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Track Circuit Assister Interference Detectors (formerly RT/E/PS/11762)

This temporary front sheet facilitates change to the new Network Rail Standards referencing nomenclature.

The Ref above will be formally allocated to this standard when it is next changed in the meantime the contents, date and issue number of this Network Rail Standard are UNCHANGED and with immediate effect it should be referred to as “(new ref) formerly (old ref)”.

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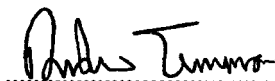


RAILTRACK LINE PRODUCT SPECIFICATION

TRACK CIRCUIT ASSISTERS INTERFERENCE DETECTORS

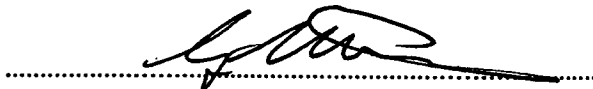
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Summary

This Line Specification states the minimum requirements for Track Circuit Assister Interference Detectors. It includes lifecycle requirements from design, safety and environmental to installation, testing and maintenance.

Issue/Revision Record

Issue	Date	Comments
I	December 2000	New Specification. The contents are based on Railway Group Code of Practice GK/RC0762 which is to be transferred to Railtrack Line in February 2001.

Implementation

The requirements of this Specification shall apply to all track circuit assister interference detectors supplied for use on Railtrack controlled infrastructure on or after 3 February 2001. It shall also apply to the alteration and maintenance of existing track circuit assister interference detectors from the same date. The following document is superseded:

Superseded document

GK/RC0762, Issue 1, June 1996 - Track Circuit Actuator Interference Detector

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I INTRODUCTION

I.1 PURPOSE

This Product Specification gives details of best practice in respect of the Track Circuit Actuator Interference Detector (TCAID) system for facilitating train detection.

I.2 SCOPE

The contents of this Product Specification apply to all three types of TCAID system, as follows, and shall be read in conjunction with RT/E/S/11752:

- TCAID(MC) -non directionally selective TCAID, mounted in a metal case (not for new work),
- TCAID-D directionally selective TCAID,
- TCAID-N non directionally selective TCAID.

I.3 INTRODUCTION

Track circuits can fail wrong-side for several reasons but one of the most common is contamination of the interface between wheel and rail. This results in a relatively high resistance being presented by the train to the track circuit with the result that the track relay (or receiver) is not shunted.

I.3.1 Origin

This problem became much more serious in the 1980s due to the advent of new diesel multiple units with good riding qualities. The good riding characteristics together with the small number of axles considerably increased the risk of not shunting the track circuit by reducing the scrubbing at the wheel rail interface. (See also RT/E/S/11752, Part F, section 8, on rail contamination.)

I.3.2 Track Circuit Assister (TCA)

To combat this effect a track circuit assister was added to the train. This device induces a high frequency (165kHz) current into the bogie axle area such that a slight rise in contamination increases the voltage between the wheel and rail and thus breaks down the contaminant. However the TCA cannot break down thicker films of rust, leaf debris or other similar contamination since the required voltage cannot be generated safely.

Although the preferred technical name is "track circuit assister", the device is more commonly referred to as "track circuit actuator".

1.3.3 Track Circuit Assister Interference Detector (TCAID)

The TCAID has been developed to detect the TCA signal injected into the rails and to then provide a supplementary shunt to the track circuit and improve the probability of correct track circuit operation. A consequence is that the TCAID will only respond to TCA fitted trains. (See also RT/E/S/11752, Part F, section 8, on train shunts.)

2 APPLICATION AND CONSTRAINTS

2.1 APPLICATION

The application of TCAIDs in selected locations facilitates the correct operation of train detection systems by TCA fitted trains and overcomes problems due to poor train shunt caused by rail contamination and/or lightweight vehicles. Their use may be seasonal, particularly when associated with leaf-fall.

TCAIDs shall not be used as a train detection device in their own right (e.g. as a substitute for a treadle).

2.2 CONSTRAINTS

TCAIDs shall be fitted regularly along the track circuit at intervals of between 90m and 183m, subject to the following restrictions:

2.2.1 Designs for New Work

Only the following designs provide the required integrity for new work:

- TCAID-D - directionally selective TCAID,
- TCAID-N - non directionally selective TCAID.

2.2.2 Rolling Stock

TCAIDs only work with TCA fitted trains. It is therefore not appropriate to fit TCAIDs unless some trains using the route are TCA fitted.

2.2.3 Electrified Areas

TCAIDs shall not be fitted in electrified areas, since the relay contact which provides the supplementary shunt cannot be guaranteed to pass any traction current without suffering damage. TCAIDs may also be damaged by the rail voltages which exist in electrified areas.

2.2.4 Automatic Warning System (AWS)

TCAID-D units must not be fitted such that the current loop encloses, or is in close proximity to, an AWS magnet or suppressor coil. There must be at least one sleeper between the end of the loop and the end of the AWS magnet or coil.

2.2.5 Level Crossings

TCAID-D units must not be used with track circuits which are part of Level Crossing control logic unless an assessment of the application has shown there will be no adverse effects from failures, e.g. TCAID must not be used in the strike-out track circuit of an AHB level crossing because false detection could raise the barriers in front of an approaching train, but could be used in the strike-in track circuit as false detection would only initiate the barrier lowering sequence.

2.2.6 Steel Sleepers

Steel sleepers increase the level of the 165kHz signal on adjacent tracks giving rise to problems of spurious operation. Consequently TCAIDs shall not be provided on lines fitted with steel sleepers, with the exception of single lines, where they may be used.

2.2.7 Cross Bonds

TCAID-N units shall not be fitted within 135m of a single rail cross bond. TCAID-D units shall be not less than 135m from a single rail cross bond, with the detection direction facing towards the cross bond. TCAID-D units shall be fitted not less than 9 metres from the cross bond, with the detection direction facing away from the cross bond.

No TCAIDs shall be used on tracks with impedance bonds fitted or double rail cross bonds.

See also Figure 7.

2.2.8 Track Circuit Extremities

a) Double Rail Track Circuits

TCAID(MC) and TCAID-N units shall not normally be fitted less than 50m from the end of double insulated rail joint track circuits.

b) Single Rail Track Circuits

TCAID(MC) and TCAID-N units shall not be fitted less than 135m from the end of single rail track circuits. TCAID-D units shall be not less than 135m from the end of a single rail track circuit, with the detection direction facing towards the track circuit boundary. TCAID-D units shall be fitted not less than 9 metres from the end of single rail track circuits, with the detection direction facing away from the track circuit boundary.

c) Jointless Track Circuits

TCAID(MC) and TCAID-N units shall not be fitted less than 135m from the end of jointless track circuits. TCAID-D units shall be not less than 135m from the end of jointless track circuits, with the detection direction facing towards the track circuit boundary. TCAID-D units shall be fitted not less than 14 metres from the end of jointless track circuits, with the detection direction facing away from the track circuit boundary. (The end of a jointless track circuit is defined for TCAID purposes as the end of the tuned zone determined by the outermost tuning components connected to the rails.)

See also Figure 7.

The consequence of the above rules is that TCAIDs cannot be fitted to single rail track circuits which are less than 144m in length or to jointless track circuits which are shorter than 149m in length.

3 FUNCTIONAL REQUIREMENTS

3.1 TYPES OF TCAID UNIT

3.1.1 General

The term TCAID is used in this Specification to refer generically to all three types of unit. The various forms of TCAID developed all share two characteristics:

TCAIDs detect the presence of TCA fitted trains by monitoring the track for the presence of a 165kHz signal which is emitted from the TCA aerials fitted to most of the vehicles considered to be at risk;

The 165kHz signal indicates the presence of a train to the signalling interlocking by directly shunting the rails, so dropping the track circuit.

3.1.1.1

TCAIDs are designed to be simple to install, and self contained. Their use involves no modifications to the signalling infrastructure and they have no requirement for an external power supply.

3.1.1.2

There are now three basic forms of TCAID. The first generation of devices, produced during 1992, are called TCAID(MC). The second generation, designed in 1993 are called TCAID-D (directional) and TCAID-N (non-directional).

3.1.2 TCAID(MC)

The TCAID(MC) units will detect a TCA fitted train anywhere, on the track to which they are fitted, at a range of typically 200m. Double rail track circuits block 165kHz signal flow very effectively. TCAID(MC) units can therefore be installed very close to the ends of track circuits separated by these joints without the risk of detecting trains before they enter a particular track circuit. Single rail track circuits and tuned zones are much less effective and thus TCAID(MC) units cannot be positioned close to the ends of these types of track circuits.

The TCAID(MC) unit is housed in a metal box which has a diagonal yellow stripe to show that its sensitivity has been correctly adjusted, and has a three-core cable for connection to the disconnection box.

3.1.3 TCAID-D

The TCAID-D units are designed to be unidirectional. They will only detect the presence of a TCA fitted train when it is on one specific side of the TCAID-D installation (at a range of typically 200m). They can be used near to but not at the ends of single rail and jointless track circuits as they will ignore signals emanating from trains on the wrong side of the TCAID-D. The suffix -D indicates the unit is directionally selective.

The TCAID-D units are housed in a plastic box with a label indicating TCAID-D. The TCAID-D units have a four core cable for connection to the disconnection box.

3.1.4 TCAID-N

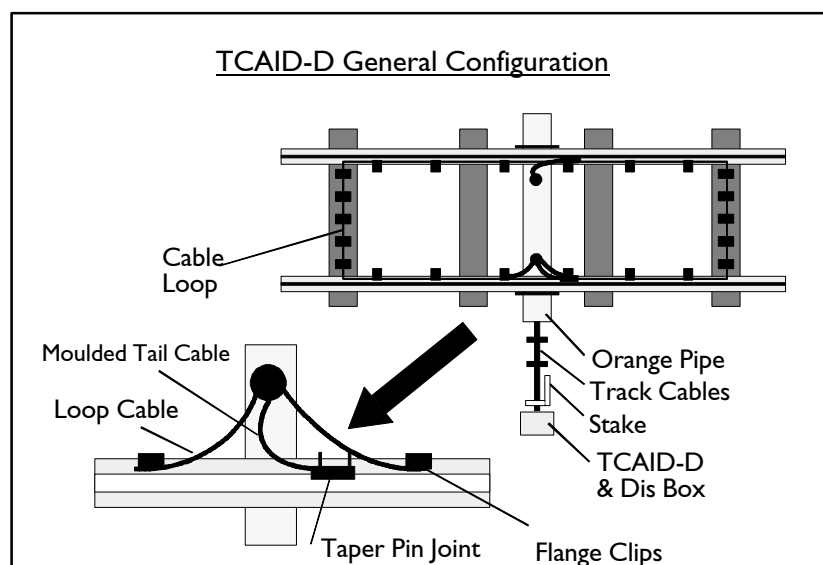
The TCAID-N units are functionally equivalent to the TCAID(MC) units, and their detection range is also 200m. They are however mechanically different, and their internal technology is closely related to the TCAID-D. They shall be used in preference to the TCAID(MC) units, no more of which will be manufactured. The suffix -N indicates that the unit is not directionally selective.

The TCAID-N units are housed in a plastic box identical to that used for TCAID-D but with a label indicating it is a TCAID-N. The TCAID-N has a three core cable for connection to the disconnection box.

3.2 PRINCIPLES OF OPERATION

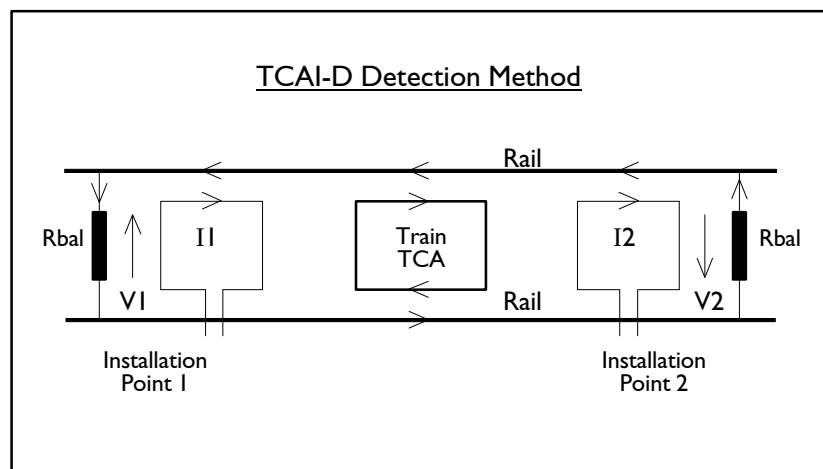
3.2.1 TCAID-D

There are two elements to a TCAID-D cable installation. Firstly a pair of cables connected to the rails themselves. Secondly a cable which forms a loop within the four foot. These cables run from the track to a disconnection box, and then on into the TCAID-D unit itself. The basic installation is illustrated in Figure 1 and Figure 15.

**Figure 1**

3.2.1.1 Track Signals Detected

The signal source that triggers the TCAID-D is the train mounted TCA aerial. This carries a 165kHz circulating current as shown in Figure 2 (the diagram shows an instantaneous view to show the direction of each current flow and voltage drop). This induces an opposing circulating current in the circuit consisting of the rails and the ballast resistance (R_{bal}). (See also RT/E/S/11752, Part F, section I, on ballast resistance.) The result of this is that a voltage drop is produced across the ballast resistance which the TCAID-D monitors through the pair of cables connected to the rails. A second effect of the current circulating in the rail is to induce an opposing current in the loop of wire located within the four foot. As two current flow reversals have now taken place (one from TCA to rails, and the other from rails to track loop) the loop current will now be flowing in the same direction as that in the TCA aerial.

**Figure 2**

Examination of Figure 2 reveals that at each of the possible TCAID-D installation points (I&2), the circulating loop currents are in the same direction (clockwise), whereas the ballast voltage drops are opposite (at point 1 the top rail is positive however at point 2 the bottom rail is positive). It is this fact that the TCAID-D uses to determine the direction in which the train is located.

For completeness it should be noted that the above explanation is only true whilst the train TCA is not directly over the TCAID-D installation point. As a TCA passes over a TCAID-D installation reversals to the rail voltage and loop current occur which may result in temporary loss of detection. This effect is however very localised and of little or no practical significance. In addition there must be some current path beyond the TCAID-D unit. This is necessary to draw enough current past the unit to induce sufficient signal into the loop.

Note that if a TCAID-D unit receives signals from both directions at once it will ignore the weaker signal and act as if it were in receipt of the stronger signal only. Thus a signal from the rear will prevent the TCAID-D unit from responding to a weaker signal in its intended detection area.

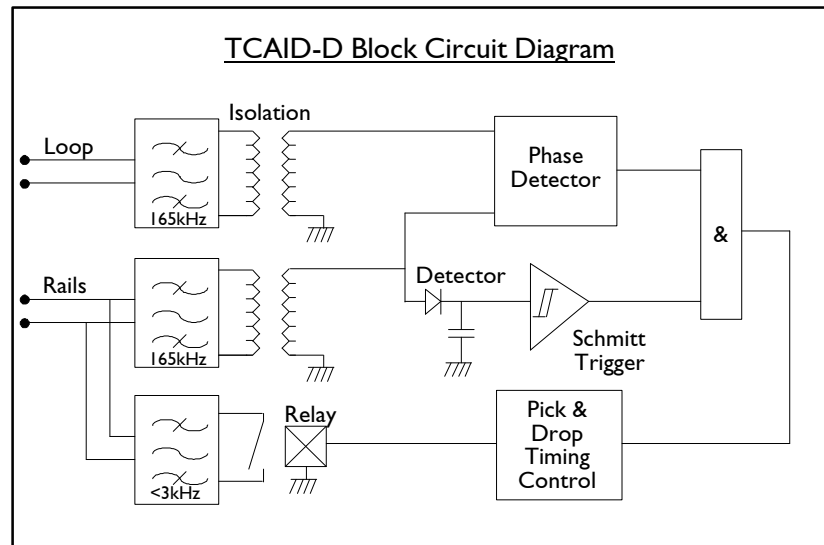


Figure 3

3.2.1.2 Circuit Operation

The electrical construction of the TCAID-D can be seen in Figure 3. The circuit has four main sections that all contribute directly to the detection of trains. One extra section is included within the production units. Its function is to reduce power consumption while no trains are present by switching off selected sections of the circuit. Details of this are not relevant to the basic operation of the system and have been excluded for clarity.

Firstly the two signals from the track (rails and loop) are band pass filtered to leave only signals near 165kHz. These signals are then coupled into the main circuit using isolation transformers. The function of the transformers is to remove any possibility of the TCAID-D erroneously feeding D.C. power, from its internal battery, out to the track as this could interfere with the correct operation of the track circuit.

The signals derived from the rails are then fed to a level detector which determines the signal strength at which the TCAID-D will activate. This controls the effective detection range and also prevents weak signals from trains on adjacent tracks falsely triggering the system.

The logic AND function will prevent the TCAID-D from indicating the presence of a train unless the phase relationship between the signal from the rails and the signal from the cable loop indicate that the train is located on the correct side of the installation. The phase detector provides this information.

Finally a timing control circuit provides a short delay. This prevents momentary detection dropping the track circuit and momentary loss of detection removing the shunt. The output from this circuit drives a relay which shorts the rails via a low pass filter. This indicates the presence of a train by forcing the track circuit to drop. The filter is designed to pass only track circuit frequencies. If it were not included the TCAID-D would short circuit its 165kHz triggering signal, causing it to release its relay. With the short circuit removed it would then re-trigger. This cycle would repeat while the 165kHz signal was present.

3.2.2 TCAID(MC) & TCAID-N

The TCAID(MC) and the TCAID-N units are functionally similar to each other. They differ in that the TCAID-N was designed with the benefit of operational data collected from the older TCAID(MC). As a result of this the TCAID-N is more robust.

The circuit used for the TCAID(MC) and the TCAID-N is similar to that already described for the TCAID-D. They differ in that there is no phase detector and so no track current loop and filter as shown in Figure 4. The remainder of the circuit is equivalent. Thus they will indicate the presence of a train on both sides of their installation point.

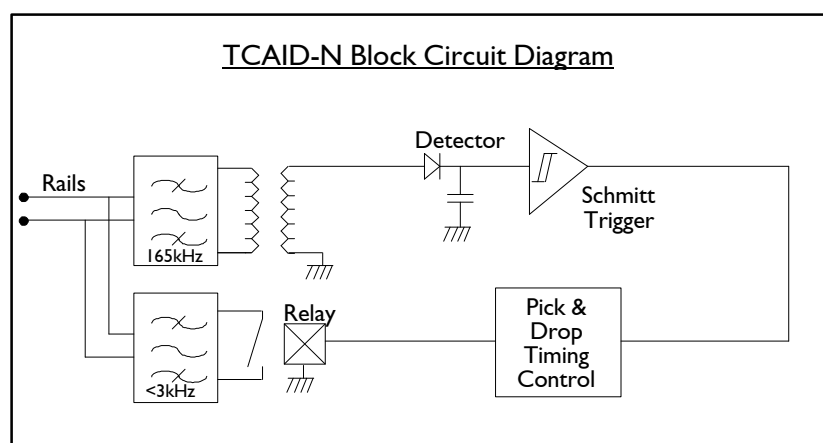


Figure 4

3.3 TECHNICAL OUTLINE

3.3.1 General

TCAIDs shall be distributed along the length of the track circuit since the TCA signal is reduced as it travels along the track.

3.3.1.1

The TCA signal is not fully isolated by double insulated rail joints and the isolation afforded by single insulated rail joints (i.e. one common rail) and between jointless track circuits is less. The Constraint Rules in this Specification are designed to ensure that the attenuation of the TCA signal from one track circuit to the next is sufficient to prevent a TCAID detecting a train on a different track circuit.

3.3.1.2

The TCAID(MC) or TCAID-N units are fitted to the centre portion of all track circuits and near the ends of track circuits where both rails are fitted with insulated rail joints. TCAID-D units are fitted near cross bonds or the ends of jointless track circuits or single rail track circuits. The TCAID-D units only detect trains positioned to one side of the device and are said to be directional .

3.3.1.3

TCAIDs have several failure modes and can only be considered effective if used such that more than one will detect a train when wheel/rail contamination may prevent correct track circuit operation. The spacing rules given ensure that this condition is generally met.

3.3.2 Planning Limits

The following data (Figure 5) is based on calculated and experimental data. The figures have been used to calculate the planning limitations imposed within this specification.

Parameter (at 165 kHz)	Value
Attenuation along track (minimum)	7dB/100m
Attenuation through a double IRJ	> 26dB
Attenuation through a single IRJ	16dB
Attenuation through a tuned zone	17dB
Maximum TCA signal injection into rails	10.6V rms
Minimum signal required to activate a TCAID	315mV
Attenuation required to block TCA signal detection	30dB
Attenuation due to the TCAID loading the rail circuit.	6dB

Figure 5

3.3.3 Measuring Points

Where minimum distances are quoted in section 3.3.4 below they refer to the shortest distances between two features as described in Figure 6:

Track Feature	Designated Measurement Point
TCAID-N	Pin joints to rails
TCAID-D	End of the loop cable (running across the four foot on a sleeper)
Single IRJ	The centre of the rail joint itself
Double IRJ	The centre of the closest individual IRJ
Tuned zone	The point at which the track circuit filter leads are connected to the rails. Note this is not the end of the track circuit.

Figure 6

3.3.4 Minimum Separations

The distances in Figure 7 are based on the attenuation figures quoted in Figure 5, together with the maximum permitted TCA radiated power and the minimum TCAID detection level.

From	To	Recommended Distances
TCAID-N	Double IRJ	50m (min) ^{#1} & 90m (max)
TCAID-N	Single IRJ	135m (min)
TCAID-N	Tuned zone	135m (min)
TCAID-D	Double IRJ	N/A ^{#2}
TCAID-D	Single IRJ	9m (min)(non-detect side)
TCAID-D	Single IRJ	135m (min)(detect side)
TCAID-D	Tuned zone	14m (min)(non-detect side)
TCAID-D	Tuned zone	135m (min)(detect side) ^{#3}
TCAID ^{#4}	TCAID ^{#4}	90m (min) ^{#5} & 183m (max) ^{#6}
TCAID-N	Cross bond	135m (min)
TCAID-D	Cross bond	135m (min) (detect side)
TCAID-D	Cross bond	9m (min) (non-detect side)

^{#1} Applies to new installations only.

^{#2} A TCAID-D will only be used with double insulated rail joint separated track circuits if there is a specific problem.

^{#3} The minimum allowable length for jointless track circuits will prevent a situation arising where this distance will be significant.

^{#4} All three types of TCAID.

^{#5} Does not apply to the non-sensitive side of the TCAID-D units.

^{#6} The attenuation figures show that the absolute maximum detection range of a TCAID on plain line is approximately 345m. This assumes that the insulation between rail and wheel is perfect.

Figure 7

3.4 TCAID CONFIGURATION

3.4.1 General

This section provides a guide to the distances to be used in planning a TCAID installation and in particular the minimum and maximum distances between TCAIDs and other track circuit equipment. Also provided is specific guidance for the installation of TCAIDs to the three main categories of track circuit.

The key below (Figure 8) identifies the symbols used in the installation diagrams included within this specification. The detection direction for a TCAID-D is indicated by the point on its symbol.

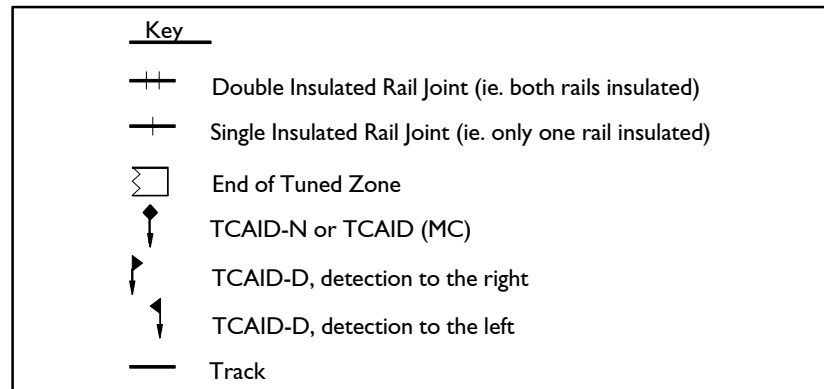


Figure 8

3.4.2 Double Rail Track Circuit

Double rail track circuits are the simplest to equip. Only TCAID-N units are used. The recommended installation for track circuits of length 500m upwards is shown in Figure 9.

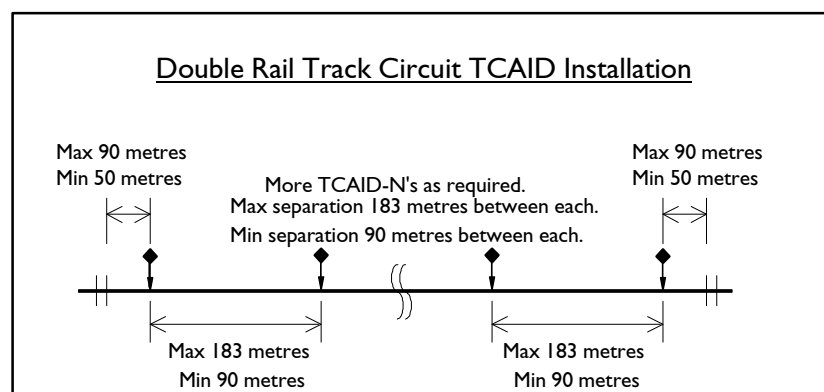


Figure 9

As track circuit length increases, more TCAID-N units shall be added so as not to exceed the maximum separation.

Double rail track circuits of length between 300m and 500m require only one TCAID-N unit positioned at the centre of the track circuit plus two TCAID-N units positioned near the ends of the track circuit as shown in Figure 9.

Double rail track circuits between 200m and 300m in length shall be fitted with just two TCAID-N units, one at either end (i.e. the centre TCAID-N units shown in Figure 9 are omitted).