

Requirements for Modular Patch Cords (e.g. RJ45 patch cords for Cat5 and Cat6 cabling systems)

Introduction

The purpose of this document is to:

- 1) provide background information beneficial to specifiers and users;
- 2) provide an overview of the relevant and applicable standards for modular patch cords;
- 3) explain the importance of specifying and using compliant modular patch cords;
- 4) indicate how modular patch cords should be specified;
- 5) detail the methods by which compliance can be shown;
- 6) recommend a course of action when non-compliant modular patch cords are uncovered.

Modular patch cords are a vital component of cabling channels, the performance of which determines how efficiently applications operate. The performance of modular patch cords is fully specified in international cabling standards. These specifications include transmission requirements, conditioning tests, and qualification test methodology – the fundamental elements required to verify modular patch cord performance.

The need for this advice has become increasingly important because market research and independent testing of modular patch cords being marketed in the UK indicates that a majority of modular patch cords purporting to be, and marked as, compliant to the cabling standards were found to be non-compliant. This is particularly true of modular patch cords at the cheaper end of the price spectrum.

Definition

Modular patch cord is a generic term that encompasses, where applicable, equipment cords, patch cords and work area cords that can be used in structured balanced cabling systems, as defined in cabling standards ISO/IEC 11801:2002, EN 50173-1 and TIA-568-B. The construction of these modular patch cords consists of 4-pair flexible cables (specified in IEC 61156 series, etc.) terminated with 8-way modular (a.k.a. RJ-45) plugs (specified in IEC 60603-7 series, etc.). The construction of the cable shall use either insulated stranded or solid conductors, dependent upon the referenced cabling standard and intended usage. The cables and connecting hardware shall be either unscreened or screened; mixing of unscreened and screened components within a modular patch cord is not standardised.

Note: *Balanced cord is a term that encompasses modular patch cord, but also includes a cord that may have different connecting hardware terminated at one or both ends, e.g. an equipment cord that has a non-modular patch at the equipment end that is compatible with the specified equipment, or a patch cord that has proprietary non-modular plugs at both ends that are compatible with the specified cross-connect connection system. Whilst this TIN specifically addresses specifications for modular patch cords, the requirements are generally applicable to all balanced cords.*

Specifications exist for Category 5 (Category 5e in TIA-568-B), Category 6 and Category 7 (ISO/IEC 11801:2002 and EN 50173-1 only) modular patch cords. The transmission performance requirements of these specifications are essentially equivalent; but there are differences resulting from the referenced standards therein that means that specifying only one of the referenced cabling standards does not ensure compliance to all.



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Standards

There are modular patch cord requirements in each of the above cabling standards. The testing of modular patch cords (cable assemblies) is covered by standards. The constituent parts of the modular patch cord – cable and connecting hardware – are both covered by standards. The relationship between these is detailed as follows.

ISO/IEC 11801:2002

- 1) “Balanced cords” are specified in ISO/IEC 11801:2002, clause 13.
 - a) The specification covers Category 5, Category 6 and Category 7 modular patch cords.
 - b) The specification covers both unshielded (UTP) and shielded (FTP, STP, etc.) constructions of modular patch cords.
- 2) Clause 13.1 (Introduction) defines the construction and the performance requirements of modular patch cords.
 - a) The cable shall be as specified in IEC 61156 series.
 - b) The cable shall meet the requirements of ISO/IEC 11801:2002 clause 9 (cable requirements).
 - c) The modular patch shall be as specified in IEC 60603-7 series.
 - d) The modular patch shall meet the requirements of ISO/IEC 11801:2002 clause 10 (connecting hardware requirements).
 - e) The performance of modular patch cords is highly dependent upon the design and quality of the component parts (cable and connecting hardware), and the effect of the cable termination to the connecting hardware. It is recommended that modular patch cords be tested to determine the quality of the assembly.
 - f) The performance requirements of modular patch cords shall be assessed, and show conformance:
 - i) initially;
 - ii) after being subjected to the mechanical stresses that are specified in IEC 61935-2.
- 3) Clause 13.2 (Insertion loss) specifies the maximum insertion loss (frequency dependent), achieved by design, and which is modular patch cord length dependent.
- 4) Clause 13.3 (Return loss) specifies the minimum return loss (frequency dependent), and which is modular patch cord length independent.
- 5) Clause 13.4 (NEXT) specifies the minimum near-end crosstalk loss (frequency dependent), and which is modular patch cord length dependent.

EN 50173-1

- 1) “Requirements for cords and jumpers” are specified in EN 50173-1:2002, clause 9, “Balanced cords” are specified in EN 50173-1:2002, clause 9.2, and the “Electrical performance requirements for patch cords” is specified in EN 50173-1:2002.
 - a) The specification covers Category 5, Category 6 and Category 7 modular patch cords.
 - b) The specification covers both unshielded (UTP) and shielded (FTP, STP, etc.) constructions of modular patch cords.



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- 2) Clause 9.2.1 (General) defines the construction requirements of modular patch cords.
 - a) The cable shall be as specified in EN 50288 series.
 - b) The cable shall meet the requirements of EN 50173-1:2002 clause 7 (Cable requirements).
 - c) The modular patch shall be as specified in EN 60603-7 series.
 - d) The modular patch shall meet the requirements of EN 50173-1:2002 clause 8 (Connecting hardware requirements).
 - e) Work area cords shall only be assembled using flexible cables of stranded construction.
- 3) Clause 9.2.2 (Cable attenuation) defines additional requirements for cables for modular patch cords.
 - a) The insulated conductor diameter of the cable shall be 1.02mm.
 - b) The maximum attenuation ratio of flexible cables shall be 1.5.
 - c) Flexible cables of the correct attenuation ratio shall be used as defined by the implementation rules of EN 50173-1:2002, clause 6.
- 4) Clause 9.2.3.1 (Insertion loss) specifies the maximum insertion loss (frequency dependent), achieved by design, and which is modular patch cord length dependent.
- 5) Clause 9.2.3.2 (Return loss) specifies the minimum return loss (frequency dependent), and which is modular patch cord length independent. The return loss performance shall be conformant:
 - a) initially;
 - b) after being subjected to the mechanical stresses that are specified in IEC 61935-2.
- 6) Clause 9.2.3.3 (Near-end crosstalk loss (NEXT)) specifies the minimum near-end crosstalk loss (frequency dependent), and which is modular patch cord length dependent. The NEXT performance shall be conformant:
 - a) initially;
 - b) after being subjected to the mechanical stresses that are specified in IEC 61935-2.
- 7) Clause 9.2.4 (Identification) specifies that each modular patch cord shall be identified to indicate:
 - a) Length.
 - b) The design insertion loss ratio of the cable.
 - c) Category of cable.
 - d) Wire-map status where a direct pin-pin relationship does not exist (i.e. cross-over cords).

TIA-568-B

- 1) TIA-568-B.1, with references to TIA-568-B.2 and including all associated addenda, specifies the following.
 - a) Clause 4 (Horizontal cabling), which can include modular patch cords, and encompassing recognised cables.
 - b) Clause 6 (Work area) including work area cords in clause 6.3.
 - c) Clause 10 (Cabling installation requirements) including patch cords, equipment cords, work area cords and jumpers in clause 10.2.4.



- 2) TIA-568-B.2, clause 6 (Cords and cross-connect jumpers) specifies the requirements for Category 5e modular patch cords.
 - a) The specification covers unscreened (UTP) and screened (ScTP) (by extension to TIA-568-B.2, annex K) constructions of modular patch cords.
 - b) Clause 4.5 (Stranded conductor cable) specifies the requirements for cables used in modular patch cords. Stranded conductor cable is recommended for use for modular patch cords, but solid conductor cable is also allowed.
 - c) Clause 5 (100 Ω balanced twisted-pair connecting hardware) specifies the requirements for connecting hardware used in modular patch cords. Reference is made to IEC 60603-7 series for modular plugs.
 - d) Annex F (Testing of patch cords) specifies the requirements for qualification of modular patch cords.
 - i) Test configurations and methodology are detailed.
 - ii) The return loss shall be conformant after each step of a mechanical stress test.
 - iii) New requirements for Category 6 modular patch cords, such as the “Modular patch cord test procedure” specified in TIA-568-B.2-1, annex J, are recommended for extension to Category 5e modular patch cords.
- 3) TIA-B.2-1, clause 6.3 (Cords) specifies the requirements for Category 6 modular patch cords.
 - a) The specification covers unscreened (UTP) and screened (ScTP) by extension to TIA-568-B.2 constructions of modular patch cords.
 - b) The specification details requirements for cable and connecting hardware, etc., by extension to TIA-568-B.2, clause 6.
 - c) Clause 7 (Transmission requirements) specifies the performance of modular patch cords.
 - d) Annex J (Modular patch cord test procedure) specifies the requirements for qualification of modular patch cords.

Technical requirements

For conformance to the appropriate cabling standards detailed above, the technical requirements for modular patch cords shall be met as follows.

- 1) Modular patch cords shall meet the H.F. transmission (insertion loss, return loss, NEXT, propagation delay, propagation delay skew) and d.c. electrical (wire map) requirements:
 - a) initially;
 - b) after being subjected to a range of mechanical and environmental conditioning tests:
 - i) tensile strength;
 - ii) flexure;
 - iii) bending and twisting;
 - iv) crushing;
 - v) dust ingress;
 - vi) coiling and uncoiling;
 - vii) climatic endurance.



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- 2) Cables for modular patch cords shall meet the H.F. electrical and d.c. electrical requirements specified in the cable standards referenced above, at all temperatures at which the cable is specified.
- 3) Connecting hardware for modular patch cords shall meet the H.F. electrical and d.c. electrical requirements specified in the connecting hardware standards referenced above:
 - a) initially;
 - b) after being subjected to a range of mechanical and environmental conditioning tests:
 - i) climatic endurance;
 - ii) mechanical operations;
 - iii) corrosive gases;
 - iv) vibration;
 - v) temperature endurance.

Testing

Modular patch cords can be tested for transmission performance and mechanical / environmental robustness conformance against the requirements of the International Standards detailed above. Typically, initial verification is demonstrated by employing the services of a competent laboratory; where this is the manufacturer's own laboratory, a good manufacturer will typically demonstrate conformance by supporting documentation from an independent laboratory. This is especially true for transmission performance where the test methodology has only recently been agreed and standardised.

The initial transmission performance characterisation of modular patch cords is usually completed by utilising a network analyser, suitable baluns, and the specified conforming mating test heads (sockets). Once initial product conformance is demonstrated, on-going verification of production can be assured through the use of appropriate portable test equipment, again fitted with the specified conforming mating test heads. The use of this portable test equipment – typically, the current level III field testers that are used for measuring permanent links and channels – also enables modular patch cords to be measured post manufacture e.g. on delivery to site or after installation.

The transmission performance of structured balanced cabling channels is specified in ISO/IEC 11801:2002, EN 50173-1:2002 and TIA-568-B. The performance of channels is specified to enable support for a wide range of applications.

Unless the uncommon channel design approach is adopted, conformance of channels to the above cabling standards is dependent upon the use of category conformant components (cable, connecting hardware, cords) with or without permanent link conformance testing.

The installed link between the telecommunications room and the telecommunications outlet is inevitably commissioned by means of field tester acceptance testing. However, this cabling does not incorporate any balanced cords – equipment, patch or work area cords. Thus, unless channel testing is further specified, the user of the channel is dependent solely upon category conformant balanced cords being used to ensure that the channel is conformant and will support the specified range of applications.

It naturally follows that the use of non-conformant balanced cords (including modular patch cords) could produce non-conformant channels with resulting problems in supporting current, let alone future applications.



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Recommendations

- 1) Manufacturers and suppliers of modular patch cords should ensure that:
 - a) the modular patch cord conforms to the cabling standards as indicated on the product and its associated documentation;
 - b) conformance is supported by a suitable test regime;
 - c) there is clear product identification, with no misleading statements in regard to performance and usage;
 - d) the product is fit for its intended purpose.
- 2) Procurement of modular patch cords should be realised only if the following are correctly specified:
 - a) conformance to appropriate cabling standard(s), including:
 - i) BS EN ISO 9000:2000 registration;
 - ii) manufacturers' support documentation (test reports, product marking, etc.);
 - iii) on-going verification of conformance through a third party independent laboratory maintenance programme:
 - b) category of transmission performance, including:
 - i) designed insertion loss ratio (determined by conductor size);
 - ii) conductor type (solid or stranded construction);
 - c) additional requirements, such as:
 - i) fire rating (IEC 60332 series);
 - ii) sheath material (PVC, LSZH).
- 3) Manufacturers, specifiers, distributors, installers, maintainers and users all have a responsibility to ensure that the products that claim to be compliant are indeed so. The Trade Descriptions Act, 1968 states:
 - a) *The law requires that any description of goods and services given by a person acting in the course of trade or business should be accurate and not misleading.*
 - b) *The Act makes it an offence to supply or offer to supply goods to which a false or misleading trade description is applied.*
 - c) *These offences are strict liability offences i.e. it is possible for a trader to commit an offence without intending to do so.*
- 4) If a non-compliant modular patch cord is uncovered, it is recommended that the supplier should be contacted so that any rogue modular patch cord can be replaced. However, if the problem appears more extensive, then a call to the supplier's local Trading Standards Office would seem appropriate.

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IMPORTANT NOTICE

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