# SPECIFICATION 712

# TRAFFIC SIGNALS

| REVISION REGISTER | | | |
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| Annexure 712C | Appendix C added | EE | 15/11/2010 |

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# SPECIFICATION 712

# TRAFFIC SIGNALS

## GENERAL

### 712.01 SCOPE

1. The work under this specification consists of the supply and installation of all components, accessories and associated operational features of traffic signal facilities, including testing and commissioning.

2. This specification covers both traffic signal facilities using ‘low voltage’ technology (LV) installations and ‘extra-low voltage’ technology (ELV) installations.

3. This document is to be read in conjunction with the Main Roads Western Australia Vehicular Signals Design Guidelines and Drawings published online.

### 712.02 REFERENCES

1. Australian Standards, Main Roads Western Australia Test Methods, Main Roads Western Australia Standards and Main Roads Western Australia Specifications are referred to in abbreviated form (e.g. AS 1234, MRS 67-08-43 or WA 123). For convenience, the full titles are given below:s

**Australian Standards**

| | |
|---|---|
| AS 1074:1989 | Steel tubes and tubulars for ordinary service |
| AS 1214:1983 | Hot-dip galvanized coatings on threaded fasteners (ISO metric coarse thread series) |
| AS 1627.6:2003 | Metal finishing – Preparation and pre-treatment of surfaces – Chemical conversion treatment of metals |
| AS 1742 (Set) | Manual of uniform traffic control devices |
| AS 1743:2001 | Road signs – Specifications |
| AS 2353:1999 | Pedestrian push-button assemblies |
| AS 2339:1997 | Traffic signal posts and attachments |
| AS 2578.1:1983 | Traffic signal controllers – Physical and electrical compatibility |
| AS 2700:1996 | Colour standards for general purposes |
| AS 2703:1987 | Vehicle loop detector sensors |
| AS 2930:1987 | Textiles – Coated fabrics for tarpaulins |
| AS 2979:1998 | Traffic signal mast arms |
| AS 4113.2:1993 | Traffic signal lamps – Lamps for a.c. operation at extra-low voltage |

**Australian/New Zealand Standards**

| | |
|---|---|
| AS/NZS 1125:2001 | Conductors in insulated electric cables and flexible cords |
| AS/NZS 1554 (Set) | Structural steel welding Set |
| AS/NZS 1768:2001 | Lightning protection |
| AS/NZS 1906.1:2007 | Retroreflective materials and devices for road traffic control purposes – Retroreflective sheeting |
| AS/NZS 2053 (Set) | Conduit and fittings for electrical installations |
| AS/NZS 2144:2002 | Traffic signal lanterns |
| AS/NZS 2276.1:2004 | Cables for traffic signal installations – Multicore power cables |
| AS/NZS 2276.2:1998 | Cables for traffic signal installations – Feeder cable for vehicle detectors |
| AS/NZS 2276.3:2002 | Cables for traffic signal installations – Loop cables for vehicle detectors |
| AS/NZS 2312:2002 | Guide to the protection of structural steel against atmospheric corrosion by the use of protective coatings |
| AS/NZS 2433:1994 | Plastics – Method for exposure to ultraviolet lamps |
| AS/NZS 3000:2007 | Australian/New Zealand Wiring Rules (including Amendments) |
| AS/NZS 3008.1.1:2009 | Electrical installations – Selection of cables – Cables for alternating voltages up to and including 0.6/1 kV – Typical Australian installation conditions |
| AS/NZS 61558.2.4:2001 | Safety of power transformers, power supply units and similar – Particular requirements for isolating transformers for general use |
| AS/NZS 61558.2.6:2001 | Safety of power transformers, power supply units and similar – Particular requirements for safety isolating transformers for general use |
| AS/NZS 3750.9:1994 | Paints for steel structures – Organic zinc-rich primer |
| AS/NZS 4677:2000 | Steel utility services poles |
| AS/NZS 4680:2006 | Hot-dip galvanized (zinc) coatings on fabricated ferrous articles |
| AS/NZS 61000.6.2:2006 | Electromagnetic compatibility (EMC) – General standards – Immunity for industrial environments |

**Other Standards**

| | |
|---|---|
| EnergySafety | WA Electrical Requirements |

| | |
|---|---|
| RTA-TC-235 | SCATS Communications Reference Manual |

**MAIN ROADS Standards**

| | |
|---|---|
| MRWA | Traffic Management requirements for Works on Roads |
| MRWA | Electrical Infrastructure Asset Drawing Guidelines<br>Part 1 – General<br>Part 2 – Traffic Control Signals |

**MAIN ROADS Specifications**

| | |
|---|---|
| Specification 703 | CLOSED CIRCUIT TELEVISION (CCTV) MONITORING CAMERAS |
| Specification 704 | CABLE CONDUITS FOR INTELLIGENT TRANSPORT SYSTEMS |
| Specification 711 | TRAFFIC CONTROL EQUIPMENT SOFTWARE |
| Specification 713 | UNINTERRUPTED POWER SUPPLY |
| Specification 901 | CONCRETE – GENERAL WORKS |
| Specification 908 | ANTI-GRAFFITI |

## 712.03 AS CONSTRUCTED DRAWINGS

1. The Contractor shall be responsible for: ***Record Changes***

   (a) Updating existing As Constructed Drawings to reflect the site and all changes to the installation, for existing sites.

   (b) Compiling As Constructed Drawings for all new installations.

   (c) Compiling As Constructed Drawings for sites where there are no As Constructed Drawings.

2. The As Constructed Drawings shall be amended and completed in accordance with Main Roads design and drawing presentation and the Main Roads Electrical and ITS Infrastructure Asset Drawing Guidelines and forwarded to the Superintendent within 20 days of practical completion of the Works.

3. The supplied As Constructed Drawings shall be in:

   (a) Electronic (AutoCAD) format; and

   (b) A3 hard copy;

   in accordance with Main Roads' requirements available on Main Roads website.

## 712.04 WORKMANSHIP AND LICENSING REQUIREMENTS

1. All works carried out under the contract shall comply with the requirements of AS/NZS 3000 and the local Supply Authority and EnergySafety Regulations. ***AS/NZS 3000 EnergySafety***

2. All workmanship shall comply with all lawful directions and requirements under the Trade Practice Act (1974) and shall be carried out by duly qualified personnel holding an appropriate electrical, or cabling licence where required.

## 712.05 POWER SUPPLY

1. The Contractor shall submit all necessary notices required by the local Supply Authority to supply power to commission the traffic signals at the site.

2. The Contractor shall make all arrangements with the local Supply Authority for the location of Point of Attachment and determine whether it is to be above ground or underground electricity supply. The requirements of the Drawing shall be met.

3. Where power supply from nearest street light switchboard is available, it shall be the preferred supply, where practicable.

4. The underground point of attachment shall be at an underground service pillar supplied and installed by the local Supply Authority.

   The Contractor shall install the consumer mains from the controller into an underground isolation fuse pit within the controller apron area and on to the underground service pillar ready for the local Supply Authority to connect.

   The consumer mains shall be 6 $mm^2$ red, black and earth double insulated round orange cable and shall be enclosed in a 32 mm orange PVC conduit.

   The isolation fuse pit shall be an un metered supply pit meeting the requirements of the local Supply Authority (may be sourced from the local Supply Authority) enclosing a 30amp authority and 20amp customer HRC fuse.

   The fuses shall be housed in separate waterproof fuse holders, labelled as “Western Power Isolating Point 30A Fuse” and “Customer Isolating Point 20A Fuse”, respectively. The labels shall be waterproof.

   An underground pillar is not necessary in the event that an UMS pit is installed, whether the supply originates from the local Supply Authority or a lighting switchboard.

5. The Contractor shall forward copies of the local Supply Authority Preliminary Notice and Notice of Completion to the Superintendent within 14 days of submission of notices to the Service Authority.

## 712.06 COOPERATION WITH OTHERS

1. The Contractor shall cooperate with other Contractors working on site. The Contractor shall not delay other Contractor’s works while working on site.

## 712.07 TEMPORARY WORKS

1. Where the Contractor is to modify the existing traffic signals, the existing traffic signals shall be kept in an operational state for traffic management for the duration of the Works.

2. The existing traffic signal detection system, or alternative detection system, shall be fully operational for the duration of the Works, unless prior written approval to dispense with this requirement has been obtained from Main Roads' Traffic Operations Centre.

3. The traffic control signals shall maintain an operational connection to the Main Roads Traffic Control Network for the duration of the Works, unless prior written approval to dispense with this requirement has been obtained from Main Roads' Traffic Operations Centre.

4. The existing traffic signals shall have the minimum number of signal faces maintained as per AS 1742.14 Section 4 for the duration of the Works, unless prior written approval to dispense with this requirement has been obtained from Main Roads' Traffic Operations Centre.

5. Electrical and operational safety shall be maintained at all times.

6. The Contractor shall liaise and co-ordinate all Works with any associated sign, road marking and road works to maintain the safety and integrity of the traffic control system at the work site.

7. Some signal layout changes may be necessary to accommodate some of the staged construction activities.

8. The Contractor shall advise the Superintendent 5 days' notice in writing of any temporary modifications to the existing signal installation.

9. The Contractor shall advise the Superintendent in writing of any changes made to the controller timings.

10. All works shall comply with AS/NZS 3000 and WA Electrical requirements.

## 712.08 COMMUNICATION SYSTEMS

1. The Contractor shall coordinate all Works associated with the installation of the communication systems and associated connections required at each site with the Systems Development Manager or Traffic Engineering Officers from Main Roads' Traffic Operations Centre on 08 9323 4848.

2. The Traffic Signal Controller is required to communicate with Main Roads' Traffic Operations Centre by way of an approved communication system**.**

3. The Contractor shall arrange and pay all costs associated with installing the communications cable to the controller and connect it to the assigned equipment terminals on the appropriate hardware inside the controller cabinet.

4. The Contractor shall purchase all necessary communication hardware equipment and install it inside the controller cabinet.

5. The Contractor shall ensure the site is communicating with Main Roads' Traffic Operations Centre at least 2 business days prior to the signals being commissioned.

**712.09 – 712.10 NOT USED**

## PRODUCTS AND MATERIALS

### 712.11 CABLES

1. Multicore power cables shall comply with AS 2276.1 and shall be of the following types: ***Power Cable AS 2276.1***

   (a) 19 core – consisting of 3 x 2.5 mm² and 16 x 1.5 mm² copper conductors of 0.6/1KV PVC insulated, PVC sheathed.

   (b) 29 core – consisting of 3 x 2.5 mm² and 26 x 1.5 mm² copper conductors of 0.6/1KV PVC insulated, PVC sheathed.

   (c) 51 core – consisting of 3 x 4 mm² and 48 x 1.5 mm² copper conductors of 0.6/1KV PVC insulated, PVC sheathed.

2. Vehicle detector feeder cables shall comply with AS/NZS 2276.2 and shall consist of screened, Twisted balanced-twin Feeder cable, 1.5 mm² (7/0.5 mm) plain annealed copper core conductors each polyethylene insulated, tinned annealed copper drain conductor, all polyethylene insulated and PVC sheathed. ***AS/NZS 2276.2***

3. Vehicle detector loop cables shall comply with AS/NZS 2276.3 and consist of one conductor 1.5 mm² (7/0.5 mm) tinned annealed copper, polypropylene insulated. ***AS/NZS 2276.3***

4. Other cables shall have copper conductors double insulated with V105 PVC insulation rated for 0.6/1kV. Colours of cable cores shall be in accordance with Table 3.5 of AS/NZS 3000 for recommended identifying colours except for: ***AS/NZS 3000***

   (a) Identifying colours for active wires to Pedestrian push-buttons and audio-tactile driver unit shall be brown, the supply power for the walk signal cable shall be orange and the neutral cable shall be blue. The cable shall comply with the requirements of AS 2353. ***Push Buttons AS 2353***

   (b) Identifying colours for active wiring to the red, yellow and green aspects shall be red, orange and white respectively. ***Colour***

   (c) All conductors shall have adequate cross sectional areas to match the full current ratings of the connected equipment with less than 5% voltage drop as measured at the load. The voltage drop to comply with the requirements of AS/NZS 3000 wiring rules. ***Voltage Drop***

5. Core identification shall be colourfast, permanent, non-conducting, compatible with the colour of the cable insulation and suitable for the location. ***Cable Insulation***

## 712.12 CONDUIT AND FITTINGS

1. Conduit and associated fittings shall be manufactured from orange rigid heavy duty un-plasticised polyvinyl chloride (UPVC) material in accordance with AS/NZS 2053. ***AS/NZS 2053***

2. The conduit interior shall be kept free from obstructions and sharp edges likely to damage electrical cables upon introduction or withdrawal from the conduit. Jointing surfaces shall be free from defects. ***Sharp Edges***

3. The dimension, form and entry of conduit fittings, such as couplers and bends, shall be in accordance with AS 2053. Conduit bends shall only be used and elbows shall not be used. The supplied lengths and diameters shall be in accordance with AS/NZS 2053.2. ***Size***

4. All conduit lengths and fittings shall be clearly marked with manufacturer's name, nominal size and heavy duty (HD) in accordance with the requirements of AS 2053. ***Marking***

5. One end of the conduit shall be formed or fitted with a socket to enable connection to conduit of the same design. The dimensions for sockets and plain conduit entries shall be as specified in AS/NZS 2053.2. ***Conduit Ends and Sockets***

6. All conduit and associated fittings shall comply with the requirements of AS/NZS 3000 "SAA Wiring Rules" and the requirements of EnergySafety Western Australia. ***AS/NZS 3000***

## 712.13 TRAFFIC SIGNAL CONTROLLERS

1. The Traffic Signal Controller shall be an Aldridge TSC4 Traffic Signal Controller, or an equivalent to be approved by Main Roads. ***Controller Types***

2. The Traffic Signal Controller electrical and physical compatibility shall be as stipulated in AS 2578. ***AS 2578***

3. The Traffic Signal Controller shall operate with SCATS (Sydney Co-ordinated Adaptive Traffic System). ***SCATS***

4. The Traffic Signal Controller shall operate on all voltages within the range 200V AC to 270V AC and frequencies within the range 48 Hz to 52 Hz. ***Operating Voltage***

5. Should the voltage subsequently fall, correct operation is to be maintained to approximately 190V. Below this voltage the controller shall go into power fail mode (i.e. FLASHING YELLOW). A restart shall not occur until the voltage is within the specified range, as per clause 712.13.04, where the controller shall restart. ***Control Failure***

6. The start-up sequence shall be as follows: ***Start-up Sequence***

   FLASHING YELLOW
   START-UP ALL RED
   "A" PHASE GREEN (or any other phase as programmed)
   COMPLETE ONE FULL CYCLE (as per the intersection personality)

   If any fault is detected in the control logic, the FLASHING YELLOW is to be displayed and the start-up sequence terminated. After a mains failure, the

start-up sequence is to be automatic on the restoration of power to within the tolerances given in clause 712.13.04.

7. The Traffic Signal Controller shall be capable of operating continuously within the ambient temperature range –10ºC to +65ºC and at up to 90% relative humidity. ***Ambient Temperature***

8. The Traffic Signal Controller shall be immune to radio frequency interference, transients and surges on the mains supply in accordance with AS/NZS 61000.6.2:2006. ***AS/NZS 6100.6.2:2006***

9. The Traffic Signal Controller shall maintain all timings and the status of essential circuits (e.g. clock) in the event of a power fail. Where battery backup is necessary to achieve this, a minimum of 24 hours reserve shall be provided. An automatic battery charger must be fitted to maintain this reserve. Batteries where needed shall be supplied as part of the controller. ***Battery Backup***

10. The Traffic Signal Controller shall provide the following components:

    Main Switch
    Neutral and earth links
    1 x Twin SSO with integral 30mA Type 2 RCD
    Circuit breakers to protect the following

    | | |
    |---|---|
    | Lamps | 20 A |
    | Detectors | 5 A |
    | GPO | 10 A |
    | Flashing yellow | 20 A |
    | Ancillaries | 10 A |
    | | |
    | Spare | 16A |

    A suitable surge device shall also be provided.

11. The Traffic Signal Controller shall contain a generator supply kit to enable the connection of an external power generator, comprising: ***Generator Plug***

    1 x 3 x position switch 20A rotary, IP66 rated c/w 2 x LED indicators. Switch to be marked MAINS, GEN, OFF

    1 x 10amp appliance inlet, 3 flat pins, 10Amp, IP66, 50Hz, grey, Clipsal56AI310 or approved equivalent with hinged clear Perspex cover

12. All Spare cables inside the controller shall be earthed as per Annexure 712D. ***Earthing of Spare Cables***

712.13.01 CONTROL FUNCTIONS

1. The minimum number of phases required is 7 and each phase shall be capable of conditional/alternative signal group displays producing a capability of at least 16 options. ***Minimum Number of Phases***

2. Each phase shall be made up of a number of independently timed periods, as detailed in Annexure 712A, and it shall be possible to specify the colour of each signal group during each of these periods (e.g. late start/minimum green/VIG/REST/Early Cut Off (ECO) yellow/yellow/all red). Each timed ***Phase Periods***

period shall have the minimum timing ranges and increments as detailed in Annexure 712A. The accuracy of all timings shall be ± 1%.

3. Signal groups shall be arranged for Vehicle, Bicycle or Pedestrian displays. The power feed to each signal display aspect shall be a nominal 240V AC 50Hz potential for an LV installation, or 42V AC 50HZ potential for an ELV installation. ***Signal Groups***

   Each vehicle signal group shall be capable of displaying only RED or YELLOW or GREEN or OFF. Transitions from one display to any other may occur except GREEN to RED.

   Each pedestrian signal group shall be capable of displaying only DON'T WALK/CYCLE (steady) or DON'T WALK/CYCLE (flashing) or WALK/CYCLE or OFF. Transitions from one display to any other may occur except WALK/CYCLE to DON'T WALK/CYCLE (steady).

4. The controller shall be able to record traffic counts on a detector by detector basis in 15 minutes intervals and transmit this data on request via a serial communication link. ***Traffic Count***

5. Other information which shall be available from an operating controller is as follows:

   (a) Current or running phase;

   (b) Position of a controller within a phase;

   (c) Next phase to be serviced;

   (d) Which phases have been demanded;

   (e) Which detectors are producing demands;

   (f) Operation of pedestrian movements;

   (g) Timings which have been set in the controller;

   (h) Which timers are operating at any given time;

   (i) Operational status of all power supplies;

   (j) Status of external lamps.

712.13.02 CONTROLLER HOUSING

1. The enclosure shall be fully equipped for a minimum of 12 signal groups, expandable to a minimum of 16 signal groups. All equipment necessary to switch a minimum of 8 signal groups shall be fitted. ***Housing***

   The controller shall have facilities for an integral 24 channel detector complement as a minimum. All equipment necessary to operate a minimum of 16 detector channels shall be fully fitted.

   The housing shall be suitable for mounting on a flat, concrete surface having 4 M12 studs set in a rectangular pattern with 254 mm x 460 mm centres and protruding 50 mm from the concrete base. Each of these

studs shall be grade 316 stainless steel, and come complete with nuts, spring washers and flat washers of the same grade.

2. The enclosure shall be fabricated from marine grade aluminium sheet of not less than 2.5 mm thickness. All internal and external panel surfaces shall have an orbital sanded finish. ***Finish Colour***

   The controller housing shall be thoroughly cleaned, etched, primed and finished to a smoke Blue No. T33 in accordance with AS2700. ***AS 2700***

   Neoprene door seals shall be fitted to ensure that water, moisture and dust cannot enter the interior of the enclosure giving IP55 degree of protection. The seals shall be such that new seals can be fitted at a later date without the necessity of removing any equipment other than the old seals.

   A clear anti-graffiti coating shall be applied in accordance with Specification 908 ANTI-GRAFFITI. ***Anti-graffiti***

3. The access door shall be hinged and it shall be possible to lock it in the 90º (or more) open position. The door shall be secured in the closed position by 2 triangular headed bolts, which shall fit the key shown on Main Roads standard drawing 7820-103. The head of these bolts shall be fully recessed into the door. ***Access Door***

4. A document pocket minimum size of 250 mm wide x 300 mm high x 20 mm capacity shall be fitted to the inside of the door. ***Document Pocket***

5. A three position vehicle/pedestrian detector control switch to select SIMULATED PERMANENT DEMAND or OFF or NORMAL shall be provided. ***Control Switch***

6. A two position Arterial Switch shall be provided for each Phase to select ON or OFF or via user friendly interface facility. ***Arterial Switch***

7. An Australian Communications and Media Authority (ACMA) approved cabling line termination unit, complete with isolation transformer and a separate access door shall be fitted to the controller housing. ***Comms Link*** ***RTA-TC-235***

   A 1 x 25 mm white conduit and 1 x 50 mm white conduit for the communications service provider line shall be installed between the base of the controller and termination unit.

   All equipment, such as a communication card, necessary to operate the controller from the SCATS computer shall be provided with the controller. Where controllers are connected to a dial up interrogation facility, the appropriate public switching network communication card is required.

   The hardware and software shall provide a compatible interface with the SCATS Regional computer through the SCATS Dial In system. The SCATS communications channel shall comply with RTA-TC-235 requirements and requirements of clause 712.08.

8. All terminal strips, components, detectors, etc. shall be accessed from the front. Adequate provision shall be made for the outgoing lantern supply cables, feeder cables and incoming power supply cable. A separate access door shall be provided for a communications connection. ***Access***

9. Terminal blocks shall be KLIPPON type SAK4, or equivalent. The terminals shall be capable of accepting a minimum of 3 x 7/0.5 cables per aspect and 2 x 32/0.20 cables per loop feeder end. The terminals for the loop feeders shall be separated from the other terminals. Each terminal shall be permanently and clearly labelled. ***Terminal Block***

10. A durable diagram showing the layout, function and type number of all equipment within the housing shall be firmly attached, and clearly displayed, inside the housing. ***Layout Diagram***

11. If the signals are star-wired, and more than 12 posts are required, a dummy controller housing is required to provide space for the connections. ***Dummy Controller Requirements***

712.13.03 DETECTORS

1. Detectors shall be in accordance with AS 2703 as qualified hereunder. ***AS 2703***

2. The output shall be either a relay or a solid state device suitable for switching 32 Volts AC or shall be integrated into the central processing system. ***Output Voltage***

3. Loop isolation transformers shall be used to individually isolate each loop. ***Loop Isolation Transformer***

4. The detector must be capable of being set to a presence time of at least 60 minutes if connected to SCATS. If the controller is isolated (i.e. not connected to SCATS), then the presence time shall be set to a time of at least 10 minutes.

5. All racks, power supplies and other equipment necessary for the operation of detectors are to be supplied and fitted. ***Fitted Equipment***

6. One continuous Detector Loop Feeder Cable shall be installed between the Controller and the assigned Loop Pit.

712.13.04 LAMP SWITCHING

1. Lamp switching shall be solid state. The current rating of each individual lamp circuit (each colour of each signal group) shall not be less than 5 amps continuous. ***Lamp Switching***

2. For any allocated group, or groups which conflicts with another, conflict monitoring shall ensure that only one group, or groups, can display green or yellow at any one time, except when the flashing yellow facility is in use. Conflict interlocks shall be applied in both software and hardware. Conflict shall require that all Red and Green signals will be switched off within 100ms. ***Conflict Monitoring***

3. The controller shall monitor the failure of any one lamp of any colour in any signal group and indicate the wattage before and after failure as a pointer to the size of lamp that has failed. ***Lamp Failure Monitoring***

4. The controller shall be capable of monitoring the supply voltage. Additionally, within the range 240V to 270V, the controller shall regulate the lamp supply voltage to 240V ± 2% for LV installations or 42V ± 10% for ELV installations. ***Voltage Regulations***

5. The dimming shall be initiated by either condition set in the personality or via SCATS. A light sensor shall differentiate between night and day. ***Dimming Conditions***

6. For an LV installation, the controller shall suitably reduce the lamp supply voltage for dimming the traffic signal lamp output produced at night. ***LV Installation Lamp Dimming***

7. For an ELV installation, the controller shall suitably reduce the present voltage on the allocated signalling wire, as specified in clause 712.15.06, for dimming the traffic signal lamp output produced at night. ***ELV Installation Lamp Dimming***

8. A flashing yellow facility shall be provided which can be initiated by either the controller logic or the FLASH position of the facility switch. The circuitry to generate this flashing yellow is to be self-contained and separate from the controller logic. It shall be possible to remove the controller logic module and still maintain the flashing yellow display. ***Flashing Yellow***

712.13.05 PROGRAMMING AND OPERATION

1. The Traffic Controller shall be programmed in accordance with Specification 711 TRAFFIC CONTROL EQUIPMENT SOFTWARE.

2. The controller shall have the ability to reset detectors via the SCATS system, without the need for special personality provisions.

712.13.06 RAILWAY CROSSINGS

1. At rail crossings the applicable rail authority shall supply the cable to connect between the Traffic Control Signal and the Railway Signal Equipment. The connection details shall be provided in the Controller documentation.

2. When a new Traffic Signal Controller is to be installed at an existing site the railway interface device should be completely upgraded to current applicable technology i.e. Omron relays type LY2N with LED, Powertran type M2860L transformer all of which shall be housed in a suitable enclosure with a transparent front cover. The front cover shall also incorporate 1 x RDA Switch with on/off escutcheon and a metal operating lever, 1 x RDB switch with on/off escutcheon and a metal operating lever, 1 x 250V 5A fuse,1 x 30V 5A fuse. The use of old existing technology such as Sprecher and Schuh relay based systems are not to be reused.

## 712.14 UNINTERRUPTED POWER SUPPLY

1. Uninterrupted power supply (UPS) shall be supplied and installed in locations selected by Main Roads as per Specification 713 UNINTERRUPTED POWER SUPPLY. ***UPS***

## 712.15 LANTERNS

712.15.01 GENERAL

1. Lanterns shall be complete with 9 Volt Light Emitting Diodes (LED) and transformers. Where indicated on the Drawings, directional arrow masks and louvres shall be fitted to the relevant aspects. Two mounting straps shall be supplied and fitted to each lantern. Visors shall be fitted to each lantern as per the design drawings. ***LED Lanterns***

The lanterns shall comply with the requirements of AS/NZS 2144 and this specification. ***AS/NZS 2144***

2. All lanterns on new traffic control signals sites shall only be fitted with LED lanterns. ***New Sites***

3. All lanterns are to be replaced with LED lanterns where any work at the site involves work fitting or refitting existing lanterns. ***Modifications***

712.15.02 LANTERN TYPES

1. General purpose vehicular lanterns shall have a lens or apparent light source (nominal signal) diameter of 200 mm. ***Vehicular Lanterns***

2. Pedestrian lanterns shall have two aspects of a nominal signal diameter of 200 mm. ***Pedestrian Lanterns***

3. Lanterns shall be capable of being supplied with one, two or three aspects. ***Aspects***

712.15.03 OPTICAL SYSTEM

1. Lanterns shall meet the requirements of AS/NZS 2144 for colour, luminance intensity, chromaticity and sun phantom. ***Photometric Tests***

712.15.04 MECHANICAL AND PHYSICAL REQUIREMENTS

1. The lantern and constituent components shall have a service life in excess of 15 years when operated within the ambient temperature range -15ºC (Degrees Celsius) to + 50ºC (Degrees Celsius). This does not include the lamps and gaskets. ***Service Life***

2. Plastic components must be constructed from first grade material, which in turn must be moulded from pure non-recycled or non-reground stock. The plastic shall be ultra violet stabilised as per AS/NZS 2433 for a minimum of 15 years life where the component is partly or fully exposed to sunlight. ***AS/NZS 2433***

3. Gaskets, where used, shall be of a resilient material having a continuous temperature rating of not less than 150ºC and be capable of being replaced in the field with the lantern installed. ***Gaskets***

4. The door of each aspect shall be capable of being unlatched and latched from the front by a simple one-handed operation. For doors secured by screws, it shall not be necessary to use a tool or to turn the screws more than half a turn to secure or release the door. The door shall be such that it can be hinged both on the left or right. Doors shall be fitted with anti-tamper inserts. ***Door*** ***Anti-tamper Inserts***

5. Lanterns shall be provided with facilities to enable them to be effectively secured between two parallel mounting straps spaced apart as shown in Figure 4.1 of AS/NZS2144. Two mounting straps (top and bottom) shall be supplied with each lantern. ***Mounting*** ***AS/NZS 2144***

6. The straps shall be manufactured from marine grade austenitic stainless steel 316 grade to AS 1449 and shall have a good quality surface finish free from protrusions, sharp edges and abrasive surface blemishes. ***Mounting Straps*** ***AS/NZS 1449***

7. Target boards, visors and arrow masks shall be in accordance with AS/NZS 2144 and Main Roads Standard Drawings. Aluminium target boards shall be made from 2 mm thick aluminium. Blanking plates shall be made from 1.5 mm thick aluminium. The aluminium shall be of grade 5005 H34, matt face. It shall be from mill cut sheets and not from coils.

***AS/NZS 2144 Accessories***

712.15.05 LED ASPECTS

1. LED arrays and the print circuit boards they are mounted on shall be in accordance with AS/NZS 2144.

2. LED circuit boards (as per clause 712.15.05.1), including those encapsulated in removable aspects, shall be separately removable from the lantern.

3. The maximum operational power consumption of LED aspects will be as follows:

| | |
|---|---|
| Red aspect | 9W |
| Yellow aspect | 15W |
| Green aspect | 9W |

4. All other operational requirements of LED aspects shall be in accordance with AS/NZS 2144.

712.15.06 LANTERN WIRING

1. Wiring shall be terminated with crimp lugs and insulated boots. The connecting wires shall be 1.0 mm² with V105 PVC insulation or better and be colour coded as follows:

***Colours***

| | |
|---|---|
| Active – Red aspect | Red Cable |
| Active – Yellow aspect | Orange Cable |
| Active – Green aspect | White Cable |
| Neutral | Black Cable |
| Earth | Green/Yellow Cable |

2. For an ELV installation an additional pink cable for dim signalling shall be terminated in accordance with clause 712.5.06.1.

3. Terminals shall be provided in an accessible position in the upper most aspect of the lantern assembly. The terminals shall be legibly and durably identified either on or immediately adjacent to the terminals. For screw type terminals, the strands of the conductors shall not be clamped directly by the terminal screws.

***Terminals***

712.15.07 TRANSFORMERS

1. Transformers used on lanterns shall comply with AS/NZS 3108. Insulation shall be minimum Class H and the vacuum impregnation method shall be used to impregnate the transformer windings with the insulating resin. The transformer's secondary voltage shall not compromise luminous intensity.

***AS/NZS 3108***

2. Transformers shall be accommodated within the lantern body with one transformer per aspect. Each transformer shall be mounted such that it can be removed mechanically and disconnected electrically and replaced in the field without the necessity to remove the lantern from its normal

***Transformer Mounting***

position. All connections to the terminal block must be accessible and the removal and replacement of leads to the transformer or incoming supply must be able to be made without removing the transformer. The mounting shall be such that in the event of a vehicle colliding with a traffic signal post, the transformer will remain attached to the body of the lantern and the mounting bracket and not become a projectile. The transformer shall be earthed.

***Earthing Transformer***

## 712.16 PEDESTRIAN PUSH-BUTTONS

1. The pedestrian push-buttons shall comply with AS 2353 and generally conform to the requirements of the Roads and Traffic Authority NSW traffic signal equipment specification No. ATS/4 and specification No. PB/6, except where qualified in this specification. ***AS 2353***

2. Pedestrian push-buttons shall be capable of being mounted to the traffic signal post and shall allow manual operation by pedestrians using a non-locking, jam proof push switch. It shall contain a maximum of extra low voltage. ***Mounting***

3. Audio-tactile units shall be capable of being mounted near the top of the traffic signal post and shall contain the driver circuitry for the detector. ***Audio-tactile Units***

   Audio-tactile units shall provide a suitable audible locating tone when the walk signal input is inactive to allow pedestrians to locate the unit.

   The fundamental tone frequency shall be 1,000 (± 50) Hz. The tone shall pulse with a repetition rate of 0.55 (± 0.05) Hz.

   Audio-tactile units shall change tone at the commencement of the walk signal input becoming active to alert pedestrians of the commencement of the crossing period.

   The change tone frequency shall decay exponentially from 3,500 Hz to 700 (± 100) Hz. The duration of the change tone shall be 115 ms (± 10) ms.

   Following this, the unit shall provide an audible crossing tone for the duration of the walk signal input being active to alert pedestrians of the duration of the crossing period. The fundamental crossing tone frequency shall be 500 (± 25) Hz.

   The tone shall pulse with a repetition rate 8.5 (± 0.5) Hz. The unit shall provide a touched sense crossing when the walk signal input is active to alert visually impaired pedestrians to the “cross” period.

4. Audible signal levels shall be automatically adjusted for consistent movements in ambient noise level. In addition, a three position switch, labelled “N”ormal, “H”igh and “L”ow shall be provided within the unit to allow the output audible signal level to be increased or decreased, respectively. ***Signal Levels***

5. The design for generating the crossing signal shall be fail-safe to ensure that the signal cannot be emitted unless the walk signal input is active. ***Interlocking***

6. The push-button shall provide a switch mechanism, normally off and actuated when depressed. The button shall be a minimum of 55mm in diameter. The buttons travel shall be 5 mm (± 1) mm. The activating and ***Button***

restoring forces of the push-button shall comply with AS 2353. The push-button shall be actuated by movement of the button through 30% of its travel from its rest state to its fully depressed state. The push-button shall be de-actuated by movement of the button through 25% of its reverse travel from its fully depressed state to its rest state. The switch shall have a minimum 500 mA current rating. The switching shall be compatible with a Main Roads approved Traffic Signal Controller.

7. A combination visual/tactile single head arrow shall be displayed on the front of the push-button assembly indicating to the pedestrian the direction of the associated crossing. The arrow shall be distinctive both visually and by touch. The arrow shall be able to rotate in the vertical plane. The arrow shall provide the tactile signals. ***Arrow***

   The pedestrian push-button assembly shall be attached to the post using the pre-drilled holes provided in the post, or by drilling and tapping new holes in an existing post such that the height of the push-button places the centre of the button 1063 mm above ground level. ***Height***

   Except for medians, the pedestrian push-button face shall be either parallel with the kerb of the associated crossing or parallel with the pedestrian crossing road markings as shown on the Drawing and to suit the intended design of the crossing.

   The pedestrian push-button face shall be parallel with the pedestrian crossing road markings where fitted on posts within median islands as shown on the Drawing. The single headed arrow disc shall point in the direction of pedestrian travel.

   Where pedestrian push-button assemblies are installed on median island posts the standard single-headed arrow disc shall be replaced with a two-headed arrow disc pointing to each direction of pedestrian travel, as indicated on the Drawing. ***Push Buttons on the Medians***

   On each post where a pedestrian push-button assembly is installed, a self-adhesive explanatory label shall be affixed above it. Care is to be taken to ensure the correct label is fitted (J-PED-1 type for exclusive pedestrian movements, J-PED-2 for combined vehicle/pedestrian movements and J-PED-3 for combined pedestrian/bicycle movements). ***Self-adhesive Labels***

8. The components shall be housed in durable weather proof housing with an IP56 protection rating. The housing shall be of sufficient mechanical strength to withstand vandalism. The housing shall be manufactured from corrosion resistant materials. The unit shall be designed to be aesthetically pleasing. It shall be arranged to prevent any injury to pedestrians and maintenance staff. The pedestrian push-button assembly shall not exceed 2 kg. The audio-tactile driver shall not exceed 7 kg. The driver unit shall be capable of being securely mounted to the post using a single U bolt M10 x 30 mm thread, arrangement supplied with the unit. The U bolt shall be supplied with 2 x M10 hex nuts, 2 x M10 thin hex nuts and 2 x Φ10 flat washers, all of which are hot dip galvanized in accordance with AS 1214. ***Housing*** ***Mounting Tactile Driver Unit AS 1214***

9. The pedestrian push-button shall have a service life in excess of 10 years with a minimum of ten million actuations, when operated continuously in the Western Australian environment. ***Design Life***

10. The audio-tactile driver shall provide the wiring connections detailed in Table 712.1: ***Wiring***

**TABLE 712.1 AUDIO-TACTILE DRIVER WIRING CONNECTIONS**

| Type | Colour | Length |
|---|---|---|
| Earth connection cable | GREEN / YELLOW | 1780 mm |
| Electrical supply cable | BROWN | 1780 mm |
| Electrical neutral cable | BLUE | 1780 mm |
| Walk signal cable | ORANGE | 1780 mm |
| Bicycle Walk Cable | ORANGE | 1780 mm |

11. When parallel walks with time delay protection are installed (new or upgraded sites) MR-GT-20 “Turning Vehicles Give Way to Pedestrians” signs to be installed as primary displays on posts nearest to the left or right turn movement where the rule applies. Signs to be removed after three months. ***“Give Way to Pedestrians” Signs***

## 712.17 PITS AND CABLE MARKERS

1. The design and construction of the pits and lids shall prevent the ingress of rain and surface water when installed. The pits and constituent components shall give a service life in excess of 20 years when installed in a temperature range of -10ºC to 55ºC and within the environment condition of Western Australia.

2. The preferred material for all pits is polymer plastic, however, glass-fibre reinforced concrete pits will be accepted for termination pits and double lid cable pits. The sides of the pit shall have sufficient strength to resist soil pressures of minimum 10kpa. The pit shall have a maximum 5 mm deformation when installed and surrounding soil suitably compacted. The termination pit shall have sufficient mechanical strength and stability to withstand vehicular traffic when installed. The termination pit and lid shall be rated at a minimum 1,000 kg wheel load. Other pits shall have sufficient mechanical strength and stability to withstand pedestrian traffic load of minimum 200 kg when installed. The pits and lids shall not be deformed and disturbed when compacting the surrounding soil. ***Material***

3. The pit walls shall be of uniform thickness and shall facilitate the installation of up to eight 80 mm (with outside diameter of 90 mm in accordance with AS/NZS2053.2) HD PVC conduits. Limits of conduit cut outs shall be marked on the pit walls. ***Conduit Entries***

4. The preferred material for all lids is polymeric plastic, however precast concrete lids will be accepted. All pit lids shall be fitted with suitable lifting arrangements designed to resist tampering by the general public. An industry standard plastic plug shall be installed to plug the lifting hole to help alleviate water and sand ingress. Each pit shall also be fitted with an industry standard plastic gasket under the lid to reduce the entry of foreign material into the pit. Any pit lid shall fit all pits of the same type of pit. There shall be no gaps between the lid and edge of the pit that cause hazards for members of the public wearing high heels or similar footwear. ***Lids***

5. Termination pits shall conform to the form and dimensions shown in Main Roads Drawing 200431-0128. The termination pit lid shall be constructed extending past pit sides and to fit securely over the pit opening with a suitable water seal. For termination pits, two opposing pit walls shall provide a shoulder or fixture for the termination box and support tray. The support tray and termination box shall be easily removed from the pit. ***Termination Pit***

6. Double Lid cable pits shall conform to the form and dimensions shown in Main Roads Drawing 200431-0128. The double lid cable pit shall be designed for a double lid assembly supported by a "T" bar as detailed in the Drawings. The "T" bar shall be aluminium and designed to suit the pit and lid. The double lids shall sit flush with and be contained within the pit surrounds. ***Double Lid Cable Pit***

7. Cable draw pits shall be a Viscount Vipit range model P4 cable pit or similar. ***Cable Draw Pit***

8. Loop and Earth pits shall be a Viscount Vipit range model P1 cable pit or similar approved. Communication pits shall be Viscount Vipit model or similar approved P4 cable pit. ***Loop, Earth and Comms Pit***

9. All conduit locations shall be marked at their ends at footpath level with cable Route Markers set in concrete. The Cable Marker shall be embossed with "MRWA Electric Cable" and an arrow showing the direction of the conduit and cable. 100 mm diameter aluminium cable markers (with the words "MRWA Electric Cable" embossed into the disk and 2 x 30 mm long hooks for casting into concrete) shall be cast into the concrete surround to identify the direction of all conduit runs using the embossed arrow. ***Conduit and Cable Markers***

10. To identify the location of underground electric cables, 150 mm wide orange danger tape shall be installed 300 mm above the conduits. ***Orange Danger Tape***

11. The pits shall have a good quality surface finish free from protrusion and abrasive surface blemishes. All edges shall be rounded with a nominal radius of 2 mm. Polymer plastic pits or lids shall have a uniform black colour. Glass-fibre reinforced concrete pits shall have a uniform grey colour. ***Finish and Colour***

12. For all Termination, Double Lid Cable, Cable Draw and Loop Pits, the wording "MRWA ELECTRIC CABLE" shall be moulded into the top of the pit lid and shall be centrally located. The height of lettering shall be 30 mm. ***Lid Identification***

13. For all earth pits, the wording "MRWA EARTH" shall be moulded into the top of the Pit lid and shall be centrally Located. ***Earth Pit Lid***

14. For all communications pits, the wording "MRWA COMMS" or "MRWA COMMUNICATIONS" shall be moulded into the top of the Pit lid and shall be centrally located. ***Comms Pit Lid***

15. Controller base Mouldings shall conform to the form and dimensions shown in the Drawings. ***Controller Base***

16. Where steel work is used, it shall be hot dip galvanised in accordance with AS/NZS 4680 and all welds shall comply with AS/NZS 1554-Part 1. ***AS/NZS 4680 AS/NZS 1554***

17. Electrical pits shall not weigh more than those specified below: ***Weight***

    (a) Termination pit lids shall not weigh more than 55 kg. Polymer plastic termination pits shall not weigh more than 50 kg. Glass-fibre reinforced concrete termination pits shall not weigh more than 91 kg. ***Termination Pit***

    (b) Cable draw pit lids shall not weigh more than 30 kg each. Polymer plastic cable draw pits shall not weigh more than 55 kg. Glass-fibre reinforced concrete cable draw pits shall not weigh more than 91 kg. ***Cable Draw Pit***

    (c) Other pit lids shall not weigh more than 30 kg each. ***Other Pits***

## 712.18 TRAFFIC SIGNAL POSTS AND MAST ARMS ACCESSORIES

### 712.18.01 GENERAL

1. Traffic signal posts, mast arms and all accessories shall be of the form, dimensions, material and finish specified in AS 2339 and AS/NZS 4677. Mast arms shall be designed in accordance with AS 2979. The posts shall be hot-dip galvanised inside and outside with a minimum coating of 200 g per square metre in accordance with AS 4680. All areas of steel exposed during machining (including holes and edges) shall be touched up with a zinc enriched primer complying with AS/NZS 3750.9. ***AS 2339*** ***AS/NZS 4677*** ***AS 2979*** ***AS 4680*** ***AS/NZS 3750.9***

2. Mounting brackets and accessories shall be designed to fit a traffic signal post of nominal outside diameter between 113.3 mm and 114.9 mm with thickness of 4.5 mm in accordance with AS 1074, AS 2339 and Main Roads Standard Drawing. ***Size*** ***AS 2339*** ***AS 1074***

3. Mounting brackets and accessories shall be designed to fit a traffic signal mast arm in accordance with AS 2979 and Main Roads Standard Drawing 0330-1946. ***Mast Arm*** ***AS 2979***

4. Traffic signal posts shall be powder coated with exterior grade lead free polyester. The finished colour and specular gloss value shall meet requirements of AS 1743, colour Golden Yellow, Y14 with anti-graffiti finish applied in accordance with Specification 908 ANTI-GRAFFITI. Minimum coating thickness shall be 60 microns. ***Traffic Signal Post Colour*** ***AS 1743***

### 712.18.02 TERMINAL ASSEMBLY

1. The terminal assembly shall allow the termination of 19 core traffic signal cable and traffic signal lantern cabling associated with traffic control signals including pedestrian push-buttons, no left/right turn signs and audible pedestrian push-button tactile drivers. The terminals shall be divided into four or five sections. Each section shall be separated by a Klippon AP end section, or approved equivalent.

    (a) Section 1, commencing at the top of the rail, shall consist of 2 earth terminals.

    (b) Section 2 shall consist of 16 terminals dedicated for signal lantern active conductors. The terminals shall be clearly numbered from top to bottom “1” to “15” and “GRY” with terminal labels.

    (c) Section 3 shall only be installed for an ELV installation. The section shall consist of 3 terminals dedicated for the dim signalling cable. The

terminals shall be electrically connected by a three way jumper bar. The terminals shall be clearly labelled with “DBW”.

(d) Section 4 shall consist of 2 terminals dedicated for signal lantern neutral conductors. Both terminals shall be electrically connected by a two way jumper bar. The terminals shall be clearly identified with a blue terminal labels.

(e) Section 5 shall consist of a single earth terminal.

2. Terminals shall be Klippon AST1 TS32 Mounting Polymide 6.6 with Push-on Tab Connections, or equivalent, consisting of 4 spade terminals horizontally oriented. The spade terminals shall be tin, nickel plated brass, or copper alloy, angled and compatible with Utilux female connectors type H1972 and Utilux insulators type H1135. Earth terminals shall be Klippon Earth Terminal EK4, or approved equivalent. The terminals shall be secured by a terminal strip locking bar.

712.18.03 FINIAL CAP

1. The finial cap material shall be polymer plastic. The finial cap form, dimensions and degree of protection shall conform to clause 4.3 and figure 4, 2 of AS 2339:1997. Two mounting slots, 7 mm wide, shall be located 180° apart at the base of the finial cap. These slots shall be 20 mm deep. The cap shall have a ridge around its base to allow the cap to be secured by suitable clamps. ***Finial Cap***

2. The finial cap shall be provided with a plastic coated multi-strand wire arrestor strap. The arrestor strap shall be of suitable strength to resist breaking should the traffic signal post be struck. The arrestor strap shall be 420 mm long. The arrestor strap shall be fitted with a connection at either end designed to be secured by an M6 bolt. ***Arrestor Strap***

3. The arrestor strap shall be securely fitted to the finial cap and located 100 mm from one of the mounting slots along the circumference of the finial cap. The fitting shall be an M6 bolt complete with flat washer, shake proof washer and a dome nut.

4. The arrestor strap, connections and cap fitting shall be marine grade 316 stainless steel. ***Finish***

5. The colour of the finial cap shall be black for an LV installation and blue for an ELV installation. ***Colour***

## 712.19 TERMINATION ENCLOSURES

1. The enclosure shall be of rigid and robust plastic material. The enclosure shall have a clear lid that is removable through bayonet type captive screws. The screws shall be operated by a quarter turn of a coin or similar tool. The enclosure shall provide a sealed and suitable environment for terminations and prevent the ingress of water or dust. Silica gel bags or similar shall be provided suitable to absorb moisture. The Silica gel bags (300 mm x 200 mm) shall contain 300 g of “Silica Gel Self indicating 5-10 mesh”. The bags shall be made of fabric called Calico. For terminating 29 core cable, a Klockner Moeller box Part No MR43XJP and for terminating ***Enclosures*** ***Silica Gel Bags***

51 core cable a Klockner Moeller box Part No MR44JP. Any other equivalent terminating core cable used to be approved by the Principal.

2. The support tray shall be 3 mm thick marine grade aluminium plate suitably moulded to fit into the termination pit and rest securely on the lip provided. The tray shall allow the enclosure to be fixed and be located appropriately within the pit. ***Support Tray***

3. 360 mm Mounting Rails TS35 (Klippon Part No 3834.0), or similar, shall be used. ***Rails***

**712.20 NOT USED**

## SURVEY

**712.21 SETTING OUT**

1. The Contractor shall mark out the position of all signal components in accordance with the Drawings. ***Contractor to Mark Out***

2. The Contractor shall in the course of the Works verify by careful excavation the location of all services and objects likely to conflict with the Works, and if necessary, modify the post, conduits, pits and controller locations. ***Contractor to Verify Location***

3. The Contractor shall advise the Superintendent in writing of any modifications to the location of posts, conduits, pits and controller from the Drawing.

4. The Contractor shall further check with the service authorities that the modified positions of components are clear of underground or overhead services. The marked location of each post and controller approved by the Superintendent prior to excavation of foundations shall constitute approval to the sitting of the post or the controller position only and shall in no way relieve the Contractor from his obligations under this clause. ***Contractor to Check***

**712.22 – 712.30 NOT USED**

## UNDERGROUND WORKS

**712.31 EXCAVATIONS**

1. The excavation depth shall be such that all conduits have a minimum cover from top of the conduit to the finished surface of 500 mm and a maximum cover of 800 mm. The minimum excavation depth for consumer main shall comply with WA Electrical requirements. ***Conduit Cover***

2. All excavations shall be kept to a minimum. The excavation width shall not exceed 530 mm. All open pits, excavations, trenches and bores shall be fenced off or protected from vehicular traffic and pedestrians during the progress of the work. Excess spoil shall be removed at the end of each day. Extra care must be taken not to damage the sides of trenching. ***Excavation Width***

3. The lines of trenches shall be as shown on Drawings. Before any pavement excavation is commenced the limits of the trench shall be pre-cut with a diamond concrete saw to a depth of not less than 70 mm. ***Line of Trenches***

4. Where excavation of reinforced concrete areas is carried out, care shall be taken not to damage the steel reinforcing rods or mesh, which shall be cut through only at the centre of the trench. In the course of excavation, the steel reinforcing may be bent aside, but shall be replaced and bars lapped in their original positions when the trench is backfilled. ***Reinforced Concrete***

5. **Prior to any excavations on bridges or structures, the Contractor shall notify the Superintendent in writing.** ***HOLD POINT***

6. Where shown on the Drawings, conduit junction pits and detector pits shall be provided. Any subsoil drains disturbed during the excavation or laying of conduits shall be reinstated to the satisfaction of the responsible Authority. ***Pits and Drains***

7. Conduits to be installed so that they enter through the side of cable pits. ***Conduit Entry***

## 712.32 PAVEMENT REINSTATEMENT PROCEDURE

712.32.01 BACKFILL MATERIAL

1. Backfill shall be excavated material free from rocks, clay, stones, sections of pavement material or organic and perishable matter and shall be of uniform composition and moisture content. Under trafficable paved areas, clean sand shall be used as backfill.

712.32.02 BEDDING

1. Prior to backfilling, the conduits shall be bedded on and surrounded by an 80 mm layer of clean yellow sand.

712.32.03 PLACING

1. Backfill materials shall be placed in layers not exceeding 300 mm loose thickness prior to compaction. ***Layer Thickness***

712.32.04 COMPACTION

1. The material shall be compacted to the bottom of the pavement under trafficable areas or natural surface in other areas to a Characteristic Dry Density Ratio (CDDR) of 96% or 8 – 9 blows using the Perth Sand Penetrometer. In the event that other than Perth sand is used for fill, compaction shall be 92% Characteristic Dry Density Ratio. ***Compaction***

2. If a penetrometer is used, a calibration certificate from a NATA registered laboratory shall be provided in respect to the material tested. The maximum test depth of the penetrometer is not to exceed 1.5 m. Where fill depths exceed 1.5 m, multiple testing shall be carried out during the backfilling operation with clear documentation provided detailing such testing. ***Testing***

3. The Contractor shall provide compaction certificates showing the location, number of tests and depth ranges for each line. The dry density ratio shall be determined at six locations per line. The locations shall be selected in accordance with Main Roads Test Method WA 0.1 Random Sample Site Location and the characteristic dry density ratio calculated in accordance with Main Roads Test Method 134.1.

712.32.05 PAVEMENT

1. The Subbase shall be 200 mm laterite gravel or 200 mm single layer limestone compacted to 94% CDDR. ***Subbase***

2. The Basecourse layer shall be 150 mm laterite gravel or 2% Bituminised Stabilised Limestone compacted to 96% CDDR. ***Basecourse***

3. The primerseal shall be a two coat seal using CRS 170/60 (cationic rapid setting class 170 bitumen) emulsion covered with granite aggregate in the following combination: ***Primerseal***

   (a) First coat – 0.9 l/m² covered with 10 mm aggregate

   (b) Second coat – 1.1 l/m² covered with 5 mm aggregate

   Primerseal width is to be set out so as to allow for any in-situ kerbing to be cast on the primerseal surface.

4. The asphalt shall be 40 mm thick dense graded granite 14 mm Intersection Mix for intersections or 30 mm dense graded granite 10 mm mix for other areas. The Contractor shall ensure not to damage the side of trenching. ***Asphalt***

5. The finished surface shall be between 0 mm to 5 mm above the existing surface. ***Finished Surface***

6. If the final asphalt is not placed the same day as backfilling, 2% BSL shall be used, laid to 5 mm above the pavement surface. ***Same Day Asphalt***

## 712.33 CONTROLLER FOOTING INSTALLATION

1. The Traffic Signal Controller shall be installed on a concrete footing or smooth pavement material that matches the surrounding pavement. The orientation of the base shall be such that the back of the controller when mounted shall face into the intersection. ***Orientation***

2. The top of the controller base shall be smooth and level, to prevent twisting of the controller frame and poor door alignment. The walls of the pits shall be left in a smooth finish to prevent damage to electrical cables. ***Level***

3. A double lid cable pit shall be installed in front of the controller. The number of conduits to be installed between the double lid pit and the controller footing shall be eight. They shall be installed in two rows, each consisting of 4 x minimum 50 mm orange conduits. The main earth electrode shall be installed in its own earth pit and connected directly to the controller earth link. ***Cable Pit***

4. After installing the controller footing, the pit opening shall be capped and adequate barricading to be maintained until the controller housing is installed.

5. The concrete apron around the Controller shall be 2440 mm x 2440 mm minimum and shall be installed in one of the following ways: ***Dimensions***

   (a) Slabbed concrete apron comprising minimum 50 mm thick slabs.

(b) Poured concrete apron. The concrete shall be laid in one continuous pour of 75 mm thickness and with a broomed finish. If this method is chosen, the Contractor shall be responsible for making sure that any Communications provider that gains access to the communications pit to install its conduit and cable without disturbing the concrete hardstand.

(c) Smooth pavement material that matches the surrounding area.

6. The finished concrete surface shall comply with Specification 901 CONCRETE – GENERAL WORKS.

### 712.34 CONDUITS NOT UNDER ROADS

1. Trenches shall be backfilled as per clause 712.32 except that clean yellow sand shall be used as the backfill. ***Backfill***

2. The top 75 mm of backfill material in unpaved areas is to be of selected material from the site of the same soil composition as the original surface material, or material of a type approved by the Superintendent as suitable. ***Material***

3. In footways paved with paving blocks or slabs, no asphaltic material shall be used, but the Contractor shall replace the paving blocks or slabs on sand compacted and levelled. ***Footways***

### 712.35 – 712.40 NOT USED

## ELECTRICAL AND COMMUNICATIONS CONDUITS

### 712.41 INSTALLATION OF CONDUITS

1. The completed underground electrical conduits with cable installed shall comply with the requirements of Australian Standard AS/NZS 3000 for Category A Underground Wiring Systems in addition to any other requirements contained in this Contract. ***Conduit Compliance***

(a) Couplings and bends used for PVC conduit shall be of sufficient length to allow the pipe to be inserted with a penetration equivalent to the nominal bore of the pipe. Couplings shall have a moulded stop in the centre to ensure equal engagement of conduits from both ends. Before insertion, the interior of the fitting and the end of the conduit shall be thoroughly cleaned then liberally coated with a conduit manufacturers approved bonding agent. ***Couplings and Bends***

(b) Conduits shall be installed generally in the locations as shown on the Drawings. Conduits shall be installed so that they enter the cable pit from the side within the specified depth. ***Installation Details***

(c) Conduit ends shall be capped at the time of installation to reduce the possibility of sand or other foreign material entering the conduits.

(d) These conduits shall cross the centre islands in the locations shown on the Drawings. When crossing slip lanes the “in” conduits shall be laid above the “out” conduits.

(e) Where conduit is cut for median island posts, the end not used shall be plugged with a conduit manufacturers approved cap glued in place to ensure dirt or sand does not enter the conduit. If there are three or more lanes, the right and centre lane loop detector cable shall be run to the median and a loop pit installed. The single 50 mm conduit, for the loop detector cable, shall then be cut and both ends terminated in the loop pit. ***Conduits to be Plugged***

(f) All conduit locations shall be marked at their ends, at footpath level, with Cable Route Markers set in concrete.

## 712.42 STAR SYSTEM OF WIRING

1. The standard arrangement for conduit installation using the star system of wiring requires each traffic signal post to be individually connected with 50 mm conduits to the controller. ***Star Wiring System Conduit***

2. For loop pits, there shall be one loop feeder 50 mm conduit per direction, linked in and out of the loop pit. Maximum of 6 loop feeder cables in a single 50 mm conduit. Install additional 1 x 50 mm conduit for next set of loop feeder cables.

3. From the controller to the first intermediate pit, 2 x 50 mm spare orange conduits and 1 x 50 mm spare white conduit shall be laid. From the intermediate pit to the last post, 1 x 50 mm spare conduit shall be laid. ***Spare Conduits***

4. The conduits shall be laid out side by side in a common trench in the following order:

   (a) Outer conduit 1 x 50 mm white for communication cables, linked from controller to each immediate pit post.

   (b) Second outer conduit 1 x 50 mm for loop feeder cables linked in and out of the Loop Pits.

   (c) Third and fourth from outer conduits 1 x 50 mm orange spare conduit.

   (d) Inner conduits 1 x 50 mm for post cables, in ascending order of each post number.

   (e) Dummy controller shall be installed next to main controller subject to site's constraints. Install conduits between the main and dummy controller as per below: ***Dummy Controller***

      (i) Install minimum of 2 x 80 mm conduit between the controller and dummy controller, including feeder loop cable requirements.

      (ii) Install minimum of one 51 core cable between the two controllers.

   (f) Install 1 x 50 mm spare orange conduit for each corner island under the Give Way signs.

## 712.43 PIT SYSTEM OF WIRING

1. The standard arrangement for conduit installation using the pit system of wiring requires 4 x 50 mm and 1 x 80 mm conduits to be laid in a ring around the intersection. The ring shall start in a clockwise direction leaving ***Pit Wiring System***

the Controller as the "out" conduits and finish at the Controller as the "in" conduits. The conduits shall be laid side by side in a common trench in the following order:

***Conduit Installation***

(a) Outer conduit 1 x 50 mm white for communication cables, linked in and out of the Termination Pits to form a ring back to the controller.

(b) Second from outer conduit 1x 50 mm for Loop Feeder cables, linked in and out of the Loop Pits.

(c) Third from outer conduit 1 x 80 mm for Ring Main cables, linked in and out of all Termination Pits.

(d) Fourth from the outer conduit 1 x 50 mm for Spare, linked in and out of all Termination Pits.

(e) Inner conduit 1 x 50 mm for Post cables, linked in and out of all Termination Pits.

### 712.44 POST CONDUITS

1. Between the conduit and the traffic signal post an orange 32 mm corrugated flexible conduit shall be used. The corrugated conduit shall be pushed inside the 50 mm conduit for a minimum of 200 mm and into the post so as to be 200 mm above ground level.

***Corrugated Conduit***

### 712.45 CLEANING OF CONDUITS

1. All conduits must be thoroughly cleaned internally prior to installing cables in the conduit. This shall be done by pulling a swab or similar through the conduit.

***Cleaning of Conduits***

2. All conduits must have smooth edges to prevent cable damage when pulling cable through the conduit.

***Smooth Edges***

### 712.46 – 712.50 NOT USED

## CABLE INSTALLATION

### 712.51 INSTALLATION AND TERMINATION OF CABLES

712.51.01 GENERAL

1. All cable sizes and wiring arrangements shall comply with the provisions listed below unless otherwise specified on the Drawings:

***Cable Sizes and Wiring Arrangements***

(a) At intersection traffic signals using a star system of wiring, the posts shall be connected, by a 19 core cable, direct to the controller through the cable draw pits in accordance with the Drawings.

(b) At intersection traffic signals using a pit system of wiring, the controller, termination pits and all cable pits adjacent to the traffic signal posts shall be connected by a 29 or 51 multicore ring main circuit as detailed on the Drawings. A 19 core cable shall be used to connect the post to the cable pit.

***Pit System***

(c) At intersections with bad drainage, where the main road is floodway and where pits hold water for a long time, posts shall be connected to the controller using Post Top Ring Main assembly and the installation shall be in accordance with the Drawings. ***Post Top Ring Main Assembly***

(d) At all installations, pedestrian push-buttons shall be connected to the terminal strip by multicore V-75 cable having two core and earth 7/0.50 – 1.5 mm².

(e) For all works, one continuous detector feeder cable for each detector loop shall be drawn through conduits from the loop detector pit near the detector loops to the controller. The use of in-line cable joints or repairs is unacceptable. An approved cable joint is only allowed for loop cables in the loop pit.

2. Interconnecting cables shall be drawn through conduits. It shall be possible to remove and replace any cable without the need for the disconnection of other cables with the exception of loop feeder cable. ***Cable Replacement***

3. Any cables in which the insulation or sheathing is damaged before or during installation shall be replaced by the Contractor at his own expense. Powdered soapstone, talc or other approved lubricant may be used as required when pulling the cable into conduits. Particular care must be taken when the outer or inner sheath is being removed and only appropriate stripping tools shall be used at all times. ***Damaged Cable***

712.51.02 TERMINATIONS

1. The following terminals, or similar, shall be used. ***Terminals***

   (a) Earth terminals EK6/35 (Klippon Part No 6612.6)

   (b) End Bracket EWK35 (Klippon Part No 3835.6)

   (c) Terminals SAKR/35 (Klippon Part No 1833.6)

   (d) Partition HP1 (Klippon Part No 4855.6)

   (e) Cross Connect QB Comb (Klippon Part No 4829.0)

   (f) End Plate AP (Klippon Part No 2113.6)

   (g) Terminal Markers (Klippon Part No Dekafix 6.5)

2. Cable glands shall be QED STB 21, STB 29 or STB 50 or similar. ***Cable Glands***

3. The 1.5 mm² and 2.5 mm² cable cores shall be connected using the following crimp-lugs: ***Crimp-lugs***

   (a) Black bootlace crimp – No 901912 size DIN 1.5 mm² individual type or No 900435 size DIN 1.5mm² magazine type

   (b) Red bootlace crimps – No 046310 size standard 1.5 mm² individual type or No 900434 size standard 1.5 mm² magazine type

   (c) Blue bootlace crimps – No 900436 size 2.5 mm² magazine type

4. The following colour coding for Bootlace Crimps shall apply: ***Lug Colours***

   (a) All 1.5 mm ring main "out" cores – black bootlace crimps

   (b) All 1.5 mm ring main "in" cores – red bootlace crimps

   (c) All 1.5mm post cable "out" cores (at controller and termination pits) – black bootlace crimps

   (d) All 2.5 mm cable cores – blue bootlace crimps

5. The crimp-lugs shall be applied using the crimping tool stipulated in this specification, or alternatively one specified by the crimp-lug manufacturer for the particular crimp-lug. ***Crimping***

6. Cable cores that are 4 $mm^2$, namely the neutral, the grey and the Earth wires contained in the 51 core cable, may be directly terminated without the use of crimp-lugs. ***4 $mm^2$ Cable Cores***

7. All Earth Stud connections shall be made using 2.5 $mm^2$ x 6 mm two hole earthing lugs. ***Earthing***

8. Alternative methods of electrical connection will not be accepted unless the Superintendent gives prior written approval.

712.51.03 CABLE JOINTS

1. The use of in-line cable joints or repairs is not acceptable. Joins in the 19, 29 and 51 core cables are not permitted. Similarly, joins are not permitted in loop cables or loop feeders except where the loop detector cable joins the loop feeder cable. ***Joints***

712.51.04 CABLE TIES

1. Only black UV stabilised cable ties shall be used. ***Colour***

712.51.05 CABLE CHART

1. The Controller shall contain a copy of the Cable Chart. It shall show the connection details for controller, all Pits and Posts. ***Cable Chart***

   All Termination pits shall contain a copy of the Cable Chart. It shall be laminated and fixed to the inside of the Termination Box lid so as to be visible without removing the lid.

   For existing Post Top Ring Main sites one copy of the wiring chart shall be placed in the Controller.

712.51.06 DIRECTION OF RING MAIN CABLE

1. All "out" cable cores shall be loomed in black spiral wrap and all "in" cable cores shall be loomed in white spiral wrap for identification. All cores of individual cables shall be contained in one loom and shall be separate to the cores of other cables. Each individual core of cables shall be brought out of the loom separately. Only non-flammable 6 mm spiral wrap shall be used. ***Spiral Wrap***

## 712.52 CABLE PITS

### 712.52.01 GENERAL

1. All Termination Pits shall be mounted sufficiently below ground level so that their lids sit flush to ground level when fitted. Double Lid Cable Pits, Loop Pits, Earth Pits and Communication Pits shall be installed with the top of their walls flush to ground level. All pits that are not set within a concreted area shall have a concrete surround. The Termination Pit and Double Lid Draw Pit shall have steel reinforced concrete surround. The surface of the concrete skirt surround shall be flush to ground level. The dimensions of the concrete skirt shall be 150 mm wide and 75 mm thick. A 5-10 mm clearance shall be allowed between the lid and surround to permit removal of the lid during maintenance. Pits that are not set within a concreted area shall have a concrete surround 150 mm wide and 75 mm thick. Loop Pits shall be mounted one metre back from the kerb face to provide maintenance workers with a safe working distance from the carriageway.

***Pits to be Flush***

***Reinforced Concrete Surround***

2. Termination Pits shall be installed in accordance with the Drawings.

3. Where the conduits enter the cable pits, a neat hole shall be cut using a hole cutter or similar tool. Pits with holes knocked in with a hammer or similar tool are not acceptable. Prior to backfilling around the pits the conduits are to be sealed to the outside of the pit using a 3:1 sand-cement mortar. Any excess mortar inside the pit must be removed. Alternatively, the conduit may be sealed to the inside of the pit using Silicone Sealant. Holes and fractures in the pit wall are not acceptable. Conduits to be terminated to the side of the pits without use of conduit bends and elbows. Conduits shall enter the pit with 50 mm of conduit penetrating into the pit.

***Making Holes***

### 712.52.02 TERMINATION BOX PREPARATION

1. The Contractor shall prepare and install in all Termination Pits a termination box of the size specified in the Cable Chart.

***Termination Pit***

2. The termination box assembly shall include the installation of the following bridging wires:

***Termination Box***

   (a) Earth wire – an Earth wire bridge (same size conductor as the ring main Earth cable core) shall be connected between the A rail Earth terminal and the B rail Earth terminal in the 29 core termination box and between the X rail, Y rail and Z rail Earth terminals in the 51 core termination box.

***Earth Wire***

   (b) Neutral – a Neutral bridge wire (same size conductor as the ring main Neutral cable core) between the X rail and Z rail neutral terminals in the 51 core termination box.

***Neutral Wire***

3. The termination box shall be fitted to the aluminium support tray using four only 4 mm x 10 mm cadmium plated screws. The support tray-termination box assembly shall be placed on the ledge provided within the Termination Pit.

***Support Tray***

4. IP68 rated waterproof cable glands shall be used where a cable enters and exits a termination box.

***Cable Glands***

## 712.52.03 TERMINATION BOX RING MAIN CONNECTION

1. Ring main cables shall enter and exit the termination box from the underside.

2. For 51 core ring main cables the “in” cable shall enter the termination box under the right side of the “X” terminal rail and the “out” ring main shall exit under the left side of the “Z” terminal rail. ***Ring Main-51 Core Cable***

3. For 29 core ring main cables, the “in” cable shall enter the termination box under the right side of the “A” terminal rail and the “out” ring main cable shall exit under the left side of the “A” terminal rail. ***29 Core Cable***

4. The cable cores within the termination box shall be neatly formed and laced to allow individual conductors to be connected and disconnected to the appropriate numbered terminal in accordance with the cable connection chart. The cores of different cables shall not be laced together in the same loom. The cores of the “in” ring main cable shall be wrapped with white Spiral wrap and the cores of the “out” ring main cable shall be wrapped with black Spiral wrap. The numbered or colour coded “in” core shall be connected to the left most hole of its assigned terminal, the corresponding “out” core shall be connected to the next hole to its right (of the same terminal number). In the 51 core termination box it leaves the right most terminal (of the same terminal number) empty. The bunching and tying of cores shall be arranged such that all terminal labelling remains visible allowing individual cores to be conveniently disconnected from any terminal for subsequent maintenance. ***Cable Cores***

5. All cables shall have sufficient slack to enable the completed termination box to be lifted out of the termination Pit and placed on the ground without placing undue strain on the cables. The surplus cable shall be coiled inside the pit in such a manner that it shall not prevent the support tray from sitting in its correct position or cause the cables to kink. ***Slack Cable***

   NOTE: All Ring Main cable cores shall be connected in the Termination Pits regardless of the controller type. However, for controllers with lamp conflict monitoring, only the cores specified on the Cable Chart shall be connected to the controller Terminals. To complete the ring main circuit at the Termination Pits the incoming and outgoing terminals shall be bridged using a two pin bridging link e.g. Weidmuller QS2 or similar approved pin Bridging Link. Where there are three posts per signal group connected in one termination box a 3 pin bridging link e.g. Weidmuller QS3 plug or similar shall be used. The use of two QS2 plugs in this situation is not acceptable.

## 712.52.04 TERMINATION BOX POST CONNECTIONS

1. Post cable entries into the termination box: ***Post Cable***

   (a) Each post cable shall have 2 m of slack cable coiled in the bottom of the Termination Pit.

   (b) The post number shall be clearly labelled with Brady Cable Markers or similar approved by the Superintendent around the sheathing close to the entry of the termination box.

(c) Post cables shall enter 51 core termination boxes from the sides.

(d) Post cables shall enter 29 core termination boxes from the front.

(e) Each post cable shall be separately loomed using black Spiral wrap and each core exits the loom separately.

(f) The post number shall be marked on each core of the post cable close to the terminal using Brady Cable Markers or similar approved by the Superintendent.

2. Post cable connections in the terminations box:

(a) The terminations shall be made according to the cable chart.

(b) The grey (common) on all post cables shall be connected (for maintenance test purposes) even if it is not required for Pedestrian Push Buttons.

(c) Unused post cable cores shall be kept to a sufficient length for future connection, insulated and contained within the same post cable loom.

(d) There are three terminals for each output in the 51 core termination box and two terminals for each output in the 29 core termination box.

712.52.05 CABLE CONNECTIONS

1. Annexure 712B shows typical connections in the terminal box for a 51 core cable ring main system and 19 core post cable. The 29 core cable ring main system is similar but uses six terminals for each signal group that is, two red, two yellow and two green. ***Terminal Box***

2. Detector cables are connected in a Loop Pit as detailed in clause 712.59. ***Detector Cable***

712.52.06 TELECOMMUNICATIONS CABLES

1. An insulated draw-wire shall be installed in the telecommunications conduit between the terminal box on the side of the controller housing, and the Communications Pit.

712.52.07 EARTHING

1. All posts, lanterns, transformers and controller shall be earthed as required by AS 3000 and EnergySafety Western Australia. An earth stake for the Main Earth shall be driven through the Earth Pit into the soil and connected to the earth bar in the controller. ***AS 3000***

712.52.08 CLEANING OF PITS

1. Pits are to have all foreign material removed and be cleaned by vacuum cleaner prior to all tests being completed and accepted by the Superintendent. ***AS 3000***

**712.53 – 712.54 NOT USED**

## VEHICLE DETECTOR LOOPS

## 712.55 GENERAL

***Loops***

1. Vehicle detector loops shall be installed in accordance with the requirements of the Drawings in the positions indicated.

2. Detector loops are normally set to the Presence mode. Passage mode will be specified in the controller documentation when required.

## 712.56 CUTTING OF SLOTS

***Cutting Loops***

1. The road pavement shall have slots cut to a depth of 35 mm minimum using a single 6 mm wide diamond saw. The use of two thinner blades to cut the slot is not permitted under any circumstance.

2. The slots shall be overrun so as to be full depth at all corners. The corners shall be rounded full depth minimum radius 25 mm so as not to present a sharp edge to the loop cables. Before cables are placed, the slot shall be clean and dried, so that no moisture, detritus, dust and other foreign matter remains in the slot.

3. A 32 mm grey corrugated conduit shall be installed between the end of the saw cuts in the pavement and the loop pit behind the kerb. At the point where the loop cables enter the corrugated conduit at road level, the surplus room in the conduit shall be plugged with an easily removable filler (for future re-use) and then sealed over.

## 712.57 INSTALLATION OF LOOP CABLE

***HOLD POINT***

1. **Cables shall not be placed until the Superintendent has inspected the slot.**

2. Loop cable shall be installed at the bottom of the saw cut, so that there are no kinks, curls or stretching of the cable. Care shall be taken not to damage the insulation when placing the cable. Metal implements such as screwdrivers shall not be used to seat the cable down. The ends of the loops are brought into a Loop Pit located near the kerb.

***Wiring Check***

3. A conduit must be installed between the end of the saw cuts in the pavement and the Loop Pit. Before the loop cables are jointed and before application of sealant to the saw-slots, the Contractor shall carry out a wiring check.

***Retainers***

4. When it has been determined that the loop cable has been correctly installed, the cable shall be retained in the slot at approximately 500 mm spacing and 100 mm from each corner with suitable plastic retainers, such as plastic wall plugs. Each cable end in the Loop Pit shall be labelled with Brady cable markers or approved equivalent cable marker. The convention in labelling shall be that the loop cable shall be labelled S 1 A for start of loop 1 section A and F 1 A for finish of the same loop. Similarly, S 5 B is the start of loop 5 section B. The A section of the loop is that section closest to the Stop Line in accordance with Drawing 200431-0167.

## 712.58 LOOP SEALING

1. SCOTEC or a suitable bitumen emulsion (e.g. THORMAC) applied strictly in accordance with manufacturers' instructions may be used for loop sealing. ***Loop Sealing***

## 712.59 LOOP CABLES AND LOOP FEEDERS

1. The loop cables should be cut to length such that they shall be no shorter than 350 mm and no longer than 500 mm above ground level. The Loop cables shall be twisted in pairs as below inside the loop pit at the rate of about 20 turns per metre.

2. Connection of the loop and the loop feeders is as follows: ***Loop and Feeder Connection***

   (a) The finish of section A is connected to the finish of section B.

   (b) The start of section A is connected to the white core of the loop feeder.

   (c) The start of section B is connected to black core of the loop feeder.

3. Detector loop cables and feeder cables shall be joined using Utilux H2050 Insulated End Crimp connectors, crimped using a GS Crimping Tool Model No. YYT7 on the Yellow setting. These joints may be housed in an AMP Catalogue No 190851-1 grease pot connector or individually sealed in Raychem or approved equivalent 6mm PD caps (hot glue heat shrink end caps). Where PD caps are used a separate heat shrink sleeve shall be installed to seal the end of the Loop Feeder Cable sheathing. After completing the joints the slack cable shall be coiled and cable tied. The AMP connector shall be screwed firmly to the wall of the Loop Pit approximately 100 mm from the top or alternatively if the connectors cannot be screwed to the pit wall the joints are sealed individually and they shall be cable tied to a plastic conduit mounted 100 mm below the top of the Loop Pit.

4. Detector loop feeder cables shall be individually wired back to the controller to enable traffic to be detected in each lane separately. All feeder cables shall be run in the one 50 mm conduit and cables other than loop feeders shall not be run in the same conduit. Cables shall be terminated with sufficient length to allow for all necessary connections plus an additional one metre of surplus cable at each end. The surplus cable shall be neatly coiled in the pit adjacent to the controller and in the Loop pits. ***Detector Feeder Cable***

## 712.60 CONNECTION OF ELECTRICAL SUPPLY

1. The Contractor shall make all necessary arrangements with the Local Supply Authority for the electrical inspection and electrical supply connection of the installation. ***Application Notices***

## 712.61 – 712.70 NOT USED

# ABOVE GROUND WORKS

## 712.71 INSTALLATION OF TRAFFIC SIGNAL POSTS AND MAST ARMS

1. **Unless otherwise directed by the Superintendent, no signal posts shall be erected until all other equipment needed for the completion of the signal installation is available to the Contractor and until the necessary channelization has advanced to a stage where all components can be installed without creating a traffic hazard.** ***HOLD POINT***

2. The Contractor shall provide a minimum 2440 mm x 2440 mm sized level hardstand area around all traffic signal posts and mast arms to allow safe ladder access to the post tops. Where posts are installed in paved, concreted, bituminised or other hard finished surfaces, these surfaces shall serve the purpose as long as the area is at least the same size as the specified size area. If the existing paved area is too small or if no type of paving exists the Contractor shall add to it or install the specified size hard stand area using 610 mm x 610 mm x 50 mm concrete slabs and half slabs laid on compacted yellow sand. Alternatively, the Contractor may extend an existing type of finish rather than extend it with concrete slabs. The Contractor shall leave all ground area around the posts in good condition and to the satisfaction of the Superintendent and the Local Government Authority. ***Hardstand to be Provided***

3. Unless otherwise indicated on the relevant Drawing, the post height shall be 3.5 m above ground level. Posts shall be erected so as to be vertical and the orientation shall be such that when pedestrian push-buttons are installed they will be as detailed in clause 712.16. The orientation must also suit the slot at the bottom of the post for cable entry. ***Traffic Signal Post Height***

4. Posts shall be installed at a standard distance of 1 m behind the kerb face. The minimum acceptable clearance for extenuating circumstances is 600 mm. Prior approval must be gained from the Superintendent before any posts are installed at distances less than 1 m. Posts installed in islands narrower than 2 m shall be centred between the two kerb faces.

5. Unless otherwise indicated on the relevant Drawing, the mast arm must have a 5.8 m clearance from the lowest part of the traffic signal lantern mounted on the mast arm outreach and the top of the roadway directly underneath it. Mast arms shall be erected so as to be vertical and the orientation shall be such that when pedestrian push-buttons are installed they will be as detailed in clause 712.16. The orientation must also suit the slot at the bottom of the post for cable entry.

6. Each post shall be identified with two sets of post numbers according to the numbering on the Drawing. The numbers shall be fixed to the primary and the secondary approach positions on each Traffic Signal Post at a height no more than 50 mm below any lantern or no more than 50 mm below the signs in the case where a sign is also fixed to the post and must be easily seen from both approaches. The numbers shall be made up of 50 mm black letters on a 50 mm x 60 mm background of self-adhesive class 2 yellow retro-reflective material as per AS 1906 – Part 1 – Retro-reflective Materials. Prior to installing the numbers the surface of the ***Numbers to be Attached*** ***AS 1906***

Traffic Signal Post shall be thoroughly cleaned with methylated spirit or similar.

7. When the connections at the top of each traffic signal post are completed, the Contractor shall cover the Terminal Block using a clear plastic bag at least 50 microns thick and with at least ten 6 mm breather holes. The Finial Cap shall be installed with the two clamps and with the arresting wire secured in place. ***Post Top Finial Cap***

8. Installation of posts shall be in the soil with a concrete surround as shown on the Standard Drawings. The concrete surround shall be 450 mm x 450 mm and 50 mm thick. The concrete surround area shall be installed separate to the rest of paved area. If the post is installed within a slabbed area, the concrete that surrounds the post may be equal to the size and shape of a half slab with a half slab installed adjacent to it. Concrete shall be added at the peg level to ensure that the post is locked. ***Concrete Surround***

9. The following concrete Mpa ratings shall apply when installing Traffic Signal equipment:

   (a) Traffic Signal Posts – 15 Mpa

   (b) Small Pit surrounds and slab fill in sections – 15 Mpa

   (c) Mast Arms – 25 Mpa

   (d) Controller Base – 25 Mpa

   (e) Termination Pit and Double Lid Cable Pit surrounds – 25 Mpa

   (f) Aerial Supply Pole – 25 Mpa

## 712.72 LANTERN INSTALLATION

1. Lanterns shall be installed complete with accessories at the locations designated on the Drawings. Where designated, signal aspects shall be fitted with symbolic masks and/or white lenses. All primary lanterns are to be fitted with short open primary visors and secondary lanterns fitted with secondary or long closed visors in accordance with Standard Drawings. ***Lanterns***

2. Lanterns shall be vertically mounted with red aspects uppermost, yellow aspects in the centre and green aspects lowermost. A maximum of two lanterns may be joined side by side to form a double lantern arrangement consisting of four, five or six aspects. The arrangement of such signal faces shall always comply with AS 1742.14 Table 3.1. All coloured symbols (such as Arrows, Bicycles etc.) must never be mounted alongside an aspect of a different colour but must retain the standard orientation for Red, Yellow, and Green. Target boards shall be fitted to the requirements of the Drawings. ***AS 7142.14***

3. For LED aspects, all individual LEDs must be the same nominal colour for each aspect.

4. The top and bottom of each lantern must be firmly attached to the mounting straps, which, in turn, must be firmly attached to the mounting brackets on the designated post. Each lantern shall be attached to its ***Lantern Attachment***

supports so as to achieve the least obstructed line of sight to the traffic, which it controls.

5. Lanterns mounted on mast arms shall be mounted on the appropriate lugs provided on the vertical section of the pole to achieve the correct orientation and mounting heights. Lanterns mounted on the mast arm outreach shall be fixed to the lugs on the vertical section of the outreach. ***Lanterns on Mast Arm Outreach***

6. Lanterns and ancillary attachments shall be mounted a maximum distance back from the kerb alignment. The minimum clearance from the lantern equipment to kerb face must be 600 mm irrespective of the post location. ***Distance from Kerb***

7. All brackets must be spaced correctly to prevent any stress on the plastic body or section joints of the lantern. Standard length mounting straps shall be used unless otherwise approved by the Superintendent. The Contractor shall use, where necessary, extra lower mounting brackets, spacers or offset straps to satisfy this requirement. ***Brackets***

## 712.73 LANTERN MOUNTING HEIGHTS

1. Signal lanterns shall be mounted at the heights specified on the Standard Drawings unless otherwise specified on the Drawings.

2. The following also applies:

   (a) 2-aspect and 1-aspect lanterns shall be mounted at a height equal to the mounting height of the same colour aspect of an equivalent size 3-aspect lantern.

   (b) 2-aspect bicycle lanterns shall be mounted to the right and at the same height as pedestrian lanterns.

   (c) Lanterns fitted with white lens aspects shall be mounted at the same height as an equivalent size lantern with a green lens aspect in place of the white lens aspect.

   (d) Internally illuminated signs shall be mounted at the height as detailed on the Drawings.

   (e) Traffic signs attached to traffic signals posts shall be mounted at the height as detailed on the Drawings.

   (f) Where indicated on Drawings, the Contractor shall make associated arrangements with the owner of the veranda and the Local Government Authority to accommodate/modify the veranda to accommodate the lanterns posts.

   (g) All other traffic signal equipment excluding push-buttons shall be mounted such that there is at least 2.4 m from the underside of the traffic signal equipment to the final pavement or ground surface at the post or supporting structure. The mounting heights set out above may be varied with the approval of the Superintendent, but there must always be at least 2 m from the underside of the target board or any other traffic signal item to the final pavement or ground surface at the post. Where local obstructions preclude mounting of lanterns in the

stipulated manner, the Contractor shall refer the matter to the Superintendent for a direction.

## 712.74 LANTERN AIMING

1. Every vehicle lantern shall be attached to the post so as to enable it to be aimed at a point located at a height of 1.5 m above the pavement surface. The aiming distances from the stop line towards the centre of the approach lanes, for stopping and for warning function are as detailed in Table 712.2 and shall be in accordance with AS/NZS 2144. After aiming, all aiming bolts shall be securely locked in position. The upper and lower mounting bracket bolts shall be tightened sufficiently to prevent the lantern from becoming misaligned during heavy winds. If misalignment cannot be prevented through normal means then the Contractor shall install the "Locking Mechanism" detailed in AS 2339 Appendix C.

***AS/NZS 2144***

***AS 2339***

**TABLE 712.2 LANTERN AIMING DISTANCES**

| Approach Speed (km/h) | Metres from Stopping Line | | |
|---|---|---|---|
| | Primary Lantern | | Secondary Lantern |
| | Stopping | Warning | |
| 40 | 40 m | 80 m | 3 m behind Stop Line at centre of approach |
| 50 | 60 m | 100 m | 3 m behind Stop Line at centre of approach |
| 60 | 80 m | 130 m | 3 m behind Stop Line at centre of approach |
| 70 | 100 m | 150 m | 3 m behind Stop Line at centre of approach |
| 80 | 120 m | 170 m | 3 m behind Stop Line at centre of approach |

2. Every pedestrian lantern shall be attached to the post so as to enable it to be aimed at the centre of the appropriate foot crossing at the opposite side of the roadway.

## 712.75 POST TOP CONNECTIONS

1. The 19 core cable shall be run from pit system terminal block in the termination pit or the controller and brought up the interior of the traffic signal post and terminated on the terminal assembly. The cable shall be firmly supported in such a manner that the weight of the cable shall not impose mechanical strain on the electrical connections. This cable shall be attached to the terminal rail between the terminal strips and the post with two (2) heavy duty nylon cable ties such that the outer sheathing is above the top of the post but below the lowest terminal.

***Cable***

2. In terminating the cables white Spiral wrap is to be used with two cores being taken through each turn of the Spiral wrap. Cores are to be cut at approximately 100 mm long to allow for future re-terminations. The numbered cores are to be connected to the corresponding number on the terminal strip starting at number 1 at the top. The grey core is to be connected to the grey terminal, the black neutral to the blue terminal at the bottom of the strip. All Star and Pit System post-top terminal connections shall be made using Utilux H135 clear insulating boots and Utilux H1972 crimps.

3. For standard star and pit system posts the cores shall be loomed to their allocated positions using white spiral-wrap. Each core shall be connected to its matching right side terminal according to its number or colour code.

4. For old Post Top Ring Main system and Spur post installations the “in” cores shall be loomed to their allocated positions up one side of the terminal strip using white spiral-wrap and using Utilux H135 clear insulating boots and the “out” cores shall be loomed up the other side of the terminal strip to their allocated positions using black spiral-wrap and Utilux H135A black insulating boots. The two looms shall be kept separate. Each core shall be connected to its matching right or left side terminal according to its number or colour code.

5. Each core shall be left with sufficient slack at the terminal to allow for three re-terminations.

## 712.76 TARGET BOARDS

1. Target boards shall be fitted where shown on the Drawings, in accordance with Main Roads Standard Drawings and the requirements of AS 2144. In this regard, specific attention shall be paid to the requirements of clause 7.9 of AS 2144 as to the gap between the lantern body and the internal edge of the target board. ***Cutting***

2. Where there are lanterns installed with other than three aspects the target boards shall be fitted with matching blanking plates. These plates are to be pop riveted in place using aluminium pop rivets.

3. Target boards shall be installed flush with the front of the lantern and a minimum clearance of 2 m below any target board shall apply. ***Minimum Clearance from Target Board***

## 712.77 PEDESTRIAN PUSH-BUTTON ASSEMBLIES

1. The pedestrian push-button assembly shall be attached to the traffic signal posts and mast arms using the pre-drilled holes provided in the post, or by drilling and tapping new holes in an existing post such that the height of the push-button places the centre of the button 1063 mm above ground level. ***Pedestrian Push Button Height***

2. The Contractor shall orientate the arrow disc on pedestrian push-button assemblies to point in the direction of pedestrian travel. In the case of push-button assemblies on median island posts the Contractor shall replace the standard supplied single-headed arrow disc with a special supply two-headed arrow disc, as indicated on the Drawings. ***Orientation***

3. On each post on which a pedestrian push-button is installed, self-adhesive labels shall be affixed in the manner shown on the Standard Drawings. Before fixing the labels to the post, the surface shall be thoroughly cleaned with methylated spirit or similar. ***Self-adhesive Labels***

4. When parallel walks with time delay protection are installed (new or upgraded sites), MR-GT-20 “Turning Vehicles Give Way to Pedestrians” signs are to be installed as primary displays on posts nearest to the left or right turn movement where the rule applies. Signs to be removed after three months. ***Give Way to Pedestrians Sign***

## 712.78 AUDIO-TACTILE FACILITIES

1. Where indicated on the Drawing, the Contractor shall install audio-tactile facilities. ***Equipment***

2. The audio-tactile driver unit shall be mounted to the same post as the pedestrian push-button that it is driving, in the area between the upper and lower mounting brackets. The access door shall face away from the road and not be obstructed by any other hardware. The audio-tactile unit lead shall enter the post top terminal assembly (excess lead shall be removed prior to connection). The conduit shall be clamped at the upper mounting bracket and cable tied at 500 mm spacings on the post. The two-core cable (white figure 8 flex) shall be taken down the inside of the signal post and connected directly to the transducer in the audio-tactile push-button assembly. The remaining cable cores from the audio-tactile driver unit shall be connected to the post top terminal rail. For electrical connections refer to the Drawing. ***Installation***

3. Where type 3 short push button posts are used for audio-tactile push-buttons the white and blue cores of the PPB post cable shall be connected directly into the audio-tactile driver unit in place of the white figure 8 flex. The standard core allocation shall be as follows:

   (a) Red — Pedestrian push-button active

   (b) Black — Pedestrian push-button return

   (c) White — Audio-tactile transducer

   (d) Blue — Audio-tactile transducer

   (e) Green/Yellow — Earth

   The supply cable and flexible conduit from the audio-tactile driver unit shall enter the post top terminal assembly and excess cable and conduit shall be removed prior to connection. The flexible conduit shall be clamped at the upper mounting bracket and cable tied to the post at 500 mm spacing along the post. The white and blue cores of the type 3 post cable shall be connected into the audio-tactile driver unit in place of the flex, via the terminations in the assigned pit for the type 3 post and via the post cable for the separate post with the relevant audio-tactile driver unit. The supply cable from the audio-tactile driver unit shall be connected to the Post Top Terminal Rail using the appropriate terminals. For electrical connections refer to the Drawings.

4. Where an audio-tactile push-button assembly is installed on a type 1 or type 2 post, the two-core audible signal cable (white figure 8 flex) shall be run down the inside of the post and connected directly to the transducer in the audio-tactile push-button assembly.

5. An Induce Voltage Suppressor (IVS) shall be installed on PSC Controllers where LED lanterns are used in conjunction with audio-tactile facilities. ***IVS***

## 712.79 EARTH CONNECTIONS

***Earth Wire***

1. The Earth wire from the 19 core cable shall be directly connected to the Upper Mounting Bracket Earth Stud.

2. A second Earth wire from the Upper Mounting Bracket Earth Stud shall be connected to the body of the post.

3. A third Earth wire from the Upper Mounting Bracket Earth Stud shall be connected to the Earth Terminal on the 19 core Post Top Terminal Rail.

***Pedestrian Push Buttons***

4. The Earth wires from all post-mounted electrical attachments such as lanterns, pedestrian push-buttons, audio-tactile driver units and flashing No Right Turn signs shall be connected into individual entries of the Earth Terminal on the 19 core Post Top Terminal Rail.

## 712.80 LANTERN CONNECTIONS

***Flexible Conduit***

1. The lantern cables shall be connected to the terminal strip fitted to the top of the post as shown on the cable chart. The cables have been pre-cut, fitted with lugs and installed in flexible conduit. The flexible conduit is to form a loop below the entry point into the lantern. The flexible conduit is clamped firmly in place by the cable clamp provided ensuring that 15 mm of the end of the conduit is covered by the finial cap. No part of any flexible, exposed conduit shall be less than 2.5 m above pavement level. When installing audio-tactile driver units, cable ties shall be used to tie the flexible conduits. The cable not enclosed by the flexible conduit is to be plaited and any excess cable shall be neatly pushed into the post.

## 712.81 COVERING OF LANTERNS

***Covers***

***AS 2930***

***AS 2700***

1. Immediately after the signal lanterns and those for Advanced Flashing Signals (AWFS) are installed, and until the signals are commissioned, the Contractor shall fit lantern covers on all lanterns, neatly attached and securely tied to ensure that they remain in position under all weather conditions. The entire AWFS sign shall be covered. The covers shall be made from a material complying with AS 2930 and shall be black colour in accordance with AS 2700.

***"Not in Use Signal" Sign***

2. "SIGNALS NOT IN USE" signs bolted on the primary and secondary post of each signal display, if left unattended. The signs shall be Main Roads sign number MR-TP-3 as detailed on Main Roads Standard Drawing 200331-090.

## 712.82 UPGRADES AND TRAFFIC SIGNAL IMPROVEMENTS AT EXISTING SIGNALISED INTERSECTIONS

***Modification and Improvement Works***

1. Any modification to existing traffic signals shall comply with the requirements of this specification and Main Roads' improvements program for signalised intersections. Details are available from Main Roads Asset Manager Traffic Systems – Electrical. This applies to Traffic Signal Controllers, UPS and finial caps.

**712.83 – 712.85 NOT USED**

## INSTALLATION OF CONTROLLER

### 712.86 CONTROLLER PREPARATION

1. Each of three sides of the Controller which most face that roadway shall be fitted with a standard controller decal, each with the site number and the free-call fault reporting phone number. ***Controller Decals***

2. A controller pit terminal assembly (Weidmuller part no. A2556/1) shall be installed in the vacant D rail position when required. A loom shall be made and installed to provide connections to this block and shall be fed from the relevant controller field terminals. The connections shall be made in accordance with the controller wiring chart. ***Pit System Controller Terminal***

3. A controller pit terminal assembly (Weidmuller part no. A2556/1) shall be installed in the vacant E rail position when required. A loom shall be made and installed to provide connections to this block and shall be fed from the relevant controller field terminals. The connections shall be made in accordance with the controller wiring chart. ***Star System Controller Terminal***

4. Extra earthing over and above the manufacturers earthing, shall be supplied as follows: ***Earthing***

   (a) Convert the common “Link” terminal for cable screens, on the Loop Feeder Board, into an Earth Terminal by wiring a 4 mm² Earth wire between the “Link” terminal and the chassis Earth Stud below the switchboard.

   (b) Install an MEN Link in 6 mm² Earth wire between the bottom terminal of the Neutral Link and the bottom terminal of the Earth link. (One end of this link must be left disconnected during workshop tests to prevent false tripping of the In House Safety Switch. The Contractor shall be responsible for reconnecting the MEN Link and removing the manufacturer’s “MEN link not fitted” tag from the Controller Switchboard panel.)

   (c) Rearrange (if necessary) the existing Earth wires in the Earth link to leave the second and third entries vacant. The second entry is for the Main Earth wire and the third entry for the Aerial (POA) Supply Post Earth wire.

5. The prepared controller, complete with all the necessary software and hardware shall be thoroughly tested prior to commissioning. All inputs, outputs, conflict matrix, time settings, detector functions and program operations shall be tested. ***Controller Test***

6. The prepared controller documentation shall be placed in the document pocket provided in the controller housing, inside a clear plastic document holder complete with clear plastic inserts and each page of the documentation visible through the insert (without taking it out of the insert). ***Controller Documentation***

7. An anti-graffiti coating shall be applied to the controller housing in accordance with Specification 908 ANTI-GRAFFITI. ***Anti-graffiti Coating***

## 712.87 CONTROLLER

### 712.87.01 GENERAL

1. Ground-mounted controllers shall be installed on the concrete footing. The Contractor shall make sure that the controller is mounted level so that the door sits square in the frame. The details of anchor bolts for the controller footing are shown on Main Roads Standard Drawings. ***Footing***

2. The consumer mains shall be brought directly into the controller base pit and sleeved with corrugated plastic conduit from the base entry to the cable support bar. The Main Earth shall be brought directly into the controller base pit and sleeved with corrugated plastic conduit from the base entry to the cable support bar. Install 1 x 25 mm conduit for Telstra or approved communication carrier and 1 x 50 mm white communications conduit for Fibre. All conduits shall pass through the controller concrete base and directly to a communications pit in the controller apron. The conduit shall include a draw wire from the communications pit to the communication access box in the side of the controller housing. All other cables shall pass through the double lid cable pit in front of the controller (minimum 8 x 50 mm conduits or equivalent). Two metres of neatly coiled slack for each cable shall be provided in the double lid pit. The cables shall then enter the controller base and run to the cable support bar. ***Cable Entries***

3. All cables shall be supported by the cable clamp bar using large cross-tied cable ties over the double insulation. The controller manufacturer's metal clamping arrangement shall not be used to clamp the cable, but may be used to form a support by releasing one of the anchoring points and swinging the bar down. The Ring Main, the Consumer Mains, the Post Cables and the Main Earth conduit shall be fixed to the controller cable clamp bar below the field terminal rails. The Loop Feeder Cables shall be fixed to the Loop Termination Panel Cable Clamp. ***Cable Clamping***

4. The Post cables shall have their respective post numbers indelibly marked on the sheathing immediately below the cable clamp bar. Loop Feeder cables shall have their respective loop numbers marked with Brady cable markers on the sheathing immediately below the cable clamp bar. ***Cable Labelling***

5. The consumer mains active shall be connected to the Mains Fuse. The consumer mains neutral shall be connected to the main neutral link behind the controller switchboard panel. The mains earth shall be connected to the earth link behind the controller switchboard panel. The MEN connection shall be in 6 mm² earth wire and shall be connected directly between the Earth link and the Neutral link behind the controller switchboard panel.

6. The orientation of the controller's base shall be such that the back of the controller when mounted is facing the intersection. ***Orientation of Controller Housing***

### 712.87.02 STAR SYSTEM SITE CONTROLLER

1. All 19 core cables shall be enclosed in the cable duct between terminal strips and shall be formed into separate looms. Each individual cable shall connect direct from the cable duct to the terminal block. The individual cores shall be neatly formed with a loop of sufficient length to make three re-terminations. All cores shall be tied and positioned such that access to the terminals is not obstructed and terminal designations are not obscured. ***Cable Connections***

Individual cores sized 2.5 mm² or less shall be fitted with bootlace crimps and cores 4 mm² and above may be terminated without lugs, but with cores twisted. All spare cores shall be wrapped in the appropriate branch of the loom and taken past the top of the terminal strip, insulated and firmly fixed to prevent movement. Each core shall be labelled with its own post number at the entry point to its designated terminal.

2. When a star system site includes a dummy controller it shall be connected by a minimum of 51 core cable to the controller. The standard branching for cable looms at the controller is as follows:

| Cable Cores | Branch Location |
|---|---|
| 01 to 12 | left of A Block |
| 13 to 24 | left of B Block |
| 25 to 36 | left of C Block |
| 37 to 48 | left of D Block |

Each core shall be labelled with its corresponding signal group at the dummy controller end at its designated terminal.

***Loop Feeder Cable***

3. The Loop Feeder cable screens shall be separated from their cables and suitably connected to the Earth Link on the Loop Termination Panel. The earth link shall be connected to main earth to comply with AS/NZS 3000. Each pair of Loop Feeder cores shall be twisted together for their entire length then formed in a cable tied loom with the others. Each twisted pair shall be numbered according to its loop number immediately before the termination point using Brady or Cabac cable markers on each core. Sufficient slack shall be left at the termination point to allow for three re-terminations with bootlace crimps used.

4. The combined loop and feeder insulation resistance at the Controller has to be greater than 100M Ohm measures at a 1000V setting.

712.87.03 PIT SYSTEM SITE CONTROLLER

1. The ring main cables shall be located in between terminal strips and shall be formed into separate looms. The “in” cable using white spiral-wrap and the “out” cable using black spiral-wrap. The individual cores shall be neatly formed with a loop of sufficient length to make three re-terminations. All cores shall be tied and positioned such that access to the terminals is not obstructed and terminal designations are not obscured. Individual cores sized 2.5 mm² or less shall be fitted with bootlace crimps and cores 4 mm² and above may be terminated without lugs, but with cores twisted. All spare cores shall be wrapped in the appropriate branch of the loom and taken past the top of the terminal strip, insulated and firmly fixed to prevent movement.

2. The standard branching for ring main cable looms at the Controller is as follows:

| Cable Cores | Branch Location |
|---|---|
| 01 to 12 | left of A Block |
| 13 to 24 | left of B Block |
| 25 to 36 | left of C Block |

37 to 48 left of D Block

3. The post cable connections in the controller shall be located between the C block and the Pit System terminal strip. The cable cores shall be loomed in black spiral-wrap and shall be run between the terminal strip and the C block. The cable cores shall be connected to the Pit System terminal strip located in the vacant "D" terminal position and shall be connected to terminals specified in the cable chart. Each core shall be labelled with its own post number at the entry point to its designated terminal. ***Post Cable***

4. The Loop Feeder cable screens shall be separated from their cables and suitably connected to the Earth Link on the Loop Termination Panel. Each pair of Loop Feeder cores shall be twisted together for their entire length then formed in a cable tied loom with the others. Each twisted pair shall be numbered according to its loop number immediately before the termination point using Brady or cable markers on each core. Sufficient slack shall be left at the termination point to allow for three re-terminations with bootlace crimps used. ***Loop Feeder Cable***

## 712.88 TEMPORARY SIGNAGE

1. Removal timeframe shall be consulted with the project team.

2. "Modified Intersection Ahead" sign (MR-TAW-7) detailed in Main Roads Standard Drawing 8720-107 shall be installed ahead of the modified intersection as per standards in consultation with the design, where clarified with project brief. ***"Modified Intersection Ahead" Sign***

3. "Traffic Signal Work in Progress" sign shall be attached to the Primary Traffic Signal Posts when work is being conducted on the Traffic Signals. The signs shall be Main Roads sign number MR-TP-2 as detailed in Main Roads Standard Drawing 8420-0555. ***"Traffic Signal Work in Progress" Sign***

4. "Caution Signals Modified" sign to be bolted to the primary signal post for 4 to 8 weeks after works which modify the traffic signals are completed. The signs shall be Main Roads sign number mr-tp-4 as detailed on Main Roads Standard Drawing 200331-0086. ***"Caution Signals Modified" Sign***

## 712.89 – 712.90 NOT USED

# INSTALLATION TESTING REQUIREMENTS UNDER NEW AND IMPROVEMENT WORKS AT SIGNALISED INTERSECTIONS

## 712.91 PRACTICAL COMPLETION

**1. The Contractor shall submit notice of their intention of practical completion for testing and commissioning a minimum of 3 working days prior to commissioning date.** ***HOLD POINT***

**The notice shall be sent to the Maintenance Manager, Electrical Maintenance Handover team (electhandover@mainroads.wa.gov.au), Main Roads Customer Information Centre (enquiries@mainroads.wa.gov.au) and Main Roads Project Manager.**

712.91.01 GENERAL

1. All works carried out at signalised intersections whether new or improvement works, shall be inspected and tested to the minimum requirements specified under clause 712.91.

712.91.02 CONTRACTOR'S TESTS TO ACHIEVE PRACTICAL COMPLETION

1. The Contractor shall carry out all such inspections and electrical tests as are necessary to ensure that the installation complies fully with the requirements of the Contract, Western Australian Electrical requirements and AS/NZS 3000. The results from all inspections and tests shall be forwarded to Main Roads Project Manager and Main Roads Lead Point of Delegate. The Contractor shall carry out the following inspections and tests, producing documentary evidence of the test results: ***Insulation Check***

   (a) Check that all hardware is positioned according to the Drawings;

   (b) Measure and record the mains voltage at the controller main switch;

   (c) Measure and record at the controller the insulation resistance of each loop (whilst disconnected from the logic module);

   (d) Measure and record at the controller the inductance of each loop;

   (e) Check operation of all pedestrian push-buttons from the controller, check that the orientation of the pedestrian push-button arrows is correct;

   (f) Check that all lantern aiming complies with all applicable drawings;

   (g) Check that all signals visors, louvres, arrow masks and other symbolic masks comply with the Drawing;

   (h) Check that all signal displays operate according to the Drawing during maintenance mode flash testing;

   (i) Check that the controller and associated circuitry operates according to the specified controller documentation;

   (j) Check that all signal displays and other facilities operate correctly;

   (k) Check that all vehicle detectors and pedestrian push buttons function according to the Drawing;

   (l) Annexures "A" and "B" to be completed and signed off for all construction stages;

   (m) As far as practicable ensure that the site has been left in a clean and tidy condition.

2. In accordance with AS/NZS 3000 Section 8, the following mandatory tests shall be made, documented and made available to Main Roads upon handover:

(a) Continuity of the earthing system (earth resistance). Each traffic signal post shall be measured, from the earth connection at the MEN to the bare metal of each post;

(b) Insulation resistance between all live conductors and earth;

(c) Polarity;

(d) Correct circuit connections;

(e) Verification of earth fault–loop impedance;

(f) Correct operation of RCDs.

3. All control circuits and devices shall be functionally checked to verify correct operation.

4. Any part of the installation found to be non-conforming shall be replaced with new materials and/or components or corrected to the satisfaction of the Main Roads Lead Point of Delegate and Main Roads Project Manager, and the faulty cable sections replaced and re-tested to confirm that acceptable insulation resistance values have been attained.

5. Prior to the Power Supply Authority's approval of the installation and connection to the supply mains, the Contractor shall have completed all tests to the Main Roads Lead Point of Delegate satisfaction.

6. ***HOLD POINT***
**On completion of the Contractors' own testing and inspection and rectification of any deficiencies found, the Contractor shall inform the Main Roads Lead Point of Delegate that the supply has been connected and that the installation is ready for tests on practical completion as nominated by the Main Roads Electrical representative and submit all documents to Main Roads Project Manager.**

712.91.03 INSPECTION AND TESTS ON FINAL COMPLETION

1. The Contractor shall give at least 3 working days' notice that the site is ready for final inspection and shall be present during the inspection. Any change can be agreed upon in consultation with the Superintendent.

2. ***Superintendent's Inspection***
Upon receipt of Annexure 712C Commissioning Checklist from the Contractor the Main Roads Lead Point of Delegate will carry out an inspection of the final installation. The inspection will include the following:

(a) The layout of signal hardware is in accordance with the Design and Standard Drawings;

(b) The operation of circuitry in the manner prescribed;

(c) Verification of correct operation of all signal displays, push-buttons, detectors and other facilities;

(d) Alignment and aiming of lanterns;

(e) All signage exist on site and aligns with the LMB drawing;

(f) All line markings have been completed and align with the LMB drawing;

(g) All As-constructed Drawings and Inventory are completed and available on site;

(h) Any other inspection as identified by the Main Roads Lead Point of Delegate or Main Roads Project Manager.

712.91.04 ASSET HANDOVER CHECKLIST

(a) Backfilling and reinstatement of excavated areas;

(b) Concreting;

(c) Site cleanliness;

(d) Lay out signal hardware is in accordance with the design and standard drawings;

(e) Check all signage has been completed and align with the onsite Drawings;

(f) Any other inspection as identified by the Superintendent or Main Roads Lead Point of Delegate or Main Roads Project Manager.

712.91.05 TRAFFIC SIGNAL SITE INVENTORY

1. The Contractor shall make a complete inventory of all site equipment at the conclusion of works in order to record any change to the type or quantity of equipment installed. A copy of the approved inventory sheet shall be left on site in the controller cabinet when the site is commissioned. The original document shall be forwarded to the Main Roads Lead Point of Delegate within seven days of commissioning.

712.91.06 STAGED WORKS DURING TRAFFIC SIGNAL UPGRADES

1. It is a requirement prior to commencing any traffic signal upgrades for the electrical contractor to contact Traffic Systems Staff at Main Roads' Traffic Operations Centre to advise when work will be commencing on site and the duration of Works.

2. All staged works forming part of an upgrade to traffic signals will require the following:

   (a) The electrical contractor must provide a Traffic Management Plan with associated drawings indicating all stages of the Works; these plans must be endorsed by a Roadworks Traffic Manager as per the requirements of Traffic Management for Works on Roads – Code of Practice.

   (b) The approved plans shall be forwarded to the Local Government Authority for their records and a copy of the plans shall be forwarded to Main Roads three weeks prior to the Works commencing.

   (c) At the completion of all works on commissioned traffic signals the electrical contractor is required to complete a controller log book entry

indicating the activities completed and the conformance to the relevant Traffic Management Plan at the end of each day's work.

712.91.07 RECORDS

1. A copy of the installation records, inventory and the As Constructed Drawings prepared shall be placed in the controller housing.

**712.92 – 712.93 NOT USED**

## AS BUILT AND HANDOVER REQUIREMENTS

**712.94 – 712.96 NOT USED**

## CONTRACT SPECIFIC REQUIREMENTS

**712.97 – 712.99 NOT USED**

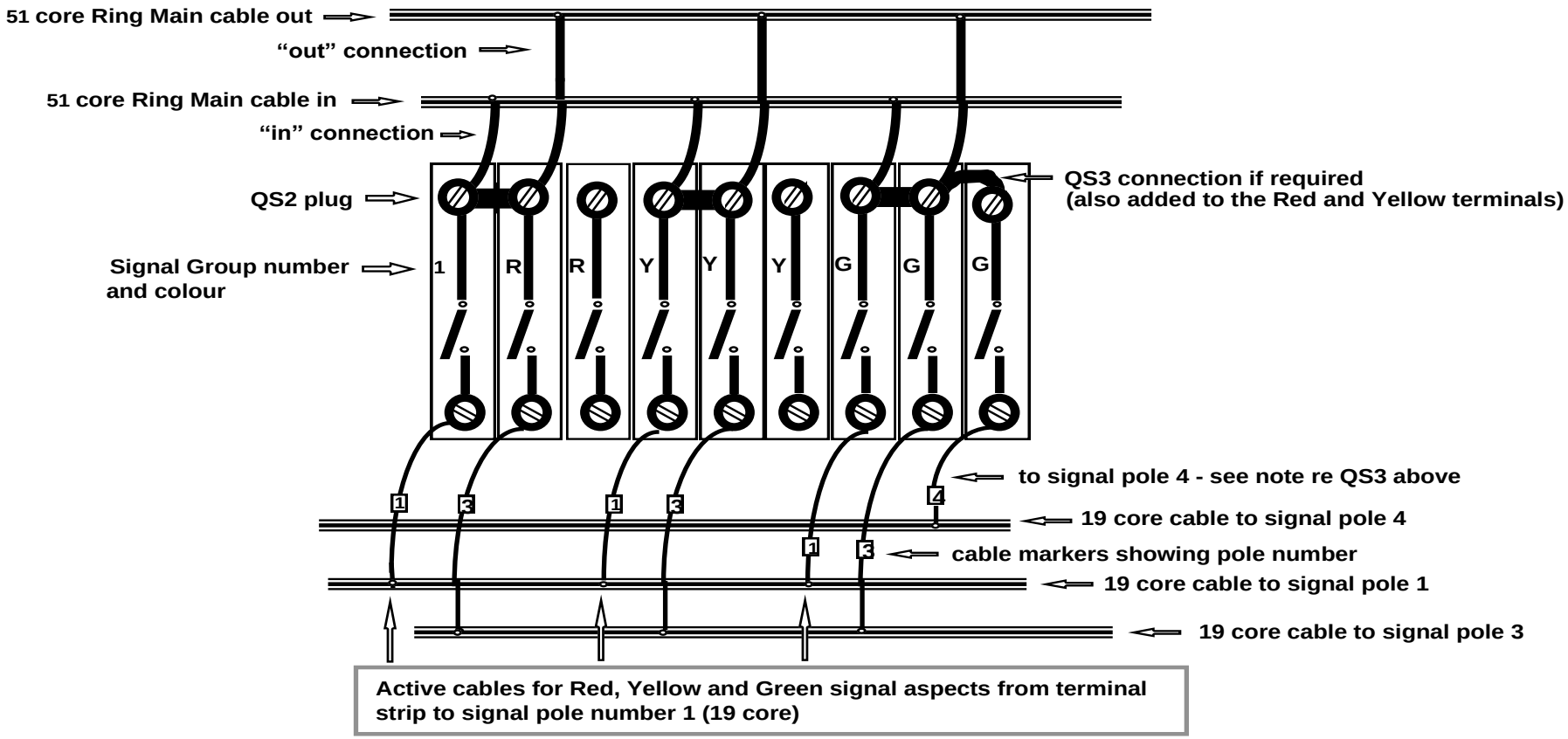
# ANNEXURE 712A

## PHASE PERIODS

| Period | Minimum Timing Range (Sec) | Increment (Sec) |
|---|---|---|
| Minimum Green | 0-20 | 1.0 |
| Maximum Green | 0-150 | 5.0 |
| Yellow | 3-6 | 0.5 |
| All Red | 0-15 | 0.5 |
| Gap (each approach) | 0-10 | 0.5 |
| Timer, Red Arrow Termination | 0-5 | 1.0 |
| Variable Initial Green (VIG) Increment | 0-5 | 0.2 |
| Maximum VIG | 0-40 | 1.0 |
| Pedestrian Clearance | 0-50 | 1.0 |
| Pedestrian Walk | 0-40 | 1.0 |
| Presence Delay Time | 0-5 | 0.5 |
| Late Start | 0-20 | 1.0 |
| Early Cut Off Green | 0-20 | 1.0 |
| Start Up Flashing Yellow | 0-15 | 1.0 |
| Start Up All Red | 5-15 | 1.0 |

# ANNEXURE 712B

## TYPICAL CORE ARRANGEMENT – 51 CORE TERMINATION BOX



# ANNEXURE 712C

## TRAFFIC SIGNALS COMMISSIONING CHECKLIST

Refer to TRIM document D16#298592

mainroads WESTERN AUSTRALIA

*Traffic Signals Commissioning Checklist*

*ES-PD-FM-6001-910*

LM: ..... Location: .....

Job Number:..... Date: .....

| NO. | OBSERVATION DESCRIPTION | Test Result | | |
|---|---|---|---|---|
| | | Pass | F/U | N/A |
| **1.0 Signs and Road Marking** | | | | |
| 1.1 | Signs & lines are in good condition (use this item for major repairs, eg. Controller replacement and multiple pole accident repairs). | | | |
| 1.2 | Signs & lines as per drawing (use this item for major upgrades & new sites) **Do not commission site if these are not in place or temporary ones not installed – do a thorough walk around.** | | | |
| 1.3 | Signal/Pedestrian Modified signs installed (upgrades only). | | | |
| **2.0 Electrical Safety** | | | | |
| 2.1 | Ensure MEN link is connected at main switchboard ( Controller or UPS) | | | |
| 2.2 | Where an UPS is fitted, as the Main Board an Alternate Earth wire must be readily available, with earth wire and MEN link marked within Controller in case UPS gets hit and has to be removed making the Controller the main board. | | | |
| 2.3 | Ensure hot/cold Fault loop readings comply prior to any comissioning | | | |
| 2.4 | Main Earth tag must be fitted to Main Earthing Conductor within the Controller | | | |
| 2.5 | Main Earthing Conductor in Main Earth Pit must have tag and connection painted with conductive paint at connection of earth rod and clamp | | | |
| 2.6 | Where UPS is installed all labels must be fitted within transfer pit | | | |
| 2.7 | Western Power Completion Notices signed by Electrician and Nominee after these works are complete | | | |
| 2.8 | A copy of Manditory test results available for review on site | | | |
| **3.0 Lanterns** | | | | |
| 3.1 | Confirm Lantern & Target Board numbers | | | |
| 3.2 | Lantern flash test (correct Signal Group for approach as per drawing 4) | | | |
| S.G | 1 / 2 / 3 / 4 | | | |
| | 5 / 6 / 7 / 8 | | | |
| | 9 / 10 / 11 / 12 | | | |
| | 13 / 14 / 15 / 16 | | | |
| 3.3 | Pedestrian lanterns (correct Signal Group. for approach). | | | |
| 3.4 | AWFS operation eg. Correct Signal Group & flashing sequence for approach (if installed). | | | |
| 3.5 | Vehicle lantern alignment (check that there are no obstructions from100m) | | | |
| 3.6 | Pedestrian lantern alignment (check for dual use lanterns). | | | |
| 3.7 | NRT operation checking correct Signal Group for approach (if installed). | | | |
| 3.8 | Wattage's reset and Fault log cleared. | | | |
| **4.0 Detection and External Inputs** | | | | |
| 4.1 | Detector Remap, set up & operation – confirm AGD's are functional (if fitted.) | | | |
| 4.2 | Railway priority operation including early & late call (if installed). | | | |
| 4.3 | Fire station priority operation (if installed). | | | |
| 4.4 | PPB Operation (including audible sounding correctly for Red/Green man). | | | |
| **5.0 Communication** | | | | |
| 5.1 | Communications Established. (PSTN,ADSL,3G Modem) | | | |
| 5.2 | SCATS connection confirmed with TOC. | | | |

**Issue Date:** 18/04/16 **Parent: This Document** **Owner:** Senior Supervisor - Construction

**Version No:** 1.1 UNCONTROLLED WHEN PRINTED **Page No** 1 of 2

mainroads WESTERN AUSTRALIA

*Traffic Signals Commissioning Checklist*

*ES-PD-FM-6001-910*

| NO. | OBSERVATION DESCRIPTION | Test Result | | |
|---|---|---|---|---|
| | | Pass | F/U | N/A |
| **6.0 Other Required Tasks** | | | | |
| 6.1 | Controller, Pole No's & PPB stickers correct. | | | |
| 6.2 | Punch list compiled (only necessary for major upgrades and new sites). | | | |
| 6.3 | Ensure pram ramps and tactiles have been completed, or temporary ones installed as a short term measure. | | | |

**Notes**

1 'Pass' result = specification met , F/U = follow up action required. Note details in space provided.

2 If any Programming changes refer sign form to the System Specialist prior to commisioning approval

**Follow Up**

| No. | Action Required | Repaired |
|---|---|---|
| | | |
| | | |
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**Comments**

**Electrical Foreman**

SIGNATURE | PRINT NAME | DATE

ORGANISATION

**MRWA Asset Delegate**

SIGNATURE | PRINT NAME | DATE

ORGANISATION

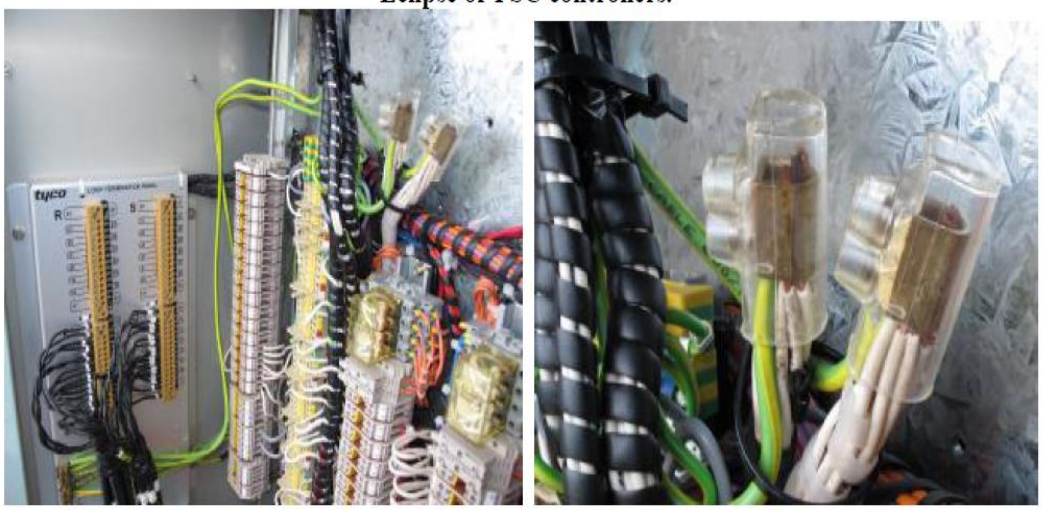
| | | | | | |
|---|---|---|---|---|---|
| **Issue Date:** | 18/04/16 | **Parent: This Document** | | **Owner:** | Senior Supervisor - Construction |
| **Version No:** | 1.1 | UNCONTROLLED WHEN PRINTED | | **Page No** | 2 of 2 |

# ANNEXURE 712D

## EARTHING OF CONTROLLER'S INTERNAL WIRING

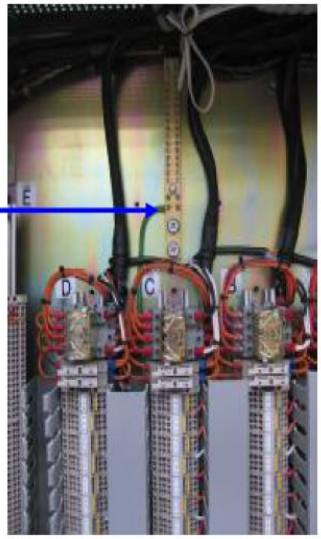
As illustrated below all the spare cables in ring main and pit systems must be connected to the earth bar to ensure that the induced voltages are "drained" to ground.

**All spares connected to earth bar on Loop Termination Panel Eclipse or PSC controllers.**



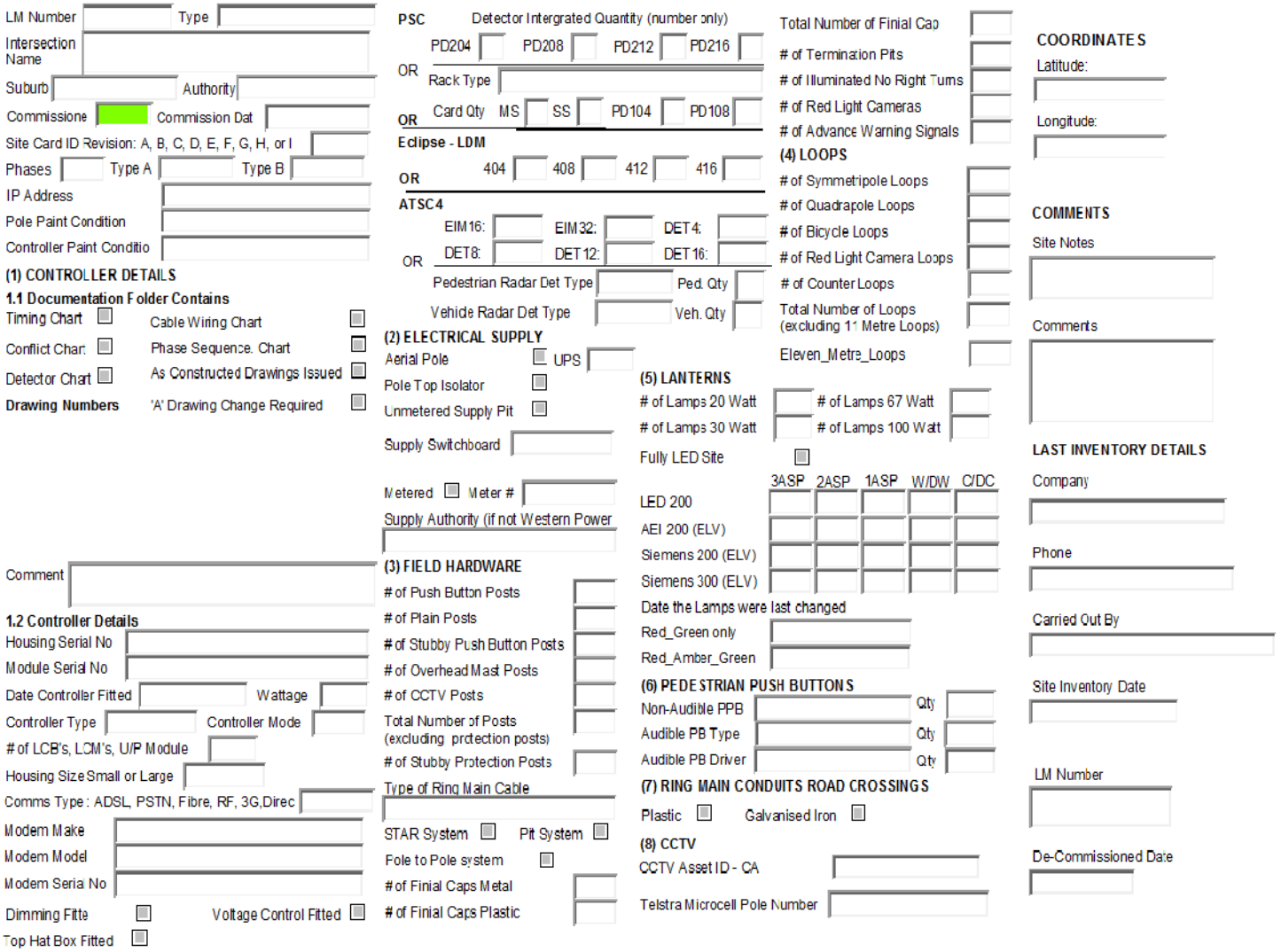
**ATSC4 controller**

**All spare cables in ring main or pit system to be connected to the earth bar.**



# ANNEXURE 712E

## ASSET INVENTORY FORM



# GUIDANCE NOTES

FOR REFERENCE ONLY – DELETE GUIDANCE NOTES FROM FINAL DOCUMENT

1. All edits to this specification are to be made using track changes, to clearly show added/ deleted text.

2. If **all** information relating to a clause is deleted, the clause number should be retained and the words **"NOT USED"** should be inserted.

3. The proposed document with tracked changes must be submitted to the Project Manager for review, prior to finalising the document.

4. Once the Project Manager's review is complete, accept all changes in the document, turn off track changes and refresh the Table of Contents.

5. The Custodian of this specification is the Electrical Engineer.

---

1. SCOPE

   1.1 This specification primarily covers the requirements for **new** Traffic Signal Software.

   1.2 Where **modifications** to existing Traffic Signals are proposed, then the scope (Clause 712.01) will need careful editing to clearly outline the extent of the Works.

2. TRAFFIC SIGNAL CONTRACTS

   2.1 Where this specification is used in a contract that is solely or predominantly for the installation of traffic signals, inclusion of and cross-referencing to other relevant specifications is likely to be required, such as:

   Specification 100 GENERAL REQUIREMENTS

   Specification 302 EARTHWORKS

   Specification 901 CONCRETE – GENERAL WORKS

   Specification 908 ANTI-GRAFFITI

# CONTRACT SPECIFIC REQUIREMENTS

The following clauses are to be placed under the CONTRACT SPECIFIC REQUIREMENTS, as required. After inserting the clause, change the clause number and heading to style “H2 SP” so it appears in the Table of Contents.

**XXX.XX SUB HEADING (H2 SP)**

1. Insert text (Main Table SP) ***XXXX***

2. Insert text (Main Table SP)

**XXX.XX SUB HEADING (H2 SP)**

1. Insert text (Main Table SP)

2. Insert text (Main Table SP)

# AMENDMENT CHECKLIST

Specification No. **712** Title: **TRAFFIC SIGNALS** Revision No: _____

Project Manager: _____ Signature: _____ Date: _____

Checked by: _____ Signature: _____ Date: _____

Contract No: _____ Contract Name: _____

| ITEM | DESCRIPTION | SIGN OFF |
|---|---|---|
| *Note: All changes/amendments must be shown in tracked changes until approved.* | | |
| 1. | Project Manager has reviewed the Specification and identified additions and amendments. | |
| 2. | Standard clauses amended? **MUST SEEK** approval from Manager Contracts and Commercial Management. | |
| 3. | Any unlisted materials/products proposed and approved by the Project Manager? If "Yes" provide details at 16. | |
| 4. | Deleted clauses shown as **"NOT USED"**. | |
| 5. | Ensure appropriate **INSPECTION AND TESTING** parameters are included in Specification 201 (test methods, minimum testing frequencies verified). | |
| 6. | **AS-BUILT AND HANDOVER** requirements addressed. | |
| 7. | **CONTRACT SPECIFIC REQUIREMENTS** addressed? Contract specific materials, products, clauses added? (refer Specification Guidance Notes). | |
| 8. | **ANNEXURES** completed (refer Specification Guidance Notes). | |
| 9. | Estimates Manager has approved changes to **SMM**. | |
| 10. | Project Manager certifies completed Specification reflects intent of the design. | |
| 11. | Independent verification of completed Specification arranged by Project Manager. | |
| 12. | Project Manager's review completed. | |
| 13. | **SPECIFICATION GUIDANCE NOTES** deleted. | |
| 14. | **TABLE OF CONTENTS** updated. | |
| 15. | **FOOTER** updated with Document No., Contract No. and Contract Name. | |
| 16. | Supporting information prepared and submitted to Project Manager. | |
| Additional information or further action: | | |

Signed: _____ *(Project Manager)* Date: _____