*u*AWM15 CV Listing

This is a list of all CVs used in the *u*AWM15 that you may customize or change from the factory settings. The "factory value" column lists the original factory settings for a new decoder. These are also the values restored after a factory reset command is received.

CV #	Factory Value	Value Range	Description
CV1	3	0-99	1-99 Primary Address
CV2	9	0-255	Motor Starting Voltage MSV
CV3	2	0-255	Motor Acceleration Rate
CV4	2	0-255	Motor Deceleration Rate
CV5	255	0-255	Maximum Motor Voltage Vmax
CV6	128	0-255	Mid-point Motor Voltage Vmid
CV8	135	135	CVP Manufacturer ID
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	4	0-15	F12 Function Key Action
CV47	3	1-15	AUX Period (x512ms)
CV48	2	0-15	AUX1 Special Effect
CV49	2	0-15	AUX2 Special Effect
CV56	0	0-255	Bump Amount
CV57	0	0 - 127	Bump duration in us
CV59	3	1-15	Headlites Effect Period (x512ms)
CV60	0	0-15	Headlights Mode 0=normal/autorev
CV61	2	0-15	Headlight Front Effect
CV62	2	0-15	Headlight Rear Effect
CV63	0	0-1	Cruise Mode - 0 Norm, 1=Track
CV96	0	0-1	Select AUX or DITCHLITE Mode
CV200	0	0-16	Frequency Select

CVP Products P.O. Box 835772 Richardson, TX 75083-5772
www.cvpusa.com 972-238-9966

The AirWire900® *micro*Motion® Decoder *µ*AWM15™ User Guide

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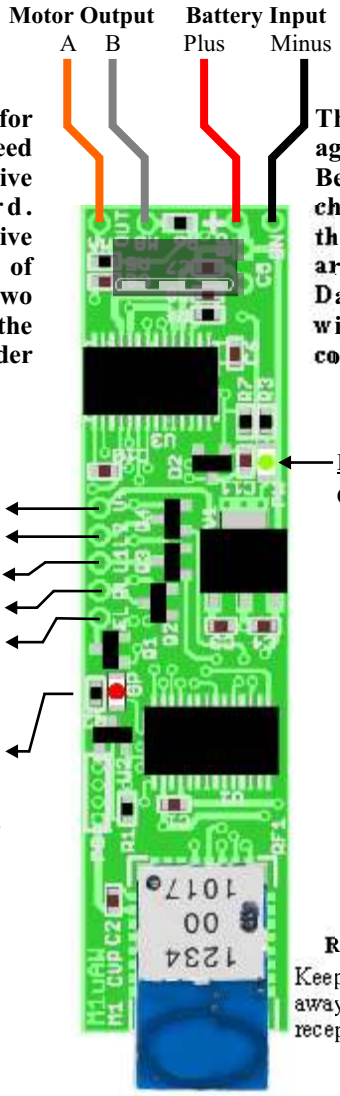


Motor Polarity

With your throttle set for forward, and the speed turned up, the locomotive will move forward. However, if the locomotive goes backward instead of forward, reverse the two motor wires either at the motor or at the decoder outputs.

WARNING

There is no protection against reverse polarity. Be sure to check, double-check and re-check that the battery connections are properly polarized. Damage to the *u*AWM15 will occur if the battery connections are wrong.

LED Driver Outputs

Voltage Source V+
L2 AUX 2 Lite
L1 AUX 1 Lite
RL Rear Lite
HL Front Lite

PWR LED - Green
On when battery power is on

GP LED - Red
On when any throttle data is received on the selected frequency (regardless of loco address)

Radio Module (Internal Antenna)
Keep wires and other metal objects away from the radio module or your reception range will decrease.

Absolute Maximum Ratings

Maximum Input Battery Voltage	18 Volts DC
Minimum Input Battery Voltage	8.2 Volts DC (7.8 typ)
Maximum Motor Output Current - Pulse	4.9 A
Motor Over Current Trip	5.0 A
Maximum Continuous Motor Output Current	1.5 A at 25°C
Maximum LED Driver Output Current	500mA per output

*u*AWM15 Headlight Modes and Effects CV Values

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

Headlight Effects [CV59, CV61 and CV62]		CV Value
Off 0%		0
Dim 6%		1
On, 100% - Full Brightness		2
Strato Light	[rate set by CV59]	3
FRED	[rate set by CV59]	4
Dome Flasher	[rate set by CV59]	5
Gyra Light	[rate set by CV59]	6
Mars Light - Figure 8	[rate set by CV59]	7
Rotary Dome light 1	[rate set by CV59]	8
reserved		9-15

uAWM15 Decoder Warranty Information
This warranty covers substantial defects in materials and workmanship in the uAWM15 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 uAWM15 decoder from one of our AirWire900 dealers, please call them first. They are your best and quickest for answers to questions about uAWM15 decoder. They are also experts in installation and offer such services should it be required. If you purchased your uAWM15 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.**

*u*AWM15 AUX Effects, Cruise Mode and Actions

AUX1 & AUX2 Lighting Effects [CV47, CV48, CV49]		CV Value
Off 0%		0
Dim 6%		1
On, 100% - Full Brightness		2
Strato Light	[rate set by CV47]	3
FRED	[rate set by CV47]	4
Dome Flasher	[rate set by CV47]	5
Gyra Light	[rate set by CV47]	6
Mars Light - Figure 8	[rate set by CV47]	7
Rotary Dome light 1	[rate set by CV47]	8
reserved		9-15

Cruise Control Mode [CV63]	CV Value
Normal (cruise off with change)	0
Tracking mode (Cruise stays on with change)	1

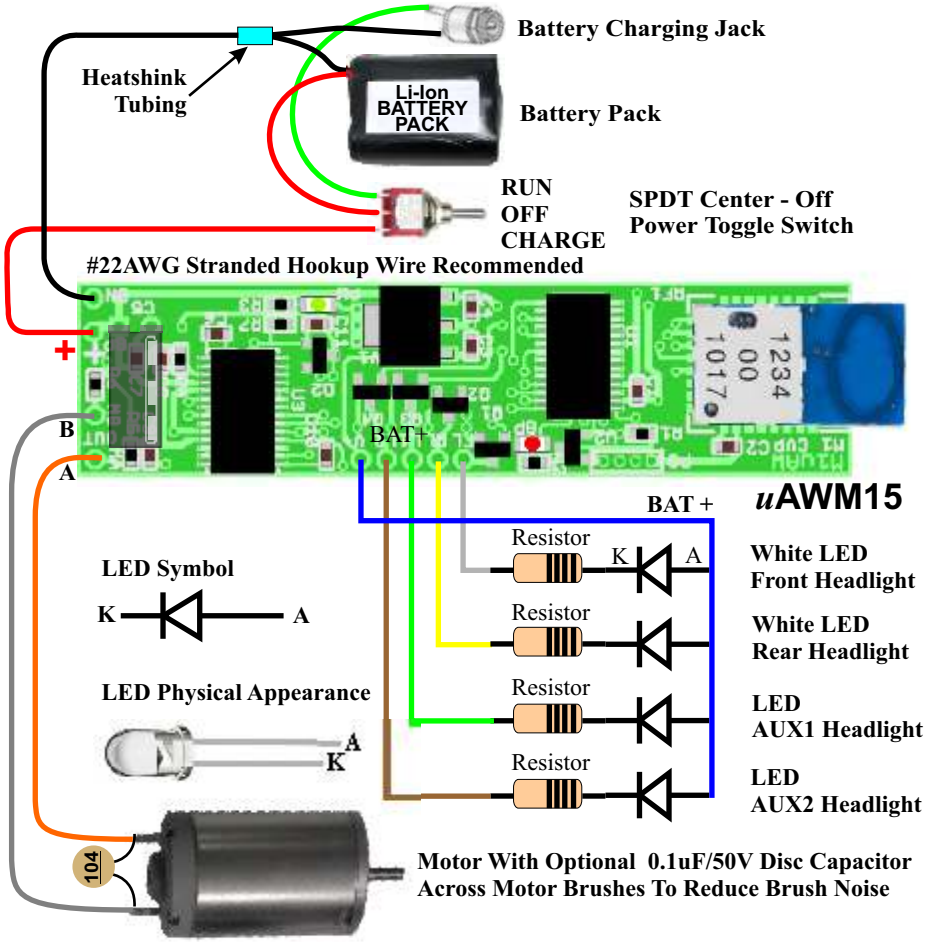
The CV values shown in the table below are the available decoder actions that can be associated with a specific throttle function key. The desired action value is set into the appropriate CV that represents a throttle function key command.

Decoder Actions [CVs 35-46]	CV Value
No Function	0
Activate Cruise Control	1
reserved	2
Toggle AUX1 on/off	3
Toggle AUX2 on/off	4
reserved	5
reserved	6
Dim Headlights on/off	7
reserved	8-14
Ditch Lights Flash Trigger	15

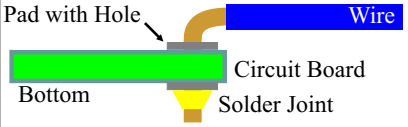
"Reserved," means the value can be set into a CV, and the motor will pulse. But, if activated, nothing will happen.

Tables continued on next page

Complete *u*AWM15 Decoder Hookup Diagram



Soldering Wires To Decoder



The traditional method usually requires a 90 degree bend in the wire. The bent wire is fragile and easily broken.

Traditional Method

- Use #30 AWG stranded wire, stripped 1/2 inch
- Tightly twist strands together and tin wire
- Insert tinned wire into hole
- Solder wire on bottom side of board
- Bend wire carefully to avoid breaking
- Trim wire to top of solder joint

This method eliminates the fragile bend. Before soldering, trim the wire and visually confirm the end of the wire will not touch adjacent pads or components.

Better Method

- Strip #30 AWG stranded wire about 1/10 inch
- Tightly twist strands together and tin wire
- Apply small amount of solder to pad
- Lay tinned wire on top of pad
- Heat joint top side of board - add a bit more solder

Recommended Soldering Tools and Solder

Soldering small wire is not difficult. However, if you don't have the correct tools, proper soldering is difficult and frustrating.

Use Small Diameter Rosin Core Solder. The choice of solder is also important. One of the things to remember is to never use acid core solder. Acid core solder will destroy the board and components. The best solder for electronics work is small diameter, 0.015 to 0.02 inch "no-clean-flux" core solder. Larger diameter solder should not be used as there is a risk of putting too much solder on the pad which will short out adjacent pads.

Use A Small Diameter Soldering Iron. Don not use so-called soldering guns. These are very high wattage and will damage delicate traces, pads and components. A 25 watt, temperature controlled iron is the best.

Tool Source: The following part numbers and prices are from Mouser Electronics www.mouser.com. They are an excellent supplier that we use as often as we use Digikey.

Apex Soldering Iron, 25W, Temperature Controlled	578-WP25
Soldering Iron Stand and Sponge Holder	578-PH100
60/40 Rosin Core Solder Roll	738-13427

Keep The Soldering Tip Clean. Buy an inexpensive soldering iron stand, that includes a holder for a small sponge. Keep the sponge damp. Swipe the tip across the damp sponge to clean it before soldering. Don't clean it after soldering - the excess solder protects the tip. Before turning off the iron's power, put a blob of solder onto the tip. This solder coats the tip and prevents oxidation.

Always Twist and Tin Stranded Wires Before Using. Stranded wire must have their individual strands twisted together followed by a applying a small amount of solder - this is called tinning. It makes soldering the wire to the board much easier.

Soldering Tips

- Do Not use too much solder. A tiny amount is all that is needed.
- Never apply the solder directly to the iron and attempt to 'paint' it onto the lead.
- Proper soldering takes a little patience. This is the most important part of learning to solder. You must watch and wait if you want to have a good solder joint. Soldering can not be rushed.
- When the joint has cooled, trim the excess lead using the wire cutters. Do not cut off the solder joint - rather trim the lead to the top of the joint.

Hookup Wire and Heatshrink Tubing Source

To avoid confusion and possible decoder damage, always use different colored wires for decoder hookup. And standardize on what each color does. Make a record of the colors used and take pictures of your installation. Take a few minutes document your installation. You might remember what you did a month from now. But what will you remember a year from now?

The suggested hookup wire comes in 100 foot rolls. This wire is #30 AWG, stranded and tinned. More important is the thin wall outer insulation. Share the cost of this wire among friends - the roll will last a long time.

Hookup Wire Color and Digikey Part Numbers:	**www.digikey.com**
Red #30 AWG Stranded and tinned	A1851R-100-ND
Black #30 AWG Stranded and tinned	A1851B-100-ND
Orange #30 AWG Stranded and tinned	A1851A-100-ND
Grey/Slate #30 AWG Stranded and tinned	A1851S-100-ND
Blue #30 AWG Stranded and tinned	A1851L-100-ND

Heatshink Tubing Kit of various diameters also from digikey.com

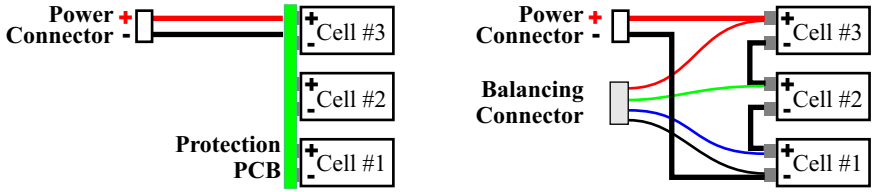
Heatshrink Kit - 180 variety pak of 6 inch pieces	Q2Z1-KIT-ND

Battery Considerations And Options *continued*

Internal Wiring Diagram - LiPo Packs With Balance Connector Without PCB

The image shows the internal hookup of a protect pack and a cell-balance pack. Notice the protection PCB is absent in one, whereas the balancing connector is absent in the other pack.

Regardless of the type of battery pack or its voltage, the power connector (or its bare wires if it doesn't have a connector) is the power output and connects to the BAT input terminals of the decoder.



Recommended Battery Suppliers

The 4 companies listed below are where we purchase our batteries. Each offers literally hundreds of cells and battery packs. We have been doing business with them for many years. There are many more vendors but they come and go at a furious pace. It may be beneficial to spend some time shopping on the Internet to compare prices and availability. Mouser sells batteries from multiple suppliers.

One precaution when purchasing on the internet. Beware of sellers that don't show stock availability. They will take your order, charge your credit card but might not ship your order for many weeks or months. If availability is not stated, call the supplier and ask. But if they don't know or won't tell you, take your business elsewhere. Don't support this unethical business practice.

Finally, beware of extra fees when ordering batteries. Some vendors may tack on an extra handling fee, implying that it is fee charged by the carrier. However, there is no such fee when batteries are shipped via ground service. Always request ground service, usually UPS.

All-Battery
436 Kato Terrace
Fremont CA 94539
(510) 979-9969
www.all-battery.com

*** Battery Space**
825 South 19th street
Richmond, CA 94804
(510)525-2328
www.batteryspace.com

PowerStream
1163 South 1680 West
Orem UT 84058
(801)764-9060
www.powerstream.com

Mouser Electronics
1000 North Main Street
Mansfield, TX 76063
(800) 346-6873
www.mouser.com

*** Caution**

When ordering batteries, always request United Parcel Service (UPS) **Ground** Shipping. Some vendor of batteries, but not all, may add "Hazardous Material Handling Fees" or other special handling fees when shipping Lithium batteries.

Battery Considerations And Options *continued*

Boost Circuit Sources

Nearly all of the small and inexpensive 3.7V to 12V boost circuits come from China. The biggest collection of these can be found on ebay.

If you want to build your own, this website link has the schematic, parts list and circuit board pattern: ***www.instructables.com/id/Step-up-Booster/***

Other sources of modules come from the many RC drone stores. This link is to a company that sells a 2.7 to 12V boost rated at 400mA for $8. ***www.helipal.com***

Purchasing Batteries - Precautions

There are hundreds of sources for Lithium batteries and packs. Their widespread use in consumer electronics, RC cars, drones and planes means they are relatively inexpensive and come in lots of different sizes. Bbeware that many batteries in the RC hobby market do not have a built-in protection circuit board (PCB). If the battery feature list doesn't state that it is protected, then it does not have pcb. Don't use this battery. Instead, look for cells that specifically state that the PCB is included. Some vendors use the acronym PCM which stands for Protective Circuit Module. PCM or PCB mean the same thing - the cell is protected.

Li-Po 3.7V Cell without PCB

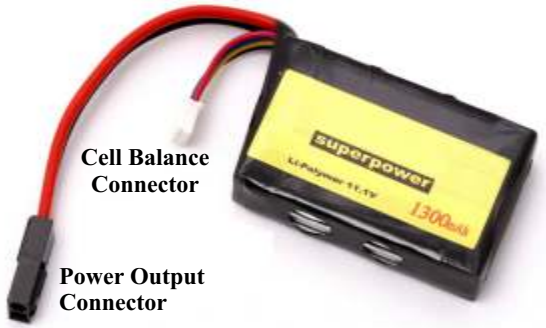
Battery marketing information is sometimes confusing. Lithium-Ion (Li-Ion) batteries are the most commonly available rechargeable battery. So are Lithium-Polymer. Some vendors claim one is better than the other. However, don't be fooled. The "Po" is short for polymer and simply means the Lithium-Ion battery is in a plastic pouch instead of a hard cylindrical shell. They are both Li-Ion batteries.

Li-Po 3.7V Cell with PCB

The images to the left show two examples of Li-Po cells. Usually, a cell with a protection circuit board has wire leads and orange colored tape covering the PCB. A LiPo cell without the PCB, almost always has thin metal tabs for connection. Get the cell or pack that includes the PCB.

Battery Packs With Extra Plugs And Sockets - Can I Use Them?

Yes! This type of battery pack is inexpensive and readily available. It is most commonly used with RC Drones, cars and paint-ball guns. These packs do not include the protection circuit board.



The 11.1V pack will have three 3.7V cells in series. The "Cell Balance" connector provides access to the individual cells that make up the pack. It is used by a special smart charger to insure the pack's cells are safely charged to maximum capacity.

With the cell-balance connector and a smart charger with the cell balance feature (sometimes called a "LiPo Charger") the charger monitors the charge on each individual cell and insures that each cell is charged to the maximum capacity. If one cell requires more time to reach full capacity, the charger will charge that cell a bit longer than the others.

If your smart charger doesn't include the cell-balance feature, then the smart charger can only monitor the full pack voltage. It will monitor the pack voltage of 11.1volts and use this voltage plus the average charging current of the pack to determine when to terminate the charge. The balance connector is not used and nothing connects to it. Leave the connector attached - don't cut it off. Cutting off the connector risks shorting out the cells which will destroy the pack.

Verify Battery Polarity - It's Cheap Insurance!

Verify Battery Connector And Wire Polarity!

If you don't have a VOM meter, you can use the testing diode that came with the decoder to verify that you have the plus and minus leads properly identified before permanently connecting the battery to the decoder. There is no protection for reversed battery wires and the decoder will be destroyed.

To verify proper identification of the two battery wires, use the steps below. This is a temporary hookup. Do not allow the battery wires to short together or brush against the decoder board. This will damage the board and the battery.

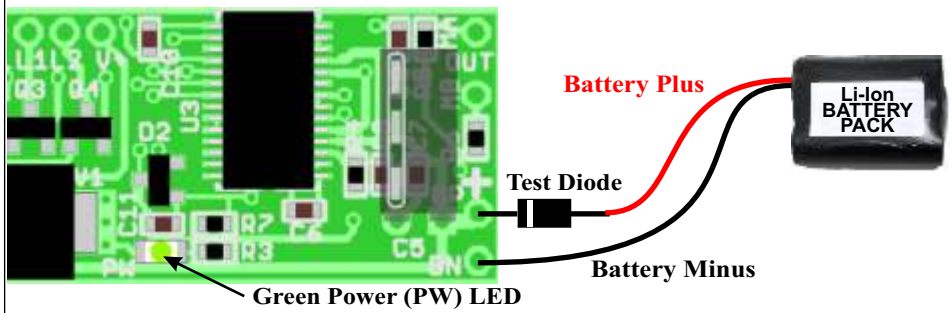
Step 1: Temporarily solder the black or negative wire from the battery (or what you think is the negative wire) to the decoder pad labeled BN.

Step 2: Temporarily solder the banded end of the test diode into decoder pad labeled with the large plus symbol.

Step 3: Touch the battery plus wire (or what you think is the plus wire) to the free end of the diode (the non-banded end). If the decoder's green LED turns on, then the polarity is correct. Label the battery's plus wire and note its color.

If the green LED does not turn on, first verify that the banded end of the diode is in the decoder's + pad. If that is OK, then reverse the two battery wires. If the green LED now turns on, mark the wire connected from the battery to the diode as the + wire.

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. Disconnected the diode - do not leave it attached. It wastes too much energy to be permanently installed.



Disconnect Track Pickups - Verify Motor Isolation

Disconnect Track Pickups

The locomotive track pickup contacts and wiring must be disconnected and removed before hooking up the decoder.

If the track pickups are not removed, there is a risk that the onboard battery voltage may appear on the track pickups and thus on the rails. Any subsequent derailments or external applied track power will short out and destroy the battery.

Beware Of Motors That Connect To Loco The Chassis

Older locomotives designed prior to the DCC-era usually have one of the motor brushes connections tied to the frame using a screw or a spring. Older HO Athearn locomotives are a great example. The motor must be completely isolated from the frame. If not isolated, the decoder's motor output or it will short circuit to the frame and/or the rails through the track pickups when connected to the motor.

Initial Decoder Checkout

The initial decoder checkout assumes you have either installed your new *u*AWM15 decoder, or are testing it on the bench. For the initial checkout, it is assumed that the *u*AWM15 has not been changed and is on the original factory settings of loco address 3 and frequency 0.

Step 1: Turn Power on to the Decoder

- The *u*AWM15's green LED will glow brightly indicating power is connected. If you have not done so, turn on your throttle. Set the throttle to loco number 3 and frequency 0. These are the original factory settings for the *u*AWM15 decoder.
- When the throttle is turned on and set to the same frequency as the decoders the 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 the red and green LEDs are turned on and glowing steady.

Step 2: Set the Throttle and Run!

- Set the desired direction and turn up the speed knob to run your locomotive. The right facing arrow is FORWARD as if you were seated in the cab.
- If the direction is backward, reverse the two motor wires.

Step 3: Head Light Control [if hooked up]

- Push the 0 key on the throttle. This is called the Function 0 key (F0). It is predefined to control the front and rear headlights only. Verify that the lights are turned on and match the direction of locomotive travel. If the headlight direction is reversed, you must reverse the motor wires.

Step 4: AUX1 and AUX2 Light Control [if hooked up]

- If you have connected lights to the AUX outputs, they are controlled by F11 and F12. You can change these assignments as described on page 14.

Changing The Decoder Address

This task is easy to do and makes use of the T5000 throttle's SERVICE PROGRAM feature - abbreviated as SVC PROGRAM. All locomotives should have their own unique address. The cab number makes a convenient decoder number since it is easy to see.

Step 1: Turn On Throttle And Desired Decoder - Turn Off All Other Decoders

On the T5000, press menu key twice. Push number 4 for SVC PROGRAM.

Next, push 1 and push ENT to select CV1 for changing the address.

Key in the decoder address which can be any number from 1 to 9999. Once you have entered the numbers, push ENT. The locomotive will pulse the motor twice for an address from 1 to 99 or 3 times for an address from 100 to 9999. Address 0 is not allowed.

Push ESC to exit back to the normal screen. Notice that the new locomotive address is entered and ready to use. Now verify the locomotive responds to the speed and direction control.

Changing The Decoder Frequency

If more than one throttle is to be used at the same time, each throttle must be on a unique frequency. Likewise, the decoder needs to be set to the throttle's frequency. As delivered from the factory, the decoder is set on frequency 0. But if you need to change the frequency, it can be set to a frequency between 0 and 16 for a total of 17 unique frequencies. The *u*AWM15 decoder allows the frequency selection directly from the throttle. The decoder frequency is remembered even if the battery is disconnected.

continued on next page

Changing The Throttle's Frequency or Address Doesn't Change The Decoder!
Simply changing the throttle's frequency or the loco number will not change the decoder in any way! The decoder must be programmed with SVC PROGRAM.

Battery Considerations And Options

Selection of a suitable battery is based on the battery size, the available physical space, the battery voltage and the battery capacity or runtime. Each factor has a direct influence on the other factors. The general guidelines will get you started down the right path. However, once you have completed your first installation, you'll be much better prepared for subsequent installations. There is no right or wrong battery answer. Let your skills and your experience guide your decisions.

Available Space - Use A Dummy Loco or Trailing Rolling Stock For The Battery

The simplest installation is where the battery is contained inside a dummy locomotive, box car or even a flat car. Not only can a larger battery be used, there is room for a charging jack, connector and toggle switch. Two small wires connect between the battery car and the locomotive where the decoder is located.

Another consideration is to put everything inside the dummy loco or trailing car including the decoder. This allows multiple locos to share a single decoder and battery. The downside of this approach is the need for more wires if you intend to use the decoder's light outputs on the lead locomotive.

Tip From The Experts: If using a dummy locomotive, consider adding internal lighting inside the dummy and make it the lead locomotive. Then, only two wires for the motor connect to the trailing locomotive. The trailing locomotive is used to push the lead locomotive.

Battery Voltage

The battery voltage rating is what the motor will receive when the throttle is at 100% of top speed. If your locomotive is primarily used as a slow speed switcher, the uAWM15 will work with voltages as low as 8 volts. *Note that a standard 7.4 volt Li-Ion pack voltage is too low and the decoder will not drive the motor.* If the locomotive is used for mainline running at relatively high speeds, an 11.1V Lithium battery may be a more appropriate choice.

Runtime or Battery Capacity

A battery's capacity is labeled on the side of the battery. For small batteries, the label will usually list the capacity in milli-Amp-hours. If the label says 500mAh, the battery will deliver 500mA for one hour. If it says 1100mAh, the battery will deliver 1.1 Amps for one hour. Most modern HO scale locomotive motors draw less than 250mA when running at top speed on level track. But as the grade increases the motor current will go up. As the number of cars attached are increased, the motor current goes up. This is why it is impossible to say how long a battery will last before it needs to be recharged - it depends.

Battery capacity and battery voltage dictate the battery's physical size. A low voltage battery will have a higher mAh rating than a high voltage battery of the same size. But the high voltage battery will have a significantly lower capacity.

Battery Size and Format

Rechargeable Lithium battery packs are available in many different sizes and formats. They can be purchased flat or cylindrical. Higher voltage battery packs are composed of groups of individual cells. Each Lithium cell is rated at 3.7V. To make a higher voltage battery, the cells are connected in series which allows the individual cell voltages to add together. Thus, it takes 3 cells to make an 11.1V battery pack.

Battery Protection

Lithium battery packs are extremely safe with exceptionally long lifetimes when they are equipped with an internal protection circuit board. When buying packs, make sure it has the protection board built in.

Single Lithium Battery Plus Boost Circuit

The single cell plus boost circuit has emerged as an option for creating higher voltages from a 3.7V cell. lower voltage cell. This approach is common when space is very limited. A single Lithium cell rated at 3.7V is connected to circuit that converts the battery's low voltage to a higher voltage. This circuit is called a boost regulator circuit. These small and inexpensive boost regulators include both fixed and variable output voltages. Boost regulators will drain batteries quicker because they are not 100% efficient.

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 chip. If the driver overheats, it will automatically shut down. When it cools sufficiently, it will resume normal operation. If this happens, the decoder either needs more ventilation or the motor requires higher current than the decoder can provide. Consider getting a higher current microMOTION decoder.

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 protection circuits. Cycle the decoder power off then back on and try again. If the problem persists, there may be problem with the battery. Or it could be as simple as a broken wire. You need to disassemble the locomotive to check these items.

Throttle Looses 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.

Thermal Management

On rare occasions, your decoder may become too hot and shut down to protect itself. No harm has occurred to the decoder if this happens. The decoder will resume normal operation when its internal temperature drops below its over-temperature trip value which is about 100 degrees centigrade.

If this becomes a recurring issue, your decoder is telling you that the power demands are too great for the available amount of ventilation. You must either improve airflow or consider changing the amount of voltage or power demanded of the decoder. The latter is a much easier job given the limited space inside small locomotives.

Clean and Lubricate The Mechanism. This is an cheap way to lower the motor current especially if you have never cleaned or lubricated the locomotive mechanism. The older the unit, the more dividends a cleaning job will pay. Motor current will drop significantly once the old grease, cat and dog hair and other unknown crud is removed.

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. An additional benefit is that batteries last longer. The downside of this is that the top speed will be lower. 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.

Get A Higher Amperage Decoder. Consider replacing the present decoder with a decoder that is rated to sustain a higher power level. See the CVP website for a list of available decoders.

Changing Decoder Frequency *continued*

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.

CV200 Stores The Decoder Frequency - the frequency number is stored even if the battery is disconnected.

Caution: For the command to work, the throttle's frequency must be initially set to the current frequency used by the decoder. Before proceeding, verify the decoder's red GP light turns on bright when the throttle is turned on and set to the present frequency. If the red GP light is off but you believe the throttle is set for the proper frequency, then you will need to follow the "forgotten frequency" section below.

Changing The Decoder Frequency

Step 1: First turn off all other decoders. If this is not done, they too will be changed.

Step 2: Turn On Throttle And The Decoder.

Step 3: On the T5000, press menu key twice. Push the number 4 key for SVC PROGRAM.

Step 4: Next push 2,0,0 and push ENT to select CV200 for changing the frequency.

Step 5: Now enter the desired frequency number (in the range of 0 to 16) and push ENT. Unlike other CV changes, the motor will not pulse when ENT is pressed. However, the motor will pulse the moment you press ESC. *Note: If you enter a frequency value larger than 16, will appear to have accepted it. However, the decoder will be set to frequency to 0.*

Step 6: Push ESC to exit back to the normal throttle screen. The motor will pulse once to indicate receipt of the frequency change command. Also notice that the new frequency is now set on your throttle. Enter the locomotive address if it is not already present. Verify the locomotive responds to the speed and direction control.

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

Forgotten Frequency? - Resetting Decoder's 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. If this occurs, follow this procedure to temporarily place the decoder on frequency 0.

Step 1 - turn off all AirWire throttles. This is very important. It is the absence of a throttle signal, plus turning the decoder's 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 *u*AWM15 if it was powered on.

Step 3 - Turn on the *u*AWM15 and wait at least 60 seconds.

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

Step 5 - Use SERVICE PROGRAM to set CV200 to the desired frequency. When you press ESC the motor will pulse when the command is received.

Notes About The Temporary Decoder Frequency Jump Mode

- The jump mode is canceled and normal operation resumes if a throttle is turned on that matches the present decoder frequency **within one minute** of the decoder power being turned on.
- If the decoder 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.
- The decoder will not jump to frequency 0 if any throttle with a matching frequency is on within one minute of turning on the decoder power. The address does not matter.

Restoring *u*AWM15 To Original Factory CV Values

CV8 is used to restore or reset the *u*AWM15 back to original settings as it comes from the factory. All values that you 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 decoder address is changed to 3 and the decoder frequency is changed to 0.

If you know your decoder's present radio frequency, then set your throttle on the same address and frequency.

If you do not remember the radio frequency, you must first use the forgotten frequency command to set the radio frequency. Once this is done, then you can reset the decoder to factory values. See page 7.

For The T5000 Throttle

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

1. Push MENU twice followed by 4 to select SVC 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.

4. Press ESC to exit SVC PROGRAM mode. When you press ESC, the decoder pulses the motor once to signify that it has been reset.

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.

In addition to the address and frequency, all of the other decoder CVs are reset to the original factory values. The back page of this manual shows the CV numbers, the original factory value and their purpose.

Not Sure About A Decoder's Address Or Frequency?

Not sure about the decoder's present address or frequency? Don't worry. Just set the address and frequency to what you need them to be. It's fast and painless.

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 and cost more, but you'll be assured of an installation that works and works well.

uAWM15 Cruise Control

The uAWM15 decoder comes equipped with a convenient 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.

Activating Cruise Control is done with Function 5 which is the original factory setting for cruise control activation. From the decoder action table, a value of 1 is the cruise activation value and it is set into CV39 [F5]. If wanted, you can change the function key assignment at any time.

Two Types Of Cruise Control Are Selected By CV63.

Cruise mode 0 is the original factory setting with a value of 0 in CV63. In this mode, the locomotive speed is held at whatever it was when cruise control was activated. But, if the throttle speed is change, up or down, or the direction is reversed, the 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 selected by setting CV63 to a value of 1. With this mode, the locomotive speed can be adjusted higher or lower without deactivating cruise. Setting the throttle to speed 0 or reversing the direction will deactivate cruise control.

Operational Considerations

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 uAWM15 decoder operates in an unlicenced band shared by many other transmitters. These transmitters can and will create interference, intermittent throttle operation or complete failure of one or more of your decoder's 17 frequencies. The sources of these external interfering signals can be from your own home or from adjacent homes and businesses. They can also be from other CVP wireless throttles and controllers.

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

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

Never Use RTV or Silicon Adhesive On The uAWM15
NEVER use RTV or other liquid adhesive to attach the uAWM15 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 uAWM15 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.

Locomotive Speed Matching Tips - *continued*

Basic Procedure: Lower the target CV value by 10% increments. For example, CV6 has a factory default value of 128 so a 10% reduction is equal to about 115. Now shut of all locos except the one to be change. Use SVC PROGRAM to change CV6 to the new value. Restore power to the other locos and evaluate the result. If the loco is still too fast, lower it another 10%.

Tip: Always have a slight amount of tension on the locomotive couplers. This will keep them from uncoupling over rough track and prevent jerky operation. Thus, the locomotives will not be perfectly matched - the lead loco should be slightly pulling on the trailing locos when running in the forward direction. However, the lead loco should never be dragging the trailing locos. Likewise, the trailing locomotives should not be pushing hard the lead loco. A small amount of coupler tension will make the individual locos run together as if they were a single unit.

Use SVC PROGRAM Only

Step 1: Match locomotives at step 14 [CV6 - factory setting 128]

Using the slower locomotive as reference, lower the value of CV6 to slow down the faster locomotive to match the speed of the slower locomotive with the throttle set at speed step 14. When the two locos are relatively close in speed, you are done. Make a note of the value used.

Step 2: Match locomotives at top speed [CV5 - factor setting of 255]

Using the slower locomotive as reference, lower the value of CV5 to slow down the faster locomotive to match the speed of the slower locomotive with the throttle set at speed step 28. When the two locos are relatively close in speed, you are done. Make a note of the value used.

Step #3: 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.

Lipstick On A Pig

None of the fine tuning techniques will compensate for an old, worn out, out-of-gauge or dirty locomotive mechanism. Take some time to clean and lubricate the mechanism. Verify the gauge of the wheels. It will be time well spent.

Assigning Throttle Function Keys To Decoder Actions

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

The *u*AWM15 decoder has many memory locations called configuration variables - shortened to CV. Each CV has a unique number, so the term CV# is a specific memory location. So CV40 means *u*AWM15 memory location number 40. The value that you put into this location dictates what the decoder does when it receives a throttle's function key command. Customizing the decoder actions is done using your T5000 throttle and a few simple steps.

Step 1: Always start by thinking through what you want your throttle to do to the *u*AWM15 decoder. For this example, here's what is wanted:

"On the AirWire throttle, I want the number **6 key** to **turn on/off AUX1** light."

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. Now you are ready to set the uAWM15 decoder so that it performs the desired action when F6 is pressed.

Step 2: Find the CV corresponding to F6.

From the table, the uAWM15 decoder uses CV40 for F6 .

Step 3: Find the desired decoder action in the action table and its value. The action value is what will be stored in CV40. You should record your CV values for later reference for each of your locos.

For this example, since the AUX1 light is to be turned on and off (toggled) the CV value is 3.

Step 4: Turn on the decoder's power. Be sure to check that your throttle is on the correct frequency. This is very important since if the frequency is wrong, the decoder will not receive the throttle's SERVICE programming command. Make sure all other locomotives are off.

Step 5: Push the throttle's menu key twice and selection option 4 - SERVICE PROG. Enter 40 for the CV to be changed and press ENT. Now enter the 3 for the CV's value and press ENT.

Press ESC and verify that the uAWM15 decoder's AUX 1 light is toggled on and off when the 6 key is pressed on the throttle

The same step sequence above is used to customize all of the available decoder CVs.

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

Decoder Action Table

Function Key Action	CV Value
No Function	0
Activate Cruise Control	1
reserved	2
Toggle AUX1 on/off	3
Toggle AUX2 on/off	4
reserved	5
reserved	6
Dim Headlights on/off	7
reserved	8-14
Ditch Lights Flash Trigger	15

A function, labeled "reserved," means the value can be set into a CV, and the motor will pulse. But, if activated, nothing will happen.

Using The Headlight Output Drivers

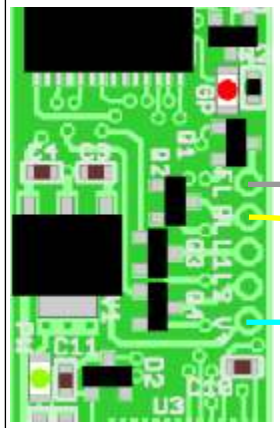
All four of the *u*AWM15 light drivers are designed to use efficient, cool and bright white light emitting diodes LED. However, you can use incandescent lamp in place of an LED but it will run the battery down quicker and appear dimmer. Also, the special lighting effects will not appear as nice as they do when using an LED. For the remainder of this manual, LEDs will be used.

The light driver outputs have a maximum rating of 500mA. Multiple lights may be powered from a light driver output by wiring them in parallel or in series. However the light outputs are not protected and can burn out if overloaded.

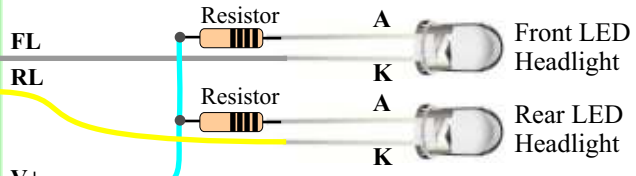
All LEDs connect between the appropriate pad on the decoder and the V+ pad. battery plus and the light driver output terminal on TM1.

Physical Appearance

Long Lead is "A" or anode



LED Symbol



Strip and tin #30 AWG wire for hookup. Don't allow wire to touch other components or each other. See page 4 for soldering techniques.

LED Current Limit Resistor Value Selection

The LED must always be used with a series limit resistor or they will instantly burn out. The value of the limit resistor depends on the battery voltage, the LED color and the desired brightness. The LED color dictates the average voltage drop across the LED which is called VF. White LEDs are the highest at about 3.2 volts.

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 different voltage drops. Red is about 1 volt VF. Green and yellow are about 2 volts VF. Use the same current rating to determine the initial limit resistor. Experiment with different resistor values to achieve the desired brightness.

To determine the required resistor value, use the equation below. The table below shows LEDs versus battery voltage and the resulting resistor value for 20mA through the LED.

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

LED Color	BAT+	LED VF	Current	Value	Closest R	Power Rating
White	11.1V	3.2	0.01	395	390	eighth watt
Green/Yellow	11.1V	2.1	0.02	450	470	quarter watt
Red	11.1V	1.0	0.02	505	510	quarter watt

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 uAWM15 feature of motor bumping. The bumping feature can be used along with 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 uAWM15 will automatically transition from the slow-speed bump to the high resolution speed curve operation as the locomotive gains speed.

Motor Bump Value is Set With CV56. The 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 disables the motor bump and is the original factory value. A value of 128 will literally apply half of full speed to the motor.

Motor Bump Duration is Set With CV57. 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. The original factory setting is 0.

Experimenting With Motor Bumping

To use the motor bump feature, the following procedure is recommended.

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.

Locomotive Speed Matching Tips

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.

Since Service Mode Must Be Used, Take Care To Program Only One Locomotive Turn Off All Other Locomotives To Avoid Unwanted Changes.

continued on next page

Motor Acceleration and Deceleration Control

Locomotive inertia is the rate at which a locomotive accelerates when changing from a slow speed to a higher speed. Locomotive momentum is the rate at which a locomotive decelerates from a high speed to a lower speed.

Inertial and Momentum are simulated by values in CV3 and CV4. The values change how the locomotive responds to throttle speed changed.

Motor Acceleration Rate is Set With CV3. CV3 deals with the rate of acceleration when the throttle 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. The original factory setting is a value of 2 which provides for a relatively quick response to speed increases.

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 usually uncomfortable for users - they think something is wrong with the locomotive. The acceleration rate applies equally in either the forward or reverse direction.

Motor Deceleration Rate is Set With CV4. 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. The original factory setting is a value of 2 which provides for a relatively quick response to speed decreases.

Surprisingly most users prefer a *faster* deceleration rate compared to the acceleration rate. 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 original factory setting of 2 is seldom changed. Users want to slowly start the train, but quickly stop it. The deceleration value applies applies equally in either the forward or reverse direction.

Beware Of Large Values For CV3 and CV4

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.

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 uAWM15 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.

More LED Hookup Options

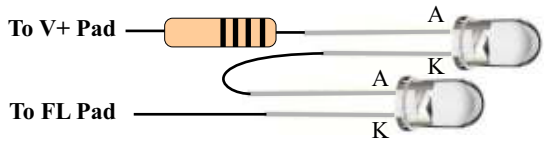
Series Hookup of LEDs

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 vs battery voltage.

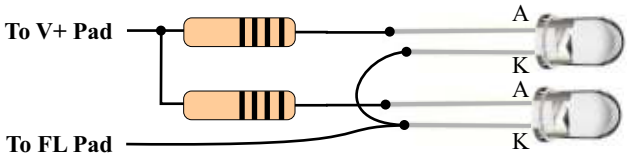
LED Color	BAT+	LED VF	Current	Value	Closest R	Power Rating
White	11.1V	3.2x2	0.01	470	470	eighth watt



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.



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

Customizing Headlight Operation

The uAWM15 Decoder allows the front headlight and the rear backup light to operate in different modes. The different modes control if and when the headlight dims and how the front headlight and rear headlight change with locomotive direction.

The Headlight Mode options is determined by the value of CV60. Use SVC PROGRAM mode to set CV60 to the desired value.

Normal Operation (original factory setting): The original factory setting for CV60 is a value of 0. This means that the front headlight is on and the rear headlight is off when the locomotive is moving in the forward direction. When the direction control is set for reverse, the rear headlight turns on and the front headlight turns off.

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.

The table below lists the mode and the corresponding CV value for CV60. Experiment with the various modes and select the one that you like the best.

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

Headlight Mode Example: Front Headlight With Auto-Dimming

CV60 is used to change the operating mode of the front and rear headlights. Auto-dimming is a headlight operating mode that means that when the locomotive speed command is zero, the headlights will automatically dim.

Also, 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, set CV60 to a value of 1. This value sets up normal, auto-reversing headlight operation except when the locomotive is stopped. When stopped, the headlight will automatically dim.

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 uAWM15 decoder is powered up, all lights are off.

Locomotive Motion Control and Fine Tuning *continued*

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 CVs 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.

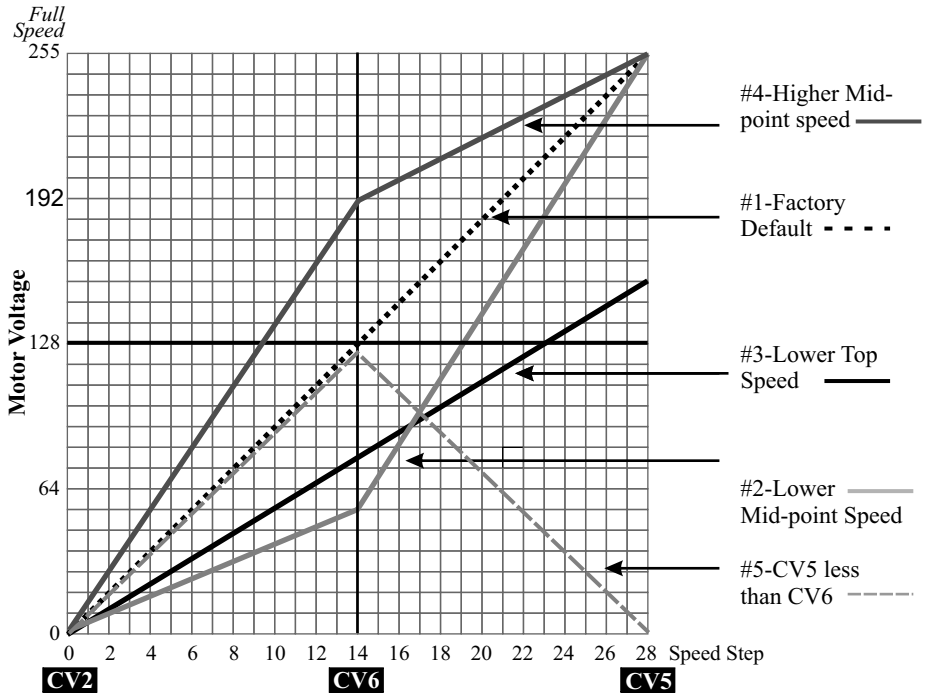
Motor Starting Voltage Value (MSV) is Set With CV2 . CV2 sets the MSV of the motor voltage that corresponds to speed step 1 (in a 28 speed step setting). The original factory value is 9. You can decide if you wish the motor to be moving at a good rate of speed or just barely moving by changing the MSV. 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) is Set With CV6. The mid-point voltage is the motor speed when the throttle is at half of full speed which is speed step 14 when the throttle is set for 28 speed step setting. CV6 is used to set the motor voltage with 128 being the factory default value which is exactly half way between 0 and 255. If a lower half speed is needed, for example in speed matching application, set CV6 to a smaller value.

Maximum Motor Voltage Value (Vmax) is set with CV5. The top speed voltage (full speed) corresponds to speed step 28 when the throttle is set for 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.

The graph below shows the relationship of the 3 CVs and how they affect the motor speed.



Special Headlight Effects

In addition to how the headlights react to direction changes, each headlight can have a special lighting effect assigned to it. For example, you can set the rear headlight to always be dim whenever it is turned on. Simulated gyra lights can also be assigned to headlights.

Front Headlight Effect is stored in CV61. The original factory setting is a value of 2 which means the front headlight is on at 100% brightness when activated.

Rear Headlight Effect is stored in CV62. The original factory setting is a value of 2 which means the rear headlight is on at 100% brightness when activated.

Effects That Utilize Specific Time Period or Rate use the value in CV59 to set the time multiplied by ½ second. The original factory setting is a value of 3 which sets the interval at 1.5 seconds. The rate or time affects the lighting effects that offer a repeating pattern.

The range for CV59 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. A value of 0 shouldn't be used although if you accidentally enter 0, the uAWM15 will automatically change it to a value of 1.

Special Lighting Effects: The table below lists the lighting effects and the CV value to select the lighting effect. Also shown is whether CV59, the timing rate, applies to these effects. All of these effects are optimized for LED lighting.

Headlight Effects [CV59, CV61 and CV62]		CV Value
Off 0%		0
Dim 6%		1
On, 100% - Full Brightness		2
Strato Light	[rate set by CV59]	3
FRED	[rate set by CV59]	4
Dome Flasher	[rate set by CV59]	5
Gyra Light	[rate set by CV59]	6
Mars Light - Figure 8	[rate set by CV59]	7
Rotary Dome light 1	[rate set by CV59]	8
reserved		9-15

Headlight Lighting Effects Examples and Tips

Front Headlight With Mars Light: First, look up the value for CV61 to implement the Mars light. From the above table the value is 7. Use SVC PROGRAM to load the value of 7 into CV61. Note that CV61 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.

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

In this example, there are 3 locomotives that are consisted together at the throttle. Each locomotive has a *u*AWM15 decoder. The locomotives all face the same direction. The desire is for the lead 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 both 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

Using The AUX1 and AUX2 Output Drivers

The *u*AWM15 has 2 more independent LED drivers, called AUX1 and AUX2. Each AUX driver can have a different lighting effect assigned to it. As with all the other *u*AWM15 light drivers, white LED use which look best for all lighting effects. Be sure to include the limit resistor. Without the resistor , the LED will burn out and the driver may be damaged.

Assigning Throttle Function Keys To Control AUX1 and AUX2 LED Outputs

Controlling AUX LEDs 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 AUX output and load the CV value into the CV number for the selected throttle function key. F0 is special and can't be used.

If the desired key has been previously assigned to a *u*AWM15 function, a new assignment will automatically overwrite the old assignment.

Function Key Assignment	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

The original factory setting for assigned function keys are F11 for AUX1 and F12 for AUX2.

For example, to control AUX1 with the throttle 6 key, set CV40 to a value of 3.

Function Key Actions	CV Value
Toggle AUX1 on/off	3
Toggle AUX2 on/off	4

Function key assignments are permanently stored in the decoder memory until changed or the decoder is reset.

Using AUX Outputs As Ditch Lights

The AUX1 and AUX2 outputs have two modes of operation. The standard mode allows each output to operate independently. Each AUX output can have separate special lighting effects. The second mode is where the two outputs are configured as a pair of ditch lights that can be triggered to flash by a function key.

Ditch Light Mode Set With CV96: To switch the AUX outputs to ditch light operation, set a value of 1 into CV96. This automatically configures the two AUX outputs to turn on when throttle function 0 is pressed. A second throttle function key is then assigned to trigger the alternate flashing of the ditch lights.

Ditch Light Trigger: The original factory setting for triggering the ditch lights is throttle function key 4 (F4). You may assign any function (1 to 12) to trigger the ditch light flashing. Load the appropriate function key CV with a value of 15.

Ditch Light Operation: The ditch lights are both turned on when the headlights are turned on with F0. Now push the function key assigned to trigger the ditch light flashing. The flashing will continue for about 15 seconds and then stop with both lights turned on.

Reset Mode Back To Normal AUX Output: To disable the ditch light feature, set CV96 to a value of zero. With CV96 set to 0, the ditch light trigger will no longer affect the AUX1 and AUX2 outputs.

Special Lighting Effects For AUX1 and AUX2

Similar to the headlight effects, the AUX1 and AUX2 LED outputs can be given a variety of special lighting effects. The effects can be different on each AUX output. For effects that have a repeating pattern, another CV is used to set the timing which is shared by the effects assigned to AUX1 and AUX2.

AUX1 Special Light Effect Value Is Stored in CV48: The original factory value is 2. This means that AUX1 turns on to full brightness when activated.

AUX2 Special Light Effect Value Is Stored in CV49: The original factory value is 2. This means that AUX1 turns on to full brightness when activated.

Effects That Utilize A Specific Time Period or Rate use the value in CV47 to set the time multiplied by ½ second. The original factory setting is a value of 3 which sets the interval at 1.5 seconds. The rate or time affects the lighting effects that offer a repeating pattern. The range for CV47 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. A value of 0 shouldn't be used although if you accidentally enter 0, the uAWM15 will automatically change it to a value of 1.

Special Lighting Effects List: The table below lists the lighting effects and the CV value to select the lighting effect. Also shown is whether CV47, the timing rate, applies to these effects. All of these effects are optimized for LED lighting.

AUX1 & AUX2 Lighting Effects [CV47, CV48, CV49]		CV Value
Off 0%		0
Dim 6%		1
On, 100% - Full Brightness		2
Strato Light	[rate set by CV47]	3
FRED	[rate set by CV47]	4
Dome Flasher	[rate set by CV47]	5
Gyra Light	[rate set by CV47]	6
Mars Light - Figure 8	[rate set by CV47]	7
Rotary Dome light 1	[rate set by CV47]	8
reserved		9-15

An effect labeled "reserved," means the value can be set into a CV, and the motor will pulse. But, if activated, nothing will happen.

AUX Lighting Effects Not For Ditch Light Mode

The lighting effects do not apply when AUX1 and AUX2 are configured as ditch lights. When configured as ditch lights, the two outputs will alternately fade in and fade out just like real ditch lights. When not flashing, the ditch lights turn on along with the headlights when F0 is activated.