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ABB ebus portfolio

General introduction

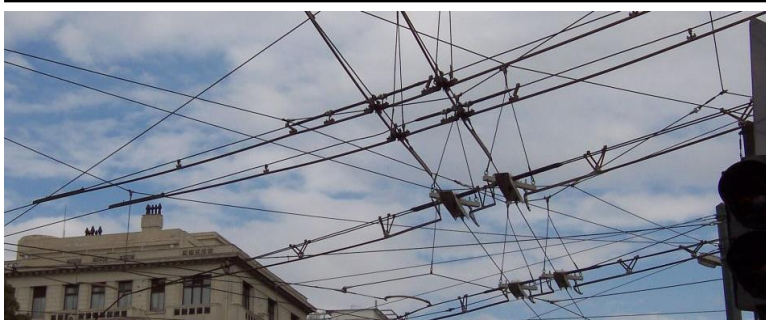
TrolleyMotion Solingen, 2018



In-Motion Charging

Use cases

Existing grid – Line Crossings



Line crossings of trolley lines (tram lines) are costly in investment and maintenance.

With the option to drive without catenary these intersections can be eliminated.

Reduction of maintenance costs of existing lines

Existing Grid- line extension



Utilizing of existing infrastructure and extension of lines without investment in new catenary.

Driving 50% under catenary enables 50% cat free driving

Extension of lines with existing infrastructure

New BRT line- partially catenary



Cost for 1km Catenary (2 directions incl. substation) 500`000 EUR

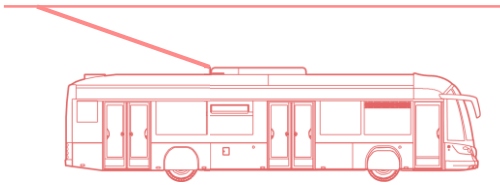
Operation with 50% catenary
→ 250`000 EUR/km (2 directions)

Competitive solution for BRT lines

In-Motion Charging

Operational Modes

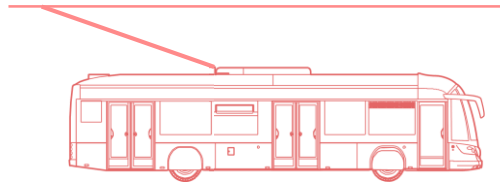
Driving and Charging



During driving the power taken from the grid is used to feed the traction motors and auxiliaries. Remaining balance power feeds the battery.

- Full operation also at low line voltages
- In average 1km in-motion charging enables 1km cat free driving

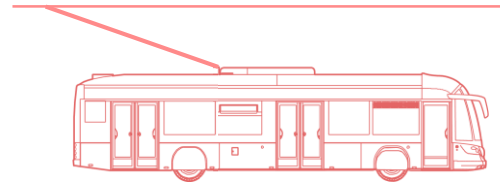
Braking / Recuperation



Braking energy is stored in the battery

- Up to 15% energy can be saved compared to traditional systems where the energy is fed back to the grid.

Charging at Bus stop



During the dwell time at each bus stop the battery is charged.

- Charging at bus stops extends the autonomy of cat free operation without additional charging time

Catenary free operation



During operation without overhead lines the traction batteries feed the traction motors and the auxiliaries.

- No diesel gen sets → weight advantage
- Reduction of maintenance intensive line crossings
- Line extension without any extra costs

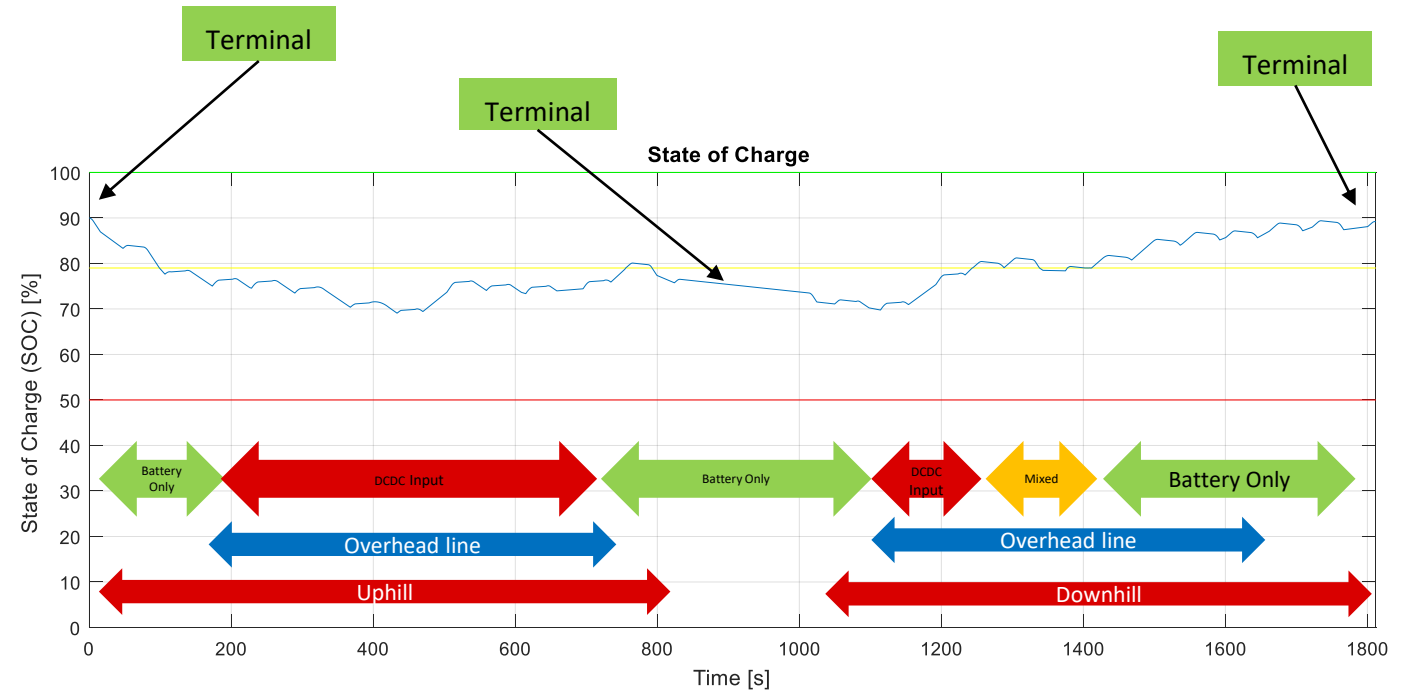
Energy Calculation

Simulation

DC/DC Converter with dynamic trigger to store energy from recuperation at driving downhill.

Almost no Input from Overhead line at driving downhill necessary

Trigger level of DCDC converter allows optimal usage of battery



Blue Graph = State of Charge

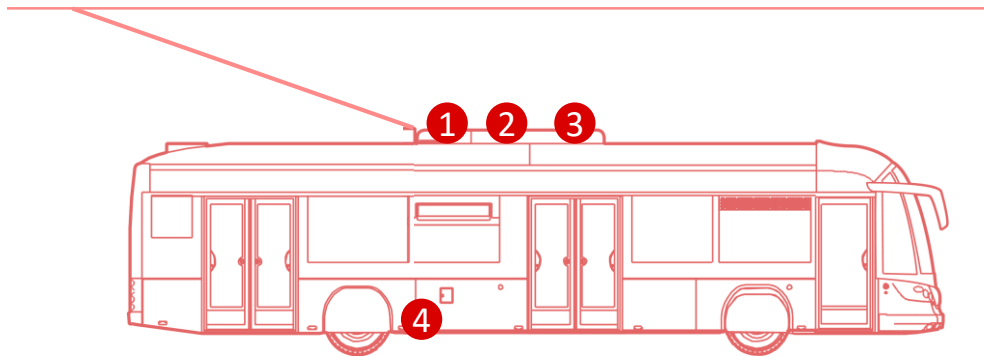
Red Line = preferred minimum SOC to extend battery lifetime

Yellow Line = Trigger Level of DC/DC Converter at 79%

The trigger level of the DC/DC converter defines whether it is providing power into the DC-Link or not. If the SOC is below the trigger level, the DC/DC converter is providing power for the traction chain and charging the battery. If the SOC is above the trigger level, the converter is switched off and the vehicle is running on battery power only.

ABB Trolleybus solutions for in-motion charging

Portfolio



1



ABB BORDLINE CC200 DC-DC:

- Galvanic separation and double isolation to enable the use of not double isolated drivetrain components on the secondary side

2

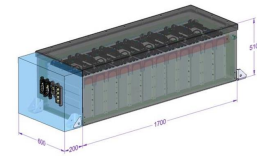


ABB Traction Battery:

- High Power Battery with long lifetime
- Modular design for easy exchange of power banks

3



ABB BORDLINE CC200:

- All in one solution to accommodate motor converter and auxiliary drives

4



ABB Traction Motor:

- Synchronous reluctance motor with PM assistance water cooled for high efficiency

BORDLINE CC200

DC/DC front-end converter

Galvanic isolation allows for standard eBus insulation on secondary side

Enables Synergies with standard eBus Drivetrain and ESS components

Ideal in combination with an ESS → No dedicated ESS chopper required

At low line voltages ESS boosts DC-Link

Outside of normal operation output power supplied both from DC/DC and ESS

Bidirectional power flow as an option for hilly topologies

Single-stage topology with minimum of passive components

Large input capability: 400V... 900V

→ Compatible with 600V and 750V grids

Rating 200kW

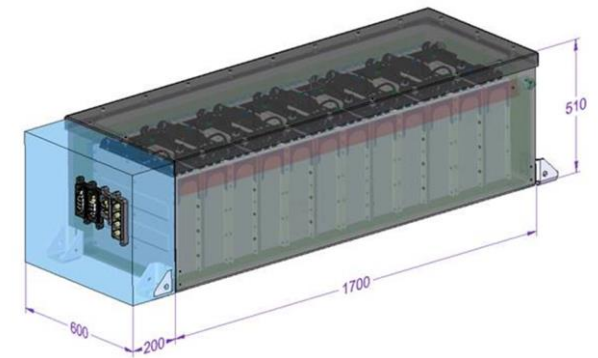


BORDLINE ESS – System Overview

30.5 kWh, 660 Vdc, Roof ESS

Facts and figures:

- Modular system, 30.5kWh
- High power, LTO
- Liquid cooled
- Laser welded
- High cycle life
- System know-how on traction applications



Traction motor

Permanent magnet assisted Synchronous reluctance motor

Advantages

- **Efficient** motor helps to optimize energy storage size
- **Innovative** ABB control software enables the elimination of speed sensors
- **Economic** higher motor torque allows the use of lower gear ratios for the axle
- **Sustainable**: Use of reluctance torque reduces the use of magnets

Applications:

12m Bus	1x 190kW	i=6.2
18m Bus	2x 160kW	i=6.2
24m Bus	2x 160kW	i=7.36



BORDLINE CC200

Traction and Auxiliary Converter

Advantages

- **Compact** Design
- **Integrated** Solution to minimize cabling and complexity
- **Modular**: covers all types of eBus applications Trolley, Fast-DC charged, TOSA (Flash Charged) and Serial hybrid with one converter

Control

- **Common Controls** for Prop und AUX
- **Energy Management** (Battery and Recuperation of Braking Energy)
- **Best Efficiency** Motor Control (part load optimization)
- soft start function for large aux loads
- BORDLINE VIEW® most advanced **diagnostic** and **monitoring** tool for entire drivetrain including Battery



Traction converters for trolley buses (Switzerland)

Catenary-free operation

Country:

Switzerland

Cities:

Zurich (1x 18m in 2017)

Zurich (3x 24m in 2018)

Bern (24 in 2017/18)

Biel (10 in 2017/18)

Category:

ebus

Scope of supply:

BORDLINE® CC200

Traction Motors

Key data:

2x 160kW peak power

Deliveries:

2017 - 2018

Customer need

- State-of-the-art propulsion enabling catenary-free operation

ABB solution

- Drivetrain consisting of BORDLINE® CC200 (traction converter including auxiliary converter) and two permanent magnet motors

Customer benefits

- Customized solution based on well-proven standard building blocks
- High energy efficiency due to permanent magnet motors fitting perfect to needs of battery operation



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OppCharge: ebuses with standardized charging interface

Interoperability on the rolling stock, infrastructure and operator side

Country:

Switzerland

Cities:

Bern L17 (5x 18m bus)
drivetrain and infrastructure

Category:

ebus

Scope of supply:

OppCharge and drive
components

Key data:

450 kW DC output power

Deliveries:

2018 - 2019

Customer need

- Minimal amount of charging infrastructure
- Energy efficiency and emission reduction

ABB solution

- Charging stations for depot and terminal station
- Drivetrain including integrated traction power converters (motor inverters, auxiliary battery charger, auxiliary drives) and traction motors

Kundenvorteile

- Standardized charging system interfaces
- Standardized drivetrain platform
- Remote access to charging infrastructure



Traction converters for eBRT (Switzerland and France)

Catenary-free operation

Country:

Switzerland, France

Cities:

Geneva (12x 18m bus)

Nantes (22x 24m bus)

Category:

ebus

Scope of supply:

BORDLINE® CC200

Traction Motors

Traction batteries

Infrastructure

Key data:

2x 160kW peak power

Deliveries:

2017 - 2019

Customer need

- Operation of battery buses on highly demanding line

ABB solution

- Drivetrain consisting of BORDLINE® CC200 (traction converter including auxiliary converter), two permanent magnet motors and traction battery

Kundenvorteile

- Customized solution based on well-proven standard building blocks
- High energy efficiency due to permanent magnet motors fitting perfect to needs of battery operation
- Designed for high performance lines operated by high capacity buses



ABB