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TECHNICAL REPORT

colour inside

Effects of engaging and separating under electrical load on connector interfaces in cabling used to support IEEE 802.3af (power-over-ethernet) applications

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CONTENTS

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Technical Report IEC 62652 has been prepared by subcommittee 48B: Connectors, of IEC technical committee 48: Electromechanical components and mechanical structures for electronic equipment.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The text of this standard is based on the following documents:

DTR	Report on voting
48B/2076/DTR	48B/2146/RVC

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INTRODUCTION

The ISO/IEC/JTC1/SC25 subcommittee requested IEC SC 48B to prepare an engaging and separating under electrical load test method to be referenced in their standards. This test method standard was published as IEC 60512-9-3:2006. The experts of SC 48B/WG5 were concerned about the effect of engaging/separating under electrical load on the IEC 60603-7 series connector interfaces that would be typically used in the IEEE 802.3af (PoE) applications. The experts developed a set of tests to evaluate the effects, the results of which are reported in this Technical Report.

NOTE "Engaging" and "Separating" are terms used in most IEC TC 48 publications to describe the physical mating or un-mating of connectors.

IEC 60050-581:1978, 581-08-08[1] defines the terms as follows:

engaging and separating force
connector mating and unmating force (deprecated)
The force required to engage fully or separate a pair of mating components including the effect of a coupling, locking or similar device.

The IEC 60603-7 series of standards use the terms mating and un-mating throughout. To avoid confusion in reading this Technical Report and also the IEC 60603-7 series of standards, it is important to know that the term "engaging" is equivalent to "mating" and the term "separating" is equivalent to "un-mating".

1 IEC 60050-581:1978, *International Electrotechnical Vocabulary – Chapter 581: Electromechanical components for electronic equipment*

EFFECTS OF ENGAGING AND SEPARATING UNDER ELECTRICAL LOAD ON CONNECTOR INTERFACES IN CABLING USED TO SUPPORT IEEE 802.3af (POWER-OVER-ETHERNET) APPLICATIONS

1 Scope

This Technical Report is intended to provide information on the effects of engaging and separating under electrical load on the connector interfaces in cabling, used to support IEEE 802.3af (Power-over-Ethernet (PoE)) applications.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60512-9-3:2006, *Connectors for electronic equipment – Tests and measurements – Part 9-3: Endurance tests – Test 9c: Mechanical operation (engaging/separating) with electrical load*

IEC 60603-7, *Connectors for electronic equipment – Part 7: Detail specification for 8-way, unshielded, free and fixed connectors*

IEC 60603-7-7, *Connectors for electronic equipment – Part 7-7: Detail specification for 8-way, shielded, free and fixed connectors, for data transmissions with frequencies up to 600 MHz*

IEC 61076-3-110, *Connectors for electronic equipment – Product requirements – Part 3-110: Detail specification for shielded, free and fixed connectors for data transmission with frequencies up to 1 000 MHz*

IEC 61156 (all parts), *Multicore and symmetrical pair/quad cables for digital communications*

ISO/IEC 11801:2002, *Information technology – Generic cabling for customer premises*
Amendment 1 (2008)

IEEE 802.3af, *"Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications – Data Terminal Equipment (DTE) Power Via Media Dependent Interface (MDI),"*

3 Abbreviations

For the purposes of this document the following abbreviations and special terms apply.

IEEE	The Institute of Electrical and Electronics Engineers
LLCR	Low-Level Contact Resistance
S/FTP	Acronym for a twisted pair cable with overall braid screened cable with foil screened balanced elements
U/UTP	Acronym for a twisted pair cable with no overall screen and unscreened balanced elements

4 General

This Technical Report summarizes information on the effects of engaging and separating under electrical load on the connecting hardware in cabling used to support IEEE 802.3af (Power-over-Ethernet (PoE)) applications. It is intended to make the industry aware of possible problems utilizing modular connectors in applications with increasing power levels and to encourage further investigation of the effects of the connector engaging under electrical load.

This report also includes information regarding test procedures and test results. It is not the intention of this report to recommend any test procedure or specify requirements (to be utilized in order to evaluate the connecting hardware) for connectors in cabling used to support IEEE 802.3af applications.

The tests were conducted using fixed and free connectors made by US, European and Asian-Pacific suppliers. The evaluation utilized several test procedures and took place at test facilities located in the USA and Switzerland. The bulk low level contact resistance was used as a criterion in measuring the effects of engaging cycles under the electrical load on connector durability. In some cases the electrical load was applied for the separating cycles only, in other cases the electrical load was used in both engaging and separating. The electrical load power exceeded the corresponding requirements of the IEEE 802.3af standard.

5 Telecommunications industry information

With the advent of generic cabling used in the telecommunication industry, connectors are now used for a multitude of applications. In the past the great majority of such applications all were of a low power level: 4 W or less.

The development of the IEEE 802.3af (Power over Ethernet (PoE)) standard changed the situation. This application requires transmitting power of up to 15 W over the connectors with a nominal voltage of 48 V_{dc}. And already new IEEE projects are under way to increase the transmitted power level up to 40 W.

Different telecommunication connectors subject to the ISO/IEC standards can be used in IEEE 802.3af applications. Some of the connectors used in this study are illustrated in Figures 1 and 2. Figure 1 shows a connector according to IEC 60603-7 which is typically used for applications up to 500 MHz. Figure 2 illustrates a connector according to IEC 60603-7-7 or IEC 61076-3-110 which is typically used for applications up to 1 000 MHz.

While transmitting some power over engaged connectors is within the specification for continuous current, the problem starts when the plug is removed / disconnected under electrical load. The breaking of a live contact produces discharges that may damage the surfaces on the connector contacts.

Different factors that could affect the connector interfaces were evaluated, including: power levels from 10 W to 20 W, cable length from 2 m to 100 m, the electrical load polarity, and speed of disconnect. The report includes observations based on the visual inspection prior and after multiple engaging cycles and the temperature and humidity conditioning. The report contains a proposal for additional future testing.

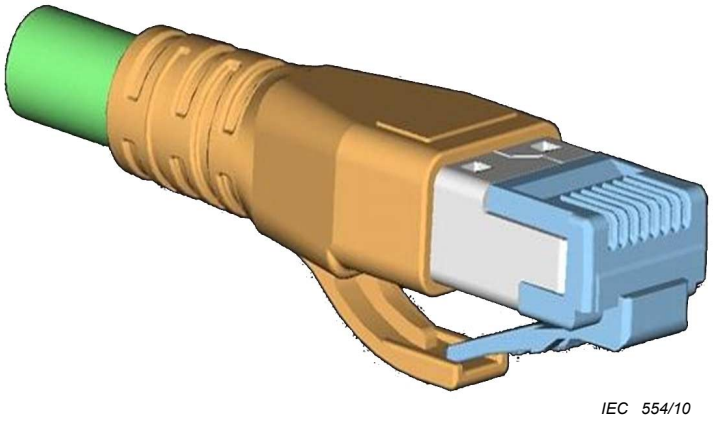


Figure 1 – Illustration of a typical shielded 8-way connector according IEC 60603-7

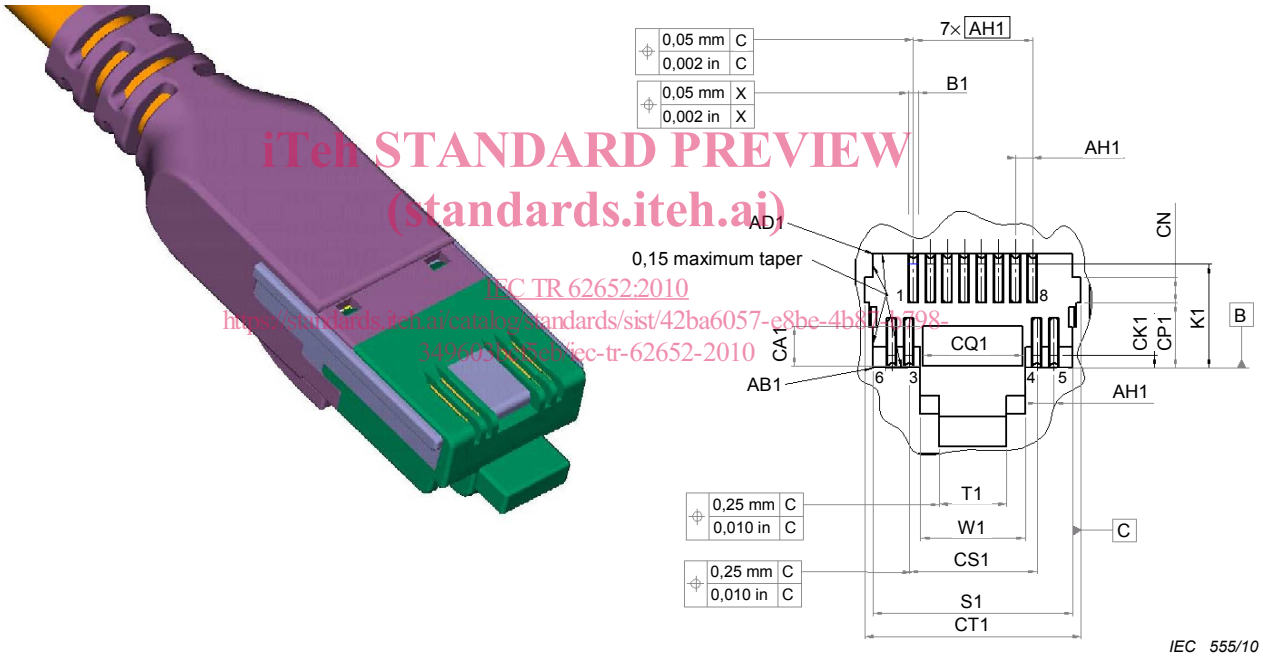


Figure 2 – Illustration of an IEC 60603-7-7 or IEC 61076-3-110 connector

6 Technical information

6.1 Electrical discharges

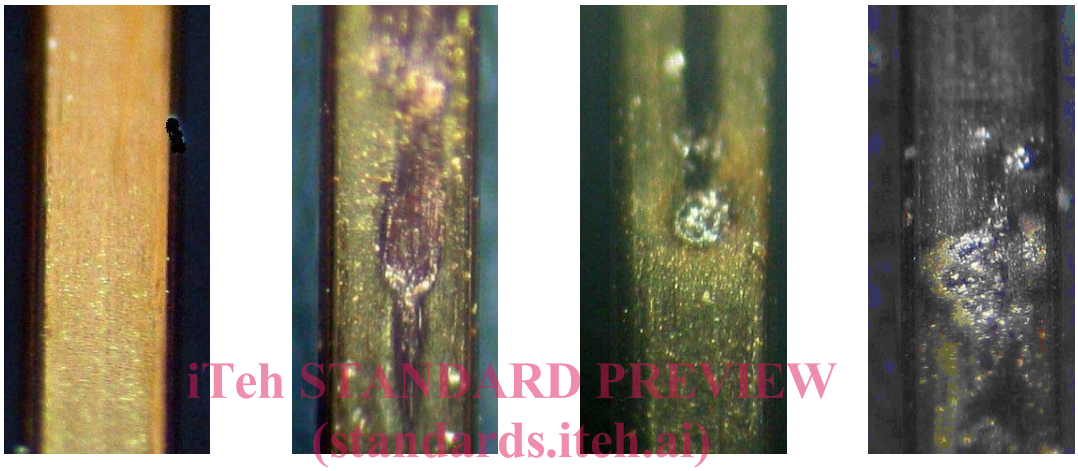
The process of connector engaging and separating causes mechanical damage to the surface of the interface. Such damage could be accelerated or accentuated by the electrical potential between a plug and jack if the electrical load is present during the engaging cycle. In general, there are two such phenomena: corona discharge and spark discharge.

The corona discharge is caused by ionized gas in the presence of an electrical field with a high potential gradient. It is a time-dependent process, which may cause erosion, pitted surface and multiple but shallow craters. There are two distinct types of corona – positive and

negative. For IEC 60603-7 type connectors in a IEEE 802.3af environment corona discharge may not be relevant, since there are no long term, high potential gradients present.

Another type of discharge is spark. The spark discharge is to be considered a single and irregular event. Due its high speed it is considered for this work to be time-independent. The damage caused by a spark is usually limited to a singe crater. However, it is not possible to differentiate with certainty if a particular crater was caused by corona or spark.

The effects of the discharges are accompanied by changes in the interface appearance caused by mechanical operations. Connecting hardware contacts are shown in Figure 3.



Key

A Fresh unused

B Mechanical operations without electrical load

C Crater caused by a spark

D Multiple craters

Figure 3 – Connecting hardware contacts

6.2 Surface plating. long and short term effects

The connector contacts made of copper alloys are protected from the environmental damage by plating. Typical plating consists of nickel plating on the copper alloy base metal, typically 2,5 µm to 3,5 µm, with a noble metal (gold or palladium-nickel) plating on top of the nickel. Surface damage that did not expose the copper alloy is not considered significant. However, when the copper alloy base metal is exposed, it is premature to conclude that the damage affects the connector electrical function.

Such damage can cause short term effects such as loss of mechanical or electrical functionality, as well as long term effects such as corrosion, that also lead to the loss of electrical functionality.

For this reason the study included environmental tests that are often used as accelerated life tests. Also the evaluation of the long-term effects is recommended in future tests proposed later in this Technical Report.