

INTERNATIONAL STANDARD



**Connectors for electrical and electronic equipment – Tests and measurements –
Part 99-002: Endurance test schedules – Test 99b: Test schedule for unmating
under electrical load**



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Part 99-002: Endurance test schedules – Test 99b: Test schedule for unmating
under electrical load**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

CONNECTORS FOR ELECTRICAL AND ELECTRONIC EQUIPMENT – TESTS AND MEASUREMENTS –

Part 99-002: Endurance test schedules – Test 99b: Test schedule for unmating under electrical load

FOREWORD

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This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition IEC 60512-99-002:2019. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

IEC 60512-99-002 has been prepared by subcommittee 48B: Electrical connectors, of IEC technical committee 48: Electrical connectors and mechanical structures for electrical and electronic equipment. It is an International Standard.

This second edition cancels and replaces the first edition published in 2019. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) Test group UEL has been revised with respect to the order of the test phases, the test severities and the requirements.

The text of this International Standard is based on the following documents:

Draft	Report on voting
48B/2922/FDIS	48B/2938/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

A list of all parts in the IEC 60512 series, published under the general title *Connectors for electrical and electronic equipment – Tests and measurements*, can be found on the IEC website.

Future standards in this series will carry the new general title as cited above. Titles of existing standards in this series will be updated at the time of the next edition.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

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- withdrawn,
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CONNECTORS FOR ELECTRICAL AND ELECTRONIC EQUIPMENT – TESTS AND MEASUREMENTS –

Part 99-002: Endurance test schedules – Test 99b: Test schedule for unmating under electrical load

1 Scope

This part of IEC 60512 is used for ~~testing~~ the assessment of connectors within the scope of SC 48B that are used in twisted pair communication cabling with remote power, such as ISO/IEC 11801-1 Class D, or better, balanced cabling in support of ~~IEEE Std 802.3bt™, (PoE Plus – Power over Ethernet Plus)~~ IEEE 802.3bt™ (Power over Ethernet, supporting up to 90 W from the power sourcing equipment).

The object of this document is to detail a test schedule to determine the ability of ~~pairs~~ sets of connectors to withstand a ~~sequence of tests with a total of 100 engagements and separations. The electrical current is passed through the connectors during the separation (unmating) step only, in accordance with IEC 60512-9-3~~ minimum of 100 mechanical operations with electrical load, where an electrical current is being passed through the connectors in accordance with IEC 60512-9-3 during the separation (unmating) step.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 60512-1-1, *Connectors for electronic equipment – Tests and measurements – Part 1-1: General examination – Test 1a: Visual examination*

IEC 60512-2-1, *Connectors for electronic equipment – Tests and measurements – Part 2-1: Electrical continuity and contact resistance tests – Test 2a: Contact resistance – Millivolt level method*

IEC 60512-3-1, *Connectors for electronic equipment – Tests and measurements – Part 3-1: Insulation tests – Test 3a: Insulation resistance*

IEC 60512-4-1, *Connectors for electronic equipment – Tests and measurements – Part 4-1: Voltage stress tests – Test 4a: Voltage proof*

IEC 60512-9-3:2011, *Connectors for electronic equipment – Tests and measurements – Part 9-3: Endurance tests – Test 9c: Mechanical operation (engaging and separating) with electrical load*

IEC 60512-11-7, *Connectors for electronic equipment – Tests and measurements – Part 11-7: Climatic tests – Test 11g: Flowing mixed gas corrosion test*

~~IEC 60512-99-001, Connectors for electronic equipment – Tests and measurements – Part 99-001: Test schedule for engaging and separating connectors under electrical load – Test 99a: Connectors used in twisted pair communication cabling with remote power~~

~~ISO/IEC 11801(all parts): Information technology – Generic cabling for customer premises~~

~~ISO/IEC TS 29125: 2017, Information technology—Telecommunications cabling requirements for remote powering of terminal equipment~~

~~TIA-568-A:1995, Commercial building telecommunications cabling standard~~

~~TIA-568-B.2:2001, Commercial building telecommunications cabling standard, Part 2: Balanced twisted-pair cabling components~~

~~TIA TSB-184-A:2017, Guidelines for supporting power delivery over balanced twisted-pair cabling~~

IEEE Std 802.3™-2018, IEEE Standard for Ethernet

IEEE Std 802.3bt™-2018, IEEE Standard for Ethernet. Amendment 2: Physical Layer and Management Parameters for Power over Ethernet over 4 pairs

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

4 General

~~An application-specific current and the associated open circuit voltage are specified, that correspond with the current and voltage of the supported application. This test schedule is suitable for verification of separating of connectors under PoE Plus load conditions; although it is a misuse of the connector, it may occur in practice.~~

~~As it is recognized that not all connectors will see these currents and voltage, this test schedule is regarded as an optional test, not normative for all connectors.~~

Although separating (unmating) connectors under the scope of this document, while used for remote powering, is a misuse of the connector, it may occur in practice.

This test schedule is suitable for verification of separating (unmating) of connectors under load conditions representative for Power over Ethernet Type 4 as specified per IEEE 802.3bt™. An application-specific current and the associated open circuit voltage are specified, that correspond with the current and voltage of the supported application.

5 Preparation of specimens

Each specimen shall consist of a mated set of connectors ~~pair~~ with its terminations. Specimens shall ~~be conformant~~ conform to the relevant IEC connector standard. Each free and each fixed connector shall be terminated with 3 m (max.) of the maximum conductor size cable for which it is intended to be terminated, according to the appropriate IEC standard(s). ~~A printed circuit board may be used for the fixed connectors, so as not to influence the test results.~~ Fixed connectors may alternatively be terminated ~~as the free ones~~ using a printed circuit board which shall not influence the test results.

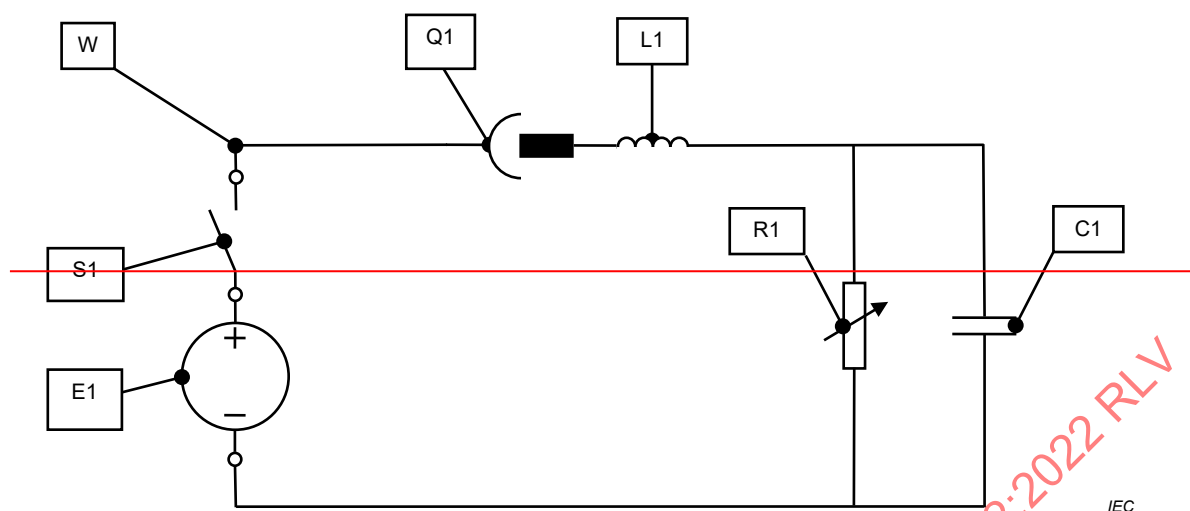
For each specimen, all circuits (mated contacts) shall be wired in parallel as given in IEC 60512-9-3, ~~(see Figure 1)~~, and all circuits shall be tested.

6 Test circuit requirements

6.1 General

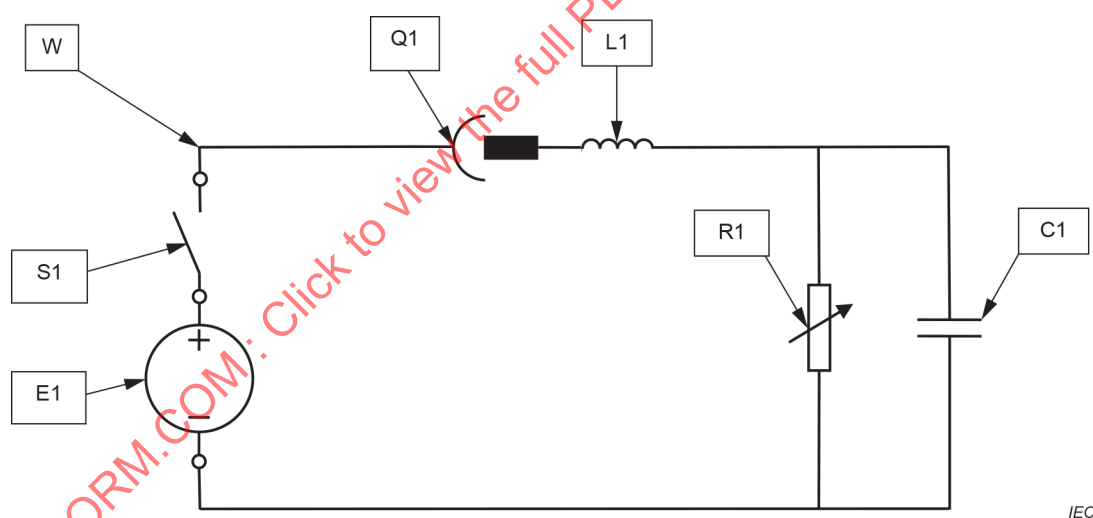
The values for the circuit components and the details of the test circuit, referenced in IEC 60512-9-3, shall be as shown in Figure 1.

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Key

- W Cables in accordance with 5
- Q1 Connector under test
- L1 Inductor $L = 100 \mu\text{H}$
- R1 Variable resistor (e.g. 50Ω to 300Ω)
- C1 Capacitor $5 \mu\text{F}$
- E1 Voltage source
- S1 Switch



Key

- W Cables in accordance with Clause 5
- Q1 Specimen under test
- L1 Inductor, $L = 100 \mu\text{H}$
- R1 Variable resistor (e.g. $R = 25 \Omega$ to 300Ω)
- C1 Capacitor, $C = 5 \mu\text{F}$
- E1 Voltage source
- S1 Switch

Figure 1 – Test circuit details

NOTE 1 Only one circuit of the ~~connector~~ specimen under test, as referenced in IEC 60512-9-3, is shown for clarity. Items W, ~~Q1~~, L1, R1 and C1 are replicated for each circuit of the ~~connector~~ specimen. Items E1 and S1 may be single or multiple. All circuits of the specimen are wired in parallel with appropriate duplication of circuit components, and all circuits of the specimen are operated simultaneously.

NOTE 2 The variable resistor is used to adjust the current to the specified value.

~~Each circuit of the specimen may be wired in parallel with the other circuits of the specimen, and all circuits of each specimen shall operate simultaneously. The variable resistor(s) shall be used to adjust the current(s) to the specified value.~~

6.2 Voltage and current

~~ISO/IEC TS 29125 specifies a maximum current as shown in Table 1 and an open circuit voltage of 55 V DC. The test current has been set to 2,0 A because a maximum of 4 contact pairs can be connected in parallel. In the highly probable case that one contact is separated after all others, this contact will carry this 2,0 A just before disconnecting.~~

~~As the resistive load is likely to rise due to heating and due to wear of contacts in the connector under test, care should be placed in keeping the value of test current within the specified tolerance range e.g. by means of a suitable feedback control circuit acting on the value of the variable resistor. See Annex A (informative) for further guidance.~~

~~The test procedures for Type 1 and Type 2 are defined in IEC 60512-99-001. For Type 3 and Type 4 the variable resistor(s) shall be set so that the electrical current in each circuit (mated contacts) of the specimen is $2,0 \text{ A} \frac{+0,05}{0}$. When the specimen is unmated, the open circuit voltage, in all circuits, shall be $55 \text{ V DC} \frac{+1}{0}$ V DC. When the specimen is mated, the open circuit voltage, in all circuits, shall be 0 V DC by operating the switch, S1, before each connector engagement (mating).~~

Table 1 – Maximum electrical circuit current

PSE Type	Nominal highest current per pair (I_{Cable} , A)	Number of powered pairs	Channel pairset maximum DC loop resistance (R_{Ch} , Ω)	Minimum cabling type
Type 1	0,350	2	20,0	Class D (ISO/IEC 11801) or Category 5 (ANSI/EIA/TIA-568-A: 1995)
Type 2	0,600	2	12,5	Class D (ISO/IEC 11801) or Category 5 (ANSI/EIA/TIA-568-A: 1995)
Type 3	0,600	2 or 4	12,5	Class D (ISO/IEC 11801) or Category 5 (ANSI/EIA/TIA-568-B.2: 2001)
Type 4	0,960	2 or 4	12,5	Class D (ISO/IEC 11801) or Category 5 (ANSI/EIA/TIA-568-B.2: 2001)

~~In Type 3 and Type 4 operation, the current per pairset may be impacted by pair-to-pair system resistance unbalance. See 33.2.8.5.1 of ISO/IEC TS 29125:2017. For additional information on Type 4 current unbalance, see TIA TSB-184-A and ISO/IEC TS 29125.~~

The variable resistor(s) shall be set so that the electrical current in each circuit (mated contacts) of the specimen is $2,0 \text{ A} \frac{+0,05}{0}$. During the separation (unmating) step, the open circuit voltage, in all circuits, shall be $55 \text{ V DC} \frac{+1}{0}$. During the engagement (mating) step, the open circuit voltage, in all circuits, shall be 0 V DC by operating the switch, S1, before each connector engagement (mating).

IEEE 802.3™-2018 and IEEE 802.3bt™ specify Power over Ethernet systems with a nominal highest current per pair depending on the type of power sourcing equipment (PSE) and the number of powered pairs, and with an open circuit voltage of 55 V DC.

For PSE Type 4, the nominal highest current per pair is 0,96 A when all four pairs are powered, giving a total source current of 1,92 A. The test current per contact has been set to 2,0 A to represent the highly probable case that one contact is separated after all others, causing this contact to carry the full current just before disconnecting.

As the resistive load is likely to rise due to heating and due to wear of contacts in the connector under test, care should be placed in keeping the value of test current within the specified tolerance range, e.g. by means of a suitable feedback control circuit acting on the value of the variable resistor. See Annex A (informative) for further guidance.

6.3 Auxiliary equipment

Switches may be used to reverse polarity. However, use of such switches shall not influence the test parameters.

7 Test methods

7.1 ~~Initial cycles~~ Mechanical operations with electrical load

An electrical load, current and open circuit voltage, as detailed in 6.2, shall be applied to each specimen ~~during the separation step only.~~

For the purpose of this test, one connector shall be fixed and the other disengaged at a speed of 150 mm/s $\pm$ 10 mm/s.

One engagement and one separation constitute one cycle.

25 cycles at one polarity of the DC source shall be performed. The polarity of the DC source shall then be reversed and 25 further cycles at the other polarity shall be performed (50 cycles total). The electrical current shall be applied during the separation step only.

7.2 Flowing mixed gas corrosion

The flowing mixed gas corrosion test ~~(method 1)~~ shall be performed ~~for~~ according to IEC 60512-11-7, method 1, with a test duration of 4 days. ~~Half of the samples mated; half of the samples unmated.~~

Half of the specimens shall be unmated and the other half shall be left mated during the test.

~~7.3 Final cycles~~

~~25 cycles at one polarity of the DC source shall be performed. And then the polarity of the DC source shall be reversed, and 25 further cycles at the other polarity shall be performed (50 additional cycles total). The electrical current shall be applied during the separation step only.~~

8 Tests and test schedule – Test group UEL 1

A minimum of 8 specimens shall be prepared for this group; then tested according to Table 1.

Table 1 – Test group UEL 1

Test phase	Test			Measurement to be performed		
	Title	IEC 60512 test No.	Severity or condition of test	Title	IEC 60512 test No.	Requirements
UEL 1.1	General examination			Visual examination	1-1	There shall be no defects that would impair normal operation
UEL 1.2				Contact resistance- Millivolt level method	2-1	As specified in the relevant connector standard
UEL 1.3			100 V DC Method A Mated connectors	Insulation resistance	3-1	As specified in the relevant connector standard
UEL 1.4			Contact to contact 1 000 V DC, or 1 500 V AC peak, All signal contacts to shield and test panel, as applicable Method A Mated connectors	Voltage proof	4-1	There shall be no break down or no flashover
UEL 1.5	Mechanical operations with electrical load	9-3	Per 7.1			
UEL 1.6	Flowing mixed-gas test	11-7	Per 7.2 Method 1, 4 days			
UEL 1.7	Mechanical operations with electrical load	9-3	Per 7.3			
UEL 1.8				Contact resistance- Millivolt level method	2-1	As specified in the relevant connector standard
UEL 1.9	General examination			Visual examination	1-1	There shall be no defects that would impair normal operation. However, physical deterioration of the contacts may be observed. Such deterioration shall not be cited as a failure of this test.
UEL 1.10			Contact resistance	Contact resistance- Millivolt level method	2-1	As specified in the relevant connector standard
UEL 1.11			100 V DC Method A Mated connectors	Insulation resistance	3-1	500 MΩ minimum

Test phase	Test			Measurement to be performed		
	Title	IEC 60512 test No.	Severity or condition of test	Title	IEC 60512 test No.	Requirements
UEL 1.12			Contact to contact 1 000 V DC or 1 500 V AC peak. All signal contacts to shield and test panel, as applicable Method A Mated connectors	Voltage proof	4-1	There shall be no break down or no flashover

Test phase	Test			Measurement to be performed		
	Title	IEC 60512 test No.	Severity or condition of test	Title	IEC 60512 test No.	Requirements
UEL 1.1	General examination			Visual examination	1a	There shall be no defects that would impair normal operation
UEL 1.2				Contact resistance- Millivolt level method	2a	As specified in the relevant connector standard
UEL 1.3			100 V DC Method A Mated connectors	Insulation resistance	3a	500 MΩ minimum
UEL 1.4			Contact to contact 1 000 V DC or 1 000 V AC peak. All signal contacts to shield and test panel, as applicable 1 500 V DC or 1 500 V AC peak. Method A Mated connectors	Voltage proof	4a	There shall be no breakdown or flashover
UEL 1.5	Mechanical operations with electrical load	9c	Per 7.1			
UEL 1.6	Flowing mixed gas corrosion test	11g	Per 7.2			
UEL 1.7				Contact resistance- Millivolt level method	2a	20 mΩ maximum change from initial
UEL 1.8	Mechanical operations with electrical load	9c	Per 7.1			
UEL 1.9			Contact resistance	Contact resistance- Millivolt level method	2a	20 mΩ maximum change from initial

Test phase	Test			Measurement to be performed		
	Title	IEC 60512 test No.	Severity or condition of test	Title	IEC 60512 test No.	Requirements
UEL 1.10			100 V DC Method A Mated connectors	Insulation resistance	3a	500 MΩ minimum
UEL 1.11			Contact to contact 1 000 V DC or 1 000 V AC peak. All signal contacts to shield and test panel, as applicable 1 500 V DC or 1 500 V AC peak. Method A Mated connectors	Voltage proof	4a	There shall be no breakdown or flashover
UEL 1.12	General examination			Visual examination	1a	There shall be no defects that would impair normal operation. However, physical deterioration of the contacts may be observed. Such deterioration shall not be cited as a failure of this test.

Annex A (informative)

Test voltage and current setting instructions

A.1 General

IEEE 802.3™-2018 and IEEE 802.3bt™ specify Power over Ethernet systems with a nominal highest current per pair as shown in Table A.1 and an open circuit voltage of 55 V DC. A test procedure for connectors for use with Type 1 and Type 2 is defined in IEC 60512-99-001.

Table A.1 – Maximum electrical circuit current per IEEE 802.3

PSE type	Nominal highest current per pair A	Number of powered pairs
Type 1	0,350	2
Type 2	0,600	2
Type 3	0,6	2 or 4
Type 4	0,6	2
Type 4	0,96	4

It is possible that confusion as to how to set the required voltages and currents may arise. Given below are a set of informative instructions as to how this may be achieved.

A.2 Rationale

The open circuit voltage requirement is stated such that during unmating under load, the stated voltage is available to 'drive' arcing.

Some power sources have an 'open circuit' setting which is used to clamp the voltage to prevent an over voltage condition. As no source voltage is stated for the supply in a constant voltage mode, an interpretation of the requirements could be to set some level of source voltage (the DC supply constant voltage setting) below, e.g., 55 V, and to set the maximum open circuit voltage at, e.g., 55 V. But, under this interpretation, upon unmating the constant voltage setting would not allow the voltage to reach the intended open circuit level.

A.3 Suggested setting instructions

The DC source voltage and variable resistors should be adjusted such that the current in each circuit (each mated pair of contacts within the connector under test) is the required value (e.g. 1,0 2,0 A) when mated and the open circuit voltage is the required value (e.g. 55 V) when unmated. For each test circuit the suggested setting instructions are as follows.

- a) With the DC power supply off and all variable resistors adjusted at a suitably high value (e.g. 200 Ω), perform the initial mating of the connector.
- b) Place the power supply in a constant voltage mode with the voltage adjustment set at 0 V, and the current adjustment at its maximum setting.
- c) Turn on the power supply.
- d) Adjust the constant voltage setting to the required voltage.
- e) Reduce the resistance of the variable resistor in each circuit until the required current value is flowing in the circuit being adjusted.

Bibliography

~~IEC TR 62652, Effects of engaging and separating under electrical load on connector interfaces in cabling used to support IEEE 802.3af (power over ethernet) applications~~

~~IEEE 802.3 Standard for Information technology — Telecommunications and information exchange between systems — Local and metropolitan area networks — Specific requirements — Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications — Amendment 3: Data Terminal Equipment (DTE) — Power via the Media Dependent Interface (MDI) Enhancements~~

IEC 60512-99-001, Connectors for electronic equipment – Tests and measurements – Part 99-001: Test schedule for engaging and separating connectors under electrical load – Test 99a: Connectors used in twisted pair communication cabling with remote power

ISO/IEC 11801-1: Information technology – Generic cabling for customer premises – Part 1: General requirements

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**Connectors for electrical and electronic equipment – Tests and measurements –
Part 99-002: Endurance test schedules – Test 99b: Test schedule for unmating
under electrical load**

**Connecteurs pour équipements électriques et électroniques – Essais et
mesures –**

**Partie 99-002: Programmes d'essais d'endurance – Essai 99b: Programme
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TESTS AND MEASUREMENTS –****Part 99-002: Endurance test schedules –
Test 99b: Test schedule for unmating under electrical load****FOREWORD**

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IEC 60512-99-002 has been prepared by subcommittee 48B: Electrical connectors, of IEC technical committee 48: Electrical connectors and mechanical structures for electrical and electronic equipment. It is an International Standard.

This second edition cancels and replaces the first edition published in 2019. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) Test group UEL has been revised with respect to the order of the test phases, the test severities and the requirements.

The text of this International Standard is based on the following documents:

Draft	Report on voting
48B/2922/FDIS	48B/2938/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

A list of all parts in the IEC 60512 series, published under the general title *Connectors for electrical and electronic equipment – Tests and measurements*, can be found on the IEC website.

Future standards in this series will carry the new general title as cited above. Titles of existing standards in this series will be updated at the time of the next edition.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

CONNECTORS FOR ELECTRICAL AND ELECTRONIC EQUIPMENT – TESTS AND MEASUREMENTS –

Part 99-002: Endurance test schedules – Test 99b: Test schedule for unmating under electrical load

1 Scope

This part of IEC 60512 is used for the assessment of connectors within the scope of SC 48B that are used in twisted pair communication cabling with remote power, such as ISO/IEC 11801-1 Class D, or better, balanced cabling in support of IEEE 802.3bt™ (Power over Ethernet, supporting up to 90 W from the power sourcing equipment).

The object of this document is to detail a test schedule to determine the ability of sets of connectors to withstand a minimum of 100 mechanical operations with electrical load, where an electrical current is being passed through the connectors in accordance with IEC 60512-9-3 during the separation (unmating) step.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 60512-1-1, *Connectors for electronic equipment – Tests and measurements – Part 1-1: General examination – Test 1a: Visual examination*

IEC 60512-2-1, *Connectors for electronic equipment – Tests and measurements – Part 2-1: Electrical continuity and contact resistance tests – Test 2a: Contact resistance – Millivolt level method*

IEC 60512-3-1, *Connectors for electronic equipment – Tests and measurements – Part 3-1: Insulation tests – Test 3a: Insulation resistance*

IEC 60512-4-1, *Connectors for electronic equipment – Tests and measurements – Part 4-1: Voltage stress tests – Test 4a: Voltage proof*

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

IEC 60512-11-7, *Connectors for electronic equipment – Tests and measurements – Part 11-7: Climatic tests – Test 11g: Flowing mixed gas corrosion test*

IEEE Std 802.3™-2018, *IEEE Standard for Ethernet*

IEEE Std 802.3bt™-2018, *IEEE Standard for Ethernet. Amendment 2: Physical Layer and Management Parameters for Power over Ethernet over 4 pairs*

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

4 General

Although separating (unmating) connectors under the scope of this document, while used for remote powering, is a misuse of the connector, it may occur in practice.

This test schedule is suitable for verification of separating (unmating) of connectors under load conditions representative for Power over Ethernet Type 4 as specified per IEEE 802.3bt™. An application-specific current and the associated open circuit voltage are specified, that correspond with the current and voltage of the supported application.

5 Preparation of specimens

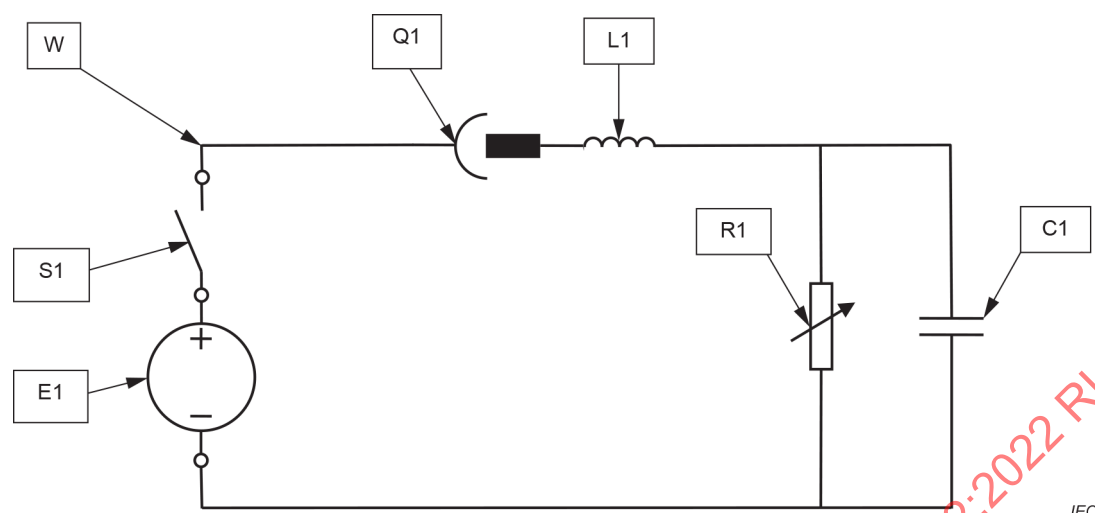
Each specimen shall consist of a mated set of connectors with its terminations. Specimens shall conform to the relevant IEC connector standard. Each free and each fixed connector shall be terminated with 3 m (max.) of the maximum conductor size cable for which it is intended to be terminated, according to the appropriate IEC standard(s). Fixed connectors may alternatively be terminated using a printed circuit board which shall not influence the test results.

For each specimen, all circuits (mated contacts) shall be wired in parallel as given in IEC 60512-9-3, and all circuits shall be tested.

6 Test circuit requirements

6.1 General

The values for the circuit components and the details of the test circuit, referenced in IEC 60512-9-3, shall be as shown in Figure 1.

**Key**

- W Cables in accordance with Clause 5
- Q1 Specimen under test
- L1 Inductor, $L = 100 \mu\text{H}$
- R1 Variable resistor (e.g. $R = 25 \Omega$ to 300Ω)
- C1 Capacitor, $C = 5 \mu\text{F}$
- E1 Voltage source
- S1 Switch

Figure 1 – Test circuit details

NOTE 1 Only one circuit of the specimen under test, as referenced in IEC 60512-9-3, is shown for clarity. Items W, L1, R1 and C1 are replicated for each circuit of the specimen. Items E1 and S1 may be single or multiple. All circuits of the specimen are wired in parallel with appropriate duplication of circuit components, and all circuits of the specimen are operated simultaneously.

NOTE 2 The variable resistor is used to adjust the current to the specified value.

6.2 Voltage and current

The variable resistor(s) shall be set so that the electrical current in each circuit (mated contacts) of the specimen is $2,0^{+0,05}_0$ A. During the separation (unmating) step, the open circuit voltage, in all circuits, shall be 55^{+1}_0 V DC. During the engagement (mating) step, the open circuit voltage, in all circuits, shall be 0 V DC by operating the switch, S1, before each connector engagement (mating).

IEEE 802.3™-2018 and IEEE 802.3bt™ specify Power over Ethernet systems with a nominal highest current per pair depending on the type of power sourcing equipment (PSE) and the number of powered pairs, and with an open circuit voltage of 55 V DC.

For PSE Type 4, the nominal highest current per pair is 0,96 A when all four pairs are powered, giving a total source current of 1,92 A. The test current per contact has been set to 2,0 A to represent the highly probable case that one contact is separated after all others, causing this contact to carry the full current just before disconnecting.

As the resistive load is likely to rise due to heating and due to wear of contacts in the connector under test, care should be placed in keeping the value of test current within the specified tolerance range, e.g. by means of a suitable feedback control circuit acting on the value of the variable resistor. See Annex A (informative) for further guidance.

6.3 Auxiliary equipment

Switches may be used to reverse polarity. However, use of such switches shall not influence the test parameters.

7 Test methods

7.1 Mechanical operations with electrical load

An electrical load, current and open circuit voltage, as detailed in 6.2, shall be applied to each specimen.

For the purpose of this test, one connector shall be fixed and the other disengaged at a speed of $150 \text{ mm/s} \pm 10 \text{ mm/s}$.

One engagement and one separation constitute one cycle.

25 cycles at one polarity of the DC source shall be performed. The polarity of the DC source shall then be reversed and 25 further cycles at the other polarity shall be performed (50 cycles total). The electrical current shall be applied during the separation step only.

7.2 Flowing mixed gas corrosion

The flowing mixed gas corrosion test shall be performed according to IEC 60512-11-7, method 1, with a test duration of 4 days. Half of the specimens shall be unmated and the other half shall be left mated during the test.

8 Tests and test schedule – Test group UEL 1

A minimum of 8 specimens shall be prepared for this group; then tested according to Table 1.

Table 1 – Test group UEL 1

Test phase	Test			Measurement to be performed		
	Title	IEC 60512 test No.	Severity or condition of test	Title	IEC 60512 test No.	Requirements
UEL 1.1	General examination			Visual examination	1a	There shall be no defects that would impair normal operation
UEL 1.2				Contact resistance- Millivolt level method	2a	As specified in the relevant connector standard
UEL 1.3			100 V DC Method A Mated connectors	Insulation resistance	3a	500 MΩ minimum
UEL 1.4			Contact to contact 1 000 V DC or 1 000 V AC peak. All signal contacts to shield and test panel, as applicable 1 500 V DC or 1 500 V AC peak. Method A Mated connectors	Voltage proof	4a	There shall be no breakdown or flashover
UEL 1.5	Mechanical operations with electrical load	9c	Per 7.1			
UEL 1.6	Flowing mixed gas corrosion test	11g	Per 7.2			
UEL 1.7				Contact resistance- Millivolt level method	2a	20 mΩ maximum change from initial
UEL 1.8	Mechanical operations with electrical load	9c	Per 7.1			
UEL 1.9			Contact resistance	Contact resistance- Millivolt level method	2a	20 mΩ maximum change from initial
UEL 1.10			100 V DC Method A Mated connectors	Insulation resistance	3a	500 MΩ minimum

Test phase	Test			Measurement to be performed		
	Title	IEC 60512 test No.	Severity or condition of test	Title	IEC 60512 test No.	Requirements
UEL 1.11			Contact to contact 1 000 V DC or 1 000 V AC peak. All signal contacts to shield and test panel, as applicable 1 500 V DC or 1 500 V AC peak. Method A Mated connectors	Voltage proof	4a	There shall be no breakdown or flashover
UEL 1.12	General examination			Visual examination	1a	There shall be no defects that would impair normal operation. However, physical deterioration of the contacts may be observed. Such deterioration shall not be cited as a failure of this test.

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Annex A (informative)

Test voltage and current setting instructions

A.1 General

IEEE 802.3™-2018 and IEEE 802.3bt™ specify Power over Ethernet systems with a nominal highest current per pair as shown in Table A.1 and an open circuit voltage of 55 V DC. A test procedure for connectors for use with Type 1 and Type 2 is defined in IEC 60512-99-001.

Table A.1 – Maximum electrical circuit current per IEEE 802.3

PSE type	Nominal highest current per pair A	Number of powered pairs
Type 1	0,350	2
Type 2	0,600	2
Type 3	0,6	2 or 4
Type 4	0,6	2
Type 4	0,96	4

It is possible that confusion as to how to set the required voltages and currents may arise. Given below are a set of informative instructions as to how this may be achieved.

A.2 Rationale

The open circuit voltage requirement is stated such that during unmating under load, the stated voltage is available to 'drive' arcing.

Some power sources have an 'open circuit' setting which is used to clamp the voltage to prevent an over voltage condition. As no source voltage is stated for the supply in a constant voltage mode, an interpretation of the requirements could be to set some level of source voltage (the DC supply constant voltage setting) below, e.g., 55 V, and to set the maximum open circuit voltage at, e.g., 55 V. But, under this interpretation, upon unmating the constant voltage setting would not allow the voltage to reach the intended open circuit level.

A.3 Suggested setting instructions

The DC source voltage and variable resistors should be adjusted such that the current in each circuit (each mated pair of contacts within the connector under test) is the required value (e.g. 2,0 A) when mated and the open circuit voltage is the required value (e.g. 55 V) when unmated. For each test circuit the suggested setting instructions are as follows.

- a) With the DC power supply off and all variable resistors adjusted at a suitably high value (e.g. 200 Ω), perform the initial mating of the connector.
- b) Place the power supply in a constant voltage mode with the voltage adjustment set at 0 V, and the current adjustment at its maximum setting.
- c) Turn on the power supply.
- d) Adjust the constant voltage setting to the required voltage.
- e) Reduce the resistance of the variable resistor in each circuit until the required current value is flowing in the circuit being adjusted.

Bibliography

IEC 60512-99-001, *Connectors for electronic equipment – Tests and measurements – Part 99-001: Test schedule for engaging and separating connectors under electrical load – Test 99a: Connectors used in twisted pair communication cabling with remote power*

ISO/IEC 11801-1: *Information technology – Generic cabling for customer premises – Part 1: General requirements*

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COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

**CONNECTEURS POUR ÉQUIPEMENTS ÉLECTRIQUES ET
ÉLECTRONIQUES – ESSAIS ET MESURES –****Partie 99-002: Programmes d'essais d'endurance –
Essai 99b: Programme d'essai pour le désaccouplement sous charge
électrique****AVANT-PROPOS**

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L'IEC 60512-99-002 a été établie par le sous-comité 48B: Connecteurs électriques, du comité d'études 48 de l'IEC: Connecteurs électriques et structures mécaniques pour les équipements électriques et électroniques. Il s'agit d'une Norme internationale.

Cette deuxième édition annule et remplace la première édition parue en 2019. Cette édition constitue une révision technique.

Cette édition inclut les modifications techniques majeures suivantes par rapport à l'édition précédente:

- a) Le groupe d'essais UEL a été révisé en ce qui concerne l'ordre des phases d'essai, des sévérités d'essai et des exigences.

Le texte de cette Norme internationale est issu des documents suivants:

Projet	Rapport de vote
48B/2922/FDIS	48B/2938/RVD

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à son approbation.

La langue employée pour l'élaboration de cette Norme internationale est l'anglais.

Ce document a été rédigé selon les Directives ISO/IEC, Partie 2, il a été développé selon les Directives ISO/IEC, Partie¹ et les Directives ISO/IEC, Supplément IEC, disponibles sous www.iec.ch/members_experts/refdocs. Les principaux types de documents développés par l'IEC sont décrits plus en détail sous www.iec.ch/standardsdev/publications.

Une liste de toutes les parties de la série IEC 60512, publiées sous le titre général *Connecteurs pour équipements électroniques – Essais et mesures*, se trouve sur le site web de l'IEC.

Les futures normes de cette série porteront le nouveau titre général cité ci-dessus. Le titre des normes qui existent déjà dans cette série sera mis à jour lors de leur prochaine édition.

Le comité a décidé que le contenu de ce document ne sera pas modifié avant la date de stabilité indiquée sur le site web de l'IEC sous webstore.iec.ch dans les données relatives au document recherché. A cette date, le document sera

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CONNECTEURS POUR ÉQUIPEMENTS ÉLECTRIQUES ET ÉLECTRONIQUES – ESSAIS ET MESURES –

Partie 99-002: Programmes d'essais d'endurance – Essai 99b: Programme d'essai pour le désaccouplement sous charge électrique

1 Domaine d'application

La présente partie de l'IEC 60512 est utilisée pour évaluer des connecteurs relevant du domaine d'application du SC 48B, qui sont utilisés dans les câblages de communication à paires torsadées permettant une alimentation à distance, tels que les câbles à paires symétriques conformes à la classe D de l'ISO/IEC 11801-1 ou à une classe supérieure, à l'appui de la norme IEEE 802.3bt™ (Power over Ethernet (alimentation électrique par câble Ethernet), prenant en charge jusqu'à 90 W provenant de l'équipement de source d'alimentation).

L'objet du présent document est de détailler un programme d'essai permettant de déterminer l'aptitude des jeux de connecteurs à supporter au moins 100 manœuvres mécaniques avec charge électrique lorsqu'un courant électrique traverse les connecteurs conformément à l'IEC 60512-9-3 pendant la séparation (désaccouplement).

2 Références normatives

Les documents suivants sont cités dans le texte de sorte qu'ils constituent, pour tout ou partie de leur contenu, des exigences du présent document. Pour les références datées, seule l'édition citée s'applique. Pour les références non datées, la dernière édition du document de référence s'applique (y compris les éventuels amendements).

IEC 60512-1-1, *Connecteurs pour équipements électroniques – Essais et mesures – Partie 1-1: Examen général – Essai 1a: Examen visuel*

IEC 60512-2-1, *Connecteurs pour équipements électroniques – Essais et mesures – Partie 2-1: Essais de continuité électrique et de résistance de contact – Essai 2a: Résistance de contact – Méthode du niveau des millivolts*

IEC 60512-3-1, *Connecteurs pour équipements électroniques – Essais et mesures – Partie 3-1: Essais d'isolement – Essai 3a: Résistance d'isolement*

IEC 60512-4-1, *Connecteurs pour équipements électroniques – Essais et mesures – Partie 4-1: Essais de contrainte diélectrique – Essai 4a: Tension de tenue*

IEC 60512-9-3, *Connecteurs pour équipements électroniques – Essais et mesures – Partie 9-3: Essais d'endurance – Essai 9c: Fonctionnement mécanique (d'accouplement et de désaccouplement) avec charge électrique*

IEC 60512-11-7, *Connecteurs pour équipements électroniques – Essais et mesures – Partie 11-7: Essais climatiques – Essai 11g: Essai de corrosion dans un flux de mélange de gaz*

IEEE Std 802.3™-2018, *IEEE Standard for Ethernet*

IEEE Std 802.3bt™-2018, *IEEE Standard for Ethernet. Amendment 2: Physical Layer and Management Parameters for Power over Ethernet over 4 pairs*

3 Termes et définitions

Aucun terme n'est défini dans le présent document.

L'ISO et l'IEC tiennent à jour des bases de données terminologiques destinées à être utilisées en normalisation, consultables aux adresses suivantes:

- IEC Electropedia: disponible à l'adresse <http://www.electropedia.org/>
- ISO Online browsing platform: disponible à l'adresse <http://www.iso.org/obp>

4 Généralités

Bien que la séparation (désaccouplement) de connecteurs relevant du domaine d'application du présent document, utilisés pour l'alimentation à distance, soit un usage inapproprié du connecteur, ce scénario peut se produire dans la pratique.

Ce programme d'essai est approprié pour vérifier la séparation (désaccouplement) des connecteurs en conditions de charge représentatives de l'alimentation électrique par câble Ethernet de Type 4, conformément à la norme IEEE 802.3bt™. Une intensité spécifique à l'application et la tension en circuit ouvert associée sont spécifiées; elles correspondent à l'intensité et à la tension de l'application prise en charge.

5 Préparation des spécimens

Chaque spécimen doit consister en un jeu de connecteurs accouplés avec leurs sorties. Les spécimens doivent être conformes à la norme de connecteur IEC pertinente. Chaque fiche et chaque embase doivent comporter sur leur sortie une longueur (maximale) de 3 m de câble présentant la section de conducteur maximale à laquelle elles sont destinées, conformément à la ou aux normes IEC appropriées. Les embases peuvent par ailleurs être équipées en sortie d'une carte de circuit imprimé qui ne doit pas avoir d'impact sur les résultats d'essai.

Pour chaque spécimen, tous les circuits (contacts accouplés) doivent être câblés en parallèle, comme indiqué dans l'IEC 60512-9-3, et tous les circuits doivent être soumis à l'essai.

6 Exigences relatives au circuit d'essai

6.1 Généralités

Les valeurs des composants du circuit et les détails du circuit d'essai, référencés dans l'IEC 60512-9-3, doivent être comme représentés à la Figure 1.