Miniature circuit breakers

Breaking capacities
Tripping characteristics

Miniature circuit breaker (magnetic trip setting)			BS EN 60898** Breaking capacity (A)		BS EN 60947-2* Breaking capacity (A)			
Type	**Ratings (A)**	**Page**	**1 P 240V**	**2,3,4P 415V**	**1 P 220V/240V**	**2,3,4P 220V/240V**	**2,3,4P 380V/415V**	**2,3,4P 440V**
C60HB MCB (type B: 3-5In)	1A to 63A	12/13	10,000	10,000	15,000	30,000	15,000	10,000
C60HC MCB (type C: 5-10In	1A to 63A	12/13	10,000	10,000	15,000	30,000	15,000	10,000
C60HD MCB (type D: 10-14In)	1A to 63A	12/13	10,000	10,000	15,000	30,000	15,000	10,000
C120 HB MCB	10A to 125A	17	15,000	15,000	15,000	30,000	15,000	10,000
C120 HC MCB	10A to 125A	18	15,000	15,000	15,000	30,000	15,000	10,000
C120 HD MCB	10A to 125A	19	15,000	15,000	15,000	30,000	15,000	10,000
NG125 N	10A to 125A	35	-	-	25,000	50,000	25,000	20,000
NG125 H	10A to 80A	38	-	-	36,000	70,000	36,000	30,000

* Breaking capacities quoted are Icu. Ics = 50% of Icu.
** Breaking capacities quoted are Icn. Ics = 75% of Icn.

Note: For UL/CSA approved MCB's consult us.
Maximum operating voltage 440V + 10%

Magnetic tripping characteristics (50/60Hz)

BS EN 60898			I EC947-2			
Type	**In min.**	**In max.**	**Type**	**In min.**	**In max.**	**Typical applications**
B	3	5	**U**	5.5	8.8	Moderately inductive, e.g. commercial and general industrial
C	5	10	**C**	5	10	Highly inductive, e.g. heavy industrial
D	10	14	**D**	10	14	More highly inductive, e.g transformers, motors and certain lighting systems

Note: BS EN 60898 calibration temperature 30°C
BS EN 60947-2 calibration temperature 40°C

Temperature derating of MCB's

Miniature circuit beakers listed in the service current tables may be used at temperatures ranging from -30˚C to 60˚C. The tables show the maximum current to be employed as a function of certain ambient temperatures. Figures in bold type are the nominal current ratings at the calibration temperature.

Derating of MCB's grouped in enclosed installations.

When a number of circuit breakers or combined RCD/MCB's that operate simultaneously are mounted side by side in a small enclosure, the temperature rise inside the enclosure may cause a reduction in the service current. The reduction can be calculated by multiplying the maximum service current by a 'grouping factor'.

■ Grouping factors

C60HB, C60HC, C60HD } 0.8

C60H B and C curves

	Temperature °C								
Rat. (A)	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**
1	1.05	1.02	**1.00**	0.98	0.95	0.93	0.90	0.88	0.85
2	2.08	2.04	**2.00**	1.96	1.92	1.88	1.84	1.80	1.74
4	4.24	4.12	**4.00**	3.88	8.76	3.64	3.52	5.40	5.30
6	6.24	6.12	**6.00**	5.88	5.76	5.64	5.52	5.40	5.30
10	10.6	10.3	**10.0**	9.70	9.30	9.00	8.60	8.20	7.80
16	16.8	16.5	**16.0**	15.5	15.2	14.7	14.2	13.8	13.3
20	21.0	20.6	**20.0**	19.4	19.0	18.4	17.8	17.4	16.8
25	26.2	25.7	**25.0**	24.2	23.7	23.0	22.2	21.5	20.7
32	33.5	23.9	**32.0**	31.4	30.4	29.8	28.4	28.2	27.5
40	42.0	41.2	**40.0**	38.8	38.0	36.8	35.6	34.4	33.2
50	52.5	51.5	**50.0**	48.5	47.4	45.5	44.0	42.5	40.5
63	66.2	64.9	**63.0**	61.1	58.0	56.7	54.2	51.7	49.2

C60H D curve

	Temperature °C								
Rat. (A)	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**
1	1.10	1.08	1.05	1.03	**1.00**	0.97	0.95	0.92	0.89
2	2.18	2.14	2.08	2.04	**2.00**	1.96	1.90	1.86	1.80
4	4.52	4.40	4.24	4.12	**4.00**	3.88	3.72	3.56	3.44
6	6.48	6.36	6.24	6.12	**6.00**	5.88	5.76	5.58	5.46
10	11.4	11.1	10.7	10.4	**10.0**	9.60	9.20	8.80	8.40
16	17.9	17.4	16.9	16.4	**16.0**	15.5	15.0	14.4	13.9
20	22.2	21.6	21.2	20.6	**20.0**	19.4	18.8	18.2	17.6
25	27.7	27.0	26.5	25.7	**25.0**	24.2	23.5	22.7	21.7
32	35.2	34.2	3.6	32.9	**32.0**	31.0	30.4	29.4	28.4
40	44.4	43.6	42.4	41.2	**40.0**	38.8	37.6	36.4	34.8
50	56.0	54.5	53.0	51.5	**50.0**	48.5	46.5	45.0	43.0
63	71.8	69.9	67.4	65.5	**63.0**	60.4	57.9	55.4	52.9

DPN, DPN N

	Temperature °C								
Rat. (A)	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**
1	1.04	1.02	**1**	0.98	0.96	0.93	0.91	0.89	0.86
2	2.08	2.04	**2**	1.96	1.91	1.87	1.82	1.77	1.72
6	6.26	6.13	**6**	5.87	5.73	5.60	5.45	5.31	5.16
10	10.5	10.3	**10**	9.73	9.45	9.17	8.87	8.57	8.25
16	16.7	16.4	**16**	15.6	16.2	14.8	14.4	14	13.5
20	20.9	20.4	**20**	19.5	19	18.7	18	17.5	17
25	26.1	25.5	**25**	24.4	23.8	23.3	22.7	22.1	21.4
32	33.6	32.8	**32**	31.2	30.3	29.4	28.5	27.6	26.7
40	42	41	**40**	39	37.9	36.8	35.7	34.6	33.4

Temperature derating/grouping factors

DPN Vigi, DPN N Vigi, (30 and 300mA)

	Temperature °C								
Rat. (A)	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**
6	6.26	6.13	6	5.87	5.73	5.60	5.45	5.31	5.16
10	10.5	10.2	10	9.75	9.49	9.23	8.96	8.67	8.38
16	16.8	16.4	16	15.6	16.2§	14.8	14.3	14.9	13.4
20	21	20.5	20	19.5	19	18.5	17.9	17.4	16.8
25	26.1	25.5	25	24.4	23.9	23.3	22.7	22.1	21.4
32	33.4	32.7	32	31.2	30.5	29.7	28.9	28	27.1
40	41.6	41.8	40	38.2	38.3	37.4	36.5	35.6	34.6

NG125

	Temperature °C								
Rat. (A)	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**
10	11	10.75	10.5	10.25	**10**	9.75	9.5	9.25	9
16	17.6	17.2	16.8	16.4	**16**	15.6	15.2	14.8	14.4
20	22	21.5	21	20.5	**20**	19.5	19	18.5	18
25	27.5	26.87	26.25	25.62	**25**	24.37	23.75	23.12	22.5
32	35.2	34.4	33.6	32.8	**32**	31.2	30.4	29.6	28.8
40	44	43	42	41	**40**	39	38	37	36
50	55	53.75	52.5	51.25	**50**	48.75	47.5	46.25	45
63	69.3	67.72	66.15	64.57	**63**	61.42	59.85	58.27	56.7
80	88	86	84	82	**80**	78	76	74	72
100	110	107.5	105	102.5	**100**	97.5	95	92.5	90
125	137.5	134.3	131.2	128.1	**125**	121.8	118.7	121.8	112.5

C120H

	Temperature °C								
Rat. (A)	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**
10	10.7	10.4	**10**	9.4	9.2	8.8	8.4	8.1	7.8
16	17.1	16.6	**16**	15	14.7	14	13.4	13	12.6
20	21.3	20.7	**20**	18.7	18.3	17.5	16.7	16	15.5
25	27.1	26	**25**	23.8	22.7	21.2	20.2	19.6	19
32	34.7	33.3	**32**	30.5	29	27.1	25.8	25	24.2
40	43	41.5	**40**	38	36	34	32	31	30
50	53.9	51.9	**50**	47.8	45.7	43.3	41	39.8	38.6
63	68	65.5	**63**	60	57	54	51	49.5	48
80	85	82.5	**80**	77	74	60.5	57	55.3	53.6
100	107	103.5	**100**	96	92	87.5	83	80.5	78
125	135	130	**125**	118.5	114	108	102	99	96

Table 1: fluorescent lighting

Depending on the power supply and the number and types of lighting units, the table gives the circuit breaker rating based on the following assumptions:

- Installation in an enclosure with an ambient temperature of 25˚C (derating coefficient = 0.8).
- Power of ballast: 25% of tube power.
- Power factor: 0.6 for non-compensated fluorescent lighting. 0.86 for compensated fluorescent lighting.

Circuit breakers mounted in an enclosure with an ambient exterior temperature of 25˚C: derating coefficient = 0.8.

Single phase system: 230V
Three phase + N system: 400V between phases

Types of lighting unit	Power of tubes (W)	Number of lighting units per phase												
Single phase non-compensated	**18**	4	9	29	49	78	98	122	157	196	245	309	392	490
	36	2	4	14	24	39	49	61	78	98	122	154	196	245
	58	1	3	9	15	24	30	38	48	60	76	95	121	152
Single phase compensated	**18**	7	14	42	70	112	140	175	225	281	351	443	562	703
	36	3	7	21	35	56	70	87	112	140	175	221	281	351
	58	2	4	13	21	34	43	54	69	87	109	137	174	218
Two phase 2x18 = compensated 2x36 =	**36**	3	7	21	35	56	70	87	112	140	175	221	281	351
	72	1	3	10	17	28	35	43	56	70	87	110	140	175
2x58 =	**118**	1	2	6	10	17	21	27	34	43	54	68	87	109
MCB rating		**1**	**2**	**6**	**10**	**16**	**20**	**25**	**32**	**40**	**50**	**63**	**80**	**100**

Calculation: non-compensated fluorescent lighting example (star connection)

$$\text{Number} = \frac{(\text{rating} \times 0.8)\ (U \times 0.6)}{(P \times 1.25)}$$

Table 2: high pressure discharge lamps

Table valid for 230V and 400V, with compensated or non-compensated ballast.

Mercury vapour + fluorescent substance	Rat. (A)
P(1) ≤ 700W	**6**
P(1) ≤ 1000W	**10**
P(1) ≤ 2000W	**16**
Mercury vapour + metal halides	
P(1) 375W	**6**
P(1) 1000W	**10**
P(1) 2000W	**16**
High pressure sodium vapour lamps	
P(1) 400W	**6**
P(1) 1000W	**10**

Electrical auxiliaries

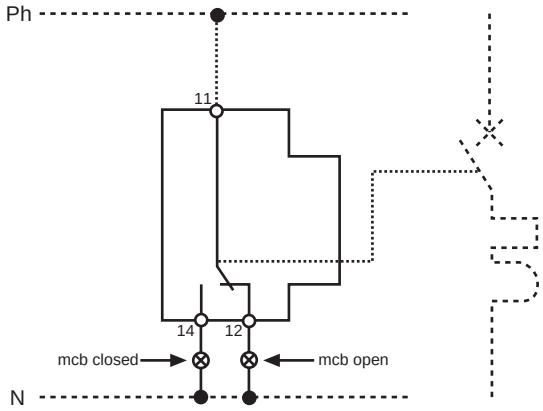
For C60/C120 MCB's

Auxiliary ON/OFF switch (OF)
Alarm switch (SD)
Shunt trip unit (MX)
Under voltage release (MN)

Auxiliary ON/OFF switch (OF) to indicate the 'open' or 'closed' position of a circuit breaker

Assembly
Clip on the left side of the circuit breaker.

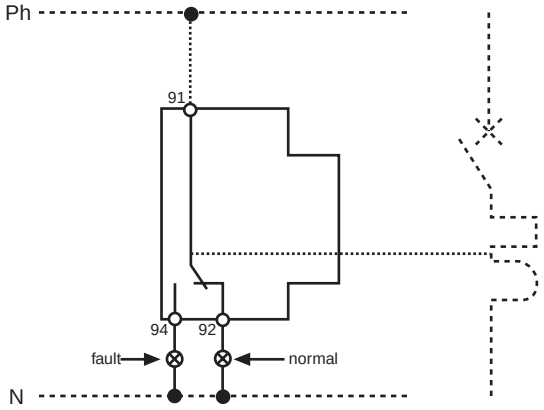
Applications
Audible or visual indication of the open or closed state of the circuit. The indication can be given on the front of a cubicle or enclosure or grouped on a control desk. Can be used in conjunction with an alarm switch.



Alarm switch (SD) to indicate circuit breaker opening on a fault (tripped)

Assembly
Clip on the left side of the circuit breaker.

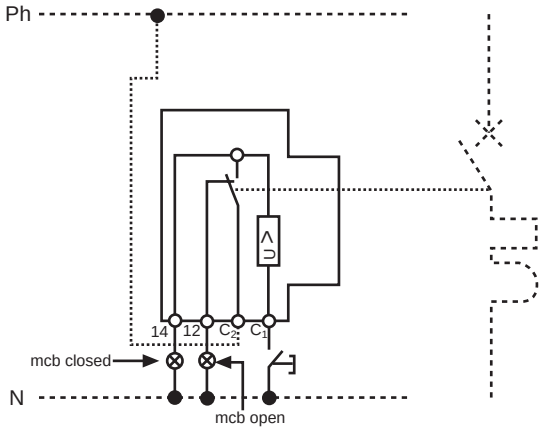
Applications
Audible or visual indication of a fault on an electrical circuit in air conditioned rooms, passenger and goods lifts, ventilation etc. May be used in conjunction with an auxiliary ON/OFF switch.



Shunt trip unit (MX) for remote tripping

Assembly
Clip on the left side of the circuit breaker.

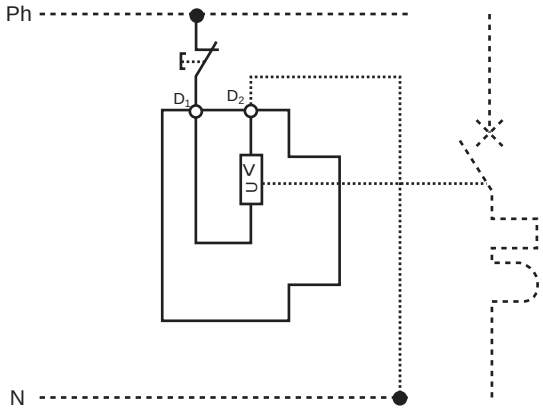
Applications
remote opening of electrical circuits.



Under voltage release unit (MN) to ensure automatic tripping in case of under voltage and for remote tripping by EMERGENCY STOP push button

Assembly
Clip on the left side of the circuit breaker.

Applications
Automatic tripping of a circuit breaker whenever the voltage drops sufficiently below its nominal rated voltage. Remote tripping of a circuit breaker by 'emergency stop' or other N.C. push button.

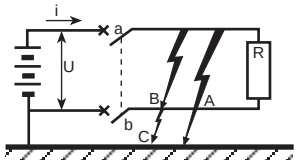
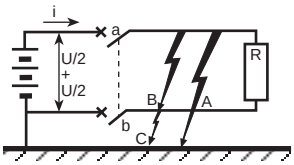
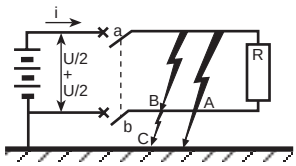


DC operation
Miniature circuit breakers

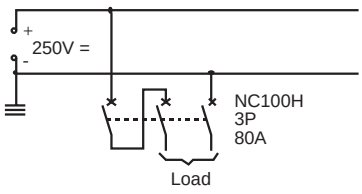
Selecting the circuit breaker
The selection of the type of circuit breaker most suitable for protection of a d.c. installation depends mainly on the following criteria:
- The rated current, which determines the rating of the equipment;
- The type of system (1,2 or 3), (see below);
- The rated voltage, which determines the number of poles to be involved in breaking;
- The maximum short-circuit current at the point of installation, which determines the breaking capacity. Magnetic trip threshold increases by 1.4.

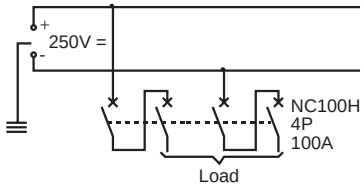
Breaking capacity of miniature circuit-breakers on d.c.
(in brackets, the number of poles involved in breaking)

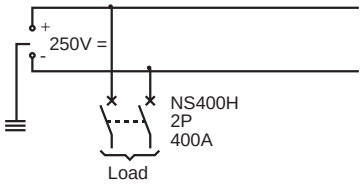
Type of circuit breaker	D.C. breaking capacity(kA)-L/R < 0.015s (IEC 947-2 ,Icu)			
Voltage	**24/48V**	**125V**	**250V**	**500V**
C60HB/HC	20 (1)	25 (2)	50 (4)	-
C60HD	20 (1)	25 (2)	50 (4)	-
C120	-	25,000	25,000	-
NG125N	-	36,000	36,000	-
NG125H	-	36,000	36,000	-

Type of system		**Earthed systems**		**Insulated systems**
		One polarity of the DC supply is earthed	A centre point of the DC supply is earthed	
Diagrams and various cases of faults				
Fault effect	Fault **A**	Max. Isc the positive polarity is the only one involved	Isc close to max. Isc the positive polarity is the only one involved, voltage U/2	No effect
	Fault **B**	Max. Isc both polarities are involved	Max. Isc both polarities are involved	Max. Isc both polarities are involved
	Fault **C**	No effect	Same as fault A but this is the negative polarity which is involved	No effect
Most unfavourable case		Fault **A**	Faults **A** and **C**	Fault **B**
Distribution of the breaking poles		The poles required to perform the break are in series on the positive polarity (1),(2)	On each polarity there must be the number of poles required to perform the break of max. Isc at U/2	the poles required to perform the break are shared between the 2 polarities

(1) Or negative if the positive polarity is earthed.
(2) An extra pole will be needed on the earthed polarity to provide isolation







Calculation the short-circuit current (Isc) across the terminals of a battery
When a short-circuit occurs across its terminals, a battery discharges a current given by Ohm's law:

$$Isc = \frac{Vb}{Ri}$$

Where Vb = the maximum discharge voltage (battery 100 % charged).
and Ri = the internal resistance equivalent to the sum of the cell resistances (figure generally given by the manufacturer according to the capacity of the battery).

Example
What is the short-circuit current at the terminals of a standing battery with the following characteristics:
- Capacity: 500 Ah;
- Max. discharge voltage: 240 V (110 cells of 2.2 V);
- Discharge current: 300 A;
- Autonomy: 1/2 hour;
- Internal resistance: 0.5 mΩ per cell.

Ri = 110 x 0.5 10-3 = 55 x10-3

$$Isc = \frac{240}{55\ 10^{-3}} = 4.4kA$$

As the above calculation shows, the short-circuit current is relatively weak.

Note: If the internal resistance is not known, the following approximate formula can be used: Isc = kC, where C is the capacity of the battery expressed in Ampere-hours, and k is a coefficient close to 10 but in any case always lower than 20.

240 V DC
300 A
500 Ah
Ri = 0.5 mΩ/cell

The greater part of multi 9 circuit breakers can be used on 400Hz networks. Short-circuit currents at 400Hz generator terminals do not, in general, exceed the nominal current by more than 4 times. Therefore, breaking capacity problems are very rare.

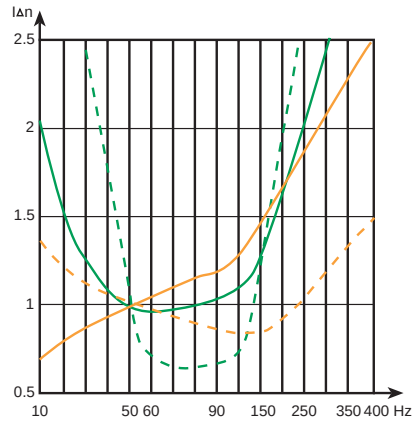
Multi 9 circuit breakers

- ■ No thermal derating
- ■ Increase of magnetic thresholds:
- □ Coefficient 1.5 for DPN
- □ Coefficient 1.48 for C60
- ■ Residual current circuit-breakers from the multi 9 range can be used on 400Hz networks. It should be noted that the mA threshold varies depending on the network's frequency (see curves below).

Note:

In 400 Hz, the test circuit for residual current devices may present the risk of not functioning when actioning the test button because of threshold variation. According to international studies (IEC 60479-2), the human body is less sensitive to a 400Hz current that passes through the body; so well that, even though the residual current device has had its frequency desensitised, these devices still ensure the protection of persons. The method for choosing residual current devices in 400 Hz is thus the same as that for 50Hz.

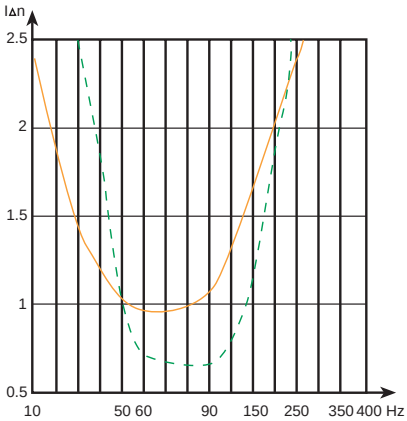
RCCB



Operating residual current variation curves

Class	Rating	Curve no. Sensitivity (mA)				
	(A)	10	30	100	300	500
AC	25	2	1	-	1	1
	25-40	-	1	1	1	1
	63-80-100	-	2	1	1	1
A	16-25-40-63	-	3	-	2	2
"si" type			4	-	4	-
Selective S (AC, A)		-	-	-	2	2

Vigi C60



Operating residual current variation curves

Class	Rating	Curve no. Sensitivity (mA)				Sens. (A)	
	(A)	10	30	100	300	1A	3A
Vigi C60 110/220 V - 50 Hz							
AC	25	2	1	1	-	-	
	63	-	2	1	-	-	
Vigi C60 2, 3 and 4P 220/415 V - 50 Hz							
AC	25	2	1	1	-	-	
	40-63	-	2	1	-	-	
A	25-63	3	3	2	2	-	
All types							
Selective S			-	4	2	2	-
C60 "si"							
			4				

Miniature circuit breakers

For use in conjunction with motor starters and transformers

Motor starters

In general miniature circuit breakers can give only short circuit protection to motor loads due to the high starting currents which may be encountered; typically 3 to 12 times full load current (FLC).

Assumptions

The tables give recommended mcb ratings for motors up to 37kW based on the following assumptions:

- **Direct-on-line starting**
  starting current = 7 x FLC
  run-up time =
  6seconds, motors <3kW
  10 seconds, motors < 22kW
  running currents = average values only (individual manufacturer's figures will vary). four-pole motors, i.e. speed approx. 1500 rev/min.

For higher inertia loads, i.e. hoists or fans, run-up times may be considerably longer than those assumed above. The rating of the mcb must take account of the greater run-up time and starting current. The required mcb rating can be determined by reference to time/current curves (consult us).

- **Star/delta starting**
  Since, during the changeover from star to delta, a high current surge in the order of DOL values may be met, the mcb rating selected should be the same as that recommended for DOL starting.

Table 1 - 3 phase 415V AC D.O.L. starting

			Recommended MCB		
kW	hHp	Running I	**C60HB**	**C60HC**	**C60HD**
0.12	0.166	0.65	2	2	1
0.18	0.25	0.7	2	2	1
0.25	0.33	0.87	4	2	1
0.37	0.5	1.35	4	4	2
0.55	0.75	1.55	4	4	2
0.75	1.0	1.93	6	4	4
1.1	1.5	2.5	6	6	4
1.5	2	3.5	10	10	6
2.2	3	4.8	16	10	10
3	4	6.4	20	20	10
3.75	5	7.8	25	25	16
4	5.5	8.1	25	25	16
5.5	7.5	11	32	32	16
7.5	10	14.4	50	50	20
9.33	12.5	17.3	63	50	20
11	15	21	63	63	25
13	17.5	25	-	-	32
15	20	28	-	-	40
18.5	25	35	-	-	50
22	30	40	-	-	50
30	40	54	-	-	63
37	50	65.5	-	-	-

Table 2 - 1 phase 240V AC D.O.L. starting

kW	Hp	Running I	**C60HB**	**C60HC**	**C60HD**
0.12	0.166	0.95	4	2	1
0.18	0.25	1.5	4	4	2
0.25	0.33	1.7	6	4	2
0.37	0.5	3	10	6	4
0.55	0.75	4.5	16	10	6
0.75	1	5.5	16	16	10
1.1	1.5	8.5	25	25	16
1.5	2	10.5	32	32	20
2.2	3	15.5	40	40	25
3	4	20	63	63	32
3.75	5	24	-	63	40
5.5	7.5	34	-	-	50
6.3	8.5	36.5	-	-	63
7.5	10	45	-	-	63
11	15	66.5	-	-	-

Transformers

High inrush currents are also produced when transformers are switched on, typically 10-15 times full load current.

Assumptions

The tables give recommended mcb ratings for single phase transformers up to 12500 VA and three phase transformers up to 30000 VA based on the following formula.

Table 3 - 3 phase transformers 415V AC supply

VA	Primary In (A)	C60HB	C60HC	C60HD
500	0.7	4	2	1
750	1.04	6	4	2
1000	1.39	10	6	4
2000	2.78	16	10	6
5000	6.95	40	25	16
10000	13.89	-	50	25
15000	20.84	-	63	32
20000	27.78	-	-	50
25000	34.73	-	-	63
30000	41.67	-	-	63

Table 4 - 1 phase transformers 240V AC supply

VA	Primary In (A)	C60HB	C60HC	C60HD
50	0.21	2	-	-
100	0.42	4	2	1
250	1.04	6	4	2
500	2.08	16	10	4
1000	4.17	25	16	10
2500	10.42	63	32	16
5000	20.84	-	63	32
10000	41.66	-	-	63
12500	52.08	-	-	-

Inrush currents

When LV/LV transformers are switched on, very high inrush currents are produced which must be taken into account when choosing overcurrent protection devices. The peak value of the first current wave often reaches 10 to 15 times the rated rms current of the transformer and may reach values of 20 to 25 times the rated current even for transformers rated less than 50kVA. This transient inrush current decays very quickly (in a few milliseconds).