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Responsible committee: EPL/66 Safety of measuring, control and laboratory equipment

Interested committees:

Title: BS EN 61010-1 Amendment 2 - Safety requirements for electrical equipment for measurement, control, and laboratory use - Part 1: General requirements

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Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/Figure/ Table/Note	Type of comment	Commend (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	



66/769/CD

COMMITTEE DRAFT (CD)

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IEC TC 66 : SAFETY OF MEASURING, CONTROL AND LABORATORY EQUIPMENT

SECRETARIAT:
United Kingdom

SECRETARY:
Ms Stephanie Lavy

OF INTEREST TO THE FOLLOWING COMMITTEES:

PROPOSED HORIZONTAL STANDARD:



Other TC/SCs are requested to indicate their interest, if any, in this CD to the secretary.

FUNCTIONS CONCERNED:

☐ EMC

☐ ENVIRONMENT

☐ QUALITY ASSURANCE

☒ SAFETY

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TITLE:

Amendment 2 - Safety requirements for electrical equipment for measurement, control, and laboratory use - Part 1: General requirements

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CONTENTS

1		
2	FOREWORD.....	12
3	INTRODUCTION.....	15
4	1 Scope and object.....	16
5	1.1 Scope.....	16
6	1.1.1 Equipment included in scope.....	16
7	1.1.2 Equipment excluded from scope.....	16
8	1.1.3 Computing equipment.....	17
9	1.1.4 Gas and vapor detectors or sensors.....	17
10	1.2 Object.....	17
11	1.2.1 Aspects included in scope.....	17
12	1.2.2 Aspects excluded from scope.....	17
13	1.3 Verification.....	17
14	1.4 Environmental conditions.....	18
15	1.4.1 Normal environmental conditions.....	18
16	1.4.2 Extended environmental conditions.....	18
17	2 Normative references.....	18
18	3 Terms and definitions.....	20
19	3.1 Equipment and states of equipment.....	20
20	3.2 Parts and accessories.....	21
21	3.3 Quantities.....	21
22	3.4 Tests.....	22
23	3.5 Safety terms.....	22
24	3.6 Insulation.....	24
25	4 Tests.....	25
26	4.1 General.....	25
27	4.2 Sequence of tests.....	25
28	4.3 Reference test conditions.....	25
29	4.3.1 Environmental conditions.....	25
30	4.3.2 State of equipment.....	26
31	4.4 Testing in SINGLE FAULT CONDITION.....	28
32	4.4.1 General.....	28
33	4.4.2 Application of fault conditions.....	28
34	4.4.3 Duration of tests.....	30
35	4.4.4 Conformity after application of fault conditions.....	31
36	5 Marking and documentation.....	31
37	5.1 Marking.....	31
38	5.1.1 General.....	31
39	5.1.2 Identification.....	32
40	5.1.3 External electrical supply sources.....	32
41	5.1.4 Fuses.....	34
42	5.1.5 TERMINALS, connections and operating devices.....	34
43	5.1.6 Switches and circuit-breakers.....	34
44	5.1.7 Equipment protected by DOUBLE INSULATION or REINFORCED INSULATION.....	35
45	5.1.8 Field-wiring TERMINAL boxes.....	35
46	5.1.9 Specially protected equipment.....	35
47	5.1.10 Weight.....	35
48	5.1.11 Packaging.....	

49	5.2	Warning markings	35
50	5.3	Durability of markings	36
51	5.4	Documentation	36
52	5.4.1	General	36
53	5.4.2	Equipment RATINGS	37
54	5.4.3	Equipment installation	37
55	5.4.4	Equipment operation	38
56	5.4.5	Equipment maintenance and service	38
57	5.4.6	Integration into systems or effects resulting from special conditions	39
58	6	Protection against electric shock	39
59	6.1	General	39
60	6.1.1	Requirements	39
61	6.1.2	Exceptions	39
62	6.2	Determination of ACCESSIBLE parts	39
63	6.2.1	General	39
64	6.2.2	Examination	40
65	6.2.3	Openings above parts that are HAZARDOUS LIVE	40
66	6.2.4	Openings for pre-set controls	41
67	6.3	Limit values for ACCESSIBLE parts	41
68	6.3.1	Levels in NORMAL CONDITION	41
69	6.3.2	Levels in SINGLE FAULT CONDITION	41
70	6.4	Primary means of protection	44
71	6.4.1	General	44
72	6.4.2	ENCLOSURES and PROTECTIVE BARRIERS	44
73	6.4.3	BASIC INSULATION	44
74	6.4.4	Impedance	44
75	6.5	Additional means of protection in case of SINGLE FAULT CONDITIONS	44
76	6.5.1	General	44
77	6.5.2	PROTECTIVE BONDING	45
78	6.5.3	SUPPLEMENTARY INSULATION and REINFORCED INSULATION	48
79	6.5.4	PROTECTIVE IMPEDANCE	48
80	6.5.5	Automatic disconnection of the supply	48
81	6.5.6	Current- or voltage-limiting device	49
82	6.6	Connections to external circuits	49
83	6.6.1	General	49
84	6.6.2	TERMINALS for external circuits	49
85	6.6.3	Circuits with TERMINALS which are HAZARDOUS LIVE	49
86	6.6.4	TERMINALS for stranded conductors	50
87	6.7	Insulation requirements	50
88	6.7.1	The nature of insulation	50
89	6.7.2	Insulation for MAINS CIRCUITS of OVERVOLTAGE CATEGORY II with a nominal supply voltage up to 300 V	53
91	6.7.3	Insulation for secondary circuits derived from mains circuits of overvoltage category II up to 300 V	56
93	6.8	Procedure for voltage tests	61
94	6.8.1	General	61
95	6.8.2	Humidity preconditioning	62
96	6.8.3	Test procedures	62
97	6.9	Constructional requirements for protection against electric shock	63
98	6.9.1	General	63

99	6.9.2	Insulating materials	64
100	6.9.3	Colour coding	64
101	6.10	Connection to the MAINS supply source and connections between parts of	
102		equipment	64
103	6.10.1	MAINS supply cords	64
104	6.10.2	Fitting of non-detachable MAINS supply cords	65
105	6.10.3	Plugs and connectors	66
106	6.11	Disconnection from supply source	67
107	6.11.1	General	67
108	6.11.2	Exceptions	67
109	6.11.3	Requirements according to type of equipment	67
110	6.11.4	Disconnecting devices	68
111	7	Protection against mechanical HAZARDS	68
112	7.1	General	68
113	7.2	Surfaces, edges or corners	69
114	7.3	Moving parts	69
115	7.3.1	General	69
116	7.3.2	Exceptions	69
117	7.3.3	RISK assessment for mechanical HAZARDS	69
118	7.3.4	Limitation of force and pressure	70
119	7.3.5	Gap limitations between moving parts	71
120	7.3.6	Unwanted movement	73
121	7.3.7	Over-travel	73
122	7.3.8	Risk of uncontrolled movement	73
123	7.3.9	Safety distances	73
124	7.4	Instability	74
125	7.5	Provisions for lifting and carrying	74
126	7.5.1	General	74
127	7.5.2	Handles and grips	74
128	7.5.3	Lifting devices and supporting parts	75
129	7.5.4	Mechanical handling of packaged equipment	75
130	7.6	Wall mounting	75
131	7.7	Expelled parts (Ejected Objects)	75
132	7.8	Hand-transmitted vibration	76
133	7.9	Protective barriers and enclosures	76
134	7.9.1	General	76
135	7.9.2	Fixed protective barriers	76
136	7.9.3	Movable protective barriers	76
137	8	Resistance to mechanical stresses	77
138	8.1	General	77
139	8.2	ENCLOSURE rigidity tests	77
140	8.2.1	Static test	77
141	8.2.2	Impact test	78
142	8.3	Drop test	79
143	8.3.1	Equipment other than HAND-HELD EQUIPMENT and DIRECT PLUG-IN	
144		EQUIPMENT	79
145	8.3.2	HAND-HELD EQUIPMENT and DIRECT PLUG-IN EQUIPMENT	79
146	9	Protection against the spread of fire	80
147	9.1	General	80

148	9.2	Eliminating or reducing the sources of ignition within the equipment	82
149	9.3	Containment of fire within the equipment, should it occur	82
150	9.3.1	General	82
151	9.3.2	Constructional requirements	82
152	9.4	Limited-energy circuit	86
153	9.5	Requirements for equipment containing or using flammable liquids	88
154	9.6	Overcurrent protection	88
155	9.6.1	General	88
156	9.6.2	Permanently connected equipment	89
157	10	Equipment touch temperature limits and resistance to temperatures	90
158	10.1	Surface temperature limits for protection against burns and frostbite	90
159	10.2	Temperatures of windings	91
160	10.3	Other temperature measurements	91
161	10.4	Conduct of temperature tests	92
162	10.4.2	Temperature measurement of heating equipment	93
163	10.4.3	Equipment intended for installation in a cabinet or a wall	94
164	10.5	Resistance to temperatures	94
165	10.5.1	Integrity of CLEARANCES and CREEPAGE DISTANCES	94
166	10.5.2	Polymeric ENCLOSURES	94
167	10.5.3	Insulating material	94
168	11	Protection against HAZARDS from fluids and solid foreign objects	95
169	11.1	General	95
170	11.2	Cleaning	95
171	11.3	Spillage	95
172	11.4	Overflow	96
173	11.5	Battery electrolyte	96
174	11.6	Equipment RATED with a degree of ingress protection (IP code)	96
175	11.6.1	General	96
176	11.6.2	Conditions for testing	96
177	11.6.3	Protection against solid foreign objects (including dust)	97
178	11.6.4	Protection against water	97
179	11.7	Fluid pressure and leakage	97
180	11.7.1	Maximum pressure	97
181	11.7.2	Leakage and rupture at high pressure	98
182	11.7.3	Leakage from low-pressure parts	99
183	11.7.4	Overpressure safety device	99
184	12	Protection against injury from radiation, sonic and ultrasonic pressure	99
185	12.1	General	99
186	12.2	Equipment producing ionizing radiation	100
187	12.2.1	Ionizing radiation	100
188	12.2.2	Accelerated electrons	101
189	12.3	Optical radiation	101
190	12.4	Microwave radiation	102
191	12.5	Protection against HARM from acoustic noise	102
192	12.5.1	General	102
193	12.5.2	Sound Pressure Level (SPL)	103
194	12.5.3	Exposure Threshold Values and Noise Protection Measures	103
195	12.5.4	Ultrasonic pressure	103
196	12.6	Laser sources	104

197	13	Protection against liberated gases and substances, explosion and implosion	104
198	13.1	Poisonous and injurious gases and substances	104
199	13.2	Explosion and implosion	104
200	13.2.1	Components	104
201	13.2.2	Batteries and battery charging	104
202	13.2.3	Implosion of cathode ray tubes	105
203	14	Components and subassemblies	105
204	14.1	General	105
205	14.2	Motors	106
206	14.2.1	Motor temperatures	106
207	14.2.2	Series excitation motors	106
208	14.3	Overtemperature protection devices	106
209	14.4	Fuse holders	107
210	14.5	MAINS voltage selection devices	107
211	14.6	MAINS transformers tested outside equipment	107
212	14.7	Printed wiring boards	107
213	14.8	Capacitors	108
214	14.9	Circuits used to limit TRANSIENT OVERVOLTAGES	108
215	14.10	Microprocessor and/or microprocessor-system as a protective component	109
216	15	Protection by interlocks	109
217	15.1	General	109
218	15.2	Prevention of reactivating	109
219	15.3	Reliability	109
220		Protection against harm related to the use of the equipment	109
221	16	109	
222	16.1	General	109
223	16.2	Unattended operation	110
224	16.3	Combination of equipment	110
225	16.4	Manually-moved mobile equipment	110
226	16.5	Prevention of trapping	110
227	16.6	Unintended actuation of controls	111
228	16.7	Incorrect fitment of parts	111
229	16.8	Ergonomic aspects	111
230	Annex A (normative)	Measuring circuits for touch current (see 6.3)	112
231	A.1	Measuring circuits for a.c. with frequencies up to 1 MHz and for d.c.	112
232	A.2	Measuring circuits for sinusoidal a.c. with frequencies up to 100 Hz and for	
233		d.c.	113
234	A.3	Current measuring circuit for electrical burns at high frequencies	114
235	A.4	Current measuring circuit for WET LOCATION	115
236	Annex B (normative)	Standard test fingers (see 6.2)	116
237	Annex C (normative)	Measurement of CLEARANCES and CREEPAGE DISTANCES	118
238	Annex D (normative)	Parts between which insulation requirements are specified (see	
239		6.4 and 6.5.3)	122
240	Annex E (deleted)		125
241	Annex F (normative)	Routine tests	126
242	F.1	General	126
243	F.2	Protective earth	126
244	F.3	MAINS CIRCUITS	126

245	F.3.1	General	126
246	F.3.2	MAINS CIRCUITS with voltage limiting devices	127
247	F.4	Floating circuits.....	127
248	Annex G (informative)	Leakage and rupture from fluids under pressure	128
249	G.1	General.....	128
250	G.2	Pressures above 2 MPa and a product pressure and volume greater than	
251		200 kPa·l	128
252	G.2.1	General	128
253	G.2.2	Conduct of hydrostatic tests for G.2.1	129
254	G.2.3	Initial tests	130
255	G.2.4	Modifications to minimize leakage	130
256	G.2.5	Additional tests if modification succeeded in minimizing leakage	130
257	G.2.6	Additional test if modifications failed to reduce leakage.....	131
258	G.3	Pressures between 50 kPa and 2 MPa, and pressure times volume above	
259		200 kPa·l	131
260	G.4	Pressures below 50 kPa, or pressure times volume below 200 kPa·l.....	131
261	G.5	Overpressure safety devices	131
262	Annex H (normative)	Qualification of conformal coatings for protection against	
263		POLLUTION.....	133
264	H.1	General.....	133
265	H.2	Technical properties	133
266	H.3	Qualification of coatings	133
267	Annex I (normative)	Line-to-neutral voltages for common MAINS supply systems.....	136
268	Annex J (informative)	Risk Management	137
269	J.1	RISK management procedure	137
270	J.2	Achieving TOLERABLE RISK.....	138
271	J.3	An application of RISK assessment procedures.....	139
272	J.4	As Low As Reasonably Practicable	140
273	J.5	Risk reduction using functional safety standards	140
274	J.5.1	General	140
275	J.5.2	Determination of the relevant SIL or PL	141
276	J.5.3	Architecture	142
277	J.5.4	Application of the level	142
278	J.5.5	Process and documentation	142
279	Annex K (normative)	Insulation requirements not covered by 6.7	143
280	K.1	Insulation for MAINS CIRCUITS.....	143
281	K.1.1	General	143
282	K.1.2	CLEARANCES and CREEPAGE DISTANCES for MAINS CIRCUITS	144
283	K.1.3	Solid insulation for MAINS CIRCUITS	145
284	K.2	Insulation in secondary circuits.....	149
285	K.2.1	General	149
286	K.2.2	CLEARANCES.....	149
287	K.2.3	CREEPAGE DISTANCES.....	152
288	K.2.4	Solid insulation	153
289	K.3	Insulation in circuits not addressed in 6.7, Clause K.1 or Clause K.2	155
290	K.3.1	General	155
291	K.3.2	CLEARANCE calculation	156
292	K.3.3	CLEARANCES in circuits having recurring peak voltages, or having	
293		WORKING VOLTAGES with frequencies above 30 kHz	159

294	K.3.4	CREEPAGE DISTANCES.....	160
295	K.3.5	Solid insulation	160
296	K.4	Reduction of TRANSIENT OVERVOLTAGES by the use of overvoltage limiting	
297		devices	161
298	Annex L (informative)	Index of defined terms	162
299	Annex M (normative)	Flammability test for magnesium alloy fire ENCLOSURES or flame	
300		barriers (see 9.3.2)	164
301	M.1	General.....	164
302	M.2	Samples	164
303	M.3	Mounting of samples	164
304	M.4	Test flame.....	164
305	M.5	Test procedure.....	164
306	Annex N (informative)	Human Behaviour	165
307	N.1	General.....	165
308	N.2	User Types	165
309	N.3	Use Conditions.....	166
310	N.4	Determining Use Situations	166
311	N.5	Assessment of Use Conditions	167
312	Annex O (informative)	Tests after repair	169
313	O.1	Protective earth.....	169
314	O.2	Reliability of insulation	169
315	O.3	Leakage current	169
316	Figure 1	Measurements through openings in ENCLOSURES	40
317	Figure 2	Maximum duration of short-term ACCESSIBLE current in SINGLE FAULT	
318		CONDITION (see 6.3.2 b)).....	42
319	Figure 3	Capacitance level versus voltage in NORMAL CONDITION and SINGLE FAULT	
320		CONDITION (see 6.3.1 c) and 6.3.2 c)).....	43
321	Figure 4	Acceptable arrangement of protective means against electric shock	45
322	Figure 5	Examples of binding screw assemblies	47
323	Figure 6	Distance between conductors on an interface between two layers	54
324	Figure 7	Distance between adjacent conductors along an interface of two insulating	
325		layers	55
326	Figure 8	Distance between adjacent conductors located between the same two	
327		insulating layers.....	56
328	Figure 9	Detachable MAINS supply cords and connections	65
329	Figure 10	Impact test using a sphere	79
330	Figure 11	Flow chart to explain the requirements for protection against the spread of	
331		fire 81	
332	Figure 12	Baffle	84
333	Figure 13a	Area of the bottom and sides of an ENCLOSURE to be constructed as	
334		specified in 9.3.2 c) 1)	85
335	Figure 13b	Examples of cross-sections of designs of top openings suitable for the	
336		containment of fire	85
337	Figure 13c	limiting area of the top and side of an enclosure	86
338	Figure 14	Ball-pressure test apparatus	95
339	Figure 15	Ratio between test pressure and maximum working pressure	99
340	Figure 16	General requirements for equipment with ionizing radiation sources	100
341	Figure 17	Flow chart for conformity options 14.1 a), b), c) and d)	106

342	Figure A.1a – Measuring circuit for a.c. with frequencies up to 1 MHz and for d.c.	
343	(normal condition).....	112
344	Figure A.1b – Measuring circuit touch current for a.c. up to 1 MHz and for d.c.	
345	weighted for let go-immobilization (single fault condition).....	113
346	Figure A.2 – Measuring circuits for sinusoidal a.c. with frequencies up to 100 Hz and	
347	for d.c.....	113
348	Figure A.3 – Current measuring circuit for electrical burns	114
349	Figure A.4 – Current measuring circuit for wet contact	115
350	Figure B.1 – Rigid test finger.....	116
351	Figure B.2 – Jointed test finger	117
352	Figure C.1 – Examples of methods of measuring CLEARANCES and CREEPAGE DISTANCES	121
353	Figures D.1a) to d) – Protection between HAZARDOUS LIVE circuits and ACCESSIBLE	
354	parts.....	123
355	Figures D.1e) to h) – Protection between HAZARDOUS LIVE circuits and circuits with	
356	ACCESSIBLE external TERMINALS.....	123
357	Figures D.2 a) and D.2 b) – Protection between a HAZARDOUS LIVE internal circuit and	
358	an ACCESSIBLE part which is not bonded to other ACCESSIBLE parts	124
359	Figures D.2 c) and D.2 d) – Protection between a HAZARDOUS LIVE primary circuit and	
360	circuits which have ACCESSIBLE external TERMINALS.....	124
361	Figure D.3 – Protection of external ACCESSIBLE TERMINALS of two HAZARDOUS LIVE	
362	circuits	124
363	Figure G.1 – Conformity verification process (see G.2)	129
364	Figure H.1 – Test sequence and conformity	135
365	Figure J.1 – Iterative process of RISK management	137
366	Figure J.2 – RISK reduction	139
367	Figure J.3 – RISK reduction using functional safety standards	141
368	Figure K.1 – Distance between conductors on an interface between two layers	147
369	Figure K.2 – Distance between adjacent conductors along an interface of an inner	
370	layer.....	148
371	Figure K.3 – Distance between adjacent conductors located between the same two	
372	layers	149
373	Figure K.4 – Example of recurring peak voltage.....	159
374	Figure N.1 - Use situations.....	167
375	Table 1 – Symbols	33
376	Table 2 – Tightening torque for binding screw assemblies	47
377	Table 3 – Multiplication factors for CLEARANCES of equipment RATED for operation at	
378	altitudes up to 5 000 m.....	51
379	TABLE 4 – CLEARANCES and CREEPAGE DISTANCES for MAINS CIRCUITS of OVERVOLTAGE	
380	CATEGORY II up to 300 V	53
381	Table 5 – Test voltages for solid insulation in MAINS CIRCUITS of OVERVOLTAGE	
382	CATEGORY II up to 300 V	54
383	Table 6 – CLEARANCES and test voltages for secondary circuits derived from MAINS	
384	CIRCUITS of OVERVOLTAGE CATEGORY II up to 300 V	57
385	Table 7 – CREEPAGE DISTANCES for secondary circuits.....	58
386	Table 8 – Minimum values for distance or thickness (see 6.7.3.4.2 to 6.7.3.4.4)	60
387	Table 9 – Distances between TERMINALS and foil.....	61
388	Table 10 – Correction factors according to test site altitude for test voltages for	
389	CLEARANCES	

390	Table 11 – Values for physical tests on cord anchorages	66
391	Table 12 – Protective measures against mechanical HAZARDS to body parts	70
392	Table 13 – Minimum maintained gaps to prevent crushing for different body parts	72
393	Table 14 – Maximum gaps to prevent access for different body parts	73
394	Table 15 – Impact energy levels, test height and corresponding IK codes	79
395	Table 16 – Acceptable perforation of the bottom of an ENCLOSURE	84
396	Table 17 – Limits for power sources without an overcurrent protective device	87
397	Table 18 – Limits for power sources with an overcurrent protective device	87
398	Table 19a – Hot surface temperature limits in NORMAL CONDITION	90
399	Table 19b – Cold surface temperature limits in NORMAL CONDITION.....	91
400	Table 20 – Maximum temperatures for insulation material of windings	91
401	Table 21 – Lamp or lamp systems considered photobiologically safe	102
402	Table 22 – Lamp or lamp systems considered photobiologically safe under certain	
403	conditions	102
404	Table 23 – Bridging insulation by IEC 60384-14 subclass Y capacitors	108
405	Table 24 – Impulse voltages for OVERVOLTAGE CATEGORY II	108
406	Table C.1 – Dimensions of X.....	118
407	Table F.1 – Test voltages for ROUTINE TESTS of MAINS CIRCUITS	127
408	Table G.1 – Test pressures for equipment with pressures above 14 Mpa.....	131
409	Table H.1 – Test parameters, test conditions and test procedures.....	134
410	Table I.1 – Line-to-neutral voltages for common MAINS supply systems	136
411	Table J.1 – Severity of harm	139
412	Table J.2 – Probability of harm.....	139
413	Table J.3 – Example of a RISK category matrix.....	140
414	Table J.4 – Example of RISK category matrix with ALARP	140
415	Table J.4 – Risk ranking matrix.....	142
416	Table K.1 – Multiplication factors for CLEARANCES for equipment RATED for operation at	
417	altitudes up to 5 000 m.....	144
418	Table K.2 – CLEARANCES and CREEPAGE DISTANCES for MAINS CIRCUITS of OVERVOLTAGE	
419	CATEGORY II above 300 V	144
420	Table K.3 – CLEARANCES and CREEPAGE DISTANCES for MAINS CIRCUITS of OVERVOLTAGE	
421	CATEGORY III	145
422	Table K.4 – CLEARANCES and CREEPAGE DISTANCES for MAINS CIRCUITS of OVERVOLTAGE	
423	CATEGORY IV	145
424	Table K.5 – Test voltages for solid insulation in MAINS CIRCUITS of OVERVOLTAGE	
425	CATEGORY II above 300 V	146
426	Table K.6 – Test voltages for solid insulation in MAINS CIRCUITS of OVERVOLTAGE	
427	CATEGORY III	146
428	Table K.7 – Test voltages for solid insulation in MAINS CIRCUITS of OVERVOLTAGE	
429	CATEGORY IV	146
430	Table K.8 – Test voltages for testing long-term stress of solid insulation in MAINS	
431	CIRCUITS	147
432	Table K.9 – Minimum values for distance or thickness of solid insulation	148
433	Table K.10 – CLEARANCES and test voltages for secondary circuits derived from MAINS	
434	CIRCUITS of OVERVOLTAGE CATEGORY II above 300 V	150
435	Table K.11 – CLEARANCES and test voltages for secondary circuits derived from MAINS	
436	CIRCUITS of OVERVOLTAGE CATEGORY III	150

437	Table K.12 – CLEARANCES and test voltages for secondary circuits derived from MAINS	
438	CIRCUITS of OVERVOLTAGE CATEGORY IV	152
439	Table K.13 – CREEPAGE DISTANCES for secondary circuits	153
440	Table K.14 – Minimum values for distance or thickness (see K.2.4.2 to K.2.4.4)	154
441	Table K.15 – CLEARANCE values for the calculation of K.3.2	157
442	Table K.16 – Test voltages based on CLEARANCES	158
443	Table K.17 – CLEARANCES for BASIC INSULATION in circuits having recurring peak	
444	voltages or WORKING VOLTAGES with frequencies above 30 kHz	160
445	Table N.1 - Use scenarios for Operator and Bystander.	165
446	Table N.2 - Required protection for use conditions	168
447		
448		

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**SAFETY REQUIREMENTS FOR ELECTRICAL EQUIPMENT FOR
MEASUREMENT, CONTROL, AND LABORATORY USE –****Part 1: General requirements****FOREWORD**

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International Standard IEC 61010-1 has been prepared by IEC technical committee 66: Safety of measuring, control and laboratory equipment.

It has the status of a group safety publication, as specified in IEC Guide 104.

This third edition cancels and replaces the second edition published in 2001. It constitutes a technical revision.

This edition includes the following significant changes from the second edition, as well as numerous other changes.

- The scope of the standard has been expanded to include all locations where these products may be used, so that both professional and non-professional versions of these products are within the scope.
- The requirements for testing and measuring circuits (in various subclauses and the entirety of Clause 16) have been removed and included in a particular standard IEC 61010-2-030.
- Insulation requirements (6.7) have been completely rewritten.
- Specific requirements have been added for solid insulation and thin-film insulation.

- Subclause 6.7 now contains only the insulation requirements for MAINS CIRCUITS of OVERVOLTAGE CATEGORY II up to 300 V, and for secondary circuits.
- The insulation requirements for all other circuits have been moved to a new Annex K.
- Additional requirements for protection against mechanical HAZARDS (Clause 7) have been included.
- Surface temperature limits (Clause 10) have been modified to conform to the limits of EN 563.
- Radiation requirements (Clause 12) have been modified, and take into account a distinction between intended emission and unintended emission.
- Requirements for reasonably foreseeable misuse and ergonomic aspects have been added (Clause 16).
- A new clause (Clause 17) has been added to deal with HAZARDS and environments not covered by the standard, along with a new informative annex (Annex J) dealing with RISK assessment.
- A new informative annex (Annex E) addresses methods of reducing the POLLUTION DEGREE of a micro-environment.
- Requirements for the qualification of coatings for protection against POLLUTION have been added (Annex H).
- A new informative annex (Annex I) has been added to further explain how to determine the WORKING VOLTAGE of a MAINS CIRCUIT.

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

FDIS	Report on voting
66/414/FDIS	66/423/RVD

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

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

A list of all parts of the IEC 61010 series, under the general title: *Safety requirements for electrical equipment for measurement, control, and laboratory use*, may be found on the IEC website.

In this standard, the following print types are used:

- requirements and definitions: in roman type;
- NOTES: in smaller roman type;
- conformity and tests: in italic type;
- terms used throughout this standard which have been defined in Clause 3: SMALL ROMAN CAPITALS.

540 The committee has decided that the contents of this publication will remain unchanged until the
541 stability date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to
542 the specific publication. At this date, the publication will be

- 543 • reconfirmed,
544 • withdrawn,
545 • replaced by a revised edition, or
546 • amended.

547

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

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INTRODUCTION

552 This [International](#) Standard specifies the safety requirements that are generally applicable to
553 all equipment within its scope. For certain types of equipment, these requirements will be
554 supplemented or modified by the special requirements of one, or more than one, particular part
555 2 of the standard which must be read in conjunction with the part 1 requirements.

556

SAFETY REQUIREMENTS FOR ELECTRICAL EQUIPMENT FOR MEASUREMENT, CONTROL, AND LABORATORY USE –

Part 1: General requirements

1 Scope and object

1.1 Scope

1.1.1 Equipment included in scope

This group safety publication is primarily intended to be used as a product safety standard for the products mentioned in the scope, but shall also be used by technical committees in the preparation of their publications for products similar to those mentioned in the scope of this standard, in accordance with the principles laid down in IEC Guide 104 and ISO/IEC Guide 51.

This part of IEC 61010 specifies general safety requirements for the following types of electrical equipment and their accessories, wherever they are intended to be used. *It is intended to be used in conjunction with the manufacturer's RISK management file, but not to replace this.*

a) Electrical test and measurement equipment

This is equipment which by electromagnetic means tests, measures, indicates or records one or more electrical or physical quantities, also non-measuring equipment such as signal generators, measurement standards, power supplies for laboratory use, transducers, transmitters, etc.

NOTE 1 This includes bench-top power supplies intended to aid a testing or measuring operation on another piece of equipment. Power supplies intended to power equipment are within the scope of IEC 61558 (see 1.1.2 f)).

This standard also applies to test equipment integrated into manufacturing processes and intended for testing manufactured devices.

NOTE 2 Manufacturing test equipment is likely to be installed adjacent to and interconnected with industrial machinery in this application.

b) Electrical industrial process-control equipment

This is equipment which controls one or more output quantities to specific values, with each value determined by manual setting, by local or remote programming, or by one or more input variables.

c) Electrical laboratory equipment

This is equipment which measures, indicates, monitors, inspects or analyses materials, or is used to prepare materials. This equipment may also be used in areas other than laboratories.

1.1.2 Equipment excluded from scope

This standard does not apply to equipment within the scope of:

- a) IEC 60335 (Household and similar electrical appliances);
- b) IEC 60364 (Electrical installations of buildings);
- c) IEC 61439 (Low-voltage switchgear and controlgear assemblies);
- d) IEC 60601 (Medical electrical equipment);
- e) IEC 62368 (Audio/video, information and communication technology equipment, except as specified in 1.1.3);
- f) IEC 61558 (Power transformers, power supply units and similar);
- g) IEC 61010-031 (Hand-held probe assemblies);

h) IEC 61243-3 (Live working – Voltage detectors – Part 3: Two-pole low-voltage type).

1.1.3 Computing equipment

This standard applies only to computers, processors, etc. which form part of equipment within the scope of this standard or are designed for use exclusively with the equipment.

1.1.4 Gas and vapor detectors or sensors

Detectors, sensors or other devices, including controllers and analysers, which are both intended to measure, sense or detect hazardous levels of gas or vapors, and are intended for signalling or safety alarm initiation, notification or release, may only be evaluated to IEC 61010-1 when used in conjunction with a standard providing suitable requirements for performance and reliability (Examples may include but are not limited to products within scope of IEC 60079 series and IEC 62990 series).

1.2 Object

1.2.1 Aspects included in scope

The purpose of the requirements of this standard is to ensure that HAZARDS to the OPERATOR and the surrounding area are reduced to a tolerable level.

Requirements for protection against particular types of HAZARD are given in Clauses 6 to 13, as follows:

- a) electric shock or burn (see Clause 6);
- b) mechanical HAZARDS (see Clauses 7 and 8);
- c) spread of fire from the equipment (see Clause 9);
- d) excessive temperature (see Clause 10);
- e) effects of fluids and fluid pressure (see Clause 11);
- f) effects of radiation, including lasers sources, and sonic and ultrasonic pressure (see Clause 12);
- g) liberated gases, explosion and implosion (see Clause 13).

It is recognized that this document cannot cover exposure to every hazard resulting from all possible equipment within the scope of this standard, as well as it cannot cover all cases of reasonably foreseeable misuse of such equipment or the possible exposure to hazards that can arise from the functions of the equipment. Therefore, the manufacturers are encouraged to conduct their own risk assessment and implement the appropriate risk reduction measures regarding reasonably foreseeable misuse and the functions of the equipment where there are no prescribed means for mitigation in this document.

An example of the process to manage these risks can be found in Annex J.

NOTE Attention is drawn to the existence of additional requirements regarding the health and safety of labour forces.

1.2.2 Aspects excluded from scope

This standard does not cover:

- a) reliable function, performance, or other properties of the equipment not related to safety (see 1.1.4);
- b) effectiveness of transport packaging;
- c) EMC requirements (see the IEC 61326 series);
- d) protective measures for explosive atmospheres (see the IEC 60079 series).

1.3 Verification

This standard also specifies methods of verifying that the equipment meets the requirements of this standard, through inspection, TYPE TESTS, ROUTINE TESTS, and RISK assessment.

1.4 Environmental conditions

1.4.1 Normal environmental conditions

This standard applies to equipment designed to be safe at least under the following conditions:

- a) indoor use;
 - b) altitude up to 2 000 m;
 - c) **ambient** temperature 5 °C to 40 °C;
 - d) maximum relative humidity 80 % for temperatures up to 31 °C decreasing linearly to 50 % relative humidity at 40 °C;
 - e) MAINS supply voltage fluctuations up to ± 10 % of the nominal voltage;
 - f) TRANSIENT OVERVOLTAGES up to the levels of OVERVOLTAGE CATEGORY II;
- NOTE 1 These levels of transient overvoltage are typical for equipment supplied from the building wiring.
- g) TEMPORARY OVERVOLTAGES occurring on the MAINS supply
 - h) applicable POLLUTION DEGREE of the intended environment (POLLUTION DEGREE 2 in most cases).

NOTE 2 Manufacturers may specify more restricted environmental conditions for operation; nevertheless the equipment must be safe within these normal environmental conditions.

1.4.2 Extended environmental conditions

This standard applies to equipment designed to be safe not only in the environmental conditions specified in 1.4.1, but also in any of the following conditions as RATED by the manufacturer of the equipment:

- e) outdoor use;
- f) altitude above 2 000 m;
- g) ambient temperatures below 5 °C or above 40 °C;
- h) relative humidity above the levels specified in 1.4.1;
- i) MAINS supply voltage fluctuations exceeding ± 10 % of the nominal voltage;
- j) WET LOCATION;
- k) TRANSIENT OVERVOLTAGES up to the levels of OVERVOLTAGE CATEGORY III or IV (see Annex K).

2 Normative references

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

IEC 60027 (all parts), *Letter symbols to be used in electrical technology*

IEC 60065, *Audio, video and similar electronic apparatus – Safety requirements*

[IEC 60068-2-5, Environmental testing – Part 2-5: Tests - Test S: Simulated solar radiation at ground level and guidance for solar radiation testing](#)

IEC 60068-2-14, *Environmental testing – Part 2-14: Tests – Test N: Change of temperature*

IEC 60068-2-75, *Environmental testing – Part 2-75: Tests – Test Eh: Hammer tests*

IEC 60073, *Basic and safety principles for man-machine interface, marking and identification – Coding principles for indicators and actuators*

IEC 60227 (all parts), *Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V*

IEC 60245 (all parts), *Rubber insulated cables – Rated voltages up to and including 450/750 V*

IEC 60309 (all parts), *Plugs, socket-outlets and couplers for industrial purposes*

- 692 IEC 60320 (all parts), *Appliance couplers for household and similar general purposes*
- 693 IEC 60332-1-2, *Tests on electric and optical fibre cables under fire conditions – Part 1-2: Test*
694 *for vertical flame propagation for a single insulated wire or cable – Procedure for 1 kW pre-*
695 *mixed flame*
- 696 IEC 60332-2-2, *Tests on electric and optical fibre cables under fire conditions – Part 2-2: Test*
697 *for vertical flame propagation for a single small insulated wire or cable – Procedure for [diffusion](#)*
698 *flame*
- 699 IEC 60335-2-24, *Household and similar electrical appliances – Safety – Part 2-24: Particular*
700 *requirements for refrigerating appliances, ice-cream appliances and ice-makers.*
- 701 IEC 60335-2-89, *Household and similar electrical appliances – Safety – Part 2-89: Particular*
702 *requirements for commercial refrigerating appliances with an incorporated or remote refrigerant*
703 *condensing unit or compressor*
- 704 IEC 60364-4-44:2007, *Low-voltage electrical installations – Part 4-44: Protection for safety –*
705 *Protection against voltage disturbances and electromagnetic disturbances*
706 [IEC 60364-4-44:2007/AMD1:2015](#)
- 707 IEC 60417, *Graphical symbols for use on equipment*
- 708 IEC 60529, *Degrees of protection provided by enclosures (IP Code)*
- 709 IEC 60664-3, *Insulation coordination for equipment within low-voltage systems – Part 3: Use of*
710 *coating, potting or moulding for protection against pollution*
- 711 IEC 60695-11-10, *Fire hazard testing – Part 11-10: Test flames – 50 W horizontal and vertical*
712 *flame test methods*
- 713 [IEC 60695-11-3, Fire hazard testing – Part 11-3: Test flames – 500 W flames - Apparatus and](#)
714 [confirmational test methods](#)
- 715 IEC 60799, *Electrical accessories – Cord sets and interconnection cord sets*
- 716 IEC 60825-1, *Safety of laser products – Part 1: Equipment classification and requirements*
- 717 IEC 60947-1, *Low-voltage switchgear and controlgear – Part 1: General rules*
- 718 [IEC 60947-2, Low-voltage switchgear and controlgear – Part 2: Circuit-breakers](#)
- 719 IEC 60947-3, *Low-voltage switchgear and controlgear – Part 3: Switches, disconnectors,*
720 *switch-disconnectors and fuse-combination units*
- 721 IEC 61010-031, *Safety requirements for electrical equipment for measurement, control and laboratory*
722 *use – Part 031: Safety requirements for hand-held probe assemblies for electrical measurement*
723 *and test*
- 724 IEC 61180 (all parts), *High-voltage test techniques for low-voltage equipment*
- 725 IEC 61180-1, *High-voltage test techniques for low-voltage equipment – Part 1: Definitions, test*
726 *and procedure requirements*
- 727 IEC 61180-2, *High-voltage test techniques for low-voltage equipment – Part 2: Test equipment*
- 728 IEC 61672-1, *Electroacoustics – Sound level meters – Part 1: Specifications*
- 729 IEC 61672-2, *Electroacoustics – Sound level meters – Part 2: Pattern evaluation tests*
- 730 IEC 62262, *Degrees of protection provided by enclosures for electrical equipment against*
731 *external impacts (IK code)*
- 732 [IEC 62471, Photobiological safety of lamps and lamp systems](#)

IEC TR 62471-2, *Photobiological safety of lamps and lamp systems – Part 2: Guidance on manufacturing requirements relating to non-laser optical radiation safety*

IEC 62598, *Nuclear instrumentation – Constructional requirements and classification of radiometric gauges*

IEC Guide 104, *The preparation of safety publications and the use of basic safety publications and group safety publications*

ISO/IEC Guide 51, *Safety aspects – Guidelines for their inclusion in standards*

ISO 306:2013, *Plastics – Thermoplastic materials – Determination of Vicat softening temperature (VST)*

ISO 361, *Basic ionizing radiation symbol*

ISO 11228-1, *Ergonomics – Manual Handling – Part 1: Lifting and carrying*

ISO 3266, *Eyebolts for general lifting purposes*

ISO 3746, *Acoustics – Determination of sound power levels of noise sources using sound pressure – Survey method using an enveloping measurement surface over a reflecting plane*

ISO 4892-2, *Plastics – Methods of exposure to laboratory light sources – Part 2: Xenon-arc lamps*

ISO 7000, *Graphical symbols for use on equipment*

ISO 9614-1, *Acoustics – Determination of sound power levels of noise sources using sound intensity – Part 1: Measurement at discrete points*

ISO 13857, *Safety of machinery – Safety distances to prevent hazard zones being reached by upper and lower limbs*

EN 378-2, *Refrigerating systems and heat pumps. - Safety and environmental requirements. Design, construction, testing, marking and documentation*

EN 1005-2, *Safety of machinery – Human physical performance – Part 2: Manual handling of machinery and component parts of machinery*

CAN/CSA C22.2 No. 0.17, *Evaluation of Properties of Polymeric Materials*

UL 746C, *Polymeric Materials – Use in Electrical Equipment Evaluations*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1 Equipment and states of equipment

3.1.1

FIXED EQUIPMENT

equipment fastened to a support, or otherwise secured in a specific location

[IEC 60050-826:2004, 826-16-07, modified]

3.1.2

PERMANENTLY CONNECTED EQUIPMENT

equipment that is electrically connected to a supply by means of a permanent connection which can be detached only by the use of a TOOL

3.1.3

PORTABLE EQUIPMENT

equipment intended to be carried by hand

3.1.4**HAND-HELD EQUIPMENT**

PORTABLE EQUIPMENT intended to be supported by one hand during NORMAL USE

3.1.5**TOOL**

external device, including keys and coins, used to aid a person to perform a mechanical function

3.1.6**DIRECT PLUG-IN EQUIPMENT**

equipment with a MAINS plug that is attached to the equipment housing without the use of a MAINS supply cord so that the equipment is supported by the MAINS socket-outlet

3.1.7**MOBILE EQUIPMENT**

equipment that, once installed and placed into service, is intended to be moved from one location to another while supported by its own wheels or equivalent means

3.2 Parts and accessories**3.2.1****TERMINAL**

component provided for the connection of a device to external conductors

[IEC 60050-151:2001, 151-12-12, modified]

NOTE TERMINALS can contain one or several contacts and the term therefore includes sockets, connectors, etc.

3.2.2**FUNCTIONAL EARTH TERMINAL**

TERMINAL by which electrical connection is made directly to a point of a measuring or control circuit or to a screening part and which is intended to be earthed for any functional purpose other than safety

NOTE For measuring equipment, this TERMINAL is often called the measuring earth TERMINAL.

3.2.3**PROTECTIVE CONDUCTOR TERMINAL**

TERMINAL which is bonded to conductive parts of equipment for safety purposes and is intended to be connected to an external protective earthing system

3.2.4**ENCLOSURE**

part providing protection of equipment against certain external influences and, in any direction, protection against direct contact

NOTE ENCLOSURES may also provide protection against the spread of fire (see 9.3.2 c)).

3.2.5**PROTECTIVE BARRIER**

part providing protection against direct contact from any usual direction of access

[IEC 60050-195:1998, 195-06-15]

NOTE Depending on its construction, a PROTECTIVE BARRIER can be called a casing, cover, screen, door, guard, etc.

A PROTECTIVE BARRIER can act alone; it is then only effective when it is in place. A PROTECTIVE BARRIER can also act in conjunction with an interlocking device with or without guard locking; in this case, protection is ensured whatever the position of the PROTECTIVE BARRIER.

3.3 Quantities**3.3.1****RATED (value)**

quantity value assigned, generally by a manufacturer, for a specified operating condition of a component, device or equipment

[IEC 60050-151:2001, 151-16-08, modified]

3.3.2**RATING**

set of RATED values and operating conditions

[IEC 60050-151:2001, 151-16-11]

3.3.3**WORKING VOLTAGE**

highest r.m.s. value of the a.c. or d.c. voltage across any particular insulation which can occur when the equipment is supplied at RATED voltage

NOTE 1 Transients and voltage fluctuations are not considered to be part of the WORKING VOLTAGE.

NOTE 2 Both open-circuit conditions and normal operating conditions are taken into account.

3.4 Tests**3.4.1****TYPE TEST**

test of one or more samples of equipment (or parts of equipment) made to a particular design, to show that the design and construction meet one or more requirements of this standard

NOTE This is an amplification of the IEC 60050-151:2001, 151-16-16 definition to cover design as well as construction.

3.4.2**ROUTINE TEST**

conformity test made on each individual item during or after manufacture

[IEC 60050-151:2001, 151-16-17]

3.5 Safety terms**3.5.1****ACCESSIBLE (of a part)**

able to be touched with a standard test finger or test pin, when used as specified in 6.2

3.5.2**HAZARD**

potential source of harm

3.5.3**HAZARDOUS LIVE**

capable of rendering an electric shock or electric burn

3.5.4**MAINS**

low-voltage electricity supply system to which the equipment concerned is designed to be connected for the purpose of powering the equipment

3.5.5**MAINS CIRCUIT**

circuit which is intended to be directly connected to the MAINS for the purpose of powering the equipment

3.5.6**PROTECTIVE IMPEDANCE**

component or assembly of components whose impedance, construction and reliability are suitable to provide protection against electric shock

3.5.7**PROTECTIVE BONDING**

electrical connection of ACCESSIBLE conductive parts or protective screening to provide electrical continuity to the means for connection of an external protective conductor

- 871 **3.5.8**
872 **NORMAL USE**
873 operation, including stand-by, according to the instructions for use or for the obvious intended
874 purpose
- 875 **3.5.9**
876 **NORMAL CONDITION**
877 condition in which all means for protection against HAZARDS are intact
- 878 **3.5.10**
879 **SINGLE FAULT CONDITION**
880 condition in which one means for protection against HAZARD is defective or one fault is present
881 which could cause a HAZARD
- 882 NOTE If a SINGLE FAULT CONDITION results unavoidably in one or more other fault conditions, all the failures are
883 considered as one SINGLE FAULT CONDITION [IEC Guide 104].
- 884 **3.5.11**
885 **OPERATOR**
886 person operating equipment for its intended purpose
- 887 **3.5.12**
888 **RESPONSIBLE BODY**
889 individual or group responsible for the safe use and maintenance of equipment
- 890 **3.5.13**
891 **WET LOCATION**
892 location where water or another conductive liquid may be present and is likely to cause reduced
893 human body impedance due to wetting of the contact between the human body and the
894 equipment, or wetting of the contact between the human body and the environment
- 895 **3.5.14**
896 **REASONABLY FORESEEABLE MISUSE**
897 use of a product in a way not intended by the supplier, but which may result from readily
898 predictable human behaviour
- 899 **3.5.15**
900 **RISK**
901 combination of the probability of occurrence of harm and the severity of that harm
- 902 **3.5.16**
903 **TOLERABLE RISK**
904 RISK which is accepted in a given context based on the current values of society
905 [ISO/IEC Guide 51:1999, 3.7]
- 906 **3.5.17**
907 **OVERVOLTAGE CATEGORY**
908 numeral defining a TRANSIENT OVERVOLTAGE condition (see Annex K)
- 909 **3.5.18**
910 **TRANSIENT OVERVOLTAGE**
911 short duration overvoltage of a few milliseconds or less, oscillatory or non-oscillatory, usually
912 highly damped
913 [IEC 60050-604, Amendment 1:1998, 604-03-13]
- 914 **3.5.19**
915 **TEMPORARY OVERVOLTAGE**
916 power frequency overvoltage of relatively long duration
917 [IEC 60050-604, Amendment 1:1998, 604-03-12]

3.6 Insulation**3.6.1****BASIC INSULATION**

insulation of HAZARDOUS LIVE parts which provides basic protection

[IEC 60050-195:1998, 195-06-06]

NOTE BASIC INSULATION may serve also for functional purposes.

3.6.2**SUPPLEMENTARY INSULATION**

independent insulation applied in addition to BASIC INSULATION in order to provide protection against electric shock in the event of a failure of BASIC INSULATION

[IEC 60050-195:1998, 195-06-07, modified]

3.6.3**DOUBLE INSULATION**

insulation comprising both BASIC INSULATION and SUPPLEMENTARY INSULATION

[IEC 60050-195:1998, 195-06-08]

3.6.4**REINFORCED INSULATION**

insulation which provides protection against electric shock not less than that provided by DOUBLE INSULATION

NOTE REINFORCED INSULATION may be composed of several layers which cannot be tested singly as SUPPLEMENTARY INSULATION or BASIC INSULATION.

[IEC 60050-195:1998, 195-06-09, modified]

3.6.5**POLLUTION**

addition of foreign matter, solid, liquid or gaseous (ionized gases), that may produce a reduction of dielectric strength or surface resistivity

3.6.6**POLLUTION DEGREE**

numeral indicating the level of POLLUTION that may be present in the environment

3.6.7**POLLUTION DEGREE 1**

no POLLUTION or only dry, non-conductive POLLUTION occurs, which has no influence

3.6.8**POLLUTION DEGREE 2**

only non-conductive POLLUTION occurs except that occasionally a temporary conductivity caused by condensation is expected

3.6.9**POLLUTION DEGREE 3**

conductive POLLUTION occurs, or dry, non-conductive POLLUTION occurs which becomes conductive due to condensation which is expected

NOTE In such conditions, equipment is normally protected against exposure to direct sunlight, precipitation, and full wind pressure, but neither temperature nor humidity is controlled.

3.6.10**POLLUTION DEGREE 4**

continuous conductivity occurs due to conductive dust, rain or other wet conditions

3.6.11**CLEARANCE**

shortest distance in air between two conductive parts

3.6.12**CREEPAGE DISTANCE**

shortest distance along the surface of a solid insulating material between two conductive parts

[IEC 60050-151:2001, 151-15-50]

4 Tests**4.1 General**

Tests in this standard are TYPE TESTS to be carried out on samples of equipment or parts. Their only purpose is to check that the design and construction ensure conformity with this standard. In addition, manufacturers shall perform the ROUTINE TESTS of Annex F on 100 % of equipment produced which has both HAZARDOUS LIVE parts and ACCESSIBLE conductive parts.

The equipment shall at least meet the requirements of this standard. It is permissible to exceed the requirements. If, in this standard, a lower limit is specified for a conformity value, then the equipment may demonstrate a larger value. If an upper limit is specified for a conformity value, the equipment may demonstrate a lower value.

Tests on subassemblies that meet the requirements of the relevant standards specified in this standard, and used in accordance with them, need not be repeated during TYPE TESTS of the whole equipment.

Conformity with the requirements of this standard is checked by carrying out all applicable tests, except that a test may be omitted if examination of the equipment and design documentation demonstrates conclusively that the equipment would pass the test. Tests are carried out both under reference test conditions in conditions of normal use (see 4.3) and under fault conditions (see 4.4).

Where conformity statements in this standard require inspection, this may include examination of the equipment by measurement, examination of the markings on the equipment, examination of the instructions supplied with the equipment, examination of the data sheets of the materials or components from which the equipment is manufactured, etc. In each case, the inspection will either demonstrate that the equipment meets the applicable requirements, or will indicate that further testing is required.

Where the intended use or equipment functions present HAZARDS to the OPERATOR or to the surrounding area, other than those mitigated through the means and requirements in clauses 6 to 16, the manufacturers risk management document, and Annex J, can be consulted, to determine tests and operating conditions, to reduce such HAZARDS, as listed in clause 1.2, to a tolerable level.

If, when carrying out a conformity test, there is any uncertainty about the exact value of an applied or measured quantity (for example voltage) due to the tolerance:

- a) manufacturers should ensure that at least the specified test value is applied;
- b) test houses should ensure that no more than the specified test value is applied.

4.2 Sequence of tests

The sequence of tests is optional unless otherwise specified. The equipment under test shall be carefully inspected after each test. If the result of a test causes doubt whether any earlier tests would have been passed if the sequence had been reversed, these earlier tests shall be repeated.

4.3 Reference test conditions**4.3.1 Environmental conditions**

Unless otherwise specified in this standard, the following environmental conditions shall exist in the test location:

- a) a temperature of 15 °C to 35 °C;
- b) a relative humidity of not more than 75 %, but not exceeding the limits of 1.4.1 b);

- c) an atmospheric pressure of 75 kPa to 106 kPa;
d) no hoar-frost, dew, percolating water, rain, solar radiation, etc.

4.3.2 State of equipment

4.3.2.1 General

Unless otherwise specified, each test shall be carried out on the equipment assembled for NORMAL USE and under the least favourable combination of the conditions given in 4.3.2.2 to 4.3.2.14.

If dimensions or mass make it unsuitable to carry out particular tests on completely assembled equipment, tests on sub-assemblies are allowed, provided it is verified that the assembled equipment will meet the requirements of this standard.

Unless otherwise specified, the equipment shall be operated in a draught free environment within the test conditions specified in 4.3.1. These combinations of test conditions may be different for each individual test and they shall be recorded together with any measurements for each test. In case of doubt, tests shall be performed in more than one combination of conditions. If testing at the least favourable RATED environmental conditions is necessary to allow realistic assessment of conformity criteria, the tests shall be conducted under these conditions.

TRANSIENT OVERVOLTAGES, TEMPORARY OVERVOLTAGES, and POLLUTION DEGREE need not be considered as part of test conditions in NORMAL USE (i.e. these conditions need not be applied during the conformity tests of this standard unless otherwise specified).

4.3.2.2 Position of equipment

The equipment shall be in any position of NORMAL USE as specified in the manufacturer's instructions. Equipment intended to be built into a wall, recess, cabinet, etc., shall be installed as specified in the manufacturer's instructions. For HAND-HELD EQUIPMENT, all possible orientations are considered to be positions of NORMAL USE.

NOTE - see also requirements for equipment installation in 5.4.3.

Where no information related to the positioning of equipment, or where no ventilation requirements are given in the manufacturer's instructions, the equipment may, for the tests in normal condition, be placed in a corner, in any orientation, while still allowing for any connected cables to bend freely.

Equipment which can be positioned horizontally and vertically, shall be assessed in both positions.

4.3.2.3 Accessories

Accessories and OPERATOR-interchangeable parts available from, or recommended by, the manufacturer for use with the equipment under test shall be either connected or not connected.

4.3.2.4 Covers and removable parts

Covers or parts which can be removed without using a TOOL shall be removed or not removed.

4.3.2.5 Electrical supply source

The following requirements apply.

- a) The supply voltage shall be between 90 % and 110 % of any RATED supply voltage for which the equipment can be set or, if the equipment is RATED for a greater fluctuation, at any supply voltage within the fluctuation range. The supply voltage shall be the least favourable for the specific test performed.
- b) The frequency shall be any RATED frequency, whichever is least favourable for the specific test performed.
- c) Equipment for both a.c. and d.c. shall be connected to an a.c. or d.c. supply.
- d) Equipment for single-phase a.c. supply shall be connected both with normal and reverse polarity.

e) If the means of connection permits reversal, battery-operated and d.c. equipment shall be connected with both reverse and normal polarity.

f) Equipment powered by a bus (for example: USB) or by a current loop (for example: 4-20 mA) shall be operated at RATED voltage or according to the specifications of the specific interface.

NOTE – IEC 62368-3 is applicable for DC power transfer through communication cables and ports

4.3.2.6 Input and output voltages

Input and output voltages, including floating voltages but excluding the electrical supply source voltage (see 4.3.2.5), shall be set to any voltage within the RATED voltage range.

4.3.2.7 Earth TERMINALS

PROTECTIVE CONDUCTOR TERMINALS, if any, shall be connected to earth.

FUNCTIONAL EARTH TERMINALS shall be connected or not connected to earth.

4.3.2.8 Controls

Controls which an OPERATOR can adjust without the use of a TOOL shall be set to any position except that:

- a) MAINS selection devices shall be set to the correct value;
- b) combinations of settings shall not be made if they are prohibited by the manufacturer's marking on the equipment.

4.3.2.9 Connections

The equipment shall be connected for NORMAL USE, or not connected.

4.3.2.10 Load on motors

Load conditions of motor-driven parts of equipment shall be in accordance with the NORMAL USE.

4.3.2.11 Output

For equipment giving an electrical output:

- a) the equipment shall be operated in such a way as to provide the RATED output power to the RATED load;
- b) the RATED load impedance of any output shall be connected or not connected.

4.3.2.12 Duty cycle

Equipment for short-term or intermittent operation shall be operated for the longest RATED period and shall have the shortest RATED recovery period consistent with the manufacturer's instructions.

Equipment for short-term or intermittent operation that develops significant heat during the startup phase, and that relies on continued operation to dissipate that heat, shall also be operated for the shortest RATED period followed by the shortest RATED recovery period.

4.3.2.13 Loading and filling

Equipment intended to be loaded with a specific material in NORMAL USE shall be loaded with the least favourable quantity of the materials specified in the instructions for use, including not loaded (empty) if the instructions for use permit this in NORMAL USE.

NOTE If the specified material could cause a HAZARD during test, another material may be used provided that it can be shown that the result of the test is not affected.

4.3.2.14 Special External Services

Special external services such as air, coolant, etc. shall be supplied at the least favourable temperature, flow rate etc. allowed by the equipment instructions.

4.4 Testing in SINGLE FAULT CONDITION

4.4.1 General

The following requirements apply.

- a) The equipment design, specifications, and operating instructions shall be examined to identify the fault conditions which are liable to result in exposure to a HAZARD and which, therefore, shall be applied.
- b) Fault tests shall be made as specified for checking conformity, unless it can be demonstrated that no HAZARD could arise from a particular fault condition.
- c) The equipment shall be operated under the least favourable combination of reference test conditions (see 4.3). These combinations may be different for different faults and they shall be recorded for each test. If the environmental limits of the reference test conditions (see 4.3) do not allow realistic assessment of SINGLE FAULT CONDITIONS, the test shall be conducted at the least favourable RATED environmental conditions of the equipment.

4.4.2 Application of fault conditions

4.4.2.1 General

Fault conditions shall include:

- a) Any fault conditions determined as applicable through the examination of the equipment as required in clause 4.4.1;
- b) Applicable fault conditions as specified in clauses 4.4.2.2 to 4.4.2.15; and
- c) Any fault condition specified in clauses 6 to 16 dealing with the protection against each HAZARD.

The fault conditions shall be applied only one at a time and shall be applied in turn in any convenient order. Multiple simultaneous faults shall not be applied unless they are a consequence of an applied fault.

NOTE For example, fans may be stopped one fan at a time unless they share a common power or control source. In that case, the common fans should be stopped simultaneously by interrupting the power or control source.

After each application of a fault condition, the equipment or part shall pass the applicable tests of 4.4.4.

4.4.2.2 PROTECTIVE IMPEDANCE

The following requirements apply.

- a) If a PROTECTIVE IMPEDANCE is formed by a combination of components, each component shall be short-circuited or disconnected, whichever is less favourable.
- b) If a PROTECTIVE IMPEDANCE is formed with a single component that meets the requirements of 6.5.4, it need not be short-circuited or disconnected.

4.4.2.3 Protective conductor

The protective conductor shall be interrupted, except for PERMANENTLY CONNECTED EQUIPMENT and equipment utilizing a connector meeting the requirements of IEC 60309.

4.4.2.4 Equipment or parts for short-term or intermittent operation

These shall be operated continuously if continuous operation could occur in a SINGLE FAULT CONDITION. Individual parts may include motors, relays, other electromagnetic devices and heaters.

4.4.2.5 Motors

Motors shall be stopped while fully energized or prevented from starting, whichever is less favourable.

One supply phase of any multi-phase motor shall be interrupted while the motor is operating at its intended full load.

4.4.2.6 Capacitors

Capacitors (except for self-healing capacitors or short circuit proof capacitors) in the auxiliary winding circuits of motors shall be short-circuited.

4.4.2.7 Transformers relied upon for safety

4.4.2.7.1 General

The secondary windings of transformers shall be short-circuited as specified in 4.4.2.7.2, and overloaded as specified in 4.4.2.7.3.

A transformer damaged during one test may be repaired or replaced before the next test.

Tests for transformers tested as separate components are specified in 14.6.

Switch mode transformers and other pulse driven transformers shall be tested in the circuitry, with applicable single component faults.

4.4.2.7.2 Short circuit

Each untapped output winding, and each section of a tapped output winding, which is loaded in NORMAL USE, shall be tested in turn, one at a time, to simulate short circuits in the load. Overcurrent protection devices remain fitted during the test. All other windings are loaded or not loaded, whichever load condition of NORMAL USE is less favourable.

NOTE – The least favourable load conditions for other windings may vary for each test depending on the winding subjected to short circuit conditions.

4.4.2.7.3 Overload

Each untapped output winding, and each section of a tapped output winding, is overloaded in turn one at a time. During each test any other windings shall be loaded or not loaded, to achieve the highest current through primary or secondary overcurrent protection without them activating, whichever load condition of NORMAL USE is less favourable.

NOTE – This test is to achieve the highest winding temperature of the transformer without exceeding the 1 hour characteristic of any overcurrent protection.

If any overloads arise from testing in the fault conditions of 4.4, secondary windings shall be subjected to those overloads.

Overloading is carried out by connecting a variable resistor across the winding. The resistor is adjusted as quickly as possible and readjusted, if necessary, after 1 min to maintain the applicable overload. No further readjustments are then permitted.

If overcurrent protection is provided by a current-breaking device, the overload test current is the maximum current which the overcurrent protection device is just capable of passing for 1 h. Before the test, the device is replaced by a link with negligible impedance. If this value cannot be derived from the specification, it is to be established by test.

For equipment in which the output voltage is designed to collapse when a specified overload current is reached, the overload is slowly increased to a point just before the point which causes the output voltage to collapse.

In all other cases, the loading is the maximum current obtainable from the secondary winding under test, with any other windings loaded or not loaded, whichever represents the least favourable condition.

Transformers with overtemperature protection which meets the requirements of 14.3 during the short-circuit test of 4.4.2.7.2 need not be subjected to overload tests.

4.4.2.8 Outputs

Outputs shall be short-circuited and/or overloaded one at a time.

4.4.2.9 Equipment for more than one supply

Equipment which is designed to be operated from more than one type of supply shall be simultaneously connected to these supplies, unless this is prevented by the construction.

4.4.2.10 Cooling

Equipment cooling shall be restricted as follows, one fault at a time:

- a) air-holes with filters shall be closed;
- b) forced cooling by motor-driven fans shall be stopped;
- c) cooling by circulation of water or other coolant shall be stopped;
- d) loss of cooling liquid shall be simulated.

4.4.2.11 Heating devices

In equipment incorporating heating devices, the following faults shall be applied one at a time:

- a) timers which limit the heating period shall be overridden to energize the heating circuit continuously;
- b) temperature controllers, except for overtemperature protection devices meeting the requirements of 14.3, shall be overridden to energize the heating circuit continuously.

4.4.2.12 Insulation between circuits and parts

Insulation between circuits and parts which is below the level specified for BASIC INSULATION shall be bridged to check against the spread of fire if the method of 9.1 a) is used.

4.4.2.13 Interlocks

Each part of an interlock system for the protection of the OPERATOR shall be short-circuited or open-circuited in turn if the system prevents access to HAZARDS when a cover, etc. is removed without the use of a TOOL.

4.4.2.14 Voltage selectors

Voltage selectors which an OPERATOR can set for different RATED supply voltages shall be set for each possible setting with the equipment connected to each of its RATED supply circuits.

4.4.2.15 Interruption of electrical supply and other energy sources

Each of the required electrical supply or other energy supply sources shall be removed and/or restored.

Consideration shall be given for equipment with automatic restart function such that it shall resume in a safe state.

4.4.3 Duration of tests**4.4.3.1 General**

The equipment shall be operated until further change as a result of the applied fault is unlikely. If there is an indication that a HAZARD of electric shock, spread of fire or injury to persons may eventually occur, the test shall be continued until the HAZARD occurs or until it becomes clear that a HAZARD will not occur.

NOTE Each test is normally limited to 1 h since a secondary fault arising from a SINGLE FAULT CONDITION will usually manifest itself within that time. Normally, a HAZARD will manifest itself within 4 h if it does not within 1 h.

4.4.3.2 Current limiting devices

If a device which interrupts or limits the current during operation is included to limit the temperature of parts which can easily be touched, the maximum temperature attained by those parts shall be measured, whether the device operates or not.

4.4.3.3 Fuses

If a fault is terminated by the opening of a fuse and if the fuse does not operate within approximately 1 s, the current through the fuse under the relevant fault condition shall be measured. The pre-arcing time/current characteristics of the fuse shall be evaluated to find out whether the minimum operating current is reached and what is the maximum time before the fuse operates. The current through the fuse may vary as a function of time.

If the minimum operating current of the fuse is not reached in the test, the equipment shall be operated for a period corresponding to the maximum fusing time or continuously for the duration specified in 4.4.3.1, with the fuse replaced with a short-circuit.

4.4.4 Conformity after application of fault conditions

4.4.4.1 General

Conformity with requirements for protection against electric shock after the application of single faults is checked as follows:

- a) *by making the measurements of 6.3.2 to check that no ACCESSIBLE conductive parts have become HAZARDOUS LIVE;*
- b) *by performing a voltage test on DOUBLE INSULATION or REINFORCED INSULATION to check that the protection is still at least at the level of BASIC INSULATION. The voltage tests are made as specified in 6.7 and 6.8 (without humidity preconditioning) with the test voltage for BASIC INSULATION;*
- c) *by measuring the temperature of transformer windings if the protection against electrical HAZARDS is achieved by DOUBLE INSULATION or REINFORCED INSULATION within the transformer. The temperatures of Table 20 shall not be exceeded.*

4.4.4.2 Touch Temperature

Conformity with requirement for temperature protection is checked by determining the temperature of the easily touched surface and all other components, the failure of which could result in a hazardous situation due to the temperature. Examples of, but not limited to, these components may include windings, terminals, insulating materials, batteries, and capacitors. (See Clause 10, 14, and Annex C).

4.4.4.3 Spread of fire

Conformity with requirements for protection against the spread of fire is checked by placing the equipment on white tissue-paper covering a softwood surface and covering the equipment with cheesecloth. No molten metal, burning insulation, flaming particles, etc. shall fall on the surface on which the equipment stands and there shall be no charring, glowing, or flaming of the tissue paper or cheesecloth. Melting of insulation material shall be ignored if no HAZARD could arise.

4.4.4.4 Other HAZARDS

Conformity with other requirements for protection against HAZARDS is checked as specified in Clauses 6 to 16.

5 Marking and documentation

5.1 Marking

5.1.1 General

Equipment shall bear markings as specified in 5.1.2 to 5.2. Except for marking of internal parts, these markings shall be visible from the exterior, or be visible after removing a cover or opening a door without the aid of a TOOL, if the cover or door is intended to be removed or opened by an OPERATOR. Markings applying to the equipment as a whole shall not be put on parts which can be removed by an OPERATOR without the use of a TOOL.

For rack- or panel-mounted equipment, markings are permitted to be on a surface that becomes visible after removal of the equipment from the rack or panel.

Letter symbols for quantities and units shall be as specified in IEC 60027. Graphic symbols shall be in accordance with Table 1 if applicable. There are no colour requirements for symbols. Graphic symbols shall be explained in the documentation.

NOTE 1 IEC or ISO symbols should be used if available.

NOTE 2 Markings should not be on the bottom of the equipment, except on HAND-HELD EQUIPMENT or where space is limited.

Conformity is checked by inspection.

5.1.2 Identification

The equipment shall, as a minimum, be marked with:

- a) the name or trade mark of the manufacturer or supplier;
- b) a model number, name or other means to identify the equipment. If equipment bearing the same distinctive designation (model number) is manufactured at more than one location, equipment from each manufacturing location shall be marked so that the location can be identified.

NOTE The marking of factory location may be in code and need not be on the equipment exterior.

Conformity is checked by inspection.

5.1.3 External electrical supply sources

The equipment shall be marked with the following information.

a) Nature of supply:

- 1) a.c.: RATED MAINS frequency or range of frequencies;
- 2) d.c.: symbol 1 of Table 1.

NOTE 1 For information purposes it may be useful to mark

- equipment intended for a.c. with symbol 2 of Table 1;
- equipment suitable for both a.c. and d.c. with symbol 3 of Table 1;
- equipment for three-phase supply with symbol 4 of Table 1.

b) The RATED supply voltage(s) or the RATED range of supply voltages.

NOTE 2 RATED voltage fluctuations may also be marked.

c) The maximum RATED power in watts (active power) or volt-amperes (apparent power), or the maximum RATED input current, with all accessories or plug-in modules connected. If the equipment can be used on more than one voltage range, separate values shall be marked for each voltage range unless the maximum and minimum values do not differ by more than 20 % of the mean value. *The measured value shall not exceed the marked value by more than 10 %.*

d) Equipment which can be set for different RATED supply voltages shall be provided with means for the indication of the voltage for which the equipment is set. *Except for PERMANENTLY CONNECTED EQUIPMENT* the indication shall be visible from the exterior. If the equipment is so constructed that the supply voltage setting can be altered without the use of a TOOL, the action of changing the setting shall also change the indication.

e) Accessory MAINS socket-outlets accepting standard MAINS plugs shall be marked with the voltage if it is different from the MAINS supply voltage. If the outlet is for use only with specific equipment, it shall be marked to identify the equipment for which it is intended. If not, the maximum RATED current or power shall be marked, or symbol 14 of Table 1 placed beside the outlet with the full details included in the documentation.

Conformity is checked by inspection and by measurement of power or input current to check the requirements of 5.1.3 c) have been met. The measurement is made at each RATED voltage range with the equipment in the condition of maximum power or current consumption as applicable with all accessories or plug-in modules connected. If the input current varies during the normal operating cycle, the steady-state current is taken as the mean indication of the highest measured r.m.s. value during a 10 s period of the normal operation cycle. To exclude any initial inrush current the measurement is not made until the current has stabilized (usually after 1 min). Transients are ignored.

1334

Table 1 – Symbols

Number	Symbol	Reference	Description
1		IEC 60417-5031 (2002-10)	Direct current
2		IEC 60417-5032 (2002-10)	Alternating current
3		IEC 60417-5033 (2002-10)	Both direct and alternating current
4		IEC 60417-5032-1 (2002-10)	Three-phase alternating current
5		IEC 60417-5017 (2006-08)	Earth (ground) TERMINAL
6		IEC 60417-5019 (2006-08)	PROTECTIVE CONDUCTOR TERMINAL
7		IEC 60417-5020 (2002-10)	Frame or chassis TERMINAL
8			Not used
9		IEC 60417-5007 (2009-02)	On (Power)
10		IEC 60417-5008 (2009-02)	Off (Power)
11		IEC 60417-5172 (2003-02)	Equipment protected throughout by DOUBLE INSULATION or REINFORCED INSULATION
12			Caution, possibility of electric shock
13		IEC 60417-5041 (2002-10)	Caution, hot surface
14		ISO 7000-0434B (2004-01)	Caution ^a
15		IEC 60417-5268 (2002-10)	In position of a bi-stable push control
16		IEC 60417-5269 (2002-10)	Out position of a bi-stable push control
17		ISO 361	Ionizing radiation
18		ISO 7010 – W010 (modified)	Caution, risk of frostbite
19		ISO 7010 W021	Flammable material

^a See 5.4.1 which requires manufacturers to state that documentation must be consulted in all cases where this symbol is marked.

5.1.4 Fuses

For any fuse which may be replaced by an OPERATOR, there shall be a marking beside the fuseholder, which will enable the OPERATOR to identify the correct replacement fuse (see 5.4.5).

Conformity is checked by inspection.

5.1.5 TERMINALS, connections and operating devices

5.1.5.1 General

If necessary for safety, an indication shall be given of the purpose of TERMINALS, connectors, controls, and indicators, including any connections for fluids such as gas, water and drainage. Where there is insufficient space, symbol 14 of Table 1 may be used.

NOTE 1 For additional information, see IEC 60445 and IEC 60447.

NOTE 2 Individual pins of multi-pin connectors need not be marked.

Push-buttons and actuators of emergency stop devices, and indicators used only to indicate a warning of danger or the need for urgent action, shall be coloured red and coded as specified in IEC 60073. If the meaning of colour relates to the safety of persons or the environment, supplementary means of coding shall be provided (see IEC 60073).

NOTE 3 National authorities may require that equipment used in certain environments meet the man-machine interface requirements pertinent to that environment.

Conformity is checked by inspection.

5.1.5.2 TERMINALS

TERMINALS for connection to the MAINS supply shall be identifiable.

The following TERMINALS shall be marked as follows:

- a) FUNCTIONAL EARTH TERMINALS with symbol 5 of Table 1;
- b) PROTECTIVE CONDUCTOR TERMINALS with symbol 6 of Table 1, except when the PROTECTIVE CONDUCTOR TERMINAL is part of an approved MAINS appliance inlet. The symbol shall be placed on the TERMINAL or close to it;
- c) TERMINALS of circuits which are permitted by 6.6.3 to be connected to ACCESSIBLE conductive parts, with symbol 7 of Table 1 unless connection is self-evident;
NOTE This symbol may also be considered as a warning symbol in that it indicates that a HAZARDOUS LIVE voltage must not be connected to the TERMINAL. The symbol should also be used if it is likely that an OPERATOR could make such a connection inadvertently.
- d) TERMINALS supplied from the interior of the equipment and which are HAZARDOUS LIVE, with the voltage, current, charge or energy value or range, or with [symbol 12](#) of Table 1. This requirement does not apply to MAINS supply outlets where a standard MAINS socket outlet is used.

Conformity is checked by inspection.

5.1.6 Switches and circuit-breakers

If the power supply switch or circuit-breaker is used as the disconnecting device, the off-position shall be clearly marked.

NOTE It is recommended that the on-position also be marked.

[Symbols 9 and 10 of Table 1](#) can, in some cases, also be suitable as the device identification (see 6.11.4.2) if the symbols are marked on or adjacent to the switch or circuit-breaker. A lamp alone is not considered to be a satisfactory marking.

If a push-button switch is used as the power supply switch, symbols 9 and 15 of Table 1 may be used to indicate the on-position, or symbols 10 and 16 to indicate the off-position, with the pair of symbols (9 and 15, or 10 and 16) close together.

Conformity is checked by inspection.

5.1.7 Equipment protected by DOUBLE INSULATION or REINFORCED INSULATION

Equipment which is only partially protected by DOUBLE INSULATION or REINFORCED INSULATION shall not be marked with symbol 11 of Table 1.

NOTE Equipment protected throughout by DOUBLE INSULATION or REINFORCED INSULATION may be marked with symbol 11 of Table 1.

Conformity is checked by inspection.

5.1.8 Field-wiring TERMINAL boxes

If the temperature of the TERMINALS or the ENCLOSURE of a field-wiring TERMINAL box or compartment exceeds 60 °C in NORMAL CONDITION at an ambient temperature of 40 °C, or at the maximum RATED ambient temperature if higher, there shall be a marking to warn the installer to consult the installation instructions before determining the temperature RATING of the cable to be connected to the TERMINALS. The marking shall be visible before and during connection, or be beside the TERMINALS. Symbol 14 is an acceptable marking.

Conformity, in case of doubt, is checked by measurement as specified in 10.3 a) and, if applicable, by inspection of markings.

5.1.9 Specially protected equipment

Only equipment that meets the requirements of 11.6 may be marked with an IP Code.

NOTE 1 See IEC 60529 for details of the IP code marking.

Enclosures may have different degrees of protection according to the mounting arrangements, or the degree of protection may depend on the assembly or operating condition. IP Code markings shall be clear to avoid misunderstanding and misuses.

Conformity is checked by inspection.

5.1.10 Weight

Equipment with a mass greater than 18 kg, which is intended, between use, to be lifted or carried by the operator (see 7.5), shall be marked with its mass on the equipment.

Conformity is checked by inspection.

5.1.11 Packaging

Equipment, as packaged by the manufacturer with a total packaged mass greater than 18 kg, which is intended to be lifted or carried by the operator, shall be readily visible marked with the total mass on the packaging.

If any precautions are necessary for safe handling of the packaged equipment, those instructions shall be readily visible marked on the packaging.

Conformity is checked by inspection.

5.2 Warning markings

Warning markings specified in **this standard** shall meet the following requirements.

Warning markings shall be visible **and legible** when the equipment is ready for NORMAL USE. If a warning applies to a particular part of the equipment, the marking shall be placed on or near that part.

The size of warning markings shall be as follows:

- a) symbols shall be at least 2,75 mm high. Text shall be at least 1,5 mm high and contrast in colour with the background;
- b) symbols or text moulded, stamped or engraved in a material shall be at least 2,0 mm high. If not contrasting in colour, they shall have a depth or raised height of at least 0,5 mm.

If it is necessary for the RESPONSIBLE BODY or OPERATOR to refer to the documentation to preserve the protection afforded by the equipment, the equipment shall be marked with symbol

1426 14 of Table 1. Symbol 14 is not required to be used if other symbols which address the safety
1427 aspects are used and explained in the documentation.

1428 If the instructions for use state that an OPERATOR is permitted to gain access, using a TOOL, to
1429 a part or location which in NORMAL USE may present a HAZARD, there shall be a warning marking
1430 indicating that the equipment must be placed in safe state before access. Symbol 14 shall be
1431 used for this purpose with the warning text included in the documentation. Additional symbols
1432 may be marked to indicate the nature of the HAZARD such as symbol 12, 13, or 17 as appropriate.

1433 Symbols are the preferred marking method over text warnings. Supplemental text may be
1434 provided adjacent to the symbol.

1435 *Conformity is checked by inspection.*

1436 5.3 Durability of markings

1437 Required markings shall remain clear and legible under conditions of NORMAL USE and shall
1438 resist the effects of the cleaning agents specified by the manufacturer.

1439 *Conformity is checked by performing the following test for durability of markings on the outside
1440 of the equipment. The markings are rubbed by hand, without undue pressure, for 30 s with a
1441 cloth soaked with each specified cleaning agent (or, if not specified, with 70 % isopropyl
1442 alcohol).*

1443 *After the above treatment the markings shall be clearly legible and adhesive labels shall not
1444 have worked loose or become curled at the edges.*

1445 5.4 Documentation

1446 5.4.1 General

1447 The following information necessary for safety purposes, as needed by the OPERATOR or the
1448 RESPONSIBLE BODY, shall be contained in the documentation provided with the equipment. Safety
1449 documentation for service personnel authorized by the manufacturer shall be made available
1450 to such personnel:

- 1451 a) intended use of the equipment;
- 1452 b) technical specification;
- 1453 c) name and address of the manufacturer or supplier from whom technical assistance may be
1454 obtained;
- 1455 d) the information specified in 5.4.2 to 5.4.6;
- 1456 e) information about how to mitigate residual RISKS;
- 1457 f) for equipment which for safety reasons requires specific accessories (for example probe
1458 assemblies) with specific characteristics, the documentation shall indicate that only
1459 accessories which meet the manufacturer's specifications shall be used;
- 1460 g) if a HAZARD could be caused by an incorrect reading when measuring, indicating or detecting
1461 harmful or corrosive substances, or HAZARDOUS LIVE electrical quantities, the instructions
1462 shall provide guidance on how to determine that the equipment is functioning correctly;
- 1463 h) instructions for lifting and carrying (see 7.5.1);
- 1464 i) instructions for transport, handling and storage. Where lifting accessories for mechanical
1465 handling are fitted, or supplied, or there are facilities to fit them, the instructions shall
1466 include, as appropriate:
 - 1467 1) removal/fitting/re-fitting instructions for the lifting accessories
 - 1468 2) the load specification for externally provided lifting accessories
 - 1469 3) a requirement to inspect the lifting accessories and their correct fitting before any
1470 mechanical lifting operation.
- 1471 j) instructions related to IP rating (see 11.6.1)

1473 Warning symbols and warning statements that are marked on the equipment shall be explained
1474 in the documentation. In particular, the documentation shall include a statement that it must be

1475 consulted in all cases where symbol 14 of Table 1 is marked, in order to find out the nature of
1476 the potential HAZARDS and any actions which have to be taken to avoid them.

1477 NOTE 1 Markings and text on equipment are considered equivalent to the documentation.

1478 NOTE 2 If NORMAL USE involves the handling of harmful or corrosive substances, instruction should be given on
1479 correct use and safety provisions. If any harmful or corrosive substance is specified or supplied by the equipment
1480 manufacturer, the necessary information on its constituents and the correct disposal procedure should also be given.

1481 Documentation may be provided on printed or electronic media, however printed information is
1482 required for all information necessary for safety that might not be available in electronic form at
1483 the time it is needed. The documentation shall be delivered with the equipment. Consideration
1484 shall be given to the ability of the RESPONSIBLE BODY to read the media.

1485 *Conformity is checked by inspection.*

1486 5.4.2 Equipment RATINGS

1487 Documentation shall include the following:

1488 a) the supply voltage or voltage range, frequency or frequency range, and power or current
1489 RATING;

1490 b) a description of all input and output connections as required by 6.6.1 a);

1491 c) the RATING of the insulation of external circuits as required by 6.6.1 b);

1492 d) a statement of the range of environmental conditions for which the equipment is designed
1493 including:

1494 1) indoor or outdoor use

1495 2) altitude

1496 3) temperature

1497 4) relative humidity

1498 5) MAINS supply voltage fluctuations

1499 6) OVERVOLTAGE CATEGORY, except for cord/plug-connected equipment

1500 7) WET LOCATION, if applicable

1501 8) POLLUTION DEGREE of the intended environment,

1502 e) for equipment RATED for ingress protection according to IEC 60529 the information required
1503 in 11.6.1;

1504 f) for equipment with an impact RATING less than 5 J, the RATED IK code, energy level, and test
1505 method per IEC 62262.

1506 *Conformity is checked by inspection.*

1507 5.4.3 Equipment installation

1508 The documentation shall include installation and specific commissioning instructions and, if
1509 necessary for safety, warnings against HAZARDS which could arise during installation or
1510 commissioning or as a result of improper installation or commissioning of the equipment. Such
1511 information includes, if applicable:

1512 a) Lifting and carrying;

1513 b) assembly, location and mounting requirements;

1514 c) instructions for protective earthing;

1515 d) connections to the supply;

1516 e) for PERMANENTLY CONNECTED EQUIPMENT:

1517 1. supply wiring requirements;

1518 2. requirements for any external switch or circuit-breaker (see 6.11.3.1) and external
1519 overcurrent protection devices (see 9.6.2) and a recommendation that the switch or
1520 circuit-breaker be near the equipment;

1521 3. field wiring temperature rating requirements (see 5.1.8 and 10.3)

- 1522 f) ventilation requirements;
- 1523 g) requirements **and safety characteristics** for special **external** services, for example: **maximum**
1524 **and minimum temperature, pressure, or flow of** air or cooling liquid;
- 1525 h) instructions relating to sound level (see 0).
- 1526 i) **for equipment that is intended to be connected to potentially hazardous substances,**
1527 **instructions of proper connection and verification of the connection shall be stated in the**
1528 **user or service manual, whichever is applicable.**

1529 NOTE It is recommended to add a statement in the documentation for the installation that the safety of any system
1530 incorporating the equipment is the responsibility of the assembler of the system.

1531 *Conformity is checked by inspection.*

1532 **5.4.4 Equipment operation**

1533 Instructions for use shall include, if applicable:

- 1534 a) identification and description of operating controls and their use in all operating modes;
- 1535 b) instructions not to position the equipment so that it is difficult to operate the disconnecting
1536 device;
- 1537 c) instructions for interconnection to accessories and other equipment, including indication of
1538 suitable accessories, detachable parts and any special materials;
- 1539 d) specifications of limits for intermittent operation;
- 1540 e) explanations of symbols related to safety which are used on the equipment;
- 1541 f) instructions for replacement of consumable materials;
- 1542 g) instructions for cleaning and decontamination;
- 1543 h) a statement listing potentially poisonous or injurious substances that can be liberated from
1544 the equipment, and possible quantities;
- 1545 i) detailed instructions about RISK reduction procedures relating to flammable liquids (see 9.5);
- 1546 j) details of methods of reducing the RISKS of burns from surfaces permitted to exceed the
1547 temperature limits of 10.1.

1548 **Accessories or sub-assemblies conforming to their applicable product safety standards, when**
1549 **used with equipment conforming to this standard, and if there is a HAZARD due to moisture or**
1550 **liquids, the instructions for use shall specify any additional precautions necessary.**

1551 There shall be a statement in the instructions that, if the equipment is used in a manner not
1552 specified by the manufacturer, the protection provided by the equipment may be impaired.

1553 *Conformity is checked by inspection.*

1554 **5.4.5 Equipment maintenance and service**

1555 Instructions shall be provided to the RESPONSIBLE BODY in sufficient detail to permit safe
1556 maintenance, inspection **and testing** of the equipment, and to ensure continued safety of the
1557 equipment after the maintenance, inspection **and test** procedure.

1558 If applicable, manufacturer's documentation shall instruct against replacing detachable MAINS
1559 supply cords by inadequately RATED cords.

1560 For equipment using replaceable batteries, the specific battery type shall be stated.

1561 The manufacturer shall specify any parts which are required to be examined or supplied only
1562 by the manufacturer or his agent.

1563 The RATING and characteristics of replaceable fuses shall be stated.

1564 Instructions on the following subjects shall be provided for service personnel, as necessary to
1565 permit safe servicing and continued safety of the equipment after servicing if the equipment is
1566 suitable to be serviced:

- 1567 a) product-specific RISKS that may affect the service personnel;

b) protective measures for these RISKS;

c) verification of the safe state of the equipment after repair.

d) Equipment shall be supplied with a list of specifications of all the special equipment, TOOLS and accessories essential to enable it to be safely adjusted and maintained.

NOTE Instructions for service personnel need not be supplied to the RESPONSIBLE BODY, but should be made available to service personnel.

For equipment that is connected to hazardous substances, instructions shall be provided to guide the RESPONSIBLE BODY to ensure that the connection is properly tested following maintenance of the equipment.

Conformity is checked by inspection.

5.4.6 Integration into systems or effects resulting from special conditions

Aspects resulting from integration into systems or effects resulting from special ambient or application conditions shall be described in the documentation.

Conformity is checked by inspection of the documentation.

6 Protection against electric shock

6.1 General

6.1.1 Requirements

Protection against electric shock shall be maintained in NORMAL CONDITION and SINGLE FAULT CONDITION (see 6.4 and 6.5). ACCESSIBLE parts (see 6.2) shall not be HAZARDOUS LIVE (see 6.3). Voltage, current, charge or energy between an ACCESSIBLE part and earth, or between any two 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 levels of 6.3.1 in NORMAL CONDITION nor of 6.3.2 in SINGLE FAULT CONDITION.

Conformity is checked by the determination of ACCESSIBLE parts as specified in 6.2 and by the measurements of 6.3 to establish that the levels of 6.3.1 and 6.3.2 are not exceeded, and as specified in 6.4 to 6.11.

6.1.2 Exceptions

If it is not feasible for operating reasons to prevent the following parts being both ACCESSIBLE and HAZARDOUS LIVE, they are permitted to be ACCESSIBLE to an OPERATOR during NORMAL USE while they are HAZARDOUS LIVE:

a) parts of lamps and lamp sockets after lamp removal;

b) parts intended to be replaced by an OPERATOR (for example, batteries) and which may be HAZARDOUS LIVE during the replacement or other OPERATOR action, but only if they are ACCESSIBLE only by means of a TOOL and have a warning marking (see 5.2);

If any of the parts in a) and b) receives a charge from an internal capacitor, they shall not be HAZARDOUS LIVE 10 s after interruption of the supply.

If a charge is received from an internal capacitor, conformity is checked by the measurements of 6.3 to establish that the levels of 6.3.1 c) are not exceeded.

6.2 Determination of ACCESSIBLE parts

6.2.1 General

Unless obvious, determination of whether a part is ACCESSIBLE is made as specified in 6.2.2 to 6.2.4 in all positions of NORMAL USE. Test fingers (see Annex B) and pins are applied without force unless a force is specified. Parts are considered to be ACCESSIBLE if they can be touched with any part of a test finger or test pin, or if they could be touched in the absence of a covering which is not considered to provide suitable insulation (see 6.9.2).

ACCESSIBLE parts do not include those that become ACCESSIBLE when floor standing equipment having a mass exceeding 40 kg is tilted.

1615 *If, in NORMAL USE, an OPERATOR is intended to perform any actions (with or without a TOOL) that*
 1616 *could increase the accessibility of parts, such actions are taken before performing the*
 1617 *examinations of 6.2.2 to 6.2.4.*

1618 NOTE Examples of such actions include:

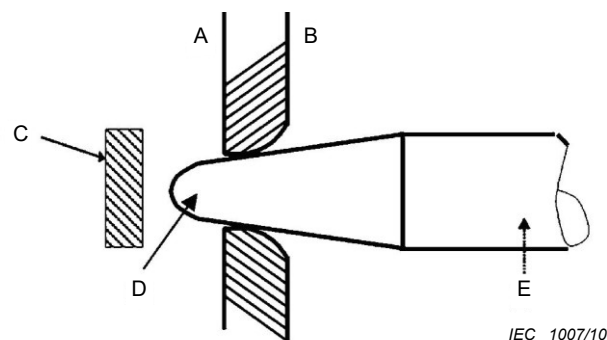
- 1619 a) removing covers;
- 1620 b) opening doors;
- 1621 c) adjusting controls;
- 1622 d) replacing consumable material;
- 1623 e) removing parts.

1624 *Rack-mounted and panel-mounted equipment is installed as specified in the manufacturer's*
 1625 *instructions before making the examinations of 6.2.2 to 6.2.4. For such equipment, the*
 1626 *OPERATOR is assumed to be in front of the panel.*

1627 6.2.2 Examination

1628 *The jointed test finger (see Figure B.2) is applied in every possible position. If a part could*
 1629 *become ACCESSIBLE by applying a force, the rigid test finger (see Figure B.1) is applied with a*
 1630 *force of 10 N. The force is exerted by the tip of the test finger so as to avoid wedge and lever*
 1631 *action. The test is applied to all outer surfaces, including the bottom. However, on equipment*
 1632 *accepting plug-in modules the tip of the jointed test finger is inserted only to a depth of 180 mm*
 1633 *from the opening in the equipment.*

1634 *The test finger is likewise applied to all openings in the ENCLOSURE, including holes and*
 1635 *TERMINALS. In these cases, the ACCESSIBLE parts of the ENCLOSURE are considered to include*
 1636 *any part of the test finger which can be inserted into the hole or TERMINAL (see Figure 1).*



1637

1638 Key

- 1639 A inside of equipment
- 1640 B outside of equipment
- 1641 C HAZARDOUS LIVE part
- 1642 D tip of test finger is considered to be ACCESSIBLE
- 1643 E test finger

1644 **Figure 1 – Measurements through openings in ENCLOSURES**

1645 6.2.3 Openings above parts that are HAZARDOUS LIVE

1646 *A metal test pin 100 mm long and 4 mm in diameter is inserted into any openings above parts*
 1647 *which are HAZARDOUS LIVE. The test pin is suspended freely and allowed to penetrate up*
 1648 *to 100 mm.*

1649 *The additional safety measures of 6.5.1 for protection in SINGLE FAULT CONDITION are not*
 1650 *required solely because a part is ACCESSIBLE only by this test.*

1651 NOTE This exception is permitted because the insertion of an object similar to this test pin is considered to be a
 1652 SINGLE FAULT CONDITION and one means of protection is sufficient.

1653 *This test is not applied to TERMINALS.*

6.2.4 Openings for pre-set controls

A metal test pin 3 mm in diameter is inserted through holes intended to give access to pre-set controls which require the use of a screwdriver or other TOOL. The test pin is applied in every possible direction through the hole. Penetration shall not exceed three times the distance from the ENCLOSURE surface to the control shaft or 100 mm, whichever is smaller.

6.3 Limit values for ACCESSIBLE parts

6.3.1 Levels in NORMAL CONDITION

Voltages above the levels of a) are deemed to be HAZARDOUS LIVE if any of the levels of b) or c) are exceeded.

a) The a.c. voltage levels are 30 V r.m.s., 42,4 V peak and the d.c. voltage level is 60 V. For equipment intended for use in WET LOCATIONS, the a.c. voltage levels are 16 V r.m.s., 22,6 V peak and the d.c. voltage level is 35 V.

b) The current levels are:

1) 0,5 mA r.m.s. for sinusoidal waveforms, 0,7 mA peak for non-sinusoidal waveforms or mixed frequencies, or 2 mA d.c., when measured with the measuring circuit of Figure A.1a up to 1 MHz. If the frequency does not exceed 100 Hz, the measuring circuit of Figure A.2 can be used. The measuring circuit of Figure 0 is used for equipment intended for use in WET LOCATIONS.

2) 70 mA r.m.s. when measured with the measuring circuit of Figure 0. This relates to possible burns at higher frequencies (above 30 kHz).

c) The levels of capacitive charge or energy are:

1) 45 µC charge for voltages up to 15 kV peak or d.c.; line A of Figure 3 shows the capacitance versus voltage where the charge is 45 µC.

2) 350 mJ stored energy for voltages above 15 kV peak or d.c.

6.3.2 Levels in SINGLE FAULT CONDITION

Voltages above the levels of a) are deemed to be HAZARDOUS LIVE if any of the levels of b) or c) are exceeded at the same time.

a) The a.c. voltage levels are 50 V r.m.s., 70 V peak and the d.c. voltage level is 120 V. For equipment intended for use in WET LOCATIONS, the a.c. voltage levels are 33 V r.m.s., 46,7 V peak and the d.c. voltage level is 70 V.

b) The current levels are:

1) 5,0 mA r.m.s. for sinusoidal waveforms, 7,1 mA peak for non-sinusoidal waveforms or mixed frequencies, or 15 mA d.c., when measured with the measuring circuit of Figure A.1b up to 1 MHz. If the frequency does not exceed 100 Hz, the measuring circuit of Figure A.2 can be used. The measuring circuit of Figure 0 is used for equipment intended for use in WET LOCATIONS;

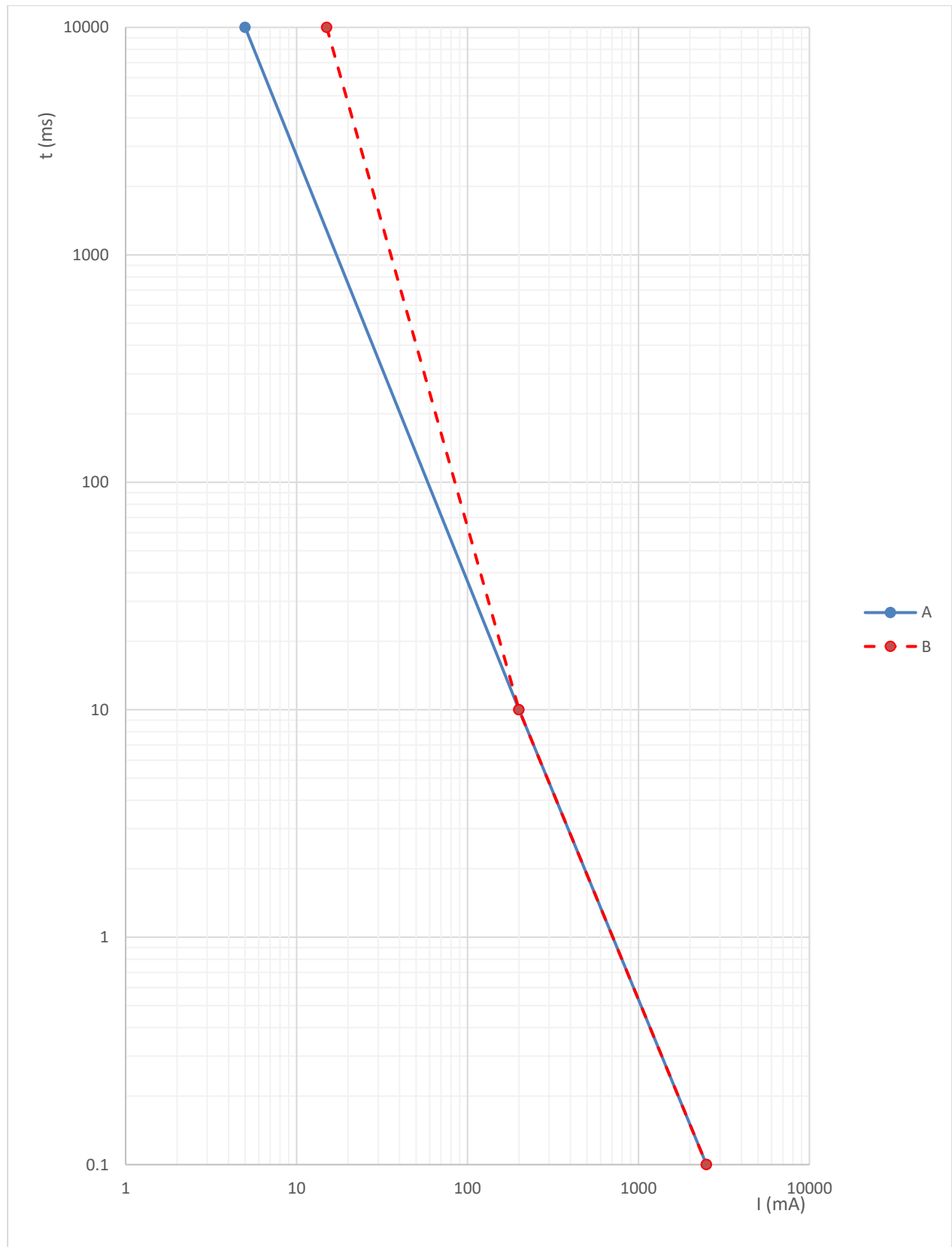
2) 500 mA r.m.s. when measured with the measuring circuit of Figure 0. This relates to possible burns at higher frequencies (above 30 kHz).

For accessible current of short duration, the maximum duration versus current level is defined by Figure 2. For accessible current of less than 0,1 ms in duration, the maximum current level is 2,5 Apk.

c) The levels of capacitance or energy are:

1) line B of Figure 3 or

2) 1,6 J stored energy for voltages above 40 kV peak or DC.

**Key**

A Current AC

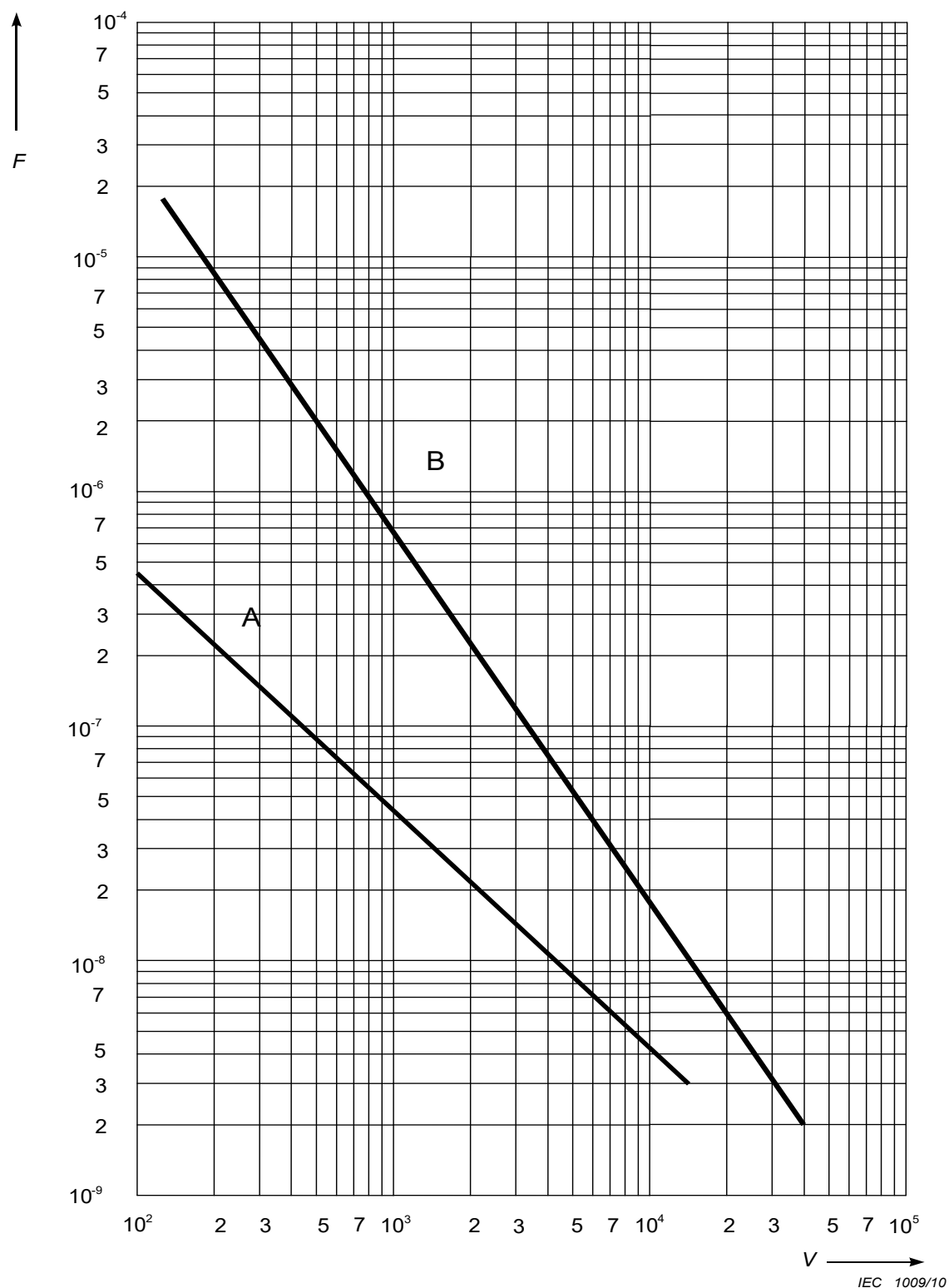
B Current DC

NOTE this figure is based on IEC TS 60479-1:2005 Figures 20 and 22, and IEC TS 60479-2:2007 Figure 20

**Figure 2 – Maximum duration of short-term ACCESSIBLE current
in SINGLE FAULT CONDITION (see 6.3.2 b))**

**Documents**

Document Sharing Hub



1707

1708 **Key**

1709 A NORMAL CONDITION

1710 B SINGLE FAULT CONDITION

1711 **Figure 3 – Capacitance level versus voltage in NORMAL CONDITION and SINGLE FAULT**
 1712 **CONDITION (see 6.3.1 c) and 6.3.2 c))**

6.4 Primary means of protection

6.4.1 General

Access to HAZARDOUS LIVE PARTS shall be prevented by ENCLOSURES or PROTECTIVE BARRIERS (see 446.4.2) and ACCESSIBLE parts shall be prevented from becoming HAZARDOUS LIVE by one or both of the following means (see Annex D):

- a) ENCLOSURES or PROTECTIVE BARRIERS (see 6.4.2);
- b) BASIC INSULATION (see 6.4.3);
- c) impedance (see 6.4.4).

Conformity is checked by inspection and as specified in 6.4.2 to 6.4.4.

6.4.2 ENCLOSURES and PROTECTIVE BARRIERS

ENCLOSURES and PROTECTIVE BARRIERS shall meet the rigidity requirements of 8.1.

If ENCLOSURES or PROTECTIVE BARRIERS provide protection by insulation, they shall meet the requirements of BASIC INSULATION.

If ENCLOSURES or PROTECTIVE BARRIERS provide protection by limiting access, CLEARANCES and CREEPAGE DISTANCES between ACCESSIBLE parts and HAZARDOUS LIVE parts shall meet the requirements of 6.7 and the applicable requirements for BASIC INSULATION.

Rack-mounted and panel-mounted equipment are installed as specified in the manufacturer's instructions.

Conformity is checked as specified in 6.7 and 8.1.

6.4.3 BASIC INSULATION

CLEARANCES, CREEPAGE DISTANCES and solid insulation forming BASIC INSULATION between ACCESSIBLE parts and HAZARDOUS LIVE parts shall meet the requirements of 6.7.

Conformity is checked as specified in 6.7.

6.4.4 Impedance

An impedance used as a primary means of protection shall meet all the following requirements:

- a) it shall limit the current or voltage to not more than the applicable level of 6.3.2;
- b) it shall be RATED for the maximum WORKING VOLTAGE and for the amount of power that it will dissipate;
- c) CLEARANCE and CREEPAGE DISTANCE between terminations of the impedance shall meet the applicable requirements of 6.7 for BASIC INSULATION.

Conformity is checked by inspection, by measuring the voltage or current to confirm that they do not exceed the levels of 6.3.2, and by measuring CLEARANCE and CREEPAGE DISTANCE as specified in 6.7.

6.5 Additional means of protection in case of SINGLE FAULT CONDITIONS

6.5.1 General

ACCESSIBLE parts shall be prevented from becoming HAZARDOUS LIVE in SINGLE FAULT CONDITION. The primary means of protection (see 6.4) shall be supplemented by one of a), b), c) or d). Alternatively one of the single means of protection e) or f) shall be used. See Figure 4 and Annex D.

- a) PROTECTIVE BONDING (see 6.5.2);
- b) SUPPLEMENTARY INSULATION (see 6.5.3);
- c) automatic disconnection of the supply (see 6.5.5);
- d) current- or voltage-limiting device (see 6.5.6);
- e) REINFORCED INSULATION (see 6.5.3);

f) PROTECTIVE IMPEDANCE (see 6.5.4).

Conformity is checked by inspection and as specified in 6.5.2 to 6.5.6.

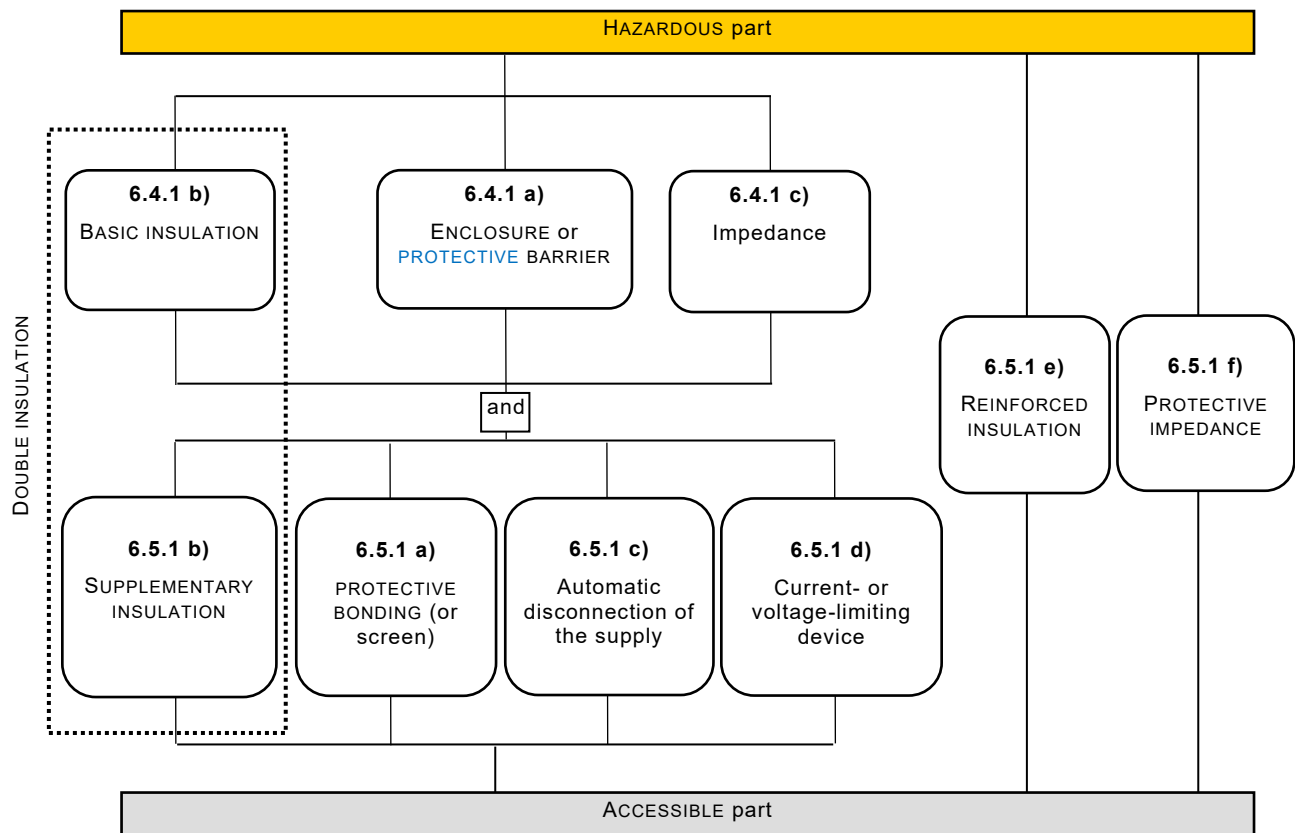


Figure 4 – Acceptable arrangement of protective means against electric shock

IEC 1010/10

6.5.2 PROTECTIVE BONDING

6.5.2.1 General

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 means of protection specified in 6.4. Alternatively, such ACCESSIBLE parts shall be separated from parts which are HAZARDOUS LIVE by a conductive protective screen bonded to the PROTECTIVE CONDUCTOR TERMINAL.

Conformity is checked as specified in 6.5.2.2 to 6.5.2.6.

6.5.2.2 Integrity of PROTECTIVE BONDING

The integrity of PROTECTIVE BONDING shall be assured as specified below.

- a) PROTECTIVE BONDING shall consist of directly connected structural parts or discrete conductors, or both. It shall withstand all thermal and dynamic stresses to which it could be subjected before one of the overcurrent protective means specified in 9.6 disconnects the equipment from the supply.
- b) Soldered connections subject to mechanical stress shall be mechanically secured independently from the soldering. Such connections shall not be used for other purposes such as fixing constructional parts.
- c) Screw connections shall be secured against loosening.
- d) If a part of the equipment is removable by an OPERATOR, the PROTECTIVE BONDING for the remainder of the equipment shall not be interrupted (except for a part that also carries the MAINS input connection to the whole equipment).

e) Unless they are specifically designed for electrical inter-connection and meet the requirements of 6.5.2.4, movable conductive connections, for example, hinges, slides, etc., shall not be the sole PROTECTIVE BONDING path.

f) The exterior metal braid of cables shall not be regarded as PROTECTIVE BONDING, even if connected to the PROTECTIVE CONDUCTOR TERMINAL.

g) If power from the MAINS supply is passed through equipment for use by other equipment, means shall also be provided for passing the protective conductor through the equipment to protect the other equipment. The impedance of the protective conductor path through the equipment shall not exceed that specified in 6.5.2.4.

h) Protective conductors may be bare or insulated. Insulation shall be green-and-yellow, except in the following cases:

1) for earthing braids, either green-and-yellow or colourless-transparent;

2) for internal protective conductors, and other conductors connected to the PROTECTIVE CONDUCTOR TERMINAL in assemblies such as ribbon cables, busbars, flexible printed wiring, etc., any colour may be used provided that no HAZARD is likely to arise from non-identification of the protective conductor.

Equipment using PROTECTIVE BONDING shall be provided with a TERMINAL that is suitable for connection to a protective conductor and meets the requirements of 6.5.2.3.

Conformity is checked by inspection.

6.5.2.3 PROTECTIVE CONDUCTOR TERMINAL

PROTECTIVE CONDUCTOR TERMINALS shall meet the following requirements.

a) The contact surfaces shall be metal.

NOTE 1 Materials of PROTECTIVE BONDING systems should be chosen to minimize electro-chemical corrosion between the TERMINAL and the protective conductor, or any other metal in contact with them.

b) The integral protective conductor connection of an appliance inlet shall be regarded as the PROTECTIVE CONDUCTOR TERMINAL.

c) For equipment provided with a rewirable flexible cord and for PERMANENTLY CONNECTED EQUIPMENT, the PROTECTIVE CONDUCTOR TERMINAL shall be located near the MAINS supply TERMINALS.

d) If the equipment does not require connection to a MAINS supply, but nevertheless has a circuit or part which is required to be protectively earthed, the PROTECTIVE CONDUCTOR TERMINAL shall be located near the TERMINALS of that circuit for which protective earthing is necessary. If this circuit has external TERMINALS, the PROTECTIVE CONDUCTOR TERMINAL shall also be external.

e) PROTECTIVE CONDUCTOR TERMINALS for MAINS CIRCUITS shall be at least equivalent in current-carrying capacity to the MAINS supply TERMINALS.

f) Plug-in type PROTECTIVE CONDUCTOR TERMINALS combined with other TERMINALS and intended to be connected and disconnected without the use of a TOOL, shall be designed so that the protective conductor connection makes first and breaks last with respect to the other connections. Examples include plugs and appliance couplers for MAINS cords and connector assemblies of plug-in units.

g) If the PROTECTIVE CONDUCTOR TERMINAL is also used for other bonding purposes, the protective conductor shall be applied first and secured independently of other connections. The protective conductor shall be connected in such a way that it is unlikely to be removed during servicing that does not require disconnection of the protective conductor.

h) For equipment in which the protective conductor is required for protection against a single fault in a measuring circuit, the following shall apply:

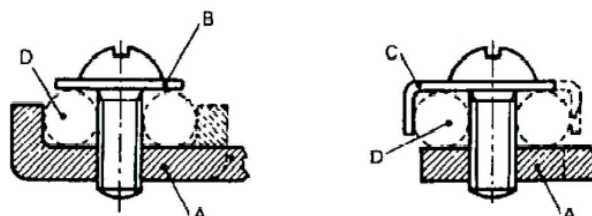
1) the PROTECTIVE CONDUCTOR TERMINAL and protective conductor shall have at least the current RATING of the measuring TERMINALS;

2) the PROTECTIVE BONDING shall not be interrupted by any switching or interrupting device.

i) FUNCTIONAL EARTH TERMINALS (for example, measuring earth TERMINALS) shall allow a connection which is independent from the connection of the protective conductor

NOTE 2 Equipment may be equipped with FUNCTIONAL EARTH TERMINALS, irrespective of the protective means taken.

- j) If the PROTECTIVE CONDUCTOR TERMINAL is a binding screw assembly (see Figure 5), it shall be of a suitable size for the bond wire, but with a thread size no smaller than 4,0 mm, with at least three turns of the screw engaged.
- k) The contact pressure required for a bonding connection shall not be capable of being reduced by deformation of materials forming part of the connection.



IEC 1011/10

Key

- A fixed part
B washer or clamping plate
C anti-spread device
D conductor space

Figure 5 – Examples of binding screw assemblies

Conformity is checked by inspection. Conformity for j) is also checked by the following test.

The binding screw assembly is to be tightened and loosened three times, together with the least favourable conductor to be secured, using the tightening torques specified in Table 2. All parts of the binding screw assembly shall withstand this test without mechanical failure.

Table 2 – Tightening torque for binding screw assemblies

Thread size mm	4,0	5,0	6,0	8,0	10,0
Tightening torque N·m	1,2	2,0	3,0	6,0	10,0

6.5.2.4 Impedance of PROTECTIVE BONDING of plug-connected equipment

The impedance between the PROTECTIVE CONDUCTOR TERMINAL and each ACCESSIBLE part for which PROTECTIVE BONDING is specified shall not exceed 0,1 Ω . If the equipment has a non-detachable power cord, the impedance between the protective conductor plug pin of the MAINS cord and each ACCESSIBLE part for which PROTECTIVE BONDING is specified shall not exceed 0,2 Ω .

Conformity is checked by applying a test current for 1 min and then calculating impedance. The test current is the greater of

- a) 25 A a.c. r.m.s. at RATED MAINS frequency or d.c.,
b) a current equal to twice the RATED current of the equipment.

If the equipment contains overcurrent protection devices for all poles of the MAINS supply, and if the wiring on the supply side of the overcurrent protection devices cannot become connected to ACCESSIBLE conductive parts in the case of a single fault, the test current need not be more than twice the RATED current of the internal overcurrent protection devices.

6.5.2.5 Impedance of PROTECTIVE BONDING of PERMANENTLY CONNECTED EQUIPMENT

PROTECTIVE BONDING of PERMANENTLY CONNECTED EQUIPMENT shall be of low impedance.

1871 *Conformity is checked by applying a test current of twice the value of the overcurrent protection*
1872 *means specified in the equipment installation instructions for the building supply MAINS CIRCUIT*
1873 *for 1 min between the PROTECTIVE CONDUCTOR TERMINAL and each ACCESSIBLE conductive part*
1874 *for which PROTECTIVE BONDING is required. The voltage between them shall not exceed*
1875 *10 V a.c. r.m.s. or d.c.*

1876 *If the equipment contains overcurrent protection devices for all poles of the MAINS supply, and*
1877 *if the wiring on the supply side of the overcurrent protection devices cannot become connected*
1878 *to ACCESSIBLE conductive parts in the case of a single fault, the test current need not be more*
1879 *than twice the RATED current of the internal overcurrent protection devices.*

1880 **6.5.2.6 Transformer PROTECTIVE BONDING screen**

1881 If the transformer is fitted with a screen for PROTECTIVE BONDING purposes that is separated only
1882 by BASIC INSULATION from a winding that is connected to a HAZARDOUS LIVE circuit, the screen
1883 shall satisfy the requirements of 6.5.2.2 a) and b), and be of low impedance.

1884 *Conformity is checked by inspection and by one of the following tests:*

1885 *a) a test current of twice the value of the overcurrent protection means of the winding is applied*
1886 *for 1 min between the screen and the PROTECTIVE CONDUCTOR TERMINAL. The voltage*
1887 *between them shall not exceed 10 V a.c. r.m.s. or d.c.;*

1888 *b) the test of 6.5.2.4 using test current twice the value of the overcurrent protection means of*
1889 *the winding. The impedance shall not exceed 0,1 Ω .*

1890 *NOTE If test a) or b) is carried out, a specially prepared sample transformer having an extra lead-out wire from*
1891 *the free end of the screen is used to ensure that the current during the test passes through the screen.*

1892 **6.5.3 SUPPLEMENTARY INSULATION and REINFORCED INSULATION**

1893 CLEARANCES, CREEPAGE DISTANCES and solid insulation forming SUPPLEMENTARY INSULATION or
1894 REINFORCED INSULATION shall meet the applicable requirements of 6.7.

1895 *Conformity is checked as specified in 6.7.*

1896 **6.5.4 PROTECTIVE IMPEDANCE**

1897 A PROTECTIVE IMPEDANCE shall limit the current or voltage to the levels of 6.3.1 in NORMAL
1898 CONDITION and 6.3.2 in SINGLE FAULT CONDITION.

1899 Insulation between the terminations of the PROTECTIVE IMPEDANCE shall meet the requirements
1900 of 6.7 for DOUBLE INSULATION or REINFORCED INSULATION.

1901 A PROTECTIVE IMPEDANCE shall be one or more of the following:

1902 a) an appropriate single component which shall be constructed, selected and tested so that
1903 safety and reliability for protection against electric shock is assured. In particular, the
1904 component shall be:

1905 1) RATED for twice the maximum WORKING VOLTAGE;

1906 2) if a resistor, RATED for twice the power dissipation for the maximum WORKING VOLTAGE.

1907 b) a combination of components.

1908 A PROTECTIVE IMPEDANCE shall not be a single electronic device that employs electron
1909 conduction in a vacuum, gas or semiconductor

1910 *Conformity is checked by inspection, by measuring the current or voltage to confirm that they*
1911 *do not exceed the applicable levels of 6.3 and by measuring CLEARANCES and CREEPAGE*
1912 *DISTANCES as specified in 6.7. Conformity of a single component is checked by inspection of its*
1913 *RATINGS.*

1914 **6.5.5 Automatic disconnection of the supply**

1915 An automatic disconnection device shall meet both the following requirements.

1916 a) It shall be RATED to disconnect the load within the time specified in [Figure 2](#).

1917 b) It shall be RATED for the maximum RATED load conditions of the equipment.