IEEE Standard for Passenger Information System for Rail Transit Vehicles

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Abstract: Rail transit vehicle passenger information system interfaces with the vehicle's carbody, train crew, control system, power system, and passengers are described in this standard. The physical, logical, and electrical interfaces of the passenger information system for rail transit vehicle systems and subsystems are specified.
Keywords: passenger information system, rail transit vehicles, trains

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Introduction

(This introduction is not part of IEEE Std 1477-1998, IEEE Standard for Passenger Information System for Rail Transit Vehicles.)

This standard describes rail transit vehicle passenger information system interfaces with the vehicle's carbody, train crew, control system, power system, and passengers. It is intended for the following uses:

— By individuals or organizations who write specifications for rail transit vehicle rehabilitation, retrofit, or new vehicle procurement.
— By manufacturers for the development of new products.

This standard is designed to help individuals and organizations achieve the following objectives:

— High-quality product;
— Compatibility;
— Interchangeability among different manufacturers' products;
— Installation and maintenance ease;
— High reliability; and
— Low product cost and good availability.

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IEEE Standard for Passenger Information System for Rail Transit Vehicles

1. Overview

This standard is divided into four clauses. Clause 1 provides the scope of this standard. Clause 2 lists references to other standards that are useful in applying this standard. Clause 3 provides definitions for technical terms used in this standard. Clause 4 establishes interface standards for four subsystems within the passenger information system of rail transit vehicles.

1.1 Scope

This standard applies to external and internal audiovisual communication of passenger information, destination/trip information, and announcements related to safety and emergencies, as well as advertisement/community information for rail transit vehicles. It specifies the physical, logical, and electrical interfaces of the passenger information system for rail transit vehicle systems and subsystems. This includes the following equipment: passenger information signs, public address system, passenger/crew call intercom system, internal display system, and radio system interface with the public address system.

1.2 Purpose

The purpose of the standard is to establish the minimum interface requirements for passenger information systems in order to enable product interchangeability and component commonality.

1.3 Application

This standard is intended to be used in specifications for the procurement of new rail passenger vehicles (light, heavy, and/or commuter rail vehicles). It is also intended to be used, as applicable, in specifications for rehabilitating or retrofitting existing rail passenger vehicles and for replacement systems.

This is an interface standard that defines vehicle passenger information interfaces but is not intended to specify any minimum number of required passenger information features.

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The current standard covers electrical and physical interfaces. Logical interfaces will be addressed in a future draft IEEE Standard for Transit Communications Interface Profiles for Rail Applications.[1]

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 shall take precedence. Those provisions of the referenced documents that are not in conflict with this standard shall apply as referenced.

IEEE Std 100-1996, IEEE Standard Dictionary of Electrical and Electronics Terms.[2]

IEEE P1473 (Draft 3.4, September 1998), Draft Standard for Communications Protocol Aboard Trains.[3]

IEEE P1476 (Draft 3.5, September 1998), Draft Standard for Passenger Train Auxiliary Power Systems Interfaces.

PCMCIA/PC Card Standard, Release 6.1, vols. 1–13, March 1997.[4]

3. Definitions and abbreviations

3.1 Definitions

English words throughout this standard are used in accordance with their definition in the latest edition of *Webster's New Collegiate Dictionary* [B2].[5] Electrical and electronics terms that are not defined in *Webster's New Collegiate Dictionary* are used in accordance with their definition in IEEE Std 100-1996. Definitions for words that are not provided in these two publications follow.

3.1.1 basic operating unit: (A) A single vehicle designed for independent operation. **(B)** A permanent or semi-permanent combination, designed for independent operation, consisting of two or more vehicles of one or more types.

3.1.2 consist: The makeup or composition (number and specific identity) of individual units on a train.

3.1.3 light-emitting diode: A p-n junction solid-state diode, whose radiated output is a function of its physical construction, material used, and exciting current. The output may be in the infrared or in the visible region. When used as a visible element, the output shall be limited to the visible region.

3.1.4 liquid crystal display: A display made of material whose reflectance or transmittance changes when an electric field is applied.

3.1.5 passenger information sign: A device that displays or annunciates transit trip information to passengers.

3.1.6 stroke width: In character recognition, the distance between two stroke edges, measured perpendicular to the stroke centerline.

3.1.7 train: A consist of one or more basic operating units.

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[1]For information about this and other Rail Transit Vehicle Interface Standards Committee (RTVISC) projects, see the web site at http://www.tsd.org/wg.htm.
[2]IEEE 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/).
[3]Numbers preceded by P are IEEE authorized standards projects that were not approved by the IEEE Standards Board at the time this publication went to press. For information about obtaining drafts, contact the IEEE.
[4]The PCMCIA/PC Card Standard is available from the Personal Computer Memory Card International Association, 2635 North First St., Ste. 209, San Jose, CA 95134 USA (http://www.pcmcia.org/).
[5]The numbers in brackets correspond to those of the bibliography in Annex A.

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3.1.8 train control system: The system for controlling train movement, enforcing train safety, and directing train operations.

3.1.9 vehicle: A land conveyance assembly for carrying or transporting people or objects, capable of traversing a guideway, having structural integrity and general mechanical completeness but not necessarily designed for independent operation.

3.2 Abbreviations

LCD	liquid crystal display
LED	light-emitting diode
PCMCIA	Personal Computer Memory Card International Association
TCS	train control system

4. Standard practices and procedures

Passenger information system interface practices and procedures for the procurement of new or rehabilitated rail passenger vehicles (light, heavy, and commuter) shall be as specified in one or more of the following subsystems: passenger information signs, public address system, radio communication system, and passenger/crew call intercom system.

4.1 Passenger information signs

4.1.1 General

This standard is applicable to any of the following electronic alphanumeric sign technologies: light-emitting diode (LED), liquid crystal display (LCD), flip-dot electronic segment readout, plasma discharge, electroluminescent, vacuum fluorescent, or three-sided electromagnetically activated element displays.

Where destination or route information is displayed on the exterior of a vehicle, illuminated signs shall be provided on both ends of each train and on the boarding side(s) of each vehicle.

All signs shall be of modular design, self-contained, and so designed and installed to permit easy installation, removal, and access for maintenance.

4.1.2 Exterior side signs

Exterior side signs shall meet the following requirements:

Characters on signs shall have a width-to-height ratio between 3:5 and 1:1 and a stroke width-to-height ratio between 1:5 and 1:10, with a “wide” spacing (generally, the space between letters shall be 1/16 the height of uppercase letters), and shall contrast with the background, either dark-on-light or light-on-dark.

NOTE — One of the following display options is recommended:

a) Characters to spell the destination and one or two color columns immediately before the destination, capable of indicating one of five colors: red, orange, yellow, green, or blue. Characters shall be up to 102 mm (4 in) high and color columns shall also be up to 102 mm (4 in) high.
b) One alphanumeric character up to 152 mm (6 in) high, followed by a space and alphanumeric characters up to 102 mm (4 in) high.
c) A combination of a) and b).

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4.1.2.1 Carbody interface

Side signs shall be sized so that they fit in the following space, which shall be provided at designated locations in the vehicle:

a) Length (longitudinal): not to exceed 1067 mm (42 in).
b) Depth (transverse): not to exceed 127 mm (5 in).
c) Height: not to exceed 254 mm (10 in).

4.1.2.2 Power interface

The equipment shall be protected against voltage transients of at least 2.5 kV at 80 watt-seconds (ws), electrical short circuits, reverse polarity, and ground faults.

Power availability and wiring per sign shall be one of the three following standard ranges:

— 10 A, 28 Vdc, over the range specified in IEEE P1476. Supply shall be from two #14 American Wire Gauge (AWG) copper wires minimum.
— 10 A, 37.5 Vdc, over the range specified in IEEE P1476. Supply shall be from two #14 AWG copper wires minimum.
— 5 A, 74 Vdc, over the range specified in IEEE P1476. Supply shall be from two #16 AWG copper wires minimum.

The sign shall operate without degradation over the respective voltage range as specified above. For cases where the sign is a shed load when battery power is used, the lower limit of the voltage range shall be the voltage at which the load is shed.

4.1.2.3 Operator interface

The displayed information shall be controlled automatically or manually in accordance with the user's specification. A small display that duplicates the information on the side signs shall be provided on the operator's control panel or at another suitable location.

4.1.2.4 Control interface

The active control console shall transmit information sign message selection to all other vehicles in the train. Transmission of all signals and controls shall utilize digital technology. The equipment shall be protected against voltage transients of at least 2.5 kV at 80 ws, electrical short circuits, reverse polarity, and ground faults. A means shall also be provided to prevent equipment performance degradation due to extraneous noise, ground loops, circulating currents, and other interference signals.

The control interface wiring shall consist of one #16 AWG copper twisted shielded pair for serial digitally controlled systems and seven #18 AWG copper conductors for parallel digitally controlled systems. Intersystem communication protocol shall be in accordance with IEEE P1473. The time required to change information, shall not, with any combination of information, exceed 2 s for serial interface digital signs and 5 s for parallel digital signs at rated voltage. The system shall monitor voltage level, signal input, signal output, and displayed message. If an anomaly is detected that would cause an incorrect display, the sign shall have a dark display.

4.1.2.5 Passenger interface

Displayed information shall be readable at a distance of up to 23 m (75 ft), in expected ambient lighting conditions, to a viewer with vision corrected to 20/20, and within viewing angles of 160 degrees horizontally and 45 degrees vertically above and below the sign.

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4.1.3 Exterior end signs

Exterior end signs shall comply with the following requirements:

Characters on signs shall have a width-to-height ratio between 3:5 and 1:1 and a stroke width-to-height ratio between 1:5 and 1:10, with a “wide” spacing (generally, the space between letters shall be 1/16 the height of uppercase letters), and shall contrast with the background, either dark-on-light or light-on-dark.

NOTE — One of the following display options is recommended:

a) Characters to spell the line color and one or two color columns at each side of the descriptive word, capable of indicating one of five color codes: red, orange, yellow, green, and blue. Characters shall be up to 102 mm (4 in) high and color columns shall also be up to 102 mm (4 in) high.
b) One alphanumeric character up to 152 mm (6 in) high, followed by a space and alphanumeric characters up to 102 mm (4 in) high.
c) A combination of a) and b).

4.1.3.1 Carbody interface

Signs shall be sized so that they fit in the following space, which shall be provided at designated locations in the vehicle:

a) Length (longitudinal): not to exceed 914 mm (36 in).
b) Depth (transverse): not to exceed 213 mm (8 in).
c) Height: not to exceed 254 mm (10 in).

4.1.3.2 Power interface

See specifications in 4.1.2.2.

4.1.3.3 Operator interface

See specifications in 4.1.2.3.

4.1.3.4 Control interface

See specifications in 4.1.2.4.

4.1.3.5 Passenger interface

For signs with characters up to 102 mm (4 in) tall, displayed information shall be readable at a distance of up to 23 m (75 ft) in daylight, to a viewer, with vision corrected to 20/20, within a viewing angle of 160 degrees.

4.1.4 Interior message display signs

All interior message display signs shall be installed in locations selected by the user. Equipment shall be of modular design, self-contained, and so designed and installed to permit easy installation, removal, and access for maintenance.

The sign shall be capable of displaying a minimum of 20 characters no less than 58 mm (2.3 in) high. The sign shall have a scrolling capability. The sign shall provide messages such as the next station stop, destination, route, time of day, elevators/escalators that are out of service, and other messages. Stored messages shall be in nonvolatile memory and shall be easily updated by a plug-in portable device, an integrated PCMCIA device (PC Card), or through the vehicle communication network.

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Textual and audio messages shall be coordinated with one another. The user shall specify the storage capacity for messages, the type of messages, and their duration.

NOTE — Every effort should be made to have audio and visual information of similar content so that both the hearing impaired passengers and visually impaired passengers receive the same information nearly simultaneously.

4.1.4.1 Carbody interface

Signs shall be sized so that they fit in the following space, which shall be provided at designated locations in the vehicle:

a) Width: not to exceed 750 mm (30 in).
b) Height: not to exceed 150 mm (6 in).
c) Depth: not to exceed 200 mm (8 in).

All equipment accessible to the public shall be of vandal-resistant construction and be secured against unauthorized access. The message display shall be pitched slightly downward to allow maximum visibility to passengers and minimize reflections on the ceiling.

4.1.4.2 Power interface

Equipment shall be powered by the vehicle's low-voltage dc system and connected to use the vehicle's battery supply. If the equipment is used for emergency announcements, it shall not be load shed. The equipment shall be protected against voltage transients of at least 2.5 kV at 80 ws, electrical short circuits, reverse polarity, and ground faults.

Power availability and wiring for each sign shall be one of the three following standard ranges:

— 5 A, 28 Vdc, over the range specified in IEEE P1476. Supply shall be from two #16 AWG copper wires minimum.
— 3 A, 37.5 Vdc, over the range specified in IEEE P1476. Supply shall be from two #16 AWG copper wires minimum.
— 3 A, 74 Vdc, over the range specified in IEEE P1476. Supply shall be from two #16 AWG copper wires minimum.

The sign shall operate without degradation over the respective voltage range as specified above. If the sign is a shed load when battery power is used, the lower limit of the voltage range shall be the voltage at which the load is shed.

4.1.4.3 Operator/control interface

The active control console in the train shall control the signs on all vehicles. Transmission of all signals shall utilize digital technology. The sign's input shall have a minimum of one shielded twisted pair #16 AWG copper trainline wires and be able to automatically accept input messages from any of the following sources:

a) Stored messages automatically synchronized with train operation and the public address system.
b) Stored messages chosen by the train crew.
c) Messages transmitted from the remote central control station via the radio or wayside-to-train communication.
d) A test feature that, when activated, will cause a message to be displayed together with an announcement. The test shall repeat until deactivated.
e) Door operation annunciation.

The equipment shall be protected against voltage transients of at least 2.5 kV at 80 ws, electrical short circuits, reverse polarity, and ground faults. A means shall also be provided to prevent equipment performance degradation due to extraneous noise, ground loops, circulating currents, and other interference signals. Control/location data may use either train lines or a local network in accordance with IEEE P1473.

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The control conductors shall not only carry the digital control signals for the message display system, but shall also transmit system performance data to the vehicle monitor.

4.2 Public address system

Each vehicle shall be equipped with a public address system permitting transportation system personnel, or recorded or digitized human speech messages, to announce stations and provide other passenger information to passengers in the vehicle via the interior speakers and, optionally, to passengers on the station platform via the interior and exterior speakers located on the rail vehicle.

Provision shall be made for audible warning signals controlled by the door control system to alert passengers of closing doors.

NOTE — Exterior speakers should be active only on the boarding side(s).

The public address system equipment shall be of modular design, and so constructed and installed to permit easy installation, removal, and access for maintenance. The system shall incorporate automatic compensation for variations in input level and ambient noise level immediately prior to the announcement, on a per vehicle basis. The range of automatic level adjustment shall be a minimum of 10 dB.

The public address system shall be used to announce all live and/or prerecorded messages, and it shall be capable of being linked to the vehicle monitoring and diagnostic system (VMDS) and using a communication protocol in accordance with IEEE P1473.

4.2.1 Carbody interface

An Association of American Railroads (AAR) mounting base or 483 mm (19 in) rack mount configuration shall be used to attach the power amplifier unit to the vehicle.

All interior public address speakers in each individual vehicle shall be electrically identical, physically interchangeable, and full flush mounted in enclosures, and shall not require a depth of more than 102 mm (4 in).

All readily accessible interior mounted equipment shall be of vandal-resistant construction and be secured against unauthorized access.

Exterior speakers shall be of weather-resistant construction, and shall be full flush mounted in enclosures.

All exterior mounted equipment shall be aerodynamically enclosed and of vandal-resistant construction.

4.2.2 Power interface

The public address system shall be powered by the vehicle’s low-voltage dc system and connected to use the vehicle’s battery supply during periods of primary power loss. The equipment shall be protected against voltage transients of at least 2.5 kV at 80 ws, electrical short circuits, reverse polarity, and ground faults.

Power availability and wiring shall be one of the three following standard ranges:

— 5 A, 28 Vdc, over the range specified in IEEE P1476. Supply shall be from two #16 AWG copper wires minimum.
— 5 A, 37.5 Vdc, over the range specified in IEEE P1476. Supply shall be from two #16 AWG copper wires minimum.
— 5 A, 74 Vdc, over the range specified in IEEE P1476. Supply shall be from two #16 AWG copper wires minimum.

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The public address system shall operate without degradation over the respective voltage range as specified above.

4.2.3 Crew interface

A means shall be provided to enable initiation of the public address announcement through manual or automated methods. Manual announcements shall always override automatic announcements. There shall be a visual indicator to advise the crew whether the audio level of manual announcements is too low, at the proper level, or too high.

The crew interface (control panel), if required, may be at one or more locations throughout the vehicle. The crew interface shall support the following functions:

a) Recall one or more prerecorded messages for immediate announcement.
b) Have a microphone (and a push-to-talk switch) for direct announcement.
c) Intra-train intercom system for train crew private communication.
d) The radio communication system.
e) Option for one or more pre-recorded announcement.

Annunciation of door operation shall be provided.

4.2.4 Control interface

The active cab control console shall make or control public address announcements to all other vehicles in the train. Audio information, along with associated control signals and other data, shall be transmitted on a shielded twisted pair(s) of wires. Digital control shall be in accordance with IEEE P1473. The equipment shall be protected against voltage transients of at least 2.5 kV at 80 ws, electrical short circuits, reverse polarity, and ground faults. A means shall also be provided to prevent equipment performance degradation due to extraneous noise, ground loops, circulating currents, and other interference signals.

The public address system signal input shall have a minimum of two shielded twisted pairs #16 AWG copper trainline wires (one pair for audio and one pair for control/communication). It shall automatically be able to accept input messages from any of the following sources:

a) Any of the on-board operator control panels.
b) The train control system (TCS).
c) The remote central control station via the Radio Communication System.

The control conductors shall not only carry the analog and/or digital audio signals for the public address system components, but shall also transmit system performance data to the vehicle monitor.

4.2.5 Passenger interface

The maximum permissible variation in announcement sound levels among vehicles in a train consist shall be 5 dB under the same ambient noise conditions, regardless of the number of vehicles. The announcement sound levels throughout the passenger compartment of each vehicle at a height of 1.63 m (5 ft 4 in) above the vehicle's interior finished floor shall be in the range of 75–95 dBA, varying directly with the ambient noise level. The system shall provide the level of intelligibility specified below, under the maximum ambient noise and vibration conditions specified by the user.

The audio sound pressure level throughout the passenger compartment of each vehicle at a height of 1.63 m (5 ft 4 in) above the vehicle's interior finished floor, shall not vary by more than 3 dB for a pink noise signal over the octave band, centered at 4 kHz. Frequency response of the public address system interior speakers as installed, shall be ±5 dB from 100 to 8000 Hz, with a plateau of at least 8 dB in the 2500 to 3500 Hz band, compared to the 1000 Hz response. There shall be a gradual roll-off in response over 7000 Hz. The dispersion angle shall be at least 120 degrees. The nominal

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axial sensitivity shall be a minimum of 92 dBA at 1.22 m (4 ft) with one watt input. Speakers shall be of adequate power handling capacity to avoid rattling during announcements.

External loudspeakers shall have a frequency response of 350 to 10 000 Hz and a dispersion angle of 115 degrees.

4.3 Radio communication system

The radio system shall be capable of communicating with fixed or mobile stations.

The equipment shall be protected against voltage transients of at least 2.5 kV at 80 ws, electrical short circuits, reverse polarity, and ground faults. A means shall also be provided to minimize equipment performance degradation due to extraneous noise, ground loops, circulating currents, and other interference signals.

The system shall have the capability of transmitting and receiving both voice and data.

The actual number of active channels to be utilized shall be specified by the user; however, there shall be provision for installation of the following communication channels between each train and the remote central control station:

a) A single half duplex analog audio channel
b) Three digital audio channels
c) Two digital data channels

4.4 Passenger/crew call intercom system

An emergency passenger/crew intercom system shall be provided on each vehicle to enable the passenger to clearly communicate at any time with a train crew member. Equipment shall be of modular design, self-contained, and so designed and installed to permit easy installation, removal, and access for maintenance.

4.4.1 Carbody interface

The passenger/crew call station shall be installed at locations that are readily accessible to all patrons, including wheelchair occupants. The mounting height shall be such that the controls are 1219 mm (48 in) maximum above the vehicle's interior finished floor.

All vehicle-mounted passenger call station speakers and microphones shall be of weather-resistant construction.

All equipment accessible to the public shall be of vandal-resistant construction and be secured against unauthorized access.

4.4.2 Power interface

The passenger/crew intercom shall be powered by the vehicle's low-voltage dc system and connected to use the vehicle's battery supply during periods of primary power loss. The equipment shall be protected against voltage transients of at least 2.5 kV at 80 ws, electrical short circuits, reverse polarity, and ground faults.

Power availability and wiring shall be one of the three following standard ranges:

— 3 A, 28 Vdc, over the range specified in IEEE P1476. Supply shall be from two #16 AWG copper wires minimum.
— 3 A, 37.5 Vdc, over the range specified in IEEE P1476. Supply shall be from two #16 AWG copper wires minimum.
— 3 A, 74 Vdc, over the range specified in IEEE P1476. Supply shall be from two #16 AWG copper wires minimum.

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The passenger/crew intercom shall operate without degradation over the specified voltage range.

4.4.3 Operator/passenger interface

The unit shall be activated by the passenger or crew member pressing the designated button once. A visual indication shall alert the passenger or crew member when the unit is in operation.

4.4.4 Control interface

The equipment shall be protected against voltage transients of at least 2.5 kV at 80 ws, electrical short circuits, reverse polarity, and ground faults. A means shall also be provided to prevent equipment performance degradation due to extraneous noise, ground loops, circulating currents, and other interference signals.

The passenger intercom system shall utilize at least one dedicated shielded twisted pair of copper trainline wires for control/communication and another for the analog audio signal. Control/location data may use either train lines or a local network in accordance with IEEE P1473.

The passenger-to-crew intercom system shall have provisions to additionally interface with the VMDS vehicle health monitor via the communication bus in accordance with IEEE P1473.

Annex A
Bibliography
(Informative)

[B1] *Urban Public Transportation Glossary*. Transportation Research Board, Washington, D.C., 1989.

[B2] *Webster's New Collegiate Dictionary*. Springfield, MA: Merriam-Webster, Inc.

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