

Table 4B1 – Rating factors for ambient air temperatures other than 30 °C to be applied to the current-carrying capacities for cables in free air

Ambient temperature °C	Insulation			
	70 °C thermoplastic	90 °C thermosetting	Mineral ^a	
			Thermoplastic covered or bare and exposed to touch 70 °C	Bare and not exposed to touch 105 °C
25	1.03	1.02	1.07	1.04
30	1.00	1.00	1.00	1.00
35	0.94	0.96	0.93	0.96
40	0.87	0.91	0.85	0.92
45	0.79	0.87	0.78	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.

Table 4B2 – Rating factors for ambient ground temperatures other than 20 °C to be applied to the current-carrying capacities for cables buried direct in the ground or in an underground conduit system to BS EN 50086-2-4

Ground temperature °C	Insulation	
	70 °C thermoplastic	90 °C thermosetting
10	1.10	1.07
15	1.05	1.04
20	1.00	1.00
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

Table 4B3 – Rating factors for cables buried direct in the ground or in an underground conduit system to BS EN 50086-2-4 for soil thermal resistivities other than 2.5 K.m/W to be applied to the current-carrying capacities for Reference Method D

Thermal resistivity, K.m/W	0.5	0.8	1	1.5	2	2.5	3
Rating factor for cables in buried ducts	1.28	1.20	1.18	1.1	1.05	1	0.96
Rating factor for direct buried cables	1.88	1.62	1.5	1.28	1.12	1	0.90

NOTE 1: The rating factors given have been averaged over the range of conductor sizes and types of installation included in the relevant tables in this appendix. The overall accuracy of rating factors is within ± 5%.

NOTE 2: The rating factors are applicable to cables drawn into buried ducts. For cables laid direct in the ground the rating 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 BS 7769 (BS IEC 60287).

NOTE 3: The rating factors are applicable to ducts buried at depths of up to 0.8 m.

Table 4C1 – Rating factors for one circuit or one multicore cable or for a group of circuits, or a group of multicore cables, to be used with current-carrying capacities of Tables 4D1A to 4J4A

Arrangement (cables touching)	Number of circuits or multicore cables												To be used with current-carrying capacities, Reference
	1	2	3	4	5	6	7	8	9	12	16	20	
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
Single layer on wall or floor	1.00	0.85	0.79	0.75	0.73	0.72	0.72	0.71	0.70	0.70	0.70	0.70	Method C
Single layer multicore on a perforated horizontal or vertical cable tray system	1.00	0.88	0.82	0.77	0.75	0.73	0.73	0.72	0.72	0.72	0.72	0.72	Methods E and F
Single layer multicore on cable ladder system or cleats etc.	1.00	0.87	0.82	0.80	0.80	0.79	0.79	0.78	0.78	0.78	0.78	0.78	

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 rating factor need be applied.

NOTE 3: The same factors are applied to:

- groups of two or three single-core cables;
- multicore 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: The rating factors given have been averaged over the range of conductor sizes and types of installation included in Tables 4D1A to 4J4A the overall accuracy of tabulated values is within 5%.

NOTE 7: For some installations and for other methods not provided for in the above table, it may be appropriate to use factors calculated for specific cases, see for example Tables 4C4 and 4C5.

NOTE 8: When cables having differing conductor operating temperature are grouped together, the current rating is to be based upon the lowest operating temperature of any cable in the group.

NOTE 9: 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 rating 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.

TABLE 4D2A - Multicore 70 °C thermoplastic insulated and thermoplastic sheathed 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 A (enclosed in conduit in thermally insulating wall etc.)		Reference Method B (enclosed in conduit on a wall or in trunking etc.)		Reference Method C (clipped direct)		Reference Method E (in free air or on a perforated cable tray etc.)	
	1 two-core single-phase a.c. or d.c.	1 three-core cable* or 1 four-core cable, three-phase a.c.	1 two-core single-phase a.c. or d.c.	1 three-core cable* or 1 four-core cable, three-phase a.c.	1 two-core single-phase a.c. or d.c.	1 three-core cable* or 1 four-core cable, three-phase a.c.	1 two-core 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

* with or without a protective conductor

TABLE 4D2B

VOLTAGE DROP (per ampere per metre):

Conductor operating temperature: 70 °C

Conductor cross-sectional area	Two-core cable, d.c.	Two-core cable, single-phase a.c.		Three- or four-core cable, three-phase a.c.	
	(mV/A/m)	(mV/A/m)	(mV/A/m)	(mV/A/m)	(mV/A/m)
1	2	3	4		
(mm ²)	(mV/A/m)	(mV/A/m)	(mV/A/m)		
1	44	44	38		
1.5	29	29	25		
2.5	18	18	15		
4	11	11	9.5		
6	7.3	7.3	6.4		
10	4.4	4.4	3.8		
16	2.8	2.8	2.4		
25	1.75	1.75	1.50	1.50	1.50
35	1.25	1.25	1.10	1.10	1.10
50	0.93	0.93	0.80	0.80	0.81
70	0.63	0.63	0.55	0.55	0.57
95	0.46	0.47	0.41	0.41	0.43
120	0.36	0.38	0.33	0.33	0.35
150	0.29	0.30	0.26	0.26	0.29
185	0.23	0.25	0.21	0.21	0.25
240	0.180	0.190	0.165	0.165	0.21
300	0.145	0.155	0.135	0.135	0.185
400	0.105	0.115	0.100	0.100	0.160

**WRITE ALL YOUR WORK IN THE ANSWER BOOK PROVIDED.
EVERY ANSWER SHOULD INCLUDE ALL WORKINGS, NECESSARY
DIAGRAMS AND FORMULAE.**

START EACH ANSWER ON A FRESH PAGE.

Choose any **FIVE** questions.

- 1a) Before starting work on a new installation, the electrician must obtain information from the local supply utility, Enemalta Corporation.
Mention five (5) main requirements that the electrician need to obtain from the utility. (10 marks)
- b) Considering the local Electricity Supply Regulations (ESR), draw a detailed diagram of a single phase supply showing the general layout of the equipment at the supply input of the electrical installation. (10 marks)
- 2a) Briefly explain the difference between the following types of devices
- i) Circuit Breaker (3 marks)
 - ii) Switch (3 marks)
 - iii) Isolator / Disconnecter (3 marks)
- b) Comparing a High Rupturing Capacity (HRC) cartridge type fuse to BS88 with a semi-enclosed fuse to BS3036, give two (2) advantages and one (1) disadvantage for each. (6 marks)
- c) An electric water heater rated 6kW is to be protected by a HRC (BS88) fuse.
Calculate
- i) The load current. (3 marks)
 - ii) The fuse rating. (2 marks)
- 3a) What precautions should be taken before carrying out an insulation resistance test of a lighting installation incorporating dimmer switches? (5 marks)
- b) With the aid of simple diagrams, explain how an insulation test is carried out on:
- i) a cooker circuit. (4 marks)
 - ii) a 13kW cooker connected to the above circuit. (4 marks)
- c) State the minimum acceptable test values for (b i) and (b ii). (4 marks)
- d) If the final circuit is protected by a residual current device, what other test would be appropriate? (3 marks)

- 4a) Draw a neat and well-labelled diagram of:
- i) Normally Closed Relay. (6 marks)
 - ii) Normally Open Relay. (6 marks)
- b) Give a short description of the type of relays you drew in (a) above. (4 marks)
- ci) State an example where a Normally Closed Relay is used in domestic installations. (2 marks)
- ii) State an example where a Normally Open Relay is used in domestic installations. (2 marks)
- 5a) Draw and explain a three heat switch. State one application where the three heat switch is **commonly** used (8marks)
- b) Draw and explain a thermostat showing clearly the main components. State one application where the thermostat is used. (6marks)
- c) Draw and explain a simmerstat showing clearly the main components. State one application where the simmerstat is used. (6 marks)
6. Explain the term "voltage drop" and specify the percentage voltage drop allowable by the I.E.E regulations. (4 marks)
- A small installation load consists of a 3kW 230V, 50Hz, single-phase air conditioner which requires to be fed from a double pole fuse switch outlet and a 0.5kW discharge lighting circuit. The total distance from the distribution board to the air conditioner and lighting circuit switch device is 40 meters. Two separate multi-core non-armoured cables are to be routed in the service shaft of the building and clipped direct on the wall. The ambient temperature is 40°C. While all assumptions are to be clearly shown, calculate:
- (a) The minimum size of the cable required for the Air-conditioner. (5 marks)
 - (b) The minimum size of the cable required for the lighting circuit. (5 marks)
 - (c) The voltage drop as a percentage of the nominal supply voltage of both cables. (4 marks)
 - (d) The practical rating of the fuse/MCB (Qty 2 in consumer unit) protecting each circuit. (2 marks)

(Refer to the IEE Regulations tables provided)

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**EXAMINATION FOR THE ISSUE OF A LICENCE TO
ACT AS WIREMAN - LIC 'A'**

JULY 2013

Paper II (Electrical Installation Technology)

Time Allowed - 3Hrs

