

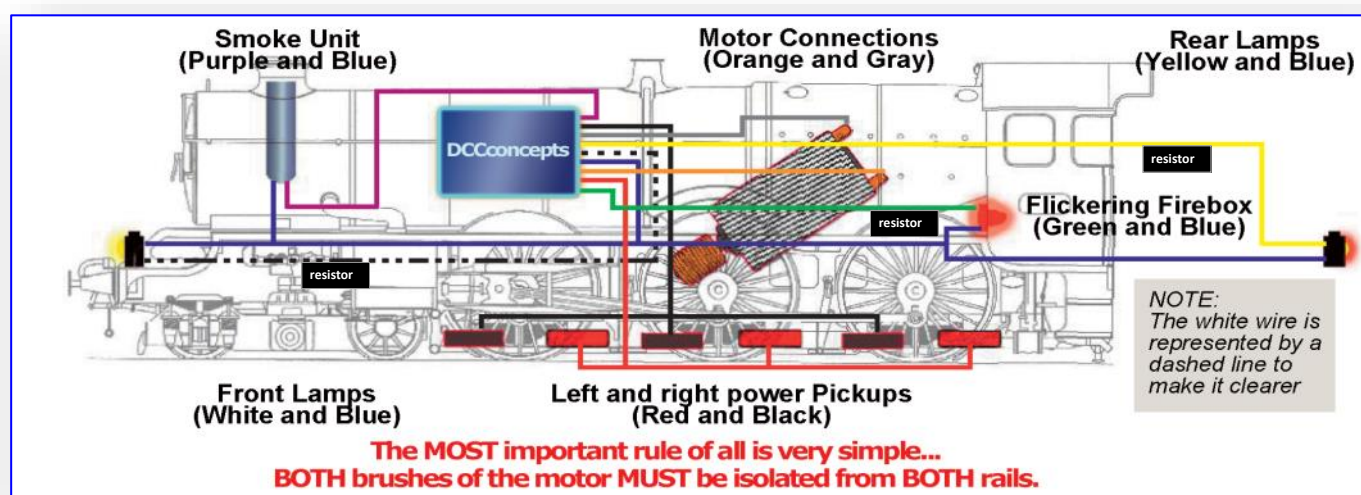
## Decoder wiring, colour codes, connections and more...

We are going to cover many common question areas in this document.

- \* Wires and their functions on Pages 1~7
- \* Standard connectors and Stay Alive on Pages 8~15
- \* Sound + speaker issues on Pages 16~20
- \* Suppression and suppressor parts on pages 21~22
- \* Install, warranty & tools on pages 23~26.

So... this document is 26+ pages long, but we'll start with a couple of generic installations.

These two drawings should prime the subject well. While they show relatively generic decoders, they show a standard approach to the wiring of a diesel or steam locomotive in OO or HO scales.



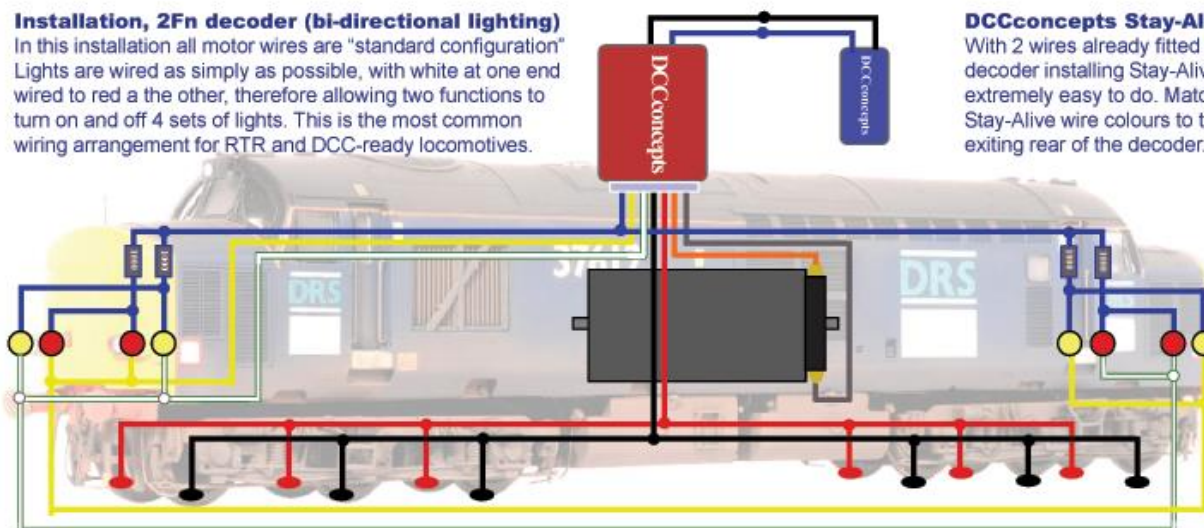
## Installation example - DCCconcepts 2 function decoder

### Installation, 2Fn decoder (bi-directional lighting)

In this installation all motor wires are "standard configuration" Lights are wired as simply as possible, with white at one end wired to red at the other, therefore allowing two functions to turn on and off 4 sets of lights. This is the most common wiring arrangement for RTR and DCC-ready locomotives.

### DCCconcepts Stay-Alive

With 2 wires already fitted to the decoder installing Stay-Alive is extremely easy to do. Match the Stay-Alive wire colours to those exiting rear of the decoder.



### Wire Colour - Motor/track connection

Red = Track pickup, Right rail (loco drivers view)  
 Black = Track pickup, Left rail (loco drivers view)  
 Orange = Motor wire, Usually top or RH brush  
 Gray = Motor wire, Usually lower or LH brush

### Wire Colour Information - Active Functions

Blue = Common positive for all light functions  
 Yellow = Rear lights - In this installation, yellow controls the front red lights  
 White = Front Lights - In this installation, white controls the front main lights  
 Lights directional and will change based on loco direction. They are turned on and off using the FO or "headlight" controller button

## Decoder wiring, colour codes and what the wires all do...

### On to the detail: first things first, what are all those coloured wires for?

Like most things, this looks complicated but it is really simple, and we are fortunate in that an excellent set of NMRA DCC and European NEM standards which are respected globally means that the coloured wires will do the same job on every decoder brand.

For those that need wire for installations, DCCconcepts stocks a full range of decoder wire.

We also have some really nice fine wire strippers and fine cutters that are excellent for working with decoder wiring and installations. You can review them by clicking images in this bulletin.

- **RED WIRE** – this is to pick up power from the track. Traditionally, this should be connected to the pickups that collect power from the RIGHT rail (That is, right from the loco driver point of view).
- **BLACK WIRE** – this is also to pick up power from the track. Traditionally this should be connected to the pickups that collect power from the LEFT rail. (That is, left from the loco driver point of view)
- **ORANGE WIRE** – this wire connects the decoders motor drive output to one of the motor brushes. (Normally this would be the right hand or top motor brush but it can vary as not all manufacturers comply with conventions).

*If the loco runs backwards when wired, swap the Orange and Grey wire (best way) OR you can also change the value in CV29 to make the loco run the other way (add 1 to the value in CV29).*

- **GREY WIRE** – this wire connects the decoders other motor drive output to the second motor brush. (Normally this is the left hand or bottom brush but it can vary as not all manufacturers comply with conventions)

*If the loco runs backwards when wired, swap the Orange and Grey wire (best way) OR you can also change the value in CV29 to make the loco run the other way (add 1 to the value in CV29).*

### A very important thing to be aware of in relation to the red, black, orange and grey wires:

Red and Black wires must **NEVER** share any form of direct electrical connection with Orange or Grey wires. Nor should Grey and Orange wires ever share a connection with pickups in any way.

Fail to check or ignore this and you will destroy your decoder immediately – The result of this contact, no matter how slight, is usually a puff of smoke and a black hole in one of the decoder ICs. Decoders damaged in this way are **NOT** covered by warranty.

### For the best way to test for a sneak path between pickups & motor brushes see page 21 (B)

- **BLUE WIRE** – this is the COMMON wire for all functions. It is used as the common return wire with all of the other accessory or lighting wires. The blue wire is always POSITIVE and is used in combination with all active functions. For example, front light = white + blue, rear light= yellow + blue.

**Please note:** there are exceptions. In tiny 6-pin direct decoders, the BLUE wire may not exist. (this is also true of our ZEN decoder ZN6D, but you CAN use the blue stay alive wire in that case)

In place of the blue wire, these decoders use the red or black wire (either, but not both) as the common return second half of the lighting / function connections. Because it is taking the ground reference from outside the decoders electronics, this method deliver only half-wave power.

When installing, you can choose to do it one way or another, but do not attempt to use a blue wire AND a red or black ground wire for lighting in the same installation or damage may occur.

**Decoders damaged in this way are NOT covered by warranty.**

**Need a blanking plug for an 8-pin NEM652 DCC-wired loco? That's a simple job!**

**Just make two U-shaped staples from wire, then place one staple between the Orange and Red sockets and the other between the Grey and Black. Sockets.**







## Decoder wiring, colour codes and what the wires all do...

*Continued...*

- **WHITE WIRE** –this is usually termed either **Function 1, FL or front light**.

To connect to this function, use the white NEGATIVE wire and the Blue POSITIVE wire. How your decoder controls this wire will be clearly stated in the instructions, but it is usually set at the decoder default to operate via function zero on your controller, and to turn headlights on ONLY when the locomotive is going forwards (Controllers often have a special second F0 marked LIGHT)

**Note:** lighting functions can be configured to have special effect, plus MANY other options.

- **YELLOW WIRE** – this is usually termed either **Function 2, FR or rear light**.

To connect it, use the Yellow NEGATIVE wire and the Blue POSITIVE wire. How your decoder controls this wire will be clearly stated in the instructions, but it is usually set at the decoder default to operate via function zero on your controller, and to turn headlights on ONLY when the loco is going backwards (Controllers often have a special second F0 marked LIGHT )

**Note:** lighting functions can be configured to have special effect, plus MANY other options.

**Note:** Rear light functions can often be used for things like firebox flicker on steam loco's.

- **GREEN WIRE** – this is usually termed either **Aux 1 or Function 3**.

It can be used for anything you wish, including lights or for powering and controlling smoke units or similar things. To connect it, use the Green NEGATIVE wire and the Blue POSITIVE wire. If you don't know its power handling, assume 100mA to be safe (check decoder instructions to be sure).

How your decoder controls this wire will be clearly stated in the instructions. As a guide, on most non-sound decoders, this will be usually be set ex-factory for operation by function 1

- **PURPLE WIRE** – this is usually termed either **Aux 2 or Function 4**.

It can be used for anything you wish, including lights or for powering and controlling smoke units or similar things. To connect it, use the Purple NEGATIVE wire and Blue POSITIVE wire. If you don't know its power handling, assume 100mA to be safe (check decoder instructions to be sure).

How your decoder controls this wire will be clearly stated in the instructions. As a guide, on most non-sound decoders, this will be usually be set ex-factory for operation by function 2

- **BROWN WIRE** – this is usually termed either **Aux 3 or Function 5**.

It can be used for anything you wish, including lights or for powering and controlling smoke units or similar things. To connect it, use the Brown NEGATIVE wire and Blue POSITIVE wire. If you don't know its power handling, assume 100mA to be safe (check decoder instructions to be sure).

How your decoder controls this wire will be clearly stated in the instructions. As a guide, on most non-sound decoders, this will be usually be set ex-factory for operation by function 3

- **PINK WIRE** – this is usually termed either **Aux 4 or Function 6**.

It can be used for anything you wish, including lights or for powering and controlling smoke units or similar things. To connect it, use the Pink NEGATIVE wire and the Blue POSITIVE wire.

If you don't know its power handling, assume 100mA to be safe (check decoder instructions to be sure). How your decoder controls this wire will be clearly stated in the decoder instructions. As a guide, on most non-sound decoders, this will be usually be set ex-factory for operation by function 4.

**When installing decoder, good tools really help. This is the business-end of DCCconcepts' fine wire stripper. The ability to set and lock the stripper gap means that even the finest wires can be stripped cleanly, improving installation quality.**





## Decoder wiring, colour codes and what the wires all do...

*Continued...*

Sometimes... decoders have other wires for added functionality or different purposes. Here is a general overview of a few of them that are commonly used.

### **SECONDARY WIRING or non-standard decoder wiring:**

Sometimes manufacturers will add other wires to do other things, and because there are only so many wire colours they may well be the same as those in the main harness. Here are some examples.

- **BLUE and BLACK Pair:** DCCconcepts decoders, including the Zen range, have two wires coming out of them, usually placed at the end opposite the main wiring harness. (on Zen Buddha large scale decoders, there is a 2-pin socket for a small 2-wire Blue and Black harness). These wires are for connecting the decoder to the "Stay Alive" that we include with our decoders. Just match these wires to the blue and black wires that are fitted to our Stay Alives. You CAN parallel up to 3 stay alive units safely, however they MUST all be identical and while this will increase the stay-alive performance, be ware that it may increase the load on the decoder so that it will no longer be readable on the programming track. If so, disconnect them to program.
- **Twin BROWN wires:** Most sound decoder manufacturers use two BROWN wires for the speaker connections. Unless more than one speaker is used, it does not matter which wire goes to which terminal on the speaker. When more than one speaker is used, it DOES matter and we have covered wiring multiple speakers later in this document on page **16**
- **STRIPED BLACK wire:** Some brands use this as the negative side of a stay alive connection but this is not consistent, so check the specific decoder manual to be sure.

**There are a few other exceptions from decoder manufacturers - so for other brands of decoders, please always be sure to check the instructions included with the decoder rather than guessing.**

### **By the way, decoders may always follow standards... but sadly, locomotives are another story.**

Unfortunately... Locomotive makers of rarely ever follow the DCC wiring standards for wire colour when making their locomotives, even if they are adding "DCC-ready" sockets!

In fact, most brands simply use black for everything, so if you want to hard-wire a decoder, you'll have to trace the wiring or replace it totally if you want colour coding consistency throughout your fleet.

### **Wire for installations... what sort of wire, which wire to use... when?**

**Installations are usually done using stranded wire of approximately 32 gauge. However, while that is the common choice for most of us, its not always the best choice!**

Experienced decoder installers know that sometimes, its better to use a less flexible wire that stays put when you wire a loco, rather than the flexible wire that most modellers use all of the time.

This is especially useful when doing installation work in smaller locos or in N scale where space is a premium as a stiffer wire does not move and get in the way - or perhaps get chafed by being jammed between chassis and body or get in the way and stop the body going on-and-off easily.

DCCconcepts therefore offer not only the complete colour range in 32 gauge... we also have some top quality silver-plated "Kynar wire" for tight spaces and complex install work... and if that is not fine enough, we also offer enamel coated copper wire down to a ultimately small, super-fine 0.1mm (0.12mm over the enamel insulation) for where there is NO spare space... or where the wiring needs to be invisible for loco footplate wires or similar detail installations!

**We cover the DCCconcepts wire range and some really helpful wiring items on the next 2 pages.**

## Decoder wiring, colour codes and what the wires all do...

*Continued...*

**CLICK on the pictures to see more and find pricing!**

### Top quality 32 gauge decoder wire in all colours >

**The best general-use decoder wire is stranded and should also be reasonably flexible, but not floppy!**

Each pack contains 6 metres of wire, all colours available and some twin-wire so you can buy any colour you may need. 6m is enough for lots and lots of installations. You can buy each colour separately OR in a pack that includes the most common ten colours and save.



### < Solid copper silver plated KYNAR wire with hard, thin insulation

**Sometimes, especially in smaller locos or N scale etc., you really need a wire that will stay where it is put.** KYNAR wire was originally created for high-end circuit prototyping and is expensive, but it can easily make tight installations MUCH easier because when you dress it along a loco chassis, it will stay where you put it. The insulation loves superglue too, so you can fix it in place with a tiny drop. Super stuff!



### High precision wire strippers >

**We had these made for us based on some I'd used for 20+ years.** We also added a second stripping groove and a sharp cutting edge between them for neat wire trimming that my original didn't have! These are the ultimate stripper for fine work. The locking adjustment lets you set them in any position so you are guaranteed to strip only the insulation, not the core. Adjustment is so fine you can take the strip size as high as 3mm - or as small as 0.1mm.



### < Twinned decoder wire.

**Tidiness pays off, and running the pickup wires as a twin wire keeps them clearly identifiable, especially in complex installs where the loco and tender are both involved.** This has been so successful for us in our own installations that we have introduced many more twin wire variants, for example, white + blue, yellow + blue and more.



### The slightly quirky "Weight-Mate" weight bag >

**The Weight-Mate is based on something we made to help us with our own installation work.**

Made from a soft velvet bag & containing 500 grams (over 1lb) of fine but heavy shot, it is an invaluable aid for programming, especially for smaller locos in OO or HO and it is super-helpful for N scale.

It guarantees good program track contact for first time programming every time! Only c.£1 more than the same weight in shot, it's a "no-risk" tool to try as if you don't like using it, you unpick the seam and use the shot inside to add weight to your locomotives!

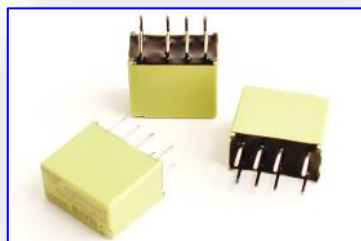




## Decoder wiring, colour codes and what the wires all do...

Continued...

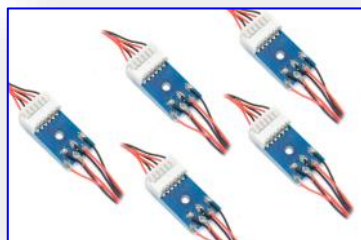
**CLICK on the pictures to see more and find out about pricing!**



**< Top quality, TINY DPDT micro relay, both latching and standard**  
**Adding a relay increases function versatility and makes it possible to do things not possible any other way.** You can also use a relay to switch more power than a decoder function could ever handle. These quality relays are only 10.6 x 5.6 x 8.6mm. - Perfect for DCC installation switching or other forms of control. **Gold contacts with a 1 amp rating.**

### **6-way connectors for installations between loco and tender >**

**Perfect for connections between body and chassis or locomotive and tender.** These connectors are at the same fine spacing as NEM651 6-way decoders so can be used either for lighting or as a plug and socket for 6 pin decoder installation.



### **< 4-way connectors for installations between loco and tender**

**Perfect for connections between body and chassis or locomotive and tender.** These connectors can be split into 2x 2-way connections for separation of loco chassis and body when installing lighting. They make tidy installations easier.

### **A 12 pack of Installation PCBs 25x10mm with fixing screws >**

**If you have ever done a hard-wires sound decoder installation, you will understand why we made these.** Twelve really handy mini PCBs to help you keep complex installations neat and tidy. Supplied with 24 screws. **Can also be fixed with glue or double sided tape.**

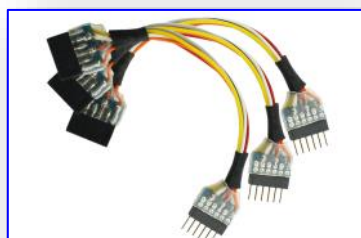


### **< Heat Shrink, Assorted Colours (36 Pack)**

**This is the key item that makes reliable installations possible...** An assorted pack of 36pcs total covering all small heat-shrink colours. Fine heat-shrink is essential for decoder installations. There is enough in one pack for well over 150 joints. **Also in red, black or clear.**

### **Kapton Tape, 33metres of 8mm wide super-thin insulating tape >**

**Kapton is extremely thin but also very hard.** Therefore it makes the perfect insulation tape for decoder installations needing good quality insulation without bulk. Great for insulating connections from the chassis or adding "insurance" in tight spaces too. **Fantastic value!**



### **< A range of useful harnesses in packs of 3.**

**Usable for far more than just decoder installations...** They'll give you a handy way to do neat installations without wires running everywhere. MUCH tidier than adding a separated socket, if you wire in one of these you'll be DCC-ready without much effort! **Wide range available.**



## Decoder wiring, colour codes and what the wires all do...

*Continued...*

### **Some comments about decoder and function power:**

**Decoder power ratings are a little deceptive. Just because a decoder has a rating of 1 amp does NOT mean you can load it at 1 amp long term and expect it to survive.**

Think of the decoder like a car motor. No matter who makes a car, or how powerful it is, if you do try to extract its maximum RPM ability or horse-power constantly, then it WILL very quickly break.

**So - 1 amp means "1 amp just for a moment" - NOT long term!**

Hold the limit of power for much longer and heat will build up, blowing key parts like the rectifiers, and this will result in the meltdown some of you have seen in the past... and any failure that causes heat damage can only come from short circuits or overloads, so it is never warranty!

**This is by the way made more of an issue by the way makers specify their decoders... most of them exaggerate somewhat unfortunately when they claim "1 amp" ability.**

The critical part that carries ALL of the load is always the bridge rectifier, which may be either 4 diodes or one "diode bridge". If you look up the part numbers that are used for the bridge rectifier you will find that it is very often rated at only 500mA to 700mA in even the best decoder... so DO be conservative in loading, as any more than a few seconds at "full rated power" and it WILL be toast!

(Our background is in high end electronics so we are somewhat more conservative in rating all of our products. We therefore rate Zen decoders at 750mA or 3/4 of an amp even though they use the same parts as other brands which unfortunately claim 1 amp power rating). This still of course more than enough for all N, OO, HO or On30 locos, and not a few efficient O scale locos too!

**Power handling is NOT just how much current the motor drive will take!**

**It is important that you understand quite clearly that ANY decoders power rating is the overall total of the motor drive PLUS any current that is drawn by any active functions...**

### **Example:**

Decoder rating 750mA or 3/4 of an amp.

Allow 300mA for a low quality inefficient locomotive motor and if the decoder has 4 functions, that leaves only 100mA for each of them... and you are already at 700mA...

Of course most locos draw 120mA or so, so its not an issue - BUT - if you DO have a current-hungry locomotive, loading down the other functions with smoke units and the like may not be a good idea!

If faced with this situation, it is better to let the decoder ONLY power the motor, and add a second "lighting only" decoder to take care of the light functions. Give them both the same number and once installed you will never notice there are two of them as operation will be the same as for one decoder!

### **Getting more from function power:**

Sometimes, things like smoke units need more power than one function can deliver, so what do you do?

If the item you want to power needs more than one functions rating (and if you do not know what the function rating really is please use 100mA as a conservative guide) you can still do it - just parallel two functions to make ONE higher power function.

i.e. Green AND Purple to one side of the smoke unit, Blue to the other side.

When wiring up two functions like that, you should also always re-map (re-allocate) the control of the wires you used to a single function button so that they always turn on and off at the same time.

**(We explain function-mapping in DCC advice article #13, which is all about configuring and setting CVs. We'll base advice there on OUR decoders but it will apply to many brands. Some CV numbers may vary, so if setting brands other than DCCconcepts or Zen, check the manual!)**

## Decoder "Standard connectors" and Stay-Alives...

*Continued...*

**We have covered wire colours and wire types, so now it is time to tell you about the range of standard NMRA/NEM compliant connectors... and to detail a few oddball choices made by Brands like Hornby and Bachmann in their UK prototype models.**

Like wire colours, the American NMRA and European NEM standards also cover connections for DCC installations. ... these are generally followed by loco makers, with a few odd and quite unnecessary and annoying exceptions which have been introduced by some UK brands for no sensible reason!

There are several approved connectors that you will come across.

- For N scale and some TT, OO and HO locomotives, the NEM-651 SIX pin connector
- For OO and HO scale (and On30) the NEM652 EIGHT pin connector
- For OO and HO the 21MTC 21 pin connector.
- For all scales, variants of the PLUX connector, which can be 8, 12, 16 or 22 pins.

### **The 6 PIN NEM651 or "Small NMRA Connector":**

**The small 6-pin connector was originally created for N scale but is now sometimes also used in EU for HO scale (mostly by Fleischmann) and in English OO in small locomotives by Bachmann.**

It has a current rating of 0.5 Amp continuous, 0.75 Amp peak so, to be frank, I believe Fleischmann may be in error using it as their heavy 3 pole motors are very capable of exceeding these levels!

This connector is unique in that it offers no BLUE wire for accessory functions. Accessories or lights must connect to the appropriate function wire plus either the red or black wires. This gives half-wave rectified power and not full power as with installations that use the blue positive ground wire.

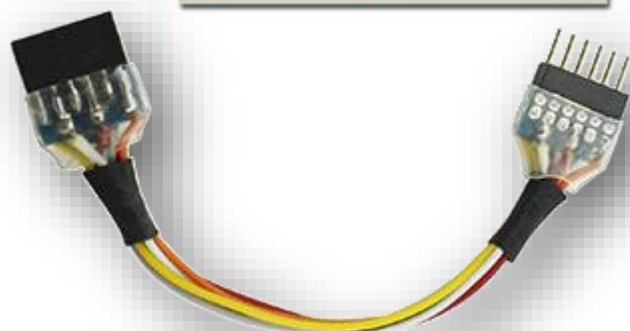
The drawing below shows the pin-out numbering looking into the socket of the connection system, as you would see it if the loco is DCC ready. The images show you what it should look like.

**Which way is up?** Uniquely among connectors that meet the standards, this plug has no natural orientation. In general the TOP of the decoder should face you as you insert it.

On DCCconcepts Zen decoders this is the side with the Zen logo - on European decoders (which very often have no heat-shrink on them) "which side is up" is not always very obvious.

Just try if you are not sure... nothing will work if it is upside down. Just reverse it if needed!

**The NEM-651 connector  
(looking at the plug face)**



**A useful NEM-651 harness  
6-pin male to 6-pin Female**

**Zen 6-pin ZN6D decoder**





## Decoder "Standard connectors" and Stay-Alives...

*Continued...*

### Pin configuration for the 6-PIN NEM651 (small NMRA connector):



#### The colour codes for this connector are as follows:

- **ORANGE (1)** Motor wire (by convention, right or upper brush of motor). Often marked with a star.
- **GREY (2)** Motor Wire (by convention, left or lower brush of motor)
- **RED (3)** Track power pickup wire (By convention, this wire should be attached to the pickup wire etc. that collects power from the RIGHT rail)
- **BLACK (4)** Track power pickup wire (By convention, this wire should be attached to the pickup wire etc. that collects power from the LEFT rail)
- **WHITE (5)** Accessory - Always front Light, switchable usually by F0 by default. (White and yellow are usually also set up to act only in the direction of travel to act as front/rear lights automatically. With good quality decoders the function allocated can be changed if needed).
- **YELLOW (6)** Accessory - Always rear light, switched usually by F0 by default. The yellow wire is the negative in any circuit. (White and yellow are usually also set up to act only in the direction of travel to act as front/rear lights automatically. With good quality decoders the function allocated can be changed if needed).

#### As mentioned, the NEM-651 connector does NOT include the common positive blue wire!

This done to save space in N scale where the absence of one wire makes life much easier. It is less helpful in OO or HO though. If you want lights you either have to wire lights for half wave operation by connecting one side of the LED or bulb to the white or yellow and the other to the chassis....

**Or:... you can use a DCCconcepts ZEN ZN6D decoder. The blue wire that is attached to this decoder to use with the Stay-Alive can double-up as a common positive function wire!**

### The 8-PIN NEM652 (Medium NMRA Connector):

This is the one most people call the NMRA plug. it is also called the NEM 652 Medium connector for HO scale and larger. It is the most common of all connectors and is found across the world. It is configured with two rows of four pins spaced at 0.1" apart. It is suitable for applications up to 1.5 Amps continuous current applications with a 3 Amps peak.

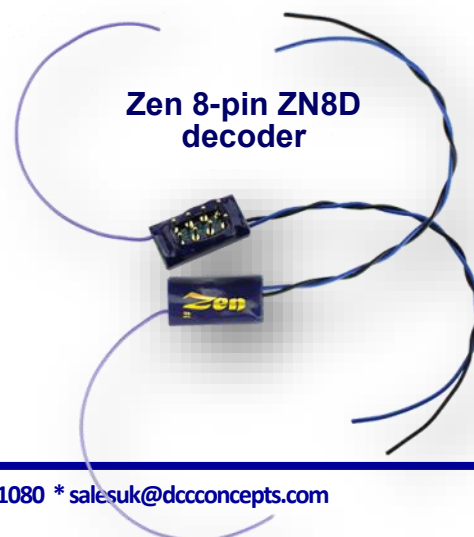
The design is clever in that if you insert the plug backwards, then no harm will come to the decoder.... Its easy to know when you get it wrong - if your loco runs backwards instead of forwards and the lights do not work as you expect... you have it in backwards!

The drawing below shows the pattern and pin-out numbering as if you are looking down on to the socket or at the wires on the top of the plug (the view you see on a DCC ready loco).



**Inset at right... the VERY small 4-function Zen direct decoder.**

**The ZN8D is literally only the same size as the blanking plug. It is the world's smallest 8-pin direct-plug decoder and we are sure that it will fit ANY 8-pin locomotive you may buy!**



## Decoder "Standard connectors" and Stay-Alives...

*Continued...*

### Pin configuration for the 8PIN NEM652 (medium NMRA connector):



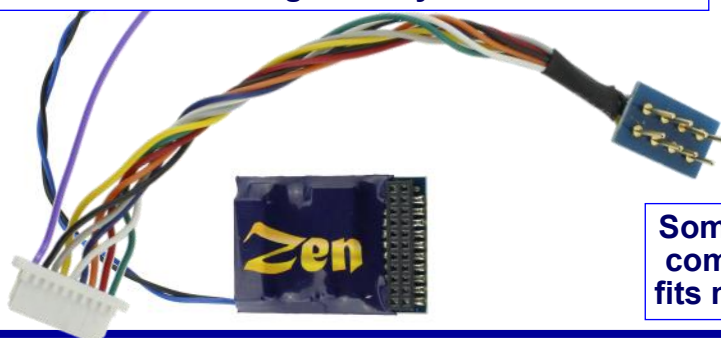
### The drawing above shows the face of the 8 pin socket:

The drawing shows the face of the socket for this connector, as wired to the loco. The decoder has the plug fitted to its harness. The drawing above shows the colour and number for each connector pin. Where there are other wires (commonly an additional free purple wire) this will need to be hard-wired.

### The colour codes for this connector are as follows:

- **ORANGE (1)** Motor wire (by convention, right or upper brush of motor). Often marked with a star.
- **YELLOW (2)** Accessory - Always **rear light by default** (usually controlled by F0 by default). The yellow wire is the negative in any circuit. White and yellow are usually also set up to act only in the direction of travel to act as front/rear lights automatically. With good quality decoders the way the light operates and which function it is controlled by can be changed if needed.
- **GREEN (3)** Accessory - optional, and found only on decoders with more than two lighting functions. It is usually switched by the function 1 button by default. The green wire is also the negative in any circuit. White and yellow are usually also set up to act only in the direction of travel to act as front/rear lights automatically. With good quality decoders the way the light operates and which function it is controlled by can be changed if needed.
- **BLACK (4)** this wire attaches to the pickups to transfer power from the track to the decoder. usually, the black wire is connected to the pickups that collect power from the LEFT rail (That is, left rail from the loco drivers point of view).
- **GREY (5)** Motor Wire (by convention, left or lower brush of motor)
- **WHITE (6)** Accessory - Always **front light by default** (Usually controlled by F0 by default). The yellow wire is, again, the negative in any circuit. White and yellow are usually also set up to act only in the direction of travel to act as front/rear lights automatically. With good quality decoders the way the light operates and which function it is controlled by can be changed if needed.
- **BLUE (7)** This is the **Common POSITIVE for ALL accessory functions** of the decoder.
- **RED (8)** This wire attaches to the pickups to transfer power from the track to the decoder. usually, the red wire is connected to the pickups that collect power from the RIGHT rail (that is, right rail from the loco drivers point of view).

The ZN218 decoder. It has a full NEM652 8-pin harness, but it also incorporates a full 21 pin MTC interface making it a very useful decoder!



Sometimes wires just get in the way. Zen360 is a compact direct-plug 8-pin NEM652 decoder that fits most locos irrespective of socket orientation.

## Decoder "Standard connectors" and Stay-Alives...

*Continued...*

### Pin configuration for the "21 pin MTC" Direct-plug Connector:



VCC	Controller internal VCC	12		11	NO Pin	Coding or registration
AUX 3	Output 5	13		10	LS	Loudspeaker Terminal B
AUX 2	Output 4	14		9	LS	Loudspeaker Terminal A
AUX 1	Output 3	15		8	FRONT LIGHT	Output 1 / Front Light
V+	Controller Plus (behind rectifier / Blue)	16		7	REAR LIGHT	Output 2 / Rear Light
MOTOR 3	Motor Output 3	17		6	TBDTA	Train BUS - Data Line
MOTOR 2 MR	Motor Output 2	18		5	TBCLK	Train BUS - Clock Line
MOTOR 1 MF	Motor Output 1	19		4	AUX 4	Output 6 / Pick-up control
GND	Controller GND (Behind rectifier)	20		3	HALL 3	Hall Sensor #3
TRACK LEFT	2 Railtrack Left/3 rail outside rails	21		2	HALL 2	Hall Sensor #2
Track Right	2 Railtrack Right/3 rail centre rail	22		1	HALL 1	Hall Sensor #1

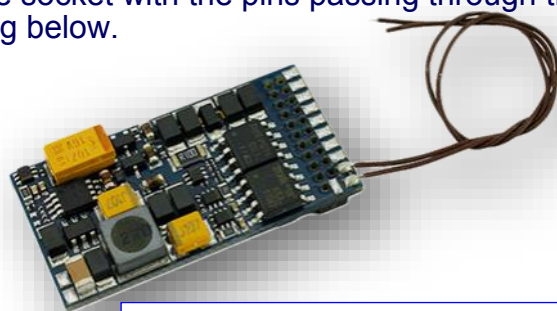
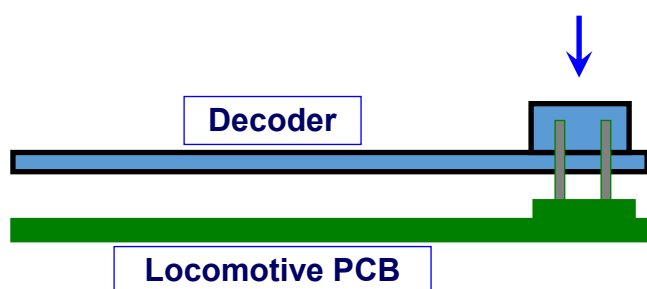
### The drawing above shows the pin allocations of this connector, from above:

The drawing shows the face of a 21MTC connector as viewed from the top of the decoder. The purpose of each connector position is clearly indicated. To further clarify things, we've added coloured squares in appropriate wire colours to the pin positions.

The male 21MTC is always pre-fitted onto a PCB which is actually part of the locomotive itself and there are therefore NO wires to worry about with this connector, as the decoder is simply fitted directly to the 21MTC male plug that is part of the locomotives ex-factory wiring.

### Orientation of this decoder:

Note pin 11, which is a blank position with NO hole. (The red/blue circle above) Look carefully and you will see there is no pin at the # 11 position on the loco. This establishes the orientation of the decoder in the locomotive. The 21MTC decoder is fitted directly to the socket with the pins passing through the decoder PCB and up into the connector as per the drawing below.



The real thing from ESU, to show the 21 MTC connector

### This connector allows for many more connections than most need:

**Background of the 21MTC connector:** This connector was never really planned for - it came about when ESU were creating a new Marklin decoder series (MFX) and Marklin needed also something with more pins to accommodate their 3 wire C-sine motor plus other functions.

It was quite quickly adopted by several other ESU clients including Bachmann, and can be found in all continents now - especially in UK and Europe where many brands use it. The 21MTC has gone global now. In USA it appears in Bachmann and PCM.

### This is the 21MTC logo

it should appear on the box of any locomotive that has this DCC connector installed.





## Decoder "Standard connectors" and Stay-Alives...

*Continued...*

### Summarising the 21MTC connector:

While not initially an approved connector, it was, after some discussion, added to the NMRA approved connector list and given formal NEM recognition, and is part of many locos in many brands, so it is very much "here to stay" for now.

The core concept of the 21MTC connector was good in that there are more digital control possibilities than the 8-pin plug allowed - but its application is not necessarily the best that could have been created as it has some shortcomings.

NMRA connectors are usually designed to "save" decoders and electronics if incorrectly used (the 8 and 6 pin for example can be inserted backwards with no loco or decoder damage - but the 21 pin cannot. If you force it in backwards, you WILL damage the decoder! )

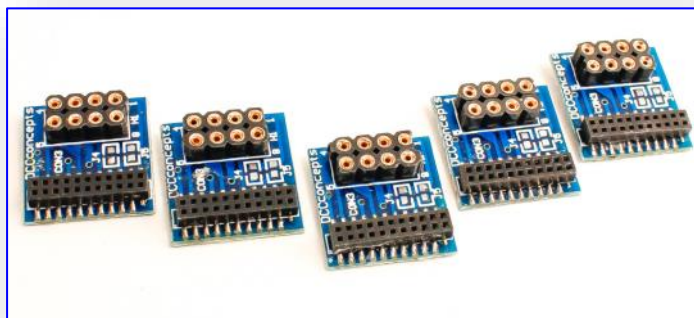
So... in time, this connector will possibly be superseded by the PLUX 22 that we review next. This is a connection structure which uses an almost identical with a differently placed "blanking pin" and quite different pin allocations designed to allow "sub-sets" of 22, 16, 12 or 8 pins to be used, depending on loco needs and decoder function availability.

### What do you do if you have a 21 pin locomotive and an 8 pin decoder you wish to use?

The 21 pin is a totally no-wire concept. However, if your loco is 21-pin and you have a favourite brand of decoder, you'll need an adapter.

DCCconcepts have therefore designed a simple , easy to use and economical 21 pin to 8 pin adapter. That connects up to 4 functions (sold in packs of 5)

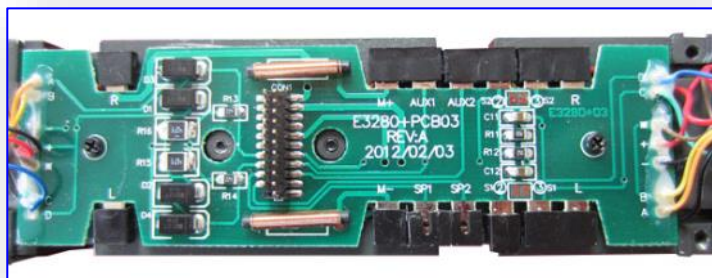
**Click on the image for more details!** It simply plugs onto the loco 21 pin plug, and you then push the 8-pin plug into it, completing the installation.



### A diesel Loco PCB with a 21 pin connector.

You can also clearly see the 2 inductors here. They can be replaced with a bit of wire!

Please note the black rubber push-connectors on each side of the PCB. It is our experience that if you take the time to solder the wires to the PCB instead of relying on them, you will end up with a neater and more reliable installation!



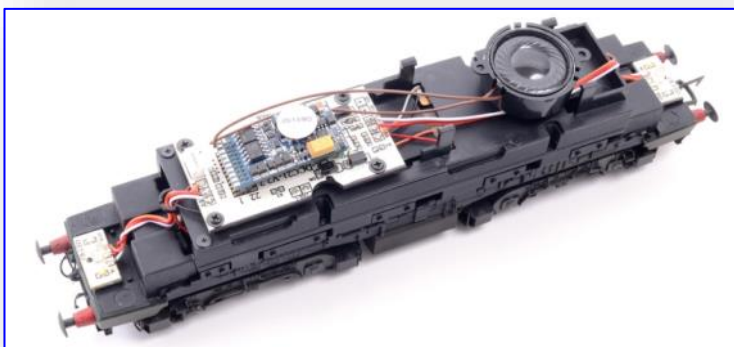
### A diesel Loco PCB with a 21 pin connector.

Another example, this time with decoder fitted.

I made comment earlier about the messy wiring we usually find in Hornby steam locomotives.

I also like to give credit when it is due and this Hornby loco's wiring is exactly the opposite

Neat, tidy and well put arranged. Really nice.



## Decoder "Standard connectors" and Stay-Alives...

*Continued...*

### **PLUX 22 - The newest 22 PIN "recommended wireless NMRA and NEM Connector".**

The size and shape of the PLUX - 22 connector is exactly the same as the 21pin MTC connector and it is simply placed on the PCB in the same way - with two big differences.

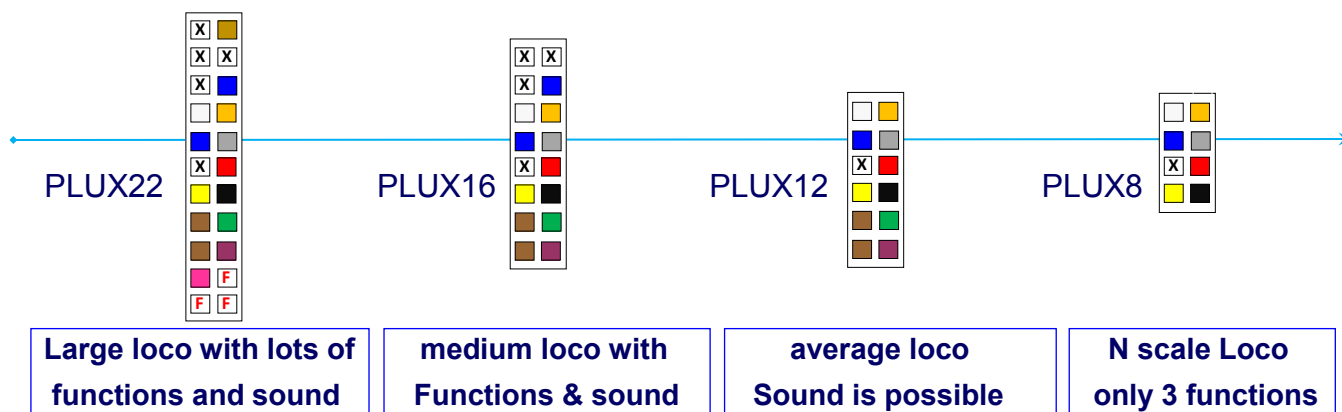
**(1) There is NO blanking plug position.**

**(2) The connector in the loco is the socket (21MTC has the pins in the loco)**

However, as you can see from the images below, there is now a sensible set of combinations possible within the overall 22 pin geometry.

Left to right, we show 22 pins, 16, 12 and 8 pin variants, all "sub-sets" of the same connections. All have variants common positions for core functions, something that's impossible with a 21MTC connector.

It is out there now having been detailed several years ago, but its proliferation is actually quite slow.



### **The "Pain in the Butt" Hornby 4-pin connector:**

**This is used in the Sentinel and some other locos** - I have no idea what Hornby were thinking about when they did this but it certainly wasn't their clients. A 6-pin NEM651 would have been ideal as a 6-pin decoder could then be fitted. We suspect Hornby just want to sell their own with a special harness!

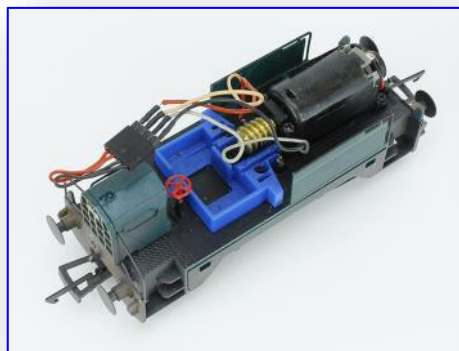
We'd considered making an adapter harness but when we opened it up, the wiring was... horrible!

**How can they add so much untidy wiring inside a tiny loco that's already short of space!**

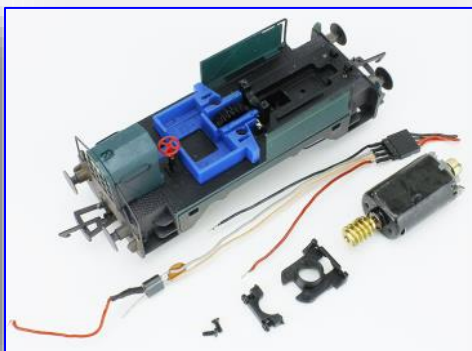
So - we recommend just taking out ALL of Hornby's messy wiring and doing it as follows.

**That will also be the quickest and easiest way for most modellers... as well as being tidier!**

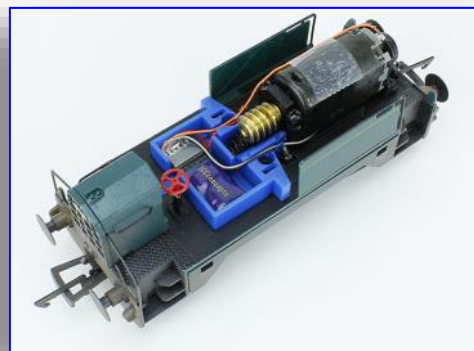
We used our Zen ZN6H decoder and an NEM651 harness for this job... easy! The photo's tell the story!



AS DELIVERED. Messy with wires much too long and a non-standard 4-Pin plug



90 seconds: All that it took to remove 4 screws, remove motor & messy wires!



10 minutes more: harness cut, soldered in, wires dressed and motor re-installed.



## Decoder "Standard connectors" and Stay-Alives...

*Continued...*

**If your locomotive does not have ANY form of socket, do not worry.**

Just cut off the 8 pin plug, then simply follow the general wiring guides on Page 1 and hard-wire your decoder to your locomotive. Make sure that any joins in the wire are protected with fine heat-shrink (see pages 5 and 6) that will prevent short circuits that will inevitably cause damage to your decoders.

When hard-wiring your decoder it is best to trim all wires to the correct lengths, carefully strip, tin and trim to length before attaching. Work tidily and take your time!

**It always seems a good idea to new DCC users... but don't!** We do not recommend adding DCC sockets to locomotives that do not have them as it is unnecessary work and only adds to the potential for problems unless soldering skills are good.

It also needs a secure way to mount the socket, which takes a surprisingly large amount of room.

**If you really, REALLY want to do it... there is an easier way.** Many of our already have a separate harness with a plug-in socket at the decoder end, so the addition of a second socket really is unnecessary (for example, take a look at the versatile ZN6H or ZN218).

**Just cut off the loco-end plug and hard wire the harness in place, then plug it into the decoder!** So - if you think about it - an additional connector is not needed! Common sense also says that hard-wiring a non DCC-ready loco will end up tidier and take less space, so why double up on the work?

~~~~~

## The DCCconcepts STAY - ALIVE™ and similar devices

### What is a "Stay-Alive"?

"Stay-Alive" is the name used by DCCconcepts. They are also called "Current keeper", "Keep alive", "Power pack" etc. by various decoder brands, in reality they are all similar types of devices designed to act as reserve power storage ready to act when your loco loses track power.

**Are they all the same? No... there are both 3-wire and 2-wire types.**

**ESU and Lenz both make a 3-wire stay alive.**

The device itself is slightly larger and much thicker than an average decoder. The 3 wires that come out of them are a ground wire, a main power wire for decoder motor drive and other circuits (sound and lighting) and a second power wire which only feeds the micro-processor of the decoder.

They can be difficult for the average modeller to install, as the 3 wires need soldering to 3 tiny solder pads on the decoder. Mistakes can be costly as, because you are soldering something to the PCB, there is NO warranty if you make a mistake. A bit of a Catch-22 for the average modeller!

These are, however, the most sophisticated types and are as a result, very expensive. In both cases, the 3-wire stay-alive is actually MORE expensive than the high-end motor drive decoders sold by ESU and Lenz, so that sophistication has a very high cost indeed!

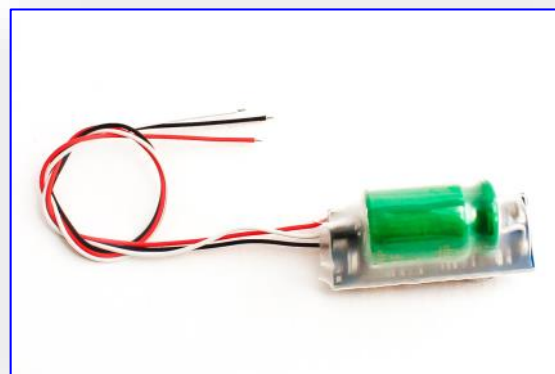
### Do they work?

Yes, they do.

We often fit the ESU power Pack to ESU sound decoders that we install and it does work well, totally eliminating sound resets and preventing locomotive stalling.

However it DOES take care in installation, space can be hard to find especially in smaller locos and the cost is high... but they DO at least deliver what they promise.

**ESU's Power-pack is available from DCCconcepts.**



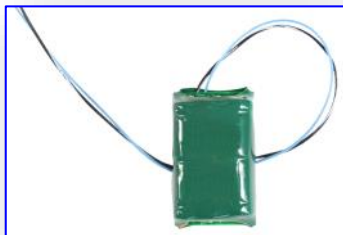


## Decoder "Standard connectors" and Stay-Alives...

*Continued...*

### Several Brands also make a 2-wire stay alive.

The two wires of this kind of stay-alive connect to the decoder PCB's "DC Negative" and the "Positive ground wire" which is the + DC terminal on the decoder-side of the rectifier.



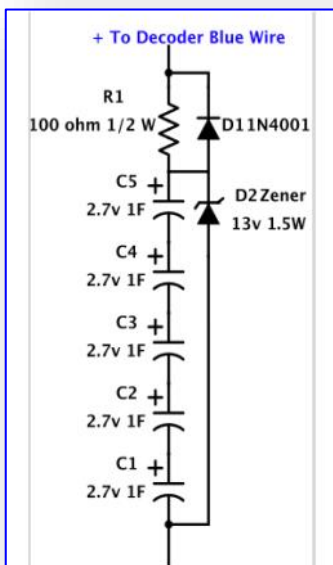
The + DC wire is easy as it is the same as the blue function common wire, however the DC - (negative) wire is harder... it must go to the anode of the two input diodes that are connected to the track input.



**Get this wrong and you may end up with a dead decoder and of course, there will be no warranty, so be careful please.**

Once you have it connected and the wires are in the right place... the "Stay-Alive" device is designed to store power ready for the moment that the locomotive fails to make good contact with the track.

When this happens, the decoder can draw on the stored power that is available in the "Stay-Alive" and keep operating properly.



**There is a second, even MORE important thing Stay-Alives can do for running quality.**

When a loco runs very slowly, you'll sometimes see that it starts to "cog" or stutter a little.

This is in part due to the cogging of the motor but this is not the whole story.

It is also in part due to constant "brown-outs" that turn the decoder on and off. This on-and-off power, in turn, makes the Back EMF reading inaccurate and creates tiny surges that are visible in the loco movement.

Adding a "Stay-Alive" will smooth this out, and adds greatly to the smoothness of locomotive running at slow speeds. We at DCCconcepts think that this "brownout prevention" is the biggest and best advantage of adding Stay-Alives.

### What is a Stay-Alive made from?

Structurally, a Stay-Alive is formed of several parts all neatly arranged on a tiny PCB so that it takes up very little space and so there is always somewhere you can find to install it in all but the tiniest of locomotives.



**The image above / at left shows a basic Stay-Alive circuit diagram. In this case, a number of 2.7V 1 farad "Super capacitors" are used in series to give it enough voltage tolerance to use on DCC.**

By all means have a go at creating your own - but please DO be quite careful. If you do get it wrong, the electrolytic capacitors can explode quite suddenly and with nearly as much energy as a small bullet!

### How long should a Stay-Alive power the locomotive?

Other brands make Stay-Alives that WILL run locos for a couple of seconds, however, because they use super-capacitors, they ARE expensive - about the same price as the average Decoder.

DCCconcepts feel that cost matters to you, pickups should be adjusted properly and track wired properly, with live-frog points used everywhere to give best performance. For this reason we generally make our Stay-Alives with the primary purpose of eliminating brown-outs at slow speed. Therefore, the Stay-Alives we pack with our decoders use high end ceramic capacitors to keep the Stay-alive small and of course smooth our running beautifully, but they will only run the motor for fractions of a second.

**HOWEVER - DCCconcepts DO listen to customers and for those who have asked us to also make a larger "Stay-Alive" there's good news - we now have the "Super Stay Alive" !**

## Sound and a general speaker installation overview

*Continued...*

### **It is time to talk a little about sound decoders, speakers and their installation**

**Sound can add a really nice "added detail level" to a well built layout, making a good layout great... or done badly, it can simply destroy the believability of the whole thing...**

However sound generates more emotion in modeller discussions than most things. We think this is because sound is like impressions of colour, so they are specific to the individual... and only as good as their memory. What makes a sound file great to one may simply annoy another... so who is to judge?

The people at DCCconcepts have worked in "real-world high-end sound" for many, many years and so technically, we know more than most... but YOUR ears tell the story to you, so we will not try to indulge ourselves in "what's good and what is not" issues here.. we will just tell it as we see it.

**First, lets get rid of some of the total BS that is often mentioned in relation to on-board sound, nonsense promulgated about the speakers used in DCC-sound installations and issues relating to DCC sound decoder specifications in general.**

**The sound files:** Lots of mumbo-jumbo and loads of BS is offered by self-professed experts.

An older analog recording that has been properly "sound sweetened" and a new digital recording can BOTH sound really great and you will NEVER hear the difference.

What matters FAR more at stage 1 is the skill of the person who assembles the sound file, combined with the technical performance of the sound decoder.

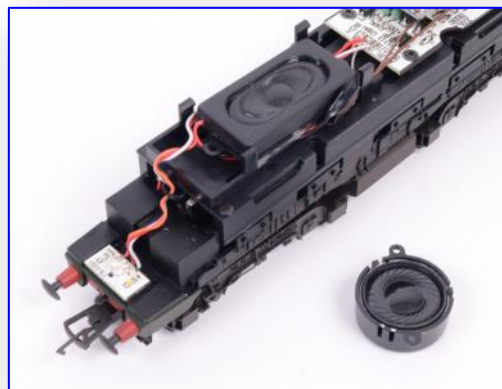
The most important thing however is the quality of the installation. How speakers are chosen and where they are put, how well the boxes are designed and how the system is wired ALL matter greatly... as does the design of the loco body and how we work with it to get the best from the sound potential of the decoder and sound file. Good work will give great results, just throwing it in will sound as it deserves.

**Speaker Bass response:** Actually, until you get to Gauge 1, there is NO BASS from any speaker!

They can call them enhanced or high bass or whatever they want. The simple truth is, they all lose energy and roll-off at around 300hz, even the good ones. That is in the lower mid range and we haven't even got to bass frequencies yet!. What the supposedly miracle speakers do is add an artificial peak between 250 and 300 Hz that makes them louder at those frequencies.. NOT lower in frequency response. Even the poorer speakers (and there ARE some) can sound much better - even perhaps good - but only if the enclosure they are used in is properly designed & they are also matched properly to the decoder!

**Sound decoder power output:** Lots of marketing hype... but X, Y or Z watts... they are actually all close to the same... some brands just stretch the laws of physics more than the others really.

What REALLY matters is properly matching speakers and using the laws of physics properly to get the best of what you have... and the difference can be spectacular. What works in works in the real world... also works well with tiny stuff like model train sound... so if you make the effort to get it right, you can usually get a great result! System balance is MORE important than power. For example, while we now have huge sound systems in movie theatres, the same sized theatres once used only 5 Watts RMS per channel... and they still sounded loud! Back then speaker design HAD to be good because big Amps didn't exist! We can learn from this in train sound! **ONE rule you should follow:** The last 10% of volume adds more distortion than it does output level, so NEVER run a sound file at more than 90% of the available maximum and you will always keep it sounding at its best at low distortion levels. Speakers last better too as distortion = heat ...and heat kills!



## Sound and a general speaker installation overview

*Continued...*

**Enough background... do the research. Here are some simple "speaker facts"**

**Speaker boxes:** It is perhaps not understood by most, but given the "Thiell Small" parameters of a loudspeaker (google "Thiell Small" to learn more), you can actually calculate the perfect speaker box design for almost ANY loudspeaker and make it as good as it can ever be performance wise.

Likewise, take any combination of speaker box and room... plus a measuring tape - and the position at which it should be placed for "best sound" can be calculated without even needing an ear to check it!

Unfortunately, in most cases, we do not have all the parameters we need to make technically perfect speaker boxes or the luxury of enough space for perfect positioning so 99% of the time... so lots of "intelligent experimentation" plus a little accumulated experience and luck are all-important.

**SO: How do we maximise our chances of good results by managing the speaker installation?**

**Here is a guideline for speaker choices - useful general advice:**

**Speaker impedance matters (The  $\Omega$  rating):** This must match the sound decoders specifications within specific limits, see next page for the possible variances.

**Speaker size matters:** Of course, it must work with the interior size and available space in the locomotive. Be aware that RTR loco makers make it easy for themselves... but that does NOT mean the speaker position or type that they choose is the best.... In fact, most of the time it is NOT

**Speaker efficiency matters:** Generally model train brands do NOT specify efficiency. This is usually expressed in dB or Decibels. It is measured at a specific frequency at a specific amplifier power (usually 1 Watt) with the microphone 1 metre from the speaker. When working with tiny speakers and low power as we are, high efficiency is FAR more important than amp power or speaker power handling.

How important is efficiency? VERY - seek out models with an efficiency greater than 90dB. Most small speakers aren't very efficient unless power handling is also low... but this isn't always an issue, as each 3dB you can gain is equivalent to halving the amp power needed to reach a specific volume of sound!

i.e. A speaker at 87dB will need 2x the power input of a speaker with 90dB efficiency to sound as loud!

**Cone area matters:** Sound is created by air moved at a specific frequency. The larger the cone area, the greater its potential to move air. Therefore the more cone area you can pack into the installation, the greater the potential of the installation. This is why long oval speakers are often better than round speakers, and why, providing you do it properly without lowering efficiency too much (see next page) an "array" of several speakers will give better sound every time.

**Speaker box design matters:** Forget fancy enclosures and stick to a perfectly sealed enclosure. Why? Because the bass is already an issue with small speakers, and if the enclosure is properly sealed, the roll off will be slower than with ANY other form of box, giving you the best possible natural bass potential from the installation, and as the springiness of the air inside the box acts to assist the suspension of the speaker, sealed enclosures also have higher power handling.

There are NO exceptions to this... it is simply a result of the laws of physics! By the way, when we say perfectly sealed, we mean it. My favourite analogy is to advise those making boxes to imagine it will be full of Novichok or something nasty, so bad sealing will lead to a problem.

Perfectly sealed means the speaker sealed to the box face with a thin film of silicone. It means every seam perfect. It means the hole where wire exits has sealer added... NO air movement in or out in fact!

**Occasionally... Install space and access makes it hard. Occasionally, the rules can't be followed.**

**If that occurs, then just experiment. Sometimes things that should never work, do. Sometimes the body shell adds a magical dimension to the sound that isn't expected... sometimes it takes away. In the end, science can only take us so far... and the only way to really KNOW is to try.**



## Sound and a general speaker installation overview

*Continued...*

**More than one speaker:** Earlier we said "cone area matters" and using multiple speakers on ONE install or box is part of maximising cone area. There are simple rules to get the best from this approach.

Keep them all the same size. If in the same box, then place them so close that the rims actually touch and work them into a single enclosure to get what is called "Acoustic coupling". If you succeed it will increase the efficiency of the enclosure by at least 3dB—and that is a LOT.

There are limits and rules here. The wiring must end up with the right impedance overall. The addition of several speakers can add in one way BUT the physical loading of several can also decrease system efficiency. Stay within the "sweet spot..."

Usually, unless you have found some miraculously efficient speakers such as "headphone transducers", then 2 or 4 speakers in a single box "array" wired in a series/parallel combination will be the limit.

We cover wiring lower on this page.

**Speaker box material matters:** The best speaker boxes I have created were cast from white-metal with a 1.5mm ply back... neat but loads of work. In general follow these rules.

Keep the box material rigid. Plywood, reasonably thick styrene, lead sheet, 1~2mm card stiffened with a coat of nail enamel or similar... they all work. Make boxes neatly and tidily and take your time. Brace boxes inside if using multiple speakers. Seal them properly.

**Speaker wiring options:** It's all about balancing the speaker system impedance to match the amplifier.

Impedance actually varies by a huge amount with the sound frequency, so to keep it easy to work with it is expressed as the nominal resistance of the voice coil as measured by a standard meter.

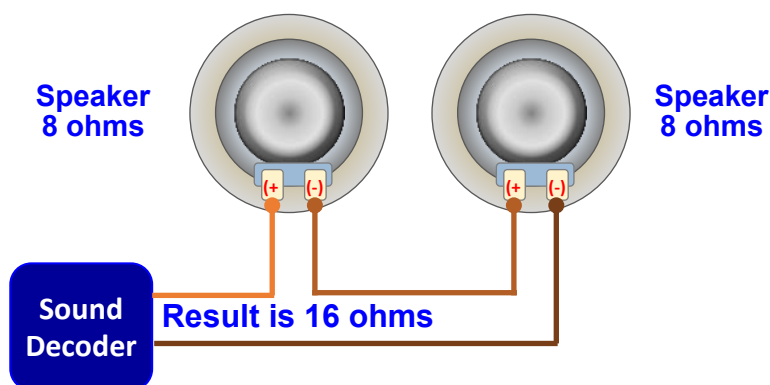
By the way... don't expect an 8-ohm speaker to always measure 8 ohms... it is quite likely that it will be between 7.5 and 8.5 ohms and that is perfectly OK. Follow the next chapters and you will be fine.

### Speakers wired in series ADD impedances.

Series wiring is like a daisy-chain.

The speakers are joined "positive to negative" as in the diagram, and the chain of speakers is placed across the amplifier speaker outputs.

It is important to get it right so the cones move in the same direction at the same time - this is called "being in phase". If you get this wrong they will work, but sound very "thin" as out of phase wiring cancels out the lower frequencies.



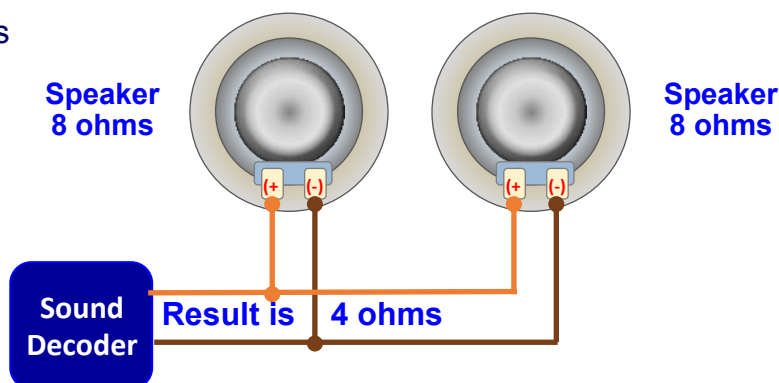
### Speakers wired in parallel divide impedances.

Parallel wiring - Speakers are across the outputs

The speakers are joined "positive to positive" as in the diagram. The group of speakers is placed directly across the amplifiers speaker outputs.

Again, phasing has to be correct (this time plus to plus ) so that the speaker cones move in the same direction at the same time.

If you get this wrong they will still work, but the result will sound very "thin" as the out-of-phase wiring makes the cones move in opposite ways and this cancels out the lower frequencies.



## Sound and a general speaker installation overview

*Continued...*

### A "Series-Parallel" Matrix does both

When installing an array of several speakers, then to keep the impedance and load balanced, we use a series-parallel arrangement like this.

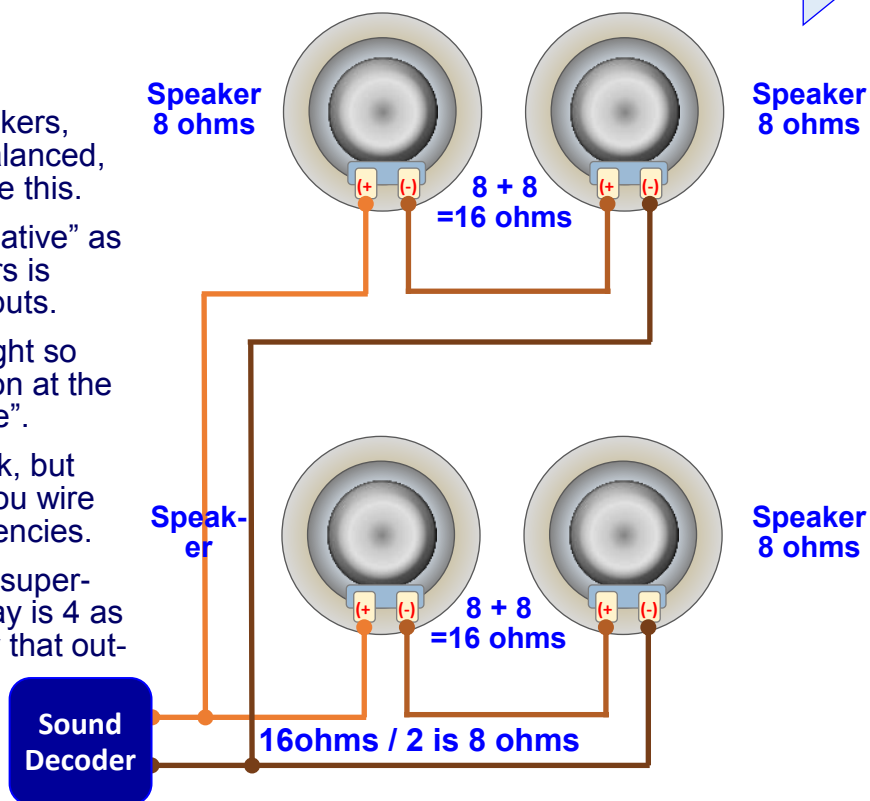
The speakers are joined "positive to negative" as in the diagram, and the chain of speakers is placed across the amplifier speaker outputs.

It's important to get speaker polarities right so that the cones move in the same direction at the same time. This is called "being in phase".

If you get this wrong they will all still work, but the sound will become very "thin" as if you wire then out-of-phase it cancels lower frequencies.

How many in an array? Unless they are super-efficient, the maximum we use in an array is 4 as any more simply has losses in efficiency that outweigh any benefits. They are usually mounted in pairs, very close together.

If possible both pairs are also kept close together.



### Matching amplifier output to speaker system impedance.

As we said earlier, it is all about balance. Keep the system balance right, and problems will be zero. In every sound decoder manual you'll find the output impedance of the sound decoder clearly stated.

For example, ESU up to LokSound V3.5 was 100 ohms and is now 4 ohms for all models. Zimo is nominally 8 ohms, as are Soundtraxx, Digitrax and QSI.

**The BEST way** is to match the speaker system to a sound decoders recommended impedance.

**The LOWEST the speaker system can safely go** is 50% of the recommended decoder impedance. If you do this the amplifier will work harder & give a slightly higher output BUT it will get warm, so please regard 85% at the "top limit" for volume settings (you will not notice any drop in level)

**The HIGHEST the speaker system impedance should be** is double the recommended decoder impedance. If you do this, the amplifier will actually have to work less hard but it will also have tighter control and less output distortion, so you can go to 100% of volume potential.

What do we recommend? We think the best choice is the one that lets you use the largest possible cone area... One large speaker will be good, two will be better. Even better if they can be within ONE enclosure, close together. If there is space... a 4 speaker array would be great.

Use your imagination, experiment and have fun... just watch the speaker phasing AND seal the boxes properly. keep the overall impedance within the limits above.

### The cast box with a thin plywood back that we mentioned earlier.

It holds 2x ESU 28mm 4 ohm speakers mounted close enough to touch.

This box is installed into the tender of a Hornby Royal Scot and it is the best we have ever heard from any installation in an OO scale loco by a country mile!



## Sound and a general speaker installation overview

*Continued...*

### Preparing the loco body shell:

If it is inside a loco, then there's often not a lot of space... but with some thought, more can be created. Sometimes you have to be a little extreme if you want great results so be brave too!

### Things you can do in the loco:

**Use part of the boiler as one side of the speaker box.** Use thin card to cut templates for the ends and face. Reproduce those parts in heavier material when you build the box in place in the locomotive.

**Move weights.** Note we do NOT say to remove the weights... this can lead to pickup problems!

**Cut away chassis parts.** It's easy to do and will make a huge difference sometimes. Don't forget to protect the motor when doing this & DO clean all metal filings way properly before assembling the loco.

**Dump the PCB & hard wire the loco.** Easier to do than you think and frees up lots of space.

### Things you can do in the tender:

**Move mounting points.** These can be awkwardly placed and prevent use of all that lovely space. We actually took away the top mounts in the Scot tender (box last page) and the top of this tender is now secured by being a neat fit around the speaker box we created. We used ALL the space for sound!

**Rewire it.** Again the tender isn't always tidy in its wiring - so re-route or remove wires where possible, get rid of anything that is in the way... including modifying the lower coal space, which you will never see when the loco is coaled up anyway!

**Get rid of unwanted resonances:** Big flat tender sides (and sometimes diesel sides) resonate. This muddies up the sound and takes away from its quality. You can easily test for this by squeezing the tender sides when the sound is playing... you can HEAR the difference immediately!

RANDOMLY add bits of high-mass material (lead sheet offcuts of odd shapes) to the inside faces of the tender sides. This prevents standing waves being created and keeps the sound tight and accurate.

### The actual speaker installation:

**De-coupling the box from the item it is installed in** - (i.e. using 3M foam tape as per the image last page or perhaps blue tack) means that the box is actually isolated from the thing that it is installed in physically. That will allow the speaker box's characteristics to stand out and not be influenced by the added resonances of the body or chassis it is placed in or attached to.

**Coupling the box to the body shell or chassis** - This means screwing it to the body or fixing with a hard adhesive such as superglue so that it passes resonant energy to the body shell, effectively turning it into an extension of the speaker! The results of this are actually hard to predict but can be either really horrid or spectacularly good.

ONLY trial and error works here... there is NO right or wrong.

Be brave. Experiment as every loco or tender is different... so only trial and error will really tell you which way is right for THAT loco.

Have fun too...everything that we do in a hobby should be enjoyable!

### Sheer luxury >

This AN class model by Auscision has lots of room for TWO large ESU oval speakers with almost no work to do!





## Loco suppression, what it is, why you should remove it.

*Continued...*

Now that we have talked about connectors, Stay-Alive™ and speakers...

**We'd like to add a few words about "Ready-to-run" and the suppression circuits that are often fitted to them, mainly for European and UK distribution:**

These suppressors are added to reduce interference when running on DC and have NO function or use when a locomotive is fitted with a DCC decoder, as the decoder alone provides better suppression!.

DCCconcepts recommends removal of all capacitors and suppression parts from all locomotives prior to installing your decoder. We make this recommendation without hesitation as we have NEVER seen any loco run better with them left in and we have seen MANY perform badly as a result of their presence.

Removing the capacitors will ensure the best quality running without exception, as the capacitors used in locomotive DC suppression circuits interfere with the very important communication between decoder and the Back EMF that is fed back from the motor, preventing things working as well as they could.

(If you are fortunate, leaving capacitors and suppression parts in results in only slight negative effects, but sometimes the interference is so strong that locos are impossible to control well at slow speeds).

There is NO downside to removal of suppression parts when installing a DCC decoder. Removing them will not have any negative result or increase the radiation of radio interference under any circumstances.

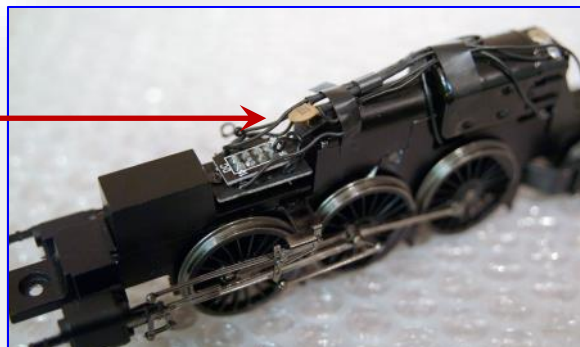
SO –for best performance, take them out. We examine the typical suppression circuit on the next page.

**HORNBY: Here's a typical Hornby suppressor example...**

You can see the biscuit coloured ceramic disc capacitor quite clearly. This is across the circuit so it can easily be snipped out or removed by un-soldering if you prefer. Once its removed put a drop of clear nail varnish or similar on the bare ends of the leads to properly insulate them.



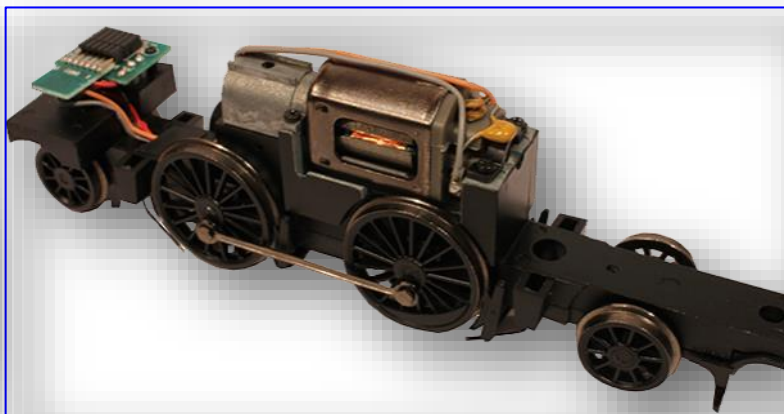
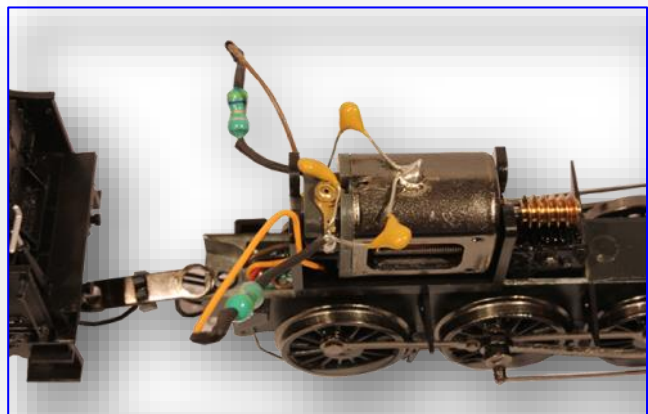
Snip it off where shown here... it only takes a moment and your loco will then have the best possible chance of running really well.



**Bachmann: Here's a Bachmann suppressor example... they will vary install-by-install and can have one or several capacitors, as these examples show. (LHS = the S&D 7F, RHS = L&Y 2-4-2 )**

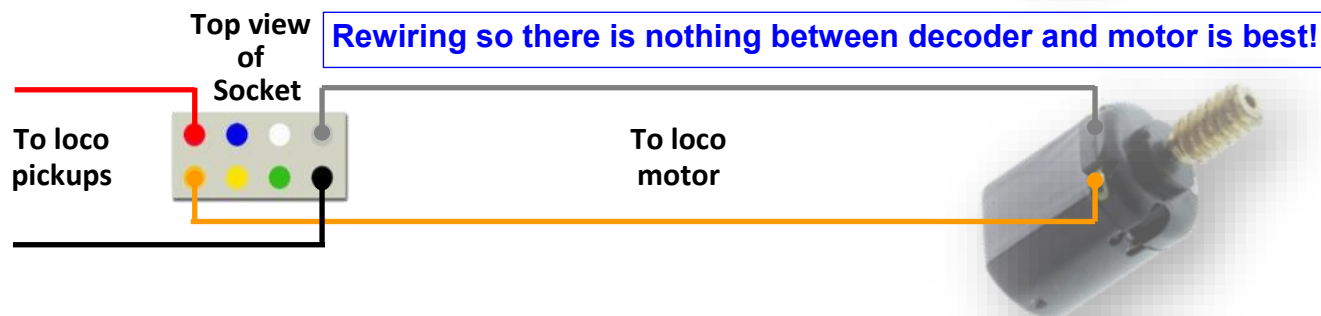
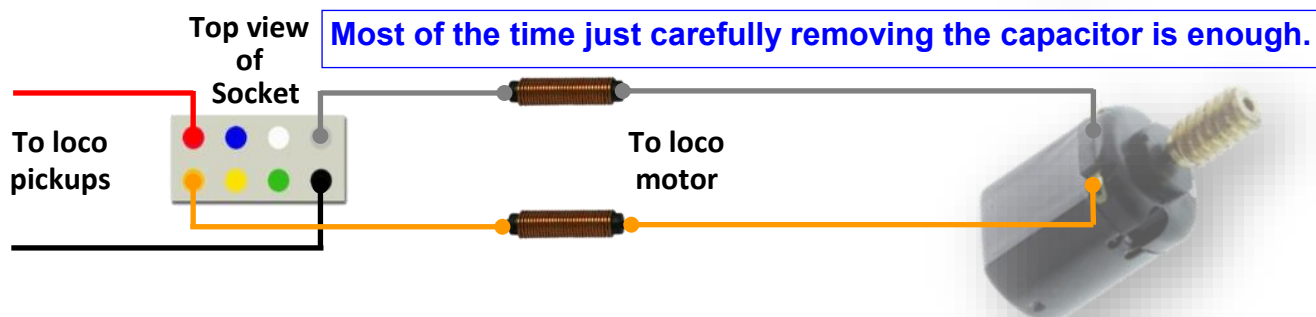
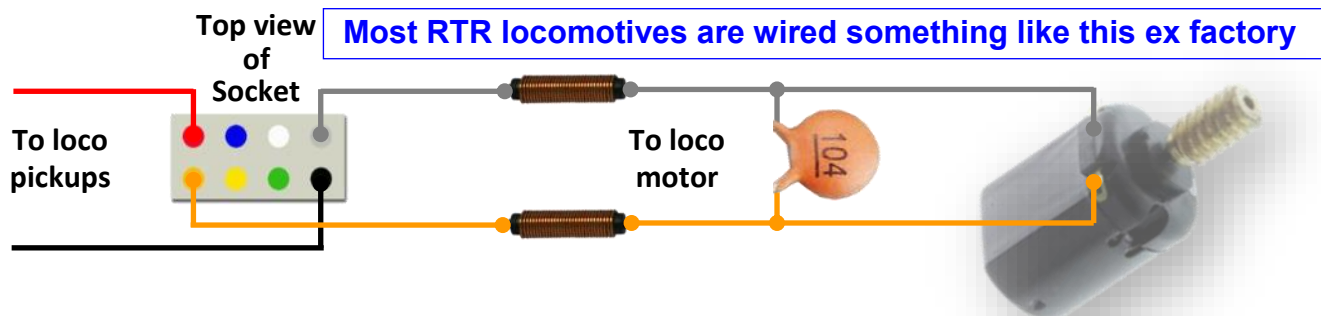
These can be snipped off OK but if you are quick with the soldering iron, it is much neater to unsolder them from the motor can. DO be quick though, as overheating the motor is not a good idea!

In the LHS image, you can clearly see both inductors and several capacitors. You can also see just how untidy ready-to-run wiring can be. Sometimes, it's much easier to remove it all & re-wire the locomotive!



# Loco suppression, what it is, why you should remove it.

The typical locomotive suppression circuit:



An inductor will look something like these examples. They can look like a wire coil, a bit like a bulky resistor, or if surface mount they can take on many similar shapes as is shown in these examples. (although most will look a bit "coil-like")



A capacitor will look something like these examples. They can look like a small disc, or if surface mounted they can take on various shapes as shown here. If they are disc type look for the number 104, as this is the most common value.



The PCB image shows both a coil & some capacitors: The C numbers on the PCB are a clue :-)



## Decoders, Installation and Warranty - plus useful tools!

### Decoders. Installation and Warranty

It is really not up to us to talk on behalf of other brands, but we thought it worth discussing this subject, because in reality, if a decoder is well made, there's very little that can go wrong with it!

The problem is: Nobody lets the smoke out on purpose, so who's to blame? HOW did the fault happen?

#### Some possible causes are:

- (A) **Bad loco etc.:** The locomotive or item which receives the decoder has a fault. This is more common than you may imagine... sometimes it's an error in design, but not often. Most of the time it is just careless wiring or something like too much solder bridging two connector terminals.  
**Running on DC. OK will not show it up, so use a meter if you can, or at least check it out visually before you commit to the installation!**  
**If your decoder is damaged by such a loco, it's not the decoder maker's fault, and in a way, not yours either. Unfortunately for you, it's NOT a warranty issue for the decoder either...so take a photo of the bad workmanship and send it to the loco maker - THEY are the cause, and they should cover the replacement!**
- (B) **Grounding of one motor brush to the frame, which is often live to one track pickup.** This is quite a common problem with non-dcc-ready installations if you are not careful. It can be caused by inadequate clearance around the motor, carelessness... or perhaps it is a legacy of the way the loco was designed in pre-DCC days for easier DC wiring.  
**You must be careful. Here is how we do it (set your multi-meter to  $\Omega$  or Ohms for this).**
- (1) Disconnect the two motor wires, leaving the motor brushes with nothing connected.
  - (2) Place the loco on a clean piece of track that is not connected. To anything at all!
  - (3) Touch one meter probe to motor brush #1 and then put the other onto one rail. Repeat with the other rail. There should be NO reaction from the meter if the brush is properly isolated.
  - (4) Repeat this process with motor brush #2. There should be NO reaction from the meter at all.
- If you cannot get to the lower brush as it is hidden under the motor when it is mounted to the chassis (as with older blue-box Athearn or some other locomotives) there is also another test method for checking for problems with the isolation of the lower brush)**
- (5) Place one meter probe onto the top motor brush. Place the other probe onto the CHASSIS. Make sure it has good contact (it is painted cast metal so you may need to press hard)
  - (6) Check the meter. If it reads it will probably be between 15 and 50 ohms... and ANY reading will mean a sneak path from the lower brush to the chassis... so it'll need more work for you to insulate it before you do the installation. **You MUST do this properly or the decoder will die!**
- (C) **Bare uninsulated wires OR wires trapped between chassis & body, cutting the insulation.** This is also often a cause of problems, and it will be either careless work by the loco maker OR unfortunately, carelessness by you. **Damage caused this way isn't warranty...** so make sure every wire is carefully routed so it cannot be crushed or have the insulation damaged. Always use heat shrink or a form of liquid insulation on all wire joints and the end of all bare wires.  
**Tip:** If you cut off any unused function wires, that just leaves a potential short at the end of every wire you cut. Buy some nail varnish and put a drop onto the end of any wire that's not used!
- (D) **Mechanism problems causing over-current problems / exceeding decoder current rating.** If a motor becomes faulty and the mechanism jams, then the current draw will shoot up. This will generate heat, and heat is what damages decoder parts. Once one part fails... others always follow. **The inevitable result is a cooked, dead decoder.**



## Decoders, Installation and Warranty - plus useful tools!

*Warranty etc. Continued...*

We have indicated a few examples that aren't warranty, but as hard as we try, decoder manufacturers are not always perfect either. Problems are rare in reality, but they CAN happen, and if they do, the sooner you find them, the sooner they can be replaced with a decoder that does what it should!

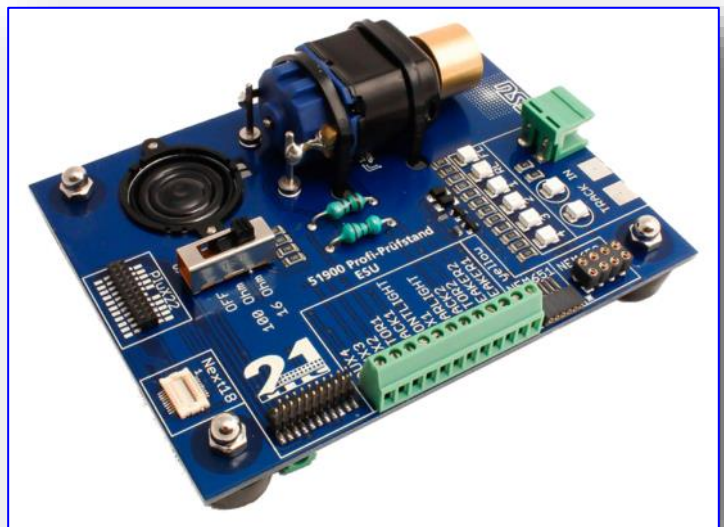
**Our suggestions to keep it fair...and keep unexpected problems to a minimum.**

- **Buy a good quality decoder tester.**
- **Pre-test EVERY decoder that you buy BEFORE you put it in a loco!**

That way there's absolutely no doubt whether the decoder ran or not before you installed it, so "warranty or not" will not be an issue.

**This decoder tester (click the image to see more detail) is our current favourite from ESU**, as it has a speaker & motor on board, and it has ALL the commonly used connectors we explained earlier, so plugging in a decoder is really easy!

Once you have it, you can also pre-set decoder addresses and set up things like acceleration and speed curves before installation, simplifying the process of adding a decoder to a locomotive.



**Follow a strict pre-check routine for all locomotives prior to installing a decoder.**

- Test run them on DC for a minute or two. Check for smooth running and if possible check current draw (put the meter into the 10 Amps range then use the meter as part of the track power circuit by putting it in series with one wire between the power supply and the track).
- Running on DC doesn't mean the socket is OK, When you take out the DC blanking plug to install a decoder, visually inspect the on-board dcc socket before plugging in - check for bad soldering.
- For non-DCC ready locos, follow the motor isolation check as per the previous page.

**MOST importantly:**

- ALWAYS put the loco on the "program track" first after adding a decoder, because the program track is current protected, and if it senses a problem it will let you know, saving the decoder!

**Another really helpful accessory" The DCCconcepts multi-gauge rolling road.**

**A rolling road is a great way to make testing and setup really easy, as it can happen right on the installers workbench.**

The DCCconcepts Rolling road is available with a set of 6 or 12 pairs of rollers and it is supplied with spacers for OO/HO, TT, N and other common modelling scales.

Just place the roller sets onto your track and sit the loco on top...

Each rolling road also includes an adapter for 3-rail use, so it's a really versatile tool.



## Decoders, Installation and Warranty - plus useful tools!

We've covered lots of wiring issues... lets take a look at a few of the tools that you'll find really useful when doing any form of installation on locomotives in any scale. Click on the images!



### First - a good quality multimeter...

It doesn't need to be overly expensive, but as with all things, you only get what you pay for.

Buy wisely, not cheap!

This meter has a great feature range, more than enough for DCC installation use.

Don't forget - they do need a good battery to work properly...don't forget to change the battery reasonably often.

### Next, you will need a good quality soldering iron and some appropriate cutters and strippers.

Again, quality matters but there is no need to break the bank. The soldering Iron here is the really excellent Atten which is temperature controlled and very versatile.

We supply it with two tips perfect for modelling.

The TOP tool on the right are really nice quality fine cutters, perfect for fine wiring work.

Next are the DCCconcepts fine wire strippers, without doubt the best fine wire stripper available.

Tough, with two exceptionally sharp stripping grooves, they also have a really nice cutting action between the grooves for the trimming of wires.

Able to be locked at any setting you choose they can strip the finest wire and are an essential tool for the modeller.



### The last three are really helpful...

De-soldering braid will pick up the all-too-common excess solder from pre-installed ready-to-run DCC connectors and let you clean up wiring generally, the No-clean flux will make sure that solder flows quickly to give you clean, reliable joints & the DCCconcepts S179 solder works effortlessly.

#### De-soldering Braid

#### Sapphire 179 solder

#### Sapphire No-clean flux





## Decoders, Installation and Warranty - plus useful tools!

*Warranty etc. Continued...*

### So - having said all that, how do **DCCconcepts** approach decoder warranty?

Background: We use a high quality manufacturer that has the most modern surface mount machinery available, PCBs are made just before manufacturing the decoders to make sure soldering quality can be optimised and we use only high quality parts. As with PCBs, parts are bought "just in time" so that there is no deterioration in pre-tinning or pre-fluxing of the solder pads, leading to dry joints.

Every decoder is automatically tested even before it is taken from the PCB sheet on which it was created .

After any post-auto insert work is done and the decoder is complete, they are all 100% tested again at the factory, this time using both a computerised system and randomly, several popular DCC systems.

Our Chinese QC people test before delivery to us. We then randomly re-test a statistically high quantity of decoders AGAIN when they are delivered to us, before they are packed for sale.

**We are therefore confident of quality and so our "Decoder Warranty" is simple and direct:**

#### **Free replacement:**

Sometimes, hardware is fine and there is no obvious reason for a fault. If, within one year of purchase a decoder with no visible physical or heat damage and a properly wired harness will not work and it will still not respond and run on address 3 after 3 attempts at a full reset then we'll replace it free of charge.

#### **Part cost replacement:**

If there is any form of heat or other kind of damage to the decoder or its heat-shrink, if the heat-shrink has been removed or there has been any soldering or modification to the PCB then it will NOT be treated as a full warranty replacement. However we DO want you to be confident and DO understand accidents happen, so we will replace it for a "part cost" of 50% of our current web price (for a single equivalent) plus return post costs.

#### **Conditions:**

- (a) Decoders should be returned with clearly written, polite notes covering what you think happened.
- (b) We may ask for a date of purchase and a valid receipt before supplying replacement decoders.
- (c) We will normally replace ONLY the decoder. Please do not return harnesses as these will not be replaced or renewed (obviously some models will include a harness where fixed to the decoder).
- (d) We will record all part replacements and we will not accept more than 3 such claims for damaged decoders from any one user within a 12 month period

**This is our approach - however, I am sure most brands also offer similar good quality service.**

**If you have problems with a decoder and don't know why, please ask. We DO understand and sometimes, even if we discover that the real cause isn't our decoders fault, we may still give you the benefit of the doubt & best possible result, providing you have approached us properly.**

**We do that because we are modellers too - we understand that sometimes things just go wrong by accident and we don't want you to be reluctant to try new things.**

**We think its better to help and teach than simply fall back on impersonal policies...**

~~~~~  
**We hope you found this manual useful.**

**Please email [questions@DCCconcepts.com](mailto:questions@DCCconcepts.com) if you need more information or help**