



NMRA Standard	
Power Station Interface	
May 24, 2020	S-9.1.2 DRAFT

1 General

1.1 Introduction and Intended Use (Informative)

The purpose of this Standard is to define communication between Command Stations and Power Stations to facilitate the basic interchange of DCC equipment produced by various manufacturers. It is applicable when Command Stations or Power Stations are tested for conformance independently of each other. It is also applicable when conformance testing an integrated DCC System, which includes both Power Station Interface and Power Station outputs. It is not applicable when conformance testing a DCC system includes only a Power Station output but no Power Station Interface output.

The main goals are as follows:

1. Define the electrical characteristics of the interface.
2. Define limits on the amount of distortion that each component can introduce to the DCC signal measured at the track.
3. Define the transmission medium of the interface.
4. Define the allowable physical topology of the interface.
5. Define the labeling of various components and connections.

1.2 References

This standard is interpreted in the context of the following NMRA Standards, Technical Notes, Technical Information, and other documents.

1.2.1 Normative

- S-9.1 Electrical Standards for Digital Command Control, which specifies DCC bit timing and track voltage.
- S-9.2.4 Fail-Safe Operating Characteristics for Digital Command Control, which specifies how system components interact under adverse conditions.
- S-9.1.2.1 Power Station Interface Feedback, which specifies feedback between Power Stations and Command Stations

1.2.2 Informative

- TN-9.1.2 Power Station Interface, which provides commentary on the Power Station Interface

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- TN-9.1.2.1 Power Station Interface Feedback, which provides commentary on the Power Station Interface Feedback
 - RCN-210 DCC Protocol Bit Transmission, with which S-9.1 is intended to be in harmony
 - NEM 670 Digital Command Control Signal DCC Bit Representation, with which S-9.1 is intended to be in harmony.

35 **1.3 Terms**

Table 1

Term	Definition
Bipolar Signal	An electrical signal that carries information having equal voltage components above and below 0 volts. In the context of the NMRA DCC standard, this signal will have a positive half-cycle and a negative half-cycle. (+ volts to - volts)
Unipolar Signal	An electrical signal that carries the same information as a bipolar signal, but only has a positive electrical component. This signal will have a positive half- cycle and a half-cycle where the output is at 0 volts.
Power Station Feedback	A means of transmitting information from a Power Station to a Command Station.
DCC Positive Polarity	The wire or rail which has a positive voltage for the first half of the DCC bipolar bit.
Command Station	The DCC system component whose purpose is to generate and send a stream of DCC bit data to the Power Station Interface.
Power Station	A device intended to amplify the low current DCC electrical signals transmitted by a Command Station for the purpose of providing high current DCC signals with sufficient power to operate model trains and any accessory decoders that are connected to the track. Also known as booster or power booster.
Power Station Interface	The communications medium ("wires") which connect a Command Station's signal generator to one or more Power Stations.
Power Station Interface Repeater	A device that amplifies the Power Station Interface signal to allow additional capacity for more Power Stations to be connected.
TIAEIA-422	ANSI differential signal standard commonly known as RS-422.
TIAEIA-485	ANSI differential signal standard commonly known as RS-485.

1.4 Requirements

This standard is required for all new products introduced after January 1st 2021. This standard is optional for all products introduced before January 1st 2021. Exemptions may be granted at the discretion of the NMRA Conformance and Inspection department. Exemptions granted must be

40 noted in the product manual and reviewed for accuracy by the NMRA Conformance and
Inspection department.

2 Electrical Characteristics

The interface interchange specifications are divided into two types: Full Scale and
Driver/Receiver. Command Station / Power Station combinations following one of these types
45 may interchange with devices of the same type. There is no exclusion of interchange between the
two types as long as the manufacture of the equipment documents the interchange.

2.1 Common Characteristics

2.1.1 Command Station (signal generator) Output Signal

The Command Station to Power Station signal described in this document shall conform to the
50 timing specifications described in the NMRA DCC Standard S-9.1.

The Power Station Interface signal is specifically designed as bipolar and not unipolar so that the
current on the two Power Station Interface wires is balanced.

2.1.2 Power Station Input to Output Distortion

A Power Station shall not alter the signal from its Power Station Interface input to its track
55 output terminals outside the range defined in Table below.

Table 2

T_{on}	Less than or equal to 5 microseconds
T_{off}	Less than or equal to 5 microseconds
$ABS(T_{off} - T_{on})$	Less than or equal to 2 microseconds

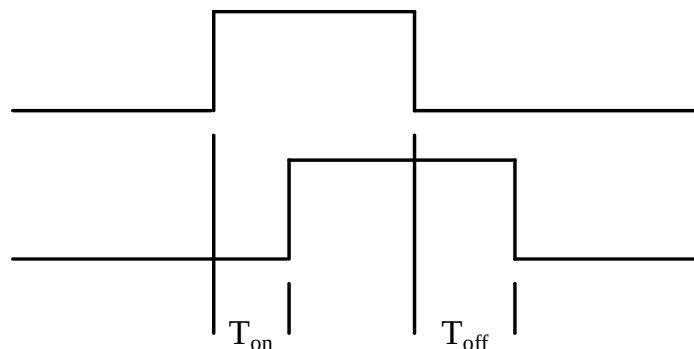


Figure 1

2.1.3 Power Station Interface Repeater Input to Output Distortion

A Power Station Interface Repeater amplifies the Power Station Interface signals so that
60 additional power stations can be supported. Only a single repeater may be used on any Power

Station Interface segment. On input, the repeater has the same requirements as a Power Station. On output, the repeater has the same requirements as a Power Station except that the total distortion is reduced as defined in Table below.

Table 3

T_{on}	Less than or equal to 1 microseconds
T_{off}	Less than or equal to 1 microseconds
ABS (T_{off} - T_{on})	Less than or equal to 0.5 microseconds

2.1.4 Power Station Common

- 65 Power Stations without electrically isolated interface inputs must provide the ability to connect the common side of their DC power supplies together. Instructions on the use of the Power Station common must be provided in the product documentation.

2.1.5 Power Station Fail-Safe

- 70 Power Stations must disable their output when a valid DCC packet is not received for more than 30 milliseconds on the Power Station Interface. This is designed to be consistent with S-9.2.4 in order to prevent a digital decoder from converting to an alternate power source.

2.2 Full Scale Interfaces

The term Full Scale is derived from the voltage levels of this interface being designed to match the standard track voltage levels defined in S-9.1.

75 2.2.1 Command Station Output Signal

A bipolar signal must appear differentially on a two-wire cable with a signal amplitude of no less +/- 8.5V and no greater than +/-22V. The Command Station output must be capable of supplying +/- 8.5V into a 100Ω resistive load, so that multiple Power Stations may be connected to this output.

- 80 The output current shall be limited to no greater than 1A to reduce hazards in case of a short circuit in the Power Station Interface. The output shall be protected to prevent damage to internal devices when a short is present at the output.

Table 4 Summary of Requirement Values

Command Station Output Voltage Max	+/- 22V (open circuit)
Command Station Output Voltage Min	+/- 8.5V (100Ω load)
Command Station Output Current Limit	1A

Test Criteria Open Circuit

- 85 Test Criteria 100Ω Load

2.2.2 Power Station Input Signal

The Power Station must accept as a valid input a bipolar signal with an amplitude of at least +/- 7V and shall be capable of accepting signals with an amplitude of up to +/- 24V without damage.

90 A power station may reject signals of less than 7 volts, but is not required to do so, with no lower limit defined.

So that multiple Power Stations may be operated by parallel connection to the same Command Station output, the Power Station shall draw no more than 25mA from its input terminals when the input signal has an amplitude of +/- 10V.

95 Because the signal is bipolar, no particular relationship of either part of the signal to a ground reference may be inferred. Power Stations shall interpret the signal at their inputs as differential in nature and shall not require any implied 3rd connection as a reference. The Power Station's response to this differential signal shall not be adversely affected by common mode voltages as great as 24V of either polarity between the Command Station's internal reference and that of the
100 Power Station.

Table 5 Summary of Requirement Values

Power Station Input Voltage Max	+/- 24V
Power Station Input Voltage Min	+/- 7V
Power Station Input Current Max	25mA at +/- 10V

2.3 Driver/Receiver Interfaces

The Driver/Receiver Interface type is characterized by the Command Station output connected to the Power Station input using a differential TIA/EIA-422 or TIA/EIA-485 driver/receiver pair. This interface also carries a ground signal which the differential signals shall be referenced to.

105 2.3.1 Command Station Output Signal

A bipolar signal must appear differentially on a two-wire cable with a signal amplitude of no less +/- 1.5V and no greater than +/- 6V. The Command Station output must be capable of supplying +/- 1.5V into a 90Ω resistive load.

The output current of each differential signal shall be limited to no greater than 250 mA when
110 shorted to the reference ground to reduce hazards in case of a short circuit in the Power Station Interface. The output shall be short circuit protected to prevent damage to internal devices when a short is present at the output connection.

These specs are intentionally designed around TIA/EIA-422 and TIA/EIA-485 standards.

Table 6 Summary of Requirement Values

Command Station Output Differential Voltage Max	+/- 6V (open circuit)
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Command Station Output Differential Voltage Min	+/- 1.5V (90Ω load)
Command Station Output Short Circuit to Ground Reference Current Limit	250 mA

115 Test Criteria Open Circuit

Test Criteria 90Ω Load

Test Criteria Short Circuit to Reference Ground

2.3.2 Power Station Input Signal

120 The Power Station must accept as a valid input a bipolar signal with an amplitude of at least +/- 200 mV and shall be capable of accepting signals with an amplitude of +/- 7V without damage.

So that multiple Power Stations may be operated by parallel connection to the same Command Station output, the Power Station shall draw no more than 1.5mA from its input terminals when the input signal has an amplitude of +/- 5V.

125 To account for common mode noise and differences in reference ground potential between the Command Station and Power Station, the Power Station's response to the differential signal shall not be adversely affected by common mode voltages up to +/- 7V relative to the Power Station's reference ground input.

Table 7 Summary of Requirement Values

Power Station Input Differential Voltage Max	+/- 7V
Power Station Input Differential Voltage Min	+/- 200 mV
Power Station Input Current Max	1.5 mA at +/- 5V

3 Physical Medium

130 The cable used for transmitting the signal from the Command Station signal generator to the Power Stations shall be a single pair of wires and may utilize any wire method from twisted pair to coaxial cable. The minimum wire size shall be 26 gauge. While there may be no particular length limitations at the data rates involved, practical consideration suggests that no Power Station or Power Station Interface Repeater should be greater than 1000 ft (300 meters) in distance from the Command Station signal generator, or Power Station Interface Repeater output
135 used to drive the Power Station Interface.

Additionally, the Driver/Receiver interface option shall carry a reference ground signal.

To reduce possible RF interference, it is advisable to use twisted pair conductors or a cable that keeps the wires totally parallel as the bus. In the unlikely event that this is insufficient to eliminate the interference, then shielded twisted pair may be used. Heavier wire, shielded wire,
140 or coaxial cable may be used if there is a need for longer run lengths, or a desire for better RF shielding. The Power Station Interface shall not require special termination.

4 Topology

Only one Command Station signal generator output or Power Station Interface Repeater output may be connected to a Power Station Interface. Inputs of many Power Stations may be connected
145 in parallel connection to the two wires of the bus. It is acceptable to use tree, star, and daisy chain connections. However, it is not allowed to connect any part of this bus in a loop. The bus, or branches, must not create a loop to themselves or to another branch.

5 Labeling

The Command Station, Power Station, or Repeater shall be directly labeled and/or provide
150 accompanying documentation to indicate the following properties:

1. Interface type used (Full Scale or Driver/Receiver).
2. Power Station Interface output capacity (Command Station and Repeater only).
3. Power Station Interface input loading (Power Station and Repeater only).
4. Positive and negative polarity signals. If labeled A and B, A must correspond to the
155 positive polarity and B must correspond to the negative polarity.
5. Power Station common (only required if Power Station input is not electrically isolated).