IEC 60027-7

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INTERNATIONAL STANDARD

NORME INTERNATIONALE

Letter symbols to be used in electrical technology –
Part 7: Power generation, transmission, and distribution

Symboles littéraux à utiliser en électrotechnique –
Partie 7: Production, transport et distribution de l'énergie électrique

IEC 60027-7:2010

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

LETTER SYMBOLS TO BE USED IN ELECTRICAL TECHNOLOGY –

Part 7: Power generation, transmission, and distribution

FOREWORD

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International Standard IEC 60027-7 has been prepared by IEC technical committee 25: Quantities and units.

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

CDV	Report on voting
25/391/CDV	25/406/RVC

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 60027 series, under the general title *Letter symbols to be used in electrical technology* can be found on the IEC website.

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

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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_{Li}	U_{LiE}	i =1,2,3 in three-phase AC networks.	volt	V	
154	195-05-01 141-03-06	line-to-line voltage	U_{LiLk}	U_{Lik}	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_{LiN}		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	