BOMBARDIER

EBI Track 200 Audio Frequency Track Circuit

Single Rail Application

M580000626A4

Scope: This manual covers single rail traction return applications. Non-electrified and double rail traction return applications are covered in companion manuals.

Documents
Document Sharing Hub

Issue 4: March 2014

Copyright Network Rail
Provided by IHS under license with Network Rail
No reproduction or networking permitted without license from IHS
Full document details: NR NR-L3-SIG-11761-B020 ISSU 2014
Licensee=Weston Williamson/5989497001, User=sam, albett
Not for Resale, 03/27/2016 19:23:25 MDT

Amendment Record

Issue		Details	Date
From	To		
0p1	1	First release (ECR 6-1230)	July 2007
1	2	Brand name change to EBI Track 200 TI21 (ECR 6-2920).	February 2009
2	3	Rewrittent to include *EBI* Track 200 digital Rx and ETUs (ECR 6-8675).	June 2010
3	3.3	Update in line with changes to mainline manual. Means of minimising crosstalk added.	January 2012
3.3	3.4	Major revision: refers to mainline manual where possible, bonding to control crosstalk and run round added.	January 2014
3.4	3.5	After initial review	January 2014
3.5	3.6	After second review	February 2014
3.6	4	Formal issue (ECR 6-82942)	March 2014

Bombardier Transportation
Estover Close
Estover
Plymouth PL6 7PU

Tel : +44 1752 725000

Fax : +44 1752 725001

email: enquiries@uk.transport.bombardier.com

This document and its contents are the property of Bombardier Inc. or its subsidiaries. This document contains confidential proprietary information. The reproduction, distribution, utilisation or the communication of this document or any part thereof, without express authorisation is strictly prohibited. Offenders will be held liable for the payment of damages.

© 2014, Bombardier Inc. or its subsidiaries. All rights reserved.

Documents
Document Sharing Hub

Copyright Network Rail
Provided by IHS under license with Network Rail
No reproduction or networking permitted without license from IHS
Full document details: NR NR-L3-SIG-11761-B020 ISSU 2014

Licensee=Weston Williamson/5989497001, User=sam, albett
Not for Resale, 03/27/2016 19:23:25 MDT

FOREWORD

This manual describes the operation and application of the Bombardier *EBI* Track 200 Audio Frequency universal track circuit equipment in single rail applications. Companion reference documents are:

- Double Rail application: *EBI* Track 200 Technical Manual, M125401A4.
- Application Notes

These are referenced in section 1.3.

The complete design is protected by patents and the copyright of this document belongs to Bombardier Inc. or its subsidiaries.

Bombardier Transportation pursue continuous product development and hence equipment supplied may differ in detail from the description in this manual.

SAFETY CONSIDERATIONS

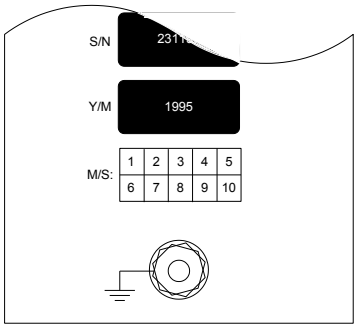
If there is concern that the parameters specified in this handbook cannot be met for a particular intended installation, please contact the manufacturer. It may still be possible to apply *EBI* Track 200 if full details of the intended application are provided. Some extreme combinations may require additional safety and monitoring measures, of which the manufacturer will advise.

It is a condition of any alterations to the generic application that the manufacturer is consulted (for which it reserves the right to make a charge to the operator).

In no other circumstances but those described above will the manufacturer accept liability for any adverse consequences arising from the operation of the *EBI* Track 200 Audio frequency Track Circuit.

MODIFICATION STATES

The equipment label on each item of *EBI* Track 200 equipment contains a panel of numbers that is used to indicate the modification status or MOD STRIKE number (1,2,3,etc.) of that item of equipment. The modification panel, identified as M/S, for an unmodified piece of equipment is depicted below:



All 10 numbers are unmarked which indicates that the unit has not been modified and is at MOD STRIKE ZERO status.

An item of equipment which has been subject to modification number one, will have the number 1 'struck out', this may be done either by scratching/stamping a diagonal line across the number 1 square or by deleting the number one with a black permanent marker pen. At each additional modification, the next number in sequence will be 'struck out', the last struck out number gives the MOD STRIKE status, e.g. if numbers 1,2,3,4,5 and 6 are struck out, that item of equipment would be at MOD STRIKE 6 status

Copyright Network Rail
Provided by IHS under license with Network Rail
No reproduction or networking permitted without license from IHS
Full document details: NR NR-L3-SIG-11761-B020 ISSU 2014
Licensee=Weston Williamson/5989497001, User=sam, albett
Not for Resale, 03/27/2016 19:23:25 MDT
Documents
Document Sharing Hub

TECHNICAL ENQUIRIES

Please send to **enquiries@uk.transport.bombardier.com**

ABBREVIATIONS

The abbreviations listed below are commonly used in this handbook.

A, amps	Ampere
ac, AC	Alternating Current
BRB	British Rail Board
CMD	Condition Monitoring Display
CRR	Common Return Rail, or Continuous Running Rail
dc, DC	Direct Current
EBI Track 200	*EBI* Track 200 TI21 Audio Frequency Track Circuit
ETU	End Termination Unit
IRJ	Insulated Rail Joint
LMU(Tx)	Line Matching Unit transmitter end
LMU(TU)	Line Matching Unit, ETU end
RX, Rx	Receiver
SPETU	Surge Protected ETU
TCU	Track Coupling Unit
TI21	*EBI* Track 200 Audio Frequency Track Circuit (TI21 was the original brand name)
TTM	TI21 Track Circuit Meter
TX, Tx	Transmitter
TU	Tuning Unit
V	Volt

Documents
Document Sharing Hub

Copyright Network Rail
Provided by IHS under license with Network Rail
No reproduction or networking permitted without license from IHS
Licensee=Weston Williamson/5989497001, User=sam, albett
Not for Resale, 03/27/2016 19:23:25 MDT
Full document details: NR NR-L3-SIG-11761-B020 ISSU 2014

Contents

		Page no.
1.	INTRODUCTION	1-1
2.	EQUIPMENT	2-1
3.	TRACK CIRCUIT AND *EBI* TRACK 200 UNIT TECHNICAL DATA	4-1
4.	TRACK CIRCUIT DESIGNER'S GUIDE	4-1
5.	SETTING-UP AND COMMISSIONING PROCEDURE	5-1
6.	CONDITION MONITORING, MAINTENANCE AND DISPOSAL	6-1
7.	EQUIPMENT ORDERING INFORMATION	7-1
8.	MISCELLANEOUS INFORMATION AND DRAWINGS	8-1
9.	*EBI* TRACK 200 TX/RX EQUIPMENT RECORD CARD	9-1
A.	APPENDIX A: SUMMARY OF CHANGES AT ISSUE 4	

Copyright Network Rail
Provided by IHS under license with Network Rail
No reproduction or networking permitted without license from IHS
Full document details: NR NR-L3-SIG-11761-B020 ISSU 2014
Documents Document Sharing Hub
Licensee=Weston Williamson/5989497001, User=sam, albett
Not for Resale, 03/27/2016 19:23:25 MDT

This page intentionally left blank

Documents
Document Sharing Hub

Copyright Network Rail
Provided by IHS under license with Network Rail
No reproduction or networking permitted without license from IHS

Licensee=Weston Williamson/5989497001, User=sam, albett
Not for Resale, 03/27/2016 19:23:25 MDT

Full document details: NR NR-L3-SIG-11761-B020 ISSU 2014

Contents

Page no.

1.	INTRODUCTION	2
1.1	Safety Requirements	2
1.1.1	Competence of Staff	2
1.2	General	2
1.3	Additional Reference Material	3

Copyright Network Rail
Provided by IHS under license with Network Rail
No reproduction or networking permitted without license from IHS
Full document details: NR NR-L3-SIG-11761-B020 ISSU 2014
Licensee=Weston Williamson/5989497001, User=sam, albett
Not for Resale, 03/27/2016 19:23:25 MDT
Documents
Document Sharing Hub

1. INTRODUCTION

1.1 Safety Requirements

The *EBI* Track 200 Audio Frequency Track Circuit must be installed and operated within the parameters specified in the *EBI* Track 200 Technical Manual, M125401A4, except where modified by the provisions of this manual.

- Safety related applications conditions specific to the single rail application are given at the beginning of section 4.
- Generic Safety Requirements for *EBI* Track 200 are referenced in section 1.1 of the *EBI* Track 200 Technical Manual, M125401A4.
- Other Specific Safety Requirements relevant to the single rail application are given in:
  - Section 2.6
  - Section 4.1
  - Section 4.2.11
  - Section 4.3.4
  - Section 4.3.7
  - Section 5.3
  - Section 5.5.
  - Section 6.2.2
  - Section 6.2.3
  - Section 6.2.4
  - Section 6.3
  - Section 6.6

1.1.1 Competence of Staff

Bombardier recommend that staff responsible for commissioning and maintenance of *EBI* Track 200 track circuits are able to demonstrate their competence as follows:

- *EBI* Track 200 training course certificate
- Manual handling course certificate
- Staff working on operational LMUs must be competent to work on voltages higher than 50V since voltages on LMU connections can reach 140V under fault conditions.

It is further recommended that access to set-up keys is restricted to trained personnel.

1.2 General

The *EBI* Track 200 Single Rail version is of the jointed type and is designed for AC or DC electrified areas where high levels of interference (arising principally from 50 Hz harmonics) may be present. The equipment is classified as universal since it meets the onerous immunity requirements of all traction systems and the needs of all known track circuits.

Three different types of track interface can be used:

- End Termination Units (ETU) are used in four pairs – A/B, C/D, E/F, G/H. One pair is used per track and the frequencies are alternated, e.g. 'frequency A' track circuit, then 'frequency B' track circuit, then 'frequency A' track circuit, and so on. Further details of design rules, including frequency allocation, are given in section 4. ETUs provide insulated rail joint (IRJ) failure detection..
- Surge Protected ETU (SPETU). The SPETU is functionally identical to the ETU except that it contains a surge protection device to ensure that high voltage transients do not damage the internal circuitry of the unit. SPETUs are normally used on DC 3rd rail traction installations where the risk of traction voltages appearing on the running rails is relatively high.
- Track Coupling Units (TCU) are used for track circuits that are too short for ETUs/SPETUs.

'Single Rail' jointed track circuits are commonly found in three areas:

- Areas using single rail traction return, where the traction currents are generally low enough such that a single rail return system does not degrade traction efficiency.

Documents
Document Sharing Hub
Copyright Network Rail
Provided by IHS under license with Network Rail
No reproduction or networking permitted without license from IHS
Licensee=Weston Williamson/5989497001, User=sam, albett
Not for Resale, 03/27/2016 19:23:25 MDT
Full document details: NR NR-L3-SIG-11761-B020 ISSU 2014

- Points and crossings where it is difficult to achieve full double rail traction return because of the physical arrangement of the rails or there is insufficient space to accommodate 20m tuned areas.
- In areas where the track layout is complicated and adjacent tracks are in close proximity, and it is not physically possible to position TUs or ETUs at the trackside because of the limited space available.

In jointed single rail mode, the tuned area is replaced by an insulated block joint in one running rail and uses End Termination Units (ETU) or SPETUs in place of Tuning Units.

The track circuit functions like the conventional AC track Circuit. Since the traction bonding is done through transverse bonding, the traction return current flows through only one rail and removes the need for Impedance Bonds. The effect of using single rail traction return must be considered carefully.

1.3 Additional Reference Material

In addition to material listed in the *EBI* Track 200 Technical Manual, M125401A4, the following application notes are available to provide additional information on specialist topics.

IS580081934A4	*EBI* Track 200/300/400 Application Note: Points and Crossings
NR/SP/SIG/11752	Train Detection (NR standard, contains best practice of for safety-critical bonding). File ref 580134549.

Documents
Document Sharing Hub
Copyright Network Rail
Provided by IHS under license with Network Rail
No reproduction or networking permitted without license from IHS
Full document details: NR NR-L3-SIG-11761-B020 ISSU 2014
Licensee=Weston Williamson/5989497001, User=sam, albett
Not for Resale, 03/27/2016 19:23:25 MDT

This page intentionally left blank

--`,,,,,,`,,,,,,`,,`,,,,,,,,`-`-`,,`,,`,`,,`---

Documents
Document Sharing Hub
Copyright Network Rail
Provided by IHS under license with Network Rail
No reproduction or networking permitted without license from IHS
Licensee=Weston Williamson/5989497001, User=sam, albett
Not for Resale, 03/27/2016 19:23:25 MDT
Full document details: NR NR-L3-SIG-11761-B020 ISSU 2014

Contents

Page no.

2. EQUIPMENT 2
2.1 End Termination Unit (ETU) 2
2.2 Surge Protected End Termination Unit (SPETU) 2
2.3 Track Coupling Unit (TCU) 2
2.2 Transmitter 3
2.3 Receiver 3
2.4 Transmitter Line Matching Unit (LMU[TX]) 3
2.5 TU/ETU Line Matching Unit (LMU[TU]) 3
2.6 Power Supply 3
2.7 *EBI* Track 200 Test Equipment 3

Copyright Network Rail
Provided by IHS under license with Network Rail
No reproduction or networking permitted without license from IHS
Full document details: NR NR-L3-SIG-11761-B020 ISSU 2014
Licensee=Weston Williamson/5989497001, User=sam, albett
Not for Resale, 03/27/2016 19:23:25 MDT
Documents
Document Sharing Hub

2. EQUIPMENT

2.1 End Termination Unit (ETU)

An End Termination Unit is used to couple energy into a track. ETUs are generally used in the following situations:

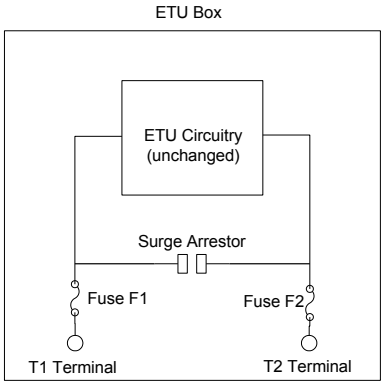
- At the end of a jointed *EBI* Track 200 track circuit which adjoins another *EBI* Track circuit.
- At the end of an *EBI* Track 200 track circuit which adjoins a non-*EBI* Track circuit.
- At the end of a *EBI* Track 200 track circuit which adjoins non-track circuited territory.

ETUs are frequency dependant, i.e. there is an ETU for each frequency, i.e. A, B, C, D, E, F, G and H.

2.2 Surge Protected End Termination Unit (SPETU)

A Surge Protected End Termination Unit is identical in function to a standard ETU as described in section 2.1 except that it contains a surge arrestor in parallel and 5A fuses in series with its rail terminals. Surge protected units are recommended for applications where fault conditions could impose traction voltages across the running rails which would then cause damage to an unprotected ETU. Such fault conditions can be produced by third rail DC traction systems when a short circuit fault develops between the third rail and one of the running rails.

SPETUs are frequency dependant, i.e. there is a SPETU for each frequency, i.e. A, B, C, D, E, F, G and H.



SPETU Protection Circuit **Figure 2.2**

2.3 Track Coupling Unit (TCU)

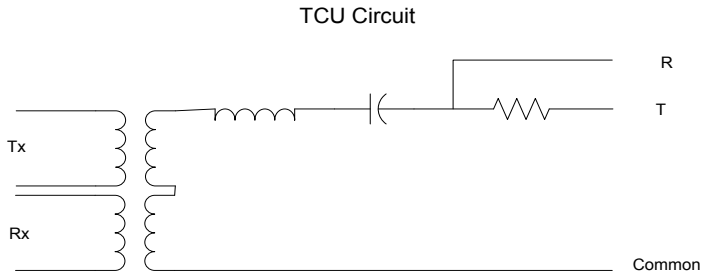
The Track Coupling Unit is used to couple energy into a track where:

- it is not convenient to mount an ETU or SPETU between or beside the rails
  and
- the maximum track circuit lengths do not exceed 200m
  and
- the Transmit end TCU-to-rail distance plus the Receive end TCU-to-rail distance is not more than 350m (or 525m if 4mm^2 cable is used), see section 4.2.6.

These conditions typically arise in station areas, sidings and depots.

TCUs are frequency specific, i.e. there is a TCU for each of the TI21 operating frequencies A, B, C, D, E, F, G and H.

Documents
Document Sharing Hub
Copyright Network Rail
Provided by IHS under license with Network Rail
No reproduction or networking permitted without license from IHS
Licensee=Weston Williamson/5989497001, User=sam, albett
Not for Resale, 03/27/2016 19:23:25 MDT
Full document details: NR NR-L3-SIG-11761-B020 ISSU 2014



TCU Circuit **Figure 2.3**

2.2 Transmitter

See the *EBI* Track 200 Technical manual M125401A4.

2.3 Receiver

See the *EBI* Track 200 Technical manual M125401A4.

2.4 Transmitter Line Matching Unit (LMU[TX])

See the *EBI* Track 200 Technical manual M125401A4.

2.5 TU/ETU Line Matching Unit (LMU[TU])

See the *EBI* Track 200 Technical manual M125401A4.

2.6 Power Supply

SAFETY REQUIREMENT	**The requirements on power supply loading in section 4.3.7 must be observed to guarantee safe operation of *EBI* Track 200 track circuits.**

For the technical description, see the *EBI* Track 200 Technical manual M125401A4.

2.7 *EBI* Track 200 Test Equipment

See the *EBI* Track 200 Technical manual M125401A4.

Copyright Network Rail
Provided by IHS under license with Network Rail
No reproduction or networking permitted without license from IHS
Full document details: NR NR-L3-SIG-11761-B020 ISSU 2014
Licensee=Weston Williamson/5989497001, User=sam, albett
Not for Resale, 03/27/2016 19:23:25 MDT
Documents
Document Sharing Hub

This page intentionally left blank

--`,,,,,,`,,,,,,`,,`,,,,,,,,`-`-`,,`,,`,`,,`---

Documents
Document Sharing Hub

Copyright Network Rail
Provided by IHS under license with Network Rail
No reproduction or networking permitted without license from IHS

Licensee=Weston Williamson/5989497001, User=sam, albett
Not for Resale, 03/27/2016 19:23:25 MDT

Full document details: NR NR-L3-SIG-11761-B020 ISSU 2014

Contents

		Page no.
3.	TRACK CIRCUIT TECHNICAL DATA	2
3.1	General	2
3.1.1	System Specification	2
3.1.2	Minimum And Maximum Track Circuit Lengths	3
3.2	Transmitter	3
3.3	Receiver	3
3.4	TX Line Matching Unit (LMU[TX])	3
3.5	TU / ETU / SPETU Line Matching Unit (LMU[TU])	3
3.6	End Termination Units - ETU and SPETU	4
3.7	Track Coupling Unit (TCU)	5
3.8	Power Supply	6
3.9	TI21 Test Meter (TTM)	6
3.10	Rocoil Current Transducer	6
3.11	Sleeper Insulation Tester (SIT)	6
3.12	SHUNT BOX	6

Copyright Network Rail
Provided by IHS under license with Network Rail
No reproduction or networking permitted without license from IHS
Full document details: NR NR-L3-SIG-11761-B020 ISSU 2014
Licensee=Weston Williamson/5989497001, User=sam, albett
Not for Resale, 03/27/2016 19:23:25 MDT
Documents
Document Sharing Hub

3. TRACK CIRCUIT TECHNICAL DATA

3.1 General

3.1.1 System Specification

System specification parameters are unchanged from the values quoted in the *EBI* Track 200 Technical Manual, M125401A4, except for those listed in Tables 3.1.1 and 3.1.2.

System Specification Table 3.1.1

Parameter	Value	Comments
Train Shunt	0.5Ω or less in main part of track circuit	This is the worst case shunt presented by a train.
TCU/ETU/SPETU to IRJ Position	Up to 3m	TCU/ETU/SPETU rail connections must be placed within 3m of the IRJ defining the end of the track circuit. In the event of staggered joints, this distance refers to the joint nearest the TCU/ETU/SPETU. Note that some rail authorities may have more restrictive conditions.
IRJ Stagger	Less than permissible dead section length.	Rail authorities may control the amount of permissible stagger in order to avoid an excessive length of dead section.
Track Feed Voltage	ETU/SPETU Low Power: 0.8V to 1.8V ETU/SPETU LP Plus: 1.1V to 2.3V TCU: 1V to 5V	Dependent on frequency and ballast condition
Track Connection Resistance	ETU/SPETU: 1 mΩ max per connection TCU 10 mΩ max per connection	
Track Connection Current Capability	ETU/SPETU: 25A minimum TCU: 5A minimum	
Maximum Number of Receivers in a Track Circuit	ETU/SPETU: 3 TCU: 1	For complex crossings which require more than the allowed receivers in a track circuit, consult Bombardier Transportation for guidance.

Documents Document Sharing Hub

Copyright Network Rail
Provided by IHS under license with Network Rail
No reproduction or networking permitted without license from IHS
Full document details: NR NR-L3-SIG-11761-B020 ISSU 2014

Licensee=Weston Williamson/5989497001, User=sam, albett
Not for Resale, 03/27/2016 19:23:25 MDT

3.1.2 Minimum And Maximum Track Circuit Lengths

MODE	TX-to-Track Distance (m) (see NOTE 4)	RX-to-Track Distance (m)	Track Circuit Length (m) (see NOTE 2)	Comments
ETU/SPETU	Low Power and Low Power Plus (See NOTE 4)			
End fed or centre fed	< 30	< 500	20 to 250 (end fed) 100 to 200 (each half, centre fed)	See sub-section 4.2.3
End fed or centre fed with LMUs	30 to 500	< 500	20 to 250 (end fed) 100 to 200 ((each half, centre fed)	See NOTE 1
TCU				
End Fed	350m total Tx + Rx cables		10 to 20 (preferred) 10 to 200 (non-preferred)	See NOTE 5 Feed length can be extended to 525m, see Section 4.2.6, RT1.

Minimum And Maximum Track Circuit Lengths Table 3.1.2

NOTE 1: This is the preferred method for extending TX-to-TU distance, see sub-section 4.2.7.

NOTE 2: (A) End fed distances are from the IRJ at the transmitter to the IRJ at the receiver.

(B) Centre-fed distances are for ***each half*** of the track circuit measured between the TX ETU/SPETU and the terminating IRJ at the receiver.

NOTE 3: Tx to track distances assume 2.5mm^2 cable. The maximum Rx-to-track distance is 500m (also in 2.5mm^2 cable). See section 4.2.7 for further information.

NOTE 4: Normal power track circuits must not be used for single rail applications. This restriction is because normal power track circuits cause high levels of crosstalk. An explanation of this effect can be found in section 4.2.1.1.
Low Power Plus is used in track circuits over points and crosssings where the longest route exceeds 150m and there are two or more receivers or in ares of known railhead contamination, e.g. level crossings. It can also be used at commissioning if unfavourable track conditions cause the Rx threshold to be set below 20mA.

NOTE 5: Because TCUs have restricted feed length and they do not provide IRJ failure detection, their use is restricted track circuits that are too short for ETUs / SPETUs. However, if feed length restrictions and IRJ failure detetction are not an issue in a given application, TCUs can be used in track circuits up to 200m in length.

3.2 Transmitter

See *EBI* Track 200 Technical Manual M125401A4 for Transmitter variants:

3.3 Receiver

See *EBI* Track 200 Technical Manual M125401A4 for Receiver variants:

3.4 TX Line Matching Unit (LMU[TX])

See *EBI* Track 200 Technical Manual M125401A4

3.5 TU / ETU / SPETU Line Matching Unit (LMU[TU])

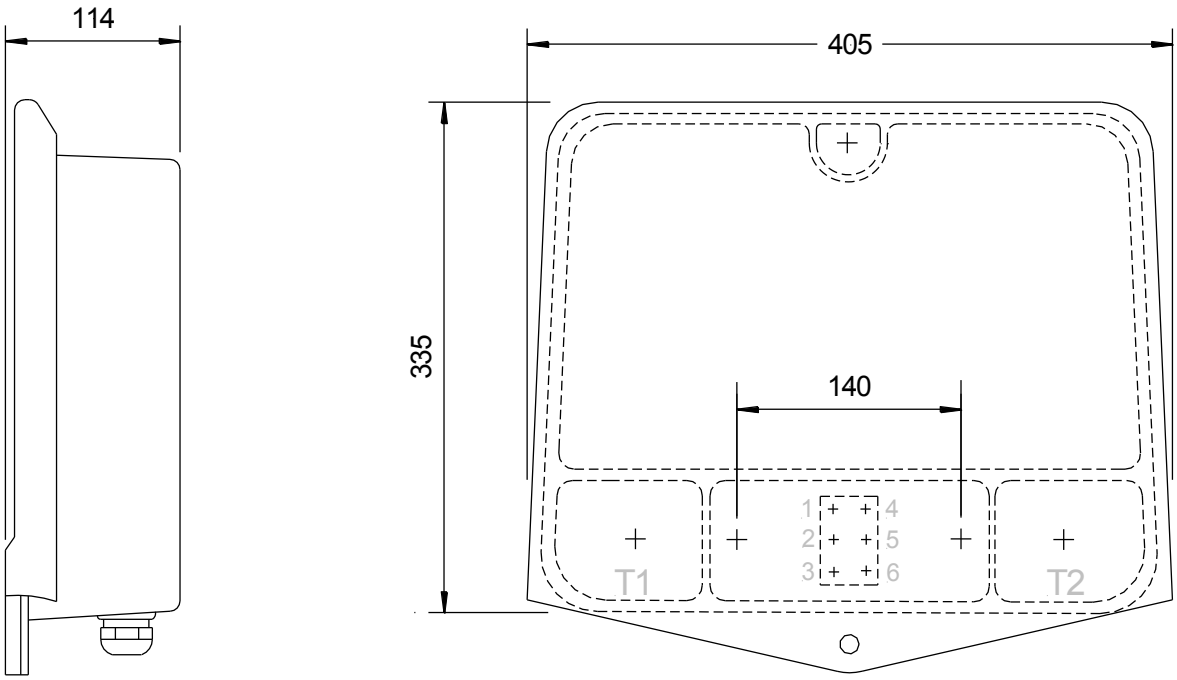
See *EBI* Track 200 Technical Manual M125401A4

Confidential and proprietary.
Copyright Network Rail
Provided by IHS under license with Network Rail
No reproduction or networking permitted without license from IHS
Full document details: NR NR-L3-SIG-11761-B020 ISSU 2014
Licensee=Weston Williamson/5989497001, User=sam, albett
Not for Resale, 03/27/2016 19:23:25 MDT
Documents
Document Sharing Hub

3.6 End Termination Units - ETU and SPETU

Vibration and Shock Resistance:	Complies with EN50125-3 'On sleeper'
Size overall:	375 mm (14.8") H x 407 mm (16") W x 106 mm (4.2") L
Maximum rail to rail volts:	110VAC/160VDC (SPETU is protected against damage through over-voltage)
Mounting:	Lineside stake or Sleeper
Weight:	7.5kg
5A Fuse (SPETU Only)	5A, 600V, Fast Acting (38.1mm x 10.31mm). Bombardier Part Number 520087014.
Note:	Cables are supplied fitted with crimp terminations but each cable requires a rail termination kit for fixing at the 'rail end', see Fig 8.6

EBI Track 200 ETU AND SPETU Outline:



Terminal Allocation for Low Power and Low Power Plus

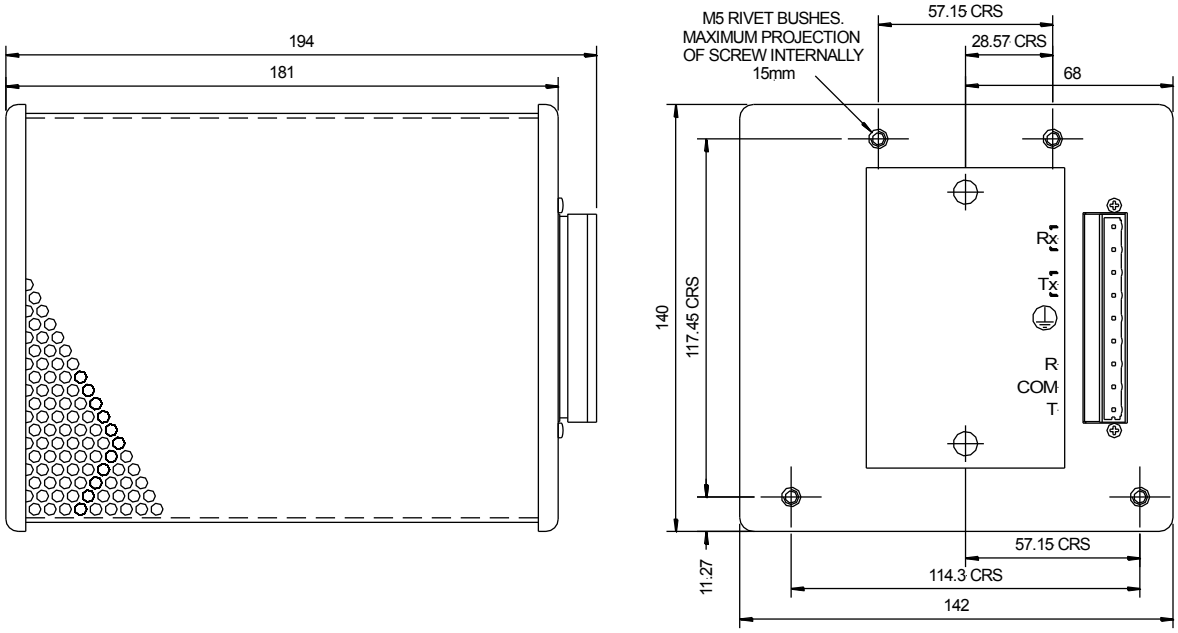
M10 Terminals		2 BA Terminal Block			
			TX Low Power	TX Low Power Plus	RX
T1	Rail connection	1	TX output	Link to 4	RX input
T2	Rail connection	2	TX output	TX output	RX input
		3	Earth terminal Used in areas prone to electrical storms, eg tropical countries		
		4		Link to 1	
		5		TX output	
		6	Not connected		

M580000626A4
Issue 4: March 2014
Confidential and proprietary.
Documents Document Sharing Hub
Copyright Network Rail
Provided by IHS under license with Network Rail
No reproduction or networking permitted without license from IHS
Full document details: NR NR-L3-SIG-11761-B020 ISSU 2014
Licensee=Weston Williamson/5989497001, User=sam, albett
Not for Resale, 03/27/2016 19:23:25 MDT

3.7 Track Coupling Unit (TCU)

Size overall:	140mm (5.5")H x 142mm (5.6")W x 198mm (7.8")L (2½ BR relay spaces)
Max. rail-to-rail volts:	$1kV_{DC}$ / $750V_{AC}$(RMS) – 3kV surge
Mounting:	Screw Fixing arranged for standard BR relay centres. (Ensure that there is at least 10 mm horizontal spacing and 75mm vertical spacing between units for air circulation). If the unit is fitted in an enclosure, allow 50mm between the connector and the enclosure door for wiring. Rear panel fixing dimensions are identical to the front panel.
Weight:	3Kg

***EBI*Track 200 TCU Outline**



Connector Allocation

Position	9-Way Connector	
	Legend	Function
1	Rx	Receiver connection
2	Rx	Receiver connection
3	Tx	Transmitter connection
4	Tx	Transmitter connection
5	Earth symbol	Earth terminal
6		Not used
7	R	Rail connection when using RX
8	COM	Rail connection to Continuous Running Rail.
9	T	Rail connection when using TX

Confidential and proprietary.
Copyright Network Rail
Provided by IHS under license with Network Rail
No reproduction or networking permitted without license from IHS
Full document details: NR NR-L3-SIG-11761-B020 ISSU 2014
Licensee=Weston Williamson/5989497001, User=sam, albett
Not for Resale, 03/27/2016 19:23:25 MDT
Documents
Document Sharing Hub

3.8 Power Supply

See *EBI* Track 200 Technical Manual M125401A4 for all Variants

3.9 TI21 Test Meter (TTM)

Refer to the Operating Instructions - M6/6/118951

3.10 Rocoil Current Transducer

Refer to the Operating Instructions - M6/6/118951

3.11 Sleeper Insulation Tester (SIT)

Refer to the Operating Instructions – M6/6/122940

3.12 SHUNT BOX

See *EBI* Track 200 Technical Manual M125401A4 for details

Confidential and proprietary.

Documents Document Sharing Hub

Copyright Network Rail
Provided by IHS under license with Network Rail
No reproduction or networking permitted without license from IHS

Licensee=Weston Williamson/5989497001, User=sam, albett
Not for Resale, 03/27/2016 19:23:25 MDT

Full document details: NR NR-L3-SIG-11761-B020 ISSU 2014

Contents

Page no

4. TRACK CIRCUIT DESIGNER'S GUIDE 2
4.1 Safety Related Application Conditions 2
4.1.1 Design 2
4.1.2 Installation and Operation 2
4.1.3 Preventative Measures against Bypass Paths 2
4.2 Track Circuit Layout Design 3
4.2.1 Overview of the Single Rail Application 3
4.2.1.1 Restrictions Caused by Single Rail Traction Return 3
4.2.2 *EBI* Track 200 Single Rail Track Circuit Configurations 6
4.2.3 Power settings for Operation with ETUs/SPETUs 8
4.2.4 Frequency Allocation and IRJ Failure Detection with ETUs/SPETUs 9
4.2.4.1 Special Case: ETU/SPETU at Single to Double Rail Return Boundary 11
4.2.5 Frequency Allocation and IRJ Failure Detection with TCUs 11
4.2.5.1 Special Case: TCU at Single to Double Rail Return Boundary 12
4.2.6 Application Rules for *EBI* Track 200 Circuits 12
Illustration of Rule RT4. Figure 4.2.6.4 17
4.2.7 Increasing TX to ETU/SPETU Feed Lengths 17
4.2.8 Adjoining Other Types of Track Circuit or Non-Track Circuited Lines 17
4.2.9 Single to Double Rail Track Circuits in Electrified Areas 18
4.2.10 Points & Crossings 18
4.2.11 Electrical Bonding of Metallic Structures to the Rails 18
4.2.12 Spare Rail in the Track Bed 18
4.2.13 Inserting an Extra Track Circuit 18
4.3 INSTALLATION REQUIREMENTS 19
4.3.1 Overview 19
4.3.2 Transmitter and Receiver Mounting 19
4.3.3 Rail Connections 19
4.3.3.1 ETUs/SPETUs 19
4.3.3.2 TCUs 19
4.3.4 Cables 20
4.3.4.1 ETUs/SPETUs 20
4.3.4.2 TCUs 20
4.3.5 Rail Bonding 23
4.3.5.1 Traction Return Current Bonding 23
4.3.5.2 Transposition Bonding for IRJ Failure Detection in TCU Circuits 23
4.3.6 Lightning Protection 24
4.3.7 Power Supply Unit Considerations 25
4.3.7.1 Power Supply Unit Loading Rules 25
4.3.7.2 24V Battery Supplies Stabilised by an Approved Charging System 25
4.3.7.3 Power Supply Location 25
4.3.8 EMC Compliance 26
4.3.9 Fusing - TX, RX, SPETU and PSU 26
4.3.9.1 TX and RX B24 26
4.3.9.2 TX and RX to Track 26
4.3.9.3 Power Supply AC Input 26
4.3.9.4 SPETU Fuses 26
4.3.10 Torque Settings for *EBI* Track 200 26

© Confidential and proprietary.
Copyright Network Rail
Provided by IHS under license with Network Rail
No reproduction or networking permitted without license from IHS
Full document details: NR NR-L3-SIG-11761-B020 ISSU 2014
Licensee=Weston Williamson/5989497001, User=sam, albett
Not for Resale, 03/27/2016 19:23:25 MDT
Documents
Document Sharing Hub

4. TRACK CIRCUIT DESIGNER'S GUIDE

4.1 SAFETY RELATED APPLICATION CONDITIONS

SAFETY REQUIREMENT	**The following requirements on design, installation and operation must be observed to guarantee safe operation of *EBI* Track 200 track circuits.**

4.1.1 Design

The following design rules must be observed for applications of *EBI* Track 200 to be adequately safe:

- The safety requirements in section 4 of the *EBI* Track 200 Technical Manual, M124501A4, must be strictly observed, except where modified in this manual.
- The safety requirements in section 4 of this manual must be strictly observed.
- The 24V DC power supplies must be located in the same equipment cabinet as the Rx or Tx that they feed. In equipment rooms, power supply cables must be less than 30m in length. Lengths over 10m must be run as twisted pairs.
- The Bonding Rules in Table 4.2.6 are affected by a number of application specific factors. These are identified in Table 4.2.1.1 and must be confirmed for each specific application.

4.1.2 Installation and Operation

The following application rules must be observed for applications of *EBI* Track 200 to be adequately safe:

- The Installation and Set Up and Maintenance sections of this manual must be strictly observed.
- An IRJ with failure detection must exist between any two track circuits of the same frequency, (eg by including a transposition bond and double IRJs).
- Where IRJs are not provided with failure detection, regular inspection may be required to prevent premature shunting (see section 6.2.4B). Note that such enhanced maintenance is not sufficient mitigation to allow the repetition of the same frequency.
- Rail insulation must be subject to regular maintenance to reduce the likelihood of nuisance failures.
- *EBI* Track 200 equipment conforms to the European EMC directive. Other equipment located in the vicinity should be checked for compatibility with *EBI* Track 200 equipment.
- For reliability, it is particularly important to observe the bonding rules in Table 4.2.6.

4.1.3 Preventative Measures against Bypass Paths

- The preventative measures against bypass paths listed in the *EBI* Track 200 Technical Manual, M124501A4 section 4.1.3, must be observed.

Documents
Document Sharing Hub
Copyright Network Rail
Provided by IHS under license with Network Rail
No reproduction or networking permitted without license from IHS
Licensee=Weston Williamson/5989497001, User=sam, albett
Not for Resale, 03/27/2016 19:23:25 MDT
Full document details: NR NR-L3-SIG-11761-B020 ISSU 2014

4.2 TRACK CIRCUIT LAYOUT DESIGN

4.2.1 Overview of the Single Rail Application

In designing a complete track circuit scheme, the designer has to consider the following issues:

- Application rules.
- The applicable track configurations.
- The optimum choice of track interface unit (ETU, SPETU or TCU)
- Suitable equipment location and signal feed arrangements.
- Frequency allocation and IRJ failure detection
- Points and crossings: shunting performance and traction bonding requirements.
- Interface to non-track circuited lines or other types of track circuit.
- Compatibility with signalling equipment on abutting or parallel lines.
- Site conditions and construction.
- Traction return rail

EBI Track 200 is designed, to operate within a set of environmental and physical conditions which are defined in this manual. A number of options allow considerable flexibility for the designer in parameters such as track length, signal cable lengths and equipment positioning. Should either environmental conditions, or the basic track circuit limiting conditions required for a specific application, be beyond those specified within this manual, please contact Bombardier Transportation Ltd for further advice.

The following sections define the design issues and options in more detail, particularly where there are interactive or conflicting requirements.

4.2.1.1 Restrictions Caused by Single Rail Traction Return

Single rail track circuits have two key issues that must be controlled in order to obtain satisfactory performance, these are:

- Detection of the train shunt in the presence of a broken rail or two disconnected bonds in the same locality.
- Interference between other track circuits of the same frequency on the same road (cross talk).

A brief introduction to these two issues is given below.

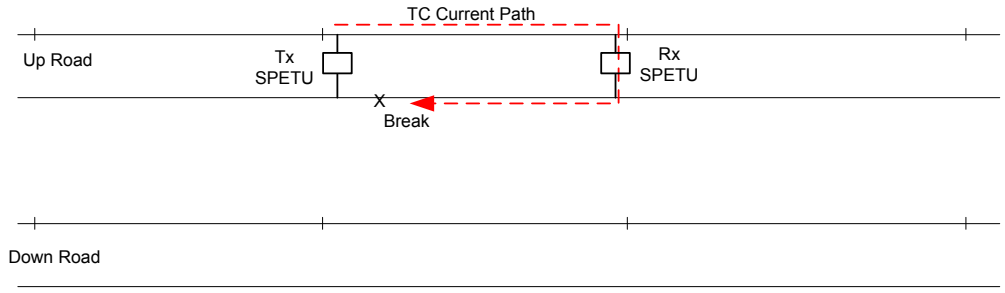
Impact of Broken Rails

Without cross bonding between roads, the top diagram in Figure 4.2.1.1a shows how the current path from transmitter to receiver is interrupted by the broken rail. Since no current flows through the receiver, the track circuit indicates occupied and the rail break is 'detected'. With cross bonding in place, a return path for the transmitter current is provided through the other road, and automatic rail break detection is lost unless the spacing between the cross bonds is sufficiently long such that the impedance of the return path via the other road is high enough to reduce the return current below the receiver threshold.

If rail break detection is lost, then the capability of the track circuit to detect a train shunt in the worst position needs to be considered. Normally, without a rail break, the train shunt diverts the transmitter current around a short path back to the transmitter, bypassing the receiver. With a rail break, the train shunt will still divert current away from the receiver, but it now has a significantly longer path to follow, resulting in much lower shunting efficiency. These are the top two scenarios shown in Figure 4.2.1.1a.

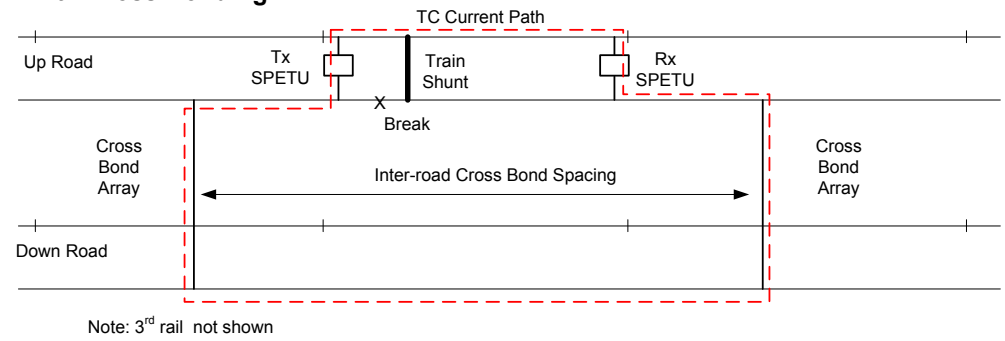
Documents
Document Sharing Hub
Copyright Network Rail
Provided by IHS under license with Network Rail
No reproduction or networking permitted without license from IHS
Full document details: NR NR-L3-SIG-11761-B020 ISSU 2014
Licensee=Weston Williamson/5989497001, User=sam, albett
Not for Resale, 03/27/2016 19:23:25 MDT

No Cross Bonding



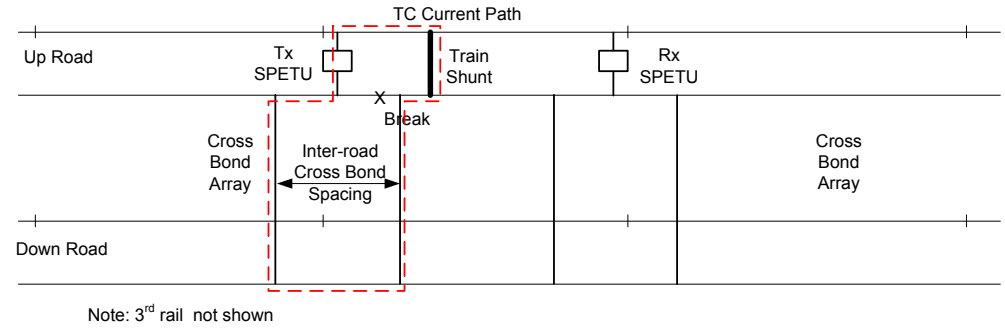
Broken rail detection secured.
Train detection secured.

With Cross Bonding



Broken rail may not be detected.
Trains may not be detected.

With Frequent Cross Bonding



Broken rail may not be detected.
Train detection secured.

Impact of Broken Rails **Figure 4.2.1.1a**

Whether the train is detected or not depends on the impedance of the return path which, in turn, is determined by the position of the cross bond arrays. Practical testing and simulation has shown that the return path is always of a low enough impedance to make train detection problematic. Adding cross bonds to the parallel road inside the track circuit in question has been shown to preserve shunting capability under broken rail conditions. This is illustrated in the third scenario in Figure 4.2.1.1a. Details of cross bonding requirements are given in Rule RB6 in Table 4.2.6.
Note that the same approach can be used for ETU/SPETU and TCU track circuits.

Cross Talk
Cross talk occurs between track circuits of the same frequency when there is an external return path in parallel with the continuous return rail which allows a circulating current to develop. This circulating current flows through the victim track circuit giving rise to the cross talk signal. Figure 4.2.1.1b shows such a path situated in the worst case position. The external path may be caused by cross-bonding to the other road, crossovers or leakage paths through earth

Documents
Document Sharing Hub
Copyright Network Rail
Provided by IHS under license with Network Rail
No reproduction or networking permitted without license from IHS
Full document details: NR NR-L3-SIG-11761-B020 ISSU 2014
Licensee=Weston Williamson/5989497001, User=sam, albett
Not for Resale, 03/27/2016 19:23:25 MDT