Presentation on DC Track Circuit

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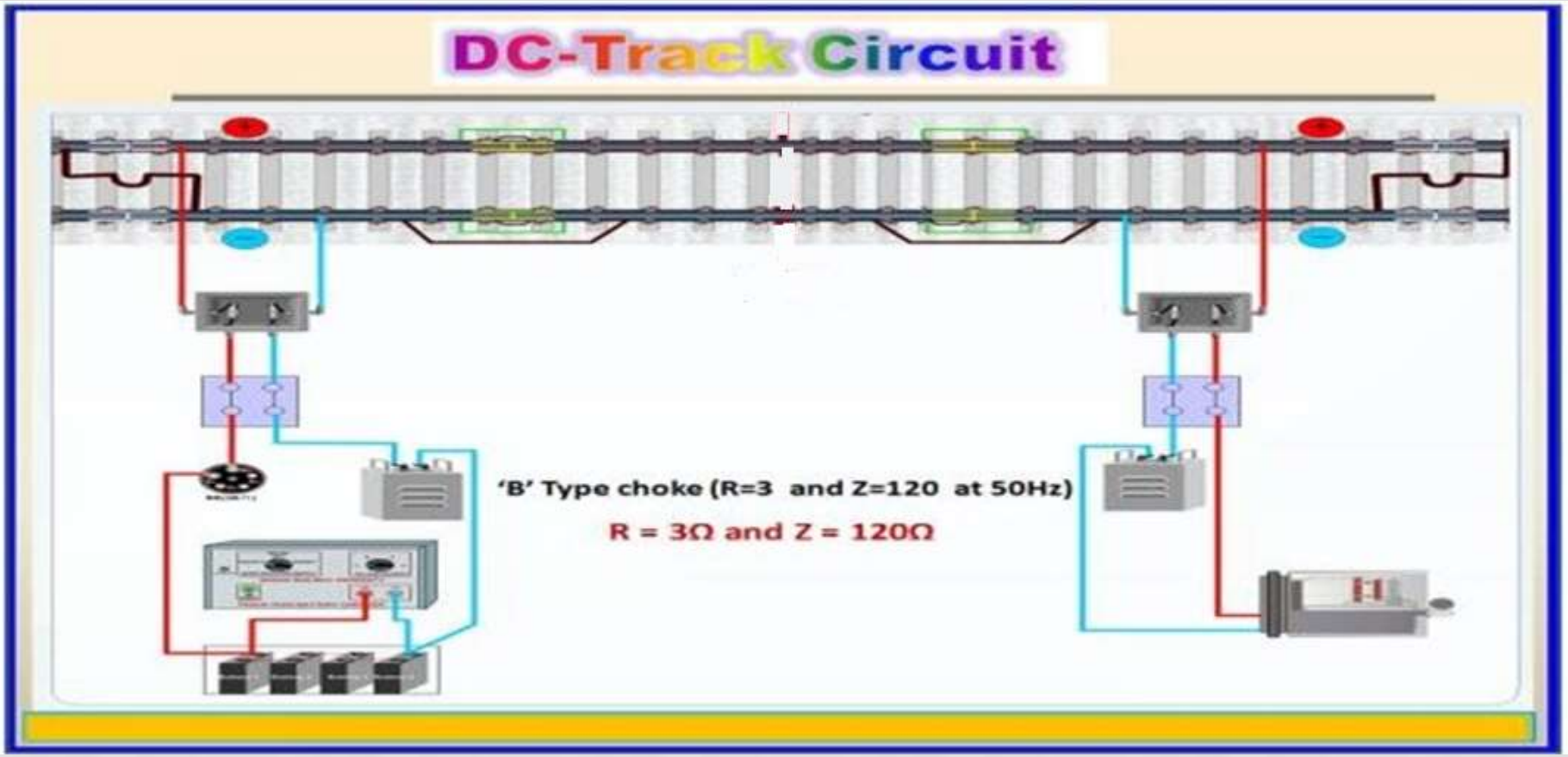
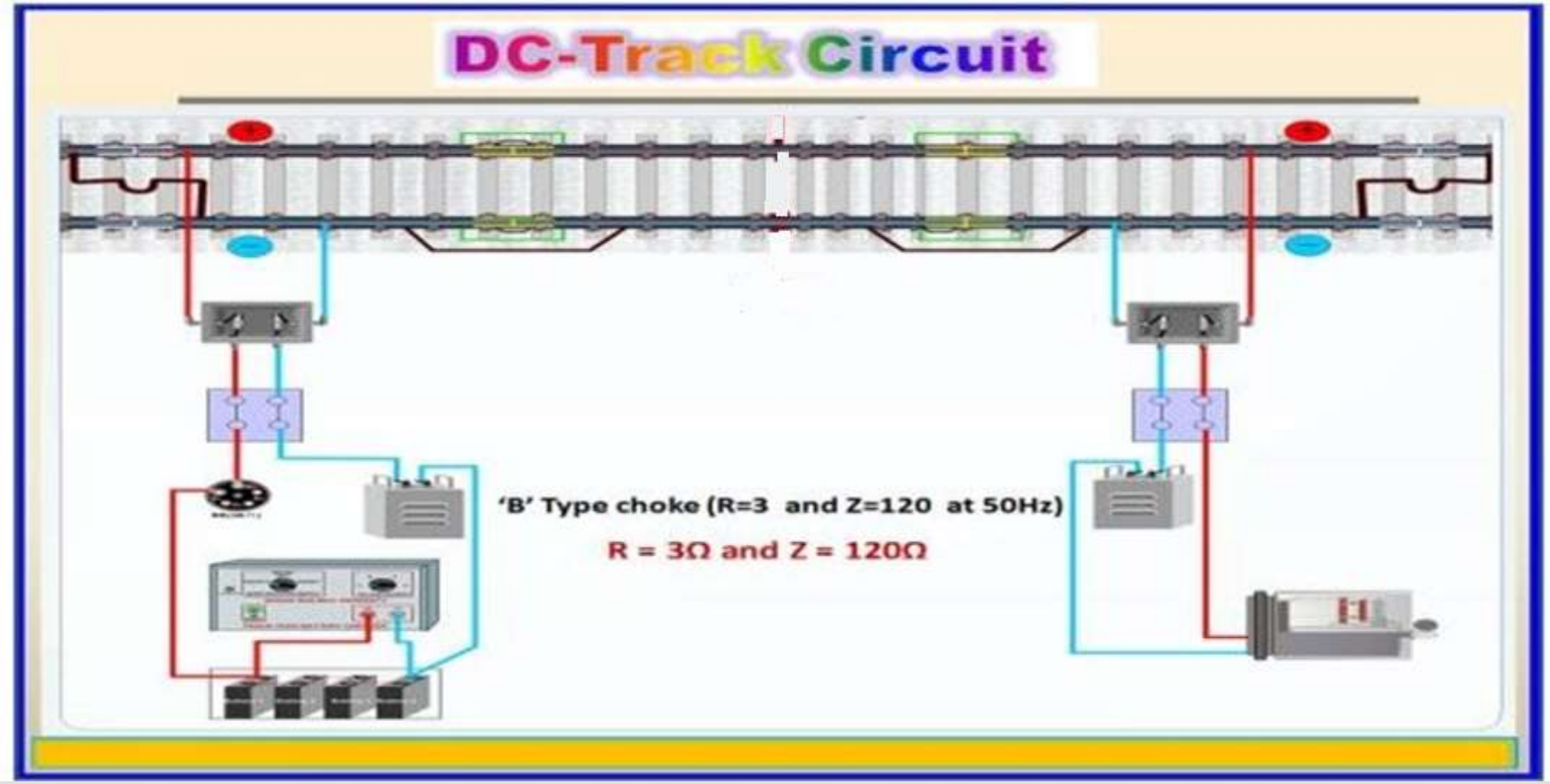
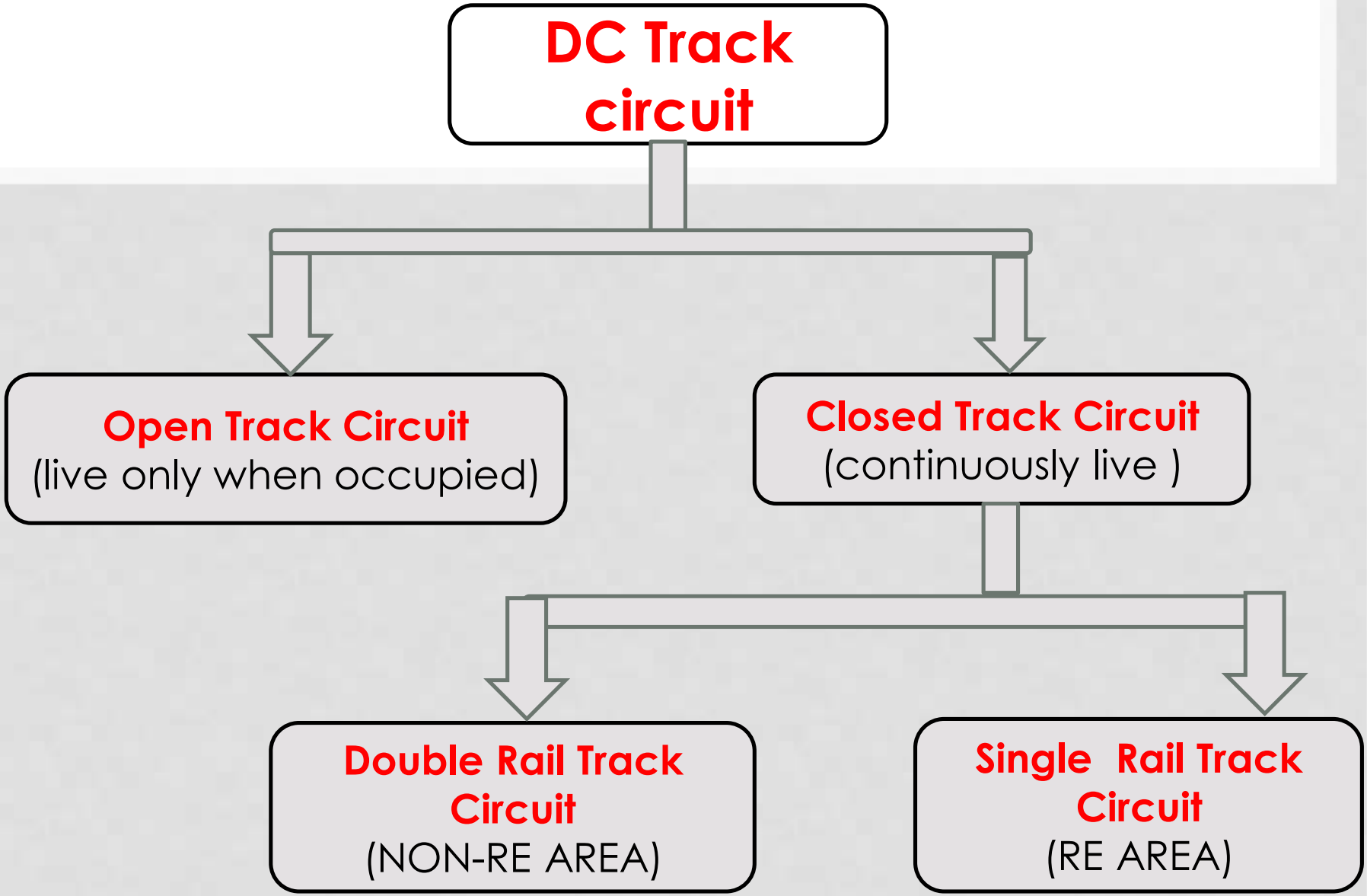


D.C. TRACK CIRCUIT

What is a Track circuit

Track circuit is a train detection device consisting of a simple electrical circuit in which the running rails form a part of the circuit of a given portion of a track.




DC Track circuit
Open Track Circuit
(live only when occupied)
Closed Track Circuit
(continuously live)
Double Rail Track Circuit
(NON-RE AREA)
Single Rail Track Circuit
(RE AREA)

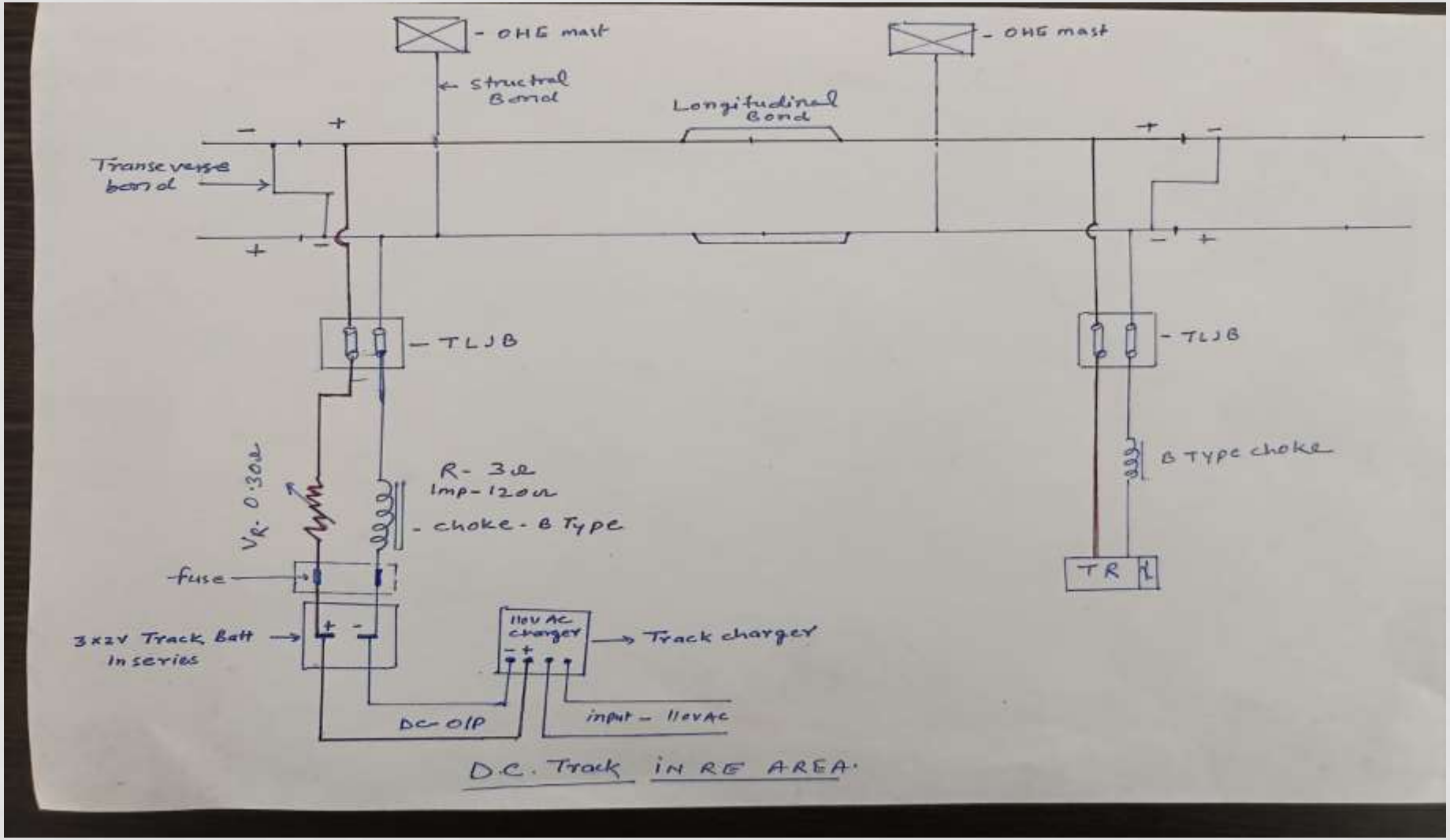
Components of track circuit

SN	Items	Details
1	Battery	80 AH secondary cells are used
2	Regulating Resistance	**0-15** ohms(with tapping at 1, 2, 4, 8), **0-30** ohms(with tapping at 2, 4, 8 ,16)
3	B type chock	Resistance =3 ohms, Impedance=120 ohms
4	Track Relay	QT2, QTA2, QBAT (9 ohms relay)
5	Insulated Joints	RDSO joints, Glued Joints
6	TLJB	
7	Track Lead	2X2.5 Sq mm
8	Continuity Bonds	8 SWG, PVC Jacketed wire
9	OHE Bonds	Structure bond, Transvers Bond, Longitudinal Bond, Cross Bond , End bond

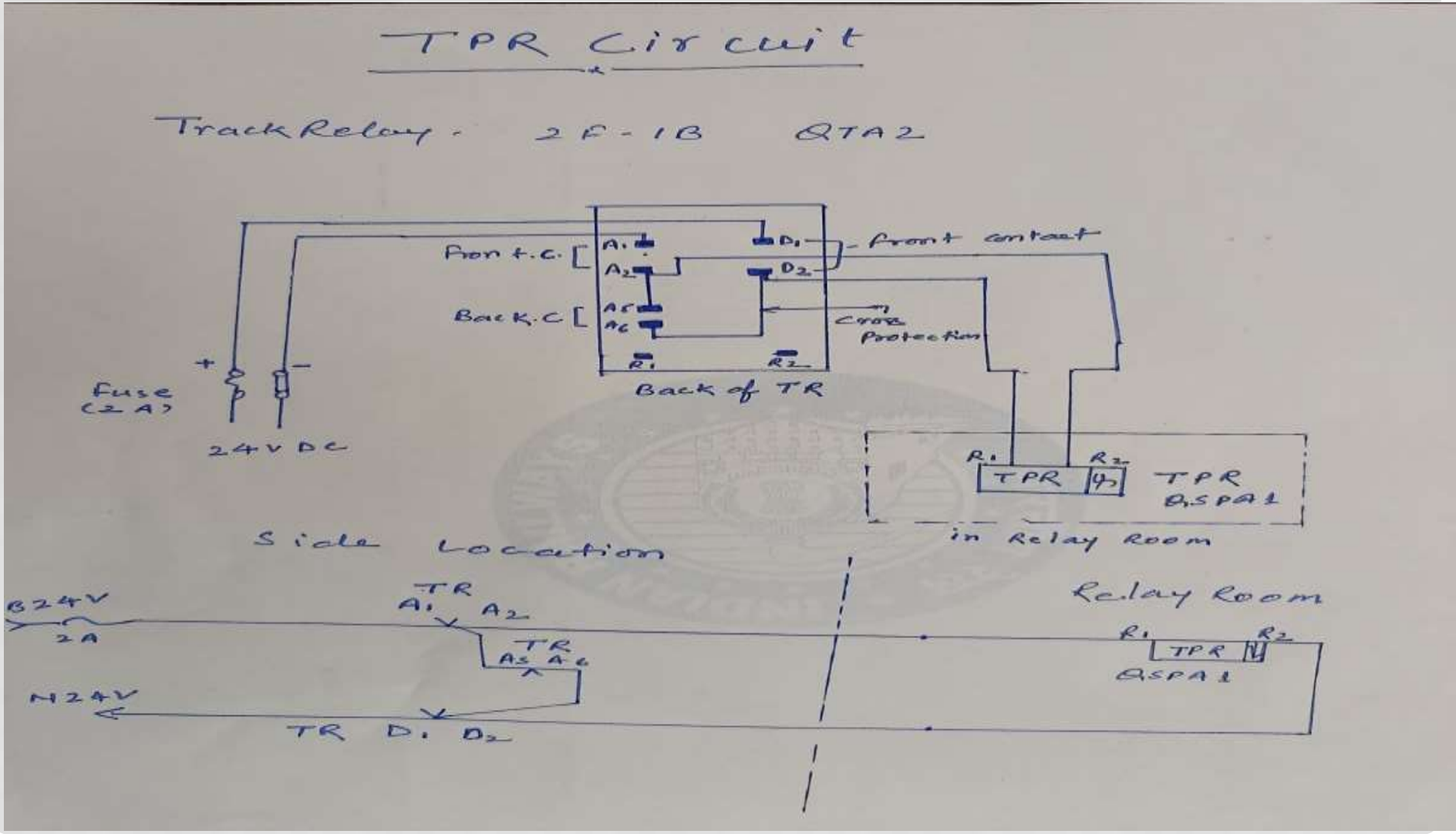
Components of track circuit

Items	Details
Regulating Resistance	
B type chock	
Track Relay	 
Track feed charger	

Connection of track circuit



TPR wiring


TPR Circuit
Track Relay : 2F-1B QTA2
Front t.c.
Back t.c.
A1
A2
A5
A6
D1
D2
R1
R2
Front contact
Cross Protection
Back of TR
Fuse (2A)
24V DC
TPR
TPR QSPA1
in Relay Room
Side Location
B24V
2A
TR A1 A2
TR A5 A6
N24V
TR D1 D2
Relay Room

Insulated Rail Joints

- **Nylon insulated rail joints**
  - Bushes 8 nos.
  - End post 1 no.
  - Channel side plate LH 2 nos.
  - Channel side plate RH 2 nos
  - Nylon insulating plate 4 nos.
  - Steel backing plate 4 nos.

- **Glued Rail Joints**
  - G3 (L) type having 6 bolts (L-Long) are of 6.2 m length
  - G3 (S) type having 4 bolts (S-Short) are of 4.2 m length
  - Insulation Resistance test in **Dry condition**: Resistance shall not be less than **25 MΩ** when a meggering voltage of **100 V DC** is applied across the joint. In **wet condition**: Resistance shall not be less than **3 KΩ**
  - **NCR maintenance guidelines** Click here

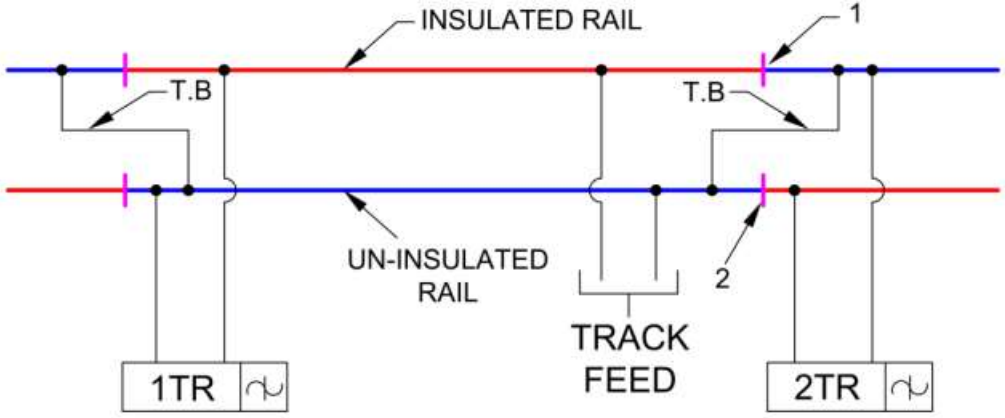
OHE Bonds

Transverse Bonds

- Negative rails of adjacent track circuits are provided with a cross connection-bonding strip in between, known as 'Transverse Bond'.

This transverse bond

- facilitates passing of traction return current from one track circuit negative rail to the other track circuit negative rail and also
- helps in detecting a block joint (insulated rail joint) failure between the two track circuits.

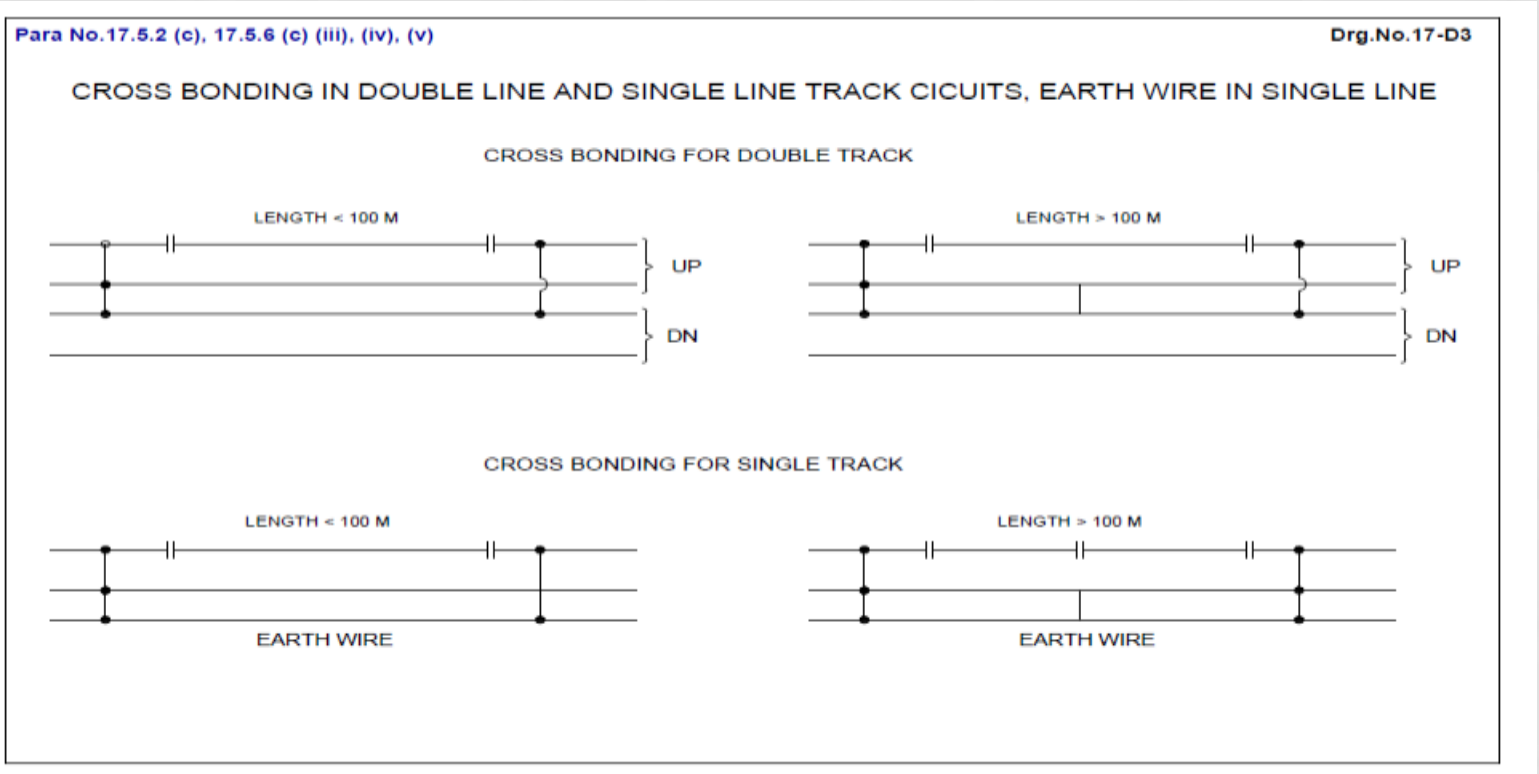


T.B: Transverse bond

OHE Bonds

Cross Bonds

Cross Bonds are provided for uninterrupted flow of traction return currents through negative rails to avoid their interference with track circuit working.



OHE Bonds

Structural Bonds

OHE Masts in Track circuited area are connected to the Negative Rail with a metallic strip known as Structural Bond. This Bond facilitates earthing of OHE mast.

Longitudinal Bonds

Longitudinal Bond is a metal strip connected across fish plates of negative rails of a Track circuit for traction return current continuity.

End Bonds

End Bond is a metal strip connected at the end of track circuited area for traction return current continuity.

Relay used in DC track circuits

SN	RE/Non-RE	Sleeper	Yard/Block	Max. length of TC (in M)	Type of relay used
1	Non-RE	Wooden/PSC	Block	1000	QT2 (9 Ohms)
2	Non-RE	Wooden/PSC	Yard	670	QT2 (9 Ohms)
3	RE	Wooden	Block	450	QTA2(9 ohms)
4	RE	Wooden	Yard	450	QTA2(9 ohms)
5	RE	PSC	Block	450	QTA2(9 ohms)
6	RE	PSC	Yard	350	QTA2(9 ohms)
7	RE	PSC	Block	750	QBAT in conjunction with B type choke at relay end

Note:
First TPR in RE area should be Slow to pickup relay i.e. QSPA1
Pick up time **(540-600 m sec)**, Release time : **140-200 m sec**, Coil resistance : **208 ohms**
Contact configuration : 8F / 4B, A/C Immunity level : **300 V AC**

Relay parameters

SN	Items	QTA2	QBAT
1	Resistance of coil in ohms	9	9
2	Pickup Voltage (in volt)	1.40	1.75
3	Pickup Current (in ma)	140	175
4	Minimum Excitation required	125%	122%
5	Maximum excitation	300%	235%
6	AC immunity up to (in volt)	50	80

Fail Safe Arrangements

Subject	Under Conditions	Track Relay Voltage
Maximum Excitation at Track Relay	Min Leakage (RB Maximum), Rr Minimum and Fully charged Battery voltage	• Not more than 250% of rated PU voltage for Shelf Type Track Relay • Not more than 300% of rated PU voltage for Plug in Type Track Relay except QBAT • Not more than 235% of rated PU voltage for QBAT
Minimum Excitation at Track Relay	Max Leakage (RB Minimum) & Minimum Battery voltage	• Not less than 125% of rated PU voltage for all Track Relays except QBAT. • Not less than 122% of rated PU voltage for QBAT
Dropping of Track Relay	Irrespective of RB conditions, with the application of TSR = 0.5Ω	• Not more than 85% of rated DA voltage

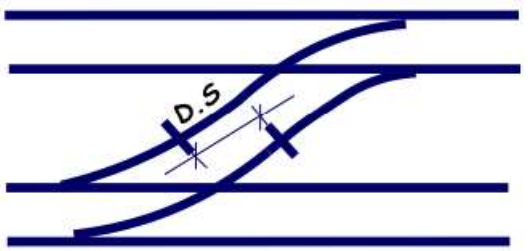
Dead Section

- These are defined as those portions of track circuits in which occupation by a vehicle cannot be detected.
- This may be due to the vehicle shunting rails of the same track feed polarity.
- This may also be due to one or both rails of that portion being bypassed by the track feed.

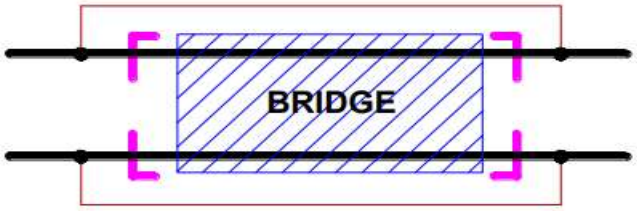
Examples

1. The block joints position on track rails is staggered either

due to rail ends on cross-overs being out of square:-



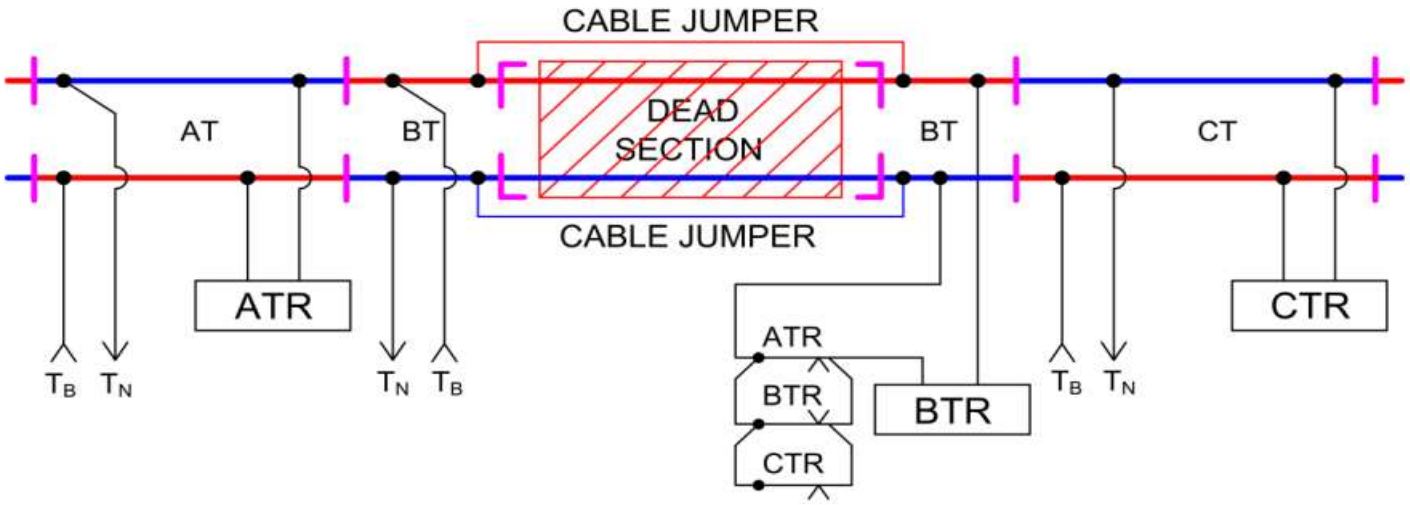
due to a bridge or culvert being under the track.



2. A track portion is excluded from track circuit either

Dead Section

- The dead section shall not accommodate a four-wheeler vehicle entirely in itself without shunting any 'live' portion of the track circuit at the same time.
- Dead section on point's zone shall not be more than 1.8 m (6') for B.G and 1.125 m (3'9") for MG/NG sections.
- If the dead section is longer than 10.8 m (36') as in the case of long bridges underneath the track, a **'Trap Circuit'** shall be provided including the control of dead section track by two other track circuits on either side which is given below.



Track Parameters

BALLAST RESISTANCE

- Ballast Resistance is the net resistance of various leakage paths across track circuit rails offered by ballast and sleepers.
- Ballast resistance is inversely proportional to length of Track circuit and also it varies as per condition (Dry/Wet) of the ballast and soil.
- It reduces with increase in the length of track circuit as leakage paths in parallel are more.

$$R_B = \frac{\text{Average Rail Voltage}}{\text{Leakage current}} = \frac{\frac{(V_F + V_R)}{2}}{(I_F - I_R)} = \frac{(V_F + V_R)}{2(I_F - I_R)}$$

Where,

V_F = Feed End track voltage

V_R = Relay End Track Voltage

I_F = Feed End Track Circuit current

I_R = Relay End Track Circuit current

Minimum Permissible Ballast Resistance

- **2 ohms** per Kilometer track length in **station yard**, and
- **4 ohms** per Kilometer track length - **block section**

Track Parameters

Rail Resistance

- Rail Resistance is the combined resistance of the track circuit rails and the continuity bonds at rail.
- 8 SWG, G.I wire (4 mm Dia) bonds are provided by the signaling staff to reduce resistance at these joints.

$$R_r = \frac{\text{(Voltage drop in the rails)}}{\text{(Average Track circuit current)}} = \frac{(V_F - V_R)}{\frac{(I_F + I_R)}{2}} = \frac{2(V_F - V_R)}{(I_F + I_R)}$$

Where,

V_F = Feed End track voltage

V_R = Relay End Track Voltage

I_F = Feed End Track Circuit current

I_R = Relay End Track Circuit current

Track circuit length	Maximum permissible rail resistance / KM
Up to 700 m	**1.5 Ohms**
More than 700 m	**0.5 Ohms**

Track Parameters

Pick Up Shunt & Drop Shunts

- The highest value of such shunting resistance that can cause the track relay to drop is referred to as '**Drop Shunt Value'.**
- The drop shunt value must be higher than the minimum permissible TSR (0.5 Ohms for DC T.C) for safe working of Track circuit .
- Shunt test shall be taken not only at Relay end but also at other parallel portions of the track such as turnouts and crossovers.
- Once the track relay is dropped, it requires a considerable increase in its voltage to pick up again. This increase can be affected by increasing the shunting resistance. This least resistance value at which the track relay picks up again is called the **'Pick up Shunt Value'** of this track circuit.

Track Parameters

Train Shunt Resistance (TSR)

- The **highest resistance** which, when applied across the track, can open the track relay front contacts is known as its 'Train Shunt Resistance' (TSR).
- TSR is **affected** by **Rail resistance / Feed end resistance** & **Ballast resistance** whose effect is given below.
- For D.C. Track Circuits, it is expected that If a Track relay drops with **0.5 ohms** shunt across rails , it will be able detect any vehicle such as Motor Trolley, Light engine , Full train which give better shunting effect if rails & wheels are not in rusted condition. Thus higher TSR of > 0.5 ohms is desirable and to be ensured

Vital Safety Checks for Track Circuits

- Track relay must drop when **shunted by any Vehicle** other than Insulated Push trolleys.
- For any adjustment on D.C. track Circuits, **TSR** Shall not be less than **0.5 Ohms.**
- **Max Excitation** at Relay end shall not exceed 250 % (Shelf Type) or **300 % (QTA2) or 235% (QBAT)** of its rated pickup value as per Relay type.
- Block Joint **protecting Fouling** shall not be less than **3 Mts from** Fouling mark. It shall be towards divergence.
- **Staggering of polarity** between adjacent rails is to be maintained.
- **Dead section** shall not be more than **1.8 m** (6').
- **Track relays** shall be located at the **entry end** of the train wherever feasible.
- **Jumper connections** shall normally so made that the whole of **track circuit is in series** excluding traction return rail. When the rails of a track circuit are in parallel, integrity of jumper connections to be ensured.

Vital Safety Checks for Track Circuits

- Where there are **rusty rails** (guidelines for rusty rail) in the track circuited area, **Zig-Zag welding** using steel wire should be done on top of the rail by P-way staff to ensure shunting of track circuit by the vehicle.
- Ensure provision of **rubber pads** & availability **of insulated liners** up to 97%.
- use **J Pandrol clip** to avoid touching of pandrol clip with the fish plates.
- **Ballast clearance** from foot of rail should be more than **50 mm.**
- **Insulation resistance of sleeper** should be minimum **500 ohms** between insert to insert.
- **Minimum length** of track circuit should **not be less than 26 meters**.
- For reception signals length of **Calling on track circuit** should not be less than **65 meters**.

Do's & Don'ts

Do's

- Check all **safety parameters** and record the exact values in track history card.
- Check **insulation joint regularly** and at the same time see its previous value. If changing, then replace such insulation joint promptly.
- Check the due date of **overhauling** of each **track relay**
- **Megge**r the track circuit **tail cable** once in year and if the value is less than **1 mega ohm** then such cable should be replaced promptly.
- Measure the **stray current**, by disconnecting the feed. If stray current persist then try any one method. (**10 ma if length <100M & 100 ma if length >100M)**
    - Interchange the positive and negative connections of the rails, so that stray voltage becomes opposite to the track feed.
    - Interchange the feed and relay ends of the track circuit. Stray voltage may disappear.
    - Splitting the track circuit, so that value of stray voltage will be negligible.

Do's & Don'ts

Do's

- Check the bond wire connections to avoid high resistance, which are causes of voltage drop.
- Prefer to provide track lead junction box vertically to avoid water accumulation in the junction box
- use **J Pandrol clip** to avoid touching of pandrol clip with the fish plates.
- Guidelines in case of auto right failures (click here)

Do's & Don'ts

Don'ts

- Don't bypass the regulating resistance at any time
- Don't tamper with the track relay at the time of track circuit failure.
- Don't forget to give disconnection memo to on-duty ASM/CASM at the time of attending failure
- Don't adjust the track circuit beyond the limit of track circuit parameters given earlier.
- Don't forget to clean the insulation joint on every visit.

Thank You