ZTC Loco Decoders
For DCC Railway Control

with RealFeel™
Operations Manual

for Model Railways operating in
DCC Digital Mode.

Rev 3.01 January 2002

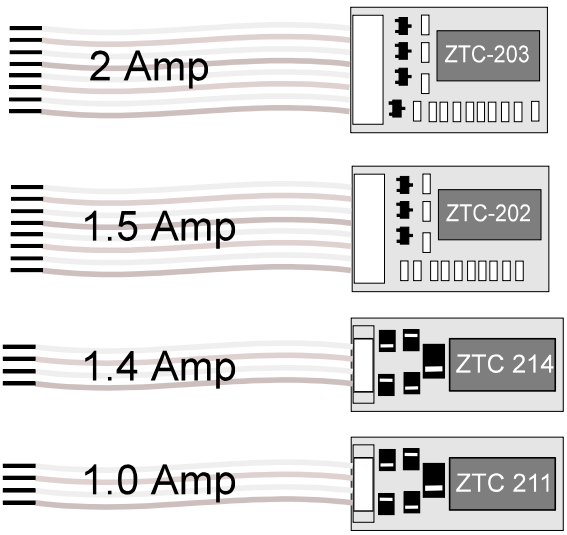
WARNING:
If you fail to read the installation instructions properly it is possible that you could accidentally damage your ZTC unit. Such damage is **NOT** covered by our guarantee. So to prevent avoidable and potentially expensive mistakes, please take the time to read these instructions before attempting to install your equipment

The ZTC System is only intended for controlling model railways by experienced modellers over the age of 14 . It should only ever be operated by young persons under competent adult supervision.

ZTC Controls
75 Portway, Wells
Somerset BA5 2BJ, England
Tel: 01749 677534 Fax: 01749 674063
E Mail: sales@ztccontrols.com
Web Site: www.ztccontrols.com

Locomotive Decoder Installation Guide
ZTC 202, 203, 211/A, and 214/A

◊Suitable for most models in N, HO, OO and O
◊ZTC 214 / 203 for OO, S and O gauges & G/1
◊Works with any DCC standard system controller
◊Compatible with ordinary DC controllers
◊Compatible with old Hornby Zero 1
◊Smooth acceleration
◊Output to motor can be up to 95% of full power
◊Programmable start voltage
◊Programmable top speed limit
◊Plug-in wiring harnesses
◊Thermal sensing trip protection



General Information

These decoders are intended for use on model railway locomotives of most gauges. They are rated according to the highest current that the loco might draw when starting from rest (stalled current). They decode the speed commands from a ZTC-DCC controller or any other controller conforming to the NMRA-DCC standard or in Hornby Zero 1. For portability, they can also be safely operated on a track with only an ordinary pure DC controller.

The locomotive decoder in each engine is able to extract only those commands specifically sent to it in order to set the speed required. It can also control the acceleration and braking performance of the loco and be fine-tuned to optimise the speed range, starting characteristics and maximum allowable speed. Even the mechanical 'stiction' can be overcome by introducing a small extra kick start pulse. The configuration variables can be set by the user by putting the loco on a stub of track connected to the programming output from the controller. There is never any need to gain physical access to the decoder itself.

The decoder has an advanced built in control system which permanently stores on-board all the loco's set-up data. It can be set-up by the user for optimum performance to match the loco requirements. These can all be reset again and changed if required. The decoders come already set-up ready for most applications with the loco address set to 3.

Speed Steps

Normally these decoders use the 28 speed step control (14 with Zero 1), but can be operated on a 14 step DCC controller if need be. When the controller in configured to send 128 step DCC commands, the decoder automatically switches to operate at the higher precision level. The ZTC decoder smoothes out the control range to provide a progressive acceleration or retardation through up to 255 speed steps.

Output Drive

The output drive to the motor is a Pulse Width Modulated (PWM) drive for high efficiency and higher torque at low speed. The frequency can optionally be preset and changed to cater for different kinds of motors. These include precision coreless types like Portescap and any other similar makes by using high frequencies. Some larger motors can benefit from slightly lower frequencies than the basic 70 Hz set at the factory to suit most applications. Occasionally certain types of motor sometimes may tend to run hot when on a PWM drive for extended periods. This can be overcome by pre-setting the frequency and top speed to more suitable values.

NMRA National Model Railroad Association

This voluntary body sets standards and practices for model railway manufacturers and enthusiasts in the USA.

The pioneering work by the DCC committee in setting down a satisfactory set of standards has been internationally accepted by a number of other manufacturers. The adoption by ZTC means that the consumer will always have further choice as more compatible products become more widely available.

Important: Do Not Handle a Decoder Unnecessarily Before Installation

These miniaturised receivers are built to the highest standards and are protected against damage by static electricity. But static damage could still be done in extreme circumstances if carelessly handled.

INSTALLATION

The decoder can either be fitted inside the loco body or in a tender if applicable. If either of these is physically impossible, it could go in the leading wagon or carriage. If possible it is preferable to avoid close contact with the motor itself to prevent possible over heating.

The basic decoder wiring goes between the 2 track current pickups and the two motor brush connections so that the decoder can regulate the power to the motor. The 4 wire power connections do not have a common lead. Hence this entails complete isolation of both motor brush contacts from the original direct track pickup connections. This is usually simple to do for can type motors and many open frame types. When the motor is built into the chassis frame, it can become more difficult.

If both brushes cannot be separated on a particular model, the loco cannot be fitted with any ZTC or DCC type decoder. However, on a DCC system, it can still be operated as loco 0 (DC or analogue mode). Where one brush remains still connected to one side's track pickup and cannot easily be isolated, if the motor is a low power or N gauge type there is an alternative (non preferred) 3 wire method for the ZTC 211 only.

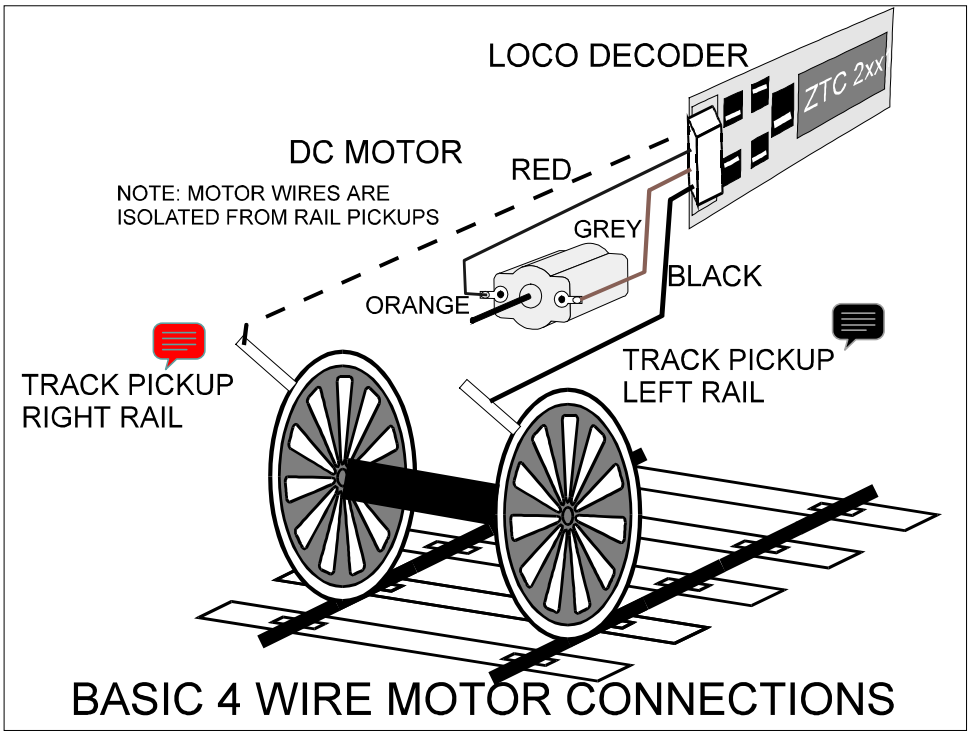
ZTC 202 and 203 have 4 extra wires which output 3 switched accessory function outputs. These may be optionally used with front and rear lights, smoke generator, sound units or even uncoupling mechanisms that might be fitted to the loco. If any of these are not used, the lead wires can be unclipped from the plug housing or cut off. The ZTC 211 does not have any accessory function outputs and therefore only has a 4 way plug harness.

The wiring harness supplied is 150mm (6 ins approx.) long and can be cut down in length if required. The decoder's wiring colour code conforms to the NMRA DCC standard. Extra decoder plug harnesses, if required, are available as a spare part. The decoder is only to be plugged in once the wiring has been thoroughly checked, preferably, with the ZTC 601.

The ZTC 601 Loco Decoder Installation Tester should be used to ensure that the wiring harness has been properly connected. If this has not been done prior to plugging in the decoder and powering up there is a possibility of a malfunction or worse. Permanent damage could be done to the device by the track power. Such damage is not covered by ZTC's guarantee.

The miniaturised electronics in the decoder are designed to be robust in service and last practically indefinitely. They can however be damaged by careless installation. If a motor short circuits due to inadequate insulation, the output transistors might be damaged, though they can be repaired by ZTC. Should the decoder overheat in operation, it will protect itself by turning off the motor drive until it has cooled sufficiently.

NOTE: WARRANTY VOID IF THE PROTECTIVE PLASTIC SHRINK SLEEVE IS REMOVED.



BASIC 4 WIRE MOTOR CONNECTIONS

Decoder Wiring Harness

ZTC follows the NMRA wiring colour code but may differ from other makers' schemes, so only follow the ZTC wiring instructions**.**

Should it be necessary to remove the decoder from service, a dummy unit ZTC 204 (4 way plug) or ZTC 208 (8 way), can be plugged in its place. Thus bridging the track to motor connections enabling normal DC or loco 0 operation.

The decoders are supplied with a separate wiring harness and plug designed to mate together after the installation of the wiring has been completed and tested. Should the wires be accidentally damaged or cut too short during installation, you can get a replacement as a spare part.

Individual wires can be removed from the plug housing by releasing the tiny plastic barb. This can be done with a watchmaker's screwdriver or a fine probe. When gently lifted, the wire will easily slide out of the housing.

To insert the plug into the decoder, check that you have it the right way up. The plug is polarised and will not go in upside down. With the decoder grasped between the thumb and forefinger, the plug can be pressed gently home with the other hand.

To remove the plug, the decoder should be grasped between the fingers whilst pinching all the wires together with the other hand, close to the plug body. The plug can then be carefully eased out. If you do not pull all the wires together there could be a risk of placing undue strain on one and breaking it.

Installation Procedure

The installation should be planned very carefully and followed through in an orderly way. You will need a low power soldering iron and 60/40 multicore solder. Insulation sleeving and other sundries may be required.

The other tools you may need will depend on the loco make and type.

1. Test Loco to be Modified Beforehand

There is no point starting to install decoder in a loco unless you have checked that it is in good mechanical order and runs sweetly on ordinary DC control. Check for fluff, dust, dirt and excess oil and clean appropriately.

2. Check the Motor Current.

The loco's motor current must not exceed the rating of the chosen decoder.

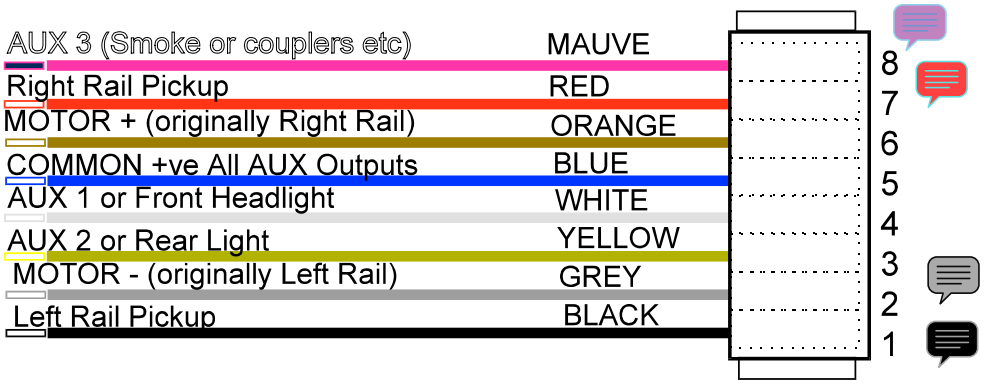
You should therefore check the motor current before installing the decoder. This can be done by either using an ordinary DC controller with a multimeter set to DC amps or the ZTC 511 set in DC mode (as per instructions sec 9.2).

With the loco on a piece of test track, measure the current drawn when the motor is briefly stalled at its normal maximum voltage.

The current recorded should not exceed the rating of the decoder to be used.

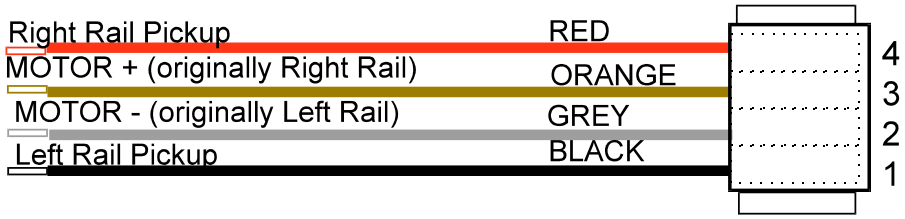
It is worthwhile to also check the free running current for the motor. For a healthy motor it should be significantly lower than the stalled current. A typical figure would be 1/4 to 1/3 of the stalled current.

8 Way Harness for ZTC-202 or ZTC-203



ZTC Part Number:
ZTC 008

4 Way Harness for ZTC-211



ZTC Part Number:
ZTC 004

3. Motor Isolation

In order that the decoder can regulate both speed and direction, the motor must be completely isolated from the original track pickup connections or chassis.

Most modern designs permit this easily but disassembly of the major loco components might be necessary.

Some designs of loco have a motor with one or both brushes intimately mechanically and electrically bonded to a live chassis. These types will require more mechanical ingenuity to isolate the brush or chassis itself. Failure to isolate the motor brushes completely with a 4 wire power connection will result in destruction of the decoder output circuit if it were ever placed on a fully powered track. This should not happen if the test procedure is followed properly!. The alternative 3 wire connection is only suitable for N gauge and small lower powered models of other gauges.

4. Basic wiring connections

Before making any soldered connections to the decoder wires, place the loco or motor assembly on a metal tray or slightly damp cotton cloth. This will dissipate any static electricity which might accidentally damage the decoder.

On all decoders there are 4 basic power control wires; 2 to track pickups and 2 to the motor. There is no motor common connection with the track pickup.

Any motor suppression components across the brushes should be left intact as they reduce possible radio interference from sparking. These will not affect digital control operation.

Alternative 3 Wire Motor Wiring

This method can only be used for low power motors such as N gauge and other motors normally consuming less than 0.5 amps. Zero 1, Portescap and Faulhaber coreless motors are also unsuitable for this technique. When in use, the motor runs on half wave power from the track signal and there may be some “singing” from the motor due to the high frequency content of the signal. Only the ZTC 211A and ZTC 214A decoders should be used in this configuration. Spare 3 wire harnesses are available for this product, Part No. ZTC 003.

DO NOT set CV9 lower than 187 when used in this configuration or permanent damage to the decoder will result.

The connections to the motor (ORANGE and GREY) should be soldered to the brush tags or pins using a low power iron. Ensure that only the minimum amount of heat is applied to make a good joint. Remember to put insulation sleeving on the wires before making the joints so that the brush connections can be protected afterwards.

COLOUR	WIRE FUNCTION
RED	Right Rail Power Pickup
BLACK	Left Rail Power Pickup
ORANGE	Motor + Drive (originally right rail)
GREY	Motor - Drive (originally left rail)

On some designs, it may be possible to fit push on tags to the decoder wire ends, but it is generally better practice to solder them.

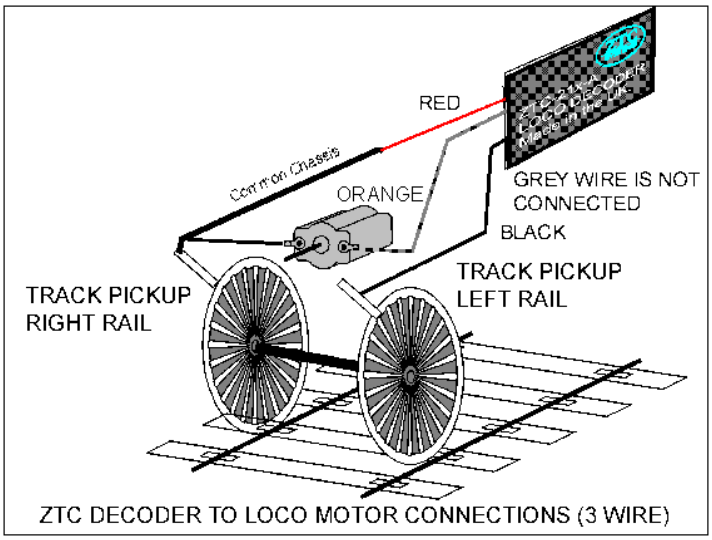
If you happen to mix-up which brush of the motor is which, do not worry. The direction of travel sense can actually be reversed by the decoder if you have the Orange and Grey wires swapped. This is done later at the programming stage when CV 29 can be set to reverse direction. (Set 2 or 0 for normal, 3 or 1 for reversed Orange & Grey.)

5 Track Pick Up Connections

The RED and BLACK wires take the track power to the decoder. Where these can be attached varies from loco to loco type. Sometimes there are tags available otherwise you may have to make your own arrangements.

Usually part of the chassis will be live to one rail or the other or be a split chassis in two halves. Which part connects with the left hand side wheels and that with those on the right should be obvious.

To solder the wires on to the chassis may be difficult. so it may be necessary to screw on tags or pins or resort to other measures.



ZTC DECODER TO LOCO MOTOR CONNECTIONS (3 WIRE)

Loco Accessories

The ZTC202 & 203 decoders have additional outputs which can be switched on and off from the controller in order to operate loco accessories. These outputs are completely independent of the motor drive and do not vary with its speed. These ~~cannot~~ be operated from a Zero 1 controller.

The loco decoder's accessory power is derived from its own bridge rectifier and is therefore always DC

Wiring Loco Accessories

The AUX outputs (Functions) may be used for any of the lights, sound, couplers, smoke units or anything else you might have or wish to fit. However, the power available from any output must not exceed its current rating (see specifications).

In some locos, the existing lighting is operated by series diodes connected to the motor windings. If these are left in place, they will operate as before, going dim at low speeds.

The better solution is to discard the diodes and the original connection and wire the lighting to the appropriate decoder outputs.

Low Voltage Lamps & LED's

Other devices can be substituted for incandescent lamps shown in the diagrams.

These may only be connected to the accessory outputs with resistors placed in series with the leads to restrict the current. For 1.5V micro lamps, a resistor of 470 ohms down to 270 ohms (1/2Watt) will generally restrict the voltage down to a safe level.

For LED's the resistor chosen depends on the brightness you want and the efficiency of the LED lamp. The exact value is not critical; between 4.7K ohms and 220 ohms (1/2 Watt) will be suitable.

COLOUR	WIRE FUNCTION
WHITE	Function 1 (Front Lamp or AUX 1) Switched to 0 Volts DC
YELLOW	Function 2 (Rear Lamp or AUX 2) Switched to 0 Volts DC
MAUVE	Function 3 (Smoke, couplers, cab light etc or AUX 3) Switched to 0 Volts DC
BLUE	Common Return for above (Positive at + Track Volts less 1.2 Volts approx. 14 V. nominal)

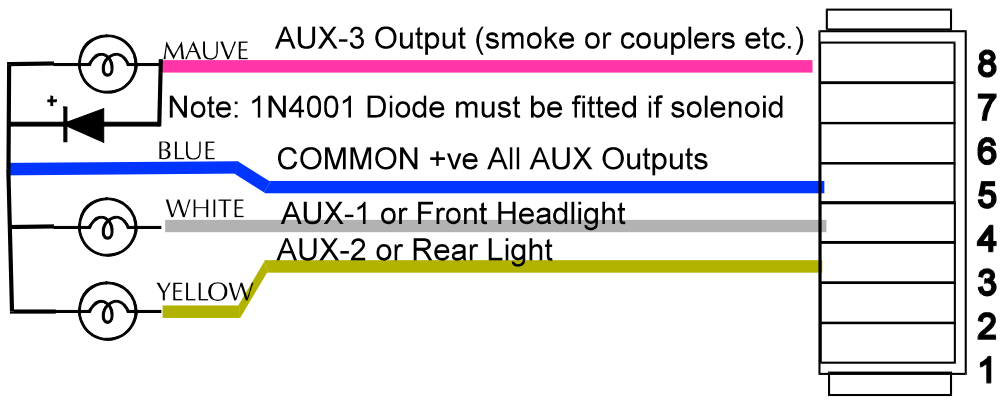
Unused output wires should either be removed from the plug housing or cut off short to avoid any possibility of short circuits from a stray wire.

Solenoids

If the loco has a solenoid operated device, such as an operating coupler, a diode should be across the coil. The banded end (+ve or cathode) goes to the common. This prevents the kick-back energy from the inductance of the solenoid coil possibly destroying the decoder's switching transistors.

An additional diode will be required for every solenoid fitted and connected similarly as shown. Any diodes in the 1N4000 series are suitable for this job and are widely available at very low cost.

FULL VOLTAGE OPERATION OF LOCO LIGHTS



Remember: The total load of all accessories connected to the decoder plus the maximum motor current must not exceed the current rating of the decoder.

Alternative Lighting Wiring

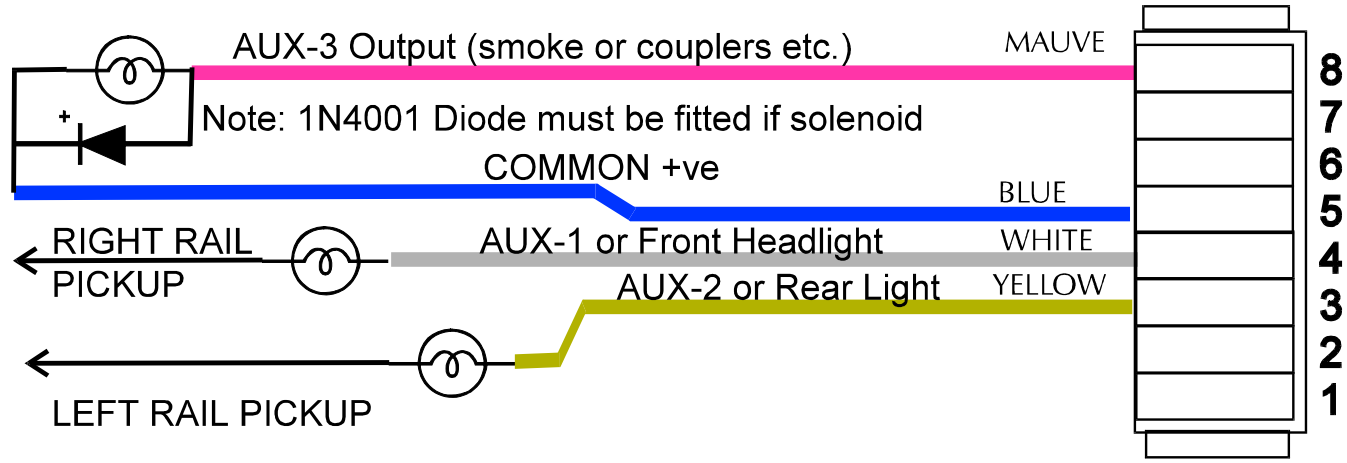
If full brightness of the lamps is not required or the bulbs rated at or below 12 volts it is better to use the alternative half wave wiring method instead of using the BLUE common return wire from the decoder which provides positive DC.. By taking a return to one of the track pickups, the lamp(s) operates on half wave power, effectively reducing the voltage by half.

Here it does not matter which lamp or accessory return goes to which rail pickup. Indeed, all three could go to either the left or right rail only. In the diagram, for example, we show each one wired to a different option.

IMPORTANT

If the BLUE common is not used, it must either be removed or properly insulated. If it should ever come into contact with any other connection, the decoder will be destroyed.

HALF WAVE OPERATION OF LOCO LIGHTS CONNECTIONS



Decoder Positioning

Try to position the decoder away from direct contact with the motor. At high output levels, it is normal for the decoder to warm up. This should be born in mind when locating a suitable position.

The decoder may be stuck down to an internal surface of the locomotive using a piece of double sided self adhesive foam or a small blob of silicone rubber compound.

Should the decoder overheat, it will automatically shut down until the temperature has dropped sufficiently. This could take several minutes, during which, it will not respond to speed commands.

SETTING UP LOCO DECODERS

Inside the decoder 'chip' is a small non-volatile memory. This stores all the various parameters specific to the loco in registers called **Configuration Variables** or CVs for short.

These CVs save not only the loco's unique address to allow its specific control, but other set-ups to optimise loco performance on the track. To look at the full list of these as specified by the NMRA may be daunting for the beginner. Suffice to say that you only need to set the loco address (CV 1) to get the engine going. The most vital CVs can be left in their factory set states until you are ready to fine-tune performance.

When we mention programming in this text, what we mean is 'CV set-up procedure', and nothing to do with actual software, programs or computers. Of course, behind it all, there is software which allows for such a flexible system.

Programming Track

You can set-up an individual loco decoder when the loco placed the programming track. This is a short siding or stub of track connected to the programming output socket on the ZTC 511 Master Controller or other DCC system unit

If you are a Zero 1 user with the Hornby R950 Controller it is also possible to set up a decoder on its output track (see P.11)

DCC Programming Methods

There are two main modes for programming ZTC locomotive decoders. These are the so called E1 Paged Mode and the E2 Direct Mode.

ZTC decoders respond to both modes, but other makes nominally conforming to the NMRA specifications may not work with the newer E2 mode. The ZTC 511 controller can operate either method, but the E1 is to be preferred.

When a decoder is successfully set-up with a new CV value, it acknowledges back to the controller with a current pulse. This is achieved by turning on the motor momentarily. Some motors consume so little power, they can make this test difficult for the controller to detect. This only really affects the operation of the verify test. The decoder will still set-up correctly, but you would only be able to see the results when it is run.

There are a number of CVs available to set-up particular performance and feature characteristics for a particular loco. Many of these you may never need to touch. **Indeed, do not change anything unless you really understand the implications**.

DCC Loco Address

The only CV essential to set-up is number 1, the loco address. This should uniquely identify the loco from any others that might be on the track at any one time. The best rationale is to use the last 2 digits of the cab-side number.

You should not be able to set numbers above 127 as the NMRA specified basic range is 1 - 127 for loco decoders. The address range of some other makes of controller may be further restricted (see makers' instructions).

Address Query Test

This obsolete test method polls the loco decoder to try and find out its address. It only works for addresses 1 - 111 for reasons of compatibility. A more general, and better way to find out a loco address is to use the controller to (read) verify CV 1 using either the E1 or E2 methods

Table of Important Loco Decoder Configuration Variables

CV	DESCRIPTION	Default	MIN.	MAX ZTC	Notes
1	Primary Loco Address	3	1	127	
2	Vstart (Starting Voltage)	8	0	255	not practical above 128
3	Fixed Loco Acceleration Rate	0	0	15	
4	Fixed Loco Deceleration Rate	0	0	15	
5	Vhigh Loco Max Speed	255	15	255	don't use below 15
6	Vmid Speed Curve modifier	0	8	250	0 = feature off
9	PWM Output Drive Frequency	215			see table
12	Power Source Conversion	5	0		see table
65	Kick Start Pulse Time	0	0	63	
55	Kick Power Level	63	0	255	
11	Time out delay	6	3	255	
56	Drift rate on signal loss	4	0	15	
49	ZERO 1 LOCO ADDRESS	4	1	16	ZERO 1 MODE ONLY

There are more CVs than are specified here, some are for future options, some are not supported by ZTC in the interests of simplicity. Some CVs are reserved for manufacturing set-ups. In any case it is unwise to tamper or 'poke' at any non-specified CV number.

Configuration Variables Programming Notes
(In order of importance)

CV 1 Primary Loco Address

If this is set to 0, the loco will no longer respond to DCC control. This could be used as a method for temporary retirement of used locos. Any number between 1 and 127 inclusive may be used and changed when need be.

If you attempt to use numbers above 127, i.e. 128 to 255, the results would conflict with other system addresses and future facilities.

CV 2 Start Voltage

This sets the proportion of full power that the decoder uses as a base level for the bottom speed step. It is intended to be just enough to keep the motor turning at its lowest possible speed. A perfect motor would work well with 0, but to overcome motor and mechanism friction a small to modest value will improve the control range. Poorer motors will demand a higher figure. An ideal value for this CV can only be found by experimentation for a given model.

On ZTC decoders, numbers 0 to 255 are possible although if it needs numbers above 100, it would suggest that the model has considerable friction!

CVs 3 and 4 Acceleration and Deceleration

When the controller sends increasing speed commands to the loco, if these values are both 0, the response will be fast and may look jerky. By introducing acceleration and deceleration factors, the loco decoder smoothes out the speed steps.

However, If the values are high, the response of the loco will remain sluggish. Some experimentation is needed to find the best compromise for a particular loco.

On ZTC decoders the number range is 0 to 15 with 15 being the slowest response.

CV 5 Max Speed

This sets the proportion of full power that can be applied to the motor on the top regulator notch (speed step) and therefore limits the top speed of the loco.

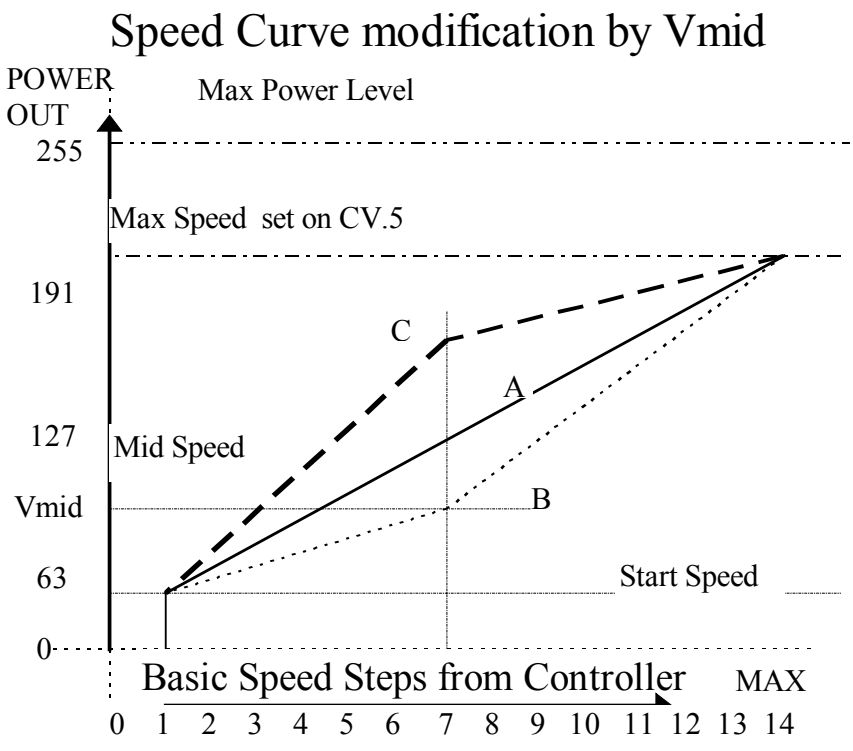
Some locos do not ever need full power and so if this value is reduced from its maximum value you will get better speed control over the operating range. On ZTC decoders the range is 0 - 255 with 255 being the full power value. If zero is ever set the loco will never move!. A lower practical limit is about 64 for very sensitive motors.

CV 6 Mid Step Speed (Vmid)

When this speed curve modifier value is zero the control speed curve for the power delivered to the motor is linear from the start voltage to the max voltage.

However by setting this CV to somewhere between the two values will bend the power curve, generally improving the low end control range if Vmid is set below half the Vmax value as for curve B.

For advanced users another CV exists in ZTC decoders to move the break point position along the speed step (horizontal axis). The Vmid step at CV 25 is set to 0 by default and this sets the break point half way along the step speed scale (at 7). However it can be changed from 1 to 13 to vary the break position across the basic speed step) scale from controller regulator position. Values of 7 to 12 are most useful.



Note: A 14 step relative scale is used whatever mode the decoder operates in being either 14, 28 or 128 steps.

CV65 Kick Start Pulse

This sets the duration of an extra pulse of power to the motor when the controller tries to start the loco from rest. If used with a value greater than 0, it helps overcome the initial starting friction (sometimes called stiction). Experiment for best results. The default power level is 1/4 of full track voltage. This too can be varied by advanced users by changing CV 55.

CV 12 Power Source Conversion

This selects the decoder's available options for control if it loses the normal DCC signal by running on a different system track. If the loco address is set to 0, it will only use one of the options for control as set.

The default value for CV 12 is 5, i.e. Analogue and Zero 1 enabled. If you do not ever want Zero 1 compatibility, it is better to reset CV 12 to 1,

i.e. DC compatible only. (no Zero 1)

If CV 12 is set to 0, only DCC operation is used. This can speed up restarts after bad current collection situations such as dirty track or dead frogs.

CV 12 <u>Advanced Users Only</u>

As the CV number is made up of what are called control bits, you need to use the table below to work out what number it should be set to. Not all makes of decoder will have all the options listed here. The default is 5 if you want Zero 1 compatibility.

CV 12 Table

Bit No	FEATURE	Add value	Notes
0	Analogue Power	1	Always include this for DC compatibility
1	N/A	2	Future option
2	Zero 1 Enable	4	Switches on Zero 1 decoding
3	Trix	8	N/A to ZTC decoders
4	N/A	16	
5	Zero 1 first	32	When powering up try to use Zero first then DCC. Only set this if you ever use Zero 1
6	N/A	64	future option
	TOTAL ALL BIT VALUES		FOR CV 12

N/A = not applicable.

Examples:

Set 0 for DCC only with no DC mode (analogue)

Set 1 for DCC and also DC mode (analogue).

Set 37 for Zero 1 as primary mode and DCC 2nd.

CV 29 Basic Configuration Register

The default value for ZTC decoders used with the ZTC 511 is simply the value 2. If you get the motor wiring the wrong way round, it can be fixed without rewiring simply by changing it to 3.

If you are going to use the decoder with a Lenz or other older controller with only a 14 step speed mode, the values would be 0 for normal or 1 for reverse.

Advanced Users Only

This CV can be difficult to fully comprehend. It sets the configuration for control of the decoder. As it is made up of what are called control bits you need to use the table below to work out what number it should be set to.

CV 29 Table

Bit No	FEATURE	Add value	Notes
0	Loco Direction Reverse	1	Set this if the loco runs the wrong way round due to a wiring mistake
1	14/28 Speed Step mode	2	If NOT set the decoder is in the coarse 14 step control mode with directional light control.
2	N/A		
3	Advanced decoder acknowledge	8	Future option only
4	Speed table used	16	Not supported by ZTC decoders
5	Extended addressing	32	When set, decoder can expect loco addresses 1- 16000 (Future option)
6	N/A	64	future option
7	Accessory Decode Enable	128	Decoder operates with accessory commands and ignores loco commands
	TOTAL ALL BIT VALUES		FOR CV 29

CV 53 Function Outputs Option Register

The allows different modes of operation for the AUX outputs controlled by the function keys or automatically.

CV 53 Table

Bit No	FEATURE	Set value	Notes
	Default	0	If 28 or 128 step mode all Aux.'s controlled by Function keys
1	AUX-1 and AUX-2 operate on loco direction	2	This also happens in 14 step mode if CV 29 is 0 or 1
2	All AUX output disabled	4	Stops spurious operation if none needed.

CV 41,42, 43 AUX Output Flasher Functions.

This only applies to the ZTC 202 or ZTC 203 decoders.

If required, any of the AUX (function) outputs can be made to flash continuously to operate special feature lights. These will operate when selected ON from the controller. The pre-determined rate is set be the value set-up in the respective CV. For normal operation set 0.

CV 41 sets AUX-1 flash rate ; 1 to 127,or +128 for momentary operation. Similarly CV 42 sets AUX-2 and CV 43 sets AUX-3 rate.

Aux rate set to	Aux (Function) Output Action
0	Normal ON/OFF only (Default)
1	Fastest flash rate 8 per sec twinkle.
2	3.5 flashes per sec.
3	2.5 flashes per sec.
4	2 flashes per sec.
7	1 flash per sec.
14	1 flash every 2 seconds, etc....
28	1 flash every 4 seconds
129	Momentary ON for 1/16 sec
130	Momentary ON for 1/8sec
133	Momentary ON for 1/4 sec
156	Momentary ON for 1 sec etc...
	All timings are approximate

CV 9 Output PWM Frequency

This allows the motor drive pulse width modulation (PWM) frequency to be changed. The factory default value is 216 which sets a frequency of about 70 Hz. This suits most type of DC motor. However larger motors benefit from lower frequencies such as 50 Hz set by 230 or more. Coreless motors should such as Portescap and Faulhaber should not be run below 125 Hz. Try values between 187 and 100 for a best compromise of whine and performance. Do not run larger can or open frame motors with CV 9 below 190.

CV 9 value	**PWM Freq Hz**	Notes
255	31	LARGE MOTORS ONLY
251	33	
247	35	
243	38	
239	41	
235	45	
231	49	
227	55	
223	61	
219	65	
216	**69**	**Default**
215	70	
211	75	
207	82	
203	89	
199	98	
195	109	
191	123	
187	**131**	**Most small motors**
183	140	
179	151	
175	164	
171	179	
167	197	
163	219	
159	245	
155	262	
151	280	
147	302	
143	327	Portescap and other low power precision motors only
139	357	
135	393	
131	437	
127	490	
123	523	
119	561	
115	604	
111	654	
107	714	
103	786	
99	874	
95	980	
91	1046	
83	1208	Use external filter with small motors only
79	1309	
75	1429	
71	1572	
67	1748	
63	1961	
59	2092	
55	2242	
51	2415	
47	2618	
43	2857	
39	3145	
35	3497	
31	3922	
27	4184	
23	4484	
19	4831	
15	5236	
11	5714	
7	6289	
3	6993	

You can use in-between values for CV 9 not show in the table for intermediate frequencies

TYPICAL CV 9 SETTINGS

LOCO / MOTOR TYPE	**CV 9 range**
Bachmann 00	190-230
Hornby Ringfield	190-230
Hornby XO-4 etc open frame	205-240
Mashima Can	191
Portescap RG4	191-17
Portescap RG7	191-17
Wrenn & Hornby Dublo (must be a ZTC 203)	230-255
Graham Farish 5 pole N gauge	191-185

ZERO 1 OPERATION ONLY

ZTC Loco Decoders are designed to operate with the obsolescent Hornby Zero 1 system. This they will do automatically when placed on a Zero 1 operating track. For more information, see the ZTC Decoder Zero 1 Supplement.

TESTING

Before plugging in the decoder, you must thoroughly check the wiring connections. These can be tested either with the ZTC 601 Loco Wiring Tester or with a conventional continuity checker or multimeter which uses low voltage and current.

Using conventional methods check the following

- No continuity between either brush and any wheel or track current collector.
- No short across motor brushes (Orange / Grey wires)
- No short between the track current collectors or shoe or pantograph if applicable.
- Check that any lights or other accessories are correctly isolated.
- Inspect for stray whiskers or bare wire showing which might short out in service.
- The wires need to be neat and tidy with no possibility of fouling any gears, shafts, flywheels, rods or other moving parts.

Please note: Any short circuit once in service within the wiring will cause destruction of the decoder which may be irreparable.

If possible use the ZTC 511 or other controller with a programming output to check the installed decoder by attempting to set its loco address. If there is any undetected wiring problem, testing this way will be safe. Only then put the decoder equipped loco on the main line for a full power test.

DC Compatibility

ZTC Loco Decoders are designed to be able to operate on a DC controlled track. This is done by the 'chip' measuring the voltage on the track and converting the value to a speed command to regulate the motor drive in PWM the same way it would under digital control. This is so called analogue mode.

Because the electronics need power to run before controlling anything, there is now an offset in the control range of about 8.5 volts before the motor will start to run.

Only a controller which puts out pure DC will control the loco properly. Half wave rectified DC and PWM controllers will not operate a converted loco satisfactorily.

Guarantee

ZTC Loco Decoders are warranted for any manufacturing defects one year from purchase. However, this does not cover damage due to mishandling, abuse or short-circuits.

If you should damage your decoder we will undertake to repair it for a fixed fee.

SPECIFICATION	ZTC 211 (Obsolete)	ZTC 202 (Obsolete)	ZTC 203	ZTC 214
SIZE width x length x thickness (approx.))	12 x 27 x 7mm	16 x 25 x 8 mm	16 x 24 x 7 mm	12 x 27 x 7 mm
Max Output Current	1.0 amp 3.0 sec	1.5 amp 3.0 sec	2.0 amp 3.0 sec	2 amp for 3 sec
Max. Continuous	0.75 amp	1.0 amp total load	1.5 amp total load	1.5 amp total load
Max. Track Volts	25 volts peak	25 volts peak	25 volts peak	25 volts peak
Min. Track Volts	8.5 volts	8.5 volts	8.5 volts	8.5 volts
Loco Function Outputs	NONE	2 at 0.2 amp DC max 1 at 0.5 amp DC max (F3)	2 at 0.2 amp DC max 1 at 0.5 amp DC max	NONE
Wiring Harness	ZTC 004 4 wire	ZTC 008 8 wire	ZTC 008 8 wire	ZTC 004 4 wire
MOST SUITABLE GAUGES	N, TT, HO/ OO & smaller O	Some N, TT, HO/ OO & smaller O	Larger HO/OO, O, small Gauge 1	N, TT, HO/ OO & smaller O

DCC COMPATIBLE

75 Portway, Wells, Somerset BA5 2BJ, England
Tel: 01749 – 677534 FAX 01749 – 674063
E mail: sales@ztccontrols.co.uk Web: www.ztccontrols.co.uk