Minimise Downtime by Coordination of your Electrical Distribution Network

a brand of Schneider Electric

Merlin Gerin

LV protection coordination: How to optimize your electrical installation

I. Electrical distribution optimization

II. Low Voltage example: supply of office buildings in an industrial environment

III. Focus on enhanced discrimination

IV. Panorama of documents and tools

V. Conclusion

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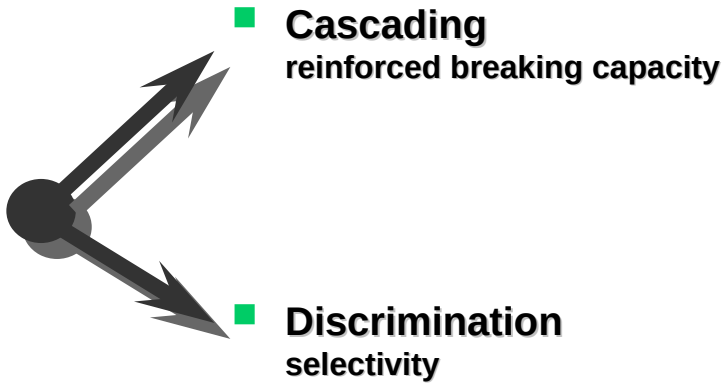
AS 3858 ➡ IEC 947-2 = AS 60947-2

The standard for Low Voltage Switchgear
&
Control Gear Circuit Breakers

APPENDIX A = Details Test Conditions for Co-Ordination

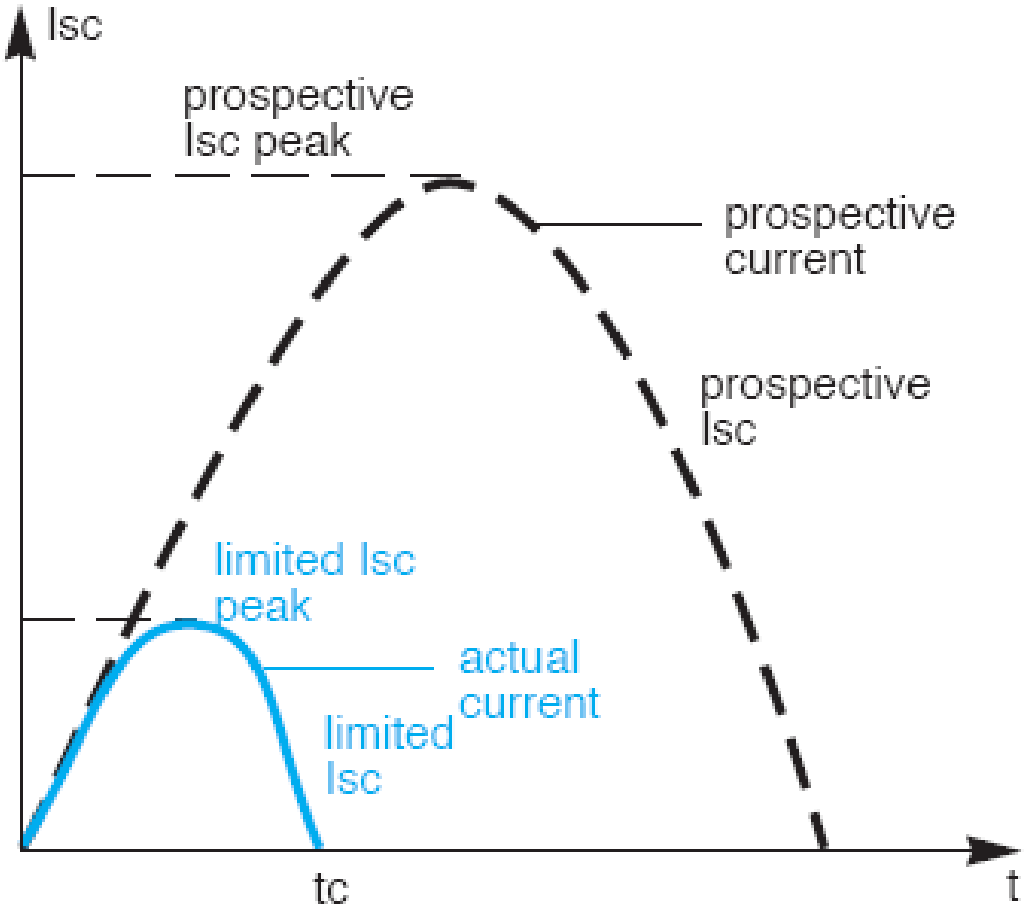


I. Electrical distribution optimization

Introduction

- **Current limitation: reduction of harmful effects**
  - The actual short-circuit current is limited by the fast opening of the circuit breaker's contacts
- **Cascading: enhanced breaking capacity**
  - The upstream current limiting circuit-breaker (or fuse) increases the breaking capability of the downstream circuit-breaker.
  - Reduction of the cost of the switchgear Supply is maintained on the rest of the installation
- **Discrimination: for better continuity of service**
  - Only the circuit-breaker placed immediately upstream of a fault will trip
- **Coordination is defined in AS60947-2**

What is current limitation ?



- **Current Limitation is the ability of a circuit breaker to limit the actual current to a value far smaller that the estimated prospective fault current.**

Current limitation
-How does it work?

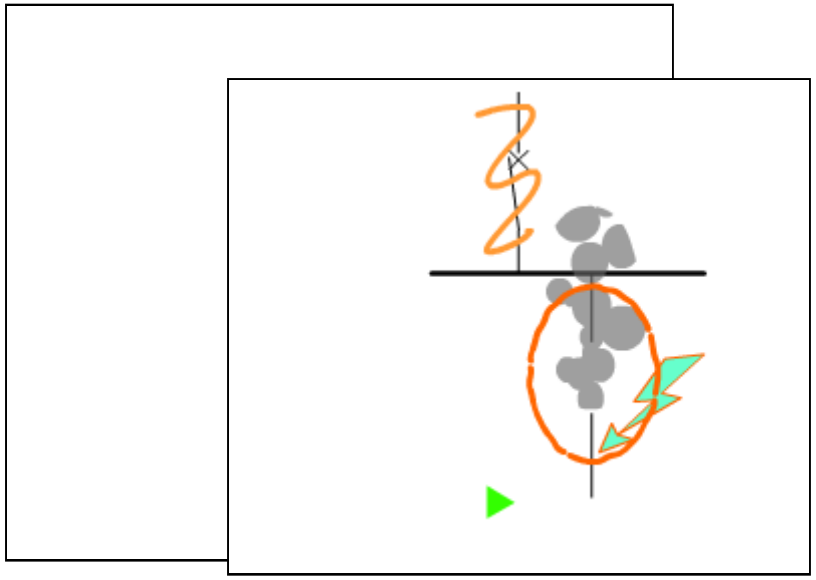
- **Reduced peak current reduces the mechanical stress on the conductors and support structures during short circuits**
  - less mechanical damage
  - reduced maintenance requirements after short circuits

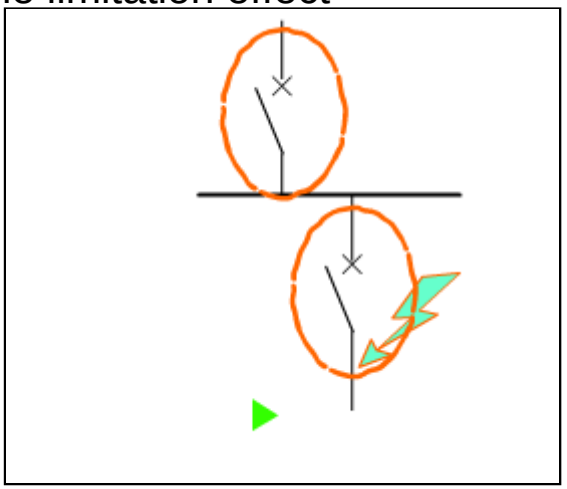
- **Reduced energy dissipation reduces the heating effects on conductors, resulting the heating stress to insulators**
  - less damage to conductors
  - extended life of installation

I. Electrical distribution optimization

Introduction

- **Cascading: enhanced breaking capacity**
  - The upstream current limiting circuit-breaker increases the breaking capacity of the downstream circuit-breaker
  - Both the upstream fuse or circuit breaker need to open to provide the limitation effect





Exercise:
What is the enhanced breaking capacity of a C60N when located downstream of an NS160H MCCB ___kA

CASCADING TABLE

380/415v

upstream Compact		NS 100N	NS 100H	NS 100L	NS 160N	NS 160H	NS 160L
rated breaking capacity		25	70	150	36	70	150
downstream	rated brk cap.	enhanced breaking capacity					
C60N	6	25	30	30	25	30	30
C60H(≤40A)	10	25	50	50	30	50	50
C60H(50-63A)	10	25	40	40	30	40	40
C120N	10	25	25	25	25	25	25
C120H	15	25	25	25	25	25	25
NG125H	36		50	100		50	100

I. Electrical distribution optimization

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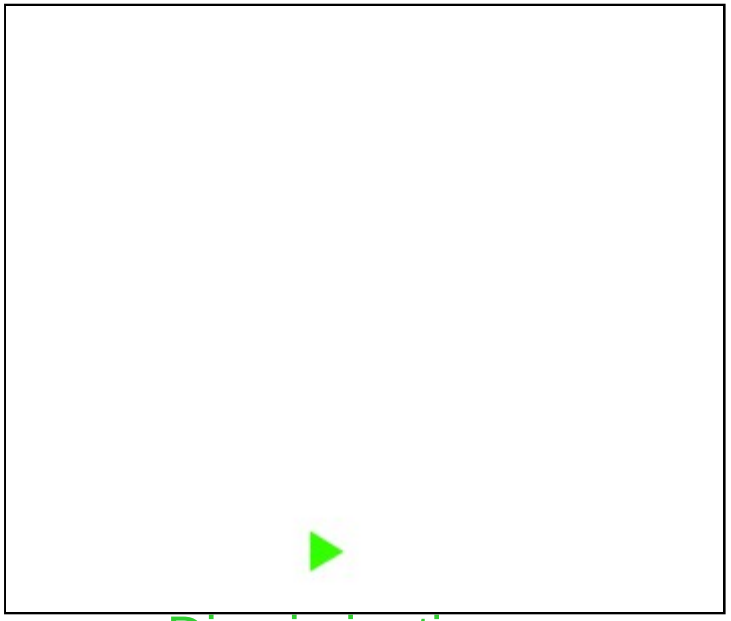
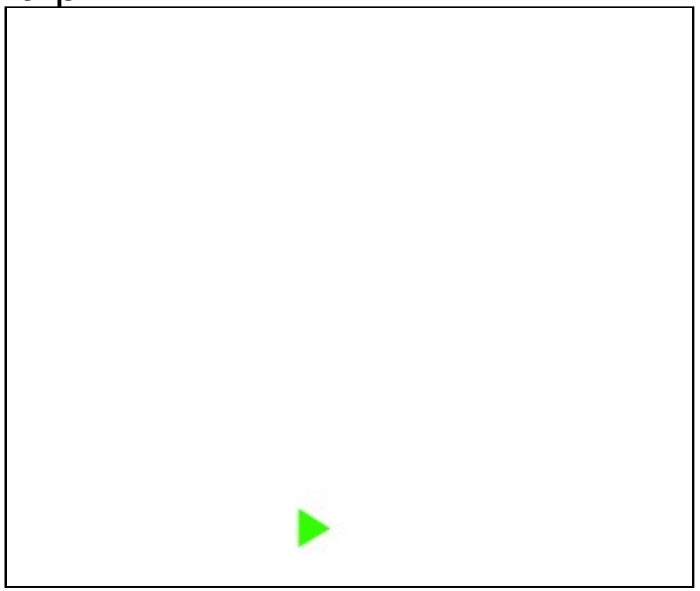
- **Discrimination: for better continuity of service**
  - Only the circuit-breaker placed immediately upstream of a fault will trip



Discrimination



No discrimination

TECHNIQUES FOR DISCRIMINATION

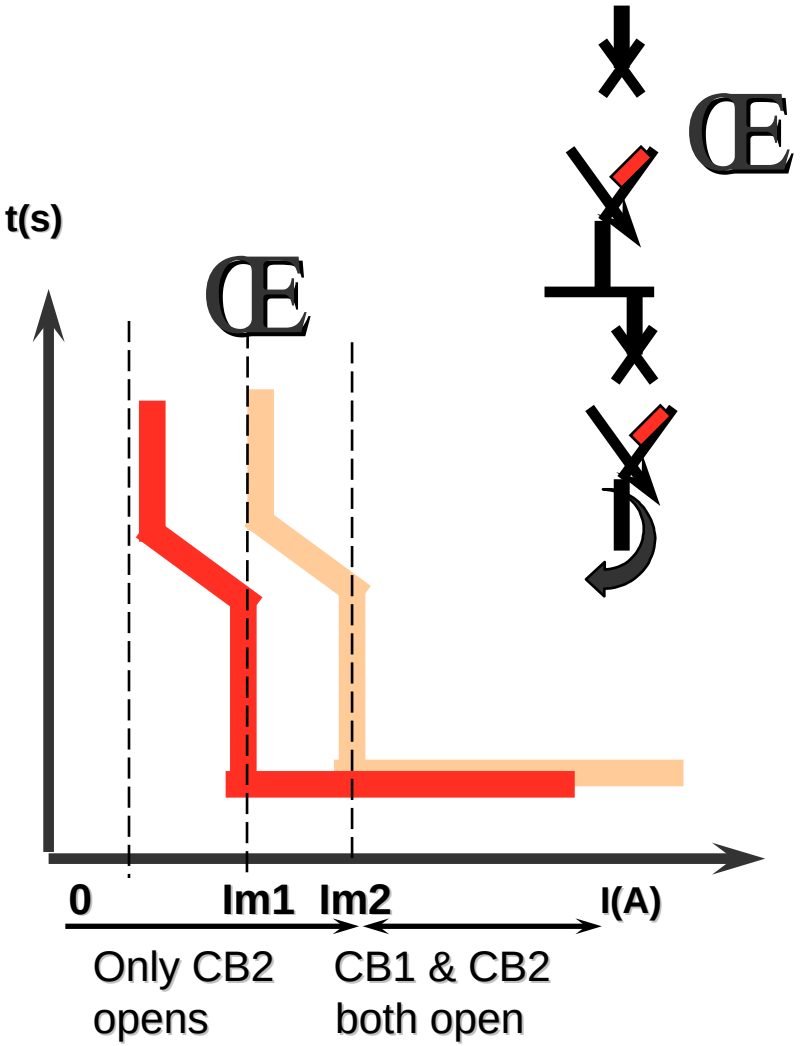
CURRENT

TIME

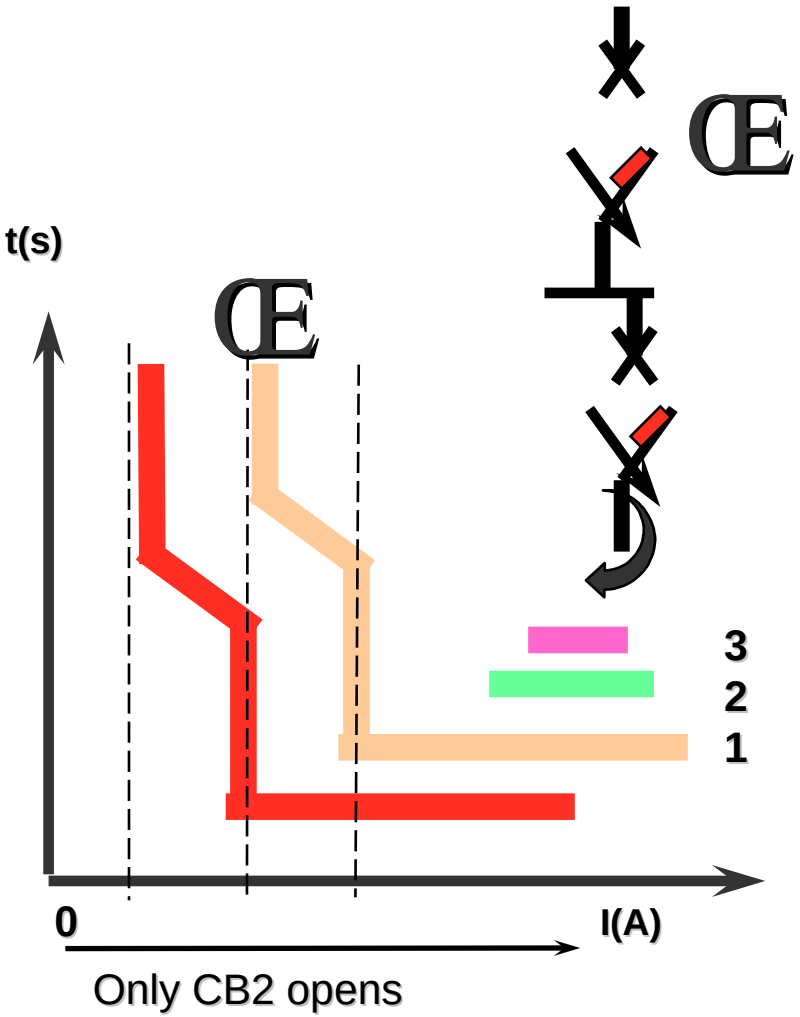
ENERGY

ZONE SELECTIVE INTERLOCKING

DISCRIMINATION TECHNIQUES
Current Discrimination

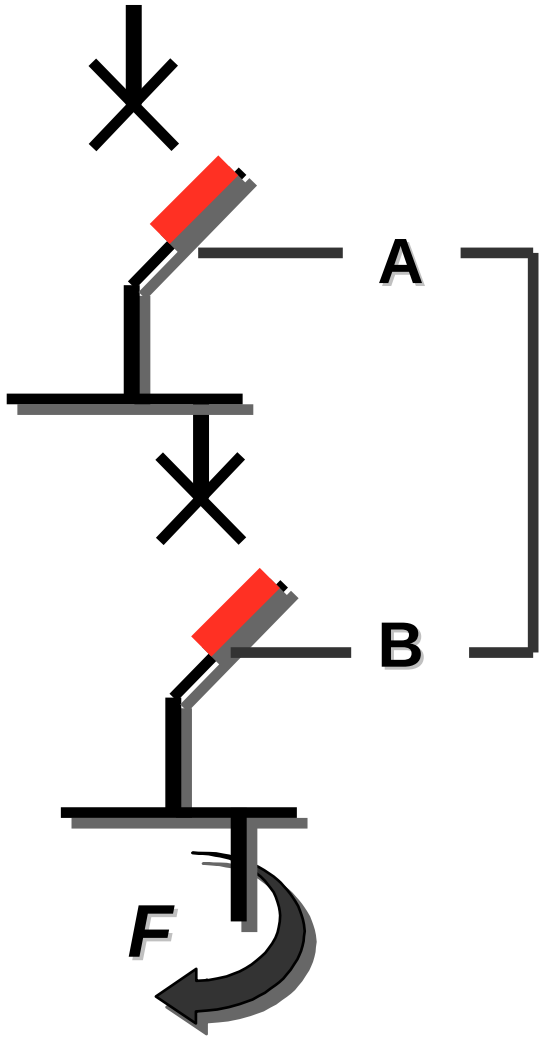


- partial discrimination up to value of Im2, only CB2 will operate (assuming long time discrimination)
- at Im2 both devices may operate, therefore discrimination referred to as partial



DISCRIMINATION TECHNIQUES
Time Discrimination

- **total discrimination - the time delay on CB1 is one of several positions that can be selected.**
- **‘selective type’ trip units eg. CB1 has type micrologic 5.0 trip unit**



DISCRIMINATION TECHNIQUES

Zone Selective Discrimination

- total discrimination with time delays(short circuit & earth fault only)
- pilot wire interconnects circuit breakers of the installation
- for a fault between CB A & B, relay A will trip instantaneously reducing stress on the network.

Discrimination Curve Study Limitations

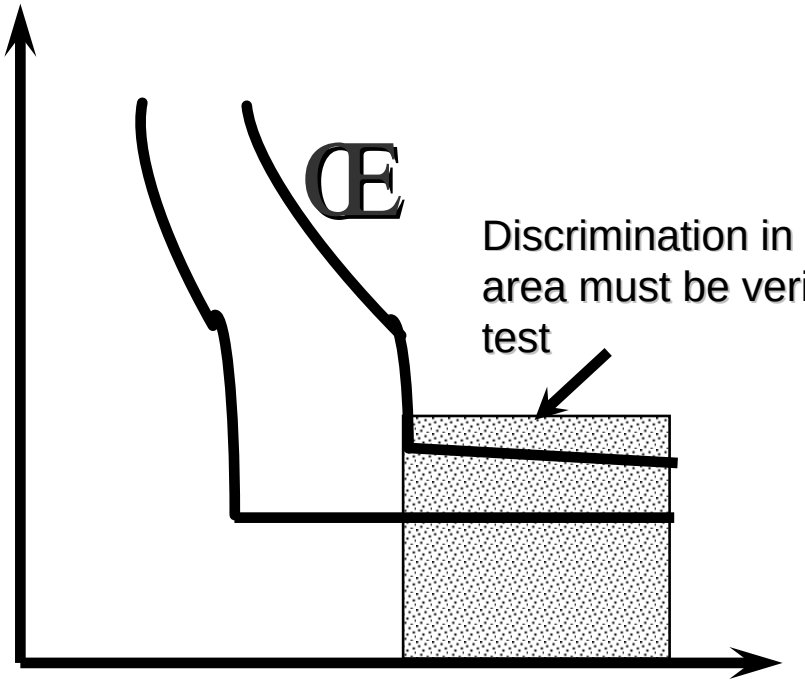
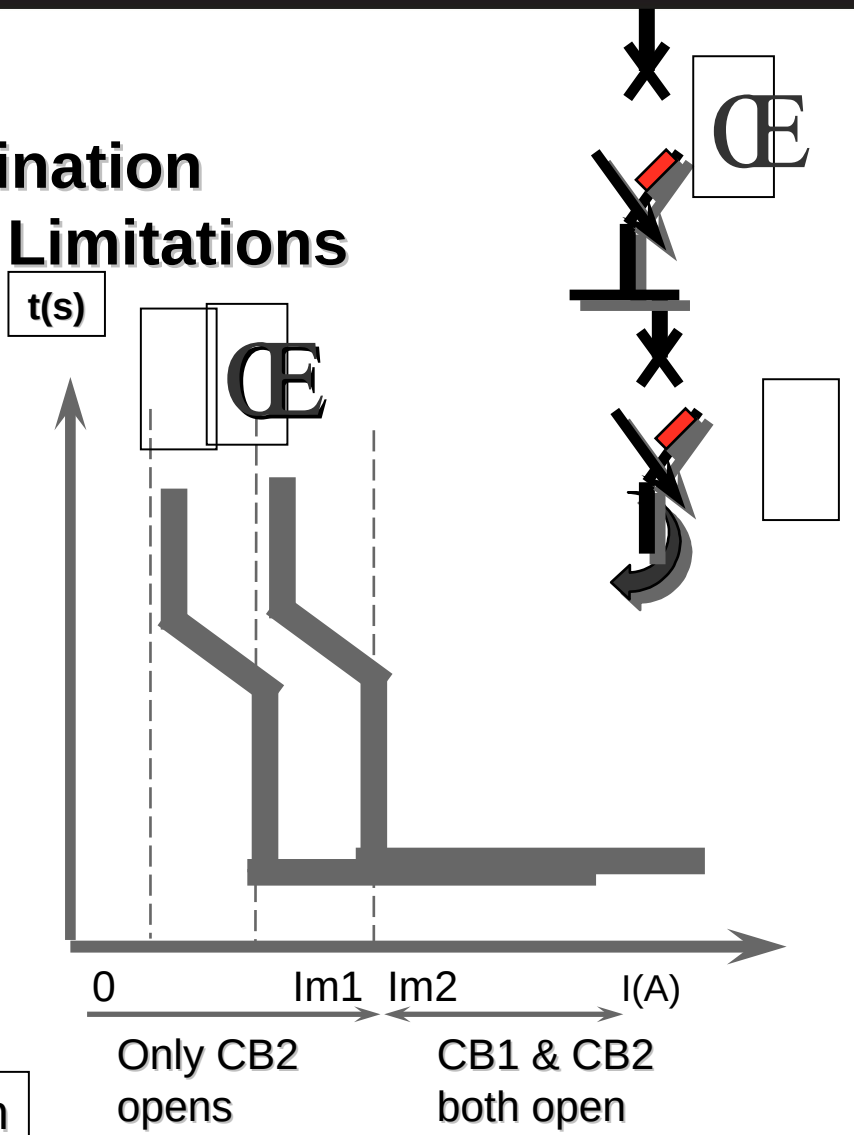


Figure A.2 (AS3947.2)

Short Circuit Tolerance not normally shown



Discrimination Table

upstream breaker: Compact NS100 to NS250

upstream circuit breaker: Compact NS100 to NS 250

upstream		NS100N/H/L		NS160N/H/L		NS250N/H/L		
		trip unit TM-D						
downstream	rating (A).	80	100	125	160	160	200	250
DPN		0.63	0.8	T	T	T	T	T
C60N	≤63	0.63	0.8	T	T	T	T	T
C60H	≤40	0.63	0.8	T	T	T	T	T
C60H	50-63		0.8	T	T	T	T	T

NOTE: Selectivity limit is in kA

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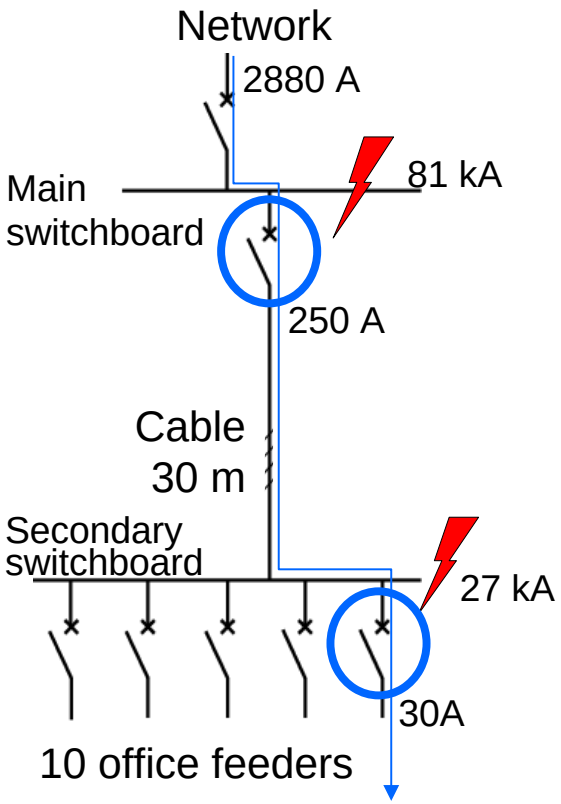
II. Low Voltage example: supply of office buildings in an industrial environment

Supply of office buildings in an industrial environment



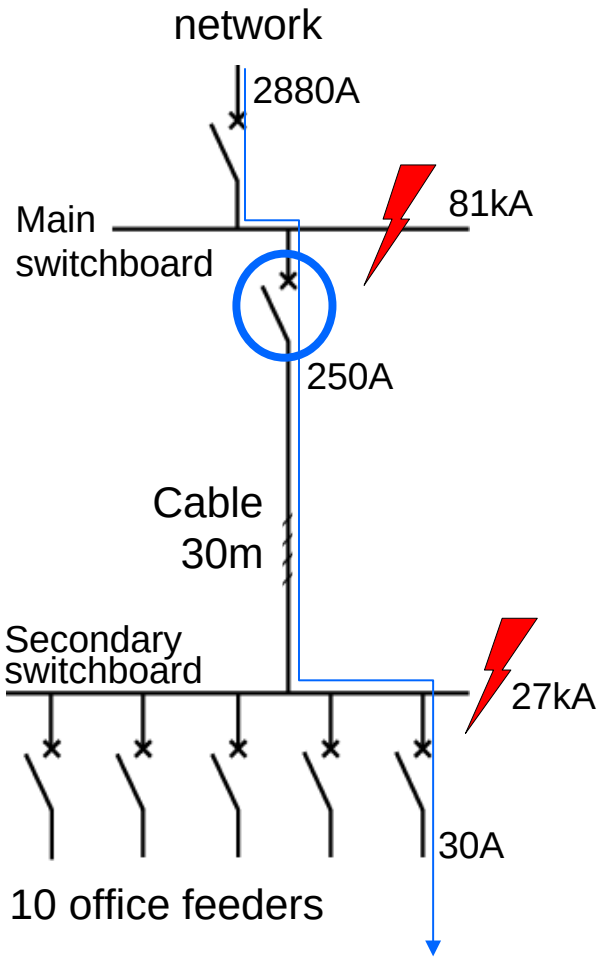
- **Installation characteristics:**
  - 2x1600kVA in parallel, 415V
  - MEN system

- **Circuit-breaker selection approach**
  - **Basic selection**, function of performance and current rating
  - Implementation of **cascading**
  - **Discrimination** check

Selection of Main Switchboard circuit breaker

LV Catalogue

Compact NS250 L

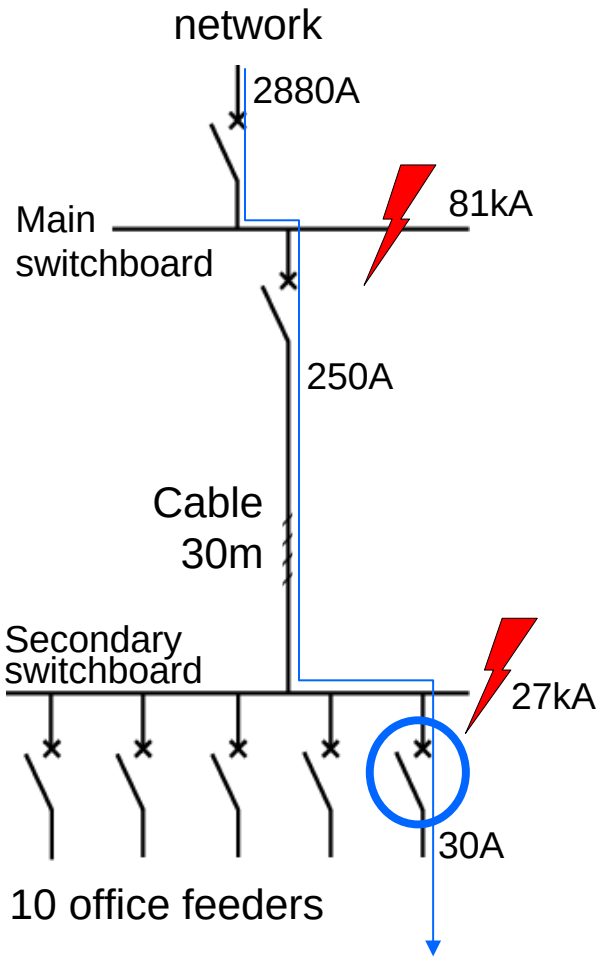


Compact NS100 to 630

Breaking capacity Icu at 415 V

	NS100	NS160	NS250	NS400	NS630
L 150 kA	■	■	■	■	■
H 70 kA	■	■	■	■	■
SX 50 kA	■	■	■		
N 50 kA				□	□
N 36 kA	□	□	□		
NE 25 kA					

Selection of "office feeders" circuit-breakers



LV catalogue

ratings	type	curves	magnetic threshold In	breaking capacity at 415 V (kA) 16	25	36	50
80 to 125	NG125a	C	8				
10 to 125	NG125N	C	8				
32A	NG125H	C	8				
10 to 80	NG125L	B, C, D	4 - 8 - 12				

NG125H 32A

Implementation of cascading

LV catalogue

LV Distribution Guide

Upstream		Compact	NS250N	NS250SX	NS250H	NS250L
Rated breaking capacity kA			36	50	70	150
Downstream		rated brk.cap.kA	enhanced breaking capacity kA			
Multi 9	C60N	6	25	30	30	30
Sq D	QOE	10	25	30	30	30
	C60H (⩽ 40A)	10	30	40	40	40
	C60H (50-63A)	10	30	30	30	30
	C120N/H	10/15	25	25	25	25
	NG125H	36		50	50	100
	NG125LMA	50		50	70	150

- Breaking capacity NG125H alone: 36kA
- Breaking capacity of NG125H with upstream NS250L: 100kA
- Requested breaking capacity: 27kA
- Other possible selection: C60N 32A

Discrimination check

LV catalogue

LV Distribution Guide

Upstream		**NS250SX/H/L**		
		50/70/150 kA		
	trip unit			
Downstream	rating	160	200	250
C60N 6 kA	⩽16	30/30	30/30	30/30
or	20 - 25	30/30	30/30	30/30
QOE 10 kA	32 - 40	30/30	30/30	30/30
	50	30/30	30/30	30/30
	63	30/30	30/30	30/30

- Cascading and enhanced discrimination between Compact NS 250L and Multi 9 C60N 32A **up to 30kA**

Normally Cascading & Discrimination
cannot occur
at the same time

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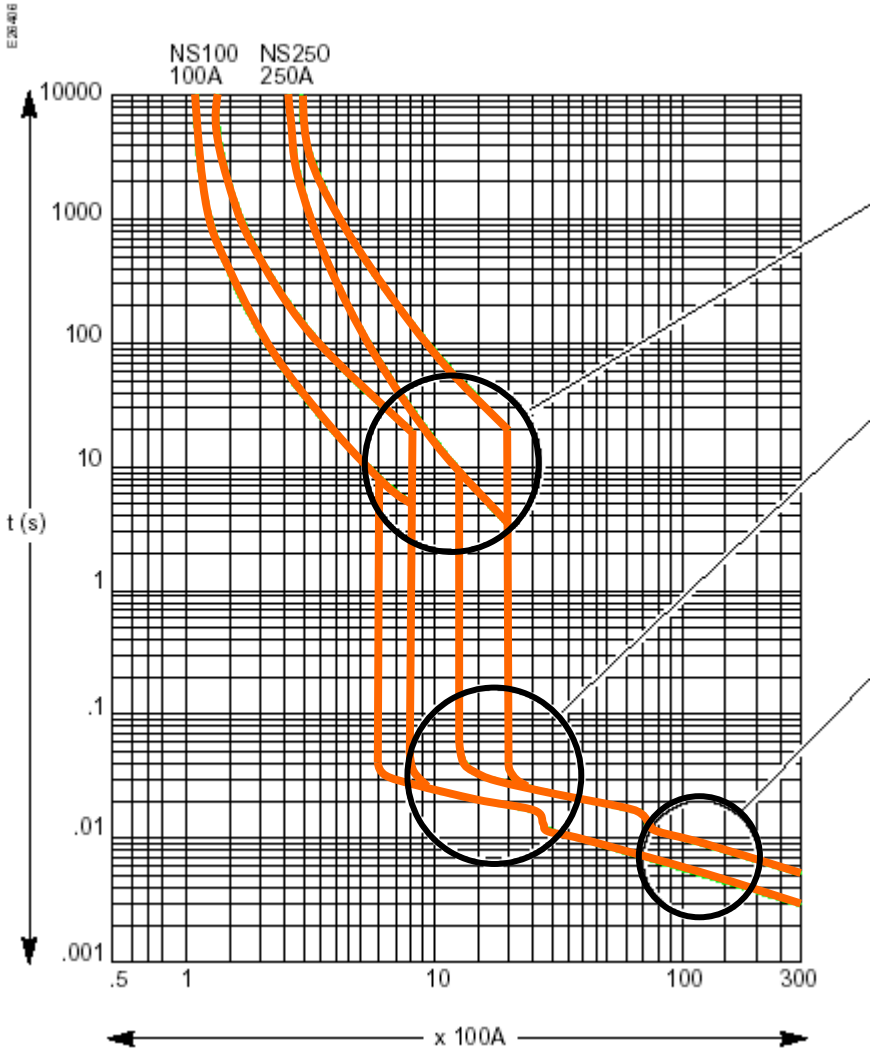
Focus on enhanced discrimination



Use of tripping curves of upstream and downstream circuit-breakers:

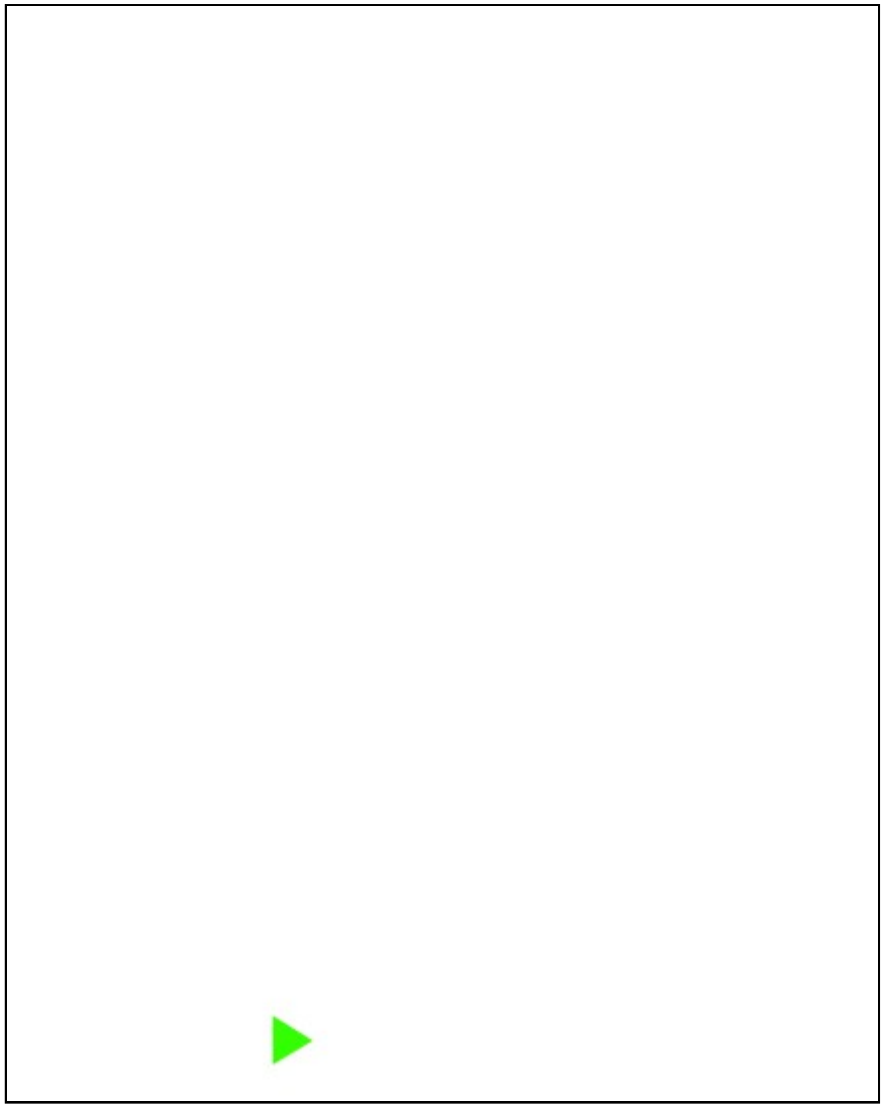
- **current** discrimination
- **time** discrimination
- **energy** discrimination

Focus on enhanced discrimination

A sophisticated technique which combines: current limitation, cascading and discrimination

Only available on circuit breakers (not on fuses !)

- Architecture of one pole of Compact NS circuit-breaker



Focus on enhanced discrimination

A sophisticated technique which combines: current limitation, cascading and discrimination

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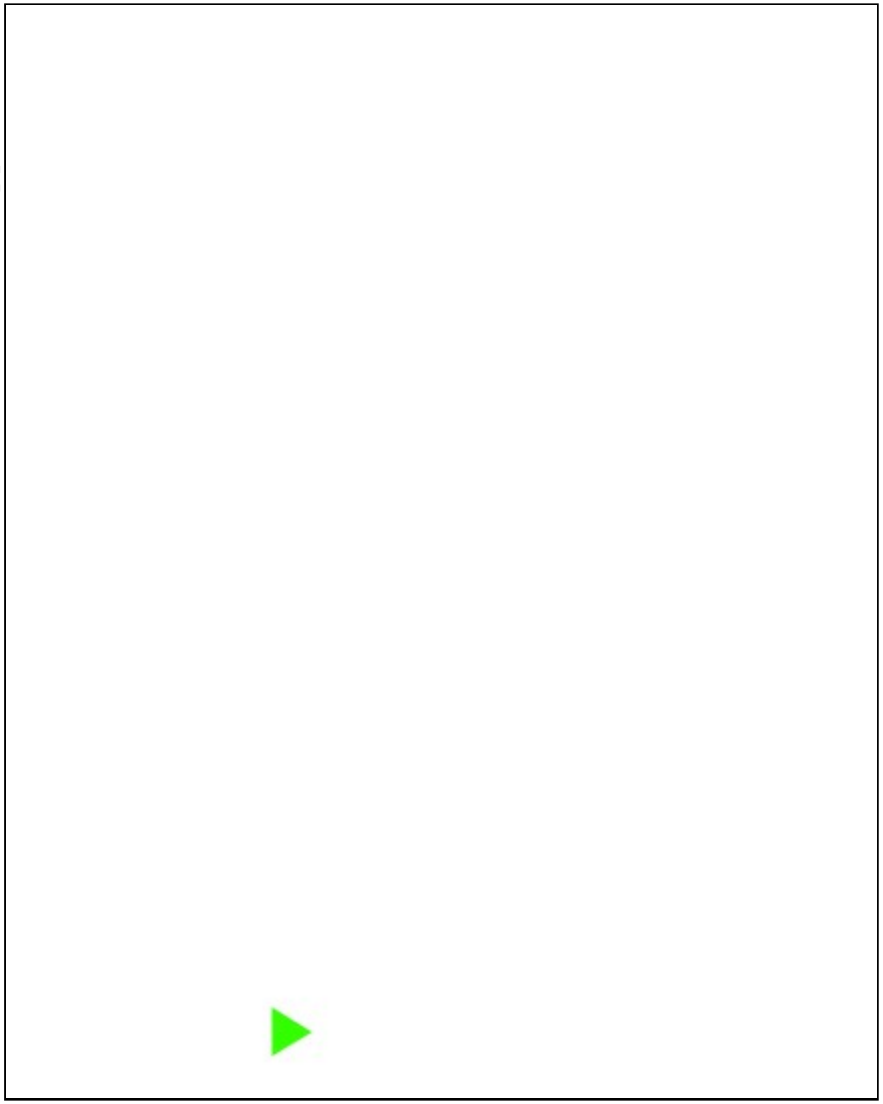
- Short circuit current breaking process in Compact NS circuit-breaker

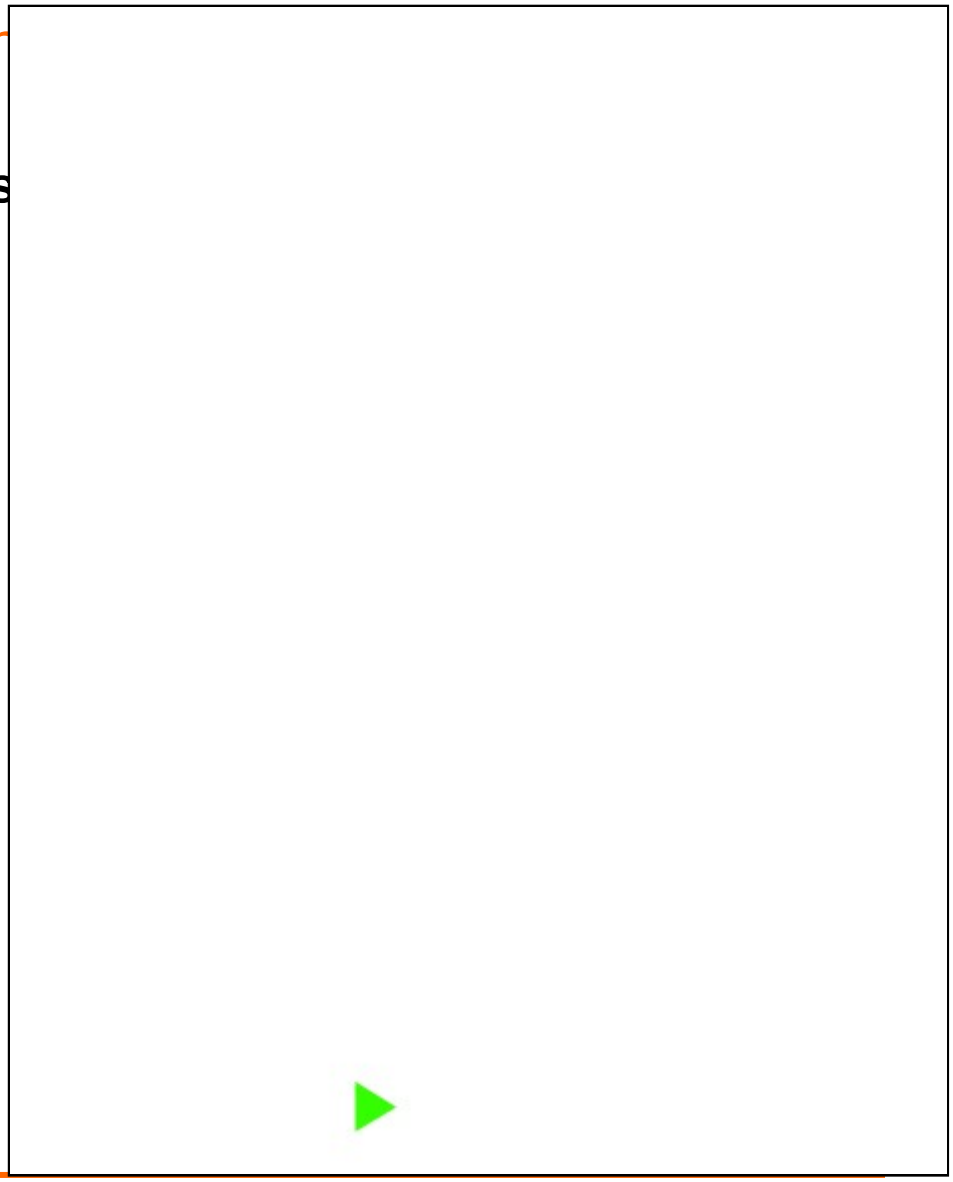


Focus on enhanced discrimination

A sophisticated technique which combines current limitation, cascading and discrimination

Only available on circuit breakers (not on fuses !)

- Discrimination enhanced by cascading



Enhanced Discrimination Table

380/415v
upstream

downstream		trip unit rating	NS 160N 36 kA TM-D 100	NS 160N 36 kA TM-D 125	NS 160N 36 kA TM-D 160
C60N	6kA	≤16	25 / 25	25 / 25	25 / 25
C60N	6kA	20-25	25 / 25	25 / 25	25 / 25
C60N	6kA	32-40	25 / 25	25 / 25	25 / 25
C60N	6kA	50	15 / 25	25 / 25	25 / 25

- for each combination of two circuit breakers, the table indicates the

15/25

- downstream device breaking capacity enhanced by cascading
- selectivity limit

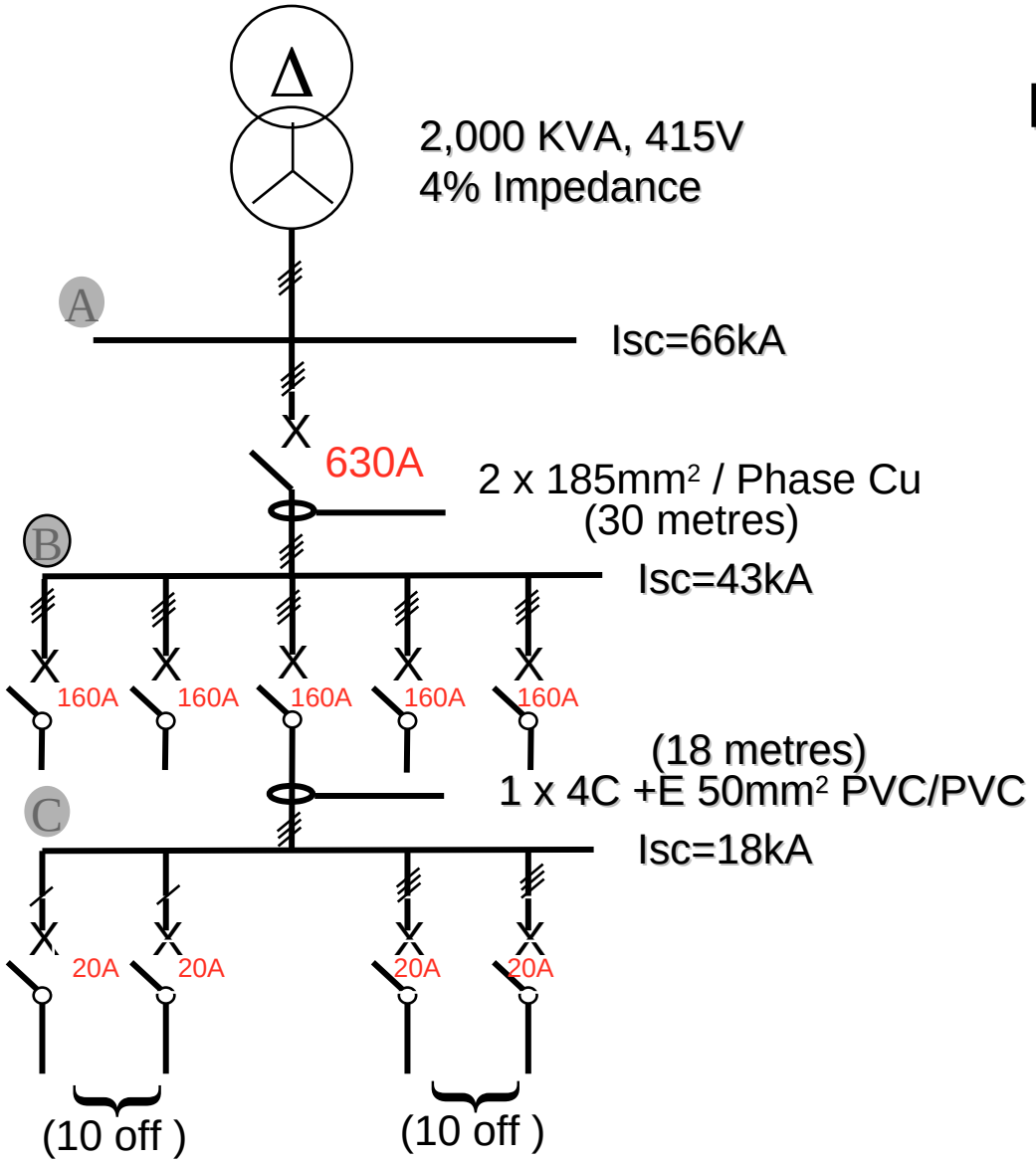
380/415v

Enhanced Discrimination Table

upstream			NS 160N		
			36 kA		
		trip unit	TM-D		
downstream		rating	100	125	160
C60N	6kA	≤16	25 / 25	25 / 25	25 / 25
C60N	6kA	20-25	25 / 25	25 / 25	25 / 25
C60N	6kA	32-40	25 / 25	25 / 25	25 / 25
C60N	6kA	50	15 / 25	25 / 25	25 / 25

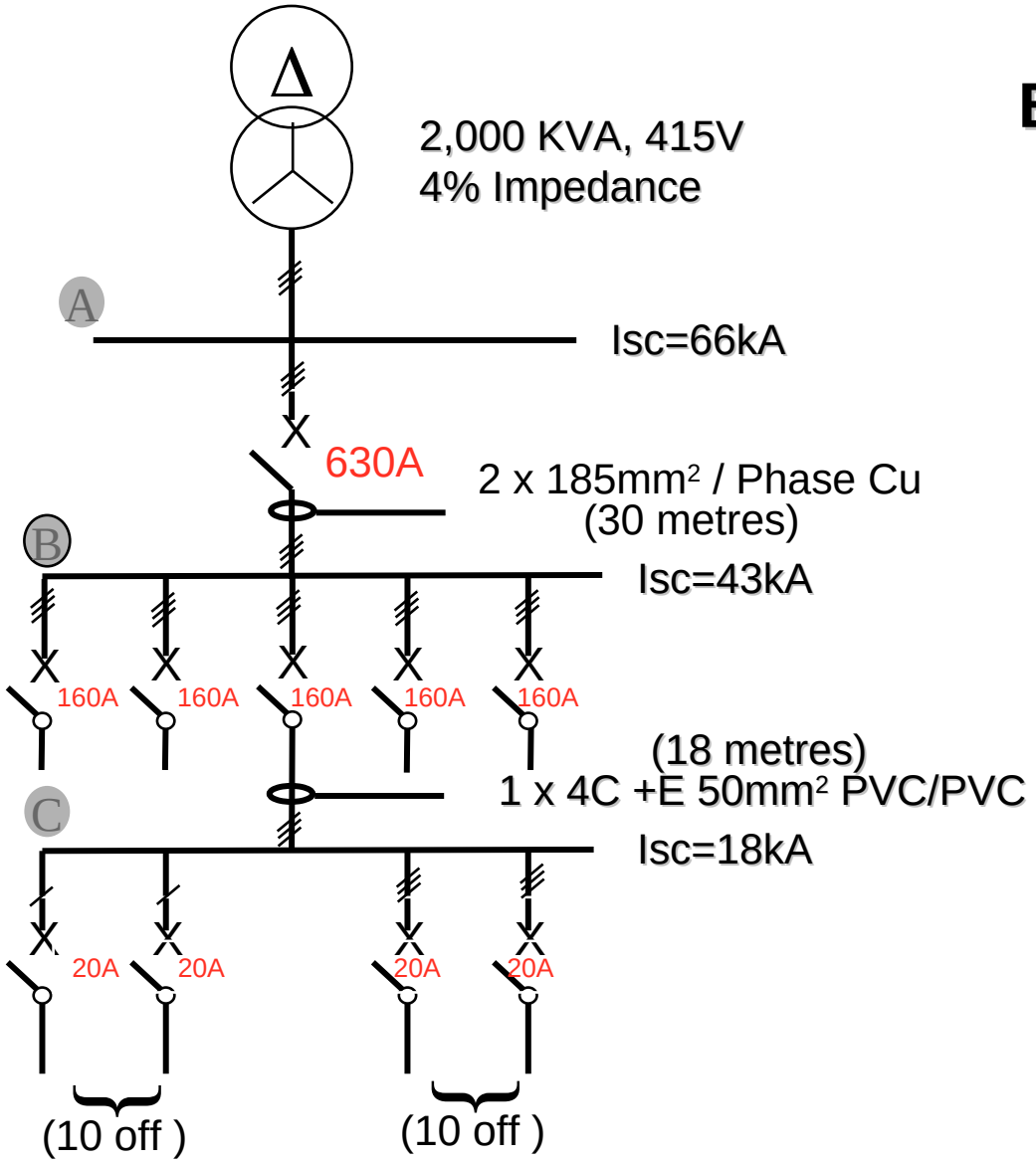
- the shaded background indicates the two values are equal

25/25



Based on Actual Fault Level

NS630H	**$ 2546**
NS160H	**$ 1095 X 5**
NG125H	**$ 432 X 10**
NG125H	**$ 140 X 10**
Total	**$13,741**



Based on Cascading

NS630H	**$ 2546**
NS160N	**$ 877 X 5**
C60N	**$ 138.00 X 10**
C60N	**$30.70 X 10**
Total	**$8618**

Demo centre - DC ED01

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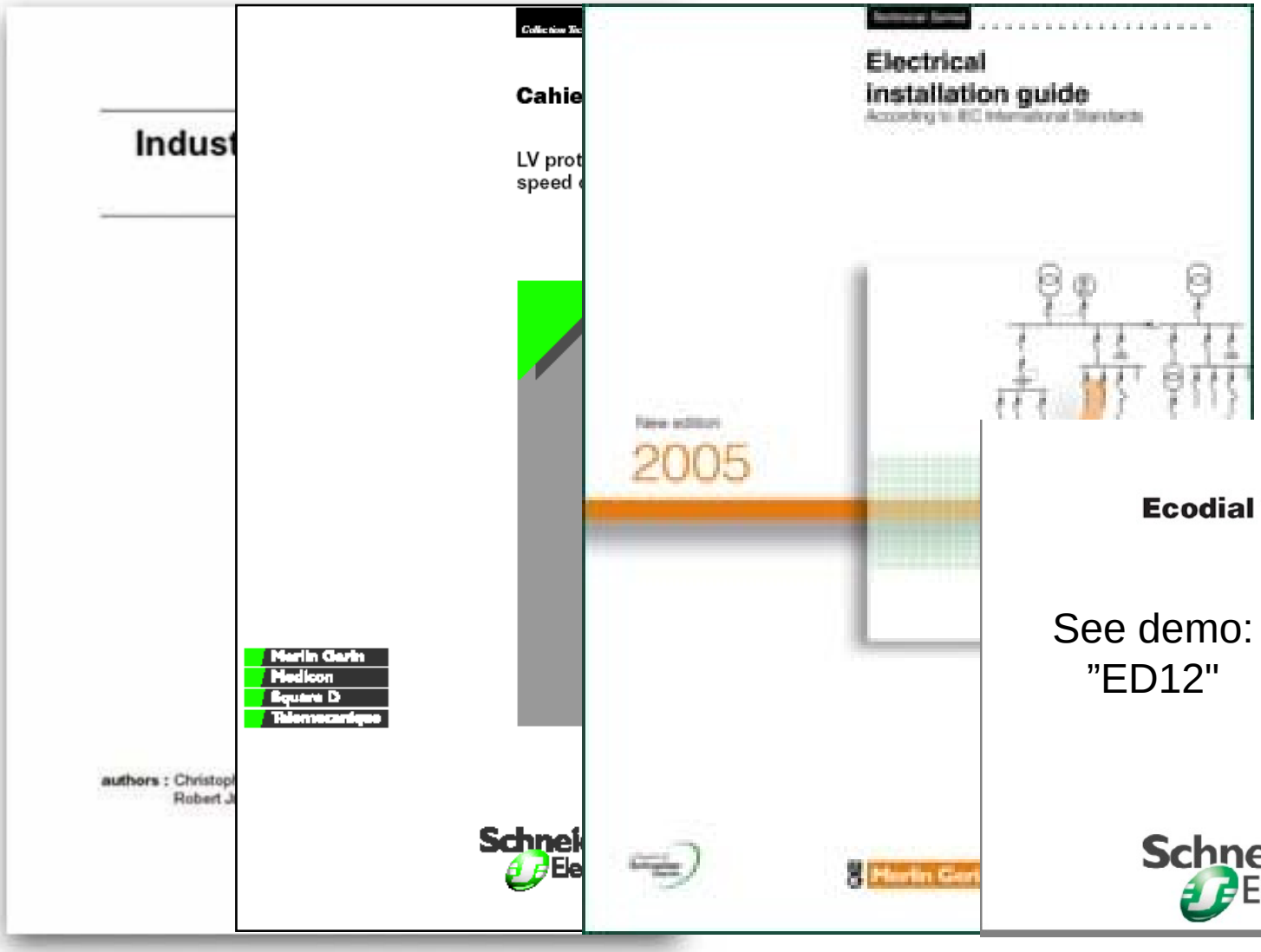
Panorama of documents and tools



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- **Implementation of protection is the central issue in the electrical installation design**

- **Proper coordination of switchgear allows for**
  - Improved safety of people and security of goods,
  - Improved continuity of supply,
  - Reduced installation cost / Operating costs

Thanks to Merlin Gerin
The Guiding System

Questions & answers

Thanks

for your attention