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PRESS Mechanical Working Group

# ECP Passenger Cable-Based Brake DC Power Supply—Performance Requirements

**Abstract:** This safety standard contains the minimum performance requirements for the DC power supply of electronically controlled pneumatic (ECP) cable-based brake systems operating on passenger cars.

**Keywords:** brake, ECP, emulation, rail car, train

**Summary:** This standard identifies the minimum performance requirements for the DC power supply of electronically controlled pneumatic (ECP) cable-based brake systems operating on passenger cars

**Scope and purpose:** This standard has been developed to ensure that vehicles equipped with APTA-approved ECP brake systems from different manufacturers are interoperable and function consistently and uniformly, and that such APTA-approved electronic brake systems meet a high standard for safety and reliability.

# Table of Contents

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## Introduction

*This introduction is not part of APTA PR-M-S-023-19, "ECP Passenger Cable-Based Brake DC Power Supply—Performance Requirements."*

This standard applies to all:

1. Railroads that operate intercity or commuter passenger train service on the general railroad system of transportation; and
2. Railroads that provide commuter or other short-haul rail passenger train service in a metropolitan or suburban area, including public authorities operating passenger train service.

This standard does not apply to:

1. Rapid transit operations in an urban area that are not connected to the general railroad system of transportation;
2. Tourist, scenic, historic, or excursion operations, whether on or off the general railroad system of transportation;
3. Operation of private cars, including business/office cars and circus trains; or
4. Railroads that operate only on track inside an installation that is not part of the general railroad system of transportation.

# ECP Cable-Based Brake DC Power Supply—Performance Requirements for Passenger Applications

## 1. Overview

### 1.1 Purpose

The supply of electrical power to the electronically controlled pneumatic (ECP) brake controllers and the other electronic components on passenger cars are vital to the safe and reliable operation of the system. The power to the brake system on each car is maintained through power supplied from the car battery and a redundant rechargeable battery system on the car brake control system. The purpose of the ECP power supply is to provide the battery charging supply from the locomotive(s) in the consist to each car, through the hard-wire trainline, sharing the same conductors with the communication signals. It is therefore essential that the quality of the electrical power supplied to the line be sufficiently well-controlled so as not to interfere with the communications. The basic requirement of the ECP power supply is that it converts a nominal 74 VDC (locomotive battery) supply and delivers a 230 VDC supply to the trainline at a power level of up to 2500 W. The power supply also shall be required to provide a 24 VDC output on the same conductors, rated at a minimum of 30 W.

### 1.2 Requirements

The ECP power supply shall include a control function in accordance with the requirements defined in APTA PR-M-S-021-17 “ECP Passenger Cable-Based Braking System – Performance Requirements” latest revision, and APTA PR-M-S-024-19, latest revision, “Intratrain Communication Requirements for ECP Cable-Based Passenger Train Control Systems.” The power supply control function may be provided as an integrated controller or an external controller.

## 2. Electrical performance

### 2.1 Input voltage

The power supply input is nominally 74 VDC with an operating range from 40 to 100 VDC.

#### 2.1.1 Input isolation

Input and output conductors shall be isolated from the chassis and from one another to withstand 1.5 kV rms or an equivalent peak DC voltage.

#### 2.1.2 Input transients

The converter power supply shall provide the specified output in the presence of transients on the input lines as specified in IEC 1000-4-4, Electrically Fast Transients, Level 4.

 

### 2.1.3 Input protection

The power supply shall not be damaged by input voltages in the range from 25 to 135 VDC. The power supply shall not be damaged or malfunction when the input is subjected to high-energy transients as specified in IEC 1000-4-5, Surge Immunity Test, Level 3.

### 2.1.4 In-rush current

When enabled by the output on/off control specified in Section 2.5, the power supply in-rush current shall not exceed 200 A.

## 2.2 Output voltage

The power supply shall provide either a high-voltage output or a low-voltage output on the same output conductors.

### 2.2.1 High-voltage range

The power supply high-voltage output is nominally 230 VDC. Under all line and load conditions, the output voltage shall remain in the range from 225 to 248 VDC.

### 2.2.2 Low-voltage range

The power supply low-voltage output is nominally 24 VDC. Under all line and load conditions, the output voltage shall remain in the range from 22.8 to 30.0 VDC.

## 2.3 Output impedance

The power supply differential mode output impedance shall be not less than 500Ω in the frequency range 100 to 450 kHz.

## 2.4 Output load current

The output load current shall be in the range from 0 to 10.9 A when the power supply 230 VDC output is enabled. The output load current shall be in the range from 0 to 1.0 A maximum when the power supply 24 VDC output is enabled.

## 2.5 Output load startup

The power supply 230 VDC output shall be capable of energizing the train with up to 160 ECP car control devices and an end-of-train device connected as defined in APTA PR-M-S-021-17, “ECP Cable-Based Brake Systems—Performance Requirements,” latest version. Each of these devices will present a load typical of a switching regulator input with a steady-state maximum power input of 10 W.

For determining power supply startup characteristics, assume that all network devices start up at 50 VDC and have a minimum impedance of 80 mΩ between them.

## 2.6 Output protection

### 2.6.1 Current limit

The 230 VDC output shall current limit at not more than 15 A and shall return to normal operation when the overload is removed.

The 24 VDC output shall be current limited and short circuit protected.

 

### 2.6.2 Overvoltage

The output overvoltage limit shall be set at 265 VDC maximum. If this voltage is exceeded, then the power supply shall latch "OFF," requiring the input power to be turned "OFF" to reset.

### 2.6.3 Reverse polarity protection

Since the presence and polarity of the trainline voltage at the output of the power supply cannot be predefined when its output is not enabled, adequate protection shall be provided to ensure that the power supply (including any output filter circuits) shall not be damaged by voltage applied from the trainline of either polarity. Trainline current flowing into the power supply output when not energized shall be less than 5 mA at a train line voltage of 230 VDC.

### 2.6.4 Output transients

The power supply, under any output load condition including low-voltage output and disabled output, shall not be damaged and shall recover automatically when the output is subjected to high-energy transients as specified in IEC 1000-4-5, Surge Immunity Test, Level 4. The power supply shall provide the specified output in the presence of transients on the output lines as specified in IEC 1000-4-4, Electrically Fast Transients, Level 4.

## 2.7 Power supply control

The power supply and its associated power supply control shall be in accordance with the requirements of APTA PR-M-S-021-17, latest revision, "ECP Passenger Cable-Based Brake Systems—Performance Requirements,", and APTA Standard PR-M-S-024-19, latest revision "Intratrain Communication Requirements for ECP Cable-Based Passenger Train Control Systems."

The power supply control function may be provided by one of two methods.

### 2.7.1 External control

The power supply shall provide at a minimum two inputs to control the selection of output voltage (230 VDC or 24 VDC) and to enable the output.

### 2.7.2 Integrated control

The output voltage at the power supply shall be selected and enabled in response to HEU control and beacon messages by means of an EIA 709.1- and EIA 709.2-compliant network device integrated directly into the power supply.

### 2.7.3 Line voltage polarity

The output control of the power supply shall incorporate an automated means to detect the presence and polarity of an existing supply on the trainline and to prevent enabling the power supply in the event of a polarity mismatch. If no existing supply is detected, then the power supply is free to apply a voltage at its default polarity. If voltage is detected on the trainline, as defined in APTA PR-M-S-021-17, latest revision, "ECP Passenger Cable-Based Brake Systems—Performance Requirements," then the power supply output voltage polarity shall be corrected, if required, and it may be enabled by the HEU as a secondary power supply. Polarity matching shall not be required when the 24 VDC power supply output is selected.

## 2.8 Power supply performance monitoring

The internal or external power supply controller shall provide power supply performance data as required to meet the requirements defined in APTA PR-M-S-021-17, latest revision, "ECP Passenger Cable-Based Brake Systems—Performance Requirements," and APTA PR-M-S-024-19, latest revision "ECP Passenger Cable-

 

Based Brake System Cable, Connectors & Junction Boxes – Performance Requirements." At a minimum, the following data shall be provided:

- Power supply input voltage, 1.0 VDC resolution, ±5 percent of full-scale accuracy.
- Power supply output current, 0.1 ADC resolution, ±5 percent of full-scale accuracy.
- Trainline voltage, 1.0 VDC resolution, ±5 percent of full-scale accuracy.
- Power supply output control state (disabled, enabled 230 VDC primary, enabled 230 VDC secondary, enabled 24 VDC).

# 3. Electromagnetic compatibility

## 3.1 Radiated emissions

Radiated emissions, measured at a distance of 1 m, shall not exceed 30,000 µV/m from 10 to 200 kHz decreasing to 100 µV/m at 27.2 MHz, 90 µV/m from 27.3 to 88 MHz, 150 µV/m from 88 to 216 MHz, and 210 µV/m from 216 to 1000 MHz. The following are specially guarded bands:

- 30 µV/m from 27.2 to 27.3 MHz
- 30 µV/m from 158 to 165 MHz
- 70 µV/m from 450 to 460 MHz

Radiated emissions shall be tested in accordance with the procedure defined in MIL-STD-462D, RE102. Testing shall be conducted with unshielded cables used for the power supply input.

## 3.2 Output-conducted emissions

Output-conducted emissions on the trainline generally shall meet the requirements of FCC Section 15.107. Specifically, the conducted emissions as measured on the trainline in differential mode may not exceed 106 dBµV from 9 to 40 kHz, 86 dBµV from 40 to 125 kHz, 36 dBµV from 125 to 140 kHz, 56 dBµV from 140 to 450 kHz, and 48 dBµV from 450 kHz to 30 MHz.

# 4. Environmental conditions

The power supply shall operate under the following conditions or natural combinations of conditions.

## 4.1 Operating temperature

The power supply shall operate within the temperature range from −40 to +70 °C.

## 4.2 Storage temperature

The power supply shall survive storage within the temperature range from −50 to +85 °C.

## 4.3 Vibration

The power supply shall survive and operate in an environment where it shall experience the following vibration inputs:

- Frequency range 5 to 10 Hz: 0.3 in amplitude sine wave
- Frequency range 10 to 300 Hz: a level of 3g in any axis

## 4.4 Shock

The power supply shall survive and operate in an environment where it shall experience shock at a level of 3 g for 11 ms half sine wave in any axis.

 

## 4.5 Rain/moisture intrusion

The power supply enclosure shall be sealed so that it is capable of operating in a water-saturated environment, such as the cavity below the locomotive cab floor or inside the nose compartment of the locomotive, where the door may have been left open. Direct water spray testing to NEMA 250-2014 M6.7.1 or equivalent will be accepted as evidence of compliance with this requirement.

## 4.6 Airflow

The power supply shall be cooled by natural convection and shall not depend on ambient airflow for cooling.

 

## Related APTA standards

The following standards are the complete set of Passenger ECP standards:

**APTA PR-M-S-020-17,** "Passenger Electronic 26C Emulation Braking System—Performance Requirements"
**APTA PR-M-S-021-17,** "ECP Passenger Cable-Based Braking System—Performance Requirements"
**APTA PR-M-S-022-19,** "ECP Passenger Cable-Based Brake System Cable, Connectors and Junction Boxes—Performance Requirements"
**APTA PR-M-S-023-19,** "ECP Passenger Cable-Based Brake DC Power Supply—Performance Requirements"
**APTA PR-M-S-024-19,** "Intratrain Communication Requirements for ECP Cable-Based Passenger Train Control Systems"
**APTA PR-M-S-025-19,** "ECP Passenger Cable-Based and Passenger Emulation Braking System—Approval Procedure"
**APTA PR-M-S-026-19,** "ECP Passenger Cable-Based Braking System—Interoperability Procedure"
**APTA PR-M-S-027-19,** "ECP Passenger Cable-Based Braking System—Configuration Management"

## References

American National Standards Institute standards:
ANSI/EIA-709.1-A, Control Network Protocol Specification, April 1999
ANSI/EIA-709.2-A, Control Network Power Line Channel Specification, December 1999

Department of Defense, MIL-STD-462D, Test Method Standard for Measurement of Electromagnetic Interference Characteristics

Federal Communications Commission, FCC Part 15, Section 15.107

International Electrotechnical Commission standards:
IEC 1000, 4-5, Surge Immunity Test
IEC 1000, 4-4, Electrically Fast Transient/Burst Immunity Test

National Electrical Manufacturers Association 250-2014 Enclosures for Electrical Equipment M6.7.1

## Abbreviations and acronyms

| | |
|---|---|
| **µV** | microvolts |
| **A** | amperes direct current |
| **AAR** | Association of American Railroads |
| **ADC** | amperes |
| **dBµV** | decibels relative to 1 microvolt |
| **ECP** | electronically controlled pneumatic |
| **FCC** | Federal Communications Commission |
| **g** | acceleration due to gravity |
| **HEU** | head end unit |
| **IEC** | International Electrotechnical Commission |
| **kHz** | kilohertz |
| **kV** | kilovolt |
| **mA** | milliamperes |
| **ms** | milliseconds |
| **MHz** | megahertz |
| **NATSA** | North American Transportation Services Association |

 

**NEMA** National Electrical Manufacturers Association
**rms** root mean square
**VDC** volts direct current
**W** watts

## Summary of document changes

- This is the first publication of this standard.

## Document history

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