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## LOOP DETECTOR AND CABLE TERMINATIONS INSTALLATION AND COMMISSIONING HANDBOOK

**THIS DOCUMENT IS ELECTRONICALLY HELD AND APPROVED**

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DATE: 13/03/2013  
ISSUE: 13

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## SAFETY WARNING

### HEALTH AND SAFETY AT WORK

#### Safety of Installation and Maintenance Personnel

In the interests of health and safety, when installing, using or servicing this equipment the following instructions must be noted and adhered to:

- (i) Only skilled or instructed personnel with relevant technical knowledge and experience, who are also familiar with the safety procedures required when dealing with modern electrical/electronic equipment are to be allowed to use and/or work on the equipment. All work shall be performed in accordance with the Electricity at Work Regulations 1989.
- (ii) Such personnel must take heed of all relevant notes, cautions and warnings in this Handbook and any other Document or Handbook associated with the equipment including, but not restricted to, the following:
  - (a) The equipment must be correctly connected to the specified incoming power supply.
  - (b) The equipment must be disconnected/isolated from the incoming power supply before removing any protective covers or working on any part from which the protective covers have been removed.
  - (c) Any power tools and equipment must be regularly inspected and tested.
  - (d) Any personnel working on site must wear the appropriate protective clothing, e.g. reflective vests, etc.

#### Safety of Road Users

It is important that all personnel are aware of the dangers to road users that could arise during installation, repair and maintenance of traffic control equipment.

Ensure that the junction area is coned and signed as necessary to warn motorists and pedestrians of any dangers and to help protect the personnel working on the site.

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## 1. INTRODUCTION

### 1.1 Purpose

This handbook is one of a series of General Traffic handbooks that cover common aspects of planning, installation and commissioning of STC traffic controllers and associated street equipment.

### 1.2 Scope

This handbook describes the procedures for the installation and commissioning of slots, loop detectors, cabling of loops and cable terminations.

### 1.3 Related Documents

#### 1.3.1 Other STC Traffic Installation Handbooks

General Principles Installation Handbook	667/HE/20661/000
Installation Testing Handbook	667/HE/20664/000
Above Ground Detectors Handbook	667/HE/20665/000
ST4R Loop Detector Handbook	667/HB/27663/000
SLD4 Loop Detector Handbook	667/HB/45200/000
Helios Signals and Poles Handbook	667/HB/30000/000

#### 1.3.2 Peek/Sarasota Detector Handbooks

The handbooks for the Peek/Sarasota detectors can be obtained from Peek Ltd., Kingsworthy, Hampshire SO23 7QA.

These handbooks contain full details and should be consulted when installing and operating Peek/Sarasota detectors.

#### 1.3.3 Maintenance Provision for Peek/Sarasota Detectors

The manufacturer's MP documents for the relevant detector must be consulted before any detector installation, commissioning or maintenance work is carried out.

#### 1.3.4 Siemens Self-Tune Detectors

667/1/27663/000 – Siemens ST4R Detector

667/1/45200/001 – Siemens SLD4 Detector

667/1/17180/etc - Note that these detectors are no longer available and the handbook is only applicable where sites equipped with existing detectors are to be maintained.

## 1.4 Issue State

Pages	Current Issue	Type	Part ID
All	13	Meridian	667/HE/20663/000

## 1.5 Glossary

UD	Uni-directional
LRT	Light Rapid Transport
SDE/SA	Speed Discrimination Equipment/ Speed Assessment
SCOOT	Split, Cycle, Offset Optimisation Technique
STS	Site to Scale (drawing)
VA	Vehicle Actuation

## 2. INSTALLATION OF TRAFFIC LOOPS AND FEEDER CABLES IN SLOTS

Before the work is carried out, the tools listed in the General Principles Installation handbook (see section 1.3.1) should be available.

### 2.1 Loop Cable and Slot Dimensions

Loop slots are cut into road surfaces for the installation of the following loop cables:

998/4/70671/001	50/0.25 EPR insulated
998/4/85264/000	30/0.25 EPR insulated
998/4/82021/000	30/0.25 EPR/PCP insulated

The works specification specifies cable to be used.

Slots for the installation of cables must be of sufficient width to permit the free entry of cables. Minimum slot widths are as listed:

998/4/85264/000	6 mm
998/4/82021/000	8.5 mm
998/4/70761/001	8.5 mm

Slot depths are dependent upon the number of turns in the loop or number of conductors within a slot, as follows:

998/4/85264/000	4 mm x turns/conductors )	Plus 50 mm where slots are cut in a black top cover, or 25 mm where slots are cut in concrete.
	)	
998/4/82021/000	6.5 mm x turns/conductors )	
	)	
998/4/70671/001	6.5 mm x turns/conductors )	

Note: The number of turns is specified in Section 2.5.

### 2.2 Positioning of Loops and Loop Tails/Feeders

Loop locations containing the following obstructions should be dealt with as indicated.

#### 2.2.1 Metal Reinforcing

When installing loops in concrete roads containing a metallic reinforcing mesh, there must be at least 50 mm of vertical spacing between the top of the mesh and the bottom of the slot or loop cable. The same rule applies to metal damp courses found in some elevated roadways.

#### 2.2.2 Buried Metal Objects

Generally speaking, heavy metal objects such as girders and pipes have little effect on System D and Turning Detector Loops, providing the nearest point is 50 mm or more below the loop.

However, in the case of SDE/SA loops, the presence of an isolated heavy metal object can distort the electromagnetic effect of one of the pair of loops so that a false speed assessment is given. In these cases it is necessary to re-site the loops 1 metre away from such objects.

Buried tramlines may present a problem as the metal tie rods sometimes make an intermittent electrical connection with the running rails. Any intermittent connection of this type placed under the loop can cause spurious detector signals and it is advisable to remove the track from the area of the loop leaving 305 mm clearance. (One metre clearance for SDE/SA loops).

### 2.2.3 Buried Cables

Buried Electrical Supply cables do not cause interference with Detectors. However, SDE/SA Loops should be kept 1 metre away from heavier armoured type of cable as the metal content could cause the distortion mentioned in section 2.2.2.

### 2.2.4 Surface Objects

Loop slots should be kept one metre clear of manhole covers, drain covers, expansion joints and similar disturbances in the road surface. Failure to observe this can weaken the road surface and may cause subsequent breaking up.

### 2.2.5 Blast Furnace Slag

Occasionally road surfaces incorporating blast furnace slag in their construction will be encountered. This has a de-sensitising effect on detector loops. It is not possible to detect the presence of slag from the road surface appearance and it will usually be discovered only during commissioning in the form of insensitive loops.

Commercial should make it clear that if this material is encountered the customer will be responsible for work involved in overcoming the problem. Avoiding multiple loops on a channel may increase working sensitivity. This will involve some re-cutting and probably additional detector cards. However it may be necessary to replace the material in the vicinity of the affected loops.

### 2.2.6 Loop Tails

It is advisable that loop tails are twisted with at least 10 twists per metre, outside of the slot. See Figure 14.

However loop tails may be untwisted loop tails over a short distance where they are taken across or along the carriageway to a connection point at the roadside. The length of untwisted loop tails must not exceed 30 metres. No more than 15 metres of tails from any other loop should be laid in a common slot, and then only if the loops are driven from the same detector unit.



## 2.2.7 Feeders

Sharing of a multi-pair feeder cable between different detectors is not recommended. See section 2.7 for feeder types.

## 2.3 Loop Configurations

Loop positions will be marked prior to slot cutting, as per the positioning instructions shown on the STS.

Loop configurations are normally of the following types:

Chevrons -	Vehicle actuation, SDE/SA
Diamonds -	Vehicle actuation (use for replacement or MOVA only)
Rectangle -	Turning loops, SCOOT, COUNT, QUEUE and special purpose (Required for SDE/SA for previous detector types).
Special loops -	MOVA loops (diamonds are recommended)

### 2.3.1 Replacement Controllers

Replacement controllers should continue to use existing diamond Vehicle Actuation loops where they are in good condition. Any existing SDE/SA loops for replacement controllers should be re-cut to the new 3.6 m standard prior to commissioning.

### 2.3.2 Replacement VA Loops

If a diamond loop needs re-cutting it should be re-cut as a diamond. However if all the loops on an approach are to be re-cut then the chevron loop configuration should be used. It is permitted to have all chevrons on one approach and all diamonds on another subject to the following clause; where two or more VA loops are connected to the same detector channel they must all be to the same configuration, i.e. ALL Diamond or ALL Chevrons.

### 2.3.3 Replacement SDE/SA Loops

If a 3.05 m spacing SDE/SA loop needs re-cutting it should be re-cut to the same spacing as the original unless every approach on that controller is re-cut. In that case the new 3.66 m spacing should be used and the controller set up or reconfigured accordingly. Controllers cannot accept inputs from loops of mixed spacing.

### 2.3.4 Use of Soundmark Test Sets

Care must be taken when selecting the loop pitch on Soundmark Test Sets. Selecting PLE selects the old Plessey loop pitch of 3.05 m (10 ft). Selecting GEC selects 3.6 m (12 ft) which is now common for GEC, Microsense and NEW STC equipment.

### 2.3.5 Procedure for Marking Position of Diamond Loops Prior to Slot Cutting

These notes are to be read in conjunction with Figure 1 and Figure 2 but kerbs and distances from carriageway centre lines are subject to any standing Local Authority instructions.

Refer to the STS drawing and mark the distance of the loop from the stop line, at the road edge.

- 1) From this point, mark a datum line to the road centre at right angles to the road edge.
- 2) Measure in from the road edge 0.3 metres and mark this point on the datum line. This point is referred to as the datum point.
- 3) Measure in 1 metre from the road centre and mark this point on the datum line. This point is referred to as the end point.
- 4) Measure the distance between the datum point and the end point. Reference to Figure 2 will determine the appropriate loop configuration to be constructed.
- 5) Determine the length of the loop diagonal as follows:
  - i) For single loop configuration, the loop diagonal is the distance between the datum point and end point.
  - ii) For double loop configuration, the loop diagonal is the distance between the datum point and the end point divided by 2.
  - iii) For the triple loop configuration, the loop diagonal is the distance between the datum point and the end point divided by 3.
  - iv) For the quad loop configuration, the loop diagonal is the distance between the datum point and the end point divided by 4.
- 6) Starting at the datum point, mark the length of the loop diagonal along the datum line for as many diamonds as are required in the configuration. Figure 1 shows a double loop configuration by way of example.
- 7) Refer to Figure 2 to determine the length of the loop side.
- 8) Anchor a measuring tape at the datum point and using the tape and chalk, strike arcs either side of the datum line, whose radius equals the length of the loop side.
- 9) Strike similar arcs from the point on the datum line indicating the length of the loop diagonal. The intersection of these arcs on either side of the datum line fixes the position of the loop corners.
- 10) Repeat this procedure along the datum line for the required number of diamonds in the configuration.
- 11) Join up the points with chalk to form the loop configuration required.

### 2.3.6 Chevron type loops – marking of loops

These notes are to be read in conjunction with Figure 3 but distances from kerbs and carriageway centre lines are subject to any local authority instructions.

- 1) Refer to the STS drawing and mark the locations ax, bx, cz 1.1 metres towards the top line for the loop approach distances X, Y, Z shown on the STS drawing. (In Figure 3 loop 'a' is for a three lane configuration, 'b' is a two lane and 'c' is a one lane configuration loop.)
- 2) From the point 'ax' in loop 'a' mark the point 'aa' 1 (one) metre from the centre line and at right angles to the kerb through point 'ax'.
- 3) Measure the linear distance between points 'ax' and 'aa' and divide this distance by the number of traffic lanes, which in this case is three. Assuming S1 is 1/3 of total distance between 'ax' and 'aa', mark points 'ax' and 'aa'. Mark points 'ay' and 'az' at distances D1 as shown.
- 4) At measurements D1 from points from 'ay and 'aa' mark points 'ay1', 'aa1' as shown.
- 5) Loops b and c are marked out using identical techniques, but for two and one lane respectively.
- 6) When all points referred have been marked, the points 'xx' can be marked 1.1 metres from the marked points as illustrated.
- 7) When the marking of loop structure points have been completed, the points can be joined together if necessary for slot cutting purposes.

### 2.3.7 UD Loops – SDE/SA, SCOOT, Count and Queue

Figure 4 illustrates a three-lane VA approach system D with diamond loops. The UD loop overlays the actuating loop by 1/3 of the loop diagonal as shown. Diamond UD loops can be used with Plessey ST, Microsense detectors and Sarasota units.

Figure 5 illustrates a three-lane chevron loop approach.

This configuration can be used with Microsense, Plessey ST and Sarasota detector units.

Note: In a two-lane approach the angle of the UD loops should be reversed to line up with the Y and Z loops.

Figure 6 illustrates a SCOOT detector site with two carriageway loops.

The length of SCOOT Loops in the direction of travel is fixed as 2 m. This is a compromise between a loop being short enough to detect gaps in the traffic stream and long enough to detect stationary vehicles in a queue.

The width of the loop is dependent on site conditions and should not be less than 1 m, or more than two lanes wide. Factors affecting the width are:

- a) The offside edge of the loop should be approximately 1 m from the centre line of the road to reduce the probability of under-counting and over-counting due to vehicles straddling the centre line. The centre line is taken to be the line least occupied by vehicles in either direction and may not coincide with the marked centre line.
- b) The loop should be sited where the risk of parking over it is minimal. Experience has shown that double yellow lines are insufficient safeguard and unless other physical deterrents to parking exist (e.g. guard-rail) it is recommended the nearside edge of the loop to be located 2 m from the kerb.

- c) In the case of multi-lane links where more than one loop is provided, the gap between two adjacent detectors on a link should be approximately 2.5 m (based on the width of an average vehicle) so as to balance under-counting and over-counting errors.
- d) Where carriageway width is restricted, the minimum 1m wide loop may still be clipped by oncoming traffic. Where this problem is expected unidirectional loops should be considered.
- e) The dimensions of the UD loop overlay are illustrated in Figure 6. These SCOOT loop configurations can be used with Microsense, Plessey ST, and Sarasota detector units.

Figure 7 illustrates a N+1 count loop configuration where N is the number of traffic lanes. The length of count loops, in the direction of travel is fixed at 1.8 m. The width of loops and their spacing 'B' are dependent on site conditions, these dimensions being shown on the appropriate site drawings. The distance of the nearside loop to the kerb also varies with site conditions and should be detailed on the site drawing.

The dimensions of the UD loop overlay are illustrated in Figure 7.

### 2.3.8 Turning Loops and SDE/SA Loops

Figure 8 to Figure 10 illustrate configurations for turning loops, and SDE/SA loops. The turning loop Figure 9 can be connected to Siemens/Plessey, Microsense and Sarasota detectors observing the calculation for loop turns listed in section 2.5 of this document.

The rectangular loop SDE/SA configuration, Figure 8 is for connection to Siemens/Plessey, Microsense or Sarasota detector units.

The chevron loop SDE/SA configuration Figure 10 should be used with Sarasota MTS and Microsense MXE series detectors. This improves speed measurement accuracy for motorcycles.

NOTE: Siemens controllers and Pelicans for new installations will be configured for 3.66 metre speed measuring base in line with current GEC and Microsense controllers. Earlier Plessey controllers may have been configured for 3.05 metre speed measuring base and other manufacturers' earlier controllers for various different bases. When re-cutting an existing loop check with the existing controller for the correct loop spacing.

With intersection controllers the configuration must be checked to verify the loop spacing.

With T110 Pelicans Address 217 should be greater than 0 for 3.66 metre speed measuring base.

### 2.3.9 MOVA Loops

Figure 11 and Figure 12 illustrate MOVA loops; it is recommended that diamond loops should be used where lane width allows, with a minimum size of 1 sq m and 1.6 m to 1.7 m in the direction of travel. Where lane width is restricted, other loop configurations may be used. For example, where MOVA

stopline is required, chevron loops away from the direction of traffic should be used.

### 2.3.10 Special Loops

Figure 13 illustrates queue loops and special purpose loops whereby fixed and limits of variable dimensions are shown. These loop configurations can be connected to Siemens/Plessey, Microsense and Sarasota detectors observing the calculations for loop turns as listed in section 2.5 of this handbook.

## 2.4 Loop Slot Details

Loop and loop tail slots will be cut in the surface of the roadway with a motor driven saw.

Prior to cutting the slots refer to section 2.1 to determine minimum slot widths, and minimum slot depths. Refer to Figure 14 for typical examples.

When adjacent loops are connected to different detectors, their loop tails must be laid in different slots spaced 150 mm apart and connected to separate feeder cables to each detector unit.

When cutting loops, the saw blade should be lowered to form a dip in the floor of the slots at the point where the slots cross. This will allow the extra bulk of crossing cables to lie in the dip while still maintaining the 50 mm covering for the top cable (See Figure 15). The same rule applies to all loops at the point where the feeder cables join the loop.

The corners of slots should not be cut away at diamond loop crossovers but must be cut away to ease the bend on loop cables turning through an angle of less than 90° (See Figure 16). An alternative is to protect the cable from a sharp corner by inserting a short length of 1 mm thick vinyl or plastic strip formed by bending to fit the corner (Figure 17 refers).

Slots must be cleared of stones, loose material and free water before cable laying. Drying out can be assisted by using a compressor and air line. It is not acceptable to lay cables in a wet slot as backfilling materials do not bond to wet surfaces although the slightly damp surface obtained after using the air line is acceptable. (Definition of a wet slot is a slot that contains free-standing water.)

**NOTE: If the saw breaks through into the hardcore bed, work should be stopped and the customer informed that loops cannot be installed to this Siemens specification.**

## 2.5 Loop Turns and Feeder Lengths

All loops shared on one detector channel are to be connected in series.

The maximum feeder length quoted below includes the total length of any separate pairs fed back for series connection in the controller and the lengths of loop tails.

## 2.5.1 Siemens ST4R / SLD4 Detectors

FACILITY	SHAPE	NO.OF LANES	NO.OF TURNS	MAX FEEDER
V/A	Chevron/Diamond	1 to 3	3	300 m
V/A	Chevron/Diamond	4	3	250 m
V/A	Chevron/Diamond	5	3	200 m
V/A	Chevron/Diamond	6	3	150 m
SDE/SA	Rectangle	1	3	300 m
SDE/SA	Chevron	1	3	300 m
COUNT/QUEUE	Rectangle	1	3	600 m*
SCOOT	Rectangle	1 or 2	3	600 m*
MOVA	Diamond	1 to 3	3	300 m
MOVA	Diamond	1 to 3	3	600 m*

**Note:** \* = Not cycle sensitive

## 2.5.2 Peek/Sarasota and Microsense MXED Detectors

FACILITY	SHAPE	NO.OF LANES	NO.OF TURNS	MAX FEEDER
V/A	Chevron/Diamond	1 to 3	3	300 m
V/A	Chevron/Diamond	4	3	250 m
V/A	Chevron/Diamond	5	3	200 m
V/A	Chevron/Diamond	6	3	150 m
SDE/SA	Rectangle	1	3	300 m
SDE/SA	Chevron	1	3	300 m
COUNT/QUEUE	Rectangle	1	3	300 m
SCOOT	Rectangle	1 or 2	3	300 m

**Note:** Sarasota MTS 36ZE and MTS 38ZE (667/7/21031/102 and /104) detectors have a built-in extension timer and must **not** be used with Traffic Signals.

## 2.5.3 Plessey ST and Microsense MSE Detectors

**Note:** These detectors are now obsolete. The following is included for information only.

FACILITY	SHAPE	NO.OF LANES	NO.OF TURNS	MAX. FEEDER
V/A	Chevron/Diamond	1 to 4	3	150 m
V/A	Chevron/Diamond	5 to 6	3	100 m
SDE/SA	Rectangle	1	3	150 m
SDE/SA	TBA	1	TBA	TBA
COUNT QUEUE	Rectangle	1	3	150 m
SCOOT	Rectangle	1 or 2	3	150 m

## 2.6 Cable Laying and Slot Backfilling Procedures

### 2.6.1 Loop Cable Laying

The loop cable should be dry. Loops are laid starting at the kerb, running the tails out winding the loop and returning via the same slot to the kerb. When winding a multiple diamond loop, the cables must cross at the point where the diamonds meet. When loops are connected to feeder cable in the crown of the road, loops are laid starting at and returning to the crown of the road. It is acceptable to run short lengths of loops cable pairs taped together in the soil under the pavement or grass verge but the run should be kept as short as possible and should not exceed 4.5 m. When longer runs are required, feeder cables part no. 667/4/03082/etc must be used (See Section 2.7).

When a pair of tails run inside the detector pedestal or controller case they should be taped or tied together at 100 mm spacing.

The free ends should be labelled with the loop identity using Hellerman HC7 sleeving.

### 2.6.2 Slots Containing Loop Cable

Slots must be backfilled immediately following the laying of cables. The backfill of loops in the United Kingdom consists of two different techniques:

- i) Complete cover of the loop cable with dry sand to a depth of 6mm to 12mm and backfilling of the slot by hotpour bitumen.
- ii) A 10 mm cover of cables by a two-part epoxy resin, and remaining slot backfill completed by hotpour bitumen. Note that the loop cable must be dry as the resin will not bond to wet plastic.

Two part epoxy resins and approved hot pour bitumen are listed in section 2.6.3

Prior to backfill of slots, refer to customer's instructions for preferred backfill.

### 2.6.3 Suppliers for Resins and Compounds

#### Epoxy Materials

- 1) PX212ZE  
Robnorganic Systems Ltd.  
Highworth Road,  
South Marsten,  
Swindon,  
Wilts.
  
- 2) CALKTITE COLDPOUR LSM/30  
(new improved grade)  
Sealocrete PLA Ltd.,  
Greenfield Lane,  
Rochdale,  
OL11 2LD

## Joint Sealers for Road Expansion Joints

### 1) CALKTITE JOINT SEALERS

Polyurethane: P J Sealant

or

Polysulphide: Sealant 195

Sealocrete PLA Ltd.,  
Greenfield Lane,  
Rochdale,  
OL11 2LD

### 2) CLARES BLACK JOINTING COMPOUND SM3

R.S. Clare & Co. Ltd.,  
Stanhope Street,  
Liverpool  
L8 5RQ

## Hot Pour Compounds

- 1) R85 or R95 - Note that the number is the melting point in °C. To order follow the temperature with the pack size, e.g. R85/25 for 85°C melting bitumen in 25-Kg blocks.

Colas Construction Ltd.,  
Western Region  
Gabriels Wharf  
Water Lane  
Exeter  
Devon  
EX2 8BZ

### 2) PLIASTIC 77 or 90 (Export Only)

Expandite Ltd  
1 – 9 Chase Road  
London  
NW10 6PS

## **2.7 Feeder Cables**

In areas where the customer has no special requirements the following instructions are to be followed.

A polythene sheathed feeder cable must be used when more than 4.5 m (15 feet) of feeder is to be laid directly in the soil under the pavement or soft verges.



The feeder cable is supplied with 1.5 mm<sup>2</sup> or 2.5 mm<sup>2</sup> copper conductors and may be manufactured with or without steel wire armour to meet customer specification. The referred types are 1 or 2 pair non-armoured cables with 1.5 mm<sup>2</sup> conductors and an orange coloured outer covering. Armoured cable, also orange coloured and with 1.5 mm<sup>2</sup> conductors, is recommended where the joint between loop tails and feeder cable is made in the road, or where ducts do not protect cables.

It is most important that the 2 cores of each pair are identified and correctly connected. With 2 pair Quad cable, opposite cores always form a pair. (Red is opposite blue and yellow is opposite black). With 3 and 4 pair cable the pairs are twisted and it is not possible to identify pairs by colours alone.

The feeder must be joined to the loop ends using crimp connectors encased in an appropriate joint box. The crimp connectors must be suitable for joining 1.5 mm<sup>2</sup> / 2.5 mm<sup>2</sup> solid copper feeder cable conductors to 1.5 mm<sup>2</sup> / 2.5 mm<sup>2</sup> stranded loop conductors.

The feeder cable codes are as follows:

	1.5 mm <sup>2</sup> Plain cable	1.5 mm <sup>2</sup> Armoured cable
1 pair	998/4/85263/900	998/4/85263/000
2 pairs	998/4/85263/901	998/4/85263/001

The following 2.5 mm<sup>2</sup> cables are no longer recommended but are listed here for completeness:

	2.5 mm <sup>2</sup> Plain cable	2.5 mm <sup>2</sup> Armoured cable
1 pair	667/4/03082/900	667/4/03082/000
2 pairs	667/4/03082/901	667/4/03082/001
3 pairs	667/4/03082/902	667/4/03082/002
4 pairs	667/4/03082/903	667/4/03082/003

## 2.8 Feeder Cable Slot Details and Backfilling

Feeder cable slots will be cut in the surface of the roadway using a motor driven saw.

Slots must be cut at least 2 mm wider than the cable being installed and deep enough to allow 65 mm of cover.

The minimum slot widths are as follows:

	1.5 mm <sup>2</sup> plain cable	1.5 mm <sup>2</sup> armoured cable
1 pair	10mm	14mm
2 pairs	12mm	16mm

	2.5 mm <sup>2</sup> plain cable	2.5 mm <sup>2</sup> armoured cable
1 pair	12mm	16mm
2 pairs	14mm	18mm
3 pairs	18mm	22mm
4 pairs	20mm	24mm

Backfilling shall be with fine cold asphalt rammed into the slot and finished with a surface layer of hotpour of 20 mm nominal depth.

## 2.9 Joint Loop Tails to Feeder Cables

STC approved joint is the acrylic joint to specification 915/4/03118/etc. These joints can be used in underground chambers, soil and encapsulated in slots in carriageways. When customers specify heat shrink joints, joints to specification 667/4/15084/etc. will be used. These joints are only suitable for encapsulation in slots in carriageways.

Where joints are installed in the road surface, the joint is to be made within one metre of the loop, or the nearest loop to the feeder cable where a series of loops are joined together by tails. Slot widths for the various joints are as follows:

915/4/03118/000	40 mm
915/4/031188001	55 mm

When using heat shrink joints 667/4/15084/etc feeder slots to be widened by 10mm for insertion of joint.

Guidance for loop to feeder joint connections as follows:

915/4/03118/000 - Use with 3 pr and 4 pr cables, maximum loop conductor 8

915/4/03118/001 - Use with 3 pr and 4 pr cables, maximum loop conductor 12

667/4/15084/000 - 1, 2 or 3 loops to a 1 pair cable

667/4/15084/001 - 2 or 3 loops to a 1 pair cable, 2 loops to a 2 pair cable

667/4/15084/002 - 2 or 3 loops to a 1 pair cable, 3 loops to a 3 pair cable

667/4/15084/003 - 2 or 3 loops to a 1 pair cable, 4 loops to a 4 pair cable

The depth of slots for joints must be such that their cover of epoxy/asphalt/hot pour is not less than 65 mm. Prior to commencing backfill, the joint shall be laid evenly on the floor of the slot then covered with epoxy resin, and if possible left for 30 minutes before commencing the next operation. Following the application of epoxy resin, fine cold asphalt should be rammed into the slot built up to approximately 10 mm below road level. Following this, the fine cold asphalt must be covered with hot bitumen and allowed to cool.

## 2.10 Cable Entry Through and Under the Kerb

The feeder cable or, where permitted, short lengths of loop tails as described in section 2.6.1, shall be through a duct laid through or under the kerb as shown in Figure 28 and Figure 29. The concrete or cold asphalt shall be compacted into a smooth bed between the floor of the slot and the duct. The cable(s) shall be laid on this bed before backfilling to the road surface.

## 2.11 Loop Detector Settings

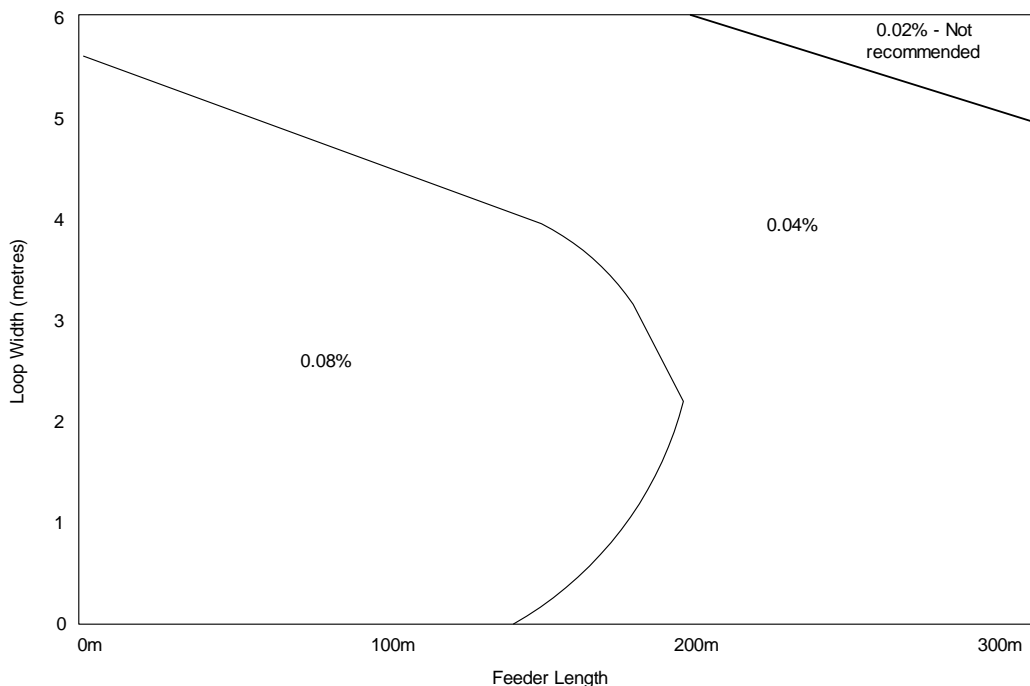
### 2.11.1 Sensitivity

For normal VA purposes the detectors should be set to give bicycle detection. This requires a sensitivity setting of 0.01% or 0.02%. If the setting is too sensitive the detector will be unduly sensitive to vehicles in adjacent lanes. This is most likely where a single small loop is installed on a detector channel i.e. without sharing. If this is a problem on a particular site the sensitivity may be reduced but not to below 0.04%.

For SDE/SA the two loops must be set to the same sensitivity.

For SCOOT, the sensitivity setting depends on the feeder length and loop size (all SCOOT loops are 2 metres in the direction of travel and vary in width). The diagram below may be used as a guide to sensitivity settings. However the target response for a SCOOT detector is that a 'detect' output should start as the first metal part of a normal 4-wheeled vehicle crosses the front of the loop and no response should be obtained from vehicles in adjacent lanes. This should be confirmed or the sensitivity altered to achieve this before leaving the site.

MOVA loops should be set to medium sensitivity (~0.1%) with the exception of stop line loops that should be high sensitivity (~0.1% - 0.5%).

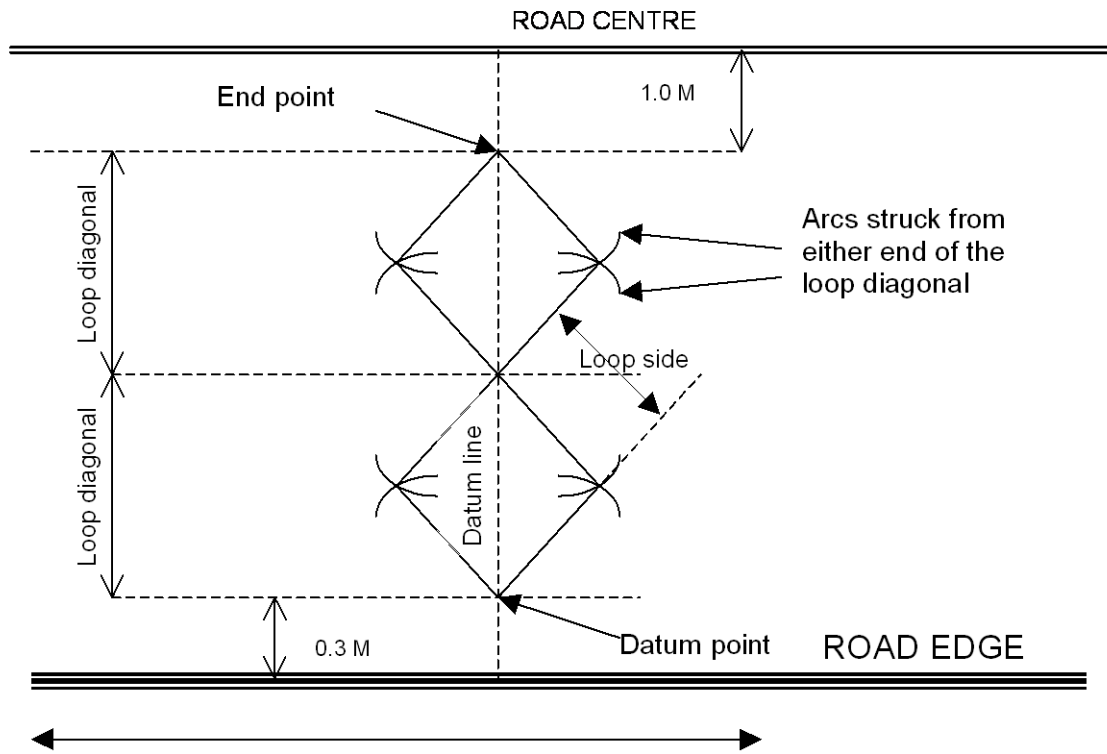


### 2.11.2 Presence Time

This is defined as the time for which a 'detect' output is held when a vehicle enters and stops within a loop. After the presence time has expired the detector retunes to the new value of loop inductance. For Road Traffic use it is normally set to 4 minutes.

**Figure 1 - Marking out Diamond Loops**

(Use for replacement or MOVA only)



See Figure 21 for distance from stop line.

**Figure 2 - Table of Dimensions for Diamond Loops**

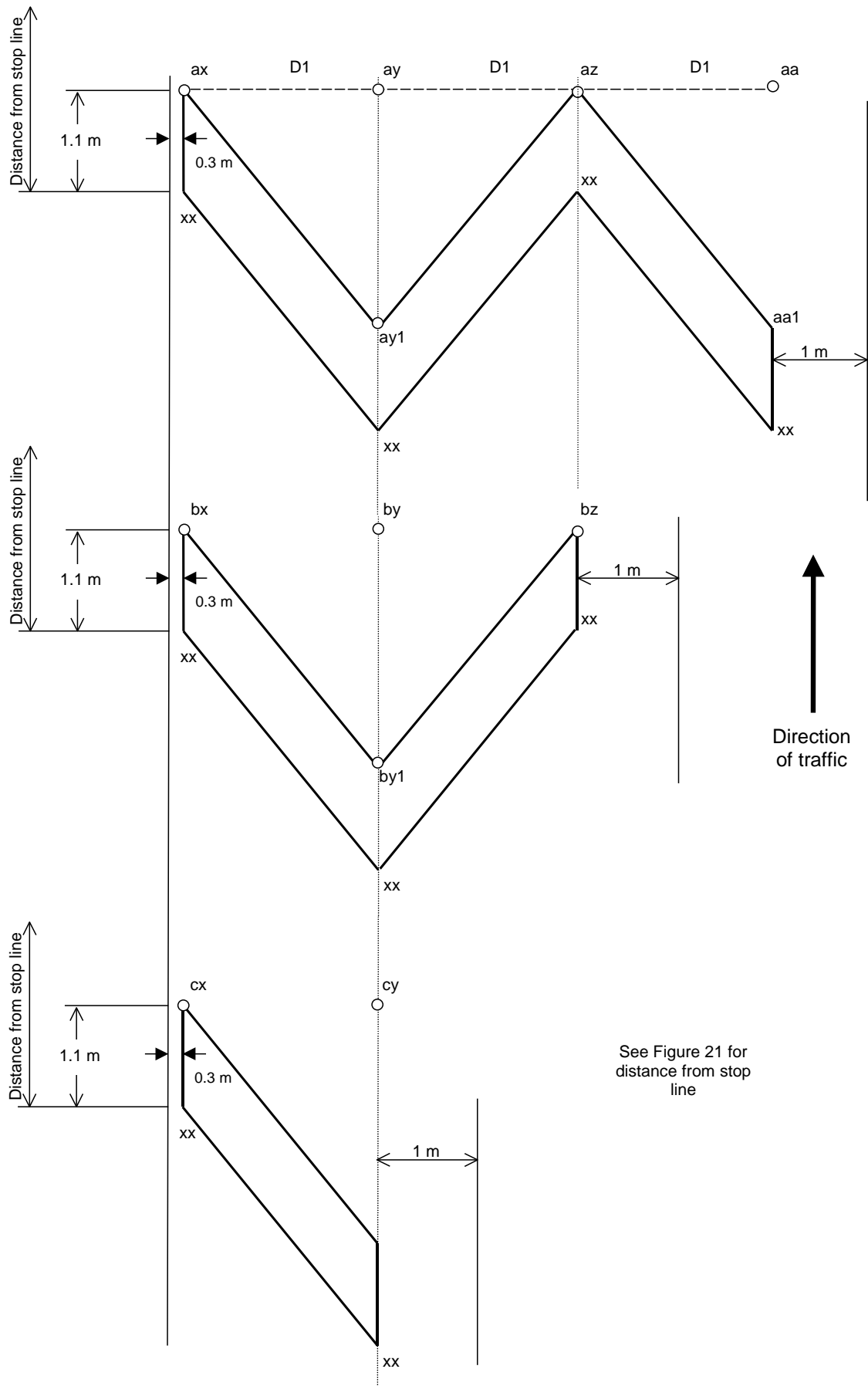
(Use for replacement or MOVA only)

Distance between Datum Point and End Point within the range	Loop Configuration	Example
1.2 – 3.6 metres	Single	
3.7 – 7.2 metres	Double	
7.3 – 10.8 metres	Triple	
10.9 – 14.4 metres	Quad	

## Calculation of Loop Dimensions

Loop Diagonal		Length of Side	
Feet	Metres	Feet	Metres
4.00	1.22	2.83	0.86
4.50	1.37	3.18	0.97
5.00	1.52	3.54	1.08
5.50	1.68	3.89	1.19
6.00	1.83	4.24	1.29
6.50	1.98	4.60	1.40
7.00	2.13	4.95	1.51
7.50	2.29	5.30	1.62
8.00	2.44	5.66	1.72
8.50	2.59	6.01	1.83
9.00	2.74	6.36	1.94
9.50	2.90	6.72	2.05
10.00	3.05	7.07	2.16
10.50	3.20	7.42	2.26
11.00	3.35	7.78	2.37
11.50	3.51	8.18	2.48
12.00	3.66	8.49	2.59

Figure 3 - Marking Out Chevron Loops



See Figure 21 for distance from stop line

Figure 4 - Typical Loop Configurations with UD Dimensions – Diamonds

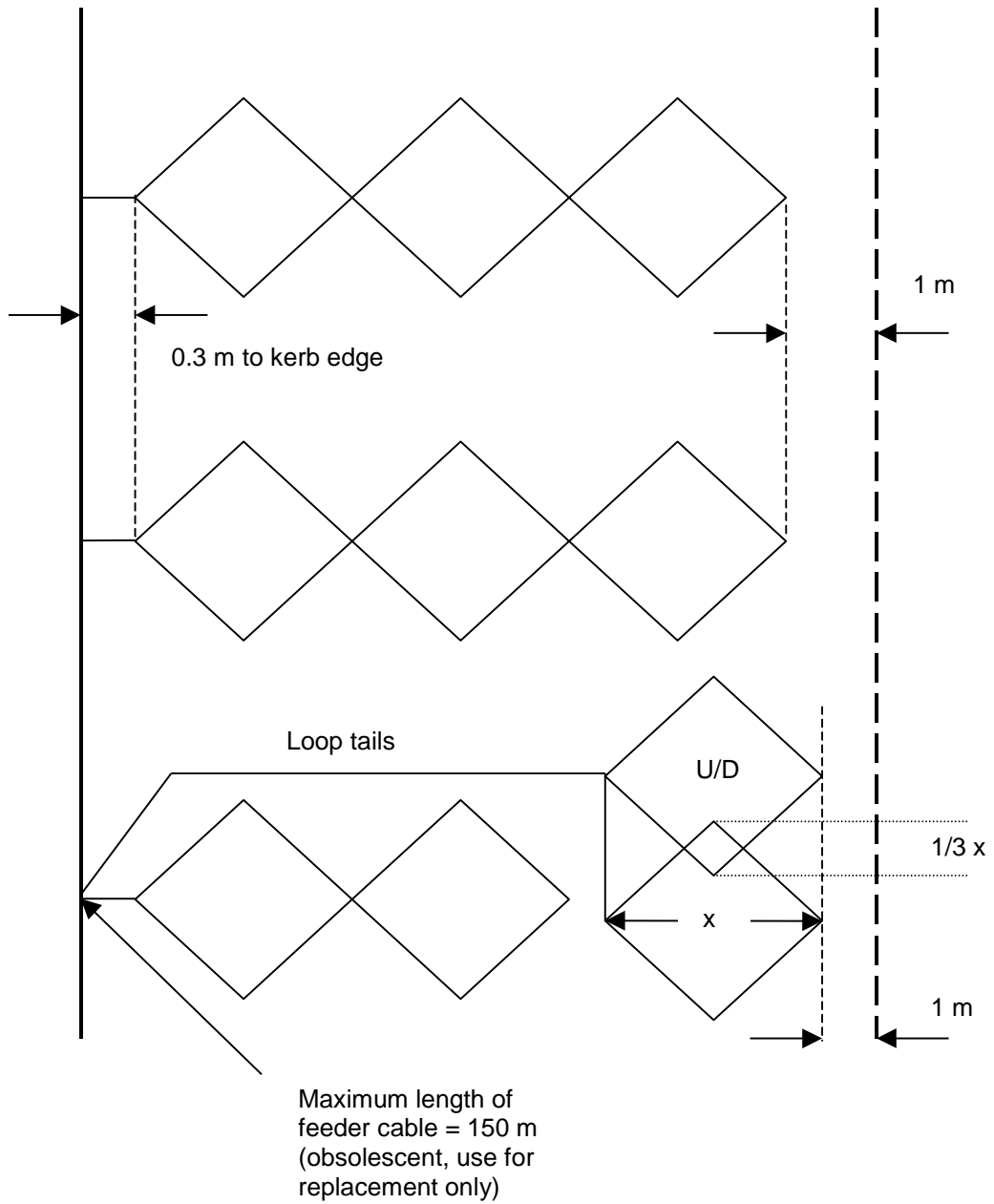
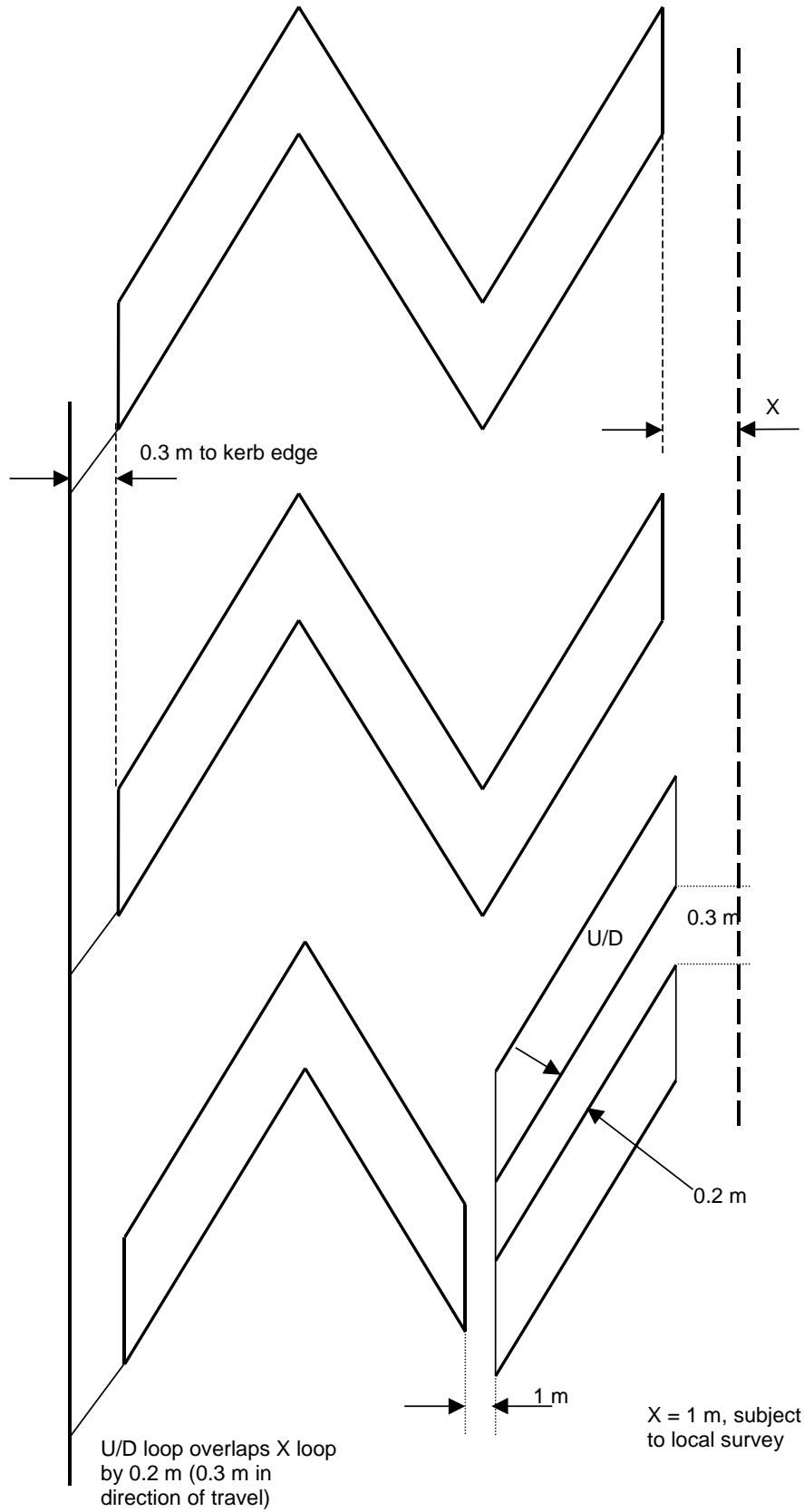
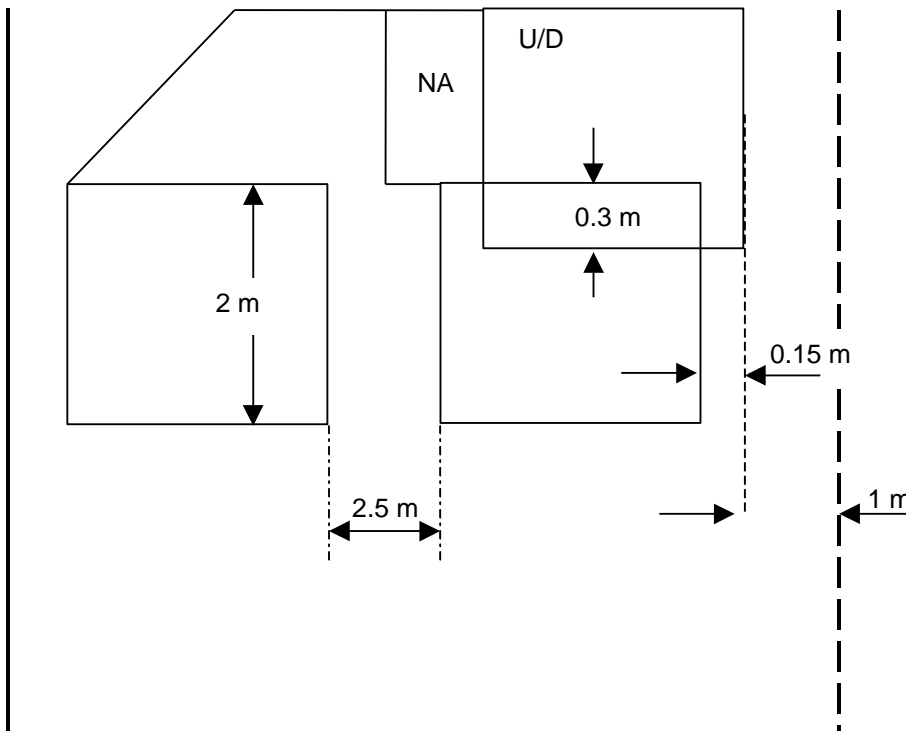


Figure 5 - Typical Loop Configurations with UD Dimensions – Chevrons

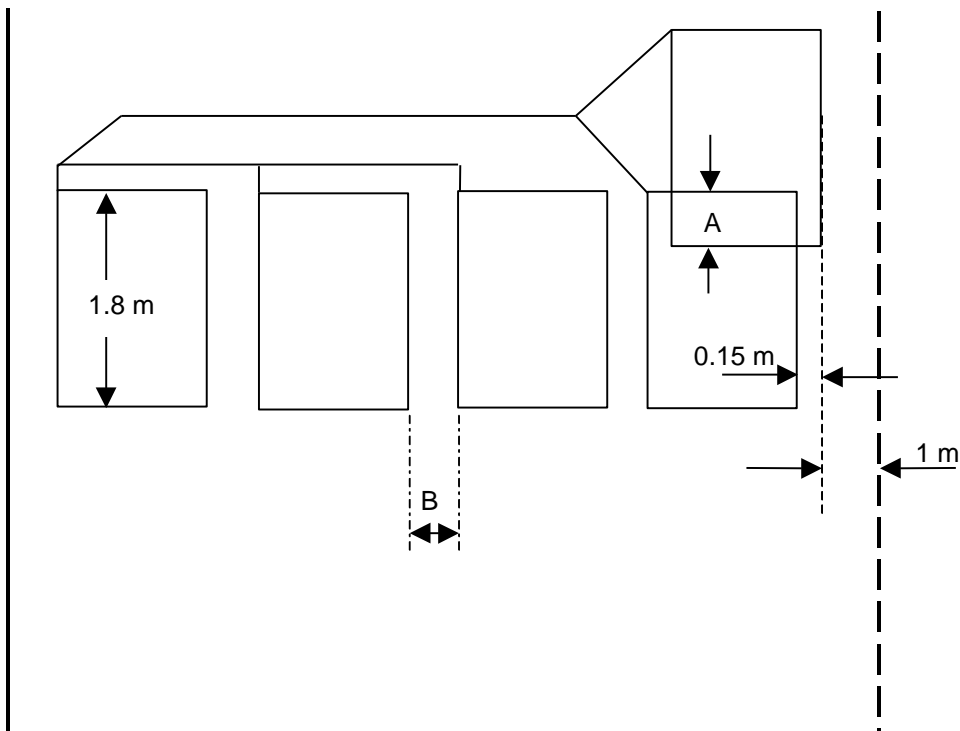




**Figure 6 - Typical SCOOT Loop Leading Dimensions**



**Figure 7 - Typical Count Loop Leading Dimensions**



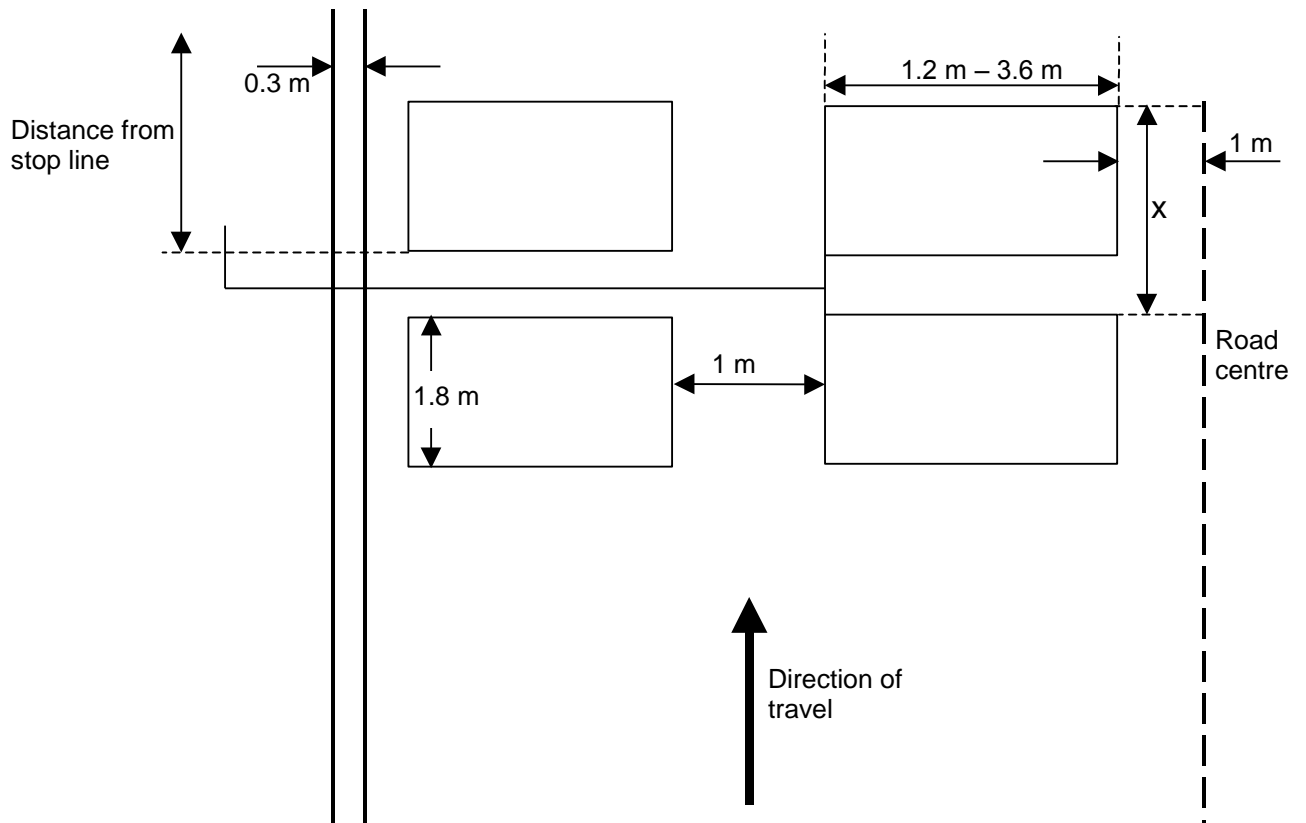
Dimension A = 0.27m

Dimension B = Refer to Figure 23 to Figure 27.

Dimensions to be marked up on STS drawing after installation.

### Figure 8 - Rectangular SDE/SA Loops

Refer also to section 2.3.8 and Figure 10 for SDE/SA loop options.



x = Refer to note in section 2.3.8 for dimensions.

Note that on dual carriageways the loops should be 0.3 metres from the central reservation.

Distance from stop line – See Figure 22.

All loops to be 3 turns.

### Figure 9 - Rectangular Turning Loops

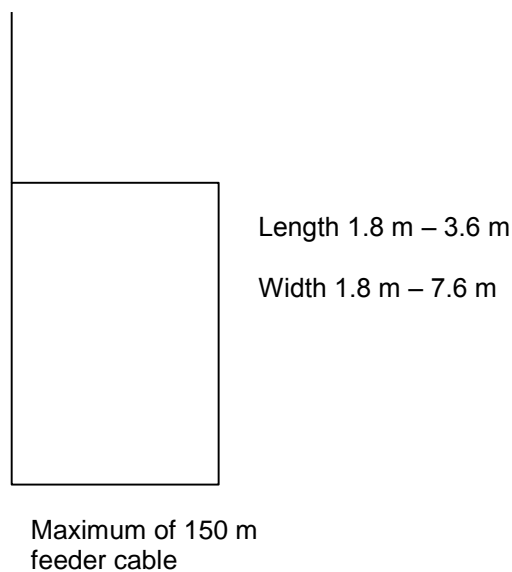
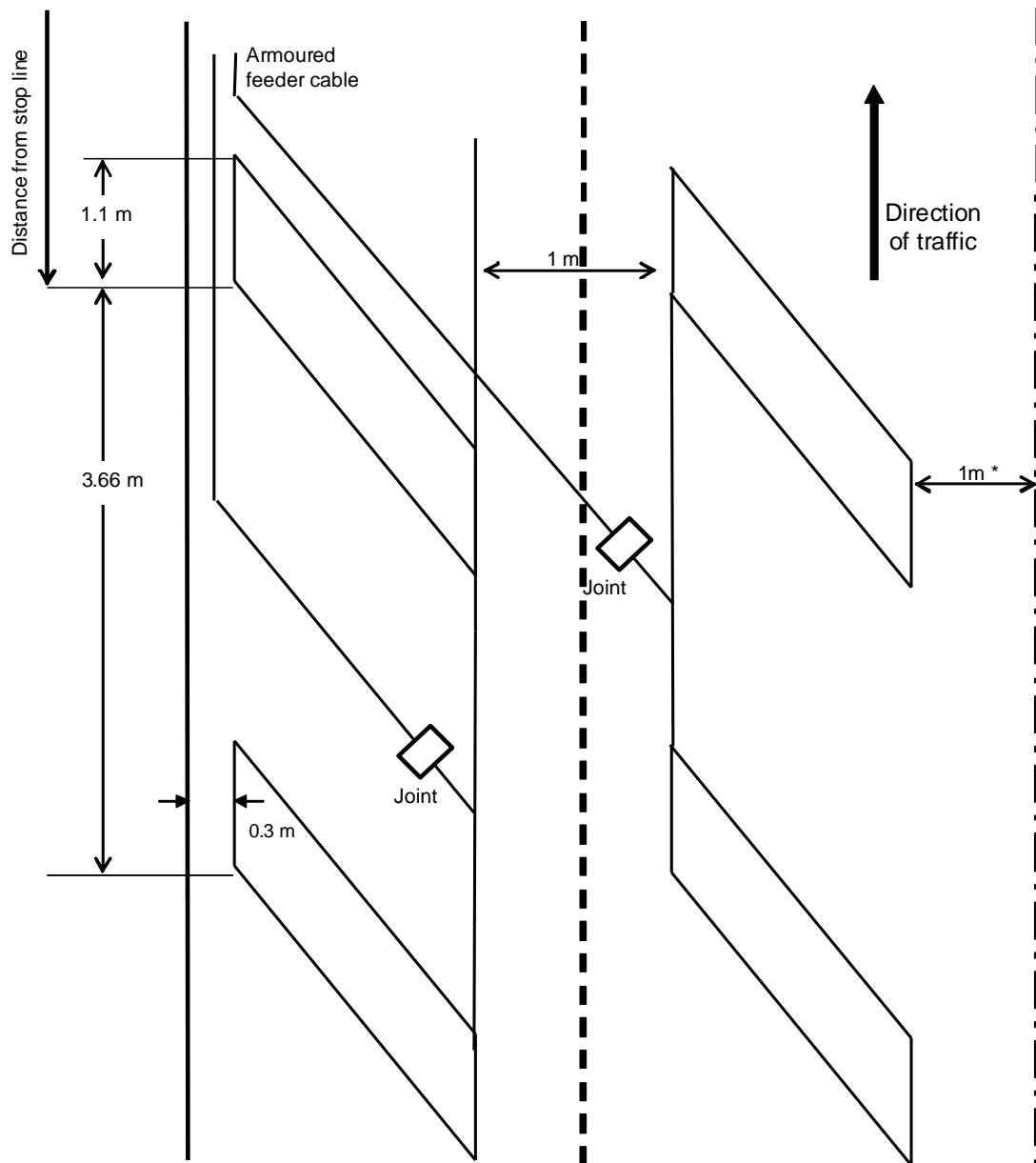


Figure 10 - Chevron SDE/SA Loops



\* On dual carriageways the loops should be 0.3 metres from the central reservation.

Distance from stop line – See Figure 22.

All loops to be 3 turns.

Figure 11 - MOVA Loops One Way Street or Dual Carriageway

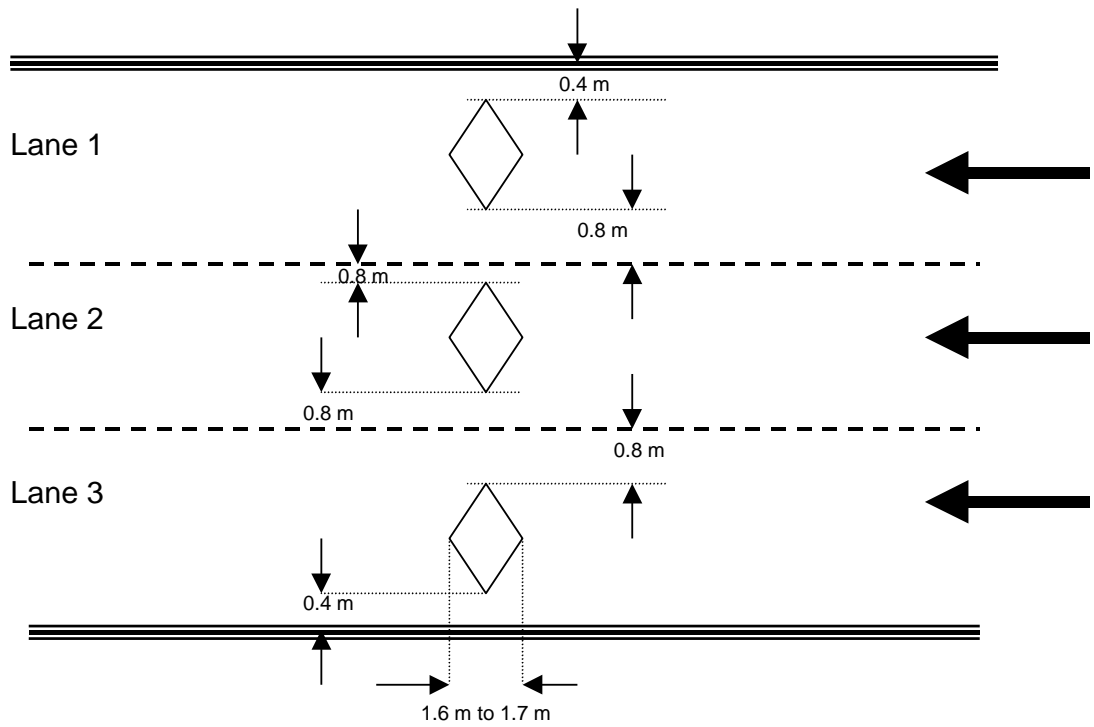
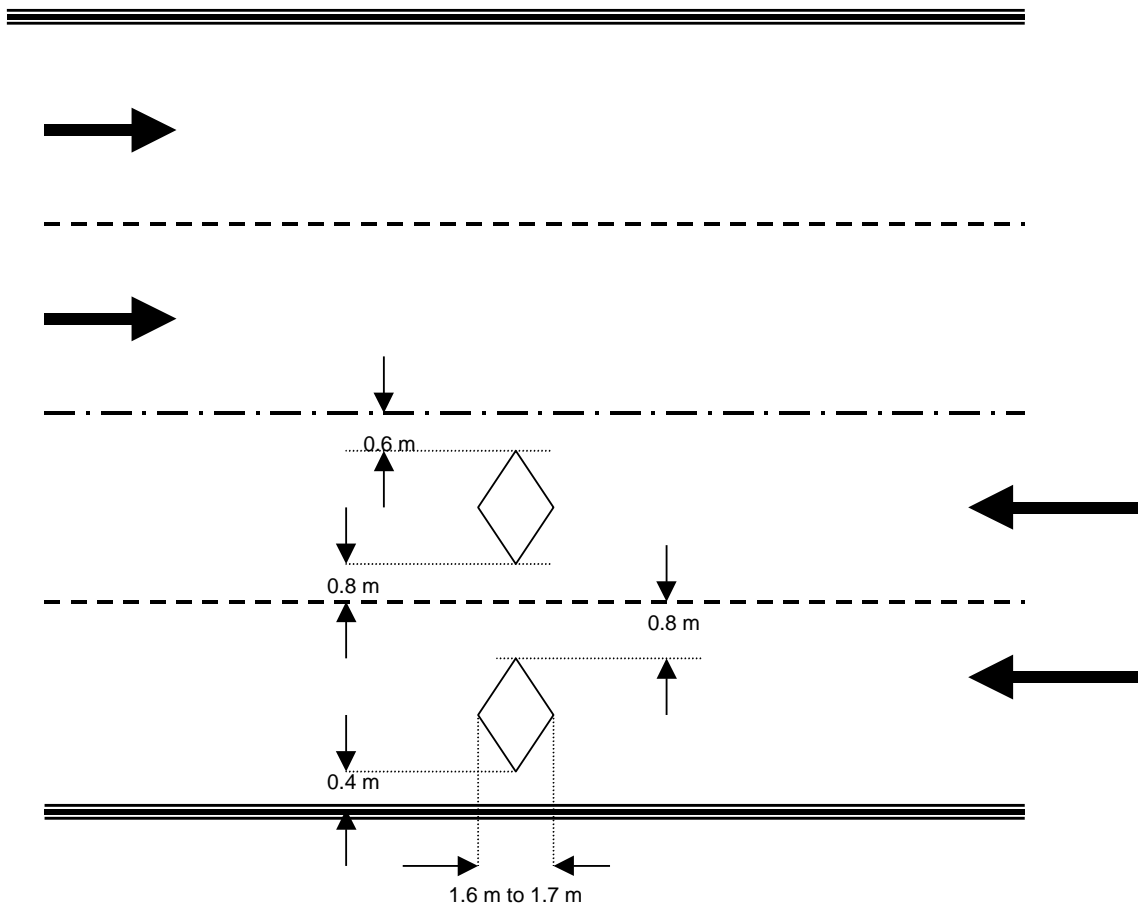
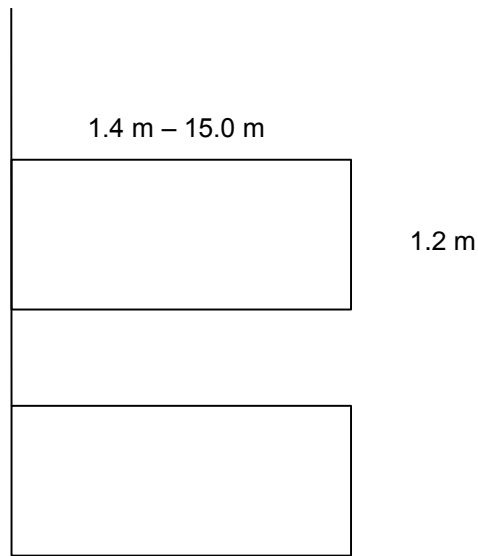


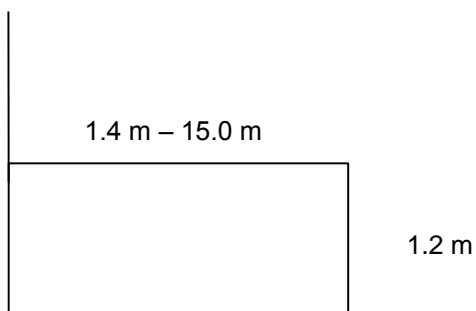
Figure 12 - MOVA Loops Two Way Carriageway



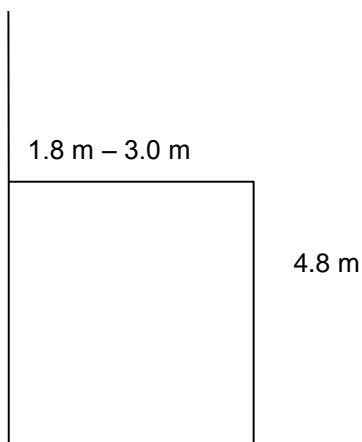
**Figure 13 - Special Purpose Loops**



(a) Call and Extend loops  
Non-bicycle sensitive. Not approved for use on roads in UK.

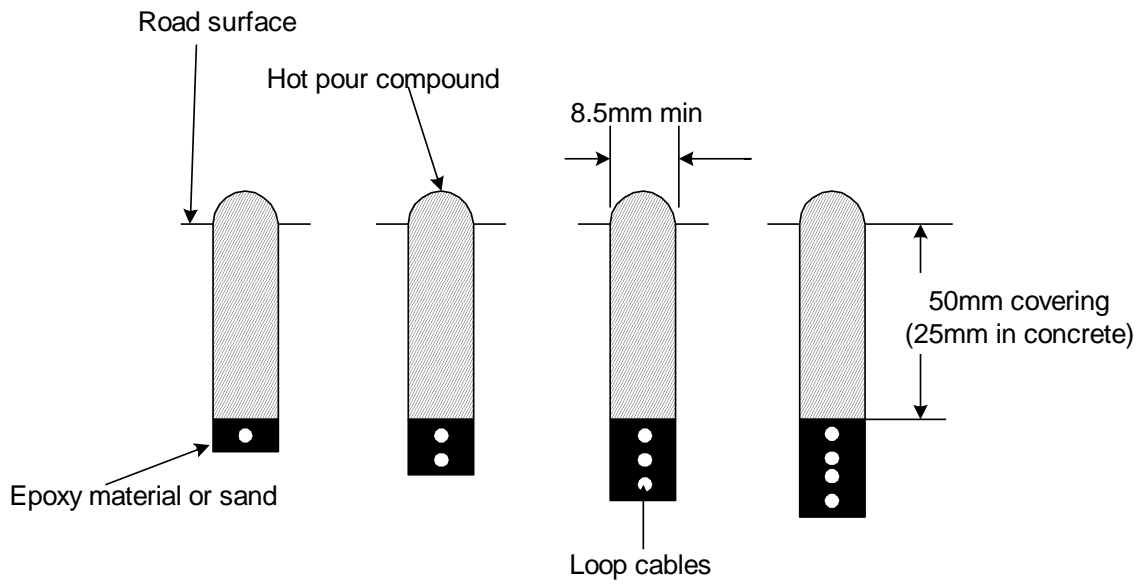


(b) Call and Extend loop  
Non-bicycle sensitive. Not approved for use on roads in UK.

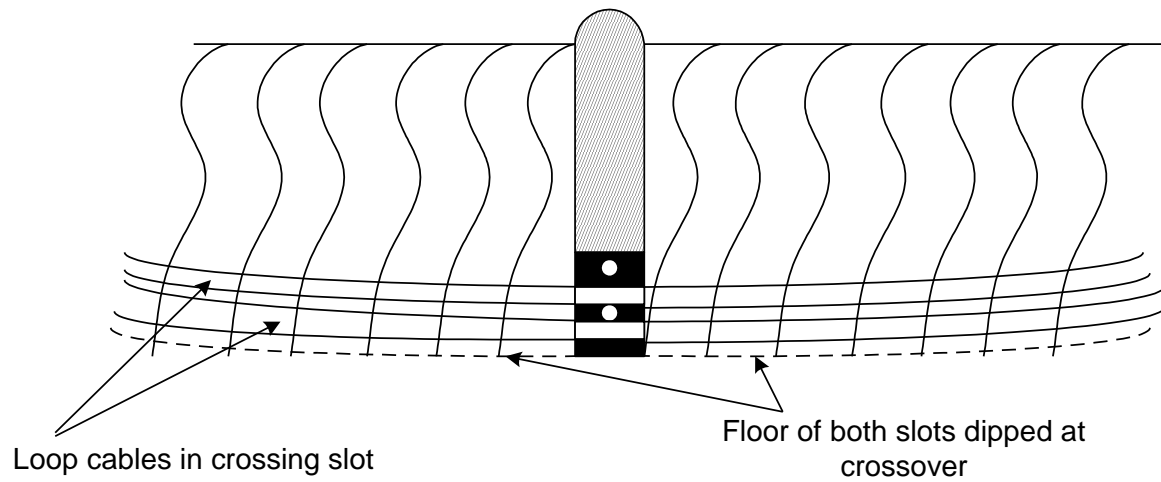


(c) Queue loop

**Figure 14 - Slot Details**

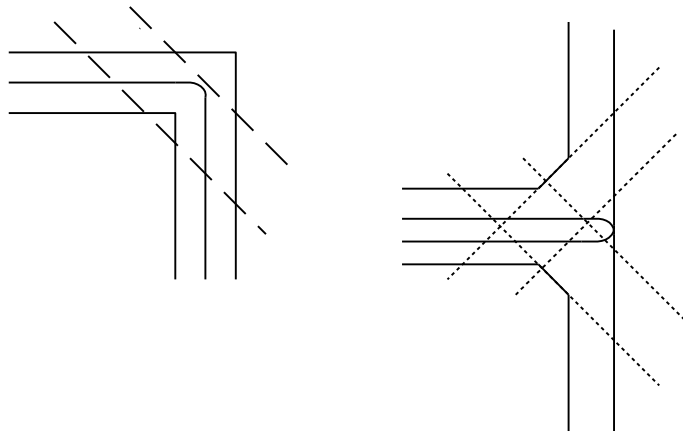


**Figure 15 - Maintaining 50 mm Covering at Crossovers**

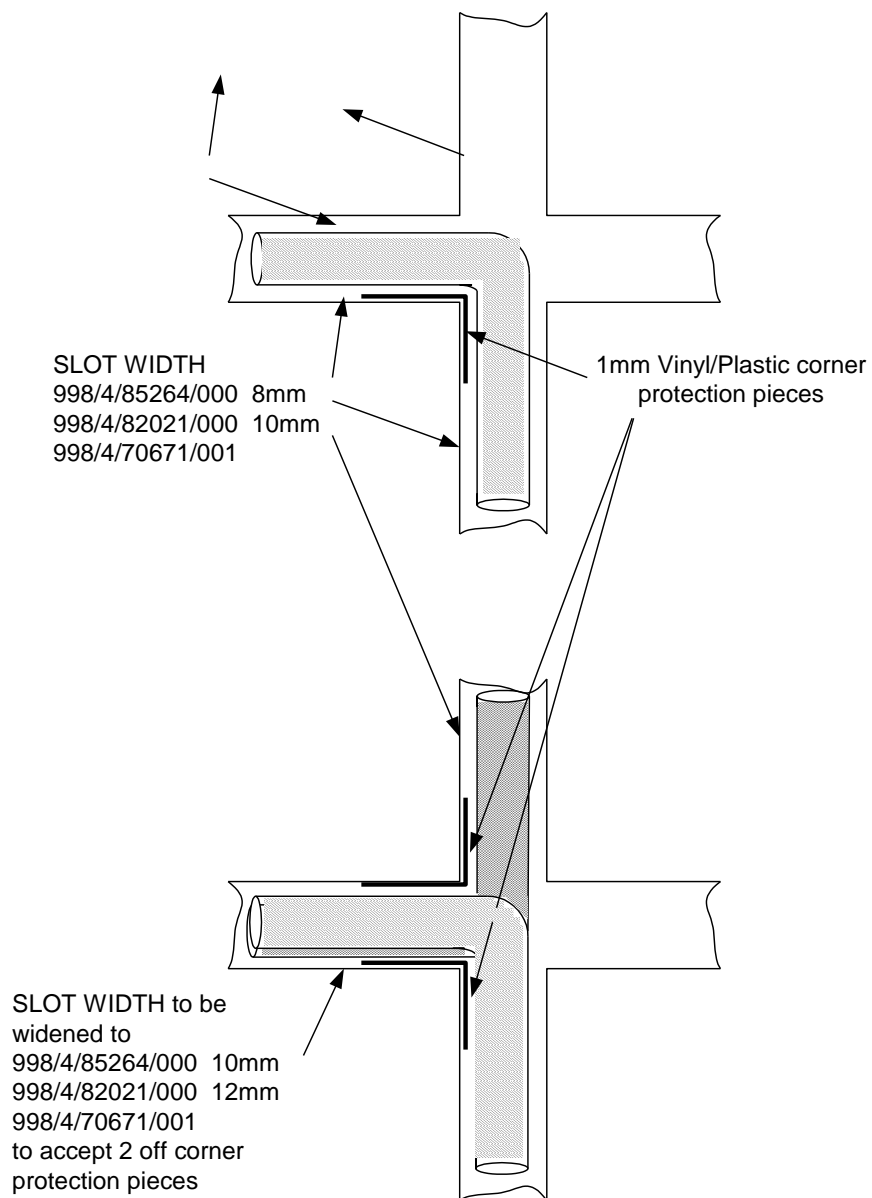


Note: Not to be carried out at diamond crossovers

**Figure 16 - Cutting Away Sharp Corners**



**Figure 17 - Slot Corners Protected by Corner Pieces**



**Figure 18 - Standard Loop Configurations (a)**

(Diamonds are largely obsolescent, use for replacement or MOVA only)

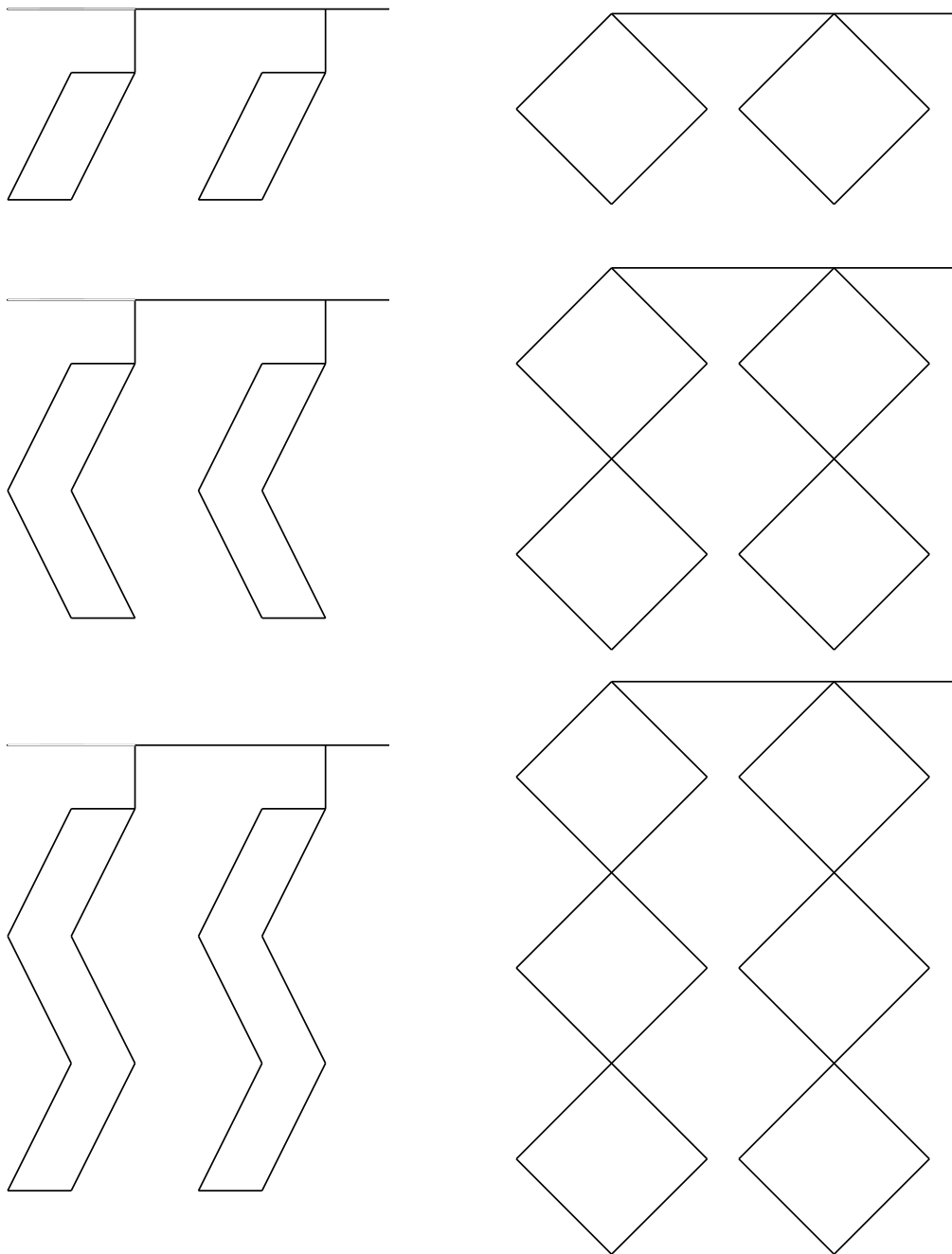
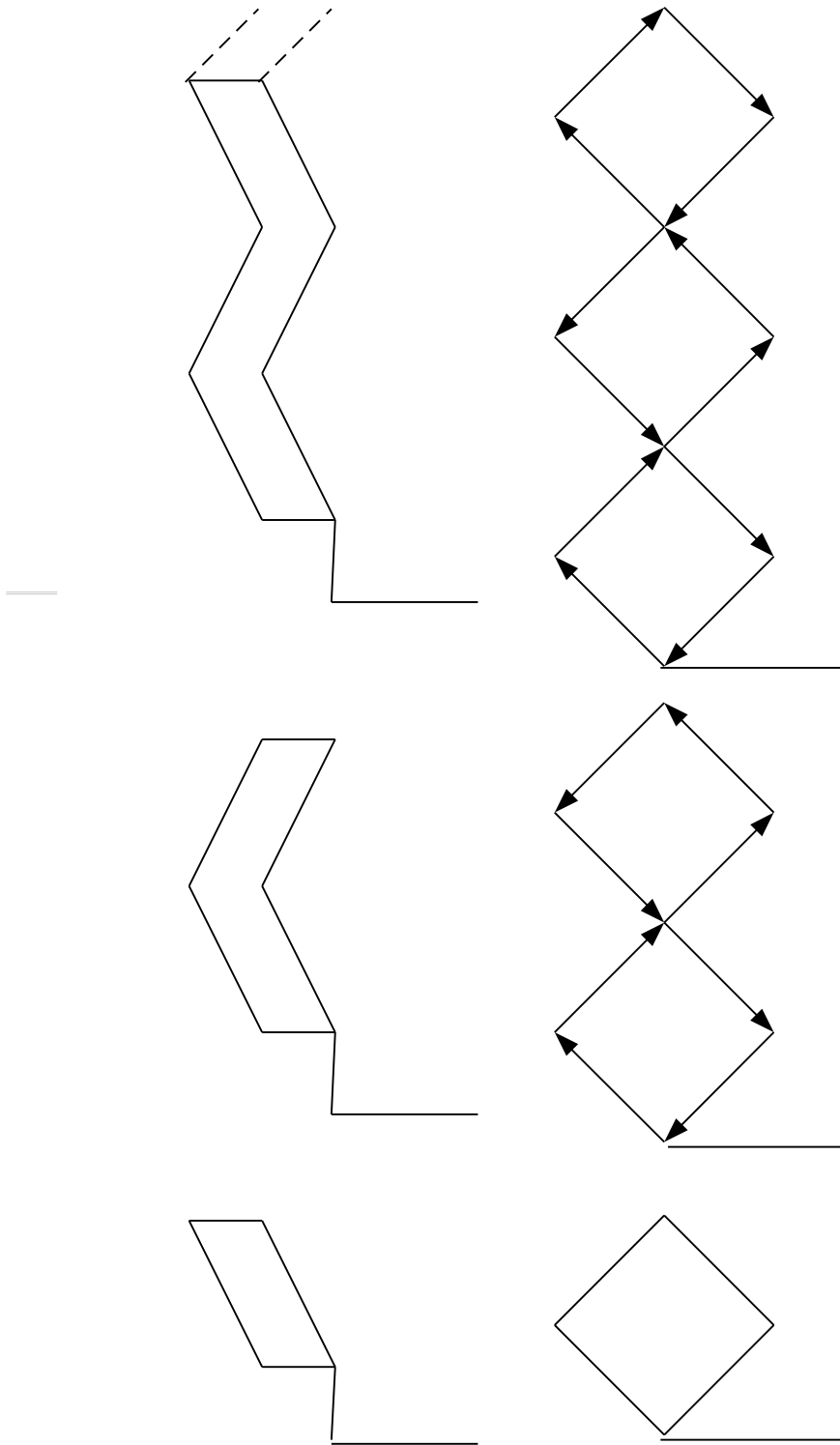




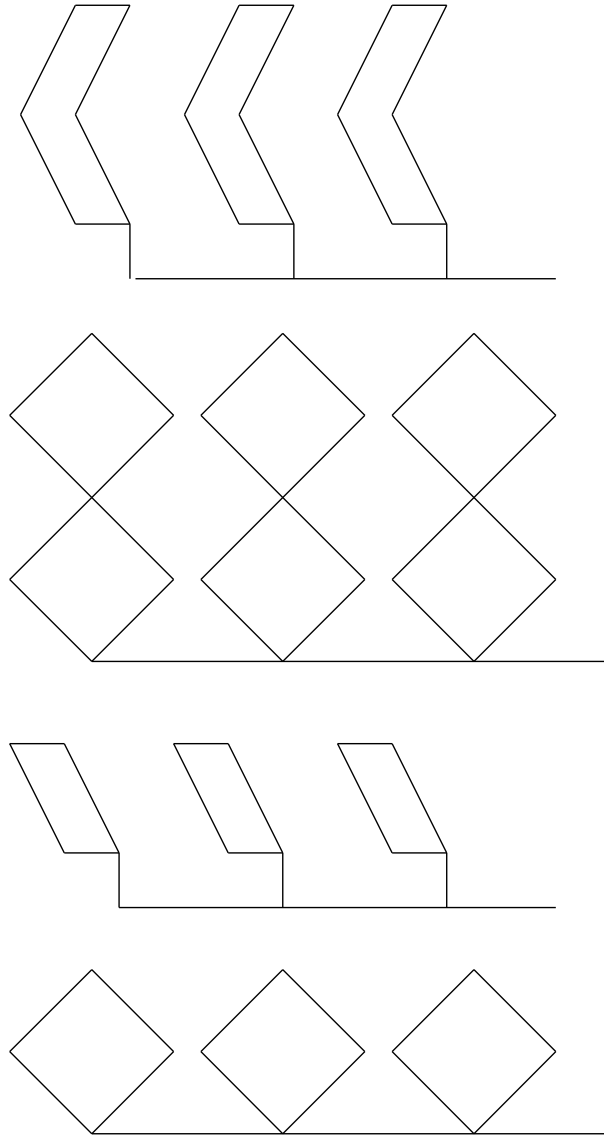
Figure 19 - Standard Loop Configurations (b)



(Diamonds are largely obsolescent, use for replacement or MOVA only)

**Figure 20 - Standard Loop Configurations (c)**

(Diamonds are largely obsolescent, use for replacement or MOVA only)  
 THIS CONFIGURATION TO COVER 6 LANES MAXIMUM AS SHOWN



**Figure 21 - Distance X, Y and Z Loops to Stop Line**

Distance from Stop Line to X loop	Number of Loops	Distance from Stop Line to Y loop	Distance from Stop line to Z loop
39 m	3	25 m	12 m
30 m	3	18 m	7 m
18 m	2	-	6 m

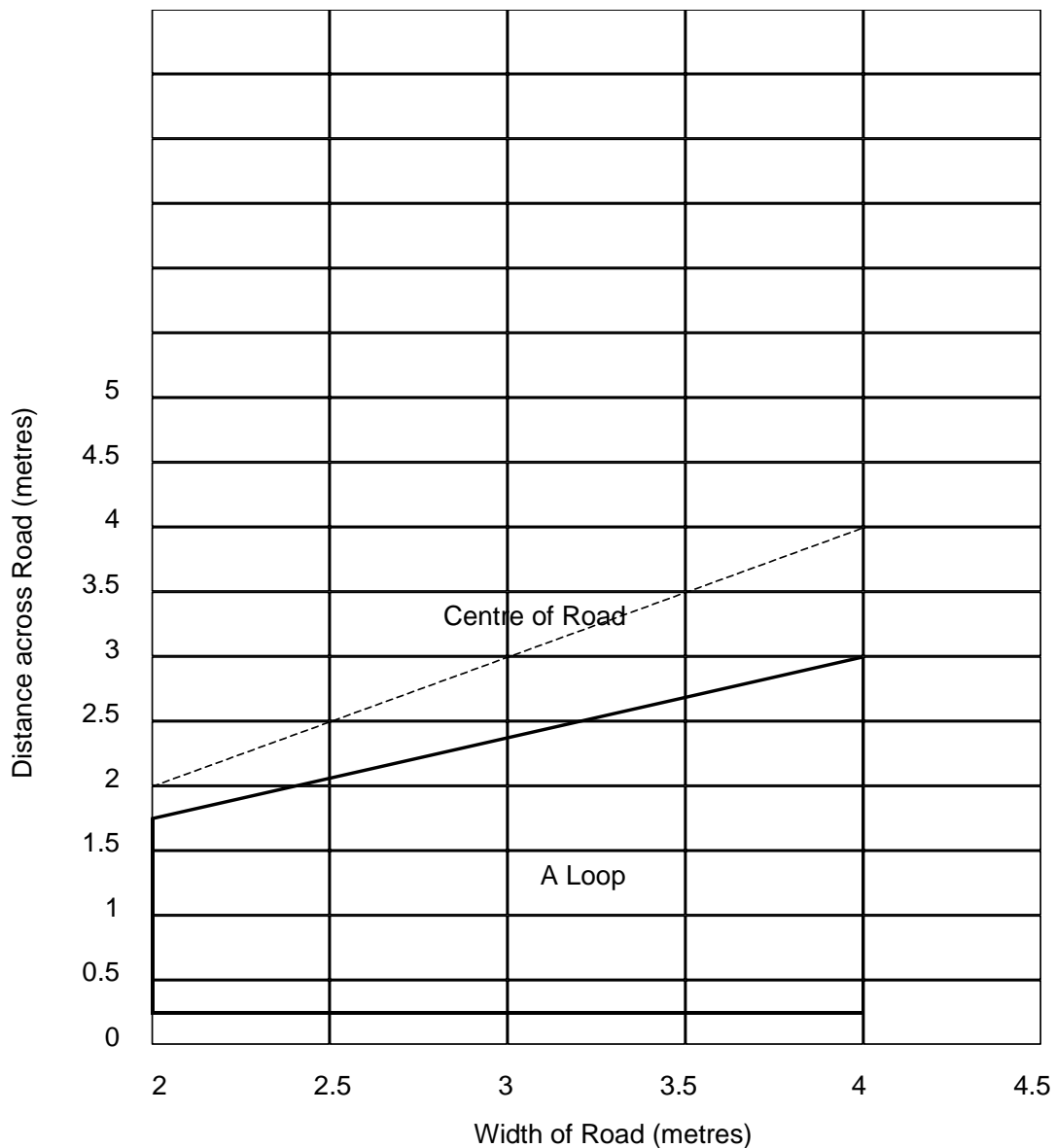
**Figure 22 - Distance SDE-SA Loops to Stop Line**

Traffic Signal and Pelican Extension	Distance
Double SDE	79 metres
Triple SDE – Inner	91 metres
Triple SDE – Outer	159 metres
Speed Assessment	151 metres

Note: For full details refer to HA Specification MCE 0108B.

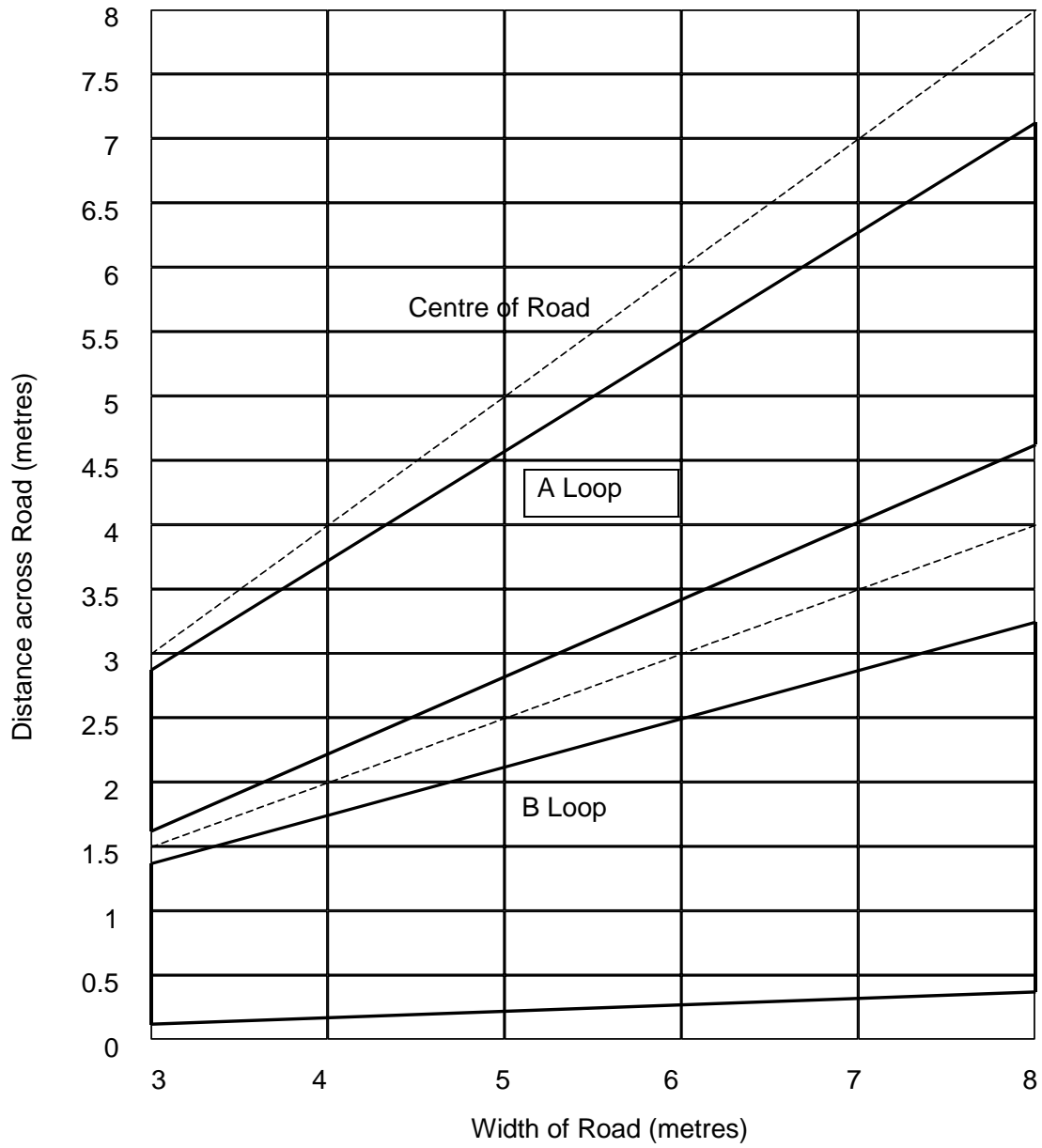
**Figure 23 - Dimensions – 1 Lane Counting Loop**

For full details, refer to HA specification MCE 0115A



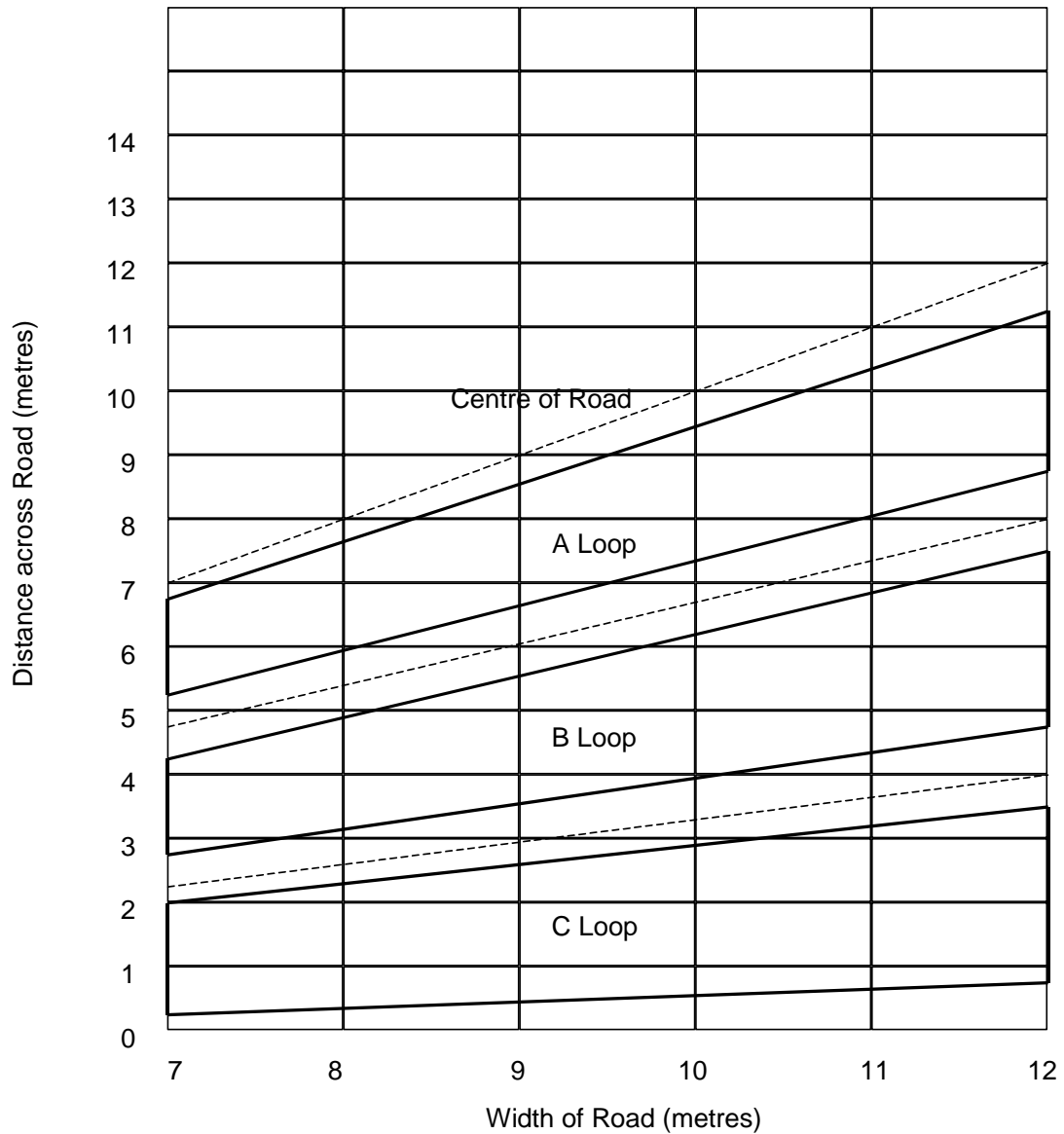
**Figure 24 - Dimensions – 2 Lane N Counting Loops**

For full details, refer to HA specification MCE 0115A



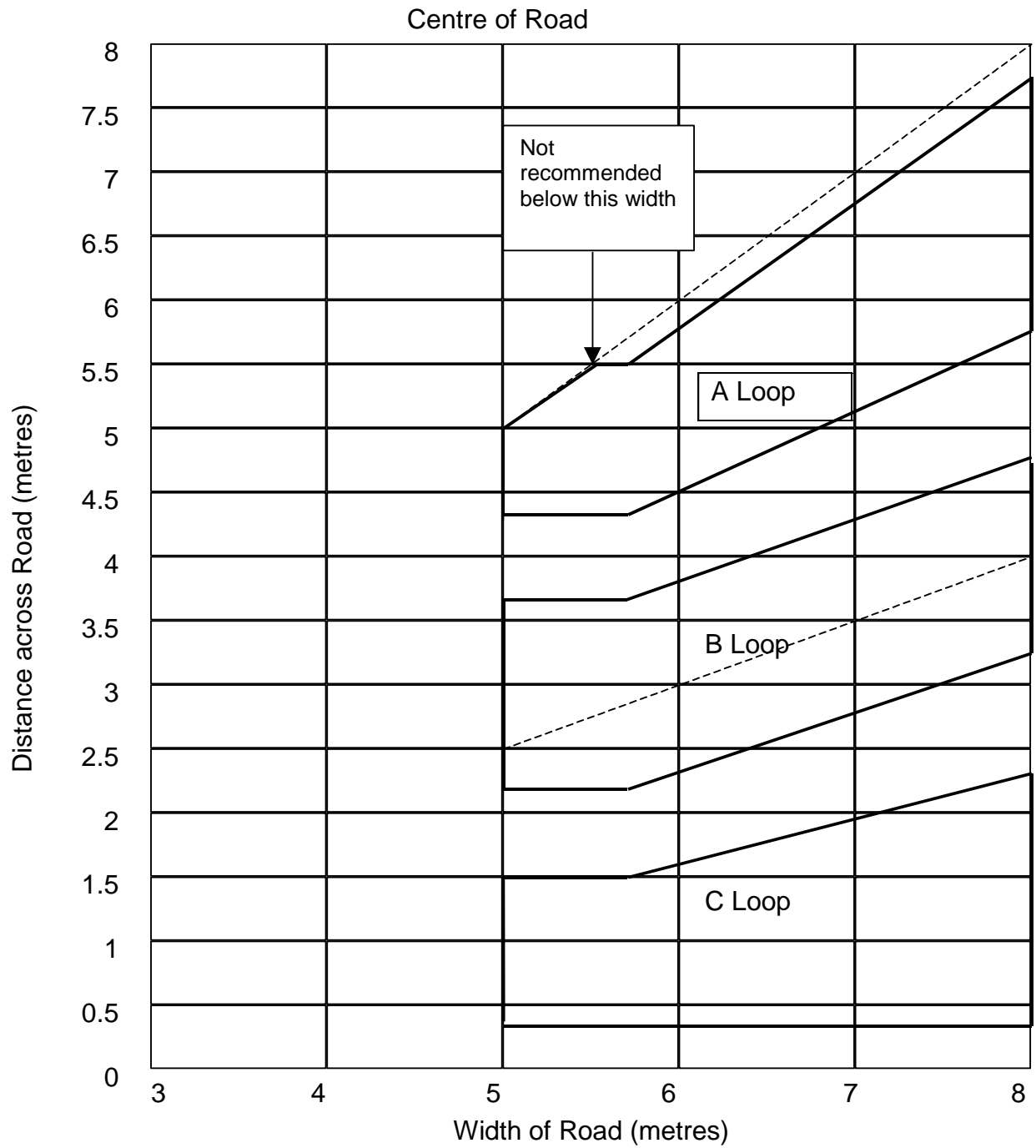
**Figure 25 - Dimensions – 3 Lane N Counting Loops**

For full details, refer to HA specification MCE 0115A



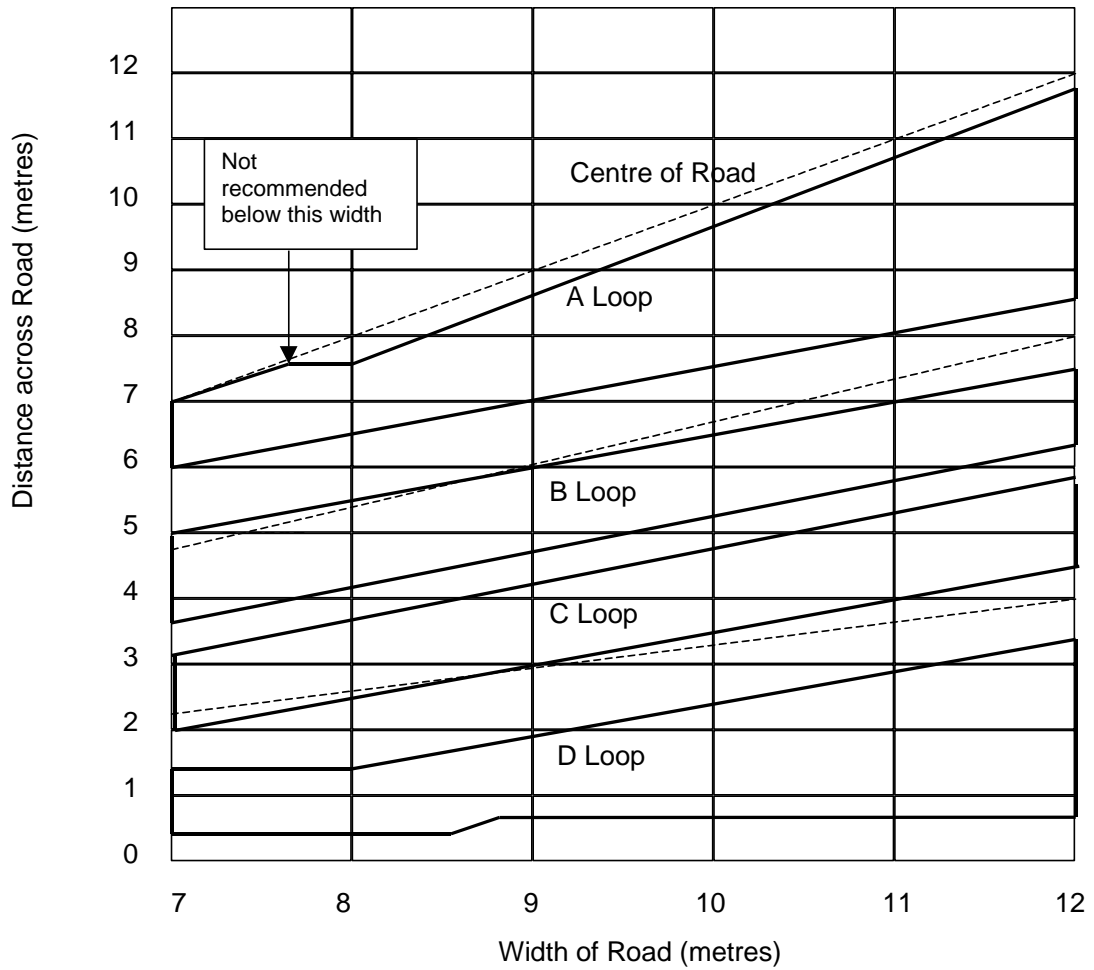
**Figure 26 - Dimensions – 2 Lane N+1 Counting Loops**

For full details, refer to HA specification MCE 0115A



**Figure 27 - Dimensions – 3 Lane N+1 Counting Loops**

For full details, refer to HA specification MCE 0115A



**Figure 28 - Cabling Through the Kerb**

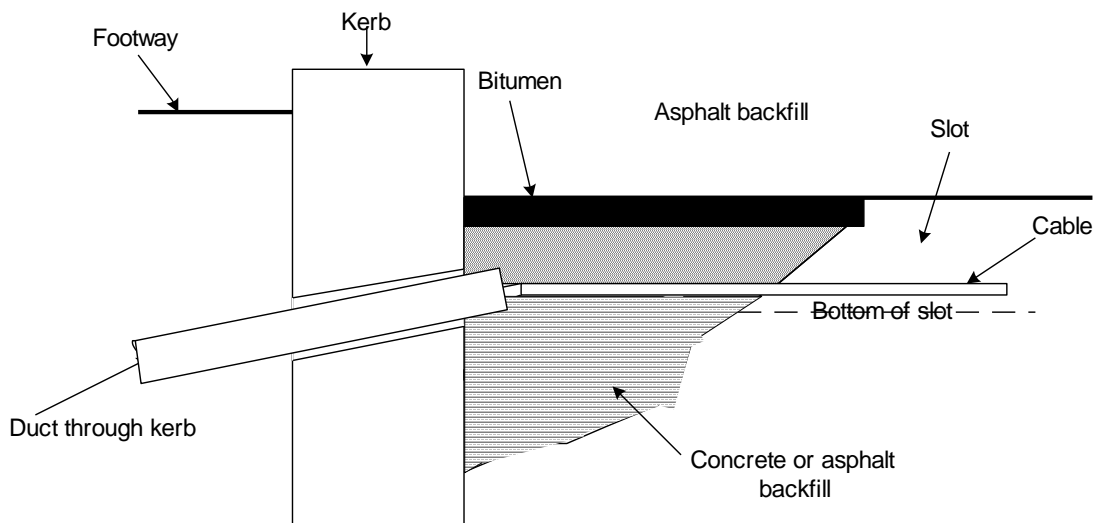
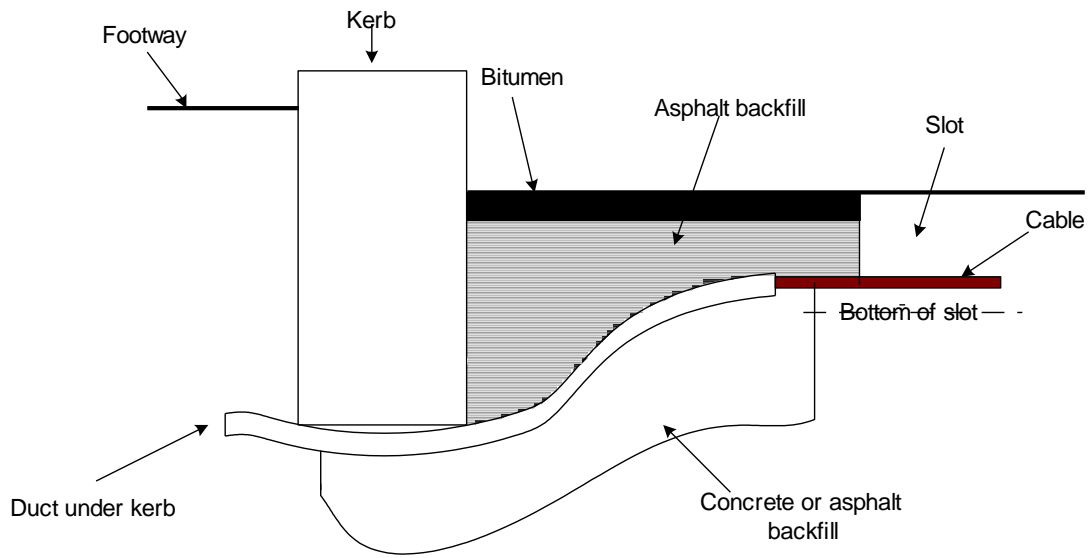


Figure 29 - Cabling Under the Kerb





## 3. CABLING

This section applies to paired loop feeder cable and multicore cable to Detector Pole Boxes and Signals Heads.

### 3.1 Cabling and Preparation of Cables for Termination

1. Traffic intersections are cabled in accordance with the schedule shown on the STS drawing.
2. Prior to commencing cabling, the operation should be planned so that, as far as possible, cable drums are handled as little as possible and the number of cable drums transported to site reduced to a minimum. During the laying of cable, cable jacks or drum rollers should be used to advantage, especially on long cable runs.

### 3.2 Cabling Jointing

In traffic signal installation work there are two types of cable joints that have to be made. These are feeder cable to feeder cable and feeder cable to detector loop tails. The feeder cable may be armoured or un-armoured.

All jointing of feeder cable to feeder cable should use the BICC MPJ series (MPJ1 or MPJ2) resin filled torpedo joint unless the customer specifies other jointing systems.

Jointing of feeder cable to detector loop tails will use the same joint unless the Authority specifies a heatshrink or other type of joint. Refer to section 2.7 for identification of pairs.

Some Authorities are specifying joints based on short lengths of cable duct with cable duct plugs. The manufacturers' instructions must be followed in particular in ensuring good contact and joint sealing. Any instructions regarding moisture-removing precautions must be strictly adhered to.

#### 3.2.1 Feeder Cable to Feeder Cable using the BICC MPJ Series Joint

Ignore instructions marked \* referring to armour where not applicable.

Assumes MPJ1 or MPJ2 jointing kit used. See Figure 30 and Figure 31.

The following additional items are also required if armoured feeder is to be joined:

PVC insulated wire - green/yellow 6 sq. mm.

Earthing bands – 2 off.

Worm drive clips – 2 off.

\* Cut the earth wire to length and bare the ends.

\* Using the hacksaw provided in the installation tool kit cut through the outer insulation of one cable approximately 120 mm from the end ensuring that the armour is well scored.

- \* Remove the outer insulation and break off the armour by repeated bending.
- \* Cut through the outer insulation 50 mm from the end of the armour without cutting into the armour.
- \* Remove outer insulation.
- \* Terminate the bedding so that 10 mm projects beyond the armour.
- \* Slide a worm drive hose clip over the cable. Open the armour and position the earthing band underneath. Lay the earthing wire end with the armour and bring the worm drive hose clip forward to secure the earthing wire and armour down onto the earthing band. Tighten the clip to achieve a good mechanical and electrical joint.

For non-armoured cable cut through the outer insulation of one cable approximately 120 mm from the end to reveal the inner cores with their insulation.

Repeat for the other cable end.

Cut cable cores to length ensuring that the joints will be staggered and crimp using blue crimps.

Insulate each crimped joint as required.

Cut the stepped ends of the shell halves so that they fit over the outer insulation of the cable without interference, but at the same time, giving minimum clearance in order to avoid eccentricity.

Check, and adjust as necessary, the clearances between the joint components and the joint components and the shell.

Clean the outer insulation at the box entry positions with a dry cloth. Position the box shells centrally round the joint and secure them together by hand, tightening the cable ties provided, ensuring that the tightening does not distort the half shells and thus destroy the resin seal. Remove the backing tape from the sealing tape provided and wrap the sealing tape round each stepped end and stretching it sufficiently to form a seal between shells and outer insulation. Mix the resin in accordance with the instructions given in section 3.2.3 and pour resin into the box through the central opening until the box is full.

Fit the central filling cover plate by bending it slightly along its length and snapping it into position.

If the joint is not positioned at its final location prior to pouring the resin it must be left to cure before being placed in its final location.

### **3.2.2 Feeder Cable to Loop Tails using the BICC MPJ Series Joint**

Assumes MPJ1 and MPJ2 jointing kit used.

Prepare feeder cable as described in section 3.2.1.

Cut cable cores and detector loop tails to length ensuring that the joints will be staggered and crimp using blue crimps.

Insulate each crimped joint as required.

Cut the stepped ends of the shell halves so that they fit over the outer insulation of the cable and the bundle of detector loop tails without interference but, at the same time, giving minimum clearance in order to avoid eccentricity.

Continue as described in section 3.2.1.

### 3.2.3 Preparation, Mixing and Pouring of BICC Bi-Cast Acrylic Resin

The resin is provided as a two-part mix. The powder component is in a plastic bag and the liquid component in a tin.

Check the last two digits of the style reference numbers are identical, e.g.

BC 73190 - 57 (Powder)

BC 73195 – 57 (Liquid)

If the last two digits are not the same, **on no account** should they be mixed together.

Check that the use-by date printed in the powder label has not been exceeded.

Mixing must take place away from naked lights. Avoid exposure of the tin to hot sun as heat could cause a pressure build-up in the tin. In the event of such exposure the tin of liquid should be pierced at arms length to guard against a jet of wet vapour onto the face.

Carefully unfasten the bag, unroll the free end and remove the clip.

Allow air into the bag and re-roll the open end several times round the clip to effect a seal and entrap air.

Grip the bag securely at each end and up-end it 4 or 5 times to disturb the powder settlement, paying particular attention to the bag corners.

Open the tin of liquid, unroll and open the bag. Pour all the contents of the tin into the bag ensuring spillage of liquid does not occur.

Fold the corners of the bag to the middle and roll around the clip several times to effect a seal and entrap air.

Grip the bag securely at each end and thoroughly mix the liquid and powder. This is best achieved by holding the bag vertically for  $\frac{1}{4}$  minute to allow the powder to settle into the liquid, shaking the bag top to dislodge powder from the corners and repeatedly oscillating the bag through 180 degrees with a tumbling action (speeding up as mixing progresses) for  $\frac{1}{2}$  minute. Finish off with a more vigorous end to end shaking of the bag for a further  $\frac{1}{4}$  minute.

Remove the clip and re-wrap it diagonally across the corner of the open end of the bag to provide a convenient sized pouring hold and handle to assist the pouring operation. The resin should be poured through the filling port immediately after mixing. Top up if necessary.

Fit the cover plate.

Adequately support the joint both underneath at each end before backfilling the joint hole. Backfilling may take place immediately or be delayed until the resin has set hard.

**CAUTION: Certain individuals are susceptible to sensitisation and if a skin rash develops medical advice should be sought. Any resin splashes on the skin should be removed before the resin hardens.**

### 3.2.4 Feeder Cable to Detector Loop Tails using the Heatshrink Joint

The part number of the kit to be used is 667/4/15084/etc.

There are 4 variants. Their uses and the length of armour to be stripped (where applicable) are given below:

000	-	1 pair to 1, 2 or 3 loops	(80 mm)
001	-	2 pair to 2 loops or 1 pair to 2 or 3 loops	(100 mm)
002	-	3 pair to 3 loops or 1 pair to 2 or 3 loops	(120 mm)
003	-	4 pair to 4 loops or 1 pair to 2 or 3 loops	(135 mm)

Feed the outer sleeves onto the feeder cable.

For armoured cable:

Using the hacksaw provided in the installation tool kit cut through the outer insulation of the cable at the dimension given above from the end ensuring that the armour is well scored.

Remove the outer insulation.

Break off the armour by repeated bending.

Terminate bedding so that 10 mm projects beyond the armour.

For un-armoured cable:

Remove the outer insulation at the dimension given above for stripping armour.

Cut cable cores to length ensuring that the joints will be staggered and crimp as described in section 3.3.

Wrap black mastic tape around the end of the armoured cable, in and around the connectors and loop tails and squeeze.

Centre up the outer sleeve allowing 75 mm overlap on the armour cable and clean cable ends with cleaning pads.

Starting up at the centre of the joint and using a heating torch shrink evenly to both ends until mastic sealant is visible.

Allow the joint to cool before applying any mechanical strain.

### 3.3 Use of Crimp Tools in Jointing

The following procedure is to be adopted when preparing cables for jointing in BICC or similar joint kits.

Prepare the feeder cable as detailed for the type of joints and the joint kit to be used.

Cut the conductors to length ensuring that the joints will be staggered within the joint shell. The outer sheath must project at least 50 mm into the joint shell in the finished joint and no crimp joint should be closer than 75 mm to the end of the shell.

Remove 12 mm of insulation from each core.

Slide a rubber grommet over the core.

Prepare loop tail ends as in section 3.2.4. If one tail end only is to be crimped in a crimp sleeve, remove 24 mm of insulation from the tail and double the end back prior to crimping. This will ensure that a secure crimp is made.

Insert the prepared core and tail end(s) into opposite ends of the crimp sleeve, allowing a 2 mm protrusion at each end and crimp both ends of the sleeves using the correct crimping tool. The crimps must be made in the same plane.

Position the rubber grommet in the centre of the crimped sleeve and visually inspect the completed crimp to ensure that no loose strands are present.

Apply a pull test to each crimp joint.

Complete the assembly of the joint in accordance with the appropriate section.

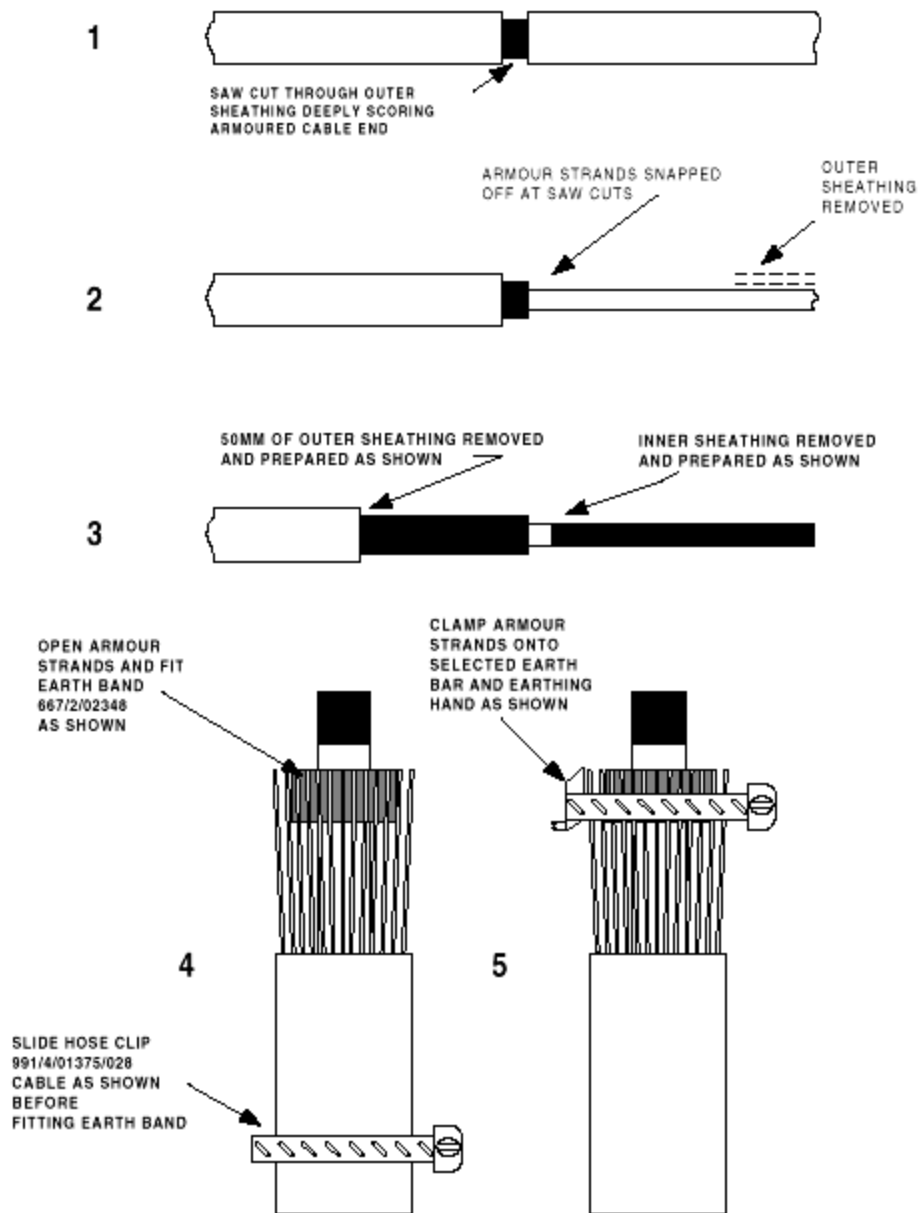


Figure 30 - Preparation of Armoured Cable End

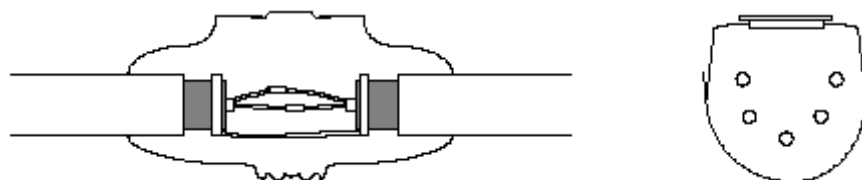


Figure 31 - Armoured Cable to Armoured Cable Joint

## APPENDIX A - PRECAUTIONS TO BE TAKEN WHEN PLANNING THE INSTALLATION AND MAINTENANCE OF TRAFFIC CONTROL EQUIPMENT IN THE VICINITY OF LIGHT RAPID TRANSPORT SYSTEMS

### Introduction

The details given in this Appendix are designed to assist in the planning of installation and maintenance of traffic control equipment in the vicinity of LRT systems. Advice is given on the prevention of accidental contact between LRT track or vehicles and street furniture, which would permit traction current to return through the Traffic control equipment earthing system.

### Reference Documents

The following documents were consulted in the preparation of this Appendix:

GEC Alstom Transportation Projects Limited report no. TPL25/S/026 – Earthing and Bonding Policy for Manchester Metrolink.

GEC Alstom Transmission and Distribution Projects Limited report no. S/Sdq 856 – Metrolink Report on Touch Voltages for Phase 1 dated 19<sup>th</sup> October 1990. Reference 732/XREP27.

### Background

LRT track and the vehicles running on it may be at a potential other than the local earth potential. This is due to track resistance and the return traction current flowing through it.

In the Manchester Metrolink system the highest track/vehicle potential, known as the “touch voltage” is estimated to be 34.9 V for trains crush loaded on minimum headway and 109 V under short circuit fault conditions. The fault is said to persist for a maximum of 100 ms.

The traction current is DC and the resulting track/vehicle potential is said to be safe for humans from the touch voltage point of view.

However, the source impedance could be low and it is desirable to prevent the touch voltage coming into contact with traffic control equipment street furniture and cables that are bonded to the electricity supply earth.

Any contact could cause heavy currents to flow, which would give rise to excessive temperatures in the earth conductors of the traffic control equipment, with resultant fire and explosion risk.

The recommendations that follow are aimed at preventing this.

### Spacing of Street Furniture from LRT Track and Vehicles

It is recommended that 3 metres separation should always be maintained between the nearest points on street furniture and LRT track and vehicles.

This nearest point should take into account that the separation can be reduced when vehicle and equipment doors are open.

The installation manuals for all street furniture including cabinets, poles, signals, detectors, key switches and push buttons should be amended where necessary to include this information.

## **Spacing of Cables from LRT Track**

Vehicle detector loops and feeder cables may have to be laid under LRT tracks to detect the passage of light rail vehicles.

The insulation of the cables should be adequate to withstand the maximum touch voltage and the installation procedure should ensure adequate separation to prevent chafing due to track movements.

## **Avoiding Accidental Contact with Tools and Test Equipment**

It is common practice to connect power tools and test equipment to the controller maintenance socket. The case of the tools or test equipment will therefore be connected to the controller earth and should not come into contact with the LRT track or vehicles.

Neither the RCD if fitted nor the mains supply fuse will provide protection against the possible heavy current resulting from accidental contact.

Care must be taken when using metal ladders to gain access to above ground detectors and signals heads to prevent making contact between the street furniture and LRT track or vehicles. Installation and maintenance manuals should be amended where necessary to include this information.

## **Isolation of Interface between LRT and Traffic Control Equipment**

The design of the interface between remote LRT outstations and traffic control equipment should be isolated so that it is not affected by different earth potentials at the two sites. The isolation should apply to the signals conductors and any cable armour or screen, so that earth leakage current cannot flow between the cabinets.



## APPENDIX B - SETTING UP MICROSENSE / PEEK / SARASOTA DETECTOR UNITS

APPLICATION	MICROSENSE	PEEK/SARASOTA DETECTORS					
		Front Panel binary switches				Link 28 on PCB	Peek /Sarasota Mode
	MSED/MXED Detectors	Setting of sensitivity switches			Setting of presence switch		
	Setting for front panel rotary switch	1	2	4			
VA	7	OFF	ON	ON	ON	0V	1
Queue, presence call/cancel	14	ON	OFF	ON	OFF	5V	2
SDE/SCOOT/MOVA	5	OFF	OFF	ON	ON	0V	3
OTHER							4

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