Table 43
Voltage drops and interruptions immunity test

Reference test	None
EUT configuration	According to manufacturer's specifications
Initial measurements	According to PFVP (2.5)
Supply voltage and frequency	U_e min to 0 (zero) V, F_n
Test description	–
AC supply interruption	–
Duration base	0,5 period, starting at zero-crossing (1), (2)
Number of trials	20
Time interval between trials	1 s < time interval < 10 s
–	–
DC supply interruption	–
Duration	PS1: ≥ 1 ms; PS2: ≥ 10 ms (2)
Number of trials	20
Time interval between trials	1 s < time interval < 10 s
Measurement and verification during loading	According to PFVP (2.5)
–	Normal operation shall be maintained (3)
–	–
Verification after tests	According to PFVP (2.5)
Performance criteria	A

(1) Optionally, the manufacturer may elect to interrupt supply at a random phase angle.

(2) The manufacturer may state longer interruptions.

(3) Fast responding inputs energized by the same power supply may be affected temporarily during the disturbance but shall resume normal operation after the disturbance.

10 Electromagnetic compatibility (EMC) information to be provided by the manufacturer

Information to be made available can be in other than printed form.

General rules of installation are noted in IEC 61131-4. Specific installation information shall be provided by the manufacturer.

The manufacturer shall state if its devices are intended to be used under normal service conditions or in a less severe environment (for example, office environment). If the PLC is intended for other than Zone B (which encompasses Zone A), the manufacturer shall state the intended zone.

The test report shall describe all the tests, the rationale for the selection of the typical (representative) configuration of the EUT and the test results.

The EUT software used during the test shall be documented.

10DV D2 *Modification of 10:*

This clause is informative.

11 Safety requirements

This section specifies safety requirements for PLC-systems equipment (i.e. MPU, RIOSs, permanently / non-permanently installed peripherals). Components connected to the mains power supply of the installation, such as power supplies, I/O modules, communication interfaces, and memory subsystems are also subject to the applicable provisions of this clause.

11.1 Protection against electrical shock

Protection against electric shock of the PLC-system shall be maintained in normal and singlefault condition. Accessible parts of equipment shall not be, or in the case of a single fault become, hazardous live. Although they are principally directed at enclosed equipment, these requirements also apply to open equipment. When applied to open equipment, the equipment shall be considered to be installed, according to the manufacturer's instructions.

Protection shall be by compliance with the dielectric strength requirements in 11.1.4, the operator accessibility requirements of 11.1.5, the normal condition requirements of 11.1.6, the single-fault requirements in 11.1.7 and the clearance and creepage requirements in 11.4.

SELV/PELV circuits do not pose a risk of electric shock and do not require additional evaluation.

11.1DV D2 *Modification of 11.1:*

Protection against electric shock is only required in normal conditions, and is demonstrated by compliance with the normal condition requirements of the following: dielectric strength requirements in 11.1.4, the shock protection requirements of 11.1.5, the normal condition requirements of 11.1.6, and the clearance and creepage requirements in 11.4.

11.101DV D2 *Addition to 11.1:*

Circuits identified in Annex DVD as not posing a risk of electric shock do not require additional evaluation other than as noted in Annex DVD.

11.1.1 Permissible limits for accessible parts

To ensure that accessible parts are not hazardous live, the voltage, current, charge or energy between an accessible part and reference test earth, or between any 2 accessible parts on the same piece of equipment within a distance of 1,8 m (over a surface or through air), shall not exceed the values of 11.1.1.1 in normal condition nor of 11.1.1.2 in single-fault condition.

The accessible voltage shall be measured. If the voltage is below the limit of 11.1.1.1 or 11.1.1.2 as applicable, accessible current and capacitance need not be measured. If the voltage exceeds that value, the current and capacitance shall be measured.

11.1.1.1 Values in normal condition

Values above the levels of a), b) or c) in normal condition are deemed to be hazardous live.

a) The voltage levels are a.c. 30 V r.m.s. and 42,4 V peak or d.c. 60 V.

b) If the voltage exceeds one of the values of a), the current levels are

– a.c. 0,5 mA r.m.s. for sinusoidal waveforms, 0,7 mA peak for non-sinusoidal waveform or mixed frequencies, or d.c. 2 mA, when measured with the measuring circuit of IEC 61010-1, Annex A, Figure A.1. Alternatively, the measuring circuit of IEC 61010-1, Annex A, Figure A.2 can be used if the frequency does not exceed 100 Hz;

– a.c. 70 mA r.m.s. when measured with the measuring circuit of IEC 61010-1, Annex A, Figure A.3.

NOTE This relates to possible burns at higher frequencies.

c) If the voltage exceeds one of the values of a), the charge or energy of capacitance levels are

– 45 µC charge for voltages up to 15 kV peak or d.c.;

– 350 mJ stored energy for voltages above 15 kV peak or d.c.

11.1.1.1DV D2 *Modification to part b) of 11.1.1.1:*

Reference UL 61010C-1, Annex A, Figures A.1, A.2 and A.3 for current measuring.

11.1.1.2 Values in single-fault condition

Values above the levels of a), b) or c) in single-fault condition are deemed to be hazardous live.

a) The voltage levels are a.c. 50 V r.m.s. and 70 V peak or d.c. 120 V.

b) If the voltage exceeds one of the values of a), the current levels are

– a.c. 3,5 mA r.m.s. for sinusoidal waveforms, 5 mA peak for non-sinusoidal waveform or mixed frequencies, or d.c. 15 mA, when measured with the measuring circuit of IEC 61010-1, Annex A, Figure A.1. Alternatively, the measuring circuit of IEC 61010-1, Annex A, Figure A.2 can be used if the frequency does not exceed 100 Hz;

– a.c. 500 mA r.m.s. when measured with the measuring circuit of IEC 61010-1, Annex A, Figure A.3.

NOTE This relates to possible burns at higher frequencies.

c) If the voltage exceeds one of the values of a), the capacitance levels are those of IEC 61010-1, Figure 2.

11.1.1.2DV.1 D2 *Modification to part b) and c) of 11.1.1.2:*

Reference UL 61010C-1, Annex A, Figures A.1, A.2 and A.3 for current measuring.

11.1.1.2DV.2 D2 *Modification of 11.1.1.2 by adding the following item d):*

d) Circuits identified in Annex DVD as not posing a risk of electric shock do not require additional evaluation other than as noted in Annex DVD.

11.1.2 Open PLC-system equipment

Open PLC-system equipment is equipment that may have live electrical parts accessible, for example, a main processing unit.

Protection against electric shock shall be provided for those interfaces that are intended for operator access (see Table 44 for clarification). No other means of protection against electric shock are required except the enclosure required for the ultimate application.

Open equipment is to be incorporated into other assemblies manufactured to provide safety.

11.1.3 Enclosed PLC-system equipment

Enclosed PLC-system equipment is equipment which is enclosed on all sides, with the possible exception of its mounting surface, to prevent personnel from accidentally touching live or moving parts contained therein, to protect the equipment against ingress of 12,5 mm diameter and greater solid foreign bodies, and meeting requirements of mechanical strength, flammability, and stability (where applicable). The protection degree must be ≥ IP20.

NOTE IP ratings as defined in IEC 60529.

As part of the requirement to provide protection against electrical shock, each entity of an enclosed PLC-system shall comply with the requirements of class I (see 11.1.3.1), class II (see 11.1.3.2), class III (see 11.1.3.3) or a mix thereof. The protection degree shall be ≥ IP20.

Protection against electric shock shall be provided for those interfaces that are intended for operator access (see Table 44 for clarification).

11.1.3DV D2 *Modification of 11.1.3:*

11.1.3DV.1 The minimum required enclosure rating is type 1 as defined in Annex DVE.

11.1.3DV.2 Class 2, limited voltage/current and limiting impedance circuits, as described in Annex DVD, need not be so enclosed.

11.1.3.1 Class I equipment

Class I equipment is equipment in which protection against electric shock does not rely on basic insulation only, but which includes an additional safety precaution in such a way that means are provided for the connection of accessible conductive parts to the protective earth conductor in the fixed wiring of the installation in such a way that accessible conductive parts cannot become live in the event of a failure of the basic insulation.

NOTE Class I equipment may have parts with double insulation or reinforced insulation, or parts operating at safety extra-low voltage.

Equipment for use with a flexible cord (such as PADTs) shall include a provision for a protective earth conductor that must be part of the cord set.

Accessible conductive parts of a PLC-system, which may become hazardous live in the event of a single fault, shall be connected to the protective circuit of the PLC-system. This does not apply to accessible conductive parts, such as screws, rivets and nameplates, which can become hazardous live under single-fault conditions.

When a part of the PLC-system is removed from the enclosure, for normal maintenance, for example, the protective circuits serving other parts of the PLC-system shall not be interrupted.

Protective earthing requirements shall be as specified in 11.9.

11.1.3.2 Class II equipment

Class II equipment is equipment in which protection against electric shock does not rely on basic insulation only, but in which additional safety precautions, such as double insulation or reinforced insulation are provided, there being no provision for protective earthing or reliance upon installation conditions.

Such equipment may be of one of the following types:

1) insulation-encased class II equipment: equipment having a durable and substantially continuous enclosure of insulating material which envelops all conductive parts, with the exception of small parts, such as nameplates, screws and rivets, which are isolated from hazardous live parts by insulation at least equivalent to reinforced insulation;

2) metal-encased class II equipment: equipment having a substantially continuous metal enclosure, in which double insulation is used throughout, except for those parts where reinforced insulation is used;

3) equipment which is a combination of types 1) and 2).

NOTE 1 The insulated enclosure of a class II equipment may form a part of the whole of the supplementary insulation or of the reinforced insulation.

NOTE 2 If equipment with double insulation and/or reinforced insulation throughout has a protective earthing terminal or contact, it is deemed to be of class I construction.

NOTE 3 Class II equipment may have parts operating at safety extra-low voltage.

Protective impedance may be used in lieu of double insulation provided the protective impedance limits the accessible conductive parts to a current of 5 mA or limits open-circuit voltage to values for SELV.

Class II equipment may be provided with means for maintaining the continuity of circuits (i.e. grounded internal components or conductive surfaces) provided that these circuits are double insulated from the accessible circuits of the equipment.

Class II equipment may be provided with means for connection to the earthing terminals for functional purposes (such as radiofrequency interference suppression) provided the double insulation system is still provided for protective purposes.

11.1.3.2DV DR *Modification of 11.1.3.2:*

Class II construction is not permitted for permanently connected equipment.

11.1.3.3 Class III equipment

Class III equipment is equipment in which protection against electric shock is provided by circuits supplied by safety extra-low voltage (SELV) and where voltages generated do not exceed the limits for SELV.

Class III equipment may be provided with means for connection to the earthing terminals for functional purposes (such as radiofrequency interference suppression).

Wiring for SELV/PELV circuits shall be either segregated from the wiring for circuits other than SELV/PELV, or the insulation of all conductors shall be rated for the higher voltage. Alternatively, earthed screening or additional insulation shall be arranged around the wiring for SELV/PELV circuits or around the wiring of other circuits.

11.1.3.3DV D2 *Modification of 11.1.3.3 by adding the following:*

11.1.3.3DV.1 Internal wiring

11.1.3.3DV.1.1 For other than Class 2 or Class 3 circuits, as defined in Article 725 of the National Electrical Code, NFPA 70, the equipment shall be constructed so that a conductor, including a field-installed conductor of any circuit is segregated by means of a minimum permanent 6.4 mm physical separation or separated by means of a barrier from physical contact with:

a) A conductor connected to any other circuit unless the conductors of both circuits shall be insulated for the maximum voltage of either circuit.

b) An uninsulated live part of any other circuit.

11.1.3.3DV.1.2 A conductor subject to movement during normal operation shall maintain separation of circuits during the full range of movement.

11.1.3.3DV.1.3 Isolated secondary circuits as defined in Annex DVD are considered to comply with these requirements.

11.1.4 Dielectric strength

The dielectric withstand type test of 12.2.1 shall be performed between all parts and circuits where basic, reinforced or double insulation are specified for protection against electric shock.

However, the dielectric withstand type test of 12.2.1 need not be carried out

– between SELV/PELV circuits and operator-accessible conductive parts (frames, enclosures, earth terminal, etc.);

– on units (parts of the basic PLC-system) which have been tested separately according to the relevant standards provided:

– when the values given in Table 52, Table 53 and Table 54 have been met, as appropriate, and

– their dielectric strength is not impaired by assembly.

11.1.4DV D2 *Modification of 11.1.4 by adding the following:*

11.1.4DV.1 Dielectric strength tests conducted in conjunction with temperature, Overload and Endurance tests outlined in Clause 12 are considered to cover requirements in this clause.

11.1.4DV.2 The dielectric withstand type test of 12.2.1 must be carried out for equipment rated not more than 50 volts.

11.1.5 Operator accessibility

Table 44 defines operator accessible ports of a PLC-system. Under special circumstances, some ports of either open or enclosed equipment may or may not be considered operator-accessible. This must be agreed upon between the manufacturer and the user.

Table 44
Operator accessibility for open and enclosed equipment

Port	Operator accessible	
	Open equipment	Enclosed equipment
AI (communication interface/port for local IO extension rack)	No	Yes
Ar (communication interface/port for remote IO station)	No	Yes
Be (open communication interface/port also open to third-party devices (for example, personal computer used for programming instead of a PADT)	Yes	Yes
Bi (internal communication interface/port for peripherals)	No	Yes
C (interface/port for digital and analogue input signals)	No	Yes
D (interface/port for digital and analogue output signals)	No	Yes
E (serial or parallel communication interfaces/ports for data communication with third-party devices)	Yes	Yes
F (mains power interface/port)	No	Yes
G (interface/port for protective earthing)	No	Yes
H (interface/port for functional earthing)	No	Yes
J (I/O power interface/port used to power sensors and actuators)	No	Yes
K (auxiliary power output interface/port)	No	Yes

11.1.6 Protection in normal condition

Operator-accessible parts shall be prevented from becoming hazardous live under normal condition by one or more of the following means:

a) basic insulation;

NOTE This can be provided by suitable insulating materials, transformers, and opto-isolators.

b) enclosures or barriers;

c) protective impedance (see 11.1.7.3).

Enclosures and barriers shall meet the rigidity requirements of 11.7.2.2. If enclosures or barriers provide protection by insulation, it shall meet the requirements for basic insulation.

Clearances, creepage distances and insulation between accessible parts and hazardous live parts shall meet the requirements of 11.4 and the applicable dielectric strength requirements for basic insulation.

Compliance is checked

a) by the determination of 12.1.2;

b) by the requirements of 11.1.4 for dielectric strength of basic insulation;

c) by the tests of 12.1.7 for rigidity of enclosures and barriers.

NOTE Materials, which can easily be damaged, are not considered to provide suitable insulation, for example lacquer, enamel, oxides, anodic films. Non-impregnated hygroscopic materials such as paper, fibres and fibrous material are also not considered to provide suitable insulation.

11.1.7 Protection in single-fault condition

Additional protection shall be provided to ensure that operator-accessible conductive parts are prevented from becoming hazardous live when a single fault occurs. This additional protection shall be provided by one or more of the following means:

protective earthing and bonding (see 11.1.7.1),

supplemental insulation (see 11.1.7.2), or

protective impedance (see 11.1.7.3).

A single fault shall be considered to occur when a single component providing protection is unable to continue providing that protection.

Fault tests shall be performed on protective impedances, parts intended for short-term or intermittent operation, mains-connected transformers, outputs, cooling provisions and insulation. The testing shall consist of shorting, opening, blocking, etc. the part, as appropriate, while the equipment is operating under least favourable test conditions. Tests shall be applied one at a time.

After the application of the faults, the equipment shall be verified: not to have any operator-accessible parts hazardous live and to satisfy the dielectric withstand verification of 12.2.1, without pre-conditioning. If a fault is terminated by the opening of a fuse and if the fuse does not open within approximately 1 s, the equipment shall be operated for a period corresponding to the maximum specified fuse-opening time.

Requirements of this subclause are verified in accordance with 12.3.

11.1.7DV D2 *Modification of 11.1.7 by adding the following:*

Protection against electric shock is only required in normal conditions. This national difference does not apply to isolated secondary circuits as noted in Annex DVD.

11.1.7.1 Protective earthing and bonding

Operator-accessible conductive parts shall be bonded to the protective conductor terminal if they could become hazardous live in case of a single fault of the primary protective means specified in 11.1.6. Alternatively, such accessible parts shall be separated from parts that are hazardous live by a conductive protective screen or barrier bonded to the protective conductor terminal.

Operator-accessible conductive parts need not be bonded to the protective earth terminal if they are separated from all hazardous live parts by double insulation or reinforced insulation.

Compliance is checked by inspection.

11.1.7.1DV D2 *Modification of 11.1.7.1 by adding the following:*

Operator-accessible conductive parts shall be bonded to the protective earth terminal. This national difference is only needed if the national difference 11.1DV is applied.

11.1.7.2 Supplemental insulation

Clearances shall be in accordance with 11.4.1 and 11.4.2. Creepage distances shall be in accordance with 11.4.3. Fulfilling the requirements for double or reinforced insulation satisfies the requirements for protection under single-fault conditions.

11.1.7.3 Protective impedance

The protective impedance shall limit the voltage from becoming hazardous live under normal or single-fault conditions on operator-accessible parts or to values for SELV.

The use of a single component not liable to become defective in such a manner as to cause a risk of hazard is allowed (see IEC 61010-1, 14.6).

Requirements of this subclause are verified in accordance with 12.3.2.

11.1.7.3DV D2 *Modification of 11.1.7.3:*

Evaluation of secondary circuits under normal and abnormal conditions are as noted in Annex DVD.

11.2 Protection against the spread of fire

There are no requirements for protection against the spread of fire within limited power circuits as described in 11.3. Components and spacings within limited power circuits need not be evaluated.

Protection against the spread of fire must be evaluated between limited power circuits and other circuits.

If limited power circuits are not employed, all remaining subclauses of Clause 11 shall be applied with regard to spread of fire.

Where breakdown of components is involved, compliance is verified according to 12.3.1.

11.3 Limited power circuits

A limited power circuit is a circuit supplied by sources such as a battery or a transformer winding where the open-circuit potential is not more than a.c. 30 V r.m.s. and 42,4 V peak or d.c. 60 V, and the energy available to the circuit is limited according to one of the following means:

– the maximum output current and power are inherently limited to not more than the values of Table 45;

– the maximum output current under all conditions and power are limited by impedance to be not more than the values of Table 45;

– an over-current protective device limits the maximum output current and power to not more than the values of Table 46;

– a regulating network limits the maximum output current and power to not more than the values of Table 45 in normal use or as a result of one fault in the regulating network; or

– a regulating network limits the maximum output current and power to not more than the values of Table 45 in normal use, and an over-current protective device limits the output current and power to not more than the values of Table 46 as the result of any one fault in the regulating network.

Where an over-current protective device is used, it shall be a fuse or a non-adjustable non-self-resetting device.

Conformity is checked by measuring the output voltage, the maximum output current and the maximum available output power under the following conditions.

1) Output voltage is measured in no-load condition.

2) Output current and available power are measured after 60 s of operation, with any overcurrent protective devices short-circuited, with a resistive load (including short-circuit) which produces the highest value of current and power respectively.

Table 45
Limits of output current and output power for inherently limited power sources

Open-circuit output voltage *U*		Maximum output current	Maximum output power
AC V r.m.s.	DC V	A	V × A
≤20	≤20	≤8,0	≤5 × *U*
20< *U* ≤ 30	20< *U* ≤30	≤8,0	≤150
–	30< *U* ≤60	≤150/*U*	≤150

For non-sinusoidal a.c. and for d.c. with ripple exceeding 10 %, the peak voltage shall not exceed 42,4 V peak.

Table 46
Limits of output current, output power and ratings for over-current protective devices for non-inherently limited power sources

Open-circuit output voltage *U*		Maximum output current	Maximum output power	Rated current value of over-current protective device
AC V r.m.s.	DC V	A	V × A	A
≤20	≤20	≤1 000/*U*	≤250	≤5
20< *U* ≤30	20< *U* ≤60	≤1 000/*U*	≤250	≤100/*U*

Rated current values for over-current protective devices are for fuses and circuit-breakers which break the current within 120 s at a current value of 210 % of the value in the last column of the table.

11.3DV.1 DR *Modification of 11.3:*

Class 2 circuits, as defined in Annex DVD, are considered equivalent to Limited Power Circuits.

11.3DV.2 DR *Modification of Table 45 and Table 46:*

Add table 11 (a) and (b) of the National Electrical Code, NFPA 70, as replacement table without class 3 columns.

11.4 Clearance and creepage distances requirements

Clearance and creepage distances shall be designed in accordance with this clause.

Creepage values are primarily directed at accommodating pollution concerns. Clearance values are primarily directed at accommodating overvoltage concerns.

Clearance and creepage distances between circuits shall meet the requirements associated with the higher of the voltages of the circuits.

There are no requirements for clearance and creepage distances for the inner layers of multilayer printed-circuit boards.

The actual clearance and creepage distances requirements shall be based (1) on the working voltages for the circuit under evaluation and (2) on the pollution degree specified by the manufacturer.

The clearance and creepage distances within a particular circuit which serve only to permit the functioning of the device, and which do not serve to meet the requirements for galvanic isolation, need only be of a size to prevent faults from occurring which would lead to a risk of fire.

Linear interpolation of creepage distance is permissible. Interpolation of clearance is only permissible for a circuit or part that has no direct connection to the mains, but is powered from a transformer, converter, or equivalent isolation device. For voltage values less than or greater than those tabulated below, the tables in IEC 60664-1 may be used.

Components mounted to printed-circuit boards shall not degrade the galvanic isolation characteristics of the circuit under consideration. This determination shall be made in accordance with the requirements in Table 50, Table 51, Table 52, Table 53 and Table 54 or in accordance with the test requirements in Table 58 or Table 59.

For SELV/PELV circuits and ungrounded accessible parts, the requirements for double insulation shall apply to the clearance and creepage distances between these and hazardous live parts. Clearances and creepage distances within SELV/PELV circuits are based on functional needs and are not defined with respect to safety.

In all cases the values given shall be met or exceeded.

NOTE The extent to which the manufacturing process can control the mechanical tolerance decides the limits to which practical clearance and creepage distances can approach the theoretical minimum values given in Table 47, Table 48, Table 49, Table 50, Table 52, Table 53 and Table 54.

It is possible to approach minimum values when the equipment is manufactured in a factory under controlled conditions and finished to a point where additional assembly other than the connections to the field wiring terminals prior to placing the equipment in service is not necessary.

Replacement of components, normally affected in service shops or in normal use (for example, fuses), is considered to be part of controlled conditions.