

Technical Specification

**Transport and Main Roads Specifications
MRTS204 Vehicle Detectors**

October 2017

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1 Introduction

This Technical Specification defines the design, supply, installation, testing and commissioning, functional, performance, documentation, training and maintenance requirements of vehicle detectors.

This document applies to the following types of vehicle detectors:

- Loop Detectors
- Radar Vehicle Detectors, and
- Infrared Vehicle Detectors.

The scope of this Specification includes the following:

- design of the site-specific system
- supply and installation of the above indicated vehicle detectors together with necessary accessories
- supply and installation of the associated structures
- electrical switchboard and associated internal wiring compliant with MRTS228 *Electrical Switchboards*
- provision and connection of mains power compliant with MRTS210 *Provision of Mains Power*
- communications between vehicle detectors and field processor, and
- connection to the Transport and Main Roads telecommunications network as per MRTS232 *Provision of Field Processors* and MRTS245 *ITS Telecommunications Network (ITS TN)*.

This is a new Technical Specification on vehicle detectors. Previous versions of this Technical Specification dealt with inductive loop detectors. The general requirements were kept in the main body of the Specification. Other requirements relating to each particular type of detector are listed in the appendices.

The requirements of traffic counter / classifier are not within the scope of this document and reference should be made to MRTS251 *Traffic Counter/Classifier* for specific requirements of traffic counter and classifier.

The vehicle detector system shall be connected to STREAMS via a field processor to transmit vehicle volume, occupancy, speed and headway data.

This Technical Specification shall be read in conjunction with MRS204 *Vehicle Detectors*, MRTS01 *Introduction to Technical Specifications*, MRTS50 *Specific Quality System Requirements*, MRTS201 *General Equipment Requirements* and other Technical Specifications as appropriate.

This Technical Specification forms part of the Transport and Main Roads Specifications Manual.

2 Definition of terms

The terms defined in MRTS201 *General Equipment Requirements* apply to this Technical Specification. Additional terminology relevant to this Technical Specification is defined in Table 2.

Table 2 – Definitions

Term	Definition
ARRB	Australian Road Research Board
CDO	Camera-Detected Offences
Detector	A device by which the presence and / or passage of vehicles or pedestrians is registered
Detector loop	One or more loops of wire embedded into the road surface and used to detect vehicle
ELV	Extra Low Voltage as defined by AS/NZS 3000
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
GUI	Graphical User Interface
Headway	Time gap between successive vehicles in a traffic stream (measured at the same point on the two vehicles)
HV	High Voltage as defined by AS/NZS 3000
IRVD	Infrared Vehicle Detector
ISM	Industrial Scientific Medical, allocated radio frequency bands
LED	Light Emitting Diode
LV	Low Voltage as defined by AS/NZS 3000
MRTS	Transport and Main Roads Technical Specification
MTBF	Mean Time Between Failures
NTP	Network Time Protocol
Occupancy	Proportion of time that a designated point in a traffic lane is covered by vehicles
PDD	Photographic Detection Device as defined in Act and / or Legislation
PER	Packet Error Rate
PHCS	Product Host Control System, consisting of a device that runs manufacturer software to permit equipment configuration and viewing of data
PoE	Power over Ethernet, standardised ELV power distribution via communications cables and connectors
RF	Radio Frequency
RPEQ	Registered Professional Engineer of Queensland as defined by the <i>Professional Engineers Act</i> of Queensland
RVD	Radar Vehicle Detector
SNR	Signal-to-Noise Ratio
Traffic flow data	Data describing traffic speed, volume, occupancy, headway and classification
Traffic speed	As per ARRB glossary of terms
TRUM	<i>Traffic and Road Use Manual</i> published by Transport and Main Roads
TSC	Traffic Signal Controller

Term	Definition
VAC	Volts alternating current
Vehicle length	Length of discrete vehicles measured in metres
Vehicle speed	Velocity of discrete vehicles in km/h
Vehicle volume	The number of discrete vehicles passing over a sensor per hour
Wiring Rules	AS/NZS 3000

3 Referenced documents

The requirements of the referenced documents listed in Table 3 of MRTS201 *General Equipment Requirements* and Tables 3(a) and 3(b) below, apply to this Technical Specification. Where there are inconsistencies between this Technical Specification and the referenced MRTS (including those referenced in MRTS201), the requirements specified in this Technical Specification shall take precedence.

Table 3(a) – Referenced Australian Standards

Reference	Title
AS 2703	<i>Vehicle loop detector sensors</i>
AS/NZS 1768	<i>Lightning protection</i>
AS/NZS 2276.2	<i>Cables for traffic signal installations – Feeder cable for vehicle detectors</i>
AS/NZS 3000	<i>Electrical installations - building structure and premises (wiring rules)</i>
AS/NZS 3100	<i>Approval and test – General requirements for electrical equipment</i>
AS/NZS 60529	<i>Degrees of protection provided by enclosures (IP Code)</i>
AS/NZS 60950.1	<i>Information technology equipment – Safety – General requirements</i>
AS/NZS 61000.6.1	<i>Electromagnetic compatibility (EMC) – Generic standards – Immunity for residential, commercial and light-industrial environments</i>
AS/NZS 61000.6.3	<i>Electromagnetic compatibility (EMC) – Generic standards – Emission standards for residential, commercial and light-industrial environments</i>
AS/NZS 61558	<i>Safety of Power Transformers, Power Supplies, Reactors and Similar Products - General requirements and tests</i>
AS/NZS CISPR 11:2004	<i>Industrial scientific and medical (ISM) radio-frequency equipment – Electromagnetic disturbance characteristics - Limits and methods of measurement</i>
AS/NZS CISPR 22	<i>Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement</i>

Table 3(b) – Referenced departmental Technical Specifications and Standard Drawings

Reference	Title
Form M4300	Vehicle Detector Loop Settings and Measurements Record
MRTS01	<i>Introduction to Technical Specifications</i>
MRTS50	<i>Specific Quality System Requirements</i>

Reference	Title
MRTS51	<i>Environmental Management</i>
MRTS93	<i>Traffic Signals</i>
MRTS201	<i>General Equipment Requirements</i>
MRTS204	<i>Vehicle Detectors</i>
MRTS210	<i>Provision of Mains Power</i>
MRTS226	<i>Telecommunication Field Cabinets</i>
MRTS228	<i>Electrical Switchboards</i>
MRTS232	<i>Provision of Field Processors</i>
MRTS245	<i>ITS Telecommunications Network (ITS TN)</i>
MRTS251	<i>Traffic Counter/Classifier</i>
MRTS257	<i>Feeder Cable and Loop Cable for Vehicle Detector</i>
Standard Drawing 1424	<i>Traffic signals - Detector loops formed insitu in asphalt installation details</i>
Standard Drawing 1425	<i>Traffic signals - Detector loops placement details</i>
Standard Drawing 1701	<i>Traffic Signals - Detector loops counting/right turn loops and diode connection details</i>
Standard Drawing 1702	<i>Traffic Signals - Detector loops motorways and ramp placement, and installation details</i>
TRUM Vol 4 Part 5	Configuration and Placement of Vehicle Detection Sensors

The title changed in Standard Drawing 1424, due to incorporating new details for detector loop installation. Standard Drawing 1700 and 1704 are withdrawn after being reviewed for currency. The part of Standard Drawing 1703 is withdrawn and superseded by Standard Drawing 1425.

4 Quality system requirements

The quality system requirements defined in MRTS201 *General Equipment Requirements* apply to this Technical Specification.

4.1 Hold Points and Witness Points

General requirements for Hold Points and Witness Points are specified in Clause 5.2 of MRTS01 *Introduction to Technical Specifications*.

The Hold Points and Witness Points applicable to this Technical Specification are summarised in Table 4.1. There are no Milestones defined.

Table 4.1 – Hold Points and Witness Points

Clause	Hold Point	Witness Point	Milestone
4.3	1. Plans for site acceptance testing and certification		
4.5	2. Documentation submitted prior to commencement of works		

Clause	Hold Point	Witness Point	Milestone
13	3. Installation requirements		
15	4. Documentation	1. Documentation	
Appendix A 3.3		2. Inductance range and frequency	
Appendix A 6.1	5. Commencement of works		
Appendix A 6.2	6. Loop configuration and loop spacing		
Appendix A 8.2		3. Testing equipment requirements	
Appendix A 8.4		4. Loop measurement records	
Appendix A 8.5		5. Loop measurement records	
Appendix B 10	7. Testing and commissioning	6. Testing and commissioning	
Appendix C 9	8. Testing of Radar Vehicle Detector	7. Testing of Radar Vehicle Detector	

4.2 Samples for evaluation and product type approval

The Contractor shall make available for approval by the Principal / Administrator a sample of either a complete vehicle detecting system, or materials intended for the construction of the device at least 14 days prior to planned commencement of fabrication.

4.3 Plans for Site acceptance testing and certification

The Contractor shall supply site acceptance test plans to the Superintendent for approval 28 days prior to the site acceptance start date. **Hold Point 1**

The site acceptance test for the installed equipment shall be included in a report to the Superintendent for approval prior to the date of practical completion.

All non-conformances identified during the site acceptance testing shall be rectified at no cost to the Principal.

4.3.1 Product type approval

Only those products that have been type approved by ITS & Electrical Technology unit of Transport and Main Roads can be installed in the network.

4.4 Guarantee / warranty

The Contractor shall guarantee the equipment system supplied for a period of 24 months after the date of practical completion handover. The component parts shall each have a warranty guarantee of at least two years from the date of handover and at least five years for any part that is battery powered.

4.5 Documentation submitted prior to commencement of Works

Prior to the commencement of Works, the successful tender will provide to the department for approval and retention, three copies of:

- fabrication and assembly drawings that include all of the components installed
- manufacturer's specifications (catalogue extracts) of all major components detailing ratings and performance characteristics of the same
- a schematic layout of components, building details and interconnection diagrams
- the Quality Assurance system in compliance with MRTS50 within 14 calendar days of the Letter of Acceptance
- recommendations for routine maintenance tasks
- contractors compliance with MRTS51, and
- recommendations on spare parts.

Hold Point 2

5 Functional requirements

The vehicle detection system shall provide at least the following data:

- vehicle volume
- lane occupancy
- vehicle speed
- per direction average speed
- per lane average speed, and
- headway data.

In the case of vehicle loop detectors, electrical cables connect the point of detection (loop) to the detector module. This is not the same for other types of detectors. The requirements on system communications are different for different types of detectors.

Vehicle detectors also used for camera-detected offences.

The vehicle detection system shall be able to communicate real-time data to the Principal's traffic management system (STREAMS) via a field processor and Principal's telecommunication system as per the provisions in MRTS232 and MRTS245.

The vehicle detection system shall consist of an internal clock. Facilities shall be available for the date and time of the internal clock to be set via the field processor to synchronise with NTP. All data shall consist of time details.

Each vehicle detector system shall be able to automatically re-tune / reset at the power on or detection of abnormality and load the site-specific configurations. It is also necessary to have local and remote reset facilities. When the detector system automatically re-tune / reset, it must advise the field processor of the start and end of the automatic re-tuning process.

The vehicle detection system shall have facility to store data within the system in non-volatile memory up to five million vehicles. In case of loss of communication with the traffic management system, data during the period of communication lost shall be automatically uploaded to the traffic management system once communication is resumed. Type of the data to be uploaded shall be user-configurable. The data stored within the vehicle detection system shall be accessible through the Principal's telecommunication network.

The vehicle detection system shall have Windows®-based Graphic User Interface (GUI) for viewing real-time data and stored data. GUI shall be able to operate on all versions of Windows current at the time of procurement of the vehicle detection system. Viewing options shall be user-configurable. The GUI shall be able to run in both the traffic management system and PHCS. GUI shall have facility to display traffic history pattern at least for the last 1.5 sec together with current traffic data.

The firmware shall be upgradable through any communication port remotely using the Principal's telecommunication network or local connection at the site.

The vehicle detection system shall be reliable (MTBF greater than 10 years at 95% confidence level), low maintenance (minimum maintenance period greater than one year) and operate in all environmental conditions specified in MRTS201.

The above functional requirements are common to all vehicle detectors, except for those used for camera-detected offences. Functional requirements pertaining to specific kinds of vehicle detectors are listed in the appendices.

6 Operational requirements

The operational requirements defined in MRTS201 *General Equipment Requirements* are applicable to this Technical Specification. System-specific operational requirements are listed in the appendices.

7 Performance requirements

The vehicle detection data shall have the following accuracies / performance parameters when individual vehicle speeds are between 20 km/hr and 110 km/hr and traffic flow up to 2400 vehicles/hr/lane, excluding vehicle detectors used for camera-detected offences:

- vehicle speed – 5 km/hr
- per direction average speed – 95% averaged over 15 minutes
- per lane average speed – 95% averaged over 15 minutes
- vehicle volume – 98% averaged over 15 minutes
- lane occupancy – 98% averaged over 15 minutes
- headway data – 98%, and
- detection finalisation time < 80 ms.

The detection system and associated structure shall be able to operate in environmental conditions listed in MRTS201 and variation in operating conditions specified in AS 2703. The vehicle detection system shall be able to operate in rain up to 100 mm per hour. All system components shall have at least 20 years life span.

The detection system shall automatically start to operate within 10 seconds of power up or interruption of power.

The latency of the vehicle detection system shall meet the requirements of STREAMS.

Further performance requirements pertaining to specific types of vehicle detectors are listed in the appendices.

8 Mechanical and physical requirements

The mechanical and physical requirements defined in MRTS201 apply to this Technical Specification. All pavement-mounted hardware shall withstand vibration of repeated pavement impacts from up to 50,000 vehicles per day.

All power supply units and other additional hardware that are required to be installed in the field cabinet shall be mountable in 19-inch rack and meet the provisions of MRTS226.

Further mechanical and physical requirements pertaining to specific kinds of vehicle detectors are listed in the appendices.

9 Design requirements

Detail design drawings, design calculations, manufacturer Specifications and schematic layout of the components shall be forwarded to the Principal for review. All designs shall be certified by a suitably qualified RPEQ.

Vehicle detectors associated with Camera-Detected Offences (CDO) shall have detail design drawings, design calculations, specifications and schematic layout of the relevant components shall be forwarded to the Photographic Detection Device (PDD) Manufacturer for review and certification by an appropriately qualified RPEQ prior to installation.

10 Electrical requirements

The electrical requirements defined in MRTS201 and MRTS228 apply to this Technical Specification. Main power shall be provided at each site in accordance with the provisions in MRTS210. All electrical work shall be in accordance with the Electrical Legislation, AS/NZS 3000 and AS/NZS 3100.

Additional electrical requirements under this Technical Specification are as follows:

- Unless otherwise specified, power supply to the vehicle detector system shall be 230 VAC +/- 10%. Power converters shall be used to obtain other power requirements.
- The mains power supply input shall be fused and isolated. The output from the LV power supply shall be protected against short circuit conditions and provide overload protection. All fault conditions shall be cleared by an electrical protection device in less than 400 ms in compliance with AS/NZS 3000 and MRTS228, and
- A main power switch shall be located on the front faceplate and illuminated to indicate the availability of mains power and LEDs shall be located on the power supply front faceplate to indicate available regulated output voltages.

Further electrical requirements pertaining to specific kinds of vehicle detectors are listed in the appendices.

10.1 Lightning / surge protection

Lightning / surge protection shall be provided to all power supply and communication cables into the field cabinet and equipment in order to mitigate effect from voltage transient in accordance with provisions in AS/NZS 1768.

11 Telecommunication requirements

Each vehicle detection site, excluding vehicle detectors used for Camera-Detected Offences, shall be provided with telecommunication port through the Principal's telecommunication network in accordance with provisions in MRTS245. The telecommunications requirements defined in MRTS201 apply to this Technical Specification.

All radio communication and telecommunications equipment shall comply with relevant Australian Communications and Media Authority technical standards and requirements.

11.1 STREAMS compatibility

Each vehicle detection system shall communicate with STREAMS either through a field processor or direct Ethernet. If communication with STREAMS is through a field processor, the vehicle detection system shall consist of field processor device driver, enabling communication between the vehicle detection system and the field processor. To satisfy these requirements, the vehicle detection system shall possess STREAMS compatibility certification.

The vehicle detection system shall allow automatic operation and local manual operation independent of STREAMS. Initiation of local operation shall be through separate switch at the site or plug in of PHCS to one serial port. Vehicle detection data shall be communicated to STREAMS while system is in local manual operation.

11.2 Communication

The vehicle detection system shall consist of two communication ports.

Communication between the vehicle detection system and field processor either shall be direct serial using either EIA/RS 422 or 4-wire EIA/RS 232 through any port, or Ethernet using TCP/IP protocol. Serial protocol shall use recognised industry standards.

The communication requirements specified in MRTS201 apply to this Technical Specification. Further communication requirements pertaining to specific kinds of vehicle detectors are listed in the appendices.

12 Electromagnetic compatibility

All equipment shall be C-Tick tested and comply with EMI and EMC requirements of AS/NZS 61000.6.1 and 61000.6.3. System-specific requirements are specified in the appendices.

13 Installation requirements

Only Transport and Main Roads type approved vehicle detector systems shall be used. All vehicle detector systems, except vehicle detectors used for Camera-Detected Offences, must have a current Transport and Main Roads type approval and hold a current STREAMS interface approval.

The installation requirements listed in MRTS201 apply to this Technical Specification.

To ensure proper operations of the detector after installation, verification of the detector site by a manufacturer's representative after installation shall be carried out. **Hold Point 3**

Additional system-specific installation requirements are listed in the appendices.

14 Testing and commissioning

The testing and commissioning requirements as defined in MRTS201 apply to this Technical Specification.

Tests for checking detector operational performance shall be similar, as applicable, to the tests specified in Appendices A, B and C of AS 2703 for inductive loop detectors.

Specific tests, similar to those shown in AS 2703, are required to demonstrate that the detector system can meet the performance requirements. AS 2703 is the standard for loop detectors, but similar tests for other types of detection system are required.

Additional system-specific testing and commissioning requirements are listed in the appendices.

The operation of the vehicle detector shall be tested in accordance with the manufacturer's Specification. This may include the Principal testing the detector in their traffic management software, which in most cases will be STREAMS. The contractor shall allow the Principal five working days to verify the operation of the loops, after they have notified the Principal of successful testing, as well as provided copies of conforming test results.

15 Documentation

The documentation requirements defined in MRTS201 apply to this Technical Specification.

Additionally, if required, Form M4300 shall be submitted to the Principal within five working days of installation. The form shall be fully populated to the satisfaction of the Principal. **Witness Point 1**

Prior to practical completion, all documentation must be updated to reflect any variations from the original design.

All engineering design drawings shall be certified to meet the requirements of relevant Australian and International Standards by a RPEQ who is practicing within the appropriate / relevant field of engineering.

All updated manufacturer equipment manuals, maintenance manuals, procedures, design documentation, engineering drawings and system specific software and hardware configurations shall be supplied to the Principal for acceptance. **Hold Point 4**

Additional system-specific documentation requirements are listed in the appendices.

16 Training

The training requirements defined in MRTS201 apply to this Technical Specification. Additional system specific training requirements are listed in the appendices.

17 Handover

The handing over requirements defined in MRTS201 applies to this Technical Specification. Additional system-specific requirements are listed in the appendices.

18 Maintenance

The maintenance requirements defined in MRTS201 apply to this Technical Specification. Additional system-specific maintenance requirements are listed in the appendices.

Appendix A - Loop detectors

The contents of this appendix had been extracted from the previous version of MRTS204 on Vehicle Loop Detectors.

1 General

Vehicle loop detectors use the change of inductance of a wire loop buried below the road pavement surface for the detection of vehicles passing or standing over the loop. The loop can be rectangular or quadruple as shown in Standard Drawing 1424.

Although rectangular loops are more popular now than quadruple loops, quadruple loops are still in use and this type of inductive loop is still specified in this Technical Specification.

The vehicle loop detector includes a detector loop buried below the road surface, field termination, feeder cable, loop termination panel / block and a detector module that includes a power supply, processing circuitry and associated cables.

New notes on red light camera installations.

Details on the configuration and placement of vehicle detector loops used in red light camera installation are shown in Standard Drawing 1425 and 1701.

The requirements listed in this appendix are additional requirements specific to this particular type of technology and are to be read in conjunction with the requirements listed in the main document.

2 Equipment components

Each vehicle loop detector installation shall include:

- detector loops
- detector loop field termination
- loop feeder cables
- loop feeder cable terminal panel / block
- cable connecting the loop feeder terminal panel and the detector module
- independent vehicle detector module
- connection between detector module and field processor
- field processor (not for vehicle detectors used for camera-detected offences)
- connection to Principal's telecommunications network in accordance with the provision of MRTS245 and necessary hardware
- interface to STREAMS
- telecommunication field cabinet that complies with MRTS226, and

- provision of power supply that complies with MRTS210.

3 Operational requirements

The performance of the loop detector system is based upon vehicles entering the detection zone at speeds of between 8 to 120 km/h and a detection zone length of between 1 m and 4.5 m as per AS 2703.

3.1 Operating modes

Each detector shall be able to operate in passage or presence mode. The detector shall generally be configured to operate in presence mode. However, where installed as a permanent counting site it shall be configured to operate in passage mode.

Speed measurement in loop detectors shall be implemented using dual loops installed in accordance with the department's *Traffic and Road Use Management Manual, Volume 4 Part 5, Configuration and Placement of Vehicle Detector Sensors*:

- Standard Drawing 1424 – *Traffic Signals – Detector loops formed insitu in asphalt installation details*, and / or
- Standard Drawing 1425 – *Traffic Signals - Detector loops placement details*
- Standard Drawing 1701 – *Traffic signals - Detector loops counting / right turn loops and diode connection details*.

3.2 Length of detector feeder cable

The detector module shall be capable of operating with detector feeder cable up to 250 m.

3.3 Inductance range and frequency

The detector module shall automatically adjust to operate in accordance with the requirement of this specification when input impedance of the loop is between 50 μ H and 700 μ H, 70 μ H for camera-detected offences and 'Q' factor in the range of:

- 5 to 50 below 60 kHz, and
- 3 to 50 above 60 kHz.

For vehicle classification or identification the 'Q' factor for a loop shall be in the range from 15 to 50.

The original record shall be provided to the Principal and a copy shall be placed in the cabinet housing the vehicle detector. Any vehicle detector which does not operate as per manufacturer's Specification shall be highlighted and specifically brought to the Principal's attention. **Witness Point 2**

Under the above conditions, the operating frequency of the sensor shall be in the range of 20 kHz to 150 kHz. Facility shall be available to select the operating frequencies of the detector either on the printed circuit board or via an operator terminal.

3.4 Actuation range

The vehicle detector module shall respond to change of inductance between 0.02% and 10% of the initial inductance and the resultant output shall be maintained until the inductance level returns to the initial value.

3.5 Sensitivity settings

Facility shall be available to select sensitivity adjustment of each channel individually, preferably on the front panel of the detector card. The sensor unit shall be capable, as a minimum, of sensitivity adjustments in the following steps 0.02%, 0.05%, 0.1%, 0.2% and 0.5%. The tolerance on the threshold for each sensitivity setting shall be +0%, -10% in accordance with the requirements of AS 2703.

3.6 Turn-off time

The turn-off time following an actuation shall be within +/- 25 m/sec of the measured response time for the same actuation.

3.7 Presence time

The output of presence detector shall comply with the requirements of AS 2703.

3.8 Automatic drift compensation (tracking)

The detector sensor shall automatically compensate for variation of operating conditions as per the requirements of AS 2703.

3.9 Recovery from positive inductance change

In the event of sensor unit experiences positive inductance change, the sensor unit shall automatically re-tune.

3.10 Susceptibility to interference

The detection system shall comply with the requirements of AS 2703.

3.11 Crosstalk

The detector sensor shall employ sequential channel sampling or a similar technique to eliminate crosstalk between channels and shall comply with the requirements of AS 2703.

3.12 Leakage to earth

Susceptibility to earth leakage as specified in AS 2703 is applicable to this Technical Specification.

4 Mechanical and physical requirements

The detection system components shall be of modular construction to permit minimisation of redundant capacity when installed. Each detector installation shall allow expansion to a minimum of 24 detector loop inputs. The detector equipment shall be supplied in a basic configuration and shall be expandable by installation of additional modules if / when required.

4.1 Detector card dimensions

The detector electronics / cards shall comply with the requirements of either ANSI/NEMA TS1 Part 7 or Standard Eurocard Format. Rack-mounted cards shall utilise industry standard connectors.

4.2 Indicators

Each channel of the vehicle loop detector electronics / cards shall have at least one associated LED located on the front faceplate of the detector card. The LEDs shall be illuminated for the duration of each output signal, or if the loop terminals are short-circuited or open-circuited.

Indicators shall meet the requirements of AS 2703.

4.3 Switches and adjustment facilities

Switches and adjustment facilities shall meet the requirements of AS 2703. The manual re-tune facility shall be externally accessible for each detector channel. Each detector card shall have a reset push-button accessed from the front faceplate.

4.4 Connection facility

The requirements of AS 2703 on the connection facilities for independent sensor units are applicable to this Technical Specification.

5 Electrical requirements

The voltage impressed on the feeder cables by the sensor unit shall not exceed ELV under any condition of operation. Electrical isolation shall be provided between the supply mains and the loop terminals by means of a transformer complying with the requirements of AS/NZS 61558.

Neither the detector loop nor the sensor unit shall suffer damage if any of the connecting cables (other than power supply cables) are short-circuited, open-circuited or disconnected while the equipment is energised.

6 Installation requirements

Only the department's type approved vehicle detector systems shall be used. All vehicle detector systems must have a current departmental type approval and hold a current STREAMS interface approval.

The installation of vehicle loop detectors shall be in accordance with MRTS93 in addition to the requirements outlined in this Technical Specification.

Reference to MRTS257 for the requirements on the installation of loop cable and feeder cable.

The installation of detector feeder cable and detector loop cable shall be in accordance with MRTS257, the Guidelines for the Configuration and Placement of Vehicle Detection Sensors, and in accordance with the following Standard Drawings:

Inclusion of additional Standard Drawings 1426, 1701 and 1702.

- SD1424 *Traffic Signals – Detector loops formed insitu in asphalt installation details*
- SD1425 *Traffic Signals – Detector loops placement details*
- SD1701 *Traffic Signals – Detector loops counting/right turn loops and diode connection details, and*
- SD1702 *Traffic Signals – Detector loops motorways and ramp placement, and installation details.*

6.1 Commencement of Works

At least one full working day prior to intending to install the vehicle detector loops, the Contractor shall notify the Principal of the proposed work. The method of notification is as determined by the Principal.

The Contractor shall not proceed with the works until the Principal has issued acceptance of the proposed works. **Hold Point 5**

6.2 Loop configuration and loop spacing

Loop configuration and loop spacing shall be verified during installation against Transport and Main Roads Standard Drawings for the dimensioned layout that shows the spacing and lane separation.

Hold Point 6

6.3 Loop feeder terminal panel

The detector loops shall be connected to the loop feeder terminal panel via loop feeder cables complying with the requirements of AS/NZS 2276.2. The loop feeder terminal panel shall provide terminal strips for all detector loops.

Cable looms are to connect the loop feeder terminals to the detector module. The cable looms shall provide a minimum of 24 vehicle detector inputs. Each set of adjacent terminals is denoted a designated pair. The conductors of each pair shall be twisted together at approximately eight turns / metre over the entire length of the loom.

All cables within the harness or loom leading from the loop feeder terminal panel or terminal strip to the detector module shall incorporate screening and / or noise suppression. The loom connecting the loop feeder terminal panel shall have a length of one metre.

The drain conductors for all detector feeder cables shall be connected to earth in the detector cabinet. Loop feeder cables shall be installed so as to minimise likelihood of crosstalk between channels.

7 Communication

Where specified, the vehicle detector system shall provide solid state digital outputs to the field processor through a 50-way ribbon cable connector in accordance with MRTS201. The 50-way ribbon cable shall be supplied with the detector system.

8 Testing and Commissioning

IRVD shall be EMI rates for AS/NZS CISPR 11, AS/NZS CISPR 22 Class B, and safety approval shall be compliant to AS/NZS 60950.

8.1 General

The loop detector system shall have type approval from the department or certification for the tests listed in Appendix B4 of AS 2703. The tests shall be carried out at a NATA-approved facility and test results shall be forwarded to the Principal prior to commencement of the project.

All loops shall be tested during installation, before the saw cut is sealed or the overlay placed on pre-fabricated loops. Each circuit shall be tested again when the loop feeder twin is connected to the loop lead-in cable before the connection is sealed.

Insulation resistance of the feeder cable and the loop cable shall be measured. Two other characteristics of the loop circuit to be measured are the inductance and resistance.

The testing of the loops is the same for both quadrupole and rectangular loop. The major determining factors on the inductance value of a loop are the configurations and the dimensions of the loop. All measurements are to be recorded on the appropriate form M4300.

Insulation resistance of the feeder cable and the loop cable will be measured once. Resistance and inductance of the loop circuit shall be measured at several stages during the installation. These measurements shall be recorded for each individual loop.

Where two or more loops are connected to the one vehicle detector sensor channel, the inductance and the resistance of the loop and feeder cable circuit is to be measured as a total.

All Works shall meet the requirements of the Wiring Rules, MRTS228 and the local electricity supply authority.

8.2 Testing equipment requirements

All measurements shall be undertaken using a device with the following performance characteristics:

- measurement tolerance of $\pm 3\%$
- measurement range of 40 to 700 μH
- inductance measurement at loop tuned frequency
- self-tuning in the range of 40 to 800 μH
- input loop reading resonance between 15 kHz and 140 kHz
- a Q of ≥ 3 at typical resonant frequency for loops of the specified inductance range
- loop insulation integrity verification $> 100 \text{ M}\Omega$ and within $\pm 10\%$ accuracy, and
- DC resistance range 0.3 Ω to 9 Ω .

The Contractor shall nominate the device to be used and provide a copy of its current calibration certificate to the Principal before testing commences. **Witness Point 3**

8.3 Testing of feeder cable

The feeder cable shall be tested after installation and before being connected to the loop and the detector.

The drain conductors for all detector feeder cables are to be connected to earth in the detector sensor cabinet.

Earth continuity for the drain conductor shall not exceed 1.4 $\Omega/100 \text{ m}$. Core insulation resistance between the two cores and between earth and either core shall exceed 1 $\text{M}\Omega$. Cables that fail any of these tests shall be removed and new cables installed.

8.4 Testing of individual loop

For loops fabricated on-site, all loop measurements are taken when the loop cable has been laid in the saw cut and the retaining wedges are in place to ensure the loop cable does not move in the saw cut. If possible the lead-in cable, from the loop, shall be placed in its saw cut. Any lead-in cable not placed in a saw cut shall be twisted to have a minimum of one full turn every 10 cm (10 turns per meter) before any measurements are taken.

For loops pre-fabricated, all measurements are taken when the loop cable has been laid in place and secured to ensure the loop cable does not move. The lead in cable from the loop should be twisted to have a minimum of one full turn every 10 cm before any measurements are taken.

The loop internal resistance and inductance shall then be measured.

Record the measurements for all loops on Form M4300 and any measurements which are not within the requirements of Section 4 on operational requirements shall be highlighted and specifically brought to the Principal's attention before the close of business on the next working day.

Witness Point 4

8.5 Testing of loop cable and feeder cable circuit

The inductance and resistance shall be measured again after the loop is connected to the loop feeder cable and before the connection joint is sealed. The results of these measurements should be the sum of the previous measurement for the loop and the increased resistance and inductance of the loop feeder cable. Any measurements which are not within 15% of the values calculated using Table A-8 shall be highlighted and specifically brought to the Principal's attention before the close of business on the next working day. The final measurements for all loop circuits shall be recorded on Form M4300 and submitted to the Principal within five working days of installation. **Witness Point 5**

Where two or more loops are connected to the one vehicle detector sensor channel, the inductance and the resistance of the combined loops and the feeder cable circuit is to be measured as a total.

For loops connected in series the formulae for calculations are:

$$R_t = R_1 + R_2 \quad \text{Resistance in Ohms } (\Omega)$$

$$L_t = L_1 + L_2 \quad \text{Inductance in micro Henry } (\mu\text{H})$$

For loops connected in parallel the formulae are:

$$R_t = (R_1 \times R_2) / (R_1 + R_2) \quad \text{Resistance in Ohms } (\Omega)$$

$$L_t = (L_1 \times L_2) / (L_1 + L_2) \quad \text{Inductance in micro Henry } (\mu\text{H})$$

8.6 Testing during installation

Insulation resistance, inductance and resistance of the loops shall be measured prior to installation and before the saw cut is sealed or the overlay placed on pre-fabricated loops.

The feeder cable shall be tested after installation and before being connected to the loop and the detector. Resistance of the conductors shall not exceed 1.4 Ω /100 m. Core insulation resistance between the two cores and between earth and either core shall exceed 1 M Ω . Cables that fail any of these tests shall be removed and new cables installed.

Each circuit shall be tested again when the loop feeder is connected to the loop lead-in cable before the connection is sealed. These measurements shall be recorded for each loop. The original record shall be provided to the Principal and a copy shall be placed in the cabinet housing the vehicle detector.

Where two or more loops are connected to the one vehicle detector sensor channel, the inductance and the resistance of the loop and feeder cable circuit is to be measured as a total.

Any measurements which are not within the guidelines set out in the Table A-8 below shall be highlighted and specifically brought to the Principal's attention before the close of business on the next working day.

After connection of the loop circuit to the vehicle detector, the operation of the vehicle detector shall be tested in accordance with the manufacturer's specification, including testing of the system using the Principal's Traffic Management System.

Table A-8 – Detector feeder cable characteristics

Length of loop feeder (m)	Increase in resistance (Ω)	Increase in inductance (μHenry)
50	0.7	33
100	1.4	67
150	2.0	100
200	2.7	133
250	3.4	167

Appendix B - Infrared Vehicle Detectors

This is a new appendix on the requirements of infrared vehicle detectors.

1 General

Infrared Vehicle Detectors (IRVD) use the events of break-and-make of infrared beams between transmitter and receiver mounted across the road, in perpendicular to traffic flow, for the detection of vehicle passing, and the calculation of vehicle parameters. Break-and-make events of the infrared beams occur when the infrared beams are blocked by the wheels of the vehicles. In most applications, multiple beams are used for obtaining vehicle parameters.

The requirements listed in this Appendix are additional requirements specific to this particular type of technology and are to be read in conjunction with the requirements listed in the main sections of the document.

2 Equipment components

Each IRVD installation shall include:

- infrared transmitter
- infrared receiver
- provision of power supply that complies with MRTS210
- TCP/IP connection between infrared receiver and field processor / network switch using CAT 5 cable or alternative 3G wireless connection
- field processor, and
- connection to the Principal's telecommunications network in accordance with the provision of MRTS245 and necessary hardware.

3 Functional requirements

In addition to the functional requirements listed in Section 5, the following specific requirements are applicable to IRVD systems:

- remote monitoring of infrared transmitter power, receiver power, beam degradation alarm or lens block alarm
- remote monitoring of battery parameters, such as voltage level and remaining battery capacity if batteries are used as power source
- method of verifying alignment (height, roll, pitch and yaw) for installation in existing roads without road closure and additional tools to assist installation in new constructions, and
- remote monitoring of alignment details, including tilt, pitch, yaw and height of the beam with respect to ground or correction of the alignment through the Principal's telecommunication network.

4 Operational requirements

The following additional operational requirements are applicable to IRVD.

5 Power

The infrared beam shall have sufficient power to avoid system performance degradation due to soiling or other environmental effects which lead to frequent maintenance. The maintenance interval shall be more than one year. The power level of the IR beam shall not cause any safety or health hazards.

5.1 Modulation

The beams shall be suitably modulated to avoid environmental effects.

5.2 Misalignment

The transmitter and receiver shall be able to operate with minimum of 10 degree misalignment.

5.3 Transmitter power and receiver sensitivity adjustment

The transmitter power and receiver sensitivity shall be able to adjust in order to meet requirements at the site. The adjustment of power and receiver sensitivity shall be either automatic or manual.

6 Mechanical and physical requirements

Infrared transmitter and receiver mounting arrangement shall consist of independent adjustment in all three axis for alignment together with locking arrangement to avoid change of alignment due to vibration and other environmental effects.

Printed circuit boards in the system shall be coated with protective layer to protect against moisture and water ingress. Transmitter and receiver shall be rated for IP 68 in accordance with AS/NZS 60529.

7 Electrical requirements

Power supply to the transmitter and receiver shall be ELV. Whenever mains power is used as power source, power converter equipment shall be installed in a separate cabinet.

8 Electromagnetic compatibility/safety approval

IRVD shall be EMI rated for AS/NZS 55022 Class B and safety approval shall be compliant to AS/NZS 60950.

9 Installation requirements

Only departmental type approved vehicle detector systems shall be used. All vehicle detector systems must have a current departmental type approval and hold a current STREAMS interface approval.

Installation of IRVD system shall meet the following requirements:

- transmitter and receiver shall be perpendicular to the traffic direction
- transmitter and receiver shall be aligned (height, roll, pitch and yaw)
- external housing shall be flushed with curb to avoid build-up of litter
- concrete apron to road edge shall be installed if required
- IR beam shall clear crown of the road at least by 50 mm, and
- vehicle bodies shall not obstruct the IR beam in near lanes.

The IRVD shall be configured to the road geometry.

10 Testing and commissioning

IRVD installations shall confirm the following aspects of alignment using software or hard tool:

- height
- roll
- pitch, and
- yaw.

Details of beam power level at the receiver shall be tested using software or other tool and shall meet the requirements of the manufacturer.

The testing of the IRVD system shall be in accordance with the manufacturer's recommendations.

Hold Point 7

Before the handover of the system the contractor shall notify the Principal in writing of the successful testing and provide copies of conforming test results and then allow the Principal five working days to verify the operation of the IRVD system. **Witness Point 6**

Appendix C - Radar Vehicle Detectors

This is a new appendix on the requirements of radar vehicle detectors.

1 General

Radar vehicle detectors (RVD) use reflection of transmitted electromagnetic radar signal, from the vehicles, for the detection of vehicle passing and calculation of vehicle parameters. The radar signal transmitter is mounted on the roadside perpendicular to the traffic flow. In most applications, multiple radar signal beams are used for obtaining vehicle parameters.

The requirements listed in this appendix are additional requirements specific to this particular type of technology and are to be read in conjunction with the requirements listed in the main sections of the document.

2 Equipment components

Each radar vehicle detector installation shall include:

- radar transmitter and receiver
- provision of power supply complying with MRTS210
- RS 232, RS 285 or TCP / IP connection between radar unit and field processor / network switch using standard cables or CAT 5 cable as applicable, and
- connection to the Principal's telecommunications network in accordance with the provision of MRTS245 and necessary hardware.

3 Functional requirements

In addition to the functional requirements listed in Section 5, the following specific requirements are applicable to RVD systems:

- RVD system configuration shall be automatic or manual
- automatic configuration shall include defining of lanes within the detection area using probability density function of the detected vehicles
- manual configuration minimum increment level shall be less than 0.25 m
- remote monitoring of transmitted power and average receiver signal strength, and
- remote monitoring of input voltage.

4 Operational requirements

The following additional operational requirements are applicable to RVD.

4.1 Frequency

Radar signal frequency shall be ISM unlicensed band or other frequency band with appropriate license.

4.2 Side lobes

Side lobes power level shall be less than – 40 dB to avoid interference with other equipment.

4.3 Bandwidth

Bandwidth of the radar signal shall be greater than 240 MHz in order to achieve un-windowed radar resolution of at least 0.75 m.

4.4 Transmitter power and receiver sensitivity adjustment

Transmitter power and receiver sensitivity shall be able to adjust in order to meet requirements of various locations. The adjustment of power and receiver sensitivity shall be either automatic or manual.

4.5 Beamwidth stability

Beamwidth stability of the transmitted radar signal shall be more than 1%.

4.6 Frequency channels

Number of frequency channels should facilitate installation of multiple units in the vicinity without interference and minimum of four channels is preferable.

5 Mechanical and physical requirements

The radar unit shall be mounted directly to the mounting assembly fastened to a pole or other structure and have facility of movement in all three axis for alignment.

The printed circuit boards in the system shall be coated with protective layer to protect against moisture and water. Radar unit shall be rated for IP 68 in accordance with AS/NZS 60529. Radar unit housing shall be resistive to UV, fungus and corrosion.

6 Performance requirements

The following additional performance requirements are applicable to RVD:

- minimum detection range less than 2 m
- maximum detection range greater than 80 m
- number of detection lanes greater than 10
- any variation of lane width
- detection over barrier whenever more than 50% of the vehicle is visible to the radar, and
- minimum separation between vehicles shall be less than 1.7 m.

7 Electrical requirements

Only departmental type approved vehicle detector systems shall be used. All vehicle detector systems must have a current departmental type approval and hold a current STREAMS interface approval.

Vehicle detectors used for camera-detected offences, do not require STREAMS interface approval.

If power supply to the radar unit is ELV, the power converter equipment shall be installed in a separate cabinet.

8 Installation requirements

Site-specific installation plan shall be approved by the system manufacturer or system designer approved by the manufacturer. The site-specific installation plan shall contain installation details of the radar vehicle detector.

9 Testing of Radar Vehicle Detector

The testing of the RVD system shall be in accordance with the manufacturer's recommendations.

Hold Point 8

Before the handover of the system the contractor shall notify the Principal in writing of the successful testing and provide copies of conforming test results and then allow the Principal five working days to verify the operation of the RVD system. **Witness Point 7**

Appendix D - Form M4300

Vehicle Detector Loop Settings and Measurements Record

Location

Detector manufacturer's name

Date of loop installation

Site identification number

Detector model

Date data collected

Loop number	Loop			Loop and feeder cable		Detector data					
	Insulation resistance (MΩ)	Resistance (Ω)	Inductance (μH)	Resistance (Ω)	Inductance (μH)	Sensor & channel numbers	Sensitivity setting	Frequency (kHz)	Mode PAsage/ Presence	Resistance (Ω)	Q or Manufacturer information
1.											
2.											
3.											
4.											
5.											
6.											
7.											
8.											
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