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Level 2

Train Protection & Warning System (TPWS) Track Sub-System Installation Requirements

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Compliance

The compliance date for NR/L2/SIG/10173 shall be 26th August 2008 and is mandatory upon Network Rail.

When this standard is implemented, it is permissible for all projects that have formally completed GRIP Stage 4 to continue to comply with the Issue of any relevant Network Rail Standards current when GRIP Stage 4 was reached and not to comply with requirements contained herein, unless the designated Standard Owner has stipulated otherwise in the accompanying Briefing Note.

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1 PURPOSE

This Specification has been prepared to define the detailed requirements for installation of the track sub-system equipment associated with the Train Protection and Warning System (TPWS).

2 SCOPE

This Specification applies to TPWS equipment supplied by Thales Communications UK, the TPWS Failure Indication Unit supplied by NRS and the TPWS UPS supplied by UPS Ltd.

The Specification details the requirements for the installation of TPWS trackside equipment and the associated interfaces for fitment of TPWS to signals, speed restrictions and buffer stops.

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3 REFERENCE DOCUMENTATION

BR Spec 829	Specification for Plugboards for Miniature Relay Units for Railway Signalling (Now a Common Domain document).
BR Spec 930	Specification for Miniature Tractive Armature DC Neutral Line Relay (Plug In Type) for Railway Signalling Purposes.
BRS-SC5	BR mechanical standard drawing: Block (concrete) 6 way - 24 high for point rod rollers.
BS714	Specification. Cartridge fuse-links for use in railway-signalling circuits 1992.
BS7671	IEE Wiring Regulations
GE/RT8030	Requirements for a Train Protection & Warning System (TPWS).
GI/RT7007	Low Voltage Electrical Installations
PA05/00446	Product Acceptance Certificate – TPWS Trackside Equipment
PA05/00941	Product Acceptance Certificate - Internal UPS System for TPWS Project
PA05-01440	Product Acceptance Certificate – D.C. To D.C. Converter For The FIU
PA05/01175	Product Acceptance Certificate - External UPS System for TPWS Project
NR/L2/ELP/27021	Electric Track Equipment Layout Design for DC Electrified Lines.
NR/GN/SIG/11600	Signalling and Operational Telecommunications Design: Technical Guidance
NR/GN/SIG/11720	Signalling Installation Handbook.
NR/L2/SIG/10134	TPWS Track Sub-system Equipment.
NR/L2/SIG/10133	TPWS Signalling Interface Design Requirements
NR/L2/SIG/10138	TPWS Transmitter Loops: Requirements And Positioning.
NR/GN/SIG/11210	Signalling Installations
NR/L2/SIG/11630	BR930 Series Pin Code Allocations And Contact Arrangements.
NR/GN/SIG/19046	SINTAN 046 Treadles
NR/L2/SIG/00005	Railway Signalling Cables (formerly GS/ES0872 - Equipment Specification: Railway Signalling Cable).
NR/L2/SIG/00011	Product Specification - Train Protection & Warning System (TPWS) - Failure Indication Unit
SSI 8503	Earthing and Bonding of Solid State Interlocking Equipment

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4 DEFINITIONS

Term	Definition
AWS	Automatic Warning System
Baseplates	Purpose built unit housing one Signalling Interface Module and one other TPWS Module. For fitting in existing lineside apparatus cases or relay room.
BRL	Below Rail Level
FTE	Fast Transient Earth
GRP	Glass Re-enforced Plastic
LED	Light Emitting Diode
MET	Main Earth Terminal
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.
REB	Relocatable Equipment Building
REC	Regional Electricity Company
SBP	Security Bypass Panel
SPAD	Signal Passed at Danger
SPOSS	Self Powered Overspeed Sensor System
SPOSM	Self Powered Overspeed Sensor Module
SSI	Solid State Interlocking
TFM	SSI Trackside Functional Module
Thales	Thales Communications UK Limited (formerly Redifon MEL)
TPWS	Train Protection & Warning System
Trackside Enclosures	Thales Communications Ltd lineside apparatus cases specifically for the housing of trackside TPWS equipment. They do not contain signalling interface relays.
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.
UPS	Uninterruptible Power Supply

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5 TPWS GENERAL DESCRIPTION

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 a set of 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 a brake application on the train.

The TPWS track sub-system equipment consists of two main elements:

- a) the trackside equipment - consists of the TPWS control equipment, power supply and signalling interfaces;
- b) the track mounted equipment - consists of transmitter loops secured to the track.

The TPWS track mounted equipment is connected to the TPWS trackside equipment by transmitter loop feeder cables and tail cables, and to the signalling system by a signalling interface cable or internal wiring in a relay room or apparatus case.

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6 TPWS TRACK MOUNTED EQUIPMENT

6.1 General Installation Requirements

Except where stated specifically within this document, the installation of TPWS equipment shall be carried out in accordance with the requirements of the Signalling Installation Handbook NR/L2/SIG/11720.

6.2 Positioning Of Transmitter Loops

Details of how to determine the positioning requirements for TPWS transmitter loops are given in NR/L2/SIG /10138 - 'TPWS - Transmitter Loop Requirements and Positioning'. Details of restrictions on the position with regard to the proximity of other on-track equipment are detailed further on the TPWS Product Acceptance Certificate - PA05/00446.

In general, TPWS transmitter loops shall be kept at least 1 metre from any significant on-track metal object.

Where it is required to position the loops within a set of points, a distance of 300mm from the switch rails to the nearest part of the loop shall be maintained.

It is the intention that TPWS provides the best possible mitigation in the event of a potential or actual SPAD. This is achieved by placing the Train Stop System (TSS) loops at the foot of the signal fitted, and the Overspeed Sensor System (OSS) loops at an appropriate distance before the signal / speed restriction / buffer stops to which they relate. 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, speed restriction or buffer stops and the set speed of the OSS are accurately set to the tolerances defined in NR/L2/SIG/10138, which also defines other constraints on the positioning of transmitter loops. If the transmitter loops cannot, for whatever reason, be positioned in the exact location shown on the signalling scheme plan or track plan, then advice should be sought from the signalling designer.

Individual TPWS loops are non-directional with regards the direction of traffic, and will work equally well either way around. The drawings in Appendix B show the two TSS loops facing each other, which is the preferable orientation with regards the direction of the cabling.

6.3 Transmitter Loops In 4th Rail Areas

Should it be necessary to install TPWS in areas where there is a 4th rail in the four foot, either as the principal traction return system or for additional traction re-enforcement, then arrangements should be made for the 4th rail to be gapped at the transmitter loop locations. The ramp at the end of the 4th rail shall be at least 2 metres away from the transmitter loop itself.

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Gapping of the third rail is not a requirement for the installation of TPWS transmitter loops even when the fourth rail is required to be gapped.

6.4 Transmitter Loops Where Derailment Guard Rails Exist

Whilst gapping of guard rails is permitted, it is not desirable both due to the workload involved and the possible impact on continuous derailment protection. This is particularly so for guard rails mounted on curved track. The preferred solution is an alternative positioning of the TPWS loops, which should be considered prior to resorting to the gapping of the guard rails.

6.4.1 Alternative TPWS Equipment Positioning

TSS transmitter loop positioning is critical and the requirements of Network Rail Company Standard NR/L2/SIG/10138 section 3.2 - 'TSS Positioning Rules' should be adhered to. However, these rules do provide for the TSS to be positioned greater than 2 metres in rear or greater than 6 metres beyond the signal subject to risk assessment.

The position of the OSS is less critical than the TSS and offers a greater opportunity for repositioning either off of the guard rails completely or off of the curved section. This will depend largely on the actual Safe Overrun Distance, the attainable speed on approach, and the gradient. Details of the actual installation should be discussed with the Infrastructure Controller, to decide whether there is a suitable alternative position for the OSS transmitter loops.

6.4.2 Gapping Guard Rails

If it is not possible to re-position the transmitter loops, and gapping of the guard rails is the only solution, then the following requirements apply:

6.4.2.1 Straight Track

Where the guard rails are mounted on straight track then the guard rails may be gapped. For the purposes of gapping for TPWS loops, straight track is considered to be locations where the track is between 'straight' and a curve radius greater than 1000 metres.

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The geometry of any gap introduced on straight track should follow the principles shown in Network Rail drawing RE/PW/077. This includes the angle and length of the tapered run on to the cut guard rails and the use of a wooden block to guide any trailing vehicle couplings. It will be necessary to taper the ends of the guard rails, as shown in the photograph below.



6.4.2.2 Curved Track

Where the guard rails are mounted on track with a curve radius of less than 1000 metres, then permission to gap the guard rails shall be sought from the Track Maintenance Engineer. The exact solution will be site specific and shall be agreed with the parties involved.

One possible solution is to provide an outside guard rail (sometimes called a 'wing rail') on the outside of the curve as detailed in Network Rail drawing RE/PW/077. This solution involves replacing the existing sleepers over a reasonable distance with an extended length of 300mm projecting out to the outside of the curve to support the outside guard rail. The ends of the outside guard rail also need to be flared to guide any derailed wheel sets.

6.4.2.3 Gap Length And Geometry

For a TSS, the minimum gap length will need to be 4100mm to accommodate the pair of TSS loops and allow a one metre clearance at each end. This dimension should be measured to the ends of the cut rail and not to the end of the wooden block. In practice it will be necessary to consider actual loop positions bearing in mind sleeper spacing and the limits of loop positioning on particular sleepers, and the need to end the gap on a sleeper to attach the wooden block on. However, the gap length shall be kept to a minimum within these constraints. For an OSS, each loop position should be gapped to a minimum of 3100mm to accommodate one loop and allow at least a one metre clearance at each end. Again, the constraints given above shall be adhered to.

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6.5 Fitment Methods For Transmitter Loops

A variety of methods of attaching TPWS transmitter loops to known sleeper types have been developed. In general, the transmitter loop panels are fastened across adjacent sleepers and are secured to a glass re-enforced plastic (GRP) beam using M8 x 25 mm stainless steel bolts inserted into elastomeric neoprene bushes to absorb on-track vibrations and to absorb sleeper movements. The GRP beams are secured to the track either by use of the rail fastening or by directly securing to the sleeper, the method selected being dependent upon the type of sleeper at the required position of the loop.

TPWS transmitter loops are suitable for installation on steel sleepers track, provided that the running rails are electrically insulated from the steel sleepers.

There are currently seven versions of the GRP beams to enable fixing to approved sleeper types, fixing arrangements for which are shown in Appendix A of this document (TSS installations only are shown). Each transmitter loop will be supplied with a kit of parts for fixing to the specified sleeper type. All of the kits come in different versions for OSS and TSS, with the TSS kit having a central fixing bar that is different to the others, in that it supports both of the two TSS loops.

Where none of the fixing methods listed below can be used, for instance with older concrete sleepers that cannot be drilled, and wheel timbers on bridges not using Pandrol clips, an alternative method of fixing the transmitter loops may be necessary. In this case, consideration should first be given to the replacement of the sleepers at the required loop positions, with a sleeper fitted with a Pandrol or Fastclip rail fixing, thus allowing the use of one of the above fixing methods. Where this is not practicable, the installation contractor will be required to put forward to Network Rail for acceptance, a suitable method of fixing the loops. The top of the loop panel shall be situated between 60 and 100 mm below the height of the rail head. The exceptions to this are for transmitter loops mounted on concrete slab track, the heights for which are given in section 6.6. This measurement is critical to the strength of the magnetic field transmitted to the trainborne equipment.

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Sleeper Type	Fixing Details	Thales Kit No.	Thales Colour code	Reference d In Section / Appendix
Concrete sleepers, slab track & steel sleepers with Pandrol "PR" or "e" clips.	GRP beam with integral stainless steel yokes. Clamped to the inner Pandrol shoulders by e2001 Pandrol clips.	1	Orange	Section 6.5.1 & Appendix A1
Wooden sleepers without suitable Pandrol clips.	GRP beam with integral stainless steel yokes. Attached to the sleeper by screwing directly into the timber.	4	Brown	Section 6.5.2 & Appendix A2
Other concrete sleeper types & slab track without suitable Pandrol clips.	GRP beam with integral stainless steel yokes. Attached to the sleeper by Hilti stud anchors.	5	Brown	Section 6.5.3 & Appendix A2
SHC fastening	GRP beam with integral stainless steel SHC style yokes. Clamped to the inner shoulders by existing SHC clips.	3	Black	Section I) & Appendix A3
Concrete or steel sleepers with Pandrol G44 Fastclip fastenings	GRP beam with integral stainless steel Fastclip style yokes. Clamped to the inner shoulders by existing Fastclips.	6	Green	Section 6.5.5 & Appendix A4
600D steel sleepers with Pandrol G45 Fastclip fastenings	Shorter GRP beam with integral stainless steel Fastclip style yokes. Clamped to the inner shoulders by existing Fastclips.	9	Red	Section 6.5.5 & Appendix A4
Concrete sleepers with Vossloh W14 fastenings	GRP beam with integral stainless steel yokes. Clamped to the inner shoulders by existing Vossloh fixings.	7	Blue	Section 6.5.6 & Appendix A5

Table 1 - Transmitter Loop Fixing Details

The colour codes used in the table will be marked on the end of the GRP loop fixing bars, inside the yoke, for identification purposes.

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Diagrams showing the fixing methods above are shown in Appendix A.

Details of the procedures for fixing the loops are shown in sections 6.5.1 to 6.5.6 below.

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6.5.1 Pandrol Fixing (Appendix A1)

The GRP beams are fitted between the two inside Pandrol shoulders of adjacent sleepers. To the ends of each GRP beam are fitted 2 yokes, which locate around the 'heel seat' of the Pandrol shoulder preventing both lateral and longitudinal movement. Vertical movement is contained by removing the existing Pandrol clip and fixing the yoke with a e2001 Pandrol clip. This will be supplied with the loop fixing kit.

The majority of steel sleepers currently in use, have a Pandrol weld on or push up shoulder for use with the Pandrol "PR" or "e" clip rail fastening (although some newer steel sleepers have a Pandrol Fastclip fastening). The dimensional requirements and insulation system are similar to those required for concrete sleepers with a Pandrol "PR" or "e" clip fastening, and hence this method of attaching transmitter loops can be used with steel sleepers as well.

Tools required for installation will include:

- torque wrench to assemble the loop panel to the GRP beam;
- Pandrol insertion tool for removing and inserting Pandrol clips.

Installation procedure:

- remove the existing inner Pandrol clips from the designated sleepers with the Pandrol insertion tool and dispose of them in an approved manner;
- inspect insulators and check that rail pads are present, if any are damaged or missing they will require replacement;
- check that the tops of the sleepers are clear of ballast and other debris;
- position the yokes of the two beams over the Pandrol shoulders;
- install the new Pandrol e2001 clips supplied with TPWS loop, using the Pandrol Insertion tool to secure the beams to the sleepers (it may be necessary to partially install the Pandrol clip for one rail, and then to partially install the clip for the opposite rail, in order to prevent the beam from being forced away from the chair by the tension of the Pandrol clip);
- connect the tail cables to the loop panels;
- attach the loop(s) to the supplied beam(s), adjusting the loop fixing brackets to allow for sleeper spacing;
- inspect and if necessary adjust the position of the loop panel so that it is sitting correctly;
- tighten the panel securing bolts to hand tightness (for guidance, 8 Nm +/- 2 Nm);
- secure the panel securing bolts by bending up the anti-vibration tab washers.

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6.5.2 Wooden Sleeper Fixing (Appendix A2)

There are many different wooden sleeper rail fastenings mainly on cast base plates. The solution for fitment to wooden sleepers, therefore ignores the rail fastening type and uses a short GRP beam screwed directly onto the sleepers.

To the ends of each GRP beam are fitted 2 yokes with three smaller holes for coach screws, which are supplied with the loop fixing kit. The GRP beams for this installation method have a hole in the centre which shall be used to align the beam with the track centre line.

It may be necessary to add packing beneath the anti-vibration mount and the loop panel, so that the loop is between 60 and 100 mm below the head of the rail.

Tools required for installation will include:

- torque wrench to assemble the loop panel to the GRP beam;
- power driver to insert coach screws into sleeper;
- rule/tape and chalk/marker to determine the centre line of the sleeper;
- a means of measuring the loop height relative to the level of the rail head.

Installation procedure:

- a) check that the tops of the sleepers are clear of ballast and other debris;
- b) mark the track centre line to an accuracy of +/- 10 mm on the sleepers;
- c) connect the tail cables to the loop panels;
- d) attach the loop(s) to the supplied beam(s), adjusting the loop fixing brackets to allow for sleeper spacing;
- e) position beams and loops on the track centre line;
- f) screw the supplied coach screws into the three small holes in the ends of the beam brackets into the wooden sleeper using the power driver;
- g) If necessary, add packing spacers so that the loops are the correct height relative to the top of the rail (see section 6.8);
- h) inspect and if necessary adjust the position of the loop panel so that it is sitting correctly;
- i) tighten the panel securing bolts to hand tightness (for guidance, 8 Nm +/- 2 Nm);
- j) secure the panel securing bolts by bending up the anti-vibration tab washers;
- k) Confirm the height of loop relative to the level of the top of the rail.

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6.5.3 Other Concrete Sleeper Fixing (Appendix A2)

There are a small number of other types of concrete sleeper which will not facilitate any of the beam types described in sections 6.5.1, I), 6.5.5 and 6.5.6. The fixings provided for such sleepers are the same as those provided for timber sleepers (see section 6.5.2), however the sleeper is drilled in a manner similar to that used for AWS fixings on concrete sleepers. There is a large hole in each yoke for a HSA-KR M12 x 80 Hilti stud anchor, used to fix down the transmitter loop beams. The Hilti stud anchors are supplied with the loop fixing kit. The GRP beams for this installation method have a hole in the centre which may be used to aid alignment of the beam with the track centre line.

It may be necessary to add packing beneath the anti-vibration mount and the loop panel, so that the loop is between 60 and 100 mm below the head of the rail.

Tools required for installation will include:

- torque wrench to assemble the loop panel to the GRP beam;
- drill and bit for drilling Hilti stud anchor holes;
- rule/tape and chalk/marker to determine the centre line of the sleeper;
- a means of measuring the loop height relative to the level of the rail head.

Installation procedure:

- a) check that the tops of the sleepers are clear of ballast and other debris;
- b) mark the track centre line to an accuracy of +/- 10 mm on the sleepers;
- c) position the transmitter loop beam along the track centre line and mark the location of the holes to be drilled;
- d) remove the transmitter loop beam and drill holes for Hilti stud anchors, clean the top of the sleeper and fit Hilti studs to the sleepers;
- e) connect the tail cables to the loop panels;
- f) attach the loop(s) to the supplied beam(s), adjusting the loop fixing brackets to allow for sleeper spacing;
- g) secure the beams to the HSA-KR M12 x 80 Hilti stud anchor to a torque of 50 Nm;
- h) inspect and if necessary adjust the position of the brackets so that the panel is sitting correctly;
- i) If necessary, add packing so that the loops are the correct height relative to the top of the rail (see section 6.8);
- j) tighten the panel securing bolts to hand tightness (for guidance, 8 Nm +/- 2 Nm);

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- k) secure the panel securing bolts by bending up the anti-vibration tab washers;
- l) Confirm the height of loop relative to the level of the top of the rail.

6.5.4 SHC Clip Fixing (Appendix A3)

The SHC clip does not have a conventional shoulder but uses a steel hoop set into the concrete. Therefore a different yoke is provided to attach the beam to the sleeper.

Tools required for installation will include:

- torque wrench to assemble the loop panel to the beam;
- crow bar or lever to remove SHC fastenings;
- hammer to re-install SHC fastenings.

Installation procedure:

- a) remove the inner SHC fastenings with the lever or crow bar and dispose of them in an approved manner;
- b) inspect insulators and check rail pads are present, if any are damaged or missing they will require replacement;
- c) check that the tops of the sleepers are clear of ballast and other debris;
- d) position the two beams over the SHC inner hoops;
- e) install the new SHC fastenings supplied as part of the loop fixing kit with the hammer to secure the beams to the sleepers;
- f) connect the tail cables to the loop panels;
- g) attach the loop(s) to the supplied beam(s), adjusting the loop fixing brackets to allow for sleeper spacing;
- h) inspect and if necessary adjust the position of the loop panel so that it is sitting correctly;
- i) tighten the panel securing bolts to hand tightness (for guidance, 8 Nm +/- 2 Nm);
- j) secure the panel securing bolts by bending up the anti-vibration tab washers.

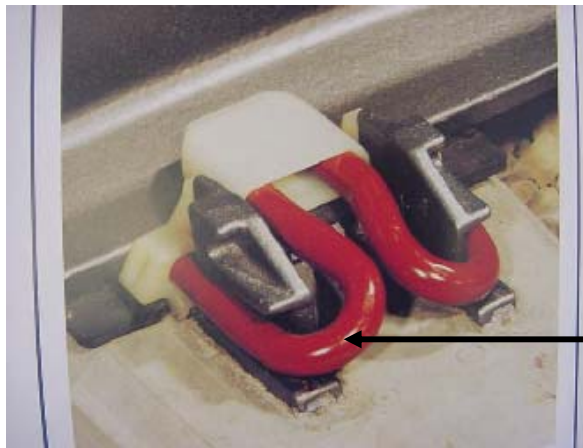
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6.5.5 Fastclip Fixing (Appendix A4)

The Fastclip fixing differs in design from the conventional Pandrol clip and therefore a different yoke is provided, however the same principles used in fixing the loops are applied.

Some steel sleepers have a Pandrol weld on or push up shoulder for use with the Pandrol Fastclip fastening. The dimensional requirements and insulation system are similar to those required for concrete sleepers with a Pandrol Fastclip fastening, and hence this method of attaching the transmitter loops can be used with steel sleepers as well.

There are two variations of the Pandrol Fastclip rail fastening, which are identifiable as follows:



Standard Pandrol Fastclip Chair

Standard Pandrol Fastclip rail fastenings have a space between the location housings for the Pandrol



Corus 600D Pandrol Fastclip Chair

The Corus 600D Pandrol Fastclip rail has no space between the Pandrol Fastclip housing legs.

These different versions of the Fastclip rail fastening require different TPWS transmitter loop fixing kits, as identified in Section 6.5 above.

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Tools required for installation will include:

- torque wrench to assemble the loop panel to the beam;
- Pandrol Fastclip installation / extraction hand tools.

Installation procedure:

- remove the existing inner Fastclips from the designated sleepers with the Pandrol Fastclip extraction tool. Retain those removed for re-insertion;
- inspect insulators and check rail pads are present, if any are damaged or missing they will require replacement;
- check that the tops of the sleepers are clear of ballast and other debris;
- position the two beams over the sides of the Fastclip shoulders;
- re-install the original Fastclips with the Pandrol Fastclip installation tool to secure the beams to the sleepers;
- connect the tail cables to the loop panels;
- attach the loop(s) to the supplied beam(s), adjusting the loop fixing brackets to allow for sleeper spacing;
- inspect and if necessary adjust the position of the loop panel so that it is sitting correctly;
- tighten the panel securing bolts to hand tightness (for guidance, 8 Nm +/- 2 Nm);
- secure the panel securing bolts by bending up the anti-vibration tab washers.

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6.5.6 Vossloh Fixing (Appendix A5)

The Vossloh fixing differs in design from the conventional Pandrol clip and therefore a different yoke is provided, however a similar principle is used in fixing the loops.

The Vossloh fastener system comprises a spring clip that is retained to the sleeper by a square headed screw. It is these screws that are used to attach the TPWS mounting beam to the sleeper.

Tools required for installation will include:

- torque wrench to assemble the loop panel to the beam;
- socket and driver for use with Vossloh screws.

Installation procedure:

- remove the inner Vossloh screws from the designated sleepers with the socket and driver but do not remove the clips. Retain the screws removed for re-insertion;
- inspect the insulators under the clips and check that rail pads are present, if any are damaged or missing they will require replacement;
- check that the tops of the sleepers are clear of ballast and other debris;
- position the GRP beams over the centre of the spring clips;
- re-install the original Vossloh screws through the hole in the end yokes of the beam and tighten to the Vossloh recommended torque;
- connect the tail cables to the loop panels;
- attach the loop(s) to the supplied beam(s), adjusting the loop fixing brackets to allow for sleeper spacing;
- inspect and if necessary adjust the position of the loop panel so that it is sitting correctly;
- tighten the panel securing bolts to hand tightness (for guidance, 8 Nm +/- 2 Nm);
- secure the panel securing bolts by bending up the anti-vibration tab washers.

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6.6 Transmitter Loops On Concrete Slab Track

For the installation of the TPWS transmitter loops, the term 'concrete slab track' is defined as paved concrete slab track with a steel reinforcement mesh that is capable of significantly attenuating the transmitted TPWS field. Typically this applies to plain lines where the concrete slab is used to maintain tight gauge clearances or to contribute to the structural integrity of tunnel linings. The platforms of some terminal stations, such as St. Pancras and Glasgow Central, also have a form of concrete slab track comprising pre-cast concrete sleepers that are tied to a steel reinforcement mesh.

TPWS has been approved for general application on concrete slab track types fitted before January 2003. Any novel types of concrete slab track after this date shall be referred to Network Rail for loop fitment requirements.

Track formations with concrete embedded sleepers without a reinforcement mesh, as used at some other terminus stations, are not within this definition. If TPWS transmitter loops have to be installed on concrete track formations that are close to the level of the foot of the rail, and it cannot be determined if reinforcement mesh is incorporated in the concrete, the formation should be treated as concrete slab track.

Voids or pits beneath the transmitter loop, where there is at least 300 mm distance between the underside of the transmitter loop panel and the top surface of the concrete slab, are also outside of this definition of 'concrete slab track', and the measures identified within this section do not apply.

The TPWS transmitter loops may need to be installed where concrete slab track joins a conventional track formation. TSS or OSS loop panels shall not be installed with the transmitter loops installed above an interface between conventional and concrete slab track. A minimum separation distance of 1 metre shall be maintained between the nearest edge of the transmitter loop panel and the Concrete Slab Track. This is necessary to reduce the risk of uneven distortion of the fields transmitted by the arming and trigger loops. For an OSS with a Passenger Set Speed of less than 25 mph, the arming and trigger loops should be on the same track type (that is either conventional track or Concrete Slab Track).

Paved concrete slab track could be used on sub-surface routes where the concrete slab also serves as an evacuation route. At these sites, the installation of the TPWS transmitter loops could present additional trip hazards under evacuation conditions. For such locations this issue may require special consideration by the Signal & Telecoms Maintenance Engineer.

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6.6.1 Installation Requirements For Transmitter Loops On Concrete Slab Track

In most concrete slab track applications the drilled 'other concrete' fixing kit (No. 5) is required to install the transmitter loops. The TPWS transmitter loops shall be installed on the slab track generally in accordance with the instructions contained within other sections of this document. Additionally, the following issues should be taken into consideration:

- A longitudinal separation distance between the mounting beams of 650 mm $\pm$ 50 mm is suggested.
- The depth of the top of the standard TPWS transmitter loop panel BRL shall lie between 60 mm and 20 mm (see section 6.6.2).
- Use Hilti stud anchors of the appropriate length if 50mm or 100mm packing pieces are required (see section 6.8).
- When using 50 mm packing pieces, use rubber pads that are located between the concrete slab and the packing pieces.
- For buffer stop mini-loops on concrete slab track, the bottom surface of the mini-loop panel shall be mounted at least 50mm above the concrete slab.

6.6.2 Depth of TPWS Transmitter Loops Below Running Rail Level

Where TPWS transmitter loops are located on concrete slab track, the transmitter loops are required to be installed at a depth of between 20 mm and 60 mm Below Running Rail Level (BRL).

To compensate for the attenuation effect caused by the length of TPWS loop feeder cabling used, it is suggested that the depth of the TPWS transmitter loop BRL is reduced as the length of loop feeder cabling increases. Suggested maximum depths for the transmitter loops BRL are given in the following table:

Approximate Loop Feeder Cable Length (m)	Suggested Maximum TPWS Transmitter Loop Depth Below Running Rail Level (mm)
0 - 50	60
50 - 150	50
150 - 250	40
250 - 350	30
350 – 500	20

Table 2 – Depth Of Transmitter Loop BRL

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The above figures are for guidance, and the commissioning test of the TPWS track sub-system could be passed if the transmitter loops are installed at greater depths below running rail level. No TPWS transmitter loop shall be installed at a depth of less than 20 mm BRL for gauging considerations.

In order to achieve the required depth of the TPWS transmitter loop BRL, kits of packing pieces are available from Thales (see section 6.8).

6.6.3 Loop Feeder Cabling

To a certain degree, the field strength radiated from a TPWS transmitter loop decreases as the length of the loop feeder cable increases. To provide the maximum drive signal to TPWS transmitter loops that are installed on paved concrete slab track, it is recommended that the lengths of the loop feeder cables to the transmitter loops installed on concrete slab track are kept as short as possible. The attenuation effect of the loop feeder cables can be compensated for by reducing the depth of the transmitter loop below running rail level, as discussed within Section 6.6.2 above.

The way in which the TPWS loop feeder cables pass from the TPWS transmitter loops, beneath the running rail, and to the ccess may also require special consideration for installations on paved concrete slab track where the foot of the running rail is laid on the surface of the concrete slab. In locations where it is not possible to use existing cable routes, the guidance of the Track Maintenance Engineer should be sought if it is necessary to remove concrete beneath the running rail.

6.6.4 Buffer Stop Mini-Loops On Concrete Slab Track

The reinforcing metal mesh found in Concrete Slab Track affects the Buffer Stop Mini-Loop output by attenuating the electromagnetic field emitted. To overcome this effect, the bottom surface of the Buffer Stop Mini-Loop panel shall be mounted at least 50mm above the concrete slab, and the top of the panel shall be between 60 and 20mm Below Rail Level. It may be necessary to pack the sleeper fixing bars by more than 50mm above the surface of the concrete slab so that the loop is between 60 and 20mm below rail level as set out above.

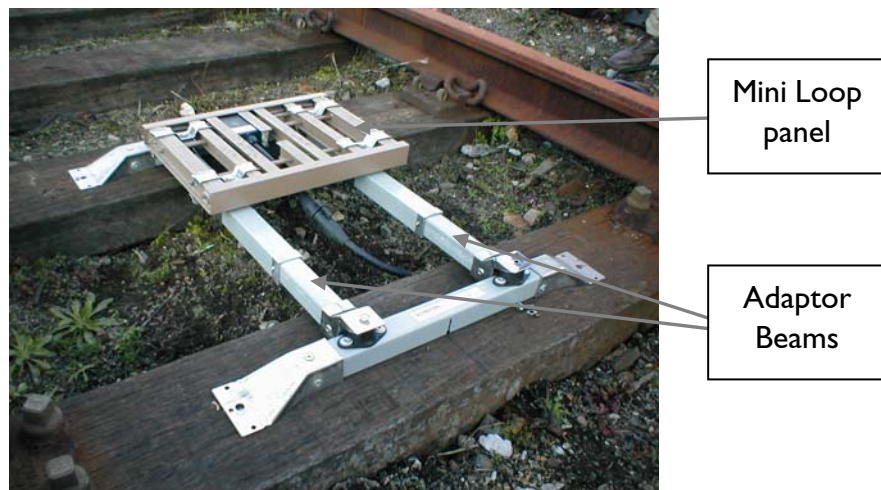
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For installation using drilled concrete fixing kits, a 50mm packing piece kit is available from Thales, which fits between the concrete slab and the bottom of the stainless steel end yokes of the sleeper fixing bars. The kit includes longer Hilti bolts and a rubber pad. The rubber pad shall be inserted on the concrete slab under the packing piece. Two such spacers can be stacked if required to achieve a 100mm lift, noting the longer Hilti studs (HST RM 12/120) will then be required. For installation using other sleeper fixing kits, e.g. Pandrol fixings, standard 10mm, 20mm or 30mm spacer kits may be used as required so that the 50mm minimum is maintained.

Both the Arming Loop and the Trigger loop of the OSS shall be mounted on the Concrete Slab Track so that the emitted fields are closely matched. Where a Buffer Stop Mini-Loop is mounted on standard concrete or timber sleepers but abuts a section of Concrete Slab Track, then a minimum separation distance of 1 metre shall be maintained between the nearest edge of the transmitter loop panel and the Concrete Slab Track.

6.7 Buffer Stop Mini-Loops

Due to the slow speed tripping phenomena discovered with OSS loops on the approach to Buffer Stops, a purpose designed buffer stop OSS transmitter loop is used for all applications of OSSs for Buffer Stops. This is known as the Buffer Stop Mini-Loop and shall only be used for this application, due to its speed performance limitations. The Buffer Stop Mini-Loops are installed on the same range of fixing beams as standard loops (as shown in Appendix A), using an adaptor kit.



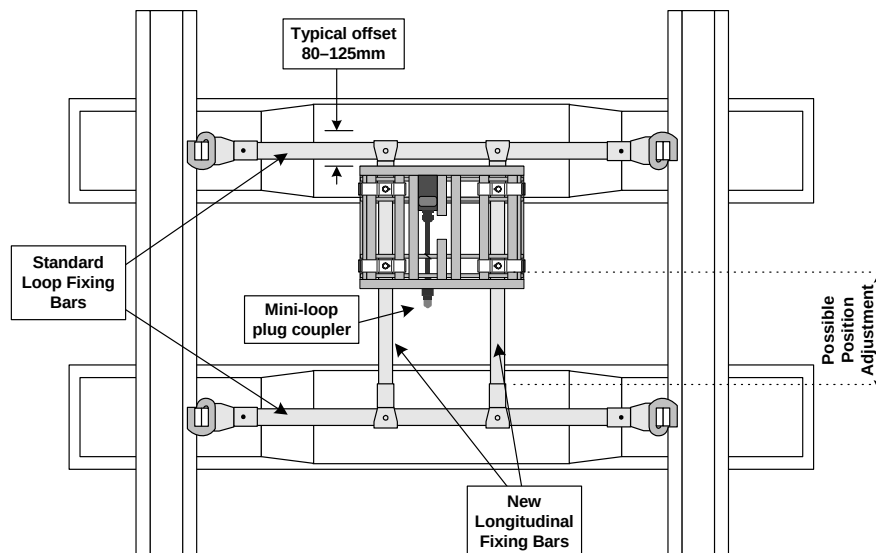
Buffer Stop Mini Loop On Timber Sleepers

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The Buffer Mini-Loop is made of the same materials as the conventional loop, has the same width (440 mm) and general structure. The main differences are the length of the loop (323 mm) and the requirement for an adaptor kit to fix the Buffer Stop Mini-Loop panel to the existing range of sleeper/rail fixing kits. Part numbers for Buffers Stop Mini-Loop equipment available from Thales are shown in Appendix J.

The Buffer Stop Mini-Loop has been designed to be fully compatible with existing trackside equipment including TPWS control modules, loop feeder tail cables, loop fixing bars, loop spacer kits, maintenance and commissioning jigs, test aerials and leads, Fluke TPWS meter and the plug coupler tool.

6.7.1 Installation Requirements

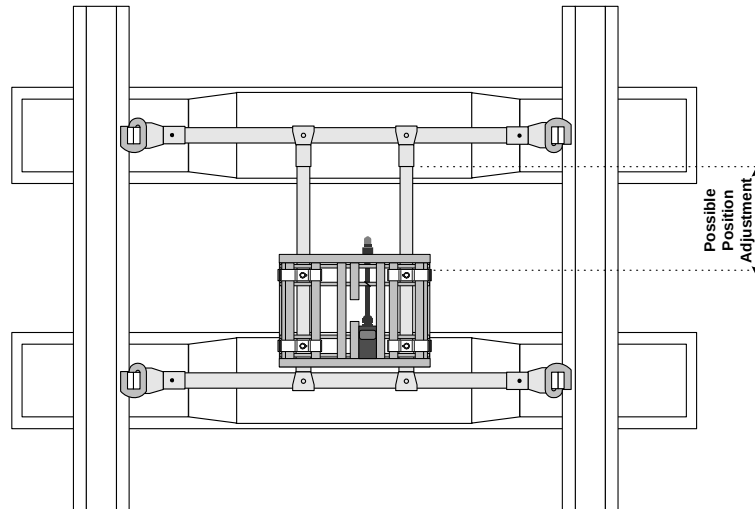


Layout Of Buffer Stop Mini Loop Fixings

The Buffer Stop Mini-Loop is secured to the rail using two longitudinal telescopic fixing bars, which are fixed to the resilient mounts on the standard transmitter loop fixing bars, using standard securing bolts.

The Buffer Stop Mini-Loop can be positioned at any location between the pair of transverse loop fixing bars excluding a space of nominally 38mm immediately adjacent to the transverse loop fixing bar. Complete coverage within these limits is obtained by reversing the orientation of the longitudinal telescopic bars (as shown below). The telescopic bars have been designed to cater for sleeper pitches between 600mm and 788mm. The telescopic bars allow the longitudinal position of the Buffer Stop Mini-Loops to be finely adjusted within the sleeper spacing. The Buffer Stop Mini-Loop aerial are not to be clamped to the smaller width sliding section of the telescopic bars.

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Should it not be possible to maintain the required installation tolerances, then one or both of the loops should be moved to an adjacent sleeper bay. Under no circumstances should the loop panel be mounted such as to overhang the sleeper fixing bar.

The standard lateral positioning tolerance of $\pm 10\text{mm}$ from track centre line applies equally to the Buffer Stop Mini-Loop as to the standard 1000mm loop,

When the required position has been established, the supplied Buffer Stop Mini-Loop panel securing bolts (held in place by the supplied 'o' ring') shall be tightened to a torque setting of $8\text{ Nm} \pm 2\text{ Nm}$, and secured with the anti-vibration tab washers supplied.

6.7.2 Buffer Stop Mini-Loops On Steel Sleepers

Buffer Stop Mini-Loops are suitable for installation on steel sleepers track, provided that the running rails are electrically insulated from the steel sleepers.

The Buffer Stop Mini-Loop transmitter panel are not to overlap the top surface of the steel sleeper by more than 50 mm, when viewed from vertically above the Buffer Stop Mini-Loop. If the Buffer Stop Mini-Loop does overlap the steel sleeper, the bottom surface of the transmitter loop panel shall be at least 70 mm above the top surface of the steel sleeper.

6.7.3 Buffer Stop Mini-Loops On Concrete Slab Track

Buffer Stop Mini-Loops are suitable for installation on concrete slab track, provided that the bottom surface of the Buffer Stop Mini-Loop panel is mounted at least 50mm above the concrete slab, and the top of the panel is between 60 and 20mm Below Rail Level.

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It may be necessary to pack the sleeper fixing bars by more than 50mm above the surface of the concrete slab so that the loop is between 60 and 20mm below rail level as set out above.

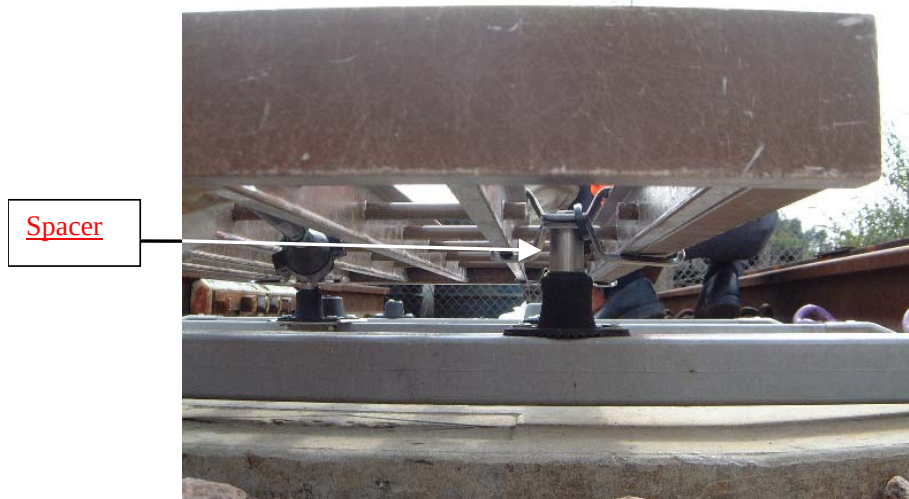
Both the Arming Loop and the Trigger loop shall be mounted on the Concrete Slab Track so that the emitted fields are closely matched.

Where a Buffer Stop Mini-Loop is mounted on standard concrete or timber sleepers but abuts a section of Concrete Slab Track, then a minimum separation distance of 1 metre shall be maintained between the nearest edge of the transmitter loop panel and the Concrete Slab Track.

6.8 Transmitter Loop Packing Spacers

The top of the Transmitter Loop panel shall be within the range 60mm and 100 mm below the top of rail head (except for mini-loops and standard loops on concrete slab track). This distance is controlled by the design of the loop fixing kits for Pandrol (Kit No 1), Fastclip (Kit Nos 2 and 9), SHC (Kit No 3) and Vossloh (Kit No 7) type rail fastenings. However, for fixing kits required to be screwed/bolted to the sleeper (Kit No's 4 and 5) it may be necessary to pack the loop to reach the minimum height.

Thales Communications can supply 3 packing spacer kits to enable the loop panel to be raised by 10mm, 20mm or 30mm. The spacers are inserted between the neoprene mounting on the cross bar and the loop panel itself as shown below.



Transmitter Loop Packing Spacer in Position

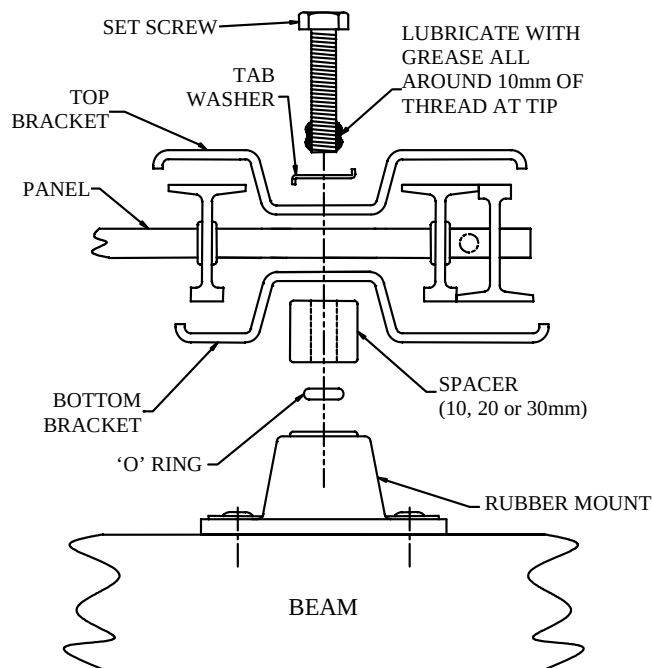
The loop spacer kits contain all materials that may required to raise a pair of loops. New set screws, tab washers and 'O' ring seals are provided in the kit. The Thales Communications part numbers for the spacer kits are as shown in Appendix J.

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6.8.1 Packing Spacers Installation Instructions

The selection of which spacer kit to use should be made on the basis of packing the loop by the minimum height required to be within the permitted height range. Although it is permitted to have the loop panel surface at 60 mm below rail level, the lower the loop is the less is the risk of damage from objects hanging from trains.

To install the Packing Spacer, fit a new tab washer to the set screw and pass the set screw through the loop panel fixing brackets, loop panel itself and the spacer, attaching the supplied rubber 'O' ring to hold the assembly firm. Apply grease to the bottom 10 mm of thread on each set screw and attach the loop panel as normal.



Loop Spacer Assembly

6.8.2 Packing Spacers With Buffer Stop Mini-Loops

The standard loop packing spacers are compatible with the new Buffer Stop Mini-Loop. The spacers shall be applied between the neoprene anti-vibration mounts on the existing transverse sleeper fixing bars and the new longitudinal telescopic bars (as shown below). The spacers shall not be inserted between the Buffer Stop Mini-Loop aerial securing brackets and the sliding clamps on the longitudinal telescopic bars, as the securing screws supplied with the spacers are too long to clamp the Buffer Stop Mini-Loop panel to the longitudinal bars.

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Mounting Location of Loop Spacers

6.8.3 Packing Spacers With Concrete Slab Track

The packing pieces are installed between the surface of the concrete slab and the yoke of the 'other concrete' type mounting beams. The kit includes eight 50 mm packing pieces, eight longer Hilti stud anchors and eight rubber pads. One of the rubber pads shall be inserted on the concrete slab under each packing piece.

Two 50 mm nylon packing pieces can be stacked if required to achieve a 100 mm lift, noting that the longer Hilti stud anchors (HST-R M 12/120) will then be required. The additional packing pieces and Hilti stud anchors are also available as a kit that contains eight of each item.

Each of the above kits will be sufficient to pack the arming and trigger loops of either one OSS function or one TSS function. For the TSS function, two packing blocks, two rubber pads and two Hilti stud anchors will be spare.

Note that the Hilti HSA-KR M12 x 80 stud anchors that are supplied as standard with mounting kits 608035-05 and 608036-05 are too short to use with the 50 mm spacers. Hilti stud anchors of the required length are supplied within the 50 mm spacer kit, part no. 608859-00. If it is necessary to use two 50 mm packing pieces to raise the TPWS transmitter loop by 100 mm above the concrete slab, the longer Hilti stud anchors, HST-R M 12/120, which are supplied with kit no. 608859-01, shall be used.

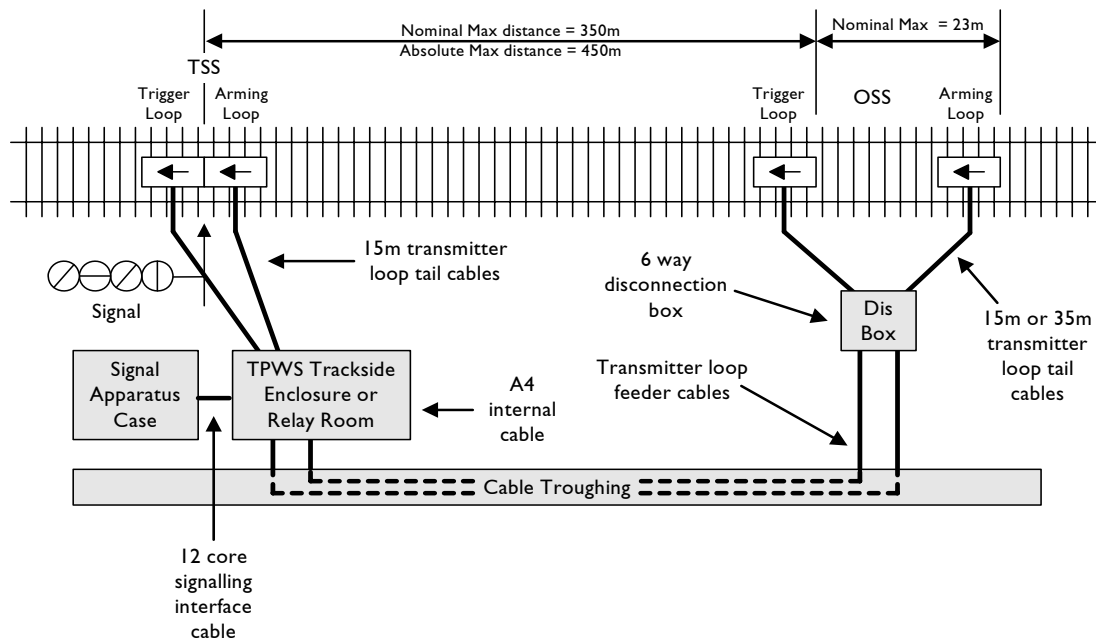
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7 TPWS CABLE REQUIREMENTS

7.1 General Cable Arrangements

The TPWS cable system comprises several distinct parts, including the transmitter loop feeder cable system which connects the transmitter loops to the TPWS trackside equipment and the signalling interface cable or internal wiring, which connects the TPWS trackside equipment to the signalling system. A typical trackside cable arrangement for a signal installation is shown below.



Typical Layout Of TPWS Cable System

The TPWS transmitter loop feeder cable is a screened twisted pair cable manufactured in accordance with section C3 of NR/L2/SIG/00005 - Railway Signalling Cables (A4 for internal cabling or E3 for sub-surface installations). It connects the loops to the TPWS plug-in modules. This cable comprises several parts, a short transmitter loop tail cable which connects to the loop plug coupler, the external transmitter loop feeder cable (normally only required for an OSS) and an A4 internal transmitter loop feeder cable for use within relay room and lineside apparatus case trunking, where necessary. Should any part of this cable system be damaged, for example by the action of on-track machinery, then this portion of cable can be replaced in isolation, without the need to replace the transmitter loop itself or the remainder of the cabling.

Each transmitter loop requires a separate loop feeder cable system.

The transmitter loop feeder cable shall not be run in the same cable route as traction cables or other cabling carrying high currents (i.e. traction feeder cables – this does not include 650V AC signalling supplies).

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7.2 Transmitter Loop Tail Cable

The transmitter loop tail cable is provided as part of the TPWS equipment and installation kit supplied by Thales. It comes in two pre-formed lengths of 15m or 35m. The most appropriate length of cable shall be used for connection according to the distance between the loops and the disconnection box or trackside enclosure / apparatus case.

The tail cables are provided with a three-pin plug coupler on one end for connection to the plug coupler on the transmitter loop flying lead. This plug coupler has one larger pin and is configured in an isosceles triangle so as to eliminate the possibility of incorrect connection. Handling requirements for tail cables and plug couplers are detailed in section 7.6.2 below.

The tail cables for the TSS transmitter loops are generally terminated directly into either the Thales trackside enclosure or the lineside apparatus case containing the TPWS control modules as appropriate. When the TPWS trackside enclosure is not mounted in close proximity to the associated signal, additional transmitter loop feeder cable may be required, in which case either a 6-way disconnection box mounted midway between the loops, or two 3-way disconnection boxes can be used at trackside located adjacent to the transmitter loops. The tail cables for the OSS transmitter loops are terminated in a trackside disconnection box due to the longer distance from the signal fitted.

Tail cables and loop feeder cable ends should not be left exposed to the elements at trackside during installation, as this can lead to moisture ingress and equipment faults.

The tail cables should be cut back to an appropriate length before termination. All tail cables shall be adequately labelled at both ends so that in the event of loops being disconnected for any reason, the correct cable can be re-connected to the correct loop, e.g.

“ *** TPWS TSS Arming Loop ” or “ *** TPWS OSS Trigger Loop ”
(Where *** is the appropriate signal / speed restriction / buffer stops identification)

Suggested layouts for on-track equipment and cross track cabling are shown in Appendix B.

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