CANSU YILDIRIM & HENNING FRIEDRICH, SEPTEMBER, 2019

Short-Circuit Fault Current Limiters

I_S-limiter and FC-Protector

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Introduction

Importance of a short-circuit study

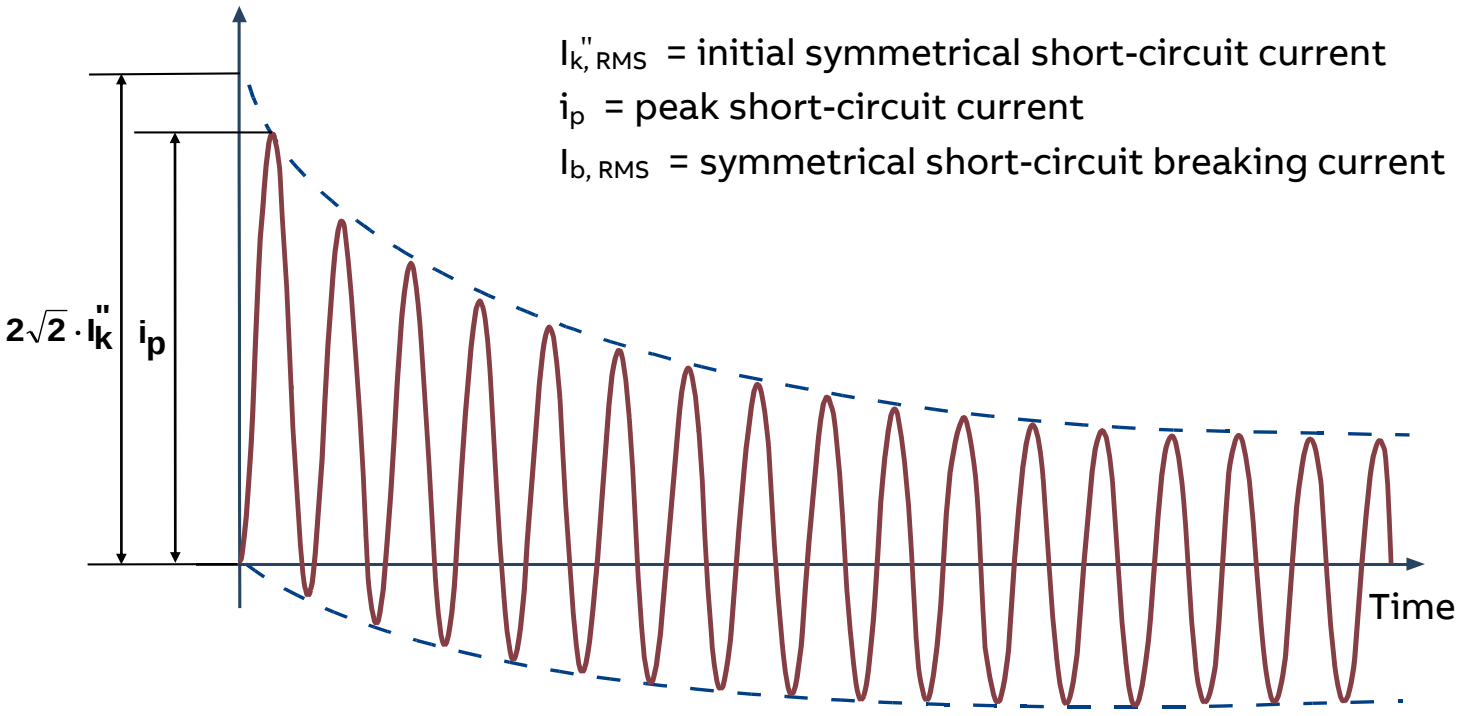
What causes short-circuit faults ?

Short-circuit faults due to

- Insulation deterioration
- Human errors
- Over voltage
- Faults due to birds, lizards, reptiles etc.

How to make sure that the complete system is safe ?

- Perform a short-circuit study
- Simulate short-circuit at different buses
- Select equipments rated higher than maximum short-circuit in a network / sub-system



$I''_{k,RMS}$ = initial symmetrical short-circuit current

i_p = peak short-circuit current

$I_{b,RMS}$ = symmetrical short-circuit breaking current

Current Curve of a short-circuit current

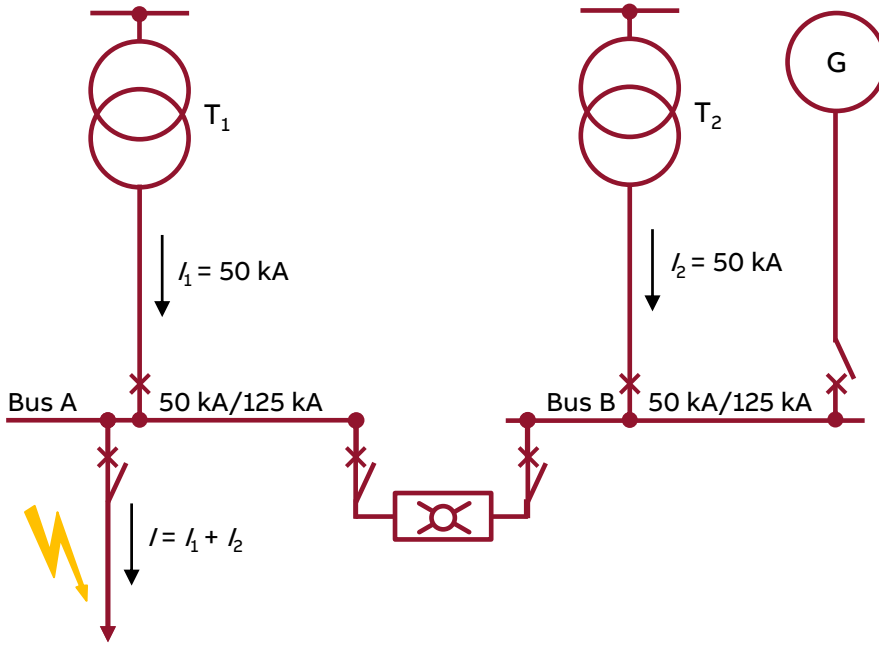
Fault current limiter

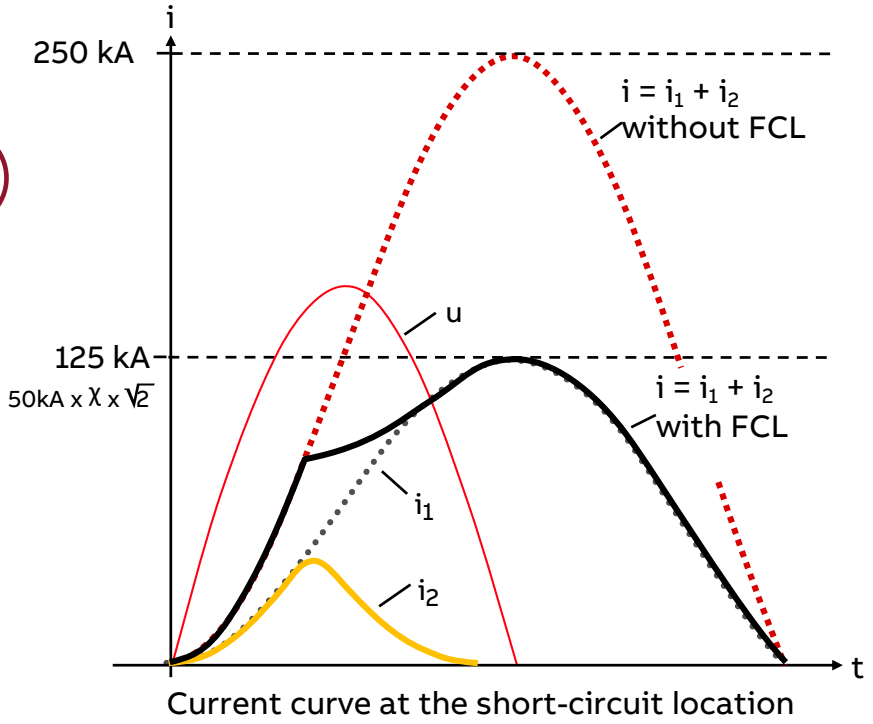
Breaking of short-circuit current with FCL

Example of application

- FCL immediately separates two systems in case of a short-circuit fault
- Limitation before reaching the first peak
- Short-circuit fault isolation
- Remaining fault level not critical

Fast tripping for a safe equipment operation



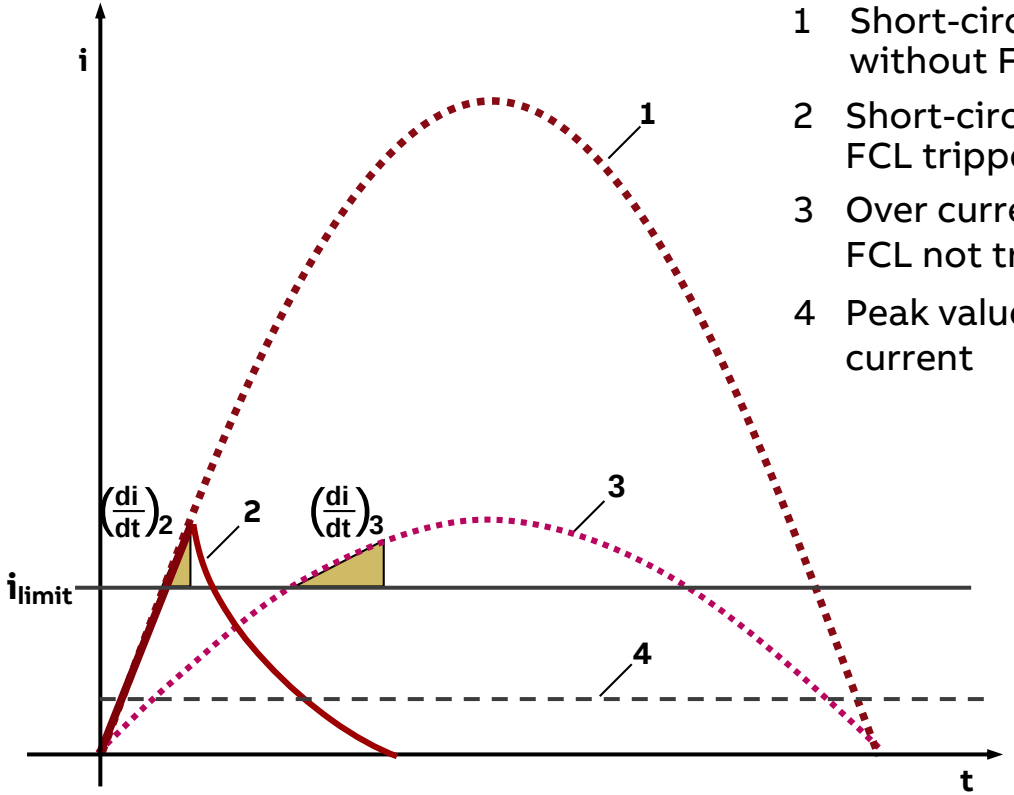


Current curve at the short-circuit location

Working Principle

Project specific techniques

Tripping based on instantaneous + di/dt measurment



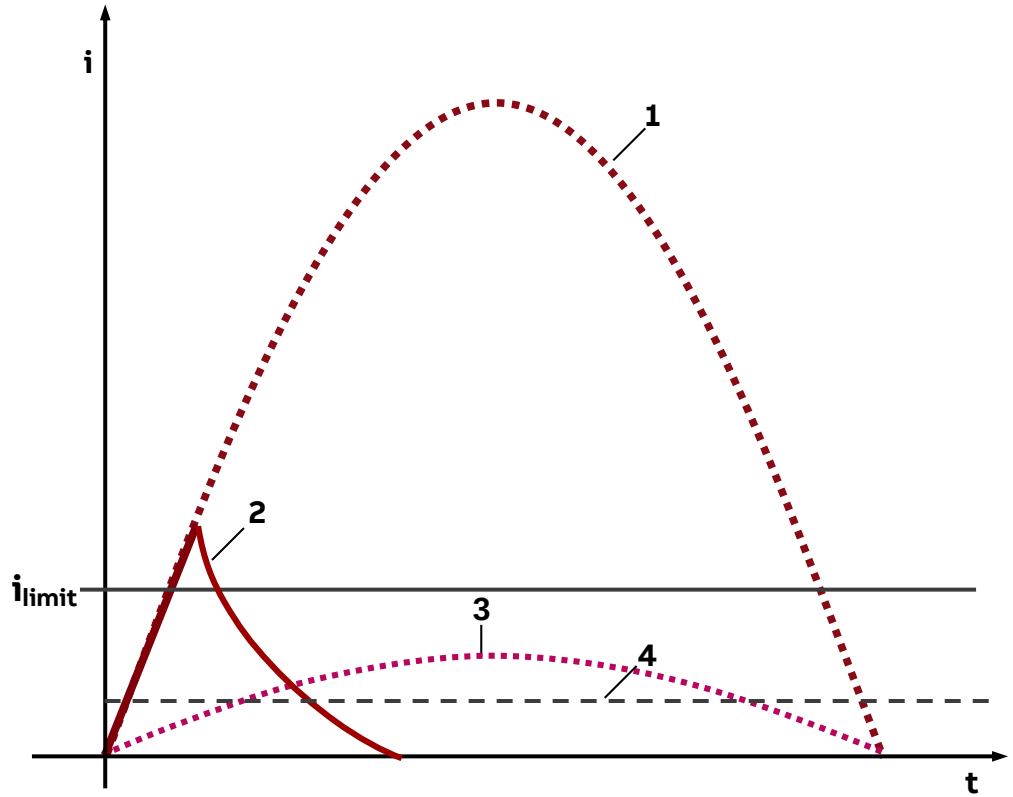
1 Short-circuit current without FCL

2 Short-circuit current FCL tripped

3 Over current FCL not tripped

4 Peak value of service current

Tripping based on instantaneous current measurment only



Components and Operation

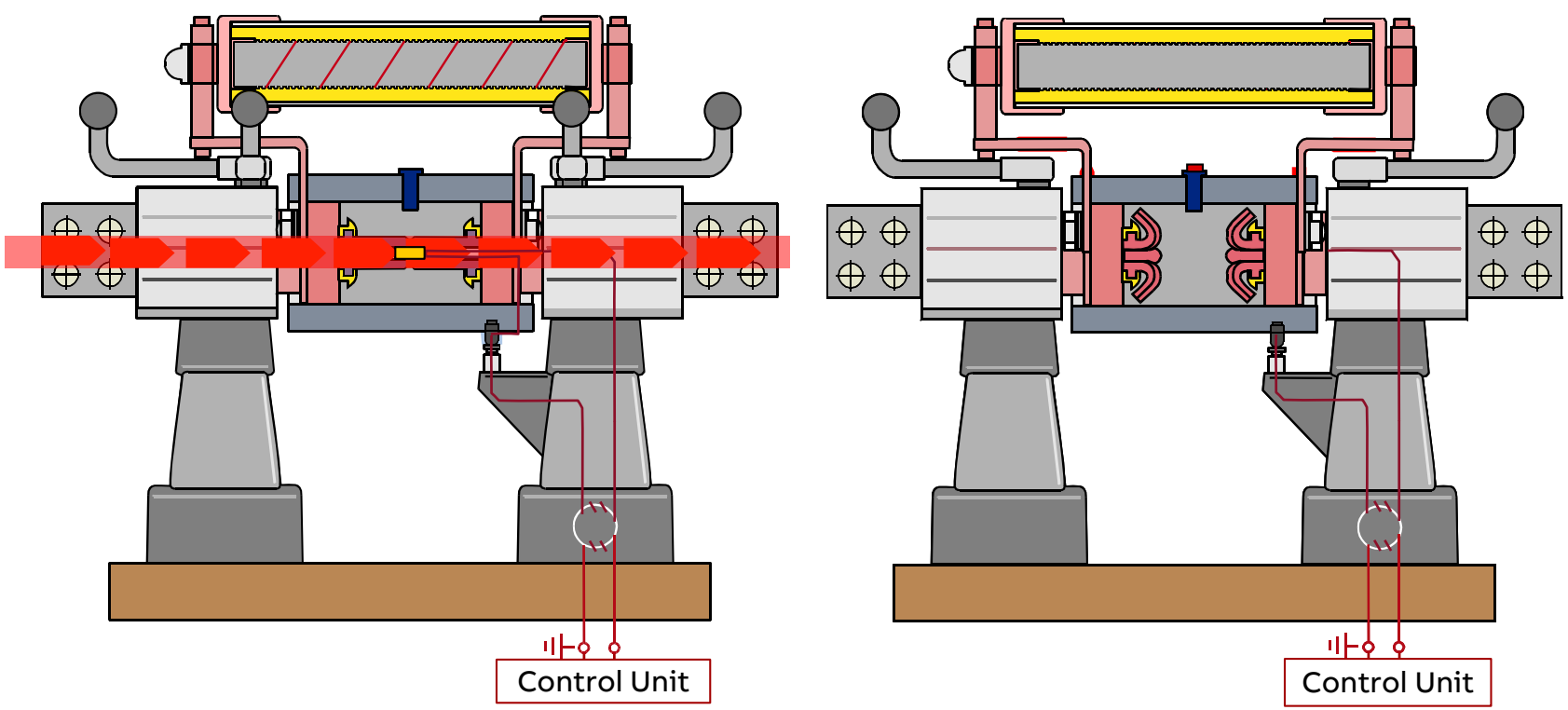
Function and operation

Normal operation

- Current flow through main current path
- Monitoring of current regarding the setting values through control unit

Fault detected

- Setting value(s) reached and pyrotechnical charge triggered
- Opening of main current path
- Melting of fuse
- Interruption of short-circuit current



An airbag for your system!

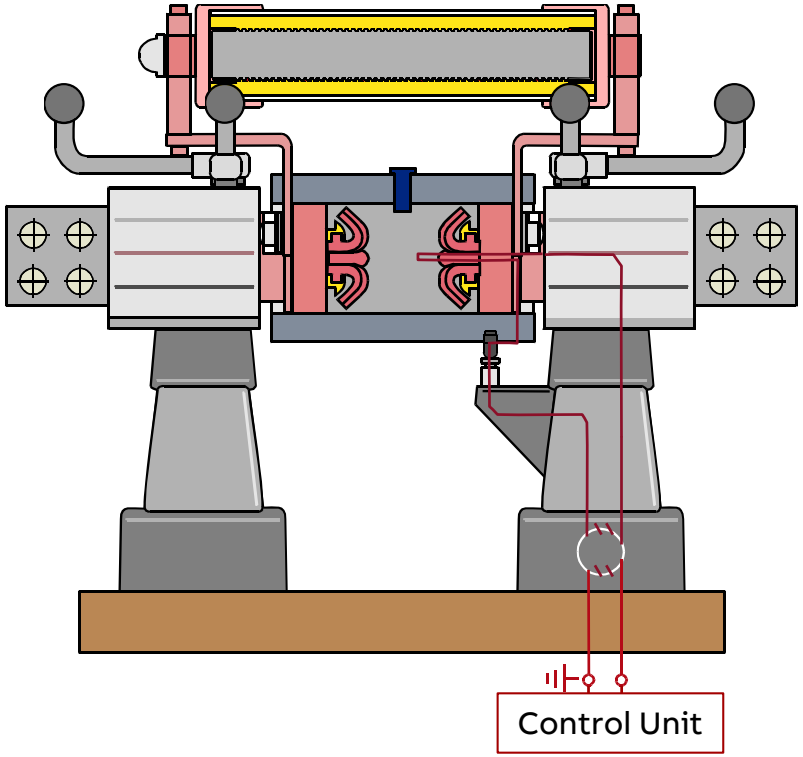
Components and Operation

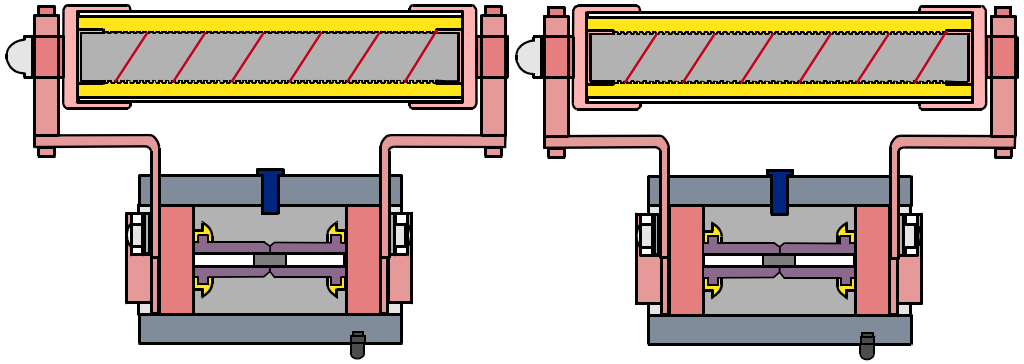
Function and operation

Insert replacement

Tripped inserts:

- No special training to change tripped inserts
- **Automatic connection** with the control unit when replacing the inserts
- Tripped inserts can be **refurbished** by ABB

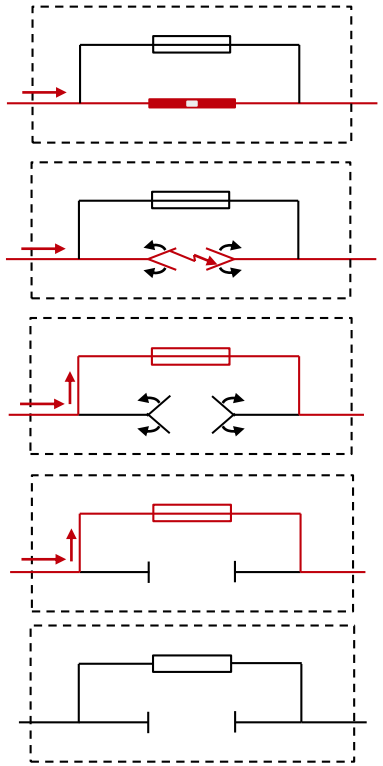




A customer friendly design!

Fault current limiter

Schedule for tripping



T_0: Reaching time for tripping criteria (î and di/dt)

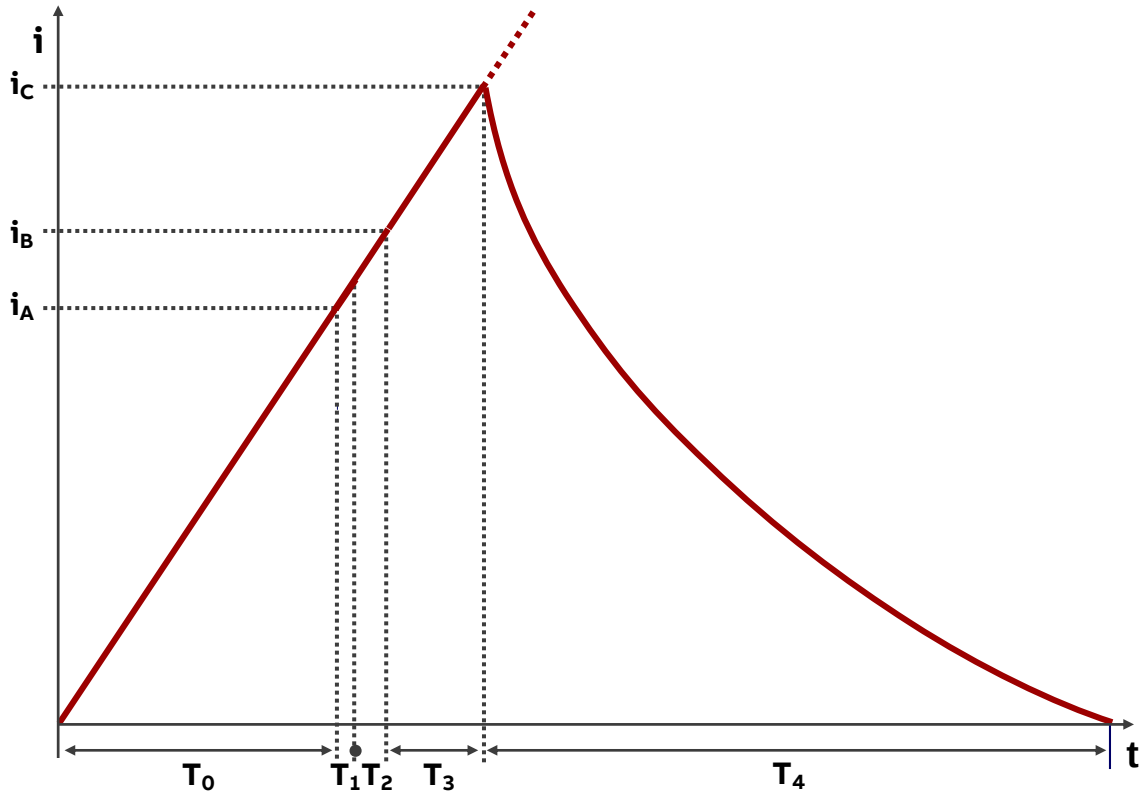
T_1: Response time of the electronic approx. 15 µs

T_2: Time for opening the bursting bridge and for commutating the current to the fuse element approx. 85 µs

T_3: Melting time of the fuse element approx. 500 µs

T_4: Arc duration

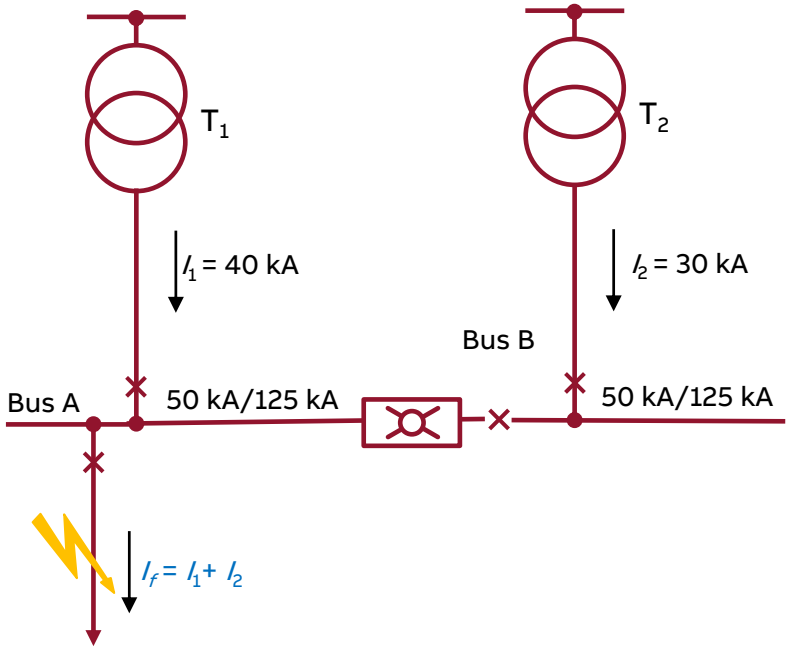
Breaking of current by the fuse



Applications & Advantages

Standard source paralleling applications without selectivity

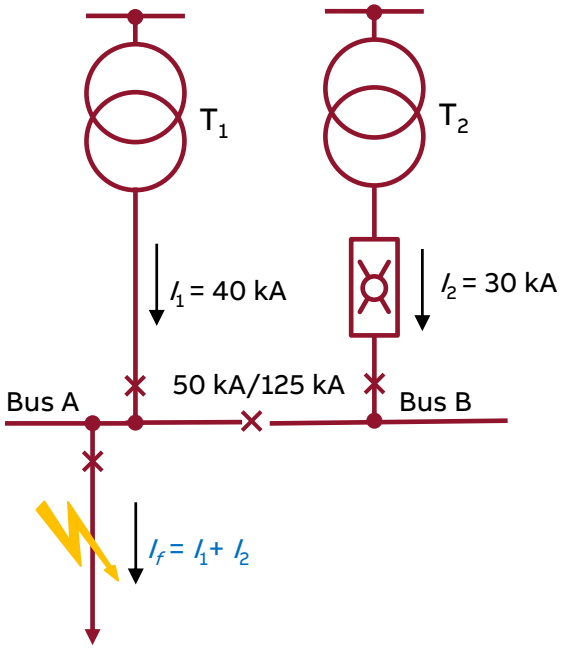
FCL in series with bus-coupler



Fault level at Bus A (without FCL): I_k'' = 70 kA

Fault level at Bus A (with FCL): I_k'' = 40 kA

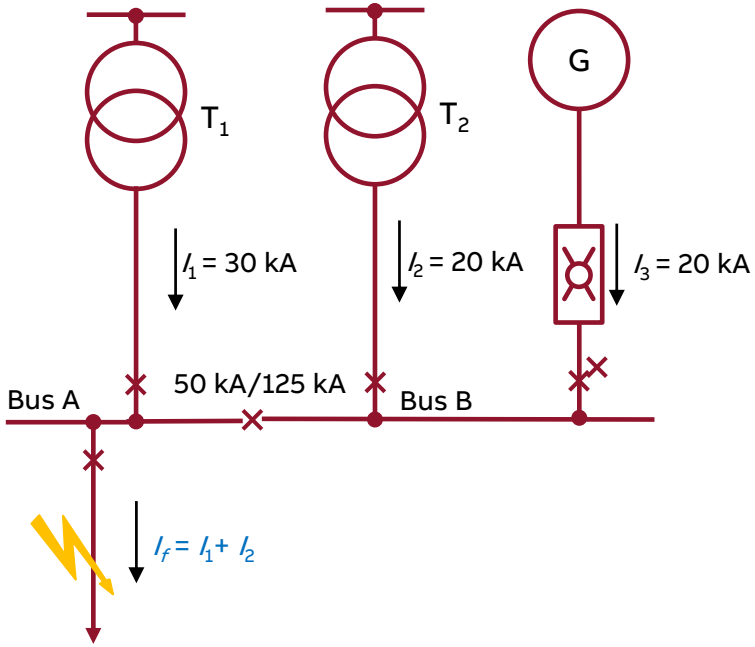
FCL in series with transformer



Fault level at Bus A (without FCL): I_k'' = 70 kA

Fault level at Bus A (with FCL): I_k'' = 40 kA

FCL in series with generator



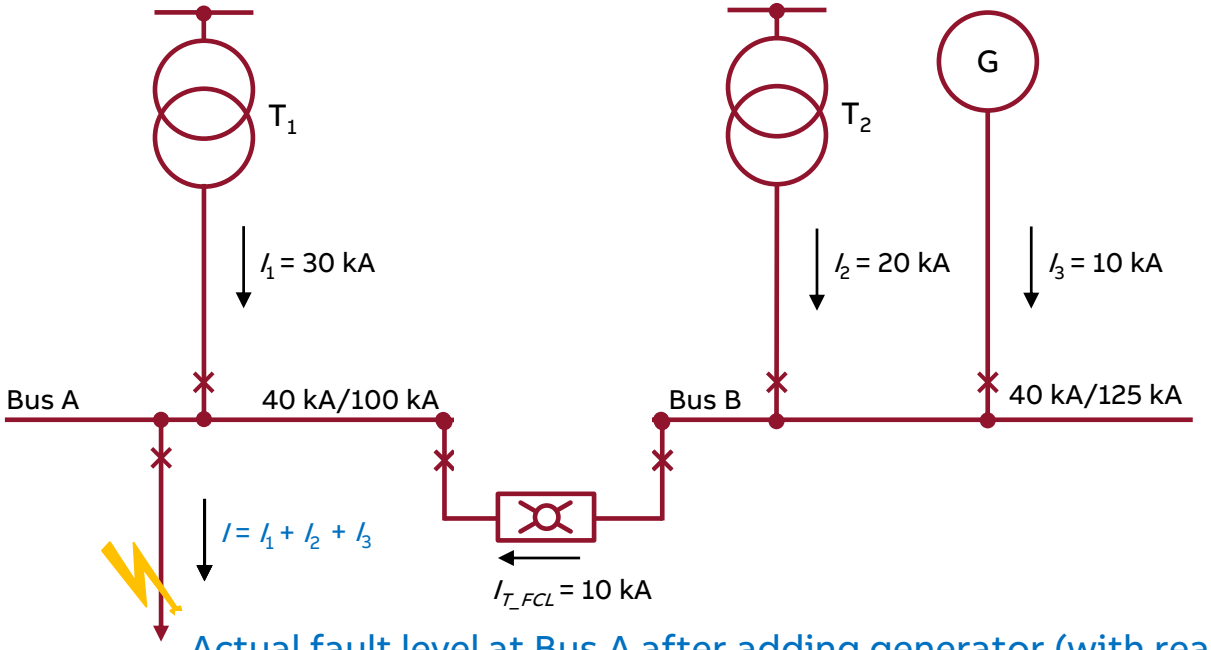
Fault level at Bus A (without FCL): I_k'' = 70 kA

Fault level at Bus A (with FCL): I_k'' = 50 kA

Applications & Advantages

FCL used for replacing or bypassing a reactor

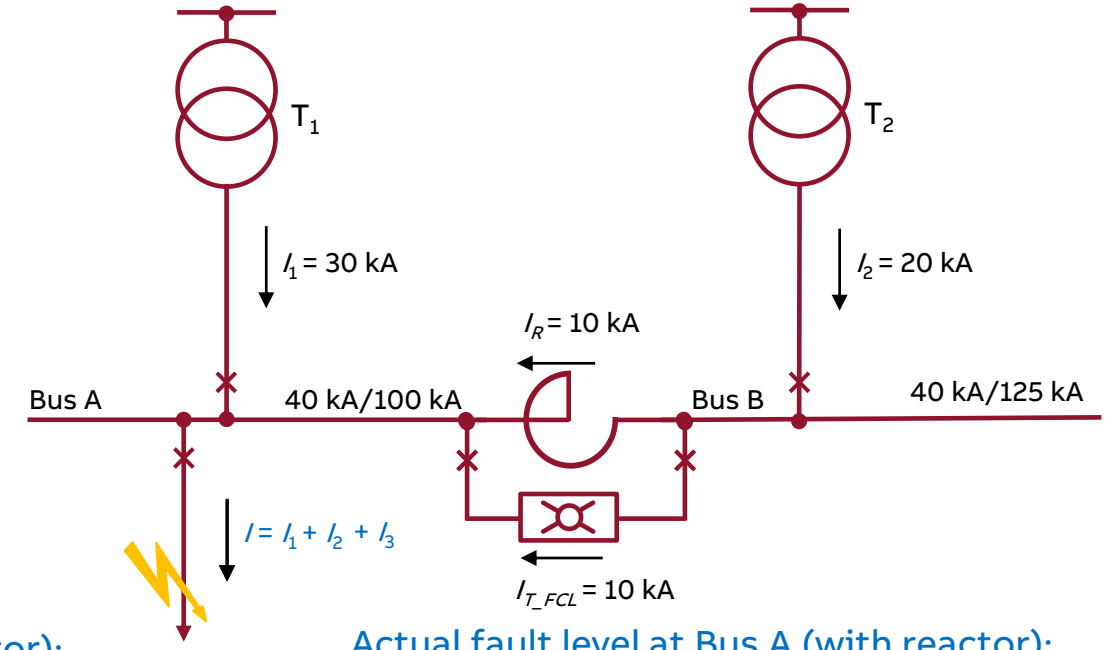
Replacing a reactor



Actual fault level at Bus A after adding generator (with reactor):
I''_k= 45 kA / i_p= 112,5 kA (i_p= 2.7 * I''_k)

Actual fault level at Bus A (with FCL):
I''_k= 30 kA / i_p= 75 kA (i_p= 2.7 * I''_k)

Bypassing a reactor



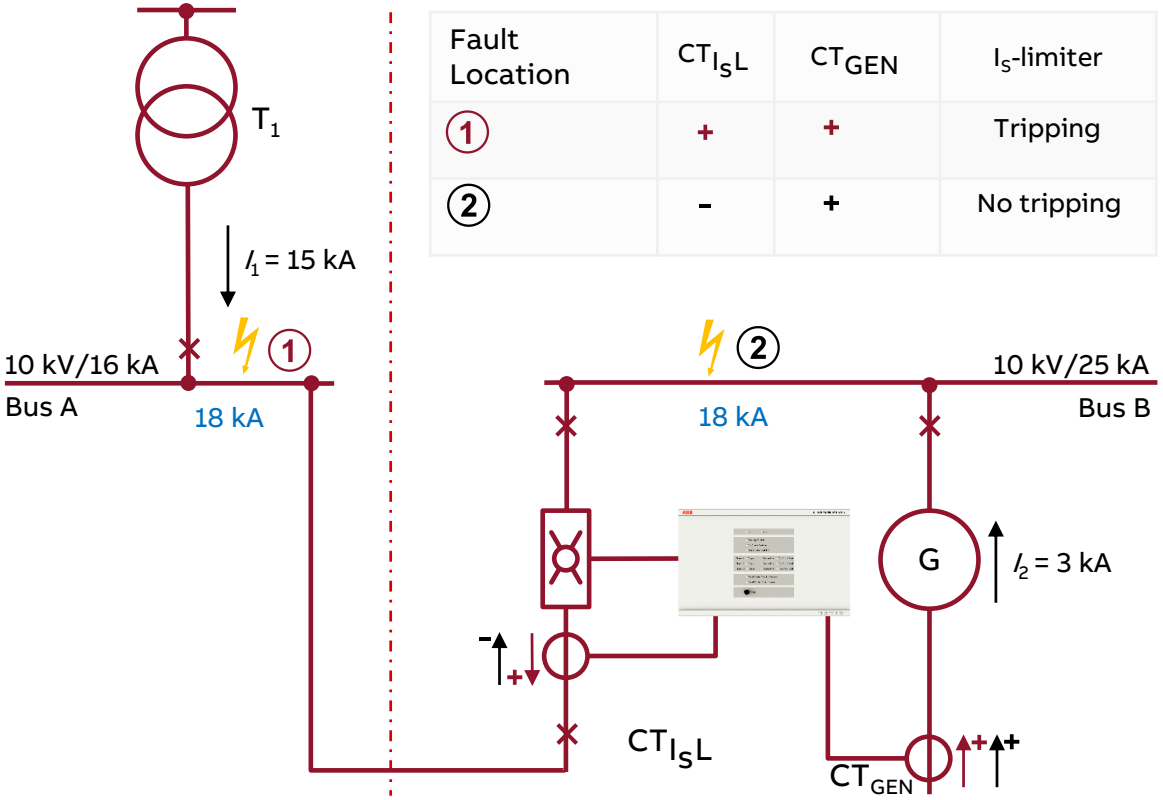
Actual fault level at Bus A (with reactor):
I''_k= 40 kA / i_p=100kA (i_p= 2.7 * I''_k)

Actual fault level at Bus A (with FCL):
I''_k= 30 kA / i_p= 75 kA (i_p= 2.7 * I''_k)

Applications & Advantages

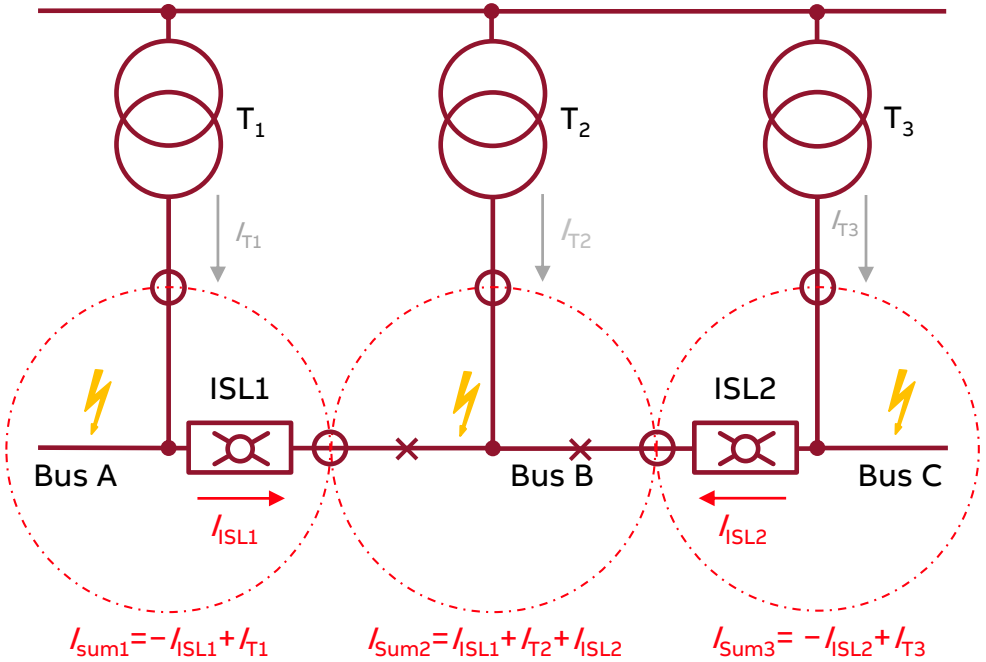
FCL in application where selective tripping is useful

FCL with directional selectivity



Fault Location	CT_{I_SL}	CT_{GEN}	I_S-limiter
①	+	+	Tripping
②	-	+	No tripping

FCL with summation selectivity



Actual fault level at Bus A (without FCL):
I''_k = 18 kA / i_p = 45 kA (i_p = 2.7 * I''_k)

Actual fault level at Bus A (with FCL):
I''_k = 18 kA / i_p = 45 kA (i_p = 2.7 * I''_k)

Fault current limiter applications

Application overview

I_s-limiter ™

- Indoor systems

- Standard Applications
  - Coupling of two systems
  - Transformer connection
  - Generator connection
  - Reactor replacement or bypass

- Complex applications
  - Directional selectivity
  - Summation selectivity

FC-Protector ®

- Indoor and Outdoor systems

- Standard Applications
  - Coupling of two systems
  - Transformer connection
  - Generator connection
  - Reactor replacement or bypass

Great variety of solutions for any possible requirement

Fault current limiter

Fault current limiter family

I_S-limiter™/FC-Protector® components

Low and medium voltage components

Integration in OEM panels

Flexible solution for retrofit

Installation in outdoor applications

I_S-limiter™ truck mounted

Integration into ABB's Safegear and UniGear ZS1 line-ups

Type tested solution

Connection through busbar and cable

FC-Protector/I_S-limiter™ fixed mounted

Low footprint stand-alone solution

One-panel cable in/out connection to GIS or OEM panels

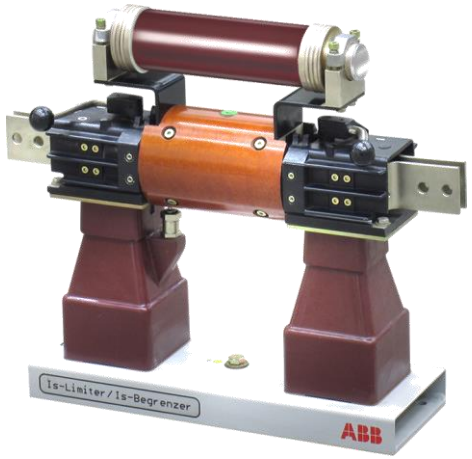
Stand-alone I_s-limiter™ panel

Integration into ZS8.4

Fault current limiter

Portfolio

	FC-Protector	I_s-limiter
Application	Indoor & Outdoor	Indoor
Application type	Standard	Standard & Complex
Ratings	7.2 kV … 17.5 kV … 3150 A … 63 kA_{RMS}	0.75 kV … 40.5 kV … 5000 A … 210 kA_{RMS}
Tripping criteria	Magnitude	Magnitude & rate of rise
Selectivity	On request	Yes
Availability in switchgear	Yes (AIS)	Yes (AIS)



Medium voltage I_s-limiter component

FC-Protector (outdoor) component

[1] FCLs can be paralleled for higher rated currents

Fault current limiter

Typical Applications

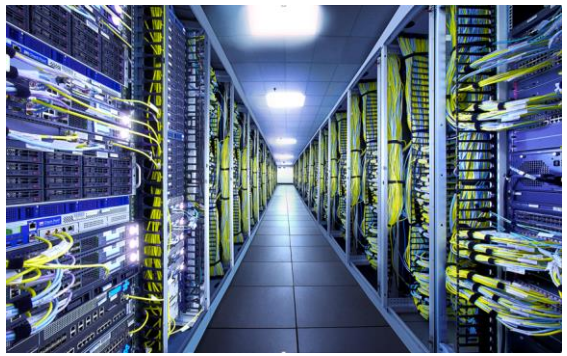
Industry

- Oil & Gas
- Cement
- Aluminum / Steel Mills
- Paper mills
- Car industry
- Ships and vessels
- On- /Offshore platforms

Utilities

- Fault level management
- Independent power producer integration
- Industry co-generation connecting to grid

Datacenters



- Instantaneous fault isolation
- Equipment protection
- Power supply reliability improvement

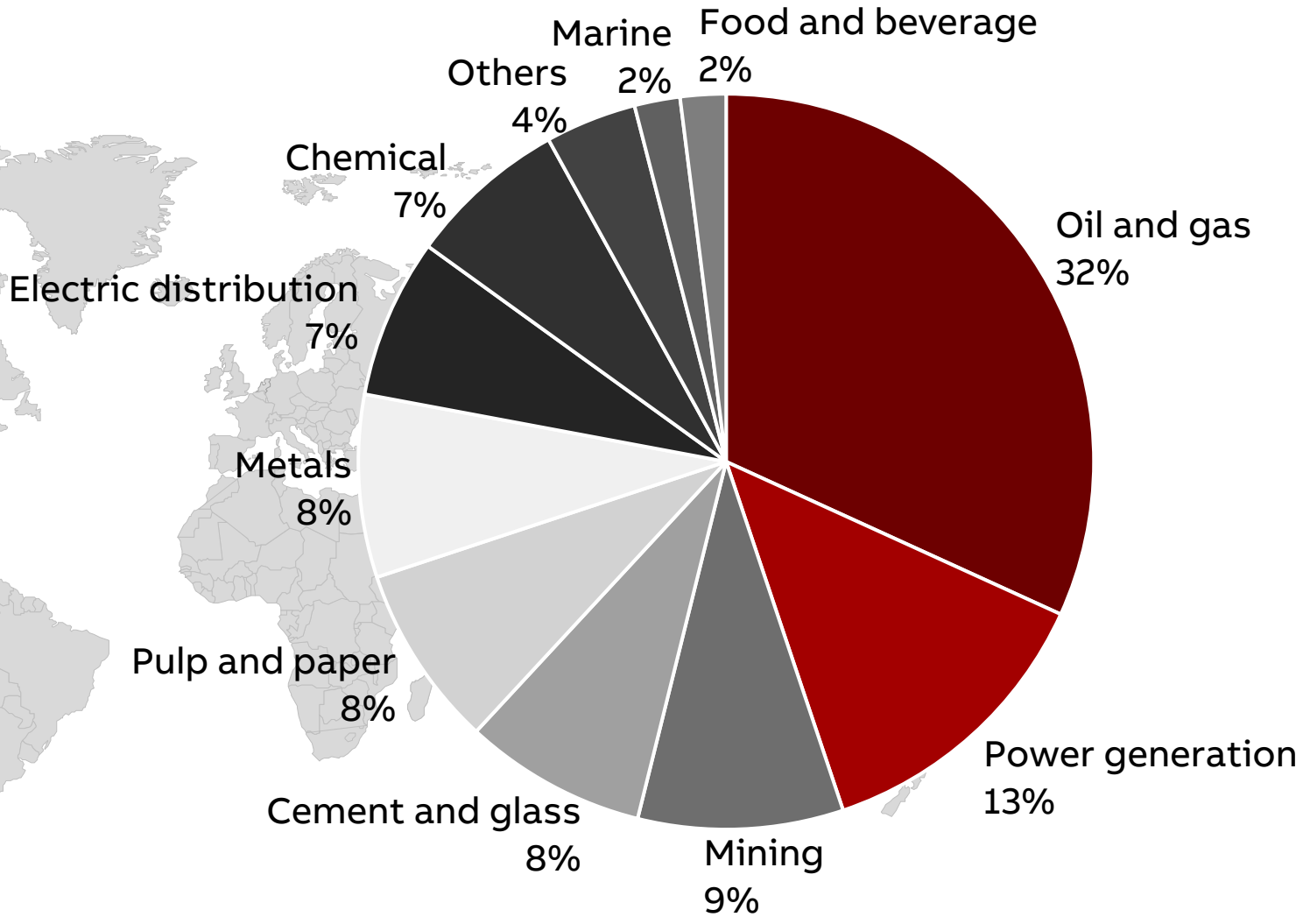
Power Generation

- Renewables
- Integration of solar and wind
- Conventional power generation
- Hydro power

Market & References

References

- Oil and gas
- Pulp and paper
- Metals
- Cement
- Utilities
- Mining
- Food and beverage



Fault current limiter

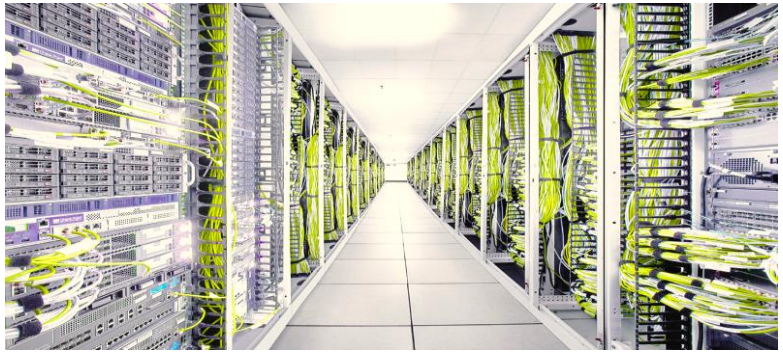
Why do we need FCLs?

Short-circuit problems

Reducing losses

Reduce downtime

Improve Reliability



Connect systems

Downsize

Our resources for you

Additional information

Product web page
https://new.abb.com/medium-voltage/apparatus/fault-current-limiters

Product information
Presentation, flyer, technical catalogue, manual

For inquiries via e-mail, please contact Fault Current Limiter Support DE
DE-FCL@abb.com