



## Innovative ground-based static charging system for streetcars and buses

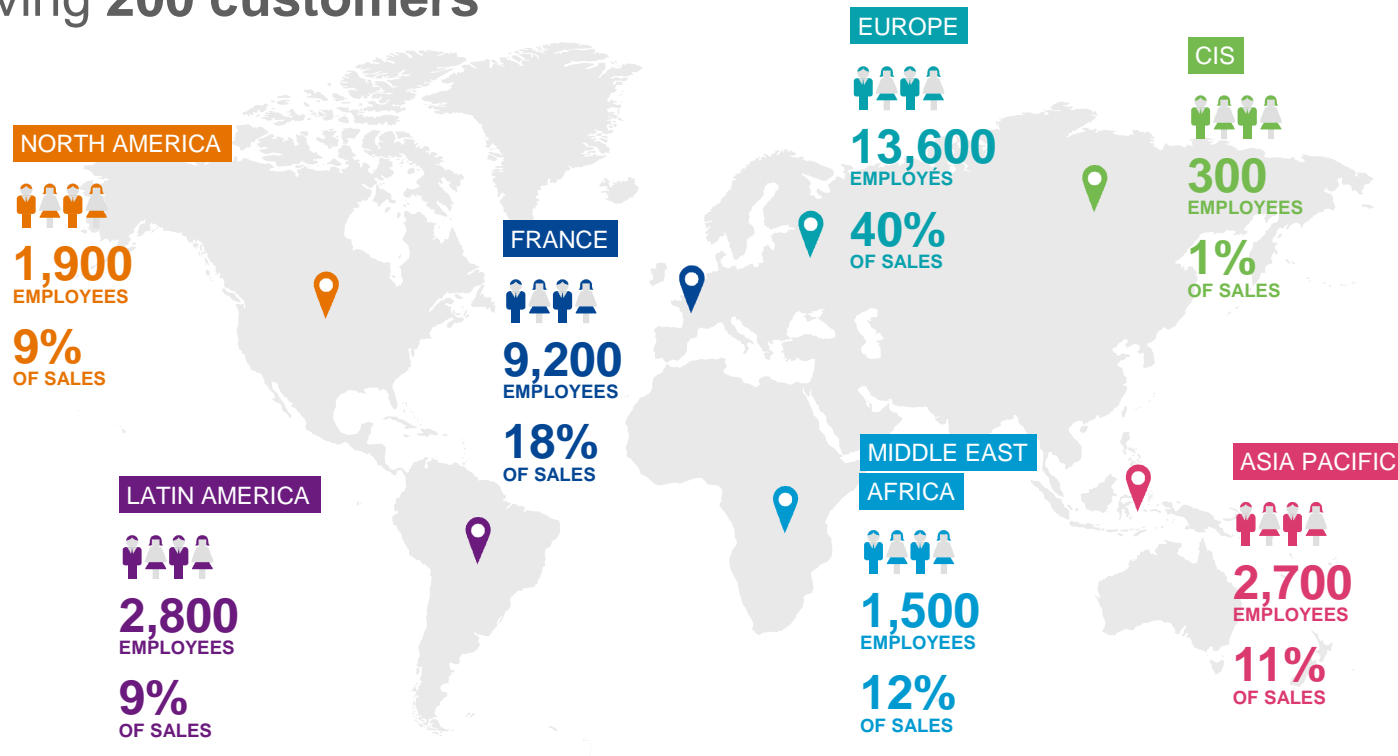
Jean-Luc Hourtané

16-May-2016

**ALSTOM**  
*Designing fluidity*

# Alstom, a worldwide organisation

- **32,000 employees** working on **105 sites** in **60 countries** serving **200 customers**



Being a reference player in each Region

# A leading position in rail transport

## TRAINS



- Streetcars, metro, suburban/regional, high speed, very high speed, locomotive
- Components: traction, bogie, motor

45%



## SERVICES



- Maintenance
- Modernisation
- Spare parts, repairs & overhaul
- Support services

23%



## SIGNALLING



- Signalling solutions portfolio for:
  - Main lines
  - Urban
  - Control and security
- Sold as products or solutions

20%



## SYSTEMS



- Integrated solutions
- Infrastructure

12%



A group with annual sales of over €6 billion

# Alstom: No. 1 in catenaryless solutions for streetcars thanks to APS (ground-level feeding system), since 2003

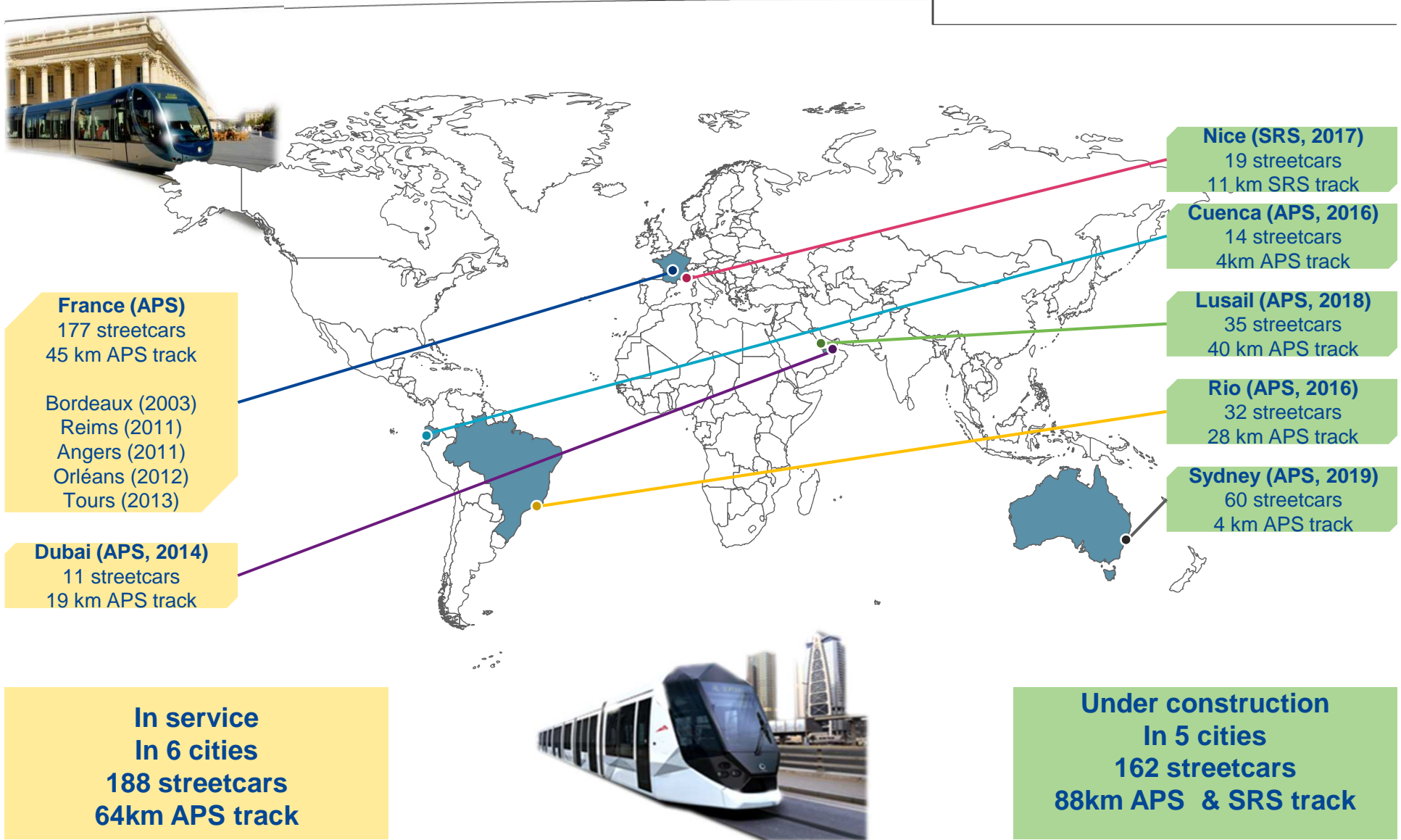


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**ALSTOM**

# APS & SRS: 11 cities, 336 streetcars, 162 km of APS & SRS tracks, 22 million km run in APS



**France (APS)**  
177 streetcars  
45 km APS track

Bordeaux (2003)  
Reims (2011)  
Angers (2011)  
Orléans (2012)  
Tours (2013)

**Dubai (APS, 2014)**  
11 streetcars  
19 km APS track

**In service  
In 6 cities  
188 streetcars  
64km APS track**



**Nice (SRS, 2017)**  
19 streetcars  
11 km SRS track

**Cuenca (APS, 2016)**  
14 streetcars  
4km APS track

**Lusail (APS, 2018)**  
35 streetcars  
40 km APS track

**Rio (APS, 2016)**  
32 streetcars  
28 km APS track

**Sydney (APS, 2019)**  
60 streetcars  
4 km APS track

**Under construction  
In 5 cities  
162 streetcars  
88km APS & SRS track**

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# Catenaryless solutions

- APS
- Ground level power supply delivery to traction for streetcars.
- 1MW conductive solution
- Application : streetcars
- 10 cities worldwide



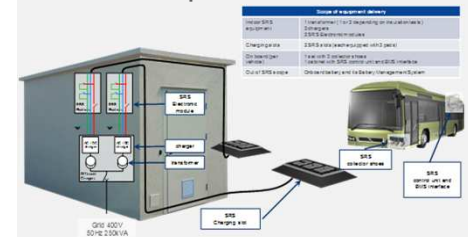
- ERS
- Ground level power supply delivery to traction for Vehicle on Highway
- 300m demonstrator on Volvo truck test track in Sweden (Gothenburg)
- Results shown at CERV 2015



- SRS for streetcars
- Ground level power supply delivery for stationary recharge onboard batteries for streetcars.
- Application: Streetcars
- 11km under construction in France (Nice)



- SRS for buses
- Ground level power supply delivery for stationary recharge onboard batteries for urban vehicles.
- Application: Urban vehicles (bus)
- Innovation under development



# SRS



# SRS for streetcars

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# SRS for streetcars - Key features

- Based on APS principle: **same components** for both **location control** and **energization** (with bi-directional communication)
  - **Power rails** contain conductive segments and antenna
  - **Collector shoe** contains contact power strips and antenna
  - **Cabinet** contains power contactors and emitter/receiver of the signals
- SRS is **an all-in-one system**: no need for extra signaling or vehicle detection devices



Differentiator: control and energization within the same equipment

# SRS for streetcars - Key features

- The power required depends on the type of application:
  - An on-board supercapacitor to **charge in less than 20 seconds** at passenger stations
  - or*
  - An on-board battery to **charge for several minutes** at each terminus of a bus line



SRS for streetcars: designed for 1600 A / 750 V (1.2MW) during 20 seconds

# SRS for streetcars benefits vs. other fast-charging solutions

## ■ Ground-based solution *vs. overhead solutions*

- Less **obtrusive** and **compatible with any vehicle dimensions**
- Compact solution: **easy integration** into urban landscape
- No mobile infrastructure: **high availability** of charging spot
- **Facilitated** maintenance of fixed infrastructure

## ■ By contact *vs. inductive solutions*

- **Fast** and **efficient energy transfer**
- **Unlimited** power
- **Facilitated** maintenance of fixed infrastructure

## ■ Proven, safe and reliable technology

- Derived from Alstom's **APS**, designed for catenary-free streetcars



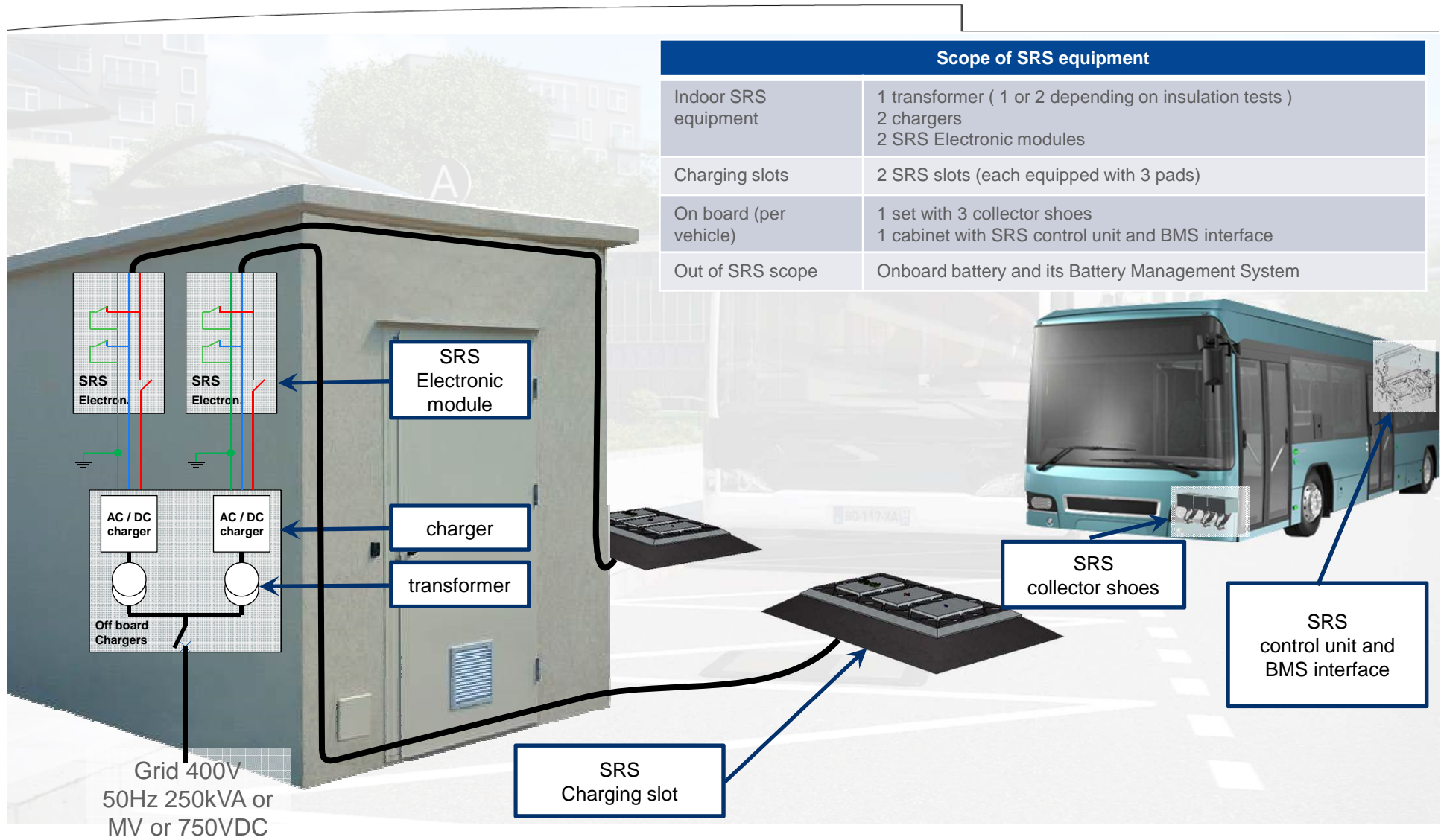


# SRS for Bus

# SRS for bus - Performances

	SRS product
Electric performances of power transfer to onboard batteries	
Operating voltage	0-900VDC
Charging current	Up to 900A RMS
Power	50kW – 800kW
Source power supply	< 250kVA : 3 phases 400V, 50Hz AC > 250kVA : Medium AC voltage or 750VDC from traction substation
Positioning accuracy where the driver is allowed to stop	
Lateral (reference to the curb)	- 0 / + 25cm
Longitudinal (reference mark on the floor)	+/- 20cm
Shoe raising or lowering time	< 2 seconds
Number of charging spots	$\frac{\text{Charging time}}{\text{Headway}} + \text{Spare} + \text{Depot}$ ( typically 5 )

# SRS for bus - Electric architecture and scope



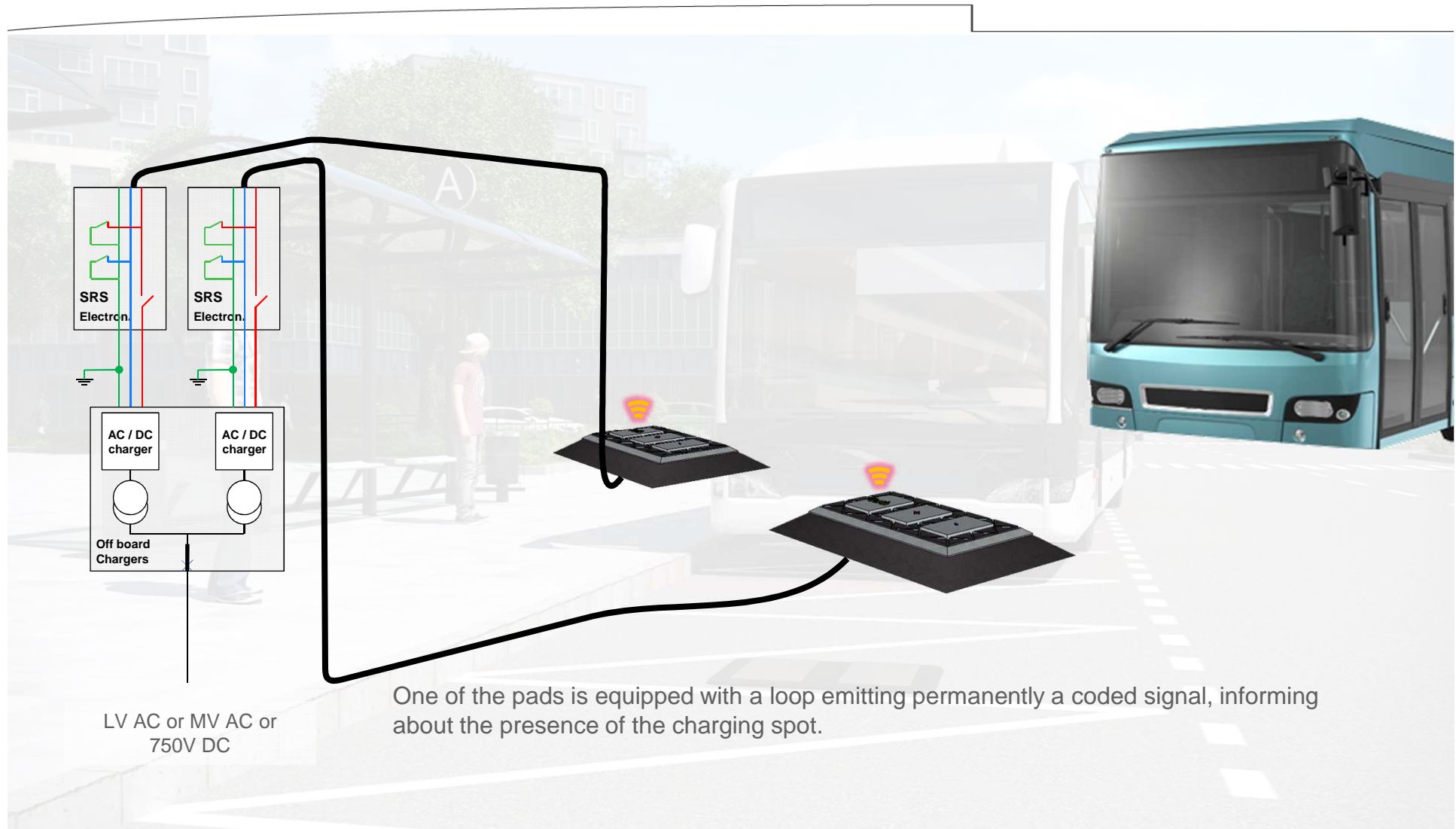
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# SRS for bus – Safety first

- When no vehicle is on the charging spot :
  - The pads are electrically connected to the earth
  - People can walk safely on the pads
  - The connection of the pads to the earth is verified permanently with a high level of safety
  - The onboard collector shoe is electrically disconnected from the battery and connected to the vehicle frame
- When a vehicle is on the charging spot :
  - Energization only when the vehicle covers the pads with a high level of safety
  - Earthing of the vehicle body is permanently verified during charging
  - The charging spot is surrounded with an earthed voltage barrier to ensure no propagation of the voltage on the ground
  - If earthing test of the vehicle body fails or if the signal vehicle to ground is no longer received, then the pads voltage goes back to earth voltage

# SRS for bus - Sequences

## 1. Permanent emission of radio signal from the ground

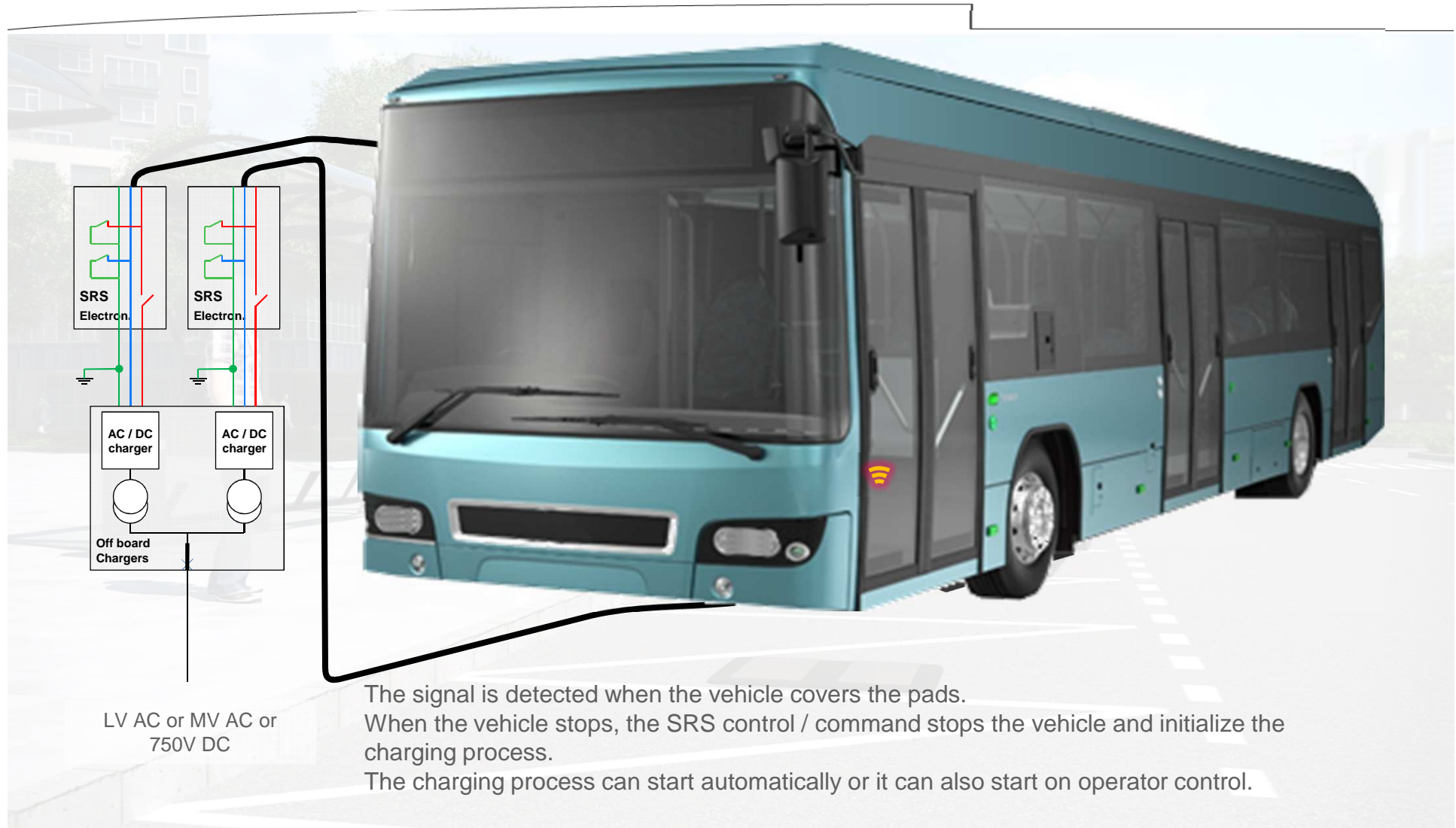


One of the pads is equipped with a loop emitting permanently a coded signal, informing about the presence of the charging spot.



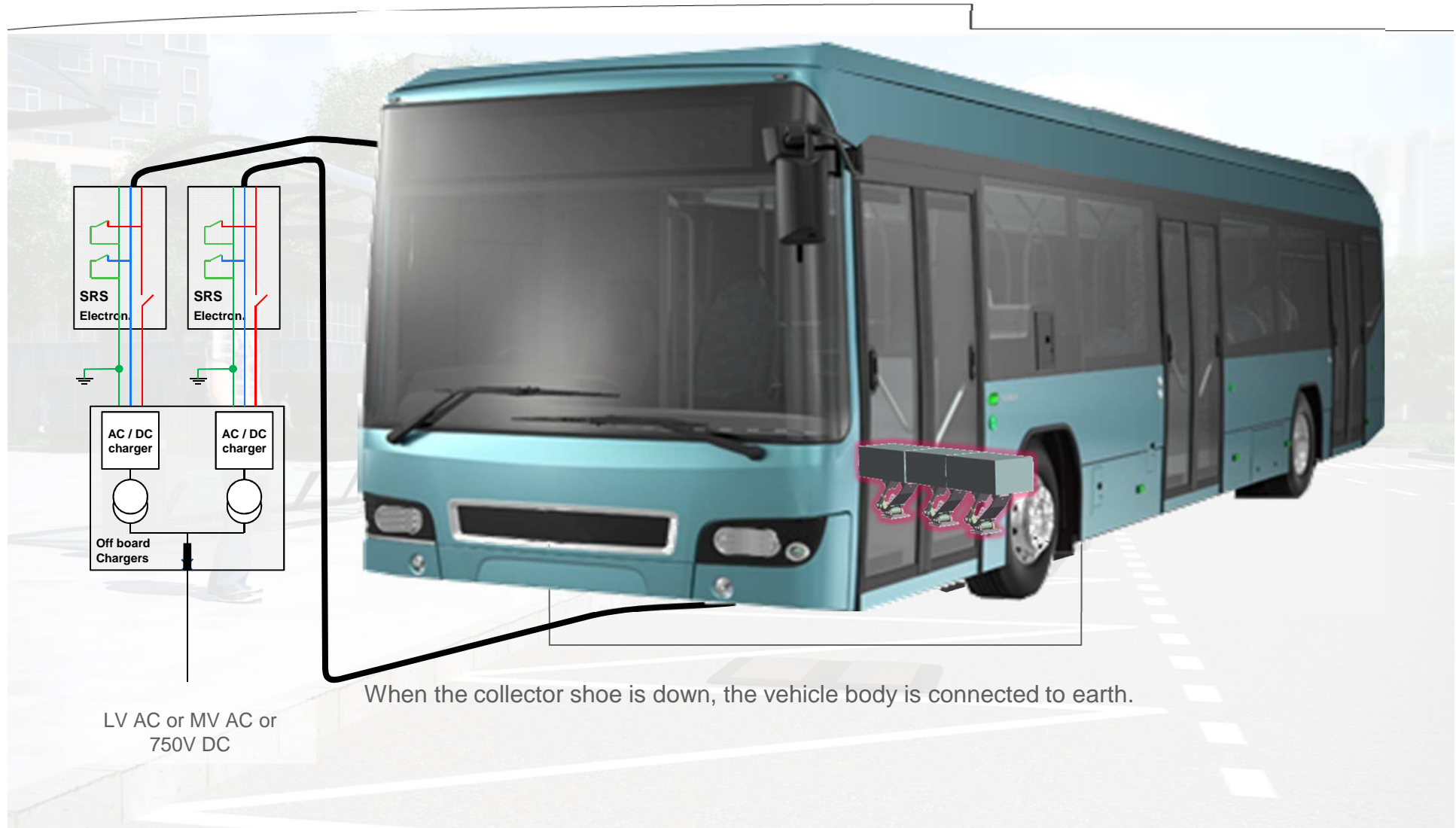
# SRS for bus - Sequences

## 2. Detection of the charging spot and immobilization of the vehicle



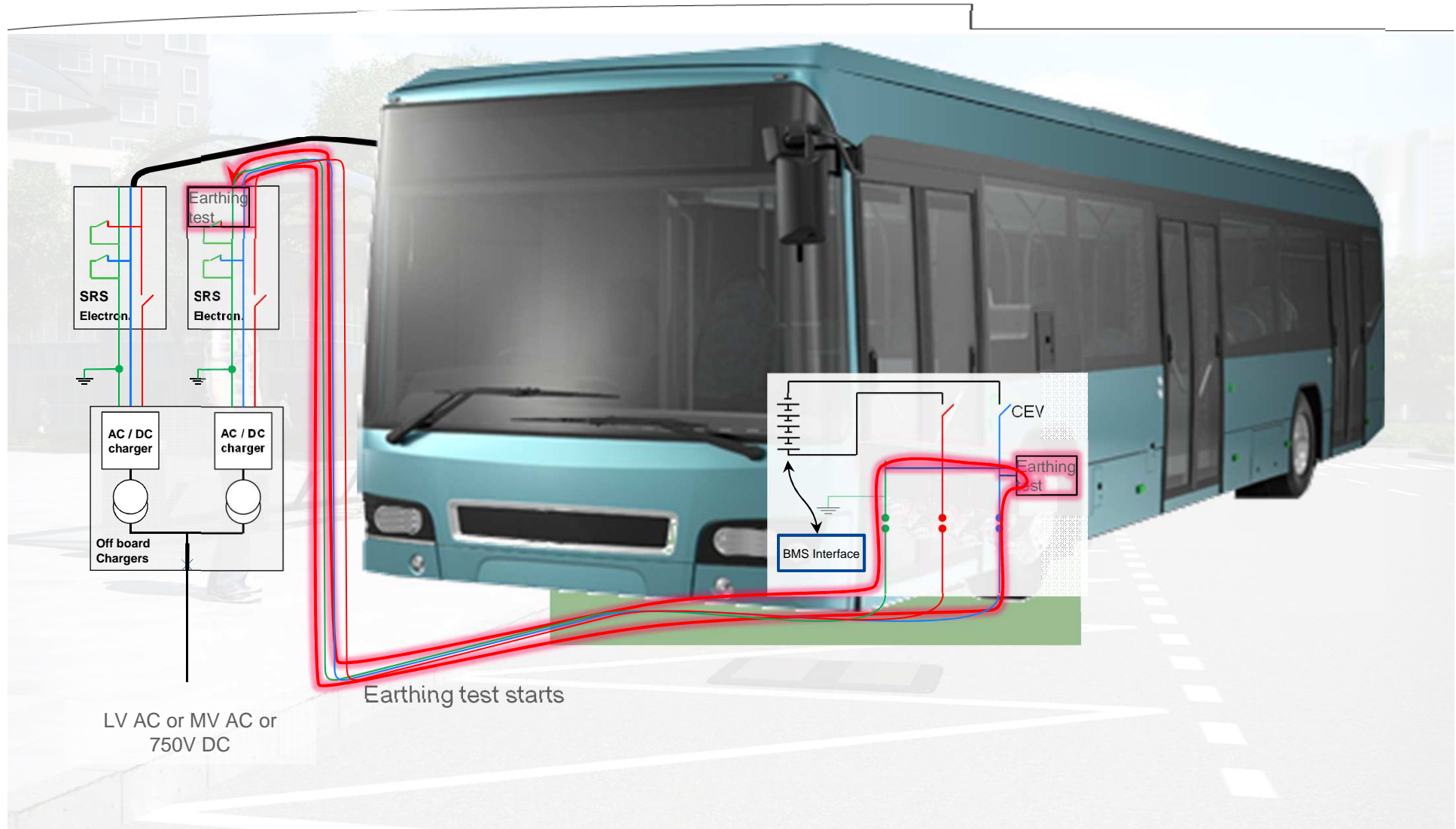
# SRS for bus - Sequences

## 3. Lowering down of the collector shoes.



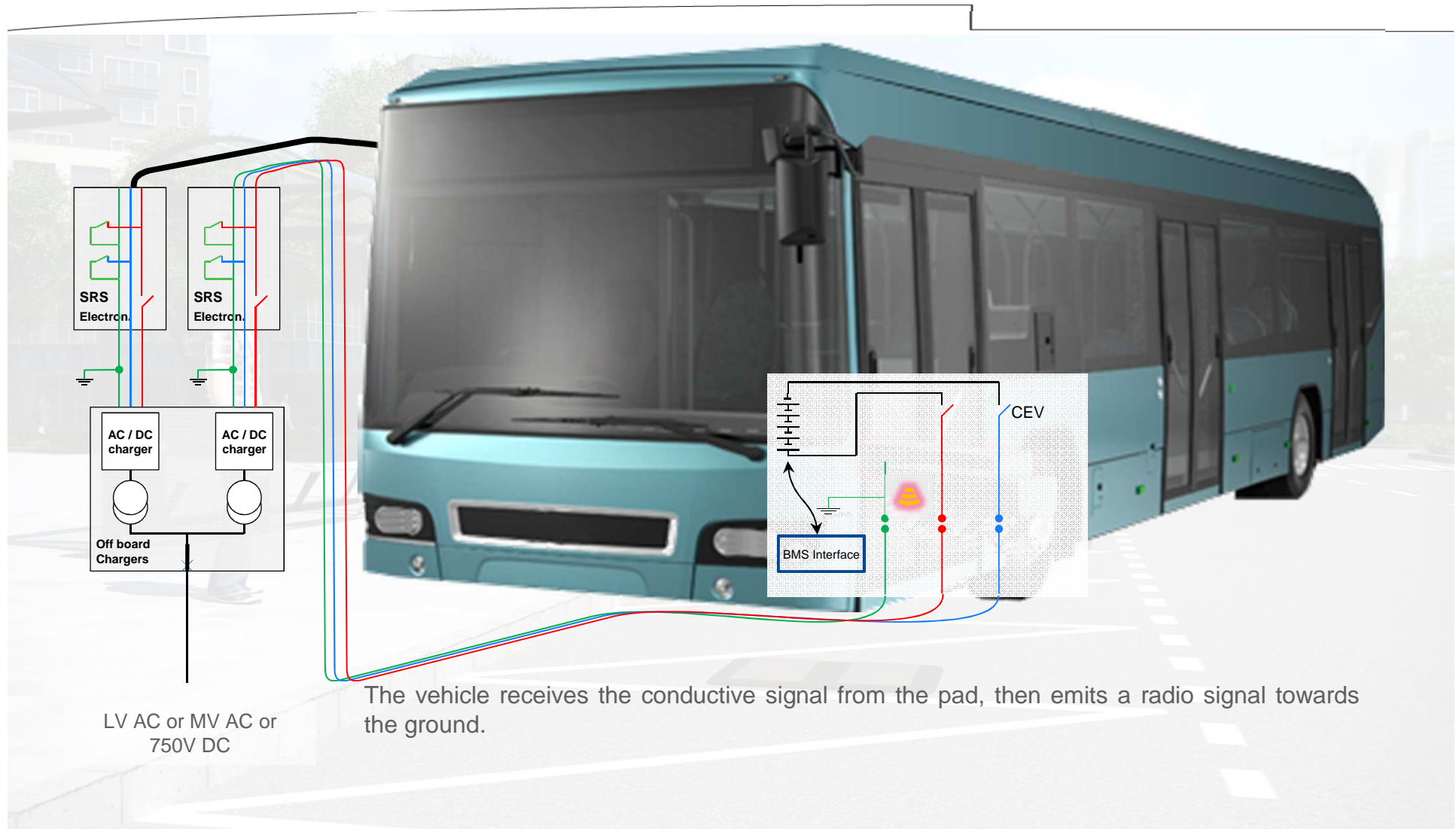
# SRS for bus - Sequences

## 4. Earthing test



# SRS for bus - Sequences

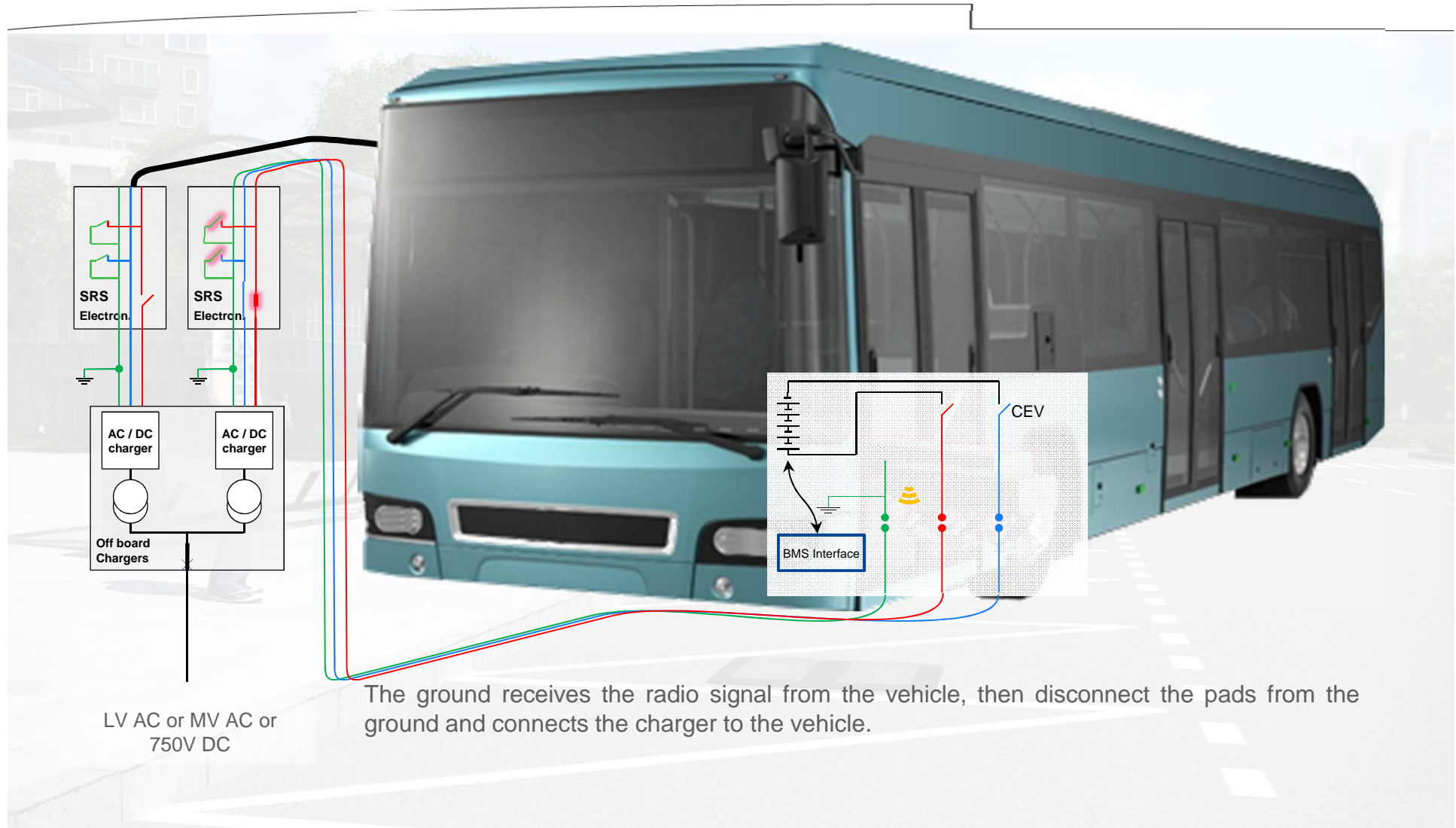
## 5. Emission of vehicle to ground signal



# SRS for bus - Sequences

## 6. Earthing disconnection

### Connection of charger to the vehicle

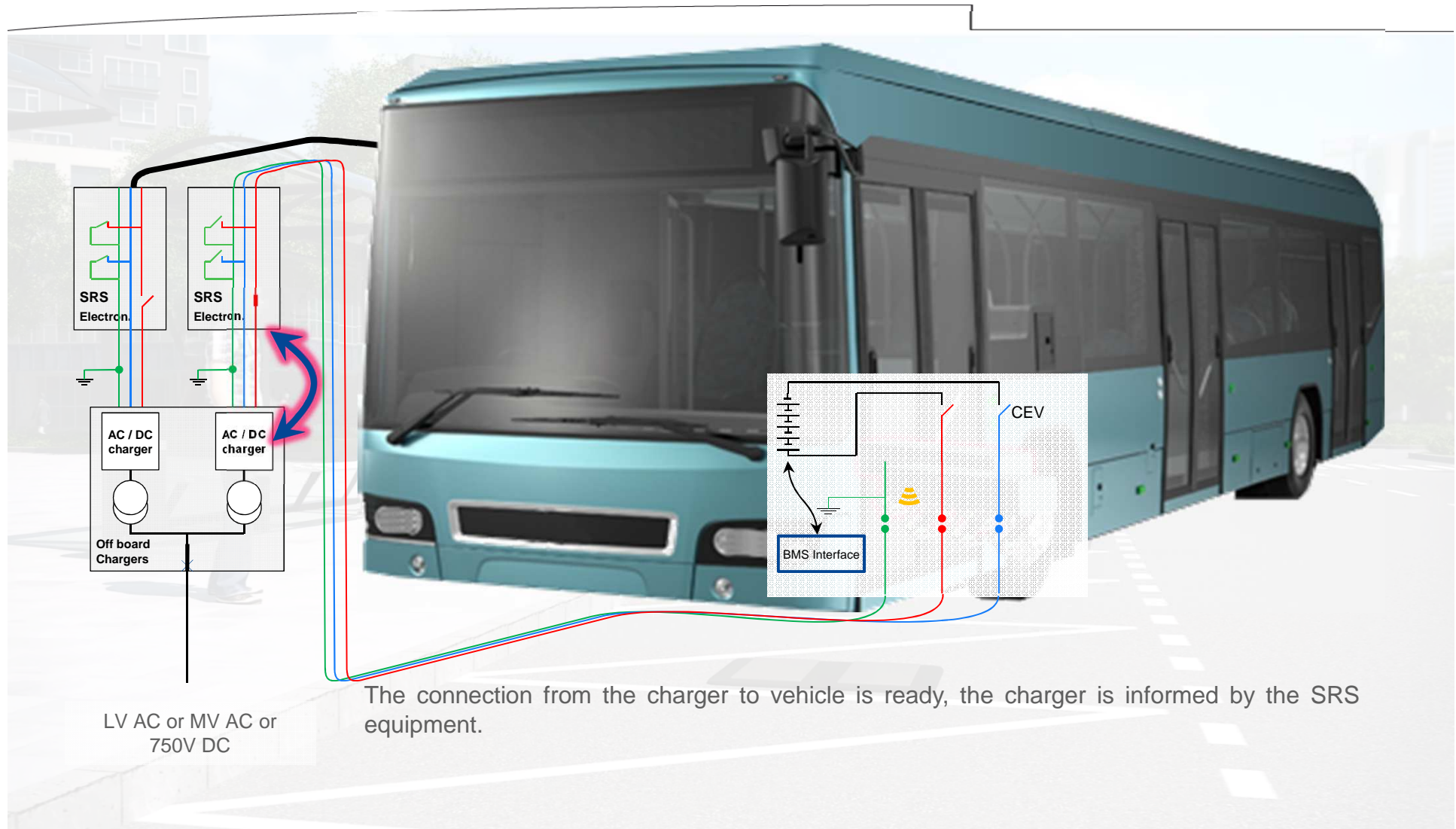


LV AC or MV AC or  
750V DC

The ground receives the radio signal from the vehicle, then disconnect the pads from the ground and connects the charger to the vehicle.

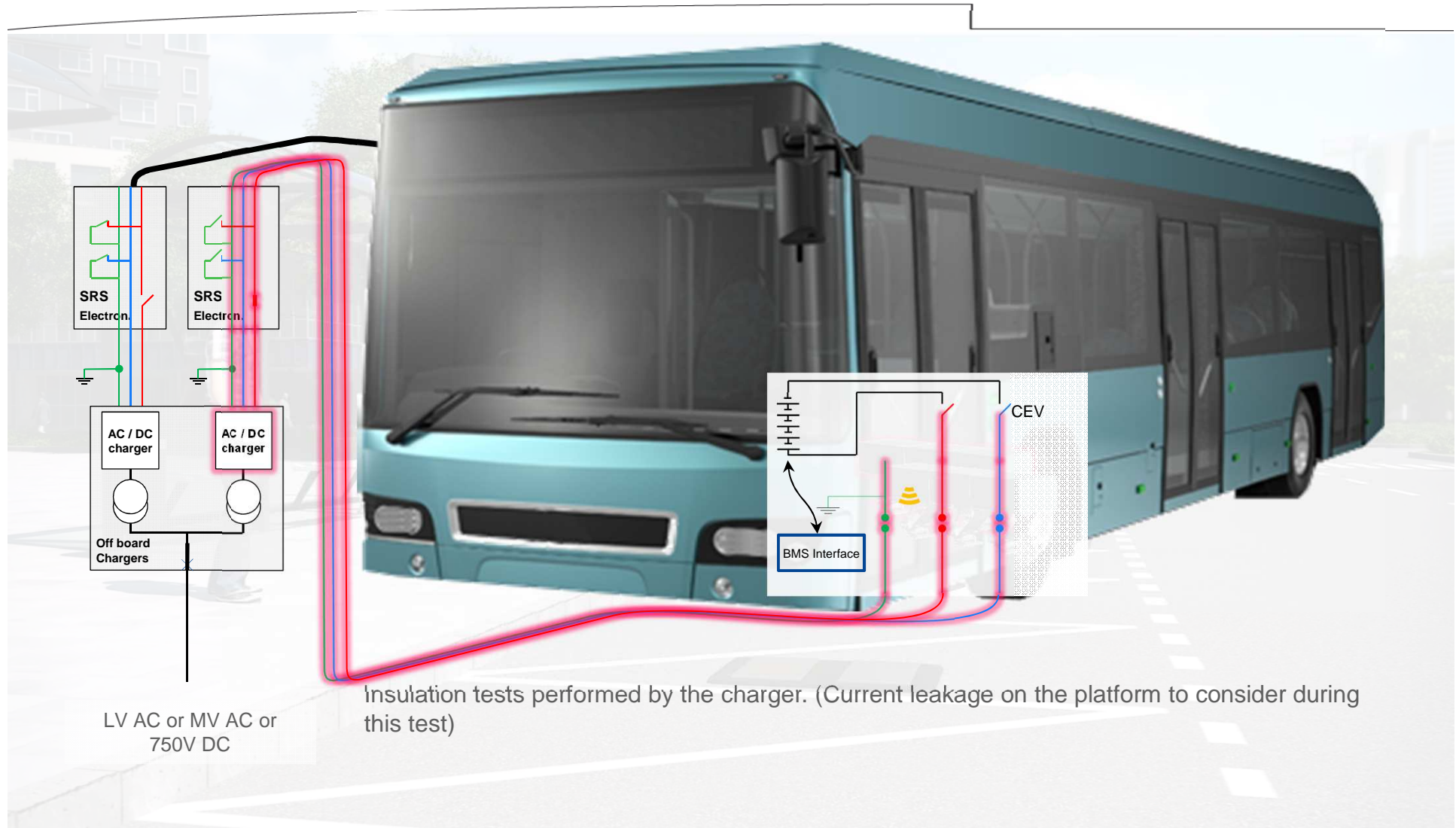
# SRS for bus - Sequences

## 7. Inform charger



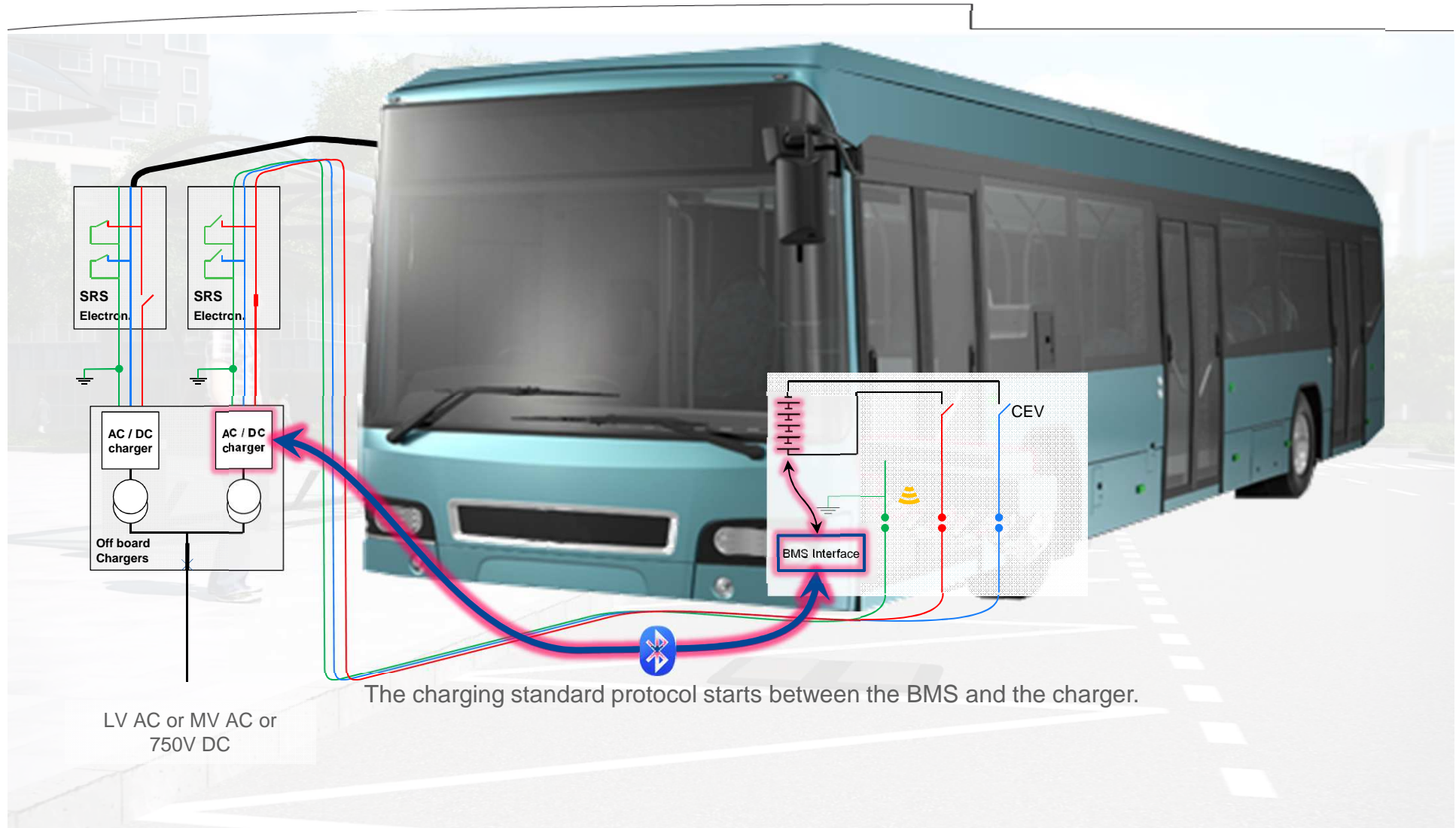
# SRS for bus - Sequences

## 8. Charger insulation test



# SRS for bus - Sequences

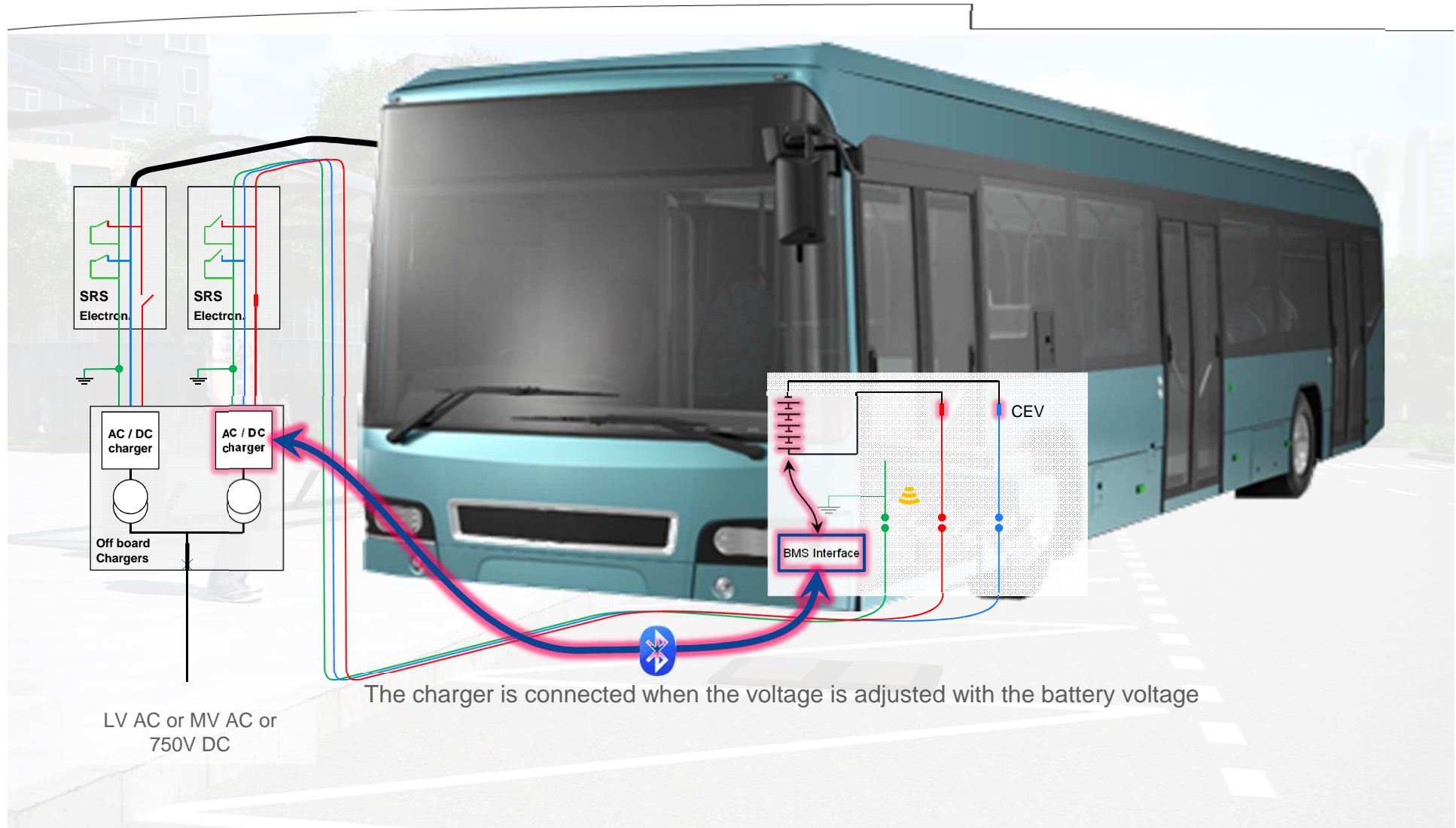
## 9. Wireless communication between the charger and the on board Battery Management System





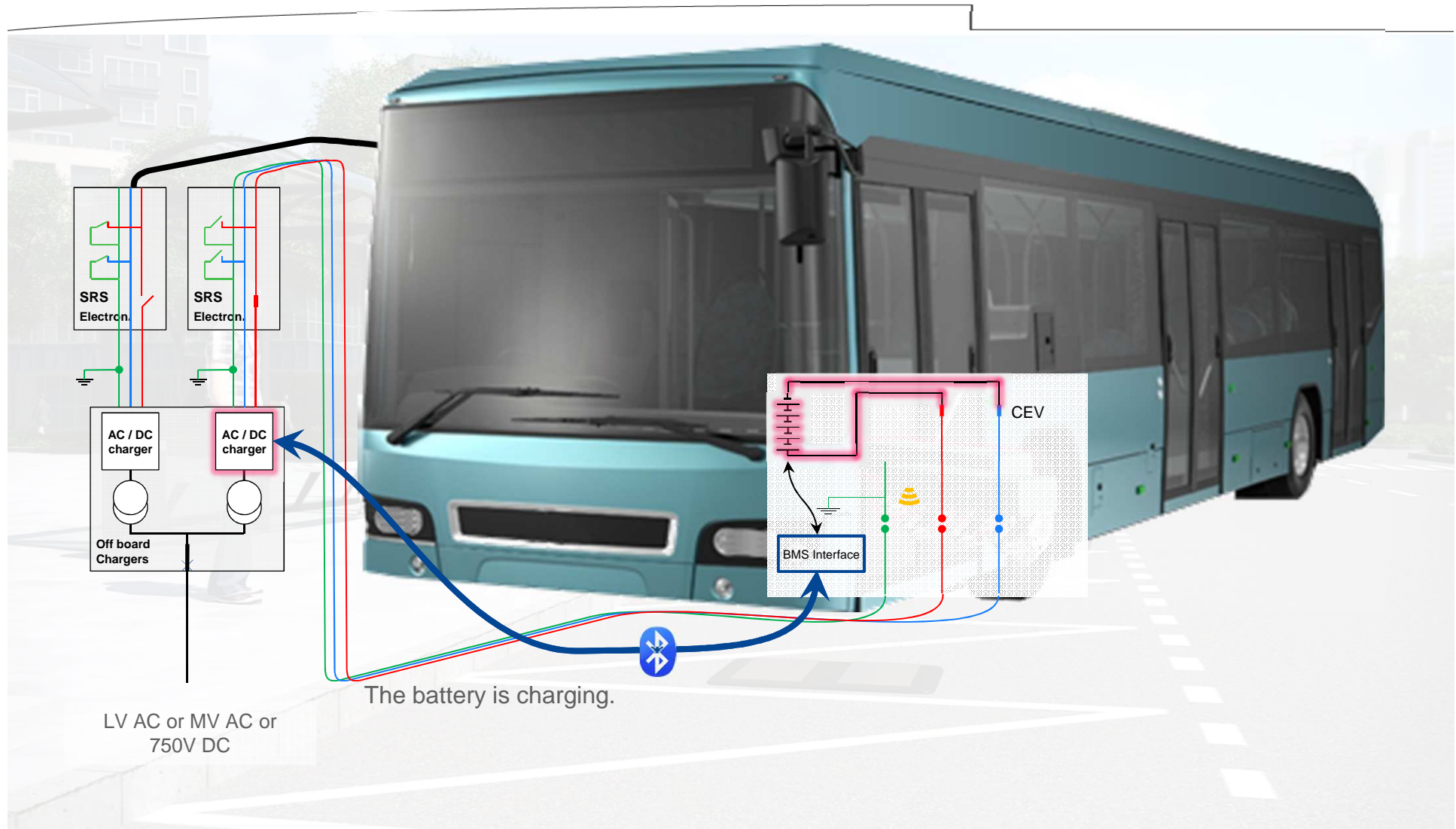
# SRS for bus - Sequences

## 10. Charger –Battery voltage adjustment and connection with the battery



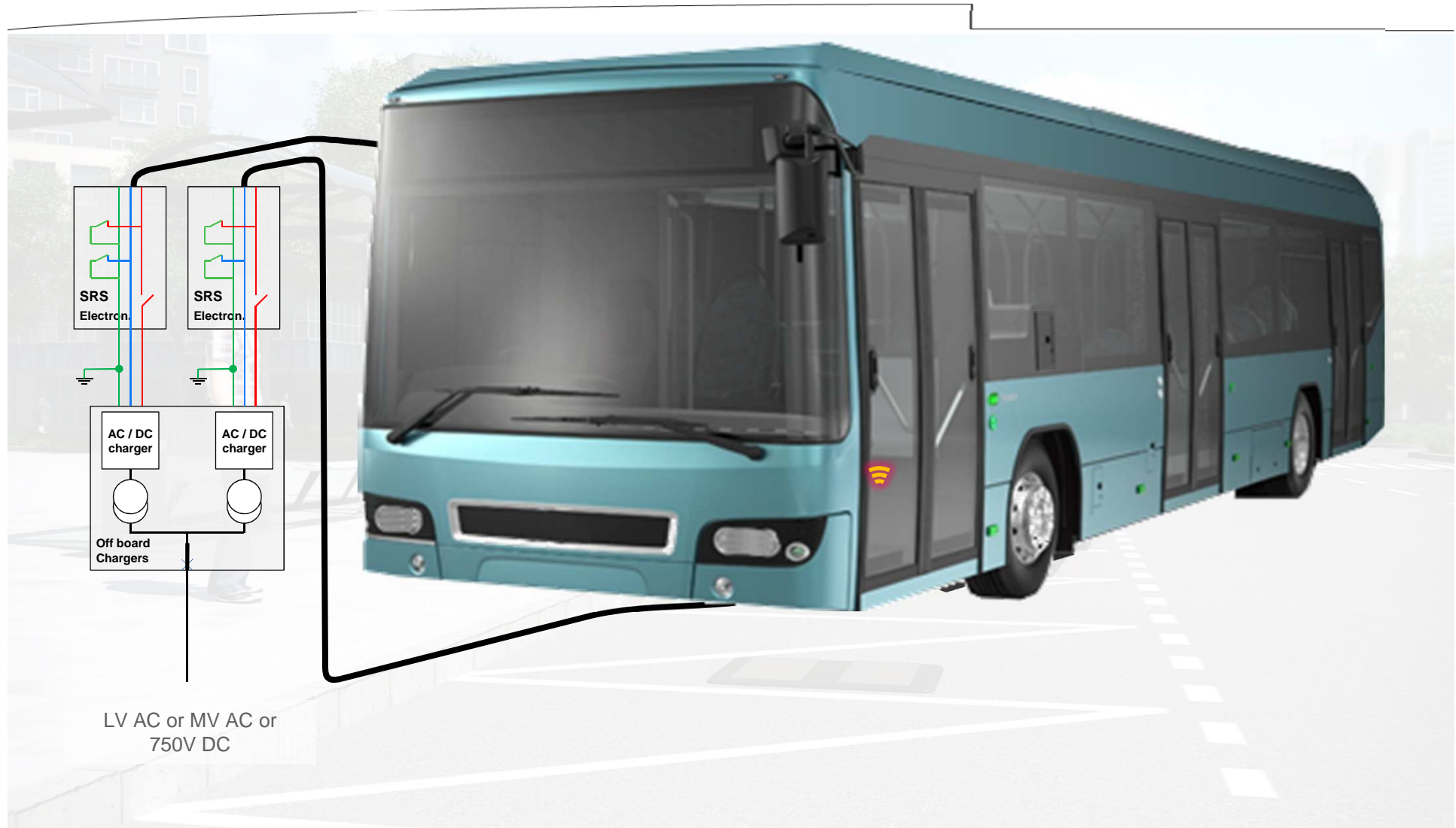
# SRS for bus - Sequences

## 11. Charge Battery

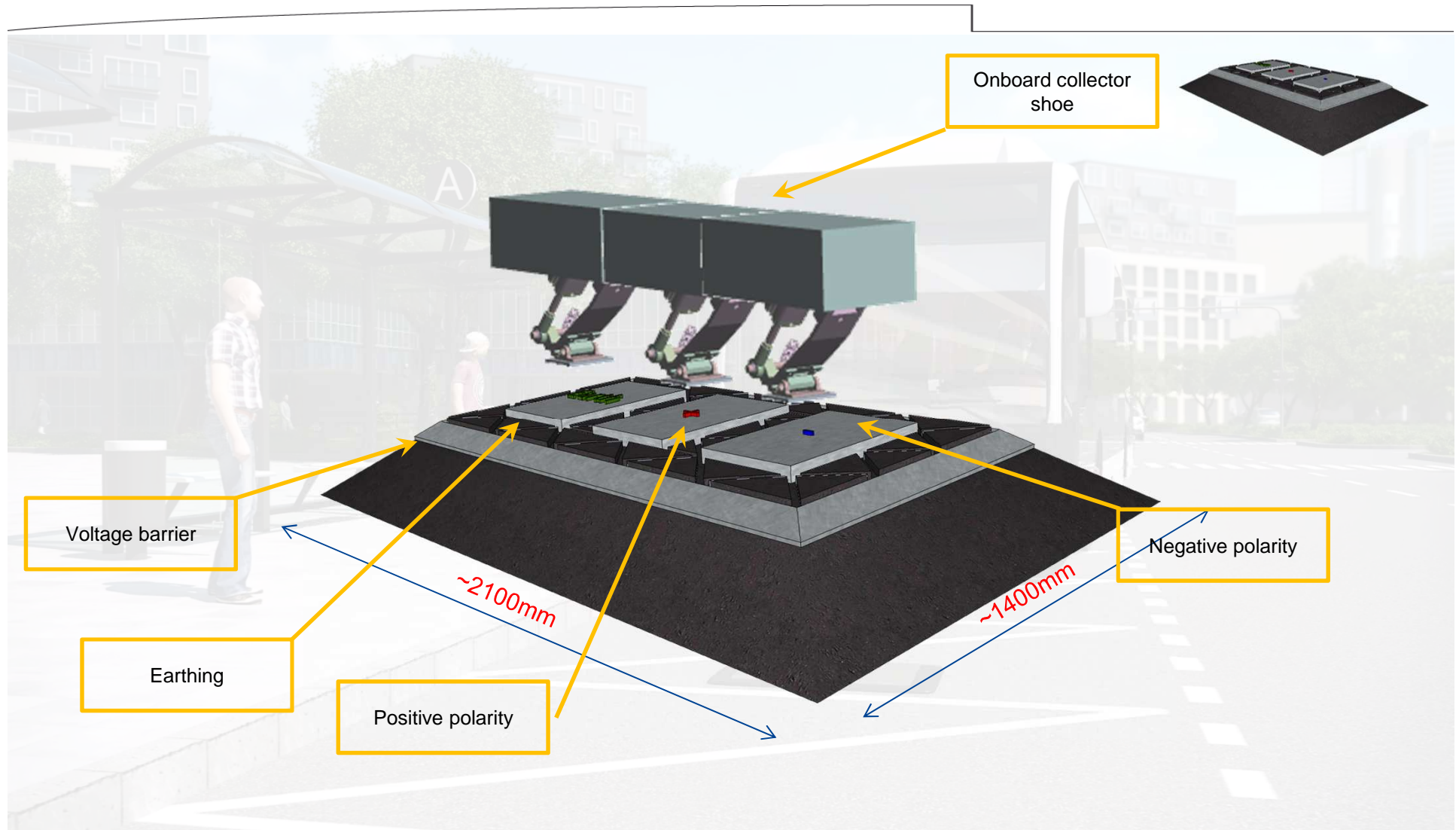


# SRS for bus - Sequences

12. End of charge will almost follow the opposite process



# SRS for bus - Contact Infrastructure – vehicle



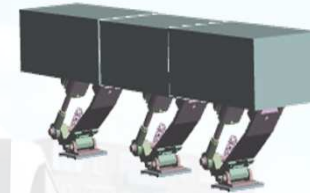
# SRS for bus - Infrastructure features

- Specific provisions for climatic conditions:
  - Rain, water on the ground, ice, snow
- Specific provisions for pollutants:
  - Gravel, pieces, coins, dust on the pad
- Pad dimensions : 2100mm x 1400mm x H50mm.
- Indoor room for charger and SRS. Size and location depends on the required number of slots and power level.
- Distance Pad – SRS Electronic up to 100m



# SRS for bus - On-board interface requirement

- Collector shoe interface requirement
  - Collector shoes to be integrated under the bus body
- Integration of on-board SRS control
  - The on-board SRS contains the wireless interface between the off-board charger and the on-board BMS.



# SRS for Buses benefits vs. other fast-charging solutions

## ■ Ground-based solution vs. overhead solutions

- Less **obtrusive**
- Compact solution: **easy integration** into urban landscape
- **No height constraint** for vehicles (single or double-decker buses)
- No mobile infrastructure: **high availability** of charging spot
- **Facilitated** maintenance of fixed infrastructure

## ■ By contact vs. inductive solutions

- **Fast** and **efficient energy transfer**
- **Unlimited** power
- **Lower** vehicle and infrastructure cost/complexity
- **Better resistance** to heavy loads
- **Facilitated** maintenance of fixed infrastructure

## ■ Proven, safe and reliable technology

- Derived from Alstom's **APS**, designed for catenary-free streetcars



# SRS

for Streetcars or Bus  
Smart energization concept  
for e-mobility with Alstom  
Thank-you!





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*Designing fluidity*