

G3 Configuration Variables List

This is the complete list of all CVs used in the G3. The factory settings are what the G3 decoder has when it is brand new. To reset the CV values to their original settings, see page 7. If you have forgotten the G3 frequency or the G3 address, see page 8. Resetting a forgotten frequency uses a brand new procedure. Please read page 8 before attempting to reset the frequency.

Note: All CV settings are remembered without battery voltage

CV #	Factory Setting	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	0-15	F1 Function Key Action
CV36	0	0-15	F2 Function Key Action
CV37	0	0-15	F3 Function Key Action
CV38	15	0-15	F4 Function Key Action
CV39	1	0-15	F5 Function Key Action
CV40	0	0-15	F6 Function Key Action
CV41	0	0-15	F7 Function Key Action
CV42	0	0-15	F8 Function Key Action
CV43	4	0-15	F9 Function Key Action
CV44	2	0-15	F10 Function Key Action
CV45	3	0-15	F11 Function Key Action
CV46	0	0-15	F12 Function Key Action
CV47	3	1-15	ELITE Period (x512ms)
CV48	4	0-15	ELITE1 Special Effect
CV49	4	0-15	ELITE2 Special Effect
CV50	4	0-15	ELITE3 Special Effect
CV51	4	0-15	ELITE4 Special Effect + Timer
CV52	0	0-255	ELITE4 Auto-off timer (0=manual)
CV53	3	1-15	DLITE Flash Rate (x250ms)
CV54	0	0-1	DLITE Mode 0=on, 1=off
CV55	15	0-255	DLITE Flash TimeOut (seconds)
CV56	0	0-255	Bump Amount
CV57	0	0 - 127	Bump duration in us
CV58	0	0-16	RF Frequency number
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
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

CV Value	Function Key Action
0	No Function
1	Toggle Cruise Control on/off
2	Toggle Smoke Generator 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
15	Ditch Lights Flash Trigger
8-14	reserved

CV Value	Special 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 with change)
1	Tracking mode (Cruise stays on with change)

CV Value	Head/Rear Lites Action
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

These CV Tables Apply Only To The G3 Decoder

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Always check the website for updated versions of this booklet!

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The AirWire900® 3rd Generation Decoder

The G3™

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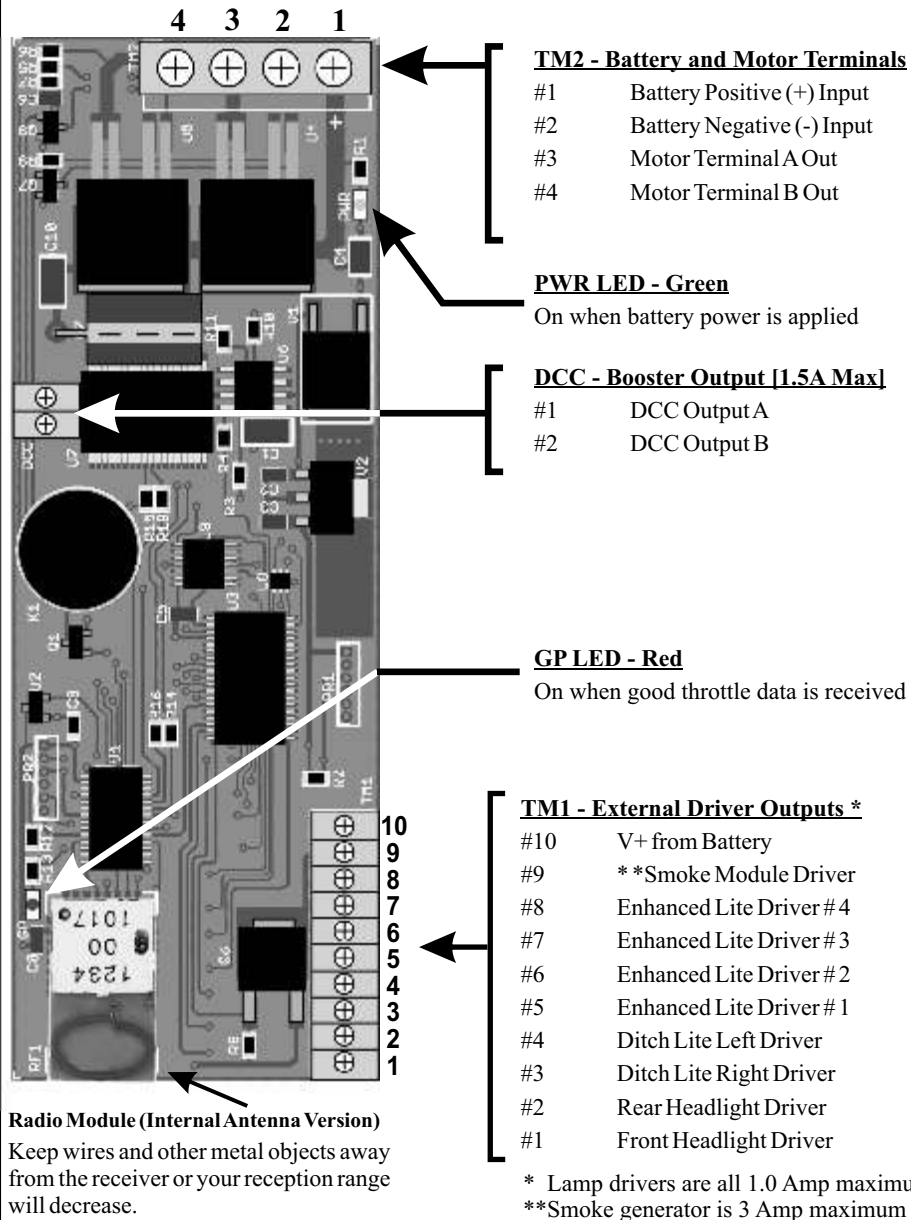
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1 ohm 2W resistor

G3 Decoder Connections



Take a moment and familiarize yourself with the G3 and its indicators, connection points and other important parts.

Simple 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, CV11 to a value of 0. Any other value and the locomotive will come to a halt when the throttle signal is gone 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 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 G3 decoder. There is nothing more annoying than a diesel horn that is stuck on so the G3 includes a special feature that prevents stuck horns. If for any reason, the G2 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.

G3 Decoder Warranty Information

This warranty covers substantial defects in materials and workmanship in the G3 decoder.

What This Warranty Does Not Cover

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

Warranty Duration

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

Repairs and Returns

If you purchased your G3 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 G3 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.**

Power Through The Rails - Some Considerations

The G3 decoder is designed for battery powered operation. Although power can be supplied through the rails, we do not recommend it. If you plan to use something other than batteries, consider the following points before your final decision.

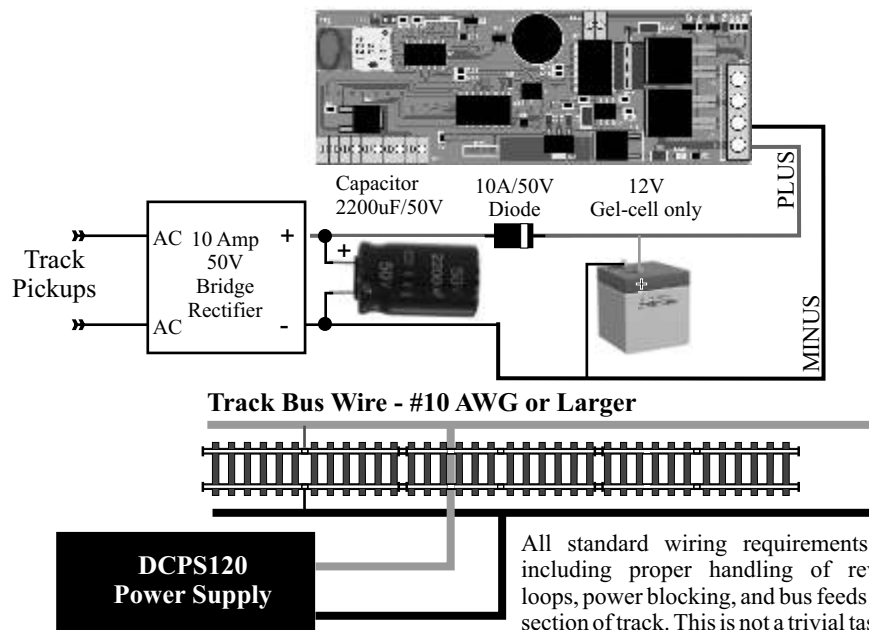
Clean wheels and clean track are mandatory if power is not supplied by batteries. Battery powered outdoor locomotives never need to have wheels cleaned and never need to have the track cleaned. Don't let anybody fool you into thinking they never clean track. It is not always dirt that causes problems.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

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

Wiring the railroad becomes a long and boring chore. If you use battery powered locomotives, your wiring job reduces 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.

However, if you insist, then here is the hook up diagram and the required external components to allow the G3 decoder to draw DC power from the battery AND the rails. Don't forget that the motor must still be disconnected from the track pickups and wired directly to the decoder output. This technique **CANNOT** be used with lithium battery packs - it will damage them.

To power the rails, use a well regulated DC power supply for best performance under varying load conditions. Using 12V gel-cell batteries ONLY. The DCPS120 power supply is used to keep the gel-cell battery charged. Be sure and feed the DCPS120 from a GFI protected outlet. Set the DCPS120 power supply to 15 volts. This will provide sufficient voltage to charge the battery. This charging technique will not work for any other battery type.



The DCPS120 Power supply is a 120 Watt, adjustable DC power supply with excellent load regulation. The output voltage is variable from 15V to 24V. It has built in overload and short circuit protection. It is available direct from CVP Products. See the website for ordering details.

Quick Start Instructions

The "Quick Start" section assumes you have installed your new G3 decoder (or are testing it on the bench) and the G3 is on the original factory settings of frequency 0 and address 3.

Step 1: Turn Power on to the Decoder

- The G3'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 G3'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: Set the Decoder Address

This is a very important step and must be done to insure that all of the new G3 features work properly.

- Select SERVICE PROGRAM mode on your throttle. For T5000 throttle, press menu twice and then push the number 4.
- For T5000 users, push 1 and push ENT to select CV1 for changing the address.
- Enter the decoder address that you want to use. The address must be unique. The cab number is always a good idea. Once you have entered the numbers, push ENT.
- 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.

Step 3: Set the Desired Decoder Frequency If Frequency 0 Is Not Wanted

- As delivered, the decoder is set for frequency 0. If you want to use a different frequency, follow these simple steps.
- Set your throttle to the new decoder address.
- Select OPS PROGRAM mode. On the T5000, push MENU once and then 0.
- Enter 58 followed by ENT. CV58 is where the desired frequency is stored in the decoder.
- Enter the 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.
- Push ESC to cancel OPS mode.

Step 4: Set the Throttle And Run!

- Set your throttle to the new decoder frequency.
- Set the direction and turn up the speed knob and you are in control.
- For T5000 users, 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 G3 is to set the desired locomotive address. If the sound decoder is attached, it will be set to the same address at the same time.

WARNING

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

Need Help? Contact Your Dealer/Installer First!

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

G3 Frequency Selection Using The T5000 Throttle

Each throttle/decoder pair must be on a unique frequency so as not to jam other throttle/decoder pairs. The G3 decoder features remote frequency selection directly from the throttle. If you have our previous generation decoders, the most obvious difference will be the absence of the frequency selection switch. Read and follow these instructions carefully and you will immediately see the benefit of being able to set the decoder frequency without ever having to open up the locomotive. 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 desired frequency is stored inside the decoder in configuration variable number 58 which is abbreviated CV58. You need to know the decoder's address as well as its current frequency in order to use OPS PROGRAM mode to set CV58.

Caution: *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. OPS programming is the safest method to change the decoder's frequency without fear of changing another G3 decoder that might hear a SERVICE PROGRAM command.*

T5000 Key Sequence

1. Set throttle to decoder address.
2. Set throttle to decoder's present frequency.
3. Push MENU once and then push 0 to select OPS PROGRAM mode..
4. Enter 58 followed by ENT.
5. Enter the frequency number and push ENT. The decoder chirps once to indicate receipt of the new frequency. The range is 0 to 16.

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.

6. Push ESC to cancel OPS mode.
7. Change throttle to new frequency and operate locomotive.
8. 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 G3 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 8 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 G3 if it was powered on.

Step 3 - Turn on the G3 and wait at least one minute. [The r9G3 will 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 CV58 to the desired frequency. It will chirp when the command is accepted.

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 locomotive will quickly drain the batteries.

Derating Maximum Output Current In Hot Climates

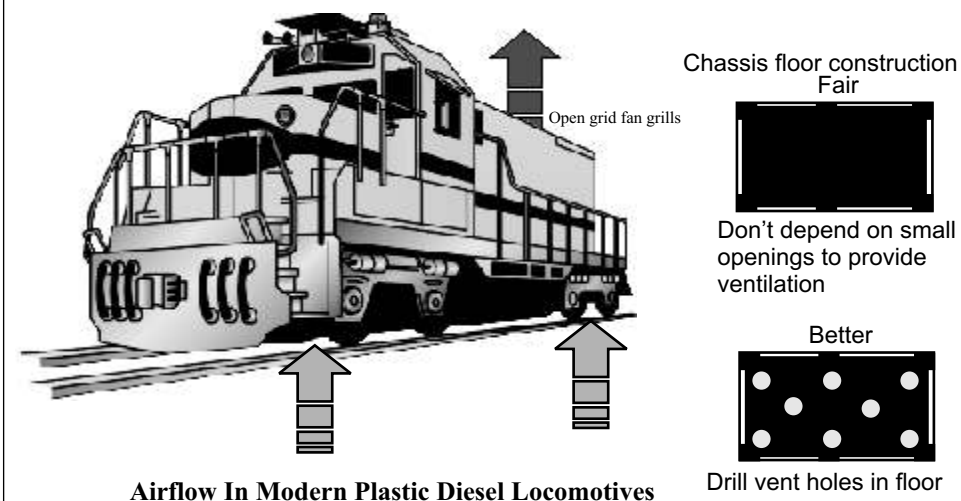
High outdoor temperatures will result in hot interior temperatures even when there is good airflow. The G3 output current is limited based on the temperature of the transistor drivers. If the drivers overheat, because of excess motor current or because of a hot interior, the devices will shut down to protect themselves.

A good rule of thumb is to derate the available current by about 1 Amp per 10 degrees 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.

G3 Decoder Thermal Fault Clearing

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

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



Heat and Hot Weather Tips -Managing Heat Buildup

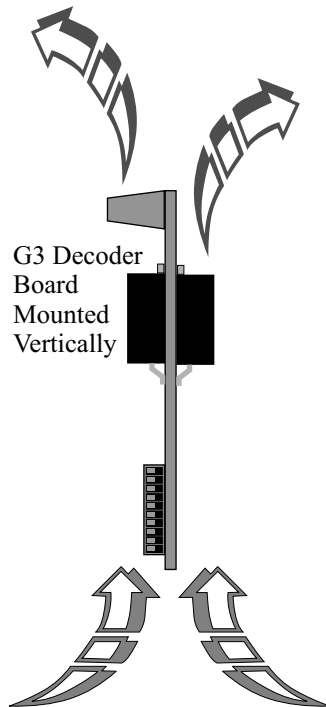
When operating the G3 decoder near its maximum current capacity, the decoder can become as hot as a 100 Watt light bulb. Since most decoders are mounted inside plastic locomotives and rolling stock, the interior temperature can reach harmful levels leading to decoder shutdown unless this heat is removed. 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!

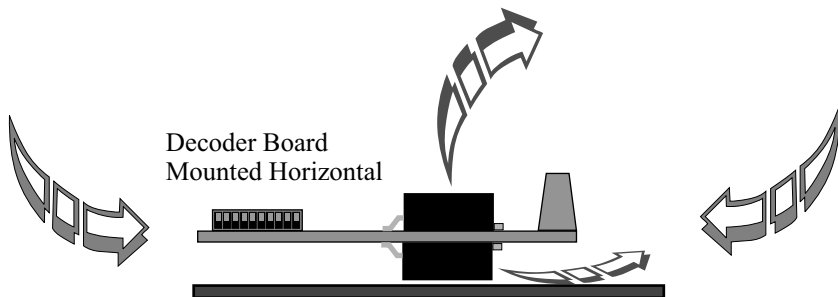
The decoder should be mounted such that the large black power transistors are open to free air movement. If at all possible, allow the transistors to be near an opening in the chassis or car floor. Cool air will be pulled towards the transistors as the hot air rises away from the decoder.

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



Vertical board mounting allows better airflow

continued on next page



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

G3 Frequency Selection Using The T9000 Throttle

The G3 decoder uses frequencies numbered from 0 to 16 and these are the numbers used when setting the G3 to the desired frequency. However, the T9000 throttle uses different numbers for the frequencies, depending on what command is used to set the T9000 transmit frequency.

To use just the G3's first 8 frequencies, 0 thru 7, then you may use the same frequency number for both the G3 and the T9000 throttle. However, you must use the SEL-1 command to set the desired frequency into the T9000 and you are limited to just the first 8 frequencies.

To use all 17 available frequencies, 0 thru 16, on the G3 decoder, you must set the T9000 throttle transmit frequency to the appropriate number from the table below using the SEL-0 command.

G3 Frequency	T9000 SEL-1 Mode	T9000 SEL-0 Mode
0	0	74
1	1	68
2	2	50
3	3	39
4	4	27
5	5	21
6	6	15
7	7	3
8		93
9		87
10		81
11		61
12		56
13		44
14		33
15		9
16		54

T9000 Key Sequence

1. Set throttle to decoder address.
2. Set throttle to decoder's present frequency. Be sure you use the appropriate SEL command and use the frequency number from the table above.
3. Push OPR followed by the SEL key.
4. One at a time push the following keys: *, 5, 8, *. In the display, Cn means configuration number which is what we call a CV. The T9000 LCD can't display the V.
5. Push the # key, then the desired frequency number, and then # again. The decoder chirps to indicate receipt of the new frequency.

Note that the decoder's CV58 is always set to a frequency number from 0 to 16. Do not confuse the T9000 transmit frequency number with the decoder's frequency number.
6. Push OPR key to exit OPS mode.
7. Change the throttle to the new frequency (see below) and operate the locomotive.
8. Write down the new frequency.

Note The Different T9000 Command To Use G3 Frequencies 8 to 16

You will be delighted to know that your T9000 is already capable of accessing all of the available G3 frequencies. Your T9000 has an undocumented command, SEL-0, that is used to set its transmit frequency to these new frequencies. Note that there is no direct match between the T9000's new frequency numbers and the G3 decoder's frequency numbers.

G3 Frequency Selection Using The RF1300 Throttle

Each throttle/decoder pair must be on a unique frequency so as not to jam other throttle/decoder pairs. The G3 decoder features remote frequency selection directly from the throttle. If you have our previous generation decoders, the most obvious difference will be the absence of the frequency selection switch on the decoder. Read and follow these instructions carefully and you will immediately see the benefit of being able to set the decoder frequency without ever having to open up the locomotive. The decoder frequency is remembered even if the battery is disconnected.

RF1300 users are restricted to the first 8 frequencies from 0 to 7. T9000 and T5000 throttle users can use all 17 frequencies.

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.

Setting The Frequency - The desired frequency is stored inside the decoder in configuration variable number 58 which is abbreviated CV58. You need to know the decoder's address as well as its current frequency in order to use OPS PROGRAM mode to set CV58.

Caution: The throttle's frequency must be set to 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 page 4 for how to reset the decoder's frequency. OPS programming is the safest method to change the decoder's frequency without fear of changing another G3 decoder that might hear a SERVICE PROGRAM command.

RF1300 Key Sequence

1. Set the present locomotive address into the throttle.
2. Be sure the throttle's transmit frequency matches the frequency set in the decoder. Use the table below for the G3 frequency to RF1300 throttle DIP switch setting.
3. Push the 9 key to initiate OPS mode programming. The direction indicators will begin to alternately flash. To cancel OPS mode programming, push the 9 key again.
4. Push * 5 8 * to enter the desired CV number. Notice that the mode indicator is added to the flashing LEDs upon entering the first *. Once the number is entered and the * is pressed again, the mode indicator turns on solid while the direction indicators continue to flash.
5. Push #, followed by the desired frequency number and push # again. The decoder will chirp to indicate it received the command.
6. Push the 9 key to terminate OPS mode programming.
7. Open up the throttle and reset the DIP switches to the new decoder frequency and operate the locomotive.
8. Write down the new frequency.

G3 Frequency	RF1300 Switch Settings	G3 Frequency	RF1300 Switch Settings
0		4	
1		5	
2		6	
3		7	

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, the CVP recommended battery pack is rated at 4.4 Amp-hours. In other words, the battery will last about 1 hour if the locomotive pulls 4.4 Amps. 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 And 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 G3 decoder has a built in timer that shuts off the generator after about 2 minutes. This will insure that it will automatically turn off should you forget. So, unless you keep retriggering the generator, its current draw will be minimized.

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.

G3 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	2 Amp

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.

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. Also, the jack used to connect the locomotive to the car, is the same jack used to connect the charger.

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 G3 decoder operates in an unlicensed band shared by many other transmitters. These transmitters can and will create interference, intermittent throttle operation or complete failure of one or more of your 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, unlicensed personal communication devices, lawn sprinkler controllers, remote starter switches, cordless light switches, outdoor lighting controllers, toys, wireless headphones, and games. Of course, if you have additional wireless throttles, make sure each is on its own frequency. Two throttles on the same frequency will jam each other.

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

Never Use RTV or Silicon Adhesive On The G3

NEVER use RTV or other liquid adhesive to attach the G3 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 G3 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.

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

Restoring G3 To Original Factory CV Values

CV8 is used to restore or reset the G3 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 G3 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 know your decoder's address and its present radio frequency, then set your throttle on the same address and frequency. In this mode you will use OPS PROGRAM commands to issue the reset and no other decoders will be affected even if they are powered up and on the same radio frequency..

If you do not remember the radio 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]

For The T5000 Throttle

Turn on the T5000 by pushing MENU. Verify it is set to the same frequency and address as the decoder.

1. Push MENU once followed by 0 to select OPS PROGRAM mode.
2. Press 8 and then ENT to enter CV8.
3. Press 1,3,5 then ENT to enter the reset value. All other values are rejected. When you press ENT, the decoder will chirp from 1 to 3 times to signify that it has been reset.
4. Press * to exit OPS PROGRAM mode.

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

For The T9000 Throttle

Turn on the T9000. Verify it is set to the same frequency and address as the decoder.

1. Push OPR then the SEL key to enter the OPS programming mode.
2. One at a time, push the following keys: *, 8, *.
3. One at a time, push the following keys: #, 1, 3, 5, #. Listen for the decoder to chirp from 1 to 3 times signifying the decoder has been reset.
4. Push the OPS key to return to normal operation or cycle the throttle's power switch..

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

If you do not know the decoder's frequency, you must use the "forgotten frequency" step first, described on page 8. Once the frequency has been set, you may followup with the factory reset.

Forgotten G3 Frequency

There may come a time when you do not remember the G3 decoder's assigned frequency. If this happens, use the following technique to reset the G3's frequency.

How This Works: This problem is easily solved with what we call the "Jump Mode." When Jump Mode is activated, the G3 temporarily "jumps" to frequency 0. Once your G3 decoder has jumped, you then use service mode to change the frequency to whatever you wish.

To Reset Frequency Using Jump Mode And SERVICE PROGRAM

- Step 1: Turn off **all** AirWire throttles. This is very important since it is the absence of any throttle signal that forces the G3 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 G3 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, it will slowly blink during the wait time. Listen for the 5 second count down chirp*. When the chirps stop, the GP LED will be dark and the G3 is temporarily on frequency 0. You must wait the full minute before moving to step 4.
- Step 4 - Turn on your throttle, and set the throttle frequency to 0. If visible, the G3's GP LED will now turn on steady.
- Step 5 - Use **SVC PROGRAM** to set CV58 to the desired frequency. Be sure and reset your throttle to the new frequency. Don't forget to reset your throttle to the new frequency too.
- Step 6 - Cycle the power to the G3 to activate the new frequency. Make sure to change your throttle to the new frequency.

Using OPS PROGRAM During Jump Mode

If you are confident you know the decoder's address, then you can use OPS PROGRAM to change the G3'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 address. If you are not sure, or have forgotten the address, 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 G3 to temporarily jump to frequency 0.
- Step 2 - Turn off the G3 if it was powered and then turn it back on. .
- Step 3 - Wait at least one minute. If you can see the GP LED, it 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 G3 is now temporarily on frequency 0. You must wait the full 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 G3's GP LED will now turn on steady.
- Step 5 - Use **OPS PROGRAM** to set CV58 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 G3 setting within one minute of the decoder power being turned on.
- If the G3 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 G3 will stay on frequency 0, until power is cycled or you change the frequency by setting CV58 to a new value. If you did not change the frequency, the G3 will revert back to its previously stored frequency as soon as its power is cycled off then back on.
- The G3 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 G3 "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.

Additional CVs

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 Setup **CV29**
Range is 0-255 [2]

CV29 is a a multipurpose CV whose value sets several options at once. The G3 sets this CV automatically for you so there should be no need to change it. However, if you accidentally change it and the locomotive no longer runs, you can either reset it back to a value of 2 or use a factory reset to erase all changes and restore CV29 to its default value of 2.

Decoder Frequency Number **CV58**
Range is 0-16 [0]

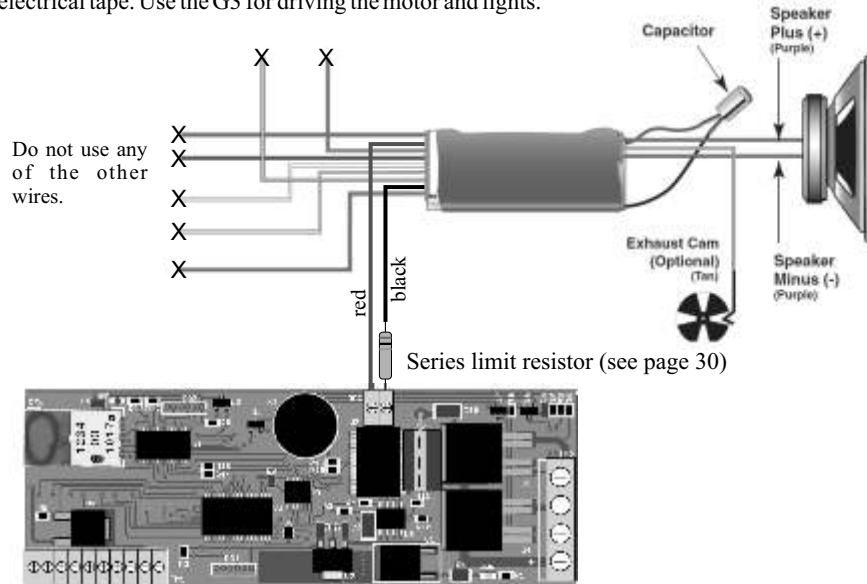
CV58 holds the assigned frequency number for the G3 decoder. If a number larger than 16 is attempted, the decoder rejects it and automatically sets itself to frequency 0. If you have forgotten the frequency, see page 8 for the procedure to temporarily force the G3 to a known frequency.

G3 Decoder And Soundtraxx Tsunami Decoder

The Tsunami decoder plus a G3 makes an great alternative to the Phoenix products sound decoders. Hookup is very simple with only the red and black wires attaching to the G3's H1 header. If you use the recommended 14.8V battery, or your G3 is the r9G3 version, the resistor is not required and the black wire connects directly to the G3. Older G3 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 G3 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 G3 for driving the motor and lights.



Setup/Program Sound Decoders With The AirWire900 Throttle

Use your T5000 throttle to setup and program the operation of the attached sound decoder. All of the programming commands from your 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 G3 and attached sound decoder have matching addresses. See page 9.

Numerous Shared CVs

There are numerous shared CVs between the Tsunami decoder and the G3. 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 G3.

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 than the power switch.

Some Terminology - What is a CV?

The world of AirWire and DCC makes use of some abbreviations and words that may be new to you. This page lists a couple of important ones along with their definitions.

“CV#” is the abbreviation for Configuration Variable Number: A CV number is a unique and specific memory location inside the decoder, designated by the “number” into which CV values are stored that 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 G3 decoder are on the back cover.

Below is a typical G3 explanation for a configuration variable. Each CV description is in the same format. The first line gives the function controlled by the CV number. The specific number follows the textual phrase and this entire line is bold faced. The line immediately following the CV number provides the range and the value in square braces is the original factory setting. If there are any special notes or precautions, these are listed next.

Changing the Locomotive Address..... CV1

Range is 1 - 9999 [3]

Setting, Loading or Programming CVs: We use these words when changing the operation of the G3 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 number to make it perform in a certain way. In simple terms, you are changing how the decoder works. CV values are sent to the G3 decoder using any AirWire900 throttle - nothing else is required.

SERVICE PROGRAM 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 be changed.

OPERATION or OPS PROGRAM Mode is a method of changing settings within the decoder that requires the correct address be used. This is the recommended method of programming since it affects only the decoder with the specified address. Other decoders, sharing the same frequency, will ignore the programming commands.

The throttle frequency and the decoder frequency must match in order to make any changes to the decoder.

Setting The Throttle To A New Frequency or Address...

Just changing the throttle will not change the decoder in any way! You must “program” the decoder's address and/or frequency CVs. Once programmed, the decoder will remember the programming forever or until you reprogram it again.

Battery Wiring And Polarity Verification

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

Each of the following sections describes the connection of various terminals on the G3 decoder. Use these diagrams as a generic guide to the connection of the G3 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 heatshrink tubing. First, hook up all of the battery minus wires.

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

Polarity Verification - one way to quickly end the life of the G3 decoder is to connect up the battery with the plus and minus reversed. Included with the G3 decoder is a small polarity testing diode that is used to verify that you have the plus and minus leads properly identified before you connect them to the decoder.

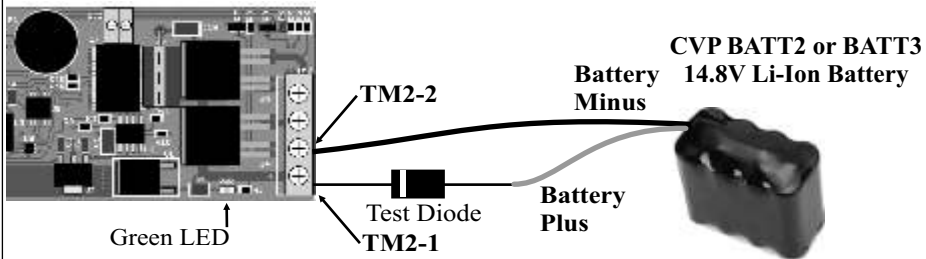
TM2 is the large 4 pin terminal strip on the end of the G3 board. Pin 1 is the bottom pin when the terminal strip faces to the right as in the picture. Terminal strip references are shortened to the terminal designator, TM2 and a specific pin number. For example, TM2-1 is where the battery plus always connects.

Step 1: Before using the diode, first connect the battery minus lead, the black wire, to the decoder's TM2-2 and tighten the screw. TM2-2 is the battery minus connection.

Step 2: Insert the banded end of the diode into TM2-1 and tighten the screw. Touch the battery plus lead, the red wire, to the non-banded end of the diode. If the G3's bright green LED turns on, then the polarity is correct.

If the G3 green LED does not turn on, then 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. 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. It can not handle the high motor current and will fail almost instantly.

G3 Decoder and Phoenix P8 Operation Tips

P8 Setup Recommendations

- The throttle will directly program the Phoenix P8 address when you use SERVICE PROGRAM of CV1 for the G3. Just make sure the P8 is connected and powered on. The remaining setup must be done from the P8 computer port and with the Phoenix software.

- You must set the MTS mode to "disabled" so the DCC commands work correctly.
- Make sure all trigger pins are disabled since all commands come via the throttle.
- Save your configuration file under the locomotive number before disconnecting the computer interface.
- The table of throttle function key assignments to sound effects works well for most P8 installations. You must use the P8 computer interface to make these assignments. These are not programmable from the throttle.

P8 and G3 Shared CVs

The P8 shares some CV numbers with the G3. These CVs are CV49 through CV53. Sending programming commands, OPS or SERVICE, to one decoder will program both. We recommend the following procedure to avoid inadvertent changes.

First, program the the P8's CV numbers to their desired values. Then, turn off the power to the P8 and then program the CVs in the G3.

Recommended P8 Effects Assignment Changes From Default

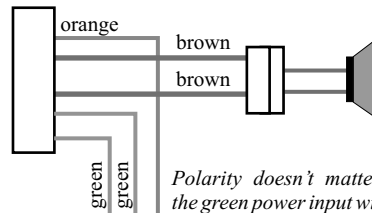
All P8 settings done with Computer Interface			
P8 MTS mode	Disabled	Stopping horn volume	0
Shutoff Delay	0	Toot holdoff	0
DCC Timeout	0	Airpop	F11
DCC address	3	Compressor Trigger	F6
REVUP DCC	none	Dynamic Brake	F9
REVDWN DCC	none	Brake Release	F10
Bell	Manual	All Function buttons	Latched except F2
Bell Stop Speed	0	Peak Wattage	2W
Stopping Bell Duration	OFF	Compressor Pin	Auto
Startup bell duration	OFF	Brake Release Pin	Auto
Triggered bell duration	OFF	Wheel Squeel	not assigned
Autobell speed limit	OFF	Airpop Pin	Auto
Bell holdoff	0	Track Noise	100%
FWD horn volume	0	Detector Pin	none
REV horn volume	0		

Recommended P8 Function Key Assignments - All Done From The PC Interface To The P8

F1	Bell	Toggles Bell on/Off	Latched
F2	Horn	Push for horn, release to stop	Momentary
F3	Coupler clang	Push to trigger sound	Latched
F4	Grade Crossing	Push to trigger grade crossing horn	Latched
F5	Station Announcement	Push to trigger sound	Latched
F6	Compressor	Push to trigger sound	Latched
F7	Volume Up	Push starts vol ramp up, push to stop ramp	Latched
F8	Volume Down	Push starts vol ramp down, push to stop ramp	Latched
F9	Dynamic Brake	Push to trigger sound	Latched
F10	Brake Release	Push to trigger sound	Latched
F11	Air Pop Valve	Push to trigger sound	Latched
F12	Shut down	Toggle Prime Mover Shutdown or startup	Latched

G3 Decoder and Phoenix P8 Hookup

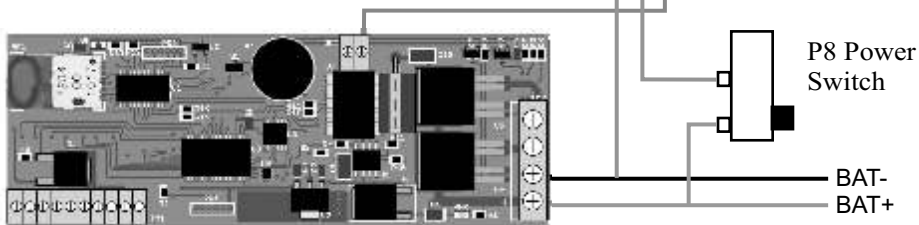
P8 Hookup Option 1



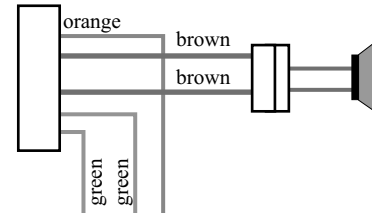
Polarity doesn't matter for the green power input wires

Hookup Option #1

This option allows the P8 to draw power directly from the battery, bypassing the G3's DCC driver. Any battery voltage may be used up to the G3 limit of 24V. This provides for maximum power to the P8 with no worry about surge currents.



P8 Hookup Option 2



Limit resistor: See page 30 for details on its use.

P8 Power Switch

Hookup Option #2

This option needs just two wires from the G3 to the P8. Use this option if you are using 12V batteries.

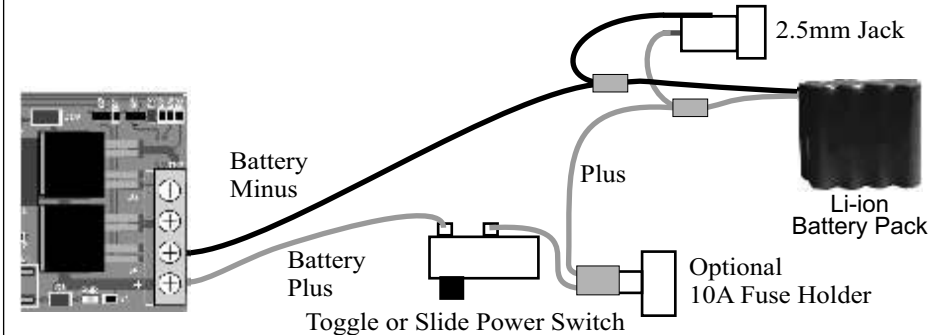
See page 30 for notes about the resistor usage.



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 heatshrink tubing.

The optional 2.5mm jack is for the battery charger. See below for where to get this jack and more useful accessories.

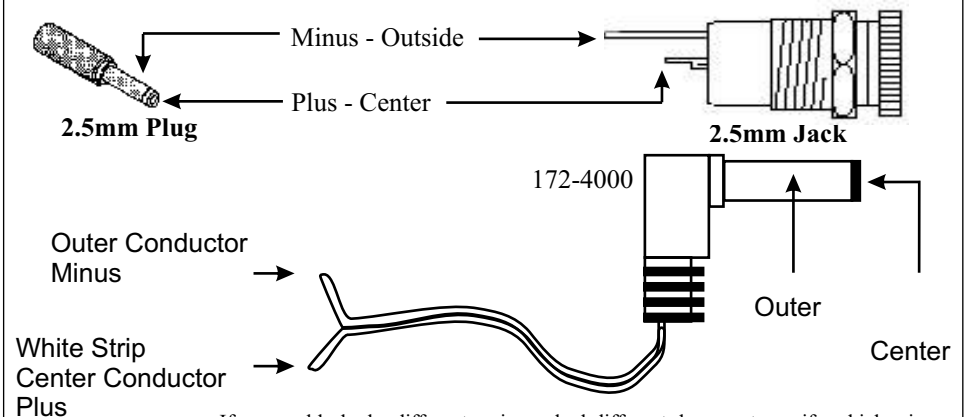


Do Not Use The Locomotive's Internal Circuit Boards - Do not attempt to use any of the loco's built-in circuit boards for wiring and connections especially to the motor. This is one of the most common causes of decoder damage and or failure of the constant speed feature.

Wiring Accessories - Plugs, Jacks and Cord Sets

From the Mouser Catalog - www.mouser.com

Description	Part Number
Heatshink tubing assortment kit	562-Q2F3X-QK1-KIT106
72 inch cord, 20 gauge wire with right angle 2.5mm plug	172-4000
72 inch cord, 18 gauge wire with straight 2.5mm plug.	172-4001
2.5mm threaded metal jack with long shank	163-4026
2.5mm snap-in jack (thin wall plastic only)	163-1061-EX
2.5mm threaded metal jack with short shank	163-4025
2.5mm plug (for making your own cord)	1710-2510
DPDT Miniature Slide Switch	611-JS202011AQN



If your cable looks different or is marked different, be sure to verify which wire connects to which part of the plug. Incorrect polarity applied to the G3 will damage it.

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 battery pack and charger are available directly from CVP Products.

The CVP BATT2 or BATT3 battery packs are small, lightweight and packs a lot of power into a small package. The BATT2 can power a large USA-Trains SD70 for more than 3 hours.

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

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



BATT2 Battery Pack



CVP Li-Ion 14.8V Charger

CVP offers hookup cables having battery socket and plug connectors to match AirWire batteries and decoders. Download the AirWire catalog for more information.

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 G3 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-cel battery having the same energy capacity. However, unlike a gel-cel, the new battery technologies are much more sensitive to poor charging. The battery will also be much more expensive. The matching charger will also be more expensive. However, when properly used and charged with an appropriated charger, the batteries will have a long lifetime.

Absolute Maximum Input Voltage For The G3 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, when fully charged, a 12V lead-acid battery will measure about 14 volts. The CVP 14.8V lithium battery pack will read about 16.5 volts when fully charged.

Never exceed 24 volts input voltage or you will damage the G3 decoder. Always measure the battery voltage when fully charged and confirm that it is below 24 volts.

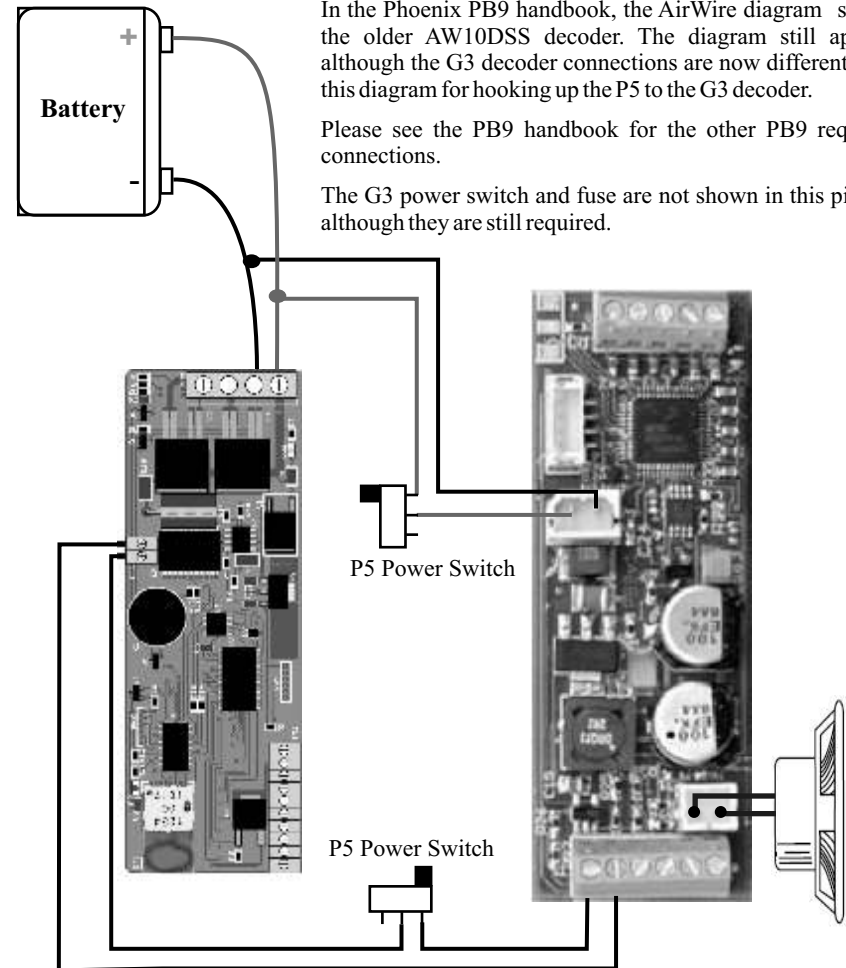
G3 Decoder And Phoenix PB9 Hookup

The PB9 connects directly to the G3 decoder's auxiliary DCC outputs. The G3 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 G3 decoder connections are now different. Use this diagram for hooking up the P5 to the G3 decoder.

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

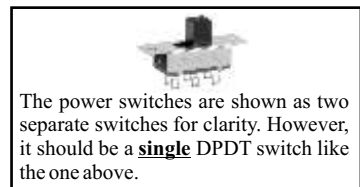
The G3 power switch and fuse are not shown in this picture although they are still required.



Programming The Sound Decoder Address

To program *any* external sound decoder's address, first connect the sound decoder to the G3 decoder. Set the G3 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 G3 and the attached sound decoder to the same address at the same time. See the throttle manual for detailed instructions.

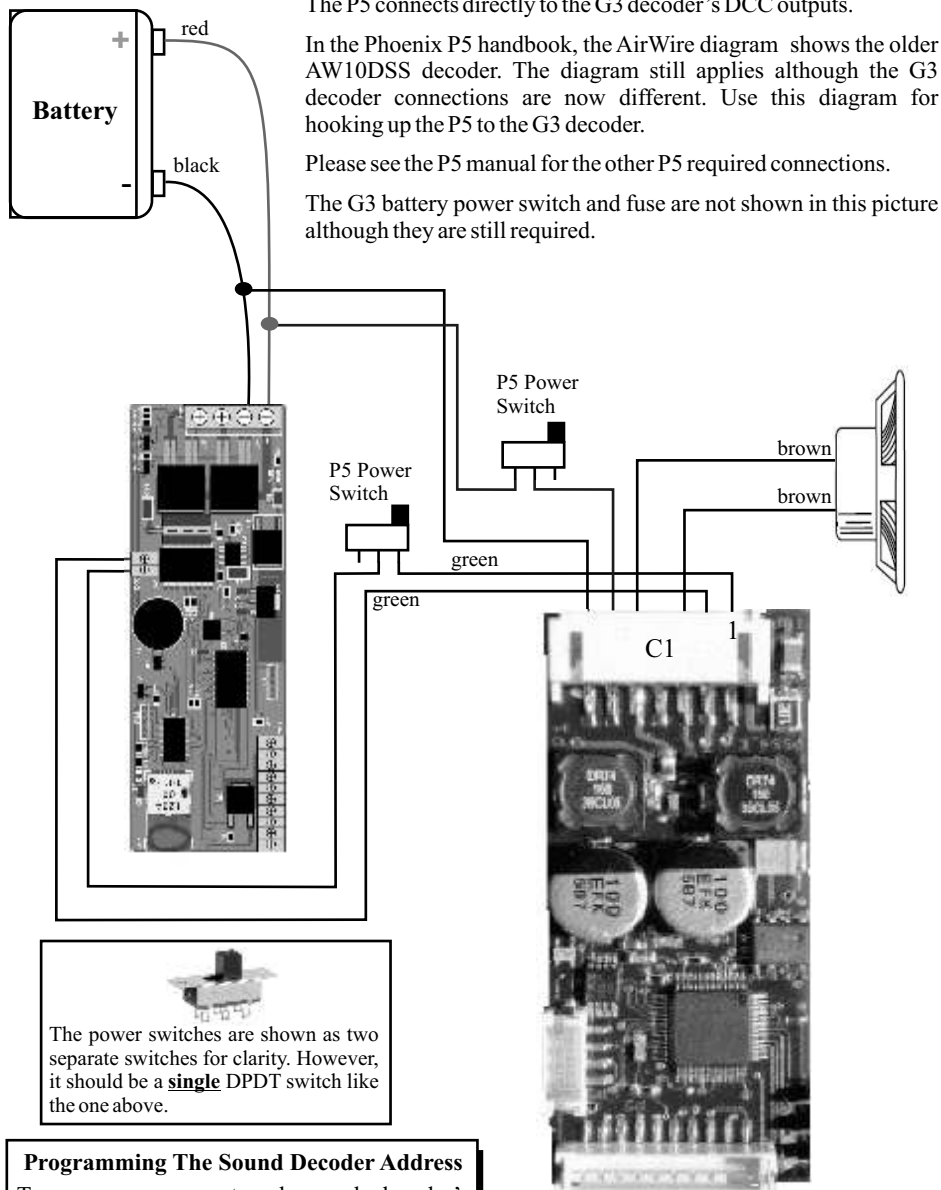


The power switches are shown as two separate switches for clarity. However, it should be a **single** DPDT switch like the one above.

Shared CVs

You may program the G3 without fear of changing the P5 programming. The only shared CVs are the address CVs, which are 1, 17 and 18.

G3 Decoder And Phoenix P5 Hookup



The P5 connects directly to the G3 decoder's DCC outputs.

In the Phoenix P5 handbook, the AirWire diagram shows the older AW10DSS decoder. The diagram still applies although the G3 decoder connections are now different. Use this diagram for hooking up the P5 to the G3 decoder.

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

The G3 battery power switch and fuse are not shown in this picture although they are still required.

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 G3 decoder. Set the G3 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 G3 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 G3 without fear of changing the P5 programming. The only shared CVs are the address CVs, 1, 17 and 18.

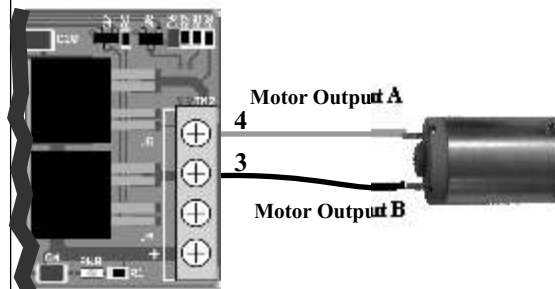
Decoder to Motor Hookup

G3 Motor Output Terminals on Terminal Strip TM2

Terminals TM2-3 and TM2-4 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 just be barely showing outside the terminal clamp. If you can't see the bare wire, the clamp might contact the insulation resulting in poor connection. If the bare wire is too long, it might short out adjacent wires. Fasten the wires out of the way and make sure the 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.

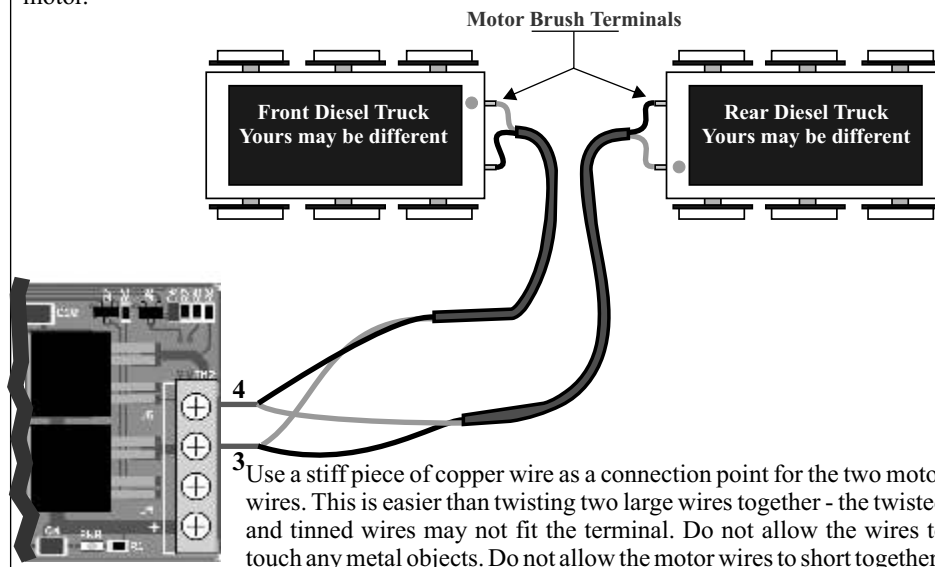


Incorrect operation of the constant speed feature will occur if there is other circuitry, including lighting circuit boards, connected to the G3 motor terminals. Only motors can connect to the G3 motor terminals.

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.



Smoke Generator Hookup And Precautions

Terminal 9 of TM1 is used to control 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.

Older smoke generators are nothing more than a coiled piece of wire in a reservoir that 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.

The USA-Trains fan equipped smoke generator uses a small circuit board for control. The G3 output connects to this board at the location labeled INPUT. This model is not polarity sensitive.

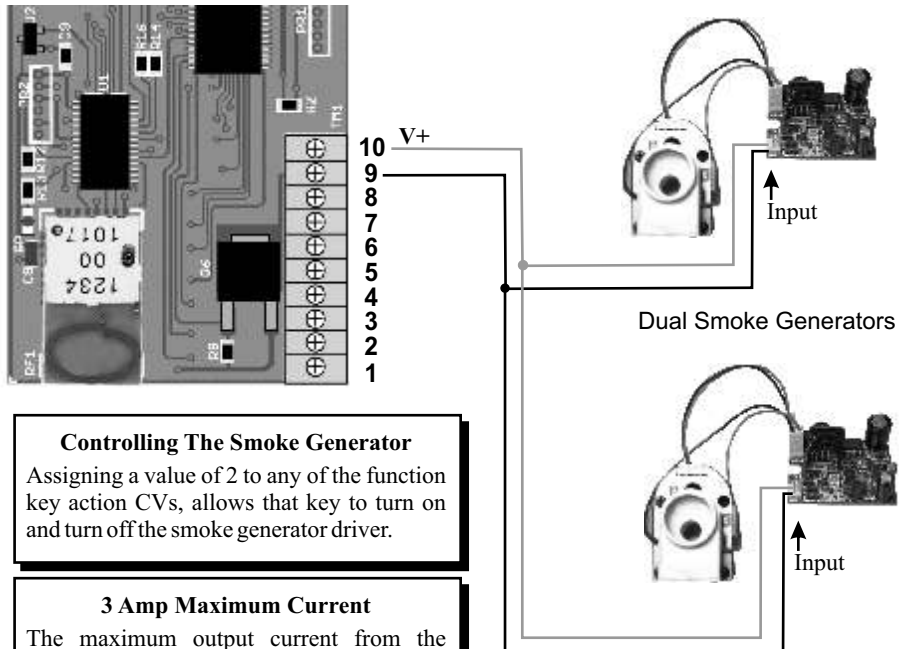
Smoke generator boards may be connected directly to the G3 without any trouble. This is one of the few times you may use a locomotive's internal board with the G3.

In normal operation, 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 +. TM1-10 is a convenient connection point, or you can connect directly to the battery + wire.

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.

Two Minute Automatic Shut-Off Built In: The G3 decoder will automatically turn off the smoke generator after two minutes of continuous use. This protects both the smoke generator and the G3.



Controlling The Smoke Generator

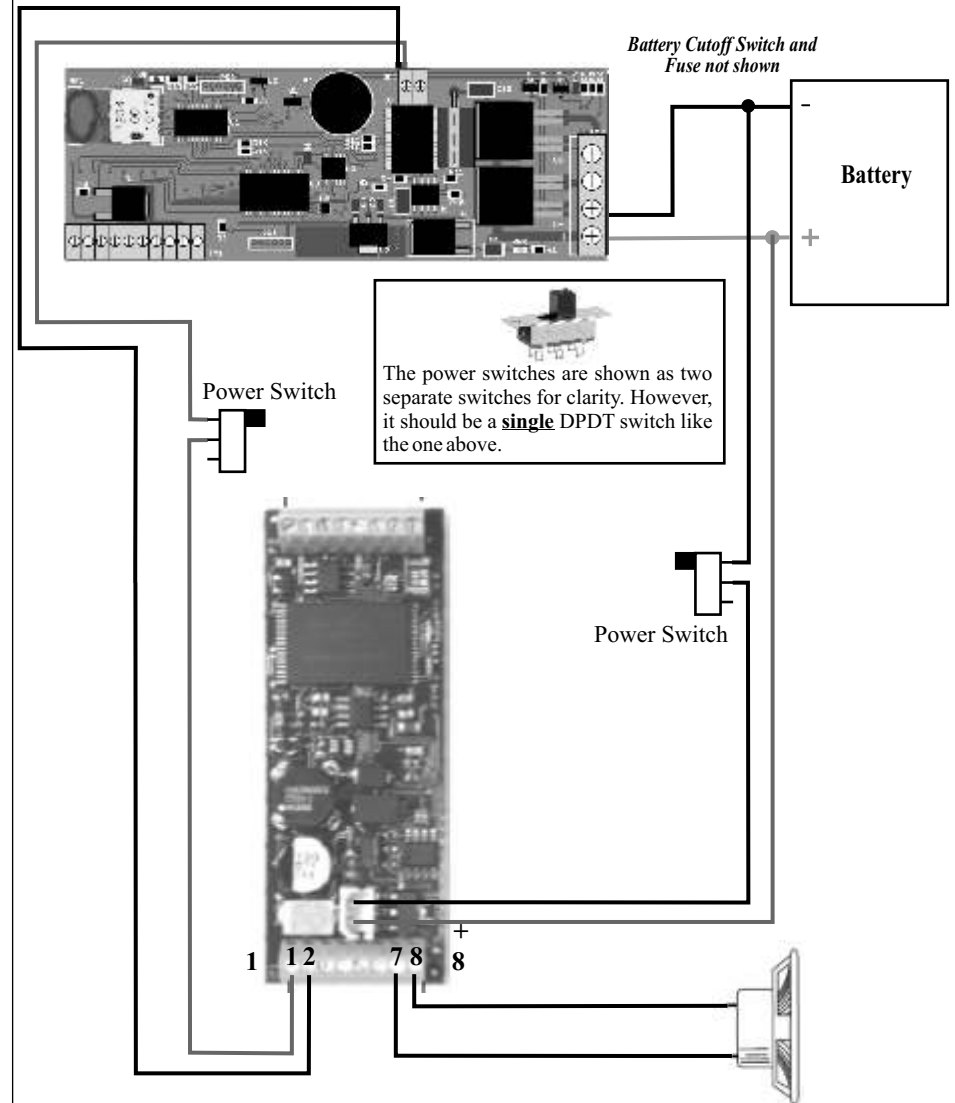
Assigning a value of 2 to any of the function key action CVs, allows that key to turn on and turn off the smoke generator driver.

3 Amp Maximum Current

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

G3 Decoder And Phoenix 2K2 Sound Hookup

This hookup diagram shows the required connections between the G3 decoder, the battery and the 2K2 module. See the 2K2 installation manual for programming information and detailed instructions for the remaining connections. The G3 power switch and fuse are not shown but need to be included in the final installation.



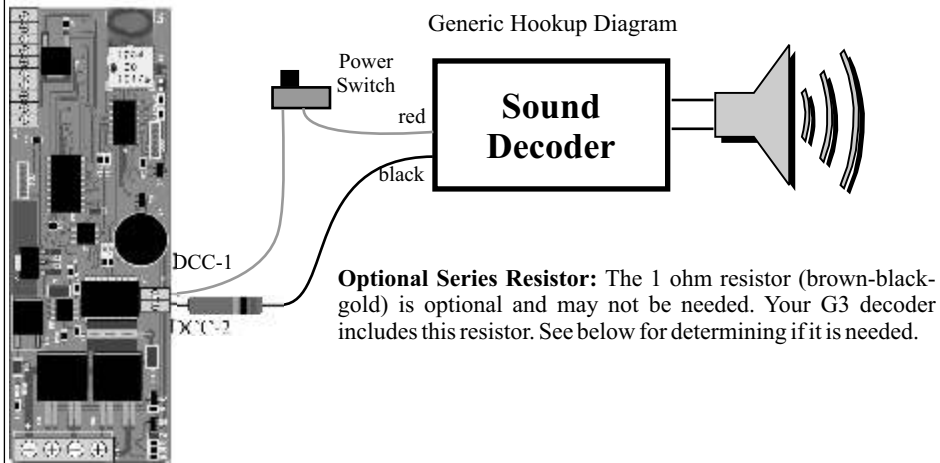
Programming Notes

When programming the G3 + 2K2 decoder's address, you will need to do it twice to ensure the 2K2 is properly programmed.

Shared CVs

You may program the G3 without fear of changing the P5 programming. The shared CVs are the address CVs, 1, 17 and 18.

Using The DCC Booster Output



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 older sound decoders, such as the Soundtraxx DSX are rated only up to 18 volts.

Max DCC Output Current: The G3 decoder provides an auxiliary 2.5 Amp DCC-Booster output suitable for driving any NMRA-DCC compatible sound and function decoders.

Use a Separate Power Switch for 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. For example, power up both the G3 and the sound decoder. Program the sound decoder first. Then turn off the sound decoder and program the G3.

Addresses Must Be The Same: In normal operation, the external sound or function decoder and the G3 decoder have the same address. If you use SERVICE PROGRAM of CV#1, this will be automatic as long as the G3 and the attached sound decoder are both turned on.

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 G3.

Programming Sound/Function Decoder Address: To program the external decoder's address, first connect the sound decoder to the G3 decoder. Set the frequency to match the throttle's frequency and turn on power to both. Use Service Mode programming and set both the G3 decoder and the external decoder to the desired address.

Customizing Sound Decoder CVs: Once the external decoder has its desired address programmed, you can use OPS mode programming to customize the various CVs. Remember that you must always use the appropriate locomotive address in order to transmit the programming commands to the proper locomotive. If the CV is common to the G3, set the sound decoder first, then turn off the sound decoder, and set the G3 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 probably not necessary but is included with the G3, just in case. See the next paragraph for when it might be necessary.

Note: If the sound decoder has a separate pair of wires that connect directly to the battery, then the resistor is not needed.

Regular DCC track powered sound decoders have a large current surge when power is first applied. With high battery voltage and high decoder surge current, the G3 DCC output protection circuit may trip. If your sound decoder will not turn on, when power is applied, insert the series resistor between one of the output terminals and one of the the sound decoder's input wires. Either terminal and either wire can be used.

Assigning Throttle Function Keys To G3 Actions

Use this step-by-step sequence to assign or change what a function or action throttle key does. The assignment and the action are stored in the decoder's memory even if power is turned off.

The G3 decoder has many memory locations so we use the term CV# where # is a specific memory location. So CV40 means G3 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 G3 decoder. For this example, here's what is wanted:

“On the throttle, I want the 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 G3 decoder so that it performs the desired action when F6 is pressed.

Step 1: Find F6 in the assignment table.

From the table, the G3 decoder uses CV40 for F6.

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

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

Step 3: Turn on the decoder's power. Set your throttle to the decoder's frequency and locomotive address if it has not yet been set. This is very important since if either the frequency or the locomotive address is wrong, the G3 will not hear the throttle's OPS PROGRAM command.

Step 4: OPS PROGRAM CV40 to a value of 2. The decoder will chirp indicating it heard and accepted the command. Escape out of OPS PROGRAM and verify that the G3 decoder's action is correct when the 6 key is pressed on the throttle.

This same sequence is used to assign or change what any of the available function keys do.

Function Key Assignment Table

Description	CV#
F1 Function Key Action	CV35
F2 Function Key Action	CV36
F3 Function Key Action	CV37
F4 Function Key Action	CV38
F5 Function Key Action	CV39
F6 Function Key Action	CV40
F7 Function Key Action	CV41
F8 Function Key Action	CV42
F9 Function Key Action	CV43
F10 Function Key Action	CV44
F11 Function Key Action	CV45
F12 Function Key Action	CV46

Function Key Action Table

Function Key Action	CV Value
No Function	0
Activate Cruise Control	1
Toggle Smoke Generator on/off	2
Toggle EL1 on/off	3
Toggle EL2 on/off	4
Toggle EL3 on/off	5
Toggle EL4 on/off	6
Dim Headlights on/off	7
Ditch Lights Flash Trigger	15
reserved	8-14

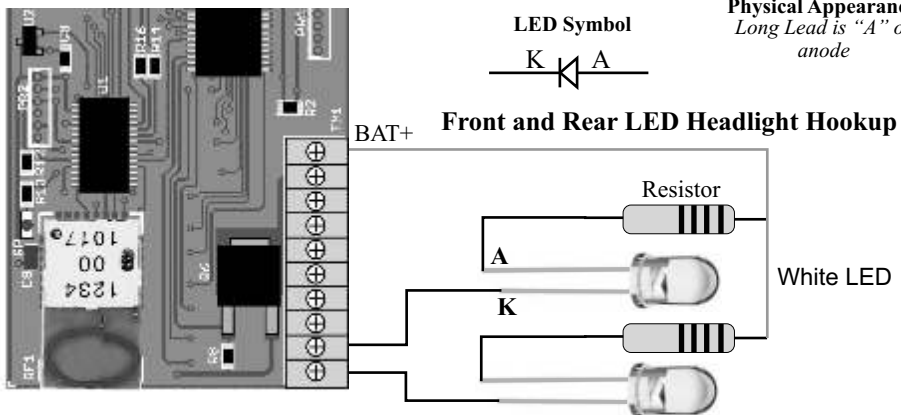
Using The Light Drivers

All of the G3 light drivers are designed to use efficient, cool and bright white light emitting diodes LED. However, you can use incandescent lamp in place of an LED but it will run the battery down quicker and appear dimmer. Also, the special lighting effects will not appear as nice as they do when using an LED.

All lights connect between the battery plus and the light driver output terminal on TM1. For convenience, an extra battery plus terminal is provided on TM1-10. Do not connect to your factory supplied locomotive lights unless you are sure the lamps have the same voltage rating as the battery.

The light driver outputs are rated at 1.0 Amps.

Multiple lights may be powered from a light driver output by wiring the LEDs in parallel or in series. Make sure not to exceed the 1.0 Amp rating of the driver.



LED Current Limit Resistor Value Selection

The LED must always be used with a series limit resistor. The value of the limit resistor depends on the battery voltage, the LED color and the desired brightness. Most white LEDs, are at full brightness between current values of between 10mA (0.01A) and 20mA (0.02A). A lower current will lengthen the battery life. Colored LEDs have slightly different maximum currents but the resistor calculation is the same.

To determine the required resistor value, use the equation below. A white LED voltage is about 3.2V. Once you have calculated the resistor value, it can be rounded up to the closest standard 5% resistor value. The table below shows common values versus battery voltage for white LEDs running on 20mA. At 18V and below, a 1/4 watt sized resistor is adequate. Above 18V use a half watt resistor.

$$R \text{ (in ohms)} = [\text{Battery Voltage}] - [\text{LED voltage VF}] \text{ divided by } [\text{desired current in Amps}]$$

LED Color	BAT+	LEDVF	Current	Value	Closest R	Rating
White	14.8V	3.2	0.02	580	620	quarter watt
White	18V	3.2	0.02	740	750	quarter watt
White	20V	3.2	0.02	840	910	half watt
White	22V	3.2	0.02	940	1000	half watt
White	24V	3.2	0.02	1040	1100	half watt

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

G3 Cruise Control

The G3 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 G3 are two extra CVs, CV64 and CV65. These allow you to finely tune your cruise control to your specific locomotive.

The G3 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**
Range is 0 - 1 [0]

There are two 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**
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**
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 G3 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 multiunit 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.

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 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.

More LED Hookup Options

Series Hookup of LEDs

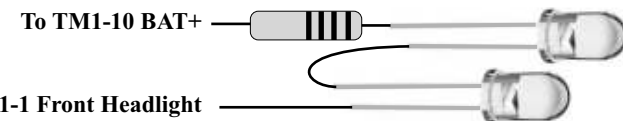
LEDs can be connected in series, one connected to the other. A common application is when a locomotive has a dual-beam headlight.

Since the LEDs are in series, they each get the same current which is 0.02A. However, since two LEDs are in series, calculating the resistor requires that 2 times the LED-VF value be used.

The table below shows the new resistor value for two LEDs in series.



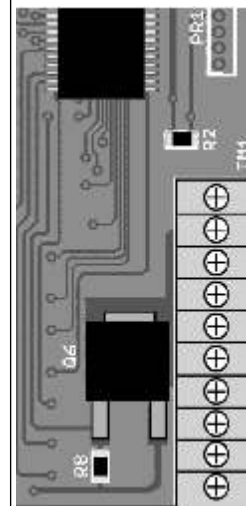
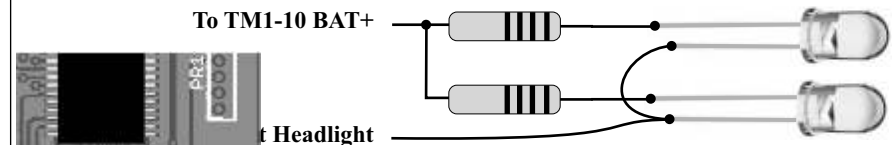
LED Color	BAT+	LED VF	Current	Value	Closest R	Rating
White	14.8V	3.2 x 2=6.4V	0.02	420	430	quarter watt
White	18V	6.4	0.02	580	620	quarter watt
White	20V	6.4	0.02	680	750	half watt
White	22V	6.4	0.02	780	810	half watt
White	24V	6.4	0.02	880	910	half watt



Parallel Hookup of LEDs

LEDs can be connected in parallel. The only difference is that each LED must have its own limit resistor. Otherwise, they will not share the current equally resulting in different brightness for each one.

For parallel LEDs, the series resistor will be the same value as if there was only a single LED.



TM1-	Output
10	V+ from battery
9	Smoke generator driver
8	ELITE #4 driver
7	ELITE #3 driver
6	ELITE #2 driver
5	ELITE #1 driver
4	Ditch light left driver
3	Ditch light right driver
2	Rear headlight driver
1	Front headlight driver

Customizing Headlight Operation Mode

The G3 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 operate. 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 operating 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.

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.

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 special effects. 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.

Front and Rear Headlight Actions	CV Value
Normal, autoreverse	0
Normal with rule17	1
Front headlight on always	2
Front headlight on always with rule17	3
Rear headlight on always	4
Rear headlight on always with rule17	5
Front and Rear both on always	6
Front and Rear both on always with rule17	7
Front/Back Reversed with Auto Reverse	8
Front/Back Reversed w/ Auto Reverse & rule 17	9
reserved	8-15

Head Lights Are Turned On With F0

F0 is shorthand for throttle function key 0. To turn headlights on or off the headlights, push the 0 key on your throttle.

Lights Are Normally Off

When the G3 decoder is powered up, all lighting effects are off.

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 G3 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 G3 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 G3 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.

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**
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**
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, G3 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, G3 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 - neither of which is very uncomfortable.

Special Headlight Effects

There are a variety of special lighting effects that can be applied to the G3 decoder's headlight drivers. To apply an effect, determine which headlight is to have the effect, front or rear or both, find the desired effect in the effects table, note the CV value and then load this value into the CV 61 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 can 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 Mars and Gyra lights. The period range is 1 to 15 and is in units of 1/2 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 shouldn't be used although if you accidentally enter 0, the G3 will automatically change it to a value of 1.

The following table 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.

Special Lighting Effects	CV Value	CV59 Applies
Off 0%	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

All Lighting Effects Are Optimized For High Brightness LEDS

Headlight Lighting Effects Examples and Tips

This page describes a few examples of headlight effects and some interesting combinations of headlight effects.

Front Headlight With Mars Light

This is relatively easy. First, lookup the CV that controls the front headlight effect which is CV61. Next, look up the value for CV61 to implement the Mars light. From the lighting effects table the desired action is a value of 10. Use your throttle to load the value of 10 into CV61. Once loaded, the effect becomes active the moment you turn on the headlights. The Mars effect only applies to the front headlight. If the locomotive direction set to reverse, the front headlight goes out and the rear headlight turns on steady at 100% brightness since CV62 has not been changed.

Changing the Mars Light Period

Now let's change the period of the Mars light and slow it way down. From the table on the adjacent page the CV that controls the headlight period is CV59. A value of 5 will be used which will be a very slow rate of 2.5 seconds - (5 x 0.5s). Use your throttle to load a value of 5 into CV59.

Turn on the front headlight again and observe the change in Mars light pattern.

Front Headlight With Mars Light and Auto-Dimming

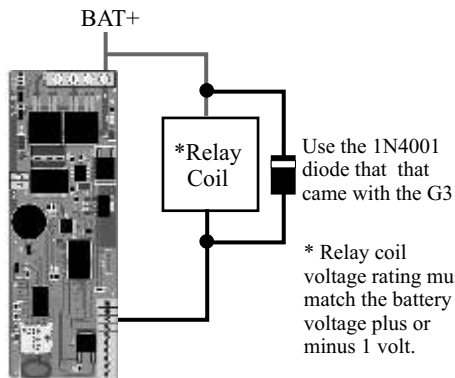
CV60 is used to change the operating mode of the two headlights. Auto-dimming is a headlight operating mode that means that when the locomotive speed is at idle, the headlights will automatically dim. If there is an effect applied to the headlight, it will be turned off. The moment the speed is increased, the headlight comes on at full brightness and with whatever effect is active. For this example, simply load CV60 with a value of 1. This value sets up normal, auto-reversing operation as well as auto-dimming when the locomotive is stopped.

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

In this example, there are 3 locomotives that are consisted together. The locomotives all face the same direction. The desire is for the leading unit to have the front headlights 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 middle unit has the headlights turned off. The CV numbers and their values are shown for the leading and trailing locomotives. All locomotives share the same frequency.

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

Hooking Up A Relay Instead Of An LED



A relay or a solenoid can be driven by the G3 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 LED driver.

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 CV52. A value of 0 disables the timer and restores normal operation of manual on and off. See page 22 for details.

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.

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.

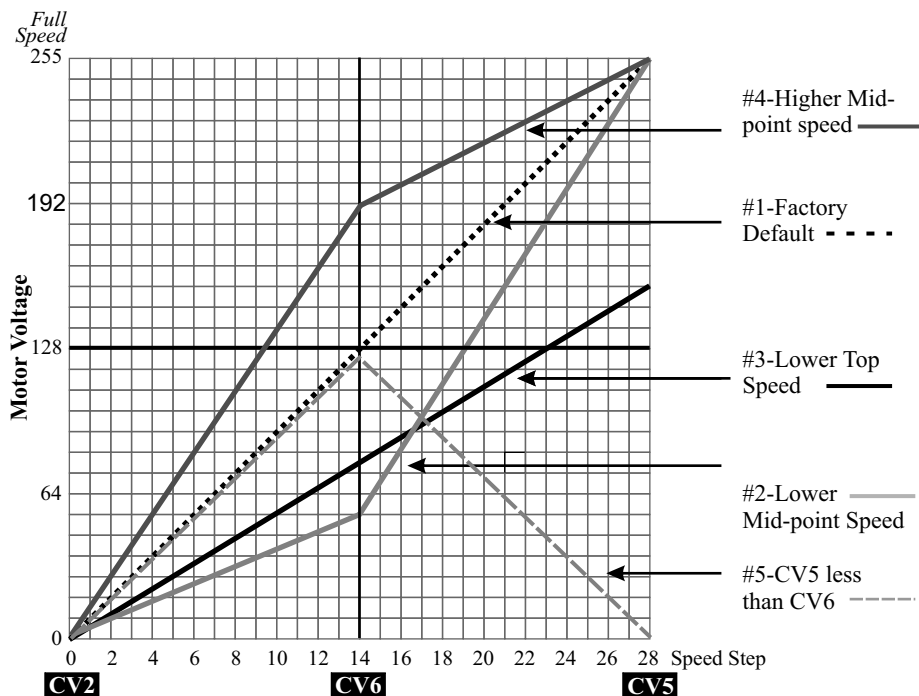
Note: regardless of the throttle's speed step setting, the G3 will automatically adjust for the 14 speed step or the 28 speed step settings.

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.

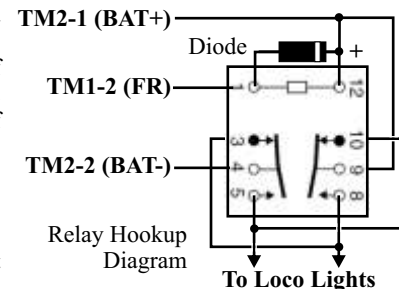


Controlling Polarity Driven Lights

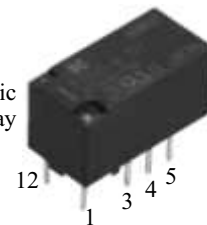
For older USA-Trains locomotive factory supplied lighting circuits that respond to track polarity, an external relay is required. The relay is wired to flip the polarity of the battery voltage that is driving the lighting circuit. This circuit uses the FR output of the G3 to flip the polarity of the connected lights.

In operation, the forward 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, appropriate headlight is 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 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. The 1N4001 or 1N4148 diode is essential for proper operation. It must be oriented exactly as shown.



12VDC Panasonic Relay



Customizing Ditch/Crossing Lights Operation

The G3 decoder has two outputs designed for driving of ditch and/or crossing lights. In modern diesels, these lights alternately flash on and off when activated, usually for grade crossings. On the G3, these are called ditch-light left, or DLL, and ditch-light-right, or DLR.

The factory settings for the G3 Ditch/Safety light turn on both of the ditch lights, DLL and DLR, when the headlights are turned on. We have already assigned throttle function 4, F4, to initiate ditch light flashing. When activated with F4, the ditch lights begin to alternately flash on and off. The flash rate is about a 3/4 second on followed by a 3/4 second off. This flashing continues for about 15 seconds. 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. Turning off the headlight with F0 turns off the ditch lights and terminates the flashing effect if it was active.

To force an early termination of the flashing, just turn off the headlights. Doing so will stop the flashing.

There are three CVs used to customize Ditch Light operations.

Ditch Light Flash Rate CV53
Range is 1-15 [3]

The value sets the rate or frequency at which ditch lights flash when 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. The original factory setting sets the flash rate to about 3/4 of a second. A value of 0 shouldn't be used although if you accidentally enter 0, the G3 will automatically change it to a value of 1.

Ditch Light Mode CV54
Range is 0-1 [0]

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 Timeout CV55
Range is 1- 255 [15]

This value sets the length of time, in seconds, for the duration of the ditch light flashing once triggered. A value of 0 shouldn't be used although if you accidentally enter 0, the G3 will automatically change it to a value of 1.

Ditch Lights Are Turned On With The Headlights - F0

More Light Drivers - ELITE #1 through #4

The G3 has 4 independent light drivers, called ELITES, that may be used to drive additional LEDs. Each ELITE can have a different lighting effect assigned to it. Also, ELITE #4 has a special timer option built-in so it will be discussed separately here and on the next page.

As with all the other G3 light drivers, white LED use which look best for all lighting effects. Be sure to use an external series resistor of the appropriate value as described in the headlights section on page 16.

Do not use an incandescent bulb since the lighting effects look poor and the bulbs consume a lot of power.

Assigning Throttle Function Keys To Control ELITES

Controlling the ELITES from the throttle is done by assigning a throttle function key using the table below. Determine which throttle key will be used to control the specific ELITE and then load the CV value into the CV number matched to the throttle key.

If the desired key has been previously assigned to a G3 function, a new assignment will automatically overwrite the old assignment.

Description	CV#	Function Key Action	CV Value
F1 Function Key Action	CV35	Toggle ELITE #1 on/off	3
F2 Function Key Action	CV36	Toggle ELITE #2 on/off	4
F3 Function Key Action	CV37	Toggle ELITE #3 on/off	5
F4 Function Key Action	CV38	Toggle ELITE #4 on/off	6
F5 Function Key Action	CV39		
F6 Function Key Action	CV40		
F7 Function Key Action	CV41		
F8 Function Key Action	CV42		
F9 Function Key Action	CV43		
F10 Function Key Action	CV44		
F11 Function Key Action	CV45		
F12 Function Key Action	CV46		

Function Commands Are Shared

When the throttle sends a function command, both the G3 and the attached sound decoder will respond. Keep this in mind when assigning function keys.

If you decide you don't like the combination or later decide to make a change, a simple OPS PROGRAM change lets you change the assignments at any time.

ELITE #4 Has A Special Timer Function Built-in NEW!

ELITE #4 has a special timer attached to it. You may set the timer to turn off the ELITE, once activated. You may use this with any lighting effect as well as with external relays but it only works for ELITE #4. If you are using a relay, do not use an effect. Instead, set the ELITE effect to continuous on.

CV52 sets the time delay and has a range of 1 to 255 seconds. If CV52 is set to 0, the timer is disabled and the ELITE will stay on until you manually turn it off.

Note: If you intend to use a relay, be sure to set the ELITE #4 effect, CV51, to a value of 4 which sets the ELITE #4 output to continuous on.

ELITE #4 On-Time Duration Timer CV52
Range is 0-255 [0]

Here's how to setup ELITE#4 to drive a relay. For example, first set ELITE#4 for continuous output. Use OPS mode programming to set CV51 = 4 (100% full ON). Next, determine how long the timer will remain on, once triggered from the throttle. You may select from 1 to 255 seconds. Using OPS PROGRAM, set CV52 with the number of seconds. See page 20 for how to hookup a relay.

Assigning ELITE Special Effects

There are a variety of special lighting effects that can be applied to the G3 decoder's ELITE drivers. Each ELITE can have a different effect. The ELITE timing CV47 is shared by all.

To use an effect, first select the proper CV number for the specific ELITE. Next find the desired effect in the effects table and note its CV value. Finally, load this value into the CV number. The original factory CV value is 4 for each of the ELITE effects. This means they turn on at full brightness when activated.

ELITE #1 Effect CV48
Range is 0-15 [4]

ELITE #2 Effect CV49
Range is 0-15 [4]

ELITE #3 Effect CV50
Range is 0-15 [4]

ELITE #4 Effect CV51
Range is 0-15 [4]

ELITE #4 On-Time Duration Timer NEW! CV52
Range is 0-255 [0]

ELITES Effect Timing Rate CV47
Range is 1-15 [3]

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 CV47. Examples of repeating patterns that apply to lighting effects are Mars and Gyra lights. The period range is 1 to 15 and is in units of 1/2 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

Special Lighting Effects	CV Value	Cv47 Applies
Off 0%	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

apply when the selected effect is either full bright, dim or random flickering.

A value of 0 shouldn't be used although if you accidentally enter 0, the G3 will automatically change it to a value of 1.

This table 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.