BS EN 60027-7:2010

BSI Standards Publication

Letter symbols to be used in electrical technology —

Part 7: Power generation, transmission and distribution

National foreword

This British Standard is the UK implementation of EN 60027-7:2010. It is identical to IEC 60027-7:2010.

The UK participation in its preparation was entrusted to Technical Committee SS/7, General metrology, quantities, units and symbols.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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(IEC 60027-7:2010)

Symboles littéraux à utiliser en électrotechnique - Partie 7: Production, transport et distribution de l'énergie électrique (CEI 60027-7:2010)

Formelzeichen für die Elektrotechnik - Teil 7: Energieerzeugung, -übertragung und -verteilung (IEC 60027-7:2010)

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CENELEC

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Foreword

The text of document 25/391/CDV, future edition 1 of IEC 60027-7, prepared by IEC TC 25, Quantities and units, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 60027-7 on 2010-09-01.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN and CENELEC shall not be held responsible for identifying any or all such patent rights.

The following dates were fixed:

– latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2011-06-01
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2013-09-01

Annex ZA has been added by CENELEC.

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Endorsement notice

The text of the International Standard IEC 60027-7:2010 was approved by CENELEC as a European Standard without any modification.

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Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

The following referenced documents 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.

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Publication	Year	Title	EN/HD	Year
IEC 60027-1 + A1 + A2	1995 1997 2005	Letter symbols to be used in electrical technology - Part 1: General	EN 60027-1 - + A2[1)]	2006 - 2007
IEC 60027-2	2005	Letter symbols to be used in electrical technology - Part 2: Telecommunications and electronics	EN 60027-2[2)]	2007
IEC 60038	2009	IEC standard voltages	-	-
IEC 60050-121 + A1	1998 2002	International Electrotechnical Vocabulary (IEV) - Part 121: Electromagnetism	- -	- -
IEC 60050-131 + A1	2002 2008	International Electrotechnical Vocabulary (IEV) - Part 131: Circuit theory	- -	- -
IEC 60050-141	2004	International electrotechnical vocabulary - Part 141: Polyphase systems and circuits	-	-
IEC 60050-151	2001	International Electrotechnical Vocabulary (IEV) - Part 151: Electrical and magnetic devices	-	-
IEC 60050-195 + A1	1998 2001	International Electrotechnical Vocabulary (IEV) - Chapter 195: Earthing and protection against electric shock	- -	- -
IEC 60050-411 + A1	1996 2007	International Electrotechnical Vocabulary (IEV) - Chapter 411: Rotating machinery	- -	- -
IEC 60050-421	1990	International electrotechnical vocabulary (IEV) - Chapter 421: Power transformers and reactors	-	-
IEC 60050-441 + A1	1984 2000	International Electrotechnical Vocabulary (IEV) - Chapter 441: Switchgear, controlgear and fuses	- -	- -

[1)] EN 60027-1 includes A1 to IEC 60027-1.

[2)] EN 60027-2 is superseded by EN 80000-13:2008, which is based on IEC 80000-13:2008.

Publication	Year	Title	EN/HD	Year
IEC 60050-442	1998	International Electrotechnical Vocabulary - Part 442: Electrical accessories	-	-
IEC 60050-448	1995	International Electrotechnical Vocabulary (IEV) - Chapter 448: Power system protection	-	-
IEC 60050-466	1990	International electrotechnical vocabulary (IEV) - Chapter 466: Overhead lines	-	-
IEC 60050-601 + A1	1985 1998	International Electrotechnical Vocabulary (IEV) - Chapter 601: Generation, transmission and distribution of electricity - General	- -	- -
IEC 60050-603 + A1	1986 1998	International electrotechnical vocabulary - Chapter 603: Generation, transmission and distribution of electricity - Power system planning and management	- -	- -
IEC 60050-604 + A1	1987 1998	International Electrotechnical Vocabulary (IEV) - Chapter 604: Generation, transmission and distribution of electricity - Operation	- -	- -
IEC 60050-811	1991	International electrotechnical vocabulary (IEV) - Chapter 811: Electric traction	-	-
IEC 60909-0	2001	Short-circuit currents in three-phase a.c. systems - Part 0: Calculation of currents	EN 60909-0	2001
IEC/TR 60909-1	2002	Short-circuit currents in three-phase e.c. systems - Part 1: Factors for the calculation of short-circuit currents according to IEC 60909-0	-	-
IEC/TR 60909-2	2008	Short-circuit currents in three-phase a.c. systems - Part 2: Data of electrical equipment for short-circuit current calculations	-	-
IEC 60909-3	2003	Short-circuit currents in three-phase a.c systems - Part 3: Currents during two separate simultaneous line-to-earth short-circuits and partial short-circuit currents flowing through earth	EN 60909-3[3)]	2003
IEC 62428	2008	Electric power engineering - Modal components in three-phase a.c. systems - Quantities and transformations	EN 62428	2008
IEC 80000-6	2008	Quantities and units - Part 6: Electromagnetism	EN 80000-6	2008

[3)] EN 60909-3 is superseded by EN 60909-3:2010, which is based on IEC 60909-3:2009.

CONTENTS

LETTER SYMBOLS TO BE USED IN ELECTRICAL TECHNOLOGY –

Part 7: Power generation, transmission, and distribution

1 Scope

This part of IEC 60027 is applicable to generation, transmission, and distribution of electric energy. It gives names and letter symbols for quantities and units. In addition, rules for multiple subscripts and their succession are given.

This part of IEC 60027 is an addition to IEC 60027-1. Therefore letter symbols already given in IEC 60027-1 are repeated only if they have a special meaning in the field of power generation, transmission, and distribution or if they are used in this field with special subscripts.

Guidance on the use of capital and lower case letters, is given in IEC 60027-1, 2.1, and guidance on the representation of complex quantities,is given in IEC 60027-1, 1.6. Therefore in many cases only U is given instead of $\underline{U}$, $|\underline{U}| = U$ or u.

2 Normative references

The following referenced documents 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 60027-1:1992, *Letter symbols to be used in electrical technology – Part 1: General*
Amendment 1:1997
Amendment 2:2005

IEC 60027-2:2005, *Letter symbols to be used in electrical technology – Part 2: Telecommunications and electronics*

IEC 60038:2009, *IEC standard voltages*

IEC 60050-121:1998, *International Electrotechnical Vocabulary – Part 121: Electromagnetism*

Amendment 1 (2002)

IEC 60050-131:2002, *International Electrotechnical Vocabulary – Part 131: Circuit theory*

Amendment 1 (2008)

IEC 60050-141:2004, *International Electrotechnical Vocabulary – Part 141: Polyphase systems and circuits*

IEC 60050-151:2001, *International Electrotechnical Vocabulary – Part 151: Electrical and magnetic devices*

IEC 60050-195:1998, *International Electrotechnical Vocabulary – Part 195: Earthing and protection against electric shock*

Amendment 1 (1998)

IEC 60050-411:1996, *International Electrotechnical Vocabulary – Chapter 411: Rotating machines*

Amendment 1 (2007)

IEC 60050-421:1990, *International Electrotechnical Vocabulary – Chapter 421: Power transformers and reactors*

IEC 60050-441:1984, *International Electrotechnical Vocabulary – Chapter 441: Switchgear, controlgear and fuses*

Amendment 1 (2000)

IEC 60050-442:1998, *International Electrotechnical Vocabulary – Part 442: Electrical accessories*

IEC 60050-448:1995, *International Electrotechnical Vocabulary – Chapter 448: Power system protection*

IEC 60050-466:1990, *International Electrotechnical Vocabulary – Chapter 466: Overhead lines*

IEC 60050-601:1985, *International Electrotechnical Vocabulary – Chapter 601: Generation, transmission and distribution of electricity – General*

Amendment 1 (1998)

IEC 60050-603:1986, *International Electrotechnical Vocabulary – Chapter 603: Generation, transmission and distribution of electricity – Power system planning and management*

Amendment 1 (1998)

IEC 60050-604:1987, *International Electrotechnical Vocabulary – Chapter 604: Generation, transmission and distribution of electricity – Operation*

Amendment 1 (1998)

IEC 60050-811:1991, *International Electrotechnical Vocabulary – Chapter 811: Electric traction*

IEC 60909-0:2001, *Short-circuit currents in three-phase AC systems – Part 0: Calculation of currents*

IEC/TR 60909-1:2002, *Short-circuit currents in three-phase AC systems – Part 1: Factors for the calculation of short-circuit currents according to IEC 60909-0*

IEC/TR 60909-2:2008, *Short-circuit currents in three-phase AC systems – Part 2: Data of electrical equipment for short-circuit current calculations*

IEC 60909-3:2003, *Short-circuit currents in three-phase AC systems – Part 3:Currents during two separate simultaneous line-to-earth short circuits and partial short-circuit currents flowing through earth*

IEC 62428:2008, *Electric power engineering – Modal components in three-phase a.c. systems – Quantities and transformations*

IEC 80000-6:2008, *Quantities and units – Part 6: Electromagnetism*

3 Letter symbols for AC, three-phase AC, and other network quantities

Item number	Quantities					Units		
	IEV and/or IEC number	Name of quantity	Chief symbol	Reserve symbol	Remarks	Unit, coherent with the SI		Remarks
						Name	Symbol	
101		line-to-earth capacitance of a line	$C_{\mathrm{L}i}$	$C_{\mathrm{L}i\mathrm{E}}$	i = 1, 2, 3 in three-phase AC networks	farad	F	
102		line-to-line capacitance of a line	$C_{\mathrm{L}i\mathrm{L}k}$	$C_{\mathrm{L}ik}$	i, k = 1, 2, 3 with $i \neq k$ in three-phase AC networks	farad	F	
103	131-14-29 60027-2	hybrid matrix	$\boldsymbol{H}$		Names and symbols for the elements are given in IEC 60027-2.	one, ohm, siemens	1, Ω, S	
104		electric current	I		The general symbol I is used in case of three-phase AC networks if the three currents are equal or nearly equal.	ampere	A	
105	441-17-06 441-17-07 60909-0	prospective breaking current, breaking current	I_{b}	I_{a}	Current of the first opening pole of a switching device (circuit breaker) or a fuse.	ampere	A	
106		capacitive charging current	I_{C}		$I_{\mathrm{C}} = \omega C \frac{U_{\mathrm{n}}}{\sqrt{3}}$ where ω is the angular frequency, C is the positive-sequence capacity, and U_{n} is the nominal voltage of the three-phase AC line.	ampere	A	
107		capacitive earth-fault current	I_{Ce}		I_{Ce} is the capacitive single line-to-earth fault current in a network with isolated neutral (IEV 601-02-24).	ampere	A	
108	131-11-22	direct current	I_{d}	I_{DC}	average value, for instance in the case of a direct current link For the qualifier DC, see IEC 60050-151, 151-15-02	ampere	A	
109	442-01-23	earth fault current	I_{e}		See items 107 and 121.	ampere	A	
110		field (excitation) current	I_{F}	I_{f}	Current in the field winding of a machine.	ampere	A	

Item number	Quantities					Units		
	IEV and/or IEC number	Name of quantity	Chief symbol	Reserve symbol	Remarks	Unit, coherent with the SI		Remarks
						Name	Symbol	
111		no-load field (excitation) current	I_{0F}	I_{f0}		ampere	A	
112	60909-0	steady-state short-circuit current at a short-circuit location	I_k	I_{k3}	The steady state short-circuit current in the r.m.s. value of a three-phase short-circuit current at a short-circuit location in a network, which remains after the decay of all transient phenomena. Short-circuit currents with subscript k in solidly earthed or impedance earthed networks (IEV 601-02-25, IEV 601-02-26).	ampere	A	
113	60909-1	transient short-circuit current at a short-circuit location	I'_k	I'_{k3}	The transient short circuit current is the r.m.s. value of a three-phase short-circuit current at a short-circuit location after the decay of the subtransient short-circuit current.	ampere	A	
114	60909-0	subtransient short-circuit current at a short-circuit location	I''_k	I''_{k3}	The initial symmetrical short-circuit current at a short-circuit location is the r.m.s. value of the AC component of a prospective three-phase short-circuit current.	ampere	A	
115	121-11-13 MOD	line conductor current	I_{Li}		i = 1, 2, 3 in three-phase AC networks.	ampere	A	
116	411-48-16 60909-0	locked rotor current	I_{LR}	I_{an}	I_{LR} is the highest r.m.s. current of an asynchronous motor with locked rotor at the most unfavourable postion fed with rated voltage and frequency of the rotor.	ampere	A	
117		magnetizing current	I_m	I_μ	I_m is the magnetizing current of a machine, a reactor, a transformer, etc. IEC 60027-1, Table 6, Subscript m, mag.	ampere	A	
118	60909-0	peak short-circuit current at a short-circuit location	i_p	i_{p3}	The peak short circuit current is the maximum possible instantaneous value of the prospective three-phase short-circuit current.	ampere	A	
119		thermal continuous permissible current	I_{per}	I_d		ampere	A	

Item number	Quantities					Units		
	IEV and/or IEC number	Name of quantity	Chief symbol	Reserve symbol	Remarks	Unit, coherent with the SI		Remarks
						Name	Symbol	
120	411-48-23 MOD	peak short-circuit current of a generator	i_{pG}		Peak value reached by the current in the armature winding within a half cycle after the winding has been suddenly short circuited, when the conditions are such that the initial value of any aperiodic component of current is a maximum.	ampere	A	
121	421-04-05	rated current	I_r		Rated current, given from the manufacturer of electrical equipment, for a generator, motor, transformer, reactor, etc. If necessary with an additional subscript from 6.3.	ampere	A	
122		rated current of a current transformer	I_{rCT}			ampere	A	
123	411-54-07	rated field (excitation) current	I_{rF}	I_{fr}		ampere	A	
124	60909-0	rated current of a generator	I_{rG}			ampere	A	
125		earth-fault residual current	I_{rsd}	I_{Rest}	Current at the fault location of a resonant earthed network (see IEV 601-02-27)	ampere	A	
126	60909-0	rated current at the high-voltage side of a transformer	I_{rTHV}		Use I_{rTMV} and I_{rTLV}, respectively, at the medium-voltage and the low-voltage side.	ampere	A	
127	448-11-30	inrush current	I_{rush}		Inrush current of a transformer.	ampere	A	
128		rated current of a winding	I_{rW}, I_{rw}		Transformer winding at the high-voltage side (W) or the low-voltage side (w). In the case of three-winding transformers, see item 253.	ampere	A	

Item number	Quantities					Units		
	IEV and/or IEC number	Name of quantity	Chief symbol	Reserve symbol	Remarks	Unit, coherent with the SI		Remarks
						Name	Symbol	
129	60909-0	thermal equivalent short-circuit current	I_{th}		r.m.s. value of a current having the same thermal effect and the same duration as the actual short-circuit current, which may contain a DC component and may subside in time, $I_{th} = I_k'' \sqrt{m+n}$, where I_k'' is the subtransient short-circuit current (item 113), m is the factor for the heat (thermal) effect of the DC component in a short-circuit current (item 229), and n the factor for the (thermal) effect of the AC component in a short-circuit current (item 232).	ampere	A	
130		currents at the terminals of three-phase AC transformers with two windings	I_U, I_V, I_W I_u, I_v, I_w		Subscripts for the high-voltage side: U, V, W Subscripts for the low-voltage side: u, v, w	ampere	A	
131		currents at the terminals of the tertiary winding of a three-phase AC transformer	I_x, I_y, I_z		The subscripts x, y, z should be used in case of transformer windings in delta connection.	ampere	A	
132		winding current	I_{Wi}, I_{wi}		i = 1, 2, 3 in three-phase AC networks For instance index W for the high-voltage side and index w for the low-voltage side (see item 252).	ampere	A	
133		harmonic current component	I_ν		ν = (2), 3, (4), 5, ... ≠ 1; $f_\nu = \nu f$	ampere	A	
134	131-11-42	active power	P		In a three-phase AC network with symmetric sinusoidal voltages and currents: $P = \sqrt{3} U I \cos\varphi$	watt	W	In practice mostly in kW or MW Is used.
135		DC power	P_d	P_{DC}	$P_d = U_d I_d$, where U_d is the line-to-line voltage of of a SC-line (item 149) and I_d the DC-current at the same location (item 108).	watt	W	
136	121-12-11	dielectric loss	P_{diel}	P_ε		watt	W	

Item number	Quantities					Units		
	IEV and/or IEC number	Name of quantity	Chief symbol	Reserve symbol	Remarks	Unit, coherent with the SI		Remarks
						Name	Symbol	
137	421-06-03 MOD	total load loss in transformer windings at rated current	P_{krT}		In case of a two-winding three-phase transformer (T) one side is short circuited (k) and the other side is fed with the rated current (r) of this side of the main tapping. In case of three-winding transformers three measurements or calculations are necessary (see IEC 60909-0 and IEC 60909-2).	watt	W	
138		surge-impedance load of a line	P_{nat}		Surge-impedance load of a three-phase AC line in case of U_n $P_{nat} = U_n^2 / Z_W$ where U_n is the nominal value of the line-to-line voltage (item 159) and $Z_W = Z_{W1}$ is the surge impedance of a line in the positive-sequence system (item 186).	watt	W	
139		rated mechanical power of a motor	P_{rM}		For a three-phase asynchronous motor use: $P_{rM} = \sqrt{3} U_{rM} I_{rM} \cos\varphi_{rM} \eta_{rM}$ where U_{rM} is the rated voltage, I_{rM} the rated current, φ_{rM} the phase difference and η_{rM} the efficiency of the motor.	watt	W	
140	131-11-43 80000-6, 6-61	non-active power	$Q_\sim$, Q'		$Q_\sim = \sqrt{S^2 - P^2}$ where S is the apparent power (item 142) und P the active power (item 134)	volt ampere	VA	

Item number	Quantities					Units		
	IEV and/or IEC number	Name of quantity	Chief symbol	Reserve symbol	Remarks	Unit, coherent with the SI		Remarks
						Name	Symbol	
141	131-11-44	reactive power	Q		Shall be used only in three-phase AC networks with symmetric sinusoidal voltages and currents: $Q = \sqrt{3}UI \sin\varphi = S \sin\varphi$ where S is the apparent power (item 142) and $\varphi = \varphi_u - \varphi_i$ the phase difference with φ_u as the initial phase of the voltage and φ_i the initial phase of the current (IEC 80000-6, 6-48).	volt ampere	VA	In practice mostly var, kvar, Mvar is used.
142	131-11-41	apparent power	S		In a symmetrical three-phase AC network use: $S = \sqrt{3}UI$, where U is the line-to-line voltage (item 147) and I the line current (item 104).	volt ampere	VA	In practice mostly kVA, MVA is used.
143	601-01-14 MOD 60909-0	short-circuit power	S''_k		The short-circuit apparent power in a symmetrical three-phase AC network is given as: $S''_k = \sqrt{3}U_n I''_k$, where U_n is the nominal line-to-line voltage (item 159) and I''_k the subtransient short-circuit current (item 114).	volt ampere	VA	In practice mostly MVA is used.
144	60909-0	short-circuit power of a three-phase AC network feeder at the connection point Q	S''_{kQ}		$S''_{kQ} = \sqrt{3}U_{nQ} I''_{kQ}$, where U_{nQ} is the nominal line-to-line voltage and I''_{kQ} the subtransient short-circuit current at the connection point Q.	volt ampere	VA	In practice mostly MVA lis used.
145		rated apparent power	S_r		Examples for electrical equipment: S_{rG}, S_{rT} (subscripts in subclause 6.3).	volt ampere	VA	In practice mostly kVA, MVA is used.
146	62428	transformation matrix	$\boldsymbol{T}$		$\boldsymbol{T}_S$ transformation matrix for symmetrical components in the unnormalized form, (see item 256).	one	1	
147	121-11-27	voltage, electric tension	U		U is the general symbol, with no further indication: line-to-line voltage; line-to-line tension.	volt	V	
148	195-05-11	(effective) touch voltage	U_B			volt	V	

Item number	Quantities					Units		
	IEV and/or IEC number	Name of quantity	Chief symbol	Reserve symbol	Remarks	Unit, coherent with the SI		Remarks
						Name	Symbol	
149		direct voltage, direct tension	U_{d}	U_{DC}	Average value, for instance in case of a direct current link. For the qualifier DC, see IEC 60050, 151-15-02.	volt	V	
150	60909-3	earthing potential	U_{E}			volt	V	
151		field voltage, excitation voltage	U_{F}	U_{f}	Voltage at the field winding of a machine.	volt	V	
152	411-54-06	excitation system ceiling voltage	U_{Fmax}	U_{fmax}		volt	V	
153	195-05-03	line-to-earth voltage	$U_{\mathrm{L}i}$	$U_{\mathrm{L}i\mathrm{E}}$	i =1,2,3 in three-phase AC networks.	volt	V	
154	195-05-01 141-03-06	line-to-line voltage	$U_{\mathrm{L}i\mathrm{L}k}$	$U_{\mathrm{L}ik}$	i, k = 1, 2, 3 with $i \neq k$ in three-phase AC networks	volt	V	
155	195-05-02	line-to-neutral voltage	$U_{\mathrm{L}i\mathrm{N}}$		i =1, 2, 3 in three-phase AC systems with a neutral conductor (low-voltage networks)	volt	V	
156	421-09-01 60038	highest voltage for equipment	U_{m}		The highest r.m.s. line to-line voltage permanently admissible for equipment.	volt	V	
157	601-01-23 601-01-24	highest and lowest voltage of a network	U_{max} U_{min}	U_{Nmax} U_{Nmin}	IEV. Highest (lowest) voltage of a network.	volt	V	
158	601-01-32	neutral point or neutral conductor to-earth voltage	U_{NE}		IEV: Neutral point displacement voltage.	volt	V	
159	442-01-04 601-01-21	nominal voltage of a network nominal voltage of a system nominal voltage of a line	U_{n}		The nominal voltage of a network is always a line-to-line voltage.	volt	V	
160	411-49-02	synchronous generated voltage	U_{P}	U_{p}	Voltage, which would be generated in the armature windings on open circuit, in the absence of saturation, by the flux corresponding to the excitation current for the conditions under consideration.	volt	V	

Item number	Quantities					Units		
	IEV and/or IEC number	Name of quantity	Chief symbol	Reserve symbol	Remarks	Unit, coherent with the SI		Remarks
						Name	Symbol	
161	442-01-03 MOD	rated voltage	U_r		Line-to-line-voltage of electrical equipment, generator, motor, transformer, reactor, etc., if necessary with an additional index from 6.3	volt	V	
162	411-54-08	rated field voltage	U_{rF}	U_{fr}	See subclause 6.6.	volt	V	
163	421-04-01	rated voltage of a winding	U_{rW}, U_{rw}		See also item 128.	volt	V	
164	195-05-12	step voltage	U_S	U_{Step}		volt	V	
165	131-12-22	source voltage, source tension	U_s	U_q		volt	V	
166	411-49-13	direct-axis transient voltage	U'_d			volt	V	
167	411-49-14	quadrature-axis transient voltage	U'_q			volt	V	
168	411-49-11	direct-axis subtransient voltage	U''_d			volt	V	
169	411-49-12	quadrature-axis subtransient voltage	U''_q			volt	V	
170	411-50-07	direct-axis synchronous reactance	X_d			ohm	Ω	
171	411-50-08	quadrature-axis synchronous reactance	X_q			ohm	Ω	
172	411-50-09	direct-axis transient reactance	X'_d			ohm	Ω	
173	411-50-10	quadrature-axis transient reactance	X'_q			ohm	Ω	
174	411-50-11 60909-0	direct-axis subtransient reactance	X''_d		X''_d is the effective reactance of a synchronous machine at the moment of three-phase short circuit. For the calculation of short-circuit currents the saturated value of X''_d shall be used.	ohm	Ω	

Item number	Quantities					Units		
	IEV and/or IEC number	Name of quantity	Chief symbol	Reserve symbol	Remarks	Unit, coherent with the SI		Remarks
						Name	Symbol	
175	411-50-12	quadrature-axis subtransient reactance	X_{q}''			ohm	Ω	
176		mutual reactance	X_{m}			ohm	Ω	
177		self reactance	X_{s}			ohm	Ω	
178		leakage reactance	X_{σ}	X_{l}		ohm	Ω	
179	131-14-25 60027-2	admittance matrix	$\boldsymbol{Y}$	$\boldsymbol{A}$	Names and symbols for the elements are given in IEC 60027-2.	siemens	S	
180		admittance of the zero sequence system of a line per length	Y_0'		$\underline{Y}_0' = G_0' + \mathrm{j}\omega C_0'$	siemens per metre	S/m	
181		admittance of the positive sequence system of a line per Length	Y_1'		$\underline{Y}_1' = G_1' + \mathrm{j}\omega C_1'$	siemens per metre	S/m	
182		admittance of the negative-sequence system of a line per length	Y_2'		$\underline{Y}_2' = G_2' + \mathrm{j}\omega C_2'$	siemens per metre	S/m	
183	131-14-24	impedance matrix	$\boldsymbol{Z}$		Names and symbols for the elements are given in IEC 60027-2.	ohm	Ω	
184	60909-0	subtransient impedance of a generator	Z_{G}''		$\underline{Z}_{\mathrm{G}}'' = R_{\mathrm{G}} + \mathrm{j}X_{\mathrm{d}}''$	ohm	Ω	
185		surge impedance of a line in the zero sequence system	Z_{W0}		$\underline{Z}_{\mathrm{W0}} = \sqrt{\underline{Z}_0' / \underline{Y}_0'}$	ohm	Ω	
186	603-02-23	surge impedance of a line in the positive sequence system	Z_{W1}	Z_{W}	$\underline{Z}_{\mathrm{W1}} = \sqrt{\underline{Z}_1' / \underline{Y}_1'}$	ohm	Ω	
187	448-11-29 MOD	zero-sequence impedance of a line per length	Z_0'		$\underline{Z}_0' = R_0' + \mathrm{j}\omega L_0'$	ohm per metre	Ω/m	In practice often Ω/km is used.
188	448-11-27 MOD	positive-sequence impedance of a line per length	Z_1'		$\underline{Z}_1' = R_1' + \mathrm{j}\omega L_1'$	ohm per metre	Ω/m	In practice often Ω/km is used.

Item number	Quantities					Units		
	IEV and/or IEC number	Name of quantity	Chief symbol	Reserve symbol	Remarks	Unit, coherent with the SI		Remarks
						Name	Symbol	
189	448-11-28 MOD	negative-sequence impedance of a line per length	$Z_2^{'}$		$\underline{Z}_2^{'} = R_2^{'} + \mathrm{j}\omega L_2^{'}$	ohm per metre	Ω/m	In practice often Ω/km is used.
190		admittance angle	α		α = arctan(B/G) for $\underline{Y} = G + \mathrm{j}B$	radian	rad	
191		impedance angle	γ	ϑ	γ = arctan(X/T) for $\underline{Z} = R + \mathrm{j}X$	radian	rad	
192		load angle	δ_P		Load angle is the angle between $\underline{U}_{1\mathrm{G}}$ and $\underline{U}_\mathrm{P}$ of a synchronous machine.	radian	rad	
193		angle between $\underline{U}_i$ and $\underline{U}_k$	δ_{ik}	ϑ_{ik}	$\delta_{ik} = \varphi_{ui} - \varphi_{uk}$	radian	rad	
194	60909-3	earth penetration depth	δ_E		Earth penetration depth in case of infinite length of line is $\delta_\mathrm{E} = 1{,}8514 / \sqrt{\omega\mu_0 / \rho_\mathrm{E}}$, where ω is the angular frequency, μ_0 the magnetic constant (IEC 60050-121, 121-11-14) and ρ_E the earth resistivity (item 195).	metre	m	
195	60909-3	specific earth resistance	ρ_E			ohm metre	Ωm	

4 Letter symbols for space and time

Item number	Quantities					Units		
	IEV and/or IEC number	Name of quantity	Chief symbol	Reserve symbol	Remarks	Unit, coherent with the SI		Remarks
						Name	Symbol	
196		diameter of a line conductor	D_L	d_L	Apparent diameter of a stranded conductor, see IEV 581-03-51	metre	m	
197		distance	d	a	Distance between two line conductors: d_{LiLk}	metre	m	
198	466-05-13 MOD	line-to-earth clearance	d_{LEmin}			metre	m	
199		sag of a line-conductor of an overhead line	f		f_{max} maximum value in case of a horizontal span between two towers (mid span sag), see IEV 466-03-09 and its Figure 446-1.	metre	m	
200	702-01-07 MOD	eigenfrequency	f_e		$f_e = \omega_e / 2\pi$, see item 219	hertz	Hz	
201		inertia constant	H		$H = T_m / 2$	second	s	
202		effective height above ground of a line-conductor from an overhead line	h	h_e	$h = h_{max} - 0{,}7 f_{max}$	metre	m	
203		line length	l	L	overhead line or cable	metre	m	usually in km
204		cross-section	q	A	Cross-section of a line-conductor q_L	square metre	m^2	usually in mm^2
205		radius	r	r_L	Radius of a line conductor	metre	m	
206	60909-0	equivalent radius of a bundle conductor	r_B		$r_B = \sqrt[n]{n \cdot r_L \cdot r_T^{n-1}}$ where n is the number of sub-conductors; for r_L see item 205; for r_T see item 207.	metre	m	

Item number	Quantities					Units		
	IEV and/or IEC number	Name of quantity	Chief symbol	Reserve symbol	Remarks	Unit, coherent with the SI		Remarks
						Name	Symbol	
207	466-10-22 466-10-23 466-10-24	radius of the sub-conductors in a bundle	r_T		twin bundle: $r_T = a/2$; triple bundle: $r_T = a/\sqrt{3}$; quad bundle: $r_T = a/\sqrt{2}$; where a is the distance between two sub-conductors.	metre	m	
208		distance between the centres of gravity of the surfaces i and k	s_{ik}			metre	m	
209	411-48-15 MOD	expected acceleration duration	T_A		The duration that would be required to bring the rotating parts of a machine from rest to rated speed if the accelerating torque were constant and equal to the quotient of rated active power by rated angular velocity.	second	s	
210	411-48-28	direct-axis transient short-circuit time constant	T'_d		This applies to a synchronous machine.	second	s	
211	411-48-27	direct-axis transient open-circuit time constant	T'_{d0}		This applies to a synchronous machine.	second	s	
212	411-48-30	direct-axis subtransient short-circuit time constant	T''_d		This applies to a synchronous machine.	second	s	
213	411-48-29	direct-axis subtransient open-circuit time constant	T''_{d0}		This applies to a synchronous machine.	second	s	
214	411-48-26	aperiodic time constant, direct current time constant	T_a	T_{DC}	This applies to a synchronous machine.	second	s	
215	60909-0	short-circuit duration	T_k			second	s	
216		electromechanical time constant	T_m		$T_m = 2H$ where H is the inertia constant (see item 201).	second	s	
217	411-48-35	quadrature-axis subtransient short-circuit time constant	T''_q		This applies to a synchronous machine.	second	s	

Item number	Quantities					Units		
	IEV and/or IEC number	Name of quantity	Chief symbol	Reserve symbol	Remarks	Unit, coherent with the SI		Remarks
						Name	Symbol	
218	60909-0	minimal time delay	t_{min}	$T_{k\,min}$	This is the shortest duration between the beginning of the short circuit and the contact separation of the first pole to open the switching device.	second	s	
219		angular eigenfrequency	ω_e		$\omega_e = 2\pi f_e$ with f_e according to item 200.	second to the power minus one	s^{-1}	

5 Letter symbols for numerical values and ratios of quantities

Item number	Quantities					Units		
	IEV and/or IEC number	Name of quantity	Chief symbol	Reserve symbol	Remarks	Unit, coherent with the SI		Remarks
						Name	Symbol	
220		refraction factor	b		For travelling waves on lines, different for voltage and current.	one	1	
221	60909-0	voltage factor	c		Factor for the equivalent voltage at the short-circuit location.	one	1	
222		damping factor	d			one	1	
223		factor for the increase of a resistance by the proximity-effect	F_{P}		$R_{\sim} = F_{\mathrm{S}} F_{\mathrm{P}} R_{=}$	one	1	
224		factor for the increase of a resistance by the skin-effect	F_{S}		$R_{\sim} = F_{\mathrm{S}} F_{\mathrm{P}} R_{=}$	one	1	
225	60909-0	impedance correction factor	K		For impedances of electrical equipment when calculating short-circuit currents with the equivalent voltage source at the short-circuit location according to IEC 60909-0.	one	1	
226		overvoltage factor	k		$k = u_{\mathrm{o}} / (\sqrt{2} U^{\mathrm{b}} / \sqrt{3})$; u_{o}: subscript o, see item 277; U^{b}: superscript b, see item 335 (instead of U^{b} sometimes U_{m} is used).	one	1	
227		number of lines	L		This applies to three-phase AC networks.	one	1	
228		number of meshes	M		This applies to three-phase AC networks.	one	1	
229	60909-0	factor for the heat (thermal) effect of the DC component in a short-circuit current	m		See item 129	one	1	
230		number of nodes	N		This applies to three-phase AC networks.	one	1	
231		number of conductors per bundle	n		This applies to high-voltage overhead lines in three-phase AC networks.	one	1	

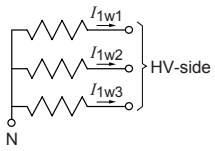
Item number	Quantities					Units		
	IEV and/or IEC number	Name of quantity	Chief symbol	Reserve symbol	Remarks	Unit, coherent with the SI		Remarks
						Name	Symbol	
232	60909-0	factor for the heat (thermal) effect of the AC component in a short-circuit current	n		See item 129	one	1	
233	60027-1	number of pairs of poles	p		This applies to synchronous and asynchronous three-phase AC machines.	one	1	
234	131-15-32	complex current reflection factor	$\underline{r}_I$		This applies to travelling waves on lines.	one	1	
235	131-15-33	complex voltage reflection factor	$\underline{r}_U$		This applies to travelling waves on lines.	one	1	
236	60909-3	reduction factor	r		This applies to the case of interference.	one	1	
237		relative short-circuit resistance of a transformer	r_T		This is the relative value in the case of a two-winding three-phase AC transformer with reference values $U_\mathrm{rT}/\sqrt{3}$ and I_rT, see also item 243.	one	1	
238		relative short-circuit reactance of a transformer	x_T		This is the relative value in the case of a two-winding three-phase AC transformer with reference values $U_\mathrm{rT}/\sqrt{3}$ and I_rT, see also item 244.	one	1	
239		relative short-circuit impedance of a transformer	z_T		This is the relative value in the case of a two-winding three-phase AC transformer with reference values $U_\mathrm{rT}/\sqrt{3}$ and I_rT, see also item 242.	one	1	
240		voltage ratio of a transformer	t		See item 241.	one	1	
241	421-04-02 436-01-15 MOD 442-01-03 MOD	rated voltage ratio of a transformer	t_rT		$t_\mathrm{rT} = U_\mathrm{rTHV}/U_\mathrm{rTLV} \geq 1$, where U_rTHV is the rated voltage at the high-voltage side and U_rTLV the rated voltage at the low-voltage side of the transformer. The rated voltage ratio may be different from the turns ratio (item 246).	one	1	

Item number	Quantities					Units		
	IEV and/or IEC number	Name of quantity	Chief symbol	Reserve symbol	Remarks	Unit, coherent with the SI		Remarks
						Name	Symbol	
242	60909-0	related short-circuit voltage of a transformer	u_k		In the case of a two-winding transformer; u_{kr} (IEV 421-07-01) rated value with the reference values: $U_{rT}/\sqrt{3}$ and I_{rT}, see also item 239, the value of u_k is equal to the value of z_T.	one	1	in practice given in %
243	60909-0	resistive component of the related short-circuit voltage of a transformer	u_R		rated value: u_{Rr}, see also item 237, the value of u_R is equal to the value of r_T	one	1	in practice given in %
244	60909-0	reactive component of the related short-circuit voltage of a transformer	u_X		For rated value: u_{Xr}, see also item 238, the value of u_X is equal to the value of x_T.	one	1	in practice given in %
245		detuning coefficient	v		This apllies to a resonant earthed neutral network (see IEV 195-04-09).	one	1	
246		turns ratio	w	n	$w = W_{HV}/W_{LV}$	one	1	
247	195-05-14 604-03-06	earth fault factor	δ			one	1	
248	60909-0	factor for the calculation of the peak short-circuit current	κ		In case of a three-phase AC short circuit: $\kappa = \frac{i_p}{\sqrt{2}I''_k}$, where i_p is the peak short-circuit current (item 118) and I''_k is the subtransient short-circuit current (item 114).	one	1	
249	60909-0	factor for the calculation of the steady-state short-circuit current	λ		For one synchronous machine: $\lambda = \frac{I_{kG}}{I_{rG}}$, λ_{max} and λ_{min}, where I_{rG} is the rated current and I_{kG} the steady-state short-circuit current of a generator..	one	1	

Item number	Quantities					Units		
	IEV and/or IEC number	Name of quantity	Chief symbol	Reserve symbol	Remarks	Unit, coherent with the SI		Remarks
						Name	Symbol	
250	60909-0	factor for the calculation of the symmetrical short-circuit breaking current	μ		$\mu = \frac{I_b}{I_k''}$, where I_b is the breaking current (item 105) and I_k'' the subtransient short-circuit current (item 114).	one	1	

6 Subscripts and superscripts

6.1 Subscripts for natural quantities and components in three-phase AC systems

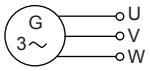
Item number	Meaning	Chief symbol	Reserve symbol	Example of use	Remarks
251	line conductors	L1, L2, L3		U_{L1}, U_{L2}, U_{L3}	
252	windings	W1, W2, W3		I_{W1}, I_{W2}, I_{W3}	Windings of electrical equipment, for instance the windings of a transformer in delta-connection, see item 253.
253	windings	1W1, 1W2, 1W3 2W1, 2W2, 2W3 3W1, 3W2, 3W3			1, 2, 3 at the beginning of the symbol defines the HV-, the MV- and the LV-side of a transformer. 1, 2, 3 at the end of the symbol defines the three windings on each of the three sides in case of a three-phase AC transformer.
254	neutral conductor	N		I_N	Applicable in low-voltage networks.
255	source	s	q	U_s, u_s	See item 165.
256	positive sequence system	1	(1)	$\underline{U}_1$, $\underline{U}_{(1)}$	Symmetrical components (IEC 62428) $\begin{bmatrix}\underline{U}_{L1}\\ \underline{U}_{L2}\\ \underline{U}_{L3}\end{bmatrix} = \begin{bmatrix}1 & 1 & 1\\ \underline{a}^2 & \underline{a} & 1\\ \underline{a} & \underline{a}^2 & 1\end{bmatrix} \cdot \begin{bmatrix}\underline{U}_1\\ \underline{U}_2\\ \underline{U}_0\end{bmatrix}$ with $\underline{a} = e^{j2\pi/3} = -\frac{1}{2} + j\frac{1}{2}\sqrt{3}$ (1), (2), (0) used in IEC 60909-0.
	negative sequence system	2	(2)	$\underline{U}_2$, $\underline{U}_{(2)}$	
	zero sequence system	0	(0)	$\underline{U}_0$, $\underline{U}_{(0)}$	
257	direct axis	d			dq0-components
258	quadrature axis	q			
259	Clarke component	α			$\alpha\beta 0$ -components
260	Clarke component	β			
261	space phasor	s		$\underline{u}_s = u_\alpha + ju_\beta$	Space phasor in a non-rotating frame of reference.
262	space phasor	r		$\underline{u}_r = u_d + ju_q$	Space phasor in a rotating frame of reference.
263	active component	P			
264	non-active component	Q			

6.2 Subscripts for operating conditions

Item number	Meaning	Chief symbol	Reserve symbol	Example of use	Remarks
265	general	a ... z			Use lower case letters for any operating condition.
266	actuated	a		I_a	Applicable to a protection device.
267	breaking	b		I_b	Breaking current of a circuit breaker. See item 105.
268	earth fault	e		I_{Ce}	In networks with isolated neutral or resonant earthed neutral. See item 107 and see also item 125.
269	induced	in		U_{in}	Induced voltage.
270	three-phase short circuit	k	k3	$I_{k,}$ I''_k, I''_{k3}	In case of a three-phase short circuit the additional subscript 3 is not necessary (IEC 60909-0). See item 112 to 114.
271	line-to-earth short circuit	k1		I''_{k1}	IEC 60909 IEV 195-04-12
272	line-to-line short circuit	k2		I''_{k2}	IEC 60909-0.
273	line-to-line short circuit with earth connection	k2E		I''_{k2EL2}, I''_{k2EL3}	I''_{kE2E} : current flowing through earth in case of a line-to-line short circuit with earth connection (IEC 60909-0).
274	maximum	max	m	U_{max}, U_m	U_m: Maximum permissible permanent voltage of electrical equipment.
275	minimum	min			
276	nominal	n	nom		
277	over	o	ov	u_o	Instantaneous value of an over-voltage.
278	peak	p		i_p	See items 118, 120.
279	rated	r	rat		
280	saturated	sat		$X_{d\ sat}$	
281	thermal	th		I_{th}	See item 129.
282	no load	0		I_{0M}	No-load current of a motor.

6.3 Subscripts for electrical equipment

Item number	Meaning	Chief symbol	Reserve symbol	Example of use	Remarks
283	general	A ... Z		U_{rT2HV}	Use upper case letters for electrical equipment or parts of electrical equipment
284	asynchronous motor	ASM	IM		IM: Induction motor.
285	bundle conductor	B			IEV 466-10-22, IEV 466-10-23, IEV 466-10-24
286	current transformer	CT		I_{CT}	

Item number	Meaning	Chief symbol	Reserve symbol	Example of use	Remarks
287	generator	G		U_{rG}	IEV 151-13-35
288	DC generator	G –			
289	AC generator	G ~			
290	three-phase AC generator	G3 ~			
291	gas insulated line	GIL			IEV 601-03-06.
292	gas insulated switching station	GIS			
293	high-voltage DC link	HVDC		P_{HVDC}	IEV 601-04-01
294	inverter	IN			IEV 151-13-46
295	overhead line, cable	L		X'_L	reactance per length in the positive sequence system: $X'_L = X'_{1L}$
296	line conductors	L1, L2, L3		I_{L1}, I_{L2}, I_{L3}	
297	motor	M		I_{rM}	
298	DC motor	M –	DCM		
299	AC motor	M ~	ACM		
300	three-phase AC motor	M3 ~			
301	machine	MA		r_{MA}	IEV 151-13-39, electric machine
302	network	N			
303	neutral conductor	N			in low-voltage networks
304	protective conductor	PE			In low-voltage networks, IEV 195-02-09
305	PEN-conductor	PEN			In low-voltage networks, IEV 195-02-12
306	power station	PS	S	S_{PS}, S_S	Apparent power at the high-voltage side of the unit transformer of a power station. IEV 603-01-01
307	earth wire	Q		d_{Q1L1}	If there are more than one earth wires use: Q1, Q2, ... Qn.
308	reactor	R	Re		
309	rotor	R			
310	rectifier	RF			IEV 151-13-45.
311	stator	S			Stator of an electrical machine or a turbine. IEV 811-14-01
312	sheath or shielding	S	Sh, Si	I_{S1}, I_{S2}, I_{S3}	Example: currents in case of three single-core cables.
313	synchronous generator	SG			
314	synchronous motor	SM			

Item number	Meaning	Chief symbol	Reserve symbol	Example of use	Remarks
315	synchronous machine	SMA			
316	synchronous phase shifter	SPH			IEV 151-13-47
317	transformer	T		S_{rT}	See items 130,132, 163, 252, 253
318	unit transformer	UT	BT	U_{rUTLV}	
319	voltage transformer	VT		U_{rVT}	
320	winding	W			

6.4 Subscripts for locations, reference points, and fault locations

Item number	Meaning	Chief symbol	Reserve symbol	Example of use	Remarks
321	location of stations	A ... Z		station A	Location of stations or parts thereof.
322	earth	E	G		G: ground (US usage).
323	fault location, short-circuit location	F		I''_{kF1}	In case of several fault locations: F1, F2, F3, ... Fn.
324	high-voltage side	HV	OS	U_{rTHV}	
325	low-voltage side	LV	NS	U_{rTLV}	
326	medium-voltage side	MV	MS	U_{rTMV}	
327	neutral point	N		U_{N}	IEV 601-02-22 MOD, neutral point in a poly-line network.
328	connection point, pole	P	K		IEV 601-03-11, pole of an equipment.
329	connection point of a network	Q	Q1, Q2, Qn	S''_{kQ}	Example: Short-circuit power at the connection point Q of a network.
330	reference earth	RE	BE		
331	connection points of three-phase AC equipment	U, V, W	u, v, w or x, y, z		Generator, motor, transformer, reactor etc. in three-phase AC networks, if necessary with additions.
332	star point	Y		U_{Y}	Common point of two-pole elements (windings) in star connection.
333	positive, negative- and zero-sequence neutral reference	01 02 00			In case of symmetrical components according to item 256.

6.5 Superscripts

Item number	Meaning	Chief symbol	Reserve symbol	Example of use	Remarks
334	after	a	n		
335	before	b	v	$I_{\mathrm{G}}^{\mathrm{b}}$	Current of a generator before a short circuit.
336	per length	′		X'_{L}	
337	transient	′		X'_{d}, T'_{d}	
338	subtransient	″		X''_{d}, T''_{d}	
339	semi-relative	* in front of the symbol		$^{*}X_{\mathrm{T}} = \frac{u_{\mathrm{kr}}}{S_{\mathrm{rT}}}$	Semi-relative quantities are used similarly to per-unit quantities for network calculations.

6.6 Multiple subscripts and their succession

Item number	Position	Meaning	Clause	Example (Remarks)
340	1	natural quantity or modal component	6.2	U_1 (positive sequence system)
341	2	operating condition	6.2	$U_{1\mathrm{k1}}$ (during a line-to-earth short circuit)
342	3	electrical equipment	6.3	$U_{1\mathrm{k1T4}}$ (at the fourth transformer)
343	4	location	6.4	$U_{1\mathrm{k1T4\ HV}}$ (on the high-voltage side)
344	5	additional indication	—	$U_{1\mathrm{k1T4HVmax}}$ (highest value)

$U_{1\mathrm{k1T4HVmax}}$: Highest voltage in the positive sequence system, during a line-to-earth short circuit, at the high-voltage side of transformer number four.

If necessary, insert a small space between the different subscripts.

Bibliography

IEC 60050 (all parts), *International Electrotechnical Vocabulary*

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