Regulatory 802.3 & IEC 950

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Review of IEEE 802.3 Isolation Requirements

- 10BASE-T
- 1000BASE-T
- Multi-Port Devices
  - Repeaters
  - Switches

10BASE-T Isolation

14.3.1.1 Isolation requirement

The MAU shall provide isolation between the DTE Physical Layer circuits including frame ground and all MDI leads including those not used by 10BASE-T. This electrical separation shall withstand at least one of the following electrical strength tests.

a) 1500 Vrms at 50 Hz to 60 Hz for 60 s, applied as specified in Section 5.3.2 of IEC 60950: 1991.

b) 2250 Vdc for 60 s, applied as specified in Section 5.3.2 of IEC 60950: 1991.

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 shall be 1.2/50 µs (1.2 µs virtual front time, 50 µs virtual time of half value), as defined in IEC 60060. There shall be no insulation breakdown, as defined in Section 5.3.2 of IEC 60950: 1991, during the test. The resistance after the test shall be at least 2 MΩ, measured at 500 Vdc.

1000BASE-T Isolation

40.6.1.1 Isolation requirement

The PHY shall provide electrical isolation between the port device circuits, including frame ground (if any) and all MDI leads. This electrical separation 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 5.3.2 of IEC 60950: 1991.

b) 2250 Vdc for 60 s, applied as specified in Section 5.3.2 of IEC 60950: 1991.

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 shall be 1.2/50 μs (1.2 μs virtual front time, 50 μs virtual time or half value), as defined in IEC 60060. There shall be no insulation breakdown, as defined in Section 5.3.2 of IEC 60950: 1991, during the test. The resistance after the test shall be at least 2 MΩ, measured at 500 Vdc.

What about multi-Port devices ?

- Repeater specification provides Isolation requirements for two ‘Environments’
  - Environment A - Intra-Building
  - Environment B - Inter-Building
- There are no electrical requirements in the IEEE 802.1D Bridge specification

Repeater

9.7 Electrical isolation

There are two electrical power distribution environments to be considered that require different electrical isolation properties.

Environment A -When a LAN or LAN segment, with all its associated interconnected equipment, is entirely contained within a single low-voltage power distribution system and within a single building.
Environment B -When a LAN crosses the boundary between separate power distribution systems or the boundaries of a single building.

The repeater unit shall comply with applicable local and national codes related to safety. See [B20].

Repeater - Environment A

9.7.1 Environment A requirements

Attachment of network segments via repeaters (sets) possessing internal MAUs requires electrical isolation of 500 Vrms, 1 min withstand, between the segment and the protective ground of the repeater unit.

For repeater ports that connect to external MAUs via an AU Interface, the requirement for isolation is encompassed within the isolation requirements of the basic MAU/medium standard. (See 8.3.2.1, 9.9.3.1, 10.4.2.1, 14.3.1.1, and 15.3.4.) The repeater unit shall not require any electrical isolation between exposed AU Interfaces or between exposed AU Interfaces and chassis ground of the repeater unit. No isolation boundary need therefore exist at any AUI compatible interface (that is, “D” connector) provided by a repeater unit.

Repeater - Environment B

9.7.2 Environment B requirements

The attachment of network segments, which cross environment A boundaries, requires electrical isolation of 1500 V rms, 1 min withstand, between each segment and all other attached segments and also the protective ground of the repeater unit.

If segments are of an electrically conductive medium, it is recommended that this isolation be provided by the use of external MAUs connected by AU Interfaces. If internal MAUs are used for attachment to conductive media segments, then the segments shall be installed such that it is not possible for an equipment user to touch the trunk cable screen or signal conductor. A repeater of this variety requires professional installation.

The requirements for interconnected electrically conducting LAN segments that are partially or fully external to a single building environment may require additional protection against lightning strike hazards. Such requirements are beyond the scope of this standard.

The Low Voltage Directive

- One International std: IEC 950 - Information Processing and Business Equipment
  - Purpose: Safety of Information Technology Equipment
- Several regional variants, inc
  - US: UL 1950 - information processing and Business equipment
  - Europe: EN 60950 - information processing and Business equipment
- Scope: Any equipment designed for use with a voltage rating of:
  - 50V to 1000V AC peak
  - 70V to 1500V DC

EN 60950

- Purpose (paraphrased)
  - take all appropriate measures to ensure that electrical equipment may be placed on the market only if, having been constructed in accordance with good engineering practice in safety matters, it does not endanger the safety of persons, domestic animals or property when properly installed and maintained and used in applications for which it was made.
- 2 Key Aspects:
  - Insulation
  - Fire Safety Requirements

- (the following 2 slides are taken from a web doc by: Iain G Moffat - reproduced as per copyright Guidelines in that document)

IEC 950 / EN60950

INSULATION:

Insulation is provided as protection from electric shock (mainly). Three classes of circuit are recognised. They should be insulated from each other (and the outside world).

Hazardous Voltage:
Circuits presenting voltages of more than 42.4V peak or 60V DC between any two points. These circuits are deemed to present a risk of electric shock if they come into contact with humans, animals, or a telephone network.

Telecommunications Network Voltage (**TNV**):
Circuits connected to a telecommunications network either directly or through components that do not constitute an isolation barrier (isolation requires transformers or opto-couplers of 3KV plus rating and 6mm plus pin spacing). It is assumed that if the telecommunications network is correctly implemented it will never present an input of greater than 1.5KV.

Safe Extra low Voltage (**SELV**) and Extra Low Voltage (ELV):
Circuits in which the voltage does not exceed 42.4V peak or 60V DC either between any two points of the circuit or to earth. Isolation requirements from hazardous or TNV circuits are comparable to those between TNV and other circuits. SELV circuits must also meet maximum fault current and maximum stored energy limits.

There are three classes of insulated equipment or appliance:

CLASS I:
Equipment relying on an earthed conducting enclosure and a fuse to disconnect the supply in the event of a short-circuit from LV circuits to the enclosure.

CLASS II:
Equipment with only 'Live' and 'Neutral' leads and relying on double insulation (or, in some circumstances, a reinforced single layer) for safety.

CLASS III:
Equipment which contains only SELV circuits (for example, powered by dry batteries) and which does not generate hazardous voltages.

Nick Stapleton, 3Com, 04/03/2000

IEC950 / EN60950

Fire Safety Requirements

Faults or misuse of an appliance or equipment should not create a risk of fire. Equipment (or separately enclosed parts of an appliance or equipment) which may draw a current in excess of 8 amps under fault conditions must be contained in a fire enclosure. A fire enclosure must:

be made of metal or a self-extinguishing plastic rated 'UL94 V1' or better,
not permit burning material to fall out of vent holes.

The fault current may be limited to 8 amps or less by a fuse, by circuit design, or the internal resistance of a battery (but beware of users substituting dry cells with Ni-Cads).

Plastic materials have flammability ratings based on tests specified in UL94 (and also in IEC950/EN60950):

UL 1950

- Application of this standard is intended to prevent injury or damage due to the following hazards:
  - Electric shock
  - Energy hazards
  - Fire
  - Mechanical and heat hazards
  - Radiation hazards
  - Chemical hazards.

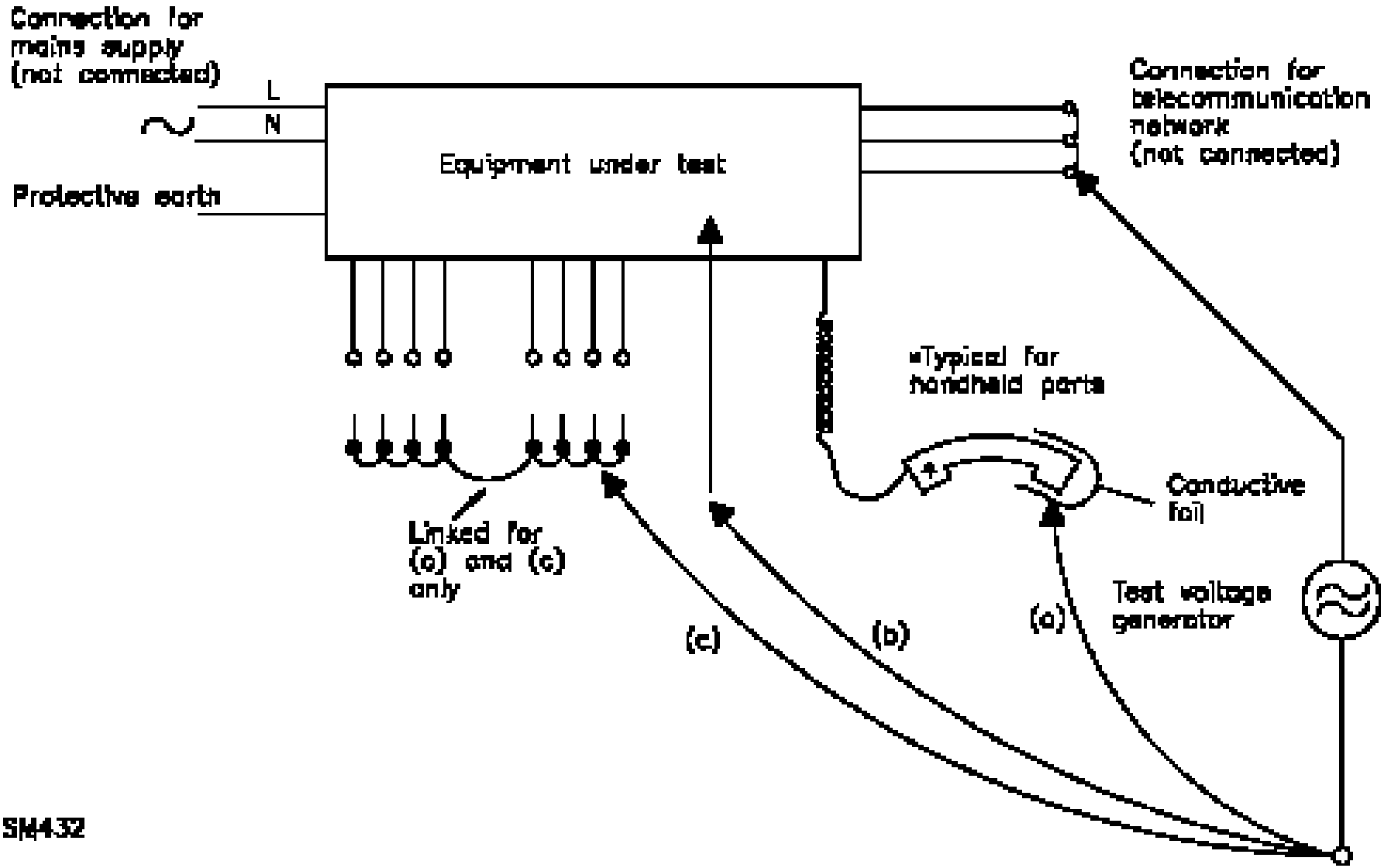
UL1950

- Key Definitions:
  - 1.1.1 Equipment covered by the standard
  - 1.2.4 Classes of equipment
  - 1.2.5 Connection to the supply
    - 1.2.5.1 - plugable eqpt type A (via outlets specd in IEC 83)
    - 1.2.5.2 - plugable eqpt type B (via outlets specd in IEC 309)
  - 1.2.6 Enclosures
  - 1.2.7 accessability
    - specifically 1.2.7.1 - operator access area
  - 1.2.8 Circuits and cct charecteristics
    - includes definitions for SELV, Primary, Secondary, etc ccts
  - 1.2.12 Power distribution
    - 1.2.12.3 IT Power system (isolated, chasis ground)
  - 1.2.14.7 Telecomunication network (definition, TNV)

UL1950

- Key sections:
  - 1.6 - Power Interface
  - 1.7.12 - High Leakage current (3.5mA)
  - 2.0 - Protection from Hazards
    - 2.1.5 Energy Hazard in operator access areas
    - 2.1.10 risk of shock from stored charge on capacitors
    - 2.2 Insulation requirements
    - 2.2.8.1 - Bridging capacitors
    - 2.3 SELV circuits
      - Shall be safe to touch, Both under normal conditions, and single fault, such as Breakdown of a layer of insulation.

UL 1950 section 6.4



UL1950

6.4 Protection of equipment users from overvoltages on telecommunication networks
6.4.1 Separation requirements:

Equipment shall provide adequate electrical separation between a TNV-1 CIRCUIT or a TNV-3 CIRCUIT and certain parts of the equipment. These parts are:

a) unearthed conductive parts and nonconductive parts of the equipment expected to be held or touched during normal use, e.g. a telephone handset or a keyboard;

b) parts and circuitry that can be touched by the test finger, figure 19, except contacts of connectors that cannot be touched by the test probe, figure 16;

c) circuitry which is provided for connection of other equipment, and telecommunication circuitry (other than earth) intentionally isolated from D2

TELECOMMUNICATION NETWORK conductors. This applies whether or not this circuitry is accessible. **It does not apply to circuitry intended to be connected to another equipment that is itself in compliance with 6.4.**

Digital equipment or dedicated systems of equipment that perform a digital line termination (such as NCTE and NT1) or similar function shall not conductively connect the TELECOMMUNICATION NETWORK to terminal equipment leads [point (c) above], and shall comply with these requirements.

These requirements do not apply where circuit analysis and equipment investigation indicate that safety is provided by other means, for example between two circuits each of which has a permanent connection to protective earth.

UL1950 - section 6.4.2

Compliance with 6.4.1 is checked by the test of either 6.4.2.1 or 6.4.2.2.

6.4.2.1 Impulse test

The electrical separation is subjected to ten impulses of alternating polarity, using the impulse test generator of annex N. The interval between successive impulses is 60 s and the initial voltage is:

— in case a) of 6.4.1: 2.5 kV;

— in cases b) and c): 1.5 kV.

NOTES

1 The value of 2.5 kV for case a) has been chosen primarily to ensure the adequacy of the insulation concerned and it does not necessarily simulate likely overvoltages.

2 In Austria, a value of U = 2.0 kV is used in cases b) and c).

6.4.2.2 Electric strength test

The electrical separation is subjected for 60 s to a substantially sinusoidal voltage having a frequency of 50 Hz or 60 Hz, or to a D.C. VOLTAGE equal to the peak value of the prescribed a.c. voltage.

The a.c. test voltage is:

— in case a) of 6.4.1: 1.5 kV;

— in cases b) and c): 1.0 kV.

The voltage is gradually raised from zero to the prescribed voltage and then held at that value for 60 s.

NOTE — Where there are capacitors across the insulation under test, it is recommended that d.c. test voltages are used.

In cases b) and c) it is permitted to remove surge suppressors, provided that such devices pass the impulse test of 6.4.2.1 for cases b) and c) when tested as components outside the equipment.

Credits

- The sections on the IEC950 / EN60950 stds are based on a Web presentation by: Iain G Moffat
  - the presentation can be found @ http://www.keme.co.uk/~g0ozs1/iee/lvd_talk/index.htm

Common Tests

ISO/IEC8802-3 (IEEE802.3)

Section 14.3.1.1 (Refers to IEC950 section 5.3.2)

Three isolation tests are listed, one of these must be met.

1) 1500V rms at 50 to 60 Hz for 60 seconds.
2) 2250V dc for 60 seconds
3) A sequence of ten 2400V impulses.

The voltage is applied between the MDI pins (shorted together) and chassis ground. In the case of 1 & 2, the voltage is gradually raised from zero to the prescribed voltage and held for 60 seconds. There shall be no breakdown of insulation during this test, the resistance after the test shall be at least 2MOhms, measured at 500Vdc. Repeat for all ports.

UL1950

Section 6.4.2.2 UL 'Case A'

1500V rms at 50 or 60 Hz for 60 seconds.

Or 2121V dc for 60 seconds (Peak value of above)

Again, the voltage is gradually raised from zero to the prescribed voltage and held for 60 seconds. The voltage is applied between the pins of one port (shorted together), and all adjacent ports (pins also shorted). There shall be no breakdown of insulation during this test. Repeat for all ports. A resistance measurement for this test is not necessary.