by dccconcepts Zen

DCC concepts thinking outside the square

Unique features, real performance and exceptional installability

This manual applies to DCCconcepts ZEN, ZEN BLUE+ and ZEN BLACK Series decoders.
(Some features are however only available in decoders from ZEN software version 12)

We have often been asked for a more detailed decoder manual, so here it is!

Please note:

The exciting features available from Zen Blue+ and Zen Black decoders were the main motivation for the creation of this very detailed manual, but if you have our original DCCconcepts ZEN decoders, this manual is for you too!

That is because as while there are definitely added things that only Zen Blue+ or Zen Black can do, many of the features, functions and CV settings you see here are also applicable to the original Zen decoder range.

An introduction plus several highly detailed manuals:

All manuals are available online at www.dccconcepts.com

A few words from us... and our manual's "creator":

- *Most things in here quite simple to do - and we have done our best to describe it all as simply as possible.*
- *CVs are covered in order AND also as part of each specialised area too, so you will always find what you need.*
- *Where setup is complex, we have included examples with every step covered so you can just copy them.*
- *Things like our unique approach to ABC automation are actually quite simple but there ARE some quite complex applications and diagrams in that area too . Blame me for that - sorry! It is NOT because you have to do it that way - it is just because we are excited at just how much our advanced ABC approach can achieve... and I really, really wanted to show you what it could do for you with very little extra effort!*
- *I also want to encourage you to "Have a go" at some of the things we have discussed here, because there is so much more than most modellers ever see, hidden inside every Zen decoder that we create.*
- *From all of us: We hope you enjoy it - thank you for sharing your hobby time with us.*

Introduction to ZEN and a little more about the things covered in this comprehensive manual:

Zen decoder software has always been smooth, clever and easy to use but our new BLUE+ and BLACK decoder ranges take this to a new level, with extended and improved automatic braking abilities and simple-to-use ONE step locomotive set-up.

Our Decoder design ideas do not just accept loco-space problems or installation difficulty... so they are designed to fit where others very probably will not. After all - great features and the best performance are of no value to you unless you can fit a decoder in a loco!

Zen decoders are assembled in an automated facility. Electronic parts have a "best before" date as critical things such as solderable surfaces need to be new for high reliability, so all parts deliveries are always "just in time".

The PCBs that we use are created within hours of assembly so that board surface preparation is still fresh and all surfaces are 100% free of defects and contamination at the time of assembly.

Actual assembly is then carried out by fully automated machinery with superb accuracy.

Critical things such as machine-applied fluxes and solder baths are replaced well before recommended dates so that dry joints cannot happen and defect-free assembly and subsequent reliability can therefore be guaranteed.

Finally, once assembled, all of our decoders are tested at least 3 times before we package them for sale, so we know that they all work perfectly when we sell them and you can be quite confident that reliability is assured.

Stay-Alive: Zen BLUE+ and BLACK decoders :

Zen Blue+ and Black decoders have improved "Brown out" protection, so we no longer provide Stay-Alives in each pack. We have also made other changes to Zen stay alive support. You will find full details of this on page 15.

- Zen decoders now have a plug-and-play 3-wire connector for the attachment of Stay-Alives.
- Rather than make Zen stay alives bulky and hard to install, they are now in two parts. A small plug-and-play control board and a selection of varying plug-and-play capacitor banks that you can select to fill your specific need for each locomotive.

Warranty Information:

Zen decoders are made with great care, so we are able to have a simple & easy-to-live-with approach to Zen warranty.

- If any Zen decoder with no visible external damage fails to perform as it should, please return it. If we cannot revive it with a simple factory reset, then we will replace it for you free of charge.
- If a Zen decoder has heat damage, a burn mark on the heat-shrink or any other form of accidental physical damage, then we will replace it for you at 50% of the new decoders recommended retail price.

Decoder pack inclusions:

Every Zen decoder is supplied complete and ready to install.

Zen BLUE+ decoders: Supplied complete with any required harness and a detailed manual.

Zen BLACK decoders: Supplied complete with any required harness and a detailed manual.

(Selected models may also be supplied with one DCD- ABC module for you to experiment with)

Additional ABC parts and Accessories:

We are confident that Zen **BLACK** owners will want to exploit the advantages of our ABC automated stopping system so we have also added some new accessory packs that include these very simple braking control boards.

DCD-ABC.3 - A pack of three ABC Automatic Brake Section control boards.

DCD-ABC.6 - A pack of six ABC Automatic Brake Section control boards.

DCD-BDC.3 - A pack of three BDC Automatic "DCCconcepts Simplified Brake on DC" section control boards.

DCD-BDC.6 - A pack of six BDC Automatic "DCCconcepts Simplified Brake on DC" section control boards.

DCD-HDR.6 - A pack containing 6 spare headers, 3x Red, 3x Blue.

Please look at page 15 and our website for details of Stay-Alive, harnesses and other accessories.

Part 1: DCCconcepts ZEN Blue, BLUE+ and BLACK decoders
General Specifications, Motor control, Loco Running and Adjustments.

Model	Peak	Continuous	Functions	Connector	Size (mm)	Actual decoder size
BLUE+ models have a BLUE background. BLACK models have a BLACK background.						(When page is printed at 100%)
ZN218.6 Black	1.1 A	750mA *See notes	6fn x 100mA	21 and 8-pin	23 x 16.5	 (ABC) 6 Function
ZN218.4.2 Black	1.1 A	750mA *See notes	4 x 100mA fn plus 2 x low power function	21 and 8-pin	23 x 16.5	 (ABC) 4 + 2 Function
ZEN Mini Black	1.1 A	750mA *See notes	4 x 100mA	8-pin wired	19 x 11	 (ABC)
ZEN MIDI Black (New High Power)	2.0 A	1.2A *See notes	6 x 100mA	8-pin wired	22 x 13	 (ABC) 6-function High Power
ZEN N18 Blue+	1.1 A	750mA *See notes	4 x 100mA	Next-18	15 x 10	
ZN8D Blue+	1.1 A	750mA *See notes	4 x 100mA	8-pin direct	16 x 8.5	
ZN8H Black	1.1 A	750mA *See notes	2 x 100mA	8-pin wired	16 x 9	 (ABC) 2-Function
ZN6D Blue+	1.1 A	750mA *See notes	2 x 100mA	6-pin direct	14 x 9	
ZN68 Blue+	1.1 A	750mA *See notes	2 x 100mA	6 and 8 pin	14 x 9	
ZN360.6 Black	1.1 A	750mA *See notes	6 x 100mA (Six full power functions)	8-pin direct	16 x 14	 (ABC) 6-Function
ZBHP Black (Buddha)	5 A	3.5 A (Conservative)	6 x 250mA (Six full power functions)	12 terminals	42 x 27	 (ABC) 5 amp 6-Function

POWER NOTES: We have been very conservative in claimed power specifications. As a result, while we use parts that are identical in real-world power specification to those of our competitors, we claim only 750mA power handling where they may claim 1 amp or more.

We do this because in reality, they are forgetting to tell you that while their decoder MAY take an amp, it will do so for only a second or two without potential problems! (In reality load any HO decoder to anywhere near an amp and you CAN expect excessive heating in just a second or so. All decoders are weakened or damaged by high heat levels and will definitely burn out if left with that sort of load.)

Our more conservative rating will help you have a long life for each decoder. You need to consider this because the load on a decoder is not just the motor current. Every light/LED or other powered accessory has to share the available power, and when the train is long or under load, the current draw of a fully featured loco will often exceed expectations. Load generates heat, and constant load just stresses everything, so being a little conservative in the way you think about power handling will lead to greater long term reliability.

Part 2: DCCconcepts BLUE, BLUE+ and BLACK decoders
LIGHTING CONTROL: Advanced options plus function button re-mapping abilities and function set-up.

The Zen Decoder range has always had full function re-mapping ability and a huge range of more than 30 different lighting control options. Our BLUE+ and BLACK Series decoders build on this giving you the best lighting ability available.

Some light settings will involve both re-mapping of functions and specific allocation of light effects to CVs, so we will group the CVs with the light functions being described, rather than list the CVs in number order. This should let you set up any function completely without having to jump back and forth to find the appropriate CVs for each effect.

(While we wrote this manual for our version 12+ BLUE+ or BLACK decoders, you may also use this instruction set for setting up of most lighting options and function mapping on previous Zen decoder versions - if there is a setting that is available only for version 12+ BLUE+ or BLACK, we will note this within the instructions)

CVs 33 to 42	Function mapping for all active / powered functions	Default =See Chart	Range = See Chart

This group of CVs lets you decide which function button will turn each of the coloured "powered function" wires on and off.

When working with function button allocation, do not forget that SOME function buttons in your controller will be set as momentary switches rather than as "Press for on and Press for off". F1 is often set this way, as it is frequently used for the "Whistle or Horn button" in sound decoders. To change this action you will of course need to refer to your controller manual.

* The CV numbers in this chart are not sequential - we have grouped them in "wire colour order" to keep it simpler for you.

* Usually directional operation will be set when you select a "lighting action" for any wire/function (see the light functions chart a little later on in this manual). However, there is a place in this chart that does have directional action. If you allocate ANY wire to F0-F or F0-R by setting its CV to 1 or 2 (usually reserved for lights/headlights or F0 / Function 0 button) then the wire/function will only operate when the locomotive is set to move in the correct direction via a DCC controller command.

* Yes, you can make a wire operate from more than one function button. To do this, add the numbers for the selected buttons. For example, if you set CV35 (Green wire) to 20 it will work with both function 1 (CV35=4) and function 3 (CV35=16) buttons.

* We do recommend that you keep all function allocations in the F0~F9 range so that they are more easily selected while "driving".

CV #	Colour	Output (Decoder Wire)	Default	F0(F)	F0(R)	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11
CV33	White	Forward light (or F1)	1	1	2	4	8	16	32	~	~	~	~	~	~	~
CV34	Yellow	Reverse light (or F2)	2	1	2	4	8	16	32	~	~	~	~	~	~	~
CV35	Green	Aux 1 (F3) = for button 0~4	4	1	2	4	8	16	32	~	~	~	~	~	~	~
CV37	Green	Aux 1 (F3) = for button 5~11	0	~	~	~	~	~	~	1	2	4	8	16	32	64
CV36	Purple	Aux 2 (F4) = for button 0~4	8	1	2	4	8	16	32	~	~	~	~	~	~	~
CV38	Purple	Aux 2 (F4) = for button 5~11	0	~	~	~	~	~	~	1	2	4	8	16	32	64
CV39	Brown	Aux 3 (F5) = for button 0~4	16	1	2	4	8	16	32	~	~	~	~	~	~	~
CV41	Brown	Aux 3 (F5) = for button 5~11	0	~	~	~	~	~	~	1	2	4	8	16	32	64
CV40	Pink	Aux 4 (F6) = for button 0~4	32	1	2	4	8	16	32	~	~	~	~	~	~	~
CV42	Pink	Aux 4 (F6) = for button 5~11	0	~	~	~	~	~	~	1	2	4	8	16	32	64

CV47	One-Step, easy to set-up "Fluorescent Flicker" lighting effects	Default =0	Settings range = See Chart

This CV lets you set up the effect of "flickering fluorescent lighting" in your passenger coaches, EMUs or DMUs.

Rather then needing to set up to six functions separately, this is done with a simple change in just one CV. You can choose from fully automatic operation for all lights (CV47=1), automation without directionality (CV47=2), semi-automatic operation (CV47=3) or, if you wish, make all functions flicker independently by setting CV47=4. Details are in the table below.

CV#	Set CV to	Default Controller Button	Output designation (Decoder wire)	Light effect that occurs when "Fluorescent flicker" is activated (will change if you re-map the control buttons)
CV 47	1	F0 (Head light)	F0-F / F1 (White)	Turns on steadily with NO Flicker when F0-Forward button is selected
			F0-R / F2 (Yellow)	Turns on steadily with NO Flicker when F0-Reverse button is selected
			AUX1 (F3) (Green)	Flickers randomly at turn-on, then stabilises (irrespective of F0 direction)
			AUX2 (F4) (Purple)	Flickers randomly at turn-on, then stabilises (irrespective of F0 direction)
			AUX3 (F5) (Brown)	Flickers randomly at turn-on, then stabilises (irrespective of F0 direction)
			AUX4 (F6) (Pink)	Flickers randomly at turn-on, then stabilises (irrespective of F0 direction)
CV 47	2	F0 (Head light)	F0-F / F1 (White)	Flickers randomly at turn-on, then stabilises (irrespective of F0 direction)
			F0-R / F2 (Yellow)	Flickers randomly at turn-on, then stabilises (irrespective of F0 direction)
			AUX1 (F3) (Green)	Flickers randomly at turn-on, then stabilises (irrespective of F0 direction)
			AUX2 (F4) (Purple)	Flickers randomly at turn-on, then stabilises (irrespective of F0 direction)
			AUX3 (F5) (Brown)	Flickers randomly at turn-on, then stabilises (irrespective of F0 direction)
			AUX4 (F6) (Pink)	Flickers randomly at turn-on, then stabilises (irrespective of F0 direction)
CV 47	3	F0-F	F0-F / F1 (White)	Turns on steadily with NO Flicker when F0-Forward button is selected
		F0-R	F0-R / F2 (Yellow)	Turns on steadily with NO Flicker when F0-Reverse button is selected
		F1	AUX1 (F3) (Green)	Flickers randomly at turn-on then stabilises (if AUX1's control button selected)
		F2	AUX2 (F4) (Purple)	Flickers randomly at turn-on then stabilises (if AUX2's control button selected)
		F3	AUX3 (F5) (Brown)	Flickers randomly at turn-on then stabilises (if AUX3's control button selected)
		F4	AUX4 (F6) (Pink)	Flickers randomly at turn-on then stabilises (if AUX4's control button selected)
CV 47	4	F0-F	F0-F / F1 (White)	Flickers randomly at turn-on then stabilises (if F0-F control button is selected)
		F0-R	F0-R / F2 (Yellow)	Flickers randomly at turn-on then stabilises (if F0-R control button is selected)
		F1	AUX1 (F3) (Green)	Flickers randomly at turn-on then stabilises (if AUX1's control button selected)
		F2	AUX2 (F4) (Purple)	Flickers randomly at turn-on then stabilises (if AUX2's control button selected)
		F3	AUX3 (F5) (Brown)	Flickers randomly at turn-on then stabilises (if AUX3's control button selected)
		F4	AUX4 (F6) (Pink)	Flickers randomly at turn-on then stabilises (if AUX4's control button selected)

The Zen Decoder range has incredibly versatile lighting abilities.

Please DO experiment with lighting - No matter which prototype or time period you model, we've included light effects to do it all, from the random flicker of an oil lamp to automatic dim, auto and manual rule 17, ditch lights and many other effects.

Its good to experiment and learn about new things - and do not worry... You cannot harm your decoder while experimenting!

As always, defaults are listed so that you can easily re-set any specific CV if things go wrong - and of course, if you just want to start again, CV8 = 8 will take your decoder back to its ex-factory defaults in all areas. An easy fix if you get completely lost along the way.

CVs 49 to 54	Allocating light functions to specific function wires	Default =See Charts	Range = See Charts

This group of CVs allocates specific light effects to specific function wires. In general it is quite a simple process, however, because rule 17 lighting and ditch lights require the use of active function wires PLUS use of a specific decoder button to activate them, there are some simple rules to be observed when setting up your decoder for those two light functions.

* IF activating Rule 17 lighting, please do not allocate any other lighting wire operation to controller function button 4, as it is needed for manual control of Rule 17 headlight dimming.

* IF activating ditch lights, please do not allocate any other lighting wire operation to controller function buttons 2 or 5 as these two functions are pre-allocated to control the ditch light flash.

* If you are not setting up Rule 17 or ditch lights, you may use any function button to activate any of the function wires.

Specific examples for complex lighting:

The next two general charts cover the CVs activating lighting effects for each of the active function wires and the values needed to activate them in forward, reverse or bi-directional modes. However complex light functions also have adjustments for light brightness and flash frequency (additionally, with Mars and Rule 17 etc, there are even speed-related changes to lighting activity).

We have, therefore, also added a special example for each of these more complex options.

Directionality and default setting:

Each active function can be set to be directional - or to stay on in either direction. The default is as shown below. In all cases, the lights are set to "constant bright light" by default.

CV #	Colour	Output wire name	Default Setting	Actions if left at the default setting
CV 49	White	F0-F (F1)	0	0 = On when in FORWARD direction only
CV 50	Yellow	F0-R (F2)	16	16 = On when in REVERSE direction only
CV 51	Green	Aux 1 (F3)	32	32 = On in BOTH directions
CV 52	Purple	Aux 2 (F4)	32	32 = On in BOTH directions
CV 53	Brown	Aux 3 (F5)	32	32 = On in BOTH directions
CV 54	Pink	Aux 4 (F6)	32	32 = On in BOTH directions

CVs 49 to 54 — General CV 49 to CV 54 setting values for specific special lighting features and effects

Lighting feature description	FWD	REV	BOTH	Notes related to each special light effect.
Constant BRIGHT Light	0	16	32	*These are the default setting on all decoder functions*
Random Flicker	1	17	33	*You can adjust random flicker rate with CV135. Default = 32.*
Mars Light Effect	2	18	34	*Adjustments with CVs 112 to 116. See separate description.*
Flashing Light	3	19	35	*Adjustments with CVs 144 to 145. See separate description.*
Strobe - Single Pulse	4	20	36	*Adjustments with CVs 140 to 141. See separate description.*
Strobe - Double Pulse	5	21	37	*Adjustments with CVs 146 to 148. See separate description.*
Rotary Beacon Effect	6	22	38	*Adjustments with CVs 118 to 122. See separate description.*
Gyra Light Effect	7	23	39	*Adjustments with CVs 112 to 116. See separate description.*
Rule 17 Lighting (dimmable)	8	24	40	***Also need to set CV61**. Rule 17 always needs Controller function 4 for dimming. Also see the separate description.*
Ditch Light Phase A	10	26	42	*Ditch lights always need to use Controller Functions 4 and 5 The Ditch light timers are CVs 63 (Ditch lights "Stay on" timer) and 117 (Phase A and B Alternation frequency). Please also see the separate description for ditch light set-up.*
Ditch Light Phase B	11	27	43	
Constant DIM Light	12	28	44	*Adjustment of level with CV64. The default setting is 4.*
Automatic Mars Light Effect	13	29	45	*Adjustments with CVs 112 to 116. See separate description.*

Specific Instructions: Random Flicker.

Random flicker is effective for oil or gas lamps and lighting in early locos - as well as for representing TV screen flicker, fires or industrial lighting in buildings, etc. In fact, it can very cost-effective to use Zen loco decoders in buildings for simple control of multi-room light control OR to perhaps link one to illuminated buffer stops in a yard, adding the "random flicker" to one or two of them to represent those lamps that are in need of trimming!

*** Set the chosen function wires CV to 1 for Forward only, 17 for Reverse only or 33 for on in both directions.**

*** If you want to change the "Random Flicker" rate, then adjust CV135.**

*** CV135 overall range is 1~255. Initially try adding in 10's then refine changes until you get the effect you want.**

*** CV135 default setting is 32.**

Specific Instructions: MARS lights.

Mars Lights are signal-safety lights used in the United States and built by the Mars Signal Light Company for railroad locomotives and firefighting apparatus. Mars Lights used various means to cause the light to oscillate vertically & horizontally to catch the attention of motorists and pedestrians.

Initially seen on US railroads during the 1930's, Mars lights still exist today. They were fitted to both diesel and steam locos, with some preserved steam locomotives also having them fitted when they are restored.

These lights used several methods to physically oscillate the light beam.

Sometimes the bulb and assembly were moved, other times a reflector was rotated. The Mars beam was usually oscillated in a triple eight pattern, i.e., the beam would oscillate up and down two or more times for every horizontal sweep, with this light pattern providing the source for the company's slogan "The Light from Mars". Mars lights are steadily being replaced by Ditch lights. A Mars light can be seen in this loco image.

ZEN decoders are able to simulate Mars lights by adjusting the brightness & pulse rates of LEDs in a variety of ways. Clever installation using 2 functions can also result in a red/white Mars light as used by some US railroads.

Note: Mars lights and Gyralights both share the same CV adjustment set.

MARS & GYRALIGHT	CV #	Default	Range	Comment and notes.
NOTE: All values must be set to above Zero. Min, Mid and Max cannot be the same and of course they must have values in an ascending order - i.e. minimum always lowest, maximum always highest and mid in between them.				
Minimum Brightness	CV 112	1	1~25	Always 1 or higher as Mars lights are never fully off.
Maximum Bright time	CV 113	9	1~255	This CV Sets how long the light will remain at its full brightness level within the light cycle.
Total Light Cycle time	CV 114	1	1~3	Increases length of the total light cycle before repeating.
Mid Brightness Level	CV 115	6	1~25	Adjust to suit the Mars or Gyralight you want to create.
Max Brightness level	CV 116	22	1~25	Set above 20 - Mars light full brightness is always high.

MARS or GYRA Lights.... What's the difference?

Both were electro-mechanical warning lights, sometimes mounted within a standard headlight structure.

Both were standard lights at normal train operating speeds but dropped into "Special light mode" when activated by lower speed or when approaching grade crossings / within yards, etc. (Please research your own prototype for the correct Mars/ Gyra operational rules).

While Mars lights tended to describe a "Figure eight" pattern, Gyralight tended to use a more circular light pattern. There are some excellent You Tube videos which show both of these interesting light effects in close-up.

Setting up manually controlled Mars lights:

As you can see in the photograph (page 20), MARS lights were usually mounted separately to the headlight.

This was the case with both steam & diesel locos. In this example (for a diesel) we will add two of them, one to each end. Because we want ONLY the Mars light at the leading end to work, we will make both of them directional.

We will use Green (Aux 1 / F3) for the front Mars light, and Purple (Aux2 / F3) for the rear Mars light in this example. Of course, if you have a 6-fn decoder, you could also choose to use Brown or Pink if you like.

* Set the Green wire light effect CV (CV51) to MARS in Forward only. CV51 = 2.

* Set the Purple wire light-effect CV (CV52) to MARS in Reverse only. CV52 = 18.

Usually MARS lights were operated at slower speeds in areas where additional warnings were needed and at road rail or grade crossings (just as ditch lights are used today). We want to keep operation simple so we want BOTH of these function wires to be controlled by the same function button. We will allocate them to Function 3.

* Allocate the Green (Front Mars) wire to Controller function 3 by setting CV35 to 16.

* Allocate the Purple (Rear Mars) wire to Controller function 3 by setting CV36 to 16.

Now... If you press Function 3, the MARS light that is on the "Forward end" of the locomotive will turn on. It will operate until you turn it off by pressing Function 3 again.

Try it... If you want to change the way the MARS light acts and looks, you can use the 5 step "Mars and Gyralight" adjustment chart shown on page 20 to alter the light actions to your own preference.

Setting up Automatic and Semi-automatic Mars lights:

Many US and other railroads world-wide ruled that Mars lights were to be used during most low speed movements, so if you just want the Mars Lights to automatically turn on at slower running speeds, you can do that too.

Auto-Mars set-up is VERY similar to manual. We will again use Green (Aux 1 / F3) for the front Mars, and Purple (Aux2 / F3) for the rear Mars light. If you have a 6-fn decoder, you could also choose to use Brown or Pink if you like.

* Set the Green wire Auto-Mars light effect CV (CV51) to "Active when moving forward" only. CV51 = 13.

* Set the Purple wire Auto-Mars light-effect CV (CV52) to "Active when in reverse" only. CV52 = 29.

Now you have another choice: have them come on with the headlights OR be activated by a separate function.

For Auto-Mars lights that only flash at slower speeds and with On/Off via the "Lights" function or F0, set as follows:

* Set the Green (front Mars) wire to turn on at the same time as the lights - Set CV 35 to 1.

* Set the Purple (rear Mars) wire to turn on at the same time as the lights - Set CV 36 to 2.

For Auto-Mars lights that only flash at slow speed and with On/Off via another function (example uses F3) set as follows:

* Allocate the Green wire (Front Mars) to F3 ~ the DCC Controller F3 function - by setting CV35 to 16.

* Allocate the Purple wire (Rear Mars) to F3 ~ the DCC Controller F3 function - by setting CV36 to 16.

Now... If you press Function 3, the MARS light that is on the current "Forward end" of the locomotive will turn on.

And...

* It will operate as a MARS light if you drop below speed step 43 (in 128 step mode) or speed step 10 (in 28 step mode).

* It will operate as a normal second headlight if you are above speed step 32 / speed step 8 in 28 step mode.

Specific Instructions: Simple FLASHING Lights.

This type of light is more common on industrial or similar locomotives, and, while there are safety standards for flash rates, etc, they have varied over time, so again, please research your chosen prototype if necessary to find the ideal settings for your own models.

Of course flashing lights are seen everywhere and on anything requiring safety, not just locomotives...

Simple FLASHING Light	CV #	Default	Range	Comment and notes.
NOTE: All values to be set to above Zero. Unlike strobes or pulsed lamps, flashers have a distinct "on and off" cycle.				
Light ON duration	CV 144	144	1~255	Adjust in steps of 10~20 initially, then refine your choice.
Light OFF duration	CV 145	48	1~255	Adjust in steps of 10~20 initially, then refine your choice.

Specific Instructions: Single phase STROBE Lights.

This type of light will tend to be roof mounted rather than in the headlight position.

There are safety standards for flash rates and light levels etc, but they have varied over time, so please research your chosen prototype if it is important to you to get it right.

Of course strobe lights are seen in many places and on anything requiring safety warnings, not just locos...

SINGLE PULSE Strobe	CV #	Default	Range	Comment and notes.
NOTE: All values to be set to above Zero. Pulsed strobe lights go from high to low levels and are never totally off.				
Light OFF duration	CV 140	200	1~255	Adjust in steps of 20 initially, then refine your choice.
Light ON duration	CV 141	20	1~255	Adjust in steps of 10 initially, then refine your choice.

Specific Instructions: Double phase STROBE Lights.

This type of light tends to be roof mounted rather than in the headlight position. The double pulse is very effective.

There are safety standards for flash rates and light levels etc, but they have varied over time, so please research your chosen prototype if it is important to you to get it right.

Double-phase flashing lights are gain seen in may places as safety warnings, not just on locomotives...

DOUBLE PULSE Strobe	CV #	Default	Range	Comment and notes.
NOTE: All values to be set to above Zero. Pulsed strobe lights go from high to low levels and are never totally off.				
Strobe long OFF duration	CV 146	200	1~255	Adjust in steps of 20 initially, then refine your choice.
Strobe Light ON duration	CV 147	20	1~255	Adjust in steps of 10 initially, then refine your choice.
Strobe short OFF duration	CV 148	50	1~255	Adjust in steps of 10 initially, then refine your choice.

Specific Instructions: ROTATING beacon.

This type of light will also tend to be roof mounted rather than in the headlight position. They can also found on the top of tall towers and buildings aviation obstruction/warning lights.

A rotating beam is actually an electro-mechanical device, so accurately simulating a realistic rotating beacon is a complex thing to do. Therefore, there are six CVs that will need to be adjusted.

Always quite common, simple rotating beacons are still used in many applications...

DOUBLE PULSE Strobe	CV #	Default	Range	Comment and notes.
NOTE: All values are usually set to above Zero. This is because we need to simulate a light that is constantly on but is set into a rotating reflector, so the light will go from higher to lower levels but the overall glow will rarely be totally off.				
Rotary Minimum brightness	CV 118	1	1~25	Adjust in steps of 3 initially, then refine your choice.
Rotary MAX brightness TIME	CV 119	5	1~255	Adjust in steps of 10~20 initially, then refine your choice.
Rotary TOTAL CYCLE time	CV 120	1	1~3	This is the time for ONE FULL ROTATION.
Rotary MID-point brightness	CV 121	15	1~25	Adjust in steps of 3 initially, then refine your choice.
Rotary MAXIMUM brightness	CV 122	25	1~25	Adjust in steps of 3 initially, then refine your choice.

Specific Instructions: RULE 17 LIGHTING.

First, let's describe Rule 17 and what it means.

Rule 17 is part of a collection of rules that govern which lights are to be illuminated on a locomotive at given times and it also relates to when they should be dimmed.

These rules may vary slightly from railroad to railroad but generally follow a similar pattern.

The general purpose of Rule 17 is to make sure that the locomotive is visible, without creating undue glare that will negatively affect the safety of others that are operating in the area.

Basically...

Except when an engine is clear of the main and stopped, both the front (and rear if the loco has one) headlights should be turned on. Also - ONLY the light in the direction of travel should be at full brightness except when:

* The locomotive is at stations and yards where switching is being done.
* When the locomotive is stopped close behind another train.
* In non-signalled (dark) territory, when the engine is stopped on the main track waiting for an approaching train.
* When approaching and passing the head end and rear end of any train on the adjacent track.
* At other times to permit passing of hand signals or if required for employee safety. (When opposite light should be dimmed).

Note:

Rule 17 is commonly used as the model railroading term, and was the traditional prototype number for this rule.

However, it has now been superceded in the real world. (It is now usually covered in USA in Rule 5.9.1 to 5.9.4.)

Setting locomotive lighting up ready for "Rule 17" operation.

Rule 17 Dimming includes three different types of functionality:

These are: (1) Opposite Dim. When the loco is moving forward the reverse light is dimmed, and when travelling in the reverse direction, the forward light will be dimmed. (2) Dim the lights when stopped. When a loco comes to a complete stop the light(s) will dim. (3) Function button controlled dimming using Controller function button #4.

Note: Button controlled dimming is in place by default any time that any lighting function is assigned to the Rule 17 lighting effect, however, Opposite Dim and Dim when Stopped must also be enabled in CV 61 before they can affect the decoders operation. See the tables & example below for more information on enabling Rule 17 Options.

SETUP for RULE 17 with CV61	Default	Comment and notes.
NOTE: CV61 is a complex CV. ADD TOGETHER the values shown below as needed and enter that total into CV61.		
Enable BEMF	*1*	*If 1 is NOT added in, BEMF will be turned OFF.*
Enable BUTTON control of BEMF	*2*	*If 2 is added in, then you can control BEMF with a function button.*
DIM the lights when stopped	16	All lights assigned to Rule 17 operation will dim when the loco stops.
DIM the OPPOSITE light	32	The light at the rear of the locomotive will be dimmed.

Specific examples for decoder set-up with "Rule 17" operation:

Example 1: Automatic "Rule 17" - This sets up the decoder so Rule 17 is automatic, head & tail lights stay directional and change automatically with the F0 or "Lights" function activated. Manual F4 operation of Rule 17 is still available.

* The light that is at the front of the locomotive will now automatically dim when the locomotive stops.
* The light that's at the front of the locomotive can be dimmed at ANY time by pressing the DC Controller's function 4 button at any time (for example, when shunting / switching beside the main line or moving within the loco depot)

Step 1: Activate "Dim the lights when stopped" by setting CV61. BEMF has CV61 already set to 1, so we will need to add 16 to that for "Dim when stopped". Therefore, we will set CV61 to 1+16 = 17.

Step 2: Set the dimming level by setting CV64. The default for CV64 is set to 4. CV64's range is 1~15.

Please note: we quite like a strongly dimmed light for this effect - so we will set CV64 to 1. (Results vary a bit by LED type/brand. Experiment with the 1~5 range and find your own preference)

Step 3: Set the "light effect" requirement CVs for the WHITE and YELLOW function wires.

* CV49 allocates a light function to the WHITE wire. CV50 allocates a light effect function to the YELLOW wire.
* The RULE 17 activation options are 8 (forward only), 24 (reverse only) and 40 (non-directional). We suggest that for simple auto-operation + F4 control, you use 8 for CV49 (white wire) and 24 for CV50 (yellow wire).

Example 2: Manual control of "Rule 17" operation. We will just summarise this here.

* Leave CV61 at 1 or, if you want opposite dim but with manual control, set it to 33.
* Allocate White (front headlight) to F0, Yellow (rear headlight) to F1. If you want added lights also Rule 17 linked, then also Green to F2 and Purple to F3 (Chart on Page 16).
* Set each wire for rule 17 operation. (Wire operation CV numbers are on page 18. Also see Rule 17 values on page 19) Now you can turn lights on and off manually AND operate rule 17 manually by pressing Function button #4.

Specific Instructions: DITCH Lights.

Ditch lights are progressively replacing all other forms of warning lights such as Mars lights and Gyralites. Ditch lights are usually mounted at about footplate height at either side of the loco front and rear ends. See image below.

Common in the USA, Australia & other places, they are often also linked to the loco horn operation.

You will most often see them in action at road/rail crossing points, but they are also used for warnings at other times - e.g. when working in yards or loco depots. Research your chosen prototype for more details of ditch light use.

DITCH LIGHT SETTINGS	CV #	Default	Range	Comment and notes.
NOTE: All values are usually set to above Zero. This is because we need to simulate two lights that are usually turned on and steady when the loco is active - but will also flash when a function button (Pre-set to function 3) is pressed				
Ditch light flash TIMER	CV63	63	1~255	Sets how long Ditch lights will flash for when triggered. (Each 10 is equivalent to about 1 second)
Ditch light flash BLINK rate	CV117	3	1~255	Sets the flash frequency.

About DITCH LIGHTS.

Ditch lights are an effect that can add a lot of interest.

Ditch lights are additional to headlights. They are only ever active at the forward end of the loco.

They work as both an additional constant light and a warning light so they are generally turned ON all of the time that a loco is operating.

To activate the Ditch light flash, you will need 2 lighting wires and ideally 2 controller function buttons for operation, one to turn them on, plus one more to activate the flashing for a pre-set period on demand.

Note: It will be useful if the DCC controller function button that you use to trigger the flashing is set to momentary operation rather than on-off.

Fortunately some DCC control systems (e.g. NCE) will already have the Whistle/horn button pre-set as a momentary function in parallel with F2. This is of course the perfect choice for a Ditch light ON button! If you use other brands, refer to your system manual for instructions on doing this)

Setting up Ditch lights takes several steps, so we will give you a fully worked example for the set up of a diesel locomotive with ditch lights.

Note:

Ditch lights and “Rule 17” are both part of many prototypical lighting setups, so in the example on the next page, we are going to set up both, with our Ditch Lights set up so that they do not conflict with Rule 17.

Most modern locomotives are able to be used with either end forward, so we will add two ditch lights at each end of the locomotive. This means 3 powered light functions at each end of the locomotive for a total of 6.

This will be really easy to do using our very versatile ZEN 6-function decoders. (ZN218.6, ZNM.HP.6 and ZN360.6

Setting locomotive lighting up ready for both RULE 17 and DITCH LIGHT operation.

Rule 17 and Ditch lights are both required in a modern loco, so we show both in this example. Because we are setting up TWO light effects at the same time, we will present this setup process as two charts, followed by notes.

** You are also able to manually dim any light Functions set for rule 17 by using function button 4.*

** The ditch lights are set to be directional so ONLY the ditch lights at the leading end will be on. They are also set to be turned on or off manually on or off via Function button 1. (F1 will turn them on in a steady state)*

** Ditch light flashing is activated by use of the horn/whistle button which is a momentary function in parallel with the Function 2 button on some controllers. One press of this button will set the ditch lights flashing for the pre-set time entered into CV 63. If you don't have a horn/whistle button, use the Function 2 button to turn them on and off.*

STEP 1: Decide which decoder function wires will connect to which light functions and activate them.
(The full chart for function mapping of decoder functions to function control buttons can be found on page 16)

Wire Colour	Used on this loco for	FN Map CV	Set to	Comment and notes
White Wire	Headlight end 1F0-F	CV33	1	FRONT headlight light - turned on by function button F0-F.
Yellow Wire	Headlight end 2 F0-R	CV34	2	REAR headlight light - turned on by function button F0-R.
Green Wire	Ditch light front Left	CV35	5	DITCH light pair #1 - turned on by function button F1. (These two will activate the front ditch lights)
Purple Wire	Ditch light front Right	CV36	5	
Brown Wire	Ditch light rear Left	CV39	6	DITCH light pair #2 - turned on by function button F1. (These two will activate the rear ditch lights)
Pink Wire	Ditch light rear Right	CV40	6	
We also need to set CV61 to permit the "Dim when stopped" action of Rule 17				
		CV61	17	Activation of dimming ability for Rule 17

STEP 2: Decide which lighting effects to enter into each wire colours "CVs for light effects & action" register.
In this case we are making all active functions semi-automatic and directional, but retaining manual control too.

** The full chart of wire-specific control CVs into which lighting effect direction value can be entered is found on page 18.*

** The full chart of the lighting effects that are available / values to be entered to use them, can be found on page 19.*

Wire Colour	Used on this loco for	Effect CV	Set to	Comment and notes
White Wire	Headlight end 1F0-F	CV49	8	Headlight at the front end. Directional. Rule 17 applied
Yellow Wire	Headlight end 2 F0-R	CV50	24	Headlight at the rear end. Directional. Rule 17 applied
Green Wire	Ditch light phase A FWD	CV51	10	Ditch light A at the front of the loco (On FWD only)
Purple Wire	Ditch light phase B FWD	CV52	11	Ditch light B at the front of the loco (On FWD only)
Brown Wire	Ditch light phase A REV	CV53	26	Ditch light A at the rear of the loco (On REV only)
Pink Wire	Ditch light phase B REV	CV54	27	Ditch light B at the rear of the loco (On REV only)

Operating the locomotive set up with both Ditch and Rule 17 lighting using the above settings	
Function 0	Turns on headlights activates Rule 17. The headlight will automatically dim when the loco is stopped
Function 1	Turns on all 4 Ditch lights. ONLY the Ditch lights at the active front end of the loco illuminate.
Function 2	(Or Whistle/Horn button) Activates Ditch light flashing (for the pre-set period that you set in CV63)
Function 4	Manual control of headlight dimming (Manual rule 17 activation for use when switching, etc.)

CV64 sets the "Constant Dimming Level": 1 to 20

- *This is how bright lights will become when dimmed by the various lighting setup options.*
- *The overall range is 1~20. We have pre-set this to 4 as we assume that the loco will have LEDs.*

General guide for settings:

- *The lower the number, the lower the light level.*
- *LEDs will need low numbers, so we recommend that you set CV64 to between 1 and 6 for LEDs.*
- *Incandescent lamps (bulbs) need more energy always, so experiment between 8 and 15 for incandescent lamps.*

Note please:

Some experimentation will be necessary - We cannot be more specific, as LED and incandescent lamp brightness and efficiencies will vary quite a lot, depending on the age and brand of the locomotive you are using. (Incandescent bulbs are particularly variable)