CIRCUIT BREAKER LABORATORY TESTING

Makmal Penyelidikan Elektrik , Bahagian Inovasi, Penyelidikan & Pembangunan Kejuruteraan (BIPPK)
Pusat Kecemerlangan Kejuruteraan & Teknologi JKR (CREaTE)
Alor Gajah, Melaka

This course will cover;
Part 1 – Miniature Circuit Breaker (MCB)

- MCB Tripping Characteristic Testing (MS IEC 60898-1)
  - Time-current characteristic
    - at 1.13 *In*
    - at 1.45 *In*
    - at 2.55 *In*
  - Instantaneous tripping
    - at 5 *In* (Type C)
    - at 10 *In* (Type C)

This course will cover;
Part 2 – Moulded Case Circuit Breaker (MCCB)

MCCB Opening Under Overload Testing (MS IEC 60947-2)

Inverse time-delay operation

at 1.05 *In*

at 1.30 *In*

Introduction

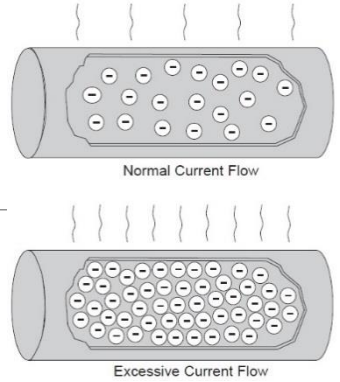
Fundamental Principles (Prinsip-prinsip asas) Electrical Installation

- Proper functioning of the installations
- Protection for safety

Introduction

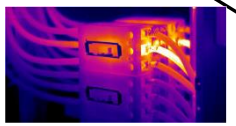
Protection for safety

- Overload current



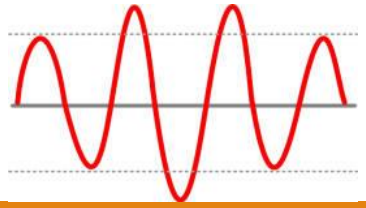
- Short-circuit

- Thermal effect



- Electric shock
  - Against direct contact
  - Against indirect contact

- Voltage disturbances



Introduction

"Protection for safety" – to protect;

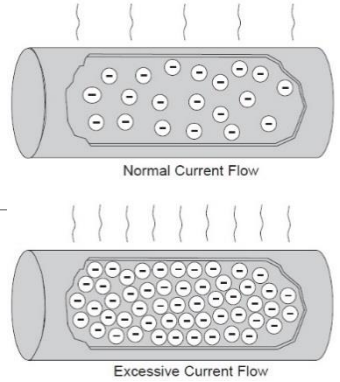
Persons

Properties (equipment, building, etc.)

Introduction

Protection for safety

- Overload current



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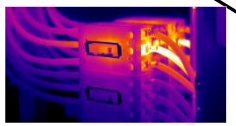
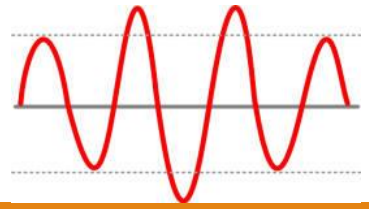


- Voltage disturbances



- Electric shock
  - Against direct contact
  - Against indirect contact

Introduction

Type of “protective devices” that can protect against overload current

Introduction

MALAYSIAN STANDARD

MS IEC 60898-1:2007
(CONFIRMED:2015)

Electrical accessories - Circuit-breakers for overcurrent protection for household and similar installations - Part 1: Circuit-breakers for a.c. operation
(First revision)
(IEC 60898-1:2003, IDT)

ICS: 29.120.50

Descriptors: fuses and other overcurrent protection devices

NOTE. This Malaysian Standard has been reviewed and confirmed as being current.

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DEPARTMENT OF STANDARDS MALAYSIA

"Product Standard" for MCB & MCCB

MALAYSIAN STANDARD

MS IEC 60947-2:2010

LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR - PART 2: CIRCUIT-BREAKERS
(SECOND REVISION)
(IEC 60947-2:2009, IDT)

IEC 60947-2:2009 is endorsed as Malaysian Standard with the reference number MS IEC 60947-2:2010.

ICS: 29.130.20

Descriptors: low voltage, switchgear, controlgear

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DEPARTMENT OF STANDARDS MALAYSIA

Introduction

How product's work

What are "Product Standard" for??

Standardization

Rules and specifications

Introduction

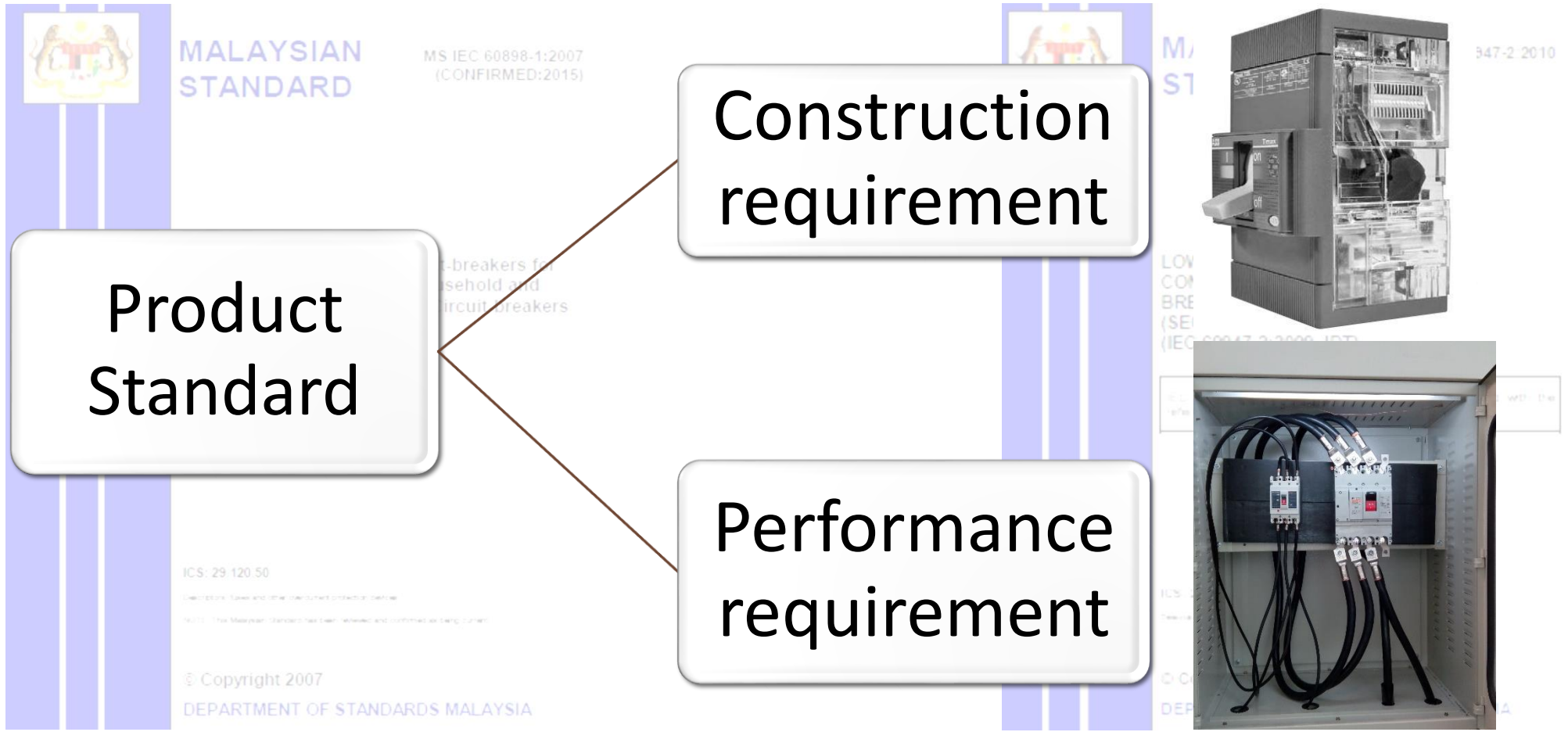
Why do we need "Product Standard"

Sell product worldwide

Improve quality

Protecting population

Introduction



Part 1 – Miniature Circuit Breaker (MCB)

MCB Tripping Characteristic Testing (MS IEC 60898-1)

- Time-current characteristic
  - at 1.13 *In*
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- Instantaneous tripping
  - at 5 *In* (Type C)
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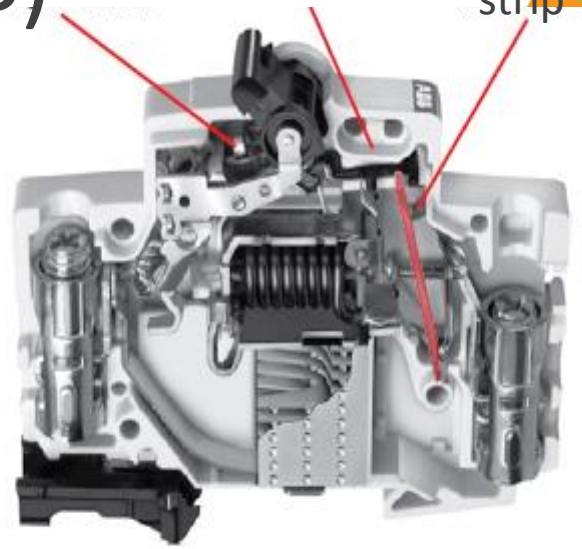

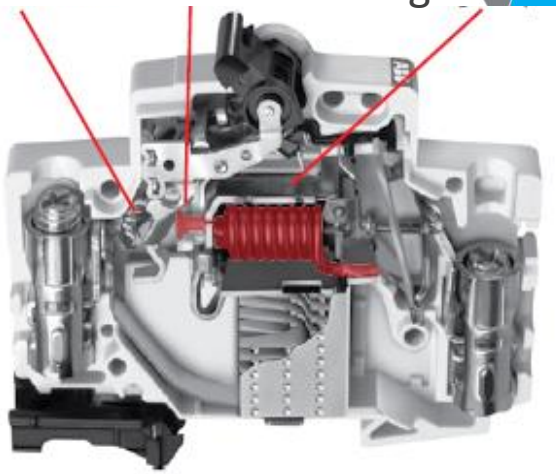

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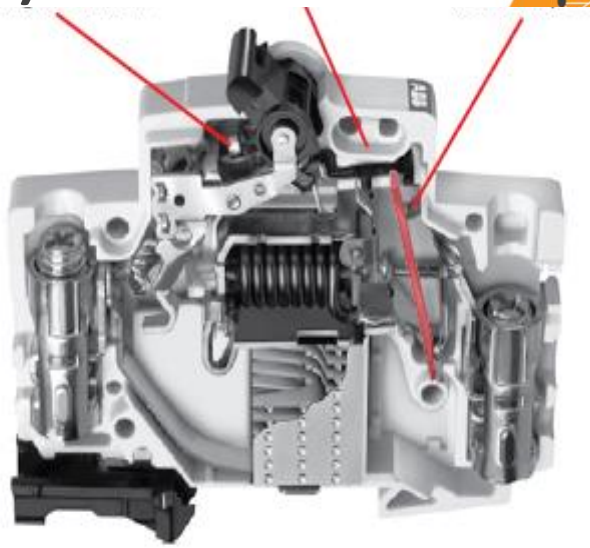
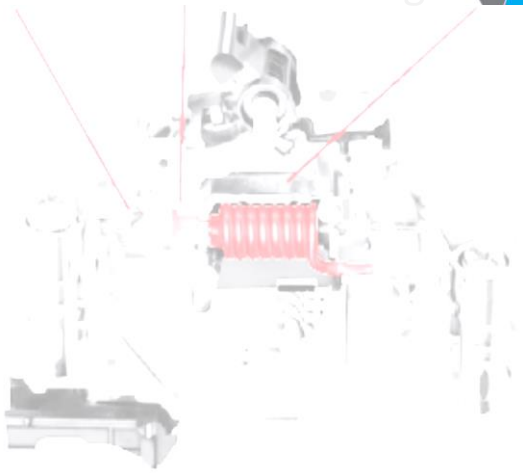
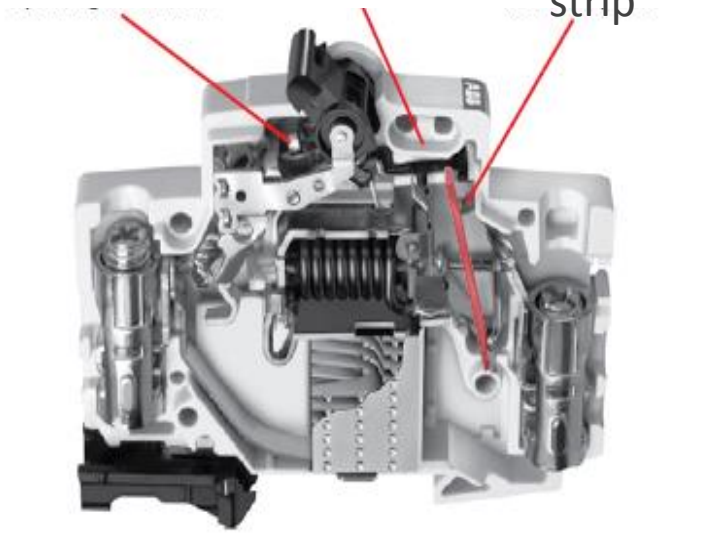




Part 1 – Miniature Circuit Breaker (MCB)

Time-current characteristic



Loading with **1.13** rated current (*In*)

i.e 10 A MCB;

=1.13 x 10 A

= 11.3 A

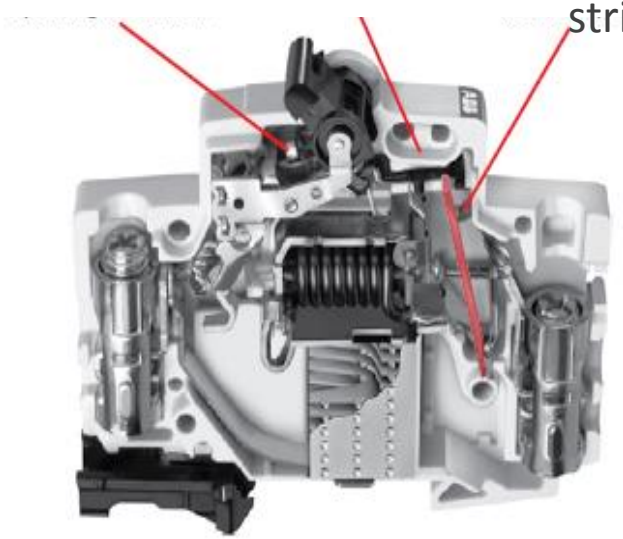
11.3 A for **1 hour**

No-tripping

1.13x*In* is a conventional **non-tripping** current

Part 1 – Miniature Circuit Breaker (MCB)

Time-current characteristic



Loading with **1.45** rated current (*In*)

i.e 10 A MCB;

=1.45 x 10 A

= 14.5 A

14.5 A

for **1 hour**

Shall Trip within 1 hour

1.45x*In* is a conventional **tripping** current

Part 1 – Miniature Circuit Breaker (MCB)

To summarize;

10 A MCB

11.3 A
(1.13xIn)
for **1 hour**

No-tripping

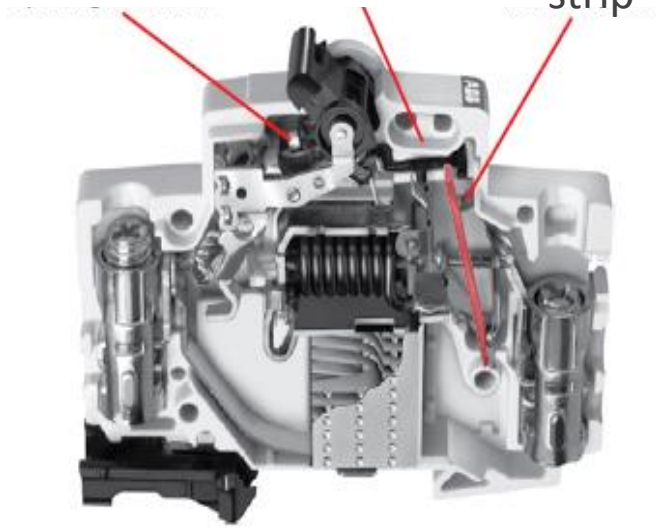
Immediately after test at 1.13xIn, current steadily increased to 1.45xIn within 5 seconds

14.5 A
(1.45xIn)
for **1 hour**

Shall Trip within 1 hour

Part 1 – Miniature Circuit Breaker (MCB)

Time-current characteristic



Loading with **2.55** rated current (*In*)

i.e 10 A MCB;

=2.55 x 10 A

= 25.5 A

25.5 A

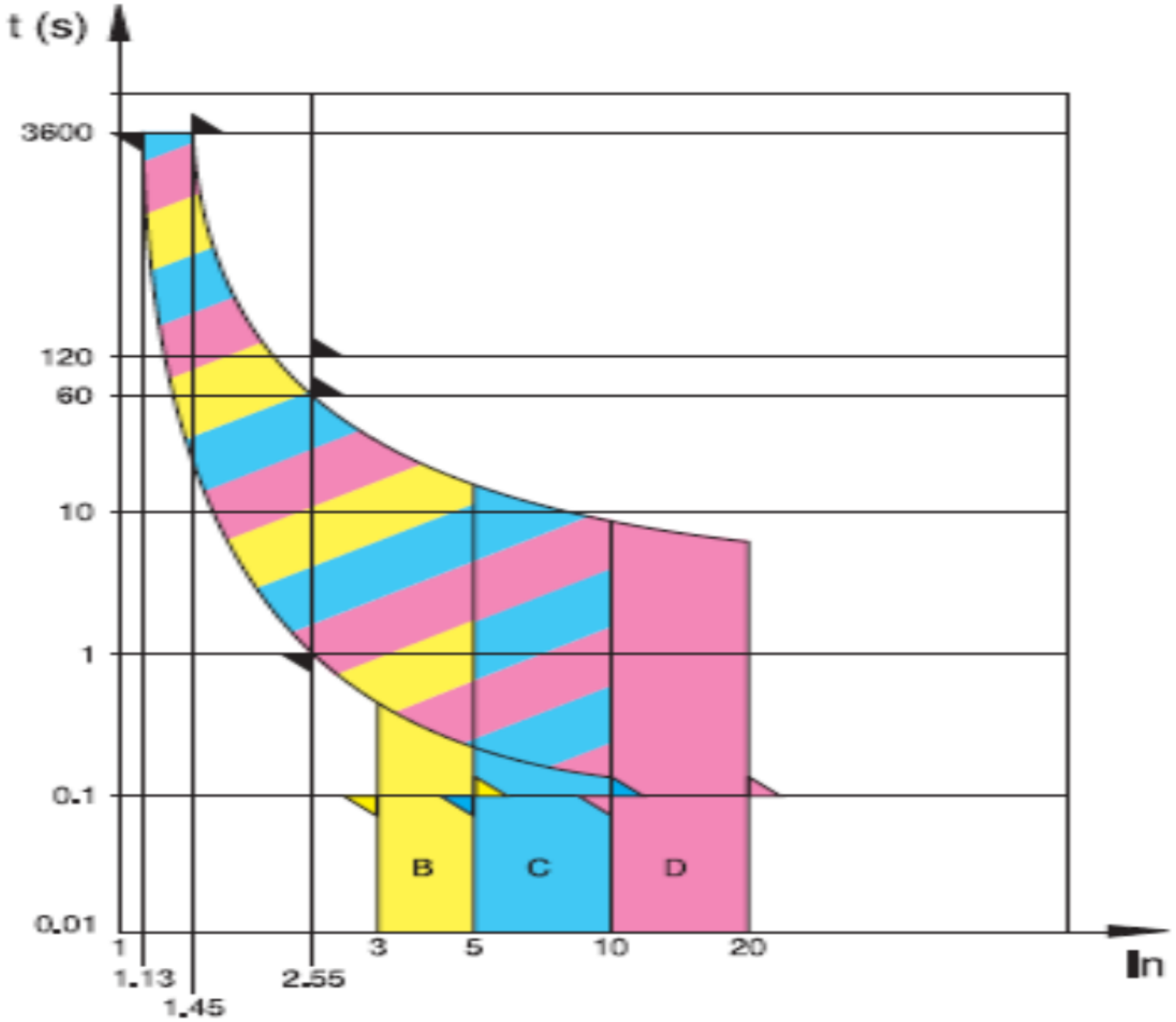
for **60 seconds***

Tripping time (t), 1s < t < 60* s

* 1s < t < 60* s (for *In*≤32 A)

1s < t < 60* s (for *In*>32A)

Tripping curve of MCB



Part 1 – Miniature Circuit Breaker (MCB)

MCB Tripping Characteristic Testing (MS IEC 60898-1)

- Time-current characteristic
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- Instantaneous tripping
  - at 5 *In* (Type C)
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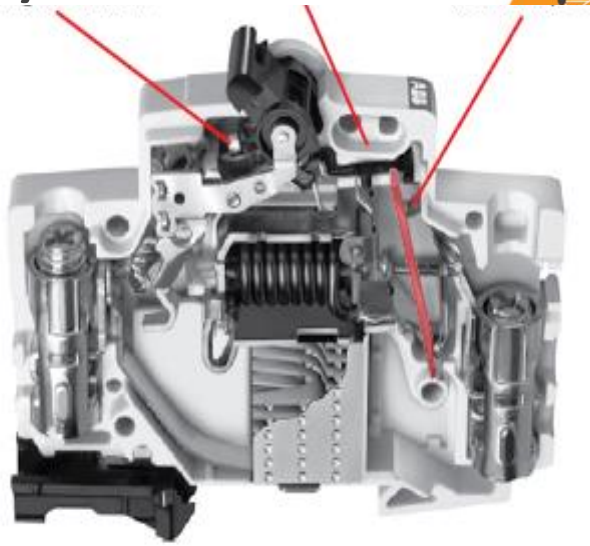

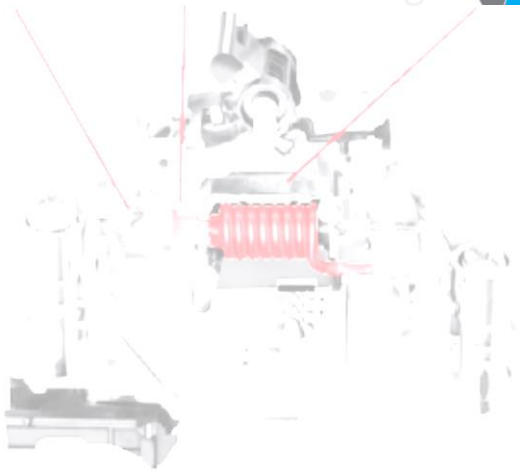

Part 1 – Miniature Circuit Breaker (MCB)

MCB Tripping Characteristic Testing (MS IEC 60898-1)

- Time-current characteristic
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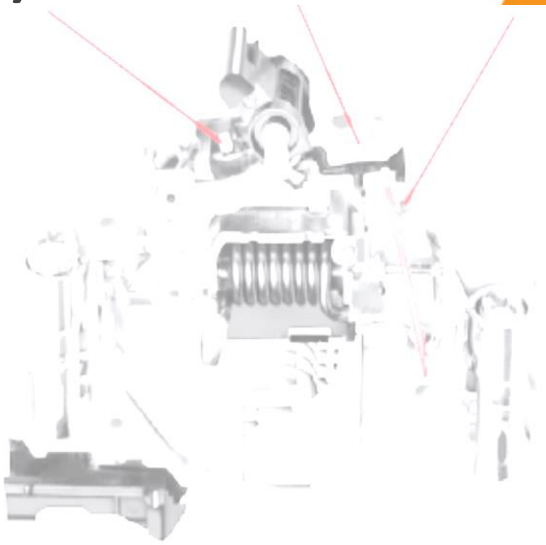
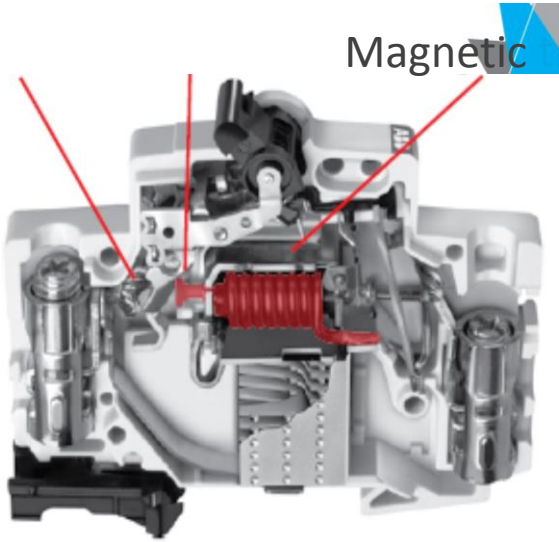
  - at 5 *In* (Type C)
  - at 10 *In* (Type C)

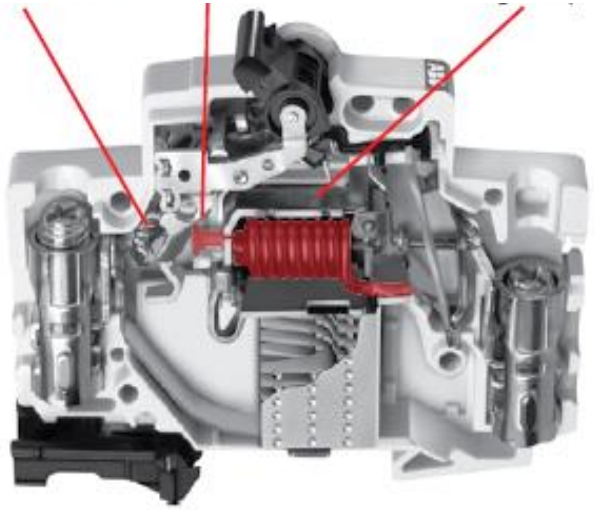




Part 1 – Miniature Circuit Breaker (MCB)

Instantaneous tripping

Magnetic trip



Loading with **5 times** rated current (*In*)

i.e 10 A MCB;

=5 x 10 A

= 50 A

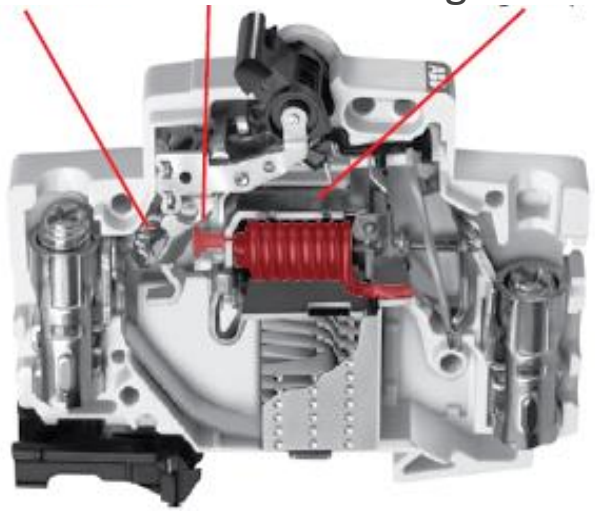
50 A for **0.1 seconds**

No-tripping

Part 1 – Miniature Circuit Breaker (MCB)

Instantaneous tripping

Magnetic trip



Loading with **10 times** rated current (*In*)

i.e 10 A MCB;

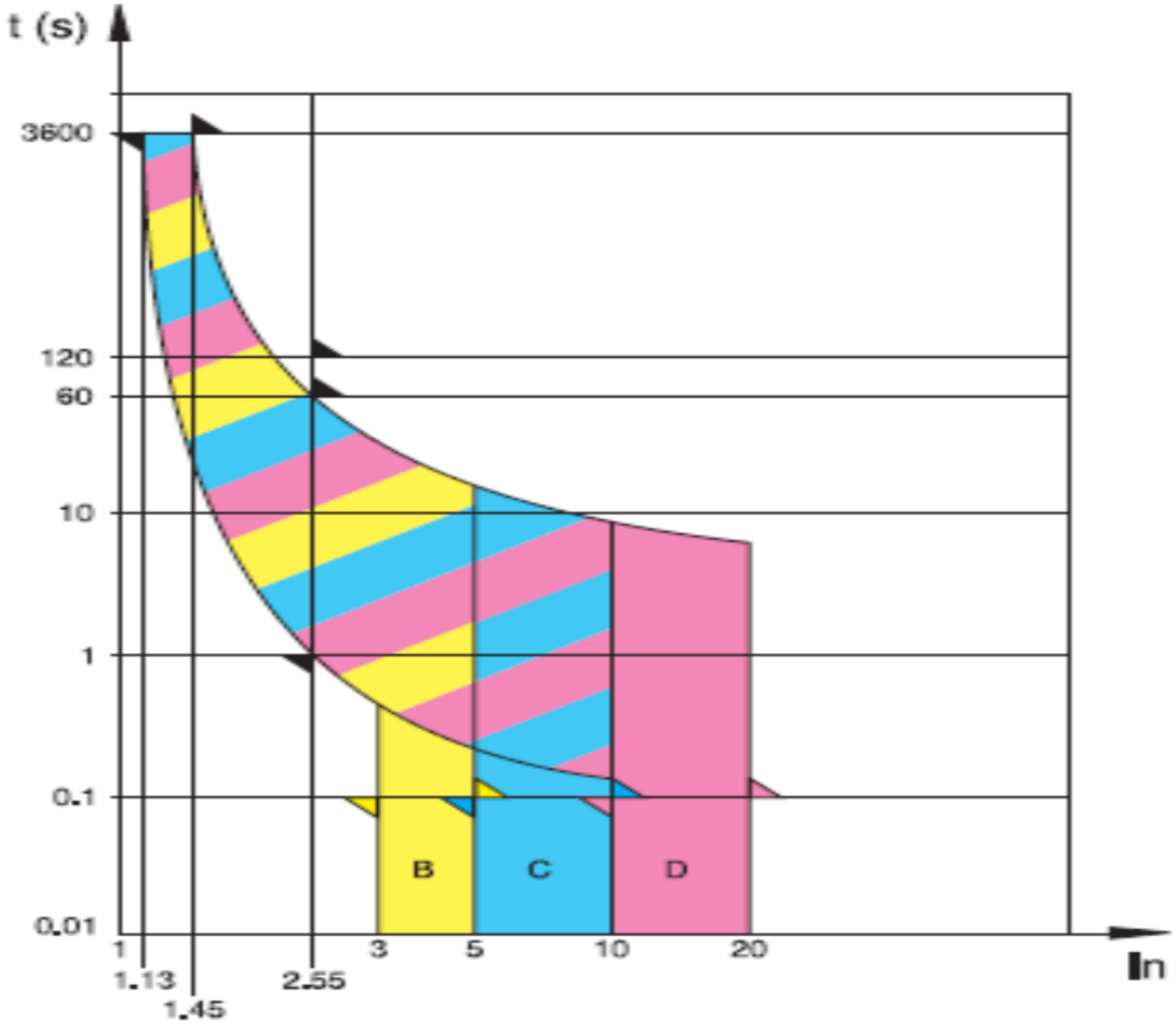
=10 x 10 A

= 100 A

100 A for **0.1 seconds**

Shall Trip within 0.1 s (< 0.1 s)

Tripping curve of MCB



Time-current operating characteristic

Test	Type	Test current	Initial condition	Limits of tripping or non-tripping time	Result to be obtained	Remarks
a	B, C, D	1,13 I_n	Cold [a]	$t \leq 1$ h (for $I_n \leq 63$ A) $t \leq 2$ h (for $I_n > 63$ A)	No tripping	
b	B, C, D	1,45 I_n	Immediately following test a	$t < 1$ h (for $I_n \leq 63$ A) $t < 2$ h (for $I_n > 63$ A)	Tripping	Current steadily increased within 5 s
c	B, C, D	2,55 I_n	Cold [a]	1 s < t < 60 s (for $I_n \leq 32$ A) 1 s < t < 120 s (for $I_n > 32$ A)	Tripping	
d	B C D	3 I_n 5 I_n 10 I_n	Cold [a]	$t \leq 0,1$ s	No tripping	Current established by closing an auxiliary switch
e	B C D	5 I_n 10 I_n 20 I_n [b]	Cold [a]	$t < 0,1$ s	Tripping	Current established by closing an auxiliary switch

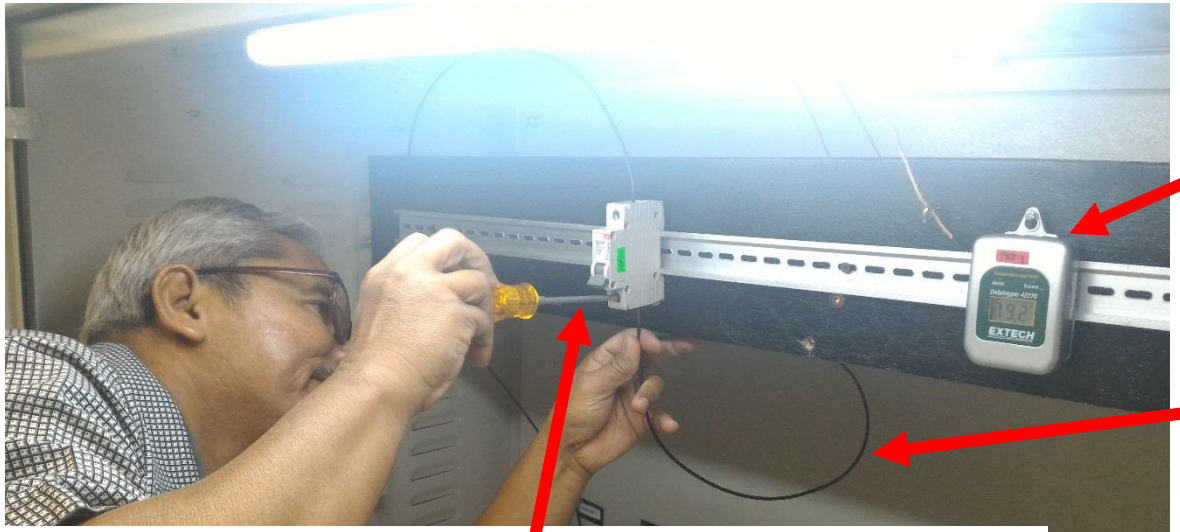
NOTE An additional test, intermediate between c and d, is under consideration for circuit-breakers of type D.

[a] The term "cold" means without previous loading, at the reference calibration temperature.

[b] 50 I_n for special cases.

Part 1 – Miniature Circuit Breaker (MCB)

Before testing, please ensure that;



Tightening torque

Control temperature (°C) and humidity (%)

Cable size

Table 10 – Screw thread diameters and applied torques

Nominal diameter of thread mm	Torque Nm		
	I	II	III
Up to and including 2,8	0,2	0,4	0,4
over 2,8 up to and including 3,0	0,25	0,5	0,5
over 3,0 up to and including 3,2	0,3	0,6	0,6

Cross-sectional areas (S) of test copper conductors corresponding to the rated currents

S mm^2	Values of the rated current I_n A
1	$I_n \leq 6$
1,5	$6 < I_n \leq 13$
2,5	$13 < I_n \leq 20$
4	$20 < I_n \leq 25$

End of Part 1 - MCB

Part 2 – Moulded Case Circuit Breaker (MCCB)

MCCB Opening Under Overload Testing (MS IEC 60947-2)

Inverse time-delay operation

- at 1.05 *In*
- at 1.30 *In*

Part 2 – Moulded Case Circuit Breaker (MCCB)

Characteristic of MCCB

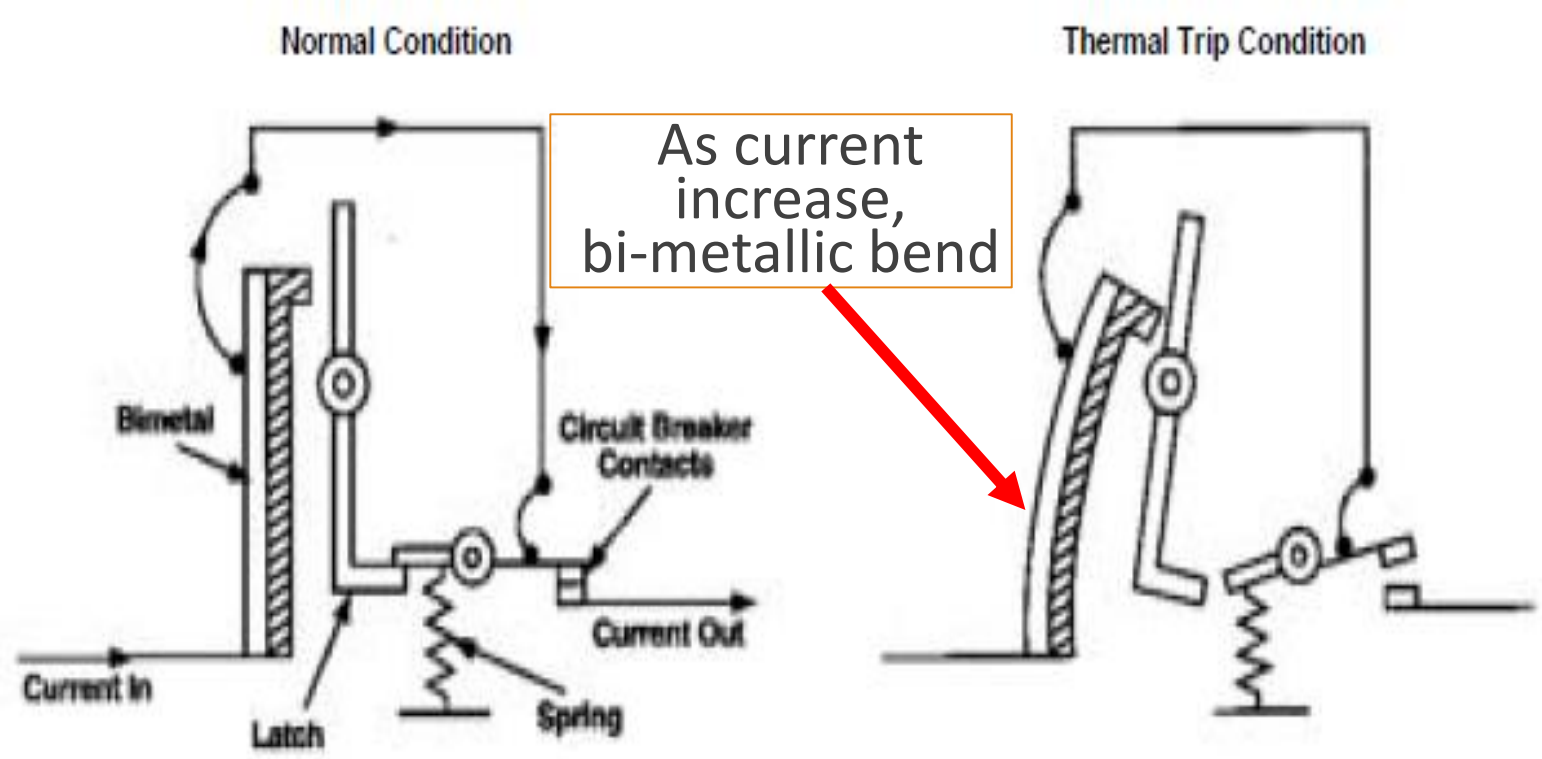
- Type
- Rated value
- Selectivity category
- Releases

Part 2 – Moulded Case Circuit Breaker (MCCB)

- Characteristic of MCCB
  - Type
  - Rated value
  - Selectivity category
  - Releases
    - Shunt release
    - Over-current release
      - Definite-time delay
      - Inverse-time delay
    - Under-voltage release

Part 2 – Moulded Case Circuit Breaker (MCCB)

Inverse-time delay release

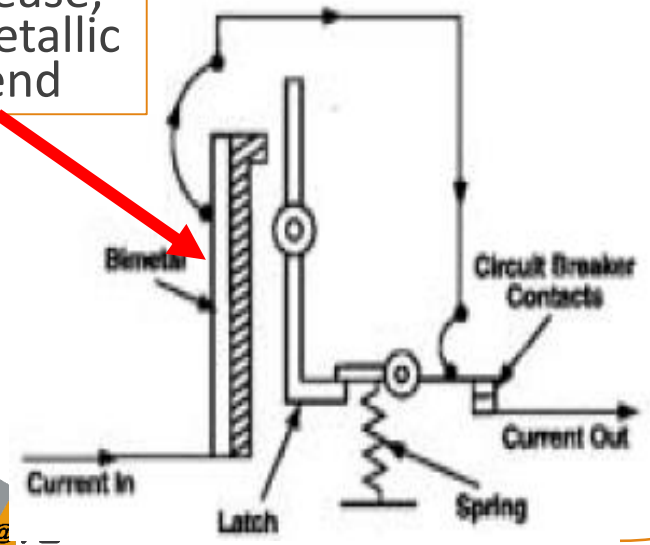


The time delay is dependent on over-current

Part 2 – Moulded Case Circuit Breaker (MCCB)

Inverse-time delay release

As current increase, bi-metallic bend



Loading with **1.05** rated current (*In*)

i.e 100 A MCCB;

=1.05 x 100 A

= 105 A

105 A for **2 hours***

* 1 hour when *In*≤63 A)

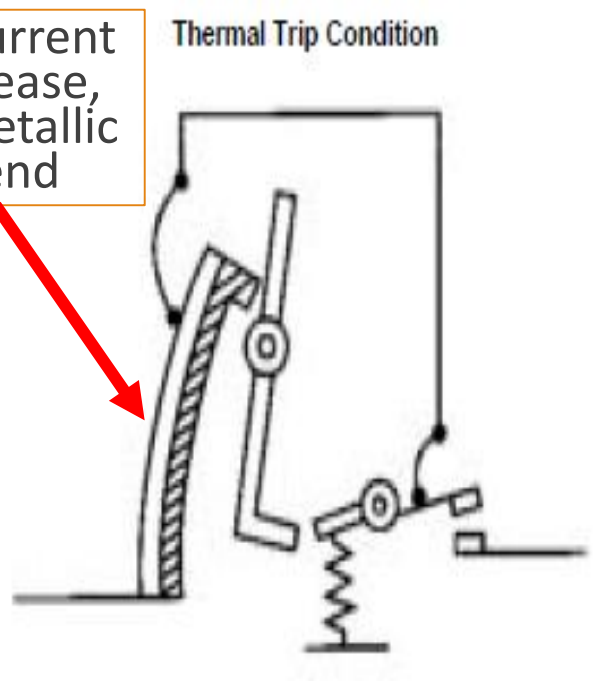
No-tripping

1.05x*In* is a conventional **non-tripping** current

Part 2 – Moulded Case Circuit Breaker (MCCB)

Inverse-time delay release

As current increase, bi-metallic bend



Loading with **1.30** rated current (*In*)

i.e 100 A MCCB;

=1.30 x 100 A

= 130 A

105 A

for **2 hours***

* 1 hour when *In*≤63 A)

Shall Trip within 2 hours*

1.30x*In* is a conventional **tripping** current

Part 2 – Moulded Case Circuit Breaker (MCCB)

To summarize;

100 A MCCB

105 A (1.05xIn) for **2 hours**

No-tripping

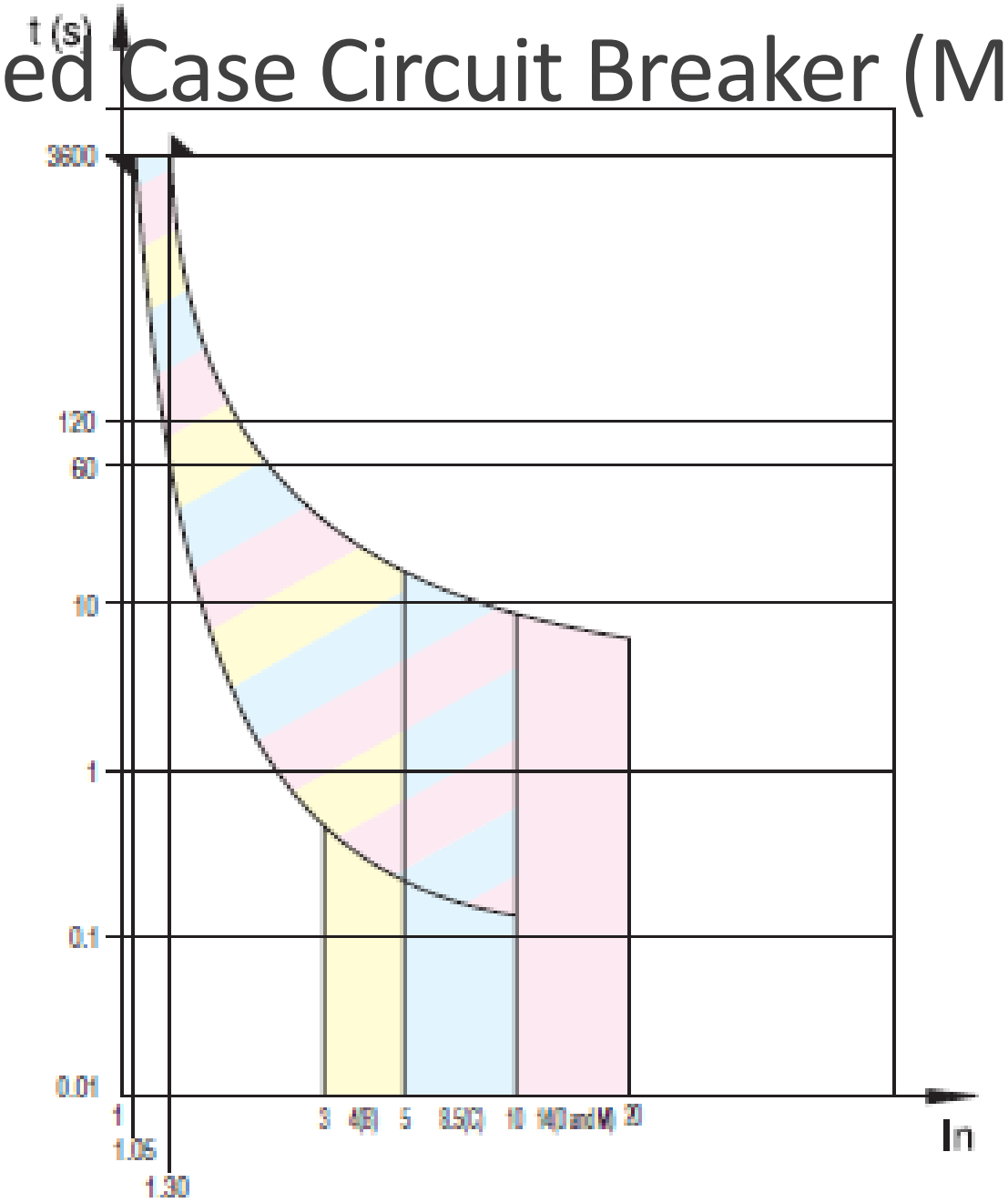
Immediately after test at 1.05xIn, current steadily increased to 1.30xIn within 5 seconds

130 A (1.30xIn) for **2 hours**

Shall Trip within 2 hours

Part 2 – Moulded Case Circuit Breaker (MCCB)

Time-current curve characteristic of MCCB



Part 2 – Moulded Case Circuit Breaker (MCCB)

Time-current operating characteristic

Table 6 – Characteristics of the opening operation of inverse time-delay over-current opening releases at the reference temperature

All poles loaded		Conventional time
Conventional non-tripping current	Conventional tripping current	h
1,05 times current setting	1,30 times current setting	2 [a]
[a] 1 hour when $I_n \leq 63$ A		

References

1. MS IEC 60364 series - Low-voltage electrical installations
2. MS IEC 60898-1 - Electrical accessories - Circuit-breakers for overcurrent protection for household and similar installations - Part 1: Circuit-breakers for a.c. operation
3. MS IEC 60947-2 - Low-voltage switchgear and controlgear - Part 2: Circuit-breakers