



NMRA Technical Note	
Power Station Interface	
Jan 30, 2021	TN-9.1.2

1 Introduction

The Power Station Interface Standard exists in order to aid in interoperability between Command Station and Power Station products from different manufacturers.

1.1 Served Use Cases

5 Document the two predominant types of Power Station Interface.

The intent is that any Command Station, Power Station, or Power Station Interface Repeater which conforms to the Standard, from any manufacturer, will be interoperable within a given Power Station Interface type.

1.2 Unserved Use Cases

10 It is not the purpose of the Standard to ensure that Command Stations, Power Stations, or Power Station Interface Repeaters are inter-operable between different Power Station Interface types.

It is not the purpose of the Standard to define Power Station Feedback (communication from the Power Station to the Command Station). Other Standard may cover this use case.

2 Annotations to the Standard

15 2.1 General

2.1.1 Introduction and Intended Use

2.1.2 References

- S-9.1.2 Power Station Interface

2.1.3 Terminology

20 2.1.4 Requirements

It is important to note that this standard has been created after the fact of multiple established products already available in the market. It is for this reason that the NMRA Conformance and Inspection department may grant exemptions for established products. This standard seeks to encompass as many of the existing product conventions as possible while providing a basis for
25 interoperability of future products.

2.2 Electrical Characteristics

While there exists two types of interface, Full Scale and Driver/Receiver, it may be possible in some cases to interchange the two types. A manufacturer may promote this interchange by providing supplemental instructions in their product documentation.

30 **2.2.1 Common Characteristics**

2.2.1.1 Command Station (signal generator) Output Signal

NMRA DCC Standard S-9.1 provides for a 3 microsecond margin between transmitter and receiver bit timing. The ABS ($T_{off} - T_{on}$) specification is designed to fit within this limit. A Power Station is allocated 2 microseconds of this margin while a Power Station Repeater is allocated 0.5
35 microseconds of the margin. The remaining 0.5 microseconds provides an additional safety factor.

In practice, the propagation delay (T_{on} and T_{off}) is only important where a receiver may bridge the gap between Power Station outputs. If the difference in propagation is too large, this may appear as a short circuit to the Power Station.

2.2.1.2 Power Station Input to Output Distortion

40 **2.2.1.3 Power Station Interface Repeater Input to Output Distortion**

2.2.1.4 Power Station Common

It is recommended that all Power Stations provide a Power Station Common even though it is only strictly required if the Power Station Interface input is not isolated.

Without Power Station input isolation, a Power Station Common becomes critically important in
45 order to be a lowest impedance path for return currents between Power Stations. With isolation, the Power Station Interface does not present an alternative return path which could be damaged by high currents.

Providing a Power Station Common can still be beneficial to Power Stations with input isolation as it can aid the transition of locomotives between Power Stations, especially if split frame/wheel
50 pickup is present.

2.2.1.5 Power Station Fail-Safe

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.

If a Power Station is not monitoring the incoming signal, it is possible that an invalid signal can
55 result in an amplified output signal which could be misinterpreted as a signal for a receiver to convert to an alternate power source.

2.2.2 Full Scale Interface

This is a common method for generating the Power Station Interface in part because it can use
60 common components with a Power Station output that may be bundled in the same product as a Command Station.

Previous versions of this standard referred to this interface type as Opto-isolated (Current) Interface. The name has been changed to better reflect the actual properties of the interface, which does not strictly require isolation at the Power Station input.

2.2.2.1 Command Station Output Signal

65 2.2.2.1.1 Test Criteria

2.2.2.2 Power Station Input Signal

The requirements listed here are derived from the historically popular 6N137 optocoupler. The typical 6N137 input circuit would place the LED of the optocoupler in series with a 1K Ω resistor. A silicon diode must be connected across the 6N137 in reverse (cathode to anode, anode to cathode) to keep the 6N137 5V reverse polarity from being exceeded.

Though the 6N137 is the original model for the requirements, the 6N137 is not required to be used. Other models of optocoupler and other types of isolation, which present less of a load, such as inductive, capacitive, and RF, may also be used. Furthermore, input isolation is not strictly required, though it is highly encouraged.

75 2.2.2.2.1 Test Criteria

2.2.3 Driver/Receiver Interface

The TIA/EIA-422 and TIA/EIA-485 driver/receiver standards have overlapping operating ranges and are commonly used together and/or interchangeably.

Table 1: Summary Comparison of TIA/EIA-422 and TIA/EIA-485¹

Parameter	TIA/EIA-422	TIA/EIA-485	Unit
Number of drivers and receivers	1 driver / 10 receivers	32	
Maximum theoretical cable length	1200	1200	m
Maximum data rate	10	>10	Mbps
Maximum common-mode voltage	± 7	-7 to +12	V
Driver differential output level	$2 \leq V_{OD} \leq 10$	$2 \leq V_{OD} \leq 5$	V
Driver load	≥ 100	≥ 60	Ω
Driver output short-circuit limit	150 to GND	250 to -7V to +12V	mA
High impedance state, power off	60	12	K Ω
Receiver input resistance	4	12	K Ω
Receiver sensitivity	± 200	± 200	mV

¹ Referenced from Texas Instruments Application Report SLLA070D: RS-422 and RS-485 Standards Overview and System Configurations

80 **2.2.3.1 Command Station Output Signal (TIA/EIA-422)**

2.2.3.2 Command Station Output Signal (TIA/EIA-485)

2.2.3.3 Power Station Input Signal (TIA/EIA-422)

2.2.3.4 Power Station Input Signal (TIA/EIA-485)

2.3 Physical Medium

85 Manufacturers are encouraged to provide installation guidance within the product documentation.

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 feet (300 meters) in distance from the Command Station signal generator, or Power Station Interface Repeater output used to drive the Power Station Interface.

90 To reduce possible RF interference, it is advisable to use twisted pair conductors or a cable that keeps the wires totally parallel. In the unlikely event that this is insufficient to eliminate the interference, then shielded twisted pair may be used. Heavier wire, shielded wire, or coaxial cable may be used if there is a need for longer run lengths, or a desire for better RF shielding.

95 The Full Scale Interface has been tested successfully through 1000 feet (300 meters) of impedance controlled twisted pair cabling. The Driver/Receiver Interface option has received considerably less testing, and may benefit from 120Ω termination at each end of the transmission line.

2.4 Topology

Improvements in the Power Station Interface signal integrity may be observed if a daisy topology is used without significant branches.

100 **2.5 Labeling**

The labeling examples below are provided as guidance only and are designed to meet the requirements. Exact labeling is up to the manufacturer. The Conformance and Inspection department, working with the product manufacturer, may use its discretion to evaluate compliance with the labeling requirements.

105 **Command Station Example**

This device provides a Full Scale Power Station (Booster) Interface output capable of supplying up to 500mA. Terminal A is the positive polarity signal and Terminal B is the negative polarity signal. The Power Station (Booster) common is labeled COM.

Power Station Example

110 This device provides a Full Scale Power Station (Booster) Interface input with a maximum loading of 15mA which is electrically isolated. Terminal A is the positive polarity signal and Terminal B is the negative polarity signal. The Power Station (Booster) common is labeled COM.

Power Station Interface Repeater Example

115 This device provides a Full Scale Power Station (Booster) Interface output (labeled Output) capable of supplying up to 500mA. Terminal A is the positive polarity signal and Terminal B is the negative polarity signal. The Power Station (Booster) common is labeled COM.

This device provides a Full Scale Power Station (Booster) Interface input (labeled Input) with a maximum loading of 15mA. Terminal A is the positive polarity signal and Terminal B is the negative polarity signal.

3 Document History

Date	Description
Jan 30, 2021	First Revision

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