TECHNICAL ARTICLE

Using Magnetics with Electrical Vehicle Applications

While still a small percentage of the overall number of vehicles, the rate of adopting electric vehicles (EV's) is increasing each year in North America. As a result, the infrastructure must be developed to support both the physical charging stations and the expected electrical load.

Currently there are four levels of EV charging:
Level 1: 120V single phase, providing 2-5 miles of range per hour of charging
Level 2: 240V single phase, providing 10-11 miles of range per hour of charging
Level 3: Typically 480V three phase, providing 50-100 miles of range per hour of charging
Level 4: Typically 480V three phase, providing 150-170 miles of range per hour of charging

Multiple Class 3 chargers can create significant power quality issues. Proper selection of transformers can help to mitigate these issues.

Level 1 & 2 chargers are primarily used for residential, public and fleet charging, with level 2 being the most common. Eight hours of level 2 charging will cover over 95% of the average person's commuting distance. Level 3 and 4 charging are typically seen in public installations and due to the high installation costs ($40k-$85k per unit), consist typically of only 1-2 charging units. Level 3 and 4 chargers provide a quick means to top off a low battery level. Vehicles typically spend less than one hour charging.

There are a few concerns for single or double level 1 or 2 point installations. These are typically in residential installations or as small service charging areas in parking lots. Utilities are concerned about the long term effects the higher concentrations of electrical vehicles will cause as residential and commercial grids will have increased charging loads in the future. These concerns include overall power quality issues caused by DC chargers, transformer losses caused by harmonics, brownouts and being able to supply the overall increased loads.

There are increasing concerns caused by the large loads of multiple class 1 and 2 chargers in facilities such a public garages and EV fleets. A single level 3 or 4 charger can have a load of a dozen or more level 1 or 2 chargers and can cause similar concerns.

Major issues include:

- **Power Quality:** Numerous studies have shown that large electric vehicle charging loads can create THDi levels in excess of the IEEE 519:2014 maximum 8%, in some cases well over twice this level. This can result in issues typical of poor power quality and additional utility charges, fines or requirements to rectify.
-
- **Current Surges:** Depending on the number of EV's, level of charger, vehicle type and individual level of battery charge, large current surges can be created from the EV chargers. These surges can cause brownouts, stress electrical components and result in higher utility demand charges. In addition, a combination of site installation issues can provide additional challenges.

- **Public Installation:** Most ventilated magnetics are not recommended to be installed in areas accessible to the general public.
  -Aesthetics may be a consideration.

- **Exterior Installation:** Magnetics must be able to handle local environmental conditions.

TECHNICAL ARTICLE

Magnetic Recommendations

Magnetic recommendations for use with electric vehicle charging:

- **High Harmonics:** At a minimum, three phase units should be specified at K=4, but it is preferred to specify at K=9.
- **Power Quality:** K-rated units will have a 200% rated neutral to deal with harmonics caused by level 1 and 2 chargers.
  -Utilizing harmonic mitigating transformers (HMT's) can provide significant power quality improvement if multiple level 1, 2, 3 or 4 charging stations are installed.
- **Local Environmental Conditions:** If installed in a non-temperature controlled area, 130°C or 115°C temperature rise units can contend with high ambient temperatures.
  -Enhanced type 3R enclosures (3RE) can be used if horizontally blowing rain or snow are a concern.
- **Safety:** Units should be installed in areas not accessible to the general public. If that is not possible, additional options can be considered including tamper resistant hardware, hinged and lockable enclosures, non-ventilated enclosures, IR viewing windows and temperature sensors.
  -Electrical code may require bollards or other installation requirements to protect transformers from vehicle damage. Transformers should also not be installed under water lines, water drains, etc. which could direct water onto the enclosure if broken.
- **Low Site Voltage:** Use integral taps or buck-boost transformers to adjust voltage.
- **Aesthetics:** Custom enclosure colors or stainless steel is available. In some cases smaller autotransformers instead of isolation transformers may be utilized.

The concerns with EV charging will be a growing issue in the future. Care should be taken when specifying systems since issues such as power quality can affect all components of the local grid, not just those devices directly supplying the EV charging points.

HPSTA1 - EV
February - 2024

hammond POWER SOLUTIONS

CANADA
595 Southgate Drive
Guelph, Ontario
N1G 3W6
1-888-798-8882

UNITED STATES
1100 Lake Street
Baraboo, Wisconsin
53913-2866
1-866-705-4684

MEXICO
Av. No. 800, Parque Industrial
Guadalupe, Guadalupe, NL,
Mexico, C.P. 67190.
819-690-8000