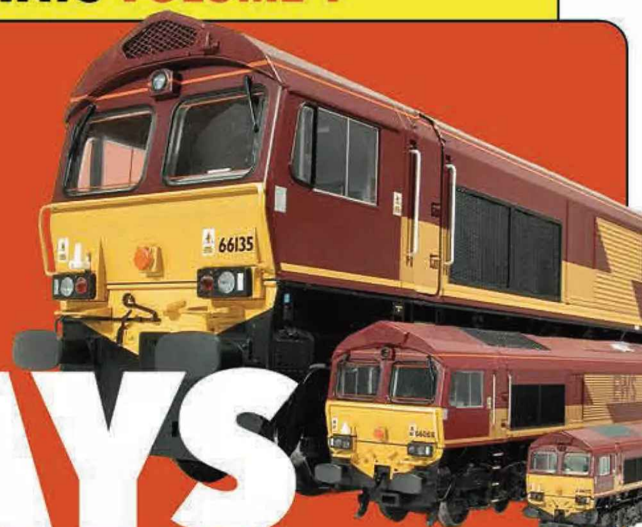
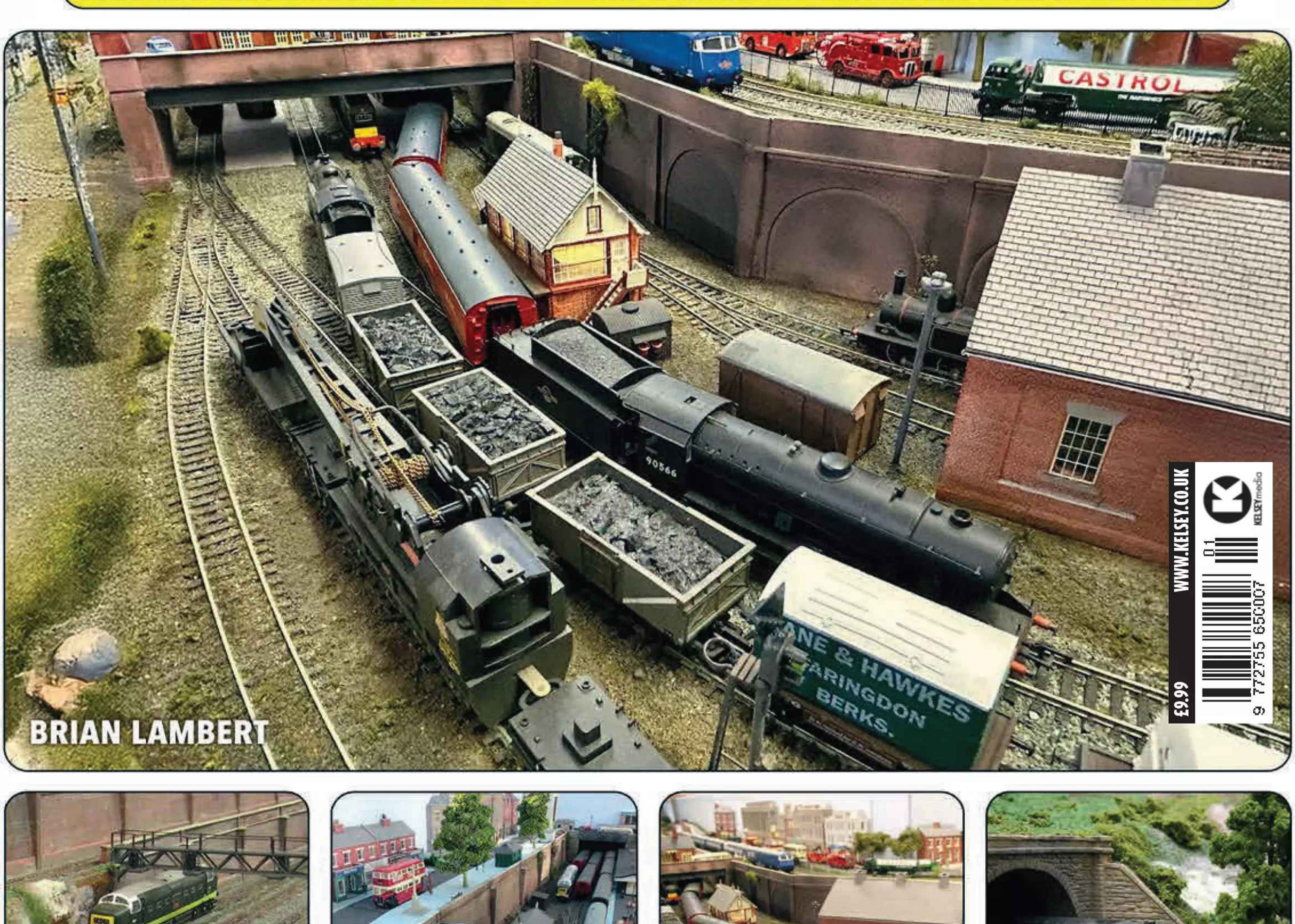
SILVER LINK MODEL RAILWAYS VOLUME 1

THE GUIDE TO MODEL RAILWAYS



FROM BEGINNER TO EXPERT – TIPS AND ADVICE FOR ALL ABILITIES



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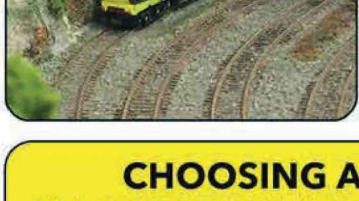

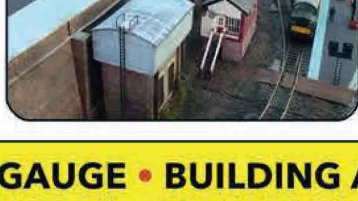

CHOOSING A GAUGE • BUILDING A BASEBOARD • LAYING THE TRACK
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PREFACE

I have been involved in model railways for many years now and though my interests are mainly in the UK '00' gauge scale, this book is written to help all modellers, no matter what the chosen gauge or scale.

For me, it all began way back in the late 1950s when, as a small child, I was given a Tri-ang Railways 'Princess Elizabeth' train set for Christmas. It was nothing more than a simple oval of clip-together plastic 'Standard' track, a tender loco and two carriages with a battery-powered controller. Christmas Day saw myself as the onlooker! My father and my uncle were kept very busy erecting the train set on the front room floor, then they spent the afternoon thoroughly checking it to see if it worked correctly. I actually never got to run or play with the set on that day!

In later years, but still as a pre-teenager, I was able to have a 'Train Set' layout permanently set up in my bedroom. As the years passed, by now into my early teens I was able to build a medium-sized layout in an unused box room, this lasted for a number of years. Finally, the call of youthful adulthood, together with its many attractions, beckoned and was taking more and more of my free time. So, the layout was taken apart and most sold off to a neighbour. During the earlier years of married life the occasional thought of a model railway and the odd model railway magazine would be obtained and reviewed. A son and daughter were born, and a few years later my son had a simple train set for a present, but this was not a model railway and slowly the need to build a fully working model railway became more than a desire. After a couple of false starts, it was the beginning of the 1990s that real railway modelling once again took a firm hold on me and eventually a fully working layout emerged.

Having moved home several times, I decided it was time to knuckle down and seriously start to build a decent model. So, 'Ridgley Vale' was drawn up and became my first attempt at a portable exhibition-quality layout. Later, I tried building another portable exhibition layout, but for whatever reason never really got beyond the track-laying stage! A further house move then saw me inherit half of an internal double garage, so I just had to have another layout, and 'Elmswood & Elmswood Central' was created, only this time it was a fixed layout that was destined never to leave home. Around 2014 I built an end-to-end layout called West Haven and that was set up in our home's conservatory. It was sold a couple of years later. During 2020 I decided to start another layout! This one is called 'High Hopes' and remains my layout today.

These revised and updated pages will, I believe, help and guide the modeller and be of help to anyone who is thinking of or has already started to build a model railway. They will, page by page, gain more information and learn the basics to allow them to build and operate a model railway, rather than just run a train set.

Class 37 37698 *Coedbach* emerges from the tunnel's darkness on the author's former layout.

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1
A DECISION ON SIZE

Model railways, as the name implies, are based on small-scale representations of the real thing, so the choice for the modeller is the actual model's scale, which is usually determined by the availability of space for what you wish to represent, and the skill level you possess – whether as a new modeller who wants to open a box and run a train immediately, known as Ready to Run (RTR) or build most items themselves from a mixture of kits or totally self-built, known as scratch building. Perhaps the best skill of all to have is patience! A model railway takes time to build, but the time spent in building it is very rewarding and extremely satisfying.

Most people will come to model railways through either being given a present, or buying for themselves, a train set. Sometimes the returning modeller will find an old set, from many years ago, hidden away in the back of a cupboard or in a loft, and decide to 'have a play' – then the model railway bug starts to bite and with time they become a more serious modeller.

Expanding the train set beyond 'what is in the box', nominally a basic oval of track, one or two locos, a few carriages or trucks and a basic controller, often follows fairly quickly from the initial box opening! Quite often the modeller will remain working in the scale of that first train set, as this is what they already have and are used too. Some, however, will opt for a larger or even a smaller scale, once they have examined the various scales available and decided what will fit into the space available for the layout.

A typical train set is shown here. Inside the box will normally be found the locomotive, carriages or wagons depending on the style of the set. An oval of track, power connecting clip or track power section and a basic train controller for setting the train's speed and direction of travel. Train sets should not be confused with 'Train Packs' which usually only contain a specific locomotive and carriages or wagons. No track or controller is included in a 'Train Pack'.

So, what is scale and track gauge?

Scale, is the relationship of the model to the real thing. The real thing could be described as being 1 to 1 (1:1) scale, so an exact half size model would be shown at a scale of 1:2, whereas 1 is the real size and 2 is the model in half size. Therefore, a quarter size model would be 1:4, while a model which is a 100th of the full size is at 1:100 scale.

A typical train set. *Image courtesy and © Hornby Hobbies*

Three scales of the same type of Class 66 locomotive. Largest is in 'G' scale, centre is 'OO' and on the right 'N' Scale. *Image courtesy British Railway Modelling*

Because most of the world has gone metric there is another range of scale terminology that's often used in model railways; the reference, for example, to 4mm/ft (four millimetres to one imperial foot) or 2mm/ft (two millimetres to one imperial foot) are two examples. Thus, a UK 'OO' modeller may be quoted as working in 4mm/ft, 1:76th scale, 16.5mm (more of this later) or just plain 'OO'!

Track gauge is as confusing as the scale, but I'll endeavour to explain. Track gauge is the distance between the inner faces of the two running rails. In the UK and many parts of the rest of the world railways use a gauge of 4 feet 8 ½ inches or 1435mm. In railway modelling there are, depending on scale, many track gauges. For example, 'N' gauge (1:148 scale in the UK) has a track gauge of 9mm. 'TT:120' uses 12mm spacing and UK 'OO' has a gauge of 16.5mm between the rails, it is also the same track gauge as used by 'HO' modellers who work in 3.5mm/ft or 1:87 scale. While '1' gauge has a massive 45mm between running rails. Even more confusion can exist when 'fine scale' models are considered.


Three sections of track. The left is 'N', centre 'OO'/'HO' and right 'O'. The distance or 'gauge' between the inner faces of the rails of each track is: 'N' 9mm, 'OO'/'HO' 16.5mm and 'O' 32mm.

Standard gauges: small to large

'T' gauge has earned the right to claim to be the smallest commercially made ready-to-run electrically powered railway system. Sold currently only in continental outline it is an incredibly small size and is produced to a scale of 1:450 or 0.002 inches to the foot and has a track gauge of 3mm.

'ZZ' gauge is the next largest scale (if largest is the correct term). Again, sold in continental outline models, it has a scale size of 1:300 running on 4.8mm gauge track.

'Z' gauge was probably the smallest working models available until the arrival of 'ZZ' and latterly 'T' gauges. Sold in continental outline, it is 1:220 scale and has a track gauge of 6.5mm. I have seen a complete layout built and running in the space occupied by a removed cathode ray tube in an old 14-inch TV cabinet.

'N' gauge enters next and is to a scale of 1:160, but UK modellers will recognise this as being 1:148; the track is at 9mm gauge. This is the first scale we meet where more than one size of scale exists on the same gauge of track! This scale is at times referred to as 2mm scale, which is not quite correct. Track and rolling stock is available as kit-built and ready-to-run.

'2mm' or 'OOO' scale runs on a track of 9.5mm gauge and is to 1:152.1 scale. This is mainly a British scale from the 1930s when 'OO' was halved. In this scale most modellers scratch-build their locos and rolling stock.

'TT', 3mm and TT:120 gauges. TT came to the UK from America and TT stands for 'Table Top'. It has a track gauge of 12mm and is in the UK to a scale of 3mm/ft or 1:101 (USA 2.54mm/ft and 1:120). Tri-ang Railways took up the cause in the UK and for a short while produced ready to run models, but they ceased production and British outline models are now only currently available as kits. 2022 saw the announcement by Peco, and then later in the same year Hornby, that they were introducing TT:120 in the UK. As the name implies it is to a scale of 1:120 and uses the 12mm track gauge.

'HO' gauge is the truer scale for 16.5mm track. It has a scale of 3.5mm/ft or 1:87, and is used internationally apart from Britain. HO stock will happily run on 'OO' track as they both share the same track gauge. Several attempts have been made to try and get the UK to drop 'OO' in favour of the more truer HO scale, but these attempts have so far always been stopped, as 'OO' has far too big a hold on the UK market. Items for this scale are available as ready to run or can be scratch built or built from kits.

'OO' gauge is the UK's answer to 16.5mm scale. The track is at 16.5mm (same as HO) and has the scale of 4mm/ft or 1:76. The oversized rolling stock on the 16.5mm track is due to the fact that the early UK manufacturers couldn't obtain electric motors small enough to fit inside a true scale (3.5mm or HO) loco's body, so 'OO' was born at an over scale size running on near scale track. Again, all items for this scale are available as ready to run or can be scratch built or made up from kits

'EM' gauge, is the first challenge by British modellers at obtaining as near true 4mm scale running. While not an exact 4mm scale, it is still at 1:76 or 4mm/ft but the track gauge is widened out to 18.2mm. Many modellers in this scale will opt to replace the standard 'OO' wheel sets of production models with their own EM gauge wheels. Plus, of course, there are kit-built locos and rolling stock available.

'P4' and 'S4' gauges, are the second, mainly UK, modellers' attempt at the true 4mm scale, often called 'Fine Scale'. S4 stands for Scalefour, while P4 is Protofour. The track gauge is at 18.83mm and again it is to a 4mm/ft or 1:76 scale, although the purists of this gauge will say it is Actually at a 1:76.2 scale which is the true 4mm scale. Track is normally hand built; but some straight track is available ready-made but all point work is hand built as are mainly all of the locos and rolling stock, though some modellers will convert a good quality 'OO' loco body by grafting it onto a hand-built chassis.

'S' gauge the only truly imperial gauge left. Not often seen nowadays, as all items have to be hand built. It has a track gauge of 7/8 inch or 22.22mm and has a scale size of 3/16 inch to the foot or 1:64.

'O' gauge has its roots at the beginning of mass-produced model railways. It has a track gauge of 32mm and is 7mm/foot or 1:43 scale in the UK (1:48 in the USA). Much credit has to be given to the early manufacturers of this scale in the UK – Bassett-Lowke and Hornby who sold thousands of clockwork and electric tin plate train sets. There is a small supply of ready-to-run items available, but mainly modellers in this scale build their own stock from kits or scratch building. Track is both commercially available and sold as individual items to allow modellers to build their own track and point work. In this gauge live steam operation is a viable option running alongside electrically powered locos.

'1' gauge, is perhaps the grandfather of all the gauges, for it was the Edwardian modeller who first started

A scene from the author's 'OO' 4mm/ft layout – High Hopes.

this large scale model railway. It was very popular until the First World War when it began to lose much of its sales. Later, in the 1960s, it became a gauge to be resurrected. It has a track gauge of 45mm and is to a scale of 9.5mm/foot at 1:32 scale, or the slightly larger but equally compatible size of 10mm/foot, or 1:30. Here again – perhaps even more so – live steam is an option. Outdoors is where this gauge really scores; though of course most other gauges can be used outside too. Perhaps this is not a gauge to be taken up by the beginner, but it is certainly a gauge and scale to be seriously considered by those who like model engineering and who would like to produce a model without any compromises in scale or detail (see also 'G' scale in the narrow gauge list).

Then of course there are the much larger sizes of gauges, such as 2.5" (Gauge 3), 3.5", 5" and 7.5", often running live steam locos with their drivers sitting behind the actual loco on specially constructed wagons. There are many other gauges too, such as 7", 12.25" and 15" and so on. All these are outside of the scope of this book.

So, in the standard gauges there are plenty of choices. Your overall space, budget and perhaps even your eyesight and dexterity will play a factor in which gauge is your final choice. Most will opt to operate in 'N', TT:120, 'OO'/'HO' or 'O'.

Other factors, such as the representation of the location of the model – British or Continental, will also have a smaller, but still important, effect on your decision. As too will the actual location of the model; TT:120 or 'N' gauge outdoors I feel isn't viable, but indoors will offer far more track available per square metre than 'OO' or any of the larger scales.

Narrow gauge

Narrow gauge is defined as any track width below the Standard gauge (4ft 8 $^{1}/_{2}$ inches) and includes 3ft 6 inches and Metre gauge would be found, but for model railway use I'll keep to those narrow gauges that are more common at home.

'009' and 'HOe' have the same track as both use 9mm track with a scale of 4mm/ft and 1:76 for '009' or 3.5mm to the foot at 1/87 for HOe. UK outline stock is limited to mainly kit-built items while continental ranges are available as both ready to run or as kits.

'HOn3' has a track gauge of 10.5mm to a scale of 3.5mm/foot at 1:87. Mainly a USA sized system used to depict their 3 feet gauge railways. Some items available as ready to run but mostly in kit form.

'HOm' runs on track set at 12mm gauge and is to the HO scale of 3.5mm/foot or 1:87. It is very popular with Swiss modellers as it represents the metre gauge railways of that country in the popular 'HO' format size. Many items are available as ready to run.

'OOn3' is not often found, but is to a scale of 4mm/foot on a track gauge of 12mm, often used to model the Irish metre gauge railways. Normally items are only available as kits to self-build.

'O-16.5' is 16.5mm gauge ('OO'/'HO') at 7mm/foot or 1:42.5 scale. This scale uses 'OO' or 'HO' chassis with kit-built bodies. No ready-to-run models are known of.

'SM 32' has a 32mm track (O) gauge with a scale of 16mm/foot. Most models are kit-built but there is a good supply of this gauge in the UK with some RTR items available from specialist retailers.

'G' gauge has a track gauge of 45mm (1 gauge). It is commonly known as 1:22.5 scale although other manufacturers produce products that range from 1:20.3 to 1:32. Many will know this scale as being represented more popularly by LGB. Introduced by Lehmann under the brand name 'LGB' – Lehmann Gross Bahnor or the Lehmann Big Train, but more recently available from numerous suppliers including Marklin, following the bankruptcy of the Lehmann company. It is ideal for the garden and of course can be used indoors. More recently released models have ventured into the replicas of full-sized UK railway locos. G gauge is readily available from many UK retailers.

These are the most common gauges; there are several others, but these tend to be of minority interest and cannot realistically be covered by this book.

2
A HOME FOR THE RAILWAY

Where is the best place for your model railway? Anywhere really, so long as its dry and free of excessive dust or can be covered over if there is a danger of having dust spread over it. Never run a train set (sorry, model railway!) directly on a carpeted floor; all you will succeed in doing is introducing fluff and dust into the loco's gearing and electrical pickups, resulting in a failed loco shortly afterwards!

Build your layout on a firm baseboard and ideally try and keep the board at least a metre (39 inches) above the floor. Some will advocate even higher baseboard heights, but I've found anything over 1 metre high isn't practical for the younger viewer and even some of the older constructors will struggle to gain access to the rear parts of a layout once it exceeds that height.

Where to put your layout is entirely up to you: be it a loft, garage, shed, spare room, bedroom, basement or even the lounge, it matters not, so long as you build with the approval and consent of your partner or parent etc. I have seen small layouts in lounges – but never construct something that will look totally out of place or cause domestic disharmony (you have been warned!).

Pros and cons

Loft

The loft is ideal for being out of the way and can offer a large area for use. Extremes of temperature are a problem, but that can be helped by a window or extractor fan being used in the summer. If you can afford it, air conditioning or a climate control unit will ensure a constant temperature and humidity level, but these units are expensive both to purchase and to run. Lack of height to walk around, especially in some modern buildings can be a problem and don't forget the water storage tanks may take up a lot of space. Never, ever, cut or alter any trusses or other roof timbers unless you really like having your roof in your lounge!

An 'N' scale model railway under construction in a specially converted loft space. This is a portable layout and can be easily taken apart section by section, passed down through the loft hatch and assembled elsewhere, such as at exhibitions or a friend's home. Quite often loft layouts are more permanent and built around the walls or the framing of the loft area.

This garden shed has been fully insulated. The portable 'N' gauge layout is seen here still under construction. Note the use of 'helix' loops nearest the camera, which allow a train to ascend or descend from one level to another in a relatively small area and without the need of long ramp sections such as that seen on the extreme right.

Also consider the thickness (depth) of rafters or joists which will need to be sheeted over to allow a flat and safe walking area. This area must be able to support at least two adult persons' weight and be covered in by at least 18-20mm boarding or floorboards. Watch out for cables and pipes that run on top of, or close to the top of joists when securing the flooring – also allow suitable access points for future building repairs and maintenance etc. Don't forget you will probably need both lighting and power supplies installed, as often there is no mains power in a loft! If in doubt, consult a professional architect and electrician.

Garage

Much the same as for lofts, due to the extremes of temperature. Though probably not quite so hot in the summer! Dust and insects (spiders especially) can be a problem here. Sealing up the main access door will help with the dust problems, assuming there is alternative access and the main garage door is not required. Usually, you will find only one course of brick or block work between the inside and external of a garage – often there is no wall cavity – though this shouldn't interfere too much with the modelling processes! But be aware that there may only be approximately 4 1/2 inches of brickwork between you and your neighbour's garage internal wall if your garages are attached, so caution is needed when drilling holes for fixings etc. Electricity in garages is normally not a problem as often both power and lighting are provided; even if not, it is not often a serious issue to get power into a garage. A nice level concrete floor will normally be found, but treat with caution, as concrete floors are renowned for producing excessive dust and making your feet feel uncomfortable. Consider laying sheet vinyl or laminate. Some form of heating will be needed for winter use.

Shed

Similar to garages, but often located remotely from the main house. Normally of wooden construction they provide little or no thermal insulation at all, so consider installing a suitable insulation material and internal cladding to the walls, ceilings and even the floor. Almost certainly there won't be any electrical supplies to a shed. This will need to be installed and the cost of installing the supply, sockets and lighting will need to be included in the overall budget, which may then become excessive. Shed size is another governing factor: if you can only accommodate an 8' x 6' shed and you plan to work in 'OO' gauge or larger you may find space is rather tight! Sheds should really be built on a solid base – patio slabs or a concrete base are ideal as these will ensure that over time the shed won't slowly sink into the ground due to all the weight being placed upon the flooring and walls. Insect invasion will almost certainly be the norm, so always de-spider/de-ant and remove all the cobwebs before a running session.

Another garden shed that has been insulated and had all the walls, ceiling and floor lined, plus good overhead lighting and mains power sockets have been installed. *Image courtesy of Steve Mumford*

Through the model room door… A spare room makes a very comfortable model railway room. *Image courtesy of Barry Clayton*

Spare room

This is probably one of the best locations for human comfort! Electricity will already be installed and often central heating too. No major issues with insect invasion and often pre carpeted. I would recommend a carpet protector though; perhaps some sort of PVC sheet or a nice clean plastic tarpaulin covering the best Axminster will ensure there are no accidental spills suddenly appearing as marks or stains onto the carpet. NOTE: There is no known remedy for removing spilt super glue from carpet tufts! Care should be exercised if you're securing the baseboards to the room's walls. Check for buried cables and pipes in the walls before drilling – use a buried service locator device to scan the wall beforehand. Similarly to sheds, the allotted space may restrict your ideas. So, always plan your layout well before commencing any construction. It is far easier to alter a paper or PC drawing than change the timber baseboards installed into a room.

Lounge or other room

Your layout here will probably be restricted in size and often will only be an 'end to end' layout that can be incorporated in the room, with all the other furniture etc. The actual construction should be in harmony with the room; use a better quality of timber to face the viewable edges of the baseboard and perhaps even consider having a hinged 'L' shaped cover to fully enclose the layout when it is not in use if this can be incorporated. This cover would also keep any dust off the layout. Remember, this is usually the main living area, so be extra careful when using liquids such as glues, solvents and paints etc. on the model. Don't allow anything to be spilt and damage the surroundings. Repairs will be costly and domestic disharmony guaranteed!

Cellar or basement

These can be used and are often ideal for the model railway as they are not normally a fully habitable room. In the UK their use is probably restricted, as cellars are normally only found in older properties and one major drawback is damp because they are normally below ground or street level, so this can become a serious problem. Only use this area if the room is damp proof and of sound construction, then it is a good home for the model railway. If the cellar is damp you will need to employ a specialist damp proofing company to eradicate the damp ingress. This work may well be at a considerable expense! Electricity for lighting, heating and providing power for the layout can normally be easily installed from the rooms above; this work should be carried out only by a qualified electrician. Investing in some form of floor covering may be well worthwhile, as often cellar floors are of concrete construction and this material will create dust and become cold to the feet. Consider laying a suitable flooring materials such as vinyl or laminate. Dry lining the walls may be a further option to enhance the comfort of the cellar for the modeller.

Specially built hobby room

Unless you are a person who has unlimited funds, a hobby room specially dedicated to the model railway can often only be little else than a pipe dream. Such rooms are often a brick-built extension to the main house. They will be built with ample electric lighting, power, heating and cooling for all year-round use. The use of 'daylight' lighting enhances the model and perhaps can even be dimmed to low levels to allow layout 'night-time' running with all the buildings on the model internally illuminated.

Out of doors

Offers the modeller a completely new dimension. The vast area available and dealing with vegetation that is on a 1:1 scale can be quite daunting. Virtually all scales from 'OO'/'HO' up will run outdoors, but some very special track bed precautions are required, and this is really a topic for a book in its own right and cannot be covered here. Remember, too, mains-voltage electricity out of doors is extremely dangerous. So always keep the mains voltages safely indoors in the dry!

3

A SOLID BASE

Having found a suitable home for the layout we now need to build a base for the track and scenery to be supported on, this is called the 'baseboard'.

There are several methods of constructing a baseboard and most do not require you to have a degree in carpentry. However, if you cannot be bothered with the effort of full baseboard construction or you just don't have the facilities to cut timber etc. you can obtain one or more baseboard sections in kit form, available from several commercial suppliers.

A quick thumb through any of the monthly railway modelling magazine advertisements will provide a shortlist of the suppliers. These kits are supplied either as a set size per baseboard or made to your own size specification. They are normally delivered to you in a flat pack kit and all that's needed is a screwdriver, hammer and some woodworking PVA glue to assemble.

Solid-topped baseboards

For many years these gave typically been constructed from 2 x 1" (44 x 21mm) Planed Square Edged (PSE) timber, the timber being placed on its narrow edge up to the baseboard underside and all being set out on an approximately one foot (300mm) to around 15 inch (400mm) square grid pattern. Larger sizes of timber can be used, but this can add extra weight – see below. I would not recommend using any timber smaller than 44 x 21mm as warping or twisting on the longer run can result.

Construction is no more complex than cutting each piece of timber to the required size with the aid of a mitre block and hand saw or a mitre frame hand saw or perhaps an electric compound saw, often called a 'chop saw'. The two most important things are that the timber is cut exactly to the correct length and the ends are cut perfectly square; here the use of the mitre block, mitre hand saw or compound saw is invaluable.

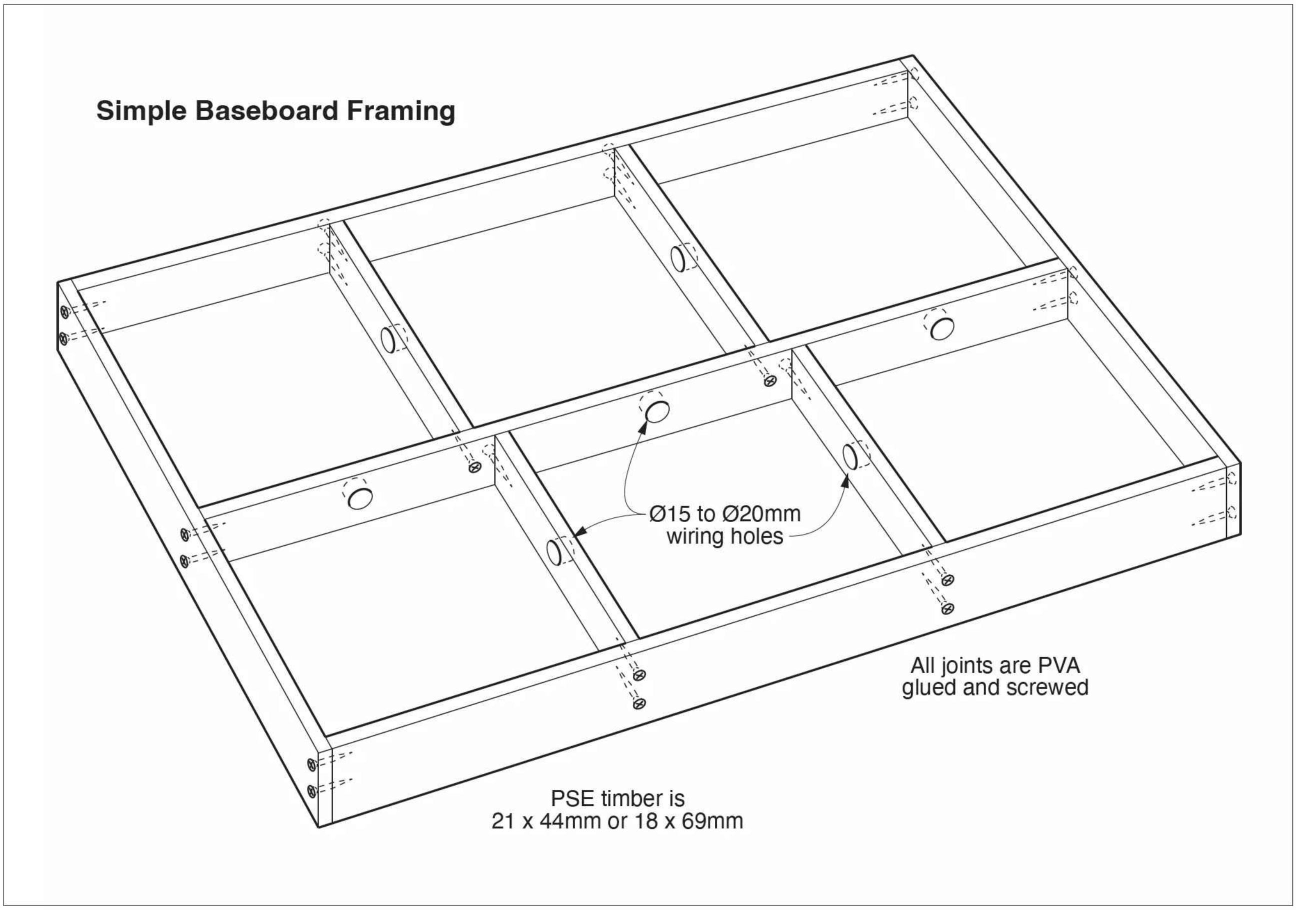
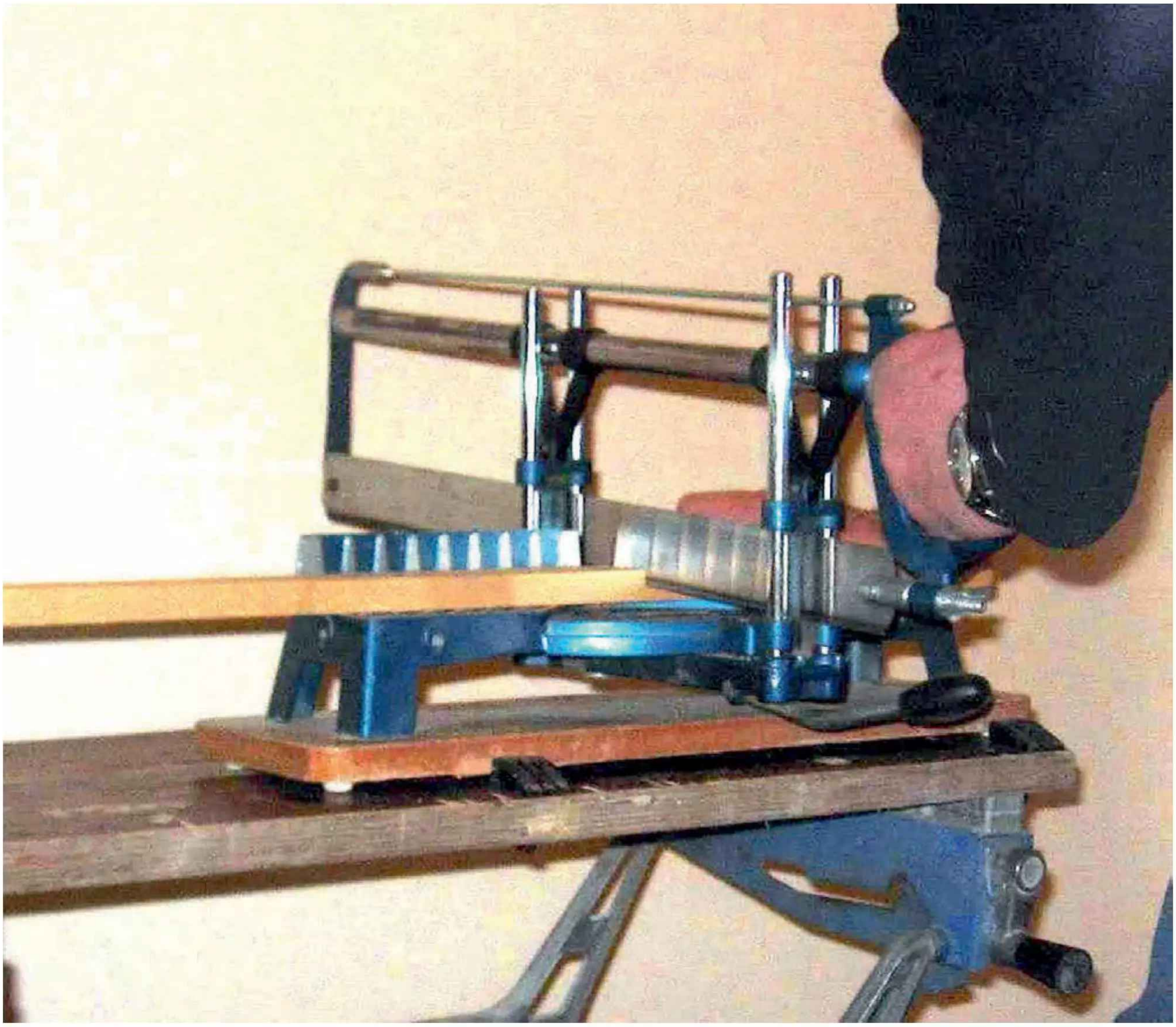


Figure 1: Simple baseboard framing. The whole top is subsequently sheeted over and all the track and scenery built onto this flat surface.



A mitre frame hand saw being used to cut square a piece of PSE timber for a baseboard.

Measure exactly and cut the four outer framing timbers first. These are then fixed together with woodworking PVA glue and fastened with wood screws to make the appropriate rectangle or square shape. To prevent end grain splitting, possibly the best method is to use a suitably sized pilot drill to make a hole right through the outer timber and into the abutting timber's end grain before the woodscrew is inserted. After the four outer frames pieces are assembled, the top surface sheet is fitted, either glued and pinned, or glued and screwed if the top is solid enough to prevent the screws from pulling through.

Now measure and cut all the internal bracing timbers, then drill a hole of 15-20mm diameter into the centre of the broader side of each before fitting them; the top of the hole should be approximately 5-10mm down from the top of the timber. These holes will later allow all the layout's wiring to pass between each bay of the baseboard. The reason for pre-drilling before fitting is that it is much harder to drill them once the timbers are fixed in place!

Now fit, by gluing and screwing, the longer cross bearer(s), then fit all the shorter right angle timber bearers; these will need to be slightly staggered to allow the woodscrews to be inserted from the central longer bearers – see Figure 1.

Don't forget to run PVA glue along the top edges of all cross bearers before fitting them as this will help bond the baseboard top to the bearers. You should also pin from the top of the baseboard down into the cross bearers to make the final construction as strong and rigid as possible.

There is no reason other than cost and weight why deeper timber than the 44mm depth can't be used. In fact, the deeper the timber is, the more its thickness can be marginally reduced!

A cutaway section of a solid baseboard top reveals the basic timber structure below. Note the simple square cut butt joints of the framing. All joints have been screwed and glued with PVA woodworking adhesive and the top has also been PVA glued and pinned in place. Note the 16mm diameter hole drilled centrally in all the internal cross bracing to allow for later wiring runs.

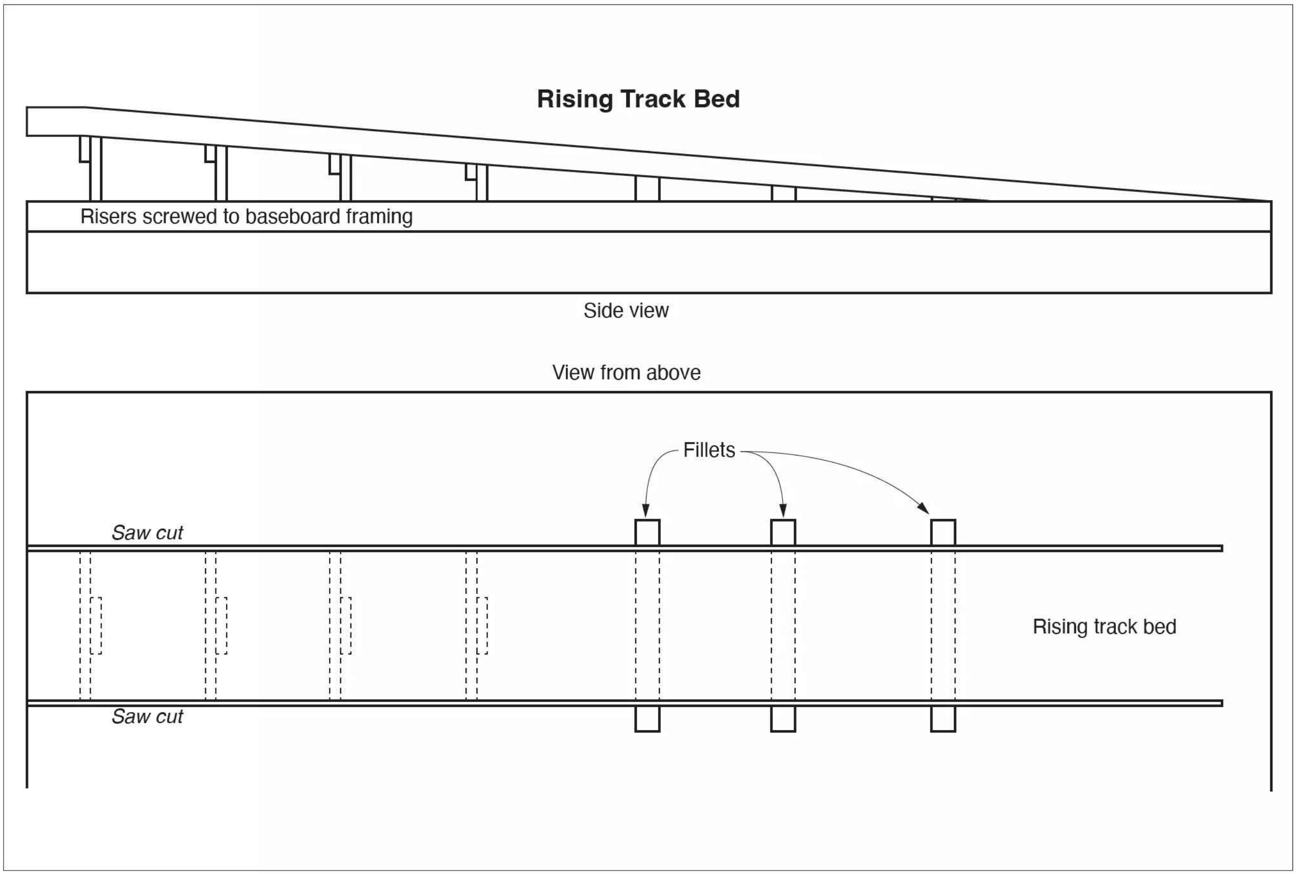


Figure 2: Constructing a rising trackbed.

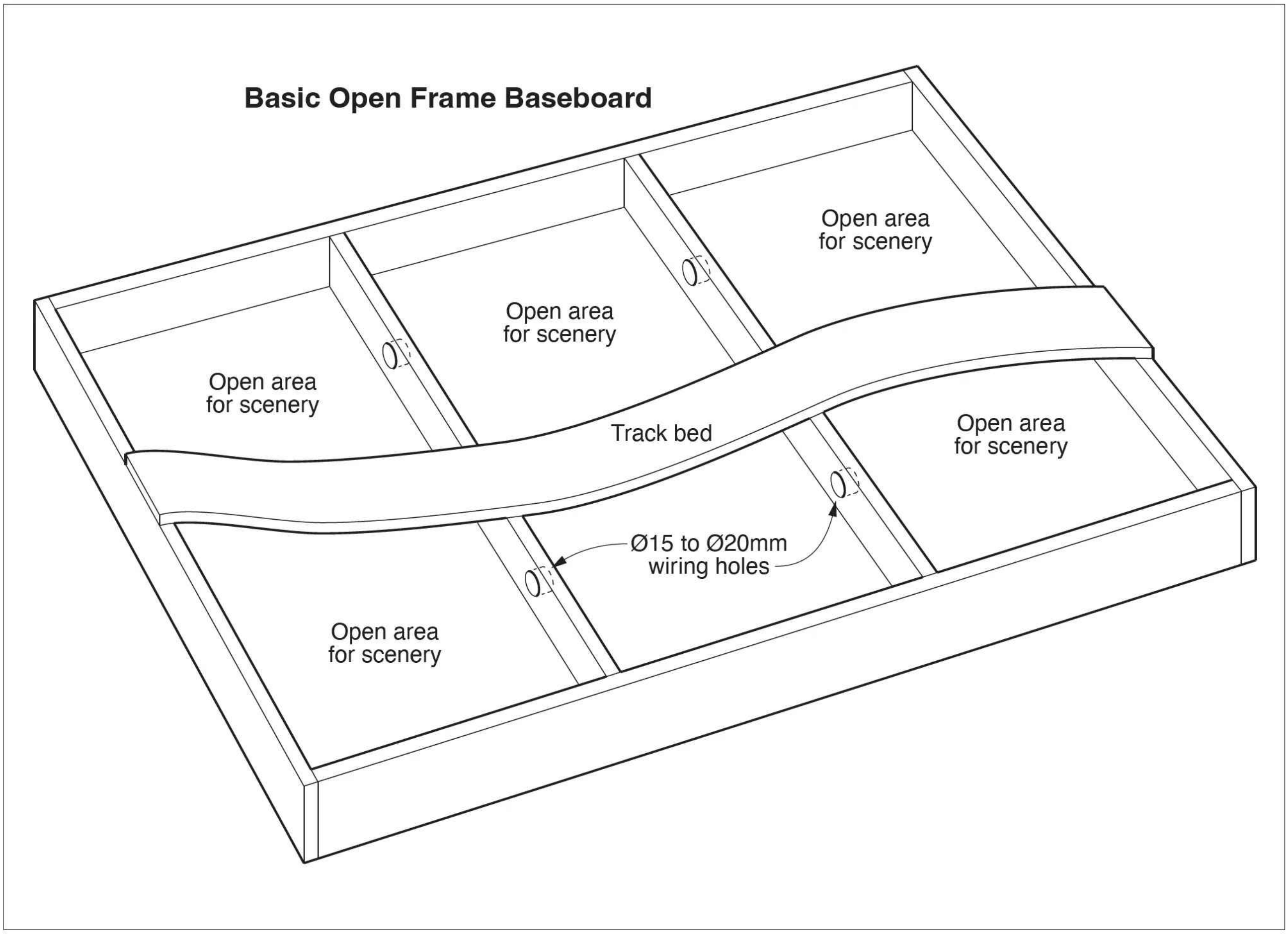


Figure 3: A basic open-frame baseboard.

Ideally, when using any timber for framing always allow the timber lengths to lay flat and unwrapped for around 48 hours in the room where the layout is to be constructed. This will 'condition' the timber and allow it to expand or contract with the room temperature and humidity. While it may not be actually possible to lay out the timbers in the final layout's location (as with portable layouts), the timber should still be 'conditioned' indoors for at least 48 hours before use.

Where inclines or underpasses are to be modelled, the baseboard surface is cut along the required length and width of the track bed and the surface is slowly raised or lowered from the datum of the flat board. Initially, on rising track, a thin fillet of wood is let in under the section to be raised with its outer edges resting on the flat baseboard surface. Spaced over a set distance, thicker fillets are added until a smooth transition from flat to gradient is produced. Once the track base is rising correctly, T-shaped risers are used to support the elevated sections in much the same way as 'L' girder baseboards work. A gradient of about 1 in 40 seems to be about the sharpest gradient up which 'OO'/'HO' locos can comfortably pull a reasonable length of coaches or wagons without too much loss of power or slipping.

A simpler method of making a rising or falling gradient, particularly where solid sheeted baseboard tops are used, are the gradient supports produced by several manufacturers. For example, in 'OO' Hornby produces an inclined and high level Pier system while Noch manufactures a continuous incline and Woodland Scenes produces a flexible foam incline in various incline gradients to suit 'N' and 'OO'/'HO' gauges.

Open-top baseboards

These can be assembled by using a similar method of frame construction, this style of baseboard allows a more natural looking scene to be depicted as the scenery can rise or fall above or below the track bed. A very simple idea is shown in Figure 3. By cutting a notch into the cross-bracing timbers a river or road can then pass under the track bed. The depth of the notch is determined by the framing timber's overall depth. These notches should never be more than 50% of the timber's actual depth to avoid causing the timber frame to become excessively weakened.

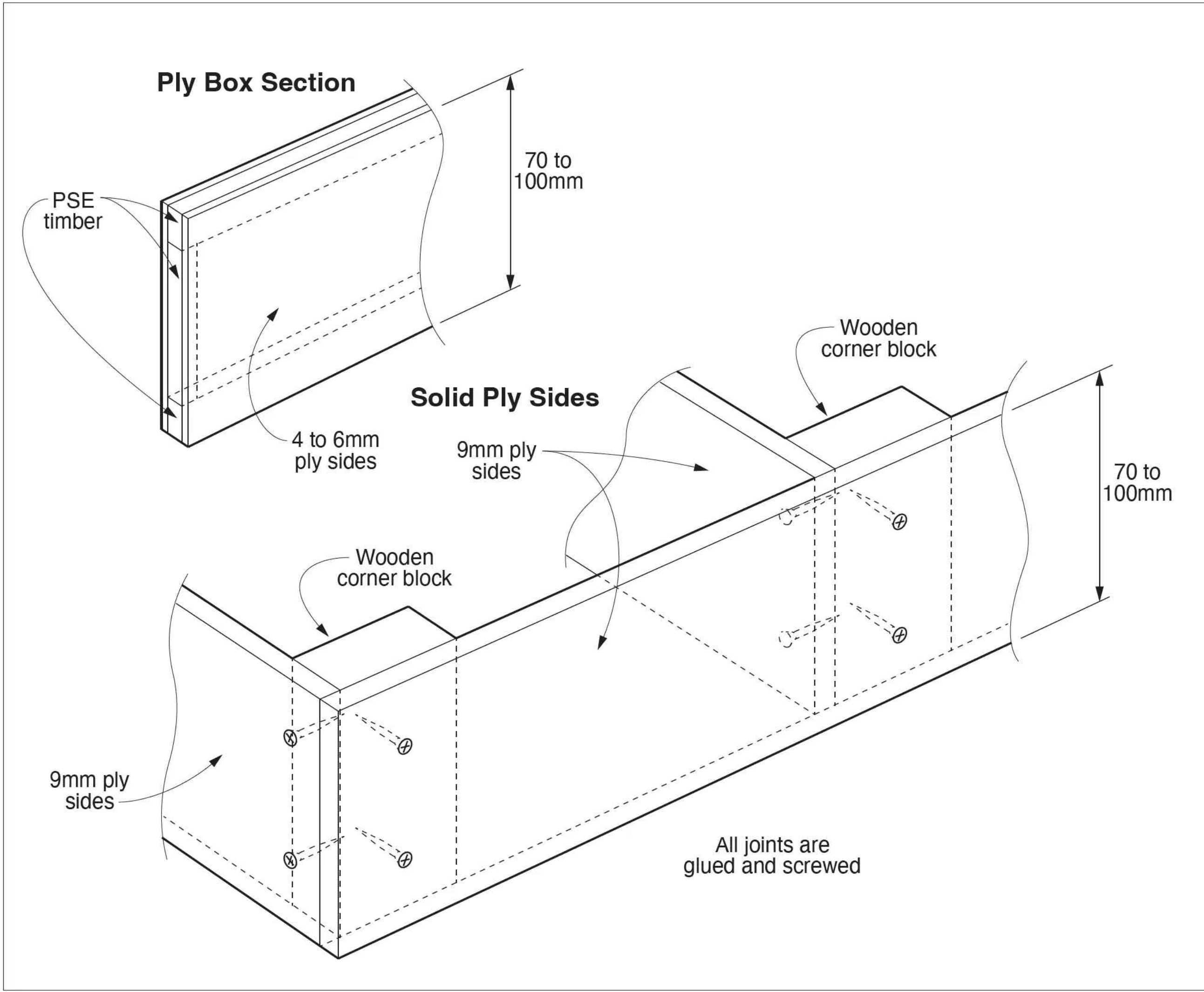


Figure 4: Plywood box construction.

Plywood box construction

This gives rigidity and lightness to the baseboard and is ideal for the portable layout. Typically 4-6mm ply is made up into a two-sided panel and an infill is made from PSE timber of between 9mm and 12mm thick, making an overall thickness of between 17 to 24mm per side panel. The depth is best kept to around 70-100mm to avoid any possibility of longitudinal sagging. Internal bracing timbers running top to bottom and giving additional support are added during construction and especially where any T-joints with other cross members occur (see Figure 4). Also, these supports will aid the insertion of woodscrews to allow 'pull up' of the joint.

Plywood on its own can be substituted for the PSE timber of the earlier all wooden frames and can produce a very strong yet reasonably light frame. The very minimum thickness to use is 9mm WBP ply and keep the sections depth to not less than 70mm to prevent longitudinal sagging. At all external corners and any internal T-joints there is a need to fit a short piece of timber block or fillet to allow the ply to be firmly fixed at right angles. These blocks are PVA glued to both faces of the ply and the joint then secured by suitable woodscrews driven through the ply into the blocks.

L-girder construction

This is another method of open-top baseboard construction, which is only suitable for permanent layouts. It is formed from either one solid length of 3 x 2" (69 x 44mm) timber or from perhaps, and easier to obtain, 3 x ¾" (69 x 18mm) PSE and 2 x ½" (44 x 12mm) PSE timbers screwed and PVA glued together to make an 'L' shape. If you're lucky and can readily access cheap 3 x 2" timber, this then has a rectangular section cut out which is some 1 x 2" (25 x 50mm). The resultant timber piece left will be 'L' shaped. This cutting will require some serious woodworking machinery to undertake the process. i.e. a bench mounted circular saw.

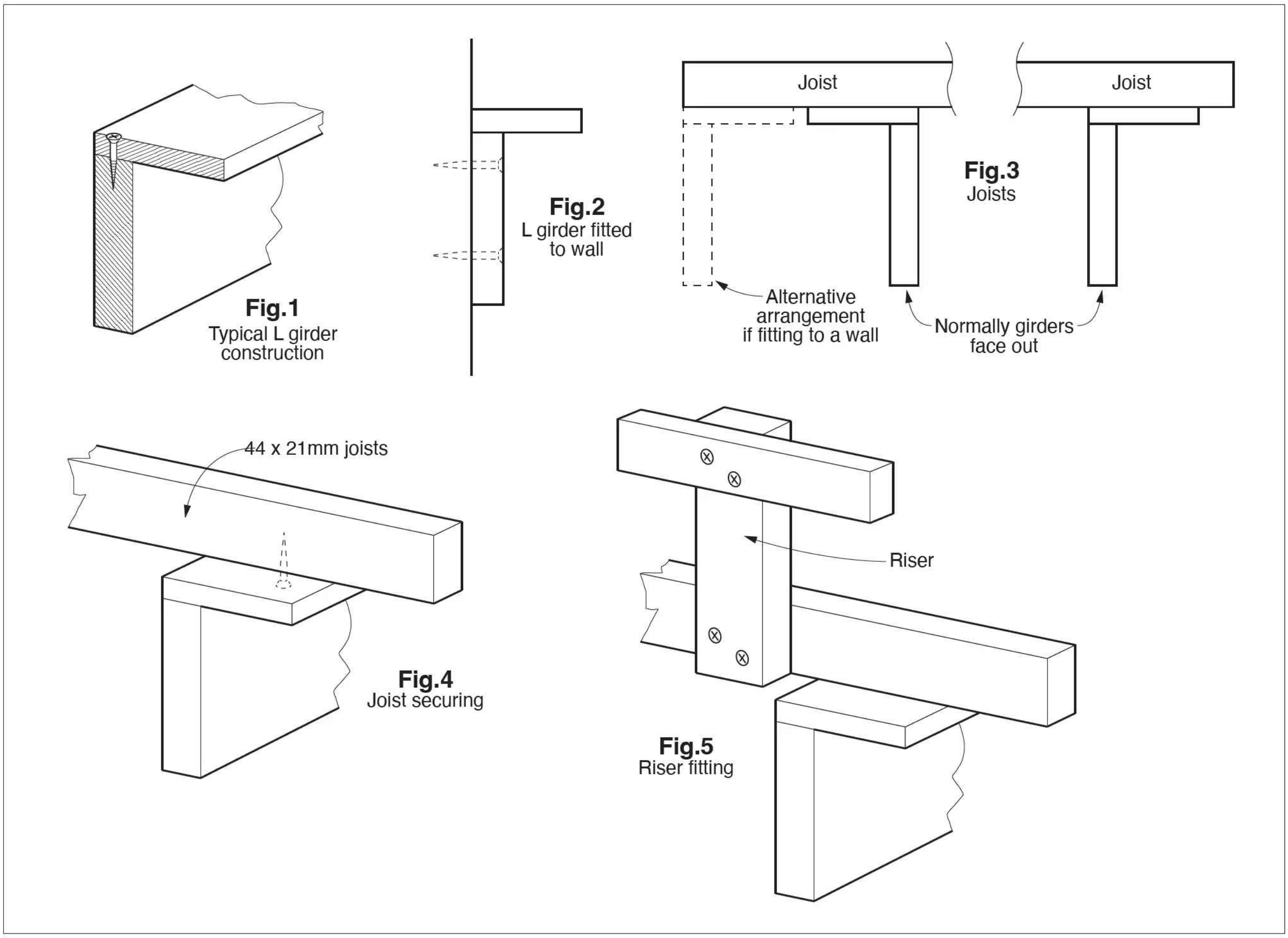


Figure 5: The basics of L-girder construction.

The basic L-girder shape of the timber. The timber shown is all PSE with the upright section being 69 x 18mm while the top section is 44 x 12mm woodworking PVA glued and screwed to the upright.

A much easier method is to screw and glue two lengths of timber together to form the basic 'L' shape. This shape is extremely strong in the downward direction and is very resistant to bowing sideways too. It may seem strange that where screwed and glued timber is being used to make the 'L' the top rail isn't the same thickness as the horizontal rail. This is because I have discovered that ½ x 2" (12 x 44mm) is adequate and when the glue has dried the resulting L-girder is extremely strong; why use a thicker and more expensive timber?

L-beams can then be held up by suitable legs spaced at approximately 6ft intervals and adjacent to each other and braced across the lower end at approximately 300mm above floor level to prevent any spreading of the legs occurring. Alternatively, one 'L' section is screwed to the wall and the other outer 'L' supported on legs as above. Two parallel L-girders are the foundation of each span

Once the two L-girders are in place they are held parallel to each other with cross joists which can often extend out beyond the L-girders. These are made from 2 x 1" (44 x 21mm) timbers screwed in place at 12" (300mm) intervals. It must be remembered that the joists are fixed without any glue – just screwed up from underneath through the top 'L' baton.

The track bed board on open topped layouts is either screwed directly to the joists' top for level or flat running or supported above the joints on risers and cross 'track bed supports'. The risers are made from more 44 x 21mm PSE and the track bed support is from the same timber set at 90 degrees to the upright risers. These are PVA woodworking glued and screwed together to make the 'T' shape. The riser is then loosely G-clamped to the joist at the correct location and its height adjusted. When all is correct the G-clamp is tightened and two woodscrews driven through the riser into the joist. The risers aren't glued to the joists. When all is secure, the G-clamp is removed.

MDF (Medium Density Fibreboard)

I have experimented with this board and used the 9mm thick variety, cut to approximately 100mm depth as an overall framing instead of the more usual 44 x 21mm timber (much like the ply sides previously discussed). It proved to be more than suitable and isn't so heavy to lift as a conventionally framed baseboard. However, I did pre-drill a series of 1½" (35mm) holes into the internal sections with the aid of a hole saw in an electric drill, which reduced its overall weight, also these holes allow ease of wiring too. In addition, I coated every section of the MDF, once the framing was made up, with a quick drying varnish to protect the frames from any ingress of moisture. Also I braced every corner and T joint with some PSE timber fillets (21 x 44mm) cut to fit inside each right-angled joint to give really firm bracing at corners, again as per the ply construction.

OSB (Oriented Strand Board)

I have used this in a 11mm thickness on my latest layout. It is proving to be a very stable baseboard surface. It has been mounting onto 69 x 18mm side rails and cross braced with smaller 21 x 44mm PSE timber batons.

Portable baseboards

These will need to be made according to three major criteria. One is that the completed board is transportable. Secondly, that it can be manhandled with some ease; third, that it needs to be protected during storage and transportation to ensure all the delicate track and scenery will remain intact.

Where size is concerned, I would recommend a maximum size per board to be no greater than 4 x 2ft (1200 x 600mm); much over this size and it becomes a

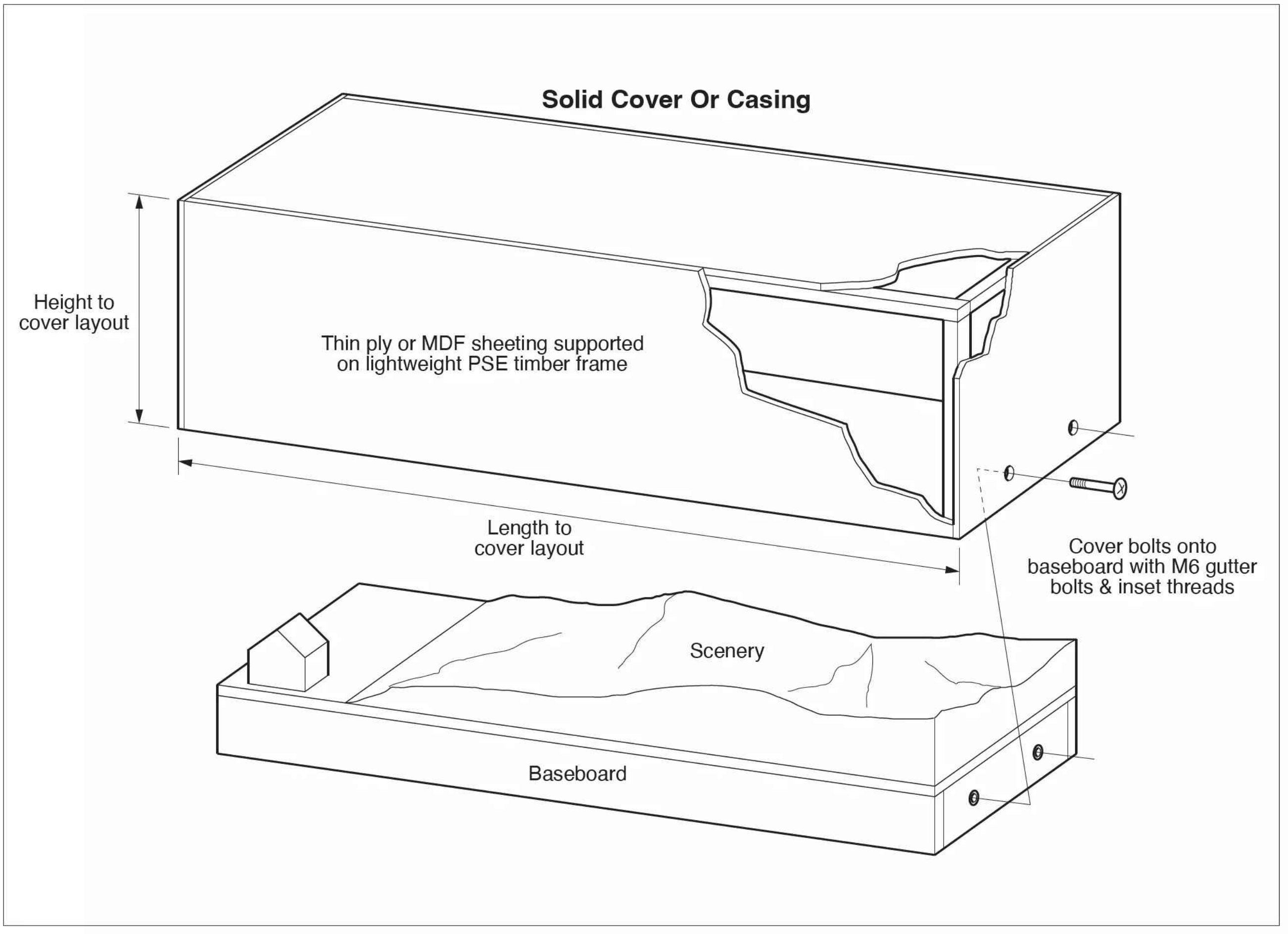


Figure 6: Casing as a protection for a portable layout.

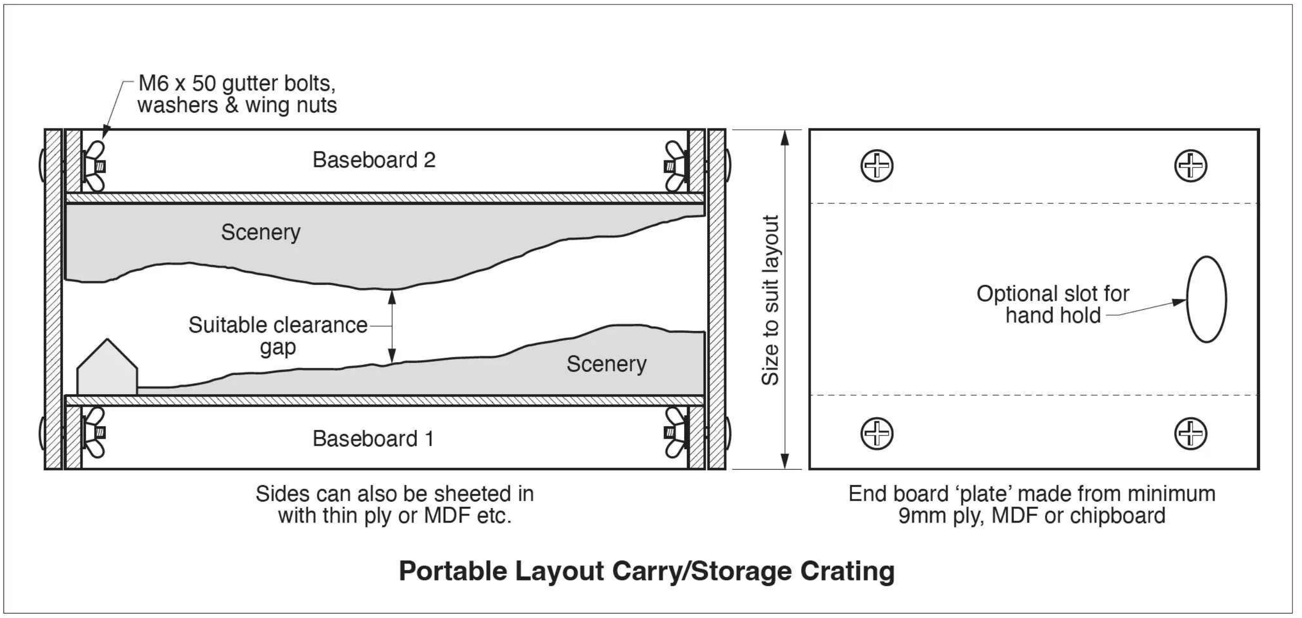


Figure 7: Crating two identically sized baseboards

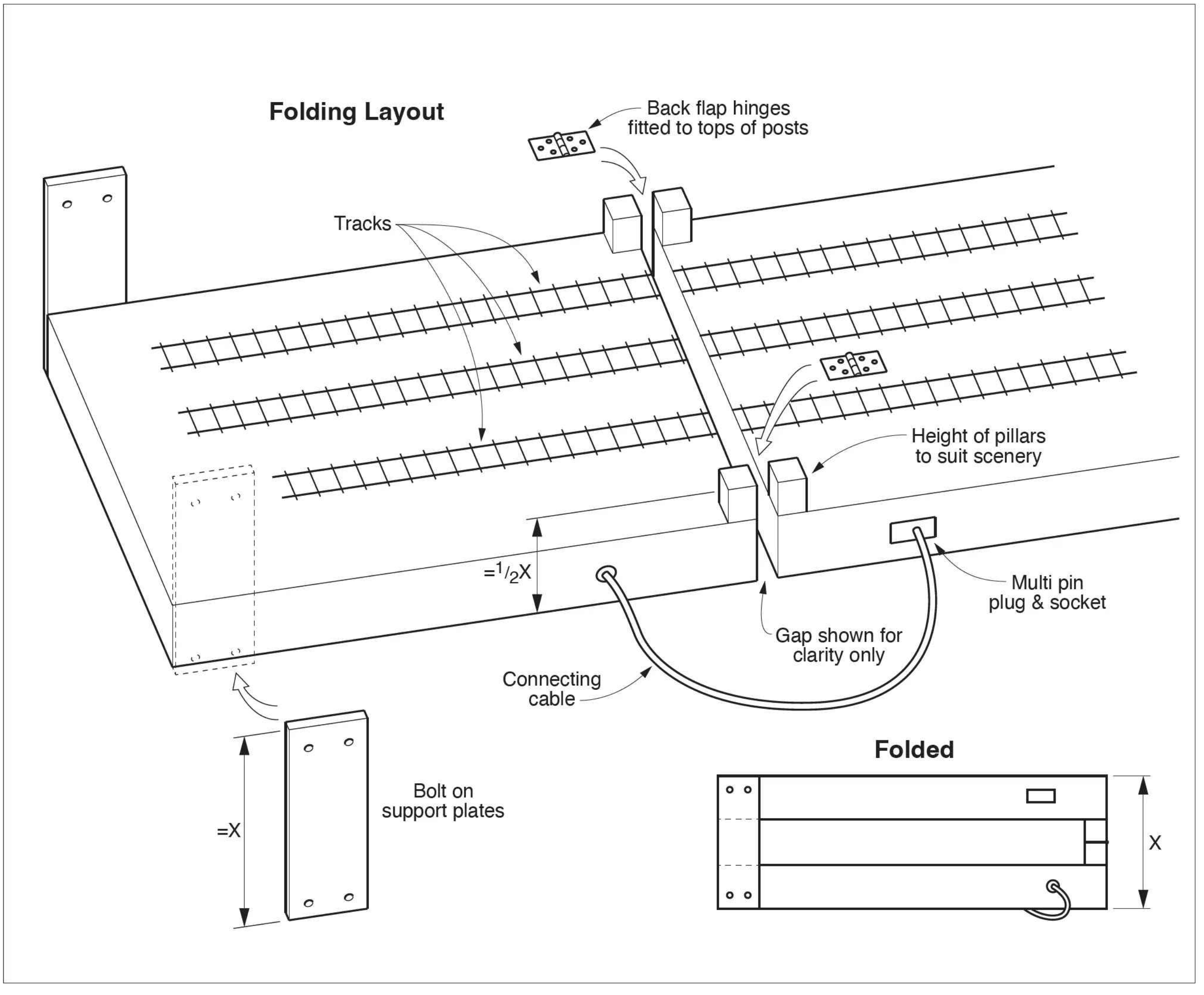


Figure 8: Two baseboards hinged together, the height of the hinge pillars keeping them separated.

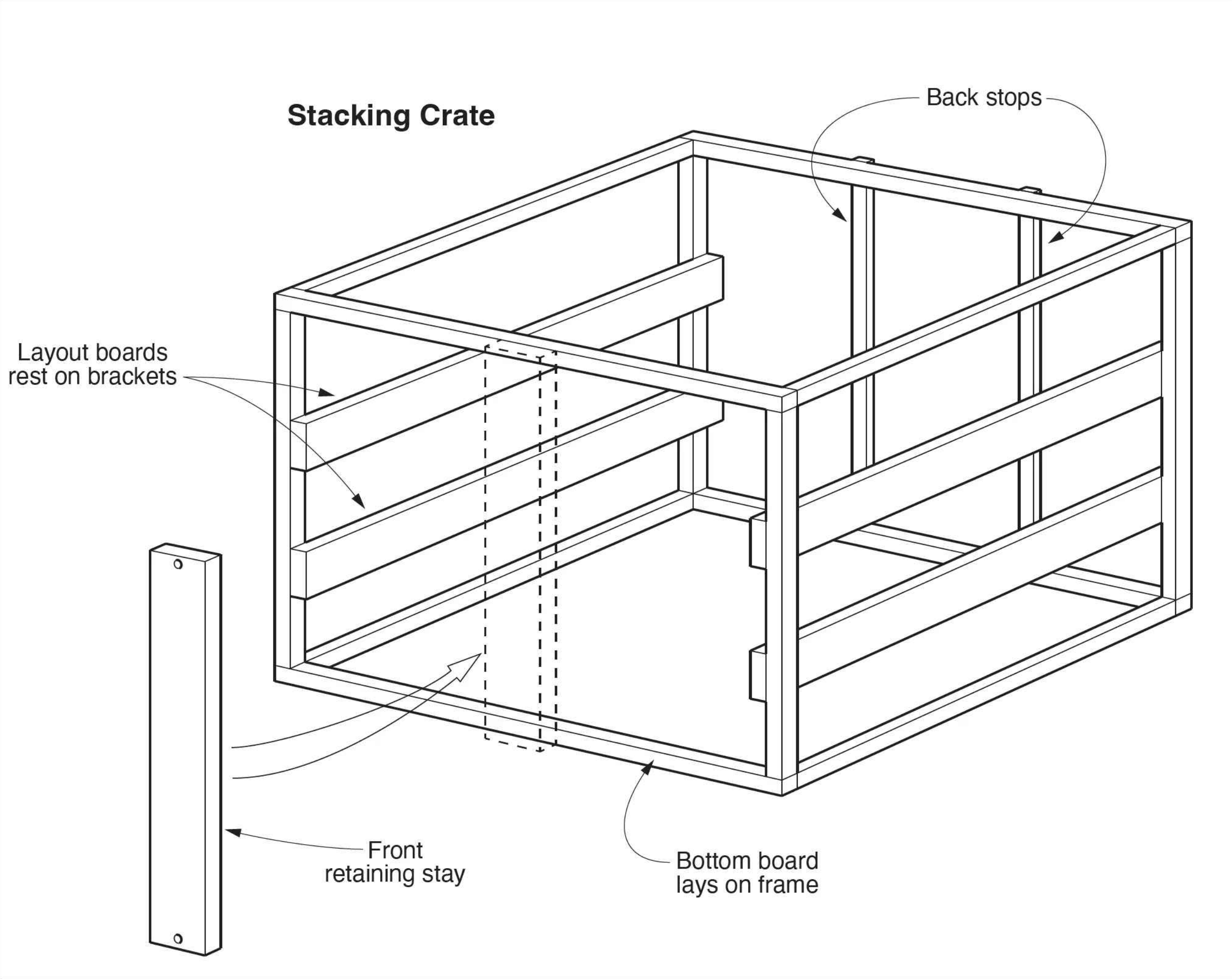


Figure 9: A stacking crate.

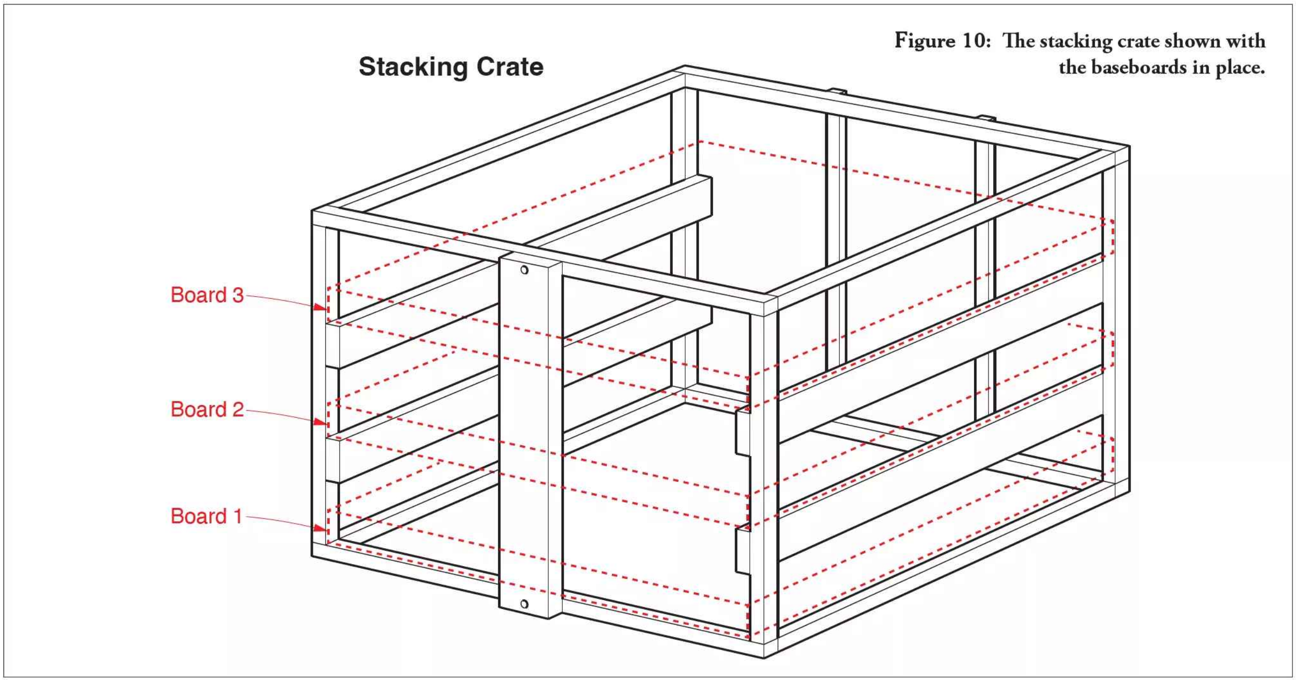


Figure 10: The stacking crate shown with the baseboards in place.

two-person lift and getting anything larger up or down stairs and through doorways becomes that much more difficult, if not near impossible at times!

Protecting the layout is, of course, vital and consideration can be given to one of three methods: casing, crating or stacking.

Casing is nothing more than taking each board and building a simple light fabrication of perhaps 3mm ply or MDF with some lightweight timber internal bracing to form a total box which fits over the whole board and offers that baseboard total cover. (See Figure 6.)

Crating consists of two identically sized baseboards held scenic side to scenic side by two end plates and where necessary a light sheeting of ply is added to both long sides to form a totally enclosed box. The other option is to make two identically sized boards, hinged and fold up onto each other. The height of the hinge pillars is determined by the two boards' scenery height plus a small amount for clearance. (See Figures 7 and 8.)

Stacking is where two or three baseboards are slid into a simple frame, made in most cases of timber. Once fully in place, either a locking baton is bolted across the full height of the stack or alternatively each board is bolted to the framework to prevent them from sliding out of the frame. (See Figures 9 and 10.)

Baseboard surfaces

Plywood

A good material to work with. Ply is ideally suited to both 'flat topped' (fully sheeted) and 'open top' construction and allows reasonably sized boards to be built without being overheavy. 9mm is the ideal thickness as this will curve gently up or down from the horizontal where any transition ramps are required to commence. 6mm ply can be used, but the main disadvantages of this thickness are noise as it starts to become a skin like a drum and it is rather thin to accept any woodscrews needed to fix point motors etc. in place. However, 6mm ply is ideal for any untracked areas where lightness of the layout for handling is required e.g. town scenes or flat country areas to be made into farmland etc.

Sundeala

It is extremely easy to push track pins into this and it holds them in place quite well afterwards. Its sound deadening qualities are good, and it too can be gently flexed up or down to allow transition slops. Often this is available via good model shops in pre-cut sheet size of 2 x 4' (600 x 1200mm) by 3/8" (9mm) thickness – which is convenient for carrying home. It is main disadvantages, if there are any, are that it is quite difficult to cut, and almost impossible to sand an edge smooth. It doesn't hold woodscrews particularly well and is a little too soft to prevent any woodscrews pulling through its surface when screwed into the framing. It is far easier to PVA glue and pin Sundeala in place onto the frame. It must also be well supported on a grid of timber which is ideally not more than a 12" (300mm) square grid or sagging of the board may occur.

MDF

This material needs very careful cutting as the dust is harmful, it also suffers from possible moisture ingress unless it is sealed completely and it is really hard to drive pins into. It cuts easily with a normal panel saw, electric jig or circular saw and can be sanded smooth too (both with suitable safety precaution observed). It will probably slightly increase any sound from the trains running, but this is often only marginal.

Chipboard

Half-inch (12mm) is quite good for model railway baseboard tops. It is cheap to buy and is readily available in pre-cut sizes. It accepts woodscrews and is quite a hard surface too. Cutting and sanding offer no serious problems (safety precaution observed). The main disadvantage is the considerable weight that it adds to the construction, but this only applies to layouts that have to be moved frequently or are designed to be fully portable.

OSB

9mm or 11mm thickness works very well for a baseboard but can be heavy if the whole surface is sheeted over. Where portable layouts are to use OSB I would consider using the thinner 9mm variety to reduce weight.

Soft Board

This is sometimes referred to as Insulation or pin board, and I would not recommend this material as this fails to hold track pins securely. It is far too soft and will often warp or sag even when supported at 300mm centres!

In short, I would recommend that the builder goes for a top made from plywood or consider using OSB.

Some modellers have used flush panel doors and I have read reports of others using 50mm thick expanded foam sheet or polystyrene sheet as baseboard tops. While these may work for some, I have serious doubts. Doors are an extremely awkward size and the physical effort to pick them up and move them is something I personally wouldn't want to face, especially if scenery has been added! They are heavy and cumbersome. I have never seen foam board or thick sheets of polystyrene used, but their ability to sag over time is a concern. Also bear in mind that any solvent spilt onto a polystyrene sheet will result in a large hole appearing before your eyes! So beware if you're going to use this material and keep all solvents well off the layout – liquid poly cement and some rail cleaning fluids will be the major contenders!

Supports or legs

Here the main issue will be if the layout is to be portable or permanently fixed in place. The height also needs to be considered. This will depend upon your personal preference, but mainly a minimum of 39 inches (one metre) to baseboard top is recommended. Lower or higher levels are all equally acceptable and where a layout is deemed for the exhibition circuit then the height of the viewing public should be considered too. It is not much good having a children's 'Thomas' layout set at 39 inches above floor level as the viewers are going to be mainly young children who won't be able to see the model at that height!

Portable layouts

Portable layouts can have support legs which are self-contained on each individual board and can be made to fold up within the confines of the board or they can be a separate self-supporting structure, such as trestles.

Trestles can be simply home made from 21 x 44mm PSE and a pair of Butt hinges and some means of preventing them from doing the splits on you! This can be a small diameter rope or small linked chain spanning across the two supporting legs. Both of these offer some form of adjustment to the overall layout height which is set by opening or closing together the leg pairs, this can be especially useful when using the trestles at exhibitions, where the floors aren't always level.

Ready-made trestles are available and are often of good solid quality. The only drawback with these is their height, which is restricted to that set by the manufacturer and may subsequently be too low for a model railway.

'Up and under' legs are the second option for portable layouts. Again, these can be made from 21 x 44mm PSE and hinged onto another piece of 21 x 44mm timber fixed to the underside of the baseboard at the required position when folded up. To enable the hinging and folding up movement, use 1¼" (30mm) back flap hinges to pivot the legs up under the baseboards. There are cross braces fitted between the two uprights some 12" (300mm) above floor level, as in the trestle construction. Then an angled brace is locked onto the open legs, this locks onto the leg's cross brace and also onto one of the baseboards framing timbers underneath. By using back flap hinges, this time with their pivot pins removed, a suitable replacement pin (nail or split pin) is used in their place (see Figure 12). Once the brace is located in place and the pivot pins inserted, the legs become very rigid. These angled braces are roughly at 45 degrees from the leg brace to

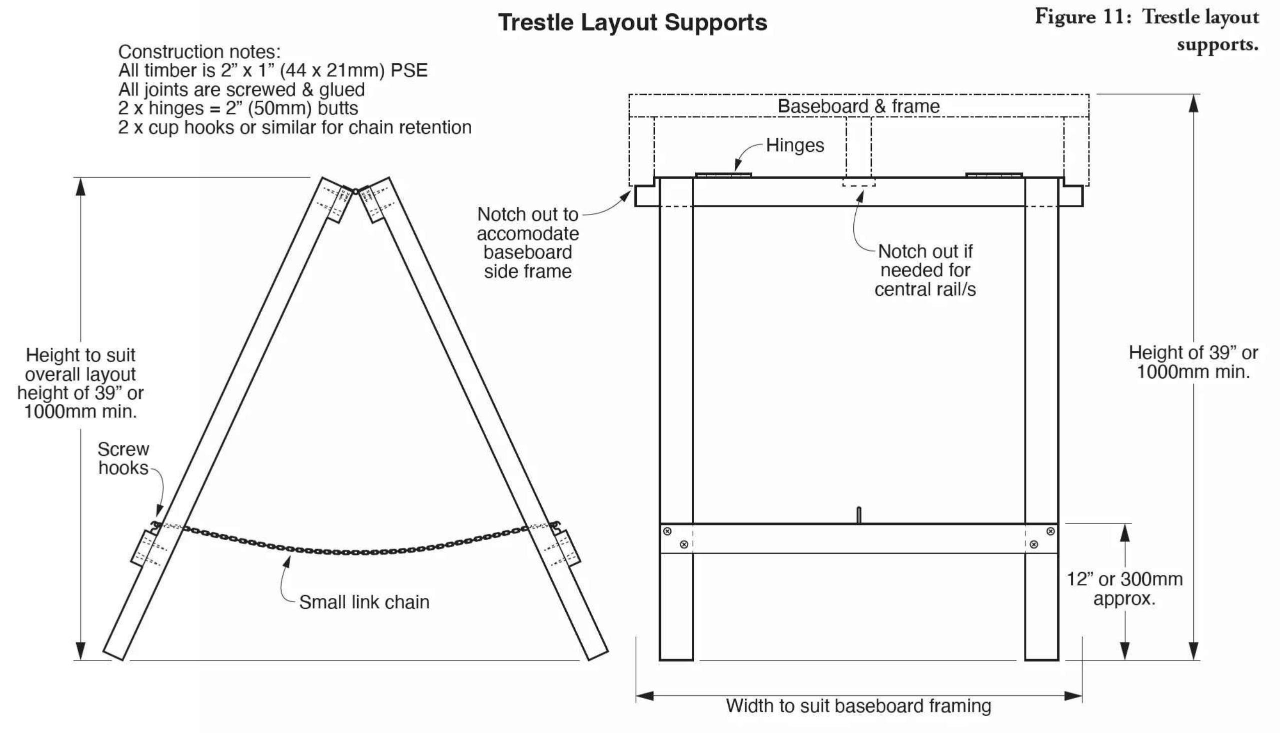


Figure 11: Trestle layout supports.

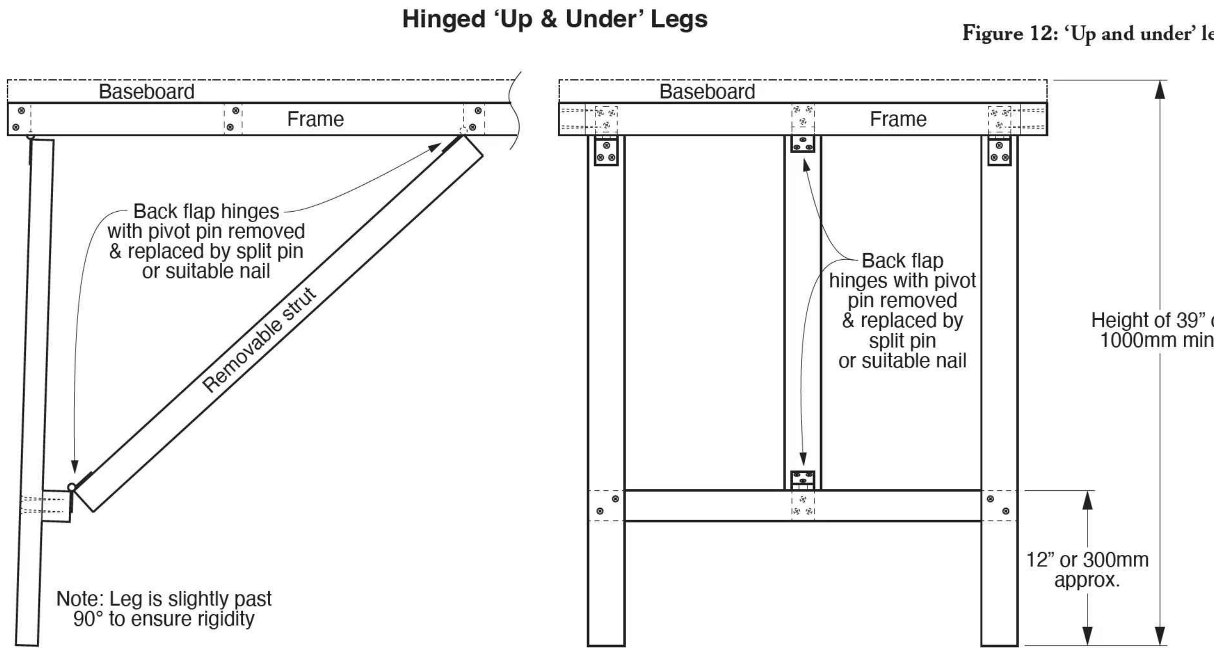


Figure 12: 'Up and under' legs.

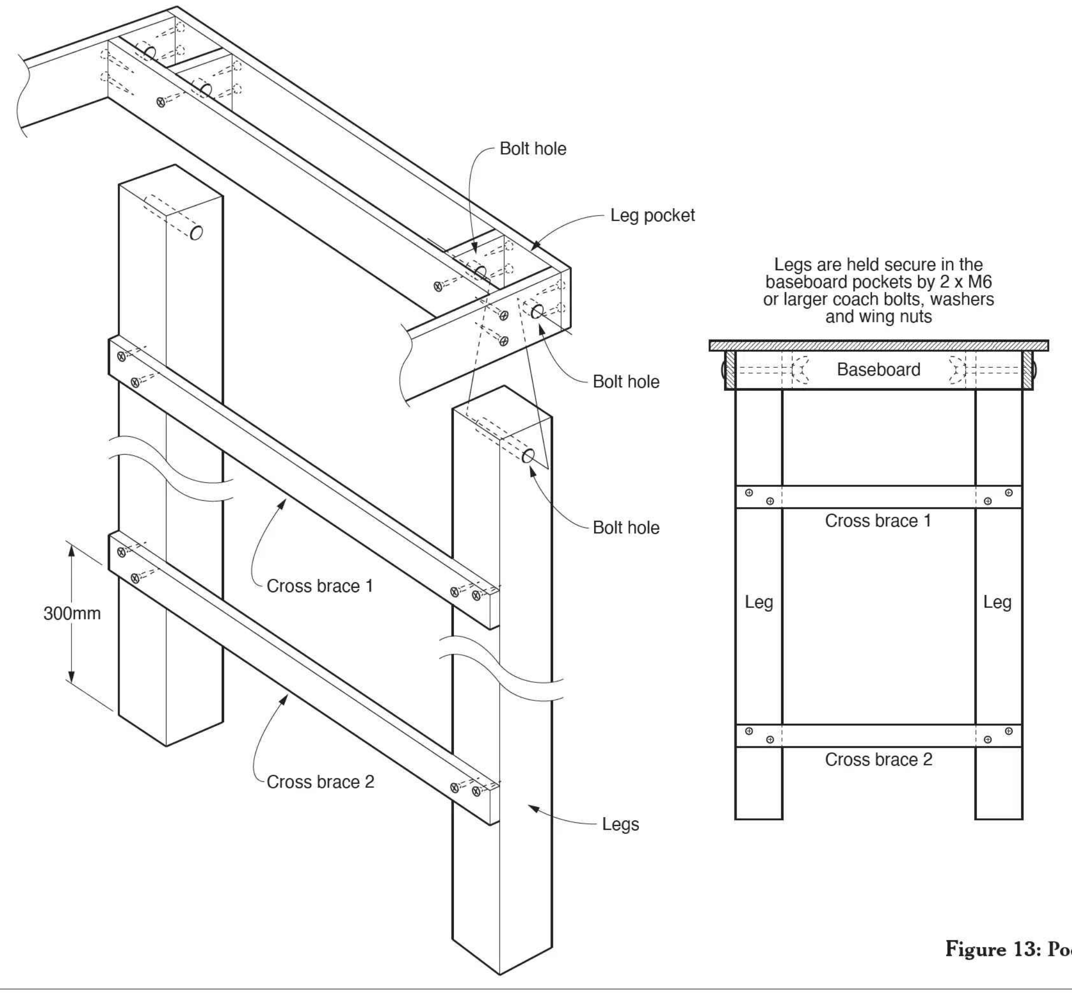


Figure 13: Pocketed legs.

Trestle layout support.

the underside of the baseboard. This construction can be clearly seen in the drawing. Note the leg actually is just over the 90-degree position when locked down to aid stability.

Pocketed legs are often made from 44 x 44mm (2 x 2") PSE timber or other suitable sized timber and are located into the underside of the baseboard into pre made compartments or 'pockets' in the corners of the outer framing. They are then held in place with the aid of a through coach bolt, washer and wing nut on the inside. Often these legs are in rigid or bolt together pairs, held together securely by two smaller sized timber cross braces (see Figure 13).

Permanent layouts

Permanent layouts will require a stronger and more solid form of support leg and here the use of fixed legs is the norm. Timber sold and produced mainly for stud wall construction is an ideal medium for permanent layout legs. It is sold as 63 x 38mm CSL timber. This is pre sanded and has all four corners semi rounded. It can be simply cut square to the required length and fixed to the layout's framing with woodscrews and some woodworking PVA glue. Additional lower level

A back flap hinge as supplied and then with the pivot pins removed.

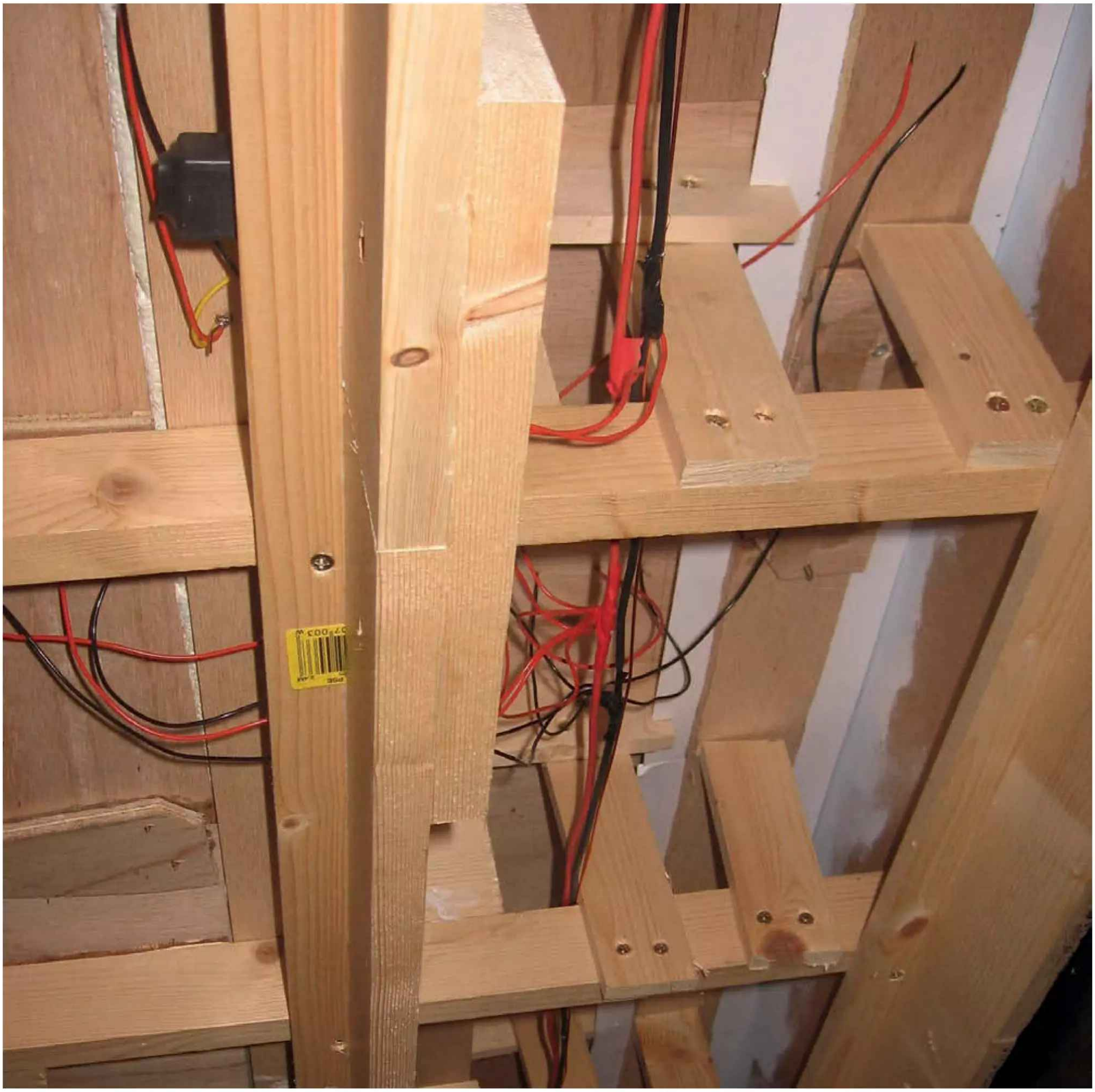
A baseboard with its support legs folded up and the central bracing stay laying in place. Note this particular board only has legs at one end as the other end locks onto and sort of 'piggybacks' to the next board.

cross bracing timbers can be fitted if needed to prevent movement and these need only be made from some 12 x 32mm PSE and fixed to the legs at around 300mm above floor level.

Fix baseboard rear timbers to the walls of the room if possible, ensure they are fitted level and use plastic wall plugs and suitably long screws to hold the timber to the wall. Always carry out a survey of the wall for any possible buried services (electric cables, gas or water pipes etc) that may be hidden from view and deep inside the wall, do this with the aid of an electronic buried services locator tool before drilling any wall fixing holes.

Where the L-girder timbers are not long enough to span the full length of the layout, fixing a 'joining plate' (fishplate) across the two abutting sections is necessary, this plate is made from the same timber as used for the 'L' upright and is around 9-12" (approx. 230-300mm)

An L-girder construction layout being installed in a garage. The fixed supporting leg can be seen in the corner of the front. The rear 'L' members are turned to face into the centre of the layout and securely fixed to the wall. A flat track bed of 9mm ply has been partly laid onto the joists and is waiting for the connecting sections to be added before track laying commences.



In this somewhat unusual picture below, the 'foundations' of the layout are shown. The two longitudinal 'L' beams can be seen together with the cross joists held in place by screws driven up through the top portion of the 'L' into the joist. The risers are fitted with woodscrews onto the joists. The risers, having been G-clamped to the joists at the correct track height, are then drilled and screwed to hold them securely in place. Once secured the G clamp is removed.

long. It is glued and screwed so that it spans across the two abutting timbers. The top section of the 'L' is able to continue without a joining plate and is just butted onto the next top section. The track bed is made from 9mm ply which is also jointed by the plated method underneath where necessary using a piece of the same ply as used for the track bed. Note: As this is a DCC layout, the partly hidden black object sitting on top of the left L section is a DCC Automatic Reverse Loop Module.

4
The track

Types of track

Model railway track is available in three basic forms: rigid sections, flexible track and hand-built track. Rigid sections are sometimes called 'Sectional' or more often 'Setrack'. Here the track is produced in ready-made lengths of straights, curves and matching point work, the curves being pre-set to a defined radius and often there are four radii. These are called Radius 1 (The smallest size) then Radius 2, 3 and 4. Radius 4 is the largest outside pre curved sectionalised track currently available in 'OO'/'HO'. The track is available either sleepered or with a pre moulded ballast infill.

Flexible track, with point work to suit, allows ready-made lengths of track to be carefully curved to the desired radius and cut to length as desired. Its set distance between two adjacent running rails is often closer and a little more prototypical-looking than Sectional track.

Hand-built track and point work is produced by the modeller to the most exacting standards, and can in the main be considered to be as prototypical as possible in virtually every aspect.

Sectional track is sold by virtually all the major model railway producers and usually included in train sets. This system offers beginners an immediate basis on which to build the model railway and get their locos running. Clip together sections of virtually unbendable track provide a quick way of track laying. The sections of track are joined together to make the simplest oval and can all be up and running in a few minutes. Later, the addition of more track to make another loop or adding a point or two gives extra interest and operating potential. The points can serve a siding or make a passing loop or even link together one loop of track to another, by making what is called a crossover.

Points on sectional track normally use what is termed an 'insulated frog', which means no special electrical feeds are needed to power a siding or passing loop and the points are self-isolating. Thus a loco can be run into a siding or passing loop and then the point moved to close off that siding or passing loop. The loco can then no longer be moved under electrical power until the point is again set for that siding or passing loop. This is a very useful feature and simplifies layout wiring. The disadvantage is the reasonably large area of the plastic frog or crossing vee built into the point. When running a loco over this frog, especially when running slowly, the loco may stall or stutter on the insulated frog section as it loses power.

Most sectional track will space two adjacent tracks a little bit further apart than perhaps is considered normal. This extra space between the two tracks helps prevent any two long vehicles, such as long carriages, touching each other when passing on the curves.

Flexible track, as its name suggests, can be pre-set to almost any desired curvature. It is usually supplied in 3" or sometimes 1m lengths with plastic sleepers representing either timber or concrete sleeper types, all factory fitted. Running beneath the rails are longitudinal sleeper joining webs, which is disconnected at every second or third sleeper, alternating from side to side. It is these missing webs that allow the length of track to be gently curved or flexed in either direction. The user then lays the track by either joining together lengths to make straight runs or by gently pre curving the track section, then laying that to a predetermined radius and butting onto the last straight section laid. The radius is usually set much larger than that of sectional track: 24" (600mm) radius is usually the tightest for 'OO' or 'HO' and 10" (250mm) in 'N' gauge. Of course, in the larger scales the radius is often in feet rather than inches.

Because the rail in each piece of track are the same length, when the track is curved the inner rail will extend beyond the sleeper ends while the other rail will be shorter. Thus the rails will need to be cut to length to maintain the correct square rail joint spacing. Cutting the rails will be discussed a little later. Once cut to the correct length, the first sleeper on each abutting section has its rail fixing chairs removed with the aid of a craft knife and then metal rail joiners are slipped onto the ends of the rails on one section. The rails in the next section are then slipped into the open ends of the joiners until the two rail ends abut. The track is then lightly pinned down to the required radius.

Point work for flexible track is usually sold in two formats, as described for the sectional track with insulated frogs or with a live frog. I'll be discussing live frogs later on as these require some special precautions to be taken during track-laying. Normally the two styles of points have identical footprints where the point work area is concerned. The spacing between two adjacent tracks is normally narrower with flexible track. So to overcome any possible collision places on tighter radius curves, the between track gap is opened up a little, so it is nearer to the spacing found on sectional tracks. However, as most flexible track is laid to around a minimum of 24 inches radius, no problems are normally encountered, unless exceptionally long rolling stock is used. There will often be more configurations of ready-made point work available in the flexible track range, such as three-way points, single or double slips and Y points, etc.

Hand-built track is that much harder to complete and requires the builder to have good soldering skills and some specialist gauges and jigs available to hand. The sleepers of hand-built track are more often than not made from specially cut pieces of copper clad material, much like that used on printed circuit boards for electronics or in the larger scales the sleepers are made from real wood.

The copper cladding is cut through in the centre of the sleeper to prevent a short circuit that it would cause rail to rail if not gapped, and the rails are soldered to the copper at a pre-set distance apart. One rail is normally soldered first throughout its complete length, then, with the aid of a roller gauge or other track spacing gauge, the second rail is slowly soldered to the copper clad sleepers, checking all the time that the gauge between the two rails is being maintained as the work progresses. Most hand-built rails are sold in 36" lengths in either Bullhead or Flat-bottom profile.

Cosmetic rail chairs are added during the soldering process or are added afterwards and held in place with glue. Some track builders will use plastic sleepered track and fit their rail into the pre moulded chairs on the sleepers. Others who use wooden sleepers will, depending on scale, use miniature replicas of real rail chairs to hold the rails, while some smaller scales use fine nails driven through the wooden sleeper into the baseboard. The rails are then soldered to the nail heads. All point work is also hand-built and the rail sections are filed down in special jigs to make the live frog crossings and point switch blades. Some points are supplied in kit form with a paper template, which is laid down onto a flat surface and the complex point work built on top of it.

Model rails tend to be made from three main materials: steel, nickel silver or brass. Initially the 'olden day' train sets had track which was produced from tin plate. This was superseded by steel or brass rails on open spaced metal sleepers. Initially locos were clockwork or real steam powered and the type of rail or sleepers didn't really matter that much. The advent of electrically powered locomotives which took their power from the running rails led to the slow demise of the metal sleeper track.

Hornby Dublo introduced a three rail electrically powered train set using a continuous central rail as the power supply and the two running rails as the return. Of course, steel rails suffer from rusting, and gradually manufacturers turned away from that material. More modern track is often commercially produced with nickel silver rail as these do not rust and provide an excellent electrical contact path to the wheels of the locos. Brass rail is now quite often the preserve of the larger gauge modeller. Both brass and nickel silver are ideal for the outdoor railway; nickel silver perhaps being the market leader in all track scales and profiles today.

Sleepers, on which the rails are supported and separated, are represented in all scales as either wood or concrete examples of the real thing. As yet the real railway's modern all steel sleeper has still to be modelled (in plastic) by a manufacturer. The copper clad sleeper is usually a representation of the prototype's wooden sleeper.

Track is commercially available in mainly the two-rail form, but there are some makes still available in the three-rail version. In the early days 'OO'/'HO' trains by Hornby Dublo, Trix, Marklin along with some other continental manufacturers, all used a three-rail or a central stud system. In the 1950s a company in the UK owned by 'Rovex' sold a two-rail electric train set to Marks & Spencer. Within two years Lines brothers had acquired the Rovex company and started production under the brand name of Tri-ang Railways offering a complete two-rail system. They quickly became a market leader alongside Hornby Dublo in the UK's 'OO' scale. As the 1950s ended Hornby Dublo, which up to that time only produced three-rail systems, had to move to two-rail operation as well. Thus, today two-rail model railways are perhaps a more realistic representation of the real thing.

As mentioned previously, rail is produced in two profiles: 'bullhead' and 'flat bottom'. The two styles are shown in end profile section in Figure 14. Note that Bullhead rail is no longer used on UK main line railways and can only now be found in some older sidings and on preserved railways. Bullhead rail on the model would usually be used to represent pre-1960s main lines.

On full sized railways the rails sit in specially made cast metal chairs and are, depending on type, held secure in the rail chair with a metal spring clip or pair of clips known as 'keys'. Bullhead rail is held firmly into the chair by either a hardwood block or sprung metal key knocked in on the outside web of the rails. The rail chair sits on and is secured to the sleeper. Sleepers (ties in some countries) normally span the full width of the single track plus some additional overhang each side. The sleeper being made from Hardwood, concrete or steel. All supported and held securely in place by normally stone ballast.

In model form, the rail is quoted as being to a 'Code', for example 'Code 100' or 'Code 55' etc. The number

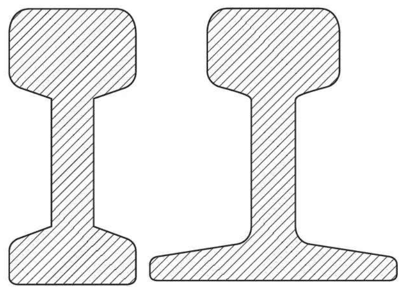


Figure 14: Bullhead (left) and flat bottom rail profiles.

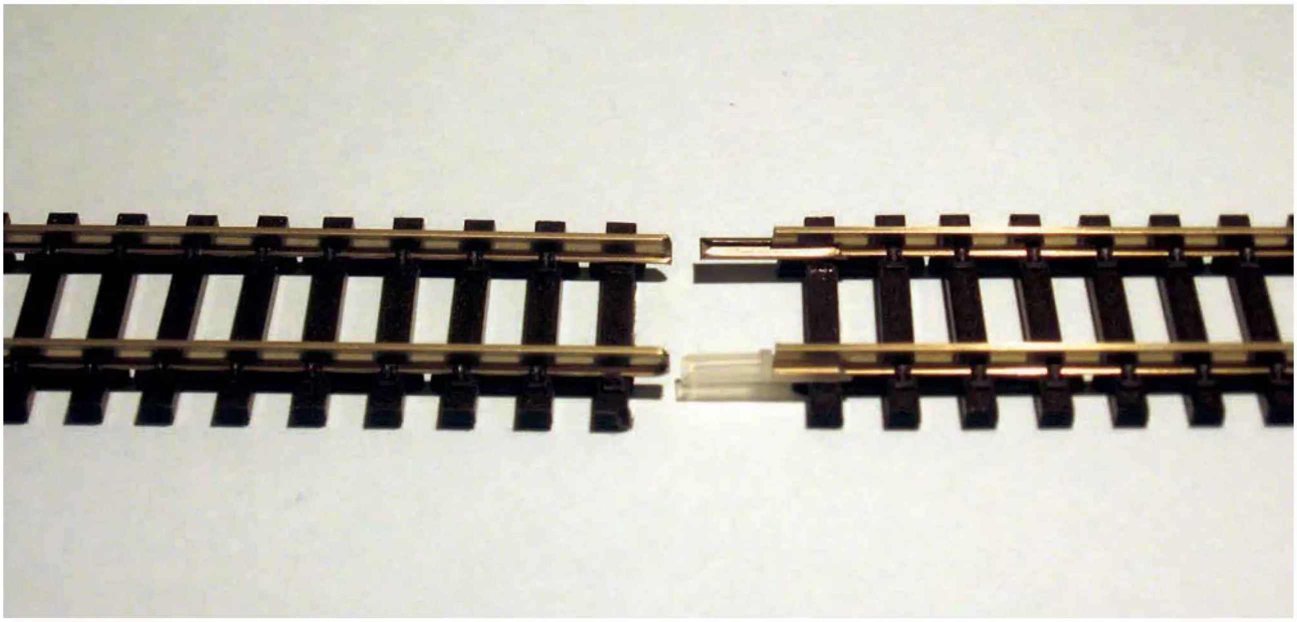
refers to the actual height of the rail in thousands of an inch ('thou' or 0.001 inch). Therefore Code 100 has a rail profile that's 100 thou (0.100 inch) high from the underside of the rail foot to the top. Code 100 is often used in 'OO'/'HO' UK layouts while Code 80 is more often used in 'N' scale. There are other versions of rail available to the fine scale modeller such as Code 75 for 'OO'/'HO' or Code 83 for US modellers. Code 55 is the 'N' gauge fine scale version. Often the same scale of track, but in differing codes sizes, can be connected together with special stepped rail joiners; so for example, with the aid of a special stepped joiner, Code 100 could be connected to Code 75 track. The only problem is that older rolling stock with deeper flanges may ride up on the shallower fine-scale rail as the deeper wheel flanges can touch the rail fixings. This is not such a problem with modern rolling stock (to be safe assume anything produced since 2002) as these have lower-profile wheels.

Joining together lengths of model railway track is done by using rail joiners, sometimes referred to as 'fishplates', which is the real railway term for the metal plates that are used for joining two abutting lengths of rail. Rail joiners are manufactured to the rails 'code' profile and are a sort of 'U' shape. They are available in metal or nylon and slide onto the ends of the rails foot with around half their length being on each piece of abutting rail. On the model their purpose is twofold: to hold together the two abutting rails to provide a level and smooth transition between these rails and usually, though not always, to provide an electrical path from one rail to the other. Nylon rail joiners still provide the same alignment as their metal versions do, but they are used to stop electrical track power flowing from one rail to the next. The nylon joiner often has a small rail stop fitted in the centre, this is to stop one rail end touching the abutting rail end. If this were to occur, it would overcome the desired effect of the joiner in stopping power flowing rail to rail. The nylon joiner is more normally referred to as an Insulated Rail Joiner or IRJ.

Cutting rails

Very occasionally sectional track will need to be cut, while with both flexible and hand-built track it will always be necessary. You can cut the rails with a junior hacksaw, a fine-toothed razor saw, electrically powered mini drill fitted with an arbour and metal slitting disc or with one of the commercially available special rail cutting tools, such as those produced by Xuron.

The easiest to use on the smaller gauge track is the Xuron rail cutter, which cuts the rails much like a pair



Both styles of rail joiner. Nearest is the nylon or insulated rail joiner while furthest is the all-metal rail joiner. These are often referred to as fishplates.

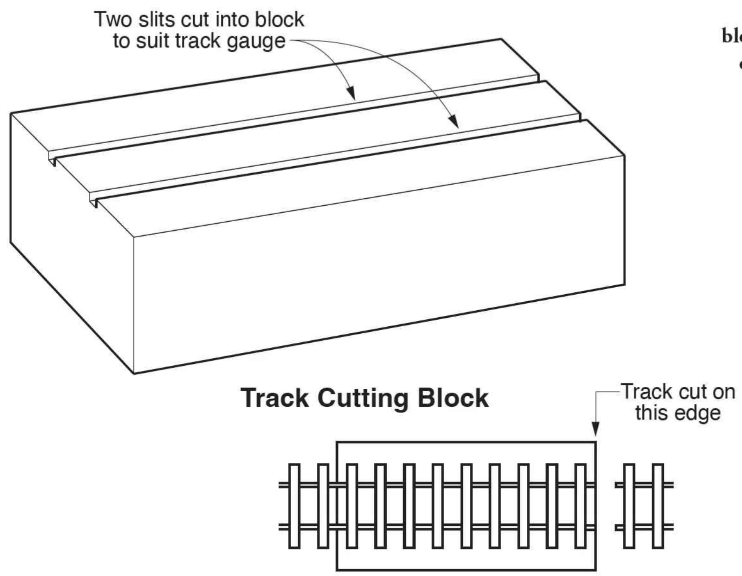


Figure 15: A simple timber block with two suitably sized slits can be useful for holding rail in place when cutting.

of wire cutters. It may be necessary to use a needle file to smooth off any small burrs remaining on the cut ends of the rail. Electrically powered mini drills, such as those produced by Dremel, make light work of rail cutting and produce a clean burr-free cut. However, the use of eye protection, such as safety goggles or safety glasses is essential, and keep any onlookers well away from the cutting area, as the slitting disc can easily shatter while turning at high speed and small particles of the disc could fly off and injure the operator or bystander.

Using a razor saw is a little slower but can be especially useful if a 'one off' cut is needed. The use of a rail holding block to prevent the rails being ripped out of their plastic rail chairs or their soldered locations on copper clad sleepers is essential when using a razor saw or hacksaw. The block need be nothing more elaborate than a piece of square cut PSE timber, which is wide enough to span both rails and around 2 to 3 inches in length. It should have two lengthwise slots cut into one face and at the same distance apart as the two running rails. The block is then placed over the two rails, which locate into the two slots and the block held firmly in place. The square cut end of the block is then used as a guide for the razor saw or hacksaw (see Figure 15).

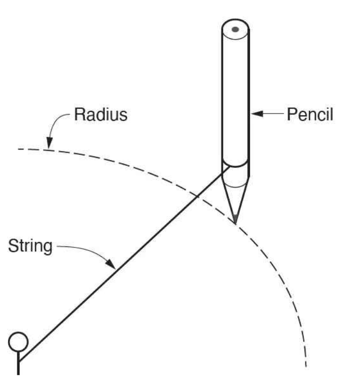


Figure 16: Drawing out a radius.

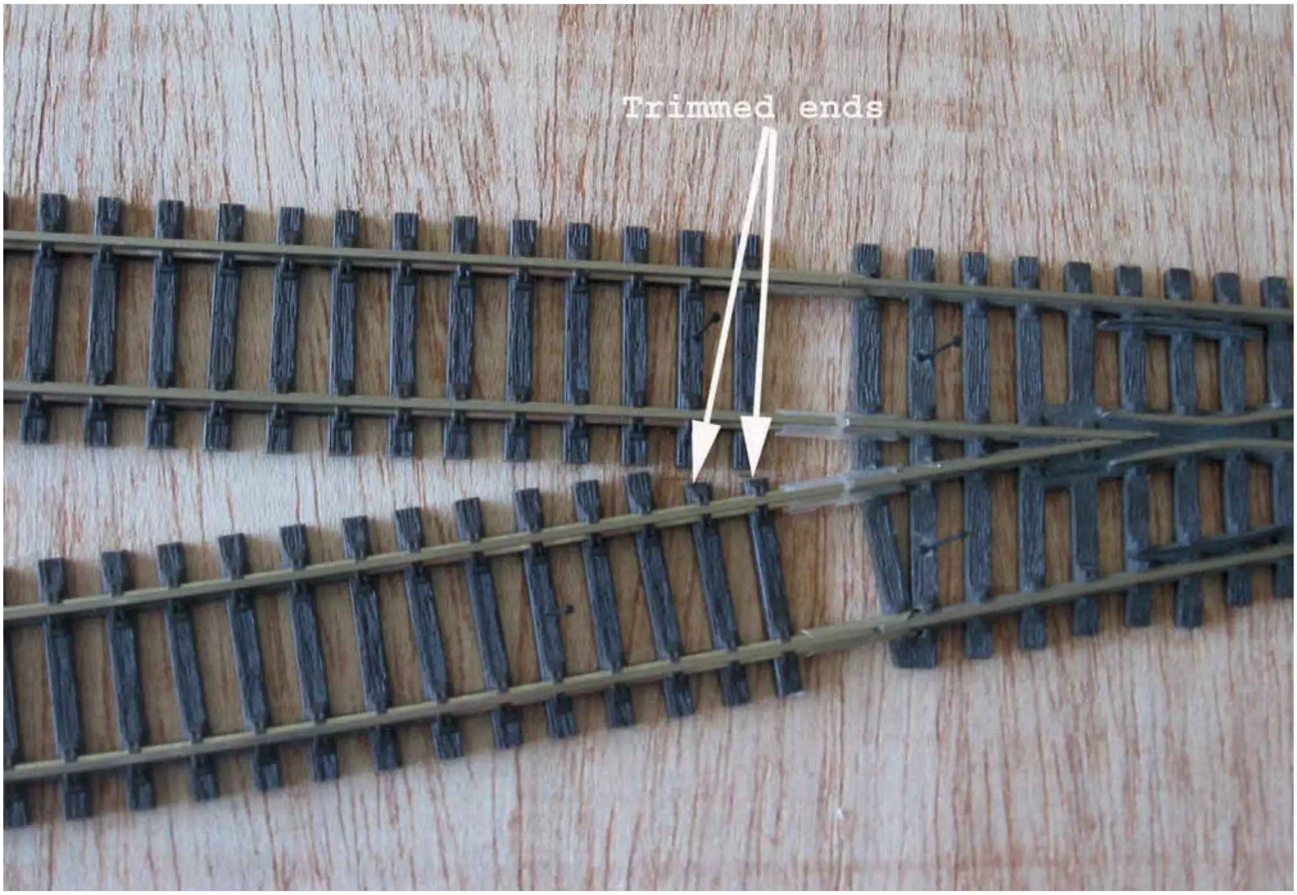
Junior hacksaws on small gauge track can only be used with the track unlaid and perhaps the easiest way to cut the track is with the track being held on the edge of a suitable cutting area away from the baseboard and then gently cut through. The use of the cutting block previously mentioned is helpful here too. Hacksaws really are not the ideal tool for small gauge rail cutting, but are of use on the larger gauges of track. Both razor saw and hacksaw cuts will always need a small smooth file to take off any remaining burrs.

Laying flexible track

If the track needs to be curved, this can be carried out with the aid of a pencil line showing the radius required. The line being drawn onto the baseboard with the aid of a pin, pencil and a length of string, and represents the exact centre line of the track where it will be fitted. The method of doing this is shown in Figure 16.

The same method of marking out can be used to make a curved template or series of differing sized templates, which can be cut from hardboard or 3mm MDF. The templates can be used against either the inner or outer rails of the proposed curve.

An alternative method of curving track is to use pre-shaped metal or plastic gauges which are placed between the two rails and the track then is lightly pinned down through the pre-cut slots in the gauge, to retain the curve of the gauge once it is removed. Once



Where points are laid and flexible track is used, there is quite often the need to trim off the outside ends of two or three sleepers from one of the abutting tracks at the Vee or frog end of the point, to allow the sleepers to mate into the points formation correctly. This trimming process is shown in the accompanying picture of which more track laying processes are still to be carried out, such as sliding the two metal rail joiners onto the points rail ends further, installing infill sleepers under the rail joints, adding real stone ballast and the gluing of the ballast and then, once fully dried, the removal of all the temporary track pins. Note the two Insulated Rail Joiners (IRJs) fitted to the ends of the two frog Vee rails, as the point shown is a live frog (electrofrog) style.

each length of track is pinned the gauge is repositioned further around the curve and that track is pinned down. The end couple of inches of the gauge are left in the previously curved and pinned area to ensure a constant curve is maintained. Tracksetta gauges are a popular make and available in several scales and in various radius and even straights.

When curving flexible track, I recommend that the length of track be initially pre curved to just a little more than the required curvature, as it will try to slightly straighten itself again. Carefully pull out the rails from one end by approximately 3 inches (75mm) and gently curve these rails between thumb and finger to again just over that required. Refit the rails back into their rail chairs in the sleepers, and then do the same at the other end, if this is also on a curve. The idea is to try and obtain a continuous curve and prevent the track from straightening up where the rail joiners are to be fitted, as this could lead to later possible derailments.

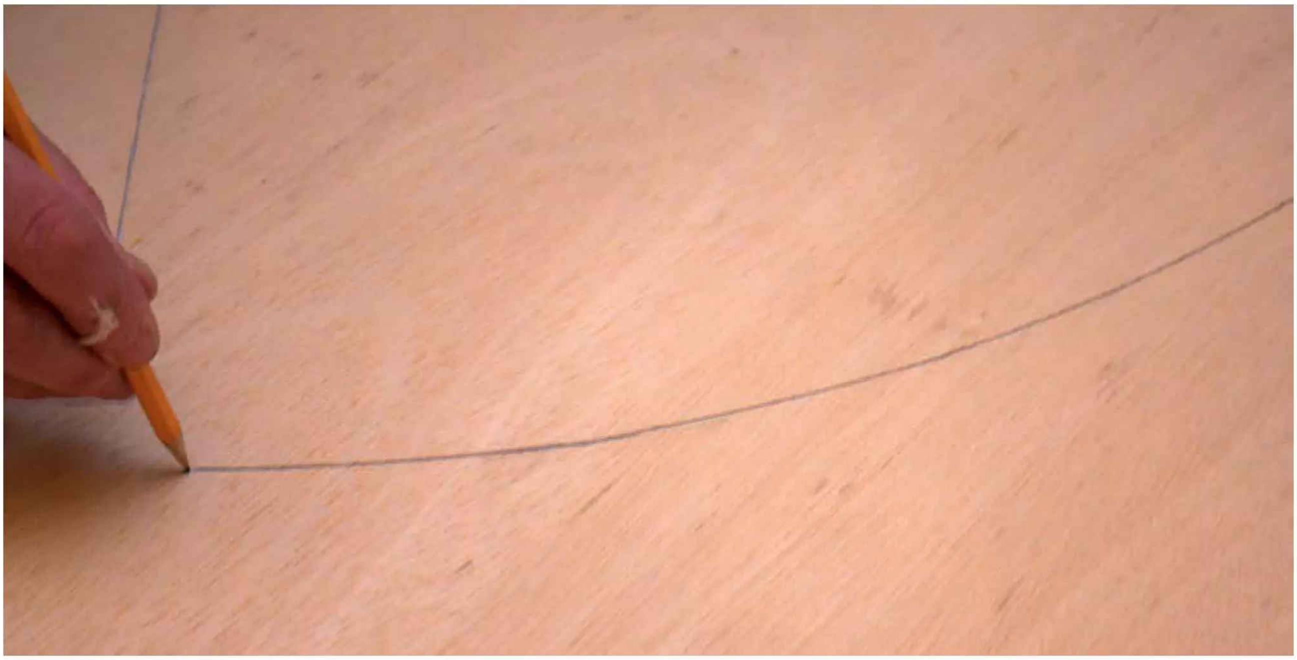
Joining flexible track is carried out by removing one sleeper from the end of one of the two lengths of track to be joined together. With the aid of a sharp craft knife, cut up from underneath through the sleeper joining web. Place the removed sleeper to one side for later reuse. If preferred, and without removing the sleepers, carefully remove the moulded rail chairs from the end sleeper with a sharp craft knife blade by cutting them off from under the rails – keep your fingers well away from the cutting area. Slide onto one end of the track, on the rails bottom foot edge, the rail joiners until they are around half way onto the end of the rails.

Then carefully offer up the abutting pre curved or straight track length. Once the two rails are fully inserted into the open ends of the rail joiners, and checked by eye that they are correctly fitted onto the bottoms of the rails, pull the rails back a little, by approximately 0.5-1mm to leave a very small gap between the two abutting rail ends. The idea here is to allow a small expansion gap which will be required for the summer months' warmer temperatures. Of course, if you are laying track in the middle of a heatwave then there is no need to allow any expansion gaps!

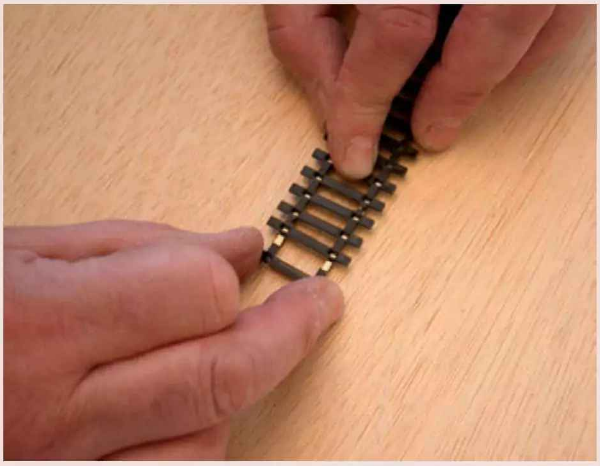
Use a curved gauge, or check by eye against the pre drawn pencil line, to make certain that all is correct. Then pin down the track, ensuring if it is on a curve the radius of the curve is being maintained throughout the join. Once the entire track section has been laid, take the formerly removed sleeper, if that option was chosen, and carefully trim off both of the moulded rail chairs. Slide the sleeper under the track and position it so as it matches the remainder of the track's sleepers, add a further trimmed sleeper if needed, to fill any further gaps.

When laying long straight lengths of flexible track, I have found the use of a 24-inch (600mm) steel rule invaluable in maintaining a dead straight look along the track. The rule's edge is placed right up against the outer edge of the rail and the track then pinned down to this alignment. Move the rule along a little at a time, pinning as you go. A line can be drawn centrally all the away along the length, before track laying commenced, to further aid true straight and correct track to track parallel alignment. Special between-track distance gauges are available to further aid this process.

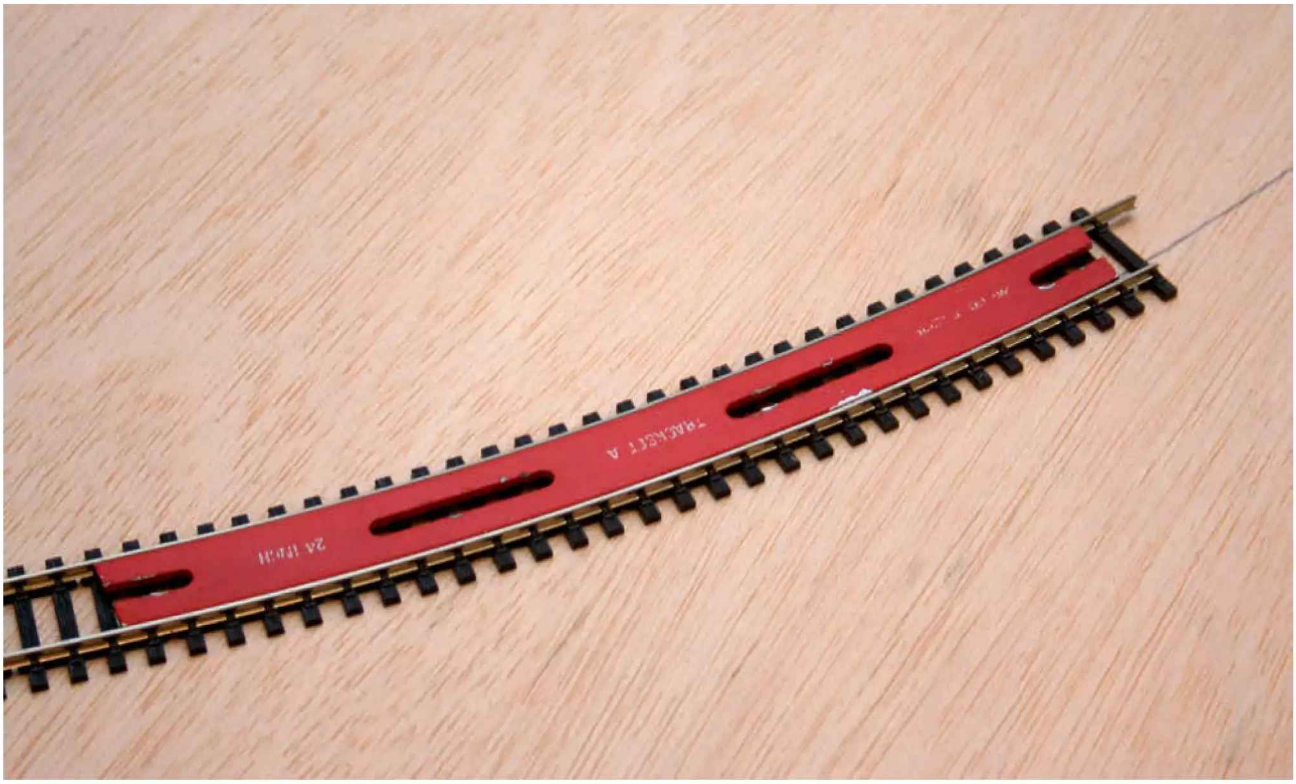
Laying flexible track stage by stage



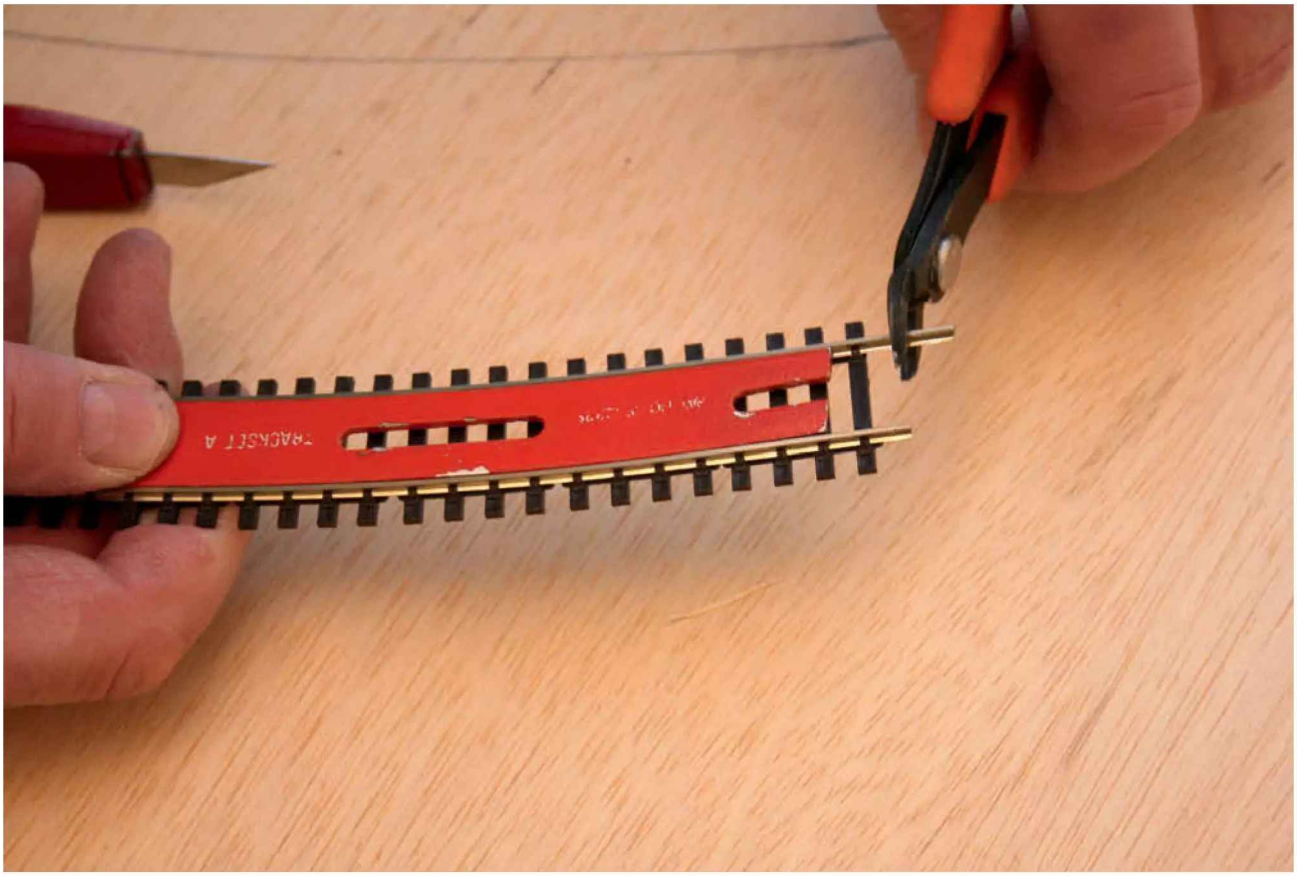
Stage 1: Where a curve is required draw the centre line of the track onto the baseboard using a pin, string and pencil. The length of string between the pin and pencil is equal to the radius of the curved track.



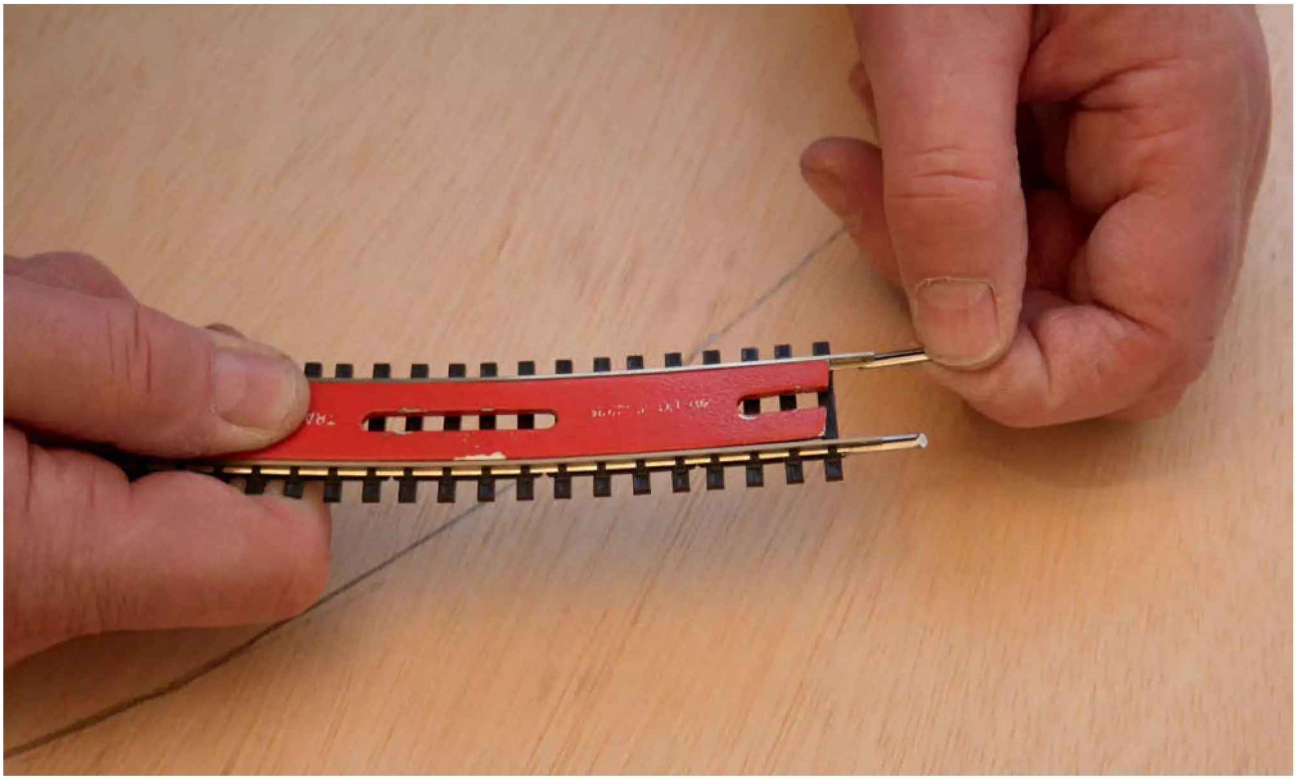
Stage 2: The last one or two sleepers are removed by cutting through the soft plastic webbing on the underside of the track. The removed sleepers are retained.



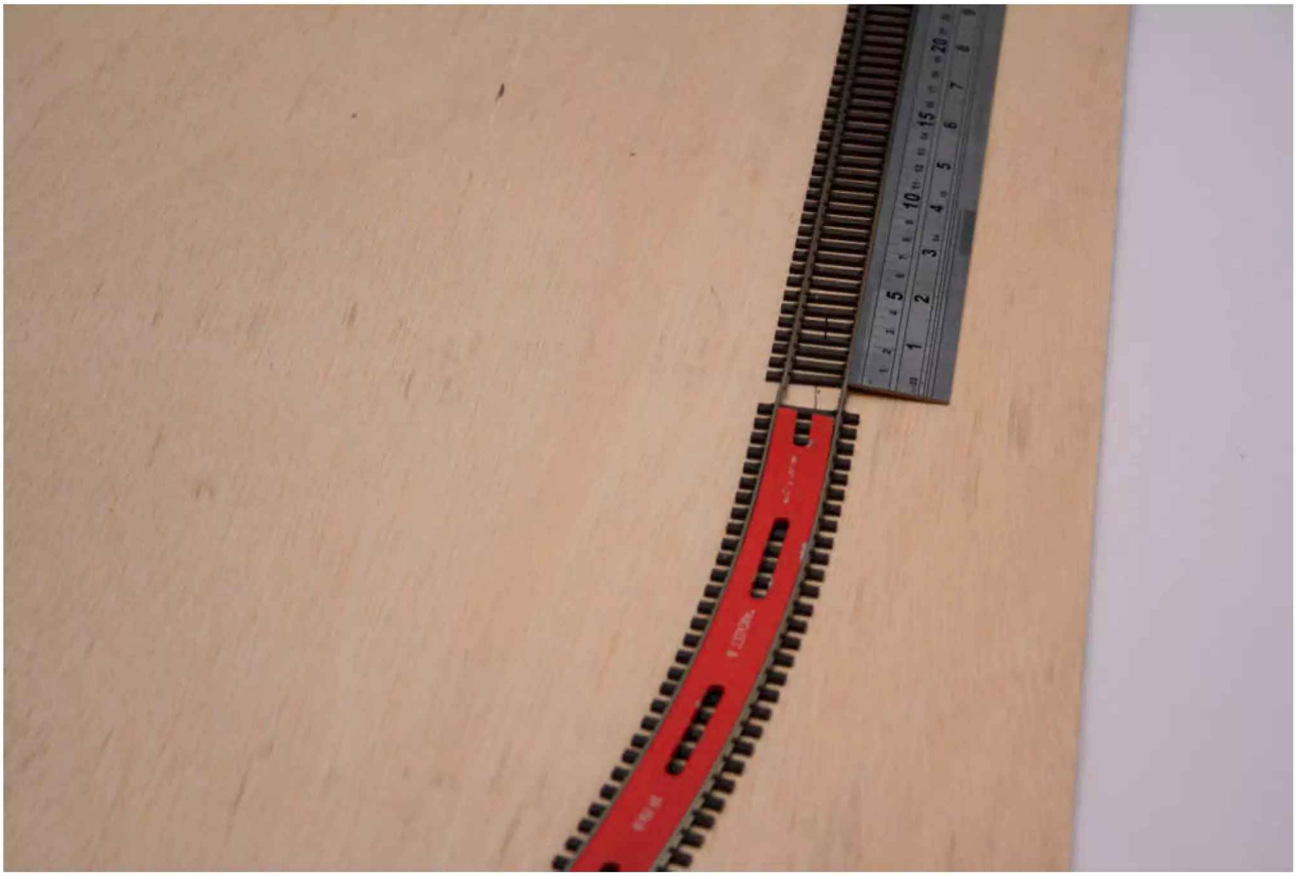
Stage 3: The track is curved to the required radius, here a 24-inch Tracksetta gauge is used to ensure the correct radius is followed. Note the inner rail has extended more than the outer rail.



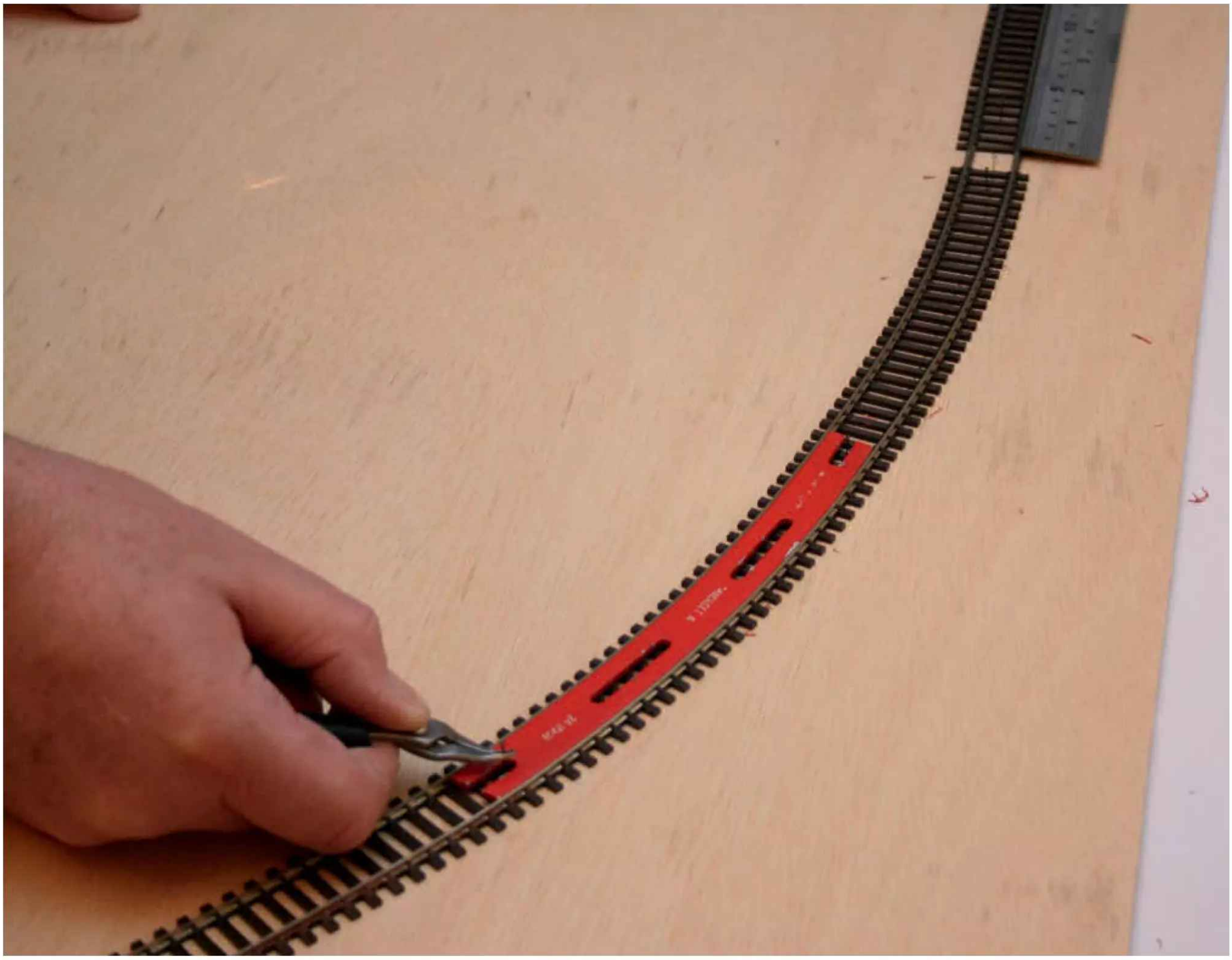
Stage 4: The longer rail is cut to the same position as the outer rail. A Xuron rail cutter is being used to trim off the unwanted rail end.



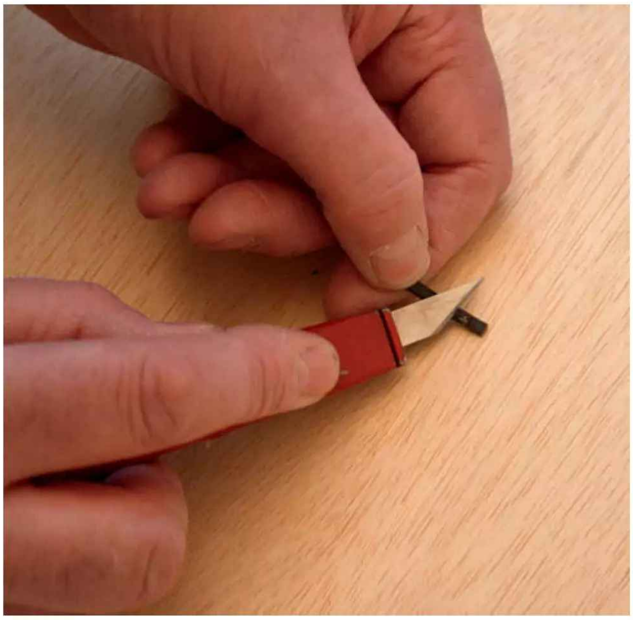
Stage 5: Rail joiners (fishplates) are slid onto the rail ends. About 50% of the joiner is pushed onto the rail.



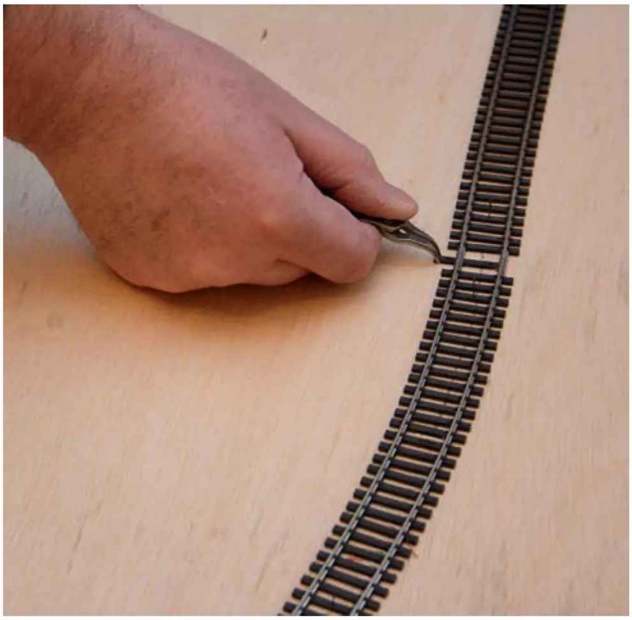
Stage 6: The curved track is now connected to the previous section and the rails pushed into the open ends of the joiners making sure the metal joiners slide onto the bottoms of the rail on each side.



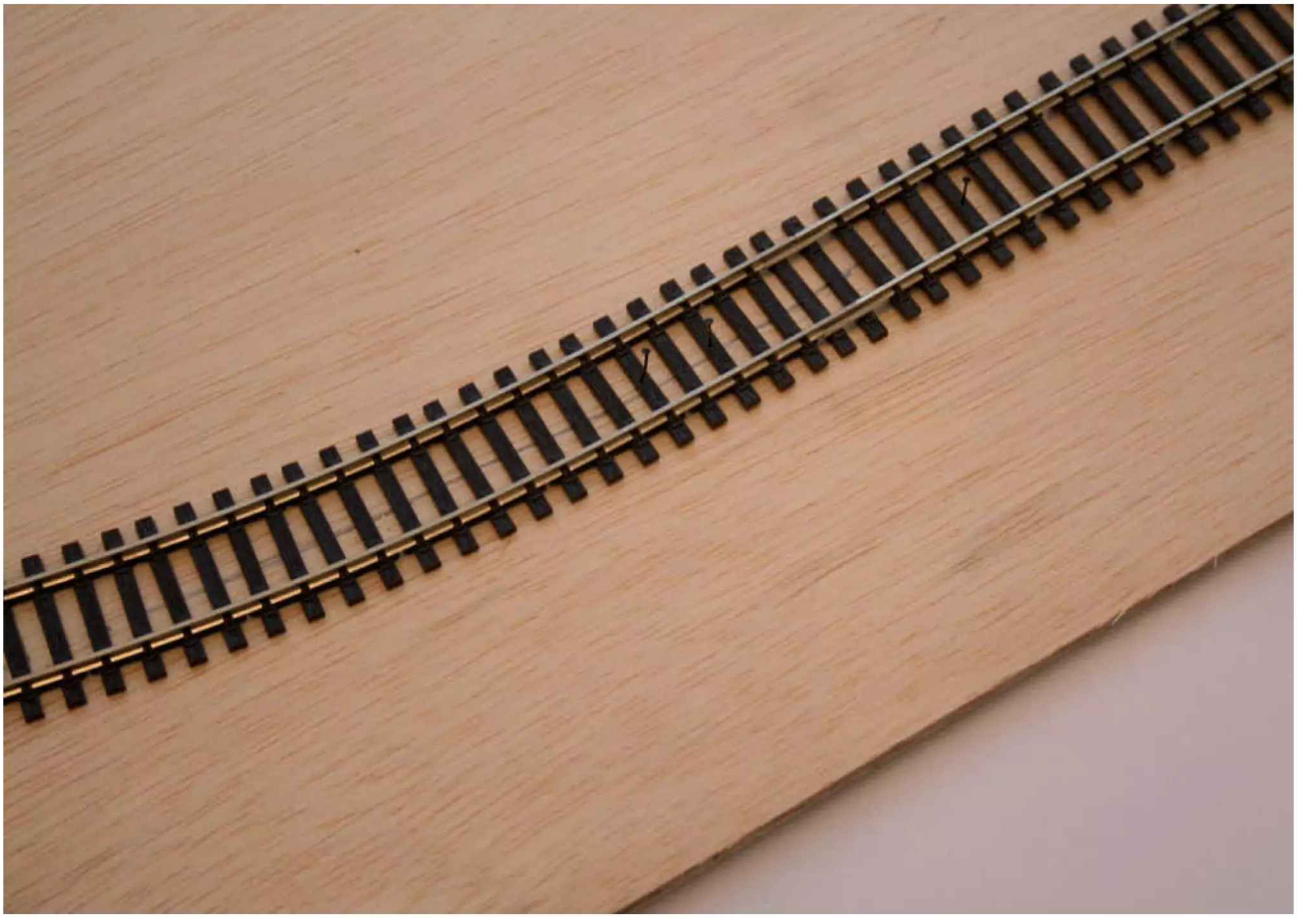
Stage 7: Continue using the Tracksetta or follow the pencil line to maintain a constant curve; pin the track through the centre of the Tracksetta as you go. The slots in the gauge assist pinning.



Stage 8: Trim off the plastic rail chairs from the previously removed sleepers.



Stage 9: Slide one or two of the trimmed sleepers into the gap underneath the rail joiners.



Stage 10: The completed section of track all laid with temporary track pins holding the curve and straights until any ballasting has been completed. Alternatively, the pins can be carefully pushed fully in to hold the track as a permanent fixing option. Note the two sleepers now under the rail joint make the joint virtually invisible.

Four Tracksetta gauges in two scales and two radiuses in each gauge are shown. From top to bottom they are 'OO'/'HO' 36-inch, 'OO'/'HO' 24-inch, 'N' 15-inch and finally 'N' 12-inch.

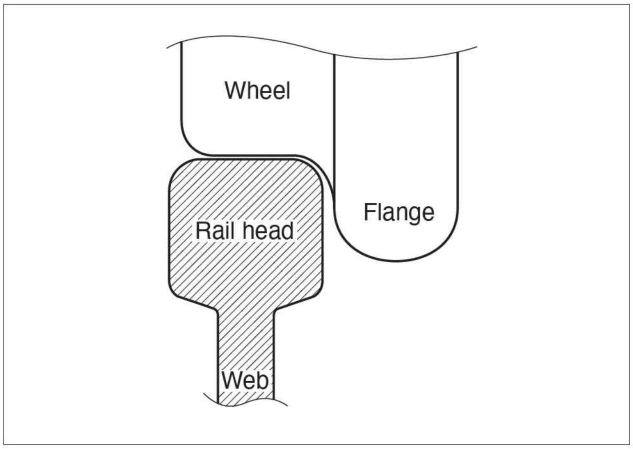


Figure 17: The relationship of wheel flange to rail head.

Points

The purpose of the point (or Turnout as some know them) is to allow a train to change direction. After all, the train has no steering wheel or steerable wheels as a car does, so direction changing is carried out by the moving blades of the point swinging over from one side to the other and making direct contact with the rail on one side only. The flanges of the train's wheels are then guided by the inner face of the rails and subsequently the wheels and train are sent in the direction selected by the closed and opposite open rails.

Some point terminology is explained in Figure 18. For ease of identifying the position of the point blades, it is better to use the real railways term of 'normal' and 'reverse'. The normal route is, in most cases, the straight ahead direction, unless the main line happens to be the curving route, in which case that would be the 'normal' side and the straight ahead direction would then become the 'reverse'.

In Figure 18, if the main line was in the straight ahead direction, then the point is shown as reversed, as its reverse side switch rail has closed against the fixed stock rail and trains will travel in the diverging (reverse) direction.

During track laying and where any points are to be laid, thought should be given to how the points will be finally operated. If some form of electrical or mechanical control of the point blade positioning is to be used, now, before track laying has been completed, consider how the operating mechanism will connect to the point.

If it is to be below baseboard, preparations need be nothing more than a suitably sized hole drilled centrally under the final position of the points moving tie bar. Or, if your chosen method is to fit electrically operated solenoid motors that are mounted directly onto the underside of the points sleepers, such as that offered by the Hornby and Peco systems, then a larger rectangular hole will need to be cut in the baseboard surface to accommodate the whole motor. Use the central marking to draw the rectangle onto the board; the rectangular hole size being approximately 40 x 25mm. Note that in 'N' gauge you will need to offset the rectangular hole to one side, depending on which way they have chosen to mount the motor onto the underside of the point. Figure 19 shows the procedure.

The hole is cut out of the baseboard by drilling four small holes (5-6mm) in each corner of the rectangle, then joining up the holes with the aid of either an electric jig saw or a hand pad saw. After point laying is completed the cut-out rectangular hole will need covering over. Thin card – a postcard is ideal – is cut to approximately 50 x 35mm in size then it is cut into two equal strips lengthways. Each strip then

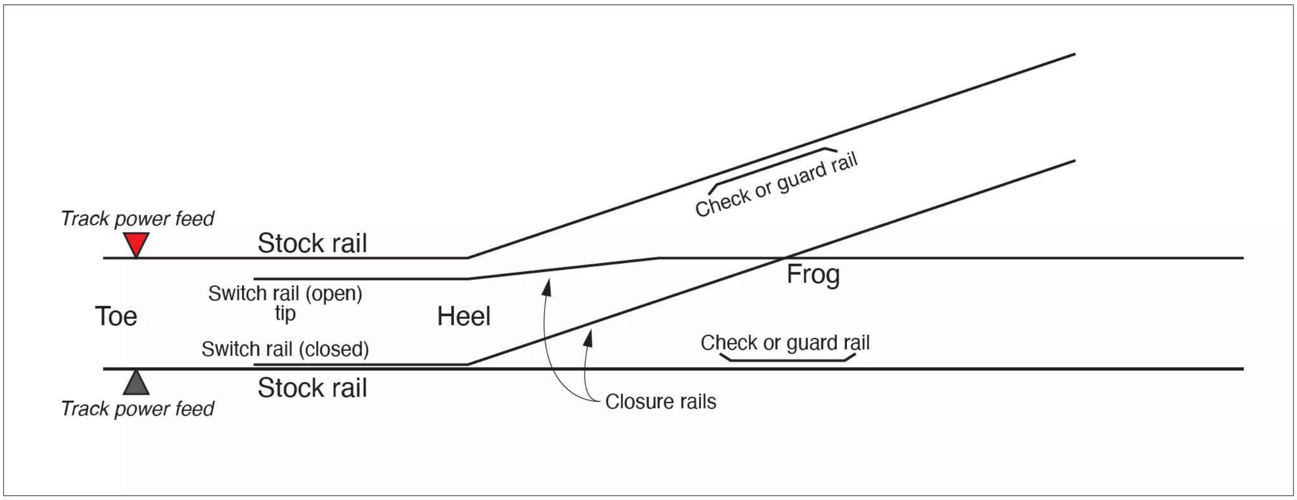


Figure 18: Point terminology. Always speak about points as if you were standing at the tip, looking into the pointwork. In this example, the right-hand switch rail is closed against the stock rail, allowing trains to use the left-hand junction track. The switch rails are held apart by tie bars (or stretcher bars). They have not been shown in this drawing for clarity. In the model, the 'frog' (or crossing) may be of two types, insulated (insulfrog) or live (electrofrog). Always feed power to the points from the tip end – ***never*** **allow power to be fed from the frog end to the tip.**

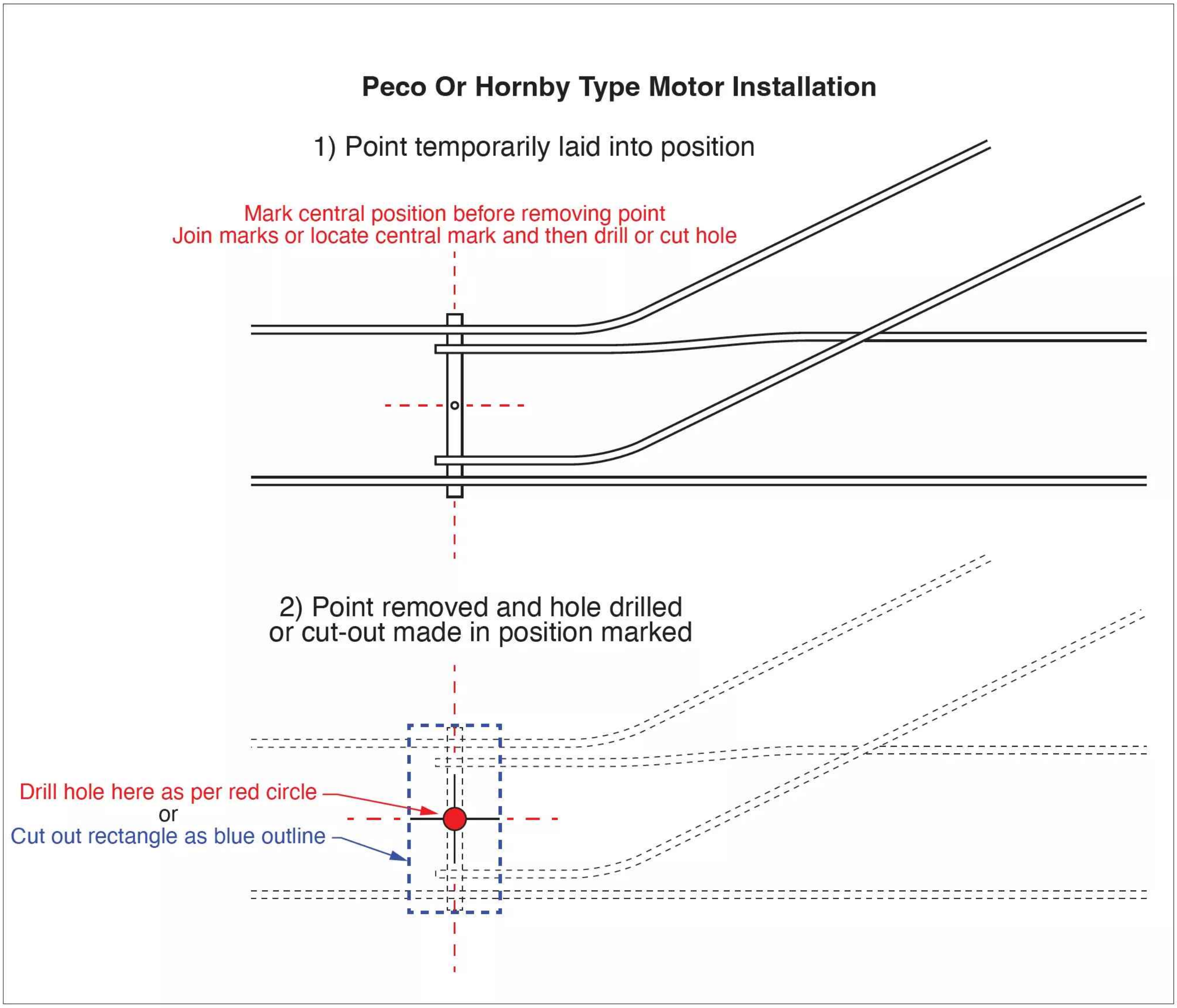


Figure 19: Peco or Hornby type point motor installation. The drawing shows the marking up of a typical point temporarily laid in its final position, but not fixed down. Where a point motor is to be used underneath and fixed to the underside of the baseboard or a mechanical method used, such as 'wire in tube' point control, a suitably sized hole needs to be drilled centrally under the tie bar. The tie bar's cross track centres are drawn onto the baseboard, then the point blades are held manually central and the position of the tie bars drive pin hole marked. Alternatively, a small drill bit is passed through the centrally held tie bar to mark a small indent into the baseboard surface. Remove the point and join up the marks as in the lower sketch or identify where the indent is in the surface. Where the two lines cross or the indent is, then this is the exact place a suitable sized hole needs drilling. For 'OO' this is approx. 9-10mm diameter; other gauges will need to be adjusted according to the amount of throw required to move the point over to both Normal and Reverse positions. Carefully remove any drill break-out swarf from the underside of the baseboard with the aid of a craft knife or a countersink drill bit.

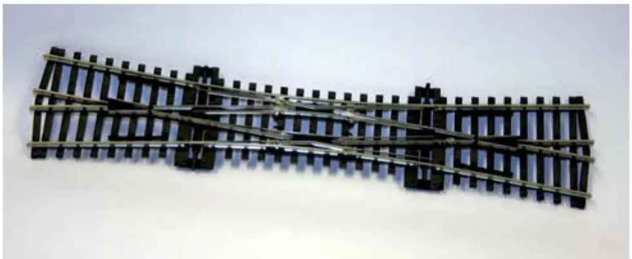
has a matching central slot of some 10mm length and 3-5mm depth cut into it and they are then slid into position under the point. If desired they can be secured to the baseboard with the aid of a little UHU type glue.

Crossovers are made from two sets of single points of the same hand i.e. two left or two right hand points depending on the direction of the crossover and abutting each other. In addition to the above configurations, there are diamond crossings, single and double slips and scissor crossovers available in the ready-made group for the layout constructor to use.

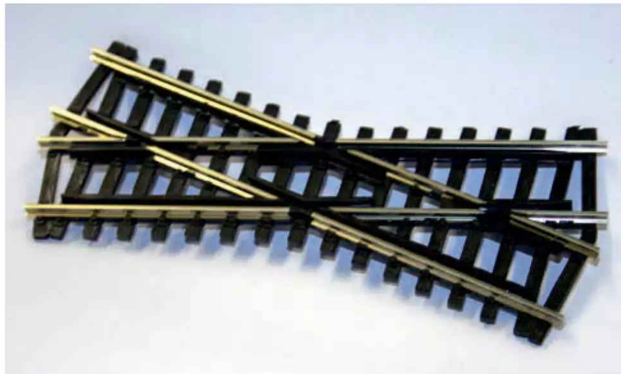
Ballasting

This is the small stones used by the real railways to retain the track in position and prevent both sideways and sleeper to sleeper movement as the train passes over. For the modeller, which style of ballast represented has to be a personal choice. The options for the modeller are: ready-made track sections with a ballast shoulder factory moulded onto the track, foam inlay ballast or, of course, real stone chippings.

Factory moulded ballast shoulders on sectional pre shaped track is perhaps the quickest way of track laying and gives a reasonable representation of real ballast. The



A Peco Code 100 insulated (dead) frog double slip.



A typical insulated (dead) frog diamond crossing.

only disadvantages I find are that the joint between each section of track does show markedly, and that the overall appearance is often rather too much that of a toy train set. Pre-ballasted track is available only in the smaller scales – N and 'OO'/'HO' being the main two.

Foam inset strip ballast offers the modeller a longer run of continuous ballast representation, but will still have joints showing at points, diamond crossings and wherever the lengths of foam strips are abutted. Its main advantage is that it does offer a soft bed for the track to sit upon which will help reduce the sound levels. Track will require some light pinning down to prevent any movement. All pins should only be lightly pressed through the sleepers and not actually pushing down the sleepers into the foam. One problem with some foam underlay is that after several years it may well start to crumble and then need replacing.

Real stone is available in various grades and is often made from finely crushed granite. It is quite common to use the next scale or gauge's size down or the very finest size of the product in the actual scale. In 'OO' scale I use a mix of 4 to 1 'N' scale ballast to fine 'OO'. Laid with the aid of a teaspoon, acting as a shovel, the ballast is then spread along the pre pinned track and the outsides too. An artist brush is used to tease the ballast into the final position; any surplus ballast being either brushed forwards for later use or completely removed.

Once the area being ballasted is correct, a 40/60 mixture of woodworking PVA glue to water plus a tiny drop of washing up liquid is mixed in a small jar and used to bond the ballast into position. But firstly, the whole area to be glued is sprayed with a mist of water, with a tiny drop of washing up liquid added. Use an indoor plant mister or an empty and thoroughly washed-out cleaning liquid spray bottle, as originally used for cleaning worktops or window glass etc. The whole area is lightly sprayed with the water/washing up liquid, then with the aid of a pipette or eye dropper the PVA glue and water mix is dropped over the whole area to flood the ballast with the glue. The use of a tiny drop of washing up liquid in both the misting spray and the glue/water mixture is to allow the liquids to flow freely into the ballast as the washing up liquid reduces the surface tension of the mixture.

Once the PVA glue mix has been used don't move any of the ballast as you cannot correct errors at this stage. Also ensure no glue can cause damage to anything under the layout should it run out of any baseboard joints or wiring holes – which it will! After at least 24 hours has passed any surplus unglued ballast can be removed; the use of a vacuum cleaner is ideal.

For economy most unstuck ballast can be reclaimed and reused later, so use a vacuum cleaner with a flexible pipe and place a stocking, pop sock or cut off tights leg inside the pipe, but held firmly on the outside of the tubing to act as a 'catcher'. When the vacuum is turned off the stocking is pulled out of the tube and all the sucked up ballast emptied out and reused.

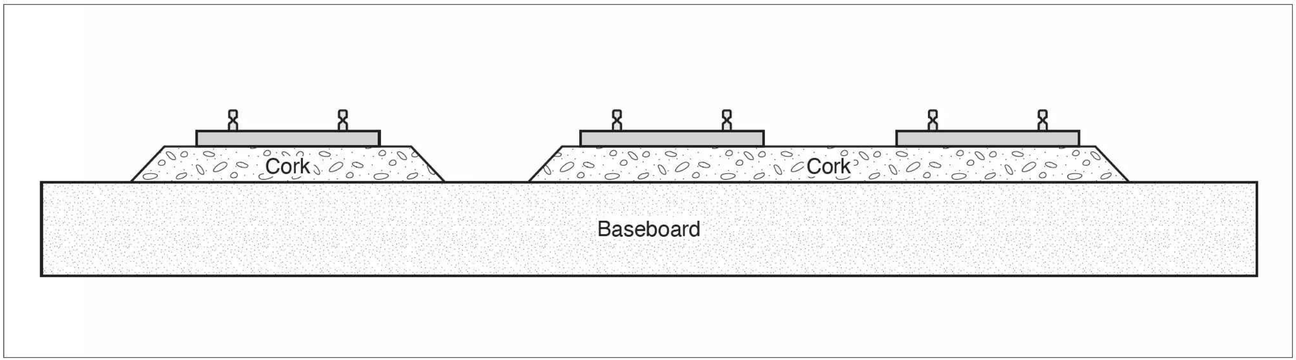


Figure 20: A cut-through section of baseboard, where cork has been laid and then trimmed and the track fitted on top. The whole area is then covered in the appropriate ballast mix and glued in place.

Some retouching of the glued area is often necessary, where any ballast has not been fully bonded, but this is normally only minimal.

Some modellers use cork to raise the track up above the baseboard's surface to represent the full height of the ballast shoulder. In 'OO' this is often 2-3mm thick cork sheet, cut and laid a little wider than the sleepers' width with the outer edges bevelled, so that the bottom is wider than the top. A cut of approximately 60 degrees is ideal (see Figure 20). Trim the cork with the aid of a sharp craft knife and steel rule on straight runs and cut to a drawn pencil line outside the sleeper edges on curves and point work.

Once cut to shape, the cork will need to be glued to the baseboard with either PVA or an impact adhesive. Once dry, the track is then laid on top of the cork and lightly pinned in place. Stone ballast or other medium is glued in place depending on the effect required. Some areas will be representing the main line or well-maintained loop or siding, while other areas may be, for example, a coaling stage. Here the track would have a considerable amount of fine coal dust mixed in with the ballast or perhaps an ash drop area in a loco stabling siding, where the stone ballast could be replaced completely by finely crushed ash.

Once all the track and ballast has been securely glued and the glue fully set any track pins can now be carefully removed. One alternative for a very simple and easy ballasting look is to use a 'Ballast Roll' as produced by, for example, Javis. This is simply rolled out, lightly glued with PVA adhesive over the whole track area and then the track laid directly on top of this medium.

Weathering

Weathering of the rails, sleepers and ballast can be carried out at this stage or if preferred the track and sleepers can be weathered prior to laying and the ballast used in the 'as supplied' colour. The use of an air brush will be of additional help in applying the shades of track colour, though a large artist brush can also be used.

Rust colour is applied to both sides of the rails and the top surface of the rail is then immediately wiped clean with a rag dipped in white spirit or turpentine to ensure all paint traces are removed, as maintaining electrical contact with the locos is essential. Remember to mix tones of black, white and brown in with the base red rust colour to add variety and realistic shading along the length of the track.

Any paint that accidently gets placed onto the rail chairs is left, as the chairs on the real railway are a rusty colour too. When weathering points, ensure the small area of the switch rail that touches the stock rail remains totally free of paint. A small strip of masking tape placed on the inside faces of the stock and switch rails will prevent accidental paint splashes. Remove the masking tape strips as soon as painting has been completed.

A section of track on the author's former layout that has had the rail sides painted with a rusty colour to improve their appearance.

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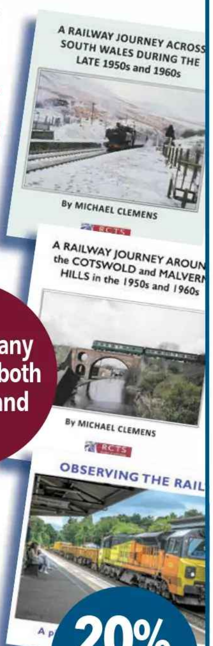

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5
The landscape

For the model railway to really come to life it is necessary to reproduce the area surrounding the railway; often this includes the area beyond the railway's boundary fence, so a realistic perception is given to the viewer. The railway can run in open country, on embankments or in cuttings, pass over bridges or viaducts where below runs a river or road. When the railway's fence line is reached we are taken into the open country, a town, village, or industrial setting. Perhaps a mix of several of these is the ideal, as the train moves around and passes through open country, then skirting an out-of-town industrial area with possibly a siding feeding a factory or gas works before finally progressing into the actual town and station area.

Some modellers may like to just model one scene, where perhaps a long terminus station and its approach tracks are depicted. The final choice is of course your own and can be based on real places and buildings or be totally fictitious.

Cuttings, embankments and landscape effects

Cuttings and embankments are possibly the easiest to model. The embankment or cutting sides can be made from either a scenic sheet of pre-coloured matting or by, perhaps a little more realistically, using plaster of Paris, plaster filler, plaster impregnated bandage or even Artex ceiling texturing compound to mould the ground contours. All of these methods will require some base foundations for the embankment or cutting to give the basic shape to the sides and offer a solid shape to fit the final ground covering onto.

There are several ways of reproducing the base ground contours by using a framework of thick card, thin MDF or ply cut to the basic shapes or formers and glued in place, using fine wire mesh similar to chicken wire or even using glued and carved Polystyrene blocks. Once the basic shape of the framework of the embankment or cutting is chosen, the area is firstly in-filled with packing, such as crumpled newspaper or polystyrene.

Next a grid of card strips is glued in crisscross fashion over the base of crumpled newspaper or polystyrene to make the basic ground shape needed or alternatively the wire mesh is cut, shaped and then pinned or glued into place. I have found the use of a hot melt glue gun very useful for this with both card strips and wire mesh as the glue rapidly sets and holds the card strips or wire mesh secure.

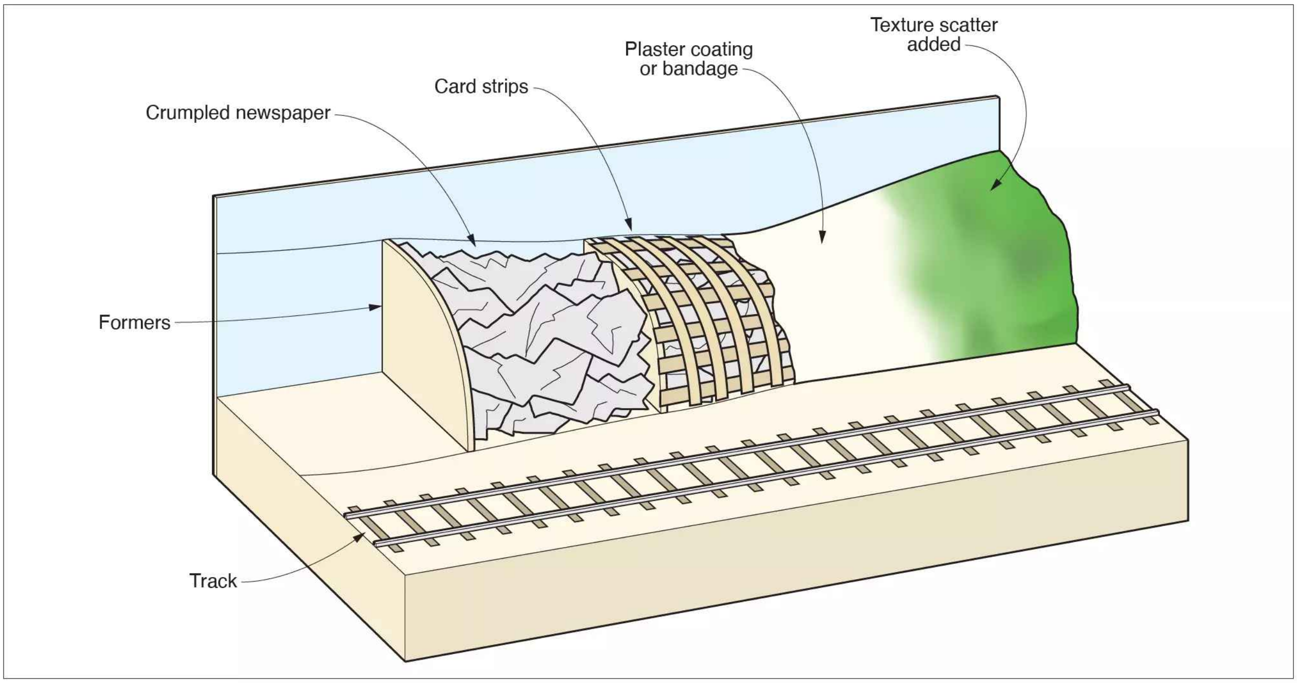


Figure 21: Basic construction techniques to form a cutting side. Where an embankment is to be modelled, the track is at a higher level and the scenic materials are taken down to baseboard level or even a little below where an open top framing is being used.

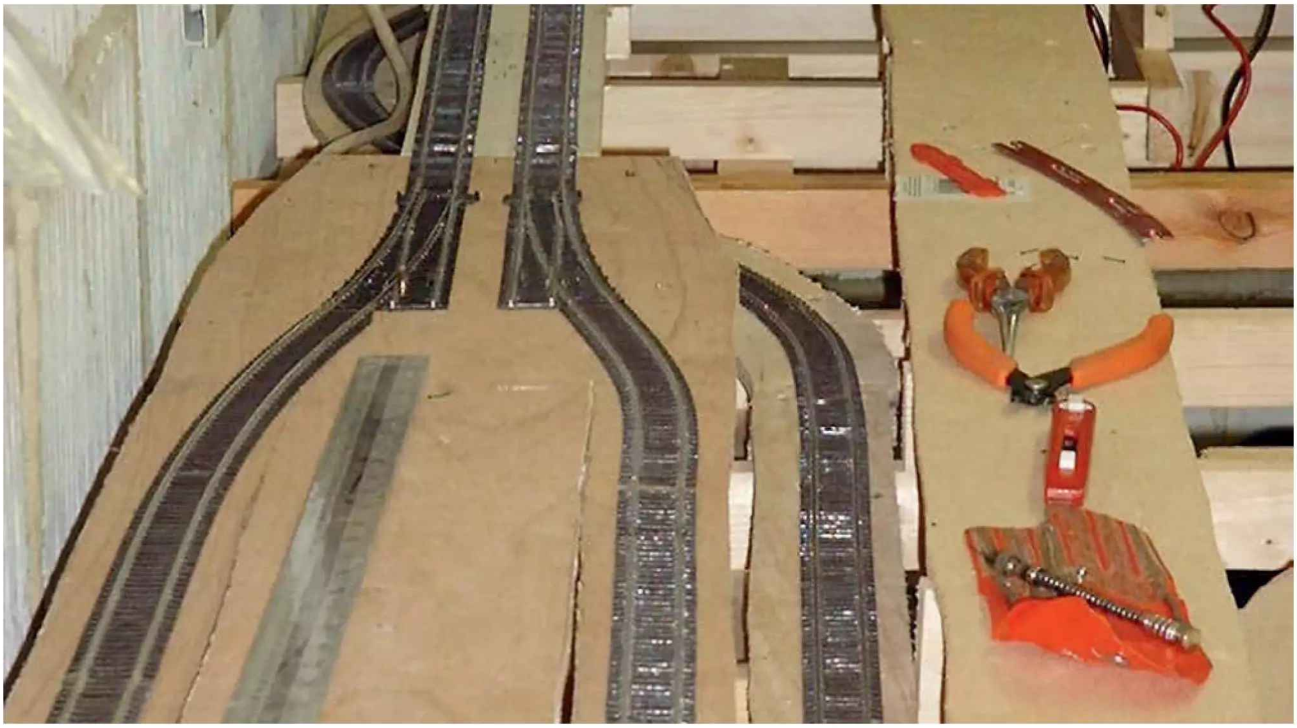
The basic shape is then covered over with plaster bandage, papier-mâché or a course cloth cut into strips, such as that sold as mutton cloth for polishing or perhaps use a ready-made grass matting. Plaster of Paris or plaster filler, as preferred, is then spread over the dried sub base. A brown earth colour, mixed from powder or acrylic paint can, if desired, be added to the plaster when it is being mixed as this helps prevent any white plaster patches showing through the surface should it become chipped. This is particularly helpful on portable layouts where possible damage to the scenery is perhaps at times unavoidable.

As it dries the coating is carved or moulded with the aid of a spatula or spoon handle to give the required textured surface finish. Once dried (allow 24 hours) the surface can be overpainted with more brown ground colour and when this has fully dried, a woodworking type PVA glue is spread over the area and selections of scatter materials are sprinkled on. Use several shades of the chosen colours freely intermixed. When this has finally dried, vacuum off all unstuck scatter using the 'stocking in the vacuums tube' method (as per track ballasting) to capture for reuse the scatter that is surplus and unstuck. Touch in any patches of scatter that may have come away and finally add bushes, trees and fencing to finish to the desired effect. The process is shown in Figure 21.

If you are using polystyrene to make up the under surface of the landscape, bond various thicknesses and shapes together using either woodworking PVA or special polystyrene adhesive. Place a weight on top of the structure to aid the gluing process. Once dried, carefully trim the polystyrene blocks to the required shape. This can be done with either a sharp craft knife or a hot wire cutter which is specially sold for cutting polystyrene. One disadvantage of using polystyrene is the hundreds of tiny balls it produces when being cut, which spread everywhere and are quite hard to clear away! But once covered with plaster or plaster bandage it makes a very lightweight and solid structure.

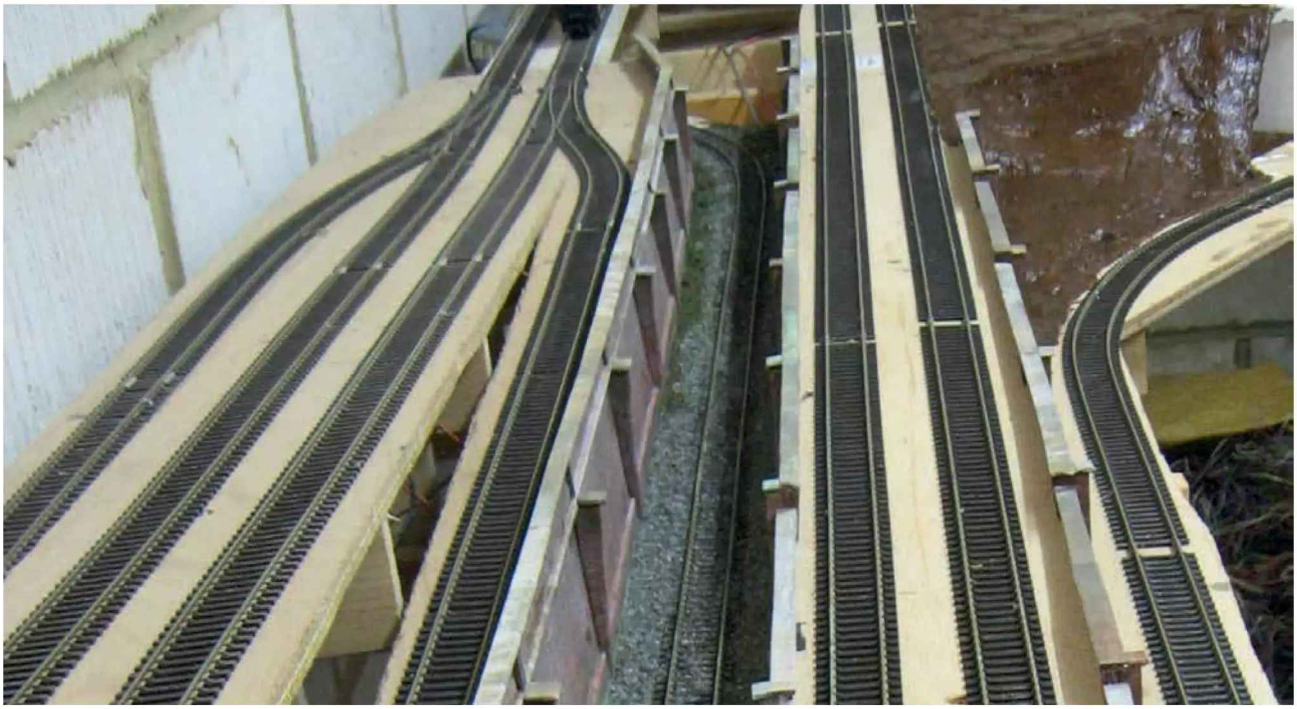
If you are using the scenic sheeting, then consider also adding some similarly coloured scatter to enhance the overall appearance of the slope. Use PVA woodworking glue spread over some of the matting and sprinkle on the scatters. Add further detailing as required and again add such features as fencing, trees and bushes. All these can be bonded on with neat PVA, which will dry clear. For fencing and bushes, apply a little drop of PVA around the base of the item after it has been glued in place and then sprinkle a tiny amount of the previously reclaimed scatter material to blend fully in with the surrounding ground covering.

Landscape construction in stages



Stage 1: Track laying beginning to take place. Note the tools used – including a steel rule to give a straight edge. A Tracksetta gauge ensures the correct radius or curve is maintained when using flexible track. A track spacing gauge (by Peco), long curved nosed pliers, Xuron rail cutters, craft knife, Archimedean drill with drill bit fitted and a set of needle files will also come in handy. Where the steel rule is laying is the start of the slope leading up to the terminus station which is to be at a higher level.

Stage 2: The basic track laying has been completed and a DMU is being used to test all track alignment and all the electrical connections are correct before moving on to ballast the track and add the scenic details.



Stage 3: Thick mounting card has been covered with brick paper making up the retaining walls, which are now fitted into place. These are downloaded printable files from Scalescenes.com which once paid for and downloaded are printable as many times as the user wishes. The first piece of track has now been ballasted. Note the large gaps in the sleeper spacing where two sections of flexible track abut. These will, before ballasting, have individual sleepers with their rail chairs removed, slipped under the rails to infill the gaps. A small amount of basic ground scenic work has also started. Once all the retaining walls are in place they are given a coating of matt spray-on varnish from an aerosol can, to help stop them absorbing any moisture from the track ballast and scenic gluing process.

Stage 4: The same area but this time in closer detail. A latticework of card has been hot melt glued into place to make a hillside. Though any card type glue could be used, such as UHU, but the 'grab time' is longer with these types of glues unless a contact adhesive is used. If necessary, crumpled newspaper will be worked under the card lattice to give a lightweight support to the lattice. All the rail sides have been painted a rusty brown colour to aid the visual effect of a real railway; any paint on the rail tops and inside top edges must be removed to allow electrical contact between rail and the loco wheels.

Stage 5: Plaster covered bandage, cut into small rectangles and soaked in a bowl of water for a few seconds, has been layered over the lattice of card and the plaster carefully moulded before it sets to a slightly uneven finish to represent the underlying ground shape. Placing some masking tape over the track and sleepers in the area prior to plastering would help prevent the sleepers becoming covered in the white plaster! It easily comes off with the aid of a stiff brush once dried, however. Next and once the plaster has fully dried, is to paint all the white plaster with acrylic artist's paint. Use a dark brown colour to represent the base soil colour, such as Burnt Umber. Leave odd patches of white if desired on sharp slopes to represent any chalk face. Rocky outcrops can be modelled by using a suitable 'off white' scatter and blending it in with the surrounding earth and grass scatters. This can be seen to the right of the single line track where the cutting rises to meet the ground above in the Stage 6 picture.

Stage 6: Almost finished! The same scene but viewed from further away. Scatters in various shades of green with a base of earth brown plus scenic clumps and foliage have all been PVA glued in place and the entire track has been ballasted. Signalling has now been added (colour lights in this case) and some further scenic detailing has occurred in the field to the left of the main lines where 'farmer Gates' is mending his tractor as the estate manager arrives to offer his help and advice! A Falcon in lime green and chestnut prototype livery heads an up direction train over the girder bridge. Just the field, in the rear far corner and to the left of the passing train now requires added detailing.

Rock or chalk cuttings can be modelled by using cork bark for a representation of a rock face. The cork, which is sold in packs that contain several pieces of cork bark, is simply glued in place until the required height and length is reached. Some green and brown scatter material mix is then PVA glued into the nooks and crannies of the rock face and finally small clumps of lichen or similar are added to represent outcrops of bushes clinging to the rock face.

Chalk can be represented by thickly laid-on plaster, crack filler or Artex which is then impressed with crumpled kitchen foil while still wet. Press the foil into the surface of the wet plaster then remove it and add additional detail carved with the aid of the spoon handle or spatula. More plaster can be added if the chalk face is not just quite correct. When dry, as the chalk face will most likely be a white or off-white colour, little additional painting will be needed. Some areas will need to be touched in to give the impression of dirtier chalk or even a little earth on the flat ledges. Add a little brown and green scatter mix to these ledges and perhaps some lichen too.

The chalk face on a more modern image layout may have some anti chalk fall netting pinned over some of its surface. Don't forget there will often be boulders of dislodged chalk laying at the base of the cutting from earlier falls, which the railway engineers will not move as they are not causing any problems to the trains or the track.

Farmland is produced by laying suitable earth or grass coloured matting or a scatter mix over a pre-glued area of the baseboard. Where a ploughed field is to be represented then corrugated cardboard can be cut and laid to the size needed. The card is then overpainted with artist's acrylic paints in a dark brown colour and lighter shades of brown near the tops of the furrows where the sun has dried the soil. The area is covered with a glued-on mix of various brown scatters. Field edges are modelled to camouflage the join between field and baseboard. This can be a simple fence, a hedgerow or even a stone wall. Perhaps a scale tractor can be placed in the field or even some grazing sheep or cows on a plain grass field, to complete the scene. Don't forget the old weatherbeaten tree in the corner of a field too!

Industrial scenes are quite simple to model, as they are normally all on the same flat level (baseboard datum or on a raised sub baseboard) and consist of brick, steel or concrete 'boxes' which represent the buildings of the scene. 'Boxes' is perhaps a bit mean, as they will actually be detailed shaped buildings. These can be scratch built from card or plastic sheets or purchased as card or plastic kits or even as ready-made units There are hundreds of kits available to the modeller in virtually all the popular model railway scales. Many of the kits sold can be fairly easily altered from the original to produce a unique building by grafting two kits together or not using all of one kit and adding some chosen details from similar matching materials.

Depending on the timespan being depicted, the industrial estate can be modelled for today's modern era, as a series of similar pre-fabricated buildings or for the pre-1970s as two or three smaller units or one large 'works' – gas works, brewery, dairy, single factory or a works producing… what *did* they make in there? These are just some ideas of what is often found adjoining the line side. Some will have a siding in use, or if in a more modern era a disused siding serving the premises. Quite often the sidings entrance is controlled by a gate, similar to that of a level crossing wooden gate. This is normally shut across the siding and only opened when a goods train is due and is shunted in or out.

Towns will involve a lot more modelling work. Depicting houses in single, semi or terraced rows. It may show their fronts and backs or be of half relief and show just the front or rear of the building, including any alleyways. Model shops and pubs, offices and even garages too both in lock-up blocks or singly belonging to a house – they all can be modelled. Roads, pavements, street signs and lampposts all become a major part of the town scene as do lots of people. There are many kits of various styles of buildings available, in card, plastic, laser cut board and ready-painted resin moulded buildings. You can even build your own buildings from card or plastic sheet or a careful mix of both.

Buildings

Scratch building your own buildings, can be to a detailed scale plan of a real-life building or just something that is made up to fit a location. Card is perhaps the easiest material to work with and produces some fine buildings. Card is often clad with either brick or stone paper or with a plastic card. When plastic card is used, this will need painting to the desired finish. Some makes of building papers are produced by Superquick, Metcalfe and Scalescenes to name but three of many available. Plastic card is available from Wills, Evergreen and Plastikard in various scales. Ready-made buildings are produced by Hornby and Bachmann in 00 and N scales and by several other producers too.

To scratch build a simple card building you will require some basic tools. Firstly, a craft knife, ideally a scalpel type with a good supply of replacement blades (cutting card and paper quickly blunts knife blades). A steel rule can be used for cutting straight edges, a small (3 or 4 inch) steel set square, pencil and perhaps a self-healing cutting mat plus of course a solid and firm surface to work on.

Choice of card needs to be considered, as some card is manufactured in a twin thin wall form, spaced apart by a corrugation. I have not found this really suitable for buildings, preferring to use a card sold for making mounts for pictures. This is often available in A1 sizes and various colours, but I prefer plain white as this will not cause any 'show through' on the final covering of brick paper, if that is the chosen finish to be used. The card is nominally around 2.5mm thick.

Finally, you will need a suitable glue. UHU or a non-solvent based impact adhesive is adequate, though some of these tube glues do produce a lot of glue stringing, which is a nuisance and should be kept off the finished model. PVA applied with a fine artist's brush, which is occasionally dipped in clean water to remove any residue PVA, is my overall choice for card modelling.

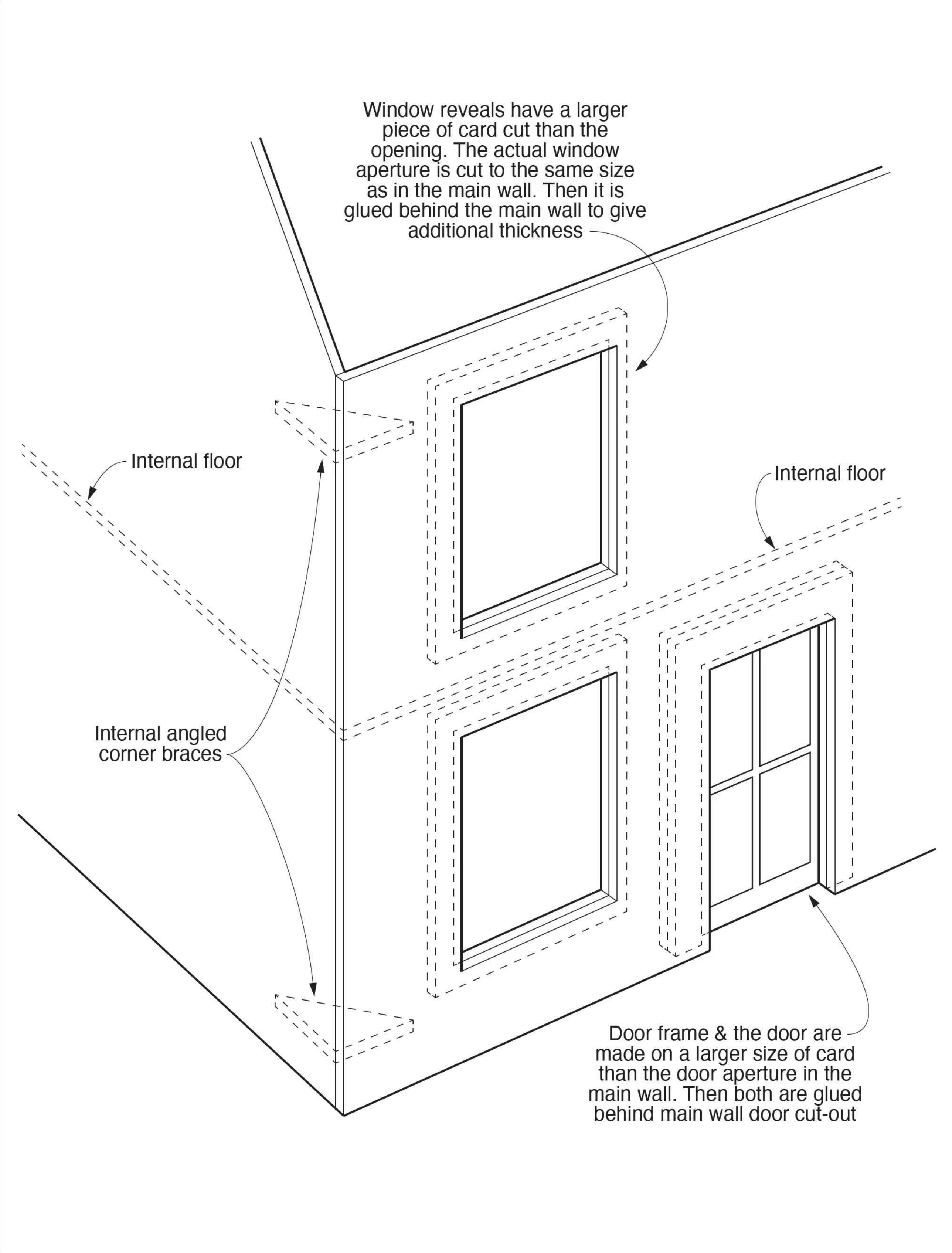


Figure 22: Basic card building construction. The door frame and door and window apertures are formed by gluing larger pieces of card behind the apertures and cutting out to the same size as the original openings.

A scene from the author's former layout West Haven.

Commence by drawing the basic shapes needed onto the card in pencil – front, back and two sides. Use the set square to ensure all right angles are true. Align the rule carefully onto the pencil line and carefully cut through the card with the scalpel, use several light strokes to make the cut. Do not press too hard or try and cut through the card in one go.

Keep your fingertips well inside the rule's edge and do not be tempted to use a wooden or plastic rule, as the knife blade will quickly cut into the edge and the rule will be useless. Next, draw the window and door apertures onto the now cut out sides, again using the set square to ensure all is drawn square. If you are going to use ready-made windows or doors, perhaps from plastic, then use these as a template and draw around them to obtain a tight or interference fit once the shape has been cut out.

To give the card model a realistic wall thickness, as seen at door and window openings, there is a simple little trick used on the model: simply cut a piece of the same card a little larger than the finished opening and then glue this onto the rear of the main wall's card, covering completely the position of the previously cut out door or window. When the glue has dried, carefully and with the aid of the steel rule and scalpel, cut through this backing card, following the originally cut out aperture sides. This then gives a double skin to the area of the aperture.

Cut some small, approximately 12 x 12mm, squares from spare card and then diagonally cut these squares into triangle shapes or fillets. Apply a continuous band of glue to one edge of the building's side and immediately butt up to this the adjoining wall. Keep the joint under light pressure until the glue grips the joint, all the time ensuring the joint is kept true in all directions and the bottom edges maintain a constant level in both directions. Now glue one triangle fillet, or as many as required, to the inside joint to set the corner joint at 90 degrees. Set aside to allow the glue to dry fully.

Proceed exactly the same with the other two walls. Once the walls are dry and set, temporarily dry assemble the four walls together and check when lightly held together that the structure is square and the walls all align correctly. Any discrepancies should be corrected at this stage by carefully removing any overly long wall sides to bring the structure back into square. Now, and only when all is correct with the dry fix, apply two strips of glue to the two edges of each wall set and carefully assemble the complete structure into the basic box shape. Once the glue has grabbed the structure, add more of the triangular fillets to square up and strengthen it. Place to one side and once the structure has been given a final check for square, leave for 24 hours.

Now, cut all the floors from card, by using the actual building as the template and drawing around the insides of the building's walls, to give the correct size for all the floors, including an internal base and any intermediate floors, plus a ceiling to fit at the top of the walls. Apply glue to the four sides of the base floor and fit into place flush with the bottom insides of the outer walls. Do not fit the intermediate or top ceiling boards at this stage.

Once the building has again been left aside to set fully, the next step is to produce the basic roof lining. Carefully measure the size of one of the roof side panels by measuring from the apex tip to the outer edge of the front wall and across the width of the two outer walls and then add a little to allow a small roof overhang all over the three wall sides. The amount of overhang needed will depend on the scale being modelled. For 'OO'/'HO', 2-3mm is probably ideal on each side. Transfer these measurements to the card and cut out one roof section. Carefully measure the other roof's overall size using the first roof panel being hand held in place on top of the building, to give the correct measurements. Cut out this roof and in pencil mark this panel as 'rear' section. Now it is time to add the exterior cladding.

Paper cladding

If you are using brick or stone paper then glue it on with the aid of either ready mixed wall paper adhesive or PVA – spreading the glue onto the card wall, not the paper. Align the brick courses level with the bottom of the building and carefully press the paper onto the glued card, covering over any door or window apertures. Lay the building, paper side down, onto the cutting mat and with a new blade in the scalpel, carefully cut the paper along the edge of the wall.

Now pierce the window and door openings centrally with the wall still laying face down on the cutting mat and then carefully slit the paper from each of the four corners to the previously made slit mark, making a sort of 'X' cut shape. Apply a little of the chosen paper adhesive all around on the inside of the aperture and along the edges of the opening too. Then carefully fold each of the little X flaps around the wall's reveal edge and secure onto the insides of the wall.

For doors only, bend over three of the flaps – the top and two sides only are glued into place around the aperture. The bottom flap is completely removed, if it has not already fallen off, following the original cutting out of the X shape. Turn the model over and do the same on the opposite and identical wall. Set aside to dry. When dry, apply glue onto one of the end walls and apply the paper, checking brick or stone courses align around the corners and also run level along the bottom of the wall.

When satisfied all is correct, very carefully trim by laying the newly papered wall, paper side down, on the cutting mat. Very carefully trim along the previously papered front and rear wall corner joints. Cut out, as before, any door or window aperture openings and glue back the flaps etc. Use artist's pastel sticks to tone in all edges and any small areas of bare card that may be showing. Use the pastel colours directly or ground into a fine dust and applied by a fine pointed brush as necessary.

Plastic cladding

If you have opted for a plastic cladding, then lay the card building onto the reverse side of the plastic card. In one corner, carefully, with the scalpel blade, draw around the wall's sides, scribing the outline onto the card. Remove the building and gently, with the aid of the steel rule, continue to deepen the scored lines until finally the knife breaks through the embossed surface and the panel can be removed. Mark this cut panel and make a matching mark on the corresponding wall e.g. '1' or 'A' and mark the top edge 'top'.

Proceed as above, marking out and cutting the remaining three walls, marking each with a unique identification number or letter and which edge is top. When all four panels have been cut, apply the chosen adhesive to one wall. Most modellers like to use an impact adhesive to bond the plastic to the card, but do test a small amount of the glue on a scrap piece of the plastic to ensure it doesn't cause any wrinkling or other unwanted effect on the plastic. Spread the glue over the wall surface and bond on the plastic.

Carefully trim off any overhangs by laying the wall face down onto the cutting mat and trimming along the card/plastic edge. Continue on and glue the remaining three sides in place ensuring that the 'top' mark is maintained throughout! Trim any overhangs as before. Cut out door and window openings in the same way as for trimming overhangs. Slivers of embossed plastic card can be cut and glued into the window and door reveals if desired.

If the chosen plastic is one of the thicker sizes e.g. Wills card, which is quite thick, there often is no need to produce a card backing as these plastic sheets will self-support. However, on the corners there will be a need to chamfer all corner joints to approximately 45 degrees inwards, which will mean each panel has to be cut over size to allow for this! Gluing plastic to plastic is quite straightforward and I recommend the use of one of the liquid types of solvent glues such as 'Metpak'. These liquids are applied to the joints,

A road over rail bridge with a station booking office building on top, shown under basic construction. The station building is still removable but has been laid into place to check dimensions. The card used is mounting card and the structure is to be covered in brick paper.

whenever possible, on their inner faces, thereby preventing any accidental glue damage to the surface of the finished model.

Simply hold the two parts to be bonded together and use an old artist's brush dipped into the liquid solvent, then run the brush along the length of the joint, applying a little more of the solvent if the area being brushed is on the long side. The liquid solvent flows under capillary action into the joint and causes the two plastic surfaces to melt and bond together. Carefully place the two joined parts to one side to allow the joint to fully dry and become solid. This may take several hours depending on the plastic and the solvent used. Other pieces of the construction can be completed while these joints dry.

When using solvent glues always ensure there is adequate fresh air entering into the room, as the fumes they emit are quite harmful. I recommend standing the bottle of solvent in an old coffee mug or use a large lump of Blu Tack or similar on the bottle's base to prevent them accidently being knocked over. It is sure to fall over and run everywhere if you don't try to prevent it!

Finishing off

Once the basic shell is complete, add any internal wall decoration as required and then glue into place the door and windows which, if plastic, have previously been painted and are thoroughly dry. Plastic windows can have some clear Acetate sheet carefully glued over their inside to represent glazing. Now glue in place any intermediate floors and the ceiling panel having firstly painted the flooring to a chosen colour. If internal details are required such as curtains, furniture or people these should be added before the appropriate intermediate or ceiling panels are fitted. Finally, glue the two roof panels into place – ensuring the ridge of the roof is kept tightly joined and runs straight. Add the chosen roof finish, which can be tile or slate paper, plastic card or individually cut tiles or slates from card or plastic and laid on from the bottom edge up and overlapping the previous row a little.

Finally, add details such as gutters, down pipes, waste or soil pipes serving bathrooms or WCs, door canopies, even perhaps on older buildings external wall tie plates often seen as 'S' shapes on the wall at intermediate floor level, and road names if the building is on a corner.

The same bridge and building now virtually complete with some further small detailing still to be undertaken.

Chimney stacks, both side and centrally located and their pots are added as required. Finely detailed parts, some as described, can be obtained from good model shops which are made from plastic or a brass etch.

Remember, it is those little details that make the model stand out from the rest!

Bridges and tunnels

These commonly form a part of the model railway. Bridges can carry a road over the railway, railway over a road, railway over another railway or a railway over a river or stream. They normally have brick, stone or concrete abutments with the bridge span made from steel plate girders, all concrete or all brick or stone arches and perhaps even a mixture of two in one bridge length can sometimes be seen. They can be very short in length, where for example a farmer uses the narrow underpass as a means of moving cattle from one field to another, known as a cattle creep or where a culvert is required to drain the land into a stream.

Much longer and normally taller bridges, called viaducts, are normally multi-arched crossings over a river or at times used where low lying land is far below where the railway line is running above on embankments. There are many ready-made bridges available as well as kits. For the scratch builder, there are sections of bridges readily available to enable them to produce a good and realistic example. Some kits allow the constructor to alter the basic configuration and produce a unique bridge suitable for the area needed to be covered by the bridge span.

Again the use of card and either brick or stone papers or embossed plastic card is a good way of producing either a complete arched bridge or just the abutments to support the chosen span's material. Metal girder spans, usually made in plastic, are sold for use in most gauges from suppliers such as Peco, Ratio and Wills.

The tunnel requires a reason to be there; therefore the surrounding land should slowly rise from the baseboard's datum to above the tunnel portal height. Usually a cutting is seen prior to a tunnel, where the real railway builder started digging out the surrounding land for the railway, then the cutting became too steep or there were other obstructions in the path of the railway, so the builder had to tunnel underground. Tunnelling when building the real railway is an extremely expensive and time-consuming option to undertake and would be avoided whenever possible.

The railway passes over a plate girder bridge spanning, unseen in the picture, a single line track and a single line tunnel portal.

The entrance to the tunnel is called a portal and is normally made from brick or stone and can span one or two tracks. Most tunnel portals will have wing or side walls retaining the ground around the tunnel entrance. The inside of the tunnel is not always a perfect circular shape, often more of an elliptical curve with shallower sides and a more curved roof.

Not all tunnels are fully brick or stone lined internally and some only have a few feet of entrance clad in brick and the rest just made from the dugout substrate of the rock or chalk. Of course from the model point, most of the internal area will need to be painted a matt black to represent the darkness of the tunnel and only the first couple of inches or so need be covered with brick or stone paper or embossed plastic card. There are many ready-made tunnel portals and some produced in kit form too. The modeller can make their own in the same fashion as bridge abutments are produced, by using card with brick or stone paper or plastic card covering.

Avoid the 'train set' ready-made tunnel which is really unrealistic and looks like a hillock stuck in the landscape.

Remember to arrange to have adequate track access to the inside of a tunnel, as it is an unwritten law that the train will derail or fail somewhere inside the tunnel and you will need to access it. There is of course also a need to clean the rails in the tunnel. Access can be from the back, underneath or via a lift-off top scenic section. Whichever access method is chosen, it must give easy access to the tracks inside the tunnel.

Painting the buildings; wherever possible, always use a matt finish paint. If you looked at a real building from around 250ft away, which is equal roughly to the scale distance you are viewing the model from at approximately 3ft away, the distance causes the gloss of the paint to appear a matt or semi matt finish on the real thing. So a matt paint finish on the model will add that little extra to the realism.

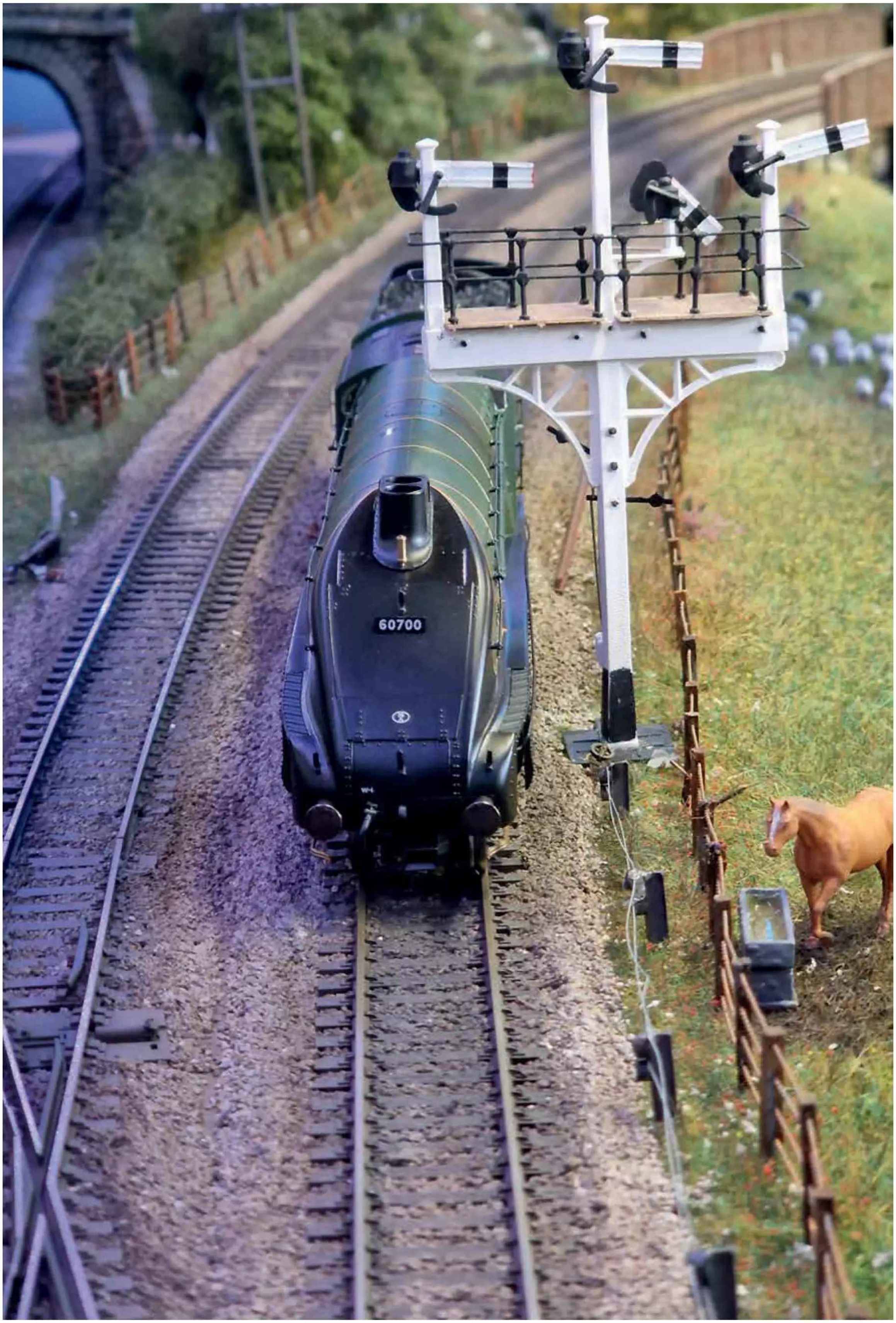
If you are using oil-based paints, such as those sold under the Humbrol range etc. and there is no matt finish available, I recommend the use of a little talcum powder mixed into the gloss paint and

A single-track line entering a tunnel portal.

thoroughly stirred up. The talc absorbs and removes most of the gloss, but do not overdo the talc or you will end up with an unworkable sludge! Mix a little and try the mixture on a scrap piece of plastic; you can always add a little more talc if need be, but it is impossible to remove any that has been overmixed! Use a high-quality artist's brush to apply the paint. Skimping here with brush quality will result in brush lines showing. Always allow at least 24 hours to pass between subsequent coats. If you can, place the painted model in a dust-free area to dry. An airing cupboard is an ideal place and put the model into an

A set of ready painted 'OO' modern track worker figures. *Picture courtesy of © Bachmann Europe Ltd*

A scene from the author's current layout – High Hopes.



Detailing can bring the model to almost lifelike reality. Note the multi-armed semaphore signal and its signal wires, animals in the field, telegraph poles and textured landscape, all enhancing the scene. *Image courtesy of Steve Mumford*

A view of the author's former layout showing people placed in realistic poses.

old shoe box or similar to prevent any dust falling or being blown onto the wet paint.

Whenever possible, apply light colours first, followed by the darker ones. However, where brick or dark stonework is being represented, the need for the base colour is often first, e.g. brick red. This base coat may at times be a darker colour than the colours used to highlight the various shades of individual bricks or stone blocks. Later on, some stones or bricks can be picked out individually.

Once the base colour has fully dried and the individual stones or bricks have been painted in and dried, use a technique called 'Dry Brushing' to lightly wipe over the base coat to infill any small areas and bring out the highlights. Often a dirty wash of colour is used for this, mixing black, grey and a little white until a grimy colour is reached. To dry brush, dip the tip of a clean brush into the paint and immediately wipe off 90-95% of the paint onto a clean tissue. Then very lightly wipe the now almost dry brush over the surface to be highlighted. What little paint the brush transfers will deepen very slightly the surface colour and cause a more realistic appearance on the model, than if left in the base colours.

Roads, vehicles and people

Roads will possibly need to be modelled to serve our countryside, certainly in the industrial areas and towns. These can be made from thin card or as I prefer, 2-3mm MDF sheet cut to the profile of the required area. Paint the road surface, if it is to represent tarmac, in a medium to dark grey matt, then add shades of darker grey nearer the road edges and centreline where traffic doesn't normally run.

White lines or road markings can be reproduced by using thin strips cut from self-adhesive paper, as used for printer labels. However, I have found road markings tend to turn a fairly realistic scene into a toy! So, use with care and only if really necessary. Pavements are not always seen in industrial or countryside areas but can be modelled. There are several manufacturers of card and plastic sheets replicating pavements and kerb stones, so there is in my opinion little point in trying to scribe thin wet plaster into paving slab shapes, as eventually it will probably crack and look poor anyway.

When laying pavements, ensure your buildings actually sit inside the pavement. This gives the building the correct appearance of being there before the pavement was laid rather than the building sitting on top of the pavement and looking like it has just been dropped there and seeming totally out of place.

Try to place scale sized road vehicles in realistic poses on the model road. I usually avoid having any vehicles turning a corner, as they never look quite correct. Have them placed as if they are about to turn the corner or enter a junction, or they are placed just after the corner or junction and have already straightened up. Add scale people to the pavements or factory yards in the industrial complex. Have them posed in a small group of two to three talking together, waiting for a bus or about to move an object and also a few just walking along doing their own thing.

People in suitable scale sizes can be obtained as either ready painted or in unpainted plastic or white metal castings, which are then painted in your own choice of colours. Always use a matt paint for people's clothing and do remove the 'block of concrete' some plastic figures have on their feet. Use a new scalpel blade to carefully slice the figure's shoes away from the moulded block. Use superglue to hold them in place on the pavement or wherever they are to be placed. An alternatively is to drill a fine hole up through one foot into the figure's leg and then glue a sewing pin into the hole and cut off the pin's head. Drill a similar sized hole in the location where the figure is to stand and place the pin into the hole, ensuring the figure's foot or shoe is correctly down onto the ground.

6
ELECTRICAL

Model railways normally operate on safe low voltage power supplies, typically 12-volt direct current (DC). There are some other styles which run at 24-volt DC or 12-volt alternating current (AC), though these are in the minority. Some use mains-based power supplies, which safely reduce the input voltage to the low voltage needed and where necessary convert the mains power from AC to DC, while others use on-board batteries, which are often rechargeable, to power their motors. Digital Command Control (DCC) nominally has a rail voltage of around 13.5 to 16 volts.

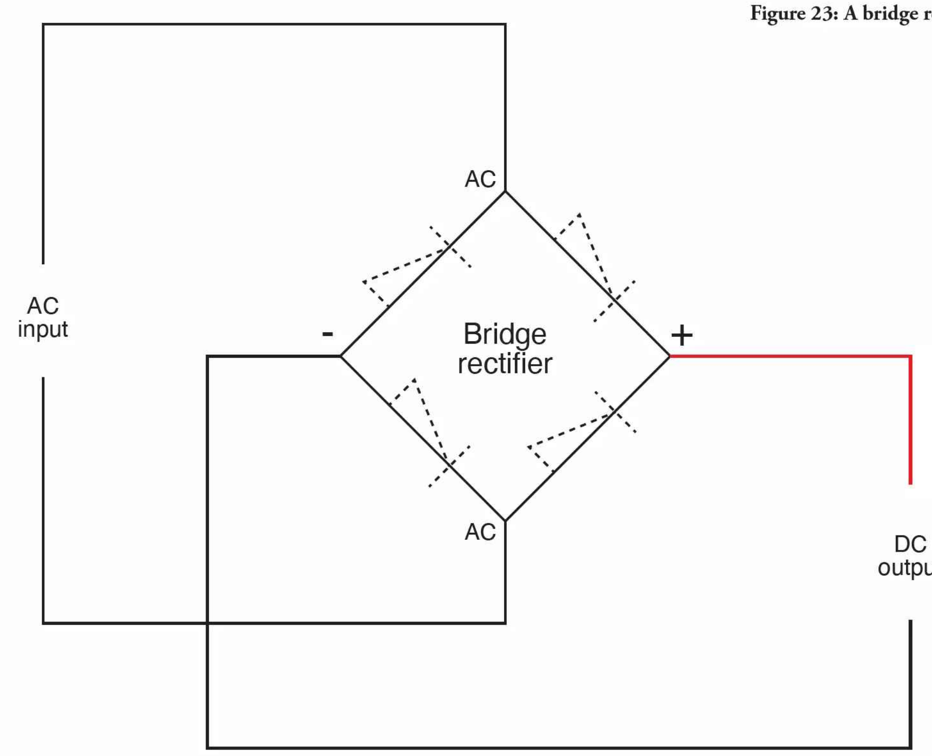
Firstly a word of warning: *never allow mains power (230v AC in the UK) to go anywhere on the baseboard. If mains voltage is allowed onto the baseboard there is a very serious risk of electrocution and possible death.* Only safe low voltages should be used here. Mains supplies and all the associated transformers should be housed in commercially made or expertly produced enclosures, which should either be 'floor' or 'off layout' mounted. Umbilical cables or individual wires then supply the appropriate safe and low voltages onto the layout.

The only exception to this rule is where a commercially made controller with built in transformer requires a direct mains input; this will normally be via a suitable flexible mains cable, often permanently fitted into the controller's casing, though some controllers employ the use of a 'kettle' or computer style mains plug and socket for the mains power input connection. Both of these styles are safe and no further action is required other than the occasional inspection of the mains cable and any plugs for possible damage. Any damage noted should immediately render the cable or unit unusable until a professional repair is undertaken or the unit is replaced.

Control equipment

The **transformer** (isolating transformer) is the means by which AC mains electricity is converted from a high to a lower voltage (the reverse is also possible i.e. low to high volts, but this isn't normally used on a

Figure 23: A bridge rectifier circuit.



A typical diode. The silver banded end is the Cathode (negative) connection.

model railway). Transformers are available in many guises; they are sold as plug in units, free standing units with one or two cables connecting into them (normally the mains input cable and low volt output leads), or sold as a totally encased unit. There is one other type which needs expert safe installation; this is known as an 'open' or uncased transformer, which can be purchased from many specialist suppliers such as Gaugemaster. All the above are all just transformers; they offer no actual control of the trains, but simply reduce the AC mains power to the required safe low voltages used on model railways.

The **rectifier** is a device used to convert AC current into DC current. Most model railway power supplies will have at least one full wave (bridge) rectifier fitted into their low voltage supplies to provide a DC power source. Modern full wave bridge rectifiers used for model railways are made from four 'rectifier diodes'. Diodes can be likened to a one way valve for the flow of electrons or electricity – the current will pass one way through the diode but is prevented from flowing back the other way. Often bridge rectifiers are factory encased into a plastic moulded block. They will have four connection terminals or wires on their casing. Two are the AC input connections marked normally as either 'AC' or with a wave form symbol (~). The two DC output terminals being marked as + (Positive) and – (Negative).

The full wave rectifier produces a reasonable, but unsmoothed, DC at its output terminals which is ideal for most model railway applications. A bridge rectifier is shown in Figure 23.

The diagram shows how the alternating current (AC) flows from its supply into the bridge rectifier then, via the four diodes, it is passed out as a DC supply. How is this achieved? When the AC frequency on the supply wires is at positive on the upper wire (negative on the lower) the positive current flows into the bridge and is blocked by the upper left diode. However, it can flow via the upper right diode out to the DC positive wire. The DC negative then returns via the black DC wire into the bridge rectifier and then can flow back to its AC negative source via the lower left diode.

The AC supply changes over polarity and now the positive side of the AC cycle is on the lower input wire. It now flows via the lower right diode to reach the DC side's positive wire. The negative DC, still on the black wire, returns to its AC negative via the upper left diode. Remember, the AC supply is changing polarity at some 50 times a second in the UK (60 times a second in some other parts of the world) and is known as the AC frequency or Hertz. The DC output still has a small ripple of AC in it which can cause problems with some electronics, so further smoothing of the DC is needed which is usually carried out by placing an electrolytic capacitor across the DC output.

Simpler half wave rectification can be produced by using just one diode wired into one AC supply's path. Unfortunately the output is a very rough formation of the direct current needed and actually has only 50% of the total AC frequency turned into the DC form. For example, where a 50Hz AC supply is converted via a single diode only half of the 50hz (half wave) is allowed to pass through the diode, therefore the output can be considered as being switched on and off 50 times every second. So it is very limited in its applications.

A bridge rectifier. The chamfered corner on the body of the bridge rectifier is the DC positive connection and is denoted by the engraved + symbol.

A Hornby plug-in UK mains transformer item P9100. *Courtesy and © of Hornby Hobbies Ltd*

One of Hornby's low voltage train controllers, item R7229. *Courtesy and © of Hornby Hobbies Ltd*

DC controllers are next in the line of train control. Here we will find many variants, but basically they are all doing the same job. They take a specified low voltage input, which is often 16 to 19 volts and usually convert it to DC via a built in rectifier. Some desk style controllers have built in transformers, such as the Hornby HM2000 or the Gaugemaster 'Model D', while others have a mains plug-in transformer and a low voltage cord to feed the controller. Some only have a 16-volt AC input and these are normally the panel mounting or hand-held controller versions.

The output from the controller is referred to as the 'controlled' supply, as turning the controller's knob up increases output while turning it down reduces it. From the controller's 'controlled' output we take this supply to the rails and power our trains. Some controllers will offer more than one output, especially where a mains transformer is built in. Typically on a single knob transformer controller there will be one 12-volt DC controlled output, one 12-volt DC uncontrolled and one 16-volt AC uncontrolled output or at times just one of the latter two.

The Hornby HM2000 twin track controller with built-in transformer. *Courtesy and © of Hornby Hobbies Ltd*

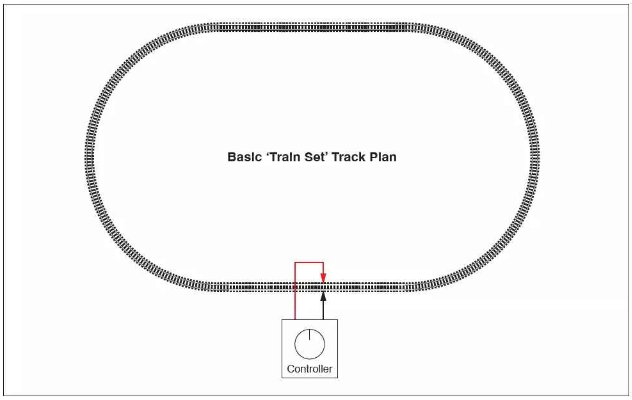


Figure 24: The basic train set controller is often one controller feeding one simple loop of track. I am showing in all these next five drawings the track as a solid line for ease of understanding and simpler drawing.

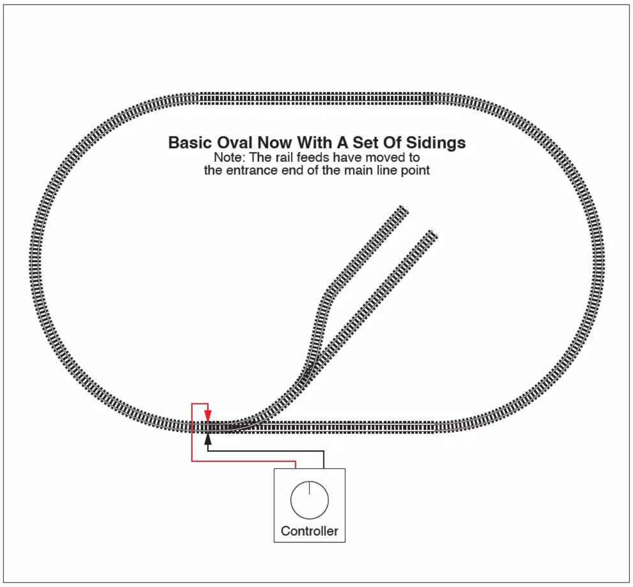


Figure 25: A siding is added to the basic oval of track. Note that the controller's rail feed has moved so that it now feeds directly into the points single end.

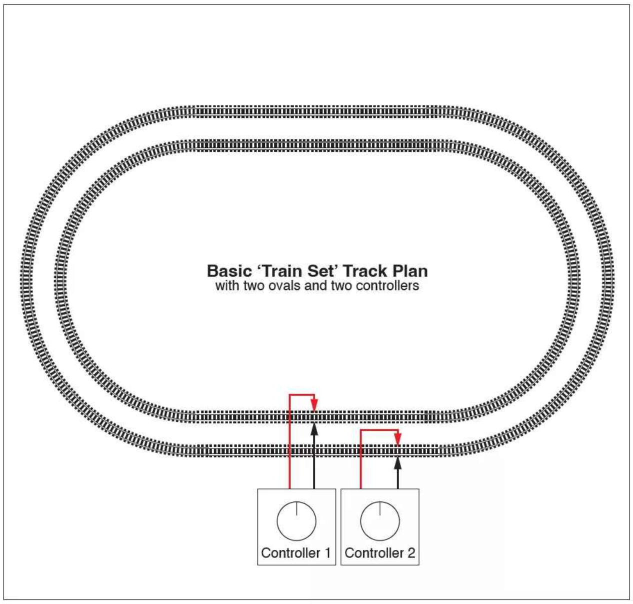


Figure 26: Adding a second loop means that another DC controller will be required, and this is shown in the basic twin controller and track feeding drawing above. Note the two controllers shown can be either two separate units or a dual controller having two separate control knobs in one case.

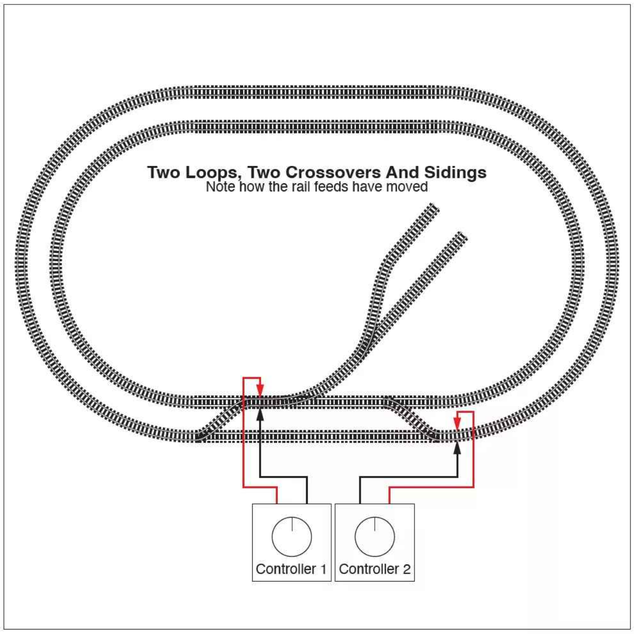


Figure 27: In this simple track plan and wiring diagram, the inner loop has two sidings added, plus two sets of crossover points connect inner to outer loops. Note too how the rail feeds have moved to ensure constant rail feeding via any point position.

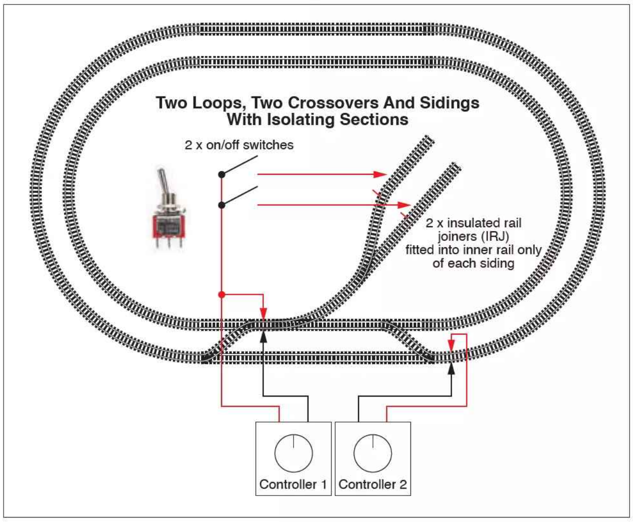


Figure 28: By installing Insulated Rail Joiners (IRJs) into one rail of each siding and adding additional rail feeds via on/off switches fed from the appropriate controller, each siding can hold a locomotive that can be isolated from the main controller, thereby allowing locos to be stabled in each siding, while running operations using other locos can be carried out on the main line and in the sidings up to the IRJs. All points in these five illustrations are the Insulated type.

The controlled output is used to power the track while the 12-volt uncontrolled DC can be used to feed a second controller or power some accessories such as building lighting. The 16-volt AC output can feed a hand-held controller or more normally this is used to provide power to operate solenoid style point motors, perhaps via a Capacitor Discharge Unit (CDU) and momentary contact lever or toggle switches. More of that later.

Wiring diagrams and track plans

Now is the time to start thinking of how the final layout will operate. Will there be one operator or more? Will there by one or more control panels or, if you decide not to use a custom made control panel, controller locations? I'll assume, for this discussion, that one control panel has been decided upon and provision for one or two operators, though one person can operate the layout single-handedly if need be.

Draw out your track plan and then start to consider where track power feeds will be required and where DC isolating sections will need to be installed. Remember, always try and feed the track power into a set of points from the single line tip or switch rail ends, never back from the frog direction. When using live frog (electrofrog) points you should install two rail isolating breaks – Insulated Rail Joiners (IRJs) – ideally placed on the points rail ends after the frog on the two vee rail ends. If you are using Insulated frog (insulfrog) points such as Hornby or Peco Setrack or the Peco Streamline insulfrog versions, then the use of insulated joiners is greatly reduced as the point switches the rail power, i.e. the track to which the point is set is the only powered section. The other direction is isolated until it is selected as the required route, then the former track becomes isolated.

Consider how you may wish to switch certain sections of track between two or more controllers, making a 'Cab Control' system. Also, are any DC isolated sections of track required for locomotive storage while the rest of the layout is being powered?

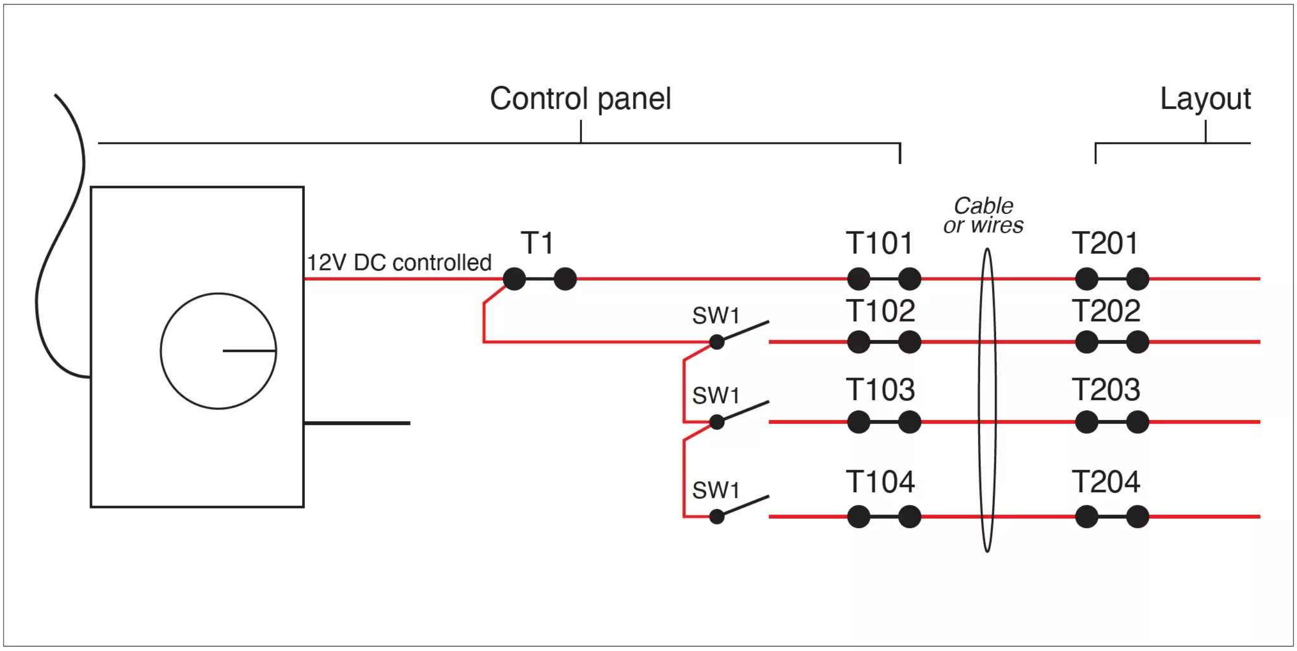


Figure 29: Wiring diagrams can be as simple as the example shown. Here, and for illustration only, one of the controller's two output terminal wires is shown feeding one direct rail track feed and three isolating switches. As the wiring passes around the layout there is a need for terminals and these are shown as 'dumbbell' symbols representing the two sides of the screw terminal block as shown in the illustration below. On a portable layout there would also be plug and socket pins to be shown to allow cross board connections. Each item is uniquely labelled to aid future wire tracing or fault finding. 16 wires, 3 switches and 9 terminals are shown. Note the switches are drawn open (isolated or off). The black return wire is not switched and runs directly to the appropriate rail(s) used as the return. It can of course connect to several places on the same handed rail around the layout to ensure a better flow of power.

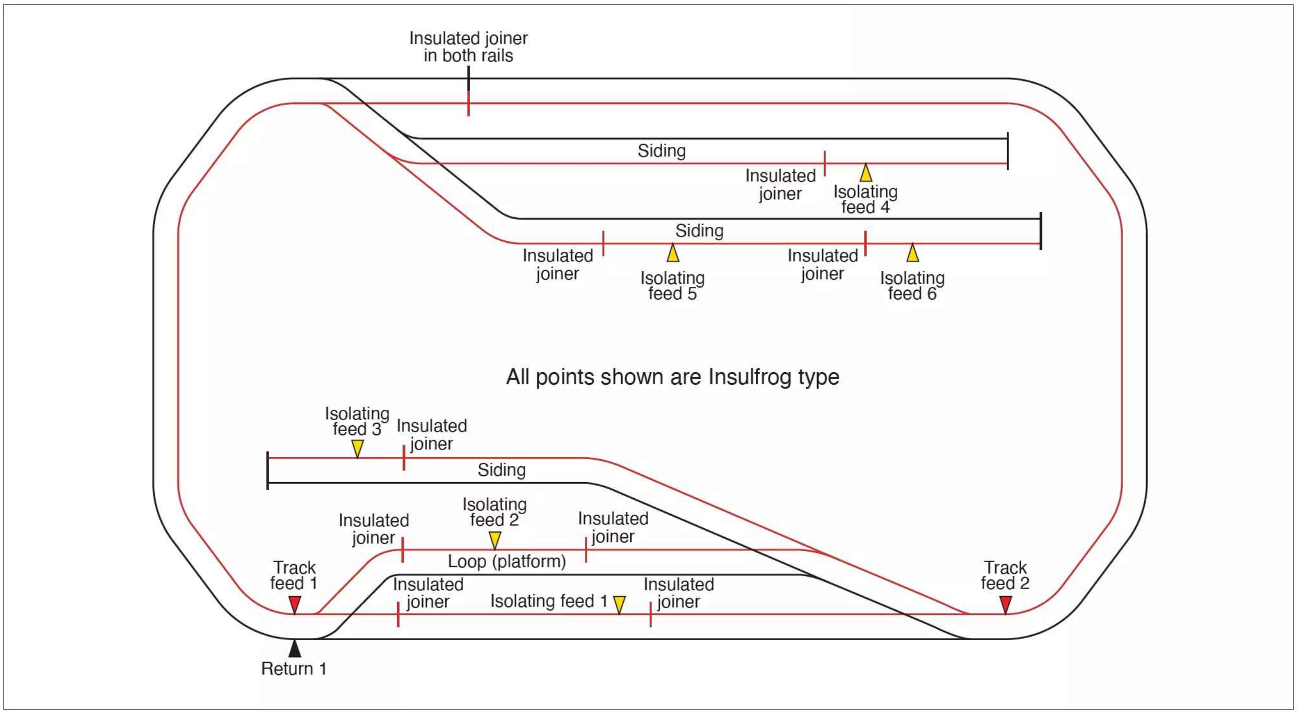


Figure 30: Track plans need to be kept reasonably simple, yet still fully represent the whole layout. Shown in the track plan here is a single track railway operated as a continuous run, with one passing loop for the station platform and three sidings.
Electrical track feeds on the track plan are shown by the triangles – solid red are positive feeds, solid black for the return or negative connections, while isolating section feeds are shown as yellow triangles. Insulated rail joints are shown in each rail as required. It will be noted that there are two track feeds 1 and 2 (red triangles) along the lower length of the track but only one black return connection. This is because the actual loop of track on the red rail is isolated by two insulated rail joiners in the platform area and another set of insulated joiners at the top. Only this time here both rails are fitted with insulated joiners. All points provide track power switching for the direction set.

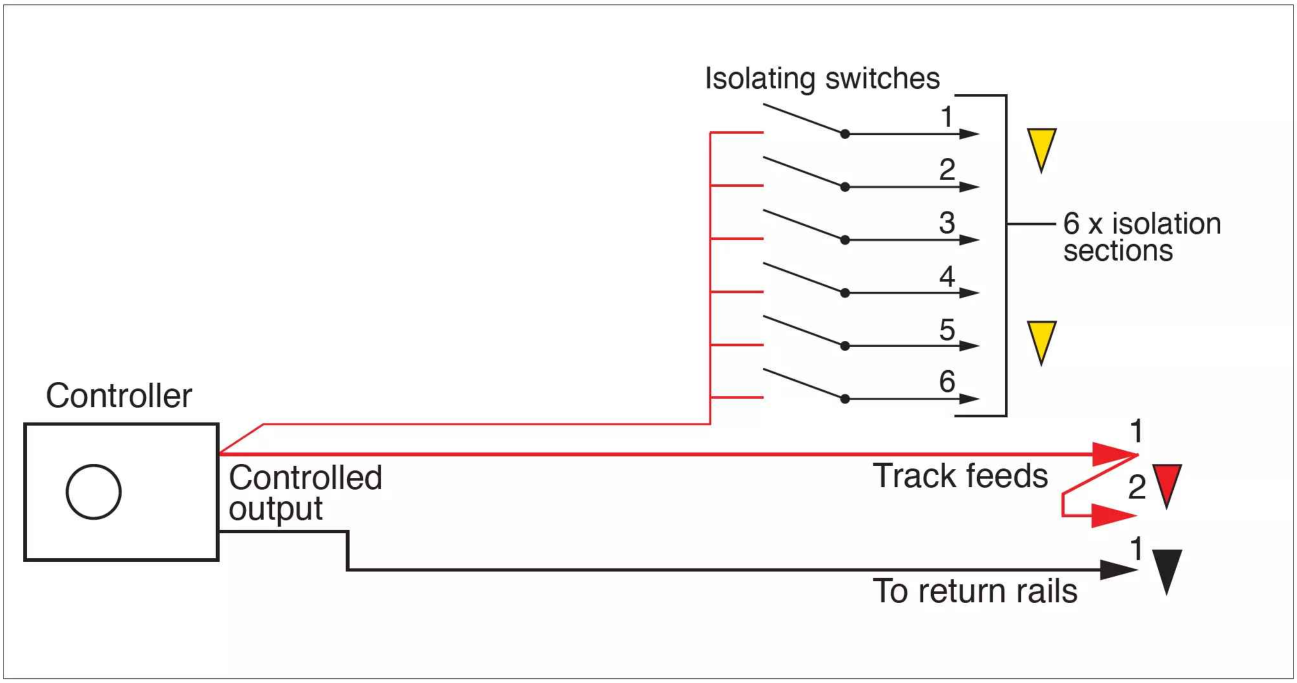
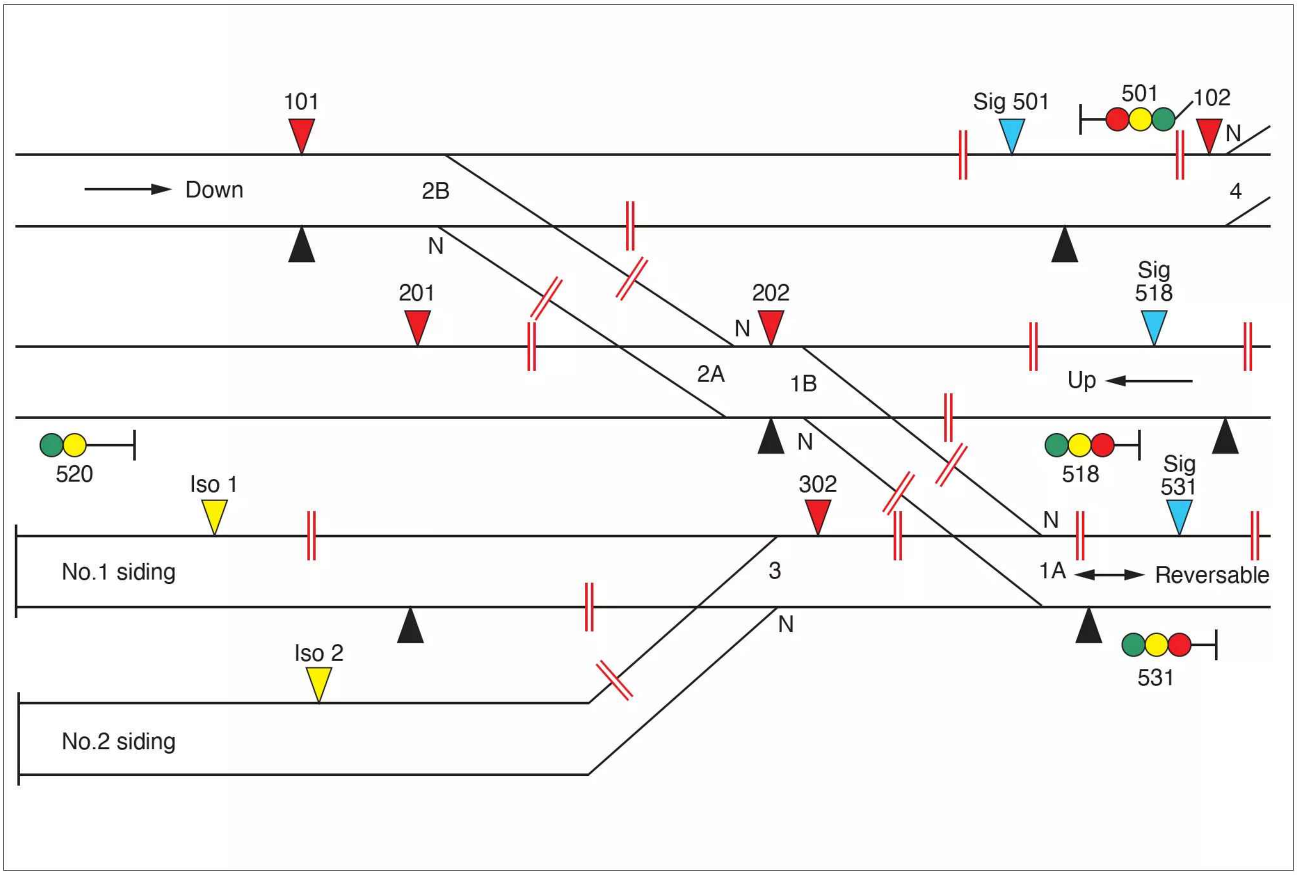


Figure 31: The actual track feed wiring diagram for this simple plan is shown here.



Reproduced here is a real track plan from a former layout. Note the use of a unique series of numbers for the down line track feeds (100 series), up line track feeds (200 series) and the introduction of point numbering and the normal position of the points shown by a letter 'N' on the switch blade side which is closed for the route chosen as normal. The blue triangles are track feeds controlled by the signals aspect. Signal at red equals track feed off, signal at yellow or green the track feed is restored. As all the points are live frog, there is a need to install more insulated rail joints, hence the red lines shown cutting across the rails. All this information helps with pre-planning, track installation, wiring and any later alterations or fault finding.

Wiring diagrams and track plans can be ignored for layouts that are little more than a basic oval of track. However, anything larger and they become virtually a must. They need not be overly complex and can be little more than sheets of text in a notebook. However, for full reference, a nicely drawn and annotated wiring sheet and track plan book is the perfect reference for later fault-finding or alterations to circuits.

What is in this book? Well, the basic track plan is drawn as lines representing the rails and all points and crossings are shown. Onto the track is drawn electrical feeds (positive and negative); all insulated rail joiners are shown and any Isolating section feeds are also shown. Additionally, signals can be depicted. Every track feed is given a sequential number, as are all the point ends. Isolating section feeds are given a different series of numbers from that used to show the main electrical feeds. If you choose to run coloured wires for certain functions, then these colours should be shown too. Any terminal blocks used should be clearly shown, together with the actual terminal number used for each circuit. Basically for wiring diagrams, one drawn line represents the actual piece of wire on the layout.

Track and wiring plans could be produced on a computer or if preferred on plain paper with the aid of a rule and some coloured pencils. There is nothing really high tech with a track plan or wiring diagram. I use a ring binder to store all my sheets, as they change far too quickly!

Common return

Common return is where all track and accessory electrical return paths are fed onto one – common – wire. Every return path is connected together, then one or more (if need be) return wires go back to one or all of the appropriate controller's output terminals for all supplies – AC and DC. The reason this method is chosen, is its simplicity of wiring and the reduced number of wires needed to get everything back to the controllers and PSUs. Note: common return is not used with DCC layouts. There are, of course, other methods of wiring and by no means is common return any better than any other.

One other method of return is by giving each return its own direct wire path, but this is hugely wasteful on wiring. Another alternative is to consider splitting returns to, say, all track power supplies, all point power, all signalling, all lighting and everything else i.e. up to five return paths. There is no advantage in this over the conventional one wire common return system.

One thing that must be certain before the common return can be used is that each low voltage output – train controller of other supply originates from a totally separate winding on the transformer or is from separate transformers. One transformer winding, feeding two outputs or controllers, with a common return wire linking their connections, will result in a certain short circuit occurring and this type of supply cannot be used for common return.

A simplistic overview of how a common return system is wired is shown in Figure 33. Note that all the supplies are from separate transformers or separate output windings on the same transformer. Then one output terminal from each supply is linked (or common connected) to the next, and finally a heavy gauge of wire is taken onto the layout for all circuit returns to connect onto. The DC and AC supplies are intermixed and all

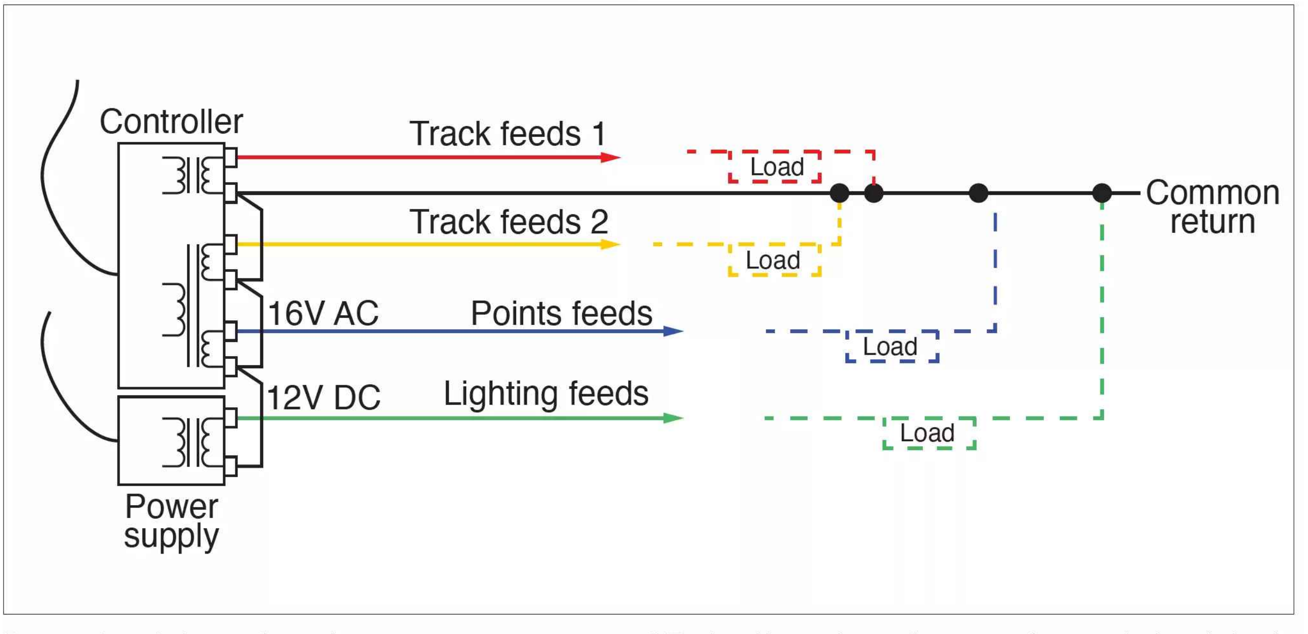


Figure 33: A simple diagram showing how a common return system is wired. The dotted lines and rectangles represent the various loads applied to the circuit, e.g. loco motors, point motors, lamps for street or station illumination and building lighting etc.

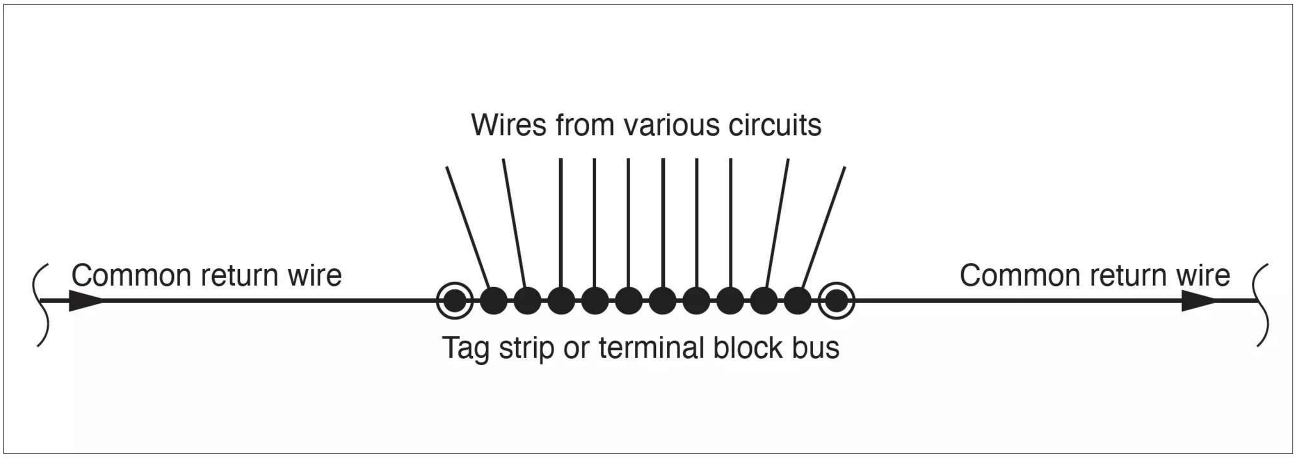


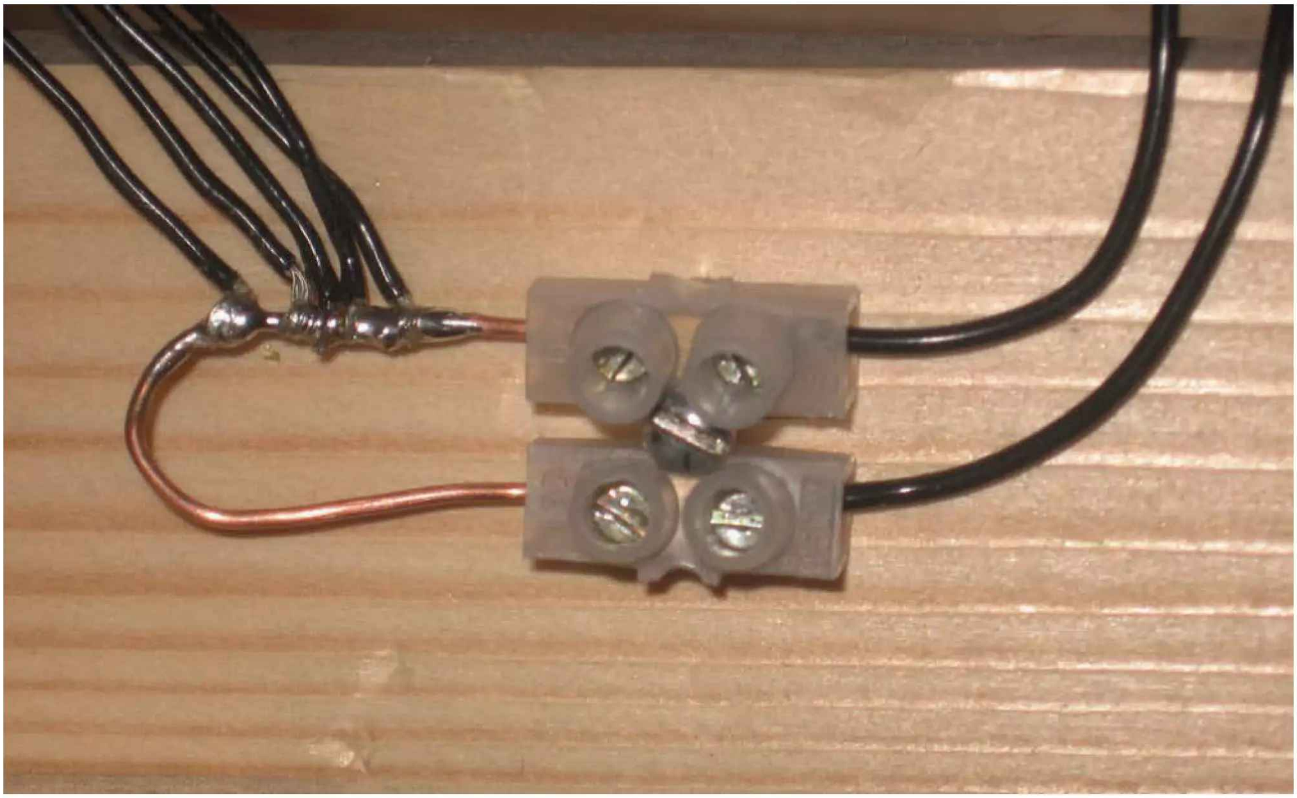
Figure 34: A common return bus bar connection.

work happily together. So long as each feed is from a totally separate supply or winding.

Roughly in the middle of each baseboard or around every 24-36 or so inches (600mm to 900mm), place a common return bus bar connection. This need be nothing more than a piece of single tag strip or two terminal connector blocks with a length of bare wire (1mm copper domestic wire is ideal) linking across the two terminals. The common return wire arrives at one terminal of the common connection, then the electrical path is via the copper bus wire to leave again via the opposite tag or terminal, leading to the other sections of the layout. The electrical returns from that baseboard or section of baseboard are soldered onto the copper wire of this common return bus bar, as shown in Figure 34.

Types of wire

Wire used on the layout should ideally be of a flexible type for all electrical work, nominally 7/0.2mm,



A two-way terminal block used as a common return bus connection point. The common return wiring is seen entering and leaving on the right, while on the left is a copper link of wire. This links incoming to outgoing return wires. Onto this linking wire are soldered the local return wires from the rails, point motors, signals and any layout lighting etc. The copper link or bus wire also gives a suitable place with easy access to connect a multimeter or other testing device's lead to enable testing and checking of circuits.

16/0.2mm, 24/0.2mm and 32/0.2mm, the latter two are often used for all common return wiring – which might be kept to a black coloured wire sheath.

The first number, for example '7', is the number of copper wire strands inside the PVC insulation or sheath and 0.2mm is the actual size of each of these individual wire strands. So there are seven copper wire strands, each of 0.2mm diameter inside the sheathing of 7/0.2mm. Therefore 16/0.2mm has 16 individual wire strands inside its insulation covering and so on.

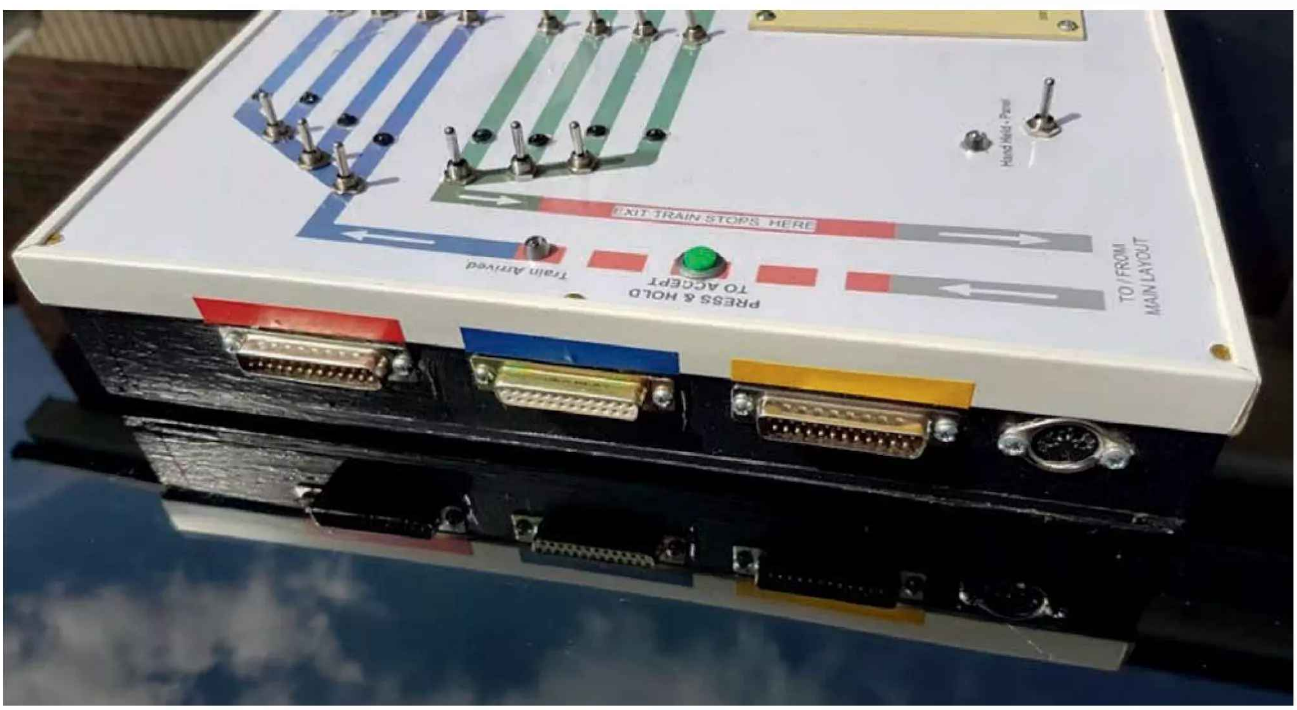
The colour of the sheathing really does not matter, red, green, blue, yellow etc. you can use all one colour or decide to make it colour specific e.g. red for all track feeds and perhaps then use all point feeds in blue, it is your choice. 7/0.2mm can carry nominally 1.4 amps, so it is ideal for most DC model railway wiring on 'N' gauge and in some situations in 'OO' gauge, while the larger 16/0.2mm can carry at least 3.0amps and is suited to the larger gauges of railways ('O' or 'G' etc). 16/0.2mm is also ideal for 'N' and 'OO' solenoid point motor wiring or on small layouts as a common return wire, where at any one time there might be a two or three amps flowing. On larger layouts consider using 24/0.2mm for point motor feeds, 16/0.2mm for track feeds and a common return wire of 32/0.2mm or 50/0.2mm to allow overcoming any volt drop and of course increased current flow.

The use of solid single strand wire should really be avoided. In the main this is the so-called telephone cable or wire or bell wire. While it will work, it breaks far too easily, suffers severe volt drop due to its small conductor size and therefore reduces the current carrying capability and is certainly not suitable for any layout that is portable. So keep with the flexible types. Cable sold for burglar alarm installations is at times a good choice though; this cable is normally sold in 4, 6, 8 or more cores in one cable sheath and has flexible conductors often of the 7/0.2mm size. It is ideal for bringing indications back to the control panel or operating colour light signals etc.

If your layout is medium to large in size, say over 10' x 6' 6" (3 x 2m), then consider carefully, at the planning stage, the size of the all control circuit wires. Allow a margin of error in wire size and opt for the next larger size if need be. If problems are encountered after wiring, such as solenoid point motors failing to throw every time, then you can always double up the problem circuits wires, this will help overcome any volt drop problems and also give more current flow potential.

How to wire a layout

As previously mentioned under the baseboard chapter, I recommend drilling 15-20mm diameter holes roughly centrally into all the cross bracing timbers below the baseboard. This will allow ample wire running access



Shown here are three 25 way sub D connectors on the side of a layouts control panel, where the connections from the panel to the layout frequently need parting. Note the coloured insulating tape above each connector which helps ensure quick and correct coupling, as does the fact that on each mating plug a similar coloured tape is applied. Also note the D connectors comprise of one socket (female-blue) and two plugs (male-red and yellow) configuration, which further ensures only the correct mating connections are used. The end circular DIN socket is for a hand held controllers connection.

and ease of wire installation, plus it keeps the wiring out of the way. The use of 'zip' cable ties to bunch the individual wires into looms makes for a very neat wiring. For all common return paths, as mentioned previously, it is recommended to use at least the 16/0.2mm wire or a larger wire size in a black colour.

Run this in first and then follow it with all the track feeds (in say red wire), mark them onto the wiring diagram as they are run in and terminated. Use identification 'tags', made from masking tape wrapped around the individual wire in a 'U' shape tag. Then write any details on this tag and only remove the tag when all has been tested and found correct.

Solder tag strips are ideal for terminating wiring at each baseboard's end where portable layouts are being used. Nothing like a nice strong soldered joint! I personally dislike, but have to use through sheer economics, the nylon twin grub screw terminal strips (12-way plastic blocks with two grub screws per termination). These have a tendency, when the grub screw is tightened down, to cause the wire end to break off, due to the tension and twisting motion placed onto the stripped wire end.

There are some blocks that have a flexible metal strip directly under the grub screw and this then presses down onto the wire as the grub screw is tightened. This type is fine but they are very hard to find, if not near impossible, in most electrical stores. Fitting crimped boot lace ferrules to wire ends will greatly diminish the chance of a wire fracturing in a screw down terminal block.

On portable layouts where across baseboard connections are needed or on a fixed layout where perhaps a removable control panel is required, the use of computer style 'D' connectors as multi way plugs and sockets is often recommended. These are available in multiples of nominally 9, 15 and 25 ways, but larger versions are available.

Using the male and female halves of a 'D' connector you can produce either in-line joints or one side can be permanently mounted on the baseboard or control panel. This allows its mating half to be connected via an umbilical flexible cable or single cores of wire made into a bundle. When more than two 'D' connectors are required, mark each one with differing coloured tape or paint and also reverse each connection, so a male plug has a female socket next to it, as this also helps in preventing incorrect accidental cross connections.

When removing the insulation from the end of a wire, use a pair of specially made wire strippers as these will remove the insulation without damaging the fine strands of copper wire inside. Alternatively, and only with practice, use wire side cutters. Never use your teeth! You only get one adult set and your dental practitioner will not appreciate you appearing with a tooth missing or a notch cut into one tooth's enamel!

The one thing the soldering novice should do is practice. Complete 20 or more trial solder joints and your skill will improve.

Soldering

There is only one way of making a solid electrical connection, as far as I am concerned, and that is by soldering! People shy away from soldered connections and I can never really understand why.

The basic requirements are a soldering iron of suitable wattage size for the work being undertaken, a clean and good condition bit, rosin-cored solder of the 60/40 type, and clean connections. For everyday soldering, a 25 watt iron with a small to medium sized bit is all that's required. Larger bit sizes and bigger wattage irons have their place, but not for most electrical joints. I use mainly two soldering irons, a 25 watt and a 18 watt Antex. Both do the same exact job, it's just that the smaller wattage one has a 1mm diameter tip fitted, while the 25 watt one has a 2.5mm bit. The smaller bit and wattage iron is ideal for electronic printed circuit board work while the 25 watt is the general purpose iron.

To make a good quality soldered joint, heat the iron for at least five minutes. Don't rush this heating up time as the iron's tip must be up to full temperature. Have to hand a damp, soldering iron tip cleaning sponge or pad. If you own a soldering iron stand it is likely it came with a tip cleaning sponge. If not, then cut a piece of ordinary sponge and use that. I have used pieces of old carwash sponge and best of all is a piece of cut up kitchen cleaning sponge! Remember to keep the sponge damp.

Once the iron is hot, wipe the tip onto the sponge to remove all previous oxidisation and any old solder residue. Assuming the tip is in good condition, apply a little of the rosin-cored solder to wet it. Never use solid stick type solder with so called 'Tinman's' flux nor the paste or liquid types of flux, unless you want to completely ruin the electrical joint. Solid solder is only for use with solid sheet metals – loco building, plumbing etc. while most liquid or paste fluxes have a considerable amount of acid in their mixture, which over a period of time will cause corrosion of the soldered electrical joint.

Before soldering a joint it must be completely grease free and clean; ideally use a glass fibre pen or scrape both surfaces of the items to be soldered with a knife blade to clean them, then if both are wires, twist join them together. The only exception to the cleaning is where a freshly stripped wire is being soldered and the wire's sheathing has kept its surface nice and clean. With the iron's tip coated in liquid solder (wetted), place the iron's tip directly onto the connection. Wait a few seconds for the heat of the tip to transfer into the component and then apply a little corded solder onto the heated joint, not onto the iron's tip.

You should see the solder start to melt and flow into and around the joint. Once sufficient solder has been applied to coat the whole joint, remove both the iron and cord solder. Do not touch or move the joint. Wait for at least 10 seconds after removing the heat to allow the joint to cool and the solder to set. What you should end up with is a solid, clean joint. Where wires are soldered together, trim off any excess wire that is overly long.

Sometimes the PVC sheath on the wire being soldered will shrink back a little. This is a nuisance at times and is due to a) the wire's PVC sheathing having a low temperature range or b) too much heat has been applied to the joint for too long.

Use heat shrinkable tubing over any 'in line' or other exposed joints. While it is a little more expensive than insulating tape, once shrunk down it gives a joint a more professional and secure finish. At times the use of PVC insulating tape cannot be avoided, such as where a 'T' shaped spur occurs. Example, where a dropper feed wire is required to connect onto a main through wire.

Finally, before you go on to solder another joint or you have finished all the soldering and before you disconnect the iron, clean the tip again on the damp sponge. You will get many years of use from a soldering iron if you keep its tip clean! Never be tempted to take a file to a modern soldering iron's tip to try and return it to service. Most modern iron tips have a special coating applied which the file will remove and the tip will not perform anywhere near as well as previously.

Replacement tips are sold for most irons and normally only cost a fraction of the overall iron's replacement cost. But if no replacement part is available then purchasing a new iron is the answer.

Track feeds

Track feed wires are connected to the appropriate rail dropper, which has been passed down through a pre-drilled hole in the board's surface. If solid droppers are used then solder them to the rail's outer web or better to the rail's underside before laying the track. Flexible wire can be used instead of the solid droppers, and gives more freedom to have sideways movement of the track.

For solid dropper wires, the track feed wiring insulation is stripped back approximately 15mm and if there is a second wire going elsewhere, then that too is similarly stripped and twisted onto the first. The wire(s) are then twisted one and half turns around the solid dropper wire. This leaves a little excess wire protruding. Push the wire(s) up the dropper until they are about 1mm from the baseboard's underside. Solder the joint and once cooled, cut off the surplus dropper wire and any surplus flexible wire not soldered onto the solid dropper (see Figures 35 and 36). Write that particular feed's unique number on the board's underside, next to the dropper, for future reference. This can then also be recorded in the wiring book.

Solid dropper wires can be made from 1.0mm^2 uninsulated copper wire. A cheap source of this can

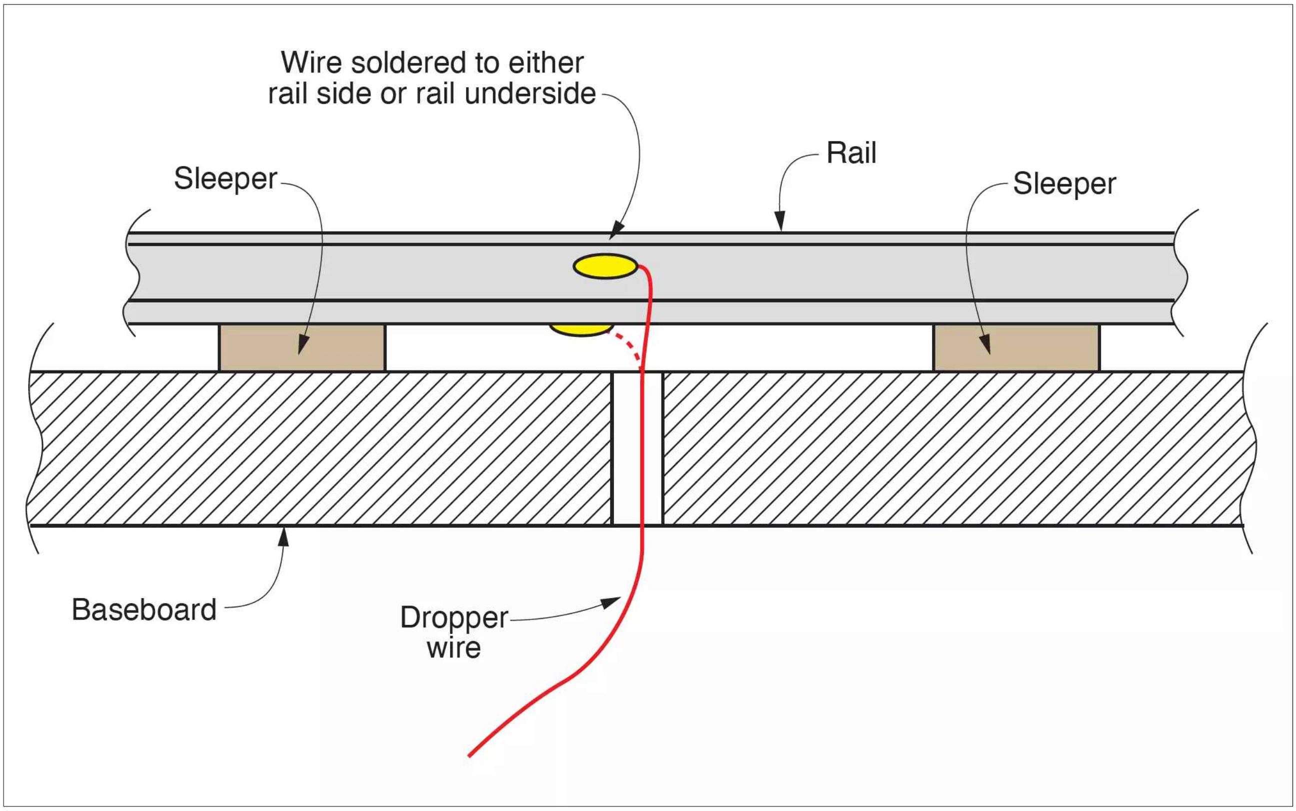


Figure 35: This drawing shows how a dropper is soldered to the rails' underside (best option if possible) or to the outer web area.

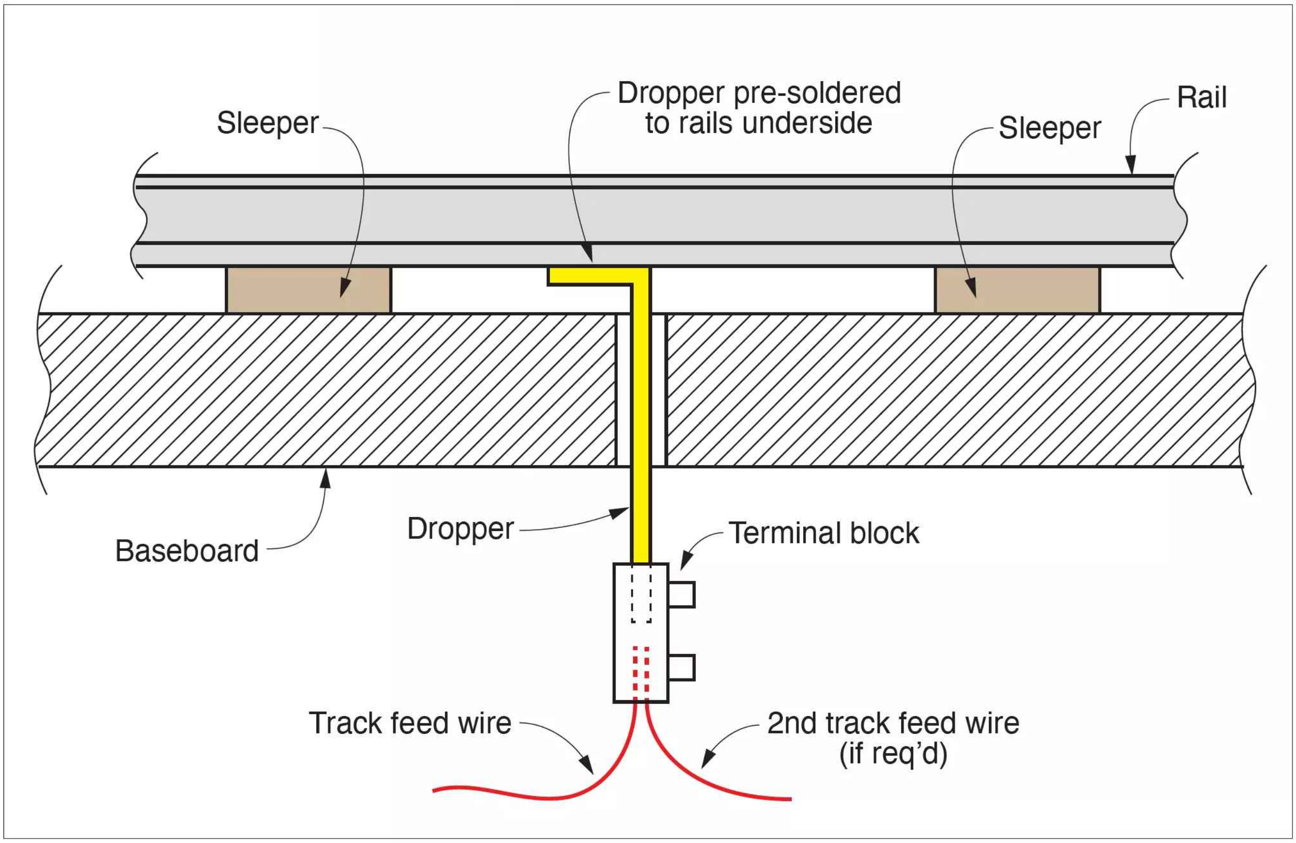
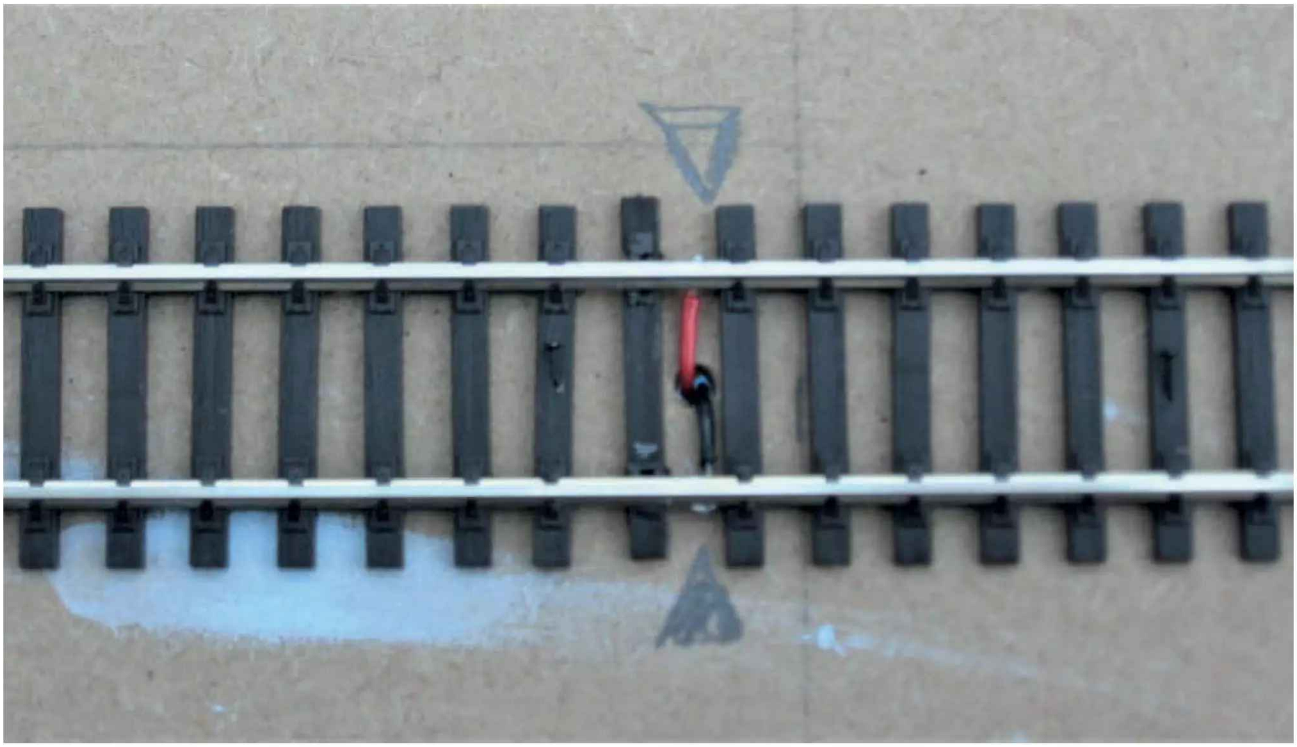


Figure 36: For those who find soldering underneath the railway baseboard difficult, a piece of terminal strip can be used on the end of the solid copper dropper.



Flexible (7/0.2mm) dropper wires soldered to the rail's undersides prior to track laying and passing down through the baseboard via a pre-drilled hole. The two drawn triangles denote which wire/rail is which, power wise. I use a solid triangle for the returns.

the bare earth wire from mains electric type cables. The dropper wire is cut to approximately 1½ inches (40mm) long. One end is then bent over at 90 degrees and then just at the 90 degree bend it is again bent over so as it will fit into the rail's web.

This second bend is at approximately 45 degrees to allow the inset. Trim off the end of the straight piece that will eventually be soldered to the rail's web to around 1/16 to 1/8 inch (1 to 2mm) long. However, I prefer to use flexible wire in 7/0.2mm or 16/0.2mm size, and here approximately 5mm of the wire's insulation is removed, the bare strands twisted tight and then solder tinned. It is then either soldered to the pre-cleaned rail's underside before track laying or to the rail's outer web if the track has already been laid.

Carry on installing all the track feed wires until they are all complete. This may, and no doubt will, include some 'through feed' wires which are not actually connecting to any items of track on that particular board, but are to feed other sections of track further around the layout. Remember to keep recording each wire in the diagram book!

I do not recommend using metal rail joiners (fishplates) as a place for soldering electrical rail feeds onto. The reason for this is that the two abutting rails will be continually moving a little inside the joiner, allowing expansion and contraction of the rails that are leading away from the joiner. This movement will ultimately introduce a high resistance (HR) into one or both sides of the joiner. This is caused over time by the small movement loosening the joiner and also microscopic dust particles in the air combining and making an almost invisible insulation between the two surfaces. Even paint, if the rails are painted with a rust colour, can get inside the joiner and form a high resistant joint! This insulation prevents or severely restricts the flow of electrical current from the joiner into the rails.

The high resistance rail joiner will often manifest itself in the locomotives running erratically or stopping for no apparent reason on a certain piece of track. It is far better to solder feed wires onto the rails themselves, even if this means installing several wires all series connected (daisy chain fashion) along the length of track being fed by that supply. Linking or 'bonding out' of the joiners is another option, by using a small sized flexible wire soldered onto the outside of the rail web and running from rail to rail bridging across the fishplated joint. But I do feel these are more unsightly than the dropper wire (see Figure 37).

Switches

These come in various styles and many can be used in model railway electrical controls. Perhaps the most common switch to be found is the toggle switch, often in the smaller 'miniature' style. The rotary switch is also popular as this allows many switching contacts to make or break with the turn of a central shaft and fitted knob.

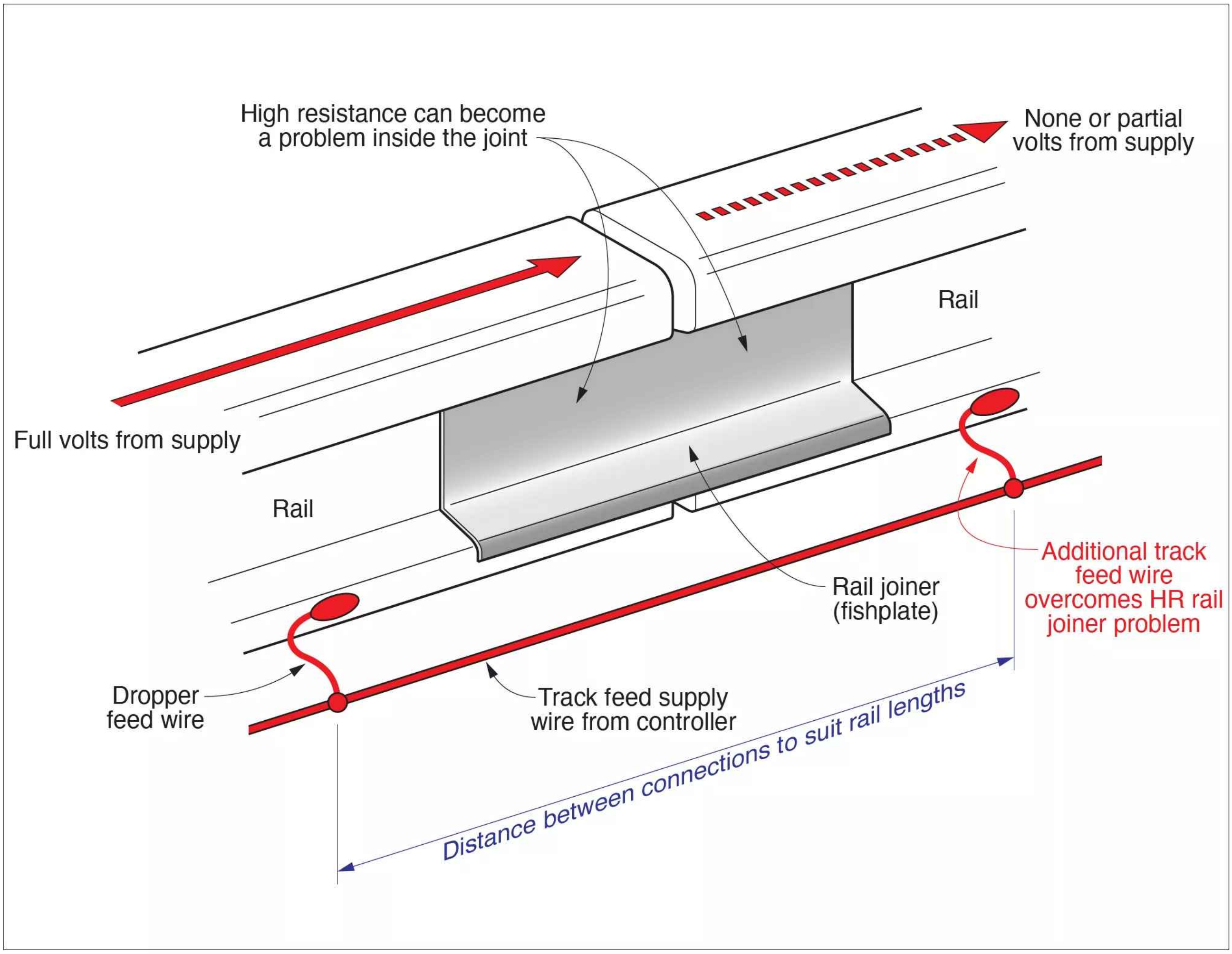


Figure 37: This sketch shows the problem and one option stated previously of how to overcome the fault. While the drawing shows the two track feeds being close together, in practice they could be two or three feet (600mm to 900mm) apart, where the rails for example are each full lengths of 36 inch (915mm) flexible track.

Switch terminology

Poles are the number of independent electrical parts within one switch's body. A switch can have one or more poles. e.g. 'SP' means Single Pole – one electrical input and output. 'DP' is Double Pole – two independent and isolated electrical parts within the switch. 'TP' is therefore Triple Pole or three independent and isolated parts within a switch's body.

Ways are the number of electrical paths or outlets a switch has. So a 1-way is just a single on/off function connecting the input (common) tag to the output tag or disconnecting the output tag when the lever is in the opposite position. A 3-way switch would have three separate outputs from one common terminal i.e. the switch can be moved to any of three positions and each position connects that outlet with the common terminal.

Throw is similar to 'ways', and is the number of electrical outlets connected to the common tag. A Single Throw switch (ST) will only provide On/Off switching therefore the switch would only have two connection tags. A conventional house light switch is a 1-way single pole (SPST) switch. While a Double Throw (DT) will make contact to either side of the switch dependent upon the toggle or lever's position, i.e. a DT switch will provide On-On to the common tag. It will have three terminals or tags and is sometimes called a 'two-way switch' (just to confuse matters!).

In all cases I have used the term C/O as meaning 'change over' when referring to switches. So to reiterate, a DPDT configuration is two independent and separate electrical paths through a switch and the switch's moving common contact travels from one contact set to the opposite contact set for both paths.

'Passing contact' switches

Some model railway manufacturers also supply signal box lever style switches. Hornby and Peco are two such manufacturers of these. In the Hornby range their R044

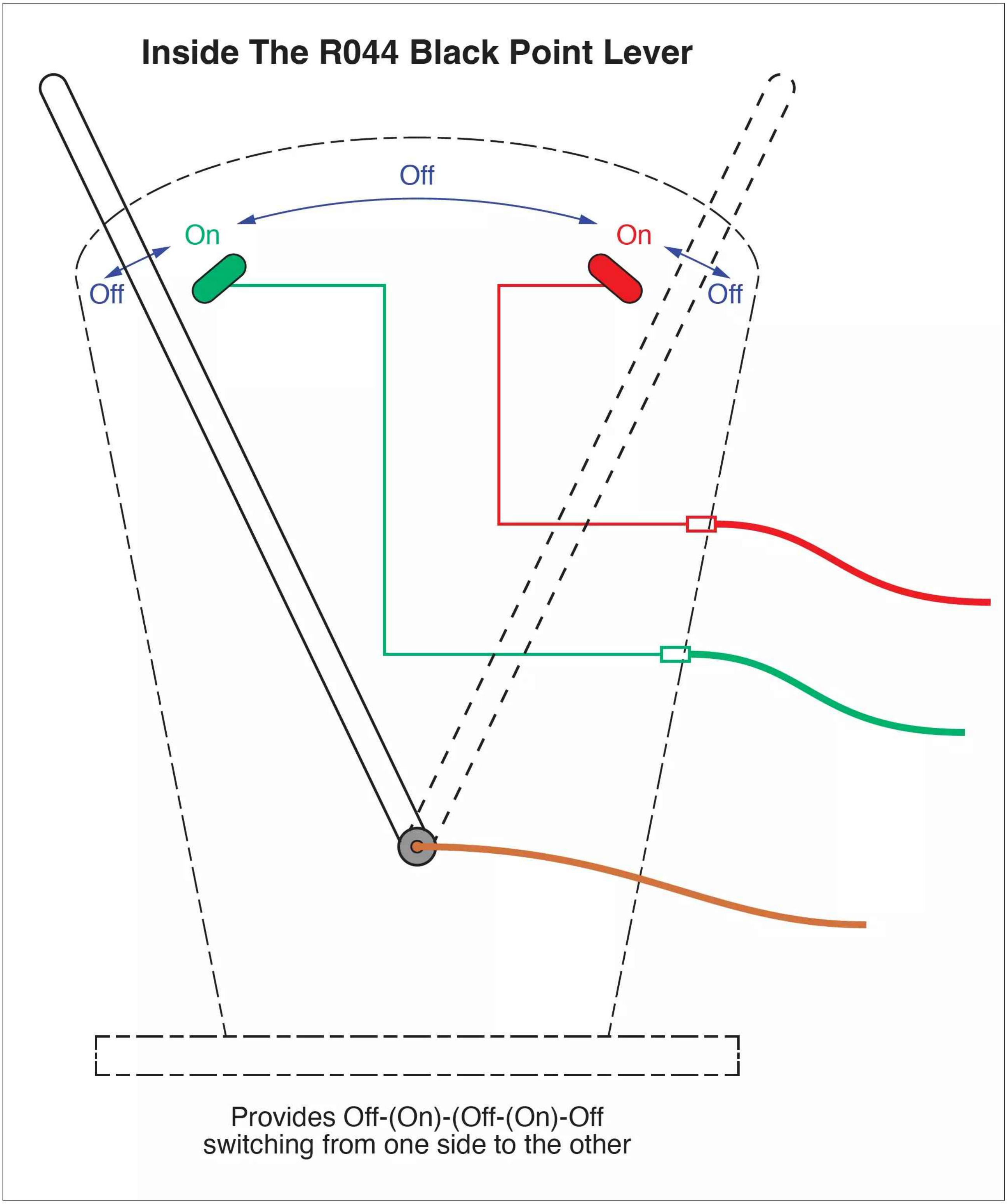


Figure 38: An internal view of a Hornby R044 black passing contact point lever switch. As the lever, which carries the input current from the brown input connection, is moved from its lefthand rest position it passes by the first (green) 'on' contact. If the point motor is already in that position the appropriate coil will still receive a pulse of current but it cannot move as it is already in that position. The lever continues to move across and now no electrical contact is available in the central area. As the lever begins to reach the opposite end of its travel it then makes contact with the opposite (red) contact. The motor's other coil now receives a pulse of power, all the while this lever's position is maintained in the red area. Finally the lever reaches fully over to the right and the (red) connection is broken and the lever is at rest. Unfortunately, due to its style of contact arrangement, the R044 Black lever does not work at all well with the CDUs (Capacitor Discharge Units) often used in solenoid motor feeding.

black point lever is a passing contact type providing off-(on1)-(off)-(on2)-off contact, with the lever moving from one side to the other. Note: the bracketed positions are contacts or non-contact positions, and are not capable of being maintained in that position permanently due to the lever's full movement.

In the case of toggle switches, an internal spring returns the toggle lever to a central Off position. In the case of the Hornby R044 point lever it is at rest at one end of the switch and not making contact – it's off. Then as it is slowly moved over, it makes contact – (on1), then breaks that contact again in the middle position – (off), makes contact with other position – (on2) and finally reaches the fully over position at the opposite side where it is off. This is called a passing contact lever as it passes two separate connection places in its travel (see Figure 38).

In the same Hornby range, yellow and green coloured levers are available. The yellow R046 lever provides on-on switching and is used for circuits that require two permanent feeds such as a two aspect colour light. The green R047 provides on-off switching and here the switch can be used for isolating track sections or turning any power feeds on and off.

Toggle switches

The toggle switch is readily available in various contact formats and lever or toggle positions i.e. on-off, on-on, on-off-on and on-off-on centre off, with some available as spring loaded to the centre off position (on)-off-(on) or even others that are biased to one position e.g. (on)-off or (off)-on depending on exactly how they are wired. Remember the bracketed item cannot normally remain locked in that position.

Toggle switches, often in the miniature style, are favoured among many railway modellers, instead of the lever type of switch. The toggle switch will quite often be mounted into a small panel or even a mimic panel (see later). There are many varieties of switch contact and lever positions available in the toggle switch range, so the buyer needs to be fully aware of the exact type needed for the particular use. Figure 39 shows a few of the toggle switch contact arrangements most commonly found for a model railway use.

Slide switches

The use of the 'Slide Switch' in model railway electrical wiring is quite common and these can be used for switching on/off isolating sections, special track feeds or operating accessories that require an on/on power arrangement, such as an electrically lit colour light signals. They are however not suitable for powering solenoid point motors as their contacts remain closed continually while the slide lever is in one position.

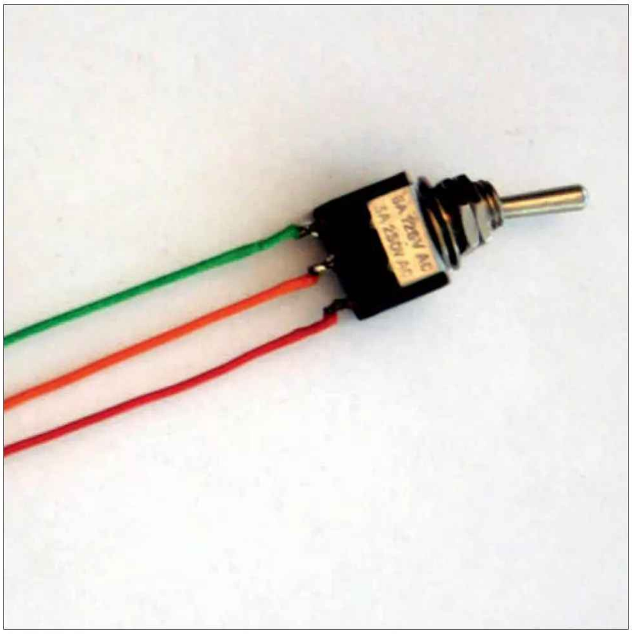
Rotary switches

These offer many contacts and normally several positions, or clicks, of the rotary shaft (or knob when fitted). Typically these can be 4 pole 3 way to 1 pole 12 way. Don't get confused here: 'ways' are the number of positions a rotary switch can be turned to.

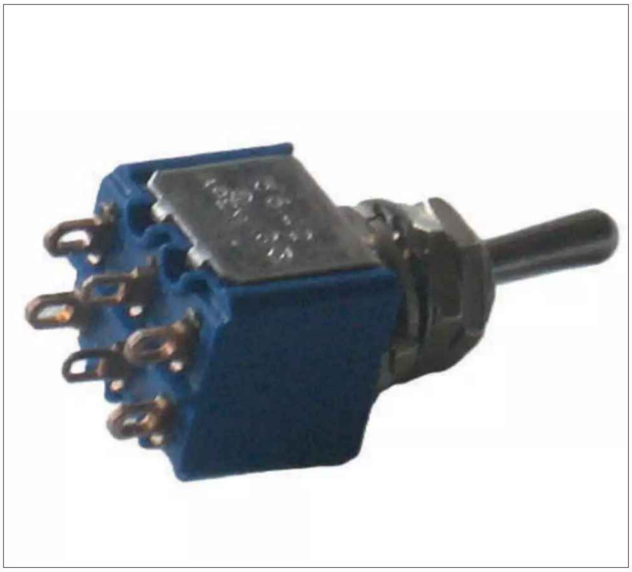
For example, a 3 way rotary switch can be turned to any of three positions, while the 12 way can turn to any of 12 positions. Therefore, a 12 way 1 pole rotary switch can click or turn to 12 positions, but it only has one input (way) physically connected to one of the 12 output positions. However, a 4 pole 3

Three Hornby lever switches. Left to right: Black R044 passing contact point switch. Yellow R046 lever switch with On/On contacts – ideal for switching two aspect colour light signals etc. R047 Green lever offering On/Off switching – ideal for track feed isolating sections or controlling building lighting. *Pictures © Hornby Hobbies Ltd*

Internal view of a Peco PL-26 momentary point switch. The PL-26 momentary lever is fine to use with a CDU.



A typical miniature toggle switch of the Single Pole Double Throw (SPDT) variety; it has three connections available to wire onto. It provides an On-On option as the central common tag is always in contact with one of the two outer tags and is controlled by the position of the toggle lever. The central (orange wired tag) is in this case the input feed and the two outer tags carry the current away to the load. The switch has been wired to operate a two aspect colour light signal. Orange is the 12-volt DC input while the red and green wires lead off to the signal itself and provide the power to illuminate the selected aspects lamp.



This toggle switch is a Double Pole Double Throw switch (DPDT) type. The switch now has an additional row of three tags, making six contact tags in all. The second row of three tags is electrically separate from the first row. This switch offers On-On switching by two separate poles or paths.

A Double Pole Double Throw Centre Off (DPDT Centre Off) switch. This switch is spring-loaded (or biased) to the central Off position, but looks similar to the DPDT switch, except the toggle lever is held centrally by the internal spring and the toggle cannot lock over permanently into one of the two On positions. This switch type, or its single pole equivalent, is ideal for operating solenoid point motors where a momentary pulse of power is only required to move the motor over. The switch offers (On)-Off-(On) selection. The bracketed items indicate that the switch cannot remain in that position.

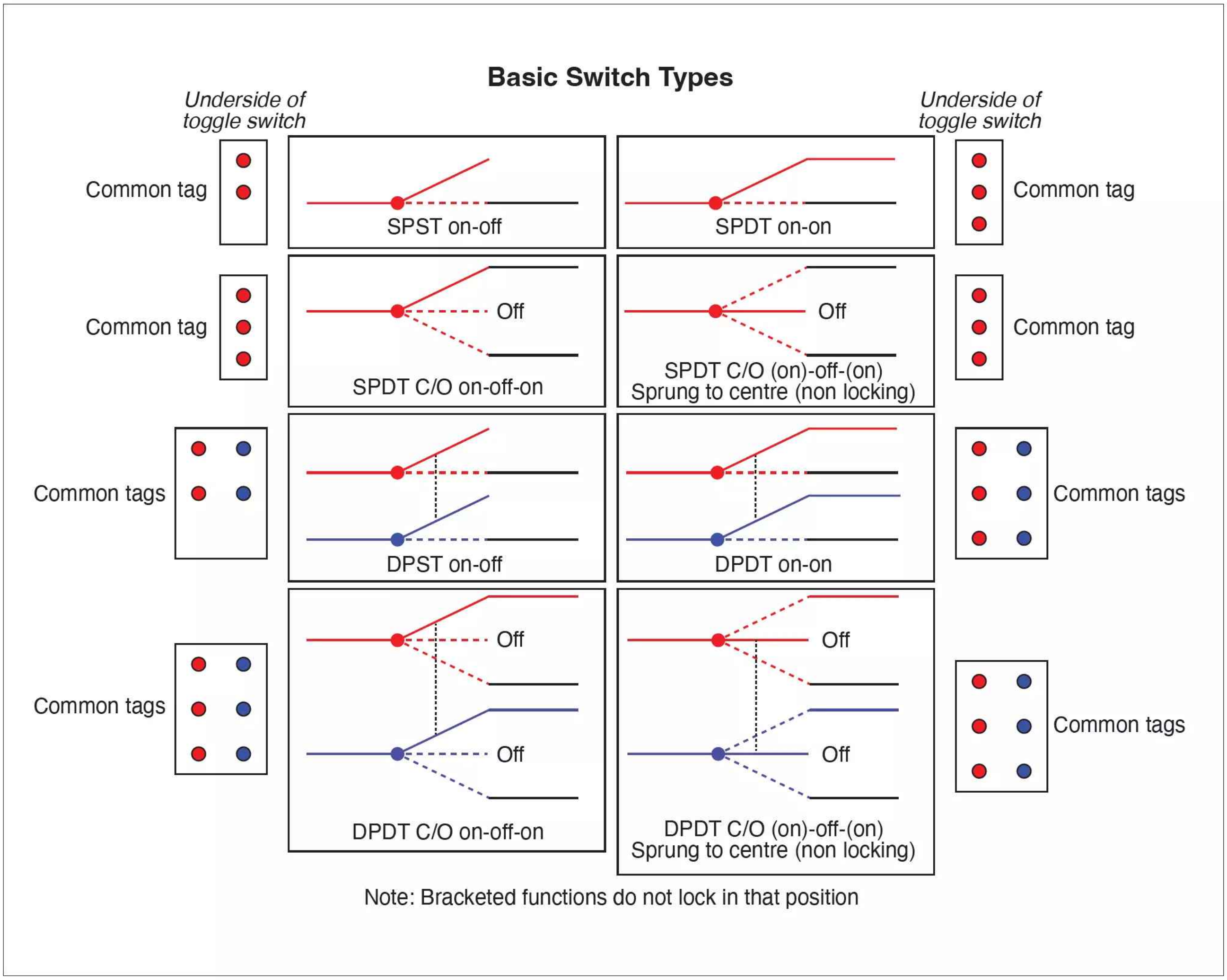
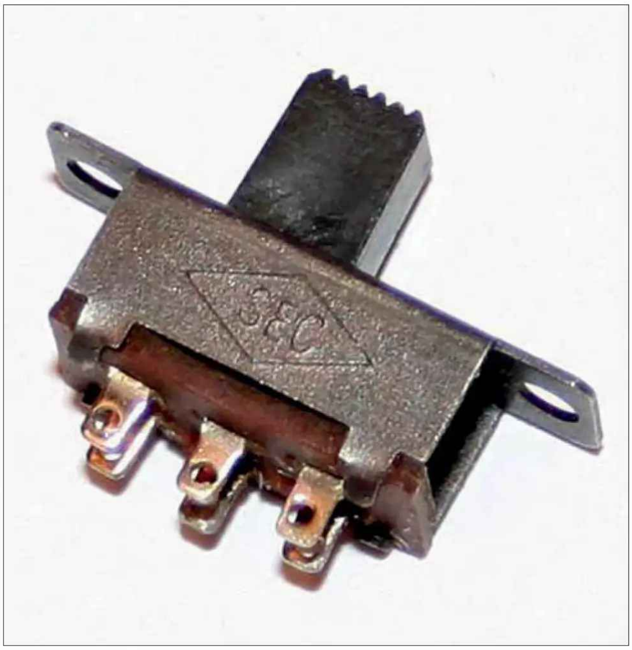


Figure 39: A few of the types of toggle switch contact arrangements most commonly found for model railway use...

A four-pole three-way rotary switch. The four central tags (Poles) are the common connections and are connected to their respective outer tags (Ways); in this case one of three, depending on the rotary shafts position.



A Double Pole Double Throw (DPDT) slide switch.

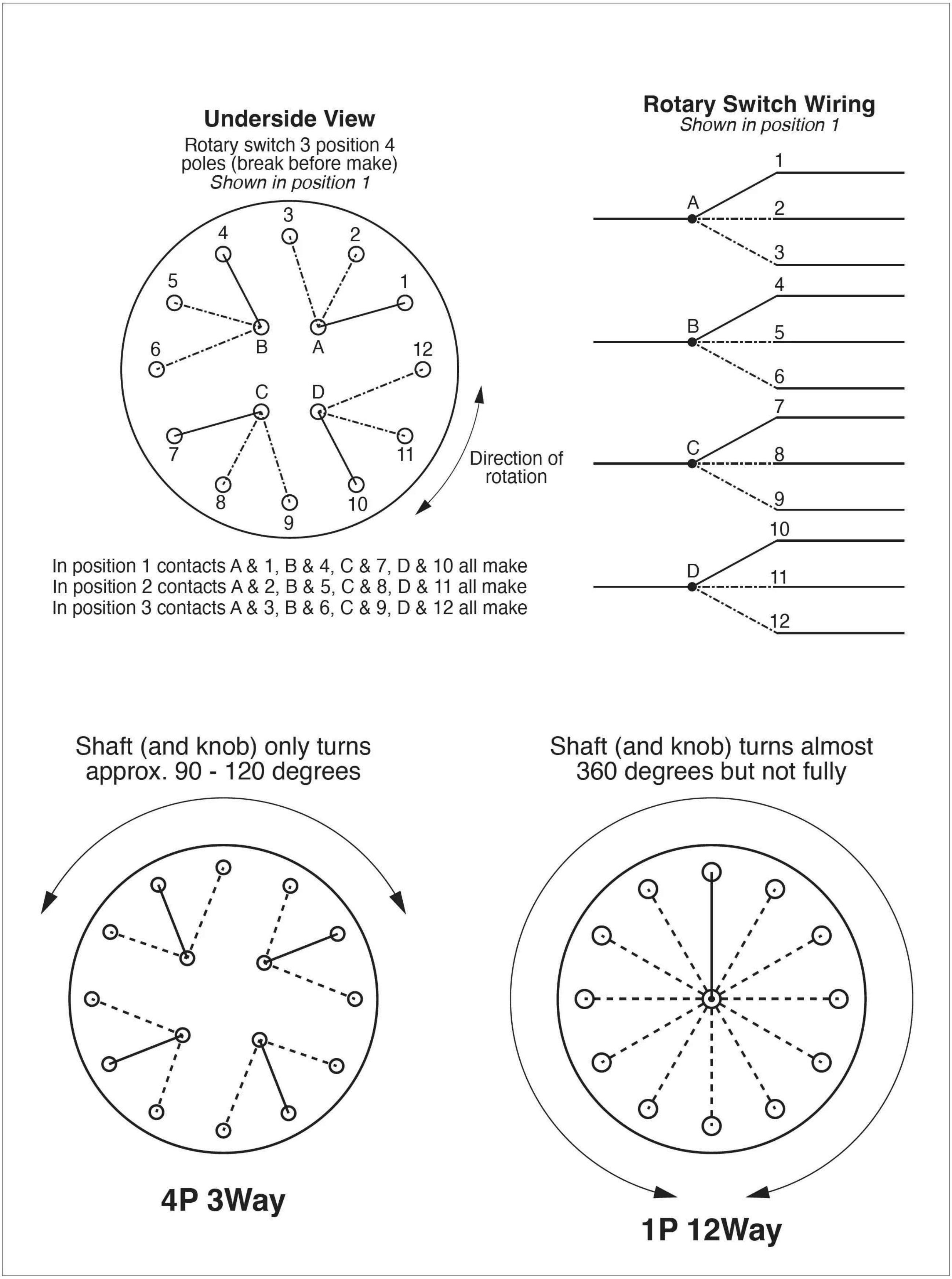


Figure 40: Rotary switch configurations.

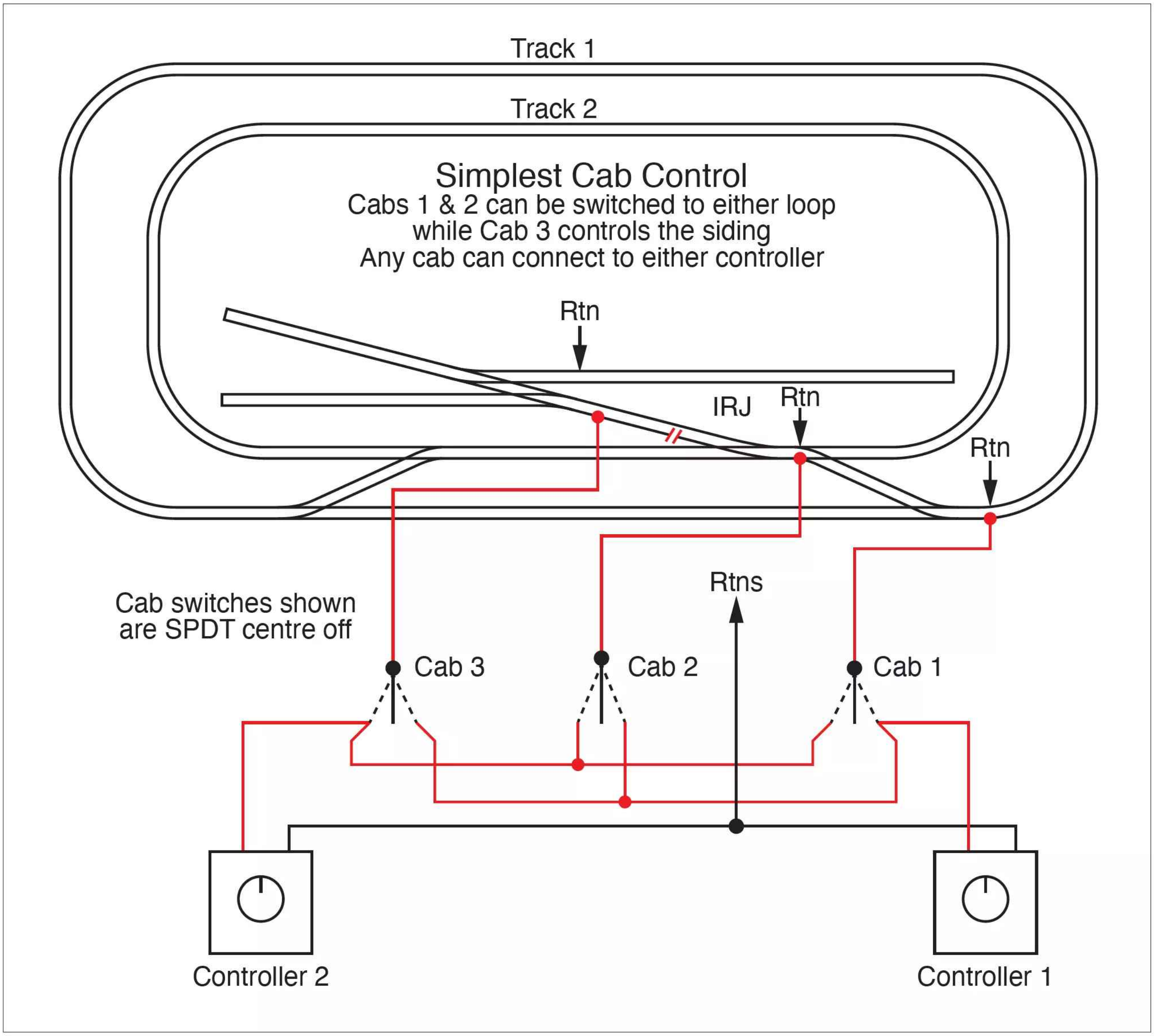


Figure 41: The very simplistic cab system as described. In reality, the track sections would be divided up into 'many' isolated sections by using IRJs and the cabs switched into each section as needed.

way can turn to any of 3 positions and has 4 inputs (poles) that can give any of three outputs each! (See Figure 40.)

To confuse matters still more, rotary switches can be supplied in 'Make before Break' or 'Break before Make' configurations! For model railway use, the 'Break before Make' style is mainly the one needed, as we need to ensure the circuit being switched is disconnected before the next circuit is connected.

Cab control

Cab Control is a means of switching one or more DC sections of track between two or more controllers. It allows one of several controllers, when the appropriate selection switch has been set, to control the track power over that section of line.

A typical example may be a stations goods yard which is switched between possibly two or three controllers. Controller one normally operates the up main line, controller two the down main line, while if a third controller is available it is used to work either up or down lines and also the goods yard.

By arranging the selection switching further, any of the controllers can be switched to operate each other's sections. In the example in Figure 41, once the appropriate points are moved, controller one could drive a train from the up main line (outer track), onto the down line (inner track) then right into the goods yard.

7
Points

Live and dead frogs

There are basically two types of model railway points – those with a live frog (sometimes termed electrofrog) and those with an insulated or dead frog (insulfrog). The two types are very similar in appearance, except the dead frog type has its frog manufactured from plastic, hence it is 'insulated'.

The dead frog is the simplest to use and is often the choice of the modeller who is new to model railways, since it does not require any additional work other than installation in the correct position on the layout; it switches track power from one direction to the other and leaves the direction it is not set towards electrically isolated or off (see Figure 43).

The live frog point does offer better running than the dead frog type, as there is no insulated area where a small wheeled locomotive might lose power. The live frog provides optimum slow running performance as a loco travels over the point slowly. The small downside of this improvement is the need to fit two insulated rail joiners (IRJs) after the frog, normally on the ends of the two Vee rails leading away from the frog, as these two rails swap polarity as the point moves over and back; without the IRJs a short circuit would occur (see Figure 44). There are other options that the user of live frog points can employ to achieve even better running: frog polarity switching and bonding the switch rail to its adjacent stock rail once insulations are fitted into both closure rails.

Mechanical point operation

How we decide to make the point blades move is the next choice and there are several options open to the modeller. Firstly, there is the finger method, where no other movement of the point blades exists save for a finger appearing on the layout and pushing the points tie bar over and back as required. This is fine, so long as you can reach all the points!

Next is perhaps the first of the remote-control operating methods – the 'wire in tube' system which uses a flexible wire inside a flexible tube, much like a bicycle brake system uses. One end of the wire is connected to the points tie bar while the other end appears some distance away at the side of the baseboard, often as a small push/pull knob. The tubing that the wire moves inside is held in place by small clips or staples in the underside of the baseboard. Then there is the point rodding and mechanical lever. This employs a similar technique to that used on the real railways before electrically operated points were used: solid rodding moving back and fore in sync with a lever and pivoted right angle cranks, transferring push/pull movement through 90 degrees or other angles. Then we have electrically operated points – solenoid coil motors or small electric motors driving a little gear chain to drive the point blades over and back.

Unifrog points

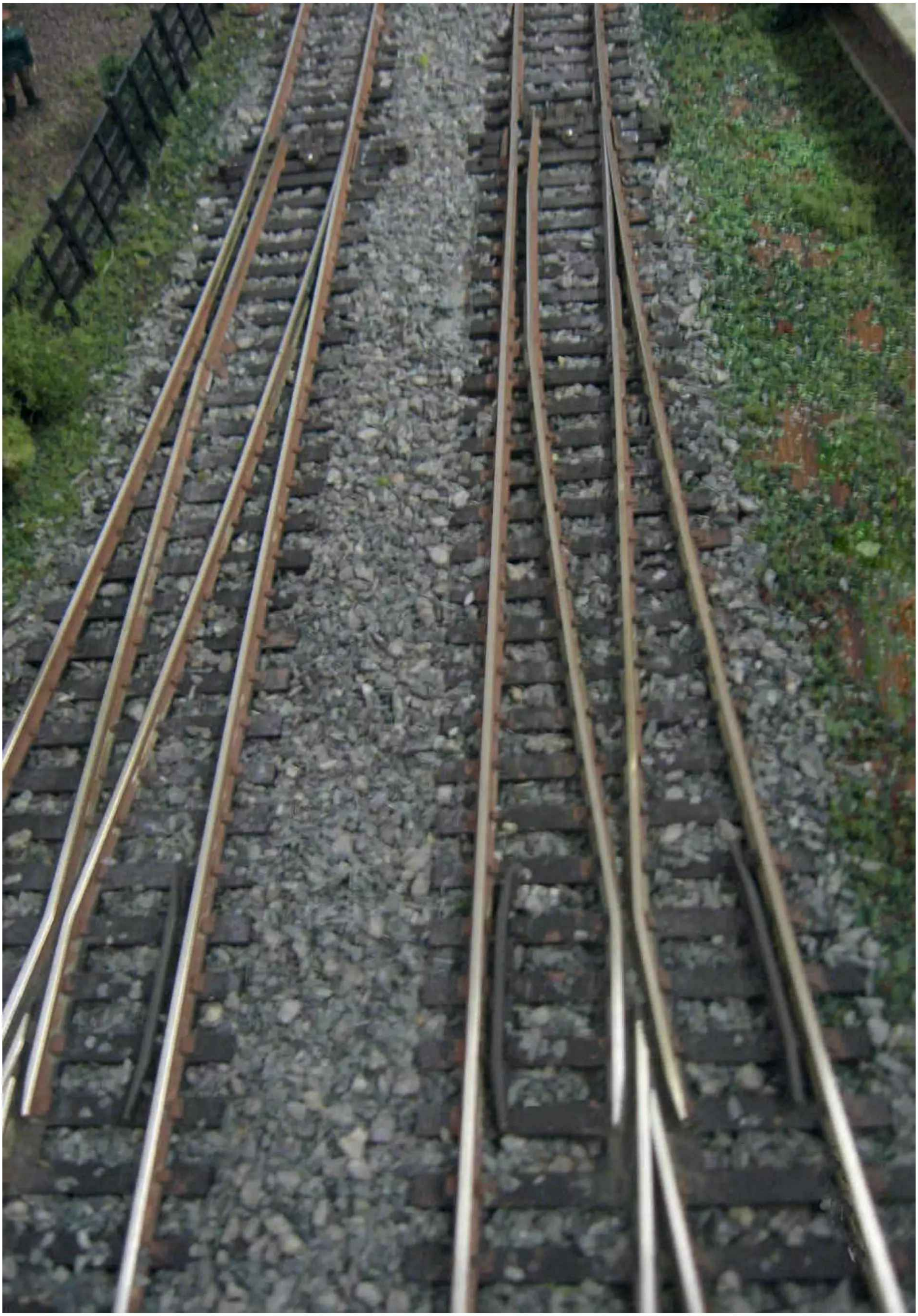
Peco have introduced a point called 'Unifrog' that is a mix of both insulated frog and electrofrog (see Figure 42). They have been slowly rolling out this point in various gauges and it will take some time (many years!) before all gauges are fully equipped with this choice of point. The idea is that, straight from the packet, the point is an Insulated frog style. The point is factory fitted with a frog wire which the Insulated frog user would usually ignore. However, ideally the frog wire is taken below baseboard for possible use later on (this then saves lifting the point in the future). The electrofrog option is available via the frog wire and suitable frog polarity switching. Hence both styles are available in one point.

In addition, the two closure rails are factory bonded to their adjacent stock rails and the closure rails are linked across to the Vee rail in the appropriate direction. The frog is of all metal rail and is electrically dead as supplied, since it sits between four rail insulation gaps, except when the frog wire is used and then the frog is fed from a suitable means of frog polarity switching.

The DC user, when in the Insulated frog mode, needs to be mindful that this point does not switch the track power off to the unset direction. Both directions from the point are powered regardless of the point blade position. If power route switching is required then the two factory fitted bonds joining outer stock rail to its adjacent switch/closure rail need to be removed. This would ideally be undertaken before laying the point. But simply adding an Insulated rail joiner (IRJ) to form an isolated section after the point is possibly the best option, rather than attempting to modify the point.

Electrical point operation

Electrically operated points are often the chosen method, and the next items to consider are how these



Sets of points on the author's layout.

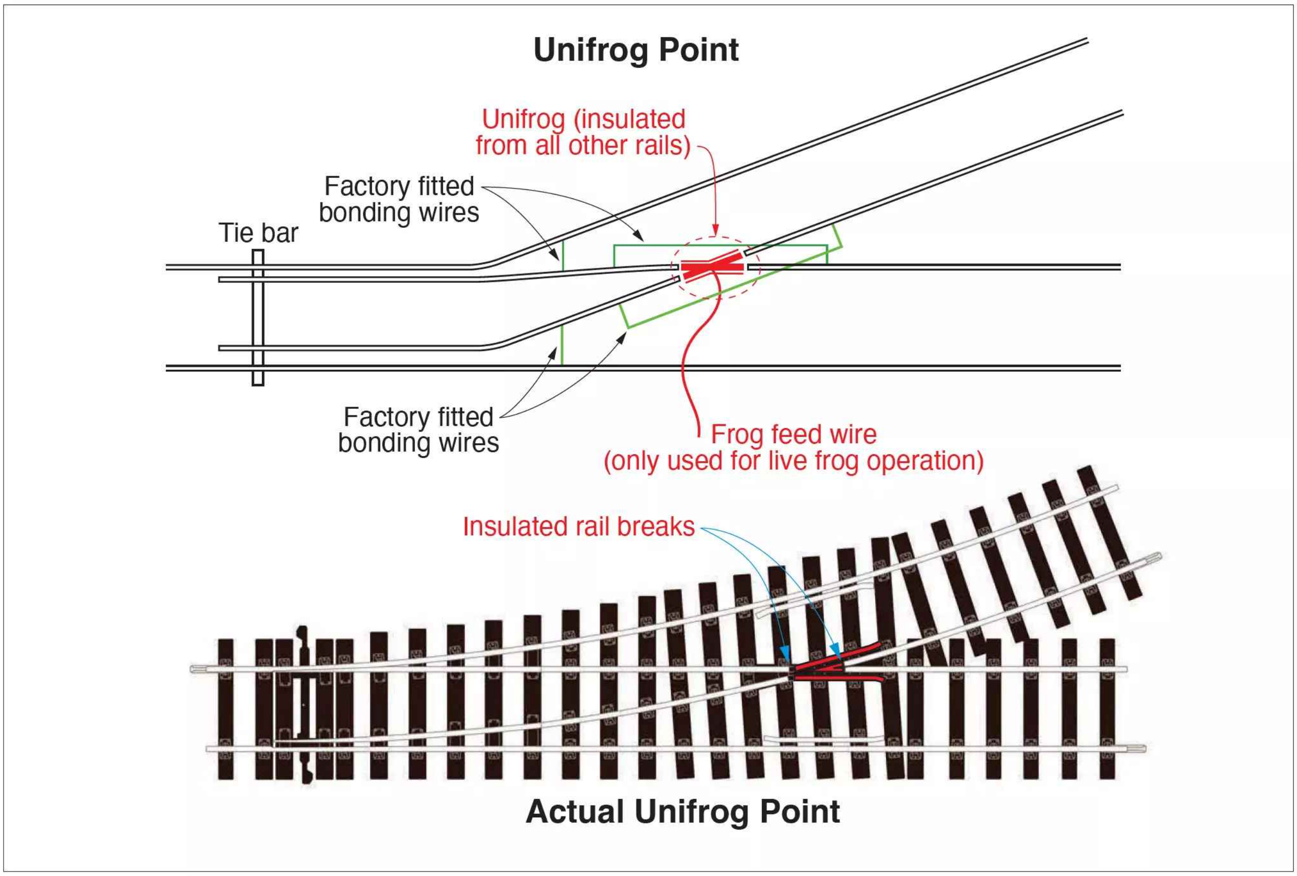


Figure 42: The Unifrog point is a mix of insulated frog and electrofrog.

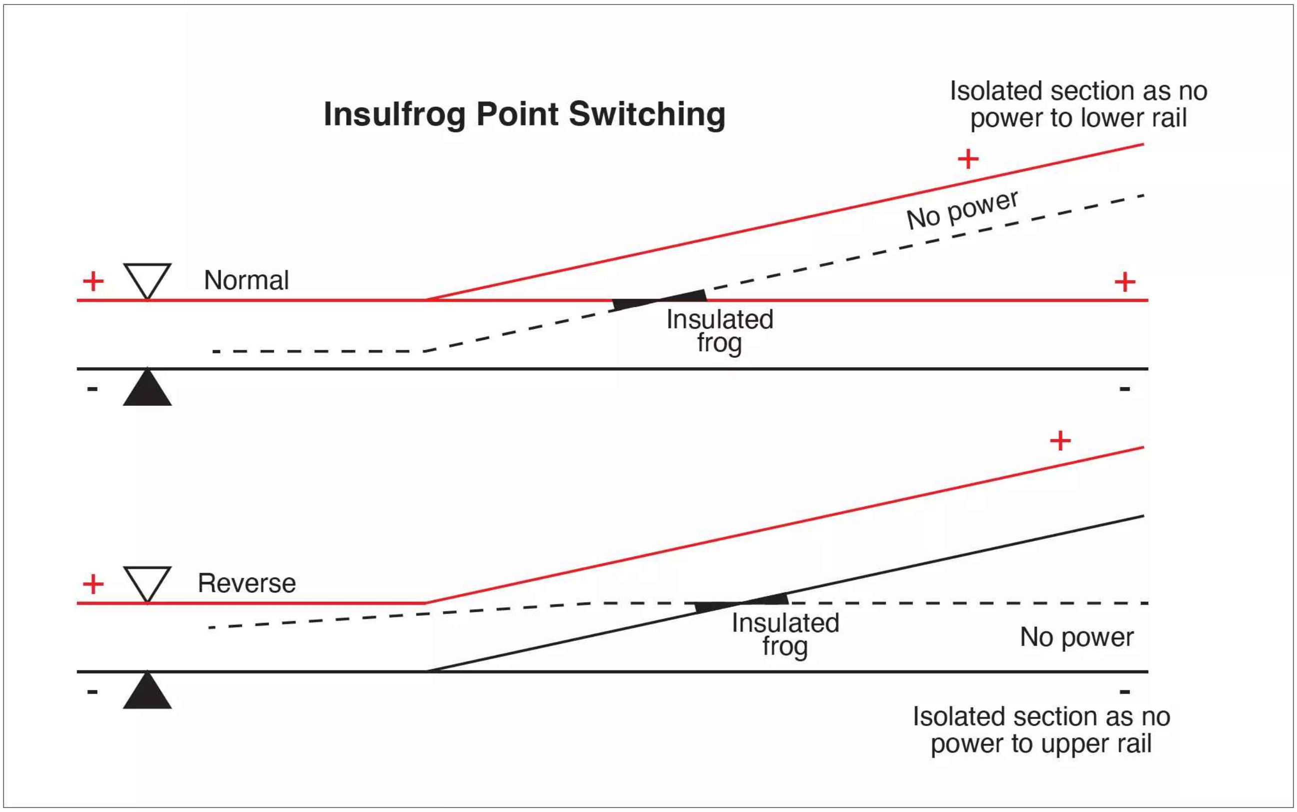


Figure 43: How an insulated frog (insulfrog) point switches the track power dependant upon its position.

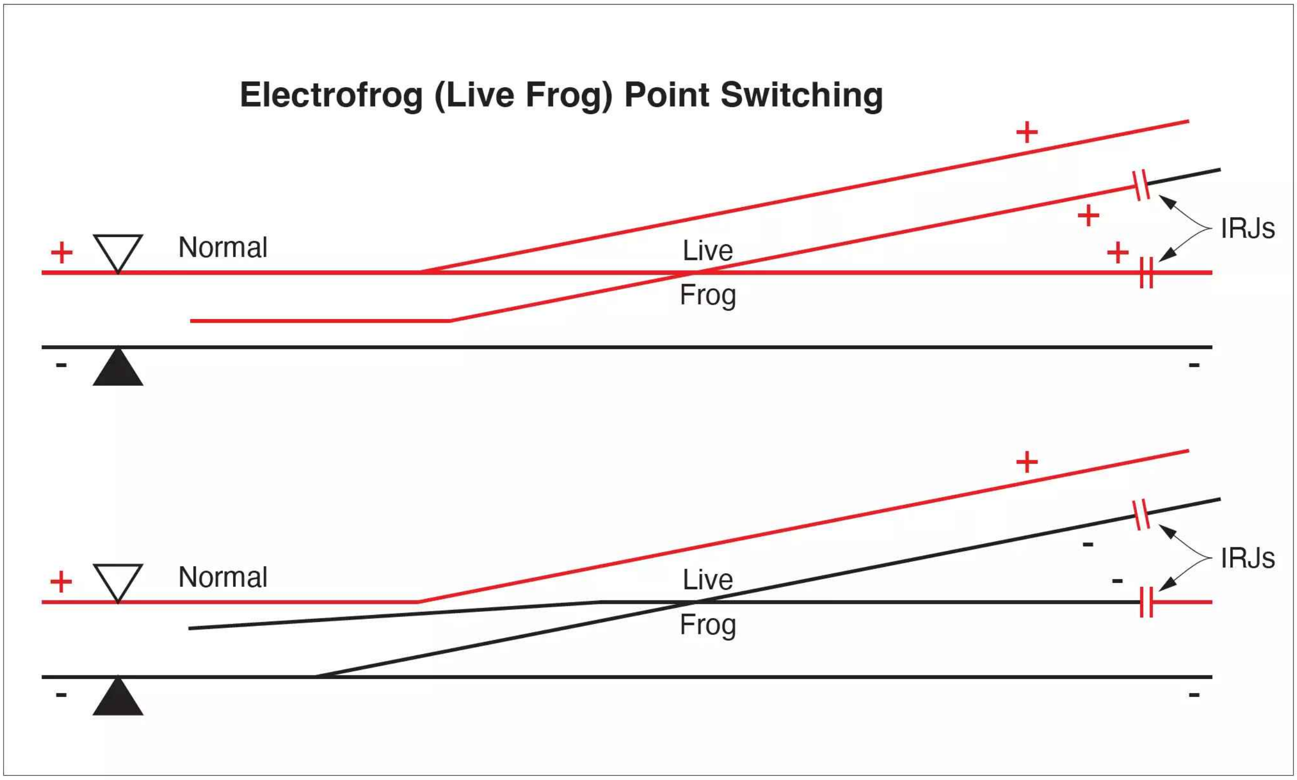
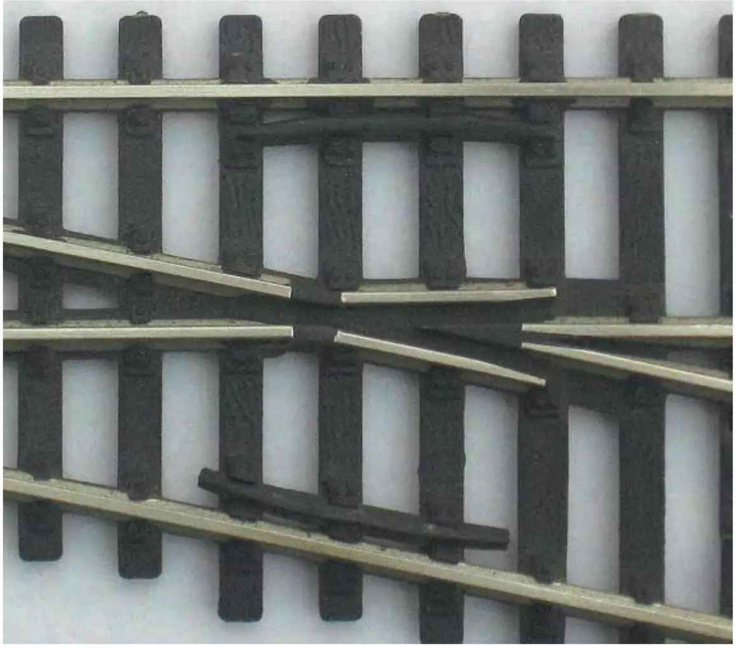


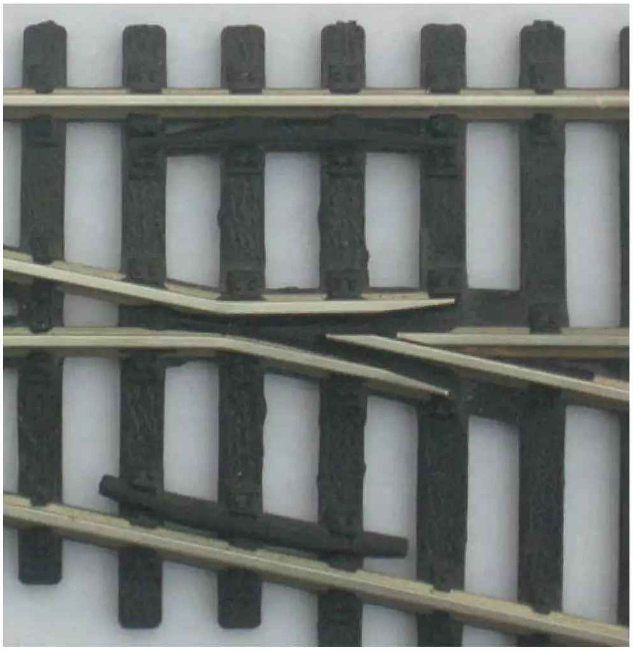
Figure 44: Point switching with a live frog (electrofrog).

will operate and their wiring requirements. Two types are common, the solenoid motor (technically not a 'motor' in the true sense) and the electric motor operated point motor, often called a 'Stall motor'.

To ensure reliable operation of a solenoid motor, a Capacitor Discharge Unit (CDU) is recommended; just one is normally required for the whole layout. The CDU provides a momentary stored pulse of high power to the solenoids coil via the selection switch, thereby overcoming any slight stiffness within the point motor or the point itself. It is wired directly across the 16- to 24-volt point supply transformers output. Consider the



A Peco code 100 insulated (insulfrog) point. Note the all-plastic frog or crossing tip.



A Peco code 100 live frog (electrofrog) point. Note here the frog or crossing is made of all metal rail.

use of a CDU, as this provides that little extra power often needed where several motors are to be moved simultaneously.

However, there is no reason why a 16-volt AC supply could not feed the point motors equally as well. Using a CDU reduces the current drawn from the transformer and also protects the solenoid coil from any possible continuous powering, which leads very quickly to coil burn out. Where solenoid motors are used I always advocate investing in a CDU; they actually cost little more than a new motor or two!

Point motors (solenoids) can be operated by several methods – 'passing contact' levers, toggle switches with a sprung to centre off position, stud and probe or two push to make non locking push buttons. In each case, the use of a CDU will ensure reliable operation. You will of course need to operate more than one point on a layout and all that is required are more studs, levers or switches, together with the wiring (two wires per motor, plus a return).

Touching the relevant stud with the probe or moving the switch or lever over allows the CDU to fire a 'one shot' discharge current through the appropriate stud or switches contact and out via the wiring to the motor's coil winding. However, only passing contact or spring-loaded centre off switches must be used, otherwise and where a CDU is not being used, the motor's coil would receive full power continuously and quickly burn out.

When two or more sets of points are required to be operated at once, as in the case of a crossover pair, simply wire the two motors onto the one lever or switch, ensuring the electrical path for the 'normal' position of each point is correctly orientated on both points. Most CDUs can operate up to three motors simultaneously and those sold as 'Heavy Duty' often can throw up to six motors all at once.

Route setting by use of a diode matrix is another option for point control, but remember that each diode loses 0.7v in volt drop! So your matrix's input voltage needs to be higher than perhaps the normal 16 volts often used. I prefer to 'route set' on the mimic control panel by actually following a route manually along its path and setting points as I pass each stud or switch.

The use of, for example, Tortoise, Cobalt or Fulgurex slow acting motors is another option and these do not require probes and studs, but do usually need switches that keep the motor's power supply on all the time they are moving and sometimes continuously. Here a CDU is not used, as they operate directly from a power supply,

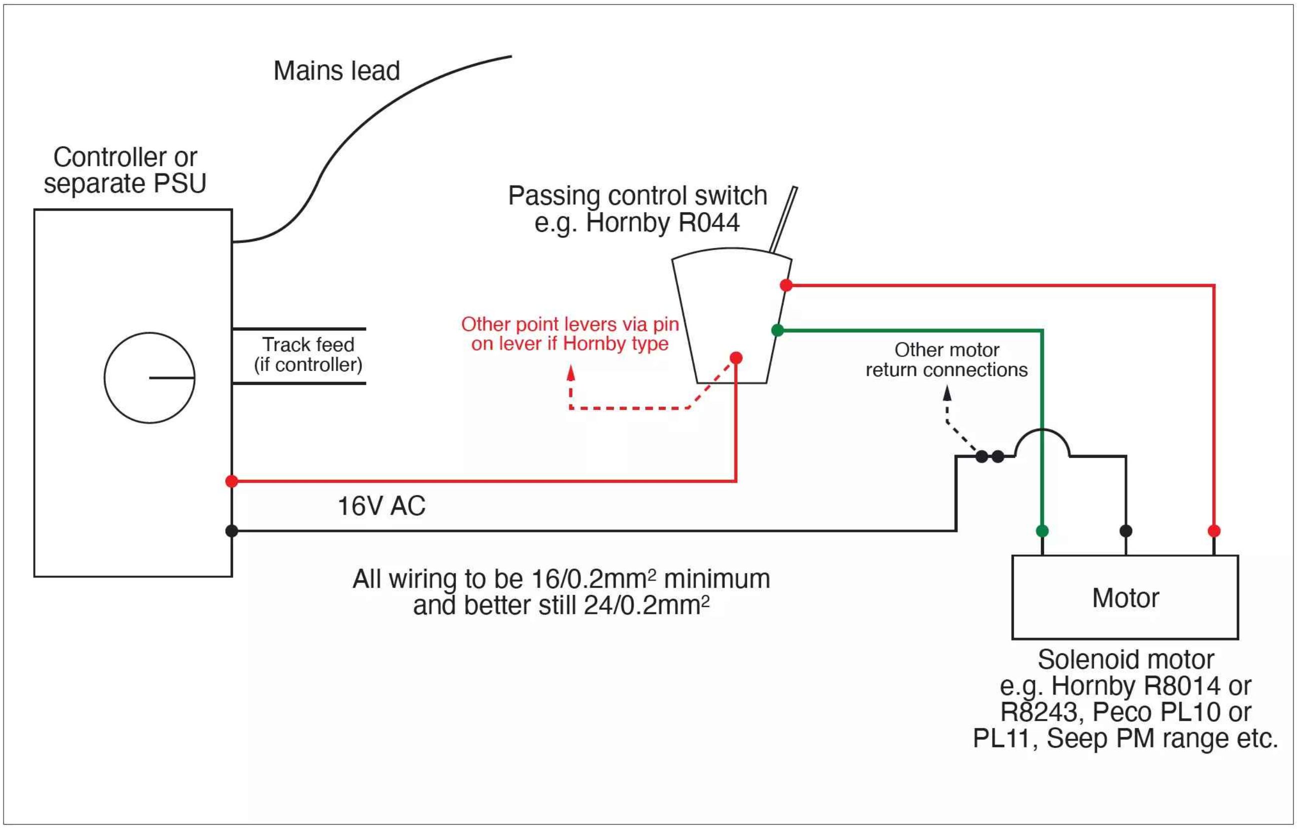


Figure 45: Basic wiring for a typical lever-operated solenoid point motor using a Hornby R044 black 'passing contact' lever. This is probably the simplest means of powering an electric point motor. Note the CDU in the feed circuit; this can if wished be omitted, with the two wires from the supply (brown and black) feeding directly to the switch and motor respectively. (It should be noted that while the wiring colours shown in this illustration are normally used, some pre-wired point motors may use different colours – always check the manufacturer's wiring guide.)

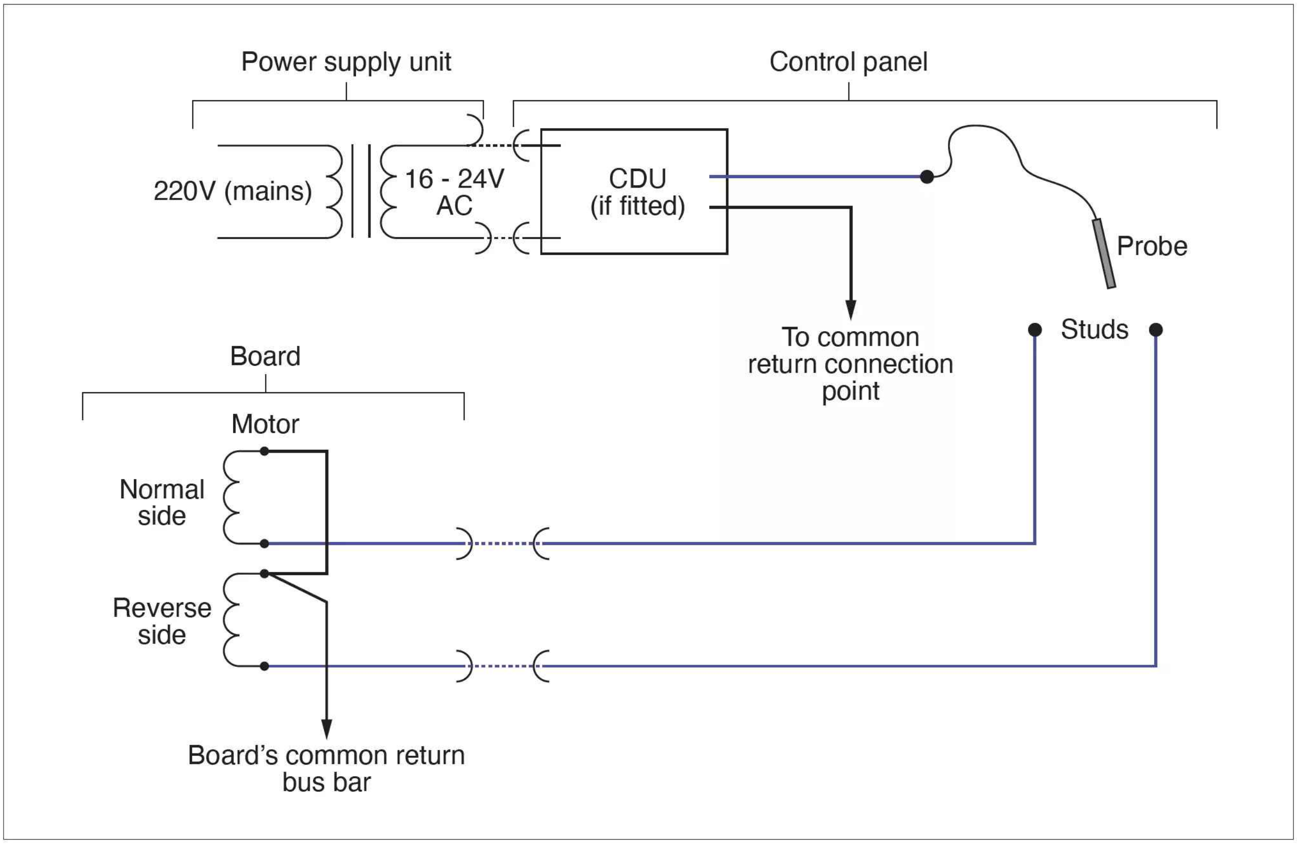


Figure 46: A very simple stud and probe switching method normally used on mimic panels. Blue has been used to show the motor operation wires, but they can be any colour.

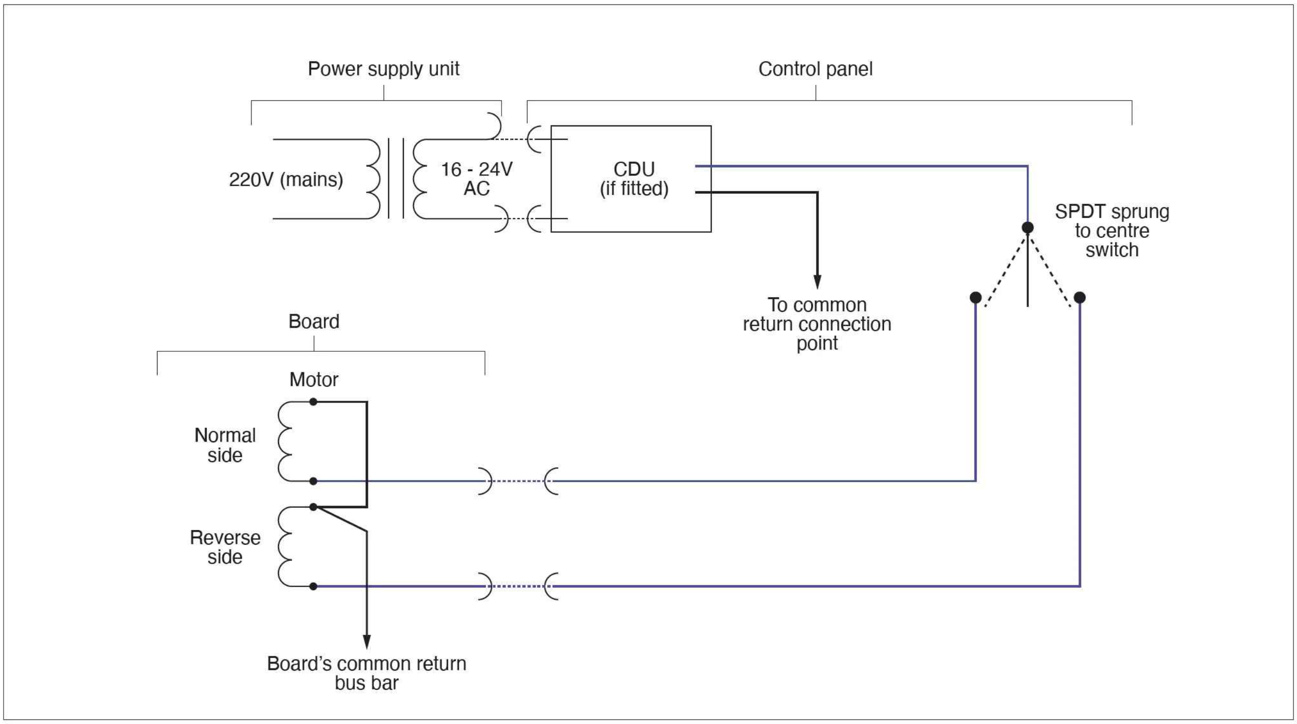


Figure 47: A dedicated point switch (centre off and sprung to the centre toggle switch) is used in this very similar diagram, but this could equally be replaced by a pair of push-to-make non locking push buttons. Note that the two drawings offer the choice of 16- or 24-volt AC supply to be used (24v is my preferred voltage). A CDU is shown in both. If the CDU is omitted then the wires from the PSU continue directly to the probe or switches common tab and the other output feed goes directly to all the motors return connection.

nominally 12 volts DC and the operating switch does not need to be of the sprung to centre type. Wiring for the different types of operations is shown in Figures 45-47.

A third style of electric point operation is via a servo and special servo control board. Servos offer a cheaper alternative to slow motion motors and can be adjusted for speed of throw and their operating arms travel from one side to the other, thereby reducing the pressure on the point blades when closed onto the stock rail.

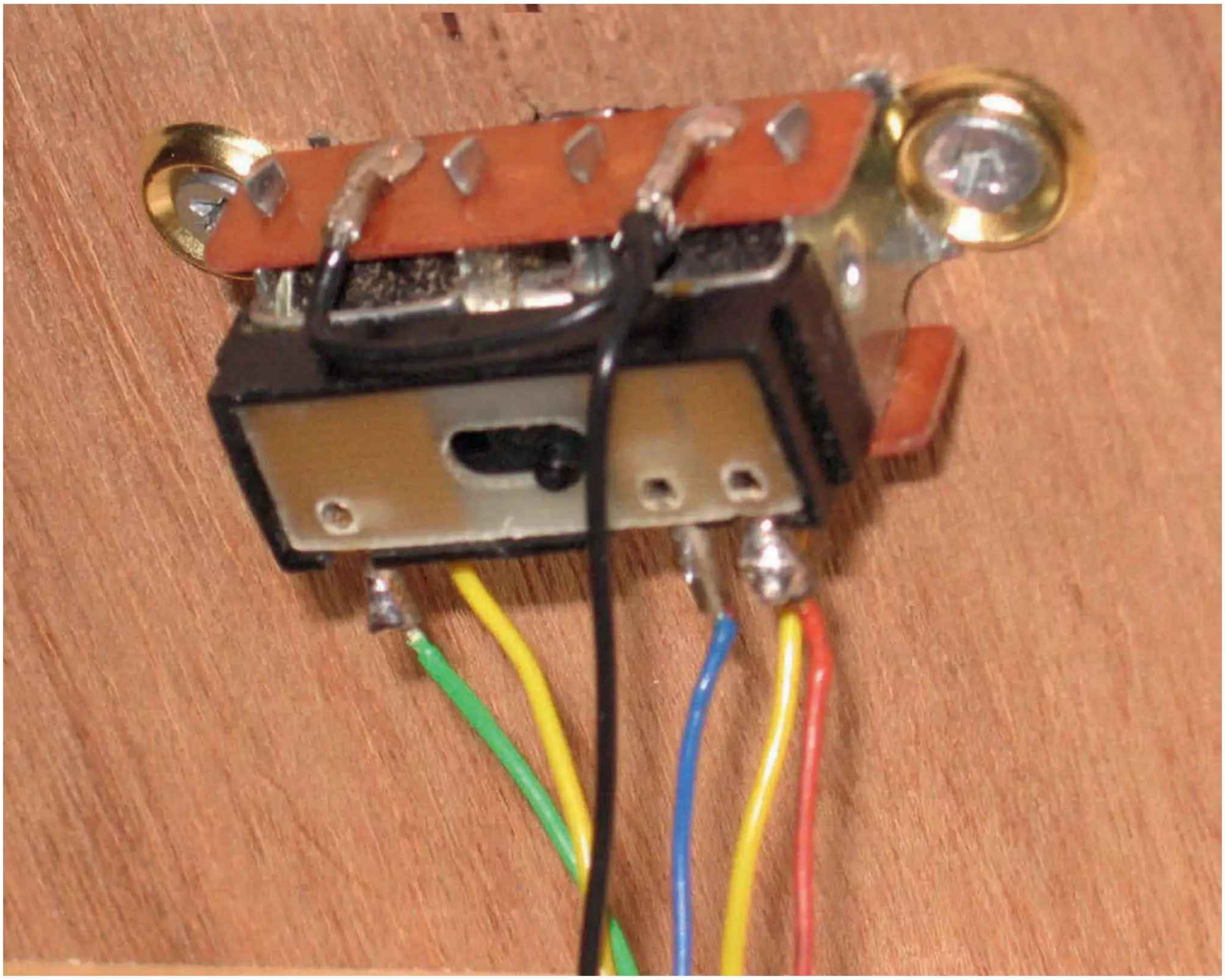
Basic lever solenoid point motor switching wiring is shown here for a typical motor using a Hornby style (R044 black) passing contact lever. This is probably the simplest means of powering and moving an electric solenoid point motor. It should be noted that while the wiring colours shown here are normally used, some pre-wired point motors may use different colours. Always check the manufacturer's wiring guide.

The use of a CDU with the R044 lever is not recommend due to the nature of the R044 internal contact arrangement. But a CDU does work well with most other passing contact levers such as the Peco PL-26.

Point motors

Point motors, or solenoids to be more specific, are two independent electrically operated coils. When powered they produce a magnetic pull upon a central pin. This pin is then pulled by induced magnetism across the hollow central area of the coil that is being energised, which produces the movement needed to move the points tie bar.

These motors are sometimes called 'Snap action' point motors, from the noise they make as they operate over and back. To call them 'motors' is technically incorrect as there is no actual electric motor in a solenoid, although it has become the recognised term. However, there are actual electric-motor-driven point machines available from manufacturers such as Tortoise DCC Concepts Cobalt range and Fulgurex. These operate on a slightly different method than the solenoid motor, some requiring a permanent DC feed to their drives. If this were applied to a solenoid motor the coil of the solenoid would quickly burn out, rendering the motor useless.



A Peco PL10E motor fitted with a PL13 accessory switch and mounted under the baseboard.

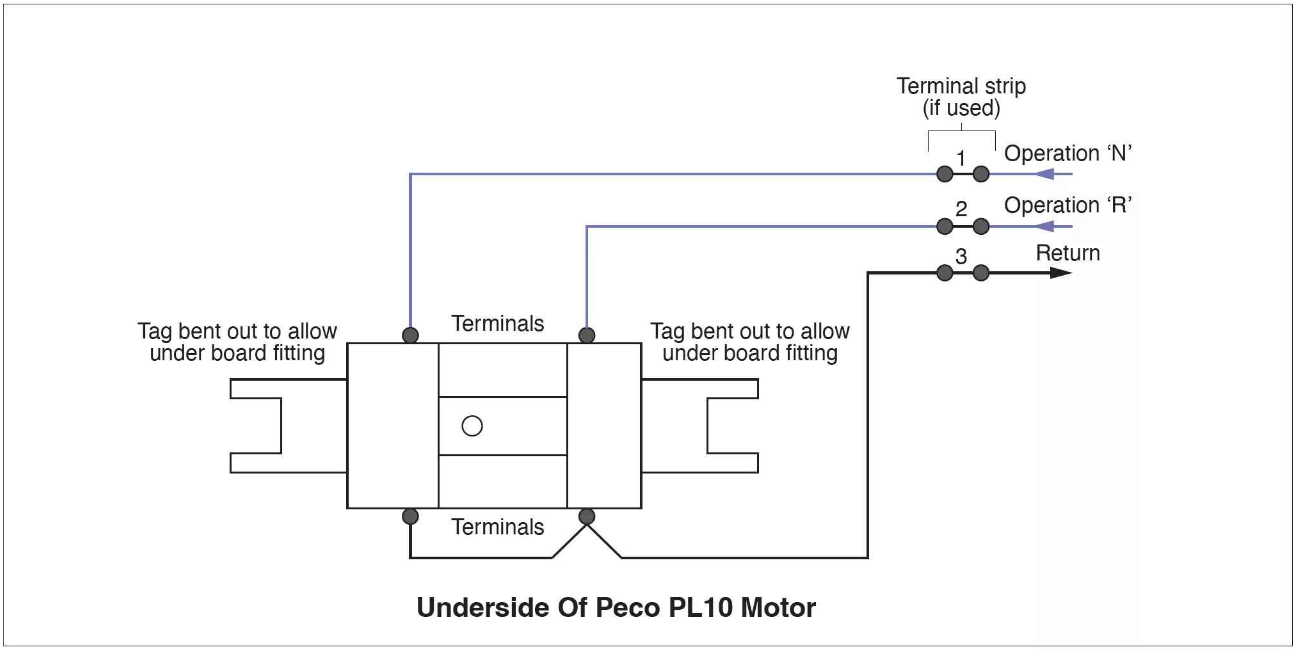


Figure 48: The wiring required on a Peco PL10 solenoid motor. Note the two coil tags which become the returns are wired together with a wire link.

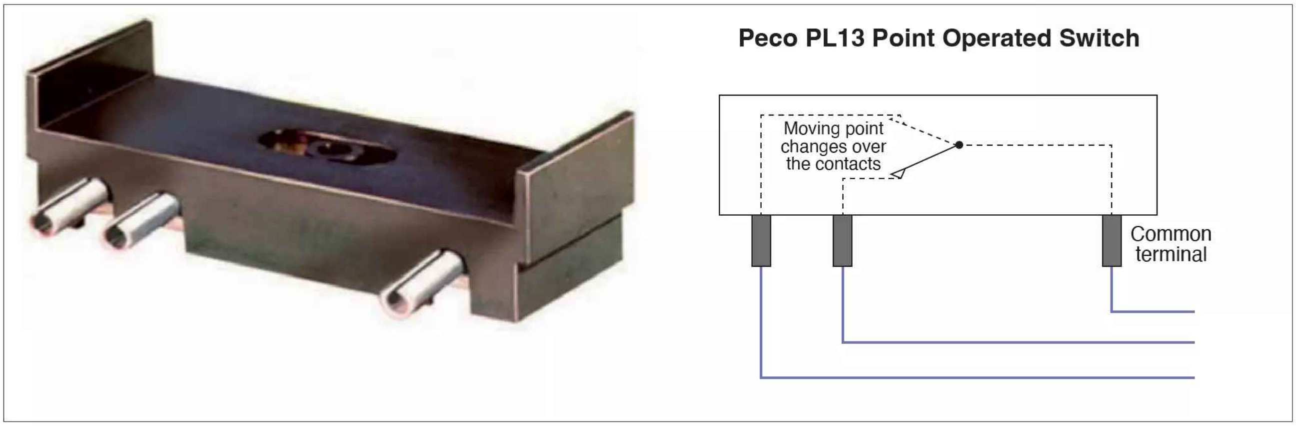


Figure 49: A Peco PL13 accessory switch and how its internal contact changes over the feed from the common tag to either of the two opposite end tags depending on which way the point motor has moved.

Figure 48 shows the wiring required for a Peco PL10 point motor. This motor can also have a PL13 or the PL15 twin accessory switch fitted to it, which will provide point-operated switching functions (see Figure 49). The PL10 is sold in three versions: first there is the PL10, the basic motor with a shortened drive pin, which is normally a direct fitting onto the underside of a Peco point. Second is the PL10E, which has an extended or longer drive pin and is used where the motor is fixed underneath a baseboard; the longer drive pin passes up through the baseboard and into the hole in the point tie bar. Finally the PL10W has a slightly higher coil resistance (approx. 10.4ohms) and is ideal for use with DCC accessory decoder outputs, where a reduced operating current is needed. It has the short drive pin length and is therefore ideal for direct mounting.

The switched normal and reverse contacts operated by the motor can be of great use to the modeller. They can be used for example on a mimic panel as indications of the actual position of the points, control of signal aspects or even to illuminate junction indicators on colour light signals and where live frog points are used they provide the track power switching to the frog.

Frog polarity switching

This technique can be used on live-front (electrofrog) points – but *not* insulated-frog points. The point is wired to enable the best electrical connection through the point and remove the need for reliance solely on the contact made by the moving switch blade onto the fixed stock rail, which can prove troublesome at times. It also enhances slow running over the closed switch rail and on past the frog.

The Seep PM-1 motor offers similar point control to that of the Peco motor. However, it also has a manufacturer-fitted changeover switch. Pictured is the Seep PM-1 motor shown upside-down to enable a clearer view of the six solder connection pads – A to F running along the edge of the motor. The coils in operation on pads A, B and C is the return. Changeover contacts are common F to either D or E depending on the position of the motor. Note the Seep PM-2 does not have the changeover contact but still uses the same PCB as the PM-1 and hence has pads marked D, E and F, but they are not connected to a working switch. Seep PM-4 (there is currently no PM-3!) is the same as the PM-1 and does have changeover contacts. It differs from the PM-1 in that the PM-4 mechanically latches in each position and is therefore ideal for points where the over-centre spring has broken or is missing.

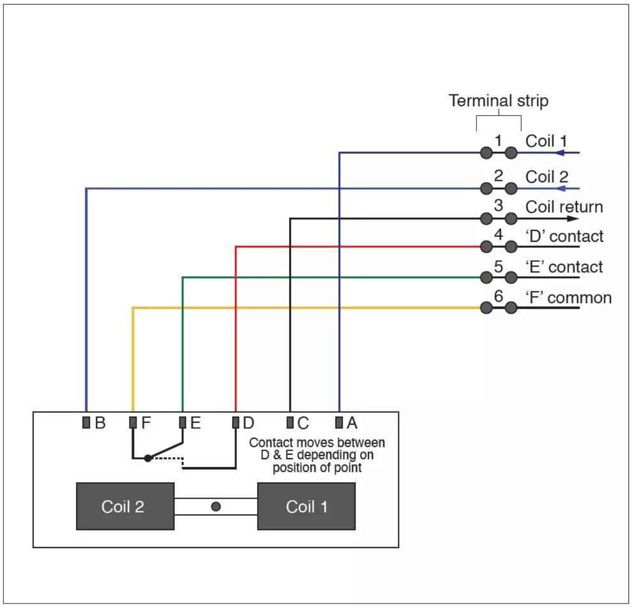


Figure 50: This drawing shows a six way terminal strip block. This allows easy off-layout pre-wiring of the motor and motor operated switch and provides a suitable place to connect incoming wires once the motor and block has been mounted on the layout; it also provides a test place too. In all cases terminals T1, T2 and T3 are all motor coil supplies while T4, T5 and T6 are for point operated switch contacts.

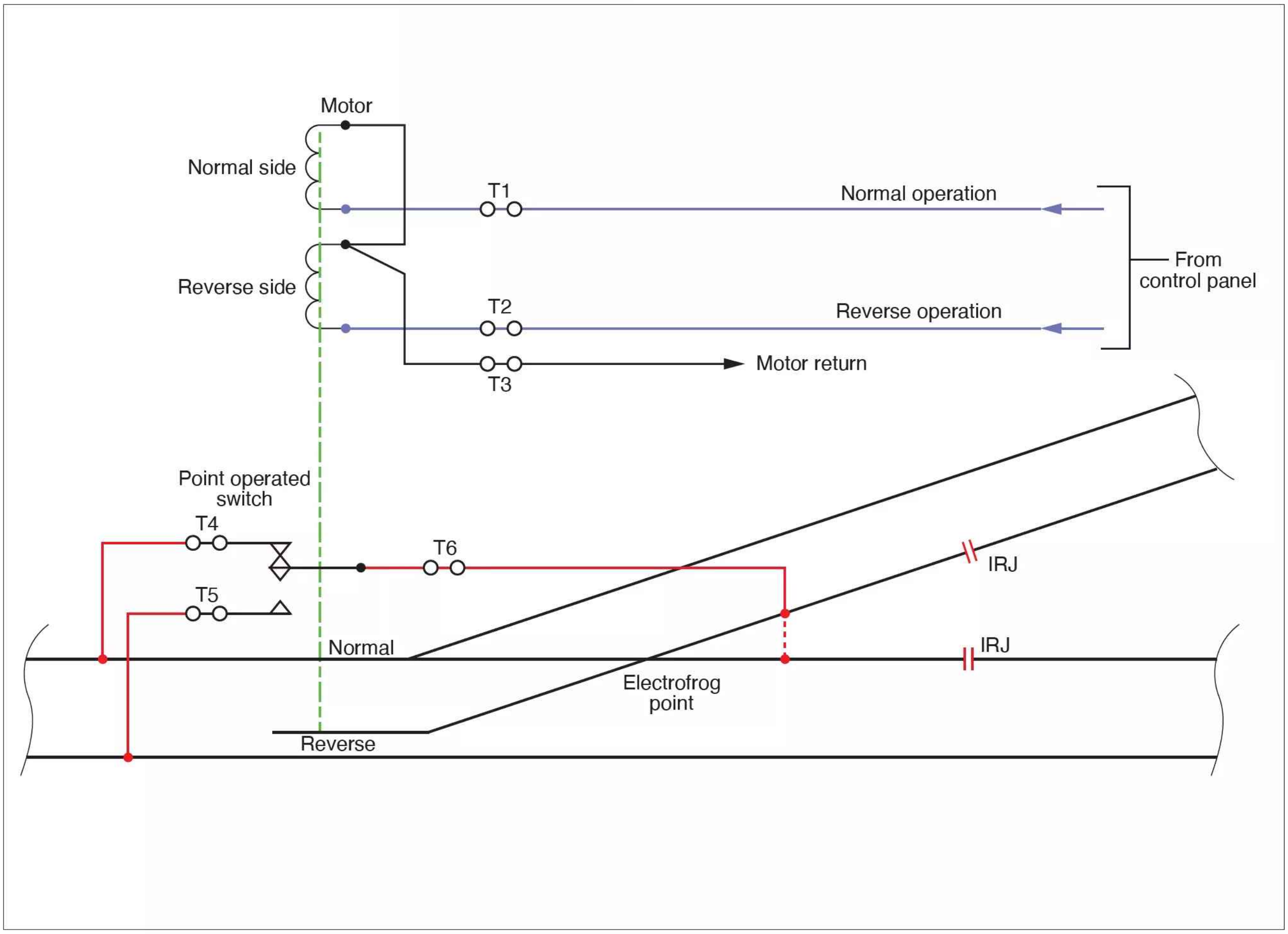


Figure 51: Live frog polarity switching. Note the need to fit the two insulated rail joiners after the frog on live frog points.

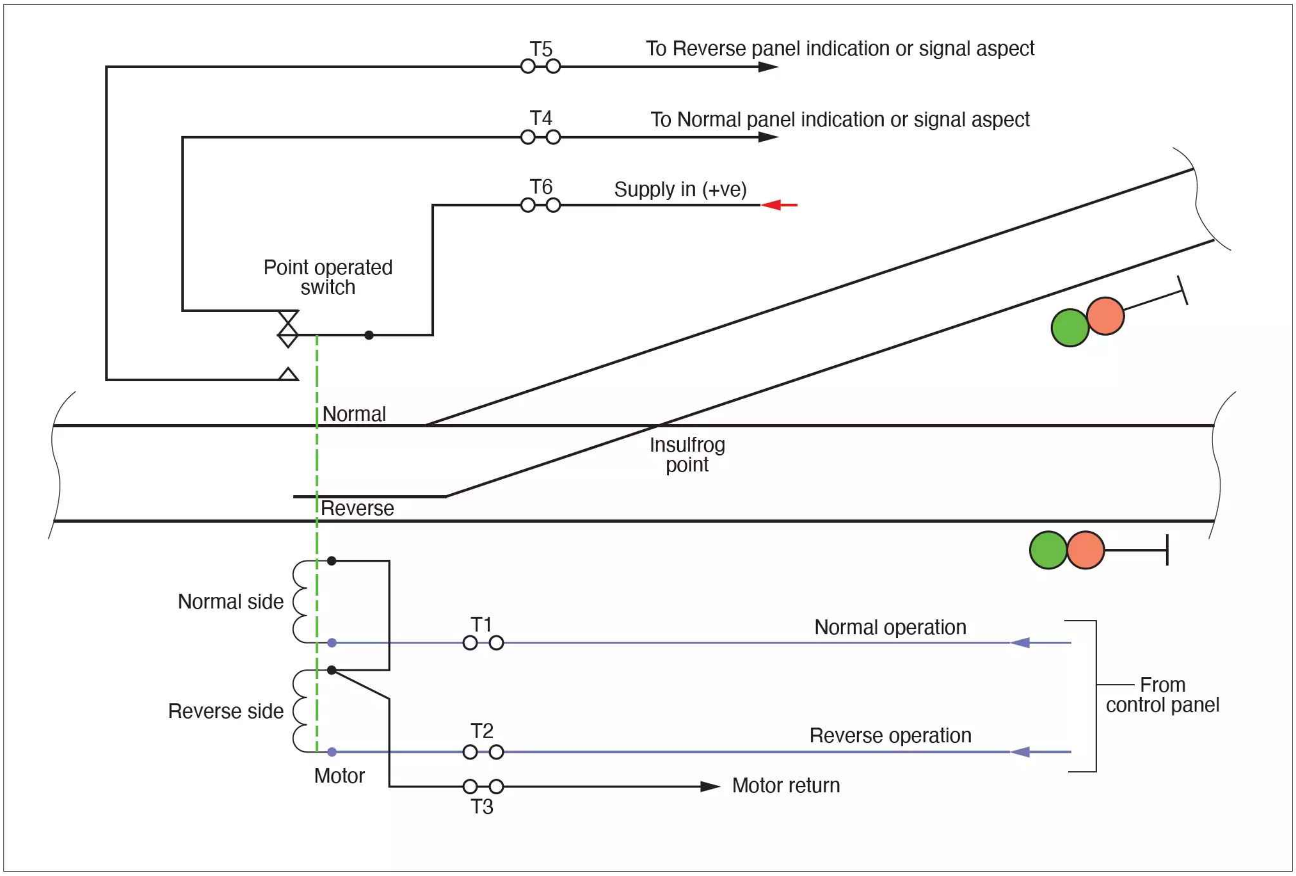


Figure 52: Basically the same layout, but using an insulated frog point. Users of insulated frog points can use the point motor-operated switch for mimic panel point indications or to control colour light signal aspects.

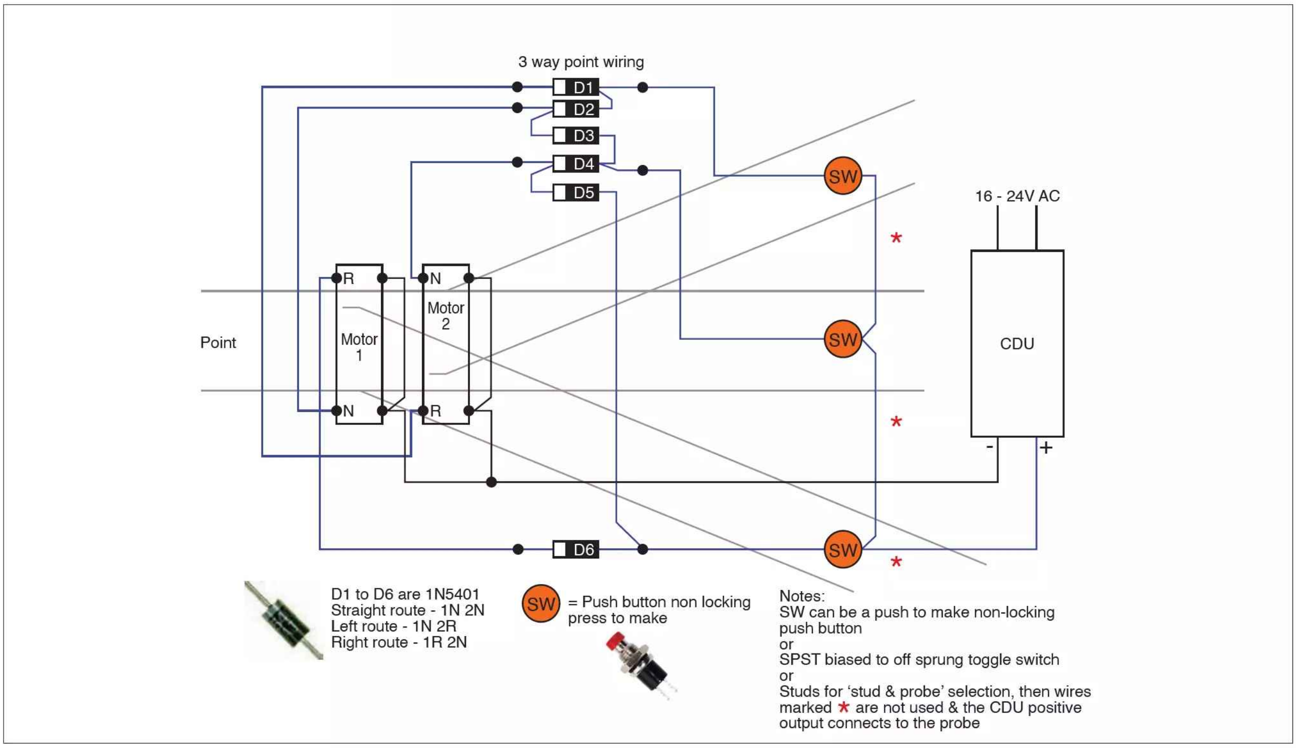
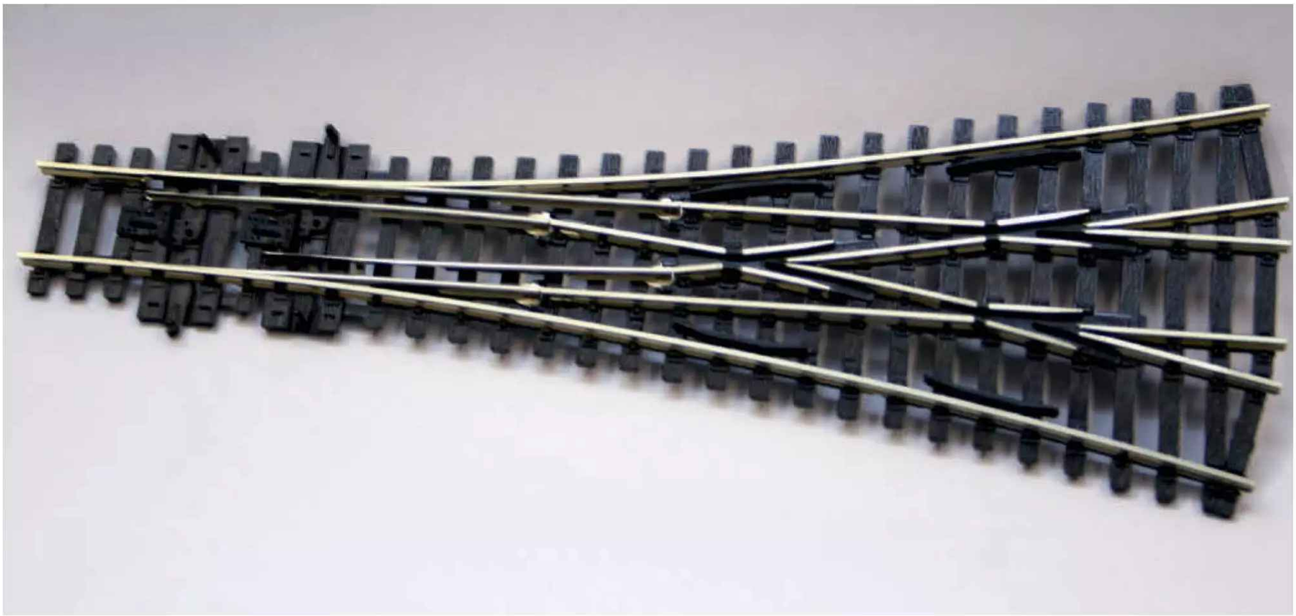


Figure 53: Wiring diagram for a three-way point. All the power is fed via a CDU to ensure that a sufficient pulse is sent to the two motors. Additionally, and to ensure that only the correct motor coils operate, a four-diode matrix is wired between the switch's outputs and the actual motor coils.



A three-way point.

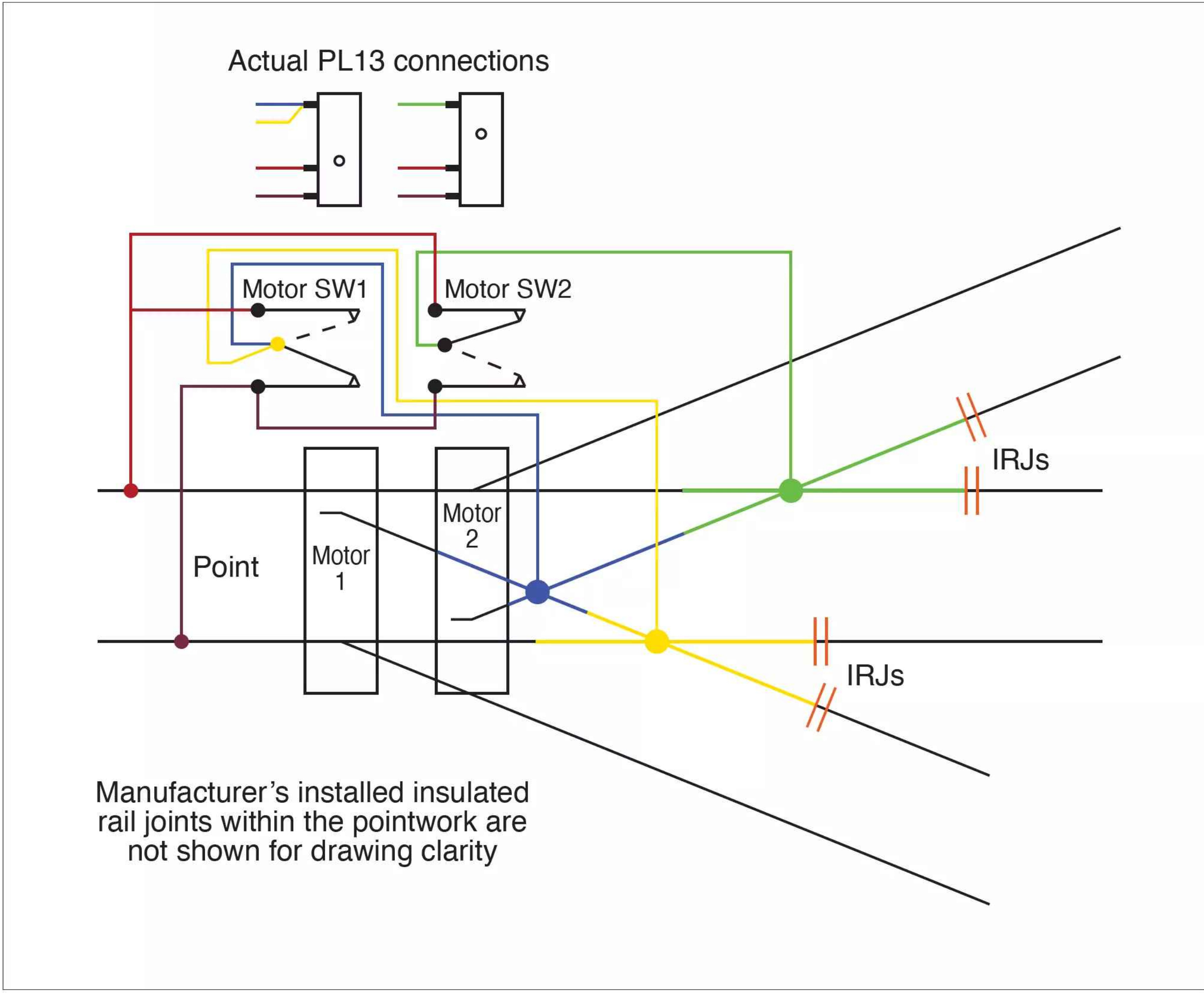
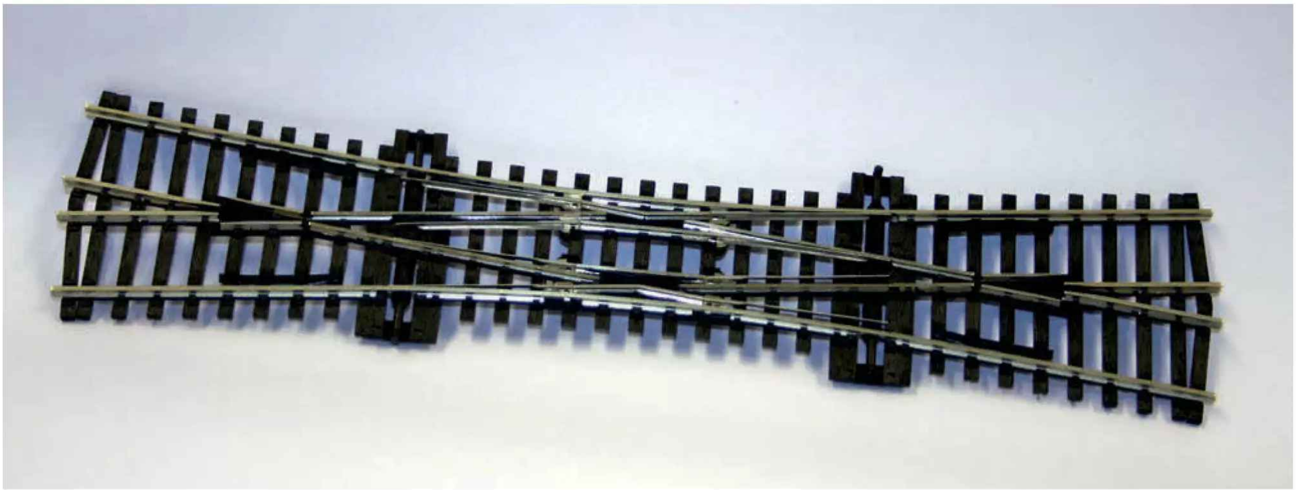


Figure 54: Wiring a live-frog three-way point. Factory-installed insulated rail joints within the pointwork have been omitted for clarity.



A Peco code 100 double slip with insulated (dead) frogs. These are much easier to wire than their live electrofrog counterparts.

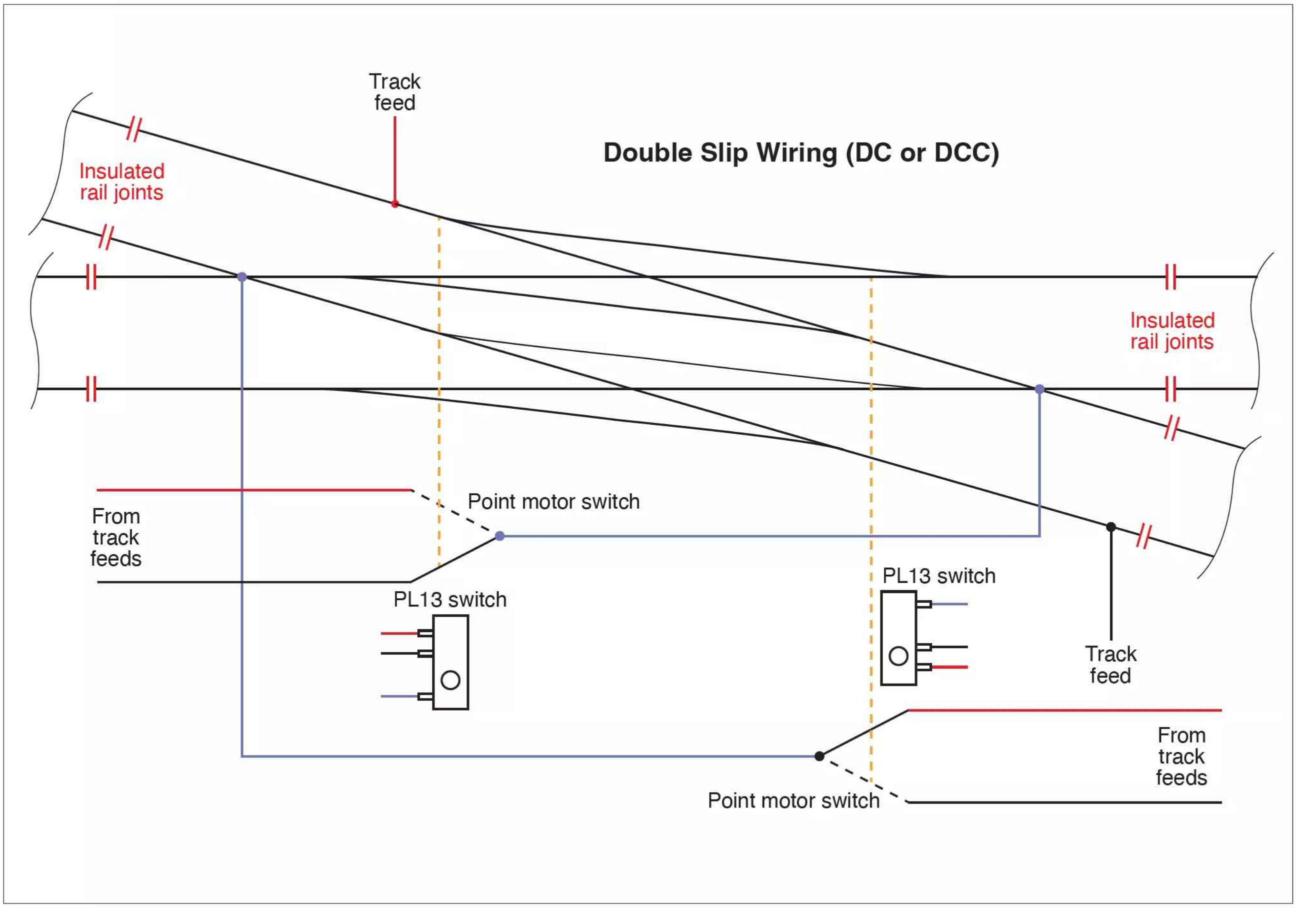


Figure 55: Wiring for a live-frog (electrofrog) double slip (DC or DCC).

A pair of changeover contacts are fitted onto the point motor and they swap over the polarity of the frog as the point motor and its point blades move from one side to the other. So, in one position the frog is at a positive track supply voltage, then the point is moved over and the motor operated switch flips the track power to the frog to a negative supply – as shown in the live frog drawings at the beginning of this chapter.

Three-way point operation at times causes concern, but it is really straightforward and Figure 53 shows a circuit using three, push to make, momentary push buttons; these could quite easily be replaced by sprung (biased) toggle switches or studs if using the stud and probe operation method. The power is all fed via a CDU to ensure a sufficient pulse of power is sent to the two motors. Additionally, and to ensure only the correct

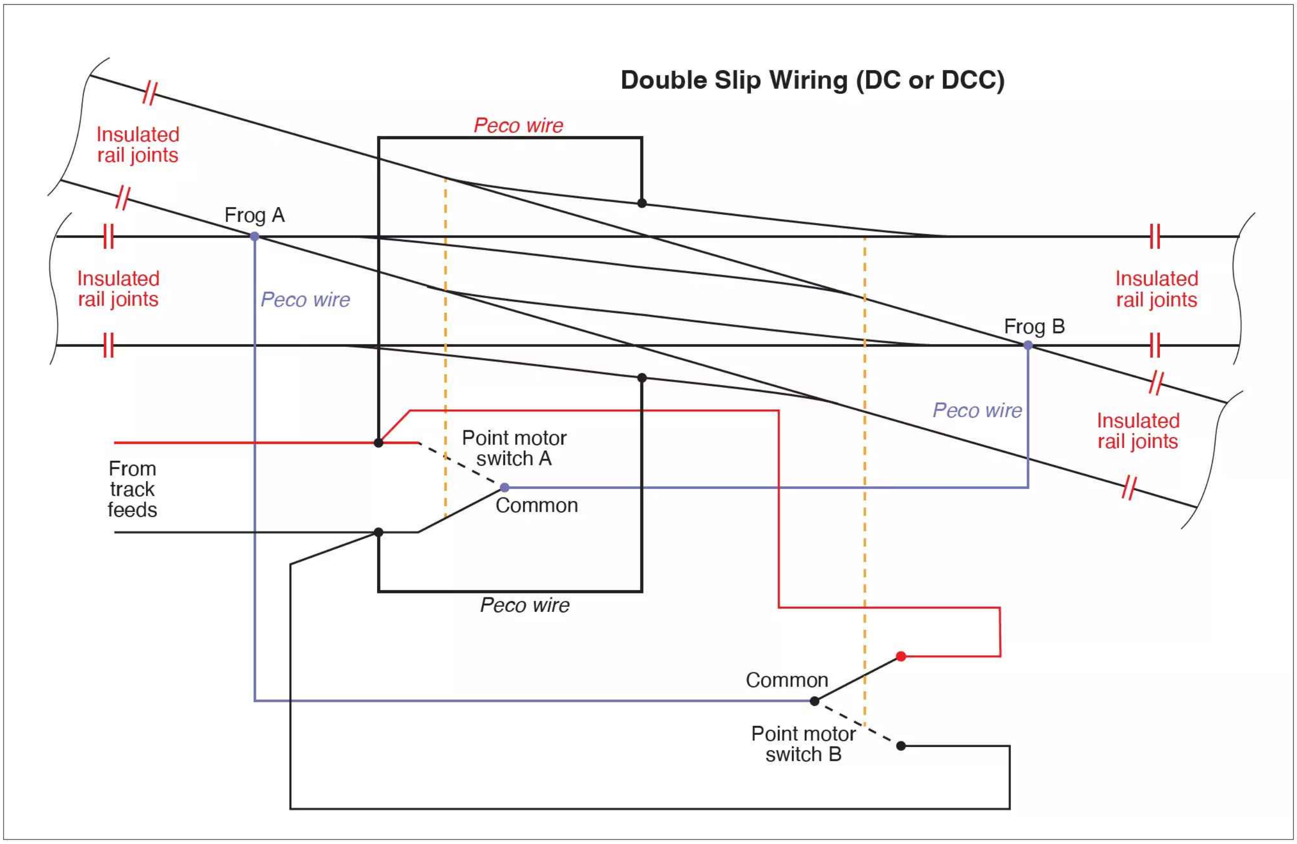


Figure 56: The Peco double slip is wired as in Figure 55, but this diagram shows the additional factory-fitted wires.

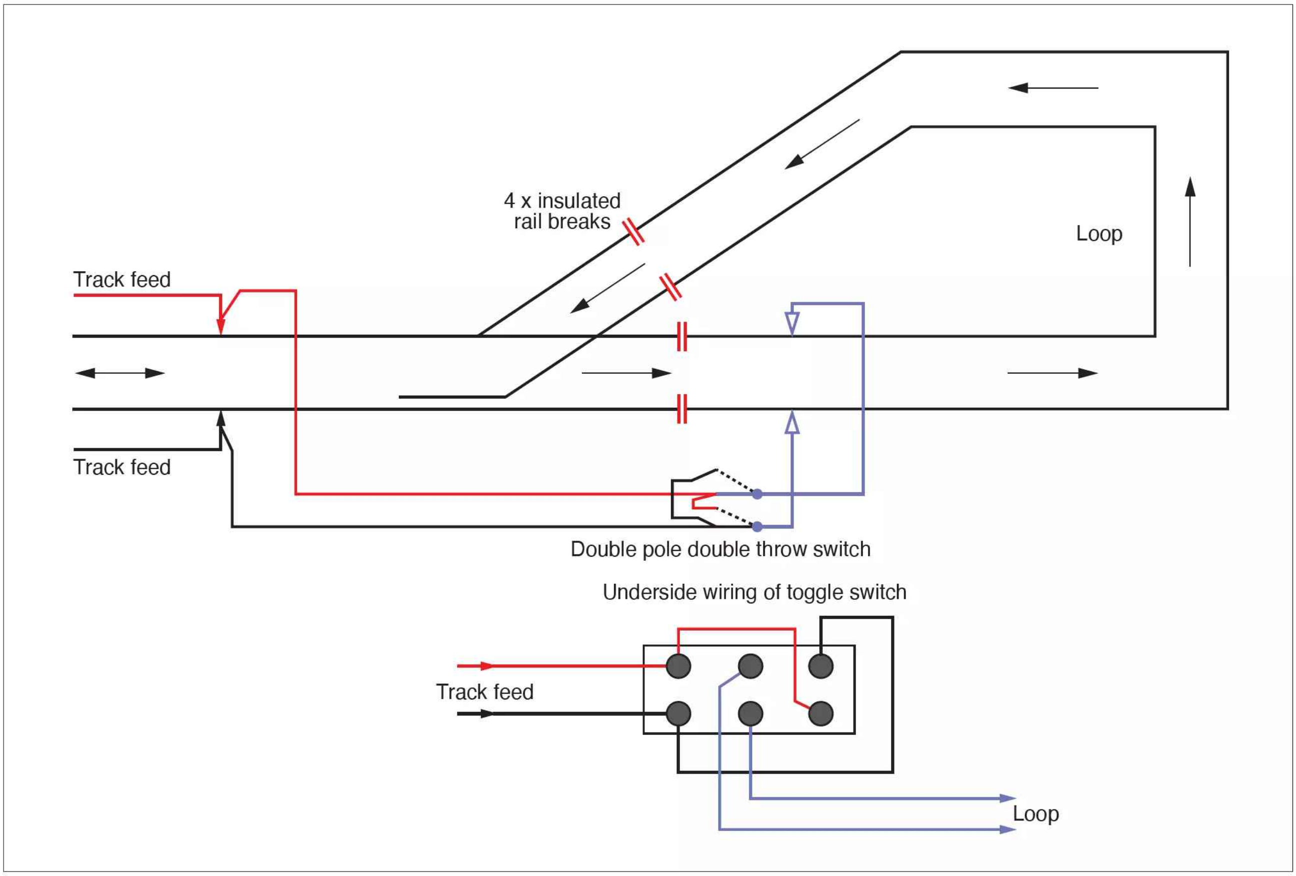


Figure 57: Wiring a reversing loop with a DPDT switch. The underside wiring detail of the toggle switch is shown in the smaller drawing.

motor coils operate, six diodes are wired between the switches outputs and the actual motor coils.

Double slips, especially the electrofrog or live frog double slip and its wiring, are another item that often causes problems for the installer. It really isn't that hard and if the two ends of the slip are considered to be no more than two normal single ended points placed together then the wiring is quite straightforward (see Figure 54).

Reversing loops

Reversing loops need special wiring using a DPDT switch as a means of reversing the loops' rail polarity. This is necessary because when the train enters the loop it must have the track polarity of the loop reversed before it can eventually exit the loop and proceed back along the track it approached on.

This is easily undertaken by installing four insulated rail joints, two at each end of the loop just after the loop points, and wiring in a Double Pole Double Throw (DPDT) switch. Note: The length of the switched loop section must be greater than the longest train (train = loco, carriages or wagons) to be run into it – ideally the reversing section being the full length of the loop.

The method of operation is as follows: the loops point and DPDT switch set for an incoming train, the train fully enters the loop's insulated section. The controller's power is turned down to off, the point is changed and the DPDT switch is reversed. The controller's direction switch is changed to the opposite direction of travel and the controller's power turned back on; and the train will now leave the loop correctly (see Figure 57).

8
Control panels, indications and lighting

Mimic panels

Mimic panels are miniature replicas of the whole or part of the track plan of the actual layout, and are sometimes used by the 'signaller' to set routes and operate signals, as per the real thing. The panel will have the track plan shown as a solid line representing each track; car lining tape can be used for this. Points and signal control via panel mounted switches will all be operated from here; real-time indications can be sent back to the panel to show point positions, while signal aspects indications can also be displayed.

Figure 58 shows a boxed mimic panel. The panel's surface can be made from any suitable materials such as white faced hardboard, MDF, Perspex or sheet metal such as aluminium etc. The body of the panel is often made from MDF or ply. Some panels are not in boxes, but are simply a flat or upright facia fitted onto the baseboard.

Mimic panels can also include the train speed controllers, in which case it is normal to use the specially manufactured panel mounting controllers. Additionally, hand-held controllers are often used, being plugged into the panel by use of multi pin plug and socket such as the DIN 4 or 5 pin type.

Route indications which illuminate to show the direction the points are set towards on a control panel can be easily made with LEDs; they illuminate to show the selected path or route for the approaching train. They can be wired by using the 12-volt uncontrolled output of a controller or via a totally separate power supply, whose DC output is then passed into the control panel and then onwards to feed out to all the point motor mounted switches; the LEDs illuminate showing the point route set on the panel's facia.

Two versions can be wired. The first uses two wires from the point operated switch back to the panel and employs just one common positive 12-volt feed wire running around the layout. Onto this common positive wire connects a wire going to every point switch's 'common' tag. Two wires are then fed back to the panel and via resistors they feed the appropriate LEDs.

Where a larger number of point indications need to be returned to the mimic panel, another method of wiring can be employed, which uses just one wire per point end going back to the panel. Again the 12-volt DC is used. The outputs of the supply (12-volt positive and 12-volt negative) are both run as a 'bus' format

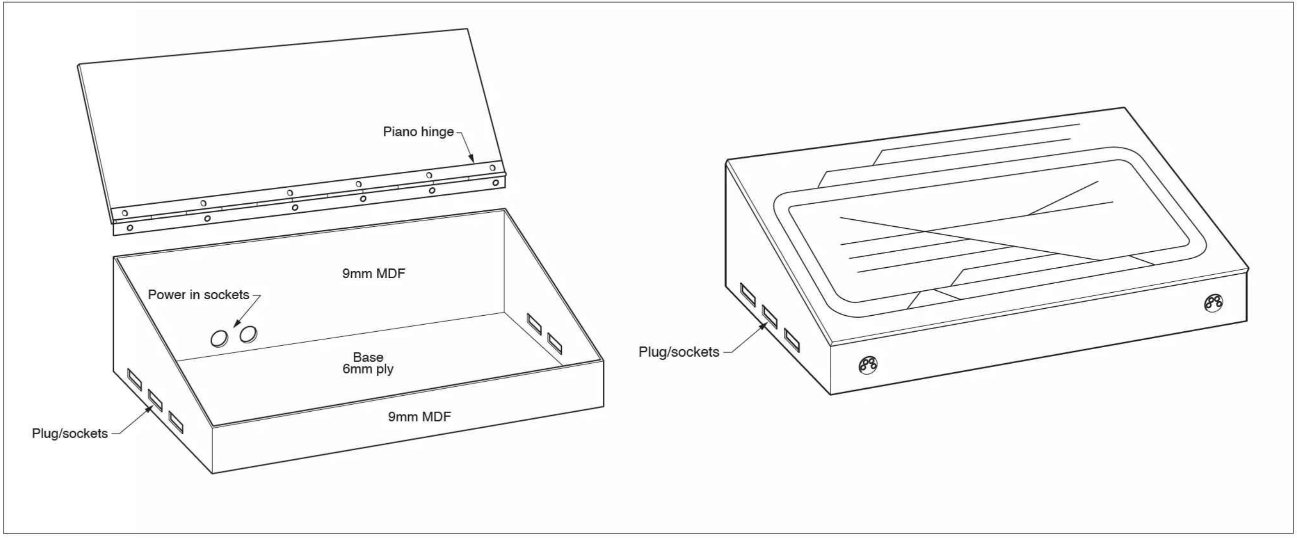
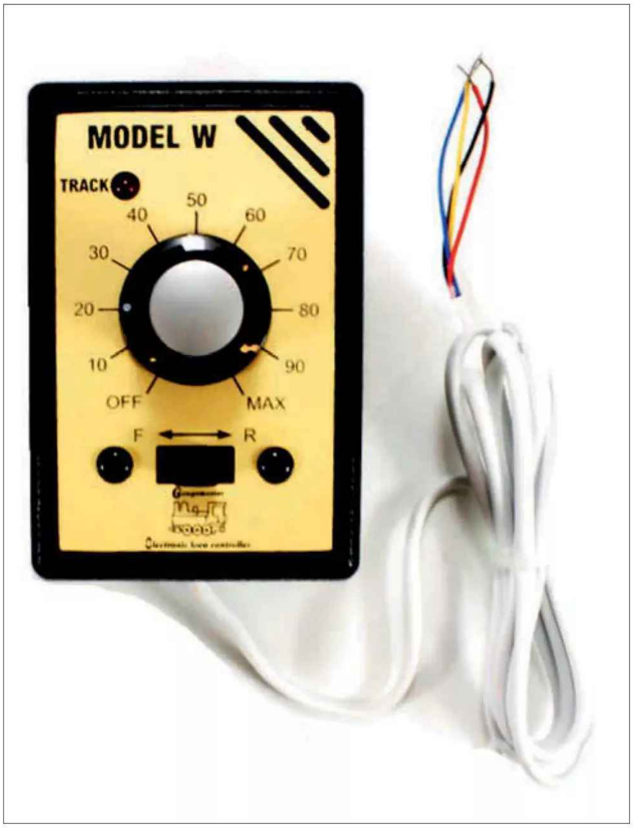


Figure 58: A boxed mimic panel. The 'box' can be free standing and placed on a suitable table adjacent to the layout, or it could be suspended from the layout's timber bracing by means of slide together 'secret' fixing plates; one half of the plate is fitted to the layout and the mating half to the rear of the panel and two or three sets of fixings are needed for a medium sized panel. Electrical connections between the panel and the layout are often made via 'sub D' multi-pin connectors and either multi-core cables or individual flexible wires made up into multi way bunches. Using 'sub D' connectors or other multi pin plugs and sockets enables the panel to be removed and stored easily.



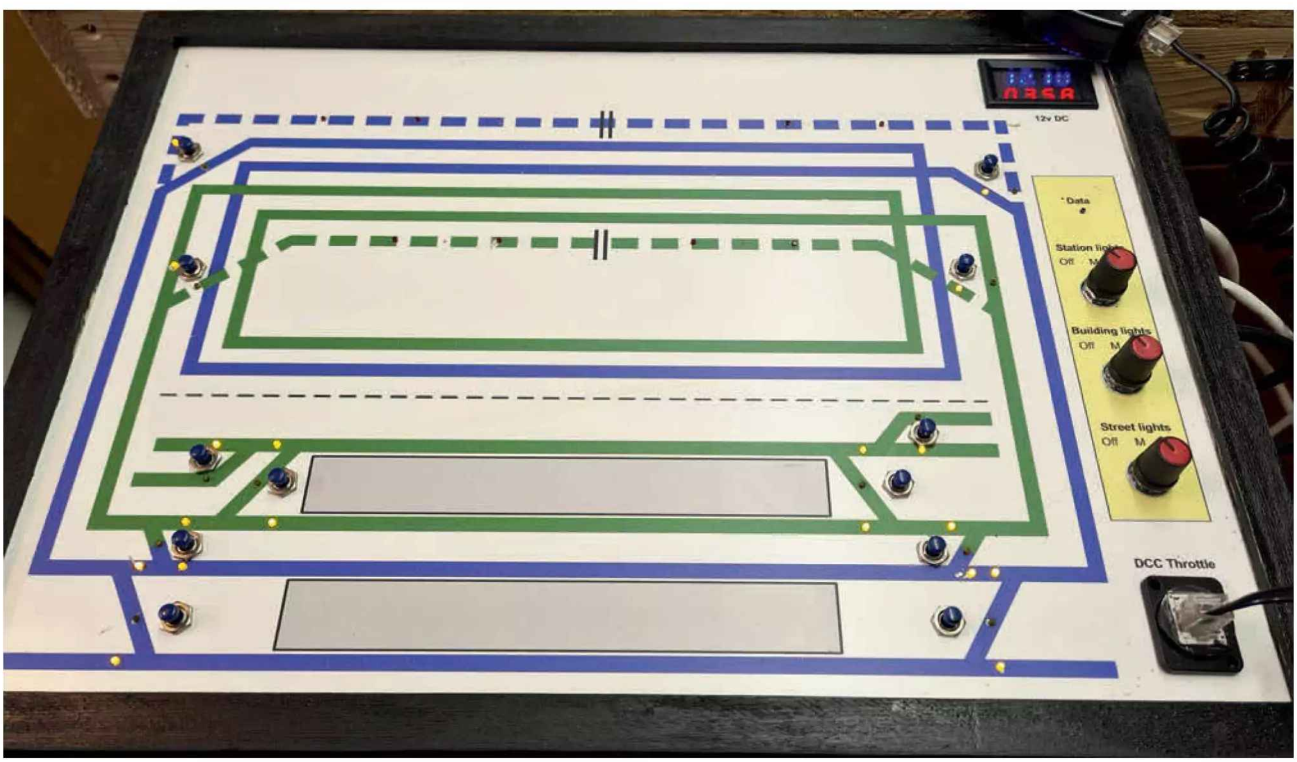
Hand-held controller. This is the Gaugemaster model W. It will be fitted with a four pin DIN plug. A mating four-way chassis socket is fitted into the panel and connects the controller to its power supply and takes the two track feed wires onto the rails.

around the layout. Wires onto each bus wire connect to the point operated switch's changeover connections. From the point motor switch's 'common' tag one wire per point end runs back to the panel (saving considerable wiring on a larger layout!) this illuminates the appropriate LED. Additionally, this 12-volt bus pair can also supply power to other accessories such as signal lamps and any buildings or street scene illumination.

One LED is mounted into the mimic panel's track diagram per route direction and all are fed via individual series resistors, one per LED. It is important to note that in the single wire circuit, each route's direction LEDs are wired opposite to the other route, i.e. when the point operated switch is moved from normal to reverse the polarity being fed to that route's LEDs along the single wire changes over, so it is necessary to ensure the reverse routes LED are wired the opposite way from the normal routes LED (see Figure 60).

Where a route is showing a crossover, from up to down line, say, then two LEDs illuminate that route – one per point end.

The 12-volt DC lighting power bus starts at the mimic panel and then goes out onto the layout to feed the individual point motor fitted switches. Use a suitable size of wire for this lighting bus to prevent serious volt drop and to ensure the full current available from the power supply is also available on the layout. Typically, this can be either 16/0.2mm^2 or 24/0.2mm^2 wire.



The author's 'High Hopes' control panel. Here, push buttons are used to select point positions and route indications of the points' true position are via small yellow LEDs. The three rotary switches on the right control layout building lighting, street lights and station canopy lighting.

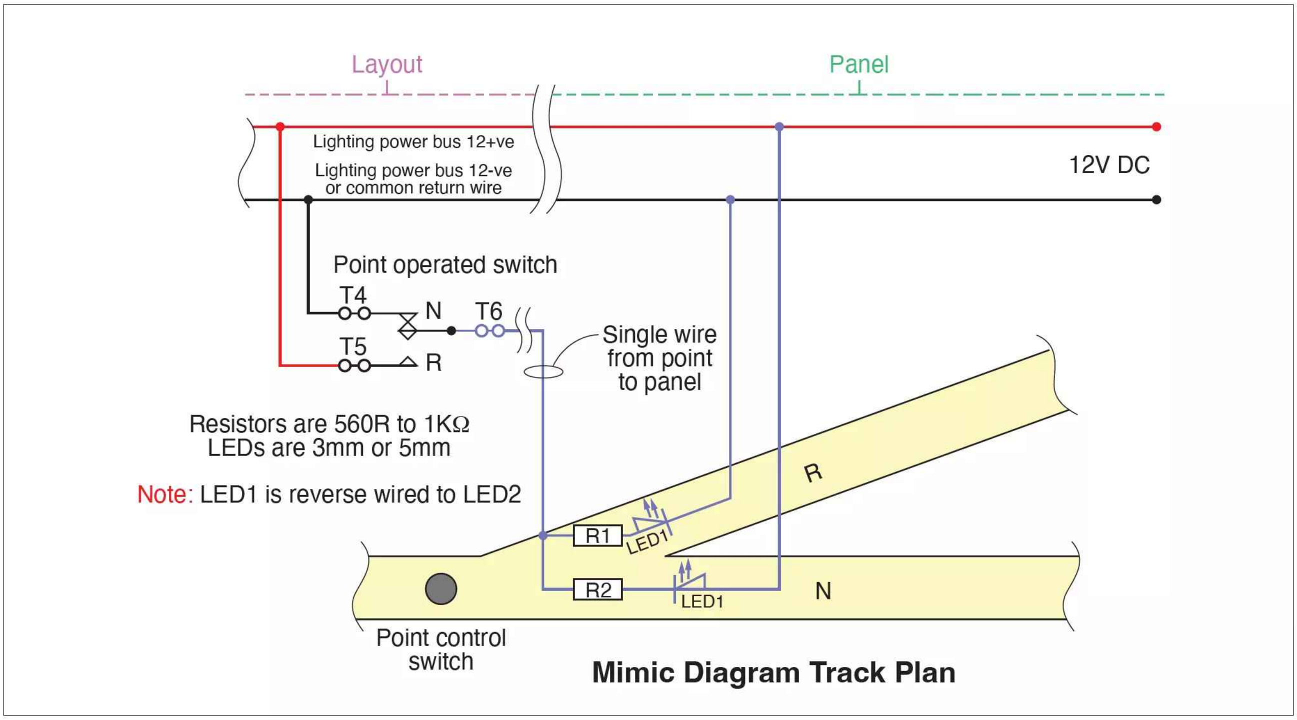


Figure 59: LED point to panel wiring.

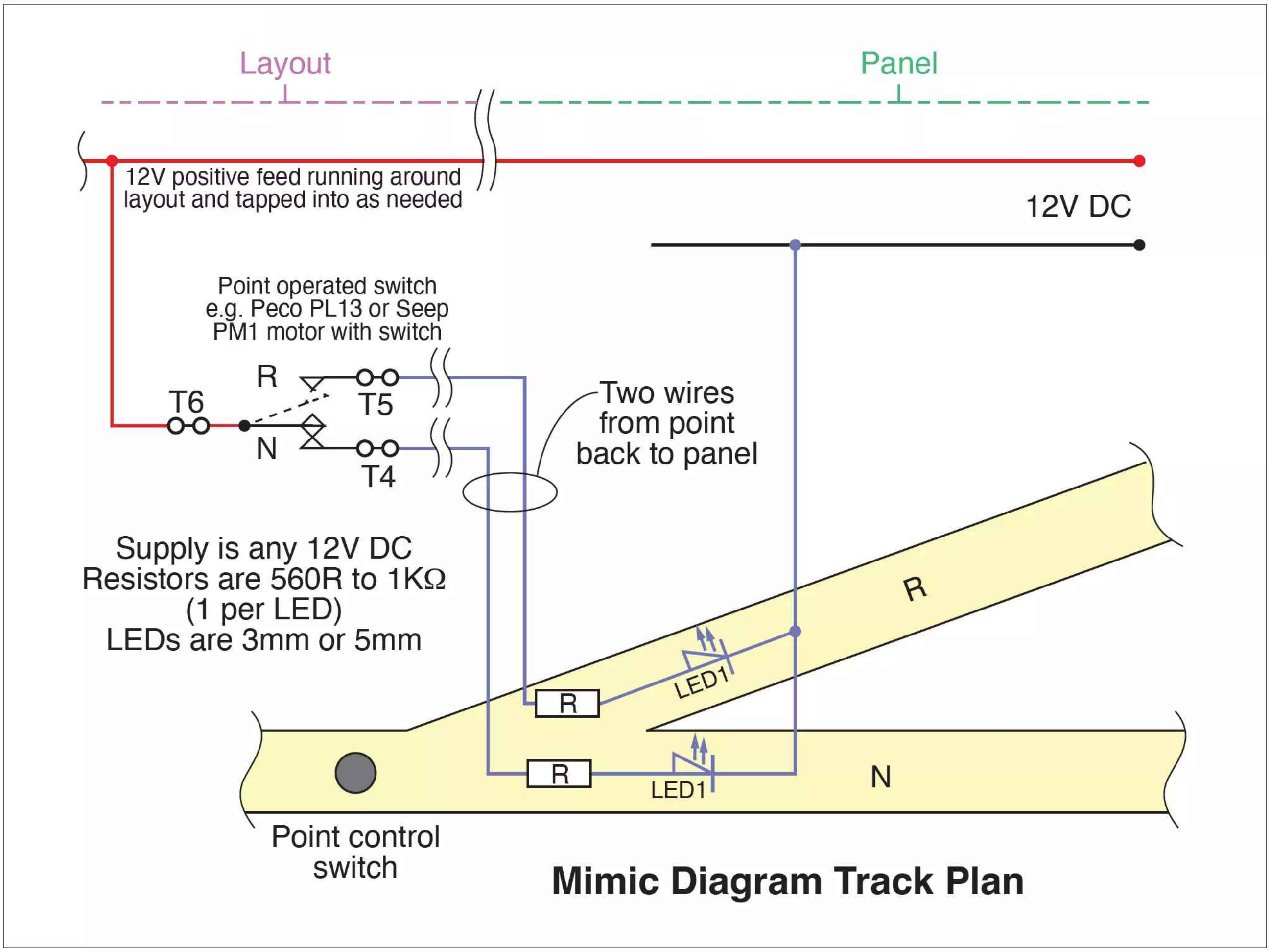


Figure 60: A simplified single lead point end route indication on a mimic panel.

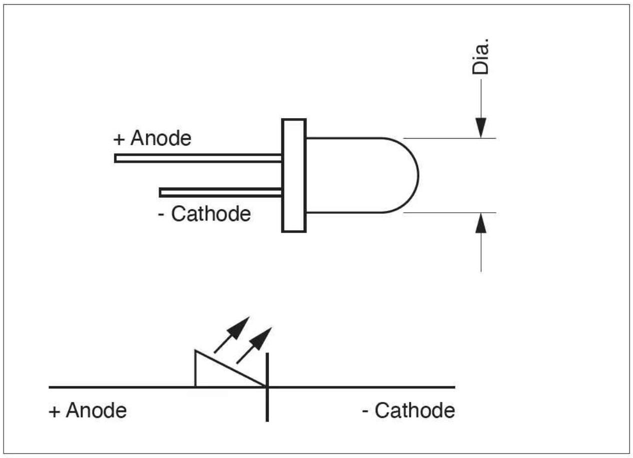


Figure 61: An LED, and how it is represented in a wiring diagram.

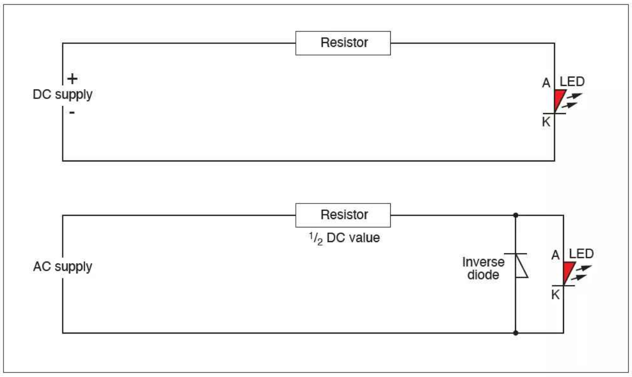


Figure 62: The upper diagram shows one LED operating from a DC supply, while in the lower drawing the same LED is powered from an AC supply; note the inverse diode fitted across the LED's supply. The inverse diode can be any small diode such as a 1N4148 or 1N4001.

Point switches

Point switches on the mimic panel are normally of the toggle switch style and are mounted directly into the plan on the panel's facia. Usually SPDT sprung to the centre off switches are used to operate solenoid points. Some panels may use stud and probe point selection instead of switches while others may use push to make non locking push buttons, here for solenoid operation, two push buttons are used per point.

Signal switches

Signal switches on the mimic panel are often toggle or rotary switches; they are mounted to the side of the track plan. Rotary switches offer the multi aspect colour light signal user the availability to control all the signals aspects individually. Normally signal indications display only a red and green indication light via a bi-coloured LED mounted adjacent to the switch. It is not really necessary to show all the colours of the proceed aspects of the signal; just a green 'OFF' indication need only be displayed. Of course for a signal that does not show a stop (red) aspect such as distant signals, the red/green should be replaced with a yellow/green bi-coloured LED.

LEDs and lamps

LEDs (Light Emitting Diodes)

LEDs come in all sorts of colours, sizes and brightness, from tiny 0.8mm to the huge 10mm or larger versions. They run virtually cold and last for many years and they all work on the same principle. Apply the correct DC voltage and the LED will light! It is applying the correct voltage and limiting the current available that often causes the installer so much difficulty!

In the main, most basic 3mm or 5mm dia. LEDs require around 2.2 volts at around 5 to 20 milliamps of current flowing to be at their brightest. There are exceptions, but these figures apply to most normal LEDs. However, a check of the manufacturer's data sheet will confirm the actual values.

How can the LEDs operate safely from our model railway power supply? Simply, a suitable series resistor is wired into the LED feed path or circuit! Ideally one resistor for each LED. To calculate the minimum acceptable value of resistance needed there is a quite simple formula. Assume the power supply as being 12 volts DC. The forward voltage of a standard LED is around 2.2 volts and its ideal forward current is around 20 milliamps.

The safe value minimum resistance formula is: 12v (the supply voltage) minus 2.2 (the forward LED volts) divided by 20 milliamps (the forward LED current) hence the sum is 12-2.2/0.020 This equals 12-2.2 = 9.8 divided by 0.020 which gives an answer of 490. This is the exact value of the resistance needed to run the LED at 20 milliamp. Unfortunately, resistors are not available in this value!

A typical yellow 3mm-diameter LED. The longer lead is the positive or anode connection.

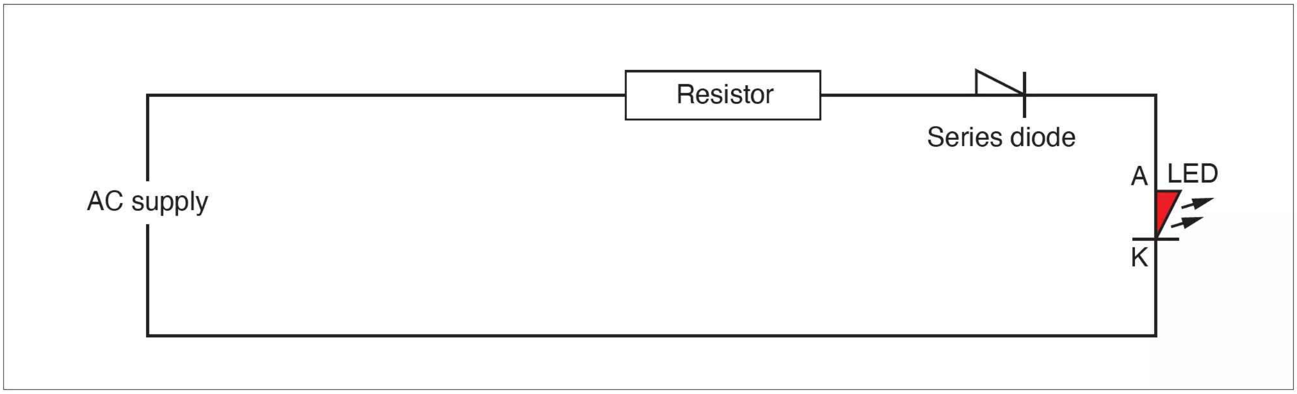


Figure 63: An alternative on AC supply using a series diode and then the resistor value is calculated to the same value as for a DC circuit.

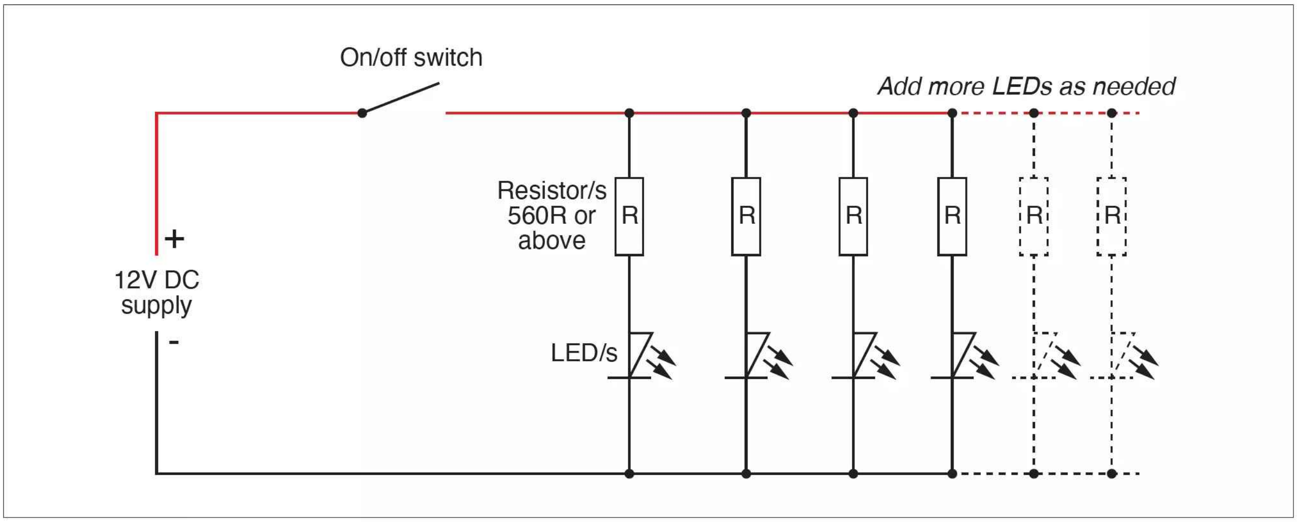


Figure 64: LEDs wired in parallel. If all are to be turned on/off at the same time, a single pole single throw (SPST) toggle switch or similar is wired into the positive feed immediately after the power supply.

The nearest preferred value above the calculation is 510 or 560ohms (510R or 560R). In most cases the resistor is rated at 0.25 watt, but a larger wattage can be chosen to run the LED if a ¼ watt isn't available. Higher value ohm resistors can usually be used and these will, as the resistance value considerably increases, cause the LED to run less brightly. I have found that there is little difference in light output when using a 560R or 1K5 (1500 Ohm) resistor. After this a small reduction will be seen in brightness as resistance increases. A LED is likely to last longer if the resistance value is always higher than calculated. They will also consume less current so whenever possible use a higher than calculated ohm value.

It is vitally important to remember that LEDs are polarity conscious devices, therefore when connected to a DC supply (with a suitable series resistance) they will only illuminate when the positive supply is connected to the correct LED anode lead – usually this is the longer lead of the two. If you want to run an LED on AC then an inverse diode should be wired across the LED and the resistance value calculated in the above formula is then halved (see Figure 62). Or alternatively add a series diode in one lead to the LED and then the ohm value of resistance needed is the same as for DC operation.

LEDs offer excellent illumination of buildings or street lights, station lamps etc. and many LEDs can be operated from one power supply. Typically a 12 DC 1.0 amp supply could power 50 LEDs operating at 20 milliamps each, though in practice a slightly smaller number of LEDs would be connected to allow a little margin on the power supply. Increasing each LED's resistor ohm value will reduce their current demand and then more LEDs can be fed from the same supply.

Filament lamps

'Grain of Wheat' (GoW) or the smaller Grain of Rice (GoR) styles were commonly used in model railways but today they are usually LEDs. While they both offer excellent illumination and are available in various colours, unfortunately filament lamps have two downfalls. One is they often tend to run extremely hot and secondly they each can draw a considerable amount of current from the power supply.

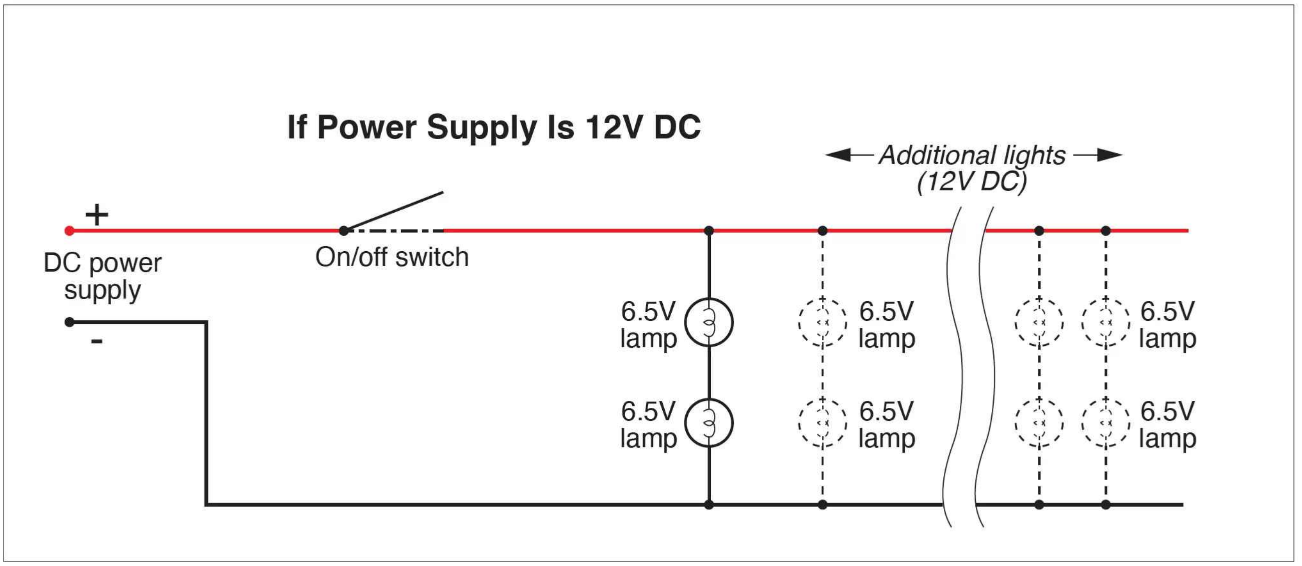


Figure 65: 6.5-volt filament lamps wired in series, two lamps running from a 12-volt supply. Note in the illustration the lamps in both series connection groups are all the same voltage – 6.5 volts. There is no reason why mixed voltage lamps cannot be used e.g. on 12 volts, a 9-volt and a 3-volt lamp can be connected in series across the supply, so long as their total rated voltage is equal to or just above the supply's voltage rating.

Whenever possible try and 'under run' filament lamps to prolong their life. That is, if the lamp is rated at 12 volts, try running it at 10 volts. Consider also if practicable, feeding filament lamps with a DC supply as opposed to the AC alternative. Though they will operate on AC, using DC to power the lamps will improve their longevity.

Always position filament lamps carefully and keep them well away from any plastic materials used in any building construction as they will, due to their extremely hot working temperature, cause the plastic to melt or distort.

The largest drawback of these lamps is the current they consume. Typically, GoW lamps will require some 60 to 80 milliamps each. So just 15 lamps will need between 900 milliamps (0.9A) and 1200 milliamps (1.2 amps). This is easily overlooked by the layout builder, especially where many lamps are connected onto the power supply. The power supply's internal overload trip operates after a few moments and the modeller then wonders why all their lamps have gone out!

They do have one advantage in that if the lamp is rated below the PSU voltage you can, by series connecting them (daisy chain fashion), wire for example two 6-volt or three 4-volt lamps to run from a 12-volt supply. The only disadvantage here is that when one lamp fails, all in that chain go out.

9

Digital command control (DCC)

The Digital Command Control system has taken the model railway world into the 21st century. It is such a leap forward that perhaps it can be compared with the change from clockwork to electric control of model trains. DCC allows multiple and totally independent locomotive operation all on one track-fed system. No isolating sections, individual track feeds or local control cabs are needed. One loco can remain stationary while a second is brought right up to it; they can even be coupled together. Double heading, also known as a ‘consist’, is easily possible and if desired under full computer control.

Using the traditional DC system (what might be called an ‘analogue’ control system) to move a locomotive, we provide nominally between 0 and 12 volts DC onto the rails. When full voltage is supplied, the train will move at the fastest speed the motor can muster. If we want the loco to run at half speed, the supplied voltage is reduced half (this isn’t quite correct, but it is near enough for this example).

By contrast, the DCC system provides full volts around 15 to 18 volts in a square waveform to the rails all the time and each loco has an ‘on board’ DCC decoder fitted (microchips on very small circuit board). The decoder is connected to the rails via the locos wheels. When a digital signal is sent out by the DCC controller or console it is received by the decoder, which then supplies the commanded voltage to the loco’s motor – full volts for half the time will give half speed running or full volts for three-quarters of the time will give three-quarter speed and so on. Technically this is called Pulse Width Modulation (PWM). Note the decoder converts the square wave AC input into DC for the motor power.

Every loco on the DCC controlled rails has a decoder fitted, and each loco’s decoder is given a unique digital

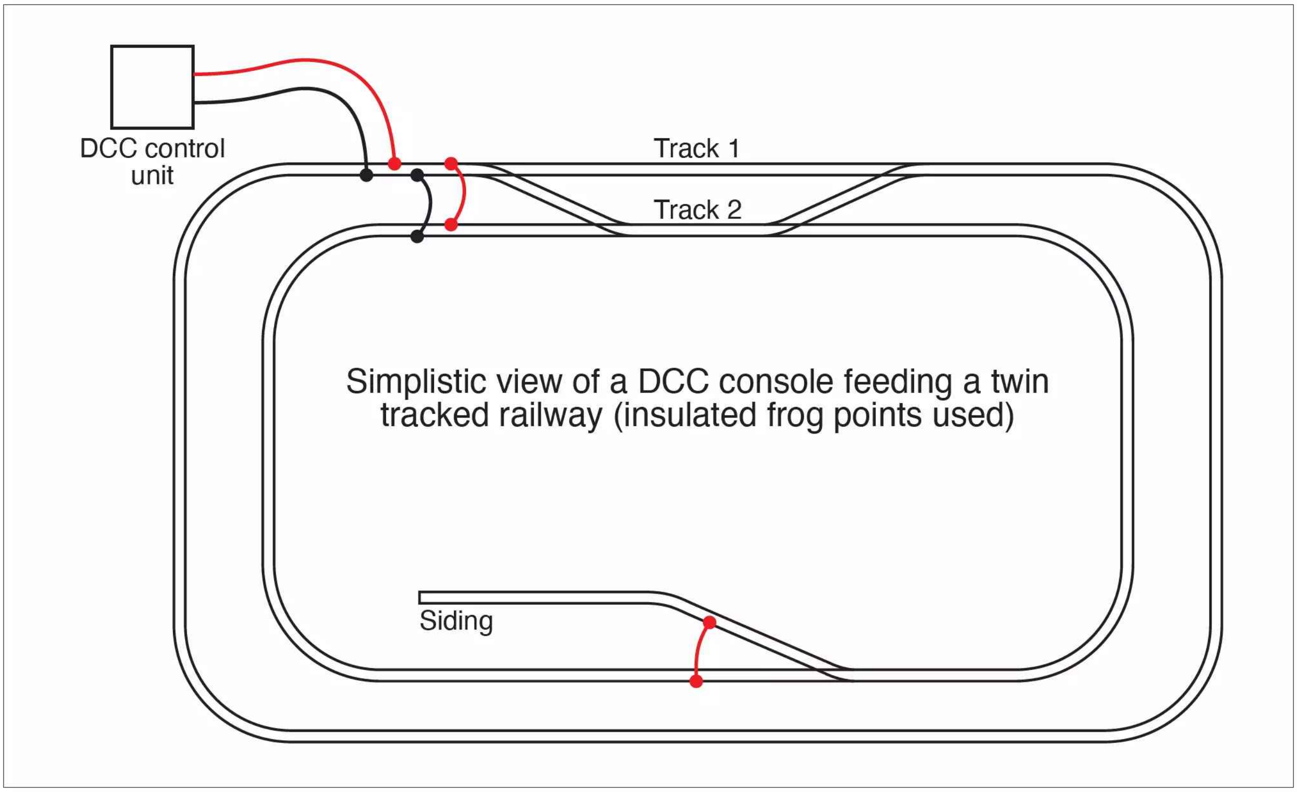


Figure 66: The simplest method of wiring a twin looped layout. Note the additional single wire connecting onto one rail of the siding to the same handed rail on the loop. This ensures the siding is always live, regardless of the position of the point. This will then allow DCC locos in the siding to have their lights or sounds operating and allow them to be moved with the point set for the main loop.

'address' or number. All loco decoders receive the data commands simultaneously, but only the decoder that has the unique digital address assigned to it will respond to that digital data signal being sent along the rails at that time; all the other loco's decoders will ignore the command. Once the decoder has seen the data arriving, it will act upon the commands and operate the device it is connected to accordingly – motor, lights, sounds etc. Once it has been set, the device will remain at that setting all the while power is available and until another unique command is received to turn that operation off or alter the last setting.

Meanwhile, the operator can call up the unique address number of another loco's decoder and a digital address is sent to allow this loco to move off or do something different from the last instruction sent to it, while the first loco continues to run at its last setting. Hence we can now operate many locos simultaneously, all on the same rails. For example, you can set the mainline train running, then call up a loco in a siding and carry out some shunting, while the first loco continues to run uninterrupted. There is normally an 'all stop' button provided on the controller for any emergency! This will stop everything and once the problem has been resolved, you will need, in most cases, to restart each loco again in turn.

DCC not only allows you to control many locos at once, it also offers the opportunity to control signals, points, train lighting and sound effects. Add to this, in some systems, the option to have your computer running the railway and you can have a total and very realistic train control system. Additionally, a number of DCC systems allow the use of a tablet or smartphone to become the interface as a controller. One advantage is that virtually all the DCC manufacturers' products are compatible and are set to defined standards written by the National Model Railroad Association (NMRA).

More recently, Bluetooth train control has appeared and a Bluetooth-enabled DCC decoder is fitted into the locomotive; it then receives its instructions via a Bluetooth signal. Train and accessory control is via a tablet or smartphone, which requires the appropriate app to be installed. One such system is the Hornby HM7000, another is manufactured by BlueRail. I'm sure other manufacturers will follow.

The Hornby HM7000 system allows a DCC console to provide track power as normal, or you can use a recommended power supply, but the DCC system doesn't send data, just rail power. The commands or data are sent wirelessly via Bluetooth. However, by connecting a Hornby DCC system to the rails you can operate conventional decoders and Bluetooth ones together on the app, this is done by adding what is known as a 'legacy dongle'. You can then control conventional decoders via the HM7000 app. At the time of writing the dongle has only been confirmed by Hornby to work seamlessly with their own brands of DCC – Select, Elite and eLink/Railmaster, though it is considered it should work with any DCC system that offers an Xpressnet connection. Users of other DCC systems have reported it does work as expected via the Xpressnet connection.

Gaugemaster have their Infinity Sovereign DCC system that uses Bluetooth between the handset and the base station, so the usual cable connection between base and handset is removed. Unlike the Hornby system, Infinity does not 'talk' directly to the loco decoder via Bluetooth. Their Prodigy system offers an optional wi-fi communication via tablet or smartphone to the Prodigy base unit, via a special add-on wi-fi unit. Both the conventional handset and a tablet or smartphone can be used together, but the tablet/smartphone options do not allow reading or programming to be undertaken, so the main corded handset has to be used for this.

DCC questions and answers

Q) How do I fit a decoder?

A) It all depends on the locomotive. Many modern locos are supplied as either 'DCC on board' (decoder is factory fitted) or 'DCC ready' (a special socket into which a decoder can be plugged, usually by the loco's owner). Other locos need the decoder to be wired and soldered into the loco's wiring (called hard wiring). In many cases this is quite simple, with usually only the split-chassis and Ringfield motor types needing additional work.

Q) Do I need to use Hornby decoders with Hornby locomotives?

A) No. Generally you can pick and choose a suitable decoder from any manufacturer. Just ensure a) that it will fit into the available space, b) That it has the correct connector fixing (plug), and c) that it has sufficient 'Function' outputs.

Q) Do I need to use decoders from the same manufacturer of my command station?

A) No not at all. All DCC equipment is made to a common defined standard, as set by the NMRA. So you can use whatever decoder is best suited to your locomotive or price range. They should all operate with a different manufacturer's controller.

Q) What about wiring for DCC?

A) Don't be fooled by the 'just two wires' statement, although it's a lot simpler than you might expect and usually much easier than conventional DC wiring. All you need to do is provide power everywhere. There is no need to provide switched sections as with DC.

Q) Can I run DC locomotives on my DCC layout?

A) While some DCC systems allow this and it is technically possible, it is not recommended. This option works by 'stretching' half of the DCC signal to give a sort of DC bias. However, the loco is still running on what is basically a sort of AC supply (hence often the high-pitched noise it makes when you put it on the DCC powered track). The DCC track power can easily destroy an electric motor. Do this at your own risk and always remove stationary unfitted locos if they are to be left standing for more than couple of minutes.

Q) Can I run DCC locomotives on a DC layout?

A) Yes. Most, if not all decoders (check the decoder instructions) allow operation on a DC layout, though this can be disabled. The decoder detects the DC track power and responds accordingly. Do ensure your DC layout does not have any electronic high frequency track cleaners or feedback controllers in use, as these can damage or confuse the decoder.

Q) My DCC-ready loco moves okay, but the lights don't work with the decoder that I have fitted. They did work correctly on DC so what's the problem?

A) If it's an 8-pin connection, try rotating the decoder plug through 180 degrees. It may have been fitted the wrong way around. Being the wrong way in the socket will give locomotive movement, but no lights. Also check that the lights have been turned on, usually by key F0.

Q) Can I mix DCC and DC controllers on the same layout?

A) Not recommended at all. It is very likely to cause problems if the lines are connected together and the two systems then interconnect. On two completely isolated or separate lines it is okay to do this – feeding one line with DC and the other with DCC. But if you connect a DCC and DC layout tracks together, it will most likely permanently damage your DCC controller or even both controllers!

Q) Can I have two or more DCC consoles feeding the tracks at the same time?

A) No. You should never allow two conventional DCC consoles outputs to become connected together on the same rails. Serious damage can result. You can however, with certain systems, have a second or third console connected to the master console. This connection has to be carried out with a special linking cable running between the second and third consoles and master console. Special cables with equally special plugs and sockets are used to ensure the correct connections are made. There are now DCC systems where the loco decoder is operated by Bluetooth technology and the DCC system or another special power supply just provides rail power.

Getting the best from DCC

Some basic DCC systems will state 'simple two wire control'. While this perhaps is true, it isn't actually often the reality. All electrical power needs to get from its source to the motor, decoder or wherever it is needed as easily as possible. Electricity is basically lazy and if an obstacle is placed in its path it won't try very hard to get over the problem, it just lays back and rolls over!

This failure to reach its final destination is often due to a high-resistance joint. Imagine the power and data signals coming from the control console onto the rails, from where it has to pass through numerous metal rail joiners (fishplates) to get from one track section to the next and so on. Eventually, it arrives at the wheels of the loco, in most cases transferred via wiper contacts touching onto the rear of the wheels to eventually reaching the decoder. How many places of possible high resistance has the power had to pass through? Probably 40 or more! These include the rail power connecting clip, if used, two rail joiners per track section, point blades touching stock rails, loco wheels running on the rails' top surface and the wheel wiping contacts taking power and data to the decoder. Each of these is a possible high resistance spot and a possible cause for trouble!

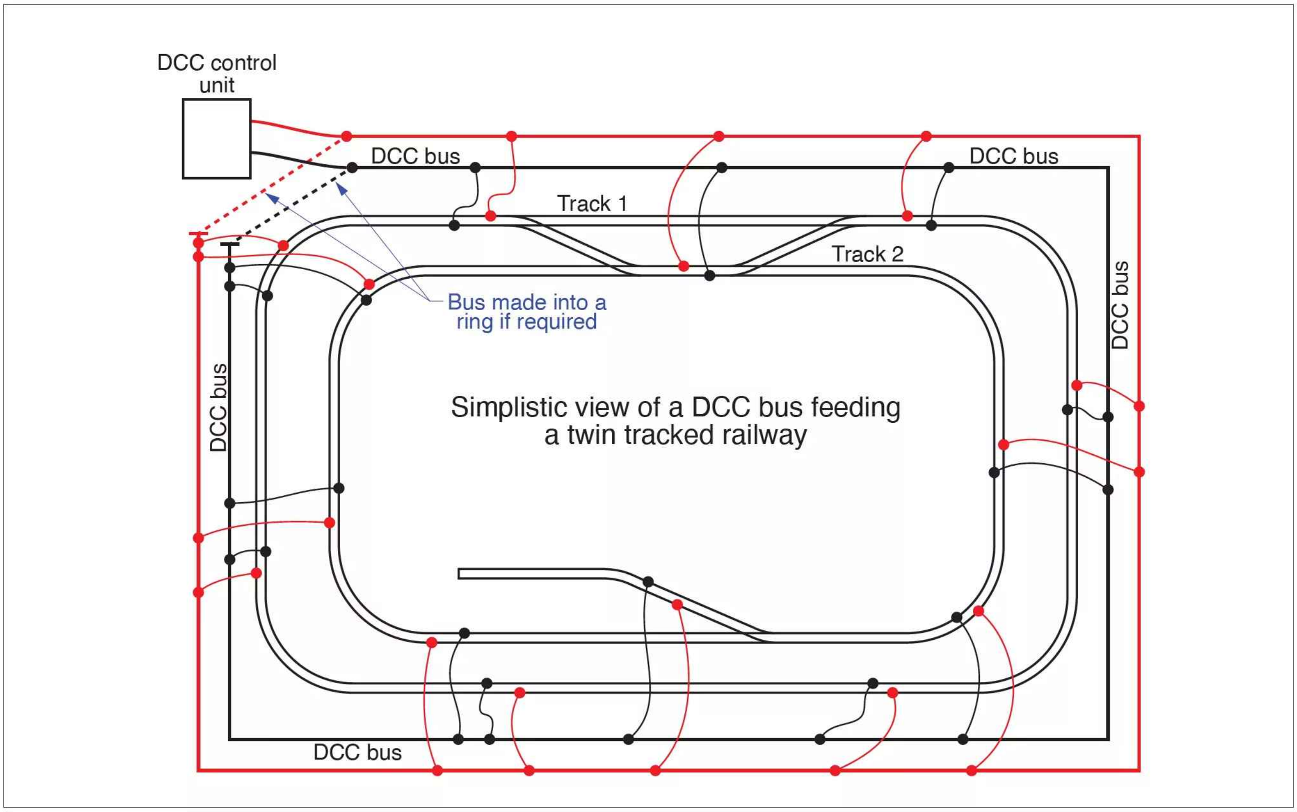


Figure 67: How the 'bus' is connected from the DCC control console unit via the two wires to the running rails. This is the same track layout as shown in Figure 66, where the feeds were only connected in two places. Using a bus and many dropper wires feeding the rails will improve electrical performance. Note that all the points shown in the above are insulated frog type.

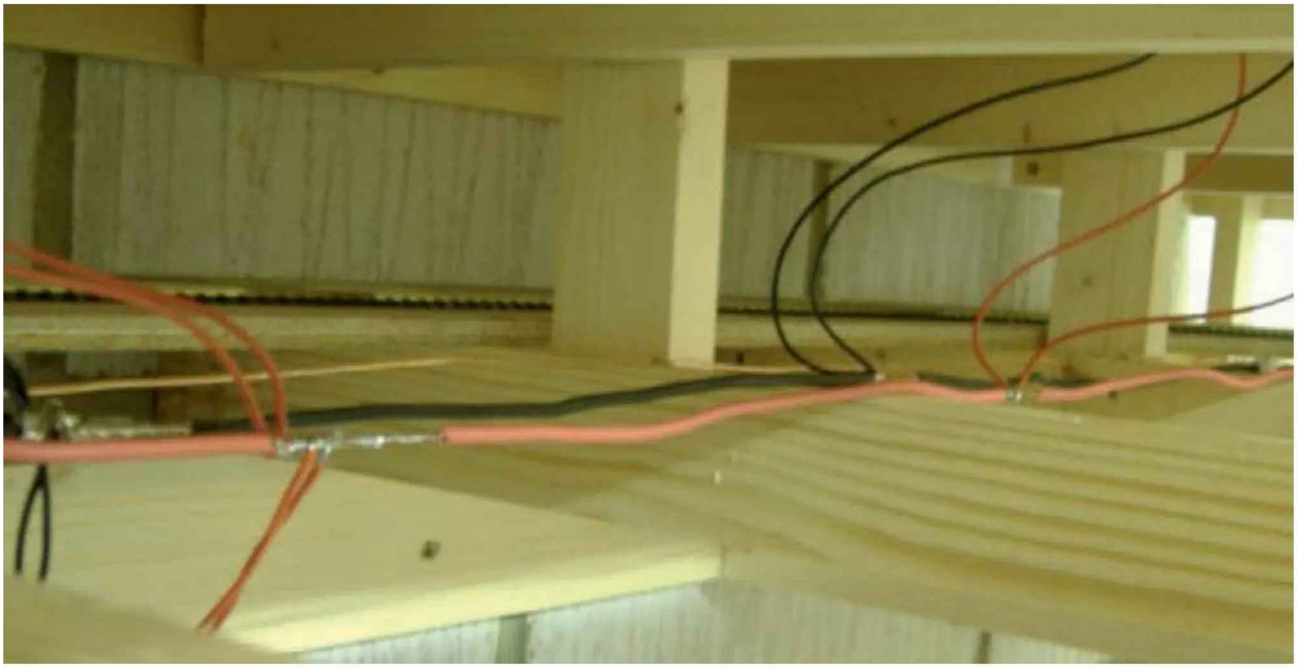
The main culprits are dirty rail surfaces, dirty wheels, dirty wheel wiping contacts and, of course, the loose or dirty rail joiners – quite a few obstacles, even without the possibility of the rail power clip itself being a poor connection (if one is used).

It is possible to avoid these problems, however. Keep the rails clean with the aid of a track cleaning rubber or special rail cleaning fluid. Keep the loco's wheels clean with the aid of a wheel cleaning brush set. Both the track rubber and the wheel cleaning brush sets are available from good model shops and from manufacturers such as Peco. Cleaning of the rails only needs to be undertaken once every week or so, so long as the layout is used regularly. However, if it is put away and not used for several weeks or months the rails should be cleaned before use, as they will have most likely tarnished. Keep the loco's wheels clean, and don't forget to clean all the rolling stocks wheels too, as these also deposit dirt on the rails. Improved running will result (while these 'good practice' comments are aimed at the DCC user, some of these should be observed by the DC user).

For improved running, best practise says do not rely on 'push in' electrical connections such as track power connectors and metal rail joiners. Solder the power wires (dropper wires) directly to the outside or to the underneath of the rails where the track has still to be laid. Also consider the improvement offered by running a DCC power bus (two wires) around the underside of the layout and tap off this as many times as possible to feed sections of track. Nickel silver rail has a greater resistance than copper wire, so the 'Bus pair' offers improved supply voltages throughout the layout.

The DCC bus pair will help to improve operations both electrically and data-wise. It is recommended that two DCC power wires (called the 'Bus' from here on) are run around the railway in a radial circuit (see Figure 67). Connected onto this bus are all of the running rails and all accessories operated via DCC accessory decoders. The bus will improve operations many fold. Thus any problems such a high resistance rail joiners (fishplates) will be overcome, as will any volt drop problems on larger layouts.

Ideally the DCC bus wire should be made from at least 1.5mm^2 or better still 2.5mm^2 wire – the wire used in domestic wiring cables is often ideal. A bus made with flexible wire is equally acceptable, but this needs to be of at least 32/0.2mm and for the larger layout 50/0.2mm. Flexible bus wire will be especially useful on portable layouts. There will be many connections between the bus and the running rails to ensure reliable data and power transfer into the rails and hence onto the loco's wheels and decoders.



A typical DCC bus running around under the layout, wired in red and black insulated wire. Though the actual colour of the wires insulation doesn't matter, so long as they are two different colours. The droppers from the tracks above can be seen connecting onto the bus wires. In the background can be seen a bare 1.5mm² copper wire. This is the common return wire for everything on the layout that is not DCC operated e.g. road and station platform lighting, colour light signals.

If using solid core mains cable, carefully strip out the two insulated conductors from the outer sheathing. Discard the outer sheath and use the two insulated conductors (red/black or brown/blue). The bare earth wire can be saved and used as perhaps rail droppers or alternatively run around the layout and used as a Common Return bus for everything else that is not directly DCC-controlled.

Radial bus wires are perhaps the more normal method used for DCC bus wiring. 'Radial' means that the bus wires start at one place, normally the console or a booster's track output and terminate at the furthest place away. There is no reason why a bus should not be wired in a ring. Ring is where each bus wire starts and ends back at the same place and each wire is connected together to make a complete ring. Using a ring bus will effectually make the current carrying and short circuit path less likely to be affected by high resistance wire runs. The advantage can be where the layout is on one board and not configured as an 'L' or 'U' shaped track plan, where a ring circuit would be very wasteful on bus wire used.

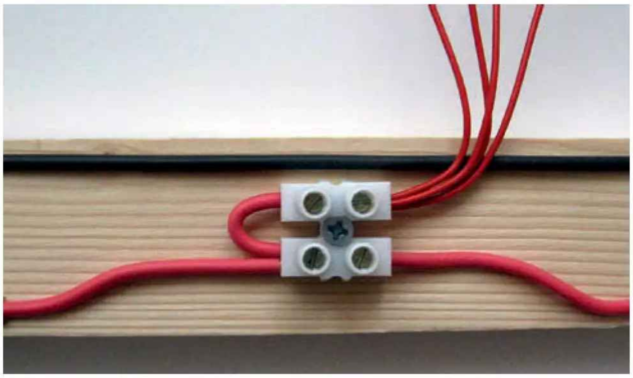
Once the bus has been installed around the underside of the layout, connect the DCC base unit's output terminals to the ends of the bus wires. A short as possible length of 24/0.2mm² or 32/0.2mm² flexible wire can be used, as solid 1.5mm² or 2.5mm² cable, or larger, will probably not fit into the console's terminals. Then connect all the rails to the bus pair, ideally soldering all connections to the bus to ensure reliable data and current flow. Now we have a reliable bus (power and data highway) by which our locos can receive power and data commands from the rails.

Having installed the DCC bus around the layout in a suitable sized cable, there is a need now to connect the bus to the rails. This is normally carried out using either 7/0.2mm or 16/0.2mm flexible wires, in the same two insulation colours as the bus – red/black or brown/blue. This is called a 'Dropper wire'. You can use solid copper wire droppers from the rails to below baseboard, then solder the flexible dropper wire onto these or alternatively solder the flexible dropper wire directly to the rail. See the Electrical chapter which refers to this method of connection onto the rail, as it is the same as for a DC layout.

To help ensure the correct dropper wires are connected to the correct rails, I have a very simple tip: take a four-wheeled wagon and place a piece of tape – masking or electrical – along one longer side of it. Place the wagon on one track with the taped side representing the rail immediately below it, which will become, say, the 'DCC red' connection. Now, without removing the wagon, run it around all the tracks by hand – use the points to pass from one line to another. Wherever the taped side on the wagon is, the rail directly under it is always connected to the red DCC bus wire. Simple! Although I have said 'Red', the choice of wiring colours is yours. But do only use two colours for all DCC track droppers and bus wiring, such as red /black or brown/blue to ensure the wiring is kept clear and easily understood.

The use of a wagon to identify the 'red' rail, as described in the text.

The DCC bus and many droppers running from the layouts tracks down to the bus. All this ensures quality operation and permanent feeds to all tracks.



Above a 15amp terminal block has been inserted into one side of the DCC bus wire and on the left a small link of the same bus wire connects from the lower 'through' terminal to the upper terminal. In the right of this upper terminal the dropper wires connect running off to the rails above. This method of bus connection is ideal for those who do not wish to make soldered connections under the baseboard. Always ensure the grub screws are fully tightened down onto the stripped wire ends. A further alternative for not soldering is to use Wago style connectors, such as the Wago 221 version available in 2-, 3-, 5- and 10-way connections.

All connections onto the bus should ideally be soldered. Simply remove a small portion of the bus cable insulation (about 20mm is ample) with a craft knife and wrap the track feed dropper wire around the bared copper bus wire then solder the joint. A small amount of insulating tape can be wrapped around the joint to prevent it touching any other part of the bus or other circuit. Where flexible wire bus has been installed the 'snap lock' clip-on connectors can be used where they automatically cut into the bus wire's insulation and the dropper wire when being closed up and make contact between both. Also worth considering, if you do not

An example of using a five-way 'Wago 221' connector block. Left to right connections are 1: Main bus input and output in 32/0.2mm wire. 2: Two 16/0.2mm wires in the one connection to feed rails. 3: Single 16/0.2mm to DCC accessory decoder. 4: Two 7/0.2mm droppers to nearby rails. 5: Single 7/0.2mm dropper to nearby rail. Note that the Wago connector has an internal bus bar connecting together all of its terminals.

wish to solder or use snap lock connectors, is to use 15amp-rated screw terminal blocks which are cut up into one- or two-way pieces and used at the connection places.

Programming track

A 'programming track' output from the DCC console is available with many systems and requires a length of separate programming track for setting up the address and CV alterations of the on board decoder in each loco. This track is usually powered from a special 'programming' output on the base unit. While it is not essential to have this facility, it really helps in setting up a decoder safely. Its use allows each loco's decoder to be programmed without causing any changes to any other decoders, which are in the locos on the main tracks. The special programming track output also normally provides a lower electrical current supply to the programming rails, to prevent decoder burnout should it not be installed correctly or if the loco is defective.

Consider, for ease of use, the end of one siding for this programming track, and make this siding so that it has insulated rail joiners (IRJs) fitted onto both rails at around 20 inches or so back from the buffer stops. This section of track is then totally insulated from the rest of the line feeding into it. Now, take two rail feeds that are connected onto this length of track to either a double-pole double-throw centre-off toggle switch or a three-way four-pole rotary switch. This then allows the siding track to be switched between 'programme', 'off' and

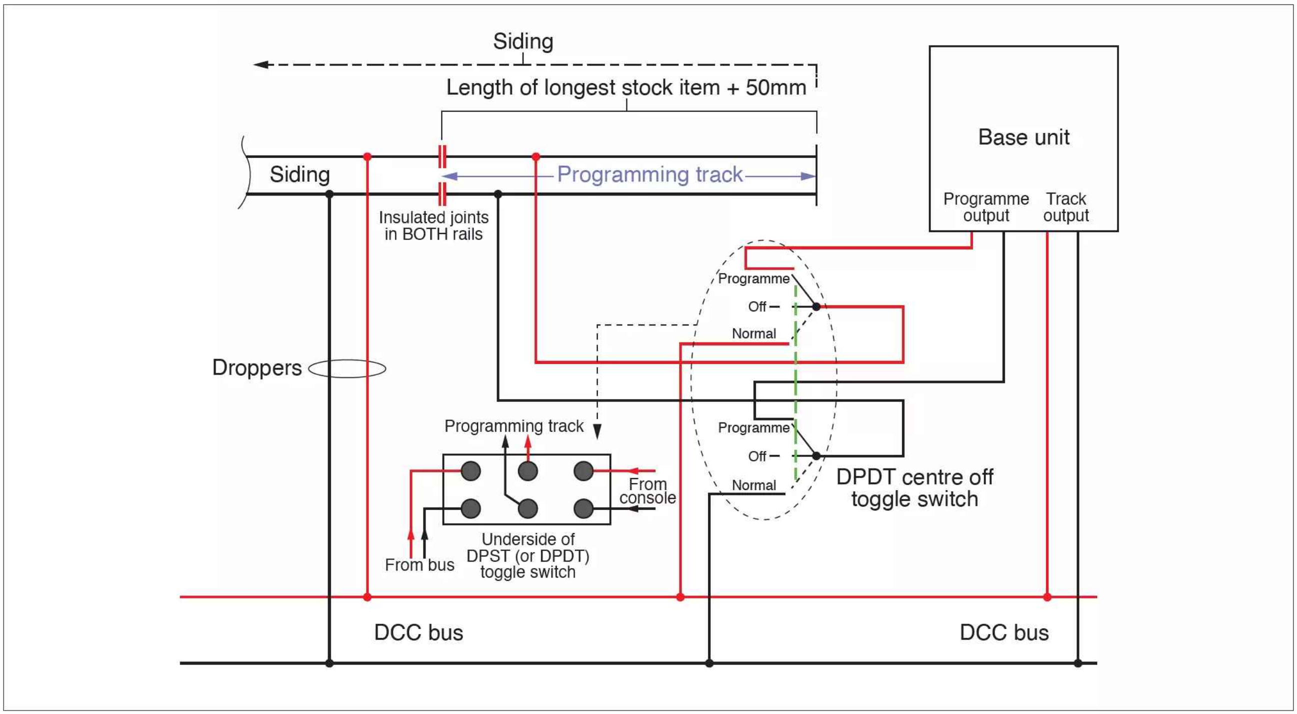


Figure 68: Wiring for a siding-end programming track with selectable switching.

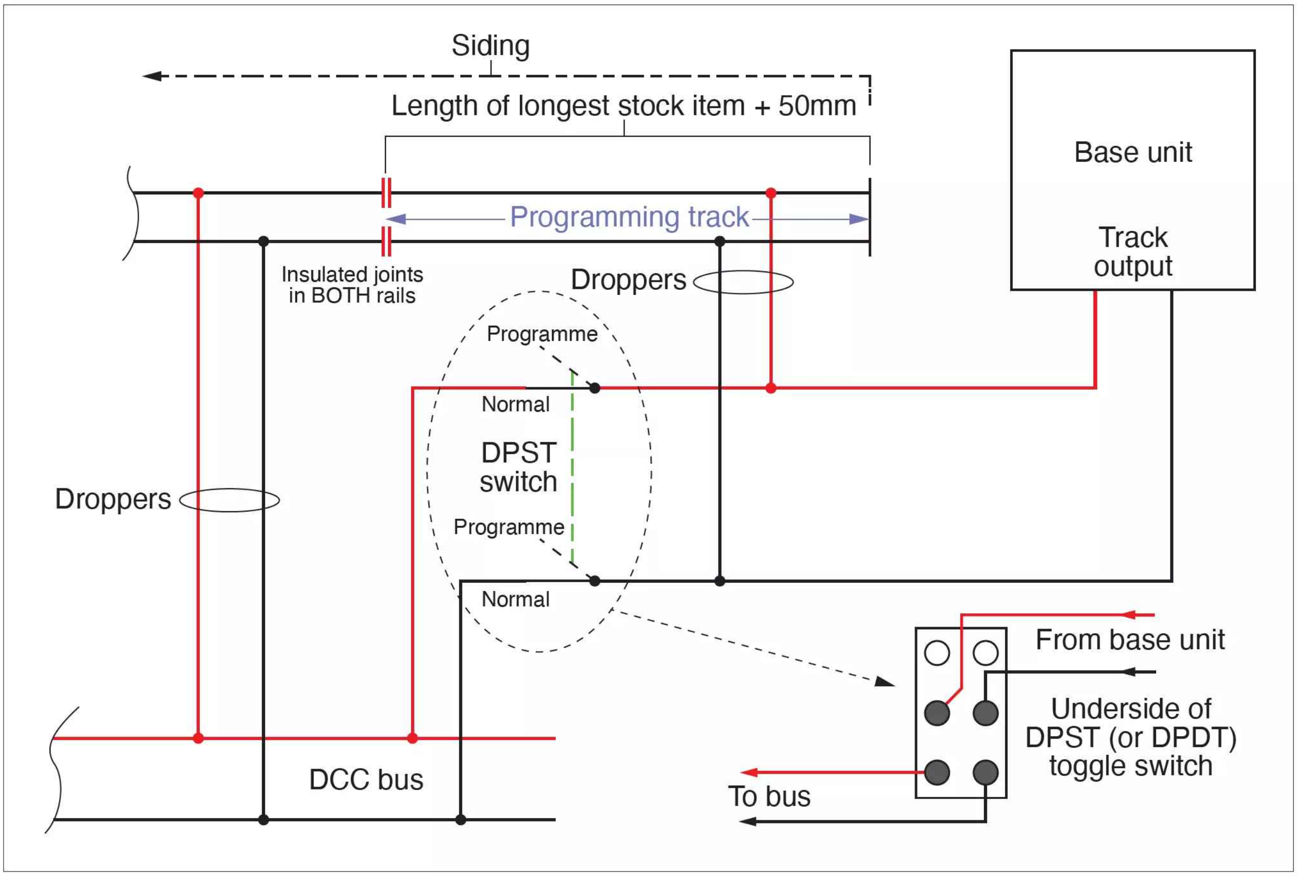


Figure 69: Wiring for an isolated section of track used for programming.

'normal' running. If a rotary switch is used which has four poles, an indication lamp (LED?) could be wired via one of the unused poles and powered from the main DCC supply so that it illuminates when the switch is in the 'programme' function position. Figure 68 shows the set-up for a siding-end programming track with selectable switching.

If you do not wish to use the end of a siding for the programming track then use a totally separate length of track and it is then used solely for programming. Should your DCC console not have a special programming track output, an isolated section of track can still be used for programming and is wired as shown. When 'programming' is selected on the switch, the feed to the main railway's bus and rails is cut off, preventing accidental programming of mainline locos.

DCC operation with insulated-frog points

Insulated frog points will require a small modification to enable full DCC operation. The simplest method is the addition of two link wires, or if a DCC Bus is used then run two new feeds from the Bus to the two vee rails (see Figure 70). This conversion is all that is required to ensure that, no matter which way the point is set, DCC power is sent to all tracks. Thereby keeping the entire track live without the point being set for that direction.

One problem the DCC user may encounter with insulated frog points is a sudden short-circuit occurring as a loco passes over the insulated frog area of the point. These are sometimes caused by the metal wheels touching both rails where the rails are at their closest. This is more common on DCC-fed layouts as both rails are permanently powered with opposing polarities and can cause the main control unit to detect the short-circuit and trip the internal overload device. The problem is easily overcome by fitting two insulated rail joiners after the frog at the ends of the two vee rails on any problematic point, then running in two linking wires from the two rails after the joiners and connecting them to the respective outer rails as shown in Figure 71.

Decoder installation

Decoder installation into a loco will depend on several factors:

a) Age of the loco.
b) Space available for the decoder's circuit board.
c) Whether the loco is 'DCC ready', that is whether the loco has a decoder 6, 8 or 21 or other pin NMRA DCC socket fitted inside by the manufacturer.

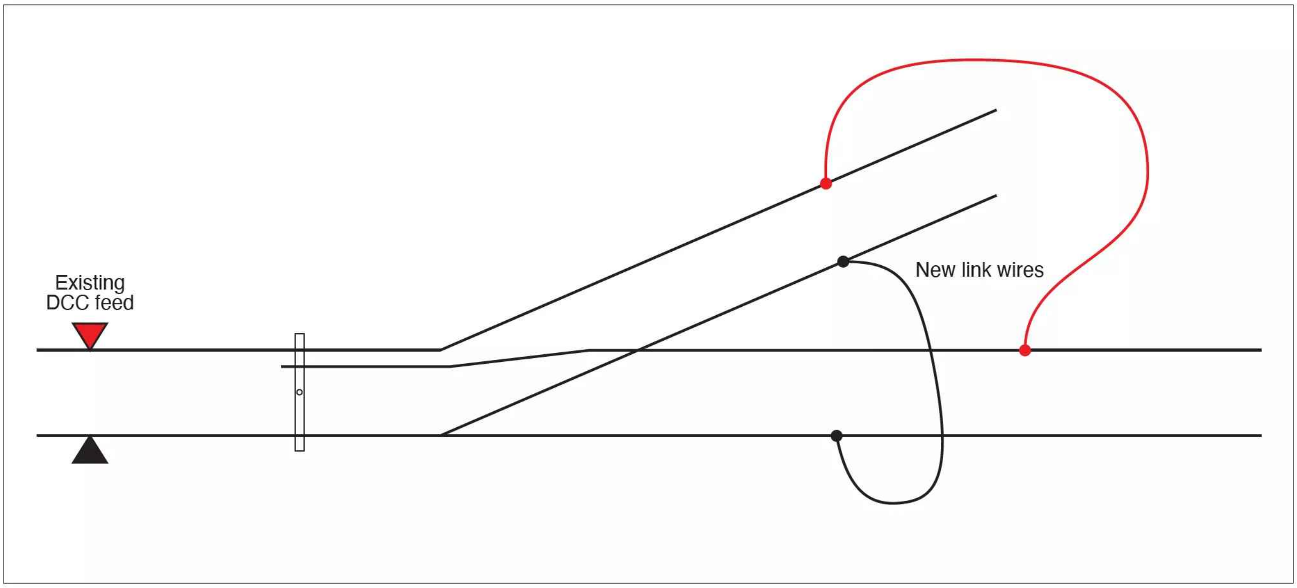


Figure 70: The simplest method of just adding two linking wires.

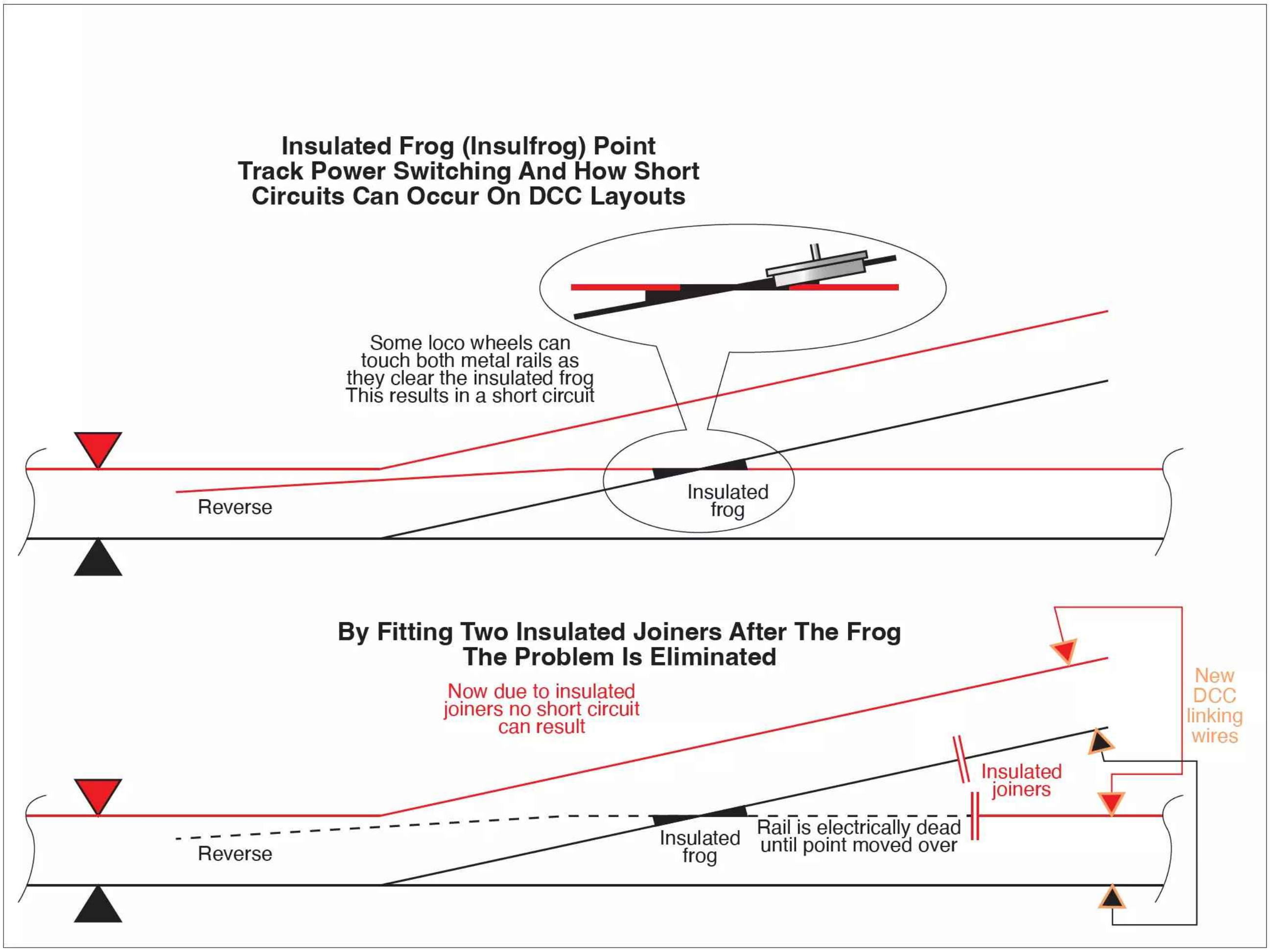


Figure 71: The upper drawing shows insulated frog point track power switching and how short-circuits can occur on DCC layouts. The lower diagram shows how the problem can be eliminated by fitting two insulated rail joiners after the frog.

Warning: *Only ever convert a loco that's proven to run well on conventional DC before attempting to convert it to DCC. Converting a poor DC running loco will result in an equally or even worse running loco on a DCC system.*

Decoder configuration

This table below shows the configuration of an 8-pin three-function decoder. Note the blue wire is common positive for all lighting functions.

Pin	Function	Wire colour
1	Motor right	Orange
2	Rear light/s	Yellow
3	Function F1	Green
4	Left rail pick-up	Black
5	Motor left	Grey
6	Front light/s	White
7	Function common	Blue
8	Right rail pick-up	Red

Compare this to an 8-pin single-function decoder. Note pins 2 and 3 are not wired.

Pin	Function	Wire colour
1	Motor right	Orange
4	Left rail pick-up	Black
5	Motor left	Grey
6	Front light/s	White
7	Function common	Blue
8	Right rail pick-up	Red

A four-function wired decoder will have a ninth wire, often Purple, which is not connected to the 8-pin NEM plug. This wire, if not used, can be either cut off at the decoder's circuit board or have its free end insulated and then tied back clear of all moving items; unless it is required for a specific function within the loco, then it is soldered to the appropriate function's negative lead and the joint suitably insulated.

With the advent of multiple sound functions, the need for new ranges of decoders arose. These can offer far more outputs than the former NEM652 decoder. They are often offered as 21-pin, Next 18 pin or the PluX range which offers interfaces of 8, 12, 16 or 22 pins to meet the demands of modern locos.

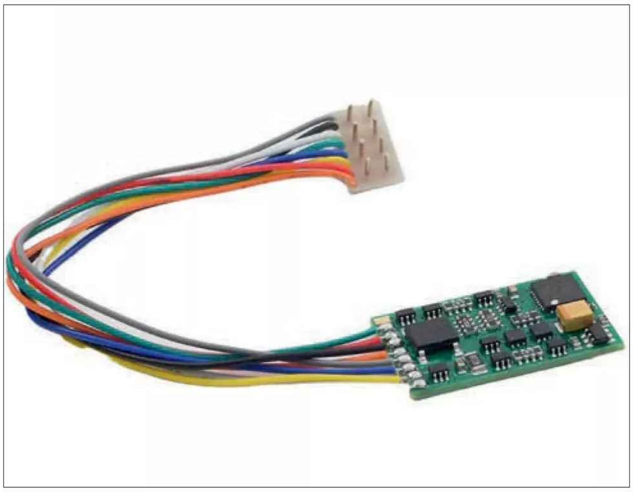
'DCC ready' locos

When installing a decoder, first check whether the loco is 'DCC ready'. 'DCC ready' means it has an NMRA DCC socket or plug fitted with a blanking plug or socket fitted allowing conventional DC operation only.

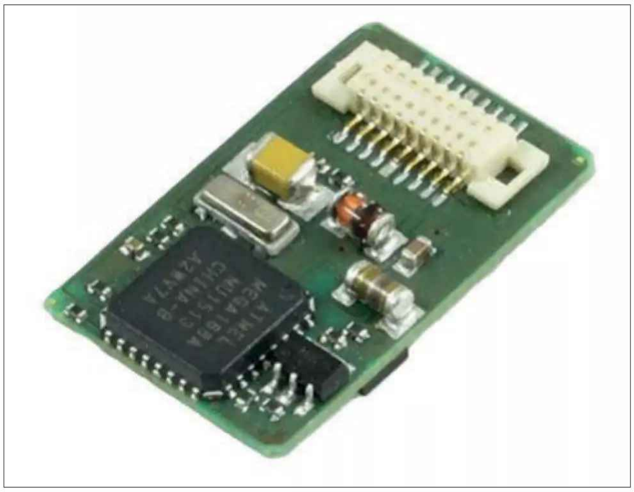
If the loco is 'DCC ready', carefully remove the body from the chassis, use the manufacturer's servicing sheet for detailed information on which screws to remove or where to unclip the body to release it from the chassis.

With the body removed, it is normal to see a factory fitted printed circuit board often located on the top of the chassis and above the motor, although its actual position varies depending on the manufacturer and loco model. On this circuit board will normally be seen a small additional raised circuit board, which appears to have two or three solder blobs on its surface or it can have small electronic components fitted on its surface – this is the DC operation 'blanking plug'. With the aid of a small screwdriver blade, carefully lift up this blanking plug – it is a push in fit into the socket below. Once the blanking plug has been removed the socket is visible. The number one pin position is usually marked on the main circuit board by either a figure 1 or a small triangle mark. Some types of decoder may fit directly onto the now exposed socket and can usually only be fitted one way around.

For decoders with 8 pin on a fly lead, push the plug into the socket ensuring the pin with the orange wire attached is at the number one position. If the plug is accidently reversed no harm should come to either the decoder or the loco – all that will happen is when powered up, the loco will travel in the opposite direction from the consoles setting and if any lighting is fitted this may not work at all. Once the plug is firmly in place find a suitable place for the decoder to be sited.



A wired 8-pin decoder and plug.



A Next 18 direct plug-in decoder.

Place PVC insulating tape over any metal chassis areas where a decoder is to be sited, then use a double-sided adhesive pad to hold the decoder in place or tuck it carefully inside a steam locos boiler tube, if space permits. Tidy up the wires from the decoder to the plug, using little pieces of insulating tape as needed. Also ensure no wires are likely to touch any moving parts. Before refitting the body, place the loco onto the programming track and check it address number, then change its address from the default 03 to the one you have chosen (often the locos running number or part of it). If all is working correctly then refit the body, ensuring no wires or other items are trapped as it is replaced. Note that many locos supplied today have either 21 pin connection, 18 pins or a similar number of connections and are normally a direct fitting to the socket on the locomotive.

Non-'DCC ready' locos

If no decoder socket is present, it must be determined whether or not the motor and its brushes are in contact with any metal of the chassis and hence to one or both of the rails via the wheels of the loco. To check if this is the case – and it is so with a lot of non DCC ready locos – once the motors wiring has been carefully unsoldered and moved clear, the motors total isolation to its metal chassis can be determined by using a multimeter switched to its ohms range, or use a simple battery operated buzzer.

Check for a reading, or a buzz, between either side of the frame/chassis and to both motor brush connections (or the motor feed terminals if the brush connections are not accessible). If a reading or buzz is obtained, then the motor brushes or motor terminals must be fully insulated from the chassis. It is not possible to describe in detail how this is achieved, as every loco is of course different, but this action is an essential process; if not undertaken the decoder will be totally ruined if power is applied to it and the motor is still in contact with one or both rails.

Of all, I consider the split chassis loco probably the hardest to convert, but even these are not impossible to convert, but they do require a little more dismantling and plenty of testing during and after reassembly to ensure there is no connection between the motor's terminals and either half of the chassis block.

Where the motor is insulated and proved to be so, the existing wires from the wheels to the motor terminals are reused. These two wires connect to the red and black decoder wires, by twisting and soldering their ends together making an in-line joint. Note on steam outline models the red decoder wire connects to the right-hand side looking forward and black to the left-hand side. Before soldering the joints, cut a small length of heat shrink tubing to cover over the final joint and slide this onto one end of the wires, then twist and solder.

Slip the heat shrink tubing over the cooled soldered joint and gently warm the tubing until it is shrunk down and has made a nice insulated cover over the joint. Use the soldering irons tip if you don't have a micro hot air tool. Now connect the orange wire to the motor terminal where the right-hand original wire was. Then do the same with the grey wire connecting it to where the left hand side wire originally came from.

Other wires from the decoder are used to control lighting functions, such as head lamps, rear lights etc. Consult the decoder's manual for full information on these functions though the two charts above list the common most connections.

When converting an older loco it is recommended that only the best quality of decoder is used. i.e. Lenz or Zimo are my choice. But there are many other makes available. Using a quality decoder will ensure that older style motors perform to their very best.

Configuration variable (CV) settings control how the decoder operates the loco. Changing CVs can vastly improve the performance of a loco and also sets how the functions operate. CVs are normally adjusted while the loco is on the programming track. Always take a note of which CV is being adjusted and from what value and by what amount, as later if the loco does not perform correctly or not as expected, you can easily refer to the notes and convert back to the original settings or readjust it to another value.

Over-current protection

There are several ways of preventing short circuits from doing serious damage to the system. The usual method is that the main DCC control unit has its own built in circuit breaker, which in some units are fully self-resetting once the problem of the short circuit has been removed. While this will provide overall protection, if it is tripped the whole layout stops. Which is not always ideal!

There are available, all electronic short circuit protection devices, which the DCC bus is fed into and then the output(s) are taken to the track possibly via local sub buses (see Figure 72). These units are available in one, two or four individually operated outputs, all on the same printed circuit board. These devices are very fast to operate and in most cases will trip long before the main DCC control unit has registered a fault current flowing. Normally they are provided with the ability to set the trip current threshold, so thereby making the output trip at a current below that of the main console or a booster. They can also provide LED indication that they have operated, making fault finding that much easier and faster. On no account use fuses or other overload devices, they are not fast enough in disconnecting the problem.

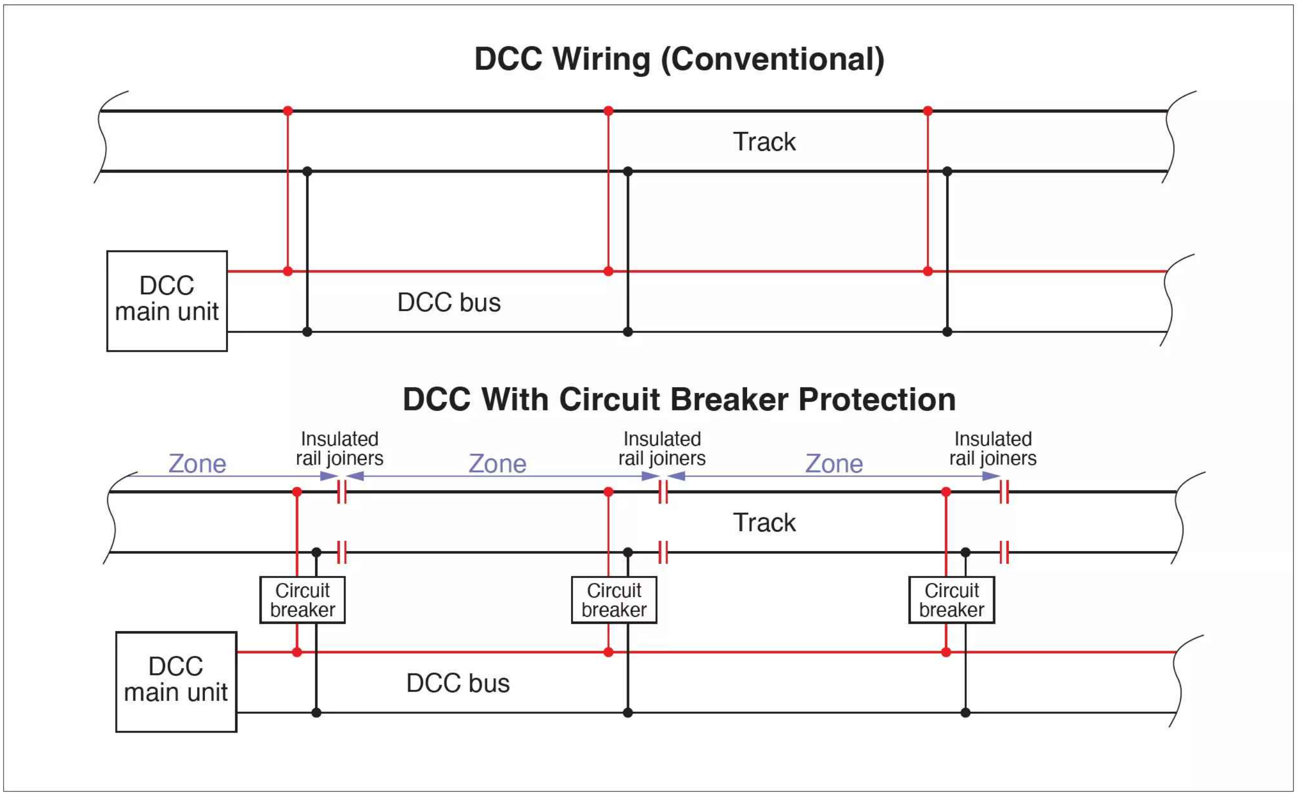


Figure 72: The simplified diagrams below show in the upper drawing a conventional DCC bus and supplies to the rails and in the lower drawing the same layout with the use of the Power circuit breakers and insulated rail joiners installed to make up individual protected zones. Of course, in reality, the zones would control a much larger area of track than shown here. An example is: The whole station area on one zone and the goods yard and sidings area on another. Therefore a short circuit occurring in the goods yard will not affect the main lines.

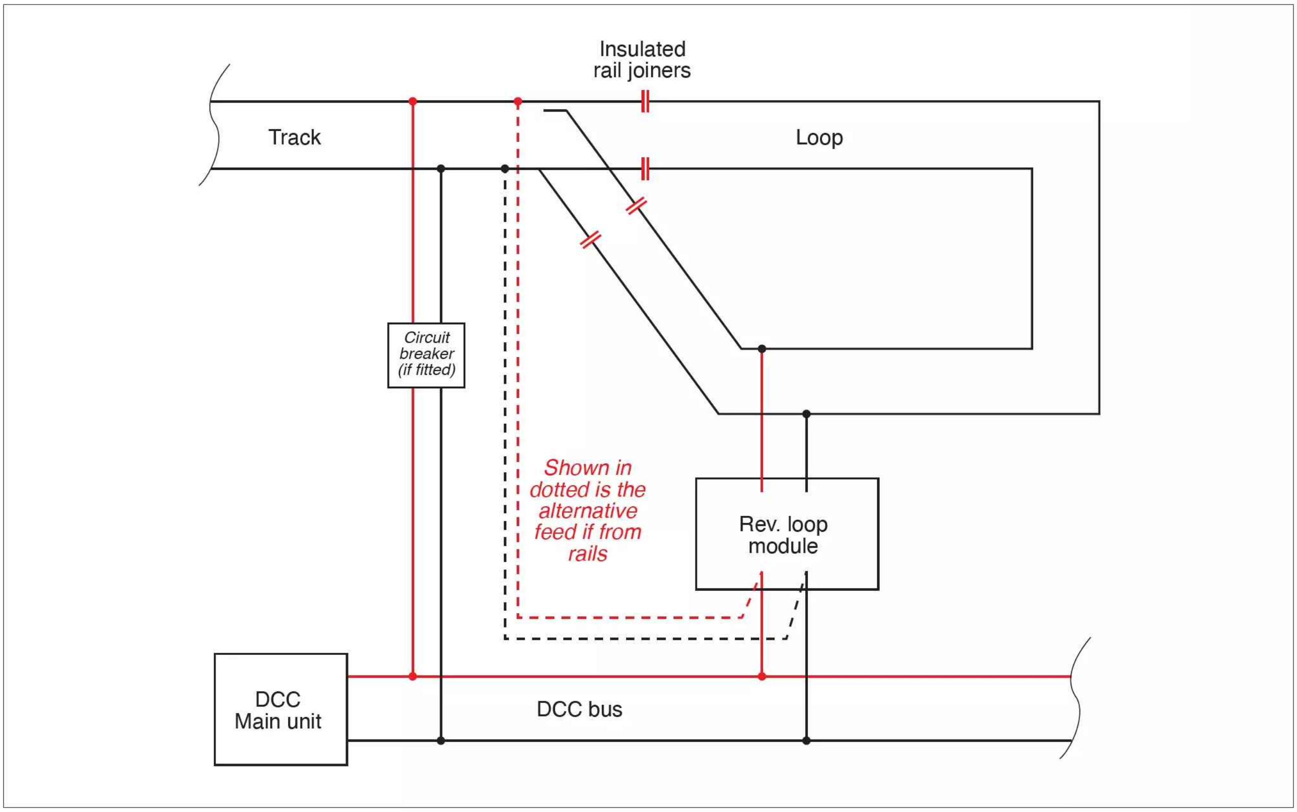


Figure 73: Wiring a reversing loop on a DCC-controlled layout.

Reversing loops

Reverse loops on a DCC operated layout usually require the fitting of a special reverse loop module. These modules often have four wires pre attached by the manufacturer or they have four terminals. They are wired with two wires onto the DCC bus or the approach track rails and the other two connections directly to the rails of the loop. The loop must be totally insulated from the rest of the layout by the insertion of four insulated rail joiners at the entrance and exit of the loop (see Figure 73).

It is also possible to flip over the loops rail polarity by using a point operated double pole double throw switch. Where a reverse loop module is used, the distance between the entrance and exit IRJs of the loop, should always be a greater distance apart than the longest train to travel over the loop. 'Train' equals the loco and all wagons or carriages.

Turntables

On a conventional DC layout, the exit line of a turntable is normally the only track, when the table is aligned with that track. With DCC, loco's can be stabled on any of the exit tracks with their lights or sounds still functioning or perhaps undertaking some minor shunting. However, some types of turntable can cause problems when a loco leaves or enters the turntables bridge, as a short circuit can occur due to the turntables bridge rotating through 180 degrees and its rails being out of phase with the approach track.

Turntables which use a split ring to feed the bridge rails normally do not require any adaption to the bridge rails feed or require an Auto Reverse Module Unit. Those which use a twin ring of contact to feed the rotating bridges rails should be treated differently.

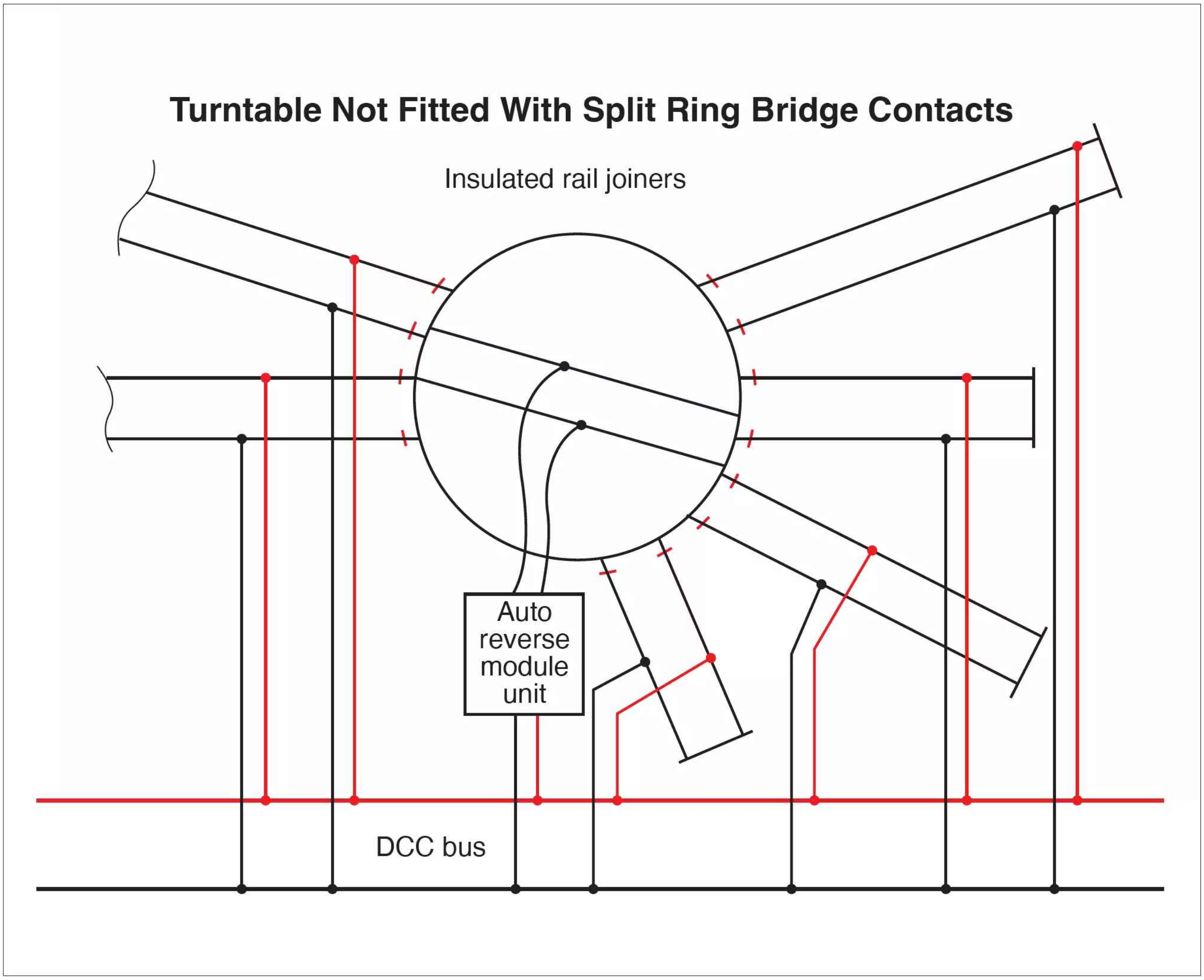


Figure 74: In the diagram below all tracks are live via the DCC bus (or from a connection onto the main approach track), while the turntables bridge rail section is fed via an automatic 'Reverse Loop Module' unit (this can be ignored if a split ring is used to feed the bridge rails). The exit or storage tracks for the turntable are often pre wired to the turntable track by the manufacturer. If this is the case, insulate both rails on all tracks just after the turntable and if necessary feed the rails on the turntables bridge from a reverse loop module. The approach and all other storage tracks are then wired directly to the DCC Bus or the main approach track for their track power.

DCC lighting

DCC Lighting can be powered directly from the DCC bus or rails and can be used to illuminate LED carriage or building lights without the use of decoders. Some very basic electronic items can be obtained and soldered together to make a suitable circuit to connect directly onto the DCC bus or, in the case of coach lighting, via a set of metal wheels on insulated axles and a pair of wheel wiping contacts. Of course, these lights would be always on. Some means of turning them off may be needed.

In Figure 75, the DCC power is taken into a bridge rectifier. This can be made by using four individual diodes, such as the UF5401 or UF4001. From the DC output of the rectifier the power is passed along to the individual LED/s via their series resistors. The resistors need to be at least 560R or better if they are a higher ohm value, and each LED has one resistor in its positive (Anode) leg. You can connect as few or as many LEDs as needed onto the outputs. So long as the maximum output of the rectifier is not exceeded.

Adding a 100µf electrolytic capacitor across the output leads of the rectifier gives some smoothing to the circuit and in the case of coach lighting a small amount of power when the coaches wheels may not be fully in contact with both rails, example is when passing over insulated point frogs.

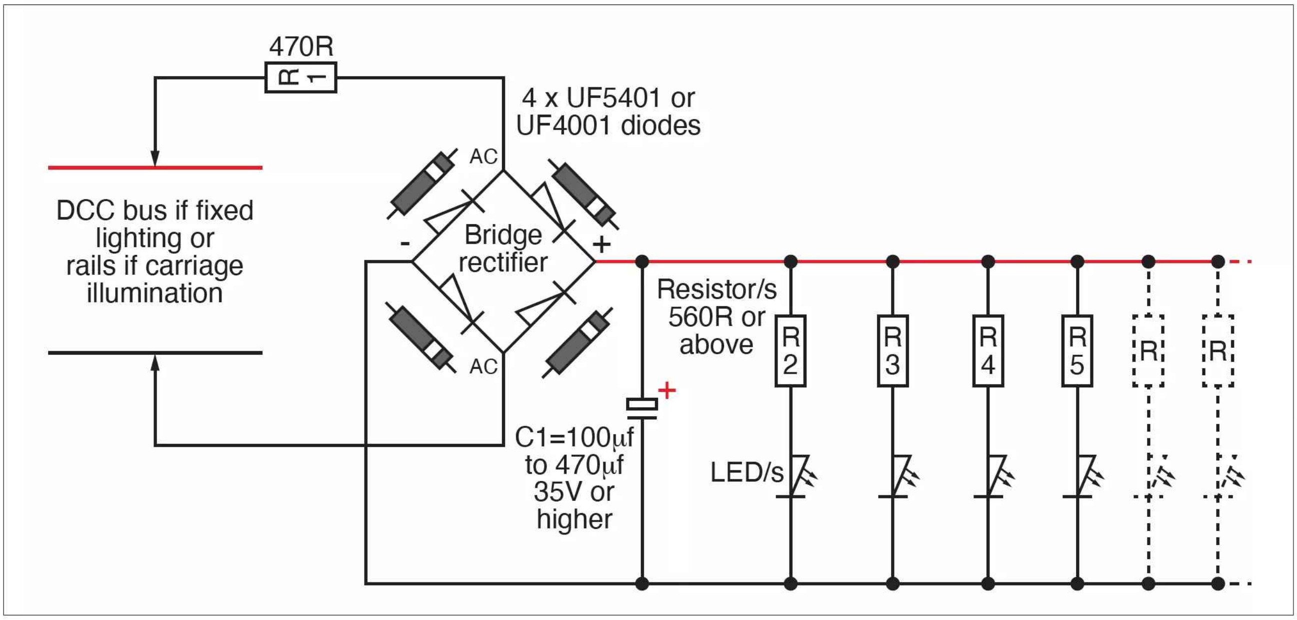


Figure 75: The only downside in this drawing is there is no means of turning off the lights, however adding a simple On/Off slide or toggle switch inserted into one of the DCC supply wires to the rectifier is all that is required.

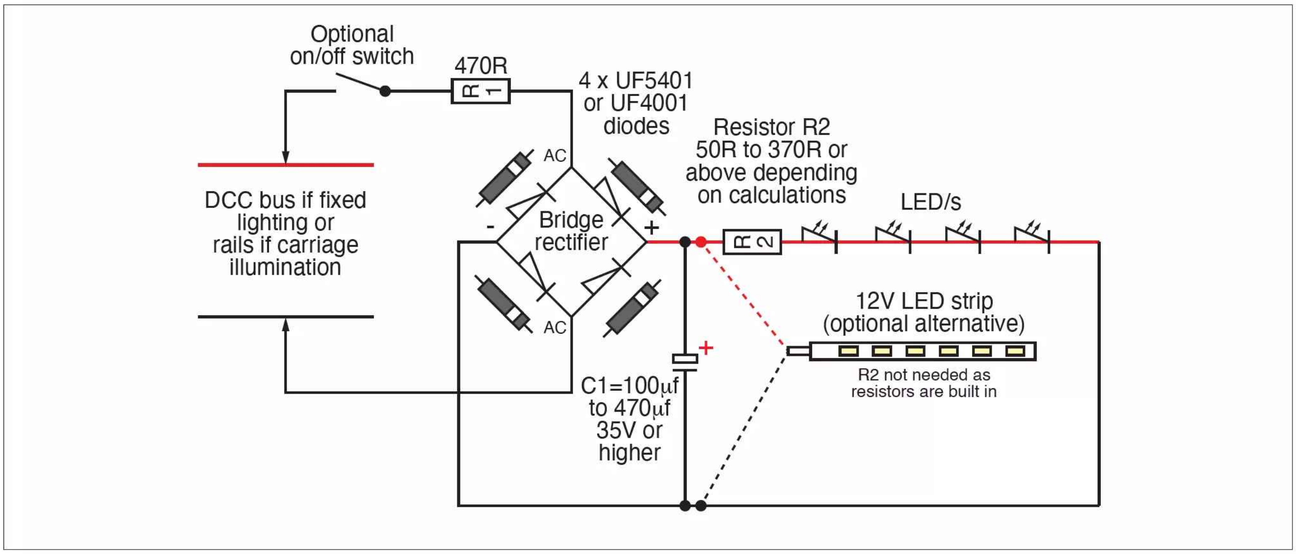


Figure 76: A similar lighting wiring diagram but with the option of using a 12-volt LED strip and single LEDs wired in series (cathode of first to anode of second and so on).

10
Maintenance and Tools

There are several factors that can influence the running of the model railway. Excluding weather effects on any outdoor track, the following tips offer some advice on simple measures that can be taken to combat the main problems and improve every day running.

Loco maintenance

If your layout, and especially the locos, have spent some years packed away in the loft or wherever, then you will certainly have to strip down each loco and lubricate all the moving parts, as any original oil will have become a solid mass and no longer be able to lubricate as intended. I would not recommend trying to run any loco no matter how great the temptation is to do so, before carrying out the basic maintenance, or it could lead to the motor itself burning out!

How to access the inside of a particular loco cannot be described here in detail as each one is different. Usually by studying the underside of the loco you can see how the manufacturer has assembled the chassis and bodywork. Some will have one, two or more small screws securing the two parts, while others will be a clip-fit and require gentle levering of the bodywork away from the chassis to free the two elements.

Where no manufacturer's service sheet is available, try if possible, an internet search using the make and, if known, the model number of the loco. Some manufacturers' websites have service sheets listed. Likewise, for the much older models there may be web sites run by enthusiasts or collectors, which may be able to offer advice or reprints of old service sheets.

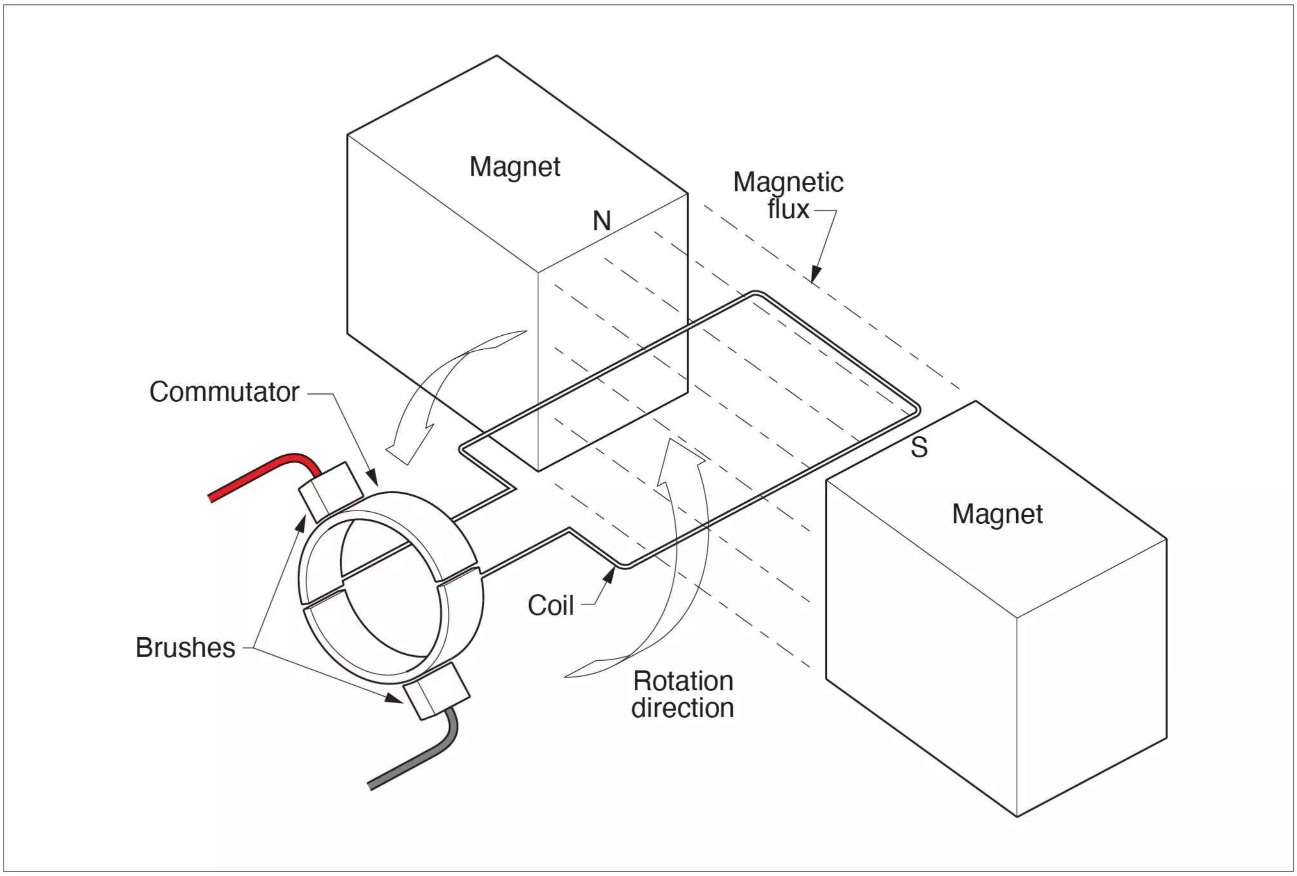
The use of a servicing cradle is helpful to hold the loco upside down and prevent damage occurring to any body details. Such a cradle, made in a 'U' shaped foam material, one such is available from Peco and suits most gauges up to 'OO'/'HO' scale.

Having determined how to gain access to the motor and gearing, the modeller will in the main be faced with three styles of electric motor. The open frame, the Ringfield or Can. Of the three the Can style is now used considerably by a number of leading manufacturers and most unfortunately they are produced quite often as a throw away item and cannot be serviced!

The open frame motor is the easiest to work on and service, and is often found in older pre-1980s locos. You can see the motors coils, the commutator and usually the motor brushes that pass current from the wheels to the motor coils. The Ringfield motor is next and this style has a large 'pancake' shaped electric motor with a series of gear cogs fitted onto one side.

Finally, the Can type is now used by a large number of leading manufacturers and, most unfortunately, is often produced as a throw-away item and cannot be serviced!

A typical 'Can' style motor which is totally unserviceable by the user.



A very simplistic diagram showing of how a DC motor works

As its name suggests, it looks like a small metal can with the motor shaft emerging from one end and perhaps either a much shorter amount of shaft at the other end or a longer shaft with a fly wheel fitted, in some locos the shaft is extended and passes onto another gear train, this is particularly found in modern diesel or electric all-wheel drive locomotives.

How does a DC electric motor work?

If you place an insulated coil of wire near a permanent magnet and then apply a low voltage DC current to the coil (typically in our case 12v DC) either the coil will be attracted to the magnet or repelled if the current flow is reversed. Take that coil of wire and wrap it around a circular former that can rotate freely, and place the coil inside two permanent magnets of north and south magnetic poles, and apply DC power to the coil. As the coil energises a magnetic field or pole is created within the coils wire.

Let us assume it is a positive when it is opposite the permanent magnets north pole and the coil is then giving a north. As the north pole produced by the magnet meets a north pole of the coil the magnetic forces repel each other (like poles repel). This magnetic force causes the coil to be pushed away (torque) and as the coil is mounted on a rotating spindle it starts to turn. As the turning movement continues, the coils north becomes under the influence of the opposite permanent magnet which is giving a south pole; as dissimilar poles are attracted, the coil tries to pull towards the permanent south pole magnet. It is not able to do so fully and the pulling power of the magnetic field helps to give the rotating coil yet another pull onwards. So now the rotating coil has moved through roughly half of its rotation and the current in the coil is now reversed.

The coil is now fed with a positive supply via the commutator segment and becomes a north pole; it is directly opposite the permanent north and the other side becomes a negative and south pole. Then under the repelling north and south poles it is forced around again and the cycle repeats. In reality there are many turns of wire making each coil and each coil is wound around a soft iron core to increase the magnetic field. Motors will generally have more than one coil – three, five or seven individual and electrically separate coils per motor are often the norm. Increasing the voltage and current to the coils increases the magnetic strength and subsequently the torque produced gives a faster rotation. Reversing the supply current reverses rotational direction.

How are the coils fed and their polarity swapped every half cycle when it is spinning around? It is achieved by using a little device called a commutator. This is normally made from copper and is circular in format and divided up into segments that are insulated from each other. Pressing onto each side of the commutator are a pair of motor brushes, normally made from carbon and held in place by small springs. Direct current is fed into the carbon brush (picked up from the rails and loco wheels), passes into the commutator segment and then to the coil. It returns via the opposite-side commutator segment and the other brush to the wheels and rails on the opposite side.

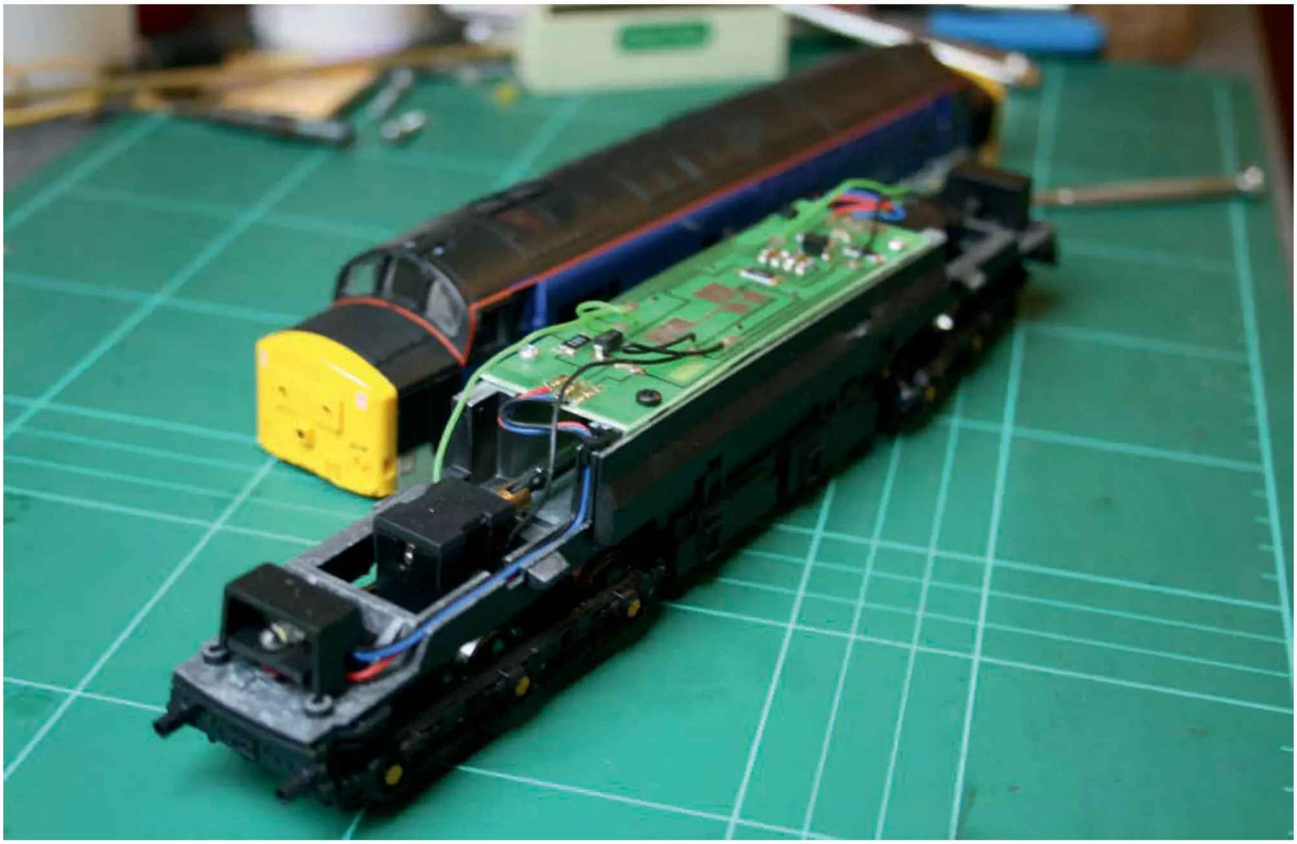
Thus our motor works on magnetism, both permanent and induced. One problem in motors of older locos that often causes poor or slow running is the permanent magnet losing its magnetic strength; this is especially the case with old Hornby Dublo loco motors. The magnet can be replaced, or even remagnetised, which is a specialist job and requires a special machine. New replacement magnets are sold for some types of motors via specialist suppliers.

So, back to the maintenance. Once the locos body has been removed, we can gain access to the motor and the gear drive train to the wheels. If you can see the commentator, now is the time to clean it and ensure the brushes are in good order. Clean the commutator with a fibre pen to remove the build-up of old carbon deposits. Do not use anything sharp that can cause scratching on the commutators copper surface. With the aid of a pin carefully scrape along the line of the insulation that separates each segment. Carefully remove the carbon brushes and if they are worn down, replace them; correct brushes are obtainable from good model shops or at times direct from the locos manufacturer. The springs that place the carbon brushes under tension must also be in good order and still provide the tension needed.

Lubricate the two ends of the motors shaft where the shaft emerges from the motors casing and bearings.

Oil used for lubrication of model locos should only be of the light oil type. Use of specially supplied oil from model shops is ideal and it often comes in a tubular syringe like applicator with a needle-like nozzle. The golden rule of model railway lubrication is that if you can see the oil on the part being lubricated, probably too much oil has been applied! You can use a pin dipped into the oil then touched onto the place of lubrication to ensure only the smallest amount of oil is applied to the component.

Apply a little light grease to the worm gear and its mating cog, but again only use special grease, available from good model shops. Do not over-grease. Failure to use special model railway grease will lead to the grease warming up when the loco is running and becoming thinner, then, under centrifugal force it will be thrown out and attach itself to the insides of your locos body. Remember that, where a worm gear is used (most



Loco servicing on a modern diesel outline 'OO' loco.

models with motors in the loco will use this method) you cannot turn the wheels to turn the motor as the worm gear train prevents this. Instead, gently turn the worm gear by finger pressure and at the same time watch for the loco wheels to slowly revolve.

Lightly lubricate all the moving parts attached to the locos wheels; this is mainly applies to the valve gear and connecting rods are attached to the wheels on steam outline locos. Also check for any bent or binding rods or valve gear that may cause poor running. Carefully check and if necessary straighten up any bent items. The use of tweezers or very fine long nosed pliers is of help here.

Once all lubrication has been completed and the motor or worm gear turns the wheels freely, clean the wheel treads, and check and adjust as necessary any wiping contacts that touch onto the wheels and transfer power to the motor. Use a fibre pen or old small blunt, flat bladed screwdriver to scrape the 'muck' off all the wheels. Clean all wheels, not just the driving or pick-up wheels.

Now it is time to apply power to the loco. Do this by either placing the loco onto the rails and apply a little power, or better still hold the loco still upside-down and use a pair of short test leads connected to the rails and the other end held onto the wheels that act as pick-ups. Alternatively, use a Peco wheel cleaning set which passes track power via a wire brush and small scraper to the wheels, thereby both powering the loco and cleaning the powered wheels at the same time.

Assuming the loco runs as anticipated, give the motor a visual check under power. Look for excessive arcing between the brushes and motor commutator (don't worry too much as there is always a little arcing), if it seems excessive turn off power and rectify the problem. Often a lack of spring pressure on the brushes or the brushes not seating correctly onto the commutator are the cause, so a little tweak of the brush springs or the actual brushes will overcome the problem. Replace the brushes with new ones if they are excessively worn. If the arcing cannot be reduced then it is possible one of the motors coils has burnt out and is shorting internally. Unfortunately in this case there is very little that can be done other than replace the motor. Some motors can be rewound by a specialist, but this is an expensive option and is only used on valuable models that cannot be repaired in any other way.

Any smoking from the motor or failure to rotate under power – perhaps just producing a buzzing noise – must be acted upon straight away. In both cases, turn off the power immediately. Smoking is normally a sign that the motors coils are short circuiting, while a failure to rotate can be the same cause, a very stiff final drive mechanism or a seized motor bearing. Further detailed examination will be required, and possible motor replacement may be needed.

Many people report their Ringfield motor is always squealing when it is run for a few minutes. This is mainly due to lack of lubrication and applying a tiny drop of the former light oil onto the both sides of the motor bearings, where the spindle emerges from the motor casing, will often resolve the problem. It can also be caused by the small gear cog fitted onto the motors drive shaft turning, particularly if the cog is of the grey coloured type. A replacement cog can be obtained via specialist model suppliers and usually the new cog will be a brass one, these are a very tight fit onto the motors shaft.

There is little the home user can actually repair on many models today. Failed parts are now normally completely replaced with a new item. General maintenance servicing should still be undertaken frequently by carrying out light lubrication and greasing of moving parts. Plus not forgetting the cleaning of all the wheels and any wheel wiping contacts.

Track maintenance

Track maintenance also needs to be undertaken on a regular basis. The keeping of the rail tops and its inner top edges spotlessly clean, is the means to ensuring your layout operates faultlessly electrically – this is especially true with a DCC layout. Rail cleaning is on a par with wheel cleaning!

Never use anything that is abrasive to clean the rails surface as this will cause minute scratches that in turn will lead to increased dirt contamination and increased cleaning – a vicious circle!

A proprietary rail-cleaning block or track rubber such as those sold by Peco or Hornby will remove most surface dirt, especially if the layout has not been used for some while. Once the rails are cleaned they can be kept in this condition without quite so much hard work by using a liquid rail cleaner, though the use of the track rubber is still needed occasionally. I use Isopropyl Alcohol (IPA) which is perhaps a little on the expensive side, but leaves no residue as it evaporates.

The IPA can be applied with the aid of a lint free cotton cloth by hand and old handkerchief is ideal for this. Or in one of the specially produced track cleaning tanker wagons. The IPA is poured into the wagon, which has special cleaning pads fitted underneath that spread the fluid onto the rails and also help wipe the surface clean. The tanker wagon is towed or pushed around the layout with the aid of a loco, cleaning as it goes.

Electrical conductivity via the metal rail joiners is a place often forgotten by the modeller, but it is essential that these joiners are maintained and are kept clean and tight, especially if they are the primary means of transferring track power from one rail to the next. If the track sections are taken apart and reassemble regularly, or if you are relaying on some track that hasn't been used for a while, before fitting the rails together clean the rail ends where the joiner will fit onto and also the insides of the joiners, ideally using a fibre pen: the pens fibre bristles will easily slip inside the open area of the rail joiner and 'scrub clean' the inside surfaces.

Additionally, once a rail joiner has been correctly fitted onto the rail ends, use a pair of long nosed pliers to carefully squeeze up the sides of the metal rail joiner onto the lower sides (foot) of the rails. This will help improve the electrical connection between tracks. Do not forget that the 'squeeze' should be carried out at both ends of each joiner.

On points, use a fibre pen to clean the inside edges of the stock rails where the switch rail touches it. Similarly brush clean the inside faces of the moving switch rail.

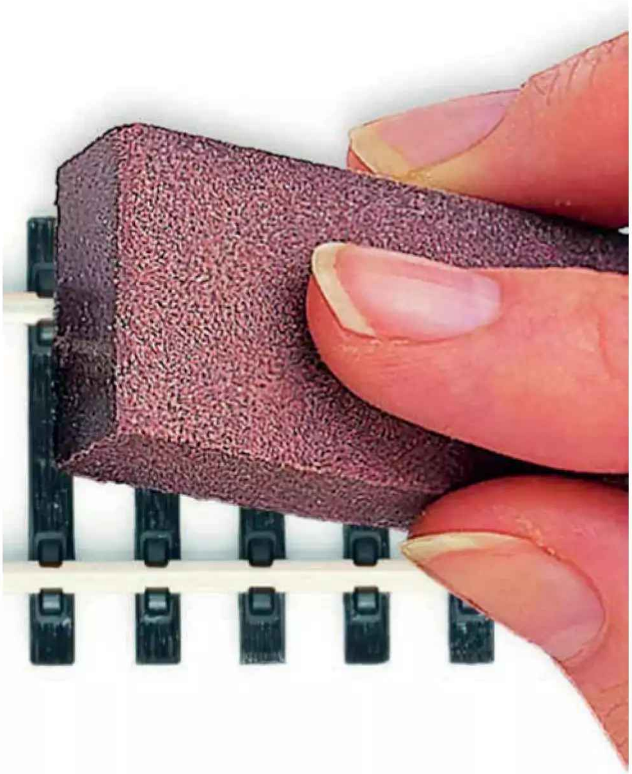
Tools

Modellers need to acquire a selection of tools to enable themselves to undertake the various tasks required. The tool kit does not necessarily have to be vast, but some easily obtainable tools are the 'bread and butter' of modelling, while some will be a specialist purchase.

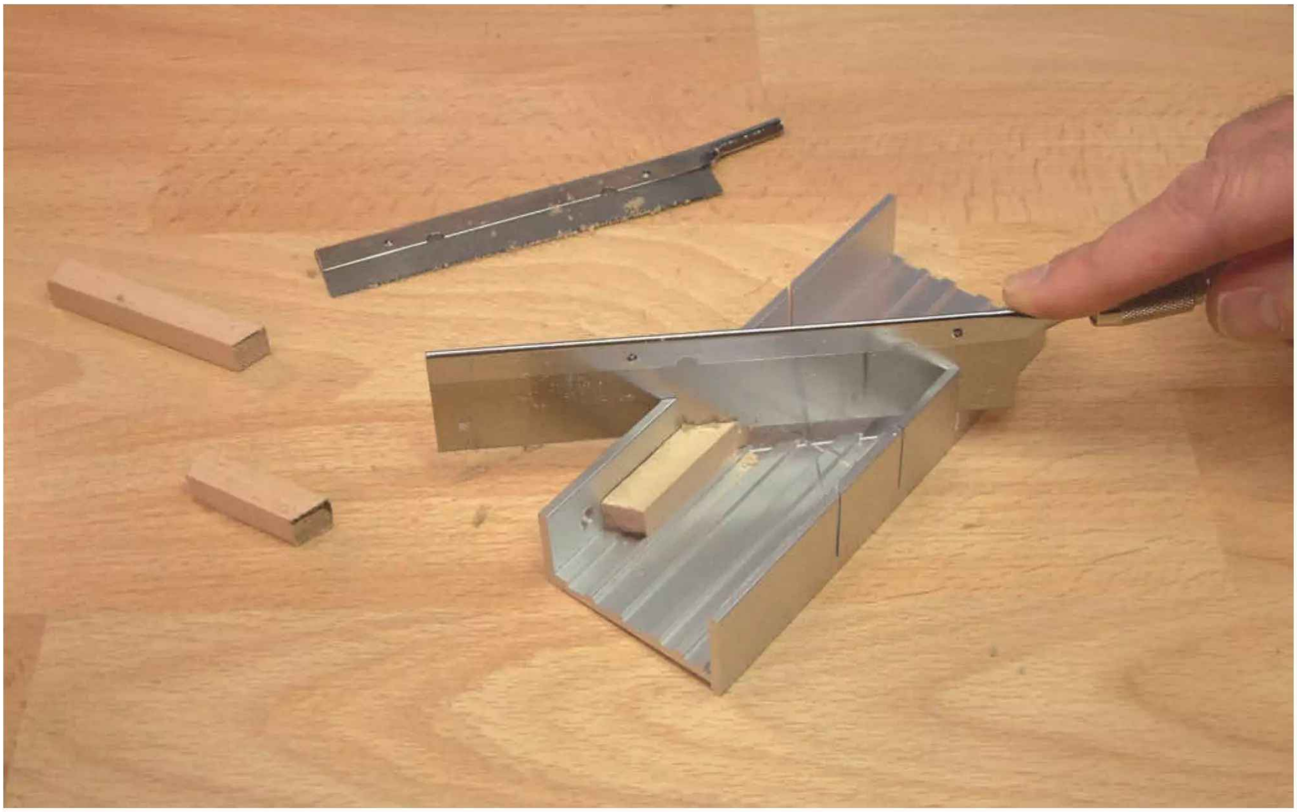
Basic tools

The basic tool kit should ideally contain some if not all of the following items:

Craft knife – Both small and heavy-duty types e.g. Stanley type knife



Picture shows a typical track cleaning rubber. *Courtesy of and © Hornby Hobbies Ltd*



Mitre block.

Electric drill (mains or cordless battery powered)
Hand wheel brace (drill)
Micro screwdriver set – often with five or six of both crosshead and flat blade drivers in a flip top box (sometimes referred to as Jewellers or instrument screwdrivers)
Mitre block

Panel saw
Pencil
Plastic clamps in small and medium openings; often sold in packs of four
Pliers and wire cutters in various versions
Precision oiler or lubricator

Screwdrivers in cross head and flat blade versions
Selection of adhesives – Woodworking PVA, Superglue, Impact adhesive and UHU type general glue
Selection of HSS drill bits. 1.0mm to 6.5mm
Set square
Soldering Iron – 18 to 25 Watt with stand
Steel rule 12-inch (300mm)
Steel tape measure (3m type)
Tack hammer (4 ounce)

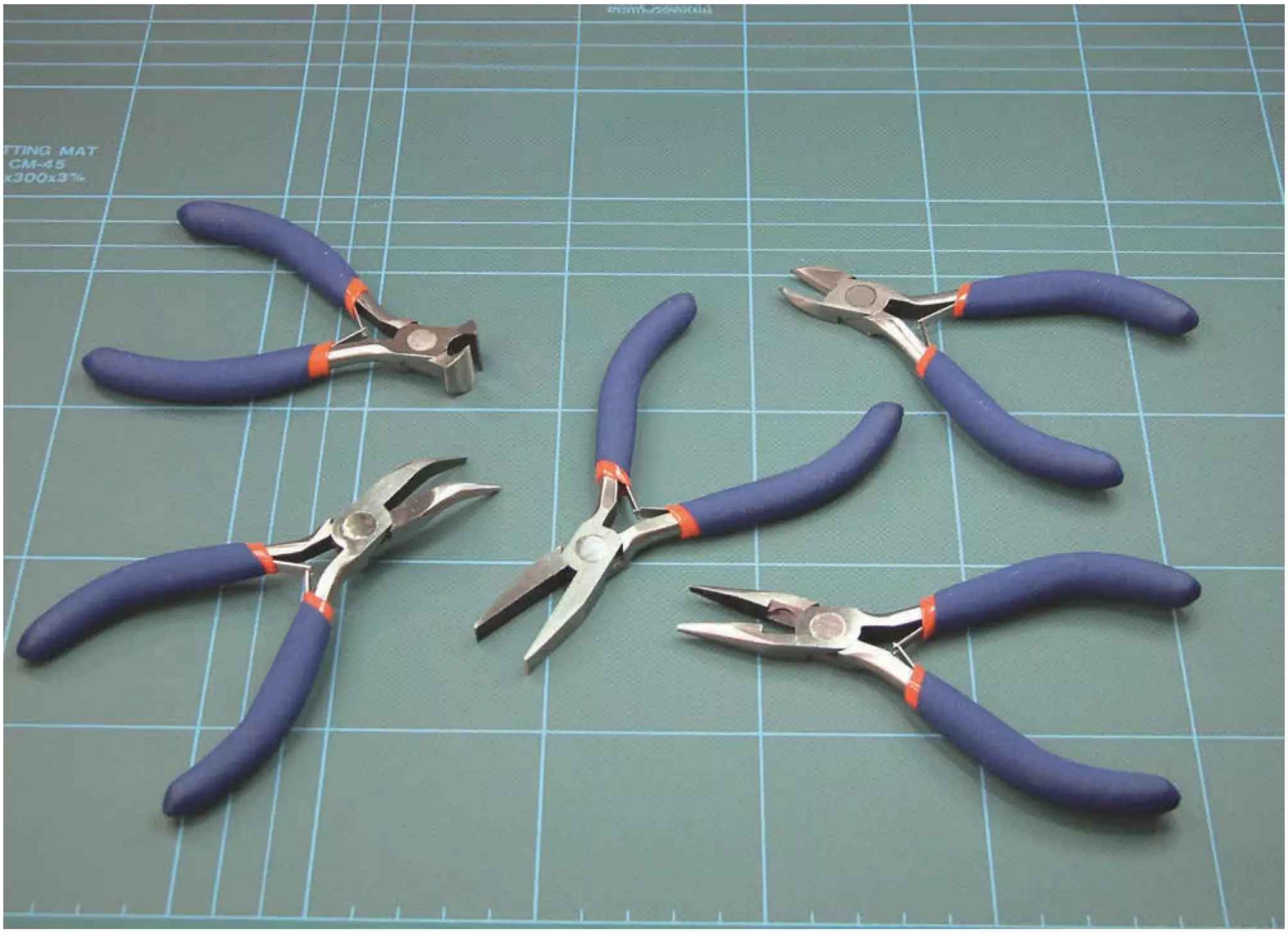
Specialist tools

Specialist tools include, but are not restricted to:

1.5lb (24oz or 0.72Kg) ball pein hammer
Adjustable combination set square 12-inch (300mm)
Archimedes drill
Automatic wire strippers
Back-to-back gauge to suit your working track gauge
Bench vice
Coping saw
Digital multimeter capable of reading DC amps, ohms plus AC and DC volts

Electric jig saw
Electric mitre saw (chop saw)
Electrically powered small lathe
Fibre pen
File smooth cut -10 to 12-inch.
Files – needle type in assorted shapes

G clamps in various widths
Gas powered soldering iron kit
HSS drill set 6mm to 10mm
Magnifying workbench lamp
Micro drill set – 0.1mm to 1.5mm



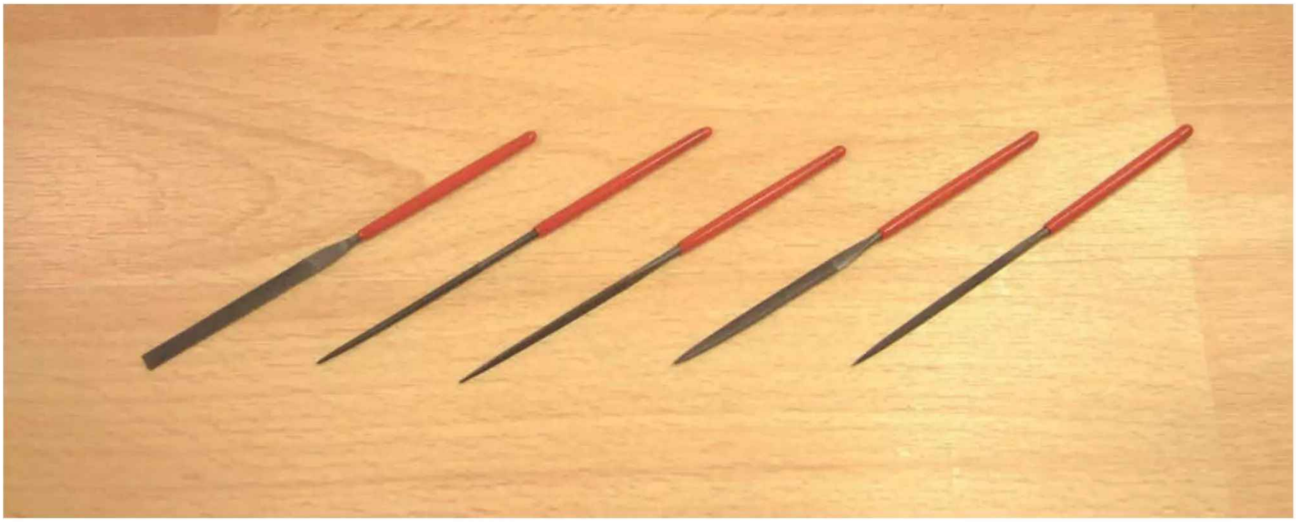
Various types of pliers and wire cutters.

Precision oiler or lubricator.

Archimedes drill.

Digital multimeter.


Fibre pen.



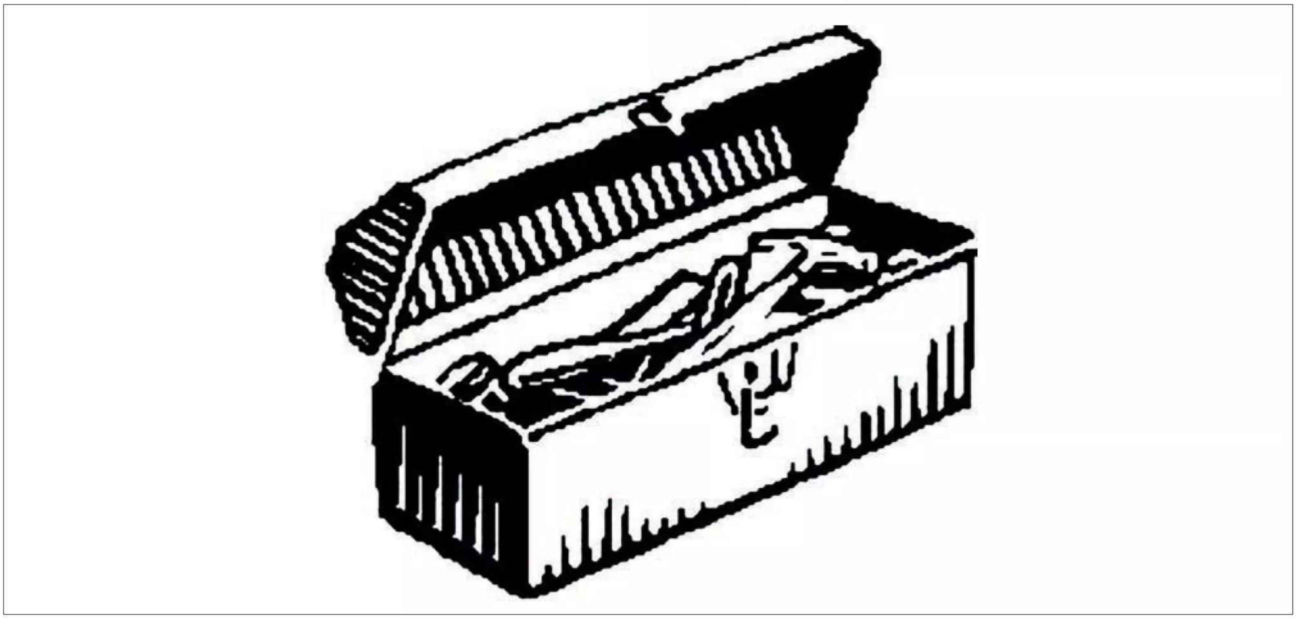
An assortment of needle files.

Razor saw.

Mini electric drill – e.g. Dremel
Panel pin punch
Razor saw

Safety cutting rule
Scalpel style knife and supply of replacement blades
Scriber
Self healing cutting mat
Solder sucker tool
Tap and die sets in metric sizes from M0.5 and BA sizes 12BA
Taper broaches
Tapered reamer to 10mm
Thermostatically controlled soldering Iron station
Tool box – cantilever or lift out tray type
Track rail gauge to suit chosen gauge
Tweezers both normally open and closed types
Wood working hand mitre saw (approx.600mm blade)

Solder sucker tool.



Woodworking countersunk bit
Work bench for the general light duty work
Workmate style bench

While these lists may seem daunting, the tools will not need to be purchased in one go. Buying a quality tool every month or so will slowly allow the modeller to build up a good selection.

Note that the lists above are not produced in any specific order. Whenever possible only purchase quality tools such as those manufactured for trade use, as these will if treated with respect, last a lifetime.

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Glossary

Abutment. A supporting structure on either side of a bridge or arch.
Accessory. An item that is not part of the train or its rolling stock, e.g. Station, platform, points and signals etc.
Accessory Decoder. A DCC decoder that is used to operate accessories such as points and signals etc.
Address. The unique number allocated to a locomotive's DCC decoder or an accessory decoder.
Adhesion. The contact between two surfaces, typically wheels to rail.
Alternating Current (AC). A current which changes polarity (or frequency) and current flow at preset intervals. UK mains AC is at 50 Hz.
Ampere (Amp). A measure of electric current flow.
Analogue. In model railways, a standard (nominally) 12-volt DC control system.
Anode. The positive end or connection of an electronic device. Denoted by the letter A.
Ballast. The small stones that retain the track in position.
Baseboard. The structure on which the model railway is supported.
Bogie. Small-wheeled centrally pivoted truck attached to the under frame of a locomotive or carriage.
Boiler. The steam producing area of a locomotive.
Booster. A DCC device for increasing the power available to the rails.
Brush (motor). A device used to transfer electrical power to the motor commutator.
Bus. A wire or solid bar that provides a continuous path to the flow of electricity and to which are connected various wires to feed equipment.
Cab. (1) The enclosure on a locomotive from which the driver operates the locomotive. (2) The device that the model railway operator uses to control speed and direction of the locomotive.
Cab Control. A means of controlling one or more trains within a specified section of the model railway.
Catenary. Overhead live wires that provide electrical power to the locomotive.
Cathode. The negative end or connection of an electronic device. Denoted by the letter K.
CDU. Capacitor Discharge Unit which is installed into the wiring of solenoid point motors immediately after the power supply and before the point lever switches. The device gives a pulse of higher power to the solenoid coils, ensuring reliable movement, especially where two or more coils are operated at once from one switch.
Chipboard. A board manufactured from particles (chips) of wood bonded together with a resin adhesive.
Coil. an electrical winding. A means of converting electrical power into a mechanical movement, as used to power a loco's the motor or a point motor.
Command station. Electronic control centre of a DCC system (see also Console).
Common Return. A means of returning all electrical feeds to their appropriate transformer connections over just one wire.
Commutator. The circular segments on an electric motor that transfers power to the motor coils.
Configuration Variable (CV). adjustable parameters on a DCC decoder, whereby the user can alter the settings the decoder manufacture has preset. Enables speed, direction, Acceleration, deceleration rates etc. to be adjusted and fine- tuned.
Consist. Means of coupling two or more locomotives together and then giving the whole group one address number and controlling all within that group (or consist) from one setting. In the UK this is known as "Double Heading".
Console. The master control position or the electronic processing unit in a DCC system.
Controller. The means by which the locomotive or trains speed is set.
Crossing. The place where one rail direction meets another in a point or diamond track configuration.
Crossover. A configuration of two points enabling moves to be made between parallel tracks
Current. The amount of flow of electricity in the circuit. (See also Ampere).
Cut-out. A circuit breaker.
Cutting. The part of the railway where it passes through a hillside, which has been partially removed to allow the railway to continue on at one level.
DCC. Digital Command Control system used to control many locomotives and accessories at once by means of a digital signal flowing along the rails to the locomotives.
DCC Fitted. A loco that has a factory fitted DCC decoder installed. Most can be run on conventional DC power tracks as well. Also known as 'DCC onboard'
DCC Ready. A DC locomotive that has a factory fitted decoder socket installed. The loco can only be operated on DC layouts. It does not have a decoder factory fitted. By removing the DC plug and fitting a suitable decoder's plug in its place the loco becomes DCC operable.
Decoder. A small printed circuit board with electronic components fitted, which controls the locomotives motor, lights and sounds or accessories.

Diagram. A means of representing what is being provided on the mode, for example. wiring or track plans drawn to show their relationship to the real thing.
Diesel. A compression engine or reference to a style of locomotive that uses a diesel engine to power it.
Digital. In model railways see DCC.
Direct Current (DC). Electric current that flows in one direction only.
Distant Signal. A signal that advises the train driver of the next signal or complete section of track ahead. Distant arm horizontal (on) or at a Yellow aspect means caution and slow down as the next signal is at stop (red).
Dropper. A track feed wire that is connected to the running rail's side or underneath and passes down through the baseboard to make further contact with other wiring.
Earth (1). The planet or the ground we can walk upon.
Earth (2). Electrical connection to the actual earth (1). Used as an electrical safety measure.
Electrofrog. The frog area of a point which is made up of all metal rails.
Embankment. The raising up of the ground of the railway to maintain its level.
Engine. In model railway terms this is the actual locomotive.
Fiddle Yard. An 'off stage' area often at the end of a layout, perhaps consisting of a series of fanned sidings where the rolling stock is held and reassembled ready to reappear as necessary.
Filament Lamp. A tungsten lamp normally comprising of a wire wound filament contained within a sealed glass envelope.
Fishplate. The metal plate joining two abutting lengths of rail.
Flange. The projecting rim or edge of a wheel that guides it in the required direction and keeps the wheels on the rails.
Frog. The crossing place of two sections of track leading away from the point's switch rails. Called a Crossing in the real thing!
Function. A DCC decoder enabled electronic switch. Used to operate lights, sounds or other accessories.
Gauge. The distance between the inside faces of the two running rails.
Grain of Rice. (GoR) a micro miniature filament lamp normally operating in the voltage ranges of 1.5 to 16 volts. Supplied fitted with wire leads.
Grain of Wheat. (GoW) similar to, but slightly larger in physical size than GoR lamps.
Hertz. (Hz), one hertz is one cycle per second (typically that which is being counted is a complete cycle); 100 Hz means one hundred cycles per second. UK AC mains is at 50Hz.
Insulfrog. Insulated frog area of a point or crossing.
LED (Light Emitting Diode). A device that, when feed with voltage emits light.
Level Crossing. Place where the road or footpath crosses the railway. Can be open, gated or protected by lifting barriers.
Lever. A device for moving an object that is often remote from the actual place of operation. e.g. a signal box lever or a model point lever.
Locomotive. The engine that pulls or pushes a train of coaches or wagons.
Locomotive Address. A DCC term (see Address).
Loop. A continuous circular connection.
MDF. Medium Density Fibreboard, a smooth surfaced board which can be used to produce baseboard tops or side framing.
Mimic Panel. A panel or console that carries a miniature version of the layout's track plan on its surface, as well as switches for point and signal control and track isolation switches on DC powered layouts. It may also have the DC train controllers mounted on it.
Motor. An electrical device for powering the train or moving a point.
Multiple Aspect Signalling (MAS). System of colour light signalling that can display more than one colour aspect. e.g. red, yellow, green or double yellow.
Narrow Gauge. A term applied to any railway whose track gauge is less than the standard gauge of 4feet 8½inches (1435mm).
NMRA. National Model Railroad Association of America, a body which controls the standards of railway modelling in the USA and sets the standards for DCC worldwide.
Normal. Position of a point when set for the normally straight ahead movement, but can also be the diverging direction, if that is the main route.
Off (1). The position of a signal when it is cleared or at proceed.
Off (2). The position of a switch when the contacts are open and preventing the flow of electricity
On (1). The position of a signal when it is at stop.
On (2). The position of a switch when the contacts are making and allowing the flow of electricity.
Permanent Way. The track bed and track when in their final position.
Pick-up. An electrical connection, normally between the loco's wheels and the wire to the motor.
Platelayer. A track maintenance person.
Plywood. A lamination of three or five or more odd numbers of thin sheets to produce a strong, easily cut sheet material.
Point. The means by which trains direction is changed. (Also called a Turnout).
Polarity. A voltage that it can be positive or negative, as at a battery terminal or electric circuit.

Power Supply Unit. (PSU) normally mains powered and often a totally encased unit containing one or more transformers supplying the safe low voltage needed.
Programming. DCC term used for setting the Configuration Variables (CV) of a decoder.
Programming on the Main. (PoM) a DCC term for the ability to set Configuration variables (CV) whilst the loco is on the main layout track.
Programming track. DCC term for a special length of track which is isolated from the main layout, where decoder CV values are safely adjusted.
Propelling. Reversing move of a locomotive or train.
PSE. Planed Square Edge timber.
PSU. See Power Supply Unit above.
PVA. Polyvinyl Acetate, normally a water-based polymer adhesive which is ideal for bonding wood to wood or bonding paper or cardboard together in model building construction, bonding scatter materials to the sub base surface and diluted with water, for bonding real stone ballast. Normally dries clear or translucent.
Radial. A circuit or wire that does not return back to its source.
Rectifier. Converts AC current into DC current.
Relay. An electrical switch that opens and closes its contacts under the control of another electrical circuit.
Reverse. The position of a point when set for movements away from the straight ahead or main line route.
Reverse Loop Module. DCC device that automatically swaps over the output supply upon detecting a short circuit occurring at the input. Thereby removing the short circuit.
Reversing. Allowing the direction of travel to be changed to go backwards.
Ring. A circuit that starts and then ends back at the same source.
Rolling Stock. Any item of rail mounted vehicle that is not normally powered, such as coaches and wagons.
Route. The direction a train is to take.
Scale. The relationship between the real thing and the model.
Scratch Building. The construction of a building or item of rolling stock from a basic selection of sheet materials as opposed to the use of a kit.
Semaphore. A signal with a mechanically operated pivoting arm which can be raised or lowered. The two types are upper and lower quadrant which when raised to approximately 45 degrees above horizontal (upper quadrant) or lowered (lower quadrant) approximately 45 degrees below horizontal are at a proceed. In both types the stop position is at horizontal The exception is a distant signal where a horizontal arm means proceed with caution and raised or lowered means line ahead is clear.
Siding. A subsidiary line often connected to the main line used to accommodate trains or locomotives.
Signal. A lineside device used to control the movement of trains.
Signal box. A building housing the equipment for operation of points and signals over a particular section of track.
Sleeper. A steel, wood or concrete beam for holding the rails apart to the correct gauge. (Also known as a Tie)
Soldering. The jointing together of two or more wires or pieces of metal by melting a low temperature metal (solder) into the joint to bond them together.
Solenoid. Electrical powered coil that, when energised will attract metal by induced magnetism.
Switch. Device for turn on or off or divert the flow of electricity.
Terminal. An electrical connection place where wires usually two or more are joined together.
Terminus. The end or departure place of a railway line, usually with station buildings and platforms.
Transformer. Electrical device that converts by magnetic induction an AC input voltage to another AC voltage. The output can be higher (step up) or lower (step down) or the same (1 to 1) as the input voltage. In the case of model railway transformers normally the output is totally separate electrically from the input e.g. an isolating transformer and of the 'step down' type.
Weathering. The art of making a model look as though it has been aged or used out of doors.
Wiring. The run of one or more wires making up the layouts electrical control paths.

Bibliography

Further information and recommended reading is available from the following:

Monthly (UK) magazines
British Railway Modelling
Continental Modeller
Hornby Magazine
Model Rail
Railway Modeller

Suggested websites to visit
www.brian-lambert.co.uk
www.metcalfemodels.com
www.model railway forum.com
www.newrailwaymodellers.co.uk
www.rmweb.co.uk
www.scalescenes.com
www.superquick.co.uk

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