QED

REFERENCE ETHERNET

Specified for Category 8.1 with 40G Ethernet

The Sound of Science

Introduction

If you are connecting an HD Audio streamer device to your home network, you want to make sure that the patch cable you use is of outstanding quality and will not introduce any unwanted timing errors caused by crosstalk between cable pairs. You also want to ensure that the bandwidth capabilities of the cable are adequate for the data rates required for Hi Res Audio streaming and that insertion losses caused by poor contact quality and impedance matching are kept to a minimum.

Most ordinary patch cables are constructed to the CAT 5e standard and are only specified for a bandwidth up to 150 MHz. The Reference Ethernet cable is an over-specified Class I Category 8.1 patch cable with a bandwidth of 2000 MHz which supports 40G ethernet - this gives it a huge amount of headroom when used in an HD audio streamer application. It can therefore easily accomodate today's hi-res PCM streams of 32 bit/384 kHz or PDM streams up to DSD512 and will be capable of even higher resolutions should they become available in the future.

The cable features low insertion-loss, gold plated, industrial grade ethernet plugs with 360 degree shielded die-cast zinc bodies and high torque cable glands to maintain low insertion loss. In addition, its four 24AWG 99.999% OFC copper twisted pairs have different twist rates to cut down on intra-pair crosstalk and to give increased noise immunity which contributes to ultra-low jitter performance. Low jitter or timing error performance of the cable is the main parameter which allows it to operate at speeds up to 40 Gb/s. A further refinement, only found on QED cables, is the inclusion of a bespoke ferrite-impregnated inner jacket designed to shield the high bit-rate signals from external high frequency noise which can contribute to loss of signal bandwidth. Each twisted pair is individually shielded and geometrically bound within a tight aluminium mylar wrap, this further contributes to the elimination of crosstalk within the cable and maintains the tight 100 ohm characteristic impedance demanded by the CAT 8 standard.

The cable is finished in an attractive pearl white PVC jacket to complement high quality hi-fi equipment.

Fig 1. QED Reference Ethernet Cable

Features

Twisted Pairs

Ethernet uses differential signalling to counteract outside interference. The receiving equipment measures the difference signal between the two wires and rejects any component of the signal that is equal but not opposite (i.e. common mode). Any noise signals electrically or magnetically coupled to the data signal affect each conductor equally thus they arrive at the receiver in common mode and are rejected. However, if the noise signal is in close proximity to the signal cables it is inevitable that one of the conductors will lie closer to the noise source than the other so that the induced noise signal is not the same for each conductor. In this instance the common mode rejection is not perfect and some of the noise is transmitted to the receiving equipment. By twisting the conductors together the cables swap between which is nearest to the noise signal once per twist. In this way the noise signal becomes the same in each conductor – common mode rejection reaches nearly 100% and the noise is eliminated.

If more than one twisted pair is present in a single data bundle (such as in ethernet cabling) then the conductors of adjacent pairs become a source of noise and can lie alongside each other for some distance partially undoing the effect of common mode rejection afforded by the twisting of the conductors. Therefore, in Reference Ethernet cables we specify that the twist rate or pitch of the conductor pairs should be dissimilar to counteract this spoiling effect and reinforce the inherent common mode rejection characteristics of the differential signalling system.

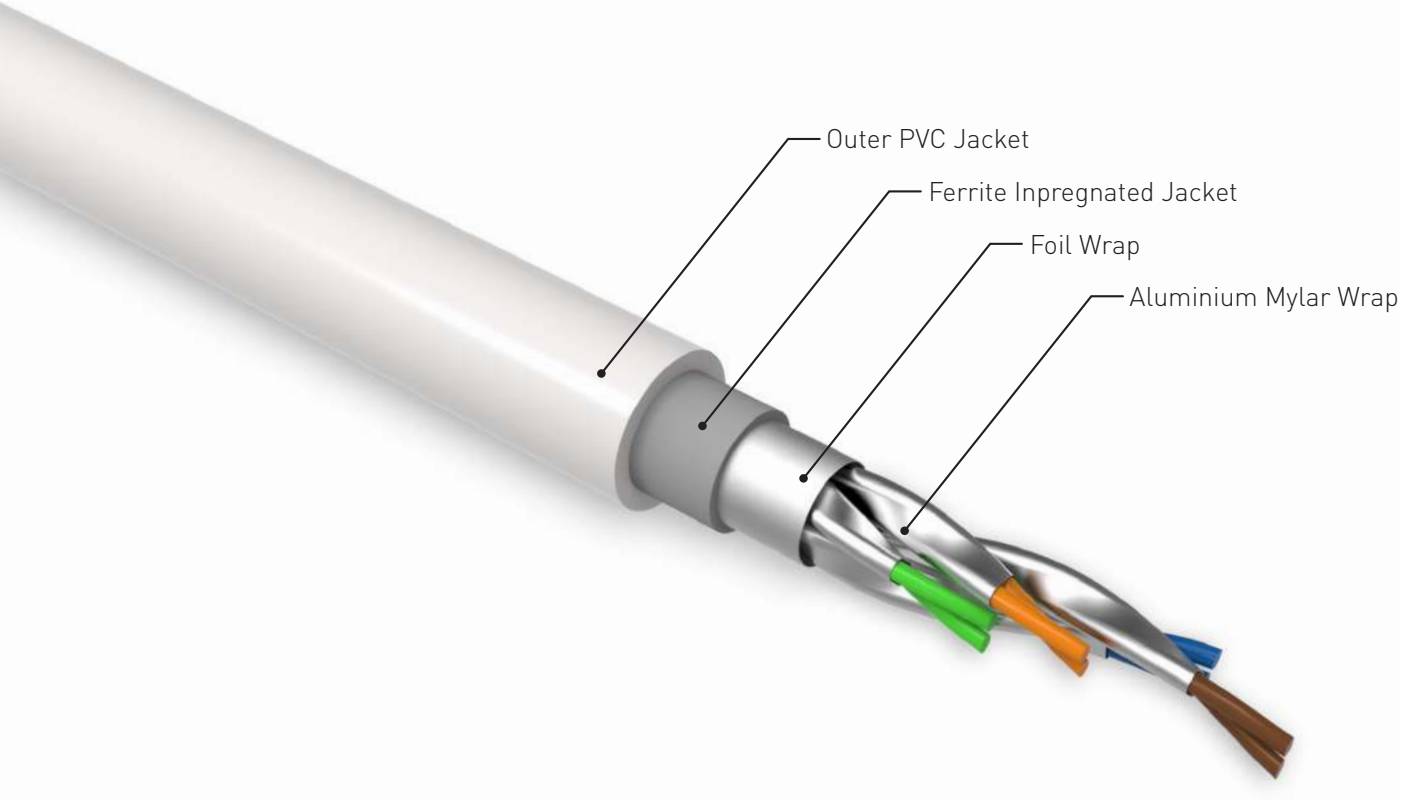


Fig 2. Inside Reference Ethernet

Insertion Loss

Insertion loss refers to the loss of signal strength at the far end of a line compared to the signal that was introduced into the line. This loss is due to the electrical impedance of the copper cable, the loss of energy through the cable insulation and the impedance caused by the connectors. Insertion loss is usually expressed in decibels dB with a minus sign. Insertion loss increases with distance and frequency. For every 3 dB of loss, the original signal will be half the original power. Due to its accurate characteristic impedance, Reference Ethernet exceeds the requirement for CAT 8 insertion loss by up to 20 dB.

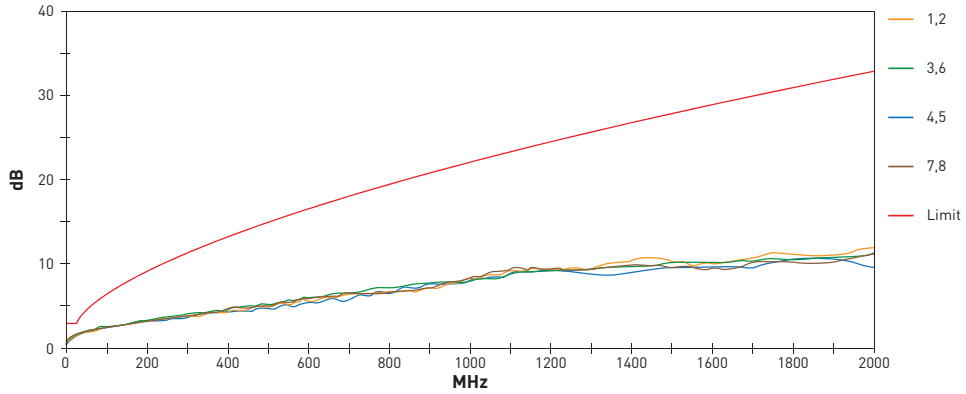


Fig 3. Reference Ethernet Insertion Loss Fluke DSX 8000 CAT 8 Cable Analyzer

Attenuation-to-Crosstalk Ratio

Attenuation-to-Crosstalk ratio (ACR) indicates how much stronger the attenuated signal is than the crosstalk at the destination (receiving) end of a communications circuit. The ACR figure must be at least several decibels for proper performance. If the ACR is not large enough, errors will be frequent. Due to its unique ferrite jacket (which is not available) from any other manufacturer QED Reference Ethernet exhibits an ACR figure up to 25 dB better then the requirement of the CAT 8 standard.

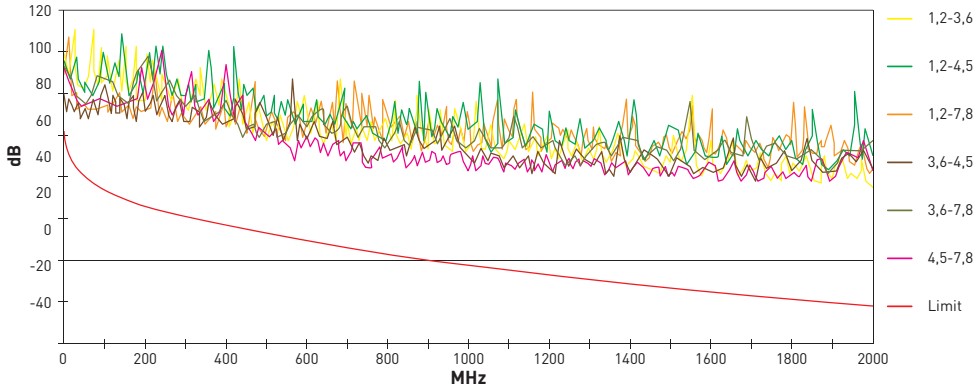


Fig 4. Reference Ethernet ACR Fluke DSX 8000 CAT 8 Cable Analyzer

TDR (Time Domain Reflectometer)

Any impedance mismatch between the cable and the source or sink will cause the signal to be reflected back and forth – this is known as return loss. In Figure 5, the reflected signal is shown by the peaks at the near end and far end of the correctly terminated cable. Ideally, no peaks would be seen, showing that all of the energy has been delivered to the load. In practice it is very difficult to get higher than 90% of the signal delivered to the load, which is why a very small reflection can still be seen in the graph.

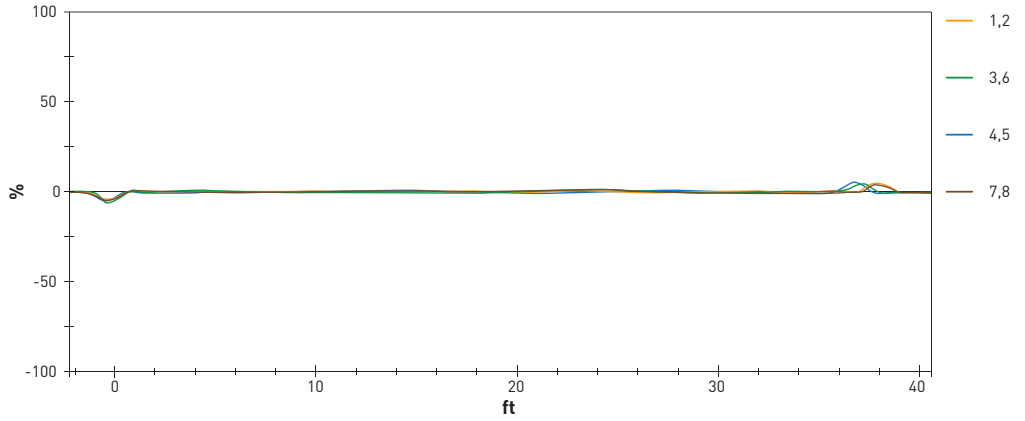


Fig 5. Reference Ethernet TDR Fluke DSX 8000 CAT 8 Cable Analyzer

Even so, due to its precision engineered Telegärtner plugs, Reference Ethernet exceeds the returns loss demanded by CAT 8 by 3.2 dB.

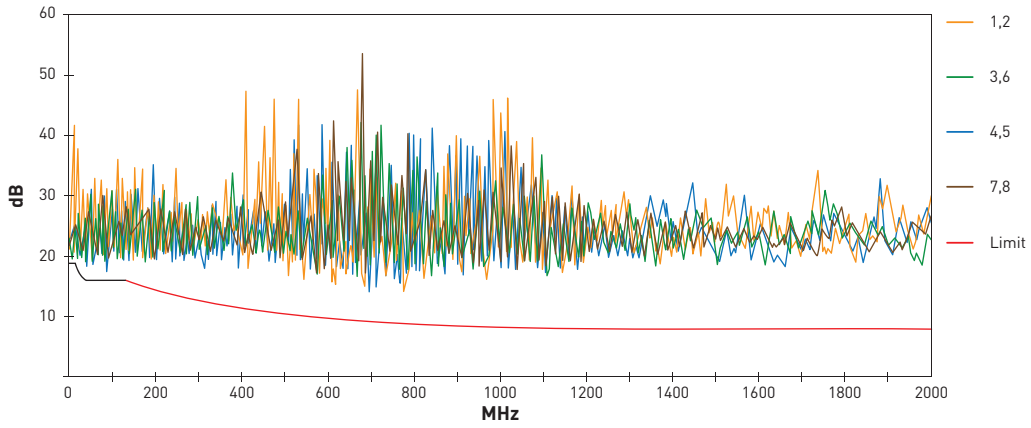
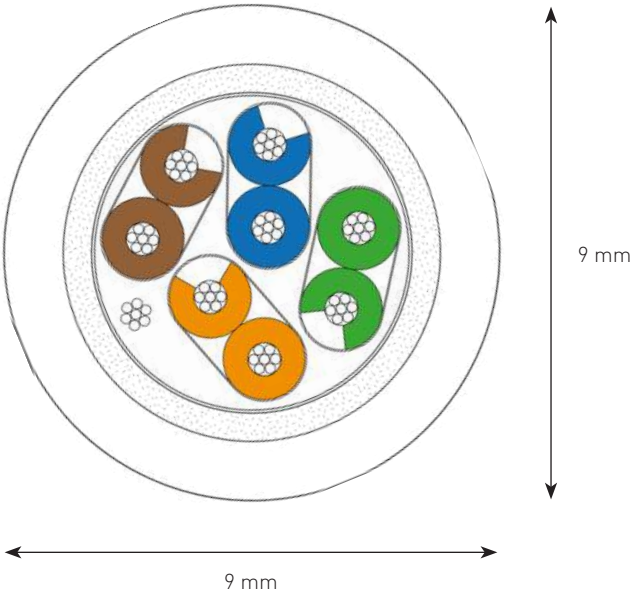


Fig 6. Reference Ethernet Return Loss Fluke DSX 8000 CAT 8 Cable Analyzer

Fig 7. The internal mechanism of the Telegärtner plug

Specification



Cable OD (mm)	9 mm
Plugs	Telegärtner Profinet CAT 8
Construction	F/FTP
Conductor size	24AWG
Characteristic Impedance	100 ohm
Patch Cable Category	Class I CAT 8.1
Maximum Bandwidth	2000 MHz
Maximum bit-rate	40 Gb/s

Transmission Characteristics CAT 8 Test Pass Margins*:

Insertion Loss	20 dB
Return Loss	3.2 dB
NEXT	11.3 dB
ACR-F	8.3 dB

**Indicates at least how much better than the CAT 8 standard the cable measured.*

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