CE Marchand M Moignard & JM Juett

NMRA Standard	
Decoder Interfaces	
Nov 24, 2026	S-9.1.1 DRAFT

1 General

1.1 Introduction and Intended Use (Informative)

This Standard is the parent Standard for interfaces between decoders, locomotives, rolling stock and other vehicles on model railroads. There are daughter Standards for each individual type of interface.

S-9.1.1.1	Six and eight pin Interface
S-9.1.1.2	JST 9 Interface
S-9.1.1.3	21MTC Interface
S-9.1.1.4	PluX Interface
S-9.1.1.5	Next18 Interface
S-9.1.1.6	E24 Interface

The purpose of these Standards is to simplify the installation and exchange of electronic devices (hereafter called decoders) which are designed to control or modify the behavior of motors, lights, and other similar accessories installed in locomotives and other rolling stock.

This Standard applies to locomotives and cars of various sizes and scales, all kinds of controllers, (digital command control decoders in particular), and 2-rail, 3-rail, (central or trackside) and overhead wire power distribution systems.

The primary purpose of an interface is to make it easy to install a decoder between the power pick-up system and the motor(s), light(s), and/or other similar accessories within the locomotive, car, or vehicle. The interface should assure an easy, precise, and error-free installation or the exchange of a decoder. Installation or exchanges of decoders would need to use the same type of interface connector. Changing from one type of connector to another will require some rewiring. When an interface and/or decoder are installed in the locomotive or car by the manufacturer, this should be done in such a manner that it does not restrict the removal of the body from the chassis.

If no decoder is installed by the manufacturer; the decoder interface on the System Board shall be replaced by a "dummy plug" that will enable the locomotive or car to operate on DC as if no interface had been present. Enough room must be available around the installed interface to enable the replacement of the "dummy plug" with a decoder and any associated wiring.

Power rating values listed in the tables for each connector is for each pin of the interface. This does not account for the power requirement of the locomotive nor the power capacity of the decoder. Application of each interface must account for the electrical current requirements of the locomotive. It is recommended that locomotive manufacturers clearly document the required power for the motor and each light/function. Similarly, decoder manufacturers should clearly document the power rating capacity for the motor and light/function connections.

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1.2 References

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

1.2.1 Normative

- S-9 Electrical Standard
- S-9.1 Electrical Standards for Digital Command Control, which specifies signal voltages.
- S-9.2 DCC Communication Standard
- S-9.2.2 DCC Configuration Variables

1.2.2 Informative

- TI-9.1.1 Sources for Connectors for DCC, which provides a list of manufacturers and part numbers for DCC interface connectors.

1.3 Terminology

Term	Definition
Vehicle	Mobile model railroad device. This includes locomotives and other rolling stock.
Decoder	DCC receiver for controlling vehicle animation.
System Board	Electronic circuit board that is considered part of the vehicle into which a decoder is intended to be plugged. Also called a motherboard.
Dummy Plug	A device when inserted in the System Board in place of a decoder will allow the Vehicle to operate on DC.
Current Source	~~Positive voltage with respect to the decoder ground.~~The positive voltage source for the function outputs. This voltage is not switched by the decoder and is available all the time. . ~~to the device is switched.~~
Current Sinking	~~Defines a negative connection point for a switched output.~~The ground, negative, -connection to the device is switched by function operation to complete the circuit.

1.4 Requirements

To meet this Standard all mechanical and electrical values mentioned must be met and conform, unless otherwise noted. It is not necessary to implement all connections of the interface. The connections belonging to unimplemented features must remain unconnected. This applies to vehicles as well as for other devices that use this interface.

2 Mechanical Properties

Please refer to individual Standards S-9.1.1.X for the specifics of each type of connector.

3 Electrical Properties

Please refer to individual Standards S-9.1.1.X for the specifics of each type of connector.

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3.1 Color Code of Wiring

In some cases, a decoder or interface (System Board) will be installed in the vehicle at the factory. The decoder or interface may be designed to install without wires and electrical connections made by means of contact points from the locomotive to the decoder or interface. In addition, the manufacturer may install a decoder or interface (System Board) by wiring at the factory and shall make all of the connections correctly. If multiple colors of wire are used it is recommended that the color code is followed to facilitate troubleshooting or service later if required.

If a decoder requires the end user to install the decoder by making wire connections supplied on the decoder, Table 3.1 provides the color code Recommended Practice for these wires. If a decoder is supplied where the end user supplies the wire for connections to the decoder or System Board (light board replacement) connection points must be clearly marked on the printed circuit board (PCB) as to their purpose and documented in the installation instructions. In all cases the manufacturer is required to provide wiring diagrams or other documentation clearly showing all connections to the decoder. All other wiring connections beyond those listed have no recommended color. Also, the purpose of any other wiring connections must be documented.

Decoders that plug into a System Board such as 21MTC, PluX, Next18 and E24 have no wires or color codes. They must follow the pin assignment within each of those standards and shall provide documentation for installation or replacement of the decoder on the system board.

If a decoder has specific outputs and is wired with a connector to a device in a vehicle such as a smoke generator, remote un-coupler or other; any color wire may be used so long as the connector is keyed in such a way that it is only used for the intended purpose.

Table 3.1 Interface Wire Color Codes

COLOR	FUNCTION
RED	right-hand rail power pick-up (center rail, outside third rail, traction/overhead wire) to motor or interface
ORANGE	interface to motor (+)[1]
BLACK	left-hand rail power pick-up to motor or interface
GRAY	interface to motor (-)[2]
WHITE	output 1 front headlight(s)
YELLOW	output 2 rear headlight(s)
BROWN or VIOLET[3]	speaker + and -
GREEN	output 3 (Aux 1)
BROWN or VIOLET[3]	output 4 (Aux 2)
[4]	output 5 (Aux 3)
[4]	output 6 (Aux 4)
[4]	output 7 (Aux 5)
[4]	output 8 (Aux 6)

Commented [MM1]: The Footnote reference here is just plain wrong. The Motor + is not connected to the right-hand rail via a decoder. It is +ve with respect to Motor – and that is all. Yes, the Motor + in a DC loco is connected to the right rail, but that analogy just does not work with DCC and we should not perpetuate this ideal. See also Footnote 2 against motor -. Which is also just wrong for the same reason.

Commented [MJ2R1]: Agreed. A remnant of an earlier version. I think they should be removed.

Commented [MJ3]: There is a version somewhere suggesting Aux3 be light blue wire and Aux4 pink wire. I have never seen it used in practice.

~~[1] Connected to right-hand rail (or center rail, outside third rail or traction wire) through the decoder.~~

~~[2] Connected to left-hand rail through the decoder.~~

[3] Previously some manufacturers used brown, others violet prior to a defined Standard color. Manufacturer may use either color but must clearly document in their installation instructions.

[4] Manufacturer may use any colors or other means to identify each wire such as a tag, but each wire must be identifiable, and this must be documented in the installation instructions. Black, red, orange, gray or blue of the same shade as the power common may only be used as defined in this table.

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COLOR	FUNCTION
BLUE	common (+) headlight(s)/output(s) power source
BLACK/WHITE STRIPE[5]	common (-) power sink or decoder ground

For analog (DC) operation without a decoder the orange wire is connected to motor (+) and is connected with a red wire to the right-hand ~~track~~ rail, center rail, outside third rail or overhead traction wire moving forward. The gray wire is connected to motor (–) and is connected with a black wire to the left-hand rail moving forward. In DCC operation the Motor + and motor - wires should be connected so that the locomotive moves forward in response to a forward Speed and Direction packet as defined in S-9.2 with CV29 bit 0 is set to 0 as defined in S-9.2.2. There are situations where some diesel locomotive prototypes were run long hood forward. The wires to the motor may have to be reversed or bit 0 of CV29 changed to 1 to obtain the desired results. A generally accepted prototype practice was to mark the front end of the locomotive with the letter F.

3.2 Interface Connections

Per Table 3.1, the switched loads are powered from the decoder's positive supply rail (V+). The lowest four outputs, Front Headlight (F0F), Rear Headlight (F0R), Output 3 (AUX1), and Output 4 (AUX2), shall be open-collector (or equivalent open-drain) current-sinking , negative connections~~outputs~~. When activated, these outputs connect the load to decoder ground (GND). The voltage supplied to the load is derived from the track input voltage through the decoder's rectifier and power-supply circuitry, producing the internal V+ supply rail.

Decoders that are hard-wired, whether using individual wires, screw terminals, or solder pads, shall provide open-collector/open-drain type negative polarity function outputs unless otherwise specified and documented by the manufacturer. Decoders intended to plug into a system board, such as the 21MTC, PluX, Next18, and E24 interfaces, may provide additional connections beyond F0F through AUX2 that implement open-collector /open-drain negative outputs, logic-level outputs, or I/O communication ports as defined by the applicable connector standard.

When LEDs are used as lighting loads, appropriately rated current-limiting resistors shall be provided. Such resistors may be installed on the decoder or on the system board. Documentation shall indicate whether the resistors are already installed or must be supplied by the installer.

Logic-level and I/O connections are intended for control or data communication functions rather than direct connection of lighting or other loads, and are referenced to the decoder GND. These connections may be used for sensor inputs, exchange data with peripheral devices or control external switching devices on the system board. Logic LOW shall be represented by a voltage of 0.4 V or less, and Logic HIGH shall be represented by a voltage between 2.4 V and 5.0 V. These connections may be used to control external switching devices on the system board or to exchange data with peripheral devices. The specific electrical function and signal assignment of such connections shall be defined by the applicable connector standard.

Commented [MM4]: I don't think this is entirely accurate. There is electronickery in between the negative connection and GND, so that the decoder can modulate the light, add effects, dim it and so on. It's not a direct connection, Suggest just removing that sentence (I haven't, as yet, because if I do, Word deletes this comment as well).

Commented [MJ5R4]: Yes, there is some circuitry inside the decoder to produce certain lighting effects including dimming via PWM. Ultimately the circuit is connected to decoder ground to complete the circuit although it may have prescribed interruptions (on/of).

Commented [MM6R4]: Ok, lets leave it as you have it

[5] Black with white stripe wire preferred. Other colors may be used and must be documented in the instructions. All efforts must be taken so as not to confuse the decoder ground with any other input or output.

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4 Document History

Date	Description
Dec 11, 2020	RP-9.1.1 became S-9.1.1. It was separated into individual Standards for each connector type. S-9.1.1 covers the overview. Errors in wire color code corrected. Added more information on wire color codes and where and how they apply. JM Juett
Jan 31, 2021	Modified foot note 3 and added footnotes 1 and 2 for Table 3.1 to clarify connections to the motor. JM Juett
24-Nov-2026	Updated logo. Added reference to E24 interface. Corrected error in reference TI-9.1.1, all connectors are in one document. Added section 3.2 Interface Connections. CE Marchand, M Moignard & JM Juett

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