
TII492 Intelligent Transport Systems (ITS) - Equipment Supply and Installation Framework - Generation 2 - Lot 4

Volume A: Works Requirements

**Part 3: Technical Specification
Section 1: Periodic Speed Limit Signs and
other DWS**

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1. INTRODUCTION

1.1 Introduction

This specification defines the requirements for the supply, installation, testing and commissioning of new Periodic Speed Limit Signs (PSLS) and other Dynamic Warning Signs (DWS) for management of the road network.

The Contractor shall design, supply and install PSLS and other DWS in accordance with this specification at the locations detailed in the Framework Agreement Call-off documents. - Lot 4

The Contractor shall test and commission Dynamic Warning Signs in accordance with this specification and Volume A - Part 4: Testing and Commissioning Specification.

1.2 Scope of Works

The scope of works includes the:

- The Contractor shall design all Dynamic Warning Signs equipment in accordance with the requirements of this specification.
- The Contractor shall supply and install all Dynamic Warning Sign equipment including all necessary mounting bracketry, power connections and communications interfaces in accordance with the requirements of this specification.
- The Contractor shall support the integration of the Dynamic Warning Sign equipment with the Associated Services, in accordance with the requirements of this specification.

The Contractor shall undertake all testing and commissioning of all Dynamic Warning Sign equipment in accordance with the requirements of this specification as well as Volume A - Part 4: Testing and Commissioning Specification.

2. GENERAL

2.1 General

The supplier shall provide warranties ensuring that spares will be available for a period of 10 years from the date of purchase.

The Contractor shall provide a warranty of 1 year following substantial completion of the works. As part of this warranty, the Contractor shall agree to repair or replace all equipment that are found to be faulting in the warranty period. The Contractor shall provide technical support to the ITS Maintenance Contractor during the warranty period.

DWS shall consist of the following basic elements.

2.2 Sign Control Device

Each DWS shall include a Sign Control Device (SCD) that shall be contained within the sign enclosure and be responsible for the control and monitoring of the given sign functionality. The SCD shall communicate with the control and maintenance applications, hosted in different locations. The SCD shall provide user access via a web-based interface for configuration and monitoring onsite (i.e. roadside) or remotely. The SCD shall communicate data to the appropriate applications using a configurable, approved protocol (i.e. Datex II, NTCIP, or similar approved by TII).

2.3 Display Modules

The DWS will consist of warning signs and dedicated programmable Light Emitting Diodes (LEDs) array(s) capable of displaying signs. These signs shall comply with the requirement of Department of Transport (DoT) Traffic Signs Manual (TSM).

2.4 Ambient Light Monitor

The DWS shall include an Ambient Light Monitor (ALM) that control the brightness of the LED array(s) in response to local lighting conditions.

2.5 Communication Module (Optional)

The optional communication module shall ensure data transmission between the control unit and control centre. The Communication Module shall support:

- Remote configuration of DWS operating parameters
- Retrieval of status and performance information
- Secure data transmission using appropriate protocols
- Time synchronisation and remote update functionality, if/where applicable
- Communication capability shall not interfere with the visibility, operation, or safety performance of the sign.

As a minimum the SCD shall communicate with the following applications to provide control, status and fault reporting:

- ATMS (Advanced Traffic Management System) hosted in the Motorway Operation Control Centre (MOCC);
- AFMS (Asset and Fault Management System) hosted by the TII ITS Equipment Maintenance Contractor.
- NIMS (Network Intelligence & Management System), hosted in the Motorway Traffic Control Centre.

If the DWS is equipped with peripheral devices that capture data, these devices shall return data using the appropriate protocol to the relevant application, including:

- Traffic Count information (Drakewell C2 Cloud), in the form of Per Vehicle Records (PVR) or aggregated time-binned data; and
- Weather Information (Vaisala).

2.6 Vehicle Detection Module (Optional)

The SCD shall have the capability of incorporating vehicle detection equipment that can detect and create records of vehicles moving towards and away from the DWS. The Detection module shall:

- Detect vehicles approaching the DWS in the appropriate traffic lane(s)
- Measure vehicle speed within defined operational parameters
- Provide reliable detection under varying traffic and environmental conditions
- The radar module shall be aligned parallel to the carriageway and orientated towards approaching traffic.
- Avoid detection of:
 1. Opposing traffic
 2. Parked vehicles
 3. Roadside objects

2.7 Weather Detection System (Optional)

The DWS shall provide an interface for an optional weather monitoring system. This shall allow logging of climatic data and triggering the display of pre-programmed messages in response to particular events.

2.8 Additional Interfaces (Optional)

The DWS, through the SCD, shall provide additional interfaces for integrating optional equipment, such as a camera for verification of correct sign functionality during trial implementations or Bluetooth monitoring device.

3. SIGN CONTROL DEVICE

3.1 General

Each DWS shall include a SCD. The SCD shall be in a single enclosure and shall control the DWS as well as providing user access to the system for both operators and maintenance operatives. The SCD shall capture and store fault reports, operational data logs and other information for retrieval and interrogation by the ATMS located in the MOCC, the AFMS and other local and remote applications.

The following requirements are common to all SCD associated with DWS:

- The SCD shall drive the Warning Sign(s) at the appropriate brightness dependent on ambient light data from the ALM;
- The SCD shall provide data and fault logs to the ATMS / NIMS and AFMS at pre-defined intervals, this may be achieved via third party cloud services or in-station services with permission of the Employer's Representative; and
- The SCD shall provide a web-based interface (accessible locally or remotely) for commissioning, testing, calibrating and monitoring of the system.

3.2 Hardware Requirements

The SCD shall interface with the warning sign(s), ALM, vehicle detector, weather detector (optional) and additional interfaces (optional).

3.3 Particular Requirements

The SCD shall include an optional communications module which can communicate with the Associated Services. This communications device must be compatible with 3/4/5G and GPRS cellular networks and shall provide the flexibility for upwards and backwards compatibility.

SIM cards for use in each communications device will be provided by the Employer.

The optional module of the SCD shall provide a RJ45 port or DB9 serial port via the RJ45/DB9 serial port to allow connection for testing/maintenance purposes or connection to a communications network via network equipment.

The module shall allow configuration and interrogation of all connected devices from a web-based interface accessible both locally, via the RJ45 port and remotely via the wireless communications device.

The IP Parameters of the communications device shall be configurable. The IP address will be assigned by TII's IP Design Authority.

The SCD shall have the ability to continue operating, in a predefined manner, in the event of communication loss.

The SCD shall include a suitable non-volatile memory with sufficient capacity to store all software and configuration files which ensures the continued operation of the equipment in the event of communication failure.

The SCD shall include a suitable Secure Digital (SD) memory card storage device with sufficient capacity to store all data-logs, for a defined period of time, which ensures the continued operation and avoids data loss in case of communication failure. The method of writing to this storage device shall be configurable via the SCD (i.e. First In First Out or Last In First Out).

3.4 Internal Interfaces

An interface shall be provided with the Vehicle Detector Unit to allow alarms, status and fault data to be sent to the SCD.

An interface shall be provided with the Warning Sign Display (WSD) modules to allow the warning messages, status data and fault data to be sent to the SCD.

An interface shall be provided with the ALM to allow the DWS to be operated at the appropriate luminance and to allow access to the fault and status reporting from the ALM.

An interface shall be provided to allow connection to an optional Weather Detector.

An interface shall be provided to allow connection to an Additional Sensor.

The data exchange requirements for the local interfaces are shown in Table 1.

Table 1 Data Exchange Requirements - Internal Interface

Data to be sent to the Sign Control Device	Data to be retrieved from the Sign Control Device
Vehicle Detection	
Alert Data	Status Poll
Fault Data	
Status	
Warning Sign	
Fault Data	Sign Control Data
Status	Status Poll
ALM	
Ambient Light Level	Status Poll
Fault Data	
Status	
Weather Detector (Optional)	
Weather Data (To be defined)	Status Poll
Fault Data	
Status	

Data to be sent to the Sign Control Device	Data to be retrieved from the Sign Control Device
Additional Sensor (Optional)	
Ambient Light Level	Status Poll

3.5 External Interfaces

A web-based interface is required to allow the signs to be setup and configured both locally and remotely. This interface as minimum shall provide XML exchange over an IP-based network.

The web-based interface shall as a minimum provide the following functionalities:

- Upload new firmware and application code to the SCD, this function shall be available remotely (i.e. without having to organise a site visit);
- Monitor the status and check faults of the whole system including individual elements via a simple graphical interface;
- Configure the sign operation (e.g. speed thresholds, timing parameters etc.);
- Download fault logs;
- Download operational data logs;
- Manual override signs for test purposes.

Any configuration changes, firmware, application code, software changes or manual override activities shall only be possible after an additional secure password is entered. The password management shall use a secure mechanism acceptable to TII.

The data exchange requirements between the SCD and the remote applications (e.g. ATMS, AFMS) are detailed in Table 2.

Table 2 Data Exchange Requirements – External Interfaces

Data to be Sent to the Sign Control Device	Data to be Retrieved from the Sign Control Device
Setup and Configuration	Operation Reports
Status Poll.	Status.
Sign Configuration Data	Time and date vehicle passed the detector.
FTP address to send daily report files to.	Minute-averaged vehicle flow.
Time to Upload vehicle data files.	Time and date for Warning Sign triggered.
Reboot the sign.	Length of time aspect triggered.
Reset the sign.	Luminance level associated with Warning sign activity.
Set sign into maintenance mode.	Vehicle Detection Data-logs
Sign Device Name.	Weather Detection Data-logs

Data to be Sent to the Sign Control Device	Data to be Retrieved from the Sign Control Device
Device IP address.	Additional Interface Data-logs
SNMP Trap Destination.	Fault Reports
Username.	Date and Time.
Password.	LED failure.
	Display Driver Fault.
	Vehicle Detector Fault.
	ALM fault.
	Weather Detector Fault (if installed).
	Additional Interfaces Fault (if installed)

3.6 Operation Reporting

The status of the sign can be queried via the XML interface.

The SCD shall be capable of providing operation reports containing the details as specified in Table 2 for statistical purposes. These shall be available as a comma separated value (CSV) file with a carriage return and a line feed between each record and be retrievable via the web-based interface (and via an automated daily service using an FTP transfer to a server located at the MOCC or other location nominated by TII). This download shall not remove the file from the daily upload.

A SD memory card shall be provided with each DWS and shall be appropriately sized to be store all data-logs for a minimum of 90 days. The capacity of the SD Memory Card shall be configurable to allow for storage of up to 1 year's data-logs. The method of writing to the storage device shall be configurable via the SCD (i.e. First In First Out or Last In First Out). The DWS supplier shall provide a data budget, tailored to each site, demonstrating the capacity of the memory.

3.7 Fault Reporting

Fault reports shall be retrievable via the web-based interface in a configurable CSV / XML file format, containing the details as indicated in Table 2. In addition, faults shall be transmitted to the Associated Services via to an SNMP Trap when a fault occurs.

The number of LED failures required to trigger a fault condition shall be configurable by the user.

Details of the content of the faults reported shall be agreed with the Employer.

3.8 Time Synchronisation

It shall be possible to set the time on the device using a Network Time Protocol (NTP) Time server via an SNTP interface.

3.9 Security

Where the Employer deems it a requirement, all connections to the SCD shall be encrypted using a Secure Sockets Layer (SSL) recommended server support of 128-bits.

3.10 Local Access

The interrogation and configuration functionality detailed above shall be available via the local connection of a suitable device to the SCD using the RJ45 port/DB9 serial.

4. DISPLAY MODULES

4.1 General

The optical design of the signs shall be light emitting and free from mechanical devices.

Each sign will consist of a display module or modules within a sign enclosure.

To reduce the number of components a dedicated array of LEDs, or equivalent emitters, may be used. A configurable matrix may also be considered to allow for flexibility of the design in terms of the different aspects a single display module can display.

The display modules shall be designed with a suitable pixel pitch to meet the relevant visibility requirements of EN 12966 and DoT TSM Chapters 3 and 6.

The display modules and the LEDs used shall comply with EN 12966 as detailed further in Section 5.2.

Front facing surfaces shall be grey in colour.

The front face of the display modules shall provide a smooth, flat, scratch-resistant and wipe-clean surface that is predominantly non-reflective. It shall be designed to meet the environmental and optical performance requirements and shall provide reflection-free viewing of the sign for the motorist when the equipment is mounted in its operational orientation. The effect of external light sources such as vehicle headlamps and street lighting shall be taken into account. Where a coating or masking material is used to achieve this, the material shall be suitable for the design life of the equipment.

4.2 Visual Performance

With reference to Section 7 of EN 12966, the required performance classes for the Yellow, White and Red LEDs are as follows:

- Colour - class C2;
- Luminance (La) - class L3;
- Luminance Ratio (Lr) - class R3;
- Beam Width - class B3;
- Uniformity shall comply with EN 12966-1 section 7.6; and.
- Visible flicker shall comply with EN 12966-1 section 7.7.
- Pixels shall have colour performance in accordance with EN 12966.

5. AMBIENT LIGHT MONITOR

5.1 General

The ALM shall provide the SCD with information necessary to adjust ambient light levels. The SCD shall use this functionality to adjust the display luminance level of the warning sign(s) under its control.

The ALM shall:

- Measure ambient light conditions in real time
- Enable automatic dimming or brightness adjustment of the display module
- Ensure visibility during daylight while preventing excessive brightness during low-light or night-time conditions
- Support compliance with driver comfort and road safety principles

5.2 Luminance Measurement

The ALM shall be designed so that its light sensor(s) measure the ambient light level in all directions from the vertical to the horizon.

The ALM shall measure ambient light levels to allow the warning signs to operate to meet the luminance requirements Section 7.3 of EN 12966.

5.3 ALM Enclosure

The ALM shall be designed and supplied with a mounting arrangement suitable for installation on the warning sign enclosure.

6. VEHICLE DETECTION

6.1 Hardware Requirements

Where required by the Frameworks Agreement Call-Offs, the detection hardware shall detect vehicles, as minimum, in 2 lanes.

The DWS shall have the capability of adding additional detection equipment to detect vehicles in additional lanes up to a maximum of 8.

The detection hardware shall be capable of being installed in either the DWS housing or at a location adjacent to the DWS.

The vehicle detector shall be capable of being deployed at an appropriate distance from the DWS to allow the visibility requirements detailed in Table 6.1 of the DoT Traffic Signs Manual (TSM) to be met.

The detector shall continuously monitor vehicles and collect vehicle data, on a per lane basis.

Where embedded induction loop detection is to be used, it shall be installed in accordance with TII specification CC_SPW-01500.

Where non-loop-based detection technologies are used, documented performance capability shall be provided and shall be subject to the approval by the Employer.

6.2 Monitoring Camera

The DWS shall have the capability for the integration of a camera for the purposes of verification of sign operation during a trial deployment. The camera shall be able to record suitable footage in day and night conditions. The camera selected for this use shall be subject to the approval by the Employer based on a demonstration of suitable performance.

The camera shall be discrete, mounted within the sign enclosure where possible and not visible to approaching motorists to reduce the risk of it being mistaken for a speed enforcement camera.

The camera shall record a 1 minute of clip for each sign activation, 30 seconds before and 30 seconds after the triggered event.

The clips shall be available for download remotely via the web-based interface for 1 month.

The camera clips shall be saved to a removable memory card capable of storing 1 month of compressed video. Any stored video shall be deleted after 1 month. The camera video settings shall be configurable to ensure that the best quality of video can be stored within the removable storage device for the duration of 1 month. Configurable items shall include frame rate, compression method and resolution of the stored video. The recommended frame rate for the camera recordings shall be 5fps.

It shall be possible to request live stream via the web-based interface for a defined duration. The manufacturer shall provide design calculations to confirm the required bandwidth for live transmission.

The removable memory card shall be accessible from the roadside (within the lockable enclosure).

7. WEATHER DETECTION

7.1 General

Where required by the Framework Agreement Call-off, weather detector shall provide the SCD with climatic data which shall be stored for 30 days. The weather detector shall be capable of measuring wind, liquid precipitation, air temperature, barometric pressure and relative humidity in accordance with the parameters defined in Table 3.

Table 3 Weather Detection Parameters

Wind	
SPEED	
Range	0 ... 60m/s
Response time	250ms
ACCURACY	
0...35m/s	±0.3m/s or ±3% whichever is greater
35m/s ... 60m/s	±5%
Output Resolution	0.1m/s, 0.1km/h
Units	0.1mpg, 0.1 knots
DIRECTION	
Azimuth	0...360°
Response time	250ms
Accuracy	±3°
Output Resolution and units	1°
LIQUID PRECIPITATION	
RAINFALL	Cumulative accumulation after the latest automatic or manual reset
Output resolutions and	
Units	0.01 mm, 0.001 inches
Accuracy	5%*
RAINFALL DURATION	Counting each ten-second increment whenever water droplet is detected
Output resolutions and units	10 sec
RAIN INTENSITY	One-minute running average in ten-second steps
Range	0...200 mm/h

Wind	
Output resolutions and units	0.1 mm/h, 0.01 inches/h
HAIL	Cumulative amount of hits against the collecting surface
Output resolutions and units	0.1 hits/cm ² , 0.01 hits/in ² , 1 hits
HAIL DURATION	Counting each ten-second increment whenever hailstone is detected
Output resolutions and units	10 sec
HAIL INTENSITY	One-minute running average in ten-second steps
Output resolutions and units	0.1 hits/cm ² /h, 1 hits/in ² /h, 1 hits/h
*Due to the nature of the phenomenon, deviations caused by spatial variations may exist in precipitation readings, especially in a short time scale. The accuracy specification does not include possible wind induced errors.	
AIR TEMPERATURE	
Range	-52...+60 °C (-60 ...+140 °F)
Accuracy for sensor at +20 °C	±0.3 °C (±0.5 °F)
Accuracy over temperature range (see graph)	
Output resolutions and units	0.1 °C, 0.1 °F
BAROMETRIC PRESSURE	
Range	600 ... 1100 hPa
Accuracy	±0.5 hPa at 0 ... + 30 °C (+32 ...+86 °F)
	±1 hPa at -52 ... + 50 °C (-60 ...+140 °F)
Output resolutions and Units	0.1 hPa, 10 Pa, 0.0001 bar, 0.1 mmHg, 0.01 inHg
RELATIVE HUMIDITY	

Wind	
Range	0 ... 100%RH
Accuracy	±3 %RH within 0 ... 90%RH
	±5 %RH within 90 ... 100 %RH
Output resolutions and Units	0.1 %RH

8. SIGN ENCLOSURES

8.1 Materials

The sign system shall consist of the sign face, sign substrate, stiffeners, brackets, posts and foundations. Sign systems shall be manufactured in accordance with IS EN 12899 and CC-SPW-01200 Traffic Signs and Road Markings.

Materials used for the sign enclosures and front panels shall be resistant to corrosion in accordance with EN 12899-1:2001, Section 5.3.5 and shall conform to the European Standard for the appropriate material where it exists. If materials not covered by European Standards are to be used, the Manufacturer shall demonstrate the durability of the material by reference to an appropriate European Technical assessment.

Where it is necessary to paint side and rear facing surfaces to achieve the required design life, these shall be to colour Medium Grey 18B21 BS4800 in non-reflective material. Unpainted surfaces shall be dulled. All finishes shall give a high-quality aesthetic appearance for the design life of the equipment.

All other loads and combinations for the design of the enclosures shall be calculated in accordance with EN 12966-1. Wind force and pressure coefficients shall be calculated in accordance with EN 1991-1-4, Eurocode 1: Actions on Structures – Part 1-4: General Actions – Wind Actions.

The deflection class for the design of the enclosure due to temporary loads shall be TDB1 in accordance with EN 12899-1.

All covers, doors, access panels, protective screens, plates, glands, external connectors etc. necessary for environmental protection, shall be provided with seals which are maintenance free and shall remain effective for the design life of the equipment.

The designs shall consider the positions of connectors, cable entries or all other features to minimise the likelihood of water ingress.

All sign enclosures shall be lockable.

8.2 Marking and Labelling

All enclosures associated with the warning signs shall be clearly, durably and visibly marked with the following information:

- Name or identifying mark of the manufacturer;
- Name and registered address of the manufacturer;
- Product name and characteristics;
- Electrical and physical ratings for the connection the supplies e.g. rated or ranged voltage, current, frequency, wattage, etc;
- Year of manufacture; and
- Asset identification label for maintenance purposes.

8.3 Protection

The sign enclosure shall be rated to a minimum of IP66.

8.4 Clips, Brackets and Cables

All clips, brackets and cables necessary for the installation of the sign and ancillary devices onto existing sign supports or new sign supports shall be provided and shall include anti-theft devices.

All cables shall be contained within the sign, where it is not possible to contain the cables within the sign enclosure, they shall be protected suitably to ensure they cannot be tampered with.

9. ADDITIONAL REQUIREMENTS

9.1 Mounting

The requirements for mounting height and the use of passively safe posts are defined in Chapter 1 of the DoT TSM. Passively safe posts shall be used where signs are to be deployed without a safety barrier and they shall comply with IS EN 12767. Information on the use of passively safe posts is given in the National Roads Authority Standard TD 89.

9.2 Physical Performance

The warning signs shall meet the physical performance requirements of Section 8 of EN 12966.

The following class designations shall be used:

- Temperature Class T1;
- Pollution Class D2; and
- Protection Class P3.

9.3 Reliability

All equipment shall be designed to have a minimum in-service life of 15 years with minimum maintenance. The supplier shall provide warranties ensuring that spares will be available for a period of 10 years from the date of purchase. The design shall provide high reliability with a system Mean Time Between Failure (MTBF) of 30,000 hours minimum when calculated in accordance with the IEC Technical Report 62380 standard.

9.4 Maintenance

The Warning Sign(s) shall use a modular design for ease of maintenance.

Display module removal shall be achieved by loosening easily accessible retaining fixings and disconnection of power and control leads only. Where it is necessary to remove any other items/modules to facilitate display module removal, these shall be limited in number and their design shall incorporate features that enable easy removal.

The manufacturer shall ensure that all maintenance activities required on the sign can be easily carried out. All signs shall have all necessary fixing points installed to carry out all necessary maintenance of the sign and additional devices attached to the sign support.

All parts of the sign shall be securely connected to the sign enclosure.

The size and weight of replaceable modules shall be kept to a minimum and suitable for easy and safe handling by one person. Any modules weighing over 10kg shall be marked with their weight.

All replaceable modules shall be fitted with retained (i.e. vibration proof) sockets and plugs as appropriate to allow easy disconnection and removal of equipment.

The earthing method for all equipment shall comply with the national rules for electrical installations.

All metalwork not normally expected to carry current shall be bonded to the earth connection point within the enclosure. Such metalwork shall include equipment panels, structural members, access doors/covers, screens, glands, conduits, sheaths etc.

To assist in maintenance and fault-finding, conductors shall be identified in accordance with the technical documentation at each termination by means of numbered collets which completely encircle the conductor. All mains wiring between modules or within an enclosure shall use the colours defined in IEC 60446.

The 'Nuisance Tripping' (the unnecessary operation of automatic over-current protection devices e.g. RCDs; MCBs) due to external factors can be a problem in a motorway environment, especially where it is not possible to readily access the equipment to reset the device. The overall design shall provide effective over-current protection while incorporating measures to minimise 'nuisance tripping'.

Lightning protection shall be provided at both ends of communications circuits. Lightning Surge Arrestors shall be installed as close as possible to the point of cable entry to the enclosure, on all cables connecting the equipment to the external power supply or communications.

The signs shall include visual status indicators to allow the status of the sign to be quickly assessed at the roadside. As a minimum the indicators shall show power status and fault status.

9.5 Power

Power supply to mains powered signs is standard single phase 220/240V AC.

Some variants of the sign types shall have the option of being powered using solar panels. The power supply requirements for each sign type can be found in the relevant section of this specification.

10. SCHOOL WARNING SIGN

10.1 Introduction

10.1.1 General

This specification provides performance requirements for a school warning sign to be used to warn drivers to drive with caution in the vicinity of schools at defined times at the start and end of school day.

10.1.2 Scope

This specification is a performance-based specification, adopting the TII requirements and objectives of a school warning sign. The primary function of the school warning sign is to warn drivers to drive with caution at defined times at the start and end of school day according to a stored timetable of activation.


10.1.3 Related Documents

School Warning Signs must meet the requirements of Chapter 6 of the DoTTSM. Table 6.1 in the DoTTSM defines the siting requirements for Warning signs. Clauses 6.17.5 to 6.17.7 define the requirements for the deployment of School Warning signs.

10.2 Warning Sign

The School Warning Sign will include two S102 Flashing Amber Signals in addition to dedicated display boards capable of displaying the following as detailed in Table 4.

Table 4 School Warning Signs

Will consist of 2 elements, a fixed plate W141 School Warning Sign and an active element consisting of a dedicated LED board capable of displaying two S102 Flashing Amber Signals positioned below the fixed plate.	
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10.3 Sign Control Device

10.3.1 General

In addition to the common SCD requirements detailed in the school warning sign control device shall have the following functionality:

- Activate and deactivate the school warning sign at user defined time periods.

The timing and duration of school warning sign activation shall be configurable

The system shall include data entry and configuration checks and prevent erroneous configuration. For example, it shall not be possible for the school warning signs to be active outside the defined timetable, e.g. over night.

10.3.2 Requirements for School Warning Sign Setting

The flashing amber signals shall be displayed by a dedicated array of LEDs controlled by the SCD.

10.3.3 Sign Trigger Configuration Parameters

School warning signs shall be activated as per a timetable stored on the SCD. The timetable will be stored within the sign and also on the designated Associated Service as identified by the Employer, including but not limited to the AFMS, Coeval Cloud Service and ATMS server, which can be uploaded to the sign.

The active elements of the warning signs shall be displayed for the period defined in the activation timetable.

The flashing amber signals will activate for the period defined in the activation timetable. When switched on the flashing amber signals shall flash intermittently at a speed of between 60 and 80 flashes per minute, this parameter shall be configurable via the web-based interface.

10.3.4 Internal Interfaces

Each SCD shall provide an interface for an ALM, optional weather detector and optional vehicle detector.

10.3.5 External Interfaces

The following additional configuration parameters (Table 5) shall be configurable via the web-based interface:

Table 5 External Interfaces Configuration Parameters

Data to be sent to the Sign Control Device	Data to be retrieved from the Sign Control Device
SETUP AND CONFIGURATION	FAULT REPORTS
Activation Timetable (to include activation time and deactivation time for X periods each day for up to years)	Flashing Amber Signal failure
Frequency of the Flashing Amber Signals (configurable between 60 and 80 flashes per minute in increments of 5)	Low Power Voltage (Solar)

10.3.6 Vehicle Detection (Optional)

10.3.6.1 Hardware Requirements

The school warning sign shall include the option of a vehicle detector for traffic monitoring purposes.

10.3.6.2 Software Requirements

The detector software shall calculate the following for monitoring purposes for vehicles travelling past the sign:

- Vehicle Count; and
- Vehicle Classification (using EURO 13 classes as defined in the Dynamic Signs Main Specification).

10.4 School Warning Aspect Requirements

School warning signs shall include W141 school warning aspect.

The size of school warning aspect shall be 600mm as per Table 6.1 of the DoT TSM.

10.4.1 Lantern Requirements

School warning signs shall also include flashing amber signals (compliant with the DoT TSM S102) as shown in Figure 1.

The minimum number of pixels per lantern shall be 150.

The diameter of the Flashing Amber Signals shall be 200mm.

Lanterns must be capable operating within the above specification following a 10% failure of LEDs.



Figure 1 Lanterns (S102)

10.4.2 Sign Enclosures

10.4.2.1 Warning Sign Dimensions

The dimensions for the warning sign enclosure shall be as shown in Figure 2.

The sign enclosures shall be deep enough to contain all the necessary hardware.

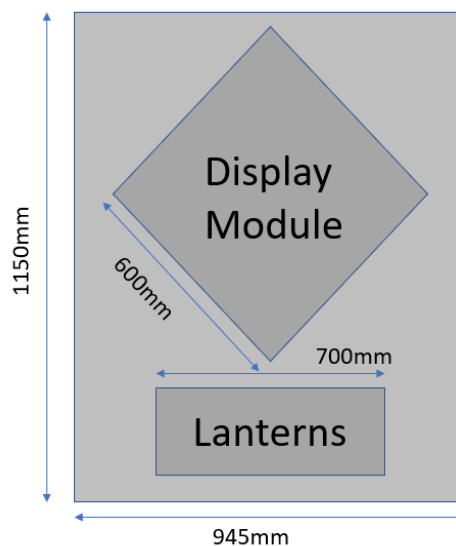


Figure 2 School Warning Sign dimensions

10.4.3 Additional Requirements

The batteries and solar panels shall be adequately specified and sized to ensure that the school warning signs can communicate at least once per day with the Associated Services which may include, but is not limited to the AFMS, Coeval, ATMS Servers. The flashing lanterns can be activated for at least 5 number 20 minute periods per day for a total of 30 school days without charging from the solar panel, at all other times the sign is in sleep mode.

The solar panel shall be adequately specified and sized to ensure that it can in normal operating conditions maintain the sign and charge the battery.

11. WRONG WAY DRIVER WARNING SIGN

11.1 Introduction

This specification provides performance requirements for a vehicle activated wrong way driver warning sign to detect vehicles and warn drivers that they have to stop and cannot proceed ahead.

11.1.1 Scope

This specification is a performance-based specification, adopting the Employer's requirements and objectives of a vehicle activated wrong way driver warning sign.

The primary characteristics of the wrong way driver warning sign are:

- It will consist of a detection system and two vertically aligned sign aspects;
- The aspects will be displayed by two dedicated LED display boards, one to display the "STOP" aspect and one to display the "NO ENTRY" aspect; and
- On activation the upper "STOP" aspect will flash at a user defined rate for a configurable duration and the lower "No ENTRY" aspect will remain active (constant on) for the same duration.

The sign shall be available in two sizes a 750mm aspect variant for slip roads and a 1200mm aspect variant for mainline signs.

11.2 Warning Sign

The wrong way driver warning sign will consist of two display boards, each having a dedicated array of LEDs, to display the "STOP" and "NO ENTRY" aspects.

11.3 Sign Control Device

11.3.1 General

The wrong way driver warning sign consists of a number of elements that enable warning signs to be activated based on the detection of approaching vehicles.

In addition to the common SCD requirements the wrong way driver warning sign control device shall have the following functionality.

- Continuously control and monitor the wrong way driver warning sign; and
- Activate the wrong way driver warning sign on detection of vehicles approaching the sign.

The system shall include data entry and configuration checks and prevent erroneous configuration. For example, it will not be possible for the sign to be activated by vehicles travelling in the correct direction.

11.3.2 Requirements for Wrong Way Driver Warning Sign Setting

The wrong way warning sign aspects shall be displayed by a dedicated array of LEDs controlled by the sign control device.

The "STOP" and "NO ENTRY" aspects shall be triggered by approaching vehicles.

When active the “STOP” symbol shall flash at a rate of 60 to 80 flashes per minute for a user configurable duration.

When active the “No Entry” aspect shall remain on for a user configurable duration.

11.3.3 External Interfaces

The following additional configuration parameters (Table 6) shall be configurable via the web-based interface:

Table 6 External Interfaces - Configuration Parameters

Data to be sent to the Sign Control Device	Data to be retrieved from the Sign Control Device
SETUP AND CONFIGURATION	OPERATION REPORTS
“No Entry” Aspect activation duration	Notification email each time signs are activated.
“Stop” Aspect activation duration	
“Stop” Aspect Flash Rate	
Destination email address for sign activation alerts.	

11.3.4 Vehicle Detection

11.3.4.1 Hardware Requirements

The vehicle detector hardware for the wrong way driver warning sign shall be a radar.

This shall be capable of detecting approaching vehicles in at least 3 lanes.

11.3.4.2 Software Requirements

The detector software shall trigger sign activation on detection of vehicles approaching the sign driving in the wrong direction.

The detector software shall not trigger sign activation on detection of vehicles driving away from the sign in the correct direction.

The detector software shall calculate the following for monitoring purposes for vehicles travelling away from the sign in the correct direction in all lanes where a detector is deployed:

- Vehicle Count; and
- Vehicle Classification (using EURO 13 classes).

11.4 Wrong Way Driver Warning Sign Requirements

Each wrong way warning sign shall consist of two vertically aligned display modules contained within a rectangular enclosure.

The size of each aspect shall be 750mm for slip road signs and 1200mm for mainline signs.

11.4.1 Warning Sign Aspects

The upper display module shall display a “STOP” symbol as shown in Figure 3 with the boundary developed with yellow LEDs and the hand and text developed with white LEDs.

The lower display module shall display a “No Entry” symbol as shown in Figure 3 with the boundary developed with red LEDs and the arrow with white LEDs.

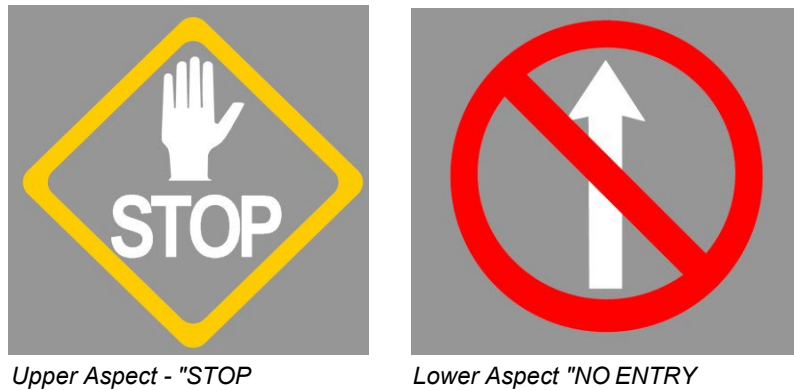


Figure 3 Wrong Way Driver Warning Sign Aspect

11.4.2 Sign Enclosures

11.4.2.1 Wrong Way Driver Warning Sign Dimensions

The dimensions for the warning sign enclosures for slip road signs (750mm aspects) and mainline (1200mm aspect) shall be as shown in Figure 4 below.

The enclosure shall be deep enough to contain all the necessary hardware.

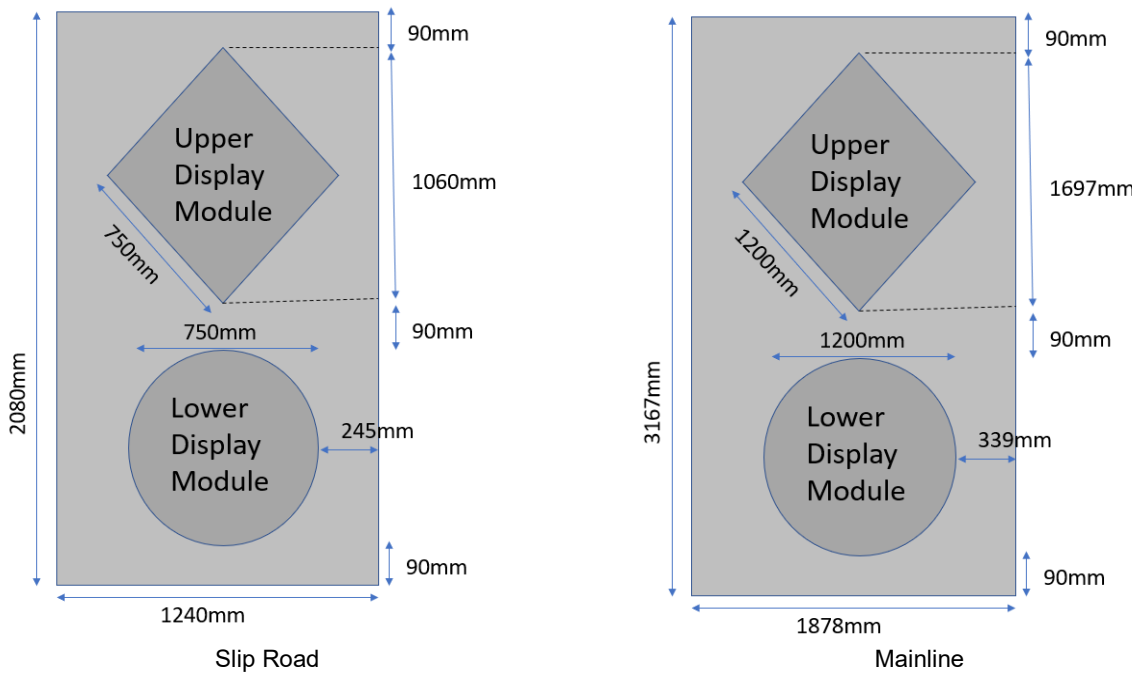


Figure 4 Variants of Wrong Way Driver Warning Signs

11.4.3 Additional Requirements

11.4.3.1 Power

The Contractor shall ensure that the wrong way driver sign is solar powered and designed with sufficient capacity to meet operational requirements.

12. BEND WARNING SIGN

12.1 Introduction

12.1.1 Scope

This section details the requirements for bend warning signs. The primary functions of a bend warning sign are:

- It shall consist of a detection system, a warning sign and multiple chevron signs that activate when the detection system is triggered;
- It shall be able to distinguish between two classifications of vehicles - trucks and cars;
- The warning signs will consist of two vertically aligned sign aspects;
- When detecting a car, the lower aspect will be displayed, which will be a W033 sign type as per the DoTTSM;
- When detecting a heavy goods vehicle (HGV), the upper aspect will be displayed, which will be a truck overturning symbol as per the American standard MUTCD W1-13 (with some minor modifications to indicate a banked curve and the removal of the turning arrow) in addition to the lower W033 aspect;
- The chevron signs will consist of both fixed sign and active elements to allow warning to be provided in the case of power or communications failure. The signs will be double (W062) or triple (W063) chevrons to allow flexibility at deployment.

The Warning Sign and Chevron Signs will be available in variants for left hand bends and for right hand bends.

12.1.2 Bend Warning Sign Overview

The bend warning system consists of a number of elements that enable warning signs to be illuminated based on the class of vehicle detected when approaching bends above defined speed thresholds.

The elements that are contained within the bend warning system are:

- **Sign Control Device:** This shall be in a single enclosure and be responsible for the overall control, communications and monitoring for the bend warning system, including the provision of local and remote access to the system and storage of data. The sign control device shall control up to 4 warning signs and up to 50 chevron signs.
- **Vehicle Detection and Classification System:** This shall be capable of detecting the speed and type of vehicle (Car or HGV) in each specified lane.
- **Warning Sign:** As shown in Figure 5 each warning sign will consist of 2 vertically aligned display modules housed within a single rectangular enclosure. The lower aspect will be displayed to cars travelling over a user defined speed threshold. In addition to the lower aspect, the upper aspect will be displayed to HGVs travelling over a second user defined speed threshold.
- **Chevron Signs:** The Chevron Signs shall be displayed to all vehicles entering the bend in accordance with user configurable parameters. The Chevron Signs

will be available as double (W062) and triple (W063) chevrons signs. The Chevron Signs shall consist of both fixed sign and active elements to allow warning to be provided in the case of power or communications failure.

- Ambient Light Monitor (ALM): An ALM shall be incorporated into the SCD.

An indicative site layout is shown on Figure 5.

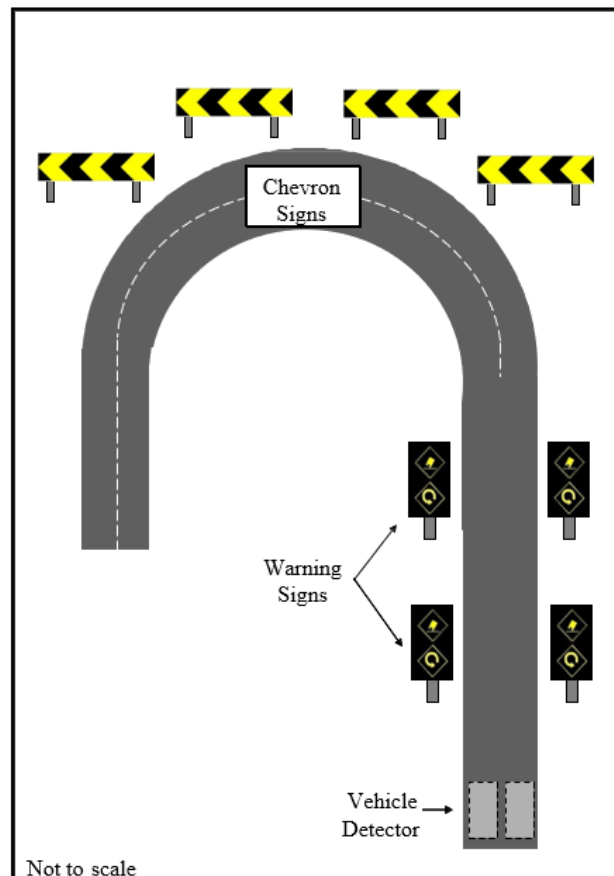


Figure 5 Indicative Site Layout

12.2 Sign Control Device

12.2.1 General

In addition to the common SCD requirements the SCD shall:

- Continuously control and monitor 1 to 4 warning signs and 3 to 50 chevron signs;
- Drive the lower aspect(s) of the warning sign(s) on detection of cars travelling over a user defined speed threshold (refer to Table 7);
- Drive the lower aspect(s) and the upper aspect(s) of the Warning Sign(s) on detection of a HGV travelling over a second user defined speed threshold (refer to Table 7); and
- Drive the appropriate number of chevron signs in accordance with user programmable parameters (Figure 5).

The duration of warning sign activation and sequencing for chevron signs shall be configurable.

The system shall include data entry and configuration checks and prevent erroneous configuration for example Speed Threshold 1 (see Table 7) shall be less than Speed Threshold 2.

12.2.2 Requirements for Bend Warning Sign Setting





The warning sign aspects (Lower - W033, Upper - MUTCD W1-13) shall be displayed by a dedicated array of LEDs (as detailed in Section3) controlled by the SCD.

There shall be two user defined speed thresholds (Speed Threshold 1 and Speed Threshold 2) which shall be configurable in kph via the web-based interface.

Table 7 below summarises the Warning Sign aspects to be displayed for different vehicle types and the corresponding conditions for activation.

The upper aspect shall be displayed for HGVs only.

Table 7 Warning Sign Aspects – Conditions for Activation

Data Warning Sign Aspects Conditions for Activation				
LEFT TURN				
	Vehicle Detected	Speed Threshold	Vehicle Detected	Speed Threshold
	HGV	1	HGV	1
	Car	2	Car	N/A
RIGHT TURN				
	Vehicle Detected	Speed Threshold	Vehicle Detected	Speed Threshold
	HGV	1	HGV	1
	Car	2	Car	N/A

12.2.3 Requirements for Chevron Sign Setting

The active chevron sign aspects shall be displayed by a dedicated array of LEDs controlled by the SCD.

The active chevron sign aspects will be displayed to all detected vehicles according to the conditions.

The Chevron Sign aspects shall be displayed to provide adequate warning to drivers in advance of the bend in accordance with Chapter 6 of the DoTTSM.

The Sign Control Device shall be able to drive a maximum of 50 Chevron signs.

12.2.4 Sign Trigger Configuration Parameters

Figure 6 and Figure 7 show examples of the sequence of events involved in a typical sign activation for a site covering the following modes of activation:

- **Example 1- Pulsing:** The active chevrons are pulsed simultaneously at a constant rate for a configurable duration.
- **Example 2- Constant On:** The active chevrons are activated simultaneously for a configurable duration.

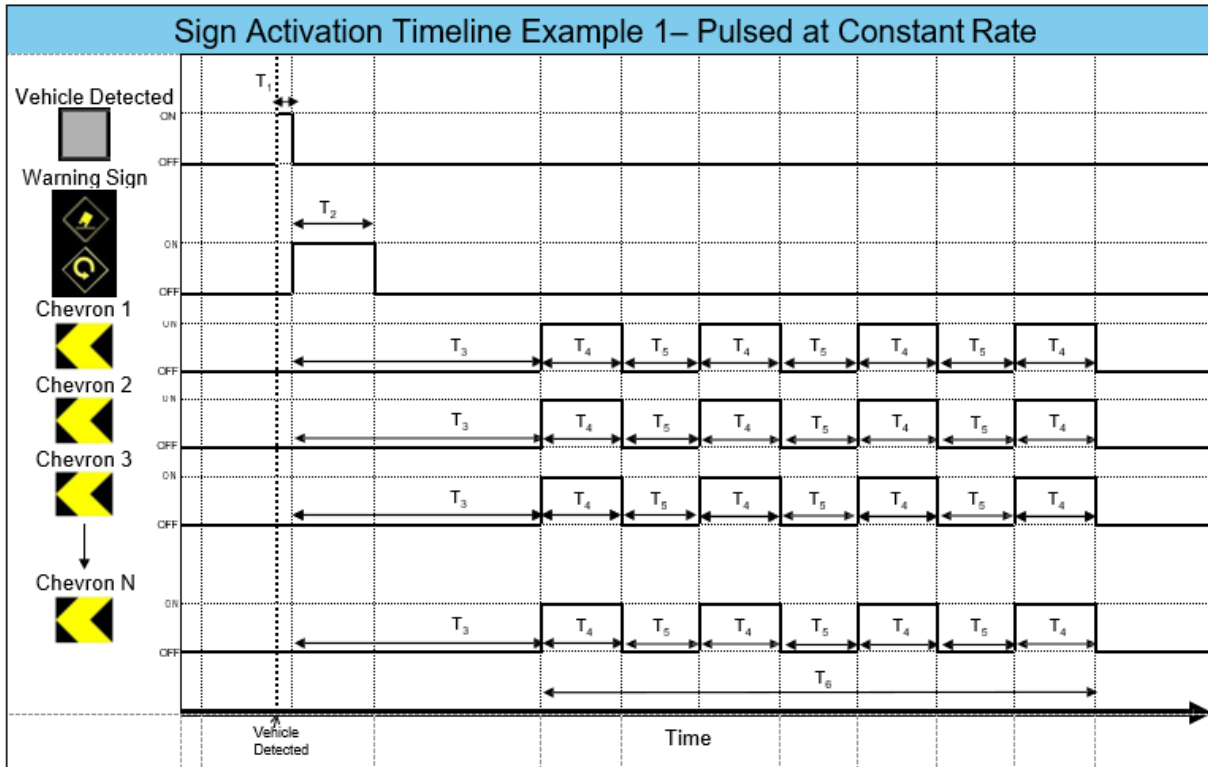


Figure 6 Sign Activation Timeline Example 1 - Pulsed at constant rate

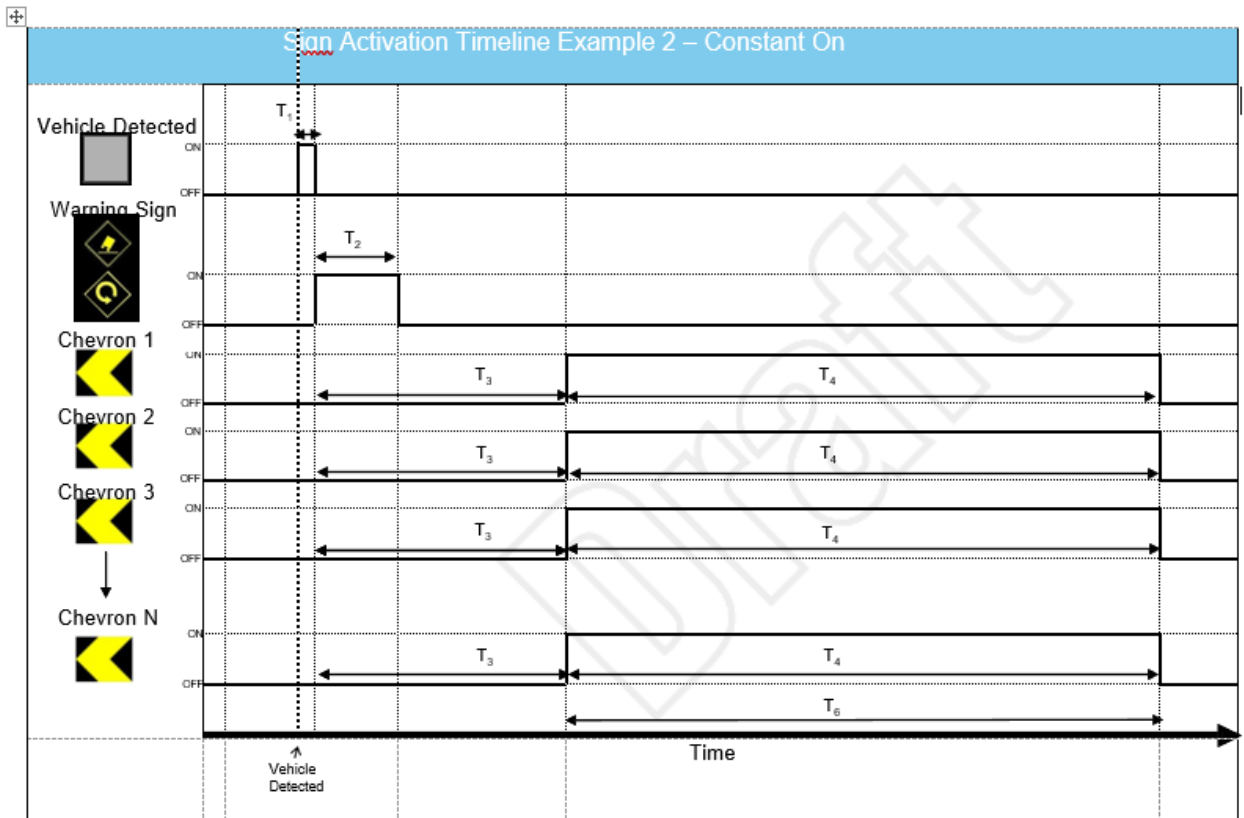


Figure 7 Sign Activation Timeline Example 2 - Constant On

Table 8 Sign Activation Parameters

	Example 1 Warning Sign activated on detection of a vehicle over one of the speed thresholds with all Chevrons pulsed simultaneously at a constant rate for a configurable duration.		Example 2 Warning Sign activated on detection of a vehicle over one of the speed thresholds with all Chevrons activated simultaneously for a configurable duration.	
Parameter	Definition	Requirements	Definition	Requirements
T1	Time between vehicle being detected and Warning Sign Activation (i.e. displaying an aspect).	T1 must be as low as possible so that the Warning Sign is activated as soon as is practicable after the vehicle is detected to provide maximum warning to drivers travelling over the threshold. Must be less than one second.	As per Example 1.	As per Example 1.
T2	Duration of Warning Sign activation.	This time shall be configurable and should be a function of the recorded speed of the detected vehicle and the distance of the Warning Sign from the detector.	As per Example 1.	As per Example 1.
T3	Time between Warning Sign activation and Chevron 1 to N activation	This time shall be configurable and should be a function of the recorded speed of the detected vehicle and the distance of Chevron Sign 1 from the detector.	As per Example 1.	As per Example 1.
T4	Duration of activation Chevron 1 to N	The pulse rate of the chevrons will be dependent on the recorded speed of the detected vehicle as shown in Table 9 below.	Duration of activation Chevron 1 to N	Total duration of activation. Must be sufficient for chevrons to remain active until a vehicle travelling at the speed limit has passed.
T5	Off time between pulses for Chevrons 1 to N	The pulse rate of the chevrons will be dependent on the recorded speed of the detected vehicle as shown in Table 9 below.	N/A	N/A
T6 Option 1	Total duration from activation of pulses. Must be sufficient for chevrons to remain active until a vehicle travelling at the speed limit has passed.	Time should be based on the recorded speed of the detected vehicle.	As per Example 1.	As per Example 1.
T6 Option 2	Timeout	If no vehicle is detected within this time the chevrons will deactivate.	As per Example 1.	As per Example 1.

Table 9 provides an example of how the recorded speed of the detected vehicle could be banded for Example 1. This allows the chevrons to pulse at a rate proportional to the speed and type of vehicle detected. The pulsing rates and speed bands shall be configurable by the user.

The chevron pulsing rate shall not change within the duration of T6 (i.e. chevron activation duration or within the timeout period depending on the option chosen).

Table 9 Chevron Pulsing Rates

For Example, 1 the pulsing rate shall be dependent on the type of vehicle detected and the recorded speed (SD) compared to the given speed threshold (ST) for that type of vehicle.			
Detected speed bands (kph)	$S_D < (S_T + 10)$	$(S_T + 10) < S_D < (S_T + 20)$	$(S_T + 20) < S_D$
Pulsing Rate (pulse/min)	80	100	120

12.2.5 External Interfaces

The bend warning sign shall have the following additional data exchange capabilities.

Table 10 External Interfaces - Configuration Parameters

Data to be sent to the Sign Control Device	Data to be retrieved from the Sign Control Device
Setup and Configuration	Operation Reports
Speed detector threshold values.	Speed of the vehicle.
Vehicle Classification Parameters.	Category of vehicle.
Chevron operational parameters.	
Timing Parameters detailed in Table 2.	

12.2.6 Vehicle Detection

12.2.6.1 Hardware Requirements

The bend warning sign shall include the option of a vehicle detector for traffic monitoring purposes. The detector hardware shall be radar.

12.2.6.2 Software Requirements

The detector software shall calculate the following for each vehicle detected:

- Vehicle Speed; and
- Vehicle Classification.

Vehicles shall be classified as either “Cars” or “HGVs”. Any vehicles classed as Type 3 and above, according to the Euro 13, system will be classified as “HGVs” and Type 1 and 2 as “Cars”.

The two speed thresholds for activation of the warning sign shall be configurable (specified in kph) via the web-based interface.

The detector software shall send an alert message to the SCD whenever the detected speed exceeds Speed Threshold 1 or Speed Threshold 2.

The vehicle classifications for “Cars” and “HGVs” shall be configurable.

12.3 Warning and Chevron Signs General Requirements

Each warning sign shall consist of two vertically aligned display modules contained within a rectangular enclosure.

The two display modules in a given Warning Sign shall be of the same variant (left or right) for the direction of bend the sign is being deployed.

The size of each aspect shall be 900mm as per Table 6.1 of the DoTTSM.

12.3.1 Warning Sign Lower Aspect

The lower display module shall display a colour inverse of the “Bend Warning W033”.

The two variants for left- and right-hand bends are shown in Figure 8 and Figure 9.

12.3.2 Warning Sign Upper Aspect

The upper display module shall display a colour inverse of the “MUTCD” aspect.

The two variants for left- and right-hand bends are shown in Figure 10 and Figure 11.



Figure 8 Bend Warning (Left Hand Bend W033)



Figure 9 Bend Warning (Right Hand Bend W033)



Figure 10 Truck Aspect (Left Hand Bend
MUTCD W1-13)

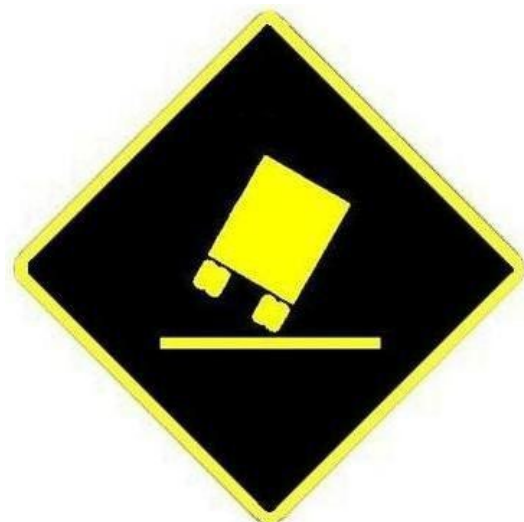


Figure 11 Truck Aspect (Right Hand Bend
MUTCD W1-13)

12.3.3 Chevrons Sign General Requirements

- There will be two types of chevron sign:
- Two Chevron Sign (W062) - with one active chevron and one fixed plate chevron.
- Three Chevron Sign (W063) - with one active chevron and two fixed plate chevrons.

The active chevron elements will consist of a display module made up of a dedicated array of LEDs. The LEDs will be mounted on a yellow backing such that the chevron is visible to drivers in the case of power or communications failure.

Triple chevron signs shall be used except where there are space limitations on site in which case double chevrons shall be used. The same type of shall be used around a bend (i.e. double and triple chevrons shall not be mixed).

12.3.4 Chevrons Sign Display Module

Each chevron sign will consist of one display module contained within a rectangular enclosure.

The dimensions of the Chevron display module are shown on Figure 12 for a left-hand bend.

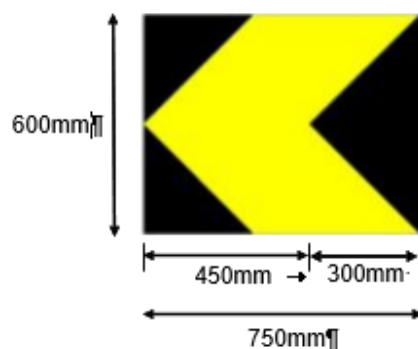


Figure 12 Chevron Display Module

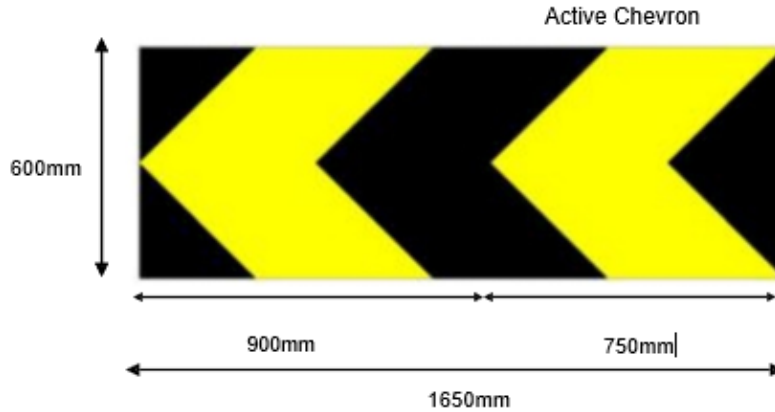


Figure 13 Two Chevron Example

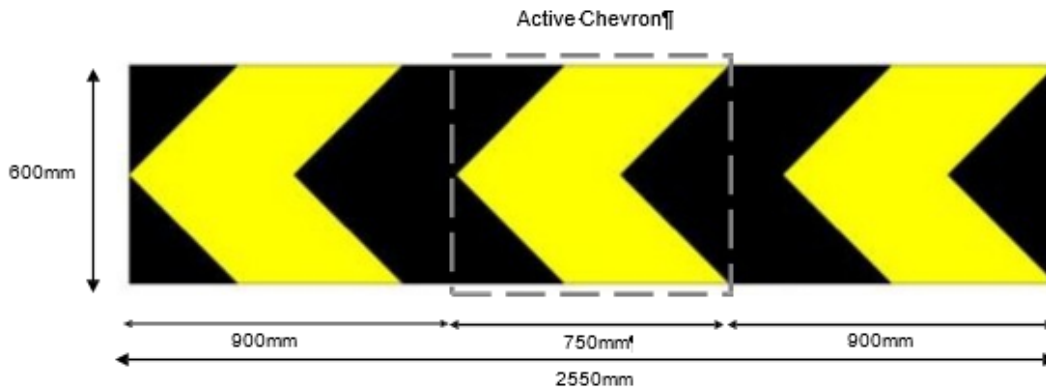


Figure 14 Three Chevron Example

The double and triple chevrons shall consist of a display module mounted flush against the surface of the rectangular enclosures to make up the W062 and W063 sign aspects.

Figure 13 and Figure 14 show how the display module fits into the fixed plate aspects of the sign enclosure to create the two and three chevron aspects.

12.3.5 Sign Enclosures

12.3.5.1 Warning Sign Dimensions

The dimensions for the warning sign enclosure shall be as shown in Figure 15 and it shall be deep enough to contain all the necessary hardware.

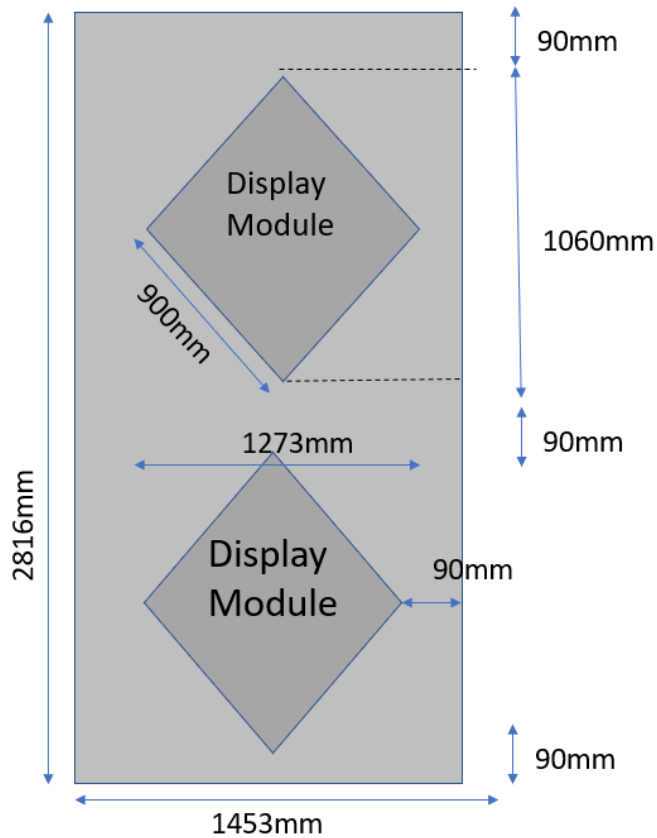


Figure 15 Warning Sign Enclosure Dimensions

12.3.5.2 Chevron Sign Enclosure Dimensions

The minimum enclosure dimensions shall 1650mm wide and 600mm tall, it shall be deep enough to contain all the necessary hardware. The chevron enclosure will include a fixed plate chevron element.

12.3.5.3 Three Chevron Sign Enclosure Dimensions

The minimum enclosure dimensions shall 2550mm wide and 600mm tall, it shall be deep enough to contain all the necessary hardware. The chevron enclosure will include 2 fixed plate chevron elements.

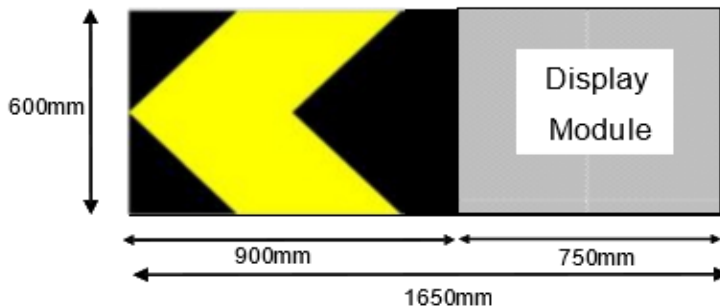


Figure 16 Two Chevron Sign Enclosure Dimensions

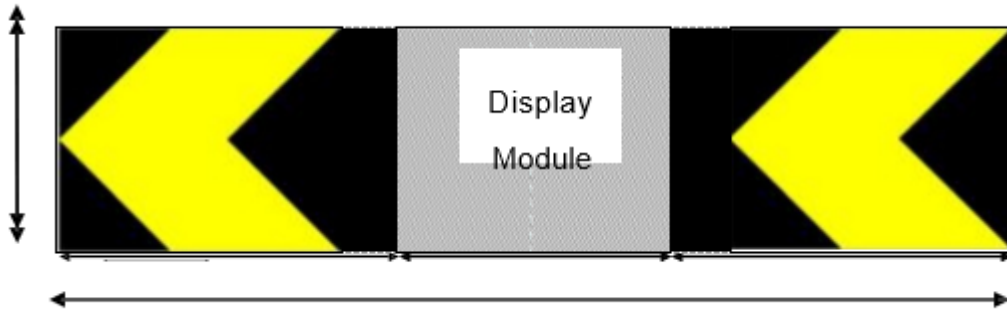


Figure 17 Three Chevron Enclosure Dimensions

13. QUEUE WARNING SIGN

13.1 Introduction

13.1.1 General

This specification provides performance requirements for a dynamic queue warning system to detect stationary vehicles and warn approaching drivers of a queue ahead.

13.1.2 Scope

The primary functions of the queue warning sign are:

- It shall consist of a detection system and a number of warning signs.
- The warning sign shall consist of a dedicated LED display board capable of displaying the W163 Queues Likely aspect from the DoTTSM;
- The queue warning sign aspect will be activated when stationary vehicles are detected; and
- The queue warning sign will include an optional built in camera to verify performance of the system for the purposes of a trial.

13.1.3 Queue Warning System Overview

The queue warning system consists of a number of elements that enable warning signs to be activated based on the detection of queuing traffic.

The elements that are contained within the queue warning system are:

- **Sign Control Device:** Each queue warning sign will include a SCD.
- **Vehicle Detection System:** This shall be capable of detecting stationary traffic in at least 2 lanes.
- **Warning Sign:** The queue warning sign will consist of a dedicated array of LEDs to display the W163 Queue Warning aspect as defined in the DoTTSM.
- **Ambient Light Monitor (ALM):** An ALM shall be incorporated into the SCD

An indicative site layout is shown in Figure 19. The number of Warning Signs required and the spacing requirements between them will be location specific and dependent on the characteristics of queuing traffic. The warning signs must be deployed in accordance with the requirements of Table 6.1 and clause 6.21.2 of the DoTTSM.

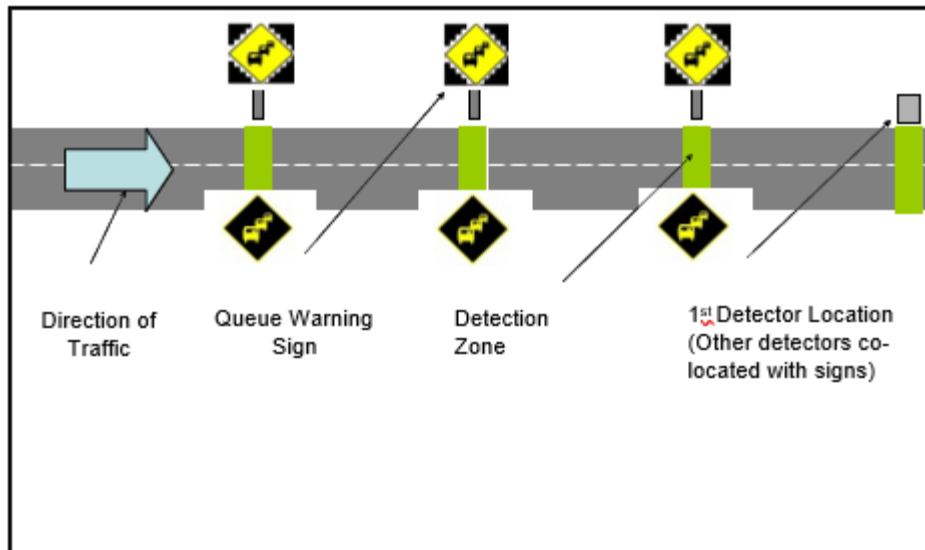


Figure 18 Indicative Site Layout

13.2 Sign Control Device

13.2.1 General

Each queue warning sign will include a SCD. A software switch shall allow the SCD to be enabled as a Master or Slave device.

In addition to the common SCD requirements the queue warning sign control device shall have the following functionality.

When enabled as a Slave device the SCD shall:

- Continuously control and monitor the queue warning sign and those immediately adjacent to it;
- Drive the queue warning sign on detection of stationary vehicles as detailed; and
- Provide data and fault logs to the Master control device at user defined intervals.

In addition, when enabled as a Master device the SCD will provide the following functionality:

- Collect fault and operational data log files from all Slave devices and send to the Associated Services at user defined intervals; and
- The Master control device will also allow access to all connected signs by the web-based interface for commissioning and maintenance purposes.

The sequence and duration of Queue Warning Sign activation will be configurable.

The system shall include data entry and configuration checks and prevent erroneous configuration for example it will not be possible for detector 1 to activate Sign 5 and there will be defined minimum times for sign activation

13.2.2 Requirements for Queue Warning Sign Setting

The queue warning sign aspects shall be displayed by a dedicated array of LEDs controlled by the SCD.

The queue warning signs will be triggered by the detection of queuing traffic downstream of the sign.

Figure 19 shows how a typical sign deployment will activate in response to the detection of queuing traffic.

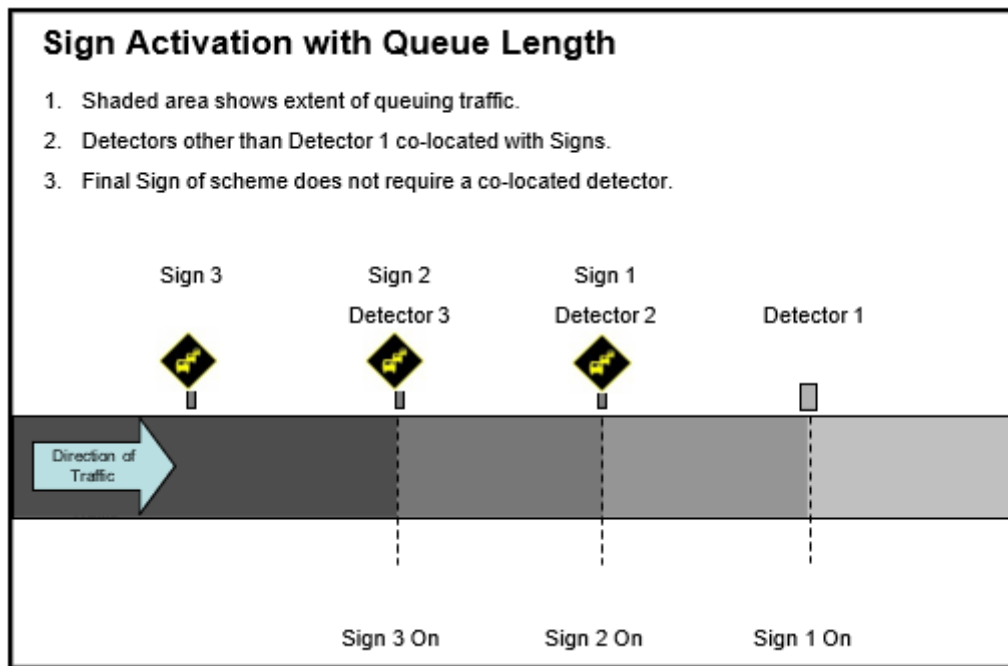


Figure 19 Typical Sign Activation

13.2.3 Sign Trigger Configuration Parameters

Figure 20 and Figure 21 show the sequence of events for two example modes of operation for a site with 5 Queue Warning Signs.

- Example 1 – All signs remain active until queue cleared at detector n.
- Example 2 – Signs deactivate when queue length passes detector n+2.

Table 11 provides details of the time periods labelled in Figure 20 and Figure 21.

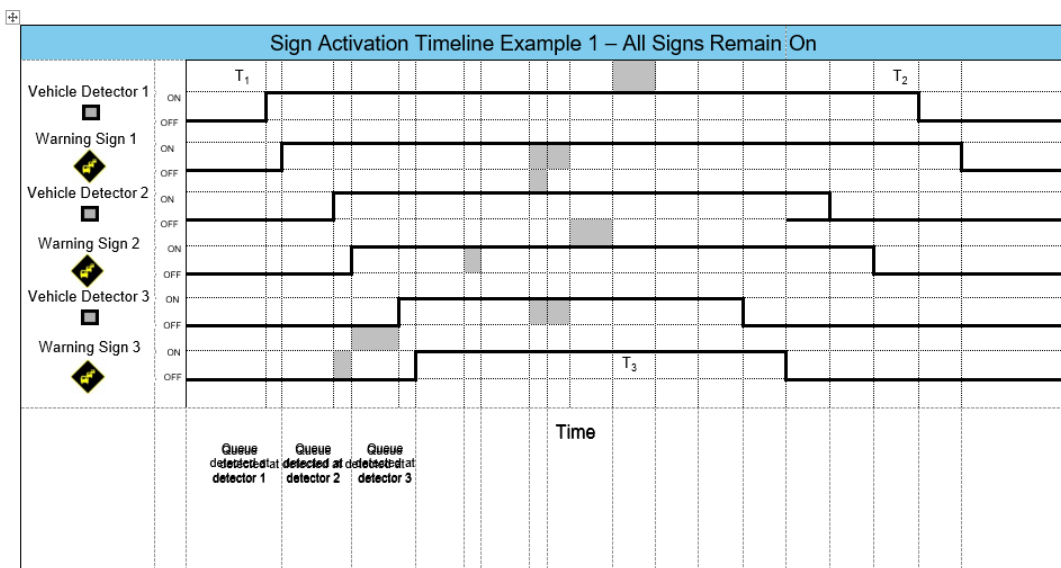


Figure 20 Sign Activation Timeline Example 1

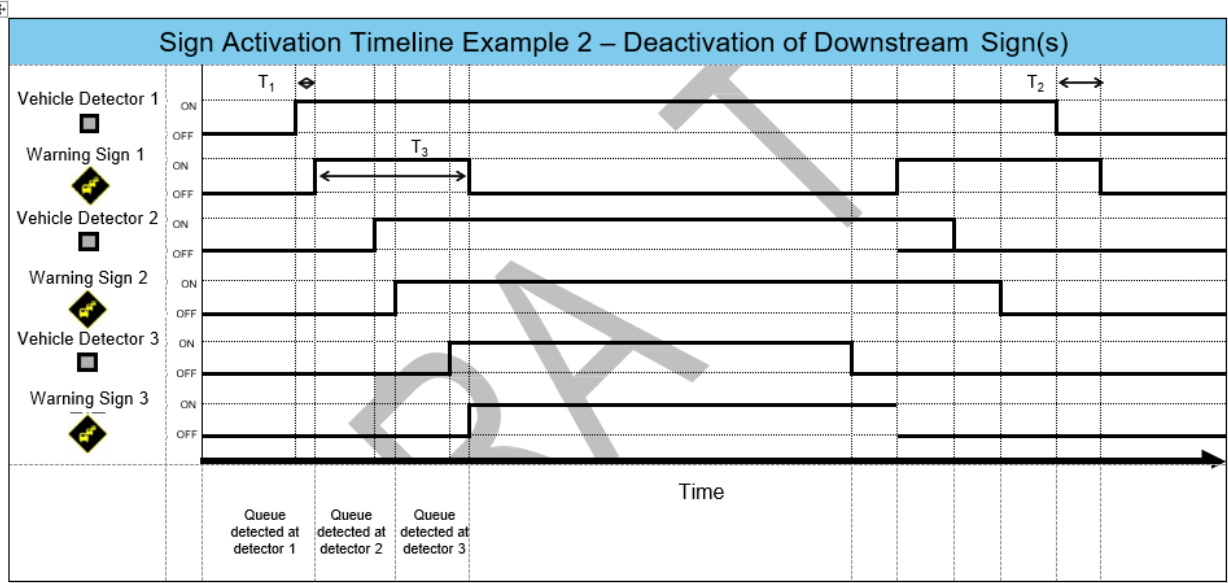


Figure 21 Sign Activation Timeline Example 2

Table 11 Sign Activation Parameters

Parameter	Definition	Requirements
T ₁	Time between vehicle being detected and Queue Warning Sign activation.	T ₁ shall be as short as possible so that the Warning Sign is activated to provide maximum warning to approaching drivers. On detection of queuing traffic.
T ₂	Time between queue dissipating and sign de-activation.	This time shall be configurable. Signs should remain active for set period after the detected queue has cleared.
T ₃	Duration of Queue Warning activation.	This time shall be a configurable minimum activation period.

13.2.4 Internal Interfaces

To allow the functionality whereby detector 2 (co-located with warning sign 1) can activate warning sign 2, each SCD must be interfaced with all other sign control devices. The communication method used must consider cost of installation, security of data and provision of user access of commissioning and maintenance purposes.

13.2.5 External Interfaces

The following parameters shall be configurable via the web-based interface.

Table 12 External Interfaces Configuration Parameters

Data to be sent to the Sign Control Device	Data to be retrieved from the Sign Control Device
Setup and Configuration	Fault Reports
Detector threshold values	Duration of queue presence.
Master/Slave device flag	
Timing Parameters detailed in Table 11.	

13.2.6 Vehicle Detection

13.2.6.1 Hardware Requirements

The first detector shall be standalone to allow detection of queuing traffic in advance of the first sign (as shown in Figure 20 and Figure 21). All other detectors can be co-located with the sign. The queue warning sign (Sign 3 in the example of Figure 20 and Figure 21) of the deployment will not require a co-located detector.

13.2.6.2 Software Requirements

The detector software shall use the HIOCC2 detection algorithm (TRRL 526) to alert the SCD of queuing traffic. This algorithm detects slow moving or stationary traffic and generates incident alerts. Alternative algorithms may be proposed by manufacturers subject to the approval of TII.

13.3 Queue Warning Signs General Requirements

Each Queue Warning Sign shall consist of a display module contained within a square enclosure as shown in Figure 22.

The size of each aspect shall be 900mm as per Table 6.1 of the DOTTSM.

The display module shall display a colour inverse of the “Queue Warning W163”.



Figure 22 Queue Warning (W163)

13.3.1 Sign Enclosures

13.3.1.1 Warning Sign Dimensions

The dimensions for the warning sign enclosure shall be as shown in Figure 23 and it shall be deep enough to contain all the necessary hardware.

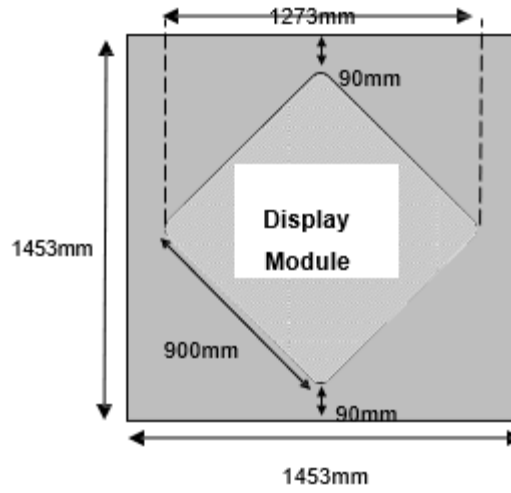


Figure 23 Warning Sign Enclosure Dimensions

14. Periodic School Limit Sign

14.1 Periodic School Limit Sign

14.1.1 Fixed Periodic School Limit Sign (FPSLS)

FPSLS consist of three vertically aligned components:

1. Two active elements with dedicated LED display boards:
 - a) One capable of displaying the 750mm RUS 045 speed limit roundel with speed variants.
 - b) Another that shows two S102 Flashing Amber Signals.
2. One fixed element: a W141 sign, positioned above or below the active elements.

An example of PSLS is represented in Figure 24.

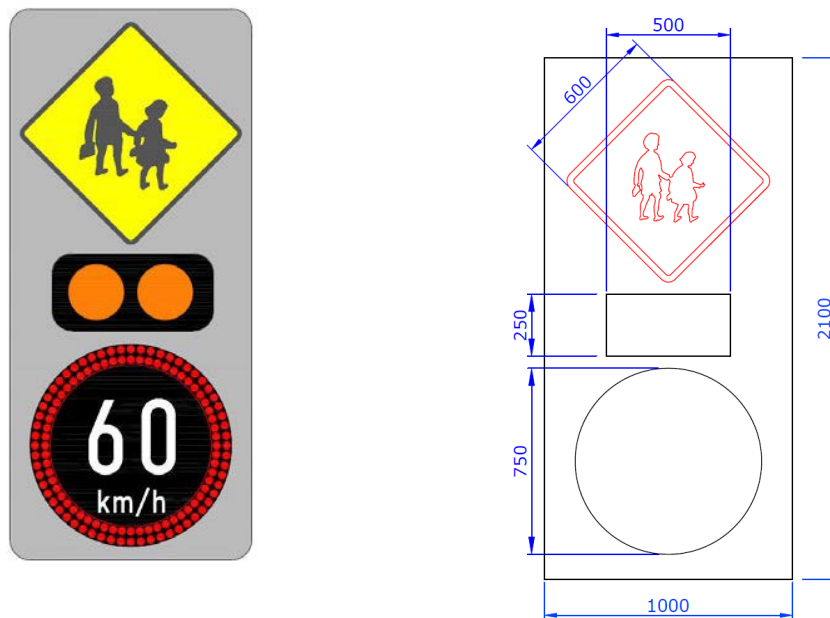


Figure 24 View of PSLS with 60 km/h Variant

In addition to the school warning aspect and flashing amber signals, FPSLS includes a speed limit roundel display module, as shown in Figure 25.

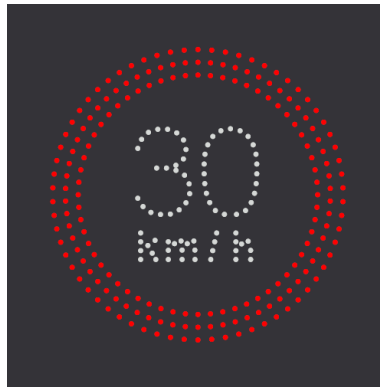


Figure 25 Example of a Roundel with 30km/h Variant

The speed limit roundels shall be 750mm diameter version of 'RUS 045'. The variant of FPSLS shall be 80, 60, 50 or 30km/h. The speed limit chosen will be determined by TII separately for each implementation.

14.1.2 Configurable Periodic School Limit Sign (CPSLS)

CPSLS are dynamic signs that enable the adjustment of speed limits in response to varying conditions. Similar to fixed Periodic Speed Limit Signs (PSLS), the CPSLS consists of three vertically aligned components:

1. **Two active elements** featuring dedicated LED display boards:
 - c) One displays the 750mm RVMS 102 variable (adjustable) speed limit roundel.
 - d) The other shows two S102 Flashing Amber Signals.
2. **One fixed element:** a W141 sign, mounted below the active elements.

Speed Limit Roundel Requirements

The variable speed limit roundels shall be 750mm diameter version of 'RVMS 102'. The VPSLS shall allow the adjustment of all possible speed limits between "0" and "99" km/h.

The roundels for VPSLS shall be Full Matrix Display as indicated in Figure 26.

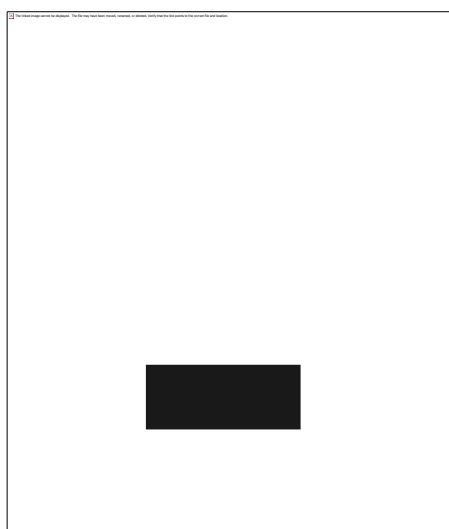


Figure 26 Full Matrix Display Configurable Speed Roundels

15. Driver Feedback Sign

15.1 Introduction

A Driver Feedback Sign (DFS) is designed to enhance road safety by providing real-time speed feedback to drivers, encouraging compliance with posted speed limits. The DFS detects vehicle speeds using radar technology and displays speed readings to the drivers. The sign must be highly visible, reliable and capable of operating in various environmental conditions.

This specification outlines the requirements of TII for the supply, installation, testing and commissioning of new DFS systems.

The Contractor shall design, supply and install DFS units and all associated ancillary equipment in full compliance with this specification and relevant Irish and European standards.

15.2 Radar

The Radar shall be CE certified and shall comply with General Safety Regulation (EU) 2019/2144, Directive 2014/53/EU Radio Equipment Directive, EN 301 489-1 Electromagnetic compatibility and Radio spectrum Matters (ERM), EN 301 489-3 Electromagnetic Compatibility standard for radio equipment and services, EN 300 440 Short Range Devices (SRD), I.S. 10101:2020 National Rules for Electrical Installation and other applicable EU Directives and standards.

- **Sensor Range:** The detector shall at least be capable of detecting vehicle speed with minimum 95% accuracy ranging between 50 meter and 300 meters. This shall be capable of detecting approaching vehicles in at least 2 lanes.
- **Speed Range:** The detector shall at least be capable to detect from 30 km/h to 120 km/h and the trigger speed shall be configurable.
- **Range Resolution:** The detector shall be capable of distinguishing between closely spaced vehicles with a minimum spacing of 1 meter.

The spatial resolution and the penetrability of the radar shall be resilient to the influences of illumination, visibility and severe weather and remain the accuracy of reading at above 95% level of confidence.

The radar shall be able to track minimum 30 vehicles simultaneously.

The radar shall operate 24/7 with solar power supply.

16. Prism (Prismatic) VMS Signs

Prismatic Variable Message Signs (VMS) shall be robust, high-reliability units designed to meet the operational and environmental demands of the national road network. Prism signs shall employ a mechanically rotating prism display system capable of presenting at least three discrete sign faces, with each face manufactured using high-grade retroreflective materials to ensure full compliance with the Department of Transport's Traffic Signs Manual (TSM), relevant EN standards (including EN 12966 for optical performance) and TII requirements for visibility, legibility, luminance and durability. The sign enclosure shall be engineered to achieve a minimum ingress protection rating of IP66, provide resistance to vibration, corrosion and wind loading and maintain structural integrity for the design life of the installation. Mechanical rotation assemblies shall be designed for long-life, low-maintenance operation.

Control systems shall provide local and remote configuration, status monitoring and fault reporting through secure web-based interfaces, with communication protocols compatible with TII systems (e.g., ATMS, AFMS, NIMS). Prism VMS units shall fail-safe, defaulting to a clearly visible static sign face in the event of mechanical or electrical failure. All power; communication and safety components shall adhere to applicable European directives and national electrical installation standards.