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***EBI* Track 200 / 300 / 400 TRACK CIRCUITS**

GUIDANCE NOTES FOR TRACTION BONDING

Extract.

This document contains guidance notes for traction bonding in *EBI* Track 200 / 300 / 400 track circuit areas. The rules in this document are concerned with the safe and reliable operation of the track circuit only, rules relating to maximum touch potentials, traction current rating etc, should be obtained from the local railway administration documentation, or other relevant project documentation.

The Local *EBI* Track 200 / 300 / 400 Manuals and railway authority rules take precedence over this document where contradictions exist.

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1 INTRODUCTION

This document is intended to give an overview of the factors that need considering when designing the traction bonding arrangements in *EBI* Track 200, *EBI* Track 300 or *EBI* Track 400 track circuited areas. Due to the diverse requirements of different railway administrations it is impossible to cover every conceivable situation.

2 REVISION HISTORY

Issue					
From	To	Date	Reason for Change	ECR No	Sig.
-	1	25/01/08	First issue	6-1685	AM
1	2	16/09/10	Additional restrictions for track circuits with two or more impedance bonds added in new section 11.4. Other restrictions added in section 11.5. Reference section 18 added.	6-14412	JPS
2	2.1	11/05/15	Re-write from section 9 to tabulate rules more logically and add ET300 and ET400 rules.	-	CM
2.1	3	14/05/15	Formal issue	6-113141	MA
3	4	04/06/15	Updates to sections 9 and 10.	6-114732	LPC

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3 TERMINOLOGY

3.1 Definitions

EBI Track 200 / 300

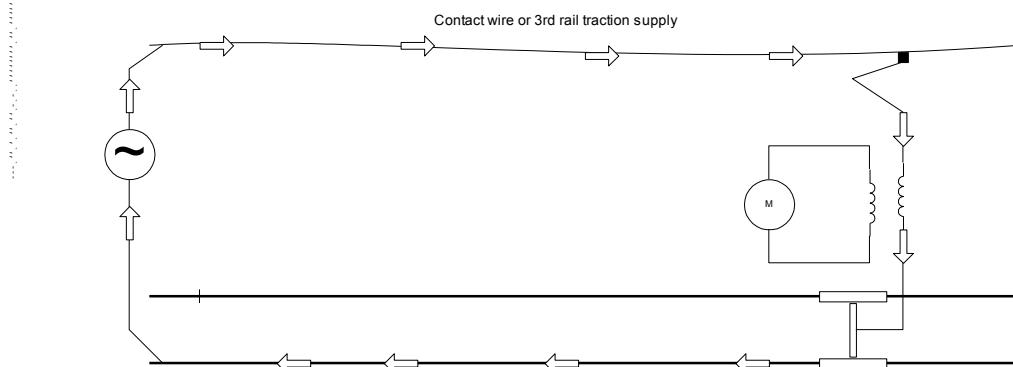
Traction immune track circuits, formerly known as TI21 and TI21M. These track circuits use a frequency modulated sine wave in the range 1532Hz to 2610Hz (*EBI* Track 200) and 5700Hz to 8600Hz (*EBI* Track 300). This modulation provides immunity against harmonics in the traction system falsely energising the track circuit relay.

EBI Track 400

A development of the *EBI* Track 200 / 300 track circuits using a phase modulated, bit-coded carrier signal to provide superior traction immunity. The Open Line variant uses the *EBI* Track 200 frequency range, while the Station Area variant uses the *EBI* Track 300 frequency range.

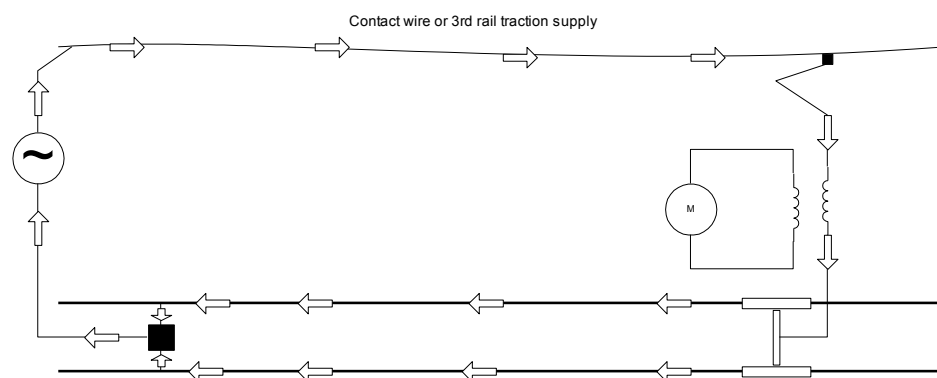
Single Rail Return

Sections of line in which a continuous path for the traction return current is provided in 1 rail only.



Double Rail Return

A section of line in which both rails are used for traction return.



Double Rail Track Circuit

A track circuit in which both running rails are buffered by a high impedance from other track circuits and the ultimate traction return system and earth. Often used in 'double rail return' territory.

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Single Rail Track Circuit

A track circuit in which one running rail is common to all track circuits, and the other is isolated between track circuits by insulated block joints. The common rail is often used for traction return, and for connection of structures

Series Bonding

The rail is bonded as a series circuit and the failure of 1 jumper, bond or IBJ will result in de-energisation of the track circuit relay.

Parallel Bonding

The rail is bonded with parallel electrical paths so that failure of 1 jumper, bond or IBJ may not result in de-energisation of the track circuit relay.

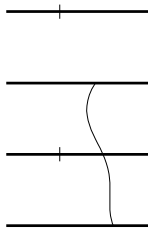
OHLE

Overhead Line Equipment

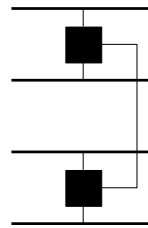
Cross-Bonds

Bonds linking the running rails to adjacent running lines, traction re-inforcing cables or earthing conductors. These connect the traction return rails and any additional return conductors in parallel reducing the impedance of the current return path to the feeder station.

Cross bond in single rail return area



Cross bond in double rail return area

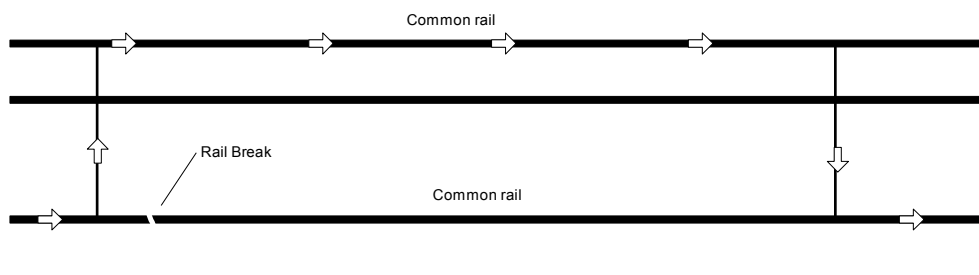


Traction re-inforcing cable

Particularly in single rail track circuits on low voltage DC systems it may be necessary to provide an additional parallel conductor to limit the losses that would otherwise occur with a high current flowing in 1 rail only.

Run round path

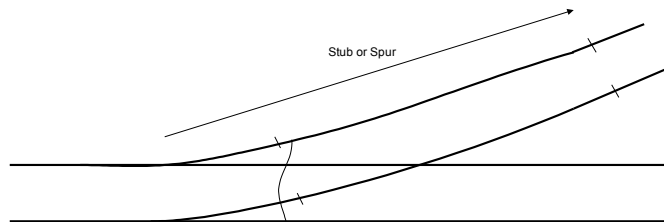
An electrical path that allows the track circuit signal to leave the running rails and travel via some parallel conductive path or earth to the receiver



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Spur or Stub

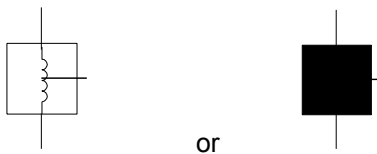
A line diverging from the main line.



Impedance Bond

Impedance bonds allow a low impedance traction current connection to be made to both rails of double rail track circuits with only a small attenuation of the track circuit signal.

In this document impedance bonds are shown as:



3.2 Abbreviations

CU	Coupling Unit (ET300/400)
ET200	EBI Track 200 track circuit family
ET300	EBI Track 300 track circuit family
ET400	EBI Track 400 track circuit family
ETU	End Termination Unit (ET200/400)
IB	Impedance Bond
OHLE	Overhead Line Equipment
PW	Protection Wire
RSF	Right Side Failure, i.e track indicates occupied when clear
Rx	Receiver (ET200/300/400)
TC	Track Circuit
TU	Tuning Unit (ET200/300/400)
Tx	Transmitter (ET200/300/400)
WSF	Wrong Side Failure, i.e track indicates clear when occupied.

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4 REQUIREMENTS FOR HIGH VOLTAGE AC TRACTION

It is generally a requirement of AC electrification systems that trackside structures are bonded together and to a running rail in order to provide equipotential bonding.

The low current demand in high voltage AC systems means that the electrification engineer will usually be satisfied with single rail traction return even for long stretches of line. However from a track circuit point of view it is preferable to use double rail track circuits with structures connected via an impedance bond. This reduces considerably the risk of stray current paths through earth leading to a loss of train detection in the event of a fault.

5 REQUIREMENTS FOR DC TRACTION

Due to the high current demand of low voltage DC systems it is usually a requirement that all plain line sections of track are bonded for double rail traction return in order to minimise the losses. Single rail track circuits are usually acceptable only for short distances through complex junction layouts. In areas of high current demand a traction reinforcing cable may be provided in single rail track circuits to keep losses to an acceptable level. Adjacent lines are bonded in parallel via cross bonds at regular intervals in order to further reduce losses.

6 FAULT DETECTION

Wherever possible the track circuit should be designed so that the failure of a bonding cable required for train detection will result in the track circuit showing occupied. Where this is not possible the effected cables should be duplicated and clearly marked to indicate they should not be removed. Typically these cables may be marked with a yellow sleeve.

EBI Track 200 / 300 / 400 track circuits can contain up to 3 receivers (Subject to reducing Track circuit length). This allows long spurs to be used. If a spur is not protected by an additional receiver the spur length is limited to 10m or 20m depending on the track circuit type and rail break detection will be lost. Multiple receivers in 1 track circuit must all be linked together in the signalling logic to indicate as 1 track circuit. (Each half of centre fed track circuits over 400m can be regarded as separate track circuits for this requirement.)

7 EQUIPMENT LIMITATIONS

The *EBI* Track 200 / 300 / 400 tuning units, end termination units and coupling units have a maximum peak voltage tolerance of 160V across the rail connections (T1 and T2). If this is exceeded at anytime, permanent damage may result.

8 STRUCTURES

The effect of civil engineering structures close to the railway needs to be considered. Effects may include but are not limited to:

- 1 If the reinforcing bars of concrete bridge structures are not insulated from each other they can form loops within the bridge decking. Where these coincide with a *EBI* Track 200 / 300 / 400 tuned area a current is induced in the reinforcing rods. The transformer effect of this reduces the inductance of the tuned area causing a reduction in track circuit performance. The closer the re-inforcing to the track the greater this effect will be due to increased coupling between the two elements.
- 2 If a long structure is bonded electrically it may act as an extra parallel conductor. Consideration should be given to the potential of the structure to provide a run round path for the track circuit signal particularly in the event of a fault.
- 3 Equipotential bonding of lineside structures to the rails impacts the performance of the track circuit therefore the recommendations in the following sections should be followed.

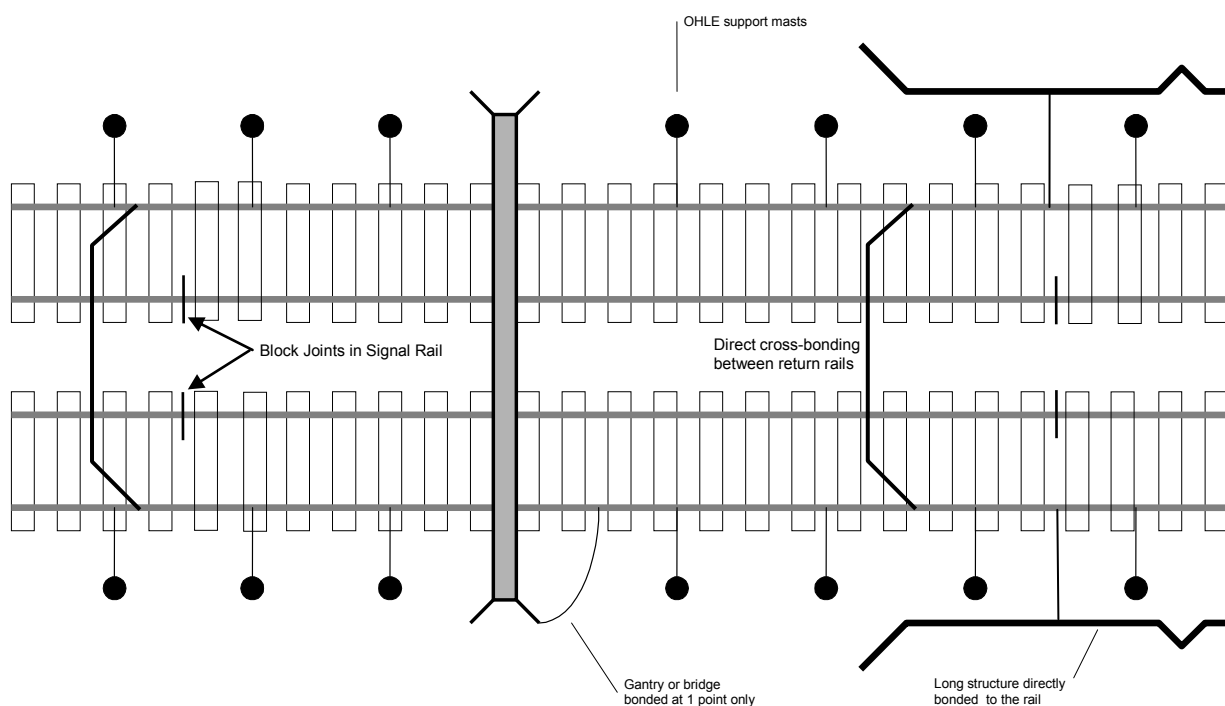
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9 SINGLE RAIL TRACK CIRCUITS – SINGLE RAIL RETURN

9.1 DESCRIPTION

A continuous path for the traction return current is provided in 1 rail only, often called the “traction rail” or “common rail”. This rail is common to all track circuits in the area and may also be connected to ground. All structures that require bonding to the rail for electrical safety are often connected directly to the “traction rail”.

9.2 TYPICAL INSTALLATION



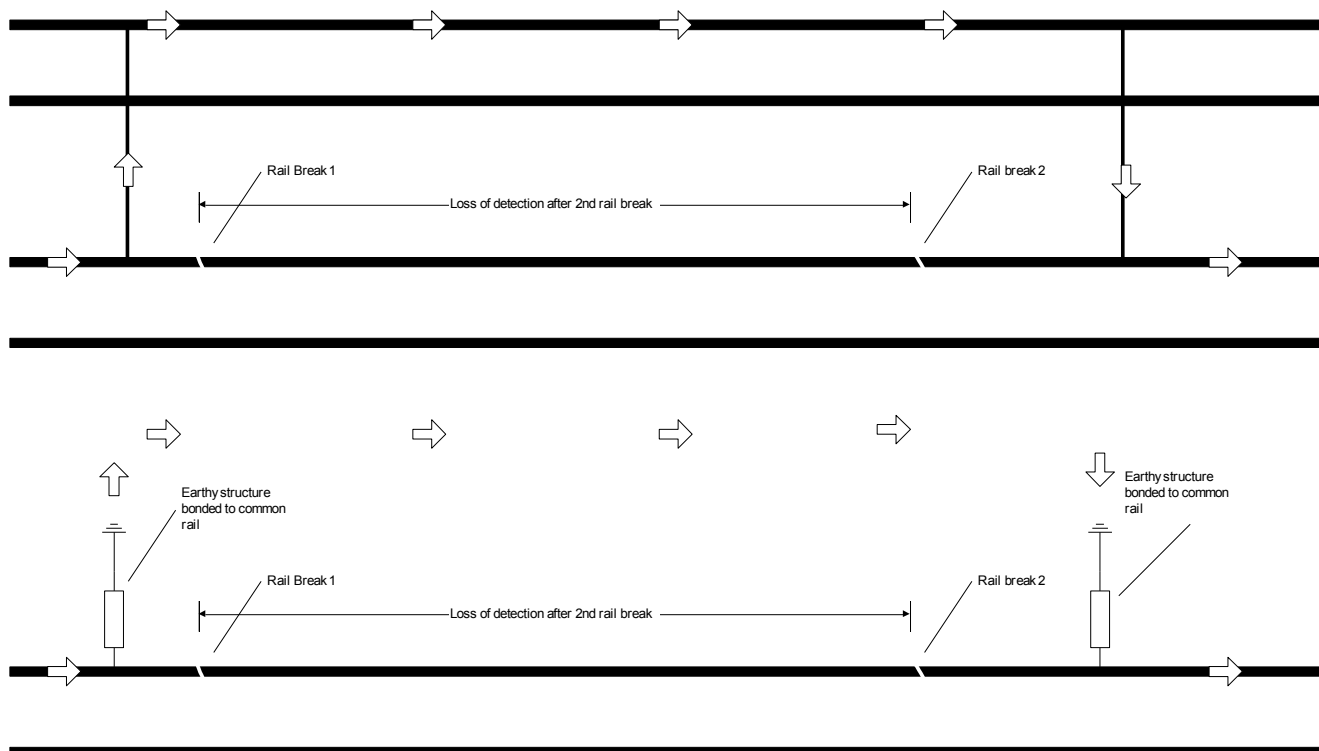
9.3 REQUIREMENTS

Impedance bonds should not be used in single rail track circuits.

Single rail track circuits are restricted to ET200 and ET400 OL track circuits.

Traction continuity, return and cross bonding shall be designed to limit the wide band frequency potential difference between the Tx and the Rx ends of a track circuit below 90 Volts (SPETUs) or 150V (ETUs). This voltage is induced by the return current running through the traction rail and can be reduced by introducing additional parallel paths for the return current through the parallel roads or return conductor.

It is not generally possible to guarantee broken rail detection in the common rail of a single rail track circuit. This is because the bonding cables required for the traction return system often provide an alternative parallel path for the track circuit signal. The diagram shows several possible scenarios.



Referring to the following diagram it can be seen that the return current flowing in the common rail causes a voltage drop along the length of the line. In the signalling rail only small stray currents flow so that this rail remains at the potential at the point of the locomotive. This can lead to a large rail-rail voltage being present. Therefore it will be necessary to limit the maximum length of each section of single rail return. This can be achieved by installing insulated rail joints at the appropriate intervals. Use of double rail return would avoid this problem.

