MARKETING & SALES

ABB in Transportation

Products & solutions for Sustainable Mobility

Agenda

1. Introduction ABB Team and mandate
2. Technical presentation – circuit breakers
3. MCCB migration to XT series
4. ABB’s 1000VDC miniature circuit breakers
5. Push-in technology vs ring-tongue
6. ABB’s Engineered solutions
7. Workmanship and standards in rail projects

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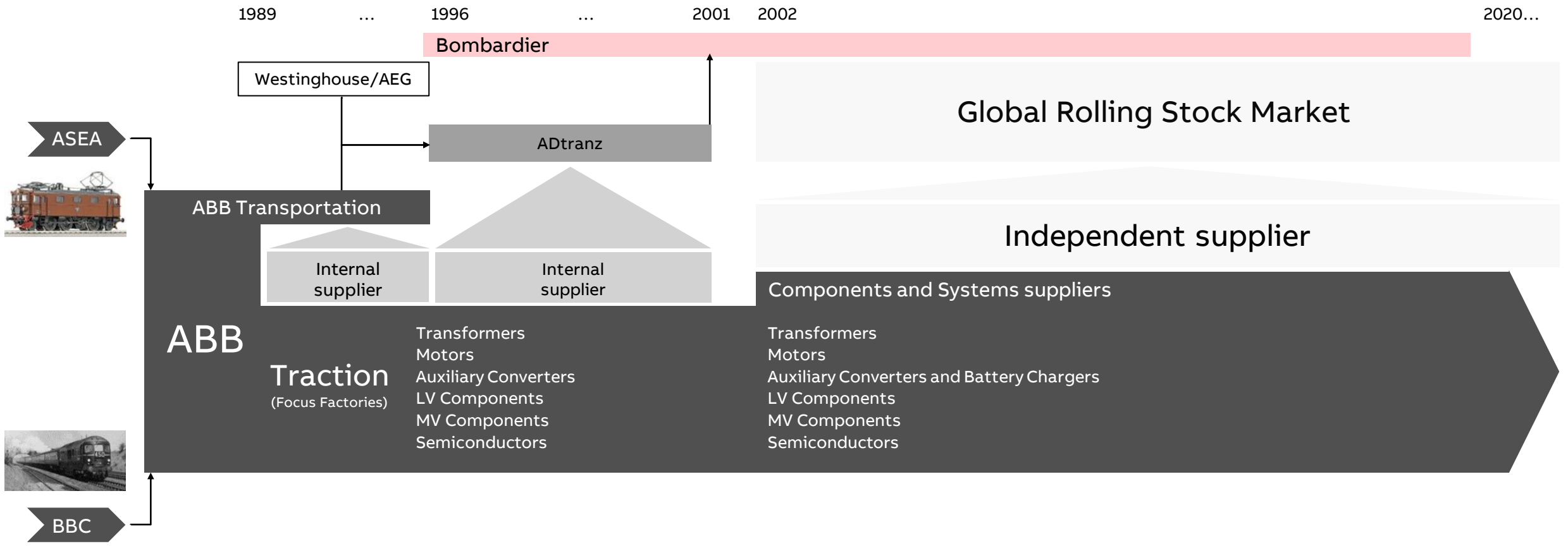
ABB in the rail industry

Since 1996 a growing independent components and systems supplier



Rolling Stock NAM - Value Proposition

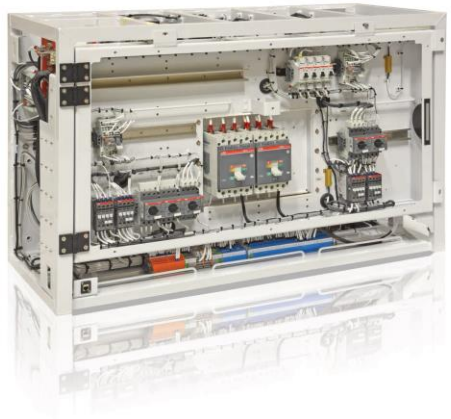
Service proven history	1	ABB is the first supplier in N.A. Rail market with more than 30,000 vehicles equipped with ABB products & systems. More then 30 years experience in the North American market.
D.B.E / W.B.E / Local content	2	ABB works with several DBE / WBE enterprise and Panel Builders that can support ABB products and solution.
Consultant	3	Good collaboration with the main consultant firms in North America which allow us to propose the right ABB solution.
Expertise	4	Team with strong expertise to support rail customers for product selection and system design.
Service	5	ABB provide aftersales support, failure analyses and repair program for maintenance repair and operations.

Rolling Stock NAM – History in North America

1990

Components providers

2021



Partner as solution supplier

- More than **30 years** experience in the North American Rail industries
- More than **1,000,000 products** or systems installed
- More than **30,000 cars** (High Speed Trains, Regional Trains, Locomotives, LRV, Metro, Trams,…)
- More than $**400MUSD** installed base (ELSP/ELSB/ELIP)

A major supplier to the NAM Rail Industry

One Sales Organization

Electrification – CoE Rolling Stock NAM

Go to market Strategy, New Projects & Overhaul

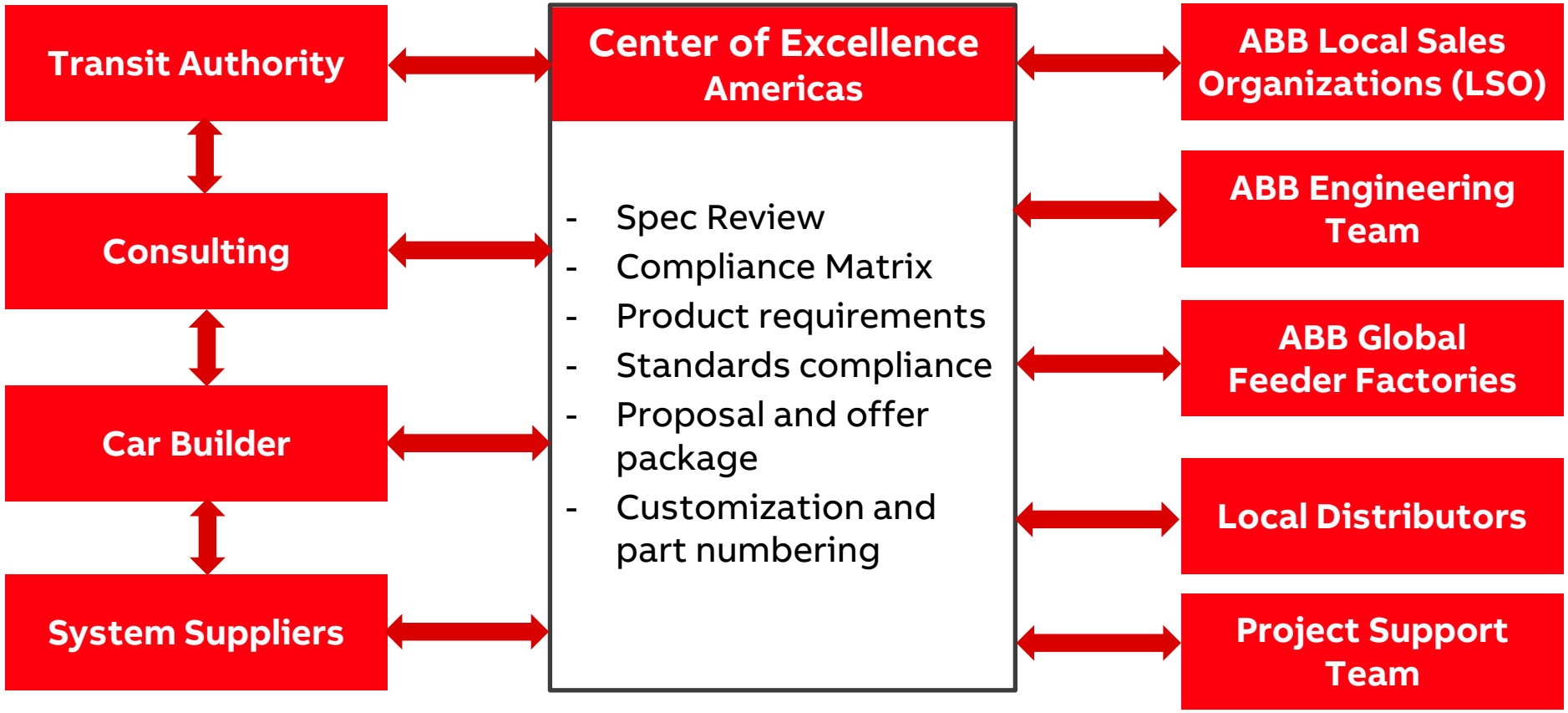


ABB NAM Railway Center of excellence + Railway Workmanship

We can supply loose components and Assembly, ABB engineered Solution or built to print Solutions assemblies

EPPC-EPBP Canada

Campus Montreal

Rolling stock NAM – New vehicles and overhaul

High-speed rail

Electrical Multiple unit trains

Locomotive, dual, electric, diesel-electric

Metro

Light Rail Vehicles, People mover

E-Bus

Rolling Stock NAM – ABB EL Portfolio, Products

Distribution Panel

Miniature Circuit Breakers

Moulded Case Circuit Breakers

Switches

Control Panel

Relays & contactor

Manual Motor Starters

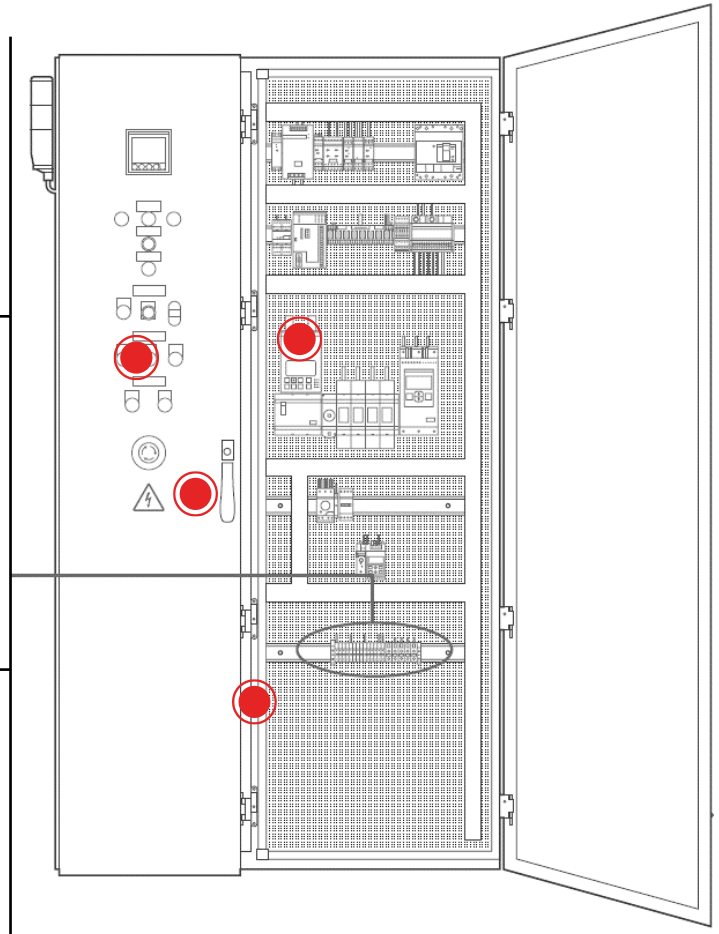
Electronic Products

Conduit fitting grounding

PMA Cable Protection

Cables ties and accessories

Braids - grounding



Rolling Stock NAM – ABB EL Portfolio, Solutions

HVAC Control Panels

Distribution Panels

Trainline Systems Control

Driver cabin

Cable Protection System

Control & Distribution panel

1000Vdc Protection

Power & Auxiliary Converters

Circuit Breakers

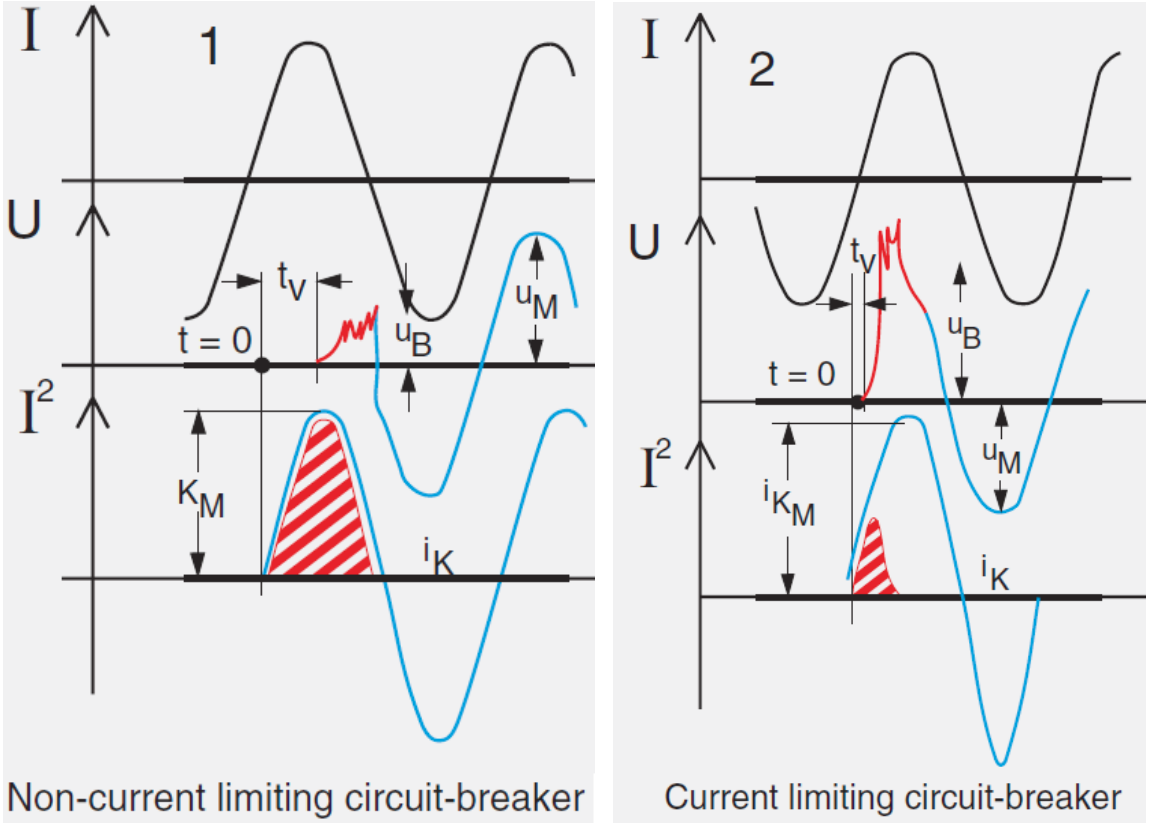
Fundamentals and operation basics

Circuit breaker fundamentals

- Circuit breakers in rail applications mainly used for the following tasks:
  - ✓ Cable protection against short circuit currents (IEC 60949)
  - ✓ Cable / load protection from damage caused by overload/overheat (NEC (NFPA 70), IEC 60364-4-43 / IEC 60898)
  - ✓ Circuit Insulation for maintenance and safety
  - ✓ Mixed objectives
- Most circuit breakers on the market are designed as per IEC 60947-2 standards while in USA/Canada UL/CSA standards are more common.
- IEC 60947-2 standard defines main circuit breakers performance and characteristics:
  - ✓ Tripping limits specified by standardized curves: B,C,D,K
  - ✓ Dielectric properties
  - ✓ Operational performance (where applicable)
  - ✓ Short-circuit breaking capacities: Isc in kA

Circuit breaker for cable protection

- Protection shall clear fault current prior wire damage
  - ✓ Wire insulation damage for insulated wire
  - ✓ Conductor damage for non-insulated wire
- Shall limit temperature rise below thermal stress of the following components:
  - ✓ Wire terminals (ex. AMP limit – 105°C).
  - ✓ Conduits
  - ✓ Wire termination connections: circuit breakers, contactors, TBs etc
- Current limit circuit breaker – limits let-through energy and allows using smaller cable
- Circuit breaker and wire protection standards
  - ✓ NEC (NFPA 70) for North America
  - ✓ IEC 60949, IEC 60364-4-43, IEC 60898, IEEE 399 (Brown Book)



iKm = maximum values of symmetrical component of short-circuit current squared shaded in

Red hatching = specific let-through energy

Circuit breaker for cable protection

- IEC 60949 protection approach (both adiabatic and non-adiabatic methods)
  - ✓ Standard estimates are based on temperature rise of the conductor:

$$Q = C_p \cdot m \cdot \Delta T \qquad (1)$$

$$substitute: \quad m = \rho_c \cdot V, \qquad \mathrm{V} = S \cdot l$$

$$Q = C_p \cdot \rho_c \cdot S \cdot l \cdot \Delta T \qquad (2)$$

  - ✓ Conductor temperature rise is due to energy of electrical heat dissipation caused by the current (material resistivity is from IEC 60287-1-1/Table 1):

$$E = Pdt \qquad (3)$$

$$substitute: \quad P = I^2 \cdot \mathrm{r}, \qquad \mathrm{r} = \frac{\rho \cdot l}{S}, \qquad \rho = \rho_0(1 + \alpha_0 \Delta T_0)$$

$$E = \frac{I^2 \cdot dt \cdot \rho_0(1 + \alpha_0 \Delta T_0) \cdot l}{S} \qquad (4)$$

C_p – specific heat $\left[{}^{J}/_{g \cdot K} \right]$

m – mass$[g]$

ΔT – temperature $change$ $[K]$

ρ_c – material dencity $\left[{}^{g}/_{mm^3} \right]$

V – volume$[\mathrm{mm}^3]$

S – conductor $cross - section[\mathrm{mm}^2]$

l – wire length$[mm]$

α_0 – $material\ temperature\ coefficient\ of\ resistance\ @\ 0°C$

ρ – material resistivity $[Ohm \cdot mm\ ]$

ρ_0 – $material\ resistivity\ @\ known\ temperature\ T_0\ (ex. 0°C), [Ohm \cdot mm\ ]$

Circuit breaker for cable protection

✓ Finally, resolving Q = E:

$$C_p \cdot \rho_c \cdot S \cdot l \cdot \Delta T = \frac{I^2 \cdot dt \cdot \rho_0 (1 + \alpha_0 \Delta T_0) \cdot l}{S} \qquad (5)$$

$$I^2 \cdot dt = \frac{S^2 \cdot C_p \cdot \rho_c}{\rho_0} \cdot \frac{\Delta T}{1 + \alpha_0 \Delta T_0} \qquad (6)$$

$$I^2 \cdot t = \frac{S^2 \cdot C_p \cdot \rho_c}{\rho_0} \cdot \int_{T_1}^{T_2} \frac{dT}{1 + \alpha_0 \Delta T_0} = S^2 \cdot \frac{C_p \cdot \rho_c}{\rho_0 \cdot \alpha_0} \ln(1 + \alpha_0 \Delta T_0) \Big|_{T_1}^{T_2}$$

$$= S^2 \cdot \frac{C_p \cdot \rho_c}{\rho_0 \cdot \alpha_0} \cdot \ln \frac{1 + \alpha_0 \Delta T_2}{1 + \alpha_0 \Delta T_1} \quad \Rightarrow \quad substitute: \quad \beta = \frac{1}{\alpha}$$

$$I^2 \cdot t = S^2 \cdot \overbrace{\frac{C_p \cdot \rho_c}{\rho_0}}^{\delta_c} \cdot \beta_0 \cdot \ln \frac{\beta_0 + \Delta T_2}{\beta_0 + \Delta T_1} = S^2 \frac{\delta_c (\beta_0 + 20) \cdot 10^{-12}}{\rho_{20}} \ln \frac{\beta_0 + \Delta T_2}{\beta_0 + \Delta T_1} = K^2 S^2 \ln \frac{\beta_0 + \Delta T_2}{\beta_0 + \Delta T_1} \qquad (6)$$

C_p – specific heat $\left[{}^{J}/_{g \cdot K} \right]$

m – mass$[g]$

ΔT – temperature $change$ $[K]$

ρ_c – material dencity $\left[{}^{g}/_{mm^3} \right]$

V – volume$[mm^3]$

S – conductor $cross - section [mm^2]$

l – wire length$[mm]$

α_0 – $material\ temperature\ coefficient\ of\ resistance\ @\ 0°C$

β_0 – $reciprocal\ of\ temperature\ coefficient$ of resistance $at\ 0°C$

δ_c – $volumetric\ specific\ heat\ @\ 20°C$

ρ_0 – $material\ resistivity\ @\ 0°C\ [Ohm \cdot mm\ ]$

ρ_{20} – $material\ resistivity\ @\ 20°C\ [Ohm \cdot m\ ]$

Circuit breaker for cable protection

✓ Final result for adiabatic process for short-circuits duration up to 5s:

$$I^2 \cdot t = K^2 \cdot S^2 \cdot \ln\left(\frac{\beta_0 + \Delta T_2}{\beta_0 + \Delta T_1}\right) \quad (IEC\ 60949)$$

$$K = \sqrt{\frac{\delta_c \cdot (\beta_0 + 20) \cdot 10^{-12}}{\rho_{20}}} \quad (7)$$

To find wire size S when short current is known:

$$S = \frac{I}{K} \cdot \sqrt{\frac{t}{\ln\left(\frac{\beta_0 + \Delta T_2}{\beta_0 + \Delta T_1}\right)}} \quad (8)$$

To find maximum short current that wire can withstand for duration t:

$$I = K \cdot S \cdot \sqrt{\frac{\ln\left(\frac{\beta_0 + \Delta T_2}{\beta_0 + \Delta T_1}\right)}{t}} \quad (9)$$

I – short – circuit current [A]

t – duration of sh*ort circuit* $[s]$

ΔT – temperature *change* $[K]$

S – conductor *cross – section* $[mm^2]$

β_0 – *reciprocal of temperature coefficient* of resistance *at* $0°C$ [K]

δ_c – *volumetric specific heat* @ $20°C$ $\left[\frac{J}{K \cdot m^3}\right]$

ρ_{20} – *material resistivity* @ $20°C$ $[Ohm \cdot m]$

K – *constant for short circuit calc.* $\left[\frac{As^{\frac{1}{2}}}{mm^2}\right]$

Ex.: 14AWG, Exane DAA1068A, Max insulation temp.: 110°C, ambient temp.: 50°C

Short duration	3ms	4ms	8ms	10ms	17ms	20ms
Max Isc	3,880A	3,360A	2,375A	2,120A	1,630A	1,500A

Circuit breaker for cable/load overload/overcurrent protection

- NEC (2017) protection approach – Articles 240.4 and 310.15
  - ✓ Wire selection background is based on Neher-McGrath equation for wire ampacity and with short current protection similar to IEC 60949.
  - ✓ Wire selection based on amperage and temperature limit – selecting wire from table 310.15(B) for thermal equilibrium at 30/40°C ambient temperature.
  - ✓ Correction factor shall be used for higher temperatures. For temperatures higher than 55°C conductors with 75/90°C shall be used. Example, @ 60°C wire ampacity shall be corrected by multiplying by 0.58.
  - ✓ CB sized to be 125% x Full continuous load + 100% x Non-continuous load. This means that CB shall not be loaded for more than 80% (exception for 100%-rated breakers).
  - ✓ The conductor protection procedure is explained in Article 240.4(B).
  - ✓ Small conductors CB sized explicitly by 240.4(D): 7A (18AWG), 10A (16AWG), 15A (14AWG), 20A (12AWG)
  - ✓ Temperature limitation of terminations – Article 110.14(C)

Circuit breaker tripping characteristics

- Define CB tripping curve (defined in IEC/EN 60898-1 or UL489/UL1077)

UL489 (AC)

Z-Curve: 2 x In < Itrip < 3 x In

C-Curve: 5 x In < Itrip < 10 x In

K-Curve: 10 x In < Itrip < 14 x In

UL1077 (AC) / IEC/EN 608098-1

Z-Curve: 2 x In < Itrip < 3 x In (UL1077 only)

B-Curve: 3 x In < Itrip < 5 x In

C-Curve: 5 x In < Itrip < 10 x In

C-Curve: 7 x In < Itrip < 15 x In

D-Curve: 10 x In < Itrip < 20 x In

K-Curve: 10 x In < Itrip < 14 x In (UL1077)

DC current – tripping values for electro-magnetic trip increased by 1.5.

Circuit breaker tripping characteristics

Most popular tripping curves

Z-Curve:

Designed to protect circuits with very low short current settings (semiconductors)

B-Curve:

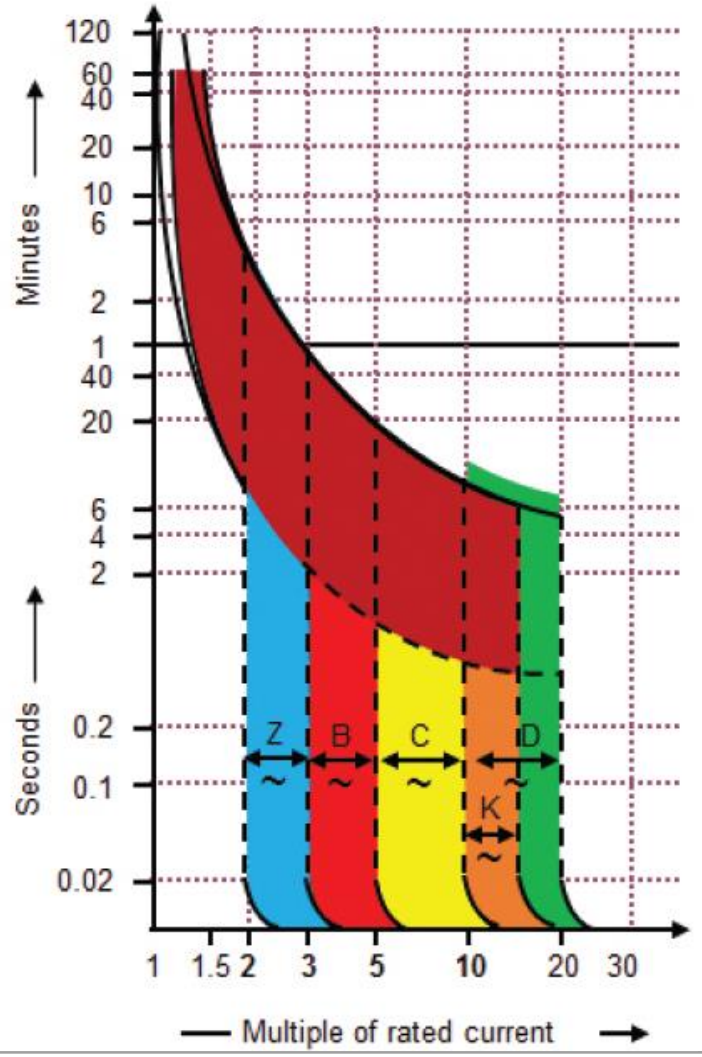
Designed for cable protection (control circuit, lighting)

C-Curve:

Designed for medium magnetic startups (lighting panels, control panels)

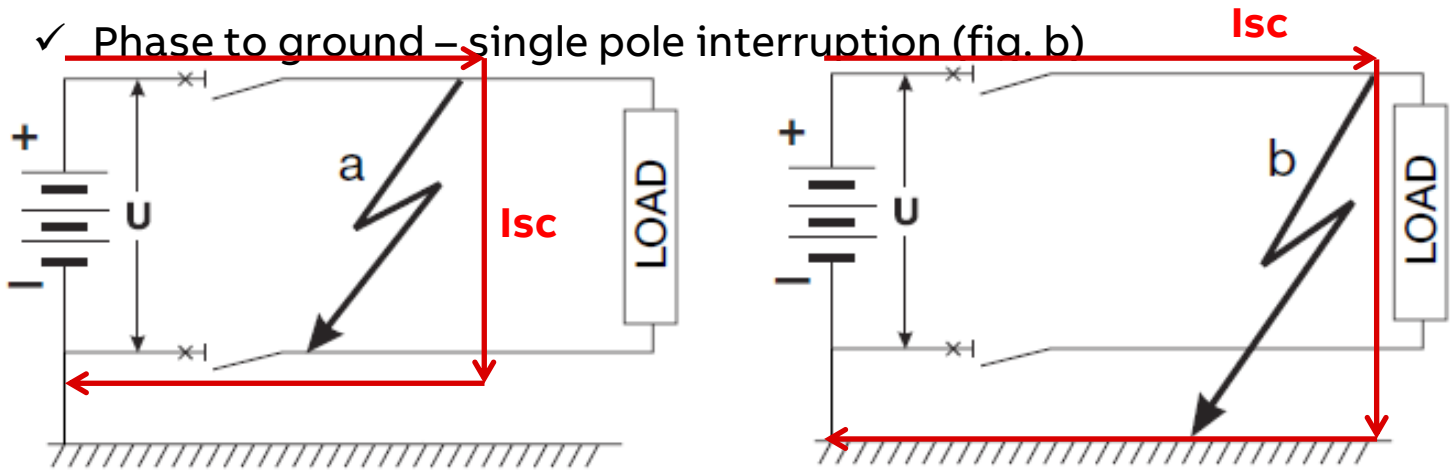
D and K-Curve:

Designed to allow high inrush loads (motors, transformers)



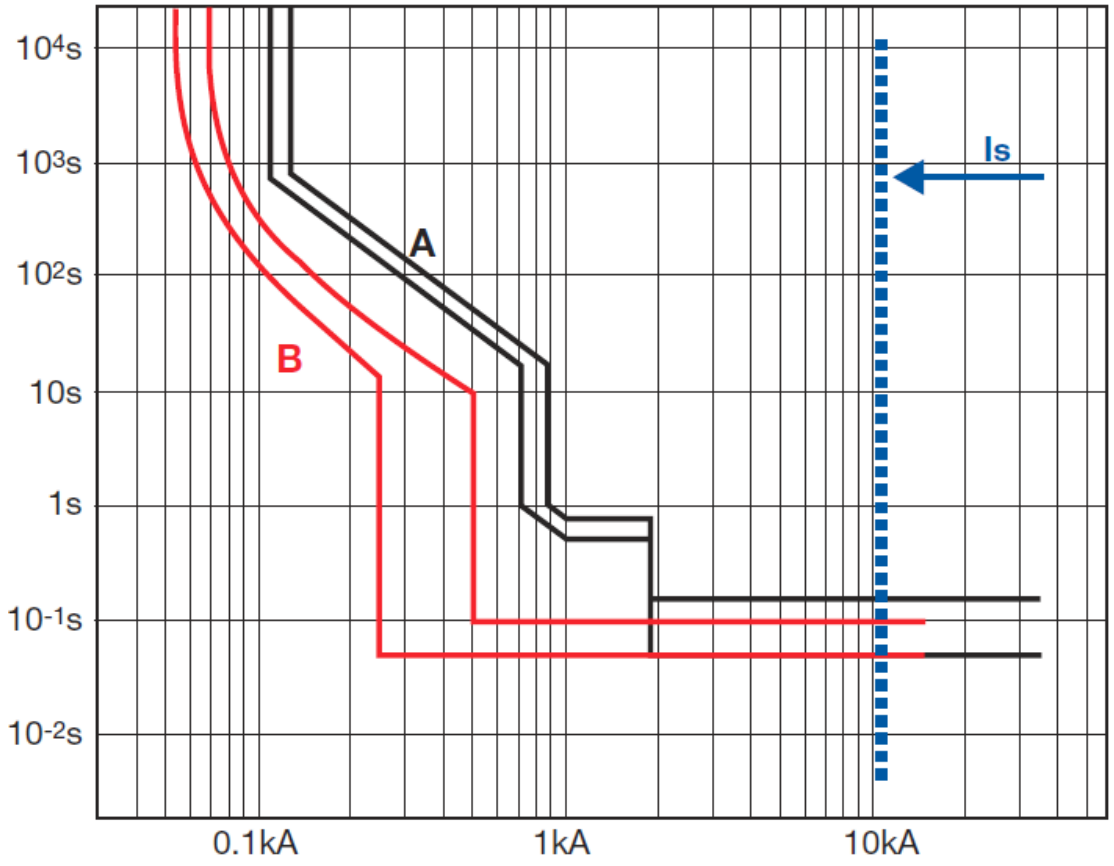
Circuit breaker rating – Voltage Slash ratings

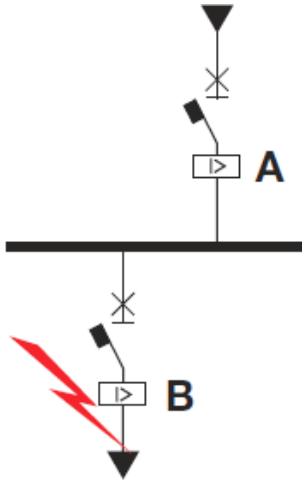
- Single Voltage rating
  - ✓ All type of circuits and connections (star/delta, grounded, ungrounded)
- Dual Voltage rating (ex. 480Y/277V or 480/277V)
  - ✓ Phase to phase – two-pole interruption (fig. a)
  - ✓ Phase to ground – single pole interruption (fig. b)



Circuit breaker rating – trip coordination

- Breakers trip coordination





Load side breaker B shall trip faster than supply side breaker A

Circuit breaker standards

- **IEC 60947-2, rating for voltages < 1000VAC/ 1500VDC**

  Common in world's IEC market place. Can be used as a stand-alone overcurrent protective device (outside North America)

- **UL489 (CSA 22.2 No.5), rating up to 600VAC (feeder) / 480VAC (branch)**

  Service entrance/Feeder (MCCB) and Branch (MCB)

  Large spacing (25mm air gap/50mm creepage for feeder, 19/32mm for branch)

  Feeder typically having rating of 15A and higher

- **UL1077, rating up to 480VAC**

  Supplementary / control

  Current limiting

  Smaller spacing (typically 17.5mm per pole)

  Usually having rating up to 63A (in some cases up to 125A).

- **UL508, rating up to 1500V (or IEC 60947-4-1)**

  Manual Motor controllers

  Smaller Spacing (except type-E), typically 45mm.

Most European Miniature Circuit Breakers are only UL1077 recognized, means they cannot be used as feeder or branch circuit protection per NEC. They can be added as a supplementary protection downstream to UL489 branch circuit breaker.

Miniature Circuit Breakers

Electrification - Transport & Infrastructure

ELSB – “ENERGY DISTRIBUTION”

ST200 MTR Miniature Circuit Breaker

Endurance and safety for rolling stock applications

Document ID.:

Rev.:

ST200 MTR Miniature Circuit Breaker

High technical performance
With ring tongue connection

Full range compatibility
With existing accessories

Compact dimensions
(88 x 69 x 17.5 mm)

COMPLIANCE TO TRACTION STANDARDS

- Fire and Smoke (NFPA-130 & EN45545-2)
- Compliant to product standards (IEC/EN 60947-2)
- Vibration and Shock approved (IEC/EN 61373)

ROBUSTNESS & HIGH ELECTRICAL ENDURANCE

- Electrical endurance with 20.000 cycles up to 32 A
- Wide temperature span from **-40°C to 75°C**
- Strong resistance to extreme humidity and dryness

SPACE & WEIGHT SAVINGS

- Compact dimensions: 88 x 69 x 17.5 mm
- Ensure high protection with a smaller cable cross-section diameter than conventional solutions, saving cable costs, space and weight

FLEXIBILITY & EASY REPLACEMENT

- Flexible range compatible with System pro M compact® standard and ring lugs accessories
- Fast and intuitive ordering thanks to self-speaking codes

ST200 MTR Miniature Circuit Breaker

High short circuit capacity
according to IEC/EN 60947-2
≤25 A: 25 kA (AC); 10 kA (DC)
>25 A: 15 kA (AC); 10 kA (DC)

Up to 1000 VDC in 4 poles Configuration

Homologated for North American market

captive and directly accessible screw

Electrical endurance
20.000 cycles up to 32A

Short circuit tested
IEC/EN 60898 10kA

High technical performance **with ring tongue** connection

ST200 MTR

Accessories Overview → for each application the fitting accessory

Accessories S2-FS. Ring tongue Range

Auxiliary contacts

Shunt Trip opening coils

Accessories S2C IEC Range

Signal / auxiliary contact (Universal)

Shunt Trip

Auxiliary contact

Rotary drive

Bottom-fitting wit auxiliary contact

Motor drive with remote switch on/off

Accessories S2C UL 489 Range

Signal / auxiliary contact (Universal)

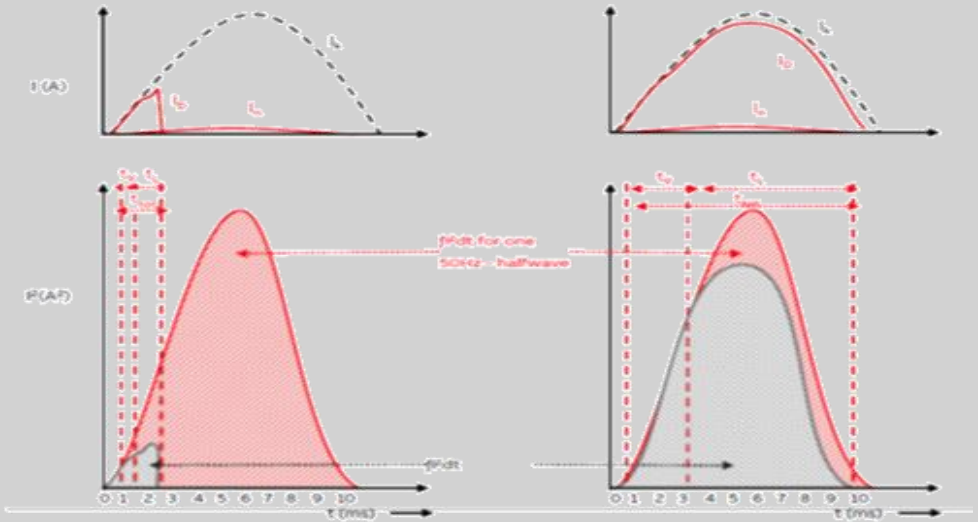
Shunt Trip

Benefits of mechanical circuit breakers

Technology comparison with hydraulic magnetic circuit breakers

TIME TO EXTINGUISH

3 – 4 ms **vs.** 10 ms



Current limiter /mechanical MCB

Zero-point extinguisher/ hydraulic magnetic MCB

TECHNOLOGY & SAFETY BENEFITS

+ Less heating of the cables
+ Lower risk of fire emergence
+ Load & Conductor Protection
+ Current Limiting (Class 3)
+ Rated current is independent from the installation position
+ 6 kA AC / 10 kA DC short circuit

Overview on the internal components

Bimetal overload trip

Benefits of mechanical circuit breakers

Technology comparison with hydraulic magnetic circuit breakers

ENSURED CABLE PROTECTION 24 A

	Mechanical MCB	Hydraulic Magnetic MCB
25 °C	14 AWG	14 AWG
70 °C	14 AWG	10 AWG → more than double size required

ECONOMIC BENEFITS

+ Space and weight savings
+ Ensuring higher protection with smaller cable section diameter to save space and costs for large cables

DESIGN BENEFITS

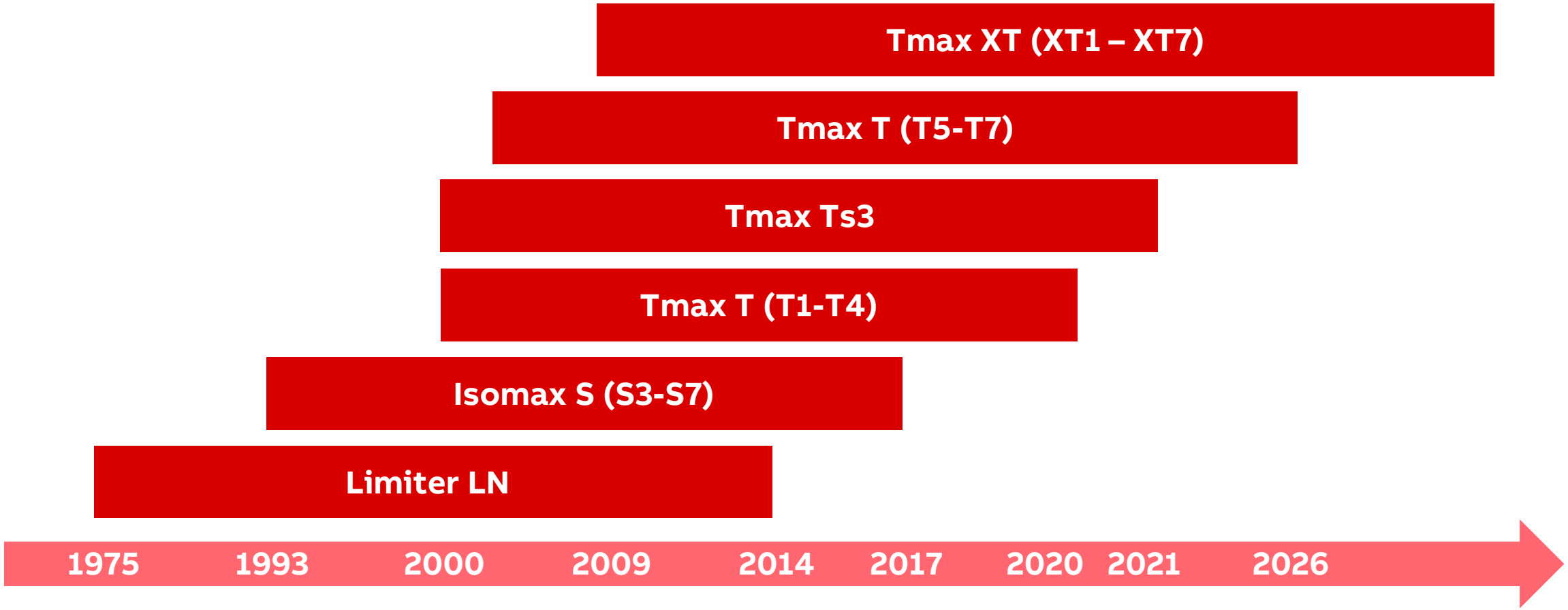
+ Standard connection
+ Captive hardware
+ Standardized component

MCCB migration to Tmax XT series

Technical solutions

Product history and major Life Cycle Management milestones

Most popular product lines used on Traction Applications in NAM



Tmax XT

Migration

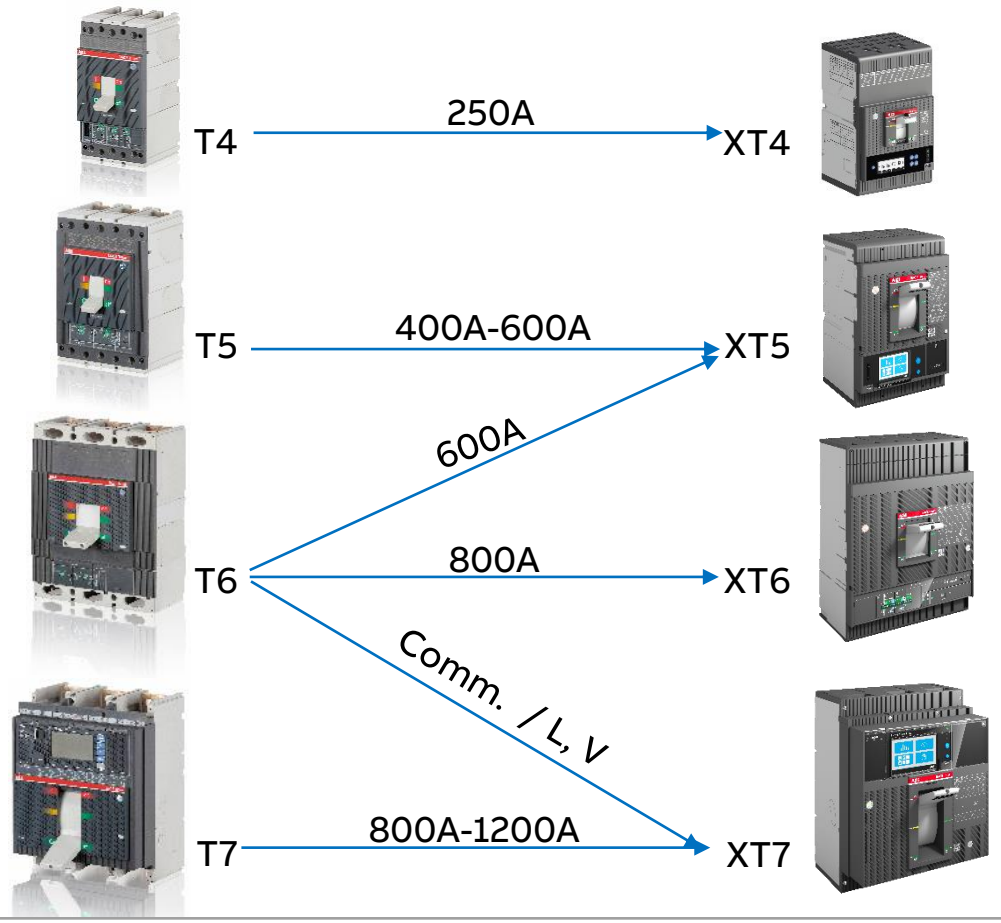
IEC

Migration drivers:

- Nominal currents
- Breaking Capacities
- Trip units

Tmax XT

Migration



IEC

Migration drivers:

- Nominal currents
- Breaking Capacities
- Trip units

UL

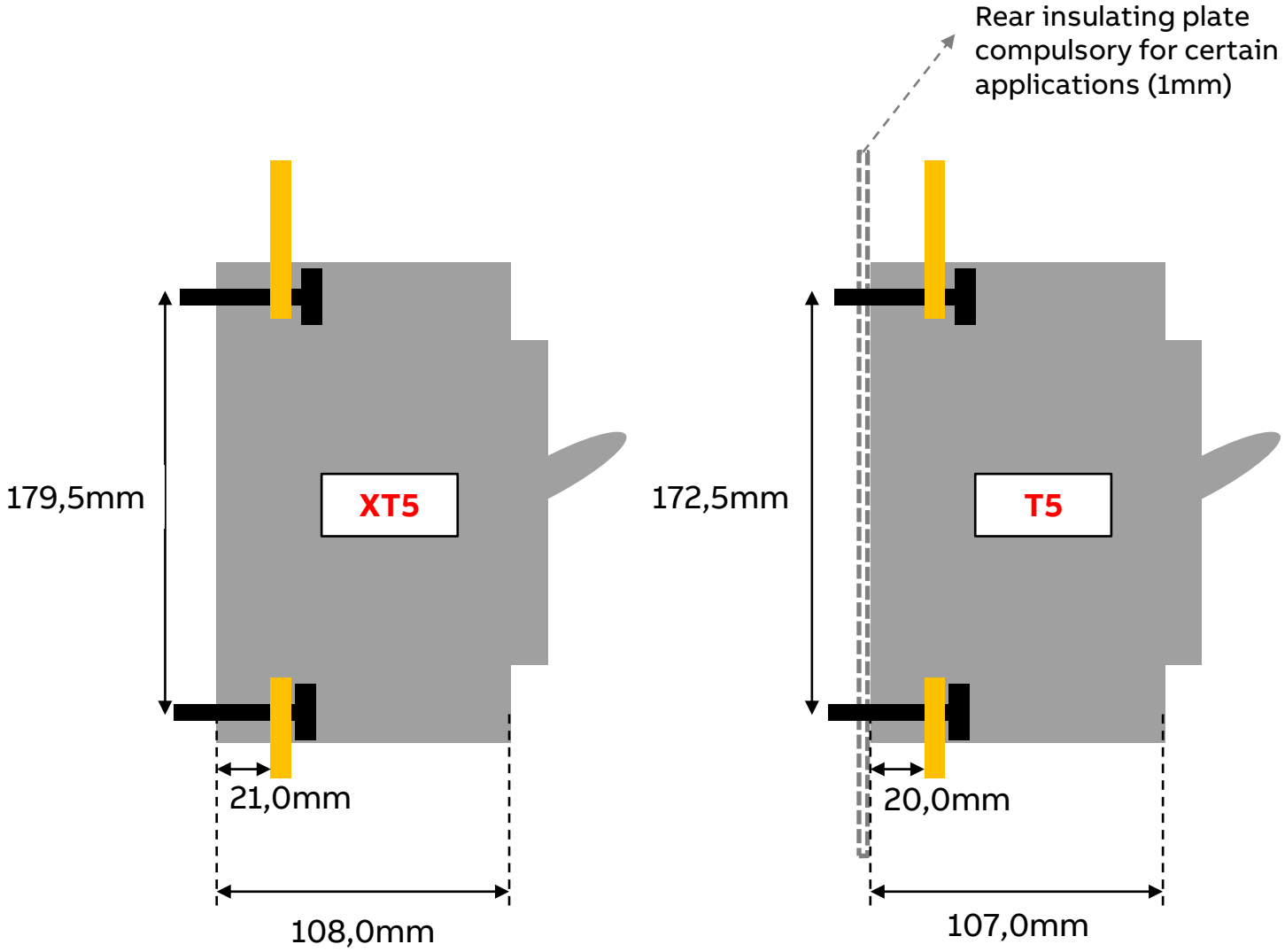
Migration drivers:

- Nominal currents
- Breaking Capacities
- Trip units

Tmax XT

Migration

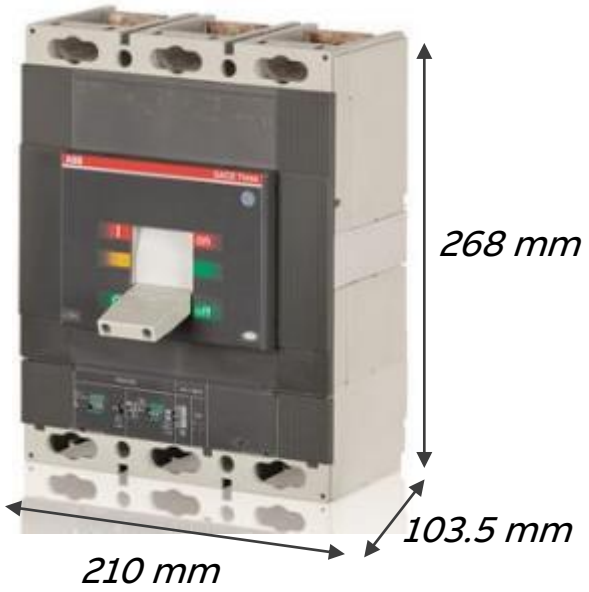
- ✗ There is a difference in the distance between bottom and top terminal connection fixing points (interaxe is now 179,5 mm, 7 mm more than Tmax T5)
- ✓ In case of **withdrawable or plug-in** version there are no differences in terms of connection points
- ✓ For **fixed version**, complete backward compatibility in case of connection with **cables**
- ✗ For **fixed version**, no backward compatibility in case of **busbars** connections and **F, EF, ES or R** terminals



Tmax XT

Migration

Tmax T6



Tmax XT7

Tmax T6

MOE

Depth:
230 mm

Tmax XT7M

Depth:
178 mm

Tmax XT

Life Cycle Management for Low Voltage Products

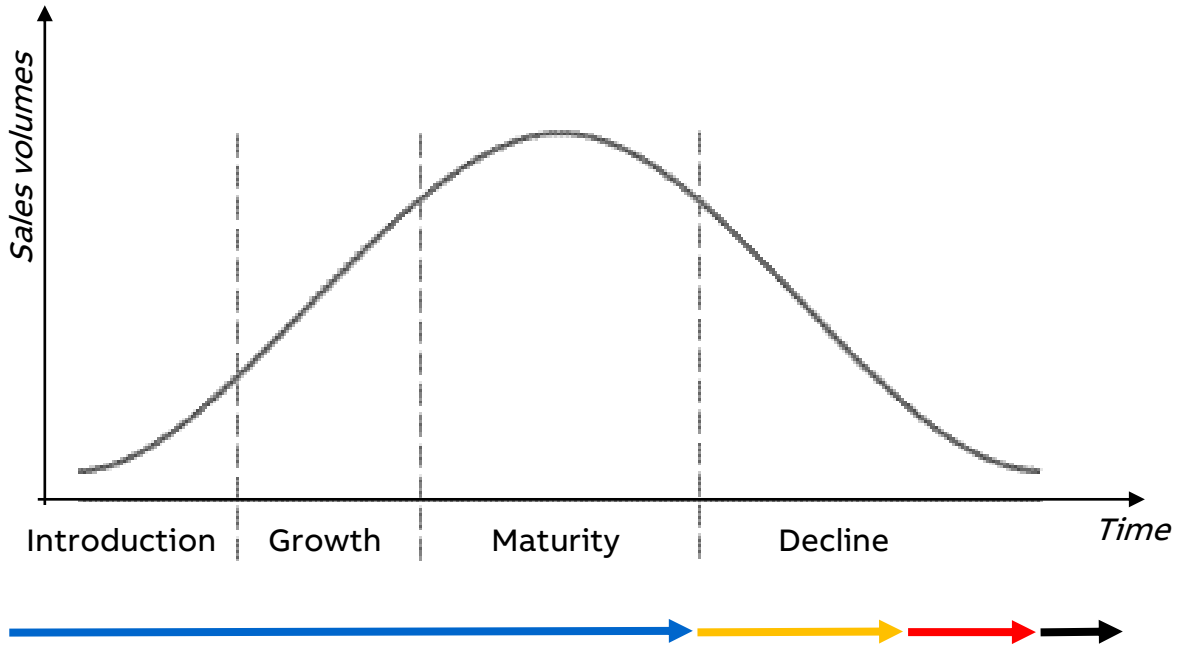
The concept

Active → Normal production, sales and development Phase

Classic → Product maintenance Phase; replacement products are guaranteed. Prices & delivery times usually increase due to lower volume, higher vendor component costs, etc.

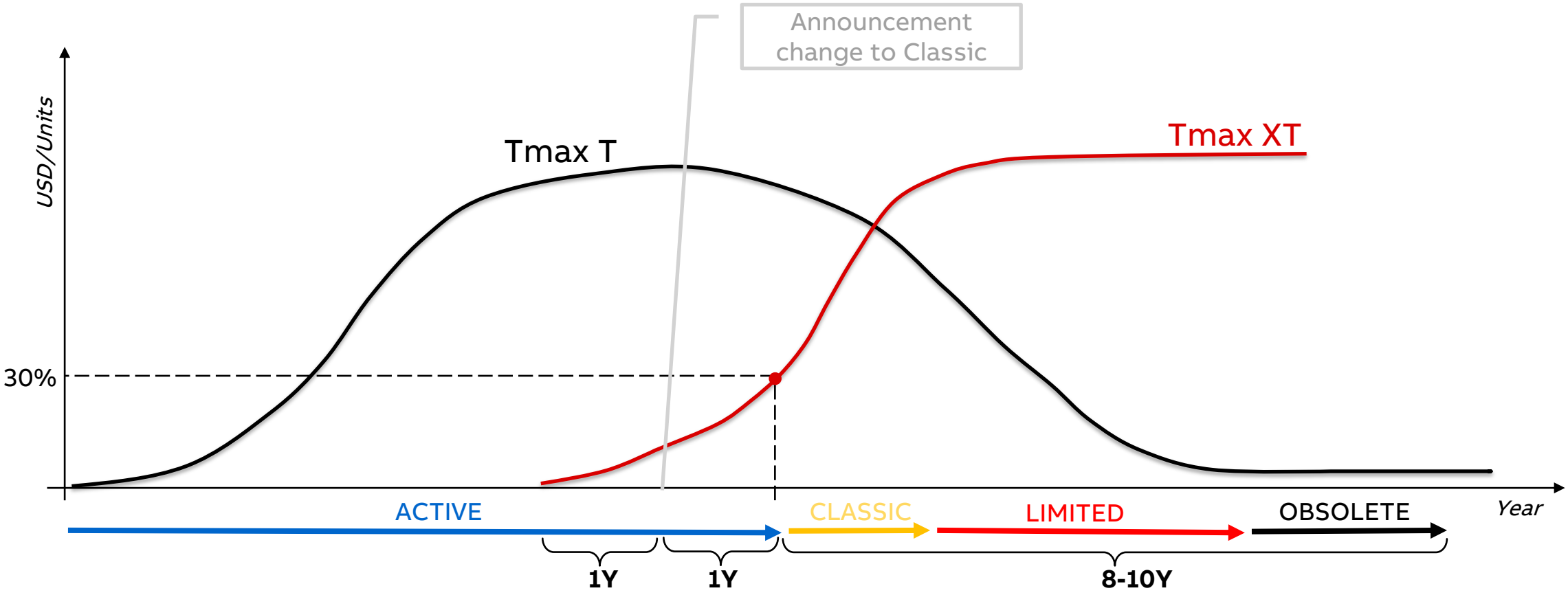
Limited → Limited production and guaranteed availability of spares

Obsolete → Reduced availability of components and Supports; availability of spares in not guaranteed.



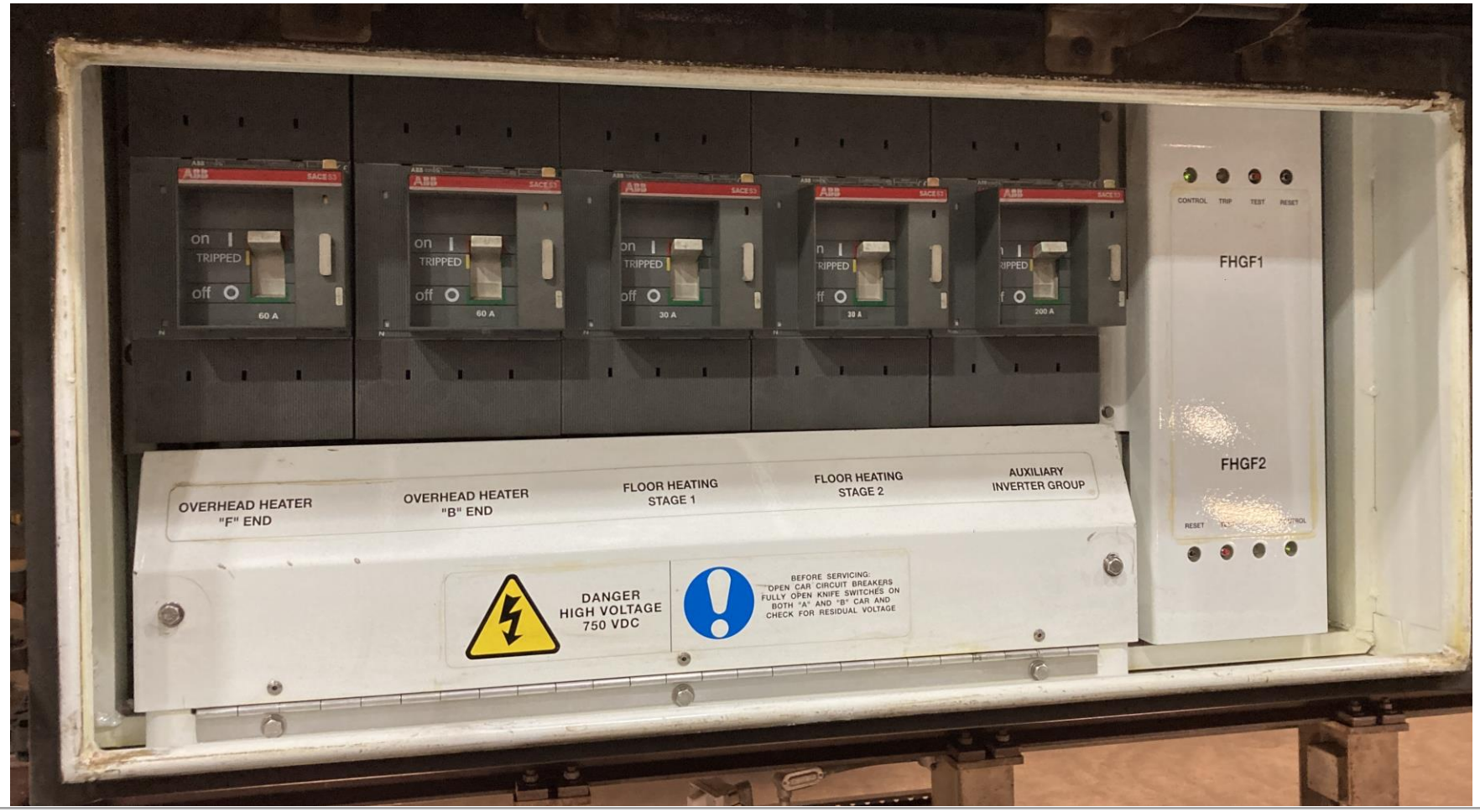
Tmax XT

When the LCM transaction will be done?



Example of traction application

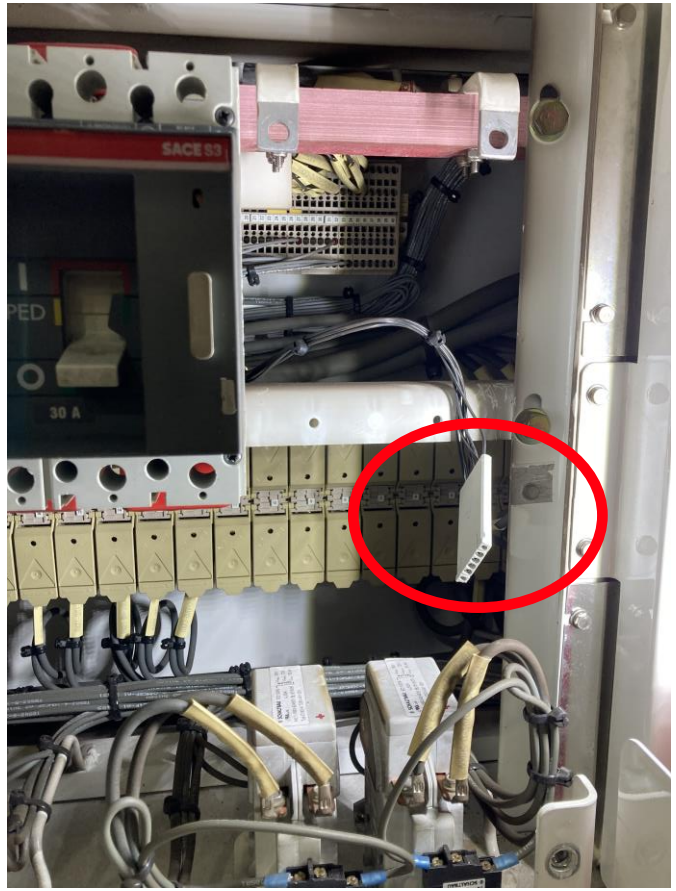
Most of MCCBs are installed in the electrical locker or inside the electrical box



Example of traction application (cont'd)

- Depending on the mounting scheme ABB provides an adapter plate solution to match the actual mounting holes
- Existing accessories used with Ts3 breakers are equipped with cable connectors. New XT breaker by design doesn't use any connector for accessories.
- ABB will provide new XT breaker with pre-installed accessories equipped with mating connector compatible with Ts3 accessory plug.

New XT4 MCCB with adapter plate



Accessory cable mating plug after Ts3 removal

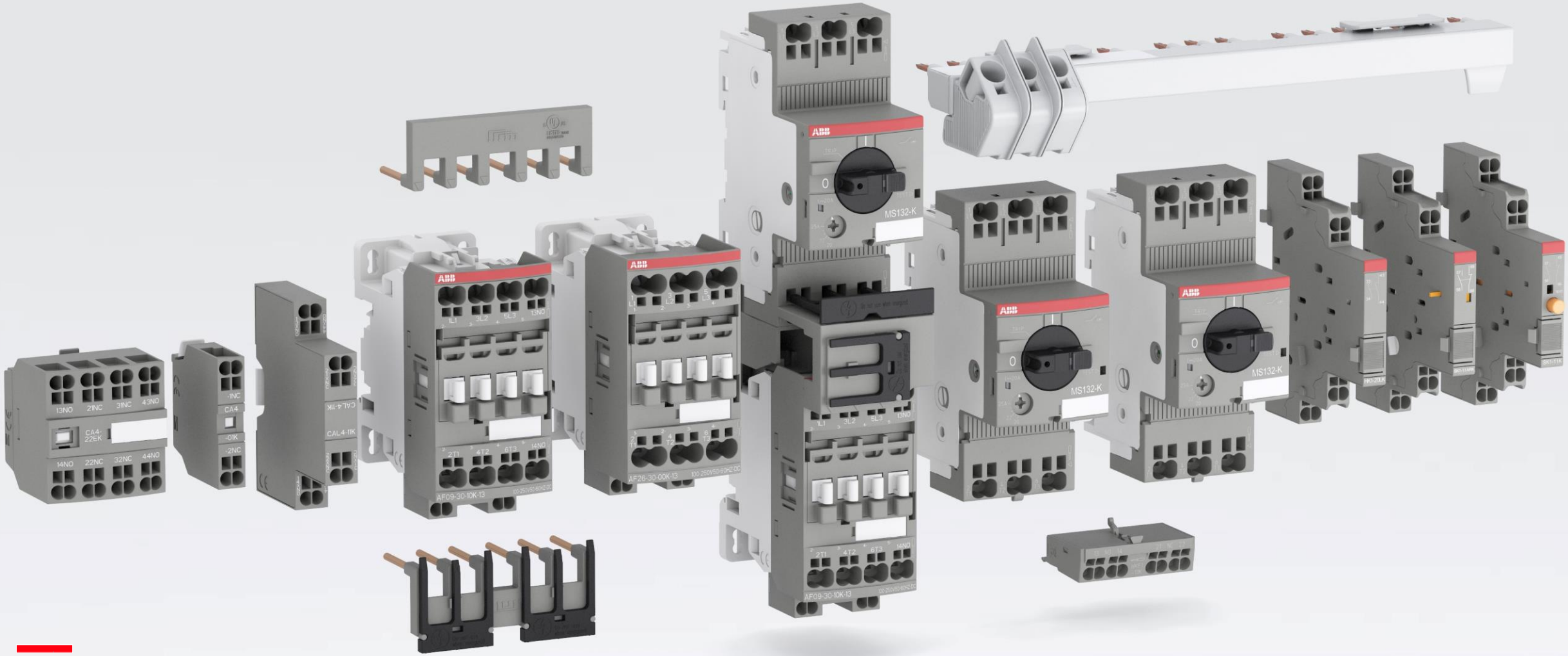
Example of traction application (cont'd)

- Once accessories connectors were secured, install new XT circuit breaker on the same location as the original Ts3 circuit breaker.

Final Result. Most-right Ts3 circuit breaker was replaced by XT4 circuit breaker

Push-in Technology

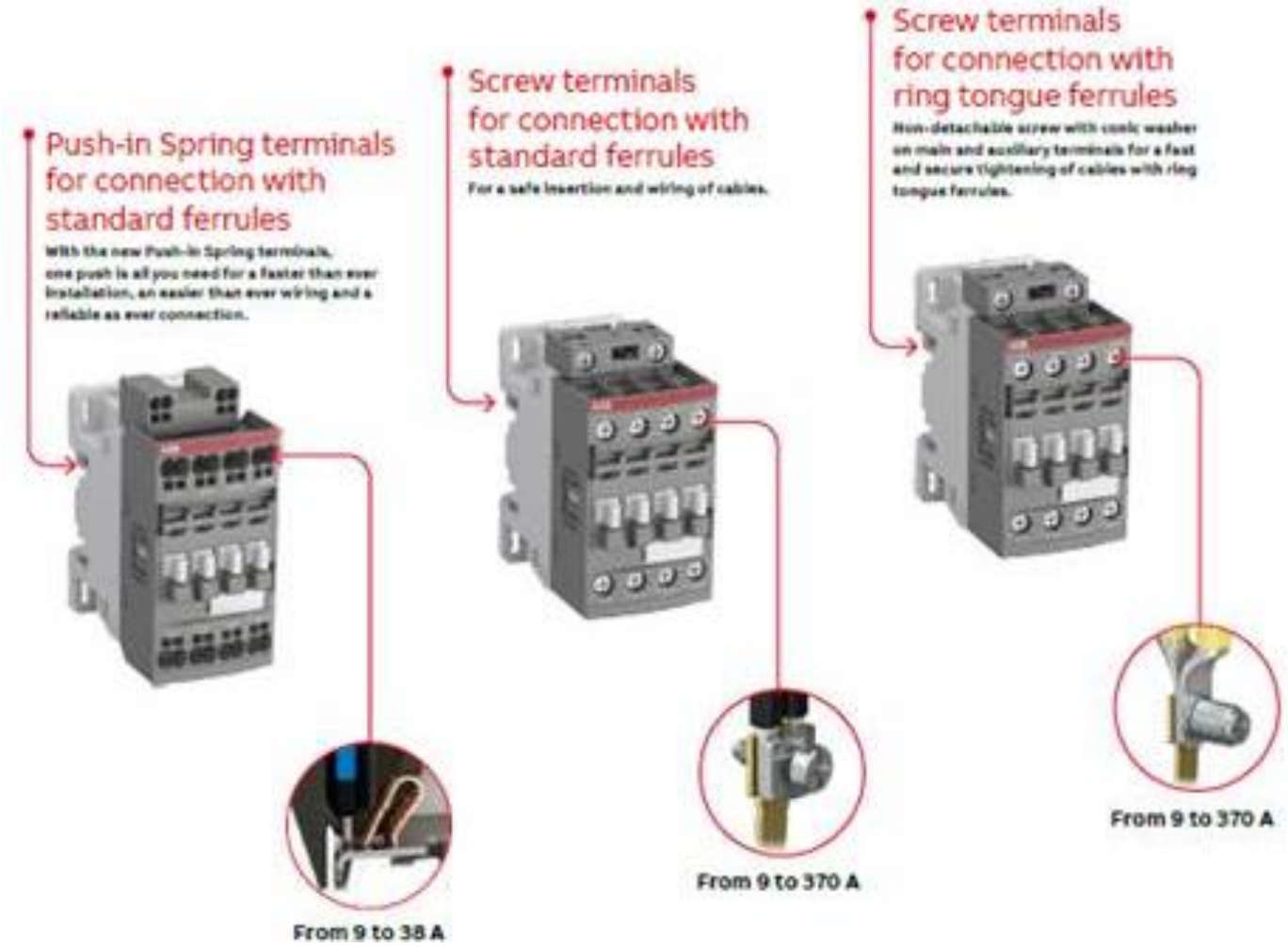
Electrification Transport & Infrastructure



Just push it

Push-in Spring motor starting solution

Connection types – The complete offering



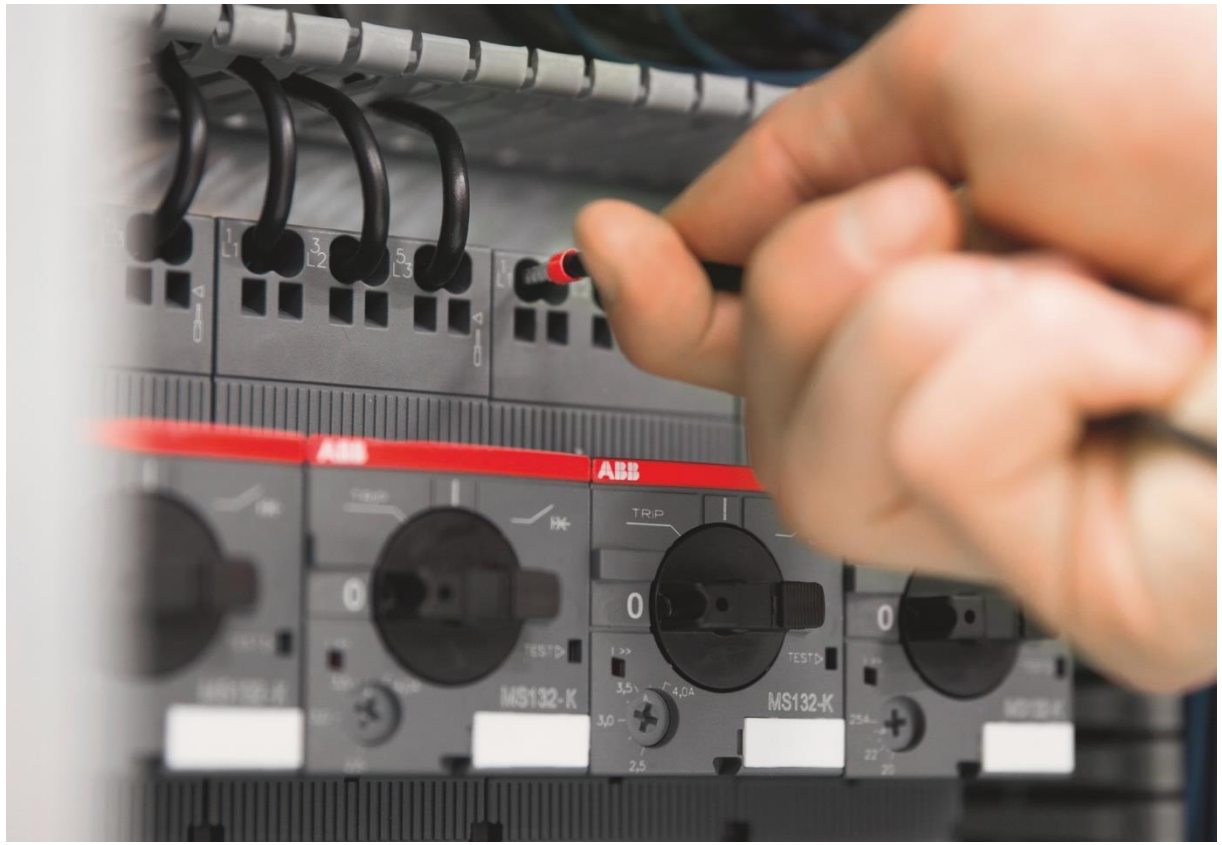
The next generation of spring technology

One push is all you need

- extremely fast wiring
- no tool is required
- save up to 50% wiring time

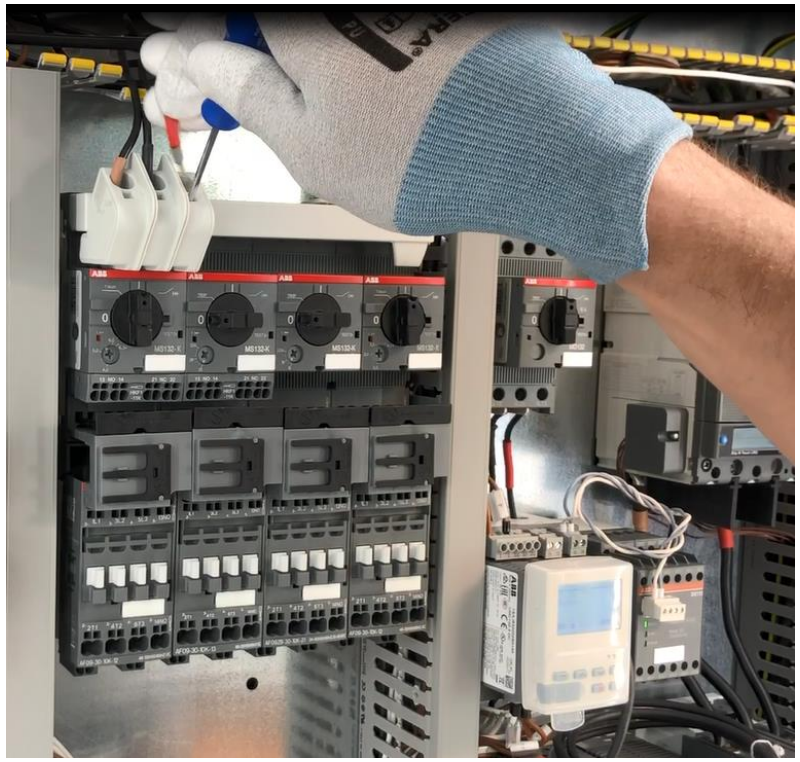
and the connections are just as reliable.

For speed, ease and reliability, just push it !

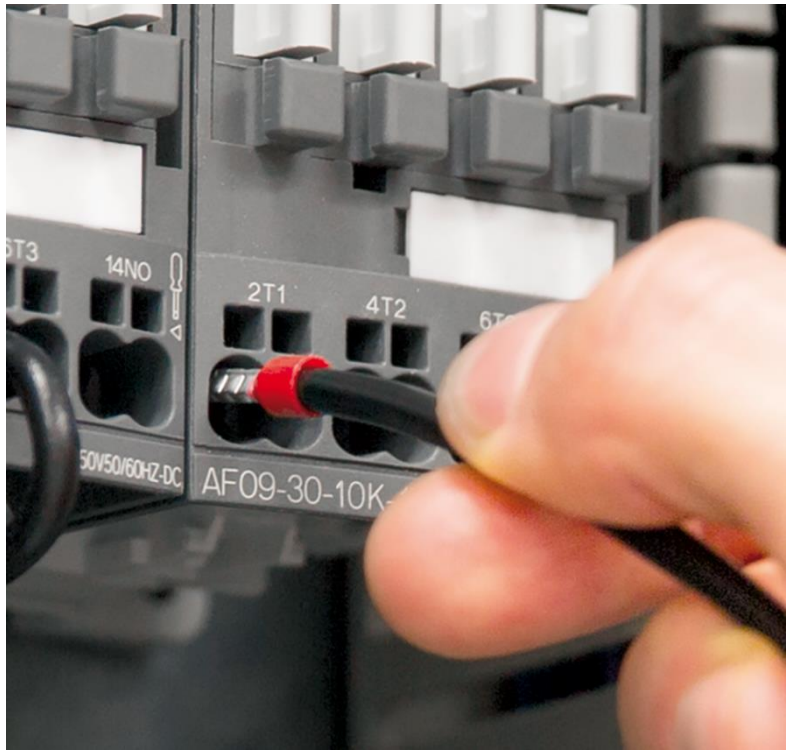


Push-in Spring solution benefits

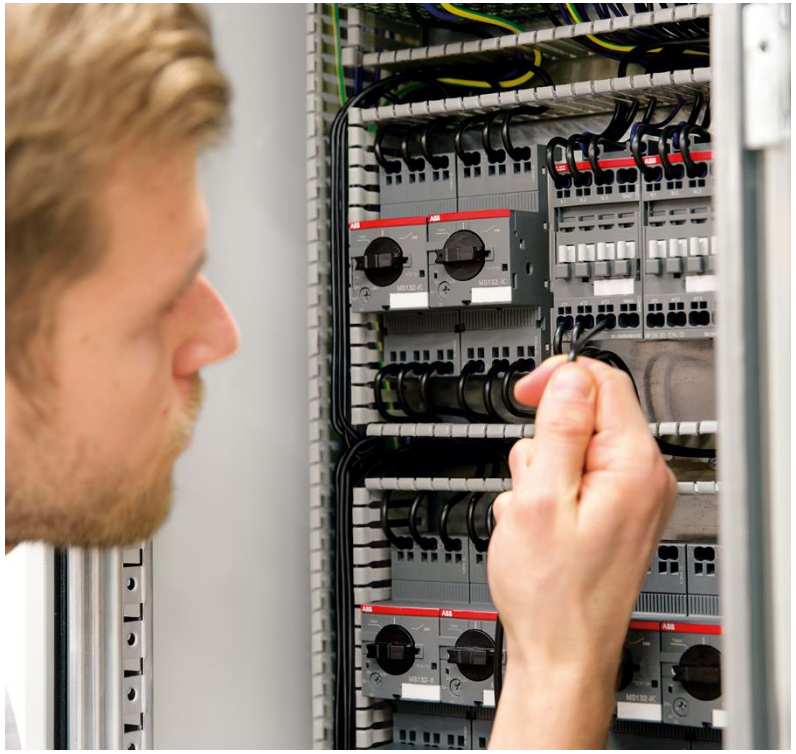
Faster than ever installation



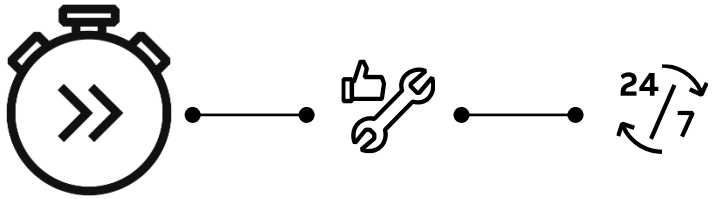
Easier than ever wiring



Reliable as ever connections



Faster than ever installation

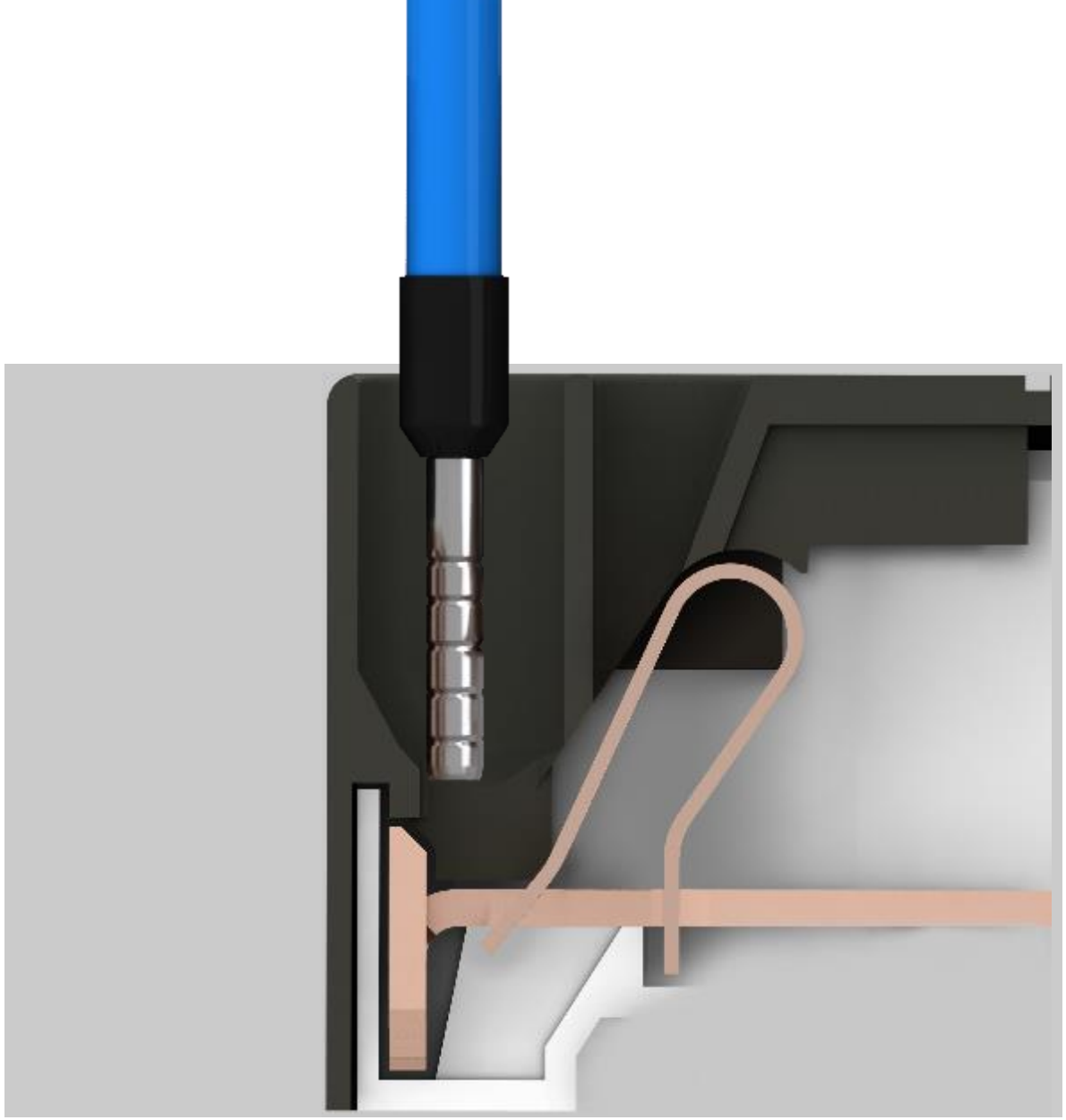


Speed up your projects

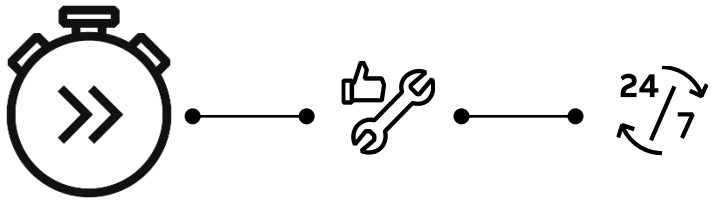
Push-in mode

Connect rigid cables or ferruled cables simply by pushing them into the cable holes

- no need to use any tools
- intuitive wiring
- self-tightening terminals
- save up to 50% wiring time



Faster than ever installation

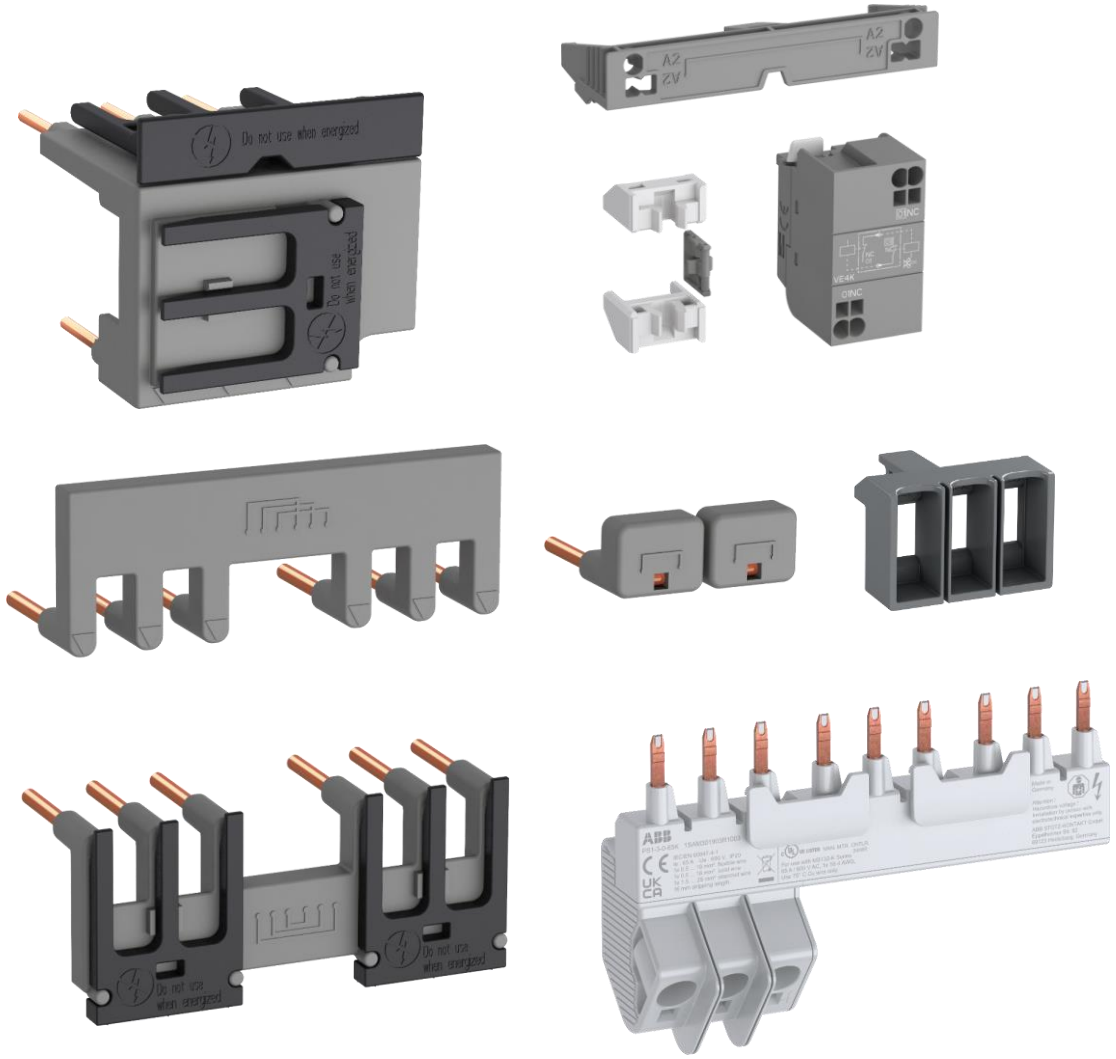


Speed up your projects

Smart accessories

Use ABB´s smart connection accessories

- 100 % tool-free mounting
- significantly reduced installation time
- busbars, connecting kits and electrical interlock
- Direct on-line, Reversing or Star-Delta starters possible without using any wires

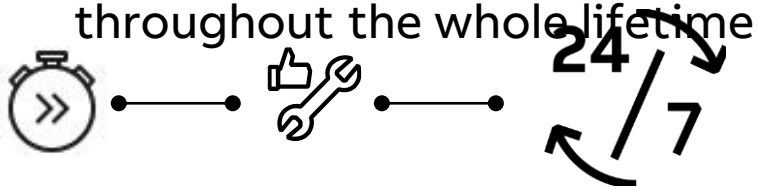


Reliable as ever connections

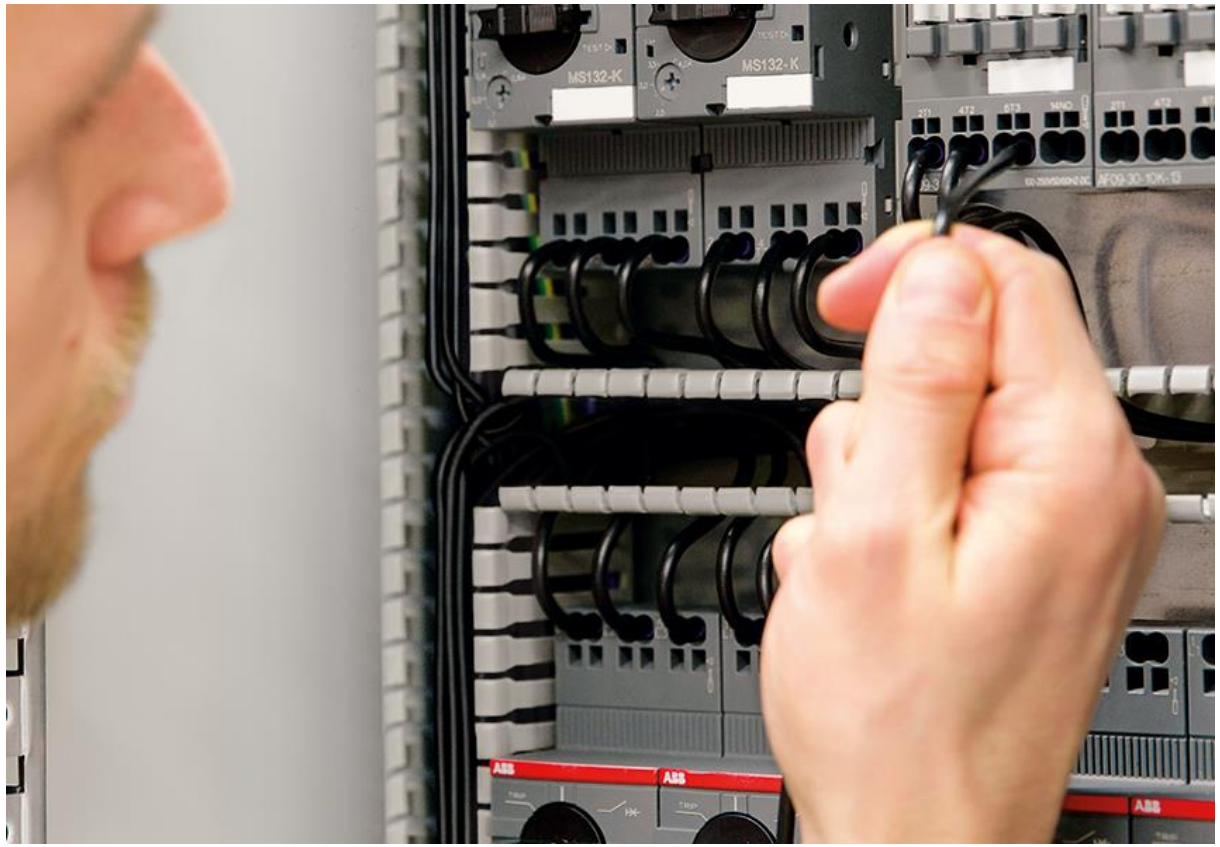
No need to re-tighten

With self-tightening terminals,

- there is no need to re-tighten after transportation
- there is no need to re-tighten during the product life
- high connection strength is guaranteed throughout the whole lifetime of the device.

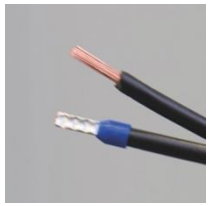


Continuous operation



Push-in Spring motor starting solution

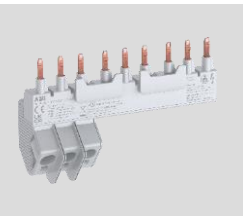
Complete range, complete efficiency



2-in-1 connection

Tool-free connecting links

Accessories compatible with screw range



Time-saving, easy & fault-free assembly with less cabling

Just one screwdriver

High connecting capacity

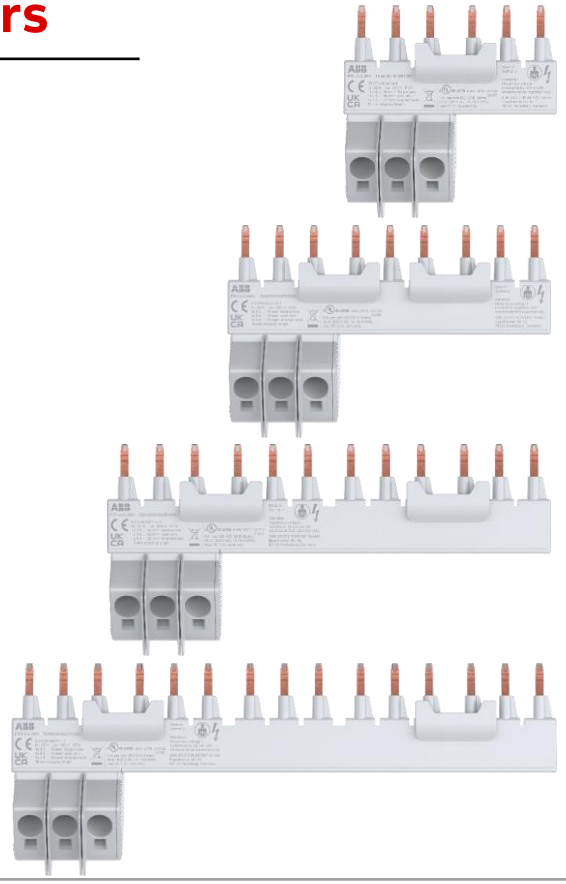
Push-in busbars

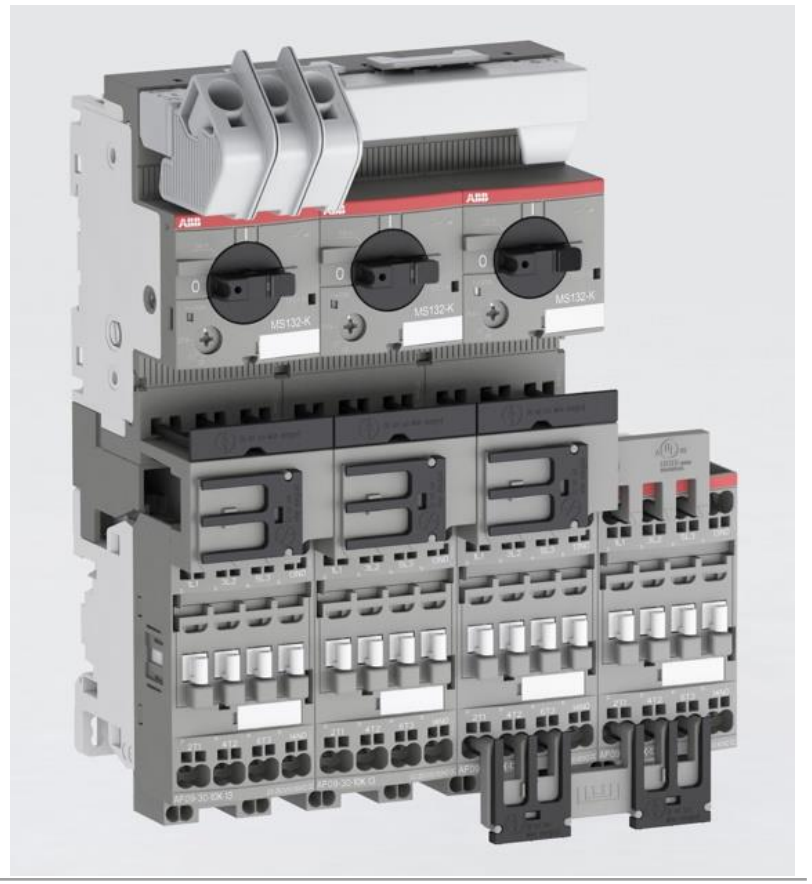
Complete range, complete efficiency

Push-in busbars for manual motor starters

The special design ensures a
- time-saving installation
- maintenance-free life cycle
- fault-free assembly with less cabling

All this for
- 2, 3, 4 or 5 manual motor starters
- with no or one lateral auxiliary contact,
- integrated feeder block and
- UL Type E / F approval.





Push-in Spring motor starting solution

Complete motor starting solution

Manual motor starters
Up to 32 A, 15kW 400 V AC-3/AC-3e
Ics up to 100 kA

Contactors
Up to 38 A, 18.5 kW 400 V AC-3/AC-3e (and 25 hp 480 V)
Up to 50 A, at 40°C AC-1 (and 45 A 600 V general use)

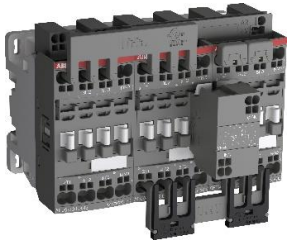
Manual motor starter accessories
Auxiliary contacts, signaling contacts and terminal spacer for UL Type E / F

Contactor accessories
Auxiliary contacts for front mounting and for side mounting

Possible combinations

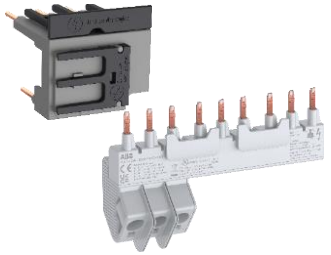
Direct on-line starters
Up to 15kW

Reversing contactors
Up to 15kW

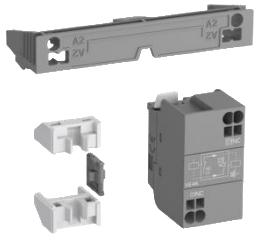


Star-delta starter
Up to 25kW

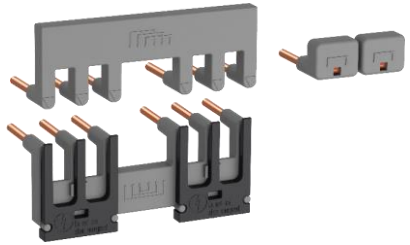
Accessories for starter combinations / group starters



Connecting links
Busbars



Plug and connect mechanical and electrical interlock set



Connecting sets for
• Reversing starters
• Star-delta starters

Product for control and protection

Applicable standards

For products' reference and application, please refer to their respective technical data pages.

Rolling stock standards	**IEC 60077-1 & IEC 60077-2**	General service conditions and general rules Electro-technical components – General rules
	EN 50155	Electronic equipment used on rolling stock for the relevant parts
	IEC 60571	Electronic equipment used on rolling stock for the relevant parts
	IEC 61373	Shock and vibration tests
	EN 50121-3-2	Electromagnetic Compatibility
	EN 50124-1	Insulation coordination – Part 1: Basic requirements Clearances and creepage distances for all electrical and electronic equipment
	EN 50125-1	Environmental conditions for equipment – Part 1: Rolling stock and on-board equipment
	TR CU 001/2011[1]	Technical Regulation of Custom Union on safety of railway rolling stock
Rolling stock Fire and smoke standards	**NFPA 130; ASTM E162, ASTM E662, BSS 7239, SMP 800-C, ASTM E1354 EN 45545**	Fire protection on railway vehicles Requirements for fire behavior of materials and components
General standards and certificates	**EN/ IEC 60947-1**	Low-voltage switchgear and controlgear – Part 1: General rules
	EN/ IEC 60947-2	Low-voltage switchgear and controlgear – Part 2: Circuit breakers
	EN/ IEC 60947-4-1	Low-voltage switchgear and controlgear – Part 4-1: Contactors and motor-starter
	EN/ IEC 60947-5-1	Low-voltage switchgear and controlgear – Part 5-1: Control circuit devices and switching elements UL 508 and UL 60947-1
	UL 508 and UL 60947-1	UL Standard for safety: Low-voltage switchgear and controlgear – Part 1: General rules
	UL 508 and UL 60947-4-1	UL Standard for safety: Low-voltage switchgear and controlgear – Part 4-1: Contactors and motor-starter – Electromechanical contactors and motor-starters
	UL 508 and UL 60947-5-1	UL Standard for safety: Low-voltage switchgear and controlgear – Part 5-1: Control circuit devices and switching elements – Electromechanical control circuit devices
	CSA-C22.2 No. 60947-1	CSA Group: Low-voltage switchgear and controlgear – Part 1: General rules
	CSA-C22.2 No. 60947-4-1	CSA Group: Low-voltage switchgear and controlgear – Part 4-1: Contactors and motor-starter – Electromechanical contactors and motor-starters
	CSA-C22.2 No. 60947-5-1	CSA Group: Low-voltage switchgear and controlgear – Part 5-1: Control circuit devices and switching elements –Electromechanical control circuit devices
	EAC[1]	Certification in Russia
	CCC	Certification in China: China Compulsory Certification

North American Standards

For Railways rolling stock

NFPA 130: Standard for Fixed Guideway Transit and Passenger Rail Systems. Includes:

- **ASTM E 662**: Standard test method for specific optical density of smoke generated by solid materials
- **ASTM E162**: Standard test method for surface flammability of material using a radiant heat energy source

SMP800-C: Bombardier Material and process specification. Toxic gas generation

BSS 7239 revision A: Boeing specification support standard Test method for toxic gas generation by material on combustion 18/01/1988

Note: BSS 7239 assessment included with SMP800

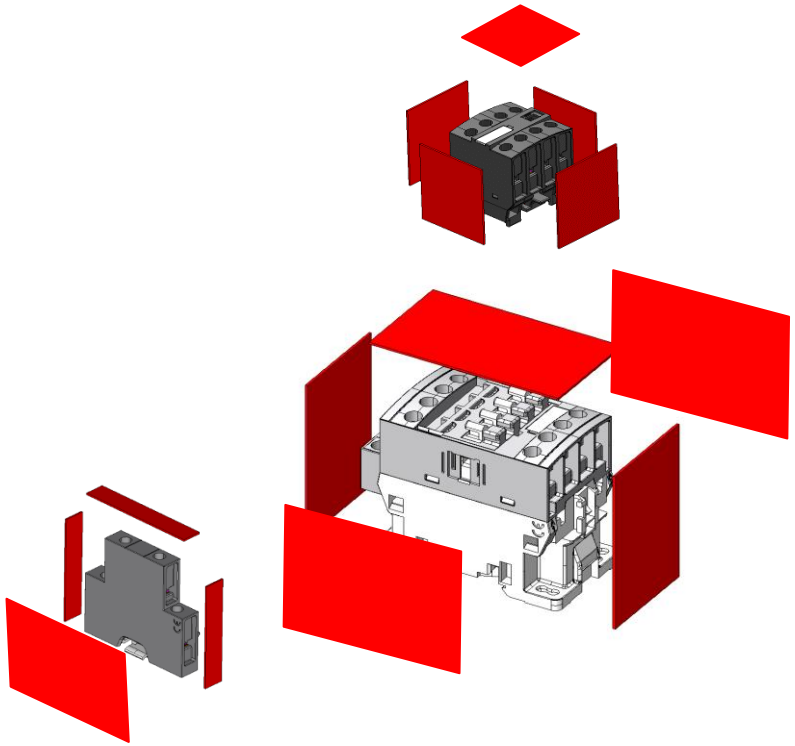
Rules for surface calculation in inch²

Surface determination

Only visible and external surface exposed to fire propagation are included inside calculation,

Rear face excluded when installed on mounting plate or DIN Rail

We will take into consideration the external area of each piece
e.g.: type of top, down, front or side exposed area.



North American Standards

For Railways rolling stock

- < 16in²
  - with device plastic material weight <10g no test except UL94 data available
  - with device plastic material weight > 10g ASTM E 162-98 / ASTM E 662-97 (without toxicity)
- > 16in²
  - ASTM E 662-97: density of smoke :
    - Ds (1.5) ≤ 100
    - Ds (4.0) ≤ 200
  - ASTM E 162-98: flammability of surface : criteria Is ≤ 35
  - Toxicity of smoke
    SMP 800 Bombardier Standard
    & BSS 7239 Boeing standard

SMP 800	BSS 7239 revision A
CO < 3500ppm	CO < 3500ppm
HF < 100 ppm	HF < 200ppm
NOx < 100ppm	NOx < 100ppm
HCL < 500ppm	HCL < 500ppm
HCN < 100 ppm	HCN < 150ppm
SO2 < 100ppm	SO2 < 100ppm
C02 < 90000ppm	
Hbr < 100ppm	

NFPA130/SMP800 Analysis reports

Product Declaration

Standard: **NFPA 130** *(ed.2020)*

PRODUCT
AF09(Z)B-30-10RT-xxU AF09(Z)B-30-01RT-xxU
AF12(Z)B-30-10RT-xxU AF12(Z)B-30-01RT-xxU
AF16(Z)B-30-10RT-xxU AF16(Z)B-30-01RT-xxU
AF09(Z)B-40-00RT-xxU AF09(Z)B-22-00RT-xxU
AF16(Z)B-40-00RT-xxU AF16(Z)B-22-00RT-xxU

Surface / Product (cm² / in²)	235,00	36,43
Total Combustible Mass / Product (g)		100,60

Conformity / Standard (mass & surface parts)	
SMP 800 (Mass > 10g ; Surface >16p²)	√
ASTM E162 (Mass > 10g)	√
ASTM E662 (Mass > 10g)	√
UL material recognised (Mass < 10g or internal part)	√

Part	Material		External surface (Cm²)	(in.²)	Weight (g)
CONTACT CARRIER	1SBA581608PXXX2	>PA 66/6T GF-30 FR<	6	0,9	10
CONTACT HOUSING	1SBA581503PXXX1	>PA 6 GF-30 FR<	17	2,6	25
COVER	1SBA581503PXXX1	>PA 6 GF-30 FR<	91	14,1	17
LABEL	1SBA581602PXXX1 (1)	>PA 66<	2	0,3	0,2
BASE HOUSING	1SBA581601PXXX1 (1)	>PA 66/6 FR<	105	16,3	38,3
COIL FRAME	1SBA581515PXXX1 (1)	>PA 6 GF-30<	(1)	(1)	6,7
COIL MODUL	1SBA581601PXXX1 (1)	>PA 66/6 FR<	14	2,2	3,4

SMP 800 Test

Material	CO	CO2	HF	Nox	HCL	HCN	SO2	HBR	Test Report		Date
1SBA581601PXXX1 (1)	305	12306	0	10	0	10	0	0	LAPI	2322.1AE0060/17	07/09/2017

ASTM E162 Test

Material	Is	Test Report		Date
1SBA581608PXXX2	5	CREPIM	D0-19-0769/B-R1	17/04/2019
1SBA581503PXXX1	10	CREPIM	DO-19-0597/A-R1	11/02/2019
1SBA581601PXXX1 (1)	5	LAPI	2322.0AS0070/17	07/09/2017

ASTM E662 Test

Material	Without flame		With flame		Test Report		Date
	D 1,5	D4	D 1,5	D4			
1SBA581608PXXX2	3	3	4	5	CREPIM	DO-19-0908/A-R1	22/05/2019
1SBA581503PXXX1	1	33	19	176	CREPIM	DO-19-0586/A-R1	11/02/2019
1SBA581601PXXX1 (1)	4,8	28,7	9,34	107	LAPI	2322.1AS0040/17	07/09/2017

Plastic material certificate on request, please consult your ABB Local sales organization

AF..ZB/ NFZB Contactors and contactor relays

Electromagnetic compatibility

Manufacturer declarations on request

Tests of electromagnetic compatibility were certified by an outside laboratory according to the requirements of IEC 60947-1 and IEC 60947-4-1 standards.

Contactors and auxiliary contactors of the AF range are in accordance with these standards for environment A.

Additional tests were realized by an outside laboratory to guarantee the conformity with the standard **EN 50121-3-2.**

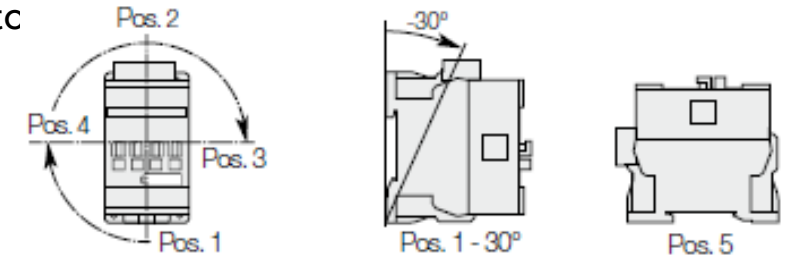
Contactors and motor protection

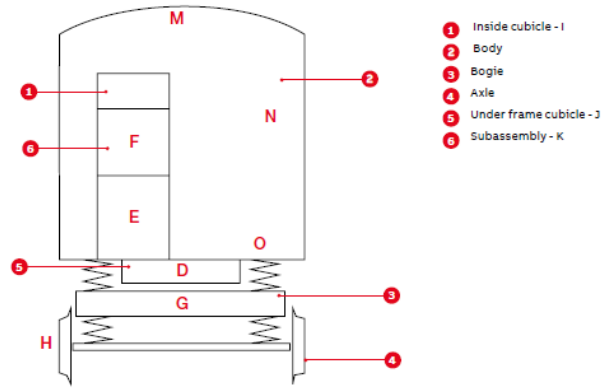
IEC 61373 – Category 1 class B

Test sequence for mounting on rail or screwing on plate

Location	Description of equipment location on Class B
D	Components mounted into an **underframe cubicle** which is in turn fixed to the car body
K and E	Components mounted into a **large internal cubicle** which is in turn fixed to the car body
F	Components mounted into **subassemblies** which are in turn mounted into a cubicle which is in turn fixed to the car body

Component position:
e.g. for AF09(Z)B…AF38(Z)B contactors and NF(Z)B contactc





Custom and Engineered products – OEM and Aftermarket

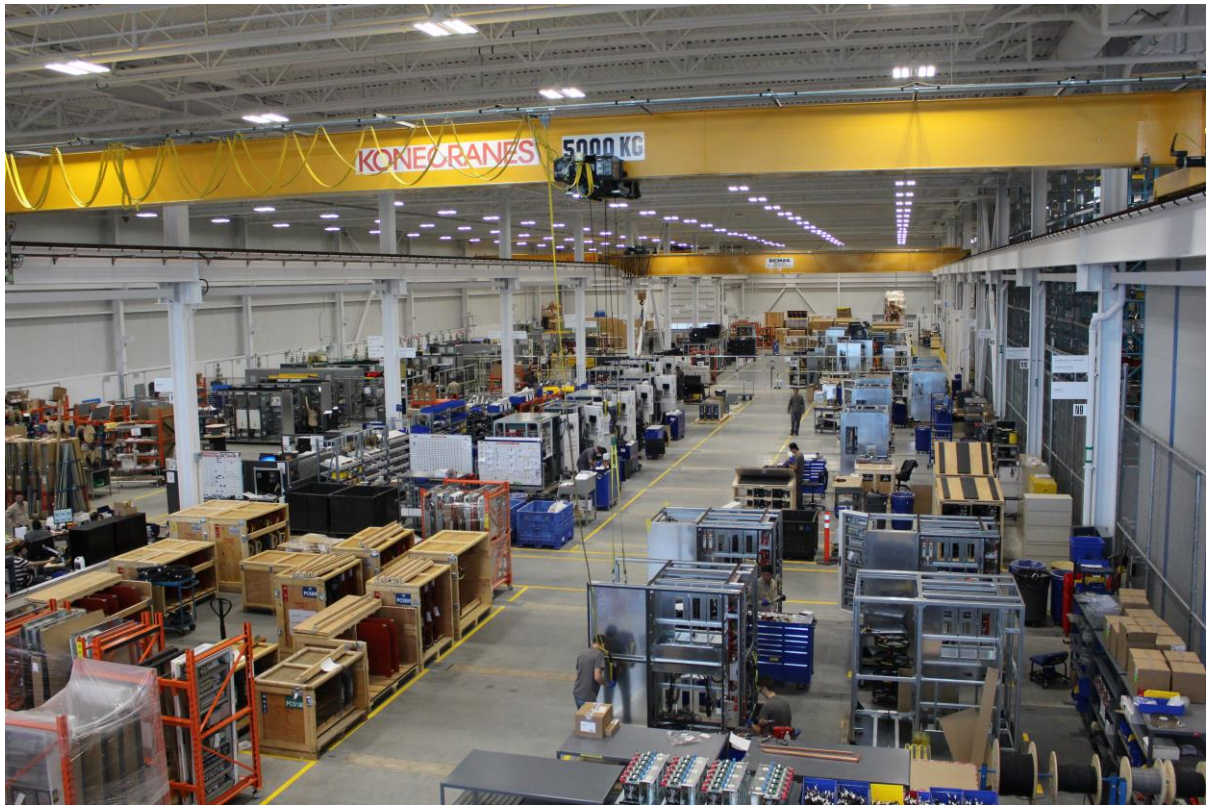
Electrification Products

Electrification Products Division – Transport & Infrastructure

Center of Excellence, Montreal Campus

Research, Development & Assembly (RDA)

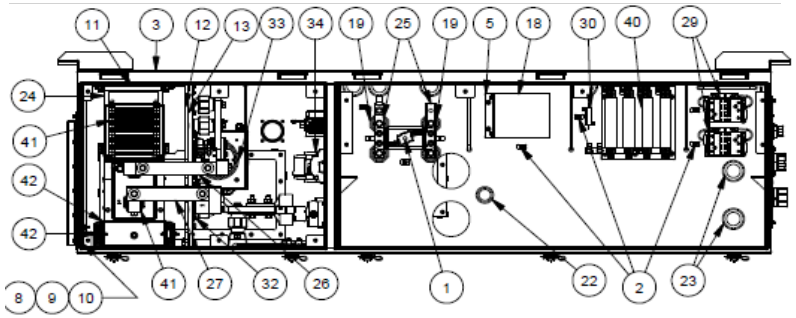
- RDA area is 12,100 square meters (130,000 sf) with a total of 100 employees (EP represent 70 employees)
- NAM mandate for Traction systems/panels, Fuel cell inverters, Power Excitation, EV Charging station, SoftStarter,…
- Full warehouse support and capabilities
- High safety procedure to maintain security for all workers



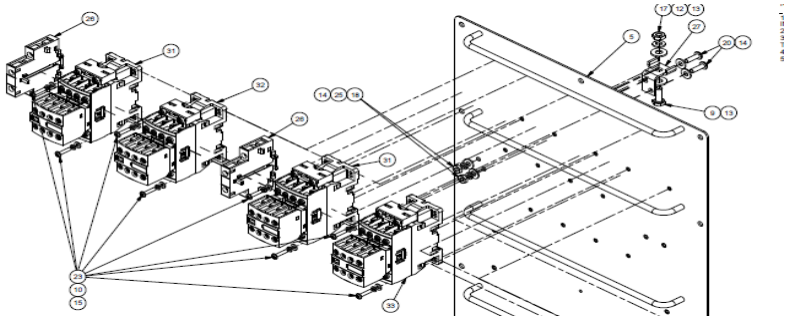
Electrification Products Division – Transport & Infrastructure

Documents and tools

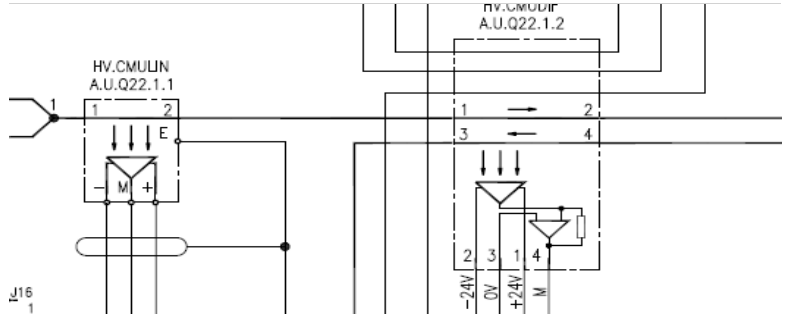
Outline drawing



Manufacturing drawings



Electrical drawings



Qualification test reports

Test method	Test	Orientation	Results
IEC 61373 (2010) Corr.1 (2011/10) Category 1 Class A Body-mounted	Functional vibration	Vertical	Pass
		Transverse	Pass
		Longitudinal	Pass
	Simulated long-life vibration	Vertical	Pass
		Transverse	Pass
		Longitudinal	Pass
	Shock	Vertical	Pass
		Transverse	Pass
		Longitudinal	Pass

Table 2: Test results

Routing test procedures

Section	Test Details	Required value		Measured value	Pass √	Fail √
		Min	Max			
1.2	**Visual Inspection**	-	-	-	-	-
1.2.4/1	The surfaces of the enclosure/mounting plate are entirely painted and free of impurities.	Yes	-	-		
1.2.4/2	The grounding wires are installed correctly.	Yes	-	-		
1.2.4/3	All parts are free of physical damages.	Yes	-	-		
1.2.4/4	All threaded studs and holes are paint free.	Yes	-	-		
1.2.4/5	All components are installed correctly according to the outline drawing 2010T0073.	Yes	-	-		

Bench test equipment

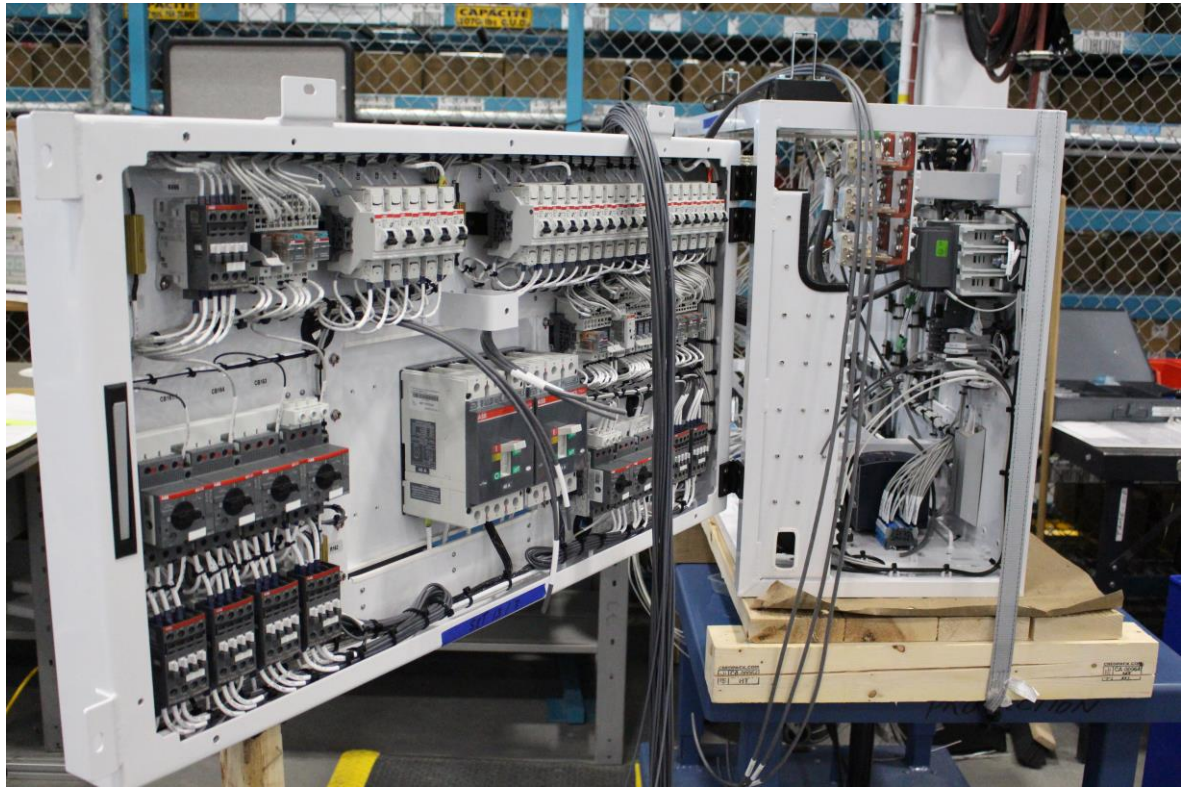
EPPC-EPBP Canada

Campus Montreal

Customized solution for rail market

Customer requirements

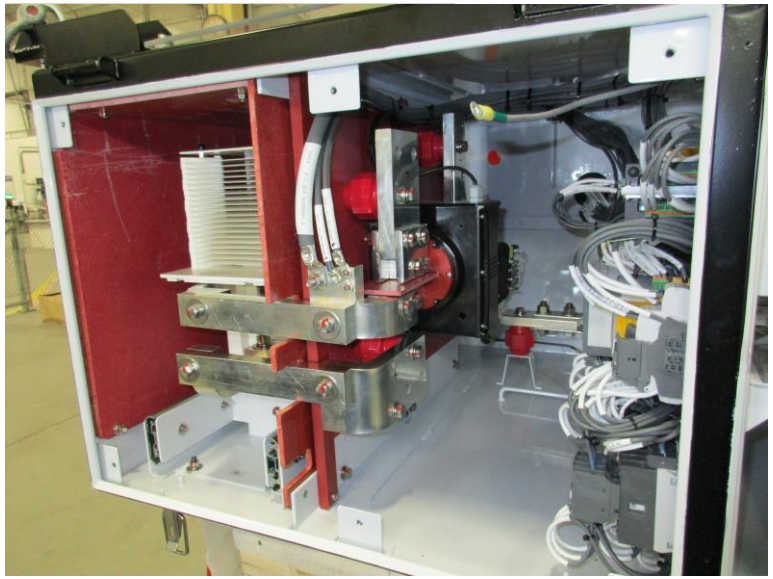
- Harness voltage grouping and segregation.
- Wire service loop.
- Electrical integrity control: continuity, Megger and HiPot tests.
- Enclosure insulation powder coating.



Electrification Products Division – Transport & Infrastructure

Center of Excellence, NAM

Distribution



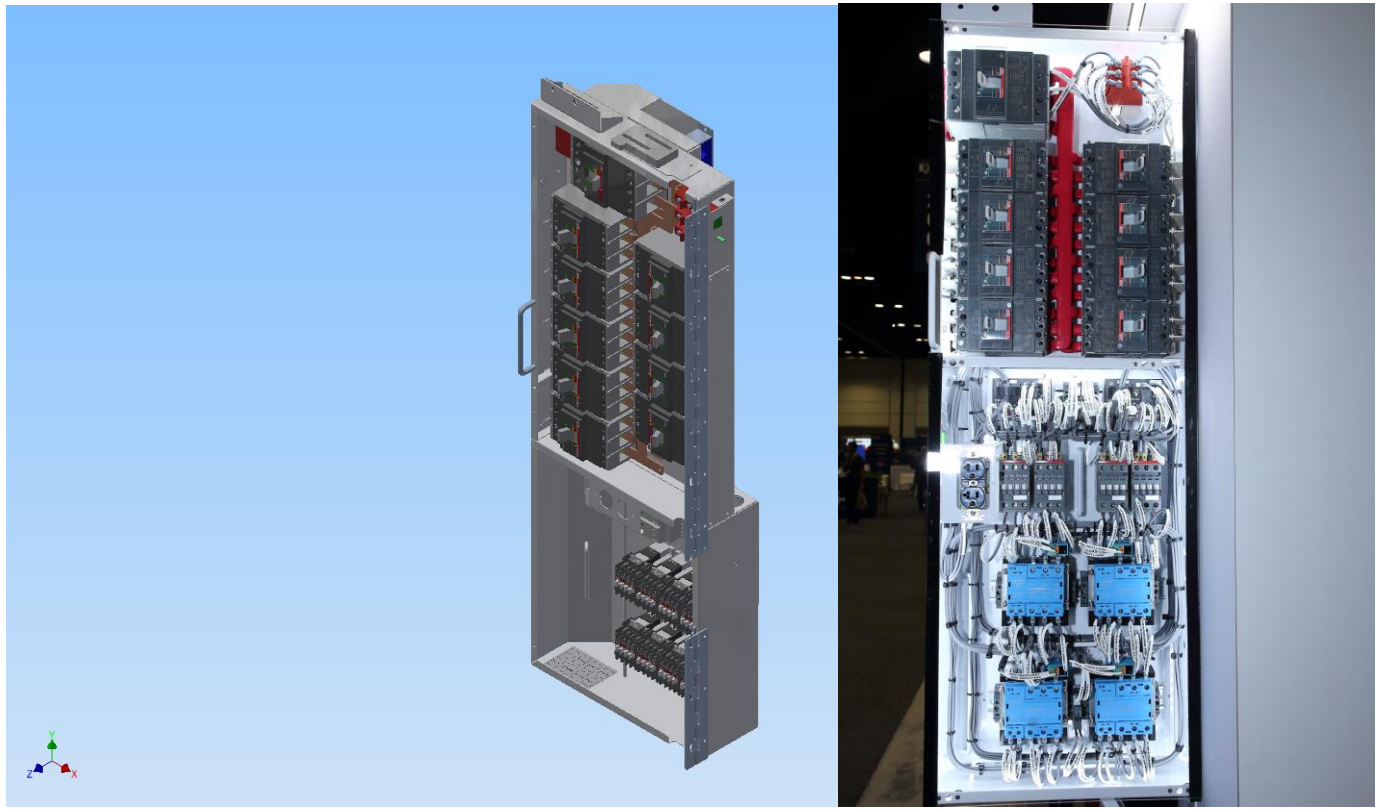
Protection

Controls

Electrification Products Division – TRANSPORTATION

ABB working with OEM to design Cabinets and Electrical panels

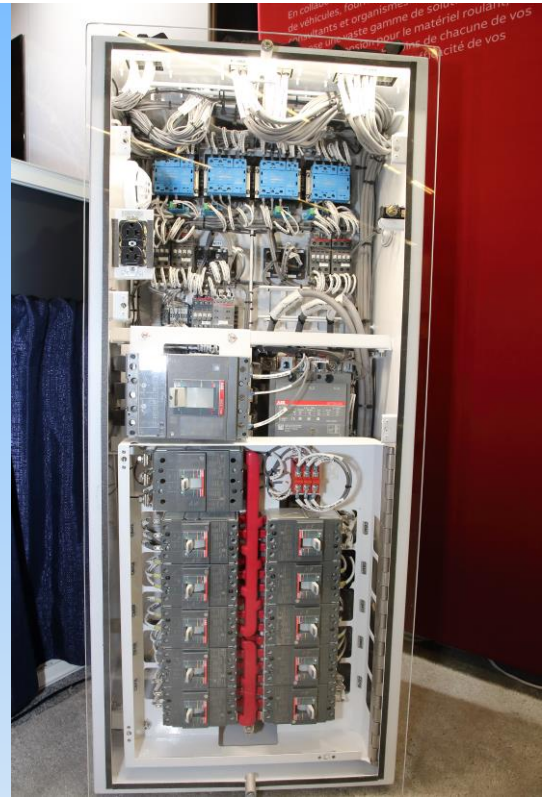
Electrical locker mounted inside an ABB designed Fire box



Electrification Products Division – TRANSPORTATION

ABB Designs on new Passenger vehicles

Electrical locker made by ABB for new Passenger vehicle




ABB