

# Overview of recent IEC activities and thoughts on preferred isolation voltages

## 802.3 Isolation Ad Hoc Meeting

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IEC activities & preferred isolation voltages

# Recent IEC activities — Documents under revision

- IEC TC 108:
  - 108/719/DC for IEC TR 62102-3: Electrical safety – classification of interfaces for equipment to be connected to information and communications technology networks.
- IEC TC 109:
  - 109/179/CDV for IEC 60664-1 ED3: Insulation coordination for equipment within low-voltage supply systems - Part 1: Principles, requirements and tests.
- IEC TC 64
  - 64/2358/CD for IEC TS 61200-102 ED1: Electrical installation guide, Part 102: Application guide on Low Voltage direct current electrical installation not intended to be connected to Public Distribution Network
  - 64/2346/CD for Part 7-720: Requirements for special installations or locations — DC power supply system in the data centre
  - 64/2280/CD for IEC 60364-7-716 ED1: Low-Voltage electrical installations - Part 7-716: Requirements for special installations or locations – DC power distribution over Information Technology Cable Infrastructure

## Recent IEC activities — Published

- IEC 62368-3:2017:
  - Audio/video, information and communication technology equipment - Part 3: Safety aspects for DC power transfer through communication cables and ports.
- IEC 62368-1:2018:
  - Audio/video, information and communication technology equipment - Part 1: Safety requirements.

## Recent IEC activities — Implications to Isolation clause – 1

- 108/719/DC for IEC TR 62102-3: Annex B, (informative), Worked examples of certain network interfaces
  - IEEE 802.3 can be Network environment 0 (no transient overvoltages) or 1 (transient overvoltages).
- 109/179/CDV for IEC 60664-1 ED3: (4 Basic technical characteristics for insulation coordination)
  - If any risk, “functional insulation shall be designed according to the requirements of basic insulation, as a minimum”.
  - Equipment of overvoltage category II is energy-consuming equipment to be supplied from the fixed installation.
  - Basic insulation overvoltage category II is type tested for 2.5 kV 1.2/50. (for a mains of up to 300 V a.c.)
- 64/2358/CD for IEC TS 61200-102 ED1: Benign
- 64/2346/CD for Part 7-720: Covers +200 V d.c. and -200 V d.c. supply for data centres
- 64/2280/CD for IEC 60364-7-716 ED1: 716.523.2.101 Limits maximum single conductor current to 0.75 A d.c.

## Recent IEC activities — Implications to Isolation clause – 2

- IEC 62368-1:2018: 5.4.9 Electric strength test
  - Basic insulation overvoltage category II is **type** tested for 2.5 kV 1.2/50 at 1767 V a.c or 2.5 kV d.c. The voltage applied to the insulation under test is gradually raised from zero to the prescribed voltage and maintained at that value for 60 s. (values for a mains of up to 300 V a.c.)
  - Basic insulation overvoltage category II is **routine** tested for 2.25 kV 1.2/50 at 1590 V a.c. or 2.25 kV d.c. (**type** test voltage reduced by 10 %).
- IEC 62368-1:2018: Table 13 – External circuit transient voltages

ID	Cable type	Additional conditions	Transient voltages
1	Paired conductor a – shielded or unshielded	The building or structure may or may not have equipotential bonding.	1.5 kV 10/700 Only differential if one conductor is earthed in the equipment
2	Any other conductors	The external circuit is not earthed at either end, but there is an earth reference (for example, from connection to mains).	Mains transient voltage or external circuit transient voltage of the circuit from which the circuit in question is derived whichever is higher.

- IEC 62368-3:2017: Benign

# IEC 62368-1:2018: Table 13 – External circuit transient voltages ID 1

- 1.5 kV 10/700 (long cable) history
  - ID 1 uses a transient voltage justified by a 1995 ITU International study involving Canada, France, Germany, Italy, Japan and the USA “The protection of telecommunications lines and equipment against lightning discharges” (Chapter 10). The study concluded that, based on rural data, the test voltage 1.5 kV, 10/700, requested by the Recommendation K.21 for the subscriber’s POTS terminal, represents an overvoltage with a probability between  $2\sigma$  (97.7%) and  $3\sigma$  (99.86%). Most of the measurements were done with cable lengths of over 5 km, sometimes tens of km.
  - Today broadband ICT equipment requires the use of much shorter lines e.g. Gfast (FTTdp) typically has a powering reach limit of 250 m (ETSI TS 101 548). Long distance cable waveform dispersion causes a reduction of overvoltage amplitude and waveshape lengthening. Significant dispersion does not happen in short cables, leading to overvoltage transients with higher voltage amplitudes and shorter waveshapes. Thus the transient overvoltage of ID 1 is inappropriate for short cables. ETSI recommends the use of IEC 61000-4-5 and Recommendation ITU-T K.21 for testing short network cables.

## Typical existing IEEE 802.3 Isolation requirement clause

This electrical isolation shall withstand at least one of the following electrical strength tests:

- a) 1500 V rms at 50 Hz to 60 Hz for 60 s, applied as specified in *Section 5.2.2 of IEC 60950-1:2001*.
- b) 2250 V dc for 60 s, applied as specified in *Section 5.2.2 of IEC 60950-1:2001*.
- c) A sequence of ten 2400 V impulses of alternating polarity, applied at intervals of not less than 1 s. The shape of the impulses is 1.2/50  $\mu$ s (1.2  $\mu$ s virtual front time, 50  $\mu$ s virtual time or half value), as defined in *Annex N of IEC 60950-1:2001*.

There shall be no insulation breakdown, as defined in *Section 5.2.2 of IEC 60950-1:2001*, during the test. The resistance after the test shall be at least 2 M $\Omega$ , measured at 500 V dc.

## Conversion of IEEE 802.3 Isolation IEC 60950-1 references to IEC 62368-1 references — 1

- Problem 1:
  - IEC 62368-1 5.4.9.2 routine test values are 1590 V a.c. or 2.25 kV d.c. for 1 s to 4 s and not at 1500 V rms at 50 Hz to 60 Hz for 60 s and 2250 V dc for 60 s.
  - IEC 62368-1 5.4.9.1 type test values are 1767 V a.c or 2.5 kV d.c. for 60 s and not at 1500 V rms at 50 Hz to 60 Hz for 60 s and 2250 V dc for 60 s.
- Possible solution
  - Let IEEE 802.3 define the test levels and IEC 62368-1 to define the procedure.
    - a) 1500 V rms at 50 Hz to 60 Hz, applied as specified in *Section 5.4.9.1 of IEC 62368-1:2018*.
    - b) 2250 V dc, applied as specified in *Section 5.4.9.1 of IEC 62368-1:2018*.

## Conversion of IEEE 802.3 Isolation IEC 60950-1 references to IEC 62368-1 references — 2

- Problem 2:
    - IEC 62368-1 5.4.9 Electric strength test does not have impulse voltage testing, only AC and DC voltage testing.
    - ID 1 impulse value is environmental and wrong for short <250 m cables
  - Possible solution
    - Let IEEE 802.3 define the test levels (as before) and IEC 62368-1 define the waveshape.
- c) A sequence of ten 2400 V impulses of alternating polarity, applied at intervals of not less than 1 s. The shape of the impulses is 1.2/50  $\mu$ s (1.2  $\mu$ s virtual front time, 50  $\mu$ s virtual time or half value), as defined in *Annex D of IEC 62368-1:2018*.

## Conversion of IEEE 802.3 Isolation IEC 60950-1 references to IEC 62368-1 references — 3

- Problem 3:
  - Find substitute for “There shall be no insulation breakdown, as defined in *Section 5.2.2 of IEC 60950-1:2001*, during the test.”

- Solution

There shall be no insulation breakdown, as defined in *Section 5.4.9.1 of IEC 62368-1:2018*.

# Conversion of IEEE 802.3 Isolation IEC 60950-1 references to IEC 62368-1 references — 4

- Problem 4:

- *Section 5.4.9.1 of IEC 62368-1:2018* for AC and DC voltage testing contains “Components providing a DC path in parallel with the insulation to be tested, such as discharge resistors for filter capacitors and voltage limiting devices, may be disconnected”.
- The AC and DC test voltage source impedance is not defined because it was assumed the insulation would not take much current. Voltage limiters, which bridge the insulation, and have an operating voltage below the test voltage, would operate and take large currents causing a test failure. That is the reason for the “may be disconnected” option.
- Any bridging voltage limiters have a minimum voltage requirement, due to the real life risk of the Ethernet cable conductors coming into contact with AC mains voltages. AC mains contact can apply up to 360 V peak to the voltage limiter. If the voltage limiter conducts, the current flow could cause overheating and possibly a fire hazard. Currently, it is expected that UL 62368-1 will incorporate the AC mains contact test from UL 60950-1 (the ITU-T already has a mains contact test for Ethernet equipment). To avoid voltage limiter operation under AC mains contact, its limiting voltage should ideally be above 500 V d.c. level used for the insulation resistance test.

- Solution

Change “The resistance after the test shall be at least 2 MΩ, measured at 500 V dc” to “The resistance after the test with the replacement of any components removed for AC or DC voltage testing shall be at least 2 MΩ, measured at 500 V dc”

## Conversion of IEEE 802.3 Isolation IEC 60950-1 references to IEC 62368-1 references — 5

- 500 V dc IEC 62368-1 reference:
  - 5.4.5.3 Compliance criteria  
Compliance is checked by measuring the insulation resistance with 500 V d.c.  
The equipment complies with the requirement if the insulation resistance measured after 1 min is not less than the values given in Table 23.

Table 23 – Values for insulation resistance

Insulation requirements between parts	Insulation resistance MΩ
Between parts separated by basic insulation or by supplementary insulation	2
Between parts separated by double insulation or reinforced insulation	4

- Option

Change “The resistance after the test shall be at least 2 MΩ, measured at 500 V dc” to Change “The resistance after the test shall be at least 2 MΩ, measured at 500 V dc” to “The resistance after the test with the replacement of any components removed for AC or DC voltage testing shall be at least 2 MΩ, measured at 500 V dc as specified in **Table 23 of IEC 62368-1:2018.**”

## IEEE 802.3 Isolation requirement clause proposal

This electrical isolation shall withstand at least one of the following electrical strength tests:

- a) 1500 V rms at 50 Hz to 60 Hz, applied as specified in *Section 5.4.9.1 of IEC 62368-1:2018*.
- b) 2250 V dc, applied as specified in *Section 5.4.9.1 of IEC 62368-1:2018*.
- c) A sequence of ten 2400 V impulses of alternating polarity, applied at intervals of not less than 1 s. The shape of the impulses is 1.2/50  $\mu$ s (1.2  $\mu$ s virtual front time, 50  $\mu$ s virtual time or half value), as defined in *Annex D of IEC 62368-1:2018*.

There shall be no insulation breakdown, as defined in *Section 5.4.9.1 of IEC 62368-1:2018*, during the test. The resistance after the test with the replacement of any components removed for AC or DC voltage testing shall be at least 2 M $\Omega$ , measured at 500 V dc as specified in *Table 23 of IEC 62368-1:2018*.