Binding Standard

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(First English Edition)

1. General

This standard defines a system as „Digital Traction“ that meets the following requirements.

1.1 Supply of Power

The supply of locomotive motors is accomplished via decoder, which is supplied with bipolar track voltage containing the appropriate power and information to control the locomotive (digital supply). Power and information are provided by a central controller and possibly via additional boosters[1)].

1.2 Supply of Information

The information for the behavior of the locomotives are specified by the central controller and at minimum cover the motor’s speed and direction.

2. Connection Principles

Connect a 2 conductor cable from the power output of a central controller or booster to either both rails of the track (for 2 conductor operations) or the rails and central conductor (for 3 conductor operations). Supply via functional overhead power wire (or side supply rail) are only possible with a symmetrical feed system per NEM 620. The motor of the locomotives obtain their power supply from their installed decoders.

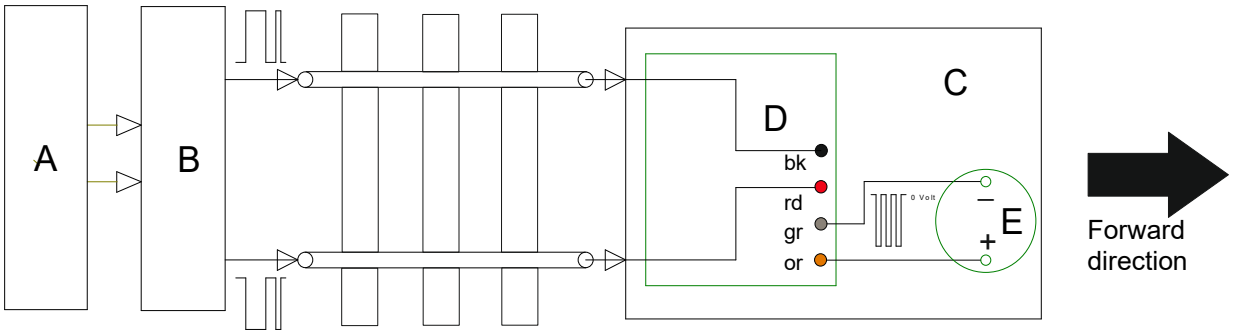

Figure 1: A = Power Supply, B = Central Controller / Booster, C = Locomotive, D = Decoder, E = DC-Motor

3. Characteristics

3.1 Generation of Track Power

Via a power supply (A) composed of a transformer or switching power supply, a central controller or booster (B) generate the bipolar track voltage. This is typically specified by the manufacturer of the central controller / booster as the effective voltage. For energy savings reasons, a transformer should not be utilized.

[1)] A booster is a power amplifier, which amplifies the information sent by the central controller.

3.2 Motor Voltage

The type of current generated by the decoder in the vehicle is fixed voltage pulse width modulated (PWM) DC current, also known as pulse width control. The maximum possible effective voltage should correspond to the maximum allowed motor voltage.
The speed of the motor is determined by changing the pulse width, known as the duty cycle. 0% corresponds to 0 Volt and 100% corresponds to the maximum voltage. The motor may be powered with a higher voltage so long as a 100% duty cycle is not applied to the motor for an extended period. The limit can be set with the DCC configuration variable CV 5 (v_{max}).

3.3 Direction of Travel

Decoders following the DCC standard should be wired up according to NEM 650, section 4.1 (see figure 1). There are decoders which can swap the direction of travel by setting a bit in a DCC configuration variable (CV 29).
If a vehicle is intended to also operate in analog mode, then the power pickup and motor connections should be made in compliance with NEM 631.

4. Overview of the Voltages

4.1 Consideration of Voltage Drops

Voltage drops of approximately 1.5 V from the decoder and approximately 0.6 V from the central controller should be accounted for with the motor voltage:

12 V DC at motor + 1.5 V = 13.5 V track voltage + 0.6 V = 14.1 V DC from power supply

Similarly, with the usage of a 15V switching power supply:

15 V DC supply - 0.6 V = 14.4 V track voltage - 1.5 V = 12.9 V DC at the motor

4.2 Table of Target Voltages

In accordance with the nominal voltage ratings at motors per NEM 630, the following named minimum values (tolerance < +/- 10%) are provided for digital traction operation per gauge.

Gauge G	6.5 mm		6.5 mm < G < 32 mm		≥ 32 mm	
Power Supply	10 V DC	7 V AC	15 V DC	10 V AC	18 V DC	13 V AC
Track Voltage	9.4 V eff	9.0 V eff	14.4 V eff	13.3 V eff	17.4 V eff	17.5 V eff
Motor	7.9 V DC	7.5 V DC	12.9 V DC	11.7 V DC	15.9 V DC	16.0 V DC

Note:

The values are rounded up or down to the nearest 0.1 Volt. The value 1.41 was utilized as the conversion factor between DC and AC.

4.3 Table of Commercial Voltages

Not all commercially available power supplies have the voltages, specified in section 4.2.
The following table shows currently used deviations (as of 2017).

Gauge G	6.5 mm		6.5 mm < G < 32 mm		≥ 32 mm	
Power Supply	9 V DC	9 V AC	15 V DC	12 V AC	18 V DC	14 V AC
Track Voltage	8.4 V eff	11.8 V eff	14.4 V eff	16.1 V eff	17.4 V eff	19.7 V eff
Motor	6.9 V DC	10.3 V DC	12.9 V DC	14.6 V DC	15.9 V DC	18.2 V DC