1 General

1.1 Introduction and Intended Use (Informative)

This Tech Note is intended to provide information and guidance to end users for wiring your 2 rail model railroad for either analog DC or Digital Command Control (DCC) which will render good performance and reliable operation. Much of what is presented here can also be applied to 3 rail AC model railroads. Some of this document is related to both DC/DCC and some is specific to DCC. For further reading, there exists on the internet; at several websites and in various books, information on wiring your model railroad. This Tech Note has been written by assembling the best practices based on experience and has been reviewed and approved by several manufacturers of DCC equipment. Therefore, we believe this document to be one of the best sourced of information for wiring your model railroad. The user does not need to fully understand DCC to make it work. Just follow the recommendations in this Tech Note-9. In some places in this document, we have added more information and theory for readers desiring more detail.

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 Electrical Standards
- S-9.1 Electrical Standards for Digital Command Control, which specifies signal voltages.

1.2.2 Informative

- Ohm’s Law

1.3 Terminology

Term	Definition
Accessories	Fixed model railroad devices. This includes turnouts, lights, signals and other devices not on the rails.
Accessory Decoder	DCC receiver for controlling accessories.
Block	Section of track isolated from other tracks for the purpose of control (DC), detection (DC or DCC) or power management. A block may exist in a power sub-district.
Bus	A set of wires to carry power and or control signals. In DCC there may exist an accessory bus in addition to the DCC track bus. A bus can be used in DC analog as well as AC 3rd rail systems.

Term	Definition
CT Coil	Also known as a Current Transformer. A coil of wire wrapped on a magnetic core which couples to a secondary wire passed through the hole of the coil, one or more times; thereby isolating the two circuits yet coupling and inducing a current in the coil when there is a current in the wire. Commonly used in DCC occupancy detection circuits. Not suitable for pure DC circuits.
Decoder (mobile)	DCC receiver for controlling vehicle animation.
Feeder Drop	Smaller wires making a connection from the track rails or accessory to the bus. A feeder drop can be used in DC or DCC systems, for track or accessories.
Impedance	The opposition to the flow of an alternating current in an electric circuit that is analogous to the resistance in a direct current circuit. **Z=E/I.** Where Z is the impedance. Impedance can also shift the phase of the current relative to the voltage.
Ohms Law	**E = I x R** Where E=voltage, I=current and R=resistance
Power District	Section of track isolated from other track and powered by a separate power station (DCC).
Power Sub-district	A section of a power district protected by a separate circuit breaker.
Power Pack (DC)	A DC power supply and controller which varies the voltage and polarity to control DC vehicles. It may also provide fixed low voltage power AC or DC to accessories.
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. The power station may be a separate device or may be combined with the command station and/or throttle. Sometimes a standalone Power Station is referred to as a booster.
Ringing	A distortion of the bipolar DCC signal where there is a spike at the leading edge of each pulse. This short duration spike can be several times the amplitude of the nominal peak voltage of the DCC signal.
Slew Rate	In electronics, slew rate is defined as the change of voltage or current, or any other electrical quantity, per unit of time. Expressed in SI units, the unit of measurement is volts/second or amperes/second.
Vehicle	Mobile model railroad device. This includes locomotives and other rolling stock.
Zip Cord	A type of electrical cord with two or more conductors held together by an insulating jacket that can be easily separated simply by pulling apart.

2 Electrical Properties

With DC operation the power supply usually drives one or a few locomotives on one train at any given time. The voltage on the rails will vary according to the speed setting of the DC controller (Power Pack). With DCC, many vehicles (locomotives) and accessories may be driven from one power station. Full voltage of the DCC signal is present at all times, unless switched off. The current in both cases will depend on the number of vehicles present and their speed. Although in some cases a model railroads previously wired for DC may work just fine on DCC, updating the wiring may, in a few cases, be necessary to obtain optimal performance. The increased power requirement may dictate updating the wiring for DCC.

DCC decoders have a minimum voltage at which they will operate reliably. A minimal voltage is required to properly drive the motor in the vehicle. In addition, proper operation of circuit protection requires adequate current. Good wiring practices and following these guidelines will assure that at any point on the model railroad, sufficient voltage and current are present for safe and reliable operation.

2.1 Voltage loss

All electrical conductors have some resistance. Because rail has more resistance than the copper wire that is typically used in the bus, one should not depend on long stretches of rail to conduct power and DCC signals. More information follows below in section 2.1.1 Bus Wire Size

2.1.1 Bus Wire Size

The bus wire conducts the power and DCC signal from the power station to the track. Both the length of run and current draw must be considered. The critical factor is bus resistance and voltage drop. Though smaller wire may be rated in amp capacity well above the power station rating, it is the bus resistance that is the main concern. As the length of run increases, the bus resistance increases. As the current draw increases, the voltage drop increases. Ohm's Law applies. $E = I \times R$. Wire size and wire material will also affect voltage loss. It is recommended that copper wire be used. The wire may be stranded or solid; the wire gauge accounts for the conductive cross sectional area be it stranded or solid.

A solid wire of a given gauge will fit in a smaller terminal slot than the same gauge of stranded wire. If the bus used wire will not fit a power station or circuit breaker terminal, it is permissible to use a short section of smaller gauge stranded wire that will fit into the terminal and connect that to the larger bus wire with a secure connection, such as a butt connector, terminal strip or wire nut. The added resistance of a very short section of wire is negligible. Although a solid wire of a given gauge may fit in a terminal where a stranded wire would not, care should be taken to avoid creating a stress on the terminal to avoid damage to the terminal. Stranded wire is more flexible and less prone to break if subjected to repeated bending or vibration that would be experienced in a module or portable model railroad.

The maximum voltage rating for decoders is different for each scale. Refer to NMRA S-9.1. For best performance the bus size in American Wire Gauge (AWG) shall be such that there is no more than a 5% voltage loss at the furthest point from the power station at the maximum current of the power station. The Charts 2.1 – 2.4 below give recommended wire sizes for length of run and at various currents.

As a matter of safety, voltage drop is important because the booster must be able to fully drive its rated current for the overload protection to trip. Too much voltage drop (inline resistance) may limit the drive current of the booster during a short condition leading to excessive heat built up and damage to equipment. E.G., An 8-Ampere power station with 12V peak to peak DCC (typical HO) can only tolerate less than 1.5 ohms total loop resistance to any hard short and be able to detect a fault that may be welding a truck or wheel set to a rail.

A good method to check that the circuit breaker in the power station or external circuit breaker, is working properly is to place a metal object across the rails at multiple points from the power station or breaker to verify that the breaker trips. This is commonly referred to as the quarter test, as a quarter is placed across the rails to create a short. In larger scales a larger coin or other large metal object would be required to short across both rails.

The maximum current for the power station varies between scales. For N scale a power station limit of 3-5 amps is typical, for HO 5-8 amps, for O scale and larger power stations of 10 amps are common.. However, this will vary by the size of the model railroad, amount and type of equipment (vehicles and accessories[1]) used. The graphs below show the voltage loss for common copper wire sizes at various distances. The calculations include the resistance loss out and back combined. Each graph is for different currents that are common ratings for power stations.

Table 2.1 Copper Wire Resistance[2]

Gauge	Ohms per 1000 feet	Diameter inches
#10 AWG	0.9989	0.1019
#12 AWG	1.5880	0.0808
#14 AWG	2.5250	0.0640
#16 AWG	4.0160	0.0508
#18 AWG	6.3850	0.0403
#20 AWG	10.15	0.0320
#22 AWG	16.14	0.0254
#24 AWG	25.67	0.0201

Table 2.2 Nickel Silver Rail Resistance

Rail Size	Ohms per 1000 feet[3]
Code 250	4.2
Code 140	17.1
Code 100	17.4-30.6
Code 80	45.0-115.8
Code 83	39.3-83.1
Code 70	50.9-75.7
Code 55	76.3-150.3

[1] A separate bus for accessory decoders can divide the load between two busses. In addition, a short on the track will not kill the power to the accessory bus.

[2] Copper wire is recommended over coper clad aluminum, which has a much higher resistance.

[3] These are typical values measured. The rail resistance will vary from one manufacturer to the next because the cross sectional area can vary, as different dies are used to extrude the rail. Brass rail will have a lower resistance. Nickel Silver values were chosen because of the popularity of this material due to its lower oxidation rate as compared to brass. However, these values can vary due to the different alloys used.

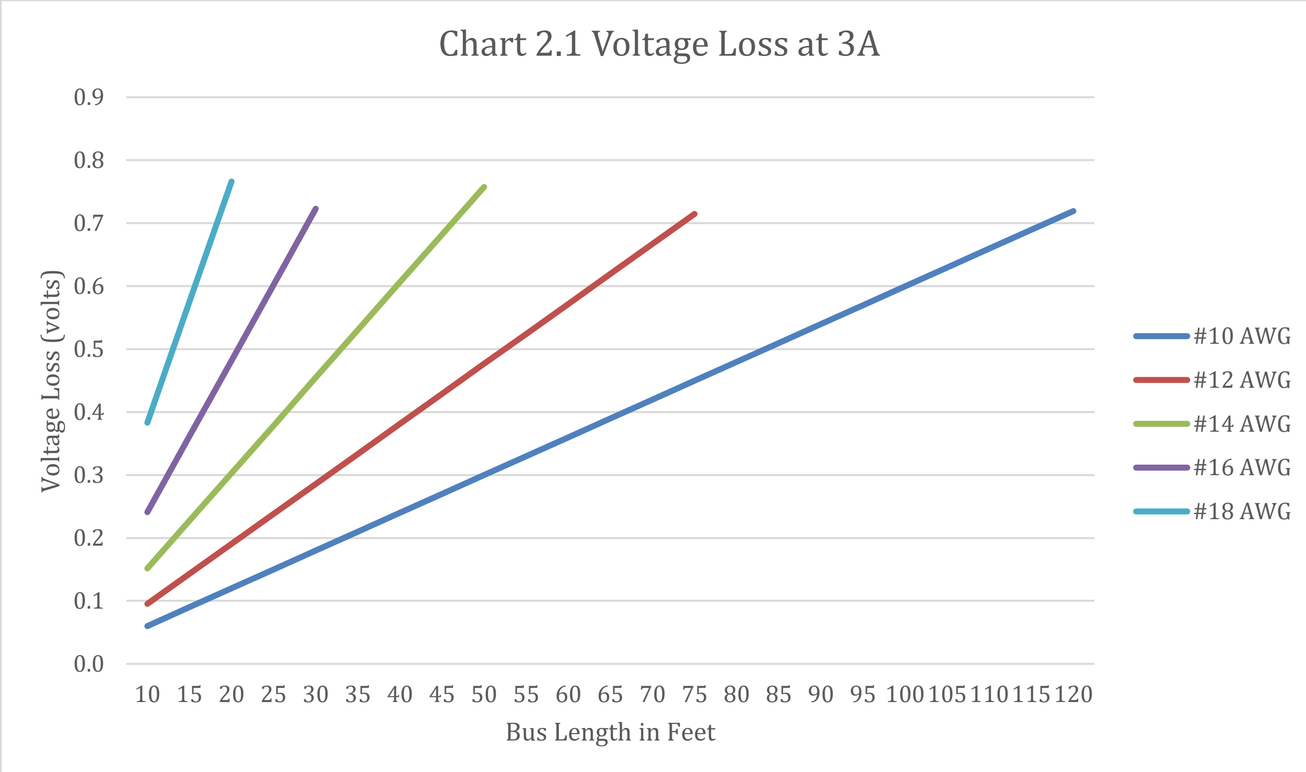


Chart 2.1 Voltage Loss at 3A
Voltage Loss (volts)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 105 110 115 120
Bus Length in Feet
#10 AWG
#12 AWG
#14 AWG
#16 AWG
#18 AWG

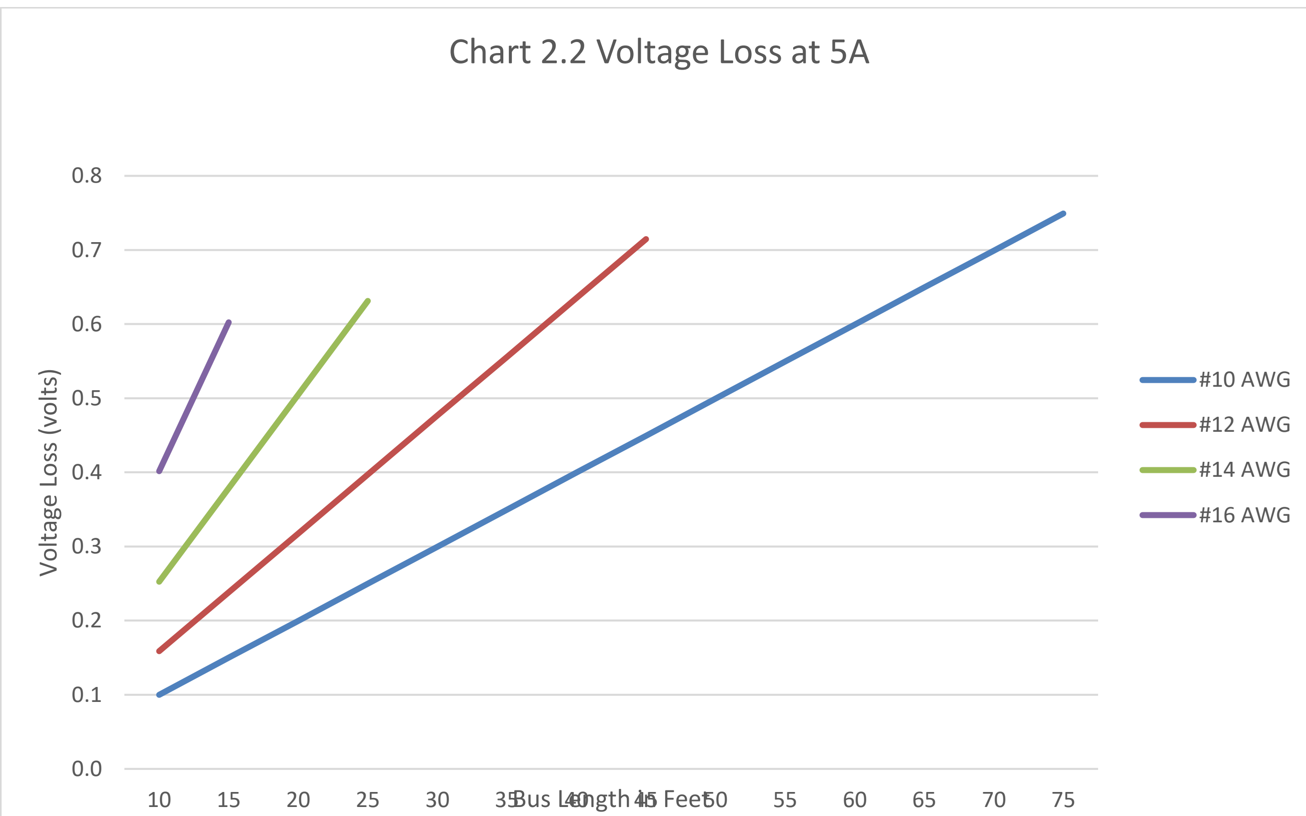


Chart 2.2 Voltage Loss at 5A
Voltage Loss (volts)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
10 15 20 25 30 35 40 45 50 55 60 65 70 75
Bus Length in Feet
#10 AWG
#12 AWG
#14 AWG
#16 AWG

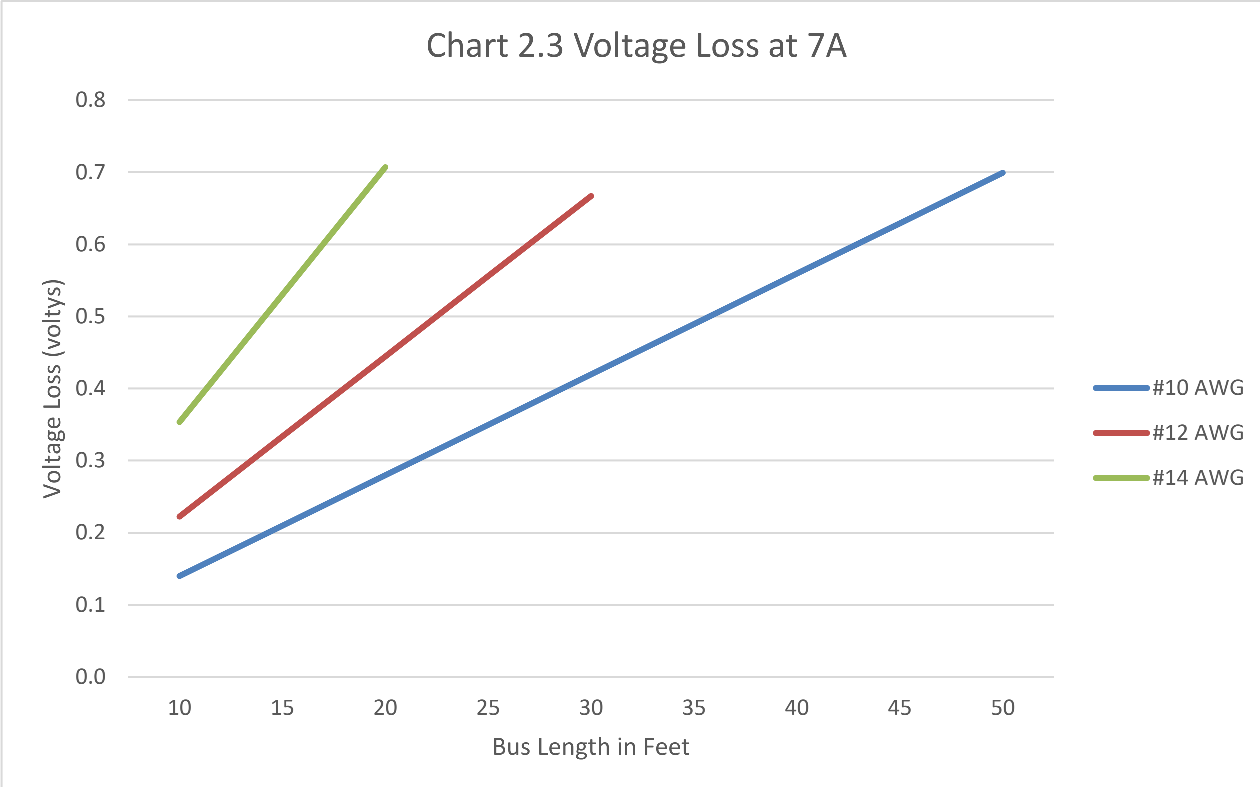


Chart 2.3 Voltage Loss at 7A
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Voltage Loss (voltys)
10
15
20
25
30
35
40
45
50
Bus Length in Feet
#10 AWG
#12 AWG
#14 AWG

100

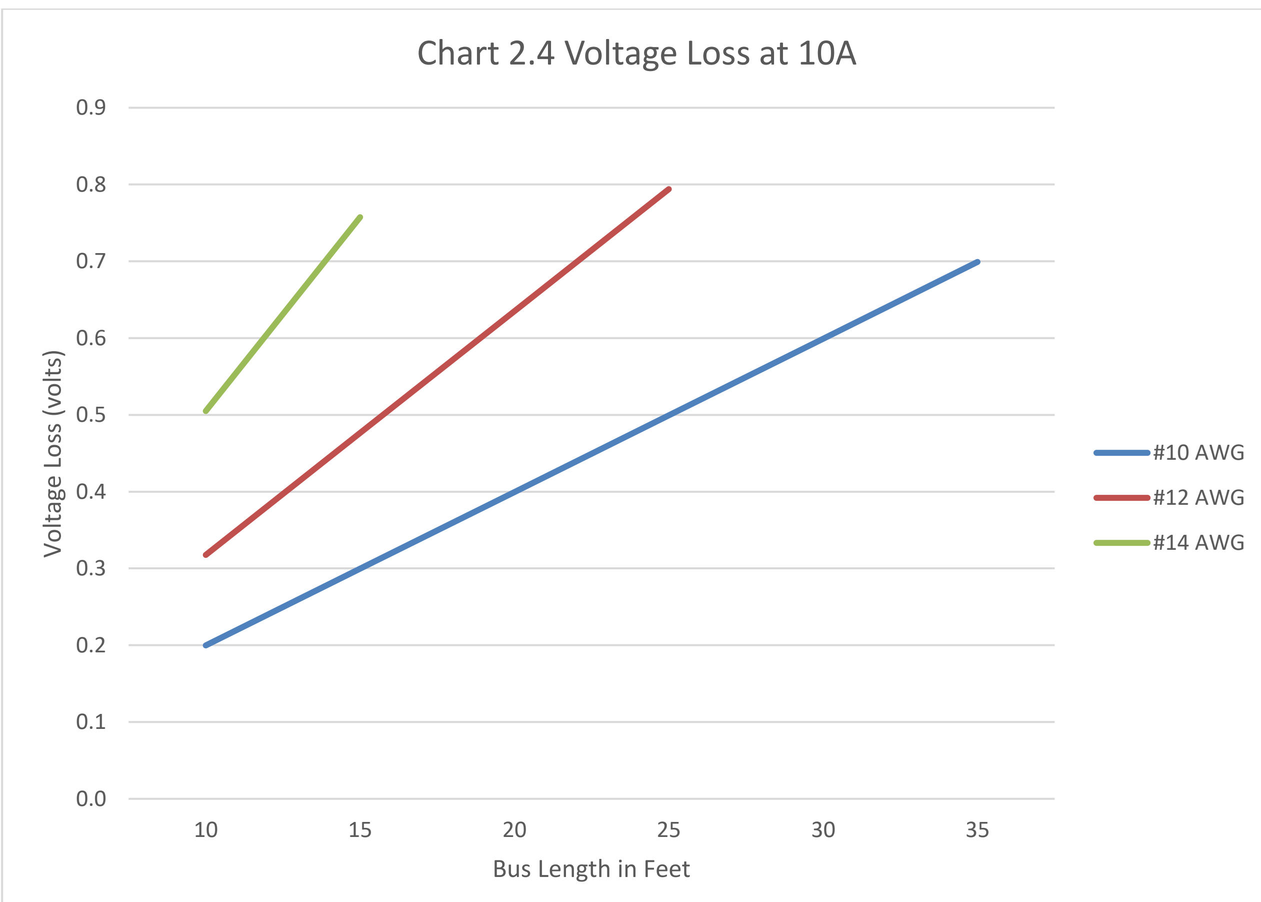


Chart 2.4 Voltage Loss at 10A
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Voltage Loss (volts)
10
15
20
25
30
35
Bus Length in Feet
#10 AWG
#12 AWG
#14 AWG

Should sections of track exceed the length of run supported by a given wire size, the power station may need to be located closer to the track section, or the center of the section of track to feed in both directions or break up the track into power districts and use multiple power stations, one supplying each power district.

2.1.2 Feeder Drops

The feeder drop attached to the rail or accessory is typically smaller than the bus wire to accommodate connecting the feeder to the rail. The feeder drop should be securely attached to the rail. The feeder drop may be either a solid or stranded wire. As stated previously a solid wire is more subject to damage and breakage from vibration or repeated bending than a stranded wire. A feeder, being smaller is more prone to breakage than a bus wire.

In smaller scales soldering the feeder drop to the rail is a good method for attachment. The feeder drop may be soldered to the side of the rail (field side) or to the bottom between ties. With a little practice one can solder to the bottom of track with plastic ties without melting them. Once the track is painted and ballasted the connections nearly disappear.

For large scale track (G & F) the mass of the rail makes getting enough heat to make a good solder connection difficult. For large scale track, mechanical connectors with screw terminals make a good method to connect the feeder drops to the track.

Never rely on a friction connection such as a slide on rail joiner. The connection should be by means of soldering or tight screw terminals. The contact of a switch point against a stock rail is also unreliable. Point rails of switches should be connected back to the bus with secure connections, either a separate feeder, or a jumper to the stock rail. Often a jumper between a point rail and the stock rail is a soldered printed circuit board tie. The point rail should be connected electrically to the adjacent stock rail, as a metal wheel passing an open point could bridge the gap between the point and stock rail. If they are opposite phase (rail A & B) a short can occur. Therefore, the frog must be isolated from the rails leading to it with an insulating air gap. Powering the frog with a single pole double throw device (to change the phase according to the switch position) will further improve reliability.

In larger scales the rail resistance is less than in smaller scales. See Table 2.2 below. With larger rail it is not necessary to have a feeder on each section of rail so long as the electrical connections (rail joiners) between each section of rail is secure such as a soldered rail joiner or a mechanical connection secured with screws properly tightened.

With smaller rail, code 100 and under; no more than 3 feet (or about 1 Meter) of rail should be fed by a single feeder drop. Some modelers put a feeder drop on each section of rail. Other methods include a feeder drop and soldered rail joiner feeding 3 feet (1 Meter) of rail in opposite directions. One can leave an expansion joint between pieces of rail with feeder drops by installing an unsoldered rail joiner and leaving an approximate gap of 0.020” (0.05 cm) gap between the ends of the rails. This is about the thickness of a normal business card or the NMRA Standards Gauge. In no case should an unsoldered rail joiner be relied on to conduct the power and signal. For very short sections of rail, less than 6 inches (15 cm); a soldered rail joiner may be used to connect that short rail section to an adjacent rail with a feeder drop.

Each accessory decoder should have a pair of feeders attached unless the accessory decoder takes its power directly from the rail. Some accessories such as turnouts come with an accessory decoder integrated, which draw current from the rails.

Feeder drops should be sized based on the maximum current capacity of the power station or the rating of the breaker protecting that section. In a short circuit condition, the full current capacity of a power station (or the max trip current of the breaker) could flow through a single feeder drop. Therefore, feeder drops should be sized for the worst condition that could be encountered.

Table 2.2 Typical Feeder Drop Size

Max Current[4]	Feeder Drop Min wire size
3A	22 AWG
5A	20 AWG
7A	18 AWG
10A	16 AWG

The feeder drop may be attached to the bus wire by various means, including stripping each wire wrapping and soldering, displacement connectors, or other suitable means for a secure connection. Bare connections should be covered by heat shrink tubing, electrical tape or other suitable means of insulation. Feeder drop wires should be kept as short as possible.

2.2 Signal Distortion

2.2.1 Ringing

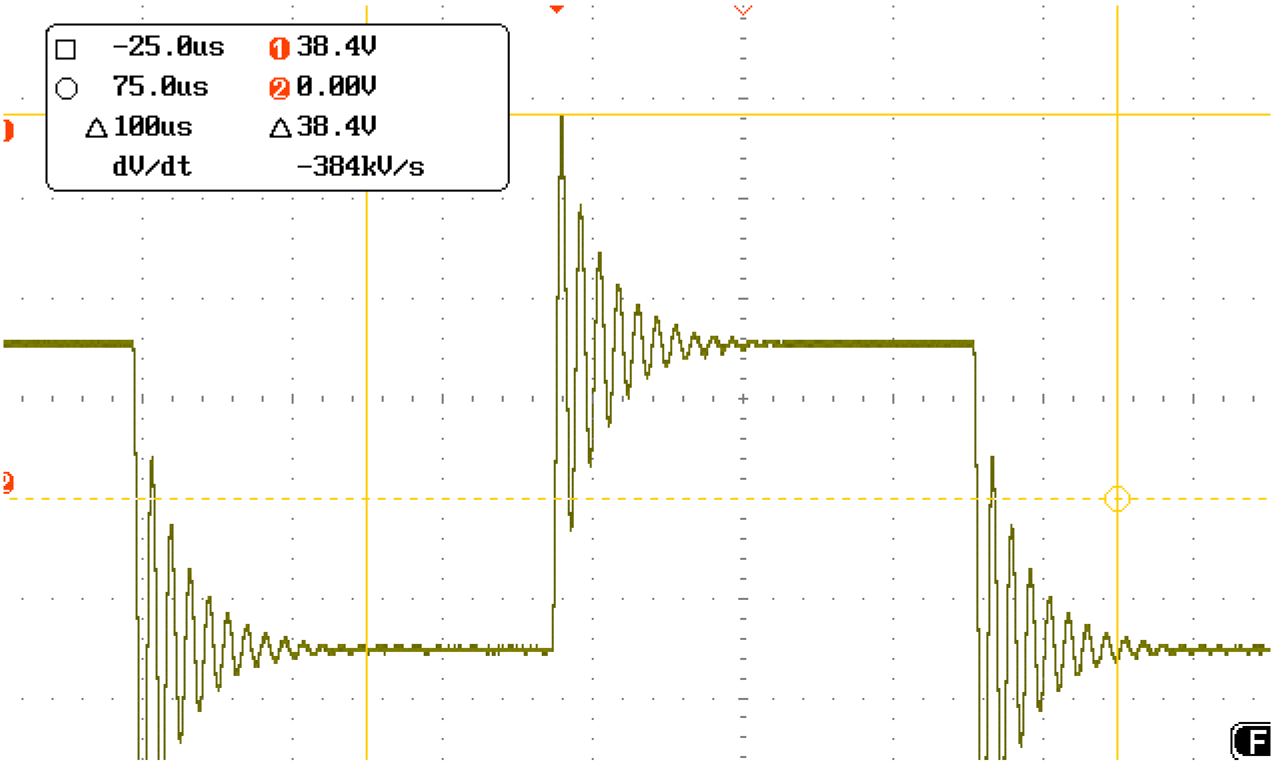
Ringing is a distortion of the bipolar DCC signal where there is a spike at the leading edge of each pulse. The duration of each pulse determines if the bit is a 0 or a 1. This short duration spike can be several times the amplitude of the nominal peak voltage of the DCC signal. In some cases it can make reading the signal difficult and in the extreme can damage the decoder. See Figure 2.1 below for an example of ringing captured on an oscilloscope trace.

There are several factors that affect the amount of ringing present. Length of the bus run, load on the bus, how the wiring is installed and the power station. Each power station is different. Some produce more ringing than others. Often this is a design compromise. If the output is driven too hard ringing is present. If driven too softly the slew rate[5] becomes too large (too long) making it difficult to read the DCC signal.

[4] Max current on this section of bus. This may be the current rating of the power station. If external protection is used, the current in Table 2.2 would be the trip current of the protective device for this section of bus.

[5] Rate of change of voltage on the DCC signal.

Figure 2.1



2.2.2 Twisted bus pairs

To reduce induction and high frequency interference the pair of bus wires should be as close as possible. For smaller wires a zip cord is one solution. For heavier wire they may be available only as individual wires. Twisting the wires at a rate of at least 3-5 turns per foot (30cm) will put them in close proximity, yet will allow enough room to attach feeder drops. Where there is a run where no feeder drops are to be attached the number of twist per unit length may be increased.

Twisting the bus reduces inductance which reduces ringing. It also increases capacitance which reduces ringing. It also reduces susceptibility to common mode noise (interference) from other sources as well as potential RFI emissions from the wiring where DCC is used.

Be aware that this increased capacitance downstream from a current sensing occupancy detector can cause false occupancy indications. Wire downstream from the detector generally should not be twisted to avoid false occupancy indications.

2.2.3 Bus terminations

The DCC bus may be fitted with a resistor capacitor (RC) filter using a 150Ω resistor of adequate wattage in series with a 0.1µf 50V capacitor across the bus. See Table 2.3 below.

Table 2.3 Termination Resistors 150Ω

Scale	Max Voltage	Wattage
Z & N	14V	1W
HO	17V	1W
S & O	19V	2W
G & F	22V	2W

The purpose of such filters is to reduce ringing and to shunt any voltage spikes created when there is a short circuit created by a derailment or equipment running into a turnout set against it. Results will vary for each situation depending on the length of the bus, the load on the bus and the power station.

Although different brands and models of power stations may conform to NMRA Standards, the outputs will behave somewhat differently. If the power station output is driven hard, there will be more ringing in the signal. The less load there is on the bus the more ringing will be observed. The location of the load(s) on the bus will change the behavior and ringing. Adding an RC filter may reduce this ringing. Generally placing the RC filter at the end of the bus is the more common location for placement, if used. However, placement(s) in other locations may further alleviate the ringing.

Determining if there is ringing on the bus and where to place RC filters to reduce the ringing is an advanced technique requiring an oscilloscope and somewhat advanced electronic expertise.

Such RC filters will draw a small amount of current and should not be placed down line from any current sensing occupancy detector.

2.2.4 Routing of Bus

In wiring for DCC, the bus should be laid out linearly as far as possible. One should avoid having the bus loop back on itself, nor should there be a loop that goes out to a branch and comes back to connect to the main. If this is not possible, keep the loop as short as possible. The reason for this is to prevent reflection in the DCC signal timing as it reaches the decoder.

The bus should not be run parallel for long distances to other data busses such as Computer Model Railroad Interface (C/MRI) or Layout Command Control (LCC). Coupling and induction of signal is possible. Given that most railroads and models are linear it is not always possible to avoid running various wiring parallel. The DCC bus should be separated from other busses by at least 3 inches (7.6cm) for long distances.

2.3 Short Circuit Protection

2.3.1 DC Short Circuit Protection

Given that in DC, the power pack usually controls one train at a time (one or more locomotives MUed together) per output. The short circuit protection is usually built in each output by the manufacturer according to the rating of the power pack.

2.3.2 DCC Power Stations

A power station is defined as a DCC device that supplies a DCC signal with adequate power to drive a vehicle or accessory. The command station generates the DCC wave form which is imposed on the power supplied by a booster. Within any system there can be only one command station but there may be many power stations (boosters). A power station may be a combination command station and booster in one enclosure or it may be a booster with the DCC signal originating from a command station outside of that enclosure.

2.3.3 DCC Power Districts

Depending on the size of the model railroad, how much track, how many vehicles (locomotives), accessories and operators are in use at any given time; it may be beneficial to divide the track into multiple power districts. Should a short circuit occur in one location, the circuit breaker for that section would protect it; without interrupting the power to other power districts.

Although in the past some have used 12VDC automotive tail light bulbs to protect against short circuits, today there are circuit breakers that are much faster and can be set for various trip currents and response times. It is no longer recommended to use tail light bulbs for short circuit protection.

Should the number of vehicles (locomotives) in use exceed the power capacity of the initial power station, power stations (boosters) may be added to supply additional power. Each Power Station should supply a separate power district. Sub-districts may be divided, each protected by individual external circuit breakers. Power stations should **never** be connected in parallel to supply a power district.

2.3.4 Wiring Multiple Power Stations (Boosters)

Always consult the manual for your system. The manufacturer's instructions supersede any recommendation here. There are many different systems of various configurations and we cannot cover them all and future product offerings.

Generally, power stations should be tied together with a system common, using a wire of adequate size to handle the current. Using a wire of the same size as the bus wire will assure it is of adequate size. This wire can be connected to the power stations at a point provided by the manufacturer. Often the connection to the power stations is to the metal enclosure by means of a fork or ring crimp on connector attached to the wire and placed under a screw on the power station enclosure.

This common connection provides a path for power between one power station and the next. This prevents any point on the layout from ever having a higher voltage than the power supply positive and a lower voltage than the common. It also provides a common return path for track power that is drawn between booster districts, either normally or during a short circuit condition. Because of the need to protect during short circuit conditions, the common wire should be the same size as the normal power district bus wire.

This common connection is very important to; prevent the potential for double voltage on common rail systems where one section is out of phase, and to allow locomotives with offset pickups to pass from one power district to another without stalling, or drawing propulsion current via the small gauge wire of power station drive lines.

This power station common, in most cases, should not be tied to earth or electrical system ground. Damage to equipment is possible if it is grounded and there is a power surge such as a lightning strike. The power supply to the power station may be grounded or isolated. Again consult the manual for your system for the manufacturer's recommendation.

Most manufacturers now produce systems with galvanic isolation of the command station. This is necessary if common rail wiring is in use to avoid a DCC signal on computers attached to the power station. In some cases, the cable from the command station to the computer is isolated. Again check your manual for specific instructions for your system.

2.4 Common Rail Wiring

Where one rail or the bus wire for that rail is continuous through the model railroad is called common rail. Although this can be implemented in DC powered model railroads, where each power pack (controller) has its own transformer. If used on DCC model railroads there is a risk, should two adjacent power districts or sub districts use common rail wiring without a system common between the power stations and the adjacent districts, be out of phase because one pair of bus wires was flipped; a voltage that exceeds the maximum voltage rating of the decoder could be present at the gap between these sections. Essentially this puts double the voltage of the power station at the single gap between the two districts. This can destroy a decoder.

It is recommended to have a power station common if using common rail wiring. See section 2.3.4 above.

2.5 Occupancy Detection

There exist several types of occupancy detection. We will not address external types such as magnetic reed switches or optical detectors (photo sensors or infrared), as they are external to the wiring of the track. The two common methods of current sensing detection are a voltage drop across a diode or bridge rectifier and a current transformer (CT).

2.5.1 Voltage Drop Detection

A diode or bridge is inserted between the Power Pack or Power Station and the track. As current flows to the track the forward bias of the diode is 0.7V. A transistor base is connected to the diode(s) and used as a switch to turn on a detection circuit when a current flows to the track. This does result in a voltage loss at the track. In DC the train will run slower for any given throttle setting. In DCC the power station voltage should be increased by 0.7V to compensate for this loss.

2.5.2 Coupling Transformer Detection

A short section of wire inserted in the bus is wrapped through the hole in a current transformer hole. The more wraps of the wire, the more current is induced in the CT coil for a given current in the bus. Using a CT coil keeps the detection circuit isolated from the bus. Circuitry connected to the coil detects the current and drives an occupancy detection indication. Often such circuits are equipped with a potentiometer for sensitivity adjustment of the detection circuit. This is particularly useful in DCC applications where capacitance and inductance of the bus is affected by the external bus wiring. See more details in 2.5.4 below.

2.5.3 DC Detection

Only a voltage drop type of detection works with DC propulsion wiring. The voltage to the trains will be reduced as mentioned above. The only other advisement is to keep the different track blocks separate when wiring.

2.5.4 DCC Detection

Either method will work with DCC. See recommendations in 2.4.1 above to compensate for the reduction of voltage at the track. Because DCC is a 10 KHz signal the impedance (capacitance and inductance) of the bus comes into play. One of the common detection methods used with DCC is a current sensing CT coil. When a vehicle which draws power is present on the track a current will flow. This could be a vehicle with a decoder, a light or a resistance wheel set. This current is coupled to the detection circuit through the CT coil.

Therefore, an RC filter as mentioned in 2.2.2 should not be used downstream from the current sensing detector. The small current passing through the RC circuit may give a false occupancy indication. Likewise twisting bus wires downstream from the detector can increase the capacitance of the bus, resulting in a current flow and may create a false occupancy indication.

3 Document History

Date	Description
Feb 23, 2021	First Release
Apr 9, 2021	Typos, punctuation and spelling corrected. Added definitions for zip cord, ringing and slew rate.
June 22, 2021	Added Figure 2.1
Dec-27-2023	Minor edits and clarifications section 1.3 Terminology. Additional information and clarifications added in sections throughout the document.

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 document.

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.