Queensland Colour Light Signalling

By Lincoln Driver

Contents

1. Overview

Colour light signalling in Queensland is largely used in conjunction with a safeworking system known as Remote Controlled Signalling (RCS). But it can also be found in other safeworking areas such as Direct Traffic Control (DTC) and Staff & Ticket (S&T). In this presentation we will explore examples of Colour light signals in RCS territories.
Queensland's Colour light signalling design and principles has primarily evolved from British practise. As the primary concern in the operation of a railway is safety, the signalling system is designed to operate with that in mind.

There are 5 basic principles in how Queensland's signals operate and they are as follows:

1. Interlocking of points and signals to prevent the possibility of conflicting movements or indications
For colour light signals to display a proceed aspect, opposing/conflicting signals need to be proved to be at stop and points in the route need to be set, locked and detected in the correct position.

2. A 'Token' system to ensure that 2 opposing trains cannot enter a single line section of track at the same time
In RCS territory, track circuits and axle counters are used to prove a single line section of track is clear of rail traffic. A corresponding proceed aspect in a running signal is proof that the track is clear of traffic. The 'Token' authority is the proceed aspect colour that is displayed to the driver. This is the driver's authority to enter that section of track and that there are no opposing trains.

3. An absolute space interval to be maintained between following trains
Block Sections are defined through the use of track circuits/axle counters. Block sections are setup at regular intervals along the track. Each section is proved clear and entry is controlled by a signal. Therefore, a safe space interval is maintained between following trains.

4. A braking system that can be applied by a driver or guard to every wheel of the train and which it automatically applies in the event of the train being inadvertently divided due to derailment or uncoupling
Signalling indications given to a driver must be directly related to the capabilities of the train braking system. This principle refers to the Westinghouse train brake system which can be either vacuum or compressed air operated. In Queensland the compressed air train brake system is used. It is a braking system that is continuous from the front to the rear of the train. The brakes can be applied by a driver, guard or automatically if a train becomes divided as a result of a undesirable situation.

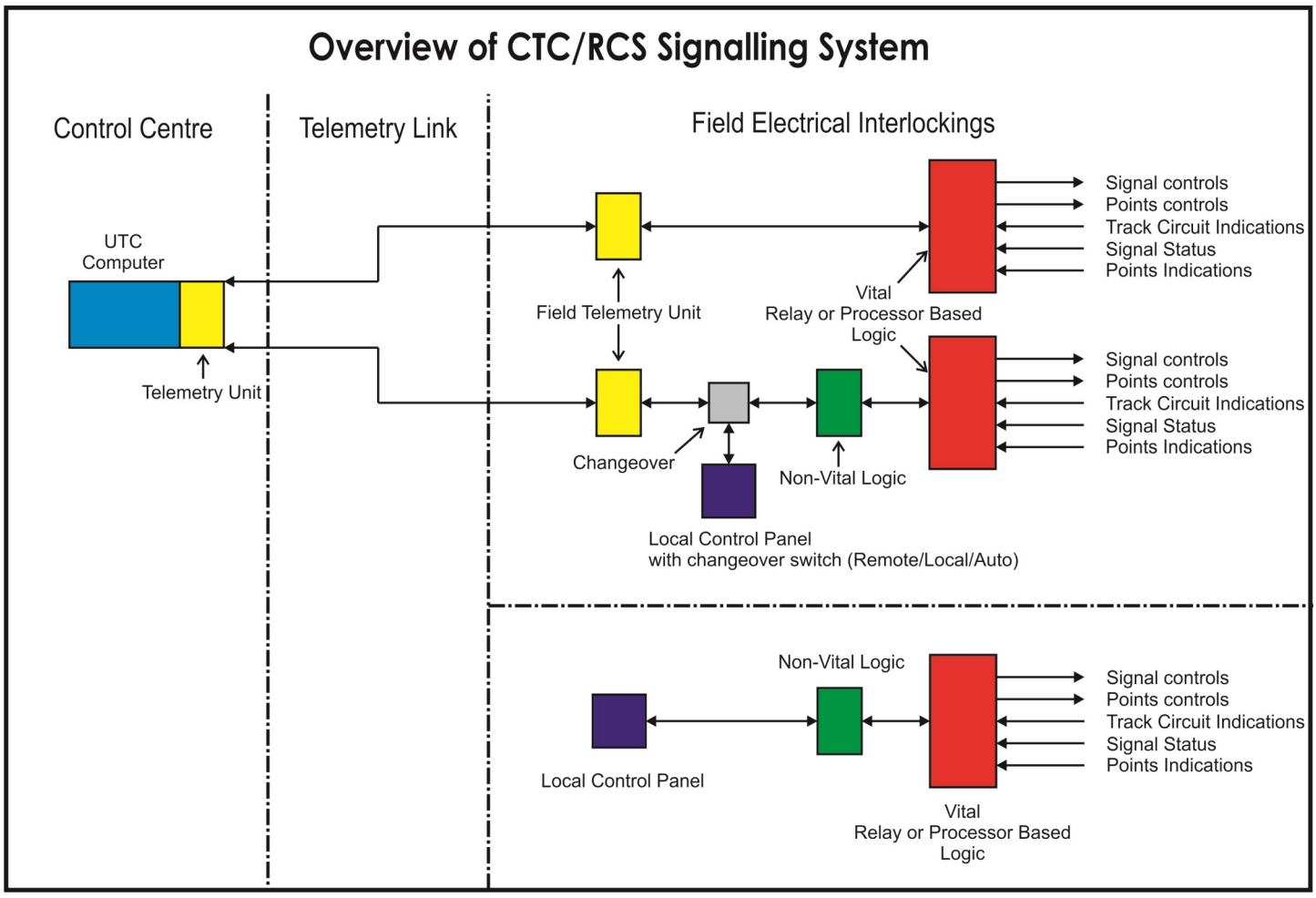
5. In the event of the signalling system or associated equipment failing, the safety of the system must be ensured
This is a very important aspect in the design of signalling systems. If any equipment used in signalling fails to operate in the way it was intended, an unsafe situation shall not be a result. The term used for this essential principle in the design of signalling equipment/ circuits is 'Fail Safe'.

3 way cross at Bundaberg

Meadowvale

2. Remote Controlled Signalling

Remote Controlled Signalling (RCS) is a form of safeworking that Queensland Rail (QR)/ Aurizon use to facilitate the safe control and passage of rail traffic over a given section of railway line. It works on the principle of allowing only one train on a section at one time. The exception to that principle is to allow for shunting of trains to occur. Trains are controlled by placing colour light signals at strategic locations such as junctions, crossovers, crossing loops, level crossings and stations. Points and signals are controlled by a Train Controller (now known as a Network Control Officer or NCO) located in a control centre, that can be hundreds of kilometres away from the field signalling equipment. The NCO manipulates points and signals via a Universal Traffic Control (UTC) computer. On the NCO's computer monitor, indications of the location can be viewed, such as track circuit occupancy, points detection and signal status. Centralised Traffic Control (CTC) was the predecessor to UTC. CTC was based on a control room located remotely from the field signalling equipment like UTC. However, controls and indications were displayed on mimic panels which could only be controlled from the that centre. UTC as the name suggests, can be operated from anywhere providing there is an internet connection to the control centre telemetry unit. UTC started replacing CTC in the mid 1990's.



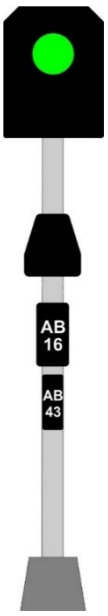
3. Types of Signal Authorities/Train Movements

Colour light signal authorities can be categorized in to 2 types:

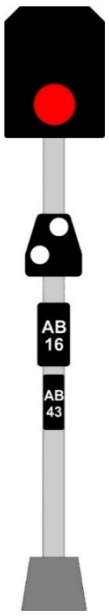
Running Signals and Shunt Signals

Running signals can be used to authorise a running manoeuvre or a shunting manoeuvre, whereas a shunt signal can only authorise a shunting manoeuvre.
Running manoeuvres are normally at the maximum allowable track speed for that section of track. Shunting manoeuvres are conducted at low speed (<25KPH).

It may seem obvious but trains can only travel in 2 directions and to differentiate the 2 directions, trains travelling in one direction are known as UP trains and trains travelling in the opposite direction are DOWN trains. As a result, signals are also named UP or DOWN depending on the direction of rail traffic they are facing. No matter whether a rail line is running East-West or North-South, each line has a designated UP and DOWN direction.



Running Signal



Shunt Signal

In RCS territory the big difference between the two types of proceed authorities is; a running signal authority indicates that the track beyond that signal to the next intervening stop signal has proved that the points have been set locked and detected for the intended route and that the track occupancy has been proved clear of all rail traffic. On the other hand, a shunt signal proceed authority only proves that the points have been set locked and detected for the intended route and does not prove that track occupancy is clear of rail traffic. The reason for this is obvious as shunt manoeuvres allow the amalgamation of rollingstock.
For running signal authorities, a driver of a train shall always be provided with one warning/caution signal prior to any signal that is at stop. With a shunt signal authority, it must be assumed that the next intervening stop signal is at stop.

3.1 Running Signals

A running signal can be any of the following configurations - 1, 2, 3 or 4 aspects. The following list shows the aspects that can be shown in running signals, (not all aspects can be shown in every signal as it will depend on numerous factors including location, purpose etc.). In all cases though the most restrictive aspect is always at the bottom of the signal head.

	Colour	Meaning
	Green	Proceed
	Flashing Green	Proceed- Signifies a change from Remote Controlled Signal territory to another form of safeworking (e.g. Direct Traffic Control or Staff and Ticket). Must have the new authority of the applicable safeworking territory before proceeding.
	Double Yellow	Caution- Proceed, expect to find the next signal to be a Yellow (Or the next but one signal is at stop) Double Yellows are confined to the Brisbane Suburban Area (BSA).
	Yellow	Caution- Expect the next signal will be at stop. Proceed with caution and prepare to stop prior to the next Stop signal.
	Flashing Yellow	Special Caution- Proceed at a speed not exceeding 40km/h to the next Stop signal. This aspect is displayed if certain conditions are present, such as any of the following: • Points beyond the next stop signal are set against the train and or the track immediately beyond the next stop signal is occupied by another train. • Shunting movements are being carried out on an adjacent line • Level Crossing equipment has not operated
	Red	Stop

3.1.1 Controlled or Non Controlled

Running signals can be broken up into 2 sub categories of being either Controlled or Non Controlled.

Controlled- These signals are controlled by an officer in charge/Network Control Officer

Non Controlled- These signals are operated by the detection of trains by means of track circuiting

Despite these 2 categories of signals, in certain situations/locations they can be taken out of their normal state of control to allow for the opposite function to be carried out. Examples include shunting purposes near level crossings and worksite protection.

Moura Mine

Example of a Controlled Colour Light Signal. These signals (Both Running & Shunt) are controlled by a Network Control Officer located in the Rockhampton Network Control Centre. At some locations provision is made to allow Train crew (now known as Rail Traffic Crew or RTC) to operate signals using Emergency Push Buttons. This only occurs during a telemetry failure where the NCO can't operate the signals and permission is given to train crew to use the Emergency Push Buttons.

Ebbw Vale Station UP Road Automatic/Non Controlled Signal

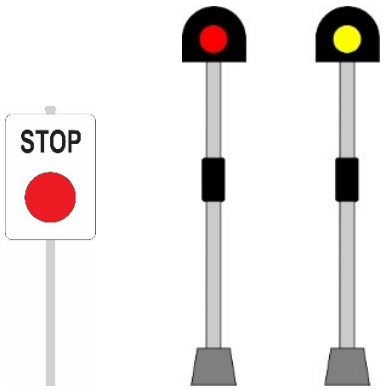
Example of a Non Controlled Colour Light Signal that operates by detection of rail traffic via track circuits.

Lakes Creek Rd/Emu Park Rd Level Crossing

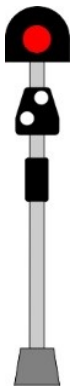
Example of Non- Controlled Colour Light Signal that can be controlled by “throwing” the signal lever to Stop and therefore disabling the level crossing for shunting purposes. Under normal operation, this signal will clear to a proceed when the level crossing protection activates with an approaching train. This particular signal is located in a Staff & Ticket Territory , however it demonstrates the theory of being able to change it from a Non Controlled to a Controlled signal.

3.1.2 Single Aspect Signals

There are only 2 colours possible in a single aspect signal, either a Red or Yellow.
A single Red aspect can be used to protect the end of a line in lieu of a stop board or in conjunction with a set of stop blocks/buffer stops. But their primary use is in conjunction with a subsidiary shunt/position light signal attached to the same signal post.
Although not a colour light signal, a Stop Board is also considered to be a running signal that is permanently fixed at stop. They can be installed anywhere and will usually have another sign below the stop board with safeworking instructions.
A Single Yellow aspect is used only as a permanent caution to the next signal.



Stop Board, Single Aspect Red or Yellow Signal



Single Aspect Red Signal with Subsidiary Shunt Signal

Stop Board

Single Aspect Red

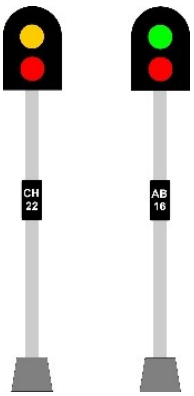
Single Aspect Red with Sub Shunt Signal

3.1.3 2 Aspect Signals

There are 3 different configurations possible with 2 Aspect signals: Yellow and Red
Green and Red
Green and Yellow

Yellow and Red 2 Aspect signals are used primarily as an intermediate type signal in large yards. An example is Callemondah, which has numerous 2 aspect Yellow and Red signals. Another example includes leaving a siding on to a mainline like the Dinmore Cattle Siding.

Green and Red 2 Aspect signals can be used as Starter (Absolute Block -AB) Signal, Cane Railway Crossing Stop Signal, Level Crossing Protection Stop Signal.

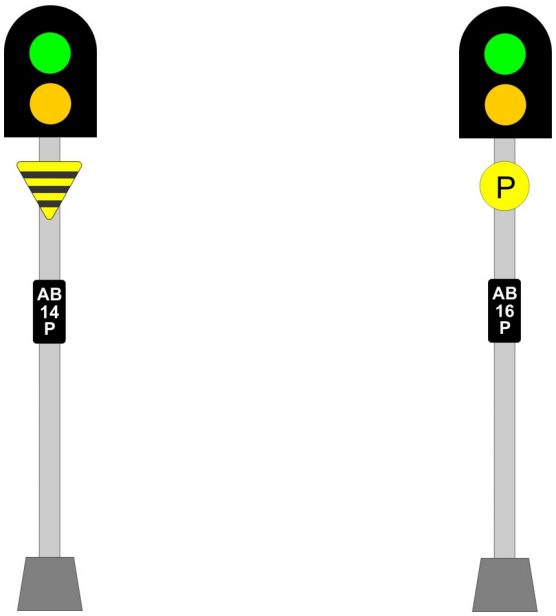


2 Aspect Stop Signals Yellow/Red & Green/Red

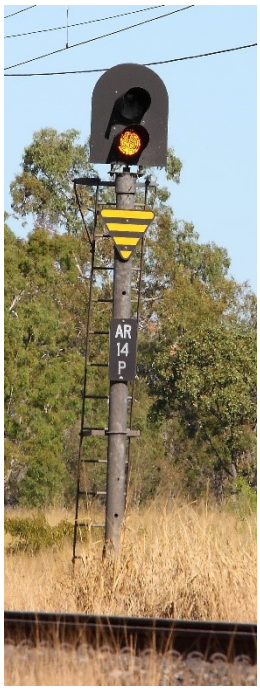
2 Aspect Yellow/Red Signal

2 Aspect Green/Red Signal

Green and Yellow 2 Aspect signals can have 2 purposes, either as an approach signal or a repeat signal. The only way to tell the 2 apart is by the sign that is mounted below the signal head. The difference will be covered later in the document.



2 Aspect Approach and Repeat Signal



Approach Signal

Repeat Signal

3.1.4 3 Aspect Signals

The only configuration possible in a 3 aspect signal is Green, Yellow and Red.
3 Aspect Signals can be used as Automatic, Home, Intermediate, Starter (if Advance Starter is installed) or Double Track Starter Signals (if fitted with a Junction Route Indicator).

3.1.5 4 Aspect Signals

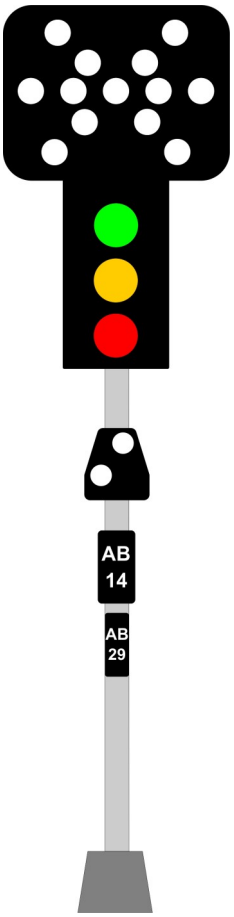
The only configuration possible in a 4 Aspect signal is Yellow, Green, Yellow and Red.
4 Aspect Signals are confined to the Brisbane Suburban Area and are used to reduce the distance between 2 trains travelling in the same direction on the same line. (known as Headway). This will be explained later in the document.

3.1.6 Junction Route Indicators

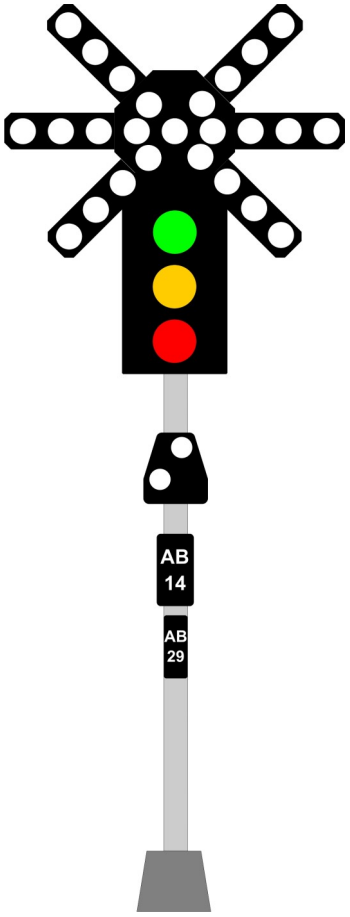
As the name suggests Junction Route Indicators identify the route which has been set for the passage of a train.

Junction Route Indicators (JRI) are a series of white lights that come off at an angle to the top of a main signal head. They can be either a 3 Lunar Light JRI or a 5 Lunar Light JRI and can be fitted to any 2, 3 or 4 aspect stop signal. More than 50% of the JRI lights for the particular position need to be proved to be working, for a proceed indication to be given in the main signal. This is to ensure that a clear indication of the intended route is displayed to a driver. Signals that have more than one JRI share the light directly above the main aspects (known as a pivot light). JRI's can be used with either running or shunt signal authorities. For running signals, the JRI will be displayed with a yellow aspect to indicate caution.

At some locations provision is made for the running signal to step up to a green providing the next signal is displaying a proceed aspect too.

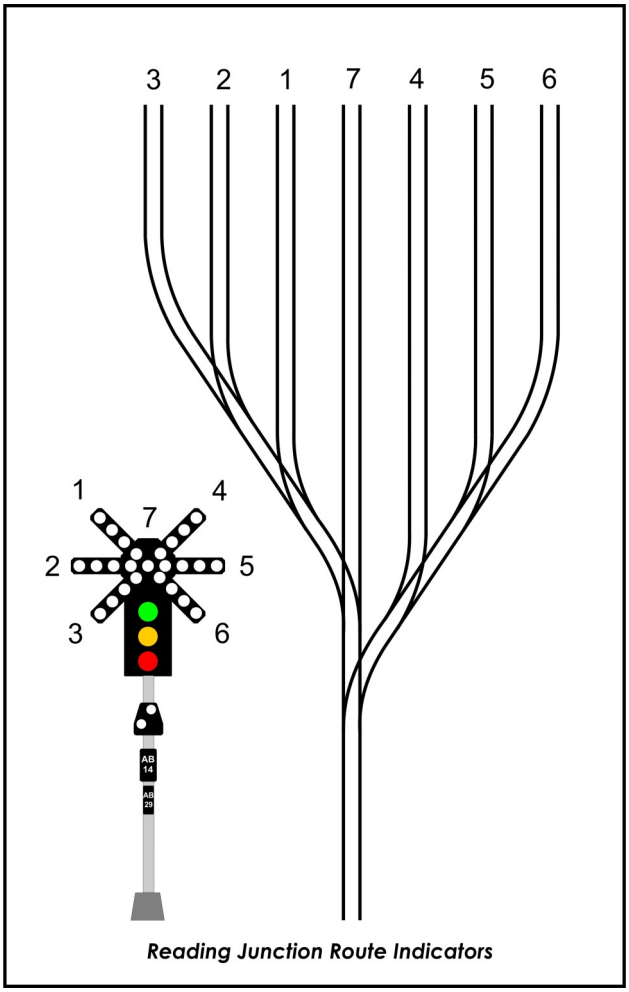


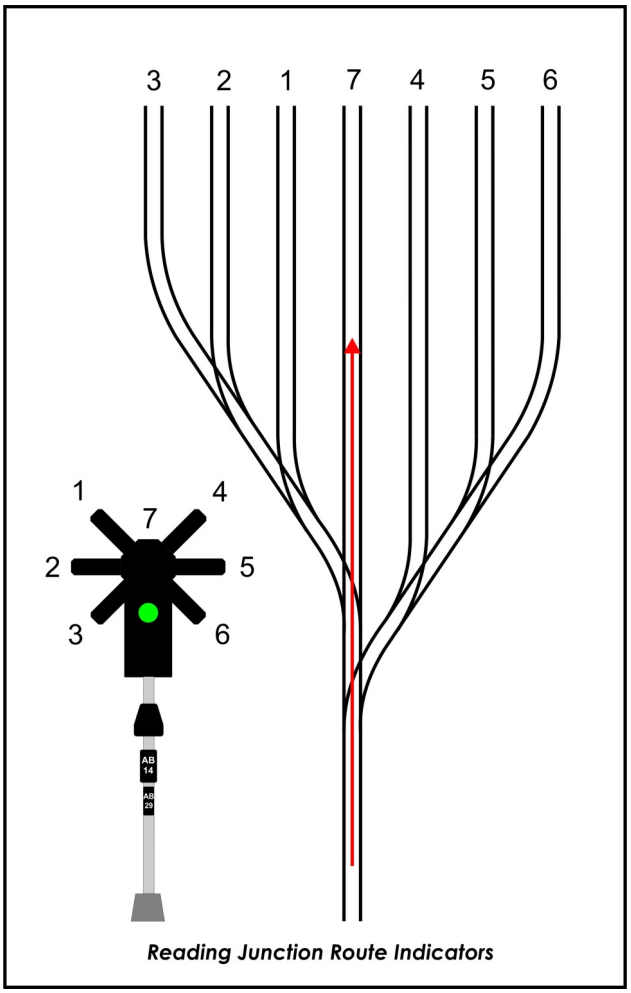
3 Lunar Light JRI



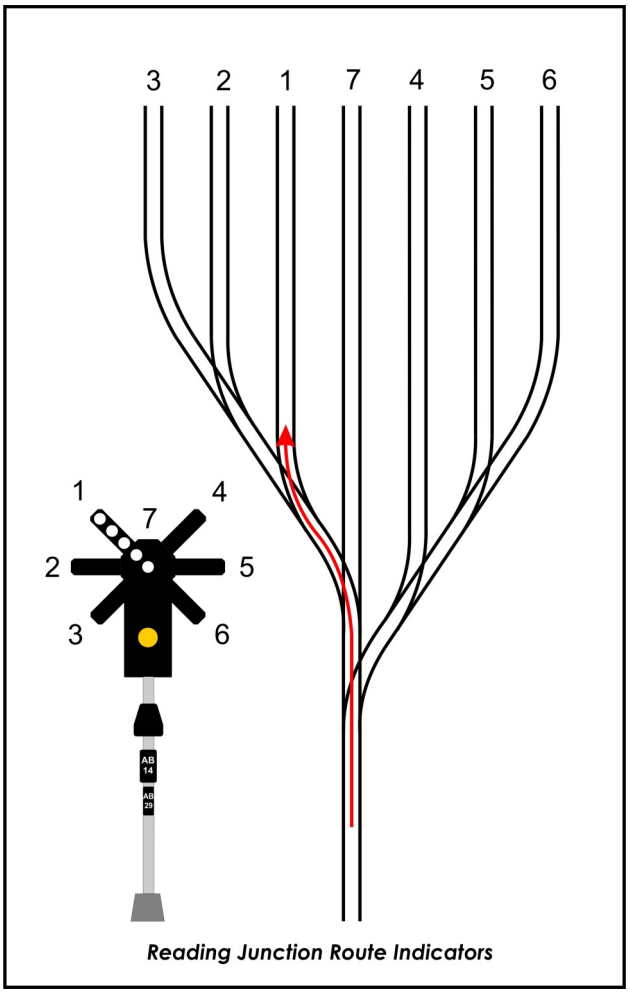
5 Lunar Light JRI

As can be seen in the diagram on the following page, signals fitted with JRI's are limited to 7 potential routes, a mainline/straight ahead, 3 routes to the left and 3 to the right.

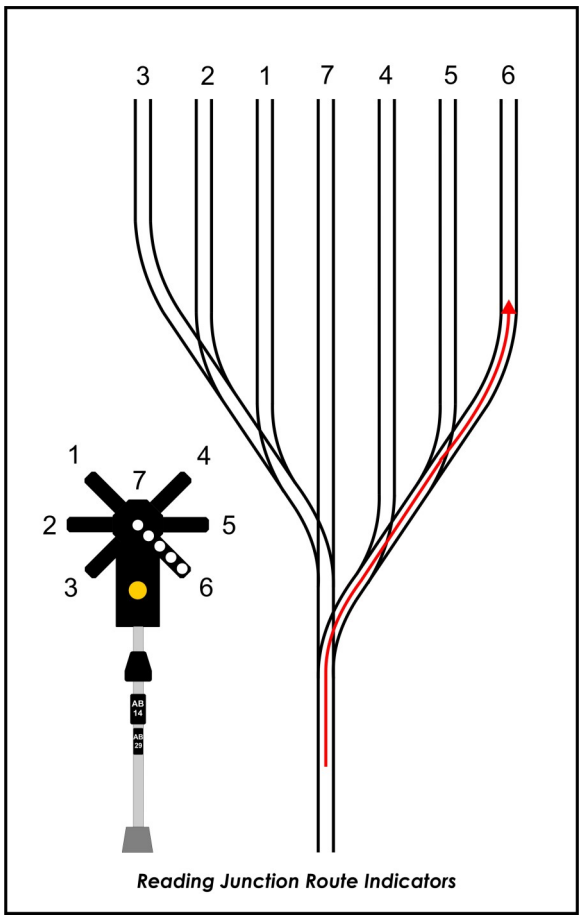




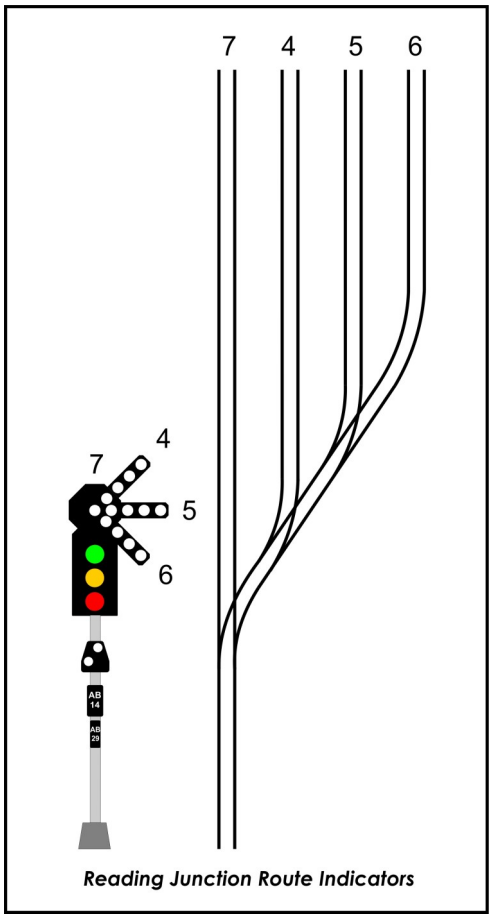
Mainline Position 7



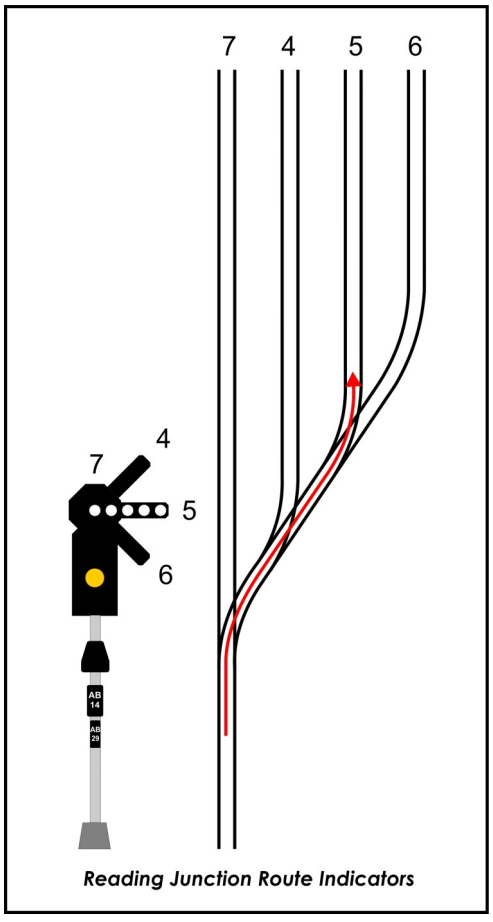
First Route to the left – Position 1



Third route to the right – Position 6



Routes position numbers stay the same



Second route to the right Position 5

3 Aspect Signal with JRI (Position 1)

3 Aspect Signal with JRI (Position 1)

3 Aspect Signal with JRI (Position 4)

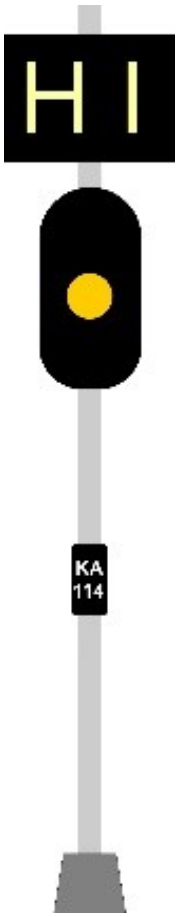
3 Aspect Signal with Multiple JRI (Position 1 & 4)

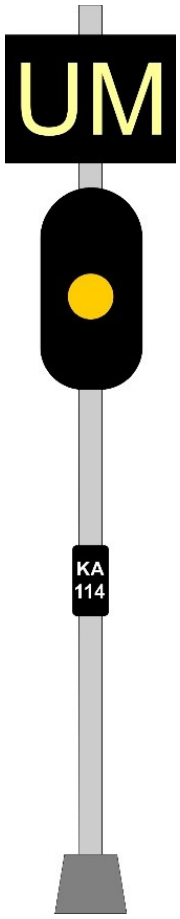
3 Aspect Signal with Multiple JRI (Position 1, 4 & 5)

3 Aspect Signal with 3 Lunar Light JRI (Position 1)

3.1.7 Route Indicators

Route Indicators can be attached to running signals, siding signals and position light signals. Their purpose is to identify the route for which a train is to take, but unlike a Junction Route Indicator they are not limited to a maximum of 7 routes. They can comprise either numbers, letters or an alpha numeric indication. A proceed indication in either a running or shunt signal must also accompany the route indication.



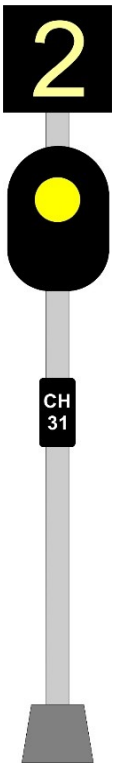


Holding Road #1 **Up Main**

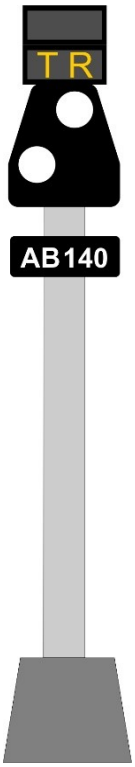
3 Aspect Signals with Route Indicators

No. 3 Road **Loop**

3 Aspect Signal with Route Indicator



2 Aspect Signal with Route Indicator
Road # 2



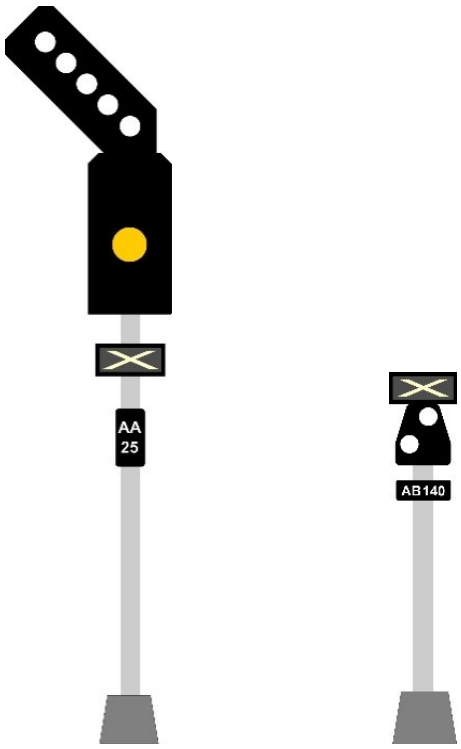
Position Light Signal with Route Indicators
Through Road

3 Aspect Signal with Route Indicator

Position Light Signal with Route Indicators

3.1.8 Non Wired Route Indicator

In electrified territories not all routes are ‘wired’ for passage of electric trains. Signals that authorise entry into a route that are not wired will have a Non Wired Route Indicator mounted on the signal. When a signal is cleared for a non-wired route, a white X will be displayed in the indicator along with the relevant proceed authority. If the signal is cleared for a route that is ‘wired’ the X will not be illuminated. Electric trains are not to proceed past the signal if the Non Wired route indicator is illuminated. Unless there are local instructions allowing an electric train to proceed past for shunting purposes.

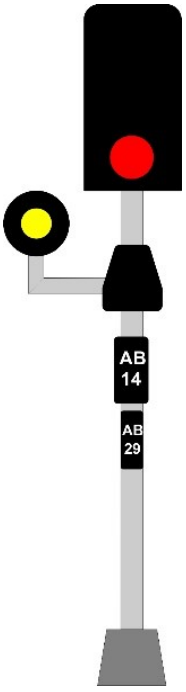


Non Wired Route Indicator fitted to Running and Shunt Signals

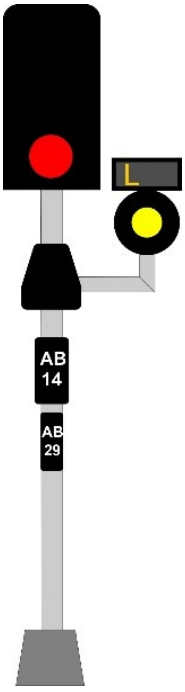
Non Wired Route Indicator - Not Illuminated

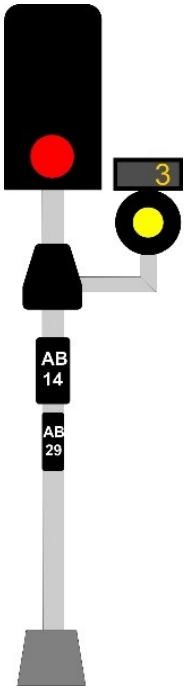
3.1.9 Siding Signals

Siding signals (or Offset Yellows) are another form of colour light signalling that indicate a diverging route off a mainline into either a loop line or siding. They consist of a single yellow aspect signal mounted on a bracket off a main running signal post. The red aspect must be proved to be working before the siding signal can be given. Otherwise if the main signals red aspect is not working and the offset yellow is lit, it could be confused (particularly at night) to be a straight yellow pertaining to mainline running when in fact it pertains to a diverging route which in some cases could be a speed significantly lower than the main line speed. If a single offset yellow signal pertains to multiple routes, a route indicator will be mounted on top of the main signal, siding signal or separately mounted.



Siding Signal to the left

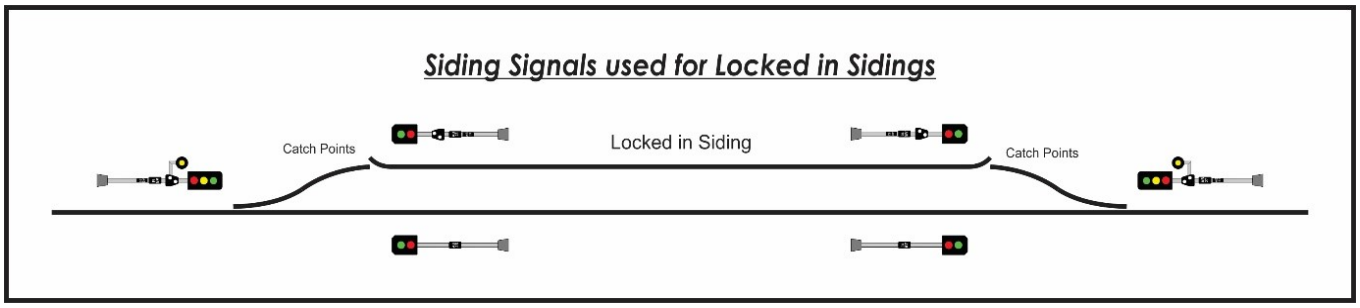




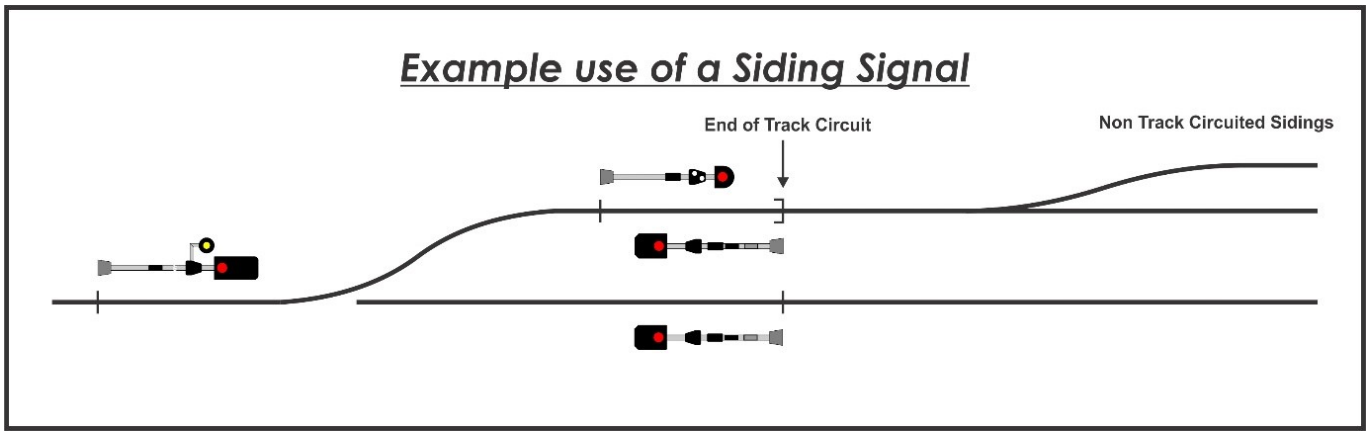
Siding Signal to the right L (Loop) and 3 (3rd Road)

3 Aspect Signal with Siding Signal (Offset Yellow)

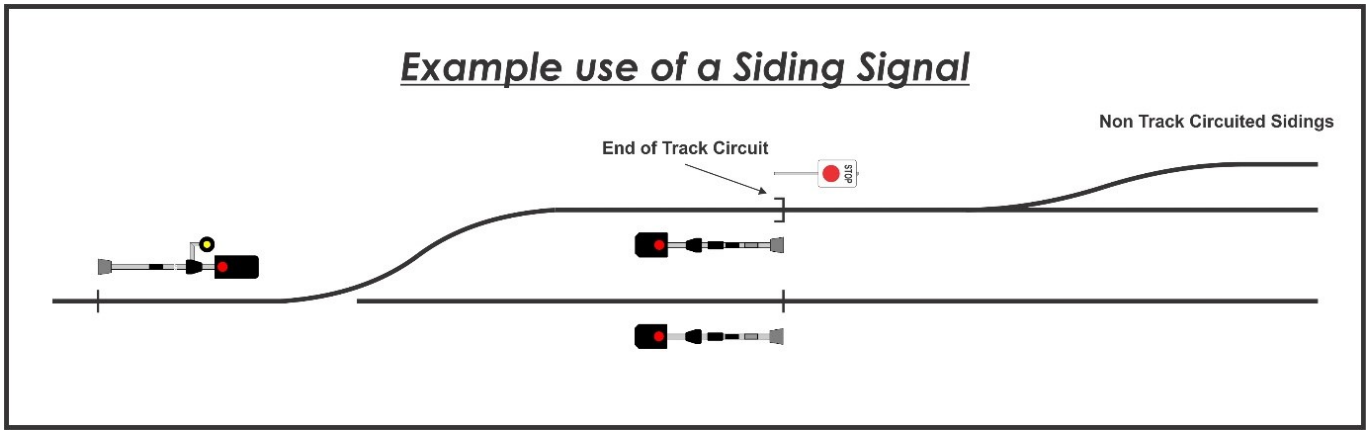
The term siding is used loosely with these signals. The definition in standards used by the railways describe a siding as a section of track other than a running line, used for shunting and storage of rollingstock. However, the most common use for siding signals in Queensland is to provide an entrance signal into crossing loops. Siding signals are used extensively on the North Coast Line between Rockhampton and Townsville, as well as crossing loops on the Toowoomba range. On the other hand, loops with catch points either end (locked in siding) are considered to be a siding used for storage. Examples of Siding Signals for loops fitted with catch points include, Dinmore Cattle Siding, Bluff 4th and 5th roads, Gladstone 3rd road, Bororen 3rd road, North Bundaberg Loop (Prior to 2013 Flood), Maryborough West 5th road, Palmwoods 3rd Road (Buderim Loop).



When these signals are used for entering an actual siding (such as a freight yard / loading point), it is still a running movement. So the signalling system needs to prove that the track beyond the siding signal is proved clear of rail traffic. Therefore a signal is placed at the end of track circuit like a shunt signal or STOP board. A shunt signal authority or permission to pass a STOP board is required to enter a siding that is not proved clear by the use of track circuits. The following diagrams show an examples of this scenario.



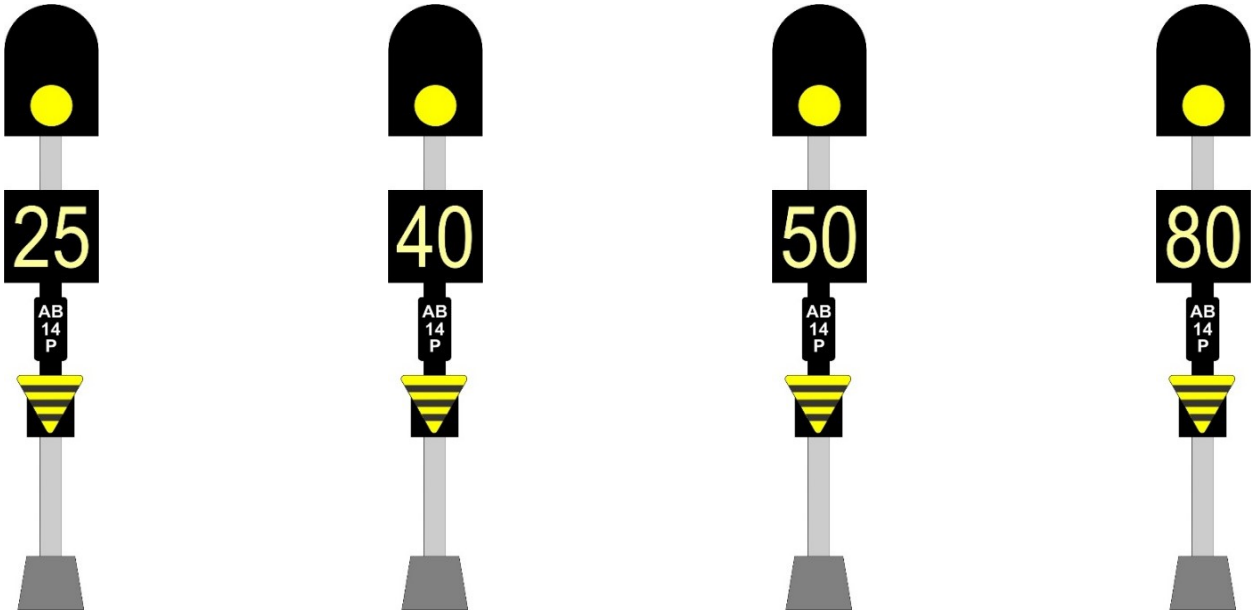
Entering a siding fitted with Stop Signal and Sub Shunt



Entering a siding fitted Stop Board

3.1.10 Dynamic Speed Indicators

Dynamic Speed Indicators (DSI's) are a numerical indicator that can be fitted below a 2, 3 or 4 aspect signal. A 2 aspect signal that is fitted with a DSI must be capable of displaying a yellow aspect (Yellow/Red or Green/Yellow). They are used to indicate the maximum entrance speed at the next signal. This could be because a diverging route is to be taken at the next signal or a safe speed for a driver to confirm the aspect shown in the next signal. It also indicates to a driver that the next signal is at proceed.
Possible speeds (in km/h) capable of being displayed in a DSI include, 25, 40, 50 or 80. Not all DSI's can show every speed, as it will depend on the location, distance between the next 2 signals, and or diverging route speed. A DSI will only be shown with a Yellow aspect in the main signal and will not be shown if the next signal is at red.



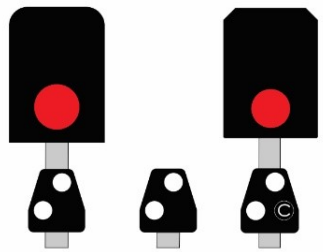
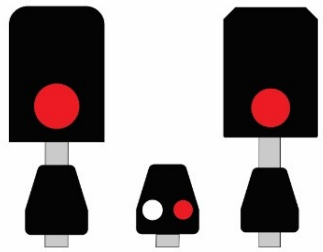
DSI fitted below an Approach Signal

DSI fitted below a 3 Aspect Signal

3.2 Shunt Signals

Shunts signals (also known as Position Light Signals) can be either a 2 or 3 aspect signal. A 2 aspect shunt signal (Subsidiary Shunt) displays 2 white lights at 45-degree angle and can only be used when it is attached to a main running signal capable of displaying a red aspect. Whereas a 3 aspect shunt signal has the same 2 white lights as well as a single red aspect opposite the bottom (pivot) white light. 3 aspect shunt signals are used as a standalone signal.

Unless accompanied with a Route Indicator, Shunt/Position Lights do not indicate the way in which points are set and therefore the route of which is to be taken. They also do not prove that the track in advance is occupied or not, so it must be expected that the track ahead is occupied.

	Colour/ Indication	Meaning
	2 White lights at a 45 degree angle 2 White lights at a 45 degree angle and a White Letter C in bottom right lens	Proceed at Restricted speed (max 25Kph) as far as the line is clear or to the Limit of Shunt Board or the next intervening stop signal. Calling On Signal - Proceed as far as the track is clear or to the next stop signal or as instructed by the officer in charge.
	Red Aspect or a White and Red aspect horizontally	Stop

2 Aspect Sub Shunt Signal

3 Aspect Position Light Signals

3.2.1 2 Aspect Subsidiary Shunt/Position Light Signal

As described earlier subsidiary shunt/ position light signals only have 2 white aspects and they have to be attached to a main running signal capable of displaying a red aspect. So a repeat or approach signal cannot have a Sub Shunt/Position Light signal fitted to them. They are widely used to allow shunting manoeuvres past a Stop Signal.

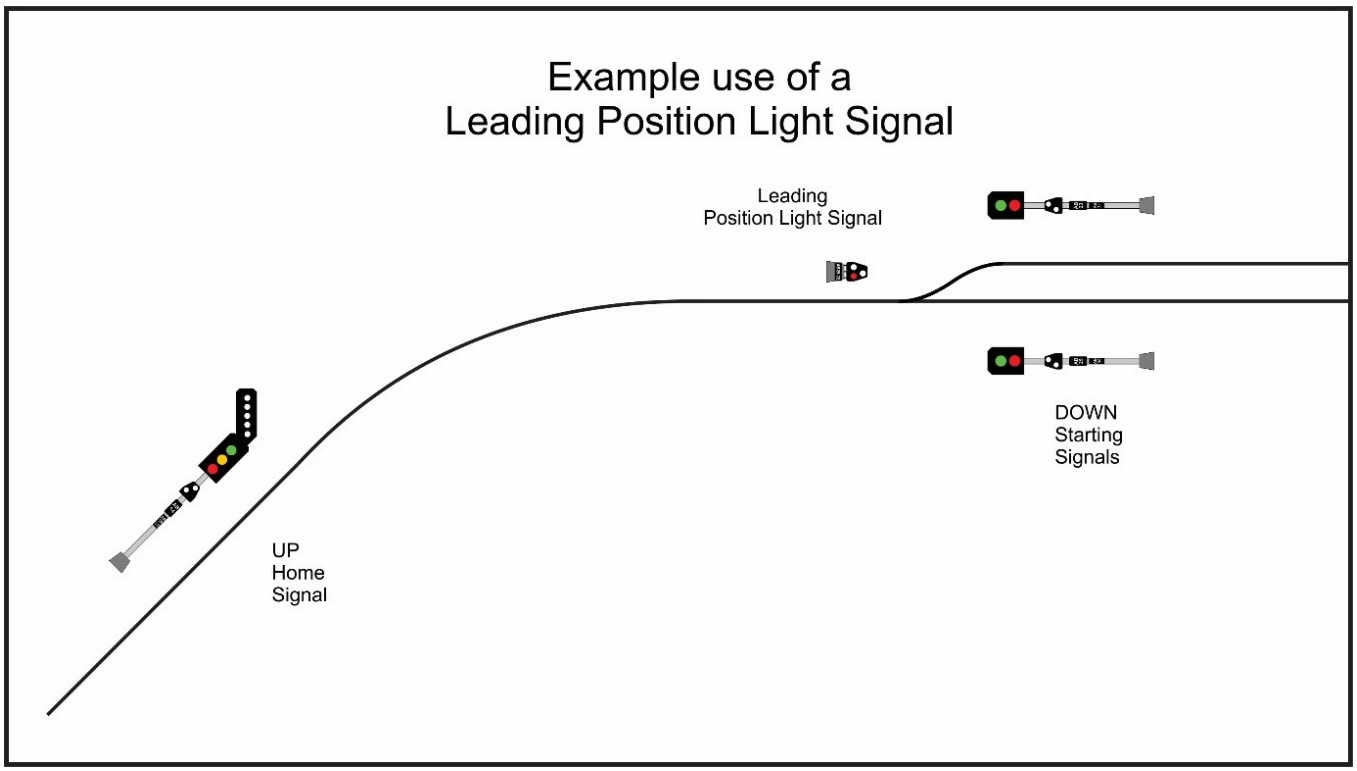
3.2.2 3 Aspect Standalone or Leading Shunt/Position Light Signal

3 Aspect Shunt Signals can be used for 2 purposes, either as a standalone signal or as a Leading Shunt/Position Light Signal.

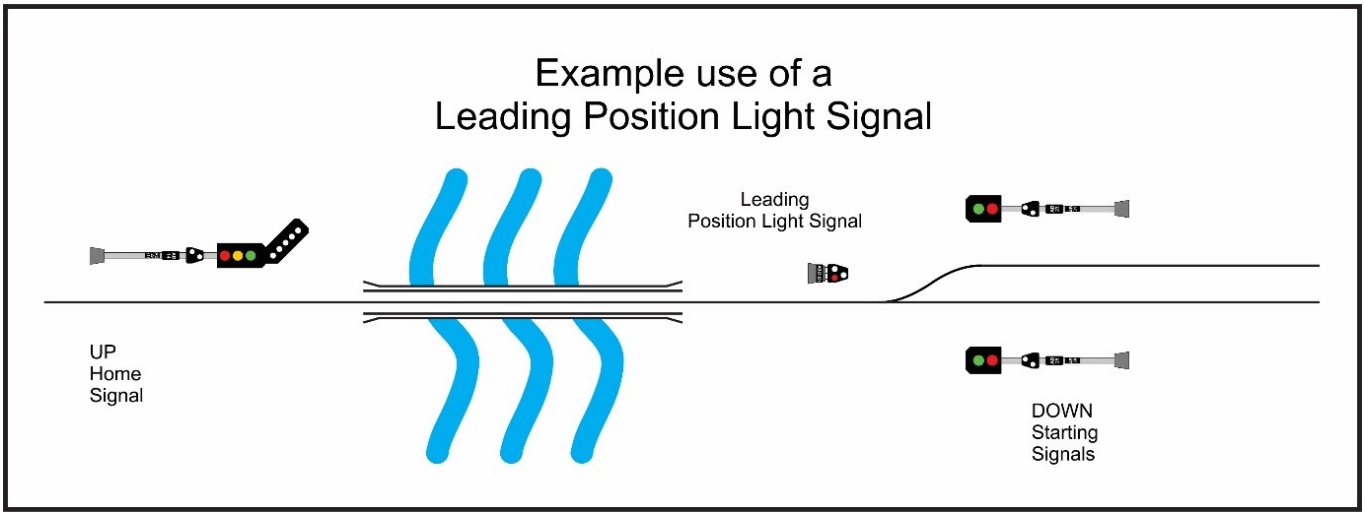
Standalone Position Light Signals can be used as entrance signals to sidings to which a running signal cannot permit. They can also be used to permit the exiting of a siding back on to a main line.

Leading Shunt/Position Light Signals are still considered to be standalone signals, but unlike other standalone signals they can be used for either a running or shunting movement. Leading Position Light Signals are located between two main running signals (usually prior to a set of points). The main reason they are used, is to allow shunting manoeuvres to be conducted without the need to clear the whole train past a running signal and then set back into another road. Locations for their use include: running signal located a large distance from a set of points (for example around a curve for better visibility), bridge or road crossing located between the running signal and a set of points.

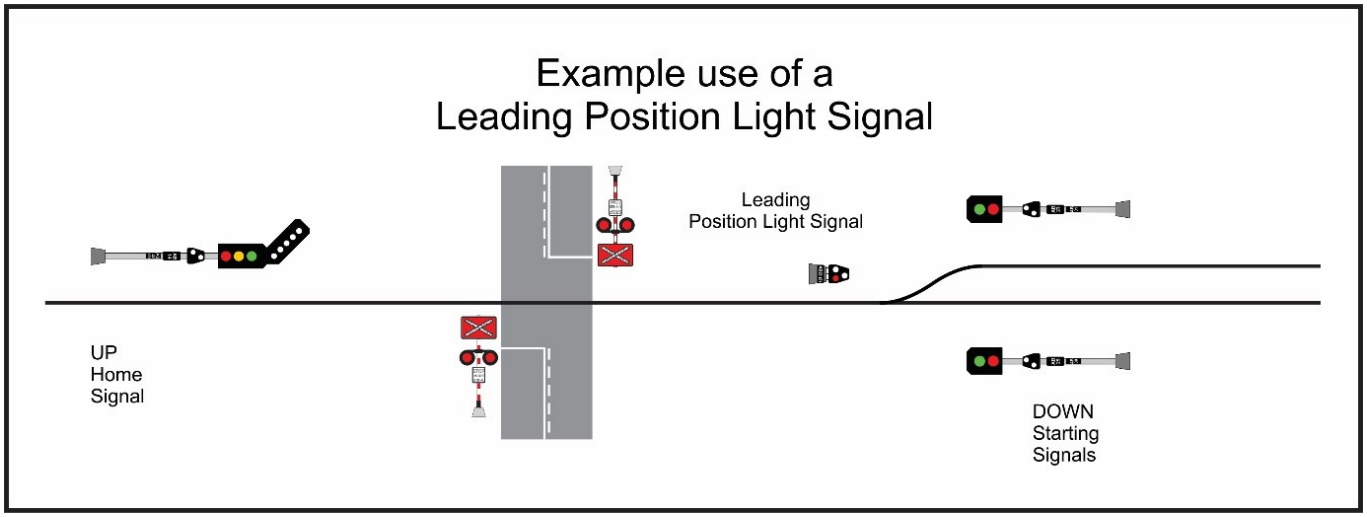
The following diagrams help demonstrate the reason for Leading Position Light Signals.



Running signal located prior to a curve for better visibility

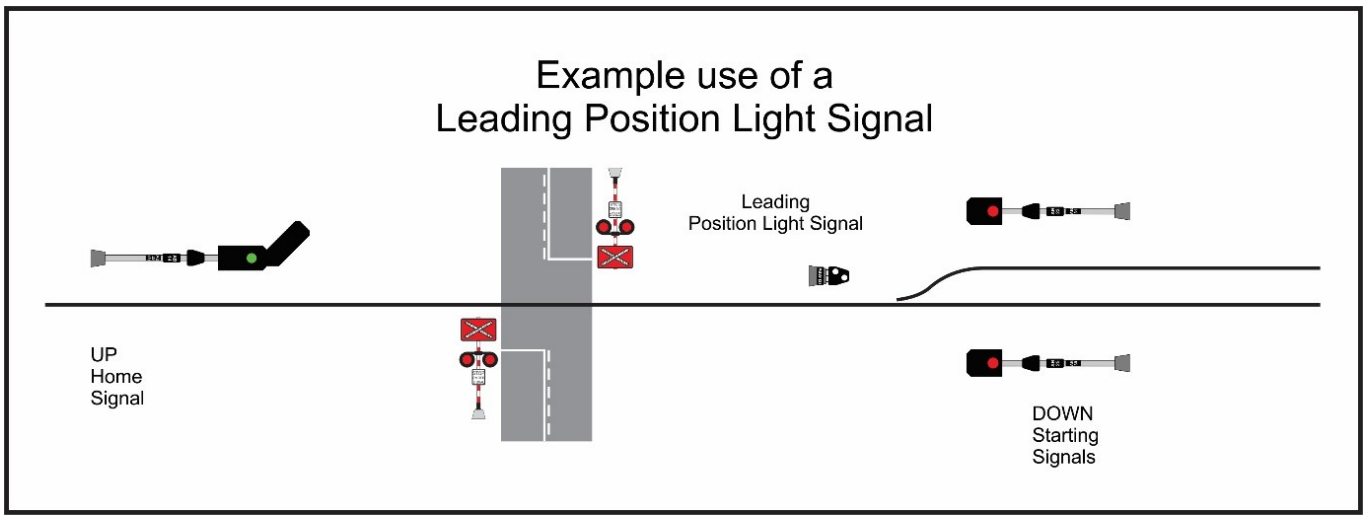


Bridge located between Running Signal and Points

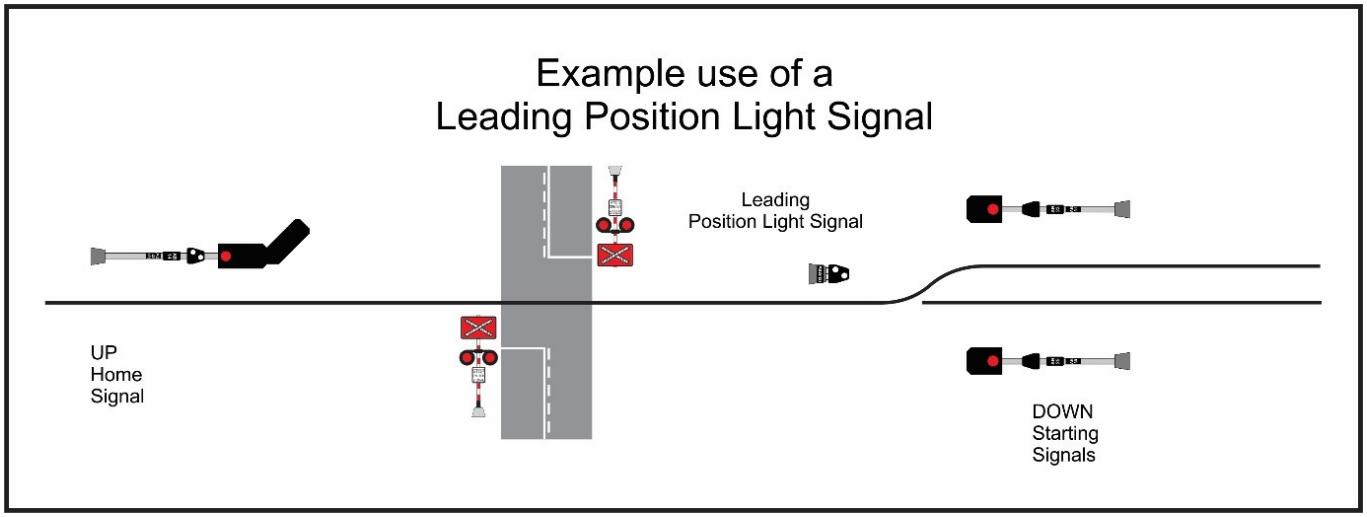


Level Crossing located between Running Signal and Points

When used as a running signal, the main running signal preceding it proves that the track ahead is clear of rail traffic, whereas when it is used as a standalone shunt signal track occupancy is irrelevant.

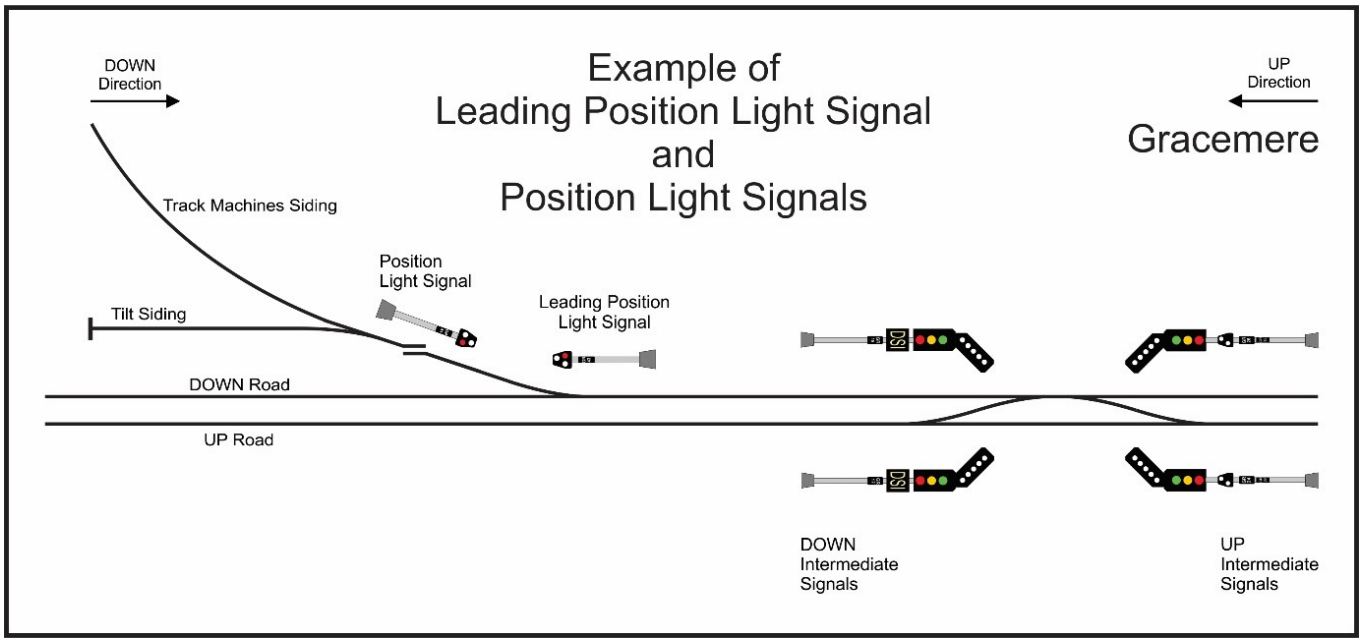


Leading Position Light Signal used as a running signal

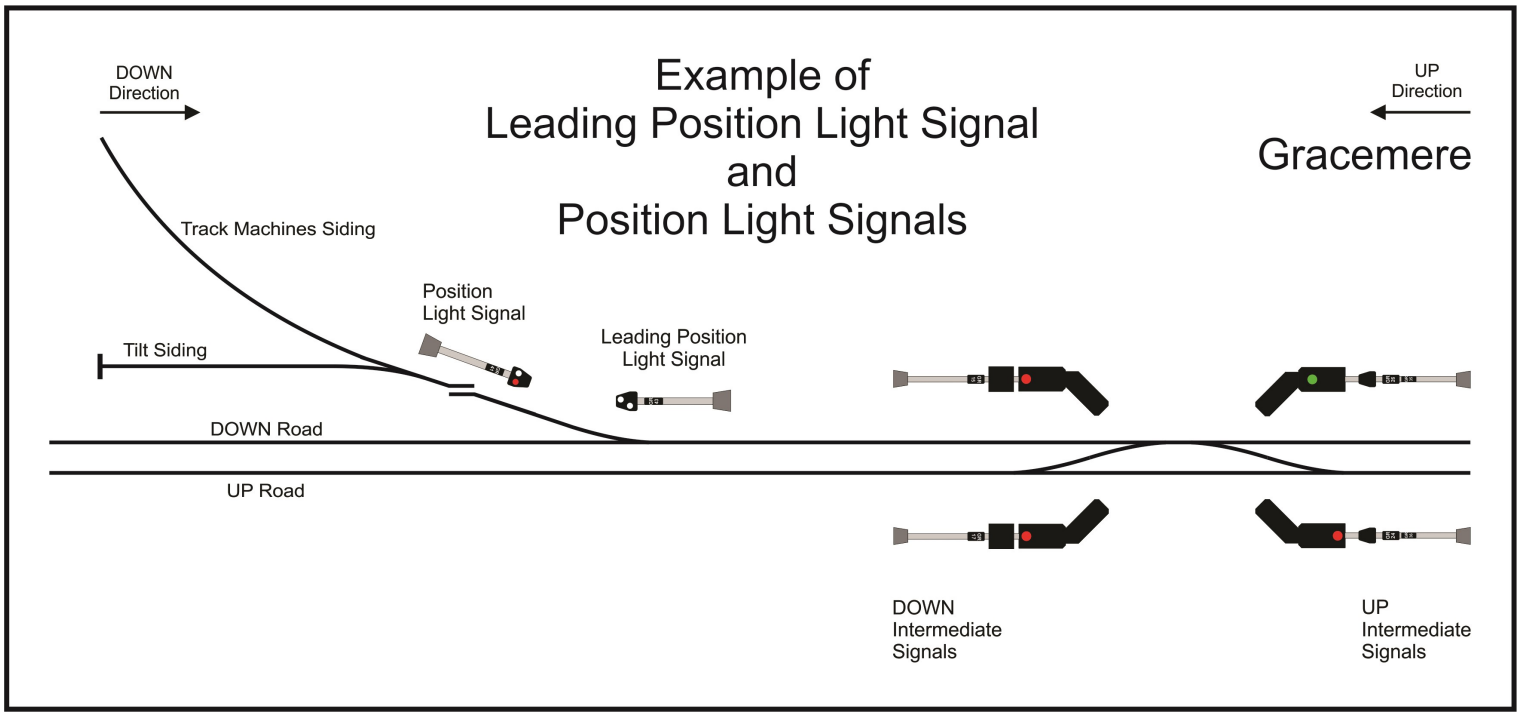


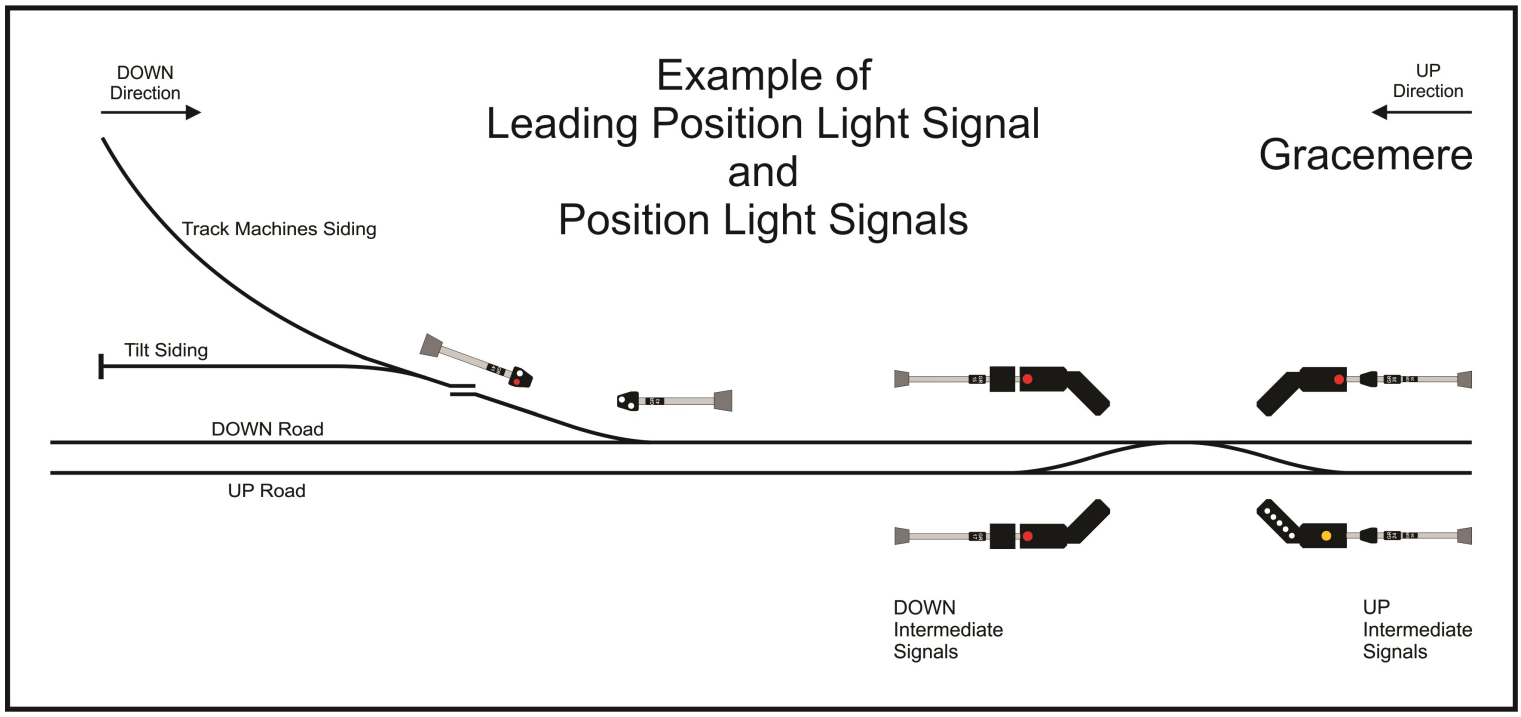
Leading Position Light Signal used as a shunt signal

The diagram below shows both a standalone and a leading position light signal. Both signals are considered to be a standalone position light signal but only the one on the down road is considered to be a leading position light signal.

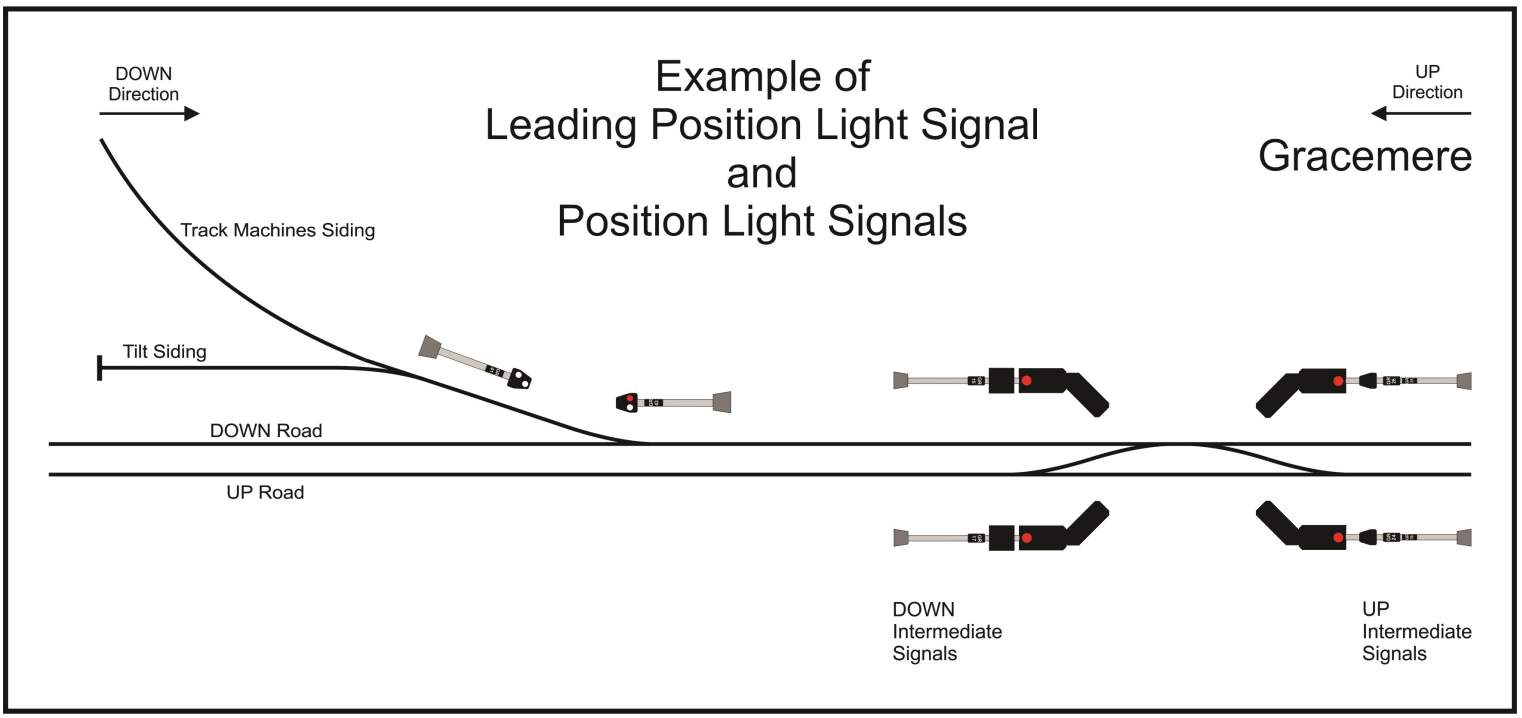


The diagrams below show the Leading Position light signal cleared when a running signal pri-or (Up Intermediate) is cleared as well.





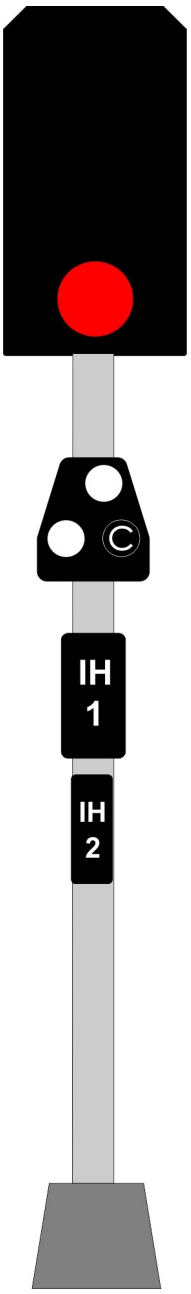
The diagram below shows the Position Light Signal for the siding cleared on to the down road. Based on this indication to a driver, the train may travel as far as the line is clear, to a Limit of Shunt board or to the next intervening Stop signal. In this case a train exiting the siding could travel as far as the Down Intermediate signal which is at Stop.



3.2.3 Calling On Signals

Calling On Signals operate in the same way that a 2 aspect Subsidiary Shunt signal works. They are mounted below a main running signal capable of displaying a Red aspect. Points are proved to be set locked and detected, but track occupancy is not known. So it must be assumed that the track ahead is occupied. When proceeding on a Calling On signals authority, drivers are to proceed as far as the track is clear up to the next intervening Stop signal or told to stop by an officer in charge.

There are a few examples left and they are mainly in Brisbane, such as Roma St, Mayne and Ipswich. They used to close up trains on the same platform or to amalgamate two 3 car suburban sets in to a 6 car set.



4. Types of Signals at RCS Crossing Loop Stations

Approach Signal – Typically a 2 Aspect Green/Yellow Signal located at braking distance before the Home (or Outer Home if installed or any standalone stop signal) signal. Can be fitted with a Dynamic Speed Indicator (DSI). Signified by a yellow and black upside down triangle sign known as a Beacon. A green aspect indicates that the next signal is at proceed. A yellow or flashing yellow aspect indicates that the next signal is at stop. At some stations an Approach Beacon may be used in lieu of a 2 aspect colour light signal (numerous stations between Rockhampton and Townsville feature approach beacons only). Approach Beacons are the equivalent of a single aspect permanent yellow approach signal.

2 Aspect Approach Signal

Approach Beacon

Outer Home Signal - Typically a 3 Aspect Green/Yellow/Red located prior to the inner Home Signal. If installed, the Outer Home signal is the first signal to permit entry into a station yard.

Down Outer Home Signal

Up Outer Home Signal

Home (Inner) Signal - Typically a 3 Aspect Green/Yellow/Red located prior to the yard proper. Can be fitted with JRI's, Siding Signals, Route Indicators, DSI and /or Position Lights. Home signals define the start of a station yard and therefore permit entry into a station yard.

Down Home Signal

Intermediate Signal – Typically a 3 Aspect Green/Yellow/Red located prior to a set of points/crossover or level crossing or cane railway crossings in the middle of a yard. Can be fitted with JRI's, Route Indicators, DSI and/or Position Lights.

Up Intermediate Signals

Starting Signal – Can be either a 2 Aspect Green/Red or a 3 Aspect Green/Yellow/Red if there is an Advance Starting Signal or double track prior to crossovers. Located prior to the end of a yard. Can be fitted with JRI's (if double track) and/or Position Lights. Starting signals in CTC days were known as AB Signals (Absolute Block) and they permit entry into a block section, hence now they are the starter on to a block section.

Mainline and Loop Starting Signals

Loop Starting Signal

Advance Starting Signal – A 2 Aspect Green/Red located on the mainline after the yard proper. If installed these are the entry signal into a block section.

Up Advance Starter Signal

Down Advance Starter Signal

Repeat Signal – 2 Aspect Green/Yellow Signal signified by a yellow disc with a black letter P. These signals are placed prior to any stop signal that has reduced sighting distance due to the track curvature, cutting etc. Other locations for use include; where there are stop signal/s fitted to adjacent lines and no stop signal is present on another adjacent line. For continuity of signals a repeat signal is installed.

The significant difference between an approach and repeat signal, is that a repeat signal is not located at braking distance to the signal it is repeating.

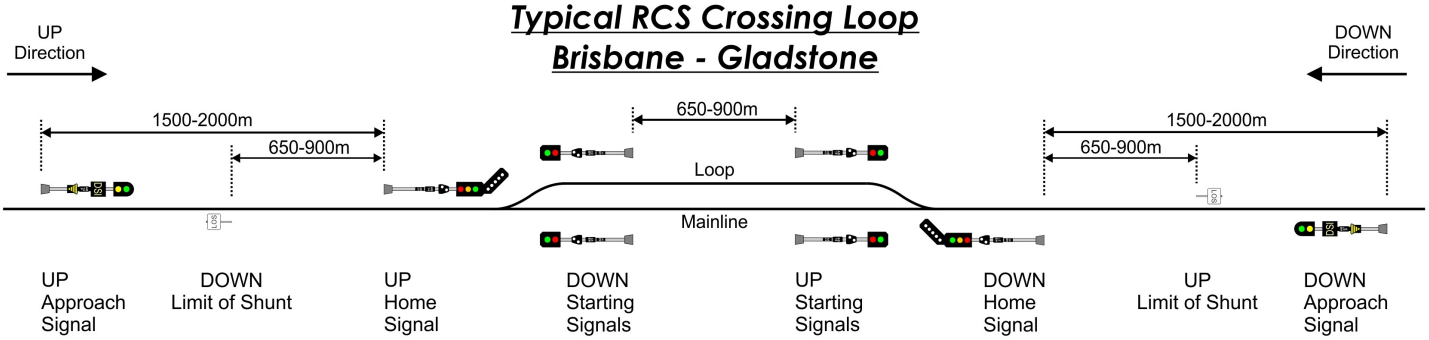
A green aspect indicates that the signal it is repeating is at proceed. A yellow indicates that the signal it is repeating may be at stop, be prepared to stop at the next signal. A Flashing yellow indicates that the next signal is at stop, prepare to stop prior to the next signal.

Loop and Mainline Repeat Signals
Repeating Starting Signals due to reduced sighting distance)

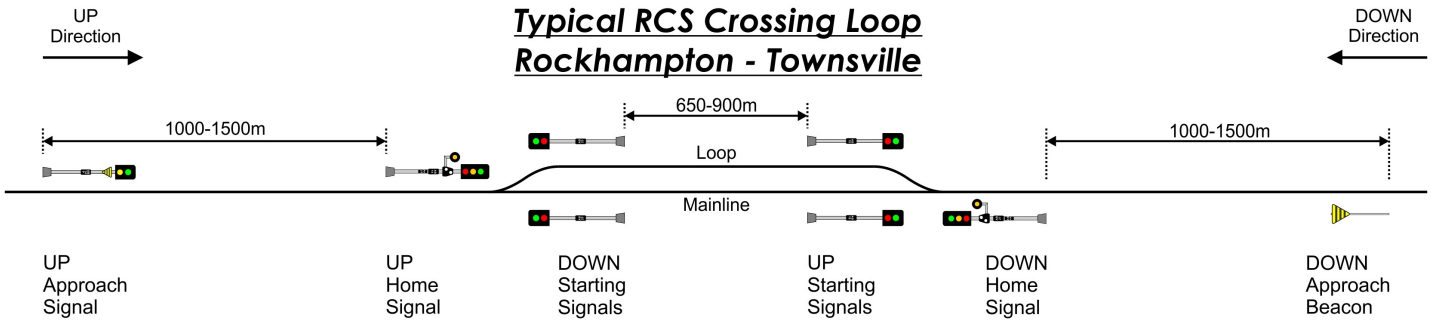
Repeat Signal on mainline only, for continuity of signals

The following diagrams show typical signalling arrangements for single track crossing loops and double track crossing locations in regional areas.

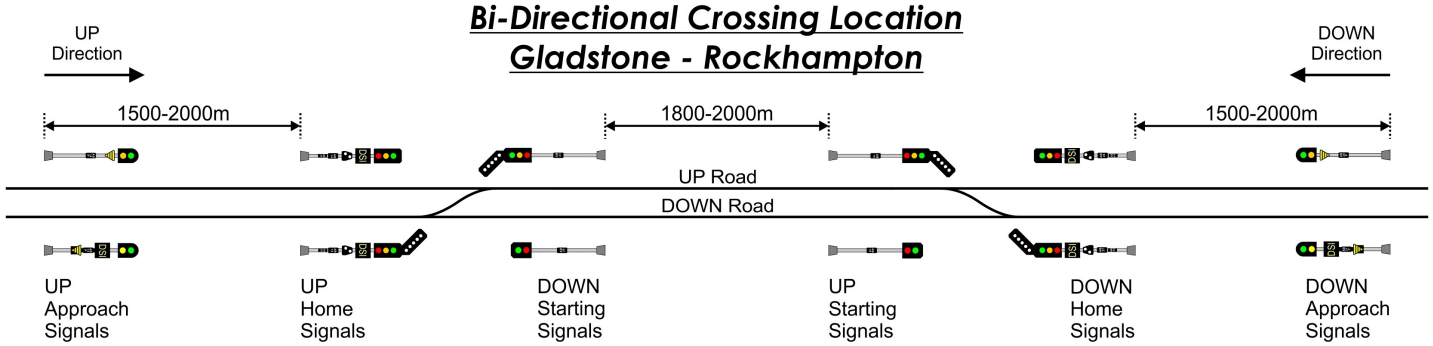
Typical RCS Crossing Loop
Brisbane - Gladstone



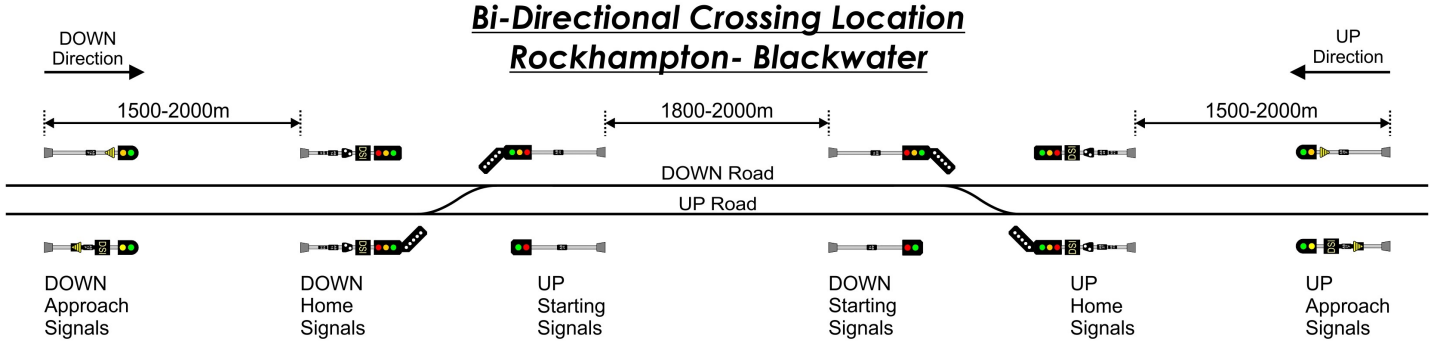
Typical RCS Crossing Loop
Rockhampton - Townsville



Typical RCS Double Track
Bi-Directional Crossing Location
Gladstone - Rockhampton

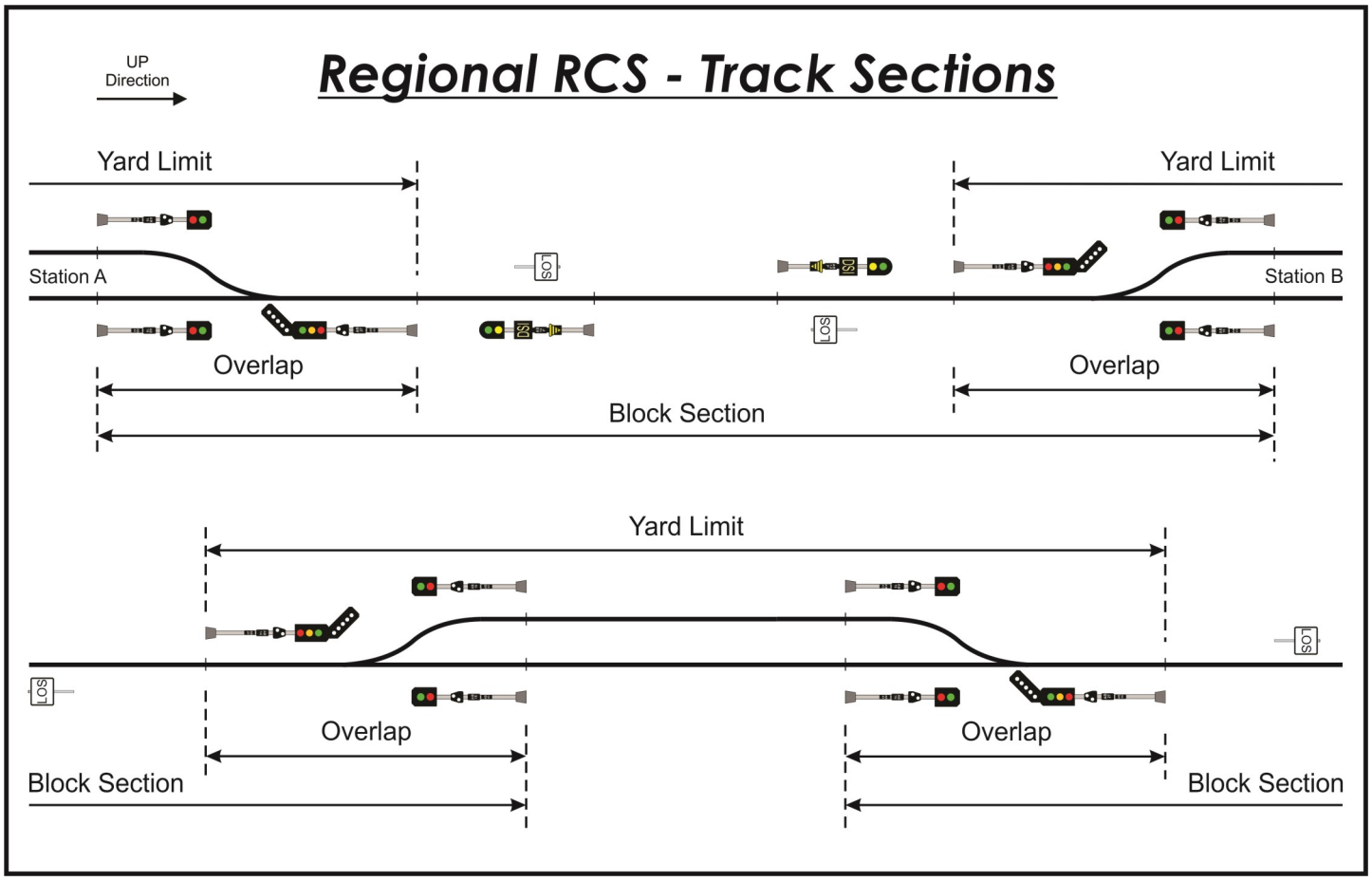


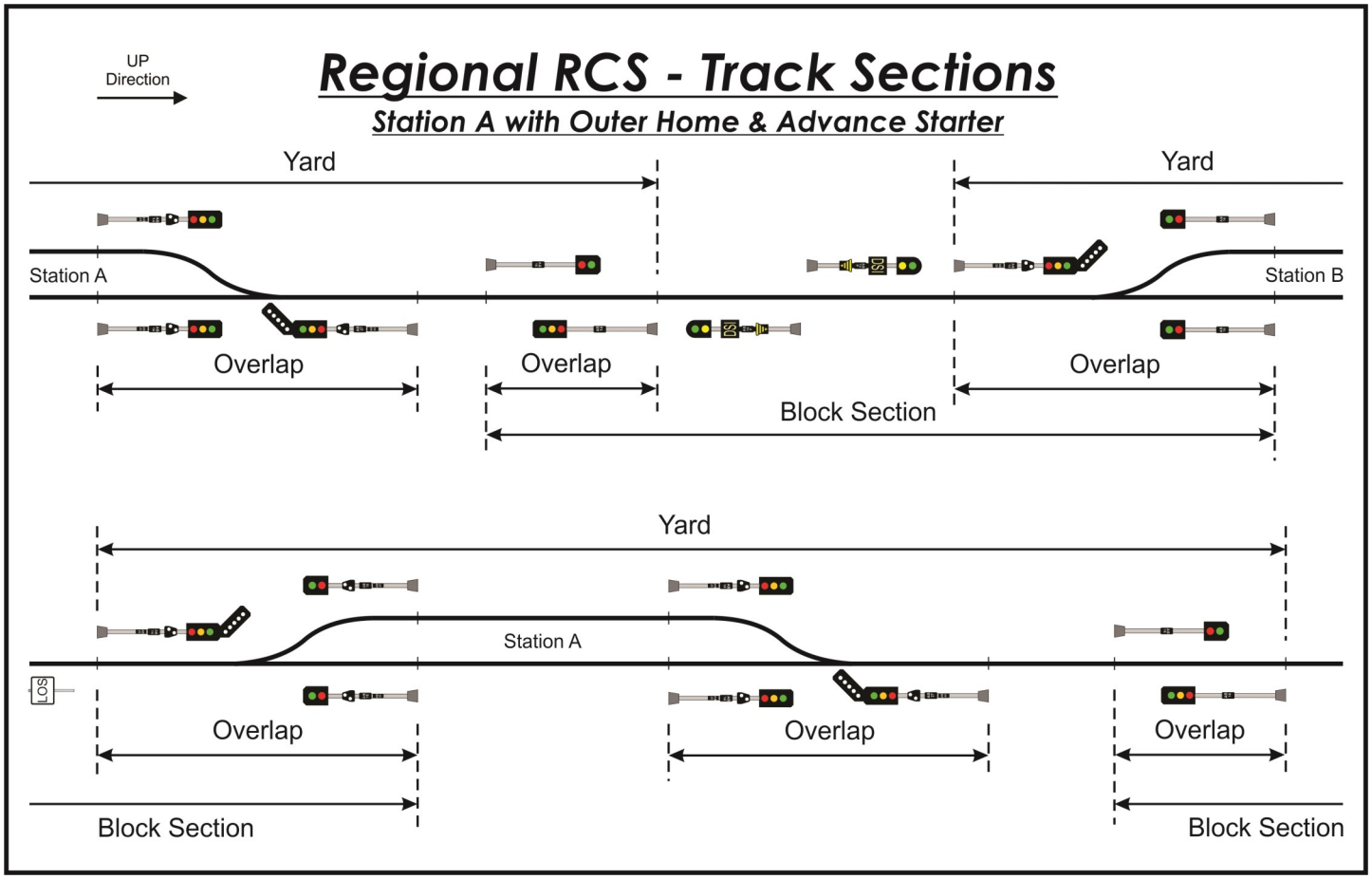
Typical RCS Double Track
Bi-Directional Crossing Location
Rockhampton- Blackwater



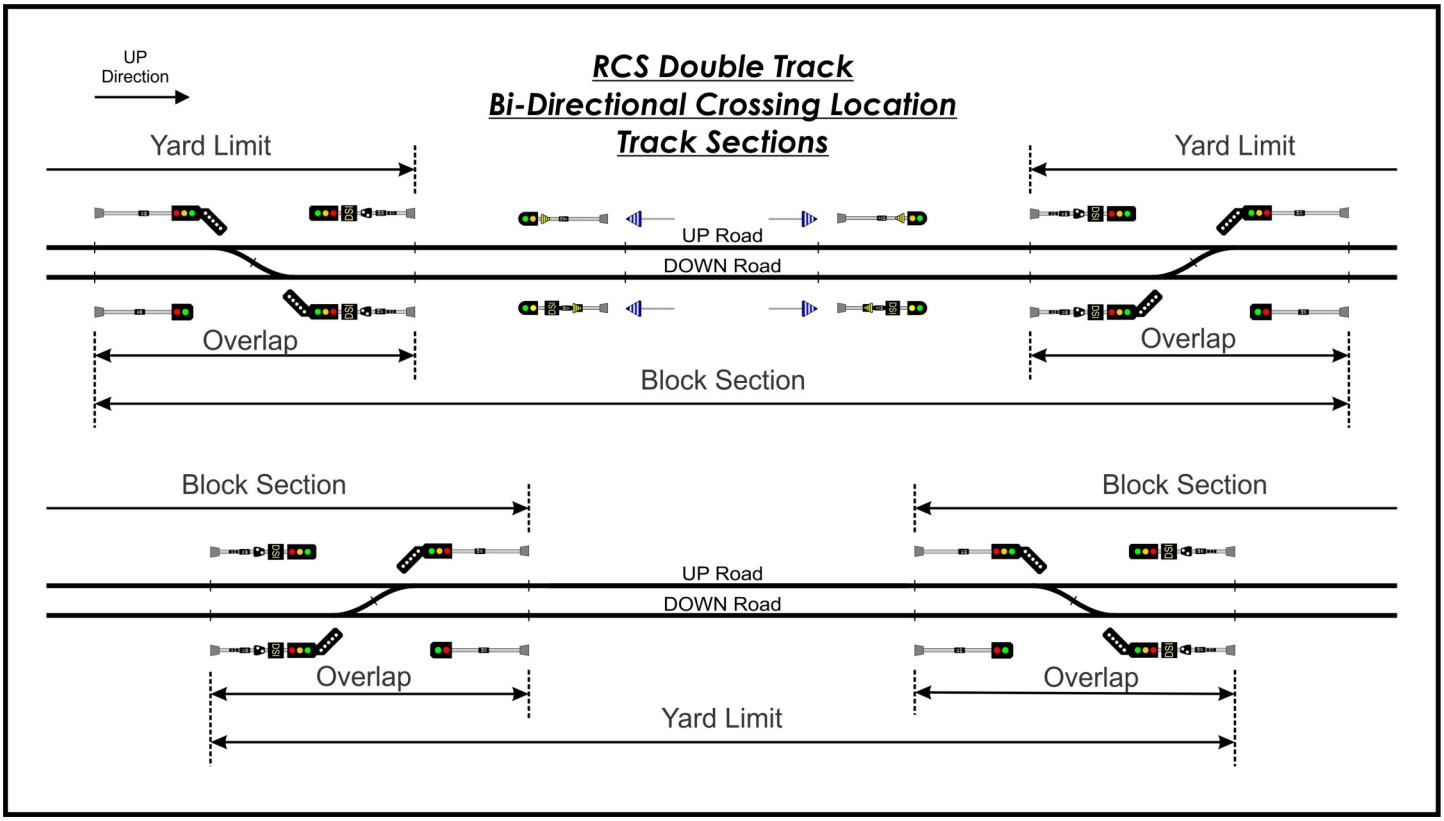
Yard limits are defined as being between home signals (or Outer home if installed).
A Block section is from the starting (or Advance Starter) signal of the first yard to the opposing starting signal/s of the next station.

The following diagrams show where yard limits and block sections begin and end.



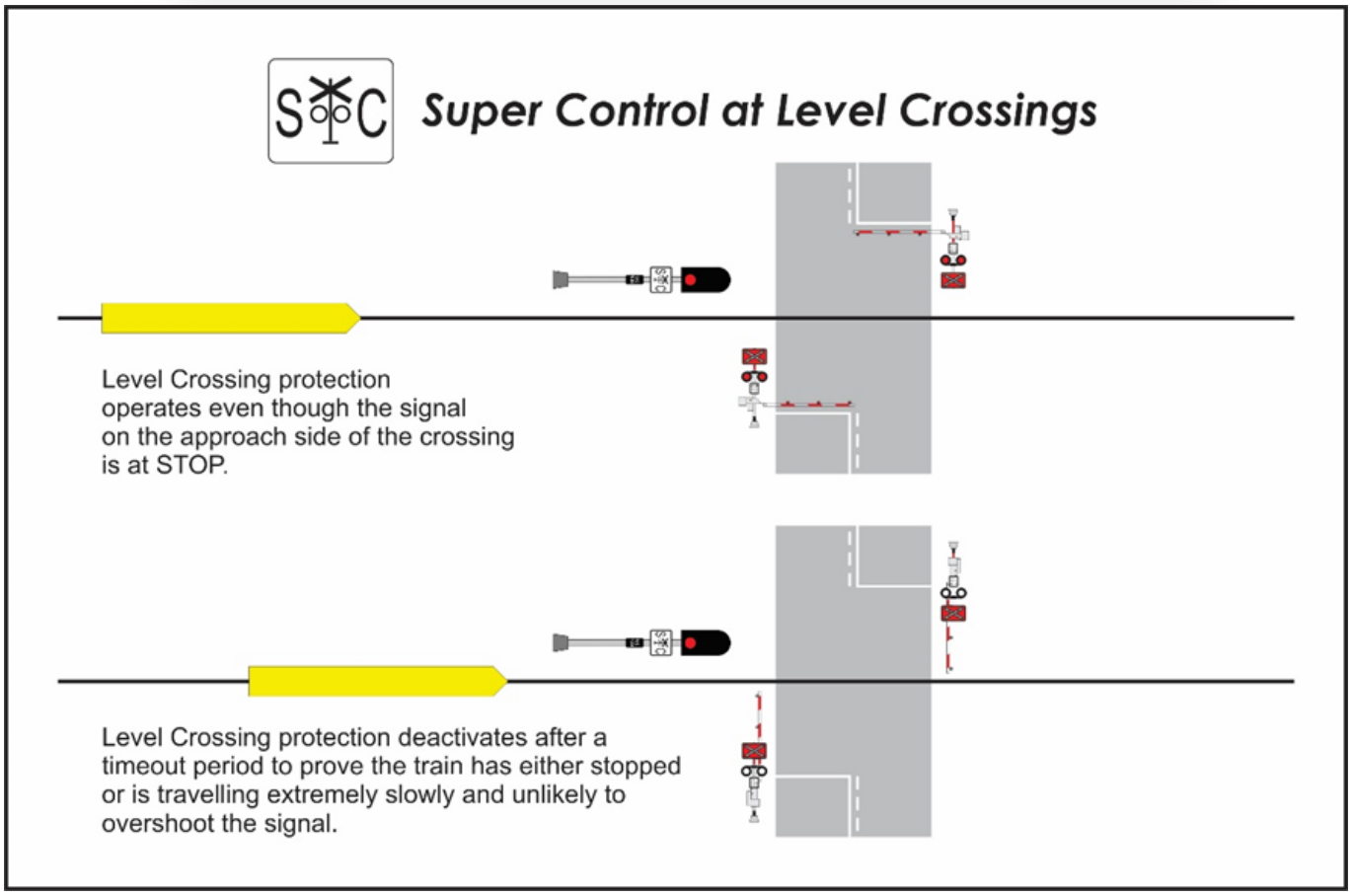


The same principle of defining yard limits and block sections applies to Bi-Directional Crossing Locations, as can be seen in the following diagram.



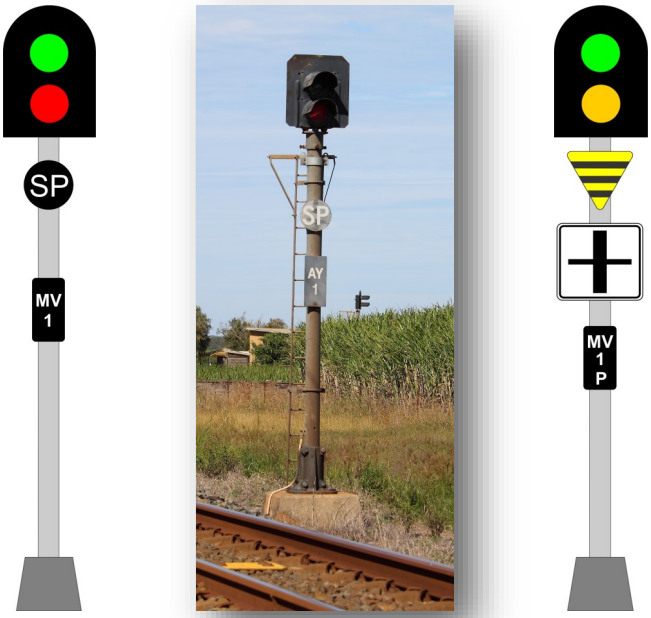
5. Super Control Signals

In some locations it is necessary to place signals in close proximity to a level crossing and as a result increases the risk of reduced warning time of level crossing equipment in the event of a train passing that signal at stop (SPAD).
Super Control (SC) is a special feature of the signalling system, that ensures automatic level crossing protection activates even when a train is on the approach of an SC signal that is at Stop.



6. Cane Railway Crossing Signals

Cane railway crossings over the QR mainline can comprise 2 types of signals, that being a Stop Signal prior to the actual crossing location and an Approach Signal/Beacon fitted with a Cane Railway Crossing sign. These signals are Non Controlled signals, as they operate with the detection of an approaching train.
Typically, the signal protecting the crossing is a 2 aspect green/red signal fitted with black and white SP plate. The SP stands for Stop and Proceed. Without going into the full procedure, if the mainline signals fail to clear to proceed for an approaching mainline train, a signal fitted with an SP plate allows the train to proceed provided the driver has performed a series of checks to ensure there are no cane trains about to proceed through the crossing and that catch points are open protecting the crossing.



The Cane Rail traffic can be protected via either a catch point disc signal if it is a diamond crossing or a 2 aspect Stop Signal if it is a drawbridge crossing over the QR. The later will also have a repeat signal prior to the stop signal.

7. Change of Safeworking Territory Signals

Because there are other forms of safeworking other than RCS in Queensland, there is a requirement to have a colour light signal that indicates a change of safeworking territory. And it is due to this reason that there is one last signal aspect that is only used at these locations and that is a flashing green aspect. As indicated earlier in the aspect meaning table, before proceeding on a flashing green signal the train shall have the relevant new authority. This aspect is used only when going from RCS to another safeworking and not the other way around.

North Rockhampton - RCS to Staff Territory

Earlsfield - RCS to DTC Territory

8. Signal Numbering

Signals in RCS territories are numbered to uniquely identify every signal. Both letters and numbers are used to help identify each signal.

8.1 Controlled Signal Numbering

For controlled signals, the letters identify the station and the numbers identify the particular signal.
The letters are a 2 character mnemonic, usually derived from the first and last letter of a stations name (E.g. RN – Rockhampton). When a station's name has 2 words, usually the first letter of each word is used. (E.g. MW – Maryborough West) However, where there are 2 stations with the same abbreviation, another letter is chosen so as to uniquely identify that station. Conflicting abbreviations is only an issue whereby the two stations are within the same train control territory. An example of conflicting abbreviations in the same train control territory, are two stations on the central line called Wycarbah and Windah which are under the control of the Rockhampton Near West Control. Wycarbah is abbreviated to WH and Windah is abbreviated to WN.
The numbers uniquely identify each signal and can be 1, 2 or 3 numbers in length.

The letter P can be added to the end of signal number to indicate either an approach or repeat signal. The number is the same number of the signal it is repeating.

Signals that can be controlled by an Electric Release Ground Frame use the principle of using the number of the lever within the ground frame. Ground Frames are numbered Frame A, B, C etc. So for numbering of a signal controlled from a Ground Frame that is numbered MM 5B, it is controlled by lever number 5 in Ground Frame B.

At some locations signals can be controlled by both a Network control centre and from a Ground Frame. Where this occurs, it will sometimes be indicated on the signal number plate in brackets.

For cane rail traffic, only drawbridge crossings have colour light signals and these are numbered 4A and 4B. The reason the later have the same number, is because both signals clear at the same time when the drawbridge has been lowered. The A and B after the number ensures that each signal is numbered individually for installation/maintenance identification. The respective repeat signal has the addition of a P to the number. They are controlled by an NCO when the drawbridge is lowered. For a standalone Cane Railway Drawbridge or Diamond Crossings, signals on the mainline are numbered 1 and 2. As described earlier the mainline signals are Non Controlled signals, for continuity it has been included in this section.

In small yards/crossing locations both the running signal and shunt signal are numbered individually. In larger yards like Gladstone, Callemondah and Rockhampton there can be hundreds of signals and the practice of numbering individual subsidiary signals can be omitted.

8.2 Non Controlled/Auto Signal Numbering

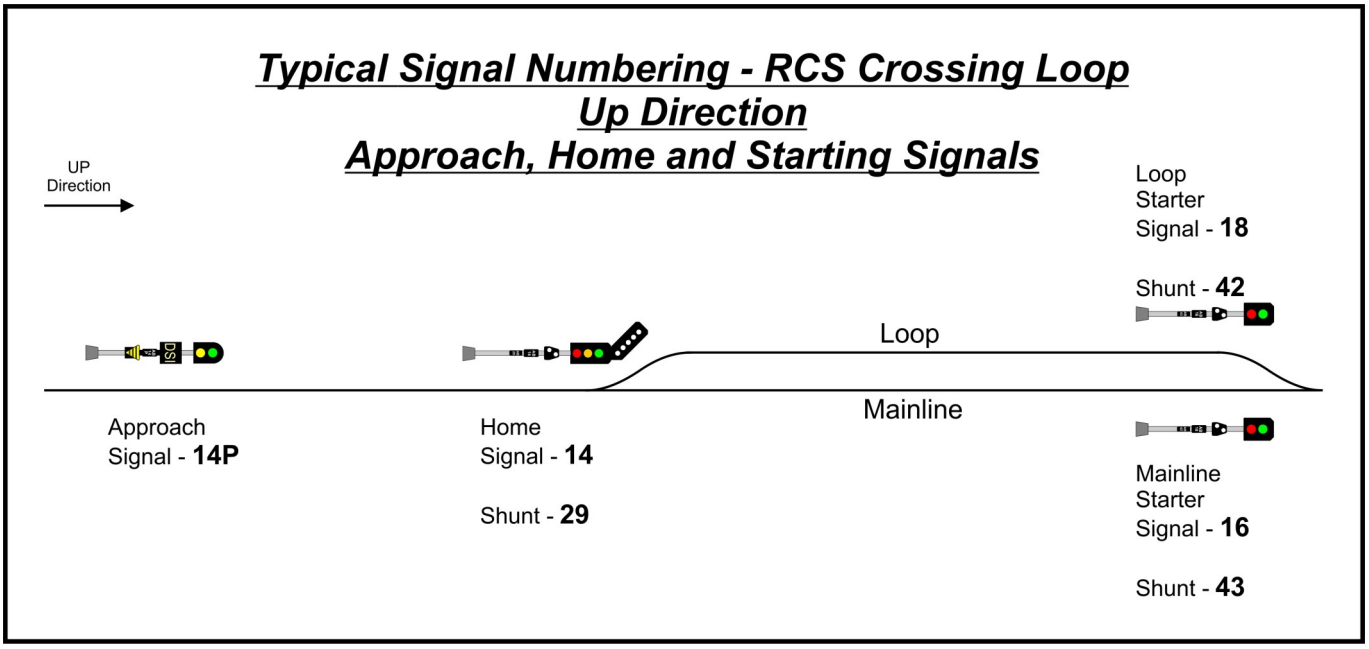
For non-controlled signals the letter/s identify the track that the signal pertains to and the numbers identify either that particular signal or the distance along the line in BSA. The letter/s are a mnemonic from which the track/line section is named. (E.g. S—Shorncliffe, WM – Western Main, NU – Northern Up)
Numbering of non-controlled (auto) signals is based on the distance a long that particular line. E.g. a signal numbered WM 025 is a signal on the western main 2.5km from start of that track. The numbers also indicate whether the signal is for the up or down direction. Odd numbers indicate Down direction signals and even numbers indicate Up direction signals.

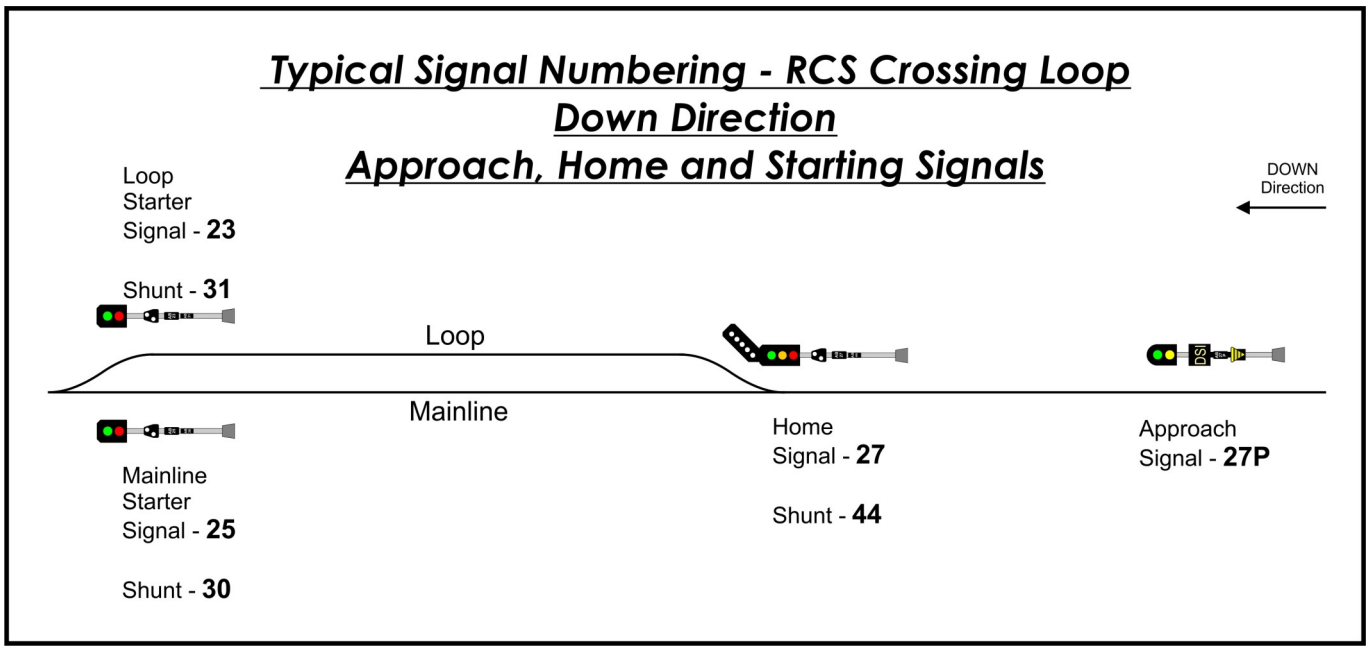
Western Line 31.5km Down Direction

Western Line 31.6km Up Direction

8.3 Typical Signal Numbering in Regional RCS Areas

Signal numbering in RCS regional areas is interesting, as certain numbers are consistently used to identify particular types of signals at a crossing loop/location. So it doesn't matter where you are, you can easily identify certain signals as being home, intermediate or starting signals. This signal numbering sequence is believed to have been developed by contractors Westinghouse/McKenzie & Holland who won a lot of the signal construction contracts.
The following diagrams show how signals are numbered in regional RCS locations:

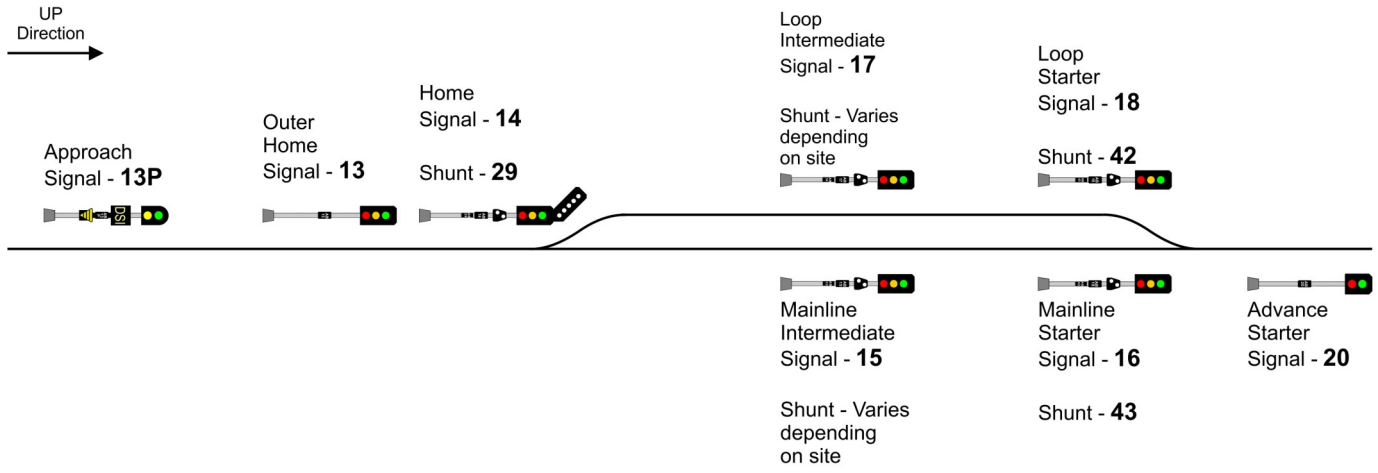




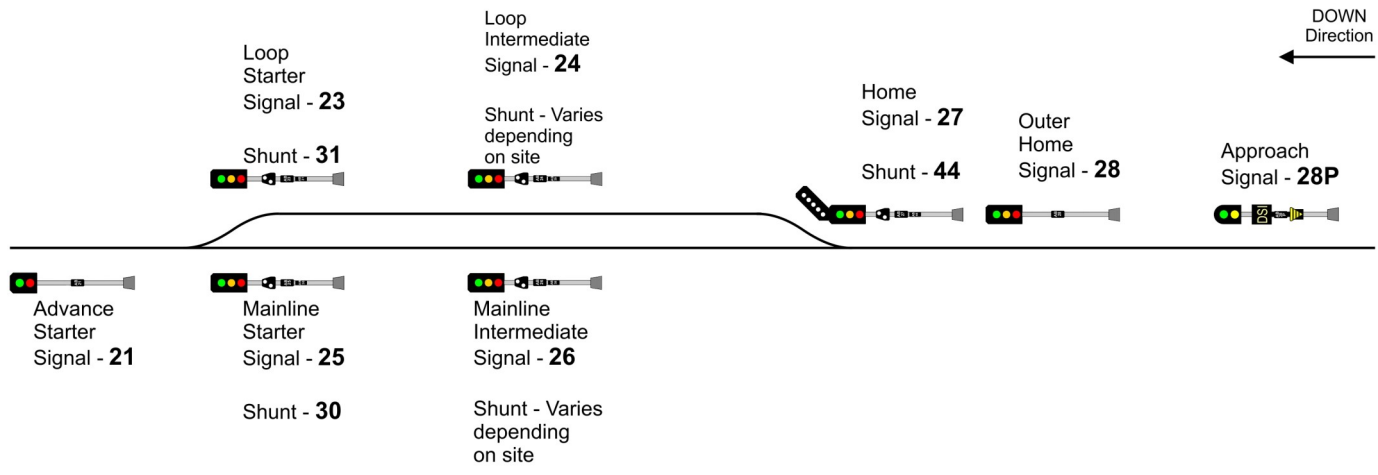
As can be seen in the diagrams, running signal numbers go either up or down depending on the direction of travel.
So in the Up direction it can be seen that the home signal is 14 and if travelling through the mainline the next signal's number is higher (16). Conversely travelling in the Down direction the home signal is 27 and again travelling through the mainline the next signal number is lower (25). It doesn't matter if travelling through the loop the number is still lower (23).

The following diagrams show the same crossing loop, with the addition of an outer home, intermediate and advance starting signals. They show the same principle of signal numbers going up or down depending on the direction.

Typical Signal Numbering - RCS Crossing Loop
Up Direction
Including Outer Home, Intermediates and Advance Starter

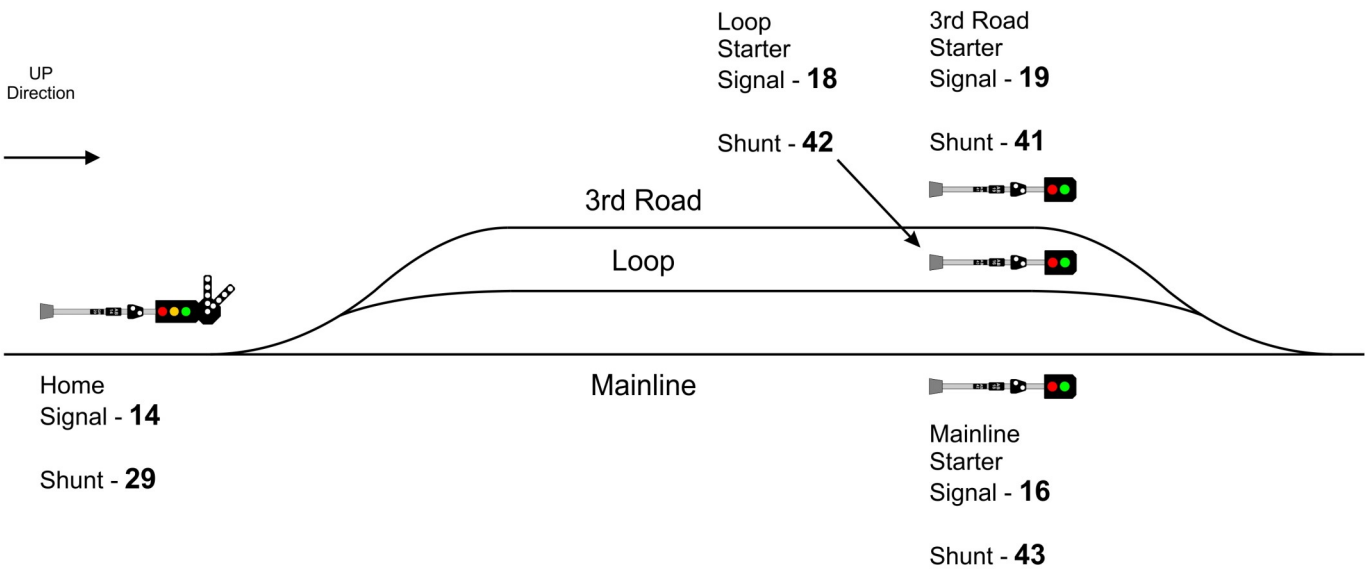


Typical Signal Numbering - RCS Crossing Loop
Down Direction
Including Outer Home, Intermediates and Advance Starter

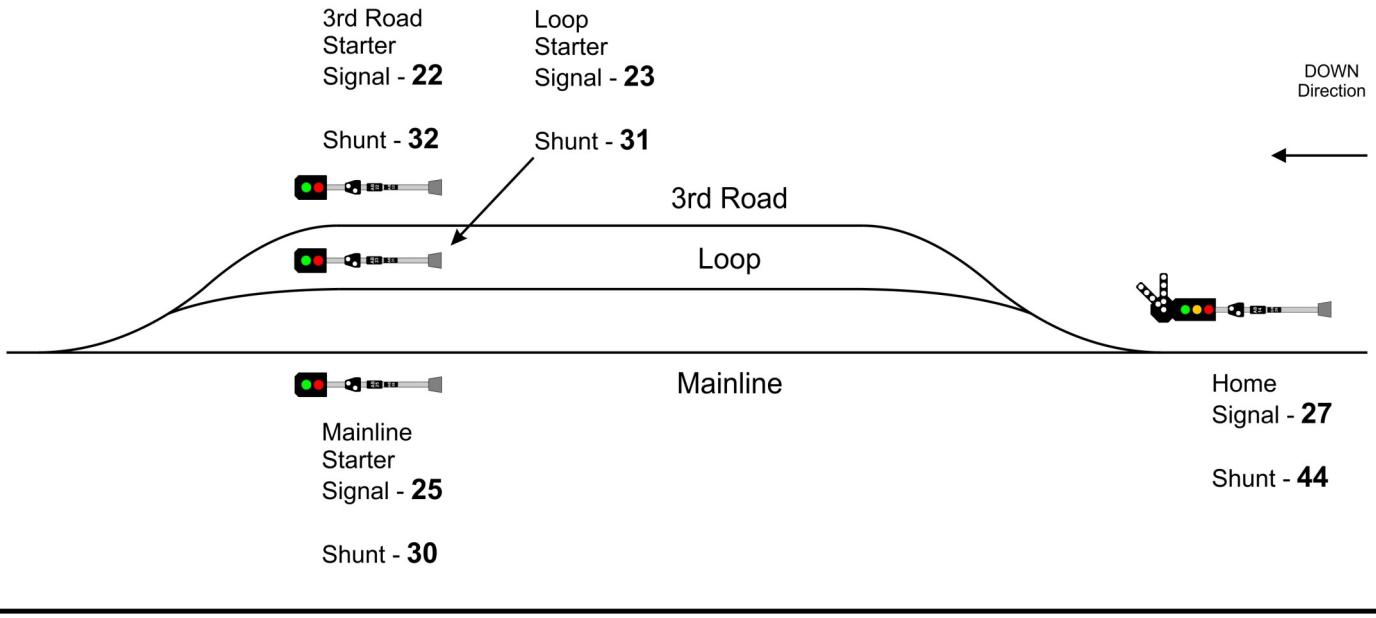


The following 2 diagrams show the addition of a 3rd Road to the crossing loop location and the extra signals associated with the third road.

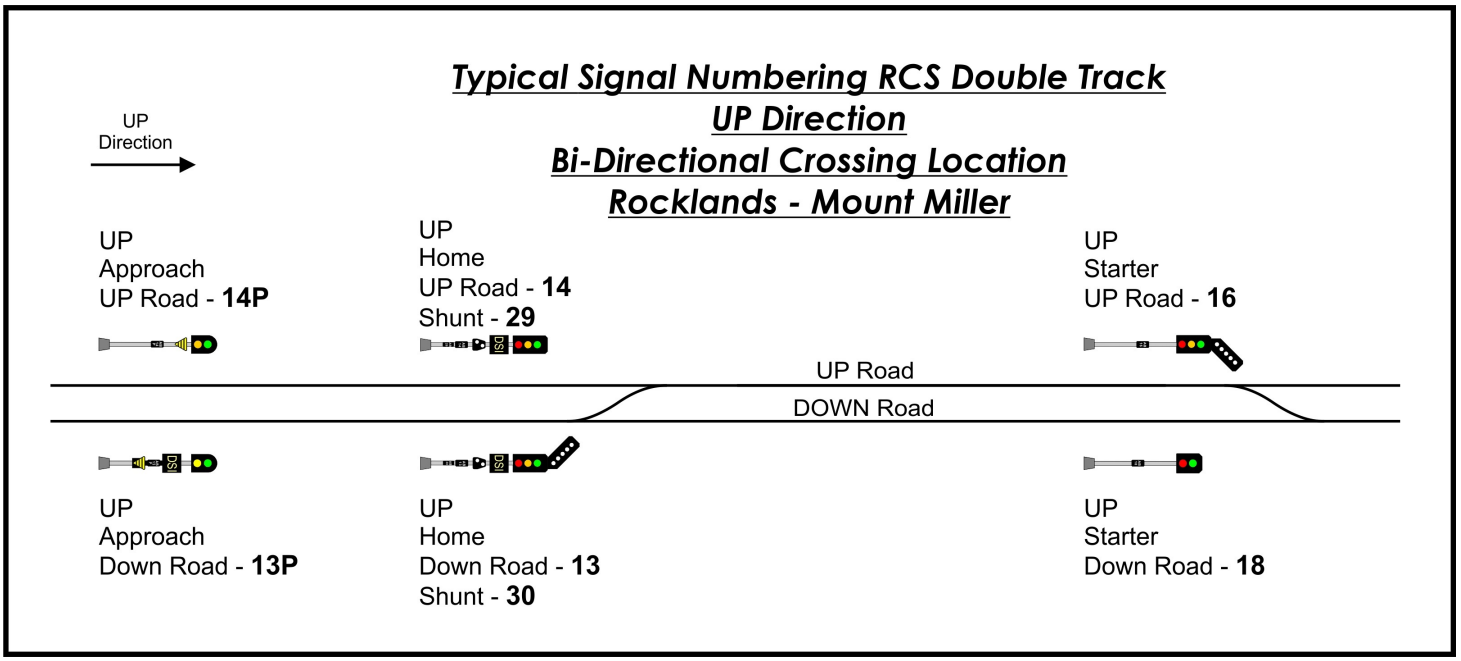
Typical Signal Numbering - UP Direction RCS Crossing Loop and 3rd Road



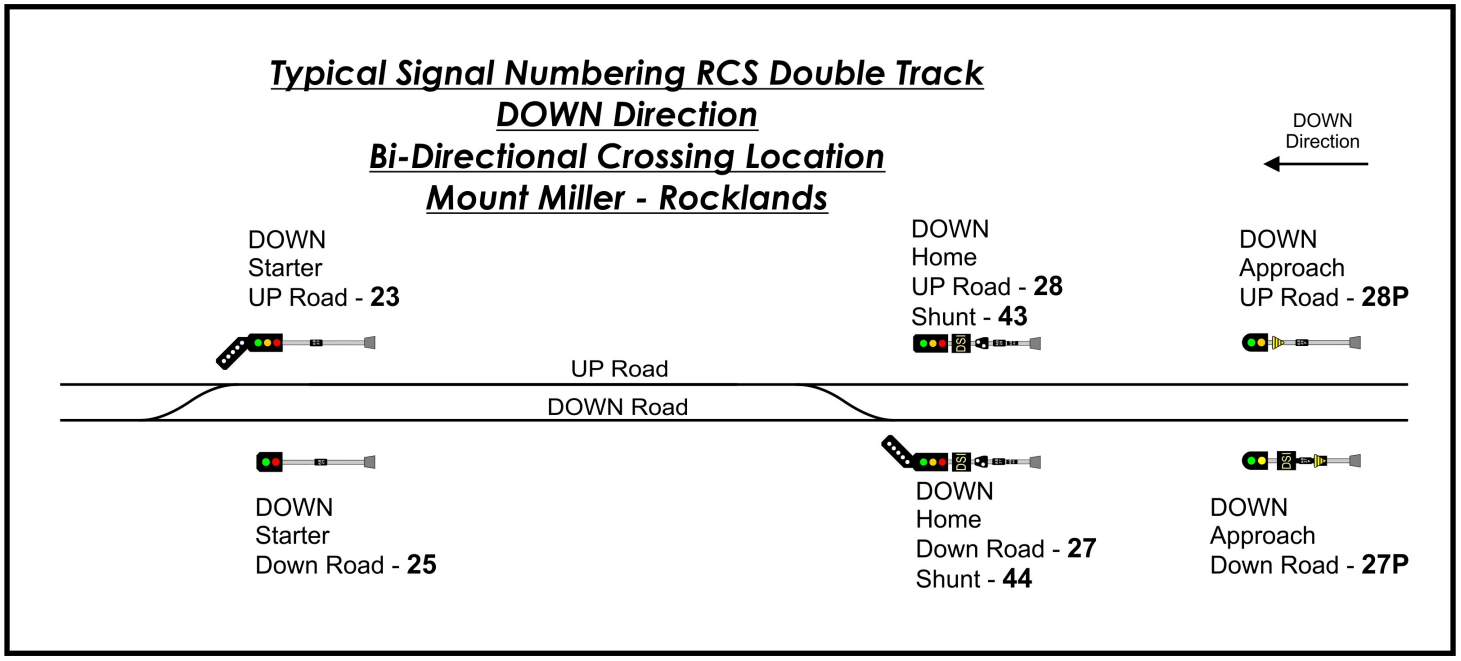
Typical Signal Numbering - DOWN Direction RCS Crossing Loop and 3rd Road



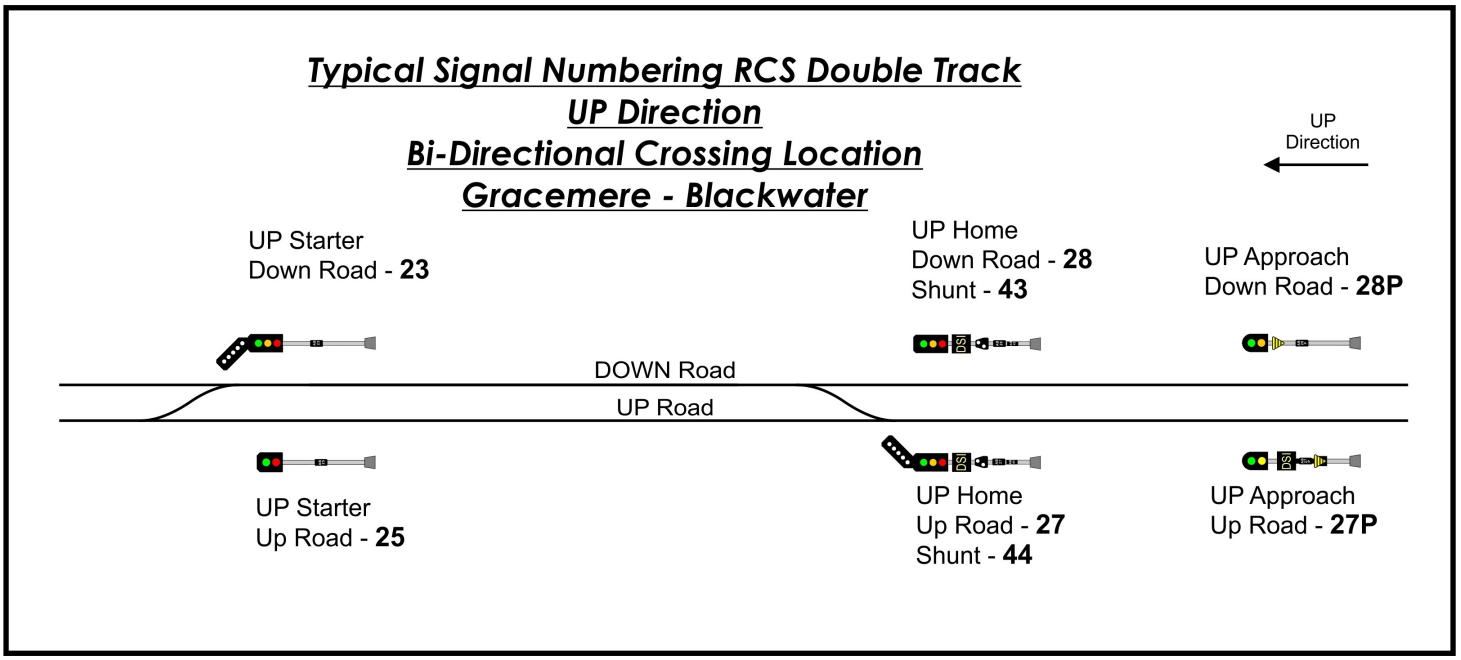
With Double Track Bi-Directional tracks, signal numbering follows a similar principle to a single track crossing loop. The Up Home signal on the Up road is the same (14), as well as the starter on the Up road (16). The Up Home signal on the down road uses the same number as an Up Outer Home signal (13) in single track crossing loop locations. Likewise, the Up Starter on the down road takes the same number as an Up Loop Starter signal (18).

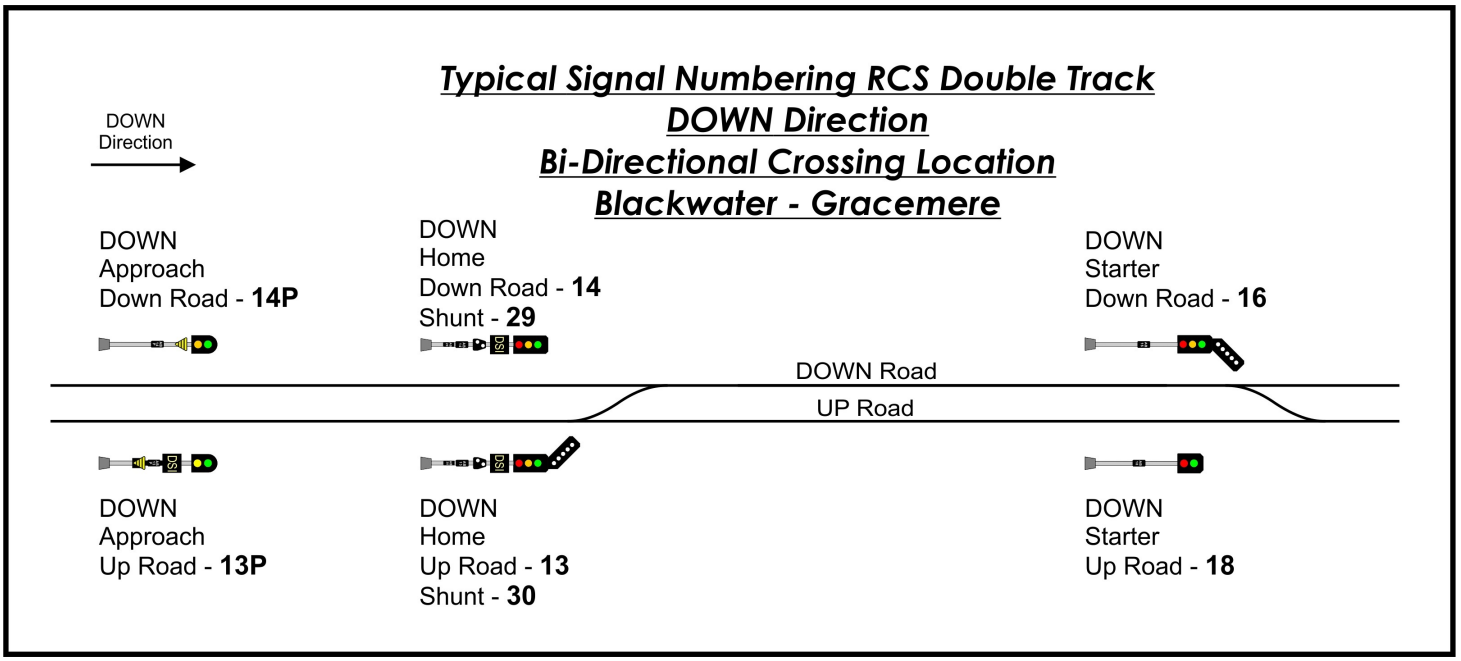


So for the Down direction the same principle applies as the Up direction.



On the Central Line, for reasons unknown the signals are numbered opposite to normal practise. So for an Up Road Up Home signal, it is numbered 27 not 14. The only conceivable reason for this, is uniformity of numbering of signals throughout the journey of a coal train. For empty coal train traffic leaving Gladstone/Callemondah, they leave as a down train on the NCL. When they 'turn the corner' at Rocklands to head west on the Central Line they become an Up train. For loaded coal traffic they leave the mines as a down train and likewise when they 'turn the corner' at Rocklands they become an Up train on the NCL. So even though the train changes from a Down to Up or Up to Down, the signal numbering continues as though there hasn't been a change of direction.



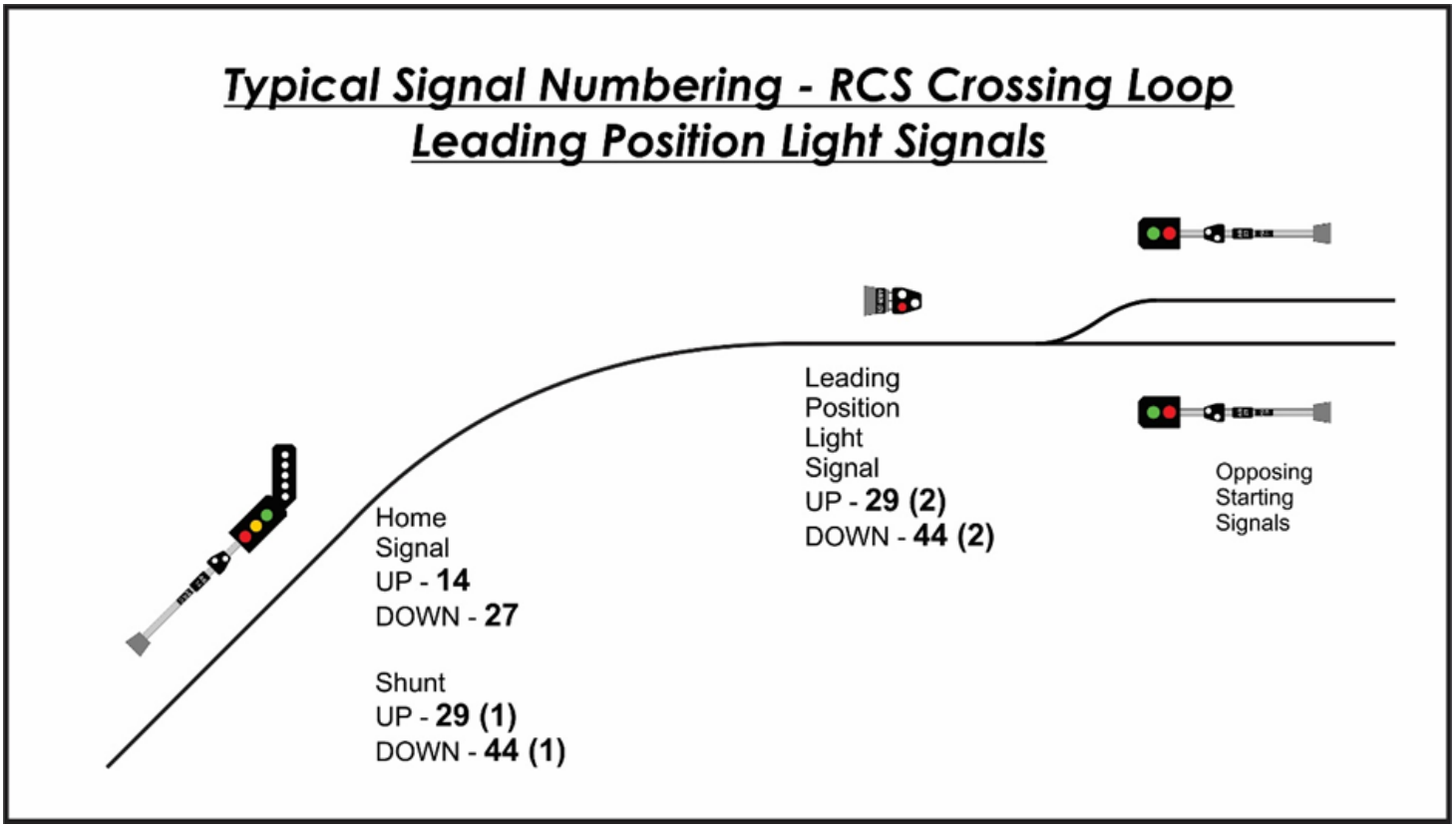


Note: - For Bi-directional duplicated tracks the easiest way to identify the road name is by the following principle. If you are an Up train travelling in the Up direction and you are travelling on the left hand road means that you are on the Up Road. So for a Down train travelling in the Down direction on the left hand road means you are on the Down Road.

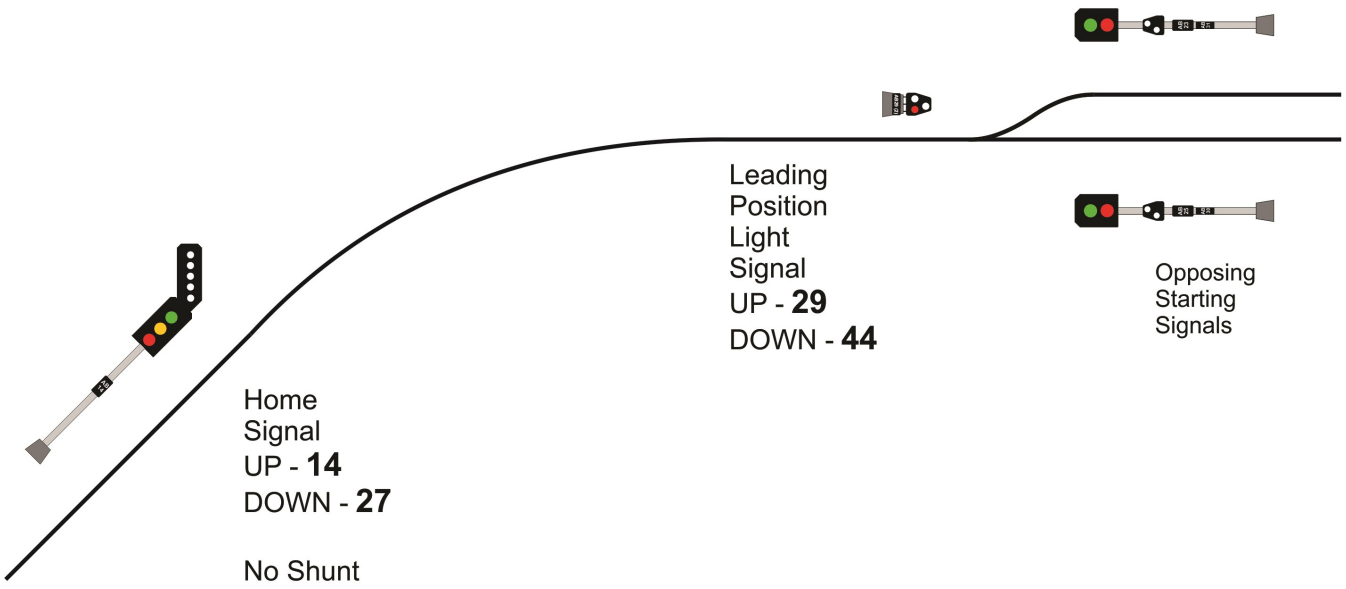
8.4 Leading Position Light Signal Numbering

Single track RCS Crossing Loop stations that have a Leading Positon Light Signal between the Home Signal and the points of the crossing loop, use the same number as the home shunt signal. So if the Up Home signal is fitted with a Shunt signal, the number will be 29 and have a one in brackets (1) beside it - 29(1). The leading position light signal will be the same number except with a two in brackets (2) beside it - 29(2). The reason for this, is when a shunt signal is called, both the 29 (1) and 29 (2) signals will clear at the same time. But when the leading position light signal is used for a running manoeuvre only the 29 (2) signal shows a proceed. When the Home signal doesn't have a shunt signal fitted, the leading position light signal will assume the typical number of the Home shunt signals number.

The following diagrams illustrate the numbering.



Typical Signal Numbering - RCS Crossing Loop
Leading Position Light Signals
No Shunt Signal on Home Signal

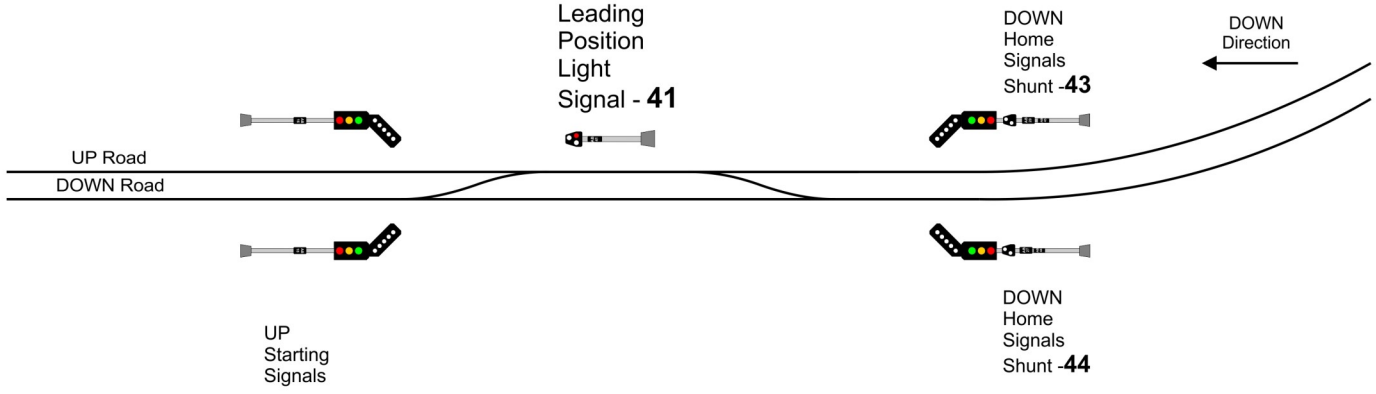


There can also be Leading Position Light Signals within a yard. For example, before crossovers or points leading to a 3rd Road etc. These Leading Position Light signals are numbered between 34 to 39 depending on where they are located within the station yard.

Leading Position Light Signals in Double Track Bi-Directional locations follow the same principle as single track locations with one exception. If a Leading Position Light Signal can lead multiple running signals, the Position Light Signal must be uniquely numbered. In other words, it won't have the same number as a shunt signal fitted to a running signal before it.

The following diagram shows an example of this.

Example Signal Numbering - Leading Position Light Signal
Double Track Bi-Directional Crossing Location



9. Automatic Signalling Operation

Automatic Signals as described earlier are considered to be non-controlled signals, as under normal operation they cannot be controlled. They operate by the detection of rail traffic via track circuits. There are some Automatic signals in the BSA that have been fitted with key switches. These key switches are used to restore and hold that signal at stop for track protection purposes.

Automatic Signals are a feature of the BSA, that allows two consecutive trains travelling on the same line to travel to in close proximity to each other. The distance between two consecutive trains is known as Headway.

Headway is made up of Sighting Distance, Braking Distance, Overlap and Train Length. Total headway distance will vary depending on what colour aspects are being displayed.

Sighting Distance - the distance prior to a stop signal of which a driver shall have a minimum of 8 seconds viewing of a signals aspect at the maximum track speed and be no less than 100m, whichever is greater.

Braking Distance - the distance required to stop a train prior to a stop signal using a service brake application. There are factors in determining braking distance such as types of trains, maximum speed, deceleration rates, gradient of track. Braking Distance must be the longest of all the types of trains that normally work over that route.

Overlap - a safety margin distance provided on the departure side of a limit of authority. Overlap is provided in case a train exceeds the limit of its authority due to a driver misjudging (slippery rails etc.). Overlap Distance is typically 100m, but can be reduced depending on factors like maximum track speed.

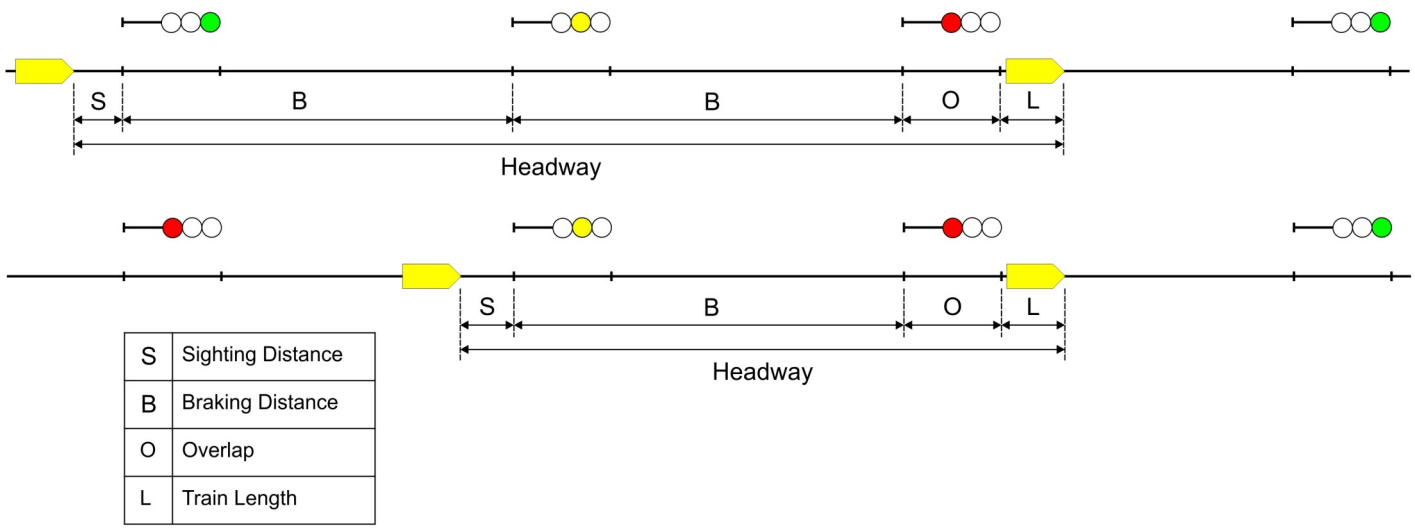
Train Length - Length of train which can vary.

Automatic signals can have either 3 aspects or 4 aspects. The later allows a reduction in headway between consecutive trains. This is due to the additional aspect of a Double Yellow. In 3 Aspect Automatic Signalling, a Green aspect can mean that the next signal is either a Green or Yellow. Upon sighting a Yellow signal, the distance to the next signal (which is at Red) is at braking distance.

In 4 aspect signalling the additional Double Yellow aspect gives more accurate information about the next two signals. So a Green can mean the next signal is either a Green or Double Yellow. A Double Yellow means the next signal is Yellow and the signal after that is at Stop/Red. The Double Yellow is the first caution signal and as a result it is at braking distance to the signal that is at Red. So approaching a Yellow in 4 Aspect Automatic Signalling is located at half the braking distance to the signal that is at Red.

The following diagrams show headway for 3 Aspect and 4 Aspect Colour Light Signalling.

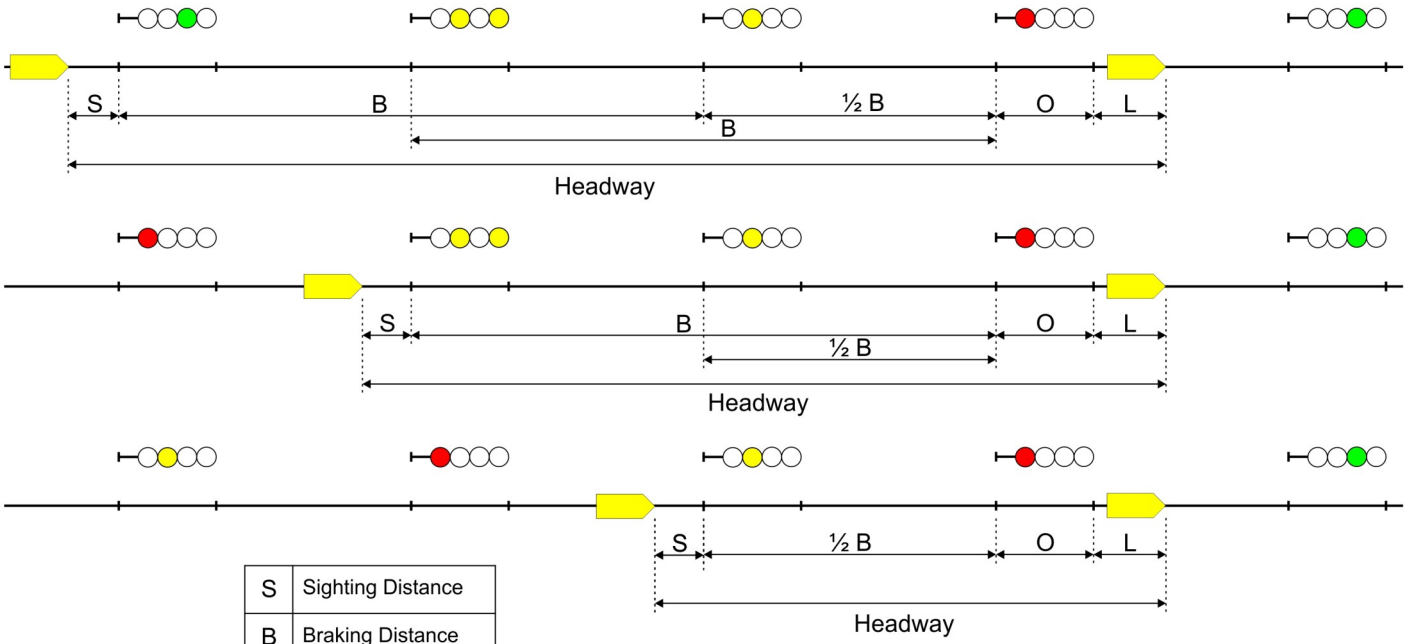
3 Aspect Automatic Colour Light Signalling Headway



S	Sighting Distance
B	Braking Distance
O	Overlap
L	Train Length

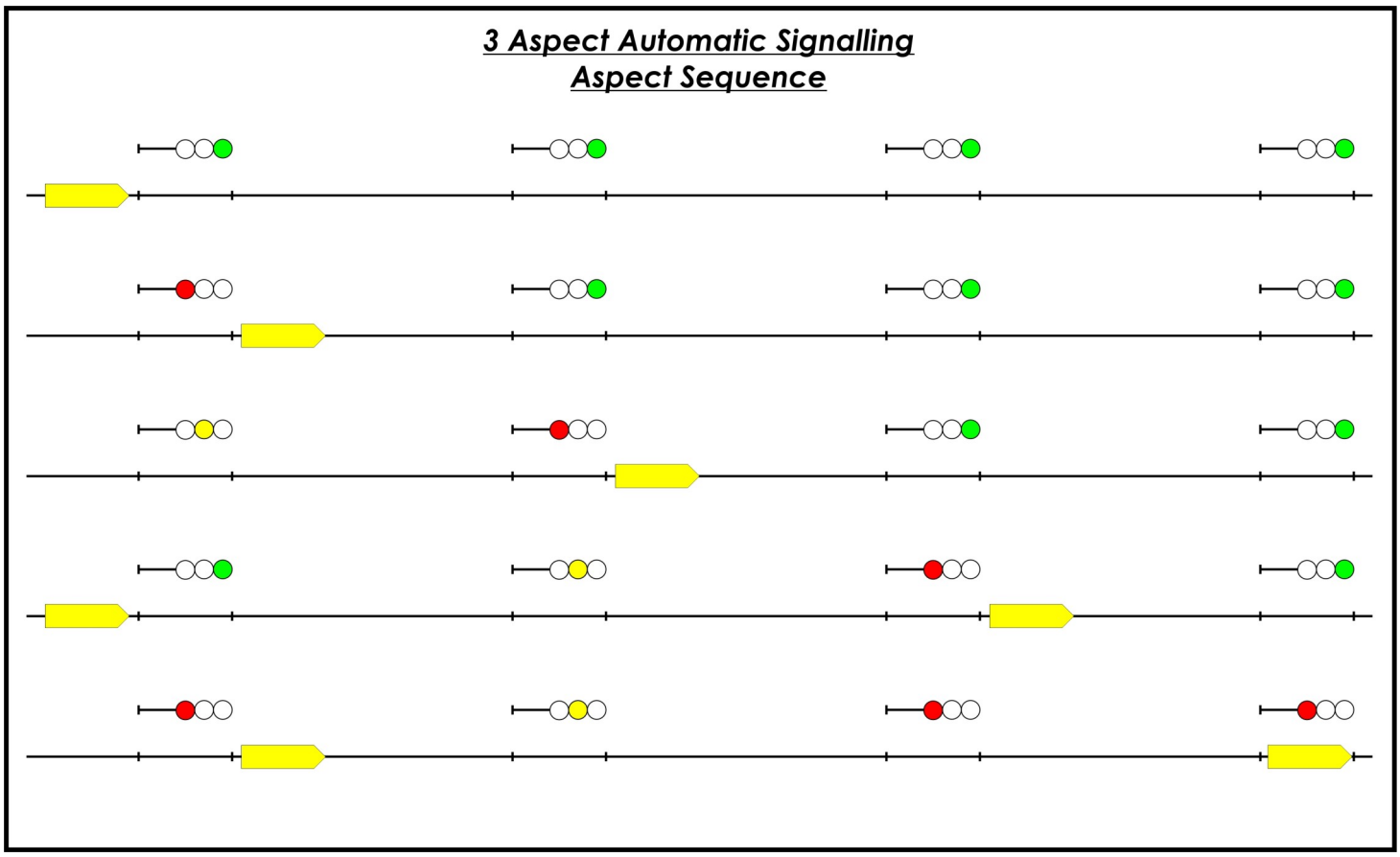
Headway at maximum track speed is shown at the top of each diagram, with the following train running on green aspects. Minimum headway is shown at the bottom of each diagram, with the following train running at reduced speed on yellow aspects.

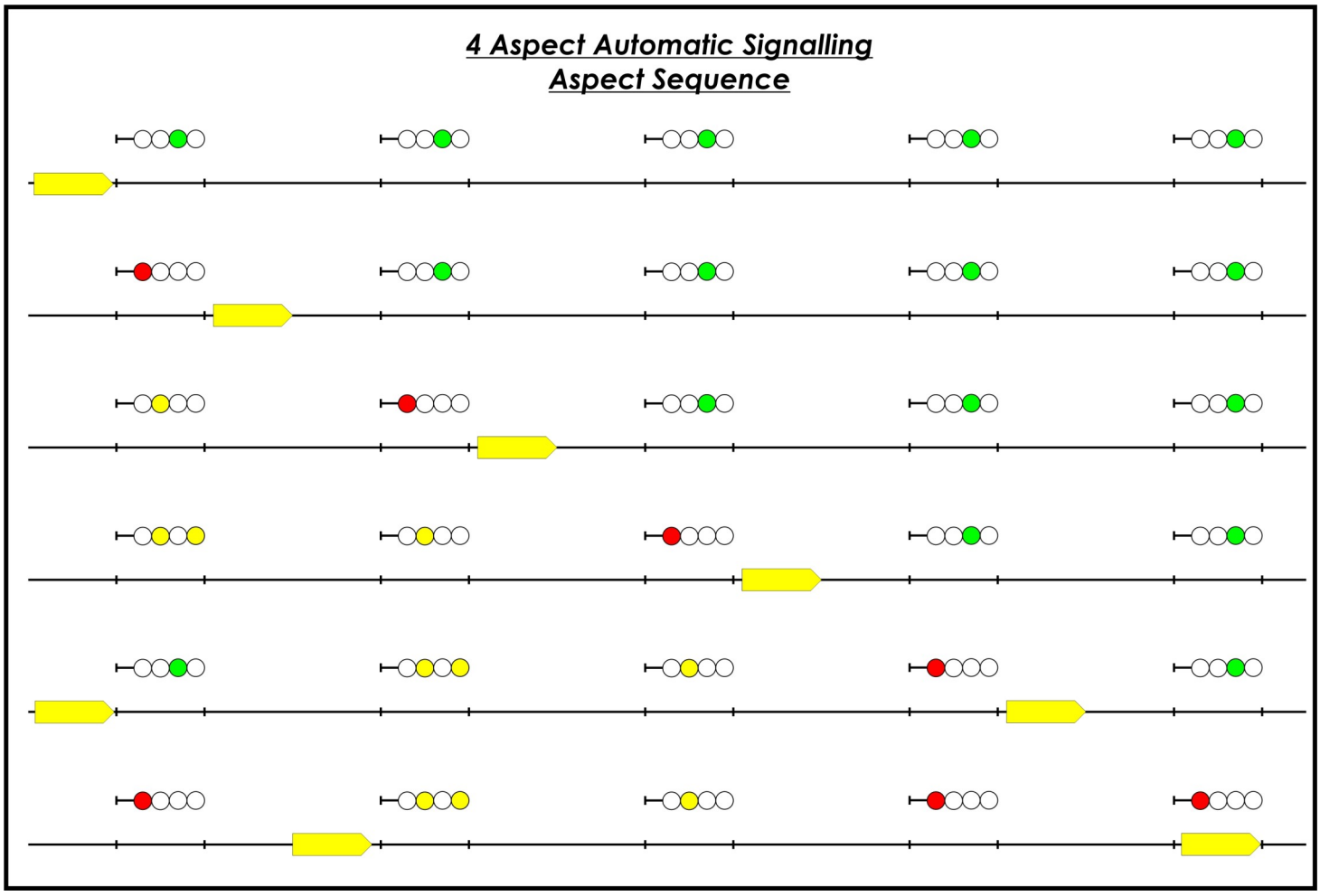
4 Aspect Automatic Colour Light Signalling Headway



S	Sighting Distance
B	Braking Distance
O	Overlap
L	Train Length

The following two diagrams illustrate the change in signal aspects as a train proceeds through a section of track with Automatic Signals.





10. Detecting Track Occupancy

An essential part of operation of Remote Controlled Signals is detecting the occupancy of a section of track. This relates to principle number 2, in which a proceed authority into a single line section is a driver's authority to enter that section knowing that the section has been proved clear of rail traffic and opposing signals are at stop.

There are two methods in which rail traffic can be detected in RCS areas; that being track circuits and axle counters. Both methods use the wheels/axles of rollingstock to detect if a section is clear or occupied.

Track Circuits

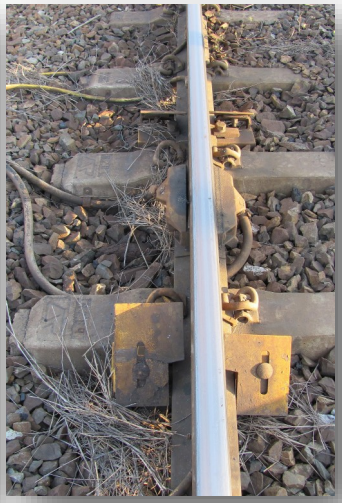
Insulated Rail Joints, Track Circuit leads & Track Connection Boxes

Insulated Rail Joint (Glued)

Insulated Rail Joint (Mechanical)

Axle Counters

Trackside Box



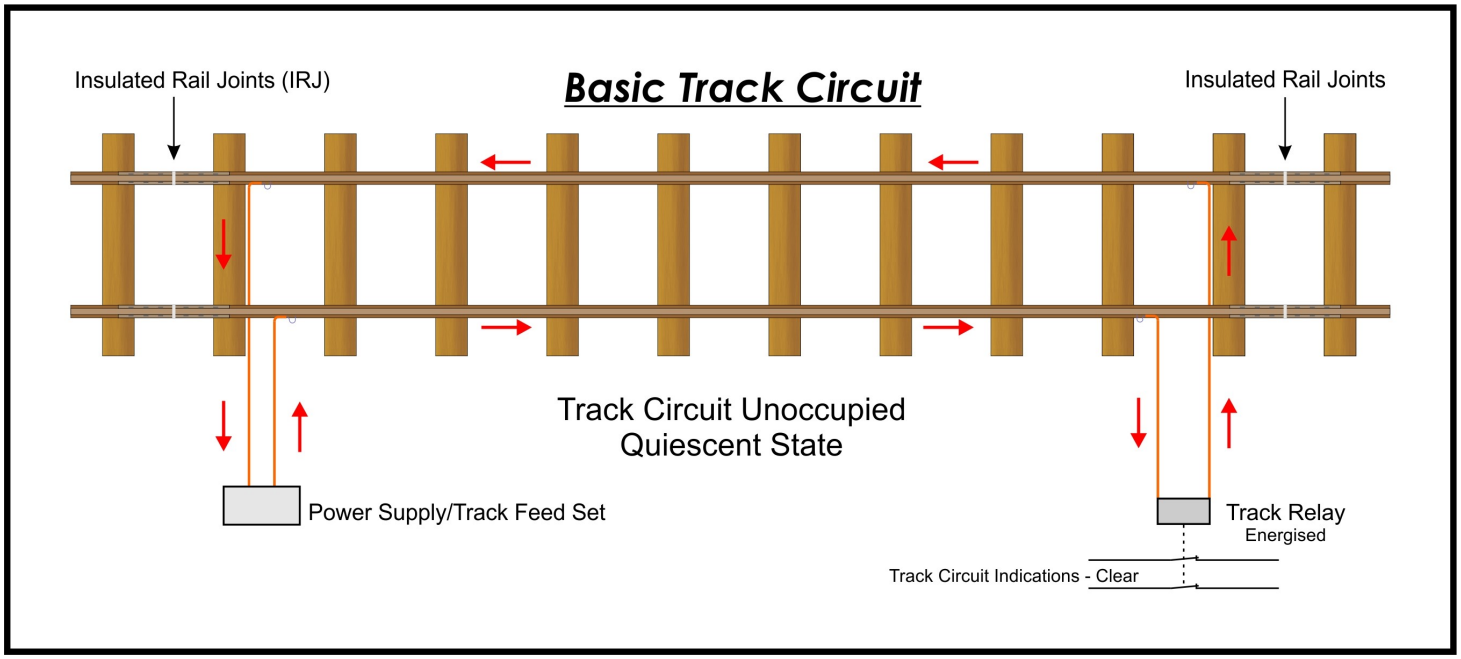
Wheel Detector

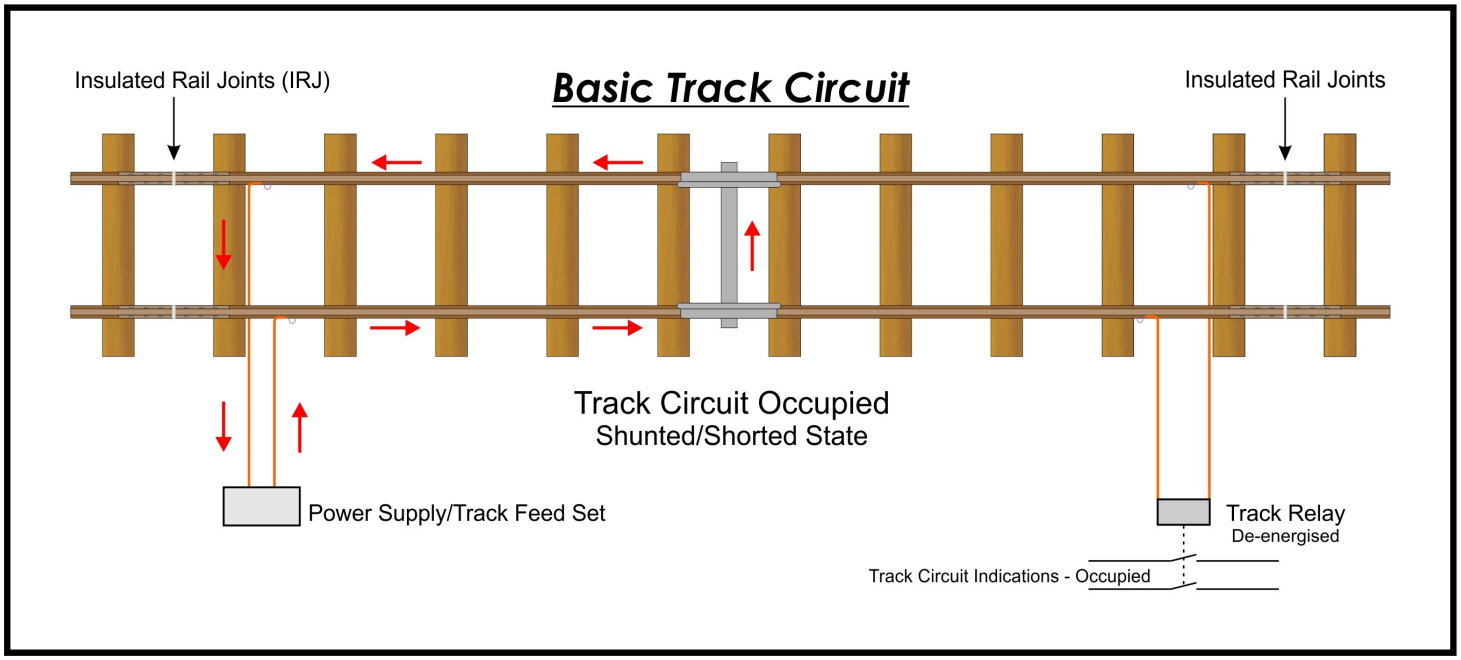
Trackside Box and Wheel Detector

10.1 Track Circuits

Track circuits are an electrical circuit that uses the running rails of a track to form part of the circuit. There are various types of track circuits but the basic principle is the same. The track is divided into sections that are electrically independent to one another. At one end of the track is a power supply that feeds power to the rails. A track relay is then connected to the rails at the other end of the track. When power is applied to the rails it energises the track relay at the other end. When the relay is energised, it indicates the track is clear of rail traffic. The main safety feature of the track circuit is, if set up correctly they are fail safe. So if the power supply or relay fails, or if there was a broken wire or a broken rail, the relay de-energises and indicates that the track is occupied. When a train enters a section of track that is circuited, the wheelset applies a short across the rails and current that was flowing directly to the track relay is now predominately flowing through the wheelset. As a result, the track relay de-energises and indicates that that section of track is occupied.

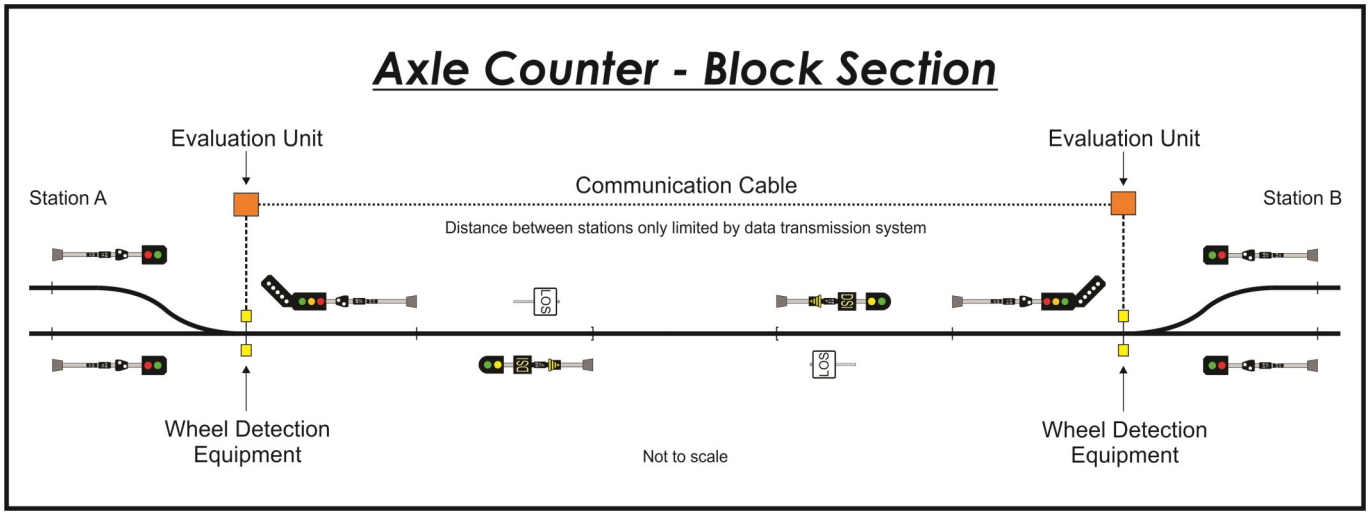
The following diagrams help illustrate both states of a track circuit.

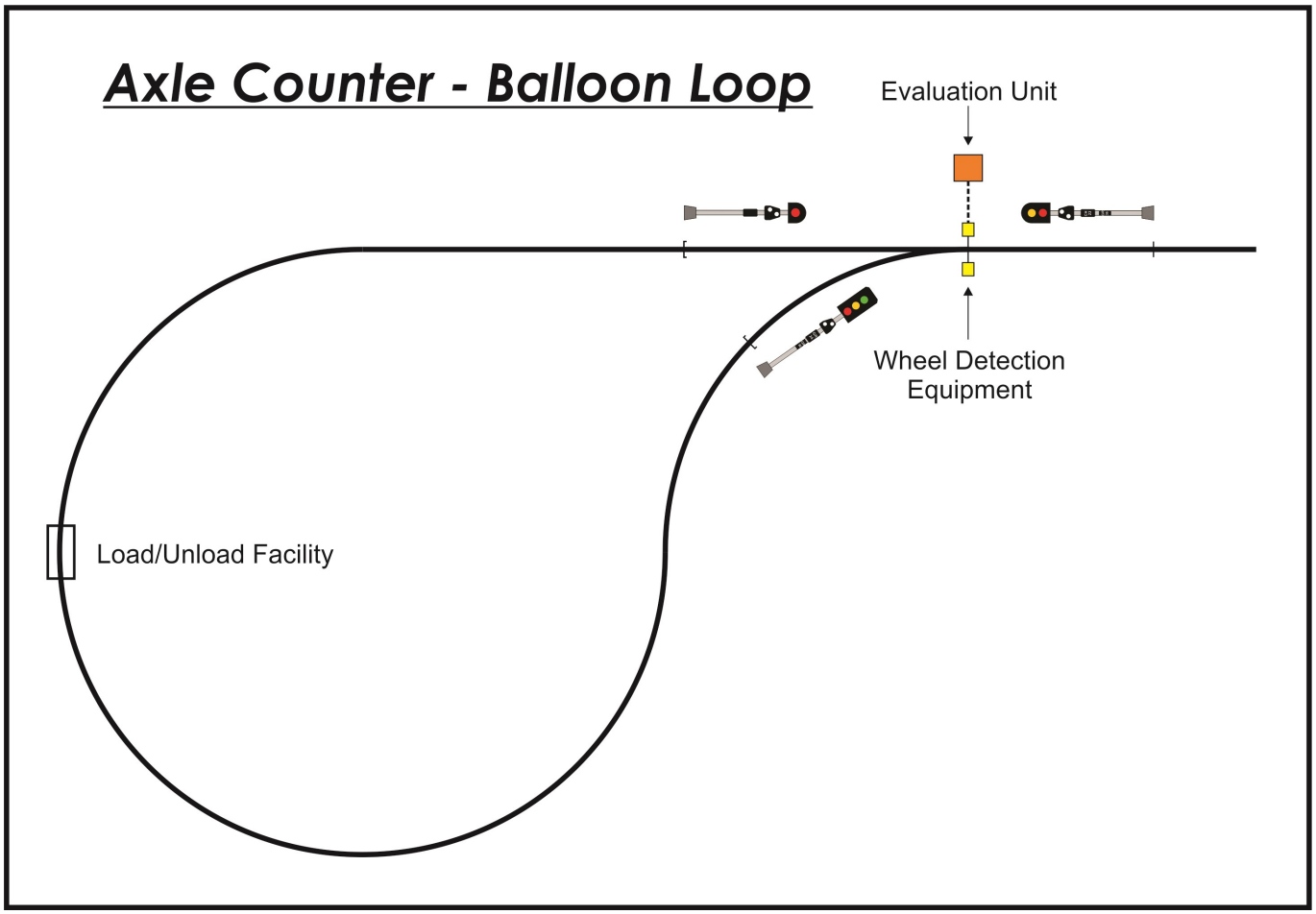




10.2 Axle Counters

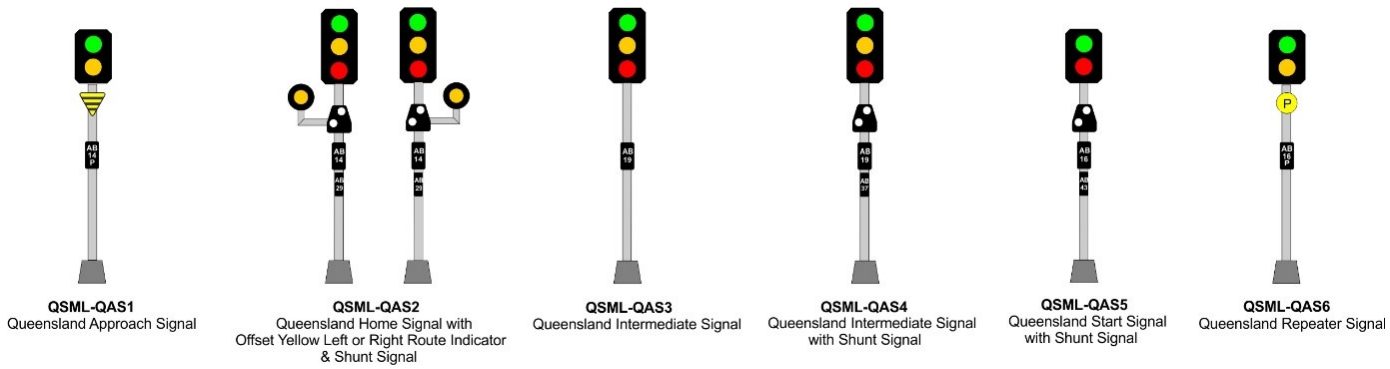
Axle Counters are another form of detecting track occupancy that QR/Aurizon use. They work on the principle of counting the number of axles into a section and the corresponding number of axles out of the section. If the count out of a axle counter section is less than the count in, the track is deemed to still be occupied. Axle counters are ideal for use on long block sections between stations, as the equipment required to detect track occupancy is far less when compared with traditional track circuit equipment. As a result, the cost of installation and maintenance is also significantly less. Another example use for axle counters are Balloon loops. In certain circumstances it may only be necessary to have 1 axle counter head for balloon loops. But this will depend on the arrangement of the signalling around the balloon. In recent years Aurizon has been predominately using axle counters for detecting track occupancy, irrespective of how small a section is. The one negative aspect of using axle counters versus track circuits, is that axle counters do not provide broken rail protection.





11. Model Signals and Associated Equipment for HO Scale

Queensland Scale Models and San Mateo Line in a joint project, are developing a range of kit and ready to place signals specifically for the QR market.
The range of signals will cover every type of signal needed for a single track crossing loop station.



QSML-QAS1
Queensland Approach Signal

QSML-QAS2
Queensland Home Signal with Offset Yellow Left or Right Route Indicator & Shunt Signal

QSML-QAS3
Queensland Intermediate Signal

QSML-QAS4
Queensland Intermediate Signal with Shunt Signal

QSML-QAS5
Queensland Start Signal with Shunt Signal

QSML-QAS6
Queensland Repeater Signal

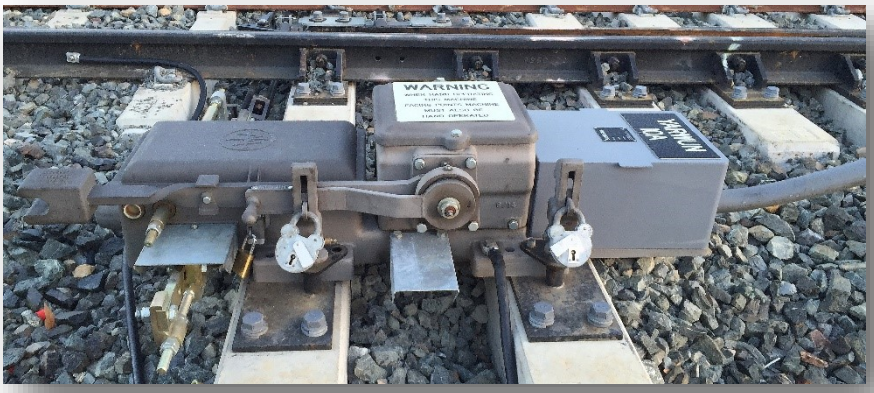
Uneek Model Products offer a range of signal equipment detail parts that can be used by the QR modeller. The following items can be used:

These are marketed as Breakout Boxes/Trackside Control Box. QR calls these Location Cases or Loc Boxes for short. The larger box is a 'Full Width Location Case' while the smaller is a 'Half Width Location Case'

Ground Frame, Uneek has these in either a 2 or 3 lever versions.

Details West have numerous trackside detail parts that can be used by the QR modeller. The following items resemble equipment used by QR.

SM-903 Westinghouse/Siemens M23A Style Points Machine



EC-901 Full Width Location Case

DD-905 Dragging Equipment Detector (DED)

Although it is 4mm scale Peco offer a points machine that is similar in appearance to GEC HW2000 Points machine, which is used throughout the BSA.

SL-47

12. Commonly used Abbreviations in Signalling

AB - Absolute Block

ATC - Automatic Train Control

ATP - Automatic Train Protection

AWS - Automatic Warning System

BSA - Brisbane Suburban Area

CTC - Centralised Traffic Control

DSI - Dynamic Speed Indicator

DTC - Direct Traffic Control

DED - Dragging Equipment Detector

ER – Electric Release

GFR - Ground Frame (Manual operation of points and signals from a lever frame)

GIJ – Glued Insulated Joint

IRJ - Insulated Rail Joint

JRI - Junction Route Indicator (Lunar Lights)

LPS – Leading Positon Light Signal

LOS- Limit of Shunt

NCO - Network Control Officer

RAPAD – Red/Restored And Passed At Danger

RCS - Remote Controlled Signalling

RIFOT – Red/Restored In Front Of Train

RTC – Rail Traffic Crew

SPAD – Signal Passed At Danger

UTC - Universal Traffic Control

13. Acknowledgements

I would like to thank Carl Millington and Frank Tybislawski who were of great assistance to me whilst compiling these notes for the Modelling the Railways of Queensland Convention 2016.

Also thanks to Graham Nicolson from Queensland Scale Models and Anton Bognar from Anton's Trains for use of drawings/photos.