

# OPERATING MANUAL



## THE ULTIMATE CONTROL SYSTEM

USA EDITION

HORNBY RAILWAYS



Zero 1 is the ultimate control system. With just two connecting wires from the controller to the track it enables you to control up to 16 locomotives and up to 99 sets of switches/turnouts.

Exciting developments in computer micro-technology plus Hornby expertise and model railroad know-how have combined to bring you a system which offers a number of outstanding features not available in traditional systems.

With Zero 1 any one of up to 16 locomotives on a layout can be called up and controlled by the Master Control Unit alone, 1 under complete speed and direction control, the others running at constant pre-set speeds and directions. The addition of 3 Slave Control Units gives you complete speed and direction control over 4 locomotives simultaneously.

With traditional model railroad control systems locomotives were controlled on sections of track by regulating the amount of power in the rails. This meant that if there were two locomotives on the same

track section, not only did they share the current and therefore run at lower speeds, they also accelerated and decelerated together. Independent locomotive control could only be achieved by fitting isolating rails and wiring up switches from different sections of circuit to different controllers. Zero 1 has changed all this.

With this system the control takes place in the locomotive and not on the track. Computerised signals from the Master Control Unit are passed down the track and are received and interpreted by an operating module fitted to the locomotive. This means that locomotives can be independently controlled even when they are in the same section.

Another powerful Zero 1 feature allows you to allocate up to 4 levels of momentum to different trains as required; slow acceleration for a Mallet for example, rapid acceleration for a Streamliner.

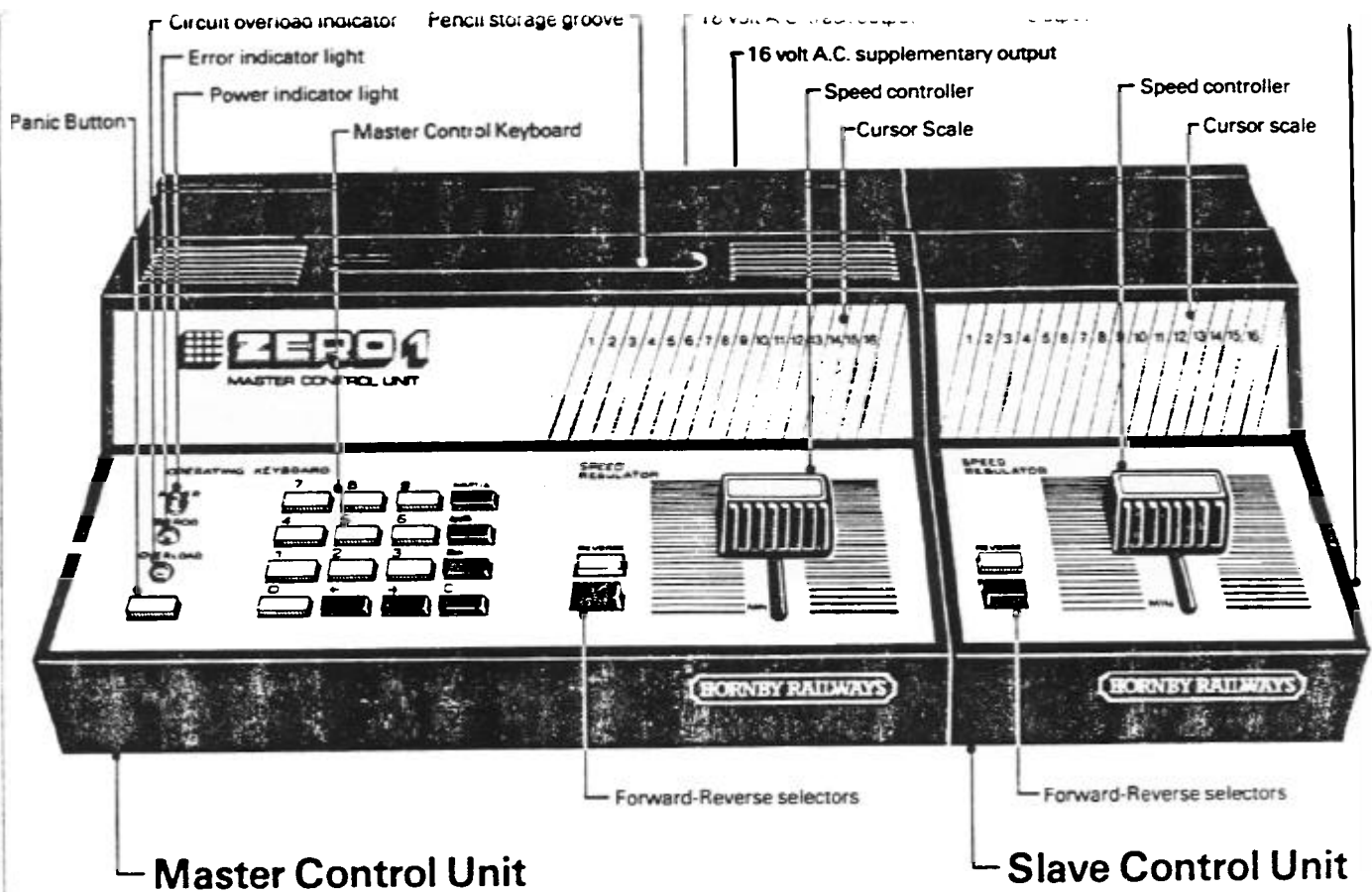
Conversion of an existing layout to Zero 1 locomotive control must be complete since it is not possible to combine it with a traditional train control system. This is because there is 18 volts A.C. across the

track at all times. (This also means incidentally, that coach and locomotive lights are always fully illuminated). The operating module which must be fitted to each locomotive converts the 18 volts down to 12 volts D.C. needed by the majority of model railroad motors.

There is a supplementary output from the Master Control Unit which can be used to supply current to existing accessories.

This manual shows you how to use the various control features built into the powerful miniature computer which is at the heart of the system. It provides a means of checking the various instruction procedures and identifies what happens in case of mistakes or faults.

Zero 1 is a great simplification on previous systems. The built in electronic technology eliminates the necessity for complicated wiring. So all you need to do is fit operating modules to your locomotives, plug in the Master Unit, and go. You'll have lots of fun experimenting and finding out just what the system is capable of. Remember, Zero 1 is the ultimate control system.



## Important

Under no circumstances must a locomotive be placed on a track connected to Zero 1 unless a locomotive module has been fitted.

Electrical accessories must not be connected to the track or track output terminals except through the Zero 1 accessory module.

Static electricity can damage the locomotive module. Always ensure that any static on your hands is discharged (by touching water pipe, etc.) before opening module package.

Zero 1 is specifically designed for 12 volt direct current motors. Other types may not produce satisfactory running.

Do not reconnect Zero 1 to the supply in less than 30 seconds after disconnection.

If the air vents on top of the Master Unit are obstructed overheating will occur.

All locomotives must be in good mechanical and electrical condition. Over-oiling and bad connections will interfere with the transmission of information to the 'chip'.

All track connections must be tight. A loose rail joiner will produce a high resistance joint causing loss of power. Do not connect the supplementary output terminals to the track or track connections.

When connecting 'slave' units to Master or each other, do not 'wriggle' this connection push straight on.

When double heading always ensure locomotives are placed on the track facing the same direction, i.e. if "Forward" is left to right, all locomotives run left to right.

Under no circumstances should the coding pad of a locomotive module be soldered.

High frequency/voltage track cleaning, sound systems or lighting units must not be used with Zero 1.

On pulse power some high current, inefficient or poorly serviced motors, and some motors with double heavy flywheels will tend to run warm. If this happens the motor should be stopped and allowed to cool. Removal of one flywheel will be found to be an improvement.

# Trouble shooting

1. No lights on Master Unit.	<i>Check electrical input.</i>
2. Green and yellow lights on.	<i>An "error" has been registered. Press 'C'.</i>
3. Red light on, green off.	<i>"Overload" situation. Check track and locomotives. Press 'C'.</i>
4. Locomotive "buzzes" and jerks.	<i>A.C. to motor. Remove locomotive immediately and check module connection.</i>
5. Locomotive runs erratically.	<i>Dirt on wheels/track or motor. Clean.</i>

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## The keyboard

**Master Controller Numeric Keys**  
These keys are used for calling up locomotives or accessories, assigning controllers and allocating momentum levels.

**Power Indicator Light (Green)**  
Lights up when power is available at the output terminals.

**Error Indicator Light (Amber)**  
Lights up when an incorrect keyboard entry has been made.

**Overload Indicator (Red)**  
Lights up when the circuit is overloaded, or accidentally short circuited.

**The 'Panic' Button (Red)**  
Useful when you're controlling several locomotives and you're about to crash. Stops everything until you reset the system with the 'clear' button.

**Enter and Left/Right Keys (Green)**  
These keys perform two tasks. Firstly, either one will enter a keyboard instruction into the computer. Secondly, when controlling switches/turnouts, signals, etc., they are used to control the direction of change.

**The Speed Regulator**  
This is the throttle control to regulate the speed of a locomotive under the control of the Master Control Unit.

**Forward and Reverse Selectors**  
No matter which way you place your locomotive on the track, the forward selector will always make it go in one direction and reverse selector in the other direction.

**The Cursor Scale**  
Over the Master Keyboard there is a simple scale numbered 1 to 16 with a cursor. This is a useful device to help you keep track of which locomotive is which and to remind you which one is under control. Mark under each code the description of the appropriate locomotive. For example if you have a coded a Streamliner as locomotive 1 write Streamliner under 1 on the scale, etc. Move the cursor along to remind you which locomotive is being controlled.

These keys are used, together with the numeric keys to instruct Zero 1's computer.

- The Momentum Assignment Key
- The Locomotive Assignment Key
- The Controller Assignment Key
- The 'Clear' Key  
Used to reset the circuit when an error is to be corrected an overload has been cleared, or after using the 'panic' button.

# The loco operating module

Instead of regulating the amount of current in the track, the Zero 1 system works by digital signals down the track to a miniature receiver called an operating module. There is 18 volts A.C. across the track at all times. This means that it is not possible to run locomotives on the layout unless they have been fitted with a locomotive operating module. This converts the 18 volt A.C. to 12 volt D.C. used by the locomotive motors.

The signals sent down the track by the Master Controller are coded so that they can be recognised only by the operating module for which they are intended. The signal contains the instructions for direction and speed. All locomotive operating modules are delivered coded '1'. To operate locomotives with a different code number you can recode the module to the number of your choice.

To code a module a small blob of electrical conductive fluid is used on the coding pads at the end of the module (see diagram). If an even code is required it is simple to break the link by scratching with a pin or a craft knife. Some module code pads may have perforations; if so, a twist of wire can be used providing a good tight contact is made. Do not solder code pad. This will destroy the chip bond and render the module useless.

The module can be coded from 1 to 16 as

per the diagram. If you wish to recode a module it is an easy matter to scratch away the conductive fluid. For coding information see diagram.

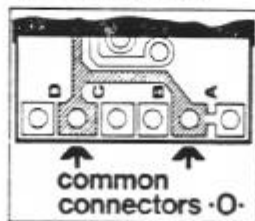
## Fitting

The module is supplied with leads of sufficient length to enable most types of locomotive to be catered for. If required, the leads can be lengthened or shortened to suit. The basic connections are:— green lead to left pick-up, red lead to left motor brush, black lead to right motor brush. The wire lead between the left pick-up and the left brush must be removed. Some locomotives may have pick-ups on both trucks.

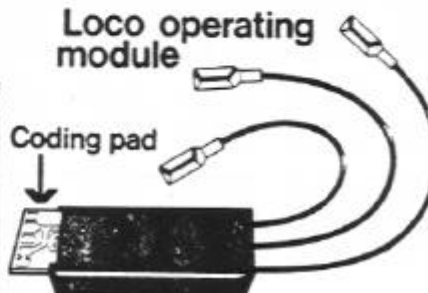
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
A																	A
0																	0
B																	B
C																	C
0																	0
D																	D

In preparation for fitting a module it is better to remove the wire lead between left brush and left pick-up and test locomotive on D.C. If locomotive moves you have not broken contact to one brush. It is imperative that before fitting the module and connecting to Zero 1 that you have no direct connections between the left side of the chassis and the motor. See diagrams on page 15 for guidance.

Enlarged view of Coding pad



Loco operating module



# Setting up a simple layout

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So you get used to using the system and so you can discover all its fascinating control features, we suggest to start with you try it out using a basic layout. You'll quickly find out why we call it the ultimate control system.

Take an oval of track on which to practise. Fit an operating module to a locomotive. Fit the leads provided to the 18 volt A.C. output marked 'Track A, B' on the back of the Master Control Unit. Connect the other ends to your track in the normal way.

## Now You're in Control

You will find that whenever you plug in you will have immediate control over the locomotive fitted with the locomotive operating module coded '1'. We'll call that 'locomotive 1' for short. You don't need to do any keyboard operations at this stage. Select direction by using forward/reverse selector and use speed regulator to control locomotive speed.

When changing from forward to reverse you should first, of course, reduce speed to minimum, just as an engineer would in real life. If by chance you forget, however, Zero 1's computer brain will automatically slow the locomotive to a halt before putting it into reverse and building speed back up again.

Your Master Control Unit is now operating like a normal power controller.

When Zero 1 is first plugged in your locomotive will accelerate and decelerate quite slowly. This is to give you a little time to make sure everything is set up correctly, turnouts are switched the right way and so on. If you have coded your first locomotive anything other than locomotive 1 you will need to 'key in' the right code number to the Master Control Unit before you can control that locomotive.

Press the key marked . This tells the Master Control Unit that you are going to instruct a locomotive. Then press the locomotive's code number say, and then press the green entry key either or it doesn't matter which. Here's the sequence again: or

Now locomotive 3 is under the control of the Master Control Unit and you can regulate its speed and direction.

## Momentum

Zero 1's momentum feature simulates the rates of acceleration or deceleration which different types of trains would have in real life. A long heavy freight train will pick up speed only slowly because it has more momentum than a suburban passenger train. Once it has built up speed though, it will take longer to slow down. So just as engineers have to do on full sized trains, you will have to practise

coming into stations to avoid over-running.

4 different levels of momentum can be used. These are — when momentum is 'natural' and a locomotive will speed up or slow down exactly in line with your use of the speed regulator and will depend on the power of the locomotive and the weight of coaches it is pulling. Momentum will assume that the locomotive is pulling a heavier load and acceleration will be slower. Momentum has even slower acceleration, and momentum level will take over 20 seconds to accelerate to full speed or slow down to a halt, depending upon the weight of the locomotive and the train. To give the locomotive a momentum level press the keys as follows:

or or

Now locomotive 1 will accelerate at momentum level 3 up to the speed you set the speed controller. Other locomotives can be given the same or different momentum levels

## Momentum Memory

Zero 1's powerful computer memory will remember which momentum level you give to each locomotive. Though you may make many other keyboard entries it will remember which rate of acceleration you have allocated to each locomotive until the system is unplugged or a new momentum instruction is keyed in.

Having seen what happens with just one locomotive on a basic layout now try adding more.

## Calling up a different locomotive

Any of 16 differently coded locomotives can be brought under the control of the Master Control Unit. To control the speed and direction of locomotive 9 for example, press these keys: **[STOP]** **[9]** **[D]**. Now use speed and direction controls as normal.

Momentum level **[1]** will automatically be allocated to start with. This can be adjusted at any time.

## Running 2 locomotives

Set one locomotive to run at a selected speed in a chosen direction using the above procedure.

To bring another locomotive under control use the same procedure. For example with locomotive 9 already running round the layout bring locomotive 3 under control by pressing these keys: **[STOP]** bring speed regulator to stop **[3]** **[D]**

Locomotive 9 will continue to run at the

speed and in the direction selected when the key **[STOP]** was pressed. Now the speed and direction of locomotive 3 will be under the control of the Master Control Unit.

Momentum can be adjusted in just the same way as described above whilst the locomotive is running

## Up to 16 locomotives

More locomotives can be set running by using the procedure outlined above. Each time an additional locomotive is called up the previous one will continue to run at a speed and in the direction last set. Up to 16 different locomotives can be set running this way. 15 at set speeds and one under the full control of the Master Controller. However, the power capacity of the system, which is limited to 4 amps continuous, may be exceeded and the circuit overloaded.

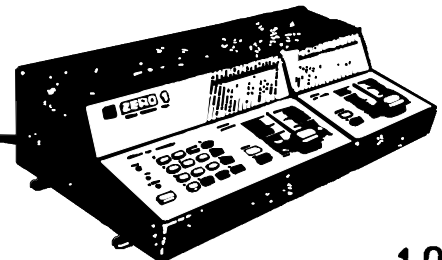
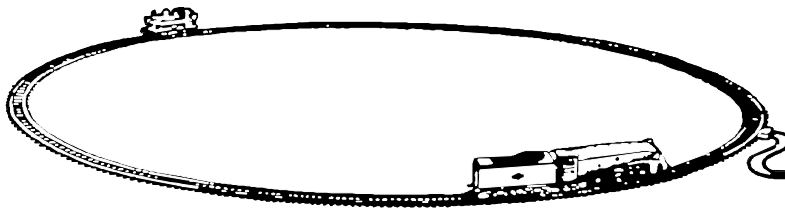
To go back to alter speed or direction of a locomotive already running at a set speed just use the same procedure as calling up initially. For example, if locomotives **[9]**, **[5]** and **[3]** are running at set speeds and **[5]** is under immediate control, to go back to regulate the speed or direction of **[3]** press these keys: **[STOP]** setting direction and regulator to correspond with locomotive and

then press **[3]** **[D]**. The other locomotives will continue to run at their speeds. Locomotive **[5]** will go into memory at its last speed instruction.

## The Panic Button

Obviously with several trains running at once you could get into trouble. If a crash seems imminent, or you get flustered, just press the 'panic' button — the red button under the overload light. The computer will instruct all locomotives to stop immediately. You can now make adjustments to locomotive instructions whilst everything is at a standstill. You can key-in a locomotive and switch it to reverse for example. And you may want to make track adjustments like moving turnouts. Once you have made any necessary adjustments you can get everything moving again by pressing the 'clear' key **[C]**. Zero 1's computer will temporarily allocate momentum to all locomotives — so immediate acceleration will be slow — giving you time to make further instructions if necessary, to avoid disaster.

# on the layout



## Double Headers

One of the advantages of the Zero 1 system is that you can run realistic double headers very easily. For example, if you want to have two locomotives, say **[3]** and **[9]**, pulling one train — for a long incline or to pull a very long freight — then press keys as follows: **[STOP]** **[3]** **[STOP]** **[9]** **[D]**

Now the speeds and direction of both locomotive **[3]** and locomotive **[9]** can be regulated simultaneously. If they had previously been allocated different momentum levels the lower level of momentum will be selected.

To change momentum level of a pair of engines in a double header, new instructions need only be given to one of them. For

example **[MOMENTUM]** **[4]** **[STOP]** **[3]** **[D]** will allocate the slowest acceleration, momentum **[4]** to the double header with locomotives **[3]** and **[9]**. If a locomotive is to be 'deallocated', that is taken out of the command of a controller, (this may be desirable when splitting up a double header for example). The locomotive can be assigned to a 'dummy' controller. Press keys as follows: **[STOP]** **[0]** **[STOP]** **[3]** **[D]**

NOTE: When double heading, it is essential that all locomotives run in the corresponding direction, i.e. if locomotive runs left to right when forward is selected all other locomotives should respond in the same way.

If the controller is overloaded by running too many locomotives or accessories an electronic circuit protector will come into operation switching off the power to the track. The green 'power' light will go off and the red circuit overload indicator will come on. When this happens remove the overload or short circuit (the same protecting circuit will operate with an accidental short circuit across the tracks). Then press the clear key **[C]**. All locomotives will then start up again with a temporary allocation of momentum level 2.

(N.B. if color light signals are also being operated by Zero 1 they will all revert to red provided they were wired to show red when the key **[D]** is pressed, see page 14).

## Assigning a Slave Unit

A Slave Unit is instructed to take over the control of a locomotive by the Master Control Unit. When instructing a Slave Unit to take control over a locomotive you are "assigning" that locomotive to it. Each Slave Unit is a controller. With the addition of a Slave Unit, the Master Control Unit becomes "Controller 1" the Slave Unit is described as "Controller 2", the next Slave Unit as "Controller 3" and so on.

When the system is plugged in locomotives are automatically assigned to their respective controllers. So locomotive 1 comes immediately under control of Controller 1 (the Master Control Unit) locomotive 2 under control of Controller 2 (the first Slave Unit) and so on. So when first plugging in, Controller 2 will immediately control the speed and direction of locomotive 2.

To enable a Slave Unit to control other locomotives than those automatically assigned when plugging in, for example putting locomotive 9 under the control of Controller 2 press the keys as follows:

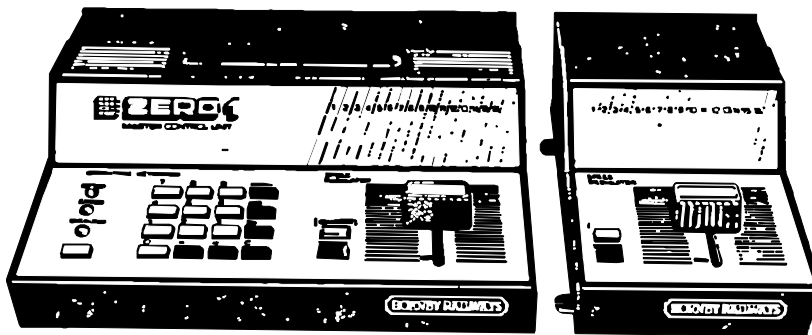
**[2] [9] [STOP] [2] [STOP]** regulator to stop **[9] [2]**

Any locomotive under the command of Controller 2 at the time of this instruction will continue to run at the speed and in the direction set until reassigned to a controller and its instructions altered.

## Reassignments

Locomotives can be assigned or reassigned to different controllers at anytime. For example to bring locomotive 9 under the control of the master Control Unit press these

# Slave controller



keys: **[2] [1] [STOP] [9] [STOP]**

Double headers can be assigned to Slave Units as to the Master Control Unit.

For example double heading a train with locomotives **[3]** and **[9]** under controller **[2]** is done like this: **[2] [3] [2] [9] [2]**

## Momentum and Slave Units

Momentum levels are given to locomotives by the Master Control Unit. Its computer memory will remember which locomotive has been given which momentum level independently of the controller instructing it

— even if the locomotive is assigned or reassigned to different controllers.

To change the momentum level of a locomotive under the control of a Slave Unit just use the standard momentum procedure, for example: **[MOMENTUM] [2] [5] [2]**

## Number of Slave Units

As described earlier the amount of power in the circuit is limited to 4 amps continuous. And the power consumed by many more than 4 locomotives at one time is likely to exceed this output. So the number of Slave Units which can, at the moment, be added on to the Master Controller is limited to 3. You can have a lot of fun operating 4 locomotives at once!

# The layout

One of the advantages of Zero 1 is that it is compatible with any type or manufacture of trackwork. All you need to do is disconnect your old throttle and re-connect Zero 1. If you are on "switched block control" just parallel all your feeds to the two leads from A and B on the Master Unit. You can use Zero 1 with Cab Control providing it is NOT wired on common return. All changeover/selector switches must be double pole/double throw type.

## Using more than 16 locomotives

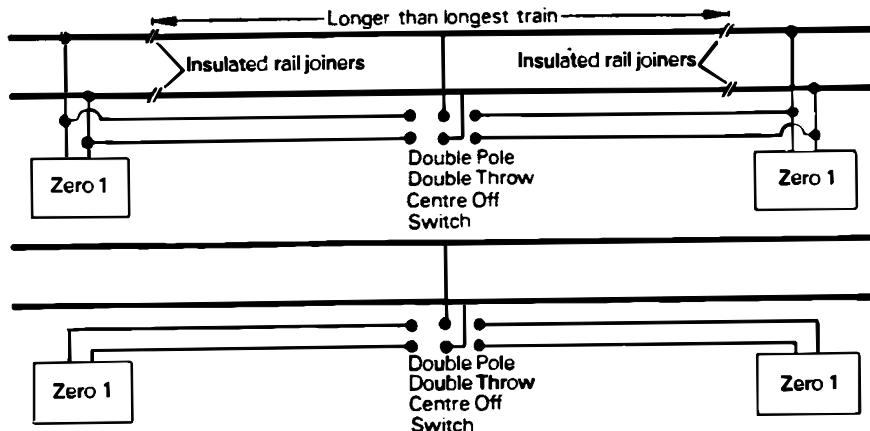
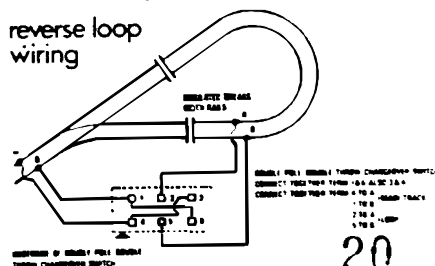
If it is wished to use more than 16 locomotives on your layout, more than one locomotive can be given the same operating code number, but of course, if these locomotives are on energised trackwork they will both respond to the commands given by the Master Controller.

## Reverse loops

With Zero 1 the locomotive operating module will always respond to the direction instructions given by the coded pulses from the Master Unit, i.e. if forwards is selected whichever way the locomotive is placed on the track it will still go forwards. It is this feature of Zero 1 that simplifies the reverse loop.

You can now drive the train right round the loop without changing controller or stopping the locomotive as in many conventional systems. The only item needed is a double pole/double throw changeover toggle switch of the type supplied by many Hobby shops and this is arranged so that when the turnout is operated the polarity is changed in the loop section (see diagram).

reverse loop wiring



# Electrical accessories

Un-plug Master Unit from electrical input before wiring accessories.

High frequency/voltage track cleaning devices or light/sound systems must not be connected to the Zero 1 system.

Electrically powered switches/turnouts and signals can be connected to the 16 volt A.C. supplementary terminals 5 and 6 on the back of the Master Unit and controlled in the conventional way. The supplementary terminals must not be connected to the track terminals.

## Accessory Operating Module

With Zero 1 the microprocessor is programmed to control up to 99 two state accessories, either left/right for turnouts or on/off for signals, lights or other devices needing continuous supply.

The accessory operating module will control four outlets, any of which may be switched for a 'burst' or an 'on/off' mode. To operate the accessory module you allocate each module with a code in the same way as you have given each locomotive its own code. The accessory module can be coded (odd numbers only) by arranging a finger switch. In the same way the operation of burst or on/off

is also selected by another finger switch, so enabling the coding to be changed if and when required. Having given our turnouts/signals the appropriate code, i.e. 25, we type on the keyboard **2** **5** and then either **←** or **→**. It is advisable when connecting the turnout signal to ensure that when the **←** key is pressed all turnout signals move in this direction and similarly with the **→** key. When the module is coded 25 the other outlets will number consecutively upwards, see diagram.

The module collects its power and information from the track by the means of two wires so enabling the module to be placed at any point on the layout convenient to the accessories that it will control. There is no need to wire back to the Master Unit. If you require to operate two accessories at the same time, one on continuous and one on burst operation it is possible to code another module with the same code. In this way it is possible to have modules overlapping, i.e. module 25 controls outputs 25, 26, 27 and 28, and similarly module 27 controls 27, 28, 29 and 30. Whenever 27 or 28 is instructed on the Master Unit both outlets on the modules will operate. The only limiting factor of the number of modules operating with the same code is the current limit from the output of the

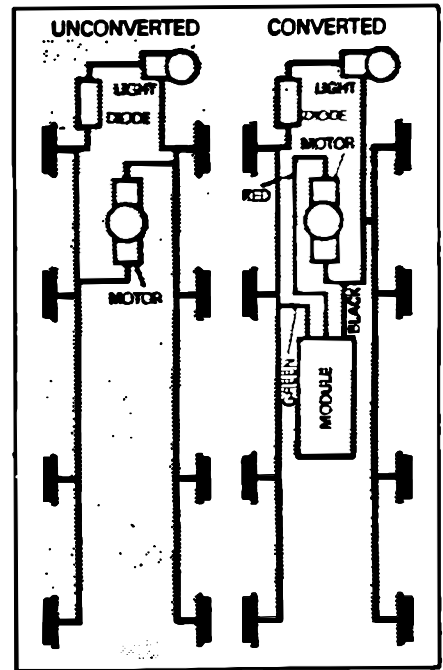
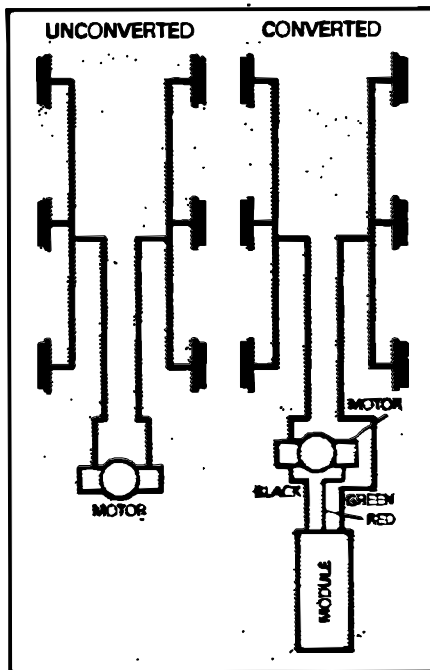
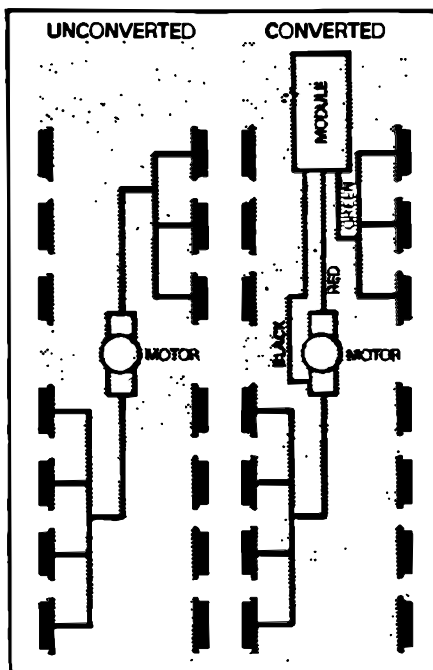
Unit, i.e. 4 amps. The accessory operating module is protected by the same overload protection (red light) as the locomotives. If the overload situation comes into effect all accessories operating on continuous current will revert to the state equivalent to an instruction **←**, i.e. if colour light signals have been wired to go green when **←** is entered they will all revert to green. Accessories using the 'burst' current will not be affected.

## Turntable

If a turntable is required to be operated from the Master Controller it can either be given a locomotive module and driven in the same manner as a locomotive, i.e. forward/reverse fast or slow or it can be driven from the continuous mode of an accessory operating module. This would only give constant speed in one direction which would be suitable for the 'sensing' type of turntable. The use of a turntable allied to a roundhouse is the ideal way of storing more than 16 locomotives on a layout, but remember all locomotives must have a Zero 1 module fitted to them.

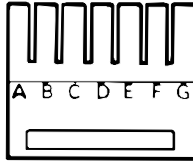
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# Loco conversion



**IMPORTANT** Unconverted locomotives should not be used on trackwork connected to Master Controller.

# Coding of the accessory module



Module outputs	0	I	II	III	"Finger pattern" (see chart)
1st Module Code Nos.	21	22	23	24	Remove finger B
2nd Module Code Nos.	23	24	25	26	Remove fingers B & E

No more than one accessory should be connected to the same module output.

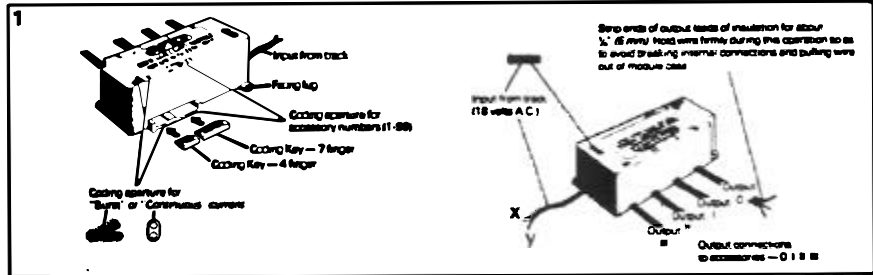
Code No.	Coding Finger						
	A	B	C	D	E	F	G
1-4							
5-8						X	
9-12							X
13-16	X				X		
17-20	X				X		
21-24		X					
25-28		X					
29-32		X					X
33-36	X	X			X		
37-40	X	X			X		
41-44		X					
45-48		X					
49-52		X					X

Code No.	Coding Finger						
	A	B	C	D	E	F	G
3-6					X		
7-10					X		
11-14	X						
15-18	X						
19-22	X						
23-26	X	X			X		
27-30	X	X			X		
31-34		X					
35-38		X					
39-42		X					
43-46		X					
47-50		X					
51-54	X						

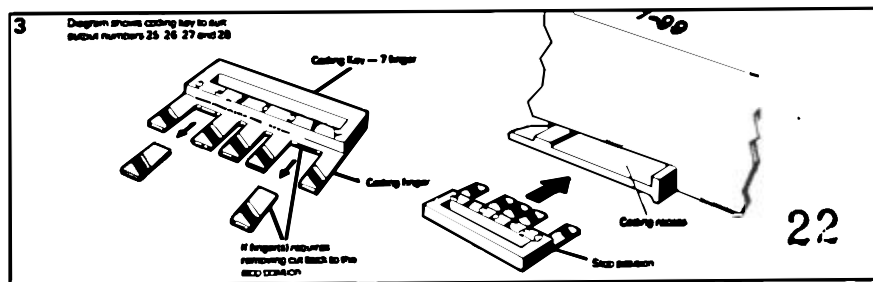
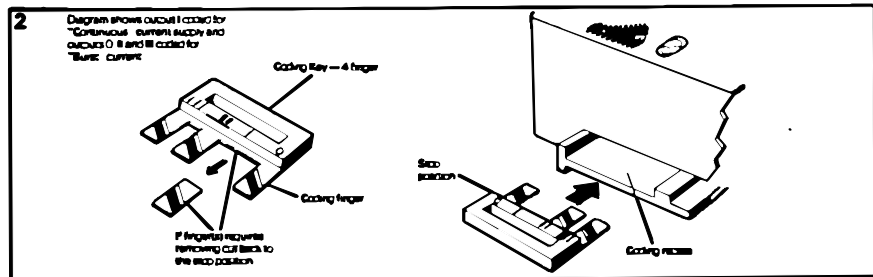
Code No.	Coding Finger						
	A	B	C	D	E	F	G
53-56	X						
57-60	X						
61-64	X						
65-68	X						
69-72	X						
73-76	X						
77-80	X						
81-84	X						
85-88	X						
89-92	X						
93-96	X	X			X		
97-99	X	X			X		

There are certain instances (e.g. track configurations such as crossover) where the operator may wish to operate two accessories simultaneously.

This can be achieved if two modules are employed and one accessory is connected to an output of each. The module outputs should be given identical code numbers, either all four outputs being duplicated, or just two of each module as shown.

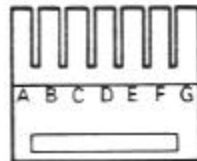


Code No.	Coding Finger						
	A	B	C	D	E	F	G
55-58	X						
59-62	X						
63-66	X						
67-70	X						
71-74	X						
75-78	X						
79-82	X						
83-86	X						
87-90	X						
91-94	X						
95-98	X						





# Coding of the accessory module



Module outputs	0	I	II	III	"Finger pattern" (see chart)
1st Module Code Nos.	21	22	23	24	Remove finger B
2nd Module Code Nos.	23	24	25	26	Remove fingers B & E

No more than one accessory should be connected to the same module output.

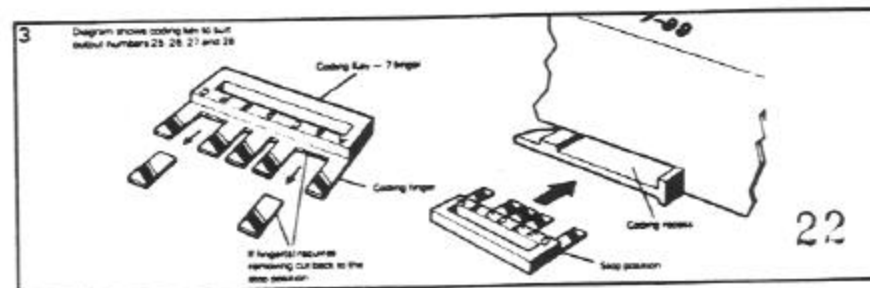
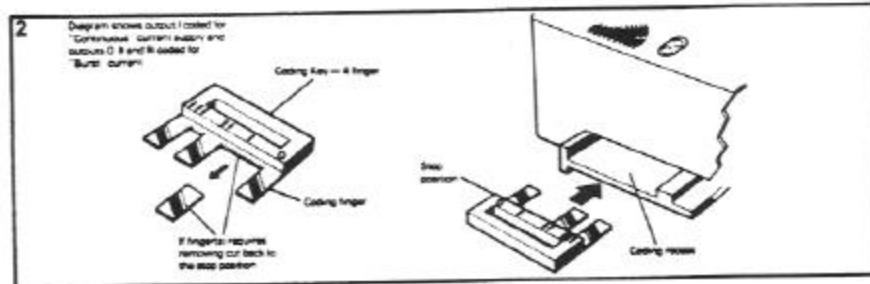
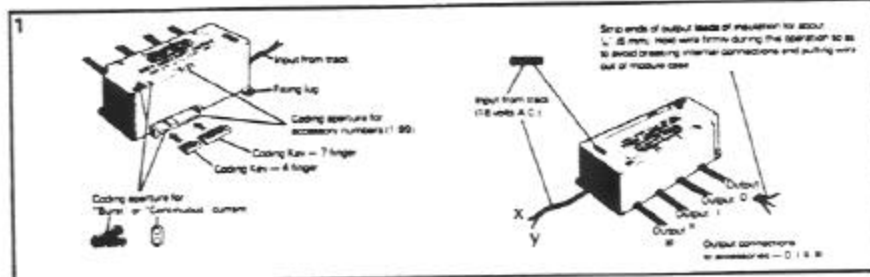
Code No.	Coding Finger						
	A	B	C	D	E	F	G
1-4							
5-8							
9-12							
13-16	X						
17-20	X						
21-24	X						
25-28	X						
29-32	X						
33-36	X	X					
37-40	X	X					
41-44	X	X					
45-48	X	X					
49-52	X	X					

Code No.	Coding Finger						
	A	B	C	D	E	F	G
3-6							
7-10							
11-14	X						
15-18	X						
19-22	X						
23-26	X						
27-30	X						
31-34	X	X					
35-38	X	X					
39-42	X	X					
43-46	X	X					
47-50	X	X					
51-54	X	X					

Code No.	Coding Finger						
	A	B	C	D	E	F	G
53-56	X						
57-60	X						
61-64	X						
65-68	X						
69-72	X						
73-76	X						
77-80	X						
81-84	X	X					
85-88	X	X					
89-92	X	X					
93-96	X	X					
97-99	X	X					

There are certain instances (e.g. track configurations such as crossover) where the operator may wish to operate two accessories simultaneously.

This can be achieved if two modules are employed and one accessory is connected to an output of each. The module outputs should be given identical code numbers, either all four outputs being duplicated, or just two of each module as shown.



Code No.	Coding Finger						
	A	B	C	D	E	F	G
53-56	X						
59-62	X						
63-66	X						
67-70	X						
71-74	X						
75-78	X						
79-82	X						
83-86	X	X					
87-90	X	X					
91-94	X	X					
95-98	X	X					

# Technical specifications

## Master Control Unit

Electrical input: 110/120 Volt AC  
60 Hz.

Rated output voltage:

Track (terminals A and B): 12 Volt A.C.  
square wave. (Track voltage when  
measured by a conventional meter  
can read up to 25 volt A.C.)

Supplementary output (terminals 5  
and 6): 16 volt A.C.

Track and supplementary output  
protected by electronic circuit breaker.

Maximum current 4 amps

## Locomotive Operating Module

Maximum rated output: one amp  
continuous when used with Master  
Controller.

## Accessory Operating Module

Maximum rated output: one amp  
continuous per channel when used  
with Master Controller.

### Dimensions of Master Unit

Length 10.9" — 277mm  
Depth 9.3" — 236mm  
Height 4.1" — 104mm

### Dimensions of Slave Unit

Length 5.0" — 127mm  
Depth 9.3" — 236mm  
Height 4.1" — 104mm

## Dimensions of Locomotive Operating Module

Length 1.44" — 37 mm  
Depth 0.56" — 14 mm  
Height 0.31" — 7 mm

## Dimensions of Accessory Operating Module

Length 3.87" — 98 mm  
Depth 1.37" — 35 mm  
Height 1.87" — 47 mm

Enquiries regarding service and  
spares or fitting instructions should  
be addressed to Traintronics