

SystemOneTM

OPERATION MANUAL

The Equipment described within this manual is compatible with the NMRA Digital Command Control Standards, as passed at the August 1994 meeting of the National Model Railroad Association and all of the applicable Recommended Practices as approved by the NMRA Board of Directors.

BY

WANGROW ELECTRONICS, INC.

Innovations in Model Railroad Electronics

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WHAT'S NEW

For software revision Nov. 29, 1995

- When you are presented with a choice such as “ENTER=ADV 1=OLD”, you no longer have to press ENTER after pressing 1.
- Enhanced Fast Clock Operation - 12 or 24 hour, Start (resume) and Stop.
- LOCO IN USE message if someone else is controlling the Loco that you are selecting. This protection may be turned off.
- If Emergency Stop is pressed 3 times, the message “Layout Stopped” is broadcast to all Cabs. Press **ENTER** to clear.
- Many more RS-232 Serial commands.
- More options during Loco programming. You are presented with a menu of choices at the start to permit you to go to a particular section. Also new is a way to program any CV on the mainline.
- Assign-able Horn and Bell functions.
- Assign-able number of RECALL's, from 1 to 6.
- Expanded programmability of Cab operations: The number of Cabs polled and the maximum Cab number that is allowed to alter the various programming (6 different settings).
- All Command Station configurations can be changed with the Cab, there is no need to open the Command Station and change Dip switches.
- Better Accessory operation.
- Accessory Decoder programming - both on the programming track and on the main.
- The short and consist address were limited to 111. Now that has been expanded to 127.
- Various cleanups.

WHAT'S NEW

For software revision Jan. 22, 1998

- NMRA conformance certificate #96-4 issued for this version of command station software.
- The Emergency Stop key now works at *any* time.
- When entering numbers, the existing number, if any, will clear when the first number is entered.
- Cab response has been improved and Cab 1 can now be used.
- Deluxe cab LCDs are again refreshed when assigning a loco to cab.
- Loco Aliasing is supported when using advanced consist. When setting up a consist, a long address can be entered for the lead loco. This address is the alias for the consist. If the consist address is an existing loco, the long address can be used to control a short address loco.
- Dynamic Cab Polling. The Number of Cabs setting in the Set Command Station has been removed. Cabs 1 through 6 are always polled, other Cabs are polled within 1.5 seconds. Once found, they are added to the polling sequence. This way any Cab number may be used.
- 200 Macros that each control up to 10 accessories (route control) are now supported along with a new user interface. There is a way to have a macro control more than the 10 accessories by linking.
- There is now an eighth selection under the **PROG** key. This selection is now PROGRAM MACROS. This is for setting up the new routing macros.
- Because there are now 8 menus to select from when pressing the **PROG** key, it is possible to "jump" directly to the desired menu. After pressing the **PROG** key, press a number from **1-8** to access the programming menus according to the following table:

- 1 = Program on Mainline
- 2 = Assign Loco
- 3 = Set clock
- 4 = Use Programming Track
- 5 = Setup Command Station
- 6 = Setup Cab
- 7 = Program Accessories on the main
- 8 = Setup or review routing macros

Press **9** or **0** to escape from an accidental **PROG** key press.

- During "SET CFG" on the programming track and mainline programming you are prompted for two new entries. They are as follows:

DIR BIT?	This sets CV29 bit 0 to 1 if the direction of the loco is to be reversed from normal (Check with the Decoder documentation to see if your Decoder supports this setting),
ENTER=NORM 1=REV	
ADV ACK?	This sets CV29 bit 3 to 1 if the advanced feedback from the decoder is to be enabled (this is for future use when the NMRA Recommended Practices implement advanced feedback).
ENTER=NO 1=YES	
- Due to popular request, there is a "hidden" fourth option to the "1=STD 2=CV 3=REG" prompt for using the programming track. If you press <4> you will be presented with a new prompt for reprogramming the entire decoder back to factory condition. This is only for System One, North Coast and Ramtraxx decoders. 64 Configuration variables will be programmed. 1->32 and 65->96
- There is a "hidden" fifth option to the "1=STD 2=CV 3=REG" prompt for using the programming track. If you press <5> you will be presented with a new prompt for programming the decoder with one of 10 pre-programmed speed tables. Press a number from 0 to 9 for the desired speed table. This is only for System One, North Coast and Ramtraxx decoders.
- Factory programming now programs both CV95 and CV9 with the motor PWM frequency for compatibility with both older and new decoders.
- New **SystemOne**™ Decoders (V1.6 and above for HO/N and V1.7 for 4 Amp) use CV9 for the PWM frequency to be conformant to RP-9.2.2.
- A new RS-232 command ('I') to support the Auxillary Input Units and the Block Occupancy Detectors.
- New serial commands to set the speed, direction, and functions in one command.
- A new serial command to request the status of any loco.
- A binary command set for the serial interface.

GETTING STARTED

ACKNOWLEDGMENTS

We at Wangrow Electronics, Inc. would like to extend our thanks to each of the many NMRA members who volunteered their time and expertise in developing and up-dating this great Digital Command Control Standard and the accompanying tentative Recommended Practices. Because of their effort a hobbyist will be able to select the level of DCC control and those particular operating features that he needs from the various manufacturers that are building their products to the standards.

ABOUT WANGROW ELECTRONICS, INC.

We, Don Wangrow (HO scale) and Dennis Ingersoll (N scale), have been model railroad enthusiasts for a combined total of over 60 years. We became seriously interested in Digital Command Control in 1993 while planning a layout of our own. Discouraged by the amount of time and money that would have to be spent in wiring, we saw Command Control as a way to greatly simplify the job we faced. Not being happy with the early DCC products on the market, we decided to design and manufacture a DCC compatible system of our own.

Our first order of business was to survey as large a cross section of hobbyists as we could, to determine the control and operating features they desired. After compiling data from all of these responses, we developed specifications for a product that contained the features requested by hobbyists in a format that would not be excessive in cost.

Our next task was to find a good engineering firm that had a Project Manager, Karl Kobel (HO scale), that was also a seasoned model railroader. Karl, and the team under him at MDS, have been fantastic in improving our original design concept. Karl is also the owner of K² Engineering, the company that provides us with EasyRamp, Commando, and LocoCommand.

Rather than do our programming in-house, we chose to work with a member, Jim Scorse (O scale), of the DCC Committee to assure immediate and total compatibility with the DCC Standard. This also assured us of a very quick Start-up time. Jim has been a real asset in the great ideas he has put into the software. Jim is also the owner of North Coast Engineering and provides engineering and manufacturing for a number of our products..

We are quite happy with our product line and feel that the hobbyist is getting a good product for his dollar. Our ongoing questionnaires, and owner feedback, will assure us that the hobbyist's opinion will always be heard and heeded.

As you may notice from above we also represent three scales on our staff. This was accidental, but assures us of thinking of many scales when the thoughts involve product development.

CUSTOMER SERVICE

Customer Service is directly through Wangrow Electronics. Please write or call us before returning any products to our offices. If writing make sure you include your a phone number and the times that you can be reached at this number. This will greatly expedite our service to you if you have questions.

Wangrow Electronics, Inc.
1500 W. Laverne
Park Ridge, IL 60068-2562

Phone:..... 847-696-3294

Fax:..... 847-696-3797

E-Mail Address:systemone@wangrow.com

World Wide Web Home Page:..... <http://www.wangrow.com>

WARRANTY INFORMATION

We provide a five-year warranty on all items except three years for loco decoders sold by Wangrow Electronics, Inc. The only exceptions are damage due to intentional misuse, dropping, installation contrary to the instructions in this Operation Manual, customer-attempted repairs or modifications, and Acts of God. We reserve the right to either repair or replace **SystemOne™** components sent to us for in-warranty service.

The warranty period will begin on the date shown on your retail sales receipt.

REPAIRS

We provide out-of-warranty repairs for all items we sell. Repairs will be performed for the cost of replacement parts plus labor and return shipping charges.

Please do not send anything for repair without first writing or calling to explain the problem. We will promptly reply to your inquiry, send you an estimate of the cost of that repair and a repair order number that you should place on the outside of your package. Please note that we will not accept any package without this repair number. Also include your address and phone number.

WHY SHOULD I REGISTER MY SYSTEM?

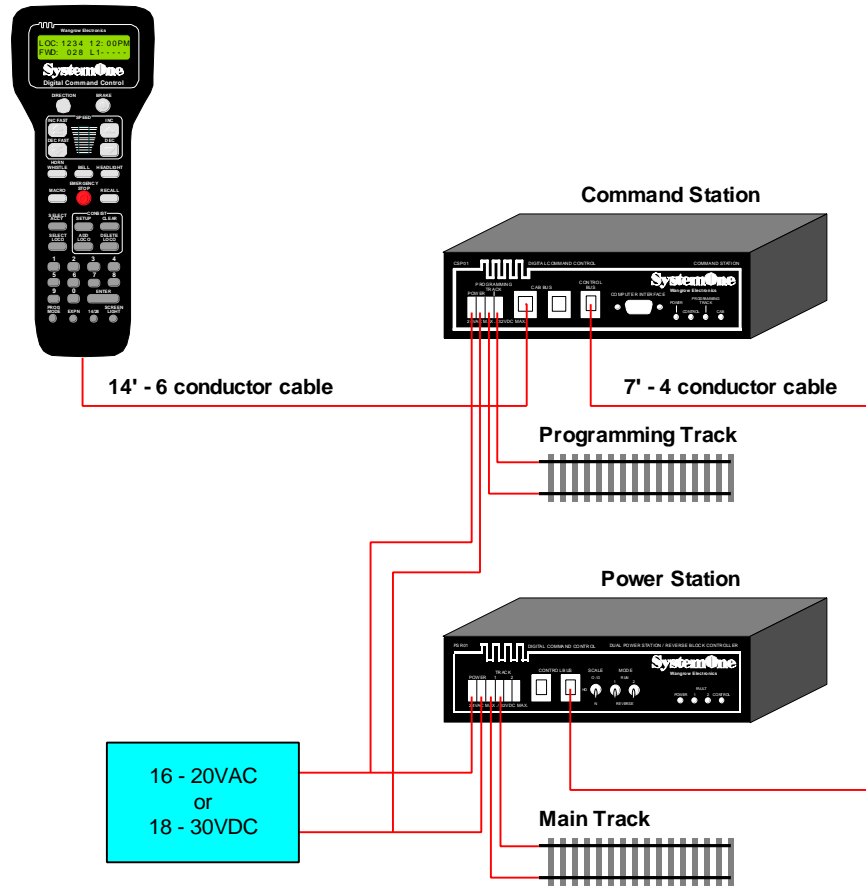
By registering your **SystemOne**[™] DCC system with us you will receive personal notification of any software and hardware up-dates.

We also hope to use these mailings as an opportunity to pass along noteworthy installation information, wiring hints and optional interface and programming tips developed by other users.

QUICK START

UNPACKING YOUR SYSTEM

All the devices and cables are in a **STARTER PACK** except the decoders, which need to be purchased separately. Disconnect the existing power supplies from your layout.



We recommend that you first connect your system similar to the above diagram. After your system is checked out completely then consider the final location for all components.

CONNECTING THE COMPONENTS

- Connect the 14 foot, 6 wire cable from the Command Station Cab Bus port to the Cab.
- Connect the 7 foot, 4 wire cable from the Command Station Control Bus port to the Power Station/Reverse Block Controller.
- Connect the Power Station/Reverse Block Controller Track #1 terminal points to the track system.
- Set the Scale switch to the scale of your layout. **10Amp Power Station owners check section on page 2-9 for correct voltage switch positions.**

Switch Pos.	Scale (as marked)	Scale (as recommended by the NMRA)	Voltage
Up	Large	G	22VDC
Center	HO	O, S, HO and N	14VDC
Down	N	Z	10VDC

- Set Mode Switch #1 UP for Run. This is the switch that controls Track #1 which is the basic track power.
- Once you understand the features, and have operated some trains, you will be able to determine the best way to block the layout and set the mode switches for permanent installation.
- Set Mode Switch #2 DOWN for Reverse. This is the switch that controls Track #2 which is now set for operating reverse blocks, wyes, and crossovers.
- Now provide power to the Command Station and Power Station/Reverse Block Controller from your existing power supply. Use fixed AC or DC only, not variable DC. **Please note that a minimum of 20VA is required to operate the Command Station, Power Station and one HO loco.** Failure to provide this amount of power will cause erratic loco operation or no operation at all.
NOTE: This should be considered temporary. Please see Section 7-26 for suggestions for the correct transformer.
- Now install your decoder in a loco. It is easier if just the track and motor wires are connected at this time. Leave the shell off for now.

INSTALLING THE DECODER

Read the section on decoders before starting. There are shortcuts to temporary installation of the other components, but do not shortcut the decoder. We strongly suggest that the decoder plug be used and you do not cut off the wires, if possible.

PROGRAMMING THE DECODER

All decoders come with the loco address of **3**. Install and test your Loco's using this address. Programming should wait until after the loco is known to work properly. When programming make sure that you go through *all* of the standard programming steps. This assures that the configuration variable is set correctly (the most common mistake is choosing a long address and not setting the long address selection in the CFG section). See programming section starting on page 4-15.

RUNNING YOUR FIRST DCC LOCO

The Cabs are factory set to dial. First turn the dial all the way down. Press **SELECT LOCO** then enter the number **3** for the loco address and press **ENTER**. If you are using **SystemOne™** decoders you will want to press the 14/28 key until the lower right screen displays "128". Now increase the loco's speed by slowly moving the dial up, and you are on your way. Do not use the address "**03**" as it represents a long address. All decoders come factory set with the Short Address = "3" so that they may be used on the systems that only address the basic features.

GENERAL INSTALLATION

DEVICE LOCATIONS

The physical locations for the Command Station and Power Station/ Reverse Block Controller can be anywhere. We *suggest* a location where the LED's on the front can be easily seen should there be a problem. Each CAB BUS BOARD comes with a 14 foot cable to connect to the next one. This we feel is the average distance between plugs. In yard areas more will be needed and along long stretches of scenic routes the distances could be longer. We suggest that a plug be no more than three feet from any siding where and operator would most likely stop and spend some time.

POWER REQUIREMENTS

Power for a Power Station should be about 10 percent over the needs of the track blocks. No consideration is given below for switch machine or other accessory operation by decoders. Those hobbyists that feel these products will be on their layout in the future should leave additional amperage free for expansion.

EXAMPLE #1:

DUAL 5 AMP POWER STATION FOR HO LAYOUT

TRACK #1 - LAYOUT POWER	5 AMPS
TRACK #2 - REVERSE BLOCK POWER	2 AMPS
POWER STATION POWER LOSSES	<u>1 AMP</u>
TOTAL POWER REQUIREMENT	8 AMPS

This power can be provided with an 8 Amp, 16 volt transformer or larger. $8A \times 16V = 128VA$ or 128 Watts. A transformer of a larger voltage and smaller amperage can be used, as long as it has 128 Watts or greater, the Power Station will convert the voltage to amperage. Our recommended transformer is 10 amps at 18 volts for the dual 5 amp booster. This provides a safe overhead of power for all conditions.

EXAMPLE #2:

DUAL 5 AMP POWER STATION FOR HO LAYOUT

TRACK #1 - LAYOUT POWER	5 AMPS
TRACK #2 - LAYOUT POWER	5 AMPS
POWER STATION POWER LOSSES	<u>1 AMP</u>
TOTAL POWER REQUIREMENT	11 AMPS

This power can be provided with an 11 Amp, 16 volt transformer or larger. $11A \times 16V = 176VA$ or 176 Watts. A transformer of a larger voltage and smaller amperage can be used, as long as it has 176 Watts or greater, the Power Station will convert the voltage to amperage. Our recommended transformer is 12 amps at 22 volts for the 10 amp booster. This provides a safe overhead of power for all conditions. See EX #1

The Command Station can be powered by the same transformer as long as the transformer is sized large enough. Figure that the Command Station uses 2 Amps at 12 Volts or 24VA and add this to the total requirements of that transformer. If a transformer is oversized for your needs it will run cooler and last much longer. See the Appendix, page 6-6, for recommended transformers.

PROGRAMMING TRACK

We suggest that the Programming Track is connected with a double-pole double-throw switch that is used to isolate this segment from the rest of your layout. This is needed to complete the necessary start up programming for each decoder-equipped loco. A good location would be a siding that allows you easy access for placing locomotives on this track, is close to your double-pole double-throw switch and allows you to clearly see the status lights on the Command Station. See schematic on page 6-6.

When using the Programming Track, the remainder of the layout is stopped. Except for the loco's address, all other parameters can be changed on the mainline, using the "Programming on the Main: feature, without shutting down the whole layout. This cannot be done with your MRC or Older Lenz and Older Digitrax decoders. The Programming track can be in multiple locations on the layout but, it is not used often and one convenient location will be plenty. Some owners have setup their shop loop to be DC, DCC, and DCC Programming Track, then they can do all the testing in their shop and have only ready-to-run loco's on the layout.

REVERSE BLOCKS, WYES, AND CROSSOVERS

We suggest that unless it is likely that trains will cross over the insulation points of multiple reversing blocks at the same time, do not run off and purchase an extra Power Station/Reverse Block Controller until it has been proven that more units are needed. Our suggestion is to wire each Reverse Block to separate points on a terminal block and jumper them there, that way if it is found that an additional Reverse Block Controller is needed, removing jumpers and rewiring will be kept to a minimum.

WIRING

If you already have a layout, your existing wiring most likely can be used without problems. If wiring from your blocks was terminated at terminal blocks, we suggest jumpering them together there. If your track power was provided by parallel "bus" wires that followed the track, you will have no problem either. The only important details about the wiring system used for **SystemOne™** are that the main conductors be sized for the total amperage they are going to carry and that all termination's are solid. Of course this is the way any layout should be wired. Given the 5 ampere limit on each Power Station circuit the only reason to use wiring larger than #16 gauge is to prevent voltage drop over long runs. A number of hobbyists do not sleep well if the wire size is not at least #10.

For the hobbyist wiring up a new layout our suggested wire sizes based on voltage drop are:

Dual 5 Amp Power Station

Runs to six feet	#16
Runs to fifty feet	#14
Runs over fifty feet	#12

10 Amp Power Station

Runs to six feet	#16
Runs to fifty feet	#12
Runs over fifty feet	#10

There is no special requirement for routing the power conductors with DCC. Parallel wires, twisted wires, whatever is convenient for you. No signals are lost or added to others.

OPERATING FEATURES

SYSTEM FEATURES

- Designed and built to NMRA standards S-9.1 and S-9.2 for Digital Command Control (DCC), and Recommended Practices RP-9.1.1, RP-9.2.1, RP-9.2.2, RP-9.2.3, and RP-9.2.4.
- Suitable for all scales, N through G.
- Compatible with DCC systems manufactured by North Coast Engineering, RamTraxx, Lenz, Digitrax, MRC, Arnold and any future system built to the NMRA standards.

CSP-01 COMMAND STATION

- Open addresses range with 9,999 possible numbers.
- Operate up to 255 locomotives and/or consists independently.
- Utilize up to 63 Cabs simultaneously for locomotive control.
- Microcontroller based design means that future upgrades can be made by installing new software through the removable EPROM. There will be no need to replace **SystemOne™** hardware.
- Memory feature allows you to connect and disconnect operating Cabs at will. Trains will continue at their last setting until you reconnect your Cab and send a new instruction.
- Battery Back-up for Command Station settings and macros.
- RS-232 plug - Computer Terminal Plug for communication with your PC.
- Software that allows all decoder settings to be changed while the loco is being operated (except for changing the decoder address).
- The ability to write and use “Macros” - Route lists that control the Accessory Decoder. Program and select 200 different “routes” with up to 10 Accessory commands per route. Use Commando Software to make it easier to program and save your routes.
- Consist set up both the Basic style (MRC, older Lenz and Digitrax) and Advanced (**SystemOne™**) decoders. You can even add multiple consists to a consist.
- Operate loco's in the 14, 28 or 128 speed step modes. Some entry level decoders by others may restrict you to the use of 14, or 28 speed step mode only for their decoders.
- Analog locomotive control plug.

SBR-01 DUAL 5 AMPERE POWER STATION AND REVERSE BLOCK CONTROLLER

- Dual unit, a user may set the two sub-units to operate as dual signal boosters, a signal booster and reverse block controller, or two reverse block controllers.
- Automatic Reverse Block Controller handles reversing blocks and wyes transparently.
- Each sub-unit will handle up to 5 amperes continuously.
- Accepts input voltages over a range of 16 to 20VAC and 18 to 30VDC.
- Selectable outputs of 10, 14, and 22 volts. 8, 12, and 20 volts to the motor.
- Computer-grade power regulation employing no waiting for a thermal overload to cool. Remove the short or overload, and all loco's immediately start operating again.

SBR-11 10 AMPERE POWER STATION AND REVERSE BLOCK CONTROLLER

- Automatic Reverse Block Controller handles reversing blocks and wyes transparently.
- The circuit will handle up to 10 amperes continuously.
- Accepts input voltages over a range of 16 to 22VAC and 18 to 30VDC.
- Select-able outputs of 15.5 volts and variable 11.5 to 22.5 volts..
- Computer-grade power regulation employing no waiting for a thermal overload to cool. Remove the short or overload and all loco's start operating again after a short delay (switch set-able).
- Current Monitor Output - 0.1 volts per 1 amp.

WCT-01 WALK-A-ROUND CAB

- Tethered, hand-held unit. Your choice of fixed or movable tether by simply changing connecting cords.
- Movable tether is equipped with a standard, 3-wire, 1/4" diameter phone plug for durability and ease of connection.
- Backlit liquid crystal display LCD screen that displays the address of the loco being controlled, Scale Time, Loco direction, Loco speed step, and Loco function Status.
- Set speed, direction, momentum and braking functions from Cab.
- Equipped with both push-button and thumbwheel speed controls. Choose the operating mode you prefer.
- User select-able "momentum" for simulating the effects of inertia on train operation.
- Operate one locomotive or consist from each Cab or several. The **RECALL** key which can be set to recall from 1 through 6 loco's conveniently. (You'll only be limited by your dexterity and nerve.)
- 128 step speed control forward and reverse. (14 or 28 step speed control when using momentum.)
- Capable of operating 14, 28, and 128 step decoders from other DCC systems.
- Sound-ready, with provisions for controlling customized steam, diesel, horn, whistle and bell effects from each Cab. The only line of Cabs that allows you to be changing the locos speed *while* you are blowing the Horn/Whistle, or changing a Function output.
- Provision for operating decoder-equipped switch machines and accessories from each Cab.
- Scale Time. Ability to set ratio from 1/1 through 25/1. Operate either with a 12 hour (AM/PM) or 24 hour (Military, Canadian, and European) clock.
- Use as a Dispatcher and assign Basic Cabs the loco or consist that engineer will be operating and for dispatcher control of switch machines and other accessories.
- Configurable 'Safe Mode' that does not jump the new loco to the previous loco's speed when using recall. Also, the Brake key will set the loco's speed to zero. To regain control, rotate the knob to the present speed.

WCT-02 WALK-A-ROUND CAB

- Same Basic Features as the WCT-01
- Fully digital speed control knob.
- Speed keys and knob are simultaneously active.
- The Brake key is always active.
- Audible feedback (user set-able for key press, knob speed changes, and when the speed reaches zero).
- Select-able Yard Mode setting. When enabled, rotating the knob up from speed zero, will increase the speed in the forward direction. Rotating the knob down from speed zero, will increase the speed in the reverse direction.
- Digitally controlled backlight. The on/off state is remembered by the microprocessor's non-volatile memory.

WCT-11 and WCT-21 BASIC WALK-A-ROUND CAB

- Tethered, hand-held unit. Your choice of fixed or movable tether by simply changing connecting cords.
- Movable tether is equipped with a standard, 3-wire, 1/4" diameter phone plug for durability and ease of connection.
- Set speed and direction functions from Cab.
- Equipped with speed control knob (WCT-11).
- Equipped with speed control buttons (WCT-21).
- Buttons for Headlight, Horn, and Bell.
- Separate Forward and Reverse buttons.
- Emergency Stop button.
- 128 step speed control forward and reverse. (14 or 28 step speed control when using momentum.)
- Capable of operating 14, 28, and 128 step decoders from other DCC systems.
- Sound-ready, with provisions for controlling customized steam, diesel, horn, whistle and bell effects from each Cab. The only line of Cabs that allows you to be changing the locos speed *while* you are blowing the Horn/Whistle, or changing a Function output.
- Ready for installation of the RU-01 Radio Unit to make the Cab wireless (future product).

WCT-31 and WCT-41 INTERMEDIATE WALK-A-ROUND CAB

- Tethered, hand-held unit. Your choice of fixed or movable tether by simply changing connecting cords.
- Movable tether is equipped with a standard, 3-wire, 1/4" diameter phone plug for durability and ease of connection.
- Set speed and direction functions from Cab.
- Equipped with speed control knob (WCT-31).
- Equipped with speed control buttons (WCT-41).
- Numeric keypad for functions 1-8 and selecting loco's.
- Buttons for Headlight, Horn, and Bell.
- Separate Forward and Reverse buttons.
- Emergency Stop button.
- 128 step speed control forward and reverse. (14 or 28 step speed control when using momentum.)
- Capable of operating 14, 28, and 128 step decoders from other DCC systems.
- Sound-ready, with provisions for controlling customized steam, diesel, horn, whistle and bell effects from each Cab. The only line of Cabs that allows you to be changing the locos speed *while* you are blowing the Horn/Whistle, or changing a Function output.
- Ready for installation of the RU-01 Radio Unit to make the Cab wireless (future product).

BOD-20 BLOCK OCCUPANCY DETECTOR

- Can detect Locomotives and rolling stock.
- No electrical connection to track wiring.
- Very low sensitivity - down to 1.8mA (even lower for Power Station with maximum outputs lower than 5 Amps).
- Two wire interface - self powered.
- Small size - 1.2" x 0.75"

AIU-14 AUXILLARY INPUT UNIT

- 14 general purpose inputs
- Plugs into Cab Bus
- Set-able address

CBB-01 CAB BUS BOARD

- Equipped with 2 - 1/4" diameter, 3-wire phone jacks for connection of operating Cabs.
- 2 built-in RJ-12 6-wire telephone jacks for Cab Bus connections.
- Boards may be interconnected using standard 6-conductor 22 gauge telephone wire with RJ-12 plugs on each end. "Daisy-chain" as many together as you need (Do *not* close the loop). Cable, plugs, and a crimp tool is sold at Radio Shack & Digi-Key, and plugs are available at most hardware stores. This will allow you to run cables from Cab Bus to Cab Bus at the proper length, if desired.

NOTE: If you make your own cables, be sure to fully crimp the connector to the cable or you'll damage the socket on the Command Station or Power Station (I speak from experience on this one, KK). Also, AMP connectors work the best.

CBT-02 CAB BUS TEE TRANSFORMER

- 800 milli-amp, 12 volt DC power supply, with 3.5mm plug, for CBT-01.

LOCOMOTIVE DECODERS

- 7 bit short address for compatibility with the Basic systems by Arnold, Lenz, MRC, and Digitrax.
- 14 bit long address for being able to address any loco number through 9,999.
- 7 bit Consist address for being able to define a Consist address different from a loco address. Now the consist can be addressed as the train number as long as it is no higher than number 127.
- Ability to reprogram all of the following configuration while the loco is in operation on the main track as well as on the Programming Track.
 - Acceleration.
 - Deceleration.
 - Starting voltage.
 - Speed step mode (14, 28, 128).
- Use of standard or alternate speed stable.
- Change between the short and long address at will.
- Ability to change the individual speed steps of a decoder to truly have *any* loco's operate the same at any speed step. See listing on **EasyRamp** software, on page 1-22, for the ability to do this quickly.
- Plenty of function outputs for Front and Read Head Lights, Strobe Lights, Mars Lights, and Ditch Lights. The operator will find a use for all of them and want more.
- Overload shutdown protection.
- Factory software upgradable microprocessor, except DN-103 and DH-104.
- All of our decoders have the ability to operate on DC (conventional) layouts.
- Momentum, which can be set as long as 3.8 minutes for zero to full speed. The train made up of two loco's and 125 cars will respond like it should, - - - eventually.

DN-103

1.0 ampere, 3 function decoder for N scale and low current drawing HO and S locomotives that don't have room for larger Decoders.

DH-105

1.0 ampere, 5 function decoder for HO and S locomotives. Has 3 outputs wired with 2 additional for you to wire out if needed. Meant to fit in the area designed for the Lenz LE-100R in the European loco's.

DH-155 (Black Cover) - original decoder

1.5 ampere, 5 function decoder for HO and some S and O scale locomotives. Can be reprogrammed to operate on DC power.

DH-155 (White Cover) - new smaller replacement

1.5 ampere, 5 function decoder for HO, S and some O scale locomotives.

DH-155 (White Cover) -

1.5 ampere, 5 function decoder for HO, S and some O scale locomotives.

DH-104

1 ampere, 4 function decoder for specific Atlas, Kato, and Steward Locos.

DO-407

4 ampere, 7 function decoder for O, G and some HO and S scale locomotives

DO-407 - New design dated 1-MAR-96

4 ampere, 7 function decoder for O, G and some HO and S scale locomotives

DH-157A

1.5 ampere, 7 function decoder for Athern locomotives

DH-103

1 ampere, 3 function decoder for Atlas S series locomotives

STATIONARY DECODERS

- Ability to reprogram the following configuration setting changes without removing the track termination's and connecting to the programming track..
 - Output ON time.
 - Other future features.
- Re-programmable micro-processor for up-grading the software.
- Compatible with the NMRA Standards and Recommended Practices.
- 1.5 ampere overall current capacity.
- 0.5 ampere (500ma) minimum is available for the each switch machine.
- All outputs are both current sinking and sourcing.
- ON time programmable from 0.1 second to 25.5 seconds, and always ON.
- LED indicator to verify proper DCC packet information is being received.
- LED indicators for showing active outputs. Great for trouble-shooting.
- Terminals for manual Push Button control.
- Capable of being controlled from the full featured cab, a dispatch program on a PC, and local push buttons.
- Addressable from 1 through 511. This allows 2044 switch machines to be controlled (4 x 511).
- Allowable auxiliary power from 3VDC to 20VDC to reduce the power requirements of the Power Station.
- Capable of driving snap-type coil, slow motion motor, and capacitive discharge directly with no additional circuitry.
- Now add signal displays using LocoCommand and other PC based software.

SOFTWARE

EasyRamp

This software program is a Windows based program on a 3.5" disk that is used for redefining the individual speed steps, short address, long address, start voltage, acceleration, deceleration and other configuration variables of their decoders. The ramps can be saved to files for reuse. It also can read the present ramp and other parameters from the decoders. The program comes with a number of pre-defined ramps for the hobbyist to browse through and try in their decoders. For the hobbyist that wants to change the speed tables to make dissimilar loco's operate the same, this program is a real Godsend.

The program requires a minimum of a 80286 or better microprocessor, MS DOS 3.1/WINDOWS 3.1 or Windows 95 Operating System, hard drive space of 500k or better, for saving ramps, and a mouse. While it needs only 2MB of system memory, 4MB allows faster operation.

- Provides the ability to fine tune all loco's to act equal if you so choose. Now that project was shortened considerably with this program as compared with using the Cab for speed step value changes.
- Assign all decoder values quickly. Make new loco's operate exactly like an existing one quickly by copying the speed table to its decoder fast.
- Windows 95™ compatible.

Commando

Commando is a program to save and restore Command Station settings (like EasyRamp for the Command Station). You can backup your settings for later restoring, or save several files for different operating sessions. It can also be used to change those settings. If many Macros are utilized, Commando shows each macro, and it's counterpart, at a glance.

The user interface is arranged as a set of Tabs on the main dialog. In Windows 95 these are known as Property Pages. Click on the Title (the Tab) of the page to bring it to the front. Now you can view and change the setting for that page. The following is a list of all of the pages.

- Assign Loco to Cab
- Set Clock
- Macros
- Command Station Parameters
- Cab Parameters
- Loco Alias's

When Read is pressed, the settings are read for all of the pages. When Send is pressed, the settings on all of the pages are sent to the Command Station.

The program requires a minimum of a 80286 or better microprocessor, MS DOS 3.1/WINDOWS 3.1 or Windows 95 Operating System, hard drive space of 500k or better, for saving setups, and a mouse. While it needs only 2MB of system memory, 4MB allows faster operation (8MB for Windows 95).

LocoCommand

LocoCommand is a program to make it easier to control all or part of your layout. It runs on a computer connected to a **SystemOne™** Command Station. The user accomplishes this by entering commands in a list. Commands are executed one after another, based on some “time”. The time can be real-time (the PC’s clock) or SystemOne’s Fast Clock, and can be absolute (do something at 10:55) or relative (do something 30 seconds from the last command). The following is a list of the commands.

- Loco Send speed and direction to a particular loco
- Function Turn functions on or off
- Accessory Control accessories
- Cab Display two line of text on any display type Cab
- Message Display message in the lower right corner of any display type Cab.
- Loop Go back to and line in the list a specified number of times.
- Wait Wait for an input from the AIU.
- Skip Skip the next command based on an input from the AIU.
- Goto Go to any line.
- Execute Start or Stop another open list of commands.

There can be any number (limited only by your memory) of open command lists, and lists can be saved and loaded individually, or as a set of lists (a project).

The program requires a minimum of a 80286 or better microprocessor, MS DOS 3.1/WINDOWS 3.1 or Windows 95 Operating System, hard drive space of 500k or better, for saving setups, and a mouse. While it needs only 2MB of system memory, 4MB allows faster operation (8MB for Windows 95).

Railroad & Co.

Railroad & Co. provides you with the ease of point & click to operate your switches, signals, routes and other accessories displayed on track diagram panels, which are individually created for each yard or section as desired. You can run your trains with on-screen throttles, external Cabs connected to your computer, or with the SystemOne Cab. Far reaching automation features make railroad operations manageable by one person, which match those found on the largest club layouts. Train indicators enable you to display on the screen which engine/train is on which track

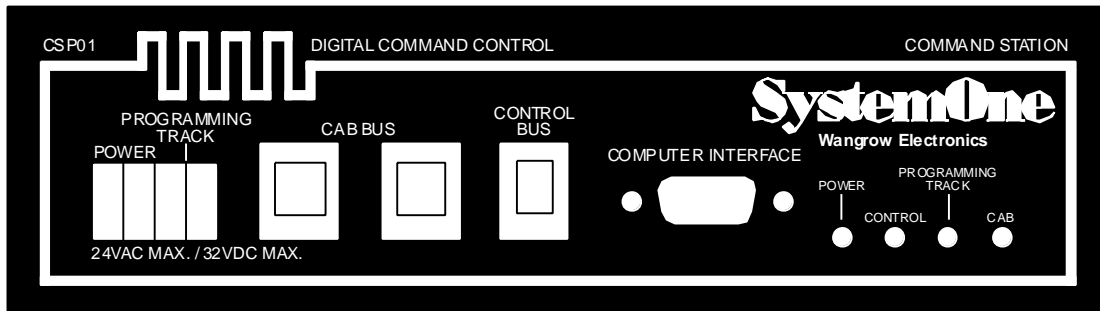
- Use of *Railroad & Co.* is possible without the need to be a Computer expert or programmer.
- Graphical items are provided instead of an abstract command syntax.
- The operation is based on natural objects like trains, switches, signals etc. instead of digital addresses or something else.
- Activities are natural:
- Point to a signal and set it to red with a simple mouse click instead something like "set contact output of decoder 35 to 1".
- Accelerate a train to speed 35 mph instead something like "set speed level of train decoder 16 to 7".
- Automatic Operation can be arranged within minutes without the need to learn a programming language first.

Requirements

- The minimum hardware requirements cannot be determined exactly. But the software operates well on the following configuration:
- IBM-compatible Personal-Computer
- CPU: INTEL 386 SX 16 MHz when using the Dispatcher 486 or better recommended
- Graphics: VGA 640 x 480
- Memory: 4 MB (8 MB for Windows 95, 16 MB for Windows NT)
- Hard-Disk: 2 MB free space
- I/O-port: 1 free serial communications port
- MS-Windows 3.1 or 3.11, Windows 95 or Windows NT

GETTING TO KNOW YOUR EQUIPMENT

GETTING TO KNOW YOUR COMMAND STATION



COMMAND STATION

FRONT PANEL CONNECTIONS

POWER - TERMINALS

The Power Terminals should be connected to a power supply of between 16 to 20VAC or 18 to 30VDC. We recommend using a 16VAC or 18VDC power supply. The terminals will accept any wire size up to #12. Minimum recommended wire size is #16.

INPUT VOLTAGE NOT TO EXCEED 20VAC OR 30VDC

PROGRAMMING TRACK - TERMINALS

The two connecting wires from your Programming Track should be connected here. If the track is to be used for train operation as well, it should also be connected to a double-pole/double-throw switch. To do this please refer to the wiring schematic showing the double-pole/double-throw switch on page 6-6.

CAB BUS - TWO 6 WIRE RJ-12 SOCKETS

Allows two Cab Bus cables to be connected. For small layouts and for checking-out the system before final wiring, the Cabs can be directly connected to the Command Station. For larger layouts this provides the ability to route Cab Buses in two separate directions.

DO NOT FORM A LOOP BY CONNECTING THE TWO ENDS TOGETHER.

CONTROL BUS - 4 WIRE RJ-H SOCKET

Connect the 4 pin cable from this socket to the first Power Station.

RS-232 PLUG - COMPUTER TERMINAL

This terminal allows those hobbyists who want to have access to their layout via a personal computer to do so. See the section on **RS232 SERIAL COMPUTER INTERFACE** on page 5-2.

POWER - LIGHT

Indicating light showing that the Command Station has power.

CONTROL - LIGHT

Indicating light shows that the control output is being routed to the Power Station and the Main. When the Command Station is in the "Use Program Track" mode, this light is OFF.

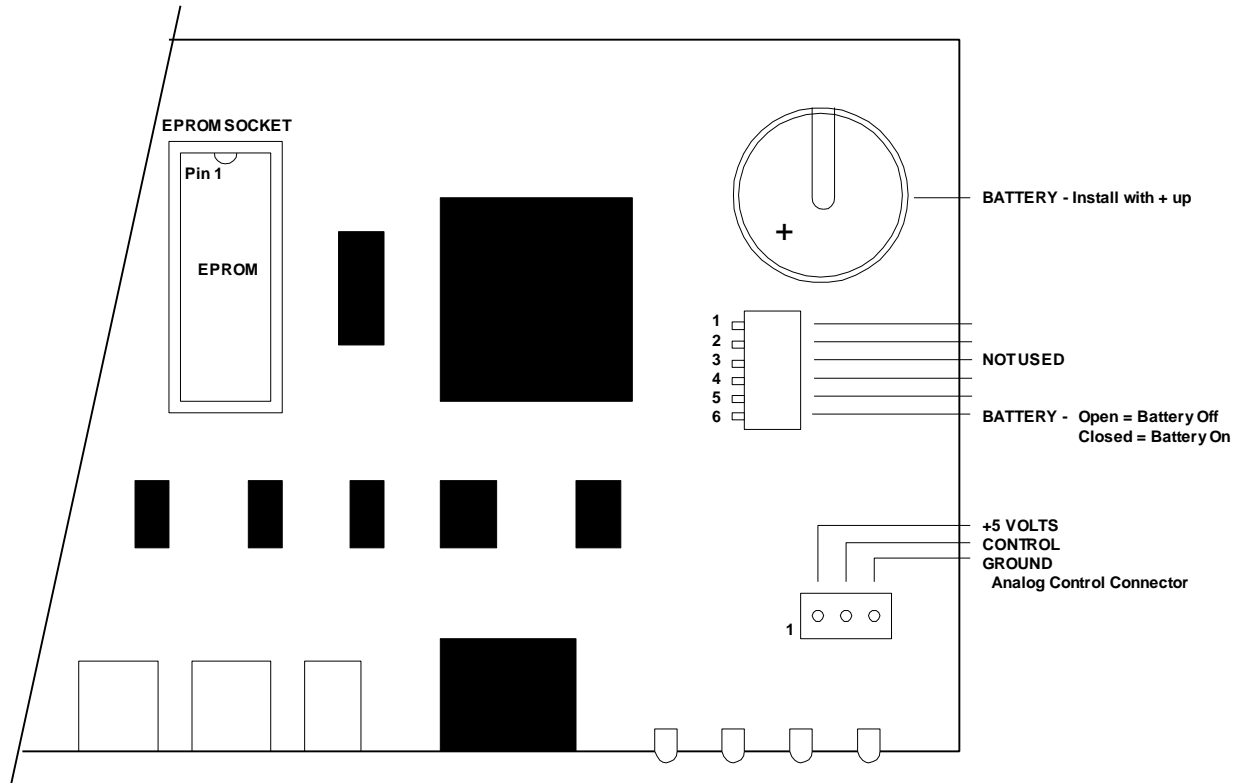
PROGRAMMING TRACK - LIGHT

Indicating light shows that the control output is being routed to the Programming Track, and that Command Station is in the "Use Program Track" mode. In this mode, some of the other indicating lights will change status and all trains will come to a stop.

CAB - LIGHT

Is always on when the Command Station has power.

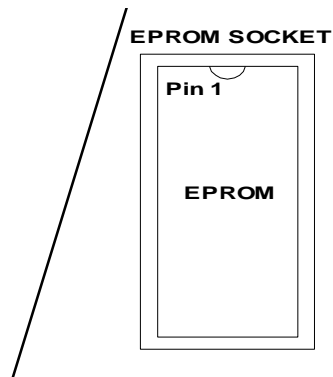
IMPORTANT INTERNAL COMPONENTS



PARTIAL PLAN OF COMMAND STATION
(Shown with housing removed)

The components shown in the plan above and described below are the only internal components you need to know about (user serviceable). To open the Command Station remove the four screws from the bottom and slide the top cover off to the rear.

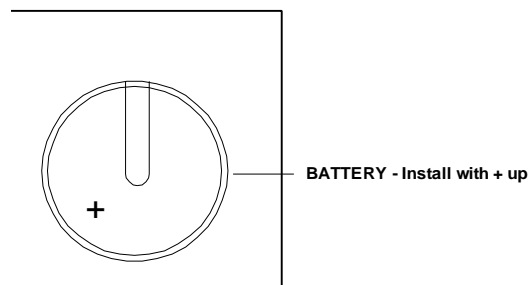
EPROM



The **EPROM** is replaceable for future software up-dates. Do not remove it for any other reason. When a software up-date becomes available we will inform all registered owners by mail. At that time you will be provided with upgrade procedures and cost.

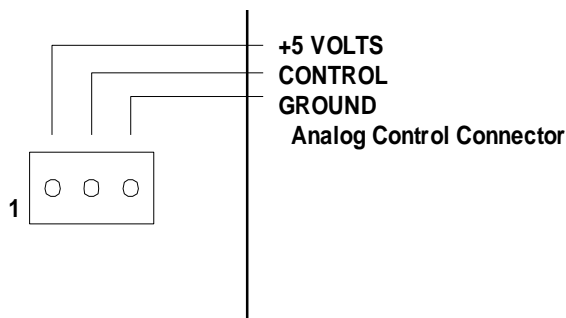
When replacing the E-prom note that the notch is to the rear of the box. **THIS IS VERY IMPORTANT TO GET RIGHT.**

BATTERY



A battery back-up is provided to allow **SystemOne™** remember Cab assignments etc. when the power is turned off. The battery should be replaced with a **CR-2330 3 VOLT LITHIUM** in about 3 years. Contact us if you can not find it in a computer store.

ANALOG LOCOMOTIVE CONTROL PLUG

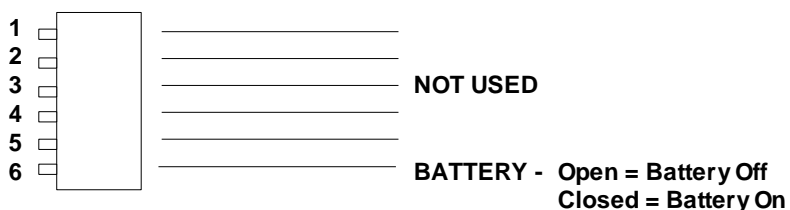


This is the plug to operate one stock analog locomotive without a decoder. Expect any loco operated this way to make strange sounds. Refer to page 6-7 for schematic of Cab. (Controller not included).

Locomotive manufactures do not recommend leaving a non DCC locomotive on a powered DCC track for extended periods of time. The motor magnets can be de-magnetized by the AC on the track.

CONFIGURATION SWITCHES

The new software has eliminated the need for most of these switches. The features that these switches controlled can now be set from a full featured Cab. See Programming section starting an page 4-24. The only switch that is being used is switch 6.



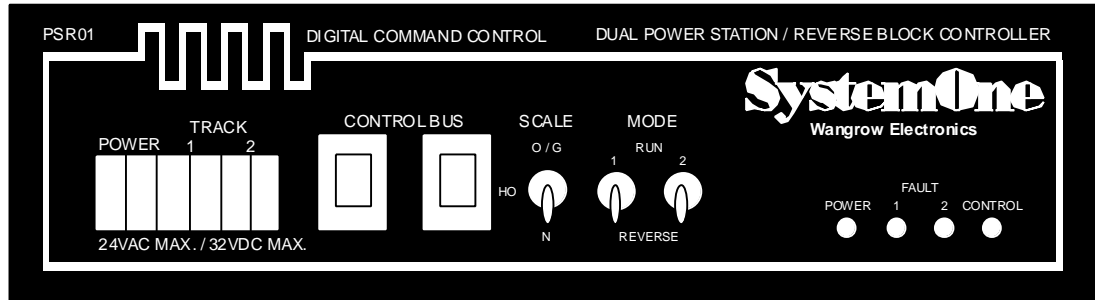
SWITCH 4

Baud rate. If this switch is open (default), the serial baud rate is 9600. If this switch is closed, the serial baud rate is 19200.

SWITCH 6

Battery on. Should the operator want to reset the Command Station to “FACTORY SETTINGS” turn the battery OFF, turn the power to the Command Station OFF, then ON. All changes have now been cleared. Now turn the battery back on. Default = On.

GETTING TO KNOW YOUR DUAL 5 AMPERE POWER STATION/REVERSE BLOCK CONTROLLER



Power Station/Reverse Block Controller Elevation

FRONT PANEL CONNECTIONS

POWER - TERMINALS

The Power Terminals should be connected to a power source within the ranges given below, as determined by the voltage level that is appropriate for the scale being powered. The terminals will accept any wire size up to #12. (Allied Electronics (Phone 1-800-433-5700) 10 Amp, 18VAC, Cat No 836-6155 is suggested.

INPUT VOLTAGE NOT TO EXCEED 20VAC OR 30VDC

The Power Station will automatically step down the voltage and increase the amperage according to the standard $WATTS = VOLTS \times AMPERES$ formula. So as you provide an increased voltage to the power terminals (within limits noted) the Power Station will transform the output according to the Scale Switch position.

We recommend 18VAC or 20VDC for HO and N scale layouts, and 22VAC or 24VDC for larger scales. NOTE: Most transformer voltage ratings are measured at the full current rating. Make sure that the voltage is not higher than 24VAC at high AC line conditions.

TRACK 1 AND TRACK 2 - TERMINALS

The voltage output is determined by the position of the Scale Switch, but will not exceed the input voltage. The amperes available are slightly less than the amperes arrived at by using the $W=V \times A$ formula for a total between the two tracks, but in no case will either track be allowed to exceed 5 amperes. The terminals will accept any wire size up to #12.

CONTROL BUS - 4 WIRE RJ-H PLUG

Connect the 4 wire cable from the Command Station to one of the Control Bus jacks. If there are more Power Stations, connect them in a daisy chain, with additional 4 wire cables to the remaining Power Stations.

SCALE SWITCH

Set the switch to the scale being powered.

Switch Pos.	Scale (as marked)	Scale (as recommended by the NMRA)	Voltage
Up	Large	G	22VDC
Center	HO	O, S, HO and N	14VDC
Down	N	Z	10VDC

MODE SWITCH - TRACK 1 AND TRACK 2

These switches determine if the electronics in the section controlling each track are for powering the layout or for controlling reversing blocks. When used for reverse block control there is no need to provide a controller for each reverse block unless it is expected that during operation more than one loco would be crossing a block isolation point simultaneously.

CONTROL - LIGHT

Indicating light showing the Control Bus signal is being received from the Command Station.

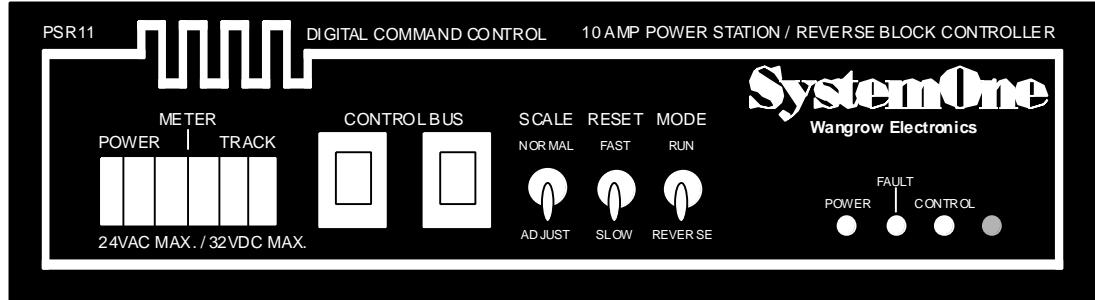
FAULT - TRACK 1 AND TRACK 2 - LIGHT

These lights will light continuously if a short is detected. They will also be on if no signal is being received from the Command Station. This happens during programming track usage and when power to the system is turned OFF the lights will be ON because no signal is being received and the large capacitors inside are now discharging.

POWER -LIGHT

Indicating light showing that the Power Station has power.

GETTING TO KNOW YOUR 10 AMPERE POWER STATION/REVERSE BLOCK CONTROLLER



10 Amp Power Station/Reverse Block Controller Elevation

FRONT PANEL CONNECTIONS

POWER TERMINALS

The Power Terminals should be connected to a power source within the ranges given below, as determined by the voltage level that is appropriate for the scale being powered. The terminals will accept any wire size up to #12.

DO NOT LET INPUT VOLTAGE EXCEED 22VAC OR 30VDC

The Power Station will automatically step down the voltage and increase the amperage according to the standard $WATTS = VOLTS \times AMPERES$ formula. So as you provide an increased voltage to the power terminals (within limits noted) the Power Station will transform the output according to the Scale Switch position. The DC input voltage must be at least 2.5 volts greater than the desired output voltage. The AC input voltage must be at least 15 volts to get 15 volts (normal) to the rails. Be sure the transformer you are using is capable of supplying enough current to ensure good operation. Not enough available current is probably the largest single cause of poor operation. The recommended transformer is 18 volts AC at 12 Amps for all output voltages up to 19 volts. (Allied Electronics (Phone 1-800-433-5700) 12 Amp, 22VAC, Cat No 836-6185 is suggested.

Be sure to use a computer style surge protector to prevent power spikes from damaging your Power Station.

METER TERMINALS

These terminals provide a means of reading the current being supplied by the Power Station to the track. The current is read by connecting a voltmeter that has a 1 or 2 volt scale. Each 0.1 volts equals 1 Amp. A reading of .876 volts indicates that 8.76 Amps are being used on the track. There will be an indication (usually less than .030 volts) of some current draw even when there are no loco's on the track. This is OK, it is what is called the "quiescent current" of the Power Station. Just mentally subtract it the total current being used to get a correct reading (or do like I did and turn the offset screw on the meter below zero - KK).

TRACK TERMINALS

The voltage output is determined by the position of the Scale Switch, but will not exceed the input voltage. The Amperes available are slightly less than the amperes arrived at by using the $W=V \times A$ formula. The terminals will accept any wire size up to #12.

CONTROL BUS - 4 WIRE RJH PLUGS

Connect the 4 wire cable from the Command Station to one of the Control Bus jacks. If there are more Power Stations, connect them in a daisy chain, with additional 4 wire cables to the remaining Power Stations.

SCALE SWITCH

Set the switch to the scale being powered.

NORMAL (for O SCALES) - Output is 15.5 volts - **Do Not use for N, HO or most S Scale layouts.**

ADJUST (for "non-standard" voltages) - Output is adjustable from 11.5 to 22.5 volts, factory set at 18 volts. The adjustment dial is accessed by removing the cover of the Power Station and turning R16.

RESET SWITCH

This switch selects how long the Power Station takes to re-apply power to the track after a short circuit. In the **SHORT** position the time-out is approximately 1.5 seconds. In **LONG** the time-out is approximately 4.5 seconds. The longer time is primarily for layouts where loco's may carry large capacitors to supply propulsion power over the very dirty track found on outdoor layouts. The 4.5 seconds should be long enough for these capacitors to "bleed down".

MODE SWITCH

This switch determines if the electronics in the section controlling the track is for powering the layout or for controlling a reversing block. When used for reverse block control there is no need to provide a controller for each reverse block unless it is expected that during operation more than one train would be crossing a block isolation point simultaneously. By train we mean the loco's and cars of a train that use electrical power. NOTE: if a 10 Amp Power Station is set up to power reverse loops the adjoining track sections must be powered by Power Stations capable of equal or greater current.

CONTROL - LIGHT

Indicating light showing the Control Bus signal is being received from the Command Station.

FAULT LIGHT

This light will light continuously if a short is detected. It will also be on if no signal is being received from the Command Station. This happens during programming track usage. When power to the system is turned OFF the lights will be ON because no signal is being received and the large capacitors inside are now discharging, they will go out in several seconds.

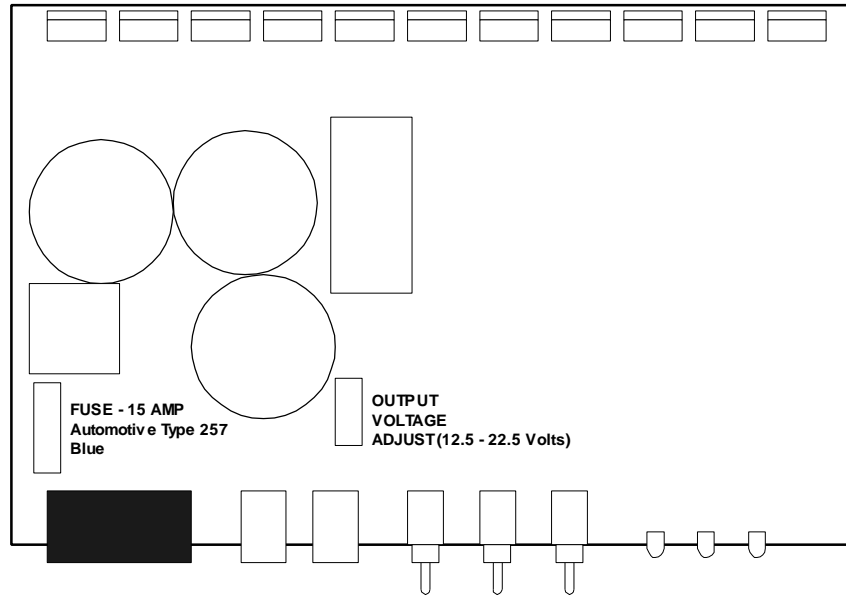
POWER LIGHT

Indicating light showing that the Power Station has power.

EMPTY HOLE

We use the same metal casing for both Power Stations which leaves one empty hole in the 10 Amp Power Station.

IMPORTANT INTERNAL COMPONENTS



PARTIAL PLAN OF 10 AMP POWER STATION
(Shown with housing removed)

VOLTAGE ADJUST

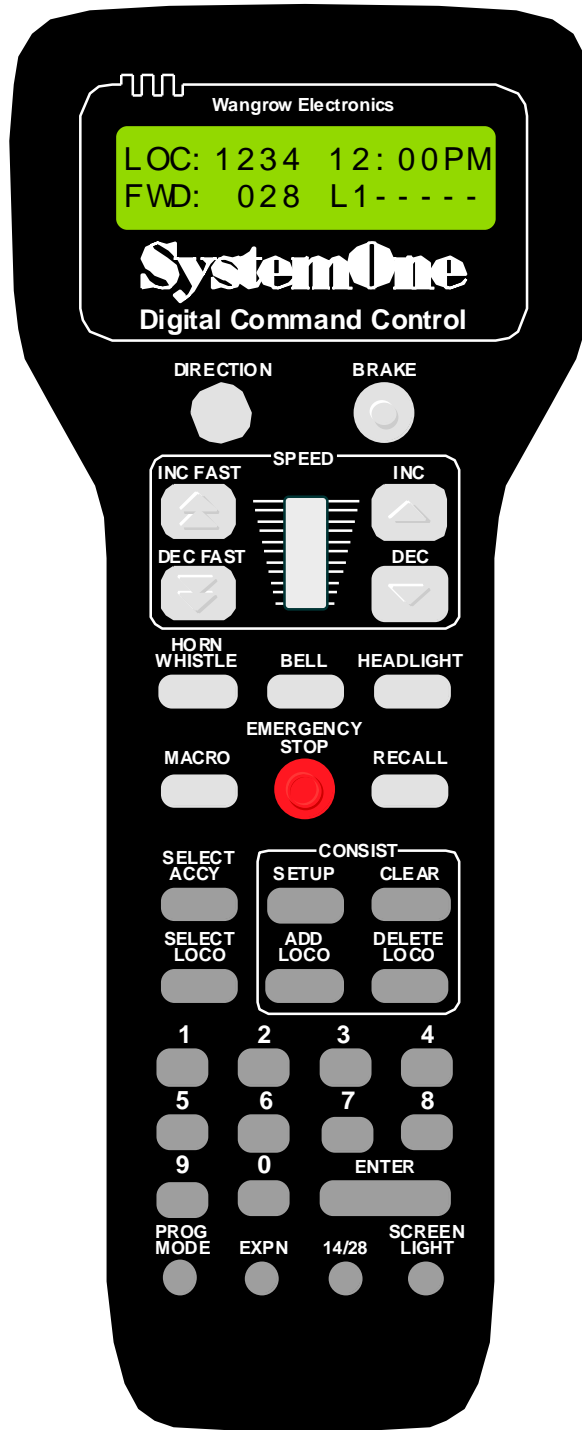
To access the output voltage adjustment, remove the four screws that hold the Power Station cover located on the bottom of the unit. Slide the cover off and locate R16. R16 is a thumbwheel located near the center of the circuit board. It may be easier to use a small flat blade screwdriver to turn the adjuster. The adjustment range is from approximately 11.5 to 22.5 volts.

FUSE

An internal 15 Amp fuse is provided to prevent your power supply (transformer or power pack) from over heating in case of a catastrophic failure inside the Power Station. This is an automotive type (ATO) fuse. Replacements are available at most gas stations, auto parts stores or even Walmart. ATO fuses are color coded indicating the current rating. A 15 Amp fuse is blue.

NOTE: This fuse is *not* a replacement for proper fusing between your transformer and the wall plug. *Always* protect your transformer with a fuse.

GETTING TO KNOW YOUR WALK-AROUND CAB



Walk-Around Cab Elevation

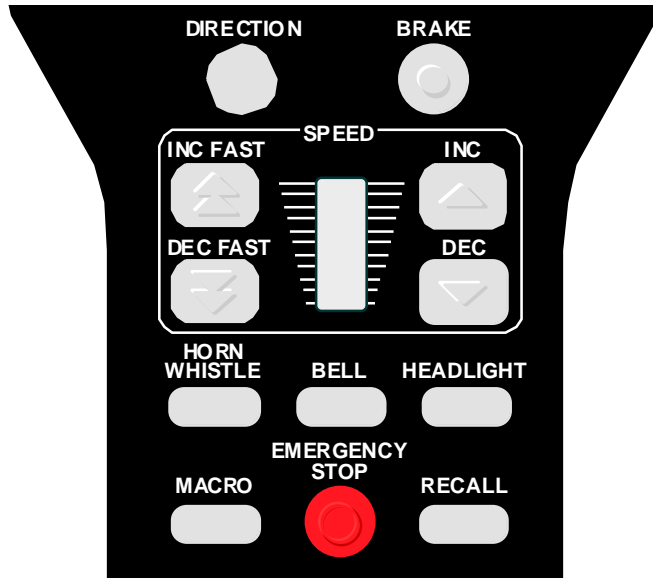


COMMAND STATION FEEDBACK

SCREEN

The screen provides you with feedback from the Command Station. This information includes: your loco's status, scale time, command prompts and messages regarding programming loco's, decoders and Cabs.

In the picture above we have shown how the display will look during normal operation. The top line of the display includes the loco number being controlled and the scale time. The second line shows the locomotive direction, speed step, and the status of the functions outputs. The functions are represented with "L" for headlight or the function number 1 through 6 being ON. A dash ("-") indicates that the function is OFF.



LOCOMOTIVE CONTROL AREA

DIRECTION

The **DIR** key toggles the direction of your loco or consist. The current direction is displayed as the first three characters of the second line on the screen.

BRAKE

The **BRAKE** sends the speed “0” to the active loco. If no speed change is made the loco will come to a complete stop. In knob mode, the **BRAKE** key will disconnect the speed control from the loco. Rotate the knob back to zero and the loco can be controlled again. This “Safe” mode can be turned on and off using the SET CAB PARMS, or by holding SELECT LOCO when plugging the Cab in..

SPEED SECTION

The Cab allows you to use either the speed keys or the knob. This can be changed either via the keyboard through the **PROG** key or by holding down the **Select Loco** key when re-plugging in the Cab Cable, this will put the Cab in the programming mode for setting up the Cab.

The left two keys increase or decrease the speed by either 4 or 10 speed steps, depending on the speed step mode (14, 28 or 128), whereas the right keys increase and decrease the speed by one speed step at a time.

The knob increases the speed by pushing it up and decreases the speed when it is pulled down.

HORN/WHISTLE

Factory defaulted to operate function “2”. This can be changed in the **Set Cab Params** section, to operate the function output that is to control your Sound System’s Horn/Whistle. Unlike other keys which toggle the function this key blows the horn as long as the key is held down.

BELL

Factory defaulted to operate function “3”. This can be changed in the **Set Cab Params** section, to operate the function output that is to control your Sound System’s Bell. This key toggles the Bell ON and OFF.

HEADLIGHT

Toggles the Headlight on and off. It is defined as Function 0, and pressing the 0 (zero) key will perform the same function, but we felt the headlight key deserved a more convenient location.

MACRO

The macro key and support screens are explained in detail later in this manual.

EMERGENCY STOP

Pressing the **EMERGENCY STOP** key once will stop the active loco/consist for this Cab only. Speed will be immediately set to zero (no momentum). Loco is restarted by changing the speed step or direction.

WHOLE LAYOUT EMERGENCY STOP

Pressing the **EMERGENCY STOP** key three times in quick succession will bring the *entire* layout to a stop. “LAYOUT STOPPED!” will be displayed and is cleared by pressing the **ENTER** key. Only the Cab that executed the Emergency Stop can clear it or the system must be turned off and then on again. Each Loco or Consist can now be restarted by sending it a command, such as a speed step increase or decrease, or by toggling a Function output.

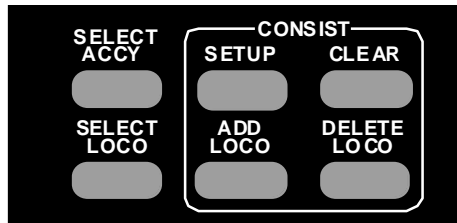
RECALL

This key toggles between the last two to six loco's addressed. **RECALL** allows you to operate two to six loco's and/or consists and still be able to address the lead loco to dim the headlight, blow the horn, or operate the bell.

When you **RECALL** to a different loco, the speed set by the knob is not immediately jumped to. Rotate the knob up or down close to the current speed of the loco. The loco can be controlled again. This "Safe" mode can be turned on and off using the SET CAB PARMS, or by holding SELECT LOCO when plugging the Cab in..

Think of **RECALL** as being a set of memory boxes. To set a Recall position, press **SELECT LOCO** and enter the loco or consist to be operated. Next press **RECALL** to the next "memory box". Now press **SELECT LOCO** and enter the second loco. When an additional loco/consist is to be added a **RECALL** with "000" or an expendable loco/consist must be displayed in the **LOC** position on the screen as whatever is in that display will be replaced with the new loco/consist.

The number of **RECALLS** can be changed within the "SET CMD STATION" routines. Reference the **PROGRAMMING PROCEDURES** on page 4-24.



LOCO AND ACCESSORY SELECTION AND CONSIST AREA

SELECT ACCESSORY

Available for addressing decoders that operate accessories such as switch machines.

SELECT LOCO

This allows the selection of a locomotive/consist to operate. Press this key, then the loco/consist number, then **ENTER**.

CONSIST

Supports not only the advanced decoders that address the Extended Packet Format but also the entry level decoders that are presently on the market. For complete operating instructions on consist makeup's read the section on **SETTING UP A CONSIST**.

SETUP

Starts the procedure for either creating an advanced or old style consist.

CLEAR

Kills (clears) a consist.

ADD LOCO

Adds a loco to a consist.

DELETE LOCO

Drops a loco from a consist.



DATA ENTRY AND PROGRAMMING AREA

NUMBER KEYS

The keys **0** through **9** serve two purposes. First, when operating a loco/consist if a number key is pressed it toggles that function on the loco (if that function is connected and supported by the decoder). The second purpose is for typing in the loco/consist that is to be selected and also for responding to screen selections during programming.

ENTER

Used to confirm numerical inputs and select a programming mode.

PROGRAM MODE

Allows the selection of the various programming functions available for setting up decoders, Cabs, time, etc. See page 4-2 for complete explanation of this important key.

EXPANSION

Reserved for future features. At present it toggles between the display of lines 1 and 2 and the display of lines 3 and 4 which have nothing to display this time. The LocoCommand software program will be able to send messages to the engineer via these two lines.

14/28

Provides the ability to toggle between 14, 28, and 128 speed step operation of the active loco/consist. The 14 speed step is for first generation decoders. The 28 speed step is second generation decoders and the momentum operation of advanced decoders. The 128 speed step is the ability to operate a loco as if you still had the old analog DC control. When using this key the lower right will display the speed step mode you have selected. This display will be cleared the next time a function is toggled.

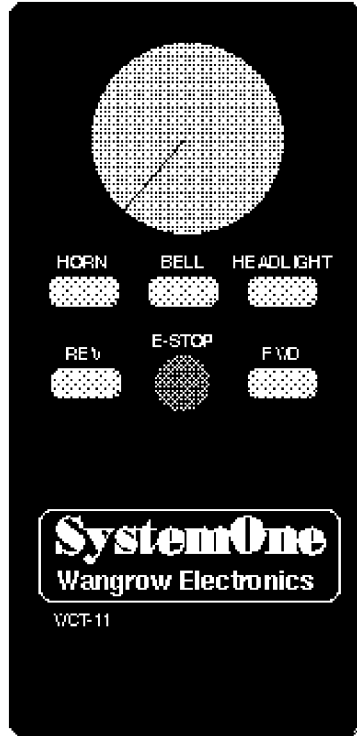
SCREEN LIGHT

Toggles the screen back light on and off. If you have many Cabs we suggest that the operator start with the screen light off and test screen readability based on the type of room lighting available. If not satisfied then try the screen readability with the light on. It is a draw on the Command Station power, but this is not significant until more than 8 Cabs with screen lights on are being used simultaneously. In this case it becomes necessary to wire external power to the Cable Connector Panels. For wiring the external power see the schematics for the Cable Connector Panel on page 2-31. You can also add a CBT-01 Cab Bus Tee Connector, see page 2-26.

TIP

If the 'Safe Mode' is enabled and you lose where the speed of the loco is, press the BRAKE key, and then rotate the speed knob to zero.

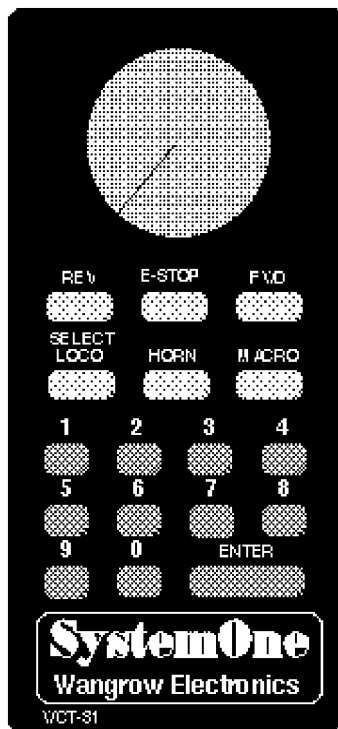
GETTING TO KNOW YOUR BASIC/INTERMEDIATE CAB



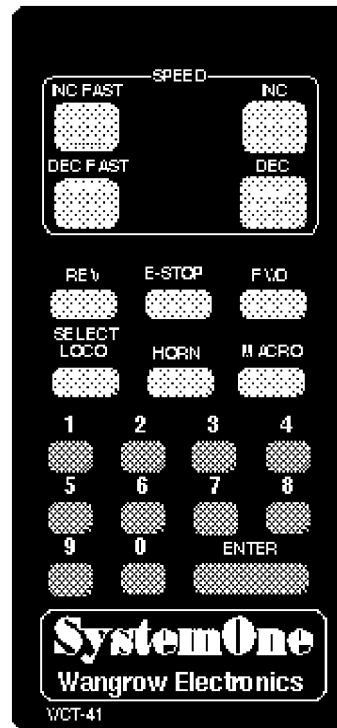
WCT-11



WCT-21



WCT-31



WCT-41

The previous page shows the layout of the four different Basic/Intermediate Cabs. All of the Cabs operate in a similar manner but have different options. Two of the Cabs have speed control knobs, and the other two have speed keys. Two of the Cabs have Numeric/Function keys (1-9, 0, and Enter), and two do not. The Cabs with Numeric/Function keys are Intermediate Cabs.

LOCOMOTIVE CONTROL AREA

STATUS LED

Toward the top of the Cab is a status LED. It will flash whenever a key is pressed. It will also indicate that data entry is required, or that Whole Layout Emergency Stop has been invoked.

KNOB (WCT-11 and WCT-31)

The Knob controls the speed of the Loco, the same as on an analog control power pack.

SPEED KEYS (WCT-21 and WCT-41)

The left two keys increase or decrease the speed by between 4 or 10 speed steps, whereas the right keys increase and decrease the speed by one speed step at a time.

HORN

Factory defaulted to operate function “2”. This can be changed in the **Set Cab Params** section (with a Full-Featured Cab), to operate the function output that is to control your Sound System’s Horn/Whistle. Unlike other keys which toggle the function this key blows the horn as long as the key is held down.

BELL (WCT-11 and WCT-21)

Factory defaulted to operate function “3”. This can be changed in the **Set Cab Params** section (with a Full-Featured Cab), to operate the function output that is to control your Sound System’s Bell. This key toggles the Bell ON and OFF.

HEADLIGHT

Toggles the Headlight on and off.

DIRECTION KEYS

There are two keys for direction, the **FWD** key will cause the Loco to move in a forward direction and the **REV** key will cause the Loco to move in a reverse direction. Pushing *both* keys at the same time does the same thing as pressing **ENTER** (for clearing E-Stop on a WCT-21 or WCT-41 which has no **ENTER** key). When using this method to clear the E-Stop, press both key at *exactly* the same time. If the E-Stop does not clear, press E-Stop three times, and try again. This restriction will be fixed in the next version of the Command Station software.

EMERGENCY STOP

Pressing the **E-STOP** key once will stop the active loco/consist for this Cab only. Speed will be immediately set to zero (no momentum). Loco is restarted by changing the speed step or direction.

WHOLE LAYOUT EMERGENCY STOP

Pressing the **E-STOP** key three times in quick succession will bring the *entire* layout to a stop. The Status LED will light and is cleared by pressing the **ENTER** key (or by pressing the **FWD** and **REV** keys at the same time). Only the Cab that executed the Emergency Stop can clear it. Each Loco or Consist can now be restarted by sending it a command, such as a speed step increase or decrease, or by toggling a Function output.

DATA ENTRY AREA

NUMBER KEYS (WCT-31 and WCT-41)

The keys **0** through **9** serve two purposes. First, when operating a loco/consist if a number key is pressed it toggles that function on the loco (if that function is connected and supported by the decoder). The second purpose is for typing in the loco/consist that is to be selected. Use the **0** key for Headlight and the **3** key for Bell.

ENTER (WCT-31 and WCT-41)

Used to confirm numerical inputs and clearing E-Stop.

SELECT LOCO (WCT-31 and WCT-41)

This allows the selection of a locomotive/consist to operate. When this key is pressed, the Status LED will light indicating that a numeric entry is expected. Enter the loco/consist number, then press **ENTER**.

MACRO (WCT-31 and WCT-41)

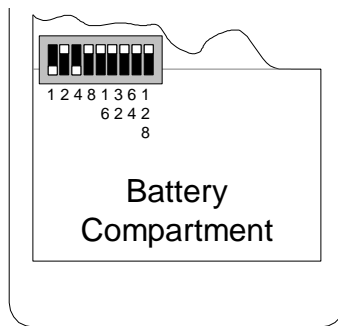
The macro language and support screens are explained in detail later in this manual. When this key is pressed, the Status LED will light indicating that a numeric entry is expected. Enter the macro number, then press **ENTER**.

ADDRESS SELECTION NOTE

With older versions of the Command Station software, addressing a Basic/Intermediate Cab to an address one above a Full Featured Cab will cause the display on the Full Featured Cab to be corrupted. To avoid this, skip one address between the Basic/Intermediate Cab and the Full Featured Cab. Example: If a Full Featured Cab is addressed at 6, address the Basic/Intermediate Cab at 8. This restriction will be fixed in the next version of the Command Station software.

ADDRESS SELECTION

The Basic/Intermediate Cabs ships factory programmed to address 5. To change this address, turn the Cab over and open the battery cover (for the future radio option). In the upper left hand corner of the opening, under the plastic, is an 8 position DIP switch. Refer to the figure and the table below for address selection. NOTE: up = move the switch toward the top of the CAB, dn = move the switch toward the bottom of the CAB. Also, not all of the addresses are in the table. To calculate the desired address, add the “dn” switches. E.g., Address 25 = 16 + 8 + 1. 64 & 128 should always be up.



Back of Basic/Intermediate Cab

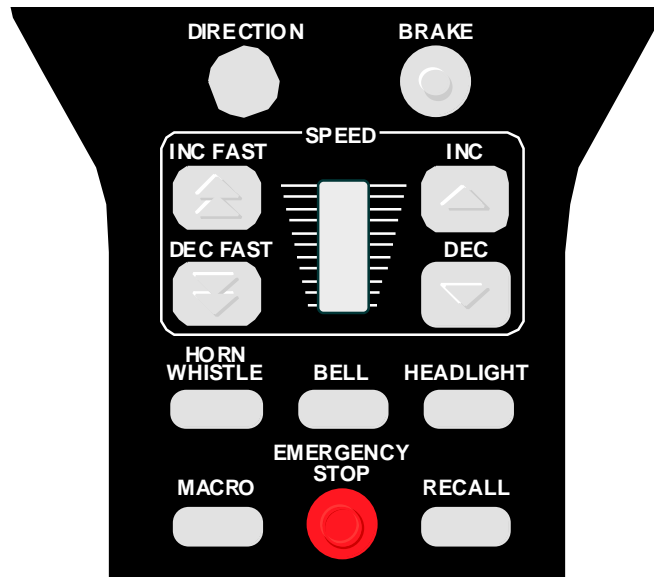
Address Table

Address	Sw 1	2	4	8	16	32	64	128
1	dn	up	up	up	up	up	up	up
2	up	dn	up	up	up	up	up	up
3	dn	dn	up	up	up	up	up	up
4	up	up	dn	up	up	up	up	up
5	dn	up	dn	up	up	up	up	up
6	up	dn	dn	up	up	up	up	up
7	dn	dn	dn	up	up	up	up	up
8	up	up	up	dn	up	up	up	up
9	dn	up	up	dn	up	up	up	up
10	up	dn	up	dn	up	up	up	up
20	up	up	dn	up	dn	up	up	up
30	up	dn	dn	dn	dn	up	up	up
40	up	up	up	dn	up	dn	up	up
50	up	dn	up	up	dn	dn	up	up
60	up	up	dn	dn	dn	dn	up	up

GETTING TO KNOW YOUR DIGITAL CAB - WCT-02

The basic operation and layout of the Pro Cab is the same as the standard full featured Walk-around Cab, WCT-01. The following outlines the features that are different.

1. Fully digital speed control knob.
2. Speed keys and knob are simultaneously active.
3. The Brake key is always active.
4. Audible feedback (user set-able for key press, knob speed changes, and when the speed reaches zero).
5. Select-able Yard Mode setting. When enabled, rotating the knob up from speed zero, will increase the speed in the forward direction. Rotating the knob down from speed zero, will increase the speed in the reverse direction.
6. Digitally controlled backlight. The on/off state is remembered by the microprocessor's non-volatile memory.



LOCOMOTIVE CONTROL AREA

DIRECTION

The **DIR** key toggles the direction of your loco or consist. The current direction is displayed as the first three characters of the second line on the screen. This key is disabled when Yard Mode is enabled.

BRAKE

The **BRAKE** sends the speed “0” to the active loco. If no speed change is made the loco will come to a complete stop. The **BRAKE** key always works.

SPEED SECTION

The Cab allows you to use either the speed keys or the knob, they are both active.

Regular Mode

The left two keys increase or decrease the speed by either 4 or 10 speed steps, depending on the speed step mode (14, 28 or 128), whereas the right keys increase and decrease the speed by one speed step at a time.

The knob increases the speed by pushing it up and decreases the speed when it is pulled down. When the speed reaches zero, rotating down further will not decrease the speed.

Yard Mode

The left two keys increase or decrease the speed by either 4 or 10 speed steps, depending on the speed step mode (14, 28 or 128), whereas the right keys increase and decrease the speed by one speed step at a time.

The knob moves the Loco forward, from zero, by pushing it up, and moves the Loco in reverse, from zero, when it is pulled down.

SELECT LOCO

Along with the normal, select loco operation, this key allows the user to quickly enter the Cab setup mode. Hold this key down while plugging the Cab in.

PROGRAM MODE

Allows the selection of the various programming functions available for setting up decoders, Cabs, time, etc. See page 4-xx for complete explanation of this important key.

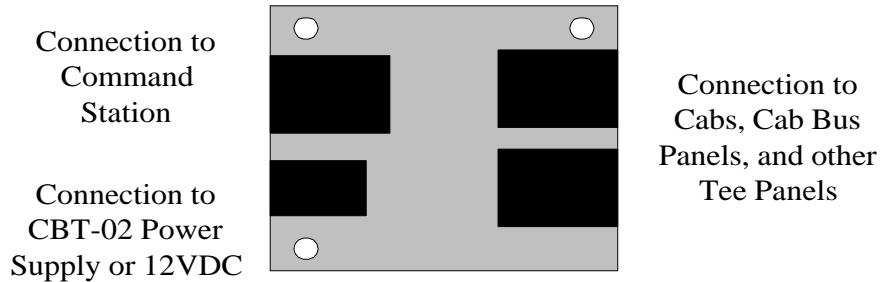
SETUP MODE

The setup mode allows the user to change the operational characteristics of the Cab. The following lists the set-able parameters and the allowable values.

Parameter	Range	Description
Cab Address	1 - 63	This sets the Cab address. Each Cab must have a unique address.
Speed Beep	0 - 9	This sets the volume of the beeper when the speed is changed.
Zero Beep	0 - 9	This sets the volume of the beeper when the speed reaches zero.
Key Beep	0 - 9	This sets the volume of the beeper when the keys are pressed.
Yard Mode	0 - 1	If set to 0, the Cab operates normally (similar to the standard walk-around Cab). If set to one, Yard Mode is enabled.

The beep volume can be set from 0 to 9. 1 is short/quiet, 9 is long/loud. Set to 0 for no Beep.

CAB BUS TEE CONNECTOR



1 built-in RJ-12 6-wire telephone jack for connection to the Command Station.

2 built-in RJ-12 6-wire telephone jacks for Cab Bus connections.

1 power connector for connecting a CBT-02 power supply. Cabs connected to either of the two Cab Bus connectors will be powered from this supply. The power comes from the Command Station (or the previous Tee connector) when the CBT-02 is dis-connected.

We have found that multiple cabs with the backlight on, or long Cab Bus cable runs drain the available power from the Command Station. The Cab Bus Tee Panel was designed to help with Cab Bus wiring, and to provide a convenient way to provide additional power for the Cabs. The CBT-02 is a Wall-Wart type power supply that will power approximately 4 Full-featured Cabs or approximately 8 Basic Cabs.

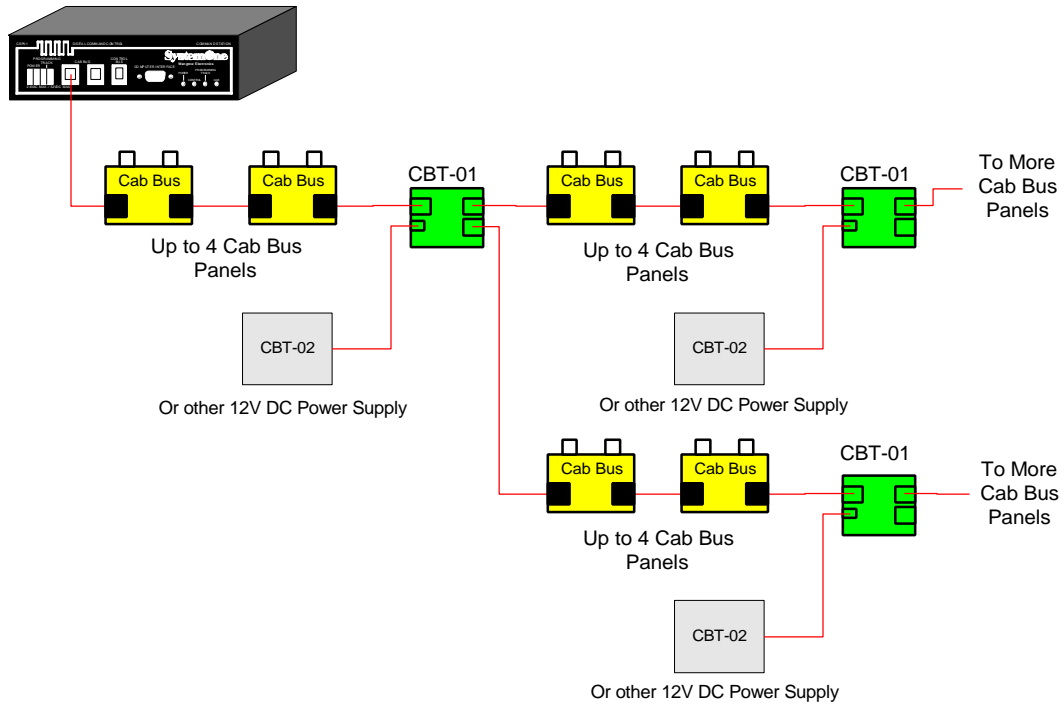
Tee Panels should be connected after the forth CBB-01, but not more than 65 feet of cable length from the Command Station or previous CBT-01.

Boards may be interconnected using standard 6-conductor 22 gauge telephone wire with RJ-12 plugs on each end. "Daisy-chain" as many together as you need. Cable, plugs, and a crimp tool is sold at Radio Shack & Digi-Key, and plugs are available at most hardware stores. This will allow you to run cables from Cab Bus to Cab Bus at the proper length, if desired.

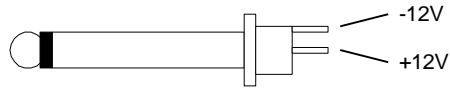
NOTE: If you make your own cables, be sure to *fully* crimp the connector to the cable or you'll damage the socket on the Command Station or Power Station (I speak from experience on this one, KK).

DO NOT CONNECT THE ENDS OF THE TWO CAB BUSES LEAVING THE COMMAND STATION TO FORM A LOOP.

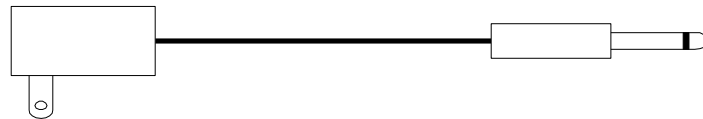
CAUTION!! THE CAB BUS CABLES ARE CONNECTED OPPOSITE OF THE CABLES SOLD AT THE TELEPHONE COMPANY. SEE "SYSTEM CABLES" FOR CORRECT CONNECTOR ARRANGEMENT (Page 6-2).



Typical Cab Bus Tee Panel connections.



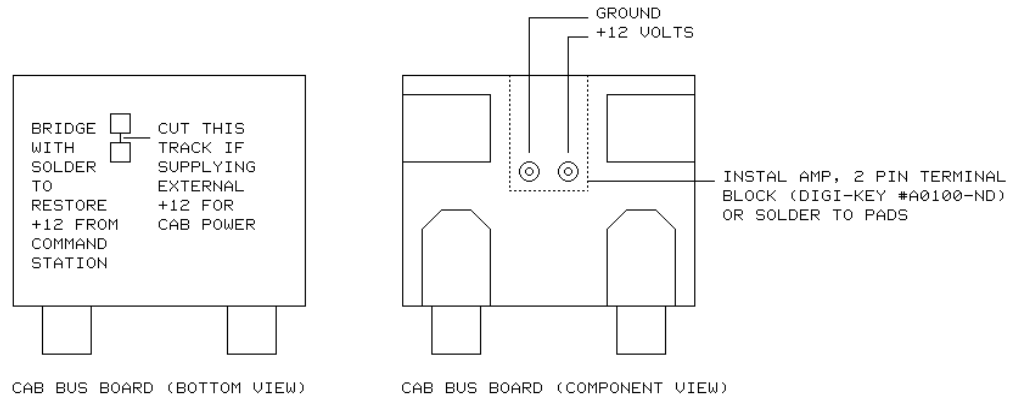
3.5mm male plug wiring detail.



Cab Bus Tee Connector Power Supply

- 800mA at 12VDC
- 3.5mm male plug
- Wall mount transformer

CAB BUS PANEL



The Cab Bus Panel was built for those operators that requested a 1/4" dia. phone plug.

For layouts using more than 8 Cabs at a time, the power drain on the Command Station becomes too large and you will have to install the auxiliary 12VDC power supply to the Cab Bus Panels as shown in the detail above. Do not forget to cut the bridge indicated in the left illustration.

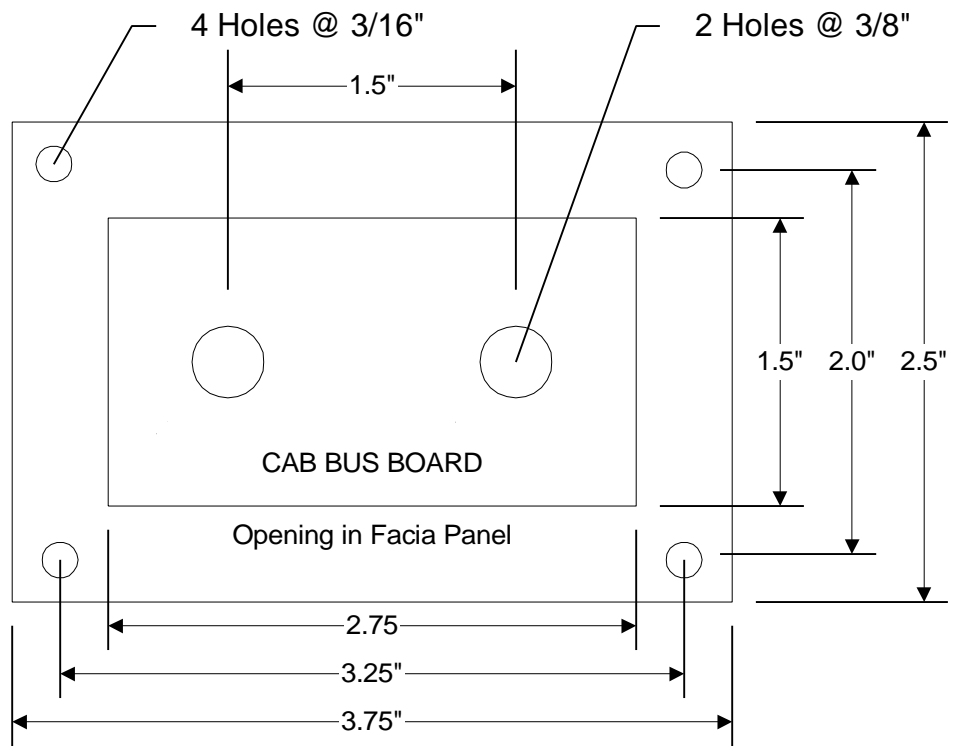
Boards may be interconnected using standard 6-conductor 22 gauge telephone wire with RJ-12 plugs on each end. "Daisy-chain" as many together as you need. Cable, plugs, and a crimp tool is sold at Radio Shack & Digi-Key, and plugs are available at most hardware stores. This will allow you to run cables from Cab Bus to Cab Bus at the proper length, if desired.

NOTE: If you make your own cables, be sure to *fully* crimp the connector to the cable or you'll damage the socket on the Command Station or Power Station (I speak from experience on this one, KK).

DO NOT CONNECT THE ENDS OF THE TWO CAB BUSES LEAVING THE COMMAND STATION TO FORM A LOOP.

CAUTION!! THE CAB BUS CABLES ARE CONNECTED OPPOSITE OF THE CABLES SOLD AT THE TELEPHONE COMPANY. SEE "SYSTEM CABLES" FOR CORRECT CONNECTOR ARRANGEMENT (Page 6-2).

For those owners that choose to change the plugs to DIN plugs a wiring diagram is provided in the WIRING DIAGRAM SECTION.



Recommended Facia Panel

DECODERS

PRECAUTIONARY INSTALLATION NOTES.

- 1. IF YOU DO NOT HAVE AND UNDERSTAND THE WORKINGS OF AN AMMETER/VOLTMETER DO NOT ATTEMPT TO START INSTALLING YOUR OWN DECODERS.**
- 2. MAKE SURE NO METAL PART OF THE LOCOMOTIVE TOUCHES ANY METAL PART OF THE DECODER. APPLY ELECTRICAL TAPE TO THE INTERIOR OF THE LOCO AT ANY QUESTIONABLE POINTS.**
- 3. THERE MUST BE NO ELECTRICAL CONNECTION BETWEEN THE MOTOR AND THE RAILS. BOTH MOTOR TERMINALS MUST BE ELECTRICALLY ISOLATED FROM THE MOTOR FRAME AND BODY.**
- 4. DO NOT BEND WIRES AT DECODER OR PLUG. GENTLY FORM BENDS AT OTHER LOCATIONS ON WIRE.**
- 5. DO NOT USE WITH CORELESS MOTORS.**

DECODER INSTALLATION

- Inspect for broken wires. DO NOT ATTEMPT TO MAKE ANY REPAIRS.
- Test the locomotive to assure good analog operation. Poor running loco's will not run well with DCC either. Test the loco under a "stalled" condition. First connect ammeter between the power supply and the track. Removing the loco's shell. Now stall the motor by squeezing the flywheel until it stops. Note the reading on the meter with the loco operating at full voltage. The decoder rating needs to exceed the highest amperage reading otherwise the decoder will cause the loco to have intermittent stops when operating at the decoders rated amperage.
- We suggest installing the wiring harnesses with plugs for all leads being used in order to facilitate decoder removal in the future. Small plugs can be found in your hobby shop or write us for information.
- Lights and other function loco's should not exceed the values listed for each decoder. Nor should their total exceed the amount of current remaining after testing the loco motor "stalled". The Function common (blue wire), is track voltage. To cut the voltage in half, use one of the rails as the common.

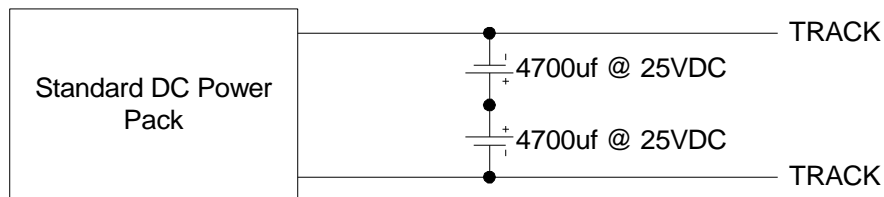
- Make a wiring diagram of your loco's motor power and lighting. Copy it and add how you are going to insulate the motor from the frame, if it is not, and where you are going to cut the wires from the track pickups to the motor and lights.
- The power for the Functions normally is connected to the V+ line (the Blue wire). This will supply the lights with 14-16 volts (for the HO setting). If you connect the lighting common to one of the rails (Red or Black), the voltage to the lights will be half (7 - 8 volts, for the HO setting). NOTE: If you connect Functions in this manner, using analog control will affect the intensity of the lights.

Place the loco on the programming track and refer to the section "PROGRAMMING ON THE PROGRAMMING TRACK" on page 4-15. All decoders come from the factory with the address "3".

REMEDIES FOR ERRATIC DC OPERATION

Many conventional DC power packs put out pulsating (non-filtered) track voltage. Although satisfactory operation is usually obtained from these power packs, **SystemOne™** decoders have been designed to give optimum performance on filtered DC. If this decoder operates erratically on a standard DC power pack, a non-polarized electrolytic capacitor may be added to filter the pulsating DC that comes from many conventional power packs.

To make a non-polarized capacitor, you can connect two normal electrolytic capacitors in series with the plus terminals connected together, as shown in the diagram below. The 4700 μ f values are not critical, but should be equal to or greater than 4700 μ f. Similarly, the 25 VDC rating should be considered the minimum, any higher voltage rating is OK. Be aware that adding the capacitors may increase the voltage coming out of the power pack by 1.4. In other words, if you have a power pack that puts out a pulsating 12 volts, it will now put out 16VDC at full speed.



A 4700 μ f 35VDC capacitor is available from Radio Shack, part number 272-1022.

DN-071 - .75 AMPERE RATED WITH 1 FUNCTION

This page represents two pages that will be sent to all registered owners with the information on the .75 ampere decoder when it becomes available

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DN-103 - 1 AMPERE RATED WITH 3 FUNCTIONS

DN-103 Decoder	Orange	Right Hand Motor Lead
	Red	Right Hand Rail
	Green	Function 1 Output
	Blue	Function Common, +V
	Violet	Function 2 Output
	White	Headlight Output
	Black	Left Hand Rail
	Gray	Left Hand Motor Lead

SPECIFICATIONS:

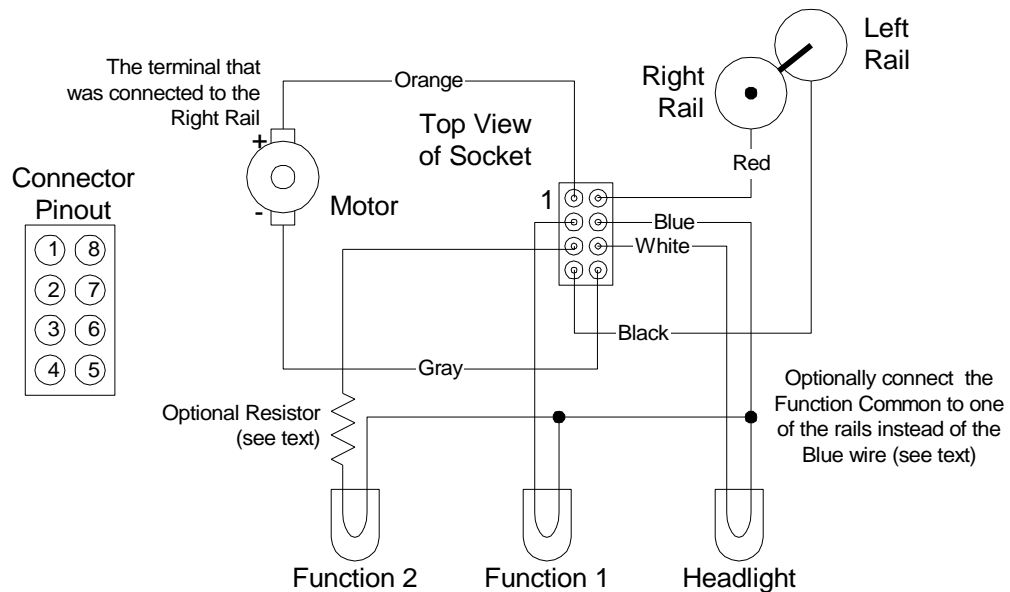
- Compatible with the NMRA Standards and Recommended Practices.
- 1.0 ampere overall current capacity.
- 1.0 ampere motor capacity for permanent magnet type DC motors.
- 0.3 ampere (300ma) minimum for the functions (100ma maximum per function). As an example: with a motor drawing 0.75 ampere “stalled”, there is .25 ampere (250ma) available for functions.
- 3 function outputs wired.
- Over temperature protected.
- 3 programmable address - Short (7 bit) address for backward compatibility, Long (14 bit) address for assigning any number to 9999, Consist (7 bit) address for assigning to a consist.
- Re-programmable micro-processor for upgrading software.
- Operates on DC.
- Programmable speed curve with both standard table and individual point capabilities.
- Programmable starting voltage.
- Programmable momentum for acceleration and deceleration adjustable from immediate to 3.8 minutes for standing stop to full speed.
- Operator control of front headlight and rear headlight. Lights do not change with loco direction.
- Operates with 128 speed step (feels like analog DC control) or 28 speed step with momentum.
- Ability to be “Programmed on the Main”.

WIRE COLOR CODE

Orange	Right Hand Motor Lead
Red	Right Hand Rail
Green	Function 1 Output
Blue	Function Common, +V
Violet	Function 2 Output
White	Headlight Output
Black	Left Hand Rail
Gray	Left Hand Motor Lead

Right hand rail is the rail to the right of the observer standing between the rails with their back to the front of the locomotive, also referred to as the “engineers side”. For traction systems this is the overhead wire.

LOCO WIRING



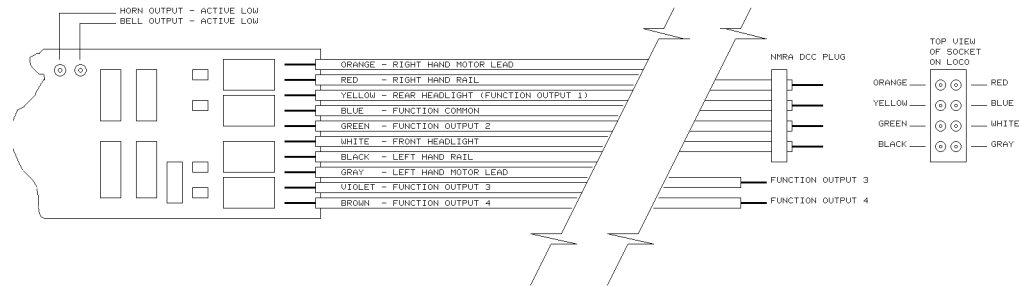
A series resistor may be needed to drop the voltage to match the lamps you are using. For 12V-14V bulbs, start with a 100Ω resistor and work your way down to get the proper brightness. For 1.5V bulbs, start with a 470Ω resistor. You can drop the voltage to the functions in half by connecting the common to one of the Rails instead of the Blue wire.

DH-105 - 1 AMPERE RATED WITH 5 FUNCTIONS

This page represents two pages that will be sent to all registered owners with the information on the 1 ampere decoder when it becomes available. This decoder will be a LE-100R look-a-like. It will have 3 functions wired out to the plug and 2 functions with soldering pads for you to wire out if needed.

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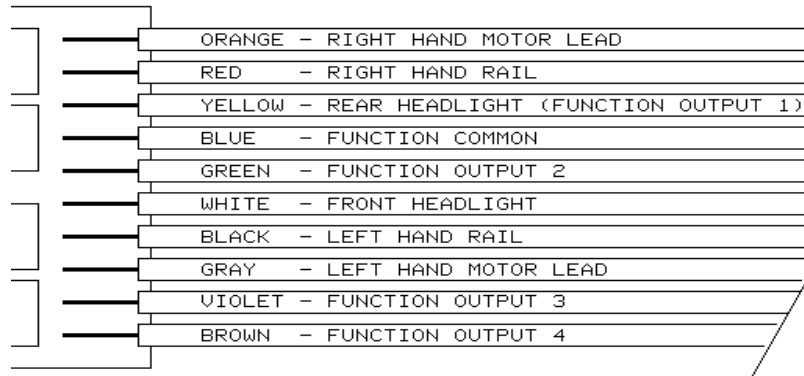
DH-155 - 1.5 AMPERE RATED WITH 5 FUNCTIONS BLACK COVERING - ORIGINAL DESIGN



SPECIFICATIONS:

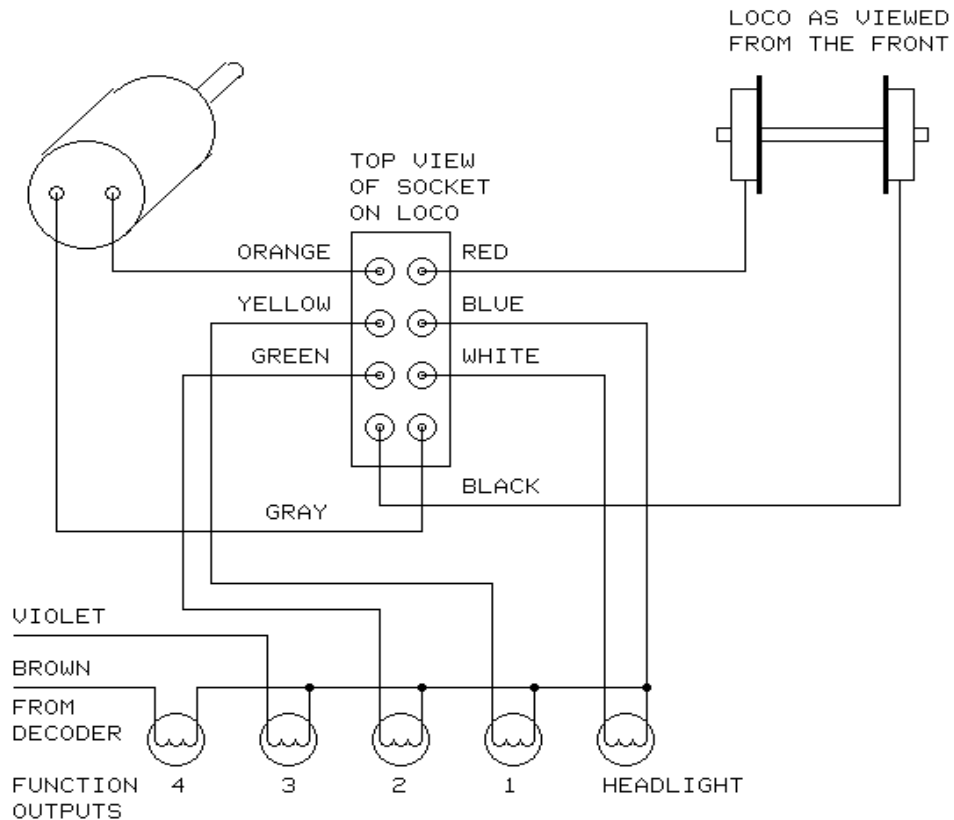
- Compatible with the NMRA Standards and Recommended Practices.
- 1.8 ampere overall current capacity.
- 1.5 ampere motor capacity for permanent magnet type DC motors.
- 0.3 ampere (300ma) minimum for the functions (100ma maximum per function). As an example: with a motor drawing 1 ampere “stalled”, there is 0.8 ampere (800ma) available for functions.
- 5 function outputs wired plus soldering contacts for connecting Horn and Bell functions. **IF THE HORN AND BELL CONTACTS ARE TO BE WIRED OUT, THIS MUST BE DONE BY THE HOBBY SHOP WHERE THEY WERE PURCHASED OR WARRANTY IS VOID.**
- Overload and short circuit protected.
- 3 programmable addresses - Short (7 bit) address for backward compatibility, Long (14 bit) address for assigning any number to 9999, Consist (7 bit) address for assigning to a consist.
- Microprocessor can be re-programmed with new software. One of the new features will be that it can operate on DC.
- Programmable speed curve with both standard table and individual point capabilities.
- Programmable starting voltage.
- Programmable momentum for acceleration and deceleration adjustable from immediate to 3.8 minutes for standing stop to full speed.
- Operator control of front headlight and rear headlight. Lights do not change with loco direction.
- Operates with 128 speed step (feels like analog DC control) or 28 speed step with momentum.

WIRE COLOR CODE

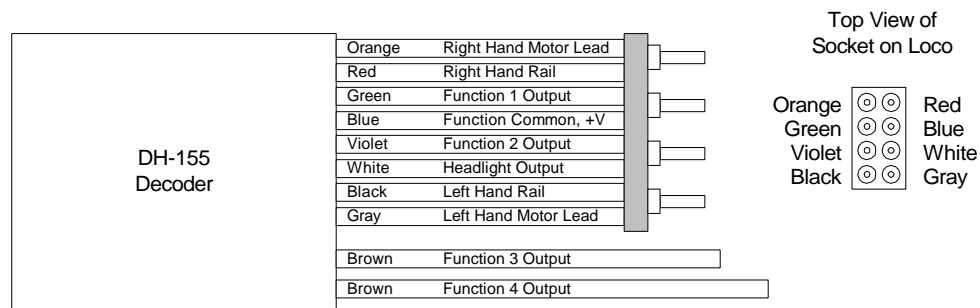


Right hand rail is the rail to the right of the observer standing between the rails with their back to the front of the locomotive, also referred to as the “engineers side”. For traction systems this is the overhead wire.

LOCO WIRING



DH-155 - 1.5 AMPERE RATED WITH 5 FUNCTIONS WHITE COVERING - AUGUST 1995 DESIGN



SPECIFICATIONS:

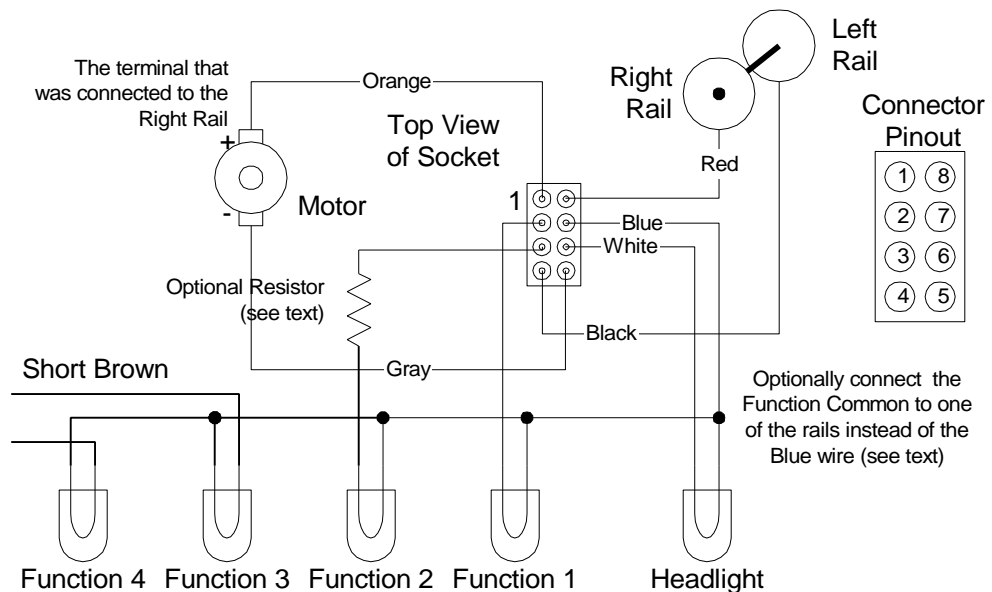
- Compatible with the NMRA Standards and Recommended Practices.
- 1.8 ampere overall current capacity.
- 1.5 ampere motor capacity for permanent magnet type DC motors.
- 0.3 ampere (300ma) minimum for the functions (100ma maximum per function). As an example: with a motor drawing 1 ampere “stalled”, there is .8 ampere (800ma) available for functions.
- 5 function outputs wired.
- Overload and short circuit protected.
- 3 programmable address - Short (7 bit) address for backward compatibility, Long (14 bit) address for assigning any number to 9999, Consist (7 bit) address for assigning to a consist.
- Re-programmable micro-processor for upgrading software.
- Operates on DC.
- Programmable speed curve with both standard table and individual point capabilities.
- Programmable starting voltage.
- Programmable momentum for acceleration and deceleration adjustable from immediate to 3.8 minutes for standing stop to full speed.
- Operator control of front headlight and rear headlight. Lights do not change with loco direction.
- Operates with 128 speed step (feels like analog DC control) or 28 speed step with momentum.

WIRE COLOR CODE

Orange	Right Hand Motor Lead
Red	Right Hand Rail
Green	Function 1 Output
Blue	Function Common, +V
Violet	Function 2 Output
White	Headlight Output
Black	Left Hand Rail
Gray	Left Hand Motor Lead
Brown	Function 3 Output
Brown	Function 4 Output

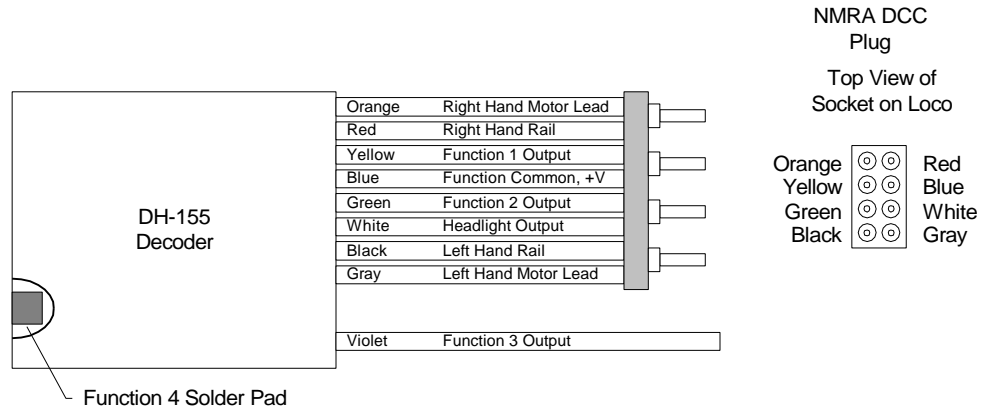
Right hand rail is the rail to the right of the observer standing between the rails with their back to the front of the locomotive, also referred to as the “engineers side”. For traction systems this is the overhead wire.

LOCO WIRING



You can drop the voltage to the functions in half by connecting the common to one of the Rails instead of the Blue wire. Be aware that if you operate a non-DCC loco (analog), the brightness will change with the analog loco speed using this method.

**DH-155 - 1.5 AMPERE RATED WITH 5 FUNCTIONS
 WHITE COVERING - WITH CABLE HARNESS
 MARCH 1998 DESIGN**



SPECIFICATIONS:

- Compatible with the NMRA Standards and Recommended Practices.
- 1.5 ampere overall current capacity.
- 1.5 ampere motor capacity for permanent magnet type DC motors.
- 100ma maximum per function. As an example: with a motor drawing 1 ampere “stalled”, there is .5 ampere (500ma) available for functions.
- 5 function outputs wired. The fifth is a solder pad at the rear of the Decoder.
- Thermal protected.
- 3 programmable address - Short (7 bit) address for backward compatibility, Long (14 bit) address for assigning any number to 9999, Consist (7 bit) address for assigning to a consist.
- Re-programmable micro-processor for upgrading software.
- Operates on DC.
- Programmable speed curve with both standard table and individual point capabilities.
- Programmable starting voltage.
- Programmable momentum for acceleration and deceleration adjustable from immediate to 3.8 minutes for standing stop to full speed.
- Operator control of front headlight and rear headlight. Lights do not change with loco direction.
- Operates with 128 speed step (feels like analog DC control) or 28 speed step with momentum.
- Detachable cable harness, compatible with other manufacturers harnesses.

WIRE COLOR CODE

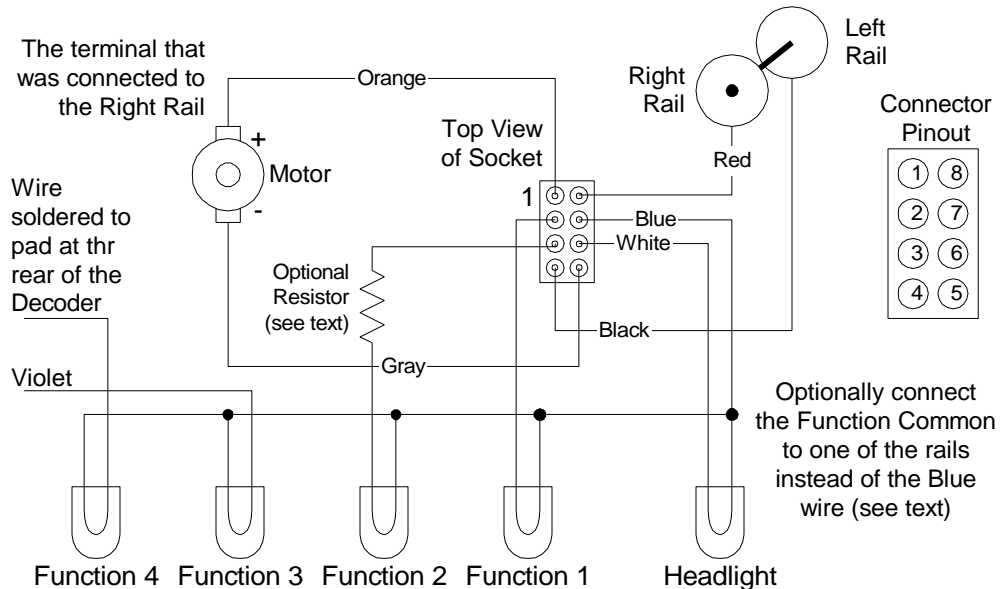
Orange	Right Hand Motor Lead
Red	Right Hand Rail
Yellow	Function 1 Output
Blue	Function Common, +V
Green	Function 2 Output
White	Headlight Output
Black	Left Hand Rail
Gray	Left Hand Motor Lead
Violet	Function 4 Output

Function 4 Output - Pad at rear of Decoder

NOTE: This Decoder is using a wire harness that has the same wire colors as the rest of the industry. IE: Yellow wire for rearlight (our F1), and green for F2. The connections at the NMRA plug are the same as before.

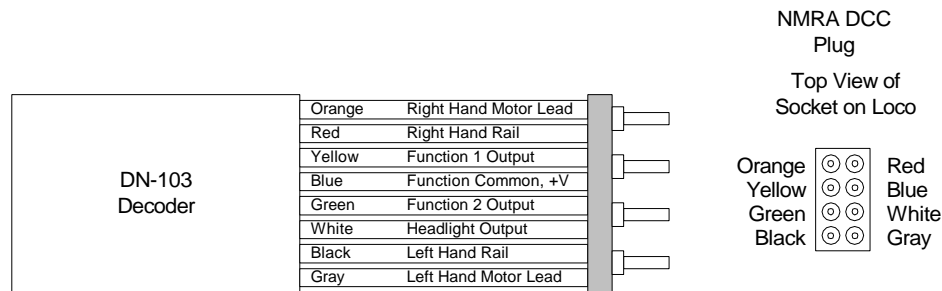
Right hand rail is the rail to the right of the observer standing between the rails with their back to the front of the locomotive, also referred to as the “engineers side”. For traction systems this is the overhead wire.

LOCO WIRING



To connect to Function 4, cut away a small portion (about 3/16's of an inch) at the rear of the Decoder, as shown in the figure above. Solder a wire to the pad. Make sure the wire is soldered to the pad only and does not touch any of the internal components.

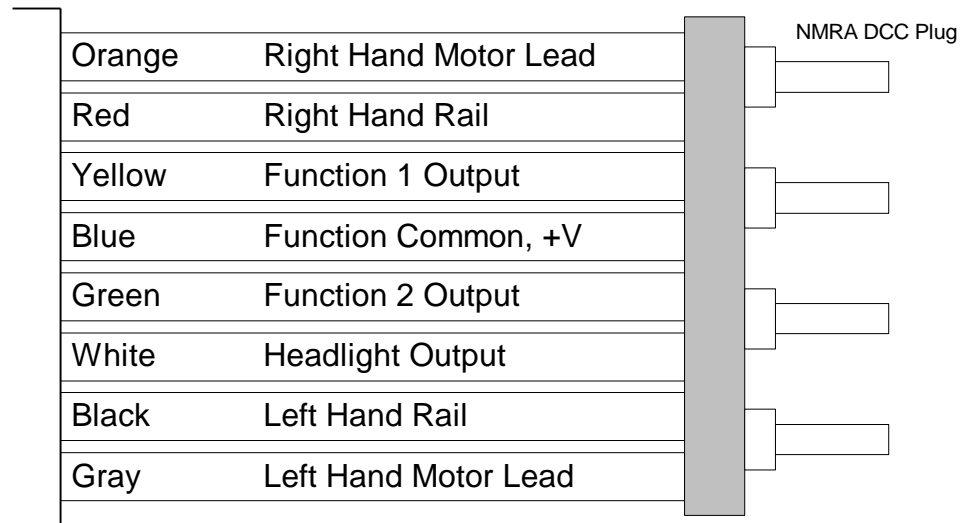
DN-103 - 1 AMPERE RATED WITH 3 FUNCTIONS - WITH NMRA 8-PIN MEDIUM PLUG



SPECIFICATIONS:

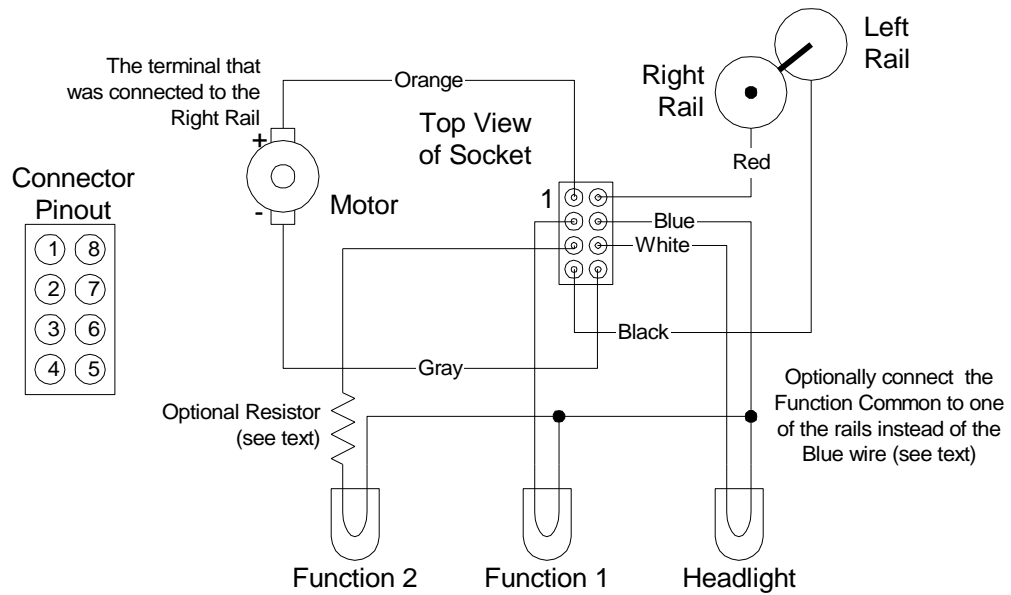
- Compatible with the NMRA Standards and Recommended Practices.
- 1.0 ampere overall current capacity.
- 1.0 ampere motor capacity for permanent magnet type DC motors.
- 0.3 ampere (300ma) minimum for the functions (100ma maximum per function). As an example: with a motor drawing 0.75 ampere “stalled”, there is .25 ampere (250ma) available for functions.
- 3 function outputs wired.
- Over temperature protected.
- 3 programmable address - Short (7 bit) address for backward compatibility, Long (14 bit) address for assigning any number to 9999, Consist (7 bit) address for assigning to a consist.
- Operates on DC.
- Programmable speed curve with both standard table and individual point capabilities.
- Programmable starting voltage.
- Programmable momentum for acceleration and deceleration adjustable from immediate to 3.8 minutes for standing stop to full speed.
- Operator control of front headlight and rear headlight. Lights do not change with loco direction.
- Operates with 128 speed step (feels like analog DC control) or 28 speed step with momentum.
- Ability to be “Programmed on the Main”.

WIRE COLOR CODE



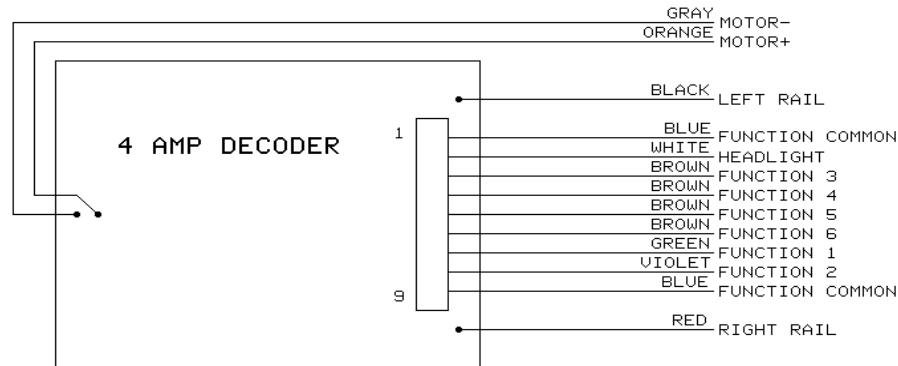
Right hand rail is the rail to the right of the observer standing between the rails with their back to the front of the locomotive, also referred to as the “engineers side”. For traction systems this is the overhead wire.

LOCO WIRING



A series resistor may be needed to drop the voltage to match the lamps you are using. For 12V-14V bulbs, start with a 100 Ω resistor and work your way down to get the proper brightness. For 1.5V bulbs, start with a 470 Ω resistor.

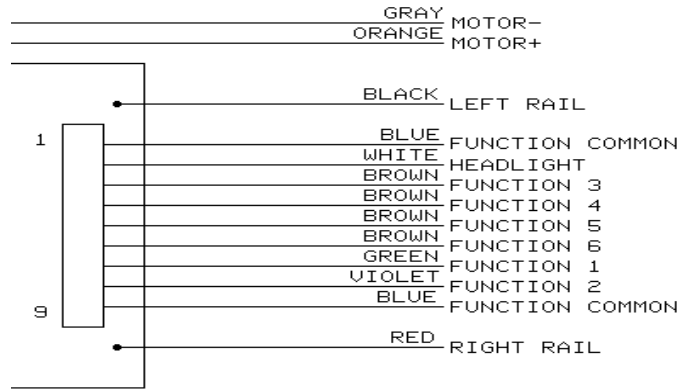
DO-407 - 4 AMPERE RATED WITH 7 FUNCTIONS - ORIGINAL DESIGN



SPECIFICATIONS:

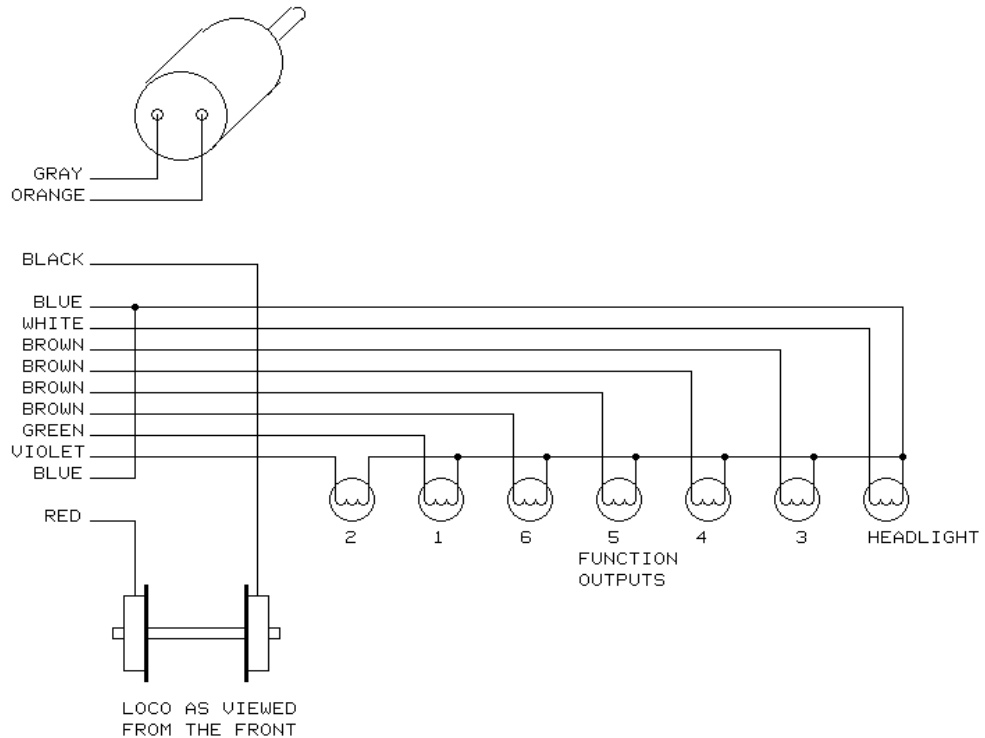
- Compatible with the NMRA Standards and Recommended Practices.
- 4.5 ampere overall current capacity.
- 4.0 ampere motor capacity for permanent magnet type DC motors. A Weaver loco draws about 2 amperes. If more weight is added it will draw more current.
- 0.5 ampere (500ma) minimum is available for the functions. As an example: with a motor drawing 2.5 amperes “stalled”, there is 2 amperes still available for functions.
- 7 functions outputs wired plus soldering contacts for connecting Horn and Bell functions.
 - F0 (HEADLIGHT) and F1 - 400ma
 - F2 through F6 - 200ma each
- Overload and short circuit protected.
- 3 programmable address - Short (7 bit) address for backward compatibility, Long (14 bit) address for assigning any number to 9999, consist (7 bit) address for assigning to a consist.
- Re-programmable micro-processor for up-grading software.
- Programmable speed curve with both standard table and individual point capabilities.
- Programmable starting voltage.
- Programmable momentum for acceleration and deceleration adjustable from immediate to 3.8 minutes for standing stop to full speed.
- Operator control of front headlight and rear headlight. Lights do not change with loco direction.
- Operates with 128 speed step (feels like analog DC control) or 28 speed step with momentum.
- Resets to DC voltage for operation on older layouts.

WIRE COLOR CODE

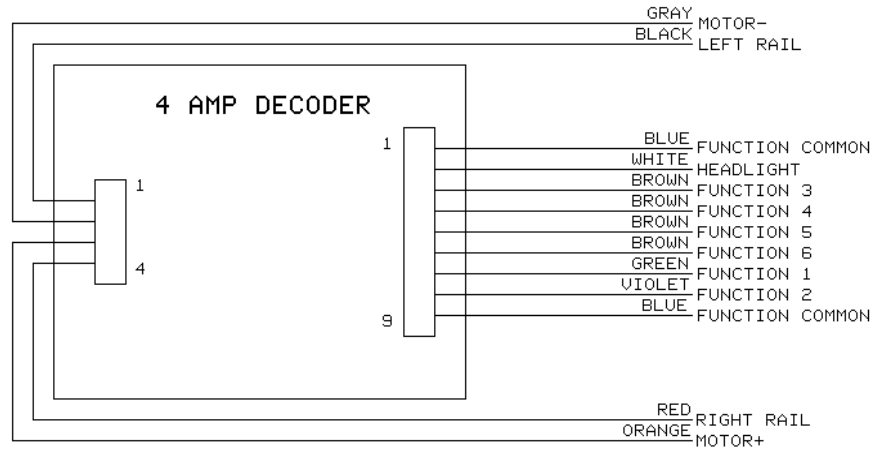


Right hand rail is the rail to the right of the observer standing between the rails with their back to the front of the locomotive, also referred to as the “engineers side”. For traction systems this is the overhead wire.

LOCO WIRING



DO-407 - 4 AMPERE RATED WITH 8 FUNCTIONS - NEW DESIGN DATED 1-MAR-96



This new design adds a connector to the motor outputs, but should be connected the same as the previous design. Refer to the previous 3 pages for more information.

The Decoder is protected by a thermal overload detector. It has a peak current output of approximately 8 Amps. If more than 4 Amps are drawn continuously, the Decoder will begin to overheat and shut itself down. It will restart after several seconds of cooling. The motor is stopped, and all function outputs are turned off during the over-temperature shutdown.

SPECIAL NOTE FOR DIGITRAX and LENZ OWNERS

This Decoder comes preset to address 3, 14 speed step mode, and DC operation disabled. Program register 5 to the following values to enable other modes of operation.

- 0 = 14 speed steps, standard speed table, DC disabled
- 2 = 28 speed steps, standard speed table, DC disabled
- 4 = 14 speed steps, standard speed table, DC enabled
- 6 = 28 speed steps, standard speed table, DC enabled
- 16 = 14 speed steps, alternate speed table, DC disabled
- 18 = 28 speed steps, alternate speed table, DC disabled
- 20 = 14 speed steps, alternate speed table, DC enabled
- 22 = 28 speed steps, alternate speed table, DC enabled

SystemOne™ can add 32 to the above values to enable the long (4 digit) address.

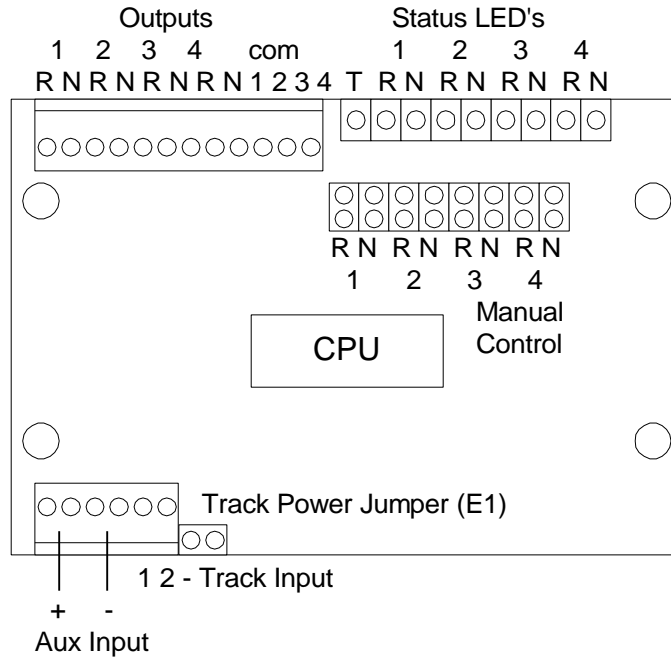
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STATIONARY DECODERS

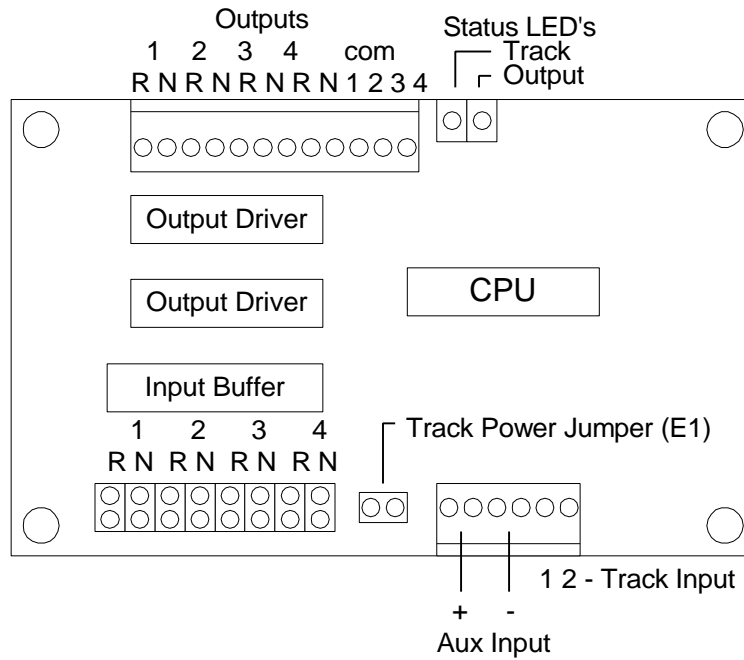
SM-104 - SWITCH MACHINE DECODER FOR 4 MACHINES

SPECIFICATIONS

- Compatible with the NMRA Standards and Recommended Practices.
- 1.5 ampere overall current capacity.
- 0.5 ampere (500ma) minimum is available for the each switch machine.
- All outputs are both current sinking and sourcing.
- ON time programmable from 0.1 second to 25.5 seconds, and always ON.
- ON time re-programmable while in place. Allows setting changes without removing the track termination's and connecting to the programming track..
- LED indicator to verify proper DCC packet information is being received.
- LED indicators for showing active outputs. Great for trouble-shooting.
- Terminals for manual Push Button control.
- Capable of being controlled from the full featured cab, the intermediate cabs using Macros, a dispatch program on a PC, and local push buttons.
- Addressable from 1 through 511. This allows 2044 switch machines to be controlled (4 x 511).
- Allowable auxiliary power from 3VDC to 20VDC to reduce the power requirements of the Power Station.
- Re-programmable micro-processor for up-grading the software.
- Capable of driving snap-type coil, slow motion motor, and capacitive discharge directly with no additional circuitry.



Older, Pre-1999 Design



Newer, 1999 Design

IMPORTANT DEVICES

TRACK OK LED (T)

This LED should always be lit when the power is ON. It indicates that DCC packets of information are being received by the decoder.

STATUS LED's (N and R)¹

These LED's are ON when in operation. At no time will both the N and R LED's be lit at the same time. The output is active while the LED is on. When the ON time is limited, the individual LED will only be ON for the length of time programmed.

TRACK SUPPLIED POWER JUMPER (E1)

This jumper is removed when auxiliary power is being supplied to power the outputs. When all power is being provided by the DCC track power, it is to be left in place. Using the auxiliary power input reduces the power requirements of the Power Station. Recommended for larger layouts.

DCC TRACK POWER TERMINALS (1 & 2)

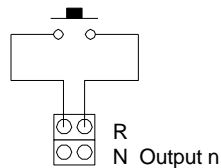
The DCC track power should be connected here. **NOTE:** The switch machines are powered from these terminals unless jumper E1 is removed (see next section).

AUXILIARY POWER TERMINALS (+ & -)

Auxiliary power should be connected here. Power should be limited to 3VDC to 20VDC. If Auxiliary Power is connected, the E1 jumper (see above) *must* be removed. There are two connections for each input, the for the + input, and two for the - input. This allows for easy daisy-chaining to following Decoders.

MANUAL CONTROL TERMINALS

If Push Buttons are to be used also they should be connected here.



Connect manual SPST push button to terminals. Each pair of terminals controls one output.

¹ The 'N' stands for Normal and the 'R' stands for Reverse or Route

OUTPUT TERMINALS (N, R, & COM)¹

Switch machines should be connected to the R and N terminals, with the common wire connected to the corresponding COM terminal.

PROGRAMMING INSTRUCTIONS

DECODER ADDRESS

The Decoder address needs to be programmed before it is installed. Note that the Accessory address is different from the Decoder address. Each Decoder address covers 4 Accessory addresses. Connect the DCC track terminals to the Programming Track Terminals. Alligator clips from the programming track will work fine. The address is at CV 513 and CV 521 (it's also mapped at CV 1 and 9²).

CV 513 holds the lower 6 bits

CV 521 holds the upper 3 bits

Decoder Address	CV 513	CV 521	Accessory Output 1	Accessory Output 2	Accessory Output 3	Accessory Output 4
1 *	1	0	1	2	3	4
2	2	0	5	6	7	8
3	3	0	9	10	11	12
4	4	0	13	14	15	16
5	5	0	17	18	19	20
6	6	0	21	22	23	24
64	0	1	253	254	255	256
192	0	2	765	766	767	768

PARTIAL ACCESSORY ADDRESS TABLE

* - Factory Default

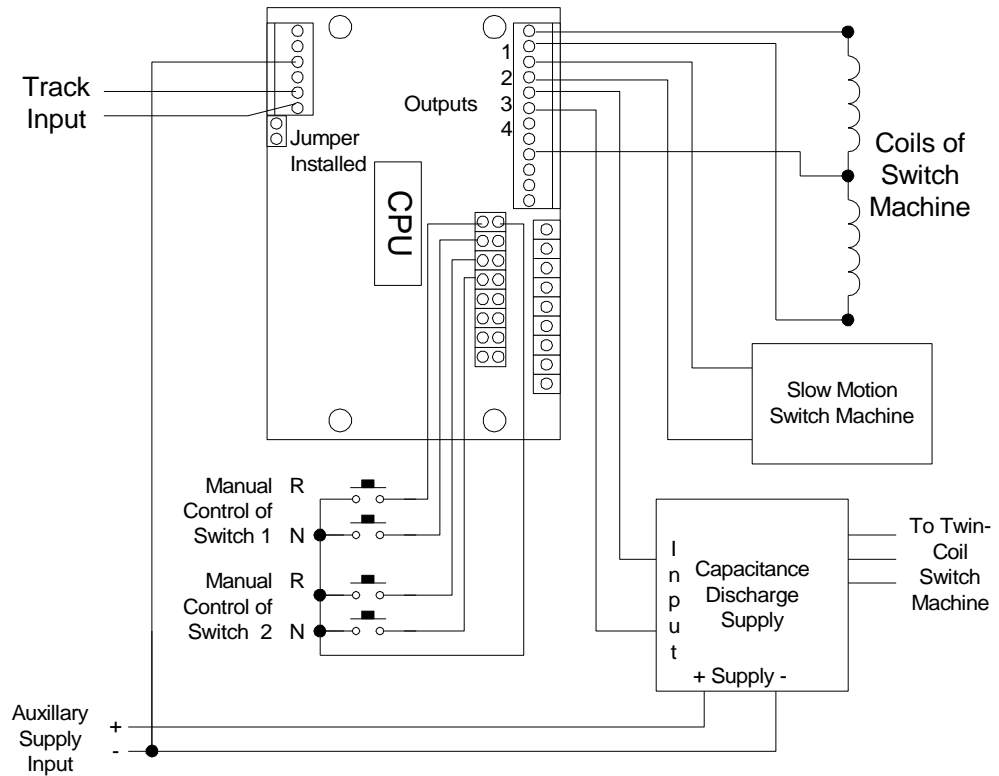
OUTPUT ON TIME

The ON time is adjustable from 0.1 second to 25.5 seconds. Use 0 for constant ON (no time-out). There is one setting for each of the four outputs.

Output Number	CV	Alternate CV	Default	Default Time
Output 1	515	2 ²	20	2 Sec
Output 2	516	3 ²	20	2 Sec
Output 3	517	4 ²	20	2 Sec
Output 4	518	5 ²	20	2 Sec

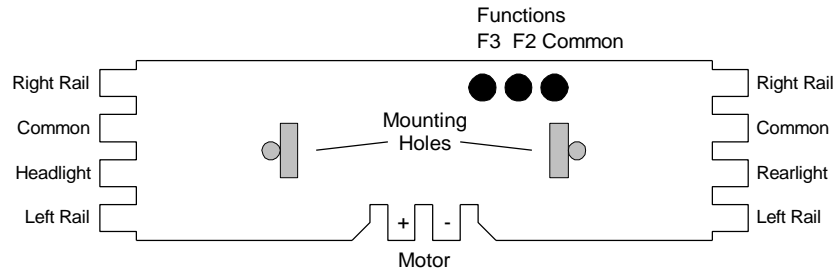
² The current NMRA Recommended Practices specify the CV's should be from 512 to 516 for accessory decoders.

WIRING INSTRUCTIONS



Wire the Stationary Decoder according to the diagram above. The switch machine connected to output 1 is a low-current snap switch (less the 0.5 Amp). For larger twin-coil switch machines, connect a Capacitance Discharge Supply, such as the circuit published by Bruce Chubbs, as in output 3. Connect slow-motion machines as shown connected to output 2. Use small values for the Output On Time for the Twin-Coil switch machines (from 0.1 to 0.5 max.), and 1 - 2 seconds, or constant on, for slow-motion switch machines. **NOTE:** If a time greater than 0.5 seconds is used for a snap or twin-coil switch machine, damage to both the switch machine and the Decoder will occur.

DH-154 - 1.0 AMPERE RATED WITH 4 FUNCTIONS DESIGNED FOR ATLAS, KATO, AND STEWART LOCOMOTIVES



SPECIFICATIONS:

- Compatible with the NMRA Standards and Recommended Practices.
- 1.4 ampere overall current capacity.
- 1.0 ampere motor capacity for permanent magnet type DC motors.
- 0.4 ampere (400ma) minimum for the functions (100ma maximum per function).
- Specifically designed to fit Atlas, Kato, and Stewart locomotives.

Atlas locomotives: RS1 RS3 RS11 RSD12 RSD4
 RSD5 GP7 C424 C425 U33
 U36 C30-7

and any new Loco using the same PC board as the U33/6.

Kato locomotives: GP-35 SD-40 C44-9

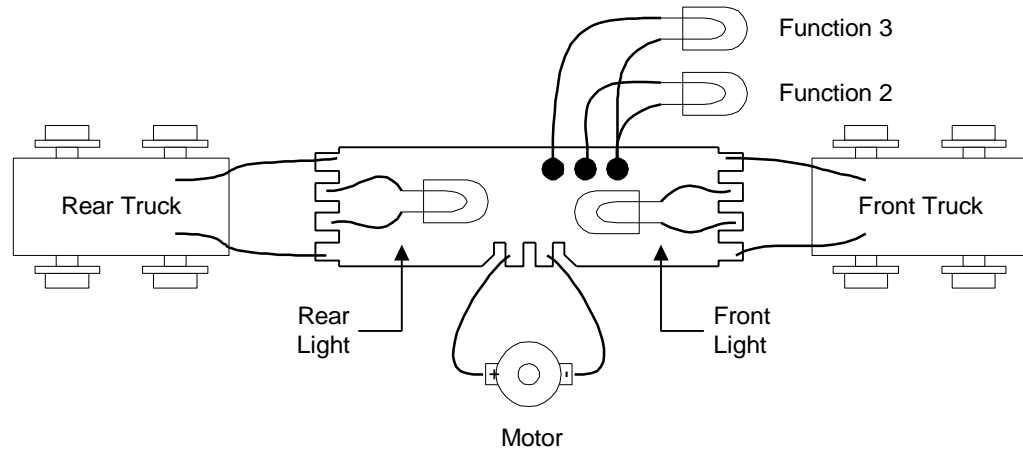
Stewart locomotives: F3, F7, and F9 (all phases, both A and B units)

FT (with a little work)

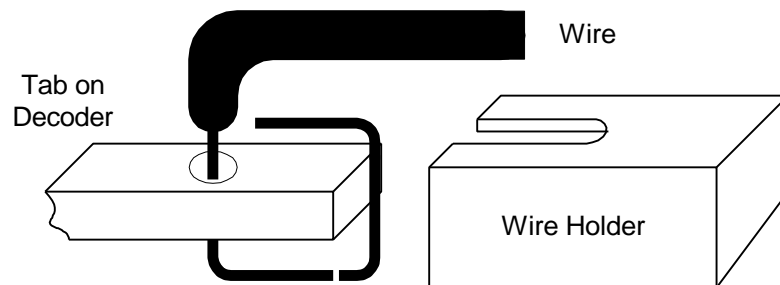
Life-Like Proto 2000 locomotives: SD7 SD9

- Slip-on connectors or solder.
- Function Animation for F2 an F3.
- Thermal overload protected.
- 3 programmable addresses - Short (7 bit) address for backward compatibility, Long (14 bit) address for assigning any number to 9999, Consist (7 bit) address for assigning to a consist.
- Operates on DC.
- Programmable speed curve with both standard table and individual point capabilities.
- Programmable starting voltage.
- Programmable momentum for acceleration and deceleration, adjustable from immediate, to 3.8 minutes from stop to full speed.
- Operator control of front headlight and rear headlight. Lights do not change with loco direction.
- Operates with 128 speed step (feels like analog DC control) or 28 speed step with momentum.

LOCO WIRING



Install the Decoder with the components facing down. Connect the wires coming from the front and rear trucks to the outside tabs. The wires from the trucks should connect to their respective sides. Strip the wire about 3/16" and slip the wire through the hole. Wrap the wire around the outside of the tab. Slide the wire holder over the tab with the wire coming out the side with the slot. Be careful to assure that the bare wire does not touch any components on the bottom of the board (see illustration). You could solder the wire directly to the tabs if you desire.



Make sure that the bare end does not touch any components (keep the length under the wire holder).

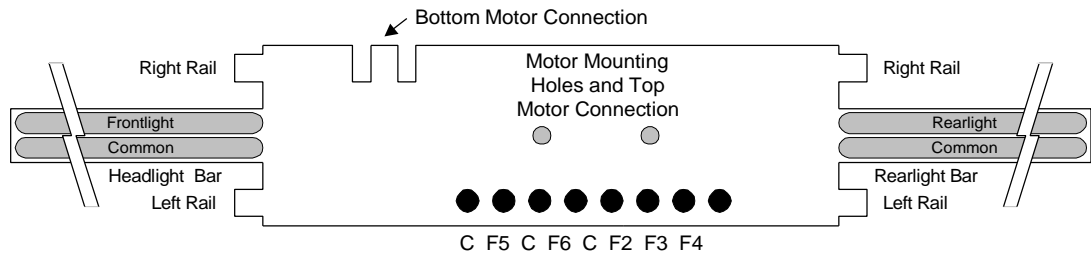
Connect the front light and the rear light in a similar manner to the inside tabs. Connect the motor to the tabs on the side. If the Loco has copper strips connected to the motor, they will have to be cut back and wires soldered to them to connect to the Decoder.

ANIMATION CV

CV 49 is the animation control register.

CV Value	Animation Effect
0	F3 operates normal
1-127	F3 blinks at ≈ 1.2 second rate, the intensity controlled by the value. The higher the value the brighter/longer the blink. Depending on the bulb, a value of 5-6 is required to see the blinking.
128	F2 and F3 blink alternately at equal intensity.
129-255	As this value is increased, F2 blinks shorter, while F3 blinks longer. If you wire F2 through a resistor, connected to the same bulb as F3, a Mars light can be simulated.

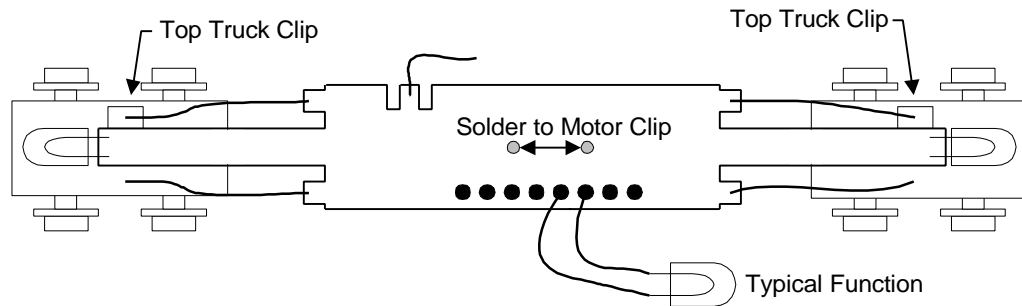
DH-157A - 1.5 AMPERE RATED WITH 7 FUNCTIONS DESIGNED FOR ATHERN LOCOMOTIVES



SPECIFICATIONS:

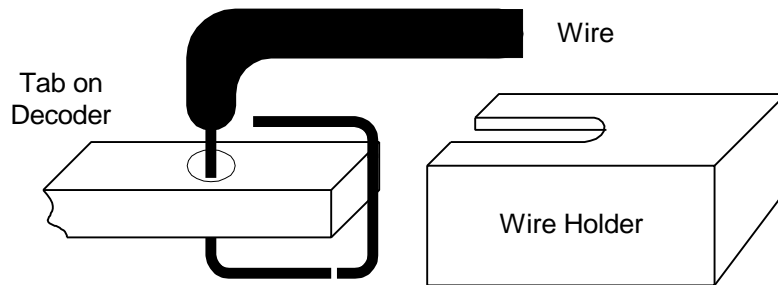
- Compatible with the NMRA Standards and Recommended Practices.
- 1.5 ampere overall current capacity.
- 1.0 ampere motor capacity for permanent magnet type DC motors.
- 0.5 ampere (500ma) minimum for the functions (100ma maximum per function).
- Specifically designed to fit Athearn locomotives.
- Slip-on connectors or solder.
- Thermal overload protected.
- 3 programmable addresses - Short (7 bit) address for backward compatibility, Long (14 bit) address for assigning any number to 9999, Consist (7 bit) address for assigning to a consist.
- Operates on DC.
- Programmable speed curve with both standard table and individual point capabilities.
- Programmable starting voltage.
- Programmable momentum for acceleration and deceleration, adjustable from immediate, to 3.8 minutes from stop to full speed.
- Operator control of front headlight and rear headlight. Lights do not change with loco direction.
- Operates with 128 speed step (feels like analog DC control) or 14/28 speed step with momentum.

LOCO WIRING



SLIP-ON CONNECTIONS

Strip the wire about 3/16" and slip the wire through the hole. Wrap the wire around the outside of the tab as shown. Slide the wire holder over the tab with the wire coming out the side with the slot. Be careful to assure that the bare wire does not touch any components on the bottom of the board. You could solder the wire directly to the tabs if you desire.

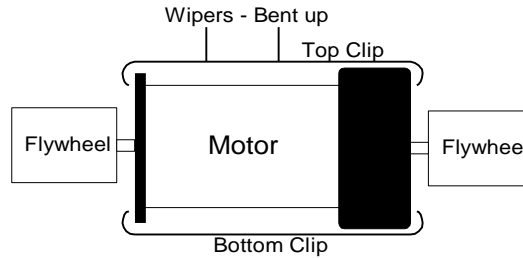


Make sure that the bare end does not touch any components (keep the length under the wire holder).

INSTALLATION

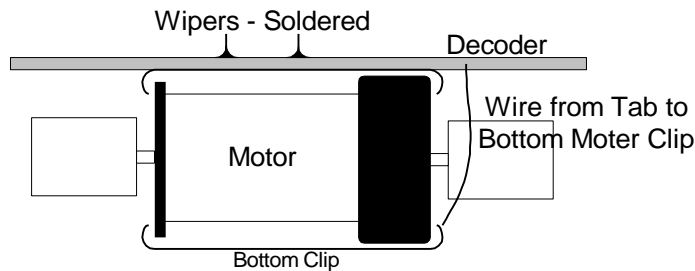
The key to success in installing a Decoder in an Athern locomotive is keeping the wiring out of the mechanism. This Decoder was designed to mount on top of the motor, with narrow fingers front and rear, to mount the lights. These fingers (bars) may be cut to the correct length, and can be soldered together to raise or lower the lights. This way all of the wiring and the lights are on the chassis, not connected to the shell.

NOTE: Cutting the bar does *not* invalidate your warranty.



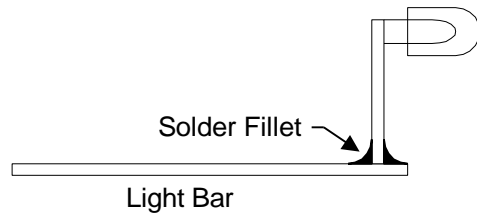
Remove the motor from the chassis. Carefully remove both motor clips (watch for the brush springs) and re-install the bottom clip on the top of motor, and the top clip on the bottom. Bend both of the wipers on the top clip straight up. Slide the Decoder over the wipers, components facing down, with the end of the Decoder marked front, on the brush side of the motor. Solder the Decoder to the motor at the wipers. Depending on the loco, you may have to cut the wipers off.

Connect a wire from the side tab to the bottom motor clip. Place a piece of tape on the chassis under the motor, and re-install the motor.



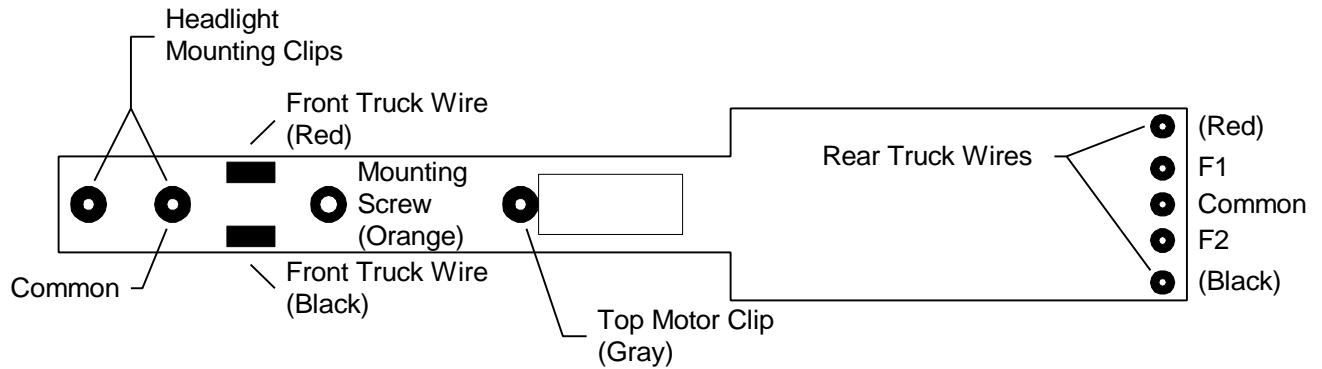
Connect wires coming from the top metal clip on the front and rear trucks to the respective outside tabs. Connect wires from the other outside tabs to the chassis. This can be done by soldering wires to the metal sideframe (preferred), or drilling a hole and attaching the wires using a sheet metal screw, or by soldering the wires to the chassis light mounting clip (least preferred). Remember, the better the electrical contact, the better the loco will run.

Measure the bar lengths by holding the shell aside the chassis. Cut the bars to the measured lengths. Depending on the loco, the lights can be mounted directly on the bars (top or bottom), or pieces of bar can be soldered together to raise or lower the lights as necessary. Use the bars to locate the lights as close to the correct position as possible when the shell is re-installed.



You can also isolate sections of the PC tracks on the light bar to mount lights other than the front and read light and to mount dropping resistors.

DH-103S - 1.0 AMPERE RATED WITH 3 FUNCTIONS DESIGNED FOR ATLAS S-SERIES LOCOMOTIVES

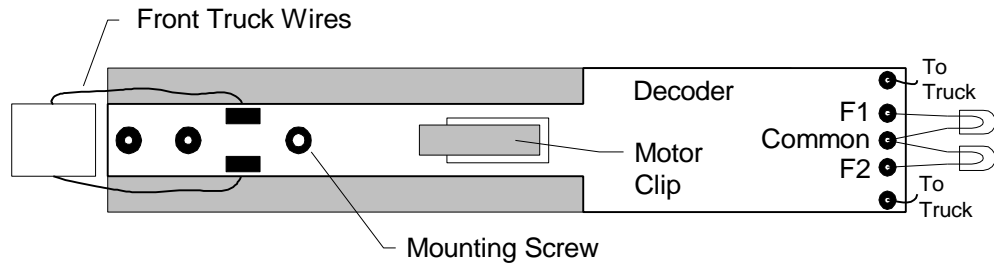


NMRA wire colors shown in parentheses

SPECIFICATIONS:

- Compatible with the NMRA Standards and Recommended Practices.
- 1.0 ampere overall current capacity.
- 1.0 ampere motor capacity for permanent magnet type DC motors.
- 0.3 ampere (300ma) minimum for the functions (100ma maximum per function).
- Specifically designed to fit the Atlas S-series locomotives.
- Slip-on connectors or solder.
- 3 programmable addresses - Short (7 bit) address for backward compatibility, Long (14 bit) address for assigning any number to 9999, Consist (7 bit) address for assigning to a consist.
- Operates on DC.
- Programmable speed curve with both standard table and individual point capabilities.
- Programmable starting voltage.
- Programmable momentum for acceleration and deceleration, adjustable from immediate, to 3.8 minutes from stop to full speed.
- Operator control of front headlight and rear headlight. Lights do not change with loco direction.
- Operates with 128 speed step (feels like analog DC control) or 14/28 speed step with momentum.

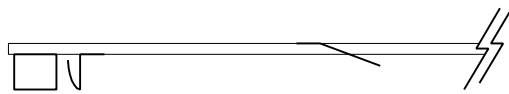
LOCO WIRING



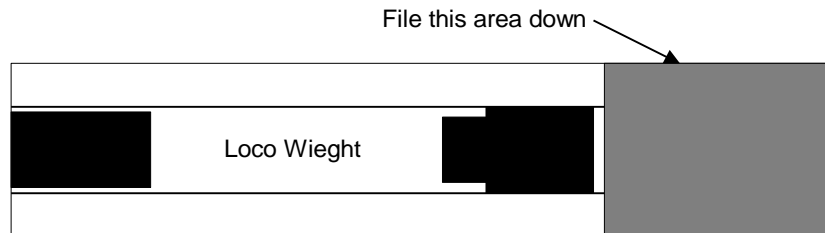
INSTALLATION

Remove the cab and the front hood from the loco. Disconnect the wires coming from the trucks at the PC board and remove it. File off the rivets on the PC board holding the motor and light clips, and remove them. Place the motor clip in the square cutout over the PC board hole as shown, and solder in place.

If you are going to use the existing front light, solder the light clips to the front PC holes as shown. Install the light bulb.



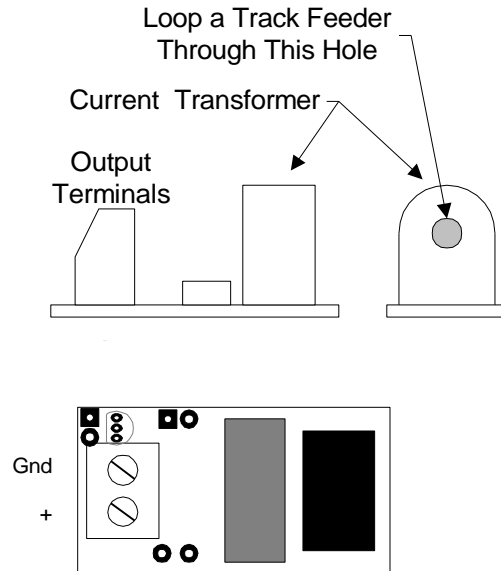
The weight under the Decoder needs to be filed down about 1/16. Insulate the area under the back portion of the Decoder with a piece of tape. Alternately, you can remove the back portion of the weight.



Mount the Decoder using the same screw that held the original PC board. Solder the two front truck wires to the rectangular pads just behind the front light. Solder the two rear truck wires to the two outside pads at the rear of the Decoder. Keep the wires from the trucks connected to the same side of the Decoder.

You may install a rearlight (F1) and another light connected to F2 by wiring to the three pads at the rear of the Decoder, as shown in the loco wiring diagram above.

GETTING TO KNOW YOUR BLOCK OCCUPANCY DETECTOR



The BOD-20 block detector module is normally used to indicate the presence of a locomotive, caboose, or other rolling stock in a track section by sensing electrical current drawn by that rolling stock. Locomotives will naturally trigger the detector because they draw current through their DCC decoder. Unpowered rolling stock will not trigger the detector unless equipped with some means of drawing current from the rails such as lights or a resistor wheel set.

Unlike other detection units the BOD-20 requires no direct electrical connection to the track. This block detector can be used with any sized DCC power booster of up to 20 Amps capacity. The track feeder wire for one rail of the block is just passed through the hole in the current transformer on the module (see figure 1) before connecting the feeder to the track. The more times the wire goes through the hole in the current transformer the more sensitive the detector becomes. See the section on Decoder Sensitivity for some limits on this matter.

An LED can easily be added for simple indication of staging track occupancy, progress through a helix, etc. The LED indicator requires a DC power supply of between 5 and 15 Volts to power the LED option.

FALSE TRIGGERING

You may get false triggering of the detector if the block is too long. The capacitance between the rails actually conducts a small amount of the DCC

signal and can cause the detector to trigger. If you think you have problems with this see the section on desensitizing the detector.

DETECTOR OUTPUT

The output of the detector is “open collector” (figure 2) to be compatible with most signal system logic boards on the market today. Trac-tronics is one manufacturer of signal logic circuitry that is compatible. If you design your own signal logic circuitry the output transistor of the detector specifications apply to a load of 500uA (10K pullup to 5 volts). Max. rating is 10mA at 18 volts. The transistor turns on connecting the “+” output to the ground when current is detected.

DESENSITIZING THE DETECTOR

If you have problems with false triggering due to humidity, ballast glue, track oil, etc. providing a conduction path for track current, a resistor may be installed on the PC board to desensitize the detection circuit. Figure 3 shows the location of the desensitizing resistor mounting holes. The resistor should be ¼ watt and mounted vertically. The value is determined by trial and error (a pot could be used).

OPTIONAL LED INDICATOR

If you decide to use the optional LED indicator you must also provide a DC power supply of between 5 and 15 Volts. This is connected to the holes indicated in Figure 3 (hooking it up backwards would probably blow up the PNP transistor, so be careful).

Steps to installing the optional LED

Install a 1K (¼ Watt) resistor at the indicated location in Figure 3, if necessary

Install a PNP small signal transistor (2N3906, 2N2907, or 2N4403 or similar are OK)

Install an LED with the cathode in the square hole. The cathode is usually the short lead of the LED. You can “remote” the LED to a control panel instead of soldering it directly to the detector if you want.

SENSITIVITY AND OTHER TECHNICAL STUFF

Detector sensitivity may be increased by putting more “turns” through the hole in the current transformer. There is a limit to the number of turns based on the power output capability of the booster. If you put too many turns through the hole for the capacity of the booster, you may damage the detector module.

Table 1 lists various popular booster sizes and has an “x” in areas where the detector limits will be exceeded. There are 2 sensitivity tables. Table 1 lists the number of milliamps through the track feeder wire required to bring the

collector of the detector output transistor down to 0.7 volts (5 volt supply with a 10K pullup) which is enough to give a reliable indication on TTL logic chips. Table 2 is the same table, but with the collector drawn down to 1.0 volts for "HC" logic compatibility.

Number of Turns	Power Station Output				
	3 Amp	4 Amp	5 Amp	10 Amp	20 Amp
1	8mA	8mA	8mA	8mA	8mA
2	4mA	4mA	4mA	4mA	X
3	2.5mA	2.5mA	2.5mA	X	X
4	1.9mA	1.9mA	1.9mA	X	X
5	1.5mA	1.5mA	X	X	X

Table 1: Typical sensitivity in mA (0.7 volt output) based on the number of turns.

Number of Turns	Power Station Output				
	3 Amp	4 Amp	5 Amp	10 Amp	20 Amp
1	7.6mA	7.6mA	7.6mA	7.6mA	7.6mA
2	3.8mA	3.8mA	3.8mA	3.8mA	X
3	2.5mA	2.5mA	2.5mA	X	X
4	1.8mA	1.8mA	1.8mA	X	X
5	1.5mA	1.5mA	X	X	X

Table 1: Typical sensitivity in mA (1.0 volt output) based on the number of turns.

MAKING RESISTOR WHEEL SETS

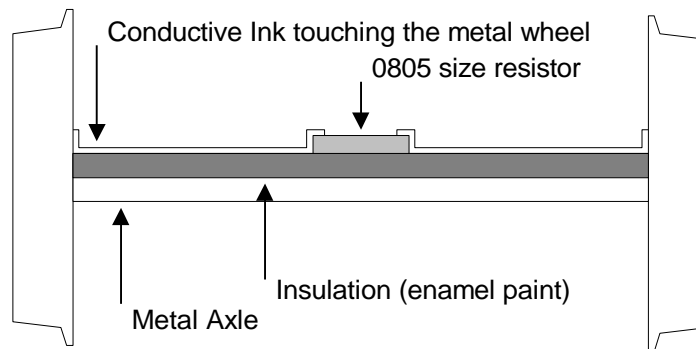
Metal wheel sets such as those available from North West Shortline, Jaybee, Kaydee, and others can easily be converted to draw current from the rails for block detection and other current sensing purposes. Our method makes it easy to connect a resistor from one wheel to the other without drilling or soldering. The suggested parts list includes 3.3K ohm resistors which will draw about 5 milliamps per wheel set. Use a larger amp resistor to decrease the current. If you want to increase the current you will have to use a physically larger resistor such as a 1206 or 1812 size in order to dissipate heat generated in the resistor by the current flow.

Parts to obtain from Mouser Electronics (1-800-346-6873 MC/Visa OK):

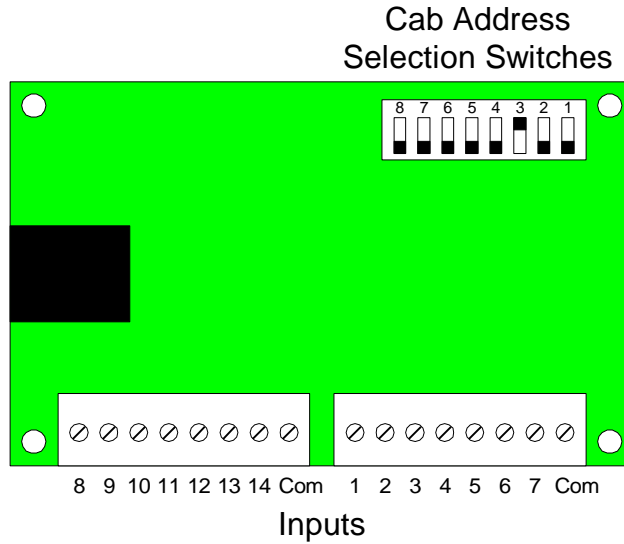
Item	Part Number
Circuit Works Conductive Ink Pen	5168-2200ST
Circuit Works Overcoat Pen	5168-3300G
Surface mount resistors (size:0805 1/10 watt 3.3K ohms)	260-3.3K

Instructions (all steps refer to the wheelset drawing below):

1. Paint an insulating stripe down the metal axle with either the overcoat pen or some good old Testors enamel paint. The enamel costs less but takes 1-2 days to dry.
2. Glue a resistor to the axle taking care to keep the glue off the metal ends of the resistor as we will need to make connections here later.
3. Use the conductive ink pen to connect one metal end of the resistor to its corresponding wheel. Connect the remaining end of the resistor to the other wheel.
4. Viola! You now have a resistor wheel set.



GETTING TO KNOW YOUR AUXILIARY INPUT UNIT



The Auxiliary Input Unit (AIU) is a Cab Bus device that allows devices to be monitored by the Command Station. These can be switch contacts, open collector devices (like track detectors), or our BOD-01 Block Detector. These are read by the Command Station and can be read by a computer through the RS-232 port (see).

Since the AIU is a Cab Bus device, its address must be set to a number that is not used by any existing Cab. We suggest that you set it to a very high number, say between 50 and 60.

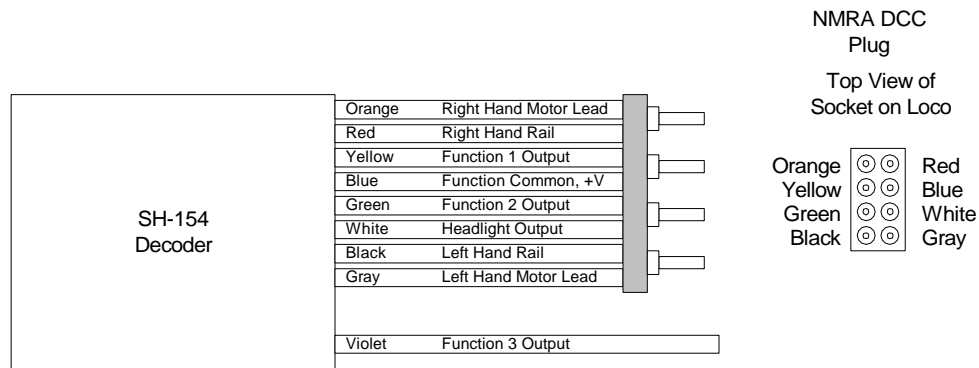
ADDRESS SELECTION

The AIU ships factory programmed to address X. To change this address, is an 8 position DIP switch. Refer to the figure and the table below for address selection. NOTE: up = move the switch toward the top of the AIU, dn = move the switch toward the bottom of the AIU. Also, not all of the addresses are in the table. To calculate the desired address, add the “dn” switches. E.g., Address 25 = 16 + 8 + 1. 64 & 128 should always be up.

Address Table

Switch Value								
Switch Position								
Address	1	2	3	4	5	6	7	8
1	dn	up	up	up	up	up	up	up
2	up	dn	up	up	up	up	up	up
3	dn	dn	up	up	up	up	up	up
4	up	up	dn	up	up	up	up	up
5	dn	up	dn	up	up	up	up	up
6	up	dn	dn	up	up	up	up	up
7	dn	dn	dn	up	up	up	up	up
8	up	up	up	dn	up	up	up	up
9	dn	up	up	dn	up	up	up	up
10	up	dn	up	dn	up	up	up	up
20	up	up	dn	up	dn	up	up	up
30	up	dn	dn	dn	dn	up	up	up
40	up	up	up	dn	up	dn	up	up
50	up	dn	up	up	dn	dn	up	up
60	up	up	dn	dn	dn	dn	up	up

SH-154 - 1.5 AMPERE RATED WITH 4 FUNCTIONS



SPECIFICATIONS:

- Compatible with the NMRA Standards and Recommended Practices.
- 2 ampere overall current capacity.
- 1.5 ampere motor capacity for permanent magnet type DC motors.
- 100ma maximum per function. As an example: with a motor drawing 1.5 ampere “stalled”, there is .5 ampere (500ma) available for functions.
- 4 function outputs.
- Thermal protected.
- 3 programmable address - Short (7 bit) address for backward compatibility, Long (14 bit) address for assigning any number to 9999, Consist (7 bit) address for assigning to a consist.
- Operates on DC.
- Support for *all* programming modes.
- Programmable speed curve with both standard table and individual point capabilities.
- Programmable starting voltage.
- Programmable momentum for acceleration and deceleration.
- Operator control of front headlight and rear headlight. Lights do not change with loco direction.
- Operates with 128 speed step or 28 speed step with momentum.
- Lighting Animation:
Individual or directional headlights.
Rule 17, dimmable front and rear light
Mars and ditch lights.
- Detachable cable harness, compatible with other manufacturers harnesses.

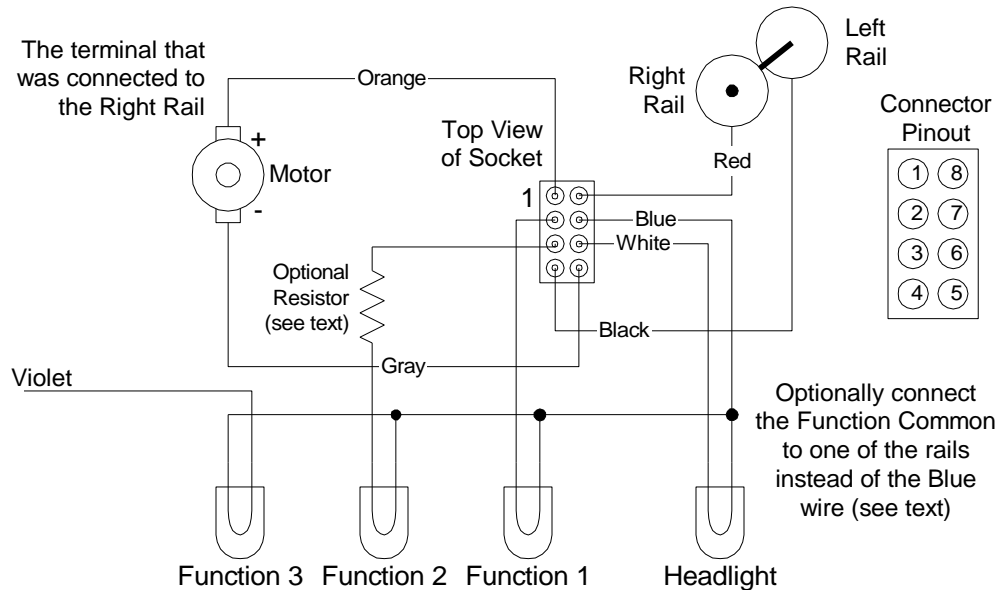
WIRE COLOR CODE

Orange	Right Hand Motor Lead
Red	Right Hand Rail
Yellow	Function 1 Output
Blue	Function Common, +V
Green	Function 2 Output
White	Headlight Output
Black	Left Hand Rail
Gray	Left Hand Motor Lead
Violet	Function 3 Output

NOTE: This Decoder is using a wire harness that has the same wire colors as the rest of the industry. IE: Yellow wire for rearlight (our F1), and green for F2. The connections at the NMRA plug are the same as before.

Right hand rail is the rail to the right of the observer standing between the rails with their back to the front of the locomotive, also referred to as the “engineers side”. For traction systems this is the overhead wire.

LOCO WIRING



To connect to Function 4, cut away a small portion (about 3/16's of an inch) at the rear of the Decoder, as shown in the figure above. Solder a wire to the pad. Make sure the wire is soldered to the pad only and does not touch any of the internal components.

CV Programming

CV	Description	Range	Value
1	Short Address	1-127	3
2	Start Voltage	0-31	4
3	Acceleration	1-31	1
4	Deceleration	1-31	1
7	Version Number (Read only)		
8	Manufacturer ID (Read only)		12
17-18	Long Address	0-255	
19	Consist Address	0-255	0
23	Acceleration Trim	0-255	0
24	Deceleration Trim	0-255	0
29	Decoder Configuration byte 1 Bit 0: Direction Bit 1: 14/28 Speed Step Mode Bit 2: DC mode enable Bit 3: Reserved Bit 4: Speed Curve Bit 5: Long Address enable Bit 6: Reserved Bit 7: Reserved	0-255	2
50	Decoder Configuration byte 2 Bit 0: Not Used Bit 1: CV 23 and 24 enable Bit 2: Decelerate on DC enable Bit 3: Not Used Bit 4: Not Used Bit 5: Not Used Bit 6: Not Used Bit 7: Not Used	0-255	0
51	Bit 0: Bit 1: Bit 2: Bit 3: Bit 4: Bit 5: Bit 6: Bit 7:		
52			
53	Bit 0: Not Used Bit 1: Bit 2: Bit 3: Bit 4: Bit 5: Bit 6: Bit 7:		
54	Bit 0: Not Used Bit 1: Bit 2: Bit 3:		

	Bit 4: Bit 5: Bit 6: Bit 7:		
55	Bit 0: Not Used Bit 1: Bit 2: Bit 3: Bit 4: Bit 5: Bit 6: Bit 7:		
56			
67-94			
105			
106			

OPERATING PROCEDURES

OPERATING SCREENS EXPLAINED

NORMAL OPERATION

LOC:1234 12:30PM FWD: 120 L123456

LINE 1 - FROM THE LEFT

Loco/Consist Number Scale Time

LOC: or **CON:**

LOC: indicates that a loco is being operated.

CON: indicates that a consist is being operated.

12:30PM

Scale Time in either 12 hour or 24 hour format.

LINE 2 - FROM THE LEFT

Direction Speed Step Functions

FWD: or **REV:**

Indicates whether loco or consist is going in the forward or reverse direction.

120

Indicates the speed step that the active loco/consist is presently set at.

L123456 or - - - - -

Indicates which function outputs are ON. Those outputs that are OFF are displayed as dashes (-).

Other status information may be displayed in this area.

ADDRESSING A LOCOMOTIVE OR CONSIST

ENTER LOCO/CONSIST NUMBER

LOC: 501 12:30PM ENTER LOCO: _

Enter the 1 to 4 digit address of the loco/consist to be operated, followed by the **ENTER** key. A “Leading Zero” is necessary for **long** addresses below 128. An asterisk will be displayed before any long address below 128.

Example:

501 = Long Address

045 = Long Address as Entered.

*045 = Long Address as Displayed

45 = Short Address

CON: will be displayed when addressing a Consist.

SELECT ACCESSORIES

ENTER THE ACCESSORY NUMBER TO BE OPERATED

CONTROL 12:30PM
ACC NUMBER: _

Press **SELECT ACCY** key. Enter the address of the accessory to be operated. Followed by pressing the **ENTER** key.

TURN ACCESSORY ON OR OFF

ACC: 003 12:30PM
1=N(ON) 2=R(OFF)

Press **1** to turn accessory ON. (Switch machine set to STRAIGHT or NORMAL)

Press **2** to turn accessory OFF. (Switch machine set to CURVED or REVERSE)

SELECT MACROS

ENTER THE MACRO NUMBER TO BE EXECUTED

LOC: 003 12:30PM
MACRO NUMBER:_

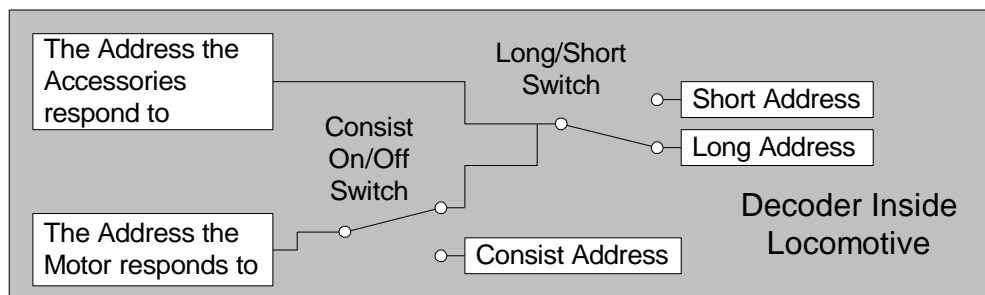
Press **MACRO** key. Enter the number of the macro to be executed, followed by pressing **ENTER**. See the **Macros Explained** section on page 3-21.

SETTING UP A CONSIST

OLD AND ADVANCED CONSISTS EXPLAINED

Before setting up any consist an explanation is needed to understand the operating differences between the old style consist (MRC, older Lenz, and Digitrax) and the advanced consist operations. MRC presently manufactures only basic decoders that have a 7 bit address but no CONSIST address.

ADVANCED



Advanced decoders have a short (7 bit) address for being able to operate on MRC, Lenz, and Digitrax layouts, a long (14 bit) address to utilize the full four digit classification number of most loco's, and a consist (7 bit) address for consist operation. See the diagram above.

The Long/Short *Switch* is changed by choosing the long/short selection in CFG programming or by setting configuration variable 29. See CFG and CV programming on page 4-8 for Main Track programming and 4-18 for Programming Track programming. The Consist On/Off *Switch* is changed when a loco is added to, or dropped from a consist. See the Add Loco section on page 3-8, and Drop Loco on page 3-18.

An advanced Command Station sends an advanced decoder a command to activate the consist address with the consist number. It will now listen to the consist address for speed and direction. This has many advantages including less need for communications on the track and no keeping track of consist set-ups on the layout.

Each loco in an advanced consist can still respond to function commands at the original address. This means that the operator can turn on or off lights and other functions for each loco individually. The lights of functions will all go on and off together if the command is sent to the consist address.

To kill a consist, a command is broadcast on the tracks, and each decoder with that consist address clears its consist address, and returns to individual operation.

OLD STYLE

Digitrax (Chalanger and Big Boy) and Lenz, builds and keeps track of each consist in the memory of the Command Station, and each command to the consist from the Cab generates a separate command to each of the decoders in the consist.

To kill a consist the memory of that consist is cleared within the command Station. The decoder does not know it is in a consist.

CAUTION: Any Decoder in an old style consist can still be addressed by it's original address for speed and direction. This potential problem is common with all Lenz and Digitrax consists *and* our old style consists.

ADVANCED CONSISTS

SETUP CONSIST

```
CONSIST 12:30PM
ENTER=ADV 1=OLD
```

To set up a consist press **CONSIST - SETUP**. This screen allows you to choose the type of consist to be created. For those consists that only contain advanced decoders, press **ENTER** to select the advanced mode. Please note that an advanced decoder consist has *no* limit as to the number of loco's assigned.

ENTERING THE CONSIST NUMBER

```
SETUP 12:30PM
CON ADDR: _
```

The consist number can be any number from 1 through 127. Enter the number followed by pressing the **ENTER** key.

ENTERING THE LEAD LOCO NUMBER

```
SETUP 12:30PM
LEAD LOCO: _
```

The lead loco can be any number from 1 through 9999. This address is the *alias* for the address entered above. Enter the number followed by pressing the **ENTER** key.

ENTERING THE LOCO'S DIRECTION

```
CONSIST 12:30PM
DIR THIS LOCO: F
```

If the loco is to operate in the correct direction press **ENTER**, otherwise press the **DIRECTION** key followed by pressing the **ENTER** key. This informs the decoder if the loco is in the line-up facing forward or reverse. For instance, in an A-B-A consist the lead A loco and the B loco will be setup in the Forward direction, and the second A loco will be setup in the Reverse direction.

ADDING A LOCO TO THE CONSIST

```
CONSIST 12:30PM  
ADD LOCO: _
```

Enter your loco number (decoder address) followed by pressing the **ENTER** key.

ENTERING THE LOCO'S DIRECTION

```
CONSIST 12:30PM  
DIR THIS LOCO: F
```

If the loco is to operate in the correct direction press **ENTER**, otherwise press the **DIRECTION** key followed by pressing the **ENTER** key. This informs the decoder if the loco is in the line-up facing forward or reverse. For instance, in an A-B-A consist the lead A loco and the B loco will be setup in the Forward direction, and the second A loco will be setup in the Reverse direction.

ENTERING THE LOCO NUMBER

```
CON:012 12:30PM  
ADD LOCO: _
```

The above two screens will be repeated so that the operator can add all of the loco's in the consist. Once complete, press **ENTER** with no loco number on the **ADD LOCO** screen.

ADDING A LOCO TO AN ADVANCED CONSIST

SELECT AN EXISTING CONSIST

```
ADD LOCO 12:30PM  
CONSIST ADDR: _
```

Press **CONSIST - ADD**. Enter the number of the existing consist, or alias, to which the loco is to be added and then press the **ENTER** key.

ENTERING THE LOCO NUMBER

```
ADD LOCO 12:30PM  
ADD LOCO: _
```

Enter the loco's number and press the **ENTER** key.

ENTERING THE LOCO'S DIRECTION

```
CONSIST 12:30PM  
DIR THIS LOCO: F
```

If the loco is to operate in the correct direction press **ENTER**, otherwise press the **DIRECTION** key followed by pressing the **ENTER** key. This informs the decoder if the loco is in the line-up facing forward or reverse.

DROPPING A LOCO FROM AN ADVANCED CONSIST

SELECT LOCO

```
DEL LOCO 12:30PM  
ENTER LOCO: _
```

This will drop the loco identified from whatever consist it was part of. There is no need to know the consist number for this operation.

CLEARING AN ADVANCED CONSIST

SELECT THE CONSIST TO BE CLEARED

```
LOC:1234 12:30PM  
KILL CONSIST:_
```

Enter the consist number and press **ENTER**. This sends a command to all decoders with this consist address to clear this consist address. All loco's that were assigned to this consist will no longer respond to the consist address.

OLD STYLE CONSISTS

SETUP CONSIST

```
CONSIST 12:30PM
ENTER=ADV 1=OLD
```

To set up a consist press **CONSIST - SETUP**. This screen allows you to choose the type of consist to be created. For those consists that will contain any of the basic decoders, press **1**. Please note that our limit on an old style consist is four loco's.

INITIAL SCREEN DISPLAYED

```
CON: 000 12:30PM
000 000 000
```

This screen is displayed to show all 4 "slots" for loco's in the consist are empty. Press the **ENTER** key to continue.

Press the **ADD LOCO** key.

ENTERING THE LOCO NUMBER

```
CON: 000 12:30PM
ADD LOCO: _
```

Enter the loco number followed by the **ENTER** key. The first loco to be added will be the lead loco (the loco number displayed on the screen during normal operation). The consist will respond to this number. If the lead loco has an advanced decoder or the consist address wanted is different than the lead loco enter a number between 1 and 127 that is not assigned to any loco. The Command Station will send signals to the "loco" also but does not know that nothing is listening.

ENTERING THE LOCO'S DIRECTION

```
SETUP 12:30PM
DIR THIS LOCO: F
```

The loco's direction is assumed to be forward, if it is to operate in reverse press the **DIRECTION** key. This informs the decoder if the loco is in the line-up facing forward or reverse. This effects only the direction of the loco, not lighting. Press the **ENTER** key to continue.

The operator needs to press **ADD LOCO** for every loco to be added. This operation leaves the consist as the active unit for this Cab. By pressing **RECALL** the operator can change to another loco/consist but the old style consist will stay with this Cab until it is either passed by assigning it to another Cab or is cleared.

OLD STYLE CONSIST FULL

CON: 012 12:30PM
CAN NOT ADD LOCO

The consist contains four loco's which is the maximum amount that we support in this style of consist. Press the **ENTER** to continue.

FOLLOW-UP SCREEN

CON: 012 12:30PM
CONSIST NOW FULL

This screen reaffirms the previous screen. Press the **ENTER** key to continue.

THIS SCREEN WILL BE DISPLAYED WHEN OPERATING OLD STYLE CONSISTS.

CON: 012 12:30PM
078R 023 4254R

The **R** indicated that the loco is backwards in the consist.

Loco 12 is an basic decoder and the Lead Loco.

Loco 78 is an basic decoder operating backwards.

Loco 23 is a basic decoder.

Loco 4254 is an advanced decoder operating backwards.

ADDING A LOCO TO AN OLD STYLE CONSIST

SELECT AN EXISTING CONSIST

```
CON: 012 12:30PM  
FWD: 120 L123456
```

First the Cab must have the old style consist as the active loco.

ENTERING THE LOCO NUMBER

```
CON: 012 12:30PM  
ADD LOCO: _
```

Enter the loco's number and press **ENTER**.

ENTERING THE LOCO'S DIRECTION

```
CON: 012 12:30PM  
DIR THIS LOCO: F
```

This informs the decoder if the loco is facing forward or reverse in the line-up. This effects only the direction of the loco, not lighting. Also the loco does not need to be reset when being dropped from a consist.

DROPPING A LOCO FROM AN OLD STYLE CONSIST

SELECT AN EXISTING CONSIST

```
CON: 012 12:30PM  
FWD: 120 L123456
```

First the Cab must have the old style consist as the active loco.

SELECT LOCO

```
DEL LOCO 12:30PM  
ENTER LOCO: _
```

This will drop the loco identified from whatever consist it was part of. Enter the loco number and the press **ENTER**.

ERROR MESSAGE

```
DEL LOCO 12:30PM  
NOT IN CONSIST:
```

This message will display when the loco selected is not in the active consist.

CLEARING AN OLD STYLE CONSIST

```
CON:12 12:30PM  
024 056 078
```

First the Cab must have the old style consist as the active loco.

CONFIRM THE CONSIST THAT IS TO BE KILLED

```
KILL? 12:30PM  
ENTER=NO 1=YES:
```

Press 1 to clear the consist from the Command Station memory.

MACROS EXPLAINED

Macros are really switch lists, or accessory lists. They can be set up as Entrance/Exit Interlocking. There are a total of 200 of them (numbers 0 through 199), with each one controlling up to 10 accessories (or switches). The reason that there are 200 is for easier recall of the normal/route macro. For instance, if the normal (mainline) direction is macro 1, the divergent (siding) direction could be macro 101.

MACRO EXECUTE

```
LOC:0123 12:30PM  
MACRO NUMBER:_
```

To execute a macro press the **MACRO** key and then enter the macro number (0 to 199)

MACRO NOT DEFINED

```
ERROR: 12:30PM  
-MACRO IS EMPTY-
```

This message will be displayed if no macro has been programmed for the number entered.

MACRO PROGRAMMING

To program a macro see the **PROGRAMMING MACRO** section on page 4-31.

LOCO ALIASING

If you want to alias a short (1-128) address to a long (0-9999) address, use the Consist setup.

```
CONSIST 12:30PM
ENTER=ADV 1=OLD
```

To set up a loco alias press **CONSIST - SETUP**. This screen allows you to choose the type of consist to be created. Press **ENTER** to select the advanced mode.

ENTERING THE SHORT ADDRESS

```
SETUP 12:30PM
CON ADDR: _
```

The short address number can be any number from 1 through 127. Enter the number followed by pressing the **ENTER** key.

ENTERING THE LONG ADDRESS

```
SETUP 12:30PM
LEAD LOCO: _
```

The long address can be any number from 1 through 9999. This address is the *alias* for the address entered above. Enter the number followed by pressing the **ENTER** key.

ENTERING THE LOCO'S DIRECTION

```
CONSIST 12:30PM
DIR THIS LOCO: F
```

If the loco is to operate in the correct direction press **ENTER**, otherwise press the **DIRECTION** key followed by pressing the **ENTER** key.

ADDING A LOCO TO THE CONSIST

```
CONSIST 12:30PM  
ADD LOCO: _
```

Just press the **ENTER** key. This completes the aliasing. The display will show **CON** instead of **LOC**.

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HELPFUL HINTS FOR OPERATION

- A quick way to switch the method of speed control: unplug Cab; hold down **SELECT LOCO** while reconnecting Cab - press **ENTER** to skip setting the Cab address - now select the method of speed control.
- Passing an old style consist: Use **ASSIGNING A BASIC CAB** to transfer the old consist to any other Cab on the system. This causes a swap between the active consist on your Cab and the active loco/consist on the target Cab.
- Nesting consists: A large freight is approaching a long grade and helpers are needed. The loco consist is made up of advanced decoders as is the pusher consist. The pusher consist is brought out of the siding at the base of the grade and put in place. A "old style" consist is now set up containing the freight's consist number and the pusher's consist number and operated to the grade crest. Upon reaching the cutoff siding at the crest of the grade the "old style" consist is killed and the pushers are addressed to move to the siding. The freight consist continues on.
- I want to set the mid-point on my Digitrax decoders: To do this go to **SETTING THE CONFIGURATION VARIABLES**. We suggest reading the explanation starting on page 4-7 and 4-18.
- To reset a locomotive, tip the loco on the track so that you lift the wheels off the rails for a second or two.
- If you are using the Speed Dial in 128 speed step mode, the numbers go up by 2 if your moving the Dial slowly. This is to reduce the "bounce" between two adjacent numbers. To get to the other number, press the INC or DEC. Use this technique when you want to alter the speed by a small amount.
- There is a miniature banana plug made by EFJohnson that is available through Digi-Key. This plug fits into the square holes of the screw terminals of the Command Station and the Power Station (I know, I know, round peg in a square hole, but it works - KK). This lets you connect and disconnect the Stations quickly. This is not quite as good as a permanent connection, but works great for the programming track, or for the work bench. The part number is J457 and J458 for "miniature banana plugs" (red and black respectively). Cost is about \$11 for ten.

- When setting up an old style Consist, you may want to use a Loco number that does not exist for the first Loco (Consist address). This will allow you to recall the actual lead Loco to operate the headlight, and the sound Loco to operate the Horn and Bell.
- If the Loco is lurching, the track or wheels might be dirty. Confirm this by pressing the **14/28** key until the display reads **SPD 128**. This completely turns off momentum. If the Loco now runs OK, check the track and wheels for dirt. If the Loco still runs eraticly, the pickup within the Loco should be checked.
- If a Cab does not respond after plugging it in, press the **ENTER** key. This will exit from any mode it was in when it was un-plugged.
- If you really want to find your dirty track and loose connections, set a loco in the 28 speed step mode with the acceleration set to about 30 and slowly travel around your layout. Every time a dirty spot or loose connection causes the decoder to loose power, it resets itself, causing the loco to stop and then slowly start moving again.
- When making your own cables using RJ plugs, use AMP connectors as some other have plastic that is too wide between the wires.
- When using a **CBT-01** for a series run, put it right before the fifth **CBB-01** and use one female connection to it and the other to the sixth **CBB-01** down the line. This will save on the number of **CBT-01**'s needed.
- Some owners have experienced erratic operation with the keys on the Cab. We suggest that the PC board under the keys be cleaned with alcohol and then coated with a small amount of **CONDUCTA-LUB**.

CONNECTING THE WIRES³

- The terminal blocks for the Command Station and Power Booster require the wire to be stripped back about 1/2 to 5/8 inch. This is longer than you would expect by just looking at the front of the unit. Be sure to insert the wires all the way into the terminal block before tightening the screw.
- Sometimes the wires "catch" as you are trying to take them out of the terminals and seem to defy removal short of violently ripping them out. If this happens tighten the screw back down and unscrew it again while pushing the wire slightly back into the terminal. Nine times out of 10 this helps.

³ These Tips are provided courtesy of Jim Scorse.

POWER BOOSTER

- Your power booster can put out considerable power. Sufficient input power is required for it to perform to its optimum. We suggest an 18 volt 10 to 12 Amp transformer. Proper AC wiring and fusing to this transformer is required to prevent melted wiring or possibly a fire.
- If you have a 10 Amp power booster it is internally protected by an internal 15 Amp automotive type fuse.
- The 10 Amp power booster is factory set to put out 16 volts to the track in the "normal" position and 18 volts in the "adjust" position. The adjust position (18 volts) is the correct voltage recommended by the NMRA for G Scale. The "normal" position is preset to be compatible with power boosters from Digitrax, ZTC and Lenz. The "adjust" position may be changed with a range of 11.5 to 22 volts by turning the blue control inside your power booster. The voltage delivered to the motor or a loco will typically be about 2 volts less than the voltage on the track.

USING THE DELUXE CAB

- In DCC there are 2 kinds of addresses (loco numbers), long and short. When entering the address of the loco you wish to control long addresses from 1 to 127 are entered by preceding the actual number by a zero. Short addresses are entered without a leading zero. Long addresses in the range of 1 -127 are displayed on your cab with an asterisk before the loco number. i.e.: "*028" indicates the long address for loco twenty eight and "028" indicates the short address. All North Coast Engineering, System One, Ramtraxx decoders and the Digitrax "FX" series support long (4 digit) addresses. Marklin, Arnold, Trix, Lenz and most Digitrax decoders support only short addresses.
- When entering numbers if you make a mistake there is no "erase" or "backup" key. If you keep typing digits the display will clear allowing you to start entering your number over again.
- If you wish to abandon what you are doing when in the middle of entering a number push the "prog" key and you will be returned to normal operation.
- During various operations where you are doing something other than normal loco operation such as "set up consist" or "select accessory" speed control of the loco is not available, however the Emergency Stop will still work if you need to stop your loco.
- During programming on the programming track the command station first reads the value of a location (such as "short address" or "acceleration") and displays it on your cab. If you wish to accept this

value just press enter to continue or type in a new number if you want to change it.

PROGRAMMING TRACK

- The command station checks for a short circuit on the programming track before applying power. If your loco has lights or other current drawing devices wired directly to the track instead of a decoder function output the command station will probably think is has a short and say "SHORT DETECTED" each time you start to program this loco. If you wish you will be allowed to override the short and continue. This short detection is there to protect decoders from damage if they are mis-wired. For this reason we find always try a new decoder installation on the programming track first instead of putting it directly on the layout. If the programming works the installation is most likely correct.
- Lenz and most Digitrax decoders do not report correct Manufacturer or Version numbers and do not support long addresses. Lenz, Markiln and Arnold decoders may be better programmed using "register" programming (option 3 at the "PROG TRK" menu) and Digitrax decoders can be easily programmed using "CV" programming (option 2 at the "PROG TRK" menu).

Most often used CVs (configuration variables):

CV #	Description	Register #
1	Short Address	1
2	Start Voltage	2
3	Acceleration	3
4	Deceleration	4
17	Long Address High byte	--
18	Long Address Low Byte	--
19	Consist Address	--
23	Acceleration Adjust	--
24	Deceleration Adjust	--
29	Configuration byte	--

PROGRAMMING PROCEDURES

PROGRAM MODE SCREENS EXPLAINED

To access the various programming modes, press the **PROG** key. The following messages will be displayed for each press of the **PROG** key. When the desired mode is displayed, press the **ENTER** key to enter that mode. To quickly get to a programming mode, press the **PROG** key and then press the number of the screen. If you have pressed the **PROG** key by mistake, or want to exit out without having to press the **PROG** key several times, press the **0** key.

SEL MODE 12:30PM PROGRAM ON MAIN	To program on the main press ENTER . Screen 1.
SEL MODE 12:30PM ASSIGN LOCO->CAB	To program on the Program Track press ENTER . Screen 2.
SEL MODE 12:30PM SET SYSTEM CLOCK	To assign a loco/consist to a Cab press ENTER . Screen 3.
SEL MODE 12:30PM USE PROGRAM TRK	To set the Command Station press ENTER . Screen 4.
SEL MODE 12:30PM SET CMD STATION:	To set the System Clock press ENTER . Screen 5.
SEL MODE 12:30PM SET CAB PARAMS	To set the Cab parameters press ENTER . Screen 6.
SEL MODE 12:30PM PROG ACCESSORIES	To program accessories on the main press ENTER . Screen 7.
SEL MODE 12:30PM PROGAM MACROS	To program accessories on the main press ENTER . Screen 8.

Refer to the following sections for the individual programming instructions.
To escape from any programming session press the **PROG** key.

PROGRAMMING MENUS

The following is a chart of all of the programming modes and each section within each mode. Refer to the detail in the following sections.

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PROGRAMMING ON THE MAIN

Programming on the Main is also called Operations (OPS) Mode Programming. OPS Programming allows you to change parameters while the loco is on the main track (even while it's *running*). This does not affect other loco's on the track. The only parameter that cannot be changed is the loco address, the address can only be changed on the Programming Track.

WHICH LOCO

```
OPS PROG 12:30PM
PROG LOCO: _
```

Enter the loco's decoder address. This can be up to a four digit number and we suggest that the loco's actual number be used. On the advanced decoders you need to distinguish them from the older models when assigning them a number below 127 by entering a zero as the first character. Old decoder = 45 Advanced = 045.

WHAT TO PROGRAM

```
LOC:1234 12:30PM
1=STD 2=CV 3=CFG
```

This screen allows the user to select the specific area that is to be programmed. Press **1** to program the standard parameters, press **2** to program any CV, and press **3** to set the config variable (CV 29).

STANDARD PROGRAMMING

The Acceleration and Deceleration Adjusts *add* to the Acceleration and Deceleration programmed in Program Track programming, see page 4-15. It is possible to lower the normal value by using “negative” numbers. The Cab will not let you enter negative numbers directly, so you will have to enter a high positive value that represents a negative number. The following chart shows the first few numbers. The rest of the numbers can be calculated by taking the desired negative number and adding it to 256. Example: If you need to lower the Acceleration by 10, add -10 to 256 and enter 246.

Negative Number	Value to Enter	Negative Number	Value to Enter
-1	255	-11	245
-2	254	-12	244
-3	253	-13	243
-4	252	-14	242
-5	251	-15	241
-6	250	-16	240
-7	249	-17	239
-8	248	-18	238
-9	247	-19	237
-10	246	-20	236

ACCELERATION ADJUST

```
LOC:1234 12:30PM
ACCEL ADJUST:_
```

This can be set to a number from 1 to 99. Each unit represents 32 microseconds. At 99 counts per each of 28 speed steps this amounts to the loco accelerating from stop to full speed in $28 \times .032 \times 99 = 88.7$ seconds or 1.5 minutes.

DECELERATION ADJUST

```
LOC:1234 12:30PM
DECEL ADJUST:_
```

This can be set to a number from 1 to 99. Each unit represents 32 microseconds. At 99 counts per each of 28 speed steps this amounts to the loco decelerating from full speed to stop in $28 \times .032 \times 99 = 88.7$ seconds or 1.5 minutes.

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CONFIGURATION VARIABLE (CV) PROGRAMMING

ENTER CONFIG VAR NUMBER

```
PROG CV 12:30PM
ENTER CV NUM: _
```

All configuration variables are detailed in the Appendix on page 6-11. Those that are normally used are set through screen inputs such as speed tables, start voltage, acceleration and deceleration settings. This screen may be skipped by pressing **ENTER**.

ENTER CONFIG VAR VALUE

```
PROG CV 12:30PM
ENTER VALUE: _
```

If a configuration variable number was entered in the previous screen the input value would be entered here.

If you enter 1 (Short Address), 17 or 18 (Long Address) in the CV NUM above, the prompt will be SHORT ADDR: or LONG ADDR: will be displayed whichever is not in use. If the address is in use the display will show CAN NOT PROG ADDR IN USE. This way you can program the *address* on the main, just not the current address. Set CV 29 (CFG) to a short address to program the long address, the set CV 29 to use the new long address.

PROGRAMMING CV 29

You can program CV 29 (the CFG variables in the next section) by building up the value from each of the individual values. Start with '0' and add each value shown below, and program CV 29 with the total.

- 1 Loco Direction
- 2 28 speed step mode
- 4 DC mode on
- 8 Advanced Acknowledgment
- 16 Alternate speed table
- 32 Use long address

SET CONFIGURATION VARIABLES

NOTE: If you change the Decoder address you may need to press **1** to enter the CFG section to make sure that the long/short address is set correctly.

```
SET CFG? 12:30PM
ENTER=NO 1=YES:_
```

Press **ENTER** to bypass the setting of the configuration variables. The configuration variables pertaining to normal loco operation are provided below with screen prompts for your assistance. Other variables that are not addressed via the screen below do not normally need to be changed.

Press **1** to reach the screens to set the configuration variables.

DIRECTION BIT - NORMAL OR REVERSE

```
DIR BIT? 12:30PM
ENTER=NORM 1=REV
```

Press **ENTER** for normal direction or press **1** to switch the direction of the loco.

SPEED STEPS - 28 OR 14

```
SPEED 12:30PM
ENTER=28 1=14 _
```

Press **ENTER** for all newer 28 step decoders. If the decoder is an early 14 step decoder then press **1**.

DC MODE

```
DC MODE 12:30PM
ENTER=NO 1=YES _
```

Press **ENTER** to turn DC mode off, press **1** to turn DC mode on.

ADV ACK

ADV ACK? 12:30PM
ENTER=NO 1=YES _

Press **ENTER** to turn Advanced Acknowledge mode off, press **1** to turn Advanced Acknowledge mode on.

SPEED TABLE SELECTION

SPEED TBL12:30PM
ENTER=STD 1=ALT _

If the Standard Speed Table is to be used, press **ENTER**. If the Alternate Speed Table is to be used, press **1**. Before selecting the Alternate Speed Table see the section **SPEED TABLES EXPLAINED** on page 6-14.

ADDRESS TO BE USED

ADDRESS 12:30PM
ENTER=S 1=LONG: _

The short address is used when operating on DCC systems that do not use long addresses. If you are going to take your loco to a friend's layout and he has a MRC, or Arnold system or older Lenz or Digitrax, , you will need to set this prior to packing.

ASSIGNING A LOCO TO A CAB

This allows an operator to pass a loco from one cab to another. This is especially useful when the other operator is a novice or has a Basic Cab. The loco passed is removed from the Cab that passes it.

ASSIGN THE LOCO

```
ASSIGN 12:30PM  
WHICH LOCO: _
```

Enter the loco/consist number then press **ENTER**.

ASSIGN THE CAB

```
LOC:1234 12:30PM  
TO WHICH CAB? _
```

Enter the Cab number then press **ENTER**.

This operation is also to be used to transfer old style consists to different Cabs.

SET THE SYSTEM CLOCK

This allows the operator to start or stop the clock, set it, choose 12 or 24 hour operation, or change the fast clock ratio.

STOPPING THE CLOCK

```
STOP? 12:30PM
ENTER=NO 1=STOP
```

Press **1** to stop the clock, press **ENTER** to leave the clock running and continue with clock programming. If the clock is stopped, re-entering **SET THE SYSTEM CLOCK** will let you re-start it.

SETTING 12 or 24 HOUR MODE

```
SET TIME 12:30PM
1=12HR 2=24HR _
```

Press **1** for 12 hour mode, press **ENTER** for 24 hour mode.

ENTERING THE HOUR

```
SET TIME 12:30PM
ENTER HOURS: _
```

Enter the starting hour. For times in the A.M. use 0 to 11. For times in the P.M. use 12 to 23. Press **ENTER**.

ENTERING THE MINUTE

```
SET TIME 12:30PM
ENTER MINUTES:_
```

Enter the starting minute. Use 0 through 59. Press **ENTER**.

ENTERING THE RATIO

```
SET TIME 12:30PM
ENTER RATIO: _
```

Enter the ratio that the clock should run at with 1 being the normal speed. The ratio can be any number from 1/1 to 25/1. Press **ENTER**.

STARTING THE CLOCK

```
START? 12:30PM
ENTER=NO 1=START
```

If the clock was stopped, entering SET THE SYSTEM CLOCK will display this screen to let you start (or restart) the clock. Press **1** to start the clock, press **ENTER** to leave the clock stopped and continue with clock programming (see above).

USE PROGRAM TRACK

This allows the operator to change all of the configuration variables in the loco, including the address. These variables will remain as programmed until the operator changes them.

WHAT TO PROGRAM

```
PROG TRK 12:30PM
1=STD 2=CV 3=REG
```

This screen allows the user to select the specific area that is to be programmed. Press **1** to program the standard parameters (see page 4-15), press **2** to program any CV (see page 4-21), and press **3** to use the register mode programming used on Lenz decoders (see page 4-22). Press **4** to enter Decoder Factory Programming mode (see page 4-22). Press **5** to quickly load 1 of 9 speed tables (see page 4-23). Pressing **6** through **9** will display - **4=FCTRY 5=SPDTBL.**

STANDARD PROGRAMMING

DECODER MANUFACTURER

```
MAIN OFF 12:30PM
MANUFACTURER:012
```

Returns the number of the manufacture of the decoder. Current **SystemOne™** Decoders respond with 12, older revision Decoders respond with the revision (the NMRA DCC committee changed the CV number after the earlier Decoders were shipped). This is not presently available with Lenz and Digitrax decoders. This will be helpful in the future when additional software versions may be on the market.

The following is a list of the manufactures currently known.

- | | |
|-------------------------------|-----------------------------------|
| 11 - North Coast Engineering | 133 - ICC |
| 12 - Wangrow Electronics, Inc | 135 - CVP Products |
| 14 - PSI-Dynatrol | 137 - A-Train Electronics |
| 15 - RamFixx Technologies | 139 - Real Rail Effects |
| 99 - Lenz Electronic GmbH | 141 - Throttle-Up |
| 129 - Digitrax | 143 - Model Rectifier Corporation |
| 131 - Trix Modelleisenbahn | 145 - Zimo Elektronik |
| 132 - ZTC | |

DECODER VERSION

```
MAIN OFF 12:30PM  
DECODER VER: 015
```

Returns the software version in the decoder. This is not presently available with Lenz and Digitrax decoders. This will be helpful in the future when additional software versions may be on the market.

```
MAIN OFF 12:30PM  
CAN NOT READ CV
```

Any advanced decoder will not show this screen unless there is a problem reading the decoder..

ENTERING THE SHORT ADDRESS

```
MAIN OFF 12:30PM  
SHORT ADDR:
```

The short address is available for using our decoders on layouts using the present versions of Lenz and Digitrax systems. The address should follow their recommended practice of using the last two digits of the loco's number. This will accept a number in the range of 1 to 127. See recommendation for short addresses below.

We recommend that if a long address is used, leave the short address at 3. This has two advantages. One, if the long address is forgotten, the short address is always 3. Two, the consist addresses share the 1 to 127 address range available to the short addresses. Using the same address for the Consist as an existing loco with it's short address will cause unpredictable results.

ENTERING THE LONG ADDRESS

MAIN OFF 12:30PM
LONG ADDR:

The long address follows the NMRA Recommended Practice RP-9.2.1 (Extended Packet Formats For Digital Control). Any number from 1 through 9999 can be used. You need to distinguish advanced decoders from the older models when assigning them a number below 128 by entering a zero as the first character. You want to remember though that the consist addresses are limited to 1 to 127, so it may be advantageous to not enter a long address below 128.

Example: Old decoder = 45 Advanced = 045

We recommend that if a long address is used, leave the short address at 3. This has two advantages. One, if the long address is forgotten, the short address is always 3. Two, the consist addresses share the 1 to 127 address range available to the short addresses. Using the same address for the Consist as an existing loco with it's short address will cause unpredictable results.

ACCELERATION

MAIN OFF 12:30PM
ACCELERATION:

This can be set to any number from 1 to 255. Each unit represents 32 microseconds. At 255 counts per each of 28 speed steps this amounts to the loco accelerating from stop to full speed in $28 \times .032 \times 255 = 228.48$ seconds or 3.8 minutes.

DECELERATION

MAIN OFF 12:30PM
DECELERATION:

This can be set to any number from 1 to 99. Each unit represents 32 microseconds. At 255 counts per each of 28 speed steps this amounts to the loco accelerating from stop to full speed in $28 \times .032 \times 255 = 228.48$ seconds or 3.8 minutes.

START VOLTAGE

MAIN OFF 12:30PM
START VOLTAGE:

This can be set from 0 to 256. Each unit represents 1/256 of full voltage. See explanation starting on page 6-14.

SETTING THE CONFIGURATION VARIABLES

SET CFG? 12:30PM
ENTER=NO 1=YES:

The configuration variables pertaining to normal loco operation are provided below with screen prompts for your assistance. Other variables that are not addressed via the screen below do not normally need to be changed. Press **1** to reach the screens to set the configuration variables.

NOTE: *Do Not* press enter here if you are programming the Decoder for the first time. The following screens are very important to complete the Decoder programming (such as the long/short address selection).

SPEED STEPS - 28 OR 14

SPEED 12:30PM
ENTER=28 1=YES:

Press **ENTER** to bypass this screen. The only need for this screen is to define your Digitrax decoders to operate on Lenz controlled layouts. **SystemOne**[™] decoders will automatically adjust to the control system being used.

Lenz only produces 14 step decoders at this time. Digitrax produces 28 and 128 step decoders. **SystemOne**[™] only produces 128 step decoders that use 28 steps for momentum.

DC MODE

DC MODE 12:30PM
ENTER=NO 1=YES _

Press **ENTER** to turn DC mode off, press **1** to turn DC mode on.

SPEED TABLE SELECTION

SPEED TBL12:30PM
ENTER=SDT 1=ALT:

If the standard speed table is to be used press **ENTER**. If the alternate speed table is to be used press **1**. Before selecting the Alternate Speed Table please read the explanation starting on page 6-14.

ADDRESS TO BE USED

ADDRESS 12:30PM
ENTER=S 1=LONG:

The short address is used when operating on DCC systems that do not address the long addresses. If you are going to take your loco to a friend's layout and he has a Lenz or Digitrax system, you will need to set this prior to packing.

SETTING THE INDIVIDUAL 28 SPEED STEPS

SPEED STEP NUMBER AND VALUE

```
SPD TBL? 12:30PM
SPD STEP XX
```

The **XX** will automatically increment from speed step 1 to speed step 28. Enter the value for each speed step. This can be set from 0 to 255. Each number represents 1/256 of full voltage. Before setting the speed steps please read the explanation starting on page 6-14.

THE SPEED TOTAL

```
SPD TBL? 12:30PM
SPEED TOTAL:
```

The speed total is the value of the highest speed step the loco is to reach.

CONFIGURATION VARIABLE (CV) PROGRAMMING

ENTER CONFIG VAR NUMBER

```
PROG CV 12:30PM
ENTER CV NUM: _
```

All configuration variables are detailed in the Appendix. Those that are normally used are set through screen inputs such as speed tables, start voltage, acceleration and deceleration settings. This screen should normally be skipped by pressing **ENTER**.

ENTER CONFIG VAR VALUE

```
PROG CV 12:30PM
ENTER VALUE: _
```

If a configuration variable number was entered in the previous screen the input value would be entered here.

PROGRAMMING CV 29

You can program CV 29 (the CFG variable, see page 4-18) by building up the value from each of the individual values. Start with '0' and add each value shown below, and program CV 29 with the total.

- 1 Loco Direction
- 2 28 speed step mode
- 4 DC mode on
- 8 Advanced Acknowledgment
- 16 Alternate speed table
- 32 Use long address

REGISTER PROGRAMMING

The programming section is included to make setting of Lenz Decoders easier. Refer to the document that is included with the Decoder for register information.

ENTER THE REGISTER TO PROGRAM

```
PROG TRK 12:30PM
REGISTER?  _
```

Enter the register number and press **ENTER**. The current value will be read from the Decoder and displayed.

ENTER REGISTER VALUE

```
PROG CV 12:30PM
REGISTER 2= _
```

Enter the value you want to program into the register you selected above and press **ENTER**.

FACTORY DEFAULT PROGRAMMING

The programming section is included to allow the user to set *all* of registers of the Decoder to the values that were programmed into it at the factory.

FACTORY REPROGRAM

```
FACTORY 12:30PM
REPROGRAM? 1=YES
```

Press **1** to enter Factory Reprogram mode.

FACTORY PROGRAMMING

```
FACTORY 12:30PM
PROGRAMMING: 001
```

Each register will be programmed to the factory defaults. As each register (CV) is programmed the CV number is displayed.

SPEED TABLE PROGRAMMING

The programming section is included to allow the user to quickly program the Decoder with one of several speed tables.

FACTORY REPROGRAM

ENTER 12:30PM SPEED TABLE NUM:

Press **1 - 9** to enter one of the nine speed tables.

SET COMMAND STATION

This allows the operator to view the Command Station's version number and set various parameters.

DISPLAY SOFTWARE VERSION AND DATE

```
VERSION: 12:30PM  
THU JAN 22 1998
```

This screen is important for when the time comes to call or write about a question or a problem.

The following screens are in place should a need arise to change any of the factory settings. There is no reason to access these screens at this time, and in doing so it may be necessary to RESET your Command Station as explained in the GETTING TO KNOW YOUR COMMAND STATION SECTION on page 2-2.

NUMBER OF STOP PACKETS

```
NUMBER 12:30PM  
OF STOP PKTS 000
```

This adjusts the number of packets sent when a stop command is sent to the Loco.

NUMBER OF TEMP PACKETS

```
NUMBER 12:30PM  
OF TEMP PKTS 005
```

This adjusts the number of packets sent when a temp (such as Functions On/Off) command is sent.

NUMBER OF ACCESSORY PACKETS

```
NUMBER 12:30PM  
OF ACC PKTS: 004
```

This adjusts the number of packets sent when an accessory command is sent.

NUMBER OF HORN LOOP

NUMBER 12:30PM
OF HORN LOOP 001

This adjusts the number of times around the Cab poll loop that the Horn command is checked.

NUMBER OF PROGRAM PACKETS

NUMBER 12:30PM
OF PROG PKTS: 04

This adjusts the number of packets sent when a programming command is sent to the Loco.

TEST FOR LOCO IN USE

TEST FOR 12:30PM
LOCO IN USE? YES

TEST? 12:30PM
1=YES 2=NO

If this is set to YES, a warning will be issued to the operator if a Loco is selected that is in use by someone else. If set to NO, no warning is issued.

LAST CAB TO PROGRAM ON MAIN

LAST CAB 12:30PM
TO PRG ON MAIN00

This sets the highest Cab address that will be able to Program on the Main. Cabs above this setting will skip the PROGRAM ON MAIN menu selection. 00 = all Cabs.

LAST CAB TO ASSIGN LOCO

LAST CAB 12:30PM
TO ASSIGN LOCO00

This sets the highest Cab address that will be able to Assign Loco to Cab. Cabs above this setting will skip the ASSIGN LOCO->CAB menu selection. 00 = all Cabs.

LAST CAB TO SET CLOCK

LAST CAB 12:30PM
TO SET CLOCK 00

This sets the highest Cab address that will be able to Set the Clock. Cabs above this setting will skip the SET SYSTEM CLOCK menu selection. 00 = all Cabs.

LAST CAB TO USE PROGRAM TRACK

LAST CAB 12:30PM
TO USE PRG TRK00

This sets the highest Cab address that will be able to Use the Program Track. Cabs above this setting will skip the USE PROGRAM TRK menu selection. 00 = all Cabs.

LAST CAB TO SET COMMAD STATION

LAST CAB 12:30PM
TO SET CMD STA00

This sets the highest Cab address that will be able to Set the Command Station. Cabs above this setting will skip the SET CMD STATION menu selection. 00 = all Cabs.

LAST CAB TO SET ITSELF

LAST CAB 12:30PM
TO SET ITSELF 00

This sets the highest Cab address that will be able to Program the Cab Parameters (itself). Cabs above this setting will skip the SET CAB PARAMS menu selection. 00 = all Cabs.

LAST CAB TO PROGRAM ACCESSORIES

LAST CAB 12:30PM
TO PROGRAM ACC00

This sets the highest Cab address that will be able to Program Accessories. Cabs above this setting will skip the PROG ACCESSORIES menu selection. 00 = all Cabs.

LAST CAB TO PROGRAM MACROS

LAST CAB 12:30PM
TO PROG MACROS00

This sets the highest Cab address that will be able to Program macros. Cabs above this setting will skip the PROGRAM MACROS menu selection. 00 = all Cabs.

FUNCTION REPEAT RATE

FUNCTION 12:30PM
REPEAT RATE: _

This parameter controls the rate at which Function Group One (F0-F4) packets are repeated on the rails after the "normal" number (TEMP PACKETS) of times. When set to zero the function packets are never repeated. If non-zero, Function Group One packets are generated and sent out over the rails for the currently active locomotive on each cab. The rate of sending these packets is approximately $.004 * n$ seconds (where $n =$ value). Example: $n = 250$ refreshes all function group one packets about 1 second. This should be only be used when using Decoders which do not remember the Function status after a power interruption. All Wangrow Decoders remember the Function status, and therefore do not need this set to anything other than zero. It is recommended that this value be set above 200.

SETTING THE CAB PARAMETERS

This allows the operator to set the Cab Address, the control method (Knob or Keys), and which functions are activated when the Horn/Whistle and Bell keys are pressed.

NUMBER OF RECALLS

```
NUMBER 12:30PM
OF RECALLS: 02
```

This adjusts the number of Loco's that are cycled through when the **RECALL** key is pressed. Enter the number of Recalls from 1 - 6 and press **ENTER**. This can be set differently for each Cab.

CLEAR RECALLS

```
CLEAR 12:30PM
RECALLS 1=YES:
```

Clears the current **RECALL** storage. Press **1** and **ENTER** to clear the **RECALLS**, press **ENTER** to leave the **RECALLS** alone.

SETTING THE CAB ADDRESS

```
CAB ADDR 12:30PM
ENTER=NO 1=SET
```

Press **ENTER** to bypass or **1** to set address.

NOTE: The following set of screens may be different depending on the model of the Cab. These screens are for the WCT-01. Consult the instructions that come with your Cab.

CAB ADDRESS

```
CAB _ 12:30PM
V1.7 USING: KNOB
```

The Cab address can be any number from 1 through 63 (although we recommend using 2 as the lowest Cab number). The Command Station is factory set to scan only Cabs with addresses from 1 through 11. If you need to use additional Cabs the Number of Cabs setting needs to

be changed before it will recognize any Cab addressed above 11 (See **SET COMMAND STATION** on page 4-24). **DO NOT SET TO 0 OR 00.** If the Cab is set to 0 or 00 it will lock-up, to correct this pull the Cab jack out of the Cab Bus Panel and then with the **SELECT LOCO** key held down plug it back in. Now you can correct the Cab address.

SETTING THE SPEED CONTROL VIA KNOB OR KEYS

KEYS OR KNOB:
1=KNOB 2=KEYS _

Enter either a **1** for knob control or a **2** for key control of speed. It is suggested that if the operator is using the Recall key for switching between two loco's that the key setting be used. They have no position and this is important at this point because when recalling the other loco it will start to change to the speed setting of the knob.

This ends the Cab specific setup screens.

ASSIGNING THE HORN/WHISTLE FUNCTION

ASSIGN 12:30PM
HORN TO FUNC: 2

Enter the function number that should be activated when the Horn/Whistle key is pressed. The NMRA Recommended Practices suggests using 2, however any function number may be used.

ASSIGNING THE BELL FUNCTION

ASSIGN 12:30PM
BELL TO FUNC: 3

Enter the function number that should be activated when the Bell key is pressed. The NMRA Recommended Practices suggests using 3, however any function number may be used.

PROGRAMMING ACCESSORIES ON THE MAIN

This allows the operator to set Accessory Decoder CV while they are connected to the Track (Accessory programming on the Main).

ENTER THE ACCESSORY ADDRESS

```
PROG ACC 12:30PM  
ACC. ADDR: _
```

Enter the Accessory Decoder address and press **ENTER**.

ENTER THE CV NUMBER

```
PROG ACC 12:30PM  
ENTER CV NUM:_
```

Enter the CV number that you want to program and press **ENTER**.

ENTER THE CV VALUE

```
PROG ACC 12:30PM  
ENTER VALUE: _
```

Enter the value you want in the CV and press **ENTER**.

PROGRAMMING MACROS

This allows the operator to program Macros (switchlists).

SELECT MACRO PROGRAM OR REVIEW

```
MACRO: 12:30PM
1=PROG 2=REVIEW
```

Press **1** to program a Macro or press **2** to review a programmed Macro.

If **1** is pressed the following screen is displayed.

ENTER THE MACRO NUMBER

```
MACRO: 12:30PM
MACRO NUMBER: _
```

Enter the Macro number that you want to program (0-199), and press **ENTER**.

ENTER THE ACCESSORY ADDRESS

```
MAC: 000 12:30PM
ACCESSORY #: _
```

Enter the Accessory Address that you want to control, and press **ENTER**.

SELECT THE ACCESSORY OUTPUT

```
MAC: 000 12:30PM
ACC: 001 1=N 2=R
```

Press **1** for Normal or **2** for Route.

The above two screen will repeat up to 10 times to allow you to enter 10 accessories. After 10 accessories have been entered the SELECT MACRO PROGRAM OR REVIEW screen will be displayed. If you want to enter less than 10 accessories, leave the accessory # blank (just press **ENTER**).

If **2** is pressed on the SELECT MACRO PROGRAM OR REVIEW screen, the following screen is displayed.

ENTER THE REVIEW MACRO NUMBER

```
REVIEW: 12:30PM
MACRO NUMBER:_
```

Enter the Macro number that you want to review (0-199), and press **ENTER**.

REVIEW MACRO

```
MAC: 000 12:30PM
ACCESSORY: 001=N
```

The Accessory number and output will be shown. Press **ENTER** to see the next Accessory in the Macro. If there are no more Accessories in the Macro, the following screen will be displayed.

END OF MACRO REVIEW

```
MACRO: 12:30PM
--END OF MACRO--
```

After **ENTER** is pressed, the SELECT MACRO PROGRAM OR REVIEW screen will be displayed.

SOFTWARE

COMMANDS

All commands use the ASCII character set and are terminated with a Carriage Return (Enter). The examples below do not show the Carriage Return. The formats show the data for each command and the number of digits required. The spaces in the command and the exact number of digits must be correct for the command to execute. When the command completes successfully, the command prompt "COMMAND:" will be returned, otherwise an error message will be returned.

A - ASSIGN LOCO TO CAB

This command will allow the computer to assign a loco to a Cab. This is useful when using a simple Cab with no display, or in a club situation to speed setup. You must pad the address to 4 characters, long address padded with zeros, short addresses padded with dashes.

Format:

A dddd cc - dddd = loco address, cc = Cab address (1-60).

Example:

A 3741 04 - Assign loco 3741 (long address) to Cab 4.

A ---3 02 - Assign loco 3 (short address) to Cab 2.

C - READ SCALE TIME

This command will return the current scale time.

Format:

C - no data required.

Example:

C - Return the scale time in the format
<HH:MM><AM/PM> <Ratio>
<0=12Hr/1=24Hr>.

```
COMMAND:C  
08:01AM 10 1
```

C0 - STOP THE CLOCK

This command will stop the clock.

Format:

C0 - no data required.

Example:

c0 - Stop the Clock

C1 - START OR RESUME THE CLOCK

This command will start (resume) the clock.

Format:

C1 - no data required.

Example:

c1 - Start the Clock

CH - SET THE CLOCK HOURS

This command will set the hours of the clock.

Format:

CH dd - dd = hours.

Example:

CH 12 - Set the hours to 12.

CM - SET THE CLOCK MINUTES

This command will set the minutes of the clock.

Format:

CM dd - dd = minutes.

Example:

CM 30 - Set the minutes to 30.

CS - SET THE CLOCK RATIO

This command will set the ratio of the clock. NOTE: some ratios are not attainable due to round-off errors of binary division. For instance, if you set the ratio to 23 you will actually get 25.

Format:

CS dd - dd = ratio.

Example:

CS 12 - Set the ratio to 12 to 1.

D - DEQUEUE PACKET

This command will remove a DCC command, by loco number, from the main command queue. The main queue continuously sends the command until it is removed with this command.

Format:

D xx xx - xx xx = loco address in hex. The top two bits in the first byte are set to indicate a long address.

Example:

D c0 03 - Remove the loco #3 command (long address) from main queue.

D 00 03 - Remove the loco #3 command (short address) from main queue.

E - ENABLE MAIN TRACK

This command will enable the track voltage for normal operations.

Format:

E - Enable main track.

Example:

E - Enable main track.

F - DISPLAY MEMORY

This command will display a section of the Command Station's PROM in hex and ASCII. This is used mostly for diagnostic purposes.

Format:

F y xxxx - y = hex lines - 0 = 256d, xxxx = hex address.

Example:

F 6 0000 - Display 6 lines of memory from 0000h.

```
ADDR  0  1  2  3  4  5  6  7  8  9  A  B  C  D  E  F  ... (C) 1994 NOR
0000  C3 99 00 20 28 43 29 20 31 39 39 34 20 4E 4F 52  TH COAST ENG ...
0010  54 48 20 43 4F 41 53 54 20 45 4E 47 20 FF FF FF  .....
0020  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF  .....
0030  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF  .....
0040  7B 4C 7E 4C 81 4C 84 4C 87 4C 0A 4D B9 4C 17 4D  {L~L.L.L.L.M.L.M
0050  6E 4B 4F 4C FF FF FF FF FF FF FF FF FF FF FF FF  nKOL.....
COMMAND:
```

I - STATUS OF AUXILLARY INPUT UNIT (AIU)

This command returns the status of an AIU. The first four digits are the most significant followed by least significant current input status. The next four digits are the most significant followed by least significant of the inputs that have changed since the last **I** command.

Format:
I cc - cc = Cab address (1-60).

Example:
I 8 - Read status of AIU at address 8.
00 01 00 01

K - KILL MAIN TRACK

This command will turn off the voltage to the mainline track. All trains on the mainline will stop. This will also clear all of the command queues.

Format:
K - no data required.

Example:
K - Kill main track.

LM - SPEED STEP MODE

This command will set the speed step mode. NOTE: This command does not tack effect until the next time a Cab selects the Loco. Issue a Assign Cab command to force it to take effect earlier.

Format:
LM dddd d - dddd the Loco address, d - speed step mode.
1=14, 2=28, and 3=128.

Example:
LM 1234 2 - Set Loco 1234 to speed step 28.

LR - RETURN THE CURRENT SPEED STEP MODE

This command will return the speed step mode for the Loco requested.

Format:
LR dddd - dddd the loco address.

Example:
LR 1234 - Return the speed step mode for Loco 1234.

M - PROGRAMMING MODE

This command will turn off the voltage to the main track, and go into programming mode. See **USE PROGRAM TRACK** on page 5-15 and **PROGRAMMING MODE COMMANDS** on page 6-12. All trains on the mainline will stop.

Format:

M - no data required.

Example:

M - Go to programming mode.

**** PROGRAMMING MODE - MAIN TRACK NOW DISCONNECTED ****
COMMAND:

Q - QUEUE PACKET

This command will put a DCC command in the main command queue. The main queue continuously sends the command until it is removed with the DEQUEUE PACKET command or replaced with another command with the same loco address. The command should be constructed using the NMRA DCC standard documentation (the Yellow book). The checksum must be calculated and added to the end of the command. This was done to facilitate sending an incorrect checksum during new equipment development.

Format:

Q xx xx ... - xx = hex byte, these may be repeated as necessary up to six bytes (you must send your own checksum).

Example:

Q 03 47 44 - Put a command for loco #3, speed 6, forward direction, in main queue.

Q 03 40 43 - Put a command for loco #3, speed 0, forward direction, in main queue.

S - SEND PACKET

This command will put a DCC command in the temporary send queue. After the number of times to be repeated is finished, the command will be automatically removed from the queue. The command should be constructed using the NMRA DCC standard documentation (the Yellow book). The checksum must be calculated and added to the end of the command. This was done to facilitate sending an incorrect checksum during new equipment development.

Format:

S Cyy xx ... - Cyy = the number of times to send in hex, xx = hex byte, these may be repeated as necessary up to six bytes (you must send your own checksum).

Example:

S C05 03 83 80 - Turn on functions 1 and 2 for loco #3 (note checksum 80. Send the command 5 times.

S C0A 80 98 18 - Turn on accessory number 1 (note checksum 18). Send the command 10 times.

V - VERSION NUMBER

This command will display the version number of the Command Station.

Format:

V - no data required

```
WANGROW ELECTRONICS
SYSTEM 1 COMMAND STATION
Thu Jun 22 13:04:09 1995
COMMAND:
```

W - WRITE MEMORY

This command will write to any memory location. NOTE: Use this with extreme caution. Improper use of this command may cause the Command Station to behave erratically.

Format:

W xxxx xx - xxxx = hex address, xx = hex data.

Example:

W 1000 10 - Set the memory location 1000H to 10H.

X - DISPLAY TEXT ON LINE 3

Y - DISPLAY TEXT ON LINE 4

This command will allow the computer to display a message on any Cab with a display. The operator can press ENTER to clear the message. Only uppercase characters are displayed, any lowercase characters are converted to uppercase.

The Cab's display can be thought of as having 4 lines, with only 2 of the lines showing at any one time. These commands write to lines 3 and 4 without disturbing lines 1 and 2. When these commands are received, the Cab switches to showing lines 3/4. When the operator presses ENTER, the Cab switches back to lines 1/2. Currently pressing EXPN will flip from lines 1/2 to lines 3/4, and back again.

Format:

X (or Y) cc 16chars - cc = Cab address (01-60), 16chars = 16
ASCII characters

Example:

X 02 PLEASE HOLD AT - Display message on Cab 2 (note
Y 02 UNION JUNCTION that there are two spaces required after
each of these lines to get the character
count to 16)

Z - DISPLAY TEXT IN THE LOWER RIGHT CORNER

This command will allow the computer to display a message on any Cab with a display. The operator can press ENTER to clear the message. Only uppercase characters are displayed, any lowercase characters are converted to uppercase.

Format:

Z cc 8chars - cc = Cab address (01-60), 8chars = 8
ASCII characters

Example:

Z 02 PROCEED - Display message on Cab 2 (NOTE: a
space is included preceding the message
to separate it from the loco's speed.

H or ? - HELP

This command will display help for all of the available normal operations mode commands:

Format:

?

- no data required

A dddd dd	Assign loco dddd to cab dd (decimal numbers)
LR dddd	Return speed and speed mode of loco dddd
LM dddd d	Set speed mode of loco dddd to d, 1=14, 2=28, 3=128)
NOTE:	Pad long loco address leading zeroes
NOTE:	Pad short loco address with leading dashes
C	Read scale time. Returns HH:MM RATIO 1 0
C0	Clock stop
C1	Clock resume (start)
CH dd	Set clock hours to dd (decimal)
CM dd	Set clock minutes to dd (decimal)
CR dd	Set clock ratio to dd (decimal)
D xx [xx]	Dequeue packet (xx [xx] = loco address in hex) if it exists
E	Enable main track
F y xxxx	Display y lines of system memory at xxxxx
I dd	Inquire on status of Cab Bus Aux Input Unit dd (decimal)
K	Kill main track and it,s queues
M	Maintenance (programming) mode
Q xx...	Queue hex bytes (will replace any packet of same address)
S Cyy xx...	Send packet xx xx... Cyy times (hex bytes)
V	Return manufacturer, model, version of command station
W xxxx xx	Write memory location xxxx with xx
X dd 16char	Send 16 bytes to Cab dd (decimal) LCD line 3
Y dd 16char	Send 16 bytes to Cab dd (decimal) LCD line 4
?	This help screen

COMMAND:

PROGRAMMING MODE COMMANDS

R - READ CV

This command will allow the computer to read any CV in the loco on the programming track.

Format:

Rxxx - xxx = CV number

Example:

R001 - Read CV at location 1

```
COMMAND:r001
003 03h
COMMAND:
```

P - PROGRAM CV

This command will allow the computer to program any CV in the loco on the programming track.

Format:

Pxxx xxx - xxx = CV number, xxx = value

Example:

P001 003 - Program CV at location 1 with 3

D - DUMP 10 CV'S

This command will allow the computer to display a group of CVs in the loco on the programming track.

Format:

Dxxx - xxx = starting CV number

Example:

D000 - Dump a group of Cvs starting with CV 0

```
CV 000 : 000 00h
CV 001 : 003 03h
CV 002 : 004 04h
CV 003 : 002 02h
CV 004 : 002 02h
CV 005 : 000 00h
CV 006 : 000 00h
CV 007 : 000 00h
CV 008 : 000 00h
CV 009 : 000 00h
COMMAND:
```

X - EXIT PROGRAMMING MODE

This command will exit programming mode, and return to normal operations mode. The main track will be automatically enabled.

Format:

X - no data required

Example:

x - Exit program mode

COMMAND: **** RETURNING TO OPERATIONS MODE ****

H or ? - HELP

This command will display help for all of the available programming mode commands:

Format:

? - no data required

Example:

? - Exit program mode

**** COMMAND SUMMARY ****

Rxxx	Read CVxxx (0 = CV 256)
Pxxx xxx	Program CVxxx with decimal data xxx
Dxxx	Dump 10 CVs starting at xxx
Sx xxx	Program register x with decimal data xxx
Vx	Verify (read) register x
X	Exit programming mode
?	Help

NOTE: xxx = range 000 -> 255

NOTE: x = range 1 -> 8

V - READ REGISTER

This command will allow the computer to read a CV register in the loco on the programming track. This is for the new indexed mode Lenz decoder.

Register 1 = CV1 Short address
Register 2 = CV2 Start voltage
Register 3 = CV3 Acceleration
Register 4 = CV4 Deceleration
Register 5 = CV29 (Lenz index register)
Register 6 = error register (Lenz data register)
Register 7 = software version number
Register 8 = manufacturer number

Format:

Vx - x = Register number form 1 - 8.

Example:

V1 - Read register 1.

```
COMMAND: v1
003 03h
COMMAND:
```

S - WRITE REGISTER

This command will allow the computer to program a CV register in the loco on the programming track. This is for the new indexed mode Lenz decoder.

Register 1 = CV1 Short address
Register 2 = CV2 Start voltage
Register 3 = CV3 Acceleration
Register 4 = CV4 Deceleration
Register 5 = CV29 (Lenz index register)
Register 6 = error register (Lenz data register)
Register 7 = software version number
Register 8 = manufacturer number

Format:

Sx xxx - x = register number from 1 - 8, xxx = value.

Example:

S1 003 - Program register 1 with 3.

BINARY COMMANDS

The RS-232 port binary commands are designed to work in a computer friendly way.

Command format is: <cmd number> <data> <data> ...

Commands range from 0x80 to 0xBF

Commands and formats supported:

CMD FORMAT	DESCRIPTION	# OF BYTES RETURNED	POSSIBLE RESPONSES
0x80	NOP, dummy instruction	(1)	!
0x81 xxxx cc	assign loco xxxx to cab cc	(1)	!,1,2
0x82	read clock	(2)	<hours> <minutes>
0x83	Clock stop	(1)	!
0x84	Clock start	(1)	!
0x85 xx xx	Set clock hr/min	(1)	!,3
0x86 xx	Set clock 12/24	(1)	!,3
	0=12 hr 1=24 hr		
0x87 xx	Set clock ratio	(1)	!,3
0x88 xxxx	Dequeue packet by loco addr	(1)	!,1,3
0x89	Enable main trk, kill prog	(1)	!
0x8A cc	Return status of AIU cc	(4)	<current hi byte> <current lo byte> <change hi byte> <change lo byte>
0x8B	Kill main trk, enable prog	(1)	!
0x8C	Dummy instruction to get "!"	(3)	! CR/LF
	followed 0x0D and 0x0A		
0x8D xxxx mm	Set speed mode of loco xxxx to mode mm, 1=14, 2=28, 3=128	(1)	!,1,3 <speed mode, 0 to 3>
0x8E aaaa nn <16 data bytes>	Write nn bytes, start at aaaa Must have 16 data bytes, pad them out to 16 if necessary	(1)	!,4
0x8F aaaa	Read 16 bytes, start at aaaa	(16)	16 bytes
0x90 cc xx...	Send 16 char message to Cab cc LCD line 3. xx = 16 ASCII char	(1)	!,2
0x91 cc xx...	Send 16 char message to Cab cc LCD line 4. xx = 16 ASCII	(1)	!,2

	char		
0x92 cc xx...	Send 8 char message to Cab cc LCD line 2 right. xx = 8 char	(1)	!,2
0x93 ss <3 byte packet>	Queue 3 byte packet to TEMP_Q Send ss times	(1)	!
0x94 ss <4 byte packet>	Queue 4 byte packet to TEMP_Q Send ss times	(1)	!
0x95 ss <5 byte packet>	Queue 5 byte packet to TEMP_Q Send ss times	(1)	!
0x96 ss <6 byte packet>xx	Queue 6 byte packet to TEMP_Q Send ss times	(1)	!
0x97 aaaa xx	Write 1 byte to cmd sta RAM	(1)	!
0x98 aaaa xx xx	Write 2 bytes to cmd sta RAM	(1)	!
0x98 aaaa <4 data bytes>	Write 4 bytes to cmd sta RAM	(1)	!
0x98 aaaa <8 data bytes>	Write 8 bytes to cmd sta RAM	(1)	!
0x9B yy	Return status of AIU yy (short form of command 0x8A)	(2)	<current hi byte> <current lo byte>
0x9C xx	Execute macro number xx in the range of 0->199	(1)	! = success 0 = macro "empty" 3 = macro number
0x9D aaaa	Read 1 byte of RAM from aaaa	(1)	1 byte
0xA3 <3 byte packet>	Queue 3 byte packet to TRK_Q (replaces any packet with same address if it exists)	(1)	!,1
0xA4 <4 byte packet> 0xA4 xx xx...	Queue 4 byte packet to TRK_Q (replaces any packet with same address if it exists)	(1)	!,1
0xA5 <5 byte packet> 0xA5 xx xx...	Queue 5 byte packet to TRK_Q (replaces any packet with same address if it exists)	(1)	!,1

Commands 0x9D to 0xA2 and 0xA6 to 0xBF are not used and return '0'

Errors returned:

- '0'= command not supported
- '1'= loco address out of range
- '2'= cab address out of range
- '3'= data out of range
- '4'= byte count out of range
- '!'= command completed successfully

Assign a loco to a cab

Loco address for this command is always 2 bytes. The first byte is zero in the case of a short address. If the address is long then bits 6,7 of first byte must be set to 1

Format: 0x81 xxxx cc
xxxx = loco address
cc = cab number (0x01 to 0x3f)

Returns: != success
1 = bad loco address
2 = bad cab address

Read the clock

Format: 0x82
Returns 2 bytes: HOURS
MINUTES

Stop the clock

Format: 0x83 Clock stop
Returns: != success

Start the clock

FORMAT: 0x84 Clock resume (start)
Returns: != success

Set the clock

Format: 0x85 hh mm Set clock hours, minutes
Returns: != success
3 = hours or minutes data too large

Set the clock 12/24 hour format

Format: 0x86 xx Set clock 12/24 hours
xx=0 means 12 hour clock
xx=1 means 24 hour clock

Returns: ! = success
 3 = 12/24 format not 0 or 1

Set the clock ratio

Format: 0x87 xx Set clock speed (ratio)

Returns: ! = success
 3 = Ratio greater than 25 or zero

Dequeue loco packet

The loco address for this command is always 2 bytes. The first byte is zero in the case of a short address. If the address is long then bits 6,7 of first byte must be set to 1.

The loco address is used for comparison to see if a packet should be replaced.

Format: 0x88 xxxx
 xxxx = 8/14 bit address

Returns: ! if success
 1 if bad loco address
 3 if packet not found

Connect main, disconnects programming track.

Format: 0x89

Returns: ! (always success)

Return 2 status of Auxiliary Input Unit.

Returns four bytes. The first 2 bytes are a bit map of the 14 AIU inputs. The last 2 bytes are a bit map of any changes since this command was last given. If the cab is greater than 63 it will be "forced" to 0. The first time this command is given for a cab after the command station is powered up or reset the change bytes will be 0x3fff.

Format: x8A cc (cc=cab number 0-63)

Returns 4 bytes: current high byte (AIU inputs 9-14)
 current low byte (AIU inputs 1-8)
 change high byte 1=input changed since last read,
 0=no change
 change low byte 1=input changed since last read,
 0=no change

Disconnect main track and clears all packet queues

Format: 0x8B
Returns: ! (always success)

Set the speed mode of loco dddd.

The loco address for this command is always 2 bytes. The first byte is zero in the case of a short address. If the address is long then bits 6,7 of first byte must be set to 1.

Format: 0x8D xxxx mm
 xxxx = 8/14 bit address (short address 1st byte=0)
 (long address 1st byte bits 6,7 are set to 1)
 mm = mode 1=14spd, 2=28spd, 3=128spd
Returns: ! if success
 1 if bad loco address
 3 if bad speed mode, only 1,2 or 3 accepted

Write bytes to a command station RAM address

16 data bytes are always required by the command. Only the specified number will be written. You must "pad" out the command with extra bytes to meet the 16 byte requirement even if all are not to be written.

Format: "0x8E aaaa nn <16 data bytes>"
 aaaa= RAM address, high byte first
 nn = number of bytes to use
Returns: !,4

Return 16 bytes from a RAM address

Format: "0x8F aaaa "
 aaaa= RAM address, high byte first
Returns: 16 data bytes

Send a message LCD line 3 of a cab

The characters to be printed are NOT range checked. They must be in the range of 0x20 to 0x5F

Format: 0x90 cc <16 ASCII characters>
 cc = cab number (0-63)
Returns: ! for success
 2 bad cab address

Send a message LCD line 4 of a cab

The characters to be printed are NOT range checked. They must be in the range of 0x20 to 0x5F.

Format: 0x91 cc <16 ASCII characters>
 cc = cab number (0-63)

Returns: ! for success
 2 bad cab address

Send a message LCD the right hand side of line 2 of a cab.

The characters to be printed are NOT range checked. They must be in the range of 0x20 to 0x5F.

Format: 0x92 cc <8 ASCII characters>
 cc = cab number (0-63)

Returns: ! for success
 2 bad cab address

Put a 3 byte packet in the TEMP_Q.

Packet addresses are NOT verified so be careful! A "send times" of zero is OK... the packet will not be sent. If "send times" of 255 is requested it will be adjusted to 254, due to a system limitation. The packet checksum must be included with the packet data

Format: 0x93 <send times> <3 packet bytes>

Returns: ! = success

Put a 4 byte packet in the TEMP_Q.

Packet addresses are NOT verified so be careful! A "send times" of zero is OK... the packet will not be sent. If "send times" of 255 is requested it will be adjusted to 254, due to a system limitation. The packet checksum must be included with the packet data

Format: 0x94 <send times> <3 packet bytes>

Returns: ! = success

Put a 5 byte packet in the TEMP_Q.

Packet addresses are NOT verified so be careful! A "send times" of zero is OK... the packet will not be sent. If "send times" of 255 is requested it will be adjusted to 254, due to a system limitation. The packet checksum must be included with the packet data

Format: 0x95 <send times> <3 packet bytes>

Returns: ! = success

Put a 6 byte packet in the TEMP_Q.

Packet addresses are NOT verified so be careful! A "send times" of zero is OK... the packet will not be sent. If "send times" of 255 is requested it will be adjusted to 254, due to a system limitation. The packet checksum must be included with the packet data

Format: 0x96 <send times> <3 packet bytes>

Returns: ! = success

Put a 3 byte packet in the TRK_Q.

The TRK_Q is only for speed and direction commands to a loco. Do not send anything else as any other command will replace the existing speed command for that loco. TRK_Q is limited to loco addresses. The loco address is used for comparison to see if a packet should be replaced. The packet checksum must be included with the packet data

Format: 0xA3 <data> <data> <data>

Returns: ! = success
1 = bad loco address

Put a 4 byte packet in the TRK_Q.

The TRK_Q is only for speed and direction commands to a loco. Do not send anything else as any other command will replace the existing speed command for that loco. TRK_Q is limited to loco addresses. The loco address is used for comparison to see if a packet should be replaced. The packet checksum must be included with the packet data

Format: 0xA4 <data> <data> <data>

Returns: ! = success
1 = bad loco address

Put a 5 byte packet in the TRK_Q.

The TRK_Q is only for speed and direction commands to a loco. Do not send anything else as any other command will replace the existing speed command for that loco. TRK_Q is limited to loco addresses. The loco address is used for comparison to see if a packet should be replaced. The packet checksum must be included with the packet data

Format: 0xA5 <data> <data> <data>

Returns: ! = success
1 = bad loco address

INSERT YOUR “EASYRAMP” MANUAL HERE

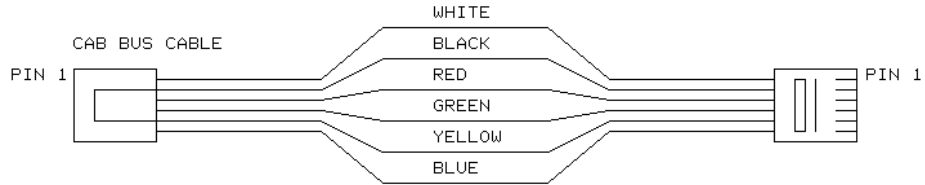
INSERT YOUR “COMMANDO” MANUAL HERE

INSERT FUTURE SOFTWARE MANUALS HERE

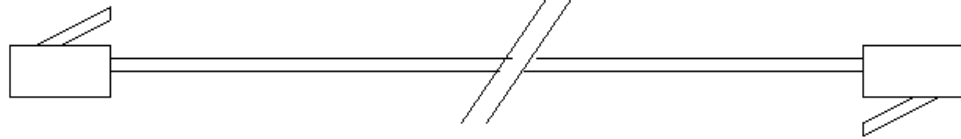
APPENDIX

SYSTEM CABLES

6 WIRE CAB BUS CABLE WITH RJ-12 CONNECTORS

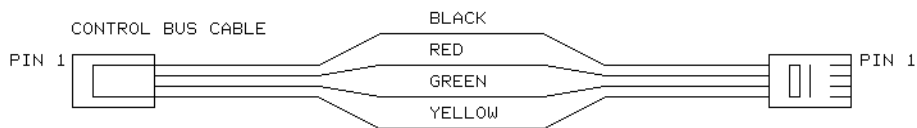


GENERAL RJ TYPE CABLE ORIENTATION

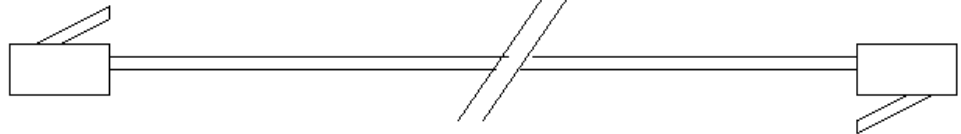


Pin #	Color	Description
Pin 1	White	No Connection
Pin 2	Black	Ground
Pin 3	Red	- RS-485
Pin 4	Green	+ RS-485
Pin 5	Yellow	+12 volts
Pin 6	Blue	Direction of the communications

4 WIRE CONTROL BUS WITH RJ-H CONNECTORS

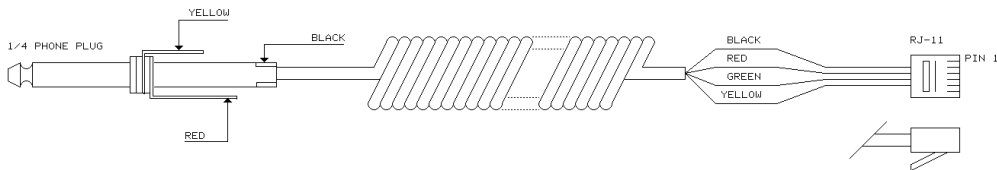


GENERAL RJ TYPE CABLE ORIENTATION



Pin #	Color	Description
Pin 1	Black	Feedback from Power Station
Pin 2	Red	- Control
Pin 3	Green	+ Control
Pin 4	Yellow	Ground

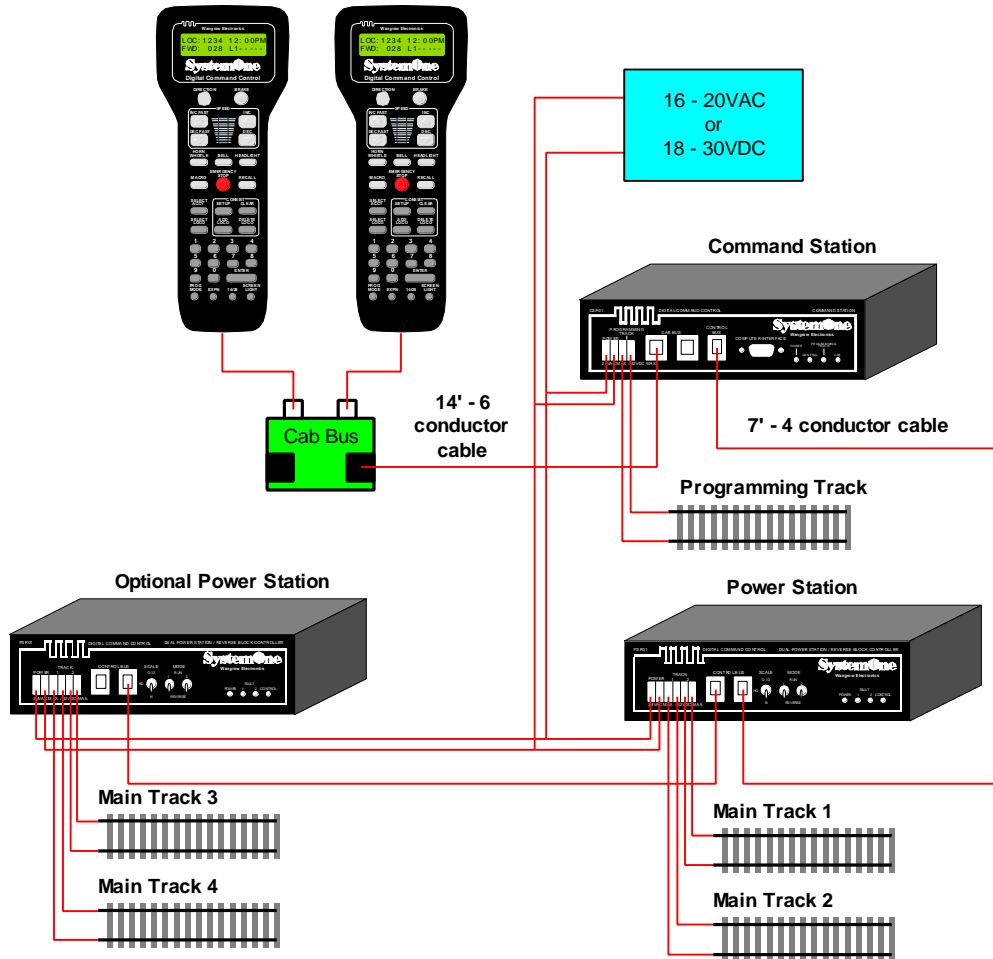
4 WIRE CAB CABLE WITH RJ-11 AND 3 WIRE PHONE PLUG



Pin #	Color	Description
Ring	Black	Ground
Sleeve	Red	Signal
Tip	Yellow	+ 12 volts

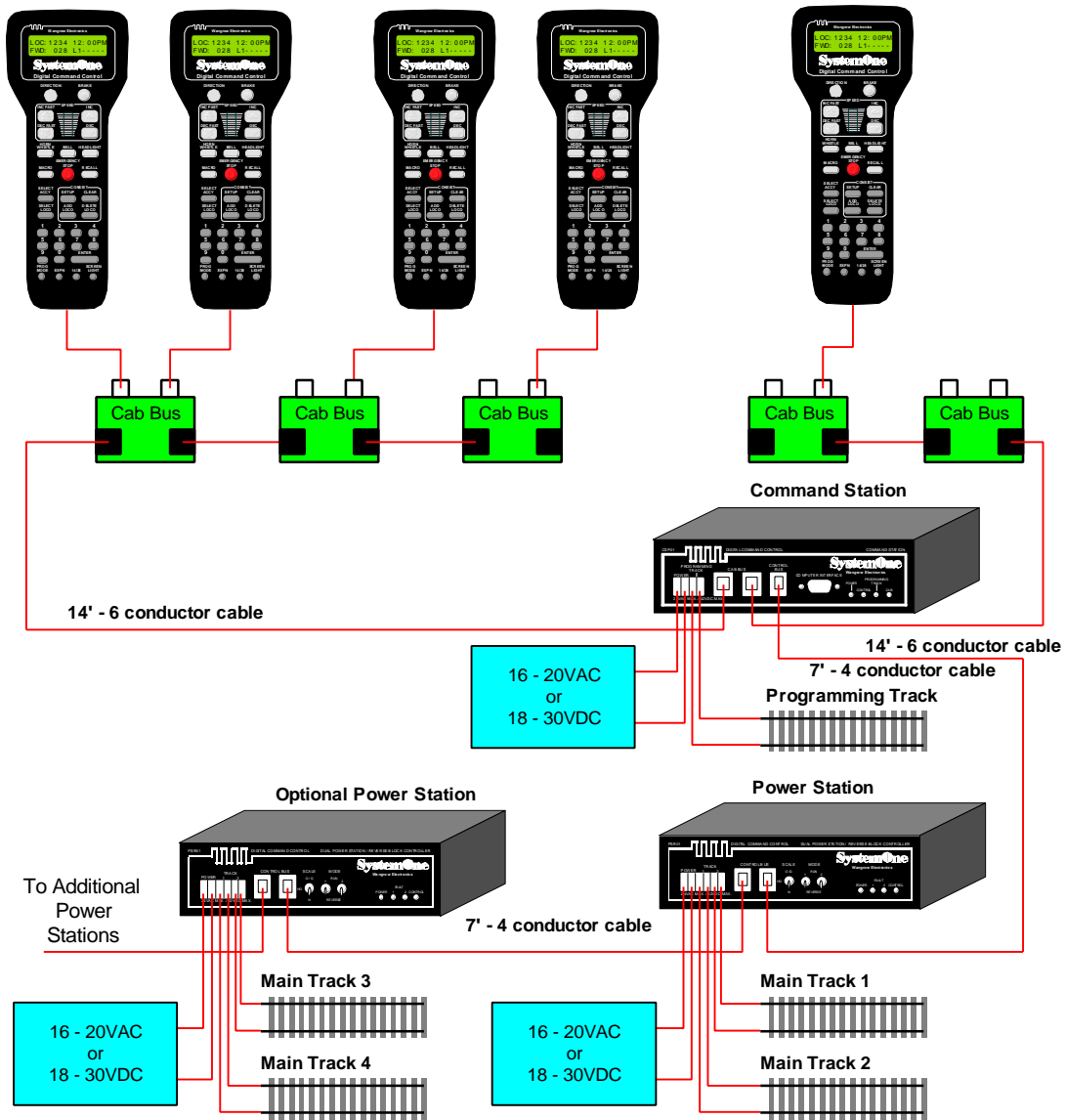
WIRING DIAGRAMS

SIMPLE HOME LAYOUT



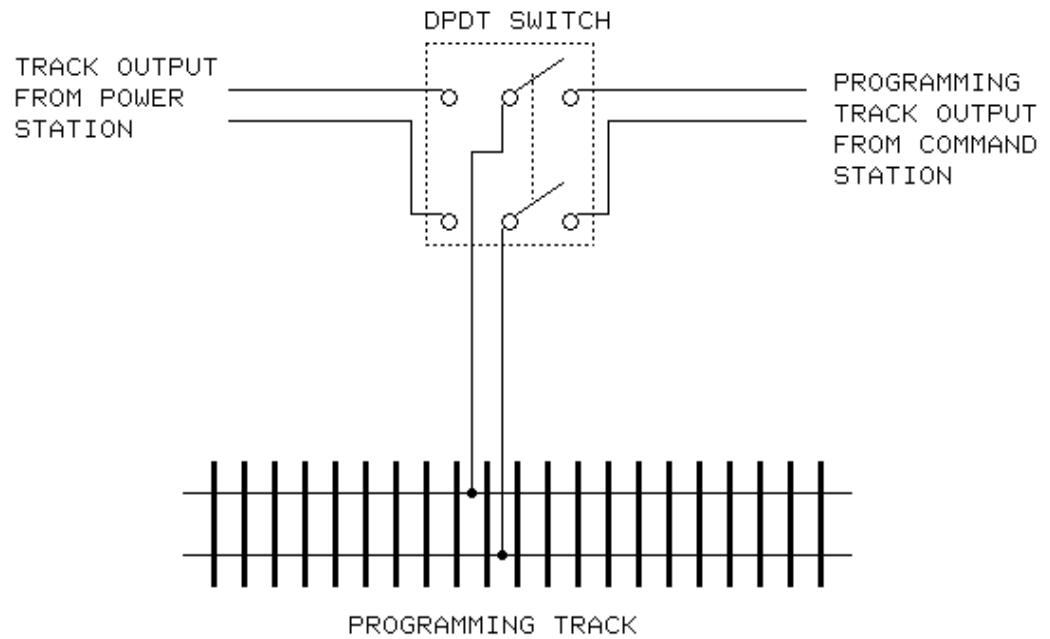
The simple home layout does not need to have Cab Bus Panels in use, and more than likely will only have one Power Station. This is also the arrangement to use when you first unpack your **SystemOne™** from the box in order to get familiar with the product.

EXPANDED CLUB LAYOUT



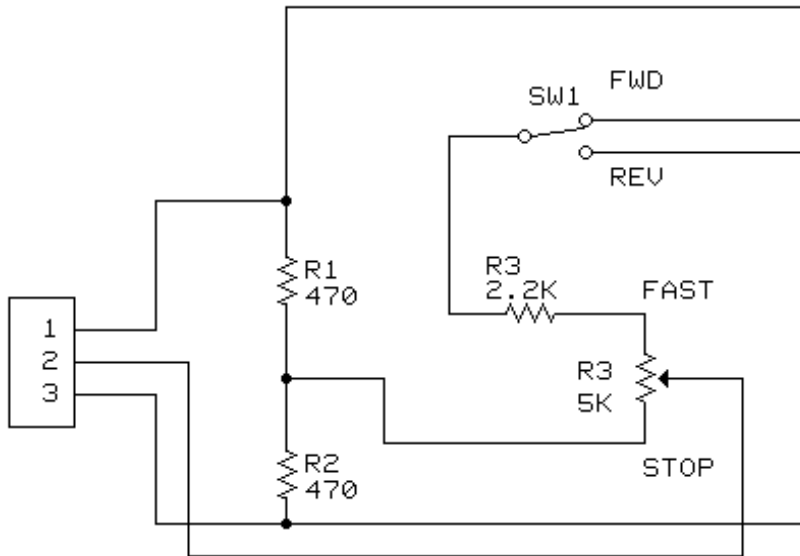
A Club or large layout is distinguished by the need for more than one Power Station and many Cab Bus Panels for multiple Cabs. Each individual Power Stations have separate power supplies. They should each be connected to an isolated block of such size as to not have more loco's and lighted cars to exceed the 5 ampere loading. On many layouts that is the whole layout. See page 2-26.

PROGRAMMING TRACK SWITCH SCHEMATIC



The Programming Track should be a siding located convenient to the Double Pole/ Double Throw Switch and in view of the lights on the Command Station.

BUILDING AN ANALOG LOCO CONTROLLER



ANALOG CONTROL SCHEMATIC

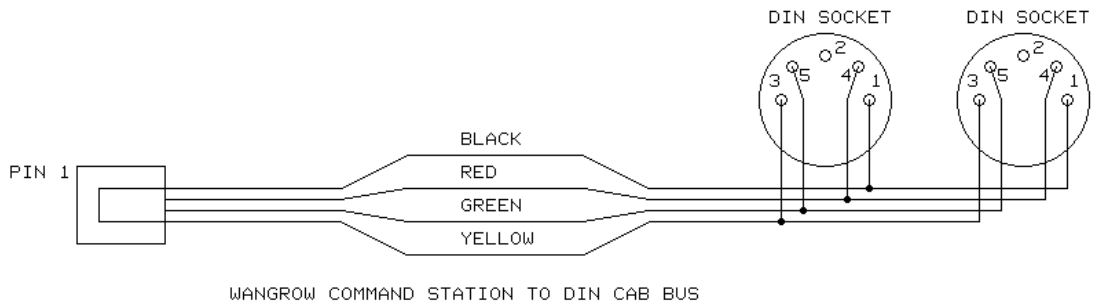
Parts List:

Qty.	Description
1	3 pin 0.1" center socket
1	SPDT toggle switch
1	5K ohm linear pot w/knob
1	2.2K ohm ¼ watt resistor
2	470 ohm ¼ watt resistor
1	Suitable project box

The above schematic will provide the Analog Loco Controller that some people may be interested in. This will allow operation of one loco without a decoder on the layout. It should be noted again that the loco is to be expected to operate noisy. The plug (1-2-3) gets connected inside the Command Station as explained in the section on the Command Station.

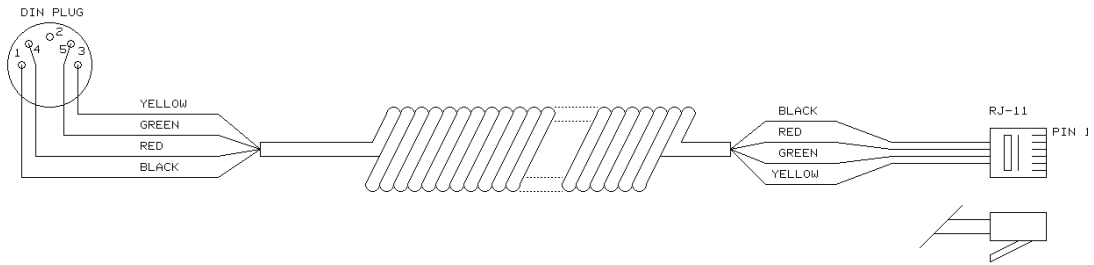
Any DC motor that is allowed to stand powered on a DCC (AC power) powered track will eventually become de-magnetized or burn up. This feature was made part of our product at the DCC Committee's request. We suggest that you do not use it.

WIRING TO DIN SOCKETS



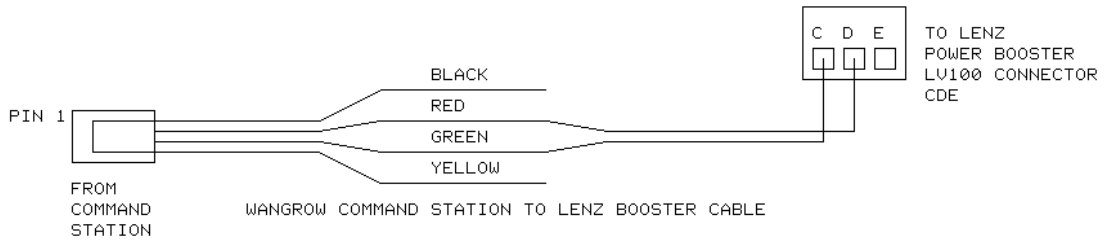
This wiring diagram is provided for the operator that prefers using a DIN sockets.

4 WIRE CAB CABLE WITH DIN PLUG



This wiring diagram is provided for the operator that prefers using a DIN connectors. This is the cable that connects the Cab and the Cab Bus panel when using DIN sockets..

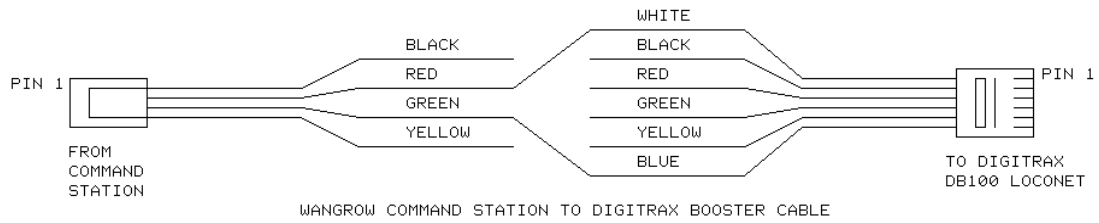
WIRING TO A LENZ POWER BOOSTER



This wiring diagram is provided for the operators that have switched from an Existing LENZ system to **SystemOne™**. This cable splicing is required to the first LV100 only. Other LV100's can be “daisy-chained” as already installed.

We are sorry, but your LENZ Command Station and Cabs will not work on our system at this time. Watch for our future Black Box that will allow you to continue using your Lenz Cabs.

WIRING TO A DIGITRAX POWER BOOSTER



This wiring diagram is provided for the operators that have switched from an Existing DIGITRAX system to **SystemOne™**. This cable splicing is required to the first DB-100 only. Other DB-100's can be "daisy-chained" as already installed. Always leave the "Ground to Sync" Jumper installed.

We are sorry, but your DIGITRAX Cabs will not work on our system.

CONFIGURATION VARIABLES (CV'S)

MULTI-FUNCTION DECODERS

CV #	Description
1	Primary (Short) Address
2	Start Voltage
3	Acceleration Rate
4	Deceleration Rate
7	Manufacture Version Number
8	Manufacture ID
17-18	Extended (Long) Address
19	Consist Address
23	Acceleration Adjust
24	Deceleration Adjust
29	Configuration Variable 1
67-94	Speed Table
95	Speed Table Total PWM period

CONFIGURATION VARIABLE 1 - CV 29

Bit #	Description
Bit 1	Locomotive Direction
Bit 2	28 Speed Step Mode
Bit 4	Power Source Conversion
Bit 10	Alternate Speed Table
Bit 20	Long Addressing
Bit 80	Accessory Decoder

ACCESSORY DECODERS

CV #	Description
513	Address
515	Time On for F1
516	Time On for F2
517	Time On for F3
518	Time On for F4
519	Manufacture Version Number
520	Manufacture ID
521	Address MSB

SPEED TABLES EXPLAINED

The following pages explanation on how motor speed is controlled by a decoder was written by Jim Scorse our Director of Programming and active member of the DCC Committee. Jim is also president of North Coast Engineering of Webster, NY.

HOW MOTOR SPEED IS CONTROLLED BY A DECODER

Most DCC decoders control motor speed by using what is called Pulse Width Modulation or **PWM**. Pulses of voltage are sent to the motor to make it run slower or faster depending upon the width of the pulse. The pulse width determines the amount of power supplied to the motor which in turn determines how fast the motor will run. A short pulse runs the motor slowly, longer pulses cause it to run faster. Ultimately, at top speed the pulses grow so long that they run together and become pure DC voltage.

Figure 1 shows the voltage supplied by a decoder running a motor slowly. As you can see the motor is getting power only a very small percentage of the time. The pulses are supplied to the motor at a fast enough rate so that the motor will coast between pulses giving the appearance of continuous smooth operation.

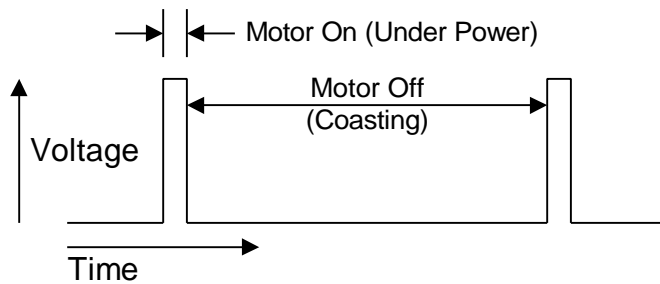
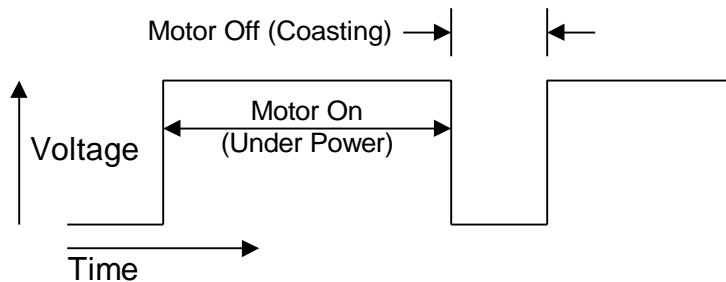


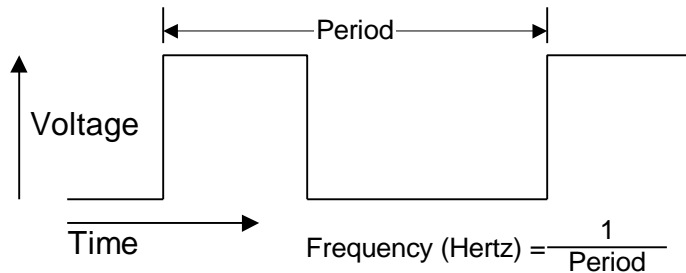
Figure 2 shows a motor being run at a much higher speed. Power is being supplied to the motor a large percentage of the time. The motor spends much less time coasting and more time being driven so it runs faster.



FREQUENCY

The rate at which pulses are repeated is called the **frequency** of the PWM. Frequency is expressed in cycles per second or, to use a more modern term, "Hertz". Frequency is determined by simply dividing 1 by the **period** (pulse rate). **SystemOne™** decoders come preset from the factory with a period of .014336 seconds. This is a frequency of 1 divided by .014336 which equals just about 70 Hz (Hertz is abbreviated Hz). Pulses are sent to the motor at a rate of about 70 times per second. Generally speaking for model railroad use, frequencies between 30 and 300 Hz (cycles per second) are useful.

Figure 3 illustrates the relationship between period and frequency.



DESCRIPTION OF SPEED STEPS

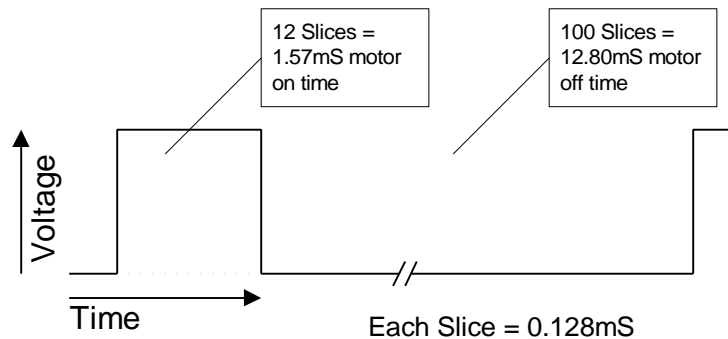
SystemOne™ decoders support both 14, 28, and 128 speed step operation. We will discuss 28 speed step operation. This means that pulses are supplied to the motor in 28 different widths for 28 different speeds. These different speed steps are stored within the decoder in a form called a **speed table**. The speed table is simply a chart (or 'lookup table' as it is sometimes called) that the decoder uses to determine what pulse width to supply to the motor for each speed step. In order to keep the number of zeroes after the decimal point down, and make the numbers easier to read, we will refer to time in thousandths of a second or **milliseconds** (abbreviated mS). The decoder supplies pulses to the motor in 'slices' of 0.128 mS (128 microseconds). This means that the shortest possible pulse to the motor is 0.128 mS. The speed table tells the decoder how many .128 mS slices out of the total period that power will be supplied to the motor. The total PWM period of 14.336 mS can contain a maximum of 112 of these increments (14.336 divided by .128 equals 112).

STANDARD SPEED TABLE

The standard speed table that is factory supplied in **SystemOne™** decoders looks like this:

Speed Step	Number of .128 mS 'slices'	Pulse Width (out of 14.336 mS)
1	4	0.51 mS
2	8	1.02 mS
3	12	1.57 mS
4	16	2.05 mS
5	20	2.56 mS
6	24	3.07 mS
7	28	3.58 mS
8	32	4.10 mS
9	36	4.61 mS
10	40	5.12 mS
11	44	5.63 mS
12	48	6.14 mS
13	52	6.66 mS
14	56	7.17 mS
15	60	7.68 mS
16	64	8.19 mS
17	68	8.70 mS
18	72	9.21 mS
19	76	9.73 mS
20	80	10.24 mS
21	84	10.75 mS
22	88	11.26 mS
23	92	11.78 mS
24	96	12.23 mS
25	100	12.80 mS
26	104	13.31 mS
27	108	13.82 mS
28	112	14.34 mS

Figure 4 illustrates the motor drive for speed step 3



START VOLTAGE

The start voltage is the number of .128 mS time slices added to each speed step. For example: if the start voltage is set to 7 then speed step 1 will have 11 slices of 'on time' instead of 4. Speed step 3 (see figure 4) will not have 12 slices of 'on time' but it will have 19 slices of 'on time'. If the start voltage causes the speed step to exceed 112 (as with speed step 27) the decoder will "max out" at 112 slices rather than go over the maximum number of slices.

ALTERNATE SPEED TABLE

SystemOne™ decoders actually come with *two* speed tables. While the **standard** speed table is recorded in the unchangeable, permanent memory of the decoder the **alternate** speed table is stored in changeable memory and may be modified to suit different locomotive motor requirements. Both the pulse widths of each speed step and the period (frequency) may be customized for a particular locomotive. The pulse widths for the alternate speed table are stored in Configuration Variables (CV) 66-94 and the Total Period (which determines the frequency of the PWM) is stored in CV95. The table on the following page contains the factory programmed alternate speed table. This table may only be changed on the programming track while using the in "USE PROGRAM TRK" mode on the Cab (see page 4-15).

FACTORY SETTINGS FOR THE ALTERNATE SPEED TABLE

These settings may be changed to suit the requirements of different locomotives.

Configuration Variable Num. ⁽¹⁾	Speed Step	Number of .128 mS 'slices'	Pulse Width (out of 14.336 mS)
67	1	3	0.38 mS
68	2	6	0.75 mS
69	3	9	1.13 mS
70	4	12	1.50 mS
71	5	15	1.88 mS
72	6	18	2.25 mS
73	7	21	2.63 mS
74	8	24	3.00 mS
75	9	27	3.38 mS
76	10	30	3.75 mS
77	11	33	4.13 mS
78	12	36	4.50 mS
79	13	39	4.88 mS
80	14	42	5.25 mS
81	15	45	5.63 mS
82	16	48	6.00 mS
83	17	51	6.38 mS
84	18	54	6.75 mS
85	19	57	7.13 mS
86	20	60	7.50 mS
87	21	63	7.88 mS
88	22	66	8.25 mS
89	23	69	8.63 mS
90	24	72	9.00 mS
91	25	75	9.38 mS
92	26	78	9.75 mS
93	27	81	10.13 mS
94	28	84	10.50 mS

INITIAL FACTORY SETTING OF THE TOTAL PWM PERIOD

Configuration Variable Number	Speed Step	Number of .128 mS 'slices' in the Total PWM Period	Total PWM Period
95	--	84	10.75 mS (93 Hz)

There are various ways the Total Period (CV95) can be played against the pulse widths of the speed steps (CVs 67-94):

If the locomotive runs at the correct speed at speed step 28 then CV95 should be set equal to CV94. This will give full available power to the motor (speed step 28 pulse width will be 100% of the Total Period) on speed step 28.

If the locomotive runs too fast then CV95 can be set to a number greater than CV94. This will give less than full available power to the motor when it reaches speed step 28. Note: remember that Start Voltage (CV2) is always added to the speed step before it is compared to CV95 in the decoder.

Selection of the total period is a trial and error process for different types of motors. Some motors respond well to higher frequencies others to lower frequencies. One motor may "rattle" or buzz at 90Hz but not at 84Hz.

PROGRAMMING THE ALTERNATE SPEED TABLE

It is less labor intensive to determine the best Total PWM Period first before rushing in and reprogramming all the speed steps. As a general, but not hard-and-fast, rule we have found that large motors ("O" and "G" scale) respond well to longer Total PWM Periods and smaller motors ("HO" and "N") seem to do better with shorter periods.

In HO start out by trying Total PWM Periods in the range of 50-80. Try various settings of CV95 and see how the motor runs on the lower speed steps (higher speeds are not critical at this point). After determining what you think is a good trade-off between noise and performance it is time to set the speed steps for the decoder.

The next action is to find the correct 1st speed step (CV67) for the motor. The correct first value is the one that makes the locomotive move at what you feel is the "right" speed for speed step 1. Contrary to what seems obvious, the "right" speed for speed step 1 is *not* the same for everyone.

When you have determined speed step 1, then pick a number for the last speed step (CV94). Normally CV94 will be programmed to the same value as the Total PWM Period (CV95) if you are happy with the loco's top speed. If the top speed is too fast then choose a number proportionally slower than that in CV95.

To fill in the remaining speed steps 2-27: Subtract the value for speed step 2 from the value for speed step 28. Divide the result by 27 to get the incremental value for each speed step. This will divide the locomotive speeds equally (linearly, for the mathematicians among us) from step 1 to step 28. Any value from 0 to 255 may be programmed into any speed step.

The decoder does not check to make sure the next speed step has a higher value than the previous one. This will allow some pretty wild speed tables even up to the point of having the speed table run 'backwards' from full speed at step 1 to a crawl at step 28 (speed 0 can not be programmed and is always "stop")

TROUBLE SHOOTING

- Loco acts strange: Sometimes decoders from all manufacturers will “get lost”. To correct this tip the loco to one side for about three seconds, raising the wheels off the track a bit. This will disconnect the decoder from the power source allowing the decoder to reset itself. If this does not work reprogramming the decoder may be necessary.
- Loco’s all stopped: Check the Fault lights on the Power Stations. **SystemOne™** Power Stations eat shorts. There are no breakers to cool down for reset or buttons to push. When the short is eliminated all loco’s will resume their movement. If that was not the problem press **ENTER** because someone may have pressed the **E-STOP** three times by accident.
- Head Light goes on and off as I change speed: You are operating a loco with an older 14 step decoder in the 28 step mode and the head light is ON only in the even speed steps.
- The programmability of the decoders give the modeler a *lot* of flexibility. However, this can lead to some un-predictable results. Here are a few tips to get you out of some situations:

Loco won’t respond

Check that the short/long bit is set correctly in the CFG variable (CV 29).

The loco might be in a consist. If you don’t remember what consist that the loco might be in, create a new consist, add that loco to it, and then clear the consist that you just created. Or you can re-program the address, which will clear the consist address.

Loco won’t run on an analog (DC) layout.

Check that the DC mode bit is set in the CFG variable (CV 29). Decoders before version 1.5 (‘15’ as reported), will not run on DC.

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FCC DISCLAIMER

This device complies with Part 15 of the FCC rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Accessories: This device has been tested and found to comply with the limits of a Class B digital device, the accessories associated with this equipment are following:

- Power Station/ Reverse Block Controller
- Walk-around Cab
- Cable Connector Panel
- Decoder

These accessories are required to be interconnected and used in the manner shown elsewhere in this operation manual in order to ensure compliance with FCC rules. It is the responsibility of the user to provide and use these accessories.

Class B Digital Device. This equipment has been tested and found to comply with the limits for a Class B digital device pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult an experienced radio/TV technician for help.

Caution to the user: The Federal Communications Commission warns the users that changes or modifications of the unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

COMPATIBLE PRODUCTS

Check with your local hobby shop to obtain products of the following manufacturers or write them for a listing of hobby shops that carry their product line:

MANUFACTURERS OF COMPLETE DCC SYSTEMS.

NORTH COAST ENGINEERING
1900 EMPIRE BLVD. SUITE #303
WEBSTER, NY 14580
Phone /Fax 716-671-0370

LENZ @ Tried and True Trains
.
Phone/Fax 508-256-3062

RanTraxx
A12-1250 Eglinton Av. West STE 106
Mississauga Ontario L5V1N3 Canada
Phone..... 905-542-2347
Fax..... 905-542-2659

Model Rectifier Corporation (MRC)
89 Newfield Av.
Edison, NJ 08837-3817
Phone..... 908-225-2100
Fax..... 908-225-0091

DIGITRAX
PO BOX 1424
NORCROSS, GA 30091
Phone..... 404-441-7992
Fax..... 404-441-0759

ZTC SYSTEMS
SIGNAL HOUSE
PO BOX 23
SAFFRON WALDEN, ESSEX
ENGLAND, CB10 2XY
Phone..... 0-1799-599800
Fax..... 0-1799-599047

MANUFACTURERS OF SUPPORT PRODUCTS TO MAKE INSTALLATION EASIER FOR THE HOBBYIST

**Machines N-Scale frames for locomotives to provide space for decoders
plus offers an array of other products..**

AZTEC MANUFACTURING CO.
2701 CONESTOGA DR.
CARSON CITY, NV 89706

Phone 702-883-3327

Fax 702-883-3357

AZTEC MFG provides frames that maintain your warranty.

CAUTION: Using frames manufactured by third parties will void your
warranty with the loco's manufacture. Also, because of the lead content of
third party frames, they should be handled with care and kept from children.

Manufacturers of transformers for DCC systems.

ALLIED ELECTRONICS
7410 Pebble Drive
Fort Worth, Texas 76118

Phone 800-433-5700

SUGGESTED TRANSFORMERS

For Dual 5 Amp Power Booster	836-6155	10 AMP	18VAC
For 10 Amp Power Booster	836-6185	12 AMP	22VAC

Manufacturers of lights, wire and miniature plugs.

MINIATRONICS
561-K ACORN ST.
DEER PARK, NY 11729

Manufacturers of lighting products.

ACCURATE LIGHTING
PO BOX 574
ASHBURN, VA 221011-0574

RICHMOND CONTROLS CO.
MS195M, PO BOX 219095
HOUSTON, TX 77218-9095

Manufacturers of compatible sound products.

REAL-RAIL EFFECTS
PO BOX 1627
HIGHLAND, IN 46322
Phone 312-202-9931

DALLEE ELECTRONICS
10 WITMER RD
LANCASTER, PA 17602
Phone 717-392-1705

Throttle-Up (SoundTrax)
P.O. Box 33924
Denver, CO 80233-0924
Phone 303-465-4435
Fax 303-465-4191

Decoder Installations.

Jim Goettsche (N scale only)
1814 Henley St.
Glen View, IL 60025
Phone 847-724-0427

Rod Miller (O scale only)
422A Douglas Ave.
Redwood City, CA 94063
Phone 415-369-1557
Fax 415-329-0423

Miniature Locomotive Back Shop (All scales)
148 Tower Rd.
Newfield, NY 14867
Phone 607-277-1820

Joseph M. Bak Jr. (All scales)
637 Crandell
Schaumburg, IL 60193
Phone 847-895-4907

Manufacturers of signal products.

MODULAR MODEL RAILROAD ELECTRONICS
625 S. PRINCETON
VILLA PARK, IL 60181
Phone 708-832-9152

TRACTRONICS INCORPORATED
1212 S. NAPER BOULEVARD
SUITE 119
NAPERVILLE, IL 60560
Phone 708-527-0000

INTEGRATED SIGNAL SYSTEMS
PO BOX 25451
ROCHESTER, NY 14625-0451
Phone 716-586-2032

NMRA STANDARDS AND RECOMMENDED PRACTICES

May we suggest that if you are not already a member of the National Model Railroad Association (NMRA) that you join. If it were not for this organization developing the various standards in the past that allow you to purchase a loco, box car, turnout, or other model device from any manufacturer, and not have to worry that it operating on your layout, the hobby as you know it would not be around. Their latest project has been Digital Command Control Standards and Recommended Practices. Lenz, Digitrax, North Coast Engineering, Wangrow Electronics, and others have built products to this standard, with others on the way.

To join send a check for \$32.00 (US currency) per year to:

National Model Railroad Association, Inc.
Headquarters Office
4121 Cromwell Road
Chattanooga, TN 37421

Phone: 423 892-2846

Fax: 423 899-4869

If you would like an up-to-date copy of the DCC Standards and Recommended Practices send along an additional \$25.00, that might get you the whole book.

GLOSSARY

Command Station ⁴	A self-contained unit that accepts layout control inputs, generates the appropriate DCC packets, and outputs them in an NMRA DCC compliant signal to the Power Station.
Power Station ⁴	A unit which accepts as input a signal from a Command Station and provides as output a power source onto which is encoded a digital packet signal in conformance with NMRA Standard S-9.1.
Cab ⁴	A unit which presents to a human operator, the controls necessary to operate a model locomotive, track switches, or layout accessories. Such controls may include both input devices (knobs, buttons, switches) and output devices (lamps, displays, audible sounding units).
Cab Bus ⁴	A Bus used to connect all kinds of Cabs, except Wireless Cabs, to a Command Station. Wireless Cabs are indirectly connected to a Cab Bus via their companion Wireless Cab Base.
Control Bus ⁴	A Bus which connects a Command Station to it's Power Stations.
Bus ⁴	A set of wires that distributes power, commands, or signals around the layout.

⁴ These definitions are re-printed from the NMRA Digital Command Control Standards & Recommended Practices, March 1997

Embedded Microprocessor ⁵	A computer where the program instructions, memory, registers, and other resources that are contained in a single physical package.
Memory ⁵	A group of storage locations - either permanent or temporary. Permanent Memory in SystemOne is EPROM, temporary Memory is RAM.
Register ⁵	A register is a temporary storage location. Every type of computer uses registers. This is often shorthand for the term physical register. Early DCC decoders used embedded microprocessors that had eight physical registers for general purposes. DCC manufacturers used these registers for accessing CVs (see definition below).
Physical Register ⁵	A physical register is one that actually exists in silicon. Physical registers are typically used to hold values that are frequently used. Most microprocessors have a limited number of registers _ some are used for special purposes, some are used for general purposes.
Pointer ⁵	In computer terms, a pointer is a register that references another register based on it's value.
Register Pointer ⁵	A pointer that references registers. (Need the context to define how this applies to DCC).
Configuration Variable(CV) ⁵	A DCC specific term to abstract memory locations used in DCC Decoders from actual physical memory locations in microprocessors. There are 1023 designated Configuration Variables.
Index ⁵	In general terms, a type of pointer. In DCC terms, a pointer (or method) that is used to access more CVs than there are physical registers. The "index" specifies which CV (1-256) value can be read from or written to. While some DCC decoders support indexing, it is not part of the NMRA Recommended Practices.
Page ⁵	Another type of pointer. In DCC terms, a page register is used to map groups of four CVs into four physical registers. The "page" value, stored in the page register specifies which group of four CVs can be read from or written to.
Register Mode ⁵	The memory addressing mode using registers to access CVs. This method is limited to seven CVs.
Indexed Mode ⁵	A special type of memory addressing used in some specific decoders. Using indexed addressing mode on a decoder that only supports paged mode can cause erratic and/or undefined operation.

⁵ These definitions are provided courtesy of Brian Barnt.

- Paged Mode⁵ The memory addressing mode used to access all CVs, in groups of four. This method uses the eighth register from register mode to access all the CVs. Each time a CV is accessed, the correct value must be calculated.
- Direct CV Mode⁵ The simplest form memory addressing for all CVs. The CV number specified is where the data is read from or written to.

SPECIFIC DECODER INSTALLATIONS

DECODER INFORMATION AND MAINTENANCE CHARTS

LOCOMOTIVE NUMBER _____ SHORT ADDRESS _____
 MANUFACTURER _____ YEAR PURCHASED _____
 ROAD NAME _____
 CLASSIFICATION _____

DECODER INFORMATION

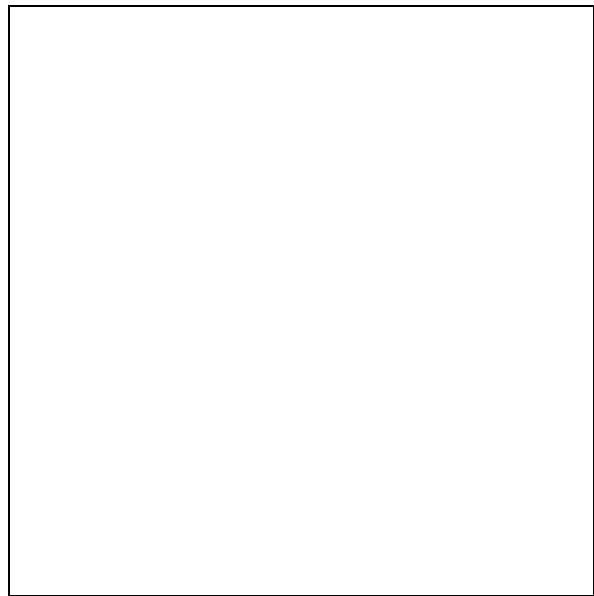
MANUFACTURER _____ CATALOG NUMBER _____
 DATE INSTALLED _____

<u>FUNCTIONS WIRED</u>	<u>LOAD</u>	<u>RESISTOR - OHMS - WATTS</u>
F0 HEADLIGHT	_____	_____
F1 _____	_____	_____
F2 _____	_____	_____
F3 _____	_____	_____
F4 _____	_____	_____
F5 _____	_____	_____
F6 _____	_____	_____
F7 _____	_____	_____
F8 _____	_____	_____

PROGRAMMING INFORMATION

8-BIT ADDRESS _____
 14-BIT ADDRESS _____
 ACCELERATION _____
 DECELERATION _____
 START VOLTAGE _____
 TOTAL VOLTAGE _____
 CV NO _____ VALUE _____
 CV NO _____ VALUE _____
 CV NO _____ VALUE _____
 CV NO _____ VALUE _____
 CV NO _____ VALUE _____
 CV NO _____ VALUE _____
 CV NO _____ VALUE _____
 CV NO _____ VALUE _____
 CV NO _____ VALUE _____
 CV NO _____ VALUE _____

WIRING DIAGRAMS



LIGHT BOARD MANUFACTURER _____

SOUND MODULE MANUFACTURER _____

