Model Electronic Railway Group
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Computer Assisted Cab Control (CACC) DEC 2005

Introduction

Computer Assisted Cab Control (CACC) is a development of conventional cab control and allows for the automatic allocation of the correct cabs in complex junction areas. It overcomes the need for operators to remember to set rotary or toggle switches as trains change lines as the system automatically connects the correct cab.

(See Technical Bulletin G16/81 for an overview of the RPC application and overall control system in use on the Beckenham and West Wickham MRC's 'Horton' layout – the test bed for CACC.)

Summary

With the signalling controlled via the RPC system, the Model Railway Computer Control Centre (MRCCC) software (see TB G16/85), running on the PC, controls the relays on DPR modules that are used to select the correct cab feeds. The DPR module relays are used to show the position of the points (turnouts). When the points are Normal, the Point Position Relay (PPR) will be de-energised. When the points are Reverse, the PPR will be energised. Normally one relay is provided per point end. If the points have two ends, normally there would be two relays. The MRCCC data is configured to operate the relay at the same time as the points control output state is changed.

The system also provides a 'fail-safe' mode, wherein if the PC or RPC systems were not functioning, the layout would still be operable in that the straight routes would be available as they are all wired across the Normally Closed (NC) contacts of the relays. Any relays that would be required to be operated (such as the ATP relays – see page 10) would be provided with an override button, or by providing a jumper plug to 0V that could be placed on the DPR edge connector to simulate the relevant bits.

Wiring

Conventional Cab Control areas are provided on the plain line each side of the station area, or junctions. These are provided with a rotary switch to select the controller output to use. The resulting selection from the rotary switch is referred to as the Cab Feed.

Common Return wiring is employed and no further mention of this rail is mentioned. All points are insulfrog with the stock and switch rails bonded on both sides for reliability.

The cab feed is taken and passed through relay contacts of the corresponding PPRs which are used to direct the cab feed to the correct track section feeds. Additional controls can be applied to provide selection between two different cab sections. These are used in the platforms, reception lines and on the bi-directional relief line on Horton to select whether to power the line from the mainline to the left, or the mainline to the right of the station area. Centre-off, 2-way toggle switches provide this manual selection of the 'Left' or 'Right' feed and are referred to as Cab Control Selection Switches.

Combined with the cab allocations provided by the PPRs, these also ensure that the train can not move away from its originating section (at the signal controlling access into the station) unless all the conditions are met. Only when all the points are selected correctly and the Cab Control Section Switch is set will the feed return and allow the train to move away from the signal. This prevents the scenario of the train being started away from the signal, getting as far as the start of the platform and stopping because an operator has forgotten a switch.

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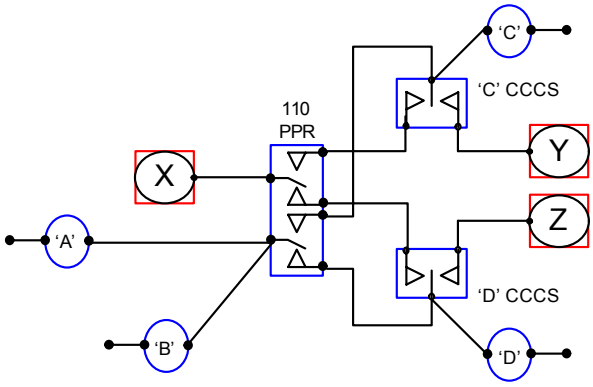
Example 1 – Facing points (turnouts)

In the first example the point (110) is facing. This means that the originating Cab Feed from a rotary switch related to the plain line by section 'A' has two choices as to where to go. Sections 'C' and 'D' are supplied with Cab Control Selection Switches (CCSS) as centre-off toggle switches to select feed from the 'Left' by section 'A', or to the 'Right' which we will ignore for now.



NOTE

In these diagrams, a red square represents a Cab Rotary, a blue circle represents an FTC track circuit, immediately prior to the rails, and the remaining boxes represent CCSS switches or PPR relays. Switches are drawn in the Off position, and relay contacts in the de-energised state.

The Cab Feed X passes through the PPR for points 110. When the points are Normal, the feed follows the Normally Closed (NC) contact and onto the 'Left' contact of the CCSS for section 'D'. The feed then returns from the 'centre' contact of the CCSS and back to the other NC contact and onto the track feed for section 'A'.

Alternatively, the CCSS can be set to the 'Right' and this allows an alternative Cab Feed to be used, in this case Cab Z. This feed passes from the 'Right' side of the 'D' section CCSS out through the 'centre' contact though 110 PPR NC contact to feed section 'A'

When the points are reversed, the Normally Open (NO) contact of 110 PPR is used and the originating Cab Feed X, passes through onto the alternative CCSS 'Left' contact of section 'C', and again returns via the 'centre' contact back through 110 PPR NO contact and onto the track feed for section 'A'. Again an alternative feed is available when the CCSS is set 'Right', in this case Cab Y.

This allows for section 'A' to be fed from any of the three cabs, and by changing the position of the CCSS will determine which cab feeds the section.

The section 'B' over the points is fed after the PPR and, depending on the position of the PPR and the CCSS, will be fed from any of the three Cabs X, Y or Z.

When the points are Normal, and section 'D' CCSS is set 'Left', section 'B' is fed by Cab X.

When the points are Reverse and the section 'C' CCSS is set 'Left' the section 'B' is fed by Cab X.

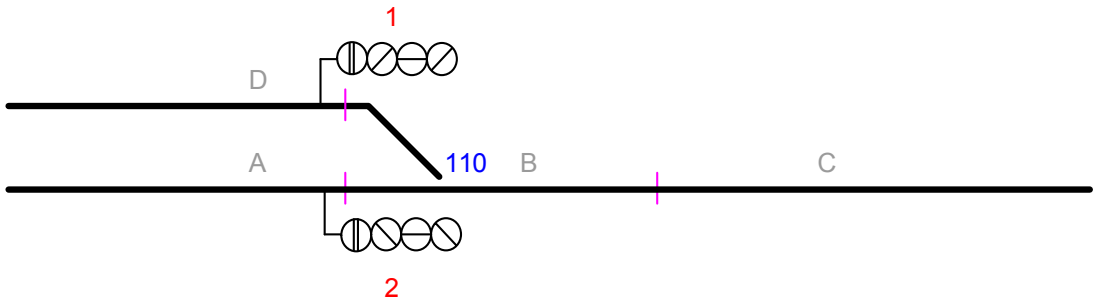
When the points are Normal and the section 'D' CCSS is set 'Right' the section 'B' feed comes from Cab Z.

When the points are Reverse and the section 'C' CCSS is set 'Right' the section 'B' feed comes from Cab Y.

In practice this means one controller could take the train to the home signal, but another from the other end of the station could drive the train away from the signal and through the station. Alternatively, the first controller could take a train right into the station.

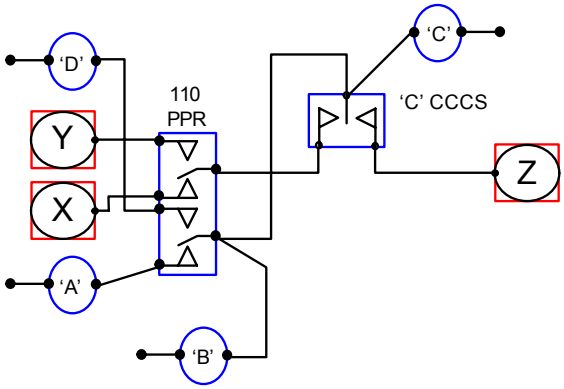
As can be seen, track sections 'A' and 'B' only get their feed when the CCSS is set to either the 'Left' or 'Right'. If the CCSS is not set either way, the feed will not return and the train will not be allowed to depart section 'A'. This may be useful if the operator is not ready to allow the train to enter the following section and the driver of the train will not be able to pass the section 'A' until the CCSS is set.

Example 2 – Trailing points (turnouts)



When the points are trailing there will only be one CCSS, section ‘C’, but there are still three potential Cab Feeds.

The ‘originating’ Cab Feed X for section ‘A’ passes out to the PPR and when the points are Normal through the NC contact onto the ‘Left’ contact of the section ‘C’ CCSS, back from the “centre” contact to the PPR and back to feed section ‘A’. In this situation no feed is possible for section ‘D’ and a train can not pass through the points in the wrong position. Cab Feed Z can be used to feed section ‘A’ when the section ‘C’ CCSS is set to the ‘Right’ position.



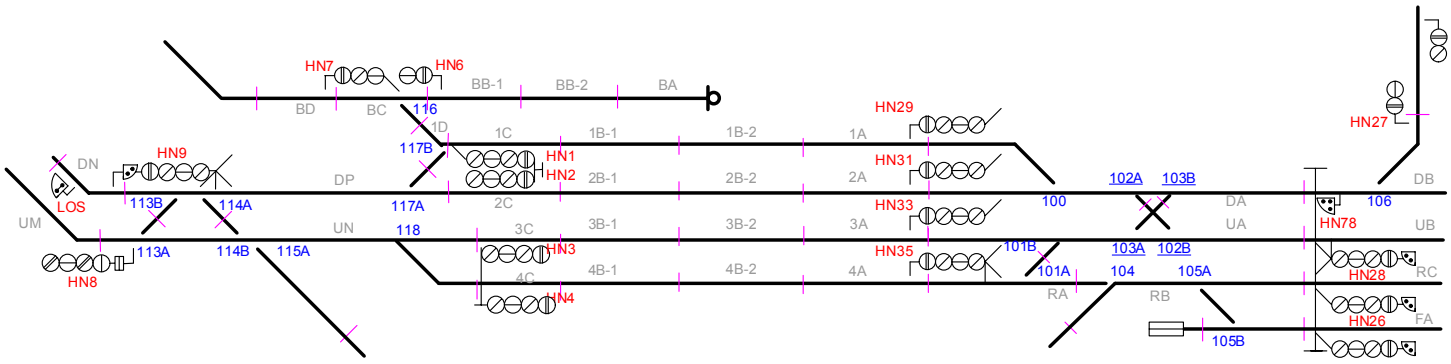
When the points are Reverse, the NO contacts are made and this allows the ‘originating’ Cab Feed Y from section ‘D’ to pass to the CCSS via the PPR and back to section ‘D’ feed. In this situation no feed is possible on section ‘A’ and a train will not be able to pass through the points in the wrong direction. Again Cab Feed Z can be used to feed section ‘D’ when section ‘C’ CCSS is set to the ‘Right’.

Section ‘B’ is fed by either Cab X when points are Normal and CCSS is set ‘Left’, or Cab Y when points are Reverse and CCSS is set ‘Left’. Section ‘B’ is fed by Cab Z whenever the CCSS is set ‘Right’ regardless of the position of the points.

Obviously this is a very simple example and could be done in other ways; however the CACC becomes useful in multiple track/complex junction areas.

Real Examples from ‘Horton’

On the following pages are some scenarios from ‘Horton’. All use the same extract of the signalling plan below. The points leading off from 115A and 104 go to a yard and are not shown on the wiring. The Branch wiring is also not shown.



Extract of signalling diagram

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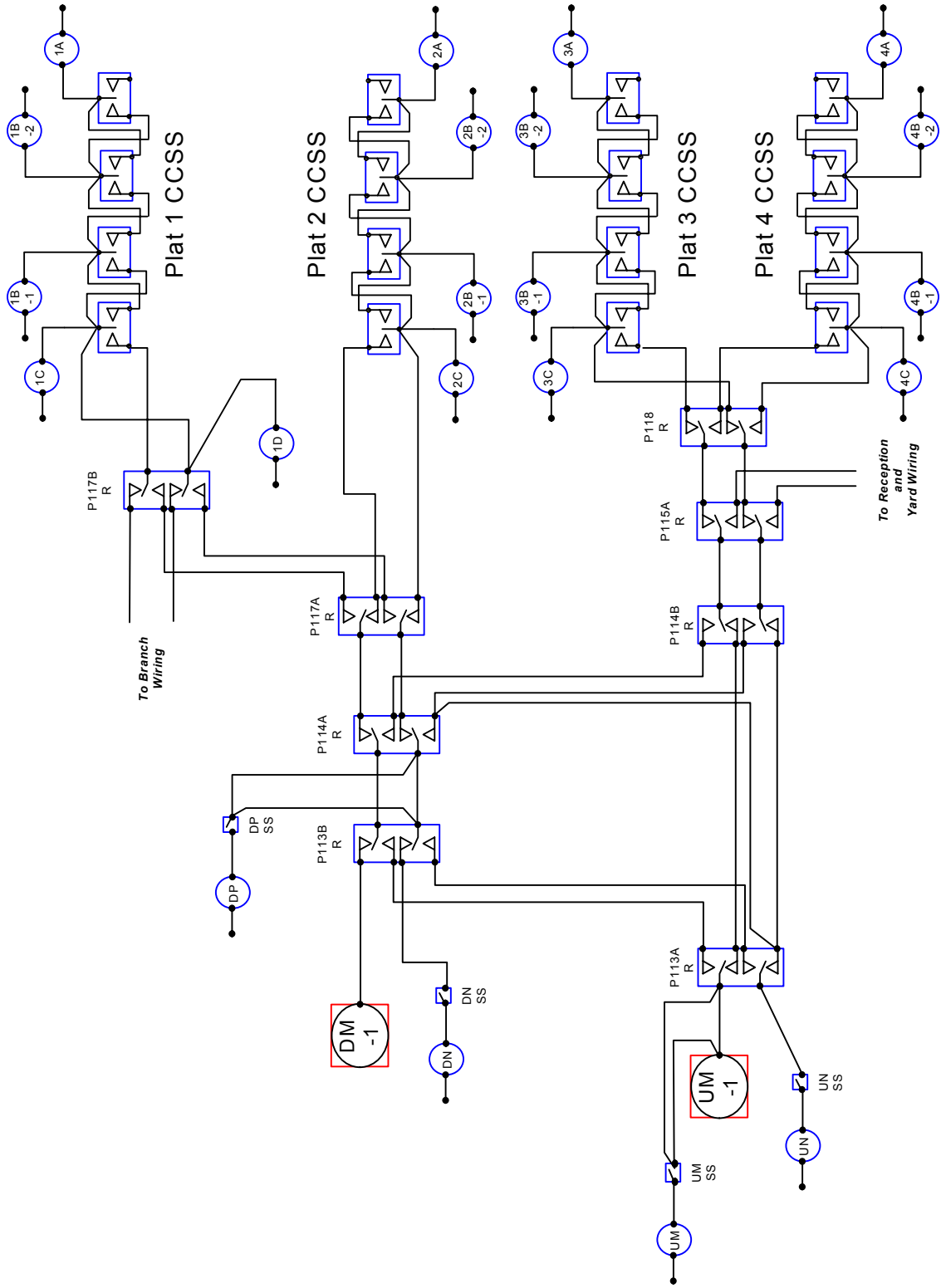
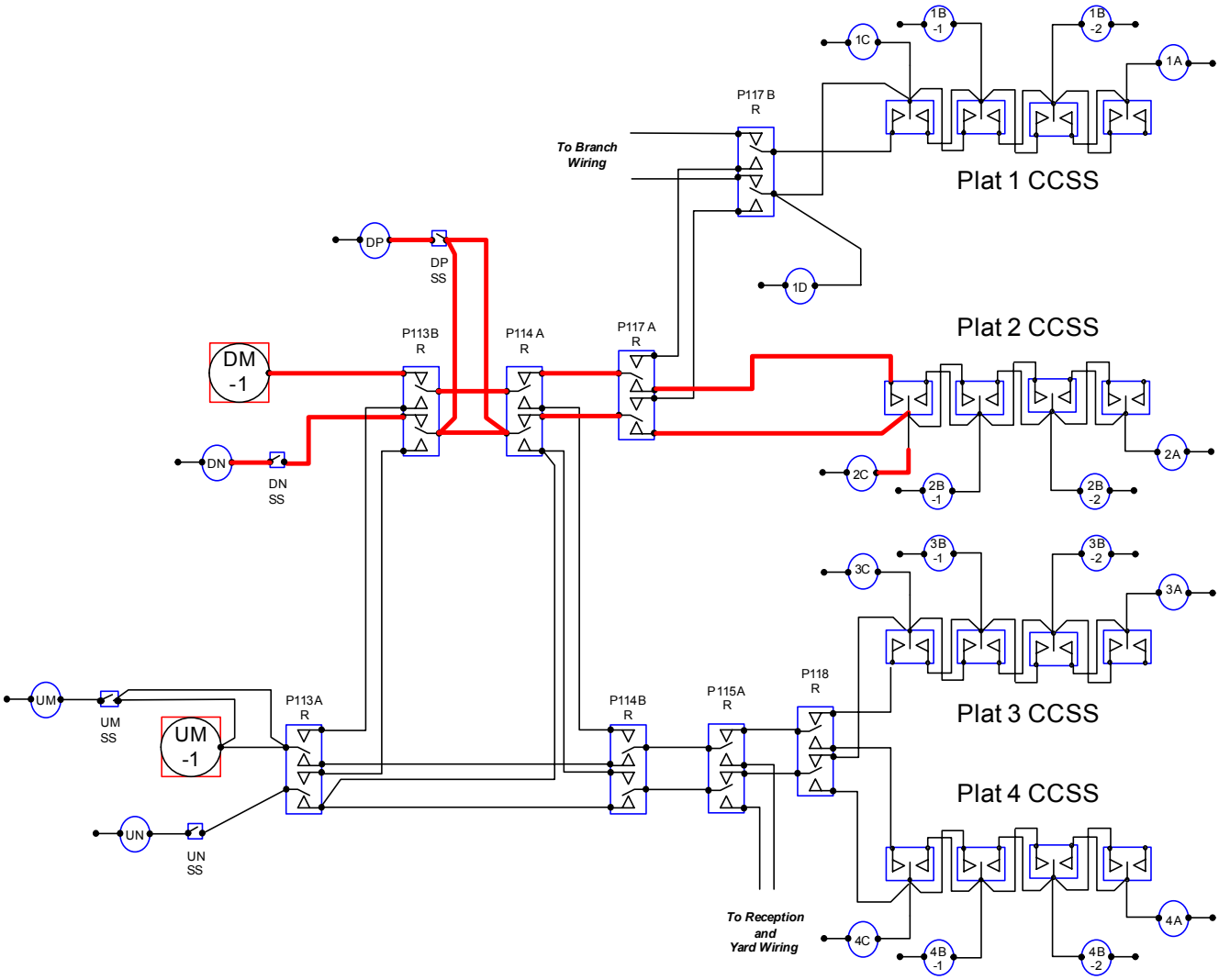


Extract of original wiring diagram

From the above, it can be seen that a complicated junction can be easily wired, and with the minimum of cab sections. The feed for the track sections between DN, UN and the platforms are switched automatically as the routes are set. These junction track sections are only fed after the feed from the 'originating' Cab Feed rotary has gone out and been selected by the platform CCSS and returned. The CCSS within the platforms provides the additional controls and prevents a train from leaving the section DN (at the protecting signal) unless the first platform CCSS is set to the 'Left' or is set 'Right' and the following CCSSs are also set 'Right'. When a train is routed to leave the platform, again the CCSS switches also need to be set correctly.

Scenario 1 – HN9 Signal (Down Main) to Platform 2

To provide an explanation, follow the scenario, highlighted in red (or in bold for those reading this in black and white), of a train routed from HN9 signal, DN track section, into platform 2.



The Cab Feed rotary DM-1 passes its feed out through the NC contact of P113B PPR. As these points are trailing, the feed can only pass through when the points are Normal. After passing through this relay it passes onto the next PPR, P114A. These points are facing and have two choices, in this situation the points will be Normal and pass straight through on the NC contact. The next relay is P117A PPR and again the points are facing, the NC contact allows the feed to pass through to the CCSS of section 2C. When the CCSS is set to the 'Left' the feed returns following the path that it took on its way to the switch. This allows Cab Feed DM-1 to power track sections 2C, DP and DN. Setting the following CCSSs for sections 2B-1, 2B-2 and 2A to 'Left' will allow the Cab DM-1 to be fed to these sections through the platform.

Should the platform CCSSs be all set to the Right, the 'originating' Cab Feed will come from a cab rotary that is to the 'Right' of the platforms. All the above sections would be allocated to this controller, enabling the train to be driven away from the signal and through the platform, even if it arrived at the signal on a different controller.

The only action taken to switch the power by the operator has been the CCSS switches in the platform. The remainder was set automatically by the action of setting the route into the platform, using the entry-exit route setting provided in MRCCC.

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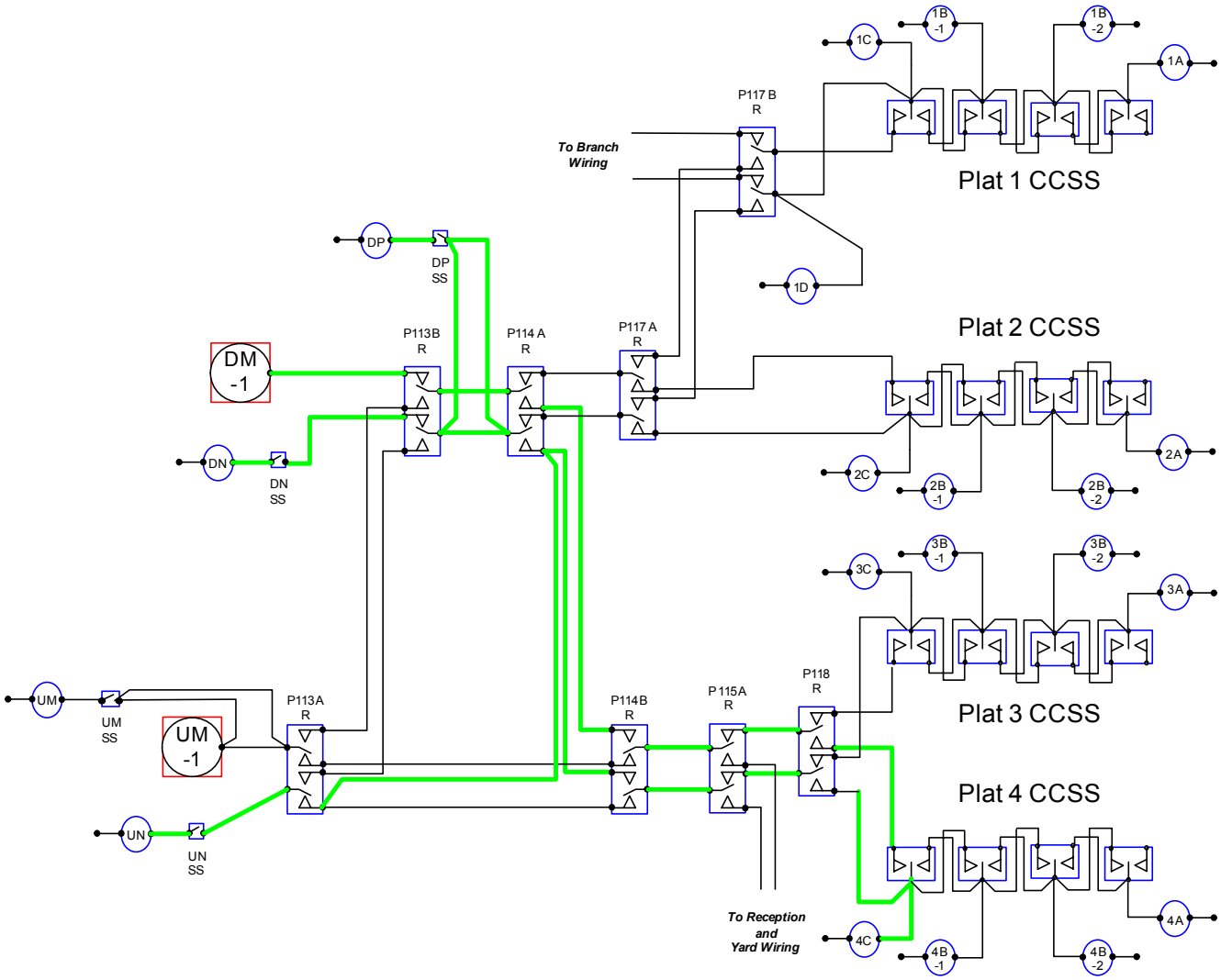
Scenario 2 – HN9 Signal (Down Main) to Platform 4

Follow the scenario, highlighted in green/bold, of a train routed from HN9 signal, DN track section, into platform 4.



The track sections DP, 4C, UN, DN are all fed by the Cab Feed DM-1 and again setting the following platform CCSS switches 'Left' will connect the rest of the platform sections.

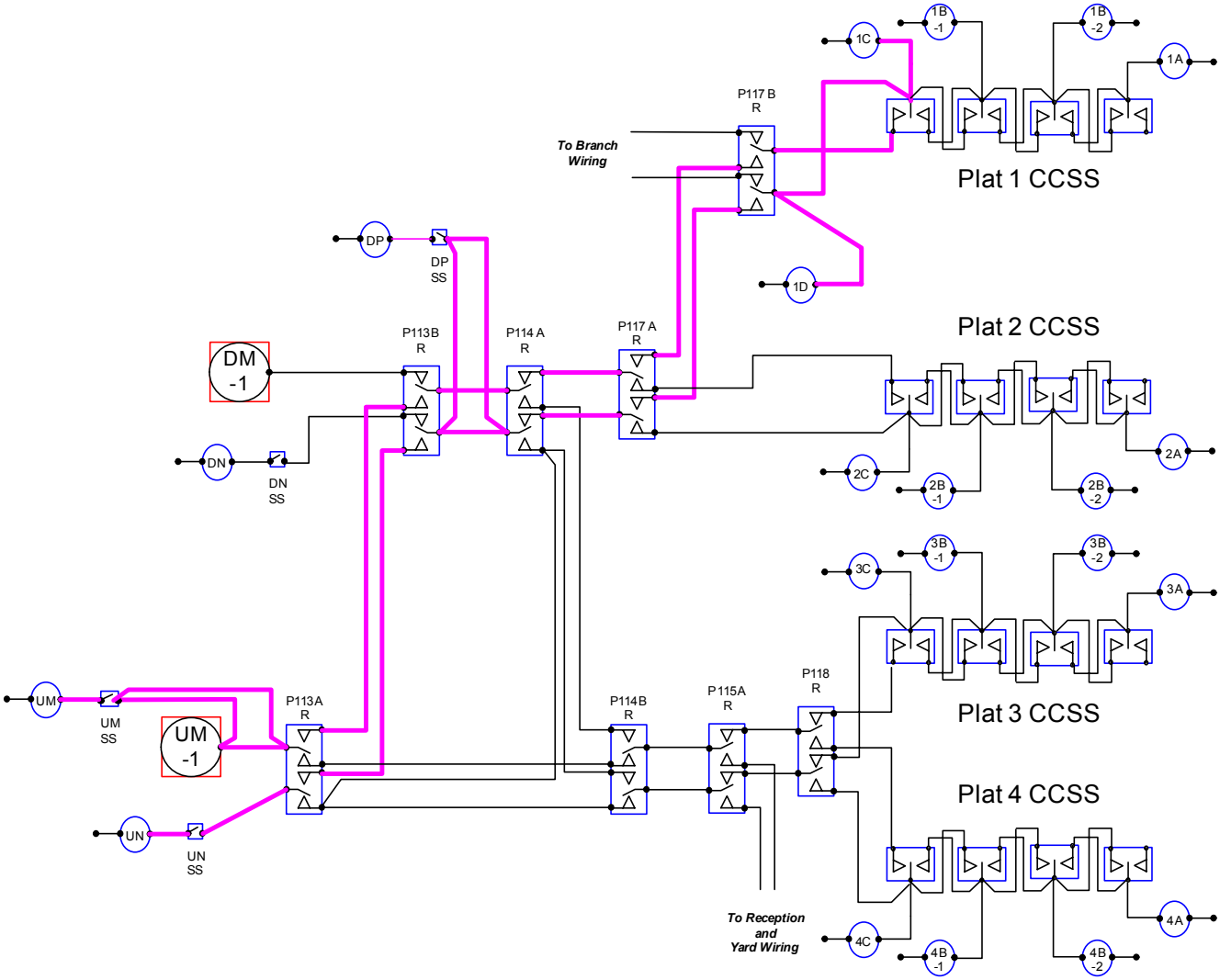
The feed 'originates' from Cab Feed DM-1 and is passed to the PPR P113B. This point is trailing and as the points will be Normal the feed will pass straight through on the NC contacts. It is passed onto P114A PPR and as these points are facing and are Reverse for this move, the NO contacts are used where it is passed onto P114B PPR. Following the NO contacts of this relay it is passed onto P115A PPR and as these points are Normal uses the NC contact to move onto P118 PPR. These points are Reverse and use the NO contact and allow the feed to connect to the 'Left' contact of the Platform 4 CCSS, section 4C. The feed is returned when the CCSS is set 'Left' and follows its original path to return to section DN, at the protecting signal.

The feed to section UN is obtained by coming back from P114A PPR and going through the NC contact of P113A PPR. This is due to the layout at this junction. If the feed to section UN was placed between P114B and P115A PPRs, it was found that a back feed existed, when P113 were Reverse, as a loop was required from the armature contact of P113A PPR to the second NC contact of P114B PPR. Wiring in this manner has resolved this issue.

If the entire platform CCSSs are set to the 'Right' then the 'originating' cab feed will come from a cab rotary that is to the 'Right' of the platform.

Scenario 3 – HN1 Signal (Platform 1) to the Up Main

Follow the scenario, highlighted in pink/bold, of a train routed from Platform 1 (HN1 signal), to the Up Main.



Track sections 1C, 1D, DP and UN are all fed by Cab Feed UM-1. Section UM, being clear of the junction and situated on the Up Main is always fed by Cab UM-1.

Removing the Cab Control Selection Switches

This arrangement provided complete control over the cab selection. However, experience showed that the checks on setting the CCSSs correctly forced the operator to set the switches correctly. If a train was entering the platform all the switches would have to be set the way the train was entering, or it didn't get right to the end of the platform. When it was leaving they would have to set the way it was leaving, at least as far back down the platform as the power pickups on the train.

If a unit or loco was to be left in the platform, the CCSSs would have to be left in the centre position to isolate it. The problem we ran into was remembering to set the switches correctly, and it was found that an automatic version was required.

This was achieved by providing relays, named CC Plat x [L] and CC Plat x [R] which would take the place of the CCSSs. The relays would be controlled by the route setting, leaving basic On-Off switches to control the isolation of sections within the platforms. It forced the whole platform to always be on the same controller, but this functionality was never exploited in practice.

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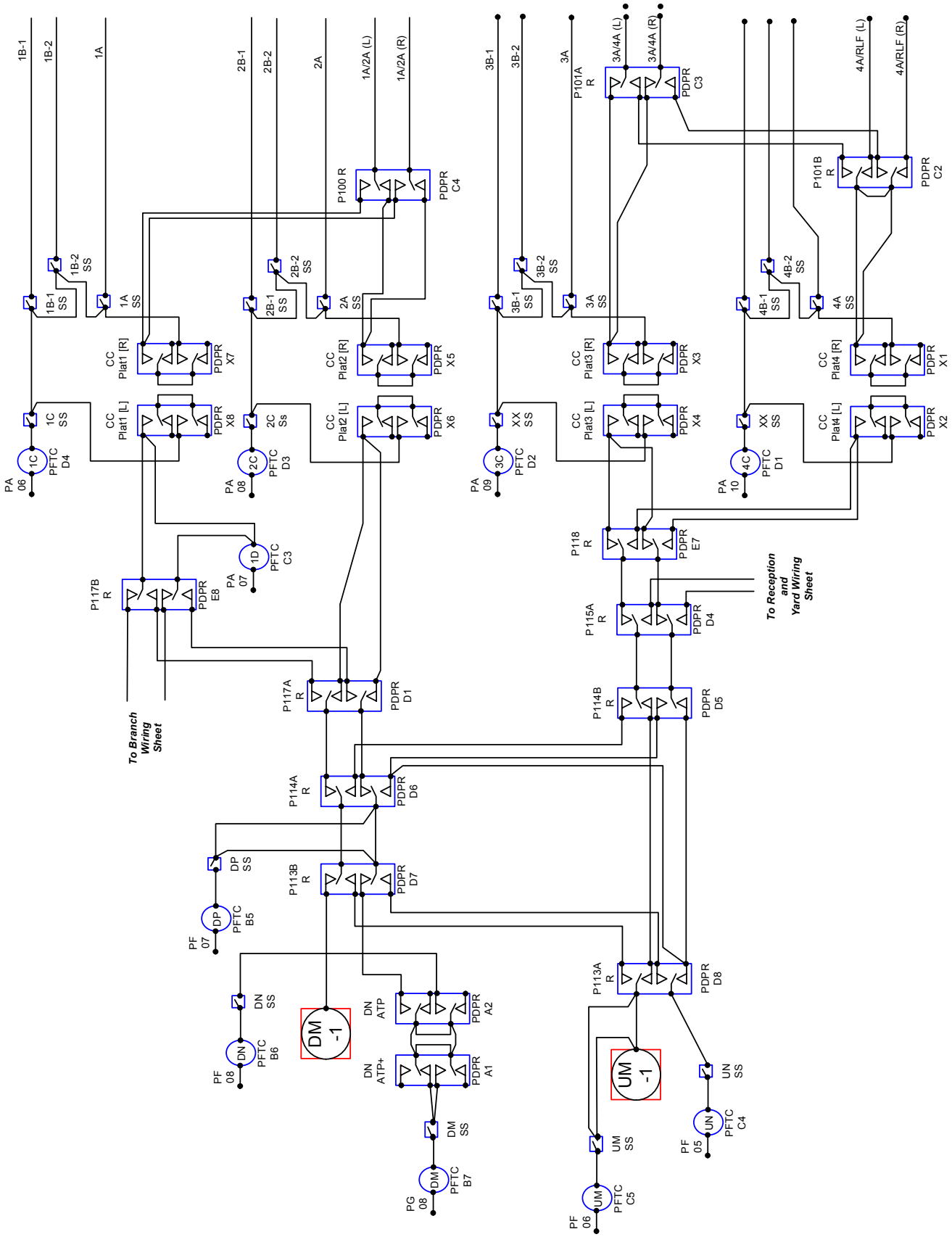
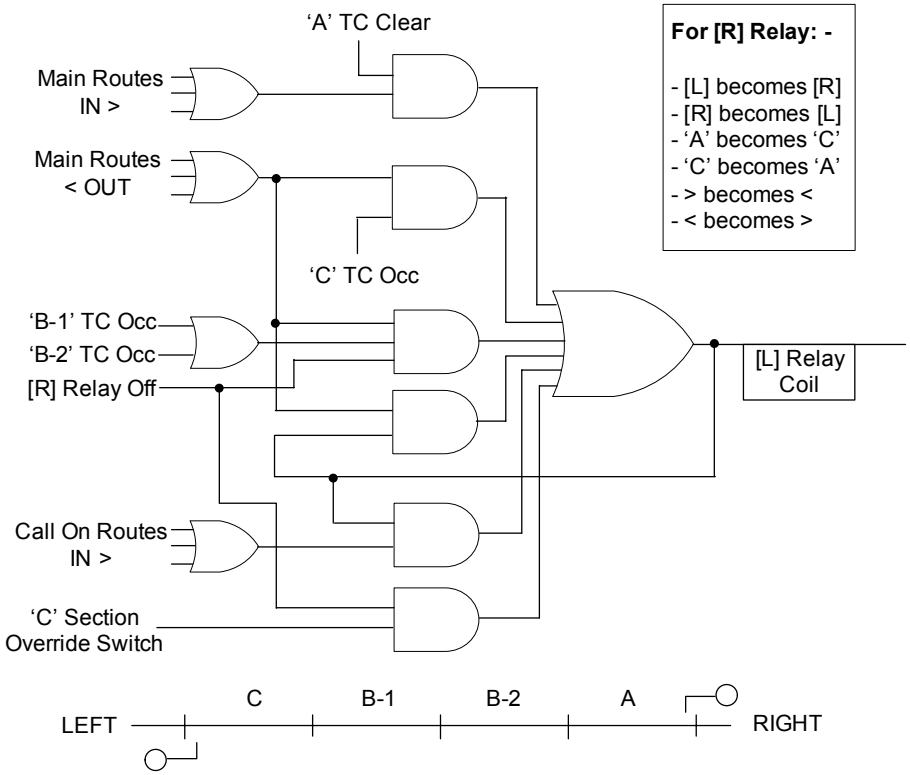
The revised wiring for this is shown below. As can be seen the wiring is greatly simplified again, and the control of the CCSSs is given over to the logic within the MRCCC data on the PC. MRCCC selects the correct [L] or [R] relay depending on which routes are set, and the position of a train within the platform.



Logic for selecting Left and Right Relays

The following logic is applied within MRCCC data to control the Left and Right relays.



When the route is set from signal HN9 into Platform 2 the [L] relay picks. As the train enters the platform the [L] relay will remain energised (due to R9B(M) route being set) until either the route is cancelled by the operator, or the last track section 2A is occupied (which is configured as an 'early release' for the route in MRCCC – see TB G16/86). When the route is set out of the platform in the same direction, the [R] relay picks and allows the train to depart.

When the route is set into the platform, and the route is also set out the other end, the [L] relay will be selected. When the train occupies section 2A at the far end of the platform, MRCCC will change the selection to the [R] relay and the train can continue moving without interruption. The Cab allocation automatically gets switched from the 'Left' cab to the 'Right' cab. If the routes had their auto buttons selected and remained set, once section 2A cleared, the selection would switch back to [L] ready for the next train.

If a train is routed into the platform, and it is to reverse direction, the train must be standing on one of the middle two sections 2B-1 or 2B-2 or the end sections 2C or 2A for which it is to depart. This proves to the system that there is a train present within the platform and allows the correct selection to be made simply by setting the routes.

If the train is standing at a point where it does not allow the relay to select, then the override push button may be operated in the direction required to travel. This will force the selection and latch the relay when it reaches one of the middle sections.

Call On Protection

When a train is to be 'called on' into a platform using a Call On class route, the [L] or [R] relay does not operate until the relevant override button is operated. This prevents the second train colliding at high speed with the back of a stationary train already in the platform, due to operator distraction. Without pressing the button, no selection is made, resulting in the train coming to a stand at the protecting signal outside the station. Pressing the override button will select the relay and latch it. Sections through the junction are selected but on clearing the junction track circuits, the route will release, and the relay will deselect. The override must be held as the train completes its move into the occupied platform.

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Automatic Train Protection (ATP)

All sections on the approach to Controlled Signals are provided with an ATP Relay in their feed. The ATP relay is controlled by MRCCC and energises when: -

- the signal is showing a proceed aspect, OR
- a train is passing the signal in question (the leading vehicle having replaced the signal to danger), OR
- a route is set through the section in the reverse direction, OR
- the override push switch on the panel has been pushed.

It was also found that just providing a single ATP Relay was insufficient for faster trains. If a train was being powered from the rear, such as a multiple unit, the train would be 'pushed' past the signal by the rear unit, allowing the front unit to pick up the power beyond the signal. The solution was to devise ATP+.

When the signal is at Red, only the ATP+ relay is energised, this allows the Cab Feed to feed into the track sections approaching the signal. When the train occupies the short section approaching the signal, the ATP+ relay de-energises removing the cab feed from both the section at the signal and the one in rear of that, isolating the rear unit. When the signal is cleared, the ATP relay energises and after passing through the CACC's PPR feeds both sections of track approaching the signal.

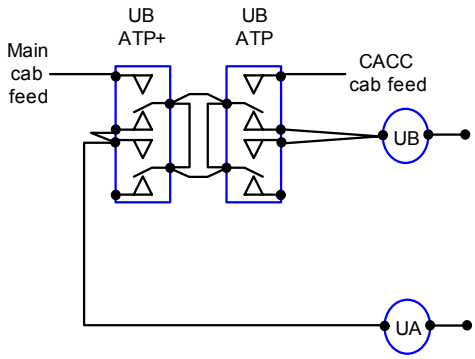
If the signal is already cleared for the train, both ATP+ and ATP relays are energised. When the train occupies the section at the signal, the ATP+ relay will again de-energise, but as the ATP is already energised the train will continue with its journey.

The logic built into the [L] and [R] relays in the platforms incorporates both ATP and ATP+ in its design.

ATP Wiring Example

The selected Cab Feed is passed into the top NO contact of the ATP+ relay. The normal cab feed is then passed out through the relevant PPRs at the junction and is fed in at the top NO contact of the ATP relay. When the signal is at Red and track UB (the section by the signal) is clear, the ATP+ relay is energised and the ATP relay is de-energised.

This allows a train to approach the signal normally, but when it occupies UB track, it will de-energise the ATP+ relay and the feed will be cut off to both UB and UA, until the signal clears, and the ATP relay energises.



Conclusion

As can be seen, utilising Computer Assisted Cab Control can bring significant simplification to wiring and control of model railway layouts. It ensures that when you make a complicated move across a junction, operators will not have to worry about Cab selection. Complex bi-directional or crossing moves that were rarely done due to the complexity of power switching suddenly become easy to achieve. The simple action of entry-exit route setting is all that is needed to correctly allocate the Cab Feeds to the relevant tracks.

A number of overrun protection features are built into the design, preventing embarrassing collisions, and for most movements it is not even necessary to have an operator at the physical control panel. The route setting can be done on a PC some distance away – perhaps outside of the layout, or with a wireless LAN or internet connection, away from the actual layout!

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