

Ref	NR/SP/SIG/10133
Issue	3
Date	April 2004

Train Protection and Warning System (TPWS) Signalling Interface Design Requirements (formerly RT/E/S/10133)

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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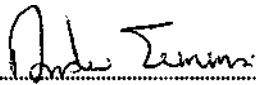
Ref	RT/E/S/10133
Issue	3
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Company Specification

Train Protection & Warning System (TPWS) Signalling Interface Design Requirements

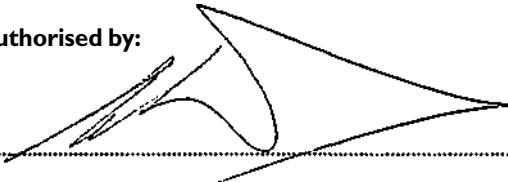
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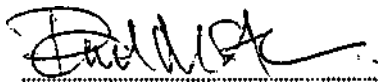
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Implementation

The implementation date for RT/E/S/10133 shall be 3 April 2004.

Compliance

The compliance date for RT/E/S/10133 shall be 3 April 2004 and is mandatory upon Network Rail. Compliance with this specification is not necessary for equipment that has a product acceptance certificate dated before 3 April 2004.

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Ref	RT/E/S/10133
Issue	3
Date	April 2004

Contents

1	Purpose	4
2	Scope	4
3	Reference Documentation	5
4	Definitions	6
5	General Description And Operational Requirements	8
6	General Design Requirements For TPWS Installations	10
7	Indication Requirements	21
8	Requirements For Mechanically Operated Signalling	28
9	Requirements For SSI Installations	33
10	Requirements For Complex Approaches	38
11	Requirements For Computer Based Interlockings	48
12	Direct Connection To Relay Installations	59
13	Requirements For TPWS+ Retro Fitment	65
14	Design Detail Requirements	68
15	TPWS Earthing And Bonding Requirements	80
16	Power Supplies For TPWS	85
17	TPWS UPS System	88
18	TPWS Failure Indication Unit	92
19	Self Powered OSS (SPOSS)	99
20	Appendices	103
	Appendix A - Examples of TPWS on signalling drawings	103
	Appendix B - List Of TPWS Typical Circuits	104
	Appendix C - Layout Of TPWS Failure Indication Unit (FIU)	107
	Appendix D - FIU Typical Equipment Wiring Arrangement	109
	Appendix E - Control Tables	111
	Appendix F - TPWS Symbols Used on IECC VDU Displays	115

Ref	RT/E/S/10133
Issue	3
Date	April 2004

I PURPOSE

This Specification details the requirements for the design of the signalling interface associated with the fitment of the Train Protection and Warning System (TPWS) to Network Rail infrastructure.

2 SCOPE

This Specification details the requirements for the design of the interface between the Thales solution for the track sub-system of TPWS and conventional signalling systems, and novel computer based interlocking and their associated power supplies. It applies to retro-fitting of TPWS to existing signalling, and to the fitment of TPWS during re-signalling. It does not apply to the fitment of TPWS in areas controlled by Radio Electronic Token Block Signalling (see Network Rail Company Standard [RT/E/S/10178](#)). This Specification also applies to the TPWS Failure Indication Unit supplied by NRS and the TPWS UPS supplied by UPS Ltd.

Ref	RT/E/S/10133
Issue	3
Date	April 2004

3 REFERENCE DOCUMENTATION

	Railway Safety Regulations: 1999
BR829	Specification for Plugboards for Miniature Relay Units for Railway Signalling (Now a Common Domain document)
BR930	Miniature Tractive Armature d.c. Neutral Line Relay, Plug-in Type For Railway Signalling Purposes
BS 1376:1974	Specification for Colours of Light Signals
RT/E/C/11004	Symbols For Use On Signalling Plans And Sketches
RT/E/C/11600	Signalling And Operational Telecommunications Design: Technical Guidance
RT/E/PS/00005	Railway Signalling Cables (Note Document to be renumbered RT/SSA/0001 in future)
RT/E/PS/00011	TPWS – Failure Indication Unit
RT/E/S/10134	TPWS Track Sub System Equipment
RT/E/S/10137	TPWS - Selection of Signals and Other Locations for Provision of Track Sub-system
RT/E/S/10138	TPWS - Transmitter Loop Requirements And Positioning
RT/E/S/10173	TPWS - Track Sub-System Installation Requirements
RT/E/S/10178	TPWS In Areas Where The Control Of Train Movements Is By RETB Signalling
RT/E/S/11202	Signalling Design – Control Tables
RT/E/S/11210	Signalling Installations
RT/E/S/11630	BR930 series Pin Code allocations and Contract Arrangements
RT/E/S/17002	SSI Applications Manual Contents (SSI8000)
RT/LS/CAT005	Index of Network Rail Documents Relating to Signalling & Communications Equipment, Part 3 - Typical Circuits
SSI8003-81	SSI Applications Manual, SSI Data Preparation - TPWS
SSI8500	SSI Applications Manual
TPWS/REF/147	Specification For a TPWS Failure Indication Unit For Mechanical Signal Boxes

Ref	RT/E/S/10133
Issue	3
Date	April 2004

4 DEFINITIONS

Term	Definition
AWS	Automatic Warning System
Baseplate	Purpose built unit housing one Power Supply & Signalling Interface Unit and one other TPWS Unit. For fitting in existing lineside apparatus cases or relay room.
BX	a.c. signalling supply
CBI	Computer Based Interlocking
EKR	Signalling first filament failure indicating relay
EMC	Electro Magnetic Compatibility
FDM	Frequency Division Multiplex
FIU	Failure Indication Unit
FTE	Fast Transient Earth
HMRI	Her Majesty's Railway Inspectorate
HR	Relay controlling the red aspect of a colour light stop signal
IECC	Integrated Electronic Control Centre
LDT	Long Distance Terminal
Leading Edge	The first edge of a TPWS loop encountered by a train travelling in the direction that the TPWS loops are designed to operate at that site.
LRU	Line Replaceable Unit
MET	Main Earth Terminal
MPM	Multi Processor Module
Normal Direction (ND)	On a line for which signalling is provided for one direction only, 'Normal' applies to the signalled direction. On a bi-directional line, 'Normal' applies to one direction (which may be chosen arbitrarily).
NRS	National Railway Supplies
NSTR	No Signaller Token Operation – Remote Passing Loop
NX	a.c. signalling supply return
Opposite Direction (OD)	On bi-directional lines opposite direction applies to the direction opposite to 'Normal'.
Other Location	Those parts of the infrastructure where an OSS is to be fitted for reasons other than protecting against SPADs
Overspeed Sensor Module (OSM)	A module which, when required, produces a pre-determined pair of frequencies which are transmitted via cables to Overspeed Sensor Loops
Overspeed Sensor System (OSS)	A facility whose function is to initiate a brake application on a train that approaches a signal showing a Danger aspect or an Other Location at excessive speed.
PPM	Panel Processor Module
POL	Phantom Overlap
PSR	Permanent Speed Restriction
REB	Relocatable Equipment Building

Ref	RT/E/S/10133
Issue	3
Date	April 2004

REC	Regional Electricity Company
RECR	Red lamp checking or proving relay
ROL	Reduced Overlap
SDS	Signaller's Display Sub-System
Self Reversion	Situation where the leading wheel set of a train passing a TPWS fitted signal, reverting the signal back to Danger and energising the TSS, then self trips the train.
Set Speed	The minimum speed at which a brake demand is initiated when a train passes over an active OSS.
Signalling Interface Module (SIM)	A module that operates as the interface between the signalling system and the Overspeed Sensor Module or the Train Stop Module. (Thales equipment labelled "Power Supply And Signalling Interface Module")
SPAD	Signal Passed At Danger
SPOSM	Self Powered Overspeed Sensor Module
SPOSS	Self Powered Overspeed Sensor System
SRG	Safety Review Group
SSI	Solid State Interlocking
TEP	Token Exchange Point
TFM	Trackside Functional Module
Thales	Thales Communications UK Ltd.
TORR	Train Operated Route Release
TPWS	Train Protection & Warning System
TPWS Control Modules	Generic term for Overspeed Sensor Modules, Train Stop Modules and Signalling Interface Modules
TPWS Transmitter Loops	Generic term for Overspeed Sensor Loops and Train Stop Loops
Track Mounted Equipment	Includes Overspeed Sensor transmitter loops and Train Stop transmitter loops.
Train Stop Module (TSM)	A module which, when required, produces pre-determined pair of frequencies which are transmitted via cables to Train Stop Loops
Train Stop System (TSS)	A facility whose function is to initiate a brake application on a train that passes a signal at Danger without authority.
TSR	Temporary Speed Restriction
UPS	Uninterruptible Power Supply
VCR	TPWS proving relay
VR	TPWS relay

Ref	RT/E/S/10133
Issue	3
Date	April 2004

5 GENERAL DESCRIPTION AND OPERATIONAL REQUIREMENTS

5.1 Background

TPWS is designed to reduce the likelihood and consequences of a Signal being Passed At Danger (SPAD), by initiating, in certain circumstances, an automatic brake application on the train. It is also able to reduce the consequence of a train exceeding an appropriate speed at a speed restriction or on the approach to buffer stops.

The objective of TPWS is to intervene in the control of a train when there is evidence in the form of a signal being passed at danger without authority or excess speed, that the train is not being driven appropriately. It is not the intention that TPWS should have any effect on the normal operation of a train.

Track mounted equipment transmits electromagnetic fields at defined frequencies which are detected by a receiver on the train. When the trainborne receiver detects specific combinations of frequencies within a specified time interval, it will initiate an automatic brake application on the train.

5.2 Key Operational Requirements

The TPWS system is not a fail-safe system in its own right since the loops are active to initiate an intervention. However the signalling interface has been designed such that failure of the circuits feeding TPWS shall, in normal circumstances, cause the TPWS equipment to be energised and hence for a train to be stopped, thus reducing the risk of undetected failure modes. It is also necessary to provide a suitable means of monitoring the functioning of the system and reporting of failures, with the following being key requirements:

- a) for signal fitments, the Signaller shall be provided with a real time indication of TPWS TSS and/or OSS failure of each TPWS installation;
- b) for signal fitments, trains shall not be allowed to approach a signal with failed TPWS trackside equipment, when it is at danger, without appropriate measures to control the risk, equivalent to those for a signal lamp not being lit when required;
- c) for buffer stops, reporting and management of failures shall be at least equivalent to the first filament failure monitoring system on signals.
- d) it is not required to report failures of TPWS at speed restrictions remotely, except for PSRs installed as part of a re-signalling scheme.

Ref	RT/E/S/10133
Issue	3
Date	April 2004

For installations of TPWS associated with a signal, the signal in rear shall normally be replaced to danger in the event of failure of TPWS at a signal. This does not apply to TPWS fitment at speed restrictions or buffer stops. Where the signal in rear is currently returned to caution instead of danger, or is unaffected by the failure of the signal lamp ahead, TPWS failure shall still be indicated by using the existing 'signal lamp out' circuit, but no alterations shall be made to make this circuit achieve replacement of the signal in rear to danger.

Where it is not reasonably practicable to achieve these requirements using signal controls, a non-compliance shall be considered by Network Rail Regional Safety Review Group.

Details of the required indications for TPWS failures are given in section 7.

5.3 Loop Positioning Constraints

It is the intention that TPWS provides the best possible mitigation in the event of a potential or actual SPAD. This will be achieved by placing the Overspeed Sensor System (OSS) loops an appropriate distance before the object to which they relate. Details of how to determine the arrangements of loops required are given in Network Rail Company Standard RT/E/S/10138 - 'TPWS - Transmitter Loop Requirements and Positioning'.

The set speed of an OSS is measured by loop separation. It is therefore important that for an OSS, the loop distance from the signal or speed restriction and the set speed of the OSS are accurately set to the tolerances defined in Network Rail Company Standard RT/E/S/10138.

In designing the installation, it is important that constraints on positioning the loop are considered, and if adjustments are made to the location, appropriate adjustments are also made to the OSS set speed.

It is important to eliminate the risk of a train returning the signal to danger before its TPWS antenna has passed the associated Train Stop System (TSS) loops. If this is not done then the train will be subject to Self Reversion (see section 6.9).

If during the installation process, the transmitter loops cannot, for whatever reason, be positioned in the exact location shown on the signalling scheme plan or track plan, then the installer is required to seek advice from the signalling designer. In this case the available positions of the transmitter loops shall be checked for compliance with Network Rail Company Standard RT/E/S/10138, or a non-compliance / derogation obtained.

Ref	RT/E/S/10133
Issue	3
Date	April 2004

6 GENERAL DESIGN REQUIREMENTS FOR TPWS INSTALLATIONS

6.1 TPWS Control Modules

The TPWS control modules fit into non-phenolic plugboards to BR829 and are held in place by a retaining wire (note the retaining wire is a bespoke item to these modules, and is not interchangeable with other spring retaining wires). The TPWS control modules are provided with pin coding and contact arrangements in accordance with Network Rail Company Standard [RT/E/S/11630](#). The outside of the TPWS control modules (except for the area which fits into the BR829 plugboard) is coloured in accordance with Table 1 below.

TPWS Control Module Type	Colour	Pin Code	Arming Loop Frequency	Trigger Loop Frequency
A.C. Signalling Interface Module (SIM)	Red with white rectangle	1035	N/A	N/A
Overspeed Sensor Module (OSM) Normal Direction (ND)	Yellow	1036	f1 - 64.25 kHz	f2 - 65.25 kHz
Train Stop Module (TSM) Normal Direction (ND)	Green	1038	f3 - 66.25 kHz	f2 - 65.25 kHz
Overspeed Sensor Module (OSM) Opposite Direction (OD)	Blue	1037	f4 - 64.75 kHz	f5 - 65.75 kHz
Train Stop Module (TSM) Opposite Direction (OD)	Brown	1039	f6 - 66.75 kHz	f5 - 65.75 kHz

Table 1 - Details Of TPWS Control Modules

If a fault occurs within the TPWS OSS or TSS when it is required to be energised, then the associated module will indicate the fault via a latched LED indication and that indication will be maintained until the module is powered down. This latching arrangement will enable a momentary fault to be identified.

The module will also provide an output to the associated SIM such that the proving contact within the SIM creates an open circuit to the TPWS proving circuit. The proving output is not latched, closing when the fault clears.

Ref	RT/E/S/10133
Issue	3
Date	April 2004

6.1.1 Use Of Opposite Direction Frequencies

Network Rail Company Standard [RT/E/S/10138](#) discusses the use of Opposite Direction (OD) frequency TPWS equipment where it is necessary to interleave TPWS functions. The use of TPWS OD equipment is left to the discretion of the designer.

The issue of spares holdings of OD TPWS equipment should be borne in mind where there is no other requirement for OD equipment to be used in a geographical maintenance area.

6.2 TPWS Input Requirements

Each TPWS OSM or TSM is fed from an associated TPWS SIM. The SIM requires the following inputs from the signalling system:

- 110 V a.c. power supply;
- 110 V a.c. Main Input;
- 110 V a.c. Suppression Input for position light signal associated with the stop main aspect and complex approaches.

Where TPWS is associated with a signal, the transmitter loops are energised in accordance with Table 2:

Signal state	TSS loops	OSS loops
Signal required to display a proceed main aspect	Not energised	Not energised
Signal required to display a proceed subsidiary / position light aspect	Not energised	Not energised (see note 1)
Signal required to be at danger, suppression required due to positions of points	Energised	Not energised
Signal required to be at danger	Energised	Energised
Buffer stops and speed restrictions	N/A	Energised

Table 2 - Energisation Of OSS And TSS Loops

The TPWS trackside sub-system is required to transmit the required loop outputs within 1.5 seconds of the signal interlocking requesting the main signal to display a danger aspect.

Ref	RT/E/S/10133
Issue	3
Date	April 2004

The OSS TPWS transmitter loops associated with a speed restriction or buffer stop shall normally be permanently energised. With the exception of the Self Powered OSS which has no inputs from the signalling system (see section 19), this is achieved by the SIM receiving the following inputs from the signalling system:

- a) 110 V a.c. power supply;
- b) 110 V a.c. Main Input (normally permanent).

Note 1 : Earlier issues of this Specification required only the TSS to be suppressed and the OSS to be left active when a move is legitimately authorised by a Subsidiary signal associated with the main aspect of a signal fitted with TPWS.

Experience has shown that non-suppression of the OSS under such moves can introduce significant operational impact when the Subsidiary signal can be sighted as 'Off' prior to the train reaching the OSS loops, and that the protection provided by this arrangement provides no additional safety benefit by the OSS for such moves.

To minimise further operational disruption, all later TPWS installations at signals with subsidiary aspects, were designed such that both the OSS and TSS are suppressed when a subsidiary proceed aspect is lit. Later versions of Thales baseplates and trackside enclosure plugboard panels incorporate the facility for both the OSS and TSS to be suppressed by energisation of the Suppression input ("Supp I/P"). These are identified by the words "OSS Suppression Enabled" on the baseplate or plugboard panel.

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6.3 TPWS Proving Output Operation

The SIM has one output, called the TPWS proving output. This is a normally open, volt-free relay contact, which responds in accordance with the conditions in Table 3:

Signal state	TSS loops	OSS loops	TSS proving contact state	OSS proving contact state
Signal required to display a proceed main aspect	Not energised	Not energised	Open	Open
Signal required to display a proceed subsidiary / position light aspect	Not energised	Not energised (see note 1)	Open	Open (see note 1)
Signal required to be at danger, suppression required due to positions of points	Energised	Not energised	Closed	Open
Signal required to be at danger	Energised	Energised	Closed	Closed
Signal required to be at danger ** Fault Condition **	Not energised (or output 6 dB below specified level)	Energised	Open	Closed
Signal required to be at danger ** Fault Condition **	Energised	Not energised (- or output 6 dB below specified level)	Closed	Open
Buffer stops and speed restrictions	N/A	Energised	N/A	Closed
Buffer stops and speed restrictions ** Fault Condition **	N/A	Not energised (or output 6 dB below specified level)	N/A	Open

Table 3 - Operation Of TPWS Proving Output

Due to the proving output contact only closing when the TPWS loops are energised, it is necessary to condition the proving output of the TPWS SIM with the status of the controlling signal in order to avoid indicating a TPWS failure when TPWS is not required to be energised. The TPWS proving output of the SIM is used to feed a local TPWS proving relay (VCR), which in normal circumstances is energised either by correct operation of the TPWS or by a proceed aspect on either the main or subsidiary signals. The approved methods of achieving this are detailed in typical circuits, a list of which is shown in Appendix B.

Ref	RT/E/S/10133
Issue	3
Date	April 2004

6.4 Location And Mounting Of TPWS Control Equipment

Where possible, the TPWS control equipment shall be positioned in close proximity to the signal being fitted because the maximum permitted length of the transmitter loop feeder cable system is 500 metres, including the transmitter loop tail cables. If the location of the controlling relays (HR/(PL)GR/VR etc.) allows the co-location of the TPWS control modules for multiple signals to facilitate this cable length (i.e. within a relay room, R.E.B. or existing signalling apparatus case), then these TPWS control modules shall be mounted as close as possible to the controlling relays.

TPWS modules shall not be housed within the same apparatus case as any FDM remote control equipment, including type RR vital reed. However TPWS can be installed in apparatus cases where FDM cables are through jumpered. Discretion is required when co-locating in relay rooms, e.g. TPWS equipment should not be housed on the same relay rack as FDM equipment.

6.4.1 Selection Of Housing For TPWS Control Equipment

TPWS control modules shall, if space is available, be accommodated in either an existing relay room or existing signalling lineside apparatus case, with each TPWS control module and associated SIM on a pre-wired baseplate. A right angle bracket is available from Thales for the mounting of the baseplate on apparatus case backboards where no rack space is available.

Should space not be available within an existing apparatus case or relay room, then the TPWS control equipment may be housed in a purpose built trackside enclosure provided by Thales. Table 4 provides guidance on the selection of an appropriate arrangement.

Number of TPWS functions	Thales 1 Function case(s)	Thales 2/4 Function case(s)	Existing Apparatus Case(s) / RR	New Apparatus case(s)	New R.E.B / Relay Room
1	Option 2	Non-preferred	Preferred option	Non-preferred	Non-preferred
2	Non-preferred	Option 2	Preferred option	Non-preferred	Non-preferred
3	Option 2 (one of each)		Preferred option	Non-preferred	Non-preferred
4	Non-preferred	Option 2	Preferred option	Non-preferred	Non-preferred
5-32	Non-preferred	Option 3	Preferred option	Option 2	Non-preferred
>32	Non-preferred	Non-preferred	Preferred option	Option 3	Option 2

Table 4 - TPWS Housing Preferences

Ref	RT/E/S/10133
Issue	3
Date	April 2004

Where there is a requirement for multiple installations of TPWS within a geographically confined area, consideration shall be given to the logical arrangement of TPWS functions. For example at a station where TPWS is required to be fitted at both ends of each platform, TPWS modules / baseplates can be grouped together within new apparatus cases such that each end of the station is controlled from one apparatus case. In order to minimise the requirements for loop feeder cable, it may be appropriate to split the TSS and OSS function baseplates for one signal into separate apparatus cases.

6.4.2 Thales Trackside Enclosure Options

Several options of TPWS trackside enclosure are available from Thales to facilitate the housing options described above:

- a) a single function case with one TSS (either ND or OD) for use where an isolated signal requires only a TSS;
- b) a single function case with one OSS (either ND or OD) for use where isolated signals, speed restrictions or buffer stops exist;
- c) a two function trackside enclosure with a full single signal set (either ND or OD) i.e. one TSS and one OSS;
- d) a four function trackside enclosure with two full signal sets (ND) i.e. two TSS (ND) and two OSS (ND).
- e) A four function Trackside Enclosure with one full signal set (ND) and one full signal set (OD).

No four function Trackside Enclosure with two full signal sets (opposite direction) is available as the number of opposite double signal installations will be low.

A Thales four function trackside enclosure uses the same basic trackside enclosure as the two function trackside enclosure. The difference is in the number of module bases, terminal bars and internal wiring.

6.5 VCR Relay Requirements

The VCR relay is required to be slow to drop for at least 200 ms, in order to not indicate a failure during the changeover of signal aspects. To achieve this a BR934A relay shall be used.

Where no 50 V d.c. supply is available, for instance in SSI areas, a BR966F7 or equivalent twin relay shall be used. Where possible this relay shall be located in the same apparatus case as the TPWS baseplates, or in the same suite of apparatus cases as the TPWS trackside enclosure containing the TPWS modules from which it is driven.

Ref	RT/E/S/10133
Issue	3
Date	April 2004

6.6 Relay Contact Wetting Current

When the signalling inputs of the TPWS SIM are fed from a relay contact, the 5 mA current drawn by the input will not be sufficient to ensure that the contact of the relay is kept clear of impurities. It will be necessary to install a 3.9 k Ω resistor in parallel with the signalling inputs to ensure that an adequate wetting current is drawn. This resistor shall be connected to the internal side of the outgoing links in the apparatus case housing the signalling control relays, mounted on a Paxolin board on the relay racking or apparatus case back board as appropriate, such that the heat dissipated within the resistor cannot affect any other equipment or wiring, and labelled with suitable warnings for staff protection. It is recommended that either a 25W metal clad resistor is used in order to dissipate the heat without risk of injury to staff.

6.7 TPWS Cabling Arrangements

Tail cables for TSS TPWS transmitter loops shall be terminated, where possible, directly into the apparatus case containing the TPWS control modules. Tail cables and trackside feeder cables for OSS TPWS transmitter loops will normally be terminated into either a single 6-way disconnection box or two 3-way disconnection boxes at the lineside close to the loops.

When the TPWS control modules are housed on baseplates within an existing signalling lineside apparatus case or relay room, the trackside feeder cable and transmitter loop tail cable shall be terminated on the outgoing cable links, with the internal side being connected to a length of 75 ohms characteristic impedance, screened twisted pair cable (A4 as defined in Network Rail Company Standard [RT/E/PS/00005](#)) run internally via the cable trunking to the baseplate termination links as detailed in Network Rail Company Standard [RT/E/S/10173](#) - TPWS Track Sub-System Installation Requirements.

The maximum length of the trackside feeder cable system (including the tail cable) for correct loop operation is 500 metres.

The number of disconnection points used in the transmitter loop cable circuit has a minor detrimental effect on the performance of the circuit. Although there are no restrictions on the number of disconnection boxes and cable terminations that can exist in the loop feeder cable circuit, they should be kept to a minimum for reliability reasons.

Ref	RT/E/S/10133
Issue	3
Date	April 2004

6.8 Circuit Length Restrictions

The maximum permitted circuit lengths between the SIM and the last controlling contact / source shall not exceed that detailed in Table 5:

Circuit	Maximum length Non-Electrified And d.c. Electrified Lines	Maximum length a.c. Electrified Lines
110v power supply input	1500 metres	300 metres *
Main Input	1500 metres	300 metres *
Suppression Input	1500 metres	300 metres *
Proving Contact Output with BR934A relay	1500 metres	1500 metres
Proving Contact Output with BR966F7 relay	300 metres	300 metres *

Table 5 – TPWS Maximum Circuit Lengths

* In accordance with current practice, it is not recommended that the length of these circuits exceeds 200 metres in a.c. electrified areas, except where the existing tail cabling to the associated signal is greater than 200 metres. Maximum lengths for line circuits as detailed in Network Rail Company Standard [RT/E/C/11600](#) continue to apply for circuits to and from the TPWS SIM.

6.9 Avoidance Of Self Reversion

In areas where TSS loops can only be placed such that they would become energised by the replacement of the signal before the trainborne TPWS receiver has passed over them, TPWS fitment requires additional controls to overcome this problem. This is known as 'Self-Reversion'.

When positioning TPWS transmitter loops to Network Rail Company Standard [RT/E/S/10138](#) - TPWS Transmitter Loop Requirements And Positioning, the situation may arise where the TSS loops are required to be positioned either less than 3.5 metres on the approach to the replacement block joint, or ahead of it. In this case, additional signalling controls may be required to prevent Self Reversion of TPWS. This can either take the form of second track circuit replacement of the signal or of an additional timing function in the TPWS signalling interface circuit to suppress the energisation of the TPWS loops until the trainborne antenna has passed.

Typical circuits for the provision of additional suppression controls for TPWS are provided in the [RT/LS/CAT005](#) - [T34000](#) series of typical circuits. A list of these circuits is shown in Appendix B.

Ref	RT/E/S/10133
Issue	3
Date	April 2004

6.10 Slotted Mechanical Signals

Where TPWS is applied to a slotted mechanical signal, the role of each slot shall be considered and TPWS provided only for those slots that meet the fitment criteria specified in Network Rail Company Standard [RT/E/S/10137](#) - 'TPWS - Selection of Signals and Other Locations for Provision of Track Sub-system'. This could mean that the TPWS is not energised with the signal at danger, if one slot is operated and the other is not, provided that TPWS protects the principal hazards for which it is provided. Using this approach, it would be rare for TPWS to require more than one slot to be cleared in order to be de-energised. This simplifies the controlling and fault reporting circuitry required.

6.11 Fixed Red Signals

Fixed signals that are required to be fitted with TPWS will require the TPWS system to be energised at all times. This can be achieved by providing the Main Input of the SIM with a permanent feed.

Fixed red signals which are fitted with TPWS are treated as normal signals, including replacement of the signal in rear. No additional controls shall be provided to allow the signal in rear to be released in the event of TPWS failure.

6.12 Stop Boards

Stop Boards at NSTR and RETB installations require TPWS fitment to protect the entry to single line sections. As there is no means of controlling the signal aspect with these methods of signalling, TPWS must be controlled such that it is suppressed when a valid token is issued.

For NSTR, circuits have been developed which operate TPWS for a set period of time after withdrawal of a token from the token machine. These are published in the [RT/LS/CAT005 - T34000](#) series of typical circuits (see Appendix B).

For RETB, a system has been developed which 'listens' for the transmission of a valid token to the site and suppresses TPWS appropriately – this is detailed in Network Rail Company Standard [RT/E/S/10178](#) – "TPWS In Areas Where The Control Of Train Movements Is By RETB Signalling".

Ref	RT/E/S/10133
Issue	3
Date	April 2004

6.13 Signals With Approach Released Routes

Failure of TPWS at signals is required to hold the signal in rear at danger while the failure is being reported. As TPWS failure indications only exist when the TPWS system is required to be transmitting, the failure can be cleared, and hence the signal in rear allowed to show a proceed aspect, once the signal with TPWS fitted is also showing a proceed aspect. Thus clearing the signal with the failed TPWS equipment automatically achieves 'double block' working.

The one scenario in which the above does not achieve the desired result, is when an approach released route is required to be set from the signal with failed TPWS.

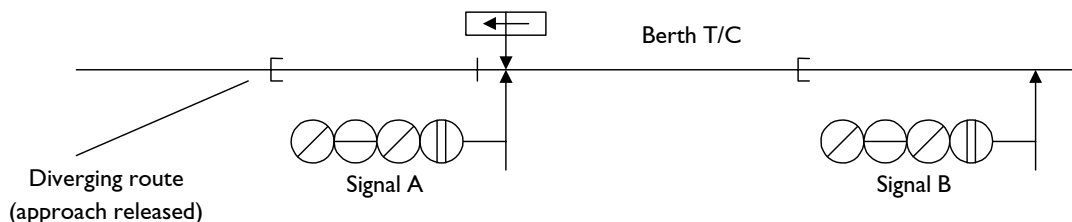


Figure 1

In the above example Figure 1, Signal A cannot normally show a proceed aspect until the train is on the berth track circuit and the train cannot occupy this track circuit as it is being held at Signal B at danger by the TPWS failure at Signal A. It may be undesirable for the Signaller to authorise the train past Signal B as he / she will be authorising a move up to a signal that could be unlit (the panel indication for Signal A has been extinguished by the TPWS failure). In this situation, the Network Rail Regional Production Manager may request additional controls to be added to allow Signal B to show a proceed aspect and for the "signal lit" panel indication for Signal A to become re-lit, in the event of TPWS failure, once the approach released route has been set ("ready to clear" in SSI areas) from Signal A.

No typical circuits for the application of approach release controls in RRI areas are available, however typical data constructs for the application of approach release controls in SSI areas (Method 1 only) are available in the Network Rail SSI Applications Manual, section SSI8003-81 "SSI Data Preparation - TPWS". For this reason, the application of approach release controls is only considered practicable where TPWS is controlled by an SSI or other Computer Based Interlocking (CBI) using a data change method.

Ref	RT/E/S/10133
Issue	3
Date	April 2004

6.14 Temporary Speed Restrictions

The design process for TPWS at TSRs shall be as described in Part L of [RT/E/C/11701](#) and Appendix B3 of [RT/E/C/11600](#), on the grounds that any TSR related design will remain in use for a limited period of time. The control measures shall follow those described in [RT/E/C/11701](#), Part L. The work is classed as 'Non-conceptual' (Ref: [RT/E/C/11701](#)) i.e. similar in nature to temporary disconnection of AWS at a TSR.

The infrastructure records for the TPWS TSR equipment designs shall not be updated (refer to [GK/RT0207](#), section 12.3.1), although local design drawings shall be prepared and located in a suitable protective container within the lineside location case or SPOSS enclosure. It is recommended that TPWS loop positions are added to any TSR layout sketches that are prepared to accompany the WON.

The TSR TPWS loop position information shall be published in Section A of the WON. Where appropriate, the following items may be added to the standard TSR entry:

- “The TPWS equipment for the TSR situated on the ___ line at ___ miles ___ chains will cause an automatic brake application in the event of excessive speed on the approach to the TSR”.
- “No TPWS at TSR on ___ line at ___ miles ___ chains”.
- “Warning Board positioned at signal no. ___ on ___ line, TPWS will cause an automatic brake application in the event of excessive speed on the approach to the TSR, irrespective of the aspect exhibited by the signal”.
- “Warning Board positioned at signal no. ___ on ___ line applies to trains proceeding towards the ___ line. TPWS will cause an automatic brake application in the event of excessive speed on the approach to the TSR, irrespective of the aspect exhibited by the signal”.
- “The second warning board and associated AWS warning indication and TPWS equipment on ___ line at ___ miles ___ chains apply only to trains proceeding to ___ line”.

Ref	RT/E/S/10133
Issue	3
Date	April 2004

7 INDICATION REQUIREMENTS

7.1 General Indication Requirements

There are two different general approaches to the reporting of TPWS failures. These are known as “retro-fitment TPWS failure reporting” and “re-signalling TPWS failure reporting”. Retro-fitment failure reporting uses the existing signal red lamp out indication, whereas re-signalling TPWS failure reporting uses a new, dedicated TPWS indication on the Signaller’s display system.

It is preferable to have all indications within a signal box the same. There are, however, circumstances where this is not practicable. The re-signalling and retro-fitment TPWS failure reporting methods shall not be inter-mixed on the same section of a signalling panel or Signaller’s workstation. It is, however acceptable to have different reporting methods on adjacent workstations within the same signalling centre or adjacent sections of the same signalling panel. Each situation shall be considered on it’s own merits and a suitable risk assessment performed, considering the risk of Signaller’s working several different positions and becoming confused as to the nature of the indications, and the risk of protracted Signalling works necessary to achieve a common form of indication, compared to the reduced risk of selecting the most straightforward method.

A decision on which TPWS failure reporting method is used should be made at the scheme plan production stage of a re-signalling scheme. However in general, the re-signalling failure reporting method shall be used when an entire signalling panel or Signaller’s workstation is replaced with a new display system. Should a section of an existing panel be replaced then a decision needs to be made on whether or not to upgrade the entire panel to the same reporting method.

A dedicated visual indication of TPWS failure on the Signaller's display shall normally be provided for all installations of TPWS at signals (including TPWS fitted automatic signals), buffer stops and speed restrictions provided as part of a re-signalling scheme. The exception to this is where the provision of dedicated TPWS indications on only part of a Signaller’s panel or VDU would lead to a conflict in indications as identified above. Where a dedicated visual indication is provided, there is no requirement to provide a list of TPWS fitments in the signal box instructions , however the Signaller shall be informed which method of failure indication applies by provision of a special signal box instruction. Where a dedicated visual indication is not provided, a list of TPWS fitments shall be provided to the Signaller in the form of a special signal box instruction.

Ref	RT/E/S/10133
Issue	3
Date	April 2004

7.2 Retro-Fitment Indication Requirements

There is no requirement for identification of TPWS fitment at signals, speed restrictions or buffer stops, on the Signaller's display. The Signaller shall be informed which signals are fitted with TPWS, and which method of failure indication applies, by provision of a special signal box instruction.

7.2.1 Mechanically Controlled Signalling

Details of the control and indication requirements for all Mechanically operated and controlled signalling (including Absolute Block, Electric Token Block and Tokenless Block working) are given in section 8.

7.2.2 Relay Controlled Signalling

The requirement for the Signaller to be made immediately aware of TPWS failure shall normally be met by the existing 'signal lamp out' indication being given to the Signaller. This will also continue to apply for genuine lamp out failures. Audible alarms are not required.

The reporting of TPWS failures will normally be achieved by means of a contact of the TPWS proving relay (VCR) in the lamp proving circuitry for the signal fitted. However, where a separate circuit proves the signal alight in the controls of the signal in rear, alterations shall be made to ensure that TPWS operation is proved in both circuits.

7.2.3 SSI Controlled Signalling

The requirement for the Signaller to be made immediately aware of TPWS failure shall be met by the existing 'signal lamp out' indication being given to the Signaller. This will also continue to apply for genuine lamp out failures. No additional audible alarms are required.

Ref	RT/E/S/10133
Issue	3
Date	April 2004

7.2.4 Buffer Stops

For retro-fitment of TPWS buffer stops in mechanically operated and controlled signalling areas, indication of TPWS failures shall be achieved by the use of the TPWS Failure Indication Unit (FIU) detailed in section 18.

For retro-fitment of TPWS to buffer stops in relay controlled signalling areas, where it is reasonably practical to do so, indication of TPWS failure shall be achieved by merging the TPWS indications (of a group of buffer stops where applicable) with the nearest appropriate first filament failure alarm circuit, if there is a suitable first filament failure (EKR) circuit within a signalling apparatus case located within 500 metres of the TPWS equipment location. This will require an update to the first filament failure display panel to indicate which TPWS installations are included in the alarm.

Where it is not reasonably practicable to achieve this, there shall be no remote fault monitoring for TPWS installations at buffer stops.

For retro-fitment of TPWS to buffer stops in SSI interlocking areas, each platform starter signal has an EKR circuit. The buffer stops TPWS installations shall be incorporated into the EKR circuit for the associated platform starter signal.

There is no requirement for an update to the diagnostic processor to provide identification of TPWS fitment on the technician's terminal display unless a data change is being undertaken for other reasons.

Ref	RT/E/S/10133
Issue	3
Date	April 2004

7.2.5 Speed Restrictions

For retro-fitment of TPWS to speed restrictions, remote fault reporting is not required. The technician shall be informed which speed restrictions are fitted with TPWS by reference to a special signal box instruction for permanent speed restrictions and by publication in the Weekly Operating Notice (WON) for temporary speed restrictions (see section 6.14). Plain Line And Auto Signals

Most plain line signals do not have a 'signal lamp out' indication on the Signaller's panel, and the provision of such a feature, even by the application of an FIU, will not be justified. Therefore, for plain line signals which do not have a 'signal lamp out' indication on the Signaller's panel, the requirements for fault reporting to the Signaller shall be met by reliance on Drivers reporting to the Signaller at the signal next in rear, which shall be held at danger by the TPWS failure at the signal ahead.

Where semi-automatic signals are only indicated to the Signaller when replaced to danger, when the signal is operating in automatic mode, it is acceptable for the requirements for reporting of TPWS failures to the Signaller shall be met by reliance on Drivers reporting to the Signaller at the signal next in rear, as for auto signals.

To assist this form of fault reporting, local instructions shall be published to Signallers to identify that TPWS fault reporting for TPWS-fitted plain line signals or semi-automatic signals is indicated by the signal next in rear being held at danger.

7.2.6 Platform Starting Signals At Terminal Stations

Most platform starting signals at terminal stations do not have a signal in rear to replace to danger in the event of the signal red aspect being unlit. There is therefore no requirement for TPWS failures at such signals, to replace the signal in rear to danger.

For retro-fitment, TPWS failures will continue to be reported using the signal lamp out indication as described in section 7.2.

For re-signalling fitment, TPWS failures will be reported using a dedicated TPWS indication as described in section 7.2.5.

7.3 Re-Signalling Fitment Indication Requirements

7.3.1 Signaller's Panels

The requirement for the Signaller to be made immediately aware of TPWS failure shall be met by a TPWS symbol incorporating a dedicated failure indication, being provided on the panel for each signal to be fitted, adjacent to the symbol for the signal to be fitted.

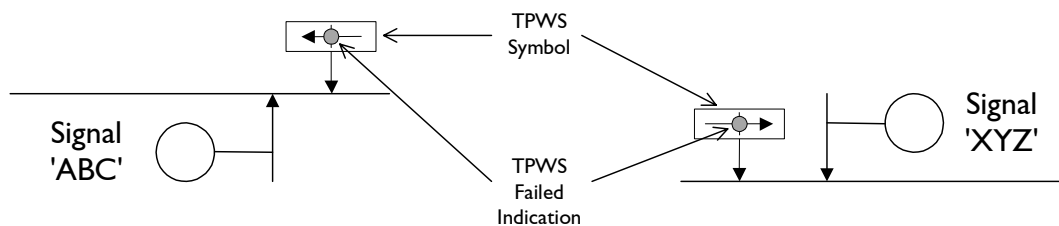


Figure 2

For re-signalling fitment of buffer stops fitted with TPWS, indication of TPWS failure should be achieved by the provision of a discrete panel indication near the buffer stops symbol:

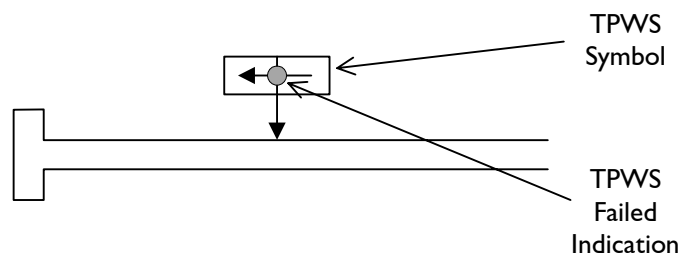


Figure 3

For re-signalling fitment of speed restrictions fitted with TPWS on signalling panels, indication of TPWS failure should be achieved by a new indication circuit for a geographical grouping of speed restrictions. The method of reporting to the Signaller shall be by an indication on the signaller's panel for the geographical group of speed restrictions.

The failure indications shall operate as follows:

- indication of correct TPWS operation shall be by the indication not being illuminated;
- indication of TPWS failure shall be by the indication flashing blue (Signal Blue, Class A, to BS 1376:1974). The flashing shall continue only while the signal with the failed TPWS equipment is at danger.

Ref	RT/E/S/10133
Issue	3
Date	April 2004

A TPWS Failure Indication Test Switch shall be provided on each panel to ascertain at periodic intervals that the TPWS Failure Indications are operating correctly. Upon operation of the TPWS Failure Indication Test Switch to the “Test” position, all TPWS Failure Indications that are not currently showing TPWS as having failed, shall be illuminated with a steady blue indication until the switch is returned to the “Normal” position. TPWS Failure Indications currently flashing to indicate TPWS failure, shall continue to flash.

There is no requirement for the reporting of TSRs on Signaller’s panels.

7.3.2 VDU Displays

TPWS indications on VDU operated signalling display systems shall comply with Network Rail Company Standard [RT/E/S/17504](#) as far as is reasonably practicable.

There is no requirement for the reporting of TSRs on VDU displays.

7.3.2.1 Signal Fitments On VDU Displays

Signal fitment shall be generally as shown in Network Rail Company Standard [RT/E/S/17504](#) item 18.2.1 (Appendix F-59). The signal number shall be shown in blue on the Detail view only. The signal number shall be permanently shown.

Display of the correct signal aspect shall indicate that TPWS is operating correctly, whether energised or not. A failure of TPWS shall not prevent display of the correct aspect.

TPWS failure shall be generally as shown in Network Rail Company Standard [RT/E/S/17504](#) item 18.3.1 (Appendix F-62). A flashing rectangular symbol shall be shown in blue adjacent to the signal number on Detail views. On Overviews, a flashing rectangular symbol shall be shown in blue indicating on which Detail view the particular signal is displayed.

In addition, a text message including the signal number shall be shown in any signalling alarm window. This shall be accompanied by an appropriate audible alarm.

7.3.2.2 Speed Restriction Fitments On VDU Displays

Speed restriction fitment shall be generally as shown in Network Rail Company Standard [RT/E/S/17504](#) item 18.2.2 (Appendix F-60). The

Ref	RT/E/S/10133
Issue	3
Date	April 2004

letter 'P' shall be shown in blue on the Detail view only, adjacent to the track (or group of tracks) to which the speed restriction(s) refer.

Display of a steady letter 'P' in blue shall indicate that TPWS is fitted.

TPWS failure shall be generally as shown in Network Rail Company Standard [RT/E/S/17504](#) item 18.3.2 (Appendix F-63). A flashing letter 'P' shall be shown in blue adjacent to the track (or group of tracks) associated with the speed restriction(s) on Detail views. On Overviews, a flashing letter 'P' shall be shown in blue indicating on which Detail view the particular speed restriction is displayed.

In addition, a text message indicating the speed restriction with failed TPWS shall be shown in any signalling alarm window. This shall be accompanied by an appropriate audible alarm.

7.3.2.3 Buffer Stop Fitments On VDU Displays

Buffer stop fitment shall be generally as shown in Network Rail Company Standard [RT/E/S/17504](#) item 18.2.3 (Appendix F-61). The final symbol at the end of the track shall be shown in blue on the Detail view only.

Display of a steady buffer stop symbol, final track symbol or exit symbol in blue shall indicate that TPWS is fitted.

TPWS failure shall be generally as shown in Network Rail Company Standard [RT/E/S/17504](#) item 18.3.3 (Appendix F-64). A flashing buffer stop symbol, final track symbol or exit symbol shall be shown in blue on Detail views. On Overviews, a flashing letter 'B' shall be shown in blue indicating on which Detail view the particular buffer stop is displayed.

In addition, a text message indicating the buffer stop shall be shown in any signalling alarm window. This shall be accompanied by an appropriate audible alarm.

Ref	RT/E/S/10133
Issue	3
Date	April 2004

8 REQUIREMENTS FOR MECHANICALLY OPERATED SIGNALLING

8.1 General Control Requirements

The TPWS VR and V(SUB)R relays are operated from RE lever bands on the appropriate signal's controlling levers. Where spare lever bands are not available, consideration shall be given to freeing an RE lever band used for an indication or train describer input, using this lever band to operate the VR relay, and then controlling the train describer or indication from this VR relay.

8.2 General Indication Requirements

For fitment to mechanically operated and controlled signalling, the requirement for the Signaller to be made immediately aware of TPWS failure shall normally be met by a TPWS Failure Indication Unit (FIU) being installed with separate indications for each signal, speed restriction or buffer stops to be fitted (see section 18).

For colour light signals operated from a mechanical signal box that have a lamp proving circuit indicated within the signal box, and also have the ability to replace the signal in rear to danger, failure of TPWS shall be reported using the lamp proving circuit as per relay based signalling, instead of the FIU.

This Specification does not prescriptively cover all possible scenarios of mechanical fitment due to the diversity of arrangements that exist. A pragmatic approach is necessary within the constraints of the TPWS fault reporting requirements stated in this Specification. If a variety of indication methods is used in one signal box, a signal box special instruction is required, stating how TPWS fault reporting is implemented.

8.3 Absolute Block / Tokenless Block

For colour light signals operated from a mechanical signal box that have a lamp proving circuit indicated within the signal box, but in the event of a lamp failure hold an absolute block or tokenless block circuit at "train on line" or "failed", it is not acceptable for failure of TPWS to force an Absolute Block circuit into a failed state where a less safe method of train operation would then be required. In such areas, all signals fitted with TPWS, which are lamp and / or normal proved in the Block Acceptance, shall use an FIU. This will mean provision of a separate line circuit from the signal box to cater for this indication.

Ref	RT/E/S/10133
Issue	3
Date	April 2004

There are a number of cases (particularly in power operated Signal boxes which have some Absolute Block working), where the signal involved may be a considerable distance from the signal box, and the provision of a separate FIU circuit will present difficulties in cable availability and core allocation, and hence be considerably more expensive to implement. In such circumstances, the TPWS reporting should be combined with the lamp indication circuit and a Block Override system provided, to enable the Signaller to operate the block and give permission for a train to approach under the provisions of Rule Book, Signaller's General Instructions - GE/RT8000, Module TSI, Section 14.2 (Defective Signals), unless alternative approved arrangements for releasing or overriding the Block section controls are available to be used once the failure has been confirmed as TPWS.

At sites where there already exists a Block Override control at the accepting signal box, which can allow a train to enter the block section when the Home signal has a lamp failure, it is acceptable for TPWS to be reported using the lamp proving circuit for this signal.

8.4 Token Block Working

The particular situation described in section 8.3 also arises when the TPWS fitted signal is a colour light signal and has red lamp proving interlocked with a token machine, so as to prevent the issuing of a token from the section in rear when the red lamp has failed.

Current Regulations require the introduction of pilotman working under these circumstances as it will not be possible to issue a section token. As above, the introduction of temporary methods of working introduce risks to train operation as reliance is placed on verbal communication and unfamiliar working practices.

In such areas, all signals fitted with TPWS, which are lamp and / or normal proved in the Block Acceptance, shall use an FIU.

8.5 Semaphore Signals At The End Of Track Circuit Block Sections.

The following drawing applies:

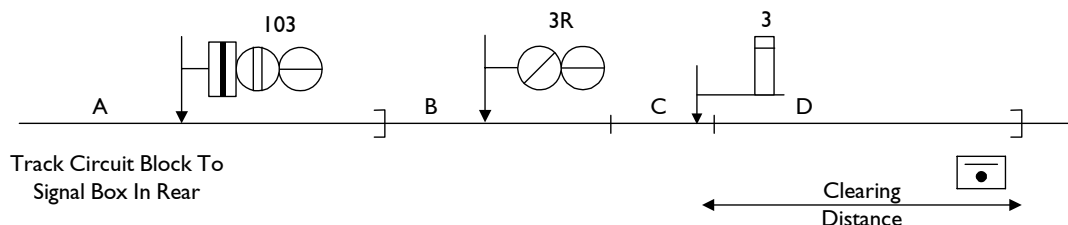


Figure 4

Ref	RT/E/S/10133
Issue	3
Date	April 2004

Track circuit block sections, which terminate with semaphore signals, require further consideration. These will normally be long sections between Signal boxes that were formally Absolute Block sections but have been converted to track circuit block auto sections with colour light signalling to increase train capacity. In such cases, the signaller may be unable to prevent a train approaching as the signal on the approach to the home signal is either an auto signal or a controlled signal of another signal box.

As the signal fitted with TPWS will be a semaphore signal, there will be no ECR circuit to the signal in rear, hence the TPWS fault indication must be included in the circuit which controls the aspect of signal on the approach to the home signal. Also the Signal box controlling the fitted signal will require the use of an FIU as there will be no ECR / lamp out indication with which to report TPWS failure.

8.6 Requirements For No Signaller Token Remote (NSTR) Installations

8.6.1 TPWS Overlay For NSTR

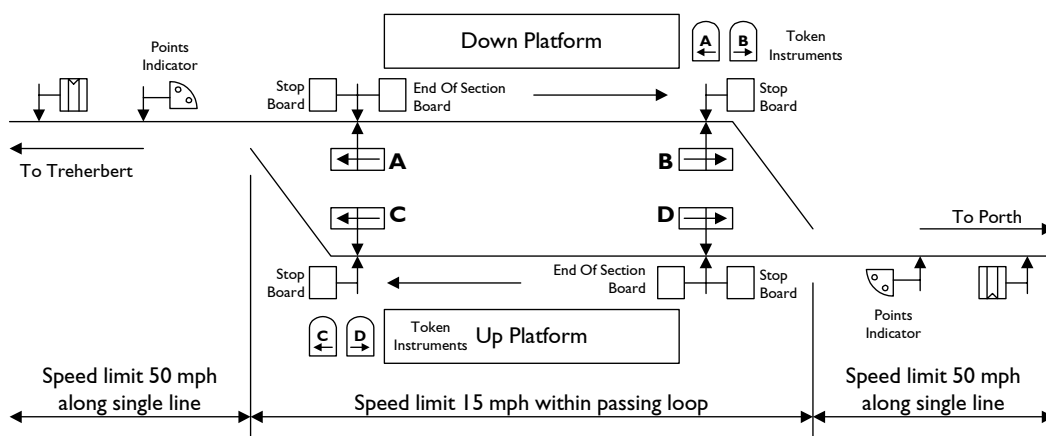


Figure 5

A typical layout of TPWS fitment at an NSTR Token Exchange Point (TEP) is shown in the example above.

To comply with Network Rail Company Standards [RT/E/S/10137](#) and [RT/E/S/10138](#), all permitted TEP exit points leading into the single line section shall be fitted with TPWS TSS equipment. This shall include both loop lines / platform exits for the same movement direction even if there is no Stop Board for the direction not normally used.

The TSS loops shall be positioned in line with the Stop Board so as to permit maximum length trains operating over the route to be accommodated within the TEP. It is not intended to provide mitigation against side collisions of two trains departing the loop in the same direction simultaneously.

Ref	RT/E/S/10133
Issue	3
Date	April 2004

As all train movements in the TEP are normally limited to 15 mph, TPWS OSSs are not required within the TEP in line with TPWS requirements at conventionally signalled locations.

8.6.2 Operation Of TPWS Equipment

When a token is removed from a token instrument, an internal contact of the token instrument is momentarily broken and then re-made. The re-making of this contact starts a timer, made up of discrete electrical components, which suppresses the TPWS Train Stop for a nominal period of 5 minutes to allow the train to enter the single line unimpeded. It will be necessary to correctly set up the previously unused token contacts to ensure reliable operation of TPWS suppression following token withdrawal. This action needs particular care to ensure that correct operation is obtained.

The timer setting shall be assessed for each TEP to determine that 5 minutes is an acceptable period to permit station duties to be performed and the train to clear the TSS loops before the time period runs out. The timer period should consider the following:

- the likely need to remove a token from the token instrument situated on the opposite platform to that normally used in case of token instrument failure,
- where traincrew are required to operate level crossings, the TPWS timeout period should not encourage the Driver to close the crossing before obtaining the token.

Should a longer period than the nominal 5 minutes be required, the assessment shall ensure that the TSS will be re-energised after the timer timeout before a following train can arrive at the TEP. The suppression circuits for TPWS are common for both Train Stops at each end of the TEP, i.e. in figure 5, both A and C TPWS would be suppressed simultaneously by the removal of a token from either token instrument A or C, B and D likewise.

Ref	RT/E/S/10133
Issue	3
Date	April 2004

8.6.3 Failure Reporting of TPWS Equipment

As there are no remote failure reporting circuits at the TEPs, new status / fault indications are required which will be observed by the Driver. A single blue LED shall be provided with the following indications:

- Steady Blue – TPWS healthy and active
- Flashing Blue – TPWS healthy and suppressed
- No indications – TPWS system unhealthy or faulty

Normally the indicator shall be steady blue when the Driver opens the TEP hut. On removal of a token from a token instrument the TPWS indication shall commence to flash blue for the duration of the TPWS suppression.

When siting the blue indicator, it is important to ensure that it cannot be mistaken as the indicator for an adjacent token instrument, where two instruments are located in the same TEP hut. This is to prevent the indicator for the opposite direction (which may well be flashing for a legitimate move in that direction) from misleading the Driver into believing that he / she has already withdrawn the token for the forward section. Appropriate separation and labelling shall be provided for the indications.

8.6.4 Power Supply

It may be necessary to supply TPWS from a TPWS Uninterruptible Power Supply (UPS) if the existing power supply is unsuitable at the site. Indication that the UPS is operating on standby supply shall be given either in an existing power on indication to the signal box (where provided) or within the existing local 'call technician' indication, observed by the Driver. The TPWS UPS is detailed in section 17 of this document.

8.6.5 Local Instructions

It shall be ensured that the signal box instructions and Sectional Appendix are amended to cover the method of operation, the meaning of the status indicators and the requirements for Drivers to report faults to the Signaller. In particular the Section P form / NSTR Special Authority card shall be re-issued to cater specifically for the requirements to operate the trainborne TPWS Train Stop Override when authorised to pass a stop board without a valid token.

Ref	RT/E/S/10133
Issue	3
Date	April 2004

9 REQUIREMENTS FOR SSI INSTALLATIONS

9.1 Selection Of Appropriate Interface

There are three Methods of interface to SSI controlled signalling as described in the Network Rail SSI Applications Manual section [SSI8500](#). These are as follows :

Method 1 - this minimises the requirement for additional relay circuits through its direct interface with a red retained SSI signal module output, and hence uses the fewest additional relays. It does, however, require a data change, and as such is not practical for isolated retro fitments of TPWS. Method 1 is the preferred method for new schemes, where the required data controls and additional hardware can be incorporated from the outset.

There are two versions of Method 1, called Method 1a and Method 1b. Method 1a uses the output to the red aspect of the signal for control of the TPWS Main Input, and hence requires less TFM outputs. Method 1b uses a dedicated output from a Signal TFM for control of the TPWS Main Input and is suitable for use with complex approaches (see section 10). Both versions require a dedicated TPWS Proving input to the TFM.

Method 2 - this is identical to the interface with relay-based schemes in all respects other than the interface via BR930-style current sensing relays. The control interface to SSI under Method 2 is implemented via BR930-style current sensing relays using an arrangement already employed in a typical circuit for driving SPAD indicators and similar equipment. Method 2 is applicable to retro-fitment where approach release controls are required and the use of Method 1 is not practical due to hardware constraints on SSI interlockings. In practice Method 2 has not been used as the number of relays required negates the cost benefits of not doing a data change.

Method 3 - this involves changes to trackside equipment wiring and relay circuits only, and removes the need for SSI data changes. Its application is limited to signals with no requirements for approach released controls or complex approaches, hence the need for Method 1 and 2, which are data dependant.

Ref	RT/E/S/10133
Issue	3
Date	April 2004

The general applicability of each of these three Methods to specific applications is as shown in Table 6:

	Method 1	Method 2	Method 3
Suitable for retro-fitment	Yes	Yes	Preferred method
Requires dedicated TFM output	Yes	No	No
Requires dedicated TFM input	Yes	Yes	No
Interlocking MPM data change required	Yes	Yes	No
Diagnostic MPM data change required	Yes	Yes	No
PPM Data change required	Yes	No	No
Suitable for Flashing Aspects	Yes	No	Yes
Suitable for complex approaches	Yes	No	No
Suitable for approach release control	Yes	Yes	No
Suitable for re-signalling schemes	Yes	No	No

Table 6 - Applicability Of SSI Interface Methods For Retro-Fitment

9.2 Requirements For All SSI Interfaces

9.2.1 Self-Reversion With SSI

Where it is necessary to introduce controls for the avoidance of self-reversion (see section 6.9) with SSI, the preferred method is to change the signal controls to last wheel or second track replacement. The use of timers within SSI data is not recommended for self-reversion controls.

9.2.2 Use Of CP0 Busbars

Irrespective of the Method chosen, TPWS fitment to SSI controlled signals necessitates alterations to the NX jumpering arrangements connected to CP0 of the TFM. Depending on the complexity of the existing CP0 jumpering arrangements, the addition of TPWS to a signal may introduce NX backfeeds, or the potential for NX backfeeds in the event of other failures. This is particularly true for signals with position light subsidiary signal heads. These backfeeds may be highly complex and difficult to identify.

It is recommended that, whenever TPWS is retro-fitted to an SSI controlled signal, and for any re-signalling installation of TPWS at SSI controlled signals, the CP0 connection to the TFM is implemented using a CP0 busbar, so that all NX connections have are connected in parallel to the TFM, thus reducing the possibility of NX backfeeds.

Ref	RT/E/S/10133
Issue	3
Date	April 2004

9.3 Method 1 Interface Requirements

9.3.1 Loading Resistors For Dummy Outputs

Where TPWS uses interface Method 1a, TPWS is driven from the red lamp output of the corresponding signal, but has a dedicated TPWS proving input. In some cases, this necessitates the creation of a new TFM solely for TPWS fault reporting, and the creation of a dummy output on this new TFM, for purposes of data correlation.

Where there are no physical outputs on a TFM, only dummy TPWS outputs, it is necessary for these outputs to have a load applied in the form of a 10k Ohm resistor connected between the output and CP0. This is to prevent failures of the output interface of the TFM with the dummy outputs caused by floating outputs. This is shown on TPWS typical circuit T34031.

9.4 Method 3 Interface Requirements

Method 3 is a non-data change method, used to achieve fitment of TPWS to existing SSI installations without the need for the additional resources / timescales involved in interlocking data changes. Method 3 uses relay circuitry to present a combined TPWS and red lamp proving indication to the SSI via a current sensing input on the TFM. This uses a 470 Ohm VCO resistor to simulate the loading of the signal lamp in the current proving circuit.

This 470 Ohm VCO resistor shall be mounted in the same mounting used for an apparatus case heater, and mounted in a similar position in relation to other equipment, such that the heat dissipated within these resistors cannot adversely affect any other equipment or wiring. The VCO resistor housing shall be coloured differently to that of a similar looking location heater housing, as an added precaution to ensure that maintainers, who are not familiar with the location wiring, do not mistakenly disconnect the VCO resistor or touch it. The VCO resistor shall be labelled appropriately, to include the information "TPWS proving resistor - do not disconnect during summer months". If the VCO is housed in a metal case, the case of the VCO resistor shall be bonded to the apparatus case main earth for safety reasons.

Particular considerations for heat dissipation may be required where are multiple TPWS installations within the same lineside apparatus case.

Where the signal is normally at red (controlled signals without the provision for auto working), the use of the 470 Ohm VCO resistor may remove the requirement for the provision of a location heater in a new apparatus case - this will need assessment on a site by site basis. The use of an apparatus case heater in place of the required 470 Ohm VCO is not acceptable, as it may exceed the maximum specified load for the CPI input to the TFM.

Ref	RT/E/S/10133
Issue	3
Date	April 2004

For SSI Method 3, it may be necessary to make adjustments to the signal head transformer to achieve the correct operating voltage for the signal lamp. Also for SSI Method 3, a label shall be added within the modified signal heads to draw to the maintainer's attention the fact that the jumper wiring has been modified to implement TPWS proving.

9.4.1 Method 3 Interface Timing Errors

Under certain circumstances, TPWS Method 3 circuits exhibit a timing feature, which can lead to the signalling performing in an unusual manner. A brief summary of the timing features is as follows:

On an aspect change, the TFM program allows a settling time for the current sensing inputs before declaring a loss of input. Once a loss of input has been detected there will be a minimum of two SSI major cycles before the interlocking can accept that the input has been restored.

Upon a TPWS fitted signal being replaced to danger, the slow to pick nature of the RECR relay used in Method 3 will result in a short term open circuit of the lamp proving circuit into the TFM (approx 2 seconds), during which time the Signaller's display will show a dark signal indication, and any controls for signals in rear which require 'lamp ahead lit' proving will be lost. This would generally mean the signal in rear being replaced to danger for the period of two interlocking major cycles, and then returning to a proceed aspect.

The software used in TFM's up to version SSI4311-C3 (used in Mk 2 and earlier TFM's) has a settling time of approximately 90 ms. The latest Mk 3 (Alstom) and Mk3A (WSL) TFM's use software versions SSI4311-C4 (Alstom) or SSI4311-D1 (WRSL) respectively, both of which have settling times of approximately 200 ms. This is adequate under most situations to bridge the time taken for the RECR to pick, and hence to eliminate the timing feature. High risk / high consequence sites exhibiting the effect have generally already been changed to Mk3 TFM's.

For the National fitment of TPWS, the use of Mk 3/Mk 3A TFM's to overcome these effects was not deemed practical due to the cost of TFM's, and was only used at sites where it was not acceptable to wait for a lower cost solution. A development of the Mk2 TFM has now received Product Acceptance (Mk2 Mod 16/17 TFM's). This uses Mk3 Software (more correctly called SSI4311-D1 for WSL and SSI4311-C4 for Alstom) with the Mk2 TFM hardware. This effectively overcomes the timing features.

Ref	RT/E/S/10133
Issue	3
Date	April 2004

Where the TPWS fitted signal is preceded by a second TPWS fitted signal, an associated 'ripple effect' has also been identified. In this case, when one signal is replaced to danger by the Signaller, all of the TPWS fitted signals on the approach to the signal replaced, will be replaced to danger in sequence. Again this effect is not considered to be dangerous but can lead to Category B SPADs, however recommendations for eliminating the possible adverse effects of this timing error and the ripple effect are outlined below:

- Mk2 TFMs, which have a settling time of approximately 90ms are prone to the timing error in most circumstances. Mk3 TFMs, which have a settling time of around 200ms are far less prone to the timing error.
- Mk2 Mod State 16 (WSL) and Mod State 17 (Alstom) TFMs are versions of Mk2 TFMs with upgraded software to make the settling time compatible with that of a Mk3 TFM. When any Mk2 TFM is sent for servicing, it will be returned as a Mod State 16 or 17 TFM.
- The use of BR948 relays for the RECR function shall not be used due to their slower pick up times. The recommended RECR is a BR941a relay.
- When a signal is running with a low signal head voltage, or running on the auxiliary filament only, the in rush current when the signal is returned to red is much lower and hence the pick up time of the RECR is longer. In these circumstance the timing error can exist with a Mk3 or Mod State 16/17 TFM.

9.4.2 Signals With Flashing Yellow Aspects

Problems have been encountered with signals capable of displaying flashing yellow or flashing double yellow which are fitted with TPWS using Method 3, reverting to red when ordered to clear from red to flashing yellow. This is caused by the RECR being slow to pick up and causing a lamp proving current to be present when the signal with the flashing aspect is showing an 'out' state, and the TFM is not expecting to see any current.

The SSI Method 3 circuits have been amended to have the TPWS proving circuit fed from the red aspect output instead of from a fuse.