

Warranty Information

This warranty covers substantial defects in materials and workmanship in the G2 decoder.

What This Warranty Does Not Cover

This warranty does not cover any problems which result from improper installation, modifications, battery polarity reversal, improper operation, leaking batteries, excessive battery voltages, excessive motor current draw, connections to 3rd party circuit boards, abuse, accidents, or acts of God such as excessive heat, floods, damage caused by exposure to moisture and rain, lightning, earthquakes, volcanic events, tidal waves or hurricanes.

Warranty Duration

The coverage of this warranty lasts for 90 days. After this period, standard repair rates apply. Depending on the problem, CVP reserves the right to repair or replace.

Repairs and Returns

If you purchased your G2 decoder from one of our AirWire900 dealers, please call them first. They are your best and quickest for answers to questions about G2 decoder. They are also experts in installation and offer such services should it be required.

If you purchased your G2 decoder directly from CVP Products, you may call the office number below.

If you are asked to return an item to CVP for service, you must follow the instructions on the website under service and support and you must obtain an RMA. There you will find the street address plus other helpful tips about sending packages to CVP Products. **Do not send items to us for repair without first obtaining authorization.**

Installation Accessories

Order direct from CVP. Prices do not include shipping or applicable sales taxes.

Split Board Kit with 3 inch flex cable [SFX3]..... \$13.95

Split Board Kit with 6 inch flex cable [SFX6]..... \$13.95

These kits includes the special very thin flat flex cable and instructions. It allows the G2 decoder circuit board to be split in to two parts: the radio receiver and the motor driver. The flex cable plugs into the existing connectors already mounted on the board. No soldering required. The thin flex cable is already pre-stripped and tinned ready for use to reconnect the two halves.

Range Extender Kit [REK1] \$14.95

Includes 36 inches of premium quality, ultra-flexible, shielded cable for motor wiring, 24 inches of 2-conductor, tightly twisted #18AWG wire for battery connections and motor brush filter capacitors and two different values of motor driver limit resistors. When installed as described in the accompanying manual, the decoder reception range can be significantly extended.

Fuse Kit [FK9] \$ 7.95

Includes in-line fuse holder with 18" wire leads, two 10A slo-blo fuses and hookup diagram. Provides catastrophic protection for the battery and motor driver.

Rigid Antenna, and Cable [CA]..... \$ 19.95

Includes 5 inch rigid antenna attached to 9 inches of RG174 coax cable. Cable solders to the AW9D10 board in place of the standard wire antenna. Allows antenna to be placed on top of car or locomotive for improved very long range reception.

Dome Antenna, and Cable [DCA]..... \$25.95

Low profile "dome" antenna. The dome is attached to 9 inches of RG174 coax cable and plug. The plug is removed and the cable solders to the receiver board in place of the standard wire antenna. It allows for an external antenna to be placed on top of a car or locomotive for improved reception.

120 Watt Adjustable DC Power Supply [DCPS120].....\$ 55.00*

* Not sold through dealers. Available direct from CVP Products.

All prices shown are suggested retail prices and are subject to change without notice. See website for the latest price list and ordering information.

A full color version of this booklet is available on the CVP website

CVP Products P.O. Box 835772 Richardson, TX 75083-5772

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The AirWire900® 2nd Generation Decoder

The G2™ Decoder

G2 Decoder Layout And Terminal Identification	2
Installation Considerations and Absolute Maximum Ratings.	3
Battery Wiring And Battery Polarity Verification.	4
Single Battery And Parallel Battery Hookup	5
Series Battery Connection And Split Battery Hookup	6
G2 To Motor Hookup Diagrams	7, 8
G2 Headlamp Wiring	9, 10
Using a Remote Frequency Selector.	10
Frequency Selector Settings	11
Using The Auxiliary DCC Booster Output With Sound Decoders.	12-16
Simplified Quick Checkout Of Installation	17
Resetting Decoder To Factory Defaults	18
Simplified Troubleshooting and Operating Notes	19
Fault Protection, Annunciation, Reset	20
Operating Tips.	21
Activating and Using Cruise Control	22, 23
Fine Tuning Locomotive Performance And Operation.	24
Customizing Decoder Performance With CVs	25-29
List of All G2 Decoder Configuration Variables	29
Batteries, Chargers and Other Useful Information	30-32
Managing Heat Buildup And Hot Climate Derating	33, 34
Power Through The Rails - Some Considerations	35
Warranty Information, Technical Support, Installation Accessories	Back

WARNING

NEVER connect the G2 decoder to any 3rd party lighting boards or other external circuit boards. Failure of the lighting board and the G2 decoder is likely and this is not covered by any warranty.

Need Help? Contact Your Dealer/Installer First!

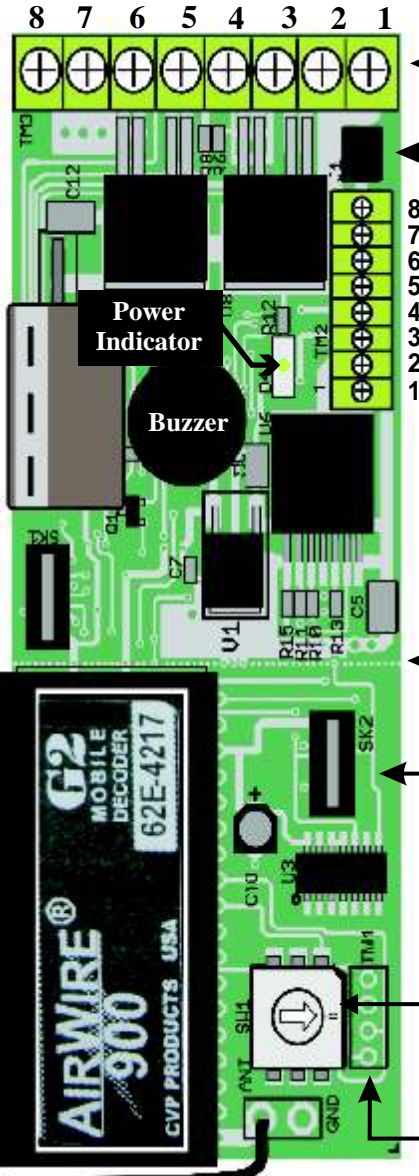
Should you have any questions regarding AirWire or installations, your dealer is your best source of information, tips and techniques. Also, almost all dealers will do installations or can recommend good installers. It might take a little more time cost a bit more, but you'll be assured of an installation that works and works well.

AIRWIRE®
900

Contents

G2 Decoder - rev10
Shielded Cable
Test Diode
This Manual

G2 Decoder Connections



TM3 - Battery and Motor Terminals

- #1 Battery Positive (+) Input
- #2 Motor Terminal A Out
- #3 Motor Terminal A Out
- #4 Motor Terminal B Out
- #5 Motor Terminal B Out
- #6 Ground for shielded cable
- #7 Ground for shielded cable
- #8 Battery Negative (-) Input

J1 Jumper

Normally, this jumper remains across the posts and the Auxiliary DCC driver output voltage is the same as the motor drive voltage.

If the jumper is removed, a lower voltage can be used for the DCC output voltage and the lights. The power source for the DCC voltage is hooked up to TM2, pin 8 - see page 9.

TM2 - Function Outputs

- #8 Lamp common plus
- #7 Same as pin #8
- #6 Rear Backup light } [CV60]
- #5 Front Head light }
- #4 FnB Output [CV62]
- #3 FnA Output [CV61]
- #2 Auxiliary DCC Output B
- #1 Auxiliary DCC Output A

The bracketed CV# is the configuration variable that allows you to customize the output. This is described in the CV customization section.

Split Board Location

The closely spaced holes allow the board to be cut apart for mounting in unusual spaces.

Split Board Sockets - SK2, SK1

Connect optional split-kit cable between SK1 and SK2 to join a split board.

Frequency Selector

Selects one of 8 operating frequencies. Must match the frequency of the throttle.

TM1 - External Selector Switch Pads

An optional external frequency selector switch may be connected here see page 10.

Antenna

The standard antenna is a short piece of #18 gauge stranded wire. Do not cut or change the length of the wire since this will restrict the range. Best orientation is perpendicular to pcb.

Warning

The G2 wiring is different than the original AWD10SS decoder. Failure to correctly hookup the G2 decoder will cause unusual operation or complete failure.

Power Through The Rails - Some Considerations

The G2 decoder is designed for battery powered operation. Although power can be supplied through the rails, we do not recommend it. If you plan to use something other than batteries, consider the following points before your final decision.

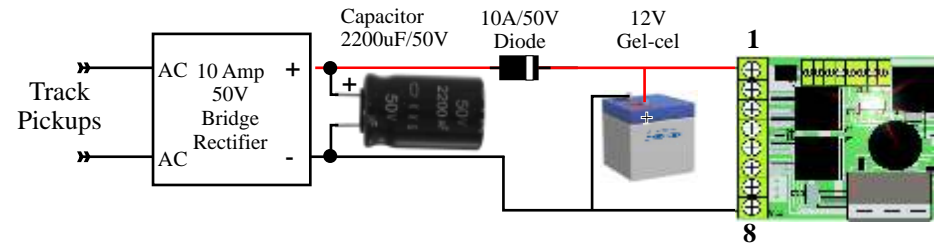
Clean wheels and clean track are mandatory if power is not supplied by batteries. Battery powered outdoor locomotives never need to have wheels cleaned and never need to have the track cleaned. Don't let anybody fool you into thinking they never clean track. It is not always dirt that causes problems. Sand, mud, bugs, leaves, grass and all other manner of detritus will cause track pickup problems. If your friend has not cleaned track, don't worry, they will have to eventually.

Electrical safety is compromised the moment you replace batteries with power derived from household power and feed it onto the rails. Do you know about and how to use a Ground-Fault-Interrupter? If not, stay with batteries - battery power is the safest form of power in the garden railway.

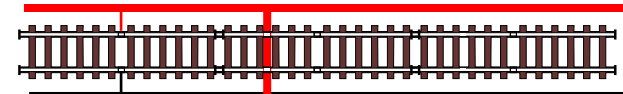
Wiring the railroad becomes a long and boring chore. If you use battery powered locomotives, your wiring job reduces down to connecting the decoder to the motor; simple and quick. There is no need to worry about reverse-loops, turnout wiring, dead frogs, opposing point switch wiring, route control wiring and the many other wiring requirements related to properly powering locomotives through the rails.

However, if you insist, then here is the hook up diagram and the required external components to allow the G2 decoder to draw DC power from the battery AND the rails. Don't forget that the motor must still be disconnected from the track pickups and wired directly to the decoder output.

To power the rails, use a well regulated DC power supply for best performance under varying load conditions. If you are using 12V gel-cel batteries **ONLY**, then the DCPS120 power supply can charge the gel-cel battery. Be sure and feed the DCPS120 from a GFI protected outlet. Set the DCPS120 power supply to 15 volts. This will provide sufficient voltage to charge the lead-acid gel-cell battery. This charging technique will not work for any other battery type.



Track Bus Wire - #10 AWG or Larger



All standard wiring requirements apply including proper handling of reversing loops, power blocking, and bus feeds to each section of track. This is not a trivial task!

The DCPS120 Power supply is a 120 Watt, adjustable DC power supply with excellent load regulation. The output voltage is variable from 15V to 24V. It has built in overload and short circuit protection. It is available direct from CVP Products and the price is \$55 not including shipping and handling.

Hot Climate Operation and Derating *continued*

Improve Air Flow

Although locomotives and cars have many openings for air to enter, the addition of more vents on the bottom and in the roof will greatly aid heat removal. For diesels, consider opening up the grid and radiator fan housings especially if they are simply cast on. Drill additional holes in the floor. Also consider removing plastic windows, especially if the locomotive is small and the decoder is in the cab. Small muffin fans, running on 12V will help considerably providing there is room for them. Be sure and use low current fans, to minimize the battery drain.

Lower The Battery Voltage

Since the power dissipated by the decoder is based on the motor current and battery voltage, a lower voltage battery will significantly lower the maximum heat generated. You'll also find that the batteries last longer. Yes, the top speed will also decrease but not by much. On hilly layouts, the use of multiple locomotives in a consist is much more efficient than a single locomotive, running at maximum power, straining to make it up the grade.

Derating Maximum Output Current In Hot Climates

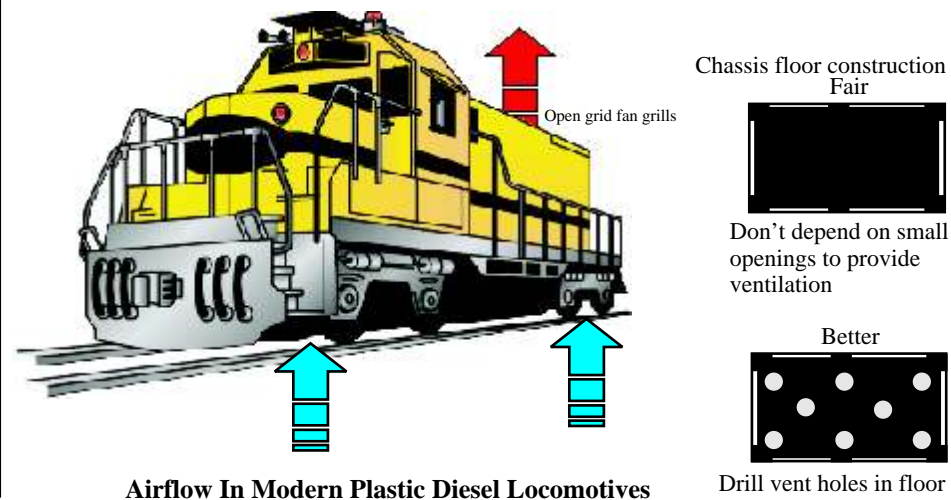
High outdoor temperatures will result in hot interior temperatures even when there is good airflow. The G2 output current is limited to a rather high value based on the temperature of the drivers. If the drivers overheat, through excess motor current or because of a hot interior, the devices will shut down to protect themselves.

A good rule of thumb is to derate the available current by about 1 Amp per 10 degrees of temperature increase above 80 degrees. For example, if the outdoor temperature is 100 degrees, the maximum allowable current should be decreased by about 2-3 Amps. The motor drive current should not exceed about 8 Amps under any conditions.

G2 Decoder Thermal Fault Clearing

Should the thermal overload protection trip on the motor drivers, turn off the power and allow the drivers to cool. Once cool, the power can be turned on and operation resumed.

If the thermal protection trips on the DCC Auxiliary drivers, the buzzer will sound. Resetting is automatic and does not require the power to be turned off. However, you should improve the air flow since this is the decoder's way of saying that it is too hot.



Airflow In Modern Plastic Diesel Locomotives

Before You Begin: Installation Considerations

Do Not Use The Locomotive's Internal Circuit Boards - Do not attempt to use any of the loco's built-in circuit boards for wiring and connections especially to the motor. This is one of the most common causes of decoder damage and or failure of the constant speed feature. Remove the boards and install the motor wiring exactly as shown in this manual.

Battery Chemistry and Battery Selection - The more exotic the battery chemistry, the lighter and smaller it will be compared to a gel-cel battery having the same energy capacity. However, unlike a gel-cel, the new battery technologies are much more sensitive to poor charging. The battery will also be much more expensive. The matching charger will also be more expensive. However, when properly used and charged with an appropriated charger, the batteries will have a long lifetime.

The Li-ion and NiMH batteries can be purchased from an on-line store specializing in RC cars and airplanes. Be sure to obtain the matching charger.

Fusing The Battery - always use a fuse in series with the battery. Large batteries can supply an astonishing amount of energy into a short circuit. If small diameter wire is used and a short circuit occurs, the wire will instantly become a heater element and melt the insulation from the wire.

Always Use a Power Switch Between Loco and The G2 - The use of a power switch will insure that the battery is not discharged by the decoders. A second power switch is highly recommended between any other decoders and the auxiliary DCC outputs.

Lower Battery Voltage Is Better - Lower voltages mean the motors and electronics run cooler. There is also a remarkable increase in effective reception range since lower motor voltage results in less electrical noise. For hilly railroads, consider the use of multiple locomotives on a train. Not only will the batteries have a longer life, but the G2 decoder will run much cooler.

Motors Are Electrically Noisy - Use the included shielded wire to connect the decoder to the motor(s).

Beware of Excessive Heat Buildup - The decoder should be placed in a location where it can receive some airflow for the large transistors. These will become warm to very hot depending on the battery voltage and motor current. Never cover the transistors or the board.

Antenna Location - The antenna should be vertical and can be bent such that it remains vertical if the board is mounted on its side. Keep the antenna away from anything metal. Also, the antenna should be kept away from motors and the battery wiring. For longer range, an optional longer antenna is available. See the back page for ordering details.

Old AirWire Motor Filter Capacitors - The 10 ohm resistor and 0.1uF capacitor supplied with CVP's older AirWire Decoder are not necessary with the G2 and should not be used.

Incorrect operation of the constant speed feature will occur if there is other circuitry, including lighting circuit boards, connected to the G2 motor terminals. Only motors can connect to the G2 motor terminals.

G2 Decoder - Absolute Maximum Ratings

Maximum Input Battery Voltage 28 Volts DC

Minimum Input Battery Voltage..... 10 Volts DC

Maximum Motor Output Current - Pulse Internally Limited ~ 18A peak

Maximum Continuous Motor Output Current ... ~ 8Amps at 25°C @ 15V

Maximum DCC Auxiliary Output Current 3Amps

Maximum Headlamp Output Current..... 1Amp

Maximum FnA, FnB Output Current 1Amp

Battery Wiring And Polarity Verification

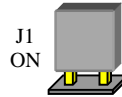
Warning: Installation of the AirWire decoder does not require special tools. However, you should be comfortable with soldering and have a general idea of how your locomotive is wired, as it comes from the factory. If you are at all uneasy about these procedures, your dealer can suggest installers who can do the job for you.

Each of the following sections describes the connection of various terminals on the G2 decoder. Use these diagrams as a generic guide to the connection of the G2 decoder to your locomotive.

Use #18 AWG wire all battery connections. For improved radio reception, tightly twist two differently colored wires together using an electric drill. Always use two different colors of wire. All naked wires must be insulated with tape and/or heatshrink tubing. First, hook up all of the battery minus wires. The battery negative wires are colored black. Next, hook up the battery plus wires which are colored red.

Always include a power switch and a fuse in every installation. The power switch is used to disconnect the battery from the locomotive. In some cases it is also used to select either the run mode or the charging jack. A 10 cent fuse protects the battery against catastrophic failures caused by improper wiring.

J1 Jumper Must Be Across Posts - Before testing polarity make sure J1 is across the two posts.

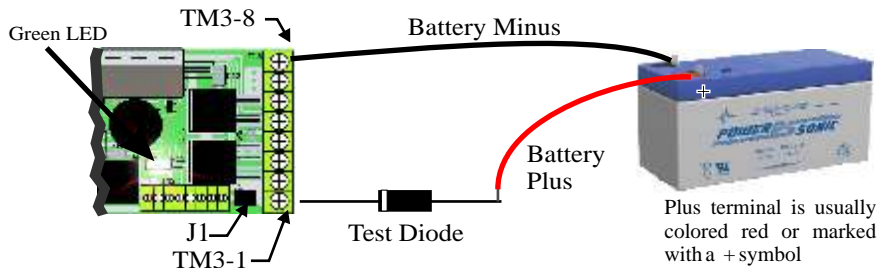


Polarity Verification - one way to quickly end the life of the G2 decoder is to connect up the battery with the plus and minus reversed. Included with the G2 decoder is a small polarity testing diode that is used to verify that you have the plus and minus leads properly identified before you connect them to the decoder.

TM3 is the large 8 pin terminal block on the end of the G2 board. Pin 8 is the top right pin when the terminal block faces to the right as in the picture. Terminal strip references are shortened to the terminal designator, either TM2 or TM3 and a specific pin number. For example, TM3-8 is where the battery minus always connects. Before using the diode, first connect the battery minus lead to the decoder's TM3-8. This must be done for the test to work.

TM3-1 is where the battery plus always connects. Insert the banded end of the diode into TM3-1. No need to trim the leads, since it will only be attached for the duration of the test. Touch the battery plus lead to the non-banded end of the diode. If the G2's bright green LED turns on, then the polarity is correct. However, if it does not turn on, inspect for reversed or broken wires.

DO NOT PERMANENTLY CONNECT THE PLUS WIRE without the diode, until you can make the LED turn on with the test diode. Once the polarity is verified, remove the test diode and connect the battery plus wire to TM3-pin1.



The test diode is not suitable for permanent installation. It can not handle the high motor current and will fail almost instantly.

Heat and Hot Weather Tips -Managing Heat Build-up!

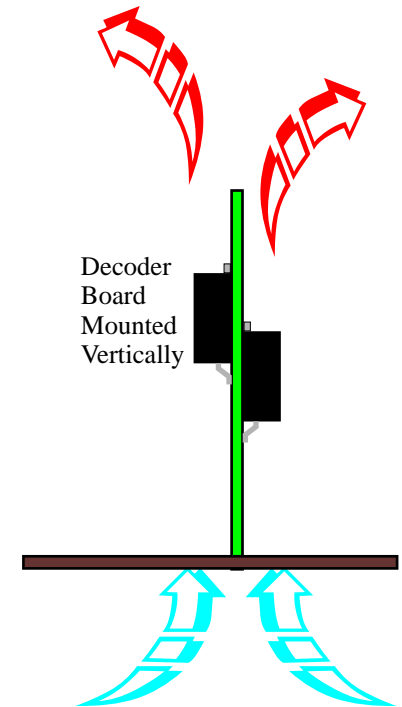
When operating the G2 decoder near its maximum current capacity, the decoder can become as hot as a 100 Watt light bulb. Since most decoders are mounted inside plastic locomotives and rolling stock, the interior temperature can reach harmful levels leading to decoder shutdown unless this heat is removed. In addition to the heat generated by the decoder, a hot climate can also cause heating of the car's interior which adds to the problem. Fortunately, minimizing the heat buildup is relatively straight forward and takes advantage of the fact that hot air rises.

Mounting Tips

Never wrap the decoder in insulating material. Never cover or coat the decoder with RTV adhesive. Not only will this cause heat build up, but almost all adhesives are conductive, especially when uncured.

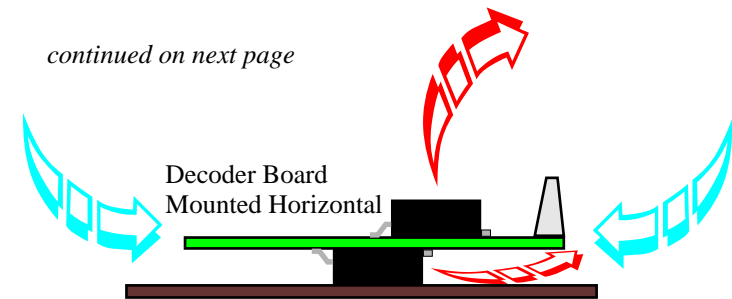
The decoder should be mounted such that the power transistors are open to free air movement. If at all possible, allow the transistors to be near an opening in the chassis or car floor. Cool air will be pulled towards the transistors as the hot air rises away from the decoder.

Although horizontal mounting is OK, the bottom power transistor's heat flow is obstructed by the circuit board. If possible, mount the decoder vertically such that both sides of the board are unobstructed.



Vertical board mounting allows better airflow

continued on next page



Mounting the decoder horizontally is OK but the airflow is blocked by the board itself

Building Your Own Battery Packs

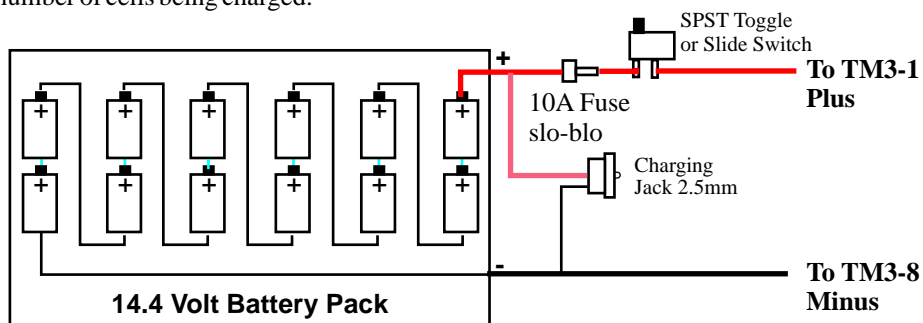
“Sub-C” rechargeable batteries, available from the supplier listed on the battery sources page, can be wired together to make a great battery pack. These cells come in different amp-hour ratings and sizes. Always select cells having the same amp-hour or milli-amp hour rating. NiMH or NiCad sub-C cells are rated at about 1.2V.

To determine the number of batteries for a specific motor drive voltage, divide the desired motor drive voltage by the cell rating which is 1.2 volts. Round up any fractions. For example, a 14.2 volt pack will take 12 cells.

Be sure to obtain a charger capable of charging the number of cells in your home made pack. The greater the number of cells, the more expensive the charger.

Connect the cells in series, elephant style, with the positive end connecting to the next cell's negative end. Wrap the cells with plastic tape to hold them together.

Be sure and use a switch and a fuse. Verify that you have the appropriate charger for the number of cells being charged.

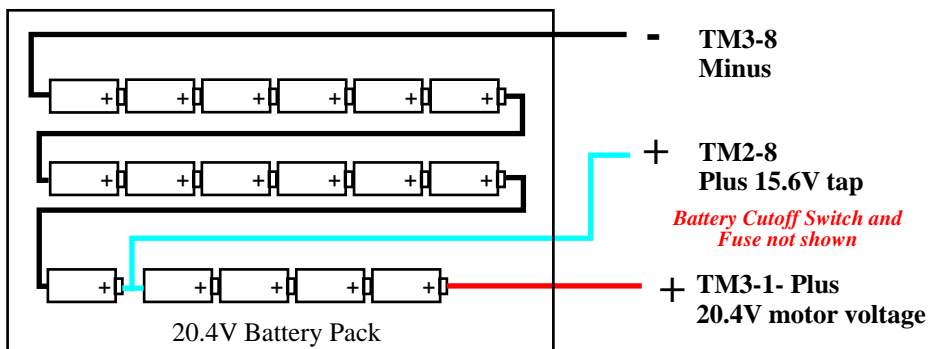


Building A Split Supply High Voltage Pack

A single large battery pack can be built. Just add a tap at the desired point to feed the low voltage input. Determining the number of cells is the same as for a low voltage pack.

The low-voltage tap may be placed at any location that provides between 9 and 16 volts. The most common reason for using a higher voltage tap is to allow higher sound volumes for the auxiliary sound decoder. However, the safe limit for most sound decoders is 16 volts. The example shows a 17 cell pack with a tap at the 15.6V location (13 cells x 1.2V).

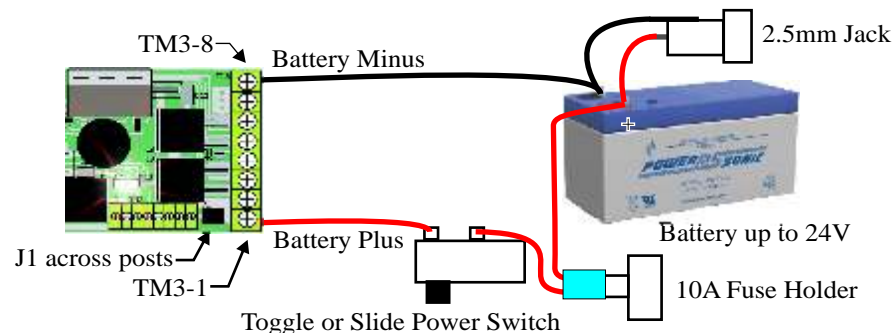
The fuse, switch and charging jack are not shown for clarity. Be sure to include them.



Single Battery Connection

This is the easiest hookup since there is only a one voltage supplied by a single battery or multiple batteries connected in parallel. The drawing shows a single battery. Make sure that jumper J1 is across the posts.

The 2.5mm jack is for the battery charger. See the section on chargers, batteries and jacks for more information.

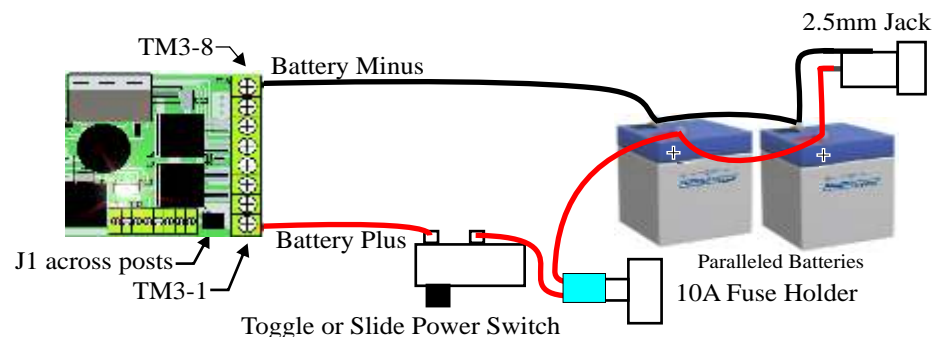


Parallel Battery Connection

Parallel batteries extend the running time but maintain the same motor voltage. Both batteries must be matched in both capacity and chemistry. Do not mix two different battery voltages. You can parallel as many batteries as you wish.

Hookup is easy - just add another battery in parallel with the first battery. Parallel means the two battery plus terminals hook together and the two battery minus terminals hook together.

When purchasing a charger, make sure the charger can handle the higher charging current of paralleled batteries. For example, two 12 volt gel-cel batteries are paralleled and each has a 2.2Ahr rating. Ahr means Amp-hour and is a measure of how much current can be continuously drawn from the battery for one hour before the voltage begins to decline. Thus, for this example, the charger needs to be rated to handle 4.4Ahr batteries or higher.



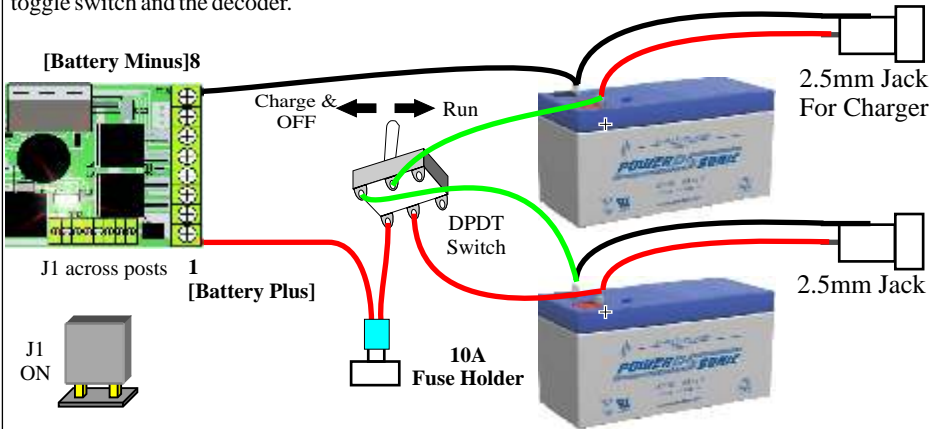
**Do not mix different battery chemistries.
Paralleled batteries must have the same voltage and chemistry.**

Series Battery Connection For Higher Voltage

The G2 Decoder will accept up to 28 volts as the source power. For example, two 12 volt gel-cel batteries, when connected together, will generate about 26 volts when fully charged. This is OK and is within the rating of the G2 decoder. Jumper J1 is across the posts for this application. There are some down sides to using higher voltages. See the section on maximizing range for some considerations.

Be careful not to exceed the 28V rating since this will activate the over-voltage protection on the auxiliary DCC drivers which will sound the warning buzzer.

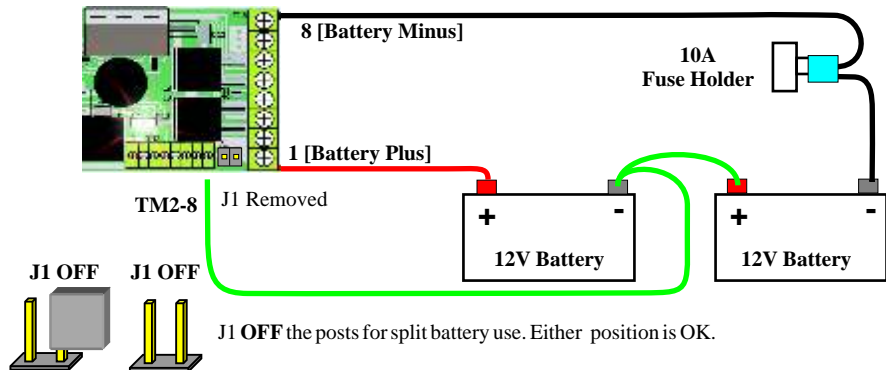
Use #18 AWG wire to connect the two batteries in series. Always solder and then insulate the connections. A single charging jack can be used but now you must purchase a programmable charger that can handle the higher charging currents and the higher voltage of the series batteries. An alternative is to install two charging jacks and a "cutout" switch that disconnects the two batteries. You can charge each battery separately or use two chargers. The drawing shows the wiring using the cutout switch that also serves as a master power switch. A 10A fuse should be inserted between the toggle switch and the decoder.



Using A Center-Tapped Battery - J1 Must Be Removed

In the rare case where you must use a lower voltage for older DCC sound decoders, or you want to have a lower voltage for lamps, then a pair of batteries with a center-tap is what you want. For easiest wiring and charging, both batteries should have the same voltage.

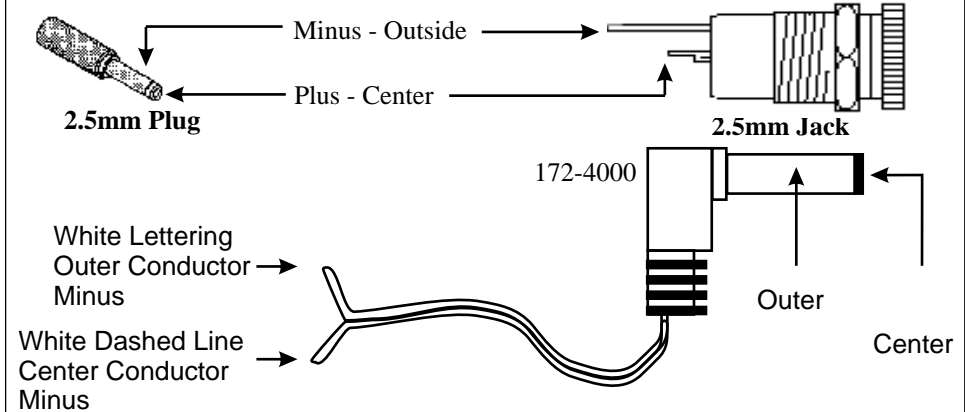
To use a center-tapped battery, **you must remove the J1 jumper**. This separates the auxiliary drivers from the motor voltage. For the example below, the motor will receive the full 24 volts, but the auxiliary DCC driver will have a peak voltage of only 12 volts. The power switch is not shown in this drawing. To use a single fuse, insert it between TM3-8 and the battery negative.



Wiring Accessories - Plugs, Jacks and Cord Sets

From the Mouser Catalog - www.mouser.com

Description	Part Number
72 inch cord, 20 gauge wire with right angle 2.5mm plug	172-4000
72 inch cord, 18 gauge wire with straight 2.5mm plug	172-4001
2.5mm threaded metal jack with long shank	163-4026
2.5mm snap-in jack (thin wall plastic only)	163-1061-EX
2.5mm threaded metal jack with short shank	163-4025
2.5mm plug (for making your own cord)	1710-2510



Recommended Battery and Charger

14.8V, 4400mAh Lithium Battery - We searched high and low for a suitable battery along with a matching charger at an affordable price. While you are not required to use our recommended battery pack and charger, they offer the best compromise among many factors such as safety, power, size, weight, voltage, motor noise and lifetime. Besides, they are the ones we use for all of our locomotives. The battery pack and charger are available directly from CVP Products. They are shipped via FEDEX ground or UPS ground only.

This small, lightweight battery packs a lot of power into a small and lightweight package. It can power a USA-Trains SD70 for more than 2 hours.

With its built-in protection circuitry and its automatic cutoff at the end of the charge, this battery offers long life, high capacity and nearly constant output voltage over the life of the charge.

The dimensions are 68mm x 72mm x 36mm. It weighs about 12 ounces.

Low Cost, Universal Input, Smart Charger - The charger works off any household line voltage from 90 to 240V 50/60Hz. The built in microprocessor will automatically cut off power when the battery is fully charged. Indicator lights show red when charging and green with the battery is fully charged. Included with the charger are a pair of spare fuses along with the appropriate connectors.



Download the latest AIRWIRE catalog for current pricing and special deals

Batteries, Chargers And Application Tips

Battery Cars - There is plenty of room for the decoder in a locomotive but the battery installation can be tricky. For your first installation, we recommend the use of an external car to hold the batteries. Battery cars are a convenient and easy way to power your locomotive. A battery car contains only batteries, perhaps an on/off switch and a jack to which the locomotive is connected. A fleet of battery cars allow some to be charging while others are being used. Because of the large amount of empty space in box cars, several batteries may be paralleled for longer running time. Also, the jack used to connect the locomotive to the car, is the same jack used to connect the charger. Although not essential, we recommend the use of an in-line fuse for protection against an accidental short circuit. Make sure the fuse is rated at 10 Amps and it should be a slow-blow style. The CVP fuse kit FK9 includes a 10 amp slo-blow fuse.

Charging Batteries in a Battery Car - The easiest way to connect a charger is to use the same size plug that the locomotive uses. The Power-Sonic Charger comes with alligator clips. Cut them off and attach a 2.5mm plug. The charger output is polarized. Make sure the wire to which the red alligator clip was attached is soldered to the plug's center pin.

Plugs - Cables - Jacks For Charging - Mouser Electronics has a wide assortment of cables, plugs and jacks and we routinely use the Kobicon 2.5mm family. However, any size may be used. The cable with the molded plug is our favorite because it is pre-built and ready to use. All cables are 24AWG which may seem small but is OK for the relatively short distances between a car and the locomotive. The illustrations show the straight and right angle cords with the center conductor identified.

Batteries and Battery Sources

Sealed Lead-Acid Gel-Cells

For simplicity, sealed, lead-acid 12 volt gel-cells, are mostly used as the power source in this guide. However, nearly any type of battery can be used. Gel-cell batteries come in a variety of sizes and are easily obtained. The following 12 volt Power-Sonic gel-cells are from the **Mouser Electronics** catalog 800-346-6873 or www.mouser.com for online ordering. Pricing updated June 2009.

<u>LxWxH (inches)</u>	<u>Part number</u>	<u>Rating</u>	<u>Price</u>	<u>Connector</u>
7.01 x 1.34 x 2.36	547-PS1220	2.5Ahr	\$24.21	0.187" Faston
7.01 x 1.34 x 2.36	547-PS1229	2.9Ahr	\$34.54	0.187" Faston
3.54 x 2.76 x 3.98	547-PS1250F1	5.0Ahr	\$21.62	0.187" Faston
3.82 x 1.62 x 2.00	547-PS1212	1.4Ahr	\$21.16	0.187" Faston

A matching battery charger is also available from Mouser; part number 547-PSC-12500A-C and sells for \$30.49. It plugs into a wall outlet and has screw-type terminals. Depending on your battery installation, you can use the charger as is or add a standard 2.5mm DC power plug and matching socket on the locomotive for easy connection. This charger is rated 12VDC at 500mA. Using this charger, a 2.0Ahr battery will be fully charged in about 4 hours.

NiMH, Lithium and other Exotic Chemistry Batteries

Although these batteries provide higher levels of current and can be physically smaller, they are more expensive. In addition, the proper charger must be used or the battery life will be considerably shorter. If you have an interest in exploring the use of these batteries, visit the website of "Only Battery Packs" at the following link. This company offers a large variety of pre-built battery packs, chargers and individual cells to build your own packs.

www.onlybatterypacks.com

ONLYBATTERYPACKS

N88 W16475 MAIN STREET, SUITE 200
MENOMONEE FALLS, WI 53051 (262) 255-1615

Decoder to Motor Hookup

Using Locomotive's Factory Wiring

The factory supplied wiring inside almost all locomotives is simple, untwisted stranded wire. Connections are made using cheap locking plastic plugs and slip on mechanical connectors. Locomotives running outdoors suffer from extremes of hot and cold as well as a lot of vibration. After only a single season, it is common for electrical contacts to corrode and mechanical contacts to work loose. Therefore, since the locomotive needs to be rewired anyway, why not consider replacing the wiring and connectors with higher quality shielded wire (included with the decoder) and soldered connections.

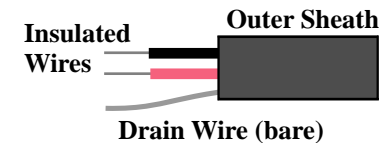
Using the Included Shielded Cable

The decoder comes with about 2 feet of shielded, small diameter, two-conductor twisted cable in a black plastic sheath. This shielded cable replaces the existing motor wire and connects between the decoder and the motor brush terminals. Do not use it to hookup the battery.

For typical applications, the shield wire, also called the drain wire, is attached to the decoder terminal strip but not to the motor itself. The drain wire is cut off right at the end of the sheath at the motor end. Only the two insulated conductors actually tie to the motor. At the decoder, make sure the drain wire does not come in contact with any other wires. Consider covering it with some tape or heatshrink tubing.

Cable Preparation

Carefully strip back the outer sheath to expose the three wires. The black and red wires hook to the motor. The bare wire is connected to the inner foil shield bonded to the plastic sheath. The foil usually comes off when the outer sheath is stripped off. The three wires should be long enough to be stripped back about 1 inch and connected to the decoder's motor output terminals without too much strain. Note that the drain wire is bare and does not have any insulation.



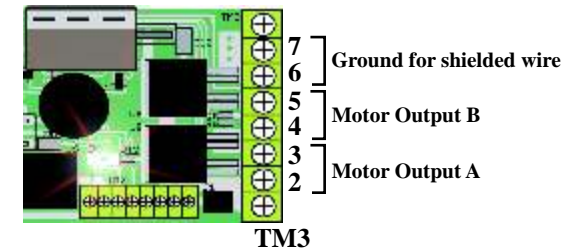
One at a time, for each of the inner conductors, strip back the insulation, twist the conductor's strands together and tin them using your soldering iron. Also, twist and tin the drain wire.

To tin wires, touch the soldering iron to the wires and hold it for a minute to get the wires hot. Touch solder to the junction of the iron and the wires. The solder will flow around the strands, locking them together.

G2 Decoder Motor Output Terminals on Terminal Block - TM3

There are 2 pairs of terminals that connect to the motor. The motor always requires a connection to an A terminal and a B terminal to run.

Either of the two sets of As or Bs may be used. The two A terminals are tied together and so are the two B terminals.

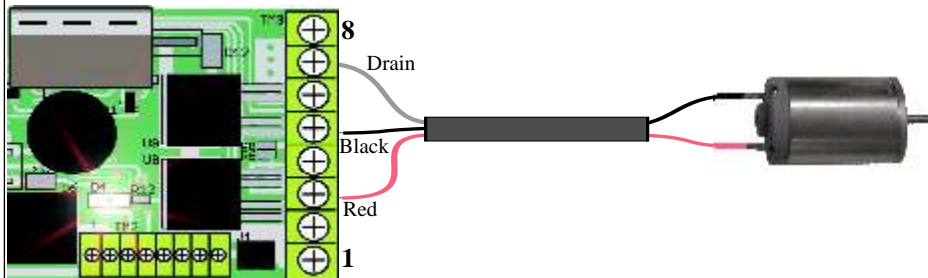


Extra ground connections are at TM3- terminals 6 and 7. These are common with the battery minus terminal, TM3-8 and are used for the drain wires of the shielded cable.

Single Motor Connection

After disassembly of the locomotive, locate the motor brush wires: In the case where the motor is mounted on the truck, there are usually 4 sets of wires. Two will go to the motor and two will go to the track wipers. Only the 2 motor wires are needed and the track wipers should be removed. Also make sure the motor wires are disconnected from any electronics that may be inside the locomotive shell. Some motor brush power connections may be tricky, like a spring or interference fit with part of the chassis. Some locos pick up brush power from the chassis through a spring. Examine the loco carefully to determine how power moves from the track pickups to the motor.

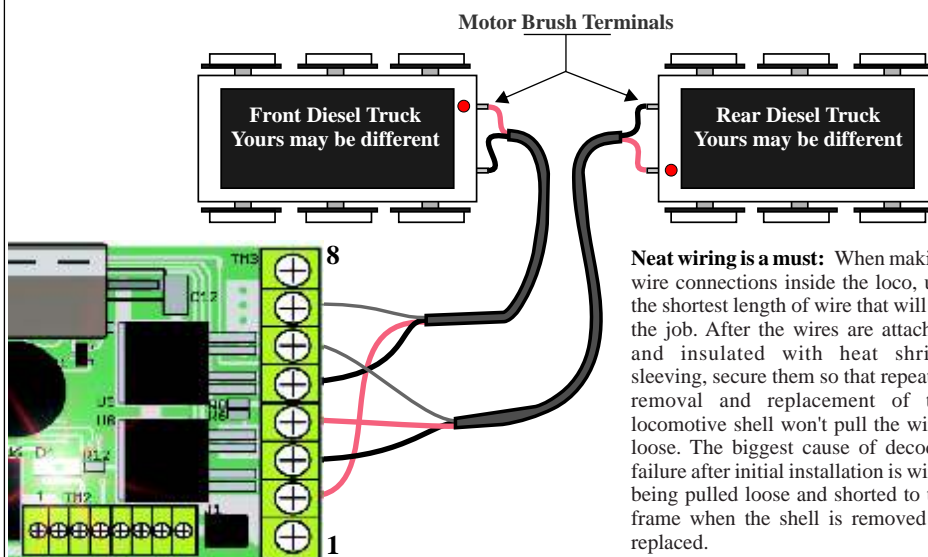
When inserting the stripped and tinned wire, the bare wire should just be barely showing outside the terminal clamp. If you can't see the bare wire, the clamp might contact the insulation resulting in poor connection. If the bare wire is too long, it might short out adjacent wires. Fasten the wires out of the way and make sure the trucks can rotate freely.



Locomotives with Two Motors

The only difficulty with two motors is that you might accidentally hook one of them up backwards. Before closing up the locomotive, verify that the motors are both going in the correct direction. As shown in the drawing, most manufacturers will label one motor terminal with a colored dot for reference.

Should you find one motor going the wrong direction, reverse the appropriate motor.



Customizing Decoder Performance With CVs *continued*

CV60 - Headlamp Mode [0]0,1,2,3 The default operation, with CV60=0, is for the two headlamp to be in autoreverse mode. When the headlamp is turned on, the throttle's direction key determines which lamp is on. Normally, the headlamp follows the direction key so forward direction turns on the front headlamp and when in reverse, the rear headlamp is turned on. The table shows the other 3 modes for the operation of the headlamps. In all cases, the headlamps are turned on and off with the throttle's 0 key.

CV60	Headlamp Operation	
0	Default auto-reverse	Forward = front lamp on, Reverse = rear lamp on
1	Reversed auto-reverse	Forward = rear lamp on, Reverse = front lamp on
2	Front lamp always on	Direction change is ignored
3	Rear lamp is always on	Direction change is ignored

CV61 - Function A Output Map [0]0 to 12 The selected value is used to set which throttle key turns on the function output. The default value of 0 disables this function and it will not respond to any throttle key. A value of 1 selects the throttle's function 1 key to activate the output; a value of 2 selects the throttle's function 2 key and so on, up to function 12.

CV62 - Function B Output Map [0]0 to 12 The selected value is used to set which throttle key turns on the function output. The default value of 0 disables this function and it will not respond to any throttle key. A value of 1 selects the throttle's function 1 key to activate the output; a value of 2 selects the throttle's function 2 key and so on, up to function 12.

CV63-Cruise Control Activate [6]1 to 12 The cruise control or BEMF feature is normally activated with the throttle's 6 key - function 6. However, if you wish to use another key, program CV63 with the desired function number. A value of 1 selects the throttle's function 1 key to activate the output; a value of 2 selects the throttle's function 2 key and so on, up to function 12.

Table Of All G2 Decoder Configuration Variables

CV#	Definition	Range/Notes	Default
1	Locomotive Address	Range from 1 to 9999	3
2	Motor Starting Voltage	At first speed step	0
3	Acceleration Rate	ACCL	1
4	Deceleration Rate	DECL	1
5	Maximum Voltage	Vmax	0
6	Mid point motor voltage	Vmid	0
8	Reset to factory defaults	RESET	n/a
11	Loss of Signal Timer	Packet Timeout	0
17	Extended Address	Automatic - do not use	0
18	Extended Address	Automatic - do not use	0
29	Decoder Setup	Various Options	2
56	Motor bump value	Bump value	10
57	Motor bump frequency	0=off, 1=60Hz	0
58	Cruise Mode Select	Select auto or manual	0
59	Cruise Buzzer	Buzzer Action during cruise	0
60	Headlamp Options	Headlamp vs Direction	0
61	Function A Map	Function key activation	0
62	Function B Map	Function key activation	0
63	Cruise Mode Activate	Function key activation	6

Customizing Decoder Performance With CVs *continued*

CV 56 - Motor Bump Value [10] 1-255 This value sets the amount of momentary motor voltage increase, called a bump, applied at each speed step. This value helps break the static friction (stiction) of the motor and helps it begin rotating at a lower voltage and/or a lower speed step. When the bump occurs, the motor sees a higher average voltage. When the bump is not present, the normal speed-step derived voltage drives the motor. In a way, it “bumps” the motor up to a higher value and then returns to the normal motor voltage. A value of 0 turns off the motor bump. A value of 128 will literally apply half of full speed to the motor in a short burst. Since the bump is momentary, it has a different effect than the motor starting voltage (CV2) which is a constant, fixed amount.

CV57 - Motor Bump Rate [0] 0 through 31 This value selects from among a set of frequencies at which the bump value, in CV56 is applied to the motor. A value of 0 disables the bump. A value of 1 sets the frequency to 60Hz; a value of two sets it to 30Hz, a value of 3 sets it 15Hz, 4=7.5Hz, 5=3.75Hz and 6=1.8Hz. Low frequency values are not very useful although you can experiment and see if you like the effect.

CV58 - Cruise Mode [0] 0 or 1 Cruise control is just like your car’s cruise control. Once activated, the locomotive will maintain the same average speed independent of the load or the terrain. It will cruise up hill and down hill, as well as snake through tight curves and turnouts at the same speed. There are two cruise control modes from which to select.

Cruise Mode 0 is selected by setting CV58 to a value of 0 which is also the factory default value. Mode 0 is easy to use. Once the train reaches the desired speed, push F6 on the throttle to enable cruise. The decoder’s buzzer will beep once to tell you it has enabled cruise mode. Any change of the throttle’s speed knob, up or down, or if you reverse direction, this will turn off cruise control. Two beeps of the buzzer tells you the cruise mode is turned off. To reactivate it, simply press F6 again.

Cruise Mode 1 is slightly different. This mode is selected by setting CV58 to a value of 1. As with the other mode, push F6 to enable cruise mode. However, in this mode, you can make changes to the initial speed using the throttle. You may increase or decrease the speed. Taking the throttle to 0 or reversing the direction will turn off cruise mode. To turn it back on, just push F6 again.

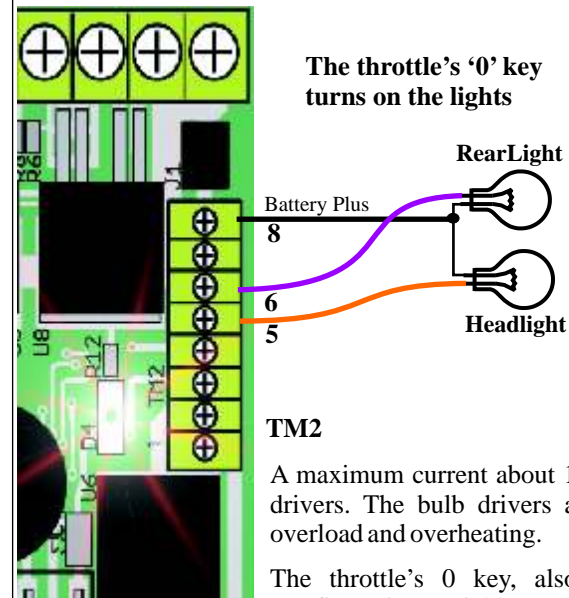
F6 activation will not be accepted at very slow speeds or at full speed. If F6 is pushed and the speed is out of range, it will beep twice to tell you the mode was rejected. In 28 speed step mode, the lowest speed step is 5 if there is no MSV and no motor bump. Using either of these features may allow a lower speed step to be accepted when F6 is pushed.

CV59 - Cruise Buzzer [0] 0 or 1 This CV allows the buzzer to be disabled when going in and out of cruise mode. A value of 0 enables the buzzer. Setting this CV to a value of 1, disables the buzzer sound when F6 is pushed. The buzzer will function normally for all other operations that use the buzzer.

Service Mode programming is the only form of programming understood by the AirWire decoder.

Service Mode programming will program both the AirWire decoder and the decoder connected to the auxiliary DCC outputs.

Headlamp Wiring



Terminal strip TM2, the smaller, 8 contact strip is where all of the lamp connections are made.

If using incandescent lamps, be sure the bulb voltage rating matches the battery voltage. Higher voltage bulbs can also be used for much longer lifetimes.

The headlight outputs are protected against overload and short circuits. Should either occur, the output will shut down. It will resume normal operation once the fault condition is fixed.

A maximum current about 1 Amp can be supplied by the lamp drivers. The bulb drivers are protected against short circuits, overload and overheating.

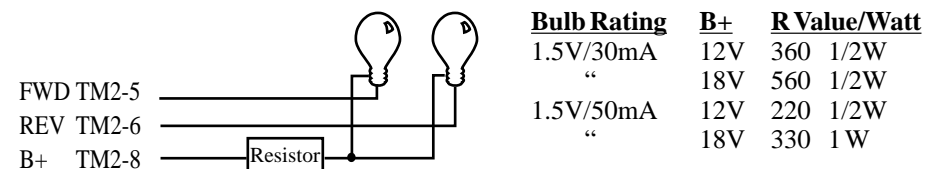
The throttle’s 0 key, also called F0, activates the lamps. Configuration variable (CV) 60 controls how the autoreversing feature is used - see page 29.

The headlight outputs are simple switches that apply full battery voltage to the lamps. Do not connect to your factory supplied locomotive lights unless you are sure the lamps have the same voltage rating as the battery. Small wires may be used since the lamp current is relatively low.

Multiple bulbs may be powered from a decoder’s lamp output by wiring the bulbs in parallel.

Select and use incandescent bulbs carefully. Inexpensive bulbs can run very hot and draw a large amount of current. This can result in damage to plastic and shortened battery life. For best results, consider using white LEDs. These have a much longer lifetime and do not drain the battery as quickly.

1.5 Volt Bulbs: Miniature, 1.5 volt bulbs must use a series limit resistor. A single limit resistor may be used as shown. This assumes that only one lamp is on at a time. Lower resistance values will increase the lamp brightness but shorten the life of the bulb. For best results, use the highest resistance compatible with bulb visibility. Always know the ratings of the bulb to be used.

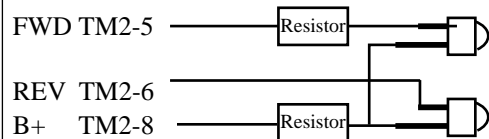


Using LEDs For Headlamps

Light Emitting Diodes - LED: These come in all colors including white. They are very bright, run cool and have a very long life. The LED operates from low voltage and always requires a series limit resistor. The value of the limit resistor depends on the battery voltage, the LED color and the desired brightness. Most color LEDs, are typically at full brightness with 20mA (0.02A) of current. LEDs are polarity sensitive and must be oriented properly to work. Lead length is used to indicate polarity. The longest lead is typically connected to the positive supply.

		Color	B+	R Value/Watt
FWD TM2-5		White	12V	460 1/4w
REV TM2-6		All others	12V	510 1/4w
B+ TM2-8		White	18V	750 1/2w
		All others	18V	910 1/4w

If you intend to have both front and rear lights on at the same time, two separate resistors of the same value should be used in place of the one common resistor.



The resistor calculation formula is:

$$R \text{ (in ohms)} = [\text{Battery Voltage}] - [\text{bulb voltage}] \div [\text{bulb current rating in Amps}]$$

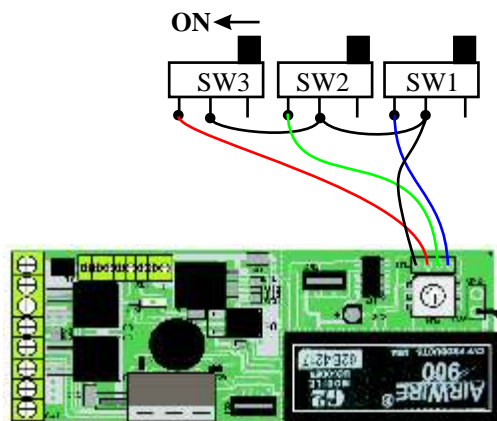
$$R \text{ wattage minimum} = R \times [\text{bulb current}]^2$$

Using Optional Remote Frequency Selector Switches

To allow the use of an external frequency selector switch, a set of terminals, TM1, are provided on the decoder. The simplest way to make connections is to use a length of 4 conductor ribbon cable. Keep the wire as short as possible and don't exceed about 6 inches. For simplicity, a set of 3 miniature slide switches are shown. However, any type of switch can be used including another rotary switch similar to the one on the board.

The onboard rotary switch must be set to setting #0 or the remote switches will not work.

FREQ#	SW1	SW2	SW3
0	OFF	OFF	OFF
1	ON	OFF	OFF
2	OFF	ON	OFF
3	ON	ON	OFF
4	OFF	OFF	ON
5	ON	OFF	ON
6	OFF	ON	ON
7	ON	ON	ON



Customizing Decoder Performance With CVs *continued*

CV 8 - Reset Loco to Defaults [n/a] n/a Sending a value of 135 to CV8 resets all CVs to the factory default value. This can be done at any time. Don't forget that the address is also reset to address 3, the default.

CV11 - Loss of Signal Timer [0] to 255 Determines the amount of time the locomotive will continue to run once the throttle commands are no longer received. There may be several reasons for this to occur. For example, you may have changed the throttle's address to control another loco. Or, perhaps the locomotive is out of range of the throttle or perhaps the throttle has been turned off. Divide the CV value by two to determine the number of seconds before the locomotive stops. For example, a CV value of 20 means the locomotive will stop 10 seconds after it no longer is receiving throttle commands. The default value is 0 which means the locomotive will maintain its last received command forever; the timer never "times out."

CV29 - Decoder Setup

CV29 - Decoder Setup [2] This is a multipurpose CV whose value sets several options at once. To use the table at the bottom of this page, select the line having the options setup that you wish to use. Load the CV29 value shown. Remember that the short or long address is automatically set when loading CV1 and should not be loaded manually.

Motor Direction: Allows the motor direction to be reversed from default. This is handy if you discover the motor runs in the wrong direction and do not wish to disassemble the chassis to physically reverse the motor wires. Changing the electrically reverses the motor wires for you. The default of "normal" makes TM3 pin 2 have a positive polarity.

Steps: Sets the decoder to provide either 14 or 28 speed steps from off to full power. The default is 28 steps. When the throttle is set to 28 speed steps, CVs 2 and 5 will affect the speed and top speed of the motor. If the throttle is set to 128 speeds steps, CVs 2 and 5 are not used.

Address: This tells the decoder if the address range is from 1 to 99 which is called a short address, or from 100 to 9999 which is called a long address. The default is a short address. When a long address is used, this value is automatically changed. To use this table, select the line that has the options desired and load the value into CV29.

CV29 options and settings

The factory reset default value for CV29 is 2 which selects the bold faced entries.

Address	# Steps	Motor Direction	CV29 Value	Notes
Short	14	Normal	0	
Short	14	Reversed	1	
Short	28	Normal	2	default
Short	28	Reversed	3	
Long	14	Normal	32	
Long	14	Reversed	33	
Long	28	Normal	34	
Long	28	Reversed	35	

Service Mode programming is the only form of programming understood by the G2 decoder.

Using CV5 and CV6

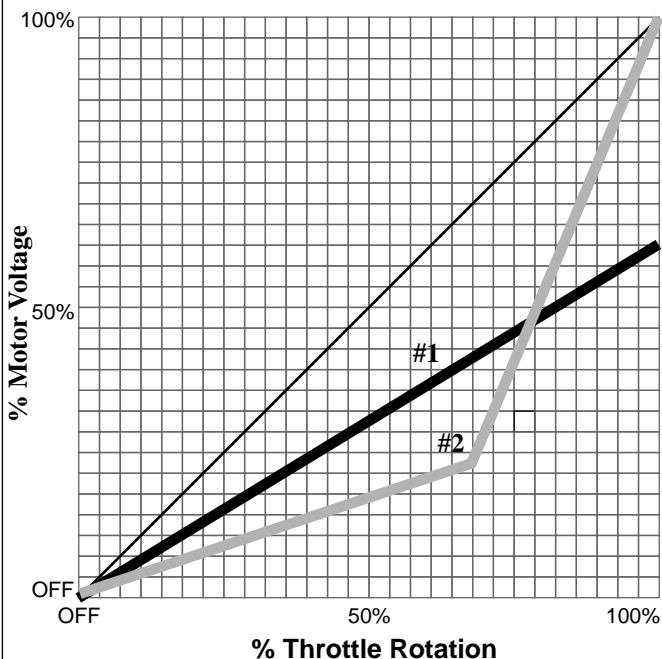
CV5 and CV6 set the relationship between the throttle position and the speed of the locomotive. Most users consider these two CVs to be the best ones with which to match the speeds of two locomotives that will be MU'd together. Experiment with these two CVs to become familiar with how they affect the performance of your locomotives.

CV5 is used to set the maximum top speed when the throttle is turned full on (100% rotation). CV5 is easy to explain as it simply changes the highest speed at which the locomotive will run when the throttle is turned full on. Curve #1 shows that the top speed will be only about 60% of full motor voltage when the throttle is full on.

CV6 sets the locomotive speed when the throttle is turned up only half way (50% rotation). Another way to think about CV6 is that it stretches out the slow speed control over a wider throttle range.

For example, the #2 curve shows that the locomotive speed is only about 25% of maximum even though the throttle is set at about 75% of full speed. Yet, it will reach 100% motor voltage when the throttle is turned full on.

The factory default for both CV5 and CV6 is 0 which means they have no affect and the throttle position to locomotive speed is a straight line from 0 speed to full speed. This is the thin black line on the graph below.



#1: Slow Speed Switching
CV5 = 160 CV6 = 0
 This sets the top speed to about 60% of maximum which is ideal for slow speed switching operations. CV6 is set to 0 which means it isn't used.

#2: Expanded Low Speed
CV5 = 0, CV6 = 190
 Using this setting allows the slow speed area to be stretched out beyond the 50% point on the throttle. This is handy for providing finer slow speed control without limiting the top speed at full throttle. CV5 is set to 0 which means it isn't used.

The thin line is the default linear speed curve when CV5 and CV6 are both 0.

Each throttle/decoder pair must be on a unique frequency so as not to jam other throttle/decoder pairs. Use the illustrations to ensure that the throttle/decoder pair have matching frequencies. Notice that the small arrow on the decoder's selector switch points at the frequency number. The frequency can be changed at any time and the new setting takes affect immediately. In the drawings below, the white square is the slider portion of the switch. For the T9000 throttle, use the frequency number from 0 to 7.

Note, if using a remote frequency selector, set the selector switch on #0.

Decoder	RF1300 Throttle	Decoder	RF1300 Throttle
Frequency 0 - 921.37MHz		Frequency 4 - 909.37MHz	
Use 0 when using remote selector			
Frequency 1 - 919.87MHz		Frequency 5 - 907.87MHz	
Frequency 2 - 915.37MHz		Frequency 6 - 906.37MHz	
Frequency 3 - 912.37MHz		Frequency 7 - 903.37MHz	

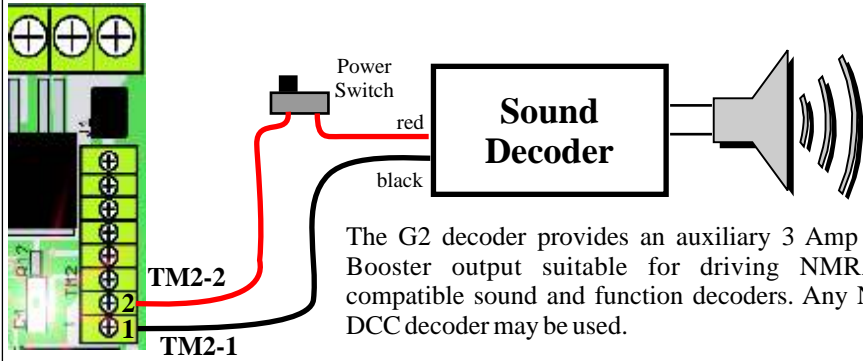
Beware of Other Transmitters

The AirWire receiver operates in an unlicensed band shared by many other transmitters. These transmitters can and will create interference, intermittent throttle operation or complete failure of one or more of your throttle's 8 frequencies. The sources of these external interfering signals can be from your own home or from adjacent homes and businesses. They can also be from other CVP wireless throttles and controllers.

Here's a list of devices known to have caused interference problems to AirWire900 equipment: wireless devices attached to computers, TV/Radio/Entertainment-center, remote controls, cordless telephones, alarm systems, baby monitors, unlicensed personal communication devices, lawn sprinkler controllers, remote starter switches, cordless light switches, outdoor lighting controllers, toys, wireless headphones, and games. Of course, if you have additional wireless throttles, make sure each is on its own frequency. Two throttles on the same frequency will jam each other.

If you find a strong interfering signal on one or more of your frequencies, don't use those frequencies. Simply select another, different frequency.

Using The DCC Booster Output



The maximum current output is limited to 3 Amps;

The DCC output voltage (track voltage) is set by the battery voltage;

The output is protected against over voltage, short circuits and over heating.

DCC Sound and Function Modules - Before using a DCC sound or multifunction decoder, check the manual or call the manufacturer to verify that it will withstand the battery voltage you will be using. Some older sound decoders, such as the Soundtraxx DSX are rated only up to 18 volts.

The simplest and lowest cost sound decoder is the DSX Sound Decoder from Soundtraxx. Simply connect the DSX red and black track wires, to the Auxiliary DCC outputs, pins 1 and 2 of terminal strip TM2. The sound decoder should use a separate power switch. Connect the purple wires to the speaker. *If the DSX doesn't accept programming, reverse the red and black wires.*

Addresses should be the same - In normal operation, the external sound or function decoder and the G2 decoder have the same address. When a throttle function key is pressed, such as F2, the command is sent to both the DCC sound decoder and the G2.

Use Service Mode programming and set both the G2 decoder and the external decoder to the desired address. See the throttle manual for detailed instructions.

Follow The Sound Module Instructions - Always follow the instructions supplied with the sound decoder.

Maximum voltage for a DSX sound decoder is 18 volts. Do not use this decoder if your battery voltage exceeds this rating. Use another brand or model that will work with your selected battery voltage. If you want to use a DSX, you must use a split supply battery configuration.

Programming Sound/Function Decoder Address

To program the external decoder's address, first connect the sound decoder to the G2 decoder. Set the frequency to match the throttle's frequency and turn on power to both.

Customizing Sound/Function Decoder CVs

Once the external decoder has its desired address programmed, you may now use OPS mode programming to customize the various CVs. Remember that you must always use the appropriate locomotive address in order to transmit the programming commands to the proper locomotive.

The G2 decoder is not affected by OPS programming directed to the external decoder's CVs.

Please refer to the appropriate sound/function decoder installation and operation manual for detailed instructions.

Customizing Decoder Performance With CVs

The G2 locomotive decoder is a combination radio receiver and motion decoder. How a locomotive operates and responds to throttle commands is based on unique performance characteristics stored inside the G2 decoder memory. These memory locations are called Configuration Variables (CVs for short). CVs can be programmed and re-programmed at any time - making them variable. The G2 decoder stores the CVs even with the power off. The G2 decoder operation is unique to the locomotive and the CV values you have stored in the decoder. Thus the locomotive performance is the same regardless of which throttle is used.

Each CV is discussed in this section. The bracketed number is the factory default value and the allowed range of values follows. You can decide to use the default or change it to a different value within the available range at any time. The changes are stored inside the decoder and are retained even if the battery is disconnected.

In case you get into trouble and totally mess up the CVs, you can always restore the factory default values with just a couple of key strokes. Below is the listing of all CVs. Subsequent pages detail how to best use them.

CV1 - Locomotive Address [3] 1-9999 Just like your house number, each locomotive needs a unique address. A handheld throttle set to the same address will send commands only to the specified locomotive. That way your locomotive can be controlled without other locomotives listening in. Each locomotive should have its own address. As delivered from the factory, each decoder always has the same default address. Most users decide to use the locomotive number, easily seen on the side of the locomotive, as the address. The address can be any number from 1 to 9999.

CV2 - Motor Starting Voltage [0] 0 to 120 This is the voltage applied to the motor in speed step 1. You can change this value so the locomotive receives a higher voltage at speed step 1. The default is 0 which means the motor starting voltage begins at 0 volts. This feature is active only when in the 14/28 speed step mode.

CV3 - Motor Acceleration Rate [1] 0 to 64 Sets the rate of change of speed upon acceleration. A higher value leads to a slower acceleration. The default value of 1 means there is a second or so of delay when the speed is increased.

CV4 - Motor Deceleration Rate [1] 0 to 64 Sets the rate of change of speed upon a decrease in throttle speed. A higher value causes the stopping time to increase which leads to longer time before the locomotive eventually come to a stop. The default value of 1 means there is a second or so of delay when the speed is increased.

If CV3 or CV4 are set to 0, a special failsafe feature is activated. If you change locomotive direction, without first stopping the loco, the decoder's buzzer will turn on and stay on until power is turned off. This is a great way to train operators to always stop before throwing the direction switch. If you don't want this feature, use a value of 1 or higher in CV3 and CV4.

CV5 - Maximum Motor Voltage [0] 1 to 255 Sets the maximum voltage applied to the motor when the throttle is full on. A value of 0 (default), or 255 will always guarantee that full battery voltage is applied to the motor. Some examples of values and the resulting top speed, expressed as a percentage of the maximum speeds are shown below. This feature is active only when in the 14/28 speed step mode.

CV5 Value	% of Top Speed
0 or 1 or 255	100% [indicates CV5 is not used]
220	80%
190	70%
127	50%

CV6 - Mid Point Motor Voltage [0] 1-255 Sets the amount of voltage applied to the motor when the throttle is set at the 50% point or half way between off and full on. The combination of CV5 and CV6 makes speed adjustments and speed matching locomotives easy. See the graphs later in this section.

Fine Tuning Locomotive Performance

Use this section to determine how to quickly make changes to your locomotive's performance. Every locomotive is unique and some work perfectly fine without any changes to the G2 decoder's factory default values used in the various configuration variables. However, some locomotives need different values for flawless performance and this section helps quickly determine which configuration variables will affect a given symptom. All changes are stored inside the decoder. This allows any locomotive to always have the same performance, regardless of which throttle is used.

To use this section, look down the column labeled "symptom." The next column is the configuration variables that will fix the symptom. The last column contains notes and suggested values.

Start loco movement at lower throttle setting - Use CV2 to give a constant voltage to the locomotive the moment the throttle is set to speed step 1. Common values to try are 3, 5, and 10. However, any value can be used.

Need finer speed control - This actually involves the throttle. Set the throttle to 128 speed steps. Check your throttle instruction manual for how to do this and experience much finer speed control.

Speed changes are too fast or too slow - Use CV3 and 4 to adjust the rate at which the speed of the motor reacts to a change of speed at the throttle. Beware that large values for either CV can result in what appears to be loss of control. However, that is not the issue, the decoder is just extremely sluggish in making the change.

Need shorter time for loss-of-signal detection and shutdown - Use CV11 to adjust the time from loss of signal to motor shutdown. Maximum time delay is about 2 minutes. Although the motor may have stopped because of a time out, power is still being applied to the lights and sound system. A value of 0 disables this feature and the motor never shuts off and continues on at the last commanded speed.

Need to reverse motor direction - Use CV29 to reverse the motor direction.

Need to fix autoreverse headlamps - Use CV60 to reverse the autoreversing headlamps.

Want to lower the maximum speed - Use CV5 to select the top speed. This feature only works with the 14/28 speed step mode.

Want fewer speed steps from min to max - Use CV29 to select 14 speed steps. You must also select 14 steps for the throttle too.

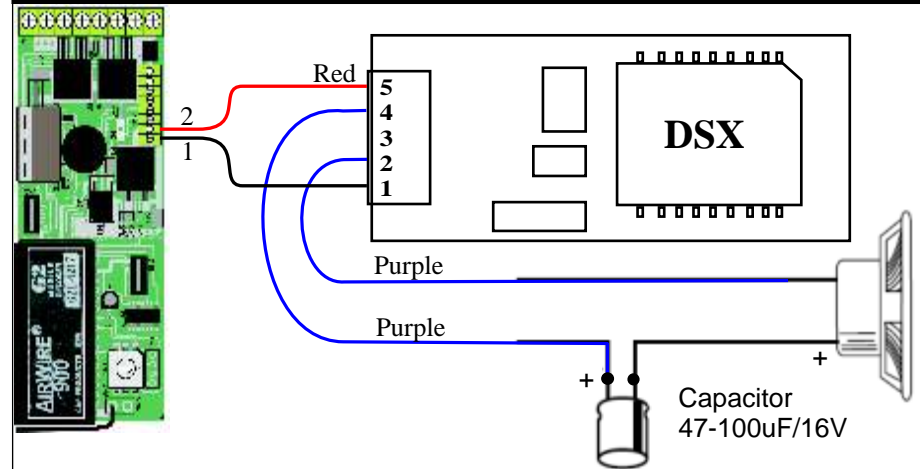
Want to adjust cruise control speed - Use CV58 to select mode 1 which allows the change of speed when cruise control is active.

Want cruise control to stop with throttle change - Use CV58 to select mode 0 which terminates cruise control the moment the throttle speed changes.

Don't want to hear buzzer when cruise implemented - Use CV59 to disable the buzzer. Set it to a value of 1 to turn off the buzzer when cruise is activated or deactivated. Buzzer will still work during programming.

When speed matching locomotives, use all of the available variables including CV2, CV3, CV56 and CV57. All of these variables change the actual locomotive speed for a given throttle speed step. They also are somewhat interactive with each other. Experimentation is the best way to evaluate their effectiveness.

G2 Decoder and DSX Diesel Hookup

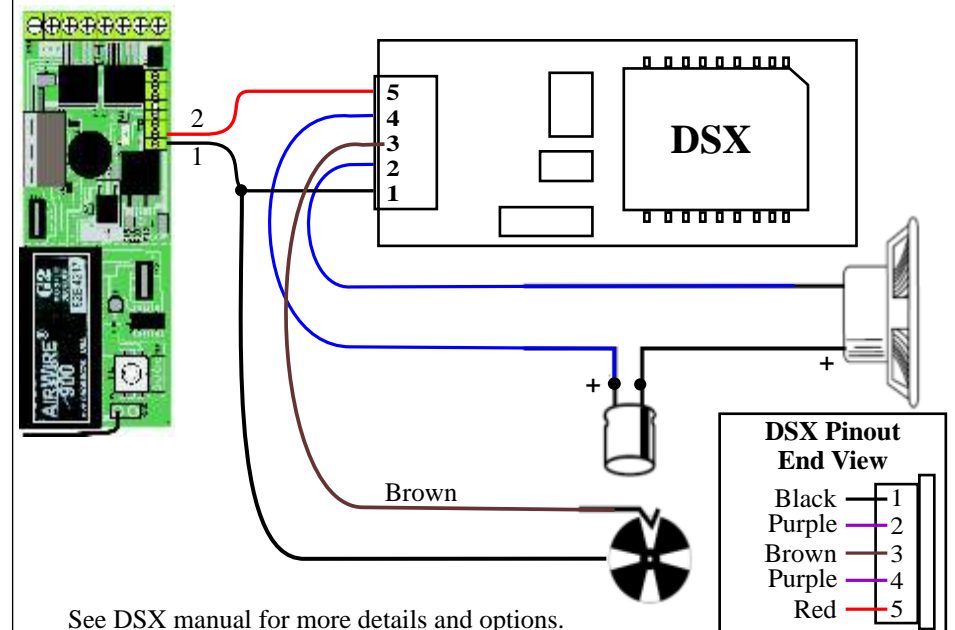


The red and black wires from the DSX decoder always connect to the AirWire decoder at terminals TM2-1 and TM2-2. However, if you discover the DSX decoder doesn't program, reverse the red and black wires.

The two purple wires go to the speaker with a capacitor connected in series with the purple wire from pin 4 of the DSX module (closest to the red wire). The other capacitor lead connects to the plus speaker terminal. If your DSX decoder comes with a "bi-polar" capacitor, polarity doesn't matter. Small wire may be used for these connections.

When using the Chuff-CAM brown wire, the return wire from the wheel/frame goes to TM2-1. If the CAM input doesn't work, move the return wire to TM4-4.

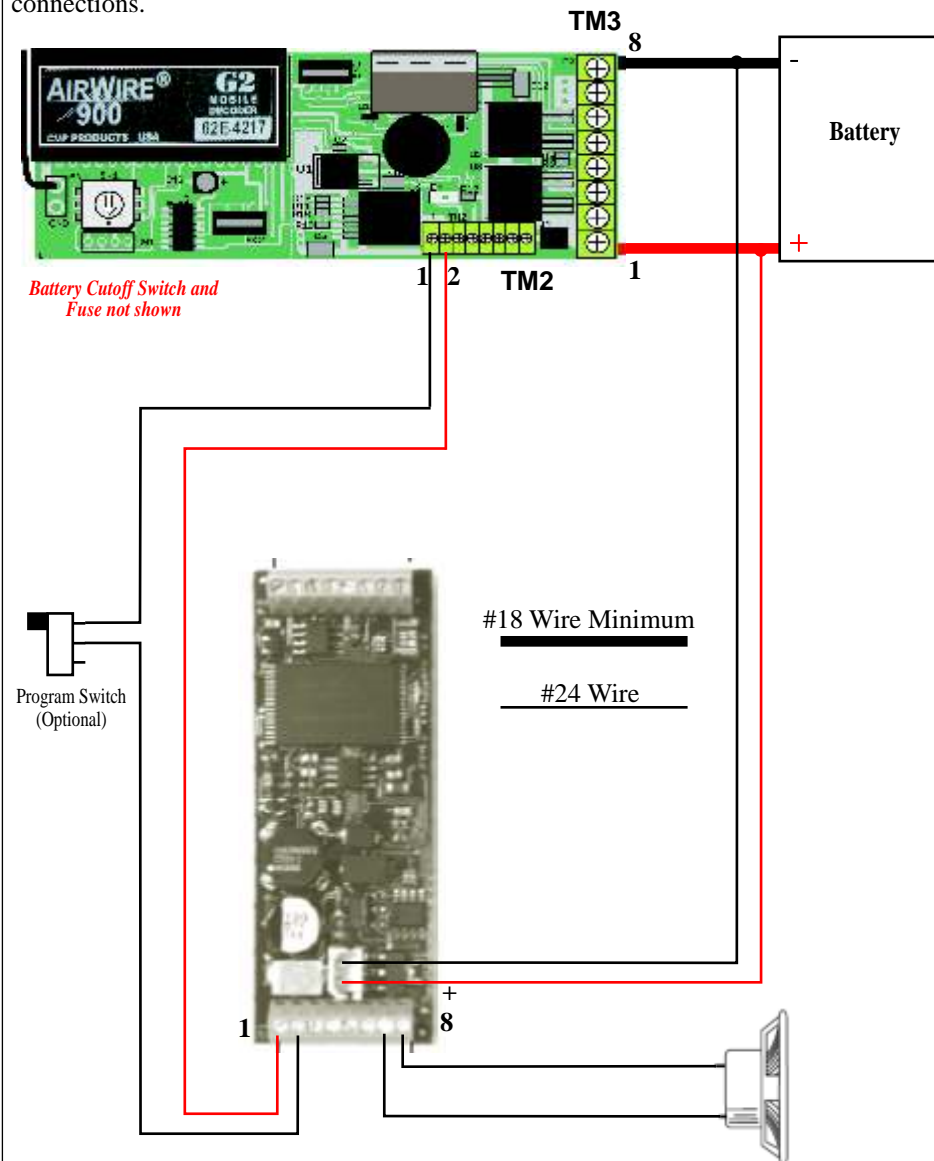
G2 Decoder and DSX Steam Hookup



See DSX manual for more details and options.

G2 Decoder And Phoenix 2K2 Sound Hookup

This hookup diagram shows the required connections between the G2 decoder, the battery and the 2K2 module. The programming switch is used to disconnect the sound module during G2 decoder programming. Normally this switch is ON. See the 2K2 installation manual for programming information and detailed instructions for the remaining connections.



The power switch and fuse are not shown in this picture although they are still required.

Cruise Control Tips

Speed Regulation Limits

Cruise control can only regulate motor speed within the range that the motor normally operates. If the locomotive struggles and lugs down, stalls or slips, cruise control will not help. Once the locomotive begins to slip, no amount of extra energy will help. The only result will be hotter drivers and a hotter motor. The solution is to use a helper engine to push the train to the top of the hill.

Speed Change Response Time

Cruise control senses speed changes in the motor and increases or decreases the drive signal going to the motor. Speed changes caused by hills and valleys usually result in gentle changes that the decoder has no problem with in maintaining a constant speed. However any significant or rapid change, such as out of scale track or some type of sudden binding, may result in slight delay before the previous speed is resumed. The rate at which the speed changes is optimized for garden railroads.

A Binding Mechanism

If the mechanism of an engine is not completely smooth, then cruise control can interact with a repeated bind and may result in speed surging. The G2 decoder checks the motor speed about 40 times per second so it is naturally less sensitive to this kind of problem. Any observable surging will also tend to smooth out as the engine speed increases.

Stalling, or Slipping

If the locomotive can't climb a hill without slipping or stalling, then the cruise mode should not be used. The locomotive simply doesn't have sufficient pulling power. All the decoder can do is apply maximum power to the motor and the motor will do what it can. If the engine slips, then the decoder will drive the motor at some high constant speed while the wheels slip the entire way. If the engine tends to lug down under load, then the decoder will try to run the power all the way up. In a sense this motor is very near a stall and will draw maximum current. This may activate the overload or overheating protection of the motor drivers. No harm, but it will be a nuisance so be sure and use a helper engine.

Battery Voltage Determines Minimum Cruise Activation Speed

Higher battery voltage means more energy per throttle speed step. A 22 volt battery will usually cause a USA Trains diesel to move at speed step 2 or 3. A 12 volt battery will not get the motor moving fast enough until the speed step is above at least 5 or 6. The G2 decoder cruise performance was optimized for battery voltages between 18 and 22 volts.

When cruise control is activated, the bump frequency and bump amount are disabled. When cruise control is deactivated, bump is automatically re-enabled.

Activating and Using Cruise Control

Cruise control is nothing more than an automatic method for maintaining the same locomotive speed regardless of hills, valleys, tight curves, less-than-perfect trackwork or other speed changing phenomena.

Just like your car's cruise control, you can activate cruise control at any time as long as the locomotive is moving. It is the RPM of the motor that is monitored and held constant. And you must be sure to have additional power remaining in order to add power if needed. The G2 decoder will not allow cruise control to be activated if the throttle is at full speed. And, just like your car's cruise control, if the locomotive is below a certain speed, cruise control will not be available.

Two types of Cruise Control

The G2 decoder features two types of cruise control. Configuration variable 58 (CV58) controls which mode is to be used. When CV58=0, this is mode 0 cruise control. If CV58=1, this is mode 1 cruise control.

Cruise mode 0, cruise is a one time activation and is deactivated with any speed change.

Cruise mode-1 is unique in that once cruise is active, you may change the cruising speed without deactivating cruise control. This allows fine tuning of the cruise speed, higher or lower. In this mode, cruise control is deactivated once speed-step 0 is received or if the direction switch is pushed.

If you do not want to hear the cruise activation/deactivation beep, use CV59 to disable it.

Activating Cruise Control - Either Mode

Note: Cruise activation can be assigned to any throttle function key. The default key is 6. Page 29 has more information on reassignment. For these examples 6 will be used.

Once the train reaches the desired speed, push F6 on the throttle to enable cruise. Just push function key 6 on your AirWire900 throttle. Activation is announced with a single beep. If the speed is too low, the deactivation is automatic and announced with a double beep. F6 will be used in the following examples.

When cruise control is active, the train will maintain the same speed as when F6 was pushed. This also means that if there is a derailment, the train will continue on to the tracks and dirt at the same constant speed.

F6 activation will not be accepted at very slow speeds or at full speed. If F6 is pushed and the speed is out of range, it will beep twice to tell you the mode was rejected.

Deactivating Cruise Control - Mode 0

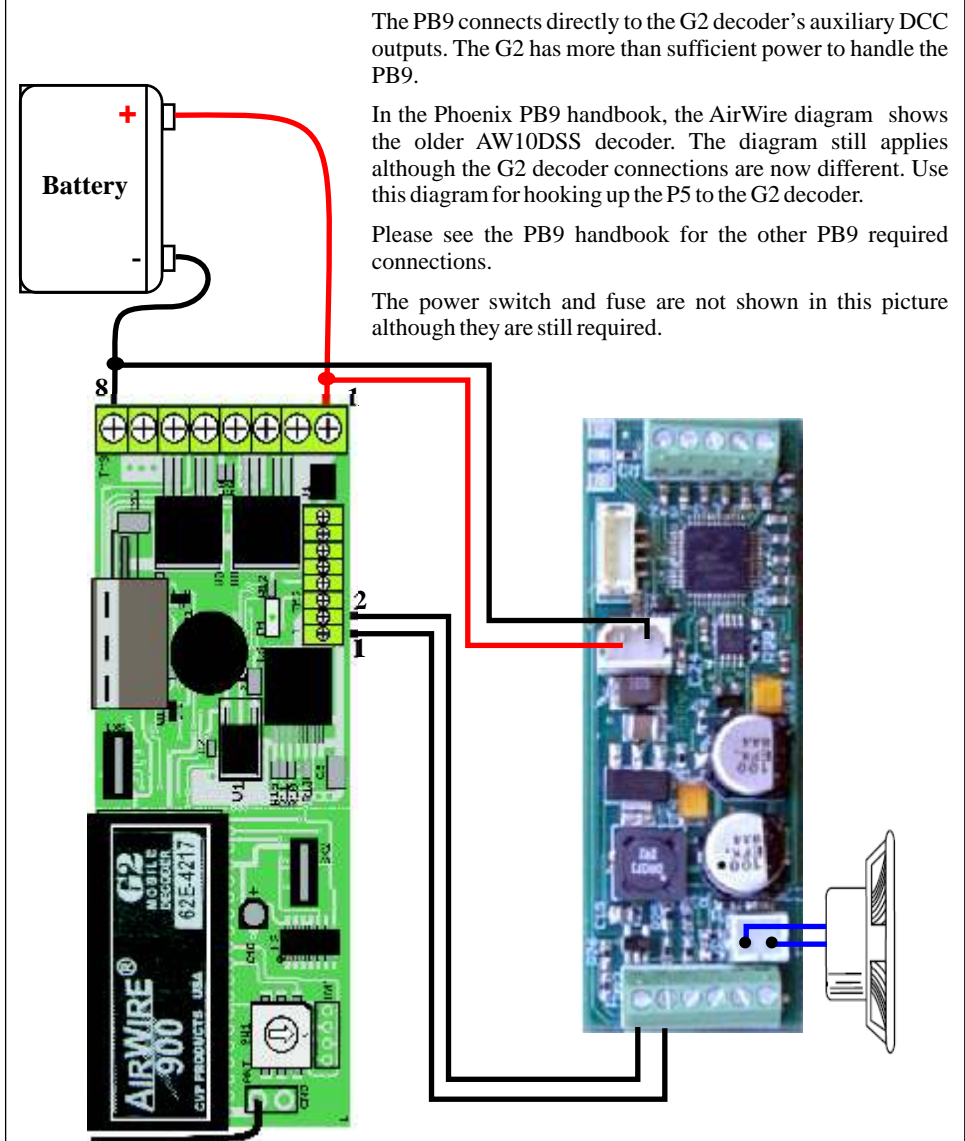
When cruise mode-0 is active, it will be automatically deactivated the moment there is a throttle commanded speed change - higher or lower. Also, cruise control is automatically deactivated if the throttle's direction key is pushed. Whenever, cruise control is deactivated, you will hear the double-beep.

Deactivating Cruise Control - Mode 1

Cruise-control mode 1 allows you can make changes to the initial F6 initiated constant speed using the throttle. You may increase or decrease the speed. Taking the throttle to 0 or reversing the direction will turn off cruise mode. To turn it back on, just push F6 again.

If locomotives are in a multiunit consist, cruise-control may not work perfectly and the locos may fight each other. However, if all locos are relatively closely matched, cruise mode 1 may be the best mode. Experiment to determine which cruise mode works best for your fleet.

G2 Decoder And Phoenix PB9 Hookup



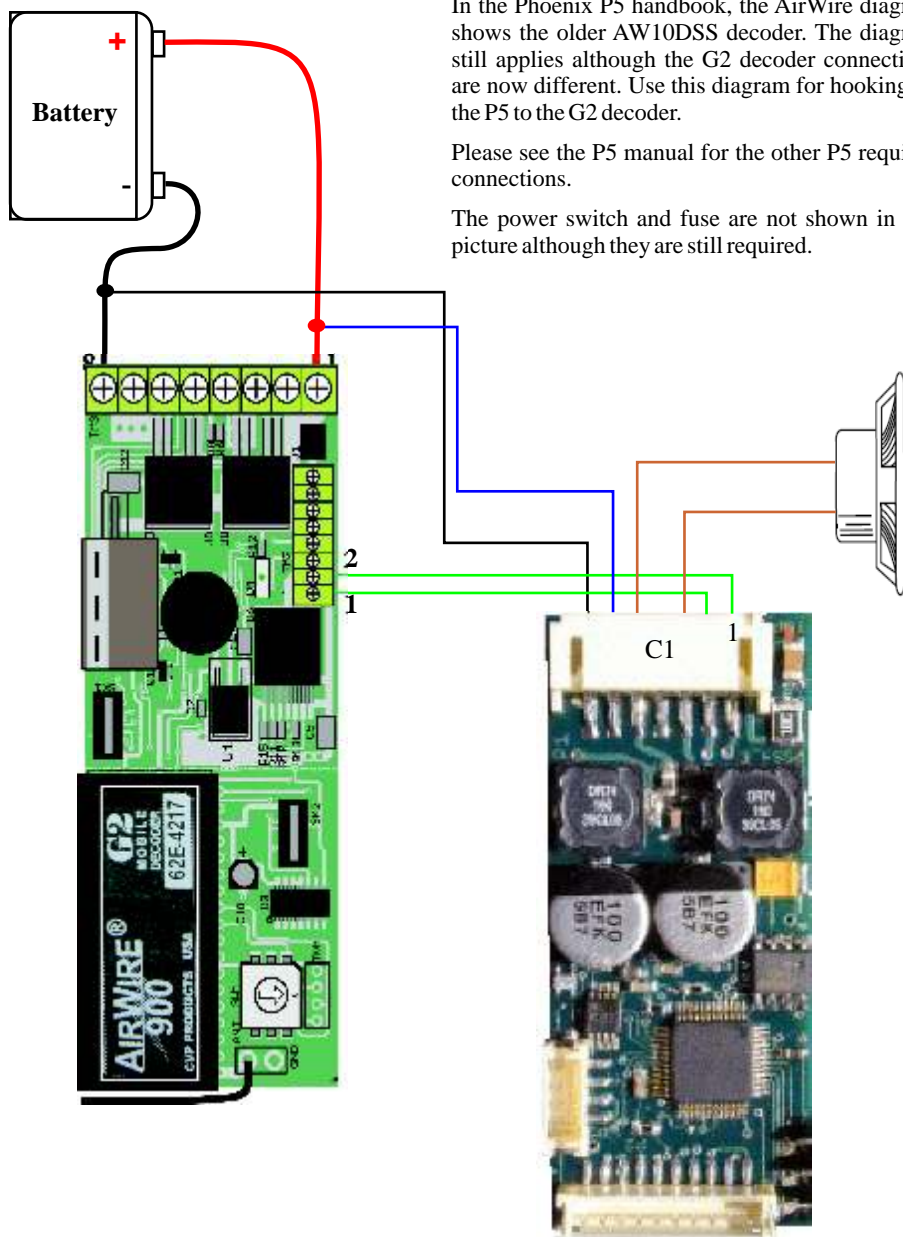
G2 Decoder And Phoenix P5 Hookup

The P5 connects directly to the G2 decoder's auxiliary DCC outputs.

In the Phoenix P5 handbook, the AirWire diagram shows the older AW10DSS decoder. The diagram still applies although the G2 decoder connections are now different. Use this diagram for hooking up the P5 to the G2 decoder.

Please see the P5 manual for the other P5 required connections.

The power switch and fuse are not shown in this picture although they are still required.



Operating Tips

Locomotive Runs Slower or Can Not Pull Many Cars

Assuming your battery is fully charged, this problem might be the result of comparing your old power pack voltage to the battery voltage. Your old power pack probably provided a higher voltage than the battery. The battery voltage sets the top locomotive speed and the pulling power. You can increase the battery voltage by using the split battery option for more pulling power.

Battery Runs Down Quickly

Battery life is directly related to how much current is consumed by the locomotive and other attached loads such as sound decoders, lamps and smoke generators. Also, garden railroad locomotives require high levels of current when starting or climbing hills. All of these conditions can shorten the running time. A simple solution is to use high amp-hour rated batteries. The downside is the extra weight. The choice is yours and only you can decide

How Long Do The Batteries Last?

This is a very common question that does not have a simple answer. This is because the answer depends on many factors such as: battery capacity and size, type of railroad, quality of the locomotive, ambient temperature, how the railroad is operated, how many cars are pulled, how many hills and so on.

A rough idea of the battery life can be determined by dividing the battery rating which is in Amp-hours (Ahr) by the motor current. For example, a battery pack rated at 1 Ahr will power a 1 Amp motor for about 1 hour. If the motor current is 2 Amps, the lifetime is half, or about 30 minutes. However if the motor is 1 Amp and the battery is rated at 5 Ahr, the locomotive will run for 5 hours before needing a charge.

For best results, use the highest amp-hour rated batteries that space permits. Minimize the motor current by running slower, designing a railroad with minimum grades, limiting the number of cars on a train, or using multiunit consists or helper locomotives.

Reception Range Tips and Hints

One of the best methods to dramatically increase range is to use lower voltage batteries. Changing from 22V NiMH battery pack to a 12V gel-cell or a 14V Li-ion batter pack results in as 2X to 4X range improvement because creates less electrical interference. See the CVP catalog for a 14.8V rechargeable lithium battery that is perfect for most installations.

Confirm that the antenna is oriented vertically and has not touching anything metal. Make sure the antenna is not broken or pinched. Best range occurs when the antenna is outside of any enclosure, especially metal. Consider using the optional external antenna for optimum, long range reception.

Electrical noise from the motors also contributes greatly to reducing range. The easiest method to reduce electrical noise pickup is to mount the decoder in a trailing car, away from the locomotive's motors. Be sure to use shielded cable to connect the decoder to the locomotive.

Another easy yet effective range extender is to insert 1-ohm, 5-watt resistors in series with the motor wires. One resistor can serve two motors. Although the resistors will subtract a small amount of motor power, they will extend your radio range by a significant amount.

If you must use high voltage batteries, consider installing our range extender kit. It contains extra noise filtering components, the 1 ohm resistors, shield cable plus tightly twisted #18 wire for hooking up batteries to the decoder.

Locomotive Runs Opposite of Direction Indicator

This is caused by motor wires being reversed. Swap the two motor wires at terminal TM1. You can also use CV29 to electronically reverse the motor wires and CV60 to fix the reversed headlights.

Fault Protection, Annunciation, Reset

There are multiple safeguards built into the G2 decoder. However, we have been surprised at how clever our users have been at finding new ways to damage decoders. The G2 was designed with these folks in mind although you will also benefit - just in case. However, there are no guarantees that the G2 protection will protect itself against all of the possible faults so the best protection is to follow hookup instructions exactly as shown. If there is any doubt, stop and get clarification. One major source of G2 decoder damage is when the motor outputs are connected to 3rd party light circuit boards and power supplies. These circuit boards can easily damage the decoder as well as the lighting board. Disconnect them completely and discard them. The motor output is designed to only drive motors.

This table each of the major drive sections along with the protection, whether the alarm buzzer sounds and how to reset the protection once it is activated. "Auto" reset means that the device will automatically reset once the fault is cleared. Power cycle reset means that the device will reset when power is turned off and then back on, providing the fault has been cleared.

<u>Section & Fault</u>	<u>Protected</u>	<u>Buzzer</u>	<u>Reset Method</u>
Motor Drivers			
Excessive Current	Yes	No	Power cycle
Short Circuit	Yes	No	Power cycle
Over Heating	Yes	No	Power cycle
Low Voltage	Yes	No	None - raise voltage
Short to BAT -	Yes	No	Power cycle
Short to BAT+	Limited	No	None, may cause damage
Auxiliary DCC Driver			
Excessive Current	Yes	Yes	Auto
Short Circuit	Yes	Yes	Auto
Over Heating	Yes	Yes	Auto
Low Voltage	Yes	Yes	Auto
Over Voltage	Yes	Yes	Auto
Short to BAT-	Yes	Yes	Auto
Short to BAT+	Limited	No	None, may cause damage
Lamp and Function Drivers			
Excessive Current	Yes	No	Auto
Short to BAT +	Limited	No	None, may cause damage
Short to BAT-	Limited	No	None, may cause damage

WARNING

NEVER connect the G2 decoder to any 3rd party lighting boards or other external circuit boards. Failure of the lighting board and the G2 decoder is very likely and not covered by any warranty.

WARNING

There is no protection against battery polarity reversal. Always use the test diode to validate you have correctly identified the plus and minus terminals and hook up wires coming from the battery.

Do not allow water to contact the decoder or allow condensation to collect inside the decoder. This will certainly cause the receive range to be much lower and may actually damage or destroy the decoder.

Simplified Quick Checkout

Assuming you've wired everything up correctly, this short list of tasks will verify that everything is set up and ready to go. Once you've gone through this list, the next task is to customize the G2 decoder to maximize your locomotive performance. But first, verify that everything is working OK.

1. Set frequency selector on the G2 decoder to match frequency set in throttle.
2. Turn on battery power to G2 decoder. The G2 green LED must be on.
3. Turn on throttle's power switch.
4. Set address on throttle to 3 by pressing # 3 #.
5. Turn up speed control, and loco will run. Verify it runs in the desired direction.
6. If headlights are wired to the decoder, turn on the headlights by pressing the 0 key.

Fault Buzzer Operations

The buzzer will sound any time there is a fault on the Auxiliary DCC driver outputs. The fault could be an excessive voltage, driver overheating, short circuits or current draw in excess of 3 Amps.

When the fault occurs, the buzzer sounds for about 3 seconds and the DCC driver outputs are turned off. The fault buzzer and the drivers are reset after 3 seconds. If all is well, the buzzer does not sound. However, if the fault is still present, the buzzer sounds again and the cycle is repeated.

The moment the buzzer sounds, disconnect the power and start checking wiring. Look for shorted or frayed wires, and/or incorrect wiring or some kind of fault with the external DCC decoder.

Motor Driver Protection

The motor drivers are protected against over heating, excessive current and input voltage that is too low. If any of these events occur, the drivers shut down and stay off. After investigating the cause, the drivers can be reset by turning the decoder power off and then back on.

Except for rare occasions, a fault on the motor drivers is caught so quickly that the buzzer will never sound. On those rare occasions, the buzzer will also be tripped by the motor drive transistors. For this to happen, the current draw had to be between 10 and 15 amps. The transistors will deliver up to 20 Amps. Anything higher than that will trip their protection circuitry - without tripping the buzzer.

Turning the decoder power off and back on will reset the motor drivers.

Take Care When Programming The G2 Decoder - Beware of Lurking Locomotives

Service mode programming is the only form of programming supported by the G2 decoder. This form of programming will program the G2 decoder *and* any other decoder connected to the Auxiliary DCC output terminals. In addition, since the programming is received from the throttle's transmitter, any other decoders, that are on *and* sharing the same frequency also will be reprogrammed, regardless of their assigned address.

Setting Up The G2 Decoder - Service Mode Programming

Turn on power to the decoder. Pick an easy to remember locomotive address. The locomotive cab number is typically used, or perhaps just the the last two digits of the locomotive cab number. For a limited number of locomotives, the cab number's last digit is sufficient. Make sure it is unique. Program CV1 to the desired address. See the throttle manual for detailed instructions.

Resetting Decoder To Factory Defaults

If nothing seems to work, try resetting the decoder back to the factory defaults. This is done by programming a value of 135 into CV 8 and turning the battery power off then back on. All CVs, including the address are reset to the factory defaults shown in the table of CVs elsewhere in this manual.

Programming the Sound Decoder Address

Always program the address for the sound decoder at the same time you program the locomotive decoder. If you have installed a cut-off switch, make sure it is turned on and the sound decoder is powered before changing the address. You can send the same address again to both decoders if you are not sure of their address. It will do no harm.

Fine Tuning Sound Decoders

Use OPS mode programming to fine tune the CVs of a sound decoder.

Resetting G2 Decoder To Factory Defaults

Reset using the RF1300 Throttle

Follow these steps to reset your G2 Decoder to its original factory defaults using the original AirWire Throttle:

1. It is recommended that only the G2 decoder to be reset be powered. All other AirWire decoders that “hear” the reset command will also be reset. Although sound and other auxiliary DCC decoders should not be affected, there is no guarantee. So, disconnect or disable all other decoders before proceeding.
2. Verify that the throttle and decoder frequencies are matched. Verify that the decoder to be reset is powered on.
3. Turn off throttle’s power switch.
4. Push **and hold** the 9 key.
5. Turn on the throttle power switch while continuing to press the 9 key.
6. Release the 9 key. Notice the direction indicators are alternately flashing signifying the throttle is in the programming mode.
5. One at a time, push the following keys: *, 8, *.
6. One at a time, push the following keys: #, 1, 3, 5, #.
7. Listen for the decoder to beep signifying the command has been sent.
8. Turn off the throttle to exit programming mode.

At this time, the decoder has been reset to factory defaults. It will be on address 3. Reset your throttle to address 3 to confirm that decoder has been reset.

Reset Using The T9000 Throttle

Follow these steps to reset your AirWire Decoder to its original factory defaults using the new T9000 throttle:

1. AirWire decoders that “hear” the reset command will also be reset. Although sound and other auxiliary DCC decoders should not be affected, there is no guarantee. So, disconnect or disable all other decoders before proceeding.
2. Turn on the throttle
3. Push the SPR key then the SEL key to enter the Service mode.
4. One at a time, push the following keys: *, 8, *.
5. One at a time, push the following keys: #, 1, 3, 5, #.
6. Listen for the decoder to beep signifying the command has been sent.
7. Push the SPR key to return to normal operation or cycle the throttle’s power switch..

At this time, the decoder has been reset to factory defaults. It will be on address 3. Set the throttle to address 3 to confirm that decoder has been reset.

Simple Troubleshooting And Operating Notes

Buzzer Sounds As Soon As Power Is Turned On

The buzzer sounding constantly means there is a short circuit on the Auxiliary DCC output drivers. Most likely there is an error in the wiring of the sound decoder. Turn off the battery power and carefully check and double check your wiring. As soon as the wiring error is fixed, the buzzer stops making noise and the drivers are re-enabled.

Motor Runs For Short Period Then Stops

There are several possible reasons for this - let’s start with the easy one first. Make sure the throttle is turned on and on the right frequency and locomotive address. If so, next verify the battery is charged and that the G2 green indicator LED is on and bright. Finally, it is possible that a momentary overload tripped the G2 motor driver protection circuit. Cycle the decoder power off then back on and try again. If it continues, your motor may be faulty, or there is an intermittent wire between the motor and the decoder.

Locomotive Stops Running - But Resumes Running After A Short Rest

This likely to be caused by overheating of the motor power drivers. If the drivers overheat, they will automatically shut down and stay off until the power is cycled off, then back on. There is no warning buzzer when this occurs. There is no harm to the decoder, but the drivers need additional ventilation. Another suggestion is to use a lower battery voltage which results in much cooler operation of the G2 decoder circuitry.

Under Heavy Load, Buzzer and Sound Turn Off & On, But Loco Keeps Running

This is likely only if you are using 26 volt or higher batteries.

When there is heavy current draw from the batteries, for example, when a long, heavy train tackles a steep grade, and the locomotive is near stalling speed, an enormous amount of electrical noise is generated in the battery wiring. This can result in voltage spikes that exceed the 30 volt rating of the Auxiliary DCC drivers. When that occurs, the DCC drivers shut down and the buzzer is sounded. There is no harm to the drivers. As soon as the spikes go away, the drivers automatically reset.

If this occurs, the decoder is warning you that you are nearing the top end of its current and voltage protection. If this is the first time this occurs and you do not believe the locomotive is under any unusual load conditions, measure the battery right after it has been charged and before it has been used.

A fully charged battery will read only a volt or so above its rated output. But if the measured voltage is significantly higher, suspect a problem with the battery charger. It may need to be replaced and it is possible the battery needs to be replaced too. This is especially true with the Lithium batteries. This type of battery does not tolerate excessive charging voltage.

No Operation, Decoder Doesn’t Respond To Throttle

1. Verify the green LED indicator on the decoder is on. If the LED is off, the decoder is not receiving power. Verify that the battery positive lead eventually ties to TM3-1 and that the battery minus lead ties to TM3-8. If you discover the polarity is reversed, the decoder is already damaged and it is highly unlikely that it is repairable.
2. Check that the throttle and the decoder are set to matching frequencies.
3. If frequencies are properly set, set the throttle to the locomotive address. If this is the first use of the decoder, set the throttle to address 3. With the throttle turned on, push #, 3, then # to set it.
4. If decoder doesn’t respond, reset the decoder to factory defaults using the procedure described in the throttle’s operation manual and on page 9 of this manual. The locomotive will physically move a ½ inch or so as an indication that the programming was received.
5. If the locomotive doesn’t move, then there is probably a problem with the motor wiring. The most common issue is a broken wire caused by a pinch between the chassis and the shell.