Electric Vehicle Charging Equipment

Much of the discussion regarding electric vehicles in the UK is centred on various customer incentive schemes to assist in purchasing the vehicles. However one important aspect of the electric vehicle market is the electric vehicle charging infrastructure that will be needed to support the various needs of the user. This article describes the charging modes applicable to electric vehicles, a summary of the electrical installation requirements, the guidance available to installers and a summary of various charging infrastructure schemes and equipment solutions.

By Paul Bicheno

What is the current charging equipment infrastructure?
There are a number of initiatives to install dedicated electric vehicle charging points throughout the UK. These include on street public charging points, off street public charging points such as car parks and places of work. Many of the public schemes are currently offering ‘free’ electricity to encourage the use of these charging points. There are also schemes where the consumer can become a member for a nominal fee and then use one of the schemes charging points for no extra cost. A consumer also needs to consider how they are likely to charge their electric vehicle while at home, therefore what are the options available for charging of electric vehicles.

Electric vehicle charging options?
Table 1 (opposite) provides a summary of the recognised options that are available for charging of electric vehicles. They are referred to as ‘charging modes 1, 2, 3 and 4’. A review of the table shows...
### Charging Mode | Electric Vehicle Charging Equipment
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1 (Standard charge) | - Connection by use of standard single-phase or three-phase socket-outlets (e.g. BS 1363, BS EN 60309)
- Supply to electric vehicle not exceeding 16A per phase and not exceeding 250V a.c. single-phase or 480V a.c. three-phase
- No control pilot function provided by the equipment

2 (Fast charge) | - Connection by use of standard single-phase or three-phase socket-outlets (e.g. BS 1363, BS EN 60309)
- Supply to electric vehicle not exceeding 32A per phase and not exceeding 250V a.c. single-phase or 480V a.c. three-phase
- Control pilot function provided by an in-cable control box (not via the standard socket-outlet)
- RCD protection provided between the plug and electric vehicle or as part of the in-cable control box

3 (Fast charge) | - Connection by use of dedicated single-phase or three-phase socket-outlets, or via a tethered cable
- Supply to electric vehicle not exceeding 32A per phase and not exceeding 250V a.c. single-phase or 480V a.c. three-phase
- Control pilot function provided by the equipment via the dedicated socket-outlet or tethered cable
- RCD protection provided as part of the equipment or supply circuit

4 (Rapid charge) | - Connection by use of a tethered cable
- Supply to the electric vehicle from the dedicated charging equipment is d.c. (typically 500V 125A)
- Control pilot function provided by the equipment

### Table 1 – Summary of charging equipment arrangements

that mode 1 provides an option to use standard socket-outlets with the lowest power rating and functionality and as such would take the longest time to charge an electric vehicle. This is also referred to as a ‘standard’ charge arrangement and would typically take 6-8 hours to fully recharge a vehicle. Figure 1 (p26) shows an example arrangement. Mode 2 has an increased power rating and would provide a ‘fast’ charge, typically up to 4 hours, via standard socket-outlets that would need to be rated appropriately. This mode includes an in-cable control box that has a control pilot function to interface with the vehicle connection to verify a protective conductor connection before charging can commence. This mode also includes the provision of a Residual Current Device (RCD) for electric shock protection which is typically included within the in-cable control box. Figure 2 (p27) shows an example of this arrangement. Mode 3 also provides a fast charge via equipment dedicated to charging of
There would be two options available for connection. The first is via a socket-outlet dedicated to electric vehicle charging that is part of the charging equipment thus needing a connecting lead to connect to the vehicle inlet. The second is a tethered cable permanently connected to the charging equipment that would then be connected direct to the vehicle inlet. A control pilot function and RCD protection is also provided as part of the equipment. Figure 3 shows an example of this arrangement. Mode 4 is the fastest mode for charging as a high d.c. voltage and current is supplied direct to the vehicle from the charging equipment and is referred to as ‘rapid’ charging. This mode also includes a control pilot function. Figure 4 shows an example of this arrangement.

What are the electrical installation requirements? Currently there are no specific requirements in BS 7671 other than the general requirements of Parts 1 to 6 for the charging of electric vehicles. However within the standardisation process there have been developments at both the IEC and CENELEC levels. There is currently a new Section 722 for the supplies to electric vehicles for charging being developed within the 60364 series of standards for electrical installations. The CENELEC document is FprHD 60363-7-722:2011 which means this it at the final draft voting stage. Therefore it is likely that this section will become a published HD in the near future. The impact of this is that this will eventually need to be published in BS 7671 as part of the development process. The new section covers a number of specific requirements such as:

- prohibiting the use of a PEN conductor in a final circuit of a TN-system supplying an electric vehicle connection point
- no diversity to be applied to a final circuit supplying a connection point
- a dedicated circuit is to be provided for the connection of electric vehicles
- Every connection point to be provided with individual
What guidance is available to installers?
The IET has worked with various stakeholders such as Government departments, electrical contractor organisations, electric vehicle manufacturers, electric vehicle charging equipment manufacturers and supply distribution organisations to develop a code of practice for the installation of electric vehicle charging equipment. This includes guidance on what needs to be checked prior to installation, general installation requirements for the equipment, more detailed electrical installation requirements covering domestic, on-street and commercial and industrial installations as well as additional information on the charging modes and types of equipment. The development process raised an important issue regarding the solutions to be applied for the scenario of a broken neutral in the PEN conductor where protective multiple earthing (PME) supplies are installed in certain scenarios such as a domestic environment. Guidance on this is included within the code of practice. Anyone installing electric vehicle charging equipment should be aware of this guidance. A copy can be can be ordered from the following site (www.theiet.org/publishing/standards/ev-charging-cop.cfm)
The following information gives an additional insight into some of the initiatives for the types of infrastructure being developed and the solutions for electric vehicle charging equipment.

**Sample list of electric vehicle charging point domestic and public infrastructure solutions**

**British Gas** offers a domestic dedicated electric vehicle charger solution ([www.britishgas.co.uk/electricvehicles](http://www.britishgas.co.uk/electricvehicles)).

**Charge Your Car** ([www.chargeyourcar.org.uk](http://www.chargeyourcar.org.uk)) this scheme has been launched in the North East of England. This is a membership scheme that enables owners and drivers of electric vehicles to access any of the Charge Your Car charging points at no additional cost.

**EDF Energy** Offers the EcoRecharge domestic dedicated electric vehicle charging solution ([www.edfenergy.com/products-services/for-your-home/electric-vehicles/](http://www.edfenergy.com/products-services/for-your-home/electric-vehicles/)).

**Electromotive** has developed the Elektrobay ([www.elektromotive.com/html/elektrobay.php](http://www.elektromotive.com/html/elektrobay.php)) electric vehicle charging infrastructure in a number of London boroughs and other parts of the UK.

**POLAR** ([www.polarnetwork.com/home](http://www.polarnetwork.com/home)) is a membership scheme providing domestic, public and workplace infrastructure solutions.

**Source London** ([www.sourcelondon.net/](http://www.sourcelondon.net/)) this is a scheme in London with publicly accessible charge points located on the street, supermarkets, London Underground car parks and car parks all over London. This is a membership scheme to enable the use of the Source London charge points to charge the vehicle at no additional cost.

**Sample list of suppliers of electric vehicle charging equipment and services**

**Chargemaster** ([www.chargemasterplc.com/](http://www.chargemasterplc.com/))

**Elektromotiv** ([www.elektromotive.com](http://www.elektromotive.com))

**POD Point** ([www.pod-point.com/](http://www.pod-point.com/))

**Typical d.c. charging equipment**

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**Figure 3 – example of mode 3 charging**

**Figure 4 – example of mode 4 charging**