CHAPTER

2 RFID TECHNOLOGY

2.0 Overview

This chapter describes the basic components of a Radio Frequency Identification (RFID) system and explores the technology, applications, and competitive advantages of RFID technology.

2.1 Introduction

RFID offers greater flexibility, higher data storage capacities, increased data collection throughput, and greater immediacy and accuracy of data collection.

An increasing number of companies in a variety of markets worldwide are embracing RFID technology to increase quality and quantity of data collection in an expeditious manner. The technology's enhanced accuracy and security makes it an ideal data collection platform for a variety of markets and applications, including healthcare, pharmaceutical, manufacturing, warehousing, logistics, transportation and retail.

2.2. Components of an RFID System

A basic RFID system consists of these components:

- A programmable RFID tag/inlay for storing item data consisting of:
  - an RFID chip for data storage
  - an antenna to facilitate communication with the RFID chip.
- A reader/antenna system to interrogate the RFID inlay.

2.3. The RFID Tag

RFID tags are categorized as either **passive** or **active**. Passive tags do not have an integrated power source and are powered from the signal carried by the RFID reader. Active tags have a built-in power source, and their behavior can be compared to a beacon. As a result of the built-in battery, active tags can operate at a greater distance

and at higher data rates in return for limited life driven by the longevity of the built in battery and higher costs. For a lower cost of implementation, passive tags are a more attractive solution.

The RFID tag consists of an integrated circuit (IC) embedded in a thin film medium. Information stored in the memory of the RFID chip is transmitted by the antenna circuit embedded in the RFID inlay via radio frequencies, to an RFID reader. The performance characteristics of the RFID tag will then be determined by factors such as the type of IC used, the read/write capability, the radio frequency, power settings, environment, etc.

The information stored in an RFID chip is defined by its read/write characteristics. For a **read-only** tag**,** the information stored must be recorded during the manufacturing process and cannot be typically modified or erased. The data stored normally represents a unique serial number which is used as a reference to lookup more details about a particular item in a host system database. Read-only tags are therefore useful for identifying an object, much like the “license plate” of a car.

For a **read/write** tag, data can be written and erased on demand at the point of application. Since a rewriteable tag can be updated numerous times, its reusability can help to reduce the number of tags that need to be purchased and add greater flexibility and intelligence to the application. Additionally, data can be added as the item moves through the supply chain, providing better traceability and updated information. Advanced features also include locking, encryption and disabling the RFID tag.

RFID systems are designed to operate at a number of designated frequencies, depending on the application requirements and local radio-frequency regulations:

Low Frequency (125KHz)

High Frequency (13.56MHz)

Ultra High Frequency (860-960MHz)

Microwave (2.45GHz)

Low-frequency tags are typically used for access control & security, manufacturing processes, harsh environments, and animal identification applications in a variety of industries which require short read ranges. The low frequency spectrum is the most adaptive to high metal content environments, although with some loss of performance. Read ranges are typically several inches to several feet.

High-frequency tags were developed as a low cost, small profile alternative to low-frequency RFID tags with the ability to be printed or embedded in substrates such as paper. Metal presents interference issues and requires special considerations for mounting. Similarly to the low-frequency technology, these tags have a read range of up to several feet.

UHF tags boast greater read distances and superior anti-collision capabilities, increasing the ability to identify a larger number of tags in the field at a given time.

The primary application envisioned for UHF tags is supply chain tracking. There are large number of additional markets with demand for UHF RFID technology such as transportation, healthcare, aerospace, etc.

ATP-Kavach RFID Tags operate in UHF band (865 to 867 MHz)

Microwave tags are mostly used in active RFID systems. Offering long range and high data transfer speeds at significantly higher cost per tag making them suitable for railroad car tracking, container tracking, and automated toll collection type applications as a re-usable asset.

The table highlights the Max Read Range of the RFID tags for the different operating frequency ranges:

Frequency Range	125 KHz	13.56 MHz	868 - 956 MHz	2.45 GHz & 5.8 GHz
Typical Max Read	Low Frequency (LF)	High Frequency (HF)	Ultra-High Frequency (UHF)	Microwave
Range (Passive Tags)	< 0.5 m	~1 m	~3m to ~10m	~1 m

2.4 Regulations in INDIA

The Department of Telecommunication (under the Ministry of Communications and Information Technology), has delicensed the spectrum in the 865–867 MHz band for use by RFID devices. The regulation on the use of wireless equipment in the band 865–867 MHz specifies that no license is required by any person to establish, maintain, work, possess, or deal in RFID on non-interference, non-protection, and nonexclusive bases, in the frequency band 865–867 MHz with maximum 1 W transmitter power, 4 W ERP, and 200 kHz carrier bandwidth.

2.5 RFID Summary

The dominant RFID dynamic behind supply chain applications is the EPC standard using the UHF frequency band: 902-928 MHz (North America) and 865-868 MHz (Europe). EPC Global, a joint venture between GS1, Inc. (formerly EAN International) and GS1 US (formerly the Uniform Code Council [UCC]) is focused on helping supply chains and industry implement the Electronic Product Code™ (EPC) through the development of global standards and support of the EPC global network™. The EPC Global Network ideally intends to transform the global supply chain through a new, open global standard for real-time, automatic identification of items in the supply chain of any company, in any industry, anywhere in the world.

2.6 Introduction to RFID Tags

This chapter describes the RFID fixing arrangement guidelines to be ensured while designing the RFID fixing arrangement for the purpose of Kavach System. This is based on Joint Procedure Order approved by Track and Signal Directorates of RDSO (STS/E/Kavach/Tender/Part-VIII dated 27.08.2015).

2.7 RFID Tag Used in Kavach

RFID Tags provide location specific static information to Locomotive. Apart from acting as Location references these provide immediate information such as crossing the signal etc. to Loco Unit.

RFID tags shall be fitted on track in station section, point zones, near Signals & in block section for giving Trackside information to Loco Kavach unit.

The RFID tags shall be fitted on the sleepers between the rails as per guidelines given for Indian Railways.

Specification of RFID tags:

(a) Suitable for reliable working at train speed upto 200 KMPH (minimum).
(b) Frequency of operation: 865-867MHz.
(c) Can be programmable with minimum 128 bits (including CRC) of user data.
(d) Shall be able to work even when submerged in water up to rail level.
(e) Under field operating conditions RFID reader antenna shall be able to read,

RFID tag from a vertical distance of 700 mm from bottom of RFID reader antenna to top of the rail level.

Fig. 2.1

2.8 Preparation of KAVACH RFID Tag –TIN Layout

RFID tag-TIN layout shall be prepared as per guidelines given in RDSO Draft Specification no. RDSO/SPN/196/2012 Ver 3.2 or latest. For preparation of Tag-TIN Layout, one should have a fair idea about classification of RFID Tags and Track Identification Numbers (TIN). The details are given in following paragraphs:

2.9 Classification of RFID Tags

RFID tags are categorized as follows:

(a) Normal tag
(b) Signal foot tag
(c) Signal approach tag
(d) Track Identification Number (TIN) Discrimination tag
(e) LC gate tag(optional)
(f) Tunnel tag (for future use)
(g) Kavach Exit tag

2.10 Following are the Guidelines for provision of RFID Tags in Tag-TIN Layout

(a) Normal tags shall be provided in the block section as well as in station section. The maximum distance between the two normal tags shall not be more than 1000m. Each Normal tag shall be linked to next two normal tags in both the directions (Nominal & Reverse).
(b) Signal foot tags shall be provided at foot of every signal post.
(c) Signal approach tags shall be provided before the approach of (typically 150 ~ 250m) every signal post to correct the odometry error.
(d) TIN Discrimination tags shall be used to indicate change in the TIN of track section.
(e) Normally it will be placed at turnouts.
(f) LC gate tag (optional) shall be provided at both sides of LC gate as required by operating Railway.
(g) Kavach Exit tag shall be provided at Kavach territory exit point.

Normal Tag:

Field Description	Data to be configured
TAG ID	RFID Tag ID as per Layout Range: 1 to 1023
Absolute Loc (in Meters)	Absolute Location in meters as per Layout. Range: 0 to 2621420 m
TIN in Nominal Dir	TIN Number as per Layout in Nominal Direction. Range: 0 to 127
TIN in Reverse Dir	TIN Number as per Layout in Reverse Direction. Range: 0 to 127
Trans from Loco-to-Stationary is necessary in Nominal Dir	Drop down menu: Yes or No

Contd…

Field Description	Data to be configured
Trans from Loco-to-Stationary is necessary in Reverse Dir	Drop down menu: Yes or No
Station/ Block ahead info in Nominal Dir	Drop down menu: Station or Block section
Station/ Block ahead info in Reverse Dir	Drop down menu: Station or Block section
Reserved	Non-configurable and default value is 0

Signal Foot Tag.:

Field Description	Data to be configured
TAG ID	RFID Tag ID as per Layout Range: 1 to 1023
Absolute Loc (in Meters)	Absolute Location in meters as per Layout. Range: 0 to 2621420m
TIN in Nominal Dir	TIN Number as per Layout in Nominal Direction. Range: 0 to 127
TIN in Reverse Dir	TIN Number as per Layout in Reverse Direction. Range: 0 to 127
Station ID	Station ID as per Layout. Range: 1 to 1023
Signal Direction	Drop down menu: Nominal or Reverse

Signal Approach Tag. :

Field Description	Data to be configured
TAG ID	RFID Tag ID as per Layout Range: 1 to 1023
Absolute Loc (in Meters)	Absolute Location in meters as per Layout. Range: 0 to 2621420m
TIN in Nominal Dir	TIN Number as per Layout in Nominal Direction. Range: 0 to 127

Tin Discrimination Tag:

Field Description	Data to be configured
TAG ID	RFID Tag ID as per Layout Range: 1 to 1023
Absolute Loc (in Meters)	Absolute Location in meters as per Layout. Range: 0 to 2621420m

Contd…

Field Description	Data to be configured
TIN in Nominal Direction	TIN Number as per Layout in Nominal Direction. Range: 0 to 127
TIN in Reverse Direction	TIN Number as per Layout in Reverse Direction. Range: 0 to 127
Station ID	Station ID as per Layout. Range: 1 to 1023
Dead end ahead in Nominal Direction	Drop down menu: Yes or No
Distance of dead-end in Nominal Direction	If Yes, distance to dead end in meters as per Layout. Range: 0 to 255 in decameters
Dead end ahead in Reverse Direction	Drop down menu: Yes or No
Distance of dead-end in Reverse Direction	If Yes, distance to dead end in meters as per Layout. Range: 0 to 255 in decameters

LC Gate Tag.:

Field Description	Data to be configured
TAG ID	RFID Tag ID as per Layout Range: 1 to 1023
Absolute Loc (in Meters)	Absolute Location in meters as per Layout. Range: 0 to 2621420m
LC Gate Approach Tag in direction of applicability	Drop down menu: KAVACH Non-KAVACH First Non-KAVACH Second Spare
LC Gate in Nominal direction	Drop down menu: Yes or No
Gate ID	Gate ID as per Working Time Table Range is from 1 to 1023

KAVACH Exit Tag.:

Field Description	Data to be configured
TAG ID	RFID Tag ID as per Layout. Range: 1 to 1023
Absolute Loc (in Meters)	Absolute Location in meters as per Layout. Range: 0 to 2621420 m
Applicable Direction	Drop down menu: Nominal or Reverse

2.11 Track Identification Number (TIN)

(a) Each track shall have designated Track Identification Number (TIN).
(b) Each Block section shall have single unique designated TIN. Block Section TIN can be repeated after a designated distance (50 km minimum along the track route).
(c) To avoid unnecessary SOS generation, adjacent TINs to be incorporated in the radio packet and adjacent line tag info. Also, location adjustment details shall be sent on radio only after there is physical separation between the tracks.
(d) Each line in the station section having berthing portion shall have different TINs. TIN can be repeated after a designated distance (10 km minimum along the track route).
(e) TINs shall be allotted in such a manner not to inhibit permissible simultaneous movements.
(f) Loco Kavach unit shall be able to self-deduce the change in its TIN whenever it changes the TIN section.

Numbering Scheme for Stationary KAVACH: The first two digits are allotted to each zonal railway and Zonal railways may decide the last three digits for the stations. A proper record shall be maintained by the Zonal Railways to avoid repetition of number as station ID should be unique number.

2.12 Guidelines for preparation of RFID TAG-TIN layout

Following guidelines shall be followed while preparing RFID tag-TIN layouts for Station/IB/LC or block sections:

1. RFID tag-TIN layout shall be prepared with Station yard layout as reference. However, the actual site considerations shall be taken into account prior to its preparation. A site survey shall be conducted to mark the locations where tags need to be placed.
2. The centre of Station Master's panel shall be taken as station's Centre Line for reference purpose.
3. Normal tags shall be provided in the block section as well as in station section. The maximum distance between the two Normal tags shall not be more than 1000m.
4. Every signal, including shunt signals, shall be provided with Signal foot tag.
5. The permanent EoA (End of Authority) Locations such as Stop Boards, Block section limiting board (BSLB), Ends of berthing track (may be with shunt signal sometimes) shall have Signal foot tag.
6. Signal Approach tag shall be provided for every Signal foot tag. They shall be provided at a distance of 150-250m from Signal foot tag. The distance from Signal Approach tag to Signal shall be mentioned on the layout.

7. All type of tags, except Junction and Adjustment tags, can be placed instead of Signal Approach tag if it offers some other advantage like reduction in number of tags.
8. To ensure linking up to the nearest location to the approaching signal, Normal tag shall be provided, in lieu of signal approach tag on Mainlines.
9. To demarcate TIN sections, TIN discrimination tags shall be placed.
10. Gate tags shall be placed at such a distance that Auto whistling for approaching LC gate can commence from at least 600m on approach of LC gate.
11. Adjustment tag shall be used, if possible, in a non-signalling area. The layout shall only mention the programmed absolute location. However, the physical distance between the Adjustment tag and nearest tag, from where physical and programmed distances are different, shall be mentioned.
12. Junction tag shall be used, if possible, in a non-signalling area. The layout shall only mention the programmed absolute location. However, the physical distance between the Junction tag and nearest tag, from where physical and programmed distances are different, shall be mentioned.
13. While moving from Kavach to non Kavach territory, Exit tags shall be provided at the exit boundary of Last Stationary Kavach unit in Kavach territory. Exit tags shall be provided in 3 sets of tags.
14. The distance between two different type of tags shall not be less than 40m. However, in case of Exit tags, the same may be reduced to20m.
15. The distance between duplicated tags shall not be more than 2 meter.
16. A single TIN section shall be represented using a single colour. The TINs in vicinity shall be represented in different colours.
17. Non-Kavach territory shall be represented through white colour.
18. The TIN layouts thus prepared, shall permit all the train movements allowed in a section as per Table of Control / Selection Table.
19. At all places, where the train is likely to move outside Kavach territory or remain stabilized for long duration for e.g., sidings, Exit tags shall be provided.
20. Following RFID Tag notations shall be used to denote different types of tags:

Type of Tag	Notation
Normal	N
Signal Foot	S
Signal Approach	SA
TIN Discrimination	T
Gate	G
Exit	X

Fig. 2.2

21. Whenever, exit tags are provided on lines permitting movement in both directions, two Normal tags shall be provided to allow the train to enter in Full Supervision as soon as possible.
22. Block Section TIN should be extended up to Block section limiting board (BSLB) on unidirectional lines (such as Double Line) and up to opposite direction Advanced Starter on Single Line. S-tag shall be provided at the Yard Exit Points not protected by Signals like BLOCK SECTION LIMITING BOARD (BSLB) etc.
23. The distances from a Normal Tag to all other Normal tags ahead in the direction of movement must be same.
24. The distance of Signal Approach (SA) Tag from corresponding Signal Foot (S) Tag should be exact multiple of 10m (1 Decameter). This should be invariably ensured during installation and verification at site.
25. Tags in Block Section shall be placed with consideration to the ease of maintenance and vandalism. These should be placed, if feasible, in vicinity of EC sockets, LC gate or any other place where a maintainer is usually required to visit.
26. Reference drawing numbers shall be mentioned on the layout.
27. Tag numbers (values in the range of 1 – 1023) and TIN numbers (values in the range of 1-127) shall be allotted by the user Railways. Sufficient spares for future needs shall be taken into consideration while allotting the numbers. The allotted numbers shall also be mentioned on the RFID tag-TIN layout.
28. Signature Block and revision history blocks shall be prepared as per the practices of User Railways.
29. Legends mentioning the notation used for the purpose of preparation of layout shall be specifically mentioned on the layout.
30. RFID tag-TIN layout need not be up to scale. If the layout is not per scale, the same shall be mentioned on the layout.
31. Absolute locations of tags, LC gates, signals and turnout switches shall be mentioned on the RFID layout.
32. Absolute location of Station center line shall be mentioned on the layout.

2.13 Preparation of KAVACH Control Table

Following guidelines shall be followed while preparing Kavach Control table:

1. Kavach control tables shall be based on the SIP of the station as well as approved RFID tag-TIN layout for the Station/IB/LC. However, overlap points shall not be proven in Kavach control table.
2. Shunt signals shall not be a part Kavach control tables. However, station shunt limits shall be specified in the Stationary Kavach application data.
3. Kavach control table shall include all signals which will be monitored by a specific stationary Kavach unit.
4. In case of permissive signals, where the inputs for signal indications are available, the ECR shall be used for the purpose of displaying signal aspect. However, movement authority shall be decided based on the signal aspect of the approaching Stop Signal.
5. In case of permissive signals, where the inputs for signal indications are not available, the signal aspect and movement authority shall be derived based on the signal aspect of approaching stop signal.
6. Following information shall be included as part of control tables:
7. Entry Signal: This shall be the approaching signal for a route.
8. Exit Signal: This shall be the next approaching signal on route.
9. Line: This shall describe the line for route for e.g. Down Main, Common Loop, etc.
10. Aspect of Entry Signal: This field shall indicate all the permissible OFF aspects of the “Entry Signal”.
11. Requires Aspects of Exit Signal: This field shall indicate requirement of signal aspect for exit signal for the corresponding “Aspect of Entry Signal”.
12. Requires Points in Route: This field shall indicate the point positions required in Normal and Reverse positions for the corresponding route. Overlap points shall not be included for the purpose of Kavach control table.
13. Requires Track Circuit Up in Route: This field shall indicate the track circuits required to be in picked UP condition for the signal to be taken OFF. Only platform berthing track circuits shall be included for the purpose of Kavach control table.
14. TINs (Track Identification Number) Requires Free: This shall mention all the TINs falling into the respective route as mentioned in approved RFID layout. TINs shall not be proved for calling on signals.

2.14 Check RFID

Entry Signal Foot Tag: This shall indicate the signal foot tag for the Entry Signal.

En-Route Tags: This shall indicate all the RFID tags falling in the corresponding route as per approved RFID tag-TIN layout. The Signal foot tag for the “Exit Signal” shall not be included in this field.

Conflicting Route Tags: This field shall indicate all the tags on which it is possible for the train to move if the point positions are not in accordance with "Requires Points in Route". For the unintended route in the same direction, this shall include tags up to the last tag on the unintended route. Signal foot tag of next signal and turnout tags shall not be included in the conflicting route tags. For the unintended route in opposite direction, this shall include tags up to and including the Signal foot tag for next signal. If a conflicting route tag is read by a train, the Kavach system shall generate SoS.

Conflicting turnout tags: The conflicting turnout tags shall be indicated in the Kavach Control table.

2.15 Turnout

Speed in kmph: Permissible speed for the turnout in route. For the purpose of Kavach control table, these have been specified as 30 kmph in case of single turnout and 15 kmph in case of multiple turnouts in route. In case, the turnout portion and loop line have different permissible speeds, the speed for both the portion shall be mentioned on the control table.

Distance to Commence: This shall be the distance from foot of "Entry Signal" to the start of first diverging point in route and shall be specified in meters.

Speed Restriction Distance: This shall be the distance from first diverging point in route. In case of entry in to the station premises, this distance shall be the distance from start of first diverging point in route to the next approaching signal plus 30m. In case of exit from the station premises, this distance shall be the distance from foot of approaching signal in route to the end of last converging point plus 10m. In case, the turnout portion and loop line have different permissible speeds, the speed restriction distance for both the portions shall be mentioned on the control table.

Distance between Entry & Exit Signal: To be specified in meters.

Movement Authority: Minimum movement authority for the corresponding signal aspect to be mentioned in meters.

Action for generating SoS to prevent Head On Collision and Rear End Collision on received communication for Block Section TIN: Stationary Kavach unit shall generate SoS to prevent Head on collision and Rear End Collision in the block section if it receives the required information, even if the train is outside the Stationary Kavach unit communication boundary.

Entry Signal for Block Section TIN: This shall specify last stop signals in UP/DN direction to be monitored by Stationary Kavach unit.

RFID Tags: These shall specify all RFID tags on the Block Section TIN for corresponding last stop signal as per RFID tag-TIN layout.

TIN: Block section TIN for the corresponding Last Stop Signal.

RFID TAG-TIN LAYOUT PREPARATION GUIDELINES

The following are the guidelines to be followed in preparation of RFID Tag-TIN Layout for Stations/IB/LC or Block Sections

Study of SIP (Signal Interlocking Plan): The SIP for a given station/yard is the primary input for preparing the RFID Tag – TIN Layout. One has to carefully study the SIP, observe the signals, number of lines, points, berthing tracks, sidings, single ended points, Stop boards, Block section limit boards, Non-signaling zones if any.

Site Survey: After carefully observing the SIP, one has to conduct a site survey which involves visual inspection of the site conditions. The geographical location of centre of the SM panel located in the Station Master room is considered as the reference point for marking the locations of various tags that are placed in the station and its vicinity. From the reference location, the distance of all the signals (including shunt signals) upto last Distant signal on one end and the Advanced starter on the other end, centre of the points, Stop boards, Block section limit boards should be measured. In lines, where there is only one signal on the berthing track, distance of the other end of the berthing track from the reference point should be measured. In addition to this, the distance of various Turn_out switches from the reference point is to be measured which shall be indicated on the Layout.

Allocation of TINs: Each berthing track in the station shall have an unique TIN (Track Identification Number). They shall have to be indicated on the Layout using different colours.

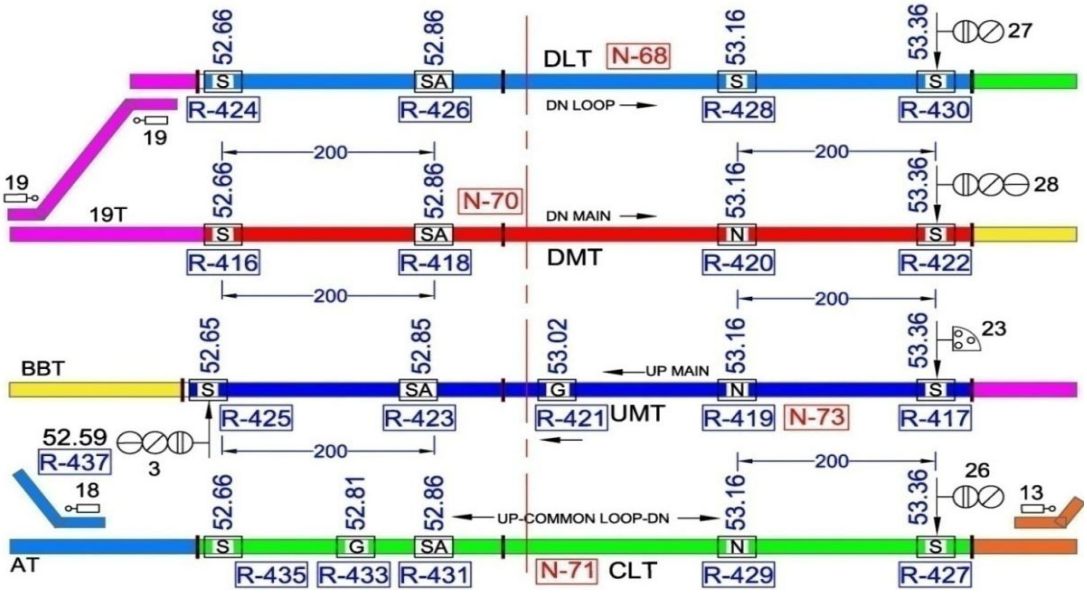

Fig. 2.3 Berthing TIN

Case I: TINs should be allocated in such a way that they do not inhibit permissible simultaneous movements

TIN demarcation to be done at points joining the two Main lines:

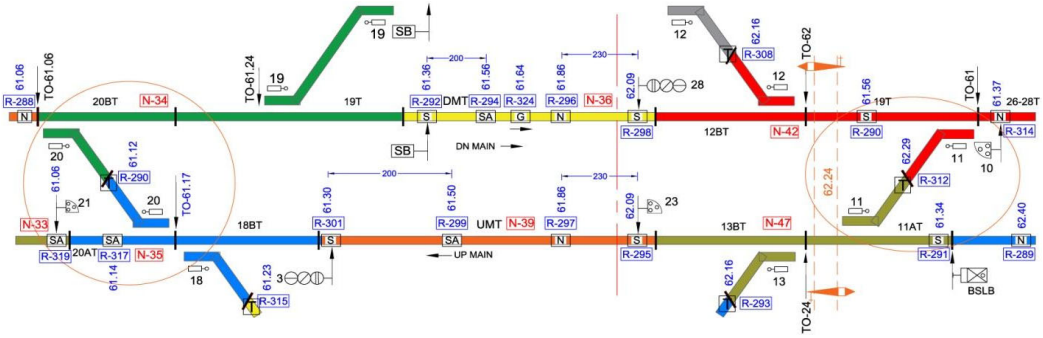

Fig. 2.4

TIN demarcation to be done at points joining the Main line and the Common Loop line:

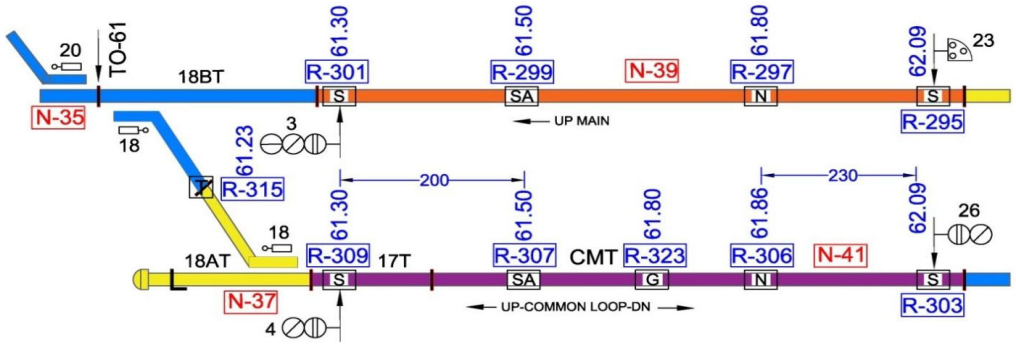

Fig. 2.5

No TIN demarcation to be done at points joining the Main Line and the corresponding Loop line:

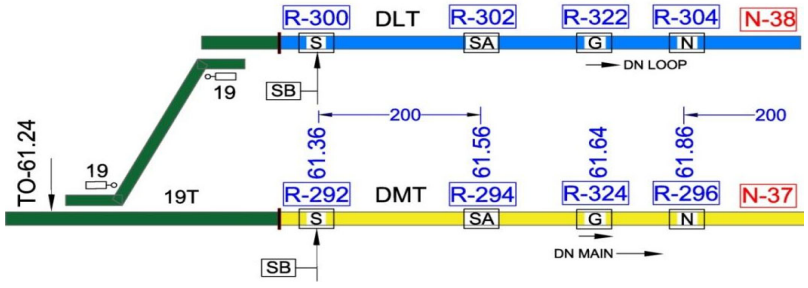

Fig. 2.6

The portion of the track leading to a dead end (sand hump) shall have different TIN:

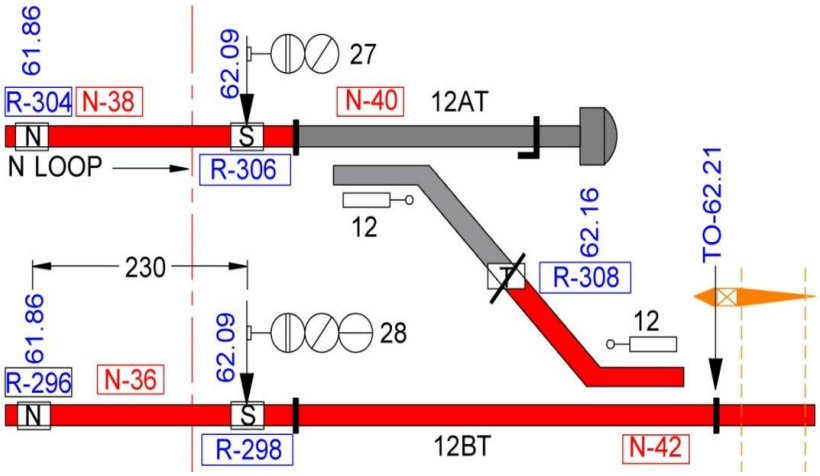

Fig. 2.7

In case of adjacent Common Loop lines, for all the points converging at a single point with just a single sand hump or no sand hump same TIN should be assigned for all the points except the last point joining the Common Loop line to the Main Line:

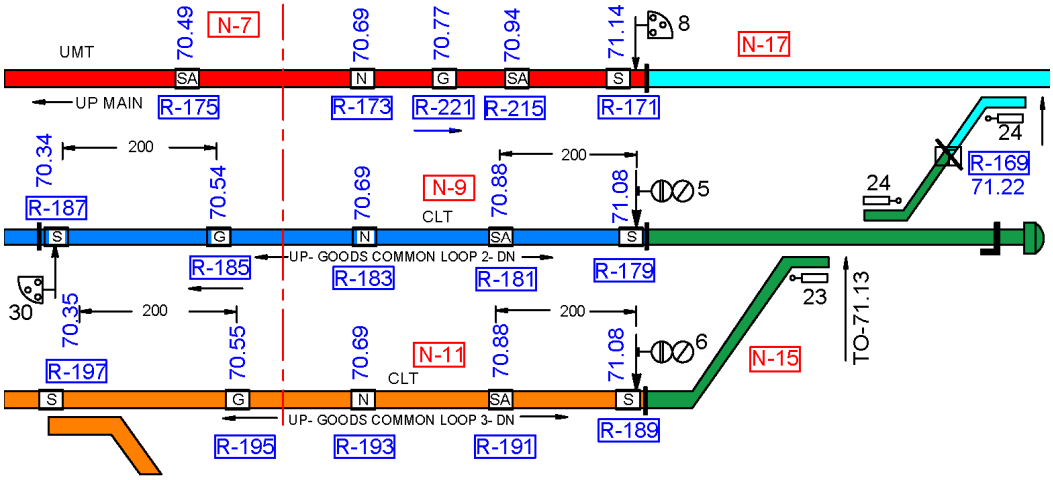

Fig. 2.8

If the adjacent Common Loop lines are accompanied with sand hump for each line, each sand hump shall be assigned with different TIN:

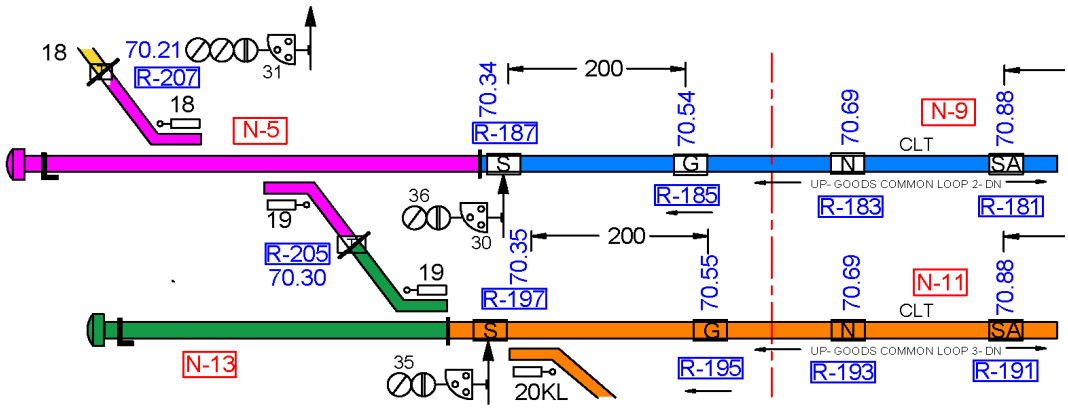

Fig. 2.9

The portion of track between the Shunt signal and the advanced starter shall be assigned a different TIN to allow shunting and movement through adjacent Common Loop line simultaneously:

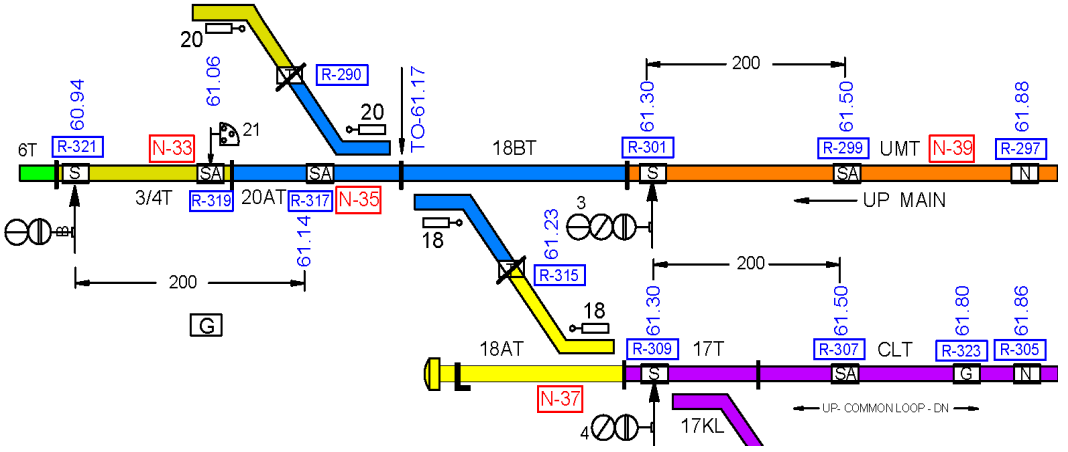

Fig. 2.10

Case II where parallel movement is possible, TINs shall be assigned in such a way that movement in one line do not restrict movement along the other lines:

The following example discusses various cases where TIN assignment is done to allow safe parallel movements. Consider the following sample Layout:

1. **TIN N-2 and N-16:** These are assigned in such a way to allow Train movement from S-17 or S 18 to S-1DA\20 and from S-48 to S-18 or S-19 or S-20 simultaneously. Also, this allows Train movement from S-1DA\20 to S-16 and from S-48 to S-18 or S-19 or S-20 simultaneously

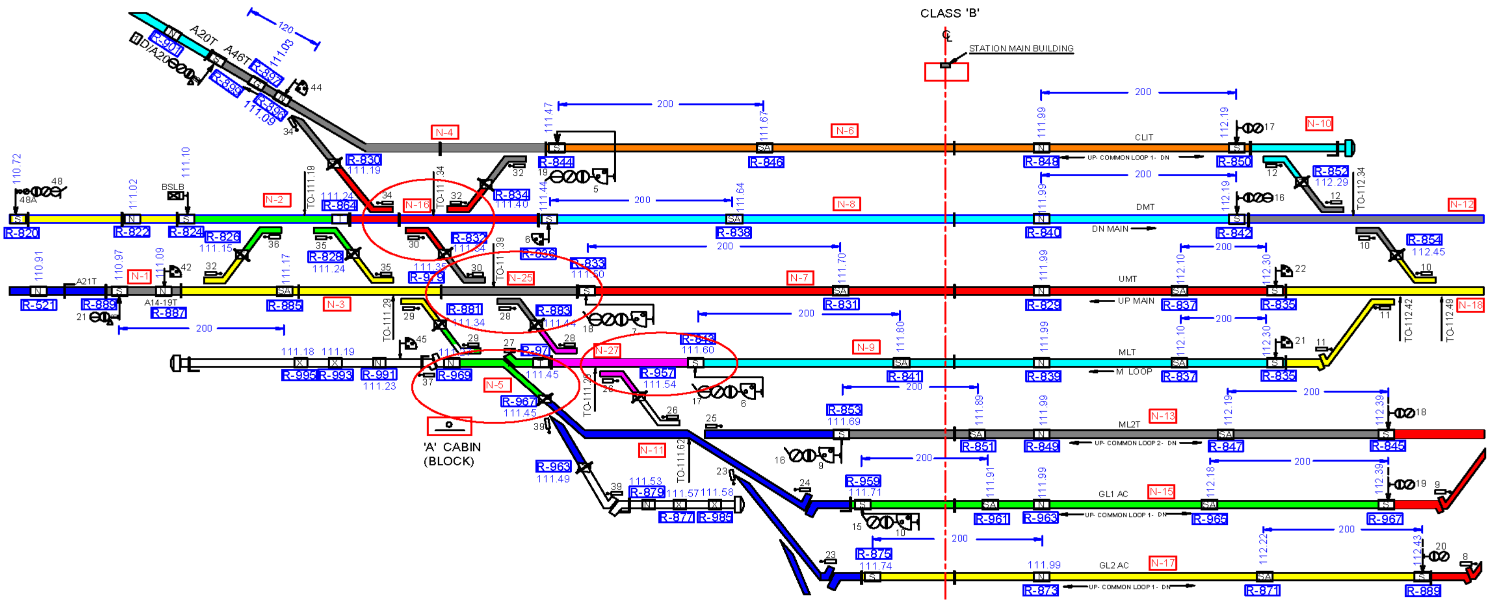
CLASS 'B'
STATION MAIN BUILDING
'A' CABIN
(BLOCK)
CLIT
DMT
DN MAIN
UMT
UP MAIN
MLT
M LOOP
ML2T
GL1 AC
GL2 AC
A20T
A46T
A21T
A14-19T
BSLB
N-1
N-2
N-3
N-4
N-5
N-6
N-7
N-8
N-9
N-10
N-11
N-12
N-13
N-15
N-16
N-17
N-18
N-25
N-27

Fig. 2.11

2. **N-25 :** TIN is assigned in such a way to allow Train movement from S-18 to S1DA\20 and from S-48A to S-18 or S-19 or S-20 simultaneously
3. **N-27:** TIN is assigned in such a way to allow Train movement from S-18 to S1DA\20 and from S-17 to S-21 simultaneously
4. **N-5:** TIN is assigned in such a way to allow Train movement from S-17 to S1DA\20 and from S- 4 or S-15 or S-16 to S-21 simultaneously.

In cases where Exit tags are provided with two sets of Normal tags, TIN shall not be assigned upto the second Normal tag which marks the entry into KAVACH territory:

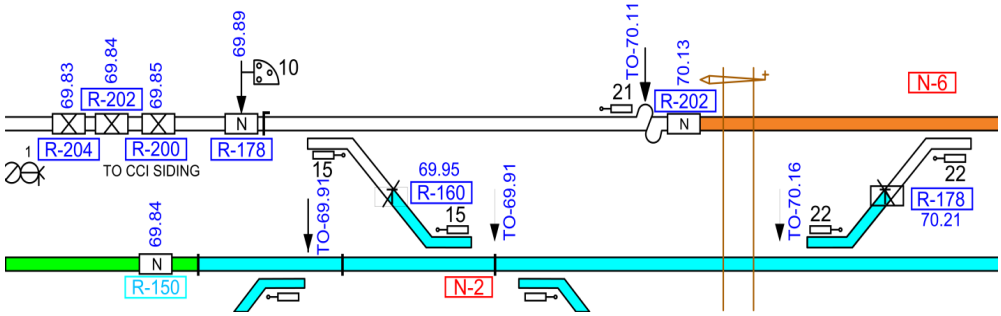

Fig. 2.12

- Each Block section shall have an unique TIN. Block section TIN can be repeated after a designated distance (50 km along the track).
- Block section TIN shall be extended up to BLOCK SECTION LIMITING BOARD (BSLB) on Double line and upto opposite direction Advanced starter in Single line.
- TINs used in one station can be reused in other stations.
- In Non-KAVACH sections or Non-Signalling sections, TINs shall not be provided and shall be indicated in White or transparent colour.

Placement of Tags:

- Normal tags shall be provided throughout the Block section and also within the Station. The distance between two Normal tags should not exceed 1000 metres.
- Normal tags shall be placed in such a way that all the Normal tags ahead in the same direction should be at equal distance.

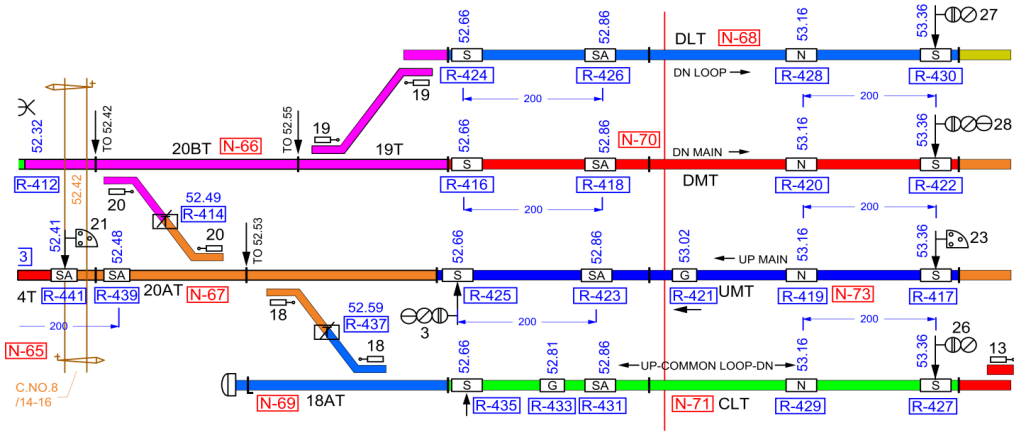

Fig. 2.13

In cases where, the distance from Normal tags of same absolute location placed in multiple Loop lines (including Common Loop line) to the next Normal tag is varying by a large margin(>50 metres), additional Normal tag should be placed on the same line to reduce the error in distance.

It shall be ensured that a Normal Tag is placed at a distance of 150m to 200m after Advance Starter in Double line and at a distance of 100m to 150m after Advance Starter in Single line which notifies the Loco KAVACH about entry into Block section. This shall make Loco KAVACH to initiate Loco to Loco communication which is useful in prevention of occurrence of any hazardous situations

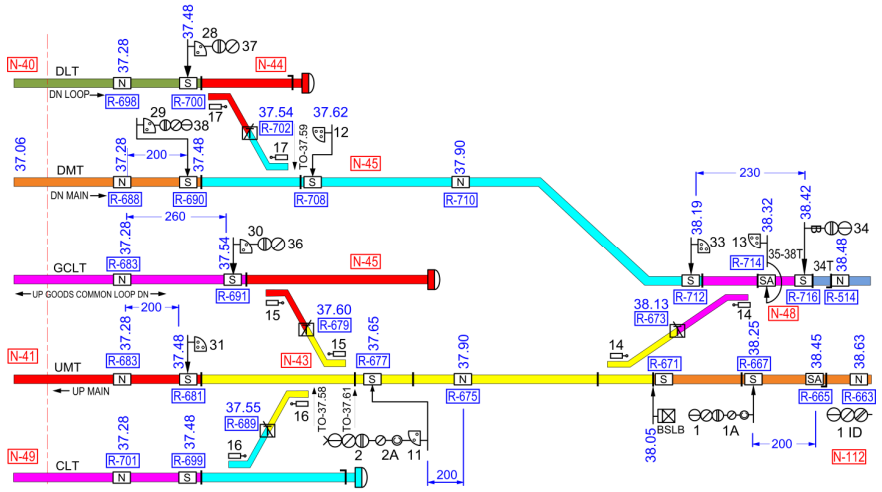

Fig. 2.14

Every signal except shunt signal is to be provided with Signal foot tag. In addition to the signals, the permanent End of authority locations like Stop board, Block section limit board and end of berthing tracks (usually provided with shunt signals) are to be provided with Signal foot tag.

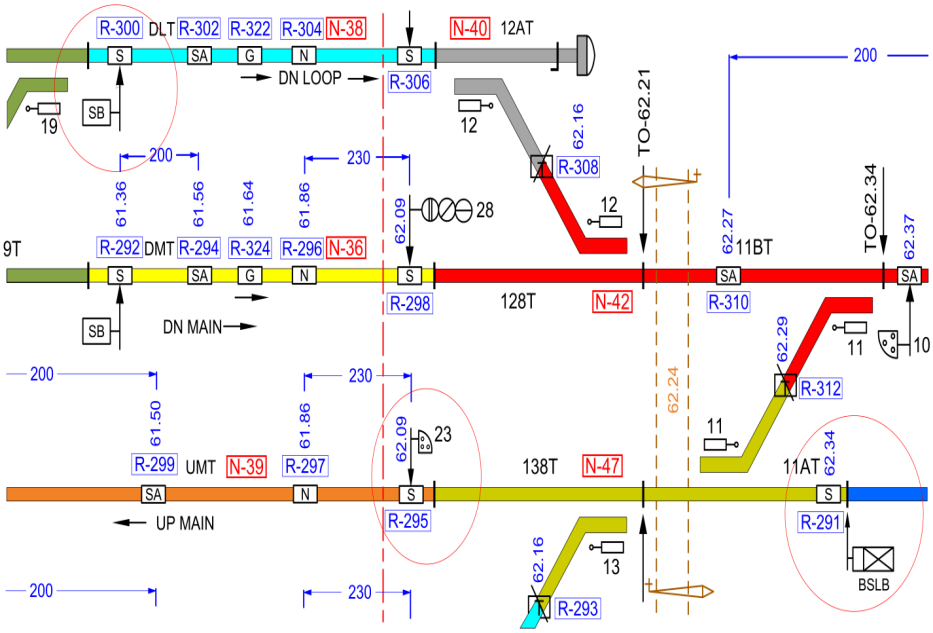

Fig. 2.15

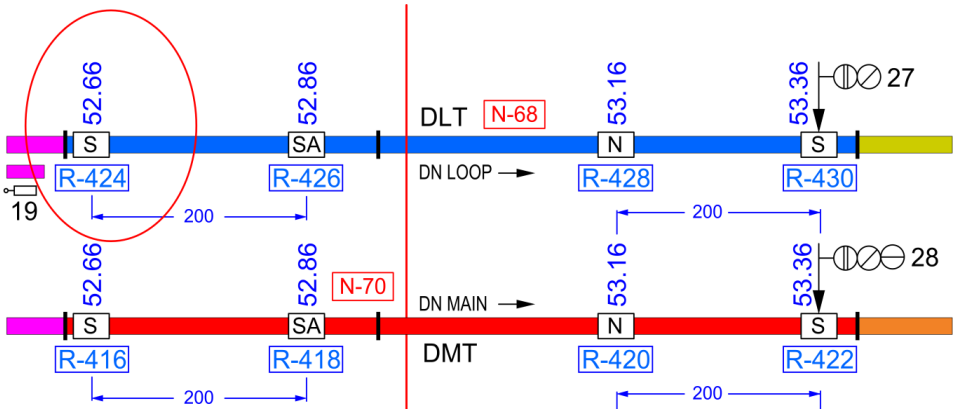

Fig. 2.16

- Shunt signals are to be provided with either Signal approach or Gate tag or Normal tag or Signal foot tag based on fulfillment of all other requirements mentioned in this document.

- Signal Approach tag is to be provided for every Signal and is to be placed at a distance that can vary from 150 metres to 250 metres from the approaching signal. Signal approach tag is not necessary for Signal foot tags placed at BLOCK SECTION LIMITING BOARD (BSLB) and Shunt signals
- All types of tags except Junction tag and Adjustment tag can be used as Signal approach tag if there is an added advantage of reduction in number of tags.
- To differentiate TINs, TIN discrimination tags are to be used.
- Gate tags shall be placed at a distance of 600 meters on main line and 400 meters on loop lines from the approaching LC Gate.
- Adjustment tag to be placed strictly in Non-Signalling area to correct any discrepancy in absolute location in cases where the physical distance between two adjacent stations is not matching the difference between the absolute location of those stations. The physical distance from the adjustment tag to the nearest tag from where the absolute location adjustment is made is to be mentioned on the layout.

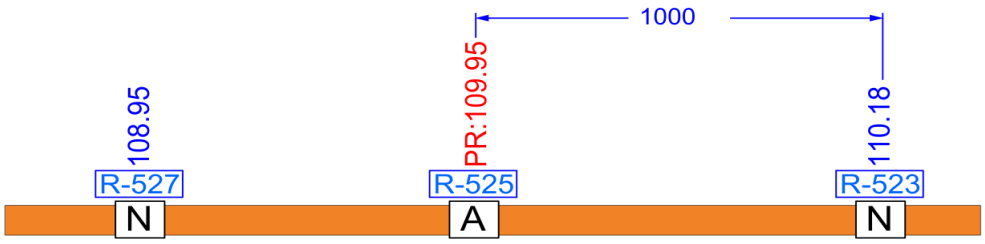

Fig. 2.17

- In sections where there is a change in absolute locations of the Stations usually occurring at Junctions, two sets of Junction tags are to be placed in the Non-signalling area. These are to be accompanied with two sets of Normal tags on either side placed at a distance of 50 meters and 100 meters respectively from the nearest Junction tag. Also, these distances are to be mentioned on the Layout. The absolute location of Junction tag is programmed '0'.
- Exit tags are to be placed where there is a transition from KAVACH territory to Non-KAVACH territory. These shall be provided in three sets of tags. Also in cases where there is a possibility of Trains getting halted for indeterminate time or move out of KAVACH territory, Exit tags are to be provided.
- Whenever Exit tags are placed in places where there is possibility of movement in either directions, two Normal tags are to be placed to enable the KAVACH equipped Train to enter into Full supervision mode on reading these two Normal tags.
- The TIN has to be shown only up to 1st N Tag and TIN shall not be shown after this leading into KAVACH territory exit.

- The distance between any two tags shall be atleast 40 meters but the Exit tags can be placed closely at a distance of upto 20 meters.
- The distance of Signal approach tags from the approaching signal should be in multiples of decameters. This should be strictly ensured and verified at site.
- In the Block section except Signal foot tags, taking into consideration, easy maintenance and to avoid vandalism, tags are to be placed, if feasible, near EC sockets and LC Gates. Make sure that Tags are placed near OHE poles in RE area.
- RFID Tag Ids and TINs shall not be repeated within a station and its corresponding block sections.

Nomenclature to be used:

- Reference drawing numbers shall be mentioned on the Layout.
- Tag numbers (1 to 1023) and TINs (0 to 127) shall be allotted by the user Railways. Sufficient spares shall be reserved for future use. Also, the allotted Tag Ids and TINs should be mentioned on the RFID Tag-TIN Layout.
- Absolute location of Station centre shall be indicated on the Tag Layout.
- Absolute location of Tags, LC Gates, Signals, Shunt Limits, PSR (Permanent Speed Restriction) start/end points and Turn_out switches shall be mentioned on the Layout. This data shall have to be collected from the field survey.
- The distance between the Signal approach tag and the approaching signal is to be mentioned on the Layout.
- Track circuits that include Berthing tracks, track circuits used to calculate Train length, Points and others that are taken as inputs to the stationary KAVACH shall be indicated on the Layout.
- Signature Block and revision history blocks shall be prepared as per the practices of User Railways.
- Legends mentioning the notation used for the purpose of preparation of Layout shall be specifically mentioned on the Layout.
- RFID tag-TIN Layout need not be up to scale. If the Layout is not per scale, the same shall be mentioned on the Layout.

Field	Signal Foot Tag		Description
	Bit positions	No. of bits	
Type of Tag (0001 : Signal Foot Tag)	x3 - x0	4	This field denotes the type of Tag. The decimal value is 1.
Unique ID of RFID Tag Set	x13 - x4	10	Unique ID of the RFID Tag. Value ranges from 1 to 1023
Absolute Loc in meters (11 1111 1111 1111 1111 : Not Applicable)	x31 - x14	18	Geographical location of the RFID Tag in terms of decameters as per Railway metrics or Location referred in the Signal Interlocking Plan of the respective stations. Value ranges from 0 to 262142

Contd…

Field	Signal Foot Tag		Description
	Bit positions	No. of bits	
TIN in Nominal Direction	x38 - x32	7	Track Identification number encountered while traversing in Nominal direction (Incremental direction of absolute location) Value ranges from 0 to 127
TIN in Reverse Direction	x45 - x39	7	Track Identification number encountered while traversing in Reverse direction (Decremental direction of absolute location) Value ranges from 0 to 127
Station Code	x55-x46	10	For Future Use Unique ID of the Station Value ranges from 1 to 1023
Applicable Direction (0 = Nominal, 1 = Reverse)	x56	1	Denotes the applicable direction of the Signal '0' if Nominal '1' if Reverse
Signal ID in Applicable Direction	Y2-y0 & x63-x57	10	y3-y2-y1-y0-x63-x62 = 001000 : Only in RFID Tag, not in Radio Packet. Loco KAVACH should apply Brake when it crosses signal with Zero ID (dead stop locations - such as end of berthing tracks with Shunt Signals) in Normal Mode. y3-y2-y1-y0-x63-x62 = 001001 : Only in RFID Tag, not in Radio Packet. Loco KAVACH should apply Brake when it crosses signal with this 'Yard Exit' type (such as at BLOCK SECTION LIMITING BOARD (BSLB)) Other than in SR mode. Apart from above, rest codes to be used in future
Whether the signal has diverging routes	Y3 (y3 = 0: No, y3 = 1: Yes)	1	Future Use, Presently to be set '0'
ID of Approaching Signal ahead in Applicable Direction	y13-y4	10	Future Use, Presently to be set '0' Same as fields of CUR_SIG_INFO of Stn-to-Loco Radio Packet for future work
Fill Zeros	y47-y14	34	Zero padding to be done
CRC	y63-y48	16	Compute CRC (Cyclic Redundancy Checksum) to check the data integrity
Total		**128**	

2.16 Refer Annexure 2 for Typical Kavach Table of Control