G4 Configuration Variables (CV) Listing

This is the list of CVs in the G4 Decoder. The "Orig Value" column shows the original factory value when new or after decoder is reset. Changes to CV values are remembered without battery voltage

CV #	Orig Value	Value Range	Description
CV1	3	0-99	1-99 Primary Address
CV2	9	0-255	Motor Starting Voltage MSV
CV3	2	0-255	Motor Acceleration Rate
CV4	2	0-255	Motor Deceleration Rate
CV5	255	0-255	Maximum Motor Voltage Vmax
CV6	128	0-255	Mid-point Motor Voltage Vmid
CV8	135	135	CVP Manufacturer ID
CV11	0	0-255	Loss of Signal Timer (seconds)
CV17	0	0-255	Loco Address Hi-Byte
CV18	0	0-255	Loco Address Lo Byte
CV29	2	0-255	Decoder configuration
CV35	0	0-99	F1 Function Key Action
CV36	0	0-99	F2 Function Key Action
CV37	9	0-99	F3 Function Key [RCOUPLR]
CV38	15	0-99	F4 Function Key Action [DL On]
CV39	1	0-99	F5 Function Key Action [CRUISE]
CV40	3	0-99	F6 Function Key Action [E1]
CV41	0	0-99	F7 Function Key Action
CV42	0	0-99	F8 Function Key Action
CV43	4	0-99	F9 Function Key Action [E2]
CV44	2	0-99	F10 Function Key Action [SMOKE]
CV45	5	0-99	F11 Function Key [E3]
CV46	0	0-99	F12 Function Key Action
CV56	0	0-255	Bump Amount
CV57	0	0 - 127	Bump duration in us
CV59	3	1-15	Headlites Effect Period (x512ms)
CV60	0	0-15	Headlights Mode 0=normal/autorev
CV61	4	0-15	Headlight Front Lighting Effect
CV62	4	0-15	Headlight Rear Lighting Effect
CV63	0	0-1	Cruise Mode - 0 Norm, 1=Track
CV64	4	1-16	Cruise Track Rate (ms)
CV65	2	1-3	Cruise Track Step Size
CV200	0	0-16	RF Frequency number
CV201	3	1-15	Light Effect Period (x512ms)
CV202	4	0-15	ELITE#1 Lighting Effect
CV203	4	0-15	ELITE#2 Lighting Effect
CV204	4	0-15	ELITE#3 Lighting Effect
CV205	4	0-15	ELITE#4 Lighting Effect
CV206	0	0-255	ELITE#4 Auto-off Timer
CV207	3	0-255	DLites Flash period (x256ms)
CV208	0	0-255	DLites Mode (0=On, 1=Off)
CV209	15	0-255	DLites Flash Timeout (seconds)
CV212	3	0-255	Smoke Timout (3 minutes)
CV213	8	0-99	Function Key 13 [FCOUPLR]
CV214	6	0-99	Function Key 14 Action [E4]
CV215	99	0-99	Function Key 15 [Cruise Off]

CV Value	Function Key Action
0	No Function
1	Activate Cruise Control
2	Smoke Enable
3	Toggle ELITE#1 on/off
4	Toggle ELITE#2 on/off
5	Toggle ELITE#3 on/off
6	Toggle ELITE#4 on/off
7	Dim Headlighs on/off [Rule 17]
8	Activate Front Coupler
9	Activate Rear Coupler
10-14	reserved
15	Activate Ditch Lights
99	Deactivate Cruise Control

CV Value	Lighting Effects
0	Off 0%
1	Dim 6%
2	Dim 25%
3	Dim 50%
4	On 100%
5	Strato Light
6	Oscillating Light
7	FRED
8	Rotary Dome light 1
9	Gyra Light
10	Mars Light
11	Rotary Dome Light 2
12	Strobe Single Pulse
13	Strobe Double Pulse
14	Reserved
15	Random flicker

CV Value	Cruise Control Mode
0	Normal (cruise off w/speed change)
1	Tracking mode (Cruise stays on)

CV Value	Front Headlight, Rear Headlight Mode
0	Normal, autoreverse
1	Normal with rule17
2	Front headlite on always
3	Front headlite on always w/ rule 17
4	Rear headlite on always
5	Rear headlite on always w/ rule 17
6	Front & Rear both on
7	Front & Rear both on w/ rule 17
8	Swap F to R Auto Reverse
9	Swap F to R Auto Reverse w/ rule 17
10-15	reserved

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r3 May 2020

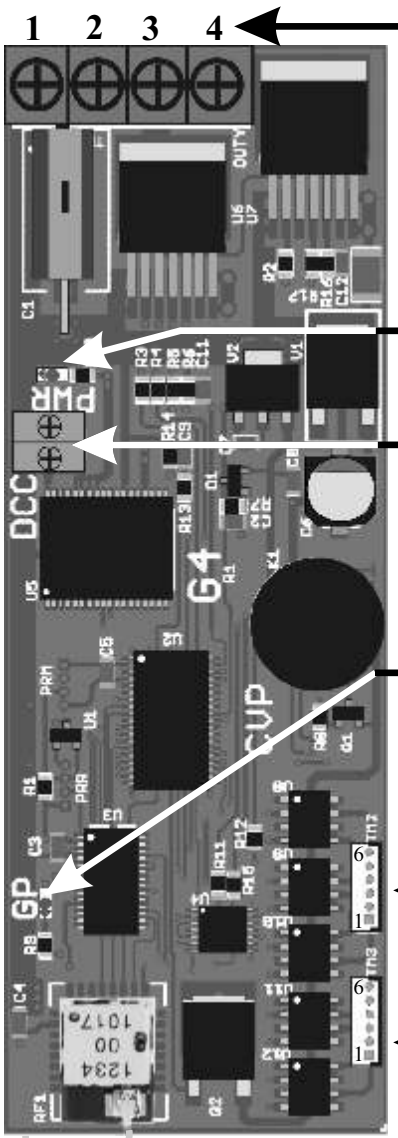
The G4™

The AirWire900® 4th Generation Motion Decoder

Contents

G4 Decoder
Double Ended Wire Harness
Test Diode
1 ohm 2W resistor
This manual

G4 Decoder Connections



TM1 - Battery and Motor Terminals

#1	Battery Negative (-) Input
#2	Battery Positive (+) Input
#3	Motor Terminal A+ Out
#4	Motor Terminal B Out

PWR LED - Green

On when battery power is applied

DCC - Booster Output [2.5A Max]

#1	DCC Output A
#2	DCC Output B

GP LED - Red

On when good throttle data is received

TM2 - Driver Outputs

#6	*ELITE #2
#5	*ELITE #1
#4	*Ditch-Light Driver Left
#3	*Ditch-Light Driver Right
#2	*Rear Headlight Driver
#1	*Front Headlight Driver

TM3 - More Driver Outputs

#6	Coupler Voltage Plus
#5	**Smoke Module Driver
#4	*Rear Remote Coupler
#3	*Front Remote Coupler
#2	*ELITE #4
#1	*ELITE #3

3.5 Inch Whip Antenna

Keep wires and other metal objects away from the antenna or your reception range will decrease.

*Maximum Current Limit 1.0 Amp
**Maximum Current Limit 3.0 Amp

Take a moment and familiarize yourself with the G4 and its indicators, connection points and other important parts.

More Troubleshooting Tips

G4 Indicator LEDs are Great Aids to Troubleshooting. The green PWR LED and the red GP LED provide several clues about what is happening on your G4. Always try to position the G4 so the indicators are visible when the locomotive is reassembled.

If the Green PWR LED is OFF there are several possible causes but the fundamental problem is the G4 is not received any power. The battery may be dead and need recharging. The battery wiring might be broken or the power switch may be bad. The battery might have been momentarily shorted out. If this occurs with a Lithium-Ion battery, the internal protective circuit will shut off the battery output. To restore normal operation, the battery must be temporarily connected to the charger.

If the Red GP LED is flashing about once per second this has two possible causes. First, it might indicate the G4 is not receiving throttle information on its assigned frequency. Turn on the throttle and verify the throttle's frequency is the same frequency as the G4.

The second possible meaning is that there is a short circuit on the DCC output driver. Disconnect the wires from the DCC output terminals. Then power up the throttle and the G4. If the GP LED is now on solid, there is a problem with the attached external decoder. The external decoder is tripping the protection of the DCC driver. You need to install the 1 ohm resistor with the external DCC decoder.

If The Red GP LED is dark and Not Flashing - this has to possible meanings. The first meaning is that the G4 was being controlled by a throttle but the throttle is no longer in use or is out of range. The G4 is waiting for the throttle signal to return. This is normal and the G4 will not perform the temporary jump to frequency 0.

However, it can also mean that the G4 never received a throttle signal on its assigned frequency. As a result, the G4 has temporarily "jumped" to frequency 0. It assumes that its originally assigned frequency will be reset. The jump to frequency 0 is preceded by 5 chirps at the end of one minute. To prevent a inadvertent jump to frequency 0, turn on the throttle first and check that it is set to the correct loco number and frequency. Then turn on the G4. Once the G4 receives a throttle signal, the jump mode is cancelled. This is true even if the throttle is later turned off or had a frequency change

Before Calling For Help With The G4

- ♦ Verify the throttle is on the G4 frequency. Use the G4 indicator LEDs for this.
- ♦ Verify the throttle's loco number is the same as the G4 assigned loco number.
- ♦ Verify the battery is charged and working normally. Or try a different battery.
- ♦ If the locomotive motor is controllable, but the sound doesn't follow, reprogram the G4 decoder and the attached sound module again. Be sure power is supplied to both before programming.
- ♦ Try resetting the decoder back to the original factory settings. Beware that the G4 reset command does not reset the attached sound decoder. Reprogram the G4 loco number with the sound decoder attached and turned on to insure both decoders have the same loco number.

G4 Decoder Warranty

This warranty covers substantial defects in materials and workmanship in the G4 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 of any kind, lightning, earthquakes, volcanic events, tidal waves or hurricanes.

Warranty Duration: The coverage of this warranty lasts for 60 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 G4 decoder from one of our AirWire900 dealers, please call them first. They are your best and quickest for answers to questions about G3 decoder. They are also experts in installation and offer such services should it be required. If you purchased your G4 decoder ***directly*** from CVP Products, call us first.

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. Customer is responsible for all shipping costs.**

Troubleshooting Tips

These tips assume the locomotive has been operating normally for a while.

Locomotive Stops Running - But Resumes Running After A Short Rest

This is 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.

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, is set to the proper frequency and locomotive address. If all of these are OK, try another throttle. If it too doesn't work, then the cause is the locomotive.

Reconnect the charger and verify that the charger indicator is visible and green. If the light is red, then the battery is depleted and needs to be recharged.

Finally, it is possible that a momentary overload tripped the battery or motor driver protection circuits. Cycle the decoder power off then back on and try again. If the problem persists, there may be a problem with one or both of the locomotive motors. There is also a remote possibility of a faulty battery. Or it could be as simple as a broken wire. You need to disassemble the locomotive to check these items.

Train Stops When It Is Far Away

This is an easy one. You need to set the loss of signal timer on your G4, CV11, to a value of 0. Any other value and the locomotive will come to a halt when the throttle signal is lost and the timer has expired.

Throttle Loses Control When Locomotive Is Far Away

This is just the normal limitation of the radio system. Do not expect the throttle to control the train when it is a thousand yards away. However, if your railroad is in a large loop, then leave the throttle on its original setting and let the train come back to you. Once the train is within range, the throttle will once again regain control. Be sure and set the G4's loss of signal timer, CV11, to 0.

Horn Won't Stay On When F2 is Pushed And Held

This is usually caused by a combination of noisy motors and distant operation and is not actually a problem Instead, it is a new automatic feature of the G4 decoder. There is nothing more annoying than a diesel horn that is stuck on so the G4 includes a special feature that prevents stuck horns. If for any reason, the G4 stops receiving throttle commands, and the last command was horn ON, then it will automatically issue a horn OFF command after a preset amount of time. This will occur more frequently as the locomotive moves further and further away from the throttle.

Terminology

Throughout this manual there will be some terms used with which you might not be familiar. This page lists a few of these and their definition.

"CV#" is the abbreviation for Configuration Variable Number: A CV number is a unique and specific memory location, designated by the "number. " The values stored into the CV number control how the decoder operates the locomotive. Rather than spell out Configuration Variable Number 1, we shorten this to CV1. So anytime you see CV1, you will know this refers to the configuration variable number 1, which is the locomotive address.

"CV Value" is the abbreviation for Configuration Variable Value:" A CV value is a number loaded into the specified memory location inside the decoder. This value controls or selects various decoder capabilities. In some cases, the value selects from a table of options such as lighting effects or which throttle key activates a locomotive function. CV values are retained inside the decoder even if the power is disconnected or another throttle is used. Thus the locomotive will operate exactly the same no matter which throttle is used. A complete listing of all CV numbers and values used in the G4 Decoder are on the back page.

Here is a typical listing of a G4 Decoder configuration variable. The first line is the title of the Configuration Variable. The CV number follows the title. The second line is the range of values that can be stored in the CV number. The value range is usually between 0 and 255. However, special ranges are specified. For example, CV1 has a unique value range of 1 to 9999. The number in the square braces is the original factory setting of the CV value. So the original factory setting of CV1 is 3. This means the decoder is set to loco number 3 when it leaves the factory.

The Locomotive Number or Decoder Address CV1

The Value Range for CV1 1 to 9999 . . . . . [3]

Setting, Loading, Assigning or Programming CVs: We use these words interchangeably when discussing changing the operation of the G4 decoder. There is nothing difficult or hard to learn about programming CVs. In fact, you aren't really programming anything - you are simply sending the decoder a CV value to make it perform in a certain way. In simple terms, you are changing how the decoder works. CV values are sent to the G4 decoder using the AirWire900 throttle - nothing else is required.

SVC PROGRAM (Service Programming Mode) is a method of changing settings within the decoder without regard to the decoders locomotive address. This is commonly used when resetting the decoder back to the original factory settings since you might not know or care what the present decoder address is. The one precaution is that any decoder that is powered up and on the same frequency will "hear" the programming commands and will also be programmed.

OPS PROGRAM (Operations Programming Mode) is a method of changing settings within the decoder that requires you to first specify the locomotive address. Except for changing the locomotive address, OPS should be used for all settings of the decoder. This is the recommended method since all programming commands and settings, sent by the throttle, affects only the decoder with the correct address. Other decoders, sharing the same frequency, will ignore the programming commands.

Loco Number, Loco Address, and Decoder Address are phrases that are used interchangeably in this manual. The phrase is a reference to the "number" programmed to the decoder in the locomotive. This is why we recommend using the number painted on the side of the locomotive as the decoder address or number. It will be easy to glance at the locomotive and know what decoder number to use.

Just changing the throttle's operating frequency or Loco number does not program or change the G4 Decoder.

Battery Hookup And Polarity Verification

Caution: 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 G4 decoder. Use these diagrams as a generic guide to the connection of the G4 decoder to your locomotive.

Use #20 AWG wire for all battery and motor 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 heat shrink tubing.

Always include a power switch in every installation. The power switch is used to disconnect the battery from the locomotive and the electronics. A fuse is not needed because the CVP battery contains built-in protection. However, a non-CVP battery may require a fuse to protect the battery against catastrophic failures caused by improper wiring. A fuse will be shown in the drawings.

Polarity Verification - one way to quickly end the life of the G4 decoder is to connect up the battery with the plus and minus reversed. So we have included polarity testing diode with the G4 decoder is that is used to verify that you have the plus and minus leads properly identified before you connect them to the decoder.

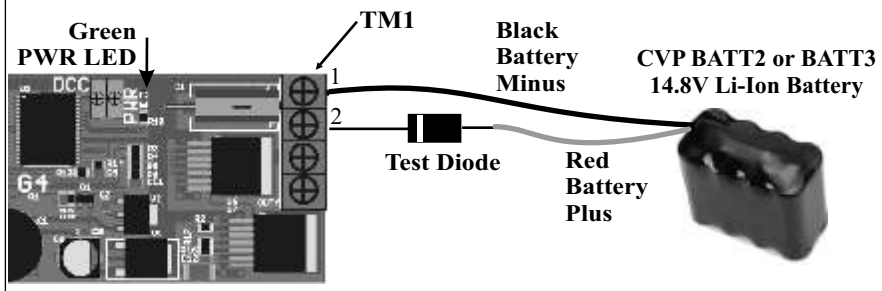
TM1 is the large 4 pin terminal strip on the end of the G4 board. It is usually colored blue. Pin 1 is at the top corner of the board when the terminal strip is facing to the right. Terminal strip references are shortened to the terminal strip name, like TM1, and a specific pin number. For example, TM1-1 is where the battery minus (negative) always connects.

Step 1: Before using the diode, first connect the battery minus lead, the black wire, to the decoder's TM1-1 and tighten the screw. TM1-1 is the battery minus connection.

Step 2: Insert the banded end of the diode into TM1-2 and tighten the screw. Now touch the battery plus lead, the red wire, to the non-banded end of the diode. If the G4's bright green LED turns on, then the polarity is correct.

If the G4's green LED does not turn on, something is not correct. There could be a broken wire or perhaps the insulation is preventing the battery's black wire from making proper contact to the terminal strip. It might be dead battery. Regardless, now is the time to find and fix the problem.

Once you have confirmed and identified the proper polarity, mark the wires or make a drawing so that you can refer to it when you are ready to make the permanent hookups.



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

Power Through The Rails - Some Considerations

The G4 decoder is designed for battery powered operation. Although power can be supplied through the rails, we do not recommend it. It defeats the purpose of why AirWire was created. But, 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.

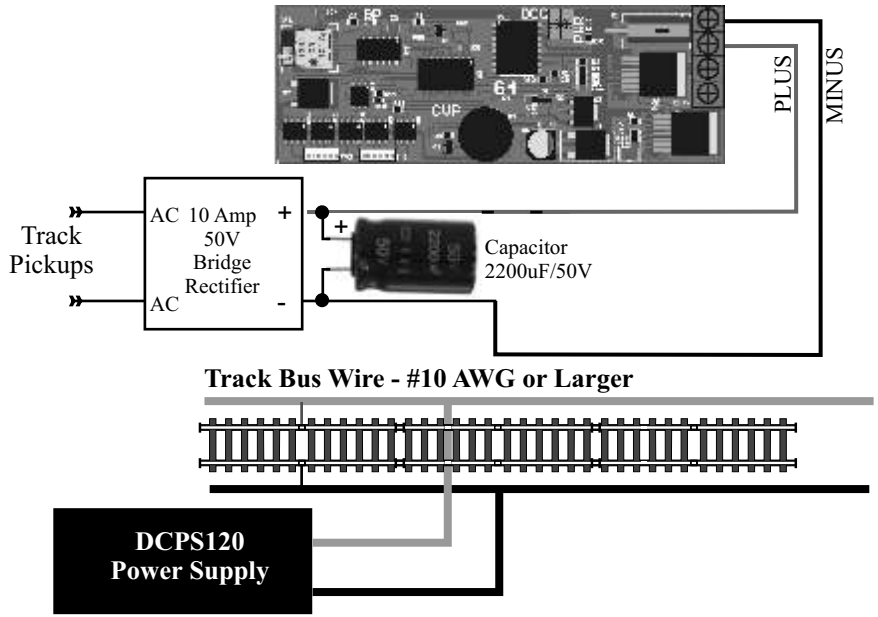
Wiring the railroad becomes a long and boring chore. If you use battery powered locomotives, your wiring job reduces to simply connecting the decoder to the motor. There is no need to worry about reverse-loops, turnout wiring, dead frogs, opposing point switch wiring, route control wiring and the many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

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!

However, if you insist, then here is the hook up diagram and the required external components to allow the G4 decoder to draw DC power from 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 high current DC power supply. CVP's DCPS120 power supply is a suitable power supply. For safety purposes, te sure and feed the DCPS120 from a GFI protected outlet. Set the DCPS120 power supply to 15 volts.

The DCPS120 Power supply is a 120 Watt, adjustable DC power supply with excellent load regulation. The output voltage is variable from 12V to 24V. It has built in overload and short circuit protection. It is available direct from CVP Products. See the website for ordering details.



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 and slipping on the grade. A slipping or stalled locomotive will quickly drain the batteries.

Derating Maximum Output Current In Hot Climates

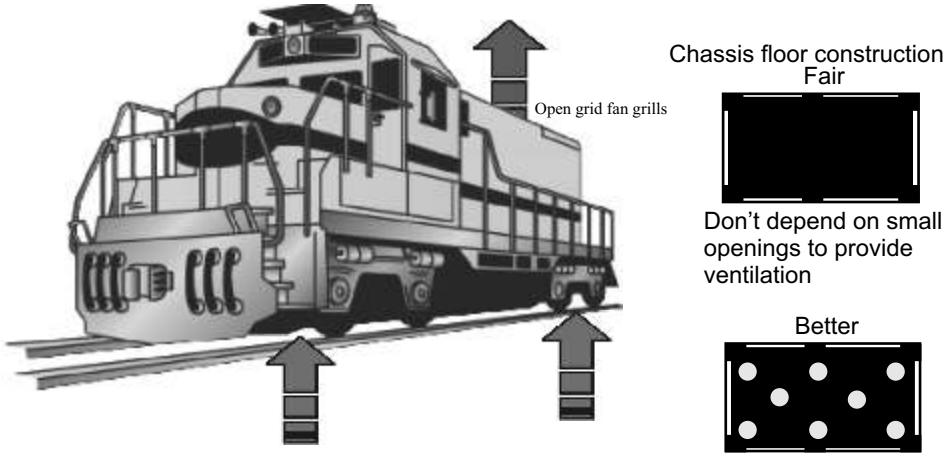
High outdoor temperatures will result in hot interior temperatures even when there is good airflow. The G4 output current is limited based on the temperature of the transistor drivers. If the drivers overheat, because of excess motor current or because of a hot interior, the transistors will shut down to protect themselves.

A good rule of thumb is to derate the available current by about 1 Amp per 10 degrees F of temperature increase above 80 degrees F. For example, if the outdoor temperature is 100 degrees F, the maximum allowable current should be decreased by about 2-3 Amps.

G4 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 output driver, 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.

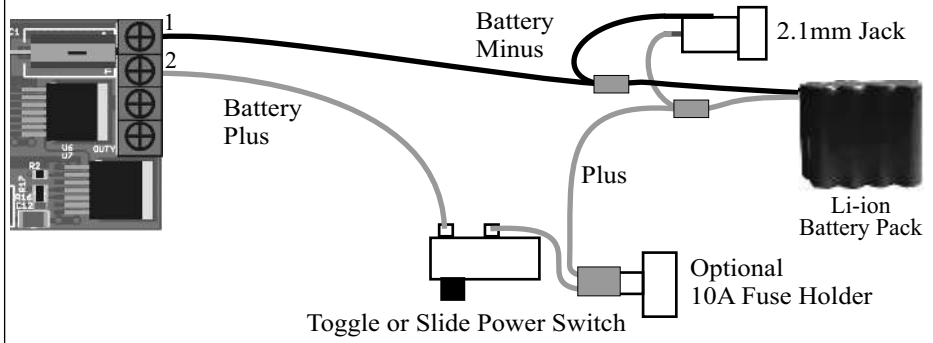


Airflow In Modern Plastic Diesel Locomotives

Final Battery Connections

Once the polarity is confirmed, and you are ready for final installation inside the locomotive, the wires can be connected permanently. Insulate all bare wires with tape or heat shrink tubing.

The optional 2.1mm jack is for the battery charger. See below for where to get this jack and more useful accessories.



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.

Matching Battery Sockets and Plugs

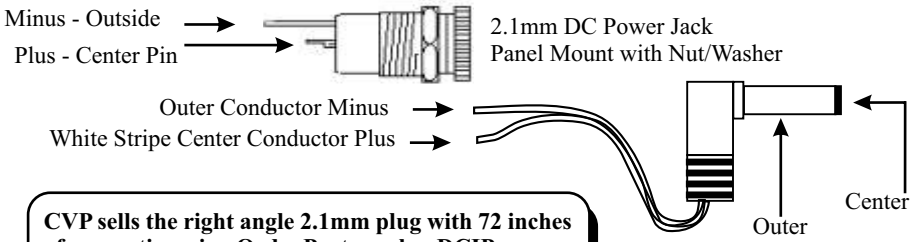
If using CVP Batteries, do not cut off the plug. This voids the battery warranty. Instead, purchase matching battery sockets from CVP. The color coding and polarity matches the CVP Battery. Connections will be easier to make as well as making it easy to swap out batteries. The sockets are inexpensive so buy several to have on hand. Separate plugs are also available. Go to the CVP website to see the options and latest .

Charging Jacks and Cords

From the Digikey Catalog - www.digikey.com

Description	Part Number
Heatshink tubing assortment kit	Q842-KIT-ND
24 inches long, 20 gauge wire with right angle 2.1mm plug	172-7445-E
2.1mm Jack Panel Mount	SC-3508
2.1mm Jack Panel Mount - High Current	839-1580
2.1mm Jack with built-in slide switch	1528-2552-ND

Great idea if you have the space. Slide switch and jack in one unit.



CVP sells the right angle 2.1mm plug with 72 inches of connecting wire. Order Part number DCIP.

Recommended Battery and Charger

A 14.8V, Lithium Battery Is Recommended - 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 CVP BATT2 or BATT3 battery packs are small, lightweight and pack a lot of power into a small package. The BATT2 can power a large USA-Trains SD70 for more than 3 hours.

BATT2 Battery Pack

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

The BATT2 dimensions are 2.9 x 2.8 x 1.5 inches.

The BATT3 dimensions are 2.75 x 1.46 x 1.46 inches.

Low Cost, Universal AC Input, Smart Charger - This charger works off any household line voltage from 90 to 240V 50/60Hz. The built in microprocessor will automatically select the correct charging profile and cut off charging when the battery is fully charged. Indicator lights show red when charging and green with the battery is fully charged. It comes with alligator clip leads.

CVP Li-Ion 14.8V Charger

The BATT2 and BATT3 battery packs are available from authorized AirWire Dealers and directly from CVP. The CVP charger is sold directly by CVP.

Using Other Batteries and Voltages

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 G4 decoder will run much cooler.

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

Absolute Maximum Input Voltage For The G4 Is 24 volts.

Do Not Exceed 24V When Battery Is Fully Charged - A fully charged battery can be from 2 to 3 volts higher than the voltage rating of the battery. For example, the CVP 14.8V lithium battery pack will read about 16.5 volts to 17 volts when fully charged.

Please Read The Battery Safety Datasheet

The safety datasheet discusses dos and don'ts of charging Li-Ion batteries. It also discusses long term storage procedure and requirements.

Heat and Hot Weather Tips -Managing Heat Buildup

When operating the G4 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.

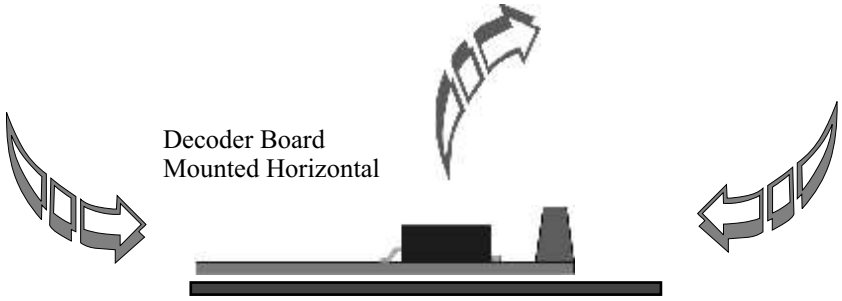
Mounting Tips

Never wrap the decoder in insulating material. Never cover or coat the decoder with RTV adhesive. Not only will this cause heat buildup, but almost all adhesives are conductive, especially when uncured. Don't take any chances!

The decoder should be mounted such that the two large black 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.

Vertical board mounting allows better airflow

continued on next page



Mounting the decoder horizontally is OK too

The bottom of the G4 board must not contact any metal. Also, the small pins of the board must not puncture any type of thin mounting tape and contact metal. Be careful not to let wire scraps or metal shavings drop onto the top or bottom of the board. If this happens, the G4 will be damaged. This type of damage is not covered by the warranty.

Run Time And Battery Charge Life

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: type of railroad, locomotive condition, 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, CVP's BAT2 battery pack is rated at 6.8 Amp-hours. In other words, the battery will last about 2.3 hours if the locomotive pulls 3Amps. Fortunately, the locomotive motors will seldom get close to that value. Under normal operating conditions, you can expect up to 3 or 4 hours from one charge.

The Motor Is The Primary Battery Drain

When running on straight and level track at about half of top speed, the twin motors of the USA-Trains will pull between 1.0 and 1.5 amps. There is also a brief but high current draw when the locomotive initially begins moving.

Locomotive speed also affects battery drain. The faster the locomotive speed, the faster the battery drain. Slow down and your battery will last longer.

If the speed is constant, but more cars are added, the faster the battery drain. But there is a limit to the number of cars that may be pulled.

Lugging down the motor by forcing to haul too many cars up the hill will very quickly drain the battery. Instead, use multiple locomotives or helpers. Your batteries will last much longer. Also, slower running decreases the battery drain. You can also limit the number of cars.

Smoke Generator Is the #2 Battery Drain

There is one other item that can quickly drain the battery - the smoke generator. The little smoke generator consumes about a half amp when running. Fortunately, the G4 decoder has a built in timer that shuts off the generator after about 3 minutes. This will insure that it will automatically turn off should you forget. The shut-off time is programmable from 1 to 255 minutes. .

Lighting And Battery Drain

If you use LEDs, the battery drain is minimal. But if you use incandescent bulbs, the current draw is substantial. To maximize battery life, replace all light bulbs with LEDs. Also, turn off all unused lights or lights that are not easily seen. For example, diesel number-boards will hardly be noticeable in broad daylight - so turn them off and save a bit of power.

G4 Decoder - Absolute Maximum Ratings

Maximum Input Battery Voltage	24 Volts DC
Minimum Input Battery Voltage	10 Volts DC
Maximum Motor Output Current - Pulse	Internally Limited ~ 18A peak
Maximum Continuous Motor Output Current	~ 8 Amps at 25°C @15V
Maximum DCC Auxiliary Output Current	2.5A
Maximum Headlamp Output Current	1 Amp*
Maximum ELITE Output Current	1 Amp*
Maximum Smoke Generator Current	3 Amp*

*Not protected against overloads or short circuits

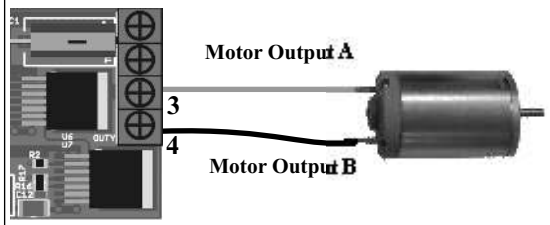
Do not allow water to contact the decoder. This will certainly cause the receive range to be much lower and can damage or destroy the decoder.

Decoder to Motor Hookup

G4 Motor Output Terminals on Terminal Strip TM1

Terminals TM1-3 and TM1-4 go to the locomotive motor. Use stranded wire to make connections. #20 wire is usually more than adequate. For best noise suppression, twist the two motor wires together. Always tin the wire before inserting it into the terminal strip.

When inserting the stripped and tinned wire, the bare wire should be just barely visible 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 locomotive trucks rotate freely.



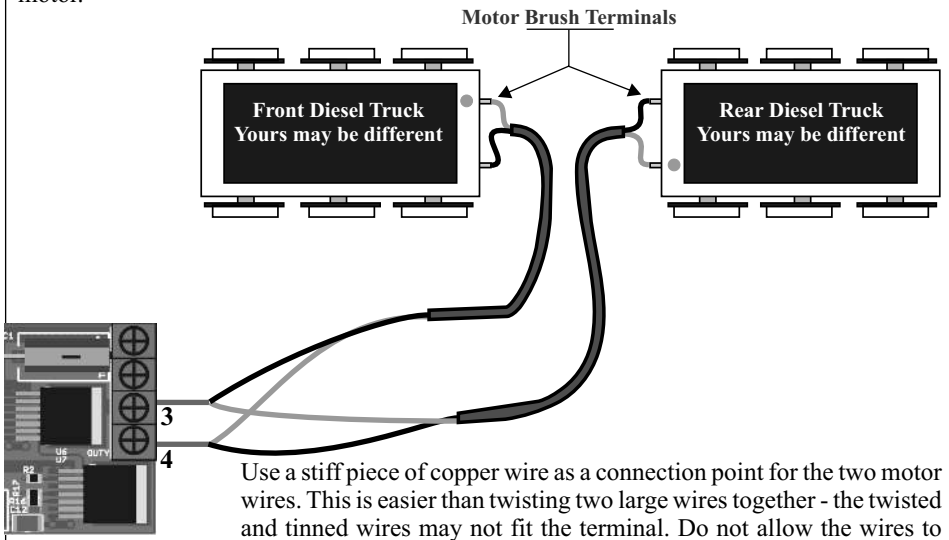
Neat wiring is a must: When making wire connections inside the loco, use the shortest length of wire that will do the job. After the wires are attached and insulated with heat shrink sleeving, secure them so that repeated removal and replacement of the locomotive shell won't pull the wires loose. The biggest cause of decoder failure after initial installation is wires being pulled loose and shorted to the frame when the shell is removed or replaced.

Incorrect operation of the constant speed feature will occur if there is other circuitry, including lighting circuit boards, connected to the G4 motor terminals. Only motors can connect to the G4 motor terminals.

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 wires on the appropriate motor.



Use a stiff piece of copper wire as a connection point for the two motor wires. This is easier than twisting two large wires together - the twisted and tinned wires may not fit the terminal. Do not allow the wires to touch any metal objects. Do not allow the motor wires to short together.

Bench Test The G4 First

It is always a good idea to test your new G4 on the bench before installation. Use an old motor and the battery you intend to use in the installation. Connect the motor and the battery to their respective terminals. Then follow the quick start instructions below. If things don't work correctly, stop and figure out why. Now is the time to resolve any questions or issues before you install the G4.

Quick Start Instructions

The "Quick Start" section assumes you have installed your new G4 decoder (or are testing it on the bench) and the G4 is on the original factory settings of frequency 0 and address 3. Also, the T5000 throttle will be used for all setup of the decoder..

Step 1: Turn Power on to the Decoder

- The G4's green LED will glow brightly indicating power is connected. If you have not done so, now turn on your throttle and set it to frequency 0 and address 3 which are the original factory settings for the decoder.
- When the throttle is turned on and set correctly the G4's red LED will glow brightly. If the red LED is not on, then your throttle is not set properly. Do not proceed to step 2 until both red and green LEDs are turned on and glowing steadily.

Step 2: Program the G4 Loco Number [also called the Decoder Address]

Note: If the original loco number of loco 3 is OK, then you can skip step 2.

- Select SERVICE PROGRAM mode on your throttle. For T5000 throttle, press menu twice and then push the number 4.
- Next, push 1 for the CV number followed by ENT. CV1 is where the loco number is stored.
- Next, key in the numbers that are to be the new decoder number followed by ENT. The range is 1 to 9999. Leading zeroes are not needed. The decoder number must be unique. Most users, use the number painted on the side of the locomotive.
- The decoder chirps 2 times for an address from 1 to 99 or 3 times for an address from 100 to 9999, Address 0 is not allowed. If you accidentally use 0, start over and use the desired address. When you hear the chirps, the decoder has accepted the new address.
- Don't push ESC unless you don't need to change the decoder frequency.

Step 3: Change the G4 Frequency [If Frequency 0 Is Not Wanted]

- The original factory setting for the G4 frequency is 0. Follow these simple steps to change it.
- Select SERVICE PROGRAM mode on your throttle. For T5000 throttle, press menu twice and then push the number 4.
- Key in 200 followed by ENT. CV200 is where the decoder frequency is stored.
- Enter the desired frequency number and push ENT. The decoder chirps once to indicate receipt of the new frequency. The red LED will go out because the decoder is now on the new frequency.

Step 4: Set the Throttle And Run!

- Set your throttle to the new decoder frequency and verify it is on the new loco number. .
- Set the direction and turn up the speed knob and you are in control.
- You can store the frequency and decoder address in throttle memory by pushing the LOCO MEM key twice. This is not mandatory but does make it easier to recall the address and automatically set the proper frequency.

The first task when configuring a new G4 is to set the desired locomotive address. If the sound decoder is attached, it too will be set to the same address at the same time.

Operational Considerations

Consider Using 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.

For this installation The in-line fuse can be placed between the jack and the battery for protection against an accidental short circuit. Make sure the fuse is rated at 10 Amps and it should be a slo-blow style. The CVP fuse kit FK9 includes a 10 amp slo-blo fuse.

Beware of Lurking Locomotives When Using SERVICE PROGRAM Mode

SERVICE PROGRAM mode is a broadcast command that can be heard and understood by any other decoder sharing the same frequency as the intended decoder. If another decoder receives the command, it too will be programmed. Play it safe and make sure to turn off all power switches on locomotives not being programmed.

Beware of Other Transmitters

The G4 decoder operates in an unlicenced 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 decoder's 17 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, unlicenced 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.

Never Use RTV or Silicon Adhesive On The G4

NEVER use RTV or other liquid adhesive to attach the G4 to the locomotive. That material is conductive and will destroy the decoder. Use only double-sided foam tape.

Decoder Placement Suggestion For Best Range

If possible, mount the decoder horizontally and as high as possible within the locomotive. If you are using the G4 with a whip antenna, a vertical antenna may offer better range although you should also try horizontal. Keep the whip antenna away from motor and battery wiring as much as possible. Never let it touch anything metal. For metal locomotives, the need for an external antenna becomes very important. CVP offers some external antennas that use the same socket as the whip antenna. See the CVP website for details.

Additional Tips To Maximize Range

One of the best methods to dramatically increase range is to use lower voltage batteries. Changing from 22V NiMH battery pack to a 14.8V Li-ion batter pack results in a 2X to 4X range improvement because there is less electrical motor noise created.

Additional CVs Not Mentioned Elsewhere

Decoder Address CV1
Range is 1-9999 . . . . . [3]

When SERVICE PROGRAM is used to set the decoder address, the throttle actually sends a group of commands to set CV1, CV17, CV18 and CV29. That is why you hear as many as 3 chirps when CV1 is set to the desired address from 1 to 9999. Do not use address 0, it is not supported.

Loss of Signal Timer (LOS) CV11
Range is 0-255 seconds . . . . . [0]

Failsafe Operation - If your locomotive goes out of range of the throttle or the throttle is no longer transmitting, you can set the locomotive to either continue running or stop after a preset amount of time. The timer range is 1 seconds to 255 seconds. A value of zero means the locomotive runs forever, or until the battery runs down.

If CV11 = 0 this selects continuous operation. In other words, the locomotive continues to operate at the last received speed command forever. The assumption is that it will eventually come back into range of the locomotive. Another reason to use continuous running is because you want to control several trains with a single throttle. Changing the throttle's address to control a new address means the original address is no longer being used. This is the same as turning the throttle off or going out of range. With the decoder set to operate continuously, the locomotive will continue to run at the last received speed command. To regain control, first set the speed knob and direction close to the locomotive's current speed and then select the new address.

If CV11 value is not equal to zero, then the locomotive will come to a smooth halt after the timer value counts down to zero.

Loco Address High Byte CV17
Range is 0-255 . . . . . [0]

Loco Address Low Byte CV18
Range is 0-255 . . . . . [0]

CV17 and CV18 are automatically set based on the setting of CV1 to the desired locomotive address. We do not recommend that manually changing these CVs. Use CV1 to set them automatically.

Decoder Frequency Number CV200
Range is 0-16 [17 frequencies available] . . . . . [0]

CV200 holds the assigned frequency number for the G4 decoder. If a number larger than 16 is attempted, the decoder rejects it and automatically sets itself to frequency 0. If you have forgotten the frequency, see page 8 for the procedure to temporarily force the G4 to a known frequency.

G4 Frequency Selection

Each throttle/decoder pair must be on a unique frequency so as not to jam other throttle/decoder pairs.

The G4 decoder features remote frequency selection directly from the throttle. The decoder frequency is remembered even if the battery is disconnected.

17 Unique Frequencies Are Available - The frequencies are numbered from 0 to 16 for a total of 17.

Write The Frequency Down - While you may remember the frequency next week; how about in 6 months? Use a sticky label on which to record the frequency set into the decoder. If you use a locomotive address other than the obvious cab number, write it down too. Place the label somewhere on the locomotive where it can be seen. We put our label on the bottom of the fuel tank or tender.

Setting The Frequency - The decoder's frequency is stored inside the decoder in configuration variable number 200 which is abbreviated CV200.

*Ca*ution: The throttle's frequency must be set on the present decoder frequency so that it will "hear" or receive the programming command to change the frequency. If you have forgotten the present decoder's frequency, see the section below for how to reset the decoder's frequency.

G4 Frequencies

The G4 decoder can be set to any of the 17 AirWire frequencies numbered 0 to 16.

Number	Frequency (MHZ)	Number	Frequency (MHZ)
0	921.37	9	924.62
1	919.87	10	923.12
2	915.37	11	918.12
3	912.37	12	916.87
4	909.37	13	913.62
5	907.87	14	910.87
6	906.37	15	904.87
7	903.37	16	916.37
8	926.12		

G4 Frequency Selection Using The T5000 Throttle

T5000 Key Sequence to Change Decoder Frequency Using SVC PROGRAM

1. Set throttle to decoder's present frequency.
2. Push MENU key twice and push 4 to enter SVC PROGRAM mode
3. Key in 200 followed by ENT. CV200 is where the decoder frequency is stored.
4. Key in the desired frequency number and push ENT. The decoder chirps once to indicate receipt of the new frequency.

Note: If you enter a frequency value larger than 16, the decoder will not accept it and, instead, will reset the frequency to 0. It still chirps even if this occurs.

5. Push ESC to cancel SVC PROGRAM mode.
6. Change the throttle's frequency to match the new decoder frequency and operate locomotive.
7. Write down the new frequency.

Optional: push LOCO MEM key twice to store locomotive address along with its new frequency in your T5000 throttle.

Quick-Start - Resetting The G4 Frequency

There may come a time when the decoder no longer responds to what you believe is the correct frequency, or you can not remember the correct frequency. See page 6 for additional notes about forgotten frequencies or forgotten addresses.

Step 1 - turn off all AirWire throttles. This is very important since it is the absence of a throttle signal, plus turning the power off and then back on (a power cycle), that allows the decoder to temporarily jump to frequency 0 where you can set a new frequency.

Step 2 - Turn off the G4 if it was powered on.

Step 3 - Turn on the G4 and wait at least one minute. The G4 *w*ill chirp 5 times at the end of 1 minute.

Step 4 - Turn on your throttle, and set it to frequency 0.

Step 5 - Use SERVICE PROGRAM to set CV200 to the desired frequency. It will chirp when the command is accepted.

See the next page additional information regarding a forgotten address or frequency.

Restoring G4 To Original Factory CV Values

CV8 is used to restore or reset the G4 back to original settings as it comes from the factory. All values that you may have entered will be erased. The original factory values for each and every CV are then restored. The back cover has a complete listing of all CVs and their original factory values. After issuing the factory reset command, the address is changed to 3 and the frequency is changed to 0. The factory reset with CV8 only works on the G4 decoder. It will not affect or reset any attached sound decoders. See the sound decoder manual for how to reset the sound decoder. .

If you do not remember the decoder's frequency, a special procedure must be used to access and reset the frequency on the decoder. See the next page.

Reset Decoder To Factory Defaults. CV8

Only a single value is accepted [all others are rejected] . . . . . [135]

Step-By-Step T5000 Instructions For Resetting G4

Turn on the T5000 by pushing MENU. Verify it is set to the same frequency and address as the decoder. This reset will be done using "Service Programming" menu option [SVC PROGRAM].

1. Push MENU to see options 0-3.
2. Push MENU again to see options 4-7.
3. Push 4 to select SVC PROGRAM.
4. Push 8 for the CV number to be programmed
5. Push ENT
6. Enter the numbers 1, 3, and 5 for value that CV8 will be programmed to.
7. Push ENT and listen for the decoder to chirp.
8. Push ESC to return to the return to the normal loco operating page.

At this time, the decoder has been reset to factory defaults. It will be on address 3 and frequency 0.

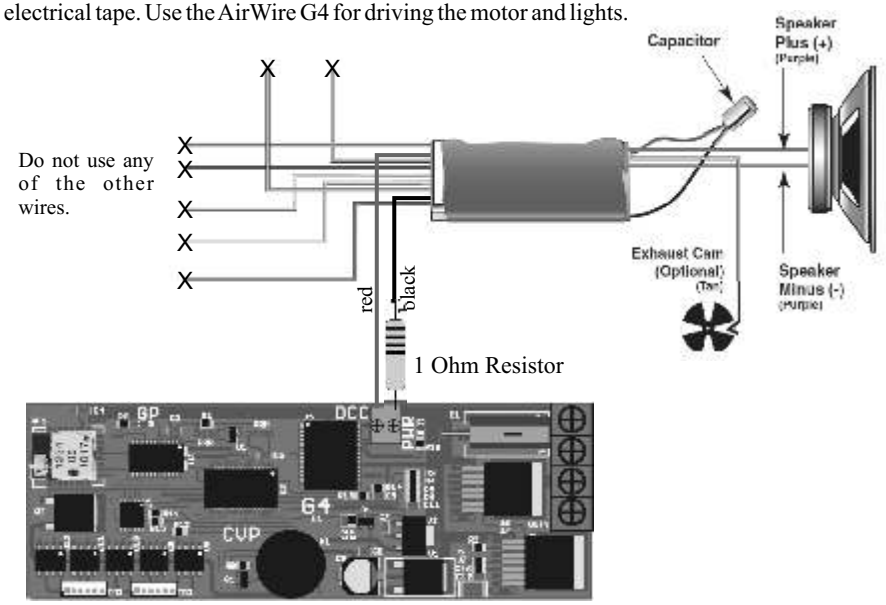
Set your throttle to loco number 3 and frequency 0 and confirm that decoder has been reset.

G4 Decoder And Soundtraxx Tsunami Decoder

The Tsunami decoder plus a G4 makes an great alternative to the Phoenix products sound decoders. Hookup is very simple with only the red and black wires attaching to the G4's H1 header. If you use the recommended 14.8V battery, or your G4 is the r9G4 version, the resistor is not required and the black wire connects directly to the G4. Older G4 decoders need the resistor to limit the Tsunami surge current.

Tsunami recommended voltage is 18 volts. Absolute Maximum Voltage is 22 volts.

There is plenty of power from the G4 driver to handle the Tsunami. But, do not use the Tsunami motor driver outputs, nor the lighting outputs (shown with an X). Cover the ends of these wires with electrical tape. Use the AirWire G4 for driving the motor and lights.



Setup Sound Decoders With The T5000 Throttle

Use your T5000 throttle to setup and program the operation of the attached sound decoder. All of the programming commands from you're your throttle will pass through to the sound decoder or module.

If The Sound Decoder Doesn't Always Turn On

Some sound decoders will not turn on their sound unless there is a throttle turned on with a matching address. Make sure your G4 and attached sound decoder have matching addresses. See page 9.

Numerous Shared CVs

There are numerous shared CVs between the Tsunami decoder and the G4. For best results, first program the Tsunami CVs and then turn off its power switch. When the Tsunami is powered off, you can program the CVs in the G4.

See the Tsunami decoder manual for more details on their CVs. Also check if the Tsunami offers a locking CV to lock out any changes. You might find this easier to use then the power switch.

Recommended Phoenix P8 Configuration and Setup

P8 Configuration and Setup Recommendations

These modifications are done with the Phoenix programming software and their PC interface hardware. Only those items that are different than the standard settings are shown. For example, the automatic tooting of the horn and ringing of the bell are turned off. If you like that effect, then don't change the original setting. Once all the changes have been loaded into the P8 module, save the configuration file under the locomotive number before disconnecting the computer interface.

Volume Levels	Was	Recommended
Fwd Horn Volume	90%	0
Rev Horn Volume	100%	0
Stopping Horn Volume	100%	0

Numeric Settings	Was	Recommended
Stopping Bell Speed	20	0
Stopping Bell Duration	8	0
Startup Bell Duration	4	0
Triggered Bell Duration	6	0
Auto Bell Speed Limit	40	0
Bell Holdoff	30	0

Selection Settings	Was	Recommended
Chuff Averaging	Disabled	Disabled
Speed From DCC	Disabled	Disabled
MTS Detection	Enabled	Disabled

Trigger Terminal Assignments	Was	Recommended
Trigger 1	Chuff Pin	<unassigned>
Trigger 2	Manual Whistle Pin	<unassigned>
Trigger 3	Bell Pin	<unassigned>
Trigger 4	Blowdown Pin	<unassigned>
Trigger 5	Station Pin	<unassigned>
Aux Board 1/T1	Drifting Pin	<unassigned>
Aux Board 1/T2	Water Fill Pin	<unassigned>
Aux Board 1/T3	Coal Load Pin	<unassigned>
Aux Board 1/T4	Coupler Pin	<unassigned>
Aux Board 1/T5	Crossing Whistle Pin	<unassigned>
Aux Board 1/T6	<unassigned>	<unassigned>

Free P8 CVP Diesel Config File From Phoenix

You may download a CVP diesel configuration file from the Phoenix website for the above features as well as the function key assignments for the P8 sound module.

www.phoenixsound.com/support/download.html

CVP Products does not provide customer support for the P8 sound module. Please contact Phoenix Sound Systems directly via email or phone.

(800) 651-2444 Email:
phoenixsound@phoenixsound.com

Forgotten G4 Frequency Recovery

There may come a time when you do not remember the G4 decoder's assigned frequency. If this happens, use the following technique to reset the G4's frequency. No other changes are made.

How This Works: This problem is easily solved with what we call the "Jump Mode." When Jump Mode is activated, the G4 temporarily "jumps" to frequency 0. Once your G4 decoder has jumped, you then use SVC PROGRAM to change the frequency to whatever you wish.

To Reset Frequency Using Jump Mode And SVC PROGRAM

- Step 1: Turn off **all** AirWire throttles. This is very important since it is the absence of any throttle signal that forces the G4 to temporarily jump to frequency 0. *Make sure there are no lurking locomotives, powered up and set to frequency 0. If so, their frequencies will be change too.*
- Step 2 - Turn off the G4 if it was powered and then turn it back on.
- Step 3 - Wait a minimum of one minute. If you can see the GP LED, is will slowly flash during the wait time. Listen for the 5 second count down chirp. When the chirps stop, the GP LED will be dark and the G4 is temporarily on frequency 0. You must wait at least one minute before moving to step 4.
- Step 4 - Turn on your throttle, and set the throttle frequency to 0. If visible, the G4's GP LED will now turn on steady.
- Step 5 - Use **SVC PROGRAM** to set CV200 to the desired frequency. Be sure and reset your throttle to the new frequency.
- Step 6 - Cycle the power to the G4 to activate the new frequency.

Using OPS PROGRAM To Change Frequency in Jump Mode

If you are confident you know the decoder's address, then you can use OPS PROGRAM to change the G4's frequency. OPS PROGRAM is the safest way to change the frequency and insures no other decoders will have their frequency changed. But the catch is you must know the decoder's. If you are not sure, then use the SERVICE PROGRAM mode above.

- Step 1: Turn off **all** AirWire throttles. This is very important since it is the absence of any throttle signal that forces the G4 to temporarily jump to frequency 0.
- Step 2 - Turn off the G4 if it was powered and then turn it back on. .
- Step 3 - Wait at least one minute. If you can see the GP LED, is will slowly blink during the wait time. Listen for the 5 second count down chirp*. When the chirp stops, the GP LED will be dark and the G4 is now temporarily on frequency 0. You must wait at least one minute before moving to step 4.
- Step 4 - Turn on your throttle, set it to frequency to 0 and enter the decoder's address. If visible, the G4's GP LED will now turn on steady.
- Step 5 - Use **OPS PROGRAM** to set CV200 to the desired frequency. Be sure and reset your throttle to the new frequency. A power cycle is not needed.

Notes About The Jump Mode

- The jump mode is canceled and normal operation resumes if a throttle is turned on that matches the present G4 setting **within one minute** of the decoder power being turned on.
- If the G4 jumps to frequency 0 because you waited too long to turn on the throttle, just cycle the decoder power and make sure the throttle is turned on within one minute.
- The jump to frequency 0 is temporary and **nothing is changed** in the decoder. However the G4 will stay on frequency 0, until power is cycled or you change the frequency by setting CV200 to a new value. If you did not change the frequency, the G4 will revert back to its previously stored frequency as soon as G4 power is cycled off then back on.
- The G4 decoder will not jump to frequency 0 if a throttle having a frequency that matches the decoder is turned on within one minute of turning on the decoder even if the address is different.
- If a frequency number higher than 16 is used, it is ignored and the decoder uses frequency 0.

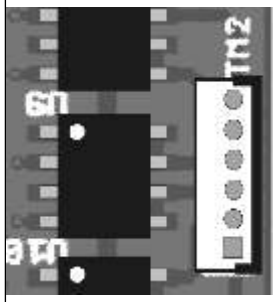
If the G4 "hears" a throttle on its frequency, within one minute of a power cycle, it will not jump to frequency 0 even after the throttle is turned off or changed to another frequency.

The Light, Smoke And Coupler Driver Outputs

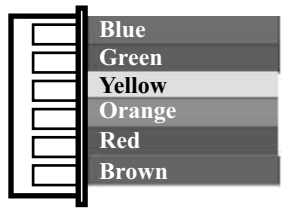
All of your locomotive lights, couplers and smoke generator connect to two small headers, TM2 and TM3. TM2 has the usual front and rear headlight connections as well as the ditch/safety light connections. Two more extra lighting outputs take the last two wires. TM3 has 2 more lighting outputs, the two remote coupler drivers and the smoke generator. With the exception of the remote couplers, all light drivers will use the BAT+ as the power source for the lights. The drivers are optimized for LEDs although 18V incandescent bulbs may be used.

The wiring harness comes as a single cable with plugs on each end of 48 inches of colored wire. Cut the wire with a pair of scissors. When cut in half, there are two plugs, one for each header. However, you may cut the cable to any length desired. Save the wire scraps. They are useful for all kinds of small wiring jobs.

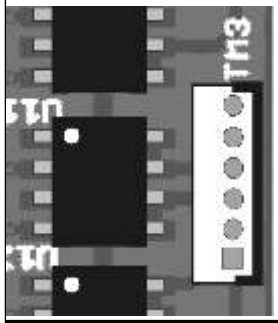
Use fingernails to strip the wire. Twist the strands together and apply a small amount of solder to the twisted wires. This is called "tinning" and keeps the wires from fraying.



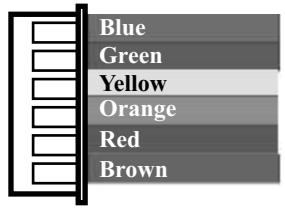
Included Cable and Plug



TM2	Output	Activate
6	ELITE#2	F9
5	ELITE#1	F6
4	Ditch Lite Left	F0+F4
3	Ditch Lite Right	
2	Rear Headlite	F0+r
1	Front Headlite	F0+f



Included Cable and Plug

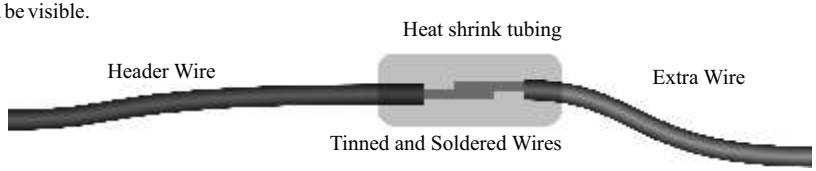


TM3	Output	Activate
6	Coupler Voltage	na
5	Smoke Generator	F10
4	Rear Coupler	F3
3	Front Coupler	F13
2	ELITE#4	F14
1	ELITE#3	F11

Wires Too Short?

For a few installations, it may be necessary to splice an additional wire to the selected harness wire. This is relatively easy to do. Use #30 gauge stranded wire. Larger wire is OK but larger wire will be stiffer. Match the color of the harness wire if at all possible.

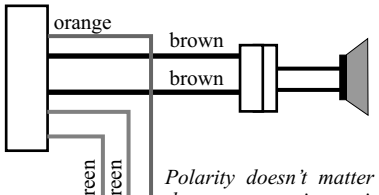
To splice the two wires together, gently strip the insulation from the ends of the two wires. A half inch of bare wire is OK. Longer is OK too but it will need to be trimmed after tinning. Twist the strands together. Heat the strands with your soldering iron and apply a small amount of solder. Trim the tinned wire to no more than a half inch. Tin and trim the other wire. Lay the two wires on top of each other and apply a bit more solder for a good joint. Cover the soldered wires with a length of heat shrink tubing. The tubing must cover the spliced wires. No bare wires should be visible.



Remington Industries sells a reasonably priced kit of 6 rolls of #30 stranded wire having the same colors as the G4 cable. It's a great addition to your workbench.
SKU: 30PTFESTRKIT www.remingtonindustries.com

G4 Decoder and Phoenix P8 Hookup

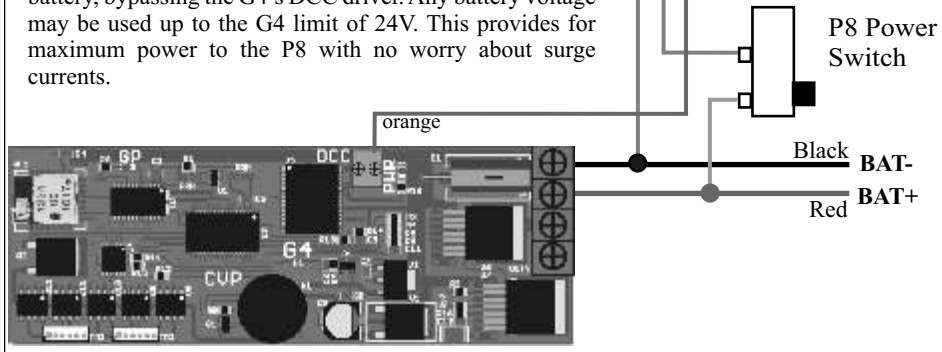
P8 Recommended Hookup



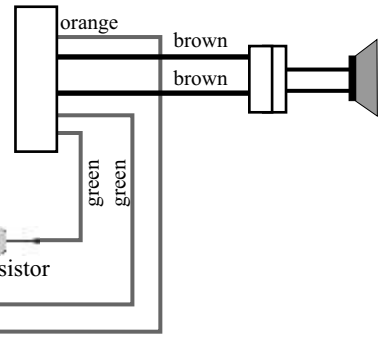
Polarity doesn't matter for the green power input wires

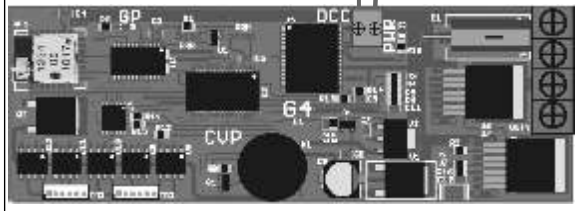
Hookup Option #1

This option allows the P8 to draw power directly from the battery, bypassing the G4's DCC driver. Any battery voltage may be used up to the G4 limit of 24V. This provides for maximum power to the P8 with no worry about surge currents.



P8 Hookup Option 2





Hookup Option #2

This option uses just two wires from the G4 to the P8. However, the limit resistor is required due to the high surge current of the P8. That is why Option 1 is highly recommended.

The Phoenix PB17 can also be used in place of the P8.

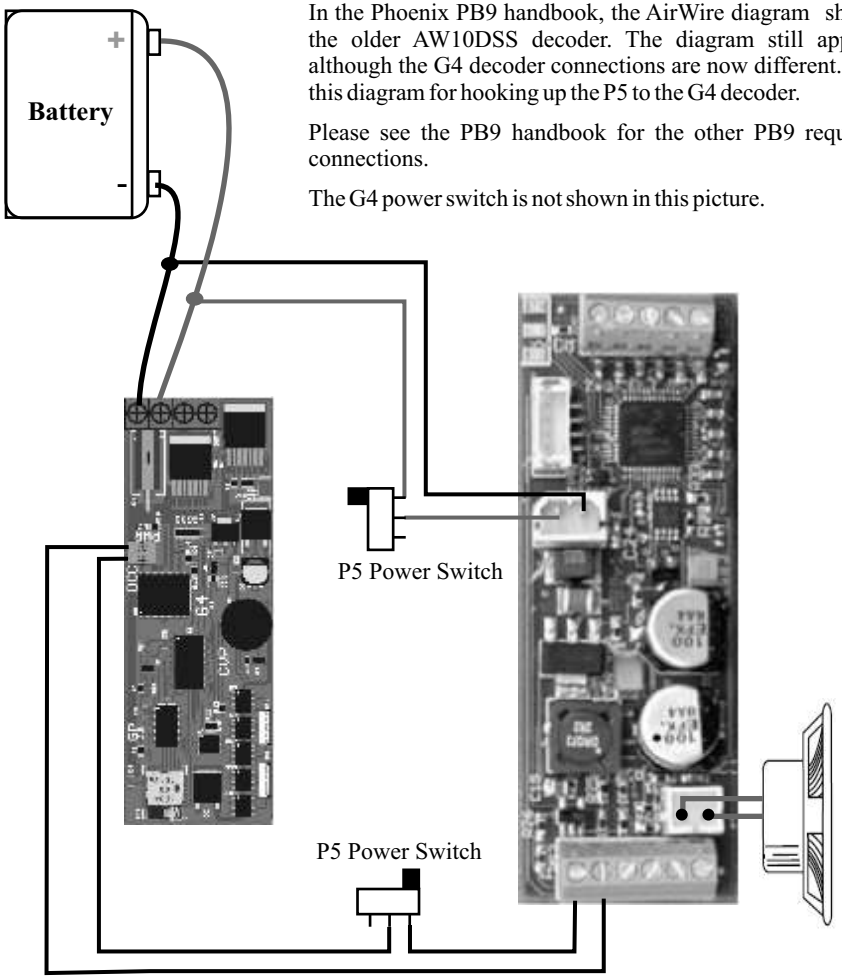
G4 Decoder And Phoenix PB9 Hookup

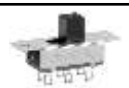
The PB9 connects directly to the G4 decoder's auxiliary DCC outputs. The G4 has more than sufficient power to handle the PB9.

In the Phoenix PB9 handbook, the AirWire diagram shows the older AW10DSS decoder. The diagram still applies although the G4 decoder connections are now different. Use this diagram for hooking up the P5 to the G4 decoder.

Please see the PB9 handbook for the other PB9 required connections.

The G4 power switch is not shown in this picture.





The power switches are shown as two separate switches for clarity. However, it should be a **single** DPDT switch like the one above.

Programming The Sound Decoder Address

To program *any* external sound decoder's address, first connect the sound decoder to the G4 decoder. Set the G4 frequency to match the throttle's frequency and turn on power to both.

Use SERVICE PROGRAM and set CV1 to the desired address. This sets both the G4 and the attached sound decoder to the same address at the same time. See the throttle manual for detailed instructions.

Shared CVs

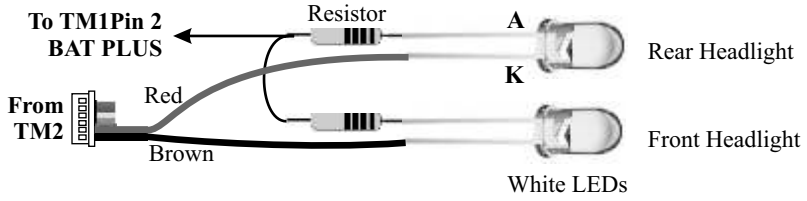
You may program the G4 without fear of changing the P5 programming. The only shared CVs are the address CVs, which are 1, 17 and 18.

Example LED Hookup

For this example, only the forward and reverse headlights will be connected to white LEDs. No other wires will be used. TM3 will not be used.

Use the picture on page 2 to identify the correct G4 header and then the correct harness wire color. Headlights are on the TM2 header. The front headlight is the brown wire. The rear headlight is the red wire.

Split the two wires from the other wires using a sharp hobby knife. The unused wires can be cut very short. Determine the desired length of the two wires. It may be necessary to splice in additional wire



Selecting LED Resistors

An LED requires a resistor to avoid burnout. The resistor value determines the LED brightness. The value of the resistor is dependent on the battery voltage and the LED color. The selection table gives the nearest 5% resistor value for a white LED consuming 10mA.

LED Color	BAT+	Closest R	Rating	Mouser Part Number
White	14.8V	1.2K	quarter watt	588-OD122JE
White	18V	1.5K	quarter watt	588-OD152JE
White	22V	2.0K	quarter watt	588-OD202JE
White	24V	2.0K	quarter watt	588-OD202JE

Selecting LED Resistors - Technical Details

You don't need to know this technical detail but some people like to know how the value of the resistor is determined.

First, all of the light drivers are the same. Consider them to be nothing more than a simple toggle switch to battery minus. When the light is activated, the switch connects the TM light driver pin to battery minus. The current flows from battery plus, through the resistors, through the LED and then through the switch to battery minus and the LED turns on. A lower resistor value, brightens the LED. A higher resistance value decreases the LED brightness.

To determine the required resistor value, use the equation below. A white LED VF is about 3.2V. The Fv for a red is about 1V, green and yellow are about 2V. Once you have calculated the resistor value, it can be rounded up to the closest standard 5% resistor value. For currents at 10mA or lower, 1/4 watt resistors are OK. For currents above 10mA and battery voltages of 18V or higher, use a ½ watt resistor. Typical LED currents are about 10mA (0.01A) to 20mA (0.02A).

R (in ohms) = [Battery Voltage] - [LED voltage VF] divided by [desired current in Amps]

Standard 5% Resistor Values (1st 3 numbers)											
100	110	120	130	150	160	180	200	220	240	270	300
330	360	390	430	470	510	560	620	680	750	810	910

Mouser Electronics www.mouser.com
800-346-6873

Smoke Generator Hookup And Precautions

TM3-5, the green wire, is for controlling an external, high current, smoke generator. Rated at 3 Amps, this output is powerful enough to drive nearly all types and brands of smoke generators including locomotives having multiple smoke generators.

The picture at right is an older smoke generator from USA-Trains. It is nothing more than a coiled piece of wire in a reservoir. The wire becomes hot when power is applied. These don't have any polarity associated with them. Newer smoke generators have more elaborate circuitry including small exhaust fans. These units may or may not need proper polarity connected to work. If you are not sure if polarity is important, contact the manufacturer of the smoke generator and ask.

Make sure that you obey the voltage limitations of the smoke generator.

For example, the newer style USA-Trains fan equipped smoke generator uses a small circuit board for control. The image below is of this model. The G4 output connects to this board at the location labeled INPUT. This controller board is not polarity sensitive.

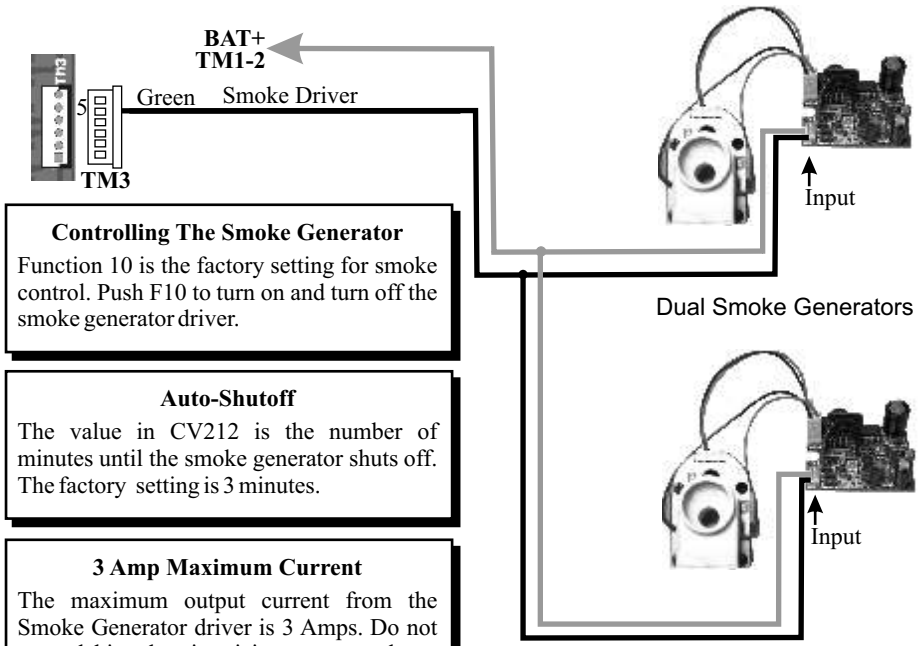
The smoke generator circuit boards may be connected directly to the G4. This is one of the few times you may use a locomotive's internal circuit board with the G4.

Just like all the light drives, when activated, the smoke generator driver connects the "minus" lead of the smoke generator to battery ground. The other lead of the smoke generator, usually a red wire, or a terminal labeled with a plus sign, connects to battery plus, TM1-2.

If your locomotive had two smoke generators, connect them in parallel with the V+ wire connecting to the same INPUT pin on both.

Allow up to a minute for smoke to begin. Don't overfill the generator or it may never smoke.

Three Minute Automatic Shut-Off Built In: The G4 decoder will automatically turn off the smoke generator after three minutes of continuous use. This protects both the smoke generator and the G4. You may change this time-out value with the smoke timer, CV212.



Controlling The Smoke Generator

Function 10 is the factory setting for smoke control. Push F10 to turn on and turn off the smoke generator driver.

Auto-Shutoff

The value in CV212 is the number of minutes until the smoke generator shuts off. The factory setting is 3 minutes.

3 Amp Maximum Current

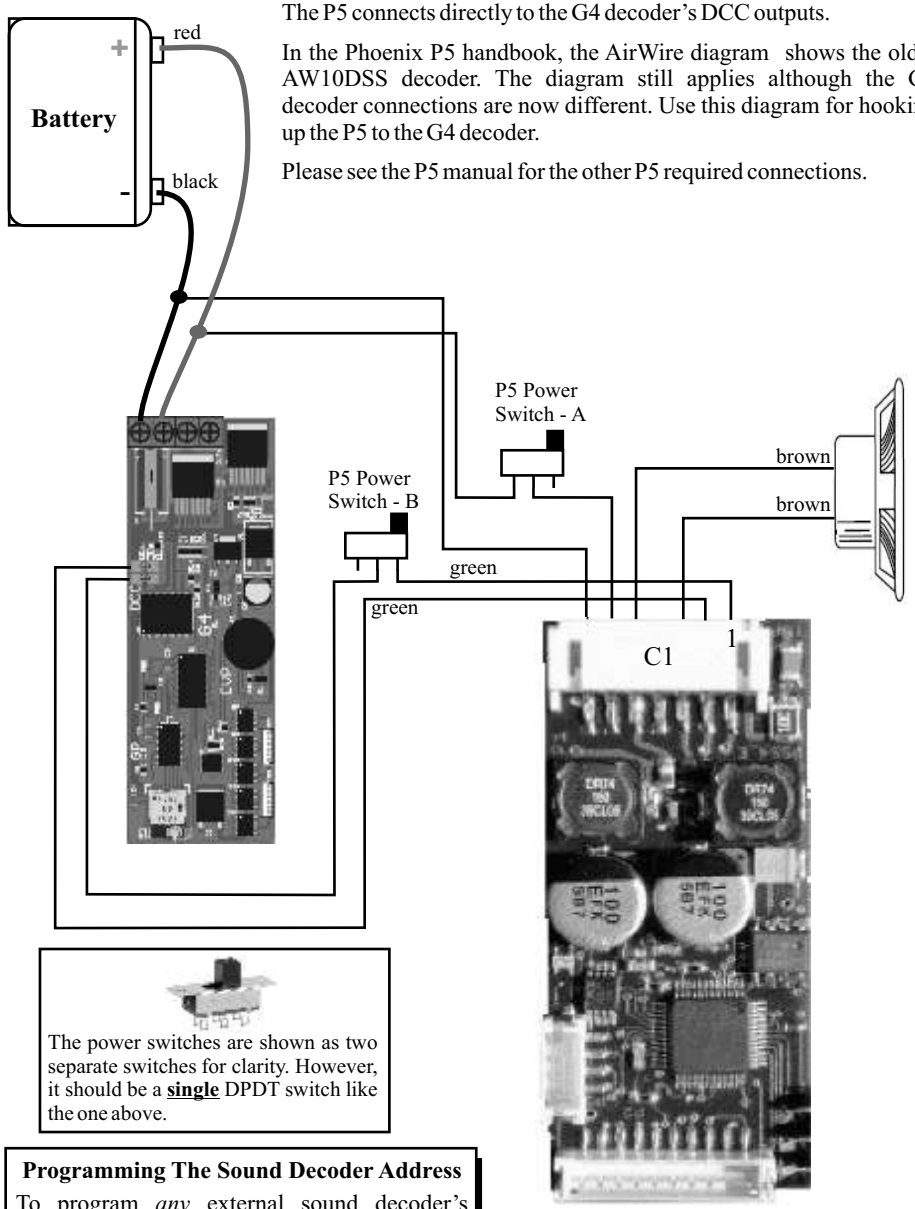
The maximum output current from the Smoke Generator driver is 3 Amps. Do not exceed this value since it is not protected.

G4 Decoder And Phoenix P5 Hookup

The P5 connects directly to the G4 decoder's DCC outputs.

In the Phoenix P5 handbook, the AirWire diagram shows the older AW10DSS decoder. The diagram still applies although the G4 decoder connections are now different. Use this diagram for hooking up the P5 to the G4 decoder.

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



The power switches are shown as two separate switches for clarity. However, it should be a **single** DPDT switch like the one above.

Programming The Sound Decoder Address

To program *any* external sound decoder's address, first connect the sound decoder to the G4 decoder. Set the G4 frequency to match the throttle's frequency and turn on power to both.

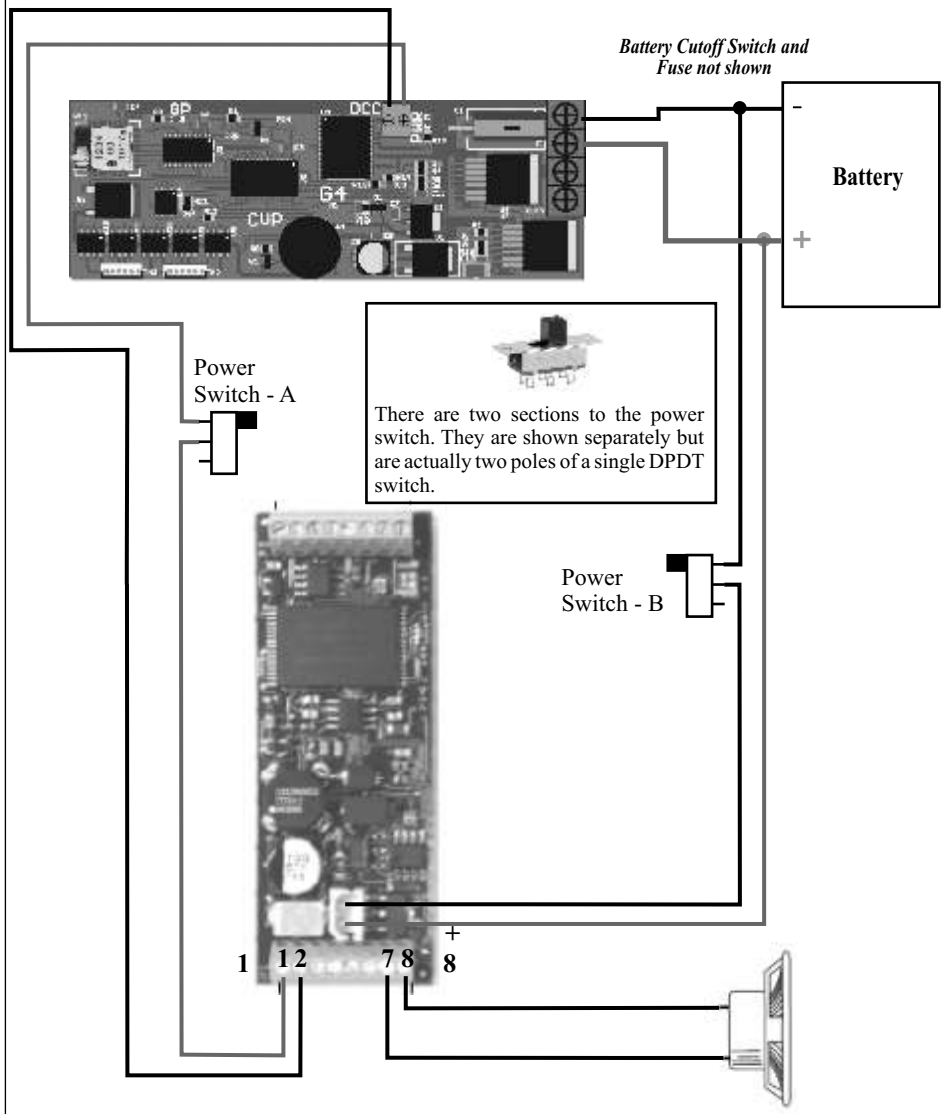
Use SERVICE PROGRAM and set CV1 to the desired address. This sets both the G4 and the attached sound decoder to the same address at the same time. See the throttle manual for detailed instructions.

Shared CVs

You may program the G4 without fear of changing the P5 programming. The only shared CVs are the address CVs, 1, 17 and 18.

G4 Decoder And Phoenix 2K2 Sound Hookup

This hookup diagram shows the required connections between the G4 decoder, the battery and the 2K2 module. See the 2K2 installation manual for programming information and detailed instructions for the remaining connections.



Programming Notes

When programming the G4 + 2K2 decoder's address, you will need to do it twice to ensure the 2K2 is properly programmed.

Shared CVs

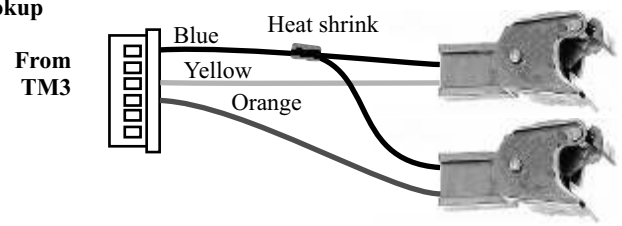
You may program the G4 without fear of changing the P5 programming. Only the loco number CVs are shared - CVs, 1, 17 and 18.

Phoenix Remote Couplers Hookup and Use

The G4 decoder includes built-in drivers for two Phoenix "solenoid" style couplers. No other controller boards are required. The G4 directly drives the couplers.

The front coupler driver is on TM3-3, the orange wire. The rear coupler driver is on TM3-4, the yellow wire. The supply voltage for the couplers is on TM3-6, the blue wire.

Coupler Hookup



Coupler Mounting

Coupler mounting is your biggest challenge. Although originally designed for truck mounting, the Phoenix coupler should be body mounted for better operation. If you find a good way to mount the coupler on the body, be sure and take pictures and share with us and Phoenix.

Couplers, connecting cables and usage guidelines can be found and ordered on the Phoenix Sound Website. Contact them with any questions about their couplers.

www.phoenixsound.com

Coupler Operation

Function key F3 has the factory setting of activating the rear coupler. Function key F13 has the factory setting to activate the front coupler. Coupler activation can be reassigned to any available throttle function keys.

The Phoenix coupler cannot have tension on the knuckle or it will not release. Thus it is called a slack-type coupler. There must be slack in the coupler so the knuckle releases when activated. So back up a bit to release the tension and then activate the coupler.

To re-couple, make sure the knuckle is open and firmly back into the car to be coupled. The knuckle will lock closed upon contact.

Replacement Wiring Harnesses, Plugs, Sockets

TM2 or TM3 Wiring Harness

Don't worry if you accidentally damaged a TM2 or TM3 wiring harness. You can purchase replacements or spares direct from CVP Products. This harness is the same type used on all of the new Drop-In decoders. Cost is only $4 plus postage.

ALT-6 Harness with plug on one end and 24 inches of 6 conductor wire. . . . . $4 each

JST 2.5mm Plug or Socket

The SKT is the matching socket for the CVP battery pack plug. The PLUG is the same as found on the CVP battery pack. Each connector includes 18 inches of flexible red and black stranded wire. Get several and use them to make plug and play connections between the CVP battery pack, power switches and the G4 decoder.

JST-SKT Black socket with 18 inches of red and black wire . . . . . $1.25 each

JST-PLUG Black plug with 18 inches of red and black wire. . . . . $1.25 each

Assigning Throttle Function Keys To G4 Actions

Use this step-by-step sequence to change what the decoder does when it receives a throttle function key command.

The G4 decoder has many memory locations so we use the term CV# where # is a specific memory location. So CV40 means G4 decoder memory location number 40. The value stored at this location dictates what the decoder does when it receives a throttle's function key command.

Always start by thinking through what you want your throttle to do to the G4 decoder. For this example, here's what is wanted:

"On the throttle, I want the throttle's 6 key to turn on the smoke generator."

Notice the underline of the important items: which throttle key is to be used, and what the decoder action will be when that key is pushed. For this example, F6 is the throttle's 6 key. Now you are ready to set the G4 so that it performs the desired action when F6 is pressed.

Step 1: Find F6 in the Function Key Assignment table.

From the table, the Throttle Function 6 action is defined by the value in CV40.

Step 2: Find the desired decoder action in the Function Key Action table and note the value. This will be what is stored in CV40.

For this example, since the smoke generator is to be turned on and off (toggled). the CV value of 2 is to be used.

Step 3: Turn on the G4's power. Check that the throttle frequency matches the G4 frequency.

Step 4: SVC PROGRAM CV40 to a value of 2. The decoder will chirp indicating it heard and accepted the command. Push ESC to escape out of SVC PROGRAM and verify that the decoder's action is correct when the 6 key is pressed on the throttle. Since the original factory setting had F10 controlling the smoke generator, it should be changed to a value of 0 which is no function. Otherwise, both F10 and F6 will control the smoke generator.

Repeat this same sequence to setup or change the other decoder functions.

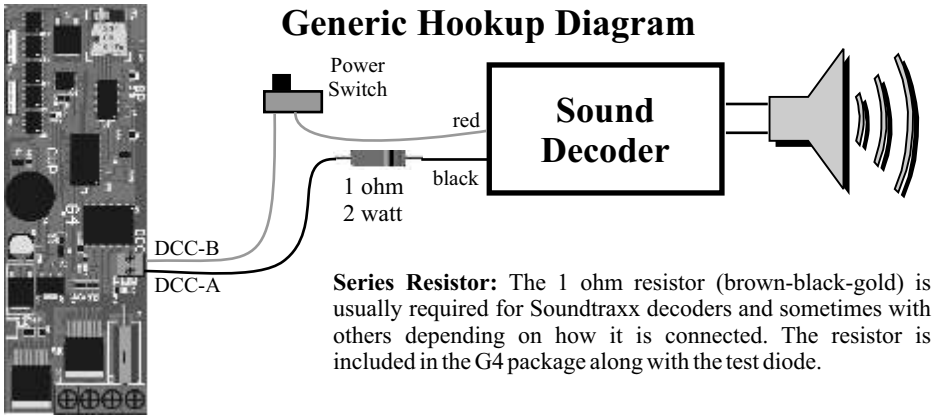
Also note that several of the Function Key Actions also have special effects available. For example an ELITE can not only be turned on, but can have a lighting effect added. See page 21.

Function Key Assignment	CV#
F1 Function Action CV	CV35
F2 Function Action CV	CV36
F3 Function Action CV	CV37
F4 Function Action CV	CV38
F5 Function Action CV	CV39
F6 Function Action CV	CV40
F7 Function Action CV	CV41
F8 Function Action CV	CV42
F9 Function Action CV	CV43
F10 Function Action CV	CV44
F11 Function Action CV	CV45
F12 Function Action CV	CV46
F13 Function Action CV	CV213
F14 Function Action CV	CV214
F15 Function Action CV	CV215

CV Value	Function Key Action
0	No Function
1	Activate Cruise Control
2	Toggle Smoke On/Off
3	Toggle ELITE#1 on/off
4	Toggle ELITE#2 on/off
5	Toggle ELITE#3 on/off
6	Toggle ELITE#4 on/off
7	Dim Headlights on/off
8	Activate Front Coupler
9	Activate Rear Coupler
10-14	reserved
15	Activate Ditch Lights
99	Deactivate Cruise Control

Using The DCC Booster Output

Generic Hookup Diagram



Series Resistor: The 1 ohm resistor (brown-black-gold) is usually required for Soundtraxx decoders and sometimes with others depending on how it is connected. The resistor is included in the G4 package along with the test diode.

DCC Sound and Multi-Function Decoders: 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 3rd party decoders, can be destroyed with battery voltages over 18 volts.

Max DCC Output Current: The G4 decoder provides an auxiliary 2.5 Amp DCC-Booster output suitable for driving any NMRA-DCC compatible sound and function decoders. The output is protected against overheating, overloads and short circuits.

Use a Separate Power Switch for the Sound Decoder: The sound decoder should use a separate power switch. This allows it to be isolated so that shared CVs can be programmed independently.

The G4 Loco Number and the Sound Decoder Loco Number Must Match: For proper operation, the external sound or function decoder and the G4 decoder must have the same loco number. If you program the loco number of both the G4 and the attached decoder at the same time, the two will have matching loco numbers.

Throttle Commands are Shared: Commands sent by the throttle are heard and shared by both the motion decoder and the external sound decoder. When a throttle function key is pressed, such as F2, the command is sent to both the DCC sound decoder and the G4.

Programming The DCC or Phoenix Decoder Loco Number: First connect the sound decoder to the G4 decoder. Make sure the G4 frequency matches the throttle's frequency and turn on power to both decoders. Use Service Mode programming (SVC PROGRAM) and set the value of CV1 to the desired loco number. The range is 1 to 9999.

Customizing Phoenix Sound Decoders: You must use the Phoenix software and interface cable to make changes to the sound decoder. Only the decoder number can be programmed from your throttle.

Customizing DCC Sound Decoders: Once the external decoder has its desired loco number programmed, you can use OPS PROGRAM or SVC PROGRAM to customize the various CVs. if using OPS PROGRAM, you must always use the appropriate locomotive number in order to transmit the programming commands to the proper locomotive. If you discover the G4 and your sound decoder share a common CV number, set the sound decoder first, then turn off the sound decoder, and set the G4 decoder CV last. Please refer to the appropriate sound/function decoder installation and operation manual for detailed instructions.

When To Use The Series Resistor: The optional series resistor is usually required for Soundtraxx decoders and other motion+sound decoders. Regular DCC track powered sound decoders usually have a high current surge when power is first applied. With high battery voltage and high decoder surge current, the G4 DCC output protection circuit may trip when first powered on.

If your sound decoder will not turn on when power is first applied, insert the series resistor between one of the DCC terminals and one of the sound decoder's input wires. Either terminal and either wire can be used. This will limit the surge current allowing the decoder to power up normally.

Sound decoders that have separate power inputs, like the Phoenix P8, do not need the resistor.

G4 Cruise Control

The G4 decoder comes equipped with a new and advanced cruise control design for maintaining the speed of a locomotive. Just like the cruise control in an automobile, once activated the locomotive will maintain the same average speed independent of the load or the terrain of your layout. It will cruise up hill and down hill as well as snake through tight curves and turnouts while maintaining the same average speed automatically without user's intervention.

New on the G4 are two extra CVs, CV64 and CV65. These allow you to finely tune your cruise control to your specific locomotive.

The G4 is shipped from factory with the cruise control disabled until you activate it with a function key (F5 is the factory default activation key). When activated the decoder will chirp one time. Pressing the function key again will not deactivate the cruise control. Deactivation depends on the selected cruise mode. The cruise mode is explained below. Once deactivated, the cruise control can only be reactivated again by pressing the function key. The decoder chirps each time it goes into or out of cruise control.

Cruise Mode Select CV63
Value Range is 0 - 1 . . . . . [0]

There are to different types or modes of cruise control.

Cruise mode 0 (factory default setting), when activated, will hold the locomotive speed constant and independent of the load, grade or track curves. If the throttle speed is change, up or down, or the direction is reversed, cruise control is deactivated. Mode 0 is easy to use. Once the train reaches the desired speed, push F5 (or what ever key you have assigned to activate cruise control) to enable cruise.

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, either higher or lower. As with the other mode, push F5 to enable cruise mode. In this mode, you can make changes to the initial speed using the throttle speed knob. 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 F5 again. The decoder chirps each time it goes into or out of cruise control.

Cruise Tracking Rate CV64
Value Range is 1 - 16 . . . . . [4]

CV64 selects the tracking rate with which the cruise control checks the locomotive speed. The value for CV64 has a range of 1 to 16 and the factory default value is set at 4. The lower the value of CV64 is, the more often the cruise control checks and corrects the locomotive cruise speed. We have found that the optimal setting to be about 4 although you can try different values since your locomotive and layout conditions might be somewhat different than ours.

Cruise Adaptation Step Size. CV65
Value Range is 1- 3 . . . . . [2]

CV65 is the adaptation step size, which sets the amount of correction when a motor speed adjustment has to be made. The default value of 2 works well for most locomotives. A value of 1 means the speed corrections are finer but it will take longer to adapt to a large change in speed. A value of 3 creates larger corrections and tracks speed changes much faster but with 50% less precision than a value of 2.

CAUTION: Do not use a value of 0 for either CV 64 or 65. If you accidentally use 0, the G4 will automatically reject it and instead use the factory default values.

Don't Use Cruise Control With Multi-unit Consists

If locomotives are in a Multi-iunit consist, cruise-control 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.

Customizing Headlight Operation Mode

There are 4 CVs that govern how a headlight operates. These 4 CVs allow headlights to be configured to match your favorite prototype railroad or you can pick your own style.

Each of the CVs will be described followed by various tables of effects that can be assigned to the headlights.

Summary Table For All Headlight Effect CVs			
CV59	3	1-15	Headlights Effect Period (x512ms)
CV60	0	0-15	Headlights Mode 0=normal/autorev
CV61	4	0-15	Headlight Front Effect
CV62	4	0-15	Headlight Rear Effect

The G4 Decoder allows the front headlight and the rear backup light to operate in several different modes. The different modes control if and when the headlight dims and how the headlight and backup light react to the locomotive direction. For example, the front headlight and the rear headlight can both be on at the same time or the front headlight can remain on, independent of the direction of travel. How the headlights behave are determined by the value stored in CV60.

Headlight Mode CV60
Range is 0-15. . . . . [0]

As with all setup options, the desired headlight mode is selected from a CV value table and the appropriate number is stored in CV60 of the decoder's memory. The mode can be changed at any time.

CV60 only affects the headlight and the backup light operating modes. It has no effect on any other locomotive light or on any lighting effect used.

Special lighting effects can be applied to the front and rear headlights and are described on the next page.

Normal Operation: The front headlight turns on at full brightness and the selected effect, if any, is applied. Normal operation also includes default headlight autoreverse. Autoreverse means that the front headlight is on when the throttle is set for the forward direction and off when set for the reverse direction. Conversely, when using autoreverse, the rear headlight light is off when in the throttle is set for the forward direction and on when set for reverse.

continued on the next page

Lights Are Normally Off

When power is first applied to the decoder, all lights are initially off.

Head Lights Are Turned On With F0

To turn headlights on or off the headlights, push the 0 key on your throttle.

Customizing Headlight Operation Mode *continued*

Auto-Dim Headlight Mode [rule 17]: When this option is selected, the headlight automatically dims when the throttle is set to zero speed. When dimmed, the headlight glows at a reduced brightness and without any lighting effect (if assigned). Turning up the speed knob automatically restores the headlight and its assigned lighting effect to full brightness. This feature is optimized for white LEDs. Locomotives that use incandescent bulbs for headlights may appear very dim when using this feature.

CV Value	CV60: Headlight Mode
0	Normal, autoreverse
1	Normal with rule17
2	Front headlight on always
3	Front headlight on always with rule17
4	Rear headlight on always
5	Rear headlight on always with rule17
6	Front and Rear both on always
7	Front and Rear both on always with rule17
8	Reversed Auto Reverse (Front to Back)
9	Reversed Auto Reverse with rule 17
10-15	reserved

Headlight Lighting Effects

There are a variety of lighting effects that can be applied to the G4 decoder's headlight outputs.

To apply an effect, determine which headlight is to have the effect, front or rear or both, find the desired effect in the lighting effects table, note the CV value and then load this value into the CV61 or 62 or both.

Front Headlight Effect CV61
Range is 0-15 . . . . . [4]

Rear Headlight Effect CV62
Range is 0-15 . . . . . [4]

Headlights Effect Timing Rate. CV59
Range is 1-15 . . . . . [3]

Lighting effects that offer a repeating pattern have the rate or speed at which the pattern is repeated. The rate is based on the value set into CV59. This CV controls the rate of a repeating pattern. Examples of repeating patterns that apply to light effects are rotating beacons, strobe lights, Mars and Gyra lights. The period range is 1 to 15 and is in units of ½ second. For example a period value of 2 gives a repeating pattern of about once per second. Bigger numbers represent slower repeat times. The period CV does not apply when the selected effect is either full bright, dim or random flickering. A value of 0 is not valid. If you accidentally enter a 0, the decoder will automatically change it to a value of 1.

The table on the next page summarizes the lighting effects and the CV value to activate the lighting effect. Also shown is whether the timing rate applies to these effects. All of these effects are optimized for LED lighting but work with incandescent bulbs too.

At any time, you may issue a reset to set all of the decoder CV values back to their original factory settings - don't be afraid to experiment. Nothing can be harmed or damaged.

Locomotive Speed Matching

Using CV2, CV6 and CV5, you can match the speeds of two or more different locomotives. One important consideration is to determine which locomotive in a consist is the slowest. It is to this slow locomotive that you will match the other members of the consist. Always match a locomotive to the slowest member of the consist since we cannot make a slow locomotive run faster than its top speed. The following examples illustrate some of the possible ways to match up locomotives.

You may find that matching locomotives at the top and mid point speeds is close enough. By all means you may stop if you are happy with the performance after steps 1 and 2. The procedures below allow you to precisely match locomotive speeds at all speed steps, not just two. The penalty is a bit more time but you will be impressed with the results.

Use OPS mode programming to make changes to the CVs.

Step 1: Match locomotives at step 14

Using the slower locomotive as reference, match the faster locomotive to the speed of the slower one at speed step 14 using CV6. Since we are modifying CV6 of the faster locomotive, we should reduce the value of CV6 until it matches the speed of the slower locomotive. At this point, both locomotives should be running at the same speed at speed step 14.

Step 2: Match locomotives at top speed

Using the slower locomotive as reference, match the faster locomotive to the speed of the slower one at speed step 28 using CV5. Since we are modifying CV5 of the faster locomotive, we should reduce the value of CV5 until it matches the speed of the slower locomotive. At this point, both locomotives should be running at the same speed at speed step 28.

Step #3: Fine tuning the top speed setting only (2 methods)

Using the slower locomotive as reference, compare the speed of both locomotives at speed step 21 (middle of the high speed setting). If both locomotives are running at more or less the same speed then no fine tuning is necessary. If not then fine tuning the high speed setting may be done next. There are two ways, using CV5 or CV6 only.

Using CV5 only is the first method and results in minor speed differences at step 28.

Reference Locomotive Is Either Slower or Faster At Step 21: Decrease the value of CV5 of the other locomotive to match the speed of the reference. Conversely, if the reference locomotive is running faster at speed step 21, then increase CV5 of the other locomotive to match the speed of the reference. Using this method can result in minor speed difference in top speed.

Using CV6 is an alternative method and results in minor speed differences at step 14.

Reference locomotive is running slower or faster at speed step 21, then lower CV6 of the other locomotive to match the speed of the reference. Conversely, if the reference locomotive is running faster at speed step 21, then increase CV6 of the other locomotive to match the speed of the reference.

Step #4: Fine tuning the low speed setting only (2 methods).

Using the slower locomotive as reference, compare the speed of both locomotives at speed step 7 (middle of the low speed setting). If both locomotives are running at more or less the same speed then no fine tuning is necessary. If not then fine tuning the low speed setting may be done next. There are two ways, using CV6 or CV2 only.

Using CV6 is the first method and results in minor speed differences at step 14.

Reference locomotive is running slower at speed step 7: lower CV6 of the other locomotive to match the speed of the reference. Conversely, if the reference locomotive is running faster at speed step 7, then increase CV6 of the other locomotive to match the speed of the reference.

Using CV2 is the alternative method and results in minor speed difference at step 1.

Reference locomotive is running slower at speed step 7: lower CV2 of the other locomotive to match the speed of the reference. Conversely, if the reference locomotive is running faster at speed step 21, then increase CV2 of the other locomotive to match the speed of the reference.

Fine Tuning Slow Speed Operation With Bumping

Many users assume that CV2 is used to control how the locomotive starts up at slow speeds. However, you should not use CV2 for that purpose. Instead take advantage of the advanced G4 feature of motor bumping.

We have completely redesigned the bumping algorithm to provide for precision slow speed control. The new algorithm uses a sophisticated algorithm that you can customize using CV56 and CV57. The new bumping feature perfectly compliments the ultra high resolution speed curve created with CV2, CV5 and CV6.

With motor bumping, you can achieve silky smooth performance at very low speeds. There are two CVs for this feature, the motor bump value, CV56 and the motor bump duration, CV57. Your G4 will automatically transition from the slow-speed bump to the high resolution speed curve operation as the locomotive gains speed.

Motor Bump Value CV56
Range is 0-255 . . . . . [0]

This value sets the amount of momentary motor voltage increase, called a bump, applied at each speed step to the help motor overcome friction. It helps get the motor rotating at a lower voltage and/or a lower speed step. Once the locomotive is moving, the bump automatically goes away. A value of 0 turns off the motor bump. A value of 128 will literally apply half of full speed to the motor.

Motor Bump Duration CV57
Range is 0-127 . . . . . [0]

This value selects the duration of time that the bump value is applied when the bump is active. A value of 0 disables the bump completely, no matter what is set in CV56.

Experimenting With Motor Bumping

To use the motor bump feature, the following procedure is recommended. It helps to have a throttle that shows the speed step being sent such as the T5000 or the T9000.

Step 1: Set the throttle to speed step 1 and observe the locomotive's wheels. They may or may not be turning.

Step 2: Set CV56 to a value of 15 and CV57 to a value of 50. Observe the locomotive wheels and see if they are now turning. Stop and then return the throttle to step 1. Look for consistent forward motion and make sure that the bump is sufficient for smooth operation over the entire length of the track at speed step 1.

Step 3: If the wheels are not yet turning, increase either CV56 or CV57 or both by a value of 5 and check again. You should make changes to the CV values in increments of 5. Smaller increments may not cause any noticeable changes.

There is a tradeoff between the bump value and the bump duration. If a small bump value is applied, then a longer bump duration will be needed. Or, if a large bump value is used, it can be applied for a shorter duration .

Careful choices of CV56 and CV57 will give not only fine control at slow speeds but allow the full range of precision speed control over the entire speed curve. Think of the motor bump as an added feature that provides an extra boost of energy to get the locomotive moving at low speeds.

New Motors Should Be Broken In Before Using

A new motor usually doesn't have motor brushes that conform well to the circular shaft of the commutator. The brushes tend to draw more than normal current, and exhibit arcing. As a result, the motor causes lots of radio noise and can even trip the G4 over-current protection circuit. To prevent this from occurring, just run the motor for an hour or so at full speed and in each direction. This will seat the motor brushes and greatly reduce radio noise generation.

Headlight Lighting Effects *continued*

CV Value	Lighting Effects
0	Off 0%
1	Dim 6%
2	Dim 25%
3	Dim 50%
4	On 100%
5	Strato Light
6	Oscillating Light
7	FRED
8	Rotary Dome light 1
9	Gyra Light
10	Mars Light
11	Rotary Dome Light 2
12	Strobe Single Pulse
13	Strobe Double Pulse
14	Reserved
15	Random flicker

Multi-Unit Consist Lighting Tip

Here is how to set up a two unit consist that uses the headlight mode feature to automatically turn on the proper headlight depending on the direction of travel.

Multi-Unit Consist With Directional Lighting For Leading and Trailing Units

In this example, there are 2 locomotives that are consisted together. The locomotives all face the same direction. The desire is for the leading unit to have the front headlight on, when in the forward direction and its rear headlight off when going in the reverse direction. For the trailing unit, only the rear headlight is on when going in the reverse direction and the front headlight is off when going forward. The CV numbers and their values are shown for the leading and trailing locomotives. Both locomotives share the same frequency but can have different loco numbers.

Leading Locomotive	CV#	Value	Trailing Locomotive	CV#	Value
Headlight Mode	CV60	0	Headlight Mode	CV60	0
Front Headlight Effect	CV61	4	Front Headlight Effect	CV61	0
Rear Headlight Effect	CV62	0	Rear Headlight Effect	CV62	4

Controlling Polarity Driven Lights

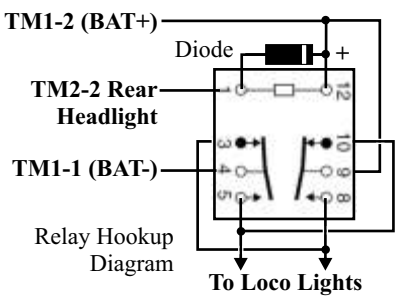
For older USA-Trains locomotives, the factory supplied lighting circuits used track polarity to determine directional headlights. To continue to use this feature when installing a G4 decoder, you must add a small relay to flip the light driver polarity.

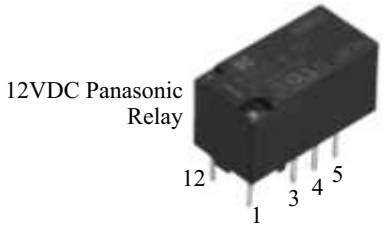
The relay is wired to flip the polarity of the battery voltage that is driving the lighting circuit. This circuit uses the Rear Headlight Driver of the G4 to flip the polarity of the connected lights.

In operation, the Front headlight is turned on the moment battery power is turned on. To allow the loco direction to match the headlight, first push F0. After that, the appropriate headlight will be on depending on the direction set in the throttle. If the lights are backwards, reverse the lighting wire hookup to the relay.

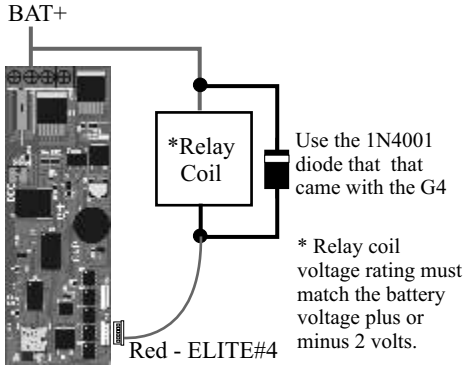
Warning: Make sure the motors are not connected to the lighting circuitry in any way. There is risk of damaging the G4 decoder.

The Panasonic 12VDC DPDT Relay (Mouser: 769-TXS2-12V) is rated at 1 amp and uses a 12VDC coil. The coil will tolerate up to 18VDC or as low as 10VDC. The1N4001 diode is essential for proper operation. It must be oriented exactly as shown.





Hooking Up A Relay Instead Of An LED



A relay or a solenoid can be driven by the G4 LED drivers. Just be sure that their rating matches your battery voltage.

Always install a diode across the relay or solenoid coil. The banded end connects to the relay coil that connects to the battery plus wire. The diode's other end goes to the relay coil that connects to the LED driver. The polarity verification diode can be used for this application

ELITE #4 output has the added feature of an automatic shutoff timer. You can set the automatic timeout to turn off the relay, from 1 to 255 seconds (~4 minutes) after it is turned on. The timer is controlled by CV206. A value of 0 disables the timer and allows manual on and off control.

Motor Acceleration and Deceleration Control

Locomotive inertia and momentum are simulated using CV3 and CV4. Inertia is the rate at which a locomotive accelerates when changing from a slow speed to a higher speed. Contrast that with momentum which is the rate at which a locomotive decelerates from a high speed to a lower speed.

CV3 deals with the rate of acceleration when the speed is increased. In other words how quickly does the operator intend for the locomotive to accelerate. The smaller the value of CV3 the quicker a locomotive will accelerate. Similarly, CV4 deals with the rate of deceleration and the smaller the value of CV4 the quicker the locomotive will decelerate.

Motor Acceleration Rate. CV3
Value Range is 1-255 . . . . . [2]

This CV sets the rate of change of locomotive speed when the throttle speed is increased. This is called the acceleration rate. Small values mean the rate of change is fast. A higher value leads to a slower rate of change.

In most cases, users prefer a *slower* rate of change for the acceleration rate. Common values are 3, 4 and 5. Large values result in extremely long delays for speed changes to take effect which are generally uncomfortable for users. The acceleration rate applies equally in the forward and reverse directions.

Motor Deceleration Rate CV4
Value Range is 1-255 . . . . . [2]

This CV sets the rate of change of speed upon when the throttle speed is decreased. This is called the deceleration rate. Small values mean the rate of change is faster. A higher value leads to a slower rate of change.

In most cases, users prefer a *faster* deceleration rate compared to the acceleration rate. The factory default of 2 is seldom changed. High values will result in extremely long delays for locomotives to slow down. If you imagine your favorite locomotive speeding towards another train, you will want to be able to quickly stop the train. This is why the factory setting of 2 is seldom changed. Users want to slowly start the train, but quickly stop it. The value applies equally in the forward and reverse directions.

GearSaver Protection

If for some reason, you set CV3 or CV4 to 0 in an attempt to achieve instantaneous stop or quick acceleration, G4 will automatically set CV3 or CV4 to 1 instead, in order to protect the locomotive gears from being stripped. So the effective range for CV3 and CV4 is from a value of 1 to 255.

Also, if you reverse the locomotive direction without first stopping it, GearSaver protects you again. In this situation, G4 will ramp the speed down to zero before reversing the direction and then ramp it back up to the speed setting of the throttle.

Beware Of Large Values

Large values for acceleration or deceleration rates will result in very slow response to throttle changes. Extreme values will result in the locomotive never starting, or, never stopping - both of which are very undesirable.

Locomotive Motion Control and Fine Tuning *continued*

Maximum Motor Voltage Value (Vmax) CV5

Range is 0-255 . . . . . [255]

The top speed voltage (full speed) corresponds to speed step 28 (in a 28 speed step setting). CV5 is used to set this voltage and 255 is the factory default. If a lower top speed is needed, for example in speed matching application, set CV5 to a smaller value. Speed curve #2 lowers the top speed to 155. So at speed step 28, the locomotive is running at 60% of the maximum motor voltage. It should be noted that every speed step from 1 to 28 will be slower accordingly.

Setting CV5 to a value less than CV6 is OK but the resultant speed curve will be an upside down V. Curve #5 on the previous page shows the extreme case with CV5 equal 0 and CV6 equal to 128, The motor will reach top speed at step 14 and then gradually slow down to a stop at step 28.

Customizing The Speed Curve To Your Requirements

Customizing a speed curve is easily done by modifying one or more of the three configuration variables. It helps to visualize the speed curve as having two separate halves as shown in the graph with the split at the 50% throttle speed position. The left half is controlled by CV2 and CV6 and responds to the first 14 speed steps (in the 28 speed step setting). The right half is controlled by CV6 and CV5 and responds to speed steps 15 to 28 (in the 28 speed step setting).

I want finer slow speed control: With CV2 and CV5 unchanged, the step size of speed steps 0 to 14 in the left half of the speed curve can be reduced to give finer control by simply reducing the value of CV6 from the default 128 to a smaller value. For example, by reducing CV6 to 100, each of the 14 steps will be reduced by a value of 2. As a result of reducing CV6 to 100, the step size for speed steps from 15 to 28 in the right half of the speed curve increase by a value of 2. The result is curve #3. Thus, you gain finer speed control at the low end of the throttle range at the expense of bigger steps at the high end. For yard operations, you will find this setting to offer precision slow speed control right when you needed it.

I want finer high speed control: With CV2 and CV5 unchanged, the step size of speed steps 15 to 28 in the right half of the speed curve can be reduced to give finer control by simply increasing the value of CV6 from the default 128 to a larger value. For example, by increasing CV6 to 156, each of the 14 steps will be increased by a value of 2. The result is curve #4. It is important to remember that as a result of increasing CV6 to 156, the step size for steps 0 to 14 in the left half of the speed curve would be increased by a value of 2.

I want both finer speed steps for slow and high speed control: With CV2 unchanged, the step size of speed steps 0 to 28 can be reduced to give finer control by simultaneously reducing the values of CV6 and CV5 to a smaller value. For example, by reducing CV6 from a default of 128 to 100, and CV5 from a default of 255 to 227, the step size for the entire speed curve is now reduced by a value of 2 to give finer control. The result is curve # 2. By reducing CV5 to a smaller value, the top speed at the high end is lower which will result in less torque at high throttle settings.

CV2 has remained unchanged in the above examples. The next set of examples, shows what you can do by modifying CV2. These are not graphed but are discussed to show that you can create an unlimited variety of speed curves using just 3 different CVs.

I want a higher MSV with finer slow and high speed control: With CV5 unchanged, the step size of speed steps 0 to 28 can be reduced to give finer control by simultaneously increasing the values of CV2 and CV6 to a larger value. For example, by increasing CV2 from a default of 9 to 37, and CV6 from a default of 128 to 156, the step size for the entire speed curve is now reduced by a value of 2 to give finer control. By increasing CV2 to a larger value, the MSV is now higher for the low end starting speed of speed step 1.

I want higher MSV and reduced top speed with finer slow and high speed control: With CV6 unchanged, the step size of speed steps 0 to 28 can be reduced to give finer control by simultaneously increasing CV2 to a larger value and reducing CV5 to a smaller value. For example, by increasing CV2 from a default of 9 to 37, and reducing CV5 from a default of 255 to 227, the step size for the entire speed curve is now reduced by a value of 2 to give finer control. This also results in a reduced top speed at speed step 28 and an increased starting speed at speed step 1.

Assigning ELITE Lighting Effects

There are a variety of special lighting effects that can be applied to the ELITES as well as the SMOKE generator. Here's the table of CVs related to the G4 light drivers.

CV201	**3**	**1-15**	**Light Effect Period (x512ms)**
CV202	**4**	**0-15**	**ELITE#1 Lighting Effect**
CV203	**4**	**0-15**	**ELITE#2 Lighting Effect**
CV204	**4**	**0-15**	**ELITE#3 Lighting Effect**
CV205	**4**	**0-15**	**ELITE#4 Lighting Effect**
CV206	**0**	**0-255**	**ELITE#4 Auto-off Timer**

To use a lighting effect, first select the CV number for the specific LITE Effect to be changed. Next find the desired lighting effect in the effects table and note its CV value. Finally, load this CV value into the CV number. The original factory setting for all ELITE lighting effects CVs is 4. This means when activated, the ELITE turns on at full brightness.

Effect Timing Rate CV201
Range is 1-15 . . . . . [3]

ELITE#1 Effect CV202
Range is 0-15 . . . . . [4]

ELITE#2 Effect CV203
Range is 0-15 . . . . . [4]

ELITE#3 Effect CV204
Range is 0-15 . . . . . [4]

ELITE#4 Effect CV205
Range is 0-15 . . . . . [4]

Lighting effects that include a repeating pattern have a variable rate or speed at which the pattern is repeated. The rate or speed at which the pattern is repeated is based on the value set into CV201. Bigger numbers represent slower repeat times. The period CV does not apply when the selected effect is either full bright, dim or random flickering.

A value of 0 cannot be used. However, if you accidentally enter 0, the decoder will automatically change the 0 to a 1 and store it for the CV value.

This table lists all the lighting effects and the CV value to activate the lighting effect. Also shown is whether the timing rate applies to these effects. All of these effects are optimized for LED lighting.

Incandescent bulbs may be used but the effect might not be as noticeable.

Lighting Effects	CV Value	CV201 Applies
Off 0% - *should not be used*	0	No
Dim 6%	1	No
Dim 25%	2	No
Dim 50%	3	No
On 100%	4	No
Strato Light	5	Yes
Oscillating Light	6	Yes
FRED	7	Yes
Rotary Dome light 1	8	Yes
Gyra Light	9	Yes
Mars Light	10	Yes
Rotary Dome Light 2	11	Yes
Strobe Single Pulse	12	Yes
Strobe Double Pulse	13	Yes
Reserved	14	No
Random flicker	15	No

Customizing Ditch/Crossing Lights Operation

TM2 has two outputs designed for driving of ditch and/or crossing lights. TM2-3 is the Ditch-light-right, or DLR. TM2-4 is the ditch-light left, or DLL. In modern diesels, these lights alternately flash on and off when activated.

Ditchlights Have Directional Dependency

With the front headlight on, the ditchlights will also be on (unless the ditch light mode is changed) and can be activated. But if the rear headlight is on and the forward headlight is off, the ditchlights will not turn on or flash if activated. If the headlights have been turned off with F0, the ditchlights will also be off and can't be activated.

Activating Ditch light Flashing

Providing the locomotive's forward headlights have been turned on with F0, the factory setting for to activate the flashing ditchlights is throttle key 4, or F4. After activation, the ditch lights begin to alternately flash on and off. They continue to flash until the timeout period has expired. The ditch light mode setting determines if the ditchlights stay on after activation or turn off. The flash rate and the timeout period can be customized.

Ditch light Mode Setting

The factory settings for the Ditch light operation mode is for both of the ditch lights, DLL and DLR, to turn on whenever the front headlights are turned on. A value of zero sets the ditch lights to turn on with the headlights. This is the original factory value. A value of 1 keeps the ditch lights off until they are activated and begin flashing. Once the flashing has timed out, the ditch lights turn off.

Ditch Light Mode CV208
Range is 0-1 . . . . . [0]

Ditch light Flash Rate

The factory setting for the ditch light flash rate is about a 3/4 second on followed by a 3/4 second off. This can be changed with the dedicated flash rate CV53. The value in CV53 sets the rate or frequency at which the ditch lights flash once activated. A value of one sets the highest rate or about 1/4 of a second. A value of 4 sets the rate to about 1 second. A value of 0 is rejected.

Ditch Light Flash Rate CV207
Range is 1-15 . . . . . [3]

Ditch light Timeout

Once the flashing has begun, the factory setting for the duration is about 15 seconds. This is called the timeout value and is stored in CV55. The value in CV55 sets the length of time, in seconds, for the duration of the ditch light flashing. A value of 0 is rejected.

Any time when the ditch lights are flashing, pushing F4 resets the timer for another 15 seconds of flashing. Once the timer expires, the ditch lights return to both on [mode dependent]. Also, the flashing can be terminated early by turning off the headlights with F0.

Ditch Light Timeout CV209
Range is 1- 255 . . . . . [15]

Ditch Lights Are Turned On With The Headlights - F0

Locomotive Motion Control and Fine Tuning

There are 3 CVs that determine how the locomotive motor responds to a throttle speed command. Following the NMRA-DCC standard, these are: CV2 (Vstart or motor-starting-voltage MSV) CV6 (Vmid), and CV5 (Vmax). The full scale motor voltage value ranges from 0 to 255 so these 3 variables also have a value range of 0 to 255. You may set these values to suit your desired locomotive performance as well as to help with speed matching of different locomotives.

Note: regardless of the throttle's speed step setting, the G4 will automatically adjust for the 14 speed step or the 28 speed step settings.

Motor Starting Voltage Value (MSV) CV2
Range is 0-255 . . . . . [9]

CV2 sets the MSV of the motor voltage that corresponds to speed step 1 (in a 28 speed step setting). This is the first speed step from off, or zero voltage. You can decide if you wish the motor to be moving at a good rate of speed or just barely moving by changing the MSV. A small MSV value means only a small extra increase in motor voltage. A larger MSV value means the motor receives a higher motor voltage.

Mid-point Motor Voltage Value (Vmid) CV6
Range is 0-255 . . . . . [128]

The mid-point voltage, or half speed, corresponds to speed step 14 (in a 28 speed step setting). CV6 is used to set this voltage with 128 being the factory default value. If a lower half speed is needed, for example in speed matching application, set CV6 to a smaller value. Speed curve #3 lowers the half speed to 55. So at speed step 14, the locomotive is running at 25% of the maximum motor voltage. Conversely, if the locomotive is running too slow at speed step 14, CV6 can be raised to increase the half speed.