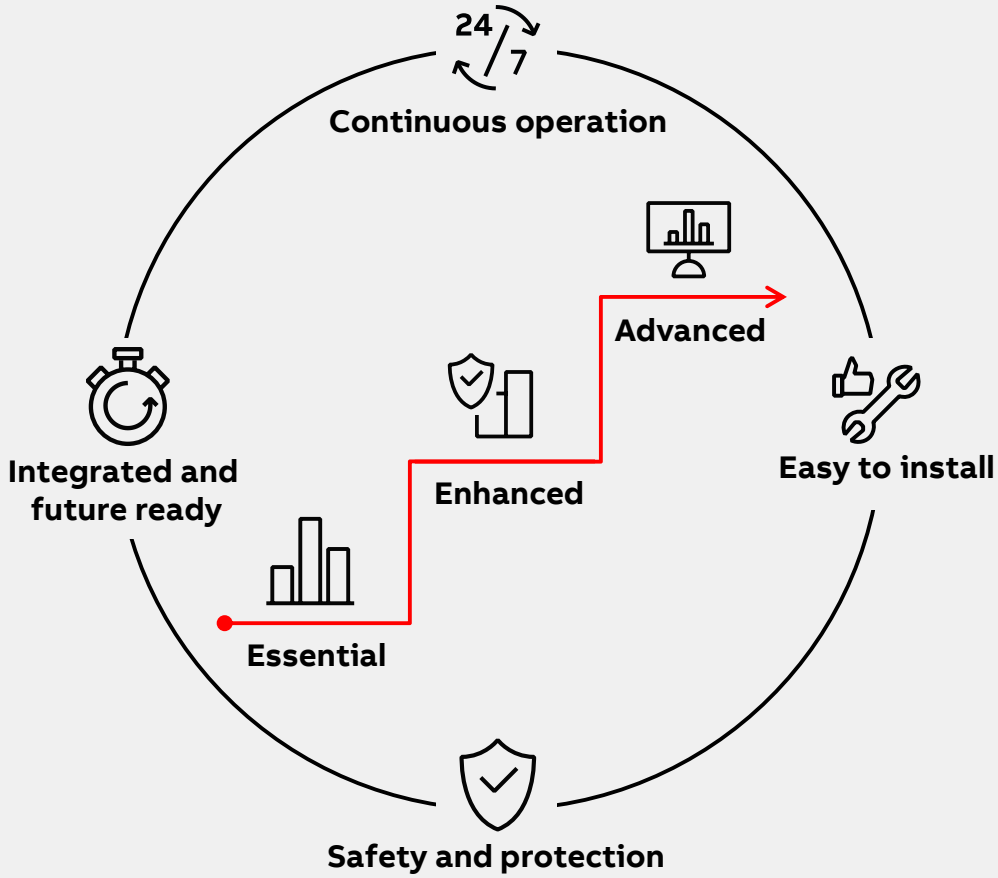



ABB CONSULTANTS TALKS- EP05- WEDNESDAY, 30 SEPTEMBER, 2020

# Motor Starting, Protection and Control

## Keep things moving with protection and control - at every level.

Amr Younis – Technical and Design Promotion Manager

# Agenda

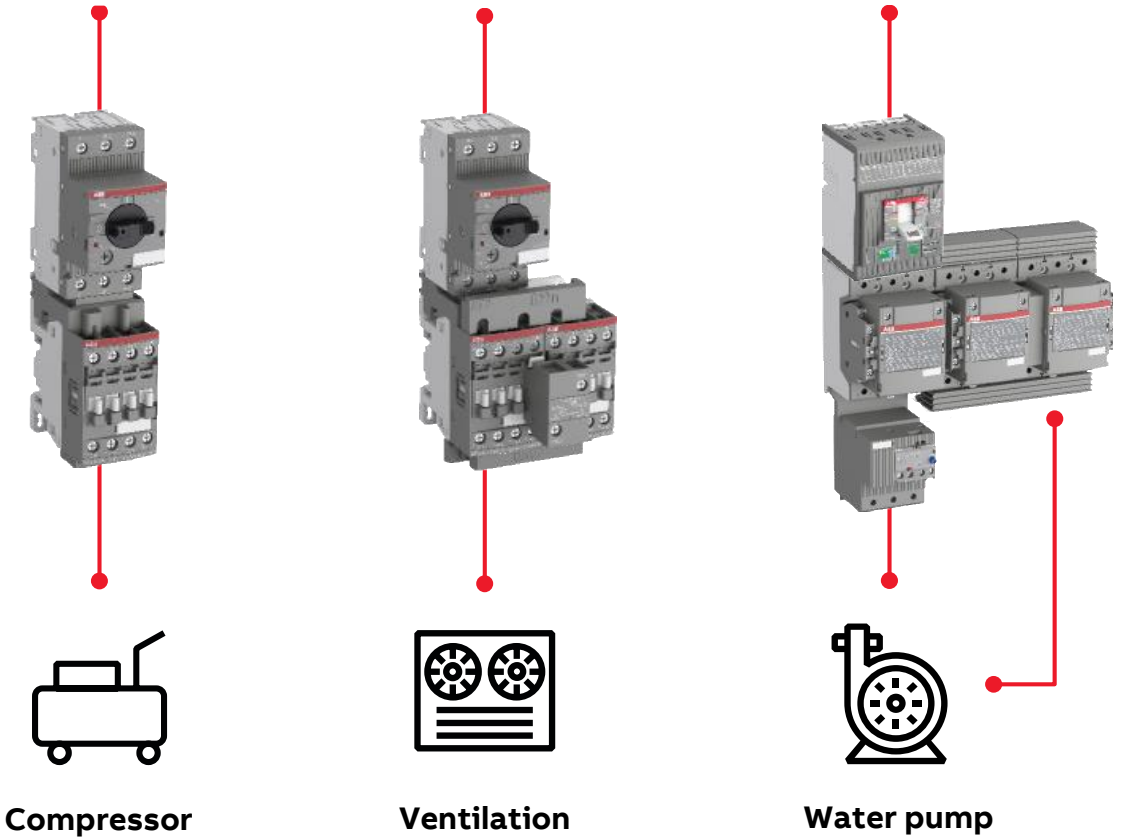
- Introduction
- Motor Protection and Control components
- Motor Staring Methods
  - Direct Online
  - Star-Delta
  - Soft starters
  - VSD’s
- Coordination of Protection

# Introduction

## Motor Starting

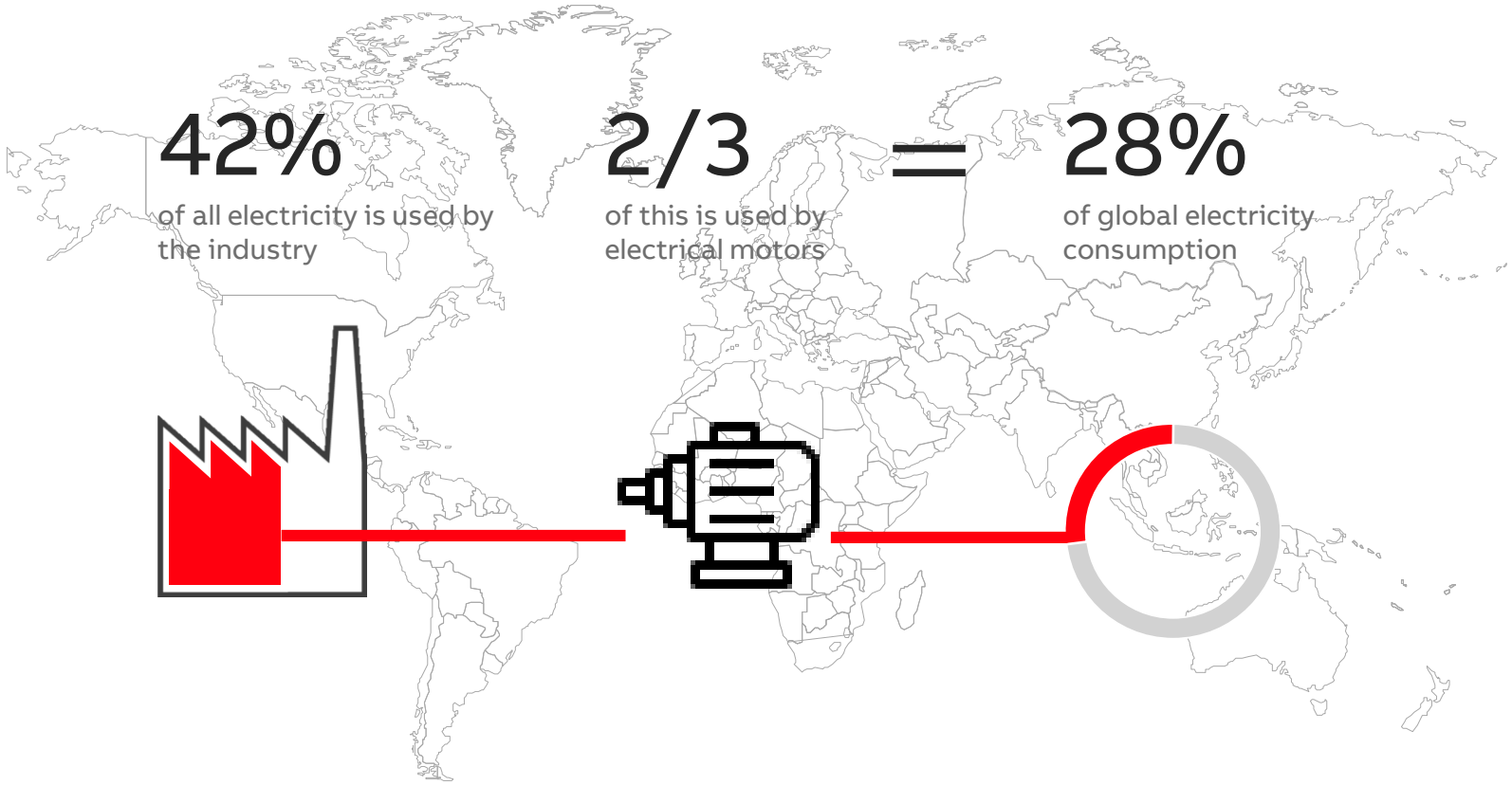
# Motor Starting Solutions

## Why it‘s important



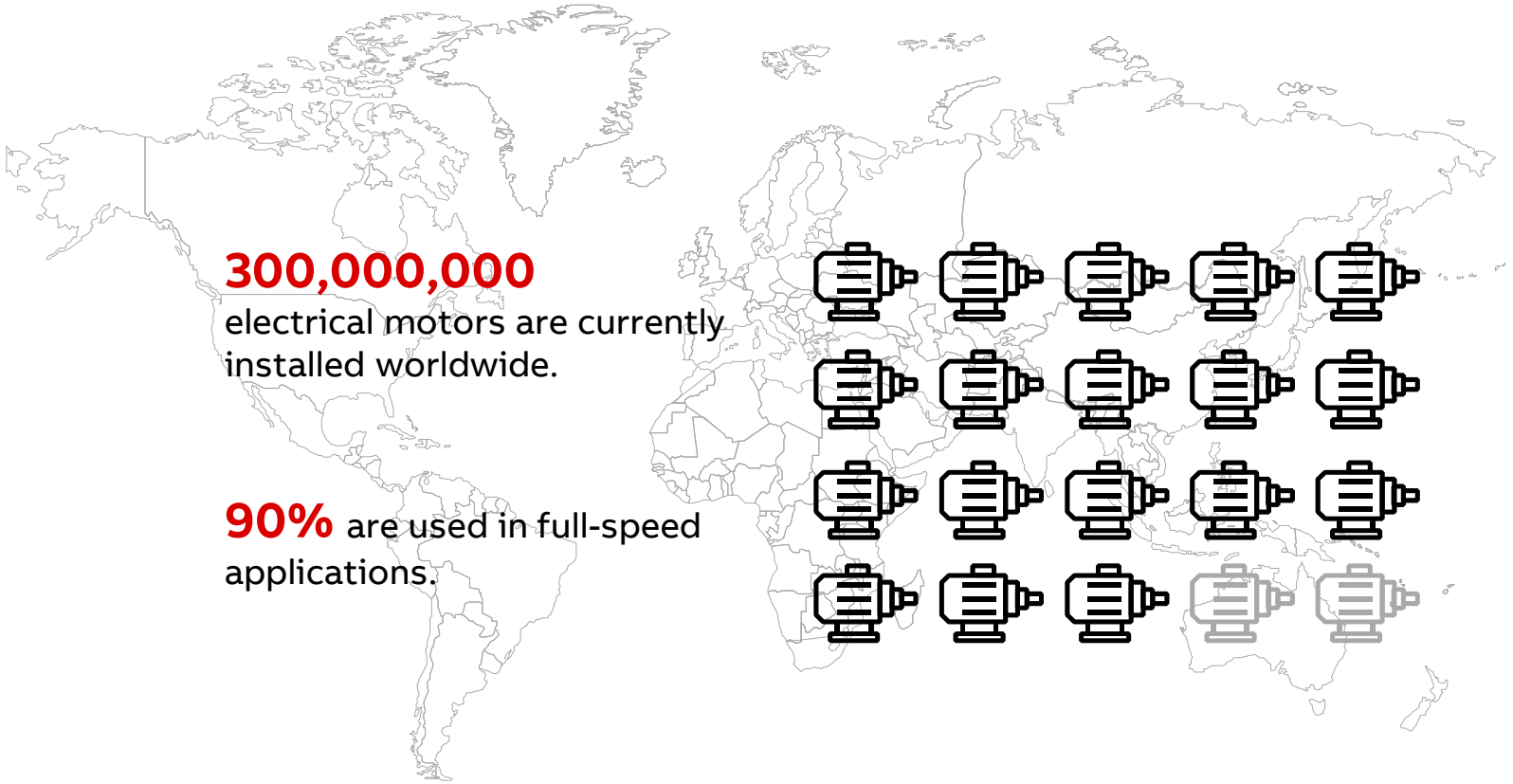
# Motors Starting

## Why it’s important?



# Motors Starting

## Why it’s important?

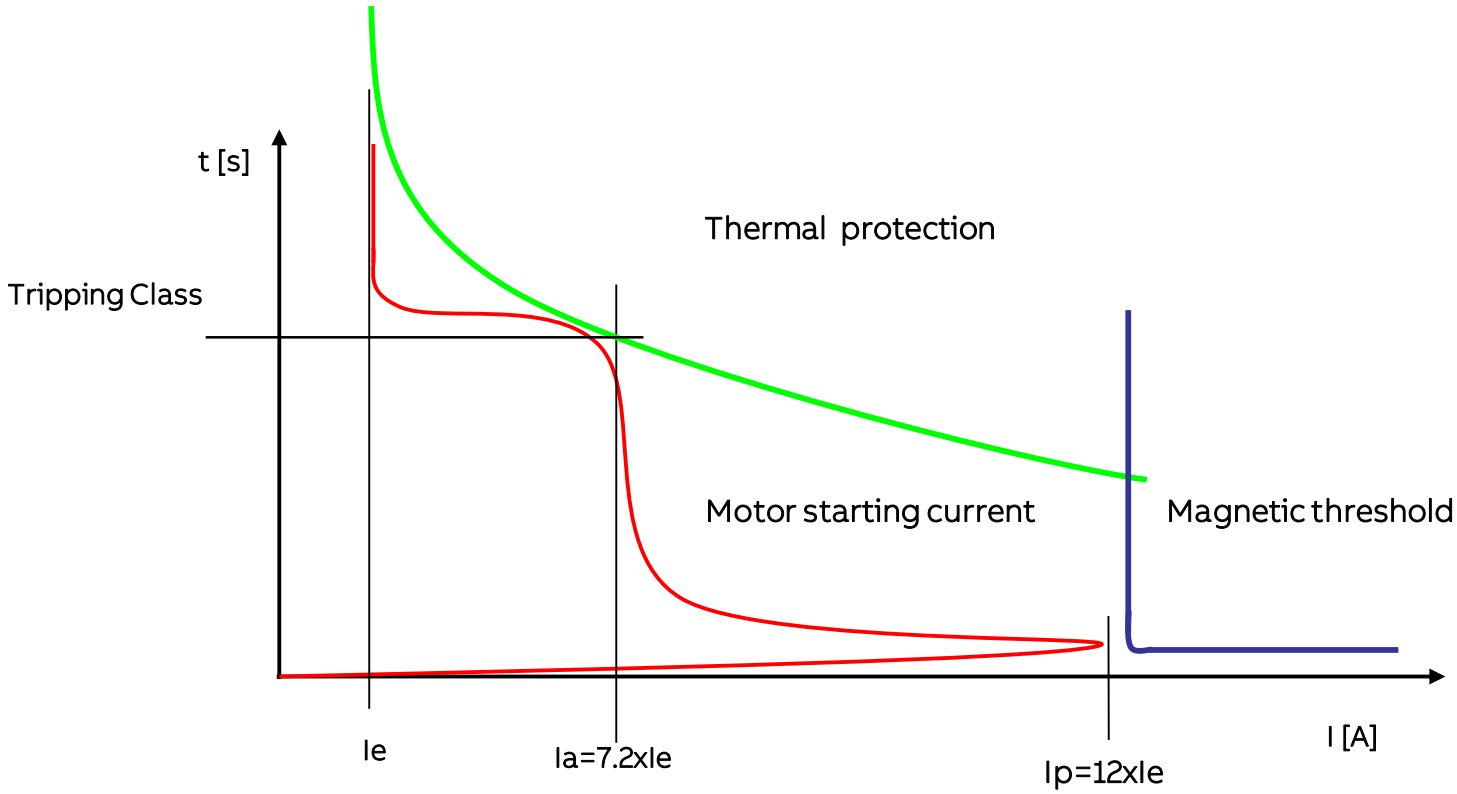


**300,000,000**
electrical motors are currently installed worldwide.

**90%** are used in full-speed applications.

# Motor starting

## General characteristics

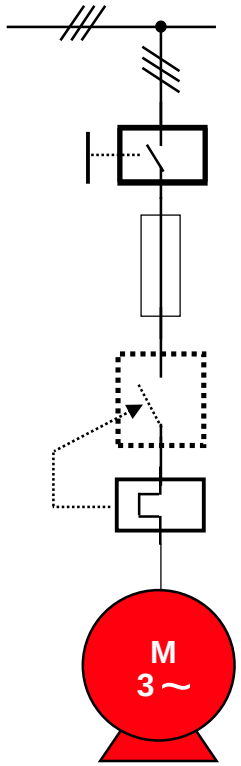


# Motor Starting

## Basic Motor Circuit Components

# Motors Starting

## Motor Protection & Control




| | |
|---|---|
| Isolation | - Disconnector<br>- Switch disconnector |
| Short Circuit Protection | - Switch Fuse<br>- Circuit Breaker (Magnetic)<br>- Manual Motor Starter |
| Control | - Contactor |
| Overload Protection/ Other protections | - Thermal Overload<br>- Electronic Overload<br>- Universal Motor Controller UMC |

# Motor Starting

## Isolation

# Motors Starting

## Isolators

### Enclosed switches disconnector

Why is isolation required?

To separate the electrical (input) source from the motor starter

Engineers can carry out maintenance/troubleshooting on the motor starter without risk of electrocution

# Motor Starting

## Control

# Motors Starting

## Contactors

### AF Contactors

Electric switching device to control the operation

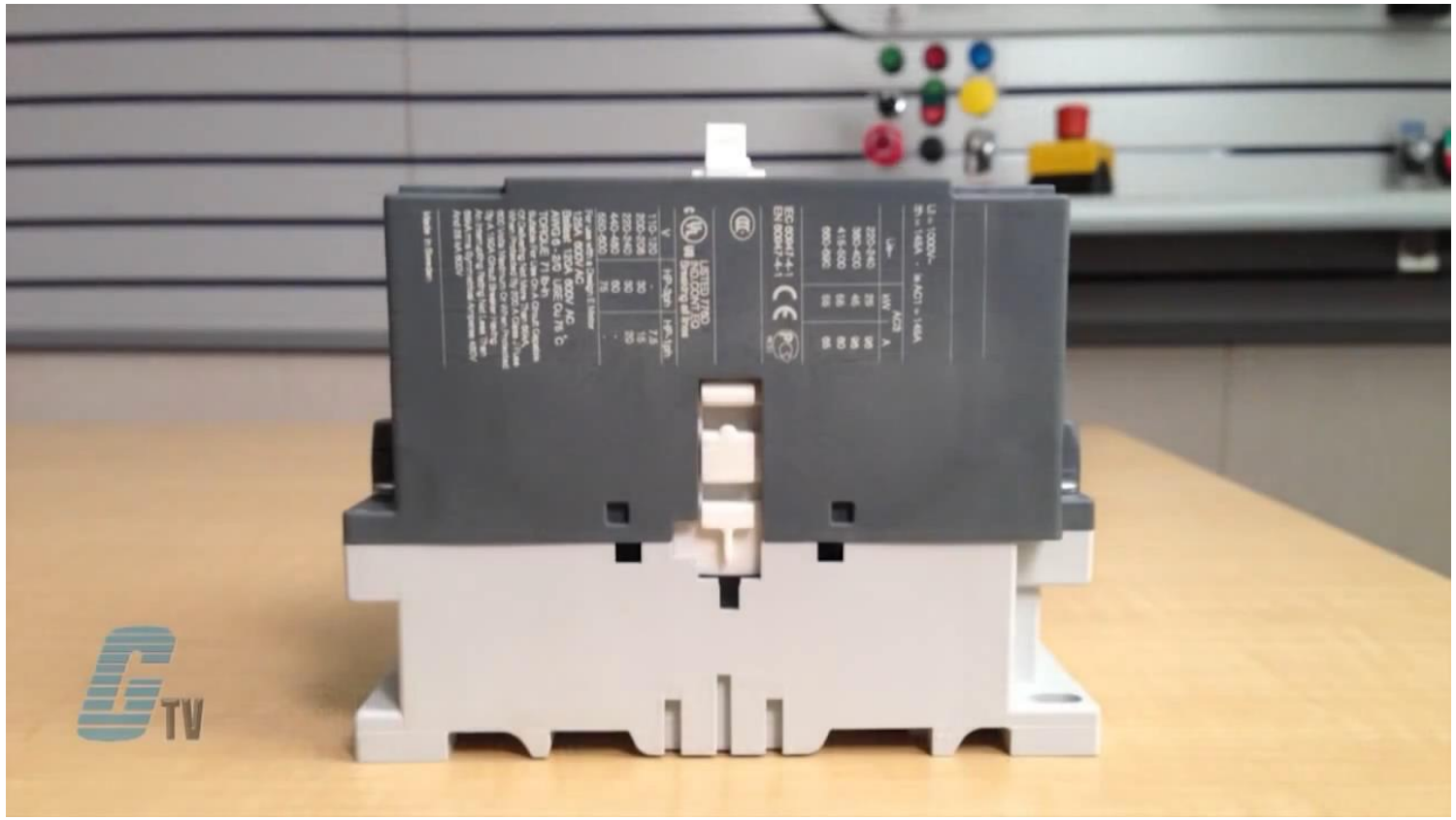
AF Contactors is used for switching ON and OFF motor loads according to IEC 60947-4-1

The full range has the following advantages

- Wide range operating coil 100-250 VAC/Dc
- Built-in Surge Suppressor
- Distinct operation (ON-OFF)
- 75-80% saving in power consumption
- 15-20% Space saving


# Essential solutions

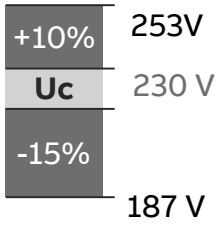
Get the essentials right with fast, reliable installations



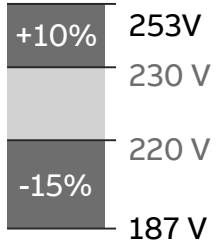
# Continuous operation

## Coil operating limits

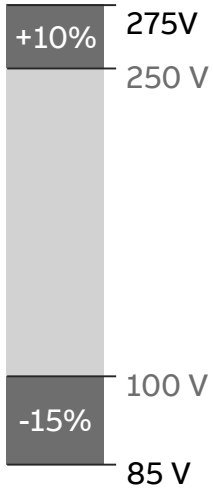
### IEC standard requirement




### Conventional coil




### AF coil



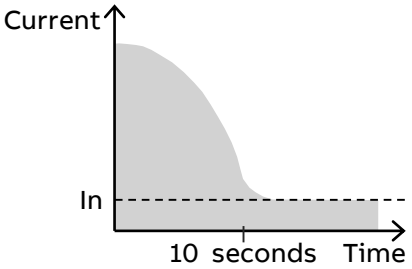



Uc = Control voltage

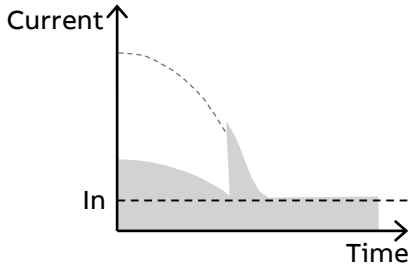
# Contactor duty cycle

## Examples of contactor duty

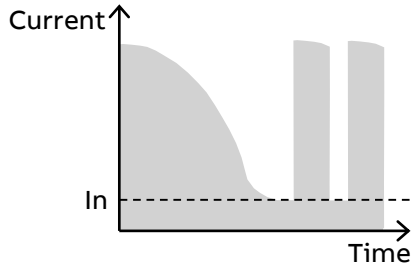
### Motor control




Direct on-line start (AC-3)
Making about 6 times nominal current
Breaking nominal current at opening

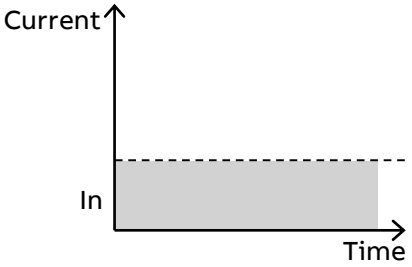



Star-delta start
Star contactor making 3 times nominal current

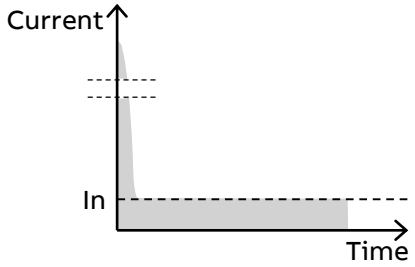



Inching (AC-4)
Making 6 times nominal current
Breaking 6 times nominal current

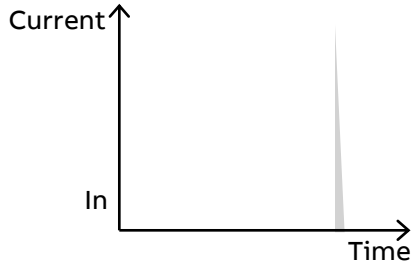
### Other application examples




Heating resistance AC-1)
Making/ breaking nominal current




Capacitor switching (AC-6b)
Making 100 times In or more




Dynamic breaking: making short time inrush current at cycle end

# Contactors in AC Power circuits

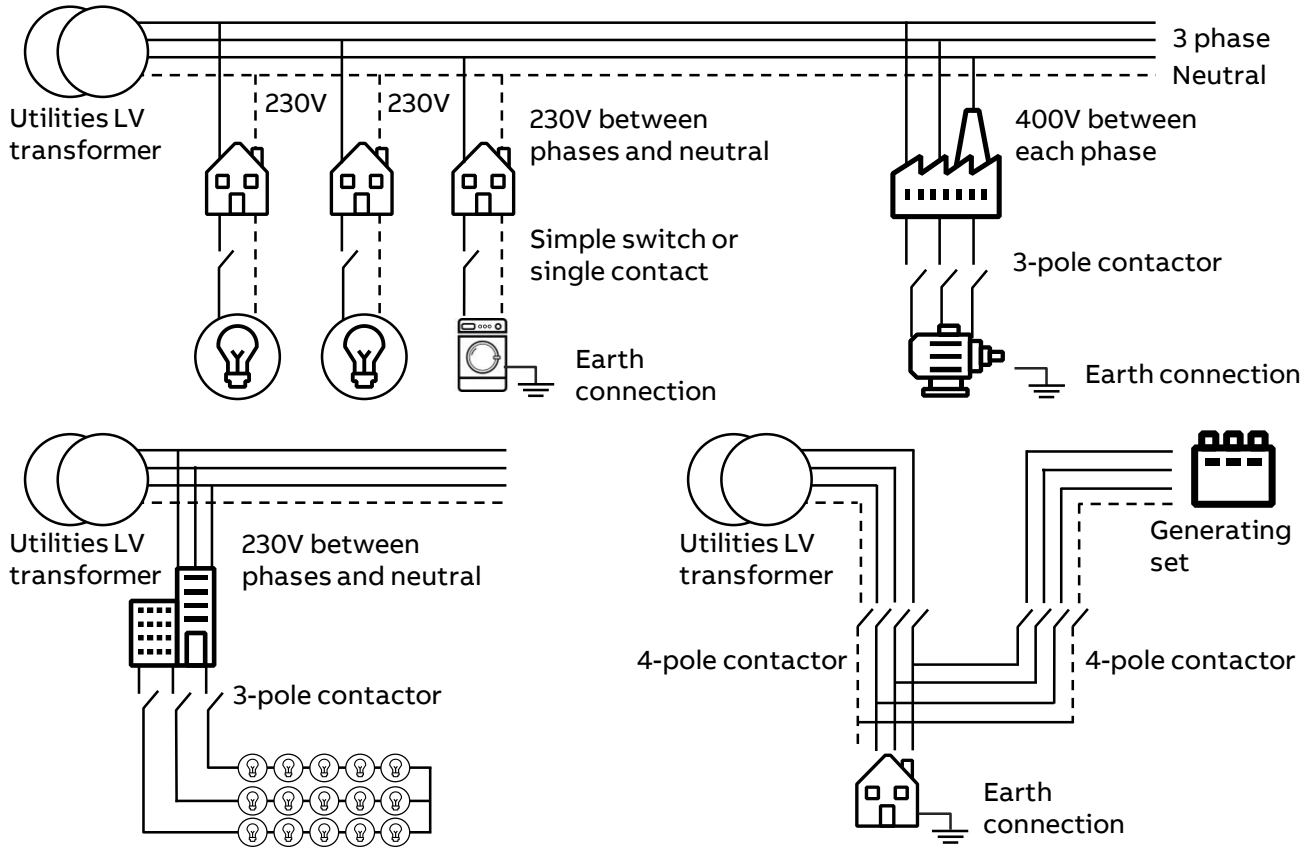
## Circuit diagram and main contacts arrangement

**Houses = low power**:
- Single phase connection, and load operated with a simple switch on the phase side

**Industry = high power:**
- 3-phase connection and load operated with a contactor

**Building, parking lots illumination**
- Three phase connection with 3-pole contactors
- Sometimes single phase connection with 2-pole or 4-pole contactors

**Generating set**
- 3-phase + neutral changeover with two 4-pole contactors



# Motor Starting

## Short Circuit Protection

# ABB Short-Circuit Protection Elements

## Short Circuit Protection

### Circuit Breakers – Magnetic Only

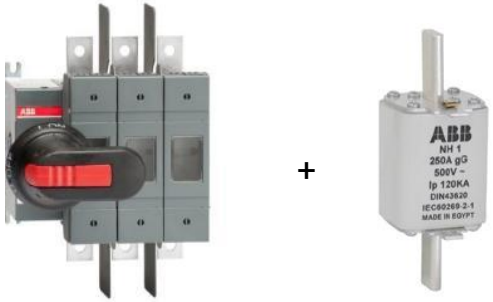
Short Circuit Protection Only

Magnetic only or Electronic trip units

Requires additional Overload protection

Protection: 12-14 In

### Switch Fuses




Short Circuit Protection Only

Requires additional Overload protection

### Manual Motor Starters

Short Circuit only

Short Circuit and Overload Protection

0.1-100 Ampere

# Manual Motor Starter

## Standard/ Premium main differences

### ABB's standard range up to 32A MS116

- ✓ IE3 ready
- ✓ World wide approvals
- ✓ Ics/Icu ratings up to 50 kA
- ✓ Coordination with AF contactors

### ABB's premium range up to 32A MS132/ MO132

- ✓ IE3 ready
- ✓ World wide approvals
- ✓ Ics/Icu ratings up to **100 kA**
- ✓ Coordinations with AF contactors
- ✓ **Trip position**
- ✓ **ATEX certified**
- ✓ **UL Type E/F ratings**
- ✓ **Combination motor controller**

### ABB's premium range up to 65A MS165/ MO165

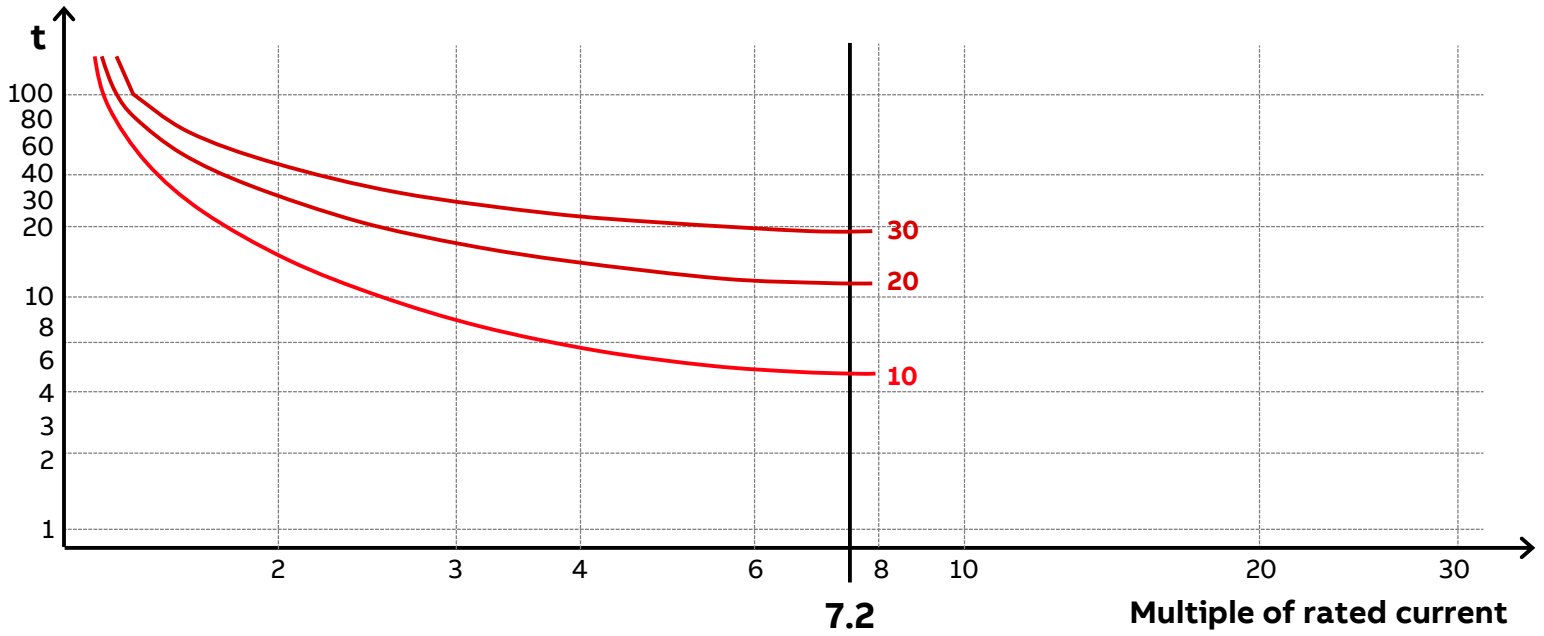
- ✓ IE3 ready
- ✓ World wide approvals
- ✓ Ics/Icu ratings up to **100 kA**
- ✓ Coordinations with AF contactors
- ✓ **Trip position**
- ✓ **ATEX certified**
- ✓ **UL Type E/F ratings**
- ✓ **Combination motor controller**

# Motor Starting

## Overload Protection/Other protections

# Overload relay

## What is a trip class?




Trip curve according to IEC 60947-4-1

- Class **10**: 4–10 s
- Class **20**: 6–20 s
- Class **30**: 9–30 s

# ABB Overload Protection offering range

## Overload Relays

### Thermal Overload - TF


Overload and phase failure protection using Bimetal trip unit

Trip Class 10

0.1-200 Ampere

Country of Origin: Germany/China

### Electronic Overload - EF


Overload and Phase failure Protection using Electronic trip unit

Trip Class: Selectable 10-20-30

0.1-800 Ampere

Country of Origin: Germany/China

### Universal Motor Controller – UMC100.3


Motor Protection

Motor Control

Motor Diagnostics

Communication

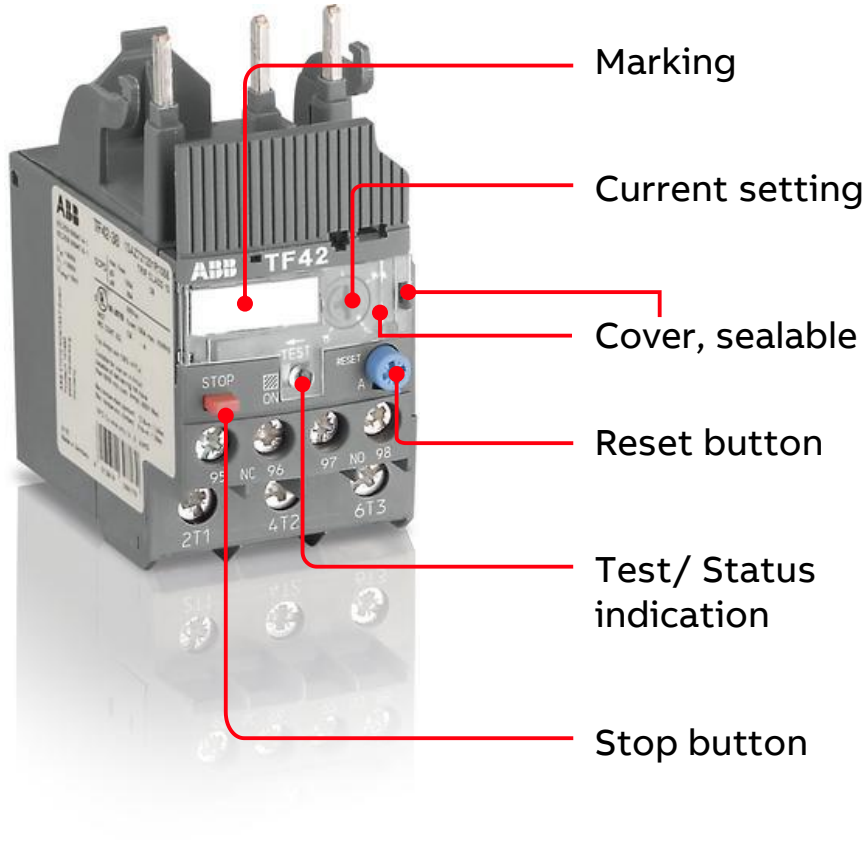
Country of Origin: Germany

# Thermal overload relays

## Basics TF series

**Based on new technology**

- Separate STOP button
- Trip Class 10
- Operating temp. range -25 up to 60°C
- Manual/ automatic reset selectable
- Test function
- Sealable cover for current setting, reset selection and test function
- Perfect match to the contactor
- Also available: ATEX certified types and kits for separate mounting

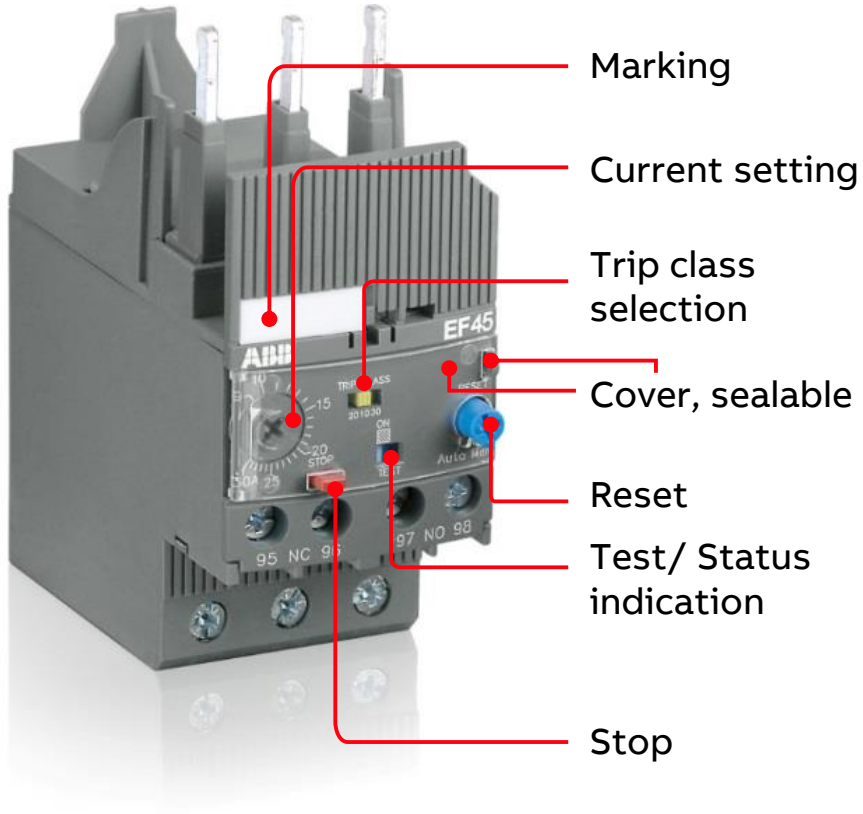


# Electronic overload relays

## Basics EF series

**Based on electronic technology**

- Separate STOP button
- Trip Class 10E, 20E, 30E selectable
- Operating temp. range -25 up to 70°C
- Manual/ automatic reset selectable
- Test function
- Sealable cover for current setting, reset selection and test function
- Perfect match to the contactor
- Also available: ATEX certified types and kits for separate mounting



# Advanced solutions

## UMC100.3 application example

**Connection to DCS, ABB Ability™ 800xA and gateway for ABB Ability™ EDCS**

**Universal Motor Controller UMC100.3**

**Industrial Ethernet**
- EtherNet/IP™
- Profinet IO
- Modbus TCP

**Fieldbus**
- Modbus RTU
- DeviceNet™
- Profibus DP

**Manual motor starter**

**Universal Motor Controller UMC100.3**

**AF contactors**

**Voltage module**

**Digital module**

**Analog / temperature module**

# Motor starter examples

## Stand alone or combined

- ✓ Disconnect
- ✓ Short-circuit protection
- ✓ Overload protection
- ✓ Phase-failure
- ✓ Manual control

- ✓ Disconnect
- ✓ Short-circuit protection
- ✓ Overload protection
- ✓ Phase-failure
- ✓ Manual control

- ✓ Control

- ✓ Disconnect
- ✓ Short circuit protection
- ✓ Manual control

- ✓ Control
- ✓ Overload protection

# Motor starting

## Control (On/Off) operation and Indication

Start Pushbutton

or

Stop Pushbutton

+

**Motor Starter Control**

AF Contactor

Starter ON

Starter OFF

Starter Tripped

**Motor Starter Indication**

Overload Relay

or

Manual motor starter

or

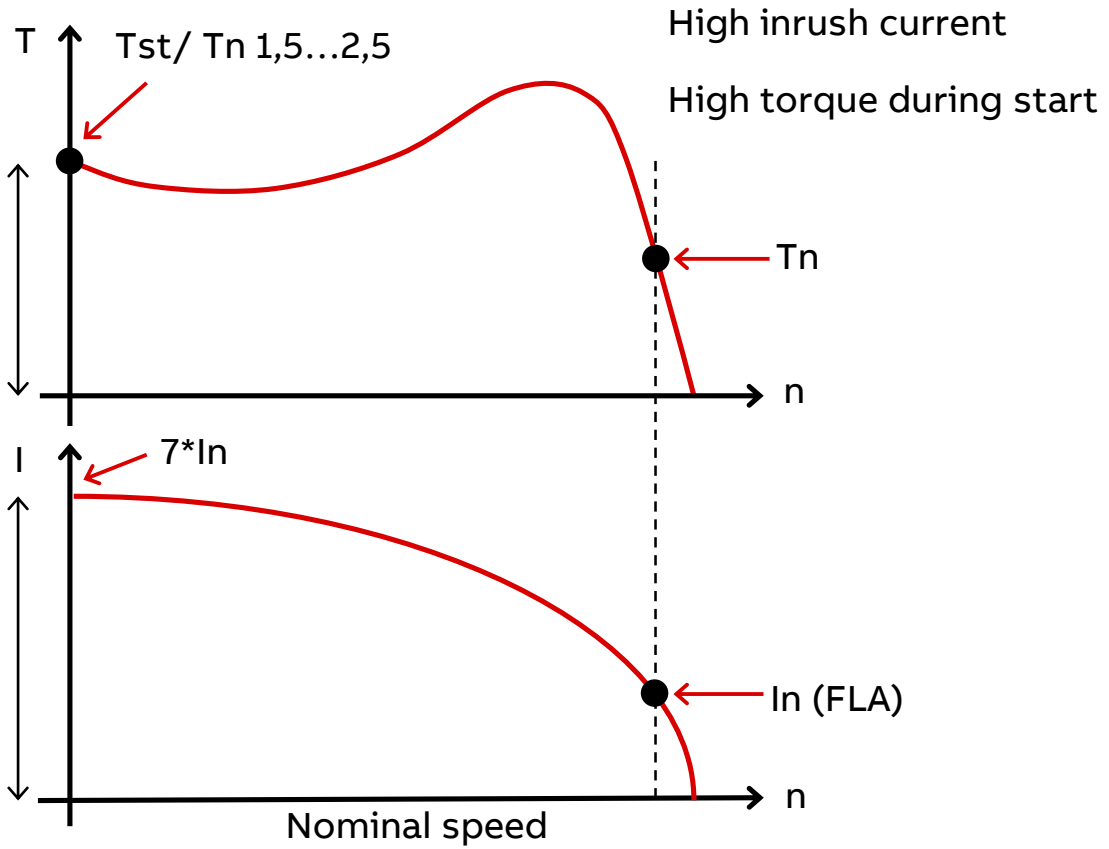
Circuit breaker

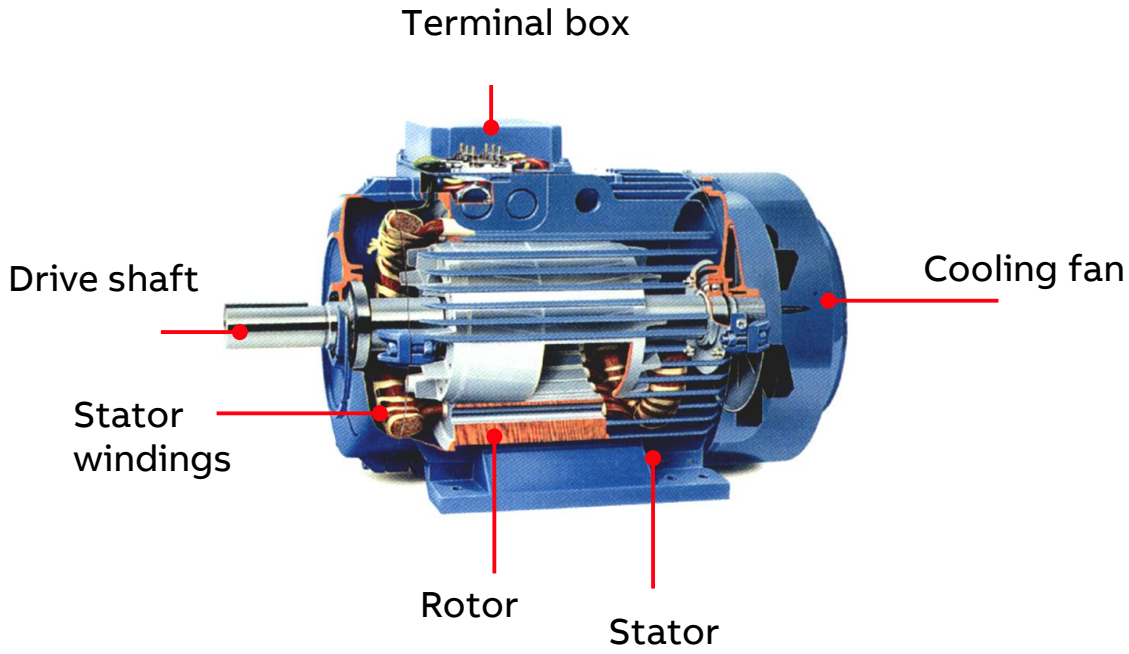
# Motor Starting

## Direct Online Starters

# Motors Starting

## Electrical and Mechanical Characteristics



# Motors Starting

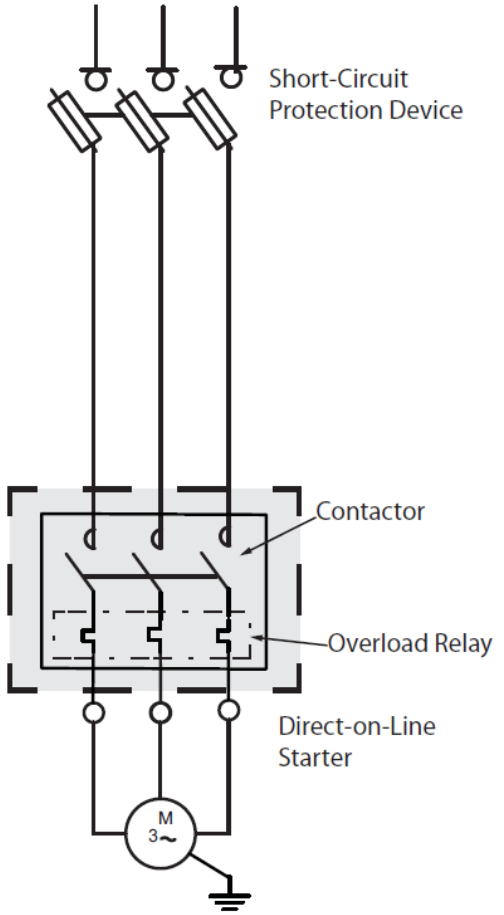
## Motor Protection and Control

### Direct Online Starters

- Traditional starting method
- Full voltage with no control of the start
- Compact and cost efficient solution
- Mostly used for small motors

**Potential electrical problems**
- Warm cables
- Tripping breakers

**Potential mechanical problems**
- Slipping belts
- Heavy wear and tear
- Damaged products




# Motor Starting

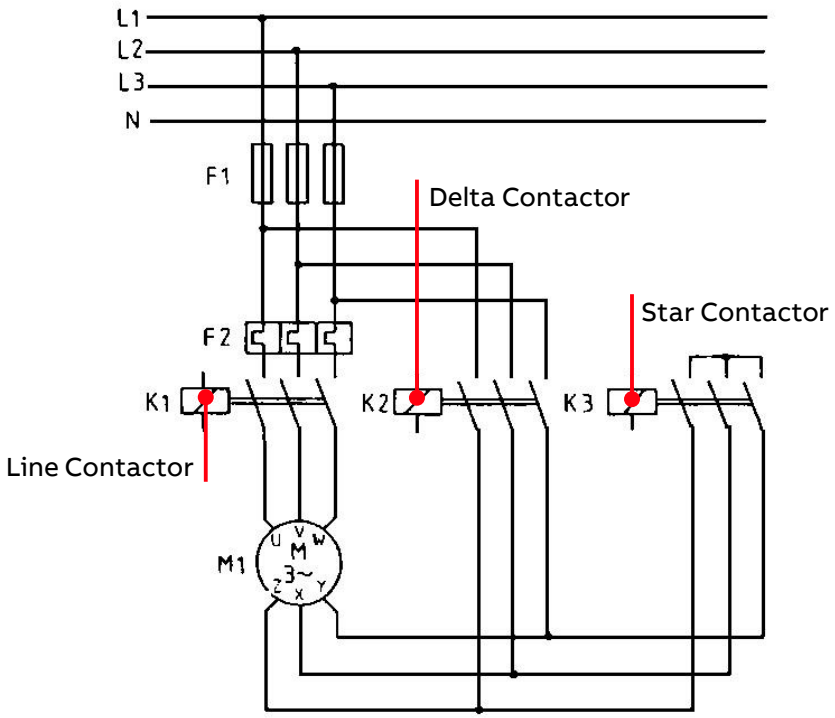
## Star Delta Starters

# Motors Starting Methods

## Star-Delta Starter

### General Characteristics

- Low starting current (only at successful start)
- Transmission peaks at loaded start
- Low starting torque (often too low)
- Long starting time
- Always direct stop
- Many devices – complex  wiring
- Double motor cables



# Motor Starting

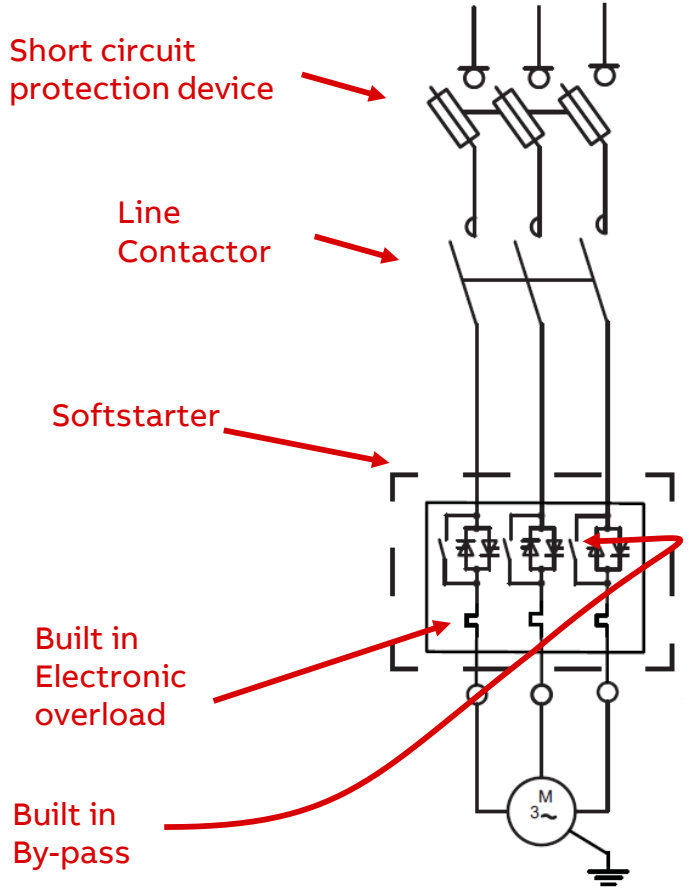
## Soft Starters

# Motors Starting Methods

## Soft Starters (Starting and Stopping)

### General Characteristics

- Adjustable starting current
- Correct starting torque matching the need
- Possibility to soft stop
- Medium long starting time
- Minimum mechanical wear.

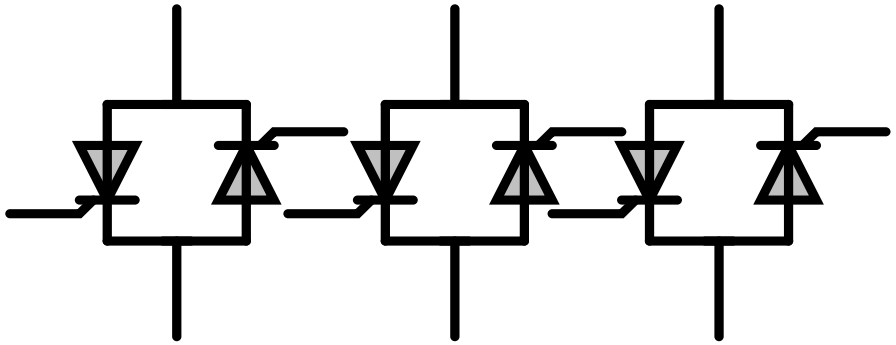


# Soft starters

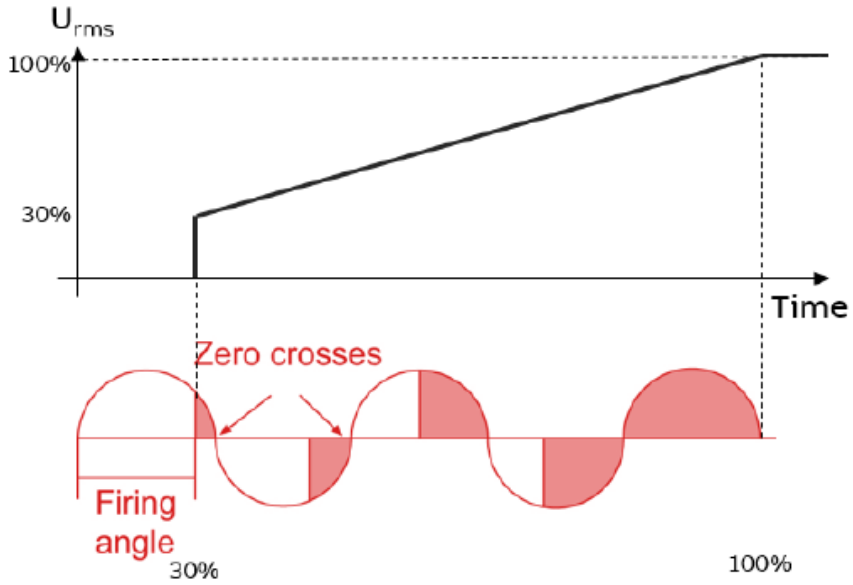
## Principal Function

### Theory of Operation

Anti-parallel connected thyristors



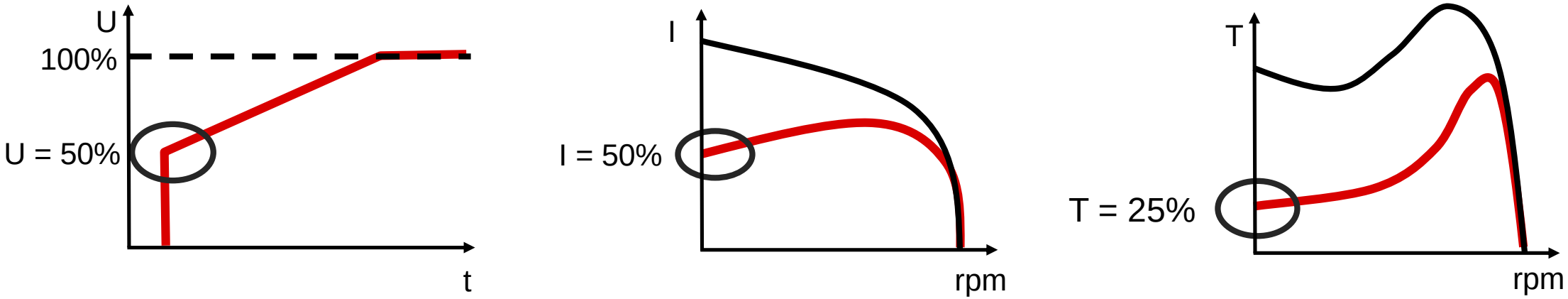
Voltage reduction during starting



# Soft Starters

Principal Function

## Theory of Operation




https://new.abb.com/drives/softstarters/software-and-tools

# Soft Starters

Sometimes the benefits are really obvious

## Conveyor Belts

https://www.youtube.com/watch?v=DFCDAsd6Hd4

## Water Hammering

https://www.youtube.com/watch?v=NGZd6DZw-IE

# Soft Starters

ABB Portfolio

## PSR - Basic Range

- 3 - 105A
- Built in bypass.
- Flexible mounting.
- Optional communication.
- Connection kits for Easy mounting with ABB MMS.

## PSE – Mid Range

- 18 - 370A
- Built in bypass.
- User friendly HMI
- Torque control.
- Current limit (1.5-7*Ie)
- Basic motor protection functions.
- Analogue output.
- Optional communication

## PSTX – Advanced Range

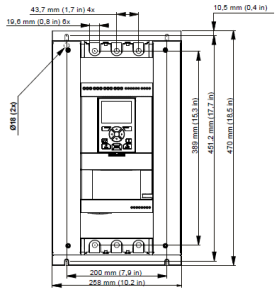
- 30 - 1250A
- Built-in bypass.
- User friendly and detachable HMI
- Basic and advanced protection functions.
- Motor Heating.
- Pump Cleaning
- Limp Mode
- Motor Jogging and Breaking
- Torque Control

# PSTX Softstarters

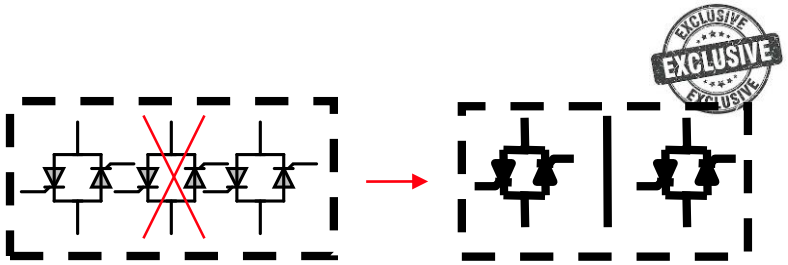
Why to use internal Bypass contactors

## It’s the latest technology!

## Reducing Panel size



## Limp Mode




3-phase control

2-phase control

## Reverse Staring and Pump cleaning


## It’s not any option any more not to use the bypass contactor

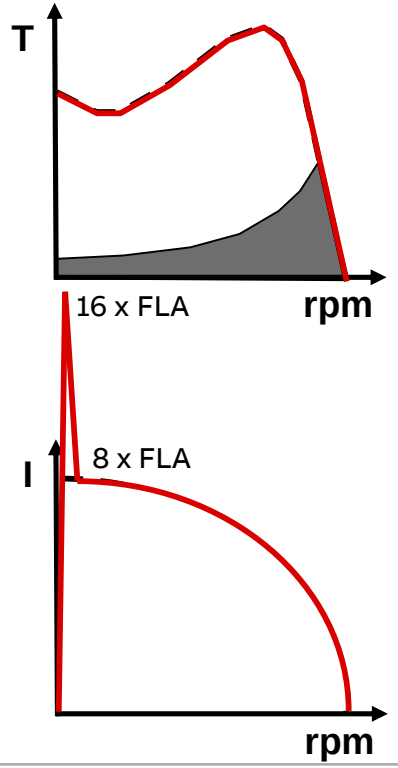
- Eliminate harmonics effect
- Decrease heat generation
- Increase thyristors lifetime

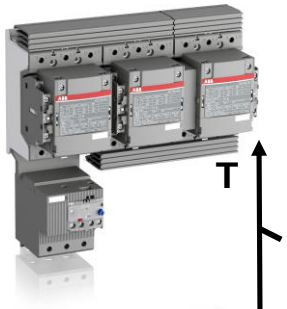
https://www.youtube.com/watch?v=Gp4Rvj-c9Dc

# Motor starting solutions

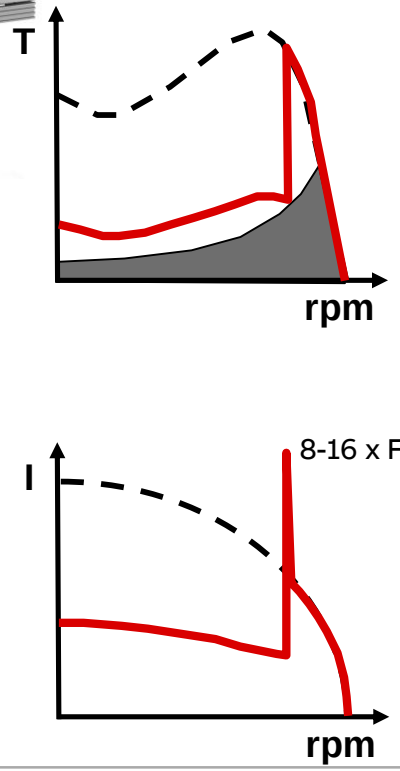
Different ways to start a motor

## DOL

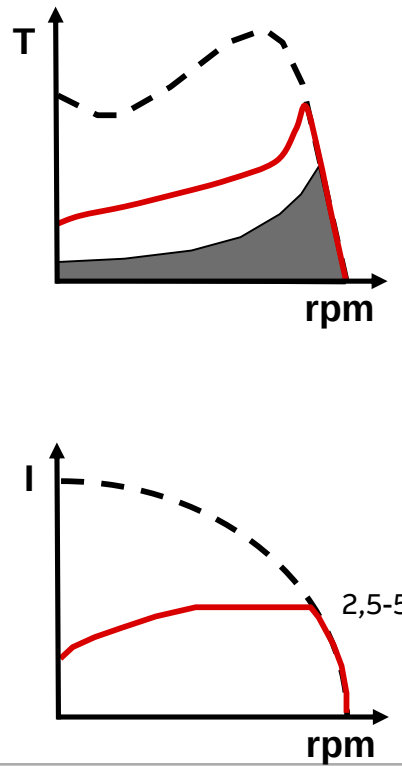


## Y/D



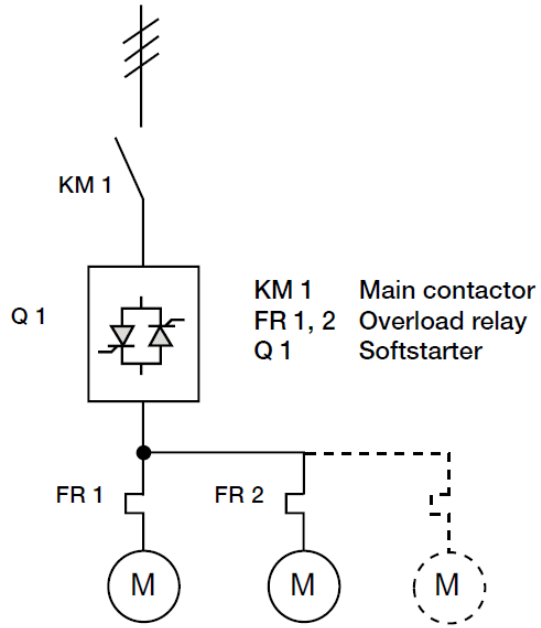

## Softstarter



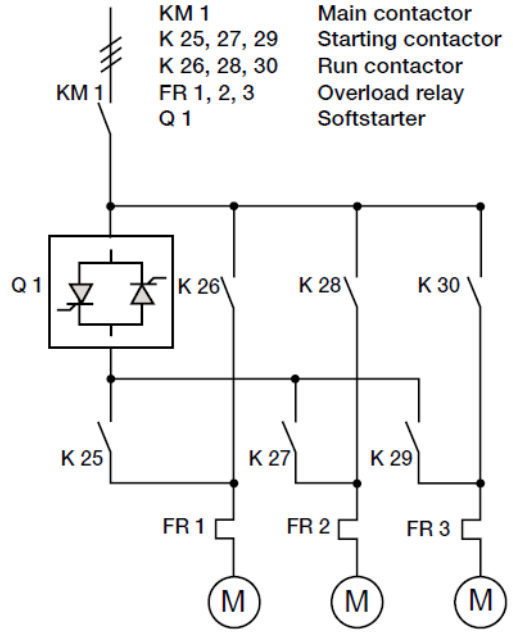
# Soft Starters

## Parallel and Sequential Starting

### Parallel Starting




### Sequential Starting



# Motor Starting

## Variable Speed Drives

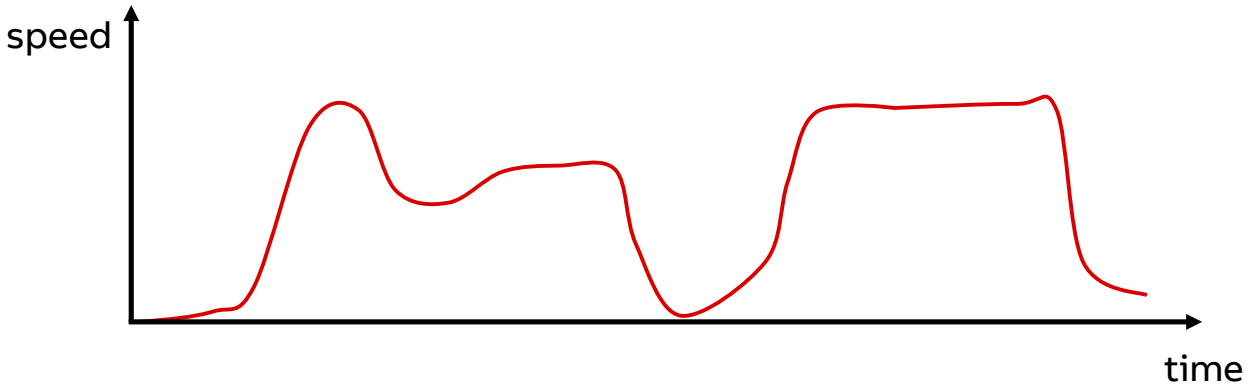
# Motors Starting Methods

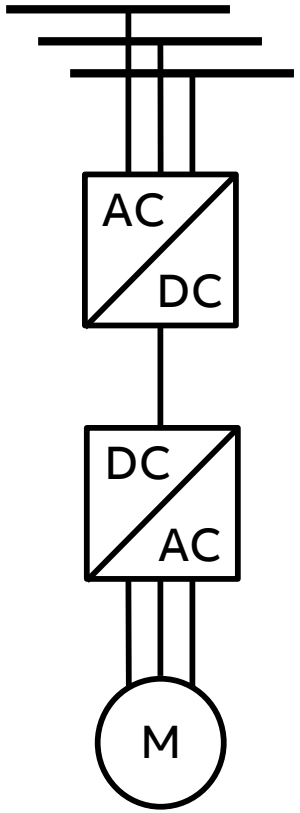
## Variable Speed Drives

https://www.youtube.com/watch?v=E0BattO-NAs

### General Characteristics

- Full control of speed, current and torque
- Energy saving from reducing speed
- Mostly used for process control
- No Value for full speed applications
- Creates Harmonics
- Heat Dissipation



# Motors Starting Methods

## Variable Speed Drives

https://www.youtube.com/watch?v=cap0baKxnwc

# Motion

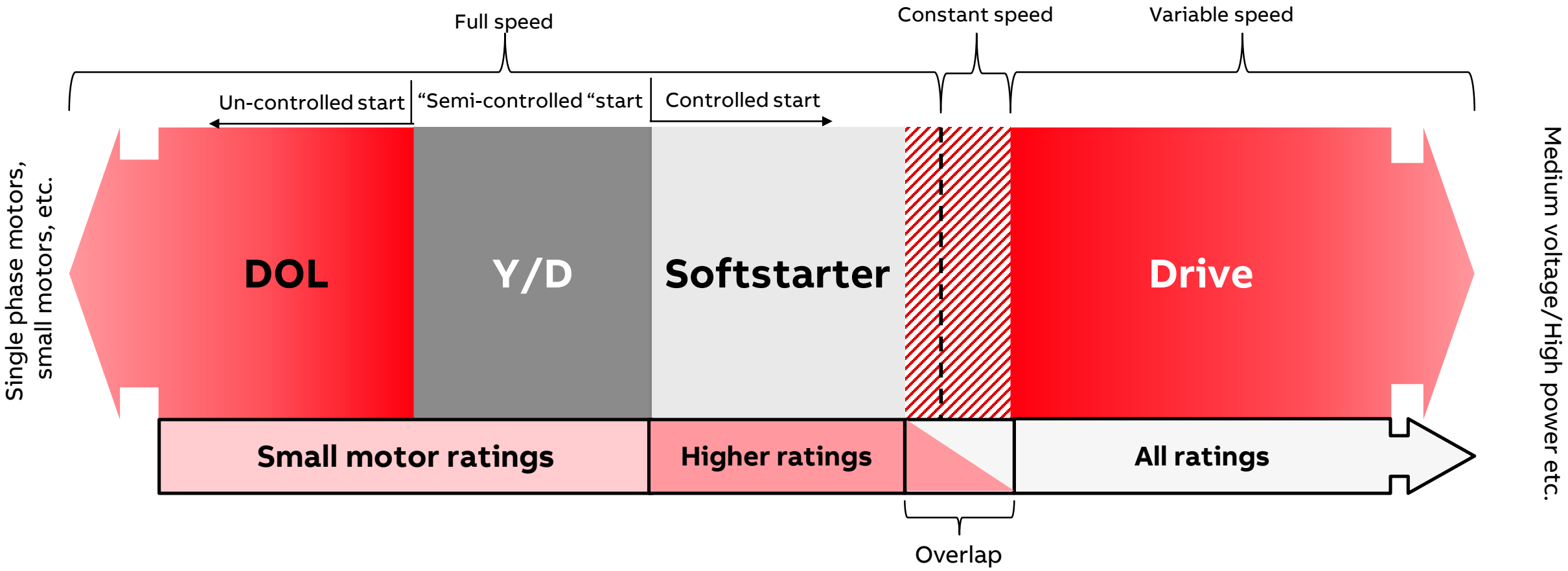
Drives

## Low Voltage Drives

- Low voltage AC 0.75 to 5600 kW
- Low voltage DC 7.5 kW to 4.8 MW
- Industrial drives
- Industrial specific drives 0.37 to 400 kW
- Drives for HVAC
- Drives for Water
- Micro drives 0.18 to 4 kW
- Machinery drives 0.18 to 560 kW
- General purpose drives 0.75 to 355 Kw
- Motion control products 0.75 to 160 kW

# The motor starting market

## Which starter shall be select






This picture doesn’t represent any actual size of market, it just a visualization to explain the market split

# Motor Starting

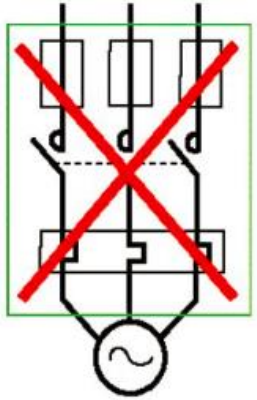
## Coordination of Protection

# Motors Starting

## Coordination of Protection

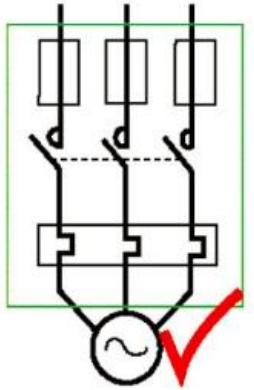
### Coordination type 1

- No risk for operators or installations
- Isolation is kept after inrush
- Before re-starting, starter repairing is necessary
- Other apparatus than contactor and overload relay shall not be damaged
- Cheaper
- Require more maintenance



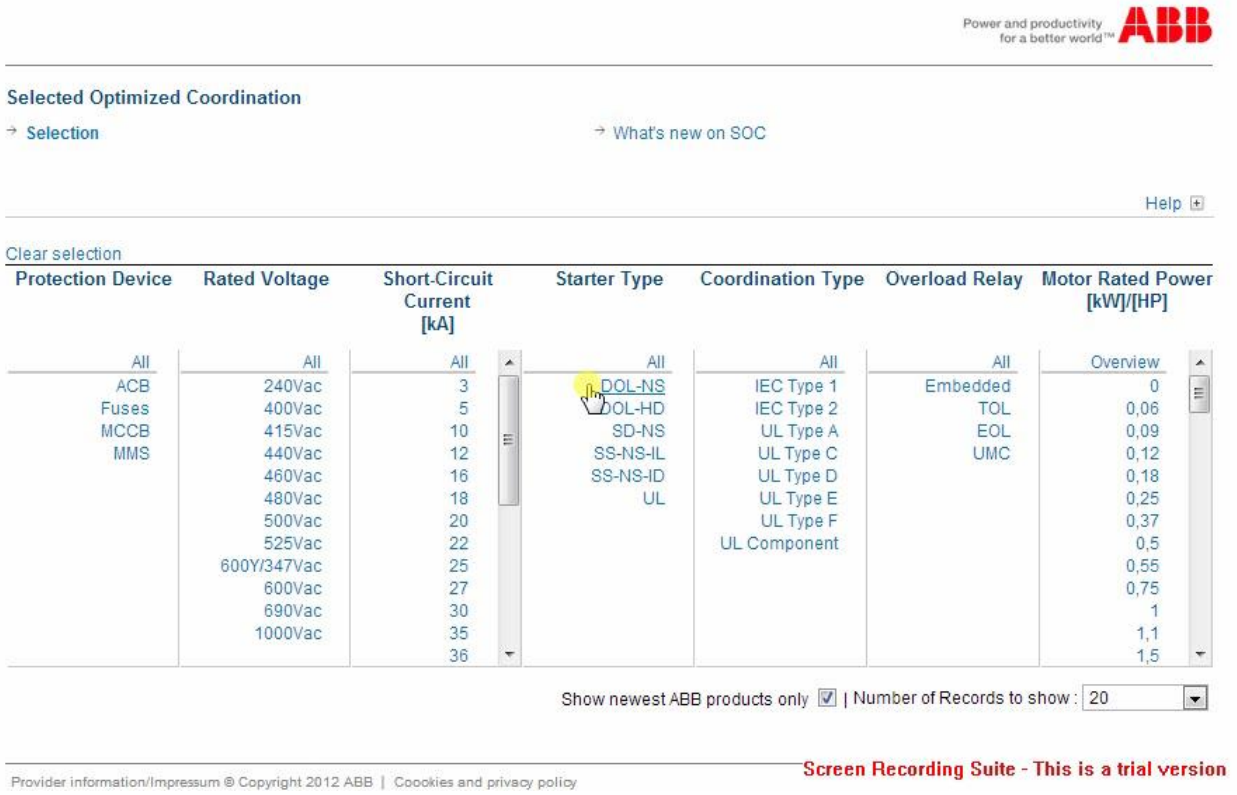
### Coordination type 2

- No risk for operators or installations
- Isolation is kept after inrush
- The starter is still working after short-circuit
- Before re-starting, a quick inspection is sufficient
- Light welding of contacts is allowed if they could be easily separated (by electrical operation or tool)
- Higher device size
- More economic in maintenance and parts



# Motors Starting

## Coordination Types



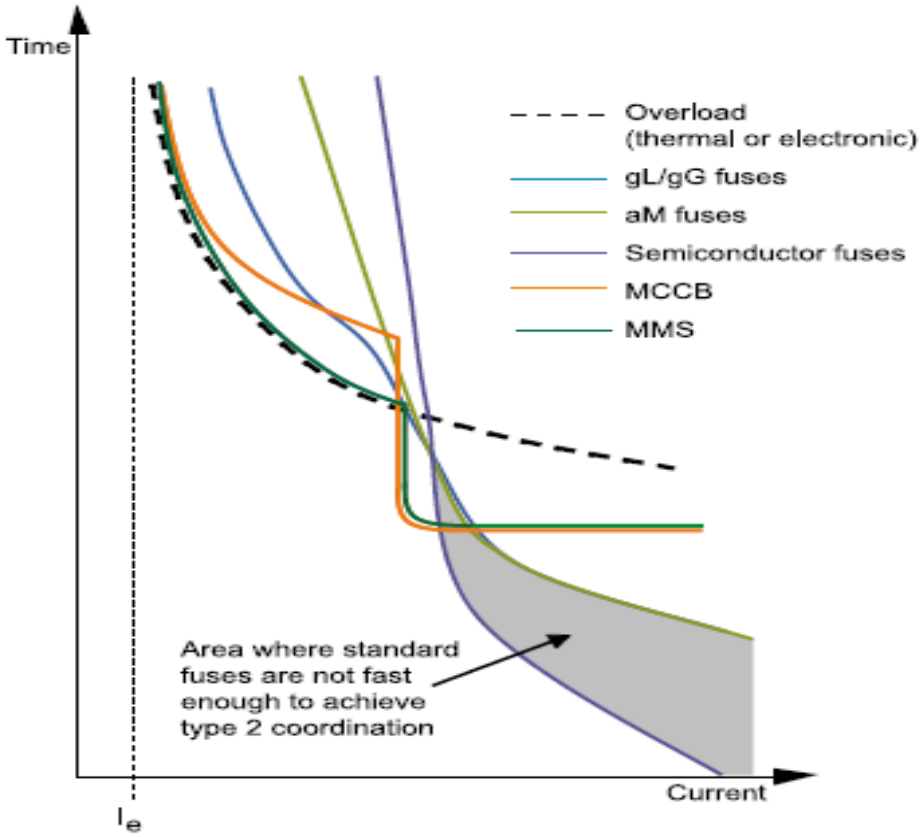

https://applications.it.abb.com/SOC/page/selection.aspx

# Soft Starters

## Coordination of Protection

### Coordination Type 2 for Soft starters

Semi-conductor fuses (High speed fuses) are the only type of fuses that are fast enough to achieve a fully type 2 coordination when using a soft starter. A separate overload relay for the motor protection is always required in combination with this type of fuse. If replacing the semi-conductor fuses with an MCCB, MMS or similar, type 1 coordination will be achieved instead.

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