The Open University of Sri Lanka
Diploma in Technology
ECX4234-Electrical Installation
Final Examination 2008/2009

Date: Friday 14th March 2009 **Time:9.30-12.30 hrs.**

This paper contains 15 pages with Eight (8) questions. Answer Five (5) questions. All questions carry equal marks. Graph papers will be available on your request.

The required data and the tables obtained from IEE wiring regulation 15th & 16th edition are attached for your easy reference.

(1) A circuit with a resistance 0.06 Ohm is protected by a 30 A semi enclosed ceramic fuse to BS3036. The external earth fault loop impedance to this circuit is 0.5 Ω and the source voltage is 240 V at 50 Hz. In case of a ground fault of effective resistance 1 Ω is occurred across the load, using suitable assumptions and calculations, determine:

a) The fault current
b) The time taken for the fuse to blow
c) The prospective fault voltage across the fault
d) The current that may flow through a typical human body if a person comes into contact with the fault at the load
e) What form of a shock is likely to happen to the person
f) If the above fuse is replaced by:
   - 30 A cartridge fuse to BS1361
   - A type B mcb to BS EN 60898.

   What would be the operating time in each case

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(2) A single-phase circuit is to be wired in single-core 70 ^{0}C pvc-insulated non sheathed cables to BS6004 having copper conductors and protected against both over-load and short-circuit by a 25 A BS88 'gG' fuse. For approximately the first third of its route it is running in a trunking with six other similar circuits in an ambient temperature 30 ^{0}C. For the remaining two-thirds of its route it is run in conduit on a wall but with no other circuits and where the ambient temperature is 50 ^{0}C.
Determine the minimum conductor cross-sectional area that can be used.

(3) A 230 V single phase circuit is run in two core 70 ^{0}C pvc insulated and sheathed cable to BS 6004, the cross sectional area of the (copper) live conductors being 16 mm^2 and that of the protective conductor 6 mm^2.
If the length of the conductor is 40 m long and the ambient temperature is 30 ^{0}C and the circuit is protected against overload by a 80 A BS88 'gG' fuse, check whether the circuit is thermally protected with the regulation 543-01-03. Assume that the earth fault loop impedance external to the circuit is 0.35 Ω.

(4) What are the tests you would normally carry out for a domestic electrical installation before requesting the supply authority to provide power supply to It.? Describe all these tests (you may use sketches)

(5) A 15 kW 3 phase motor operating at a 0.8 power factor lagging and efficiency being 90% connected to a 400 V 3Φ power supply. This motor is subjected to frequent stopping and starting and it is intended to use a pvc-insulated cable having multicore copper conductors, installed in free air. What should be their cross sectional area if the ambient temperature is 35^0 C. State any assumptions made.

(6) a) Discus the factors that affect the resistance of an earth electrode?

b) An earth electrode having r m radius and l m length is buried in a uniformly distributed soil. The earth resistivity of the soil is given as ρ Ωm. Prove that the theoretical value of the resistance of this earth electrode is $\frac{\rho}{2\pi l}\ln\frac{l}{r}$ Ω.

State any assumptions made.
Hence compute the resistance offered by an earth electrode with a rod length 2 m, pipe diameter 50 mm and soil resistivity 100 Ωm.?

c) What earthing system would you find in Sri Lanka? State the value of earth resistance that should maintain for a domestic installation in Sri Lanka

d) What are the measures you would take to improve the earth resistance if it does not satisfy the value stated in (c)?

(7) It is intended to run 8 single-core pvc insulated 2.5 mm^2 cables and 6 similar cables but of 4 mm^2 cross sectional area in a conduit. The estimated length of conduit run is 4 m and includes 2 bends. What is the maximum size conduit that can be used?
(You may use the attached appendix 12 of IEE regulation 15th edition as a reference)

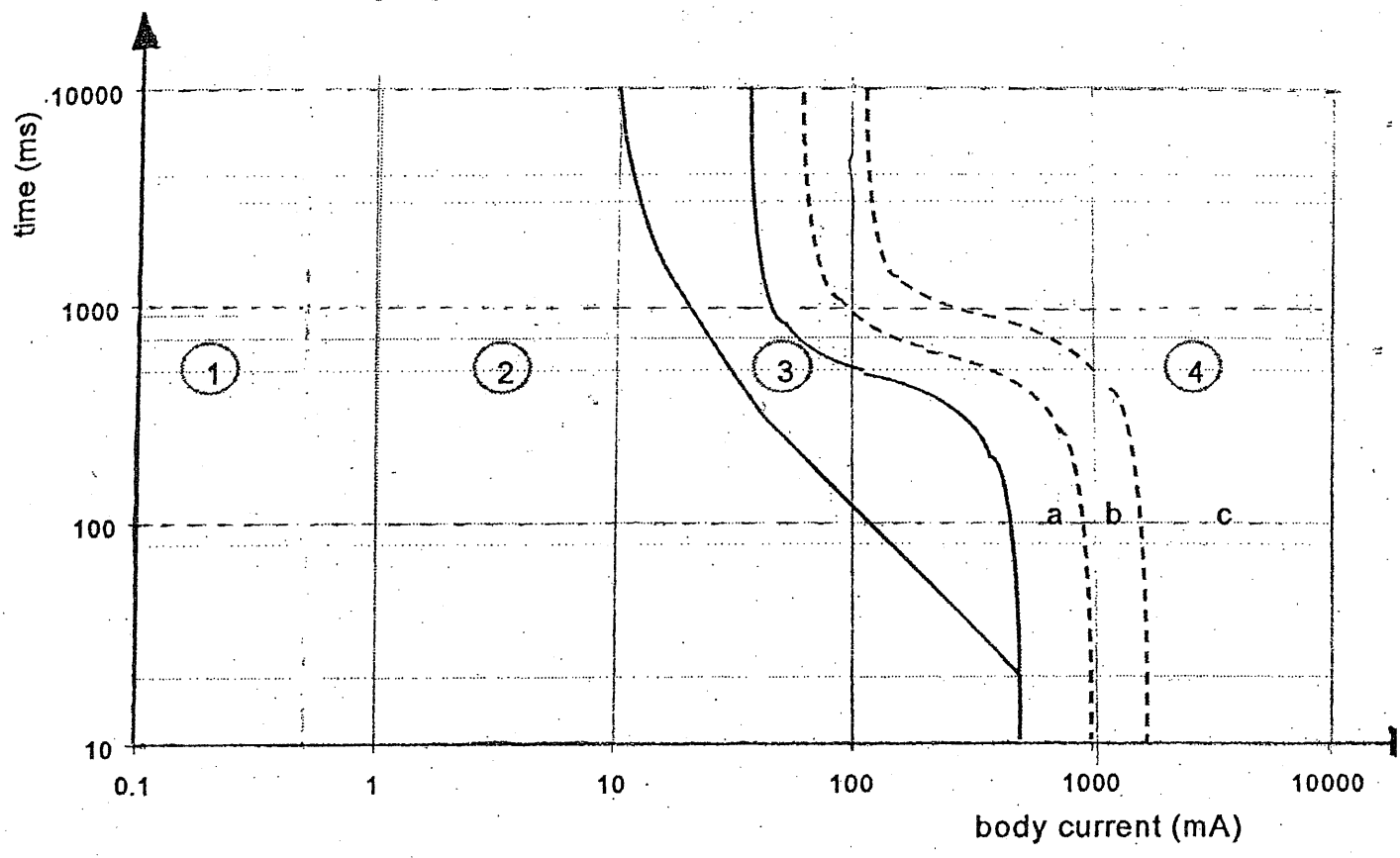
(8) A 20 A re-wireable fuse to BS 88-2.1 is used to protect a circuit consisting of a twin (2.5 mm^2) cable with protective conductor (1.5 mm^2). The cable is clip direct/surface run and the nominal operating voltage is 230 V. If the earth loop impedance external to the installation is 0.5 Ω, determine the maximum possible cable length

Following assumptions can be made during your calculation:

Phase conductor (go) + protective conductor (return) resistance = 0.03 Ω/m
Protective conductor impedance = 0.0185 Ω/m
Voltage drop in 2.5 mm^2 conductor = 18 mV/A/m
Maximum permitted voltage drop in a circuit = 2.5%
Maximum permitted *earth fault loop impedance* (Z_s) for 20 A, BS 88-2.1 fuse with 0.4 s disconnection time and operating voltage 230 V = 1.85 Ω
Maximum permitted *circuit protective conductor impedance* related to the final circuit protective device = 0.55 Ω
Maximum *earth fault loop impedance* (Z_s) for 20 A, BS 88-2.1 fuse with 5s disconnection time and operating voltage 230 V = 3.04 Ω

Time Current Zones on the Human Body

Effects of 50 Hz AC



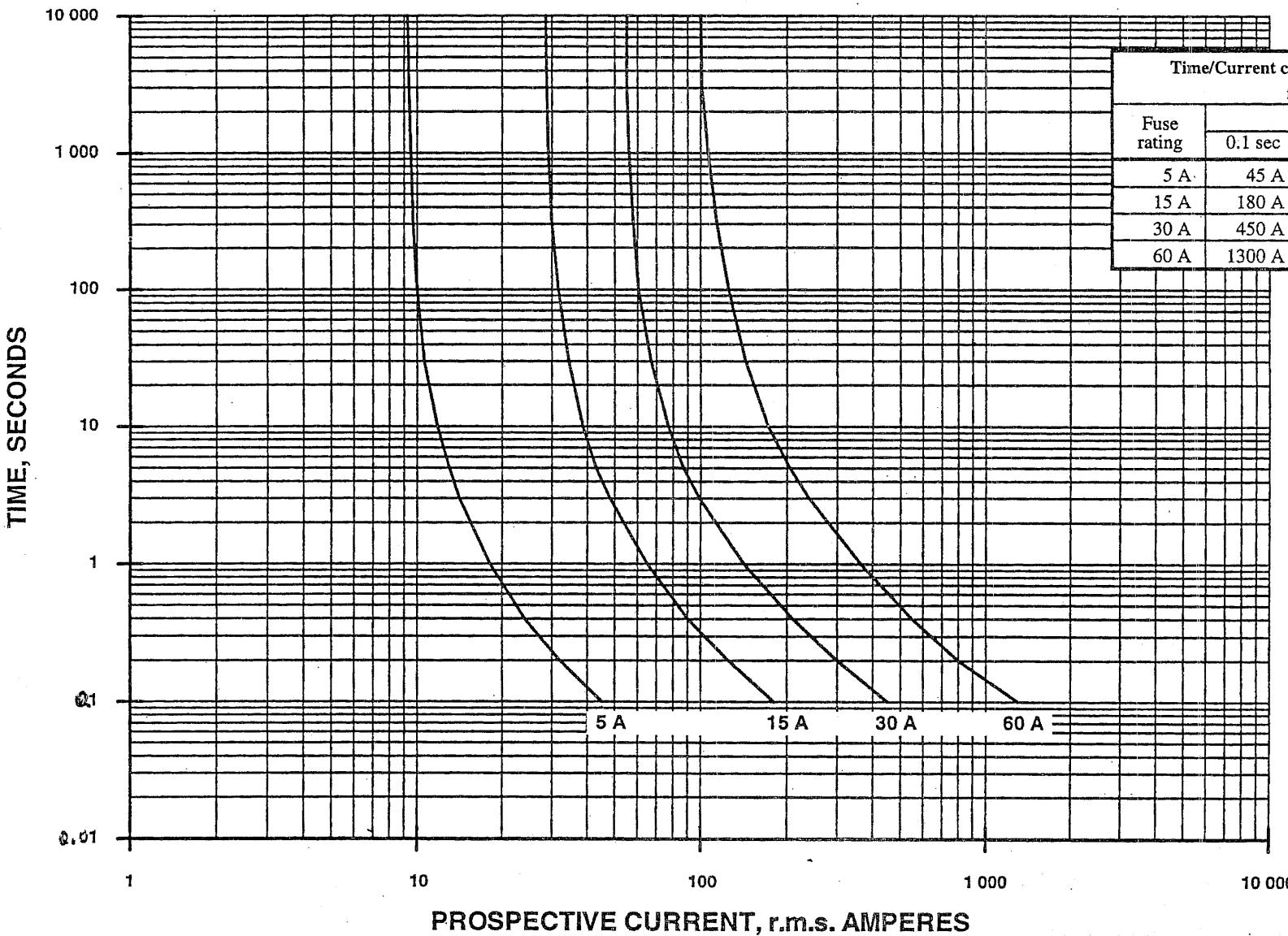
one 1 - No sensation

one 2 - Perceptibility of current, but no harmful effect (10 mA is the threshold of let-go)

one 3 - Mascular contractions and difficulty in breathing. Usually no danger of ventricular fibrillation (0.5% probability)

one 4 - Probability of ventricular fibrillation increases
a - up to 5% , b - up to 50% , c - greater than 50%

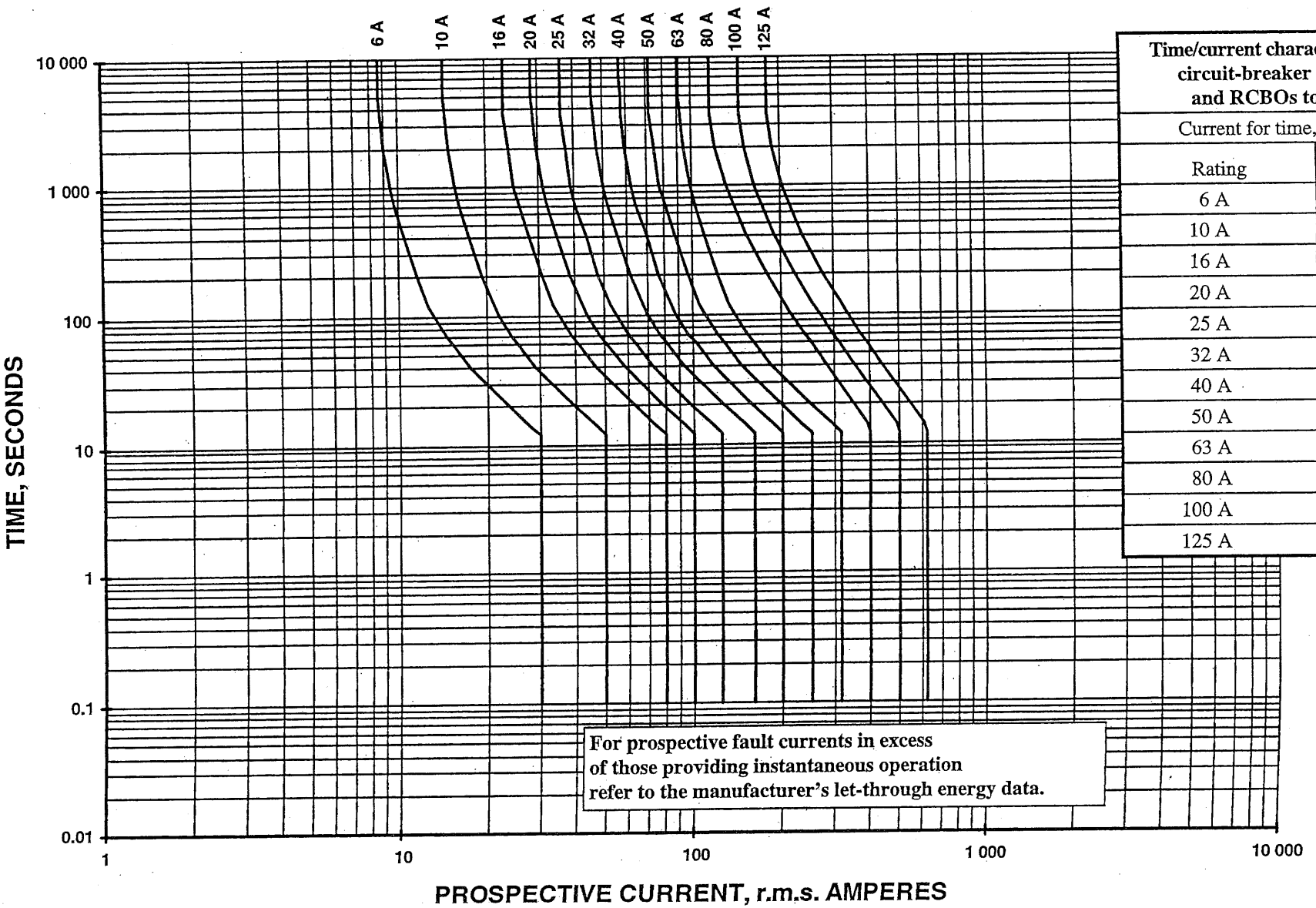
fig 3.2A **Semi-enclosed fuses to BS 3036**



Time/Current characteristics for semi-enclosed fuses to BS 3036

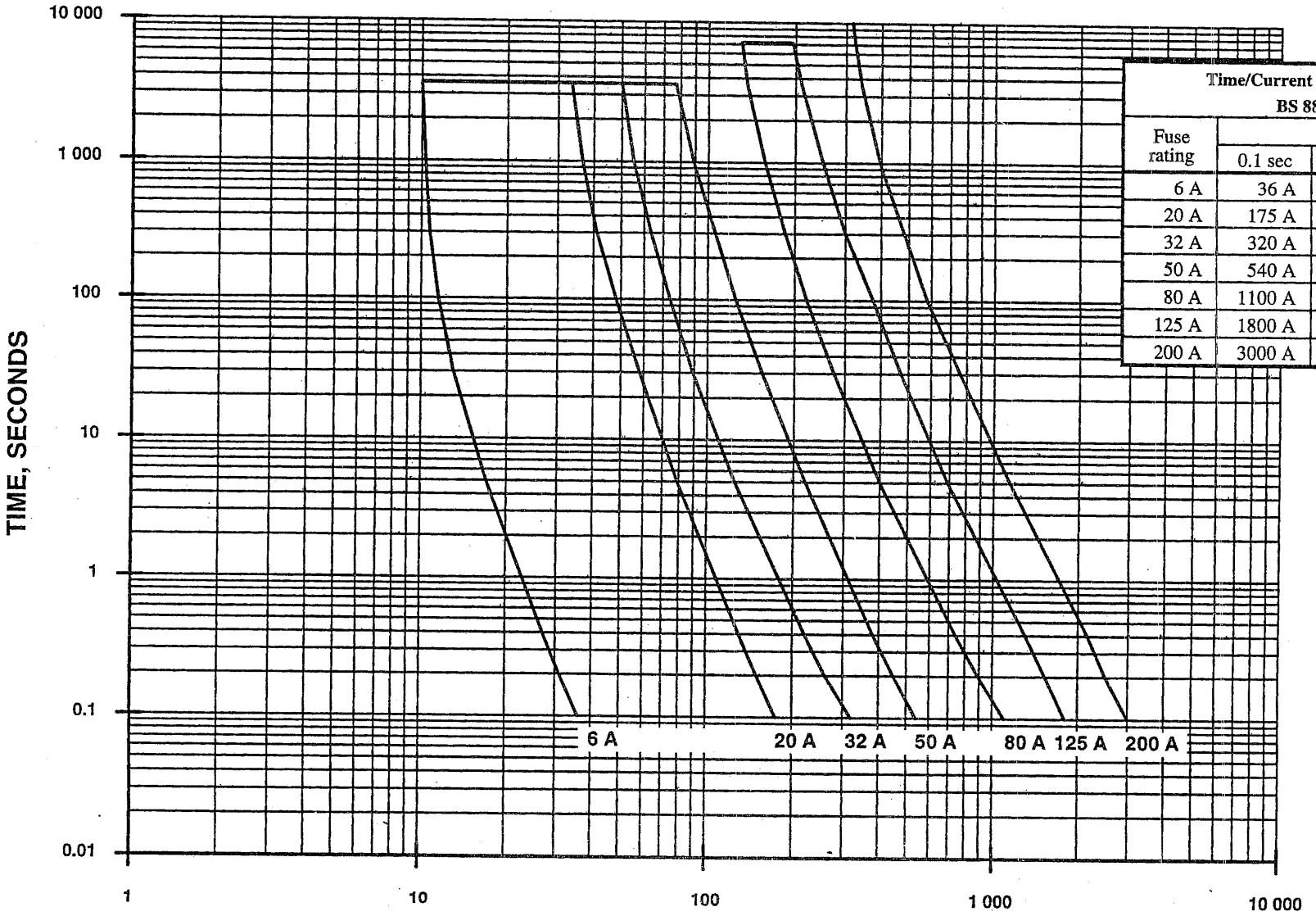
Fuse rating	Current for time			
	0.1 sec	0.2 sec	0.4 sec	5 secs
5 A	45 A	32 A	24 A	13 A
15 A	180 A	125 A	90 A	43 A
30 A	450 A	300 A	210 A	87 A
60 A	1300 A	800 A	550 A	205 A

fig 3.4 **Type B circuit-breakers to BS EN 60898 and RCBOs to BS EN 61009**



Time/current characteristics for Type B circuit-breaker to BS EN 60898 and RCBOs to BS EN 61009	
Current for time, 0.1 sec to 5 secs	
Rating	Current
6 A	30 A
10 A	50 A
16 A	80 A
20 A	100 A
25 A	125 A
32 A	160 A
40 A	200 A
50 A	250 A
63 A	315 A
80 A	400 A
100 A	500 A
125 A	625 A

fig 3.3A **Fuses to BS 88-2.1 and BS 88-6**



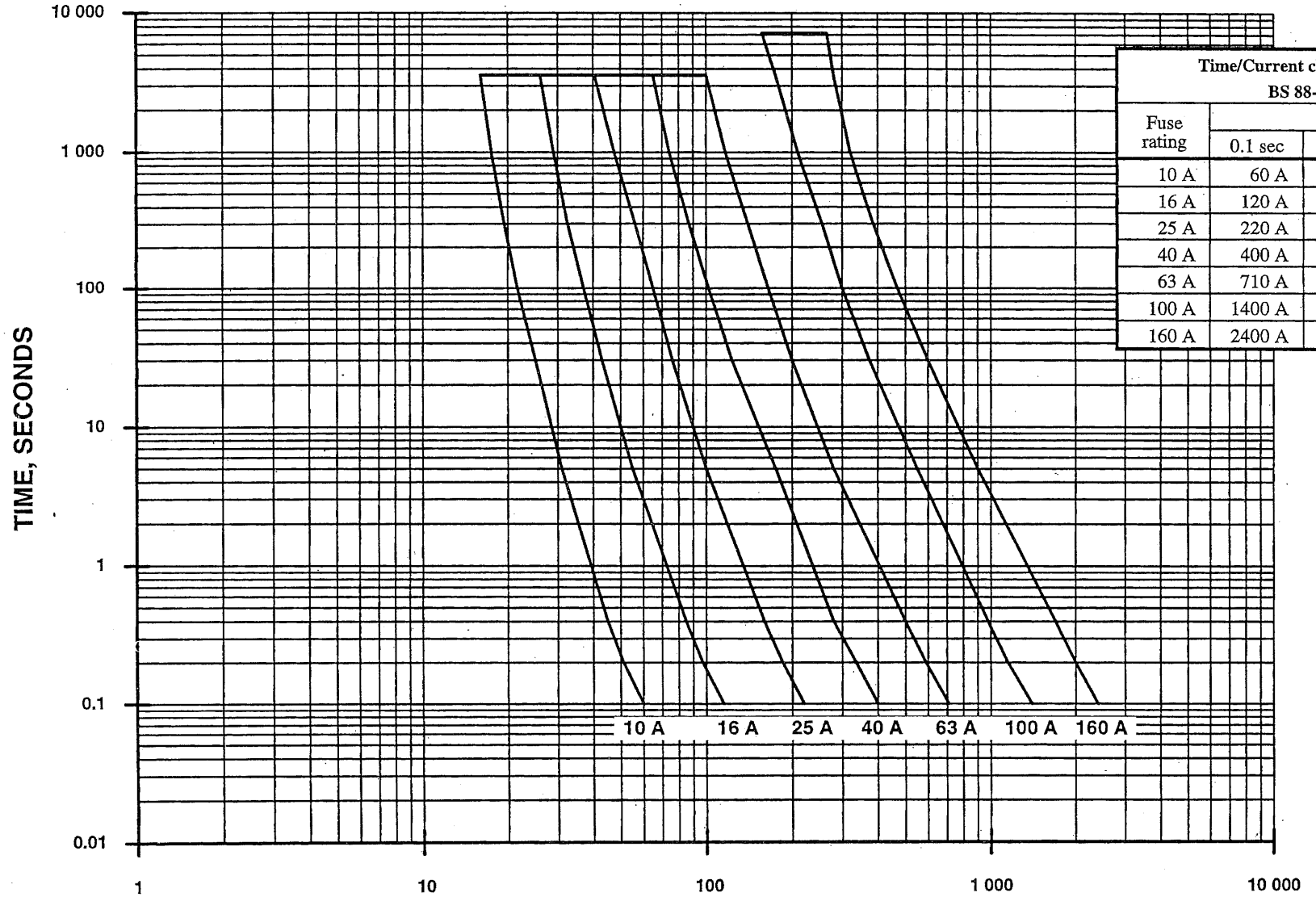
Time/Current characteristics for fuses to BS 88-2.1 and BS 88-6

Fuse rating	Current for time			
	0.1 sec	0.2 sec	0.4 sec	5 secs
6 A	36 A	31 A	27 A	17 A
20 A	175 A	150 A	130 A	79 A
32 A	320 A	260 A	220 A	125 A
50 A	540 A	450 A	380 A	220 A
80 A	1100 A	890 A	740 A	400 A
125 A	1800 A	1500 A	1300 A	690 A
200 A	3000 A	2500 A	2200 A	1200 A

100 1 000 10 000

PROSPECTIVE CURRENT, r.m.s. AMPERES

fig 3.3B **Fuses to BS 88-2.1 and BS 88-6**



Time/Current characteristics for fuses to BS 88-2.1 and BS 88-6				
Fuse rating	Current for time			
	0.1 sec	0.2 sec	0.4 sec	5 secs
10 A	60 A	51 A	45 A	31 A
16 A	120 A	95 A	85 A	55 A
25 A	220 A	180 A	160 A	100 A
40 A	400 A	340 A	280 A	170 A
63 A	710 A	590 A	500 A	280 A
100 A	1400 A	1150 A	980 A	550 A
160 A	2400 A	2000 A	1700 A	900 A

TABLE 4C1

Correction factors for ambient temperature where protection is against short-circuit

NOTE: This table applies where the associated overcurrent protective device is intended to provide short-circuit protection only. Except where the device is a semi-enclosed fuse to BS 3036 the table also applies where the device is intended to provide overload protection.

Type of insulation	Operating temperature	Ambient temperature (°C)														
		25	30	35	40	45	50	55	60	65	70	75	80	85	90	95
Thermosetting (rubber) (flexible cables only)	60 °C	1.04	1.0	0.91	0.82	0.71	0.58	0.41	-	-	-	-	-	-	-	-
Thermoplastic (General purpose pvc)	70 °C	1.03	1.0	0.94	0.87	0.79	0.71	0.61	0.50	0.35	-	-	-	-	-	-
Paper	80 °C	1.02	1.0	0.95	0.89	0.84	0.77	0.71	0.63	0.55	0.45	0.32	-	-	-	-
Thermosetting (rubber)	85 °C	1.02	1.0	0.95	0.90	0.85	0.80	0.74	0.67	0.60	0.52	0.43	0.30	-	-	-
Thermoplastic (high temperature pvc)*	90 °C	1.03	1.0	0.97	0.94	0.91	0.87	0.84	0.80	0.76	0.71	0.61	0.50	0.35	-	-
Thermosetting	90 °C	1.02	1.0	0.96	0.91	0.87	0.82	0.76	0.71	0.65	0.58	0.50	0.41	0.29	-	-
Mineral	70 °C sheath	1.03	1.0	0.93	0.85	0.77	0.67	0.57	0.45	0.31	-	-	-	-	-	-
	105 °C sheath	1.02	1.0	0.96	0.92	0.88	0.84	0.80	0.75	0.70	0.65	0.60	0.54	0.47	0.40	0.32

NOTES:

1. Correction factors for flexible cords and for 85 °C and 180 °C thermosetting (rubber) insulated flexible cables are given in the relevant table of current-carrying capacity.
2. This table also applies when determining the current-carrying capacity of a cable.
3. * These factors are applicable only to ratings in columns 2 to 5 of Table 4D1A.

TABLE 4C2

Correction factors for ambient temperature where the overload protective device is a semi-enclosed fuse to BS 3036.

Type of insulation	Operating temperature	Ambient temperature (°C)														
		25	30	35	40	45	50	55	60	65	70	75	80	85	90	95
Thermosetting (rubber) (flexible cables only)	60 °C	1.04	1.0	0.96	0.91	0.87	0.79	0.56	-	-	-	-	-	-	-	-
Thermoplastic (General purpose pvc)	70 °C	1.03	1.0	0.97	0.94	0.91	0.87	0.84	0,69	0.48	-	-	-	-	-	-
Paper	80 °C	1.02	1.0	0.97	0.95	0.92	0.90	0.87	0.84	0.76	0.62	0.43	-	-	-	-
Thermosetting (rubber)	85 °C	1.02	1.0	0.97	0.95	0.93	0.91	0.88	0.86	0.83	0.71	0.58	0.41	-	-	-
Thermoplastic (high temperature pvc)*	90 °C	1.03	1.0	0.97	0.94	0.91	0.87	0.84	0.80	0.76	0.72	0.68	0.63	0.49	-	-
Thermosetting	90 °C	1.02	1.0	0.98	0.95	0.93	0.91	0.89	0.87	0.85	0.79	0.69	0.56	0.39	-	-
Mineral: bare and exposed to touch or pvc covered	70 °C sheath	1.03	1.0	0.96	0.93	0.89	0.86	0.79	0.62	0.42	-	-	-	-	-	-
Mineral: bare and not exposed to touch	105 °C sheath	1.02	1.0	0.98	0.96	0.93	0.91	0.89	0.86	0.84	0.82	0.79	0.77	0.64	0.55	0.43

NOTES:

1. Correction factors for flexible cords and for 85 °C and 180 °C thermosetting (rubber) insulated flexible cables are given in the relevant table of current-carrying capacity.
2. * These factors are applicable only to ratings in columns 2 to 5 of Table 4D1A.

APPENDIX 12

CABLE CAPACITIES OF CONDUIT AND TRUNKING

Introduction

This appendix describes a method which can be used to determine the size of conduit or trunking necessary to accommodate cables of the same size, or differing sizes, and provides a means of compliance with Regulation 529–7.

The method employs a 'unit system', each cable size being allocated a factor. The sum of all factors for the cables intended to be run in the same enclosure is compared against the factors given for conduit or trunking, as appropriate, in order to determine the size of the conduit or trunking necessary to accommodate those cables.

It has been found necessary, for conduit, to distinguish between –

1. straight runs not exceeding 3 metres in length, and
2. straight runs exceeding 3 metres, or runs of any length incorporating bends or sets.

The term 'bend' signifies a British Standard 90° bend, and one double set is equivalent to one bend.

For the case 1, each conduit size is represented by only one factor. For the case 2, each conduit size has a variable factor which is dependent on the length of run and the number of bends or sets. For a particular size of cable the factor allocated to it for case 1 is not the same as for case 2.

For trunking each size of cable has been allocated a factor, as has been each size of trunking.

Because of certain aspects, such as the assessment of reasonable care of pulling-in, acceptable utilisation of the space available and the dimensional tolerances of cables, conduit and trunking, any method of standardizing the cable capacities of such enclosures can only give guidance on the number of cables which can be accommodated. Thus the sizes of conduit or trunking determined by the method given in this appendix are those which can be reasonably expected to accommodate the desired number of cables in a particular run using an acceptable pulling force and with the minimum probability of damage to cable insulation.

Only mechanical considerations have been taken into account in determining the factors given in the following tables. As the number of circuits in a conduit or trunking increases, the current-carrying capacities of the cables must be reduced according to the appropriate grouping factors in Appendix 9. It may therefore be more attractive economically to divide the circuits concerned between two or more enclosures.

This appendix deals with the following four cases:

– Single-core p.v.c.-insulated cables in straight runs of conduit not exceeding 3m in length.

– Single-core p.v.c.-insulated cables in straight runs of conduit exceeding 3m in length, or in runs of any length incorporating bends or sets.

– Single-core p.v.c.-insulated cables in trunking.

– Other sizes and types of cable in trunking.

For other cables and/or conduits not covered by the tables, advice on the number of cables which can be accommodated should be obtained from the manufacturers.

Single-core p.v.c.-insulated cables in straight runs of conduit not exceeding 3m in length.

For each cable it is intended to use, obtain the appropriate factor from Table 12A.

Add all the cable factors so obtained and compare with the conduit factors given in Table 12B.

The conduit size which will satisfactorily accommodate the cables is that size having a factor equal to or exceeding the sum of the cable factors.

TABLE 12A

Cable factors for short straight runs

Type of conductor	Conductor cross-sectional area mm²	Factor
Solid	1	22
	1.5	27
	2.5	39
Stranded	1.5	31
	2.5	43
	4	58
	6	88
	10	146

TABLE 12B

Conduit factors for short straight runs

Conduit dia mm	Factor
16	290
20	460
25	800
32	1400

Single-core p.v.c.-insulated cables in straight runs of conduit exceeding 3m in length or in runs of any leng incorporating bends or sets.

For each cable it is intended to use, obtain the appropriate factor from Table 12C.

Add all the cable factors so obtained and compare with the conduit factors given in Table 12D, taking in account the length of run it is intended to use and the number of bends and sets in that run.

The conduit size which will satisfactorily accommodate the cables is that size having a factor equal to or e ceeding the sum of the cable factors.

TABLE 12C

Cable factors for long straight runs, or runs incorporating bends

Type of conductor	Conductor cross-sectional area mm²	Factor
Solid or stranded	1	16
	1.5	22
	2.5	30
	4	43
	6	58
	10	105

TABLE 12D

Conduit factors for runs incorporating bends

Length of run m	Conduit diameter, mm																			
	16	20	25	32	16	20	25	32	16	20	25	32	16	20	25	32	16	20	25	32
	Straight				One bend				Two bends				Three bends				Four bends			
1	Covered by Tables 12A and 12B				188	303	543	947	177	286	514	900	158	256	463	818	130	213	388	692
1.5					182	294	528	923	167	270	487	857	143	233	422	750	111	182	333	600
2					177	286	514	900	158	256	463	818	130	213	388	692	97	159	292	529
2.5					171	278	500	878	150	244	442	783	120	196	358	643	86	141	260	474
3					167	270	487	857	143	233	422	750	111	182	333	600				
3.5	179	290	521	911	162	263	475	837	136	222	404	720	103	169	311	563				
4	177	286	514	900	158	256	463	818	130	213	388	692	97	159	292	529				
4.5	174	282	507	889	154	250	452	800	125	204	373	667	91	149	275	500				
5	171	278	500	878	150	244	442	783	120	196	358	643	86	141	260	474				
6	167	270	487	857	143	233	422	750	111	182	333	600								
7	162	263	475	837	136	222	404	720	103	169	311	563								
8	158	256	463	818	130	213	388	692	97	159	292	529								
9	154	250	452	800	125	204	373	667	91	149	275	500								
10	150	244	442	783	120	196	358	643	86	141	260	474								

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TABLE 8D

Values of $(R_1 + R_2)$ per metre for p.v.c.-insulated copper conductors

Cross-sectional area, mm^2		$(R_1 + R_2)$ ohms/metre
Phase conductor	Protective conductor	
1	1	0.055
1.5	1	0.046
	1.5	0.037
2.5	1	0.039
	1.5	0.030
	2.5	0.022
4	1.5	0.026
	2.5	0.018
	4	0.014
6	2.5	0.016
	4	0.0116
	6	0.0092
10	4	0.0098
	6	0.0074
	10	0.0055
16	6	0.0064
	10	0.0045
	16	0.0035

TABLE 4B1

Correction factors for groups of more than one circuit of single-core cables, or more than one multicore cable (to be applied to the corresponding current-carrying capacity for a single circuit in Tables 4D1 to 4D4, 4E1 to 4E4, 4F1 and 4F2, 4J1, 4K1 to 4K4, 4L1 to 4L4)**

Reference method of installation (see Table 4A1)		Correction factor (C_g)													
		Number of circuits or multicore cables													
		2	3	4	5	6	7	8	9	10	12	14	16	18	20
Enclosed (Method 3 or 4) or bunched and clipped direct to a non-metallic surface (Method 1)		0.80	0.70	0.65	0.60	0.57	0.54	0.52	0.50	0.48	0.45	0.43	0.41	0.39	0.38
Single layer clipped to a non-metallic surface (Method 1)	Touching	0.85	0.79	0.75	0.73	0.72	0.72	0.71	0.70	-	-	-	-	-	-
	Spaced*	0.94	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Single layer *multicore* on a perforated metal cable tray, vertical or horizontal (Method 11)	Touching	0.86	0.81	0.77	0.75	0.74	0.73	0.73	0.72	0.71	0.70	-	-	-	-
	Spaced*#	0.91	0.89	0.88	0.87	0.87	-	-	-	-	-	-	-	-	-
Single layer *single-core* on a perforated metal cable tray, touching (Method 11)	Horizontal	0.90	0.85	-	-	-	-	-	-	-	-	-	-	-	-
	Vertical	0.85	-	-	-	-	-	-	-	-	-	-	-	-	-
Single layer multicore touching on ladder supports (Method 13)		0.86	0.82	0.80	0.79	0.78	0.78	0.78	0.77	-	-	-	-	-	-

* Spaced by a clearance between adjacent surfaces of at least one cable diameter (D_e). Where the horizontal clearance between adjacent cables exceeds 2 D_e no correction factor need be applied.

** When cables having differing conductor operating temperatures are grouped together, the current rating shall be based upon the lowest operating temperature of any cable in the group.

\- Correction factor not tabulated.

\# Not applicable to mineral insulated cables, see Table 4B2.

TABLE 4B2

Correction factors for mineral insulated cables installed on perforated tray, (to be applied to the corresponding current-carrying capacity for single circuits for Reference Method 11 in Table 4J1A)

Tray orientation	Arrangement of cables	Number of trays	Number of multicore cables or circuits					
			1	2	3	4	6	9
Horizontal	Multiconductor cables touching	1	1.0	0.90	0.80	0.80	0.75	0.75
Horizontal	Multiconductor cables spaced ‡	1	1.0	1.0	1.0	0.95	0.90	-
Vertical	Multiconductor cables touching	1	1.0	0.90	0.80	0.75	0.75	0.70
Vertical	Multiconductor cables spaced ‡	1	1.0	0.90	0.90	0.90	0.85	-
Horizontal	Single conductor cables trefoil separated ‡‡	1	1.0	1.0	0.95			
Vertical	Single conductor cables trefoil separated ‡‡	1	1.0	0.90	0.90			

‡ Spaced by a clearance between adjacent surfaces of at least one cable diameter (D_e).

‡‡ Separated by a clearance between adjacent surfaces of at least two cable diameters (2 D_e).

\- Correction factor not tabulated.

NOTES to Tables 4B1 and 4B2

1. The factors in the table are applicable to groups of cables all of one size. The value of current derived from application of the appropriate factors is the maximum current to be carried by any of the cables in the group.
2. If, due to known operating conditions, a cable is expected to carry not more than 30 % of its *grouped* rating, it may be ignored for the purpose of obtaining the rating factor for the rest of the group.
   For example, a group of N loaded cables would normally require a group reduction factor of C_g applied to the tabulated I_t. However, if M cables in the group carry loads which are not greater than 0.3 $C_g I_t$ amperes the other cables can be sized by using the group rating factor corresponding to (N-M) cables.
3. When cables having differing conductor operating temperatures are grouped together, the current rating shall be based on the lowest operating temperature of any cable in the group.
4. Where the horizontal clearance between adjacent cables exceeds 2 D_e, no correction factor need be applied.

TABLE 4D1A

Single-core 70 °C thermoplastic (pvc) insulated cables, non-armoured, with or without sheath
(COPPER CONDUCTORS)

COPPER CONDUCTORS

CURRENT-CARRYING CAPACITY (amperes):

Ambient temperature: 30 °C
Conductor operating temperature: 70 °C

Conductor cross-sectional area	Reference Method 4 (enclosed in conduit in thermally insulating wall etc.)		Reference Method 3 (enclosed in conduit on a wall or in trunking etc.)		Reference Method 1 (clipped direct)		Reference Method 11 (on a perforated cable tray horizontal or vertical)		Reference Method 12 (free air)		
									Horizontal flat spaced	Vertical flat spaced	Trefoil
	2 cables, single-phase a.c. or d.c.	3 or 4 cables, three-phase a.c.	2 cables, single-phase a.c. or d.c.	3 or 4 cables, three-phase a.c.	2 cables, single-phase a.c. or d.c. flat and touching	3 or 4 cables, three-phase a.c. flat and touching or trefoil	2 cables, single-phase a.c. or d.c. flat and touching	3 or 4 cables, three-phase a.c. flat and touching or trefoil	2 cables, single-phase a.c. or d.c. or 3 cables three-phase a.c.	2 cables, single-phase a.c. or d.c. or 3 cables three-phase a.c.	3 cables trefoil, three phase a.c.
1	2	3	4	5	6	7	8	9	10	11	12
(mm^2)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)
1	11	10.5	13.5	12	15.5	14	-	-	-	-	-
1.5	14.5	13.5	17.5	15.5	20	18	-	-	-	-	-
2.5	20	18	24	21	27	25	-	-	-	-	-
4	26	24	32	28	37	33	-	-	-	-	-
6	34	31	41	36	47	43	-	-	-	-	-
10	46	42	57	50	65	59	-	-	-	-	-
16	61	56	76	68	87	79	-	-	-	-	-
25	80	73	101	89	114	104	126	112	146	130	110
35	99	89	125	110	141	129	156	141	181	162	137
50	119	108	151	134	182	167	191	172	219	197	167
70	151	136	192	171	234	214	246	223	281	254	216
95	182	164	232	207	284	261	300	273	341	311	264
120	210	188	269	239	330	303	349	318	396	362	308
150	240	216	300	262	381	349	404	369	456	419	356
185	273	245	341	296	436	400	463	424	521	480	409
240	320	286	400	346	515	472	549	504	615	569	485
300	367	328	458	394	594	545	635	584	709	659	561
400	-	-	546	467	694	634	732	679	852	795	656
500	-	-	626	533	792	723	835	778	982	920	749
630	-	-	720	611	904	826	953	892	1138	1070	855
800	-	-	-	-	1030	943	1086	1020	1265	1188	971
1000	-	-	-	-	1154	1058	1216	1149	1420	1337	1079

TABLE 4D2A
Multicore 70 °C thermoplastic (pvc) insulated and thermosetting insulated cables, non-armoured

800	-	-	-	-	1030	943	1086	1020	1265	1188	971
1000	-	-	-	-	1154	1058	1216	1149	1420	1337	1079

TABLE 4D2A

Multicore 70 °C thermoplastic (pvc) insulated and thermosetting insulated cables, non-armoured
(COPPER CONDUCTORS)

COPPER CONDUCTORS

CURRENT-CARRYING CAPACITY (amperes):

Ambient temperature: 30 °C
Conductor operating temperature: 70 °C

Conductor cross-sectional area	Reference Method 4 (enclosed in an insulated wall, etc.)		Reference Method 3 (enclosed in conduit on a wall or ceiling, or in trunking)		Reference Method 1 (clipped direct)		Reference Method 11 (on a perforated cable tray) or Reference Method 13 (free air)	
	1 two-core cable*, single-phase a.c. or d.c.	1 three-core cable* or 1 four-core cable, three-phase a.c.	1 two-core cable*, single-phase a.c. or d.c.	1 three-core cable* or 1 four-core cable, three-phase a.c.	1 two-core cable*, single-phase a.c. or d.c.	1 three-core cable* or 1 four-core cable, three-phase a.c.	1 two-core cable*, single-phase a.c. or d.c.	1 three-core cable* or 1 four-core cable, three-phase a.c.
1	2	3	4	5	6	7	8	9
(mm^2)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)
1	11	10	13	11.5	15	13.5	17	14.5
1.5	14	13	16.5	15	19.5	17.5	22	18.5
2.5	18.5	17.5	23	20	27	24	30	25
4	25	23	30	27	36	32	40	34
6	32	29	38	34	46	41	51	43
10	43	39	52	46	63	57	70	60
16	57	52	69	62	85	76	94	80
25	75	68	90	80	112	96	119	101
35	92	83	111	99	138	119	148	126
50	110	99	133	118	168	144	180	153
70	139	125	168	149	213	184	232	196
95	167	150	201	179	258	223	282	238
120	192	172	232	206	299	259	328	276
150	219	196	258	225	344	299	379	319
185	248	223	294	255	392	341	434	364
240	291	261	344	297	461	403	514	430
300	334	298	394	339	530	464	593	497
400	-	-	470	402	634	557	715	597

NOTES:

1. **Where the conductor is to be protected by a semi-enclosed fuse to BS 3036, see item 6.2 of the preface to this appendix.**
2. Circular conductors are assumed for sizes up to and including 16 mm^2. Values for larger sizes relate to shaped conductors and may safely be applied to circular conductors.
3. * With or without a protective conductor.