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Code of Practice for Electric Vehicle Charging Equipment Installation

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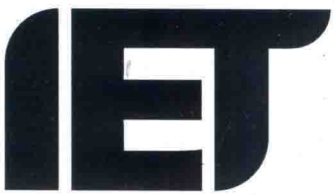

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Participants in IETSL Technical Committee 1.1

British Electrotechnical and Allied Manufacturers Association (BEAMA)
Charging point manufacturers:
- Chargemaster
- Elektromotive
- Pod Point

Department for Communities and Local Government (DCLG)
Electrical Contractors Association (ECA)
Electrical Contractors Association of Scotland (SELECT)
Energy Networks Association (ENA)
Electrical Safety Council (ESC)
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- Source East (Future Transport Systems Ltd)
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Society of Motor Manufacturers and Traders (SMMT)
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Foreword

Replacing traditional internal combustion engine road vehicles with electrically propelled vehicles is generally accepted as offering both environmental benefits, by reducing CO_2 emissions, and energy security benefits, by reducing our dependency on oil imports. For these reasons, the UK Government is actively supporting the switch to electric vehicles via incentives such as the Plugged-In Places scheme, which provides government funding for the installation of electric vehicle charging infrastructure, and the Plug-In Car Grant, which provides grants towards the purchase of new ultra-low-emission cars, such as electric cars.

The first of the latest generation of electric vehicles were predominantly small city cars, with comparatively small battery packs and a fairly limited range. They were designed to be recharged from standard BS 1363 type socket-outlets, as this was the only readily available means of charging such vehicles. However, their use of BS 1363 socket-outlets and plugs meant that they could only charge at a maximum of 10 A. This led to charge times of up to 10 hours for even these small cars.

Vehicle manufacturers quickly realised that to make electric vehicles a more viable alternative to internal combustion engine vehicles, and to increase their acceptability and desirability to potential customers, they would need to increase the range which a vehicle could travel on a single charge, whilst reducing the time taken to recharge the vehicle. However, increasing a vehicle's range would almost certainly involve increasing the size of the battery pack, which would in turn lead to an increase in the time taken to recharge the battery, unless a means of recharging at a higher rate than that permitted by a standard BS 1363 type socket-outlet could be found.

To address this issue, the vehicle manufacturers have worked with the electrical industry to develop suitable solutions. The solutions that have been developed involve dedicated electric vehicle charging equipment using dedicated socket-outlets, plugs and vehicle connectors. They also provide additional safety by requiring communication between the vehicle and the charging equipment before charging can commence. Two main charging systems have been developed: an a.c. charging system and a d.c. charging system. Depending on the capacity of the charging equipment, the new a.c. charging systems allow charging from 16 A to 70 A (single phase) or up to 63 A (three phase). The d.c. charging systems allow charging at even higher voltages and currents. These two charging systems are intended to complement one another, with each being more suitable for different charging scenarios.

The challenge now is to ensure that a sufficient electric vehicle charging infrastructure is installed and available to prevent the lack of potential charging locations being a barrier to people switching to electric vehicles.

Contents

Scope

This Code of Practice applies to the installation of dedicated conductive charging equipment for the charging of pure electric and plug-in hybrid electric road vehicles, including range-extended electric vehicles.

The installation of inductive charging equipment is not currently covered in this Code of Practice. However, the inclusion of installation requirements for inductive charging equipment will be reviewed in future, once inductive charging technology has matured and more experience has been gained with the installation of such equipment.

It covers the installation of dedicated electric vehicle charging equipment of the types described in Section 4 of the Code. It is not intended to cover socket-outlets provided for general power; references to socket-outlets in this Code are either to dedicated electric vehicle charging socket-outlets or to standard socket-outlets incorporated into dedicated electric vehicle charging equipment.

It covers the installation of both a.c. and d.c. charging equipment intended for charging electrically propelled road vehicles with four or more wheels, including both pure electric and plug-in hybrid versions of passenger cars, light goods vehicles, buses and heavy goods vehicles. Subject to compatibility, such charging equipment may also be utilised for the charging of electrically propelled scooters, motorcycles, tricycles, quadricycles and electrically assisted pedal cycles.

It applies to the installation of electric vehicle charging equipment in all locations where such equipment may be required, including:

- domestic installations, such as installations in, or adjacent to, houses and their associated garages
- on-street installations
- commercial and industrial installations, such as installations in, or adjacent to, business premises, e.g. shops, offices, factories, etc., including public and private car parks, whether single-level or multi-storey.

The objective of this Code of Practice is to provide guidance on the installation of electric vehicle charging equipment to assist the installer in ensuring that the final installation complies with the relevant requirements of BS 7671:2008 – Amendment No. 1:2011 (The IET Wiring Regulations, Seventeenth Edition) and, where necessary, the Electricity Safety, Quality and Continuity Regulations 2002 (as amended).

Whilst this Code of Practice addresses the technical aspects of electric vehicle charging equipment installation, it does not specifically address the local authority planning regulations and/or building regulations which may need to be considered when installing such equipment.

Overview of electric vehicle charging equipment

2.1 Introduction

Electric vehicle charging equipment, also known as electric vehicle supply equipment (EVSE), is a piece of fixed electrical equipment which is connected to a mains electricity supply and provides electrical energy to recharge the traction batteries of electrically propelled road vehicles.

The BS EN 61851 series of standards specifies the design and performance requirements for electric vehicle conductive charging equipment which all equipment shall comply with. Furthermore, electric vehicle charging equipment shall also comply with the EC Directives for Electromagnetic Compatibility, 2004/108/EC; Low Voltage Equipment, 2006/95/EC and be CE marked accordingly.

There is a wide variety of different types of electric vehicle charging equipment available on the market to suit different charging needs and installation locations.

2.2 Charging equipment for Modes 1, 2 and 3

Most types of electric vehicle charging equipment are designed to supply a.c. electrical current to the vehicle (Mode 1, 2 or 3 charging). The vehicle then converts this a.c. electrical input into d.c. via an on-board charger (rectifier) which is permanently installed in the vehicle.

Mode 1 charging

In Mode 1 charging, either single-phase or three-phase a.c., at up to 16 A, is supplied to the electric vehicle via a standard socket-outlet, i.e. BS 1363 or BS EN 60309, utilising a simple charging cable with no in-cable control box.

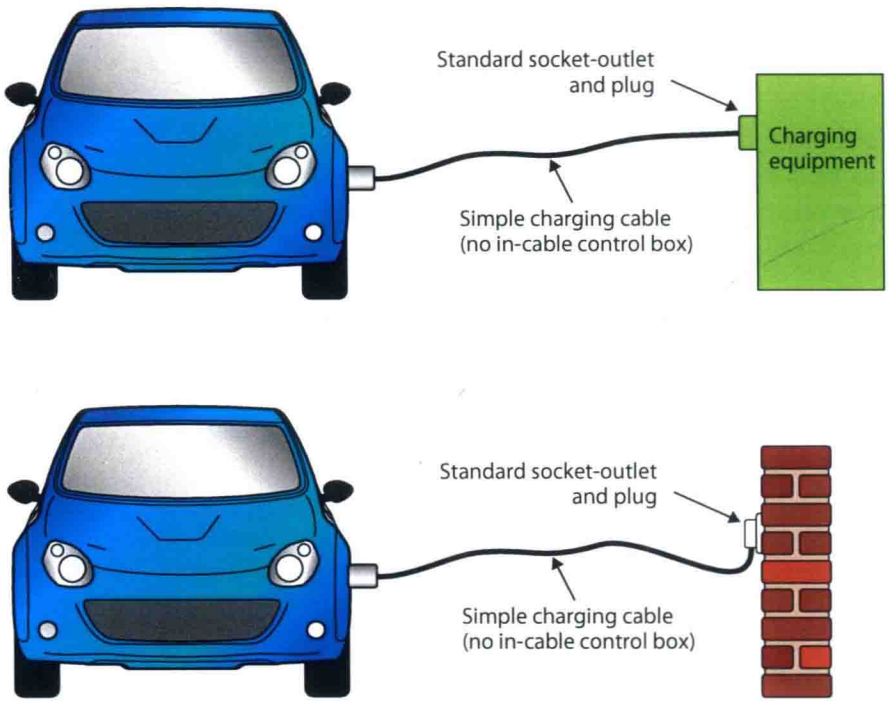

Figure 2.1 – Mode 1 charging diagram

Mode 2 charging

In Mode 2 charging, either single-phase or three-phase a.c. is supplied to the electric vehicle via a standard socket-outlet, i.e. BS 1363 or BS EN 60309, utilising a charging cable with an in-cable control box incorporating an RCD.

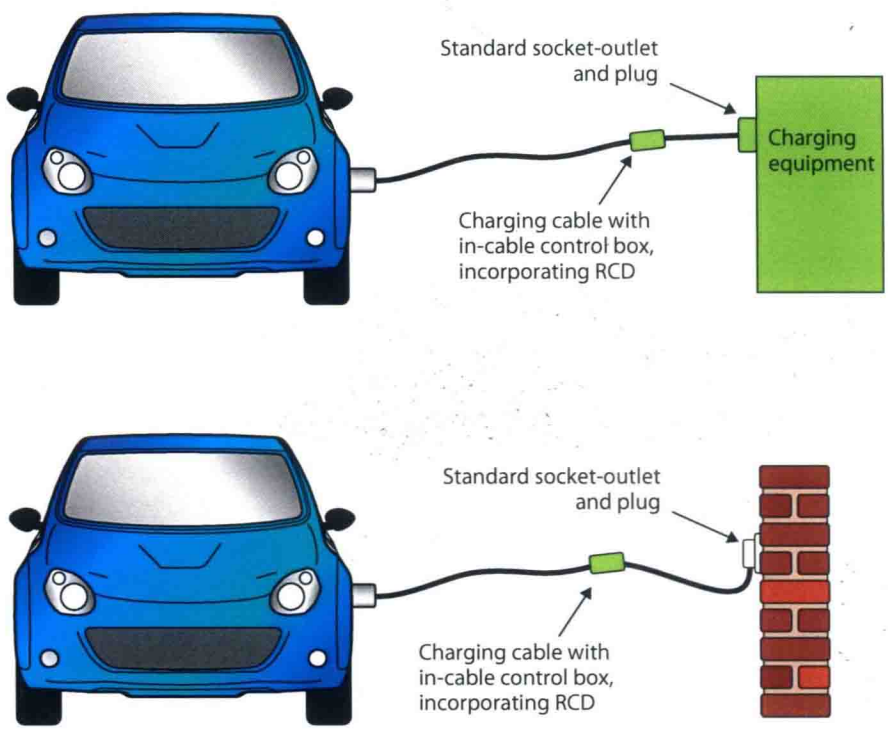

Figure 2.2 – Mode 2 charging diagram

In Mode 3 charging, either single-phase or three-phase a.c. is supplied to the electric vehicle via either a dedicated electric vehicle charging socket-outlet or a charging cable tethered to the electric vehicle charging equipment. In both cases, additional conductors are incorporated into the charging cable to allow communication between the vehicle and the charging equipment to facilitate verification of the protective conductor and selection of the charging rate prior to commencement of charging.

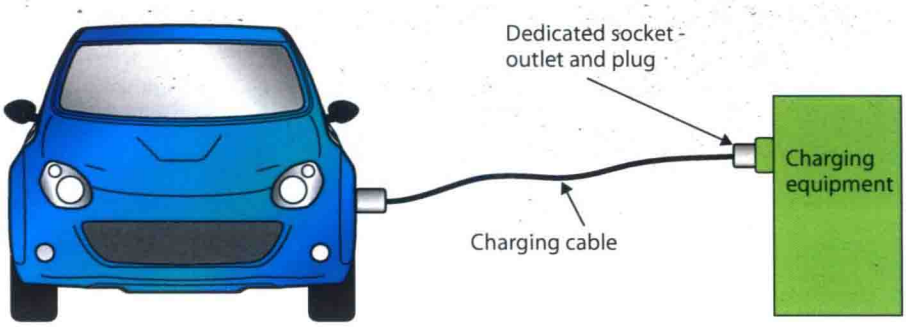

Figure 2.3 – Mode 3 charging diagram (dedicated socket-outlet)

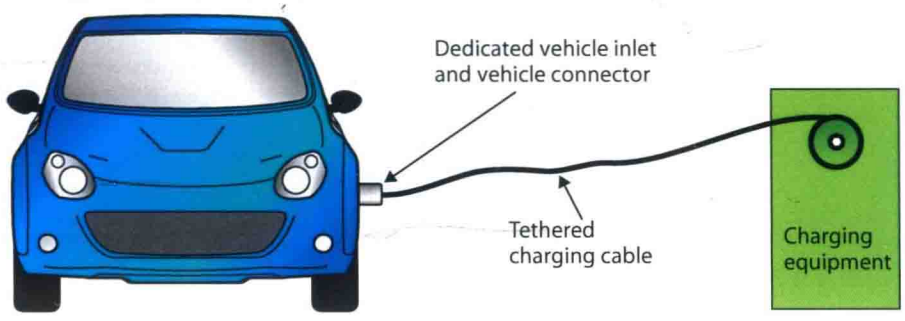

Figure 2.4 – Mode 3 charging diagram (tethered charging cable)

A.C. charging equipment tends to be either in the form of 'charging posts' or wall-mounted charging units, and come in a variety of current ratings, e.g. 13 A, 16 A, 32 A.

Figure 2.5 – Typical a.c. charging equipment

2.3 Charging equipment for Mode 4

Some types of electric vehicle charging equipment are designed to supply d.c. input to the vehicle (Mode 4 charging). These types of charger use internal rectifiers to convert a.c. supply input into d.c. This d.c. electrical output is then supplied to the vehicle and used to directly charge the vehicle's battery/batteries.

Mode 4 charging

In Mode 4 charging, either single-phase or three-phase a.c. is converted to d.c. within the electric vehicle charging equipment and this d.c. is supplied to the electric vehicle via a charging cable tethered to the electric vehicle charging equipment.

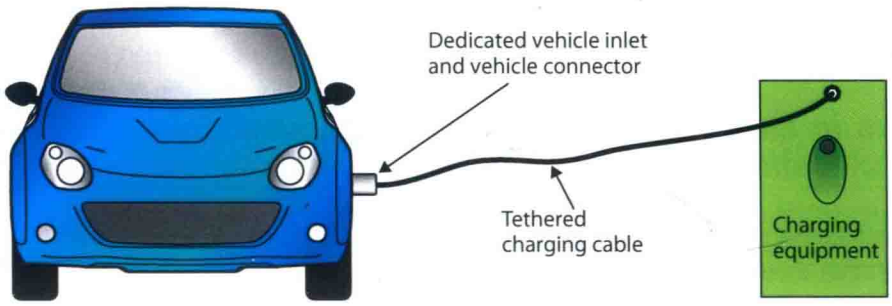

Figure 2.6 – Mode 4 charging diagram

Due to the fact that d.c. chargers are designed to work at higher voltages and currents (typically 500V, 125A), they are not considered suitable for domestic installations.

Due to its greater complexity, d.c. charging equipment tends to be in the form of larger units which are usually designed to be floor mounted.

Figure 2.7 – Typical d.c. charging equipment

2.4 Socket-outlets and charging cables

Charging equipment designed for Mode 1 and/or Mode 2 charging will be fitted with a socket-outlet conforming to either BS 1363-2:1995 or BS EN 60309-2:1999.

Charging equipment designed for Mode 3 charging will either be fitted with a socket-outlet conforming to draft BS EN 62196-2 or be fitted with a tethered charge cable equipped with a vehicle connector conforming to draft BS EN 62196-2.

Charging equipment designed for Mode 4 charging will always be fitted with a tethered charge cable equipped with a dedicated vehicle connector.

More detailed information on the charging sockets-outlets, plugs, vehicle connectors, vehicle inlets and charging cables is given in Annex A.

2.5 Other variations in electric vehicle charging equipment design and specification

In addition to the types of electric vehicle charging equipment described above, further variations in the design and specification of such equipment can be found. Typical features are described in Sections 2.5.1 to 2.5.8 below. Full details of such features and their operation are not covered by this Code of Practice, but can be found in the installation/operational instructions supplied with the charging equipment being installed.

2.5.1 Power supply

Some types of electric vehicle charging equipment are designed to operate from a single-phase a.c. power supply, whereas other types are designed to operate from a three-phase a.c. power supply.

2.5.2 Multiple socket-outlets

Some types of electric vehicle charging equipment provide multiple socket-outlets. These can either be multiple socket-outlets of the same type or different socket-outlet types to suit different modes of charging, e.g. one BS 1363-2:1995 socket-outlet for Mode 1 or Mode 2 charging and one draft BS EN 62196-2 socket-outlet for Mode 3 charging.

2.5.3 Feeder pillars

Some types of electric vehicle charging equipment require a separate feeder pillar containing the energy meter, depending on their installation location.

2.5.4 Protective devices

Most types of electric vehicle charging equipment incorporate either a circuit-breaker and a separate residual current circuit-breaker (RCCB) or a residual current circuit-breaker with overcurrent protection (RCBO).

2.5.5 Timers

Some types of electric vehicle charging equipment have built-in timers which can be set to ensure that the vehicle charging occurs during hours of off-peak demand, unless overridden.

2.5.6 Built-in energy meters

Some types of electric vehicle charging equipment have a built-in energy meter to measure, record and display the amount of electrical energy used.

2.5.7 Security features

Some types of electric vehicle charging equipment, especially those intended for installation in publicly accessible locations, incorporate security features to prevent unauthorised use of the equipment. For instance, the socket-outlet may be located behind a locked cover that can only be unlocked by a registered user presenting their individually authorised electronic key, e.g. radio frequency identification device (RFID).

2.5.8 Communications features

Some types of electric vehicle charging equipment have built-in communications features which allow data on charge station utilisation, energy usage and faults to be communicated to the owner/operator of the charging equipment. Such data may be communicated either through a wired connection, such as ethernet, or through a wireless connection, such as GPRS.