



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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INTRODUCTION

Controlling a model railway with a simple variable resistance, or voltage, regulator has been the classic way of doing things since the introduction of the electric train set at the beginning of the 20th century. Now there is the ZTC 505 Digital Controller, with RealFeel™ controls that look and perform like the real controls of a traditional locomotive.

Running a Railway

Varying the voltage on the track to control a train is quite satisfactory for a simple layout. However, when it comes to larger layouts with a number of running lines and multiple train operation, you need a lot of switching and wiring to block sections to get the power from multiple controllers to the right parts of the track. Add a reverse loop or whatever, and running one train alone can become quite complex. Running many engines, some on the same track, becomes practically impossible using conventional DC.

What's on the Track?

With Digital Command & Control or **DCC** for short, power is on all of the track all of the time. DCC power is a low voltage digital AC signal. The actual regulation of the loco speed goes on in the loco itself. A decoder fitted inside the loco, converts the AC power to run the DC motor of the loco.

So to control a loco, instead of varying the track voltage, a command is sent along the track to the loco to tell it what speed it should be going at. This remote control means that you can have as many trains in operation as you like without having to use block section switching.

Simple Wiring

This then greatly simplifies the wiring, especially for complex layouts. Since independent control of locos on the same track is possible, you can have much more realistic operations with double heading, banking and shunting.

More movements

The most important benefit of digital operation is to not have to make numerous track section switching actions every time you want to move anything. You can now have more enjoyment by letting out as many locos as you could wish whenever you want to.

More Benefits

There are many other benefits of going DCC. The control is much smoother than you would expect from a conventional controller, with very slow loco speeds being easy to achieve. You can also remotely operate auxiliary functions for each loco, such as lights, sound, smoke effects or even electric couplers if you have them.

Accessories

You can control far more than the locos, if you desire. A remote controlled device, called an accessory or stationary decoder, can be used to operate everything else on your layout from the Master Controller. Also, points, signals and other motorised accessories can be easily called-up from the keyboard, rather than relying on banks of electrical switches. Complexity of wiring is substantially reduced.

Control

The controller in a DCC layout does much more than the old-fashioned boxes with a knob. It can handle a number of locos simultaneously, up to at least 12.

You can start controlling any loco at once without having to switch power to the track. After keying in a loco number, the controller will allow you to move a particular engine and run it right up to another stationary loco, couple up, and go off double headed or as a multiple unit. Similarly, you can bank or shunt realistically. But beware, you might be in danger of having the worst prototypical accident - the head on collision!

Better Controls

This is where RealFeel comes into its own. The regulator lever is much better for controlling locomotives than rotary knobs. The controller also has a built-in memory to retain your set-up preferences.

The FWD and REV indicators are provided to show present loco direction before control is seized or when inertia causes a lag in direction response.

Multiple Train Control

One ZTC 505 can command up to 12 locos in motion at any one time from up to 9,999 different loco numbers. A roster is maintained of the currently running engines so that only one button press is needed to swap between each one.

Additional slave controllers can be plugged into the rear of the master unit so that other locos can be simultaneously operated. These slaves can either be further ZTC 505 units or one or more of the Slave Hand Controllers. In this way, Up to 15 additional friends can help operate the railway and make it much more fun. Extension leads and sockets (ZTC 309) allow remote operation from 3 to 300 metres away!

Locomotive (Loco) decoders

A locomotive decoder has to be fitted inside each loco or its tender to operate in digital mode. The exception is that DCC does allow a single loco without any decoder 'chip' to be run on the system as if it had one. The function of these 'chips' is to receive the signals sent along the track and control the power to the DC motor of the loco according to the commands decoded. The power control is on-board the loco not in the controller. However, converted locos will still run on any conventional pure DC controlled layout. These will also be able to operate on other layouts powered by other manufacturers' DCC controllers.

The decoders can be set-up for their loco addresses and all other characteristics from the keyboard of the ZTC 505 by using the programming output connected to a short stub of track. There are no links or conductive paint needed. With 9,999 numbers to choose from, even the biggest loco collections can be catered for. The memory inside the decoder storing the address and set-up characteristics is non-volatile and will remember its settings for more than 10 years and yet can be re-programmed as many times as necessary.

ZTC makes a complete range of these miniature remote control circuits of different shapes, sizes and power ratings. This will allow maximum flexibility in their application to different types of loco, scale and gauge

How the System Works

To use the ZTC System you do not need to know any of the technicalities, but the basics are: -

The actual voltage on the track is in the range of 12 to 24 VAC according to the gauge or scale requirements. Superimposed on the track voltage is a digital signal containing the commands to the various locos or accessory decoders on the layout.

Locos have a decoder between the power pickup from the wheels and the electric motor. The function of the decoder is to rectify the AC voltage on the track and convert it to DC for use by the electric motor. A power controller stage smoothly varies the applied voltage according to the received commands decoded from the track signal by a small, dedicated, microprocessor. Direction is also controlled by the same stage and has nothing to do with the polarity of the track.

Motor Drive

Moving the unmodified (no decoder installed) loco is achieved by the controller varying the symmetry of the AC voltage on the track so that a DC bias appears in one direction. The controller uses a special address to control this mode, but for the user, it is as if the loco actually had a decoder!

In a decoder, the voltage control to the DC motor in a loco is achieved by pulse width modulation (PWM). This means that the on/off ratio of an electronic switch is varied, so that the average voltage can be controlled. This method is very power efficient, a factor that must be considered due to the tiny dimensions of the typical loco decoder. The frequency at which this is done is about 70 Hz, which is generally suitable for most commercial model motors. However, not all motors have the same characteristics and so the ZTC decoders have the ability to have the PWM frequency changed. Lower frequencies suit some larger motors better such as G and Gauge 1 models. The coreless precision motors such as Portescap and Faulhaber type vibrate too much at 70 Hz, but the decoder can be set to a much higher frequency to suit them.

Power Boosting

The ZTC 505 Master Controller has a maximum current output of 3.0 amps to the track. This is of course fed to all the track in parallel. The maximum power is drawn when locos are simultaneously starting, which might be double their nominal running currents. Accessory modules may also be connected to the track or the controller and taking power as well. So eventually the system could 'run out of steam'!

The power booster operates like an amplifier, taking the signal from the master controller and providing a separate power output feed. This is connected to additional (remote) parts of the railway system and can provide up to another 5 amps of power. A separate mains transformer has to be connected to the booster to provide its source of power. More boosters can be connected if even more power is needed.

Reverse Loops

The main problem with a reverse loop is the fact that the left rail sweeps round to join up with the right and visa-versa. To prevent short circuits an insulated joint must be placed at the entry and exit of the loop. However, if the loop section is fed by a ZTC power booster (ZTC 550), continuous running will be possible through the loop. The booster senses the polarity of the track signal needed and automatically switches itself at either the entry or exit as the train passes the insulated joint.

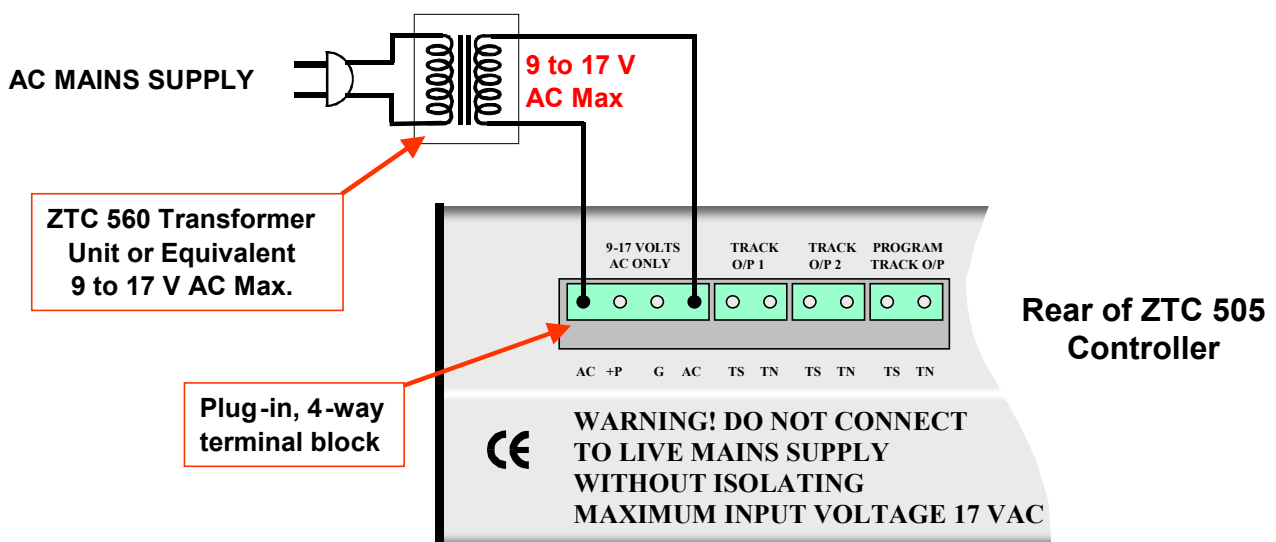
Additional material on the subject is available on the ZTC one hour DVD (ZTC 110) or the Video (ZTC 111) DCC Expert Programme or In the Digital Command Control Book sub titled “DCC for beginners” written by Stan Ames, Rutger Friberg & Ed Loizeaux, which is also available from ZTC Controls Ltd. As product number ZTC 112

1.0 Connecting Power to the ZTC 505

1.1 Transformer Required

DO NOT CONNECT THE ZTC 505 DIRECTLY TO THE MAINS POWER SUPPLY.

Power for the ZTC 505 is provided by a suitable, low voltage, transformer. The ZTC 560 transformer unit is recommended for most applications. A plug-in, 4-way, terminal block connector, with screw terminals for connecting wires, is provided with all ZTC transformers. Additional 4 pin connectors can be supplied for use with your own transformers if required. This must be used for connecting the transformer to the unit. It plugs into the power socket on the rear of the ZTC 505. Ensure that the transformer wires are connected to the two outer screw terminals. The diagram below shows how power is connected to the unit. See section 11.1 for transformer specification details and more instructions on how connections are made to the ZTC 505.



1.2 Powering Up

There is no power switch on the unit. Power is applied when the ZTC 560 transformer unit is connected to mains power. When power is applied to the unit, all the indicator lamps will illuminate for a brief period. Power on is indicated when one of the TRACK power indicators are lit continuously. The unit will also give a short "beep" to indicate that power is now present on the output. The liquid crystal display (LCD) will also show a series of start-up messages.

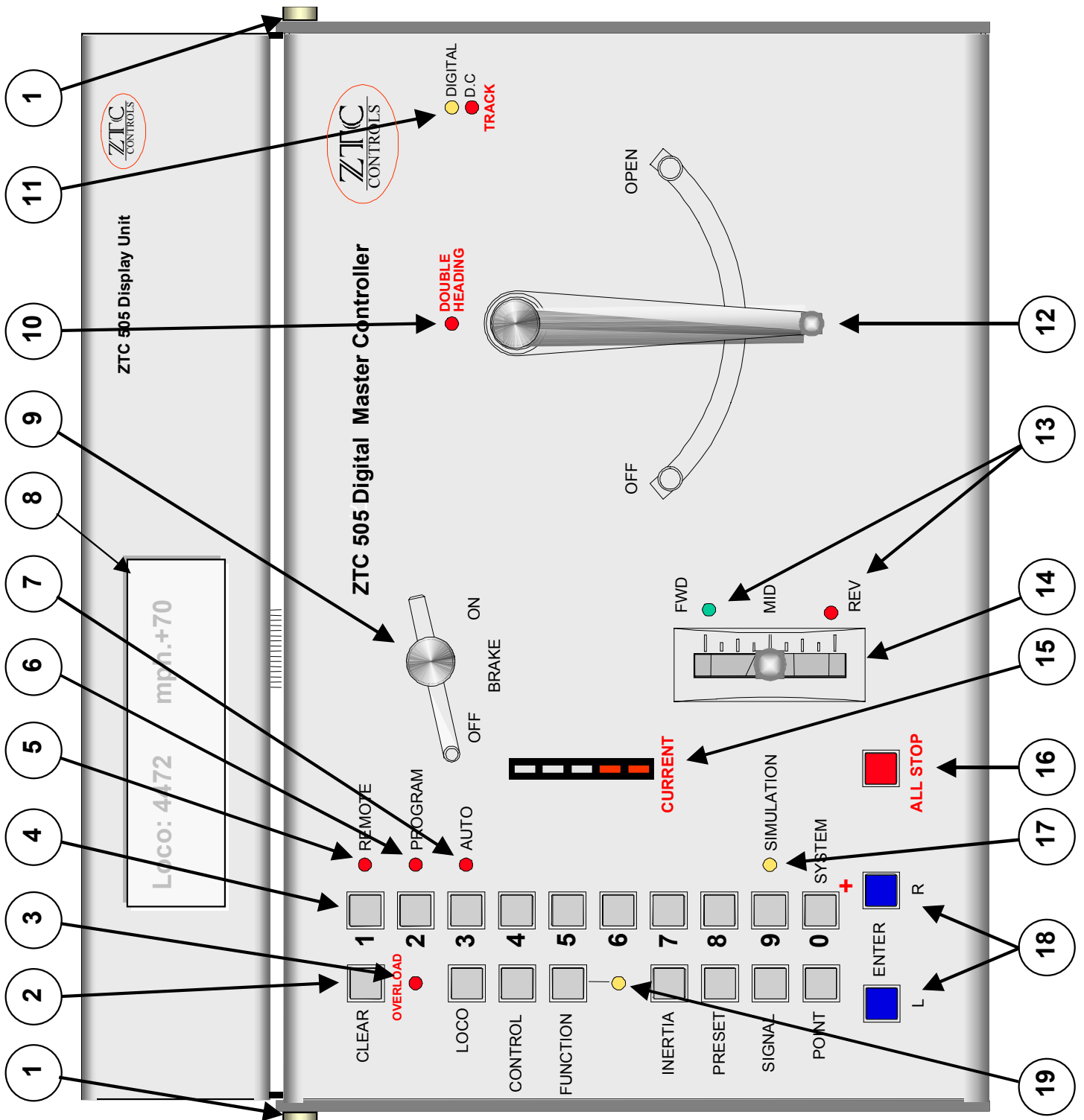
1.3 Fast Track start-up

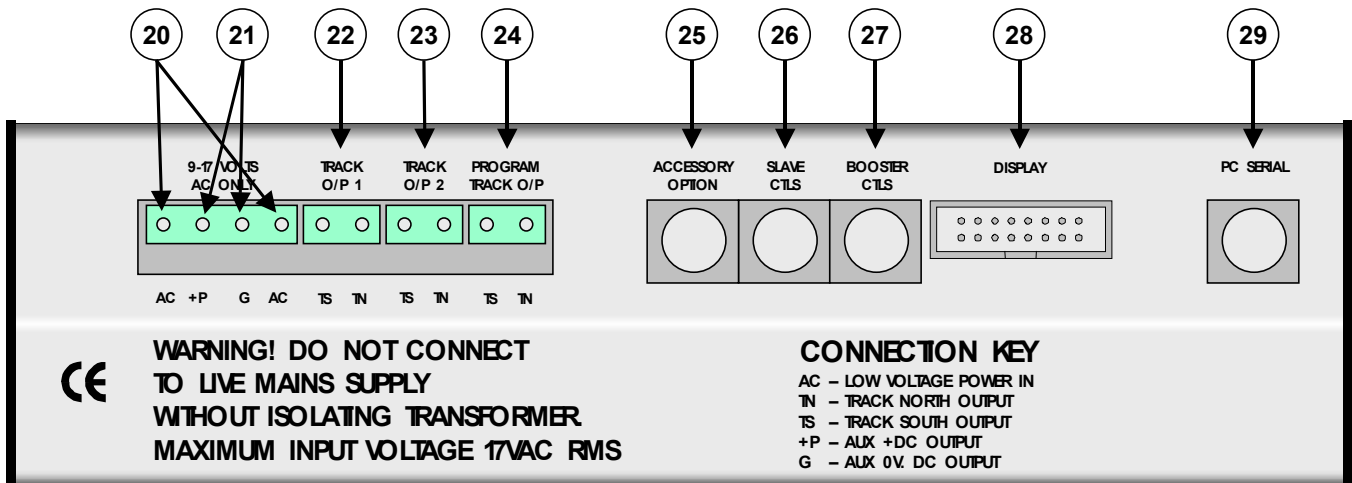
On powering-up the ZTC 505, the system will immediately operate, with loco number 3 (default address of a new loco decoder) selected.

1. Check that the ZTC 505 Display unit is plugged into its socket at the rear of the unit.
2. Plug the ZTC 56X Transformer power unit into the POWER INPUT socket
3. Plug the transformer into the mains supply and switch on.
4. Attach two wires to some track using a 2 way plug-in terminal block and plug it into the TRACK O/P 1 socket at the rear of the unit.
5. Turn the BRAKE handle fully anti-clockwise to the **OFF** position.
6. Push the reverser gear lever to the **FWD** position.
7. Operate the regulator lever to adjust the speed of the loco.

To gain the most benefit from operating the controller, read the rest of this manual before proceeding.

ZTC 505 Controls and Panel Features





Key to ZTC 505 Controls and Panel Features

Key	Description
1	Display Unit tilt adjust screws
2	Command keys
3	Overload indicator LED
4	Number keys
5	Remote LED flashes intermittently when one or more slave controllers are connected
6	Program LED illuminates when in programming mode
7	Automatic control LED - future application
8	Liquid crystal display (LCD) screen
9	Brake handle applies braking effort to loco
10	Double heading LED flashes when 2 or more locos are being linked as a multiple unit
11	Track power
12	Regulator lever controls the speed of a loco
13	Direction indicator LEDs
14	Reverser lever controls direction of loco
15	Current indicator shows the amount of current being drawn from the controller
16	All stop button is used to stop all locos in an emergency
17	Future Upgrade to ZTC 511
18	Enter keys used for entering programming commands into the controller
19	Loco functions LED illuminates when loco function can be keyed in directly
20	Isolating power transformer – 9 to 17 V AC – input terminals
21	DC power terminals for external DC power supply feed
22	Output to track feed 1
23	Output to track feed 2
24	Programming track output
25	Accessory connector – future application
26	Slave controller connector
27	Power booster connector
28	Display unit connector
29	Computer port – future application

2.0 ZTC 505 Control Features

The diagram of the ZTC 505 shows all the control features. The operation of each feature is described below:

2.1 Keypad buttons

All the keypad buttons are clustered on the left hand side of the ZTC 505 front panel.

2.2 Command Keys

The left hand column of grey push buttons is the Command keypad. Each key has a command associated with it, which is printed beside it. These keys are used, in conjunction with other keys, to configure the ZTC 505 controller and any decoder modules that are installed in locomotives or connected to the ZTC 505 output.

2.3 Number Keys

The right hand column of grey push buttons is the Number keypad. The number zero (0) push button is also a command key (SYSTEM). The number keys are used in conjunction with other keys to configure the ZTC 505 and decoder modules.

2.4 Enter Keys

On the bottom left of the front panel are two buttons marked “L” and “R”. These are referred to as the **ENTER L** and **ENTER R** buttons. These buttons are usually pressed at the end of a sequence of key presses to enter a command into the ZTC 505 computer.

2.5 Entering Keypad Commands

The entry of 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 loco 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 LOCO button first, followed by the desired loco number (e.g. 123) entered from the number keypad and then followed by the ENTER R button. The above convention is used throughout this manual.

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.

2.6 Command Key Look-up Table

The back outside cover of this manual shows a quick reference table of command key functions. Find the feature that you require in the body of the table. The first key to press will be that shown opposite the feature, in the left hand column. The second key is that shown above the feature in the top row. The “solo” column indicates that the only command key required is that shown in the left-hand column. You may have to enter a numeric value after the command key sequence, using the number keys, depending on the selected feature, followed by ENTER R.

2.7 Loco controls

Rather than the conventional knob to control the speed of a loco, the ZTC 505 provides controls similar to those used in a real locomotive. There is a regulator lever, a reverser lever and a brake handle. These represent the RealFeel™ feature of the ZTC 505 controller.

2.8 Reverser Lever

The reverser operates like a three position switch. The FWD and REV positions dictate the direction of the currently selected loco. MID represents mid-gear on a steam locomotive, or neutral on a diesel or electric loco.

Moving the reverser lever rapidly from FWD to REV (or vice versa) causes inertia to be automatically applied to the loco. The selected direction LED flashes slowly to indicate this. The loco will slow down, come to a halt and then move away in the opposite direction. This safeguard prevents abrupt changes in direction that could cause damage to locos and/or rolling stock.

2.9 Regulator Lever

The regulator lever is used to control the speed of the loco. Its immediate affect on the speed of a loco depends on other settings of the ZTC 505 and the settings of the decoder module in the loco concerned.

If inertia has been applied to a train, then moving the regulator to the OFF position will have no immediate effect on a moving train. The train will coast for a while unless the BRAKE is applied. If stopped and the regulator moved to the OPEN position, the train will slowly accelerate to the set speed.

When in the OPEN position, the regulator will only have affect if the REVERSER is fully in the FWD or REV position.

2.10 Brake Handle

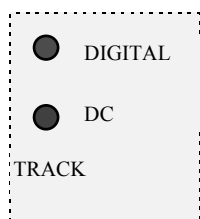
If inertia is applied to a train (see section 5.8), setting the regulator to OFF will not stop the train immediately. The train will coast for a while, depending on the amount of inertia applied. The train can be brought to a controlled stop by applying the brake. This is achieved by rotating the brake handle clockwise to progressively apply more braking effort. An emergency stop is always applied if the brake handle is wound fully on (clockwise).

Note that if the brake handle is more than half way round, any effort to start a stationary locomotive will be unsuccessful. Return the brake handle to the off position to start any loco.

In addition to the above, the brake handle control can be used to dial in certain CV values during programming steps, instead of using the number keys. See Section 15.5 for more details

2.11 All Stop Button

In pressing the **ALL STOP** button once will stop all locomotives. Power to the track is still present and any accessory decoders connected to the track or track output connectors can still be operated. Pressing the **ALL STOP** button for a second time cuts all power to the track.



To show that power has been cut, the TRACK power indicator shown at left, blinks and the LCD display will show "TRACK OFF/ALL HALTED".

3.0 Liquid Crystal Display (LCD)

The ZTC 505 comes equipped with a display unit that plugs into the back of the ZTC 505. The display unit can be tilted by loosening the two Display Tilt Adjust screws located on either side of the Display Unit with your fingers. Re-tighten the screws with your fingers when adjusted to your liking.

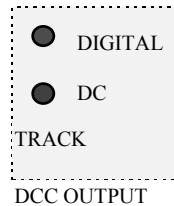
The display unit has a two-line LCD screen. The screen gives the user feedback when operating, or entering new commands into the system. When you are not entering commands, the top line of the display normally shows the loco number currently under control, along with its speed.

Loco number and speed →

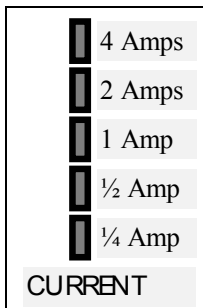


3.1 Power Mode Indicators

- **DCC Digital** - the latest and most up-to-date digital control system complying with international NMRA standards, allowing many locomotives to be controlled simultaneously. One locomotive can be operated independently without a DCC module installed. All other locomotives **MUST** have a DCC compatible module installed. Both the DIGITAL and the DC TRACK power indicators are lit.



3.2 Current Indicator



The CURRENT indicator shows the amount of current being drawn. The amount of current will depend on the number of locomotives running and the number of accessory decoders, lighting, or trackside effects connected directly to the track. The higher the current, the more sections of the current indicator will illuminate. The diagram to the left shows the approximate current value when each segment is lit. The current monitor only shows the current being provided by the ZTC 505 and not that, which may be supplied by any additional power boosters installed in the track layout.

3.3 Overload

The ZTC 505 is equipped with overload protection in the event that a short circuit occurs. On detecting a short circuit, track power is momentarily turned off. The **OVERLOAD** lamp will light when this happens and a "beep" will be heard. If the short circuit is cleared, then power will be automatically restored. If the short circuit persists for more than a few seconds, then the controller will cease attempting to restore the power and the **OVERLOAD** lamp will flash continuously and random beeping occurs to indicate that a short circuit exists. All power to the track will be switched off. Once the short circuit has been located and corrected, pressing the **CLEAR** button will restore power.

4.0 System Parameters

There are a number of parameter settings that you may want to change when first installing the ZTC 505 system.

The **Scale and Gauge Settings** set the maximum voltage and current outputs from the controller. Depending on the scale of your layout these settings may need to be changed. The factory default settings are set for OO/HO scale.

The **Loco Speed Indicator**, displayed on the LCD screen, is set in speed steps. The speed steps indicate the amount of power that the ZTC 505 is telling the loco decoder to apply to the motor in the loco. Depending on the loco control mode (14, 28 or 128 steps – see Section 5.1)

Once set, the above settings are stored in the ZTC 505 and do not need to be set again, unless a change is required.

4.1 Setting System Parameters

The system parameters can be set by using the keypad buttons to key in the required information. To view the existing settings, key in:

SYSTEM → **FUNCTION** → **ENTER R**

The system will automatically return to normal operating mode after a few seconds.

To reset the functions to factory settings, key in:

SYSTEM → **FUNCTION** → **9** → **9** → **ENTER R**

Note that there is no confirmation that a reset has taken place. You will have to view the parameters to confirm this.

4.2 Scale and Gauge Settings

Use the following keypad sequence to adjust the maximum voltage or limit the maximum current available to the track:

SYSTEM → **FUNCTION** → *system parameter number* → **PRESET** → *new value* → **ENTER R**

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

The System Parameter Table provides the **System Parameter Numbers**, the parameter each relates to, and the range of *new value* figures that may be entered. The *new value* is entered in tenths of units e.g. for 1.0 Amp enter 10, for 16.0 Volts enter 160. See the Recommended Settings Table for recommended voltage and current settings for various scales and system power modes.

Note that the maximum voltage and current available is dependant on the rating of the low voltage transformer providing power to the ZTC 505.

System Parameter Table				
System Parameter Number	System Parameter	Factory Setting	Recommended Minimum	Recommended Maximum
1	Maximum track voltage	14 Volts	90 (= approx 9 Volts)	255
2	Maximum output current	63 (5 Amps max.)	10 (= 1.0 Amp)	63 in UK for digital mode.

Recommended Settings		
Scale/Gauge	Output Voltage Parameter 1	Output Current Limit Parameter 2
DCC Digital		
OO/HO	14 VAC set 140	3.5 Amps set 44 (Max)
N	12 VAC set 120	3 Amps set 30
O	17 VAC set 170	3.5 Amps set 44 (Max)
G or Gauge 1	>20 VAC set 255	3.5 Amps set 44 (Max)
Z	10 VAC set 100	2 Amps set 20

5.0 Operating your ZTC 505

Note that one locomotive without a decoder can be operated in DCC mode. This is assigned address 0, or loco number 0. See Section 5.2 for more details.

To gain control of a locomotive you need to know the address or loco number that has been assigned to it. The following keystrokes allow you to gain control of a locomotive:

LOCO → *loco number* → **ENTER R**

The selected loco number will appear in the top left of the LCD screen. Start the loco moving by setting the reverser to the desired direction and adjust the regulator for speed. For new decoders use the number 3 which is the default value.

5.1 Loco Control Mode

The ZTC 505 can be configured to send speed control signals to a loco decoder in one of three modes. These are the 14 step, 28 step and 128 step modes. The higher the number of steps, the smoother and more precise the speed control. The default control mode is 28 step. ZTC loco decoders (version 2 and above) can operate in all three modes. Some manufacturers' loco decoders do not support the 28 or 128 step modes. If a loco, with a non ZTC loco decoder installed, shows flashing headlights when accelerating, it is an indication that the decoder does not support the control mode currently set for that loco. The control mode would need to be changed. To view the currently set control mode for a given loco press:

CONTROL → **CONTROL** → **ENTER R**

5.2 Changing Loco Control Mode

The ZTC 505 supports three control modes (14, 28 and 128 steps).

To change the control mode for a loco, firstly ensure that you have control of the desired loco and then enter the following keystrokes:

CONTROL → **CONTROL** → *mode number* → **ENTER R**

The LCD screen will show the three control modes with the *mode number* 1 to 3. Press selected number to select mode required. To save the selected control mode for the loco concerned enter the following keypad sequence:

LOCO → **PRESET** → **ENTER R**

5.3 Controlling a Locomotive Without a Decoder Installed

One locomotive without a decoder installed can be independently controlled by the ZTC 505. This locomotive is assigned an address, or loco number, of 0. However, locomotives with coreless motors such as Portescap and Faulhaber should not be used in this way. To determine if the motor in a locomotive is suitable for loco 0 operation, connect a short piece of track to the main controller output, with the rest of the layout disconnected. Place the locomotive on the track and call up loco 0 to gain control of it as follows:

LOCO → **0** → **ENTER R**

With the regulator fully OFF, look at the current indicator LEDs. **If there are more than two current indicator LEDs lit, then the loco is unsuitable for this application and should be removed from the track immediately.** If the LED display shows two or less indicator LEDs lit, then operate the regulator and reverser to check controllability. A faint buzzing noise coming from the loco is normal.

5.4 Controlling Another Loco

To take control of another loco (up to 12 can be running simultaneously) call up the loco as shown above i.e. **LOCO** → *loco number* → **ENTER R**. The loco originally under control continues running, but the ZTC 505 controls are now assigned to the other loco number. However, the newly assigned loco can only be controlled once the regulator has been moved to the OFF position, and the reverser lever has been returned to the MID position and then moved to FWD or REV as required. A direction indicator LED will flash rapidly to indicate that this must be done. Adjust the regulator to allow the loco to move off. Repeat this operation for other locos.

5.5 Switching Control Between Running Locos

As loco numbers are entered, the ZTC 505 stores these numbers in its memory location called the Loco Command Roster (see Section 5.5). To switch control to another loco in the roster, simply press the **ENTER R** or **ENTER L** keys to scroll up or down through the stored loco command roster. When you arrive at the desired loco number, after a brief pause, the ZTC 505 will automatically assign control to that loco. The desired loco number will appear at the top left of the LCD screen.

Alternatively, you may enter the desired loco number directly by calling it up using the command and number keys: **LOCO** → *loco number* → **ENTER R**

If the previously controlled loco is running in the opposite direction to that of the newly selected loco, the direction indicator LEDs, either FWD or REV, will blink slowly, showing the direction in which the newly selected loco is currently running. Move the reverser lever towards the blinking LED and position the regulator to adjust the speed. Whilst the direction indicator is blinking, a heavy inertia is applied to the selected loco, so that a sudden change in speed or direction is avoided when a loco switch is performed.

5.6 Loco Command Roster

Up to 12 locomotive numbers can be retained in the loco command roster.

(Only 12 locomotives can be operating at the same time). If a 13th loco number is entered, the ZTC 505 will search for the first loco that is halted, delete it from the roster, and then add the new loco to the roster. If all 12 locos are in motion, the system will halt the first loco in the roster, delete it, and then replace it with the new loco number. If you do not want this to happen, then you can remove a loco number from the roster manually by using the following keypad sequence:

LOCO → **CONTROL** → *loco number* → **ENTER L**

5.7 Saving Loco Parameters

The Loco Command Roster also stores the various parameters set up for individual locos. These are the Step control mode and the Maximum speed. When a loco is called up, the ZTC 505 checks its roster for a match against the loco number. If it finds a match, then the parameters that were set are recalled for that loco. If parameters are required to be changed, or stored initially for a new loco, then set the required parameters for the loco, as described in other parts of this manual, and then enter the following key sequence to save them in the roster memory:

LOCO → **PRESET** → **ENTER R**

The saved roster can be recalled at any time by pressing:

LOCO → **FUNCTION** → **ENTER R**

5.8 Automatic Recall of Loco Roster on Start-up

The ZTC 505 can be configured to automatically recall features of the last saved loco roster whenever it is powered up.

To view the available options key in:

FUNCTION → **LOCO**

Three options will be shown on the LCD screen.

- Select 1 to recall the last loco used at the previous operating session.
- Select 2 to recall the whole loco roster used at the last operating session.
- Select 3 to not recall any locos on start up at all.

Follow your selection with **ENTER R**

5.9 Deleting the Saved Loco Roster

The information about all the locos stored in the roster can be deleted by keying in the following sequence:

LOCO → **POINT** → **ENTER R**

5.10 Operating Decoder Functions

Some loco decoders, in addition to controlling the speed and direction of the loco, have a number of auxiliary functions. These can be used to operate lights, smoke generators, or sound, for example.

When a new loco is selected, the LED below the FUNCTION button is illuminated. This indicates that any number entered from the number keys will immediately operate the related function output; one press for **ON** and another for **OFF**. Once another command key is depressed the FUNCTION LED will go off and the immediate access to the number keys for operating the various functions is no longer available.

Accessing a loco decoder function is then performed by using the following keystrokes:

FUNCTION → *function number* → **ENTER R** or **ENTER L**

Depending on the state of the selected function, this will turn it on or off.

Once a function has been called up in this way, the FUNCTION LED stays illuminated and immediately pressing a function number on the keypad will toggle that feature on and off. However, as before, if another command button is depressed the FUNCTION LED will go out and immediate access to a function is no longer available. To regain access, repeat the above keystroke sequence.

Refer to the information provided with the loco decoder to determine the function numbers available. More information on decoder function programming will be found in the instructions supplied with the decoder.

5.11 Double Heading and Multiple Units

Two or more locos can be operated together as a multiple unit, providing both locomotives are on the Active Loco Roster. This is called double heading. To create a multiple unit of two locos simply key in the numbers of the required locos as follows:

LOCO → *lead loco number* → **LOCO** → *2nd loco number* → **ENTER R**

Up to five locos can be linked together by repeating the LOCO commands before pressing the ENTER R key. On pressing the ENTER R key the controller will be assigned to that group, the lead loco number being the number displayed on the LCD screen, preceded by the letters DH (Double Heading). The Double Heading indicator LED will be flashing.

Up to eight double headed pairs can be operating at once (only 16 locos can be running simultaneously).

To reselect a double headed group after controlling another loco, simply recall the lead loco number, by either scrolling through the loco roster (using ENTER R or ENTER L keys), or calling it up directly (LOCO → *loco number* → ENTER R). Note that none of the other locos that are part of the group will be able to be recalled using the scrolling technique.

When a multiple unit group is reselected the double heading symbol will appear on the LCD display but the double heading LED will not flash.

To break up a multiple unit press the following keys:

CONTROL → **LOCO** → **ENTER R**

To remove an individual loco from the group and control it individually simply reselect it as follows:

LOCO → *loco number* → **ENTER R**

Note:- A break can only be done by the controller that is driving the group

6.0 Slave Controllers

A slave controller allows an additional operator to control trains on the layout. Several slave controllers can be connected to the ZTC 505, which is then referred to as the master controller. The REMOTE LED on the ZTC 505 will blink intermittently when one or more slaves are attached to the master. The following keystrokes set the controller to be a slave.

SYSTEM → **CONTROL** 6 → **ENTER R**

6.1 Slave Controller Assignment

ZTC 505 Slave Controllers have a unique slave number that is set up on the slave keypad once it is connected to the master. The slave number cannot be changed from the master controller.

The status of all controllers (slaves and master) can be reviewed by using the following keystrokes on the ZTC 505:

CONTROL → **SYSTEM** → **ENTER R**

Pressing **ENTER R** repeatedly shows each of the loco - controller assignments used on the system. Locos that are not under direct control of any controller are indicated as FREE. To exit this display mode press **CLEAR**.

For more information on slave controllers see the individual slave controller instruction manual.

6.2 Setting up a Slave Controller and its Slave Number

The ZTC 505 Master controller should be powered up on its own, with no connections to the track.

Set the controller to work as a slave.

Set the slave number for the controller by entering:

CONTROL → *Slave Number* → **ENTER R**

The slave number must be between 1 and 30 inclusive.

Note:- Slave numbers 0 and 31 are not available.

To view the current slave number for the ZTC 505 press:

CONTROL → **ENTER R**

Important Note;- When powering up the designated Slave ZTC 505 use of a separate power transformer is recommended. Alternatively use a separate lead from the same transformer as used for the Master ZTC 505 controller. In this case you will need to add a second connector to the output of the transformer wired the same way round as the first.

If this is not done then the controller will appear to work for a short time, but will possibly damage the XBus III cable and/or the master ZTC 505 due to excess load on the power supply. Data is then passed between the two controllers using an XBus III lead connected between the Slave outputs of the two ZTC 505s.

7.0 What You Need to Know About Loco Decoders

For independent operation of several locos on the layout, each loco needs to have a loco decoder installed (except loco 0, see Section 5.3). A loco decoder contains a miniature computer chip that responds to commands (speed up, slow down, turn on lights, etc.) 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 commands it should respond to, and what commands it should ignore. To achieve this, each decoder has a unique electronic address or loco number assigned to it. Commands for a specific decoder are preceded by its electronic address, telling the decoder that the commands that follow the address are for it to respond to. New decoders all have the same address or loco number (3) which is their default setting, so the first step after installing a decoder in a loco (see specific decoder installation instructions) is to change the loco number to something different from all the other decoders on the layout. There are other features in loco decoders that can be changed as well. Each of them, including the loco number, is referred to as a **Configurable Variable**, or **CV**.

7.1 Configurable Variables (CV)

A list of important CVs is shown in the table below. Some decoders have more CVs. Not all of the CVs listed apply to all decoders. See the data sheet supplied with your decoder for details. Some of the listed CVs are explained in greater detail elsewhere in this manual. A list of available CVs can be viewed on the LCD screen by keying in the following:

POINT → **LOCO** → **ENTER R**

Pressing **ENTER R** or **ENTER L** scrolls through the list of CVs, which also shows their respective description, where applicable.

CV #	DESCRIPTION	Default	MIN.	MAX ZTC	Notes
1	Primary Loco Address	3	1	127	Some decoders support extended addressing up to 9999
2	Vstart	8	0	255	not practical above 128
3	Fixed Loco Acceleration Rate	0	0	15	
4	Fixed Loco Braking Rate	0	0	15	
5	Vhigh Loco Top Speed	255	15	255	don't use below 15
6	Vmid Speed Curve modifier	0	8	250	0 = feature off
9	Total PWM Period				See table in Section 7.15
12	Power Source Conversion				
17	Extended Address, high order bits	0	0	63	advanced users only
18	Extended Address, low order bits	0	0	255	advanced users only
29	Basic Configuration Register	2	0	3	see table in Section 8.3
65	Kick Pulse	0			

7.2 Programming Track

To perform any change to a CV requires that a special programming track be connected to the ZTC 505 (see Section 11.7). The loco containing the decoder to be changed is placed on this track. More than one loco on the track may result in both decoders being programmed the same, or not responding at all. The programming track is 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 505 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 505 is not in the programming mode.

7.3 First Time Loco Decoder Programming

Before you put any loco 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 using a track isolation switch, if installed. Once the loco has been placed on the track, press **CLEAR** to 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**.

7.4 Programming Mode

Whenever any of the programming keystrokes are entered, the ZTC 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 505 to normal operating mode press the **CLEAR** button and then confirm with an **ENTER R**.

7.5 Programming Locomotive Decoders

There are two main modes for programming locomotive decoders. These are the E1 or “**paged mode**” and the E2 or “**direct mode**”. The “**paged mode**” is the ZTC preferred method and will be used as the principal programming method in this manual. Some manufacturers’ decoders may not respond to the “**paged mode**”. If you experience difficulty in programming a decoder refer to Section 15.0 for a list of commands used in the “**direct mode**” and some programming “tricks” for certain brands of decoder.

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 (loco address) to 82 use the following:

POINT → **LOCO** → **1** → **PRESET** → **8** → **2** → **ENTER R**

7.6 Verifying the Existing Value of a CV

To verify a 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 loco address of a decoder the *cv number* would be 1.

7.7 Resetting Loco 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 loco and would prefer to return CV’s to known values. Under these circumstances the resetting feature is especially useful. The method of resetting ZTC loco decoders to factory settings. The method used depends on the type of decoder concerned.

7.8 ZTC 203, 205, 206 , 213, 214, 215, 216, 217, 218, 226, 227 and 251

Reset these decoders using the following keystrokes:

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

And confirm with another **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.

7.9 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.

For decoders not listed here, refer to the decoder instructions.

7.10 CV 1 Locomotive Address or Number

When shipped from the factory, all decoders have CV 1 set to 3. This means that the decoder will respond to loco number 3.

To change the loco number, you change the value of CV 1 to a number between 1 and 127. **Note that loco numbers from 128 to 9999 can be used if the loco decoder supports the extended address option and the option is enabled. See Section 8.4 for more details.**

7.11 CV 2 Start Voltage

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.

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 values for this CV (see decoder instructions).

7.12 CV 3 and CV 4 Loco Acceleration and Deceleration

When the controller sends speed commands to the loco, if the CV 3 and CV 4 values are both 0, the response will be fast and may look jerky. By introducing acceleration and deceleration factors, the loco decoder smoothes out the speed steps. However, if the figures are too high, the response of the loco 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.

7.13 CV 5 Max speed

This sets the proportion of full power that can be applied to the motor on the top regulator notch (speed step) and therefore limits the top speed of the loco. Some locos do not ever need full power and so if this value is reduced from its maximum value you will get better speed control over the operating range

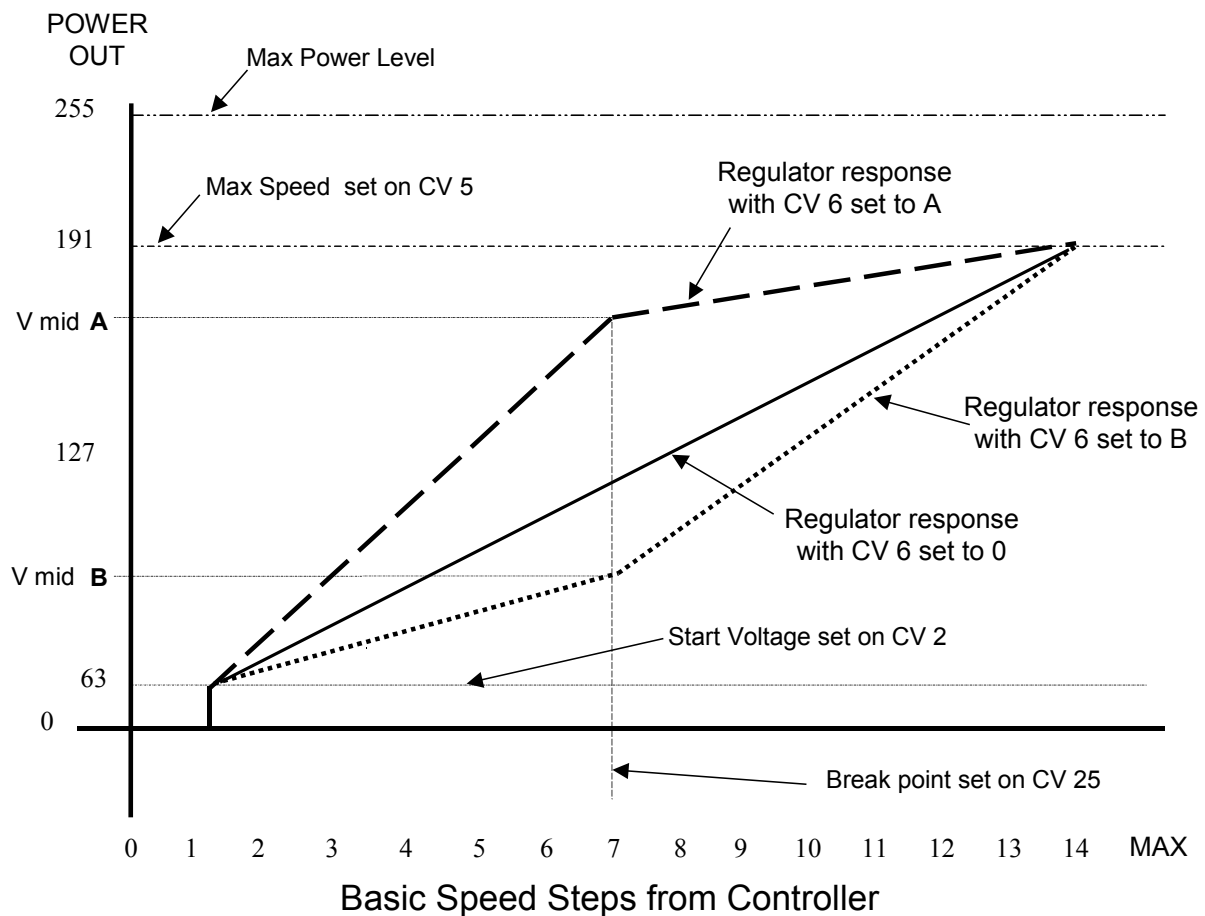
On ZTC decoders the range is 0 - 255 with 255 being the full power value. If zero is ever set the loco will never move. A lower practical limit is about 32 for very sensitive motors.

7.14 CV 6 Mid Step Speed

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 somewhere between the two values will bend the power curve, generally improving the low end control range if the value of CV 6 is set below half the maximum speed value (see V mid **B** in the diagram below).

For advanced users another CV exists in ZTC decoders to move the break point position along the speed step axis. The Vmid step at CV 25 is set to 0 by default and this sets 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



7.15 CV 9 Output PWM Frequency

Changing the value in CV 9 allows the motor drive pulse width modulation (PWM) frequency to be changed. The factory default value is 216, which sets a frequency of about 69 Hz. This value suits most DC motors. Larger motors benefit from lower frequencies. Experiment for the value most suited to your locos.

Coreless motors, such as Portescap and Faulhaber, should be run at 32 kHz. Set CV9 value to 0 for the best performance for these motor types. **Do not run larger can or open frame motors with CV 9 below 190.**

CV 9 value	PWM Freq Hz	Notes	CV 9 value	PWM Freq Hz	Notes
255	31	LARGE MOTORS	123	523	LOW POWER PRECISION MOTORS
251	33		119	561	
247	35		115	604	
243	38		111	654	
239	41		107	714	
235	45		103	786	
231	49		99	874	
227	55		95	980	
223	61		91	1046	
219	65		83	1208	
216	69	DEFAULT	79	1309	
215	70	75	1429		
211	75	71	1572		
207	82	67	1748		
203	89	63	1961		
199	98	59	2092		
195	109	55	2242		
191	123	51	2415		
187	131	MOST SMALL MOTORS	47	2618	
183	140		43	2857	
179	151		39	3145	
175	164		35	3497	
171	179		31	3922	
167	197		27	4184	
163	219		23	4484	
159	245		19	4831	
155	262		15	5236	
151	280		11	5714	
147	302	7	6289		
143	327	3	6993		
139	357	2	NOT TO BE USED		
135	393	1			
131	437	0	32 kHz	PORTESCAP MOTORS	
127	490				

7.16 CV 12 Power Source Conversion

This enables the decoder to respond to analogue power (DC), if DCC signals are not present. If you never require (DC), it is better to reset CV 12 to 1

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

See Section 8.0 for more details on how to set CV 12 options.

7.17 CV 29 Basic Configuration Register

The default value for CV 29 for ZTC decoders is the value 2. If you get the motor wiring the wrong way round (setting the ZTC 505 to a forward direction results in the loco going backwards), it can be fixed without rewiring the loco by changing the CV value to 3. See Section 8.0 for more details on how to set CR 29 options.

7.18 CV 65 Kick Pulse

CV 65 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.

8.0 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 (bits). Some CVs use all eight bits to store a single decimal number (CV 2 for example). The range of decimal numbers it can store is from 0 to 255. Other CVs store information relating to the 0 or 1 state of individual bit fields. In this case the 0 or 1 state of a bit field determines if a feature is enabled (1) or disabled (0). In this application the bits are called “control bits”. Up to eight features can be controlled by one CV in this way. However, if you wish to enter a decimal number into such a CV, you have to calculate bit fields to be sure that the desired bits are set appropriately to enable or disable desired features. It is far more convenient if you have access to each individual bit field and can set the bits according to desired features.

8.1 Changing Binary Bit Fields

For CV 10 and higher, the ZTC 505 has the capability of changing the state of individual bit fields. This saves the inconvenience of calculating bit fields for the more involved CVs like CV 12 and CV 29. This is especially useful for programming ZTC sound decoders.

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**

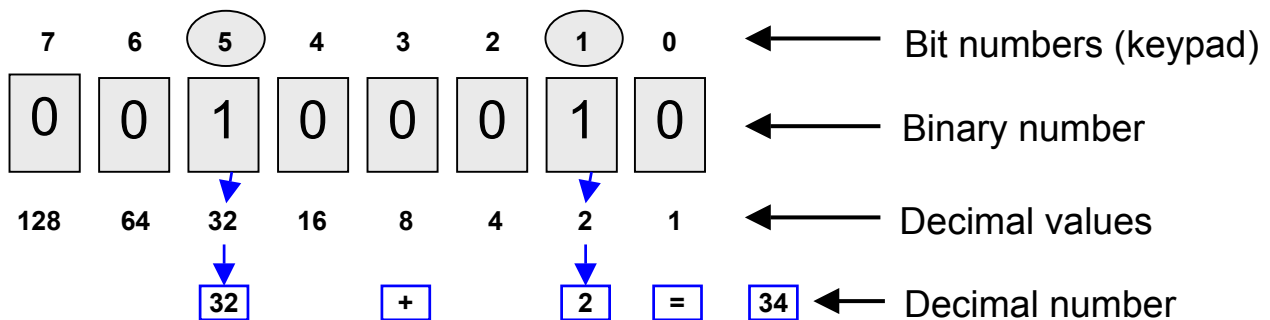
Where *cv number* is the CV required to be changed and *set bits* is when you set each of the eight bits by using the number keys 0 to 7, which toggle each bit on or off. The LCD screen displays all the bits as off or dashes by default. If a bit is set to on (1) the number of that bit is displayed in its correct position 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 : $32 + 2 = 34$)



Use the ZTC 114 Decoder Slide Rule to assist in this type of calculation.

8.2 CV 12 Feature Table

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

Not all makes or types of decoder will have all the features listed for CV 12. See the Decoder Manual for more details.

Bit No	FEATURE	Add decimal value	Notes
0	Analogue Power	1	Always include this for DC compatibility
1	N/A	2	Future option
3	Trix	8	N/A to ZTC decoders
4	N/A	16	Future option
6	N/A	64	Future option

8.3 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 value	Notes
0	Loco Direction Reverse	1	Set this if the loco runs the wrong way round due to a wiring mistake
1	14/28 Speed Step mode	2	If NOT set the decoder is in the coarse 14 step control mode with directional light control.
2	Analogue Power	4	Always include this for DC compatibility
3	Advanced decoder acknowledgement	8	Future option only
4	Speed table used	16	Not supported by all decoders. See Manual for details.
5	Extended addressing	32	When set, decoder can expect loco addresses 128- 9999
6	N/A	64	future option
7	Accessory Decode Enable	128	Decoder operates with accessory commands and ignores loco commands

8.4 Extended Addressing

The normal address range for DCC decoders is 1 to 127 inclusive. This is set in CV 1. Enabling extended addressing allows loco numbers of 128 to 9999 to be used. This would allow a complete loco cab side number to be used, making it very easy to know what a loco address is. 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** → **1** → **7** → **PRESET** → *new loco number* → **ENTER R**

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

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 to view how CV29 is already set.

POINT → **LOCO** → **2** → **9** → **ENTER R**

And make a note of the values shown. This will typically be: - - - - - 1 - {2}

Follow by **CLEAR** and wait a few seconds for the ALL HALTED message to appear flashing on the display.

Now set bit 5 of CV29 as well by keying in the following

POINT → **LOCO** → **2** → **9** → **SIGNAL** → **5** and

any other numbers shown in the above result outside of the {}, in our example a 1.

Follow with an **ENTER R** and then a confirmation **ENTER R**

If you have got it right, viewing CV29 will now show an extra 5 to the left of the {} and the number in {}, will increase by 32, giving for our example: - - 5 - - - 1 - {34}

After a short period the ALL HALTED message flashes now press **CLEAR** followed by pressing the **ENTER R** key to turn on the track power back on.

After restoring track power, the new extended address can be called up and the function of the loco 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 loco 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 loco number. See Decoder Manual for more details.

9.0 ZTC 304 Accessory Decoders

In addition to locos, points, signals and other electrically operated line side features can be operated from the controller keypad. To do this, accessory decoders (or stationary decoders), must be fitted to decode the track signal and switch each accessory actuator or light indicator as required.

Each accessory is assigned a unique address so that it can be controlled from the keypad. An accessory address is transmitted in a different way to loco addresses and therefore can use the same numbers as locos (1 - 127) without causing any interaction. The actual range, however, is greater and accessory addresses can range from 1 to 2047.

9.1 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. **For full details see decoder Manual.**

9.2 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!

9.3 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** .

9.4 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 RED GREEN	N	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.				

9.5 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.

9.6 Route Setting

The ZTC 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.

9.7 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 set up as follows:

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

SIGNAL → *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, which must contain at least one step, press:

PRESET → **PRESET** → **ENTER R**

This will save the preset sequence.

9.8 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.

9.9 Reviewing a Route

You can review the status of a Route 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.

9.10 Editing Route

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

A **single route** 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 route memory** contents key in:

PRESET → **CONTROL** → **ENTER R**

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

9.11 Operating an Accessory Preset Route

To operate an accessory preset route 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.

The storage space for routes is limited on the ZTC 505 to 2 with a total number of 16 presets per route. When the memory space is full, you will get a PRESET MEMORY FULL message.

10.0 Test and Calibration

The controls on the ZTC 505 are precision monitored by the internal processor for optimum results. From time to time it is recommended to check the controls in case of any slight mechanical drift of the end stop positions. If you find the regulator no longer gives 100% full power or the reverser no longer works properly, re-calibration may be necessary.

10.1 Testing the Controls

To test the controls, disconnect all power from the track by turning off any track isolation switches, or pull out the plugs to the TRACK O/P1, O/P2 receptacles and programming terminals on the rear of the ZTC 505.

Then key in: **CLEAR** → **SYSTEM** → **PRESET** → **2** → **ENTER R**

You can then see the values each control produces.

CONTROL	MIN VALUE	MAX VALUE	Note
REGULATOR	0	255	There is a small dead band at the beginning of travel
REVERSER	-127	+127	There is a small dead band in the mid position with an indent this should read 0
BRAKE	0	255	Does not need to be calibrated

If any control does not operate over the range shown above, the unit needs to be re-calibrated.

10.2 Calibrating the Controls

The controls are calibrated by first keying in:

CLEAR → **SYSTEM** → **PRESET** → **1** → **ENTER R**

Then, follow the displayed instructions to move each control to each extreme position, ignoring the displayed numbers. The sequence is:

Set the Regulator lever to **OFF** position

Set the Reverser lever fully **FWD** then press **ENTER R**

Set the Reverser lever fully **REV** then press **ENTER R**

Set the Reverser lever to **MID** position

Set the Regulator lever fully **OFF** then press **ENTER R**

Set the Regulator lever fully **OPEN** then press **ENTER R**

By this process, the system memorises the positions of the end-stops. The LCD screen will now be displaying the values associated with the position of each control. Check that the values displayed match those in the table when each control is moved to its extremes.

To confirm if all controls are correctly positioned mechanically, key in the following:

SYSTEM → **PRESET** → **3** → **ENTER R**

Four figures will be shown briefly on the LCD screen. If any one of them reads 0, then the controls need mechanical adjustment. This should not be attempted by an inexperienced operator. The unit should be returned to ZTC for re-calibration.

10.3 Transformer Test

The ZTC 505 is able to estimate the voltage of the transformer powering it, to determine if the voltage value is in an acceptable in range. This is performed by pressing the following keys:

FUNCTION → **SIGNAL** → **ENTER R**

The value displayed is an estimate of the AC RMS output voltage of your transformer with only a light loading (about 250mA). If it is too high, the display will say so. An exceptionally high supply voltage to the unit could do internal damage or cause rapid overheating. Pressing CLEAR will exit the test function.

10.4 LED Test

All the front panel LED indicators, except the REMOTE LED, can be forced on for testing by keying:

INERTIA → **SIGNAL** → **ENTER R**

Disconnect power from the controller to return it to normal operational mode or press

ENTER L to return to the main menu.

11.0 Installation

You should have the following items to enable installation:

Item	Quantity Required	ZTC Part No.
Two Way Terminal Block	2 supplied with unit	ZTC 028
Four Way Terminal Block	1 supplied with transformer	ZTC 030
Twin white wire (see Table of Recommended Wire Gauge). Example either 42 x 0.2mm stranded or equivalent copper wire with cross section area of at least 1 sq. mm. ZTC 100 wire is ideal.	Not supplied	ZTC 100 10 meters Rated at 10 Amps PVC Covered 42 x 0.2 mm
Screw Driver with 3mm flat blade	Not supplied	(Item not supplied)
AC Mains transformer with 12- 17 volt output at least 2 amps min AC.	1 (or more if ZTC 550 Booster units are to be used)	ZTC 56X Transformer 12 or 15 Volts AC at 5 amps max.

11.1 Power Input

WARNING: A DOUBLE INSULATED TRANSFORMER, PROVIDING A LOW VOLTAGE OUTPUT NOT EXCEEDING 17 VAC, MUST BE USED TO POWER THE ZTC 505. TRANSFORMERS MUST COMPLY WITH BRITISH STANDARD BS415 class 2 EN600065 EN60-772, OR OTHER EQUIVALENT STANDARD PUBLISHED BY UL, CSA OR OTHER STANDARDS AGENCY.

DO NOT CONNECT MAINS VOLTAGES DIRECTLY TO THE ZTC 505. THIS WILL RESULT IN AN ELECTRIC SHOCK HAZARD AND WILL DESTROY THE UNIT

The input power requirements of the ZTC 505 is low voltage only. Never attempt to directly connect live mains supply to the unit. A low voltage mains transformer or power supply must be used. The ZTC 560 is the recommended supply transformer for most UK applications.

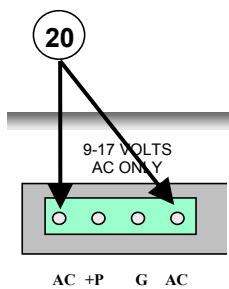
A user provided transformer must meet the relevant safety standards. See the Transformer Recommendations table for recommended voltage and current ratings for different layout scales. A transformer of a higher current rating than that listed, is acceptable as it will generally give better regulated power. If too high a voltage is used to power the unit, it will cause internal damage.

Transformer Recommendations for UK Operation

(A range of products for other countries is available)

SCALE / GAUGE	OUTPUT VOLTAGE	OUTPUT CURRENT	ZTC PART
OO / HO	15 VAC	2 to 5 amps or more	ZTC 560
N	12 VAC	1.5 to 3 amps or more	ZTC 562
O	15 VAC	1.5 to 5 amps or more	ZTC 560
G or Gauge 1	15 to 17 VAC	5 to 10 amps	ZTC 564
Z	10 to 12 VAC	1.5 to 2 amps or more	ZTC 566

11.2 Input Terminals

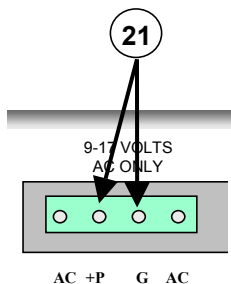


When connecting to the POWER INPUT terminal block, use wire of sufficient rating (e.g. ZTC 100) as recommended in the Table of Recommended Wire Sizes (See Section 11.4). The 4 way, plug-in, terminal block, supplied with the ZTC 505 transformer, provides a convenient removable connection. Always connect the transformer output to the **two outer connections of the 4 terminals**. It doesn't matter which way round the wire goes from the transformer as it is AC as long as it is in the two outer connections of the 4 way connector block. Check that there is no exposed copper wires or 'whiskers' at the stripped end of your wires where they go into the block. Clamp the wires using a suitable screwdriver. Do not over tighten. Do not attempt to apply power

without using the 4 way terminal block.

The two **inside connections** are not to be normally used. They provide either an unregulated DC output from the unit's internal rectifier or a means of providing DC power input.

11.3 Optional DC Power Input



This is an option you can ignore if you are using a transformer.

As an alternative, an external DC low voltage power supply can be used to power the ZTC 505 using the G (ground) and +P (+ve power) terminals. It should be 12 to 24 volts, regulated DC only. A capacity of 1.5 to 5 amps will be needed depending on your operational requirements. The supply should be suitably fused with an anti surge type fuse, not exceeding 5 amps. If the polarity is connected incorrectly, your fuse will blow and you may damage the ZTC 505.

The advantage of DC power supply operation is that the internal power dissipation is reduced, promoting cooler running at high output power levels.

11.4 Recommended Track Wiring Gauge

The wires used to connect to the track should be of a size and type suitable for the type and scale of railway and the maximum number of locos intended to be run. If the wires are too thin, there will be an increasing voltage drop along the wire, as the number of running locos increases. This causes poor loco operation.

With digital operation it is probable that the number of locos will grow from the initial phase. So it is better to use the heaviest recommended gauge wire for the job at the outset. See the table for more information. ZTC supply a self adhesive copper tape (ZTC 320) which is rated at 20 Amperes and ideal for all gauges. A flexible connection cable (ZTC 100), rated at 10 Amperes, is also available.

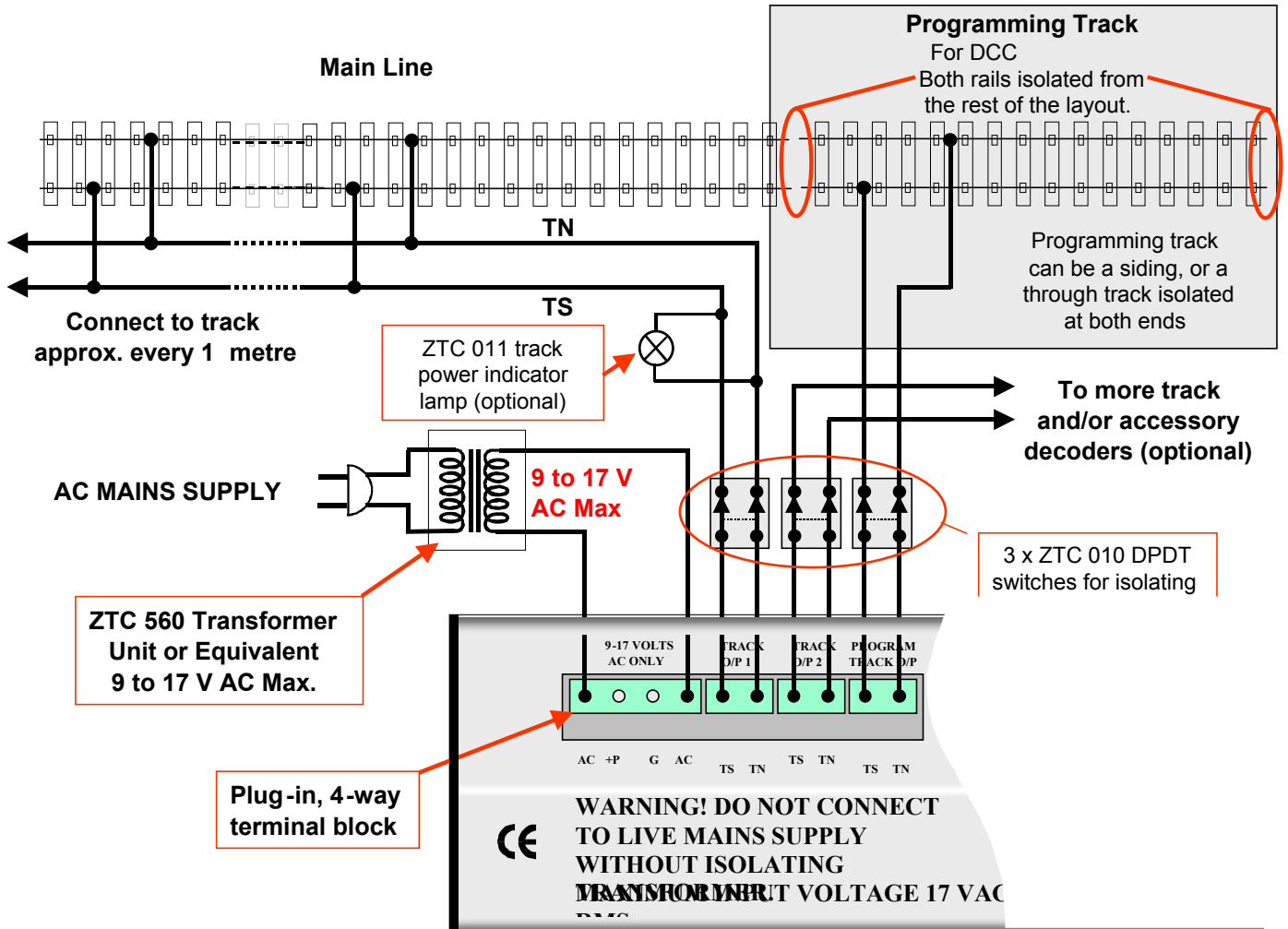
There are two terminal sockets at the rear of the unit marked, TRACK O/P 1 and TRACK O/P 2. These are identical and wired in parallel internally. Their use allows multiple feeds to spread the load to the track rather than using a single cable. Alternatively, one socket can feed the track and the other can feed any accessory decoders.

TABLE OF RECOMMENDED WIRE SIZES				
	Expected maximum output current for ZTC 505. If wiring run distance is more than 10Metres (30ft) use the next heavier gauge of wires			
TRACK CONNECTIONS	1 to 2 amps	2 to 3 amps	3 to 4 amps	5 amps (max)
Single pair cable feed or Transformer input	16 x 0.2mm (0.5 sq. mm) or 1 x 1.13mm (1 sq. mm)	23 x 0.2mm (0.75 sq. mm) or 1 x 1.13mm (1 sq. mm)	32 x 0.2mm (1.0 sq. mm) or 1 x 1.38mm (1.5 sq. mm)	32 x 0.3mm or 42 x 0.2mm (1.5 sq. mm) or 1 x 1.38mm (1.5 sq. mm)
2 cable feeds	7 x 0.2mm (0.22 sq. mm) or 1 x 0.6mm (0.28 sq. mm)	16 x 0.2mm (0.5 sq. mm) or 1 x 1.13mm (1 sq. mm)	23 x 0.2mm (0.75 sq. mm) or 1 x 1.13mm (1 sq. mm)	32 x 0.2mm (1.0 sq. mm) or 1 x 1.13mm (1 sq. mm)
3 cable feeds	7 x 0.2mm (0.22 sq. mm) or 1 x 0.6mm (0.28 sq. mm)	7 x 0.2mm (0.22 sq. mm) or 1 x 0.6mm (0.28 sq. mm)	16 x 0.2mm (0.5 sq. mm) or 1 x 1.13mm (1 sq. mm)	23 x 0.2mm (0.75 sq. mm) or 1 x 1.13mm (1 sq. mm)
Programming track output	Separate stub of track: 16 x 0.2mm (0.5 sq. mm) or 1 x 1.13mm (1 sq. mm)	If siding is part of running line: 16 x 0.2mm (0.5 sq. mm) or 1 x 1.13mm (1 sq. mm)	If siding is part of running line: 16 x 0.2mm (0.5 sq. mm) or 1 x 1.13mm (1 sq. mm)	Not recommended
Transformer feed to ZTC 505 AC voltage supply input	23 x 0.2mm (0.75 sq. mm) or 1 x 1.13mm (1 sq. mm)	23 x 0.2mm (0.75 sq. mm) or 1 x 1.13mm (1 sq. mm)	32 x 0.2mm (1.0 sq. mm) or 1 x 1.38mm (1.5 sq. mm)	32 x 0.3mm or 42 x 0.2mm (1.5 sq. mm) or 1 x 1.38mm (1.5 sq. mm)
Multi-strand wire sizes shown as "number of strands x strand diameter" with equivalent cross sectional area. Single core wire is shown as "1 x wire diameter" with equivalent cross sectional area.				

11.5 Wiring the ZTC 505 Outputs to the Track(s).

The following diagram illustrates the recommended method of connecting the ZTC 505 to the track.

Basic Track and Power Connections



operating multiple trains, the wire used should be more substantial than for a conventional layout. Dirty track and poor rail joints will not reliably pass the data signals and commands, carried on the AC track voltage to the locomotives.

It is strongly recommended that the main current to the track be carried by at least one ring main pair of wires located under the layout surface. ZTC recommends ZTC 320, a self adhesive copper tape, rated at 20 Amperes. For best results use nickel-silver track.

11.6 Multiple Track Feeds

Running at least one tape or cable pair round your layout and tapping off to the track with copper wire (ZTC 321) at regular intervals will promote good power integrity. The distance between feeds can vary depending on the gauge and average track lengths. One tapping or dropper per metre (36-40") or so is prudent for N and OO/HO. For gauge 1 this might be lengthened to 2 metres or so (6-7 feet). If the interval between feeds is too far, it will show itself in reduced performance between the feed points. With the power bus, it will be easy to add extra feeds when it appears to be needed.

When installing droppers be careful not to mix up the TRACK NORTH and SOUTH wiring polarity, as this will create a short circuit across the track.

11.7 The Programming Track

The programming output from the controller is used for setting up the loco decoders installed in the locos. This is not relevant if you only use the controller in slave mode to another unit.

The PROGRAM TRACK output is derived from the same source as the TRACK O/P 1 and 2. It can therefore feed any separate siding, stub, or through track on your layout. In the programming mode of operation, an internal relay within the ZTC 505 disconnects the rest of the layout and only the programming track remains energised at a low power level. This allows the set-up of a loco with decoder when it is placed on this special section. It should be conveniently close to the controller.

11.8 Connecting Accessory Decoder Modules

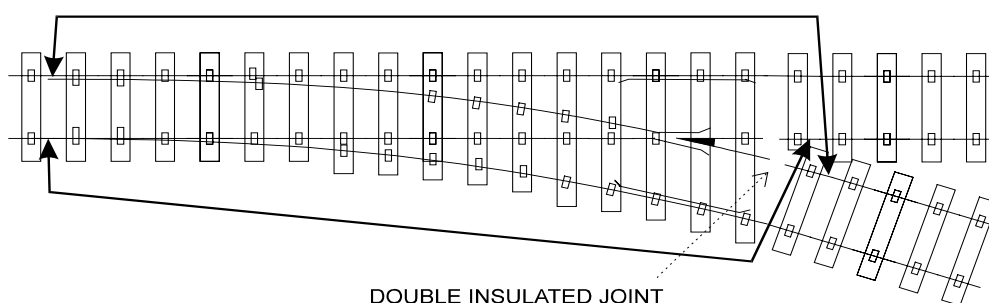
Generally these take their signal information from the same source as a loco decoder and therefore can be connected to either TRACK O/P 1 or 2. They can also be fed by taking a tap off the track feed or the track itself. See the information that comes with the Accessory Decoders for full installation instructions.

11.9 Points & Turnouts

Both insulated and live frog points may be used with the DCC system (e.g.: Peco "Insul-frog" and "Electro-frog"). Live frogs are better as they promote better continuity over the crossings, especially at low speeds. However, a small amount of extra work, when installing, will be necessary, as the rails into the frog must be insulated from the continuing rails to prevent shorts as the blades switch over. The track power is fed from the toe as in conventional practice. Both following rails should be wired so as to be permanently live.

When using insulated frog points, the switch blade usually disconnects the opposing side's rail. Unless you particularly require an isolated siding, bridge wires should also be fitted to keep both sides live.

Bridging Wires Round a Live Frog Point



With some types of insulated frog point certain locos cause problems due to excessive tyre width. These can cause occasional short circuits as they pass over the frog. The ZTC 505 controller will automatically reset itself from such a trip condition and carry on running. To avoid this situation occurring, these points can be treated the same as live frog types, with insulated joints to both frog rails and a bridge wire connected from each end of the point section. For more information on point and layout wiring contact our help desk or have a look at www.wiringfordcc.com

11.10 Large Layouts – Isolating Track Sections

When the ALL STOP button on the controller is pressed twice, all power is cut off from the track. However, it is recommended that a track isolating switch be installed between the controller outputs and the track. On large layouts, if you do get a short circuit for some reason, it will be easier to locate if each of the major sections of the layout has an isolating switch to disconnect the power from the controller. Any switch used for track isolation needs to have wiping contacts rated at 5 Amps at 24 volts AC, double pole, single throw. Both TN and TS should be switched. The ZTC 010 is the ideal switch for this purpose. An indicator lamp, ZTC 011, may also be fitted if required.

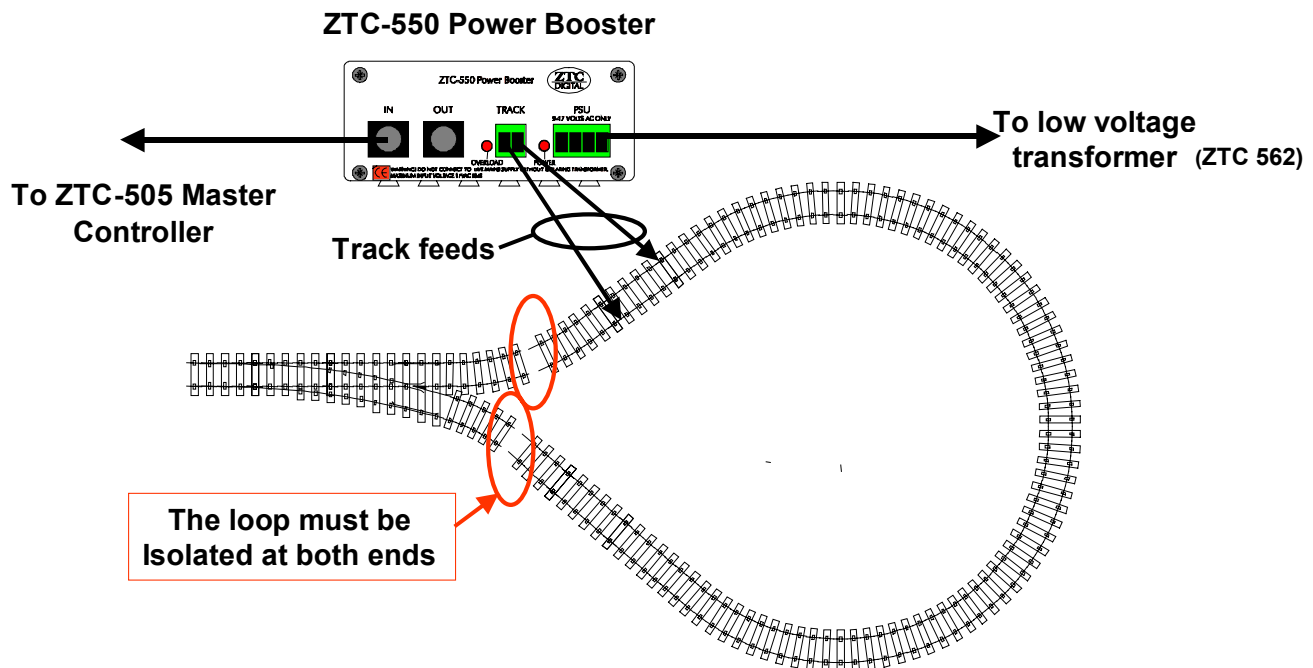
11.11 Power Boosting

The ZTC 505 Master Controller has a maximum power output of 3 Amps. The maximum power is drawn when locos are simultaneously starting which might be double their nominal running currents. Accessory modules may also be connected to the track power as well. So eventually the system could 'run out of steam'.

The ZTC 550-power booster operates like an amplifier, taking the signal from the master controller and providing a separate power output feed. This is connected to additional (remote) parts of the railway system and can provide up to another 5 amps of power. A separate mains transformer has to be connected to the booster to provide it with power. More boosters can be connected should even more power be needed.

12.0 Reverse Loops

The main problem with a reverse loop is the fact that the TRACK NORTH rail sweeps round to join up with the TRACK SOUTH rail and vice-versa, causing a short circuit. To prevent the short circuit, insulated joints are placed at the entry and exit of the loop.



However, if the loop section is fed by a ZTC 550 power booster, continuous running will be possible through the loop. The booster senses the phase of the track signal needed and automatically switches itself at either the entry or exit as the train passes the insulated joint. One booster could serve two or more reverse loops on the layout provided only one train is ever expected to pass in or out of any loop at one time.

Installation information is given in the ZTC 550 Manual.

13.0 Over Temperature Protection

During normal operation, heat is generated by the electronic components inside the ZTC 505 cabinet. If the unit has been operating for extended periods of time, at excessive current levels, then there is the possibility that internal temperatures may reach values that could affect the performance of the ZTC 505 circuitry. This is especially so if the ambient temperature is high. The ZTC 505 is protected against such an event. If the temperature reaches a critical level, then the output will automatically shut down, to prevent this happening. The message "OVER TEMPERATURE" will be displayed on the LCD screen for as long as the output is shut down. Once the temperature has dropped to a safe level, the output will be automatically restored.

14.0 Software Upgrades

Further ZTC research and development will in the future provide new and/or enhanced features for the ZTC 505 controller, which will be made available to existing users as software upgrades. The ZTC 505 can also be upgraded to the specification and performance of its big brother the ZTC 511 for full details of this please contact ZTC Controls Ltd.

15.0 Alternative Decoder Programming Modes

As discussed earlier, there are two main methods for CV programming. One is the preferred **Paged Mode** and the other is the **Direct Mode**. If a decoder does not respond to the Paged Mode, try the Direct Mode or a third method called **Physical Register Mode**. There are also different methods for verifying the value of a CV. Note that in all instances the loco needs to be on the programming track.

15.1 Direct Mode

Use the following keystrokes to change CV values:

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

The *cv value* can be any number 0 to 255, except in the case of CV 1 (loco address), which is restricted to 1 to 127.

To verify the present value of a CV use the following key sequence:

PRESET → **LOCO** → *cv number* → **ENTER R**

The controller will take a few seconds to scan the decoder and retrieve the CV value, which will be displayed on the LCD screen. If you want to repeat the test, just press **ENTER R** again. To exit the verify mode press **ENTER L** or **CLEAR** .

15.2 Physical Register Mode

In **Paged Mode**, some older non ZTC makes do not page properly nor will they work in the **Direct Mode**. Their physical registers (the equivalent of CVs) can all be directly accessed by keying numbers 2001 to 2008 to correspond to 1, 2, 3, 4, 5, 6, 7 and 8. The decoder programming is then the same as for **Paged Mode** using these +2000 CV numbers. The specific instructions for the decoder should be followed, which may be different, in number range and usage, from ZTC or other NMRA compliant types.

15.3 Loco Address Verification

In addition to using the Paged or Direct Modes for verifying CV 1 (loco address) there are two other methods. For the first one use the following keystrokes:

SIGNAL → **LOCO** → **ENTER R**

The second method requires that you use the following:

LOCO → **SIGNAL** → **ENTER R**

The second method will not work if the loco address is between 113 and 127, or if the motor current is too small to be detected. This may work for older decoders from Marklin 2 rail, Arnold and Lenz.

15.4 Loco Address Programming

In addition to programming CV 1 in the ways described above, the loco address can also be programmed using the following keystrokes:

SIGNAL → **LOCO** → *loco number* → **ENTER R**

This automatically sets CV 1 to the new loco number (address).

This method may not work with some other brands of decoder, or older models of Marklin 2 rail, Arnold or Lenz.

16.0 System Parameters

To set a system parameter value using the brake handle do the following:

CLEAR → **SYSTEM** → **FUNCTION** → *system parameter number* → **ENTER R** →
wind in the desired value → **ENTER R**

16.1 Loco Speed Indicator

The maximum speed indicated on the LCD for a loco can be selected by using:

INERTIA → **LOCO** → **ENTER R** → *wind in the desired value* → **ENTER R**

17.0 Troubleshooting

Symptom	Possible Solution(s)
Decoder will not respond to programming commands. "No Response" shown on LCD screen.	<ol style="list-style-type: none"> 1. CV may have programmed. Motor current could be too low to signal that programming was successful. Try operating the loco to see if CVs have changed. 2. Clean programming track and loco wheels 3. Try alternative programming modes 4. Reset the decoder then reprogram the decoder.
OVERLOAD light blinks and the unit beeps. Locos do not run.	There is a short circuit somewhere on the layout. Remove all locos from the layout, pressing the CLEAR button after removing each one. If the overload clears, then the last loco removed has problems. If the fault persists then there is a wiring problem in the track circuit. Check all connection to the track to ensure that they are of the correct polarity. Check points, especially if they are live frog or wired as such. Ensure that frog feeds are not present (need insulated rail joiners).
REMOTE LED does not illuminate when LED test is performed.	No fault. This is normal.
Loco goes backwards when the reverser is set to forwards.	Wires to the motor brushes in the loco have been reversed. This can be corrected, without rewiring the loco, by setting bit 0 of CV 29 to on.
Decoder does not respond to any method of programming.	Try resetting the decoder to factory settings using the method shown then try programming again.
Loco runs erratically	<ol style="list-style-type: none"> 1. Clean track thoroughly 2. Clean loco wheels thoroughly. 3. Clean all electrical pickups on wheel axles. This will likely involve dismantling the loco to some degree.
Loco will not pull away	<ol style="list-style-type: none"> 1. Brake may be on. Release brake 2. Reverser lever is in the MID position. Move it to the FWD or REV position

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