

Technical Specification

**Transport and main Roads Specification
MRTS208 Roadway Ancillary ITS Infrastructure
Monitoring and Control**

July 2018

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1 Introduction

This Technical Specification defines the design, supply, installation, testing, commissioning, performance, documentation, training and maintenance requirements for roadway ancillary ITS infrastructure monitor and control systems.

Scope of this Technical Specification is limited to monitor and control ancillary ITS infrastructure using the Principals traffic management system STREAMS through the simple device interface. Other control and monitor systems that are used in safety critical systems are not in the scope of this Technical Specification.

An ancillary ITS infrastructure monitoring system is a hardware and software system. It could actively monitor ancillary ITS infrastructure such as road lighting, tunnel lighting, UPS, pump stations, and so on. These systems shall have a Programmable Logic Controllers (PLC) or Input Output devices (I / O) integrated to sensors and actuators. They shall also have a communication interface to communicate with principal's traffic management system STREAMS through the generic simple device interface.

This Technical Specification shall be read with 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 Clause 2 of MRTS01 *Introduction to Technical Specification* apply to this Technical Specification. Additional terminology relevant to this Technical Specification is defined in Table 2 below.

Table 2 – Definition of terms

Term	Definition
CD	Compact Disc
DNP3	Distributed Network Protocol
HMI	Human Machine Interface
ITS	Intelligent Transport Systems
LCD	Liquid Crystal Display
LED	Light Emitting Diode
PLC	Programmable Logic Controller
RPEQ	Registered Professional Engineer Queensland
RTU	Remote Terminal Unit
Standard Modbus	Industrial communication protocol developed by Modicon / Schneider Electric
STREAMS	Principals traffic management system
TCP	Transport Control Protocol
Term	Definition
UPS	Uninterrupted Power Supply

3 Reference documents

Following technical documents are referenced in this Technical Specification, where there are inconsistencies between this document and referenced document, this Technical Specification shall take precedent.

Table 3 – Reference documents

Document ID	Document Name / Description
AS IEC 61131.2.2014	<i>Programmable controllers Part 2: Equipment requirements and tests</i>
AS/NZS 3000	<i>Wiring Rules</i>
AS/NZS 3100	<i>Approval and test Specification – General requirements for electrical equipment</i>
MRTS91	<i>Conduits and Pits</i>
MRTS201	<i>General Equipment Requirements</i>
MRTS233	<i>Roadway Flood Monitoring System</i>
MRTS234	<i>Communications Cables</i>
MRTS245	<i>ITS Telecommunications Network (ITS TN)</i>

4 Quality system requirements

4.1 Hold Points, Witness Points and Milestones

The quality system requirements defined in MRTS201 *General Equipment Requirements* apply to this Technical Specification. Additional requirements relevant to this Technical Specification are defined in Table 4. There are no Witness Points and Milestones defined in this Technical Specification.

Table 4.1 – Hold points, Witness Points and Milestones

Clause	Hold point	Witness point	Milestone
10	1. Certified electrical wiring diagram		
12	2. Inspection of the installation		
13	3. Testing and commissioning		
14	4. Documentation		

5 Functional requirements

Ancillary ITS infrastructure monitor and control systems shall be able to monitor and control the connected assets as programmed. It shall report back the status to the principal's traffic management centre through the principal's traffic management system STREAMS.

The monitor and control system shall be capable of withstanding the environments as specified in MRTS201 *General Equipment Requirements*. It shall be vandal proof and suitable for installation at the roadside.

The monitor and control system shall be compatible with the STREAMS simple device interface that supports Standard Modbus TCP and Standard Modbus RTU protocols.

STREAMS simple device interface does not support the Enron Modbus communication protocol (Dec 2017).

6 Operational requirements

Monitor and control systems shall be capable of integrating to:

- a) tunnel lighting
- b) UPS
- c) pump station
- d) heavy vehicle inspection
- e) other

In addition to the requirements of this Technical Specification, operational requirements specified in MRTS201 *General Equipment Requirements* applies.

If the IP rating of the system supplied is less than IP65, enclosure rated IP65 shall be supplied for the installation of the monitor and control system. Unless contract specified otherwise, installation of the system shall be inside an existing enclosure.

The system shall be able to transmit the status of the connected devices to principal's traffic management system through the simple device interface.

The control system shall have a 99.9% availability. Contractor shall provide the reliability calculations to demonstrate the availability of the system.

If the system is part of a safety critical system, it shall comply with AS IEC 61131.6 2014 in design and implementation.

This Technical Specification provides the requirements of the different monitoring and controlling systems that interface with the traffic management system STREAMS. The monitor and control systems that are specifically not mentioned in this Technical Specification shall comply with the clauses that are common and relevant.

6.1 Tunnel lighting infrastructure monitoring

1. Tunnel lighting system shall be capable of monitoring:
 - a. the status of individual circuit protection for normal operation and fault condition
 - b. the status of each individual lighting contactor for on and off
 - c. number of times each lighting circuits start and total running time
 - d. two 4-20 mA analogue portal photometers, calibrated to the expected portal luminance range, to measure the portal luminance
 - e. the status of the surge protective devices provided
 - f. the status of incoming mains supply and downstream of the isolation switch
 - g. the status of the lighting control supply
 - h. the position of the Manual Lighting Level Selector, and
 - i. the over temperature alarm of the cabinet.

2. Tunnel lighting system shall be supplied with a HMI capable of store and onsite monitor the status of the system for following:
 - a. 18 months of historical alarms and lighting level / photometer trends (individual and calculated luminance value). Maximum 5 minute sample rate
 - b. all current alarms including
 - i. control supply status
 - ii. individual lighting circuit
 - iii. protection status
 - iv. lighting contactor fault
 - v. photometer status
 - vi. lighting level requested but not achieved
 - vii. phase failure
 - viii. photometer signal fault
 - ix. photometer discrepancy
 - x. mains supply status
 - xi. mains isolator status, and
 - xii. lighting selector position (Off, Auto, 25%).
 - c. lighting level set points (switch up and down) and current lighting level (no manual lighting control from HMI required), and
 - d. number of starts and run hours for each contactor (by lighting level). Counter reset shall be password protected.
3. Tunnel lighting control system shall be support the principal's traffic management system, STREAMS to monitor:
 - a. photometer fault (includes photometer signal, surge protection operation and discrepancy)
 - b. underpass lighting fault (all faults that adversely affect the correct operation of the underpass lighting)
 - c. status of lighting control
 - d. current lighting level
 - e. each photometer instantaneous level
 - f. calculated value depending on the season, time of day by the programmed algorithm, and
 - g. temperature inside the equipment compartment.

4. Tunnel lighting control system shall be capable of controlling the tunnel lighting according to the ambient light level at portal or calculated light level based on time of the day, and seasonal effect:
 - a. Shall use a Programmable Logic Controller with a upstream communication channel that support principals Traffic Management System (STREAMS) through Standard Modbus RTU / TCP protocol.
 - b. Where a UPS is determined as being required by AS1158.5, the PLC and all associated control and communications equipment must be supplied from the UPS.
 - c. Shall provide a manual over-ride switch, capable of switching the tunnel lighting control independently of the Tunnel Lighting Control PLC. The manual switch shall over-ride the PLC control for all states except 'Auto' control, where the PLC shall control the lighting.
 - d. Shall determine the access zone luminance with two Portal Photometers.
 - e. The Access Zone Luminance, shall be determined by a 10 minute rolling average of the two Portal Photometers. Where one photometer is in fault or out of service, the Access Zone Luminance shall be determined by the remaining photometer. In the event that both Portal Photometers are in fault or out of service, control of the tunnel / underpass lighting shall occur from a Season Time Clock.
 - f. Individual Photometer Out of Service shall be selectable from the HMI.
 - g. Lighting Level control shall include a Seasonal Time Clock lighting control back-up. The Seasonal Time Clock shall accommodate four seasons. Seasonal Time Clock control shall operate in the event of failure or out of service status of both tunnel Portal Photometers but shall be over-riden by the manual over-ride switch.
 - h. Automatic switching of lighting levels and lighting circuits within each level shall be staged to manage the inrush current of LED luminaires on each lighting circuit and upstream circuit protective devices.
 - i. In the event of failure of the PLC, the lighting shall default to the middle lighting level and shall be over-riden by the manual lighting control switch.
 - j. Lighting Levels shall be labelled with Level 1 being the full lighting level, and lower levels subsequently descending.
 - k. The PLC and associated lighting control equipment shall be located in a dedicated compartment of the respective switchboard. Access to the control compartment shall include the use of Transport and Main Road's current electronic security key system. The compartment shall include filtered ventilation with temperature monitoring.

6.2 UPS monitoring and control system

UPS operational status shall be monitored using the alarm connections provided in UPS. UPS alarms shall include following alarms as a minimum:

- UPS mains fail alarm
- UPS fault alarm
- UPS bypass status (on external bypass switch if not part of UPS)

- UPS battery low alarm, and
- over-temperature of the UPS compartment.

Control and monitor system shall be support the principals traffic management system, STREAMS to monitor:

- UPS fault
- UPS in bypass
- UPS battery low, and
- battery compartment over temperature alarm.

6.3 Pump station monitoring system

Pump station monitoring system shall be able to monitor following:

- water level in pump well
- current power source
- pump running status
- current status of the UPS, and
- any other sensors as specified in the contract.

Pump station monitoring system shall raise alarms for:

- pump failure
- water level high, and
- any other alarms as specified in the contract.

6.4 Heavy vehicle inspection site control and monitoring system

Heavy vehicle inspection site shall be capable of activating the relevant signs for directing the heavy vehicles to enter an inspection site. System will normally operate by a select switch located at the inspection hut.

- System shall have a response time less than 50 ms for signs to respond for the select switch position.
- System shall report back to the principals traffic management system following:
 - current position of the select switch
 - reported status of the relevant signs of the system, and
 - operation status of the signs.
- Select switch and signs shall be interact directly for the operation of the system and only reported the status to the principal's traffic management system STREAMS.
- System shall have one or more Changeable Message Signs and one or more static signs with conspicuity devices.
- A PLC or Digital Input Output device as per Clause 7 shall be use to provide the monitor and control functionality to the site.

7 Programmable Logic Controllers

7.1 General

- EMC (Electromagnetic Compatibility) of the PLCs supplied shall be suitable for installation in location in zone B as per AS61132-2.
- PLC shall support as a minimum Ethernet and RS232 / 485 communication channels.
- PLC shall support Modbus TCP and Modbus RTU communication protocols, supporting DNP3 in addition to Modbus is preferred.
- PLC shall have an internal memory of not less than 6 KB for user program and user data.

7.2 Digital Inputs and Outputs

- Digital inputs and outputs shall be provided as directed by the scope of work. Usage of the digital inputs and outputs shall be not exceed the 75% of the total inputs and outputs.
- Current sinking digital inputs shall have standard operating ranges as defined in AS 61131.2-2014.
- All inputs shall have LED or LCD panel indication showing the present status of the relevant input.
- Digital outputs of a.c and d.c shall be operating in the ranges defined in AS 61131.2-2014.
- All outputs shall have LED or LCD panel indication showing the present status of the relevant output.
- Electromechanical relay type outputs shall be capable of performing at least 0.3 million operations at rated full load.

7.3 Analogue Inputs and Outputs

- Analogue inputs and outputs shall be provided as per the contractual documents and as per the scope of work.
- Analogue inputs and outputs shall be either voltage or current type and shall have the rated values and impedance as per the AS 61131.2-2014.

7.4 Human Machine Interface (HMI)

- Where specified in the contract, control and monitor system shall supplied with a Human Machine Interface (HMI).
- HMI shall have a minimum seven inch daylight readable touchscreen
- Malfunction in HMI shall not impact the PLC operation
- HMI shall provide warnings before the execution to the user whenever any changes to the online programme has done.

8 Sensors and actuators

8.1 Flood and water level sensors

Flood and water level sensors shall comply with requirements of the MRTS233 *Roadway Flood Monitoring Systems*.

8.2 Photometers

Photometers shall be provided as specified by the contract and as per the engineering design.

8.3 Temperature sensors

Temperature sensors shall be provided as specified by the contract and as per the engineering design.

9 Software and logic subsystems

For the proper operation of the monitor and control system, it will be required to programme the provided hardware. These programmes shall be PLC ladder logic or similar programming contents shall be provided with the system. A text version of the code with detailed comments shall be provided in PDF format.

- Programs shall be annotated as per industry standards to enable development by other developers later.
- Programs shall be provided in a compact disc (CD) in a format that is suitable to open in a program editor.
- If the principal does not own a suitable programming and debugging tool for the supplied PLC, contractor shall provide license software for editing and compiling PLC logic programs.
- The programming and debugging software shall be capable of operating on Windows 7 or later operating systems.

10 Electrical requirements

The electrical requirements defined in MRTS201 *General Equipment Requirements* apply to equipment provided under this Technical Specification.

All electrical cabling within the installation of control system shall comply with relevant requirements of MRTS91 *Conduits and Pits* and AS/NZS 3100.

The electrical equipment and associated wiring of the control and monitor system shall comply with the requirements of the Electricity act and AS/NZS 3000.

Power supply and control wiring connections / disconnections shall be designed without requirement for personnel to be holder of an electrical license to perform this task. This will generally require the use of modular type connections.

An electrical wiring diagram shall be provided with details specific to each installation. Diagrams shall have identifications for individual cables and terminations and shall be labelled accordingly in the field installation.

Detailed designs of the electrical wiring shall be reviewed and signed by the contractors RPEQ. They shall then be submitted and approved by the Principal or their delegate for verification and acceptance. **Hold Point 1**

11 Telecommunication requirements

The control system shall be able to communicate with principal's traffic management system, STREAMS via serial port of field processor or through Ethernet port via principal's telecommunication network.

The control system shall communicate with STREAMS using Standard Modbus TCP or Standard Modbus RTU protocols to connect to generic driver in STREAMS called Simple device interface.

Communication provisions as part of the control system shall comply with MRTS245 *ITS Telecommunications Network (ITS TN)* and MRTS234 *Communications Cables* for the network and physical cabling requirements.

While not mandatory compatibility with the DNP3 protocol for supporting future upgrades of STREAMS is preferable.

12 Installation requirements

Control and monitor system and associated equipment shall be installed according to the design documentation. The contractor shall allow access for inspecting the installation for the representative of the principal.

If installing cables in conduits, the conduit shall be sealed to prevent vermin entry. **Hold Point 2**

13 Testing and commissioning

The testing and commissioning requirements defined in MRTS201 *General Equipment requirements* apply to work under this Technical Specification. In addition, test sheets shall demonstrate compliance with the technical requirements of this Technical Specification prior to the delivery of the equipment to the site.

Contractor shall populate and submit a Standard Modbus register table showing Standard Modbus register addresses of control, alarms and sensor variables to be read values by the principal's traffic management system. **Hold Point 3**

STREAMS Acceptance Test (SAT) certificate shall not be required as the standard simple device interface will be used to communicate with STREAMS.

14 Documentation

The documentation requirements defined in MRTS201 *General Equipment Requirements* apply to work under this Technical Specification. **Hold Point 4**

Additional documentation requirements relevant to this Technical Specification are defined below:

- a) Commissioning documents for the control and monitor system, HMI, and STREAMS integration.
- b) Text version of the code with detailed comments.
- c) A schematic layout of components, and interconnection diagram that includes system configuration settings such as IP address, subnet mask, gateway.
- d) System operating manuals.
- e) Standard Modbus register table as per Clause 13.
- f) As constructed plans.
- g) Electrical test certificate.
- h) Recommendation for routine maintenance tasks.
- i) Recommendation on spare parts holdings.

15 Training

The training requirements defined in MRTS201 *General Equipment Requirement* apply to work under this Technical Specification.

Additional training requirements relevant to this Technical Specification are defined below:

- a) Training shall be provided to the principals representative on programming and debugging the PLC used in the control and monitor system.

16 Maintenance

The maintenance requirements defined in MRTS201 *General Equipment Requirements* apply to work under this Technical Specification.

17 Handover

The handover requirements defined in MRTS201 *General Equipment Requirements* apply to work under this Technical Specification.

Appendix A – STREAMS commissioning sheet

PLC Name		
Modbus Protocol		
Modbus RTU (Fill for Serial)		
	Field Processor	
	FP Port Number	
	Baud rate	
	Data bits	
	Parity	
	Stop bits	
	Modbus TCP (Fill for Ethernet)	
	IP Address	
	TCP Port	
Data Address		
Alarm / Value 1	Data Type	
	Alarm / Value Description	
	PLC Address	
	Region Type	
	Start Address	
	Count	
	Poll rate	
Alarm / Value 2	Data Type	
	Alarm / Value Description	
	PLC Address	
	Region Type	
	Start Address	
	Count	
	Poll rate	
Alarm / Value 3	Data Type	
	Alarm / Value Description	
	PLC Address	
	Region Type	
	Start Address	
	Count	
	Poll rate	

PLC Name		
Modbus Protocol		
Alarm / Value 4	Data Type	
	Alarm / Value Description	
	PLC Address	
	Region Type	
	Start Address	
	Count	
	Poll rate	

