# 20 TOP TIPS DIGITAL LOCOMOTIVE CONTROL

DIGITAL SPECIAL

Getting the most out of Digital Command Control can be tricky. **PAUL CHETTER** presents his top tips for getting the very best out of your locomotive fleet.


**Digital command control introduces the ultimate in freedom for locomotive movements and their operation. Knowing how to get the best from your decoders makes operation even more satisfying. Here at Felton Cement Works a 'WD' 2-8-0 passes with a through coal working while a Sulzer Type 2 runs round its recently arrived set of Presflo hoppers.**

IF THE ONLY CHANGE you make to your Digital Command Control (DCC) decoder is to give it a new address, you are almost certainly not getting the optimal performance from your models. This is because decoder manufacturers generally do not know to which model any particular decoder will be fitted. To allow for this, they are supplied with factory settings designed to operate the majority of motor types reasonably well under a wide range of conditions.

Each motor and model combination will have its own characteristics, even between those from the same production batches. How different they may be from each other will depend upon the model types and the tolerances allowed.

Configuration Variables, or CVs for short, are the method by which 'preferences' can be stored in a decoder's memory. These preferences tell the decoder how and what to do. This is the way in which the operation can be specifically tailored not only to the model, but also to the layout on which it is to run and the operator's driving style.

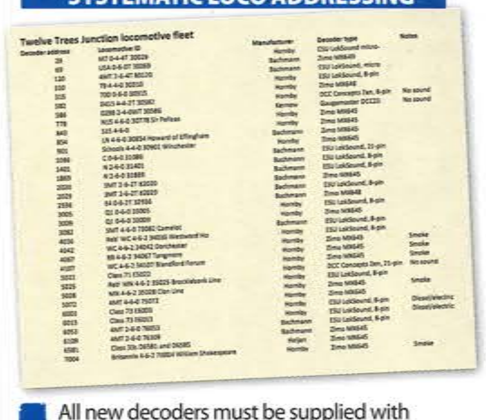
CV changes are fully reversible, so if you try something which doesn't work out as planned just change it back. Don't be afraid to experiment - there's everything to be gained and nothing to lose. If it all goes wrong, use the decoder's reset command (often CV8 = 8 but check the manual for your particular decoder type) but remember that this will also reset the address to '3'.

There are a large number of CVs possible. Some, a surprisingly small number, are mandatory for all decoders. Others are optional, but if the manufacturer includes them, there are specified ways in which they should work. Even more have no defined use so each manufacturer may use them for their own proprietary needs. Generally speaking, top quality decoders will have more scope for optimisation through a greater range of CVs, but please note that top quality is available at budget prices.

I use Zimo decoders exclusively. All of the features highlighted in the following tips are available with Zimo decoders. Which of them apply to other manufacturers will be specific to that brand or decoder type.

For this reason, many of the tips do not include lists of CVs and specific values, but are intended to point out what may be possible and how this might be achieved. Your decoder's manual will give such information specifically designed for that decoder type. Even adjustments in the basic CVs (commonly called 'programming') can produce worthwhile outcomes, which leads nicely onto the first of our 20 Top Tips.

## SYSTEMATIC LOCO ADDRESSING


Twelve Trees Junction locomotive fleet

| Decoder address | Locomotive ID | Manufacturer | Decoder type | Notes |
| --- | --- | --- | --- | --- |

1 All new decoders must be supplied with the address set at '3'. Though strictly if the decoder is supplied already fitted to a model, the seller may set a different address, in practice all manufacturers will also use '3'.

To be able to independently operate more than one locomotive concurrently on the same track each model must have a unique address. Operators can assign any of a large range of numbers to achieve this, normally between 1 and 9999, though there are decoders with restricted ranges.

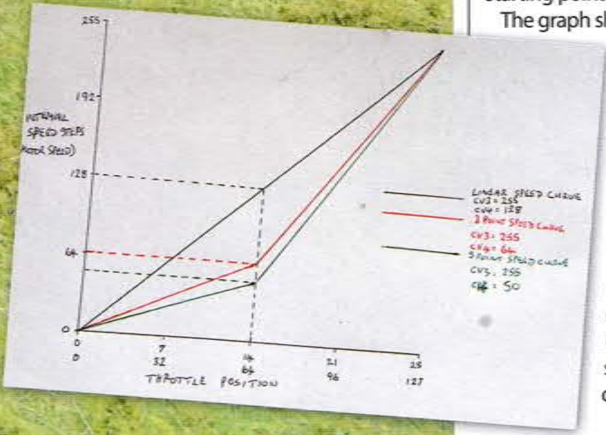
It will be beneficial in the longer term to have a numbering system in place which can be added to easily and which allows operators to quickly identify a particular model's address without needing a photographic memory. Using 1, 2, 3, 4 and so on might seem OK when you have only four locomotives, but when that goes up to a dozen or so, and some are infrequently operated, it might turn out to be unreliable.

All real locomotives have a unique number which is usually visible. Many experienced DCC users will base their system around these running numbers or TOPS classification or a combination of these since there will always be a visible clue. If you apply your chosen addressing scheme consistently, it will always be possible to deduce the address.

## MODIFY THE SPEED CURVE

2 If supported by your decoder, the value in CV6 (always used in conjunction with CV5) will determine the power available at half-throttle. In some circumstances, a linear curve will be most useful. In this case the value in CV6 should be half of the value in CV5.

If you would like finer control at low speeds, however, this can be achieved with a CV6 value less than one half of CV5. Experimentation will allow you to optimise this ratio for your own needs, but a good starting point is CV6 = 1/3 of CV5.




The graph shows that when the throttle is halfway towards the maximum, the road speed of the model is only 1/3 of the maximum. This means that at lower speeds a large movement of the throttle control is required to vary the road speed, resulting in finer control.

Although the graph suggests a sharp change at the mid-point, in reality good quality decoders interpret this as the centre of a curve rather than a single fixed point and smooth out the transition automatically.

### COMPENSATING FOR WORN COMPONENTS

**3** If there is any wear, slack tolerance or excessive end-float in your model's drivetrain, this will often manifest in jumpy starts after a change in direction. This is because the first part of the motor's acceleration occurs whilst the slack is being taken up. By the time the driving wheels can be turned, the motor is spinning. The sudden engagement of the transmission with the spinning motor causes the model to start with a jolt; like letting the clutch out too quickly in your car.

Zimo decoders use CV146. Activation causes the motor to turn at minimum speed initially (per CV2) for the duration specified by the value in CV146. This gives time for the slack to be taken up before normal acceleration begins. The value is determined by observation, effectively increasing the value until the jolt start is eliminated. This feature only operates after a direction change.

### AVOID RUNAWAYS

**4** Decoders are often supplied set up to allow them to operate on analogue as well. If through poor or dirty track or degraded DCC signal the decoder decides it is not on DCC powered track it will switch to DC operation. Since DCC track is always at full power, this commonly results in the model accelerating to full speed and running out of control until it derails or hits something. If you only operate on DCC, it can make sense to remove this potential problem at source.

CV29 is often referred to as a Configuration Register, since it stores preferences for several different features each controlled by a separate value. To enable DC operation, the value '4' is added to the other separate values in CV29. To disable DC operation without affecting any other feature controlled by CV29, the value '4' must be deducted from the existing total.

It is essential, therefore to read (and note) the value stored in CV29 before making this change. Some basic DCC controllers do not have the ability to read the existing values from decoders.


### TEMPORARY POWER SUPPLY

**5** Whilst well laid track properly maintained and cleaned is to be strived for, DCC has the ability to mitigate the impact of poor electrical supply by storing power in external capacitors for use when the track power is temporarily unavailable due, for instance, to electrically isolated sections or dirty track.

While most decoders will be able to be converted to allow this if you are prepared to solder to delicate decoder components, some are designed with external storage in mind, having proprietary 'stay alive' or 'keep alive' add-on packs whilst some Zimo decoders have onboard capacitor management circuitry to which inexpensive standard capacitors can be connected.

### SPEED TRIMMING

**6** Some models, otherwise in good mechanical condition, have a tendency to run more quickly in one direction than another. The impact of this can vary from minor inconvenience in single locomotive operation to disaster when part of a 'consist', a common name for trains with more than one locomotive.

If your decoder supports this feature, it is possible to adjust the power supplied to the motor when turning in one direction relative to that in the reverse direction. Useful to produce similar speeds in either direction (for a given throttle position), this fine tuning is called Trimming. CV66 is responsible for Forward Trim, CV95 for Reverse Trim on Zimo decoders. The higher the value, the more the voltage is increased in the respective directions of travel.



### INERTIA AND MOMENTUM

**7** With lower mass, a light engine will accelerate and decelerate more responsively than a heavy train. In model form, it is possible to automatically simulate the effects of mass by regulating the increase and decrease in power available to the motor over time. CV3 regulates the rate of acceleration to simulate the effects of inertia. The higher the value, the lower the rate of acceleration and the heavier the train will appear to be.

CV4 controls the rate of deceleration to simulate the effects of momentum. The higher the value, the lower the rate of deceleration and the heavier the train will appear to be. Even values of below 10 in these CVs will smooth out speed changes, thereby reducing oversensitivity to changes in the throttle position without unduly affecting controllability.

Larger values will have a greater effect; in CV4 this can be used to create realistic coasting effects but can result in very large stopping distances. Values over 75 are probably best left to either very experienced 'drivers' or for those decoders equipped with working brake features - see 20.

### BANKING

**8** Heavy trains climbing long steep gradients often required the temporary assistance of another locomotive. This is called banking. It can take many forms with the banking locomotive coupled or uncoupled.

A common method was for the banking engine to buffer up to the rear of the train without coupling. The banker would then take some of the load by pushing as the train's locomotive pulled from the front. When the lead locomotive was able to manage the train unaided, the banker would reduce speed, drifting off the rear allowing the train to continue its journey. The banker would return to the start position to await the next train requiring assistance.

Banking in this way is a special form of consisting which is difficult to achieve with analogue control but very straightforward for DCC. Each locomotive has a separate address, so may be controlled independently. Separate throttles or a dual throttle DCC controller offers the most convenient way to bank in this way - a single throttle can be used with practise.

### ADD SPECIAL EFFECTS

**9** A widely available facility is using the decoder's processing power to add a variety of effects to Function Outputs (FOs). By varying the frequency, intensity and duration of power available to the respective outputs, LEDs may be flashed randomly or to a fixed pattern, the output of smoke units can be varied to suit different running status, though effects can be applied in one direction only.

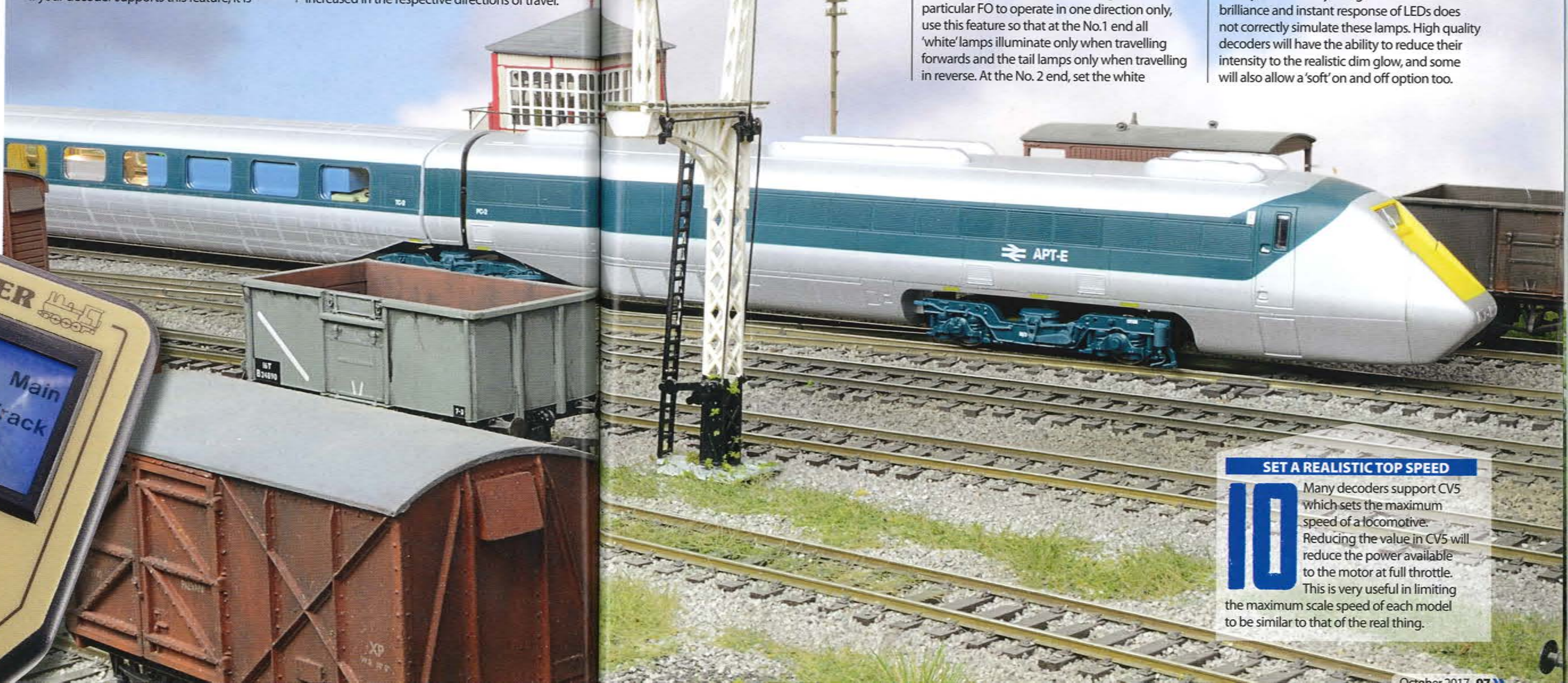
For example, using a diesel locomotive, Function Mapping (16) will allow you to assign each light type to a separate F key, but so far the control you have is limited to ON or OFF at full brightness. This may be fine for the high intensity lamp but it is not satisfactory for the others and you will have assigned up to eight F keys to lighting functions. Here are some possible improvements to simulation and convenience.

If your decoder allows the setting of a particular FO to operate in one direction only, use this feature so that at the No.1 end all 'white' lamps illuminate only when travelling forwards and the tail lamps only when travelling in reverse. At the No. 2 end, set the white lamps to illuminate only when travelling in reverse and the tail lamps when in forward.

Map similar lamps from each end to the same F key. For example, assign the two FOs which control the cab lights to F key 8, or both tail lamp FOs to F key 10. This will result in half the number of F keys used. A single key determines if the tail lamps are on or off, and the direction of travel determines at which end the lights are illuminated.

Maybe you would like to have cab lights automatically switch off when the locomotive moves and back on when stationary? Or the high intensity lamp to automatically dip or turn off completely when the model comes to rest and back on when the locomotive pulls away? Setting these preferences if available on your decoder can save a lot of button pushing.

Until recent times, UK locomotive lighting was of very low intensity using filament bulbs. The brilliance and instant response of LEDs does not correctly simulate these lamps. High quality decoders will have the ability to reduce their intensity to the realistic dim glow, and some will also allow a 'soft' on and off option too.


### SET A REALISTIC TOP SPEED

**10** Many decoders support CV5 which sets the maximum speed of a locomotive. Reducing the value in CV5 will reduce the power available to the motor at full throttle. This is very useful in limiting the maximum scale speed of each model to be similar to that of the real thing.

## LIGHTING IMPROVEMENTS

**11** As all DCC track has full voltage during operating sessions, any locomotive lighting may also be illuminated constantly.

Using the decoder's FOs and ability to receive instructions from DCC controllers, individual or individual pairs of lights may also be switched on or off remotely. LEDs produce light with low power consumption and with little heat. These features, plus the very small physical sizes available, makes them ideal for model lights. You can add LEDs to your models either using pre-wired kits or as individual units following the fitting guides featured in *Hornby Magazine* from time to time.

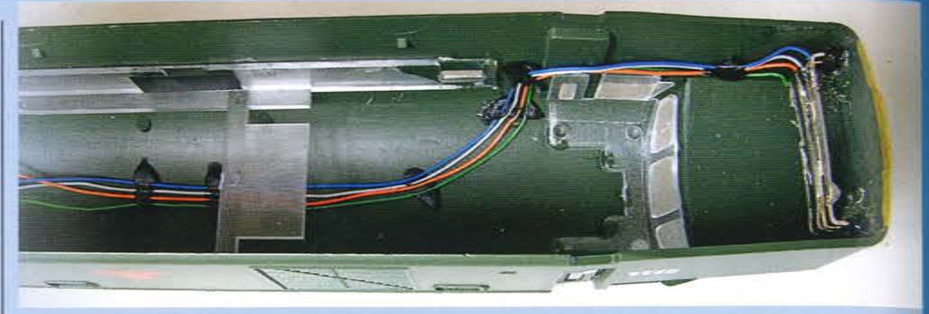
The number of FOs must match or exceed the number of lights you wish to separately control, so decide what you wish to achieve, calculate the number of FOs required then take this into account when selecting your decoder.

As an example, a model diesel locomotive is equipped with white marker lamps and red tail lamps at each end. By wiring the white lamps at one end with the red lamps at the other, they can be operated with two FOs.

But what if you wish to run with marker and tail lamps illuminated during light engine movements but without the tail lamps when the locomotive is hauling vehicles, as on the real railways? The link from each red pair to the opposing white lamps must be severed and separate power circuits provided. This means that four FOs are now required.

Developing this theme, consider a model diesel locomotive equipped with a cab light, white marker lamps, red tail lamps and a high intensity lamp at each end.

To provide full independent control will require four FOs for each end, giving a total of eight FOs overall.



## UNDERSTAND YOUR DECODER

**12** Arguably, 'Read the decoder manual' should have been first in this list, but no one wants to be told that. The features in this series of tips can help you to perfect your models' performance, but not all decoders offer the full range.

## DOUBLE-HEADING

**13** Operating multiple locomotives as one 'Consisted' power unit is common practice on real railways. The major drawback in simulating this on a model railway is that individual models react differently to a given throttle input. Poor running and even derailments can occur where the performance of motorised units are not well matched.

I have explained how, by setting preferences, we are able to determine how our models behave. You can use these techniques to closely match the starting, acceleration, road speed and deceleration characteristics of all motive power in a consisted train to ensure stable running.

## OPTIMISE MOTOR CONTROL

**14** Adjusting CVs 1 to 6, if supported, will be sufficient in most cases to achieve exhibition quality operations. For 'stubborn' models, particular motor types or ultimate finesse other motor controls are available with more fully featured decoders. CV9 can be used to modify the Pulse Width Modulation (PWM) duty cycles. This and the related CV56 Back Electro-Motive Force (BEMF) control can be tweaked in a number of ways to optimise smooth, quiet operations.

Special settings will be available to meet the requirements of the new breed of coreless motors which are becoming more popular of late. A full description of the changes to make is beyond the scope of this article, but if your decoder supports these CVs, it will be covered in the appropriate manual.

## SMOOTH STARTING

**15** The transition between a stationary locomotive and one which is beginning to move can be too abrupt. Decoders are able to smooth this out by setting a target starting voltage with CV2. The optimal value can be determined by observation. Begin with CV2 = 1 and set your throttle to speed step 1. If the model does not move, try CV2 = 2 and so on until smooth starting is achieved. Aim for the lowest value in CV2 which provides reliable smooth take off at speed step 1.

## FUNCTION OUTPUTS

**16** Virtually all DCC locomotive (or mobile) decoders also have physical connections to supply power to on-board features such as lighting and smoke units.

These are Function Outputs (FOs) also known as AUXs and the number available varies by brand and decoder type. Any electrical item you wish to be able to switch on and off independently will need to connect to a separate AUX. 'Normal', 'full power' and 'open collector' are different terms for the same thing and are the most common types. The positive lead from each item to be powered will be connected to the Common Positive terminal of the decoder and the negative to one of the AUX connections. To safeguard LEDs by restricting the available current, a series resistor may be required too to ensure that it doesn't receive too much power from the decoder.

## COACH LIGHTING

**17** It's easy to think of DCC only in terms of locomotives but Function-only decoders, or the Function portion of locomotive decoders can also be used to great effect in coaches where overhead, table, vestibule, kitchen and even lavatory lighting can be individually controlled, moving or stationary.

See HM86 where a sound decoder was used to provide both visual and sound effects, in a Hornby 12-wheel restaurant car.

## FUNCTION MAPPING

**18** The basic NMRA function mapping may not always be appropriate. You may wish different F keys to operate your FOs or it may be a sound decoder typically having sounds assigned to the lower numbered keys.

Whilst the physical connections (FOs) remain, their operating F keys can be changed in the decoder's software by assigning some or all to different F Keys in a process called Mapping. ESU decoders have a wide range of possibilities with their Indexed pages. Zimo decoder software has, in addition to the basic NMRA methodology, five or six different special and more convenient ways to remap functions. Other brands may only offer NMRA mapping.

| CV | F Key Number | Function Output 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 33 | Forward Headlight FL(f) | | | | | | | | | | | | | | d |
| 34 | Reverse Headlight FL(r) | | | | | | | | | | | | | d | |
| 35 | Function 1 | | | | | | | | | | | | d | | |
| 36 | Function 2 | | | | | | | | | | | d | | | |
| 37 | Function 3 | | | | | | | | | | d | | | | |
| 38 | Function 4 | | | | | | | | | d | | | | | |
| 39 | Function 5 | | | | | | | | d | | | | | | |
| 40 | Function 6 | | | | | | | d | | | | | | | |
| 41 | Function 7 | | | | | | d | | | | | | | | |
| 42 | Function 8 | | | | | d | | | | | | | | | |
| 43 | Function 9 | | | | d | | | | | | | | | | |
| 44 | Function 10 | | | d | | | | | | | | | | | |
| 45 | Function 11 | | d | | | | | | | | | | | | |
| 46 | Function 12 | d | | | | | | | | | | | | | |

Output Position vs. CV (a 'd' indicates the default position)

## SHUNT MODE

**19** Although the terminology may vary and the CVs used will differ, a few decoders offer the facility to temporarily halve the effective speed and reduce or eliminate the simulation of inertia and momentum with a single keystroke (CV3 and CV4). This can be very useful in shunting and other low speed movements as it gives finer speed control and instantaneous response to throttle changes. Simply disengage the operating key to restore your normal operating values.


## UPDATE FIRMWARE

**20** Decoders consist broadly of an array of physical components assembled according to the manufacturer's design and software which interprets the DCC signals from the controller in order to provide the required outcomes. Similarly, DCC controllers have hardware and software elements to provide both power and control signals.

This type of software is often called 'Firmware' as it is an essential part of the operational requirements, is normally provided exclusively by the manufacturer and often cannot be altered by users.

Many DCC controllers and most decoders are supplied on this basis. What you buy is what you get, offering no opportunity for improvement other than to replace them with new.

A few manufacturers supply 'future-proofed' DCC controllers or decoders or both. In these cases, the operational firmware can be updated to incorporate improved algorithms, bug fixes and, most exciting of all, new features.

The way in which this is achieved varies. A common way to update DCC controllers is to return the unit to the manufacturer or their agents for a factory upgrade. This is usually achieved by installing new hardware with upgraded/updated firmware already installed.

In some cases the equipment is designed so that the firmware can be updated by users. Improved firmware is developed by the manufacturer and distributed electronically. This is usually provided as a no cost download which is loaded to the controller or decoder. The recipient device instantly becomes the equivalent of the manufacturer's current model.

I would like to dispel the myth that this is an unimportant luxury feature only available in high cost equipment, so let me give you a couple of recent examples.

The Hornby Select DCC controller was launched as a no-frills budget DCC controller. With a limited power output, very restricted ability to programme decoders, and access to only 9 F keys many users quickly tired of the constraints and inconvenient menu structure. For a modest fee and return to Hornby, the latest firmware V1.5 can be installed. Whilst some operational constraints remain, the transformation is amazing within the limits of the original hardware. Access to all 29 F keys and a much improved menu structure make the unit far more versatile and convenient to operate. Plug in a 4A power supply and it will match the output of units costing three times as much.

Secondly, a high value in CV4 produces realistic coasting but massively increases stopping distances. If the effect of this high figure could be temporarily and conveniently removed, it would be possible to have realistic coasting *and* short stopping distance when required.

In 2014 Zimo introduced a Brake Key feature for Zimo sound decoders designed to achieve exactly that outcome. It has since become one of Zimo's most highly regarded features.

The retarding effect is progressive. The longer the brake key is engaged, the higher the brake force applied. This allows short 'dabs' for minor speed adjustments and longer durations for heavy braking. Furthermore, the effects are fully adjustable by the user so that locomotives can be modelled with very efficient or with poor brakes as desired. The Brake Key feature is now available on all new non-sound decoders with the latest firmware, even the £19 entry level MX600.

Fortunately for owners of older Zimo decoders or those with earlier software versions, all Zimo decoders have user-updateable firmware. The latest version (V37.01) brings a large number of useful improvements, including the Brake Key feature.

This 'new for old' policy can mean that the cost of ownership of upgradeable equipment may be lower in the medium to long term than one-shot budget items.