SAE J-3105™ Heavy-Duty Conductive Automatic Charging Recommended Practice

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Bus and Truck Working Council

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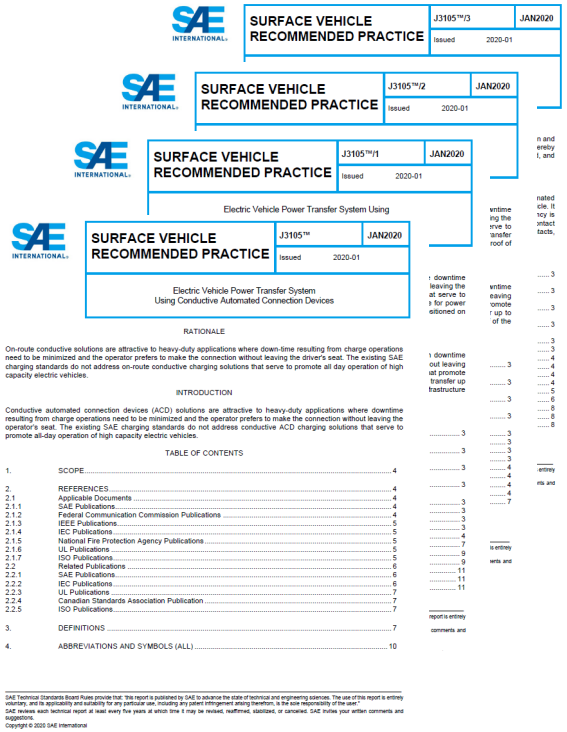
SAE J-3105 Conductive Automated Connection Devices

- The four Recommended Practices were published in January 2020 producing a family of documents connected together by a main document.
- The main document J-3105 will contain the significant common parts of the system (about 90%). It will include:
  - Electrical Interface
  - Power Flow (Voltage and Currents) (1000V and 600 A)
  - Communications
  - Safety
  - Systems
- The supplemental documents specify the detail of the connection including conductor and bus geometry
  - J-3105-1 - Infrastructure-mounted Cross Rail Connection
  - J-3105-2 - Vehicle-mounted Pantograph Connection
  - J-3105-3 - Enclosed Pin and Socket Connection

These documents enable the Transit Industry to be interoperable from OEM to OEM.

EPRI has lead this SAE committee since its inception.


SURFACE VEHICLE RECOMMENDED PRACTICE J3105™/3 JAN2020 Issued 2020-01

SURFACE VEHICLE RECOMMENDED PRACTICE J3105™/2 JAN2020 Issued 2020-01

SURFACE VEHICLE RECOMMENDED PRACTICE J3105™/1 JAN2020 Issued 2020-01

Electric Vehicle Power Transfer System Using

SURFACE VEHICLE RECOMMENDED PRACTICE J3105™ JAN2020 Issued 2020-01

Electric Vehicle Power Transfer System Using Conductive Automated Connection Devices

RATIONALE

On-route conductive solutions are attractive to heavy-duty applications where down-time resulting from charge operations need to be minimized and the operator prefers to make the connection without leaving the driver's seat. The existing SAE charging standards do not address on-route conductive charging solutions that serve to promote all day operation of high capacity electric vehicles.

INTRODUCTION

Conductive automated connection devices (ACD) solutions are attractive to heavy-duty applications where downtime resulting from charge operations need to be minimized and the operator prefers to make the connection without leaving the operator's seat. The existing SAE charging standards do not address conductive ACD charging solutions that serve to promote all-day operation of high capacity electric vehicles.

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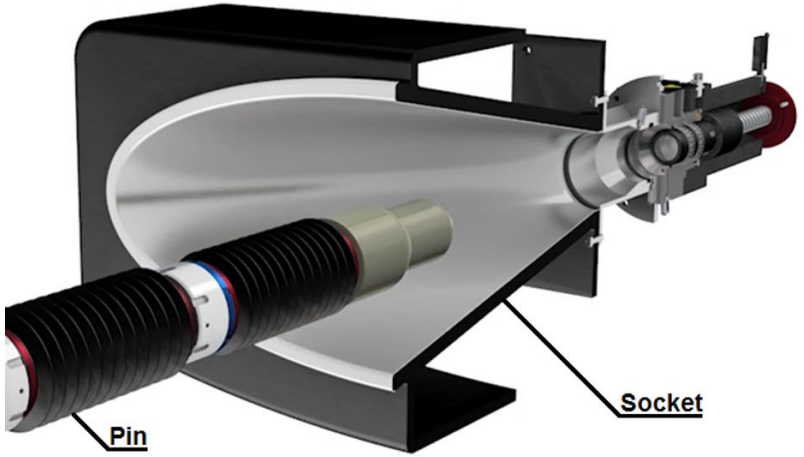
Automated Connectors

SAE J-3105-1

Infrastructure-mounted Cross Rail Connection

SAE J-3105-2

Vehicle-mounted Pantograph Connection



SAE J-3105-3

Enclosed Pin and Socket Connection

J-3105 Announced in SAE Magazine

SAE STANDARDS NEWS

SAE publishes On-Route Mechanized Conductive EV Charging Systems Recommended Practices

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SAE International published SAE J-3105 Electric Vehicle Power Transfer System Using Conductive Automated Connection Devices Recommended Practice in January 2020. The document promotes the safe testing and performance of mechanized conductive power transfer systems. Written for buses and heavy-duty vehicles in general, SAE J-3105 encompasses the general physical, electrical, functional, testing and performance requirements for conductive power transfer primarily for vehicles using a conductive automated-charging-device (ACD) connection capable of transferring DC power.

As the EV market expands, the need for the continued standardization of DC power distribution remains, and SAE J-3105 addresses three interfaces required to ensure power delivery is consistent. It defines a conductive power transfer method including the curbside electrical contact interface, the vehicle connection interface, the electrical characteristics of the DC supply and the communication system. It also covers the functional and dimensional requirements for the vehicle-connection interface and supply-equipment interface.

"As the electric bus market expands in the United States, it is imperative that we modify our standards and approach to ensure safer and more reliable usage," said Jack Pokrzywa, director of global ground vehicle standards, SAE International. "SAE J-3105 will guide this burgeoning industry to safe and efficient charging solutions that minimize downtime and promote long-term performance for heavy-duty applications."

In addition to the main J-3105 Recommended Practice document, there are also three supplemental Recommended Practices – J-3105-1, J-3105-2 and J-3105-3 – that address requirements for a specific interface defined in the supporting document. All connections will use the common requirements established in the overall J-3105 document.

- SAE J3105-1: Infrastructure-Mounted Cross Rail Connection covers the relevant connection-interface requirements for an electric vehicle power transfer system using a conductive automated-connection device based on a cross-rail design. (See figure 1)
- SAE J3105-2: Vehicle-Mounted Pantograph Connection covers the relevant connection-interface requirements for an electric vehicle power transfer system using a conductive automated-charging device based on a conventional rail vehicle pantograph design. (See figure 2)
- SAE J3105-3: Enclosed Pin and Socket Connection covers the main safety and interoperability relevant requirements for an electric vehicle power transfer system using a conductive automated-charging device based on an enclosed pin and socket design. (See figure 3)

The SAE Medium and Heavy-Duty Vehicle Conductive Charging Task Force committee, a part the SAE International Hybrid EV group, worked over the last four years to write J-3105 and follow it through the process to publication. "SAE J-3105 will help industry ensure that each connection type is safe and interoperable among manufacturers. The industry has been waiting for this Recommended Practice," said Task Force Committee Chair Mark Kosowski, who is technical executive for the Electric Power Research Institute (EPRI).

Many individuals have been involved in the standard development work with approximately 20-25 experts in regular attendance at Task Force meetings. Participants involved include bus OEMs BYD, Gillig, New Flyer, Nova Bus, Opbrid, Proterra; charger manufacturers ABB, Heliox and Siemens; pantograph and connector makers Schunk, Stäubli, Stemmann; utilities EPRI, Sacramento Municipal Utility District (SMUD), Southern California Edison (SCE); transit fleets APTA, Chicago Transit Authority, King County Metro, Los Angeles County Metropolitan Transportation Authority, NY City Transit, plus Argonne National Labs and CTE.

Visit https://www.sae.org/standards/content/j3105_202001/ for more information or to purchase J-3105. ■

Figure 1. J-3105-1: Infrastructure-Mounted Cross Rail Connection

Figure 2. 3105-2: Vehicle-Mounted Pantograph (Bus-up) Connection

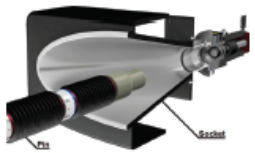
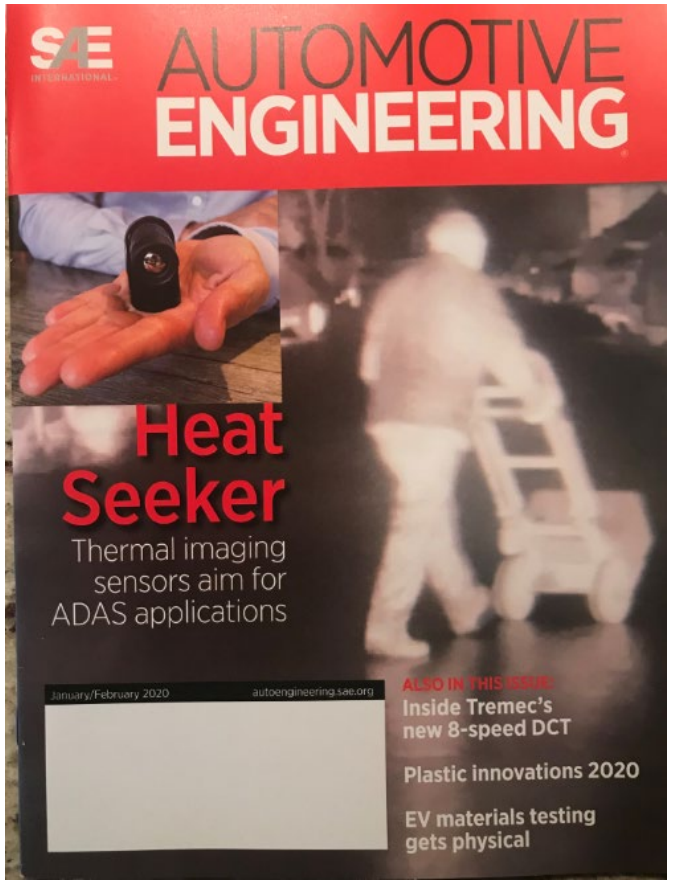


Figure 3. J-3105-3: Enclosed Pin and Socket Connection

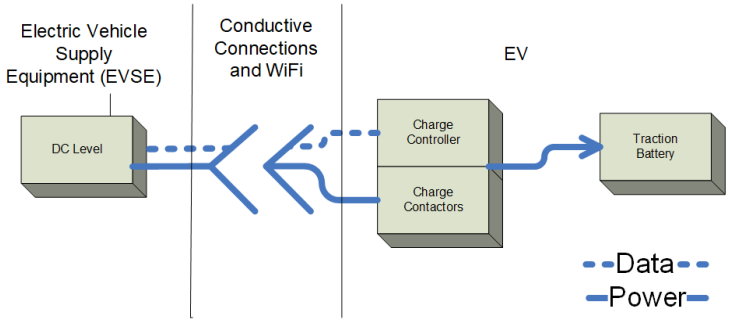
FROM LEFT: MARK KOSOWSKI, EPRI; MARK KOSOWSKI, EPRI; STAUBLI

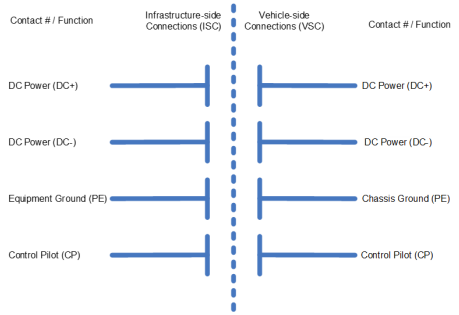


SAE Standards news article being published in the SAE Automotive Engineering Magazine for January/ February 2020

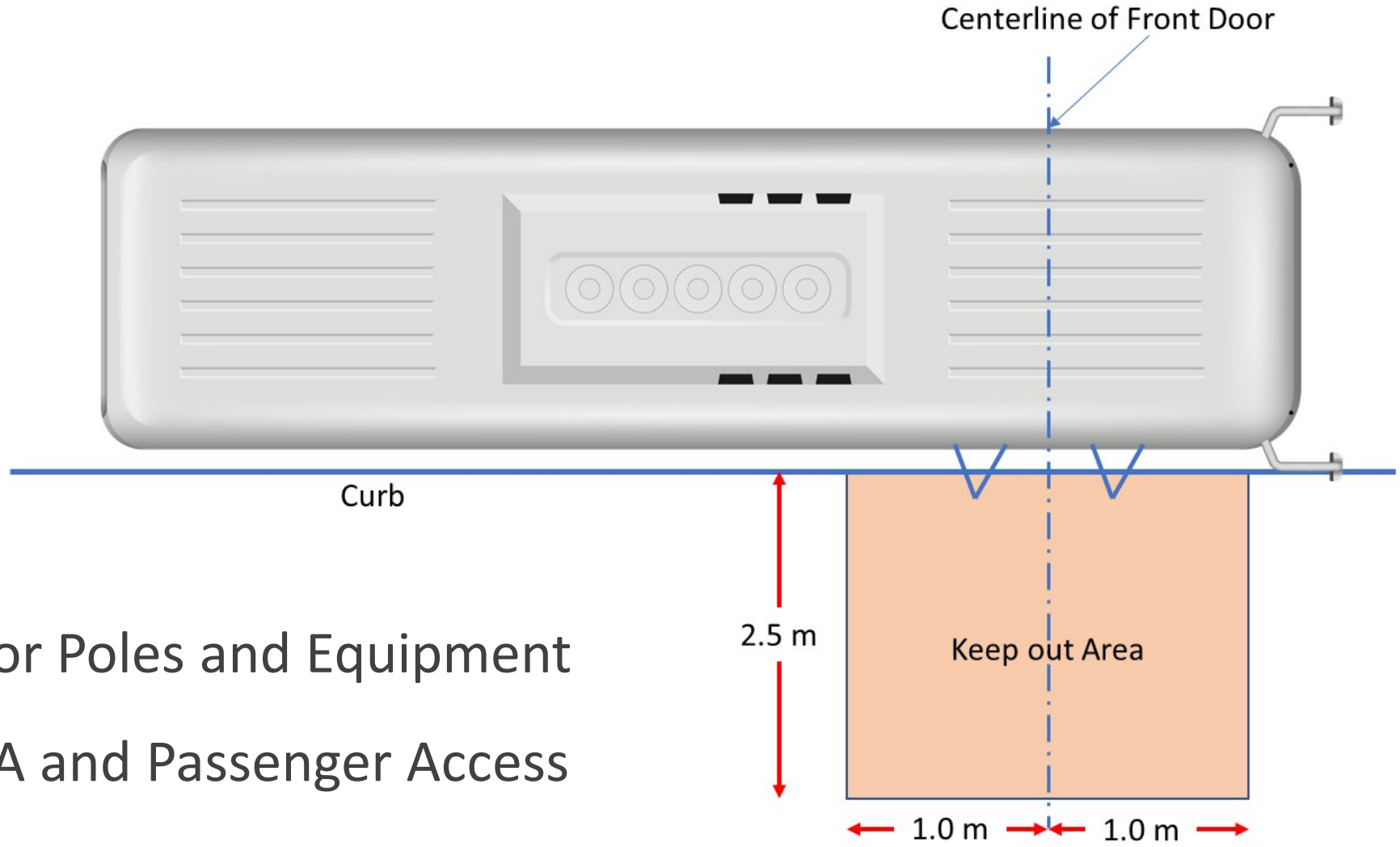
J-3105 Automatic Charging Requirements

- The Voltage Range is 250 to 1000 V
- Two Power Levels are arranged-
  - Level 1: up to 600 A (350 kW)
  - Level 2: up to 1200 A (1.2 MW)
  - Level 1 and Level 2 need to be compatible and interoperable
- The Control Pilot will be used for communications once the vehicle is connected to the infrastructure
- Wireless communications will be used to pair the vehicle with the charger- IEEE 802.11n
- Testing requirements are defined



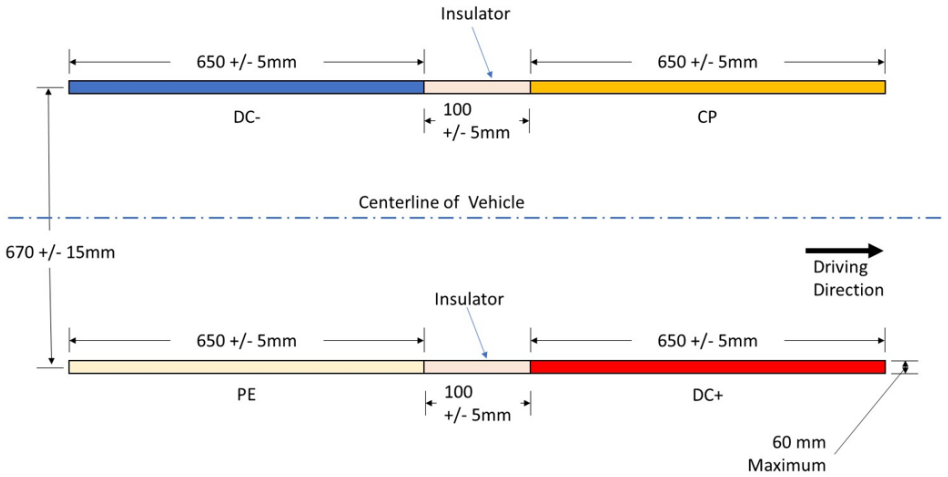


J-3105 Common Keep Out Zone

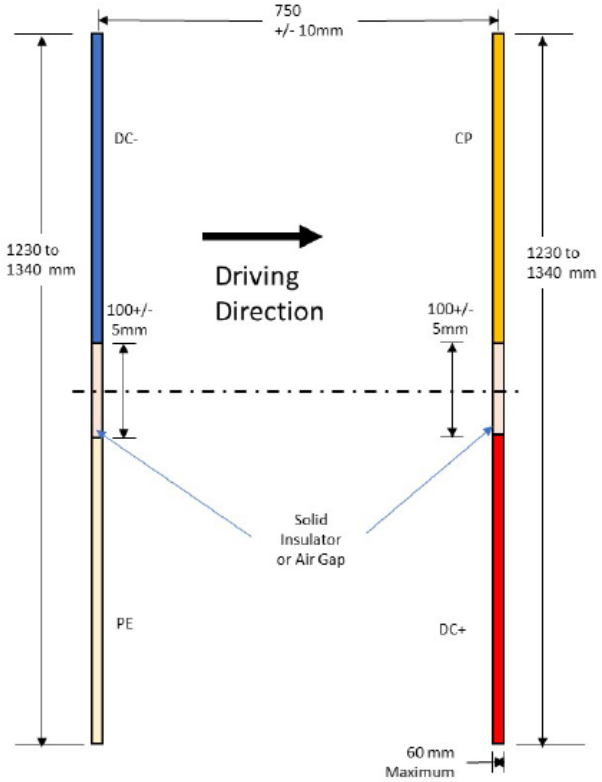


- Keep Out Zone for Poles and Equipment
- Reserved for ADA and Passenger Access

J-3105-1 Infrastructure-Mounted Cross Rail Connection

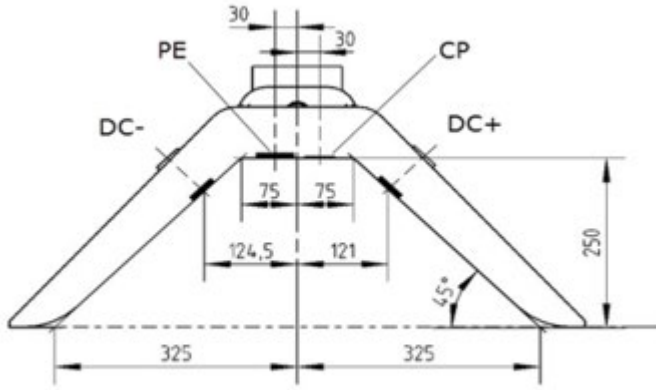


Vehicle Side Connector (VSC)

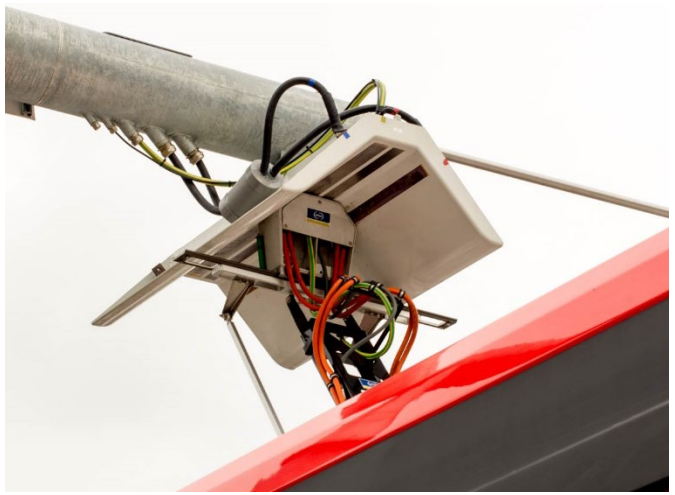


Infrastructure Side Connector (ISC)

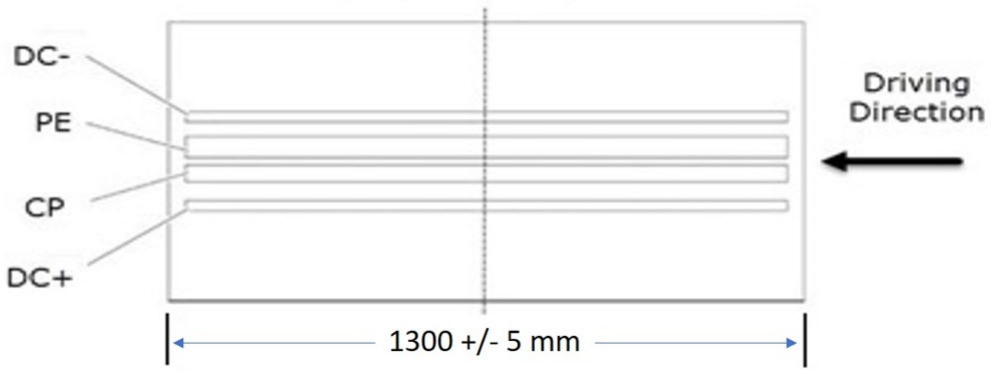
J-3105-2 Vehicle-Mounted Pantograph Connection

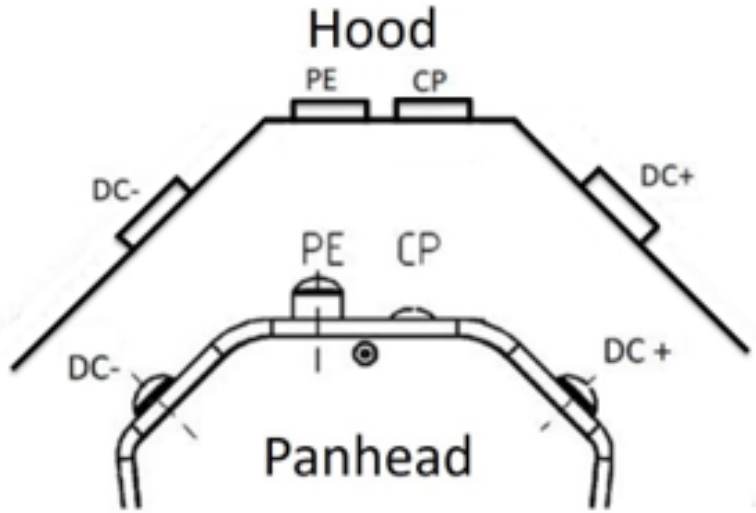


Dimensions in mm

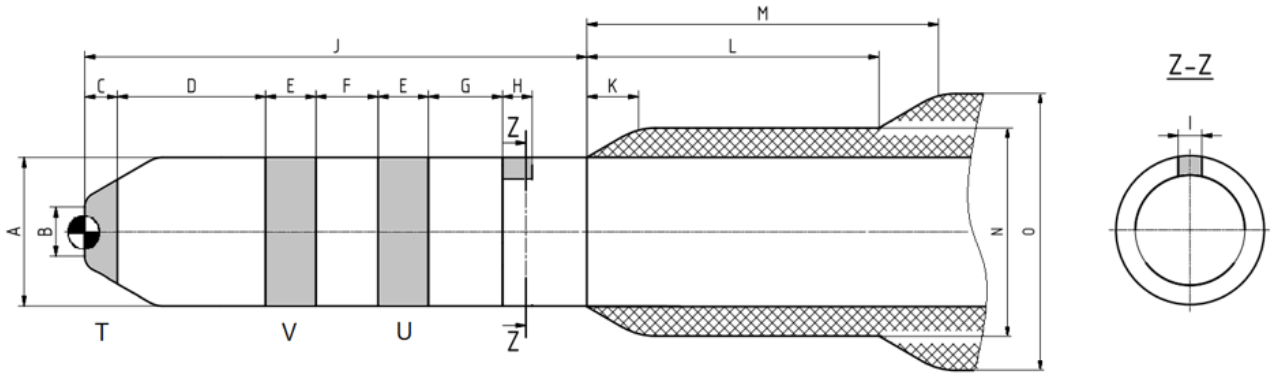


Infrastructure Side Connector (ISC)

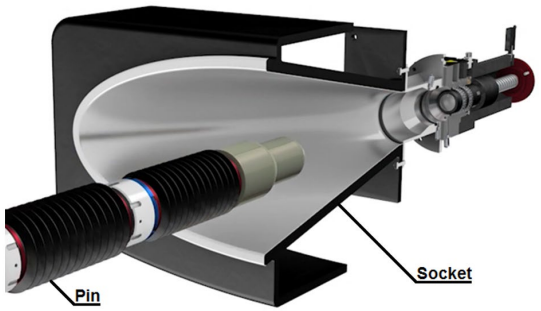




J-3105-3 Enclosed Pin and Socket Connection



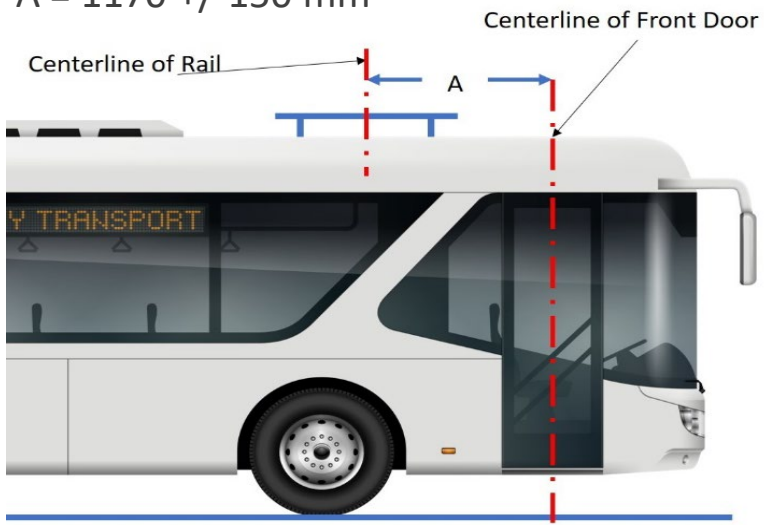
Infrastructure Side Connector (ISC)



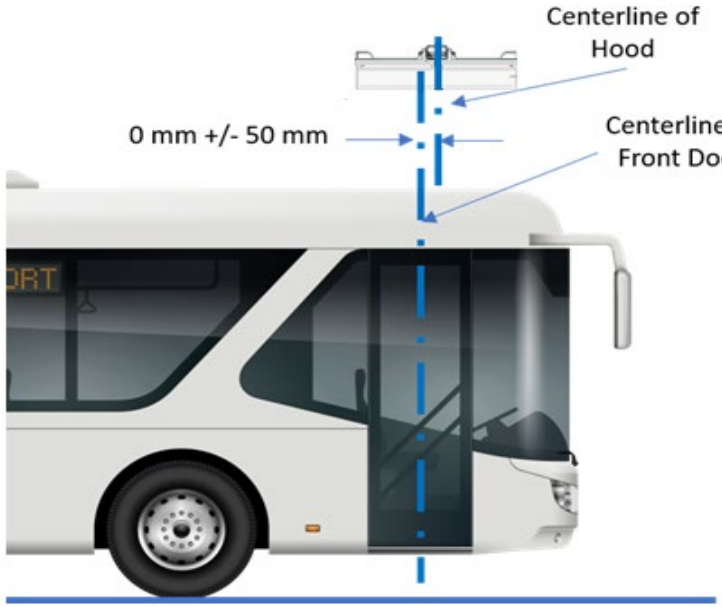
	Size 2		Size 3		
	Dimension	Tolerance	Dimension	Tolerance	Explanation
A	Ø50	0 / -0.1	Ø85	0 / -0.1	
B	Ø16	±0.5	Ø46	±0.5	PE
C	11	±0.05	11	±0.05	
D	50	+0.15 / 0	79	+0.15 / 0	
E	17	+0.05 / 0	18	+0.05 / 0	DC+ Power and DC- Power
F	21	+0.1 / 0	25	+0.1 / 0	
G	25	+0.1 / 0	33	+0.1 / 0	
H	10	+0.1 / 0	10	+0.1 / 0	Control Pilot
I	8	0 / -0.05	8	0 / -0.05	
J	176.75	± 1	290.15	± 1	
K	17.2	± 0.2	16.9	± 0.2	
L	98.6	± 0.3	141.7	± 0.3	
M	118.5	± 0.3	159	± 0.3	
N	Ø70	± 0.05	Ø104.8	± 0.1	
O	Ø93	0 / -0.1	Ø124.8	0 / -0.1	
T					PE
U					DC+ Power
V					DC- Power

J-3105-X Bus Connection Location

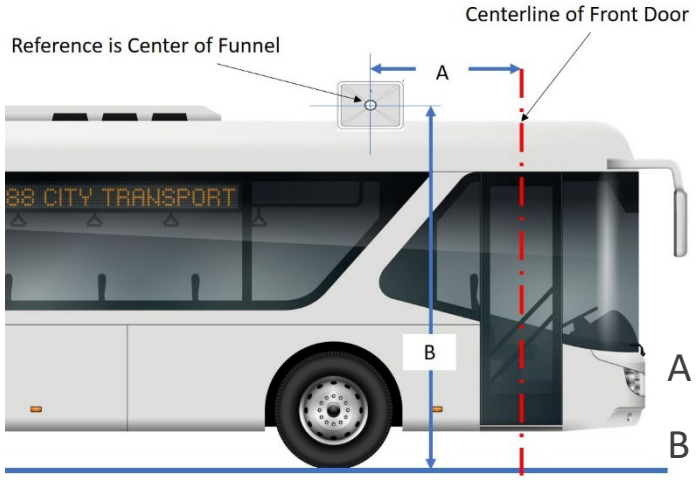
A = 1170 +/-150 mm



J-3105-1



J-3105-2

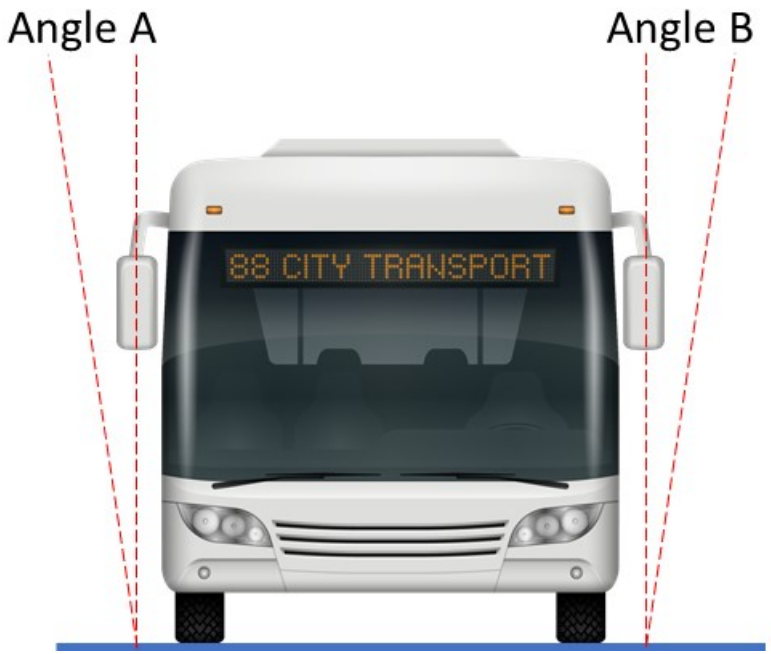


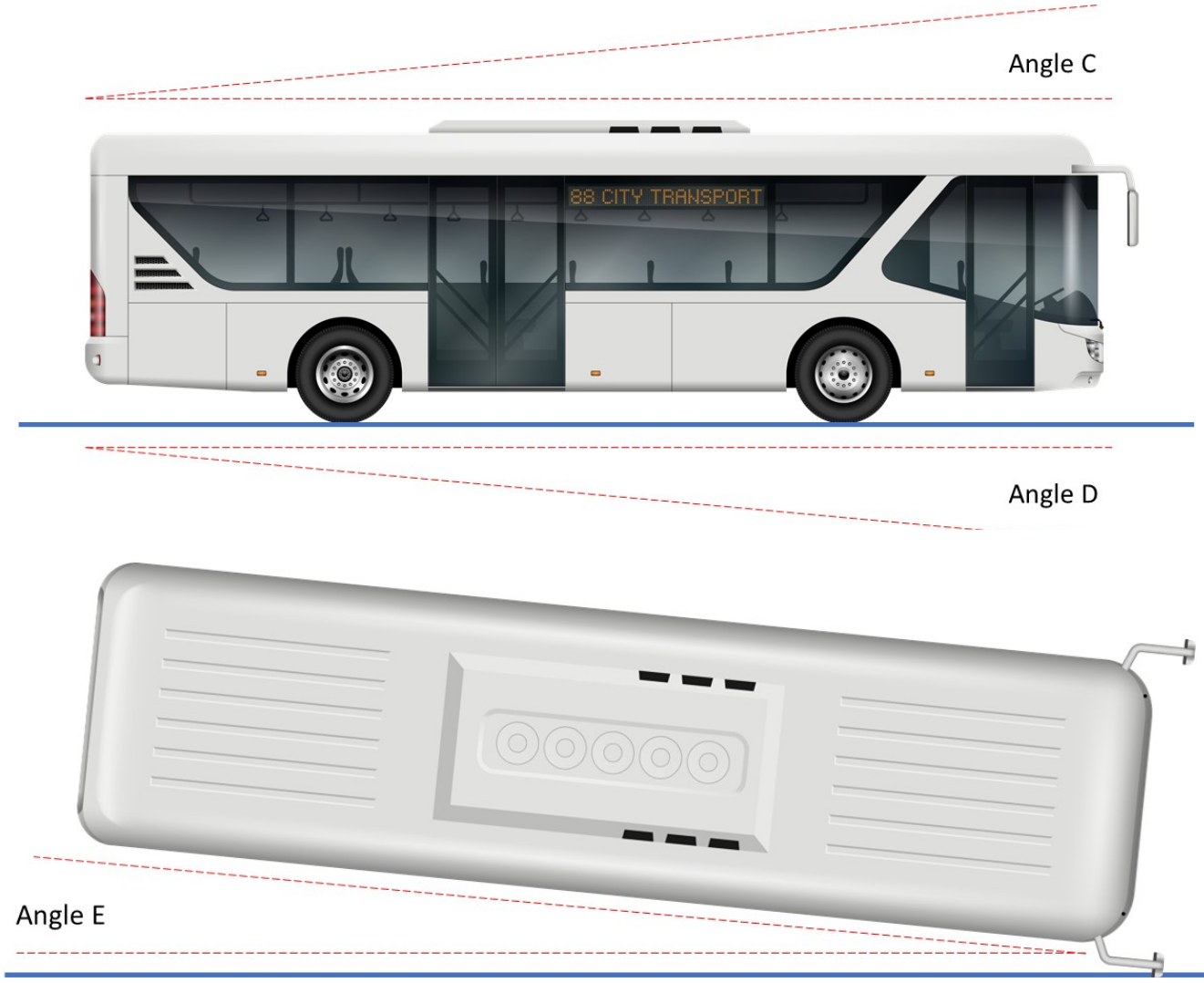
A = 1000 +/- 10 mm

B = 3050 +/- 10 mm

J-3105-3

J-3105-X Maximum Angles





Angle	Dash1 Max Degrees	Dash2 Max Degrees	Dash3 Max Degrees
A	3.5	4.0	5.0
B	3.5	2.0	5.0
C	5.0	5.0	5.0
D	5.0	5.0	5.0
E	5.0	2.0	5.0

Testing is Defined and Overviewed

Appendix G TEST OVERVIEW

The table below can be used to evaluate the general requirements of the tests. This table should be used as an overview and quick reference guide to determine when to perform which tests and the requirements of those tests. The order presented below should be used as a guideline for the order of test.

Section	Evaluation	Standard	Description	Assessment criteria	Type Test	Serial Test
F.3.1	Markings		Visual examination	Markings present and clearly legible	X	X
F.3.2	Creepage		Dimensional Evaluation	All distances must conform to minimum requried spacings	X	X
F.3.3	Cable Sizing		Sizing evaluation	All cables shall be properly sized for the rated load	X	X
F.3.4	Unimpeded Movement		Movement of the ACD Unit	ACD shall move to the maximum extension and retraction without being hindered	X	X
F.3.5	Cable Fixation		Installment of cable in their appropriate locations	Cables shall be fixed to their appropriate locations and torqued to their intended values	X	X
F.3.6	Unintentional Power Loss		Retraction to home after power loss	ACD shall be able to befully retracted to home after power failure	X	X
F.3.7	Nominal Static Force		Normal force validation/complete insertion	ACD shall provide it's intended normal force or be fully inserted.	X	X
F.3.8	Duration of Actuation		Time to move to and from home position	ACD shall move from home to full extension and back within the specified time or be fully mated.	X	X

Section	Evaluation	Standard	Description	Assessment criteria	Type Test	Serial Test
F.4.1.1	Contact Resistance	IEC 60512-5-2	Evaluation of the voltage drop at the contact interface at rated load	Determination of contact resistance from measured voltage drop.		X
F.4.1.5	Temperature Rise	IEC 60512-5-1	Evaluation of the temperature rise at ambient temperature.	Verification that upper temperature limits and contact resistance is not exceeded.		X

Section	Evaluation	Standard	Description	Assessment criteria	Type Test	Serial Test
F.4.1.1	Contact Resistance	IEC 60512-5-2	Evaluation of the voltage drop at the contat interface at rated load	Determination of contact resistance from measured voltage drop.	X	X
F.4.3.2	Damp Heat Test	IEC 60068-2-30	Evaluation of performance under high humidity environments	No degradation of materials that would impair the functionality and safety of the part. Contact Resistance, Dielectric Withstand, and Insulation Resistance pass per their respective requirements.	X	X
F.4.1.1	Contact Resistance	IEC 60512-5-2	Evaluation of the voltage drop at the contact interface at rated load	Determination of contact resistance from measured voltage drop.	X	X
F.4.1.2	Dielectric Withstand	IEC 61851-1 sec12.7	Applied test voltage to be (Un+1200V) x 2 to validate material resistance to insulation breakdown.	No flashover or breakdown of the insulating material may occur.	X	X
F.4.1.3	Insulation R	IEC 60309-1	Apply 500V AC to determine resitance of insulation	Minimum insulation resistance to be >5MΩ	X	X

Section	Evaluation	Standard	Description	Assessment criteria	Type Test	Serial Test
F.4.1.1	Contact Resistance	IEC 60512-5-2	Evaluation of the voltage drop at the contat interface at rated load	Determination of contact resistance from measured voltage drop.	X	
F.4.3.3	Resistance to Corrosion	IEC 60068-2-52	Evaluation of material and electrical performance under high salt atmospheres	No degradation of materials that would impair the functionality and safety of the part. Contact Resistance, Dielectric Withstand, and Insulation Resistance pass per their respective requirements.	X	
F.4.1.1	Contact Resistance	IEC 60512-5-2	Evaluation of the voltage drop at the contact interface at rated load	Determination of contact resistance from measured voltage drop.	X	

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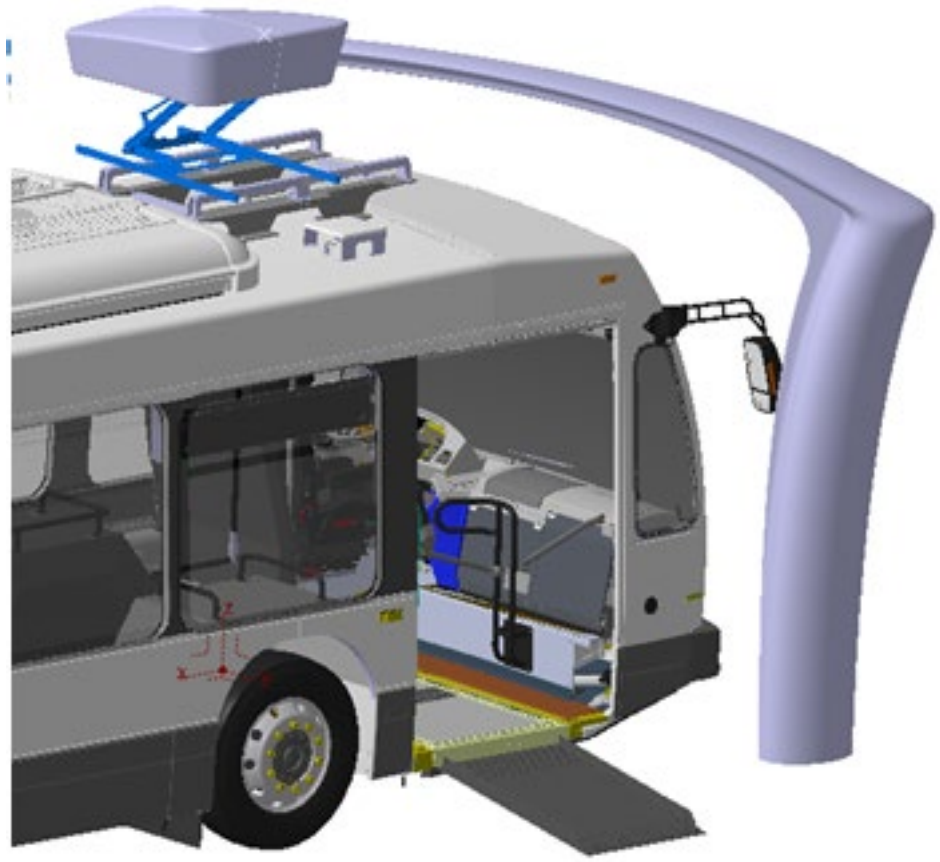
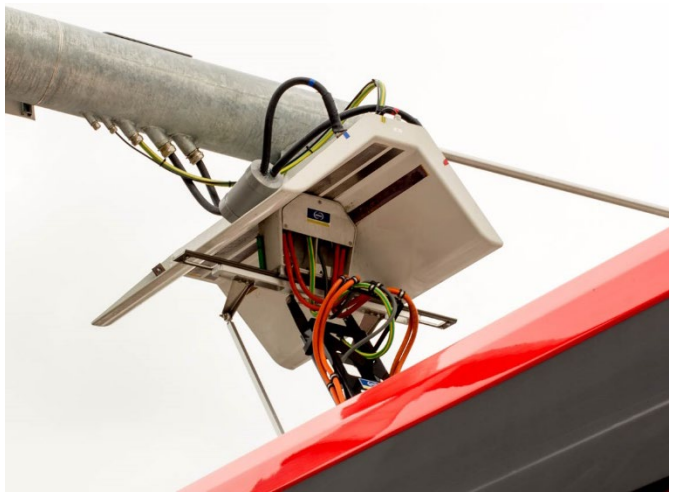
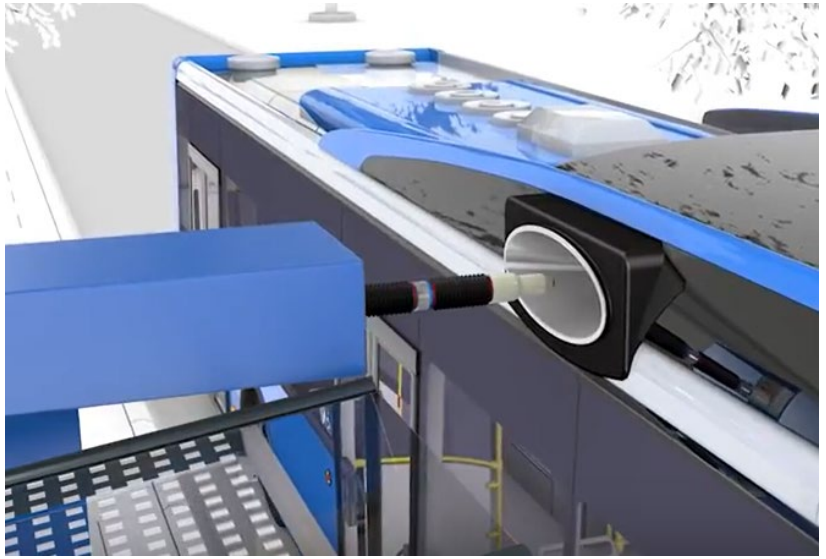
J-3105-1 Infrastructure-mounted Cross Rail Connection

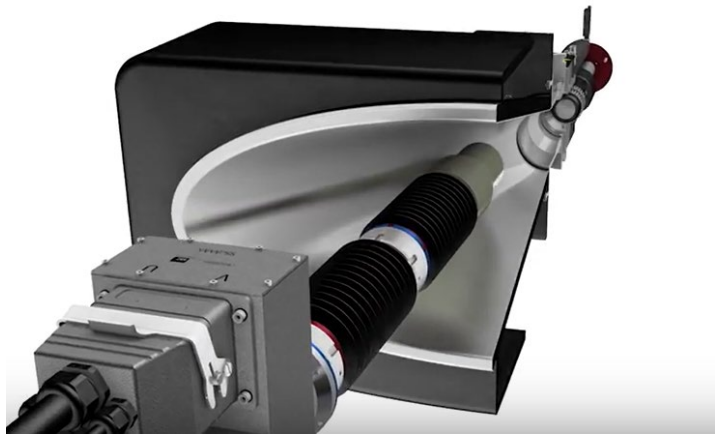


J-3105-2 Vehicle-Mounted Pantograph Connection



J-3105-3 Enclosed Pin and Socket Connection





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Automated Connectors SAE J-3105 Recommended Practice