Electronics for Model Railways

Chapter 5

Wiring points

By Davy Dick

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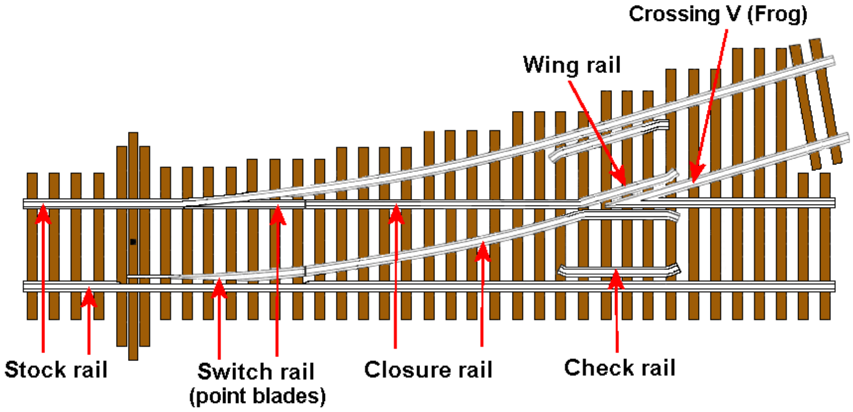
In memory of Margaret

Contents

Wiring points

Before looking at optimising the performance of points, eliminating possible sources of poor performance or shorts, it is best to remind ourselves of the names of the various parts that make up a point (according to www.britishrailways.info). Other countries may give parts different names (e.g. even calling it a turnout instead of a point) but using this illustration ensures that the rest of the material is understood.



In most points, all or part of the closure rails remain fixed and stationary, while the point blades (switch rails) are the moving parts that guide the loco and wagon wheels to the required track.
Most magazines talk about *'frogs'* and points are described as *'insulfrog'* or *'electrofrog'*. Sometimes, they refer to the area shown in the illustration as the *'crossing V'*, while other times it refers to the area that encompasses both the crossing V and the wing rails.

Point varieties

Commercial manufacturers offer points with many different constructions and wiring differences.
It is common to find *'power routing'* points. These are constructed so that power is always connected to the direction set by the point. For example, a train in a siding would be disconnected if the point was set to the main line – and automatically reconnected when the point is set back to the siding.
In many cases, all the point blades, closure rails and wing rails are bonded together by wires under the trackwork (even the crossing V might be similarly bonded).
Also, some points have both point blades bonded together, while some have each point blade bonded to its nearest stock rail. Some points have the points blades bonded to the closure rails with wire, while others use rail joiners.
In most cases, commercially-produced points have plastic check rails.

Notes

> If your pointwork runs happily for you, that's fine.
> If you are experiencing electrical problems with your points, then you might wish to consider the following alterations to your point wiring.
> If you want to achieve the best future problem-free running with your points, you might wish to implement some, or all, of the alterations that are outlined.
> If you are planning a layout, you might want to consider the following pages before selecting your points.

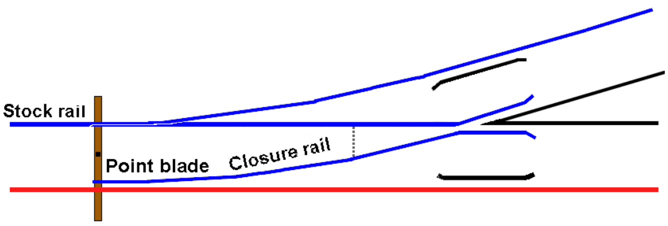
Not all the following may apply to your points. If in doubt about how your points are wired, use a multimeter to check your point setup.
A multimeter will soon tell you whether you need to consider making any alterations.

Point problems

The biggest problem experienced with points is shorting of the track power as the loco runs through the point trackwork.
If you are using DC, this may not even be noticed, apart from an occasional hiccup of the loco on the way through. That is because the loco's controller can handle the temporarily increased current for a sufficient time for the loco's momentum to take it past the point of the short. While this may seem to be acceptable, bear in mind that every time the short occurs, the spark is pitting the surface of the trackwork. So, even if your loco does not come to a complete halt on points, it may still be worth looking at improving the point's wiring.
With DCC, shorts are a bigger problem because the command station will close down when it detects an unexpected current surge. Not only will the loco come to a stop – the whole layout may come to a stop, if it is controlled by a single command station.

Shorts at point blades

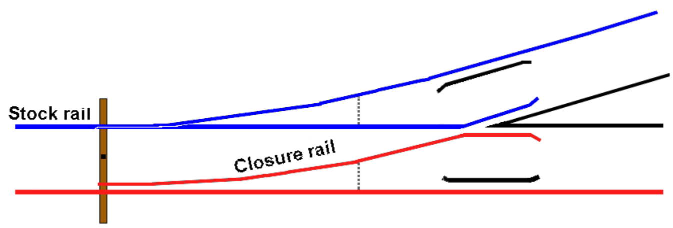
Consider the case shown in the illustration. The point is set to straight-ahead, with the upper point blade touching the upper stock rail.
Both closure rails are bonded together which results in the lower point blade sitting only a small distance from the lower stock rail – but at the opposite potential.



In an ideal world of fine tolerances, this might not pose any threat.
However, with many locos having coarse scale wheels with wide wheel treads, there is a possibility that the metal wheel will touch both the lower point blade and the lower stock rail. This produces a short across the track bus. This effect can also be caused where a wheel is out of gauge or has slack bearings. Another cause may be taking a loco round a small radius curve, such that the back of a wheel flange touches the open point rail.
The solution is to cut the link that bonds the two point blades together.
Left this way, a point blade/closure rail combination will only be 'live' when it is touching its own corresponding stock rail.

Dirt at point blade

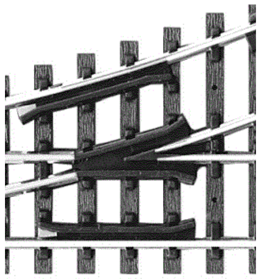
It is commonly accepted that it is best not to solely rely on a good contact between the point blade and the stock rail to provide electrical connectivity. While a new, out-of-the-box point may work happily for a while, the eventual build up of oxidization and grime on these points of contact could lead to high resistance joints, or complete loss of contact.
The solution is to have a permanent link between each point rail and its neighbouring stock rail. Both point rails,



and possibly their closure rails and wing rails, are permanently powered similarly to their stock rails.
A couple of links of Kynar wire or similar fine wire should be soldered between the point rails and their neighbouring stock rails.
As always, it is much easier to do this before a point is laid.
This modification ensures the best long-term running for both DC and DCC. Since the point rails are always at the same polarity as their nearest stock rail, DCC shorts are minimised and track pitting due to DC arcing across them is eliminated.

Shorts at frog

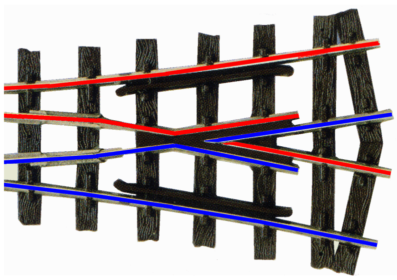
If you look at the previous illustration, you will see that there may now be a problem at the 'frog' area, depending on how a point's closure rails, wing rails and crossing V are currently connected.
As shown, there is little space between these track components, which again provides the possibility for shorts.



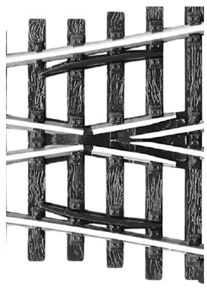
One solution from manufacturers is to manufacture that problem area from plastic, preventing possible shorts. These are often referred to as 'insulfrog' points and an example is shown in this picture.
This avoids any wiring modifications and is a suitable solution for long wheelbase locos that have pickup wheels that can span the dead gap, so that at least one set of pickups is on live track at any one time.
It is more of a problem for short wheelbase locos, or longer locos where one set of pickups is not functioning.
That is why many user prefer 'electrofrog' points, where the wing rails and the crossing V are conductive. Also, plastic frogs are more prone to wear than their metal equivalents, causing an eventual increase in derailments.

Wing rail shorts

Live frog components provide the most reliable point operation, but using electrofrog points is not without its own problems.



The picture shows just how close the wing rails and the crossing V are to each other and – more importantly – at different polarities.
Also, the junction between a wing rail and a closure rail is close to the other wing rail/closure junction.
Potential shorting can be overcome by breaking the electrical connection between the closure rails and the wing rails.
This may require cutting the junction with a cut-off disc in a Dremel drill, or something similar.



This picture shows a point that has gaps between the closure rails and the wing rails. Other prefer to cut further back down the closure rail, to further reduce any risk of shorts during derailments.
In some Peco points, these gaps may already be provided, with just wire links under the trackwork between the wing rail and its closure rail., In that case, the links should be cut.
Left this way, this would be a 'dead frog' point, which is little better than an insulfrog point. Being metal, it allows the frog area to have its polarity switched as the point is switched (see later).

Shorts at crossing V

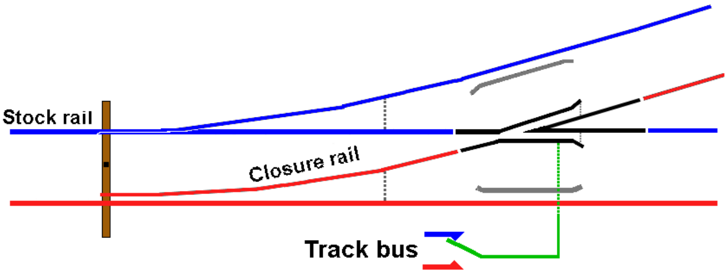
Another source of shorts is the tiny gap between the two halves of the crossing V on most points. As the above pictures show, the two rails are chamfered down to create a fine point, with almost no gap between them at the tip of the V.
The wide tread on some metal wheels are able to bridge the gap, causing shorts if both rails of the V are powered (if they are powered then they will be at opposing polarities).
A number of solutions have been offered for this.

- Applying a small touch of paint on one of the rails, at the tip of the V. Most report that this wears away and is not a permanent solution.
- Applying a small touch of glue, such as SuperGlue, to the same area. This wears better than paint.
- Both of the above are only semi-permanent remedies and both cover up a part of the conductive surface of the rail. An alternative approach is to widen the gap in between the two rails of the V. A cut-off disc fitted to a Dremel drill, or similar, can be used to grind a small section off the inner edge of each rail of the V. It need not be too wide or even too deep; simply enough to prevent wheel to rail contact. The same effect can be had using a small round jewellers file to gradually widen the gap. If required, the gap could be filled with epoxy then trimmed.
- Users have success without modifying the V at all. If the flangeway of the points (the gap between the check rail and the stock rail) is too wide, it may allow a loco's wheels to drift over the gap in the V. Gluing a thin plastic strip to the check rail narrows the gap and prevents excessive loco sideways movement. This solution is dependent on the points and locos in use.

An alternative approach does not modify the point's rails.
As shown in the illustration below, it treats all the frog components as a single condutive unit. In other words, the crossing V rails, wing rails, and maybe even part of the closure rails, are wired together. In some points, this may be how they are supplied as standard; if not, they can be wired together with Kynar wire or other fine connecting wire.
This requires additional electrical switching as below.

Frog switching

The first step is to ensure that the V is isolated from the rails that feed out from it, using insulated joiners. Similarly, the wing rails need to be isolated from the closure rails.
The illustration shows the crossing V, the wings rails, and a small part of the closure rails are wired together.



Left that way it would be a 'dead frog' point which is little better than an insulfrog point, apart from the fact that the metal frog will wear less.
Clearly, the frog area needs to be powered and, since all parts of the frog area are at the same polarity at any one time, its polarity must always corresponds to the direction to which the point rails are switched.
So, the frog area needs its own electrical feed whose polarity changes dependent on whether the point is set or unset.

Point switching can be achieved in a number of ways:

- Using the changeover switches available on some point motors (Tortoise, Hoffman, Cobalt, Fulgurex, Seep) , or purchased as point add-ons (Peco). These are often regarded as not fully reliable in the longer term.
- Using the Tam Valley Frog Joicer. This module works by detecting a short if a loco enters when the frog is at the wrong polairty to match the direction of travel. The surge in current is detected and the frog polarity is reversed. These have a number of qualifications. They are expensive (currently £57 for a module to handle 6 frogs); they cannot be located close to all 6 frogs simultaneously, requiring wires to be run from the module to distant frogs; they rely on a current spike to function (i.e. arcing and pitting have ocurred before the frog is switched).
- Using a changeover microswitch that is mechanically operated by the movement of the point's tie bar. This keeps the switch close to the point and independent of any other point wiring. Could be a little tricky to adjust for the correct switching point. Also, a low operating force microswitch is preferable, to prevent the back pressure from the microswitch moving the point blades away from the stock rails.
- Using a non-mechanical detection system such as attaching a small magnet to a location on the point operating mechanism, such that it activates a Hall Effect switch that controls a relay. An alternative might be a small shutter that breaks an infrared beam detector. These are more finicky to set up but have the advantage of placing no backlash effect on the point blades.
- Using a relay with SPDT (single pole double throw) contacts. The relay could be operated by a simple trackside or control panel switch, or by the output from a CBUS module such as the CANACC8 or an EzyBus Output Module. For example, the signal that operates a servo in a Servo4 board could also be wired to a relay to simultaneously changes the polarity of the frog.

There are plenty of options and their relative merits are a matter of debate.
It all depends on what you already have, how efficiently you expect it to work (now and in the future) and the lengths you are prepared to go to ensure trouble-free point operation.

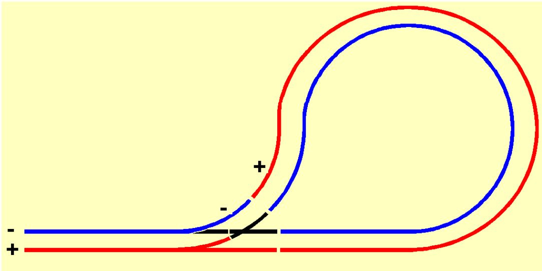
Point feedback

Throwing a switch on your control panel, or clicking a button on a screen display, does not ensure that your point has operated correctly. Any number of problems could prevent a point from moving. There may have been a cable break, bad connections, a mechanical failure, a motor coil burned out, or a chunk of ballast or other dirt stuck between the stock rail and the point blade.
Ideally, the operator should be informed that a point movement has been successful, by lighting a lamp on the control panel, or illuminating a part of a screen display. That involves taking feedback from the point back to the operator. This could be via a length of wire, or over a bus via a CBUS or EzyBus module.
If a point is fitted as supplied (with none of the above modifications), it can add a microswitch that is operated by the movement of the point's tie bar; the output from the microswitch is switched either high or low depending on the tie bar's position.

If a point has wiring for frog switching, then the most of the above wiring methods used for frog switching could also be used as the feedback.
These methods are suitable for DC or DCC, conventional wiring or CBUS or EzyBus.
Most of the time, your points work dependably. For more critical situations, such as at exhibitions or for automated layouts, feedback is much more useful if not essential.

In most situations feedback from a single source (e.g. point motor switch, microswitch, Hall Effect switch, infrared detector) will be perfectly adequate.
However, it has limitations. If the frog polarity has been successfully switched, without the point blades moving, you will soon know about it as there will be a short when the loco reaches the frog. The 'feedback' will take the form of the power being cut off from that section/power district.
If the blades partially move, as with dirt blocking full movement, there is likely to be a derailment with possible shorting once again.
In both cases, this can be prevented by having a system that detects the tie bar has moved the point blades fully in either direction. At its simplest, this might mean having a detector at either end of the tie bar – one to ensure a fully open point and one to ensure a fully closed point. Circuits can also be devised that will only power the frog when a tie bar is fully in one direction. This results in a dead frog but prevents overall shutdown, and the operator is notified of the problem.

Reverse Loops



Although not common on actual railways, reversing loops are popular on many model railways as allow trains to reverse direction without shunting or turntables.
As the illustration shows, trains can enter a loop head first and then exit head first.
The problem arises with the wiring to the track.
Without taking any steps, there would be a short circuit as the outer rail (shown as positive in the example) became the inner rail (shown as negative) at the other end of the loop.
Solutions require that a 'dead' section be created in the loop, using insulated joiners at both ends.
This unpowered section is often called the reversing section.
The only connection to the reversing section of track is through some switching system, either manual or automatic. The switching system is fed from the track bus and feeds out to the reversing section – usually two wires in and two wires out.

Before looking at different switching approaches, it is important to ensure that the length of the dead reversing section is longer than the longest train that will be on the loop. Anything that has track pickups must be included in the train length. Apart from the loco, take into account carriages with lighting, with sound, or with extra power pickups, or a train that has a loco at each end.
All of the trains pickups must be sitting in the reversing section, otherwise there will still be a short.
If a train has only a single loco, and no other pickups, it is possible to have a short reversing section.
However, that is only possible if you know that a loco will always be pulling the train and

never pushing it. Otherwise, where do you position the short dead section – near the entrance to the loop or near the exit.   To play safe, and to allow for a range of different train lengths, it is best to have a long reversing section.

Different switching approaches are adopted for DC and DCC.

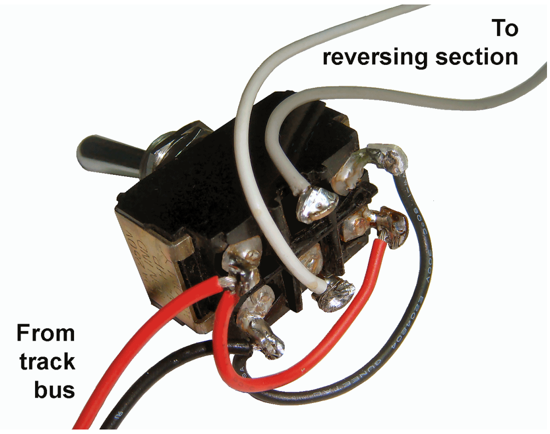
DC

The usual way of handling reversing loops in DC is manual and uses these steps:

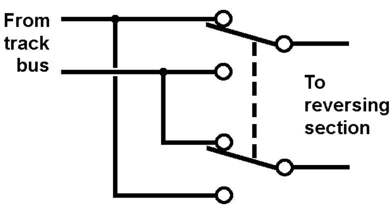
- Make sure that the reversing section is powered to match the direction of the point blades (otherwise you have a short).
- Drive the train into the reversing section.
- Stop the loco.
- Change the point.
- Reverse the mainline track power.
- Start the loco again.

As you can see, this involves the operator to be in attendance and to carry out a sequence of tasks in the correct order.
There are a number of methods of handling DC reversing loops.

Switch

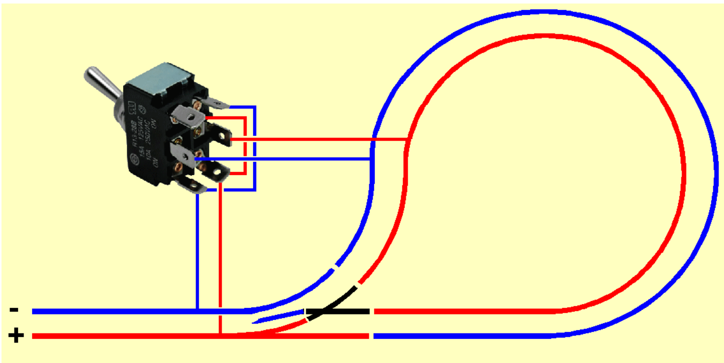


This is the most common method of manually switching the section polarity.
The picture shows the use of a DPDT (double-pole double-throw) switch to reverse the polarity of the reversing section.   When the switch is thrown to the left, the two middle tags are connected to the two leftmost tags.   When the switch is thrown to the right, the middle tags connect to the rightmost tags.   By cross-wiring the outer tags, the polarity of the output on the middle tags depends on the direction that the switch is thrown.
The illustration shows the schematic representation of a DPDT switch; this is how it will look in a circuit diagram.   The dotted line indicates that the two switches are always operated at the same time,



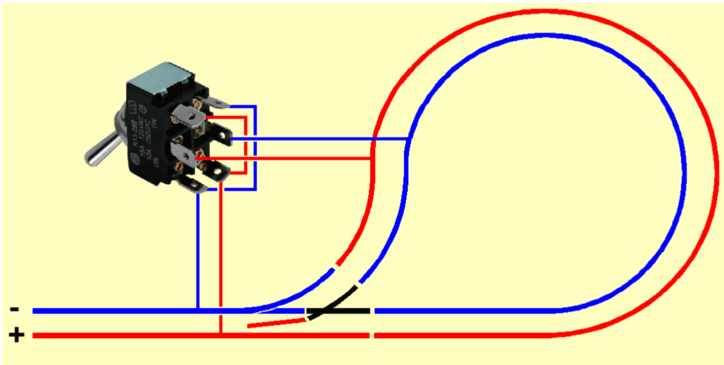
Consider the case of a train entering the loop via the 'branching' track of the point and leaving the loop via the 'main' track of the point.

This illustration shows the point being set to branch.   The switch is thrown such that the polarity of the reversing section matches that of the branching track.



The train can safely enter the reversing section, since the rail polarities match.
The track where it exits the loop has a polarity that does not match its adjacent rails; this does not matter since they are isolated from each other.

The train is run into the reversing section and stopped.



This illustration shows the point being set to main. The switch is thrown in the opposite direction from that above, making the polarity of the reversing section now match the main track of the point.
At this point, the mainline track polarity is reversed, as the loco is entering the mainline in a different direction from before.
The train can now be safely run out of the reversing loop into the main line.
The track where it originally entered the loop has a polarity that does not match its adjacent rails; this does not matter since they are isolated from each other.

Manual operation is very simple to wire but relies on the operator carrying out the sequence correctly.

Relay

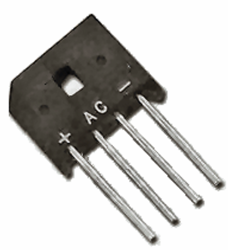
This can be improved on with the use of a DPDT relay to switch the reversing section, instead of a switch. When the point is switched, the relay is also switched, eliminating some manual operations and ensuring that the polarity of the reversing section always matches that required. This eliminates the possibility of shorts caused by the operator carrying out the sequence incorrectly.
The relay can be operated by the switch on the control panel, or by contacts on the point motor. You must use a latching relay with solenoid points, as there is nothing to keep the relay switched after voltage pulse is gone.

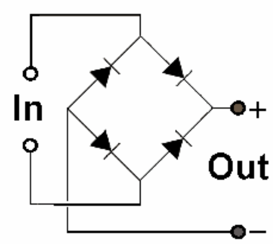
Automatic methods

Automating DC loops is possible, although complicated. The electronics has to detect when the train is fully in the loop, possibly slowing the train to a halt before reversing the track power to the reversing section.

Bridge rectifier

This method simplifies even further – provided you are happy to have the train always run round the loop in the same direction (always clockwise or always anti-clockwise).
Many reversing loops are hidden, so is often OK if loco only every goes round one way.
A bridge rectifier is just a single component that houses four diodes in a special formation
If you prefer, you can use use four separate diodes instead.



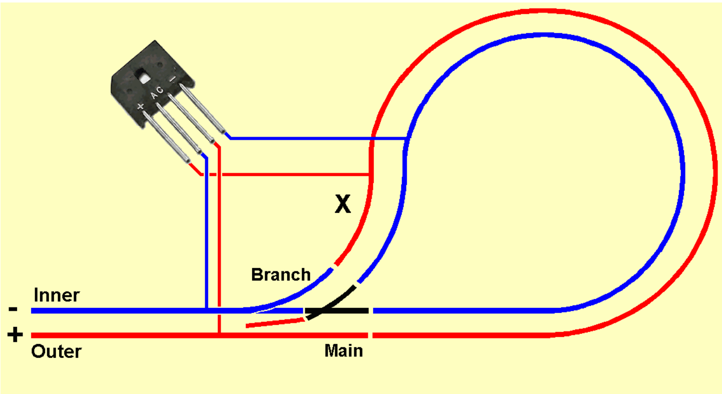


The picture shows a typical bridge rectifier and its equivalent seen as a schematic symbol in a circuit diagram.
Bridge rectifiers come in all shapes and sizes, depending on their voltage handling and current ratings.

The chief purpose of a bridge rectifier is to convert AC into DC. It has four leads. The two marked with a ~ symbol are the input connections and the other two are the positive and negative outputs.
However, a bridge rectifier can also accept a DC input. Because of the way the diodes are wired, the + and – wire will always provide a positive and negative polarity respectively – regardless of the polarity of the DC input.

This allows us to connect the reversing loop section such that it always has the same polarity on its inner and outer tracks, regardless of the polarity of the incoming track and point.

This example assumes that the loco always enters from the 'main' track and exits from the 'branch' track after going round the loop.
The operator moves the point to 'main' (i.e. straight ahead),
The illustration shows the conditions when entering the loop. The feed track has its inner rail is at negative and the outer rail is at positive. This is also the conditions fed to the reversing section.



The train will run from the main line into the reversing section and carry on round the section, even when the operator reverses the controller's output.
When the point is changed, the inner and outer rails of the feed track now match that of the reversing track, so the the loco can carry on out of the section into the main line.

This allows three options;

- The operator still stops the train in the reversing section, either for timetabling reasons or to allow time to change the feed polarity and move the point.
- The changing of the feed track polarity is wired to automatically change the point. Instead of six steps, the operator only has to change the track polarity at the correct time (when the train is fully in the reversing section).
- Using automation modules that do the job for you. Automatic methods involve electronic modules to control the points and the main line polarity, normally through computer interfacing and track detectors (such as the one marked as X in the illustration).

DCC

With DCC, there is still a need to have the reversing section isolated and connected to power in accordance with the direction of the point. The problem with shorts is still prevented by having an isolated section but there are operational differences.

With DC, locos are dependent on the polarity of the rails. Reversing a track's polarity results in the loco changing direction.

This is not the case with DCC. The loco direction is controlled by sending commands to go forward or in reverse. Once given that command, the loco keeps going in that direction, even when the track polarity is reversed.

This is handy for reverse loops. The loco drives forward into the loop, drives round the loop and is still going forward as it exits the loop – all without any change of the incoming track's polarity. Of course, you still need to change the polarity of the reversing section track once the train is fully in, to prevent shorts.

Stopping the train in the reversing section is optional. You may want to stop the train for timetabling reasons, or to give you time to change the polarity of the reversing section and to move the point. However, if you want, you can allow the train to keep driving through the loop as long as you change the section polarity and point direction before the loco exits the loop.

As before, the polarity changeover can be achieved by a variety of means;

- By manually throwing a DPDT switch.
- By linking a DPDT switch to the point's tiebar.
- By having a relay change the section polarity; the electronic signal that moves the point also operates the relay.
- By using track sensors to detect how far the train is round the loop and automatically change the point and the track polarity.

Automatic methods

Like DC, special modules are available in DCC to automate the process. Indeed, there is a greater variety of electronic modules available for DCC.

Using track detectors

MERG's kit number 823 can provide fully automatic control of both train, tracks and point movement.

Its main features are:

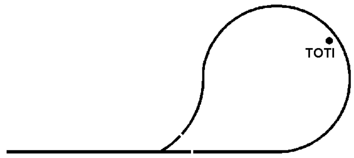
- The operator should not be able to switch the point after the train triggers the detector, until the train fully leaves the loop and the point.
- The system should allow trains to move round the loop in either a clockwise or counter-clockwise direction.
- The system should work with a range of different detectors, LDR, infrared, laser, Hall Effect, etc.
- The system should automatically switch the point and the polarity of the isolated section.
- The operator should be able to switch the point manually after the train has fully exited the loop and the point.
- The system should provide different options for fitting detectors.

Options

The kit 823 controller offers three different levels of complexity, with added functionality as you add extra detectors. You decide how far you want to go with this module.

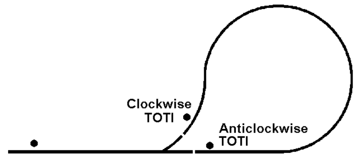
Single detector

This is the easiest to implement, with the TOTI positioned mid-way round the isolated section. This limits the train length to half the length of the isolated section. Since you don't know how long a train is, you have to set a timer to control the switching of the point and isolated section.



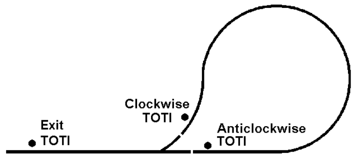
Two detectors

This method places a detector at each end of the isolated section, allowing the train to be the length of the isolated track section. You still need to set a timer.



Three detectors

This method places a detector at each end of the isolated section, plus another detector on the main track, also allowing the train to be the length of the isolated track section.



Since the 'Exit' detector indicates when the train has fully left the loop, there is no need for a timer.

A commercial example is the MREV Track Polarity Controller by Azatrax. This module also uses track detectors to know when the train has sufficiently entered the reversing section.

Short detection

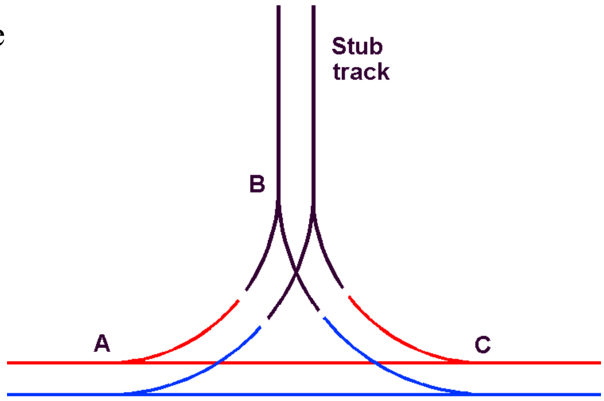
These circuits do not need track occupancy detectors.
Instead, they detect the short that is created when the loco's front wheels bridge the gap between the isolated section and the exiting track section that is connected to the point.
The current surge is detected and instead of closing down the track power, these circuits quickly reverse the polarity of the isolated section to remove the short. At the worst, there may be a slight jerk in the loco movement.
These circuits may be built into a booster, such as the SPROG SBOOST DCC Booster, or are available as stand-alone modules.
Some of these modules use relays for track switching and some use solid-state switching.
Commercial standalone auto reversing units include

- Digitrax AR1 Auto Reversing Module (see picture)
- Gaugemaster DCC40 Auto Reverse Module
- Lenz LK200 Auto Reverse Loop Unit
- Hornby R8238 DCC Reverse Loop Module
- Bachmann E-Z Command Reversing Loop Module

These have several drawbacks. They are expensive; they only handle the track power, with the operator still having to switch the point; the arcing caused by the short is not exactly an elegant solution.
All of these modules save you the job of switching the polarity of the reversing section polarity. With a combination of an auto reversing unit and a track occupancy detectors operating the point, the whole process can be automatic. The operator simply has to control the loco speed.

Wyes

This formation is much more common on USA rail systems and is rarely found in Europe. Like the reversing loop, it allows a train to enter a track configuration facing one direction and exit facing the opposite direction. The wye uses three points and a single isolated section (the 'stub end'). The train comes in to the isolated section from one mainline point and reverses out through the other mainline point. It is now back on the main line but facing a different direction. The wye uses more points than a reversing loop and is less popular, although it may better match the physical locations of some layouts. Like the reversing loop, the stub end of the wye must be long enough to accommodate your longest train.



DC

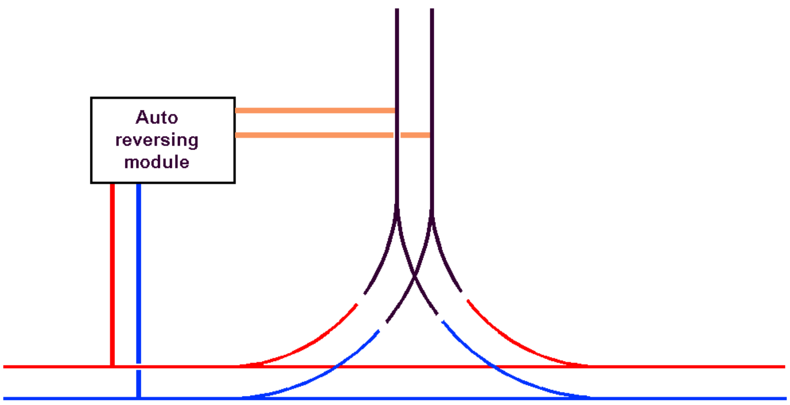
The operator's sequence might be:

- If necessary, switch point A and point B to allow the train to enter the stub track.
- Move the train into the stub track through point A and point B.
- Stop the loco.
- Change the direction of point B and point C.
- Reverse the polarity of the reversing section.
- Move the loco out of the stub track into the main line through point B and point C.
- Stop the loco.
- Switch point A and point C.
- Reverse the polarity of the track power.
- Drive the loco along the main line through point C and point A.

The train is now travelling forwards, in the opposite direction to that when it approached the wye. It is possible to have the power to the isolated section reversed by a DPDT switch or relay linked to the point operation. Nevertheless, operating a wye is a detailed process that needs to be carried out in the correct order – which is maybe another reason why it is less popular then reversing loops.

DCC

Once again, operations are somewhat simplified when using DCC. The illustration shows an auto reversing module ensuring that the stub track is always kept at the correct polarity to prevent continuous shorts.
You still have to switch points, unless automated with track occupancy detectors, etc.



Important note

The illustrations for reversing loops and wyes ignore any consideration on frog or point rail wiring or switching. This is to make the diagrams more clear. Consideration has still to given to how you wire the points themselves, as discussed earlier.