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RECOMMENDED PRACTICE

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Electrical Working Group

Diesel–Electric Passenger Locomotive Dynamic Brake Control

Abstract: This recommended practice provides a common design basis for the control and configuration of dynamic brake systems for diesel–electric passenger locomotives.

Keywords: dynamic brake, dynamic brake control, straight dynamic brake

Summary: This recommended practice details the function of diesel–electric passenger locomotive dynamic brake controls utilizing the 27-point plug, cable and receptacle, as specified in APTA PR-E-RP-017-99, "27-Point Control and Communication Trainlines for Locomotives and Locomotive-Hauled Equipment." Wire designations and functional information for the communication of configuration, activation and braking effort signals are identified. Dynamic brake setup is described, as well as the rationale for dynamic brake setup features on diesel–electric locomotives utilizing dc traction.

Foreword

The American Public Transportation Association is a standards development organization in North America. The process of developing standards is managed by the APTA Standards Program's Standards Development Oversight Council (SDOC). These activities are carried out through several standards policy and planning committees that have been established to address specific transportation modes, safety and security requirements, interoperability, and other topics.

APTA used a consensus-based process to develop this document and its continued maintenance, which is detailed in the manual for the APTA Standards Program. This document was drafted in accordance with the approval criteria and editorial policy as described. Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

This document was prepared by the Electrical Working Group as directed by the Passenger Rail Equipment Safety Standards Policy and Planning Committee.

This document represents a common viewpoint of those parties concerned with its provisions, namely transit operating/planning agencies, manufacturers, consultants, engineers and general interest groups. The application of any recommended practices or guidelines contained herein is voluntary. APTA standards are mandatory to the extent incorporated by an applicable statute or regulation. In some cases, federal and/or state regulations govern portions of a transit agency's operations. In cases where there is a conflict or contradiction between an applicable law or regulation and this document, consult with a legal adviser to determine which document takes precedence.

This document supersedes APTA PR-E-RP-006-99, Rev. 1, which has been revised. Below is a summary of changes from the previous document version:

- Updated working group roster; format updated to latest APTA standards format.
- Addition of Summary section.
- Added new Section Foreword.
- Added applicability language in the Introduction.
- Merged former sections 1.1, Scope, and 1.2, Purpose, into Scope and Purpose.
- Moved former section 2, References, to the new sections Related APTA standards and References.
- Moved former section 3, Definitions, abbreviations and acronyms into new sections Definitions and Abbreviations and Acronyms.
- Renumbered former section 5, Set-up, to new section 2.
    - Added functional list of related trainline wires.
    - Revised dynamic brake setup language to account for systems that transition from idle to a minimal dynamic brake application directly.
    - Added ac traction provisions.
    - Added note on Set-up position origin.
    - Revised jerk limit recommendations.
- Renumbered former section 6, Dynamic brake control techniques, to new section 3.
    - Added minimum combined impedance draw current recommendation.
    - Revised Figure 1 to show alternative dynamic brake characteristic curve.
    - Moved Figures 2-5 to new appendix A, Brake control compatibility devices and renewed figures 2 and 3.

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Introduction

This introduction is not part of APTA PR-E-RP-006-99, "Diesel–Electric Passenger Locomotive Dynamic Brake Control."

This standard applies to all:

- railroads that operate intercity or commuter passenger train service on the general railroad system of transportation; and
- 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:

- rapid transit operations in an urban area that are not connected to the general railroad system of transportation;
- tourist, scenic, historic, host railroads or excursion operations, whether on or off the general railroad system of transportation;
- operation of private cars, including business/office cars and circus trains, unless otherwise required by other standards or regulations; or
- railroads that operate only on track inside an installation that is not part of the general railroad system of transportation.

Scope and purpose

This recommended practice, adapted from AAR S-5018, "Dynamic Braking Control," applies to diesel–electric passenger locomotive units that are designed for multiple unit operation with straight dynamic braking. Blended dynamic/air brake systems are not covered by this recommended practice.

The purpose of this recommended practice is to provide a common design basis for the control and configuration of dynamic brake systems, as well as to promote standardization.

Diesel–Electric Passenger Locomotive Dynamic Brake Control

1. Trainlines

The control function should be trainlined between units. When using the 27-point plug, cable and receptacle, connect as specified in APTA PR-E-RP-017-99, “27-Point Control and Communication Trainlines for Locomotives and Locomotive-Hauled Equipment.” All wire number references included herein apply specifically to 27-point plug applications.

2. Setup

The dynamic brake handle controls three 74 Vdc (nominal) MU trainline wires, as follows:

1. **#17 DB Setup:** This trainline configures the locomotive to be ready to activate dynamic brake mode.
2. **#21 DB Start:** This trainline activates dynamic brake mode.
3. **#24 DB Excitation:** This variable-voltage trainline establishes how much dynamic brake effort is demanded. Dynamic brake effort increases in proportion to the trainline voltage, with maximum effort at 74 Vdc (nominal).

When the dynamic brake handle is moved to DB Setup position, corresponding with the minimum dynamic brake command (which could be 0, but often is greater to provide the engineer with train handling indication to differentiate DB Setup from an idle throttle), #17 is energized. When the handle is moved beyond DB Setup into a dynamic braking command greater than 0, all three trainlines are energized. The variable voltage on #24 is increased as the handle is advanced into higher braking effort positions.

Dc traction locomotives need to incorporate an internal several-second time delay function to allow traction voltages to decay and various contactors to reconfigure traction circuits into dynamic brake configuration. This internal several-second time delay does not cause a delay on wires #17, #21 or #24 throughout the rest of the consist.

The delay of dynamic brake initiation and the inclusion of the DB Setup position in ac locomotives are not essential to the function of the dynamic brake system in ac locomotives. The omission or inclusion of DB Setup on diesel–electric locomotives utilizing ac traction should be determined by agreement between the purchaser and manufacturer.

> **NOTE:** When dynamic brakes first appeared, all diesel–electric locomotives utilized dc traction. As indicated above, dc locomotives incorporate a delay period before dynamic braking can be engaged. In North America, when ac traction power began to be utilized for diesel–electric locomotives, this delay was incorporated into the ac locomotive dynamic brake design to homogenize the behavior of both ac and dc locomotives when entering into dynamic brake mode. This resulted in North American ac powered diesel–electric freight locomotives retaining the DB Setup position.

The rate of increase of braking effort should be limited so that the jerk limit as agreed upon by the purchaser and the manufacturer is not exceeded.

Annunciation of dynamic brake faults, as determined by the control equipment, shall be accomplished by energizing wire #20. When this wire is energized, a visual warning indication shall be activated in each control cab.

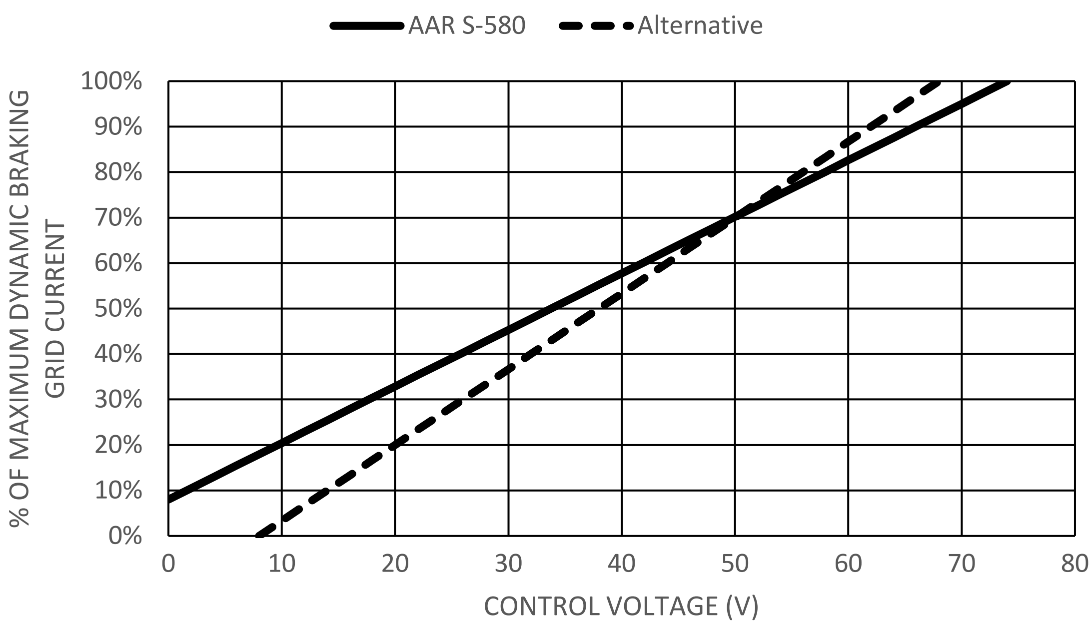
3. Dynamic brake control techniques

The response of the dynamic braking excitation and power circuits should provide a braking grid current that is related to control potential (wire #24) as shown by the characteristic curve in **Figure 1**. The relationship will be independent of speed within the design range of the dynamic brake where the maximum grid current or effort is the amperage capacity rating of the braking grids.

> **NOTE:** Traditionally dc locomotives were limited by the rated traction motor field excitation.

The minimum combined impedance of all circuits that draw current from wire #24 must not be less than 500Ω.

FIGURE 1
Dynamic Brake Characteristic Curve (Reference AAR S-5018)



Related APTA standards

APTA PR-E-RP-017-99, "27-Point Control and Communication Trainlines for Locomotives and Locomotive-Hauled Equipment"

References

Association of American Railroads, S-5018, Dynamic Brake Control.

Definitions

blended brake: The coordinated combination of two or more modes of braking (e.g., dynamic brake and friction brake) to produce the desired total retarding effort.

dynamic brake: A mode of operation of the propulsion system in which retarding is provided through the use of the traction motors as generators, converting the kinetic energy of the vehicle or train into electrical energy.

silicon-controlled rectifier (SCR): A three-lead thyristor.

straight dynamic brake: A dynamic brake that functions entirely on its own, without an interface to any other retarding or braking system (e.g., friction brakes).

Abbreviations and acronyms

Ω	ohms
AAR	Association of American Railroads
ac	alternating current
DB	dynamic brake
dc	direct current
MU	multiple unit
SCR	silicon-controlled rectifier
Vdc	volts direct current

Document history

Document Version	Working Group Vote	Public Comment/ Technical Oversight	CEO Approval	Policy & Planning Approval	Publish Date
First published	—	—	—	—	March 4, 1999
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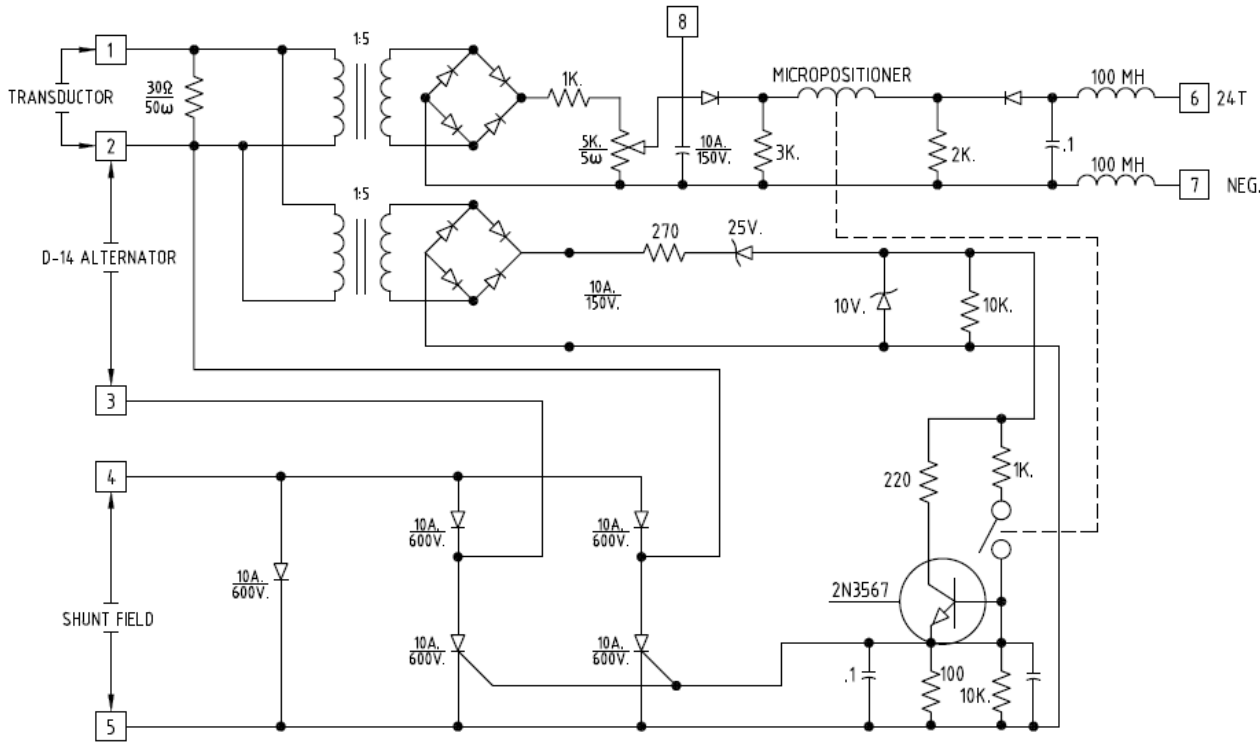
The passenger rail industry phased this recommended practice into practice over the six- month period from July 1 to December 31, 1999. The recommended practice took effect January 1, 2000.

Appendix A (informative): Brake control compatibility devices

As information, the following drawings are of simplified dynamic brake control devices developed to affect compatibility of different types of dynamic brake controls.

Figure 2 describes the SCR-type dynamic brake controller used primarily on units with field current control (field loop) system. The SCR does not require a Regohm regulator, as the circuitry has a current-limiting feature.

FIGURE 2
Field Current Control



On units already equipped with grid current (potential) control and a Regohm-type regulator, compatibility may be obtained as shown in **Figure 3**.

FIGURE 3
Recommended Dynamic Brake Control Method

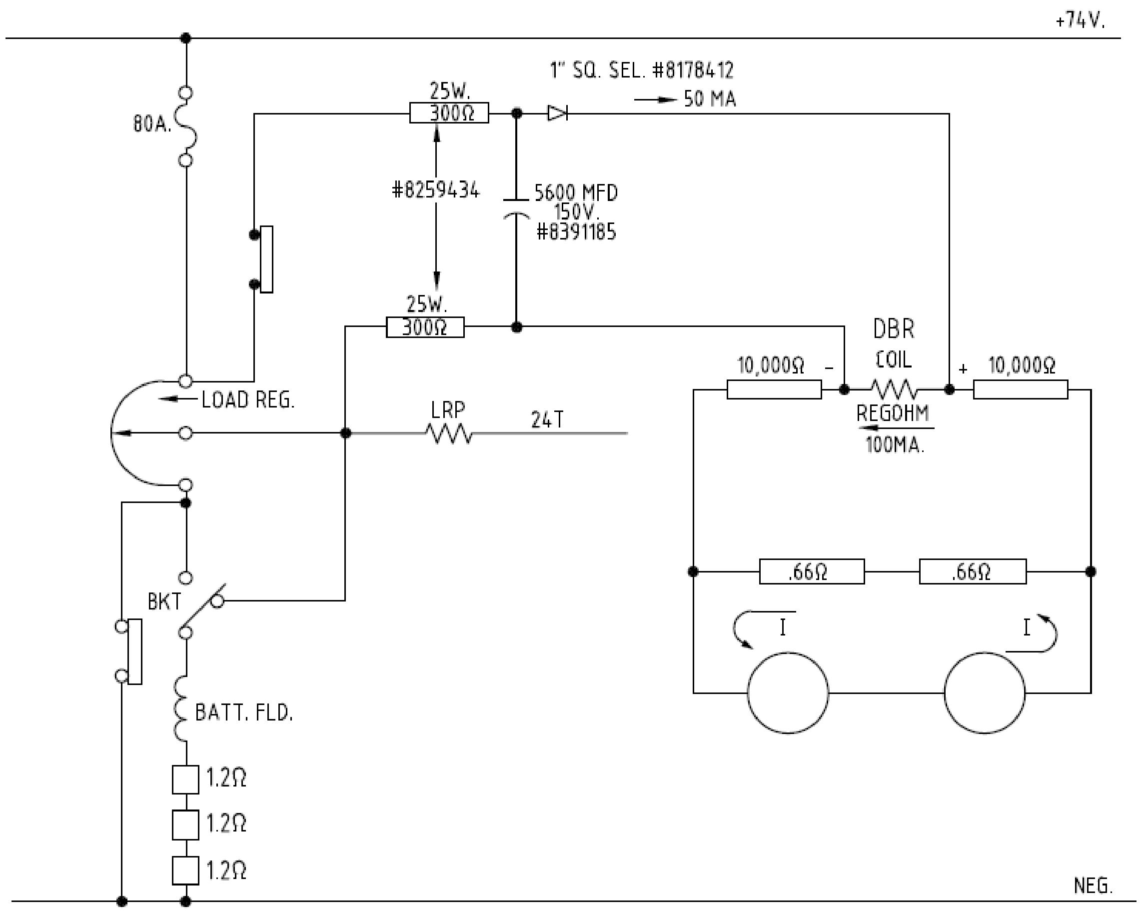


Figure 4 represents dc traction speed-braking effort curves typical to field current and grid current control systems. **Figure 5** represents a typical ac traction speed-braking effort curve.

FIGURE 4
Typical Speed-Braking Effort Curve, dc Locomotives

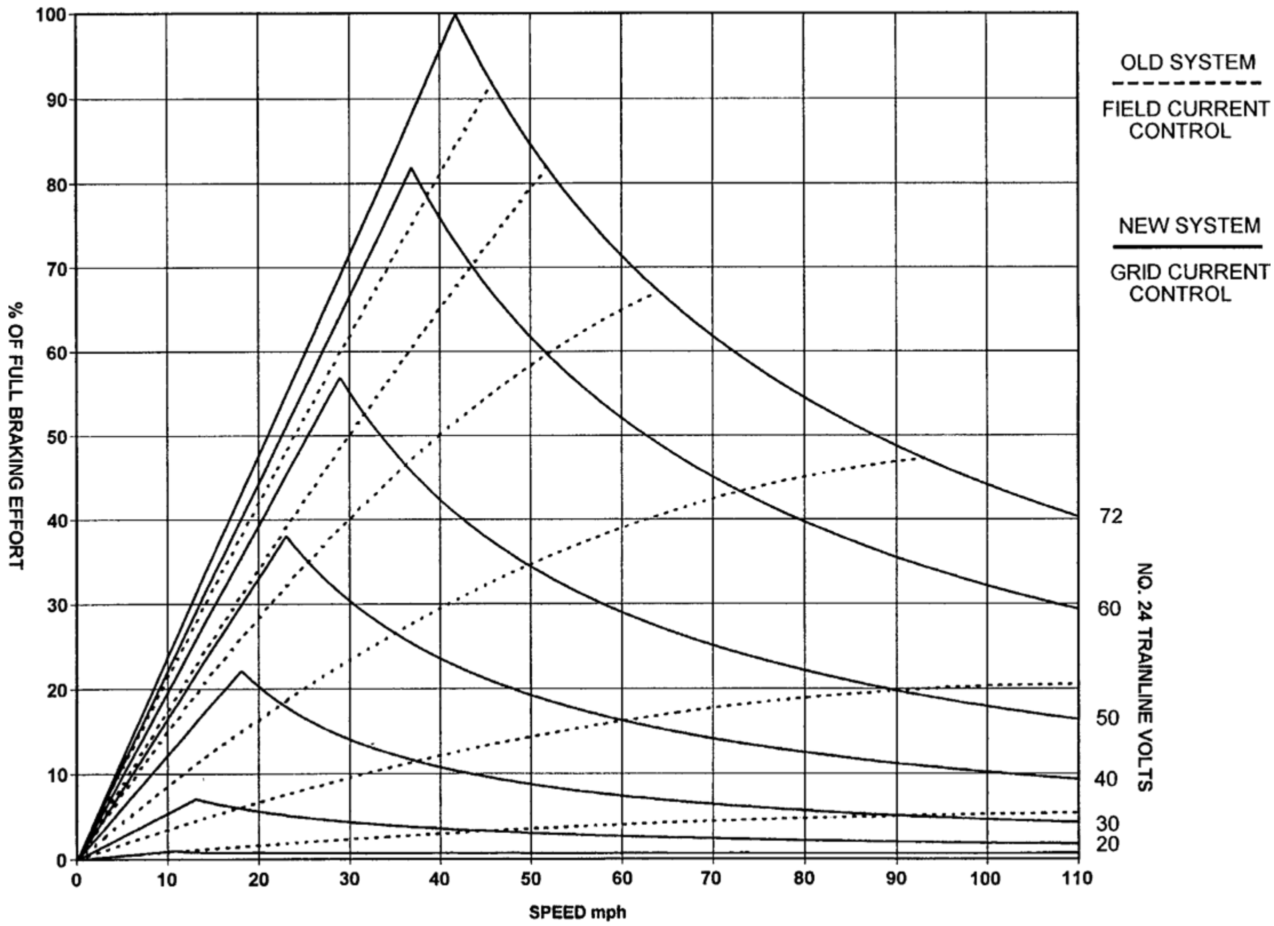


FIGURE 5

Typical Speed-Braking Effort Curve, ac Locomotives