

**AN INTRODUCTION TO
TRAIN MANAGEMENT SYSTEM
OF
WESTERN RAILWAY**

Project Title:

**An Introduction to the Train Management System Of
Western Railway**

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Sub: Attendance record for period JULY 2006 to APRIL 2007.

Dear Sir,

This is with regards to the attendance record of the following students for the purpose of B.E. project work in TMS (Western Railway) under my supervision.

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- 2) Dadasaheb Karad
- 3) Madhusudan Pawar
- 4) Milind Pilankar

Project Title: Train Management System

MONTH	Date of Attendance
JULY	12 th , 19 th , 26 th
AUGUST	2 nd , 16 th , 30 th
SEPTEMBER	6 th , 20 th
OCTOBER	4 th , 11 th
DECEMBER	16 th to 30 th
JANUARY	17 th , 24 th , 27 th , 30 th
FEBUARY	7 th , 28 th
MARCH	7 th , 14 th , 21, 28 th
APRIL	4 th , 11 th

The overall attendance record has been satisfactory.
Kindly accept this attendance report for semester VII & semester VIII to be attached with the Project Synopsis.

Thanking You,

Yours Sincerely,
Mr. Vilas Burse
[Project Guide]

ACKNOWLEDGEMENT

The written word has unfortunate tendency to degenerate genuine gratitude into stalling a formality "However this is the only way that we can recall our original feeling permanently".

We would like to thank Western Railway and **Mr. Joseph** for giving us an opportunity to undertake this project.

Among the panorama of people who provided us inspiring guidance and encouragement, we take this opportunity to thank our project guide **Mr. Vilas Burse** for his invaluable suggestions and constant encouragement.

We also like to thank **Mr. Varghese** for his whole hearted support and guidance in completing this project.

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Special thanks goes to **Mr. Khalid Kagzi** who was always there for helping us in the completion of this project as well as the challenges that lies behind it.

Abhishek Bajpai

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ABSTRACT

The aim of this report is to give the reader an in-depth knowledge about the various Signalling and Interlocking aspects employed by Indian Railways.

This report attempts to put together theories, techniques, procedures used in Western Railway by Train Management System to provide a fail safe method for systematic operation of trains between Churchgate and Virar.

This project highlights the concept of managing trains at one particular station (Mira Road) by developing a simulation through microcontroller.

Emphasis has also been given about the Historical Development of Railway Signalling.

This project finally concluded with a real life simulation of the Train Management Systems Route Relay Interlocking panel.

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TMS control center at Mumbai Central

INTRODUCTION

1. INTRODUCTION

Suburban section of Western Railway in Mumbai from Churchgate to Virar extends over 60 Km (approx.) and comprises of 28 stations. Section Churchgate to Borivali (about 34 Km) is having quadruple lines and balance section Borivali to Virar is double lines. Section handles about 1007 suburban trains which carry 3.0 million passengers during 24 hours and 154 Mail / Express / Miscellaneous movements are also handled. Train movement is based on automatic signaling system.

During peak hours (morning 8.30 to 11.30 hrs. and evening 17.30 to 20.30 hrs), trains are spaced at 3 minutes interval, thus working very close to available headway of 3'12". Sectional capacity is already over saturated.



At a glance statistical details of suburban section are given below —

1)	No. of Stations	28
2)	No. of Section Controls Churchgate - Andheri Andheri – Virar	Two 16 Stations 12 Stations
3)	i) Total No. of Suburban Trains(24 Hrs) ii) Mail/Express & misc. movements	1007 154
	Total	1161
4)	No. of EMU rakes in operation (during peak hours)	64
5)	Theoretical headway Trains spaced as per time table	3 Minutes 12 secs. 3 Minutes
6)	No. of signaling control towers No. of signals	20 500

Earlier System of Suburban Train Operations :

Suburban operation is divided into 2 controlled sections viz. Churchgate-Andheri (16 stations) and Andheri -Virar (12 stations). Controllers in the earlier system of working, used to collect information on telephone about the actual departure of each trains from the important nominated stations only, as it was not practical to collect timings from all 28 stations, keeping in view that every 45 seconds a train is passing a station. Departure timings were recorded in a pre-printed chart, each page covering ½ hour duration. Controllers in case of diversion/cancellation of trains informed various Assistant Station Masters (ASMs), who in turn were required to take action for manual updating of train indicator display boards.

Constraints of the Earlier Working:

Following are the constraints of the earlier system:-

Controller was essentially a recorder rather than managing the train movements.

Information was not available immediately regarding unusual incidents at field.

Decision/Action taken was delayed.

Decisions taken were ad-hoc.

The information displaying on Indicator display may not math with actual train-running information.

Delay in announcements.

Why TRAIN MANAGEMENT SYSTEM (TMS)?

Earlier system of manual exchange of train movement information from / to stations and to / from control office did not provide much assistance to the Controller to take timely and optimum decision for train controlling in case of any unusual event that puts operations out of gear.



Similarly, timely information to the ASMs was also not available for ensuring correct displays and announcements. To match high volume traffic of suburban section, there was need to provide 'on line' information of train movements to the various Agencies e.g. Controller, ASMs etc., who then can take timely and effective steps in case of disruption of the operation.

The Train Management System (TMS) is an information storage and display system and its primary function is to give visual information to the controllers regarding the time/destination and distinctive number of trains at various locations in the area under his control. The train number is displayed on the Wall Type indication Panel/Video Monitors in the control room. These displays are provided for each running line for entire section from CCG to VR.

TMS system primarily provides for —

'On line' display of movements of all trains with Train Numbers/Rake Nos. on video monitors as well as over view indication panel, located in control room.

Interfacing with the train indicator boards at various stations for *minute to minute* train arrival information to commuters

Provision of video display units for train running information to commuters with *countdown in minutes.*

Literature Survey

2.Literature Survey

HISTORICAL DEVELOPMENT OF RAILWAY SIGNALING

2.1 ABSOLUTE BLOCK SYSTEM

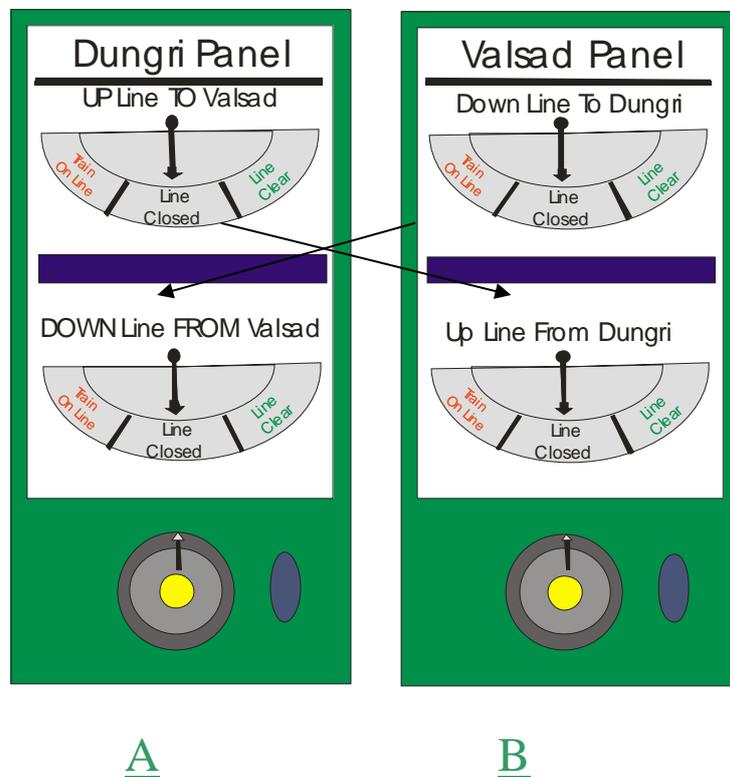
Principle:

The principle of the Indian Railways Absolute Block system is quite straight-forward (this can be referred to in Appendix). Only one train should be in any one block section at a time. The Absolute Block system applies on double or multiple lines where trains always use each line in a pre-determined direction and also on single lines but the instruments used on double and single lines are of different types.

The Absolute Block System of working on Double lines

On double lines the cabins on each end of the block sections are equipped with a Block Instrument which is usually of the SGE type mentioned earlier. It has two small windows which show the status of the UP and Down Lines and a round handle known as the Commutator which also has a plunger in the middle. The commutator can be turned through three positions but only by first pressing the plunger in the middle. Pressing the plunger sends one bell beat to the block instrument at the other end. In addition to the block instrument, a bell is also provided which gives a single beat on its gong every time the plunger at the other end is pressed. A block telephone is also provided to enable voice communication between the two block instruments. In addition a buzzer is provided to sound when the leading vehicle of the train passes the Advance Starter and enters the Block Section and an Indicator Lamp is provided which lights up when the Block Commutator becomes Free(explained in following paragraphs).

A representation of typical block instrument in operation on the IR is given on the next page. The upper panel on instrument A shows the status of the up line to the next station namely Valsad. The needle at the Line Closed position denotes that no train is allowed to enter the Block Section and neither is any train already in the block section. If Dungri station wants to send a train to Valsad he will press the yellow bell plunger once which will ring the bell at Valsad once (calling attention signal) In turn Valsad station will acknowledge by pressing his own bell plunger once and picking up the block phone. The cabinman at dungri also picks up the phone and gives the description of the train he wants to send to Valsad. For example it's the 2926 up Paschim exp. train.



When Valsad panel receives the train description he gives a Private Number to Dungri Cabin. Now both put down their phones and make an entry in a register known as the Train Signal Register (TSR). Various timings regarding the procedure are noted down in the TSR. After a minute or two depending on the current position of the train Dungri cabin will send two beats on the block bell (Line Clear Inquiry) asking Is Line Clear? If all the conditions for issuing a Line Clear are being met at Valsad, the station master at Valsad will press his block plunger twice and while

keeping it pressed the second time, will turn the commutator to the right hand position. Now the needle in the lower panel at Valsad will turn to the position Line Clear. Similarly, the needle in the upper panel at Dungri will also turn to the position Line Clear. As soon as Dungri station gets the Line Clear, his Up Advance starter is unlocked and can now be taken Off. Dungri station takes Off the advance starter which also constitutes the Authority to Proceed for the driver of the train.

Now the train passes through the station section and as soon as it passes the advance starter, a buzzer sounds in the Dungri cabin and the advance starter reverts to danger which indicates that the train is entering the block section. Now the cabinman at Dungri presses the block plunger three times (to indicate Train Entering Section) slowly and distinctly. In turn Valsad acknowledges the signal by pressing the bell plunger three times and at the third beat the plunger is kept pressed and the commutator is turned to the Train On Line position on the left most side. This also puts the needles on both the block instruments to the Train On Line position from the Line Clear position.

Now an electromagnet in the block instrument keeps the commutator locked at the Train On Line position till the conditions for giving the Train Out Of Section (TOS) signal are satisfied. When the train arrives at Valsad, it occupies the block overlap beyond the Home Signal. After clearing the block overlap, the TOS signal can be sent to Dungri. When a train occupies and then releases the Block Overlap, the Block commutator is released and is free to be turned to the Line Closed position. But before giving the TOS signal to the station in rear that is Dungri, the station master at Valsad must also verify that the train has arrived complete in all respects. It is possible that the train may have parted in the block section and only a part of the train has arrived and the rear end is still in the block section obstructing the line. To make this verification easy, a tailboard is provided on the last vehicle by day and a flashing red taillight is provided at night and is hung by the guard of the train. The tailboard has the letters LV written on it and means Last Vehicle. If the train has arrived completely then the tailboard is visible to the station master and now he can send the TOS signal to Dungri. The TOS is given by pressing the bell plunger four times and at the fourth instant keeping the plunger pressed; the commutator is

turned to the middle position i.e. the Line Closed position. Now the Block Instruments are ready for another train.

A similar procedure is observed while sending a train from Valsad to Dungri over the Down Line. Although the block instruments are combined for the Up and Down line, these lines are discrete and simultaneous movements can be conducted over both these lines without restrictions.

However, in case of emergencies, single line working can also be started on double line sections. Detailed procedures are laid out for such situations which are beyond the scope of this paper. However, in such situations, the Block Instruments may be kept suspended.

Conditions which must be satisfied for giving Line Clear:

The above paragraphs have mentioned that the Line Clear is simply given but in fact before a Line Clear is given the following conditions must be satisfied:

- 1) Previous train must have arrived completely.
- 2) Home signal at Valsad must be lit and at Danger. (Once Line Clear has been given, the Home can be taken Off).
- 3) Block Overlap of 180 meters must be clear of any obstructions at "B" Class stations and up to the Advance Starter at "C" class stations.

IR's bell code has some points of correspondence with systems used in the UK in the early part of the 20th century. The system of bell codes to convey messages from one signal box to another is given below. An 'X' indicates a short strike on the bell, and a dash indicates a pause.

Bell Codes

Message	Code
Attention	X
Line Clear Inquiry	XX
Train entering Block Section	XXX
Train leaving Block Section, Obstruction removed	XXXX
Cancel previous, Cancel last (given in error)	XXXXX
Danger or Obstruction	XXXXXX
Stop and Examine Train	XXXXXX-X
Train passed without tail lamp or missing tail board	XXXXXX-XX
Train Divided	XXXXXX-XXX
Runaway Vehicle (single line, or double line wrong direction)	XXXXXX-XXXX
Runaway Vehicle (double line, right direction)	XXXXXX-XXXXX
Instrument test	XXXXXXXXXXXXXXXXXXXX (16 beats)

The acknowledgement for each of these messages is given by repeating the same message immediately.

Sequence of the Signals

From the driver's viewpoint, while entering the block section he sees the following signals

First:

Advance Starter at Dungri-Already explained in detail above. This is usually a Two-Aspect signal showing Red or Green. But where block sections are short, this signal may be of three or four aspects and may also take the place of the Valsad Distant. In other words the Valsad distant signal may be combined with the Dungri Advance Starter.

Second:

Up Distant signal of Valsad- As explained in previous paragraphs, the Home Signal is the very first signal encountered by the driver at the station but the Home is a Stop signal and might be displaying the Danger aspect. Now an important rule of railway signalling is that a driver must never be shown the danger aspect directly but whenever he approaches a danger signal, the preceding signal must show a Caution aspect—that is the Yellow aspect. This will warn the driver that he is approaching a danger signal and will ensure that he has his train well in control before he approaches the Home at danger. Hence a permissive signal known as the Distant Signal is provided a full braking distance in rear of the Home signal. This maximum braking distance is considered to be 1000 meters on the IR. Hence the Distant is provided at a distance of 1000 meters from the Home. As the Distant is a permissive signal, the driver is never confronted by a danger aspect on a distant signal. If the Home at Valsad is displaying a less restrictive aspect then the Distant also steps up to green correspondingly.

Third:

Home Signal of Valsad— This signal is usually of the three or four aspect type depending on the yard layout ahead and may also have a number of route indicators to show the driver as to which route or line his train will be diverted onto.

Provision for Second Distant Signal on high speed routes:

On high speed routes such as Rajdhani routes, the train speeds have increased to such an extent that the braking distances of these trains has also increased considerably. In this situation, the lone distant described is insufficient to warn the driver in adequate time about the condition of the home signal ahead. Now the driver must be told about the condition ahead by the provision of another distant signal which is placed 2000 metres in rear of the Home. Hence now there are two distant signals—the first distant signal is now 2000 meters away from the Home and the intermediate Distant which was previously the Distant is now 1000 meters from the Home. If the Home is at Danger then the first distant displays Double-Yellow aspect indicating attention and the intermediate Distant displays the Yellow aspect. If the Home is green then both the distant signals are also green.

Intermediate Block Post and Intermediate Block Signal:

Usually stations are the places where Block Instruments are provided as mentioned earlier, most block sections are the distance between the two stations. But many times the distance between two stations is large such as upto 10 kilometers. If the block section is made so long then when a train enters the block section, until it reaches the next station, a following train cannot leave the station. This usually reduces the section capacity and also holds up important traffic sometimes. In order to minimize such delays, the **Block Sections** are divided into two or more parts. This can be done in two ways either by providing an Intermediate Block Post or an Intermediate Block Signal (IBS). It should be remembered that the above remedy is

available only in Double Line sections. In single lines, a much more complicated arrangement may be required.

Absolute Block System on Single Lines

On single lines, before a train is dispatched into the block section, it must be ensured that no train is already in the section and also no train is allowed to enter the section from the opposite end of the block section. To accomplish this aim, two main types of equipments are provided on single line sections.

In the older generation of equipments, a Token was extracted from one of the Block Instruments and handed over to the driver of the train which constituted his **Authority To Proceed**.

Token Block Working on Single Lines:

Usually the Neal's Ball type Co-operative Block instruments are provided. A brief introduction about its working is given in the following paragraphs.

The Block Instruments contain a number of Tokens which are spherical in shape and are also numbered serially. The mechanism of the Block Instruments and the wiring between adjacent Block Instruments is set up in such a way that at time only ONE token can be extracted from any instrument, Which means that if a token is extracted form instrument A then another token cannot be extracted from either instrument A or B. There are a total of 70 tokens provided between the two instruments and at time at least 69 tokens are always locked in the machines.

After the procedure of obtaining a Line Clear from the station in advance is obtained, a token has been extracted from the instrument; the token is handed over to the driver of the train which constitutes his **Authority To Proceed**. In addition obtaining the Line Clear also frees the Last Stop Signal (Advance Starter) if provided. Hence, now the driver can enter the section ahead and when he reaches the station in advance, he hands over the token to the cabinman who in turn inserts the token

back into the Block Instrument which again restores the total number of tokens to 70. These enables the Block Instruments to be normalized and are now ready to dispatch another train in the block section from either direction.

It should be remembered that before giving **TOS** to the station in rear, the station in advance shall verify that the train has arrived complete.

Token-Less Block Working on Single Lines:

On single lines which see heavy traffic, token-less block working has been introduced which also uses Block Instruments of a different type and relies on Occupation and release of track circuits to ensure safe working of trains. This type of block working saves time to large extent and in this type of block working the Advance Starter being taken Off constitutes the Authority To Proceed to enter the Block Section.

Disadvantages of Absolute Block System:

- As seen from the above example to move a train from one station to another several instructions have to be followed before making a move. This is fine in the sections where traffic density is low but in case of suburban traffic as in Mumbai where there are trains scheduled every three minutes, this system is certainly not feasible.
- Possibility of accidents due to negligence on the part of human beings.

To overcome the above shortcomings Automatic Block System is followed in higher density traffic areas such as in Mumbai suburban traffic.

2.2 AUTOMATIC BLOCK SYSTEM:

This system is mostly used in places where traffic density is high as in Mumbai Suburban Section.

In this particular system the signals are actuated by the trains themselves and therefore the train can follow each other between the two stations the section between the two stations is divided in to number of blocks and electric current is conveyed through the electric circuited track.

When a train enters a particular track the electric current puts the signal at danger position(red aspect) for the particular block until the train has gone nearly two blocks ahead that is for adequate distance. This system is used where traffic density is high as in Mumbai Suburban Section.

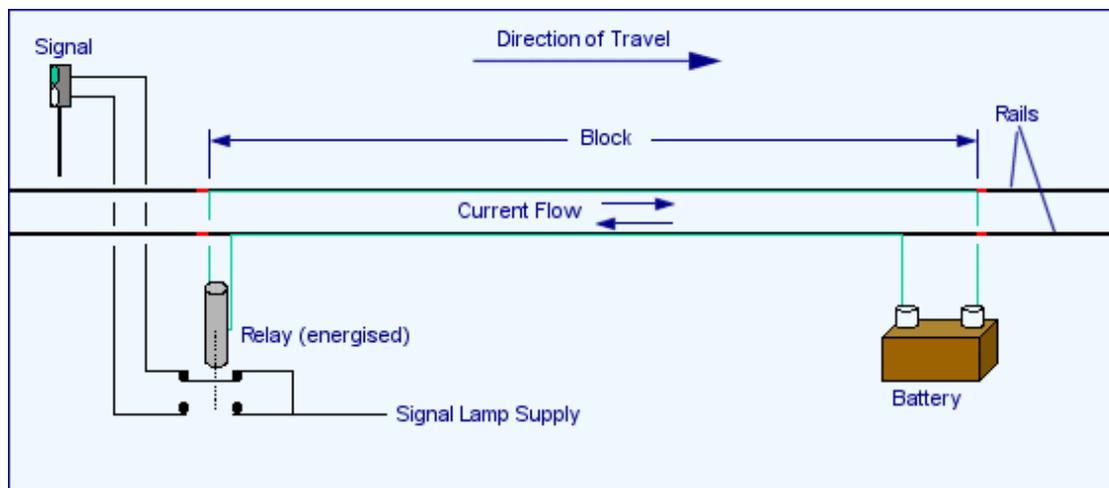
Characteristics Of Automatic Block Systems:

1. The movement of trains is controlled by stop signals which are operated automatically by the passage of trains past the signals.
2. No automatic signals assume "OFF" unless the line is clear, not only up to the stop signal ahead but also an adequate distance beyond it.
3. The line is track-circuited throughout its length and divided into a series of automatic signaling sections or blocks, each of which is governed by an automatic stop signal.

Advantages of Automatic Block Systems:

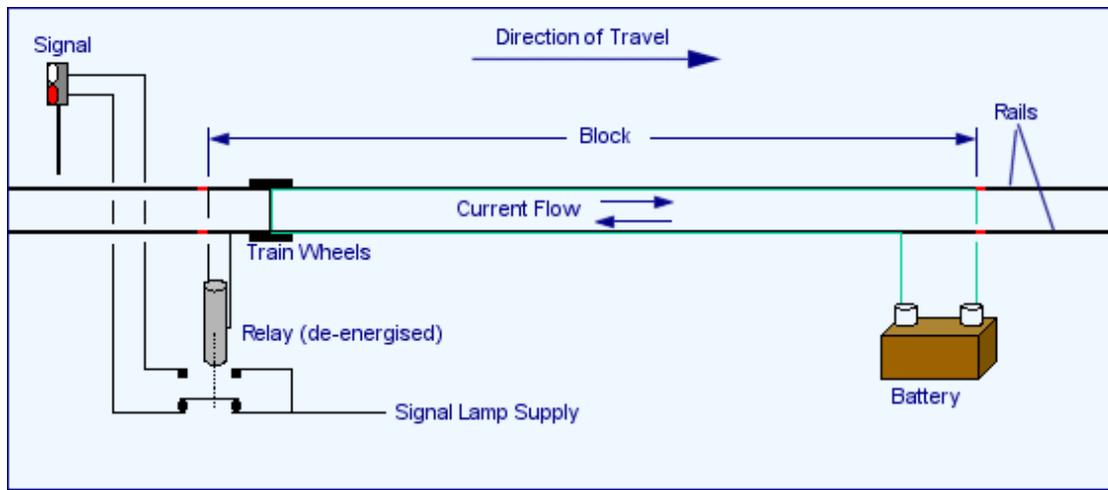
1. Due to automatic signaling, human error is eliminated which leads to greater safety and efficiency.
2. Less number of personnel for operating signals is required which reduces the operating cost
3. The system is a "**fail safe system**" i.e. in case of any failure of signals due to current, are made to bring the signals the signals at Danger position.

Track Circuit - Block Unoccupied



This diagram shows how the track circuit is applied to a section or block of track. A low voltage from a battery is applied to one of the running rails in the block and returned via the other. A relay at the entrance to the section detects the voltage and energizes to connect a separate supply to the green lamp of the signal.

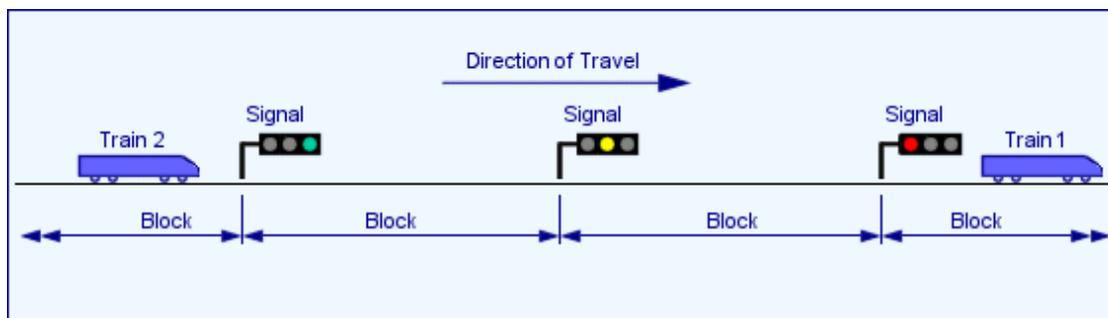
Track Circuit – Block Occupied



When a train enters the block, the leading wheel set short circuits the current, which causes the relay to de-energise and drop the contact so that the signal lamp supply circuit now activates the red signal lamp. The system is "fail-

safe", or "vital" as it is sometimes called, because any break in the circuit will cause a danger signal to be displayed.

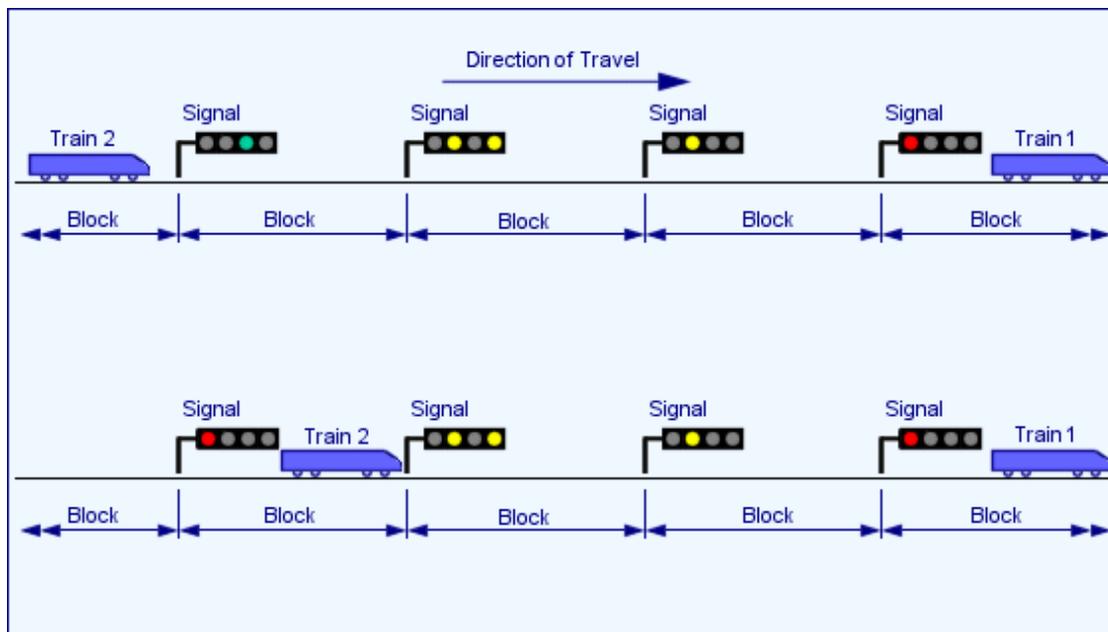
Automatic block system using 3-aspect signals



This diagram shows a line with 3-aspect signals. The block occupied by Train 1 is protected by the red signal at the entrance to the block. The block

behind is clear of trains but a yellow signal provides advanced warning of the red aspect ahead. This block provides the safe braking distance for Train 2. The next block in rear is also clear of trains and shows a green signal. The driver of Train 2 sees the green signal and knows he has at least two clear blocks ahead of him and can maintain the maximum allowed speed over this line until he sees the yellow.

Automatic block system using 4-aspect signals



The multi-aspect signaling commonly used in India today is a 4-aspect system. It works similarly to the 3-aspect system except that two warnings are provided before a red signal, a double yellow and a single yellow. This has two purposes. First, it provides early warnings of a red signal for higher speed trains or it can allow better track occupancy by shortening the length of the blocks.

Automatic Signals are of two types:

- i) **One with 'A' marker**
- ii) **Another with plate marking.**



Fig: 'A' marker signal



Fig: Plate marker

Difference between 'A' marker and Plate marking.

Automatic signals are normally not monitored by the signal man. In case of failure of the system the signal might continue to display the danger aspect while the track is clear ahead.

In such a situation driver might stop at defective signal & wait for the signal to clear. But as signal man is not monitoring the signal no one might realize about the defective signal. Because of such a possibility drivers are allowed to pass automatic signals at danger after waiting for 1 min during day time & 2 min in night.

However some signals are required to work some times in automatic as well as manual mode. Such signals are provided with 'A' marker light. When the 'A' marker light is lit the driver is allowed to pass the signal at danger. If the 'A' marker is extinguished then driver has to wait till proper authority is to proceed is given (memo).

If fixed 'A' plate marking is provided the signal is assumed to be in permanently automatic.

Implementation

3. Implementation

The R.R.I (Route Relay Interlocking) panel at each station is purely based on Relay Logic. All the data coming from the field such as Signal Aspects (Danger, Caution, Attention, and Clear), Track Circuit (Released, Occupied) and Points (Normal, Reverse) conditions are given directly to the relay room through cables. From the relay room the corresponding indications come on the panel.

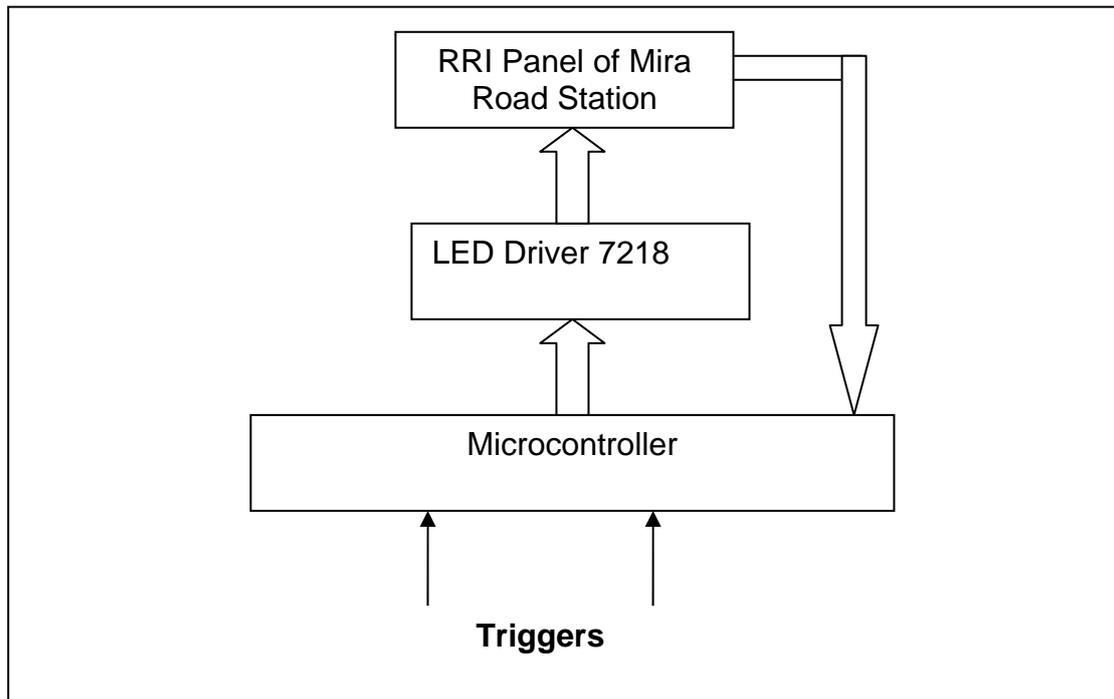
These real time data will not be available to us. Hence the idea of simulation comes in. Thus, with the help of a microcontroller four conditions were emulated which depicts all the important aspects of interlocking as well as signalling required for managing trains.

3.1 System Specifications:

For simulating the R.R.I. panel of Mira Road station the following components are required:

IC'S	Devices	Components
89C51 (Micro Controller)	7805(Voltage Regulator)	LED'S
7218 (LED Driver)	Bridge Rectifier	Push to on and SPST switches
7449 (7 segment Decoder)		Resistors, Capacitors
		7 segment display

3.2 BLOCK DIAGRAM



Description:

R.R.I. panel:

It will display the position of trains, signal aspects and point conditions. The panel contains switches mentioned earlier for performing different operations. The panel also contains two seven segment display (one for each line) for showing EIM (Expected In Minutes). One speaker is also placed for making necessary appointments.

Micro Controller:

Microcontroller will give appropriate signals to the panel whenever an initial trigger is given to it through SPST switch provided on the panel. These switches are placed for initiation of one of the 4 conditions.

The microcontroller also accepts signals from the push to on switches placed on the panel when the 2nd, 3rd, and 4th cases are simulated.

3.3 Working

Initially all the pins of port 2 are pulled up to Vcc. For the circuit to start operating the microcontroller will continuously check the voltage level of port 2 pins.

When the switch is depressed corresponding to a particular condition, it will provide a short circuit path to Vcc through pull up. Therefore the voltage at pin reduces to zero which is detected by the controller. Now the controller will jump to the appropriate subroutine to execute the particular case. In each subroutine the display pattern of LED's is changed at different instants of time.

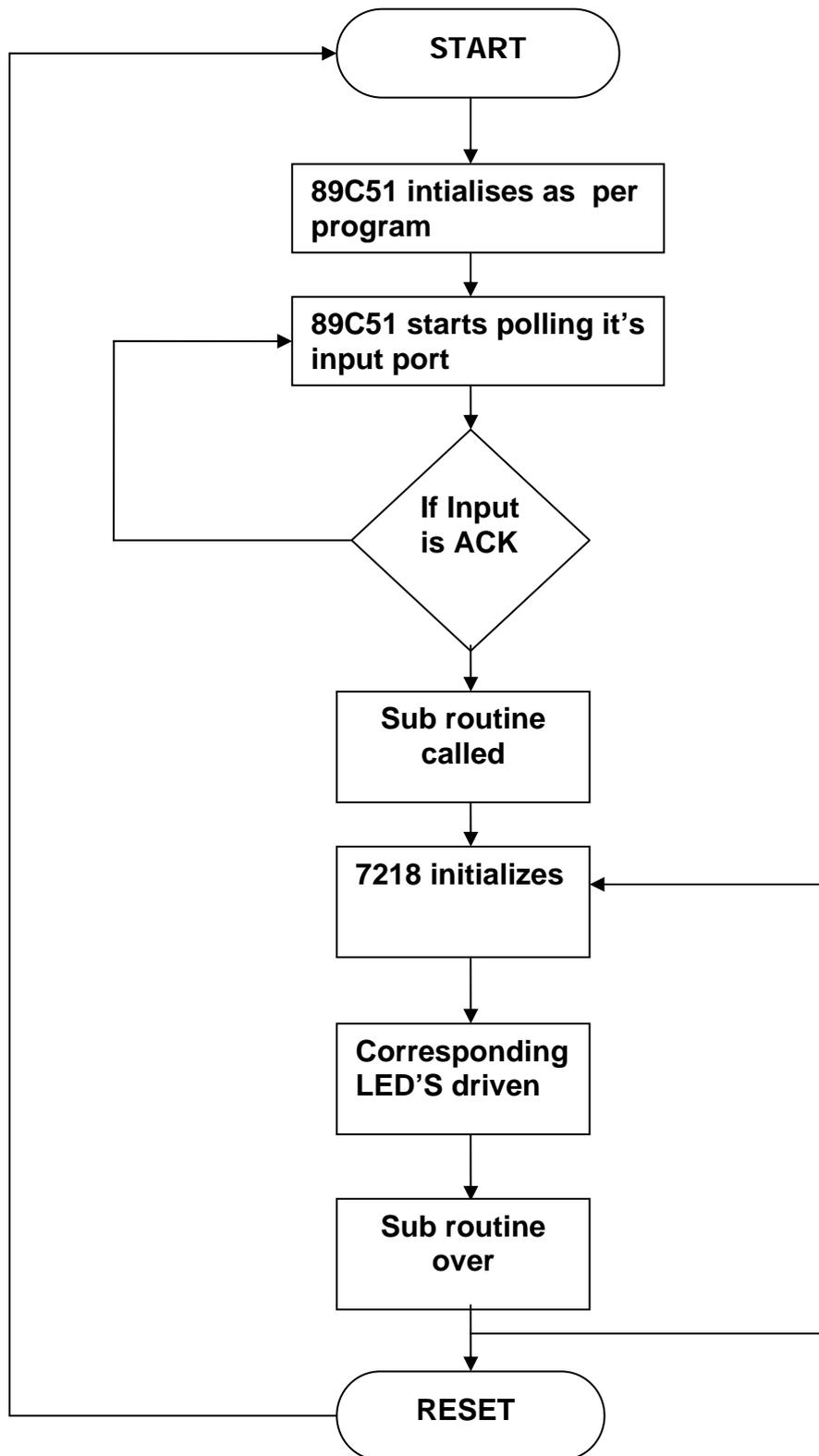
This is done in the following way:

- The LED's are controlled by updating IC 7218-A to which they are connected by means of single digit update mode.
- When the subroutine is over the controller will jump again to the start of subroutine and the process continues.
- At any point of time when the reset button is being pressed the ongoing condition will terminate and the program restarts.

Interfacing IC-7218 A To Microcontroller

The ports of the controller are connected to the data bus of 7218 and port 1 pins are applied as control pins (write, mode) .

FLOWCHART



LOGICAL FLOW OF THE PROJECT

As soon as the microcontroller is turned on, it will initialize port 2 as input port and other ports as o/p ports also it will follow the loop until an input has occurred.

When the switch corresponding to condition 1 or 2 is pressed, it will jump to the routine written for that particular condition.

In each routine we first initialize the ICM 7218A in no decode mode in which the individual LED'S can be controlled (all 64 segments).Refer datasheet for details given at the end of the report.

And then according to the movement of the train the LED'S are controlled. Condition 2 is in continuation with condition 3 and 4.

For second and third condition which involves manual operation (taking signal from Automatic working to Manual working) the microcontroller continuously monitors the status of this input at port 2 pin, as soon as the signal at this pin is low the required subroutine is called by the controller.

R.R.I. Panel Notes

<u>Button Code</u>	<u>Colour</u>	<u>Controls</u>	<u>Location</u>	<u>Function</u>
GN	Red	Main Signal	Near main signal indication	Pushed in conjunction with route button to clear the Main signal
GN	Yellow	Shunt Signal	Near main Shunt indication	Pushed in conjunction with route button to clear the Shunt signal
WN	Blue	Points/Crossover	Lower part of the panel below the controlled point	Pushed in conjunction with COPB to swing the points from Reverse to Normal and Vice-Versa
--UN	Grey	Route	Concerned Route/Track	Pushed in conjunction with Main Signal/Shunt Signal Button (GN) to set and lock the route and to clear the signal.
COPB	Blue	Common Point Operation	Top part of the panel, usually somewhere in the centre	Pushed in conjunction with individual points button(WN) to swing the points from Reverse to Normal & Vice-Versa
AGGB	Red	Manual Working	Top part of the panel	Pushed in conjunction with Semi Automatic Main Signal to take the Signal into manual mode.

LEGENDS:

Signal Aspects

Orange Led - Path set

Red Led –Path occupied

Blank – Path neither set nor occupied

White Led – “A” Marker for semi automatic signal

Blue Led – Points set and locked in reverse position.

Red Button - Main signal button

Green Button - Shunt signal button (Yellow Button in real panel)

Black Button – Route button (Grey Button in real panel)

Aspect	Meaning
Yellow Over Yellow	Attention
Green	Clear
Yellow	Caution
Red	Danger

The main signal buttons are placed along the signals which can work in both manual as well as automatic mode such as S12 in the up line and S1, S39 in the down line. All these signals are provided with 'A' marker and when it is lit indicates that the corresponding signal is working in automatic mode & when the marker is off indicates the signal is working in manual mode. These buttons can only be made functional when the corresponding signal is working in manual mode.

Simulations

4. Simulations

The four conditions taken up for simulation are as follows:

SIMULATION-1:

E M U through up main line. All signals working in **Automatic** mode.

Sr. No.	Sequence	Signals	Track
1)	When train has not occupied the track and the whole path (up track is set)	S/A 507,S 12, & S/A 505 - clear	A 509 T to A 505 T set
2)	Train arrives and occupies A 509 T.	S/A 507,S 12 & S/A 505 - clear	A 509 T occupied
3)	Train crosses S/A 507 and occupies A507 T.	S/A 507 - danger	A 509 T blank A 507 T occupied.
4)	Train crosses the overlap of S/A 507 and occupies 502 T (arrives at pl. No. 2)	S/A 507 danger	Track up to A507 T set
5)	Train crosses S12 and occupies 12 T and 101 T.	S-12 danger S/A -507 danger	Track up to 101 T set.12 AT blank
6)	Train crosses the overlap of S12 and occupies 12 A T	S-12 danger, S/A 507 caution	Track up to 101 T set.12AT occupied
7)	Train occupies A505T	S12 danger , S/A 507 caution	A507 T – 101T set, 12 AT blank, A505 T occupied.
8)	Train crosses the overlap of S/A 505	S/A 505 – danger (red aspect) S-12 caution, S/A 507 attention	All the track from S/A 509T – S/A 505 T set

Other important conditions related to first Simulation:

- a) SH-7 -> should always be on.
- b) Point 101 and 102 should be always normal.
- c) 'A' marker of S-12 should be lit since it is working in automatic mode. All other signals are purely automatic.
- d) After some time all the signals will show clear aspect since they are working in automatic mode. An automatic signal sets the route by itself.

SIMULATION 2:

E M U through down main line. S1, S39 **Manual**, S/A 506 purely **Automatic**.

Initially S1, S39 will lie in automatic mode ('A' marker lit) & S/A 506 is a purely automatic ("A" plate) signal. The whole down track is set and hence all signals will be clear. S1 will be taken into manual by pressing main signal button and AGGB (red button). As a result the 'A' marker will be off. Similarly S39 is taken into manual.

After this the main signal button of S39 and the route button 39 are pressed simultaneously. As a result the path from the overlap of S39 up to the overlap of S/A 506 will be set and S39 will show clear aspect. This is actually done with the help of RRI (Route Relay Interlocking) but in our project microcontroller (89C51) will be responsible for it.

Similarly the main signal button of S1 and the corresponding route button 01 are pressed simultaneously, the path from the overlap of S1 up to the overlap of S39 will be set and S1 will show clear aspect. After this the train arrives and the following events take place.

Sr. No.	Sequence	Signals	Tracks
1)	Train arrivals and occupies CIT.	S 1, S 39 & S/A 506 - clear.	CIT-occupied all the remaining track is set.
2)	Train cross S1 and occupies IT.	S 1 – danger S 39 & S/A 506 - clear.	CIT- blank IT - occupied.
3)	Train cross overlap of S1	S 1 - danger S 39, S/A 506 - clear	Tracks up to the overlap of S 1 is set
4)	Train arrives on platform.	S 1 – danger	Tracks up to the overlap of S 1 set and O2T occupied
5)	Train crosses S39.	S 1 - danger S 39 - danger S/A 506 - clear.	Tracks up to the overlap of O2T blank.
6)	Train crosses the overlap of S-39 and occupies 39T.	S 1 - danger S 39 - danger S/A 506 - clear.	Track up to the overlap of S 1 set. Track after the overlap of S 39 blank. 39T occupied.
7)	Train crosses S/A 506.	S 1 - danger S 39 - danger S/A 506 – danger.	Track up to the overlap of S 1 set. Tracks after the overlap of S 39 blank. 39T blank.
8)	Train crosses the overlap of S/A 506.	S 1 - danger S 39 - danger S/A 506 – danger.	Path after the overlap of S 1 up to the overlap of S/A 506 will be blank.

Other important criteria have to be satisfied:

- a) SH - 44 should be on continuously.
- b) Points 103 - 104 normal and points 111 - 112 normal.

- c) After some time S/A506 will show caution, then attention and finally clear aspect. For all this time S1 and S39 will show danger aspect since they are now in manual mode.('A' marker off) as different from first condition. Now the route can be set manually only. This is the main difference between an automatic signal and manual signal.
- d) If suppose advance starter (S/A 506) shows caution aspect. Then after setting the route for starter (S 39) will show attention aspect and after setting the route for home (S 1) will show clear aspect.

Simulation 3: (continuation from second condition)

Taking goods train into down loop Line and passing Rajdhani through main line.S1 & S39 are still in manual mode and showing danger aspect.S/A506 is showing clear aspect.

The main signal button of S1 and route button DGL are pressed simultaneously. As a result, track after the overlap of S1 up to the overlap of S35 will be set. Points 103 & 104 will be set and locked. After few seconds Route indicator will be turned on and after few seconds S1 will show caution aspect. After this the goods train enter and following events take place.

Sr. No.	Sequence	Signal	Track
1)	Goods train occupies C1T	S 1 caution S 39 danger	C1T occupied. Track after C1T up to overlap of S 35 set.
2)	Goods train crosses S 1.	S1 - danger after few seconds route indicator will be off. S 39 - danger S/A 506- clear S 35 - danger.	IT - Occupied C1T - Blank
3)	Train crosses the overlap of S 1.	S 1 - danger After few seconds route indicator will turn off. S 39 - danger S/A 506 - clear S 35- danger.	Track up to the overlap of S 1 is set.
		S 1 - danger.	

4)	Train arrives and stops at S 35.	S 39-danger S/A – 506 clear S-35-danger.	Track after the overlap of S 1 will be blank.
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Setting the route for 'RAJDHANI'

The procedure followed to set the route for RAJDHANI is same as that followed in the second condition.

Other important criteria's

- a) Trap 105 should be Open.
- b) SH 5, SH 44, S16 should be ON.
- c)
 - i) Points 101-102 normal.
 - ii) Points 102-108-normal.
 - iii) Points 111-112 normal

Simulation 4: (Continuation from third condition)

The goods train on the loop line has developed a loco failure. Hence arrangements are made for a relief engine by TLC (Traction Loco Controller) which comes from BDTs (Bandra Terminus) loco shed.

Conditions are same as for the Rajdhani case, only that the loco doesn't cross S/A 506 (The Advance Starter). The loco stands at 39 AT. After this SH – 44 (green button) and DGL (black button) are pressed together.

Thus the four conditions are established by the help of a visual display on a signal panel with the help of the monitoring system.

Conclusion and Future Work

5. Conclusion:

The Absolute Block System of working was studied initially by traveling upto Surat for getting a first hand knowledge. The study for Automatic Block system was done next.

The R.R.I. (Route Relay Interlocking) principle and various signaling concepts were studied. The project develops a simulation model for the RRI panel of Mira road. It takes all the precautions which are actually taken up by the Railways to provide a Fail Safe system of working.

The project is built on the basics of R.R.I. and Automatic Block System. This project can be used as a trainer kit for anyone who is interested in understanding this complex yet very interesting system of management.

During the course of this project hand-on experience about the working of different systems for managing trains in Indian Railways was gained. It makes one realize the complexities involved in running the "Life line "of Mumbai.

Future work:

- 1) The present R.R.I. (Route Relay Interlocking) panels is not provided with a T.D.S.(Train Describer System) i.e. Train numbers(id's) are not shown in the panel .The Panel controller of each station has been provided with a time table on a day to day basis which contains the train IDs.

- 2) R.R.I. will soon give way to S.S.I.(Solid State Interlocking).In this type of interlocking three computers are present.
Two computers will have 3 inputs coming from the field. These are:
 - a. Various aspects of signals present at the station.
 - b. Position of Points (whether normal or reverse).
 - c. Condition of Track circuits (Occupied or released).

The o/p of both the computers is given to a third computer which acts as a comparator. To set a route for an incoming train the third computer will compare the outputs from both the computer and if they match then only the corresponding route will be set.

S.S.I. is implemented in Indian Railways at smaller stations.

Appendix

Appendix

Essential Reading

I. CONTROL SYSTEMS

Control of Movement of Trains:

One of the basic objects of signalling is to control the movement of trains with a view to ensure safety by preventing accidents. The ambit of a signalling system can be divided into two parts namely the station area and the section of track which is between any two adjacent stations.

Technically the section of track between two adjacent stations is known as the "Block Section" and the procedures set up to operate trains through this section is known as the "System of Working"

On the Indian Railways (IR) there are mainly three Systems of Working namely:

- 1) The Absolute Block System of Working
- 2) The Automatic Block System of Working
- 3) The Permissive Block System of Working.

Out of the above three systems the first two are the most extensively used on the IR.

The Absolute Block System and Permissive Block System of Working will be explained later in the report under the "Development of Railway Signalling" part.

Before explaining the above systems, a few definitions are mentioned below:

Block Section:

The section of track starting from the Last Stop Signal (also known as the Advance Starter) of station A to the First Stop Signal of station B(also known as the Home Signal).

Station Section:

The section of track or the yard of a station which usually stretches between the First Stop Signal to the Last Stop Signal of the station.

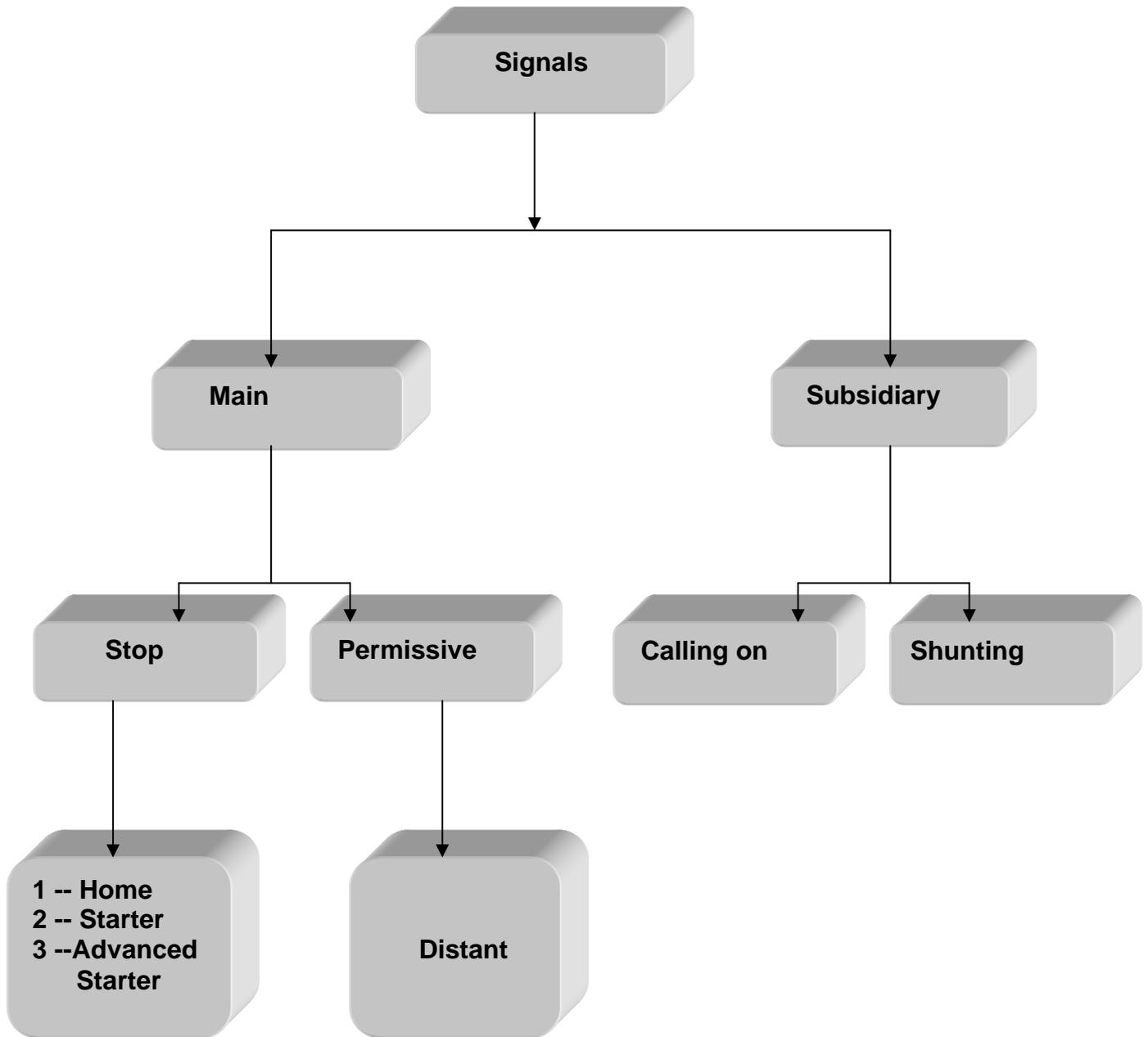
Overlaps:

Almost all running signals have a distance beyond them on the track which is required to be clear of any obstructions before a train can be received at the concerned signal if it is at danger. This safe distance is known as the Overlap. The overlap is provided to ensure that in case a driver overshoots a danger signal, the chances of an accident are minimal because of the clear track.

On the IR two types of overlaps are provided namely the Block Overlap and the Signal Overlap.

The Block overlap is 180 meters in length and the Signal overlap is 120 meters in length. The Home Signal is provided with the Block Overlap as this is the very first stop signal encountered by the driver while passing through the Block Section in which usually the maximum permissible speed is allowed and in case of a driver encountering a danger signal there are more chances of a driver being unable to control his train well in time and overshooting the signal.

The rest of the signals in the station section are provided with the standard signal overlap of 120 meters.



Signals:

There are mainly two types of signals namely Main signals and Subsidiary signals.

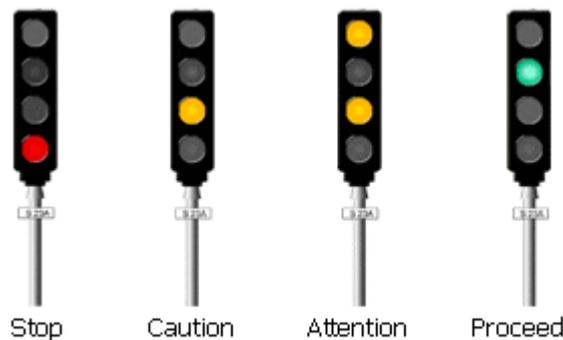
I) Main signals

Main signals are of further two types namely:

A) Stop signals

B) Permissive signals

A) Stop Signals



The most common indications shown by Stop Signals are as follows:-

a) Stop:

This requires a train to stop dead and not pass the signal except under special instructions or emergency procedures. (Stop signals may be passed after halting and waiting in automatic block territory – usually 1 min. during the day & 2 min. during the night.) This indication is also known as **Danger**.

b) Caution:

This allows a train to proceed past the signal with caution (at reduced speed), being prepared to stop at the next signal. It can mean that the next signal is at Danger, or that the track ahead has speed restrictions.

c) Attention:

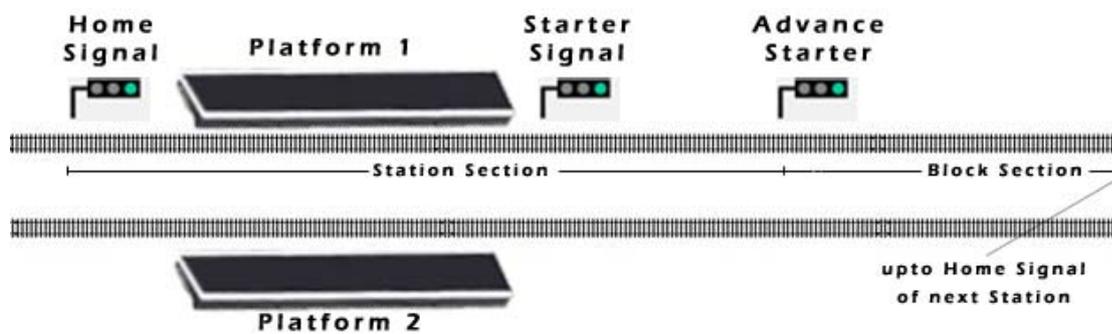
This allows a train to proceed past the signal, being prepared to slow down to an appropriate speed for the next signal. It means that the next signal may be at Caution, or may guard a divergence which requires reduced speed (in which case a stop signal at the divergence will indicate the route for which points are set).

d) Proceed:

This allows the train to proceed past the signal without slowing down or stopping.

A stop signal invariably has a danger aspect which is usually red (Danger indication) in colour.

Stop Signals are of the following types:



1) Home:

This is the first stop signal on approach to a station. The signal guards entry to the station.

A home signal at Caution indicates that the train may have to stop on the line before leaving the **block**, or that the train has to slow down to a particular speed in order for the starter signal at the entrance to the next **block** to shift to Proceed.

For stations with multiple lines where a train may be received (i.e., main running line and loop lines), normally home signals are provided with route indicators ('feathers'), just before the diverging points to the various lines, to indicate for which line the **points** have been set for the train to be received.

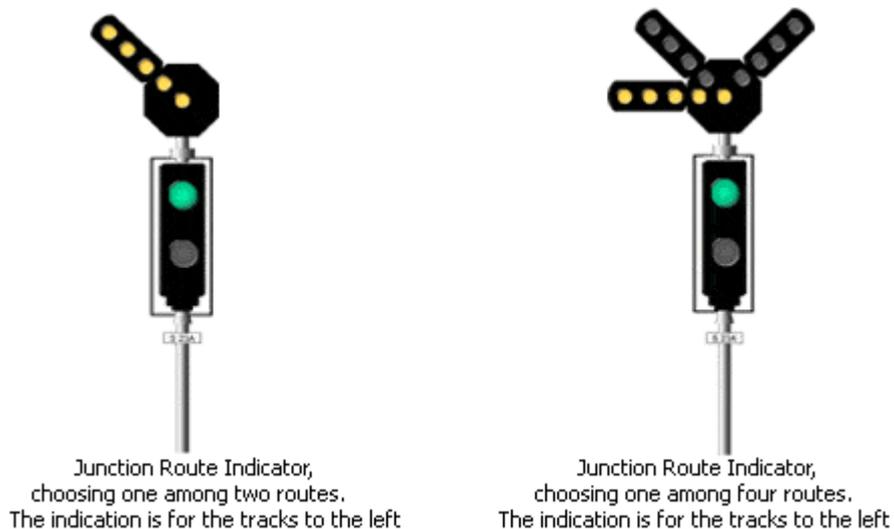


Fig: Home signal with Route Indicators

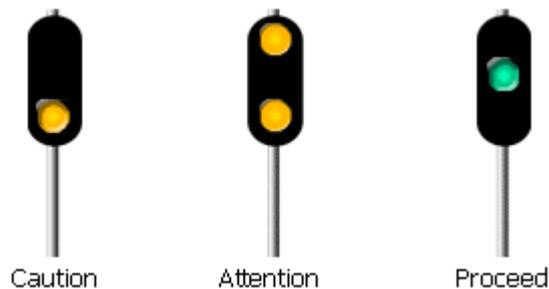
2) Starter:

This Stop signal governs the exit of a train from station limits,. Normally it is the last stop signal on departing from a station unless an advanced starter is present. If an advanced starter is provided, the starter may protect facing points to another running line at the same station/

3) Advance Starter:

It is a stop signal provided ahead of the starter signal, and therefore it is the last stop signal on departing station limits.

C) Permissive Signals



A permissive signal doesn't have a stop aspect and is used to give the driver an idea of the position of a stop signal which is coming up ahead. A permissive signal also has a "P" marker plate mounted on its pole to give the driver the indication that it's a permissive signal. This is necessary because in case a signal is totally blank due to a technical fault a Stop Signal cannot be passed by the driver and he must stop at the signal and await further instructions but if a permissive signal is found to be blank, it may be passed at a restricted speed and the concerned station master may be informed of the failure. A permissive signal is also called a Distant Signal.

ON and OFF aspects:

A signal which is displaying its most restrictive aspect is termed as being ON. For example a stop signal displaying the red aspect is termed to be ON. But a permissive signal displaying the yellow aspect is also ON because yellow is its most restrictive aspect.

A signal displaying an aspect less restrictive than the danger aspect is termed as being taken OFF. A main signal displaying a yellow, double yellow or green aspect is known as being taken OFF.

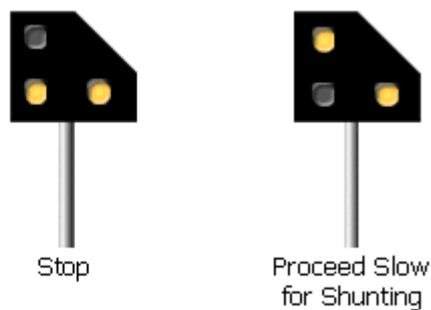
II) Subsidiary signals

Subsidiary Signals are also of two types:

A) Shunt Signals

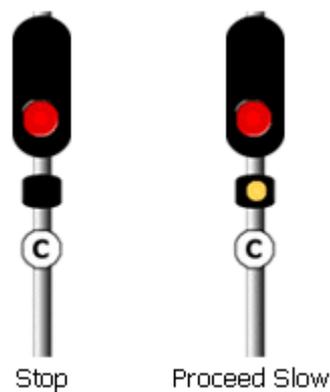
B) Calling-On Signals

A) Shunt Signals



The most common position-light signals used for shunting show two white or yellow lights arranged horizontally for the on position, and two lights at an angle (the one to the left being higher) for the off position.

B) Calling-On Signal



A major requirement for clearing the main signal is that the track upto the next signal must be clear and the overlap distance (120 m) beyond the next signal must also be clear. However sometimes a situation arises when the track upto the next signal is not clear or sometimes the overlap may not be clear. In such a situation the main signal cannot be cleared but to minimize detention to the train at the signal a subsidiary aspect is provided which is smaller in size and mounted below the main signal. When calling on is given a timing sequence of 120 seconds is initiated. After the lapse of 120 seconds, the calling-on aspect lights up. Meanwhile, the main signal remains lit at Danger. This is to remind the driver to proceed cautiously and be prepared to stop short of any obstruction on the track.

Points:

Points are the places where a train changes tracks. Points are moved either in normal or reverse with the help of a point machine.



Fig: Points in **normal** condition



Fig: Points in **reverse** condition



Fig: A Point Machine

II. Control Organization

In the above paragraphs, the movement of trains between two adjacent stations is discussed. But train operation neither starts from here nor ends here. There are many aspects which have to be managed and kept in mind and accomplished before even a single train can run. Also on a daily basis the Indian Railways are handling tremendous amounts of passenger and goods traffic across the country spanning many different railway divisions and zones.

Hence in order to keep this vast machinery in motion as also to utilize the assets to the maximum, a Divisional Control Organization is setup at each Divisional headquarters.

This Organization functions under the management of the Operating Department. The Operating Dept. is headed by a senior DOM (Divisional Operating Manager). He is assisted by other junior officers such as the DOM, Asst. DOM, Junior DOM, etc.

In addition a Control Office is also operational at the Divisional Headquarters of the Railway Division. This Control Office can be considered to be the actual brain of the Division as far as the minute-to minute management of the of the railway is considered. If the division is very large or has an unusual route layout then additional control offices may be provided at other important stations of the Division from where they can control the sections in their charge.

The hierarchy in the Control Offices is loosely in the following format:

Chief Controller (CTNL):

He is overall incharge of the control office and all controllers are subordinate to him. He is usually engaged in the macro management of the sectional traffic and dealing with abnormal events in the section under his charge.

Deputy Chief Controller (DTNL):

He is entrusted with coordinating between various other sub-controllers and also an important task of the DTNL is to "Order Trains". Ordering trains means to mobilize all resources required when a goods train is ready in the yard.

Assistant Controller (ATNL):

Also known as a ***Section Controller*** he probably has the most important task in the whole division. Each Section Controller is in charge of upto 150 kms. of a railway route which may be either single or double line and may also have a few branch lines and sidings or other not-so-common setups. This route length may include a number of stations, cabins, block-posts, large-goods and passenger yards, industrial sidings, loco sheds, etc(now collectively mentioned as "waystations"). Each and every one of the above mentioned entities is in communication with the section controller by way of an omnibus telephone circuit.

The Omnibus Telephone:

This comprises a telephone instrument at every **waystation**. This waystation telephone doesn't have a dial pad but has a press-to-talk button on the receiver of the phone. As soon as a person picks up the receiver he can listen to the conversation in progress on the telephone. If this person wants to talk to the controller, he presses the talk button on the receiver and first identifies himself and on receiving a verbal acknowledgement from the Controller, he can commence conversation. There is a specific etiquette while talking on the Control phone. A person should never interrupt an ongoing conversation except in case of a dire emergency. Also the Controller being a senior officer always has precedence in the conversation. If the controller needs to talk to a waystation, he is equipped with a dial pad and a ring button. He simply dials the waystation number and presses the ring button which sends a ring to the individual **waystation**. The waystation picks up the phone and carries on the conversation as described above. The control telephone circuit is also equipped with a facility to ring up all the way stations

collectively. In addition the setup at the control office is such that a microphone and a loudspeaker are provided to the controller so that he has his hands free. Alternatively a Headset jack is also provided for those controllers who prefer headsets. Each Omnibus Telephone Line is in Railway parlance known as simply a "Control Circuit" or a "Circuit".

Other controllers in the Control Office are also provided with their own Control Phone Circuits and are connected individually to waystations as per requirement. Circuits include those provided to the DTNL, Section Controller, Traction Power Controller, Traction Loco Controller, EMU Controller, etc. Control phone circuits are provided as per the individual requirements of the section and waystation telephones are provided as per need of the individual controllers.

Traction Power Controller:

The person involved has to monitor the power supply, tripping etc. taking place along the OH (over head) cable. If tripping occurs he can get into telephonic conversation with the sub-station etc. and has to make arrangements for the OHE (over head equipment) van to go to the tripping location for repairing purposes. Also he has to make a note for routine maintenance of the cable.

Signal and Telecommunication Controller:

This controller is available in some sections and is usually required in case of a Signal & Telecommunication failure and also monitors the routine maintenance of S&T equipments.

EMU Controller:

In Mumbai Suburban Western Division there are two car sheds available for regular maintenance, parking etc of rakes. One is present at Mahalaxmi while the other is at Kandivali.

The EMU controller knows the following details of each and every rake:

- 1) Whether the rake will be a 9 coach or 12 coaches one for the day.
- 2) Which rake will be operated as fast and which one as slow for the day.
- 3) After how many trips a rake will go to the car shed or siding etc.
- 4) Schedule Maintenance.

A daily plan is always prepared by the controller for the next 12 working hrs. on a chart.

More on the Section Controller and his Duties

As mentioned **earlier** the Section Controller has an extremely important task which is to monitor and keep track of each and every train stopped or moving in his section. In addition he also has to *Regulate* the movement of the trains in such a manner that slow moving trains so not come in the way of fast moving and important trains. On the IR a single track usually handles all kinds of traffic such as goods, passenger, parcel, suburban, High-Speed and Rajdhani. There are wide differences in the actual and average speeds of these different trains. It is also important to ensure that *all* these trains reach there destinations punctually. All these tasks are managed by the Section Controller while that train is in his section.

A much scaled down description of just *one* of his duties which is tracking the movement of various trains in his section is as follows:



Fig 1 - Screen Shot of Signaling Layout Display in Control Room

In this screen shot of part of an interlocking (Fig 1), unoccupied tracks are in grey, tracks occupied by trains are in red. Each track circuit is given a unique number, as are signals and points. Points are numbered in pairs (in yellow) where there is a crossover and they must operate together. Point numbers are provided with letters A or B to denote the ends of the crossover. Train 7752 (its ID, or "description", being displayed in a black box) is standing in the platform of Oak station on track circuit 107 awaiting permission to proceed. Signal C23 is showing a red aspect because no route has been selected and locked. The black square next to the red of C23 is the indication for shunt signal C25 covering the route into the siding. Overlaps are indicated in modern installations by a mark at the end of the track circuit concerned.

Route Set-up

In Fig 2, train 7752 is scheduled to depart on the Down line. The signalman has set up the route and his action is confirmed by the white track circuits along the route showing it is selected, available and locked. The icon of signal C23 is showing a green aspect to indicate that that the signal has cleared.

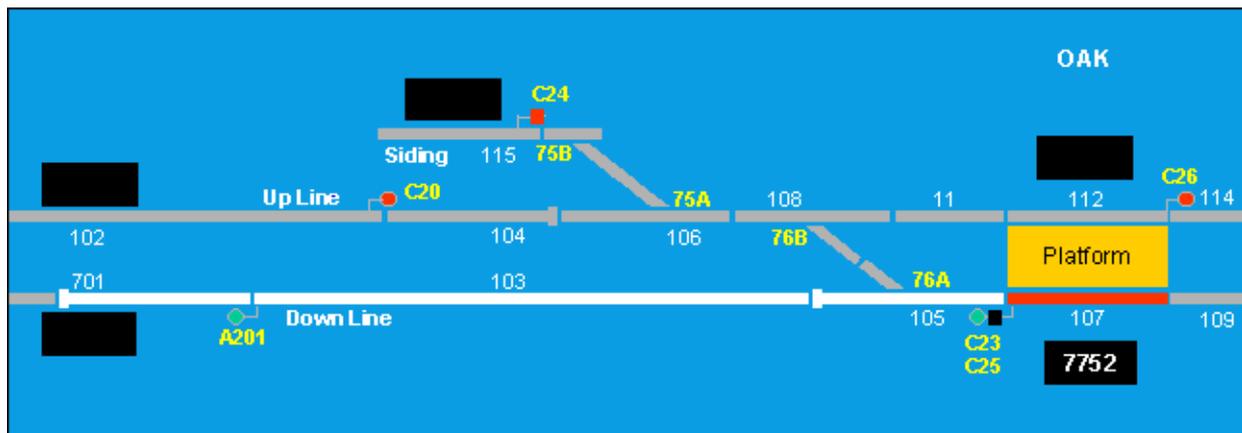


Fig 2 - Route Selection

Signals C23/C25 are approach locked. This means that routes over which they "read" cannot be set up unless track circuit 107 has been occupied for, in this example, at least 30 seconds. This ensures that a train occupying this track circuit has come to a stop and will not run onto the points while they are being changed.

Although the route is cleared, the train description will not normally be shown in the black box over the block ahead until the train occupies the block. Signal A201 is automatic and will always show a green aspect if the line ahead is clear for normal speed.

Train Movement Sequences

In Fig 3, train 7752 has started and is now occupying track circuit 105 as well as 107. Signal C23 has returned to danger. Remember that the diagram seen by the signalman is not to scale so that track circuit 105 is a lot shorter than 107. This will distort the view of the passage of the train. An experienced signalman gets used to it.

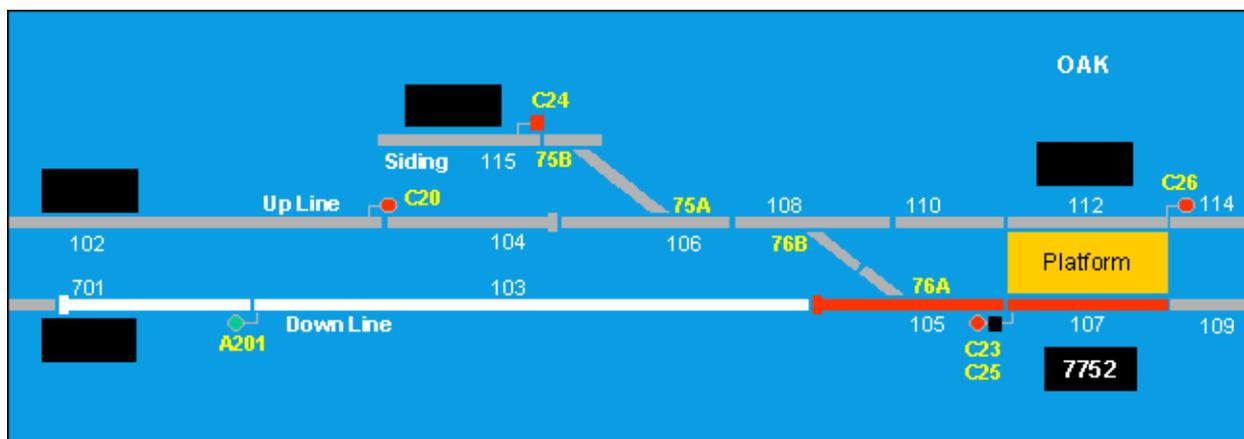


Fig 3 - Route occupation display

Note that the track circuit for crossover 76 has been split into two parts, even though the points at the two ends must be set and locked together for the crossover move. The splitting of the track circuit allows trains on the up and down lines to pass freely.



Fig 4 - Tracking the movement of the train

In Fig 4 above, train 7752 is now occupying track circuits 103, 105 and 107. The distortion of the apparent train length is even more evident now. Remember that, as soon as the first pair of wheels of the train enters the section, the track circuit detects them and switches to "occupied", hence the whole of 103 shows red.



Fig 5 - The train has released the points

Train 7752 (Fig 5 above) has now moved on some distance and the signalman's view of things has changed to match. The train is clear of the

platform and points and is occupying track circuits 103 and 701. The points are released to allow another route to be used.

Now that Train 7752 has cleared the platform its description has been cleared from the train description box and a new number, 6460, has appeared. This is the number of the next train to arrive at Oak. The signalman will know from the timetable that this train is scheduled to go into the siding and he must arrange the necessary route changes.

More Trains Arrive

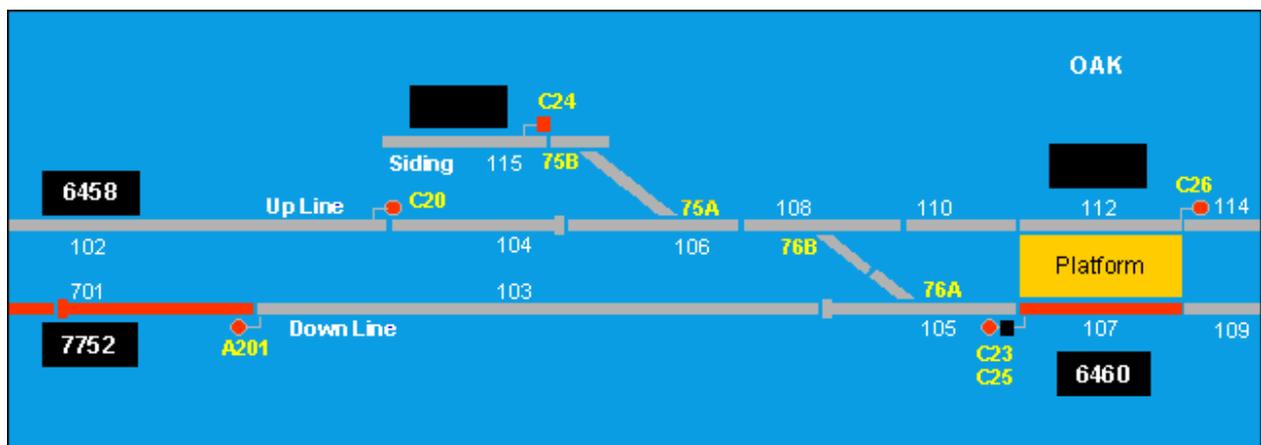


Fig 6 - Two trains are displayed

Fig 6 shows that train 6460 has now arrived at Oak and is supposed to terminate there. Passengers must be detrained and the train checked to ensure no one gets taken into the siding. While this is going on, an Up train, 6458, has also appeared on the "diagram". According to the timetable, this train should arrive at Oak before 6460 but it is running late. The signalman now has to make a choice.

He can set up the route for 6460 to get him into the siding and clear the down line. He wants to do this because there is another train due behind 6460 and he doesn't want to delay it. On the other hand, he doesn't want to

cause 6458 to be delayed further while 6460 crosses in front of it to reach the siding.

So, if he lets 6460 into the siding first, will it be quick enough to allow 6458 a clear run in? He will chance it because he knows from experience that the driver will want to get the train stabled quickly because it is the end of his duty.

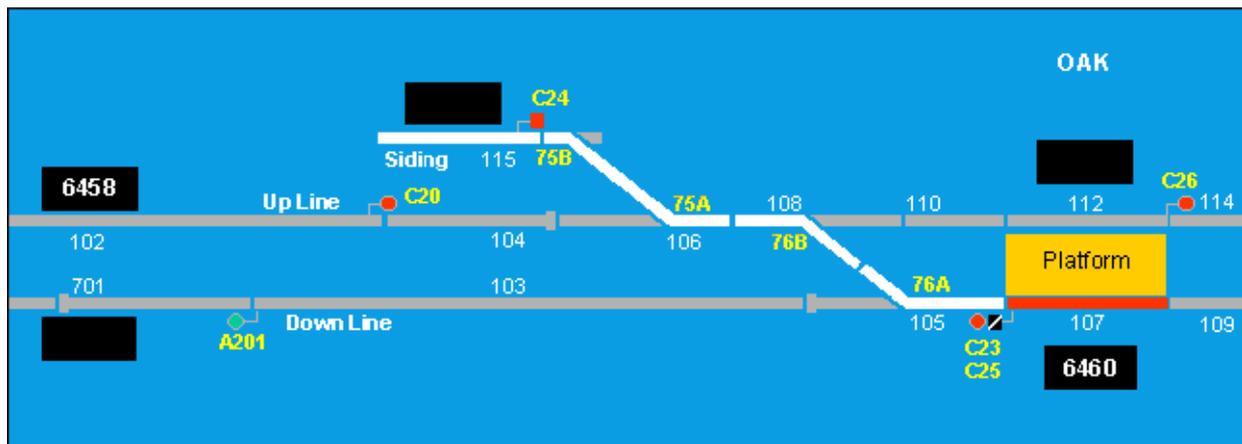


Fig 7 - A second route is selected

The signalman has decided to move Train 6460 into the siding across the path of 6458 and he has set up the route as shown in Fig 7. The white track circuit displays show that the route is set up and locked. The white diagonal on the icon of shunt signal C25 shows that the signal is showing proceed to the driver of Train 6460.

The Third Train Arrives

Time has moved forward a few minutes (Fig 12) and the signalman (to his annoyance) has seen no movement from Train 6460. However, by this time, Train 6458 has arrived on Track Circuit 102 and is standing at Signal C20. Already late, he will now be even later waiting for 6460 to clear the route.



Fig 8 - The third train arrives

The signalman has another choice to make. He can cancel the route set up for Train 6460, wait for it to "release" and then set up the route for 6458 to run into the platform or he can wait for the original move of 6460 to be completed.

If he cancels the route for 6460, the signalman must wait for it to "release" before another route can be set up. A release is an electronic timer usually set for two minutes. This is to ensure that no train moves on to a track circuit immediately after the signal has returned to red. This could happen if a driver sees a proceed aspect and starts his train, only to see the signal return to danger and finds he cannot stop before occupying the route.

The Next Move Begins

Now, at last in Fig 9, Train 6460 has begun to move. The signalman had phoned the platform staff to see what was holding up 6460 and was told they had trouble clearing the train. Someone didn't want to get off but it's now OK after they were told the police were to be called and the train will move.

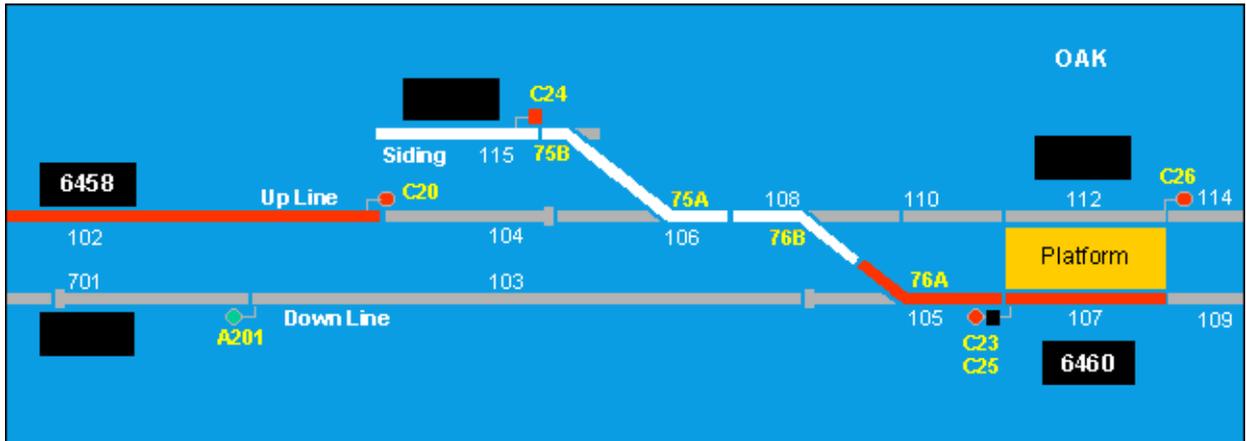


Fig 9 - Train 6460 moves towards the siding

You will see how track circuits at points reflect the layout of the points and indicate that the points are "track locked" as the train passes over them. Although 76 crossover actually has two separate track circuits, the points at each end of the crossover operate as a pair. As mentioned above, the separate track circuits are to allow trains to pass on the Up and down lines without interference.

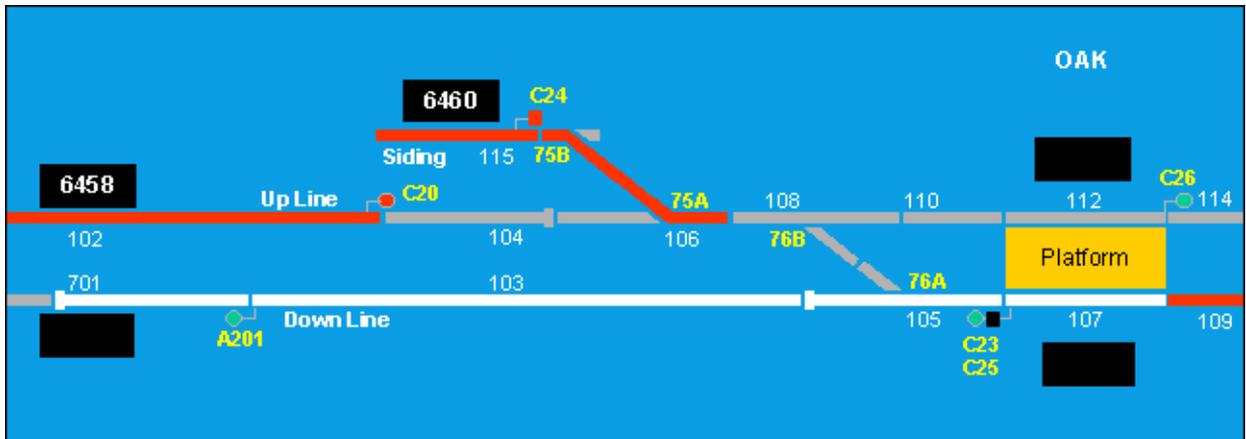


Fig 10 - The third route is set up

In Fig 10, train 6460 is now clear of 105 and 108 track circuits and the signalman has set up another route, the Down line route for the next train 7786, as indicated by the white track circuits. Signal C23 shows a proceed aspect. Train 7786, has already approached the area, occupying Track Circuit 109 and has been signaled all the way through the area.

You will see that, although the Down line route is clear for Train 7786, track circuit 701 still shows grey. This is because it is not part of the controlled area. It will only show grey when unoccupied and red when occupied.

Train 6460 is almost clear of the Up line. Immediately 75 points clear, the whole route for Train 6458 will be freed and so that it can be selected as shown on the next diagram (Fig 11 below).



Fig 11 - Two routes freed for Up and Down trains to proceed

Train 6458 now has permission to proceed into the platform and will soon start. Train 7786 is just entering the Down platform.

The above series of screen shots are representations of the sort of indications and train movements typically seen in modern control rooms. Not all installations are designed the same way but the basic principles are the same.

References

- Books:
 - a) Train Management System Document.
 - b) A text book of Railway Engineering - S.C.Saxena and S.P.Arora.
 - c) Datasheets-
ATMEL AT 89S51, 8 bit Microcontroller with 4K bytes Flash.
- Microcontrollers 8051 – Mazidi & Mazidi

- Web:
 - a) www.railway-technical.com
 - b) www.irfca.org
 - c) www.atmel.com