not. Cable connectors will not connect "in line" with other cables but only with their companion panel connectors. In line "barrel" connections (back to back connectors) are available but introduce a loss at least the same as 1 panel connection.

It should be noted that the computer industry standard for optical data connections is 62.5/125um multimode. Therefore most "off the shelf" optical cables are to this inappropriate standard. If this is used with Optocore, the losses rise dramatically and therefore the maximum distances and number of connections (where the losses actually occur) for reliable operation drop, typically by about half or more, although this not guaranteed at all.

Choice of optical connectors

Standard external cables are supplied by DiGiCo (2, 5, 100 or 150 m) supplied with the standard HMA or Fibrecast expanded beam military connector.

Digico and Soundtracs mixers can be supplied optionally built with ST sockets (twist locking bayonet style optical – similar to a BNC connector) or Neutrik OpticalCON Duo version (a type of ruggedized LC) connections.

Expanded beam HMA connectors are a “no contact” connection and effectively have no wear to the optical surfaces mounted in extremely rugged machined metal shells. In addition they are extremely resistant to dirt on the connector lens faces. These are recommended and used for typical live touring systems with frequent disconnection and reconnection of systems, Without doubt these are the most robust, long term reliable and appropriate connection for touring applications and have been used by the world’s major touring rental companies on their Digico systems for over 10 years.

ST and LC (including OpticalCON branded connections) are a butt connection style, that is the connection is made by touching the surfaces of mating connectors directly together. Over time with repeated reconnections the polished faces of the connections become worn and the associated insertion loss increases, giving these a limited life due to wear of the connector faces.

Because the connection is the size of the fibre itself, these types of connection are also very sensitive to dirt.

ST type connectors and basic LC connectors are not very robust and so are recommended as a cost effective connection method where there is no routine disconnection - for example where this is required during occasional maintenance only. Whilst ST are slightly more robust and easy to handle and have good cable retaining arrangements, basic LC have the benefit is usually being used in “duplex” pairs, preventing errors due to reversed connections.

If basic LC is to be used in an installation, the Digico system should be specified with Neutrik OpticalCON (NC) as this is compatible for these types of connectors.

The Neutrik OpticalCON is effectively an LC plug in an XLR style shell. This makes the loose cables quite robust. The cable shells and panel sockets have small spring loaded retractable dust covers which go some way to preventing problems associated with dirt. These connectors are proving suitable for applications with less frequent disconnections, such as longer running theatre shows and semi-permanent installations requiring less frequent disconnections and environmental protection than typical touring systems.

Use of single mode cable to extend optical range

The Optocore® system used in all Digico and DigiGrid products can be built to support single mode (SM) operation. These systems have a price premium and are constructed and configured to order.

The length of cable that can be operated may extend to several km (possibly in excess of 10km) and are offered for specialist needs. In general the standard multimode system fulfils the majority of applications. Digico will be pleased to discuss system requirements in detail.

The Digico Solutions line (e.g. Purple Box) is also available with a single mode option, supplied to special order. In terms of optical transmission performance these can be considered the same as Optocore SM systems.

Performance of single mode systems.

In general all the same observations and calculations that apply to multimode systems as stated above, also apply to single mode, except that the cable loss (dispersion losses) are dramatically reduced. However in most professional audio systems cable losses are so low, they can effectively be ignored.

The power budget calculations are the broadly the same as for multimode with a 6dB external connection allowable loss.

Connector losses, using the correct single mode versions of the connectors noted, that are applied to multimode connectors, also apply in the same manner to single mode systems. This means that even cable lengths well below the maximum possible (due to cable losses), will not operate if there are many intermediate connectors present.

Standard and custom installed single mode cables and connectors

Note there are no factory standard cables for single mode. SM equivalents for the standard multimode cables can be supplied to special order.

The external cables used for Optocore SM are 9um single mode, using 9/125 cable.

Users intending to operate over greater than 2km node to node should discuss specific requirements with a Digico distributor or the factory before specifying and ordering a system.

Digico mixers for single mode use can be supplied with the SM version HMA / Fibrecast expanded beam military connector or with ST sockets (twist locking bayonet style optical – similar to a BNC connector) or Neutrik OpticalCON (a type of ruggedized LC) connections. The same considerations to performance of connectors apply to single mode types as to multimode types.

Mixers and racks equipped for single mode have a yellow or blue coloured collar on these connections to indicate the SM option is fitted.

Testing optical systems

For custom installed systems, proof of performance (confirming actual cable and connector losses) is strongly recommended prior to the systems going “live”. This is especially the case if an independent subcontractor (not associated with Digico or their distributor), is installing the cables and if the benefit of all involved.

Optical test systems for fault finding and proof of performance do exist and can be quite costly. Contact the factory for suggested system information.

System operating wavelengths

The 3 systems mentioned above operate at the following wavelengths. This normally has no relevance to cable loss calculations, but will affect the use of test equipment.

Optocore 1G and 2G systems, standard multimode: 850nm
Optocore 1G and 2G systems, optional single mode: 1310nm

Optical Madi (AES-10) standard multimode and optional single mode: 1310nm