



NMRA Technical Note	
Power Station Interface	
Nov 1, 2020	TN-9.1.2 Draft

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 interoperability of future products.

25 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.

70 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.

2.2.2.2.1 Test Criteria

2.2.3 Driver/Receiver Interface

75 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

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

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

80 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

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

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

85 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.

2.4 Topology

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

95 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.

100 Command Station Example

This device provides a Full Scale Power Station (Booster) Interface output capable of supplying up to 500-mA. 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

105 This device provides a Full Scale Power Station (Booster) Interface input with a maximum loading of 15-mA 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

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

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

3 Document History

Date	Description
Nov 1, 2020	First Revision

Important Notices and Disclaimers Concerning NMRA Standards Documents

The Standards (S), Recommended Practices (RP), Technical Note (TN), and Technical Information (TI) documents of the National Model Railroad Association ("NMRA Standards documents") are made available for use subject to important notices and legal disclaimers. These notices and disclaimers, or a reference to this page, appear in all standards and may be found under the heading "Important Notices and Disclaimers Concerning NMRA Standards Documents."

Notice and Disclaimer of Liability Concerning the Use of NMRA Standards Documents

NMRA Standards documents are developed within the Standards and Conformance Department of the NMRA in association with certain Working Groups, members, and representatives of manufacturers and sellers. NMRA develops its standards through a consensus development process, which brings together volunteers representing varied viewpoints and interests to achieve the final product. NMRA Standards documents are developed by volunteers with modeling, railroading, engineering, and industry-based expertise. Volunteers are not necessarily members of NMRA, and participate without compensation from NMRA.

NMRA does not warrant or represent the accuracy or completeness of the material contained in NMRA Standards documents, and expressly disclaims all warranties (express, implied and statutory) not included in this or any other document relating to the standard or recommended practice, including, but not limited to, the warranties of: merchantability; fitness for a particular purpose; non-infringement; and quality, accuracy, effectiveness, currency, or completeness of material. In addition, NMRA disclaims any and all conditions relating to results and workmanlike effort. In addition, NMRA does not warrant or represent that the use of the material contained in NMRA Standards documents is free from patent infringement. NMRA Standards documents are supplied "AS IS" and "WITH ALL FAULTS."

Use of NMRA Standards documents is wholly voluntary. The existence of an NMRA Standard or Recommended Practice does not imply that there are no other ways to produce, test, measure, purchase, market, or provide other goods and services related to the scope of the NMRA Standards documents. Furthermore, the viewpoint expressed at the time that NMRA approves or issues a Standard or Recommended Practice is subject to change brought about through developments in the state of the art and comments received from users of NMRA Standards documents.

In publishing and making its standards available, NMRA is not suggesting or rendering professional or other services for, or on behalf of, any person or entity, nor is NMRA undertaking to perform any duty owed by any other person or entity to another. Any person utilizing any NMRA Standards document, should rely upon their own independent judgment in the exercise of reasonable care in any given circumstances or, as appropriate, seek the advice of a competent professional in determining the appropriateness of a given NMRA Standards documents.

IN NO EVENT SHALL NMRA BE LIABLE FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL, EXEMPLARY, OR CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT LIMITED TO: THE NEED TO PROCURE SUBSTITUTE GOODS OR SERVICES; LOSS OF USE, DATA, OR PROFITS; OR BUSINESS INTERRUPTION) HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY, WHETHER IN CONTRACT, STRICT LIABILITY, OR TORT (INCLUDING NEGLIGENCE OR OTHERWISE) ARISING IN ANY WAY OUT OF THE PUBLICATION, USE OF, OR RELIANCE UPON ANY STANDARD OR RECOMMENDED PRACTICE, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGE AND REGARDLESS OF WHETHER SUCH DAMAGE WAS FORESEEABLE.

Translations

NMRA's development of NMRA Standards documents involves the review of documents in English only. In the event that an NMRA Standards document is translated, only the English version published by NMRA is the approved NMRA Standards document.

Official Statements

A statement, written or oral, that is not processed in accordance with NMRA policies for distribution of NMRA communications, or approved by the Board of Directors, an officer or committee chairperson, shall not be considered or inferred to be the official position of NMRA or any of its committees and shall not be considered to be, nor be relied upon as, a formal position of NMRA.

Comments on Standards

Comments for revision of NMRA Standards documents are welcome from any interested party, regardless of membership. However, **NMRA does not provide interpretations, consulting information, or advice pertaining to NMRA Standards documents.**

Suggestions for changes in documents should be in the form of a proposed change of text, together with appropriate supporting comments. Since NMRA standards represent a consensus of concerned interests, it is important that any responses to comments and questions also receive the concurrence of a balance of interests. For this reason, NMRA, its departments, Working Groups or committees cannot provide an instant response to comments, or questions except in those cases where the matter has previously been addressed. For the same reason, NMRA does not respond to interpretation requests. Any person who would like to participate in evaluating comments or in revisions to NMRA Standards documents may request participation in the relevant NMRA working group.

Laws & Regulations

Users of NMRA Standards documents should consult all applicable laws and regulations. Compliance with the provisions of any NMRA Standards document does not constitute compliance to any applicable regulatory requirements. Implementers of the standard are responsible for observing or referring to the applicable regulatory requirements. NMRA does not, by the publication of NMRA Standards documents, intend to urge action that is not in compliance with applicable laws, and NMRA Standards documents may not be construed as doing so.

Copyrights

NMRA Standards documents are copyrighted by NMRA under US and international copyright laws. They are made available by NMRA and are adopted for a wide variety of both public and private uses. These include both use, by reference, in laws and regulations, and use in private self-regulation, standardization, and the promotion of modeling, structural and engineering practices and methods. By making NMRA Standards documents available for use and adoption by public authorities and private users, NMRA does not waive any rights in copyright to the NMRA Standards documents.

IMPORTANT NOTICE

NMRA Standards documents do not guarantee or ensure safety, security, health, or environmental protection, or ensure against interference with or from other systems, devices or networks. NMRA Standards documents development activities consider research and information presented to the standards development group in developing any safety recommendations. Other information about safety practices, changes in technology or technology implementation, or impact by peripheral systems also may be pertinent to safety considerations during implementation of the standard. Implementers and users of NMRA Standards documents are responsible for determining and complying with all appropriate safety, security, environmental, health, and interference protection practices and all applicable laws and regulations.