



Technical Article

# Rail Vehicle Phone and Device Charging Systems.

## *Design considerations and the future of onboard charging.*

Rail passengers use their phones intensively whilst travelling and value an onboard charging facility to keep their devices topped-up during their journeys. Used for entertainment, journey planning or keeping in touch with work or friends they are essential companions and low battery levels can cause anxiety, if there is no charging service available. Passengers sometimes forget their charging cables; they may be damaged, or existing USB sockets can develop faults from overuse or misuse, or there may be no charging available.

We are going to discuss, the considerations of what mix of charging points and technologies might be needed for different types of train journeys and the future of wireless, USB and power socket charger

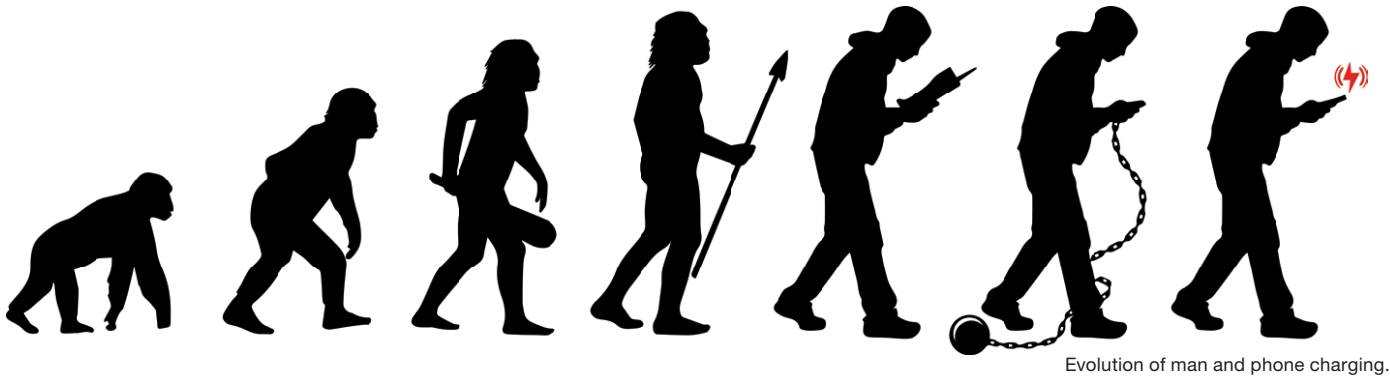
along with the challenges of installing and maintaining charging points over the long service life of a typical train.

We should consider not just the charger points themselves, but the whole charging infrastructure as a 'charging system' needing careful design and heavily influenced by whether it is for a new build or a train refurbishment.

The system encompasses the chargers themselves, whether mounted in seatbacks, seat tables, tables, train interior walls or on grab poles. Along with the power supply converters and the necessary cabling from the train power backbone to the power converters and then out to the chargers themselves wherever they are located.

All of this system needs to conform with railway safety regulations from; power surges and transients, (EN 50155), EMC emissions and immunity (EN 50121-3- 2) to vibration resistance EN 61373, Flammability (EN 45455) etc.

Whilst, it is tempting to think, that the answer to all this is just fitting a couple of three pin household sockets with a built-in USB to the train interior wall, the reality is that device charging is evolving quickly and designers spending substantial sums on hardware and installation need to think about maintenance, longevity and the future of charging itself – what will passengers need 5 to 10 years from now?



*The future of charging.  
There are two strands here, the  
charging technologies used  
and the type of USB connector  
sockets fitted.*



Seatback mounted charger.



Tabletop mounted charger.



Tabletop mounted charger.

### The future of charging

There are two strands here the charging technologies used and the type of USB connector sockets fitted on the train. Phones are constantly evolving with new models released by the main manufacturers two or three times per year. Nearly all new phones have both a USB socket and a wireless charging receiver – but how long will the USB last?

Over recent years headphones have been moving towards Bluetooth connections, despite the initial resistance when iPhone users lost their connector, consumers are now getting used to wireless connections – no tangled cables to carry, no faulty connectors etc.

In the meantime, more and more people are charging their phones wireless in their homes and offices – even if they have a separate charging pad connected via USB to a wall socket or their laptop – the immediate charging connection is wireless.

### EU Regulations

To promote compatibility and reduce waste the EU approved legislation in October 2022 that requires all phones, tablets and many other devices sold after January 2024 to use a USB-C socket and for Laptops to follow from 2026. Apple confirmed in October 2022 they will reluctantly change their phones from lightning to USB-C in time to meet the deadline, but they have long resisted this move saying it stifles innovation.

“We’ve No Choice”: Apple Says iPhones.  
Will Switch Over To USB-C To Comply

However, many commentators believe that iPhones will eventually move to wireless charging only, through further development of ‘MagSafe’. Other phone vendors are also offering magnetically coupled wireless chargers, so in the long term there is every possibility that USB-C standardisation is a stepping stone on the final path towards wireless charging. After all, even if it can be inserted in either orientation, any physical electrical connection socket in a public use environment will be subject to wear and tear.

This wear and tear has implications for the availability of working chargers and the maintenance costs for repair and replacements. Passenger safety and electrical system integrity is also important, worn equipment and faulty cables could cause electrical shorts and there have been cases in the UK where the covers to plug-in charging blocks have come off due to tight mains sockets, so exposing passengers to the 230V supply (National Incident Report 3591) or where the household socket fascia plate has become detached (NIR 3730).

### Power to the people – but how much?

Just how much power for each device should be available to passengers is still a moot point, there are 5W, 10W, 15W and even higher charger adaptors on the market, but what is the role of train chargers? Should they be offering a top-up low power charge to keep the phones running, or should passengers be able to get a full 0 to 100 % charge during their journey?

There are cost and capacity considerations to installing the charging infrastructure and providing power from the engine or overhead lines.

# Modern, railway approved power converters for under seat or bulkhead mounting.

*Democratisation of charging  
'Which passengers on which  
type of train service and in  
which seats deserve a charging  
service?'*



Tabletop mounted charger.



Seatback mounted charger.

Supplying 15W per passenger to each seat of a 12 car train needs to be considered in the overall power overhead, but modern, railway approved, AC/DC or DC/DC power converters can easily accommodate two power outputs each up to 100W in a rugged compact enclosures for under seat or bulkhead mounting – enough power even for a tablet or a laptop.

The experience so far from EAO, with its charging systems used in Austrian rail's new Nightjet train is that a 5W charger has been considered sufficient for an overnight sleeper service, whilst seated passengers on commuter trains would need a faster 10W charge. On shorter metro-type services 15W fast charging is probably necessary.

## The deserving public

So which passengers on which type of service and in which seats deserve a charging service? There are big questions here about cost and the democratisation of charging. For an intercity service, it is reasonable to expect that every passenger, whether first or second class, whether at a table, or in an airline-style should have power for their devices. But what about a commuter service, with simpler lower cost basic airline seating, the services are often an hour or more in duration with many passengers boarding and alighting at each station.

Surely it is not desirable to have phone cables stretching across from the wall socket to the aisle seat, so the charging cables need to be routed to each individual seatback or to tables.

## What do the passengers want?

We know anecdotally that phone and device charging is important to passengers and a recent small survey of commuters at Brighton station in February 2023 found that 54 % of passengers suffered 'low battery' anxiety if they were running out of charge.

When asked about what improvements to passenger convenience they would most like, 59 % of passengers considered a charging service to be 'very important'. Whilst 31 % of respondents considered wireless charging at every seat and table to be very important. Another UK passenger survey from [transportfocus.uk.org](https://transportfocus.uk.org) for Porterbrook leasing found that at seat charging was one of the most important train interior features requested by customers.

## Charging technology and power connections

Household sockets with USB A are widely used in rail carriages, but safety considerations with household sockets persist and given that they are most likely to be used with passengers' AC converters to provide DC power to a laptop, phone or tablet, rather than to an AC device like a hairdryer. So a high power 50 or 100W DC variable voltage 5V – 20V output, through the soon-to-be standardised, USB-C output socket, and therefore suitable for most devices could also be part of the future charging mix.



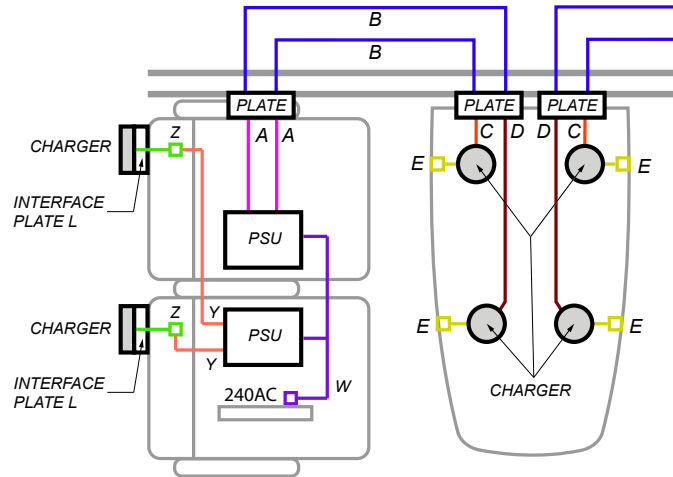
# An uncertain future – but a certain need.

*The future is wireless.  
“Wireless chargers are a safe,  
reliable and low maintenance  
option that follow the growing  
trend to cable free charging.”*

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A typical seat and table charger installation and wiring layout.

The need for phone charging on trains is a clear requirement from passengers, but the charging technology whether purely wireless, USB, or both is still uncertain.

## Wireless charging

With no physical sockets to wear out and no high voltage AC connection socket needed in the carriage, wireless chargers are a safe, reliable and low maintenance option that follows the growing trend to cable free operation and charging of portable devices.

Wireless charging systems can deliver up to 3A (15W) for fast phone charging without the need for passengers to carry cables that can be easily damaged, lost, or simply forgotten on a journey. There does not appear to be a standard for the location of the wireless charging receiver – so it varies between phone manufacturers and their different models.

To overcome this lack of standardisation, seatback chargers where phones are held in place against the charging pad need to have multiple charging coils that allow charging wherever the charging receiver is located on the device. For table mounted chargers the passenger will generally move their phone until they get confirmation that the phone is receiving charge via a screen notification, or from haptic feedback through vibration.

## Power conversion and cabling system

Any device charging system will require power conversion technology to supply the correct DC voltage and the appropriate power level to the chargers. This will be either DC/DC conversion or

AC/DC conversion depending on the voltage of the train system itself. Each power convertor will have to be mounted within the carriage bulkheads, or within the seats or tables in a mechanically robust and electrically secure manner for safety and reliability.

Depending on the charging current to be supplied to each charge point the convertor needs to be appropriately rated and might need to power two or four chargers up to 15W and be approved to all the relevant rail standards. The connection cable between the power convertor and the seat, table or grab rail also needs careful consideration this is not just a common or garden domestic charger cable, but a fire-rated cable with vibration-resistant connections to the power convertor carefully routed through the seat or table to the chargers themselves.

## An uncertain future – but a certain need

The need for phone and device charging on trains is a clear requirement from passengers, but the charging technology to be used whether purely wireless, USB, or both is still uncertain. But there is every chance that the days of the humble household 3-pin socket with a USB-A are numbered.