نمودارها و جداول هندبوک ABB

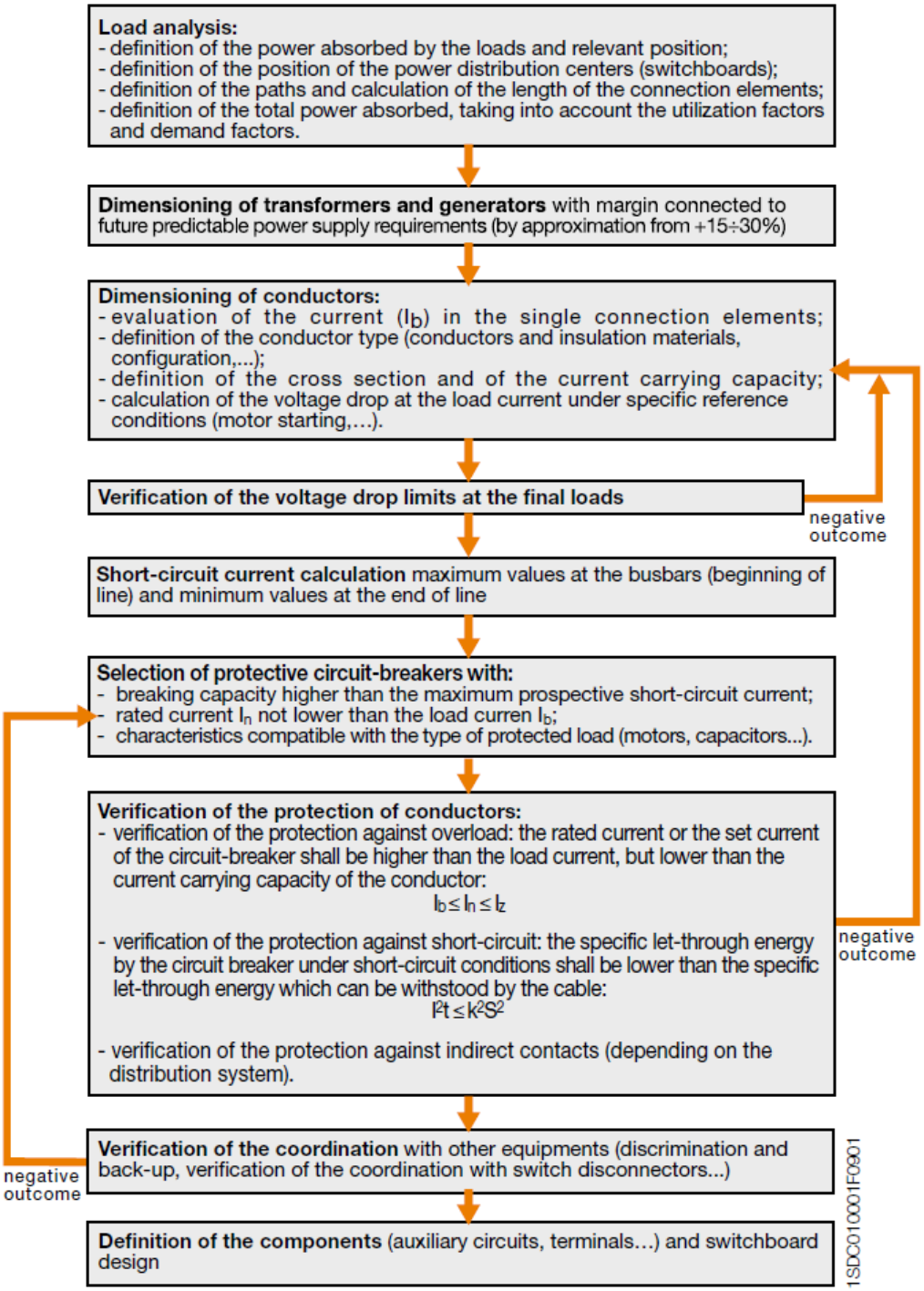
گردآوردی و تنظیم

آکادمی ماهر

زیر نظر دکتر شاهرخ شجاعیان

فهرست مطالب

فصل دوم



شکل ۱- فلوچارت مراحل طراحی تاسیسات الکتریکی

Conductors and cables		Method of installation							
		Without fixings	Clipped direct	Conduit systems	Cable trunking systems (including skirting trunking, flush floor trunking)	Cable ducting systems	Cable ladder, cable tray, cable brackets	On insulators	Support wire
Bare conductors		-	-	-	-	-	-	+	-
Insulated conductors [b]		-	-	+	+ [a]	+	-	+	-
Shealted cables (including armoured and mineral insulated	Multi-core	+	+	+	+	+	+	0	+
	Single-core	0	+	+	+	+	+	0	+

+ Permitted.
– Not permitted.
0 Not applicable, or not normally used in practice.

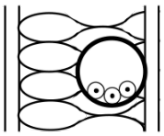
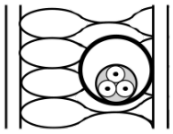
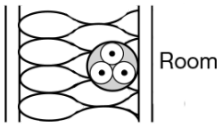
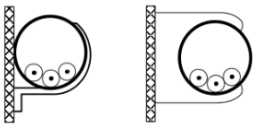
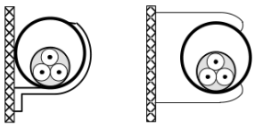
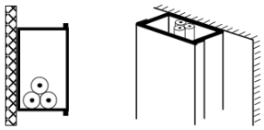
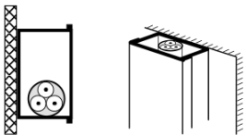
[a] Insulated conductors are admitted if the cable trunking systems provide at least the degree of protection IP4X or IPXXD and if the cover can only be removed by means of a tool or a deliberate action.
[b] Insulated conductors which are used as protective conductors or protective bonding conductors may use any appropriate method of installation and need not be laid in conduits, trunking or ducting systems.

جدول ۲-۱: راهنمای انتخاب هادی برای شرایط مختلف

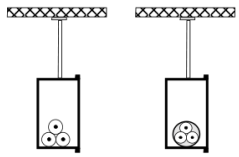
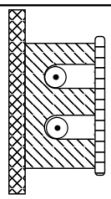
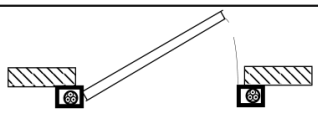
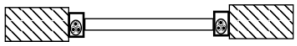
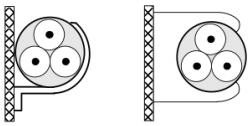
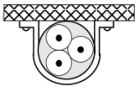
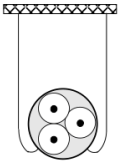
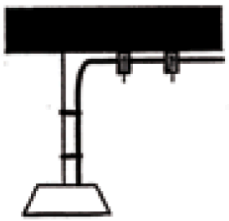
Situations		Method of installation							
		Without fixings	Clipped direct	Conduit systems	Cable trunking systems (including skirting trunking, flush floor trunking)	Cable ducting systems	Cable ladder, cable tray, cable brackets	On insulators	Support wire
Building voids	Accessible	40	33	41, 42	6, 7, 8, 9, 12	43, 44	30, 31, 32, 33, 34	-	0
	Not accessible	40	0	41, 42	0	43	0	0	0
Cable channel		56	56	54, 55	0		30, 31, 32, 34	-	-
Buried in ground		72, 73	0	70, 71	-	70, 71	0	-	-
-Embedded in structure		57, 58	3	1, 2, 59, 60	50, 51, 52, 53	46, 45	0	-	-
Surface mounted		-	20, 21, 22, 23, 33	4, 5	6, 7, 8, 9, 12	6, 7, 8, 9	30, 31, 32, 34	36	-
Overhead/free in air		-	33	0	10, 11	10, 11	30, 31, 32, 34	36	35
Window frames		16	0	16	0	0	0	-	-
Architrave		15	0	15	0	0	0	-	-
Immersed 1		+	+	+	-	+	0	-	-

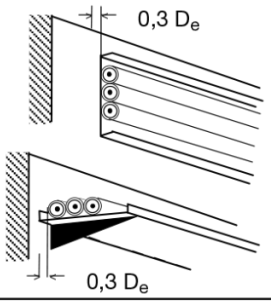
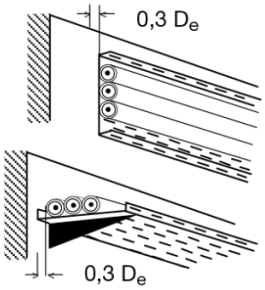
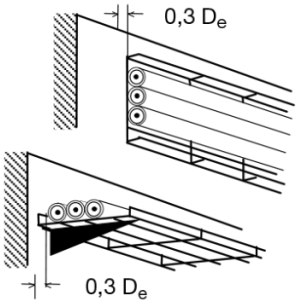
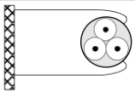
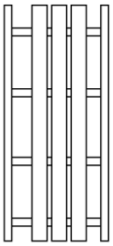
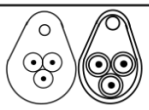
- Not permitted.
0 Not applicable or not normally used in practice.
+ Follow manufacturer's instructions.

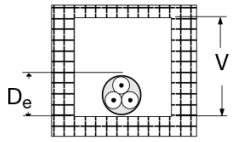
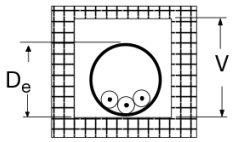
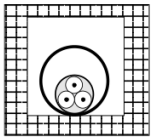
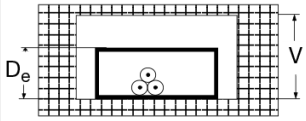
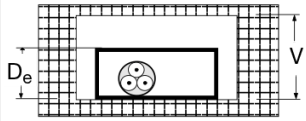
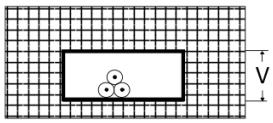
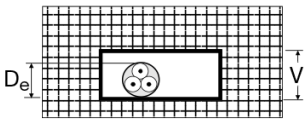
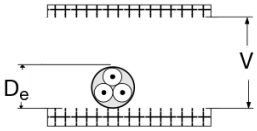
جدول ۲-۲ طبقه‌بندی روش‌های مختلف اجرا هادی‌ها

Item No.	Methods of installation	Description	Reference method of installation to be used to obtain current-carrying capacity
1		Insulated conductors or single-core cables in conduit in a thermally insulated wall [a, c]	A1
2		Multi-core cables in conduit in a thermally insulated wall [a, c]	A2
3		Multi-core cable direct in a thermally insulated wall [a, c]	A1
4		Insulated conductors or single-core cables in conduit on a wooden or masonry wall or spaced less than 0,3 × conduit diameter from it [c]	B1
5		Multi-core cable in conduit on a wooden or masonry wall or spaced less than 0,3 × conduit diameter from it [c]	B2
6 7		Insulated conductors or single-core cables in cable trunking (includes multi-compartment trunking) on a wooden or masonry wall – run horizontally [b] – run vertically [b, c]	B1
8 9		Multi-core cable in cable trunking (includes multi-compartment trunking) on a wooden or masonry wall – run horizontally [b] – run vertically [b, c]	Under consideration [d] Method B2 may be used

NOTE 1 The illustrations are not intended to depict actual product or installation practices but are indicative of the method described.

Item No	Methods of installation	Description	Reference method of installation to be used to obtain current-carrying capacity
10	 10 11	Insulated conductors or single-core cable in suspended cable trunking[b]	B1
11		Multi-core cable in suspended cable trunking[b]	B2
12		Insulated conductors or single-core cable run in mouldings[c,e]	A1
15		Insulated conductors in conduit or single-core or multi-core cable in architrave[c, f]	A1
16		Insulated conductors in conduit or single-core or multi-core cable in window frames[c,f]	A1
20		Single-core or multi-core cables: – fixed on, or spaced less than 0,3 × cable diameter from a wooden or masonry wall[c]	C
21		Single-core or multi-core cables: – fixed directly under a wooden or masonry ceiling	C, with item 3 of Table 5
22		Single-core or multi-core cables: – spaced from a ceiling	Under consideration Method E may be used
23		Fixed installation of suspended current-using equipment	C, with item 3 of Table 5

Item No.	Methods of installation	Description	Reference method of installation to be used to obtain current-carrying capacity
30		Single-core or multi-core cables: On unperforated tray run horizontally or vertically [c, h]	C with item 2 of Table 5
31		Single-core or multi-core cables: On perforated tray run horizontally or vertically [c, h]	E or F
32		Single-core or multi-core cables: On brackets or on a wire mesh tray run horizontally or vertically [c, h]	E or F
33		Single-core or multi-core cables: Spaced more than 0,3 times cable diameter from a wall	E or F or method G [g]
34		Single-core or multi-core cables: On ladder [c]	E or F
35		Single-core or multi-core cable suspended from or incorporating a support wire or harness	E or F
36		Bare or insulated conductors on insulators	G

Item No.	Methods of installation	Description	Reference method of installation to be used to obtain current-carrying capacity
40		Single-core or multi-core cable in a building void [c, h, i]	1,5 D_e V < 5 D_e B2 5 D_e V < 20 D_e B1
41		Insulated conductor in conduit in a building void [c, i, j, k]	1,5 D_e V < 20 D_e B2 V 20 D_e B1
42		Single-core or multi-core cable in conduit in a building void [c, k]	Under consideration The following may be used: 1,5 D_e V < 20 D_e B2 V 20 D_e B1
43		Insulated conductors in cable ducting in a building void [c, i, j, k]	1,5 D_e V < 20 D_e B2 V 20 D_e B1
44		Single-core or multi-core cable in cable ducting in a building void [c, k]	Under consideration The following may be used: 1,5 D_e V < 20 D_e B2 V 20 D_e B1
45		Insulated conductors in cable ducting in masonry having a thermal resistivity not greater than 2 K· m/W [c, h, i]	1,5 D_e V < 5 D_e B2 5 D_e V < 50 D_e B1
46		Single-core or multi-core cable in cable ducting in masonry having a thermal resistivity not greater than 2 K· m/W [c]	Under consideration The following may be used 1,5 D_e V < 20 D_e B2 V 20 D_e B1
47		Single-core or multi-core cable: – in a ceiling void – in a raised floor [h, i]	1,5 D_e V < 5 D_e B2 5 D_e V < 50 D_e B1

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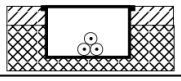
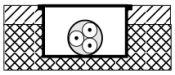
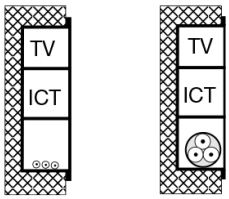
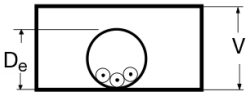
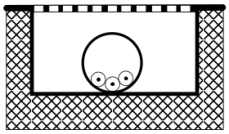
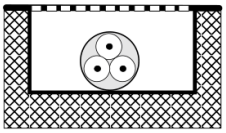
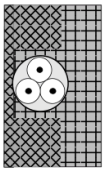
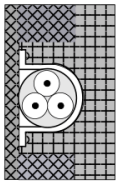
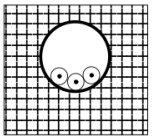
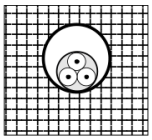
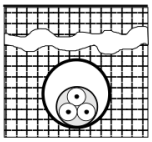
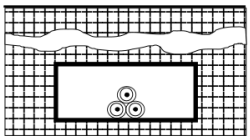
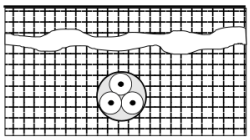
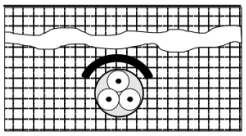
50		Insulated conductors or single-core cable in flush cable trunking in the floor	B1
51		Multi-core cable in flush cable trunking in the floor	B2
52	 52 53	Insulated conductors or single-core cables in flush cable trunking [c]	B1
53		Multi-core cable in flush trunking [c]	B2
54		Insulated conductors or single-core cables in conduit in an unventilated cable channel run horizontally or vertically [c, i, l, n]	1,5 D_e V < 20 D_e B2 V 20 D_e B1
55		Insulated conductors in conduit in an open or ventilated cable channel in the floor [m, n]	B1
56		Sheathed single-core or multi-core cable in an open or ventilated cable channel run horizontally or vertically [n]	B1
57		Single-core or multi-core cable direct in masonry having a thermal resistivity not greater than 2 K· m/W Without added mechanical protection [o, p]	C

Item No.	Methods of installation	Description	Reference method of installation to be used to obtain current-carrying capacity
58		Single-core or multi-core cable direct in masonry having a thermal resistivity not greater than 2 K· m/W With added mechanical protection [o, p]	C
59		Insulated conductors or single-core cables in conduit in masonry [p]	B1
60		Multi-core cables in conduit in masonry [p]	B2
70		Multi-core cable in conduit or in cable ducting in the ground	D1
71		Single-core cable in conduit or in cable ducting in the ground	D1
72		Sheathed single-core or multi-core cables direct in the ground – without added mechanical protection [q]	D2

Item No.	Methods of installation	Description	Reference method of installation to be used to obtain current-carrying capacity
73		Sheathed single-core or multi-core cables direct in the ground – with added mechanical protection[q]	D2

[a] The inner skin of the wall has a thermal conductance of not less than 10 $W/m^2 \cdot K$.

[b] Values given for installation methods B1 and B2 are for a single circuit. Where there is more than one circuit in the trunking the group reduction factor given in Table 5 is applicable, irrespective of the presence of an internal barrier or partition.

[c] Care shall be taken where the cable runs vertically and ventilation is restricted. The ambient temperature at the top of the vertical section can be increased considerably. The matter is under consideration.

[d] Values for reference method B2 may be used.

[e] The thermal resistivity of the enclosure is assumed to be poor because of the material of construction and possible air spaces. Where the construction is thermally equivalent to methods of installation 6 or 7, reference method B1 may be used.

[f] The thermal resistivity of the enclosure is assumed to be poor because of the material of construction and possible air spaces. Where the construction is thermally equivalent to methods of installation 6, 7, 8, or 9, reference methods B1 or B2 may be used.

[g] The factors in Table 5 may also be used.

[h] D_e is the external diameter of a multi-core cable:
- 2,2 × the cable diameter when three single core cables are bound in trefoil, or
- 3 × the cable diameter when three single core cables are laid in flat formation.

[i] V is the smaller dimension or diameter of a masonry duct or void, or the vertical depth of a rectangular duct, floor or ceiling void or channel. The depth of the channel is more important than the width.

[j] D_e is the external diameter of conduit or vertical depth of cable ducting.

[l] D_e is the external diameter of the conduit.

[m] For multi-core cable installed in method 55, use current-carrying capacity for reference method B2.

[n] It is recommended that these methods of installation are used only in areas where access is restricted to authorized persons so that the reduction in current-carrying capacity and the fire hazard due to the accumulation of debris can be prevented.

[o] For cables having conductors not greater than 16 mm^2, the current-carrying capacity may be higher.

[p] Thermal resistivity of masonry is not greater than 2 $K \cdot m/W$, the term “masonry” is taken to include brickwork, concrete, plaster and the like (other than thermally insulating materials).

[q] The inclusion of directly buried cables in this item is satisfactory when the soil thermal resistivity is of the order of 2,5 $K \cdot m/W$. For lower soil resistivities, the current-carrying capacity for directly buried cables is appreciably higher than for cables in ducts.

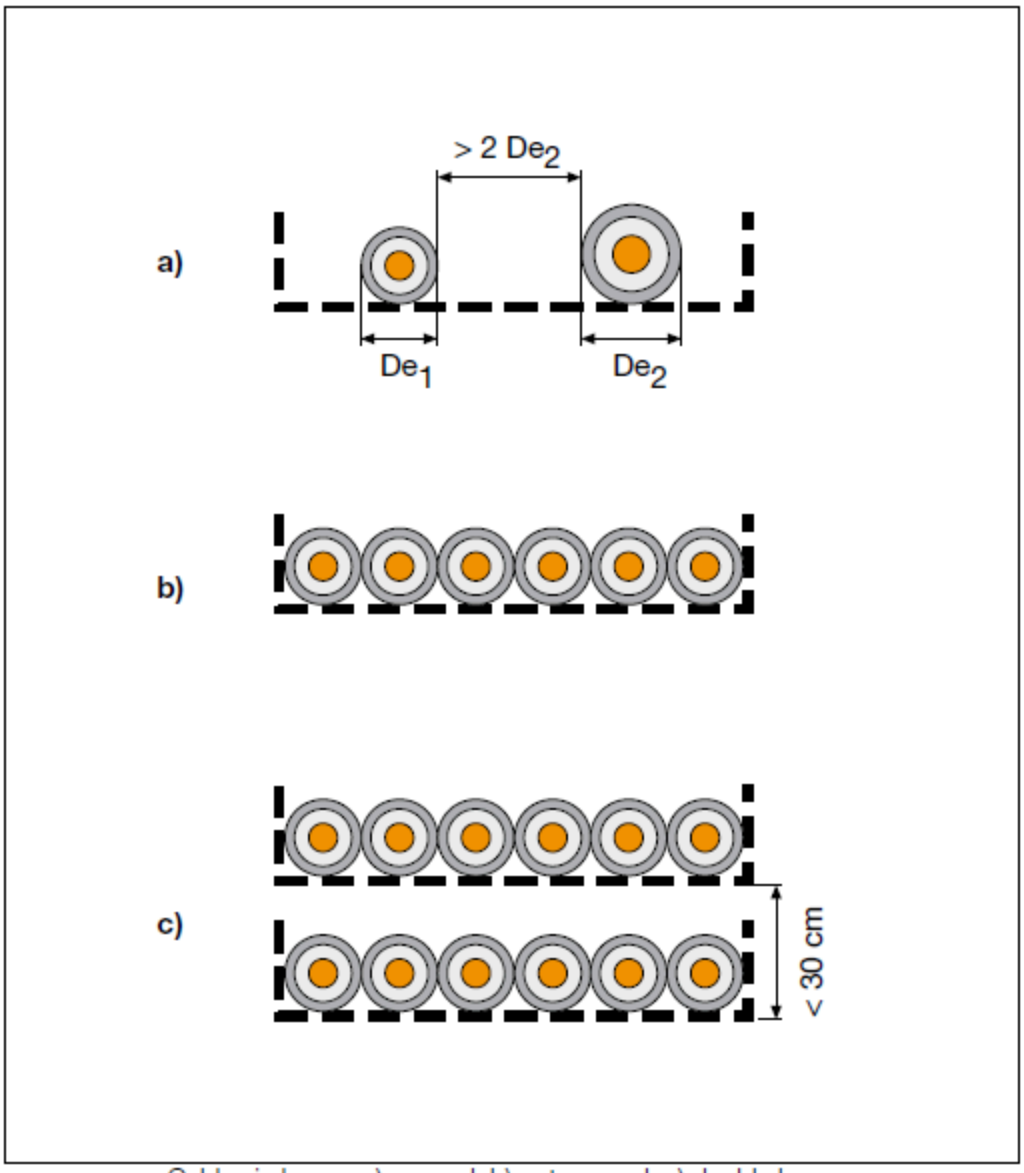
جدول ۲-۳: نمایش تصویری روش‌های مختلف اجرا هادی‌ها

Table 4: Correction factor for ambient air temperature other than 30 °C

Ambient temperature [a] °C	Insulation			
			Mineral [a]	
	PVC	XLPE and EPR	PVC covered or bare and exposed to touch 70 °C	Bare not exposed to touch 105 °C
10	1.22	1.15	1.26	1.14
15	1.17	1.12	1.20	1.11
20	1.12	1.08	1.14	1.07
25	1.06	1.04	1.07	1.04
35	0.94	0.96	0.93	0.96
40	0.87	0.91	0.85	0.92
45	0.79	0.87	0.87	0.88
50	0.71	0.82	0.67	0.84
55	0.61	0.76	0.57	0.80
60	0.50	0.71	0.45	0.75
65	–	0.65	–	0.70
70	–	0.58	–	0.65
75	–	0.50	–	0.60
80	–	0.41	–	0.54
85	–	–	–	0.47
90	–	–	–	0.40
95	–	–	–	0.32

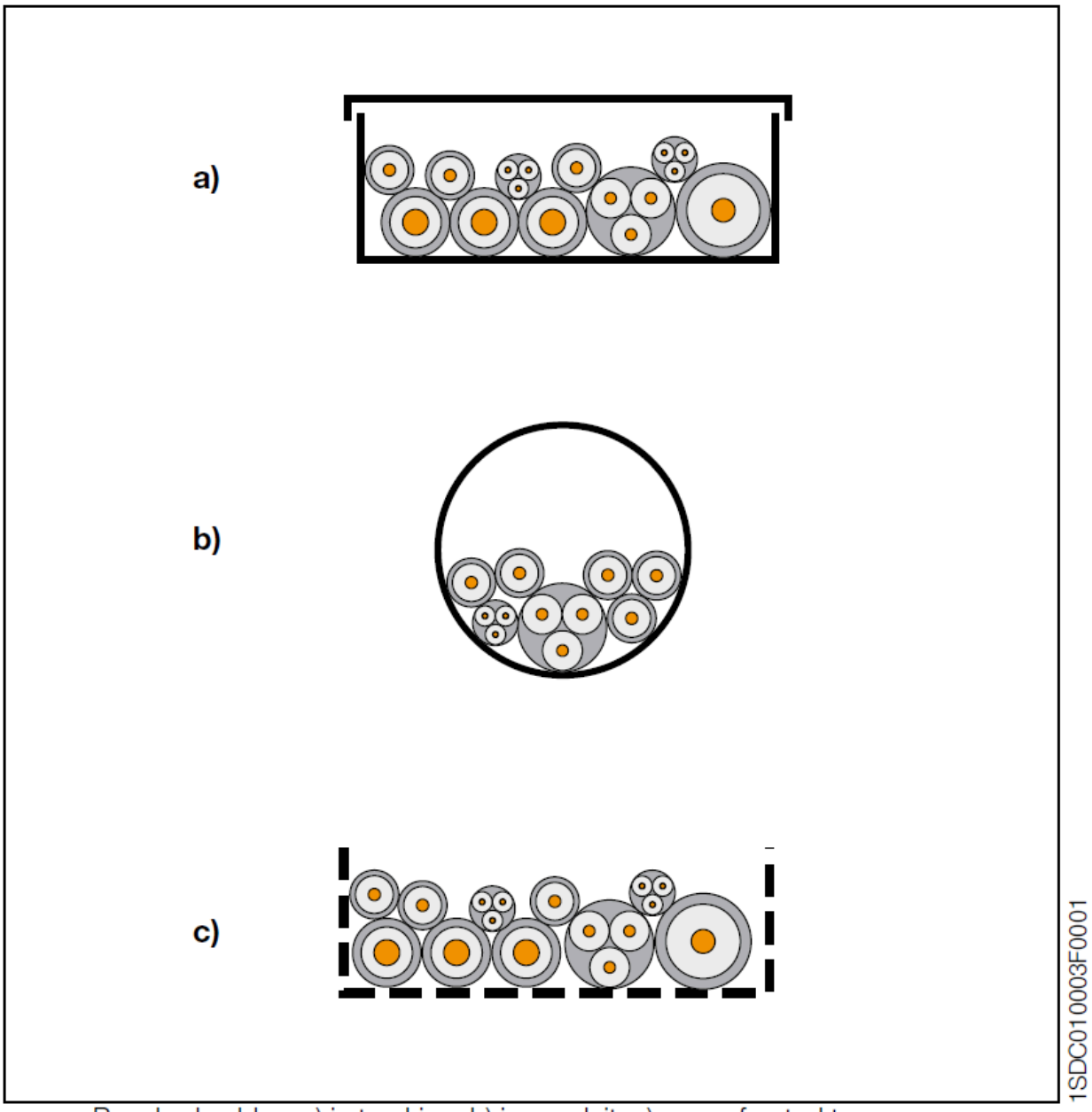
[a] For higher ambient temperatures, consult manufacturer.

جدول ۲-۴: ضریب تصحیح برای دماهای محیط غیر از ۳۰ درجه سانتی گراد



Cables in layers: a) spaced; b) not spaced; c) double layer

شکل ۲-۱: تعدادی کابل با آرایش لایه‌ای



Bunched cables: a) in trunking; b) in conduit; c) on perforated tray

شکل ۲-۲: تعدادی کابل بصورت دسته‌ای

Table 5: Reduction factor for grouped cables

Item	Arrangement (cables touching)	Number of circuits or multi-core cables 1	2	3	4	5	6	7	8	9	12	16	20	To be used with current-carrying capacities, reference
1	Bunched in air, on a surface, embedded or enclosed	1.00	0.80	0.70	0.65	0.60	0.57	0.54	0.52	0.50	0.45	0.41	0.38	Methods A to F
2	Single layer on wall, floor or unperforated tray	1.00	0.85	0.79	0.75	0.73	0.72	0.72	0.71	0.70	No further reduction factor for more than nine circuits or multicore cables			Method C
3	Single layer fixed directly under a wooden ceiling	0.95	0.81	0.72	0.68	0.66	0.64	0.63	0.62	0.61				
4	Single layer on a perforated horizontal or vertical tray	1.00	0.88	0.82	0.77	0.75	0.73	0.73	0.72	0.72				
5	Single layer on ladder support or cleats etc.	1.00	0.87	0.82	0.80	0.80	0.79	0.79	0.78	0.78				Methods E and F

NOTE 1 These factors are applicable to uniform groups of cables, equally loaded.

NOTE 2 Where horizontal clearances between adjacent cables exceeds twice their overall diameter, no reduction factor need be applied.

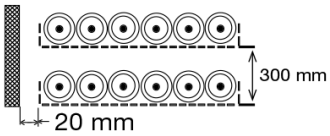
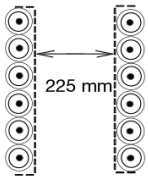
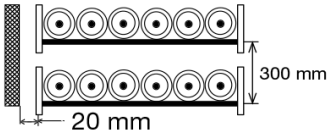
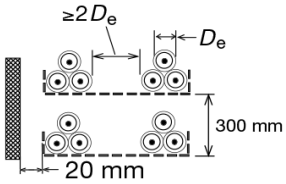
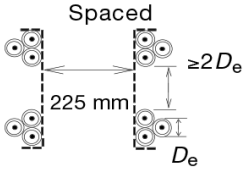
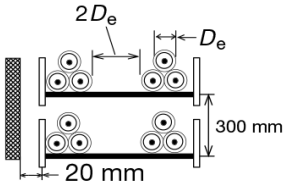
NOTE 3 The same factors are applied to:
– groups of two or three single-core cables;
– multi-core cables.

NOTE 4 If a system consists of both two- and three-core cables, the total number of cables is taken as the number of circuits, and the corresponding factor is applied to the tables for two loaded conductors for the two-core cables, and to the tables for three loaded conductors for the three-core cables.

NOTE 5 If a group consists of n single-core cables it may either be considered as n/2 circuits of two loaded conductors or n/3 circuits of three loaded conductors.

NOTE 6 For some installations and for other methods not provided for in the above table, it may be appropriate to use factors calculated for specific case, see for example tables 6-7.

جدول ۲-۵: ضریب تصحیح مجاورت برای مجموعه‌ای از کابل‌ها

Method of installation in Table 3			Number of trays	Number of three-phase circuits (note 4)			Use as a multiplier to rating for
				1	2	3	
Perforated trays (note 3)	31	Touching 	1 2 3	0.98 0.96 0.95	0.91 0.87 0.85	0.87 0.81 0.78	Three cables in horizontal formation
Vertical perforated cable trays systems (note 4)	31	Touching 	1 2	0.96 0.95	0.86 0.84	– –	Three cables in vertical formation
Cable ladder system cleats, etc. (note 3)	32 33 34	Touching 	1 2 3	1.00 0.98 0.97	0.97 0.93 0.90	0.96 0.89 0.86	Three cables in horizontal formation
Perforated cable trays system (note 3)	31		1 2 3	1.00 0.97 0.96	0.98 0.93 0.92	0.96 0.89 0.86	Three cables in trefoil formation
Vertical perforated cable trays system (note 4)	31	Spaced 	1 2	1.00 1.00	0.91 0.90	0.89 0.86	
Cable Ladder system cleats, etc. (note 3)	32 33 34		1 2 3	1.00 0.97 0.96	1.00 0.95 0.94	1.00 0.93 0.90	

NOTE 1 Values given are averages for the cable types and range of conductor sizes considered in Table 8 to 9 (installation methods E, F and G). The spread of values is generally less than 5 %.

NOTE 2 Factors are given for single layers of cables (or trefoil groups) as shown in the table and do not apply when cables are installed in more than one layer touching each other. Values for such installations may be significantly lower and should be determined by an appropriate method.

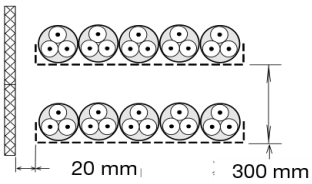
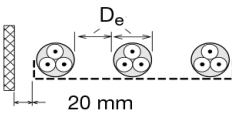
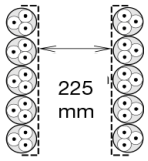
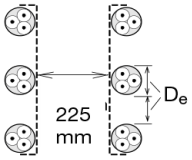
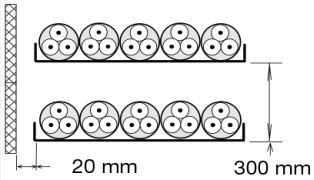
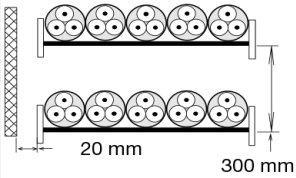
NOTE 3 Values are given for vertical spacing between cable trays of 300 mm and at least 20 mm between cable trays and wall. For closer spacing the factors should be reduced.

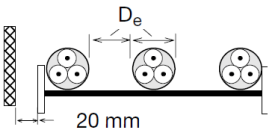
NOTE 4 Values are given for horizontal spacing between cable trays of 225 mm with cable trays mounted back to back. For closer spacing the factors should be reduced.

NOTE 5 For circuits having more than one cable in parallel per phase, each three phase set of conductors should be considered as a circuit for the purpose of this table.

NOTE 6 If a circuit consists of *m* parallel conductors per phase, then for determining the reduction factor this circuitshould be considered as *m* circuits.

جدول ۲-۶ ضریب تصحیح مجاورت برای کابل‌های تک هسته‌ای که به روش F اجرا شده باشند.

Method of installation in Table 3			Number of trays or ladders	Number of cables per tray or ladder					
				1	2	3	4	6	9
Perforated cable tray systems (note 3)	31	Touching 	1	1,00	0,88	0,82	0,79	0,76	0,73
			2	1,00	0,87	0,80	0,77	0,73	0,68
			3	1,00	0,86	0,79	0,76	0,71	0,66
			6	1,00	0,84	0,77	0,73	0,68	0,64
		Spaced 	1	1,00	1,00	0,98	0,95	0,91	–
			2	1,00	0,99	0,96	0,92	0,87	–
			3	1,00	0,98	0,95	0,91	0,85	–
Vertical perforated cable tray systems (note 4)	31	Touching 	1	1,00	0,88	0,82	0,78	0,73	0,72
			2	1,00	0,88	0,81	0,76	0,71	0,70
		Spaced 	1	1,00	0,91	0,89	0,88	0,87	–
			2	1,00	0,91	0,88	0,87	0,85	–
Unperforated cable tray systems	31	Touching 	1	0,97	0,84	0,78	0,75	0,71	0,68
			2	0,97	0,83	0,76	0,72	0,68	0,63
			3	0,97	0,82	0,75	0,71	0,66	0,61
			6	0,97	0,81	0,73	0,69	0,63	0,58
Cable ladder systems, cleats, etc. (note 3)	32 33 34	Touching 	1	1,00	0,87	0,82	0,80	0,79	0,78
			2	1,00	0,86	0,80	0,78	0,76	0,73
			3	1,00	0,85	0,79	0,76	0,73	0,70
			6	1,00	0,84	0,77	0,73	0,68	0,64

Method of installation in Table 3			Number of trays or ladders	Number of cables per tray or ladder					
				1	2	3	4	6	9
		Spaced 	1	1,00	1,00	1,00	1,00	1,00	–
			2	1,00	0,99	0,98	0,97	0,96	–
			3	1,00	0,98	0,97	0,96	0,93	–

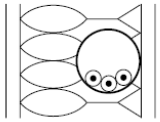
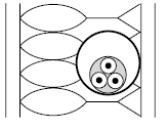
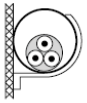
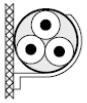
NOTE 1 Values given are averages for the cable types and range of conductor sizes considered in Tables 8 to 9 (installation methods E, F and G). The spread of values is generally less than 5 %.

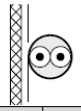
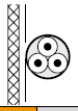
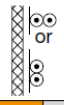
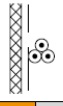
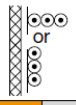
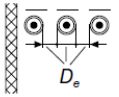
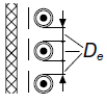
NOTE 2 Factors apply to single layer groups of cables as shown above and do not apply when cables are installed in more than one layer touching each other. Values for such installations may be significantly lower and has to be determined by an appropriate method.

NOTE 3 Values are given for vertical spacing between cable trays of 300 mm and at least 20 mm between cable trays and wall. For closer spacing the factors should be reduced.

NOTE 4 Values are given for horizontal spacing between cable trays of 225 mm with cable trays mounted back to back. For closer spacing the factors should be reduced.

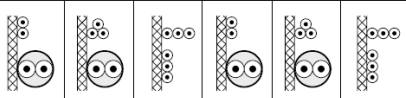
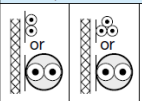
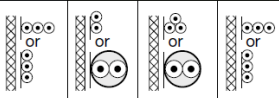
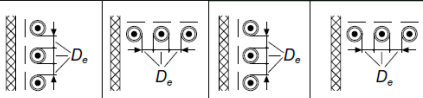
جدول ۲-۷: ضریب تصحیح مجاورت برای کابل‌های تک هسته‌ای که به روش E اجرا شده باشند.

	Installation method	A1								A2										B1						B2								C							
																																									
	Conductor	Cu				Al				Cu				Al				Cu				Al				Cu				Al				Cu				Al			
	Insulation	XLPE EPR		PVC		XLPE EPR		PVC		XLPE EPR		PVC		XLPE EPR		PVC		XLPE EPR		PVC		XLPE EPR		PVC		XLPE EPR		PVC		XLPE EPR		PVC		XLPE EPR		PVC		XLPE/EPR		PVC	
S[mm²]	Loaded conductors	2	3	2	3	2	3	2	3	2	3	2	3	2	3	2	3	2	3		2	3	2	3	2	3	2	3	2	3	2	3	2	3	2	3	2	3	2	3	2	3
1.5		19	17	14.5	13.5					18.5	16.5	14	13					23	20		17.5	15.5					22	19.5	16.5	15					24	22	19.5	17.5				
2.5		26	23	19.5	18	20	19	15	14	25	22	18.5	17.5	19.5	18	14.5	13.5	31	28		24	21	25	22	18.5	16.5	30	26	23	20	23	21	17.5	15.5	33	30	27	24	26	24	21	18.5
4		35	31	26	24	27	25	20	18.5	33	30	25	23	26	24	19.5	17.5	42	37		32	28	33	29	25	22.0	40	35	30	27	31	28	24	21	45	40	36	32	35	32	28	25
6		45	40	34	31	35	32	26	24	42	38	32	29	33	31	25	23	54	48		41	36	43	38	32	28	51	44	38	34	40	35	30	27.0	58	52	46	41	45	41	36	32
10		61	54	46	42	48	44	36	32	57	51	43	39	45	41	33	31	75	66		57	50	59	52	44	39	69	60	52	46	54	48	41	36	80	71	63	57	62	57	49	44
16		81	73	61	56	64	58	48	43	76	68	57	52	60	55	44	41	100	88		76	68	79	71	60	53	91	80	69	62	72	64	54	48	107	96	85	76	84	76	66	59
25		106	95	80	73	84	76	63	57	99	89	75	68	78	71	58	53	133	117		101	89	105	93	79	70	119	105	90	80	94	84	71	62	138	119	112	96	101	90	83	73
35		131	117	99	89	103	94	77	70	121	109	92	83	96	87	71	65	164	144		125	110	130	116	97	86	146	128	111	99	115	103	86	77	171	147	138	119	126	112	103	90
50		158	141	119	108	125	113	93	84	145	130	110	99	115	104	86	78	198	175		151	134	157	140	118	104	175	154	133	118	138	124	104	92	209	179	168	144	154	136	125	110
70		200	179	151	136	158	142	118	107	183	164	139	125	145	131	108	98	253	222		192	171	200	179	150	133	221	194	168	149	175	156	131	116	269	229	213	184	198	174	160	140
95		241	216	182	164	191	171	142	129	220	197	167	150	175	157	130	118	306	269		232	207	242	217	181	161	265	233	201	179	210	188	157	139	328	278	258	223	241	211	195	170
120		278	249	210	188	220	197	164	149	253	227	192	172	201	180	150	135	354	312		269	239	281	251	210	186	305	268	232	206	242	216	181	160	382	322	299	259	280	245	226	197
150		318	285	240	216	253	226	189	170	290	259	219	196	230	206	172	155	393	342		300	262	307	267	234	204	334	300	258	225	261	240	201	176	441	371	344	299	324	283	261	227
185		362	324	273	245	288	256	215	194	329	295	248	223	262	233	195	176	449	384		341	296	351	300	266	230	384	340	294	255	300	272	230	199	506	424	392	341	371	323	298	259
240		424	380	321	286	338	300	252	227	386	346	291	261	307	273	229	207	528	450		400	346	412	351	312	269	459	398	344	297	358	318	269	232	599	500	461	403	439	382	352	305
300		486	435	367	328	387	344	289	261	442	396	334	298	352	313	263	237	603	514		458	394	471	402	358	306	532	455	394	339	415	364	308	265	693	576	530	464	508	440	406	351
400																																									
500																																									
630																																									

	Installation method	E								F												G							
																													
		Cu		Al		Cu		Al		Cu		Al		Cu		Al		Cu		Al		Cu				Al			
	Insulation	XLPE EPR	PVC	XLPE EPR	PVC	XLPE EPR	PVC	XLPE EPR	PVC	XLPE EPR	PVC	XLPE EPR	PVC	XLPE EPR	PVC	XLPE EPR	PVC	XLPE EPR	PVC	XLPE EPR	PVC	XLPE EPR		PVC		XLPE EPR		PVC	
S[mm²]	Loaded conductors	2				3				2				3				3				3H	3V	3H	3V	3H	3V	3H	3V
1.5		26	22			23	18.5																						
2.5		36	30	28	23	32	25	24	19.5																				
4		49	40	38	31	42	34	32	26																				
6		63	51	49	39	54	43	42	33																				
10		86	70	67	54	75	60	58	46																				
16		115	94	91	73	100	80	77	61																				
25		149	119	108	89	127	101	97	78	161	131	121	98	135	110	103	84	141	114	107	87	182	161	146	130	138	122	112	99
35		185	148	135	111	158	126	120	96	200	162	150	122	169	137	129	105	176	143	135	109	226	201	181	162	172	153	139	124
50		225	180	164	135	192	153	146	117	242	196	184	149	207	167	159	128	216	174	165	133	275	246	219	197	210	188	169	152
70		289	232	211	173	246	196	187	150	310	251	237	192	268	216	206	166	279	225	215	173	353	318	281	254	271	244	217	196
95		352	282	257	210	298	238	227	183	377	304	289	235	328	264	253	203	342	275	264	212	430	389	341	311	332	300	265	241
120		410	328	300	244	346	276	263	212	437	352	337	273	383	308	296	237	400	321	308	247	500	454	396	362	387	351	308	282
150		473	379	346	282	399	319	304	245	504	406	389	316	444	356	343	274	464	372	358	287	577	527	456	419	448	408	356	327
185		542	434	397	322	456	364	347	280	575	463	447	363	510	409	395	315	533	427	413	330	661	605	521	480	515	470	407	376
240		641	514	470	380	538	430	409	330	679	546	530	430	607	485	471	375	634	507	492	392	781	719	615	569	611	561	482	447
300		741	593	543	439	621	497	471	381	783	629	613	497	703	561	547	434	736	587	571	455	902	833	709	659	708	652	557	519
400										940	754	740	600	823	656	663	526	868	689	694	552	1085	1008	852	795	856	792	671	629
500										1083	868	856	694	946	749	770	610	998	789	806	640	1253	1169	982	920	991	921	775	730
630										1254	1005	996	808	1088	855	899	711	1151	905	942	746	1454	1362	1138	1070	1154	1077	900	852

جدول ۲-۸ جریان مجاز کابل‌های PVC، EPR و XLPE که به روش‌های E، F یا G اجرا ده باشند.

جدول ۲-۹ جریان مجاز کابل‌های روغنی

	Installation method	C									E or F				G			
	Sheath	Metallic sheath temperature 70 °C			Metallic sheath temperature 105 °C			Metallic sheath temperature			70 °C	Metallic sheath temperature 105 °C			Metallic sheath temperature 70 °C		Metallic sheath temperature 105 °C	
		PVC covered or bare exposed to touch			Bare cable not exposed to touch			PVC covered or bare exposed to touch				Bare cable not exposed to touch			PVC covered or bare exposed to touch		Bare cable not exposed to touch	
	Loaded conductors																	
	S[mm²]	2	3	3	2	3	3	2	3		3	2	3	3	3	3	3	3
500 V	1.5	23	19	21	28	24	27	25	21		23	31	26	29	26	29	33	37
	2.5	31	26	29	38	33	36	33	28		31	41	35	39	34	39	43	49
	4	40	35	38	51	44	47	44	37		41	54	46	51	45	51	56	64
750 V	1.5	25	21	23	31	26	30	26	22		26	33	28	32	28	32	35	40
	2.5	34	28	31	42	35	41	36	30		34	45	38	43	37	43	47	54
	4	45	37	41	55	47	53	47	40		45	60	50	56	49	56	61	70
	6	57	48	52	70	59	67	60	51		57	76	64	71	62	71	78	89
	10	77	65	70	96	81	91	82	69		77	104	87	96	84	95	105	120
	16	102	86	92	127	107	119	109	92		102	137	115	127	110	125	137	157
	25	133	112	120	166	140	154	142	120		132	179	150	164	142	162	178	204
	35	163	137	147	203	171	187	174	147		161	220	184	200	173	197	216	248
	50	202	169	181	251	212	230	215	182		198	272	228	247	213	242	266	304
	70	247	207	221	307	260	280	264	223		241	333	279	300	259	294	323	370
	95	296	249	264	369	312	334	317	267		289	400	335	359	309	351	385	441
	120	340	286	303	424	359	383	364	308		331	460	385	411	353	402	441	505
	150	388	327	346	485	410	435	416	352		377	526	441	469	400	454	498	565
	185	440	371	392	550	465	492	472	399		426	596	500	530	446	507	557	629
	240	514	434	457	643	544	572	552	466		496	697	584	617	497	565	624	704

Note 1 For single-core cables the sheaths of the cables of the circuit are connected together at both ends.
Note 2 For bare cables exposed to touch, values should be multiplied by 0.9.
Note 3 D_e is the external diameter of the cable.
Note 4 For metallic sheath temperature 105)C no correction for grouping need to be applied.

Table 10: Correction factors for ambient ground temperatures other than 20 °C

Ground temperature °C	Insulation	
	PVC	XLPE and EPR
10	1.10	1.07
15	1.05	1.04
25	0.95	0.96
30	0.89	0.93
35	0.84	0.89
40	0.77	0.85
45	0.71	0.80
50	0.63	0.76
55	0.55	0.71
60	0.45	0.65
65	–	0.60
70	–	0.53
75	–	0.46
80	–	0.38

جدول ۲-۱۰ ضریب تصحیح دمای خاک اگر با ۲۰ درجه سانتی‌گراد متفاوت باشد.

Number of circuits	Cable to cable clearance				
	Nil (cables touching)	One cable diameter	0,125 m	0,25 m	0,5 m
2	0,75	0,80	0,85	0,90	0,90
3	0,65	0,70	0,75	0,80	0,85
4	0,60	0,60	0,70	0,75	0,80
5	0,55	0,55	0,65	0,70	0,80
6	0,50	0,55	0,60	0,70	0,80
7	0,45	0,51	0,59	0,67	0,76
8	0,43	0,48	0,57	0,65	0,75
9	0,41	0,46	0,55	0,63	0,74
12	0,36	0,42	0,51	0,59	0,71
16	0,32	0,38	0,47	0,56	0,38
20	0,29	0,35	0,44	0,53	0,66

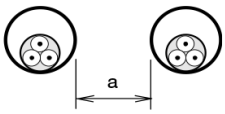
Multi-core cables

Single-core cables

جدول ۲-۱۱: ضریب تصحیح مجاورت برای کابل‌هایی که مستقیما در زمین خوابانده شده‌اند.

Number of cables	Multi-core cables in single-way ducts			
	Duct to duct clearance			
	Nil (ducts touching)	0,25 m	0,5 m	1,0 m
2	0,85	0,90	0,95	0,95
3	0,75	0,85	0,90	0,95
4	0,70	0,80	0,85	0,90
5	0,65	0,80	0,85	0,90
6	0,60	0,80	0,80	0,90
7	0,57	0,76	0,80	0,88
8	0,54	0,74	0,78	0,88
9	0,52	0,73	0,77	0,87
10	0,49	0,72	0,76	0,86
11	0,47	0,70	0,75	0,86
12	0,45	0,69	0,74	0,85
13	0,44	0,68	0,73	0,85
14	0,42	0,68	0,72	0,84
15	0,41	0,67	0,72	0,84
16	0,39	0,66	0,71	0,83
17	0,38	0,65	0,70	0,83
18	0,37	0,65	0,70	0,83
19	0,35	0,64	0,69	0,82
20	0,34	0,63	0,68	0,82

Multi-core cables



NOTE 1 Values given apply to an installation depth of 0,7 m and a soil thermal resistivity of 2,5 K·m/W. They are average values for the range of cable sizes and types quoted for Tables 8-15-16. The process of averaging, together with rounding off, can result in some cases in errors up to ±10 %. (Where more precise values are required they may be calculated by methods given in IEC 60287-2-1.)

NOTE 2 In case of a thermal resistivity lower than 2,5 K· m/W the corrections factors can, in general, be increased and can be calculated by the methods given in IEC 60287-2-1.

NOTE 3 If a circuit consists of m parallel conductors per phase, then for determining the reduction factor, this circuit should be considered asm circuits.

جدول ۲-۱۲: ضریب تصحیح مجاورت برای کابل‌های چند هسته‌ای که به صورت تکی در داکت‌های جداگانه کشیده شده‌اند.

Single-core cables in non- magnetic single-way ducts				
Number of single-core circuits of two or three cables	Duct to duct clearance			
	Nil (ducts touching)	0,25 m	0,5 m	1,0 m
2	0,80	0,90	0,90	0,95
3	0,70	0,80	0,85	0,90
4	0,65	0,75	0,80	0,90
5	0,60	0,70	0,80	0,90
6	0,60	0,70	0,80	0,90
7	0,53	0,66	0,76	0,87
8	0,50	0,63	0,74	0,87
9	0,47	0,61	0,73	0,86
10	0,45	0,59	0,72	0,85
11	0,43	0,57	0,70	0,85
12	0,41	0,56	0,69	0,84
13	0,39	0,54	0,68	0,84
14	0,37	0,53	0,68	0,83
15	0,35	0,52	0,67	0,83
16	0,34	0,51	0,66	0,83
17	0,33	0,50	0,65	0,82
18	0,31	0,49	0,65	0,82
19	0,30	0,48	0,64	0,82
20	0,29	0,47	0,63	0,81

Single-core cables

NOTE 1 Values given apply to an installation depth of 0,7 m and a soil thermal resistivity of 2,5 K·m/W. They are average values for the range of cable sizes and types quoted for Tables 8-15-16. The process of averaging, together with rounding off, can result in some cases in errors up to ±10 %. (Where more precise values are required they may be calculated by methods given in IEC 60287-2-1.)

NOTE 2 In case of a thermal resistivity lower than 2,5 K· m/W the corrections factors can, in general, be increased and can be calculated by the methods given in IEC 60287-2-1.

NOTE 3 If a circuit consists of m parallel conductors per phase, then for determining the reduction factor, this circuit should be considered asm circuits.

جدول ۲-۱۳: ضریب تصحیح مجاورت برای کابل‌های تک هسته‌ای که هر یک در یک داکت درون زمین کشیده شده‌اند.

Table 14: Correction factors for soil thermal resistivities other than 2.5 Km/W

Thermal resistivity, K · m/W	0,5	0,7	1	1,5	2	2,5	3
Correction factor for cables in buried ducts	1,28	1,20	1,18	1,1	1,05	1	0,96
Correction factor for direct buried cables	1,88	1,62	1,5	1,28	1,12	1	0,90

NOTE 1 The correction factors given have been averaged over the range of conductor sizes and types of installation included in Tables 8-15-16. The overall accuracy of correction factors is within ±5 %.

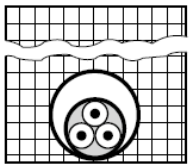
NOTE 2 The correction factors are applicable to cables drawn into buried ducts; for cables laid direct in the ground the correction factors for thermal resistivities less than 2,5 K·m/W will be higher. Where more precise values are required they may be calculated by methods given in the IEC 60287 series.

NOTE 3 The correction factors are applicable to ducts buried at depths of up to 0,8 m.

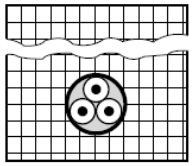
NOTE 4 It is assumed that the soil properties are uniform. No allowance had been made for the possibility of moisture migration which can lead to a region of high thermal resistivity around the cable. If partial drying out of the soil is foreseen, the permissible current rating should be derived by the methods specified in the IEC 60287 series.

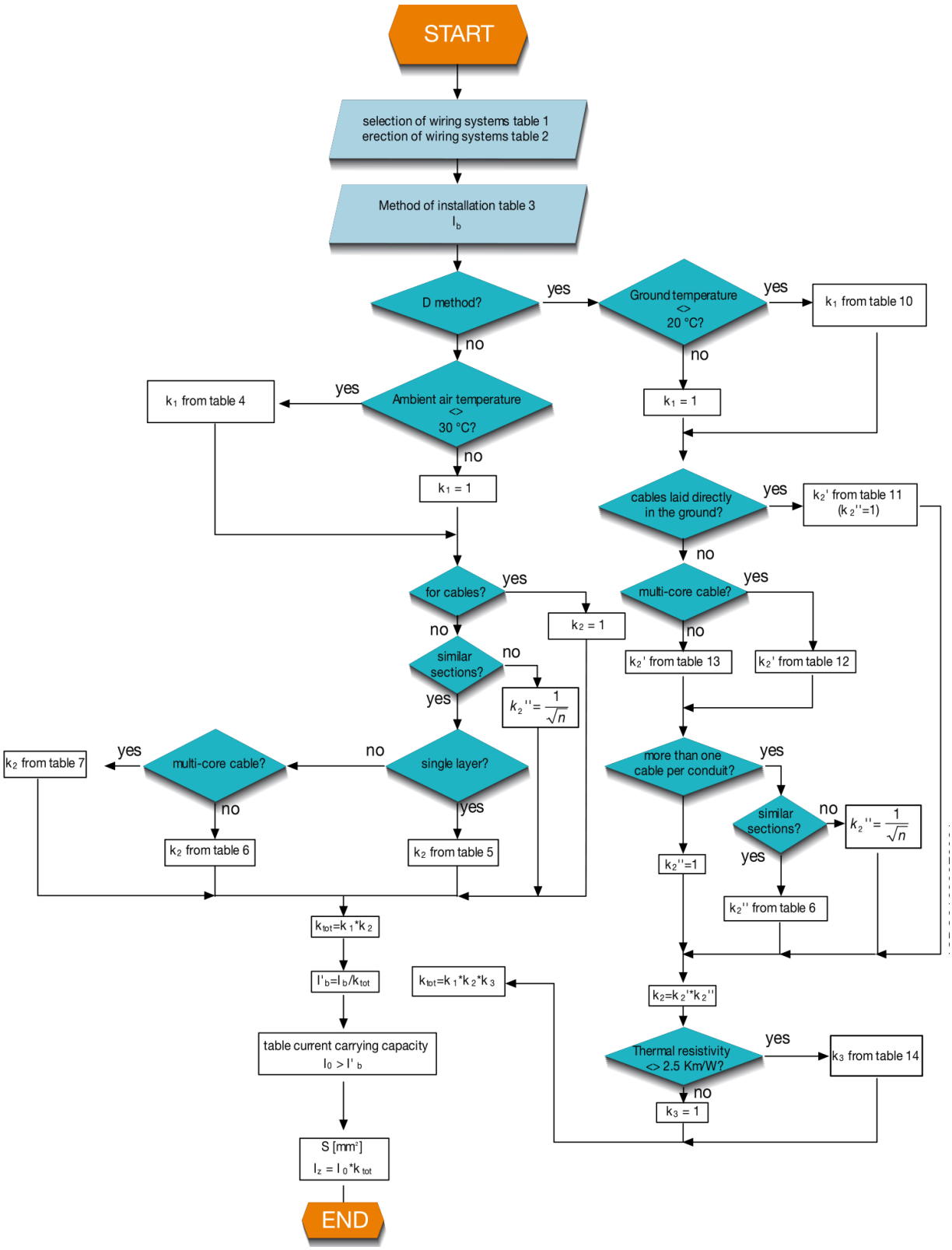
جدول ۲-۱۴ ضریب تصحیح مقاومت حرارتی خاک چنانچه در محل موردنظر، غیر از ۲.۵km/W باشد.

جدول ۲-۱۵ جریان مجاز کابل‌های مدفون در زمین (روش D1)

	Installation method	D1							
									
	Conductor	Cu				Al			
	Insulation	XLPE EPR		PVC		XLPE EPR		PVC	
S[mm²]	Loaded conductors	2	3	2	3	2	3	2	3
1.5		25	21	22	18				
2.5		33	28	29	24	26	22	22	18.5
4		48	36	37	30	33	28	29	24
6		53	44	46	38	42	35	36	30
10		71	58	60	50	55	46	47	39
16		91	75	78	64	71	59	61	50
25		116	96	99	82	90	75	77	64
35		139	115	119	98	108	90	93	77
50		164	135	140	116	128	106	109	91
70		203	167	173	143	158	130	135	112
95		239	197	204	169	186	154	159	132
120		271	223	231	192	211	174	180	150
150		306	251	261	217	238	197	204	169
185		343	281	292	243	267	220	228	190
240		395	324	336	280	307	253	262	218
300		496	365	379	316	346	286	296	247

جدول ۲-۱۶ جریان مجاز کابل‌های مدفون در زمین (روش D2)

	Installation method	D2							
									
	Conductor	Cu				Al			
	Insulation	XLPE EPR		PVC		XLPE EPR		PVC	
S[mm²]	Loaded conductors	2	3	2	3	2	3	2	3
1.5		27	23	22	19				
2.5		35	30	28	24				
4		46	39	38	33				
6		58	49	48	41				
10		77	65	64	54				
16		100	74	83	70	76	64	63	53
25		129	107	110	92	98	82	82	69
35		155	129	132	110	117	98	98	83
50		183	153	156	130	139	117	117	99
70		225	188	192	162	170	144	145	122
95		270	226	230	193	204	172	173	148
120		306	257	261	220	233	197	200	169
150		343	287	293	246	261	220	224	189
185		387	324	331	278	296	250	255	214
240		448	375	382	320	343	290	298	250
300		502	419	427	359	386	326	336	282



شکل ۲-۳ فلوچارت تعیین سطح مقطع کابل‌ها براساس جریان مجاز

Third harmonic content of phase current	Reduction factor			
%	Size selection is based on phase current	Current to take in account for the cable selection I_b'	Size selection is based on neutral current	Current to take in account for the cable selection I_b'
0 ÷ 15	1	$I_b' = \frac{I_b}{k_{tot}}$	-	-
15 ÷ 33	0.86	$I_b' = \frac{I_b}{k_{tot} \cdot 0.86}$	-	-
33 ÷ 45	-	-	0.86	$I_b' = \frac{I_N}{0.86}$
> 45	-	-	1	$I_b' = I_N$

Where I_N is the current flowing in the neutral calculated as follows: $I_N = \frac{I_b}{k_{tot}} \cdot 3 \cdot k_{III}$

I_b is the load current;
k_{tot} is the total correction factor;
k_{III} is the third harmonic content of phase current;

جدول ۲-۱۷ ضریب تصحیح مربوط به وجود هارمونیک در جریان کابل، برای کابل‌های چهار و پنج هسته‌ای

Table 18: Voltage drop

Type of installation	Lighting %	Other uses %
A – Low voltage installations supplied directly from a public low voltage distribution system	3	5
B – Low voltage installation supplied from private LV supply [a]	6	8

[a] As far as possible, it is recommended that voltage drop within the final circuits do not exceed those indicated in installation type A.

When the main wiring systems of the installations are longer than 100 m, these voltage drops may be increased by 0,005 % per metre of wiring system beyond 100 m, without this supplement being greater than 0,5 %.

Voltage drop is determined from the demand by the current-using equipment, applying diversity factors where applicable, or from the values of the design current of the circuits.

NOTE 1 A greater voltage drop may be accepted
– for motor during starting periods,
– for other equipment with high inrush current,
provided that in both cases it is ensured that the voltage variations remains within the limits specified in the relevant equipment standard.

NOTE 2 The following temporary conditions are excluded:
– voltage transients;
– voltage variation due to abnormal operation.

جدول ۲-۱۸ افت ولتاژهای مجاز

Table 1: Resistance and reactance per unit of length of copper cables

S [mm²]	single-core cable r[Ω/km] @ 80 [°C]	single-core cable x[Ω/km]	two-core/three-core cable r[Ω/km] @ 80 [°C]	two-core/three-core cable x[Ω/km]
1.5	14.8	0.168	15.1	0.118
2.5	8.91	0.156	9.08	0.109
4	5.57	0.143	5.68	0.101
6	3.71	0.135	3.78	0.0955
10	2.24	0.119	2.27	0.0861
16	1.41	0.112	1.43	0.0817
25	0.889	0.106	0.907	0.0813
35	0.641	0.101	0.654	0.0783
50	0.473	0.101	0.483	0.0779
70	0.328	0.0965	0.334	0.0751
95	0.236	0.0975	0.241	0.0762
120	0.188	0.0939	0.191	0.074
150	0.153	0.0928	0.157	0.0745
185	0.123	0.0908	0.125	0.0742
240	0.0943	0.0902	0.0966	0.0752
300	0.0761	0.0895	0.078	0.075

جدول ۲-۱۹ مقاومت و راکتانس واحد طول کابل‌های مسی

Table 2: Resistance and reactance per unit of length of aluminium cables

S [mm²]	single-core cable r[Ω/km] @ 80 [°C]	single-core cable x[Ω/km]	two-core/three-core cable r[Ω/km] @ 80 [°C]	two-core/three-core cable x[Ω/km]
1.5	24.384	0.168	24.878	0.118
2.5	14.680	0.156	14.960	0.109
4	9.177	0.143	9.358	0.101
6	6.112	0.135	6.228	0.0955
10	3.691	0.119	3.740	0.0861
16	2.323	0.112	2.356	0.0817
25	1.465	0.106	1.494	0.0813
35	1.056	0.101	1.077	0.0783
50	0.779	0.101	0.796	0.0779
70	0.540	0.0965	0.550	0.0751
95	0.389	0.0975	0.397	0.0762
120	0,310	0.0939	0.315	0.074
150	0.252	0.0928	0.259	0.0745
185	0.203	0.0908	0.206	0.0742
240	0.155	0.0902	0.159	0.0752
300	0.125	0.0895	0.129	0.075

جدول ۲-۲۰ مقاومت و راکتانس واحد طول کابل‌های آلومنیومی

Table 3: Specific voltage drop at cosφ = 1 for copper cables

	cosφ = 1			
	single-core cable		two-core cable	three-core cable
S[mm²]	single-phase	three-phase	single-phase	three-phase
1.5	29.60	25.63	30.20	26.15
2.5	17.82	15.43	18.16	15.73
4	11.14	9.65	11.36	9.84
6	7.42	6.43	7.56	6.55
10	4.48	3.88	4.54	3.93
16	2.82	2.44	2.86	2.48
25	1.78	1.54	1.81	1.57
35	1.28	1.11	1.31	1.13
50	0.95	0.82	0.97	0.84
70	0.66	0.57	0.67	0.58
95	0.47	0.41	0.48	0.42
120	0.38	0.33	0.38	0.33
150	0.31	0.27	0.31	0.27
185	0.25	0.21	0.25	0.22
240	0.19	0.16	0.19	0.17
300	0.15	0.13	0.16	0.14

جدول ۲-۲۱ افت ولتاژ مشخصه کابل‌های مسی در ضریب قدرت واحد

Table 4: Specific voltage drop at cosφ = 0.9 for copper cables

	cosφ = 9			
	single-core cable		two-core cable	three-core cable
S[mm²]	single-phase	three-phase	single-phase	three-phase
1.5	26.79	23.20	27.28	23.63
2.5	16.17	14.01	16.44	14.24
4	10.15	8.79	10.31	8.93
6	6.80	5.89	6.89	5.96
10	4.14	3.58	4.16	3.60
16	2.64	2.28	2.65	2.29
25	1.69	1.47	1.70	1.48
35	1.24	1.08	1.25	1.08
50	0.94	0.81	0.94	0.81
70	0.67	0.58	0.67	0.58
95	0.51	0.44	0.50	0.43
120	0.42	0.36	0.41	0.35
150	0.36	0.31	0.35	0.30
185	0.30	0.26	0.29	0.25
240	0.25	0.22	0.24	0.21
300	0.22	0.19	0.21	0.18

جدول ۲-۲۲ افت ولتاژ مشخصه کابل‌های مسی در ضریب قدرت ۰.۹

Table 5: Specific voltage drop at cosφ = 0.85 for copper cables

	cosφ = 0.85			
	single-core cable		two-core cable	three-core cable
S[mm²]	single-phase	three-phase	single-phase	three-phase
1.5	25.34	21.94	25.79	22.34
2.5	15.31	13.26	15.55	13.47
4	9.62	8.33	9.76	8.45
6	6.45	5.59	6.53	5.65
10	3.93	3.41	3.95	3.42
16	2.51	2.18	2.52	2.18
25	1.62	1.41	1.63	1.41
35	1.20	1.04	1.19	1.03
50	0.91	0.79	0.90	0.78
70	0.66	0.57	0.65	0.56
95	0.50	0.44	0.49	0.42
120	0.42	0.36	0.40	0.35
150	0.36	0.31	0.35	0.30
185	0.30	0.26	0.29	0.25
240	0.26	0.22	0.24	0.21
300	0.22	0.19	0.21	0.18

جدول ۲-۲۳ افت ولتاژ مشخصه کابل‌های مسی در ضریب قدرت ۰.۸۵

Table 6: Specific voltage drop at cosφ = 0.8 for copper cables

	cosφ = 0.8			
	single-core cable		two-core cable	three-core cable
S[mm²]	single-phase	three-phase	single-phase	three-phase
1.5	23.88	20.68	24.30	21.05
2.5	14.44	12.51	14.66	12.69
4	9.08	7.87	9.21	7.98
6	6.10	5.28	6.16	5.34
10	3.73	3.23	3.74	3.23
16	2.39	2.07	2.39	2.07
25	1.55	1.34	1.55	1.34
35	1.15	0.99	1.14	0.99
50	0.88	0.76	0.87	0.75
70	0.64	0.55	0.62	0.54
95	0.49	0.43	0.48	0.41
120	0.41	0.36	0.39	0.34
150	0.36	0.31	0.34	0.29
185	0.31	0.26	0.29	0.25
240	0.26	0.22	0.24	0.21
300	0.23	0.20	0.21	0.19

جدول ۲-۲۴ افت ولتاژ مشخصه کابل‌های مسی در ضریب قدرت ۰.۸

Table 7: Specific voltage drop at cosφ=0.75 for copper cables

	cosφ = 0.75			
	single-core cable		two-core cable	three-core cable
S[mm²]	single-phase	three-phase	single-phase	three-phase
1.5	22.42	19.42	22.81	19.75
2.5	13.57	11.75	13.76	11.92
4	8.54	7.40	8.65	7.49
6	5.74	4.97	5.80	5.02
10	3.52	3.05	3.52	3.05
16	2.26	1.96	2.25	1.95
25	1.47	1.28	1.47	1.27
35	1.10	0.95	1.08	0.94
50	0.84	0.73	0.83	0.72
70	0.62	0.54	0.60	0.52
95	0.48	0.42	0.46	0.40
120	0.41	0.35	0.38	0.33
150	0.35	0.31	0.33	0.29
185	0.30	0.26	0.29	0.25
240	0.26	0.23	0.24	0.21
300	0.23	0.20	0.22	0.19

جدول ۲-۲۵ افت ولتاژ مشخصه کابل‌های مسی در ضریب قدرت ۰.۷۵

Table 8: Specific voltage drop at cosφ = 1 for aluminium cables

	cosφ = 1			
	single-core cable		two-core cable	three-corecable
S[mm²]	single-phase	three-phase	single-phase	three-phase
1.5	48.77	42.23	49.76	43.09
2.5	29.36	25.43	29.92	25.91
4	18.35	15.89	18.72	16.21
6	12.22	10.59	12.46	10.79
10	7.38	6.39	7.48	6.48
16	4.65	4.02	4.71	4.08
25	2.93	2.54	2.99	2.59
35	2.11	1.83	2.15	1.87
50	1.56	1.35	1.59	1.38
70	1.08	0.94	1.10	0.95
95	0.78	0.67	0.79	0.69
120	0.62	0.54	0.63	0.55
150	0.50	0.44	0.52	0.45
185	0.41	0.35	0.41	0.36
240	0.31	0.27	0.32	0.28
300	0.25	0.22	0.26	0.22

جدول ۲-۲۶ افت ولتاژ مشخصه کابل‌های آلومینیومی در ضریب قدرت ۱

Table 9: Specific voltage drop at cosφ = 0.9 for aluminium cables

	cosφ = 0.9			
	single-core cable		two-core cable	three-core cable
S[mm²]	single-phase	three-phase	single-phase	three-phase
1.5	44.04	38.14	44.88	38.87
2.5	26.56	23.00	27.02	23.40
4	16.64	14.41	16.93	14.66
6	11.12	9.63	11.29	9.78
10	6.75	5.84	6.81	5.89
16	4.28	3.71	4.31	3.73
25	2.73	2.36	2.76	2.39
35	1.99	1.72	2.01	1.74
50	1.49	1.29	1.50	1.30
70	1.06	0.92	1.06	0.91
95	0.78	0.68	0.78	0.68
120	0.64	0.55	0.63	0.55
150	0.53	0.46	0.53	0.46
185	0.44	0.38	0.44	0.38
240	0.36	0.31	0.35	0.30
300	0.30	0.26	0.30	0.26

جدول ۲-۲۷ افت ولتاژ مشخصه کابل‌های آلومینیومی در ضریب قدرت ۰.۹

Table 10: Specific voltage drop at cosφ = 0.85 for aluminium cables

	cosφ = 0.85			
	single-core cable		two-core cable	three-core cable
S[mm²]	single-phase	three-phase	single-phase	three-phase
1.5	41.63	36.05	42.42	36.73
2.5	25.12	21.75	25.55	22.12
4	15.75	13.64	16.02	13.87
6	10.53	9.12	10.69	9.26
10	6.40	5.54	6.45	5.58
16	4.07	3.52	4.09	3.54
25	2.60	2.25	2.63	2.27
35	1.90	1.65	1.91	1.66
50	1.43	1.24	1.43	1.24
70	1.02	0.88	1.01	0.88
95	0.76	0.66	0.76	0.65
120	0.63	0.54	0.61	0.53
150	0.53	0.46	0.52	0.45
185	0.44	0.38	0,43	0.37
240	0.36	0.31	0.35	0.30
300	0.31	0.27	0.30	0.26

جدول ۲-۲۸ افت ولتاژ مشخصه کابل‌های آلومینیومی در ضریب قدرت ۰.۸

Table 11: Specific voltage drop at cosφ = 0.8 for aluminium cables

	cosφ = 0.8			
	single-core cable		two-core cable	three-core cable
S[mm²]	single-phase	three-phase	single-phase	three-phase
1.5	39.22	33.96	39.95	34.59
2.5	23.67	20.50	24.07	20.84
4	14.85	12.86	15.09	13.07
6	9.94	8.61	10.08	8.73
10	6.05	5.24	6.09	5.27
16	3.85	3.34	3.87	3.35
25	2.47	2.14	2.49	2.16
35	1.81	1.57	1.82	1.57
50	1.37	1.18	1.37	1.18
70	0.98	0.85	0.97	0.84
95	0.74	0.64	0.73	0.63
120	0.61	0.53	0.59	0.51
150	0.51	0.45	0.50	0.44
185	0.43	0.38	0.42	0.36
240	0.36	0.31	0.34	0.30
300	0.31	0.27	0.30	0.26

جدول ۲-۲۹ افت ولتاژ مشخصه کابل‌های آلومینیومی در ضریب قدرت

Table 12: Specific voltage drop at cosφ = 0.75 for aluminium cables

	cosφ = 0.75			
	single-core cable		two-core cable	three-core cable
S[mm²]	single-phase	three-phase	single-phase	three-phase
1.5	36.80	31.87	37.47	32.45
2.5	22.23	19.25	22.58	19.56
4	13.95	12.08	14.17	12.27
6	9.35	8.09	9.47	8.20
10	5.69	4.93	5.72	4.96
16	3.63	3.15	3.64	3.15
25	2.34	2.02	2.35	2.03
35	1.72	1.49	1.72	1.49
50	1.30	1.13	1.30	1.12
70	0.94	0.81	0.92	0.80
95	0.71	0.62	0.70	0.60
120	0.59	0.51	0.57	0.49
150	0.50	0.43	0.49	0.42
185	0.42	0.37	0.41	0.35
240	0.35	0.31	0.34	0.29
300	0.31	0.27	0.29	0.25

جدول ۲-۳۰ افت ولتاژ مشخصه کابل‌های آلومینیومی در ضریب قدرت ۰.۷۵

Table 1: Resistance values [Ω/km] of single-core and multi-core cables in copper and aluminium at 80 °C

	Single-core cable		Two-core/three-core cable	
S [mm²]	Cu	Al	Cu	Al
1.5	14.8	24.384	15.1	24.878
2.5	8.91	14.680	9.08	14.960
4	5.57	9.177	5.68	9.358
6	3.71	6.112	3.78	6.228
10	2.24	3.691	2.27	3.740
16	1.41	2.323	1.43	2.356
25	0.889	1.465	0.907	1.494
35	0.641	1.056	0.654	1.077
50	0.473	0.779	0.483	0.796
70	0.328	0.540	0.334	0.550
95	0.236	0.389	0.241	0.397
120	0.188	0.310	0.191	0.315
150	0.153	0.252	0.157	0.259
185	0.123	0.203	0.125	0.206
240	0.0943	0.155	0.0966	0.159
300	0.0761	0.125	0.078	0.129

جدول ۲-۳۱ مقاومت واحد طول کابل‌های تک و چند هسته‌ای مسی و آلومینیومی در دما ۸۰ درجه

Table 1: Values of k for phase conductor

	Conductor insulation					
	PVC ≤300 mm²	PVC >300 mm²	EPR XLPE	Rubber 60 °C	Mineral	
					PVC	Bare
Initial temperature °C	70	70	90	60	70	105
Final temperature °C	160	140	250	200	160	250
Material of conductor:						
Copper	115	103	143	141	115	135/115 [a]
Aluminium	76	68	94	93	-	-
tin-soldered joints in copper conductors	115	-	-	-	-	-

[a] This value shall be used for bare cables exposed to touch.

NOTE 1 Other values of k are under consideration for.
- small conductors (particularly for cross section less than 10 mm²);
- duration of short-circuit exceeding 5 s;
- other types of joints in conductors;
- bare conductors.

NOTE 2 The nominal current of the short-circuit protective device may be greater than the current carrying capacity of the cable.

NOTE 3 The above factors are based on IEC 60724.

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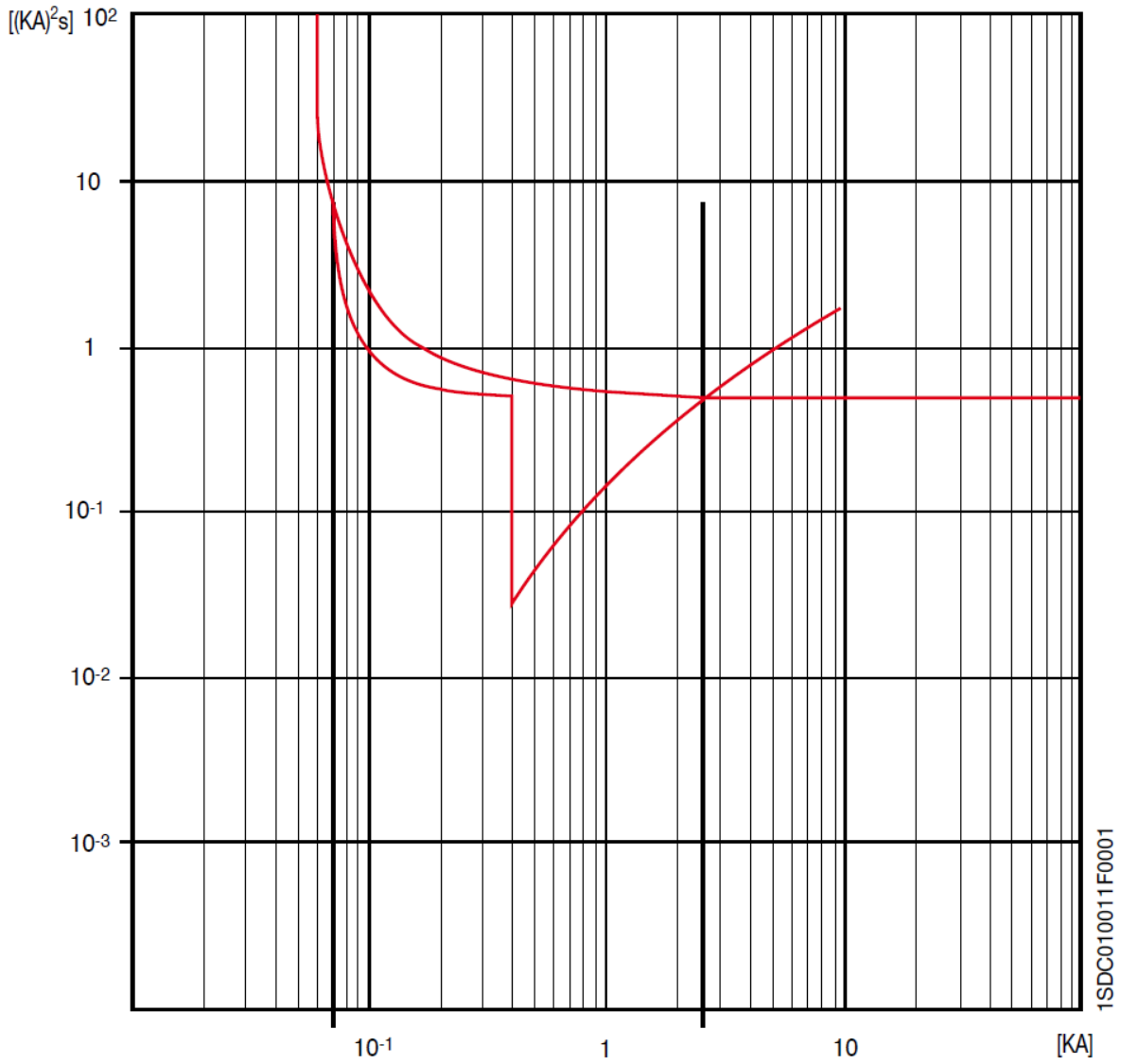
جدول ۲-۳۲ مقادیر K برای هادی‌های مختلف

Table 2: Maximum withstood energy for cables $k^2 S^2$ [$(kA)^2$ s]

			Cross section [mm²]							
Cable		**k**	1.5	2.5	4	6	10	16	25	35
PVC	Cu	115	$2.98\cdot10^{-2}$	$8.27\cdot10^{-2}$	$2.12\cdot10^{-1}$	$4.76\cdot10^{-1}$	1.32	3.39	8.27	$1.62\cdot10^{1}$
	Al	76	$1.30\cdot10^{-2}$	$3.61\cdot10^{-2}$	$9.24\cdot10^{-2}$	$2.08\cdot10^{-1}$	$5.78\cdot10^{-1}$	1.48	3.61	7.08
EPR/XLPE	Cu	143	$4.60\cdot10^{-2}$	$1.28\cdot10^{-1}$	$3.27\cdot10^{-1}$	$7.36\cdot10^{-1}$	2.04	5.23	$1.28\cdot10^{1}$	$2.51\cdot10^{1}$
	Al	94	$1.99\cdot10^{-2}$	$5.52\cdot10^{-2}$	$1.41\cdot10^{-1}$	$3.18\cdot10^{-1}$	$8.84\cdot10^{-1}$	2.26	5.52	$1.08\cdot10^{1}$
Rubber	Cu	141	$4.47\cdot10^{-2}$	$1.24\cdot10^{-1}$	$3.18\cdot10^{-1}$	$7.16\cdot10^{-1}$	1.99	5.09	$1.24\cdot10^{1}$	$2.44\cdot10^{1}$
	Al	93	$1.95\cdot10^{-2}$	$5.41\cdot10^{-2}$	$1.38\cdot10^{-1}$	$3.11\cdot10^{-1}$	$8.65\cdot10^{-1}$	2.21	5.41	$1.06\cdot10^{1}$

			Cross section [mm²]							
Cable		**k**	50	70	95	120	150	185	240	300
PVC	Cu	115	$3.31\cdot10^{1}$	$6.48\cdot10^{1}$	$1.19\cdot10^{2}$	$1.90\cdot10^{2}$	$2.98\cdot10^{2}$	$4.53\cdot10^{2}$	$7.62\cdot10^{2}$	$1.19\cdot10^{3}$
	Al	76	$1.44\cdot10^{1}$	$2.83\cdot10^{1}$	$5.21\cdot10^{1}$	$8.32\cdot10^{1}$	$1.30\cdot10^{2}$	$1.98\cdot10^{2}$	$3.33\cdot10^{2}$	$5.20\cdot10^{2}$
EPR/XLPE	Cu	143	$5.11\cdot10^{1}$	$1.00\cdot10^{1}$	$1.85\cdot10^{1}$	$2.94\cdot10^{2}$	$4.60\cdot10^{2}$	$7.00\cdot10^{2}$	$1.18\cdot10^{3}$	$1.84\cdot10^{3}$
	Al	94	$2.21\cdot10^{1}$	$4.33\cdot10^{1}$	$7.97\cdot10^{1}$	$1.27\cdot10^{2}$	$1.99\cdot10^{2}$	$3.02\cdot10^{2}$	$5.09\cdot10^{2}$	$7.95\cdot10^{2}$
G2	Cu	141	$4.97\cdot10^{1}$	$9.74\cdot10^{1}$	$1.79\cdot10^{1}$	$2.86\cdot10^{2}$	$4.47\cdot10^{2}$	$6.80\cdot10^{2}$	$1.15\cdot10^{3}$	$1.79\cdot10^{3}$
	Al	93	$2.16\cdot10^{1}$	$4.24\cdot10^{1}$	$7.81\cdot10^{1}$	$1.25\cdot10^{2}$	$1.95\cdot10^{2}$	$2.96\cdot10^{2}$	$4.98\cdot10^{2}$	$7.78\cdot10^{2}$

جدول ۲-۳۳ ماکزیمم انرژی قابل تحمل کابل‌ها $K^2 S^2$ برحسب [kA^2 .sec]



شکل ۲-۸ منحنی انرژی قابل تحمل کابل و کلید اتوماتیک

S[mm²]	120	150	185	240	300
k_{sec}	0.9	0.85	0.80	0.75	0.72

جدول ۲-۳۴ ضریب تصحیح K_{sec}

number of parallel conductors	2	3	4	5
k_{par}*	2	2.7	3	3.2

*k_{par} = 4 (n-1)/n where: n = number of conductors in parallel per phase

جدول ۲-۳۵ ضریب تصحیح K_{par}

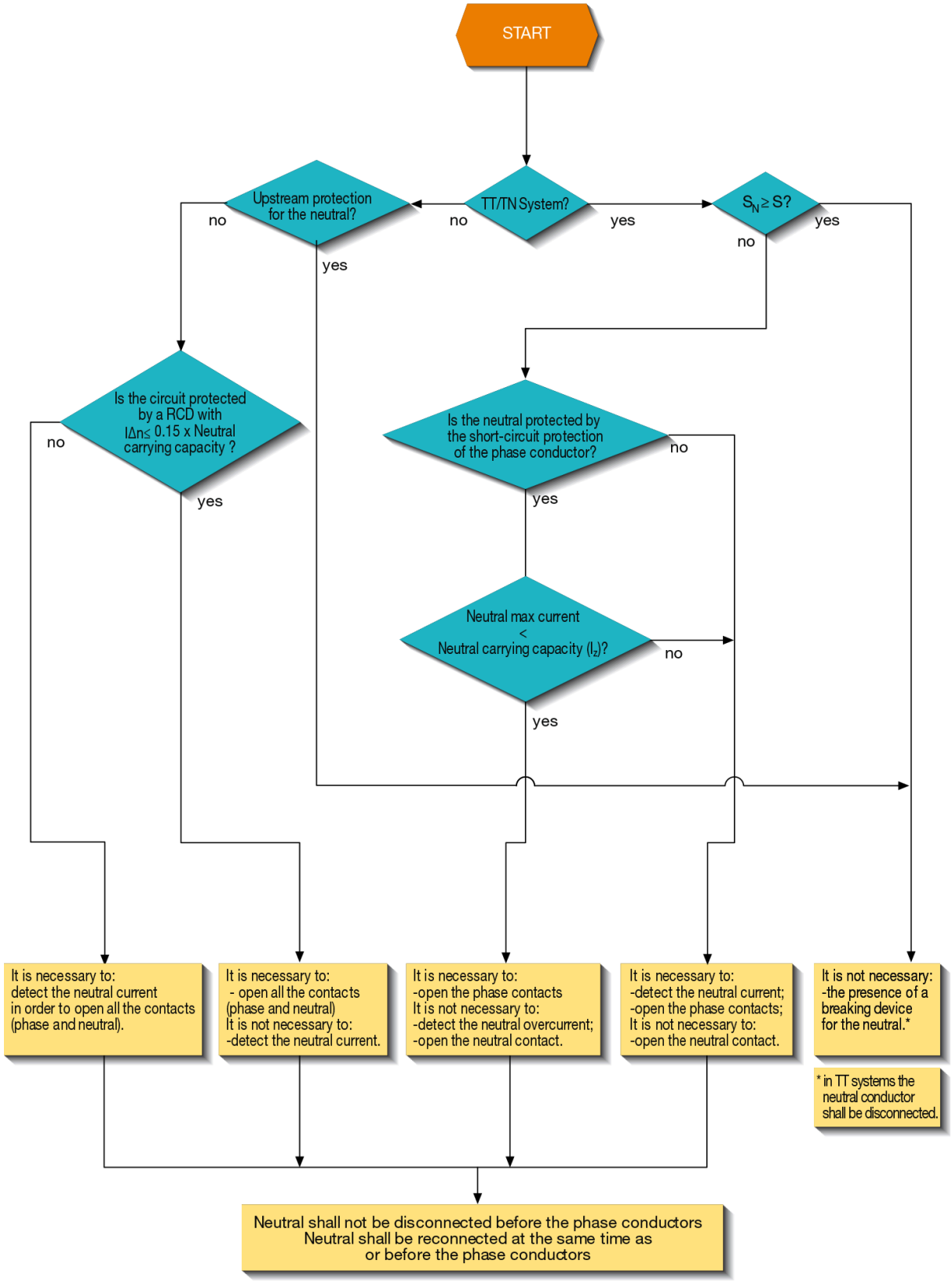
U_r [V] (three-phase value)	k_v
230(*)	0.58
400	1
440	1.1
500	1.25
690	1.73

جدول ۲-۳۶ ضریب K_v

Table 3: Maximum protected length

I_3[A]	section [mm²] 1.5	2.5	4	6	10	16	25	35	50	70	95	120	150	185	240	300
20	370	617														
30	246	412	658													
40	185	309	494	741												
50	148	247	395	593												
60	123	206	329	494												
70	105	176	282	423	705											
80	92	154	246	370	617											
90	82	137	219	329	549											
100	74	123	197	296	494	790										
120	61	102	164	246	412	658										
140	52	88	141	211	353	564										
150	49	82	131	197	329	527										
160	46	77	123	185	309	494	772									
180	41	68	109	164	274	439	686									
200	37	61	98	148	247	395	617									
220	33	56	89	134	224	359	561	786								
250	29	49	79	118	198	316	494	691								
280	26	44	70	105	176	282	441	617								
300	24	41	65	98	165	263	412	576								
320	23	38	61	92	154	247	386	540	772							
350	21	35	56	84	141	226	353	494	705							
380	19	32	52	78	130	208	325	455	650							
400	18	30	49	74	123	198	309	432	617							
420	17	29	47	70	118	188	294	412	588							
450	16	27	43	65	110	176	274	384	549	768						
480	15	25	41	61	103	165	257	360	514	720						
500	14	24	39	59	99	158	247	346	494	691						
520	14	23	38	57	95	152	237	332	475	665						
550	13	22	35	53.	90	144	224	314	449	629						
580	12	21	34	51	85	136	213	298	426	596	809					
600	12	20	32	49	82	132	206	288	412	576	782					
620	11	19	31	47	80	127	199	279	398	558	757					
650	11	19	30	45	76	122	190	266	380	532	722					
680	10	18	29	43	73	116	182	254	363	508	690					
700	10	17	28	42	71	113	176	247	353	494	670	847				
750		16	26	39	66	105	165	230	329	461	626	790	840			
800		15	24	37	62	99	154	216	309	432	586	667	787			
850		14	23	34	58	93	145	203	290	407	552	627	741			
900		13	21	32	55	88	137	192	274	384	521	593	700			
950		13	20	31	52	83	130	182	260	364	494	561	663			
1000		12	19	29	49	79	123	173	247	346	469	533	630	731		
1250			15	23	40	63	99	138	198	277	375	427	504	585	711	
1500			13	19	33	53	82	115	165	230	313	356	420	487	593	
1600			12	18	31	49	77	108	154	216	293	333	394	457	556	667
2000				14	25	40	62	86	123	173	235	267	315	365	444	533
2500				11	20	32	49	69	99	138	188	213	252	292	356	427
3000					16	26	41	58	82	115	156	178	210	244	296	356
3200					15	25	39	54	77	108	147	167	197	228	278	333
4000					12	20	31	43	62	86	117	133	157	183	222	267
5000					10	16	25	35	49	69	94	107	126	146	178	213
6300						13	20	27	39	55	74	85	100	116	141	169
8000						10	15	22	31	43	59	67	79	91	111	133
9600							13	18	26	36	49	56	66	76	93	111
10000							12	17	25	35	47	53	63	73	89	107
12000							10	14	21	29	39	44	52	61	74	89
15000								12	16	23	31	36	42	49	59	71
20000									12	17	23	27	31	37	44	53
24000									10	14	20	22	26	30	37	44
30000										12	16	20	25	30	40	49

جدول ۲-۳۷ حداکثر طول قابل حفاظت توسط کلیدهای اتوماتیک



شکل ۲-۱۳ فلوچارت تصمیم‌گیری در مورد نصب حفاظت و قطع‌کننده روی هادی نول

Table 1: Minimum cross sections of the neutral conductor

	Phase cross section S [mm²]	Min. neutral cross section S_N [mm²]
Single-phase/two-phase circuits		
Cu/Al	Any	S*
Three-phase circuits	S ≤ 16	S*
Cu	S > 16	16
Three-phase circuits	S ≤ 25	S*
Al	S > 25	25

*for TN-C systems, the Standards specify a minimum cross section of 10 mm² for copper and 16 mm² for aluminium conductors

شکل ۴۳- جدول ۲-۳۸ حداقل سطح مقطع سیم نول در مدارهای مختلف

Table 2: Cross section of the protective conductor

Cross section of line conductor S [mm²]	Minimum cross section of the corresponding protective conductor [mm²]	
	If the protective conductor is of the same material as the line conductor	If the protective conductor is not of the same material as the line conductor
S ″ 16	S	$\frac{k_1}{k_2} \cdot S$
16 < S ″ 35	16*	$\frac{k_1}{k_2} \cdot 16$
S > 35	$\frac{S^*}{2}$	$\frac{k_1}{k_2} \cdot \frac{S}{2}$

Where

k_1 is the value of k for the line conductor, selected from Table 1 Chapter 1.4 according to the materials of the conductor and insulation;

k_2 is the value of k for the protective conductor.

* For a PEN conductor, the reduction of the cross section is permitted only in accordance with the rules for sizing of the neutral conductor.

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جدول ۲-۳۹ سطح مقطع هادی ارت

Table 3: Values of *k* for insulated protective conductors not incorporated in cables and not bunched with other cables

Conductor insulation	Temperature °C [b]		Material of conductor		
			Copper	Aluminium	Steel
	Initial	Final	Values for k		
70 °C PVC	30	160/140 [a]	143/133 [a]	95/88 [a]	52/49 [a]
90 °C PVC	30	143/133 [a]	143/133 [a]	95/88 [a]	52/49 [a]
90 °C thermosetting	30	250	176	116	64
60 °C rubber	30	200	159	105	58
85 °C rubber	30	220	168	110	60
Silicon rubber	30	350	201	133	73

[a] The lower value applies to PVC insulated conductors of cross section greater than 300 mm^2.
[b] Temperature limits for various types of insulation are given in IEC 60724.

جدول ۲-۴۰ مقدار ضریب K برای هادی ارت ایزوله که جزو مجموعه هادی‌های فاز یا در کنار آنها کشیده نشده باشد.

Table 4: Values of *k* for protective conductors as a core incorporated in a cable or bunched with other cables or insulated conductors

Conductor insulation	Temperature °C [b]		Material of conductor		
			Copper	Aluminium	Steel
	Initial	Final	Values for k		
70 °C PVC	70	160/140 [a]	115/103 [a]	76/68 [a]	42/37 [a]
90 °C PVC	90	160/140 [a]	100/86 [a]	66/57 [a]	36/31 [a]
90 °C thermosetting	90	250	143	94	52
60 °C rubber	60	200	141	93	51
85 °C rubber	85	220	134	89	48
Silicon rubber	180	350	132	87	47

[a] The lower value applies to PVC insulated conductors of cross section greater than 300 mm^2.
[b] Temperature limits for various types of insulation are given in IEC 60724.

جدول ۲-۴۱ ضریب K برای هنگامی که هادی ارت یکی از هسته‌های کابل اصلی بوده یا کابل مستقلی در کنار آن باشد.

Table 1: Correction factor k_t for ambient temperature other than 40 °C

Ambient Temperature [°C]	15	20	25	30	35	40	45	50
k_t	1.2	1.17	1.12	1.08	1.05	1	0.95	0.85

جدول ۲-۴۲ ضریب تصحیح k_t برای دمای محیط غیر از ۴۰ درجه

Table 2: Current carrying capacity I_{Z0} of copper BTS

Size	Generic type	Number of conductors	I_{Z0} [A]	r_{ph}* [mΩ/m]	x_{ph} [mΩ/m]	U_r [V]
25	25A 4 cond. Cu	4	25	6.964	1.144	400
25	25A 4 cond. Cu	4	25	6.876	1.400	400
25	25A 4+4 cond. Cu	4+4	25	6.876	1.400	400
40	40A 4 cond. Cu	4	40	3.556	0.792	400
40	40A 4 cond. Cu	4	40	3.516	1.580	400
40	40A 4+4 cond. Cu	4+4	40	3.516	1.580	400
40	40A 4 cond. Cu	4	40	2.173	0.290	400
63	63A 4 cond. Cu	4	63	1.648	0.637	400
100	100A 4 cond. Cu	4	100	0.790	0.366	400
160	160A 4 cond. Cu	4	160	0.574	0.247	400
160	160A 4 cond. Cu	4	160	0.335	0.314	500
160	160A 5 cond. Cu	5	160	0.335	0.314	500
250	250A 4 cond. Cu	4	250	0.285	0.205	1000
250	250A 5 cond. Cu	5	250	0.285	0.205	1000
250	250A 4 cond. Cu	4	250	0.194	0.205	500
250	250A 5 cond. Cu	5	250	0.194	0.205	500
315	315A 4 cond. Cu	4	315	0.216	0.188	1000
315	315A 5 cond. Cu	5	315	0.216	0.188	1000
350	350A 4 cond. Cu	4	350	0.142	0.188	500
350	350A 5 cond. Cu	5	350	0.142	0.188	500
400	400A 4 cond. Cu	4	400	0.115	0.129	1000
400	400A 5 cond. Cu	5	400	0.115	0.129	1000
500	500A 4 cond. Cu	4	500	0.092	0.129	500
500	500A 5 cond. Cu	5	500	0.092	0.129	500
630	630A 4 cond. Cu	4	630	0.073	0.122	1000
630	630A 5 cond. Cu	5	630	0.073	0.122	1000
700	700A 4 cond. Cu	4	700	0.077	0.122	500
700	700A 5 cond. Cu	5	700	0.077	0.122	500
700	700A 5 cond. Cu	5	700	0.077	0.122	500
700	700A 4 cond. Cu	4	700	0.077	0.122	500

Size	Generic type	Number of conductors	I_{z0} [A]	r_{ph}* [mΩ/m]	x_{ph} [mΩ/m]	U_r [V]
800	800A 4 cond. Cu	4	800	0.047	0.122	1000
800	800A 5 cond. Cu	5	800	0.047	0.122	1000
800	800A 4 cond. Cu	4	800	0.038	0.027	1000
800	800A 4 cond. Cu	4	800	0.072	0.122	500
800	800A 5 cond. Cu	5	800	0.072	0.122	500
1000	1000A 4 cond. Cu	4	1000	0.038	0.120	1000
1000	1000A 5 cond. Cu	5	1000	0.038	0.120	1000
1000	1000A 4 cond. Cu	4	1000	0.037	0.026	1000
1000	1000A 4 cond. Cu	4	1000	0.038	0.097	1000
1000	1000A 4 cond. Cu	4	1000	0.068	0.120	500
1000	1000A 5 cond. Cu	5	1000	0.068	0.120	500
1200	1200A 4 cond. Cu	4	1200	0.035	0.021	1000
1250	1250A 4 cond. Cu	4	1250	0.034	0.023	1000
1250	1250A 4 cond. Cu	4	1250	0.035	0.076	1000
1500	1500A 4 cond. Cu	4	1500	0.030	0.022	1000
1600	1600A 4 cond. Cu	4	1600	0.025	0.018	1000
1600	1600A 4 cond. Cu	4	1600	0.034	0.074	1000
2000	2000A 4 cond. Cu	4	2000	0.020	0.015	1000
2000	2000A 4 cond. Cu	4	2000	0.025	0.074	1000
2400	2400A 4 cond. Cu	4	2400	0.019	0.012	1000
2500	2500A 4 cond. Cu	4	2500	0.016	0.011	1000
2500	2500A 4 cond. Cu	4	2500	0.019	0.040	1000
3000	3000A 4 cond. Cu	4	3000	0.014	0.011	1000
3000	3000A 4 cond. Cu	4	3000	0.017	0.031	1000
3200	3200A 4 cond. Cu	4	3200	0.013	0.009	1000
3200	3200A 4 cond. Cu	4	3200	0.015	0.031	1000
4000	4000A 4 cond. Cu	4	4000	0.011	0.007	1000
4000	4000A 4 cond. Cu	4	4000	0.011	0.026	1000
5000	5000A 4 cond. Cu	4	5000	0.008	0.005	1000
5000	5000A 4 cond. Cu	4	5000	0.008	0.023	1000

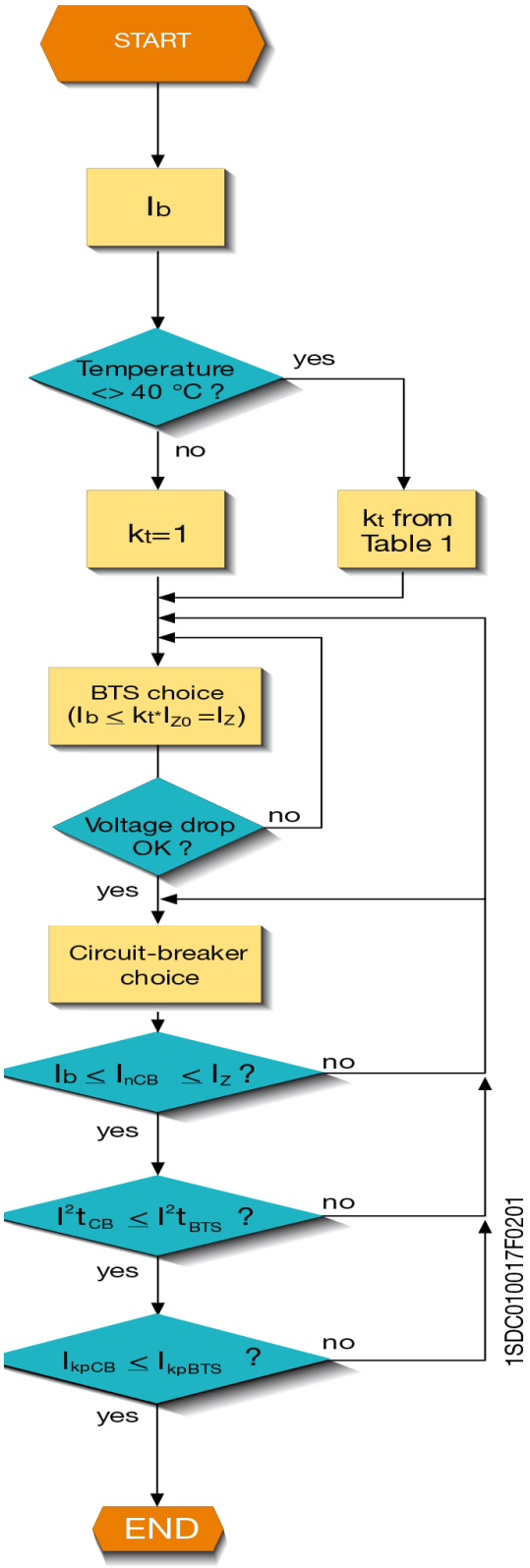
*phase resistance at I_{z0}

جدول ۲-۴۳ جریان مجاز I_{zo} برای BTS های مسی

Size	Generic type	Number of conductors	I_{z0} [A]	r_{ph}* [mΩ/m]	x_{ph} [mΩ/m]	U_r [V]
160	160A 4 cond. Al	4	160	0.591	0.260	1000
160	160A 5 cond. Al	5	160	0.591	0.260	1000
160	160A 4 cond. Al	4	160	0.431	0.260	500
160	160A 5 cond. Al	5	160	0.431	0.260	500
250	250A 4 cond. Al	4	250	0.394	0.202	1000
250	250A 5 cond. Al	5	250	0.394	0.202	1000
250	250A 4 cond. Al	4	250	0.226	0.202	500
250	250A 5 cond. Al	5	250	0.226	0.202	500
315	315A 4 cond. Al	4	315	0.236	0.186	1000
315	315A 5 cond. Al	5	315	0.236	0.186	1000
315	315A 4 cond. Al	4	315	0.181	0.186	500
315	315A 5 cond. Al	5	315	0.181	0.186	500
400	400A 4 cond. Al	4	400	0.144	0.130	1000
400	400A 5 cond. Al	5	400	0.144	0.130	1000
400	400A 4 cond. Al	4	400	0.125	0.130	500
400	400A 5 cond. Al	5	400	0.125	0.130	500
500	500A 4 cond. Al	4	500	0.102	0.127	500
500	500A 5 cond. Al	5	500	0.102	0.127	500
630	630A 4 cond. Al	4	630	0.072	0.097	1000
630	630A 5 cond. Al	5	630	0.072	0.097	1000
630	630A 4 cond. Al	4	630	0.072	0.029	1000
630	630A 4 cond. Al	4	630	0.073	0.097	500
630	630A 5 cond. Al	5	630	0.073	0.097	500
800	800A 4 cond. Al	4	800	0.062	0.096	1000
800	800A 5 cond. Al	5	800	0.062	0.096	1000
800	800A 4 cond. Al	4	800	0.067	0.027	1000
800	800A 4 cond. Al	4	800	0.071	0.096	500
800	800A 5 cond. Al	5	800	0.071	0.096	500
1000	1000A 4 cond. Al	4	1000	0.062	0.023	1000
1000	1000A 4 cond. Al	4	1000	0.068	0.087	1000
1200	1200A 4 cond. Al	4	1200	0.054	0.023	1000
1250	1250A 4 cond. Al	4	1250	0.044	0.021	1000
1250	1250A 4 cond. Al	4	1250	0.044	0.066	1000
1500	1500A 4 cond. Al	4	1500	0.041	0.023	1000
1600	1600A 4 cond. Al	4	1600	0.035	0.017	1000
1600	1600A 4 cond. Al	4	1600	0.041	0.066	1000
2000	2000A 4 cond. Al	4	2000	0.029	0.016	1000
2000	2000A 4 cond. Al	4	2000	0.034	0.053	1000
2250	2250A 4 cond. Al	4	2250	0.032	0.049	1000
2400	2400A 4 cond. Al	4	2400	0.028	0.012	1000
2500	2500A 4 cond. Al	4	2500	0.022	0.011	1000
2500	2500A 4 cond. Al	4	2500	0.022	0.034	1000
3000	3000A 4 cond. Al	4	3000	0.020	0.011	1000
3200	3200A 4 cond. Al	4	3200	0.017	0.009	1000
3200	3200A 4 cond. Al	4	3200	0.020	0.034	1000
4000	4000A 4 cond. Al	4	4000	0.014	0.008	1000
4000	4000A 4 cond. Al	4	4000	0.017	0.024	1000
4500	4500A 4 cond. Al	4	4500	0.014	0.024	1000

*phase resistance at I_{z0}

جدول ۲-۴۴ جریان مجاز I_{zo} برای BTS های آلومینیومی



شکل ۲-۱۴ مراحل انتخاب BTS

Size	Generic type	I^2t_{ph} [(kA)^{2}s]	I^2t_N [(kA)^{2}s]	I^2t_{PE} [(kA)^{2}s]	I_{peakph} [kA]	I_{peakN} [kA]
25	25A 4 cond. Cu	0.48	0.48	0.48	10	10
25	25A 4 cond. Cu	0.64	0.64	0.64	10	10
25	25A 4+4 cond. Cu	0.64	0.64	0.64	10	10
40	40A 4 cond. Cu	0.73	0.73	0.73	10	10
40	40A 4 cond. Cu	1	1	1	10	10
40	40A 4+4 cond. Cu	1	1	1	10	10
40	40A 4 cond. Cu	7.29	7.29	7.29	10	10
63	63A 4 cond. Cu	7.29	7.29	7.29	10	10
100	100A 4 cond. Cu	20.25	20.25	20.25	10	10
160	160A 4 cond. Cu	30.25	30.25	30.25	10	10
160	160A 4 cond. Cu	100	60	60	17	10.2
160	160A 5 cond. Cu	100	100	100	17	10.2
160	160A 4 cond. Cu	100	100	100	17	10.2
250	250A 4 cond. Cu	312.5	187.5	187.5	52.5	31.5
250	250A 5 cond. Cu	312.5	312.5	312.5	52.5	31.5
250	250A 4 cond. Cu	169	101.4	101.4	26	15.6
250	250A 5 cond. Cu	169	169	169	26	15.6
250	250A 4 cond. Cu	169	169	169	26	15.6
315	315A 4 cond. Cu	312.5	187.5	187.5	52.5	31.5
315	315A 5 cond. Cu	312.5	312.5	312.5	52.5	31.5
350	350A 4 cond. Cu	169	101.4	101.4	26	15.6
350	350A 5 cond. Cu	169	169	169	26	15.6
350	350A 4 cond. Cu	169	169	169	26	15.6
400	400A 4 cond. Cu	900	540	540	63	37.8
400	400A 5 cond. Cu	900	900	900	63	37.8
500	500A 4 cond. Cu	756.25	453.75	453.75	58	34.8
500	500A 5 cond. Cu	756.25	756.25	756.25	58	34.8
500	500A 4 cond. Cu	756.25	756.25	756.25	58	34.8
630	630A 4 cond. Cu	1296	777.6	777.6	75.6	45.4
630	630A 5 cond. Cu	1296	1296	1296	75.6	45.4
700	700A 4 cond. Cu	756.25	453.75	453.75	58	34.8
700	700A 5 cond. Cu	756.25	756.25	756.25	58	34.8
700	700A 4 cond. Cu	756.25	756.25	756.25	58	34.8

Size	Generic type	I^2t_{ph} [(kA)^{2}s]	I^2t_N [(kA)^{2}s]	I^2t_{PE} [(kA)^{2}s]	I_{peakph} [kA]	I_{peakN} [kA]
800	800A 4 cond. Cu	1296	777.6	777.6	75.6	45.4
800	800A 5 cond. Cu	1296	1296	1296	75.6	45.4
800	800A 4 cond. Cu	3969	3969	2381.4	139	83.4
800	800A 4 cond. Cu	756.25	453.75	453.75	58	34.8
800	800A 5 cond. Cu	756.25	756.25	756.25	58	34.8
800	800A 4 cond. Cu	756.25	756.25	756.25	58	34.8
1000	1000A 4 cond. Cu	1296	777.6	777.6	75.6	45.4
1000	1000A 5 cond. Cu	1296	1296	1296	75.6	45.4
1000	1000A 4 cond. Cu	3969	3969	2381.4	139	83.4
1000	1000A 4 cond. Cu	1600	1600	960	84	50.4
1000	1000A 4 cond. Cu	1024	614.4	614.4	60	36
1000	1000A 5 cond. Cu	1024	1024	1024	60	36
1000	1000A 4 cond. Cu	1024	1024	1024	60	36
1200	1200A 4 cond. Cu	7744	7744	4646.4	194	116.4
1250	1250A 4 cond. Cu	7744	7744	4646.4	194	116.4
1250	1250A 4 cond. Cu	2500	2500	1500	105	63
1500	1500A 4 cond. Cu	7744	7744	4646.4	194	116.4
1600	1600A 4 cond. Cu	7744	7744	4646.4	194	116.4
1600	1600A 4 cond. Cu	2500	2500	1500	105	63
2000	2000A 4 cond. Cu	7744	7744	4646.4	194	116.4
2000	2000A 4 cond. Cu	3600	3600	2160	132	79.2
2400	2400A 4 cond. Cu	7744	7744	4646.4	194	116.4
2500	2500A 4 cond. Cu	7744	7744	4646.4	194	116.4
2500	2500A 4 cond. Cu	4900	4900	2940	154	92.4
3000	3000A 4 cond. Cu	30976	30976	18585.6	387	232.2
3000	3000A 4 cond. Cu	8100	8100	4860	198	118.8
3200	3200A 4 cond. Cu	30976	30976	18585.6	387	232.2
3200	3200A 4 cond. Cu	8100	8100	4860	198	118.8
4000	4000A 4 cond. Cu	30976	30976	18585.6	387	232.2
4000	4000A 4 cond. Cu	8100	8100	4860	198	118.8
5000	5000A 4 cond. Cu	30976	30976	18585.6	387	232.2
5000	5000A 4 cond. Cu	10000	10000	6000	220	132

جدول ۲-۴۵ انرژی ماکزیمم قابل تحمل برای عبور از BTSهای مسی

Size	Generic type	I^2t_{ph} [(kA)^{2}s]	I^2t_N [(kA)^{2}s]	I^2t_{PE} [(kA)^{2}s]	I_{peakph} [kA]	I_{peakN} [kA]
160	160A 4 cond. Al	112.5	67.5	67.5	30	18
160	160A 5 cond. Al	112.5	112.5	112.5	30	18
160	160A 4 cond. Al	100	60	60	17	10.2
160	160A 5 cond. Al	100	100	100	17	10.2
160	160A 4 cond. Al	100	100	100	17	10.2
250	250A 4 cond. Al	312.5	187.5	187.5	52.5	31.5
250	250A 5 cond. Al	312.5	312.5	312.5	52.5	31.5
250	250A 4 cond. Al	169	101.4	101.4	26	15.6
250	250A 5 cond. Al	169	169	169	26	15.6
250	250A 4 cond. Al	169	169	169	26	15.6
315	315A 4 cond. Al	625	375	375	52.5	31.5
315	315A 5 cond. Al	625	625	625	52.5	31.5
315	315A 4 cond. Al	169	101.4	101.4	26	15.6
315	315A 5 cond. Al	169	169	169	26	15.6
315	315A 4 cond. Al	169	169	169	26	15.6
400	400A 4 cond. Al	900	540	540	63	37.8
400	400A 5 cond. Al	900	900	900	63	37.8
400	400A 4 cond. Al	625	375	375	52.5	31.5
400	400A 5 cond. Al	625	625	625	52.5	31.5
400	400A 4 cond. Al	625	625	625	52.5	31.5
500	500A 4 cond. Al	625	375	375	52.5	31.5
500	500A 5 cond. Al	625	625	625	52.5	31.5
500	500A 4 cond. Al	625	625	625	52.5	31.5
630	630A 4 cond. Al	1296	777.6	777.6	75.6	45.4
630	630A 5 cond. Al	1296	1296	1296	75.6	45.4
630	630A 4 cond. Al	1444	1444	866.4	80	48
630	630A 4 cond. Al	1024	614.4	614.4	67.5	40.5
630	630A 5 cond. Al	1024	1024	1024	67.5	40.5

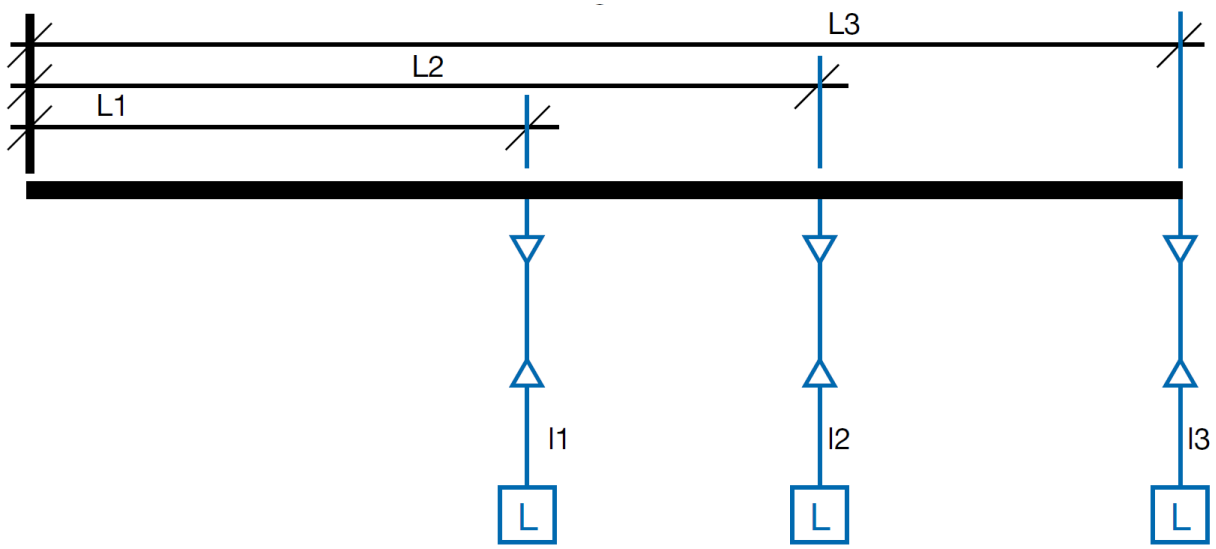
Size	Generic type	I^2t_{ph} [(kA)^{2}s]	I^2t_N [(kA)^{2}s]	I^2t_{PE} [(kA)^{2}s]	I_{peakph} [kA]	I_{peakN} [kA]
630	630A 4 cond. Al	1024	1024	1024	67.5	40.5
800	800A 4 cond. Al	1296	777.6	777.6	75.6	45.4
800	800A 5 cond. Al	1296	1296	1296	75.6	45.4
800	800A 4 cond. Al	1764	1764	1058.4	88	52.8
800	800A 4 cond. Al	1024	614.4	614.4	67.5	40.5
800	800A 5 cond. Al	1024	1024	1024	67.5	40.5
800	800A 4 cond. Al	1024	1024	1024	67.5	40.5
1000	1000A 4 cond. Al	6400	6400	3840	176	105.6
1000	1000A 4 cond. Al	1600	1600	960	84	50.4
1200	1200A 4 cond. Al	6400	6400	3840	176	105.6
1250	1250A 4 cond. Al	6400	6400	3840	176	105.6
1250	1250A 4 cond. Al	2500	2500	1500	105	63
1500	1500A 4 cond. Al	6400	6400	3840	176	105.6
1600	1600A 4 cond. Al	6400	6400	3840	176	105.6
1600	1600A 4 cond. Al	2500	2500	1500	105	63
2000	2000A 4 cond. Al	6400	6400	3840	176	105.6
2000	2000A 4 cond. Al	3600	3600	2160	132	79.2
2250	2250A 4 cond. Al	4900	4900	2940	154	92.4
2400	2400A 4 cond. Al	25600	25600	15360	352	211.2
2500	2500A 4 cond. Al	25600	25600	15360	352	211.2
2500	2500A 4 cond. Al	8100	8100	4860	198	118.8
3000	3000A 4 cond. Al	25600	25600	15360	352	211.2
3200	3200A 4 cond. Al	25600	25600	15360	352	211.2
3200	3200A 4 cond. Al	8100	8100	4860	198	118.8
4000	4000A 4 cond. Al	25600	25600	15360	352	211.2
4000	4000A 4 cond. Al	8100	8100	4860	198	118.8
4500	4500A 4 cond. Al	10000	10000	6000	220	132

جدول ۲-۴۶ انرژی ماکزیمم قابل تحمل برای عبور از BTSهای آلومنیومی

Table 6: Current distribution factor

Type of supply	Arrangement of loads	Current distribution factor
From one end only	Load concentrated at the end	1
	Evenly distributed load	0.5
From both ends	Evenly distributed load	0.25
Central	Load concentrated at the ends	0.25
	Evenly distributed load	0.125

جدول ۲-۴۷ ضریب توزیع جریان



شکل ۲-۱۵

	Length	Current	Losses
1° section	L_1	$I_1+I_2+I_3$	$P_1=3r_tL_1(I_1+I_2+I_3)^2$
2° section	L_2-L_1	I_2+I_3	$P_2=3r_t(L_2-L_1)(I_2+I_3)^2$
3° section	L_3-L_2	I_3	$P_3=3r_t(L_3-L_2)(I_3)^2$
Total losses in BTS			$P_{tot}=P_1+P_2+P_3$

جدول ۲-۴۸ نحوه محاسبات سکشن به سکشن تلفات در شکل ۲-۱۵

فصل سوم

Lamp type		Peak current	Inrush current	Turn-on time
Incandescent lamps		15In	–	–
Halogen lamps		15In	–	–
Fluorescent	Non PFC	–	2In	10 s
lamp	PFC	20In		1÷6 s
High intensity	Non PFC	–	2In	2÷8 min
discharge lamps	PFC	20In	2In	2÷8 min

جدول ۳-۱ جریان اولیه و جریان هجومی لامپ‌های مختلف

جدول ۳-۲ مشخصات ادوات حفاظت و سوئیچینگ برای لامپ‌های رشته‌ای و هالوژن

Table 1: Incandescent and halogen lamps

U_r= 400 V	I_k= 15 kA												
Incandescent/halogen lamps													
Circuit-breaker type		S200P D20	S200P D20	S200P D25	S200P D32	S200P D50		XT2N160 In63	XT2N160 In63	XT2N160 In100	XT2N160 In100	XT2N160 In100	XT2N160 In160
Setting Ekip LS/I		----	----	----	----	----		L= 0.68-12s S=8-0.1	L= 0.96-12s S=10-0.1	L= 0.68-12s S=8-0.1	L= 0.76-12s S=8-0.1	L= 0.96-12s S=10-0.1	L= 0.72-12s S=7-0.1
Contactor type		A26	A26	A26	A26	A30		A40	A50	A63	A75	A95	A110
Rated Power [W]	Rated current I_b [A]	N° lamps per phase											
60	0.27	57	65	70	103	142		155	220	246	272	355	390
100	0.45	34	38	42	62	85		93	132	147	163	210	240
200	0.91	17	19	20	30	42		46	65	73	80	105	120
300	1.37	11	12	13	20	28		30	43	48	53	70	80
500	2.28	6	7	8	12	16		18	26	29	32	42	48
1000	4.55	3	4	4	6	8		9	13	14	16	21	24

Table 2: Fluorescent lamps

U_r= 400 V	I_k= 15 kA													
Fluorescent lamps non PFC														
Circuit-breaker type		S200P D16	S200P D20	S200P D20	S200P D32	S200P D40			S200P D50	S200P D63	XT2N160 In100	XT2N160 In100	XT2N160 In100	XT2N160 In160
Setting Ekip LS/I											L= 0.68-12s S=10-0.1	L= 0.76-12s S=10-0.1	L= 0.96-12s S=10-0.1	L= 0.68-12s S=10-0.1
Contactor type		A26	A26	A26	A26	A30			A40	A50	A63	A75	A95	A110
Rated Power [W]	Rated current I_b [A]	N° lamps per phase												
20	0.38	40	44	50	73	100			110	157	173	192	250	278
40	0.45	33	37	42	62	84			93	133	145	162	210	234
65	0.7	21	24	27	40	54			60	85	94	104	135	150
80	0.8	18	21	23	35	47			52	75	82	91	118	132
100	1.15	13	14	16	24	33			36	52	57	63	82	92
110	1.2	12	14	15	23	31			35	50	55	60	79	88

جدول ۳-۳ مشخصات ادوات حفاظت و سوئیچینگ برای لامپ‌های فلورسنت

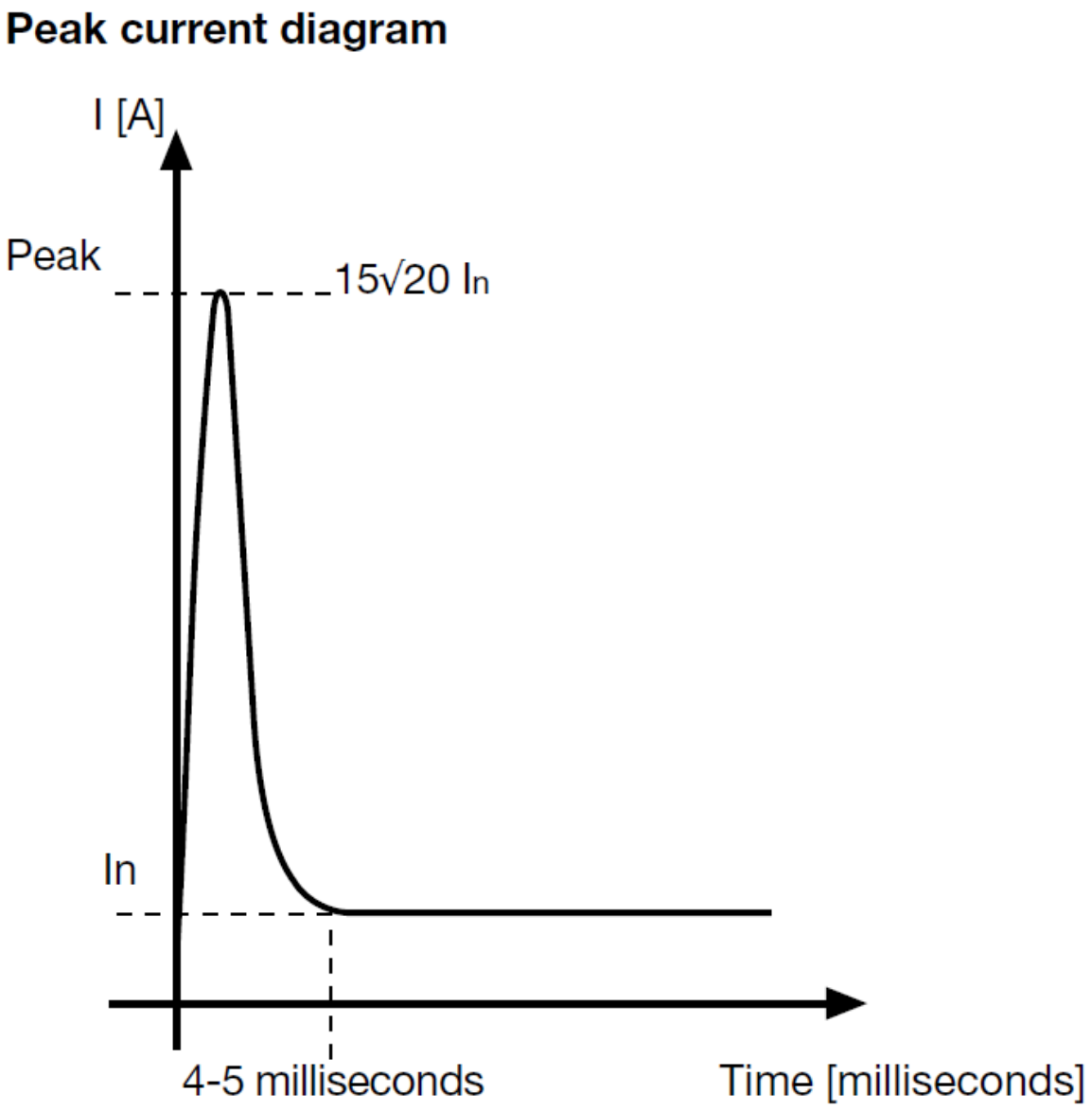
U_r= 400 V		I_k= 15 kA											
Fluorescent lamps PFC													
Circuit-breaker type			S200P D25	S200P D25	S200P D32		S200P D40	S200P D63	XT2N160 In63	XT2N160 In63	XT2N160 In100	XT2N160 In100	XT2N160 In100
Setting Ekip LS/I			---	---	---		---	---	L= 0.68-12s S=8-0.1	L= 1-12s S=10-0.1	L= 0.68-12s S=10-0.1	L= 0.76-12s S=10-0.1	L= 0.96-12s S=10-0.1
Contactor type			A26	A26	A26		A26	A30	A40	A50	A63	A75	A95
Rated Power [W]	Rated current I_b [A]	Capacitor [μF]	N° lamps per phase										
20	0.18	5	83	94	105		155	215	233	335	360	400	530
40	0.26	5	58	65	75		107	150	160	230	255	280	365
65	0.42	7	35	40	45		66	92	100	142	158	173	225
80	0.52	7	28	32	36		53	74	80	115	126	140	180
100	0.65	16	23	26	29		43	59	64	92	101	112	145
110	0.7	18	21	24	27		40	55	59	85	94	104	135

Table 3: High intensity discharge lamps

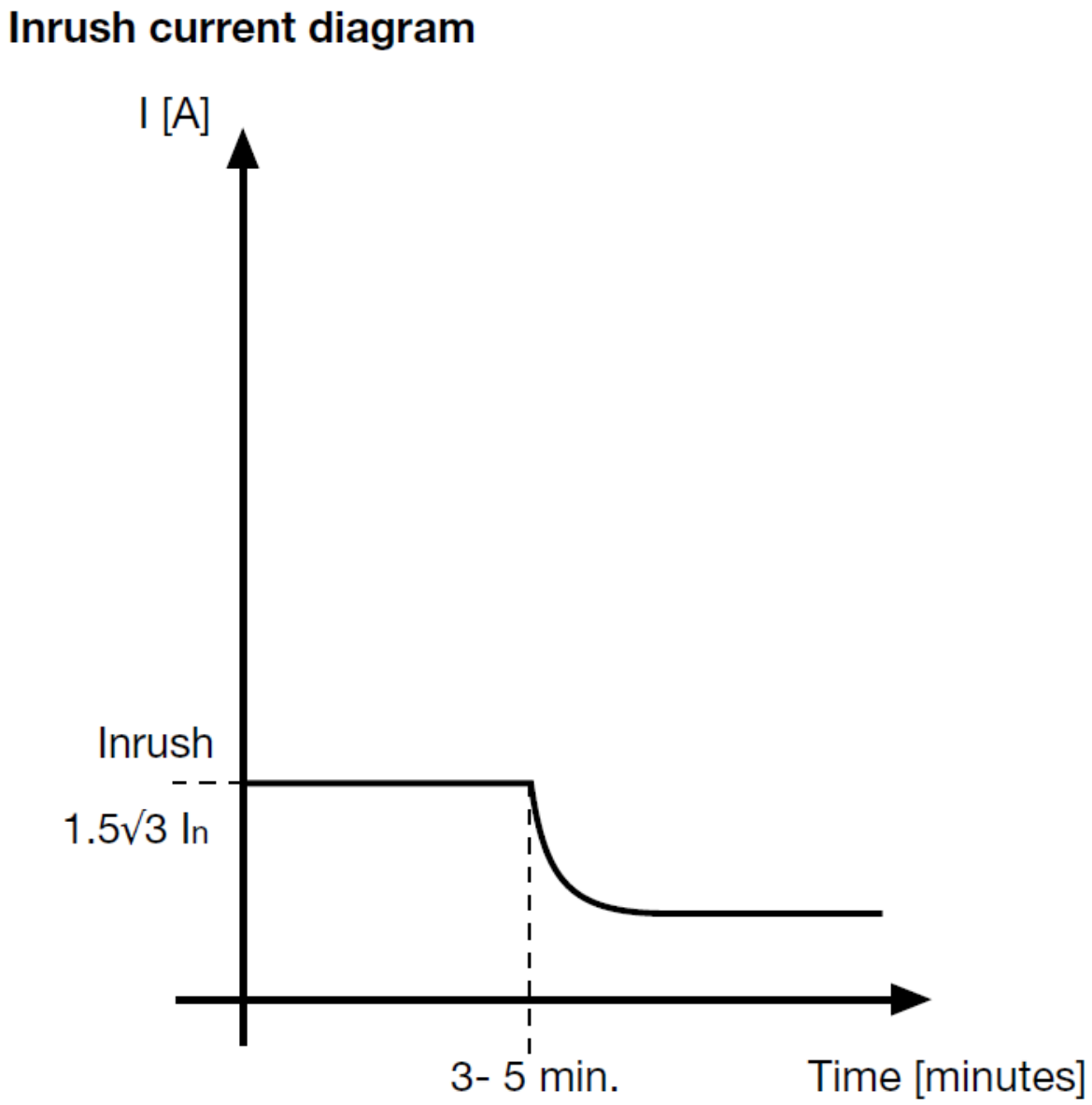
U_r= 400 V	I_k= 15 kA												
Fluorescent lamps non PFC													
Circuit-breaker type		S200P D16	S200P D20	S200P D20	S200P D32	S200P D40		S200P D40	S200P D50	S200P D63	XT2N160 In100	XT2N160 In100	XT2N160 In160
Setting Ekip LS/I											L=0.8-12s S=6.5-0.1s	L=1-12s S=8-0.1s	L=0.8-12s S=6.5-0.1s
Contactor type		A26	A26	A26	A26	A30		A40	A50	A63	A75	A95	A110
Rated Power [W]	Rated current I_b [A]	N° lamps per phase											
150	1.8	6	7	8	11	15		17	23	26	29	38	41
250	3	4	4	5	7	9		10	14	16	17	23	25
400	4.4	3	3	3	4	6		7	9	10	12	15	17
600	6.2	1	2	2	3	4		5	7	8	8	11	12
1000	10.3	-	1	1	2	3		3	4	5	5	6	7

جدول ۳-۴ مشخصات ادوات حفاظت و سوئیچینگ برای لامپ‌های تخلیه

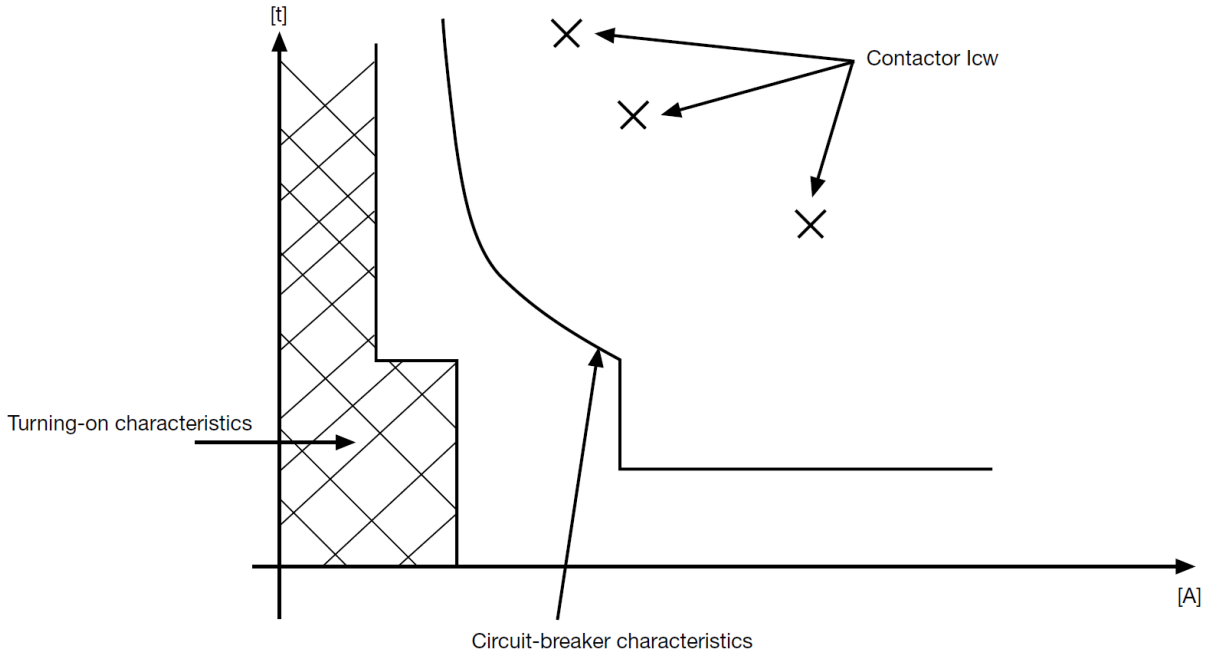
U_r= 400 V		I_k= 15 kA												
Fluorescent lamps PFC														
Circuit-breaker type			S200P D16	S200P D20	S200P D20	S200P D32	S200P D40			S200P D40	XT2N160 In100	XT2N160 In100	XT2N160 In100	XT2N160 In160	XT2N160 In160
Setting Ekip LS/I			---	---	---	---	---			---	L= 0.8-12s S=6.5-0.1s	L= 0.88-12s S=6.5-0.1s	L= 1-12s S=6.5-0.1s	L= 0.84-12s S=4.5-0.1s	L=0.88-12s S=4.5-0.1s
Contactor type			A26	A26	A26	A26	A30			A40	A50	A63	A75	A95	A110
Rated Power [W]	Rated current I_b [A]	Capacitor [μF]	N° lamps per phase												
150	1	20	13	14	15	23	28			30	50	58	63	81	88
250	1.5	36	8	9	10	15	18			20	33	38	42	54	59
400	2.5	48	5	5	6	9	11			12	20	23	25	32	36
600	3.3	65	4	4	5	7	8			9	15	17	19	24	27
1000	6.2	100	-	-	-	4	4			5	8	9	10	13	14



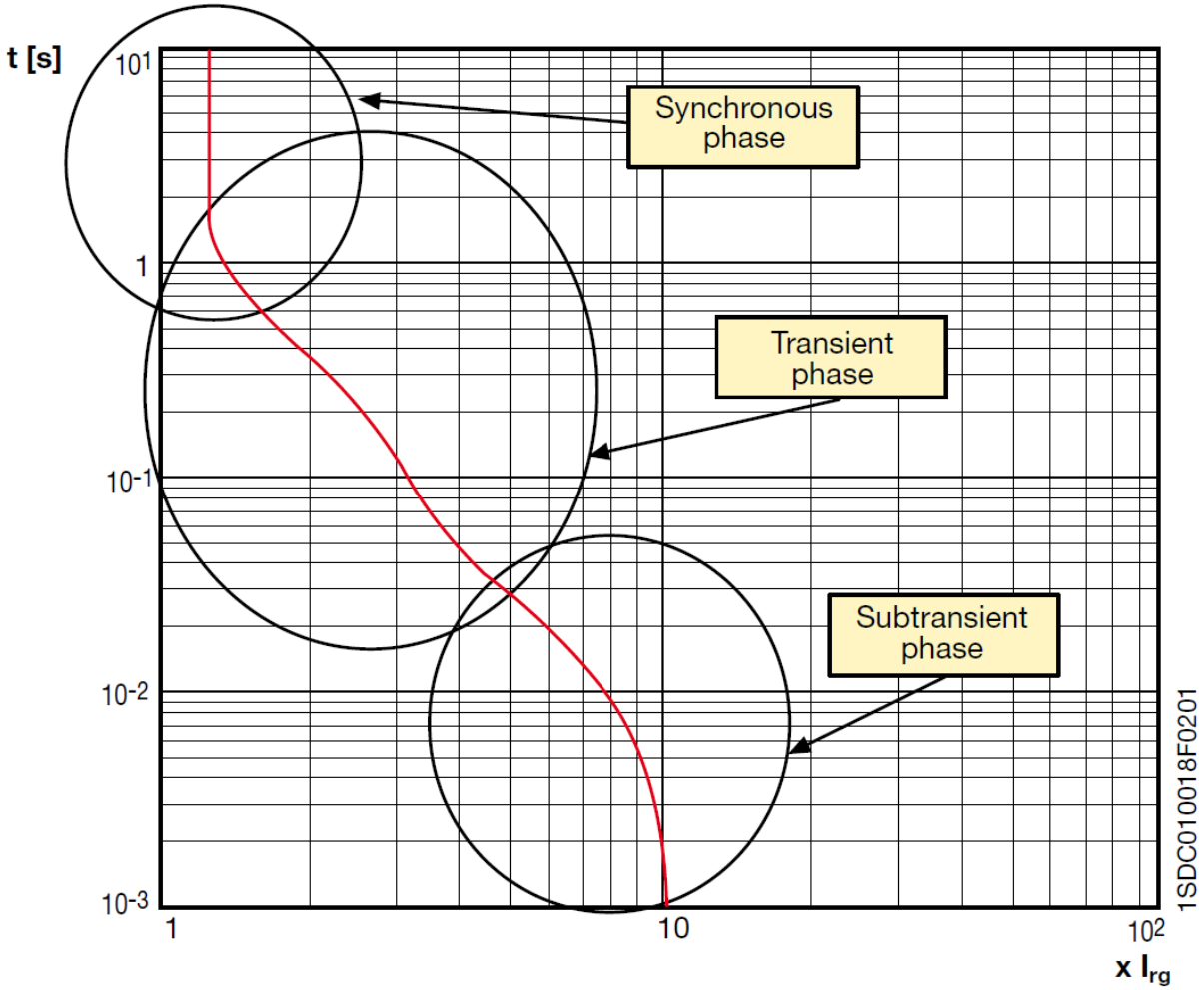
شکل ۳-۱ جریان اولیه دارای پیک زیاد به مدت کم است.



شکل ۳-۲ جریان هجومی دارای پیک کمتر ولی مدت طولانی تر است.



شکل ۳-۳ دیاگرام کلی برای هماهنگی لامپ با ادوات حفاظت و سوئیچینگ آن



شکل ۳-۴ سه حالت مختلف جریان پس از وقوع اتصال کوتاه

Table 1 400 V

S_{rg} [kVA]	MCB	MCCB	ACB
4	S200 B6	XT1 160 XT2 160	
6	S200 B10		
7 9	S200 B13		
11	S200 B16		
14 17	S200 B25		
19 21 22	S200 B32		
28 31	S200 B50		
35 38 42	S200 B63		
44 48 55	S280 B80		
69	S280 B100		
80 87 100			
111 138 159 173		XT3 250 XT4 250	
180 190 208 218		T4 320	
242		T5 400	
277 308 311 346 381 415		T5 630	X1 630
436 484		T6 800	X1 800
554 692		T7 1000	X1 1000**
727 865		T7 1250	X1 1250**
1107		T7 1600	X1 1600**
1730			E3 2500
2180 2214			E3 3200
2250 2500			E4 4000
2800 3150			E6 5000
3500			E6 6300

جدول ۳-۵ تجهیزات حفاظت و سوئیچینگ ژنراتورهای ۴۰۰V

Table 2 440 V

S_{rg} [kVA]	MCB	MCCB	ACB
4	S200 B6	XT1 160 XT2 160	
6	S200 B8		
7	S200 B10		
9	S200 B13		
11	S200 B16		
14	S200 B20		
17	S200 B25		
19 21 22	S200 B32		
28	S200 B40		
31 35	S200 B50		
38 42 44	S200 B63		
48 55	S280 B80		
69	S280 B100		
80 87 100 111			
138 159 173 180 190		XT3 250 XT4 250	
208 218 242		T4 320	
277		T5 400	
308 311 346 381 415 436		T5 630	X1 630
484 554		T6 800	X1 800**
692 727		T7 1000	X1 1000**
865		T7 1250	X1 1250**
1107		T7 1600	X1 1600**
1730			E3 2500
2180 2214 2250			E3 3200
2500			E4 3600
2800			E4 4000
3150 3500			E6 5000

جدول ۳-۶ تجهیزات حفاظت و سوئیچینگ ژنراتورهای ۴۴۰V

Table 3 500 V

S_{rg} [kVA]	MCB	MCCB	ACB
4 6 7 9 11 14 17 19 21 22 28 31 35 38 42 44 48 55 69 80 87 100 111 138		XT1 160 XT2 160	
159 173 180 190 208		XT3 250 XT4 250	
218 242		T4 320	
277 308 311 346		T5 400	
381 415 436 484		T5 630	X1 630
554 692		T6 800	X1 800**
727 865		T7 1000	X1 1000**
1107		T7 1600	X1 1600**
1730			E2 2000
2180 2214 2250 2500			E3 3200
2800 3150			E4 4000
3500			E6 5000

جدول ۳-۷ تجهیزات حفاظت و سوئیچینگ ژنراتورهای ۵۰۰V

Table 4 690 V

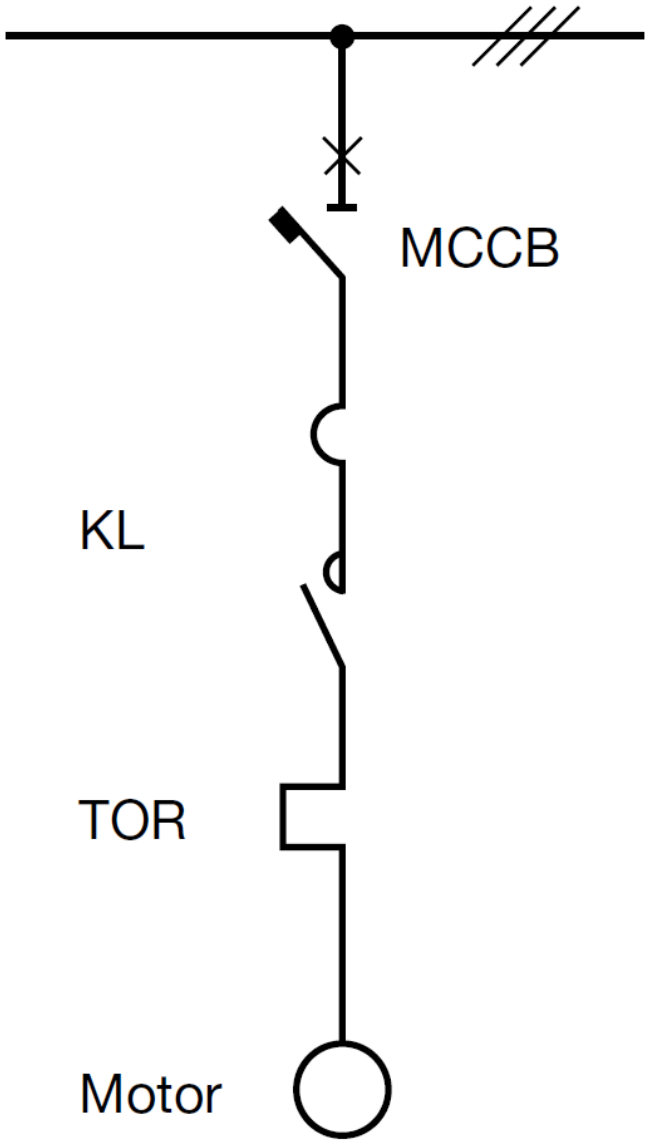
S_{rg} [kVA]	MCB	MCCB	ACB
4 6 7 9 11 14 17 19 21 22 28 31 35 38 42 44 48 55 69 80 87 100 111 138 159 173 180 190		XT1 160 XT2 160	
208 218 242 277		XT3 250 XT4 250	
308 311 346 381		T4 320	
415 436		T5 400	
484 554 692 727		T5 630	X1 630
865		T6 800	X1 800**
1107		T7 1000	X1 1000**
1730		T7 1600	X1 1600**
2180 2214 2250			E2 2000
2500 2800			E3 2500
3150 3500			E3 3200

جدول ۳-۸ تجهیزات حفاظت و سوئیچینگ ژنراتورهای ۶۹۰V

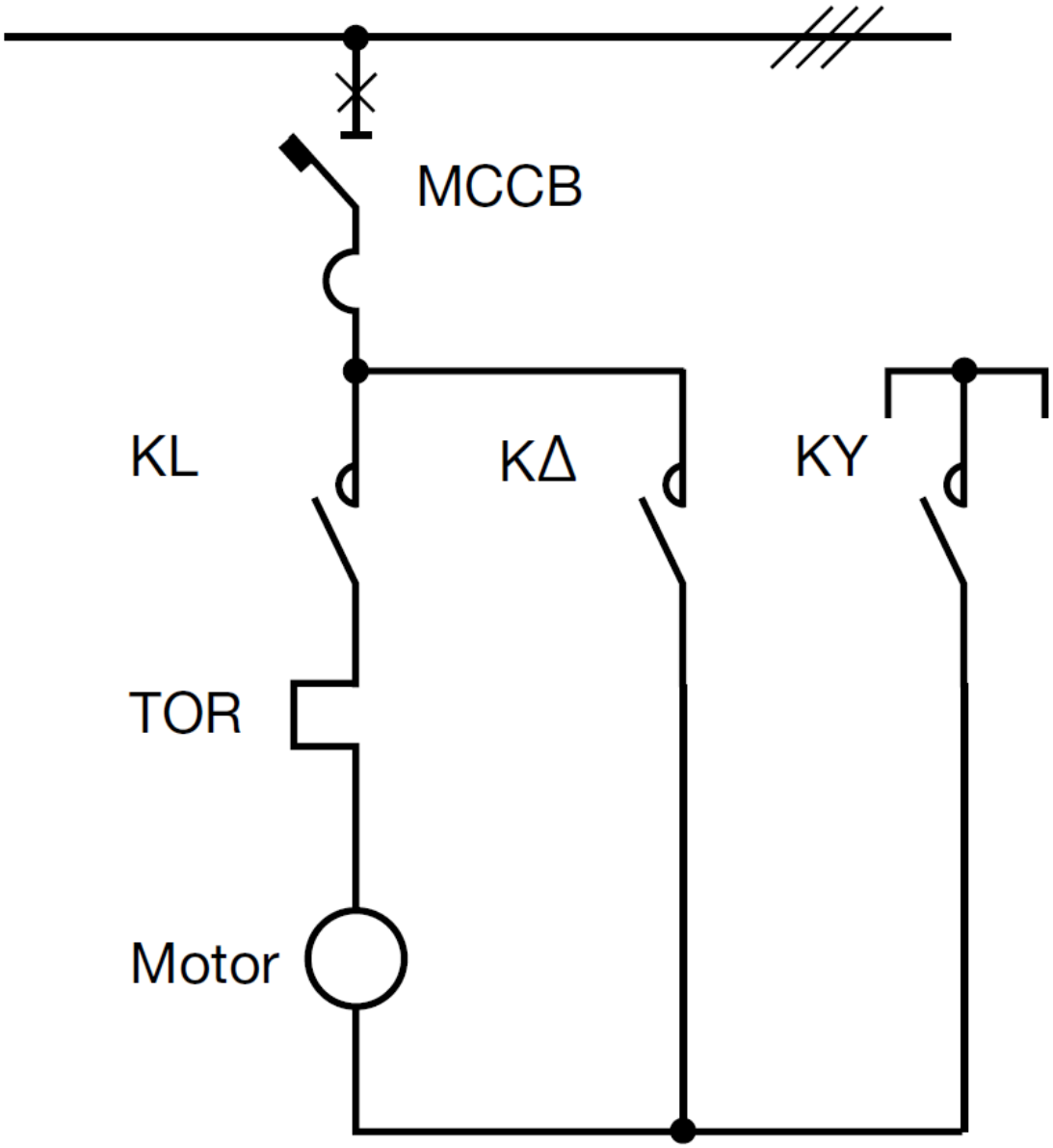
جدول ۳-۹ رده‌بندی استارترهای الکترومکانیکی برای انواع اصلی موتورها

Table 1: Utilization categories and typical applications

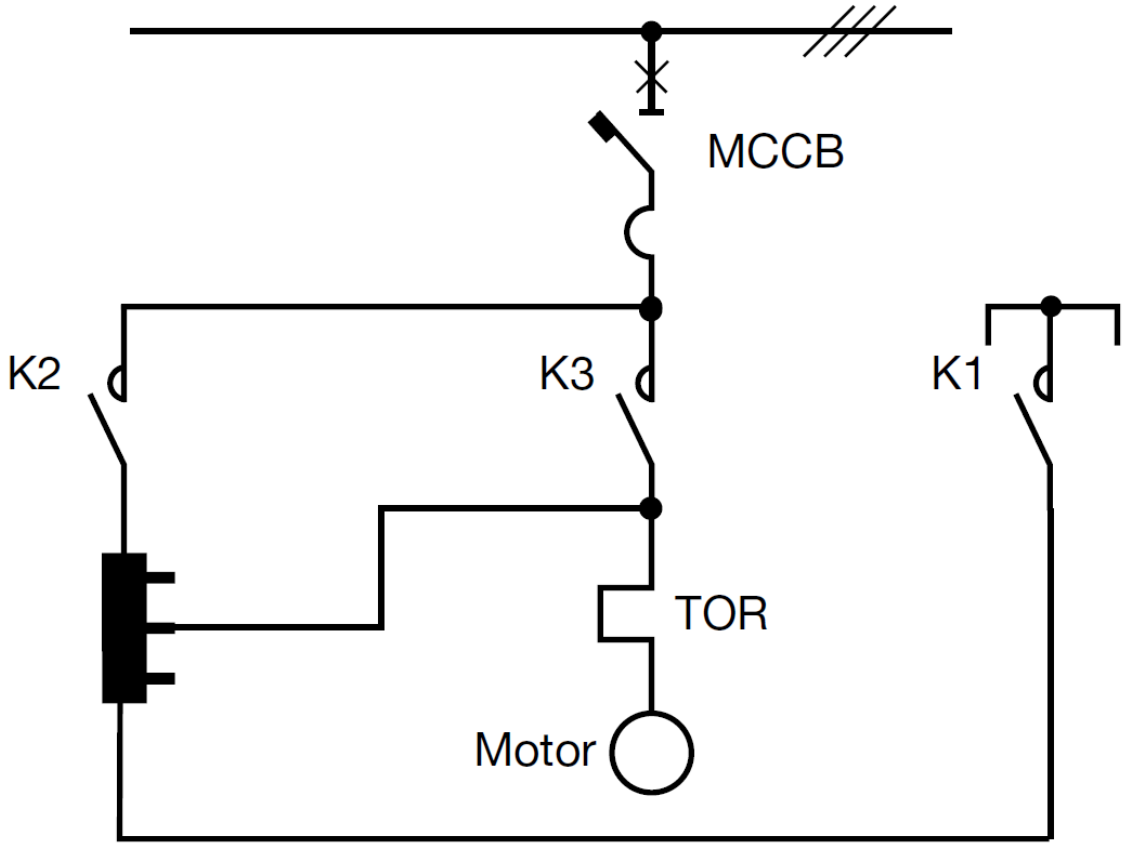
Current type	Utilization categories	Typical applications
Alternating Current ac	AC-2	Slip-ring motors: starting, switching off
	AC-3	Squirrel-cage motors: starting, switching off during running[1]
	AC-4	Squirrel-cage motors: starting, plugging, inching



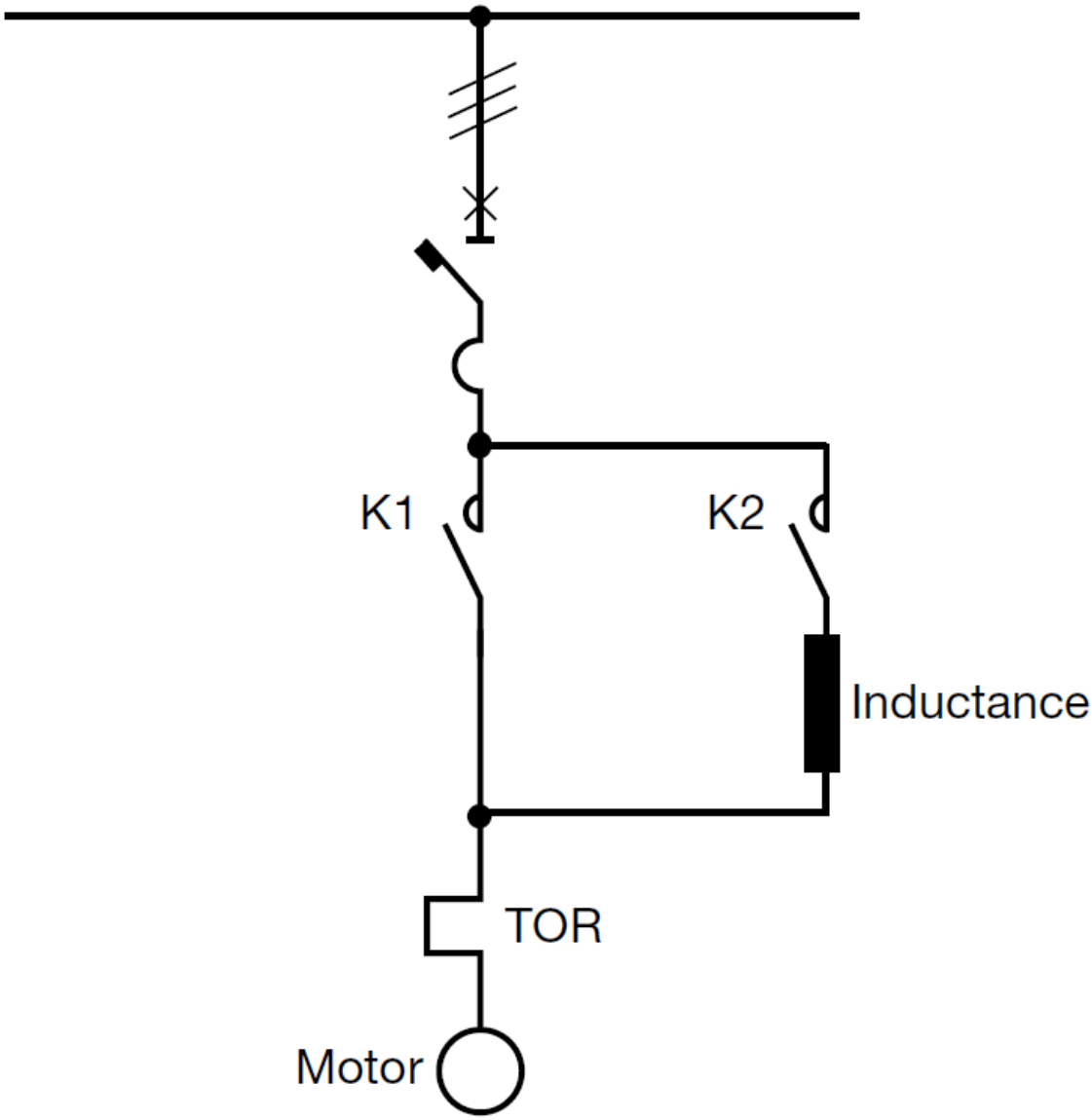
شکل ۳-۶ راه‌اندازی موتورالقایی به روش مستقیم



شکل ۳-۷ راه‌اندازی موتورالقایی به روش ستاره-مثلث



شکل ۳-۸ راه‌اندازی موتورالقایی به کمک اتوترانسفورمر



شکل ۳-۹ راه‌اندازی موتورالقایی با مقاومت یا سلف واسط

Table 2: Trip class

Trip Class	Tripping time in seconds (Tp)
10A	$2 < Tp \leq 10$
10	$4 < Tp \leq 10$
20	$6 < Tp \leq 20$
30	$9 < Tp \leq 30$

جدول ۳-۱۰ رده‌بندی استارترهای الکترومکانیکی براساس زمان قطع

Motor		Moulded Case Circuit Breaker		Contactor	Overload Relay		
Rated Power [kW]	Rated Current [A]	Type	I_3 [A]	Type	Type	Current setting range [A]	
						min	max
0,37	1,1	XT2N160 MF 2	28	A9	TA25DU1.4	1	1,4
0,55	1,5	XT2N160 MF 2	28	A9	TA25DU1.8	1,3	1,8
0,75	1,9	XT2N160 MF 2	28	A9	TA25DU2.4	1,7	2,4
1,1	2,7	XT2N160 MF 4	56	A9	TA25DU4	2,8	4
1,5	3,6	XT2N160 MF 4	56	A16	TA25DU5	3,5	5
2,2	4,9	XT2N160 MF 8.5	120	A26	TA25DU6.5	4,5	6,5
3	6,5	XT2N160 MF 8.5	120	A26	TA25DU8.5	6	8,5
4	8,5	XT2N160 MF 12.5	175	A30	TA25DU11	7,5	11
5,5	11,5	XT2N160 MF 12.5	175	A30	TA25DU14	10	14
7,5	15,5	XT2N160 MA 20	210	A30	TA25DU19	13	19
11	22	XT2N160 MA 32	288	A30	TA42DU25	18	25
15	29	XT2N160 MA 52	392	A50	TA75DU42	29	42
18,5	35	XT2N160 MA 52	469	A50	TA75DU52	36	52
22	41	XT2N160 MA 52	547	A50	TA75DU52	36	52
30	55	XT2N160 MA 80	840	A63	TA75DU80	60	80
37	66	XT2N160 MA 80	960	A75	TA75DU80	60	80
45	80	XT2N160 MA 100	1200	A95	TA110DU110	80	110
55	97	XT3N250 MA 160	1440	A110	TA110DU110	80	110
75	132	XT3N250 MA 200	1800	A145	TA200DU175	130	175
90	160	XT3N250 MA 200	2400	A185	TA200DU200	150	200
110	195	T4N320 PR221-I In320	2720	A210	E320DU320	100	320
132	230	T5N400 PR221-I In400	3200	A260	E320DU320	100	320
160	280	T5N400 PR221-I In400	4000	A300	E320DU320	100	320
200	350	T5N630 PR221-I In630	5040	AF400	E500DU500	150	500
250	430	T6N630 PR221-I In630	6300	AF460	E500DU500	150	500
290	520	T6N800 PR221-I In800	7200	AF580	E800DU800	250	800
315	540	T6N800 PR221-I In800	8000	AF580	E800DU800	250	800
355	610	T6N800 PR221-I In800	8000	AF750	E800DU800	250	800

جدول ۳-۱۱ کلیدهای حالت ۳۵kA ، DOL ۴۰۰V معمولی نوع ۲

(Tmax XT/T – Contactor – TOR/EOL)

Motor		Moulded Case Circuit Breaker		Contactor	Overload Relay		
Rated Power [kW]	Rated Current [A]	Type	I_3 [A]	Type	Type	Current setting range [A]	
						min	max
0,37	1,1	XT2S160 MF 2	28	A9	TA25DU1.4	1	1,4
0,55	1,5	XT2S160 MF 2	28	A9	TA25DU1.8	1,3	1,8
0,75	1,9	XT2S160 MF 2	28	A9	TA25DU2.4	1,7	2,4
1,1	2,7	XT2S160 MF 4	56	A9	TA25DU4	2,8	4
1,5	3,6	XT2S160 MF 4	56	A16	TA25DU5	3,5	5
2,2	4,9	XT2S160 MF 8.5	120	A26	TA25DU6.5	4,5	6,5
3	6,5	XT2S160 MF 8.5	120	A26	TA25DU8.5	6	8,5
4	8,5	XT2S160 MF 12.5	175	A30	TA25DU11	7,5	11
5,5	11,5	XT2S160 MF 12.5	175	A30	TA25DU14	10	14
7,5	15,5	XT2S160 MA 20	210	A30	TA25DU19	13	19
11	22	XT2S160 MA 32	288	A30	TA42DU25	18	25
15	29	XT2S160 MA 52	392	A50	TA75DU42	29	42
18,5	35	XT2S160 MA 52	469	A50	TA75DU52	36	52
22	41	XT2S160 MA 52	547	A50	TA75DU52	36	52
30	55	XT2S160 MA 80	840	A63	TA75DU80	60	80
37	66	XT2S160 MA 80	960	A75	TA75DU80	60	80
45	80	XT2S160 MA 100	1200	A95	TA110DU110	80	110
55	97	XT3S250 MA 160	1440	A110	TA110DU110	80	110
75	132	XT3S250 MA 200	1800	A145	TA200DU175	130	175
90	160	XT3S250 MA 200	2400	A185	TA200DU200	150	200
110	195	T4S320 PR221-I In320	2720	A210	E320DU320	100	320
132	230	T5S400 PR221-I In400	3200	A260	E320DU320	100	320
160	280	T5S400 PR221-I In400	4000	A300	E320DU320	100	320
200	350	T5S630 PR221-I In630	5040	AF400	E500DU500	150	500
250	430	T6S630 PR221-I In630	6300	AF460	E500DU500	150	500
290	520	T6S800 PR221-I In800	7200	AF580	E800DU800	250	800
315	540	T6S800 PR221-I In800	8000	AF580	E800DU800	250	800
355	610	T6S800 PR221-I In800	8000	AF750	E800DU800	250	800

جدول ۳-۱۲ کلیدهای حالت ۵۰kA ، DOL ۴۰۰V معمولی نوع ۲

(Tmax XT/T – Contactor – TOR/EOL)

Motor		Moulded Case Circuit Breaker		Contactor	Overload Relay		
Rated Power [kW]	Rated Current [A]	Type	I_3 [A]	Type	Type	Current setting range [A]	
						min	max
0,37	1,1	XT2H160 MF 2	28	A9	TA25DU1.4	1	1,4
0,55	1,5	XT2H160 MF 2	28	A9	TA25DU1.8	1,3	1,8
0,75	1,9	XT2H160 MF 2	28	A9	TA25DU2.4	1,7	2,4
1,1	2,7	XT2H160 MF 4	56	A16	TA25DU4	2,8	4
1,5	3,6	XT2H160 MF 4	56	A26	TA25DU5	3,5	5
2,2	4,9	XT2H160 MF 8.5	120	A26	TA25DU6.5	4,5	6,5
3	6,5	XT2H160 MF 8.5	120	A26	TA25DU8.5	6	8,5
4	8,5	XT2H160 MF 12.5	175	A30	TA25DU11	7,5	11
5,5	11,5	XT2H160 MF 12.5	175	A50	TA25DU14	10	14
7,5	15,5	XT2H160 MA 20	210	A50	TA25DU19	13	19
11	22	XT2H160 MA 32	288	A50	TA42DU25	18	25
15	29	XT2H160 MA 52	392	A50	TA75DU42	29	42
18,5	35	XT2H160 MA 52	469	A50	TA75DU52	36	52
22	41	XT2H160 MA 52	547	A50	TA75DU52	36	52
30	55	XT2H160 MA 80	840	A63	TA75DU80	60	80
37	66	XT2H160 MA 80	960	A75	TA75DU80	60	80
45	80	XT2H160 MA 100	1200	A95	TA110DU110	80	110
55	97	XT4H250 Ekip-I In160	1360	A110	TA110DU110	80	110
75	132	XT4H250 Ekip-I In250	1875	A145	E200DU200	60	200
90	160	XT4H250 Ekip-I In250	2500	A185	E200DU200	60	200
110	195	T4H320 PR221-I In320	2720	A210	E320DU320	100	320
132	230	T5H400 PR221-I In400	3200	A260	E320DU320	100	320
160	280	T5H400 PR221-I In400	4000	A300	E320DU320	100	320
200	350	T5H630 PR221-I In630	5040	AF400	E500DU500	150	500
250	430	T6H630 PR221-I In630	6300	AF460	E500DU500	150	500
290	520	T6H800 PR221-I In800	7200	AF580	E800DU800	250	800
315	540	T6H800 PR221-I In800	8000	AF580	E800DU800	250	800
355	610	T6H800 PR221-I In800	8000	AF750	E800DU800	250	800

جدول ۳-۱۳ کلیدهای حالت ۷۰kA ، ۴۰۰V DOL معمولی نوع ۲

(Tmax XT/T – Contactor – TOR/EOL)

Motor		Moulded Case Circuit Breaker		Contactor	Overload Relay		
Rated Power [kW]	Rated Current [A]	Type	I_3 [A]	Type	Type	Current setting range [A]	
						min	max
0,37	1,1	XT2L160 MF 2	28	A9	TA25DU1.4	1	1,4
0,55	1,5	XT2L160 MF 2	28	A9	TA25DU1.8	1,3	1,8
0,75	1,9	XT2L160 MF 2	28	A9	TA25DU2.4	1,7	2,4
1,1	2,7	XT2L160 MF 4	56	A16	TA25DU4	2,8	4
1,5	3,6	XT2L160 MF 4	56	A26	TA25DU5	3,5	5
2,2	4,9	XT2L160 MF 8.5	120	A26	TA25DU6.5	4,5	6,5
3	6,5	XT2L160 MF 8.5	120	A26	TA25DU8.5	6	8,5
4	8,5	XT2L160 MF 12.5	175	A30	TA25DU11	7,5	11
5,5	11,5	XT2L160 MF 12.5	175	A50	TA25DU14	10	14
7,5	15,5	XT2L160 MA 20	210	A50	TA25DU19	13	19
11	22	XT2L160 MA 32	288	A50	TA42DU25	18	25
15	29	XT2L160 MA 52	392	A50	TA75DU42	29	42
18,5	35	XT2L160 MA 52	469	A50	TA75DU52	36	52
22	41	XT2L160 MA 52	547	A50	TA75DU52	36	52
30	55	XT2L160 MA 80	840	A63	TA75DU80	60	80
37	66	XT2L160 MA 80	960	A75	TA75DU80	60	80
45	80	XT2L160 MA 100	1200	A95	TA110DU110	80	110
55	97	XT4L250 Ekip-I In160	1360	A110	TA110DU110	80	110
75	132	XT4L250 Ekip-I In250	1875	A145	E200DU200	60	200
90	160	XT4L250 Ekip-I In250	2500	A185	E200DU200	60	200
110	195	T4L320 PR221-I In320	2720	A210	E320DU320	100	320
132	230	T5L400 PR221-I In400	3200	A260	E320DU320	100	320
160	280	T5L400 PR221-I In400	4000	A300	E320DU320	100	320
200	350	T5L630 PR221-I In630	5040	AF400	E500DU500	150	500
250	430	T6L630 PR221-I In630	6300	AF460	E500DU500	150	500
290	520	T6L800 PR221-I In800	7200	AF580	E800DU800	250	800
315	540	T6L800 PR221-I In800	8000	AF580	E800DU800	250	800
355	610	T6L800 PR221-I In800	8000	AF750	E800DU800	250	800

جدول ۳-۱۴ کلیدهای حالت ۸۰kA ، DOL ۴۰۰V معمولی نوع ۲

(Tmax XT/T – Contactor – TOR/EOL)

Motor		Moulded Case Circuit Breaker		Contactor	Overload Relay		
Rated Power [kW]	Rated Current [A]	Type	I_3 [A]	Type	Type	Current setting range [A]	
						min	max
0,37	1,1	XT2N160 MF 2	28	A9	E16DU2.7	0,9	2,7
0,55	1,5	XT2N160 MF 2	28	A9	E16DU2.7	0,9	2,7
0,75	1,9	XT2N160 MF 2	28	A9	E16DU2.7	0,9	2,7
1,1	2,7	XT2N160 MF 4	56	A9	E16DU6.3	2	6,3
1,5	3,6	XT2N160 MF 4	56	A16	E16DU6.3	2	6,3
2,2	4,9	XT2N160 MF 8.5	120	A26	E16DU6.3	2	6,3
3	6,5	XT2N160 MF 8.5	120	A26	E16DU18.9	5,7	18,9
4	8,5	XT2N160 MF 12.5	175	A30	E16DU18.9	5,7	18,9
5,5	11,5	XT2N160 MF 12.5	175	A30	E16DU18.9	5,7	18,9
7,5	15,5	XT2N160 MA 20	210	A30	E16DU18.9	5,7	18,9
11	22	XT2N160 MA 32	288	A30	E45DU45	15	45
15	29	XT2N160 MA 52	392	A50	E45DU45	15	45
18,5	35	XT2N160 MA 52	469	A50	E80DU80	27	80
22	41	XT2N160 MA 52	547	A50	E80DU80	27	80
30	55	XT2N160 MA 80	840	A63	E80DU80	27	80
37	66	XT2N160 MA 80	960	A75	E80DU80	27	80
45	80	XT2N160 MA 100	1200	A95	E140DU140	50	140
55	97	XT3N250 MA 160	1440	A110	E200DU200	60	200
75	132	XT3N250 MA 200	1800	A145	E200DU200	60	200
90	160	XT3N250 MA 200	2400	A185	E200DU200	60	200
110	195	T4N320 PR221-I In320	2720	A210	E320DU320	100	320
132	230	T5N400 PR221-I In400	3200	A260	E320DU320	100	320
160	280	T5N400 PR221-I In400	4000	A300	E320DU320	100	320
200	350	T5N630 PR221-I In630	5040	AF400	E500DU500	150	500
250	430	T6N630 PR221-I In630	6300	AF460	E500DU500	150	500
290	520	T6N800 PR221-I In800	7200	AF580	E800DU800	250	800
315	540	T6N800 PR221-I In800	8000	AF580	E800DU800	250	800
355	610	T6N800 PR221-I In800	8000	AF750	E800DU800	250	800

جدول ۳-۱۵ کلیدهای حالت ۳۵kA ، DOL ۴۰۰V معمولی نوع ۲

(Tmax XT/T – Contactor – EOL)

Motor		Moulded Case Circuit Breaker		Contactor	Overload Relay		
Rated Power [kW]	Rated Current [A]	Type	I_3 [A]	Type	Type	Current setting range [A]	
						min	max
0,37	1,1	XT2S160 MF 2	28	A9	E16DU2.7	0,9	2,7
0,55	1,5	XT2S160 MF 2	28	A9	E16DU2.7	0,9	2,7
0,75	1,9	XT2S160 MF 2	28	A9	E16DU2.7	0,9	2,7
1,1	2,7	XT2S160 MF 4	56	A9	E16DU6.3	2	6,3
1,5	3,6	XT2S160 MF 4	56	A16	E16DU6.3	2	6,3
2,2	4,9	XT2S160 MF 8.5	120	A26	E16DU6.3	2	6,3
3	6,5	XT2S160 MF 8.5	120	A26	E16DU18.9	5,7	18,9
4	8,5	XT2S160 MF 12.5	175	A30	E16DU18.9	5,7	18,9
5,5	11,5	XT2S160 MF 12.5	175	A30	E16DU18.9	5,7	18,9
7,5	15,5	XT2S160 MA 20	210	A30	E16DU18.9	5,7	18,9
11	22	XT2S160 MA 32	288	A30	E45DU45	15	45
15	29	XT2S160 MA 52	392	A50	E45DU45	15	45
18,5	35	XT2S160 MA 52	469	A50	E80DU80	27	80
22	41	XT2S160 MA 52	547	A50	E80DU80	27	80
30	55	XT2S160 MA 80	840	A63	E80DU80	27	80
37	66	XT2S160 MA 80	960	A75	E80DU80	27	80
45	80	XT2S160 MA 100	1200	A95	E140DU140	50	140
55	97	XT3S250 MA 160	1440	A110	E200DU200	60	200
75	132	XT3S250 MA 200	1800	A145	E200DU200	60	200
90	160	XT3S250 MA 200	2400	A185	E200DU200	60	200
110	195	T4S320 PR221-I In320	2720	A210	E320DU320	100	320
132	230	T5S400 PR221-I In400	3200	A260	E320DU320	100	320
160	280	T5S400 PR221-I In400	4000	A300	E320DU320	100	320
200	350	T5S630 PR221-I In630	5040	AF400	E500DU500	150	500
250	430	T6S630 PR221-I In630	6300	AF460	E500DU500	150	500
290	520	T6S800 PR221-I In800	7200	AF580	E800DU800	250	800
315	540	T6S800 PR221-I In800	8000	AF580	E800DU800	250	800
355	610	T6S800 PR221-I In800	8000	AF750	E800DU800	250	800

جدول ۳-۱۶ کلیدهای حالت ۵۰kA ، ۴۰۰V DOL معمولی نوع ۲

(Tmax XT/T – Contactor – EOL)

Motor		Moulded Case Circuit Breaker		Contactor	Overload Relay		
Rated Power [kW]	Rated Current [A]	Type	I_3 [A]	Type	Type	Current setting range [A]	
						min	max
0,37	1,1	XT2H160 MF 2	28	A9	E16DU2.7	0,9	2,7
0,55	1,5	XT2H160 MF 2	28	A9	E16DU2.7	0,9	2,7
0,75	1,9	XT2H160 MF 2	28	A9	E16DU2.7	0,9	2,7
1,1	2,7	XT2H160 MF 4	56	A16	E16DU6.3	2	6,3
1,5	3,6	XT2H160 MF 4	56	A26	E16DU6.3	2	6,3
2,2	4,9	XT2H160 MF 8.5	120	A26	E16DU6.3	2	6,3
3	6,5	XT2H160 MF 8.5	120	A26	E16DU18.9	5,7	18,9
4	8,5	XT2H160 MF 12.5	175	A30	E16DU18.9	5,7	18,9
5,5	11,5	XT2H160 MF 12.5	175	A50	E16DU18.9	5,7	18,9
7,5	15,5	XT2H160 MA 20	210	A50	E16DU18.9	5,7	18,9
11	22	XT2H160 MA 32	288	A50	E45DU45	15	45
15	29	XT2H160 MA 52	392	A50	E45DU45	15	45
18,5	35	XT2H160 MA 52	469	A50	E80DU80	27	80
22	41	XT2H160 MA 52	547	A50	E80DU80	27	80
30	55	XT2H160 MA 80	840	A63	E80DU80	27	80
37	66	XT2H160 MA 80	960	A75	E80DU80	27	80
45	80	XT2H160 MA 100	1200	A95	E140DU140	50	140
55	97	XT4H250 Ekip-I In160	1360	A110	E200DU200	60	200
75	132	XT4H250 Ekip-I In250	1875	A145	E200DU200	60	200
90	160	XT4H250 Ekip-I In250	2500	A185	E200DU200	60	200
110	195	T4H320 PR221-I In320	2720	A210	E320DU320	100	320
132	230	T5H400 PR221-I In400	3200	A260	E320DU320	100	320
160	280	T5H400 PR221-I In400	4000	A300	E320DU320	100	320
200	350	T5H630 PR221-I In630	5040	AF400	E500DU500	150	500
250	430	T6H630 PR221-I In630	6300	AF460	E500DU500	150	500
290	520	T6H800 PR221-I In800	7200	AF580	E800DU800	250	800
315	540	T6H800 PR221-I In800	8000	AF580	E800DU800	250	800
355	610	T6H800 PR221-I In800	8000	AF750	E800DU800	250	800

جدول ۳-۱۷ کلیدهای حالت ۷۰kA ، ۴۰۰V DOL معمولی نوع ۲

(Tmax XT/T – Contactor – EOL)

Motor		Moulded Case Circuit Breaker		Contactor	Overload Relay		
Rated Power [kW]	Rated Current [A]	Type	I_3 [A]	Type	Type	Current setting range [A]	
						min	max
0,37	1,1	XT2L160 MF 2	28	A9	E16DU2.7	0,9	2,7
0,55	1,5	XT2L160 MF 2	28	A9	E16DU2.7	0,9	2,7
0,75	1,9	XT2L160 MF 2	28	A9	E16DU2.7	0,9	2,7
1,1	2,7	XT2L160 MF 4	56	A16	E16DU6.3	2	6,3
1,5	3,6	XT2L160 MF 4	56	A26	E16DU6.3	2	6,3
2,2	4,9	XT2L160 MF 8.5	120	A26	E16DU6.3	2	6,3
3	6,5	XT2L160 MF 8.5	120	A26	E16DU18.9	5,7	18,9
4	8,5	XT2L160 MF 12.5	175	A30	E16DU18.9	5,7	18,9
5,5	11,5	XT2L160 MF 12.5	175	A50	E16DU18.9	5,7	18,9
7,5	15,5	XT2L160 MA 20	210	A50	E16DU18.9	5,7	18,9
11	22	XT2L160 MA 32	288	A50	E45DU45	15	45
15	29	XT2L160 MA 52	392	A50	E45DU45	15	45
18,5	35	XT2L160 MA 52	469	A50	E80DU80	27	80
22	41	XT2L160 MA 52	547	A50	E80DU80	27	80
30	55	XT2L160 MA 80	840	A63	E80DU80	27	80
37	66	XT2L160 MA 80	960	A75	E80DU80	27	80
45	80	XT2L160 MA 100	1200	A95	E140DU140	50	140
55	97	XT4L250 Ekip-I In160	1360	A110	E200DU200	60	200
75	132	XT4L250 Ekip-I In250	1875	A145	E200DU200	60	200
90	160	XT4L250 Ekip-I In250	2500	A185	E200DU200	60	200
110	195	T4L320 PR221-I In320	2720	A210	E320DU320	100	320
132	230	T5L400 PR221-I In400	3200	A260	E320DU320	100	320
160	280	T5L400 PR221-I In400	4000	A300	E320DU320	100	320
200	350	T5L630 PR221-I In630	5040	AF400	E500DU500	150	500
250	430	T6L630 PR221-I In630	6300	AF460	E500DU500	150	500
290	520	T6L800 PR221-I In800	7200	AF580	E800DU800	250	800
315	540	T6L800 PR221-I In800	8000	AF580	E800DU800	250	800
355	610	T6L800 PR221-I In800	8000	AF750	E800DU800	250	800

جدول ۳-۱۸ کلیدهای حالت ۸۰kA ، DOL ۴۰۰V معمولی نوع ۲

(Tmax XT/T – Contactor – EOL)

Motor		Moulded Case Circuit Breaker		Contactor	Overload Relay		
Rated Power [kW]	Rated Current [A]	Type	I_3 [A]	Type	Type	Current setting range [A]	
						min	max
0,37	1	XT2S160 MF 1	14	A9	TA25DU1.4	1	1,4
0,55	1,3	XT2S160 MF 2	28	A9	TA25DU1.8	1,3	1,8
0,75	1,7	XT2S160 MF 2	28	A9	TA25DU2.4	1,7	2,4
1,1	2,4	XT2S160 MF 4	56	A9	TA25DU3.1	2,2	3,1
1,5	3,2	XT2S160 MF 4	56	A16	TA25DU4	2,8	4
2,2	4,3	XT2S160 MF 8.5	120	A26	TA25DU5	3,5	5
3	5,7	XT2S160 MF 8.5	120	A26	TA25DU6.5	4,5	6,5
4	7,4	XT2S160 MF 8.5	120	A30	TA25DU11	7,5	11
5,5	10,1	XT2S160 MF 12	175	A30	TA25DU14	10	14
7,5	13,6	XT2S160 MA 20	180	A30	TA25DU19	13	19
11	19,3	XT2S160 MA 32	240	A30	TA42DU25	18	25
15	25,4	XT2S160 MA 32	336	A50	TA75DU32	22	32
18,5	30,7	XT2S160 MA 52	469	A50	TA75DU42	29	42
22	35,9	XT2S160 MA 52	547	A50	TA75DU52	36	52
30	48,2	XT2S160 MA 80	720	A63	TA75DU63	45	63
37	58	XT2S160 MA 80	840	A75	TA75DU80	60	80
45	70	XT2S160 MA 100	1050	A95	TA110DU90	65	90
55	85	XT4S250 Ekip-I In160	1200	A110	TA110DU110	80	110
75	116	XT4S250 Ekip-I In250	1750	A145	E200DU200	60	200
90	140	XT4S250 Ekip-I In250	2000	A185	E200DU200	60	200
110	171	XT4S250 Ekip-I In250	2500	A210	E320DU320	100	320
132	202	T5H400 PR221-I In320	3200	A260	E320DU320	100	320
160	245	T5H400 PR221-I In400	3600	A300	E320DU320	100	320
200	307	T5H630 PR221-I In630	4410	AF 400	E500DU500	150	500
250	377	T6H630 PR221-I In630	5355	AF 460	E500DU500	150	500
290	448	T6H630 PR221-I In630	6300	AF 580	E500DU500*	150	500
315	473	T6H800 PR221-I In800	7200	AF 580	E800DU800	250	800
355	535	T6H800 PR221-I In800	8000	AF 580	E800DU800	250	800

جدول ۳-۱۹ کلیدهای حالت DOL ۴۴۰V، ۵۰kA معمولی نوع ۲

(Tmax XT/T – Contactor – TOR/EOL)

Motor		Moulded Case Circuit Breaker		Contactor	Overload Relay		
Rated Power [kW]	Rated Current [A]	Type	I_3 [A]	Type	Type	Current setting range [A]	
						min	max
0,37	1	XT2H160 MF 1	14	A9	TA25DU1.4	1	1,4
0,55	1,3	XT2H160 MF 2	28	A9	TA25DU1.8	1,3	1,8
0,75	1,7	XT2H160 MF 2	28	A9	TA25DU2.4	1,7	2,4
1,1	2,4	XT2H160 MF 4	56	A16	TA25DU3.1	2,2	3,1
1,5	3,2	XT2H160 MF 4	56	A16	TA25DU4	2,8	4
2,2	4,3	XT2H160 MF 8.5	120	A26	TA25DU5	3,5	5
3	5,7	XT2H160 MF 8.5	120	A30	TA25DU6.5	4,5	6,5
4	7,4	XT2H160 MF 8.5	120	A30	TA25DU11	7,5	11
5,5	10,1	XT2H160 MF 12.5	175	A30	TA25DU14	10	14
7,5	13,6	XT2H160 MA 20	180	A30	TA25DU19	13	19
11	19,3	XT2H160 MA 32	240	A50	TA42DU25	18	25
15	25,4	XT2H160 MA 32	336	A50	TA75DU32	22	32
18,5	30,7	XT2H160 MA 52	469	A50	TA75DU42	29	42
22	35,9	XT2H160 MA 52	547	A50	TA75DU52	36	52
30	48,2	XT2H160 MA 80	720	A63	TA75DU63	45	63
37	58	XT2H160 MA 80	840	A75	TA75DU80	60	80
45	70	XT2H160 MA 100	1050	A95	TA110DU90	65	90
55	85	XT4H250 Ekip-I In160	1200	A110	TA110DU110	80	110
75	116	XT4H250 Ekip-I In250	1750	A145	E200DU200	60	200
90	140	XT4H250 Ekip-I In250	2000	A185	E200DU200	60	200
110	171	XT4H250 Ekip-I In250	2500	A210	E320DU320	100	320
132	202	T5H400 PR221-I In320	3200	A260	E320DU320	100	320
160	245	T5H400 PR221-I In400	3600	A300	E320DU320	100	320
200	307	T5H630 PR221-I In630	4410	AF 400	E500DU500	150	500
250	377	T6L630 PR221-I In630	5355	AF 460	E500DU500	150	500
290	448	T6L630 PR221-I In630	6300	AF 580	E500DU500*	150	500
315	473	T6L800 PR221-I In800	7200	AF 580	E800DU800	250	800
355	535	T6L800 PR221-I In800	8000	AF 580	E800DU800	250	800

جدول ۳-۲۰ کلیدهای حالت DOL ۴۴۰V، ۶۵kA معمولی نوع ۲

(Tmax XT/T – Contactor – TOR/EOL)

Motor		Moulded Case Circuit Breaker		Contactor	Overload Relay		
Rated Power [kW]	Rated Current [A]	Type	I_3 [A]	Type	Type	Current setting range [A]	
						min	max
0,37	1	XT2S160 MF 1	14	A9	E16DU2.7	0,9	2,7
0,55	1,3	XT2S160 MF 2	28	A9	E16DU2.7	0,9	2,7
0,75	1,7	XT2S160 MF 2	28	A9	E16DU2.7	0,9	2,7
1,1	2,4	XT2S160 MF 4	56	A9	E16DU2.7	0,9	2,7
1,5	3,2	XT2S160 MF 4	56	A16	E16DU6.3	2	6,3
2,2	4,3	XT2S160 MF 8.5	120	A26	E16DU6.3	2	6,3
3	5,7	XT2S160 MF 8.5	120	A26	E16DU6.3	2	6,3
4	7,4	XT2S160 MF 8.5	120	A30	E16DU18.9	5,7	18,9
5,5	10,1	XT2S160 MF 12	175	A30	E16DU18.9	5,7	18,9
7,5	13,6	XT2S160 MA 20	180	A30	E16DU18.9	5,7	18,9
11	19,3	XT2S160 MA 32	240	A30	E45DU45	15	45
15	25,4	XT2S160 MA 32	336	A50	E45DU45	15	45
18,5	30,7	XT2S160 MA 52	469	A50	E45DU45	15	45
22	35,9	XT2S160 MA 52	547	A50	E45DU45	15	45
30	48,2	XT2S160 MA 80	720	A63	E80DU80	27	80
37	58	XT2S160 MA 80	840	A75	E80DU80	27	80
45	70	XT2S160 MA 100	1050	A95	E140DU140	50	140
55	85	XT4S250 Ekip-I In160	1200	A110	E200DU200	60	200
75	116	XT4S250 Ekip-I In250	1750	A145	E200DU200	60	200
90	140	XT4S250 Ekip-I In250	2000	A185	E200DU200	60	200
110	171	XT4S250 Ekip-I In250	2500	A210	E320DU320	100	320
132	202	T5H400 PR221-I In320	3200	A260	E320DU320	100	320
160	245	T5H400 PR221-I In400	3600	A300	E320DU320	100	320
200	307	T5H630 PR221-I In630	4410	AF 400	E500DU500	150	500
250	377	T6H630 PR221-I In630	5355	AF 460	E500DU500	150	500
290	448	T6H630 PR221-I In630	7560	AF 580	E800DU800	250	800
315	473	T6H800 PR221-I In800	8000	AF 580	E800DU800	250	800
355	535	T6H800 PR221-I In800	9600	AF 580	E800DU800	250	800

جدول ۳-۲۱ کلیدهای حالت DOL ۴۴۰V، ۵۰kA معمولی نوع ۲

(Tmax XT/T – Contactor – EOL)

Motor		Moulded Case Circuit Breaker		Contactor	Overload Relay		
Rated Power [kW]	Rated Current [A]	Type	I_3 [A]	Type	Type	Current setting range [A]	
						min	max
0,37	1	XT2H160 MF 1	14	A9	E16DU2.7	0,9	2,7
0,55	1,3	XT2H160 MF 2	28	A9	E16DU2.7	0,9	2,7
0,75	1,7	XT2H160 MF 2	28	A9	E16DU2.7	0,9	2,7
1,1	2,4	XT2H160 MF 4	56	A16	E16DU2.7	0,9	2,7
1,5	3,2	XT2H160 MF 4	56	A16	E16DU6.3	2	6,3
2,2	4,3	XT2H160 MF 8.5	120	A26	E16DU6.3	2	6,3
3	5,7	XT2H160 MF 8.5	120	A30	E16DU6.3	2	6,3
4	7,4	XT2H160 MF 8.5	120	A30	E16DU18.9	5,7	18,9
5,5	10,1	XT2H160 MF 12.5	175	A30	E16DU18.9	5,7	18,9
7,5	13,6	XT2H160 MA 20	180	A30	E16DU18.9	5,7	18,9
11	19,3	XT2H160 MA 32	240	A50	E45DU45	15	45
15	25,4	XT2H160 MA 32	336	A50	E45DU45	15	45
18,5	30,7	XT2H160 MA 52	469	A50	E45DU45	15	45
22	35,9	XT2H160 MA 52	547	A50	E45DU45	15	45
30	48,2	XT2H160 MA 80	720	A63	E80DU80	27	80
37	58	XT2H160 MA 80	840	A75	E80DU80	27	80
45	70	XT2H160 MA 100	1050	A95	E140DU140	50	140
55	85	XT4H250 Ekip-I In160	1200	A110	E200DU200	60	200
75	116	XT4H250 Ekip-I In250	1750	A145	E200DU200	60	200
90	140	XT4H250 Ekip-I In250	2000	A185	E200DU200	60	200
110	171	XT4H250 Ekip-I In250	2500	A210	E320DU320	100	320
132	202	T5H400 PR221-I In320	3200	A260	E320DU320	100	320
160	245	T5H400 PR221-I In400	3600	A300	E320DU320	100	320
200	307	T5H630 PR221-I In630	4410	AF 400	E500DU500	150	500
250	377	T6L630 PR221-I In630	5355	AF 460	E500DU500	150	500
290	448	T6L630 PR221-I In630	6300	AF 580	E800DU800	250	800
315	473	T6L800 PR221-I In800	7200	AF 580	E800DU800	250	800
355	535	T6L800 PR221-I In800	8000	AF 580	E800DU800	250	800

جدول ۳-۲۲ کلیدهای حالت DOL ۴۴۰V، ۶۵kA معمولی نوع ۲

(Tmax XT/T – Contactor – EOL)

Motor		Moulded Case Circuit Breaker		Contactor	Overload Relay		
Rated Power [kW]	Rated Current [A]	Type	I_3 [A]	Type	Type	Current setting range [A]	
						min	max
0,37	0,88	XT2H160 MF 1	14	A9	TA25DU1.0	0,63	1
0,55	1,2	XT2H160 MF 2	28	A9	TA25DU1.4	1	1,4
0,75	1,5	XT2H160 MF 2	28	A9	TA25DU1.8	1,3	1,8
1,1	2,2	XT2H160 MF 4	56	A9	TA25DU3.1	2,2	3,1
1,5	2,8	XT2H160 MF 4	56	A16	TA25DU4	2,8	4
2,2	3,9	XT2H160 MF 8.5	120	A26	TA25DU5	3,5	5
3	5,2	XT2H160 MF 8.5	120	A26	TA25DU6.5	4,5	6,5
4	6,8	XT2H160 MF 8.5	120	A30	TA25DU8.5	6	8,5
5,5	9,2	XT2H160 MF 12.5	175	A30	TA25DU11	7,5	11
7,5	12,4	XT2H160 MF 12.5	163	A30	TA25DU14	10	14
11	17,6	XT2H160 MA 20	240	A30	TA25DU19	13	19
15	23	XT2H160 MA 32	336	A50	TA75DU25	18	25
18,5	28	XT2H160 MA 52	392	A50	TA75DU32	22	32
22	33	XT2H160 MA 52	469	A50	TA75DU42	29	42
30	44	XT2H160 MA 52	624	A63	TA75DU52	36	52
37	53	XT2H160 MA 80	840	A75	TA75DU63	45	63
45	64	XT2H160 MA 80	960	A95	TA80DU80	60	80
55	78	XT2H160 MA 100	1200	A110	TA110DU90	65	90
75	106	XT4H250 Ekip-I In160	1440	A145	E200DU200	60	200
90	128	XT4H250 Ekip-I In250	1875	A145	E200DU200	60	200
110	156	XT4H250 Ekip-I In250	2250	A185	E200DU200	60	200
132	184	T4H320 PR221-I In320	2720	A210	E320DU320	100	320
160	224	T5H400 PR221-I In400	3600	A260	E320DU320	100	320
200	280	T5H400 PR221-I In400	4000	A300	E320DU320	100	320
250	344	T5H630 PR221-I In630	4725	AF400	E500DU500	150	500
290	394	T6H630 PR221-I In630	5040	AF460	E500DU500	150	500
315	432	T6H630 PR221-I In630	6300	AF580	E500DU500*	150	500
355	488	T6H630 PR221-I In630	6300	AF580	E800DU800	250	800

جدول ۳-۲۳ کلیدهای حالت DOL ۵۰۰V، ۵۰kA معمولی نوع ۲

(Tmax XT/T – Contactor – TOR/EOL)

Motor		Moulded Case Circuit Breaker		Contactor	Overload Relay		
Rated Power [kW]	Rated Current [A]	Type	I_3 [A]	Type	Type	Current setting range [A]	
						min	max
0,37	0,88	XT2H160 MF 1	14	A9	E16DU2.7	0,9	2,7
0,55	1,2	XT2H160 MF 2	28	A9	E16DU2.7	0,9	2,7
0,75	1,5	XT2H160 MF 2	28	A9	E16DU2.7	0,9	2,7
1,1	2,2	XT2H160 MF 4	56	A9	E16DU2.7	0,9	2,7
1,5	2,8	XT2H160 MF 4	56	A16	E16DU6.3	2	6,3
2,2	3,9	XT2H160 MF 8.5	120	A26	E16DU6.3	2	6,3
3	5,2	XT2H160 MF 8.5	120	A26	E16DU6.3	2	6,3
4	6,8	XT2H160 MF 8.5	120	A30	E16DU18.9	5,7	18,9
5,5	9,2	XT2H160 MF 12.5	175	A30	E16DU18.9	5,7	18,9
7,5	12,4	XT2H160 MF 12.5	163	A50	E16DU18.9	5,7	18,9
11	17,6	XT2H160 MA 20	240	A50	E45DU45	15	45
15	23	XT2H160 MA 32	336	A50	E45DU45	15	45
18,5	28	XT2H160 MA 52	392	A50	E45DU45	15	45
22	33	XT2H160 MA 52	469	A50	E45DU45	15	45
30	44	XT2H160 MA 52	624	A63	E80DU80	27	80
37	53	XT2H160 MA 80	840	A75	E80DU80	27	80
45	64	XT2H160 MA 80	960	A95	E140DU140	50	140
55	78	XT2H160 MA 100	1200	A110	E200DU200	60	200
75	106	XT4H250 Ekip-I In160	1440	A145	E200DU200	60	200
90	128	XT4H250 Ekip-I In250	1875	A145	E200DU200	60	200
110	156	XT4H250 Ekip-I In250	2250	A185	E320DU320	100	320
132	184	T4H320 PR221-I In320	2720	A210	E320DU320	100	320
160	224	T5H400 PR221-I In400	3600	A260	E320DU320	100	320
200	280	T5H400 PR221-I In400	4000	A300	E500DU500	150	500
250	344	T5H630 PR221-I In630	4725	AF400	E500DU500	150	500
290	394	T6H630 PR221-I In630	5040	AF460	E800DU800	250	800
315	432	T6H630 PR221-I In630	6300	AF580	E800DU800	250	800
355	488	T6H630 PR221-I In630	6300	AF580	E800DU800	250	800

جدول ۳-۲۴ کلیدهای حالت DOL ۵۰۰V، ۵۰kA معمولی نوع ۲

(Tmax XT/T – Contactor – EOL)

Motor		Moulded Case Circuit Breaker		Contactor	KORC		Overload Relay		
Rated Power [kW]	Rated Current [A]	Type	I_3 [A]	Type	Type	Number of turns	Type	Current setting range [A]	
								min	max
0,37	0,64	XT2V160 MF 1	14	A9			TA25DU1	0,6	1
0,55	0,87	XT2V160 MF 1	14	A9			TA25DU1	0,6	1
0,75	1,1	XT2V160 MF 2	28	A9			TA25DU1.4	1	1,4
1,1	1,6	XT2V160 MF 2	28	A9			TA25DU1.8	1,3	1,8
1,5	2,1	XT2V160 MF 4	56	A9			TA25DU2.4	1,7	2,4
2,2	2,8	XT2V160 MF 4	56	A9			TA25DU3.1 *	2,2	3,1
3	3,8	XT2V160 MF 4	56	A9			TA25DU4 *	2,8	4
4	4,9	XT2V160 MF 8.5	120	A9			TA25DU5 *	3,5	5
5,5	6,7	XT2V160 MF 8.5	120	A9			TA25DU6.5	6	5
		XT4V250 EKIP-I In 100	150	A95	4L185R/4	13**	TA25DU2.4	6	5
7,5	8,9	XT4V250 EKIP-I In 100	150	A95	4L185R/4	10**	TA25DU2.4	7,9	11,1
11	12,8	XT4V250 EKIP-I In 100	200	A95	4L185R/4	7**	TA25DU2.4	11,2	15,9
15	17	XT4V250 EKIP-I In 100	250	A95	4L185R/4	7**	TA25DU3.1	15,2	20,5
18,5	21	XT4V250 EKIP-I In 100	300	A95	4L185R/4	6	TA25DU3.1	17,7	23,9
22	24	XT4V250 EKIP-I In 100	350	A95	4L185R/4	6	TA25DU4	21,6	30,8
30	32	XT4V250 EKIP-I In 100	450	A145	4L185R/4	6	TA25DU5	27	38,5
37	39	XT4V250 EKIP-I In 100	550	A145	4L185R/4	4	TA25DU4	32,4	46,3
45	47	XT4V250 EKIP-I In 100	700	A145	4L185R/4	4	TA25DU5	40,5	57,8
55	57	XT4V250 EKIP-I In 100	800	A145	4L185R/4	3	TA25DU5	54	77,1
75	77	XT4V250 EKIP-I In 160	1120	A145			E200DU200	65	200
90	93	XT4V250 EKIP-I In 160	1280	A145			E200DU200	65	200
110	113	XT4V250 EKIP-I In 250	1625	A145			E200DU200	65	200
132	134	XT4V250 EKIP-I In 250	2000	A185			E200DU200	65	200
160	162	XT4V250 EKIP-I In 250	2250	A185			E200DU200	65	200

جدول ۳-۲۵ کلیدهای حالت DOL ۶۹۰V، ۲۵kA معمولی نوع ۲

(Tmax XT/T – Contactor – TOR/EOL)

Motor		Moulded Case Circuit Breaker		Contactor	KORC		Overload Relay		
Rated Power [kW]	Rated Current [A]	Type	I_3 [A]	Type	Type	Number of turns	Type	Current setting range [A]	
								min	max
0,37	0,64	T2L160 MF1	13	A9			TA25DU1	0,6	1
0,55	0,87	T2L160 MF1	13	A9			TA25DU1	0,6	1
0,75	1,1	T2L160 MF 1.6	21	A9			TA25DU1.4	1	1,4
1,1	1,6	T2L160 MF 1.6	21	A9			TA25DU1.8	1,3	1,8
1,5	2,1	T2L160 MF 2.5	33	A9			TA25DU2.4;	1,7	2,4
2,2	2,8	T2L160 MF 3.2	42	A9			TA25DU3.1 *	2,2	3,1
3	3,8	T2L160 MF 4	52	A9			TA25DU4 *	2,8	4
4	4,9	T2L160 MF 5	65	A9			TA25DU5 *	3,5	5
5,5	6,7	T2L160 MF 6.5	84	A9			TA25DU6.5	4,5	6,5
		T4L250 PR221-I In 100	150	A95	4L185R/4	13**	TA25DU2.4	6	8,5
7,5	8,9	T4L250 PR221-I In 100	150	A95	4L185R/4	10**	TA25DU2.4	7,9	11,1
11	12,8	T4L250 PR221-I In 100	200	A95	4L185R/4	7**	TA25DU2.4	11,2	15,9
15	17	T4L250 PR221-I In 100	250	A95	4L185R/4	7**	TA25DU3.1	15,2	20,5
18,5	21	T4L250 PR221-I In 100	300	A95	4L185R/4	6	TA25DU3.1	17,7	23,9
22	24	T4L250 PR221-I In 100	350	A95	4L185R/4	6	TA25DU4	21,6	30,8
30	32	T4L250 PR221-I In 100	450	A145	4L185R/4	6	TA25DU5	27	38,5
37	39	T4L250 PR221-I In 100	550	A145	4L185R/4	4	TA25DU4	32,4	46,3
45	47	T4L250 PR221-I In 100	700	A145	4L185R/4	4	TA25DU5	40,5	57,8
55	57	T4L250 PR221-I In 100	800	A145	4L185R/4	3	TA25DU5	54	77,1
75	77	T4L250 PR221-I In 160	1120	A145			E200DU200	65	200
90	93	T4L250 PR221-I In 160	1280	A145			E200DU200	65	200
110	113	T4L250 PR221-I In 250	1625	A145			E200DU200	65	200
132	134	T4L250 PR221-I In 250	2000	A185			E200DU200	65	200
160	162	T4L250 PR221-I In 250	2250	A185			E200DU200	65	200
200	203	T5L400 PR221-I In 320	2720	A210			E320DU320	105	320
250	250	T5L400 PR221-I In 400	3400	A300			E320DU320	105	320
290	301	T5L630 PR221-I In 630	4410	AF400			E500DU500	150	500
315	313	T5L630 PR221-I In 630	4410	AF400			E500DU500	150	500
355	354	T5L630 PR221-I In 630	5355	AF580			E500DU500***	150	500

جدول ۳-۲۶ کلیدهای حالت DOL ۶۹۰V، ۵۰kA معمولی نوع ۲

(Tmax XT/T – Contactor – TOR/EOL)

Motor		Moulded Case Circuit Breaker		Contactor	Overload Relay			
Rated Power [kW]	Rated Current [A]	Type	I_3 [A]	Type	Type*	Turns on CT	Current setting range [A]	
							min	max
0,37	1,1	XT2N160 MF 2	28	A9	TA25DU1.4 ^		1	1,4
0,55	1,5	XT2N160 MF 2	28	A9	TA25DU1.8 ^		1,3	1,8
0,75	1,9	XT2N160 MF 2	28	A9	TA25DU2.4 ^		1,7	2,4
1,1	2,7	XT2N160 MF 4	56	A9	TA25DU4 ^		2,8	4
1,5	3,6	XT2N160 MF 4	56	A16	TA25DU5 ^		3,5	5
2,2	4,9	XT2N160 MF 8.5	120	A26	TA25DU6.5 ^		4,5	6,5
3	6,5	XT2N160 MF 8.5	120	A26	TA25DU8.5 ^		6	8,5
4	8,5	XT2N160 MF 12.5	175	A30	TA25DU11 ^		7,5	11
5,5	11,5	XT2N160 MF 12.5	175	A30	TA450SU60	4	10	15
7,5	15,5	XT2N160 MA 20	210	A30	TA450SU60	3	13	20
11	22	XT2N160 MA 32	288	A30	TA450SU60	2	20	30
15	29	XT2N160 MA 52	392	A50	TA450SU80	2	23	40
18,5	35	XT2N160 MA 52	469	A50	TA450SU80	2	23	40
22	41	XT2N160 MA 52	547	A50	TA450SU60		40	60
30	55	XT2N160 MA 80	840	A63	TA450SU80		55	80
37	66	XT2N160 MA 80	960	A95	TA450SU80		55	80
45	80	XT2N160 MA 100	1200	A110	TA450SU105		70	105
55	97	XT3N250 MA 160	1440	A145	TA450SU140		95	140
75	132	XT3N250 MA 200	1800	A185	TA450SU185		130	185
90	160	XT3N250 MA 200	2400	A210	TA450SU185		130	185
110	195	T4N320 PR221-I In320	2720	A260	E320DU320^		100	320
132	230	T5N400 PR221-I In400	3200	A300	E320DU320^		100	320
160	280	T5N400 PR221-I In400	4000	AF400	E500DU500^		150	500
200	350	T5N630 PR221-I In630	5040	AF460	E500DU500^		150	500
250	430	T6N630 PR221-I In630	6300	AF580	E500DU500**^		150	500
290	520	T6N800 PR221-I In800	7200	AF750	E800DU800		250	800
315	540	T6N800 PR221-I In800	8000	AF750	E800DU800^		250	800
355	610	T6N800 PR221-I In800	8000	AF750	E800DU800^		250	800

جدول ۳-۲۷ کلیدهای حالت DOL ۴۰۰V، ۳۵kA سخت‌کار نوع ۲

(Tmax XT/T – Contactor – TOR/EOL)

Motor		Moulded Case Circuit Breaker		Contactor	Overload Relay			
Rated Power [kW]	Rated Current [A]	Type	I_3 [A]	Type	Type*	Turns on CT	Current setting range [A]	
							min	max
0,37	1,1	XT2S160 MF 2	28	A9	TA25DU1.4 ^		1	1,4
0,55	1,5	XT2S160 MF 2	28	A9	TA25DU1.8 ^		1,3	1,8
0,75	1,9	XT2S160 MF 2	28	A9	TA25DU2.4 ^		1,7	2,4
1,1	2,7	XT2S160 MF 4	56	A9	TA25DU4 ^		2,8	4
1,5	3,6	XT2S160 MF 4	56	A16	TA25DU5 ^		3,5	5
2,2	4,9	XT2S160 MF 8.5	120	A26	TA25DU6.5 ^		4,5	6,5
3	6,5	XT2S160 MF 8.5	120	A26	TA25DU8.5 ^		6	8,5
4	8,5	XT2S160 MF 12.5	175	A30	TA25DU11 ^		7,5	11
5,5	11,5	XT2S160 MF 12.5	175	A30	TA450SU60	4	10	15
7,5	15,5	XT2S160 MA 20	210	A30	TA450SU60	3	13	20
11	22	XT2S160 MA 32	288	A30	TA450SU60	2	20	30
15	29	XT2S160 MA 52	392	A50	TA450SU80	2	23	40
18,5	35	XT2S160 MA 52	469	A50	TA450SU80	2	23	40
22	41	XT2S160 MA 52	547	A50	TA450SU60		40	60
30	55	XT2S160 MA 80	840	A63	TA450SU80		55	80
37	66	XT2S160 MA 80	960	A95	TA450SU80		55	80
45	80	XT2S160 MA 100	1200	A110	TA450SU105		70	105
55	97	XT3S250 MA 160	1440	A145	TA450SU140		95	140
75	132	XT3S250 MA 200	1800	A185	TA450SU185		130	185
90	160	XT3S250 MA 200	2400	A210	TA450SU185		130	185
110	195	T4S320 PR221-I In320	2720	A260	E320DU320		100	320
132	230	T5S400 PR221-I In400	3200	A300	E320DU320		100	320
160	280	T5S400 PR221-I In400	4000	AF400	E500DU500		150	500
200	350	T5S630 PR221-I In630	5040	AF460	E500DU500		150	500
250	430	T6S630 PR221-I In630	6300	AF580	E500DU500**		150	500
290	520	T6S800 PR221-I In800	7200	AF750	E800DU800		250	800
315	540	T6S800 PR221-I In800	8000	AF750	E800DU800		250	800
355	610	T6S800 PR221-I In800	8000	AF750	E800DU800		250	800

جدول ۳-۲۸ کلیدهای حالت DOL ۴۰۰V، ۵۰kA سخت‌کار نوع ۲

(Tmax XT/T – Contactor – TOR/EOL)

Motor		Moulded Case Circuit Breaker		Contactor	Overload Relay			
Rated Power [kW]	Rated Current [A]	Type	I_3 [A]	Type	Type*	Turns on CT	Current setting range [A]	
							min	max
0,37	1	XT2S160 MF 1	14	A9	TA25DU1,4 ^		1	1,4
0,55	1,3	XT2S160 MF 2	28	A9	TA25DU1,8 ^		1,3	1,8
0,75	1,7	XT2S160 MF 2	28	A9	TA25DU2,4 ^		1,7	2,4
1,1	2,2	XT2S160 MF 4	56	A9	TA25DU3,1 ^		2,2	3,1
1,5	3,2	XT2S160 MF 4	56	A16	TA25DU4 ^		2,8	4
2,2	4,3	XT2S160 MF 8.5	120	A26	TA25DU5 ^		3,5	5
3	5,7	XT2S160 MF 8.5	120	A26	TA25DU6,5 ^		4,5	5
4	7,4	XT2S160 MF 8.5	120	A30	TA25DU11 ^		7,5	11
5,5	10,1	XT2S160 MF 12.5	175	A30	TA25DU14 ^		10	14
7,5	13,6	XT2S160 MA 20	180	A30	TA450SU60	4	10	15
11	19,3	XT2S160 MA 32	240	A30	TA450SU80	3	18	27
15	25,4	XT2S160 MA 32	336	A50	TA450SU60	2	20	30
18,5	30,7	XT2S160 MA 52	469	A50	TA450SU80	2	28	40
22	35,9	XT2S160 MA 52	547	A50	TA450SU80	2	28	40
30	48,2	XT2S160 MA 80	720	A63	TA450SU60		40	60
37	58	XT2S160 MA 80	840	A95	TA450SU80		55	80
45	70	XT2S160 MA 100	1050	A110	TA450SU105		70	105
55	85	XT4S250 Ekip-I In160	1200	A145	E200DU200		60	200
75	116	XT4S250 Ekip-I In250	1750	A185	E200DU200		60	200
90	140	XT4S250 Ekip-I In250	2000	A210	E320DU320		100	320
110	171	XT4S250 Ekip-I In250	2500	A260	E320DU320		100	320
132	202	T5H400 PR221-I In320	3200	A300	E320DU320		100	320
160	245	T5H400 PR221-I In400	3600	AF400	E500DU500		150	500
200	307	T5H630 PR221-I In630	4410	AF460	E500DU500		150	500
250	377	T6H630 PR221-I In630	5355	AF580	E500DU500***		150	500
290	448	T6H630 PR221-I In630	6300	AF750	E500DU500***		150	500
315	473	T6H800 PR221-I In800	7200	AF750	E800DU800		250	800
355	535	T6H800 PR221-I In800	8000	AF750	E800DU800		250	800

جدول ۳-۲۹ کلیدهای حالت DOL ۴۴۰V، ۵۰kA سخت‌کار نوع ۲

(Tmax XT/T – Contactor – TOR)

Motor		Moulded Case Circuit Breaker		Contactor	Overload Relay			
Rated Power [kW]	Rated Current [A]	Type	I_3 [A]	Type	Type*	Turns on CT	Current setting range [A]	
							min	max
0,37	1	XT2H160 MF 1	14	A9	TA25DU1,4 ^		1	1,4
0,55	1,3	XT2H160 MF 2	28	A9	TA25DU1,8 ^		1,3	1,8
0,75	1,7	XT2H160 MF 2	28	A9	TA25DU2,4 ^		1,7	2,4
1,1	2,4	XT2H160 MF 4	56	A9	TA25DU3,1 ^		2,2	3,1
1,5	3,2	XT2H160 MF 4	56	A16	TA25DU4 ^		2,8	4
2,2	4,3	XT2H160 MF 8.5	120	A26	TA25DU5 ^		3,5	5
3	5,7	XT2H160 MF 8.5	120	A26	TA25DU6,5 ^		4,5	6,5
4	7,4	XT2H160 MF 8.5	120	A30	TA25DU11 ^		7,5	11
5,5	10,1	XT2H160 MF 12.5	175	A30	TA25DU14 ^		10	14
7,5	13,6	XT2H160 MA 20	180	A30	TA450SU60	4	10	15
11	19,3	XT2H160 MA 32	240	A30	TA450SU80	3	18	27
15	25,4	XT2H160 MA 32	336	A50	TA450SU60	2	20	30
18,5	30,7	XT2H160 MA 52	469	A50	TA450SU80	2	28	40
22	35,9	XT2H160 MA 52	547	A50	TA450SU80	2	28	40
30	48,2	XT2H160 MA 80	720	A63	TA450SU60		40	60
37	58	XT2H160 MA 80	840	A95	TA450SU80		55	80
45	70	XT2H160 MA 100	1050	A110	TA450SU105		70	105
55	85	XT4H250 Ekip-I In160	1200	A145	E200DU200		60	200
75	116	XT4H250 Ekip-I In250	1750	A185	E200DU200		60	200
90	140	XT4H250 Ekip-I In250	2000	A210	E320DU320		100	320
110	171	XT4H250 Ekip-I In250	2500	A260	E320DU320		100	320
132	202	T5H400 PR221-I In320	3200	A300	E320DU320		100	320
160	245	T5H400 PR221-I In400	3600	AF400	E500DU500		150	500
200	307	T5H630 PR221-I In630	4410	AF460	E500DU500		150	500
250	377	T6H630 PR221-I In630	5355	AF580	E500DU500***		150	500
290	448	T6H630 PR221-I In630	6300	AF750	E500DU500***		150	500
315	473	T6H800 PR221-I In800	7200	AF750	E800DU800		250	800
355	535	T6H800 PR221-I In800	8000	AF750	E800DU800		250	800

جدول ۳-۳۰ کلیدهای حالت DOL ۴۴۰V، ۶۵kA سخت‌کار نوع ۲

(Tmax XT/T – Contactor – TOR/EOL)

Motor		Moulded Case Circuit Breaker		Contactor	Overload Relay			
Rated Power [kW]	Rated Current [A]	Type	I_3 [A]	Type	Type*	Turns on CT	Current setting range [A]	
							min	max
0,37	0,88	XT2H160 MF 1	14	A9	TA25DU1.0 ^		0,63	1
0,55	1,2	XT2H160 MF 2	28	A9	TA25DU1.4 ^		1	1,4
0,75	1,5	XT2H160 MF 2	28	A9	TA25DU1.8 ^		1,3	1,8
1,1	2,2	XT2H160 MF 4	56	A9	TA25DU3.1 ^		2,2	3,1
1,5	2,8	XT2H160 MF 4	56	A16	TA25DU4 ^		2,8	4
2,2	3,9	XT2H160 MF 4	56	A26	TA25DU5 ^		3,5	5
3	5,2	XT2H160 MF 8.5	120	A26	TA25DU6.5 ^		4,5	6,5
4	6,8	XT2H160 MF 8.5	120	A30	TA25DU8.5 ^		6	8,5
5,5	9,2	XT2H160 MF 12.5	175	A30	TA25DU11 ^		7,5	11
7,5	12,4	XT2H160 MF 12.5	175	A30	TA450SU60	4	10	15
11	17,6	XT2H160 MA 20	240	A30	TA450SU60	3	13	20
15	23	XT2H160 MA 32	336	A50	TA450SU60	2	20	30
18,5	28	XT2H160 MA 52	392	A50	TA450SU80	2	27,5	40
22	33	XT2H160 MA 52	469	A50	TA450SU80	2	27,5	40
30	44	XT2H160 MA 52	624	A63	TA450SU60		40	80
37	53	XT2H160 MA 80	840	A75	TA450SU60		40	80
45	64	XT2H160 MA 80	960	A95	TA450SU80		55	80
55	78	XT2H160 MA 100	1200	A145	TA450SU105		70	105
75	106	XT4H250 Ekip-I In160	1440	A145	E200DU200		60	200
90	128	XT4H250 Ekip-I In250	1875	A185	E200DU200		60	200
110	156	XT4H250 Ekip-I In250	2125	A210	E320DU320		100	320
132	184	T4H320 PR221-I In320	2720	A260	E320DU320		100	320
160	224	T5H400 PR221-I In400	3200	A300	E320DU320		100	320
200	280	T5H400 PR221-I In400	3600	AF400	E500DU500		150	500
250	344	T5H630 PR221-I In630	4725	AF460	E500DU500		150	500
290	394	T6L630 PR221-I In630	5040	AF580	E500DU500***		150	500
315	432	T6L630 PR221-I In630	6300	AF750	E500DU500***		150	500
355	488	T6L630 PR221-I In630	6300	AF750	E500DU500***		150	500

جدول ۳-۳۱ کلیدهای حالت DOL ۵۰۰V، ۵۰kA سخت‌کار نوع ۲

(Tmax XT/T – Contactor – TOR/EOL)

Motor		Moulded Case Circuit Breaker		Contactor	Overload Relay			
Rated Power [kW]	Rated Current [A]	Type	I_3 [A]	Type	Type*	Turns on CT	Current setting range [A]	
							min	max
0,37	0,64	XT2V160 MF1	14	A9	TA25DU0.63 ^		0,4	0,63
0,55	0,87	XT2V160 MF1	14	A9	TA25DU1 ^		0,63	1
0,75	1,1	XT2V160 MF 2	28	A9	TA25DU1.4 ^		1	1,4
1,1	1,6	XT2V160 MF 2	28	A9	TA25D1.8 ^		1,3	1,8
1,5	2,1	XT2V160 MF 4	56	A9	TA25DU2.4 ^		1,7	2,4
2,2	2,8	XT2V160 MF 4	56	A9	TA25DU3.1 ^		2,2	3,1
3	3,8	XT2V160 MF 4	56	A9	TA25DU4 ^		2,8	4
4	4,9	XT2V160 MF 8.5	120	A9	TA25DU5 ^		3,5	5
5,5	6,7	XT2V160 MF 8.5	120	A9	TA25DU6.5 ^		4,5	6,5
		XT4V250 EKIP-I In 100	150	A95	TA450SU60	7(+)	5,7	8,6
7,5	8,9	XT4V250 EKIP-I In 100	150	A95	TA450SU60	5(+)	8	12
11	12,8	XT4V250 EKIP-I In 100	200	A95	TA450SU60	4(+)	10	15
15	17	XT4V250 EKIP-I In 100	250	A95	TA450SU60	3(+)	10	20
18,5	21	XT4V250 EKIP-I In 100	300	A95	TA450SU60	3	18	27
22	24	XT4V250 EKIP-I In 100	350	A95	TA450SU60	2	20	30
30	32	XT4V250 EKIP-I In 100	450	A145	TA450SU80	2	27,5	40
37	39	XT4V250 EKIP-I In 100	550	A145	TA450SU60		40	60
45	47	XT4V250 EKIP-I In 100	700	A145	TA450SU60		40	60
55	57	XT4V250 EKIP-I In 100	800	A145	TA450SU80		55	80
75	77	XT4V250 EKIP-I In 160	1120	A145	TA450SU105		70	105
90	93	XT4V250 EKIP-I In 160	1280	A145	TA450SU105		70	105
110	113	XT4V250 EKIP-I In 250	1625	A185	TA450SU140		95	140
132	134	XT4V250 EKIP-I In 250	2000	A210	E320DU320		105	320
160	162	XT4V250 EKIP-I In 250	2250	A210	E320DU320		105	320

جدول ۳-۳۲ کلیدهای حالت DOL ۶۹۰V، ۲۵kA سخت‌کار نوع ۲

(Tmax T – Contactor – TOR)

Motor		Moulded Case Circuit Breaker		Contactor	Overload Relay			
Rated Power [kW]	Rated Current [A]	Type	I_3 [A]	Type	Type*	Turns on CT	Current setting range [A]	
							min	max
0,37	0,64	T2L160 MF1	13	A9	TA25DU0.63 ^		0,4	0,63
0,55	0,87	T2L160 MF1	13	A9	TA25DU1 ^		0,63	1
0,75	1,1	T2L160 MF 1.6	21	A9	TA25DU1.4 ^		1	1,4
1,1	1,6	T2L160 MF 1.6	21	A9	TA25D1.8 ^		1,3	1,8
1,5	2,1	T2L160 MF 2.5	33	A9	TA25DU2.4 ^		1,7	2,4
2,2	2,8	T2L160 MF 3.2	42	A9	TA25DU3.1 ^		2,2	3,1
3	3,8	T2L160 MF 4	52	A9	TA25DU4 ^		2,8	4
4	4,9	T2L160 MF 5	65	A9	TA25DU5 ^		3,5	5
5,5	6,7	T2L160 MF 6.5	84	A9	TA25DU6.5 ^		4,5	6,5
		T4L250 PR221-I In 100	150	A95	TA450SU60	7(+)	5,7	8,6
7,5	8,9	T4L250 PR221-I In 100	150	A95	TA450SU60	5(+)	8	12
11	12,8	T4L250 PR221-I In 100	200	A95	TA450SU60	4(+)	10	15
15	17	T4L250 PR221-I In 100	250	A95	TA450SU60	3(+)	13	20
18,5	21	T4L250 PR221-I In 100	300	A95	TA450SU60	3	18	27
22	24	T4L250 PR221-I In 100	350	A95	TA450SU60	2	20	30
30	32	T4L250 PR221-I In 100	450	A145	TA450SU80	2	27,5	40
37	39	T4L250 PR221-I In 100	550	A145	TA450SU60		40	60
45	47	T4L250 PR221-I In 100	700	A145	TA450SU60		40	60
55	57	T4L250 PR221-I In 100	800	A145	TA450SU80		55	80
75	77	T4L250 PR221-I In 160	1120	A145	TA450SU105		70	105
90	93	T4L250 PR221-I In 160	1280	A145	TA450SU105		70	105
110	113	T4L250 PR221-I In 250	1625	A185	TA450SU140		95	140
132	134	T4L250 PR221-I In 250	2000	A210	E320DU320		105	320
160	162	T4L250 PR221-I In 250	2250	A210	E320DU320		105	320
200	203	T5L400 PR221-I In 320	2720	A260	E320DU320		105	320
250	250	T5L400 PR221-I In 400	3400	AF400	E500DU500		150	500
290	301	T5L630 PR221-I In 630	4410	AF400	E500DU500		150	500
315	313	T5L630 PR221-I In 630	4410	AF460	E500DU500		150	500
355	354	T5L630 PR221-I In 630	5355	AF580	E500DU500***		150	500

جدول ۳-۳۳ کلیدهای حالت DOL ۶۹۰V، ۵۰kA سخت‌کار نوع ۲

(Tmax T – Contactor – TOR)

Table 26: 400 V 35 kA Y/Δ Normal Type 2
(Tmax XT/T – Contactor – TOR/EOL)

Motor		Moulded Case Circuit Breaker		Contactor			Overload Relay	
Rated Power [kW]	Rated Current [A]	Type	I_3 [A]	Line Type	Delta Type	Star Type	Type	Current setting range [A]
18,5	35	XT2N160 MA52	469	A50	A50	A26	TA75DU25	18-25
22	41	XT2N160 MA52	547	A50	A50	A26	TA75DU32	22-32
30	55	XT2N160 MA80	720	A63	A63	A30	TA75DU42	29-42
37	66	XT2N160 MA80	840	A75	A75	A30	TA75DU52	36-52
45	80	XT2N160 MA100	1050	A75	A75	A30	TA75DU63	45 - 63
55	97	XT2N160 MA100	1200	A75	A75	A40	TA75DU63	45 - 63
75	132	XT3N250 MA160	1700	A95	A95	A75	TA110DU90	66 - 90
90	160	XT3N250 MA200	2000	A110	A110	A95	TA110DU110	80 - 110
110	195	XT4N250 MA200	2400	A145	A145	A95	TA200DU135	100 - 135
132	230	T4N320 PR221-I In320	2880	A145	A145	A110	E200DU200	60 - 200
160	280	T5N400 PR221-I In400	3600	A185	A185	A145	E200DU200	60 - 200
200	350	T5N630 PR221-I In630	4410	A210	A210	A185	E320DU320	100 - 320
250	430	T5N630 PR221-I In630	5670	A260	A260	A210	E320DU320	100 - 320
290	520	T6N630 PR221-I In630	6300	AF400	AF400	A260	E500DU500	150 - 500
315	540	T6N800 PR221-I In800	7200	AF400	AF400	A260	E500DU500	150 - 500
355	610	T6N800 PR221-I In800	8000	AF400	AF400	A260	E500DU500	150 - 500

جدول ۳-۳۴ کلیدهای حالت ۳۵kA، ۴۰۰V ، Y/Δ معمولی نوع ۲

(Tmax XT/T – Contactor – TOR/EOL)

Table 27: 400 V 50 kA Y/Δ Normal Type 2
(Tmax XT/T – Contactor – TOR/EOL)

Motor		Moulded Case Circuit Breaker		Contactor			Overload Relay	
Rated Power [kW]	Rated Current [A]	Type	I_3 [A]	Line Type	Delta Type	Star Type	Type	Current setting range [A]
18,5	35	XT2S160 MA52	469	A50	A50	A26	TA75DU25	18-25
22	41	XT2S160 MA52	547	A50	A50	A26	TA75DU32	22-32
30	55	XT2S160 MA80	720	A63	A63	A30	TA75DU42	29-42
37	66	XT2S160 MA80	840	A75	A75	A30	TA75DU52	36-52
45	80	XT2S160 MA100	1050	A75	A75	A30	TA75DU63	45 - 63
55	97	XT2S160 MA100	1200	A75	A75	A40	TA75DU63	45 - 63
75	132	XT3S250 MA160	1700	A95	A95	A75	TA110DU90	66 - 90
90	160	XT3S250 MA200	2000	A110	A110	A95	TA110DU110	80 - 110
110	195	XT3S250 MA200	2400	A145	A145	A95	TA200DU135	100 - 135
132	230	T4S320 PR221-I In320	2880	A145	A145	A110	E200DU200	60 - 200
160	280	T5S400 PR221-I In400	3600	A185	A185	A145	E200DU200	60 - 200
200	350	T5S630 PR221-I In630	4410	A210	A210	A185	E320DU320	100 - 320
250	430	T5S630 PR221-I In630	5670	A260	A260	A210	E320DU320	100 - 320
290	520	T6S630 PR221-I In630	6300	AF400	AF400	A260	E500DU500	150 - 500
315	540	T6S800 PR221-I In800	7200	AF400	AF400	A260	E500DU500	150 - 500
355	610	T6S800 PR221-I In800	8000	AF400	AF400	A260	E500DU500	150 - 500

جدول ۳-۳۵ کلیدهای حالت ۵۰kA، ۴۰۰V ، Y/Δ معمولی نوع ۲

(Tmax XT/T – Contactor – TOR/EOL)

Table 28: 440 V 50 kA Y/Δ Normal Type 2
(Tmax XT/T – Contactor – TOR/EOL)

Motor		Moulded Case Circuit Breaker		Contactor			Overload Relay	
Rated Power [kW]	Rated Current [A]	Type	I_3 [A]	Line Type	Delta Type	Star Type	Type	Current setting range [A]
18,5	30,7	XT2S160 MA52	392	A50	A50	A16	TA75DU25	18-25
22	35,9	XT2S160 MA52	469	A50	A50	A26	TA75DU25	18-25
30	48,2	XT2S160 MA80	720	A63	A63	A26	TA75DU42	29-42
37	58	XT2S160 MA80	840	A75	A75	A30	TA75DU42	29-42
45	70	XT2S160 MA80	960	A75	A75	A30	TA75DU52	36-52
55	85	XT2S160 MA100	1150	A75	A75	A40	TA75DU63	45-63
75	116	XT4S250 Ekip-I In250	1625	A95	A95	A75	TA80DU80	60-80
90	140	XT4S250 Ekip-I In250	1875	A95	A95	A75	TA110DU110	80-110
110	171	XT4S250 Ekip-I In250	2250	A145	A145	A95	E200DU200	60-200
132	202	T4H320 PR221-I In320	2720	A145	A145	A110	E200DU200	60-200
160	245	T5H400 PR221-I In400	3200	A185	A185	A145	E200DU200	60-200
200	307	T5H630 PR221-I In630	4095	A210	A210	A185	E320DU320	100-320
250	377	T5H630 PR221-I In630	5040	A260	A260	A210	E320DU320	100-320
290	448	T6H630 PR221-I In630	5670	AF400	AF400	A260	E500DU500	150 - 500
315	473	T6H630 PR221-I In630	6300	AF400	AF400	A260	E500DU500	150 - 500
355	535	T6H800 PR221-I In800	7200	AF400	AF400	A260	E500DU500	150 - 500

جدول ۳-۳۶ کلیدهای حالت ۵۰kA، ۴۴۰V ، Y/Δ معمولی نوع ۲

(Tmax XT/T – Contactor – TOR/EOL)

Table 29: 440 V 65 kA Y/Δ Normal Type 2
(Tmax XT/T – Contactor – TOR/EOL)

Motor		Moulded Case Circuit Breaker		Contactor			Overload Relay	
Rated Power [kW]	Rated Current [A]	Type	I_3 [A]	Line Type	Delta Type	Star Type	Type	Current setting range [A]
18,5	30,7	XT2H160 MA52	392	A50	A50	A16	TA75DU25	18-25
22	35,9	XT2H160 MA52	469	A50	A50	A26	TA75DU25	18-25
30	48,2	XT2H160 MA80	720	A63	A63	A26	TA75DU42	29-42
37	58	XT2H160 MA80	840	A75	A75	A30	TA75DU42	29-42
45	70	XT2H160 MA80	960	A75	A75	A30	TA75DU52	36-52
55	85	XT2H160 MA100	1150	A75	A75	A40	TA75DU63	45-63
75	116	XT4H250 Ekip-I In250	1625	A95	A95	A75	TA80DU80	60-80
90	140	XT4H250 Ekip-I In250	1875	A95	A95	A75	TA110DU110	80-110
110	171	XT4H250 Ekip-I In250	2250	A145	A145	A95	E200DU200	60-200
132	202	T4H320 PR221-I In320	2720	A145	A145	A110	E200DU200	60-200
160	245	T5H400 PR221-I In400	3200	A185	A185	A145	E200DU200	60-200
200	307	T5H630 PR221-I In630	4095	A210	A210	A185	E320DU320	100-320
250	377	T5H630 PR221-I In630	5040	A260	A260	A210	E320DU320	100-320
290	448	T6H630 PR221-I In630	5670	AF400	AF400	A260	E500DU500	150 - 500
315	473	T6H630 PR221-I In630	6300	AF400	AF400	A260	E500DU500	150 - 500
355	535	T6H800 PR221-I In800	7200	AF400	AF400	A260	E500DU500	150 - 500

جدول ۳-۳۷ کلیدهای حالت ۶۵kA، ۴۴۰V ، Y/Δ معمولی نوع ۲

(Tmax XT/T – Contactor – TOR/EOL)

Table 30: 500 V 50 kA Y/Δ Normal Type 2
(Tmax XT/T – Contactor – TOR/EOL)

Motor		Moulded Case Circuit Breaker		Contactor			Overload Relay	
Rated Power [kW]	Rated Current [A]	Type	I_3 [A]	Line Type	Delta Type	Star Type	Type	Current setting range [A]
22	33	XT2H160 MA52	430	A50	A50	A16	TA75DU25	18-25
30	44	XT2H160 MA52	547	A63	A63	A26	TA75DU32	22-32
37	53	XT2H160 MA80	720	A75	A75	A30	TA75DU42	29-42
45	64	XT2H160 MA80	840	A75	A75	A30	TA75DU52	36-52
55	78	XT2H160 MA100	1050	A75	A75	A30	TA75DU52	36-52
75	106	XT4H250 Ekip-I In250	1375	A95	A95	A50	TA80DU80	60-80
90	128	XT4H250 Ekip-I In250	1750	A95	A95	A75	TA110DU90	65-90
110	156	XT4H250 Ekip-I In250	2000	A110	A110	A95	TA110DU110	80-110
132	184	T4H320 PR221-I In320	2560	A145	A145	A95	E200DU200	60-200
160	224	T4H320 PR221-I In320	2880	A145	A145	A110	E200DU200	60-200
200	280	T5H400 PR221-I In400	3400	A210	A210	A145	E320DU320	100-320
250	344	T5H630 PR221-I In630	4410	A210	A210	A185	E320DU320	100-320
290	394	T5H630 PR221-I In630	5040	A260	A260	A210	E320DU320	100-320
315	432	T6L630 PR221-I In630	5760	AF400	AF400	A210	E500DU500	150 - 500
355	488	T6L630 PR221-I In630	6300	AF400	AF400	A260	E500DU500	150 - 500

جدول ۳-۳۸ کلیدهای حالت ۵۰kA ،۵۰۰V ، Y/Δ معمولی نوع ۲

(Tmax XT/T – Contactor – TOR/EOL)

Table 31: 690 V 25 kA Y/Δ Normal Type 2
(Tmax XT – Contactor – TOR/EOL)

Motor		Moulded Case Circuit Breaker		Contactor			KORC		Overload Relay	
Rated Power [kW]	Rated Current [A]	Type	I_3 [A]	Line Type	Delta Type	Star Type	Type	N° of turns	Type	Current setting range [A]
5,5	6.7*	XT4V250 Ekip-I In100	150	A95	A95	A26	185R/4**	13	TA25DU2.4**	6-8.5
7,5	8.9*	XT4V250 Ekip-I In100	150	A95	A95	A26	185R/4**	10	TA25DU2.4**	7.9-11.1
11	12.8*	XT4V250 Ekip-I In100	200	A95	A95	A26	185R/4**	7	TA25DU2.4**	11.2-15.9
15	17*	XT4V250 Ekip-I In100	250	A95	A95	A26	185R/4**	7	TA25DU3.1**	15.2-20.5
18,5	21	XT4V250 Ekip-I In100	300	A95	A95	A30	185R/4**	6	TA25DU3.1**	17.7-23.9
22	24	XT4V250 Ekip-I In100	350	A95	A95	A30	185R/4**	6	TA25DU4**	21.6-30.8
30	32	XT4V250 Ekip-I In100	450	A145	A145	A30	185R/4**	6	TA25DU5**	27-38.5
37	39	XT4V250 Ekip-I In100	550	A145	A145	A30			TA75DU52**	36-52
45	47	XT4V250 Ekip-I In100	650	A145	A145	A30			TA75DU52**	36 - 52
55	57	XT4V250 Ekip-I In100	800	A145	A145	A40			TA75DU52**	36-52
75	77	XT4V250 Ekip-I In160	1120	A145	A145	A50			TA75DU52	36 - 52
90	93	XT4V250 Ekip-I In160	1280	A145	A145	A75			TA75DU63	45-63
110	113	XT4V250 Ekip-I In160	1600	A145	A145	A75			TA75DU80	60-80
132	134	XT4V250 Ekip-I In250	1875	A145	A145	A95			TA200DU110	80-110
160	162	XT4V250 Ekip-I In250	2125	A145	A145	A110			TA200DU110	80-110

جدول ۳-۳۹ کلیدهای حالت ۲۵kA، ۶۹۰V ، Y/Δ معمولی نوع ۲
(Tmax XT – Contactor – TOR/EOL)

Table 32: 690 V 50 kA Y/Δ Normal Type 2
(Tmax T – Contactor – TOR/EOL)

Motor		Moulded Case Circuit Breaker		Contactor			KORC		Overload Relay	
Rated Power [kW]	Rated Current [A]	Type	I_3 [A]	Line Type	Delta Type	Star Type	Type	N° of turns	Type	Current setting range [A]
5,5	6.7*	T4L250 PR221-I In100	150	A95	A95	A26	4L185R/4**	13	TA25DU2.4**	6-8.5
7,5	8.9*	T4L250 PR221-I In100	150	A95	A95	A26	4L185R/4**	10	TA25DU2.4**	7.9-11.1
11	12.8*	T4L250 PR221-I In100	200	A95	A95	A26	4L185R/4**	7	TA25DU2.4**	11.2-15.9
15	17*	T4L250 PR221-I In100	250	A95	A95	A26	4L185R/4**	7	TA25DU3.1**	15.2-20.5
18,5	21	T4L250 PR221-I In100	300	A95	A95	A30	4L185R/4**	6	TA25DU3.1**	17.7-23.9
22	24	T4L250 PR221-I In100	350	A95	A95	A30	4L185R/4**	6	TA25DU4**	21.6-30.8
30	32	T4L250 PR221-I In100	450	A145	A145	A30	4L185R/4**	6	TA25DU5**	27-38.5
37	39	T4L250 PR221-I In100	550	A145	A145	A30			TA75DU52**	36-52
45	47	T4L250 PR221-I In100	650	A145	A145	A30			TA75DU52**	36 - 52
55	57	T4L250 PR221-I In100	800	A145	A145	A40			TA75DU52**	36-52
75	77	T4L250 PR221-I In160	1120	A145	A145	A50			TA75DU52	36 - 52
90	93	T4L250 PR221-I In160	1280	A145	A145	A75			TA75DU63	45-63
110	113	T4L250 PR221-I In160	1600	A145	A145	A75			TA75DU80	60-80
132	134	T4L250 PR221-I In250	1875	A145	A145	A95			TA200DU110	80-110
160	162	T4L250 PR221-I In250	2125	A145	A145	A110			TA200DU110	80-110
200	203	T4L320 PR221-I In320	2720	A185	A185	A110			TA200DU135	100-135
250	250	T5L400 PR221-I In400	3200	AF400	AF400	A145			E500DU500	150-500
290	301	T5L400 PR221-I In400	4000	AF400	AF400	A145			E500DU500	150-500
315	313	T5L630 PR221-I In630	4410	AF400	AF400	A185			E500DU500	150-500
355	354	T5L630 PR221-I In630	5040	AF400	AF400	A210			E500DU500	150-500
400	420	T5L630 PR221-I In630	5670	AF460	AF460	A210			E500DU500	150-500
450	470	T5L630 PR221-I In630	6300	AF460	AF460	A260			E500DU500	150-500

جدول ۳-۴۰ کلیدهای حالت ۵۰kA، ۶۹۰V ، Y/Δ معمولی نوع ۲

(Tmax T – Contactor – TOR/EOL)

Table 33: 400 V 35 kA DOL Normal and Heavy duty Type 2
(Tmax XT/T with Ekip M/PR222MP – Contactor)

Motor		Moulded Case Circuit Breaker			Contactor	Allowed setting current [A]
Rated Power [kW]	Rated Current [A]	Type***	Inverse time tripping current* [A]	I_3 [A]	Type	
7,5	15,5	XT2N160 Ekip M-LIU In25	10-25	150	A63	25
11	22	XT2N160 Ekip M-LIU In25	10-25	225	A63	25
15	29	XT2N160 Ekip M-LIU In63	25-63	378	A75	50
18,5	35	XT2N160 Ekip M-LIU In63	25-63	378	A75	50
22	41	XT2N160 Ekip M-LIU In63	25-63	441	A75	50
30	55	XT4N250 Ekip M-LIU In100	40-100	600	A95	95
37	66	XT4N250 Ekip M-LIU In100	40-100	700	A95	95
45	80	XT4N250 Ekip M-LIU In100	40-100	800	A95	95
55	97	XT4N250 Ekip M-LIU In160	64-160	960	A145	145
75	132	XT4N250 Ekip M-LIU In160	64-160	1280	A145	145
90	160	T4N250 PR222 MP In200	80-200	1600	A185	185
110	195	T5N400 PR222 MP In320	128-320	1920	A210	210
132	230	T5N400 PR222 MP In320	128-320	2240	A260	260
160	280	T5N400 PR222 MP In320	128-320	2560	AF400**	320
200	350	T5N400 PR222 MP In400	160-400	3200	AF400	400
250	430	T6N800 PR222 MP In630	252-630	5040	AF460	460
290	520	T6N800 PR222 MP In630	252-630	5670	AF580	580
315	540	T6N800 PR222 MP In630	252-630	5670	AF580	580
355	610	T6N800 PR222 MP In630	252-630	5670	AF750	630

جدول ۳-۴۱ کلیدهای حالت ۳۵kA، ۴۰۰V ، DOL معمولی و سخت‌کار نوع ۲

(Tmax XT/T with Ekip M/PR222MP – Contactor)

Table 34: 400 V 50 kA DOL Normal and Heavy duty Type 2
(Tmax XT/T with Ekip M/PR222MP – Contactor)

Motor		Moulded Case Circuit Breaker			Contactor	Allowed setting current [A]
Rated Power [kW]	Rated Current [A]	Type***	Inverse time tripping current* [A]	I_3 [A]	Type	
7,5	15,5	XT2S160 Ekip M-LIU In25	10-25	150	A63	25
11	22	XT2S160 Ekip M-LIU In25	10-25	225	A63	25
15	29	XT2S160 Ekip M-LIU In63	25-63	378	A75	50
18,5	35	XT2S160 Ekip M-LIU In63	25-63	378	A75	50
22	41	XT2S160 Ekip M-LIU In63	25-63	441	A75	50
30	55	XT4S250 Ekip M-LIU In100	40-100	600	A95	95
37	66	XT4S250 Ekip M-LIU In100	40-100	700	A95	95
45	80	XT4S250 Ekip M-LIU In100	40-100	800	A95	95
55	97	XT4S250 Ekip M-LIU In160	64-160	960	A145	145
75	132	XT4S250 Ekip M-LIU In160	64-160	1280	A145	145
90	160	T4S250 PR222 MP In200	80-200	1600	A185	185
110	195	T5S400 PR222 MP In320	128-320	1920	A210	210
132	230	T5S400 PR222 MP In320	128-320	2240	A260	260
160	280	T5S400 PR222 MP In320	128-320	2560	AF400**	320
200	350	T5S400 PR222 MP In400	160-400	3200	AF400	400
250	430	T6S800 PR222 MP In630	252-630	5040	AF460	460
290	520	T6S800 PR222 MP In630	252-630	5670	AF580	580
315	540	T6S800 PR222 MP In630	252-630	5670	AF580	580
355	610	T6S800 PR222 MP In630	252-630	5670	AF750	630

جدول ۳-۴۲ کلیدهای حالت ۵۰kA ،۴۰۰V ، DOL معمولی و سخت‌کار نوع ۲

(Tmax XT/T with Ekip M/PR222MP – Contactor)

Table 35: 440 V 50 kA DOL Normal and Heavy duty Type 2
(Tmax XT/T with Ekip M/PR222MP – Contactor)

Motor		Moulded Case Circuit Breaker			Contactor	Allowed setting current [A]
Rated Power [kW]	Rated Current [A]	Type***	Inverse time tripping current* [A]	I_3 [A]	Type	
7,5	13,6	XT2S160 Ekip M-LIU In25	10-25	150	A63	25
11	19,3	XT2S160 Ekip M-LIU In25	10-25	225	A63	25
15	25,4	XT2S160 Ekip M-LIU In63	25-63	378	A75	63
18,5	30,7	XT2S160 Ekip M-LIU In63	25-63	378	A75	63
22	35,9	XT2S160 Ekip M-LIU In63	25-63	378	A75	63
30	48,2	XT4S250 Ekip M-LIU In100	40-100	600	A95	93
37	58	XT4S250 Ekip M-LIU In100	40-100	600	A95	93
45	70	XT4S250 Ekip M-LIU In100	40-100	700	A95	93
55	85	XT4S250 Ekip M-LIU In160	64-160	960	A145	145
75	116	XT4S250 Ekip M-LIU In160	64-160	1120	A145	145
90	140	T4H250 PR222 MP In200	80-200	1400	A185	185
110	171	T5H400 PR222 MP In320	128-320	1920	A210	210
132	202	T5H400 PR222 MP In320	128-320	2240	A260	240
160	245	T5H400 PR222 MP In320	128-320	2560	AF400**	320
200	307	T5H400 PR222 MP In400	160-400	3200	AF400	400
250	377	T6H800 PR222 MP In630	252-630	4410	AF460	460
290	448	T6H800 PR222 MP In630	252-630	5040	AF460	460
315	473	T6H800 PR222 MP In630	252-630	5040	AF580	580
355	535	T6H800 PR222 MP In630	252-630	5670	AF580	580

جدول ۳-۴۳ کلیدهای حالت DOL ، ۴۴۰V، ۵۰kA معمولی و سخت‌کار نوع ۲

(Tmax XT/T with Ekip M/PR222MP – Contactor)

Table 36: 690 V 25 kA DOL Normal and Heavy duty Type 2
(Tmax T with Ekip M – Contactor)

Motor		Moulded Case Circuit Breaker			Contactor	Allowed setting current [A]
Rated Power [kW]	Rated Current [A]	Type	Inverse time tripping current* [A]	I_3 [A]	Type	
11	12,8	XT2V160 EKIP M-LIU In25	10-25	150	A63	25
15	17	XT2V160 EKIP M-LIU In25	10-25	175	A63	25
18,5	21	XT2V160 EKIP M-LIU In25	10-25	225	A75	25
22	24	XT2V160 EKIP M-LIU In63	25-63	250	A75	63
30	32	XT2V160 EKIP M-LIU In63	25-63	378	A95	63
37	39	XT2V250 EKIP M-LIU In63	25-63	378	A95	63
45	47	XT2V250 EKIP M-LIU In63	25-63	504	A145	63
55	57	XT4V250 EKIP M-LIU In63	25-63	567	A145	63
75	77	XT4V250 EKIP M-LIU In100	40-100	800	A145	100
90	93	XT4V250 EKIP M-LIU In160	64-160	960	A145	120
110	113	XT4V250 EKIP M-LIU In160	64-160	1120	A145	120
132	134	XT4V250 EKIP M-LIU In160	64-160	1440	A185	160

جدول ۳-۴۴ کلیدهای حالت ۲۵kA، ۶۹۰V ، DOL معمولی و سخت‌کار نوع ۲
(Tmax T with Ekip M – Contactor)

Table 37: 500 V 50 kA DOL Normal and Heavy duty Type 2
(Tmax XT/T with Ekip M/PR222MP – Contactor)

Motor		Moulded Case Circuit Breaker			Contactor	Allowed setting current [A]
Rated Power [kW]	Rated Current [A]	Type***	Inverse time tripping current* [A]	I_3 [A]	Type	
7,5	12,4	XT2H160 Ekip M-LIU In25	10-25	150	A63	25
11	17,6	XT2H160 Ekip M-LIU In25	10-25	175	A63	25
15	23	XT2H160 Ekip M-LIU In25	10-25	250	A75	25
18,5	28	XT2H160 Ekip M-LIU In63	25-63	378	A75	63
22	33	XT2H160 Ekip M-LIU In63	25-63	378	A75	63
30	44	XT4H250 Ekip M-LIU In63	25-63	441	A95	63
37	53	XT4H250 Ekip M-LIU In63	25-63	567	A95	63
45	64	XT4H250 Ekip M-LIU In100	40-100	630	A145	100
55	78	XT4H250 Ekip M-LIU In100	40-100	800	A145	100
75	106	XT4H250 Ekip M-LIU In160	64-160	1120	A145	145
90	128	XT4H250 Ekip M-LIU In160	64-160	1280	A145	145
110	156	T4H250 PR222 MP In200	80-200	1600	A185	170
132	184	T5H400 PR222 MP In320	128-320	1920	A210	210
160	224	T5H400 PR222 MP In320	128-320	2240	A260	240
200	280	T5H400 PR222 MP In400	160-400	2800	AF400**	400
250	344	T5H400 PR222 MP In400	160-400	3200	AF400	400
290	394	T6H800 PR222 MP In630	252-630	5040	AF460	460
315	432	T6H800 PR222 MP In630	252-630	5040	AF460	460
355	488	T6H800 PR222 MP In630	252-630	5670	AF580	580

جدول ۳-۴۵ کلیدهای حالت DOL ، ۵۰۰V، ۵۰kA معمولی و سخت‌کار نوع ۲

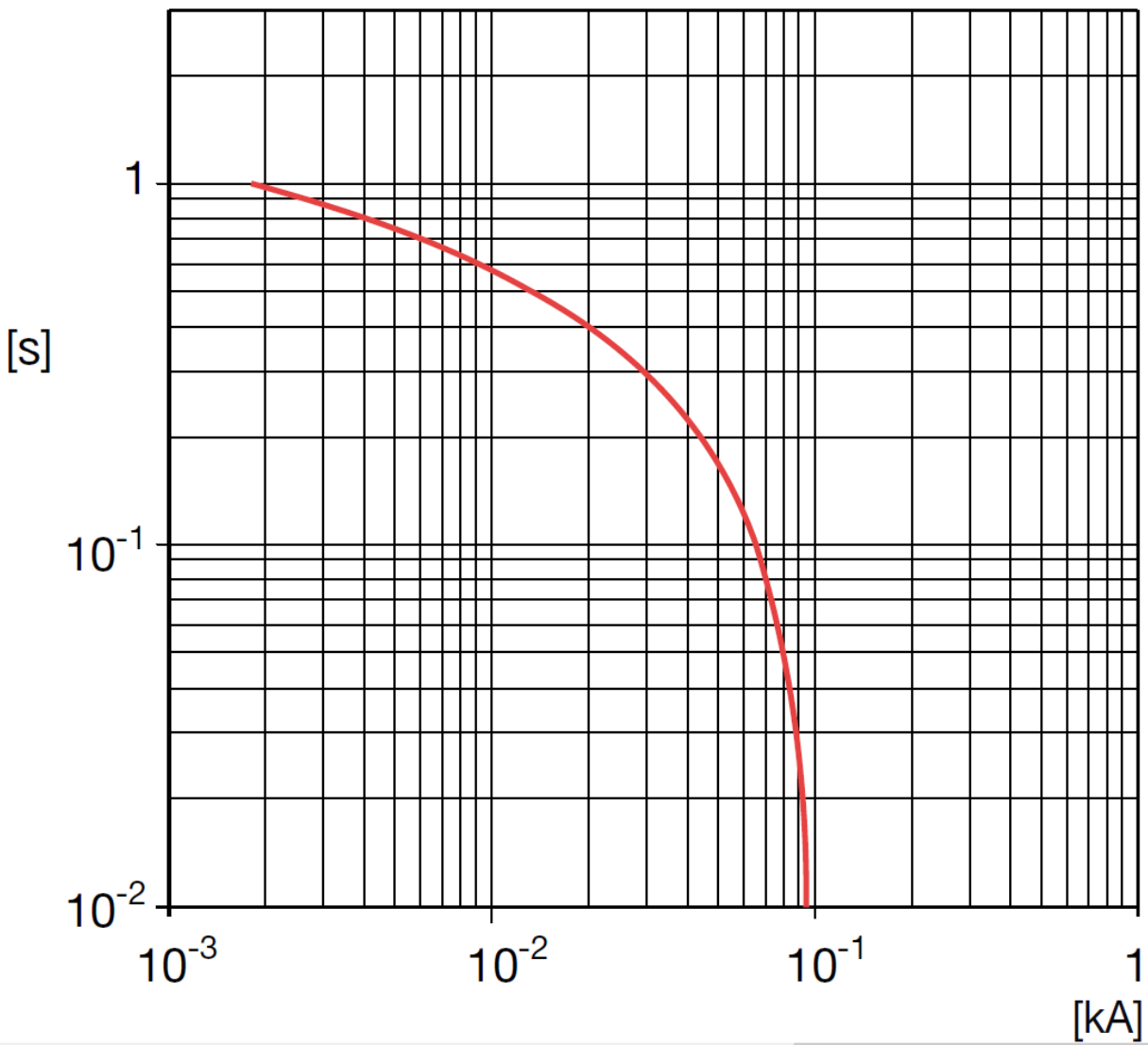
(Tmax XT/T with Ekip M/PR222MP – Contactor)

Table 38: 690 V 50 kA DOL Normal and Heavy duty Type 2
(Tmax T with PR222MP – Contactor)

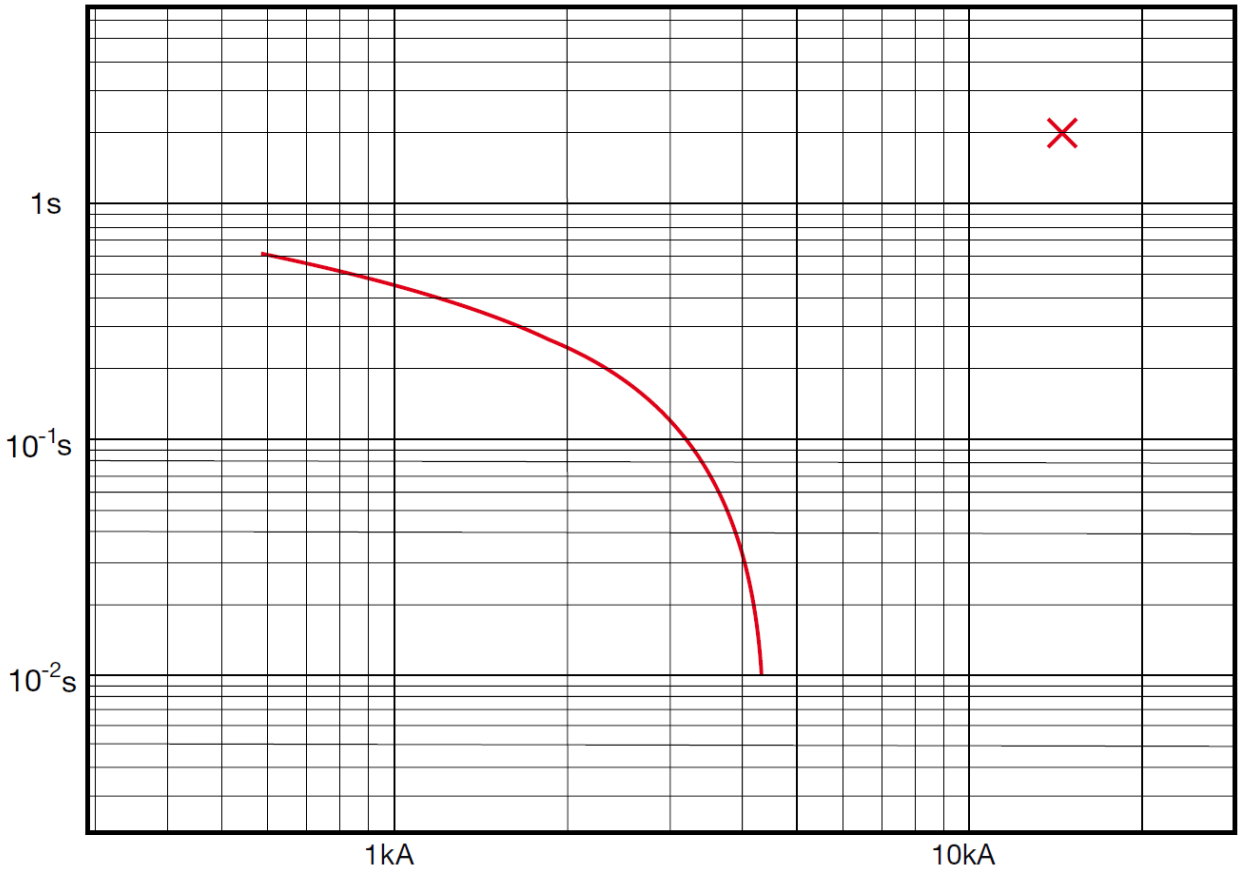
Motor		Moulded Case Circuit Breaker			Contactor	Allowed setting current [A]
Rated Power [kW]	Rated Current [A]	Type	Inverse time tripping current* [A]	I_3 [A]	Type	
45	47	T4L250 PR222MP In 100	40-100	600	A145	100
55	57	T4L250 PR222MP In 100	40-100	600	A145	100
75	77	T4L250 PR222MP In 100	40-100	800	A145	100
90	93	T4L250 PR222MP In 160	64-160	960	A145	120
110	113	T4L250 PR222MP In 160	64-160	1120	A145	120
132	134	T4L250 PR222MP In 160	64-160	1440	A185	160
160	162	T4L250 PR222MP In 200	80-200	1600	A185	170
200	203	T5L400 PR222MP In320	128-320	1920	A210	210
250	250	T5L400 PR222MP In320	128-320	2240	AF300	280
290	301	T5L400 PR222MP In400	160-400	2800	AF400	350
315	313	T5L400 PR222MP In400	160-400	3200	AF400	350

جدول ۳-۴۶ کلیدهای حالت ۵۰kA، ۶۹۰V ، DOL معمولی و سخت‌کار نوع ۲

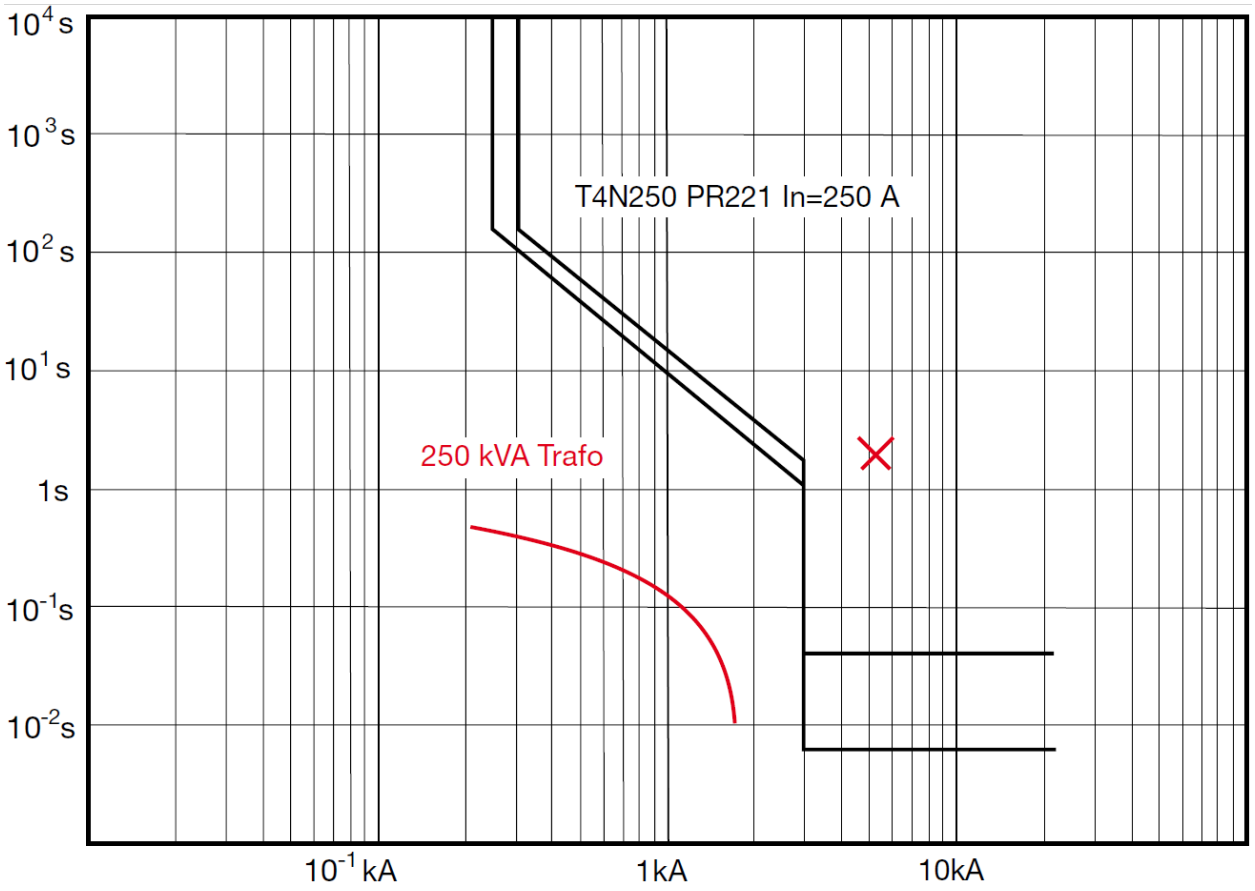
(Tmax T with PR222MP – Contactor)



شکل ۳-۱۰ جریان هجومی یک ترانسفورمر $\frac{۲۰}{۰.۴}kV$، ۴۰۰ kVA



شکل ۳-۱۱ جریان هجومی به‌همراه نقطه متناظر با جریان اتصال کوتاه مجاز ۲ ثانیه‌ای ترانسفورمر



شکل ۳-۱۲ انتخاب کلید اتوماتیک مناسب برای شکل ۳-۱۱

V1n=400

Transformer		ABB SACE Circuit-breaker			
		Circuit-breaker with thermomagnetic release		Circuit-breaker with electronic release	
S_r [kVA]	Trafo I_r [A]	Type	In [A]	Type	In [A]
1 x 63	91	XT1B-C-N-S-H	125	XT2N-S-H-L-V	160
1 x 100	144	XT3N-S	200	XT4N-S-H-L-V	250
1 x 125	180	XT3N-S	250	XT4N-S-H-L-V	250
1 x 160	231	XT4N-S-H-L-V	250	XT4N-S-H-L-V	250
1 x 200	289	T5N-S-H-L-V	320	T5N-S-H-L-V	400
1 x 250	361	T5N-S-H-L-V	400	T5N-S-H-L-V	400
1 x 315	455	T5N-S-H-L-V	500	T5N-S-H-L -V	630
1 x 400	577	T6N-S-H-L	630	T6N-S-H-L -V	630
1 x 500	722	T6N-S-H-L	800	T6N-S-H-L	800
1 x 630	909	-	-	T7S-H-L-V/ X1B-N	1000
1 x 800	1155	-	-	T7S-H-L-V/ X1B-N	1250
1 x 1000	1443	-	-	T7S-H-L / X1B-N	1600
1 x 1250	1804	-	-	E2B-N-S	2000
1 x 1600	2309	-	-	E3N-S-H-V	2500
1 x 2000	2887	-	-	E3N-S-H-V	3200

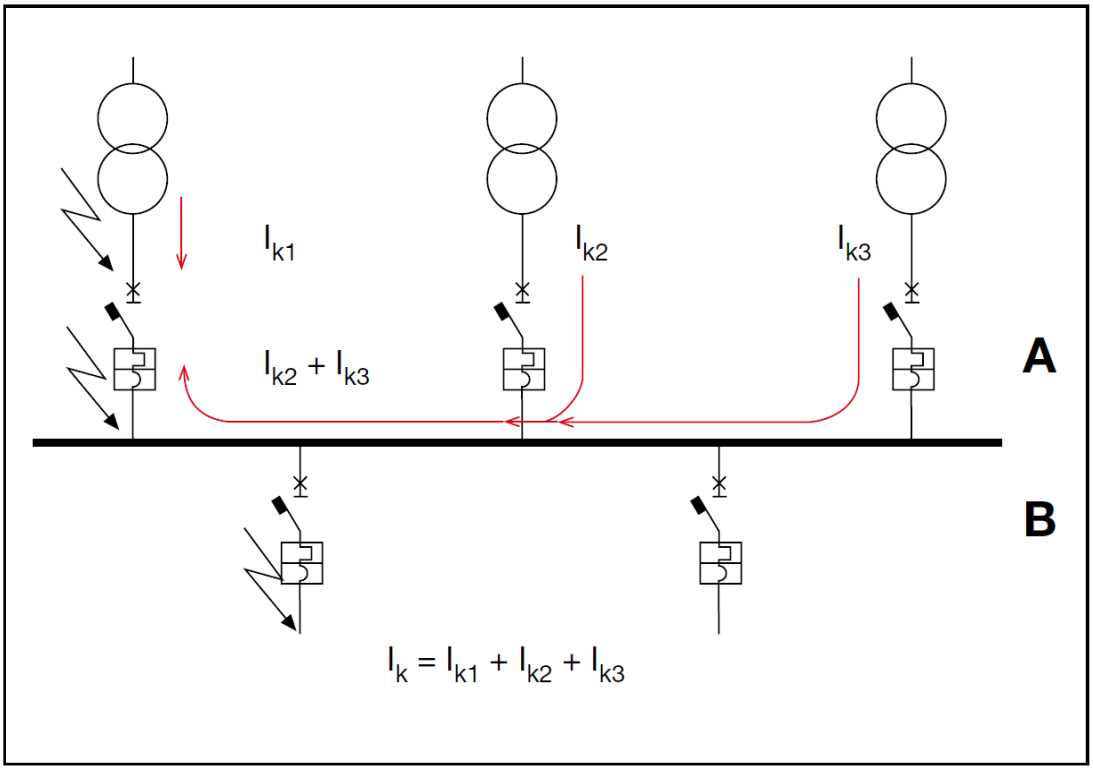
V1n=440

Transformer		ABB SACE Circuit-breaker			
		Circuit-breaker with thermomagnetic release		Circuit-breaker with electronic release	
S_r [kVA]	Trafo I_r [A]	Type	In [A]	Type	In [A]
1 x 63	83	XT1B-C-N-S-H	125	XT2N-S-H-L-V	160
1 x 100	131	XT3N-S	200	XT4N-S-H-L-V	250
1 x 125	164	XT3N-S	200	XT4N-S-H-L-V	250
1 x 160	210	XT4N-S-H-L-V	250	XT4N-S-H-L-V	250
1 x 200	262	T5N-S-H-L-V	320	T5N-S-H-L -V	400
1 x 250	328	T5N-S-H-L-V	400	T5N-S-H-L -V	400
1 x 315	413	T5N-S-H-L-V	500	T5N-S-H-L -V	630
1 x 400	526	T6N-S-H-L	630	T6N-S-H-L	630
1 x 500	656	T6N-S-H-L	800	T6N-S-H-L	800
1 x 630	827	-	-	T7S-H-L-V-X1B-N	1000
1 x 800	1050	-	-	T7S-H-L-V/ X1B-N	1250
1 x 1000	1312	-	-	T7S-H-L / X1B-N	1600
1 x 1250	1640	-	-	E2B-N-S	2000
1 x 1600	2099	-	-	E3N-S-H-V	2500
1 x 2000	2624	-	-	E3N-S-H-V	3200

Vn=690

Transformer		ABB SACE Circuit-breaker			
		Circuit-breaker with thermomagnetic release		Circuit-breaker with electronic release	
S_r [kVA]	Trafo I_r [A]	Type	In [A]	Type	In [A]
1 x 63	53	XT1B-C-N-S-H	80	XT2N-S-H-L-V	80
1 x 100	84	XT1B-C-N-S-H	125	XT2N-S-H-L-V	160
1 x 125	105	XT1B-C-N-S-H	125	XT2N-S-H-L-V	160
1 x 160	134	XT1B-C-N-S-H	160	XT2N-S-H-L-V	160
1 x 200	168	XT3N-S	200	XT4N-S-H-L-V	250
1 x 250	209	XT4N-S-H-L-V	250	XT4N-S-H-L-V	250
1 x 315	264	T5N-S-H-L-V	320	T5N-S-H-L-V	400
1 x 400	335	T5N-S-H-L-V	400	T5N-S-H-L-V	400
1 x 500	419	T5N-S-H-L-V	500	T5N-S-H-L-V	630
1 x 630	528	T6N-S-H-L	630	T6N-S-H-L	800
1 x 800	670	T6N-S-H-L	800	T6N-S-H-L	800
1 x 1000	838	-	-	T7S-H-L-V/ X1B-N	1000
1 x 1250	1047	-	-	T7S-H-L-V/ X1B-N	1250
1 x 1600	1340	-	-	T7S-H-L / X1B-N	1600
1 x 2000	1676	-	-	E2B-N-S	2000

جدول ۳-۴۷ کلیدهای اتوماتیک مجهز به رله‌های ترمومغناطیسی یا الکترونیکی، برای ترانسفورماتورها



شکل ۳-۱۳ جریان‌های اتصال کوتاه در یک پست سه ترانسه

Table 1: Protection and switching of 230 V transformers

Transformer				Circuit-breaker "A" (LV side)															
S_r	u_k	Trafo I_r	Busbar I_b	Trafo feeder I_k	ABB SACE Circuit-breaker	Release size In [A]	Release minimum setting	Busbar I_k											
[kVA]	[%]	[A]	[A]	[kA]				[kA]	32 A	63 A	125 A	160 A	250 A	400 A	630 A	800 A	1000 A	1250 A	1600 A	2000 A	2500 A	3200 A	4000 A
1 x 63	4	158	158	3.9	XT1B160*	160	1	3.9	S200		XT1B160												
2 x 63		158	316	3.9	XT1B160*	160	1	7.9	S200		XT1B160		XT3N250										
1 x 100	4	251	251	6.3	T4N320	320	0.79	6.3	S200		XT1B160												
2 x 100		251	502	6.2	T4N320	320	0.79	12.5	S200		XT1B160		XT3N250	T5N400									
1 x 125	4	314	314	7.8	T5N400	400	0.79	7.8	S200		XT1B160		XT3N250										
2 x 125		314	628	7.8	T5N400	400	0.79	15.6	S200		XT1B160		XT3N250	T5N400									
1 x 160	4	402	402	10.0	T5N630	630	0.64	10.0	S200		XT1B160		XT3N250										
2 x 160		402	803	9.9	T5N630	630	0.64	19.9	S200		XT1B160		XT3N250	T5N400	T5N630								
1 x 200	4	502	502	12.5	T5N630	630	0.8	12.5	S200		XT1B160		XT3N250	T5N400									
2 x 200		502	1004	12.4	T5N630	630	0.8	24.8	XT1B160				XT3N250	T5N400	T5N630								
1 x 250	4	628	628	15.6	T5N630	630	1	15.6	S200		XT1B160		XT3N250	T5N400									
2 x 250		628	1255	15.4	T5N630	630	1	30.9	XT1C160				XT3N250	T5N400	T5N630	T6N800/X1B800							
1 x 315	4	791	791	19.6	T6N800	800	1	19.6	XT1B160				XT3N250	T5N400	T5N630								
2 x 315		791	1581	19.4	T6N800	800	1	38.7	XT1C160				XT3N250	T5N400	T5N630	T6N800/X1B800	T7S1000/X1B1000	T7S1250/X1B1250					
1 x 400	4	1004	1004	24.8	T7S1250/X1B1250**	1250	0.81	24.8	XT1B160				XT3N250	T5N400	T5N630	T6N800/X1B800							
2 x 400		1004	2008	24.5	T7S1250/X1B1250**	1250	0.81	48.9	XT1N160				XT3N250	T5N400	T5N630	T6N800/X1N800	T7S1000/X1N1000	T7S1250/X1N1250	T7S1600/X1N1600				
1 x 500	4	1255	1255	30.9	T7S1600/X1B1600**	1600	0.79	30.9	XT1C160				XT3N250	T5N400	T5N630	T6N800/X1B800							
2 x 500		1255	2510	30.4	T7S1600/X1B1600**	1600	0.79	60.7	XT1N160				XT3S250	T5N400	T5N630	T6N800/X1N800	T7S1000/X1N1000	T7S1250/X1N1250	T7S1600/X1N1600	E2N2000			
1 x 630	4	1581	1581	38.7	T7S1600/X1B1600**	1600	1	38.7	XT1C160				XT3N250	T5N400	T5N630	T6N800/X1B800	T7S1000/X1B1000	T7S1250/X1B1250					
2 x 630		1581	3163	37.9	T7S1600/X1B1600**	1600	1	75.9	XT1S160				XT3S250	T5S400	T5S630	T6S800/E2S800	T7S1000/E2S1000	T7S1250/E2S1250	T7S1600/E2S1600	E2S2000	E3H2500		
3 x 630		1581	4744	74.4	T7S1600/E2S1600	1600	1	111.6	XT2L160				XT4L250	T5L400	T5L630	T6L800/E3V800	T7L1000/E3V1250	T7L1250/E3V1250	T7L1600/E3V1600	E3V2000	E3V2500	E3V3200	
1 x 800	5	2008	2008	39.3	E3N2500	2500	0.81	39.3	XT1C160				XT3N250	T5N400	T5N630	T6N800/X1B800	T7S1000/X1B1000	T7S1250/X1B1250	T7S1600/X1B1600				
2 x 800		2008	4016	38.5	E3N2500	2500	0.81	77.0	XT1S160				XT3S250	T5S400	T5S630	T6L800/E2S800	T7S1000/E2S1000	T7S1250/E2S1250	T7S1600/E2S1600	E2S2000	E3H2500	E3H3200	
3 x 800		2008	6025	75.5	E3H2500	2500	0.81	113.2	XT2L160				XT4L250	T5L400	T5L630	T6L800/E3V800	T7L1000/E3V1250	T7L1250/E3V1250	T7L1600/E3V1600	E3V2000	E3V2500	E4V3200	E4V4000
1 x 1000	5	2510	2510	48.9	E3N3200	3200	0.79	48.9	XT1N160				XT3N250	T5N400	T5N630	T6N800/X1N800	T7S1000/X1N1000	T7S1250/X1N1250	T7S1600/X1N1600	E2N2000			
2 x 1000		2510	5020	47.7	E3N3200	3200	0.79	95.3	XT1H160				XT4H250	T5H400	T5H630	T6H800/E3H800	T7H1000/E3H1000	T7H1250/E3H1250	T7H1600/E3H1600	E3H2000	E3H2500	E3H3200	E4H4000
3 x 1000		2510	7531	93.0	E3H3200	3200	0.79	139.5	XT2L160				XT4L250	T5L400	T5L630	T6L800	T7L1000	T7L1250	T7L1600	E4V3200	E4V3200	E4V3200	E4V4000
1 x 1250	5	3138	3138	60.7	E3N3200	3200	1	60.7	XT1N160				XT3S250	T5N400	T5N630	T6N800/X1N800	T7S1000/X1N1000	T7S1250/X1N1250	T7S1600/X1N1600	E2N2000	E3N2500		
2 x 1250		3138	6276	58.8	E3N3200	3200	1	117.7	XT2L160				XT4L250	T5L400	T5L630	T6L800/E3V800	T7L1000/E3V1250	T7L1250/E3V1250	T7L1600/E3V1600	E3V2000	E3V2500	E3V3200	E4V4000
3 x 1250		3138	9413	114.1	E4V3200	3200	1	171.2	XT2V160				XT4V250	T5L400	T5L630	T6L800	T7L1000	T7L1250	T7L1600				

Circuit-breaker "B" (Feeder circuit-breaker)

Feeder circuit-breaker type and rated current

جدول ۳-۴۹ تجهیزات حفاظت و سوئیچینگ ترانسفورماتورهای ۲۳۰V

Table 3: Protection and switching of 440 V transformers

Transformer				Circuit-breaker "A" (LV side)											Circuit-breaker "B" (Feeder circuit-breaker)								
S_r	u_k	Trafo I_r	Busbar I_b	Trafo feeder I_k	ABB SACE Circuit-breaker	Release		Busbar I_k							Feeder circuit-breaker type and rated current								
						size In [A]	minimum setting																
[kVA]	[%]	[A]	[A]	[kA]				[kA]	32 A	63 A	125 A	160 A	250 A	400 A	630 A	800 A	1000 A	1250 A	1600 A	2000 A	2500 A	3200 A	4000 A
1 x 63	4	83	83	2.1	XT1B160*	100	0.83	2.1	S200														
2 x 63		83	165	2.1	XT1B160*	100	0.83	4.1	S200		XT1B160												
1 x 100	4	131	131	3.3	XT1B160*	160	0.82	3.3	S200														
2 x 100		131	262	3.3	XT1B160*	160	0.82	6.5	XT1B160														
1 x 125	4	164	164	4.1	XT3N250*	200	0.82	4.1	S200		XT1B160												
2 x 125		164	328	4.1	XT3N250*	200	0.82	8.1	XT1B160				XT3N250										
1 x 160	4	210	210	5.2	XT3N250*	250	0.84	5.2	S200		XT1B160												
2 x 160		210	420	5.2	XT3N250*	250	0.84	10.4	XT1B160				XT3N250										
1 x 200	4	262	262	6.5	T4N320	320	0.82	6.5	XT1B160														
2 x 200		262	525	6.5	T4N320	320	0.82	12.9	XT1B160				XT3N250	T5N400									
1 x 250	4	328	328	8.1	T5N400	400	0.82	8.1	XT1B160				XT3N250										
2 x 250		328	656	8.1	T5N400	400	0.82	16.1	XT1C160				XT3N250	T5N400									
1 x 315	4	413	413	10.2	T5N630	630	0.66	10.2	XT1B160				XT3N250										
2 x 315		413	827	10.1	T5N630	630	0.66	20.2	XT1C160				XT3N250	T5N400	T5N630								
1 x 400	4	525	525	12.9	T5N630	630	0.83	12.9	XT1B160				XT3N250	T5N400									
2 x 400		525	1050	12.8	T5N630	630	0.83	25.6	XT1N160				XT3S250	T5N400	T5N630								
1 x 500	4	656	656	16.1	T6N800	800	0.82	16.1	XT1C160				XT3N250	T5N400									
2 x 500		656	1312	15.9	T6N800	800	0.82	31.7	XT1N160				XT3S250	T5S400	T5S630	T6S800/X1B800							
1 x 630	4	827	827	20.2	T7S1000/X1B1000**	1000	0.83	20.2	XT1C160				XT3N250	T5N400	T5N630								
2 x 630		827	1653	19.8	T7S1000/X1B1000**	1000	0.83	39.7	XT1S160				XT3S250	T5S400	T5S630	T6S800/X1B800	T7S1000/X1B1000	T7S1250/X1B1250					
3 x 630		827	2480	38.9	T7S1000/X1B1000**	1000	0.83	58.3	XT1H160				XT4H250	T5H400	T5H630	T6L800/X1N800	T7H1000/X1N1000	T7H1250/X1N1250	T7H1600/X1N1600	E2N2000			
1 x 800	5	1050	1050	20.6	T7S1250/X1B1250**	1250	0.84	20.6	XT1C160				XT3N250	T5N400	T5N630	T6N800/X1B800							
2 x 800		1050	2099	20.1	T7S1250/X1B1250**	1250	0.84	40.3	XT1S160				XT4S250	T5H400	T5H630	T6S800/X1B800	T7S1000/X1B1000	T7S1250/X1B1250	T7S1600/X1B1600				
3 x 800		1050	3149	39.5	T7S1250/X1B1250**	1250	0.84	59.2	XT1H160				XT4H250	T5H400	T5H630	T6L800/X1N800	T7H1000/X1N1000	T7H1250/X1N1250	T7H1600/X1N1600	E2N2000	E3N2500	E3N3200	E4S4000
1 x 1000	5	1312	1312	25.6	T7S1600/X1B1600**	1600	0.82	25.6	XT1N160				XT3S250	T5N400	T5N630	T6N800/X1B800							
2 x 1000		1312	2624	24.9	T7S1600/X1B1600**	1600	0.82	49.8	XT1S160				XT4S250	T5H400	T5H630	T6H800/E1N800	T7S1000/X1N1000	T7S1250/X1N1250	T7S1600/X1N1600	E2N2000			
3 x 1000		1312	3936	48.6	T7H1600/X1N1600**	1600	0.82	72.9	XT2L160				XT4L250	T5L400	T5L630	T6L800/E2S800	T7L1000/E2S1000	T7L1250/E2S1250	T7L1600/E2S1600	E3S2000	E3S2500	E3S3200	
1 x 1250	5	1640	1640	31.7	E2B2000	2000	0.82	31.7	XT1N160				XT3S250	T5S400	T5S630	T6S800/X1B800	T7S1000/X1B1000	T7S1250/X1B1250					
2 x 1250		1640	3280	30.8	E2B2000	2000	0.82	61.5	XT1H160				XT4H250	T5H400	T5H630	T6L800/X1N800	T7H1000/X1N1000	T7H1250/XN1250	T7H1600/X1N1600	E2N2000	E3N2500		
3 x 1250		1640	4921	59.6	E2N2000	2000	0.82	89.5	XT2L160				XT4L250	T5L400	T5L630	T7L800/E3H800	T7L1000/E3H1000	T7L1250/E3H1250	T7L1600/E3H1600	E3H2000	E3H2500	E3H3200	E4H4000
1 x 1600	6.25	2099	2099	32.5	E3N2500	2500	0.84	32.5	XT1N160				XT3S250	T5S400	T5S630	T6S800/X1B800	T7S1000/X1B1000	T7S1250/X1B1250	T7S1600/X1B1600				
2 x 1600		2099	4199	31.4	E3N2500	2500	0.84	62.9	XT1H160				XT4H250	T5H400	T5H630	T6L800/X1N800	T7H1000/X1N1000	T7H1250/X1N1250	T7H1600/X1N1600	E2N2000	E3N2500	E3N3200	
3 x 1600		2099	6298	60.9	E3N2500	2500	0.84	91.4	XT2L160				XT4L250	T5L400	T5L630	T7L800/E3H800	T7L1000/E3H1000	T7L1250/E3H1250	T7L1600/E3H1600	E3H2000	E3H2500	E3H3200	E4H4000
1 x 2000	6.25	2624	2624	40.3	E3N3200	3200	0.82	40.3	XT1S160				XT4S250	T5H400	T5H630	T6S800/X1B800	T7S1000/X1B1000	T7S1250/X1B1250	T7S1600/X1B1600	E2B2000			
2 x 2000		2624	5249	38.7	E3N3200	3200	0.82	77.4	XT2L160				XT4L250	T5L400	T5L630	T6L800/E2S800	T7L1000/E2S1000	T7L1250/E2S1250	T7L1600/E2S1600	E3H2000	E3H2500	E3H3200	E4H4000
3 x 2000		2624	7873	74.4	E3S3200	3200	0.82	111.7	XT2V160				XT4V250	T5V400	T5V630	T7V800/E3V800	T7V1000/E3V1000	T7V1250/E3V1250	E3V1600	E3V2000	E3V2500	E3V3200	E4V4000
1 x 2500	6.25	3280	3280	49.8	E4S4000	4000	0.82	49.8	XT1S160				XT4S250	T5H400	T5H630	T6H800/X1N800	T7S1000/X1N1000	T7S1250/X1N1250	T7S1600/X1N1600	E2N2000	E3N2500		
1 x 3125	6.25	4100	4100	61.5	E6H5000	5000	0.82	61.5	XT1H160				XT4H250	T5H400	T5H630	T6L800/X1N800	T7H1000/X1N1000	T7H1250/X1N1250	T7H1600/X1N1600	E2N2000	E3N2500	E3N3200	

جدول ۳-۵۰ تجهیزات حفاظت و سوئیچینگ ترانسفورماتورهای ۴۴۰V

جدول ۳-۵۱ تجهیزات حفاظت و سوئیچینگ ترانسفورماتورهای ۴۰۰V

Table 2: Protection and switching of 400 V transformers

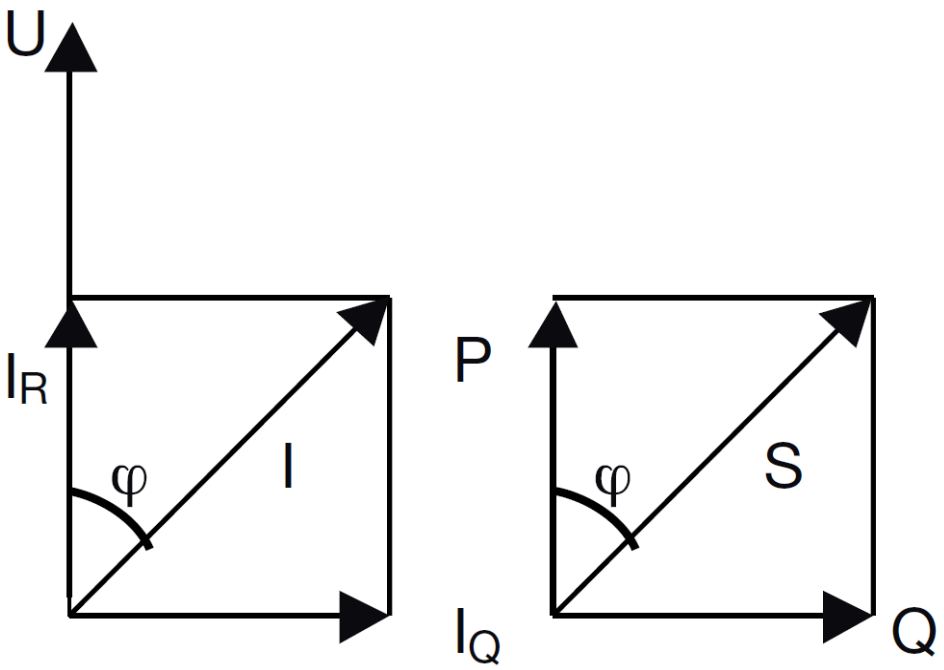
Transformer				Circuit-breaker "A" (LV side)					Circuit-breaker "B" (Feeder circuit-breaker)														
						Release			Feeder circuit-breaker type and rated current														
S_r	u_k	Trafo I_r	Busbar I_b	Trafo feeder I_k	ABB SACE Circuit-breaker	size In [A]	minimum setting	Busbar I_k	32 A	63 A	125 A	160 A	250 A	400 A	630 A	800 A	1000 A	1250 A	1600 A	2000 A	2500 A	3200 A	4000 A
[kVA]	[%]	[A]	[A]	[kA]				[kA]															
1 x 63	4	91	91	2.2	XT1B*	100	0.92	2.2	S200														
2 x 63		91	182	2.2	XT1B*	100	0.92	4.4	S200		XT1B160												
1 x 100	4	144	144	3.6	XT1B*	160	0.91	3.6	S200		XT1B160												
2 x 100		144	288	3.6	XT1B*	160	0.91	7.2	S200		XT1B160												
1 x 125	4	180	180	4.5	XT3N250*	200	0.73	4.5	S200		XT1B160												
2 x 125		180	360	4.4	XT3N250*	200	0.73	8.8	S200		XT1B160												
1 x 160	4	231	231	5.7	XT3N250*	250	0.93	5.7	S200		XT1B160												
2 x 160		231	462	5.7	XT3N250*	250	0.93	11.4	S200M		XT1B160		XT3N250										
1 x 200	4	289	289	7.2	T4N320	320	0.91	7.2	S200		XT1B160		XT3N250										
2 x 200		289	578	7.1	T4N320	320	0.91	14.2	S200M		XT1B160		XT3N250	T5N400									
1 x 250	4	361	361	8.9	T5N400	400	0.91	8.9	S200		XT1B160		XT3N250										
2 x 250		361	722	8.8	T5N400	400	0.91	17.6	XT1B160				XT3N250	T5N400									
1 x 315	4	455	455	11.2	T5N630	630	0.73	11.2	S200M		XT1B160		XT3N250	T5N400									
2 x 315		455	910	11.1	T5N630	630	0.73	22.2	XT1C160				XT3N250	T5N400	T5N630								
1 x 400	4	577	577	14.2	T5N630	630	0.92	14.2	S200M		XT1B160		XT3N250	T5N400									
2 x 400		577	1154	14	T5N630	630	0.92	28	XT1N160				XT3N250	T5N400	T5N630								
1 x 500	4	722	722	17.7	T6N800	800	0.91	17.7	XT1B160				XT3N250	T5N400	T5N630								
2 x 500		722	1444	17.5	T6N800	800	0.91	35.9	XT1N160				XT3N250	T5N400	T5N630	T6N800/X1B800							
1 x 630	4	909	909	22.3	T7S1000/X1B1000**	1000	0.91	22.3	XT1C160				XT3N250	T5N400	T5N630	T6N800/X1B800							
2 x 630		909	1818	21.8	T7S1000/X1B1000**	1000	0.91	43.6	XT1S160				XT3S250	T5S400	T5S630	T6S800/X1N800	T7S1000/X1N1000	T7S1250/X1N1250					
3 x 630		909	2727	42.8	T7S1000/X1N1000**	1000	0.91	64.2	XT1H160				XT4H250	T5H400	T5H630	T6H800/X1N800	T7H1000/X1N1000	T7H1250/X1N1250	T7H1600/X1N1600				
1 x 800	5	1155	1155	22.6	T7S1250/X1B1250**	1250	0.93	22.6	XT1C160				XT3N250	T5N400	T5N630	T6N800/X1B800	T7S1000/X1B1000						
2 x 800		1155	2310	22.1	T7S1250/X1B1250**	1250	0.93	44.3	XT1S160				XT3S250	T5S400	T5S630	T6S800/X1N800	T7S100/X1N1000	T7S1250/X1N1250	T7S1600/X1N1600				
3 x 800		1155	3465	43.4	T7S1250/X1N1250**	1250	0.93	65	XT1H160				XT4H250	T5H400	T5H630	T6H800/X1N800	T7H1000/X1N1000	T7H1250/X1N1250	T7H1600/X1N1600	E2N2000	E3N2500		
1 x 1000	5	1443	1443	28.1	T7S1600/X1B1600**	1600	0.91	28.1	XT1N160				XT3N250	T5N400	T5N630	T6N800/X1B800	T7S100/X1B1000	T7S1250/X1B1250					
2 x 1000		1443	2886	27.4	T7S1600/X1B1600**	1600	0.91	54.8	XT1H160				XT4H250	T5H400	T5H400	T6H800/X1N800	T7H1000/X1N1000	T7H1250/X1N1250	T7H1600/X1N1600	E2N2000			
3 x 1000		1443	4329	53.5	T7H1600/E2N1600	1600	0.91	80.2	XT2L160				XT4L250	T5L400	T5L630	T6L800/E2S800	T7L1000/E2S1000	T7L1250/E2S1250	T7L1600/E2S1600	E2S2000	E3H2500	E3H3200	
1 x 1250	5	1804	1804	34.9	E2B2000	2000	0.91	34.9	XT1N160				XT3N250	T5N400	T5N630	T6N800/X1B800	T7S1000/X1B1000	T7S1250/X1B1250	T7S1600/X1B1600				
2 x 1250		1804	3608	33.8	E2B2000	2000	0.91	67.7	XT1H160				XT4H250	T5H400	T5H630	T6H800/E2S800	T7H1000/E2S1000	T7H1250/E2S1250	T7H1600/E2S1600	E2S2000	E3S2500	E3S3200	
3 x 1250		1804	5412	65.6	E2S2000	2000	0.91	98.4	XT2L160				XT4L250	T5L400	T5L630	T6L800/E3H800	T7L1000/E3H1000	T7L1250/E3H1250	T7L1600/E3H1600	E3H2000	E3H2500	E3H3200	E4H4000
1 x 1600	6.25	2309	2309	35.7	E3N2500	2500	0.93	35.7	XT1N160				XT3N250	T5N400	T5N630	T6N800/X1B800	T7S1000/X1B1000	T7S1250/X1B1250	T7S1600/X1B1600				
2 x 1600		2309	4618	34.6	E3N2500	2500	0.93	69.2	XT1H160				XT4H250	T5H400	T5H630	T6H800/E2S800	T7H1000/E2S1000	T7H1250/E2S1250	T7H1600/E2S1600	E2S2000	E3S2500	E3S3200	E4S4000
3 x 1600		2309	6927	67	E3S2500	2500	0.93	100.6	XT2L160				XT4L250	T5L400	T5L630	T7L800/E3V800	T7L1000/E3V1250	T7L1250/E3V1250	T7L1600/E3V1600	E3V2000	E3V2500	E3V3200	E4V4000
1 x 2000	6.25	2887	2887	44.3	E3N3200	3200	0.91	44.3	XT1S160				XT3S250	T5S400	T5S630	T6S800/X1N800	T7S1000/X1N1000	T7S1250/X1N1250	T7S1600/X1N1600	E2N2000			
2 x 2000		2887	5774	42.6	E3N3200	3200	0.91	85.1	XT2L160				XT4L250	T5L400	T5L630	T6L800/E3H800	T7L1000/E3H1000	T7L1250/E3H1250	T7L1600/E3H1600	E3H2000	E3H2500	E3H3200	E4H4000
3 x 2000		2887	8661	81.9	E3H3200	3200	0.91	122.8	XT2V160				XT4V250	T5V400	T5V630	T7V800/E3V800	T7V1000/E3V1000	T7V1250/E3V1250	E3V1600	E3V2000	E3V2500	E3V3200	E4V4000
1 x 2500	6.25	3608	3608	54.8	E4S4000	4000	0.91	54.8	XT1H160				XT4H250	T5H400	T5H630	T6H800/X1N800	T7H1000/X1N1000	T7H1250/X1N1250	T7H1600/X1N1600	E2N2000	E3N2500	E3N3200	
1 x 3125	6.25	4510	4510	67.7	E6H5000	5000	0.91	67.7	XT1H160				XT4H250	T5H400	T5H630	T6H800/E2S800	T7H1000/E2S1000	T7H1250/E2S1250	T7H1600/E2S1600	E2S2000	E3S2500	E3S3200	E4S4000

جدول ۳-۵۲ تجهیزات حفاظت و سوئیچینگ ترانسفورماتورهای ۶۹۰V

Table 4: Protection and switching of 690 V transformers

Transformer				Circuit-breaker "A" (LV side)					Circuit-breaker "B" (Feeder circuit-breaker)								
						Release			Feeder circuit-breaker type and rated current								
S_r	u_k	Trafo I_r	Busbar I_b	Trafo feeder I_k	ABB SACE Circuit-breaker	size In [A]	minimum setting	Busbar I_k	32 A	63 A	125 A	160 A	250 A	400 A	630 A	800 A	1000 A	1250 A	1600 A	2000 A	2500 A	3200 A	4000 A
[kVA]	[%]	[A]	[A]	[kA]				[kA]															
1 x 63	4	53	53	1.3	XT1B*	63	0.84	1.3	XT1B160														
2 x 63		53	105	1.3	XT1B*	63	0.84	2.6	XT1B160														
1 x 100	4	84	84	2.1	XT1B*	100	0.84	2.1	XT1B160														
2 x 100		84	167	2.1	XT1B*	100	0.84	4.2	XT1N160														
1 x 125	4	105	105	2.6	XT1B*	125	0.84	2.6	XT1B160														
2 x 125		105	209	2.6	XT1B*	125	0.84	5.2	XT1N160														
1 x 160	4	134	134	3.3	XT1C*	160	0.84	3.3	XT1C160														
2 x 160		134	268	3.3	XT1C*	160	0.84	6.6	XT1S160														
1 x 200	4	167	167	4.2	XT3N250*	200	0.84	4.2	XT1N160														
2 x 200		167	335	4.1	XT3N250*	200	0.84	8.3	XT1H160				XT4N250										
1 x 250	4	209	209	5.2	XT3S250*	250	0.84	5.2	XT1N160														
2 x 250		209	418	5.1	XT3S250*	250	0.84	10.3	XT2S160				XT4S250										
1 x 315	4	264	264	6.5	T4N320	320	0.82	6.5	XT1S160														
2 x 315		264	527	6.5	T4N320	320	0.82	12.9	XT2H160				XT4H250	T5N400									
1 x 400	4	335	335	8.3	T5N400	400	0.84	8.3	XT1H160				XT4N250										
2 x 400		335	669	8.2	T5N400	400	0.84	16.3	XT2L160				XT4L250	T5N400									
1 x 500	4	418	418	10.3	T5N630	630	0.66	10.3	XT2S160				XT4S250										
2 x 500		418	837	10.1	T5N630	630	0.66	20.2	XT4V250				XT4V250	T5S400	T5S630								
1 x 630	4	527	527	12.9	T5N630	630	0.84	12.9	XT2H160				XT4H250	T5N400									
2 x 630		527	1054	12.6	T5N630	630	0.84	25.3	T4H250***				T4H250***	T5H400	T5H630								
3 x 630		527	1581	24.8	T5S630	630	0.84	37.2	T4H250***				T4H250***	T5H400	T5H630	T7H800/X1B800	T7H1000/X1B1000	T7H1250/X1B1250					
1 x 800	5	669	669	13.1	T6N800	800	0.84	13.1	XT2H160				XT4H250	T5N400									
2 x 800		669	1339	12.8	T6N800	800	0.84	25.7	T4H250***				T4H250***	T5H400	T5H630	T6L800/X1B800							
3 x 800		669	2008	25.2	T6L800	800	0.84	37.7	T4H250***				T4H250***	T5H400	T5H630	T7H800/X1N800	T7H1000/X1N1000	T7H1250/X1N1250	T7H1600/X1N1600				
1 x 1000	5	837	837	16.3	T7S1000/X1B1000**	1000	0.84	16.3	XT2L160				XT4L250	T5N400	T5N630								
2 x 1000		837	1673	15.9	T7S1000/X1B1000**	1000	0.84	31.8	T4H250***				T4H250***	T5H400	T5H630	T7H800/X1B800	T7H1000/X1B1000	T7H1250/X1B1250					
3 x 1000		837	2510	31.0	T7H1000/X1B1000**	1000	0.84	46.5	T4L250***				T4L250***	T5L400	T5L630	T7L800/X1N800	T7L1000/X1N1000	T7L1250/X1N1250	T7L1600/X1N1600	E2N2000			
1 x 1250	5	1046	1046	20.2	T7S1250/X1B1250**	1250	0.84	20.2	XT4V250				XT4V250	T5S400	T5S630	T6S800/X1B800							
2 x 1250		1046	2092	19.6	T7S1250/X1B1250**	1250	0.84	39.2	T4H250***				T4H250***	T5H400	T5H630	T7H800/X1B800	T7H1000/X1B1000	T7H1250/X1B1250	T7H1600/X1N1600				
3 x 1250		1046	3138	38.0	T7H1250/X1B1250**	1250	0.84	57.1	T4L250***				T4L250***	T5L400	T5L630	T7V800/E2S800	T7V1000/E2S1000	T7V1250/ES21250	E2S1600	E2S2000			
1 x 1600	6.25	1339	1339	20.7	T7S1600/X1B1600**	1600	0.84	20.7	XT4V250				XT4V250	T5S400	T5S630	T6S800/X1B800	T7S1000/X1B1000						
2 x 1600		1339	2678	20.1	T7S1600/X1B1600**	1600	0.84	40.1	T4L250***				T4L250***	T5L400	T5L630	T7H800/X1B800	T7H1000/X1B1000	T7H1250/X1B1250	T7H1600/X1B1600	E2B2000			
3 x 1600		1339	4016	38.9	T7H1600/X1B1600**	1600	0.84	58.3	T4L250***				T4L250***	T5L400	T5L630	T7V800/E2S800	T7V1000/X1B1000	T7V1250/ES21250	E2S1600	E2S2000	E3N2500	E3N3200	
1 x 2000	6.25	1673	1673	25.7	E2B2000	2000	0.84	25.7	T4H250***				T4H250***	T5H400	T5H630	T6L800/X1N800	T7S1000/E2S1000	T7S1250/X1N1250					
2 x 2000		1673	3347	24.7	E2B2000	2000	0.84	49.3	T4L250***				T4L250***	T5L400	T5L630	T7L800/X1N800	T7L1000/X1N1000	T7L1250/X1N1250	T7L1600/X1N1600	E2N2000	E3N2500		
3 x 2000		1673	5020	47.5	E2N2000	2000	0.84	71.2	T4V250***				T4V250***	T5V400	T5V630	E3S1000		E3S1250	E3S1600	E3S2000	E3S2500	E3S3200	E4S4000
1 x 2500	6.25	2092	2092	31.8	E3N2500	2500	0.84	31.8	T4H250***				T4H250***	T5H400	T5H630	T7H800/X1B800	T7H1000/X1B1000	T7H1250/X1B1250	T7H1600/X1B1600				
1 x 3125	6.25	2615	2615	39.2	E3N3200	3200	0.82	39.2	T4H250***				T4H250***	T5H400	T5H630	T7H800/X1B800	T7H1000/X1B1000	T7H1250/X1B1250	T7H1600/X1B1600	E2B2000			

فصل چهارم

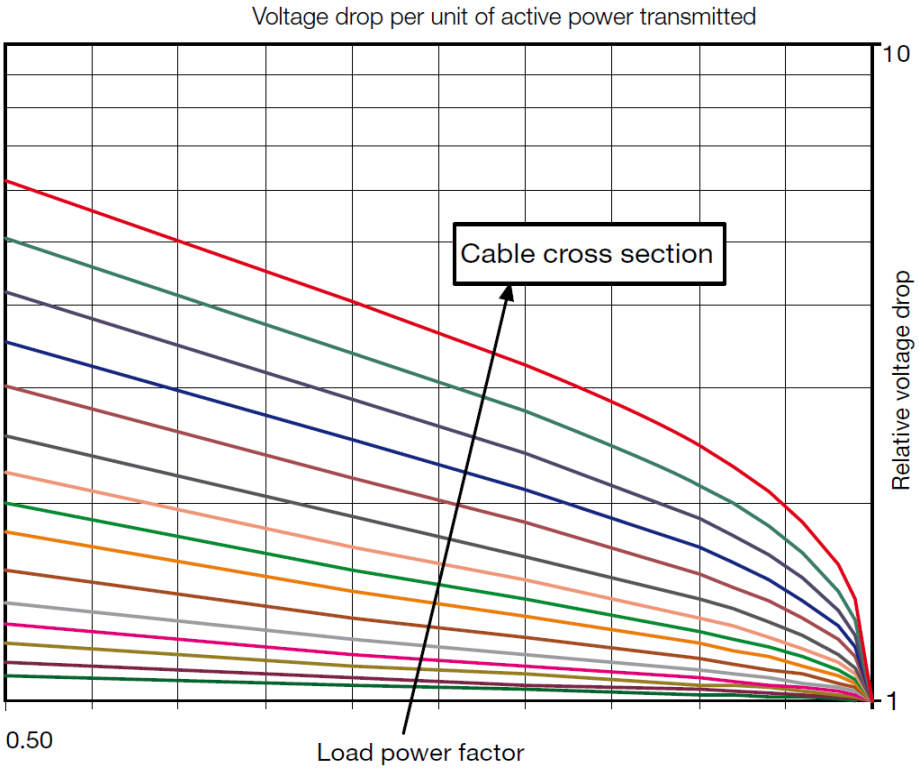


شکل ۴-۱ مثلث توان و زاویه توان

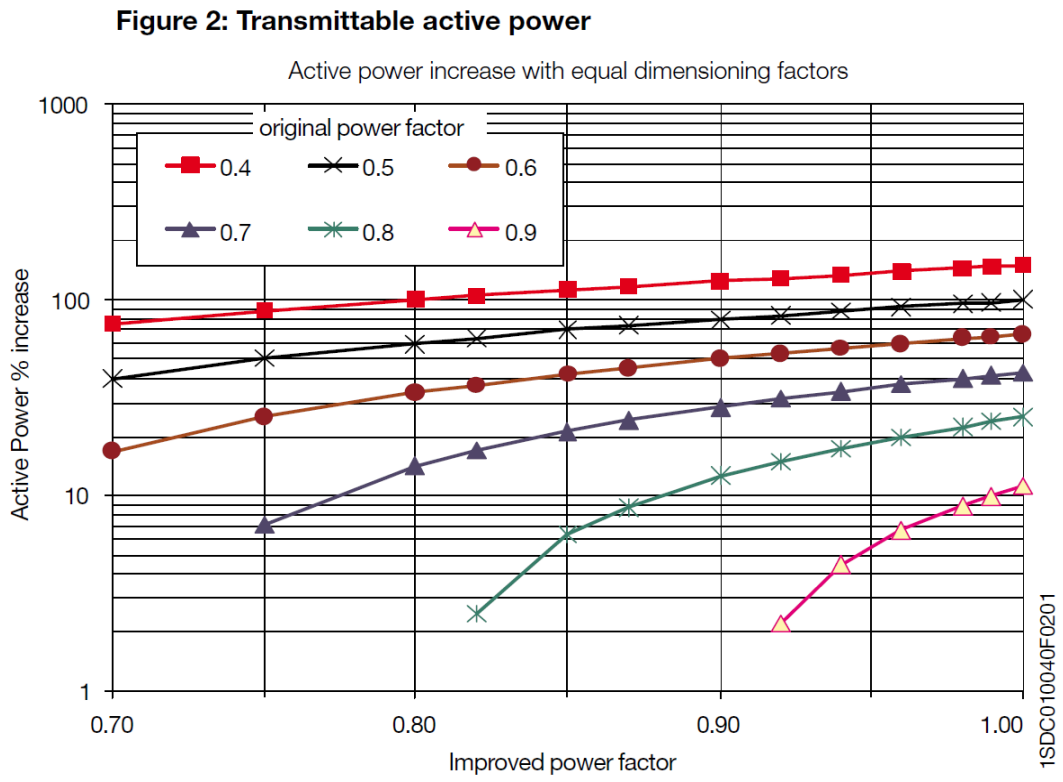
Load	cosφ power factor	tanφ reactive demand factor
Transformers (no load condition)	0.1÷0.15	9.9÷6.6
Motor (full load)	0.7÷0.85	1.0÷0.62
Motor (no load)	0.15	6.6
Metal working apparatuses:		
- Arc welding	0.35÷0.6	2.7÷1.3
- Arc welding compensated	0.7÷0.8	1.0÷0.75
- Resistance welding:	0.4÷0.6	2.3÷1.3
- Arc melting furnace	0.75÷0.9	0.9÷0.5
Fluorescent lamps		
- compensated	0.9	0.5
- uncompensated	0.4÷0.6	2.3÷1.3
Mercury vapour lamps	0.5	1.7
Sodium vapour lamp	0.65÷0.75	1.2÷0.9
AC DC converters	0.6÷0.95	1.3÷0.3
DC drives	0.4÷0.75	2.3÷0.9
AC drives	0.95÷0.97	0.33÷0.25
Resistive load	1	0

جدول ۴-۱ ضریب توان برخی از بارهای معمول

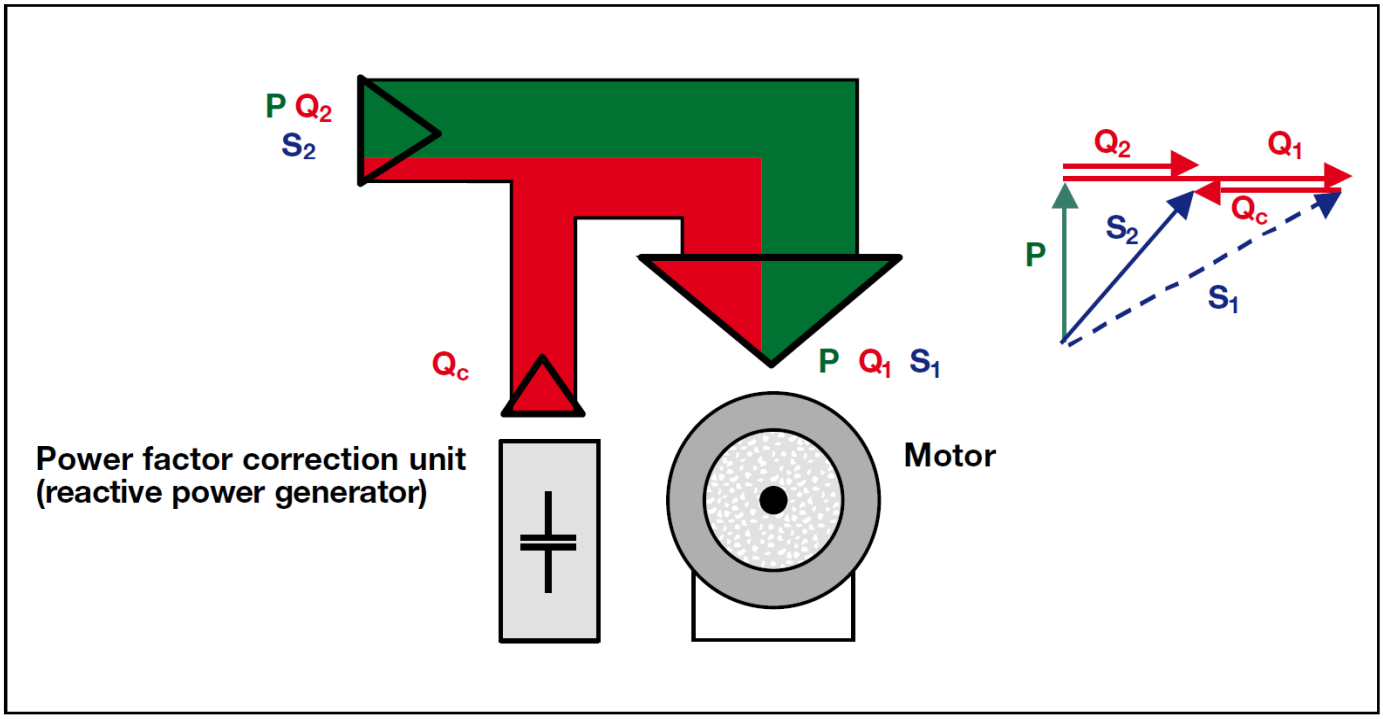
Figure 1: Relative voltage drop



شکل ۴-۳ افت ولتاژ نسبی براساس ضریب توان بار



شکل ۴-۳ تاثیر ضریب توان در میزان توان اکتیو قابل انتقال



شکل ۴-۴ نمایش نحوه جبران‌سازی توان راکتیو

Table 2: Factor K_c

K_c	$\cos\varphi_2$												
$\cos\varphi_1$	0.80	0.85	0.90	0.91	0.92	0.93	0.94	0.95	0.96	0.97	0.98	0.99	1
0.60	0.583	0.714	0.849	0.878	0.907	0.938	0.970	1.005	1.042	1.083	1.130	1.191	1.333
0.61	0.549	0.679	0.815	0.843	0.873	0.904	0.936	0.970	1.007	1.048	1.096	1.157	1.299
0.62	0.515	0.646	0.781	0.810	0.839	0.870	0.903	0.937	0.974	1.015	1.062	1.123	1.265
0.63	0.483	0.613	0.748	0.777	0.807	0.837	0.870	0.904	0.941	0.982	1.030	1.090	1.233
0.64	0.451	0.581	0.716	0.745	0.775	0.805	0.838	0.872	0.909	0.950	0.998	1.058	1.201
0.65	0.419	0.549	0.685	0.714	0.743	0.774	0.806	0.840	0.877	0.919	0.966	1.027	1.169
0.66	0.388	0.519	0.654	0.683	0.712	0.743	0.775	0.810	0.847	0.888	0.935	0.996	1.138
0.67	0.358	0.488	0.624	0.652	0.682	0.713	0.745	0.779	0.816	0.857	0.905	0.966	1.108
0.68	0.328	0.459	0.594	0.623	0.652	0.683	0.715	0.750	0.787	0.828	0.875	0.936	1.078
0.69	0.299	0.429	0.565	0.593	0.623	0.654	0.686	0.720	0.757	0.798	0.846	0.907	1.049
0.70	0.270	0.400	0.536	0.565	0.594	0.625	0.657	0.692	0.729	0.770	0.817	0.878	1.020
0.71	0.242	0.372	0.508	0.536	0.566	0.597	0.629	0.663	0.700	0.741	0.789	0.849	0.992
0.72	0.214	0.344	0.480	0.508	0.538	0.569	0.601	0.635	0.672	0.713	0.761	0.821	0.964
0.73	0.186	0.316	0.452	0.481	0.510	0.541	0.573	0.608	0.645	0.686	0.733	0.794	0.936
0.74	0.159	0.289	0.425	0.453	0.483	0.514	0.546	0.580	0.617	0.658	0.706	0.766	0.909
0.75	0.132	0.262	0.398	0.426	0.456	0.487	0.519	0.553	0.590	0.631	0.679	0.739	0.882
0.76	0.105	0.235	0.371	0.400	0.429	0.460	0.492	0.526	0.563	0.605	0.652	0.713	0.855
0.77	0.079	0.209	0.344	0.373	0.403	0.433	0.466	0.500	0.537	0.578	0.626	0.686	0.829
0.78	0.052	0.183	0.318	0.347	0.376	0.407	0.439	0.474	0.511	0.552	0.599	0.660	0.802
0.79	0.026	0.156	0.292	0.320	0.350	0.381	0.413	0.447	0.484	0.525	0.573	0.634	0.776
0.80		0.130	0.266	0.294	0.324	0.355	0.387	0.421	0.458	0.499	0.547	0.608	0.750
0.81		0.104	0.240	0.268	0.298	0.329	0.361	0.395	0.432	0.473	0.521	0.581	0.724
0.82		0.078	0.214	0.242	0.272	0.303	0.335	0.369	0.406	0.447	0.495	0.556	0.698
0.83		0.052	0.188	0.216	0.246	0.277	0.309	0.343	0.380	0.421	0.469	0.530	0.672
0.84		0.026	0.162	0.190	0.220	0.251	0.283	0.317	0.354	0.395	0.443	0.503	0.646
0.85			0.135	0.164	0.194	0.225	0.257	0.291	0.328	0.369	0.417	0.477	0.620
0.86			0.109	0.138	0.167	0.198	0.230	0.265	0.302	0.343	0.390	0.451	0.593
0.87			0.082	0.111	0.141	0.172	0.204	0.238	0.275	0.316	0.364	0.424	0.567
0.88			0.055	0.084	0.114	0.145	0.177	0.211	0.248	0.289	0.337	0.397	0.540
0.89			0.028	0.057	0.086	0.117	0.149	0.184	0.221	0.262	0.309	0.370	0.512
0.90				0.029	0.058	0.089	0.121	0.156	0.193	0.234	0.281	0.342	0.484

جدول ۴-۲ ضریب K_c

	Single-phase connection	Three-phase star-connection	Three-phase delta-connection
Capacity of the capacitor bank	$C = \frac{Q_c}{2 \neq f_r \cdot U_r^2}$	$C = \frac{Q_c}{2 \neq f_r \cdot U_r^2}$	$C = \frac{Q_c}{2 \neq f_r \cdot U_r^2 \cdot 3}$
Rated current of the components	$I_{rc} = 2 \neq f_r \cdot C \cdot U_r$	$I_{rc} = 2 \neq f_r \cdot C \cdot U_r / \sqrt{3}$	$I_{rc} = 2 \neq f_r \cdot C \cdot U_r$
Line current	$I_l = I_{rc}$	$I_l = I_{rc}$	$I_l = I_{rc} \cdot \sqrt{3}$

جدول ۴-۳ مشخصات بانک‌های خازنی تک‌فاز و سه‌فاز

P_r [kW]	Q_c [kvar]	Before PFC		After PFC	
		$\cos\varphi_r$	I_r [A]	$\cos\varphi_2$	I_2 [A]
400V / 50 Hz / 2 poles / 3000 r/min					
7.5	2.5	0.89	13.9	0.98	12.7
11	2.5	0.88	20	0.95	18.6
15	5	0.9	26.5	0.98	24.2
18.5	5	0.91	32	0.98	29.7
22	5	0.89	38.5	0.96	35.8
30	10	0.88	53	0.97	47.9
37	10	0.89	64	0.97	58.8
45	12.5	0.88	79	0.96	72.2
55	15	0.89	95	0.97	87.3
75	15	0.88	131	0.94	122.2
90	15	0.9	152	0.95	143.9
110	20	0.86	194	0.92	181.0
132	30	0.88	228	0.95	210.9
160	30	0.89	269	0.95	252.2
200	30	0.9	334	0.95	317.5
250	40	0.92	410	0.96	391.0
315	50	0.92	510	0.96	486.3

400V / 50 Hz / 4 poles / 1500 r/min					
7.5	2.5	0.86	14.2	0.96	12.7
11	5	0.81	21.5	0.96	18.2
15	5	0.84	28.5	0.95	25.3
18.5	7.5	0.84	35	0.96	30.5
22	10	0.83	41	0.97	35.1
30	15	0.83	56	0.98	47.5
37	15	0.84	68	0.97	59.1
45	20	0.83	83	0.97	71.1
55	20	0.86	98	0.97	86.9
75	20	0.86	135	0.95	122.8
90	20	0.87	158	0.94	145.9
110	30	0.87	192	0.96	174.8
132	40	0.87	232	0.96	209.6
160	40	0.86	282	0.94	257.4
200	50	0.86	351	0.94	320.2
250	50	0.87	430	0.94	399.4
315	60	0.87	545	0.93	507.9

P_r [kW]	Q_c [kvar]	Before PFC		After PFC	
		$\cos\varphi_r$	I_r [A]	$\cos\varphi_2$	I_2 [A]
400V / 50 Hz / 2 poles / 3000 r/min					
7.5	2.5	0.89	13.9	0.98	12.7
11	2.5	0.88	20	0.95	18.6
15	5	0.9	26.5	0.98	24.2
18.5	5	0.91	32	0.98	29.7
22	5	0.89	38.5	0.96	35.8
30	10	0.88	53	0.97	47.9
37	10	0.89	64	0.97	58.8
45	12.5	0.88	79	0.96	72.2
55	15	0.89	95	0.97	87.3
75	15	0.88	131	0.94	122.2
90	15	0.9	152	0.95	143.9
110	20	0.86	194	0.92	181.0
132	30	0.88	228	0.95	210.9
160	30	0.89	269	0.95	252.2
200	30	0.9	334	0.95	317.5
250	40	0.92	410	0.96	391.0
315	50	0.92	510	0.96	486.3

400V / 50 Hz / 4 poles / 1500 r/min					
7.5	2.5	0.86	14.2	0.96	12.7
11	5	0.81	21.5	0.96	18.2
15	5	0.84	28.5	0.95	25.3
18.5	7.5	0.84	35	0.96	30.5
22	10	0.83	41	0.97	35.1
30	15	0.83	56	0.98	47.5
37	15	0.84	68	0.97	59.1
45	20	0.83	83	0.97	71.1
55	20	0.86	98	0.97	86.9
75	20	0.86	135	0.95	122.8
90	20	0.87	158	0.94	145.9
110	30	0.87	192	0.96	174.8
132	40	0.87	232	0.96	209.6
160	40	0.86	282	0.94	257.4
200	50	0.86	351	0.94	320.2
250	50	0.87	430	0.94	399.4
315	60	0.87	545	0.93	507.9

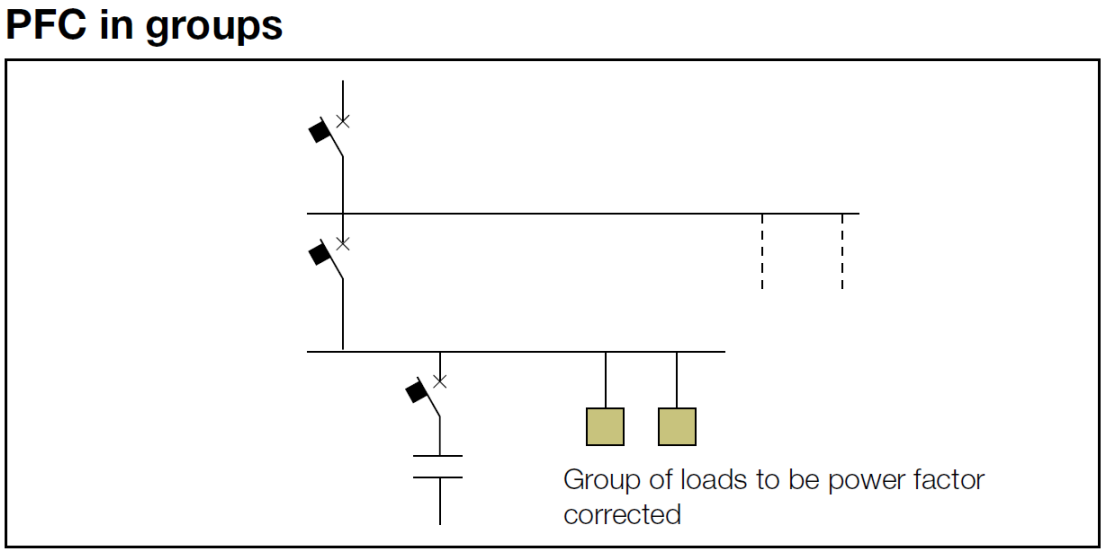
جدول ۴-۴ توان راکتیو مورد نیاز برای جبران‌سازی موتورها

Table 4: PFC reactive power for ABB transformers

S_r [kVA]	u_k% [%]	i_o% [%]	P_{fe} [kW]	P_{cu} [kW]	Q_c [kvar] load factor K_L 0	0.25	0.5	0.75	1
Oil Distribution Transformer MV-LV									
50	4	2.9	0.25	1.35	1.4	1.5	1.8	2.3	2.9
100	4	2.5	0.35	2.30	2.5	2.7	3.3	4.3	5.7
160	4	2.3	0.48	3.20	3.6	4	5	6.8	9.2
200	4	2.2	0.55	3.80	4.4	4.8	6.1	8.3	11
250	4	2.1	0.61	4.50	5.2	5.8	7.4	10	14
315	4	2	0.72	5.40	6.3	7	9.1	13	18
400	4	1.9	0.85	6.50	7.6	8.5	11	16	22
500	4	1.9	1.00	7.40	9.4	11	14	20	28
630	4	1.8	1.20	8.90	11	13	17	25	35
800	6	1.7	1.45	10.60	14	16	25	40	60
1000	6	1.6	1.75	13.00	16	20	31	49	74
1250	6	1.6	2.10	16.00	20	24	38	61	93
1600	6	1.5	2.80	18.00	24	30	47	77	118
2000	6	1.2	3.20	21.50	24	31	53	90	142
2500	6	1.1	3.70	24.00	27	37	64	111	175
3150	7	1.1	4.00	33.00	34	48	89	157	252
4000	7	1.4	4.80	38.00	56	73	125	212	333

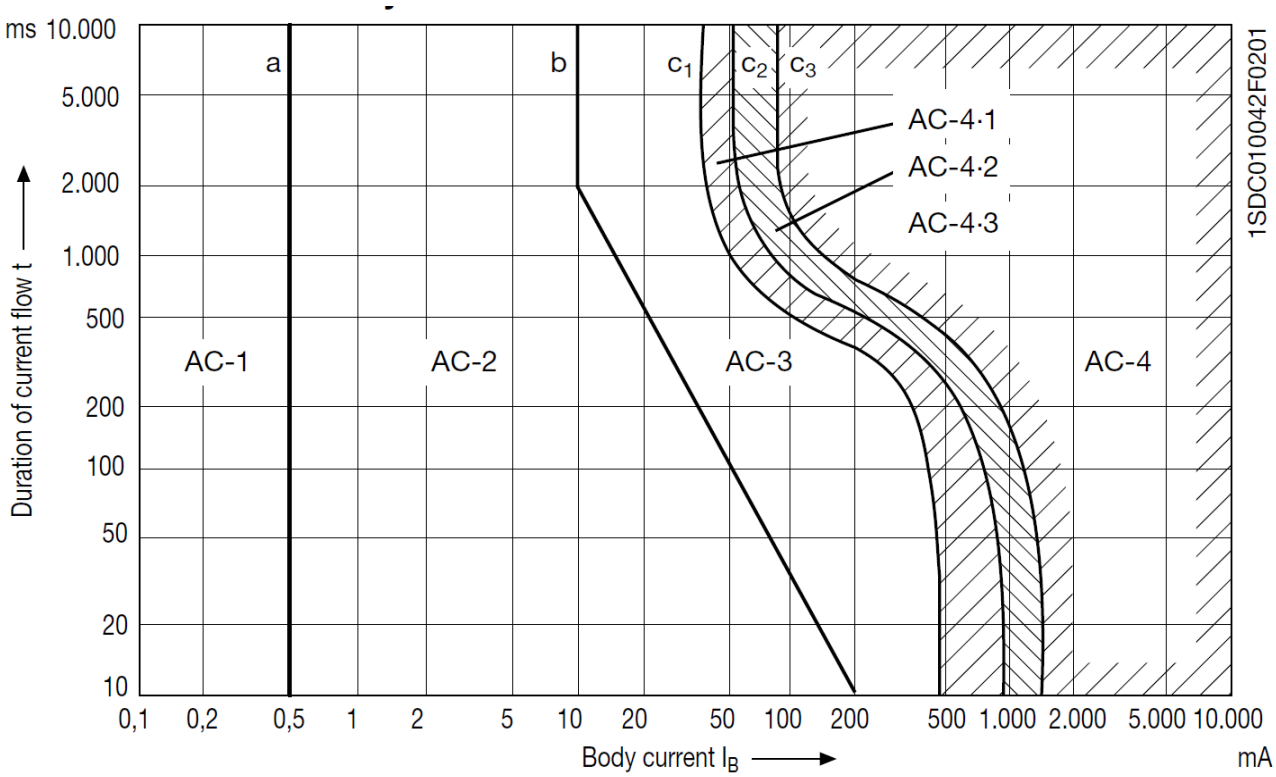
Cast Resin Distribution Transformer MV-LV									
100	6	2.3	0.50	1.70	2.2	2.6	3.7	5.5	8
160	6	2	0.65	2.40	3.1	3.7	5.5	8.4	12
200	6	1.9	0.85	2.90	3.7	4.4	6.6	10	15
250	6	1.8	0.95	3.30	4.4	5.3	8.1	13	19
315	6	1.7	1.05	4.20	5.3	6.4	9.9	16	24
400	6	1.5	1.20	4.80	5.9	7.3	12	19	29
500	6	1.4	1.45	5.80	6.8	8.7	14	23	36
630	6	1.3	1.60	7.00	8	10	17	29	45
800	6	1.1	1.94	8.20	8.6	12	20	35	56
1000	6	1	2.25	9.80	9.7	13	25	43	69
1250	6	0.9	3.30	13.00	11	15	29	52	85
1600	6	0.9	4.00	14.50	14	20	38	67	109
2000	6	0.8	4.60	15.50	15	23	45	82	134
2500	6	0.7	5.20	17.50	17	26	54	101	166
3150	8	0.6	6.00	19.00	18	34	81	159	269

جدول ۴-۵ ظرفیت PFC برای جبران‌سازی ترانس‌های روغنی و خشک ساخت ABB



شکل ۴-۶ PFC گروهی

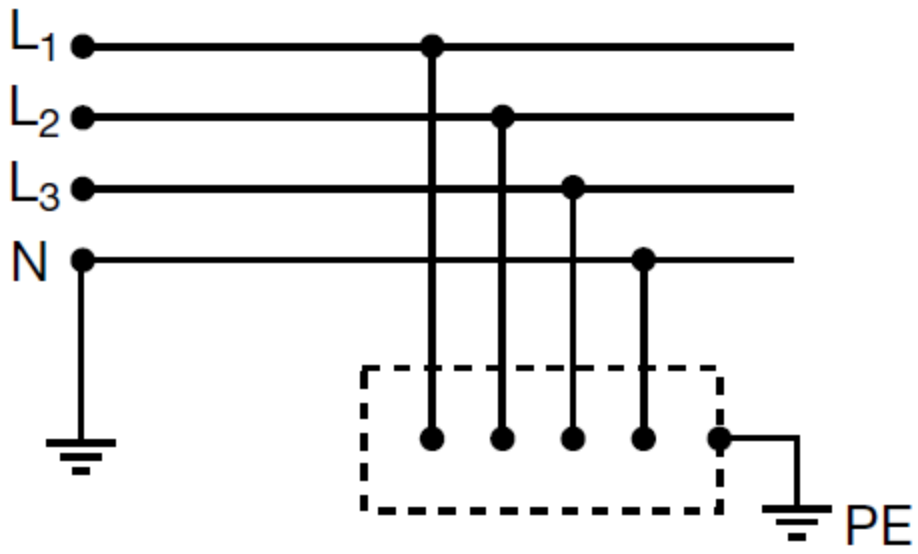
فصل پنجم

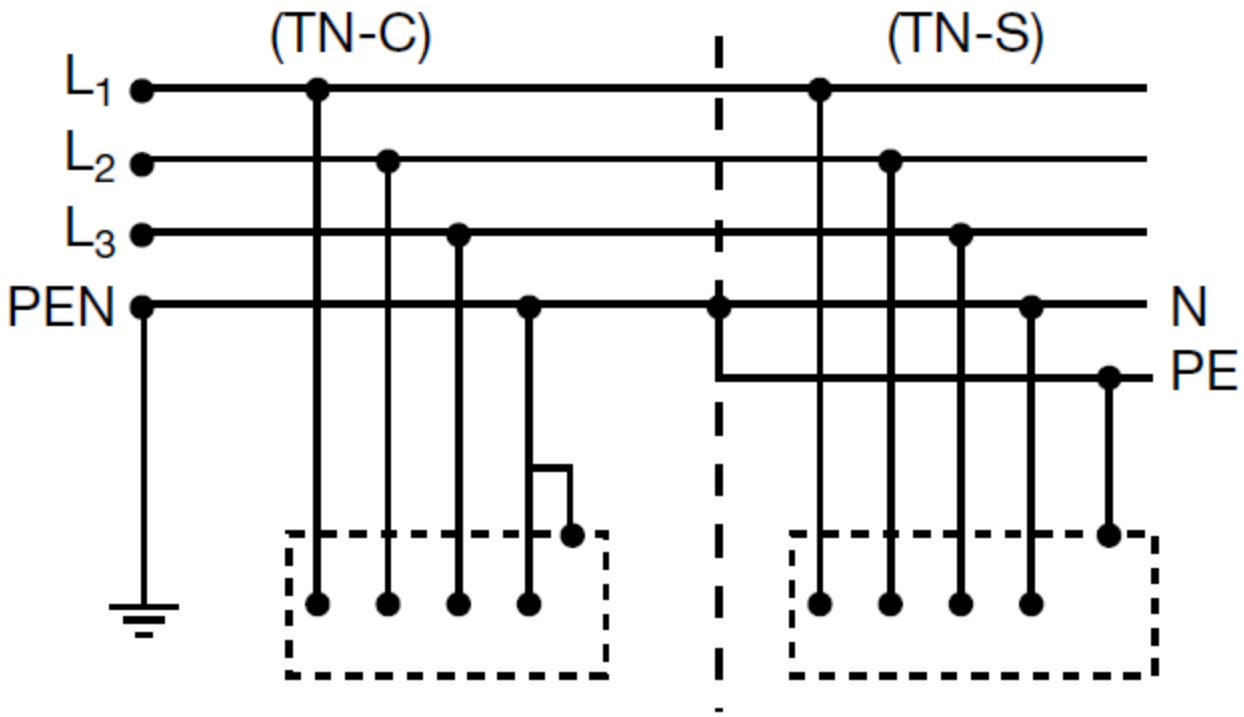


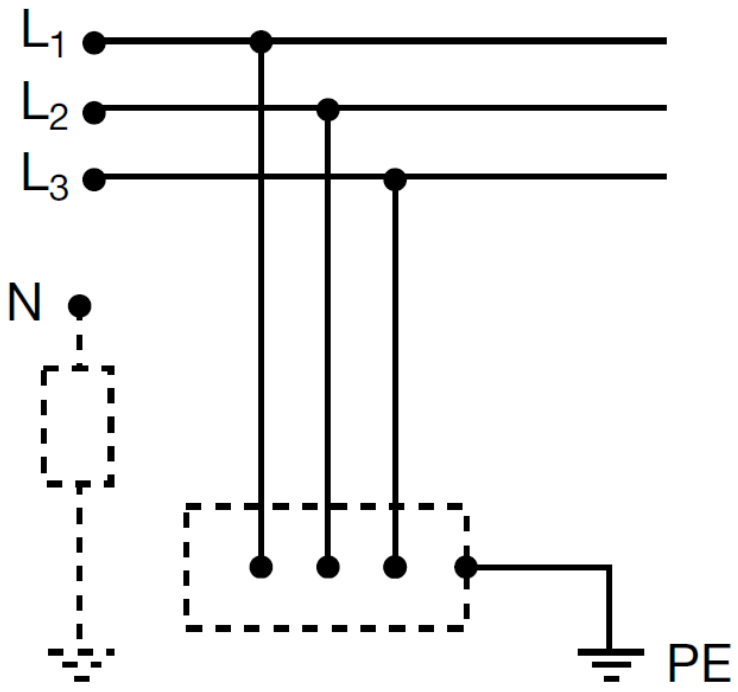
شکل ۵-۱ نمودار زمان جریان و محدوده‌های چهارگانه آن

Zone designation	Zone limits	Physiological effects
AC-1	Up to 0.5 mA line a	Usually no reaction.
AC-2	0.5 mA up to line b*	Usually no harmful physiological effects.
AC-3	Line b up to curve c_1	Usually no organic damage to be expected. Likelihood of cramplike muscular contractions and difficulty in breathing for durations of current-flow longer than 2 s. Reversible disturbances of formation and conduction of impulses in the heart, including atrial fibrillation and transient cardiac arrest without ventricular fibrillation increasing with current magnitude and time.
AC-4	Above curve c_1	Increasing with magnitude and time, dangerous pathophysiological effects such as cardiac arrest, breathing arrest and severe burns may occur in addition to the effects of zone 3.
AC-4.1	c_1 - c_2	Probability of ventricular fibrillation increasing up to about 5%.
AC-4.2	c_2 - c_3	Probability of ventricular fibrillation up to about 50%.
AC-4.3	Beyond curve c_3	Probability of ventricular fibrillation above 50%.

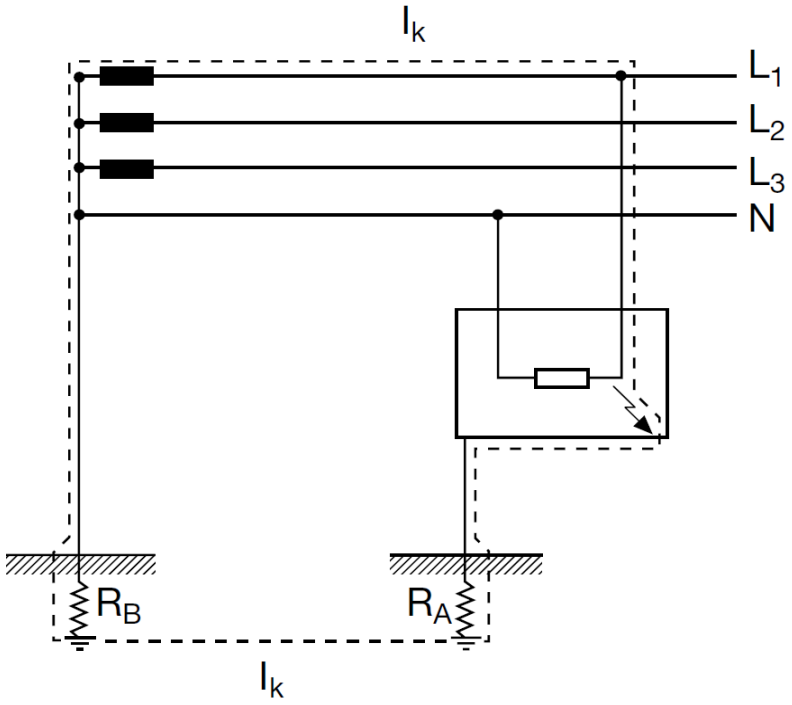
جدول ۵-۱ آثار فیزیولوژیکی عبور جریان از بدن


L1
L2
L3
N
PE

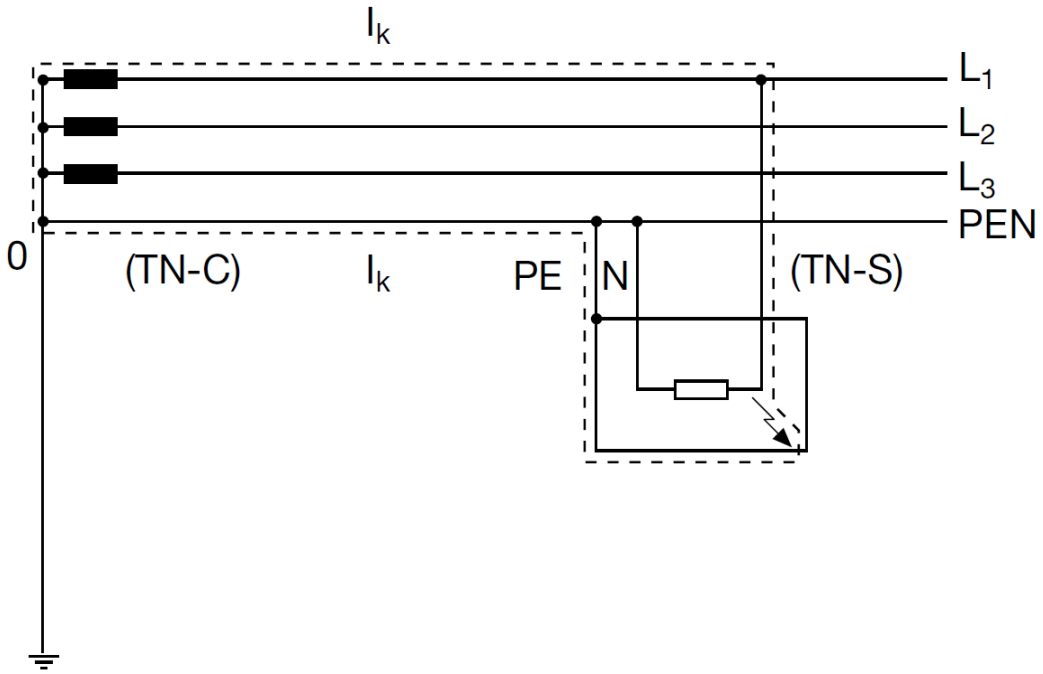

(TN-C)
(TN-S)
L1
L2
L3
PEN
N
PE



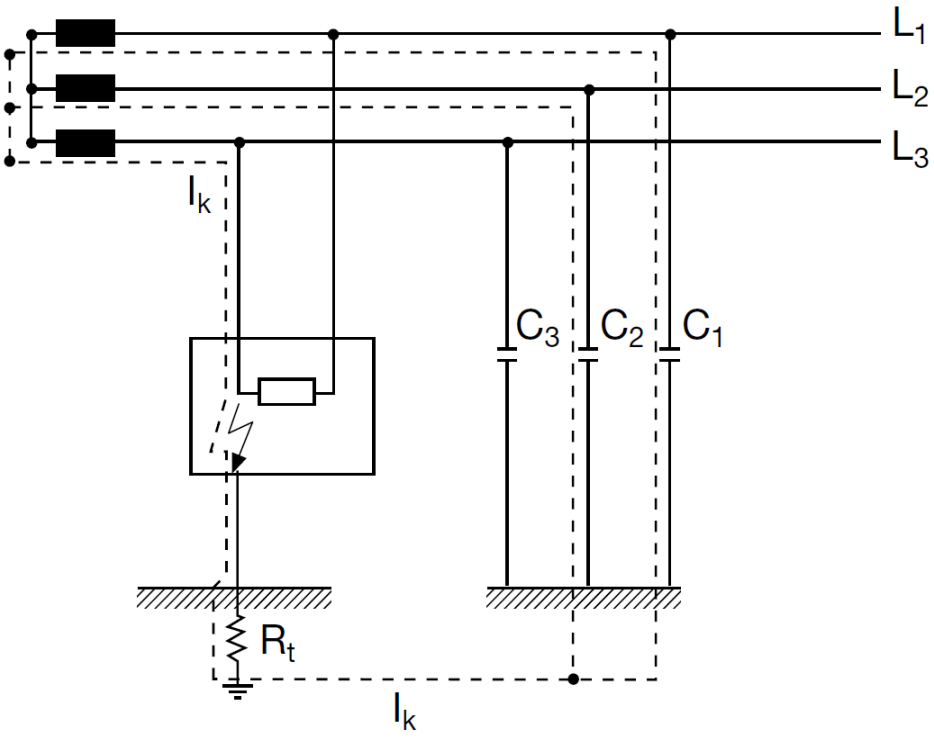
شکل ۵-۲ سیستم‌های توزیع نیرو



شکل ۵-۳ مسیر جریان اتصال کوتاه تک‌فاز در سیستم TT

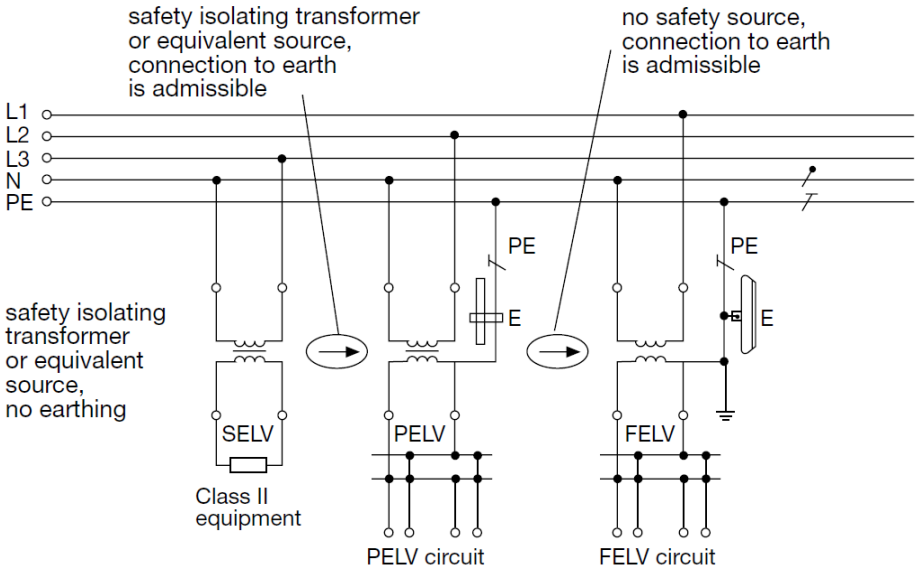


شکل ۵-۴ مسیر جریان اتصال کوتاه تک‌فاز در سیستم TN-C



شکل ۵-۵ مسیر جریان اتصال کوتاه تک‌فاز در سیستم IT

Figure 1: SELV, PELV, FELV systems



voltage limits for extra-low voltages: 50 V ac 120 V dc	E	earth connections by estraneous conductive parts, e.g. by metal pipe or structural steelwork
	PE ⏚	protective conductor earth electrode

شکل ۵-۶ سیستم‌های SELV، PELV،FELV

Table 1: Maximum disconnection times for final circuits not exceeding 32A

	$50V<U_0\leq120V$ s		$130V<U_0\leq230V$ s		$230V<U_0\leq400V$ s		$U_0>400V$ s	
System	a.c.	d.c.	a.c.	d.c.	a.c.	d.c.	a.c.	d.c.
TT	0.3	Note 1	0.2	0.4	0.07	0.2	0.04	0.1

U_o is the nominal a.c. or d.c. line to earth voltage.

جدول ۵-۲ حداکثر زمان قطع برای مدارهای نهایی با جریان نامی کمتر از ۳۲A

Table 2: Earth resistance values

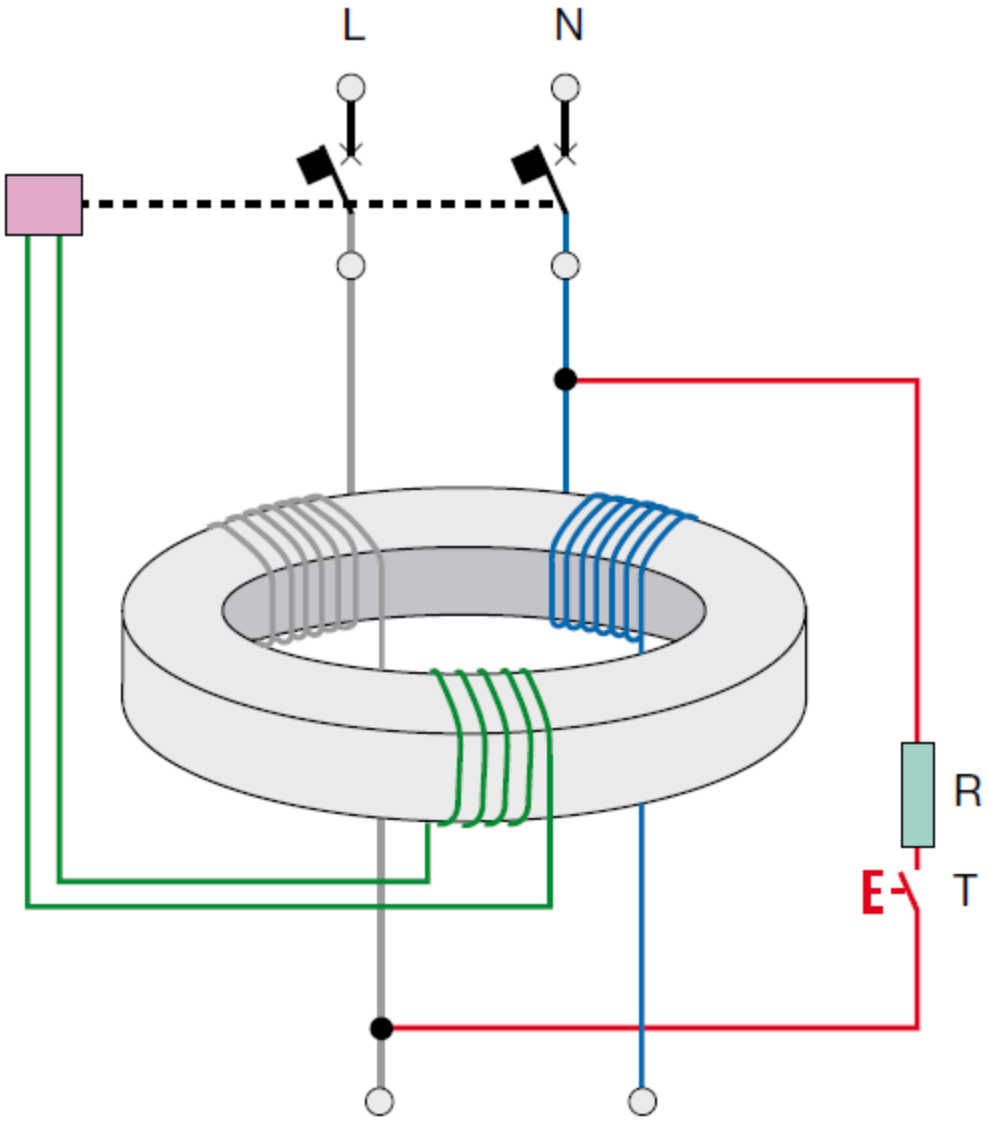
$I_{\Delta n}$ [A]	R_A [Ω]
0.01	5000
0.03	1666
0.1	500
0.3	166
0.5	100
3	16
10	5
30	1.6

جدول ۵-۳ حداکثر مقاومت مجاز سیستم ارت براساس جریان نامی RCD مدار

Table 3: Maximum disconnecting times for TN system

	$50V<U_0\leq120V$ s		$120V<U_0\leq230V$ s		$230V<U_0\leq400V$ s		$U_0>400V$ s	
System	a.c.	d.c.	a.c.	d.c.	a.c.	d.c.	a.c.	d.c.
TN	0.8	Note 1	0.4	5	0.2	0.4	0.1	0.1

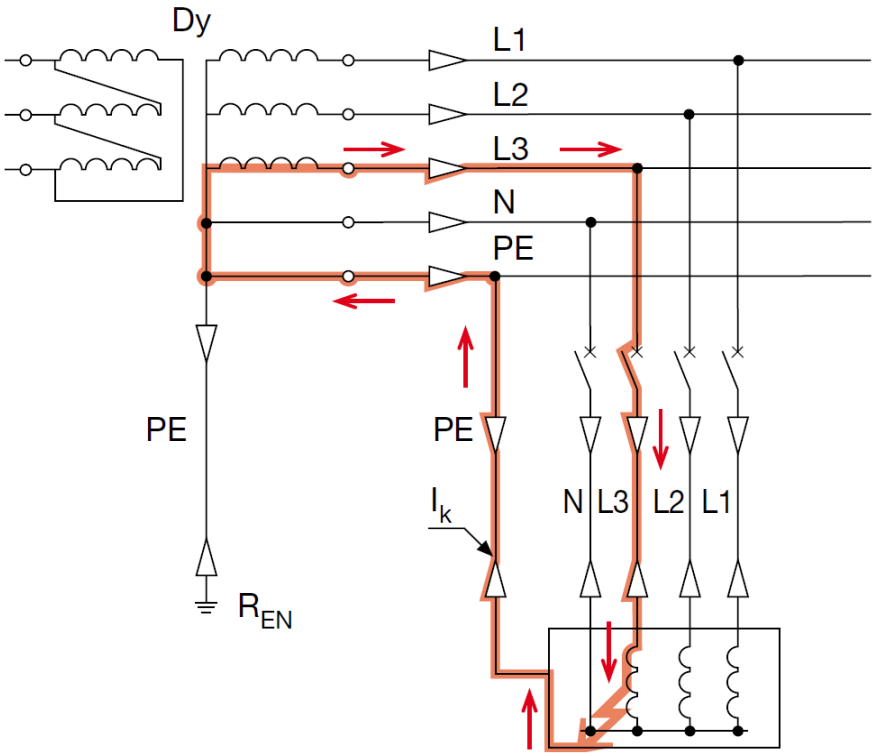
جدول ۵-۴ ماکزیمم زمان قطع برای سیستم TN



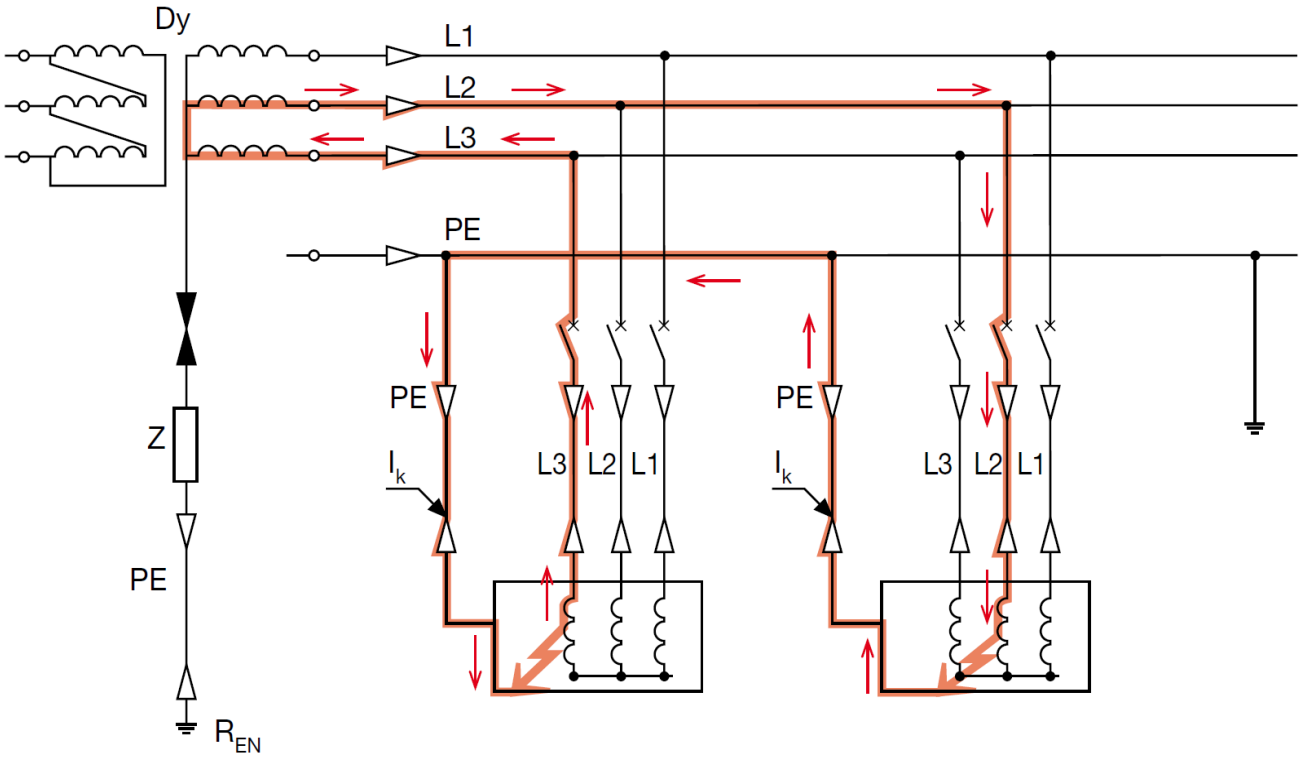
شکل ۵-۱۰ اساس کار کلید RCD

Phase conductor cross section [mm²]	120	150	185	240	300
k_1	0.90	0.85	0.80	0.75	0.72

جدول ۵-۵ ضریب تصحیح در نظر نگرفتن راکتانس برای مقاطع بیش از $۹۵mm^2$



شکل ۵-۱۳ جریان اتصال کوتاه تک‌فاز سیستم TN



شکل ۵-۱۴ جریان اتصال کوتاه تک‌فاز در سیستم IT با نول توزیع نشده

Table 1: Protective conductor cross section

Phase conductor cross section S [mm²]	Protective conductor cross section S_{PE} [mm²]
$S \le 16$	S
$16 < S \le 35$	16
$S > 35$	S/2

Note: phase and protective conductors having the same isolation and conductive materials

جدول ۵-۶ سطح مقطع هادی ارت بر اساس سطح مقطع هادی فاز

n	2	3	4	5	6	7	8
k_p	2	2.7	3	3.2	3.3	3.4	3.5

n is the number of conductors in parallel per phase

جدول ۵-۷ ضریب تصحیح تعداد کابل‌هاب موازی در هر فاز

voltage [V]	230	400	440	500	690
k_V	0.58	1	1.1	1.25	1.73

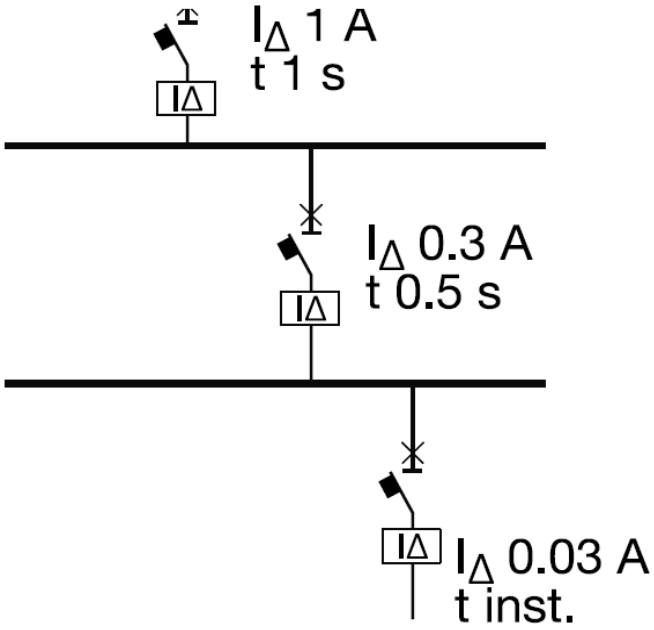
جدول ۵-۸ ضریب تصحیح متفاوت بودن ولتاژ با ۴۰۰V

k_{Al}	0.64

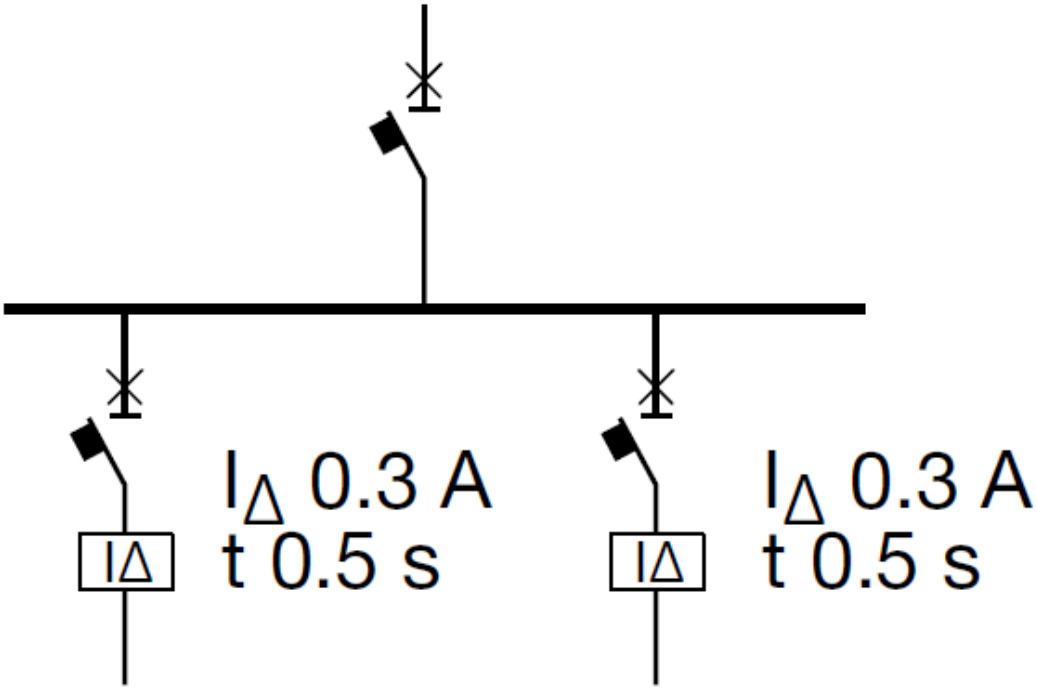
جدول ۵-۹ ضریب تصحیح برای هادی آلومینیومی

S_{PE}/S	0.5	0.55	0.6	0.66	0.75	0.87	1	1.25	1.5	2
S					k_{PE}					
≤16 mm²	0.67	0.71	0.75	0.80	0.86	0.93	1.00	1.11	1.20	1.33
25 mm²	0.85	0.91	0.96	1.02	1.10	1.19	1.28	1.42	1.54	1.71
35 mm²	1.06	1.13	1.20	1.27	1.37	1.48	1.59	1.77	1.91	2.13
>35 mm²	1.00	1.06	1.13	1.2	1.29	1.39	1.5	1.67	1.8	2.00

جدول ۵-۱۰ ضریب تصحیح مربوط به تفاوت سطح مقطع فاز و ارت با مقادیر جدول ۵-۲

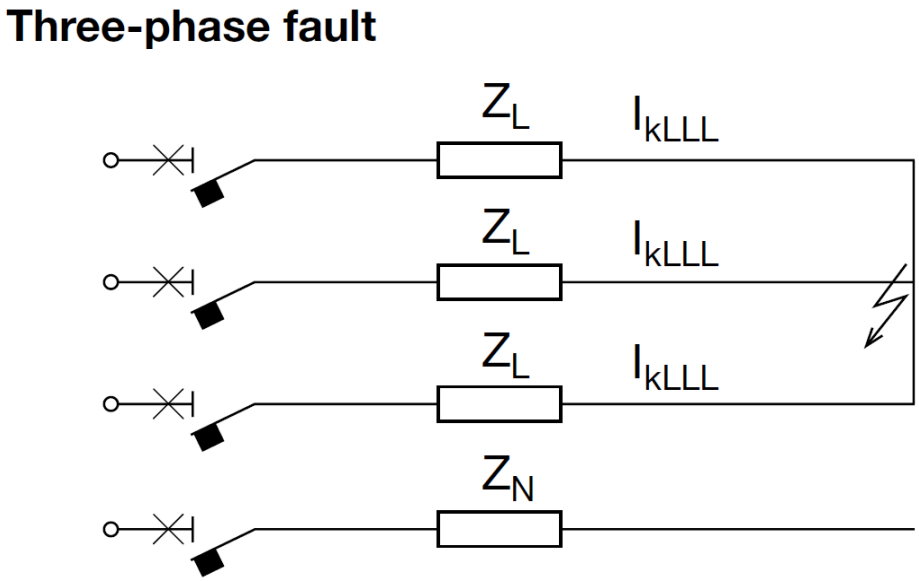


شکل ۵-۱۱ فاصله‌گذاری عمودی

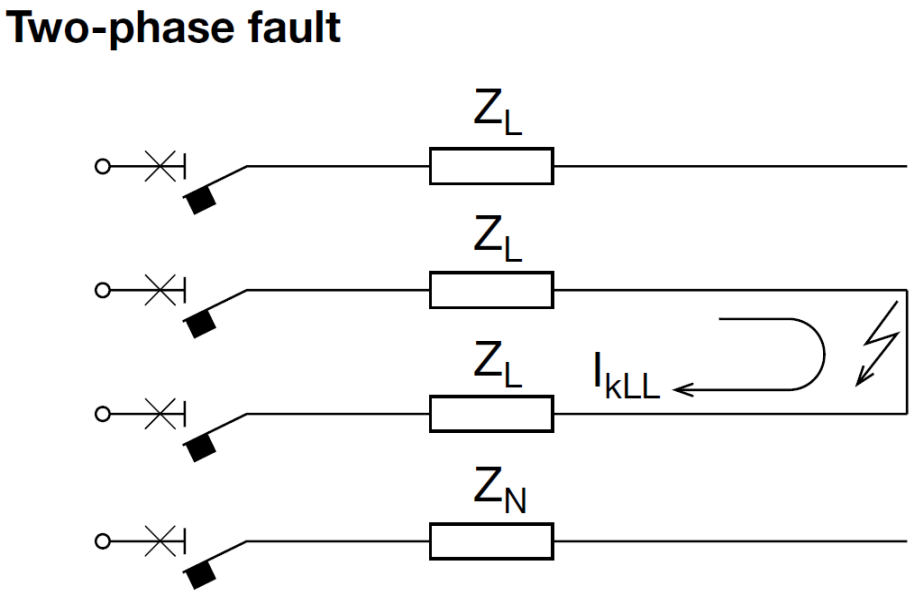


شکل ۵-۱۲ فاصله‌گذاری افقی

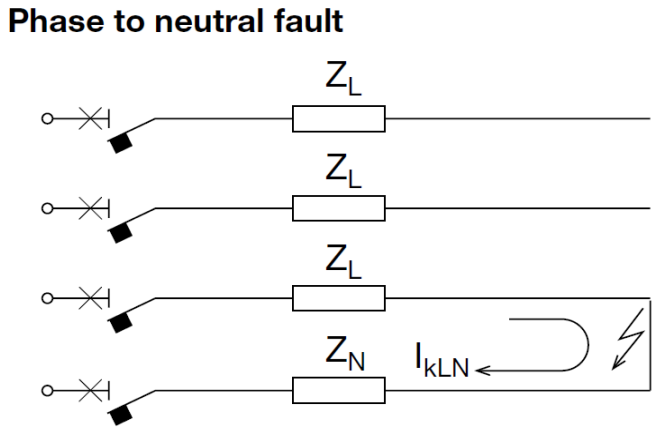
فصل ششم



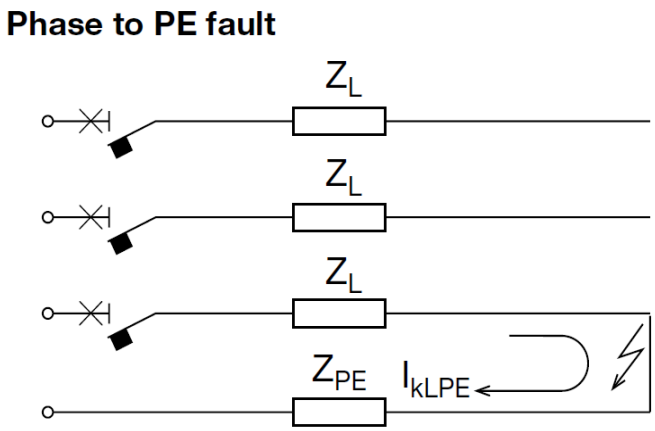
شکل ۶-۱ مدار اتصال کوتاه سه‌فاز



شکل ۶-۲ مدار اتصال کوتاه دو فاز



شکل ۶-۳ مدار اتصال کوتاه تک‌فاز به نول



شکل ۶-۴ مدار اتصال کوتاه تک‌فاز به ارت

Note	Three-phase short-circuit	Two-phase short-circuit	Phase to neutral short-circuit	Phase to PE short-circuit (TN system)
	I_{kLLL}	I_{kLL}	I_{kLN}	I_{kLPE}
I_{kLLL}	-	$I_{kLL}=0.87I_{kLLL}$	$I_{LN}=0.5I_{kLLL}$ ($Z_L = Z_N$) $I_{LN}=0.33I_{kLLL}$ ($Z_L = 0,5Z_N$) $I_{LN}=I_{kLLL}$ ($Z_N \cong 0$)	$I_{LPE}=0.5I_{kLLL}$ ($Z_L = Z_{PE}$) $I_{LPE}=0.33I_{kLLL}$ ($Z_L = 0.5Z_{PE}$) $I_{LPE}=I_{kLLL}$ ($Z_{PE} \cong 0$)
I_{kLL}	$I_{kLLL}=1.16I_{kLL}$	-	$I_{kLN}=0.58I_{kLL}$ ($Z_L = Z_N$) $I_{kLN}=0.38I_{kLL}$ ($Z_L = 0,5Z_N$) $I_{kLN}=1.16I_{kLL}$ ($Z_N \cong 0$)	$I_{kLPE}=0.58I_{kLL}$ ($Z_L = Z_{PE}$) $I_{kLPE}=0.38I_{kLL}$ ($Z_L = 0.5Z_{PE}$) $I_{kLPE}=1.16I_{kLL}$ ($Z_{PE} \cong 0$)
I_{kLN}	$I_{kLLL}=2I_{kLN}$ ($Z_L = Z_N$) $I_{kLLL}=3I_{kLN}$ ($Z_L = 0,5Z_N$) $I_{kLLL}=I_{kLN}$ ($Z_N \cong 0$)	$I_{kLL}=1.73I_{kLN}$ ($Z_L = Z_N$) $I_{kLL}=2.6I_{kLN}$ ($Z_L = 0,5Z_N$) $I_{kLL}=0.87I_{kLN}$ ($Z_N \cong 0$)	-	

جدول ۶-۱ فرمول تقریبی جریان‌های اتصال کوتاه

Net voltage U_r [kV]	Short-circuit power S_{knet} [MVA]
Up to 20	500
Up to 32	750
Up to 63	1000

جدول ۶-۲ مقادیر نوعی سطح اتصال کوتاه برای شبکه‌هایی با ولتاژ نامی مختلف

S_r [kVA]	50	63	125	160	200	250	320	400	500	630	800	1000	1250	1600	2000	2500	3200	4000
S_{kgen} [MVA]	0.4	0.5	1.0	1.3	1.6	2.0	2.6	3.2	4.0	5.0	6.4	8.0	10.0	12.8	16.0	20.0	25.6	32.0

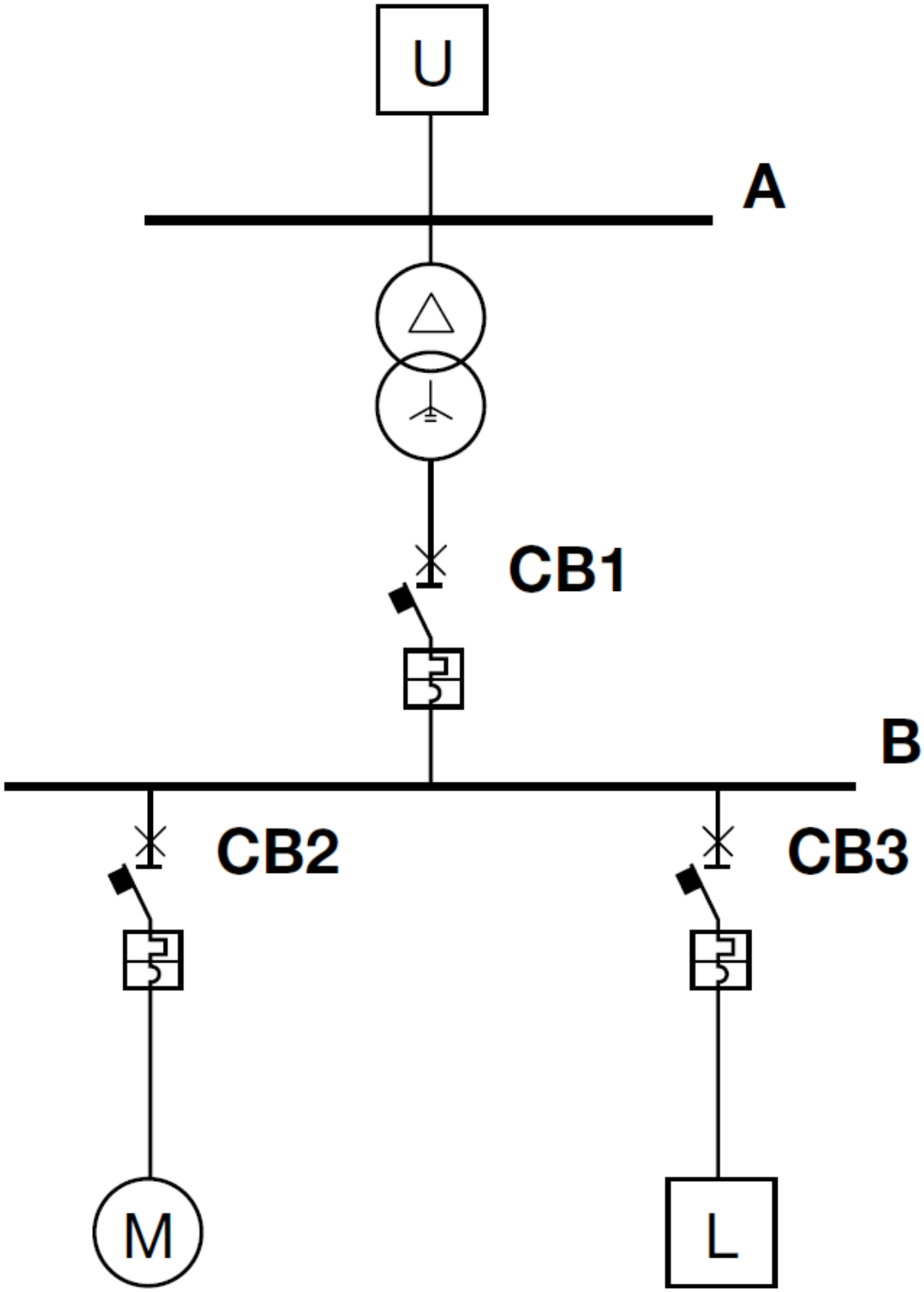
جدول ۶-۳ مقدار تقریبی توان اتصال کوتاه ژنراتورها با فرض X''_d=۱۲٫۵٪

S_r [kVA]	50	63	125	160	200	250	320	400	500	630	800	1000	1250	1600	2000	2500	3200	4000
u_k%	4	4	4	4	4	4	4	4	4	4	5	5	5	6	6	6	6	6
S_{ktrafo} [MVA]	1.3	1.6	3.1	4	5	6.3	8	10	12.5	15.8	16	20	25	26.7	33.3			

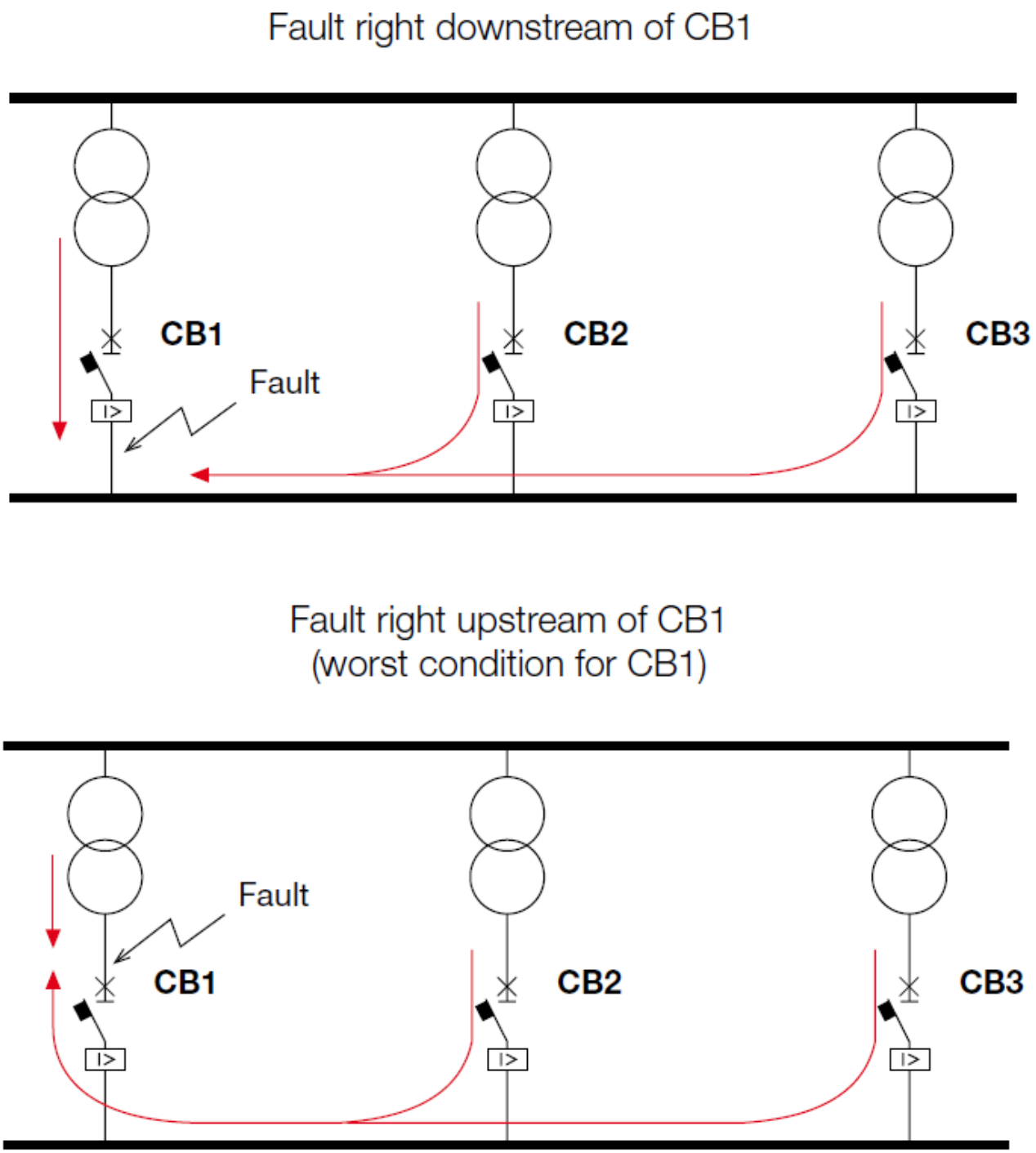
جدول ۶-۴ مقادیر تقریبی توان اتصال کوتاه برای ترانسفورماتورهای مختلف

S [mm²]	230 [V]	400 [V]	440 [V]	500 [V]	690 [V]	230 [V]	400 [V]	440 [V]	500 [V]	690 [V]
	S_{kcable} [MVA] @50 Hz					S_{kcable} [MVA] @60 Hz				
1.5	0.44	1.32	1.60	2.07	3.94	0.44	1.32	1.60	2.07	3.94
2.5	0.73	2.20	2.66	3.44	6.55	0.73	2.20	2.66	3.44	6.55
4	1.16	3.52	4.26	5.50	10.47	1.16	3.52	4.26	5.50	10.47
6	1.75	5.29	6.40	8.26	15.74	1.75	5.29	6.40	8.26	15.73
10	2.9	8.8	10.6	13.8	26.2	2.9	8.8	10.6	13.7	26.2
16	4.6	14.0	16.9	21.8	41.5	4.6	13.9	16.9	21.8	41.5
25	7.2	21.9	26.5	34.2	65.2	7.2	21.9	26.4	34.1	65.0
35	10.0	30.2	36.6	47.3	90.0	10.0	30.1	36.4	47.0	89.6
50	13.4	40.6	49.1	63.4	120.8	13.3	40.2	48.7	62.9	119.8
70	19.1	57.6	69.8	90.1	171.5	18.8	56.7	68.7	88.7	168.8
95	25.5	77.2	93.4	120.6	229.7	24.8	75.0	90.7	117.2	223.1
120	31.2	94.2	114.0	147.3	280.4	29.9	90.5	109.5	141.5	269.4
150	36.2	109.6	132.6	171.2	326.0	34.3	103.8	125.6	162.2	308.8
185	42.5	128.5	155.5	200.8	382.3	39.5	119.5	144.6	186.7	355.6
240	49.1	148.4	179.5	231.8	441.5	44.5	134.7	163.0	210.4	400.7
300	54.2	164.0	198.4	256.2	488.0	48.3	146.1	176.8	228.3	434.7

جدول ۶-۵ توان اتصال کوتاه کابل‌ها به ازا طول ۱۰ متر



شکل ۶-۷ شبکه مثال ۶-۱ (مثال ۱)

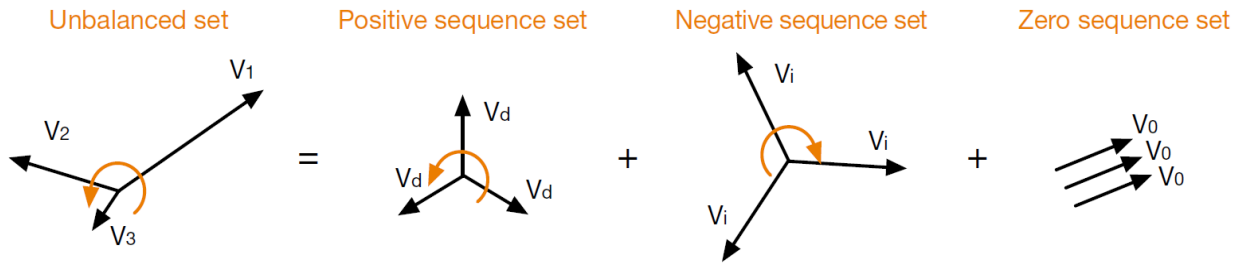


شکل ۶-۵ (الف) اتصالی دقیقا زیر CB1 رخ می‌دهد، (ب) اتصالی دقیقا بالای CB1 رخ می‌دهد.

Cable section [mm²]	Length [m]																								
1.5																0.9	1.1	1.4	1.8	2.5	3.5	5.3	7	9.4	14
2.5													0.9	1	1.2	1.5	1.8	2.3	2.9	4.1	5.9	8.8	12	16	24
4											0.9	1.2	1.4	1.6	1.9	2.3	2.8	3.7	4.7	6.6	9.4	14	19	25	38
6									0.8	1.1	1.4	1.8	2.1	2.5	2.8	3.5	4.2	5.6	7	10	14	21	28	38	56
10							0.9	1.2	1.4	1.9	2.3	2.9	3.5	4.1	4.7	5.8	7	9.4	12	16	23	35	47	63	94
16					0.9	1.1	1.5	1.9	2.2	3	3.7	4.7	5.6	6.5	7.5	9.3	11	15	19	26	37	56	75	100	150
25			0.9	1.2	1.4	1.7	2.3	2.9	3.5	4.6	5.8	7.2	8.7	10	12	14	17	23	29	41	58	87	116	155	233
35			1.2	1.6	2	2.4	3.2	4	4.8	6.4	8	10	12	14	16	20	24	32	40	56	80	121	161	216	324
50		1.1	1.7	2.3	2.8	3.4	4.5	5.7	6.8	9	11	14	17	20	23	28	34	45	57	79	113	170	226	303	455
70	0.8	1.5	2.3	3.1	3.8	4.6	6.2	7.7	9.2	12	15	19	23	27	31	38	46	62	77	108	154	231	308	413	
95	1	2	3	4	5	6	8	10	12	16	20	25	30	35	40	50	60	80	100	140	200	300	400		
120	1.2	2.4	3.6	4.8	6	7.2	10	12	14	19	24	30	36	42	48	60	72	96	120	168	240	360	481		
150	1.4	2.8	4.2	5.6	7	8.4	11	14	17	23	28	35	42	49	56	70	84	113	141	197	281	422			
185	1.6	3.2	4.8	6.4	8	10	13	16	19	26	32	40	48	56	64	80	96	128	160	224	320	480			
240	1.8	3.7	5.5	7.3	9.1	11	15	18	22	29	37	46	55	64	73	91	110	146	183	256	366	549			
300	2	4	6	8	10	12	16	20	24	32	40	50	60	70	80	100	120	160	200	280	400				
2x120	2.4	4.8	7.2	10	12	14	19	24	29	38	48	60	72	84	96	120	144	192	240	336	481				
2x150	2.8	5.6	8.4	11	14	17	23	28	34	45	56	70	84	98	113	141	169	225	281	394	563				
2x185	3.2	6.4	10	13	16	19	26	32	38	51	64	80	96	112	128	160	192	256	320	448					
3x120	3.6	7.2	11	14	18	22	29	36	43	58	72	90	108	126	144	180	216	288	360	505					
3x150	4.2	8.4	13	17	21	25	34	42	51	68	84	105	127	148	169	211	253	338	422						
3x185	4.8	10	14	19	24	29	38	48	58	77	96	120	144	168	192	240	288	384	480						

I_k upstream [kA]	I_k downstream [kA]																								
100	96	92	89	85	82	78	71	65	60	50	43	36	31	27	24	20	17	13	11	7.8	5.6	3.7	2.7	2.0	1.3
90	86	83	81	78	76	72	67	61	57	48	42	35	31	27	24	20	17	13	11	7.8	5.6	3.7	2.7	2.0	1.3
80	77	75	73	71	69	66	62	57	53	46	40	34	30	27	24	20	17	13	10	7.7	5.5	3.7	2.7	2.0	1.3
70	68	66	65	63	62	60	56	53	49	43	38	33	29	26	23	19	16	13	10	7.6	5.5	3.7	2.7	2.0	1.3
60	58	57	56	55	54	53	50	47	45	40	36	31	28	25	23	19	16	12	10	7.5	5.4	3.7	2.7	2.0	1.3
50	49	48	47	46	45	44	43	41	39	35	32	29	26	23	21	18	15	12	10	7.3	5.3	3.6	2.6	2.0	1.3
40	39	39	38	38	37	37	35	34	33	31	28	26	24	22	20	17	15	12	10	7.1	5.2	3.6	2.6	2.0	1.3
35	34	34	34	33	33	32	32	31	30	28	26	24	22	20	19	16	14	11	10	7.1	5.1	3.5	2.6	2.0	1.3
30	30	29	29	29	28	28	28	27	26	25	23	22	20	19	18	16	14	11	9.3	7.0	5.0	3.5	2.6	1.9	1.3
25	25	24	24	24	24	24	23	23	22	21	21	19	18	17	16	14	13	11	9.0	6.8	5.0	3.4	2.6	1.9	1.3
20	20	20	20	19	19	19	19	18	18	18	17	16	15	15	14	13	12	10	8.4	6.5	4.8	3.3	2.5	1.9	1.3
15	15	15	15	15	15	14	14	14	14	14	13	13	12	12	12	11	10	8.7	7.6	6.1	4.6	3.2	2.5	1.9	1.3
12	12	12	12	12	12	12	12	11	11	11	11	11	10	10	10	9.3	8.8	7.8	7.0	5.7	4.4	3.1	2.4	1.9	1.3
10	10	10	10	10	10	10	10	9.5	9.4	9.2	9.0	8.8	8.5	8.3	8.1	7.7	7.3	6.5	5.9	5.0	3.9	2.9	2.3	1.8	1.2
8.0	8.0	7.9	7.9	7.9	7.8	7.8	7.7	7.7	7.6	7.5	7.4	7.2	7.1	6.9	6.8	6.5	6.2	5.7	5.2	4.5	3.7	2.8	2.2	1.7	1.2
6.0	6.0	5.9	5.9	5.9	5.9	5.8	5.8	5.8	5.7	5.6	5.5	5.4	5.3	5.2	5.1	4.9	4.8	4.4	4.1	3.6	3.1	2.4	2.0	1.6	1.1
3.0	3.0	3.0	3.0	3.0	3.0	3.0	2.9	2.9	2.9	2.9	2.9	2.8	2.8	2.8	2.7	2.7	2.6	2.5	2.4	2.2	2.0	1.7	1.4	1.2	0.9

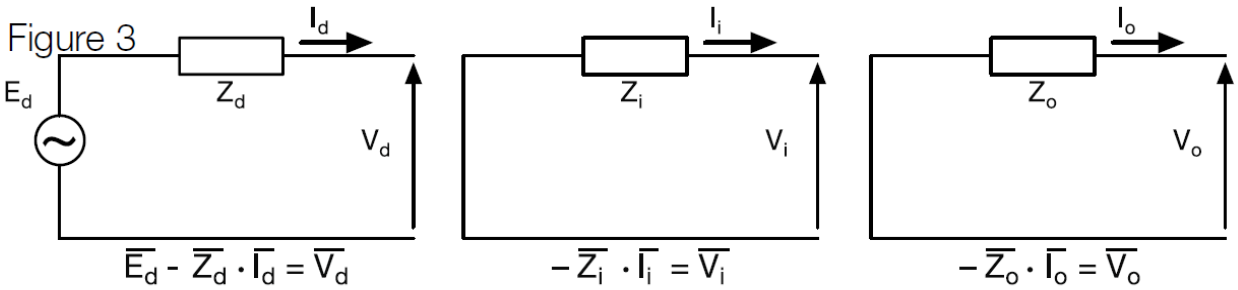
جدول ۶-۶ محاسبه جریان اتصال کوتاه در انتهای کابل‌ها



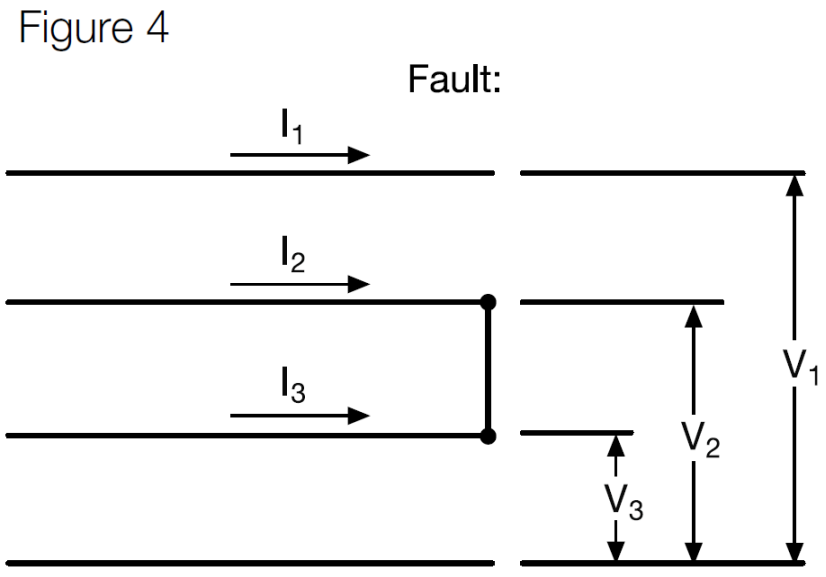
شکل ۶-۱۱ یک مجموعه بردار نامتقارن که به بردارهای متعادل توالی مثبت، منفی و صفر تبدیل شده است.

$\overline{V}_0=\frac{1}{3}(\overline{V}_1+\overline{V}_2+\overline{V}_3)$	$\overline{I}_0=\frac{1}{3}(\overline{I}_1+\overline{I}_2+\overline{I}_3)$	$\overline{V}_1=\overline{V}_0+\overline{V}_d+\overline{V}_i$	$\overline{I}_1=\overline{I}_0+\overline{I}_d+\overline{I}_i$
$\overline{V}_d=\frac{1}{3}(\overline{V}_1+\alpha\cdot\overline{V}_2+\alpha^2\cdot\overline{V}_3)$	$\overline{I}_d=\frac{1}{3}(\overline{I}_1+\alpha\cdot\overline{I}_2+\alpha^2\cdot\overline{I}_3)$	$\overline{V}_2=\overline{V}_0+\alpha^2\cdot\overline{V}_d+\alpha\cdot\overline{V}_i$	$\overline{I}_2=\overline{I}_0+\alpha^2\cdot\overline{I}_d+\alpha\cdot\overline{I}_i$
$\overline{V}_i=\frac{1}{3}(\overline{V}_1+\alpha^2\cdot\overline{V}_2+\alpha\cdot\overline{V}_3)$ 1)	$\overline{I}_i=\frac{1}{3}(\overline{I}_1+\alpha^2\cdot\overline{I}_2+\alpha\cdot\overline{I}_3)$	$\overline{V}_3=\overline{V}_0+\alpha\cdot\overline{V}_d+\alpha^2\cdot\overline{V}_i$ 2)	$\overline{I}_3=\overline{I}_1+\alpha\cdot\overline{I}_2+\alpha^2\cdot\overline{I}_3$

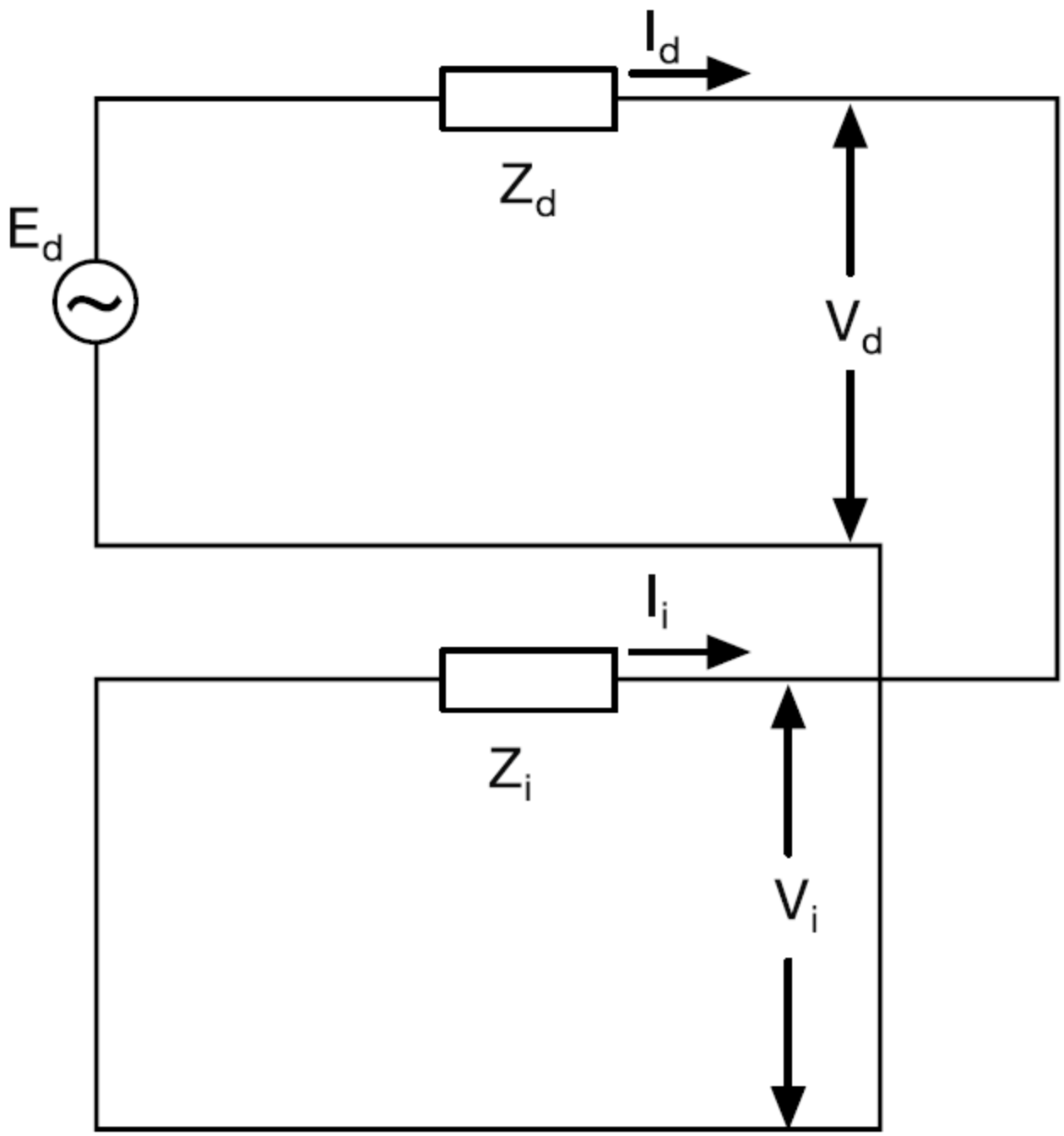
جدول ۶-۷ روابط تعیین مولفه‌های توالی مثبت، منفی و صفر



شکل ۶-۱۳ مدار توالی‌های مثبت، منفی و صفر

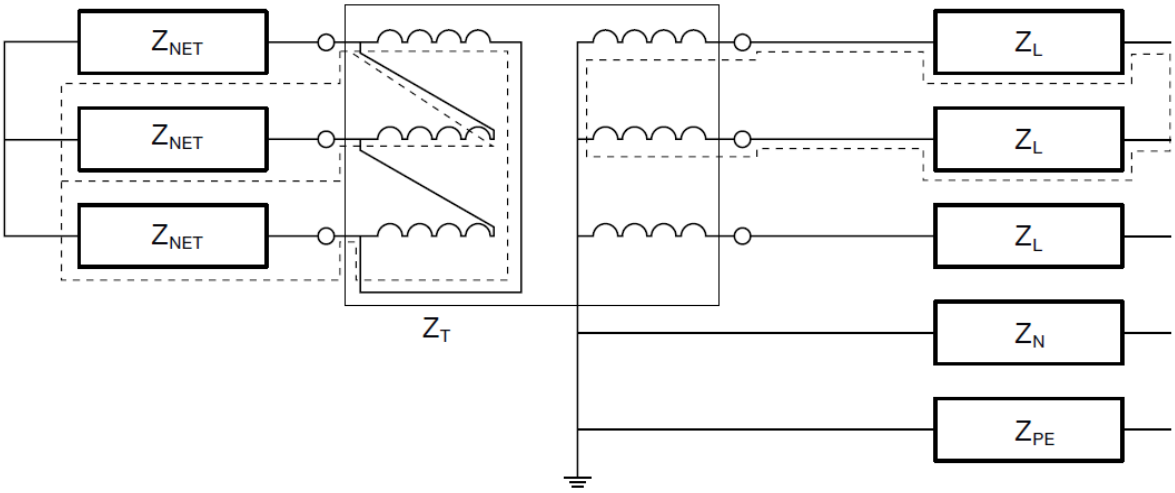


شکل ۶-۱۴ شماتیک یک اتصال کوتاه دوفاز



شکل ۶-۱۵ مدار معادل شبکه در یک اتصال کوتاه دوفاز

Figure 6

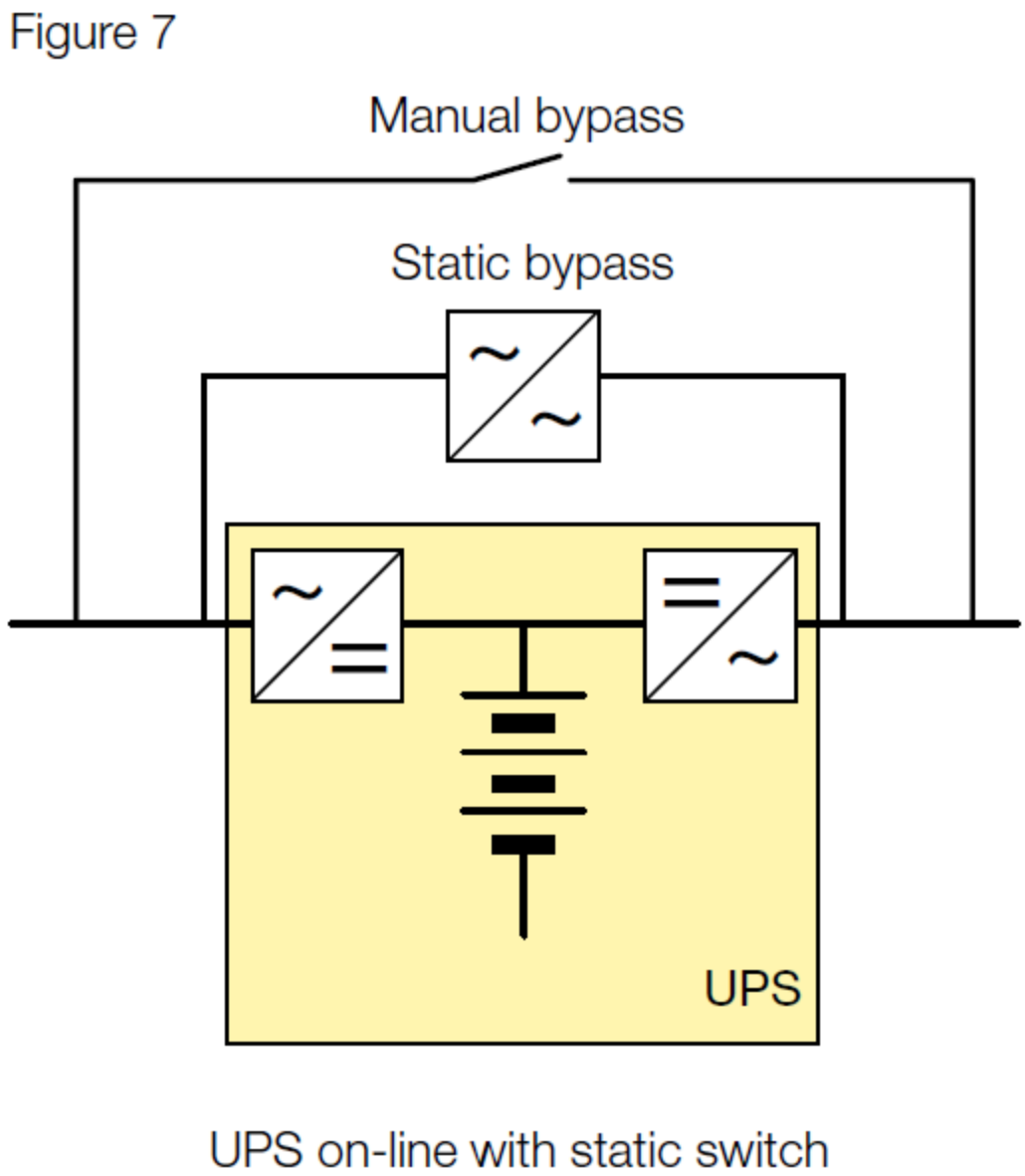


شکل ۶-۱۶ اتصال کوتاه دوفاز در شبکه‌ای شامل یک ترانس و یک کابل

Table 3

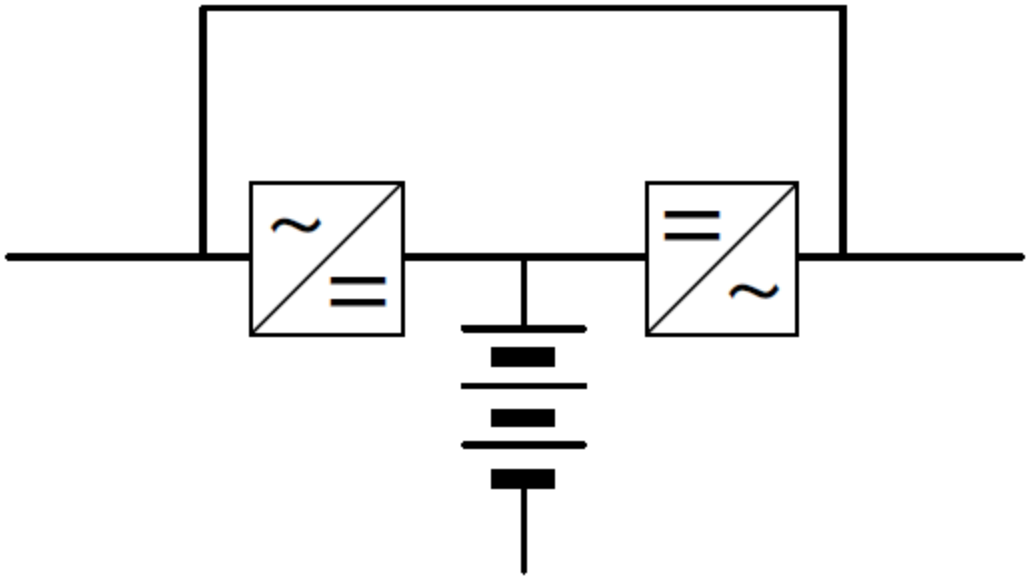
	Upstream defined power network		Upstream infinite power network $Z_{NET} \rightarrow 0$	
	Far-from the transformer	Near the transformer $Z_L \rightarrow 0$, Z_{PE} (o Z_N)$\rightarrow 0$	Far-from the transformer	Near the transformer $Z_L \rightarrow 0$, Z_{PE} (o Z_N)$\rightarrow 0$
I_{k3}	$I_{k3}=\frac{U_r}{\sqrt{3}\cdot(Z_{NET}+Z_T+Z_L)}$	$I_{k3}=\frac{U_r}{\sqrt{3}\cdot(Z_{NET}+Z_T)}$	$I_{k3}=\frac{U_r}{\sqrt{3}\cdot(Z_T+Z_L)}$	$I_{k3}=\frac{U_r}{\sqrt{3}\cdot(Z_T)}$
I_{k2}	$I_{k2}=\frac{U_r}{2\cdot(Z_{NET}+Z_T+Z_L)}$	$I_{k2}=\frac{U_r}{2\cdot(Z_{NET}+Z_T)}$	$I_{k2}=\frac{U_r}{2\cdot(Z_T+Z_L)}$	$I_{k2}=\frac{U_r}{2\cdot(Z_T)}$
	$I_{k2}<I_{k3}$	$I_{k2}=0.87\cdot I_{k3}$	$I_{k2}=0.87\cdot I_{k3}$	$I_{k2}=0.87\cdot I_{k3}$
I_{k1}	$I_{k1}=\frac{U_r}{\sqrt{3}\cdot\left(\frac{2}{3}\cdot Z_{NET}+Z_T+Z_L+Z_{PE}\right)}$	$I_{k1}=\frac{U_r}{\sqrt{3}\cdot\left(\frac{2}{3}\cdot Z_{NET}+Z_T\right)}$	$I_{k1}=\frac{U_r}{\sqrt{3}\cdot(Z_T+Z_L+Z_{PE})}$	$I_{k1}=\frac{U_r}{\sqrt{3}\cdot(Z_T)}$
	$I_{k1}>I_{k3}$ if $Z_{NET}>3\cdot Z_{PE}$	$I_{k1}>I_{k3}$	I_{k1} " I_{k3}	$I_{k1}=I_{k3}$

جدول ۶-۱۰ خلاصه روابط محاسبه جریان اتصال کوتاه در شبکه‌های مختلف



شکل ۶-۱۷ کلیدهای بای‌پس قطع‌اند و بار به واسطه UPS از شبکه تغذیه می‌شود

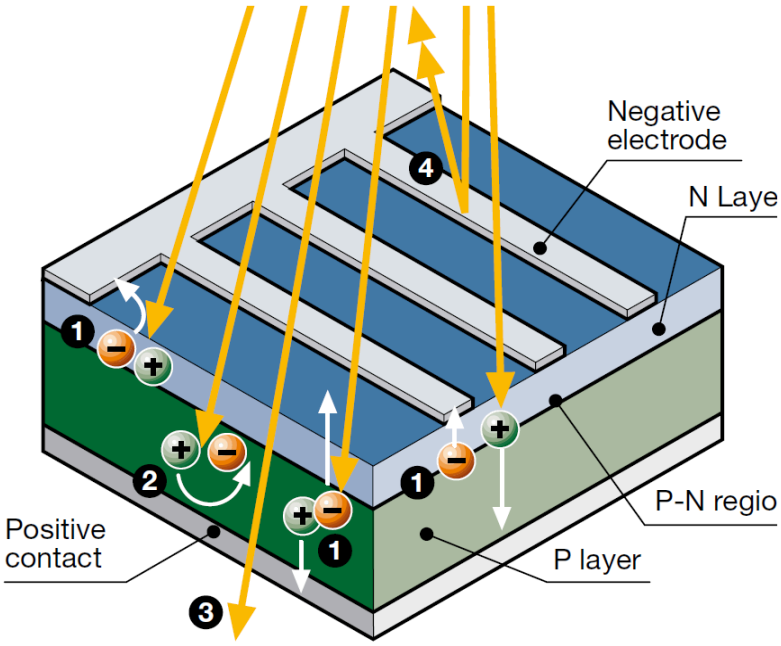
Figure 8



UPS off-line: loads directly fed by the network

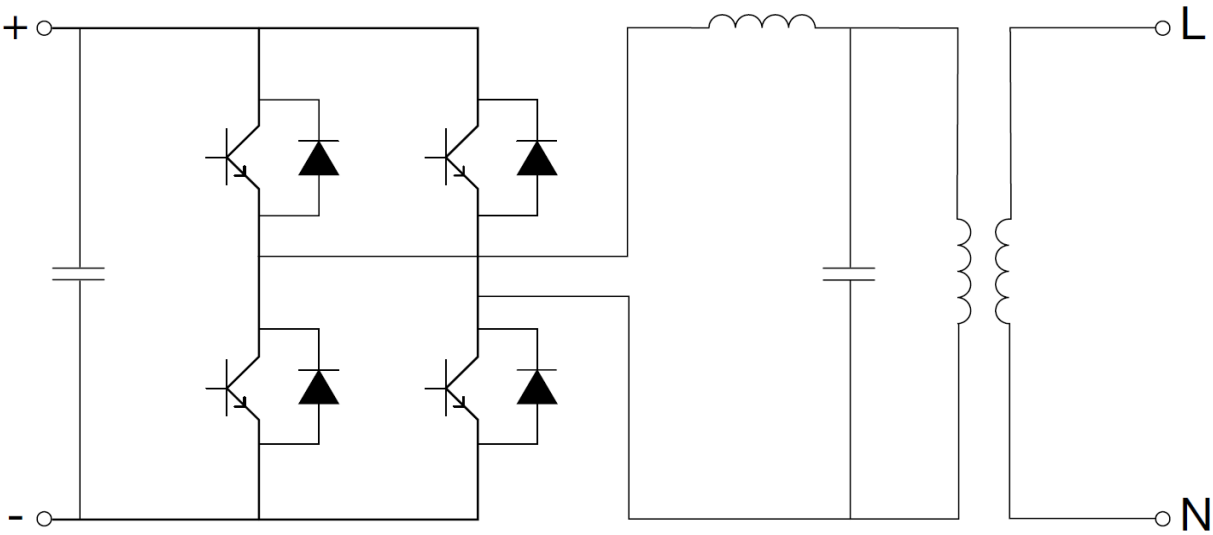
شکل ۶-۱۸ کلیدهای بای‌پس وصل‌اند و بار مستقیما از شبکه تغذیه می‌شود.

فصل هفتم

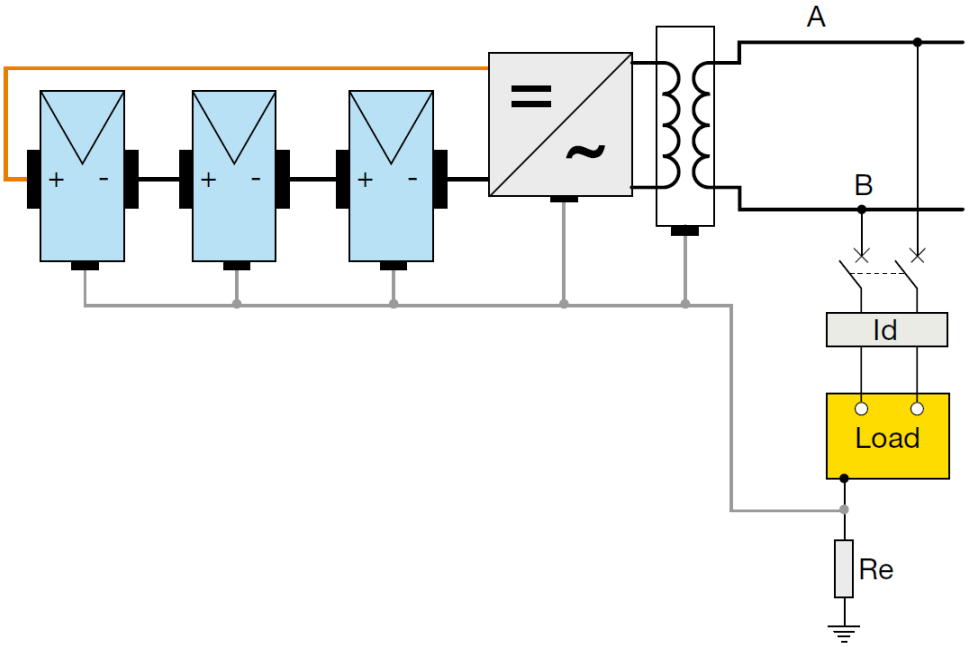


شکل ۷-۱ اثر فتوولتائیک در یک قطعه نیمه‌هادی

Principle scheme of a single-phase inverter

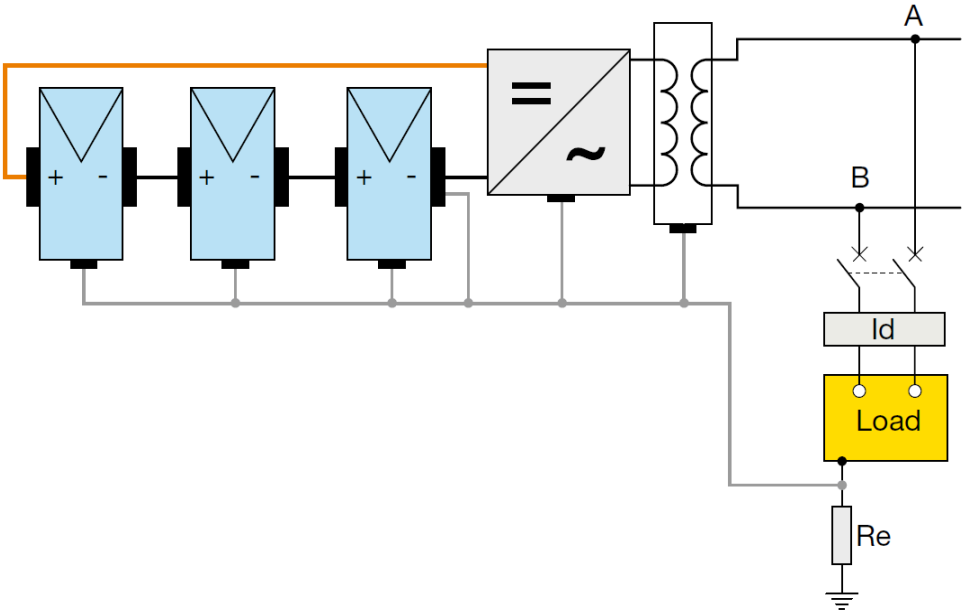


شکل ۷-۲ اینورتر مورد استفاده در یک واحد برق خورشیدی

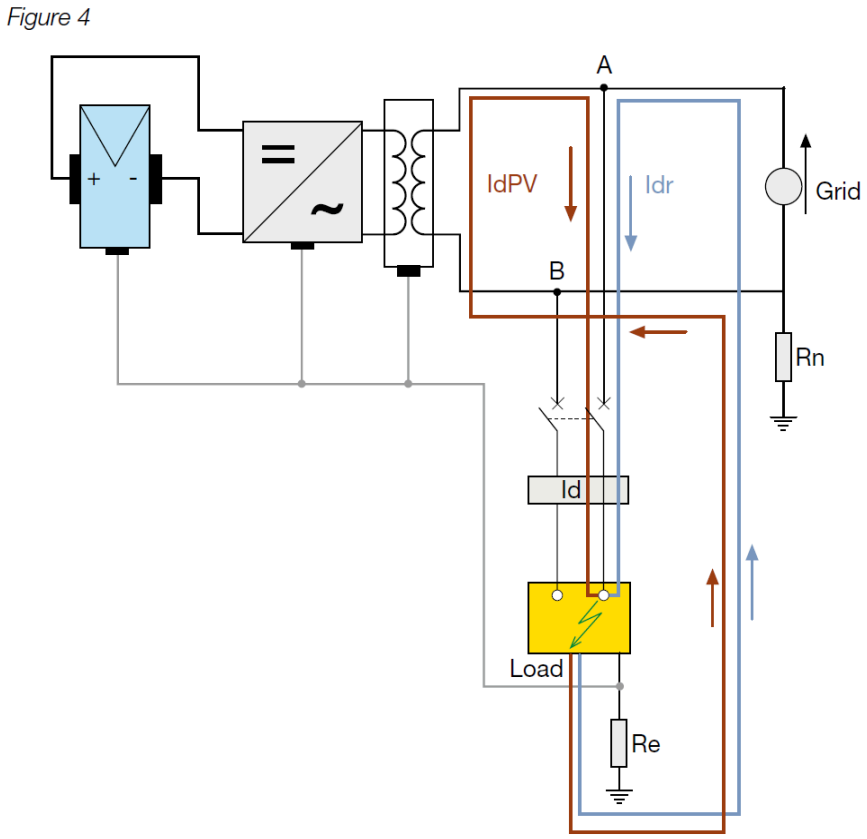


شکل ۷-۳ واحد PV با سیستم الکتریکی IT و ارتباطات آن به زمین

Figure 3

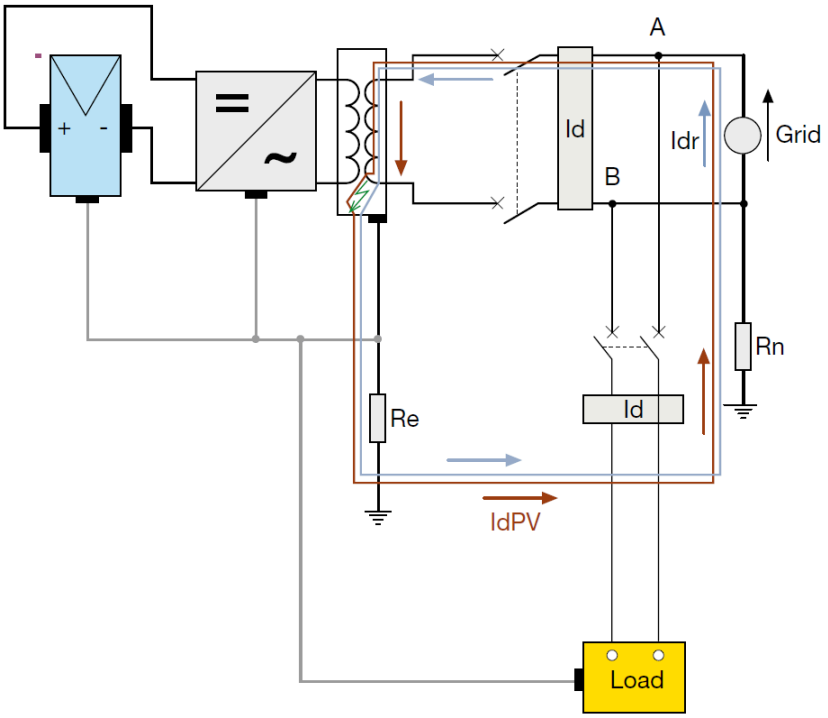


شکل ۷-۴ واحد PV با سیستم الکتریکی TN و ارتباطات آن به زمین



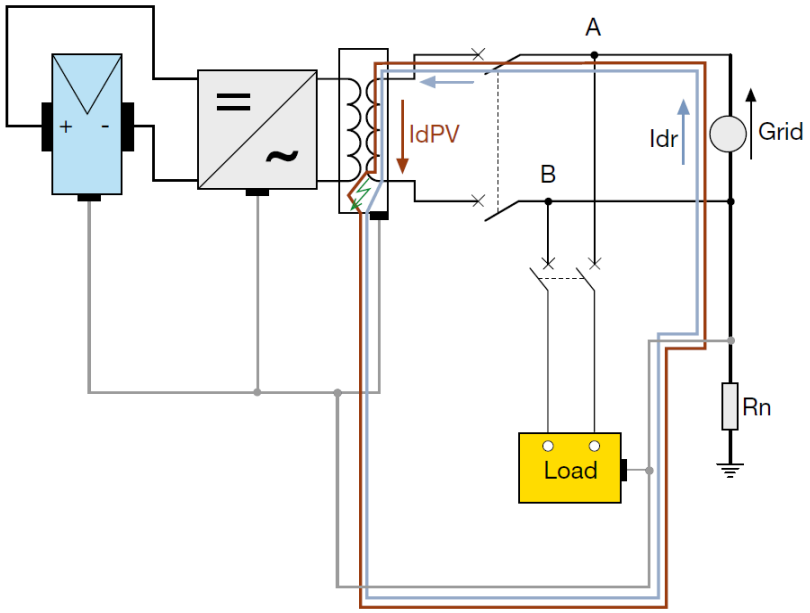
شکل ۷-۵ جریان اتصال کوتاه در سیستمی با اتصال TT و حفاظت اضافه جریان مربوطه

Figure 5

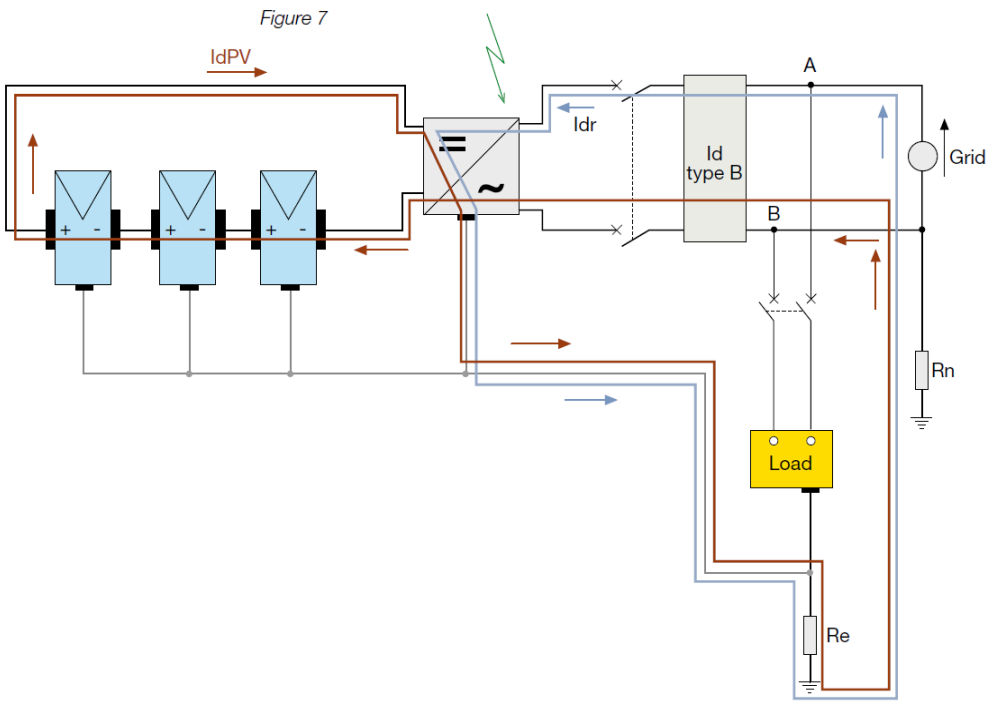


شکل ۷-۶ جریان اتصال کوتاه در سیستمی با اتصال TT و حفاظت جریان نشتی مربوطه

Figure 6

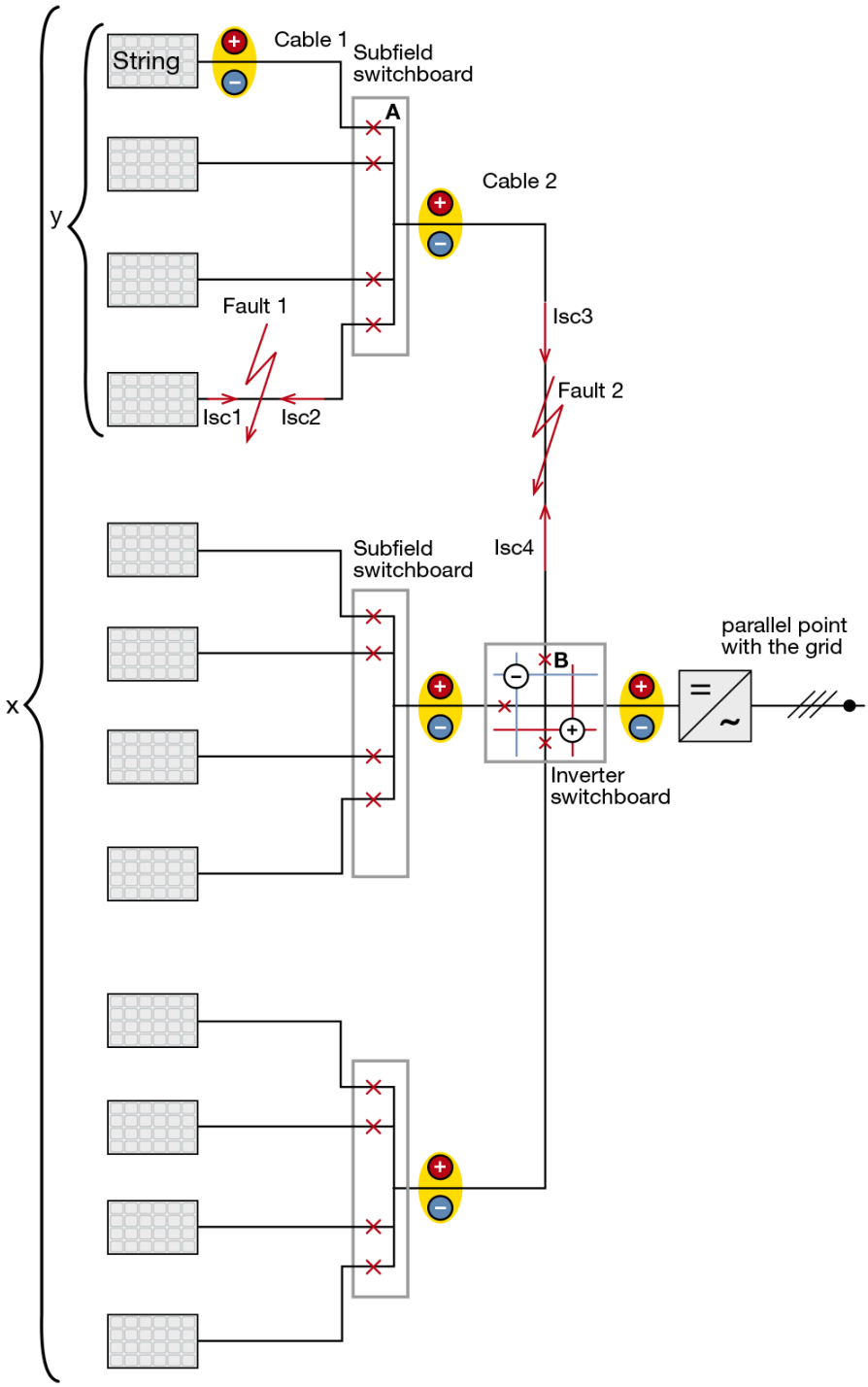


شکل ۷-۷ ارتباطات بدنه‌های هادی در سیستم TN

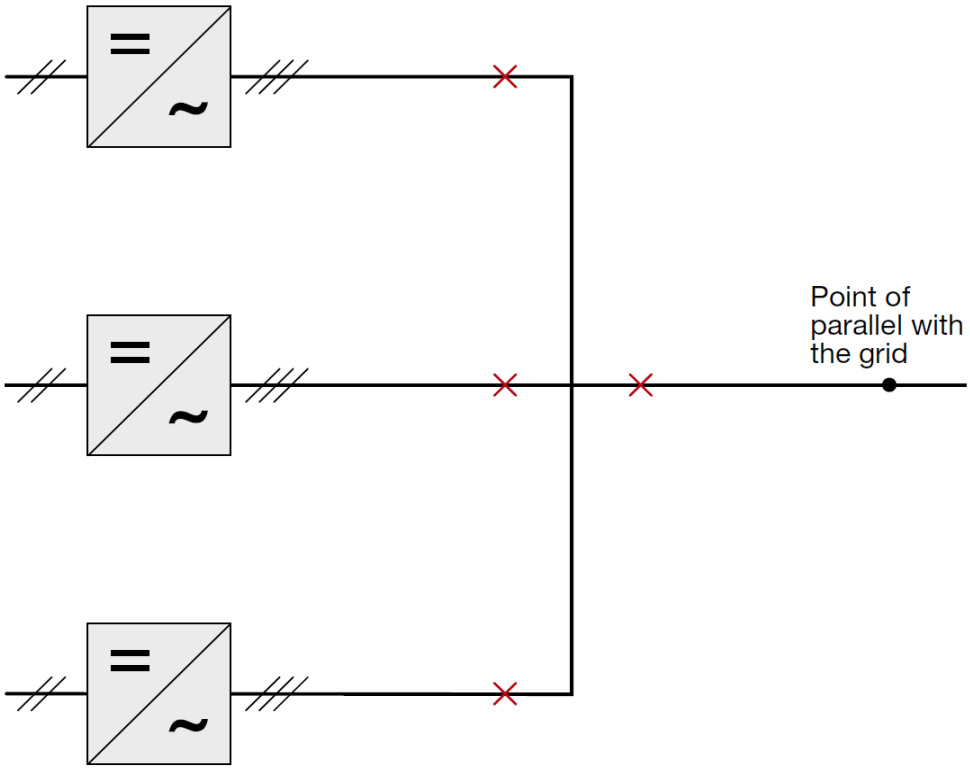


شکل ۷-۸ بروز اتصال در سمت Dc برای یک واحد فاقد ترانسفورماتور

Figure 8



شکل ۷-۹ حفاظت کابل‌ها در سمت DC یک مجموعه برق خورشیدی



شکل ۷-۱۰ سمت AC اینورترها و حفاظت‌های مربوطه

فصل هشتم

Table 1: Load current for three-phase systems with cosφ = 0.9

	U_r [V]						
	230	400	415	440	500	600	690
P [kW]	I_b [A]						
0.03	0.08	0.05	0.05	0.04	0.04	0.03	0.03
0.04	0.11	0.06	0.06	0.06	0.05	0.04	0.04
0.06	0.17	0.10	0.09	0.09	0.08	0.06	0.06
0.1	0.28	0.16	0.15	0.15	0.13	0.11	0.09
0.2	0.56	0.32	0.31	0.29	0.26	0.21	0.19
0.5	1.39	0.80	0.77	0.73	0.64	0.53	0.46
1	2.79	1.60	1.55	1.46	1.28	1.07	0.93
2	5.58	3.21	3.09	2.92	2.57	2.14	1.86
5	13.95	8.02	7.73	7.29	6.42	5.35	4.65
10	27.89	16.04	15.46	14.58	12.83	10.69	9.30
20	55.78	32.08	30.92	29.16	25.66	21.38	18.59
30	83.67	48.11	46.37	43.74	38.49	32.08	27.89
40	111.57	64.15	61.83	58.32	51.32	42.77	37.19
50	139.46	80.19	77.29	72.90	64.15	53.46	46.49
60	167.35	96.23	92.75	87.48	76.98	64.15	55.78
70	195.24	112.26	108.20	102.06	89.81	74.84	65.08
80	223.13	128.30	123.66	116.64	102.64	85.53	74.38
90	251.02	144.34	139.12	131.22	115.47	96.23	83.67
100	278.91	160.38	154.58	145.80	128.30	106.92	92.97
110	306.80	176.41	170.04	160.38	141.13	117.61	102.27
120	334.70	192.45	185.49	174.95	153.96	128.30	111.57
130	362.59	208.49	200.95	189.53	166.79	138.99	120.86
140	390.48	224.53	216.41	204.11	179.62	149.68	130.16
150	418.37	240.56	231.87	218.69	192.45	160.38	139.46
200	557.83	320.75	309.16	291.59	256.60	213.83	185.94

	U_r [V]						
	230	400	415	440	500	600	690
P [kW]	I_b[A]						
250	697.28	400.94	386.45	364.49	320.75	267.29	232.43
300	836.74	481.13	463.74	437.39	384.90	320.75	278.91
350	976.20	561.31	541.02	510.28	449.05	374.21	325.40
400	1115.65	641.50	618.31	583.18	513.20	427.67	371.88
450	1255.11	721.69	695.60	656.08	577.35	481.13	418.37
500	1394.57	801.88	772.89	728.98	641.50	534.58	464.86
550	1534.02	882.06	850.18	801.88	705.65	588.04	511.34
600	1673.48	962.25	927.47	874.77	769.80	641.50	557.83
650	1812.94	1042.44	1004.76	947.67	833.95	694.96	604.31
700	1952.39	1122.63	1082.05	1020.57	898.10	748.42	650.80
750	2091.85	1202.81	1159.34	1093.47	962.25	801.88	697.28
800	2231.31	1283.00	1236.63	1166.36	1026.40	855.33	743.77
850	2370.76	1363.19	1313.92	1239.26	1090.55	908.79	790.25
900	2510.22	1443.38	1391.21	1312.16	1154.70	962.25	836.74
950	2649.68	1523.56	1468.49	1385.06	1218.85	1015.71	883.23
1000	2789.13	1603.75	1545.78	1457.96	1283.00	1069.17	929.71

جدول الف-۱ جریان موتورهای سه‌فاز با cosϕ=۰.۹

Table 2: Correction factors for load current with cosφ other than 0.9

$\cos\varphi_{act}$	1	0.95	0.9	0.85	0.8	0.75	0.7
$k_{\cos\varphi}^{*}$	0.9	0.947	1	1.059	1.125	1.2	1.286

جدول الف-۲ ضریب تصحیح برای موتورهای تک‌فازی که ضریب توان‌شان متفاوت با cosϕ=۰.۹ باشد.

Table 3: Load current for single-phase systems with cosφ = 1 or dc systems

	U_r [V]						
	230	400	415	440	500	600	690
P [kW]	I_b [A]						
0.03	0.13	0.08	0.07	0.07	0.06	0.05	0.04
0.04	0.17	0.10	0.10	0.09	0.08	0.07	0.06
0.06	0.26	0.15	0.14	0.14	0.12	0.10	0.09
0.1	0.43	0.25	0.24	0.23	0.20	0.17	0.14
0.2	0.87	0.50	0.48	0.45	0.40	0.33	0.29
0.5	2.17	1.25	1.20	1.14	1.00	0.83	0.72
1	4.35	2.50	2.41	2.27	2.00	1.67	1.45
2	8.70	5.00	4.82	4.55	4.00	3.33	2.90
5	21.74	12.50	12.05	11.36	10.00	8.33	7.25
10	43.48	25.00	24.10	22.73	20.00	16.67	14.49
20	86.96	50.00	48.19	45.45	40.00	33.33	28.99

	U_r [V]						
	230	400	415	440	500	600	690
P [kW]	I_b [A]						
30	130.43	75.00	72.29	68.18	60.00	50.00	43.48
40	173.91	100.00	96.39	90.91	80.00	66.67	57.97
50	217.39	125.00	120.48	113.64	100.00	83.33	72.46
60	260.87	150.00	144.58	136.36	120.00	100.00	86.96
70	304.35	175.00	168.67	159.09	140.00	116.67	101.45
80	347.83	200.00	192.77	181.82	160.00	133.33	115.94
90	391.30	225.00	216.87	204.55	180.00	150.00	130.43
100	434.78	250.00	240.96	227.27	200.00	166.67	144.93
110	478.26	275.00	265.06	250.00	220.00	183.33	159.42
120	521.74	300.00	289.16	272.73	240.00	200.00	173.91
130	565.22	325.00	313.25	295.45	260.00	216.67	188.41
140	608.70	350.00	337.35	318.18	280.00	233.33	202.90
150	652.17	375.00	361.45	340.91	300.00	250.00	217.39
200	869.57	500.00	481.93	454.55	400.00	333.33	289.86
250	1086.96	625.00	602.41	568.18	500.00	416.67	362.32
300	1304.35	750.00	722.89	681.82	600.00	500.00	434.78
350	1521.74	875.00	843.37	795.45	700.00	583.33	507.25
400	1739.13	1000.00	963.86	909.09	800.00	666.67	579.71
450	1956.52	1125.00	1084.34	1022.73	900.00	750.00	652.17
500	2173.91	1250.00	1204.82	1136.36	1000.00	833.33	724.64
550	2391.30	1375.00	1325.30	1250.00	1100.00	916.67	797.10
600	2608.70	1500.00	1445.78	1363.64	1200.00	1000.00	869.57
650	2826.09	1625.00	1566.27	1477.27	1300.00	1083.33	942.03
700	3043.48	1750.00	1686.75	1590.91	1400.00	1166.67	1014.49
750	3260.87	1875.00	1807.23	1704.55	1500.00	1250.00	1086.96
800	3478.26	2000.00	1927.71	1818.18	1600.00	1333.33	1159.42
850	3695.65	2125.00	2048.19	1931.82	1700.00	1416.67	1231.88
900	3913.04	2250.00	2168.67	2045.45	1800.00	1500.00	1304.35
950	4130.43	2375.00	2289.16	2159.09	1900.00	1583.33	1376.81
1000	4347.83	2500.00	2409.64	2272.73	2000.00	1666.67	1449.28

جدول الف-۳ جریان موتورهای تک‌فاز با cosϕ=۱

Table 4: Correction factors for load current with cosφ other than 1

$\cos\varphi_{act}$	1	0.95	0.9	0.85	0.8	0.75	0.7
$k_{\cos\varphi}$*	1	1.053	1.111	1.176	1.25	1.333	1.429

جدول الف-۴ ضریب تصحیح برای موتورهای تک‌فازی که ضریب توان‌شان متفاوت با cosϕ=۱ باشد.

Table 5: Motor load current

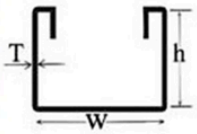
Motor power		Rated current of the motor at:							
[kW]	PS = hp	220-230 V [A]	240 V [A]	380-400 V [A]	415 V [A]	440 V [A]	500 V [A]	600 V [A]	660-690 V [A]
0.06	1/12	0.38	0.35	0.22	0.20	0.19	0.16	0.12	–
0.09	1/8	0.55	0.50	0.33	0.30	0.28	0.24	0.21	–
0.12	1/6	0.76	0.68	0.42	0.40	0.37	0.33	0.27	–
0.18	1/4	1.1	1	0.64	0.60	0.55	0.46	0.40	–
0.25	1/3	1.4	1.38	0.88	0.85	0.76	0.59	0.56	–
0.37	1/2	2.1	1.93	1.22	1.15	1.06	0.85	0.77	0.7
0.55	3/4	2.7	2.3	1.5	1.40	1.25	1.20	1.02	0.9
0.75	1	3.3	3.1	2	2	1.67	1.48	1.22	1.1
1.1	1.5	4.9	4.1	2.6	2.5	2.26	2.1	1.66	1.5
1.5	2	6.2	5.6	3.5	3.5	3.03	2.6	2.22	2
2.2	3	8.7	7.9	5	5	4.31	3.8	3.16	2.9
2.5	3.4	9.8	8.9	5.7	5.5	4.9	4.3	3.59	3.3
3	4	11.6	10.6	6.6	6.5	5.8	5.1	4.25	3.5
3.7	5	14.2	13	8.2	7.5	7.1	6.2	5.2	4.4
4	5.5	15.3	14	8.5	8.4	7.6	6.5	5.6	4.9
5	6.8	18.9	17.2	10.5	10	9.4	8.1	6.9	6
5.5	7.5	20.6	18.9	11.5	11	10.3	8.9	7.5	6.7
6.5	8.8	23.7	21.8	13.8	12.5	12	10.4	8.7	8.1
7.5	10	27.4	24.8	15.5	14	13.5	11.9	9.9	9
8	11	28.8	26.4	16.7	15.4	14.4	12.7	10.6	9.7
9	12.5	32	29.3	18.3	17	15.8	13.9	11.6	10.6
11	15	39.2	35.3	22	21	19.3	16.7	14.1	13
12.5	17	43.8	40.2	25	23	21.9	19	16.1	15
15	20	52.6	48.2	30	28	26.3	22.5	19.3	17.5
18.5	25	64.9	58.7	37	35	32	28.5	23.5	21
20	27	69.3	63.4	40	37	34.6	30.6	25.4	23
22	30	75.2	68	44	40	37.1	33	27.2	25
25	34	84.4	77.2	50	47	42.1	38	30.9	28
30	40	101	92.7	60	55	50.1	44	37.1	33
37	50	124	114	72	66	61.9	54	45.4	42
40	54	134	123	79	72	67	60	49.1	44
45	60	150	136	85	80	73.9	64.5	54.2	49
51	70	168	154	97	90	83.8	73.7	61.4	56
55	75	181	166	105	96	90.3	79	66.2	60
59	80	194	178	112	105	96.9	85.3	71.1	66
75	100	245	226	140	135	123	106	90.3	82
80	110	260	241	147	138	131	112	96.3	86
90	125	292	268	170	165	146	128	107	98
100	136	325	297	188	182	162	143	119	107
110	150	358	327	205	200	178	156	131	118
129	175	420	384	242	230	209	184	153	135
132	180	425	393	245	242	214	186	157	140
140	190	449	416	260	250	227	200	167	145
147	200	472	432	273	260	236	207	173	152
160	220	502	471	295	280	256	220	188	170
180	245	578	530	333	320	289	254	212	190
184	250	590	541	340	325	295	259	217	200
200	270	626	589	370	340	321	278	235	215
220	300	700	647	408	385	353	310	260	235
250	340	803	736	460	425	401	353	295	268
257	350	826	756	475	450	412	363	302	280
295	400	948	868	546	500	473	416	348	320
315	430	990	927	580	535	505	445	370	337
355	480	1080	1010	636	580	549	483	405	366
400	545	1250	1130	710	650	611	538	450	410
450	610	1410	1270	800	740	688	608	508	460
475	645	1490	1340	850	780	730	645	540	485
500	680	1570	1420	890	830	770	680	565	510
560	760	1750	1580	1000	920	860	760	630	570
600	810	–	–	1080	990	920	810	680	610
670	910	–	–	1200	1100	1030	910	760	680

جدول الف-۵ جریان نامی تقریبی موتورهای القایی سه‌فاز قفسه سنجابی با سرعت ۱۵۰۰rpm در ۵۰Hz

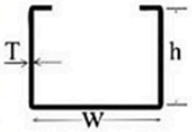
فصل نهم

type code	w (mm)	h (mm)	L (mm)	HOT DIP GALVANIZED t (mm)	HOT DIP GALVANIZED order code	GALVANIZED t (mm)	GALVANIZED order code
SPC-CT	100	40÷200	2000÷3000	1/5÷2	CT-HD 10	1÷2	CT-CD 10
SPC-CT	200	40÷200	2000÷3000	1/5÷2	CT-HD 20	1÷2	CT-CD 20
SPC-CT	300	40÷200	2000÷3000	2÷4	CT-HD 30	1/25÷2	CT-CD 30
SPC-CT	400	40÷200	2000÷3000	2÷4	CT-HD 40	1/5÷2	CT-CD 40
SPC-CT	500	40÷200	2000÷3000	2÷4	CT-HD 50	1/5÷2	CT-CD 50
SPC-CT	600	40÷200	2000÷3000	2÷4	CT-HD 60	2÷2/5	CT-CD 60
SPC-CT	700	40÷200	2000÷3000	2÷4	CT-HD 70	2÷2/5	CT-CD 70
SPC-CT	800	40÷200	2000÷3000	2÷4	CT-HD 80	2÷2/5	CT-CD 80

شش خم



چهارخم



جدول مربوط به اسلاید 59 از فصل نهم

قطر نامی لوله (میلی‌متر)	ضریب لوله
۱۶	۲۹۰
۲۰	۴۶۰
۲۵	۸۰۰
۳۲	۱۴۰۰
۳۸	۱۹۰۰
۵۰	۳۵۰۰
۶۳	۵۶۰۰

نوع هادی	سطح مقطع هادی (میلی‌مترمربع)	ضریب هادی
مفتولی	۱	۲۲
	۱٫۵	۲۷
	۲٫۵	۳۹
افشان	۱٫۵	۳۱
	۲٫۵	۴۳
	۴	۵۸
	۶	۸۸
	۱۰	۱۴۶
	۱۶	۲۰۲
	۲۵	۳۸۵

جدول مربوط به اسلاید ۶۳ از فصل نهم

نوع هادی	سطح مقطع هادی (میلی‌مترمربع)	ضریب هادی
مفتولی یا افشان	۱	۱۶
	۱٫۵	۲۲
	۲٫۵	۳۰
	۴	۴۳
	۶	۵۸
	۱۰	۱۰۵
	۱۶	۱۴۵
	۲۵	۲۱۷

جدول مربوط به اسلاید ۶۴ از فصل نهم

طول مسیر لوله (m)	قطر لوله محافظ (mm)																			
	۱۶	۲۰	۲۵	۳۲	۱۶	۲۰	۲۵	۳۲	۱۶	۲۰	۲۵	۳۲	۱۶	۲۰	۲۵	۳۲	۱۶	۲۰	۲۵	۳۲
	مسیر مستقیم				یک خم				دو خم				سه خم				چهار خم			
۱	مطابق با جداول ۱۴ و ۱۵				۱۸۸	۳۰۳	۵۴۳	۹۴۷	۱۷۷	۲۸۶	۵۱۴	۹۰۰	۱۵۸	۲۵۶	۴۶۳	۸۱۸	۱۳۰	۲۱۳	۳۸۸	۶۹۲
۱٫۵					۱۸۲	۲۹۴	۵۲۸	۹۲۳	۱۶۷	۲۷۰	۴۸۷	۸۵۷	۱۴۳	۲۳۳	۴۲۲	۷۵۰	۱۱۱	۱۸۲	۳۳۳	۶۰۰
۲					۱۷۷	۲۸۶	۵۱۴	۹۰۰	۱۵۸	۲۵۶	۴۶۳	۸۱۸	۱۳۰	۲۱۳	۳۸۸	۶۹۲	۹۷	۱۵۹	۲۹۲	۵۲۹
۲٫۵					۱۷۱	۲۷۸	۵۰۰	۸۷۸	۱۵۰	۲۴۴	۴۴۲	۷۸۳	۱۲۰	۱۹۶	۳۵۸	۶۴۳	۸۶	۱۴۱	۲۶۰	۴۷۴
۳					۱۶۷	۲۷۰	۴۸۷	۸۵۷	۱۴۳	۲۳۳	۴۲۲	۷۵۰	۱۱۱	۱۸۲	۳۳۳	۶۰۰				
۳٫۵	۱۷۹	۲۹۰	۵۲۱	۹۱۱	۱۶۲	۲۶۳	۴۷۵	۸۳۷	۱۳۶	۲۲۲	۴۰۴	۷۲۰	۱۰۳	۱۶۹	۳۱۱	۵۶۳				
۴	۱۷۷	۲۸۶	۵۱۴	۹۰۰	۱۵۸	۲۵۶	۴۶۳	۸۱۸	۱۳۰	۲۱۳	۳۸۸	۶۹۲	۹۷	۱۵۹	۲۹۲	۵۲۹				
۴٫۵	۱۷۴	۲۸۲	۵۰۷	۸۸۹	۱۵۴	۲۵۰	۴۵۲	۸۰۰	۱۲۵	۲۰۴	۳۷۳	۶۶۷	۹۱	۱۴۹	۲۷۵	۵۰۰				
۵	۱۷۱	۲۷۸	۵۰۰	۸۷۸	۱۵۰	۲۴۴	۴۴۲	۷۸۳	۱۲۰	۱۹۶	۳۵۸	۶۴۳	۸۶	۱۴۱	۲۶۰	۴۷۴				
۶	۱۶۷	۲۷۰	۴۸۷	۸۵۷	۱۴۳	۲۳۳	۴۲۲	۷۵۰	۱۱۱	۱۸۲	۳۳۳	۶۰۰								
۷	۱۶۲	۲۶۳	۴۷۵	۸۳۷	۱۳۶	۲۲۲	۴۰۴	۷۲۰	۱۰۳	۱۶۹	۳۱۱	۵۶۳								
۸	۱۵۸	۲۵۶	۴۶۳	۸۱۸	۱۳۰	۲۱۳	۳۸۸	۶۹۲	۹۷	۱۵۹	۲۹۲	۵۲۹								
۹	۱۵۴	۲۵۰	۴۵۲	۸۰۰	۱۲۵	۲۰۴	۳۷۳	۶۶۷	۹۱	۱۴۹	۲۷۵	۵۰۰								
۱۰	۱۵۰	۲۴۴	۴۴۲	۷۸۳	۱۲۰	۱۹۶	۳۵۸	۶۴۳	۸۶	۱۴۱	۲۶۰	۴۷۴								

جدول مربوط به اسلاید ۶۵ از فصل نهم

نوع هادی	سطح مقطع هادی (میلی‌مترمربع)	ضریب هادی
مفتولی	۱٫۵	۸٫۰
	۲٫۵	۱۱٫۹
افشان	۱٫۵	۸٫۶
	۲٫۵	۱۲٫۶
	۴	۱۶٫۶
	۶	۲۱٫۲
	۱۰	۳۵٫۳
	۱۶	۴۷٫۸
	۲۵	۷۳٫۹

جدول مربوط به اسلاید ۶۹ از فصل نهم

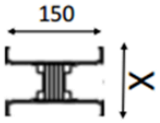
ضریب	ابعاد ترانک (mm × mm)	ضریب	ابعاد ترانک (mm × mm)
۸۵۷۲	۱۰۰ × ۲۰۰	۷۶۷	۳۸ × ۵۰
۱۳۰۰۱	۱۵۰ × ۲۰۰	۱۰۳۷	۵۰ × ۵۰
۱۷۴۲۹	۲۰۰ × ۲۰۰	۷۳۸	۲۵ × ۷۵
۳۴۷۴	۳۸ × ۲۲۵	۱۱۴۶	۳۸ × ۷۵
۴۶۷۱	۵۰ × ۲۲۵	۱۵۵۵	۵۰ × ۷۵
۷۱۶۷	۷۵ × ۲۲۵	۲۳۷۱	۷۵ × ۷۵
۹۶۶۲	۱۰۰ × ۲۲۵	۹۹۳	۲۵ × ۱۰۰
۱۴۶۵۲	۱۵۰ × ۲۲۵	۱۵۴۲	۳۸ × ۱۰۰
۱۹۶۴۳	۲۰۰ × ۲۲۵	۲۰۹۱	۵۰ × ۱۰۰
۲۲۱۳۸	۲۲۵ × ۲۲۵	۳۱۸۹	۷۵ × ۱۰۰
۴۶۴۸	۳۸ × ۳۰۰	۴۲۵۲	۱۰۰ × ۱۰۰
۶۲۵۱	۵۰ × ۳۰۰	۲۹۹۹	۳۸ × ۱۵۰
۹۵۹۰	۷۵ × ۳۰۰	۳۰۹۱	۵۰ × ۱۵۰

جدول مربوط به اسلاید ۷۰ از فصل نهم

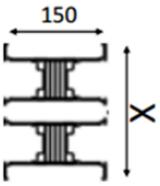
3P+N (3P+N+%50PE / 3P+N+%100PE / 3P+2N+%50PE)

LBA	X mm	LBC	X mm
LBC-A 400A	91	LBC-C 400A	81
LBC-A 500A	106	LBC-C 500A	91
LBC-A 630A	106	LBC-C 630A	101
LBC-A 800A	115	LBC-C 800A	111
LBC-A 1000A	151	LBC-C 1000A	121
LBC-A 1250A	176	LBC-C 1250A	131
LBC-A 1600A	226	LBC-C 1600A	171
LBC-A 2000A	251		

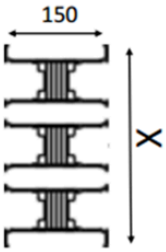
Ipk=150kA
Icw=65kA



LBA	X mm	LBC	X mm
LBC-A 2500A	301	LBC-C 2000A	191
LBC-A 3200A	401	LBC-C 2500A	211
LBC-A 4000A	451	LBC-C 5000A	451



LBA	X mm	LBC	X mm
LBC-A 5000A	576	LBC-C 3200A	291
		LBC-C 3600A	351
		LBC-C 4000A	411
		LBC-C 6300A	651



جدول مربوط به اسلاید ۸۱ از فصل نهم