Technical Guidelines for Electric Public Light Buses (Fast Charging Type) and the Associated Charging Facilities

(Second Edition: October 2021)

1. Introduction

1.1. This guidance provides the basic specifications and requirements of fast charging electric public light buses (e-PLBs) and the associated charging facilities for Hong Kong with a view to facilitating electric vehicle manufacturers, charging service providers, consultants, contractors and relevant parties in manufacturing of e-PLBs and provision and installation of the associated charging facilities in public transport interchanges (PTIs), bus termini and places where appropriate.

1.2. In Hong Kong, overnight charging for e-PLBs may not always be feasible, especially for those parked outside the charging venue at night. The basic specifications and requirements of fast charging e-PLBs and the associated charging facilities are set out to provide an alternative option for adoption of e-PLBs taking into account the daily operational requirements of the public light bus sector, e.g. frequent round trips and short charging time allowed, heavy air-conditioning requirement in hot and humid months and manoeuvres in hilly terrains.

2. Basic Specifications and Requirements of fast charging e-PLBs and the associated Charging Facilities

Overview

2.1. Opportunity charging with high power output should be provided to charge an e-PLB in a short period of time (around 5 – 10 minutes per charge) and at a quick charging rate to support a driving range of around 26 – 39 km per 5-minute charge. Longer charging time (around 15 minutes) could be allowed to fully charge it before the end of the service hours of PLB operation every day so that overnight charging is not required, especially for those PLBs parked outside the charging venue at night.

To ensure interoperability among e-PLBs and charging facilities of different suppliers, OppCharge's top-down pantograph interface should be used as the common interface for opportunity charging of e-PLBs in Hong Kong. OppCharge is compliant with European Automobile Manufacturers' Association's (ACEA) recommendations of having:

- Contact rails positioned on the roof of e-PLB above the front axle,
- Pantograph coming down from an overhead charging mast, and
- Wi-Fi protocol for communication between e-PLB and charging mast.

2.2. Fig. 1 illustrates the configuration of high-power opportunity charging solution for e-PLBs. It should comprise:

(a) DC Electric Vehicle Conductive Charging System,
(b) Pantograph Charger, and

(c) Optional Plug-in Quick Charger(s) in case the provision of additional pantograph charger for backup purpose is not available.

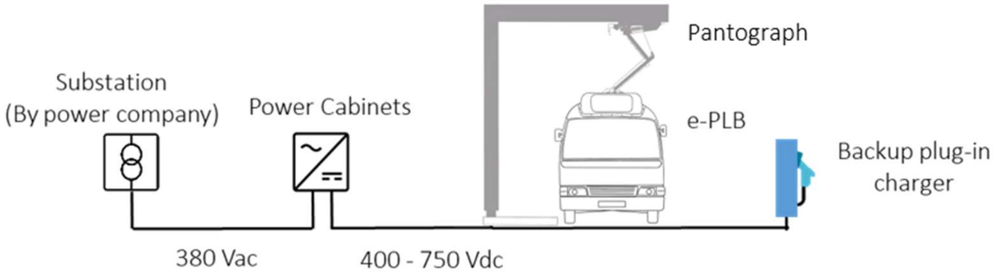


Fig. 1 Configuration of high-power opportunity charging solution for e-PLBs[1]

2.3. OppCharge is an automatic interface for charging electric vehicles based on established conductive charging standards (IEC 61851-1 and IEC 61851-23, ISO/IEC 15118), with an aim to supporting a common charging interface for commercial electric vehicles provided by different suppliers. A supplier-independent interface can also lead to cost reduction, which is another merit of standardizing a common charging interface.

2.4. OppCharge uses Wi-Fi as a media for communication between e-PLB and electric vehicle supply equipment (EVSE). Directional antennas are used for communication and association. IEEE 802.11a specifications are adopted for Wi-Fi communication. OppCharge Wi-Fi operates using 5GHz channels.

2.5. Two different levels of charging communication should be provided:

(a) Low level charging communication shall be implemented in accordance with IEC 61851-1 *"Electric vehicle conductive charging system - Part 1: General requirements"*, IEC 61851-23 *"Electric vehicle conductive charging system - Part 23: DC electric vehicle charging station"* with the exemptions listed in *"OPPCharge deviations from IEC 61851-1 and -23"*[2]

(b) High level charging communication shall be implemented in accordance with ISO 15118 *"Road vehicles — Vehicle to grid communication interface — Part 1: General information and use-case definition"* using Wi-Fi as the physical layer. An example implementation may be found in *"Example of Network and application protocol specification for OppCharge ACD (Automatic Connection Device) extension for Oppcharge ISO 15118-2"*

[1] The above drawings are not to scale and is for illustrative purposes only.
[2] OppCharge (2019). *Deviations from IEC 61851-1 and -23for OPPCharge*. Retrieved from <https://www.oppcharge.org/dok/Comparisson%20OppCharge%20EN%2061851-1%20-23.pdf>

Basic Specifications and Requirements of e-PLBs

2.6. e-PLB shall comply with the relevant ordinances and regulations such as Road Traffic Ordinance (Cap. 374) and its subsidiary regulations including the Road Traffic (Construction & Maintenance of Vehicles) Regulations related to vehicle construction, the Road Traffic (Safety Equipment) Regulations related to safety equipment, and the Vehicle Construction Approval Requirements for Electric Vehicles.

2.7. Table 1 lists the basic specifications of e-PLBs for Hong Kong:

Table 1 Basic specifications of e-PLBs for Hong Kong

Maximum Passenger Seating Capacity	19 (excluding the driver seat)
Maximum Vehicle Dimensions	7.5 m (length) x 2.3 m (width) x 3 m (height)
Maximum Gross Vehicle Weight (G.V.W.)	8,500 kg
Payload	≥ 1,500 kg
Motor Output	≥ 160 kW peak / 75 kW rated[3]
Overall System Torque[4]	≥ 9400 Nm[5]
Gradeability	≥ 25% [6]
Driving Range (worst-case scenario)[7] **(State of Charge (SOC) 100%-20%)**	≥ 40 km
Fuel Economy (worst-case scenario)[8]	≥ 1.3 km/kWh
Warrant Service Life	≥ 5 years or 550,000 km

2.8. Table 2 lists the basic specifications of traction battery for e-PLBs. Batteries with high-power charging capability, short charging time and long cycle life, e.g. lithium titanate (LTO) batteries, should be used to cope with the operational requirements of PLB sector.

Table 2: Basic specifications of traction battery for e-PLBs

Battery Type	lithium titanate batteries preferred but also welcome any other battery types with comparable performance[9]
Energy Density (system level)	≥ 62 Wh/ kg[10]
Battery Capacity	≥ 40 kWh
Operating Voltage	within 450Vdc - 750Vdc

[3] The figure is derived based on a G.V.W of 8,500 kg and is for reference only. Actual figure may vary subject to the overall specifications of the corresponding e-PLB products.
[4] Including motor torque, reduction ratio (optional), and final drive ratio.
[5] The figure is derived based on a G.V.W of 8,500 kg and is for reference only. Actual figure may vary subject to the overall specifications of the corresponding e-PLB products.
[6] The steep slopes in Hong Kong range from 10% (1:10) to 25%.
[7, 8] The estimated performance can be treated as a worst-case scenario performance under harsh operating conditions, e.g. hilly terrain and summertime.
[9] It is suggested providing test reports and/ or certificates from third party to support the battery performance
[10] This is a figure for reference only and is quoted based on a product in the market. Actual figure may vary subject to aspects such as battery system design, battery type, etc. of the corresponding battery system of the e-PLB product.

Maximum Charging Power	≥ 300 kW
Warrant Service Life	≥ 5 years or 550,000 km

Since e-PLB routes have different trip distances and road profiles, manufacturers are recommended to design e-PLB with a battery compartment which can accommodate batteries of around 40 kWh, 60 kWh and even higher capacity, so that users can select suitable battery capacity to suit their operational requirements when ordering e-PLBs and have flexibility to request for increasing the battery capacity of their in-use e-PLBs on need basis.

Table 3 shows the estimated driving ranges and fuel economies under simulated driving cycle which is based on vehicle speed profiles collected from 82 green public light bus routes in Hong Kong with full loading of air-conditioning in summer[11] for two different battery capacities. Manufacturers often quote the driving ranges of their products based on New European Driving Cycle (NEDC), Worldwide Harmonized Light vehicles Test Procedure (WLTP), Standardised On-Road Test Cycles (SORT) or China-World Transient Vehicle Cycle (C-WTVC) without taking account of air-conditioning. To facilitate conversion of the estimated driving ranges and fuel economies under the simulated driving cycle to or from driving ranges and fuel economies under other testing cycles commonly quoted by the manufacturers, Table 3 also provides the corresponding values under WLTP, NEDC, SORT and C-WTVC cycles without air conditioning.

Table 3 Total capacity of LTO batteries vs estimated driving range

Battery Capacity (kWh)	**Estimated driving range & fuel economy (SOC 100%-20%)**				
	Under simulated driving cycle (air-conditioning: full loading)	**Under WLTP driving cycle (air-conditioning: OFF)**	**Under NEDC driving cycle (air-conditioning: OFF)**	**Under SORT driving cycle (air-conditioning: OFF)**	**Under C-WTVC driving cycle (air-conditioning: OFF)**
40 kWh	40 km (1.3km/kWh)	48 km (1.5 km/kWh)	54 km (1.7 km/kWh)	56 km (1.7 km/kWh)	59 km (1.8 km/ kWh)
60 kWh	60 km (1.3km/kWh)	73 km (1.5 km/kWh)	82 km (1.7 km/kWh)	84 km (1.7 km/kWh)	88 km (1.8 km/ kWh)

2.9. Manufacturer shall provide evidence to prove that its e-PLBs with battery capacities of not less than 40 kWh and 60 kWh shall achieve a driving range not less than 48 km and 73 km respectively under WLTP driving cycle test (SOC 100%-20%); 54 km and 82 km respectively under NEDC driving cycle test (SOC 100%-20%); 56 km and 84 km respectively under SORT driving cycle test (SOC 100%-20%) or 59 km and 88 km respectively under C-WTVC driving cycle test (SOC 100%-20%).

2.10. Table 4 lists the basic specifications of charging system for e-PLBs.

[11] The driving range and fuel economy figures are simulated results based on the proposed e-PLB specifications. The figures are intended for reference only, subject to the operating conditions where an e-PLB is running at, the actual results may be different. Further verification and test are needed based on actual e-PLB products.

Table 4 Basic specifications of charging system for e-PLBs

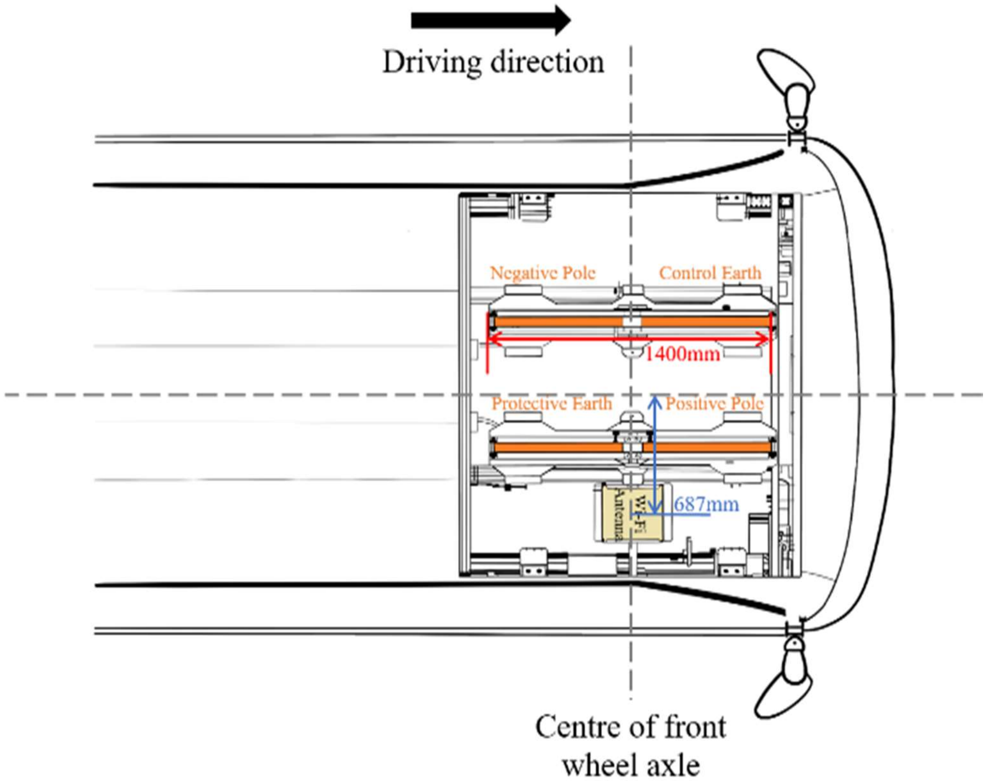
Main Charging Interface– Pantograph Charging	
Power	≥ 250 kW (300 kW recommended wherever feasible)
Interface	OppCharge 4 conductive poles
Communication Protocol	OppCharge, IEC 61851-1, IEC61851-23, ISO 15118 (via Wi-Fi)
Backup Charging Interface – Plug-in Charging	
Power	≥ 150 kW
Interface	IEC 62196 (CCS) Combo 2 Socket
Communication Protocol	IEC 61851-1, IEC61851-23 and ISO/IEC 15118

Fixed rails should be attached to the roof of e-PLBs in the following way[12]:

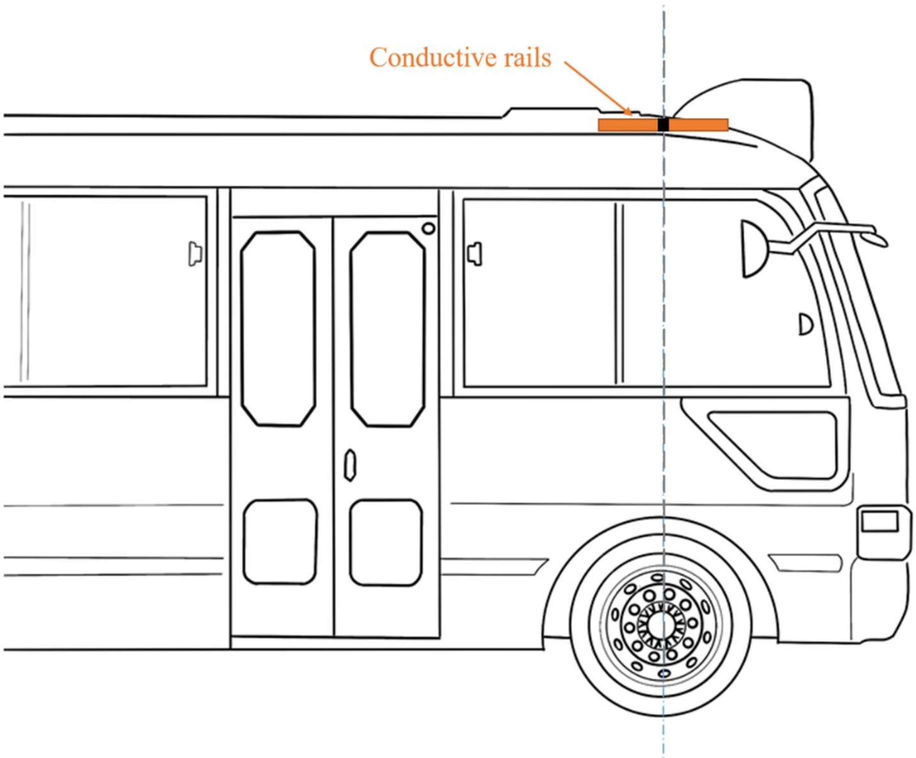
OppCharge uses 4 conductive poles for the charge interface: Positive, Negative, Protective Earth (PE) and Control Earth (CE). The Conductive Rails are centered over the front axle of e-PLB for alignment as shown in Fig. 2 Conductive rails.

- All functions of the pantograph rails shall have very precise mechanically connected and disconnected positions.
- It shall not be possible for the pantograph to remain in an undefined position.
- No unattended activation shall occur physically or electrically.
- The minimum application force of the pantograph rails shall be sufficient to fulfil charging requirements. The total maximum application force for the pantograph rails shall be less than 600 N.
- The maximum application force for each pole shall be less than 150 N during connection, charging and disconnection.
- Impact sound created by the contact of the pantograph contactors is recommended to be lower than 50 dB. Measuring points are inside e-PLB and adjacent to bus roof at rail position.

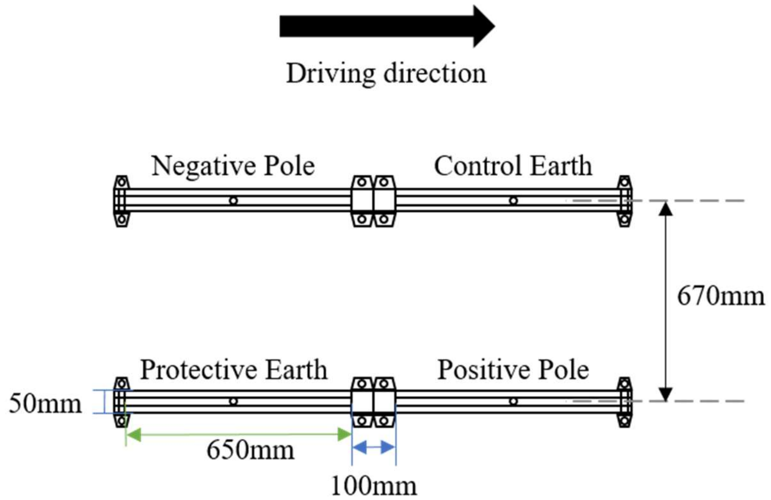
[12] Please refer to OppCharge specifications https://www.oppcharge.org/dok/OPPCharge%20Specification%202nd%20edition%2020190421.pdf


Driving direction
Negative Pole
Control Earth
1400mm
Protective Earth
Positive Pole
Wi-Fi Antenna
687mm
Centre of front wheel axle

1)


Conductive rails

2)



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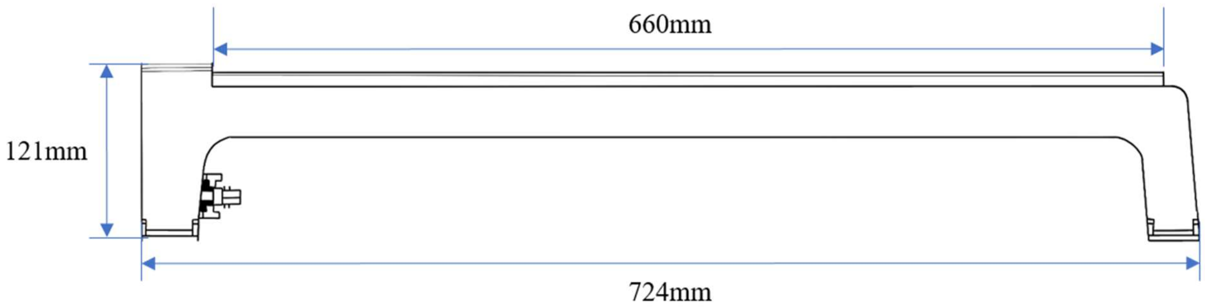

4)

Fig. 2 Conductive rails on e-PLB with reference dimensions[13] – 1) Top View of bus roof front section highlighting conductive rails and Wi-Fi antenna; 2) Side View of bus roof front section highlighting conductive rails; 3) Top View of conductive rails on roof with dimensions; and 4) Side view of a single rail (Note: Driving direction for pole orientation for roof & ASC installation.)

In addition, e-PLB is required to include an on-board data logging system that can be remotely accessible and shall provide access right to authorized parties for remote monitoring and analysis of critical data in real-time. Parameters to be monitored should include:

Vehicle related:

- Vehicle's identification (e.g. chassis number)[14]
- Vehicle speed (km/h)
- Accumulated vehicle mileage (km)
- Location of e-PLB
- Operation mode e.g. charging, idle, driving, fault, etc.
- Average energy economy (km/kWh)
- Remaining range (km)

Battery related:

[13] The above drawings are not to scale and is for illustrative purposes only.
[14] Updated in October 2021.

- Battery voltage (V)
- Battery current (A)
- Battery temperature (ºC)
- Battery State of Charge (SOC)
- Battery State of Health (SOH)
- Charging / discharging power (kW)
- Charging records
  - Date
  - Start and end time
  - Charged energy (kWh)

Motor related:

- Revolution per minute (rpm)
- Torque (Nm)
- Motor temperature (ºC)

Basic Specifications and Requirements of Charging Facility for e-PLBs

2.11. A charging facility for e-PLB mainly comprises Pantograph Charger (power cabinets and pantograph) and Plug-in Quick Charger (for backup purpose).

(a) Pantograph Charger

2.12. The power cabinets of pantograph charger, referred as DC Electric Vehicle Conductive Charging System in OppCharge, are responsible for converting AC power from the grid/substation to DC power for front-end charging interface, i.e. pantograph. The system is usually in the form of single or multiple power cabinets that consist of equipment such as isolating transformer, switch gears, electric protective devices, power converter, charger controller and ventilation system. Some manufacturers offer modular power cabinets to ease scaling up the power capability. The DC electric vehicle conductive charging system implements the standards of IEC 61851-1 and IEC 61851-23. The output voltage ranges from 450 Vdc to 750 Vdc.

2.13. The Pantograph, referred as an Automatic Connecting System in OppCharge, controls and monitors a connection device for conductive charging by a pantograph fixated to the infrastructure above the vehicle (e.g. on pole, archway, bridge, ceiling, etc.). The pantograph is equipped with automated extendable/retractable mechanism to connect/disconnect conductive components to vehicle interface for charging.

2.14. The power rating of Pantograph Charger should be at least 250 kW (equivalent to a top-up driving range of 26 km per 5-minute charge). In normal case, the corresponding electrical installation, such as switchboards, distribution boards, electricity meters, cabling, conduits and trunking, shall be designed for 300 – 450 kW for future expansion due to technological advancement. A minimum rating of 250 kW should be kept when there are critical constraints to achieve the normal case design.

2.15. There are solutions in the market that multiple pantograph chargers can share use the power cabinet(s). Such solution is equipped with load management function/system that can monitor and control the power output of each pantograph charger and ensure the overall system would not be overloaded. Suitable electrical load management system should be considered to optimize the power supply infrastructure works.

2.16. Table 5 lists the basic specifications of power cabinets and pantograph chargers[15]. Manufacturers should provide a warranty of at least 5 years.

Table 5 Basic specifications of power cabinets and pantograph chargers

Charging method	**Automatic charging by pantograph charging**
Output Power	≥ 250 kW (300 kW recommended wherever feasible[16])
Charging Standard	IEC 61851-1, IEC 61851-23, OppCharge
Output Voltage	450 Vdc – 750 Vdc or a wider range
Max. Output Current	≥ 400 A
Input AC Connection	3 Phases + Neutral + Protective Earth
Input Voltage	380 Vac, 50 Hz
Efficiency (at full load)	≥ 90%
Connection to e-PLB	4-pole automatic connection
Communication between Charger and e-PLB	Wi-Fi communication (IEEE 802.11ac) IEC 61851-1, IEC-61851-23 and ISO/IEC 15118
Feature	Load management, remote monitoring
Installation Method	Ceiling and floor (with pole) mounting options available
Environment	Indoor/ Outdoor
Operating Temperature	-20 to 50 °C
Protection	IP54 – IK10 (IP: Ingress Protection, IK: Impact Protection)

(b) Backup Plug-in Charger

2.17. In case backup pantograph charger is not provided or other emergency backup means is not feasible, plug-in chargers should be installed to serve as backup charging facilities. Currently, plug-in chargers in the market support a power range of 50 – 150 kW. Where feasible, provision of two units of the latter is preferred to facilitate quick charging at the speed close to that of a pantograph charger.

2.18. There are solutions in the market that multiple plug-in chargers can share the use of

[15] It is suggested consulting power company(ies) to evaluate if installation of local transformer adjacent to the power cabinet is required to provide sufficient supply capacity if electric supplies larger than LV service cutout is 380 V / 400 A; as well as the main switch in PTI in case of emergency and safety.
[16] According to commercially available products, the input power rating is around 350 kVA for a 300 kW pantograph charger

power cabinet(s) of pantograph chargers. Such solution is equipped with load management function/system that can monitor and control the power output of each pantograph charger and plug-in charger and ensure the overall system would not be overloaded. Such load management function/system is required.

2.19. If plug-in chargers cannot share the use of power cabinet(s) of pantograph chargers, an external controller or mechanism shall be implemented to avoid overloading the charging facilities.

2.20. Since OppCharge is based on IEC 61851 standard, the plug-in charging standard should also be IEC 61851 and the requirement of connection to e-PLB be IEC (CCS, Combo 2 connector).

2.21. Table 6 lists the basic specifications of plug-in charger for e-PLBs. Manufacturers should provide a warranty of at least 5 years.

Table 6 Basic specifications of plug-in charger for e-PLBs

Charging method	**Plug-in charging (for backup use)**
Output Power	≥ 150 kW [17]
Charging Standard	IEC 61851-1, IEC 61851-23
Output Voltage	450 Vdc – 750 Vdc or a wider range
Input AC Connection	3 Phases + Neutral + Protective Earth
Input Voltage	380 Vac, 50 Hz
Efficiency (at full load)	≥ 90%
Connection to e-PLB	CCS, Combo 2 (liquid cooled for 150 kW model)
Communication between Charger and e-PLB	IEC 61851-1, IEC61851-23 and ISO/IEC 15118 (via Wi-Fi)
Feature	Load management, remote monitoring
Installation Method	Floor-mount
Environment	Indoor/ Outdoor
Operating Temperature	-20 to 50 °C
Protection	IP54 – IK10 (IP: Ingress Protection, IK: Impact Protection)

(c) Estimated Charging Performance

2.22. Table 7 lists the estimated charging performance by assuming an e-PLB having an average energy economy of 1.56 km/kWh[18]. This empirical figure is referenced to the

[17] According to commercially available products, the input power rating is around 175 kVA for a 150 kW plug-in charger

[18] Measured average energy economy of an electric light bus trialed under the Pilot Green Transport Fund https://www.epd.gov.hk/epd/sites/default/files/epd/english/environmentinhk/air/prob_solutions/files/Interim_Report_6

measured average energy economy of an electric light bus trialed under the Pilot Green Transport Fund. The vehicle was NOT under full load and air-conditioning was NOT operated at full load. The estimated performance can be referenced for non-peaking hour operation under mild operating conditions, e.g. flat road and cool weather.

Table 7 Estimated charging performance with an average energy economy of 1.56 km/kWh under light-loading conditions

Charging Power (kW)	5-minute top-up range (km)	10-minute top-up range (km)
50	6.5	13.0
100	13.0	26.0
150	19.5	39.0
200	26.0	52.0
250	32.5	65.0
300	39.0	78.0

2.23. Table 8 lists the estimated charging performance by assuming an e-PLB having an average energy economy of 1.3 km/kWh under the conditions of hilly terrain and full loading of air-conditioning. This is a simulated figure based on the specifications in Table 1 and the assumption that the vehicle is fully loaded and running on hilly terrain with air-conditioning at the highest power consumption. The estimated performance can be treated as a worst-case scenario performance under harsh operating conditions e.g. hilly terrain and summer time. It is suggested to reference this performance when designing the operating and charging profiles of e-PLBs.

Table 8 Simulated worst-case scenario charging performance with an average energy economy of 1.3 km/kWh under hilly terrain and full loading of air-conditioning in summer time

Charging Power (kW)	5-minute top-up range (km)	10-minute top-up range (km)
50	5.3	10.5
100	10.5	21.0
150	15.8	31.5
200	21.0	42.0
250	26.3	52.5
300	31.5	63.0

2.24. Table 9 gives examples to illustrate the relationship between the battery capacity of an e-PLB and the required number of charging session for daily operation during summertime. Three typical green minibus routes with different round trip distances, Kowloon PLB Route Nos. 10M, 23B and 23M[19], are taken as examples to illustrate the

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[19] The figures of daily travel distance, round-trip distance and number of round trips per day in Table 9 are based on on-site data collection results on some PLBs of the routes 10M, 23B and 23M.

relationship for e-PLB with a battery capacity of 40 kWh and 60 kWh respectively. For routes with long daily travel distance and round trip distance, such as 10M, a larger battery capacity is preferred as this can reduce the number of charging sessions per day significantly. On the contrary, the benefit becomes less obvious for routes with short travel distance and round trip distance such as 23B and 23M.

Table 9 Simulated worst-case scenario charging requirements for 40kWh and 60kWh batteries

PLB Route No.	**Route ID**	**Start location**	**Stop location**	**Daily travel distance (km)**	**Round trip distance (km)**	**No. of round trips per day**	**No. of charging sessions per day**	
							40kWh Battery	**60kWh Battery**
10M	2211	Well On Garden	Tung Yan Street	379.7	17.3	22	21	11
23B	2124	Tung Yan Street	Cha Kwo Ling	124.2	6.4	20	6	4
23M	2125	Tung Yan Street	Lam Tin Station	90.4	3.2	28	4	3

Remark:
The simulated results are based on summertime performance with an average energy economy of 1.3 km/kWh under the conditions of hilly terrain and full loading of air-conditioning. Charging session takes place at not less than SOC 30%, and the battery will be topped up to SOC 80%. Under 250 kW power supply, it will take about 5 minutes and 7 minutes to top up batteries of 40 kWh and 60 kWh respectively from SOC 30% to 80%. Under 300 kW power supply, it will take about 4 minutes and 6 minutes to top up batteries of 40 kWh and 60 kWh respectively from SOC 30% to 80%.

3. General and Spatial Requirements for Installation of Charging Facilities

The following recommendations are provided to relevant parties who are involved in design and/or installation of charging facilities for e-PLBs in Hong Kong, for reference only. The relevant parties shall confirm the actual requirements with their suppliers:

(a) Space and Loading

- For pantograph pole: minimum 6,000 mm from the ground
- For pantograph on the ceiling/other permanent support structure: 1,600 mm from the top of e-PLB
- Loading requirement for ceiling mount: the weight of pantograph itself is generally around 300 kg whereas one should also consider the additional weight of the associated mounting kit and any other accessories after the cable connection.
- Consideration on the power supply infrastructure works should be taken into account in the spatial requirements for installation of charging facilities.

(b) Ventilation

- Minimum clearance for each side of power cabinet for air ventilation: 600 mm
- Forced ventilation may be required when power cabinets are installed in a confined/semi-confined area, e.g. a room. The consultant/contractor shall ensure sufficient ventilation for dissipating excessive heat generated from the charging facilities.
- According to products available in the market, the required ventilation airflow

for a 300 kW power cabinet or equivalent can be between 1,200 m^3/ h and 2,900 m^3/ h.

(c) **Reference dimensions of standard products in the market (with diagram and scale):**

Following reference dimensions are based on products available in the market and the actual dimensions may vary due to different site conditions and constraints.

<u>Pole-mount installation</u>

Table 10 lists the approximate figures for pole-mount installation and Fig. 3 illustrates the pole-mount installation.

Table 10 Figures of pole-mount installation

Parameters	Approximate figures
Height from the ground	6,000 mm
Pole footprint	1,100 x 400 mm
Overall weight	2,000 kg
Recommended distance from pole to curb	1,400 mm

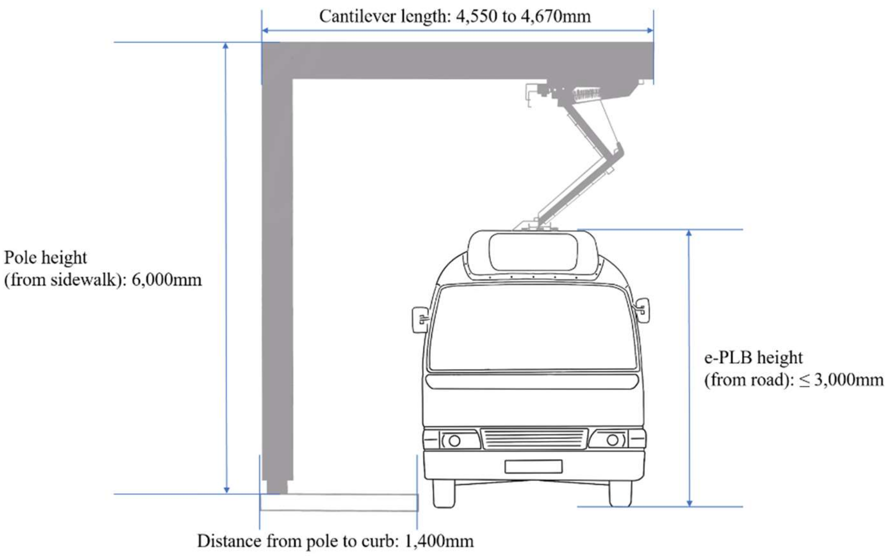

Fig. 3 Pole-mount installation[20]

<u>Ceiling-mount installation</u>

Table 11 lists the approximate figures for ceiling-mount installation and Fig. 4 illustrates the ceiling-mount installation.

[20] The above drawings are not to scale and is for illustrative purposes only.

Table 11 Figures of ceiling-mount installation

Parameters	**Approximate figures**
Height from the top of e-PLB	≥ 1,600 mm
Pantograph footprint	2,100 x 900 mm
Overall weight	300 kg

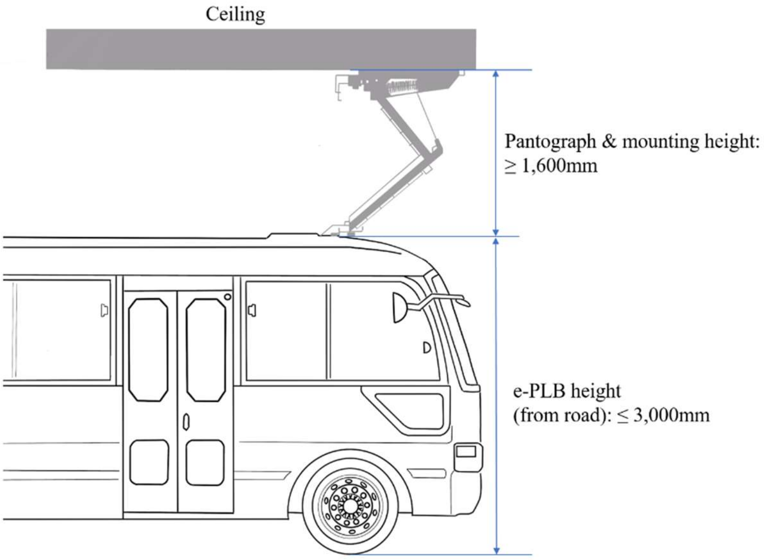

Fig. 4 Ceiling-mount installation[21]

Power cabinet

Table 12 lists the approximate figures of power cabinet with a power rating at 300 kW.

Table 12 Figures of power cabinet with a power rating at 300 kW

Parameters	**Approximate figures**
Dimensions	1,200 (W) x 1,600 (D) x 2,100 (H) mm
Overall weight	2,700 kg

(d) **Position**

The relative position of the pantograph and the vehicle's conductive rails is centred over the front axle of the vehicle. This allows for interoperability between different infrastructure and vehicle manufacturers. The positioning of the vehicle is secured using the front wheel as a reference.

[21] The above drawings are not to scale and is for illustrative purposes only.

OppCharge should not be installed where road conditions have slopes, inclines or pitches greater than ±3.5 °.

(e) **Other considerations**

(1) Cabling: It shall follow electrical engineering guidelines for optimal function.

- Use separate cable ducts for Power Cables and Signal cables
- Ducts shall be separated 300 – 500 mm apart to reduce electromagnetic interference (EMI)[22].
- Shielded cables are to be used where needed
- Implement Wi-Fi installation guidelines to reduce signal attenuation
- Define cable lengths to fulfil function
- Fulfil lightning protection where required

(2) The Control Pilot (CP) signal: It is to show the various states in the charging process below in accordance with IEC 61851.

- Pantograph rails not connected
- Pantograph rails connected to vehicle – initialization – "not charging"
- Pantograph rails connected to vehicle – "charging"
- Pantograph rails connected to vehicle – shut down – "charging" to "not charging"
- Error

It is important in the design of CP signal to safeguard signal tolerances from electromagnetic interference (EMI) caused by, for example, power cables which are in close proximity.

(3) Human Machine Interfaces (HMI): It may be designed to assist driver with intuitive and user friendly OppCharge functionality.

- Positioning and Identification used to easily locate charge interface and park
- Information in the driver display to inform driver over charging process (position, charge status, messages and notifications)
- Beacons or lamps indicating charge status of charging infrastructure
- E-Stop buttons to end the charging session quickly
- Visual & audio verification methods as well as haptic responses to inform driver of charge status

(4) Emergency Stop

- OppCharge equipment should have emergency stop switch(es) to manually stop the charge process at any time "in case of emergency".
- For OppCharge equipment installed in public area, an emergency stop switch should be protected with a switch cover to avoid unwanted activation.
- In the event of an emergency stop activation, the pantograph shall retract to the upper position and the corresponding controller shall inform the charger controller of the pantograph position.
- A remote control interface of the OppCharge equipment should be provided for relevant technical or operating personnel to actively stop the charge

[22] Please refer to OppCharge specifications https://www.oppcharge.org/dok/OPPCharge%20Specification%202nd%20edition%2020190421.pdf

process at any time “in case of emergency”.

(5) Beacon (Lamp) Function

- OppCharge equipment should have beacons to actively indicate the charging equipment status. The beacons should be visible to the driver to show if the charging equipment is operational or not.
- The beacon(s) should be visible in daylight and at night-time.

(6) General Safety:

- The charging facilities shall comply with relevant safety requirements of relevant EV charging standards (e.g. IEC 61815 or equivalent) and electrical fixed installation.
- The location of the pantograph chargers, backup plug-in chargers, and power cabinets shall be designed and arranged at places where they will be less likely to be hit by vehicles. Bollards can be installed if necessary.
- The charging facilities should be protected against reasonably foreseeable mechanical damage.
- Clear notice, user guides, warning labels shall be displayed on the charging facilities.
- High voltage labels shall be affixed at visible places of high voltage parts of the charging facilities.
- If pantograph chargers are installed outdoor, pantograph cantilever shall be protected from potential interference by the surroundings, e.g. tree branches, leaves, trash, dust, moisture, rain and strong wind.
- Safety assessment and implementation of site-specific safety measures would also be necessary.
- The charging facilities shall comply with the relevant fire safety measures required by the Fire Services Department.

(7) Appointment of Qualified Professionals and Personnel:

- The installation of the charging facilities shall be designed and supervised by suitably qualified professionals.
- The operation and maintenance of the charging facilities shall be supervised by suitably qualified personnel.

4. Other Reference Information

In addition to the above technical guidelines, it is strongly suggested to make cross-reference to:

"*Technical Guidelines on Charging Facilities for Electric Vehicles*" issued by the Electrical and Mechanical Services Department (EMSD) - As EV charging facilities are fixed electrical installations, they shall comply with the relevant safety requirements of the Electricity Ordinance (Cap. 406) and its subsidiary regulations. The electrical work on EV charging facilities including design, installation, commissioning, inspection, testing, maintenance, modification and repairing shall be carried out by registered electrical contractors and registered electrical workers of the appropriate grade.

https://www.emsd.gov.hk/filemanager/en/content_444/Charging_Facilities_Electric_Vehicles.pdf

"Code of Practice for the Electricity (Wiring) Regulations" issued by the EMSD for electrical safety requirements on design, installation, inspection, testing and certification of fixed electrical installation including charging facilities for electric vehicles.
https://www.emsd.gov.hk/en/electricity_safety/new_edition_cop_electricity_wiring_regulations/index.html

https://www.emsd.gov.hk/en/electricity_safety/periodic_test_for_fixed_electrical_installations/index.html

"*Vehicle Construction Approval Requirements for Electric Vehicles (applicable to pure electric vehicles and plug-in hybrid electric vehicles)*" issued by the Transportation Department for vehicle construction approval requirements for electric vehicles

"*FSD Circular Letter No. 4/2020 Additional Fire Safety Requirements for Car Parking Facilities installed with Electric Vehicle Charging Facilities*" issued by the Fire Services Department (FSD) for fire safety requirements for car parking facilities installed with electric vehicle charging facilities

5. Enquiries

For enquiries on the basic specifications and requirements of e-PLBs and the associated charging facilities, please email to ev@epd.gov.hk or eplb@hkpc.org.

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