NMRA STANDARD	
ELECTRICAL	
~~Jul 3, 2024~~~~Sep 4, 2024~~Nov 12, 2024	S-9 Draft

1 General

This STANDARD establishes ELECTRICAL requirements for interchange and safe and satisfactory performance of two rail equipment on model railroads. The requirements in this Standard also address center third rail (or center studs power contact systems with the understanding that the center or third rail (or center studs) provide one of two power conducting rails. Center or third rail (or center studs) equipment must be built or modified to avoid electrical shorts and ensure safe, reliable interchange on two rail layouts. Equipment originally designed and manufactured for center, or third rail (or center studs) operation may not provide insulation between outer gauge rails or the wheels.

2 References

This standard should be interpreted in the context of the following NMRA Standards, Technical Notes, and Technical Information.

2.1 Normative

- NMRA S-5 TRACTION Power Collection.

2.2 Informative

- NMRA S-9.1 DCC Electrical Standards provides information on maximum and minimum voltages at which decoders shall operate and what the command station maximum voltage should be by scale.
- NMRA RP-9 Electrical General provides information on various electrical certifications for safety, operation of power supplies and other clarifications.
- NMRA TN-9 Wiring for DC & DCC provides information concerning bus wire resistance, power districts, detection, resistance wheel sets and how these affect performance.

3 Terminology

Term	Definition
Block Control	A system of insulated sections of track permitting independent control of powered equipment in each insulated section of track. Block Control allows model engineers to run a train's addressing independently powered section(s) of track.
Command Control	A system permitting powered equipment in the same electrical section of track to be independently controlled. Command Control enables model engineers to run their trains independently.
Current	A flow of charged particles, such as electrons or ions, moving through an electrical conductor.
Interchange	A chief objective of NMRA Standards, is the concept of common scale and gauge equipment having ability to operate on other common scale and gauge tracks, modules or layouts created and complying with NMRA standards.
Outside Third Rail	Outside third rail provides a ground level alternative outside gauge rails to center third rail means of conducting electrical power to powered equipment.
Overhead Wire or Catenary	Overhead wire provides a high level (above train) alternative to center third rail means of conducting electrical power to powered equipment. Overhead wire systems may be labelled "trolley" systems.

Term	Definition
Powered Equipment or Rail Equipment	Motive power, locomotives, engines, and other models capable of self-propulsion on rails. Also referred to a vehicle in other NMRA Standards.
Three Rail Systems	Three Rail Systems may include: center or third rail, center studs, outside third rail, and overhead wire or catenary. Typically, in three rail systems outer gauge rails are both common electrical returns while the various third rail options listed above carry a positive potential. Third rail system trackage avoids electrical shorts encountered with two rail reverse loops, wyes, and turntables when reversing the physical direction of powered equipment.
Traction Power Collection	NMRA STANDARD S 5 Traction Power Collection focuses on the relative location or position of scale equipment components for reliable operation with overhead wire or outside third rail applications.
Two Rail Systems	Two rail track and equipment closely approximate prototype equipment appearance. Electrically two rail systems conduct electrical energy by a positive potential on one rail and a negative potential on the second rail. When/If track turns back upon itself as in reverse loops, wyes, and turntables electrical shorts are encountered requiring more electricity management (insulation, switches, etc.).
Volt	A unit of electrical potential or electromotive force.

4 Power

4.1 Full throttle voltage available at the rails or motor shall provide sufficient current for optimal operation in compliance with local safety standards at maximum anticipated load.

4.2 Direct Current motors and other devices in equipment such as lights, smoke units or electrically operated couplers shall be able to withstand without permanent damage maximum peak voltage ~~of~~ as appropriate for each scale and gage in the Table 4.2 below.

Table 4.2
Peak Voltage of Motors, Lights and other Components

Track Gage[1]	Peak Voltage (DC or DCC)
>~~>~~0.6" (16mm)	27v
<0.6"(16mm) and >~~>~~0.35" (9mm)	24v
<0.35(9mm)	12v

4.3 Alternating Current motors and other devices in the mobile equipment shall be able to operate at 27 VAC max.

~~4.4~~

~~4.5~~4.4 High frequency voltage superimposed upon the rails shall not interfere with the normal operation of Powered Equipment.

~~4.6~~4.5 When using a power source delivering a wave with greater harmonic content than full wave rectified sine wave, exercise care not to operate in such a manner to exceed the rated current or otherwise overheat the motor.

~~4.7~~4.6 Power may be supplied to equipment through one or more means to include; rails, center studs, overhead or catenary wires, center or outside third rail, or stored power such as

[1] Previously voltage and current specifications were by scale. Given that narrow gauge equipment is closer to the scale below it, this is now specified by track gauge rather than scale.

batteries on board powered equipment and/or consisted non-powered equipment, and on-board solar energy conversion.

5 Control

5.1 Direction control by polarity reversing shall be provided for direct current (DC) motors. Positive potential applied to the positive motor connection either directly or through a ~~Digital Command Control (DCC) decoder,~~ battery, or other electrical energy source shall produce forward motion.

Commented [Ma1]: See 5.4

5.2 For DC equipment, when the "right-hand rail" is positive, the powered equipment shall move forward. The term "right-hand rail" as used herein mean the rail to the right of the observer standing between the rails with their back to the front of the locomotive.

5.3 The positive motor terminal shall be connected to the right-hand rail in DC equipment.

5.4 For DCC equipment, when positive voltage is applied to the positive motor terminal the locomotive shall move forward.

5.5 Typically, AC powered equipment uses a "center or third rail (or stud)" to provide positive potential to motors or decoders and outside rails provide a current return path.

5.6 Alternatively, direction control by motor electrical field modification may be provided for alternating current (AC) motors.

5.7 Speed control shall be provided by means of voltage adjustment to the motor which may be achieved by devices external or internal to powered equipment.

6 Powered Equipment

6.1 Equipment shall be responsive to direction and speed controls of section 5 above.

6.2 Metallic couplers shall be insulated from the rails.

7 Non Powered Equipment

7.1 Wheelsets shall be insulated to prevent undue conductance between rails.

7.2 Where a high resistance path for lighting, detection or other purposes is required, such resistance shall be high enough to prevent significant drop in propulsion power.

7.3 Metallic couplers shall be insulated from the rails.

8 Command Control

8.1 Standards for Digital Command Control (DCC) are detailed in the S-9.1, S-9.2, and S-9.3 series of NMRA publications.

8.2 Command Control systems that do not meet the NMRA DCC Standards may not claim to be DCC 'compatible', but still need to meet the provisions of other sections of this Standard. The DCC certification mark, as used by authorized persons, certifies that the goods are compatible with the NMRA's standards and recommended practices for digital command control.

9 Document History

Date	Description
August 1984	Previous Revision of NMRA STANDARDS S-9 ELECTRICAL
~~Sep 4, 2024~~Nov 12 2024 ~~June 27, 2024~~	Migrated to new template. Included center or third rail as well as Alternating Current (AC), Digital Command Control (DCC), as well as other power sources such as battery on board and solar.~~–~~Voltage ranges set by gauge rather than scale.

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