ZTC Locomotive and Accessory Decoders

Installation and Programming

Manual

ISSUE 1.03

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.

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1.0 General Information

There are two principal types of Digital Command and Control (DCC) decoders. Those that are installed in a locomotive, or other mobile vehicle, and those that are positioned about the layout in static locations. The mobile variety are generally used to control the speed and direction of locomotives and various features such as lights, sound, or uncoupling devices located on board the locomotive or train. The stationary variety are used to remotely operate trackside accessories such as points, signals and other features of a layout, such as station or housing lighting and similar effects. Details of the Accessory Decoders can be found in Section 7.0. Locomotive decoders are described in the following text.

1.1 Locomotive Decoders

ZTC locomotive decoders are intended for use on model railway locomotives of most gauges. They are rated according to the highest current that the locomotive 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. For portability, they can also be safely operated on a layout powered with a standard 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 locomotive and be fine-tuned to optimise the speed range, starting characteristics and maximum allowable speed. Even mechanical 'stiction' can be overcome by introducing a small extra kick start pulse. There is also a decoder designed for carriage lighting (ZTC 250).

The locomotive decoder can be set up (programmed) by the user by putting the locomotive on a piece of track connected to the programming output of a DCC 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 for optimum performance to match the locomotive requirements. These can all be reset again and changed if required. Locomotive and lighting decoders come already set up ready for most applications with the address set to 3. Lighting decoders are programmed much like locomotive decoders, by placing the vehicle in which the lighting decoder is installed, on the programming track.

1.2 Speed Steps

ZTC locomotive decoders can use 14, 28 or 128 speed step control. 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 the range, up to 255 speed steps.

1.3 Output Drive

The output drive to the locomotive motor uses a Pulse Width Modulated (PWM) voltage for high efficiency and higher torque at low speed. Some decoders incorporate a feature that changes the PWM frequency and selects WhisperDrive™, making the decoder suitable for most small motor types used in model railways including the coreless types like Portescap etc.

1.4 Decoder Location

Locomotive decoders vary in size based on the current drawn by the locomotive motors and the scale of the locomotives ("O", "OO", "N" etc.) for which they are intended. Decoders

can usually be fitted inside the body, or in the tender of a loco, but can also be installed in a leading wagon or carriage if locomotive installation is not possible. In this case you will have to have decoder wires routed between the locomotive and the carriage or wagon concerned.

Try to locate the decoder away from direct contact with the motor. At high output levels, it is normal for the decoder to warm up (but not too hot to touch). This should be born in mind when deciding on a suitable mounting location. 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.

1.5 Selecting the Right Decoder

Decoders come in various physical sizes to suit the scale of the locomotives on your layout. Generally, the smaller the decoder, the lower the current rating it has. Similarly, the smaller the scale, then the current required to run the motors in the locomotive will be lower. The current rating of a decoder must not be exceeded, so you need to know the maximum current that your locomotives would draw. Some decoders do not have auxiliary outputs and others have up to six auxiliary outputs. Depending on your locos, you may choose to operate lights, smoke units etc., using the auxiliary outputs. So, the number of auxiliary outputs also needs to be known to be able to select a suitable decoder. See Appendix 1 for a table that will help you to select the right decoder for the job.

2.0 Installing the Locomotive Decoder

The typical locomotive decoder is connected between the two track voltage pickup connections and the two motor brush connections. This requires complete isolation of both motor brush connections from the original track voltage pickup connections. For can type motors and many open frame motor types, this is easily achieved. When the motor is built into the chassis frame, it is more difficult to achieve this isolation. If both brushes cannot be isolated from the track voltage pick up connections on a particular model, the locomotive cannot be fitted with any DCC decoder. However, on a DCC system, it can still be operated as locomotive 0 (DC or analogue mode).

2.1 Before You Start

2.1.1 Tools Required (Typically)

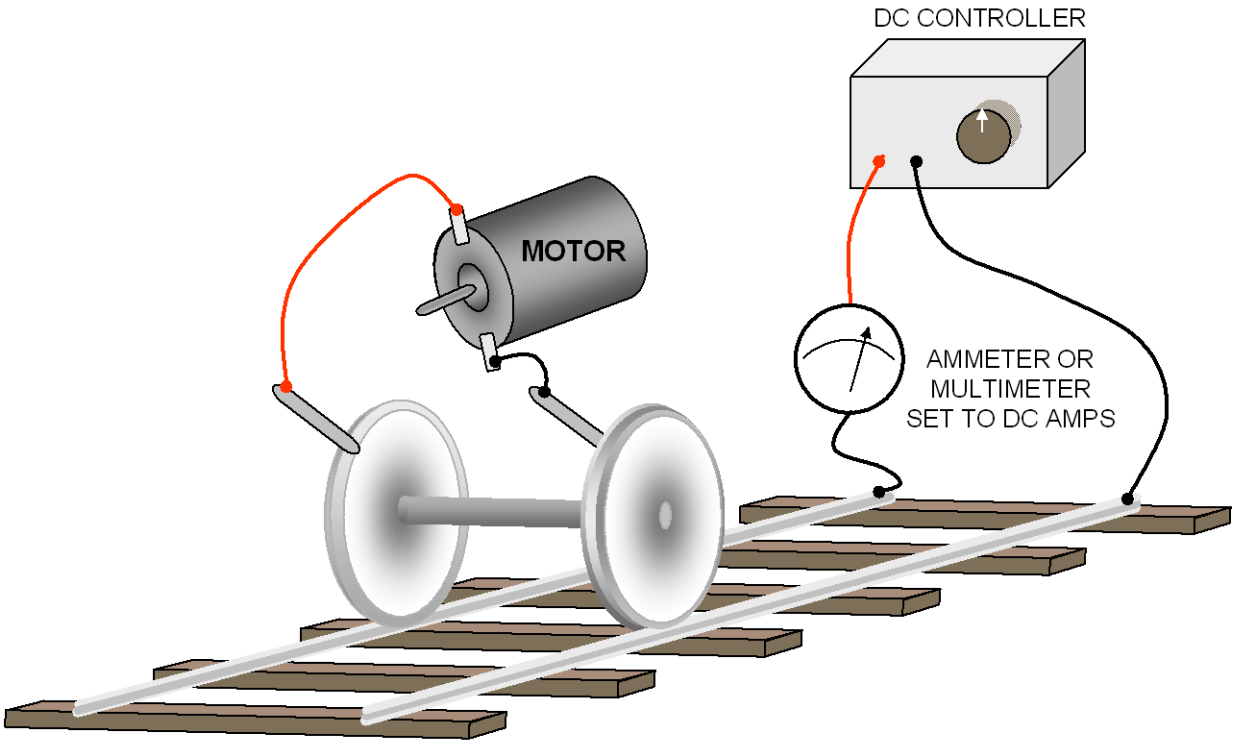
- Low power soldering iron (not greater than 40 Watts)
- 60/40 multicore solder
- Insulation sleeving (The optional ZTC 399 Zippi pack contains heatshrink and silicone sleeving together with other useful components to aid installation.)
- Screwdrivers (size and type depending on the type and brand of the locomotive concerned)
- Anti-static mat or earthed metal tray to be used as an anti-static work surface. Components in decoders can be damaged by static electricity. The anti-static work surface helps prevent static from damaging the decoder.

2.1.2 Test the Loco

DCC requires good electrical connections between the track and the decoder. This means that all pickups should be checked and cleaned of any dust, fluff, dirt and excess oil. Depending on the brand of loco, this may mean dismantling the wheel mechanism and cleaning the axles on the main driver or pickup wheels and the bearing surfaces with which they come in contact to make the electrical connection. Generally if a locomotive runs sweetly on standard DC power, it is in good shape to accept a decoder.

2.1.3 Check the Motor Current.

The type of decoder to be installed will depend primarily on the maximum current drawn by the motor. A decoder that is rated at a lower current than that drawn by the motor will be damaged and be rendered inoperable. You should therefore check the maximum motor current before installing the decoder. The maximum current drawn by a motor is that which occurs when the motor is prevented from turning (stalled) when the maximum rated voltage is applied to it. The diagram below shows how this can be done:



The diagram shows an ordinary DC controller with an ammeter or multimeter set to DC Amps. If you do not have this equipment, but you have a ZTC 511 controller, configure the ZTC 511 for pure DC output, and use it in place of the DC controller and ammeter. The current can be estimated using the two built in current monitor features of the ZTC 511 (see Section 2.5 and Section 12.4 of the ZTC 511 Manual for more details).

Adjust the DC controller to give the normal maximum voltage for the locomotive under test. Measure the current drawn when the motor is briefly stalled. Note: stalling the motor for too long will result in the motor overheating and possibly burning out. Stall for only as long as it takes to measure the current (no longer than 5 seconds). To this current reading, add the total current of all accessories (lamps etc.) planned to be operated by the decoder's auxiliary outputs (accessories must not draw more than the current rating of each individual auxiliary output).

The decoder to be fitted should have a current rating exceeding the total of the stalled motor current and the accessory currents. It is worthwhile to also check the free running current for the motor (i.e. the maximum current drawn when the locomotive is running at maximum speed). 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.

2.2 Basic wiring connections

On all decoders there are four power control connections, two which connect to the track pickups and two which connect to the motor terminals. Some decoders have several more wires and connections, but they are colour coded and conform to the NMRA DCC colour code standard. There are three connecting styles, depending on the decoder type. Some have permanently connected wires (ZTC 213 and 216), some have a miniature plug and socket arrangement (ZTC 203, 214 and 215) and others have screw terminals (ZTC 205 and 206). The table in section 2.2.2 shows the wire colours, or screw terminal numbers, for the four power control connections.

Any manufacturers' motor suppression components connected across the motor terminals **must not be removed**. These will not affect digital control operation. These components help reduce radio frequency interference from the motor, and are a legal requirement in most countries and jurisdictions. Also, removing them can have a detrimental affect on the operational performance of a DCC decoder.

2.2.1 Motor Isolation

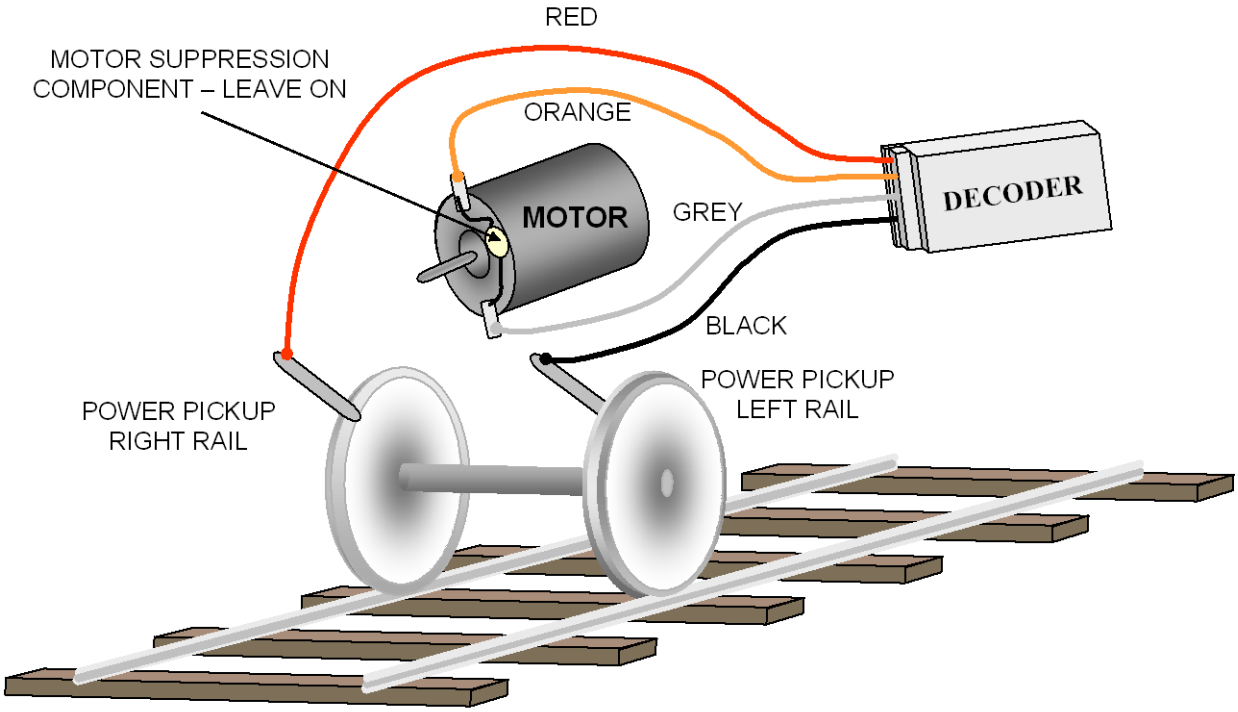
For the decoder to function, the motor terminals must be completely electrically isolated from the original track pickup connections or chassis. Most modern designs permit this easily but disassembly of major locomotive components might be necessary.
Some locomotive designs have a motor with one or both terminals intimately connected to a live chassis. These types will require more mechanical ingenuity to isolate the terminal or chassis itself. Failure to isolate the motor terminals completely will result in destruction of the decoder output circuit.
For locomotives for which decoder installation proves difficult, ZTC offers a decoder fitting service. For more information call the ZTC FREE Helpdesk at 0870 241 8730 between 9:00 am and 5:30 p.m. (U.K. time).

2.2.2 Motor Connections

The connections to the motor must be soldered to the motor terminals: ORANGE (3) to the motor connection that used to be connected to the right rail (looking from the cab towards the front of the locomotive), and GREY (4) to the other motor connection. The direction of travel of the locomotive depends on which way round the motor connections are made. If the incorrect connection is inadvertently made, this can be corrected without reversing the connections, later, when the decoder is programmed.

Ensure that only the minimum amount of heat is applied to make a good joint. Remember to put heatshrink insulation sleeving on the wires before making the joints so that the motor terminal connections can be protected afterwards. It is not recommended to use adhesive electrical tape to protect the connections, as this is prone to becoming unstuck over time and exposing the joint.

Wire Colour or terminal number		Function
RED	**1**	Right rail power pickup
BLACK	**2**	Left rail power pickup
ORANGE	**3**	Motor positive (+) drive (originally right rail)
GREY	**4**	Motor negative (-) drive (originally left rail)

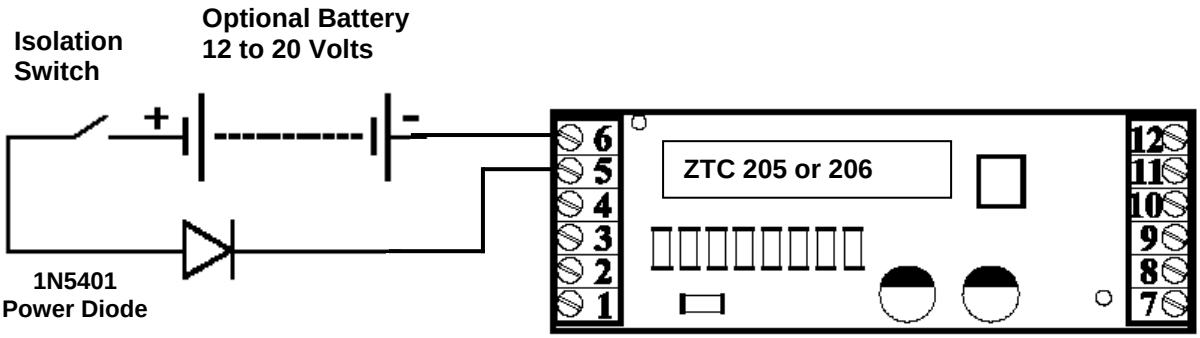


2.2.3 Track Pick Up Connections

The RED (1) and BLACK (2) wires take the track power to the decoder. Where these can be attached varies from locomotive to locomotive type. Sometimes there are solder tags available, otherwise you may have to make your own connections.
Sometimes, part of the chassis will be live to one rail or the other, or the chassis may be split into two halves. Which part connects to the left hand side wheels, and which part connects to the right hand side wheels, should be obvious. To solder the wires on to the chassis can be difficult. So it may be necessary to drill and tap a hole in the metal and then fit a screw with a solder tag to each half of the chassis.

2.2.3.1 Optional Battery (ZTC 205 and 206 only)

The ZTC 205 and 206 are designed for the larger gauges, such as G scale. This scale is often used on garden railways, where track conditions may not always allow good electrical pick up. A battery may be connected to the ZTC 205 and 206 to provide power to the decoder and motor during periods of poor power pick up from the rails. This ensures smooth operation over poor track. The diagram shows how the battery is connected to screw terminals 5 and 6. The diode is to prevent power from the tracks being fed back to the battery. The switch allows the battery to be disconnected from the decoder.



2.3 Connecting Locomotive Accessories

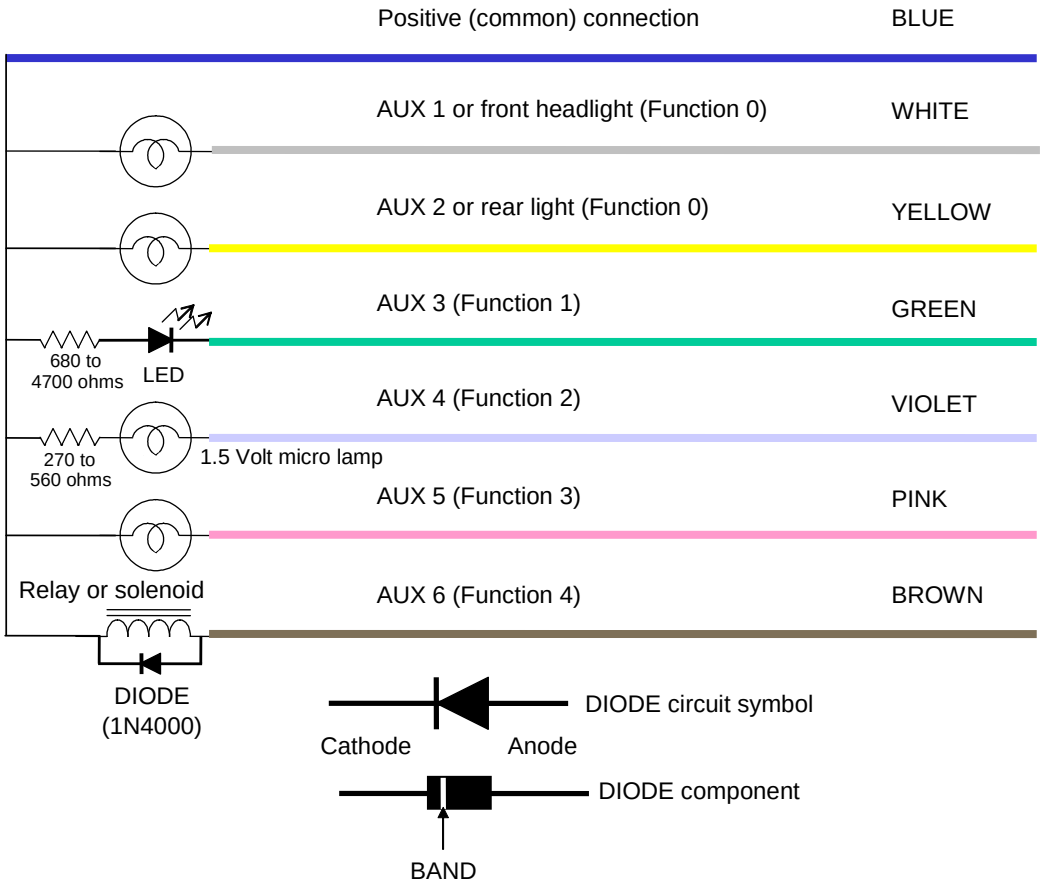
Depending on the type of decoder, up to six switched outputs, called auxiliary outputs, are available. These may be used to operate accessories such as front and rear lights, smoke generators, sound units or even uncoupling mechanisms, such as the ZTC 290, that might be fitted to the loco.

These outputs are completely independent of the motor drive and do not vary with its speed. The current that can be drawn from these outputs is limited, so care must be taken to ensure that any loads connected do not exceed the auxiliary output current rating of the particular decoder. The decoder accessory power is always DC.
Unused output wires should be properly insulated to avoid any possibility of short circuits from a stray wire. It is not recommended to cut off unused auxiliary output wires as you may wish to use them in the future.

2.3.1 Auxiliary Outputs Wiring Methods

There are three methods of wiring accessories to the auxiliary outputs. These are the full wave voltage wiring method, the half wave voltage wiring method and the voltage regulator method (ZTC 205 and 206 only). If full brightness of the lamps is not required, or the bulbs are rated at, or below, 12 volts, it is better to use the half wave voltage wiring method, instead of using the BLUE common return wire from the decoder. This is achieved by taking a return to one of the track pickups. The lamps, or other accessories, operate 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 but **they must all go to the same one**. Note that ZTC 217 and ZTC 218 can only use the half wave method, as they do not have a blue wire. On some types or make of locomotive the lights are installed with one side of each bulb connected to chassis. In which case, this wiring method is very convenient. Some accessories require additional components. See sections 2.3.3 and 2.3.4 for details.

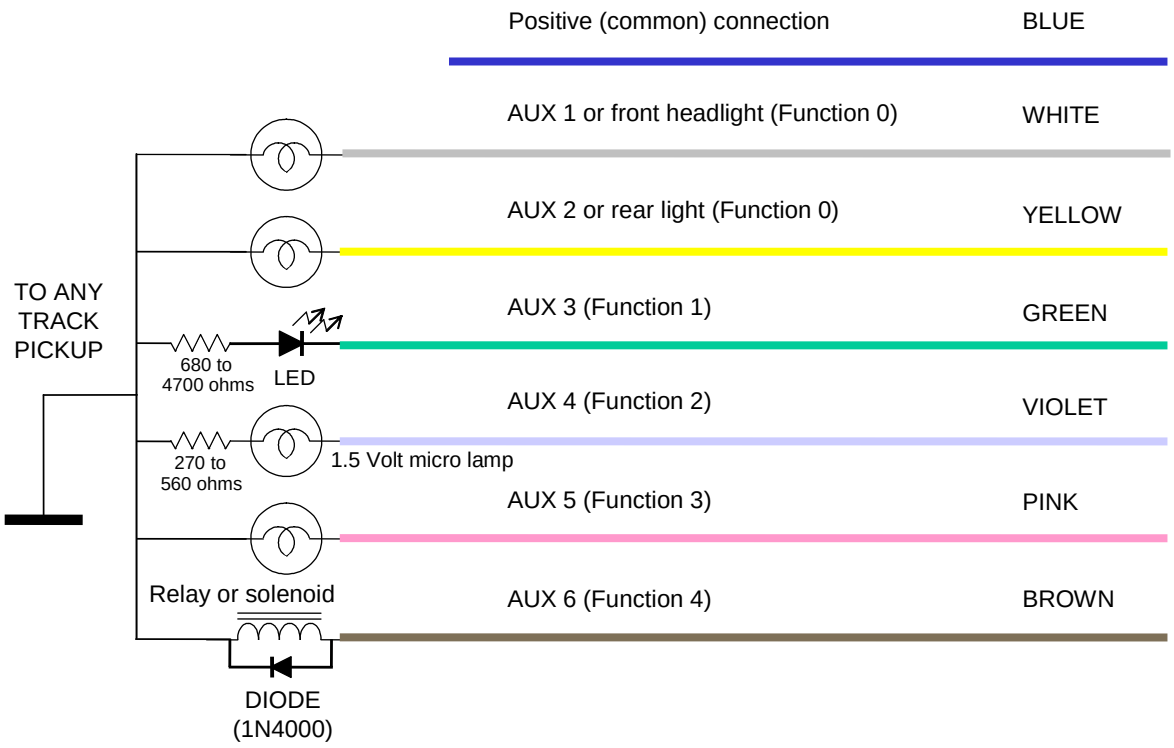
2.3.1.1 Full Wave Voltage Wiring



NOTE: Blue wire not available on ZTC 217 Decoder

Wire Colour or terminal number	Function Key	Loco Decoder Function
Blue 11		Common return. Positive (+) at track voltage less 1.2 Volts. Approximately 14 Volts nominal.
White 7	F0	Function 0. Front lamp or AUX 1 switched to 0 Volts DC
Yellow 8	F0	Function 0. Rear lamp or AUX 2 switched to 0 Volts DC
Green 9	F1	Function 1 (AUX 3)
Violet 10	F2	Function 2 (AUX 4)
Pink	F3	Function 3 (AUX 5)
Brown	F4	Function 4 (AUX 6)

2.3.1.2 Half Wave Voltage Wiring



NOTE: This is the only method of connecting lights on the ZTC 217 Decoder as they do not have a Blue wire connection.

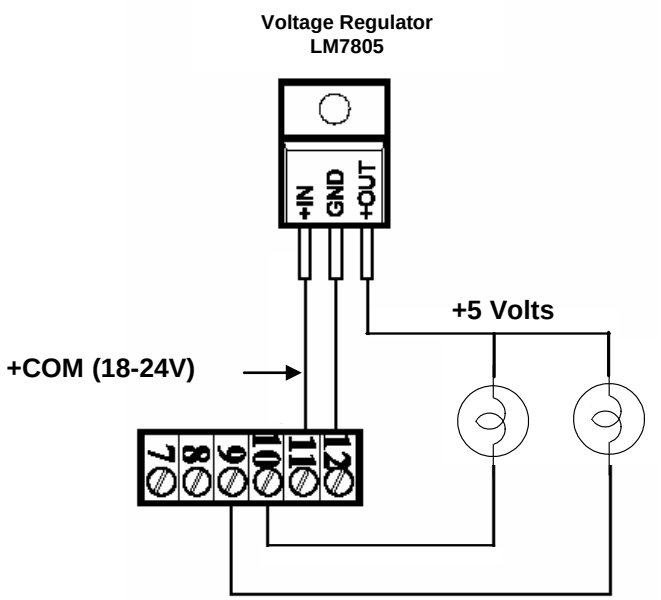
IMPORTANT
When the BLUE common wire is not used, it must be properly insulated. It should never be allowed to come into contact with any other connection or metalwork, otherwise the decoder will be destroyed.

Remember: The current drawn by an accessory must not exceed the current rating of the auxiliary output to which it is connected. Also, the total current drawn by all the accessories connected to the decoder that are likely to be operated simultaneously, plus the maximum (stall) current drawn by the motor, must not exceed the total current rating of the decoder.

Note: Take care not to mix up the brown wire on the ZTC 470 and ZTC 450 plug and harness with the fixed brown wire on the ZTC 227B decoder.

2.3.1.3 Voltage Regulator Method (ZTC 205 and 206)

As an alternative to the half wave voltage method, if the full brightness of the lamps is not required, then a voltage regulator may be used to reduce the output of the ZTC 205 and 206 decoder to a desirable value. A 5 volt regulator (LM7805) is shown in the diagram but other values may be used depending on the rating of the lamps or other accessories concerned. See Section 2.3.4. if solenoids or relays are to be powered with this method.



2.3.2 Existing lighting

In some locos, the existing lighting is operated by series diodes connected to the motor terminals. 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. Some locomotives and other vehicles with lighting, have the lamps connected directly across the motor or power pickups. If left in place these will always be on when the loco/vehicle is on the DCC powered track. As the voltage on DCC track is higher than standard DC systems, the lamps will be very bright, will generate excessive heat, which may melt plastic vehicle bodies, and burn out quickly. It is recommended that these lamps be disconnected and connected to an auxiliary output on a locomotive decoder or use the ZTC 250 lighting decoder for other vehicles.

2.3.3 Low Voltage Lamps & Light Emitting Diodes (LEDs)

Low voltage lamps will need to have a resistor wired in series to drop the voltage to an acceptable level for the lamp concerned. For 1.5 Volt micro lamps, a resistor of 270 ohms to 560 ohms, 1/2Watt (ZTC 153), will reduce the voltage down to a safe level.
For LEDs the resistor chosen depends on the brightness you want and the efficiency of the LED. The exact value is not critical, between 680 ohms (ZTC 514) and 4700 ohms (1/2 Watt) being suitable.

2.3.4 Solenoids and Relays

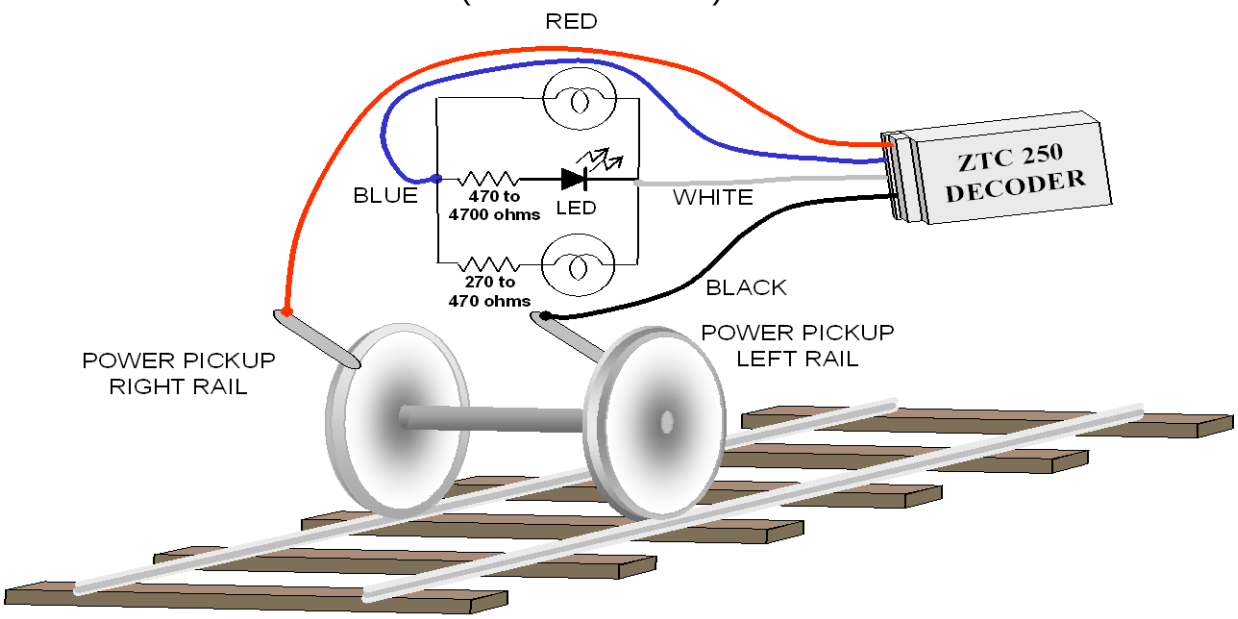
If the locomotive or other vehicle has a solenoid operated device, such as an operating uncoupler or a relay, a diode (ZTC 157) should be fitted across the coil. The banded end (cathode) goes to the common blue wire. The connection diagrams (2.3.1.1 and 2.3.1.2) show a relay connected to an auxiliary output and the correct way to recognize the cathode end of a diode. The diode prevents the kick-back energy from the inductance of the coil destroying the decoder's switching transistors. An additional diode will be required for every solenoid fitted and connected as described. Any diodes in the 1N4000 series are suitable for this job and are widely available. If you are unable to obtain any 1N4000, contact ZTC Controls who can supply them under the part number ZTC 157.

2.3.5 Lighting Decoder Wiring (ZTC 250 and 250B)

Lighting decoders are programmed with a locomotive number, just like locomotive decoders. This provides them with an address that can be called up by the controller. Once called up, the lights, or other accessories, can be operated using the Function keys.

Wire Colour	Lighting Decoder Function
Red	Right rail power pickup
Black	Left rail power pickup
Blue	Accessory – Common (positive)
White	Accessory – Supply (negative)
Yellow (ZTC 250B only)	Accessory – Supply (negative)

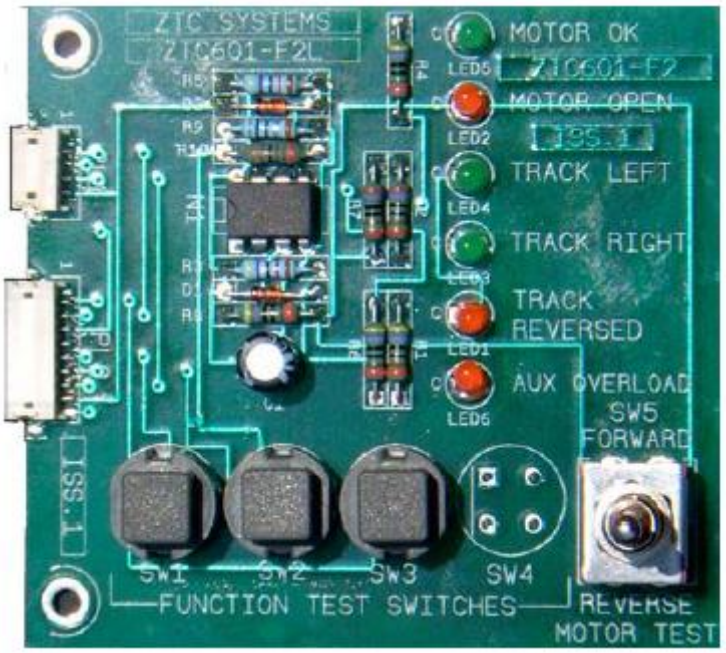
The diagram shows three lighting circuits connected for full wave voltage wiring. See section 2.3.1.2 for half wave voltage wiring. If a solenoid or relay is to be operated by this decoder a diode needs to be used (see section 2.3.4).



Note : The total current drawn by all items connected to the decoder output must not exceed the value shown in Appendix 1

2.4 Testing Your Decoder Wiring Using the ZTC 601 Harness Tester

If you have selected decoders that have a plug and socket connection, then the wiring harness connections can be checked with the ZTC 601 Harness Tester before the decoder is plugged in and connected to the locomotive. Testing will eliminate the risk of faulty wiring causing the decoder to be destroyed when connected to track power.



The ZTC 601 consists of a circuit board on which are mounted two decoder sockets (4 pin and 8 pin), 3 function switches and a motor test switch. Light emitting diodes (LED) are used to indicate pass or fail conditions. See the table below for troubleshooting details.

To use the Harness Tester a short piece of test track is required. Connect the track to a 9-volt PP3 battery, using the clip provided with the ZTC 601. The positive supply lead should be connected to the rail contacting the right hand side of the loco (as if you were in the cab) under test. Connect the 4 or 8 pin plug, of the wiring harness that you have just connected to your locomotive, to the 4 or 8 pin decoder socket, as appropriate. The plug should go in easily if you have it the right way round.

Note: The ZTC 215 harness can only be tested using the ZTC 602 adapter Harness.

Place the loco on the test track and observe the indicator LED's. Three greens and no reds shows the harness tests OK and the motor should be ready to test. Operate the toggle switch in either direction briefly to confirm that the locomotive runs in the correct direction. When the switch is operated, the state of the indicators is not meaningful. The accessories, if fitted and wired, are tested by pressing each of the function test switches in turn.

LED ON TESTER	DESCRIPTION OF PROBLEM
MOTOR OK	If this fails to light GREEN, it is likely that a short exists across the motor connections
MOTOR OPEN	If this lights RED, it is likely that the motor connections orange or grey are open circuit.
TRACK LEFT	If this fails to light GREEN, it is possible that there is a short from the black wire to the grey or orange wires
TRACK RIGHT	If this fails to light GREEN, it is possible that there is a short from the red wire to the orange or grey wires
TRACK REVERSED	If this lights RED, the red and black wires to the track pickup are the wrong way round or the loco is facing the wrong way.
AUX OVERLOAD	If this lights RED with one of the function test buttons pressed, then the accessory device or lamp connected is taking too much current and may be shorted.
FORWARD/ REVERSE	Only operate this switch if you have three GREENS as above. This selects forward and reverse power to the motor to check wiring polarity and motor free running.

3.0 What You Need to Know About locomotive Decoders

For independent operation of several locomotives on the layout, each locomotive needs to have a locomotive decoder installed (except locomotive 0, which can be a normal locomotive without a decoder). A locomotive decoder contains a miniature computer chip that responds to commands (speed up, slow down, turn on lights, etc.) encapsulated in an electronic message called a “packet”, sent to it along the rails of the train track. All the decoders on the layout receive their commands in this way, so a mechanism has to be applied so that an individual decoder knows what packets it should respond to, and what packets it should ignore. To achieve this, each decoder has a unique electronic address or locomotive number assigned to it. Packets destined for a specific decoder contain its electronic address, telling the decoder that the commands contained in the packet are for it to respond to. All new decoders are supplied with the same address or locomotive number (3), so the first step after installing a decoder in a locomotive is to change the locomotive number to something different from all the other decoders on the layout. There are other features in locomotive decoders that can be changed as well. Each of them, including the locomotive number, is referred to as a **Configuration Variable**, or **CV**.

3.1 Configuration Variables (CV)

All the CV’s supported by ZTC decoders are described throughout this manual.

CV’s hold information that determines how a decoder will respond to certain commands sent to it from the controller. This information can be changed by the user so that the operating characteristics of a locomotive (maximum speed, rate of acceleration etc.) can be adjusted to suit the type of locomotive or the demands of your layout.

The information held in a CV is stored in the decoder memory in a digital format (a series of 1’s and 0’s) . The DCC controller is capable of sending special commands to a decoder to change, or re-programme, this information. To do this, a special programming track is required.

3.2 Programming Track

To perform any change to a CV requires that a special programming track be connected to the DCC controller. All brands of DCC controller require a programming track. In this manual, reference is specifically made to the ZTC 511 or 505 DCC controller and all decoder programming commands shown relate to this equipment. However, any ZTC decoder can be programmed by any other brand of NMRA compatible controller by following the manufacturer’s instructions.

The locomotive containing the decoder to be changed (programmed) is placed on the programming track. More than one locomotive on the track will almost certainly result in both decoders being programmed with the same values, or possibly not responding at all.

The programming track must be isolated from all other parts of the layout, so that other decoders do not get re-programmed unintentionally. The programming track also allows small current pulses generated by the decoder, in response to certain commands, to be fed back to the controller as confirmation that commands have been received and executed.

Whenever a programming command is entered on the ZTC 511 or 505 controller keypad the programming track becomes active and the power to the rest of the layout is automatically disconnected. Another feature of the programming track is that the current

fed to it is limited to approximately 100 mA, just in case there is a wiring fault with a newly installed decoder. Damage to a decoder is less likely when current is limited. The programming track is fed normal power when the ZTC 511 or 505 is not in the programming mode.

3.3 Programming Decoders – ZTC 511 or 505 Controller

To set new values in a decoder (programme) requires commands to be sent from a DCC controller to the decoder in a locomotive via the programming track. For the ZTC 511 or 505 controller, these commands are sent by pressing certain keys, in a specific order. In this manual (as in all the new ZTC manuals), a sequence of keystrokes is represented by a list of command keys, or number keys, to be pressed in the order that each appears in the list. An arrow (→) is placed between each keystroke to more clearly show which key to press next. At no time are buttons held down, or more than one button pressed at the same time.

Example: **CONTROL** → **SIGNAL** → **1** → **ENTER R**

The example indicates that the CONTROL button is pressed first, then the SIGNAL button, followed by the number 1 button and finally by the ENTER R button.

Where the entry requires the user to choose a numeric value (a locomotive number, or system parameter number, for example), this is represented by words in ***bold lower case italics***.

Example: **LOCO** → ***loco number*** → **ENTER R**

This translates into pressing the locomotive button first, followed by the desired locomotive number (e.g. 123) entered from the number keypad and then followed by the ENTER R button.

The above convention is used throughout this and all ZTC manuals.

If a mistake is made in keying in a sequence of commands, provided an ENTER key has not already been pressed, pressing the CLEAR button will abort the operation and allow you to start again.

For more detailed information about using the ZTC 511 or 505 to programme any NMRA compatible decoders see the ZTC 511 or 505 Operations Manual.

3.4 First Time locomotive Decoder Programming

Before you put any locomotive on your programming track for the first time it is advisable to first cut-off all track power by pressing the ALL STOP button twice, or the preferred method is using a ZTC 010 track isolation switch.

Once the locomotive has been placed on the track, press CLEAR or reset the track isolation switch to restore power to the track.

This ensures that, should there be any wiring fault with a newly installed decoder, there is less likelihood of any damage being done to the decoder by the full track power level. A limited power level is applied to the programming track during each programming or verification attempt. Full power to the layout can be restored, after programming is completed, by pressing **CLEAR** , and confirming with an **ENTER R** .

3.5 Programming Mode

Whenever any of the programming keystrokes are entered, the ZTC 511 or 505 goes into the programming mode. This is indicated by the PROGRAM light emitting diode (LED) flashing. When the programming sequence has finished, the message **Pgm. Finished** will appear on the LCD screen followed by the **ALL HALTED** message. More programming keystrokes can be entered at this time.

To return the ZTC 511 or 505 to normal operating mode press the **CLEAR** button and then confirm with an **ENTER R**

3.6 Programming Locomotive Decoders

There are two main modes for programming locomotive decoders. These are the "**paged mode**" or E1 and the "**direct mode**" or E2. The "**paged mode**" is the simplest and ZTC preferred method and will be used as the principal programming method in this manual. Either method can be used and details of the "**direct method**" can be found in the ZTC 511 or 505 DCC controller manual.

Unless otherwise indicated, all CVs can be programmed using the following keystrokes:

POINT → **LOCO** → ***cv number*** → **PRESET** → ***new value*** → **ENTER R**

Where ***cv number*** is the CV number desired and ***new value*** is a number, the value of which depends on the CV being programmed. See Section 7.1 for a list of important CV numbers.

Example: To programme CV 1 (the locomotive address) to 82 use the following sequence:

POINT → **LOCO** → **1** → **PRESET** → **82** → **ENTER R**

3.6.1 Verifying the Existing Value of a CV

To verify the value of a CV use the following keystrokes:

POINT → **LOCO** → ***cv number*** → **ENTER R**

Where ***cv number*** is the number of the desired CV.

For example, if you wanted to verify the locomotive address of a decoder the ***cv number*** would be 1.

3.6.2 Resetting locomotive Decoders to Factory Settings

There may be occasions when an incorrect CV value is stored in a decoder, which could render a decoder inoperable. Or, you may wish to re-use a decoder in a different locomotive and would prefer to return CV's to known values (factory default settings). Under these circumstances the resetting feature is especially useful. There are two methods of resetting ZTC locomotive decoders to factory settings. The method used depends on the type of decoder concerned.

Method 1.

ZTC 202, 203, 205, 206, 211, 214, 224 and 225 - Reset these decoders using the following keystrokes:

PRESET → **POINT** → **ENTER R** and confirm with another **ENTER R**

As the restore process proceeds, the LCD screen will display an increasing number of right chevrons (>>>>….). When complete the LCD screen will display "Finished" followed by "ALL HALTED".

Press **CLEAR** and **ENTER R** to return to normal control mode.

Method 2.

ZTC 213, 215, 216, 217, 226, 227, 250 and 251 - Reset these decoders using the following keystrokes:

POINT → **LOCO** → ***8*** → **PRESET** → ***8*** → **ENTER R** → **ENTER R**

The decoder will take a few seconds to complete the resetting process. This reset method may also be used to recover decoders which have been inadvertently reset using Method 1 and now appear to be none functional.

All decoders that are shown as supporting CV 8 support this method of resetting. See Section 3.7 for details.

The ZTC 4000 Plug and Play Range are based on the standard Decoders.

ZTC Plug and Play Number	Base Decoder Number
ZTC 4001	**ZTC 214**
ZTC 4002	**ZTC 226**
ZTC 4003	**ZTC 213**
ZTC 4004	**ZTC 216**
ZTC 4005	**ZTC 226**
ZTC 4006	**ZTC 216**

Reset these decoders using the following keystrokes:

PRESET → **POINT** ***Decoder number I.E ZTC 4001 Enter ZTC 214*** **ENTER R**

As the restore process proceeds, the LCD screen may on some decoders display an increasing number of right chevrons (>). When complete the LCD screen will display “Finished” followed by “ALL HALTED”.

Press **CLEAR** and **ENTER R** to return to normal control mode**.**

3.7 Table of CV numbers supported

The table below shows which ZTC decoders support the various CV's. Some CV's have a different function in some decoders compared with others. This is a legacy from earlier ZTC designs which allows for compatibility with the obsolete, but still popular, Hornby Zero 1 controllers. Each CV number is described in detail in the corresponding reference section in this manual.

Note: Where there is an 'A' or 'B' version of a decoder, only the 'B' versions are in current production. If there is no way of determining whether a decoder is an 'A' or a 'B' version buy looking at it. Note All products purchased after December 1st 2002 are 'B' versions.

CV num.	ZTC 202 203B 225B	ZTC 205B 206B	ZTC 211A 214B 224B	ZTC 213 213A	ZTC 213B	ZTC 215 215B	ZTC 216 226	ZTC 216B 226B 227B	ZTC 217	ZTC 250	ZTC 250B 251B	Referenc eSection
1 – short address	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	4.1
2 – start voltage	✔	✔	✔	✔	✔	✔	✔	✔	✔			4.2
3 – acceleration rate	✔	✔	✔	✔	✔	✔	✔	✔	✔			4.3
4 – deceleration rate	✔	✔	✔	✔	✔	✔	✔	✔	✔			4.3
5 – maximum speed	✔	✔	✔	✔	✔	✔	✔	✔	✔			4.4
6 – mid step speed 1	✔	✔	✔	✔	✔	✔	✔	✔	✔			4.5
8 – decoder reset	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	3.6.2
9 – PWM frequency	✔	✔	✔	✔	✔		✔	✔	✔			4.6
11 – packet loss	✔	✔	✔									6.3
12 – power source	✔	✔	✔	✔	✔	✔	✔	✔				6.2
13 – enable functions				✔	✔		✔	✔				6.4
17 – extend addr's 1	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	6.5
18 – extend addr's 2	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	6.5
25 – mid step speed	✔	✔	✔	✔	✔	✔	✔	✔				4.5
29 – config register	✔	✔	✔	✔	✔	✔	✔	✔				6.4
41 – aux flash funcs	✔									✔	✔	5.1
42 – aux flash funcs	✔									✔	✔	5.1
43 – aux flash funcs	✔									✔	✔	5.1
49*	✔ 1	✔ 1	✔ 1								✔ 2	1 – 6.7 2 - 5.4
50 – lighting effects 1											✔	5.4
53 – funcs o/p option	✔	✔	✔									5.2
54 – Whisperdrive™	✔	✔	✔	✔	✔	✔	✔	✔	✔			4.7
55*	✔ 1	✔ 1	✔ 1				✔ 2	✔ 2				1 – 4.10 2 - 4.8
56*	✔ 1	✔ 1	✔ 1				✔ 2	✔ 2				1 – 6.3 2 - 4.8
57 – decay rate							✔	✔				4.8
61 – lighting control	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	5.3
62 – lighting effects 2											✔	5.4
63 – lighting effects 3											✔	5.4
64 – lighting control											✔	5.3
65 – kick pulse	✔	✔	✔									4.9

* CV 49, CV 55 and CV 56 can have entirely different functions for different decoders.

4.0 Motor Control CV Options

The following describes the various CV's that affect motor control. Not all decoders have all the features. See Section 3.7 for a table of CV's and the decoders that support them.

4.1 CV 1 Locomotive Address or Number

Default value 3. Related CV's – 17 and 18

When shipped from the factory, all decoders have CV 1 set to a value of 3. This means that the decoder will respond to locomotive address number 3. To change the locomotive address number, you change the value of CV 1 to a number between 1 and 127.

Note that locomotive numbers from 128 to 9999 can be used if the locomotive decoder supports the extended addressing option and the option is enabled. See Section 6.4 for more details.

4.2 CV 2 Start Voltage

Default value 8. Related CV's - none

This sets the proportion of full power that the decoder uses as a base level for the first 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. It can only be found by experimentation for a given model and will vary from locomotive to locomotive of the same type.
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. Other makes of decoder may use different numbering for this CV (see decoder instructions).

4.3 CV 3 and CV 4 locomotive Acceleration and Deceleration

Default value CV 3 = 0, CV 4 = 0. Related CV's - none

When the controller sends speed commands to the loco, if the CV 3 (acceleration rate) and CV 4 (deceleration rate) values are both 0, the response will be fast and may look jerky. By introducing acceleration and deceleration factors, the locomotive decoder smoothes out the speed steps. However, if the figures are too high, the response of the locomotive may be too 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.
Note: The use of 128 step mode by the controller will also greatly improve smoothness.

4.4 CV 5 Max speed

Default value 0 or 255. Related CV's - none

This sets the proportion of full power that can be applied to the motor on the maximum regulator position (speed step) and therefore limits the top speed of the locomotive. Some locomotives do not ever need full power so reducing this value from its maximum figure will provide better speed control over the operating range.
On ZTC decoders the range is 0 - 255 with 0 or 255 being the same full power value.

Note: If zero is ever set the locomotive will never move. A lower practical limit is about 32 for very sensitive motors.

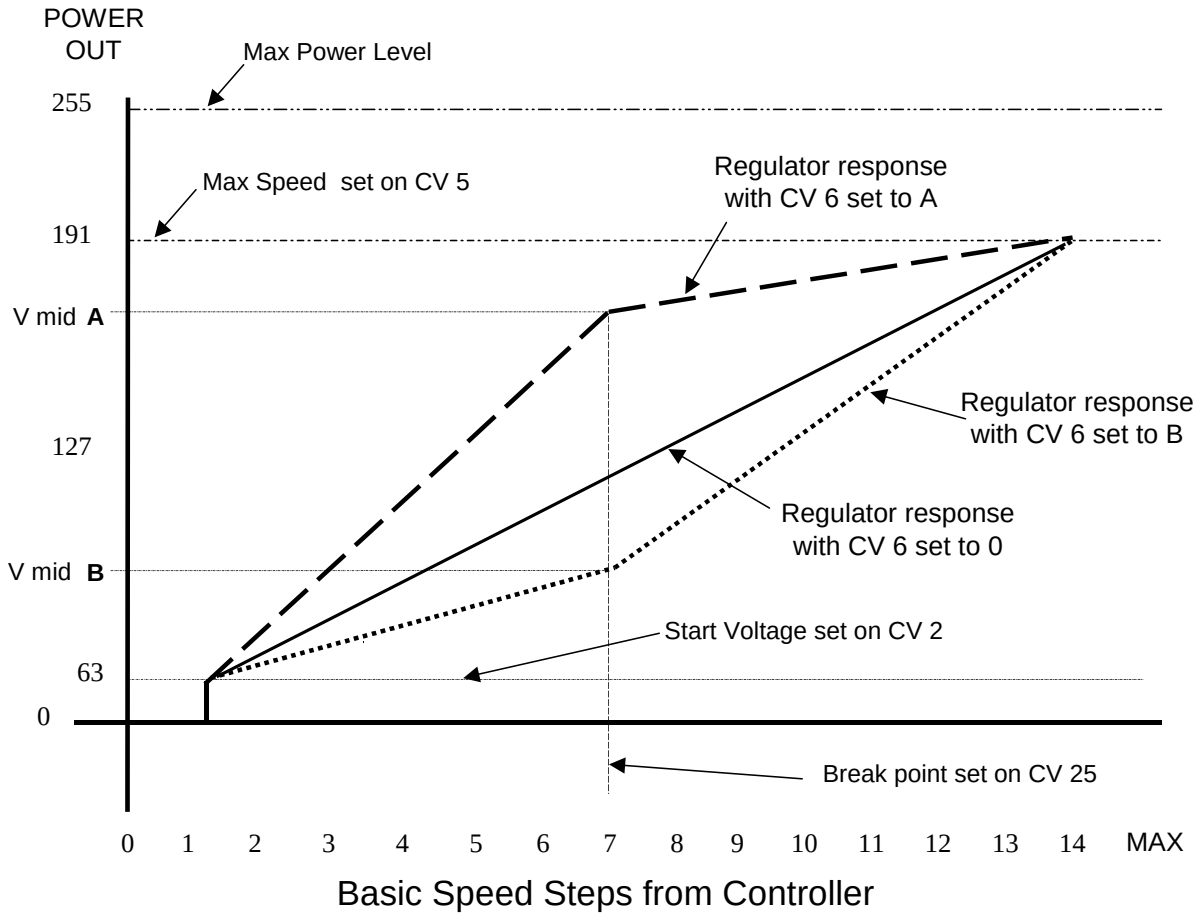
4.5 CV 6 and CV 25 Mid Step Speed

Default value CV 6 = 0, CV 25 = 0. Related CV's - 5

When this value is zero the control speed curve for the power delivered to the motor is linear from the start voltage, set with CV 2, to the maximum speed, set with CV 5. However, setting CV 6 to a number between one third and two thirds of the two values will bend the power curve, generally improving the low end control range. In particular, if the value of CV 6 is set below half the maximum speed value (see V mid **B** in the diagram below) slow running of the locomotive will improve considerably.

For advanced users another CV exists in ZTC decoders to move the break point position along the speed step axis. This is CV 25, the V mid step modifier. CV 25 is set to 0 by default and this positions the break point half way along the speed step scale, as shown in the diagram below. However, the value of CV 25 can be changed from 1 to 13 to vary the break point position along the speed step axis.

Regulator Response Modification using CV 6



4.6 CV 9 Output PWM Frequency

Default value 216. Related CV's – 54

Changing the value in CV 9 allows the motor drive pulse width modulation (PWM) frequency to be changed. The default frequency is 69 Hz, which suits most DC motors. Larger motors benefit from lower frequencies and smaller motors from higher frequencies. Experiment for the value most suited to your locomotive's motor.

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	

CV 9 value	PWM Freq Hz	Notes
143	327	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 ZTC150 ZTC151 AND ZTC156
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	
1	16 KHz	ZTC 217 only
0	32 KHz	WhisperDrive, Coreless Motors RG4, RG7 etc Mini Motors etc

Suggested CV 9 settings

Note: Coreless motors, such as Portescap, Maxon and Faulhaber, should be run at 16 or 32 KHz and certainly not below a frequency of 1208 Hz (CV value = 83) or permanent damage may occur to the motor. The ZTC 217 only has 2 settings, 0 for corless motors and 1 for smaller conventional motors for which the pwm frequency is set to 160Hz..
Set CV 9 value to 0 for the best performance for these types of motor.

If you are in doubt as to which setting to use for your motor, adjust the value of CV 9 for the lowest level of whine and best running performance. **Do not run larger can or open frame motors with CV 9 below 190.**
The following table gives starting points for the motors in some ready-to-run locomotives.

LOCO / MOTOR TYPE	CV 9 range	LOCO / MOTOR TYPE	CV 9 range
Bachmann 00	190-230	Hornby XO-4 etc open frame	205-240
Hornby Ringfield	190-230	Wrenn & Hornby Dublo (must be a ZTC 203)	230-255
Mashima Can	191	Portescap RG4 selects WhisperDrive™	0
Graham Farish 5 pole N gauge	191-185	Portescap RG7	0

4.7 CV 54 WhisperDrive™

Default value 0. Related CV's - 9

Newer decoders in the ZTC range also support WhisperDrive™, which is a system allowing decoders to drive both large and small coreless motors. The features of CV 54 are an improvement over the approach taken using CV 9, described above, when driving coreless motors. Current compensation can also be selected.

Current compensation greatly improves the performance of a locomotive, by dynamically adjusting the current drive to the motor. This overcomes the loss in torque that occurs when the motor is fed from a high frequency PWM power signal. The default status for current compensation is ON, with the value for CV 54 set to 0
.
Setting the value of CV 54 to 1 activates the WhisperDrive™ feature and maintains current compensation ON. The motor PWM frequency is set to approximately 32 KHz.

Setting the value of CV 54 to 16, disables both WhisperDrive™ and current compensation. A value of 17 in CV 54 turns on WhisperDrive™, but without current compensation. The table below summarizes the settings.

CV 54 value	High Frequency PWM	Current Compensation
0	OFF	ON
1	ON	ON
16	OFF	OFF
17	ON	OFF

4.8 CV 55, CV 56 and CV 57 Speed Stabilization

These three CVs, work together to provide the speed stabilization feature. When active and correctly adjusted, this feature allows trains to keep a steady speed, when running on straight and level ground, going around corners and when going up and down small gradients. The power made available to the locomotive motor is automatically increased when it is sensed that the locomotive is working harder e.g. going up hill. This feature also improves the slow running performance of some locomotives.

By default this feature is disabled. To enable it, CV 57 must be set to a value of 1 or higher. In most instances the factory settings of CV 55 and CV 56 can be left unaltered.

CV 57 Decay Rate.
Default value 0. Related CV's 55 and 56

The method of adjustment of CV 57 is one of trial and error. The starting point should be to set CV 57 to 1 and observe how the train performs. The train should run smoothly and at a constant speed around corners and up small gradients. The value of CV 57 should be increased in increments of 1 until the locomotive starts to hunt (rhythmically speeds up and slows down) then the value of CV 57 should be decreased by 1 digit, or until the locomotive stops hunting. This will be the best value for this particular train. Typical values for CV 57 will lie between 3 and 6.

Note that the value of CV 57 may need to be adjusted if the weight of a train changes when rolling stock is added or removed.

CV 55 Steady State Compensation.
Default value 128. Related CV's – 56 and 57

The Steady State Compensation sets the rate that the decoder compares the target speed, set by the controller, with the actual speed of the train. The higher the value, the more rapid the correction, but the stiffer the response. When set correctly a smooth and stable response will be achieved. Typical values for CV 55 will be in the range 75 to 200. The value should be adjusted in small steps of 2 or 3 at the most.

CV 56 Dynamic Compensation.
Default value 48. Related CV's – 55 and 57

The decoder measures the difference between the actual speed of the locomotive and the speed setting on the controller. This measured difference and the value in CV 56 are used to control the rate at which the locomotive will reach the desired speed. Values in CV 56 can range from 0 to 255. The higher the value, the more rapid the locomotive will attain the required speed. Be aware that if the value is set too high then instability and hunting around the set speed will result. Use the lowest value that gives a stable response.

4.9 CV 65 Kick Pulse

Default value 0. Related CV's – 55

CV 65 sets the duration of an extra pulse of power to the motor when the controller tries to start the locomotive from rest. If used with a value greater than 0, it helps overcome the initial starting friction (sometimes called stiction). Experiment for best results. Value should not exceed half of the value of CV 5 for best results.

4.10 CV55 Kick Pulse Power Level

Default value 63. Related CV's 65

On some decoders CV 55 is used to set the amplitude of the kick pulse provided by CV 65. The range of values for CV 55 is 0 to 255. The default setting gives a kick pulse of approximately 25% of full power.

5.0 Auxiliary function CV Options

The following describes the CV's that control the auxiliary functions that can operate features such as lighting and other accessories. Not all decoders support all CV's. See Section 3.7 for a table of CV's and the decoders that support them.

5.1 CV 41, CV 42 and CV 43 Auxiliary Output Flasher Functions.

Default value 0, Related CV's – 53

Note: This only applies to the ZTC 202, 203, 205 and 206 decoders.

Any of the AUX (short for auxiliary function) outputs can be made to flash continuously, or momentarily, to operate special feature lights. These will operate when selected to be ON from the controller. The type of function (flash or momentary) is set by the value entered in the respective CV. Values from 1 to 127 enable a flashing output. The lower the value the faster the flash rate. Values from 128 to 255 provide a momentary on function. The higher the number, the longer the output is on. For normal on/off operation set the CV value to 0. The table below shows examples of the effects achieved with different values.

CV 41 sets AUX-1 output, CV 42 sets AUX-2 output and CV 43 sets AUX-3 output.

Set Value	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

5.2 CV 53 Auxiliary Function Outputs Option Register

Default value 0. Related CV's – 41, 42 and 43.

This allows different modes of operation for the auxiliary outputs controlled by the function keys, or permits automatic selection, such as turning locomotive lights on and off depending on direction of travel. See the table below for settings.

Set value	FEATURE	Notes
0	Default	If 28 or 128 step mode all Aux.'s controlled by Function keys
2	AUX-1 and AUX-2 operate on locomotive direction	This also happens in 14 step mode if CV 29 is 0 or 1
4	All AUX output disabled	Stops spurious operation if none needed.

5.3 CV 61 and CV 64 Lighting Control

Default values 0. Related CV's – None.

The factory setting for CV 61 is 0. This sets the auxiliary outputs 1 (white wire or terminal 7) and 2 (yellow wire or terminal 8) to operate automatically for directional lighting. The lights can be turned on or off by using Function 0.
Changing the value of CV 61 to 1, allows each auxiliary output to be operated independently. Auxiliary output 1 is operated using Function 0, and auxiliary output 2 is operated by using Function 4.

CV 64 allows the function keys used to operate the outputs to be changed. The NMRA specifications refer to this feature as Function Mapping.The table shows the decimal values that must be in each CV to allow the different function keys to operate the outputs.
Not all decoders support this feature.

CV 64 Value	CV 61 Value	White lead or terminal 7	Yellow lead or terminal 8	Result
0	0	Function 1	Function 2	OFF
0	1	Function 0	Function 1	OFF
0	2	Function 1	Function 2	ON
0	3	Function 0	Function 1	ON
1	2	Function 3	Function 4	ON
2	2	Function 5	Function 6	ON
3	2	Function 9	Function 10	ON
1	0	Function 3	Function 4	OFF
2	0	Function 5	Function 6	OFF
3	0	Function 9	Function 10	OFF

5.4 CV 49, CV 50, CV 62 and CV 63 Setting Lighting Effects

Default values 0. Related CV's – 49, 50, 62 and 63.

The ZTC 250B and 251B has a large range of lighting effects which can be selected by programming CV 49 for the white output lead, CV 50 for the yellow output lead, 51 for the green output lead and 52 for the violet output lead with values shown in the table below.

CV Value	Resulting lighting effect.
0	Normal operation ON/OFF
1	Simulated FRED
2	Simulated Mars
3	Simulated Beacon
4	Single Pulse
5	Double Pulse
6	Medium Pulse
7	Mostly ON pulsing OFF

The flashing rate of the above functions can be adjusted using CV 62 for the white lead and CV 63 for the yellow lead. Setting a value of 0 gives the slowest rate and setting to a value of 7 the fastest rate.

6.0 Advanced CV Options

Information is stored in a CV in binary form (a series of 1s and 0s). Each CV has the capacity to hold eight 1s or 0s. Each 1 or 0 is called a bit, so each CV consists of eight bits. Some CVs use all eight bits to store a single decimal number (CV 2 for example). The range of decimal numbers any eight bit CV can store is from 0 to 255.

The more advanced CVs store information by relating to the 1 or 0 state of individual bits. In this case the 1 or 0 state of a bit determines if a feature is enabled (1) or disabled (0). Hence, the bits are called "control bits". Up to eight features can be controlled by one CV in this way.

The positions that individual bits occupy in the eight bit CV are called bit fields. When you store a decimal number in a CV, the 1 or 0 state of the bit fields will change depending on the actual decimal number stored. However, in order to be sure that the bit fields will be set to the desired 1 or 0 state, you will have to be sure that you have selected the correct decimal number to be stored. This decimal number has to be calculated, based on the 1 or 0 state of each bit field in the CV. It is far more convenient if you have access to each individual bit field and can set the bits according to desired features. This technique is called "bit mapping".

6.1 Changing Binary Bit Fields (Bit Mapping)

For CV 10 and higher, the ZTC 511 or 505 has the capability of changing the 1 or 0 state of individual bit fields. This saves the inconvenience of calculating decimal numbers for the more involved CVs like CV 12 and CV 29.
To view the current bit status of a CV use :

POINT → **LOCO** → ***cv number*** → **ENTER R**

To access the bit field entry mode use the following keystrokes:

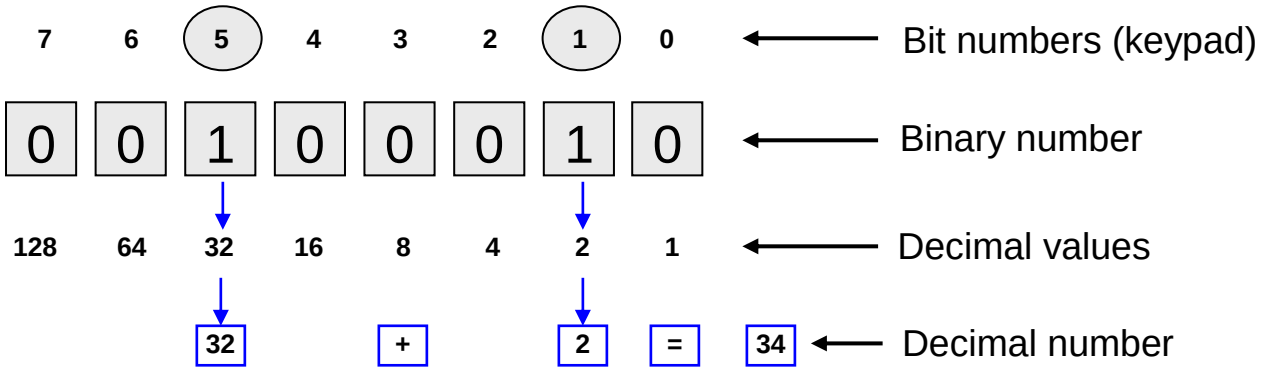
POINT → **LOCO** → ***cv number*** → **SIGNAL** → ***set bits*** → **ENTER R**

Where ***cv number*** is the CV required to be changed and ***set bits*** is where you set each of the eight bits by using the number keys 0 to 7, which toggle each bit on or off. The LCD screen displays all the bits as off, or dashes, by default. If a bit is set to on (1) the number of that bit is displayed in its correct position (bit field) in the 8 bit sequence on the LCD screen. If a bit is set to off (0) a dash appears in its place. The equivalent decimal number is displayed to the right of the bit fields. When all the bits are set as desired, pressing ENTER R completes the operation and enters the changes into the CV.

Example: **POINT** → **LOCO** → **29** → **SIGNAL** → **1** → **5** → **ENTER R**

This sets bit numbers 1 (14/28 speed step mode) and 5 (extended addressing) to on (binary 1) and thus enters decimal number 34 in CV 29.

The equivalent decimal number is calculated by adding up all the decimal values associated with each bit that is set to 1 (see diagram below : 32 + 2 = 34)



6.2 CV 12 Power Source Conversion

The ZTC 511 can operate as a DC controller, a Zero 1 controller or a DCC Digital controller. Four ZTC locomotive decoders (ZTC 203, ZTC 205, ZTC 206 and ZTC 214) can be programmed to operate in either of these modes and automatically switch to one of the none-DCC modes if DCC signals are not detected on power-up. For these decoders, the default value for CV 12 is 5. This enables the decoder to respond to analogue power (pure DC), or Zero 1 if DCC signals are not present. If you never require Zero 1 compatibility, it is better to reset CV 12 to 1 (DC compatible only). If CV 12 is set to 0, only DCC operation is used. This can speed up decoder restarts if power interruption is experienced caused by dirty track or dead frogs.

6.2.1 CV 12 Feature Table

Default value 5. Related CV's – none.

The following table provides a list of features that can be enabled or disabled by setting each of the individual bits in CV 12. The bits may be set using the decimal number method or by setting the individual bits as described in Section 6.1.

Note: Not all decoders will have all the features listed for CV 12.

Bit No	Feature	Add decimal 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 (ZTC 203, 205, 206 and 214 only)
3	Trix	8	N/A to ZTC decoders
4	N/A	16	Future option
5	Zero 1 first	32	When powering up tries to use Zero 1 first then DCC. Only set this if you use Zero 1.
6	N/A	64	Future option

6.3 CV 11 and CV 56 Packet Loss Behaviour

For normal speed control to be maintained, a decoder must receive regular command packets of information from the controller. Most decoders remember the value of any speed signals sent to them for a brief period of time. This allows for brief interruptions in signal and prevents a sudden halt when signals may be temporarily lost. CV 11 and CV 56 add another dimension to this. The value of CV 11 determines how long a decoder will wait for a command packet addressed to it before it tells the decoder to slow the locomotive to a halt. If a packet is not received before the waiting period runs out, the locomotive will start to slow down (decelerate). The rate of deceleration depends on the value in CV 56.

6.3.1 Automatic stopping of locomotives at signals

A very powerful feature of DCC allows automatic stopping of locomotives at signals by applying the features provided by CV 11 and CV 56. When a signal is set to red, a length of track leading up to the signal must be switched from DCC power to a source of pure DC power (so that no DCC command packets are received). The DC power keeps the decoder operating and the locomotive running until CV 11 times out. The locomotive will then decelerate at a rate set by CV 56 and come to a halt. This deceleration rate is totally independent of that set by CV 4 (see section 4.3). When the signal changes to green the DCC power must be restored to the track, and the locomotive will start up again and accelerate (as set by CV 3) back to its previous speed. The range of values for CV 11 and CV 56 is 0 to 255. Experiment for the best results on your layout.

6.4 CV 13 Enable Analogue Functions

Default value 0. Related CV's – none.

CV 13 allows you to define which function outputs remain active when the decoder is operating on pure DC track power (analogue power). See Section 6.3.

This CV is programmed using the bit mapping approach described in Section 6.1. There are 8 bits (0 to 7) in this CV and each bit is associated with a specific auxiliary function. Setting a bit to 1 enables its associated function when in the presence of DC analogue power. Bits 6 and 7 relate to the automatic forward and reverse lighting features. The default setting for CV 13 is 0 (all bits set to 0).

Bit Number	Function
0	F1
1	F2
2	F3
3	F4
4	F5
5	F6
6	F0 (white lead)
7	F0 (yellow lead)

6.5 CV 29 Basic Configuration Register

Default value 2 (ZTC 202, 203, 205, 206, 214), 6 (all other decoders). Related CV's – none.

CV 29 is a very powerful CV, which controls the following important features.

- selection of two or four digit addressing
- normal direction of travel
- operational speed steps (14, 28 or 128 mode)
- selection of DC analogue, Zero 1 or DCC operation
- selection of speed table

Normal direction of travel is determined by the decoder installation wiring, but if you get the motor wiring the wrong way round (setting the DCC controller to a forward direction results in the locomotive going backwards), this can be fixed be either rewiring the locomotive, or by changing the CV 29 value to an odd number i.e. 3.

NOTE:- If this method of correcting the motor wiring is used, then any automatic directional lighting feature will become reversed i.e. when the locomotive runs forward the rear light will be on and vice versa.

6.5.1 CV 29 Feature Table

The following table provides a list of features that can be enabled or disabled by setting the bits in CV 29. The bits may be set using the decimal number method or by setting the individual bits as described above.

Bit No	FEATURE	Add decimal value	Notes
0	Loco Direction Reverse	1	Set this if the locomotive 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	Analogue Power	4	Always include this for DC operation
3	Advanced decoder acknowledgement	8	Future option only
4	Speed table used	16	Not supported by all decoders
5	Extended addressing	32	When set, decoder can expect locomotive addresses 128- 9999
6	N/A	64	future option
7	Accessory Decode Enable	128	Decoder operates with accessory commands and ignores locomotive commands

6.6 CV 17 and CV 18 Extended Addressing

The normal address range for DCC decoders is 1 to 127 inclusive. This is set in CV 1. Enabling extended addressing allows locomotive numbers of 128 to 9999 to be used. This would allow a complete locomotive cab side number to be used, making it very easy to relate a locomotive address to the actual locomotive. To access extended addressing requires that the extended address (loco number greater than 127) to first be entered into the CVs that save the address. These are CV 17 and CV 18. Once this has been done then the extended address feature has to be enabled by setting bit field number 5 to 1 in CV 29. Use the following keystrokes:

POINT → **LOCO** → **17** → **PRESET** → ***new locomotive*** → **ENTER R**

This entry will have to be confirmed with another **ENTER** **.**

Wait until the programming sequence has completed (a little longer this time as CV 17 and CV 18 are both being programmed, one after the other) and ALL HALTED appears on the LCD screen, then key in the following:

POINT → **LOCO** → **29** → **SIGNAL** → **5**

(ensure that the number 5 is present in the bit display, if not, press 5 again) → **ENTER R**

This entry will have to be confirmed with another **ENTER R** **.**

After restoring track power, the new extended address can be called up and the function of the locomotive confirmed.

Be aware that verifying the values in CV 17 and CV 18 will not make much sense as the values bear no resemblance to the actual locomotive number entered.

Note: with some ZTC decoders you will have to set the CV 1 value to 0 so that it will not respond to its old CV 1 locomotive number.

6.7 CV 49 Zero 1 Locomotive Address

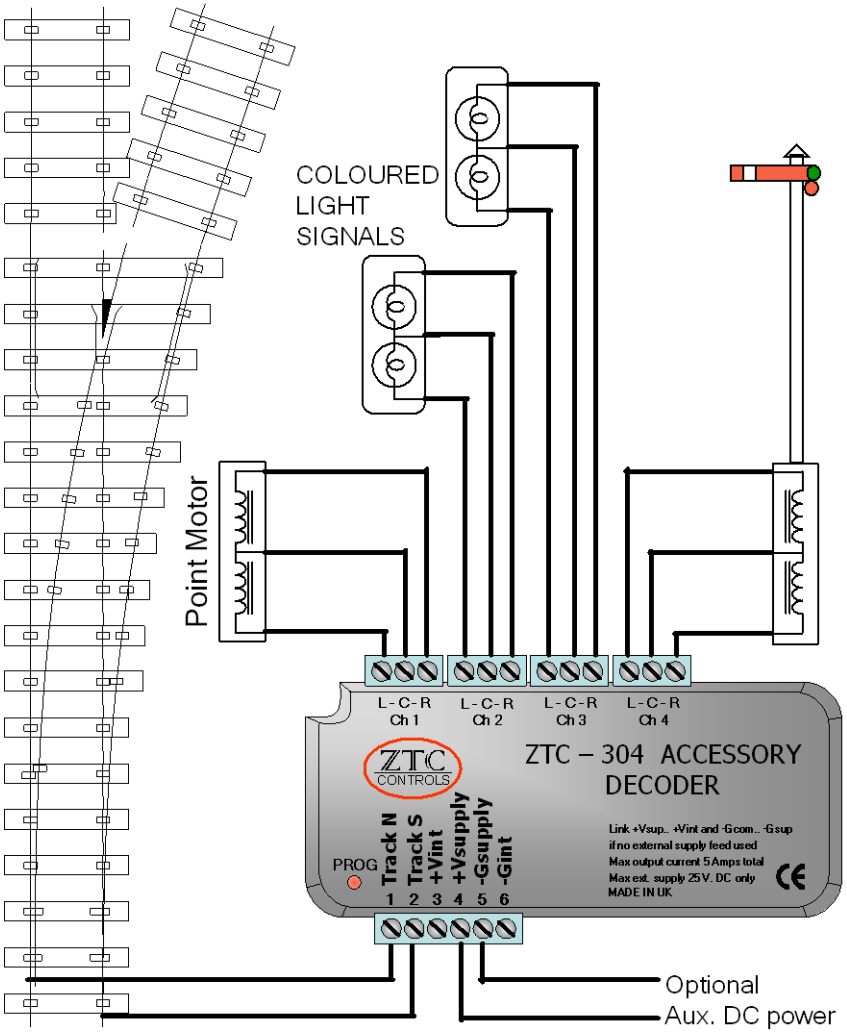
Zero 1 is an obsolete digital command control system manufactured by Hornby. See Appendix 1 for those ZTC decoders that support Zero 1. These decoders can operate in DC, DCC and Zero 1 modes. CV 49 holds the locomotive address when operating in Zero 1 mode. The CV value range is 1 through 16, with a default setting of 4. For more information about operating ZTC decoders in Zero 1 mode see the ZTC Decoder Zero 1 Appendix 2.

7.0 Accessory Decoders

In addition to locomotives, line side features such as points, signals and other electrically operated devices, can be activated from the controller keypad. To do this, accessory decoders are used to decode the command signals and operate the devices as required. The command signals for accessory decoders are transmitted along the track feed, just like those for locomotive decoders.

Each accessory is assigned a unique address. An accessory decoder address is transmitted in a different way to locomotive addresses and therefore can use the same basic numbers as locomotives (1 - 127) without causing any interaction. The actual range, however, is greater and accessory addresses can range from 1 to 2047. ZTC Accessory Decoders can be operated by any NMRA-DCC compatible controller.

7.1 ZTC 304 and ZTC 305 Features



The ZTC 304 has power output drivers capable of direct operation of large solenoid point motors drawing up to 8 amps. The ZTC 305 will drive loads up to 0.5 amps and is more suitable for light signals and other low current applications.

Each of the eight output channels of the decoders can operate one accessory or a light signal. Note: a point motor requires two channels, one for left and the other for right. These functions can be mixed together as each channel can be individually set-up in various ways for momentary action or continuous output. The channels can also be paired for 2 or 4 aspect colour light signalling.

7.2 Where to Locate Accessory Decoders on your Layout

The decoder is generally designed to be screwed underneath the layout baseboard. It could however be located in a line-side building or some other top-side feature to disguise it. It is important to locate it near to the point work and CDU (Capacitor Discharge Unit) as possible and it is recommended that the maximum wire length is 0.5 m and the minimum conductor of 1.5mm should be used.

If used outdoors, it must be protected from moisture and water ingress. This can be achieved by installing the decoder in a waterproof plastic box or other sealed enclosure. Alternatively, after an operating session, unplug it from its connections and move it to a dry place.

7.3 Power Options

The power required to operate accessories can be taken either from the normal track feed, or from a separate power supply. In both cases the accessory decoder still needs a connection to the track feed to receive command signals. If solenoid point motors are to be operated using the normal track feed supply, then the controller output voltage needs to be set to a minimum of 16 volts. See the ZTC 511 or 505 DCC Controller manual, section 4.0, to see how to set the maximum track voltage.

Having a separate power supply is beneficial when several high current devices (such as solenoid point motors) may be operated by the accessory decoders. If these were powered directly from the track feed, then the performance of running locomotives may be affected. This is because the power is being shared between the locomotives and the accessories. Figure 2 shows the details of how a separate power supply can be connected to the accessory decoders.

The power input terminals of the accessory decoders also allow the use of capacitor discharge units (CDU) ZTC 360 in combination with the accessory decoder. These can supply the high momentary peak power needed for point motors whilst keeping the overall power requirement down to a minimum and are highly recommended for reliable operation.

7.4 Command Signal Feed Options

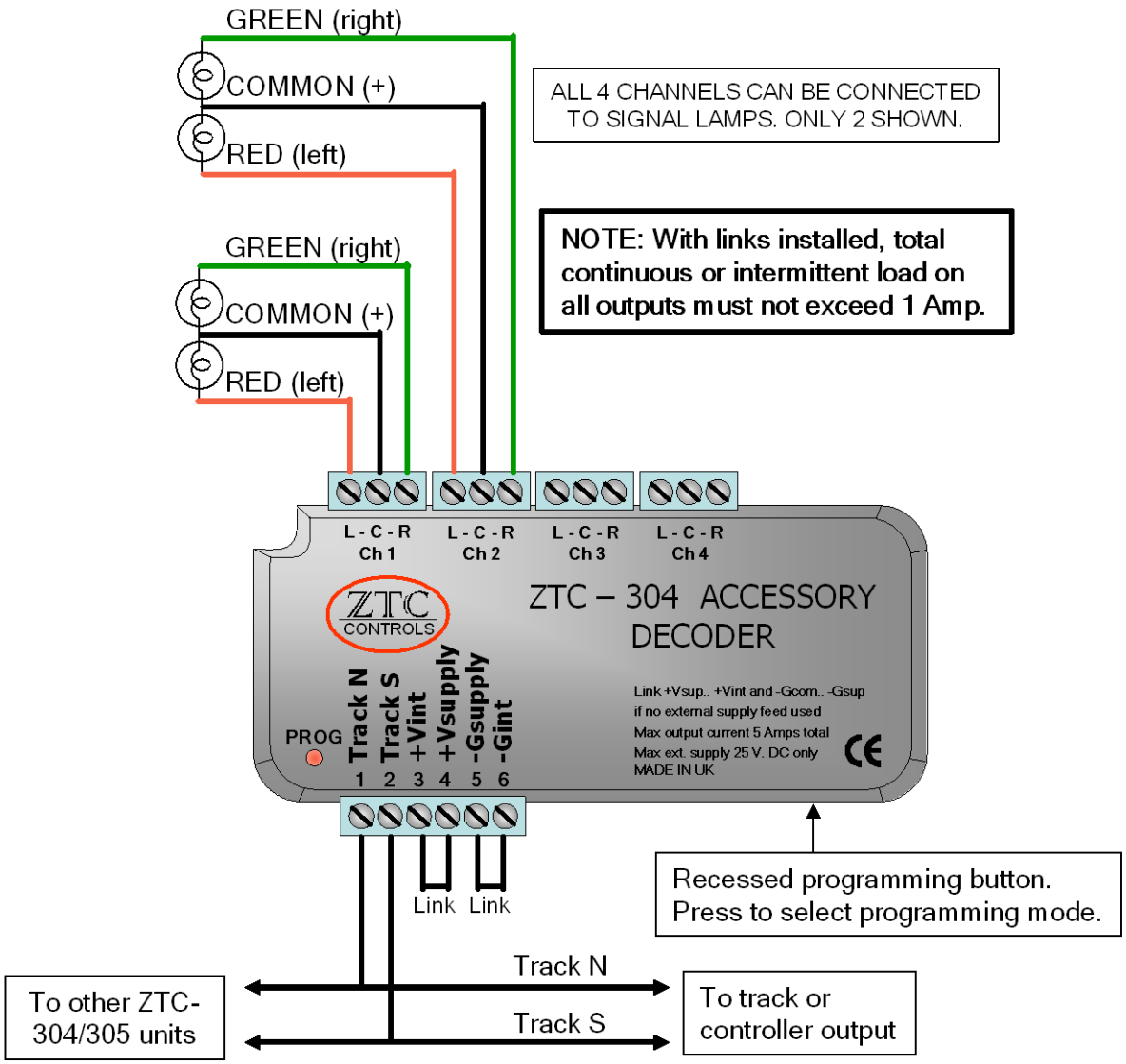
Command signals are taken from the track feed. This means that the signal input connections for the decoders (Track N and Track S) can be connected to a portion of the track bus located close to the decoder. However, to facilitate troubleshooting it is advisable to provide a separate accessory decoder command signal bus to which all decoders are connected. The ZTC 511 or 505 controller has two track feed connections. One can be used to feed the track bus and the other to feed the accessory decoder bus.

7.5 Wiring Connections

All the connections to the accessory decoders are made with plug-in screw terminals. The connection wire used should be adequate for the intended use. For solenoid point motors

use 16 x 0.2mm stranded or 1.5mm solid core wire for connections to the decoder output channel and also the power feed. For lamps, or similar accessories, the size of the wire is less important.
The polarity of the connections to the Accessory Decoder is critical. Refer to the wiring diagrams, figures 1 through 5, for the correct connections.

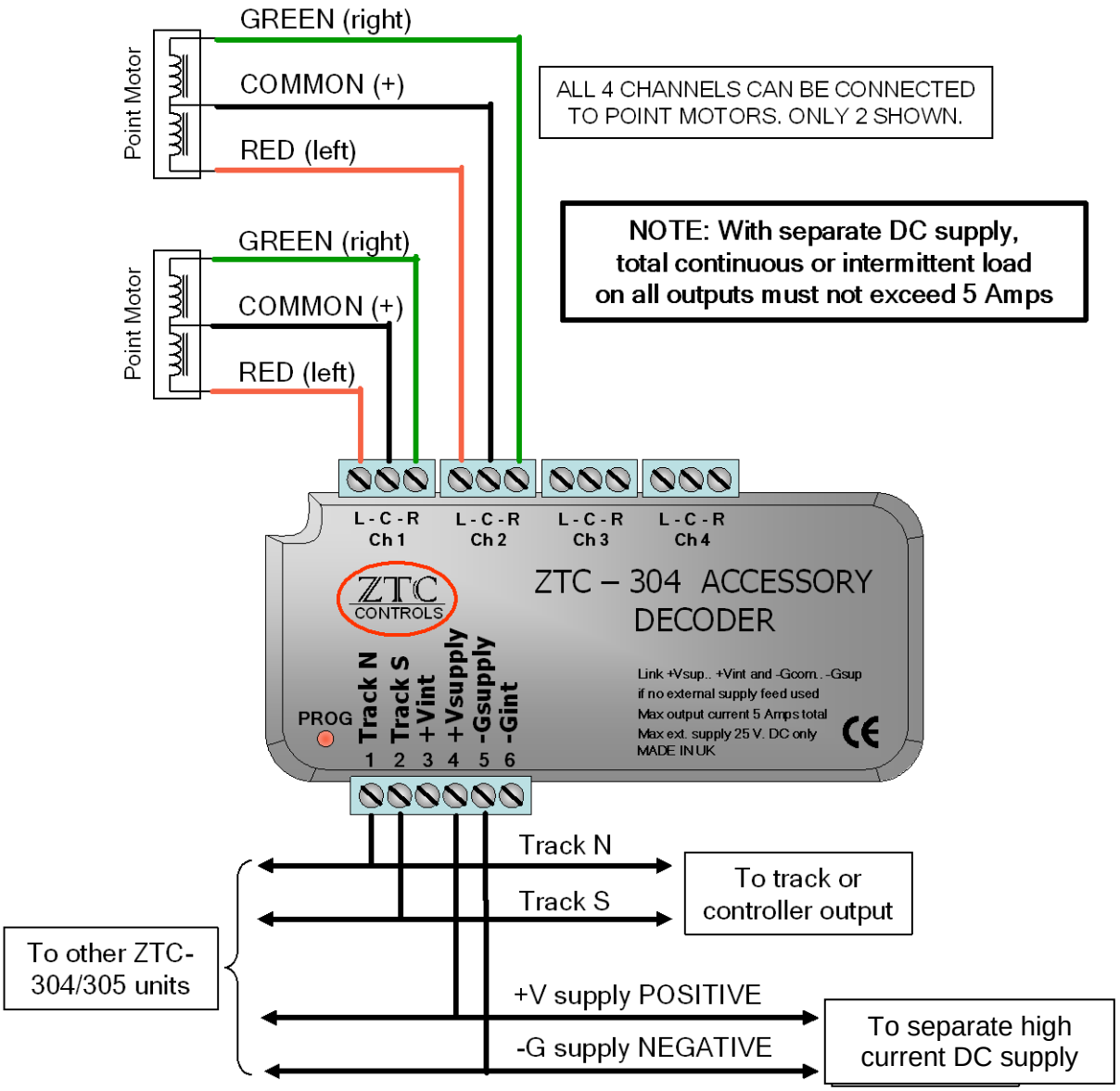
Figure 1 - Accessory Decoder Basic Application



The ZTC 304 or the ZTC 305 can be used to operate low power accessories such as lamps and electric signals. The above figure shows how to connect signal lamps, using the power from the track feed to operate them. The links are required to route the power from the track feed to the accessory circuits. The lamps can be replaced with light emitting diodes (LEDs) and the associated resistors. See Section 2.3.3 for more details on LED circuits.
CV 5 identifies channel 3 – while ***New Value 0*** tells the decoder to provide a continuous voltage output

Solenoid Motor Control (2 solenoids – Peco, Seep, H & M)

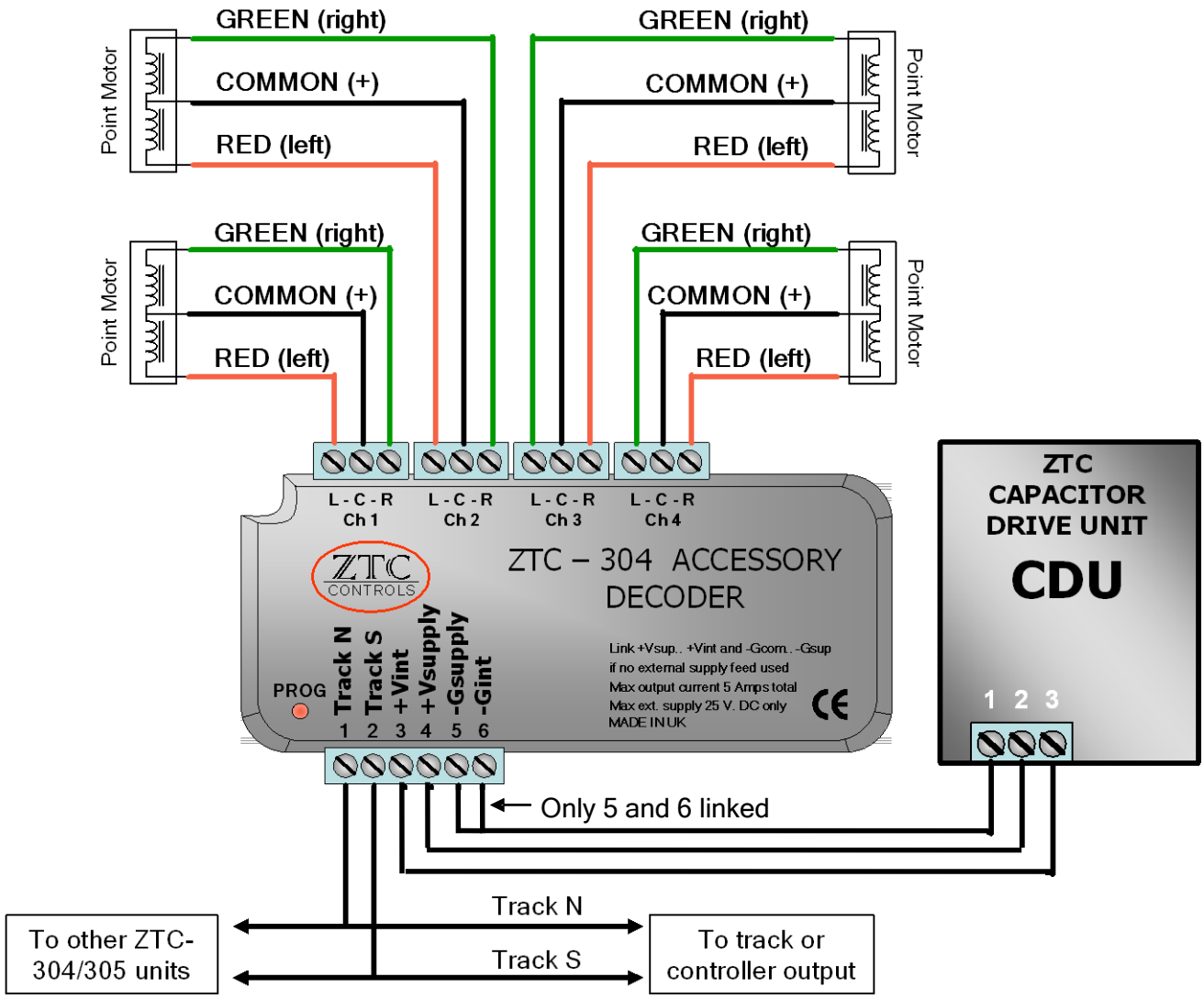
Figure 2 – Connecting Solenoid Point Motors with Separate Power Supply



For solenoid point motors the ZTC 304 must be used. It is also recommended that, if a capacitor discharge unit is not available, an external regulated high current DC power supply must be connected to reduce the load on the track feed voltage. The external power must be regulated DC only.

Note : There are <u>NO</u> links joining terminals 3 to 4 and 5 to 6.

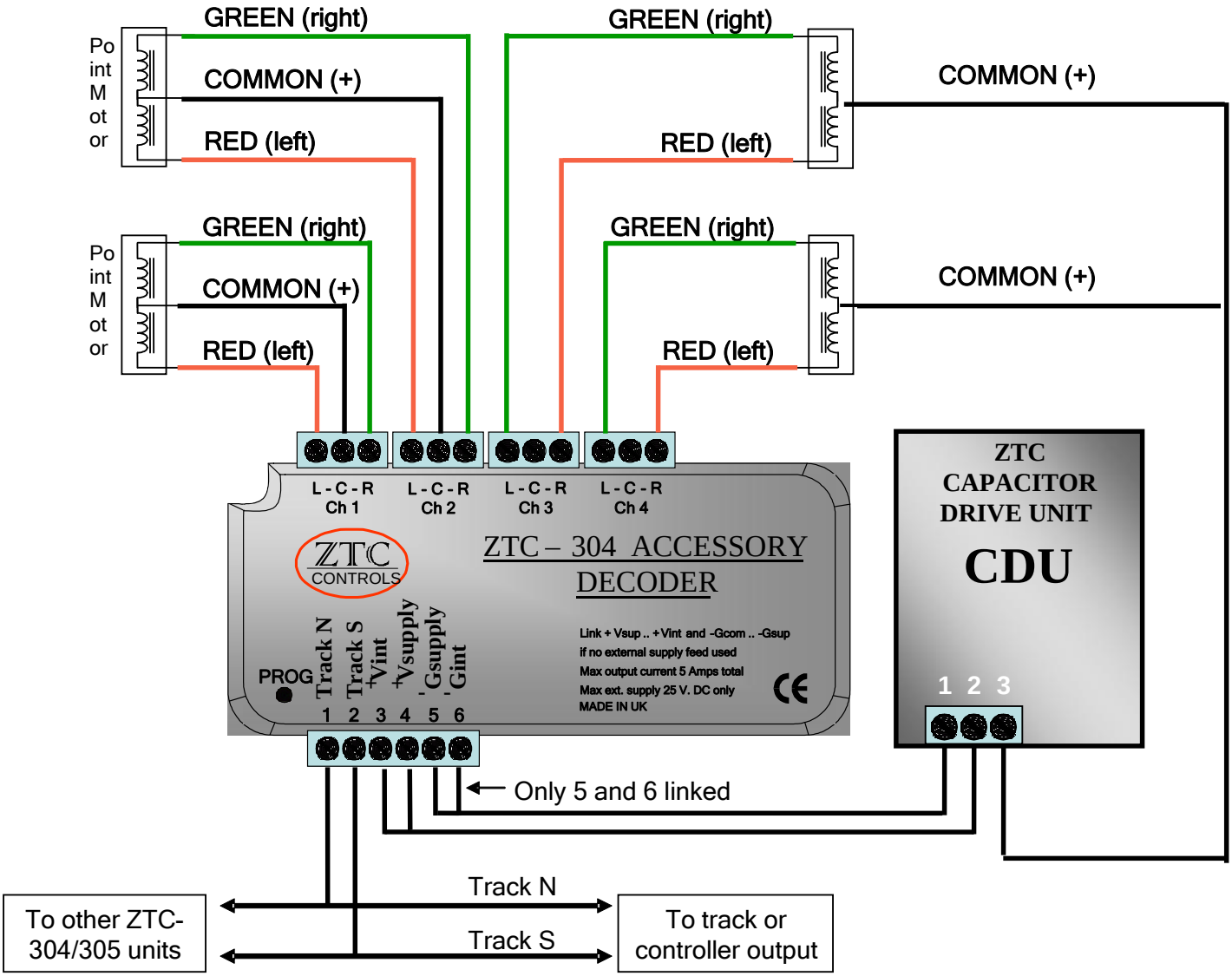
Figure 3 – Operating Solenoid Point Motors Using a Capacitor Discharge Unit (CDU)



Using a capacitor discharge unit (CDU) allows solenoid point motors to be powered from

the track feed. This is less taxing on the track feed power compared with operating point motors directly. A CDU uses the track feed voltage to charge a capacitor. The current required to charge the capacitor is much less than that required to operate the point motor directly. The energy is stored in the capacitor and, when required, is discharged into the point motor. This gives a sudden kick of energy to the point motor, providing a more positive and reliable action. A CDU also minimizes the risk of point motor burn out.
It is recommended that the track feed voltage be at least 16 Volts. If you are using the ZTC 511 or 505 DCC controller, see the controller manual, for details of how the voltage can be adjusted.
Note that a single CDU should be connected to each accessory decoder.

Figure 4 – Mixing Lamps and Point Motors with a CDU



A CDU can be used on just one channel of the decoder if only one point motor is required to be operated. Figure 4 above shows two point motors and two sets of light signals being powered through one decoder. Any combination of these can be used. Note that in this example the common terminals of the point motors are connected to the positive output terminal of the CDU, instead of the common connections on the decoder. The links on the decoder are used to route the track power to the input of the CDU.

Setting CVs for a momentary pulse, suitable for double solenoid point motor operation. (Peco , Seep , H & M)

PRESET → **SIGNAL** → ***cv number*** → **PRESET** → ***new value*** → **ENTER R**

Setting a value greater than 0 (zero), usually between 3 and 25, in the CV will provide a momentary pulse, suitable for solenoid point motor operation. For each increase in value of one, the duration is incremented by 0.02 seconds.

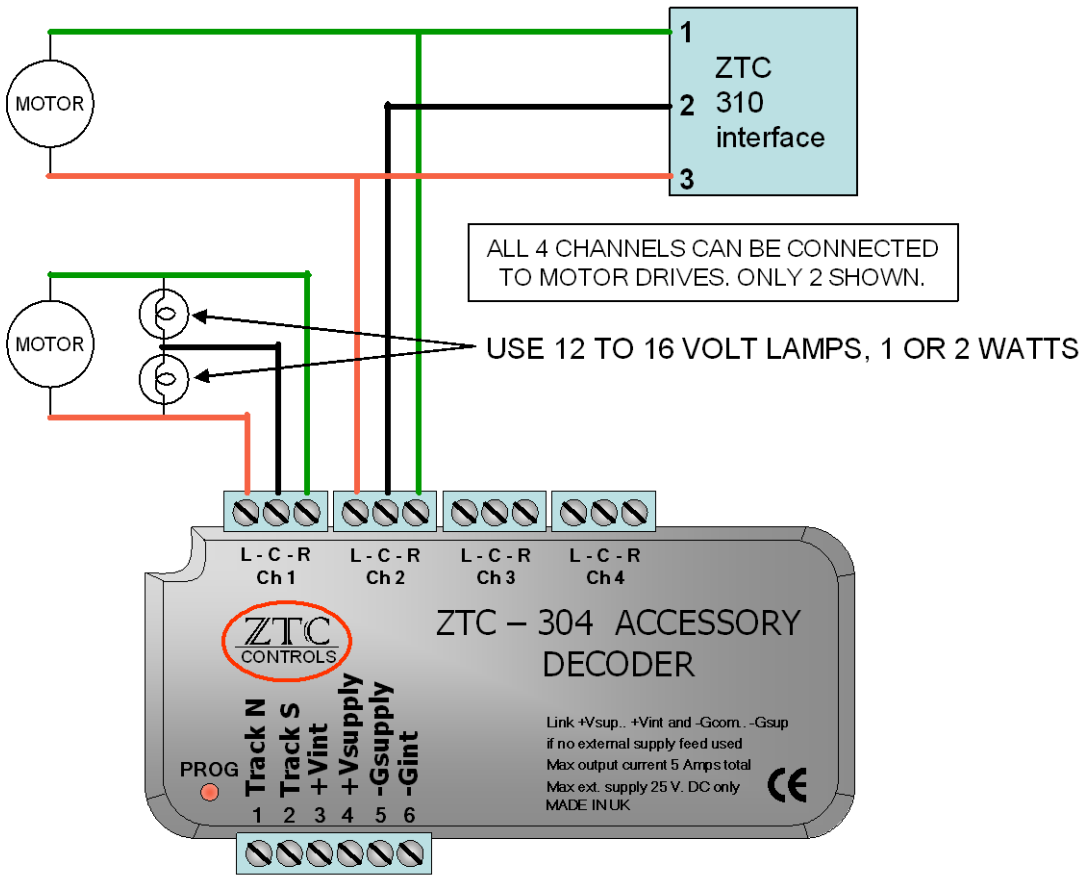
304 / 310 CHANNEL NUMBER	CV NUMBER	DESCRIPTION	NEW VALUE	Notes
1	3	Output channel Time ON	N*	N x 0.02 Sec's = Duration of pulse
2	4	Output channel Time ON	N*	N x 0.02 Sec's = Duration of pulse
3	5	Output channel Time ON	N*	N x 0.02 Sec's = Duration of pulse
4	6	Output channel Time ON	N*	N x 0.02 Sec's = Duration of pulse

For example : To give channel 2 a 0.5 second pulse you would press :-

PRESET → **SIGNAL** → ***4*** → **PRESET** → **25** → **ENTER R**

The ***CV*** '4' identifies channel 2 , while
the ***New Value*** '25' equals 0.5 of a second (25 x 0.02 sec= 0.5 second)

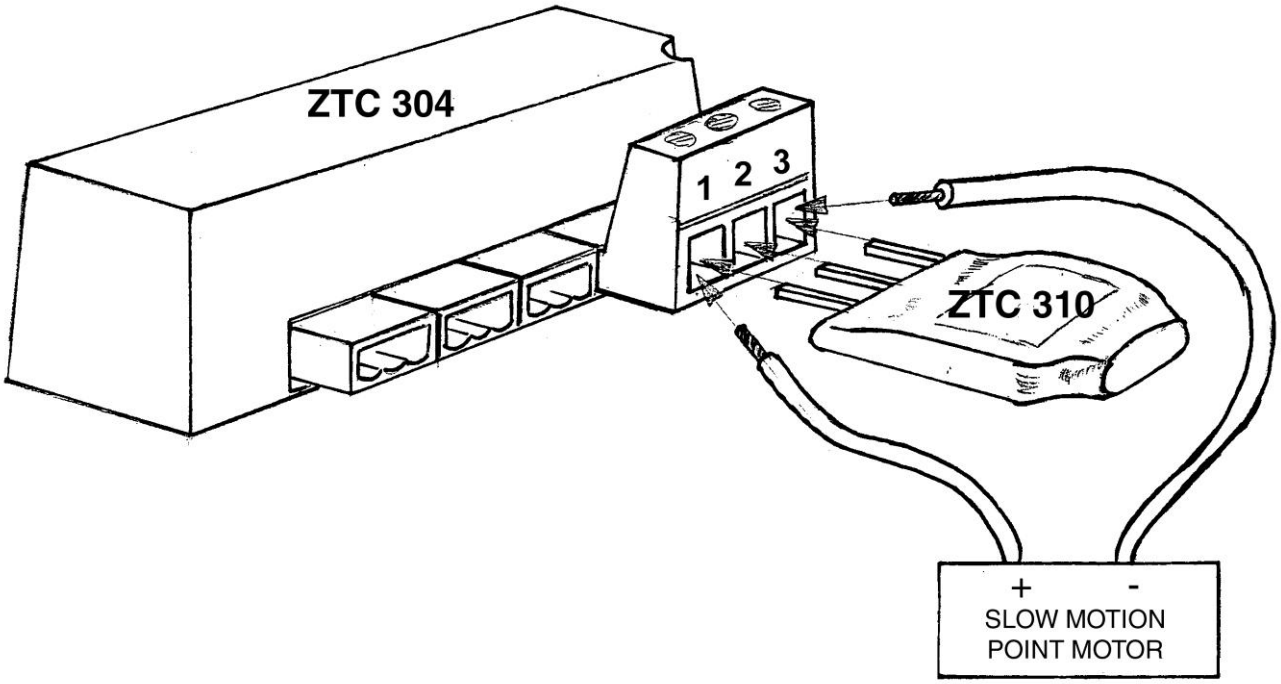
Figure 5 – Slow Motion Point Motor Drive



POWER CONNECTIONS AS FIGURE 1 OR 2

Slow motion point motors (e.g. Tortoise, Fulgarex etc.) can be operated from a ZTC 304. There are two connecting methods. The circuit connected to channel one in figure 5 has two lamps which act as a potential divider providing a quasi common return. This allows the motor to see the reversing voltage polarities required for it to change directions.
The second method uses the ZTC 310 interface. This performs the same function as the lamps in the previous example, but is far more efficient and convenient to connect. See figure 6 for connection details.

Figure 6 – Connecting a Slow Motion Point Motor using the ZTC 310



One end of the ZTC 310 has 3 pins for connecting to the accessory decoder. The pins are spaced to fit in the existing screw terminals on the accessory decoder plug. This makes installation extremely simple.

1. First slacken off all the screws in the plug of the selected ZTC 304 channel.

2. Insert the ZTC 310 fully into the connector, label uppermost, and fully tighten the middle screw only. (Pin 2 on the ZTC 310)

3. Prepare the wires on the point motor with 5mm of copper showing and insert one in the same terminal as Pin 1 on the ZTC 310 and the other into the same terminal as Pin 3. Fully tighten both screws. (Note:- It is easier to insert the wires below the pins on the ZTC 310 rather than above).

4. If the direction of movement of the motor is incorrect for your turnout (point) then the two wires can be changed over to reverse the motor's direction of travel.

The maximum continuous current for ZTC 310 is 1.0 Amp. The maximum momentary current is 2 Amps for 1 second.

Before programming an accessory decoder it is useful to make up a test circuit similar to that shown in Fig. 1, section 7.5 using 4 three way connectors and 8 12volt bulbs. Insert the connectors into the output sockets of the ZTC 304 or ZTC 305 decoder. The result of experimenting with various CV settings can be observed. After your experimentations the decoder can be reset to factory default by following the instructions in section 7.8.

7.6 Accessory Decoder Addresses

In order to send commands to the right accessory decoder, they must each be assigned a unique address number. Once the address has been set up, other parameters for a specific accessory can each be set. This set up is retained by each accessory decoder, even when disconnected from the power.
The number range to identify each accessory output device, whether a point, signal or anything else, can be in the range 1 to 2047 and will not conflict with any loco addresses of the same number.

7.6.1 Accessory Decoder Address Numbering Rule

Most accessory modules, such as the ZTC 304, have four output channels. Each accessory module is assigned a base address, which determines the addresses for each of its four output channels. The value of a base address must comply with the following rule:
Start with a number that is a multiple of 4.

Examples: 4, 8, 24…….480….2032

Then, if you subtract 3 from that number you will get a valid number for a base address. For the examples shown, the valid base addresses would be 1, 5, 21…….477…..2029. The addresses for each of the four output channels are then determined as shown in the following examples:

Base Address Examples	Output Channel Addresses
1	1, 2, 3 and 4
5	5, 6, 7 and 8
21	21, 22, 23 and 24
477	477, 478, 479 and 450
2029	2029, 2030, 2031 and 2032

Base addresses do not have to be sequential. In other words, if you assign base address number 1 to your first accessory decoder, your second decoder can have any other base address; it does not have to be 5.

7.6.2 Setting an Accessory Decoder Address

The ZTC 304 and ZTC 305 come already set with a base address of 1. That is, with addresses 1, 2, 3 and 4 for each of the four channels. The default address will have to be changed if more than one accessory decoder is to be used on your layout. The following method for changing the address is known as the Address Capture Method. Stop all trains running, and remove them from the track, or if you have a separate accessory signal bus, just unplug the track connection to the controller. This eliminates the risk of inadvertently programming loco modules. Briefly press the programming button found on the side of the accessory decoder (see figure 1). This puts the decoder into programming mode. This is confirmed by a flashing red light. Set the base address by keying in:

SIGNAL → ***base address*** → **ENTER R**

The accessory decoder will show acceptance of the new address by the RED light staying on for a few seconds. Briefly press the programming button once more to exit programming mode. Alternatively, if you are using the ZTC 511 or 505 controller, you can press the ALL STOP button twice. This kills power to the accessory decoders, resetting the programming mode. Power is then restored by pressing the CLEAR button.

Note: All ZTC 304 and ZTC 305 accessory decoders purchased before 1st November 2003 will have a factory default address of 41. This bought after this date will have a factory default address of 1.

7.7 Programming an Accessory Decoder Configuration

Just as loco modules have configuration variables (CVs), accessory decoders also have CVs. The value in the CVs determines if a decoder is set up to operate solenoid type devices (some point motors), which require a momentary output, or continuous output devices such as lamps, signals etc.
Note: Ensure that decoder outputs are not connected to any device until you are sure that the correct CV setup is programmed for the device in question.

To set an accessory decoder CV key in :

PRESET → **SIGNAL** → ***cv number*** → **PRESET** → ***new value*** → **ENTER R**

Where ***cv number*** is the CV number (1 to 64) and ***new value*** is a number (0 to 255).

Note that CV 1 (decoder base address) is best programmed using the method already discussed in Section 7.6.2.
A list of important accessory decoder CVs and ranges of values can be found in the table in Section 7.7.2.

Only the channel timers CVs 3, 4, 5 and 6 absolutely need to be considered for set-up. These determine if you have signal lamps (continuous output) or a point motor or other solenoid operated accessory (momentary output) connected to a particular channel. The other CVs should only be set with careful consideration to the accessory operation.

When supplied, the decoder is set up for momentary operation on all 4 channels to facilitate connection to solenoid point motors.

7.7.1 Accessory Decoder CV's and their Function

The following information describes the various CV's in detail.

Output Timers - CV's 3, 4, 5, 6

These CV's set the length of time that the output for each channel is in an ON state.
Note that each of the four paired output channels is individually set

Auxilary Motor Control – continuos voltage ie: point drives (Tortoise , Fulgurex , Lemoco etc) , turntables , cranes , gates , winches etc

PRESET → **SIGNAL** → ***cv number*** → **PRESET** → ***New value (0)*** → **ENTER R**

cv number – This number relates to which channel on the decoder you are setting .

new value - **0** This setting gives a continuous voltage output

304 / 310 Channel Number	CV Number	DESCRIPTION	New Value
1	3	Output channel Time ON	0
2	4	Output channel Time ON	0
3	5	Output channel Time ON	0
4	6	Output channel Time ON	0

These CV's set the length of time that the output for each channel is in an ON state. Setting a value of 0 (zero) programs the decoder to give a constant output, suitable for powering lamps or electric motors. Normally an output channel pair is toggled. That is, when one is on the other is off.

For example : Channel 3 to operate a motor driven point .

PRESET → **SIGNAL** → ***5*** → **PRESET** → ***0*** → **ENTER R**

Output Mode - CV's 41, 42, 43, 44

These CV's allow the output channels to be configured for individual control or for flashing operation.

CV Value	Affect
0 (default setting)	**Normal -** Output channel pair toggled. When one is on the other is off.
1 to 11	**Not allowed -** Will disable both left and right outputs
12	**Momentary**, but with dim output if CV51 to 54 >0. (**must not be used with solenoid point motors**
13	**Flash alternately** – at rate set by corresponding timer CV. Timer CV should be set to a value of 20 to 30 and not less than 2. E.g. Level crossing flashing lights.
14	**Individual control** – Left or right outputs separately controlled. Corresponding timer CV must be set to 0. See Section 8.3 to see how this can be used for multiple aspect signaling.
15	**Individual flashing** – Each output can be selected as flashing. Corresponding timer CV must be set to 2 or greater.

Output Dimmers CV's 51, 52, 53 54

If the decoder output channels have been set for continuous output, then four output levels can be achieved. For lamps this means four brightness levels. The values 0 through 3 entered into the CV provide the four brightness levels, with 0 being the brightest . Values of 4 or above are not effective.

The decoder achieves the dimming by pulsing the output at a variable mark/space ratio. The lamps should be of the correct voltage for the external supply or be capable of operation from 18 Volts if the internal power option is used.

Dropping resistors should be used in series with each lamp if they are rated at less than the supply voltage. The value and power rating of such resistors would have to be determined by experiment and calculation.

Power Up State CV's 31, 32, 33, 34

Each of these CV's controls the power-up state of each channel. They only apply to those outputs set for continuous output, i.e.: the relevant Timer CV set to 0. Normally for the default (when set to 0), the outputs' last commanded state will be recalled when the unit is powered up.

By setting the appropriate CV to a value of 1, the output will always power-up in the OFF state. By setting it to 2 the output will always power-up in the ON state

The operation of this CV is ignored if the output has been configured for momentary operation, e.g. for a solenoid point motor.

7.7.2 Table of Accessory Decoder CV's

CV NUM	DESCRIPTION	Default (N)	MIN	MAX ZTC	Notes
3	Channel 1 Output Time ON	5	0	255	0 = No timer, N x 0.02 Sec's
4	Channel 2 Output Time ON	5	0	255	0 = No timer, N x 0.02 Sec's
5	Channel 3 Output Time ON	5	0	255	0 = No timer, N x 0.02 Sec's
6	Channel 4 Output Time ON	5	0	255	0 = No timer, N x 0.02 Sec's
31	Chan 1 Output Power-up state	0	0	2	0 = normal as before 1 = off 2 = on
32	Chan 2 Output Power-up state	0	0	2	0 = normal as before 1 = off 2 = on
33	Chan 3 Output Power-up state	0	0	2	0 = normal as before 1 = off 2 = on
34	Chan 4 Output Power-up state	0	0	2	0 = normal as before 1 = off 2 = on
41	Chan 1 Output Mode	0	0	15	0 = normal 13 = flash (if CV 3 set >0) 14 = individual control 15 = individual flashing
42	Chan 2 Output Mode	0	0	15	0 = normal 13 = flash (if CV 4 set >0) 14 = individual control 15 = individual flashing
43	Chan 3 Output Mode	0	0	15	0 = normal 13 = flash (if CV 5 set >0) 14 = individual control 15 = individual flashing
44	Chan 4 Output Mode	0	0	15	0 = normal 13 = flash (if CV 6 set >0) 14 = individual control 15 = individual flashing
51	Chan 1 Output Brightness or power	0	0	3	0 = normal, 1 = ¾ 2 = ½, 3 = ¼
52	Chan 2 Output Brightness or power	0	0	3	0 = normal, 1 = ¾ 2 = ½, 3 = ¼
53	Chan 3 Output Brightness or power	0	0	3	0 = normal, 1 = ¾ 2 = ½, 3 = ¼
54	Chan 4 Output Brightness or power	0	0	3	0 = normal, 1 = ¾ 2 = ½, 3 = ¼
1	Base Address of Accessory decoder (low)	1	1	63	Split address set automatically by Address Capture Method. See Section 7.6.2.
9	Base Address of Accessory decoder (high)	0	0	15	

7.8 Decoder Reset

The ZTC 304 and ZTC 305 accessory decoders can be reset to factory default using the following sequence.

1. Set the accessory decoder to the program mode by pressing the concealed push button on the side of the module.
2. Press the following buttons in sequence.

   CLEAR → **PRESET** → **SIGNAL** → **9** → **9** → **ENTER R** → **ENTER R**

3. On completion of the display sequence press the Red button on the ZTC 511 or 505 twice. Your decoder is now reset.

Note: If you are using ZTC 511 V4.01 or greater then channel 1 will be set to number 1.
If you are using ZTC 505 V1.00 or greater then channel 1 will be set to number 1
If you are using ZTC 511 V3.01 or lower then channel 1 will be set to number 41.

8.0 Using ZTC 511 or 505 Controller to Operate Accessories

8.1 Operating Points with Accessory Decoders

To operate a single point on any accessory decoder module key in:

POINT → ***accessory address*** → **ENTER L** or **ENTER R**

Pressing **ENTER L** or **ENTER R** will alternately operate the point to the left or right.

However, this definition depends on the actual wiring and configuration applied to the accessory module. You can follow-on with another point by simply keying the ***accessory address*** and **ENTER L** or **ENTER R** .

DO NOT TOGGLE SOLENOID DEVICES FOR PROLONGED PERIODS AS MOST SOLENOID POINT MOTORS ARE NOT DESIGNED FOR CONTINUOUS DUTY. YOU COULD BURN OUT THE MOTOR!

8.2 Operating Signals with Accessory Decoders

To operate a single signal on any accessory decoder module key in:

SIGNAL → ***accessory address*** → **ENTER R** (red – on) or **ENTER L** (green - off)

Pressing **ENTER R** or **ENTER L** , will alternately operate a signal whether a two aspect coloured light or a solenoid actuated semaphore .

For basic signals, the convention should be that **ENTER R** puts it on to RED or caution and **ENTER L** to GREEN or off.

You can follow-on with another signal by simply keying the number and **ENTER L** or **ENTER R**
For more details see ZTC 511 or 505 manual.

8.3 Multiple Aspect Signal Operation

For these commands to work, the accessory decoder concerned must have been previously set up with output mode CV's each set for individual control.

Multiple aspect coloured light signals are connected to two consecutive accessory decoder outputs but can be operated by a single command.
To operate a pair of accessory decoder module outputs together, key in:

SIGNAL → ***1st accessory address*** → **FUNCTION** → ***function number*** → **ENTER R** **or** **ENTER L**

Where ***function number*** is the signal function number shown in the table below.

SIGNAL FUNCTION	Address N RED GREEN	Address N + 1 AMBER AMBER	LIGHT ASPECT
4	Both OFF	Both OFF	Out of action
11 *	1 ON 2 OFF	Both OFF	RED
12 *	1 OFF 2 ON	Both OFF	GREEN
13 *	Both OFF	Both ON	DOUBLE AMBER
14 *	Both OFF	1 ON 2 OFF	SINGLE AMBER
15	Both ON	Both ON	Test function
0	OFF/ON	no change	special function
1	OFF/ON	no change	special function
2	no change	OFF/ON	special function
3	no change	OFF/ON	special function
* If ENTER R is pressed again the function number is incremented to the next signal indication & similarly ENTER L decrements.			

8.4 Operating Other Accessories with Accessory Decoders

To operate any accessory connected to a decoder module, whatever the output operates, you first press **POINT** or **SIGNAL** followed by the accessory address number.

Pressing **ENTER R** or **ENTER L** will alternately operate the function on or off, left or right or otherwise. However this definition depends on the actual wiring and configuration applied to the accessory module controlled.

8.5 Route Setting

The ZTC 511 or 505 allows several accessories to be operated with a single keyed-in number. This allows a route to be set, where all the points/signals required to be set to allow a train to follow a particular route will be thrown automatically, one after the other. A group of accessories, which is required to be operated in this way, is called an Accessory Preset.

A typical example would be to make a route for a locomotive from the engine shed to the main line. By programming all the point positions first followed by all the signals the driver is not given permission to run by the signals until all the points have been thrown.

8.5.1 Setting up Accessory Presets

A Preset allows more than one accessory to be operated from a single keyed-in number. To set up an accessory Preset, first check the operation of each of the items you want to control and write down their addresses and which way you want them to operate (left, right, on, off etc.). Use the following key sequence to set up an accessory Preset:

PRESET → **PRESET** → ***Preset number*** → **ENTER R**

Where ***Preset number*** is any number from 1 to 255**.** Then operate each accessory function in the order and direction you wish it to occur in the Preset pattern as follows:

POINT → ***accessory address*** → **ENTER R** or **ENTER L** as required.

Each time this is done, another accessory is added to the PRESET.
To **delete the previous step** (in the case of an error) key in:

PRESET → **PRESET** → **ENTER L**

At the end of the sequence, press:

PRESET → **PRESET** → **ENTER R**

This will save the Preset sequence.

8.5.2 Time Delays

When a signal is added to a Preset, an automatic delay of about one-quarter of a second (0.25) will occur before the next step is operated. When a point is added to a Preset, the delay is automatically set to about 2 seconds to allow for power supply recovery before the next successive accessory operation. These Preset time delays can be changed for a step by inserting the following keystrokes after entering a step:

PRESET → **INERTIA** → ***time delay***

Where ***time delay*** is any number between 1 and 63, giving the time delay required, in seconds. This delay will be inserted between each successive event until a new time value is keyed in or a new Preset is commenced.

8.5.3 Reviewing a Preset

You can review the status of a Preset by pressing:

PRESET → **FUNCTION** → ***Preset number*** → **ENTER R**

Firstly this shows the total number of presets already stored and the total number of steps they use in memory. Then the numbered Preset is shown, step by step, as accessory number, state (1 or 0) and time delay.

Should the message ‘memory full’ appear then you have exceeded the ZTC 511 memory bank. This can be extended by fitting a ZTC 105 Route Memory Extension module available from ZTC Controls Ltd.

8.5.4 Editing Presets

Once saved, your preset operation becomes permanently stored in the controller until you decide to delete it. Editing of a stored preset is not possible. To change a preset, delete it, then recreate it correctly.

A **single preset** can be deleted by keying in:

PRESET → ***preset number*** → **ENTER L**

You will be asked to confirm the deletion by pressing **ENTER R** .

To delete the **entire preset memory** contents key in:

PRESET → **CONTROL** → **ENTER R**

You will be asked to confirm the deletion by pressing **ENTER R** .

8.5.5 Operating an Accessory Preset

To operate an accessory preset use the following key sequence:

PRESET → ***preset number*** → **ENTER R**

The points and/or signals will be set in a sequential operation, which is indicated by a beep as each is operated. Each step of the preset is flagged in the bottom left hand corner of the LCD display, if time permits.

Note that to reverse the sequence (return the route to its previous state) requires the creation of another preset.
If the preset number entered has not yet been set up, the display will indicate NOT SAVED.

Index

Appendix 1

Specs	Dimensions Width x Length x Thickness (mm)	Max. output current (including functions)	Max. Continuous current (including functions)	Max. Track Voltage	Min. Track Voltage	Function outputs	Wiring Harness	Extended Address	Zero-1 comp.	Battery Support	Speed Steps	Feedback Back EMF	PWM Adjust	Most Suitable Gauges
ZTC 202	16 x 25 x 8	1 amp for 3 sec	1.0 amp total load	25 volts peak	8.5 volts	2 @ 200 mA 1 @ 500 mA	ZTC 008 8 wire connector	No	Yes	No	14, 28	No	No	Some N, TT, HO/OO & smaller O
ZTC 203	16 x 24 x 7	2 amp for 3 sec	1.5 amp total load	25 volts peak	8.5 volts	2 @ 200 mA 1 @ 500 mA	ZTC 008 8 wire connector	Yes	Yes	No	14, 28	No	Yes	Larger HO/OO, O, small gauge 1
ZTC 203B	16 x 24 x 7	2 amp for 3 sec	1.5 amp total load	25 volts peak	8.5 volts	3 @ 500 mA	ZTC 008 8 wire connector	Yes	Yes	No	14, 28, 128	No	Yes WhisperDrive ™	Larger HO/OO, O, small gauge 1
ZTC 205	35 x 99 x 12	5 amp for 10 sec	4.5 amp total load	27 volts peak	10 volts	4 @ 300 mA	Screw terminals	No	Yes	Yes	14, 28, 128	No	Yes	O, G, 1
ZTC 206	35 x 99 x 12	10 amp for 10 sec	8 amp total load	27 volts peak	10 volts	4 @ 300 mA	Screw terminals	No	Yes	Yes	14, 28, 128	No	Yes	O, G, 1
ZTC 211	12 x 27 x 7	1.0 amp for 3 sec	0.75 amp	25 volts peak	8.5 volts	None	ZTC 004 4 wire connector	No	Yes	No	14, 28	No	No	N, TT, HO/OO & smaller O
ZTC 213	9.5 x 18 x 4.5	1.4 amp for 3 sec	1 amp total load	25 volts peak	7 volts	2 @ 150 mA	Attached 7 wires	No	No	No	14, 28, 128	No	No	Z, N, TT, HO/OO
ZTC 213A	9.5 x 18 x 6	1.4 amp for 3 sec	0.75 amp total load	25 volts peak	7 volts	2 @ 150 mA	Attached 6 wires	No	No	No	14, 28, 128	No	No	Z, N, TT, HO/OO
ZTC 213B	9.5 x 14 x 2.5	1.5 amp for 3 sec	1.25 amp total load	25 volts peak	7 volts	4 @ 500 mA	Attached 9 wires	Yes	No	No	14, 28, 128	No	Yes WhisperDrive ™	Z, N, TT, HO/OO
ZTC 214	12 x 27 x 7	2 amp for 3 sec	1.5 amp	25 volts peak	8.5 volts	None	ZTC 004 4 wire connector	Yes	Yes	No	14, 28, 128	No	Yes	N, TT, HO/OO & smaller O
ZTC 214B	12 x 27 x 7	2 amp for 3 sec	1.5 amp	25 volts peak	8.5 volts	None	ZTC 004 4 wire connector	Yes	Yes	No	14, 28, 128	No	Yes WhisperDrive ™	N, TT, HO/OO & smaller O

Note: Where there is an ‘A’ or ‘B’ version of a decoder, only the ‘B’ versions are in current production. There is no way of determining if a decoder is an ‘A’ or a ‘B’ version from looking at it. All products purchased after December 1st, 2002 are ‘B’ versions.

Appendix 1 (continued)

Note that all decoders in the ZTC range are rated for operating temperatures of 0 to 60 degrees Celsius

Specs	Dimensions Width x Length x Thickness (mm)	Max. output current (including functions)	Max. Continuous current (including functions)	Max. Track Voltage	Min. Track Voltage	Function outputs	Wiring Harness	Extended Address	Zero-1 comp.	Battery Support	Speed Steps	Feedback Back EMF	PWM Adjust	Most Suitable Gauges
ZTC 215	17.5 x 27 x 7	1 amp for 3 sec	0.8 amp total load	25 volts peak	12 volts	2 @ 75 mA	ZTC 009 7 wire connector	No	No	No	14, 28, 128	No	No	N, TT, most modern HO/OO & smaller O
ZTC 215B	16.8 x 30 x 6.4	1.25 amp for 3 sec	1 amp total load	25 volts peak	12 volts	2 @ 200 mA	ZTC 009 7 wire connector	Yes	No	No	14, 28, 128	No	No	N, TT, most modern HO/OO & smaller O
ZTC 216	9.5 x 18 x 4.5	1.4 amp for 3 sec	1 amp total load	25 volts peak	7 volts	2 @ 150 mA	Attached 7 wires	No	No	No	14, 28, 128	Yes	No	N, TT, most modern HO/OO & smaller O
ZTC 216B	9.5 x 14 x 2.5	1.5 amp for 3 sec	1.25 amp total load	25 volts peak	7 volts	2 @ 500 mA	Attached 9 wires	Yes	No	No	14, 28, 128	Yes	Yes WhisperDrive ™	Z, N, TT, HO/OO
ZTC 217	8.8 x 11.4 x 3.3	1 amp for 3 sec	0.7 amp total load	25 volts peak		2 @ 150 mA	Attached 6 wires	Yes	No	No	14, 28, 128	Yes	Yes WhisperDrive ™	Z, N, TT, HO/OO
ZTC 224	12 x 27 x 7	3 amp for 3 sec	2.5 amp	25 volts peak	8.5 volts	None	ZTC 004 4 wire connector	Yes	Yes	No	14, 28, 128	No	Yes	N, TT, HO/OO & smaller O
ZTC 225	16 x 24 x 7	3 amp for 3 sec	2.5 amp total load	25 volts peak	8.5 volts	2 @ 200 mA 1 @ 500 mA	ZTC 008 8 wire connector	Yes	Yes	No	14, 28	No	Yes	Larger HO/OO, O, small gauge 1
ZTC 226	17 x 27 x 5	2 amp for 3 sec	1.5 amp total load	25 volts peak	7 volts	4 @ 200 mA	ZTC 009 9 wire connector	No	No	No	14, 28, 128	No	No	N, TT, HO/OO & O
ZTC 226B	17 x 26.5 x 6	2 amp for 3 sec	1.5 amp total load	25 volts peak	7 volts	4 @ 500 mA	ZTC 009 9 wire connector	Yes	No	No	14, 28, 128	Yes	Yes WhisperDrive ™	N, TT, HO/OO, & O
ZTC 227B	17 x 26.5 x 6	2 amp for 3 sec	1.5 amp total load	25 volts peak	7 volts	6 @ 500 mA	ZTC 009 9 wire connector plus 2 attached	Yes	No	No	14, 28, 128	Yes	Yes WhisperDrive ™	N, TT, HO/OO, & O
ZTC 250	17.5 x 27 x 7	0.25 amp	n/a	25 volts peak	-	1 @ 200 mA	Attached 4 wires	No	No	No		No	No	N, TT, HO/OO & O
ZTC 250B	11.7 x 7.8 x 4.1	0.25 amp	n/a	25 volts peak	-	1 @ 150 mA	Attached 4 wires	Yes	No	No		No	No	Z, N, TT, HO/OO & O

ZERO 1 SUPPLEMENT

This Appendix applies to the older ZTC 202, 211 and the current ZTC 203 & 214 Decoders.

FEATURES.

- ◊ Compatible with Hornby Zero 1
- ◊ Much better loco performance than R946
- ◊ No paint or links needed to set address
- ◊ Program on track with Hornby controller
- ◊ Also works any DCC standard system controller
- ◊ Compatible with ordinary DC controllers
- ◊ Smooth acceleration
- ◊ Output to motor can be up to 95% of full power
- ◊ Programmable start voltage
- ◊ Programmable top speed limit
- ◊ Plug-in wiring harnesses
- ◊ Compatible with all model motor types

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 on a Hornby Zero 1 R950 or H & M 5000 controllers or the ZTC-511 controller in Zero 1 mode.

When used on any controller using the newer DCC standard they will automatically switch over and decode the alternative signals.

For portability, they can also be safely operated on a track with only ordinary pure DC controller.

Speed Steps

On Zero 1 mode, these decoders use the 14 speed steps sent by the controller. Internally, the control system smoothes out the control range to provide a progressive acceleration or retardation through up to 255 speed steps.

When used on a DCC controller the speed precision may be much better with either 28 or 128 step control options.

OUTPUT DRIVE

On the old Hornby decoders for Zero 1 the output drive was done by either by a Triac or two Thyristors using the track power directly. These were prone to miss-firing and erratic 'glitches'.

On the ZTC decoders, the motor is controlled by 4 transistors which are not able to be misfired. The power is derived indirectly and therefore is a much more controllable and smooth manner.

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. The heating effects of the original Zero 1 decoders on some motors can be overcome by pre-setting the frequency and top speed to more suitable values

INSTALLATION

The installation is as described in the main **Locomotive Decoder Installation Guide.**

You must use the 4 wire connection method as shown and **not** use the 3 wire connection or the same wiring as for a Hornby decoder**.**

NEVER REMOVE THE PROTECTIVE PLASTIC SHRINK SLEEVE !

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 can be operated from a Zero 1 controller.

AUX 1 and AUX 2 operate automatically according to loco direction for the directional lighting. AUX 3 operates like a mobile accessory feature. This is commanded from a Zero 1 controller by using accessory commands 60 plus the loco number. i.e.: 61 to 76.

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

Setting Up Loco Decoders

Unlike the old Zero 1 decoders, there is no paint or links needed to set-up the address for the loco. 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 CV's for short.

One special CV is used for the unique Zero 1 loco address. This can be set-up on track either with the Hornby R950 or Hammant & Morgan HM5000 controllers and or course, the ZTC-511 controller.

There are other optional CV's which can also be set by the user to optimise loco performance on the track. Not all are accessible or relevant to the Zero 1 user. These should only be changed or experimented with, only when thoroughly familiar with operating and setting-up decoders.The most vital CV's 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.

CV and AN Numbering

The memory locations for the set-up parameters, as already stated, are called CV's for short. When these are programming from a DCC controller, each is specified by its unique CV number. When programming from the Zero 1 controller, these numbers have to be different to fit in with the existing Zero 1 accessory numbering scheme. Thus they are given an alternative AN number to access them. (AN stands for Accessory Number)

ZTC ZERO 1 DECODER SET-UP PROCEDURE

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.

In Zero 1, they can still only work on loco addresses 1 to 16 due to the nature of the original Zero1 specification. A special CV (in NMRA numbering format: 49) is used for the loco address and the DCC loco address is ignored. All the other operational parameters remain valid for Zero 1 operation.

AN 99 is a special key code that opens the decoders memory for changing the set-up.

Programming Procedure from a Zero 1 controller

1. Reduce all loco speeds to zero.
2. Remove all other locos from the track or use a changeover switch to select a programming track (isolated siding).
3. If this is a first test set-up it is advisable to connect a 24 Volt lamp (2 - 6 watt) in series with the track supply as a safety device in case of faulty decoder wiring. (It will light if you have a fault)
4. Place the loco with ZTC decoder on the track
5. Key the command for accessory 99.
   i.e.: 99 ➔ on the Hornby controller or
   SIGNAL 99 ENTER R on the ZTC-511
6. You only have about 16 seconds to enter the next accessory code which will either set the loco Zero 1 address or select a CV number.
7. To set the Loco Address use :

LOCO ADDRESS	ACCESSORY NUM. *A.N.*
1	61
2	62
3	63
4	64
5	65
6	66
7	67
8	68
9	69
10	70
11	71
12	72
13	73
14	74
15	75
16	76

Examples 1

To set loco 1 from the Hornby Controller
Key in 99 ➔ 61 ➔
To set loco 4 from the Hornby Controller
Key in 99 ➔ 64 ➔
To set loco 16 from the Hornby Controller
Key in 99 ➔ 76 ➔
The new address will take effect immediately after being changed.

Since there is no feedback mechanism, you can only check success by testing afterwards.

To Set-up a CV with Zero 1

Once again accessory code 99 is the key, but to set a CV value a second **AN** key is required followed by the value you require. So three numbers are needed, e.g.:

key code CV-code CV value

99 ➔ 85 ➔ 63 ➔ on the Hornby controller

This would set **AN.**85 to its maximum speed value equivalent to CV 5 = 255.

Due to the limitations of the Zero 1 accessory number range, you can only key in values 1 to 99. So to enable full range cover of AN.85,86 & 89 (CV 5, 6 and CV 9) locations scale the keyed number is scaled by the decoder times 4 plus 3. As 0 cannot be keyed from a Hornby or H & M Zero 1 controller, the code 99 is used for zero.

So for instance AN.85 if keyed 60 would be set to the value 243. However as far as possible in the examples given here, we show the actual value keyed at the controller.

The decoder will only program if the loco is completely stationary.

Table of important Loco Decoder Configuration Variables for Zero 1 set-up

CV	DESCRIPTION	**A.N.** CODE	Value MIN-MAX	Notes
2	V start	82	1 -98	*
3	Fixed Loco Acceleration Rate	83	1-15	*use 99 for zero
4	Fixed Loco Braking Rate	84	1-15	*use 98 for zero
5	V high Loco Top Speed	85	5 -<u>63</u>	don't use below 5
6	V mid Speed Curve modifier	86	0 - <u>63</u>	98 = feature off
9	Total PWM Period	89	20 - <u>63</u>	*see table
12	Power source	92	Best set 4 for Zero 1	5 if DC mode required §
65	Kick Start	95	1 - 15	use 98 for zero
29	Basic Configuration	87	2 - 3	use 2 or 3 to reverse motor

<u>Underlined</u> values are scaled x 4 + 3

***** Power down the loco before changed value becomes effective.

§ The Hornby R950 controller produces a spurious DC pulse at switch on that can move a loco a short distance with DC mode enabled (if CV.12=5). Setting 4 avoids this movement.

Configuration Variables Programming Notes

AN.82 (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. It 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!

To set a modest start voltage from the Hornby Controller

Key in **99 ➔ 82 ➔10 ➔** (this sets a value of 10)

AN.83 & AN.84 (CV's 3 and 4) Acceleration and Deceleration

When the controller sends increasing speed commands to the loco, if these values are both 0 (set by 98), 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.

Example:

To set a minimal acceleration from the Hornby Controller

Key in **99 ➔ 83 ➔1 ➔**

Example:

To set a minimal deceleration from the Hornby Controller

Key in **99 ➔ 84 ➔1 ➔**

AN.85 (CV 5) Max Speed

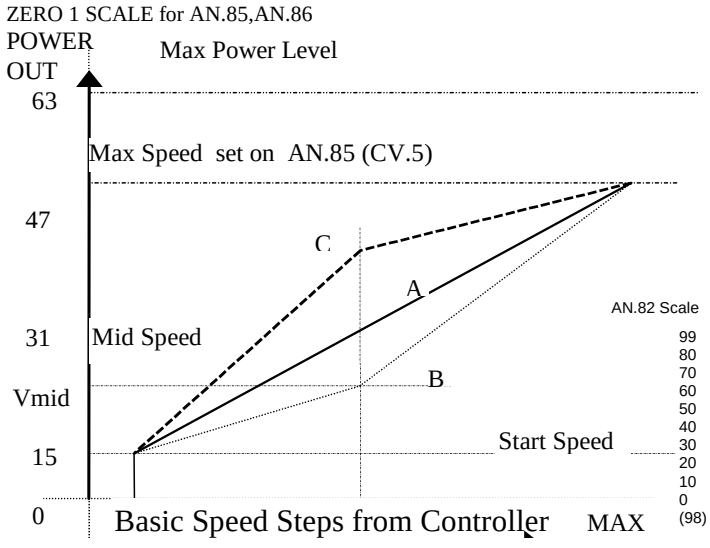
This sets the proportion of full power that can be applied to the motor on the top regulator notch (speed step) and therefore limits the top speed of the loco.

On most locos you 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

If you set a value of 63 this will give full power at maximum regulator. On a Zero 1 controller, this translates to a much higher speed than before with the original Hornby decoders.

A value of 31 would give half power at maximum and If zero is ever set the loco will never move!.
A lower practical limit is about 12 for very sensitive motors.

Speed Curve modification by Vmid



Example

To set loco max. speed of half from the Hornby Controller Key in **99 ➔ 85 ➔ 31 ➔**

AN.86 (CV 6) Mid Step Speed (V mid)

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. Use about half or less than the value set as for AN.85 (CV.5) for better low speed control.

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.

AN.95 (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.

Example

To set a modest Kick Start from the Hornby Controller

Key in **99 ➔ 88 ➔5 ➔**

AN.87 (CV 29) Basic Configuration Register

The default value for ZTC decoders used with the Zero 1 or ZTC-511 controllers 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.

Examples

To reverse motor sense from the Hornby Controller

Key in **99 ➔ 87 ➔3 ➔**

To set normal motor direction sense

Key in 99 ➔ 87 ➔2 ➔

AN. 89 (CV 9) Output PWM Frequency

This parameter allows the motor drive Pulse Width Modulation (PWM) frequency to be changed. The factory default value is set to a frequency of about 70 Hz. This suits most type of DC motor. However larger motors benefit from lower frequencies such as 50 Hz.

Coreless motors such as the Portescap and Faulhaber range should not be run below 125 Hz. Try **AN** values between 20 and 30 for a best compromise of whine and performance. **Do not run larger can or open frame motors with AN.89 below a value of 46.**

AN. 89	Equiv. CV value	PWM Freq Hz	Notes
63	255	31	
62	251	33	LARGE
61	247	35	MOTORS
60	243	38	ONLY
59	239	41	
58	235	45	
57	231	49	
56	227	55	
55	223	61	
54	219	65	
53	**215**	**70**	**Default**
52	211	75	
51	207	82	
50	203	89	
49	199	98	
48	195	109	
47	191	123	
46	**187**	**131**	**Most small**
45	183	140	
44	179	151	
43	175	164	
42	171	179	
41	167	197	
40	163	219	
39	159	245	
38	155	262	
37	151	280	
36	147	302	
35	143	327	Portescap
34	139	357	and other
33	135	393	low power
32	131	437	precision
31	127	490	motors only
30	123	523	
29	119	561	
28	115	604	
27	111	654	
26	107	714	
24	99	874	
22	91	1046	
20	83	1208	
19	79	1309	
18	75	1429	Use
17	71	1572	filter with
16	67	1748	motors only
14	59	2092	
12	51	2415	
11	47	2618	
10	43	2857	
8	35	3497	
7	31	3922	
6	27	4184	
0 (98)	3	6993	

Examples

To set the motor PWM for most small types from the Hornby Controller Key in **99 ➔ 89 ➔46 ➔**

To restore normal default (approx.) Key in

99 ➔ 89 ➔53➔

TYPICAL AN.89 (CV.9) SETTINGS

LOCO / MOTOR TYPE	**AN.89 range**
Bachmann 00	46-55
Hornby Ringfield	46-58
Hornby XO-4 etc open frame	53-59
Mashima Can	46-53
Portescap RG4	30-20
Portescap RG7	30-20
Wrenn & Hornby Dublo (must be a ZTC-203)	53-60
Graham Farish 5 pole N gauge	46-39

Testing

If possible use the 601 or ZTC-511 with programming output to check the installed decoder by attempting to set its loco address. Alternatively, the Zero 1 controller can be used by placing a 24V. lamp (2 - 6 watt) in series with the output as previously described. If there is any undetected wiring problem, testing this way should be safe.

Only then put the decoder equipped loco on the main line for a full power test.

Operational Notes

The ZTC decoder equipped loco can be operated in the same way as for the original Hornby product except that there will be now be some extra features.

The loco inertia will be much better if AN.83 & 84 (Cv.3 & 4) have been set to non-zero values. But you will then find even if the controller inertia is set the level 0 that your stopping distance is prolonged. Values of 1 to 3 are to be recommended.

If you have connected lights to the AUX-1 and 2 outputs (not on the ZTC-211) that these will operate directionally even when stationary.

If the AUX-3 is used, perhaps connected to a smoke generator, light or some other accessory, it can be operated from the Zero 1 keypad by using the loco address plus 60 as an accessory code. Thus for loco 4 keying:

64 ➔ turns on AUX-3

64 ➔turns off AUX-3

AN codes 61 to 76 operate AUX-3 for Zero 1 locos 1 to 16