1 General

1.1 Introduction and Intended Use (Informative):

The purpose of this STANDARD is to ensure that Digital Command Stations and Digital Decoders operate together in known, predictable, and compatible ways for certain key events. These events are:

A: Initialization of the DCC system

B: Conversion between different power modes

C: Occurrence of error conditions

The definition of the operation during these three key events is especially important given that the Digital Command Stations and Digital Decoders may be provided by different manufacturers.

This STANDARD is designed to be used in conjunction with the other relevant NMRA documents which relate to DCC.

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-9.1 DCC Electrical Standard
- S-9.2 DCC Communications Standard
- S-9.2.2 Configuration Variables
- S-9.2.3 Service Mode Programming

1.2.2 Informative

- RP-9 Recommended Practices Electrical

1.3 Terminology

Term	Definition
Accessory	Fixed model railroad device. This includes turnout contros, lights, signals and other devices not on the rails.
Accessory Decoder	DCC receiver, also called a stationary decoder, for controlling stationary device animation such as turnout throw.
Alternate Power Source	Recognized Alternate Power Sources include Analog Power Conversion to either Direct Current (DC) or Alternating Current (AC), Radio, Zero-1, TRIX, CTC 16 / Railcommand, or FMZ (Fleishmann); as coded in Appendix B to Standard S-9.2.2.

Term	Definition
Consist	Two or more decoders responding to the same commands. See S-9.2.2 CV19 for more information.
DCC Command Station	The DCC system component whose purpose is to generate and source a stream of DCC bit data to the Power Station Interface.
DCC Power Station	A device that amplifies 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.
DCC Throttle	The DCC Throttle is a human interface to the DCC Command Station enabled by knobs or levers and encoders or potentiometers, push buttons or toggle switches as well as software which may be incorporated into the command station base architecture or which may enable a remote device such as a smart phone connected by wires, infrared or radio signals such as Bluetooth and WiFi.
Digital Decoder	A device which by means of digital instructions conveyed by on – off bits *may* be capable of controlling speed and direction of electrical motors propelling vehicles alone or in consists whether static or in motion and which *may* control one or multiple on-off or variable electrical power functions such as lighting, sound, smoke and turnout throw.
Mobile Decoder	DCC receiver for controlling vehicle animation.
Multifunction Decoder	DCC receiver for controlling vehicle animation. Commonly called a mobile decoder, used to control multiple functions such as speed, direction, lighting and or sound.
NMRA Digital Packets	A sequence of bits meeting the full specifications of a packet including Preamble, Packet Start Bit, Address Data Bit, Address Data Byte, Data Byte Start Bit, Data Byte, and Packet End Bit as defined in S-9.2 Communications Standard.
Service Mode	A very low power mode for programming decoders on an electrically isolated programming track enabling customization of decoder functions and configuration variables and address without a known decoder address
Operations Mode	A normal power mode for operations and programming to a specified known decoder address
Vehicle	Mobile model railroad device. This includes locomotives and other rolling stock.

Contents

2 Initialization of the DCC system

Upon initialization of the DCC system two possible conditions exist:

- The DCC Command Station has retained information about the previous state of the system

- The DCC Command Station has no information about the previous state of the system

In the case where there is no information about the previous state of the system, the DCC Command Station shall send a minimum of twenty (20) digital decoder reset packets to the layout followed by a minimum of ten (10) idle packets. These packets shall be sent prior to sending any packets which contain operating instructions to the layout. The ten idle packets are required to ensure that Digital Decoders exit service mode. For further details on reset packets and idle packets refer to NMRA Standard S-9.2. For further information on Service Mode refer to S-9.2.3.

Digital Decoders must be in digital operations mode in order to interpret NMRA digital packets for the purpose of operating the railroad and its trains. Upon receiving power, Digital Decoders *shall* enter normal digital operations mode. If powering up follows only a minor interruption in power such that the Digital Decoder retains valid speed and direction information, it is permissible for the Digital Decoder to resume operation. Otherwise, the Digital Decoder shall bring the device being controlled to its initial defined state (which for locomotives is a complete stop).

3 Conversions Between Different Power Modes

When a Digital Decoder that has automatic conversion enabled in Configuration Variable (CV) #29 detects the absence of the NMRA digital signal for more than 30 milliseconds, it is permissible for the decoder to convert to an *alternate power source* which *must* be specified in CV #12. If the digital decoder converts to analog mode, it shall accelerate (decelerate) the

locomotive at the programmed acceleration (deceleration) rate in the direction specified by S9 (to the best of its ability) until the available analog power level is reached.

When the Digital Decoder is not in digital mode and detects the presence of the NMRA digital signal, it shall return to digital operations mode and at its option: 1) continue to operate at the same speed as it was operating under the alternate power source, 2) operate at the last known digital speed, or 3) come to a stop until a proper digital instruction is received.

When converting between alternate power sources, if the new direction information is such that it would cause the locomotive to reverse direction, the Digital Decoder will decelerate the locomotive (to a complete stop if necessary) until such time as either 1) the direction information is the same, 2) a command control packet is received that tells the Digital Decoder to stop, 3) a reset packet is received or 4) the track voltage drops to "0" volts for 500 milliseconds.

Configuration Variables #11, #12, #13, #27 and #29 as detailed in S-9.2.2 provide options for management of Digital Decoder operations when conversion between power modes may occur.

4 Occurrence of Error Conditions

While in digital operations mode each Digital Decoder shall have a Packet Update time-out value. While in digital operations mode, if the packet time-out value is exceeded, the Digital Decoder will bring to a stop all controlled devices. The purpose of this time-out is to ensure that each Digital Decoder receives a periodic update from the Digital Command Station and thereby help prevent runaway conditions. The user and/or original equipment manufacturer (OEM) may choose a Configuration Variable #11 value to define the time-out length *within these restrictions*:

- A Configuration Variable #11 value of 0 disables the time-out (i.e., the user has chosen not to have a time-out)

- A Configuration Variable #11 value range of 1 through TIMEOUT_MAX sets the time-out to the chosen value. The minimum value of TIMEOUT_MAX will be 20 seconds. It may be longer at the manufacturer's discretion.

5 Document History

Date	Description
July 1995	Original text received approval by the NMRA Board of Trustees.
March 1997	Revised text received approval by the NMRA Board of Trustees.
July 2012	Text changed to an NMRA STANDARD approved by the NMRA Board.
June 2025 Draft	Third Revision, adapts previous text to current (2021) NMRA Standard template with addition of definitions, minor changes to nomenclature and formatting as well as clarification of Configuration Variables (CVs) appropriate to Fail-safe operation.

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