Installation Guide

for

Navtech Radar
TS Series Radar Sensors

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Document History

Issue	Date	Description
1.0	01/06/2012	First Draft
1.1	18/03/2013	Update for FCC statement
1.2	20/03/2013	Updated the FCC statement

Contents

List of figures

List of tables

Referenced Documents

Ref	Title	Supplier	Doc Ref No
1	SPx RadarView-Lite for Windows User Manual	Cambridge Pixel	CP-25-127-03
2	Clearway witness Commissioning Guide	Navtech	
3	Navtech Service & Maintenance Manual I-TS Series Radar	Navtech	MAINT 0010
4	Clearway witness Operating Guide	Navtech	
5	Entry and User Level Firmware Commands for all W, I and AGS Series	Navtech	RND – S0069
6	TS 350-X Datasheet	Navtech	
7	TS 200-X Datasheet	Navtech	
8	Power Supply unit datasheet	Siemens	https://support.automation.siemens.com 6EP1332-1SH52 Data sheet

Drawings List

Ref	Drawing No	Title
D1	ASM 0031	Radar Housing
D2	SIT 0055	Mounting Height Comparison
D3	SUB 0119	Inline Power and Serial Cable
D4	MBP 0260	Steel bracket

1. Introduction

1.1 Scope

The Navtech *Clearway* Automatic Incident Detection system provides an automatic monitoring solution for highways incident detection and traffic management. The *Clearway* system comprises a high frequency radar sensor, linked to a software system, *witness*. This guide provides instruction for the radar sensor installation ONLY. The installation of the witness application is covered separately in [2]. Service and Maintenance procedures are also covered separately in [3].

The instructions in this guide are applicable to the following Navtech radar sensors:

- TS 350-X
- TS 200-X

Details are provided for all the hardware components required for the installation.

1.2 Essential Items

The following are **essential** additional items that you need to install a radar sensor:

(i) Electrical Power

Electrical power (110 to 230vAC) sourced from, for example, local mains, petrol generator, Pure Sine wave DC to AC convertor,(powered by a vehicle).

- 110 to 230vAC power is required for the Radar's 24vDC PSU.
- 110 to 230vAC power is also required for the Laptop Computer.

Note: Radars are network intensive. Some laptops reduce the performance of their network connection when only running on their internal battery.

(ii) A way of working safely at height

Most radars are mounted at a height of 4 to 5m, so some form of equipment or machine is required. You will need one of the following:

- Podium steps
- MEWP (Mobile Elevated Work Platform) / Cherry Picker / Sky Lift

(iii) Laptop computer

The laptop must have:

- RJ45 Ethernet connection.
- 9 pin Com port or USB to RS232 adapter
- Software – SPxRadarViewLite-V1.47.1 or higher
- Serial communication software – e.g. HyperTerminal, TeraTerm, Putty.

(iv) Cat5E shielded patch lead (or Cross over cable, if laptop doesn't have Auto-MDIX)

(v) M10 nuts and bolts for mounting radar

The minimum for **one** radar, in A4 Stainless Steel.

- x4 off M10x80 HEX Set Screw
- x4 off M10 spring washers
- x4 off M10 plain washers
- x4 off Nyloc Nuts
- x12 off M10 Full plain nuts
- x2 off 17mm Spanner for the M10 nuts and bolts above.

(vi) 5m tape measure

(vii) Digital Level[1]

(viii) X2 off 25m² Radar Target and tripod

(ix) Pair of 2 way radios

(x) An assistant

(xi) Handheld GPS (Optional)

(xii) Power Supply cable (Minimum Requirement) - see Annex C - Table 1 for specification, or Inline Radar Power, Serial and Current Cable (Optional) - see [3].

1.3 Pre requisites

1. If required, get permission to carry out the work, from the company or organisation that is responsible for the road that you are going to be installing on, or next to.

2. Consider what Traffic Management (TM) is required to perform the installation safely.

3. Before going out to the roadside, power up the radar and connect the laptop that is going to be used, to check that you have both Ethernet and Serial communications.

[1] Recommended Fisco Solatronic EN17

2. Radar sensor

The Navtech radar sensor will detect slow or stationary vehicles, pedestrians and debris, for example, on roads or in tunnels, in a wide variety of weather conditions. It is designed to cover 360 degrees, and samples data at an angular resolution of approximately 0.4 degrees. The radar antenna is designed to have a narrow beamwidth in azimuth; in this way objects within the radar field of view can be accurately located on the road surface. So far as is possible the radar has a wide beam in elevation. This allows objects close to the radar and far away to remain in the sensor field of view, even when it is mounted high on a gantry. Typical radar used in road incident detection, will have an azimuth beamwidth of approx 2 degrees, and an elevation beamwidth of approx 40 degrees in the near field.

The standard update rate for radar sensors is 120 rpm with a maximum detection distance of 500 meters radius. A signal return is produced and sent to the processing system every 0.25 meters from the sensor itself up to the maximum sensor range of 500 meters radius. This is repeated at each new azimuth angle as the antenna rotates. The system employs a frequency modulated sensor and so unlike Doppler systems, no movement is necessary to measure a vehicle, person or similar object within the radar line of sight.

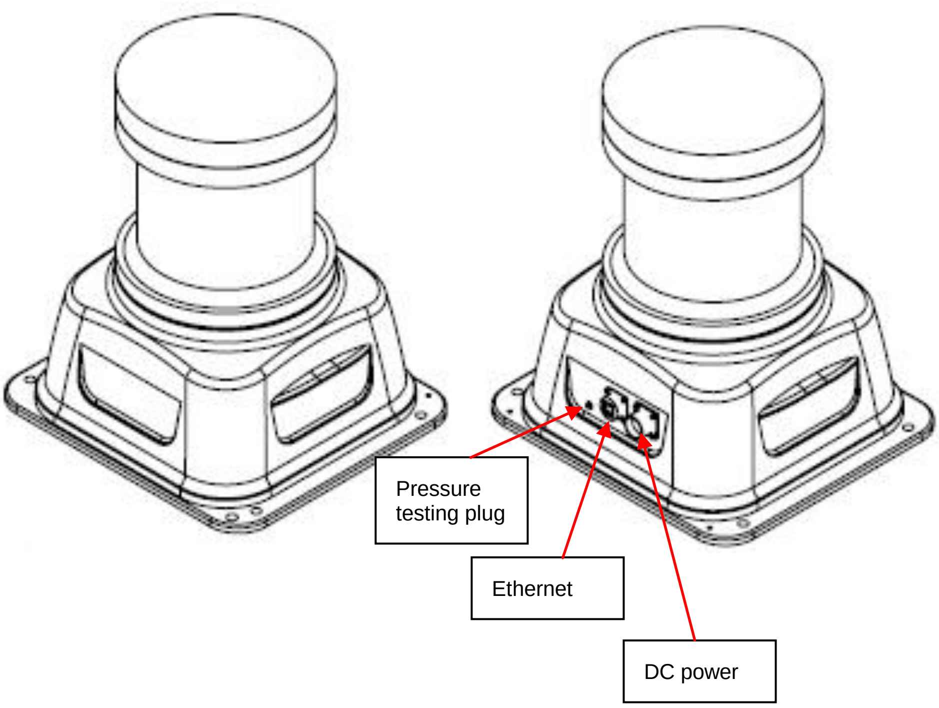


Figure 1 Radar sensor - isometric views

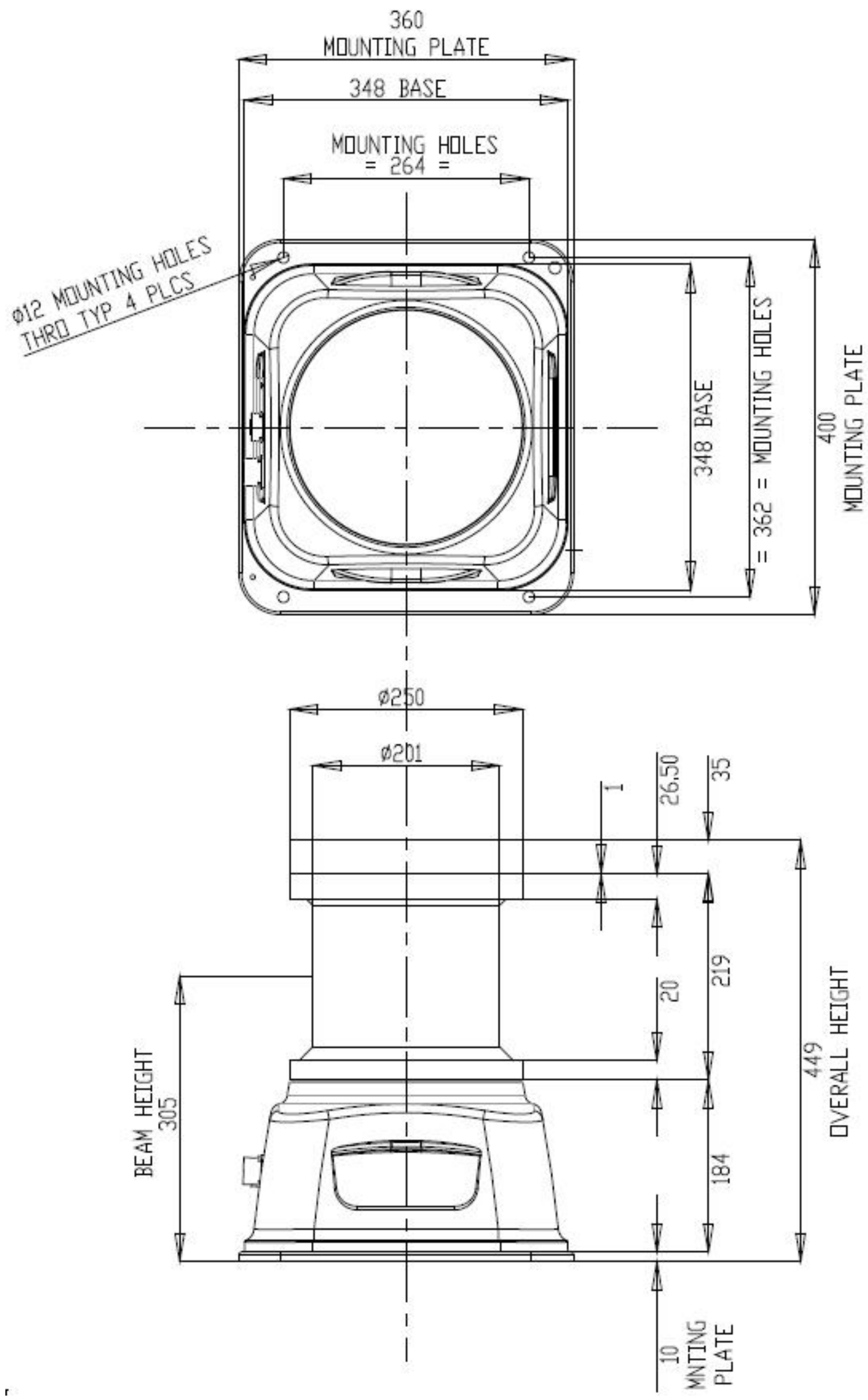


Figure 2 Radar sensor - dimensions

See [D1] for further details on the radar housing.

See the relevant datasheet [6] to [7] for the radar sensor.

3. Installing the Radar hardware

3.1 Overview

This section details the installation process, which comprises the following steps:

1. Determine radar sensor locations
2. Mount radar
3. Connect radar sensor
4. Prepare laptop
5. Connect laptop
6. Level radar sensor
7. Install Navtech *witness* software
8. Confirm sensor coverage

Note: The installation and configuration of the ***witness*** **software is covered separately in [2].**

CAUTION Before performing any installation task ensure you are aware of Health & Safety procedures. (See Section 4)

3.2 Radar sensor locations

3.2.1 Location

Radar sensors must be positioned to provide the optimum ‘line of sight’. Some guidelines to check the ‘line of sight’ are given below.

1. As a minimum stand at ground level where the radar is going to be mounted and look in both directions up and down the road. Whatever you can and cannot see will be the same for the radar.

2. Ideally you need to have your eyes at the height the radar is going to be mounted. This may require the use of ladder, podium steps, MEWP (Mobile Elevated Work Platform) / Cherry Picker / Sky Lift etc. Once your eyes are the same level as the radar, look in both directions up and down the road. Whatever you can and cannot see will be the same for the radar.

   Be aware of any street furniture (for example, lamp posts) in the radar’s area of coverage. When looking down a line of lamp posts, the further away they are the closer together they appear. A line of lamp posts at a certain angle can create a ‘wall’ which neither a person nor a radar can see through.

3. To double check the ‘line of sight’ observed from a site visit, use Google Earth and the ruler tool. (See the yellow line in Figure 3 below). Place one end of the ruler tool where the radar is going to be located and move the end as if it were the radar beam. If there is a bend in the road, put the ruler tool on the apex of the corner to see how far the radar will see.

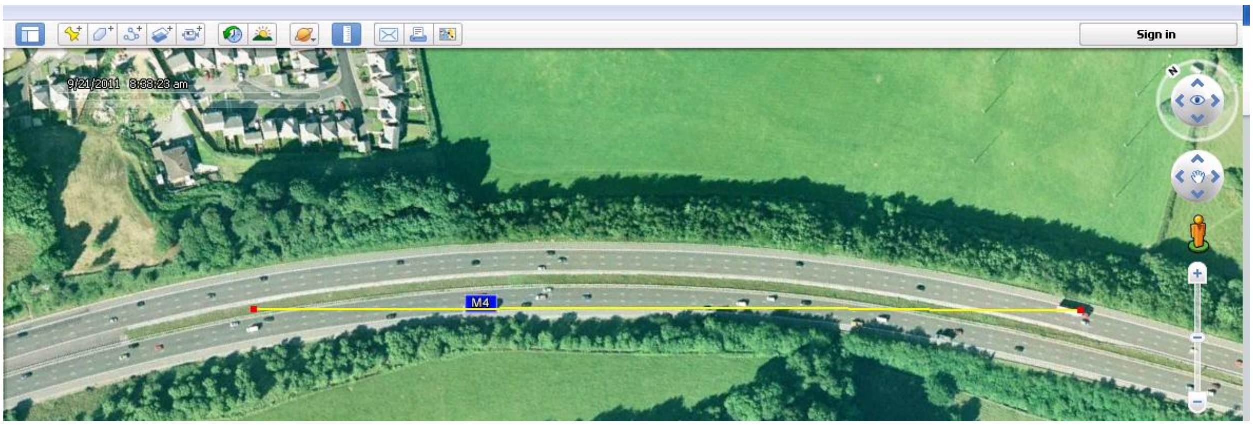


Figure 3 Google Earth showing line of sight

In a straight line the radar can detect a person from 20m away to 350m away. If the person is closer than 20m they will be below the radar and further than 350m away, they are too small for the radar to detect. However, if the road curves, the radar cannot detect people, cars, etc. out of sight around the bend. This must be taken into account when calculating the number of radar required to provide complete coverage.

Be aware that for slow or stopped vehicles, a stopped car that ultimately comes to rest directly beneath the radar will slow down well before this point. The slow vehicle alarm will be raised in this case. Reducing the radar mounting height can increase coverage close in to the radar. See [D2]. Figure 4 shows the radar mounted at 4m giving coverage to the ground of approximately16.25 m.

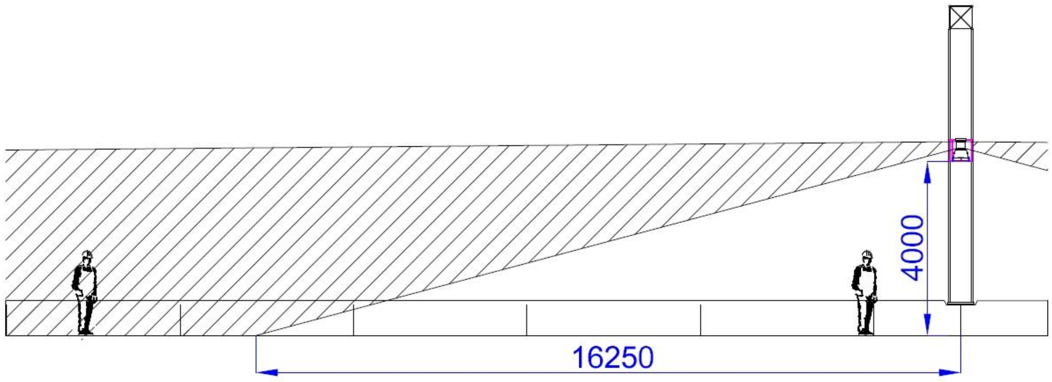


Figure 4 Radar coverage (mounted at 4 metres)

Refer 3.2.2 for typical installation mounting heights.

Example

Consider the positions of radar sensors used to provide coverage on a road. The position of the radar is determined by how straight or curved the road is either side of the mounting post/gantry and what affect the neighbouring street lights may have on the radar's 'line of sight'. When you have a line of street lights on a curve they can have the effect of creating a barrier the radar cannot see through. Moving the radar from one side to the other side of the central barrier can have a dramatic effect on improving the radar line of sight. In more extreme cases moving the radar to the roadside would be required.

In this example, each radar has a possible four locations on, or near, a gantry on the road. See Figure 5 below.

If the road has a shallow curve, radar Position A or B is selected. If the road has a pronounced curve, radar Position C is selected - where C is the outside of the curve. If the road is absolutely straight, the radar is mounted on a post (Position D). Having the radar on a post located midway between the gantry and the closest street light reduces the occlusion caused by the both the gantry and the closest street light.

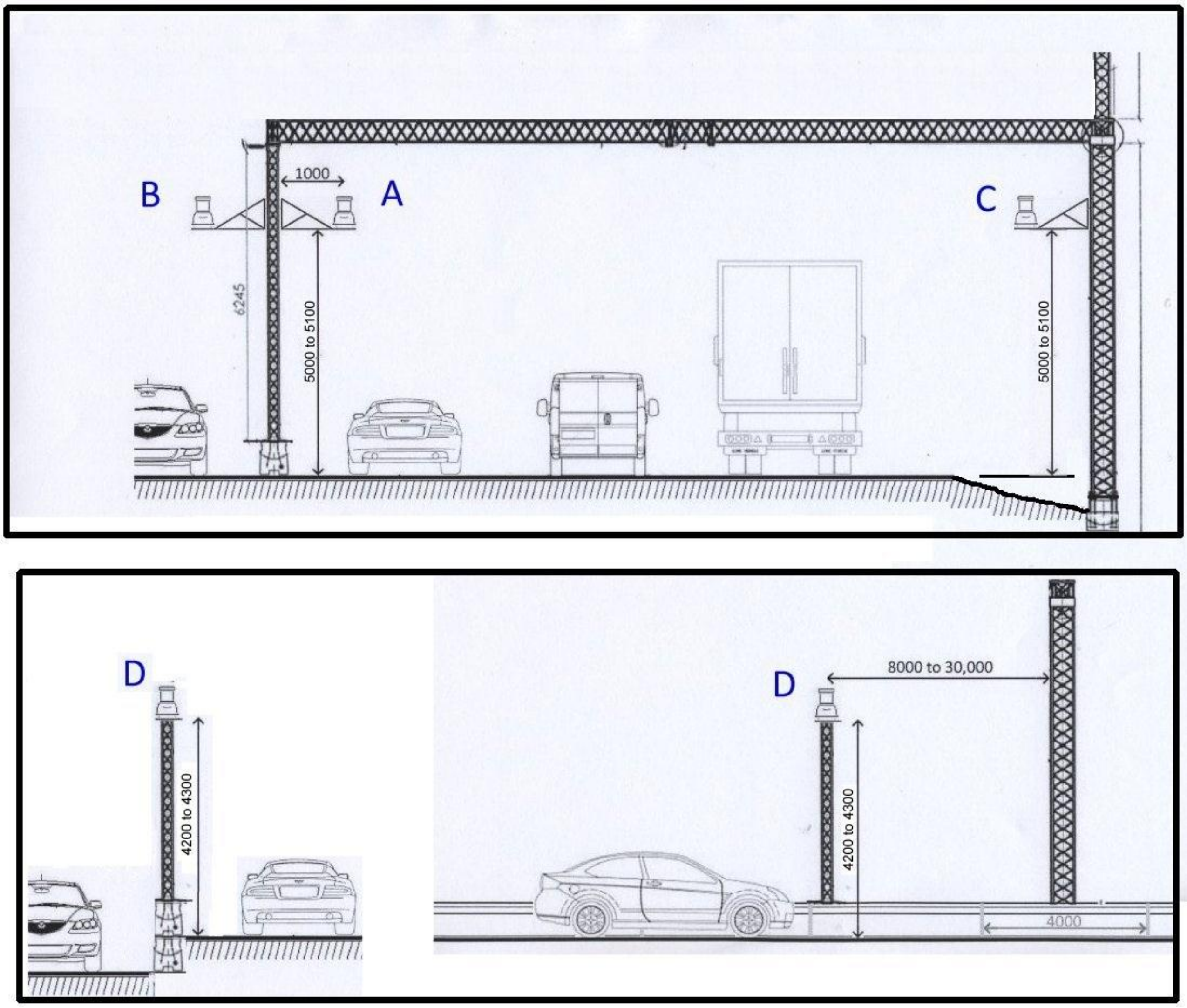


Figure 5 Example radar sensor locations

3.2.2 Mounting height

The sensors can be mounted at various heights between 2m and 8m depending on the application. Typical installation mounted heights:

- For hard shoulder monitoring only – 2m above ground level
- Coverage of multiple lanes – 4 to 5 m above road surface

Some site layouts may require the sensor to be mounted at 8m.

3.2.3 Orientation

When mounting a radar sensor on a road, the orientation is important.

The orientation is the same for mounting the radar at the side of a road or in the centre of the road. Ensure the side of the sensor with the Serial Number Label, (or the side with the connectors) is running next to one of the lanes.

Examples

- On a road running North to South, the Serial Number Label would point either East or West.
- On a road running East to West, the Serial Number Label would point either North or South.

Note: Convention would have the Serial Number Label pointing North and the connectors pointing South. It's not mandatory though.

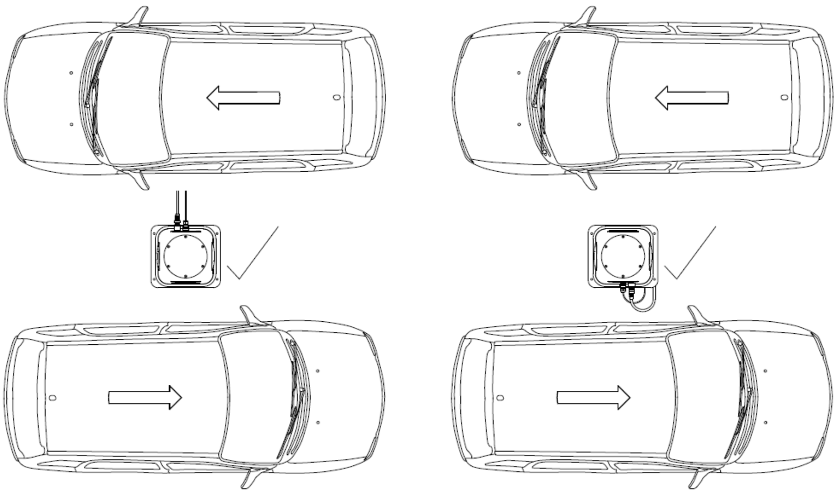


Figure 6 Correct orientation of radar

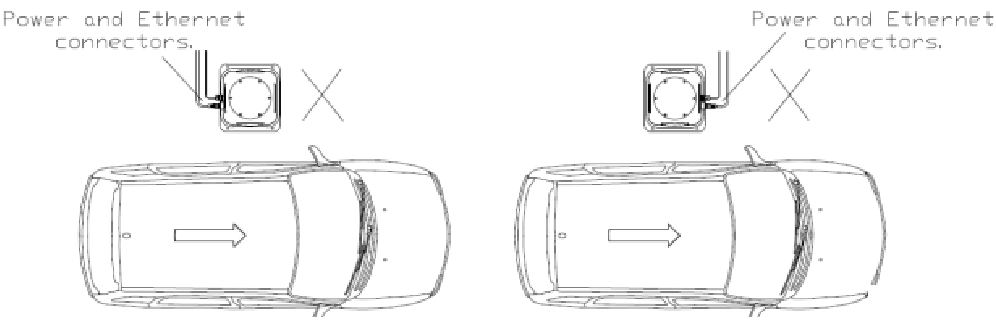


Figure 7 Incorrect orientation of radar

3.3 Mounting radar sensor

Radar sensors may be mounted on dedicated posts, or various other structures (e.g walls, roofs, gantries) using brackets. Sample posts and brackets are shown in Annex B.

Radar sensors are fitted to a plate on top of the post, or on the bracket, using nuts and bolts, which allows you to adjust the tilt [See Figure 8]. Adjusting the tilt (levelling the sensor) ensures optimum detection performance and is detailed in Section 3.7.

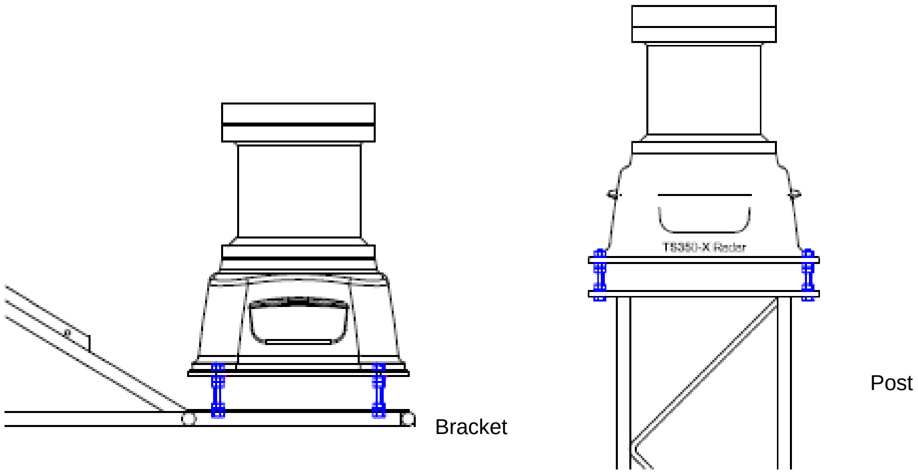


Figure 8 Mounting plate on post / bracket

The sensor mounting plate (or bracket) design allows for a simple yet effective method to fine tune the incline of the sensor. For each of the mounting holes, the bolt is fed from underneath and locked onto the mounting plate with a nut. Two more nuts are used below the radar base plate and another is used above so that the sensor can be positioned anywhere up or down the bolt thread, as necessary.

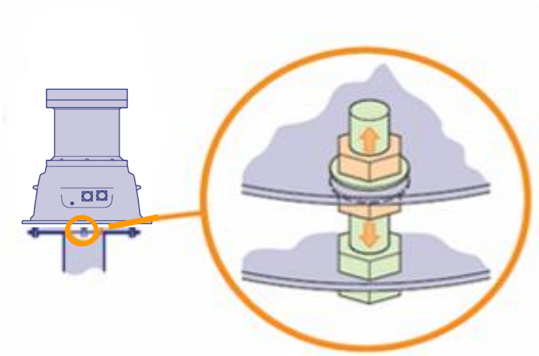


Figure 9 Levelling adjustment

1. Place the radar on the threaded studs of the plate.

3.4 Connecting radar sensor

Each radar sensor requires a power and a data connection. Both are made using military specification connectors to ensure link integrity in the harshest environmental conditions. The power and data connections run from the sensor to a conveniently placed junction box (e.g.at the base of the post) where the power supply is situated. See Figure 10.

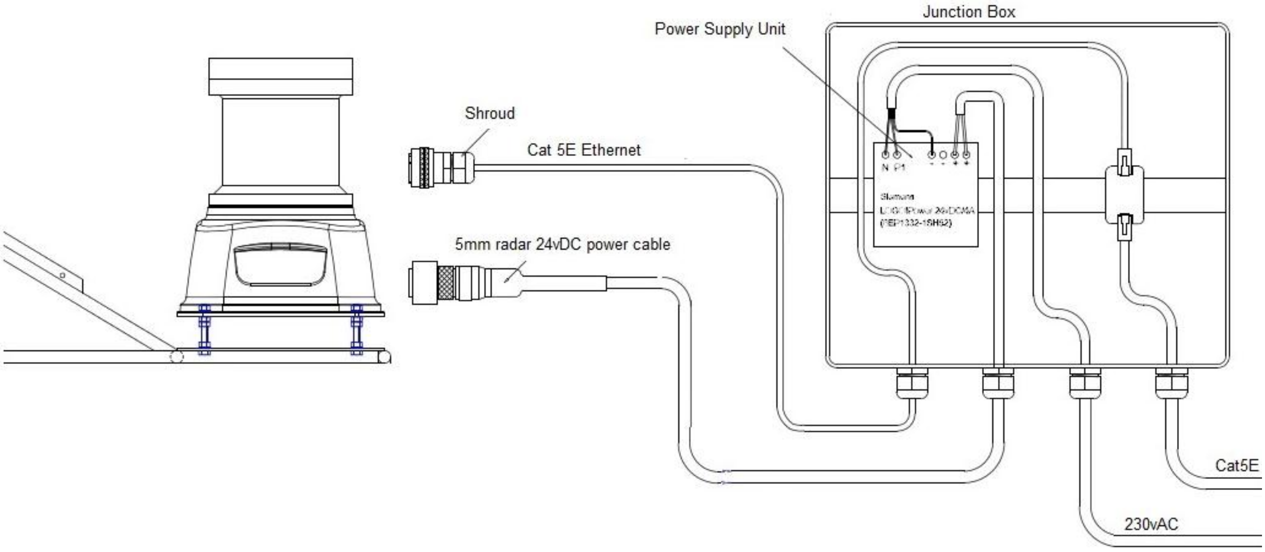


Figure 10 Connections to radar sensor

Supplied with each radar sensor are a power cable with a mil-spec connector for the sensor connection and a bare end at the junction box connection. A mil spec shroud is also supplied for use with a suitable environmentally protected Ethernet network connection. It is essential that the supplied shroud is correctly used to ensure that the data connection is water tight.

IMPORTANT: Failure to correctly fit the shroud can invalidate the warranty on sensors that have been caused to fail through water ingress.

1. Attach 24vDC connection to the radar.

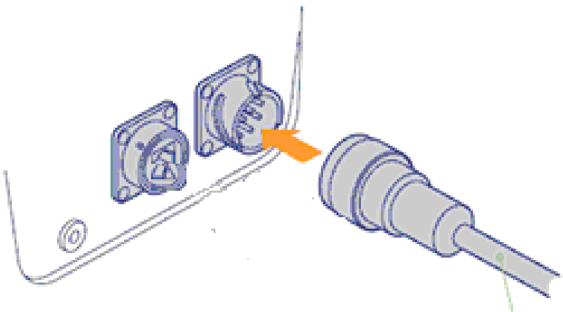


Figure 11 Connecting radar sensor

2. Ensure the Power and Ethernet cables are securely connected into junction box.

3. Ensure the junction box has the Navtech supplied 24vDC power supply installed. (The power supply unit has a peak current capacity of 4 Amps, though typically the radar draws a continuous 1 Amp). See.[8].

4. Ensure that the Power supply cabling is correctly terminated at the radar end with a secure Amphenol MIL spec connector. Pin D (Red or Brown) is 24vDC, Pin J (Blue or Black) is 0V.

IMPORTANT: To prevent floating voltage levels on the low output of the radar sensor power supply unit, link the 0v output to earth.

5. Ensure the junction box has an Ethernet cable running to the infrastructure network switch.

3.5 Preparing the laptop

IMPORTANT: Ensure that your laptop has its IP address set to operate within the same subnet as the radar sensor

3.5.1 Factory settings

The IP address (e.g. 192.168.0.1) of the radar sensor is preset before leaving Navtech Radar Limited according to client specifications and will be declared on a label attached to the outer casing.

The subnet mask of the radar sensor is often preset to 255.255.255.0 but could also be set wider (such as 255.255.0.0) if requested. Therefore, if the sensor IP address is 192.168.0.1 and the mask is 255.255.255.0, then your computer must use an IP address in the range: 192.168.0.2 to 192.168.0.254.

3.5.2 Changing factory settings

The IP address and subnet mask can be changed using firmware commands sent to the radar either via Telnet (see [5]), or using a serial connection (see [D3]).

3.6 Connecting your laptop

1. At the radar, connect the laptop via CAT5 cable to the radar.

2. Ensure that the radar sensor is powered on and is rotating - you can faintly hear the rotor when it is running.

3. Use SPx Radar View application [1] to display the radar data. (See Annex A)

3.7 Levelling radar sensor

3.7.1 Overview

The radar antenna vertical beam is designed to be wide (in range), close in to the radar but it still narrows to approximately 2 degrees at long range. For optimum detection performance it is important that each sensor is level in relation to the area that it surveys. Level in this sense may not mean absolutely horizontal. For instance, if the site has a continual slope it may prove beneficial to incline the sensor in line with the slope to ensure that the targets are correctly tracked. See Figure 12.

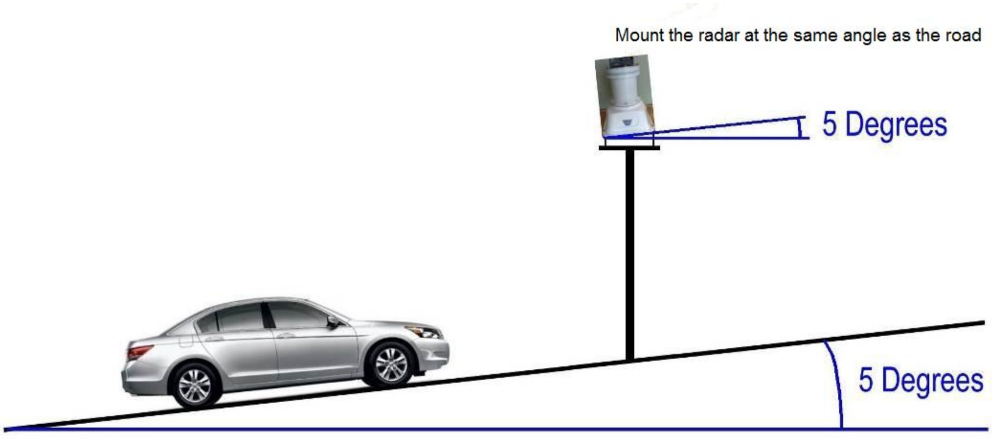


Figure 12 Levelling a radar sensor

The exaggerated examples below show how a sensor with an incorrect incline could miss targets which are lower down the slope:

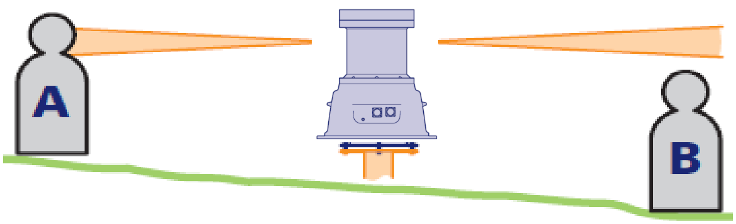


Figure 13 Horizontal radar sensor misses target B

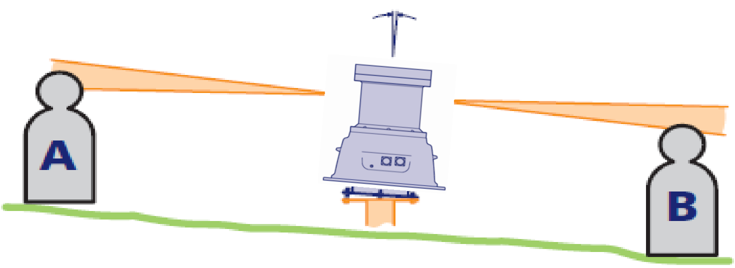


Figure 14 Inclined radar sensor locates both targets

3.7.2 Adjusting radar

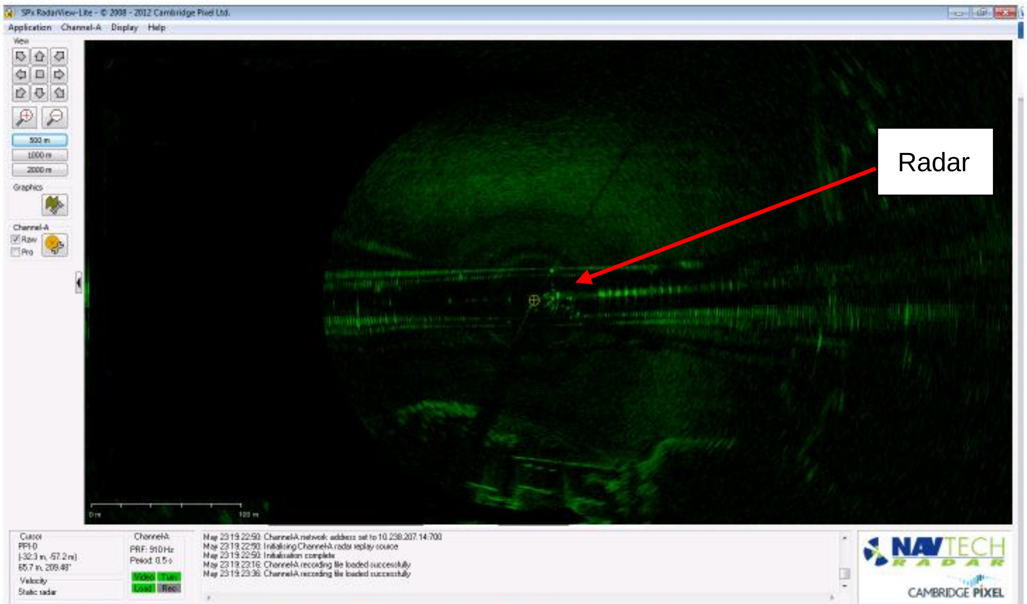


Figure 15 SPx RadarView display (A)

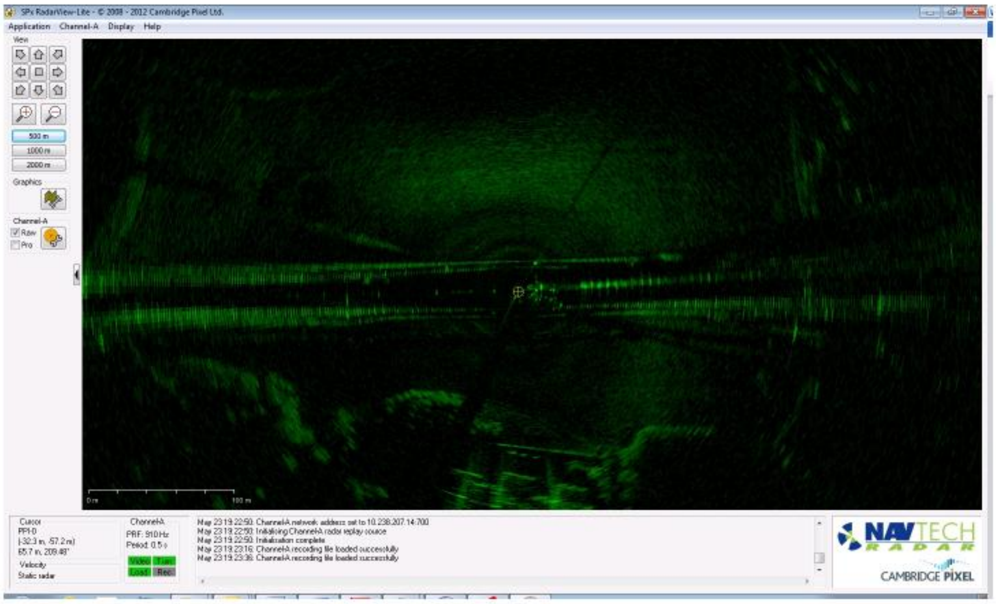


Figure 16 SPx RadarView display (B)

Using the SPx RadarView application to view the radar data (see Annex A), you are aiming to have an equal amount of data either side of the radar.

1. If there is more radar data one side than the other, as shown in Figure 15, change the angle of the radar until you have an equal amount of data either side of the radar, as shown in Figure 16.

2. Watch a vehicle travelling from one side of the radar to the other. Is it dramatically brighter/giving a stronger return signal from one side to the other? If so, tilt the radar so a vehicle has equal brightness/signal return strength on both sides of the radar.

3.7.3 Use of Radar Target (Optional)

This test is not possible if working on a live carriageway.

1. Check that the radar is level across the carriageway, then place a radar reflector on a tripod, in the centre of the carriageway, at 150m along road in each direction, (2 targets in total).

   Note: These two targets must be at the same height (suggested height 1.5 m), and the area behind the target should be clear for 10-15 m.

2. Place the Digital Level as indicated in Figure 17, ensuring the level is at right angles to the base of the radar.

Figure 17 Digital Inclinometer mounted on radar sensor

3. Adjust the radar tilt of the radar on the threaded studs, to maximise the signal level on the 2 targets, using the gradient of the road around the radar as a starting point. Signal levels are determined from the SPx RadarVew software (See Annex A for detailed instruction).

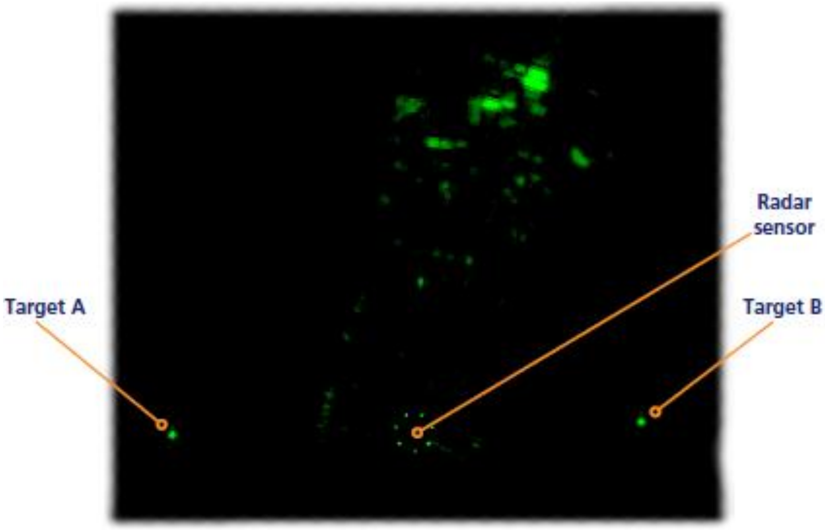


Figure 18 Radar view to locate target

3.8 Securing the radar

1. Secure the radar on the mounting bracket, or post plate. To do this: lock off the two lower nuts on each stud by tightening one against the other. (This is to ensure that, if the radar is removed, the tilt angle is not changed)

2. Record the tilt angle from the digital inclinometer. See Annex E for a sample table.

3.9 Confirming sensor coverage

1. Install and configure the witness software as described in [2].

2. Enter basic detection areas into Sentinel. (See [2]).

3. Perform a basic walk through tests of the radar and monitor the tracking performance along the carriageway, within radar line of site. See [4] for instruction on how to monitor the performance.

4. Perform a drive through test of this radar. Monitor the tracking performance along the carriageway, within radar line of site as this test is conducted.

5. During the drive through, record a radar dataset, should further detection zone alteration be required offline. During this procedure a vehicle should drive at between 20 and 30 kph from the maximum line of sight radar coverage ‘upstream’ of the normal traffic direction, to the maximum line of sight ‘downstream’ . Typically the overall coverage of a radar may be from 300 to 400 meters or more upstream, to 300 to 400 meters downstream. During the drive through the vehicle should stay in the same lane, and the lane number should be recorded against the dataset for future reference. See Figure 19 on the next page.

6. Refine the radar detection zones, based on the drive and walk through and save the settings.

7. Disconnect the laptop from the radar and connect the radar to the infrastructure network switch.

8. Repeat for each radar along the carriageway and verify coverage.

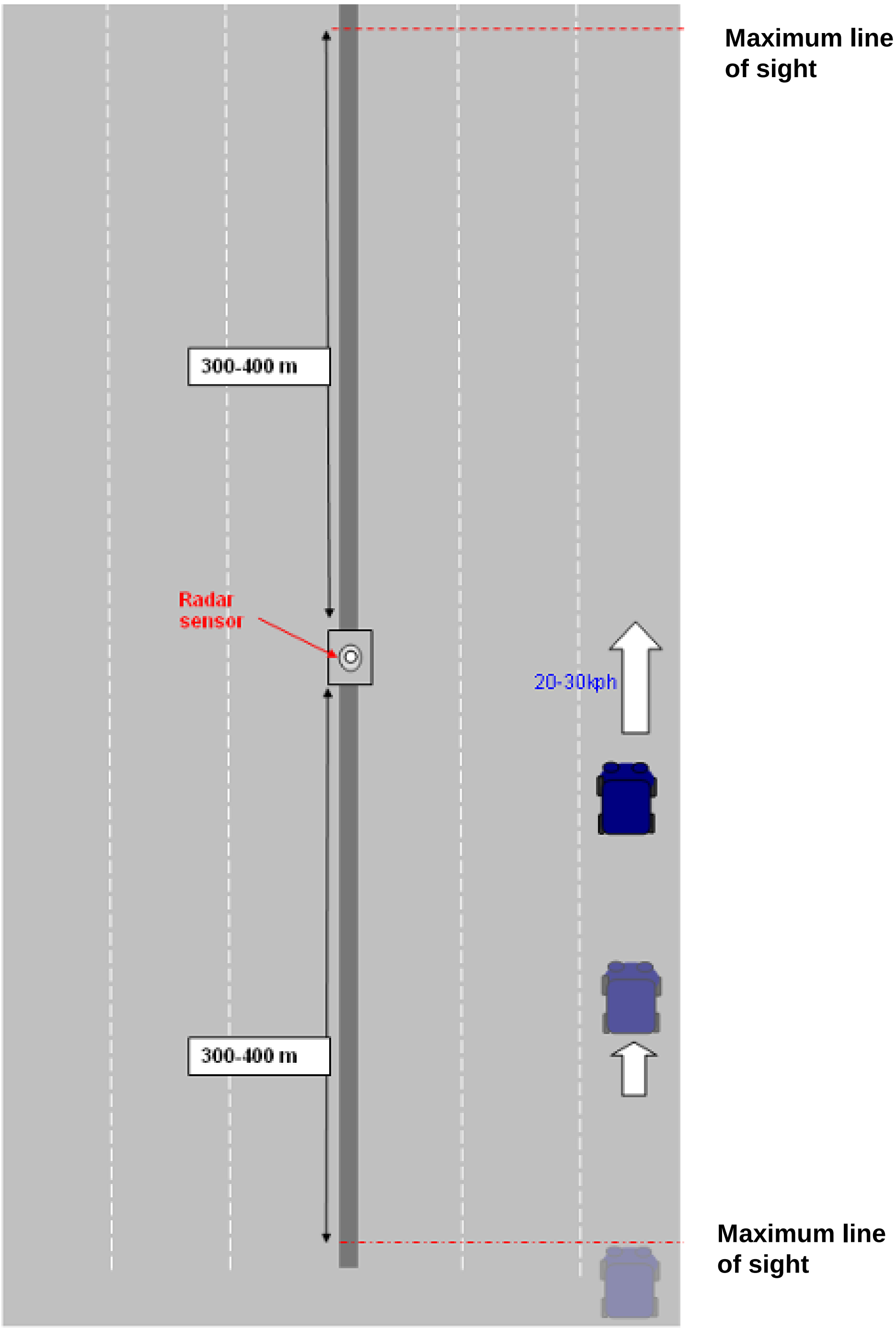


Figure 19 Drive through test

4. Health & Safety

4.1.1 General

1. A first aid kit should be available at all times.

2. In addition to the conditions detailed in this section the Site Safety Procedures for the location where the equipment is being installed must be complied with at all times.

4.1.2 Design

The design and manufacture of all equipment supplied as part of the Navtech radar tracking and monitoring system for permanent installation is CE accredited:

- European Electromagnetic Compatibility Directive 89/336/EEC
- ETSI EN301 091-1 Electromagnetic compatibility and Radio Spectrum Matters Short Range devices

4.1.3 Maintenance

1. Make sure that electrical supplies are properly isolated before removing any covers. The supply should be disconnected by the operation of the main isolating switch, removal of fuses or other acceptable method. A notice should be placed at the point of isolation showing:-

   DANGER - WORK IN PROGRESS

2. Place a barrier or guard rail round the work area.

3. When working on elevated equipment, make sure that all ladders and staging are secure. If necessary, wear a safety harness.

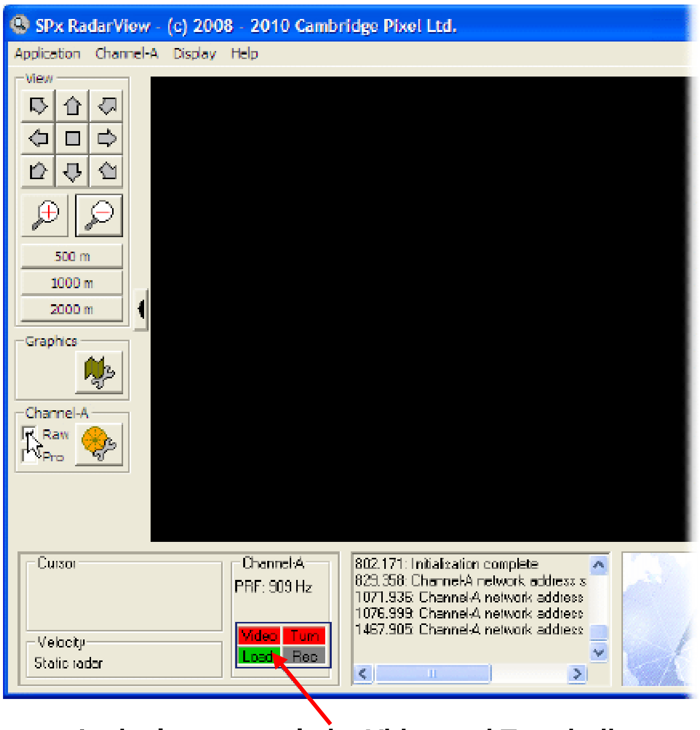
4. Be aware of any special hazards specific to the site or location where equipment is located. Take all necessary precautions.

Annex A - Using SPx RadarView

The SPx RadarView application consists of two files which must be located in the same folder (any folder) on your laptop:

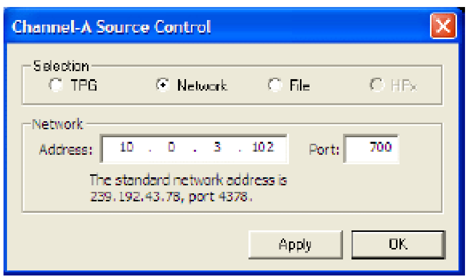
- SPXRadarView.exe
- SPXRadarView.rpi

1. Run **SPXRadarView.exe**. You should see a blank main screen:



Note: **In the lower panel, the Video and Turn indicators will be red indicating that there is no communication with the sensor.**

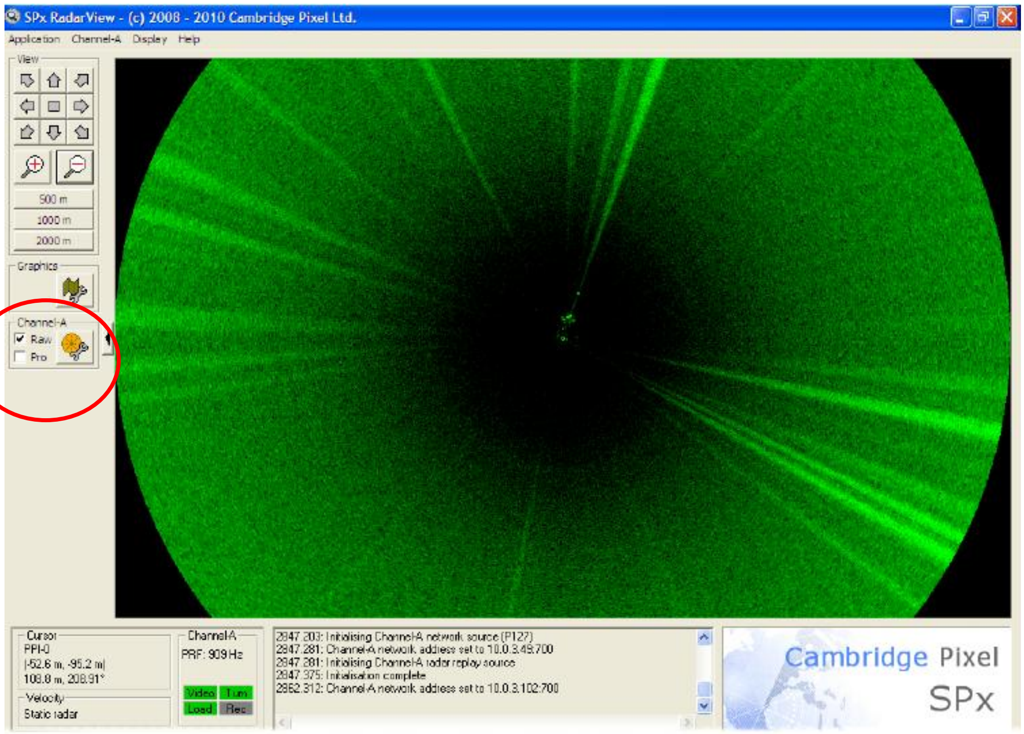
2. Click the Channel-A menu on the toolbar, and select the **Source...** option.



Ensure that the Selection option is set to **Network** and in the Address field, enter the IP Address of the sensor. The **Port** must be set to **700**.

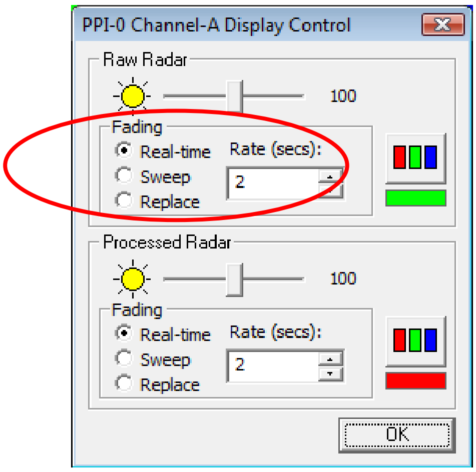
Click **OK**.

Once the IP address and port are correctly set and the application makes contact with the sensor, the **Video and Turn** indicators should turn green. Shortly afterwards, you should begin to see radar scan information within the main window.



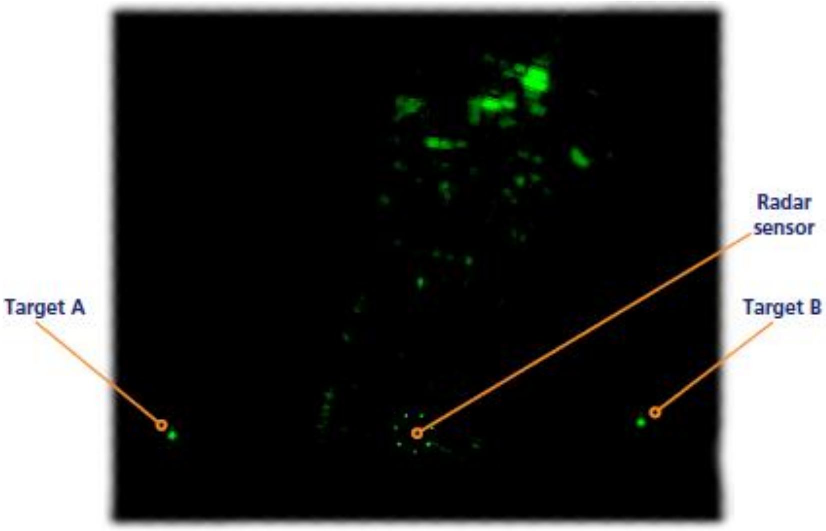
On the left side of the screen, ensure that the **Raw** option is ticked.

3. Click the  button to show the Display Control dialog box:

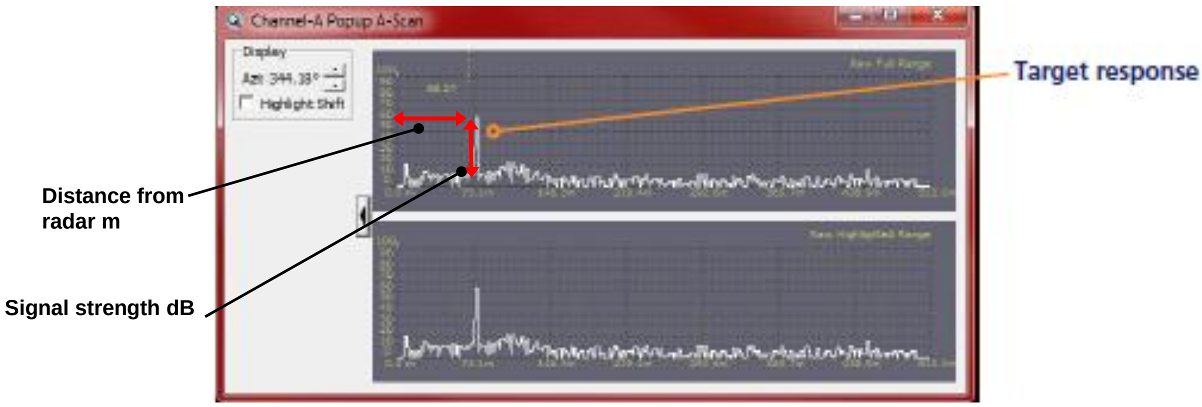


Ensure that in the Raw Radar section, the Fading option is set to **Sweep** and the Rate (sweeps) is set to **5**. Click **OK**.

4. Click the [button] button to zoom into the radar view so that you can clearly see the both of your test targets:

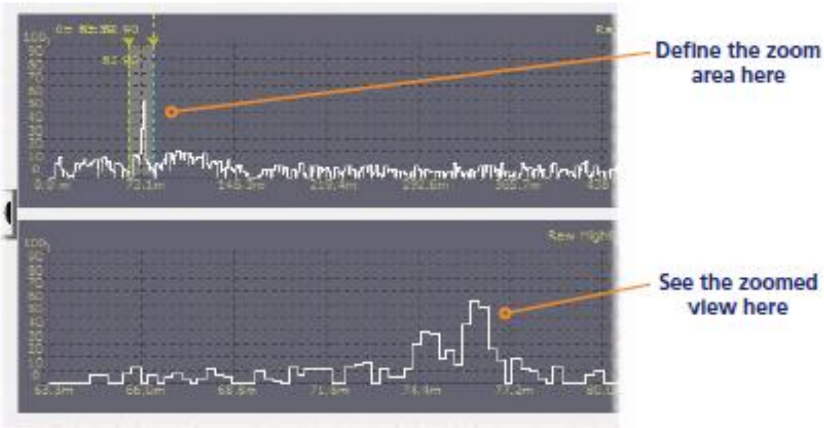


5. Right click the mouse pointer on the exact middle point of one of the targets to display a popup options box. Click the option **Popup Channel-A AScan….** to display a scan window.



The scan window provides live signal strength data concentrating only on the angular direction of the chosen target from the radar sensor. In each of the two graph plots, the x-axis shows the distance from the sensor while the y-axis indicates the returned signal strength. You should see a spike representing your target at the relevant distance.

6. On the top graph, left click on either side of the spike to create a zoomed view on the lower graph.

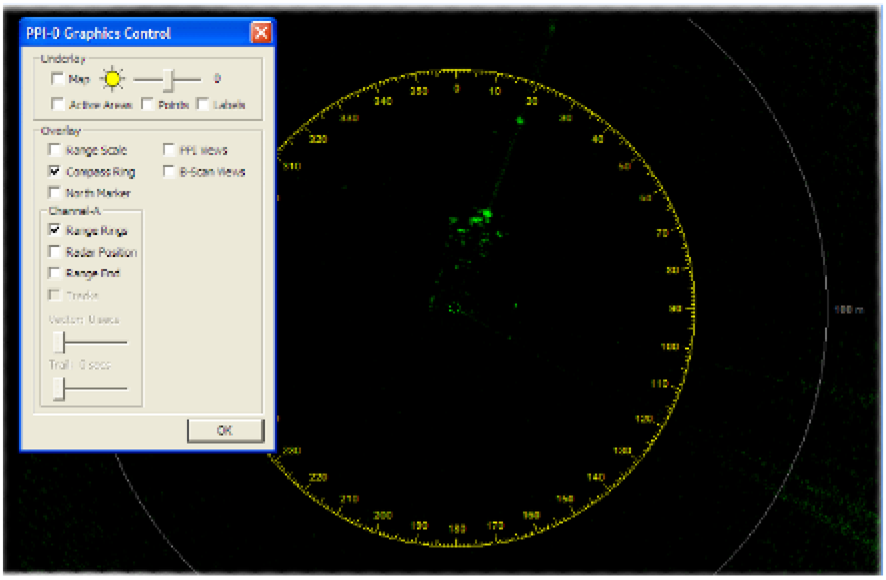


This will allow you to see small changes in the returned signal strength on the lower graph when levelling the sensor:

7. Repeat steps 5 and 6 for the other target so that you can view both on screen at the same time.

8. Adjust the radar sensor level (See Section 3.7) while checking the scan graphs to ensure the best response from both targets.

9. To assist with orientation, optionally click the  button to show the Graphics Control dialog box:



Two options within this dialog box are of particular use:

- Enable the Compass Ring option to superimpose compass graduation marks around the sensor view.

  Note: North is aligned to the zero point of the radar sensor, not magnetic north.

- Enable the Range Rings option to overlay range lines every 100m onto the sensor view

Annex B - Sample Posts and Brackets

B.1 Mounting posts

Examples of mounting posts are shown below:

Figure 20 Radar mounting posts

B.2 Mounting brackets

Typical radar sensor mounting brackets:

See [D4] for dimensions.

Figure 21 Mounting brackets

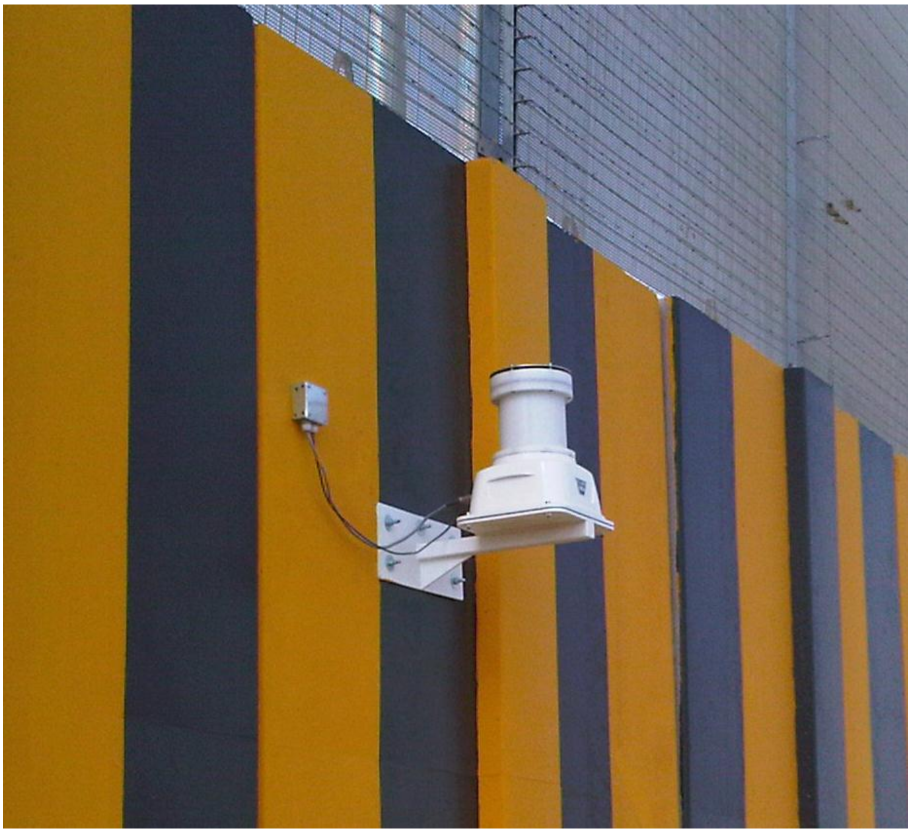


Figure 22 TS 350-X mounted on a wall

Annex C - Specifications

This Annex contains the specifications for the cables and connectors supplied by Navtech, with the exception of the Ethernet connector which is a standard RJ45 connector.

C.1 Radar power cable

318-B LSZH cable	
Part no	Eland A5Z02015BK
No of Cores x Nominal Cross Sectional Area	2 x 1.5 mm^2
Core Identification	2 cores: Blue, Brown
Current carrying capacity	Single phase AC 16 amps
Insulation	LSZH
Sheath	LSZH
Standard	IEC 60092-353
Conductor	Class 5 flexible plain copper to BSN EN 60228:2005

Table 1 Radar power cable specification

C.2 Radar Cat 5E cable

Cat 5E cable	
Part no	Eland A8NCAT5EFTPGSWB
No of pairs	4
Core Identification	4 pairs: Blue + White/Blue, Orange + White/Orange, Green + White/Green, Brown + White/Brown
Standards	ISO/IEC 11801, TIA/EIA 568B
Braiding	GSWB (Galvanised Steel Wire Braid)
Sheath	LSZH
Sheath colour	Black

Table 2 Radar Cat 5E Ethernet cable specification

C.3 Radar power cable connector (radar end)

Amphenol 97 series	
MIL Spec	MIL-C-50152
Model	3106A
Operating temperatures	–55°C to +125°C
Power pins	Pin D (Red or Brown wire) & Pin J (Blue or Black wire)
Design Characteristics	10 socket plug Single key/keyway polarization Threaded coupling, hard dielectric inserts

Table 3 Radar power cable (radar end) connector specification

C.4 Radar Cat 5E cable connector (radar end)

Amphenol RJF series	
Part No	RJF6
MIL Spec	MIL-C-26482
Data Transmission	Category 5e per ISO/IEC 11801
Mechanical	Bayonet coupling (Audible & Visual coupling signal) 4 mechanical Coding / Polarization possibilities by the user (insert rotation) RJ45 cordset retention in the plug : 100 N in the axis Mating cycles : 500 min
Environmental Protection	Sealing: IP67 Salt Spray : 48 h with Nickel plating> 96 h with black coating> 500 h with hard anodic coating and Cadmium Fire /Low Smoke: UL94 V0 and NF F 16 101 & 16 102 Vibrations : 25 –250 Hz, 5 g, 3 axes : no discontinuity> 1µs Humidity: 21 days, 43°C, 98%humidity Rapid change of Temperature: 5 –20°C / +85°C cycles

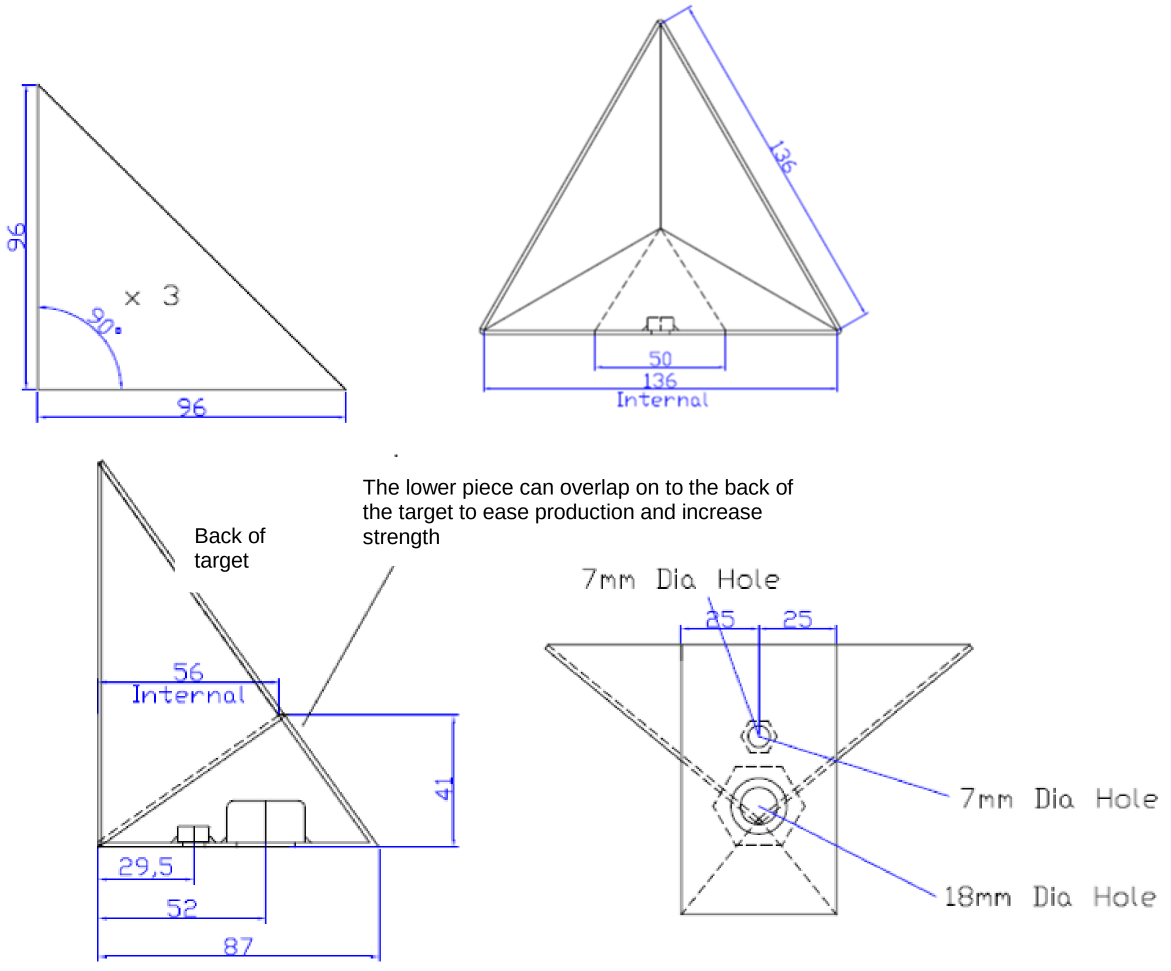
Table 4 Radar Cat 5E cable connector (radar end) specification

Annex D - Construction of test target

The following drawings show how to construct a test target.

- Tolerancing: +/- 1mm on linear dimensions
- Material: 1.5 stainless
- Finish: Bare metal

The target can be made by welding 3 flat triangles together, or by folding one piece and welding the meeting edges:



Welded on ¼ Whitworth and 5/8th UNC stainless nuts

Annex E - Radar sensor configurations

A sample table to record data for each radar.

Radar Sensor	Serial No	IP Address	Subnet Mask	Geographical position		Radar Base Plate Angle (deg)
				Lat(N)	Long (E)	
Example	*100*	*192.168.1.170*	*255.255.255.0*	*59.25023*	*17.85109*	*+1.5*
A1						
A2						
A3						
A4						

ANNEX – F Radio Frequency Energy Compliance

FCC compliance statement (United States)

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

(1) This device may not cause harmful interference, and

(2) This device must accept any interference received, including interference that may cause undesired operation.

The operation of this device is limited to a fixed position at airport locations for foreign object debris detection on runways and for monitoring aircraft as well as service vehicles on taxiways and other airport vehicle service areas that have no public vehicle access. This equipment must be mounted in a fixed location maintaining a minimum separation distance of 40cm from personnel when in general operation. This restriction of operation is specific for use in North America. For use in other regions aligned to the FCC regulations, specific country restrictions should be reviewed.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.