

IEEE Standard for Passenger Train Auxiliary Power Systems Interfaces

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Abstract: The electrical interfaces among the components comprising the auxiliary power systems and their electrical interface with other train-borne systems are described. As such, this standard treats the auxiliary power system components (e.g., static inverters and converters, low-voltage dc power supplies, back-up battery systems, and battery chargers) as black boxes and addresses only their interface requirements.

Keywords: auxiliary power systems, battery charger, intermediate-voltage power supply, low-voltage power supply batteries, nickel-cadmium batteries, rail-transit vehicles, static inverters and converters

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Introduction

(This introduction is not part of IEEE Std 1476-2000, IEEE Standard for Passenger Train Auxiliary Power Systems Interface.)

Passenger train auxiliary power systems consist of major components or subsystems that may be supplied by different manufacturers/suppliers. These different components/subsystems must be integrated to form the auxiliary power systems that provide ac and dc power to subsystems on the train, which are used for normal and emergency operations. Typically, an auxiliary power system is comprised of

- An auxiliary static inverter to supply the low- and high-power ac loads.
- A low-voltage dc power supply to provide power to the low-voltage dc loads, which may also be used to charge the low voltage dc battery.
- A low-voltage dc battery to drive the emergency/essential loads on the vehicle in case of power failure or component failure.
- A battery charger, in those systems where the low-voltage power supply is not used for charging of the battery.

Nickel-cadmium batteries are specified in 4.5 as the preferred technology for the following reasons:

- a) They have a more efficient recharge capability.
- b) They have a wider operating temperature range.
- c) They deliver more of their stored energy to the loads (lower losses).
- d) They result in lower toxic and corrosive fumes.
- e) They are lower weight than lead acid batteries for equivalent performance.

Other technologies are allowed under written approval of the authority having jurisdiction to permit their use in special situations.

There are no U.S. standards (including IEEE standards) to define the electrical interface between these components/subsystems, and there are no standards to define the electrical interface between the auxiliary power system and the vehicle subsystems receiving electrical power from it. In the absence of standards, to define these interfaces, important design information is often overlooked resulting in incompatibilities between them.

This standard addresses the electrical interfaces between the components comprising the auxiliary power systems and the electrical interfaces between the auxiliary power system and all of the components devices and subsystems receiving power from the auxiliary power system. It is the intention that through the use of this standard some of the costly design incompatibilities will be precluded.

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1. Overview

This standard applies to new procurements or major rehabilitation of rail-transit vehicles occurring on or after the publication date of this standard. Existing rail-transit vehicles and those vehicles currently being procured need not comply except when specifically required by the authority having jurisdiction. Where a need exists to maintain compatibility with existing rail-transit vehicles and to the extent defined by the authority having jurisdiction, those portions of this standard in conflict with compatibility requirements need not be applied.

1.1 Scope

This standard prescribes the electrical interfaces among the components comprising the auxiliary power systems and their electrical interface with other train-borne systems. As such, this standard treats the auxiliary power system components (e.g., static inverters and converters, low-voltage dc power supplies, back-up battery systems, and battery chargers) as black boxes and addresses only their interface requirements. It does not provide standards or recommendations for the following:

- Rotating machinery, such as motor alternator sets
- Motive power systems or auxiliary power systems required for locomotives
- Mechanical mounting or vibration isolation of equipment
- Car-body wiring, branch circuits, circuit breakers, protection, and devices to interconnect the auxiliary power components with other car-borne equipment

1.2 Purpose

The purpose of this standard is to standardize the electrical input and output requirements of the auxiliary power system components. This will be conducive to standardized designs rather than custom designs of car-borne equipment utilizing the supply voltages of the auxiliary power systems. It will also aid in more clearly defining the electrical interface requirements between the major component parts that comprise the auxiliary power systems, thus promoting their standardized design. The combined effect should increase the number of potential suppliers and correspondingly result in reduced railcar costs.

2. References

This standard shall be used in conjunction with the following publications. If the following publications are superseded by an approved revision, the revision shall apply. In case of a conflict between this standard and the referenced document, this standard takes precedence. Those provisions of the referenced documents that are not in conflict with this standard shall apply as referenced.

ANSI C84.1-1995, Electrical Power Systems and Equipment—Voltage Ratings (60 Hz).¹

IEC 60571 (1998-02), Electronic equipment used on rail vehicles.²

IEC 60850 (1988-03), Supply voltages of traction systems.

IEC 61287-1 (1995-07), Power converters installed on board rolling stock—Part 1: Characteristics and test methods.

IEEE Std 519-1992, IEEE Recommended Practices and Requirements for Harmonic Control in Electric Power Systems.³

IEEE Std 1473-1999, IEEE Standard for Communications Protocol Aboard Trains.

NEMA MG 1-1998, Motors and Generators.⁴

3. Definitions, abbreviations, and acronyms

3.1 Definitions

For the purposes of this standard, the following terms and definitions apply. The IEEE Standard Dictionary of Electrical and Electronics Terms [B2]⁵ should be referenced for terms not defined in this subclause. Webster's New Collegiate Dictionary [B5] shall otherwise apply.

3.1.1 aging factor: A quantitative factor expressing the degradation in the ability of the battery, due to usage, to deliver electrical energy under specified operating conditions such as, but not limited to, operating ambient temperature, cycling, depth of discharge, and maintenance practices.

3.1.2 authority: A geographical or political division created specifically for the purpose of providing transportation service.

3.1.3 authority having jurisdiction: That entity that defines the contractual (including specification) requirements for the procurement.

3.1.4 builder: The entity manufacturing the product.

¹This standard is available from Global Engineering Documents, 15 Inverness Way East, Englewood, Colorado 80112, USA (<http://global.ihs.com/>).

²IEC publications are available from the Sales Department of the International Electrotechnical Commission, Case Postale 131, 3, rue de Varembe, CH-1211, Genève 20, Switzerland/Suisse (<http://www.iec.ch/>). IEC publications are also available in the United States from the Sales Department, American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036, USA.

³IEEE publications are available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA (<http://standards.ieee.org/>).

⁴NEMA publications are available from Global Engineering Documents, 15 Inverness Way East, Englewood, Colorado 80112, USA (<http://global.ihs.com/>).

⁵The numbers in brackets correspond to those of the bibliography in Annex B.

3.1.5 car: *See: vehicle.*

3.1.6 car builder: The entity manufacturing the vehicle.

3.1.7 constant current loads: A load that demands constant current even when the input voltage varies.

NOTE—Typical of such loads is lighting when driven from an inverter ballast configuration.

3.1.8 constant power load: A load that demands constant power from the source even when the voltage value drops such as when switching from the low-voltage power supply to the battery.

NOTE—Typical of such loads are those that have their own built-in regulator such as propulsion control power supplies.

3.1.9 galvanic isolation: A method of electrical isolation where neither the signal nor the common of the output of the isolator is dc coupled to the signal or common of the input of the isolator, except for low-level leakage associated with non-ideal components.

3.1.10 heating ventilation and air conditioning (HVAC) system pull down: The condition wherein the air conditioning system in the car is turned on and is required to cool a car that has been sitting in the heat of the day.

NOTE—This condition usually presents the highest/longest sustained power demands on the auxiliary inverter.

3.1.11 heavy rail transit: A mode of rail rapid transit generally characterized by fully grade-separated construction, operation on exclusive rights of way, and station platforms at the floor level of the vehicles.

3.1.12 heavy rail vehicle: A vehicle operating on a heavy rail-transit system. Typically, electrically propelled, bi-directional, capable of operating in multiple unit, and designed for rapid, high-level boarding and discharging of passengers.

3.1.13 interface: The points where two or more physical systems or subsystems meet to transfer energy or information.

3.1.14 intermediate-voltage power supply (IVPS): Power supply that converts the third rail or catenary high-voltage dc or ac into an intermediate-voltage ac or dc to feed other power supplies.

3.1.15 lay-up condition: Idle condition of the equipment and systems between service operations.

3.1.16 light rail transit: A mode of rail transit characterized by its ability to operate on exclusive rights-of-way, street running, center reservation running, and grade crossings, and to board and discharge passengers at track or vehicle floor level.

3.1.17 light rail vehicle: A vehicle operating on a light rail-transit system, capable of boarding and discharging passengers at track or vehicle floor level.

3.1.18 low-voltage power supply (LVPS): A power supply that provides dc power to the low-voltage devices or circuits contained on the vehicle. It can also be configured to charge the vehicle battery.

3.1.19 manufacturer: *See: builder.*