

Information for printer users

The attached document:

RT/E/C/19048

Issue 1

contains colour on the following
electronic pages:

16, 34-42 & 46-50

Proceed to document ►

Colour pages can be purchased separately from:

The Network Rail Document Centre @ Rapidoc

Tel: 01344 404446

Fax: 01344 714440

Email: rapidoc@ihsti.com

Please have the following details to hand when purchasing:
Contact and delivery details, Standard No., Title, Quantity.
Please also have your credit card/payment details to hand

Copyright © 2016 Network Rail. All rights reserved.

Ref	NR/GN/SIG/I 9048
Issue	I
Date	April 2003

Signalling Equipment Technical Advice Notice (SIGTAN 48) - Train Protection and Warning System (TPWS) Trackside Equipment (formerly RT/E/C/I 9048)

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)”.**

This document is the property of Network Rail. It shall not be reproduced in whole or part nor disclosed to a third party without the written permission of the Standard Owner.

© Copyright 2004 Network Rail

Uncontrolled copy once printed from its electronic source.

Published & Issued by: Network Rail; 40 Melton Street, London NW1 2EE



Network Rail Company Code of Practice

This document is the property of
Network Rail.

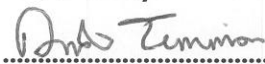
It shall not be reproduced in whole or in
Part, nor disclosed to a third party,
without the written permission of the
Standard Owner.

© Copyright 2003 Network Rail
Infrastructure Ltd.

Signalling Equipment
Technical Advice
Notice (SIGTAN 48)
Train Protection And
Warning System
(TPWS)
Trackside Equipment

ENDORSEMENT & AUTHORISATION

Endorsed by:



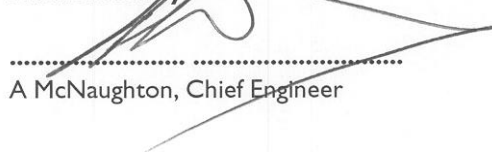
A Simmons, Professional Head of Signalling

Accepted for issue by:



P McAleer, Acting Head of Business Standards

Authorised by:



A McNaughton, Chief Engineer

NETWORK RAIL COMPANY STANDARD

Page 1 of 49



Documents

Document Sharing Hub

ISSUE RECORD

ISSUE	DATE	COMMENTS
I	April 2003	First Issue of this document

IMPLEMENTATION

This code of practice highlights issues arising from operational experience, concerning the installation and maintenance of the trackside sub-system of the Train Protection And Warning System (TPWS). Where appropriate, it gives current best practice for mitigating risk and is for implementation from 5 April 2003. Alternative practices may be accepted where they can be demonstrated to be as good or better than the contents of this document.

DISCLAIMER

Network Rail has used its best endeavours to ensure that the content, layout and text of this document are accurate, complete and suitable for its stated purpose. It makes no warranties, express or implied, that compliance with the contents of this document shall be sufficient to ensure safe systems of work or operation. Network Rail will not be liable to pay compensation in respect of the content or subsequent use of this document for any purpose other than its stated purpose or for any purpose other than that for which it was prepared except where it can be shown to have acted in bad faith or there has been wilful default.

SUPPLY

Copies of documents are available electronically, within Network Rail's organisation. Hard copies of this document will be available to Network Rail staff on request to the Document Controller and to other organisations from Technical Indexes Ltd (01344 404409).

Published & Issued by
Network Rail
40 Melton Street
London
NW1 2EE.

Contents

1. PURPOSE	4
2. SCOPE	4
3. PERSONAL SAFETY	4
4. TRACKSIDE EQUIPMENT – GENERAL INFORMATION.....	5
4.1 DESCRIPTION OF EQUIPMENT	5
4.2 PRINCIPLES OF OPERATION	5
4.3 CONTROL MODULES	6
4.4 TPWS CONTROL INPUTS.....	7
4.5 TRANSMITTER MINI-LOOPS FOR BUFFER STOPS	8
4.6 TRANSMITTER LOOP POSITIONING	9
4.7 SELF REVERSION.....	9
4.8 TEST EQUIPMENT	10
4.9 TYPICAL VALUES EXPECTED	12
4.10 TRANSMITTER LOOP CABLE JOINTING.....	13
4.11 HANDLING OF TAIL CABLES AND PLUG COUPLERS	14
4.12 TPWS UNINTERRUPTIBLE POWER SUPPLY (UPS)	15
4.13 FAILURE INDICATION UNIT (FIU).....	15
4.14 D.C. TO D.C. CONVERTER (FOR FIU)	16
5. TPWS FAILURE INDICATIONS AND CLASSIFICATIONS.....	17
5.1 FAILURE INDICATIONS	17
5.2 ACTIONS TO BE TAKEN IF TPWS 'FAULT' LED IS ILLUMINATED.....	18
5.3 FRAME FAILURE REPORT CLASSIFICATIONS	19
5.4 FAILURE REPORT CLASSIFICATIONS	20
6. FAILURE IDENTIFICATION, COMMON SYMPTOMS AND CAUSES.....	21
6.1 GENERAL.....	21
6.2 'NO CAUSE FOUND' (NCF) OR 'NO FAULT FOUND' (NFF) - FAILURE PROCEDURE	22
6.3 LOOSE TERMINALS	22
6.4 CONTAMINATION OF SPRING CONTACTS	22
6.5 THALES TRACKSIDE ENCLOSURES DOOR SEALS.....	23
6.6 CERAMIC CAPACITORS IN OSM/TSM	23
6.7 TRANSMITTER LOOP RELATED FAILURES.....	23
6.8 PLUG COUPLER RELATED FAILURES.....	24
6.9 DIFFERENTIAL LOOP READINGS.....	24
6.10 TRENDS IN LOOP VOLTAGE OR FREQUENCY	24
6.11 SSI METHOD 3 TIMING FEATURE.....	25
6.12 FAILURES RELATED TO A.C. TRACTION UNITS (CLASS 314/315).....	25
6.13 BASEPLATE FUSES.....	26
6.14 POWER SUPPLY INTERRUPTIONS.....	26
6.15 VOLTAGE TESTING AND DUMMY LOAD TESTING.....	27
6.16 RESETTING TPWS EQUIPMENT	28
7. REFERENCES AND RELATED DOCUMENTS	28
8. DEFINITIONS.....	29
APPENDICES	
A TPWS FAILURE IDENTIFICATION FLOWCHARTS	31
B TPWS FAILURE IDENTIFICATION CODES	41
C TPWS FAULT REPORT FORM	43
D TPWS AVAILABLE PARTS LIST	44
E UPS CONTACT DETAILS.....	49

1. Purpose

This document provides a record of best practice general information relating to the trackside sub-system of the Train Protection And Warning System (TPWS) used on Network Rail Signalling Infrastructure, together with relevant technical information.

2. Scope

This document covers the trackside sub-system of the Train Protection And Warning System (TPWS) only.

3. Personal Safety

All appropriate safety precautions must be observed when undertaking the work covered by this document.

This document does not address general personal safety measures. Local instructions including a COSHH assessment may be in operation and these will highlight those measures that must be taken to control any Health and Safety concerns.

4. Trackside Equipment – General Information

4.1 Description of Equipment

The TPWS track sub-system equipment consists of:

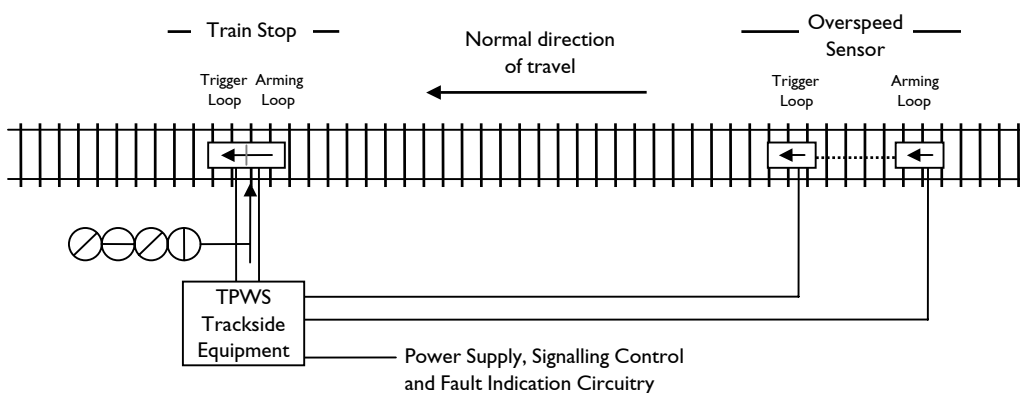
- TPWS control modules which interface with the signalling system and, dependent upon the status of the signal aspect, generate appropriate frequencies;
- the trackside enclosure or apparatus case housing the control modules;
- the TPWS transmitter loops which emit the generated frequencies to be detected by the train; and,
- the interconnecting cable system.

4.2 Principles Of Operation

TPWS is designed to reduce the number of and the consequences of SPADs (Signals Passed At Danger) and overspeeding events. Track mounted TPWS transmitter loops emit electro-magnetic fields at defined frequencies that can be detected by trainborne receivers. When the trainborne receiver detects specific combinations of frequencies within a specified time interval, it will use these to determine whether to initiate an automatic brake application on the train.

TPWS will initiate a brake application:

- at selected signals, where a train stop will operate if a train passes the signal at danger;
- at selected signals, where an overspeed sensor will operate should a train approach the signal at danger at an excessive speed; and
- at other locations (i.e. PSRs or buffer stops), where an overspeed sensor will operate should a train approach at excessive speed.



A Train Stop System (TSS) brake application will be made if, firstly a valid arming frequency is detected and then, whilst still detecting the arming frequency, the appropriate trigger frequency is detected, irrespective of train speed. The two transmitter loops of the TSS are normally mounted at the foot of the controlling signal and as close together as possible such that their magnetic fields overlap.

The Overspeed Sensor System (OSS) operates on the principle of measuring the time taken for a train to pass two points on the track. If this time is less than a pre-set time an automatic brake application is initiated. On the track, two transmitter loops, each emitting a specific frequency, define the points at which the timer on the train starts and stops. The distance between the transmitter loops and the trigger delay on the train together determine the set speed. When they are associated with a signal, the two transmitter loops are energised when the signal is required to be at danger. When associated with an Other Location (PSRs or buffer stops) the two transmitter loops are either permanently energised or, in some cases, to conserve battery life may be energised by the passage of the approaching train.

Any pair of transmitter loops that constitute either a TSS or OSS will initiate an automatic brake application only if the train receives the correct frequencies in the correct order. Different pairs of frequencies are provided for opposite direction moves and these may be interleaved with those for normal direction moves. The trainborne equipment has two separate timers, one for each direction.

4.3 Control Modules

TPWS Control Module Type	Colour	Pin code	Arming loop frequency	Trigger loop frequency
a.c. Signalling Interface Module (a.c. SIM)	Red with white rectangle	I035	N/A	N/A
Overspeed Sensor Module (OSM) Normal direction	Yellow	I036	f1 64.25 kHz	f2 65.25 kHz
Train Stop Module (TSM) Normal direction	Green	I038	f3 66.25 kHz	f2 65.25 kHz
Overspeed Sensor Module (OSM) Opposite direction	Blue	I037	f4 64.75 kHz	f5 65.75 kHz
Train Stop Module (TSM) Opposite direction	Brown	I039	f6 66.75 kHz	f5 65.75 kHz

Note: the clips that hold the TPWS control modules into the plugboard are a different length to the standard clips that hold BR930 series relays. The clips are superficially very similar and are not differently marked, the only difference being that the TPWS clips have 4mm longer side arms. It is important that the two types of clip are not interchanged during maintenance or renewal activities.

4.4 TPWS Control Inputs

TPWS control modules have two inputs, the main input ("Main I/P") and the suppression input ("Supp I/P"). Energisation of these inputs can be seen on the Train Stop or Overspeed Sensor Modules (TSM or OSM) by the illumination of the "Main I/P" and "Supp I/P" LEDs. In some older Modules these LEDs may be labelled "Main Sig" and "Sub Sig". TPWS loops are energised by applying a voltage to the main input (Main I/P) and suppressed by applying a voltage to the suppression input (Supp I/P). A voltage applied to the suppression input in the absence of a voltage applied to the main input will not cause the loops to transmit.

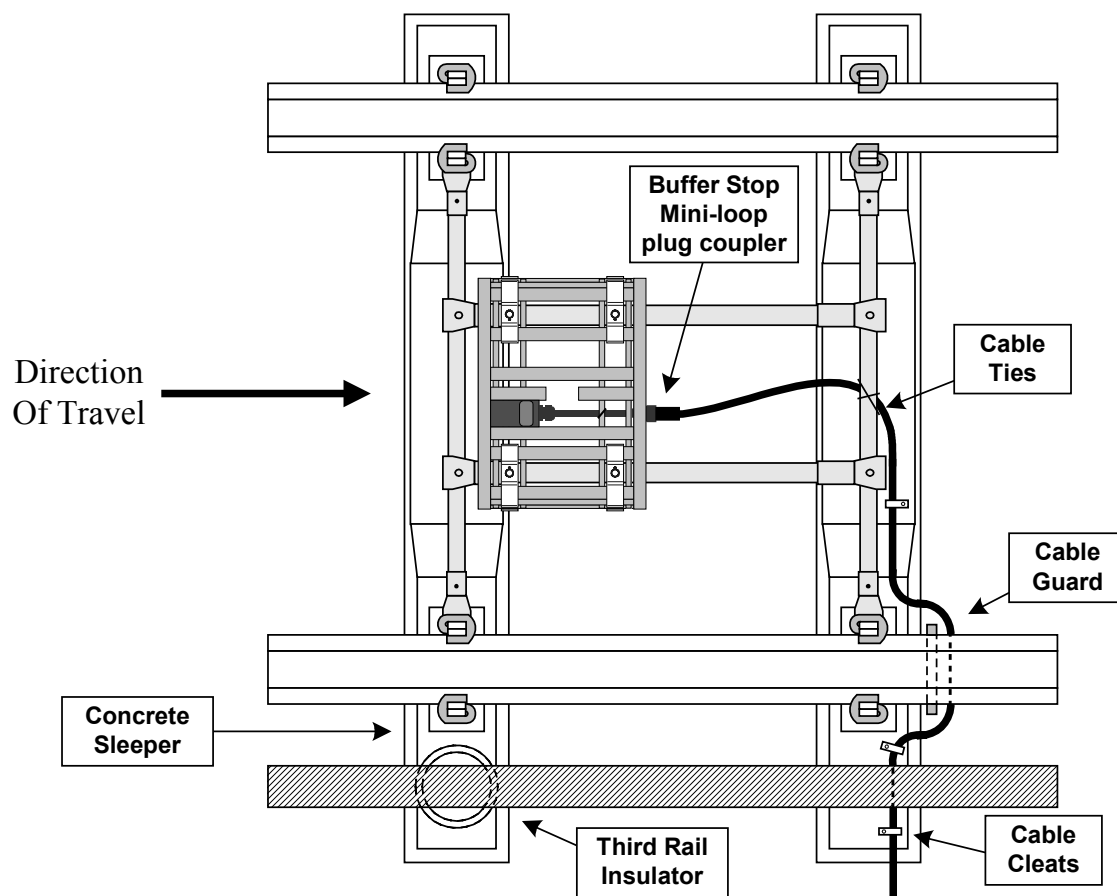
Generally the main input is energised by either the relay controlling the signal main aspect (HR), or by a direct connection to the signal red aspect 110 V a.c. feed. The suppression input is normally controlled by the relay controlling the subsidiary signal proceed aspect ((PL)GR), however, where self-reversion controls are required, the suppression input can be controlled by a TPWS suppression relay "V(Supp)R" or, in the case of complex approaches or PSRs at diverging junctions, by points indication or operating relays.

4.5 Transmitter Mini-Loops For Buffer Stops

When the first TPWS OSS were installed at Buffer Stops, it was found that with a set speed of 10 mph, trains travelling at around 5 to 6mph were being incorrectly tripped. This was found to be due to trains seeing the TPWS loop 'side lobes' which effectively lengthen the field of the OSS Loops. When a train is travelling slowly enough that it takes more than a second to clear the extended OSS Arming Loop field, the on-train timer resets and hence the OSS loop separation is effectively reduced.

The solution to this is a shorter Arming and Trigger loop for OSS at buffer stops (the "buffer stop mini-loop"), which produces a total field length that is sufficient for trains to have traversed in less than one second at the critical speed and hence the loop separation and set speed is not affected. The buffer stop mini-loop shall be used for all applications of OSSs for buffer stops.

The buffer stop mini-loop has been designed to be fully compatible with existing trackside equipment including, TPWS control modules, loop feeder tail cables, existing loop fixing bars, loop panel spacer kits and maintenance and commissioning testing jigs. It will however, emit different field strengths than the standard transmitter loop (see section 4.9).



Buffer Stop Mini Loop Cable Fixings - Concrete Sleepers

4.6 Transmitter Loop Positioning

The position of transmitter loops is critical to the designed operation of the system. A transmitter loop layout plan is required as part of the site records, showing the on-track equipment installed distances and transmitter loop frequencies. All Overspeed Sensor System (OSS) transmitter loop distances are measured from their leading edges in the direction of travel. Train Stop System (TSS) transmitter loop distances are measured from the centre point of the two transmitter loops and are generally positioned at the foot of the signal to which they are fitted. The OSS loop positions relative to the signal must be placed within 25 metres of the nominal designed position, with the OSS loop separation within 0.5 metres of the designed distance.

The longitudinal centre of the loop must be within +/- 10mm of the centre line of the track. The loop fixing bars have a hole through the centre to assist in alignment. This is particularly important for bars Hilti bolted to concrete sleepers or screwed to timber sleepers. Fixing bars that are designed to be secured by the rail fastening (e.g. Pandrol clips) will be automatically set to the correct position.

The distance below rail level from the top of the transmitter loop must be between 60mm and 100mm (except for standard loops and buffer stop mini-loops on slab track, which are mounted between 20mm and 60mm below rail level). It may be necessary to use TPWS transmitter loop packing pieced to achieve the correct height, these are detailed in Appendix D.

If loops are required to be moved during engineering work, the positions of the loops must be re-checked against the site records as part of the maintenance testing. If there are signs of disturbance to transmitter loop positions, their positions must be rechecked and appropriate action taken to rectify any deficiencies.

TPWS transmitter loops are fixed to the rail using a variety of fixing methods as detailed in RT/E/S/10173. Removal and replacement of these fixings should only be done by demonstrably competent personnel.

4.7 Self Reversion

The standard position for the TSS loops is at the foot of the signal, and at least 3.5 metres in rear of the signal replacement block joint, due to the position of the receiver on the train. In some areas TSS loops have to be installed closer to the replacement block joint than the required 3.5m, or even ahead of it. A TPWS fitted train passing over these loops would replace the signal to danger, and re-energise the TSS loops, before the train's TPWS antenna had passed over them causing the trains brakes to be applied. This is known as 'self reversion'. To avoid this situation additional signalling controls are included to suppress the energisation of the TPWS loops until the trainborne antenna has passed over them. This is normally achieved with a ten second timing circuit, however track circuit controls, or alterations to the signal replacement controls (last wheel or second track replacement) may also be used in some areas.

4.8 Test Equipment

A maintenance testing jig (see Appendix D for TCL part numbers), Mk2 (yellow) calibrated test aerial and a calibrated test aerial lead are required for annual maintenance and general fault finding. A commissioning jig will be required for testing of TPWS following track renewals where the position of transmitter loops has been disturbed. Both test jigs are compatible with standard loops and the buffer stop mini-loops.

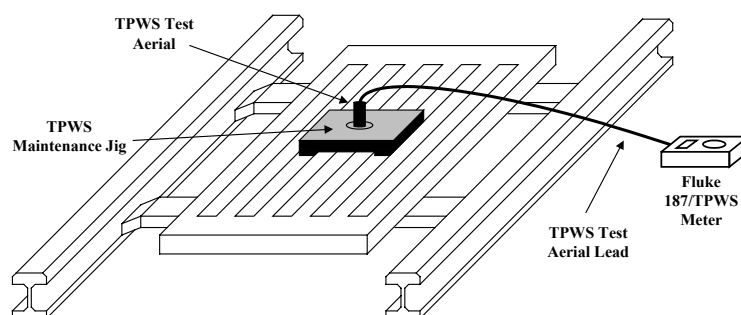
Note that the previously available 0.75 metre test aerial lead has been replaced with the 1.5 metre test aerial lead and should no longer be used for testing. The lead and aerial will require annual calibration by TCL.

For testing of TPWS transmitter loop output, due to the frequencies at which TPWS operates, meaningful results will not be obtained from digital multi-meters with a low bandwidth such as those in general use by signalling faulting teams, therefore a Fluke 187/TPWS is required. This is the only meter suitable for TPWS testing as it is capable of measuring a.c. voltages up to 200 mV with a 70 kHz minimum bandwidth and frequency count to 70 kHz to the required minimum accuracy, and it also has suitable accuracy at very low voltages (i.e. the 50mV range).

When in use, the meter shall not be held over the loop itself but shall be held outside the loop field, preferably with the test lead fully extended, as shown in the diagrams below. Failure to comply with this requirement will invalidate the test results.

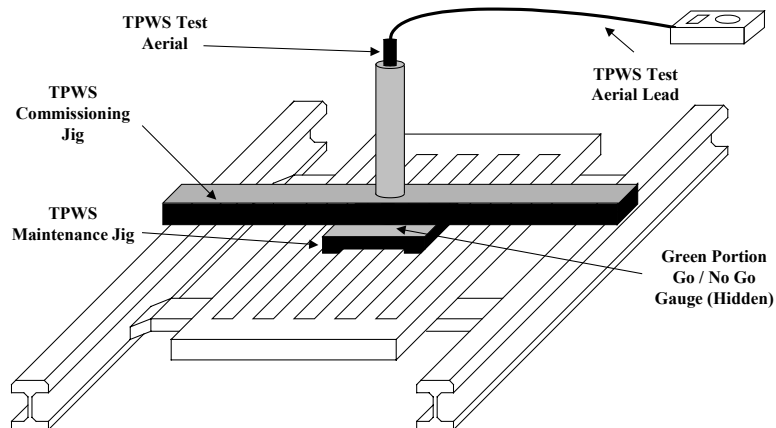
4.8.1 Use Of Maintenance Jig

To take measurements, the aerial shall be placed in the Maintenance Jig and positioned in the centre of the transmitter loop, with the test lead extended to its full length to ensure the meter is clear of the loop field as shown. The meter shall not be held over the loop itself but shall be held outside the loop field, preferably with the test lead fully extended.



4.8.2 Use Of Commissioning Jig

The commissioning jig also has an integral loop height gauge to enable confirmation that the transmitter loop is within the acceptable range of 60 to 100mm Below Rail Level (BRL). This is the green portion of the aerial holding tube. The top surface of the transmitter loop should be within the green portion of the gauge. This test is achieved without the Maintenance Jig being used.



On slab track, if the loops are less than 53mm below rail level, the Maintenance jig cannot be used to locate the commissioning jig in the centre point of the loop, and in this case the commissioning jig should be positioned manually. The meter shall not be held over the loop itself but shall be held outside the loop field, preferably with the test lead fully extended.

4.9 Typical Values Expected

Standard transmitter loop output voltage measurement (except where installed over concrete slab track), using Mark 2 yellow test aerial (see Appendix D for TCL part numbers), test aerial lead with **commissioning jig**:

When required to be energised: (using 50mV AC DMM range)	Minimum	5.65 mV
---	---------	---------

Buffer stop mini-loop, except where installed over concrete slab track, output voltage measurement using Mark 2 yellow test aerial, test aerial lead with **commissioning jig**:

When required to be energised: (using 50mV AC DMM range)	Minimum	4.26 mV
---	---------	---------

Buffer stop mini-loop, where installed over concrete slab track, output voltage measurement using Mark 2 yellow test aerial, test aerial lead with **commissioning jig**:

When required to be energised: (using 50mV AC DMM range)	Minimum	4.69 mV
---	---------	---------

Standard transmitter loop output voltage measurement using Mark 2 yellow test aerial, test aerial lead with **maintenance jig**:

When required to be energised: (50mV AC DMM range)	Minimum	29 mV
	Maximum	53 mV

When required not to be energised: (At TPWS frequency - 50mV AC DMM range)	Maximum	2 mV
---	---------	------

Buffer stop mini-loop output voltage measurement using Mark 2 yellow test aerial, test aerial lead with **maintenance jig**:

When required to be energised: (500mV AC DMM range)	Minimum	59 mV
	Maximum	107 mV

When required not to be energised: (At TPWS frequency - 50 mV AC DMM range)	Maximum	2 mV
--	---------	------

When conducting the 'not energised' test on a Train Stop, it is important that both loops of the Train Stop are de-energised to prevent the test aerial picking up a field from the adjacent loop.'

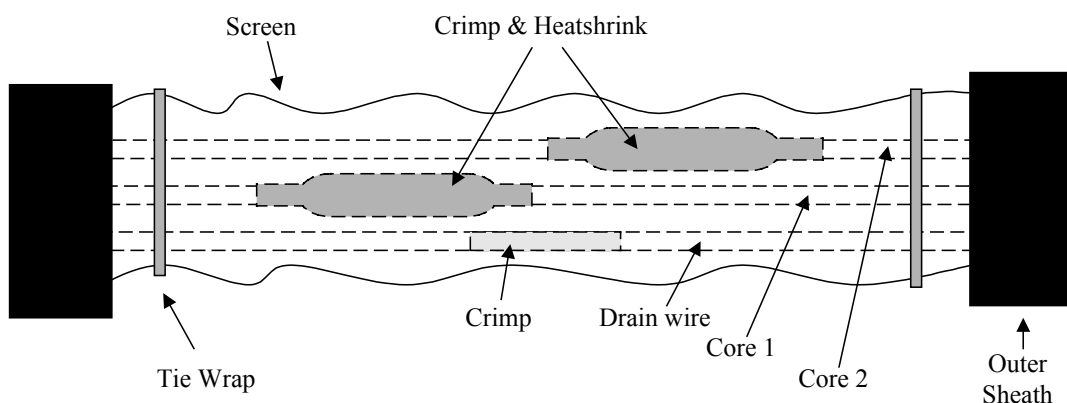
An alternative means of measuring the output of the TSM / OSM using direct voltage measurement of the transmitter loop cable circuit for (faulting purposes only) is described in section 6.15.

The frequency of the transmitter loop feeder circuit can be measured either from the loop output using the Maintenance test equipment, or from the output of the OSS / TSS modules at the terminal rail of the baseplate or trackside enclosure. Either method is equally effective. A frequency drift of greater than 10 Hz from the frequency specified in section 4.3 indicates a fault within the OSS or TSS module.

4.10 Transmitter Loop Cable Jointing

If a fault is identified in the transmitter loop cable circuit and the fault location can be identified, then if it is not possible to change the entire length of the transmitter loop cable, it is permissible to remove the damaged section and joint the remaining cable.

This must be done using a cable jointing kit approved for TPWS transmitter loop cable jointing, and must include jointing of the screen and drain wire within the cable.



It is recommended that the number of joints in a TPWS transmitter loop cable system is limited to two, and any failures after this should require full replacement of the damaged cable.

4.1.1 Handling Of Tail Cables And Plug Couplers

- The plug coupler mating halves should be protected from ingress of dirt or moisture when stored and during any on-track work requiring disconnection, until the connection is ready to be made.
- The plug coupler should not be used as the means of handling the cable while it is being installed or run out. Every effort should be made to ensure that the bond between the cable and the plug coupler remains stress free.
- A visual inspection of the plug coupler for dirt or moisture should be made before the two halves are mated. Any moisture or dirt found should be removed using appropriate means.
- As there is a limited amount of space available when the transmitter loop is fixed to the track, it is recommended that where possible the plug coupler is connected prior to the fixing down of the transmitter loop.
- Insulation resistance testing should not be carried out on the tail cables once they are connected to the loop.
- Reasonable care should be taken not to twist the tail cable in relation to the moulded plug coupler during installation, nor to rotationally twist the mated halves of the plug coupler when disconnecting it.
- Disconnection of the plug coupler should not be achieved by pulling on the attached tail cable. This action will lead to weakening of the bond between the loop tuning circuit (black box) and the loop frame.
- The TPWS Plug Coupler Tool (see Appendix D for TCL part numbers, see diagram below) should be used for the connection and disconnection of the transmitter loop to tail cable plug coupler connection.
- Once connected, the two mating halves of the plug coupler should be secured together by the use of cable ties.
- TPWS transmitter loop tail cables should be secured to the transmitter loops by the use of cable ties.



Plug Coupler Tool