Voltage Drop and Branching Circuit Design Calculations

Week 5-6-7

Cable selection criteria:

1- Cable ampacity (capacity): maximum current carried by cable, depends on burial depth, environment, air or cable tray distribution, soil temperature, grouping …etc. Current must be calculated using de-rating factors.

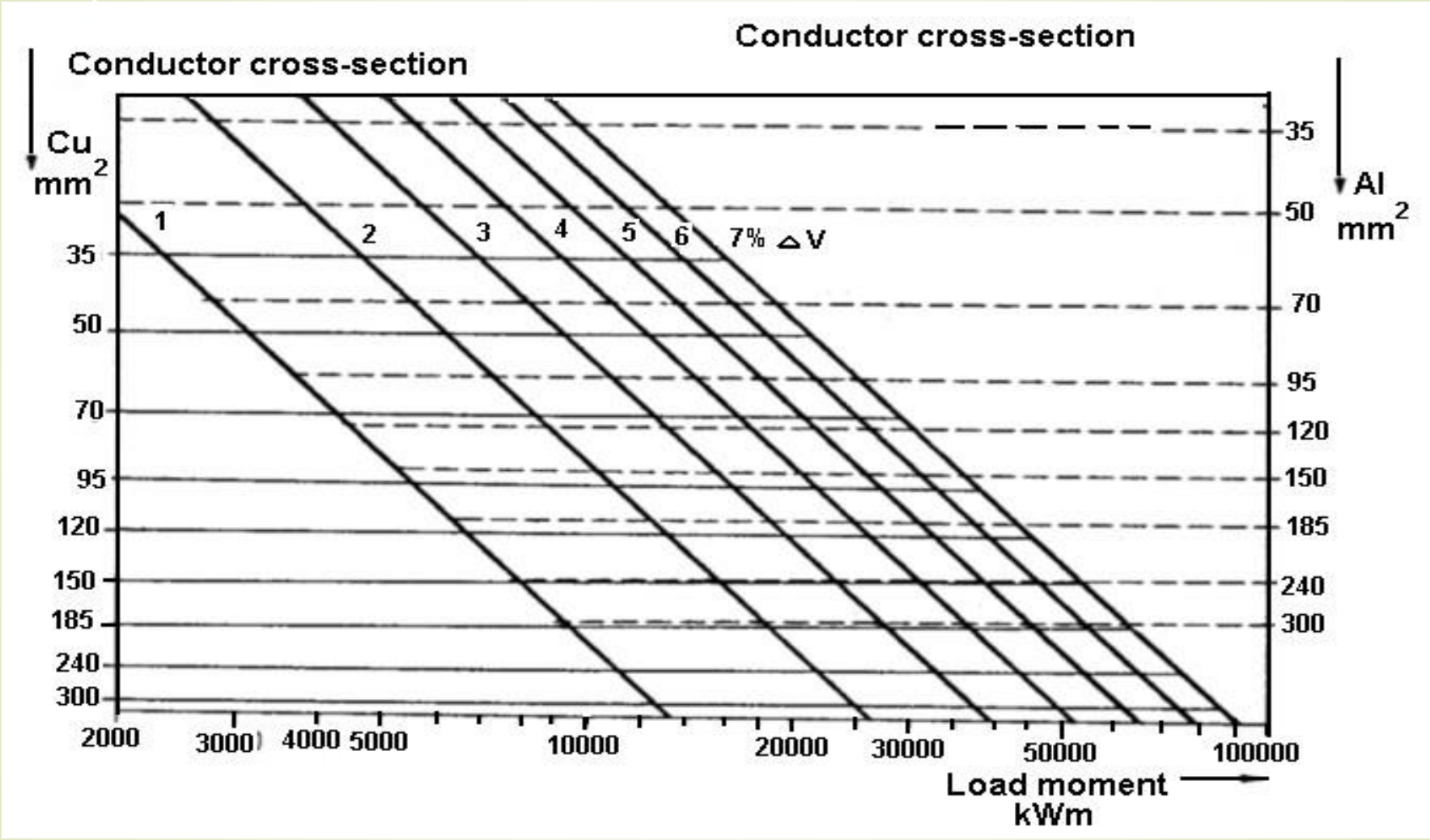
2- Voltage drop allowance: very critical in low voltage distribution networks

3- Short circuit withstand capabilities: Short circuit current versus time relation, will the selected cable withstand the expected short circuit current at fault for the given time duration or not and will the circuit breakers operate before the cable failure.

Voltage drop in distribution systems (LV) must not exceed a total of 8%

- Transformer= **1%**
- From distribution transformer to main distribution panel board (inside building)=**3%** (4% MV)
- Riser = **1-1.5%**
- Rest = **2.5%**

SIEMEN's Chart



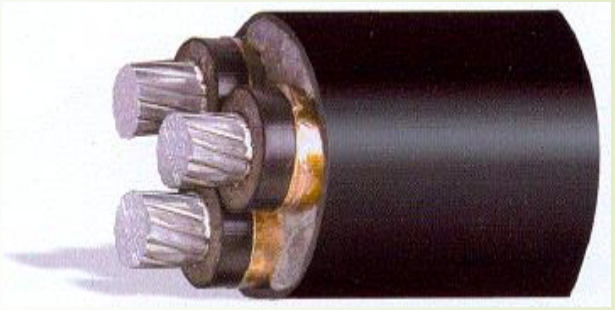
with %voltage drop (on 220/380 V supply, power factor = 0.9, conductor temperature 50°C)

Power Cables

LV cable

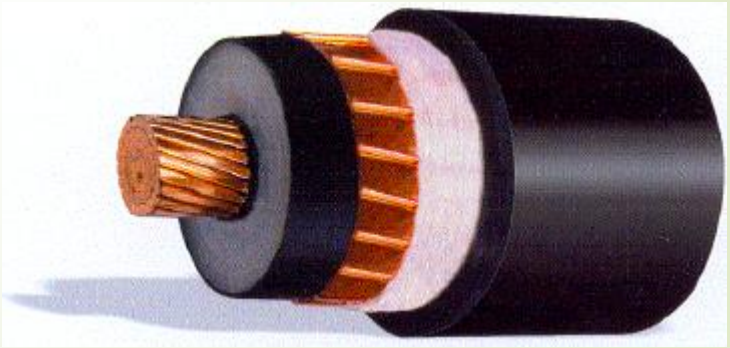
Cables are usually classified according to their operating voltage as follows:

1. Low voltage cables (up to 1kv)
2. Medium voltage cables (3kv up to 30kv).
3. High voltage cables (66kv up to 500kv).



MV cable

For same cross sectional area, single core cables Ampacity is greater than that of multi-core cables. But from economics point of view multicore cables are preferred.



HV cable

EL SEWEDY ELECTRIC
CONSTRUCTION & CONTRACTING

Power Cables

1- Conductors: different resistivity

Copper is used with low voltage for minimum voltage drop (lower resistivity than Aluminium and higher conductivity)

Aluminum is used with medium and high voltage for smaller current ampacity and thus fewer voltage drop

الكبل الألومنيوم سعته الامبيرية اقل من النحاس لنفس مساحة المقطع لكنه اخف في الوزن

2- Insulation:

Cross Linked Polyethylene (XLPE) cables

- Used with medium voltage and sometimes low but is very expensive so its more preferable in medium
- Cable tolerates higher current than PVC cables
- Withstands higher temperature, thus current carrying capability is higher than PVC (up to 90 degrees celcius)
- Higher short circuit capability than PVC

Copper cable

Aluminum cable

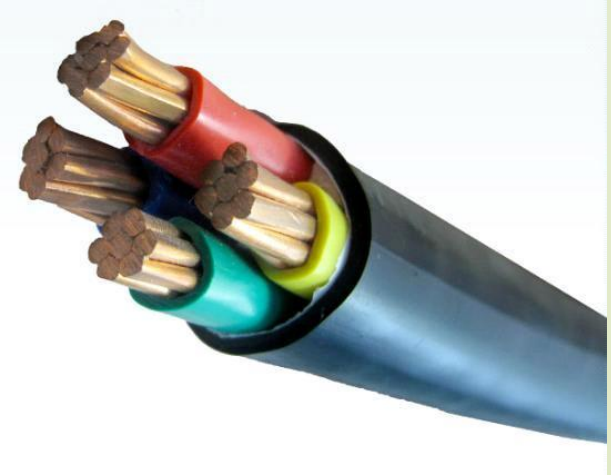
Power Cables

Polyvinyl Chloride (PVC) cables:

Popular in low voltage applications

- Lower cost than XLPE but less current capacity
- White power which is used in fabricating hard materials
- resistant to water, oil, alkalis and doesn't burn easy thus requires less replacement
- At high temperature it turns into soft material (مادة لينة) at higher than 80 degrees celcius. Thus can be used with temperature not more than 70 degrees

(XLPE) cables



Polyvinyl Chloride (PVC) cables

Power Cables

Step 1: Cable Selection:

1. Determine the **allowable current in circuit (Iz)** which is proportional to the cross section of the defined cable which includes the protective element التيار المسموح به في الدائرة و الذي يتناسب مع مقطع الكابل الذي تحميه اجهزة الحماية
2. Determine the de-rating factors (**k factor**)
3. Get **(Iz')** which is the **Iz divided by k** and this determines the cable ampacity

Step 2: Perform your voltage drop calculations:

either manually or using load moment and chart technique

Step 2: Short Circuit check:

Make sure that your selected cable cross section can withstand short circuit for a certain time interval

De-rating factors (k factor determination): Example

Derating factors

Table 2

Ground temperature derating factor

Ground temperature °C	25	30	35	40	45	50	55
PVC cables rated 70 °C	1.13	1.07	1.00	0.93	0.85	0.76	0.65
XLPE cables rated 90 °C	1.09	1.04	1.00	0.95	0.90	0.85	0.80

Table 3

Air temperature derating factor

Air temperature °C	25	30	35	40	45	50	55
PVC cables rated 70 °C	1.22	1.15	1.08	1.00	0.95	0.82	0.71
XLPE cables rated 90 °C	1.14	1.10	1.05	1.00	0.90	0.89	0.84

Applied Laying Depth

Type of Cable	*Used Depth Cm*
L.V	50 - 80
M.V	80 - 100
H.V	100 - 120
E.H.V	120 - 140

**Cable laying is a major factor affecting the cable life.*

** Our Catalogue and technical offers based on 50 cm.*

De-rating factors (k factor determination): Example

Table 4

Burial depth derating factor

Depth of laying mt.	Cables cross section		
	Up to 70 mm^2	95 upto 240 mm^2	300 mm^2 & above
0.50	1.00	1.00	1.00
0.60	0.99	0.98	0.97
0.80	0.97	0.96	0.94
1.00	0.95	0.93	0.92
1.25	0.94	0.92	0.89
1.50	0.93	0.90	0.87
1.75	0.92	0.89	0.86
2.00	0.91	0.88	0.85

Table 5

Soil thermal resistivity derating factor

Soil thermal resistivity in °C. Cm/Watt	80	90	100	120	150	200	250
Rating factor	1.17	1.12	1.07	1.0	0.91	0.80	0.73

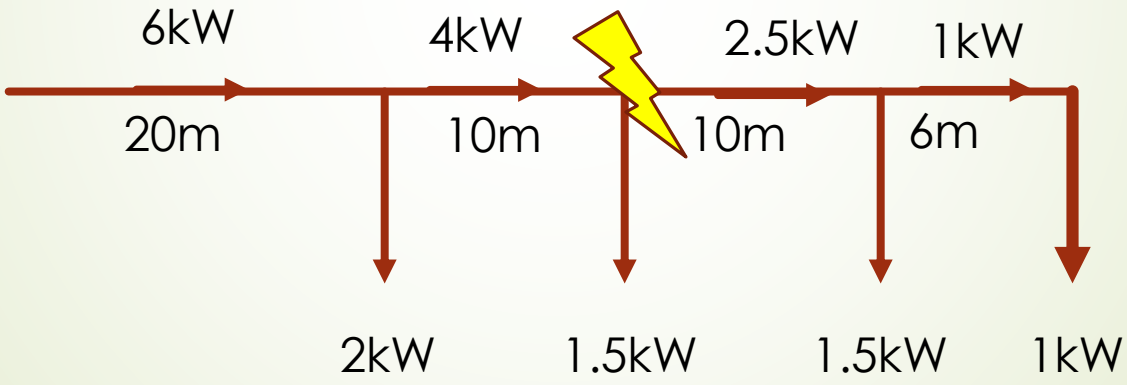
Table 6

PVC rated temperature derating factor

Type of PVC rated temperature °C	70	85	95	105
Rating factor	1.000	1.195	1.309	1.414

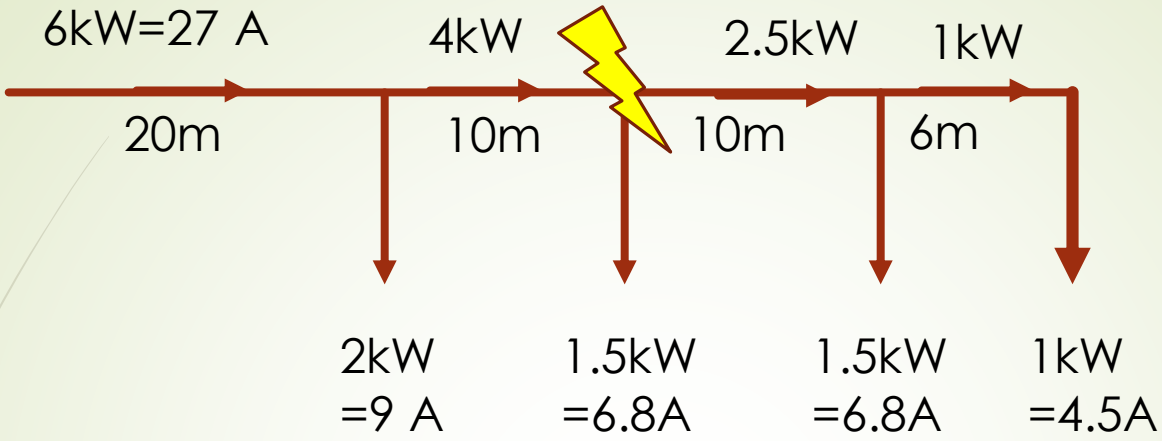
Short Circuit Current Calculation: حساب تيار قصر الدارة

- Short circuit current is the current flowing in an electrical circuit due to fault occurrence which is different than the normal current (could reach 10 times more than normal current)
- Short circuit could be :
  - Symmetric (3phase),
  - unsymmetrical (two phase, two phase to earth, single phase to earth)
  - Most occurred one is single phase to earth and symmetric 3 phase fault.



Calculate short circuit current if a single phase short circuit occurred between phase a and ground, occurring at entrance of load 2

Short circuit Current calculation: حساب تيار قصر الدارة



Assume rated voltage is 220V, single phase, resistive load, copper cables are used whose cross section area is 6 mm2

$$R = \frac{\rho L}{A} = \frac{1.78 \times 10^{-8} \times 30}{6 \times 10^{-6}} = 0.089\Omega$$

$$I_{sc} = \frac{V}{R} = \frac{220}{0.089} = 2471.94\ A$$

Short Circuit calculation for Cables

1- Symmetrical Fault تيار القصر المتماثل

$$I_{sc} = \frac{K \times A}{\sqrt{t}}$$

Isc = Short circuit rating of cable (kA)
A = Cross sectional area of conductor (mm2)
t = Time to trip (seconds)
K = Cable short circuit factor (from table 1)

2- Unsymmetrical Fault with earth تيار القصر غير المتماثل إلى موصل التأريض

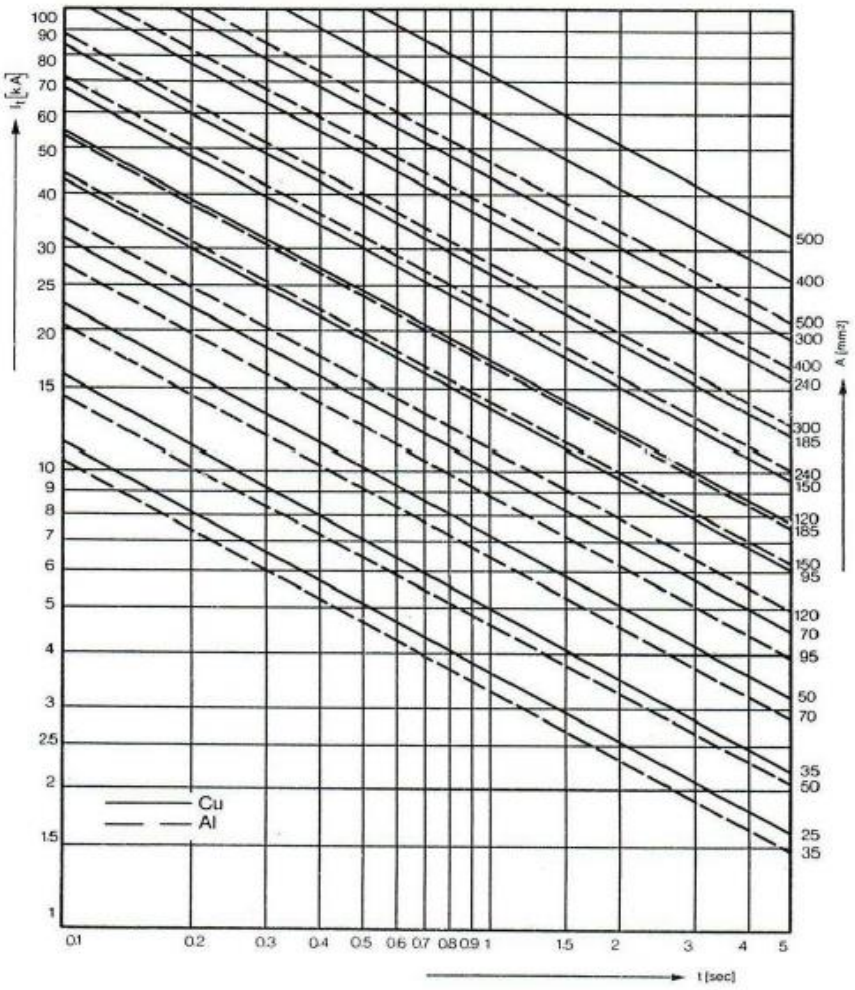
$$I_{EF} = \frac{C \times A}{\sqrt{t}}$$

C = A factor that depends on the earth path material.
A = Cross-sectional area of earth path.
t = Fault duration in seconds.

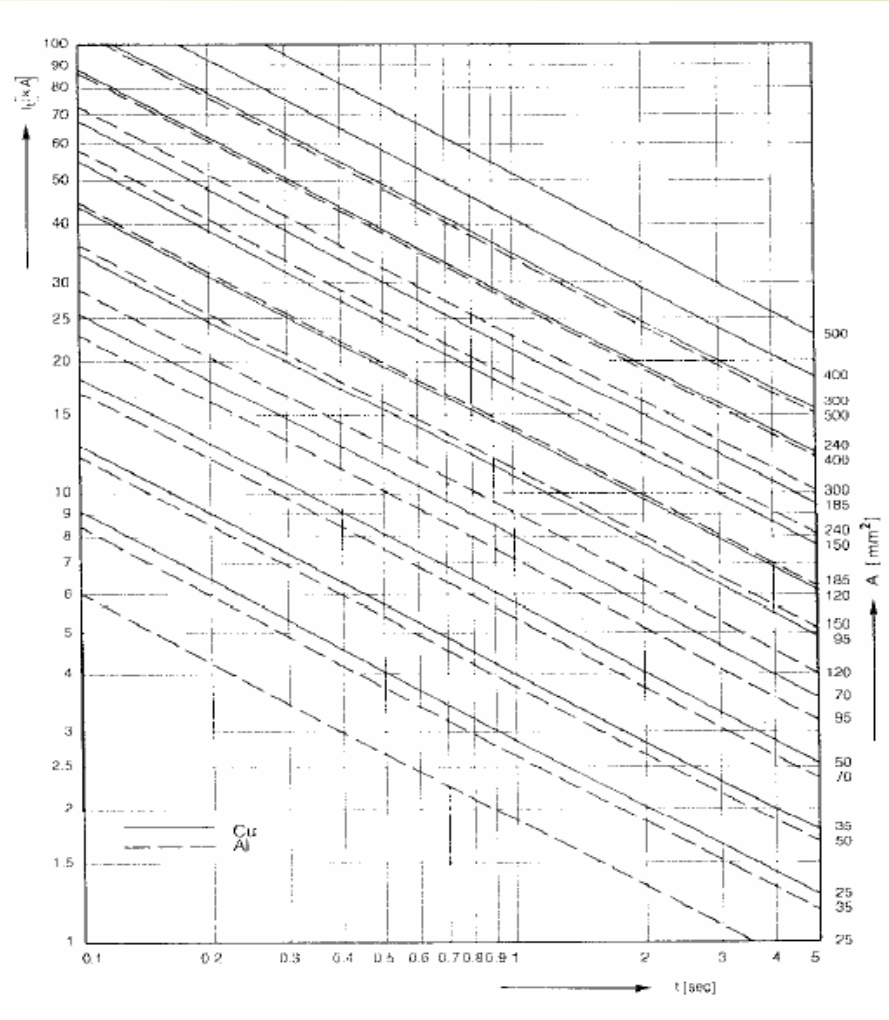
نوع عزل لكابل		درجة حرارة الموصل (°م)		معامل القصر للكابل (K)	
		درجة حرارة التشغيل	أقصى درجة حرارة	نحاس	ألومونيوم
ثرموبلاستيك	مساحة مقطع أقل من 300مم^2	70	150	0.110	0.071
	مساحة مقطع أكبر من 300مم^2	70	130	0.096	0.062
عزل بولي اثيلين متشابك		90	250	0.143	0.098
عزل ورق مشبع بالزيت		65		0.116	0.078

Table 1: Maximum temperature capability for different cables due to short circuit. Egyptian code

Short Circuit calculation for Cables



شكل رقم (7–2): تيارات القصر للكابلات المعزولة بالبولي إيثيلين المتشابك XLPE للجهود من 1 إلى 30 كيلو فولت



شكل رقم (7–1): تيارات القصر للكابلات المعزولة بكلوريد متحد الفنيل (PVC) جهد 1–10 كيلوفولت

Egyptian code

Short Circuit Capability: Example

Max. short circuit temperature for cable components

Material	Item	Temp. °C
Insulation	PVC insulation	140 For C.S.A > 300 mm2 160 For C.S.A ≤ 300 mm2
	XLPE insulation	250
Sheathing	PVC sheathing	200
	LDPE sheathing	150
	HDPE sheathing	180
	Lead sheath	170
	Lead sheath - alloy	*200

** Temp. = 210 °C for cables with rated voltages above 30kV (U_m=36 kV),*

Table 13

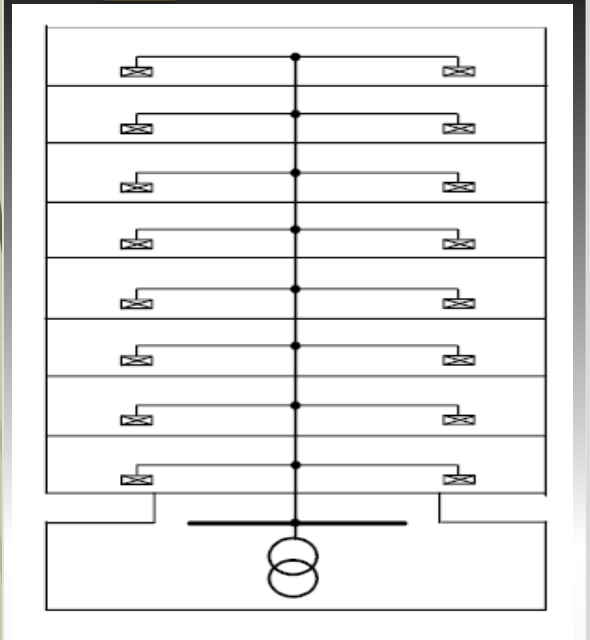
kA short circuit current - Copper conductor - PVC insulated

C.S.A. mm²	Duration sec.									
	0.1	0.2	0.3	0.4	0.5	1.0	2.0	3.0	4.0	5.0
16	5.8	4.1	3.4	2.9	2.6	1.8	1.3	1.1	0.9	0.8
25	9.1	6.4	5.2	4.5	4.1	2.9	2.0	1.7	1.4	1.3
35	12.7	9.0	7.3	6.4	5.7	4.0	2.8	2.3	2.0	1.8
50	18.2	12.9	10.5	9.1	8.1	5.8	4.1	3.3	2.9	2.6
70	25.5	18.0	14.7	12.7	11.4	8.1	5.7	4.6	4.0	3.6
95	34.5	24.4	19.9	17.3	15.5	10.9	7.7	6.3	5.5	4.9
120	43.6	30.9	25.2	21.8	19.5	13.8	9.8	8.0	6.9	6.2
150	54.5	38.6	31.5	27.3	24.4	17.3	12.2	10.0	8.6	7.7
185	67.3	47.6	38.8	33.6	30.1	21.3	15.0	12.3	10.6	9.5
240	87.3	61.7	50.4	43.6	39.0	27.6	19.5	15.9	13.8	12.3
300	109.1	77.1	63.0	54.5	48.8	34.5	24.4	19.9	17.3	15.4
400	130.0	91.9	75.1	65.0	58.2	41.1	29.1	23.7	20.6	18.4
500	162.5	114.9	93.8	81.3	72.7	51.4	36.3	29.7	25.7	23.0
630	204.8	144.8	118.2	102.4	91.6	64.8	45.8	37.4	32.4	29.0

Electrical riser الصاعد

صاعد واحد رئيسيSINGLE RISING MAIN

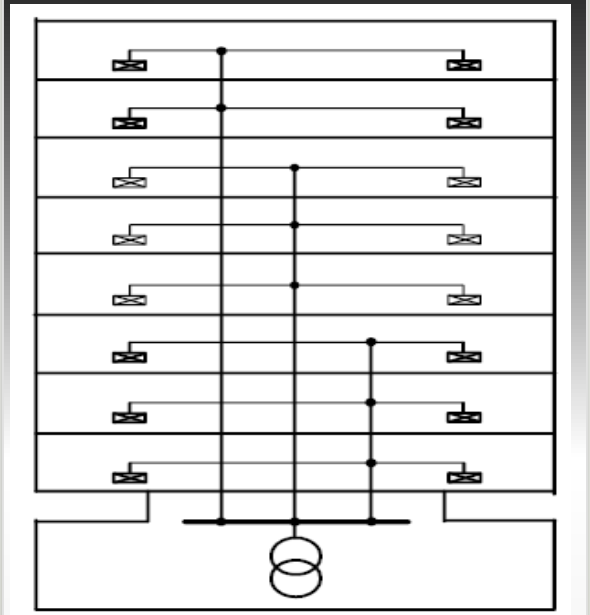
1



الاستخدام :
يستخدم في الاماكن التي لا تحتاج استمرارية التغذية بدرجة عالية
من مميزاتها : اللوحات صغيرة لوحة الشقة فقط
عيوبه : لو حدث عطل في الصاعد الرئيسي ينقطع التيار عن المبني باكمله

الصواعد المجمعة GROUPING SUPPLY

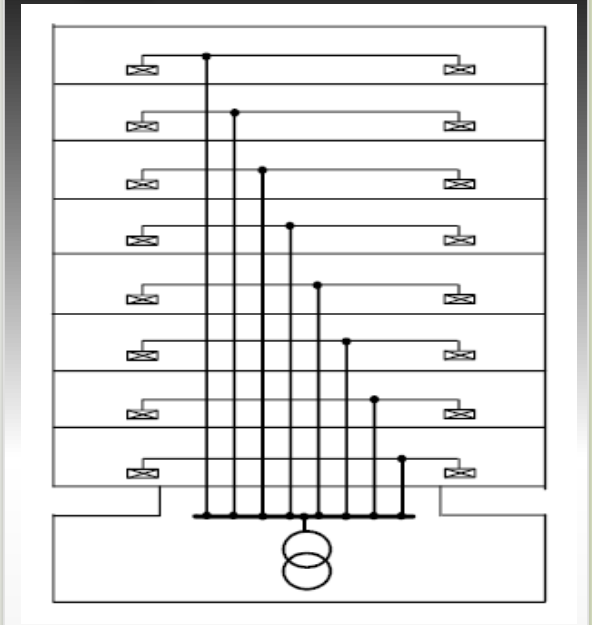
2



الاستخدام :
مباني ذات ارتفاع عالي مع حمل عالي طبقا لسماحية انخفاض الجهد
مميزاته : الصواعد ذات احمال منخفضة
عيوبه :اي عطل سيفصل التيار عن عدد من الادوار

صاعد لكل دور INDIVIDUAL FLOOR SUPPLY

3

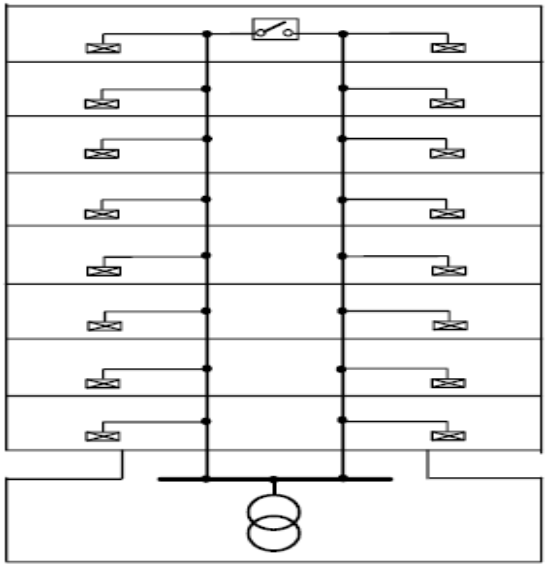


الاستخدام :
مباني ذات ارتفاع عالي و تحتاج لدرجة استمرارية للتيار عالية
مميزاته :اذا حدث عطل في صاعد يتم فصل دور واحد فقط من العمارة
عيوبه :تكلفة عالية ، اللوحة الرئيسية كبيرة

Electrical riser الصاعد

RING MAIN SUPPLY صاعد حلقي

4



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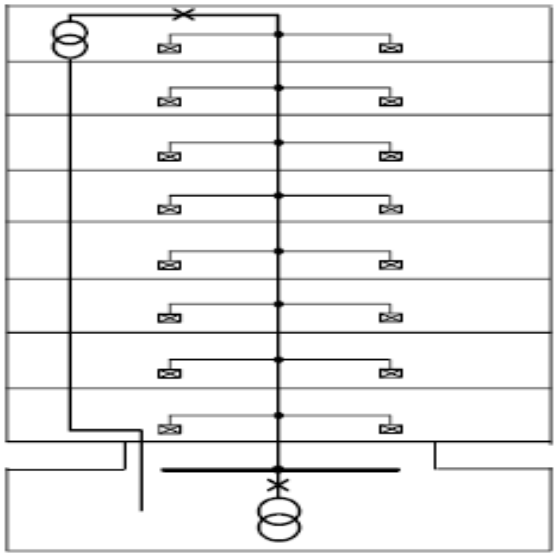
DOUBLE FEED SUPPLY صاعد ثنائي التغذية

5



الاستخدام :
مباني ذات ارتفاع عالي و حمل عالي خاصة في الادوار العليا مصاعد او تكييف او خلافه

Cable tray

For cable grouping in one individual route. Each cable has its own outlet at the end

CIRCUIT BREAKER : القواطع

MCCB CB

four pole CB

Single pole CB

- One of the protective elements and is in fact THE most important element in circuit protection.

1. Used in short circuit current protection حدوث قصر due to cable insulation failure or contact between cable conductors due to cable rupture
2. Disconnect circuit due to overload

two pole CB

CIRCUIT BREAKER : القواطع

How to read the numbers on circuit breaker

Rated operating voltage Ue (in V)

This is the voltage(s) at which the circuit breaker can be used. The value indicated is usually the maximum value.

الجهد اللي القاطع حيستخدم فيه

Rated insulation voltage Ui (in V)

This value acts as a reference for the **insulation performance** of the device. The insulation test voltages (impulse, industrial frequency, etc.) are determined based on this value.

الجهد اللي تم عنده اختبار عزل القاطع

Impulse voltage Uimp (in kV)

This value characterizes the ability of the device to withstand transient over voltages such as lightning (standard impulse 1.2/50 µs).

الجهد اللي القاطع يقدر يستحمله في حالة وجود ترانزينت

CIRCUIT BREAKER : القواطع

How to read the numbers on circuit breaker

Rated Current in (in A)

This is the maximum current value the circuit breaker can withstand on a permanent basis. This value is always given for an ambient temperature around the device of 40°C in accordance with standard IEC 60947-2, and 30°C in accordance with standard IEC 60898-1. If this temperature is higher, it may be necessary to reduce the operating current.

اعلي تيار طبيعي حيمر في القاطع دائما

Ultimate breaking capacity Icu (in kA)

This is the maximum short-circuit current value that a circuit breaker can break at a given voltage and phase angle (cos φ). The tests are executed on the breaker and following the test, the circuit breaker must continue to provide a minimum level of safety (isolation, dielectric strength).

اعلي تيار عطل يقدر يقطعه القاطع

CIRCUIT BREAKER : القواطع

How to read the numbers on circuit breaker

Standard breaking capacity Ics

This is the value expressed as a percentage of Icu. It will be one of the following values: 25% **(category A only)**, 50%, 75% or 100%. The circuit breaker must be capable of operating normally after **breaking** the Ics current several times

"maximum current can flow through the breaker from time of occurring short circuit to the time of clearing the short circuit without any permanent damage in the CB."

نسبة تيار العطل بالنسبة لاعلي تيار عطل. القاطع لابد ان يعمل طبيعيا بعد حدوث هذا التيار و كسر الدارة عده مرات

CIRCUIT BREAKER : القواطع

How to read the numbers on circuit breaker

Short Time withstand Current Icw (in ka)

This is the value of the short-circuit current that a **category B** circuit breaker is capable of withstanding for a defined period without altering its characteristics. This value is intended to enable discrimination between devices. The circuit breaker concerned can remain closed while the fault is eliminated by the downstream device as long as the energy i2t does not exceed icw2 (1 s).

discrimination between devices **زي اللي قبله و لكن لانواع اخري اللي فيها**

Utilization category

IEC 60947-2 designates circuit breakers as belonging to one of two categories:

- **Category A** for circuit breakers which do not have a time delay before tripping on a short circuit
- **Category B** for circuit breakers which have a time delay.

CIRCUIT BREAKER : القواطع

How to read the numbers on circuit breaker

Rated short-circuit making capacity Icm (kA peak)

This is the maximum current intensity a device can **make** at its rated voltage according to the conditions of the standard. This occurs when we switch on a breaker or an ordinary switch due to RL transient response. This represents the DC and AC components of current flowing in the breaker

"The breaker's contacts have to withstand this highest value of current during the first cycle of waveform when breaker is closed under fault"

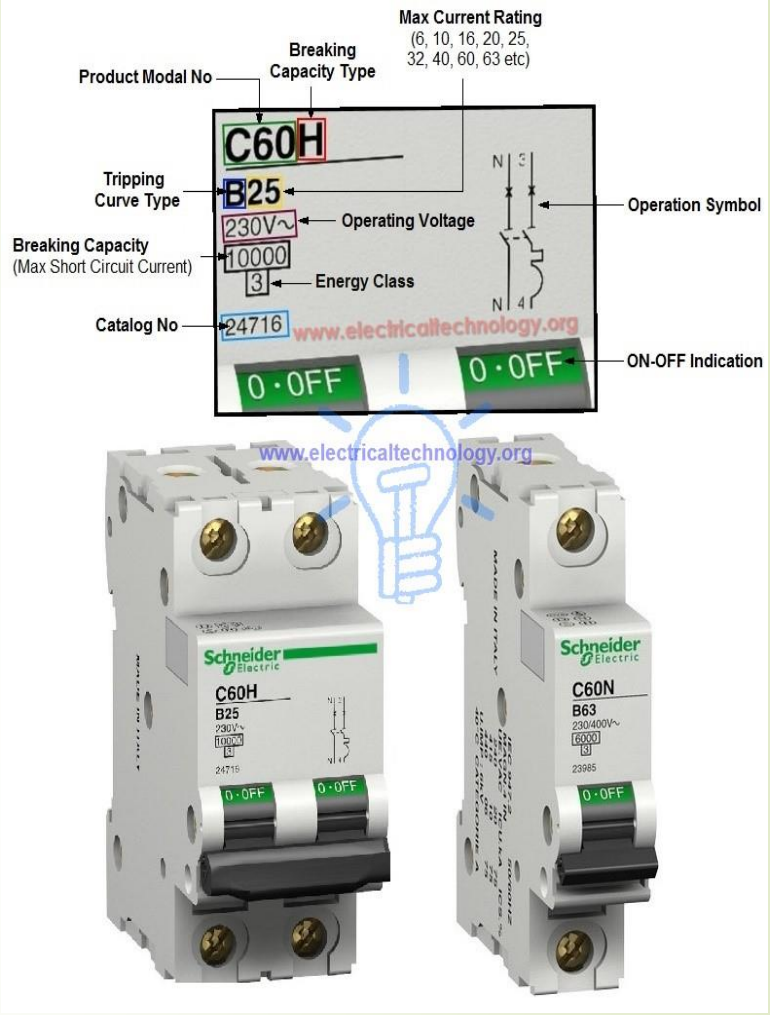
القيمة العظمي للتيار اللي القاطع حيمر فيه عند اعادة تشغيل داره

CIRCUIT BREAKER : القواطع

EXAMPLE:

4 types by the level of the rated ultimate short-circuit breaking capacity:

- Type C (Basic type),
- Type L (Standard type),
- Type M (Less high breaking type) and
- Type H (High breaking type).



5SY6 0 Miniature Circuit Breaker 1+N in 1 MW
Low Space Requirements

For applications up to 40 A
with tripping characteristics B, C,
and a switching capacity up to 6 kA,
where a switchable neutral conductor is required.

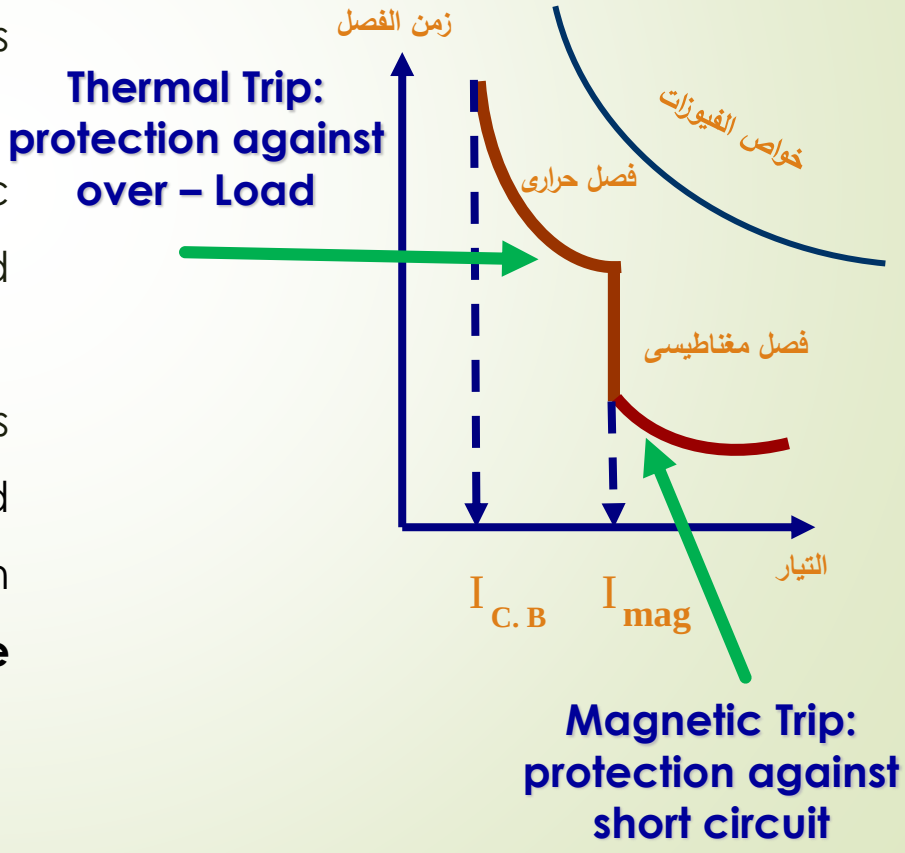
The MCB 1+N in versions
N-left or N-right and compact design
(width 1 MW = 18 mm) saves space on the distribution board.

CIRCUIT BREAKER : القواطع

three pole MCB

Thermal overload

- ***Miniature circuit breakers (MCB)***
- covering a **rated current range** between 6A and 125A under the voltage of 230/400V.
- Withstands **short circuit current** not more than 10kA (current that breaker stands before it melts for a short time)
- the optimum technical and economic solution in all sectors: Industrial, public and high-tech public, domestic.
- Exists in **C-type, B-type, D-type. Type A** is for semiconductor protection and protection of measuring circuits with transformers. Main miniature CB has **type E** curve



CIRCUIT BREAKER : القواطع

- ***Miniature circuit breakers (MCB)***

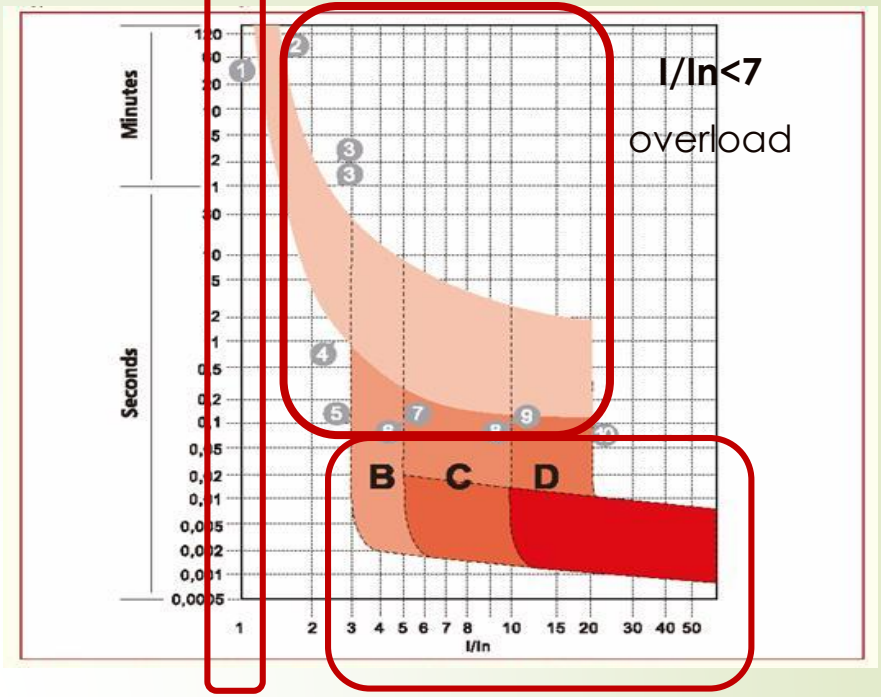
- Energy Class: MCB normally work on current limiting feature. It means that it does not allow fault to get it's peak and trip before that. But since there is some time consumed in tripping, fault current will create some energy which will exist in system. This energy is termed as let through energy. For efficient MCB operation it should be limited. On basis of amount of energy it is classified in class 1, class 2 and class 3. Here Class 3 is best which allows maximum 1.5L joule/second. This is being tested as per IS 60898.

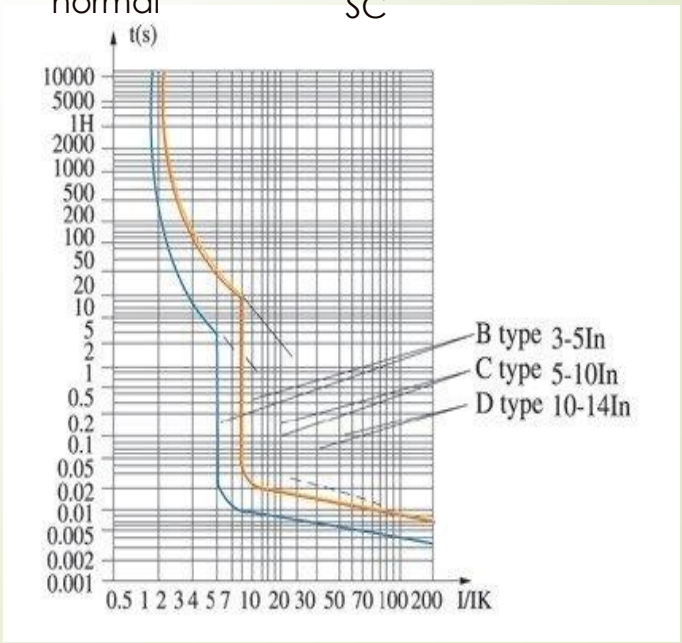
How to Read MCB Nameplate Rating Printed on It

CIRCUIT BREAKER : القواطع

- ***Miniature circuit breakers (MCB)***

- **B-type:** operates between 3-5 irated- resistive load applications. For example a 10A device will trip at 30-50A.
- **C-type:** operates between 5-10 irated- inductive load applications
- **D-type:** operates between 10-20 irated- highly inductive load applications and capacitive loads
- Type B will trip faster than type C for a given overcurrent, and type C will be faster than type D.
- Fixed settings



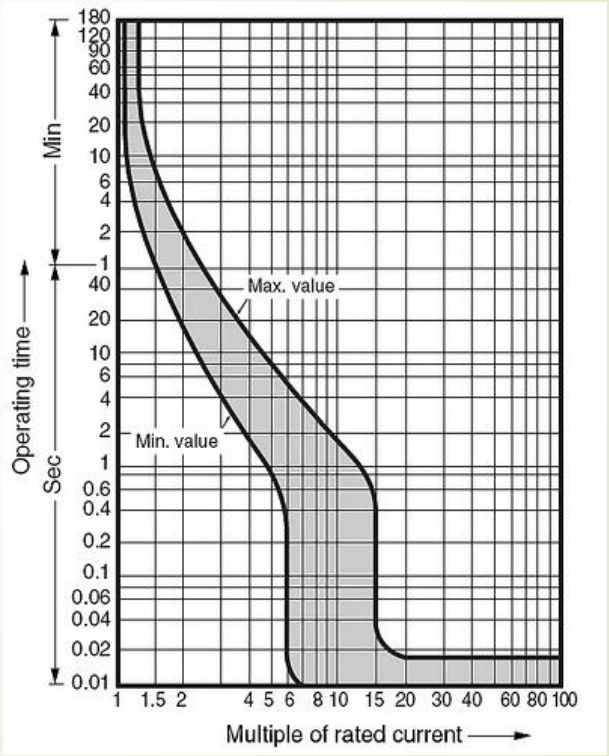


CIRCUIT BREAKER : القواطع

- ***Molded case circuit breakers (MCCB)***

- AC 50/60Hz, rated insulation voltage and operating voltage up to 690VAC and 250VDC. The rated operating current between 3A-1600A
- Complicated compared to miniature
- Withstands short circuit current up to 10kA
- protection against overload, short circuit, under voltage and can even be equipped with earth fault protection.
- Adjustable settings for (Ithermal, T, I) are adjustable and can have three curves

MCCB CB



Regions for maximum and minimum operation

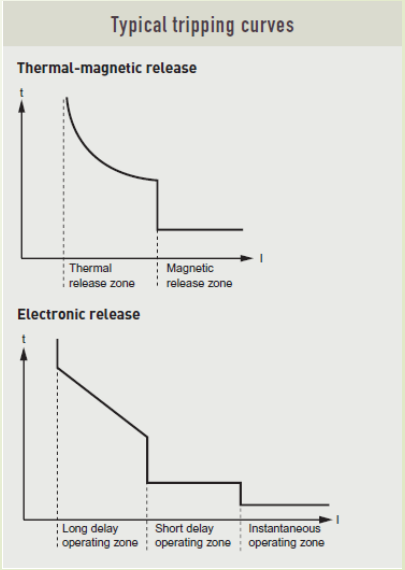
Molded Case- type Circuit breaker (MCCB)

MCCB- type	Type of Protective relay	Overload protection (Long-time delay)	Short circuit protection (short-time delay)
Domestic	Thermal- magnetic	$I_r = I_n$	Fixed at $I_m = 7$ to $10I_n$
Industrial	Thermal- magnetic	Adjustable $0.8\ I_n \leq I_r < I_n$	Adjustable $5\ I_n \leq I_m < 10I_n$
	Electronic	Adjustable $0.4\ I_n \leq I_r < I_n$	Short delay adjustable at $1.5\ I_n \leq I_m < 10I_n$
			Instantaneous fixed in range 12 to 15 I_n

Instantaneous: This provides protection against high intensity short circuits. It is either set by construction at a fixed value (5 to 20 kA), or adjustable according to the device.

Long Time delay: provides protection against lower intensity short circuits, which generally occur at the end of the line. The period of the delay may be increased by thresholds up to one second, to ensure discrimination with devices placed downstream.

Short Time delay: This is similar to the characteristic of a thermal release. It protects conductors against overloads.



CIRCUIT BREAKER : القواطع

➢ ***Earth leakage circuit breakers (ELCB)***

- safety device used in electrical installations with high earth impedance to prevent shock. It detects small stray voltages on the metal enclosures of electrical equipment, and interrupts the circuit if a dangerous voltage is detected. (could be voltage based or current based)
- Current based (RCCB)compares current in and out of circuit which should be the same. Otherwise, breaker trips.
- This is a high sensitivity device, example 5mA, 30 mA used in residential buildings which corresponds to a problem in case of human contact. 300 mA used in computer applications protection. **قيمة الحساسية للتيار المتسرب**
- **Rated current** which is the current which the breaker can stand before failure, typically 32, 40, 63, 100 A

ELCB

TEST button equipped

CIRCUIT BREAKER : القواطع

- ***Air circuit breakers (ACB)***

- protect circuit from overload, under voltage, short circuit and single phase earthing with intelligent and selective protection function
- The breaker is applicable for power stations, factories, mines (for 690V) and modern high-buildings.

Air CB

CIRCUIT BREAKER : القواطع

- ***Motor protection circuit breakers (MPCB)***

- AC voltage up to 690V and current up to 80A
- It can be used to protect a three phase cage asynchronous motor and a distribution line against overload, phase failure and short circuit, to control the motor`s infrequent starting and other infrequent load conversion. It can also serve as isolator.

MPCB

CIRCUIT BREAKER : القواطع

ب- المصاهر الأسطوانية Cylindrical Fuses

تصمم المصاهر الأسطوانية طبقا للمواصفات العالمية IEC 269 لنقل التيار المقنن للدائرة مع تحقيق أقل فقد فى الطاقة والجهد وبحيث لا يحدث تفاوت فى خواص منحنى التيار مع الزمن يتجاوز + ٥٪ وعلى أن تكون هذه المصاهر قادرة على تحمل تيار قصر فى الدائرة لا يقل عن ٥٠ كيلو أمبير .

(٢) قواطع الدوائر الكهربائية Circuit Breakers

ا- قواطع الدوائر الأتوماتيكية المنمنمة أو المصغرة Miniature Circuit Breakers

وتعمل قواطع التيار المنمنمة صغيرة الحجم يدويا وتقوم بالفصل تلقائيا (أوتوماتيكيا) بمقنن تيار حتى ١٢٥ أمبير (أحادية أو ثنائية أو ثلاثية الأطوار) وتكون هذه القواطع مزودة بعناصر حرارية للوقاية ضد زيادة التيار ، وأخرى مغناطيسية للوقاية ضد قصر الدائرة ، ويجب ألا تقل سعة القطع عن ٦ كيلو أمبير عند ٢٢٠ فولت ومعامل قدرة يتراوح بين ٠ر٥ - ٠ر٦ .

ويجب أن تطابق هذه القواطع المواصفات القياسية المصرية أو المواصفات العالمية IEC 898 .

ب - قواطع الدوائر للحماية ضد التسرب الأرضى Earth leakage protective circuit breakers

تمثل هذه القواطع وسائل حماية الأشخاص ضد اللمس المباشر ، وتتحقق هذه الحماية بالنسبة للشخص الواقع تحت تأثير جهد اللمس بأن يقوم القاطع بمنع مرور أى تيار متبقى فيه تزيد قيمته عن قيمة محدودة (هى تيار تشغيل القاطع المقنن) ويقوم القاطع بفصل الدائرة تلقائيا(أوتوماتيكيا) خلال جزء من الثانية .

وتكون هذه القواطع ثنائية أو رباعية الأقطاب و مقننة لتيارات التسرب اللازمة لتشغيلها ويوجد نوعين من هذه القواطع :

- قاطع للحماية ضد التسرب الأرضى الذى يعمل بالتيار الكهربائى
current operated earth leakage circuit breakers

- قاطع للحماية ضد التسرب الأرضى الذى يعمل بالجهد الكهربائى .
voltage operated earth leakage circuit breakers

ويستخدم القاطع ضد التسرب الأرضى الذى يعمل بالتيار عادة للوقاية فى التركيبات الكهربائية ويبين الجدول رقم (٤/٥) تأثيرات التيار الكهربائى ذات التردد ٥٠ / ٦٠ هرتز على جسم شخص بالغ فى صحة جيدة لزمن غير محدد :

جدول رقم(٤/٥)تأثير التيار الكهربى على الجسم البشرى

التيار الكهربى	التأثير على الجسم البشرى
٠.٥ ملى أمبير	غيرمحسوس
١ ملى أمبير	بداية الإدراك الحسى
من ١ الى ٣ ملى أمبير	إحساس بدون ألم
من ٣ الى ١٠ ملى أمبير	إحساس مصحوب بألم
١٠ ملى أمبير	بداية تشنج العضلات وخاصة عضلات العنق والفك
٣٠ ملى أمبير	بداية العجز عن التنفس
٧٥ ملى أمبير	بداية إنقباض عضلات القلب
٢٥٠ ملى أمبير	إنقباض عضلى للقلب (محتمل حدوثه بنسبة ٥٠ ٪ فى حالة زمن تعرض يزيد عن خمس ثوان)
٤ أمبير	بداية شلل عضلات القلب وتوقفه
أكثر من ٥ أمبير	إحتراق الأنسجة العضوية بالجسم

CIRCUIT BREAKER : القواطع

Factor to guarantee breaker doesn't heat up

$$I_{CB} = FACTOR \times I_{Load}$$

E.C	IEC	NEC
25% over load	20%over load	10% over load

$I_{C.B} = 1.25 * 18 = 22.5$ Amp.

(But there is no C.B with Ir = 22.5A)

So, from C.B standard:-

20A 25A 32A

22.5A

So, Select **C.B = 25 Amp.**

FUSES: المصهرات

- Protects electric circuits same like circuit breakers but differs as:

  1- lower cost compared to CB

  2- Faster than CB in disconnection

  3- changeable each time fault occurs on the other hand CB are changed if short circuit current occurs.

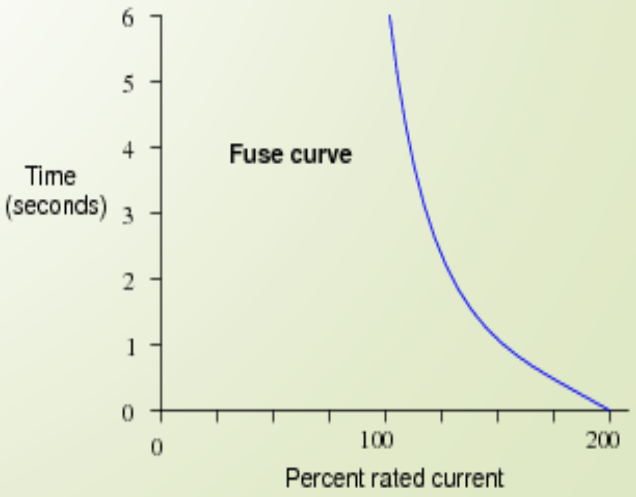
- Typical types are:

  1- Thermal fuses

  2- Cartridge fuse (ceramic and contains silicon sand for arc extinguish). Doesn't distinguish between overload and short circuit

thermal

cartridge



FUSES: المصهرات

3- High rupture capacity fuse:

- ceramic cartridge inside it a thin pure silver wire and silicon/Quartz sand filling.
- can distinguish between overload and short circuit and can be equipped with fault indicator
- Fuses are available in ratings up to1250A at low voltages and, say,100A at 11kV.

HRCF

FUSES: المصهرات

IEC standards define two classes of fuse:

- **Those intended for domestic installations,** manufactured in the form of a cartridge for rated currents up to 100A and designated type **gG** in IEC269-3, where 'G' indicates *general application*.
- **Those for industrial use,** with cartridge types designated gG (general use); and **gM** and **aM** (for motor-circuits) in IEC269-1 and 2.
- A more recent development has been the adoption by the IEC of a fuse-type **gM** for motor protection, designed to cover starting, and short-circuit conditions.