**Tauranga Transport Operations Centre**

**Document History and Status**

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Every attempt was made to ensure that the information in these documents was correct at the time of publication. Any errors should be reported as soon as possible so that corrections can be issued. Comments and suggestions for future editions are welcome and periodical reviews are undertaken on a regular basis. Users of these documents must ascertain themselves that they obtain the latest versions as valid references.

**Table of Contents**

[1. **Introduction** 4](#_Toc489608487)

[1.1 Purpose 4](#_Toc489608488)

[1.2 Who Should Use This Document? 4](#_Toc489608489)

[2. **Glossary** 5](#_Toc489608490)

[3. **Technical Criteria** 7](#_Toc489608491)

[4. **Signal Design Documentation** 8](#_Toc489608492)

[4.1 Traffic Signal Feasibility Report 8](#_Toc489608493)

[4.1.1 Modelling 9](#_Toc489608494)

[4.1.2 Traffic Signals controlling a Roundabout 9](#_Toc489608495)

[4.2 Traffic Signal Detailed Design 10](#_Toc489608496)

[4.3 Cover Sheet and Site Location Plan 11](#_Toc489608497)

[4.4 Existing Survey and Services 11](#_Toc489608498)

[4.5 Proposed Construction and Set Out 11](#_Toc489608499)

[4.6 Proposed Signal and Phasing Layout 11](#_Toc489608500)

[4.7 Proposed Ducting and Cabling Diagram 12](#_Toc489608501)

[4.7.1 Tactile Pavers and Pedestrian Details 12](#_Toc489608502)

[4.8 Controller Information Sheet 13](#_Toc489608503)

[4.9 Proposed Road Marking and Signage 13](#_Toc489608504)

[4.10 Vehicle Tracking Plan 13](#_Toc489608505)

[4.11 Standard Details 14](#_Toc489608506)

[4.12 Traffic Signal Equipment 14](#_Toc489608507)

[4.12.1 Controller 14](#_Toc489608508)

[4.12.2 Traffic Signal Post Locations 14](#_Toc489608509)

[4.12.3 Use of Overhead Signal Faces (Mast Arms) 15](#_Toc489608510)

[4.12.4 Signal Display Location 15](#_Toc489608511)

[4.13 Chamber Locations and Ducts 17](#_Toc489608512)

[4.14 Detectors 17](#_Toc489608513)

[4.14.1 Vehicle Detectors 18](#_Toc489608514)

[4.15 Detector Card Configurations for AS 2578 VC5/6 Compliant Controllers 18](#_Toc489608515)

[4.15.1 Pedestrian Detectors 18](#_Toc489608516)

[4.16 Pole Numbering 19](#_Toc489608517)

[4.17 Signal Groups 19](#_Toc489608518)

[4.18 Phasing 19](#_Toc489608519)

[4.18.1 Midblock Pedestrian Crossing 20](#_Toc489608520)

[4.18.2 Staggered Pedestrian Crossing 21](#_Toc489608521)

[4.18.3 T-Intersections 21](#_Toc489608522)

[4.18.4 Split Side Road Phases 22](#_Toc489608523)

[4.18.5 Single Diamond Overlap with Split Side Road Phases 24](#_Toc489608524)

[4.18.6 Single Diamond Overlap with Combined Side Road Phase 26](#_Toc489608525)

[4.18.7 Double Diamond Overlap 27](#_Toc489608526)

[4.18.8 Filtering Right Turn Movements 30](#_Toc489608527)

[4.18.9 Repeat Right Turn Phases 30](#_Toc489608528)

[4.18.10 Pedestrian Control 31](#_Toc489608529)

[4.18.11 Cyclists 31](#_Toc489608530)

# Introduction

The Tauranga Transport Operations Centre (TTOC) is responsible for all traffic signals operations in the Bay of Plenty region from installation through to maintenance.

This document is designed to assist all interested parties to understand the TTOC functions and the standards that have been adopted to ensure a consistent approach is maintained when designing and installing traffic signals and associated equipment.

## Purpose

The purpose of this document is to give an understanding of the TTOC requirements when undertaking the design, installation or maintenance of traffic signal installations in the TTOC regions.

## Who Should Use This Document?

All consultants, contractors, should use this document and project managers (we refer to as “**applicant”** in this document) involved in the design, installation and maintenance of traffic signals on behalf of Road Controlling Authorities (RCA) in the Bay of Plenty. Where for example an upgrade is being carried out by an RCA the applicant shall be the assigned. This would in most situations be the traffic signal contractor who would have most technical experience in providing the relevant information required.

TTOC has prepared this document to assist practitioners when designing traffic signal installations. Although this document has technical and specialist content, the applicant must read in conjunction with this document, TTOC-01 Requirements for Traffic Signal Works. TTOC-01 contains details on document management, flow charts and describes processes. The intent is to show what is expected in the application. The applicants should also refer to TTOC-00 Standard Traffic Signal Documents and Appendices.

This guideline has been created to ensure that the designs of all intersections are to the highest standard, with variations being the exception rather than the norm. It is important that the information submitted as part of new or modified traffic signal layouts are standardised as much as possible. This will enable any further changes that may result from changing traffic conditions to be implemented quickly and simply.

This document lists the information that must be shown on the drawing for the traffic signal layout plan. The guideline information covers all the basic data required for a contractor to install the traffic signal equipment. The information will assist the TTOC to review the Controller Information Sheets (CIS) and the Controller personality as well as allow the TTOC to set up the intersection on the SCATS network and provide good operational performance.

This document covers in some detail requirements that must be included in other plans. For example, requirements pertaining to any physical works such as; existing survey and services, proposed construction or road marking. These are essential to provide as complete a picture as possible. The applicant’s project team members are expected to have the experience and knowledge required to provide the relevant details, particularly the production of software and, CIS and traffic signal design. TTOC are not responsible for providing training or resources for designers who are new to the industry as there are suitable courses and consultants who can provide training.

# Glossary

|  |  |
| --- | --- |
| **AS / NZ** | Australian Standard / New Zealand Standard |
| Active Traffic Management System (**ATMS**) | Technology that provides information to road users by means of Variable Message Signage. |
| **Controller** | The equipment (including the housing) that switches power to signal lanterns and controls the duration and sequence of signal displays as defined by the controller personality. |
| Controller Information Sheets (**CIS**) | A hard copy of the information used to make a Controller Personality that is contained within the PROM. |
| Controller Personality | The unique program stored in the PROM, which configures the controller to the specific operational design of the intersection. |
| **CCTV** | Closed Circuit Television. |
| **DP** Number | Data Private Number (Prefix assigned to phone line number) |
| **FSL** | From Stop Line, measurement used for distance from start of detector loop. |
| **IDC** | Infrastructure Development Code |
| **ICP** Number | Installation Connection Point Number (for electricity power meter). |
| Intelligent Transport Systems (**ITS**) | Refers to various systems like SCATS, CCTV, VMS and ATMS systems that provide and add [information and communications technology](http://en.wikipedia.org/wiki/Information_and_communications_technology) to [transport](http://en.wikipedia.org/wiki/Transport) [infrastructure](http://en.wikipedia.org/wiki/Infrastructure). |
| **JUMA, JUSP** | Joint Use Mast Arm, Joint Use Service Pole |
| **KJB** | Kerbside Junction Box to access services, for example, detector loop feeders. |
| **NIA** | New Installation Acceptance. |
| **NZTA** | New Zealand Transport Agency. |
| **NGEN** | Software product developed by RMS to produce .SFT and .M68 files. |
| **PCMCIA** Card | A computer card containing the controller personality information housed in the TSC / AS 2578 compliant controller. |
| **PROM** | A computer chip containing the controller personality information housed in the TSC3 compliant controller. In this document PROM refers to either a PROM, a PCMCIA card or similar software storage device. |
| Road Asset and Maintenance Management (**RAMM**) | An Internet accessible system that stores the Traffic Signal assets. RAMM also records the activity of the Maintenance Contractors by the logging of faults as Dispatches and their completion by the Contractors. Contractors’ claims are generated from the RAMM system each month end. |
| **RCA** | Road Controlling Authority. |
| Roads and Marine Services (**RMS**) of New South Wales (**NSW**) | The Authority accepted by Council as the basis for the TTOC standards and for product approval. RMS also develop and own SCATS traffic signal software and other products related to SCATS and their output files. |
| **SAT** | Site Acceptance Test, commissioning checklist. |
| **.SFT / .M68** | File formats for traffic signal software (TRAFF) |
| Sydney Coordinated Adaptive Traffic System (**SCATS**) | A fully adaptive area wide control system for traffic signals that is linked to the traffic signal controllers running TRAFF software via telecommunication lines. |
| **TRAFF** | Traffic signal “base” software inside traffic controllers on site running the signals. |
| **TCC** | Tauranga City Council |
| Tauranga Transport Operations Centre (**TTOC**) | Organisation tasked with managing the traffic signals and the ITS systems for local roads and State Highways Bay of Plenty by monitoring SCATS and CCTV. |
| Vehicle Activated Sign (**VAS**) | VAS is a generic term for a type of road [traffic sign](http://en.wikipedia.org/wiki/Traffic_sign) that displays a message conditional upon the presence or speed of a [road vehicle](http://en.wikipedia.org/wiki/Category:Road_vehicles). |
| Variable Message Sign (**VMS**) | An electronic traffic sign often used to display a message or picture. The sign display is changeable and dynamic. |
| **Win Traff** | A software programme used to check the controller information by testing the software of the controller personality. |

# Technical Criteria

The design of the traffic signals must be carried out in accordance with the standards and guidelines listed below and their revised / subsequent replacements:

* TTOC-00 Standard Traffic Signal Documents and Appendices.
* TTOC-01 Requirements for Traffic Signal Works.
* TTOC-02 Traffic Signals Design Guidelines.
* TTOC-03 Regional Special Conditions to the National Specifications.
* TTOC-04 National Traffic Signal Specification.
* AUSTROADS Traffic Management Guides.
* Road Traffic Standards (RTS) 14.
* NZTA Pedestrian Planning and Design Guidelines.
* Other NZTA, TCC, RMS, AS / NZ standards as agreed from time to time.

The specification of traffic signals equipment shall comply with the current version of the TTOC Regional Special Conditions to the National Specifications (TTOC-03) or a written agreement with the TTOC for the use of specific components shall be obtained.

The contractor is responsible for ensuring that all equipment that is installed meets the minimum standards. If there is any doubt the contractor shall be required to provide evidence that the product meets the TTOC requirements.

## Reference Material

The traffic signal is very specialist and partially in New Zealand where resources and training is minimal. There we have provided some recommended documents listed below to assist in the processes required.

* NSW Roads & Maritime Services, Traffic Modelling Guidelines.
* NSW Roads & Maritime Services, Traffic Signal Design.
* Australian Road Research Board (ARRB), Traffic Signals: Capacity and Timing Analysis.
* Signals National User Group (SNUG)

## Detectors

All loop positions are to be determined early in the design.

All controlled lanes must have detector loops installed including for example left turn lanes under Give Way control to count vehicles only, if there are sufficient detector inputs available.

Advance loops may be required in some instances to optimise signal operation and enhance safety in high speed environments. If controller capacity allows, detector loops are to be included in uncontrolled slip lanes for traffic counting purposes. Loops on bridge decks or approach slabs should be avoided where practical. Refer TTOC – 09.

Where there are a high number of cyclists’ the type and style of loops shall be clearly shown. Cycle lane design requires special attention and these shall be considered on a site by site basis.

Special care is required to ensure that the placement of the loop is in the correct position within the lane. Failure to confirm positions prior to sealing can mean that another loop may be required to be saw cut into the new seal. All loop locations to be accurately located and included on as-built drawings.

The ideal or preferred methodology of installing loops is to place them under the bedding of the pavement prior to sealing in order to avoid repeatedly cutting in a short period of time.

Consult with the TTOC for details on installation methods.

The requirements for the detector numbering convention are detailed in 4.14.1. If the controller cabinet is relocated then the site must be renumbered to comply with the standard convention.

Configure virtual red light running loops in the CIS when there is spare capacity to allow, consult with TTOC as required.

### Vehicle Detectors

Detectors are numbered anticlockwise from the controller assuming that a line is drawn from the controller through the centroid of the intersection.

The first circuit is the stop line loops, departure loops and counting loops are numbered first, with the departure loop being numbered after the stop line loop it is associated with.

The second circuit is the dynamic loops, followed by the advance dynamic loops.

The reason detectors are numbered anticlockwise is so that an approach will read numerically correct left to right when viewed on a SCATS System Monitor display.

Where there is a secondary part to the signals such as at interchanges, the first circuit is around the part of the intersection closest to the controller, then around the second part of the intersection. Then back to the first part of the intersection for the second circuit. A line is drawn from the controller through the centroid of the second part of the intersection to give the starting point for each numbering circuit.

If a controller is relocated then the site must be renumbered to comply with the standard

### Detector Card Configurations for AS 2578 VC5/6 Compliant Controllers

When the new AS 2578 and VC5/6 compliant controllers were first introduced each Detector card had 16 Internal Detectors (Vehicles) and 16 External Detectors (Pedestrian). Since then the manufacturers have provided some flexibility to allow combinations to be used. It is important for the designer to understand and number the loops and pedestrian call detectors in the appropriate manner as this impacts directly on the preparation of the software. Furthermore, VC6 controllers have extended the capacity therefore check with the manufacturer on these specifications.

### Pedestrian Detectors

Pedestrian detectors are numbered depending upon the card in use. First ascertain the number of detectors available at the controller if it is an existing site or determine the requirement if new. TSC3 Controller Detector cards come in groups of four ranging between 4 and 32.

The AS 2578 Compliant controllers come with a 16, 24 or 32 input Detector card. This consists of vehicle inputs and external inputs. Again, this will depend on the type of controller and the configuration applied.

The pedestrian detectors are numbered from the highest number down as follows and may include more than four pedestrian facilities:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **PEDESTRIAN / WALK NUMBER** | **1 PED** | **2 PEDS** | **3 PEDS** | **4 PEDS** | **5 PEDS** |
| W1 | 16 | 16 | 16 | 16 | 16 |
| W2 |  | 15 | 15 | 15 | 15 |
| W3 |  |  | 14 | 14 | 14 |
| W4 |  |  |  | 13 | 13 |
| W5 |  |  |  |  | 12 |

Table 1: Pedestrian Detector Slot Numbering (16 Detector)

A similar configuration will apply across the top end for 24 and 32 detector cards.

In ground and above ground pedestrian detection systems will need to be configured as a pedestrian input. Using Table 1 as an example, for four pedestrians we use inputs 13-16 and if we were to install above ground pedestrian detection for all the walks the detection would be numbered 11-4 leaving one unused before the pedestrians. MSS bits shall be used and numbered the same as the pedestrian detector number (where possible). Furthermore all non-loop detectors shall have an MSS assigned for each unit for additional SCATS variation options and monitoring options.

## Pole Numbering

Poles are numbered in a clockwise direction from the controller assuming that a line in drawn from the controller to the centroid of the intersection.

Where there is a secondary part to the signals such as at interchanges, the intersection closest to the controller shall be numbered first then the additional part can be numbered in the same format assuming that a line is drawn from the controller to the centroid of the secondary part of the intersection.

If a controller is relocated then the site must be renumbered to comply with the standard convention.

## Signal Groups

With AS 2578 and VC5 compliant controllers, the number of signal groups can range from 4 to 32 in modules of four signal groups. The recent changes to VC6 controllers may change some of the content listed below, therefore discussions with the manufacturer is expected during design.

Pedestrian signal groups in a sixteen group controller will be denoted as: W1=16, W2=15, W3=14, & W4=13). If there are only two Pedestrian groups then W1=16 and W2=15.

## Phasing

The phasing diagram must show the following:

* Each phase in a separate box with the phase label inside the box corner A, F, F1, etc.
* Show only the movements that display green in each phase
* Indicate movements by an arrow pointing in the direction that traffic will travel
* Signal groups shown in a circle at the point of the movement arrow for vehicles and beside
* Pedestrian movements
* Any Special Flags inside the phase box Z, Z+, etc.
* Indicate if filter turn movements are permitted
* Label phasing to lanterns
* Default and Alternative phasing to be shown. Alternative phasing must show split phasing for each approach to assist in maintenance and operations.
* An all red phase to be added to all plans for operational requirements, no detector or input to be assigned to call/demand. Shall be operated only by SCATS Dwell.

The phase sequence must be shown on the plan adjacent to the phasing diagram.

In general, all traffic signals shall be consistent with the standard RMS configuration. Standard phasing configurations are detailed below. Where standard phasing configurations are not appropriate due to the site or traffic flow conditions, the phasing should be designed to:

* Minimise the number of phases
* Minimise cycle time
* Run as many compatible movements as possible in each phase
* Restrict each phase to non-conflicting movements
* Allow each movement to run in as many phases as possible (preferably allowing as many as possible to overlap from the previous phase or into the following phase), and
* Comply as closely as possible with the standard RMS configuration. Examples of a range of standard arrangements are found on the following pages of this document.

The phasing design should consider the use of filter right turn movements. The phasing design should provide the most flexible operation that will accommodate changes in traffic conditions without the need to reprogram the controller personality. This may result in a phasing sequence in which not all phases are used initially. An example of this is the inclusion of repeat right turn phases.

The phasing sequence (i.e. the order in which each phase runs) should be designed to provide the optimum coordinated flow along a corridor. This may change at different times of the day.

# Standard Types

## Midblock Pedestrian Crossing

### Required Signal Groups

#### Vehicle

* SG 1 Main road through movement clockwise from the controller
* SG 2 Main road through movement opposite to SG 1.

#### Pedestrian

The midblock crossing will normally have one pedestrian and can be catered for with a much smaller controller than would otherwise be required.

* Pedestrian Movement 1 – At a right angle to the main vehicle flow (e.g. SG 4, 8, 12 or 16) but typically SG4.

Note

Staggered / two stage pedestrian crossings require an additional signal group as the walk phases are normally split.

## Staggered Pedestrian Crossing

The configuration of a staggered pedestrian crossing should be left to right. Although this may not be practical, this requirement is so pedestrians are walking towards the main traffic flow. Careful consideration for poles and access would be required in the design.

### Required Signal Groups

#### Vehicle

* SG 1 - Main road through movement clockwise from the controller
* SG 2 - Main road through movement opposite to SG1.

#### Pedestrian

* Pedestrian Movement 1 – At a right angle with SG1 (e.g. SG 4, 8, 12 or 16) but typically SG4
* Pedestrian Movement 2 – At a right angle with SG2 (e.g. SG 3, 7, 11 or 15) but typically SG3.

## T-Intersections

### Required Signal Groups

#### Vehicle

* SG 1 - Main Road through movement adjacent to main road right turn
* SG 2 - Main Road through movement conflicting with main road right turn
* SG 3 – Right turn from main road
* SG 4 – Right turn or right and left turn from side road.

#### Pedestrian

* Pedestrian Movement 1 – across side road (i.e. parallel with SG2)
* Pedestrian Movement 2 – across main road and to the left of the side road.

### Optional Signal Groups

Where provided use next available signal group in order below.

#### Vehicle

* Left turn from main road into side road
* Left turn from side road into main road.

#### Pedestrian

If an existing controller has eight signal groups and more than four vehicle groups then it may be necessary to renumber the pedestrian signal groups.

* + Pedestrian movement across controlled left turn slip lane from main road
  + Pedestrian movement across controlled left turn slip lane from side road.

Phasing

Normal Phase Sequence = A : C : D

Alternative phase sequence A : B : C : D

A Phase – SG’s 1, 2 and Pedestrian Movement 1.

May also include left turn movement into side road from main road if controlled by a separate signal group.

Note : Where considered safe the right turn movement may be permitted to FILTER turn. Filtering will be controlled through the introduction of the Z- flag. Filtering enabled under Flexilink or Masterlink only. If filtering is enabled, the main road left turn signal group (if provided) shall be in the OFF state.

B Phase – SG’s 1 and 3.

May also include left turn from side road into main road if controlled by a separate signal group.

Note : B Phase introduction is controlled through introduction of Z+ flag in Flexilink or Masterlink only.

C Phase – SG 4 and Pedestrian Movement 2.

May also include the left turns into and out of the side road, if controlled by separate signal groups.

D Phase – SG’s 1 and 3.

May also include left turn from side road into main road if controlled by a separate signal group.

## Split Side Road Phases

### Required Signal Groups

#### Vehicle

* SG 1 - Main road through movement clockwise from the controller
* SG 2 - Main road through movement opposite to SG 1.
* SG 3 - Right turn adjacent to SG 1
* SG 4 - Right turn adjacent to SG 2
* SG 5 - Side road movements to the left of SG 1 (clockwise from SG 1)
* SG 6 - Side road movements to the left of SG 2 (clockwise from SG 2).

#### Pedestrian

* Pedestrian Movement 1 – parallel to SG 1 (e.g. SG 16)
* Pedestrian Movement 2 – parallel to SG 2 (e.g. SG 15)
* Pedestrian Movement 3 – pedestrian on the left of the C phase side road (e.g. SG 14)
* Pedestrian Movement 4 – pedestrian on the left of the D phase side road (e.g. SG 13).

### Optional Signal Groups

Where provided use next available signal group in order below.

#### Vehicle

* Right turn adjacent to SG 5 (red arrow only for pedestrian protection)
* Right turn adjacent to SG 6 (red arrow only for pedestrian protection)
* Left turn adjacent to SG 1
* Left turn adjacent to SG 2
* Left turn from C phase side road
* Left turn from D phase side road.

#### Pedestrian

* Pedestrian across controlled left turn slip lane from main road and parallel to SG 1
* Pedestrian across controlled left turn slip lane from main road and parallel to SG 2
* Pedestrian across controlled left turn slip lane from D phase side road
* Pedestrian across controlled left turn slip lane from E phase side road.

Phasing

Normal Phase Sequence = A : D : E : F

A Phase – SG’s 1, 2, Pedestrian Movements 1 and 2.

May also include left turn movements into side road from main road if controlled by separate signal groups.

Note: Where considered safe the right turn movements may be permitted to filter turn. Filtering shall be permitted on the AB (SG1) approach under the following conditions:

* The mode of operation is Masterlink or Flexilink AND XSF 1 bit is set and there is Z- flag present
* Filtering shall be permitted on the AC (SG2) approach under the following conditions:
* The mode of operation is Masterlink or Flexilink AND XSF 2 bit is set and there is Z- flag present.

Note: If filtering is enabled, the main road left turn signal groups (if provided) shall be in the “OFF” state.

B Phase – SG’s 1, 3, Pedestrian Movement 1.

May also include left turn parallel to SG1 and from D phase side road if controlled by separate signal groups

C Phase – SG5, Pedestrian Movement 3.

May also include left turn parallel to SG2 and from D phase side road if controlled by separate signal groups

D Phase (least busiest side road movement) –SG 6 and Pedestrian Movement 4.

May also include left turn from main road parallel to SG 1 if controlled by a separate signal group.

### Single Diamond Overlap with Split Side Road Phases

4.18.5.1 Required Signal Groups

Vehicle

* SG 1 Main road through movement clockwise from the controller
* SG 2 Main road through movement opposite to SG 1.
* SG 3 – Right turn adjacent to SG 1
* SG 4 – Right turn adjacent to SG 2
* SG 5 – Side road movements to the left of SG 1 (clockwise from SG 1)
* SG 6 – Side road movements to the left of SG 2 (clockwise from SG 2).

Pedestrian

* Pedestrian Movement 1 – parallel to SG 1 (e.g. SG 16)
* Pedestrian Movement 2 – parallel to SG 2 (e.g. SG 15)
* Pedestrian Movement 3 – pedestrian on the left of the D phase side road (e.g. SG 14)
* Pedestrian Movement 4 – pedestrian on the left of the E phase side road (e.g. SG 13).

4.18.5.2 Optional Signal Groups

Where provided use next available signal group in order below.

Vehicle

* Left turn adjacent to SG 1
* Left turn adjacent to SG 2
* Left turn adjacent to SG 5 (red arrow only for pedestrian protection)
* Left turn adjacent to SG 6 (red arrow only for pedestrian protection).

Pedestrian

* Pedestrian across controlled left turn slip lane from main road and parallel to SG 1
* Pedestrian across controlled left turn slip lane from main road and parallel to SG 2
* Pedestrian across controlled left turn slip lane from D phase side road
* Pedestrian across controlled left turn slip lane from E phase side road.

4.18.5.3 Phasing

Normal Phase Sequence = A : D : E : F

A Phase – SG’s 1, 2, Pedestrian Movements 1 and 2.

May also include left turn movements into side road from main road if controlled by separate signal groups.

Note: Where considered safe the right turn movements may be permitted to filter turn. Filtering shall be permitted on the AB (SG 1) approach under the following condition:

* The mode of operation is Masterlink or Flexilink AND XSF 1 bit is set and there is no Z+ flag present (i.e. C phase is not permitted to run)

Filtering shall be permitted on the AC (SG 2) approach under the following condition:

* The mode of operation is Masterlink or Flexilink AND XSF 2 bit is set and there is no Z- flag present (i.e. B phase is not permitted to run)

Note: If filtering is enabled, the main road left turn signal groups (if provided) shall be in the OFF state i.e. filtering also.

B Phase – SG’s 1, 3, Pedestrian Movement 1.

May also include left turn parallel to SG 1 and from E phase side road if controlled by separate signal groups

Note : Phase introduction controlled through introduction of Z- flag in Flexilink or Masterlink only.

C Phase – SG’s 2, 4, Pedestrian Movement 2.

May also include left turn parallel to SG 2 and from D phase side road if controlled by separate signal groups

Note : Phase introduction controlled through introduction of Z+ flag in Flexilink or Masterlink only.

D Phase (least busy side road movement) – SG 5 or SG 6 and Pedestrian Movement 3 or 4.

May also include left turn from main road parallel to SG 1 if controlled by a separate signal group.

E Phase – SG 5 or SG 6 and Pedestrian Movement 3 or 4.

May also include left turn from main road parallel to SG 2 if controlled by a separate signal group.

F Phase – SG’s 3 and 4.

May also include left turn movements from side roads, if controlled by separate signal groups.

F1 Phase – SG’s 1, 3 and Pedestrian Movement 1.

May also include left turn parallel to SG 1 and from E phase side road if controlled by separate signal groups.

F2 Phase – SG’s 2, 4 and Pedestrian Movement 2.

May also include left turn parallel to SG 2 and from D phase side road if controlled by separate signal groups.

### Single Diamond Overlap with Combined Side Road Phase

4.18.6.1 Required Signal Groups

Vehicle

* SG 1 - Main road through movement clockwise from the controller
* SG 2 - Main road through movement opposite to SG 1
* SG 3 - Right turn adjacent to SG 1
* SG 4 - Right turn adjacent to SG 2
* SG 5 - Side road to the left of SG1
* SG 6 - Side road to the left of SG2.

Pedestrian

* Pedestrian Movement 1 – parallel to SG 1 (e.g. SG 16)
* Pedestrian Movement 2 – parallel to SG 2 (e.g. SG 15)
* Pedestrian Movement 3 – parallel and to the left of SG 5 (e.g. SG 14)
* Pedestrian Movement 4 – parallel and to the left of SG 6 (e.g. SG 13)

4.18.6.2 Optional Signal Groups

Where provided use next available signal group in order below.

Vehicle

* Right turn adjacent to SG 5 (red arrow only for pedestrian protection)
* Right turn adjacent to SG 6 (red arrow only for pedestrian protection)
* Left turn adjacent to SG 1
* Left turn adjacent to SG 2
* Left turn adjacent to SG 5 (red arrow only for pedestrian protection)
* Left turn adjacent to SG 6 (red arrow only for pedestrian protection).

Pedestrian

* Pedestrian across controlled left turn slip lane from main road and parallel to SG 1
* Pedestrian across controlled left turn slip lane from main road and parallel to SG .

4.18.6.3 Phasing

Normal Phase Sequence = A : D : E

A Phase– SG’s 1, 2, Pedestrian Movements 1 and 2.

May also include left turn movements from main road if controlled by a separate signal group.

Note: Where considered safe the right turn movements may be permitted to filter turn. Filtering shall be permitted on the AB (SG 1) approach under the following condition:

* The mode of operation is Masterlink or Flexilink AND XSF 1 bit is set and there is no Z+ flag present (i.e. C phase is not permitted to run)

Filtering shall be permitted on the AC (SG 2) approach under the following condition:

* The mode of operation is Masterlink or Flexilink AND XSF 2 bit is set and there is no Z- flag present (i.e. B phase is not permitted to run).

Note: If filtering is enabled, the main road left turn signal groups (if provided) shall be in the OFF state.

B Phase – SG’s 1, 3, Pedestrian Movement 1.

May also include left turn adjacent to SG 1 if controlled by a separate signal group.

Note : Phase introduction controlled through introduction of Z- flag in Flexilink or Masterlink only.

C Phase – SG’s 2, 4, Pedestrian Movement 2.

May also include left turn adjacent to SG 2 if controlled by a separate signal group

Note : Phase introduction controlled through introduction of Z+ flag in Flexilink or Masterlink only.

D Phase – SG 5, 6, Pedestrian Movements 3 and 4.

E Phase – SG’s 3 and 4.

E1 Phase – SG’s 1, 3 and Pedestrian Movement 1.

May also include left turn adjacent to SG 1 if controlled by a separate signal group.

E2 Phase – SG’s 2, 4 and Pedestrian Movement 2.

May also include left turn adjacent to SG 2 if controlled by a separate signal group.

### Double Diamond Overlap

4.18.7.1 Required Signal Groups

Vehicle

* SG 1 Main road through movement with stretched phase, clockwise from the controller
* SG 2 Main road through movement opposite to SG 1
* SG 3 – Right turn adjacent to SG 1
* SG 4 – Right turn adjacent to SG 2
* SG 5 Side road through movement clockwise from SG 1
* SG 6 Side road through movement clockwise from SG 2
* SG 7 – Right turn adjacent to SG 5
* SG 8 – Right turn adjacent to SG 6.

Pedestrian

* Pedestrian Movement 1 – parallel to SG 1 (e.g. SG 16)
* Pedestrian Movement 2 – parallel to SG 2 (e.g. SG 15)
* Pedestrian Movement 3 – parallel to SG 5 (e.g. SG 14)
* Pedestrian Movement 4 – parallel to SG 6 (e.g. SG 13).

4.18.7.2 Optional Signal Groups

Where provided use next available Signal Group in order below.

Vehicle

* Left turn adjacent to SG 1
* Left turn adjacent to SG 2
* Left turn adjacent to SG 5
* Left turn adjacent to SG 6.

Pedestrian

* Pedestrian across controlled left turn slip lane from main road and adjacent to SG 1
* Pedestrian across controlled left turn slip lane from main road and adjacent to SG 2
* Pedestrian across controlled left turn slip lane from main road and adjacent to SG 5
* Pedestrian across controlled left turn slip lane from main road and adjacent to SG 6.

4.18.7.3 Phasing

Normal Phase Sequence = A : D : E : G.

A Phase– SG’s 1, 2, Pedestrian Movements 1 and 2.

May also include left turn movements from main road if controlled by separate signal groups.

Note : Where considered safe the right turn movements may be permitted to FILTER turn. Filtering shall be permitted on the A-B (SG 1) approach under the following condition:

* The mode of operation is Masterlink or Flexilink AND XSF 1 bit is set and there is no Z+ flag present (i.e. C phase is not permitted to run)

Filtering shall be permitted on the AC (SG 2) approach under the following condition:

* The mode of operation is Masterlink or Flexilink AND XSF 2 bit is set and there is no Z- flag present (i.e. B phase is not permitted to run)

Note: If filtering is enabled, the main road left turn signal groups (if provided) shall be in the OFF state.

B Phase – SG’s 1, 3, Pedestrian Movement 1.

May also include left turn parallel to SG 1 and left turn parallel to SG 6 if controlled by separate signal groups

Note : Phase introduction controlled through introduction of Z- flag in Flexilink or Masterlink only.

C Phase– SG’s 2, 4, Pedestrian Movement 2.

May also include left turn parallel to SG 2 and left turn parallel to SG 5 if controlled by separate signal groups.

Note : Phase introduction controlled through introduction of Z+ flag in Flexilink or Masterlink only.

D Phase – SG’s 7 and 8.

May also include left turn movements from main road, if controlled by separate signal groups.

D1 Phase – SG’s 5, 7 and Pedestrian Movement 3.

May also include left turn parallel to SG 1 and left turn parallel to SG 5 if controlled by separate signal groups.

D2 Phase – SG’s 6, 8 and Pedestrian Movement 4.

May also include left turn parallel to SG 2 and left turn parallel to SG 6 if controlled by separate signal groups.

E Phase – SG’s 5, 6, Pedestrian Movements 3 and 4.

May also include left turn movements from side road to main road if controlled by separate signal groups.

Note: Where considered safe the right turn movements may be permitted to FILTER turn. Filtering shall be permitted on the D1-E-F1 (SG 5) approach under the following condition:

* The mode of operation is Masterlink or Flexilink AND XSF 3 bit is set and there is no XSF 6 bit present (i.e. F2 phase is not permitted to run)

Filtering shall be permitted on the D2-E-F2 (SG 6) approach under the following condition:

* The mode of operation is Masterlink or Flexilink AND XSF 3 bit is set and there is no XSF 5 bit present (i.e. F1 phase is not permitted to run).

Note: If filtering is enabled, the main road left turn signal groups (if provided) shall be in the OFF state.

F1 Phase – SG’s 5, 7 and Pedestrian Movement 3.

May also include left turn parallel to SG 6 if controlled by a separate signal group.

Note: Phase introduction controlled through introduction of XSF 5 Bit in Flexilink or Masterlink only.

F2 Phase – SG’s 6, 8 and Pedestrian Movement 4.

May also include left turn parallel to SG 5 if controlled by a separate signal group.

Note: Phase introduction controlled through introduction of XSF 6 Bit in Flexilink or Masterlink only.

G Phase – SG’s 3 and 4.

May also include left turn movements from side roads, if controlled by a separate signal group.

G1 Phase – SG’s 1, 3 and Pedestrian Movement 1.

May also include left turn parallel to SG 1 and left turn parallel to SG 6 if controlled by a separate signal groups.

G2 Phase – SG’s 2, 4 and Pedestrian Movement 2.

May also include left turn parallel to SG 2 and left turn parallel to SG 5 if controlled by a separate signal groups

### Filtering Right Turn Movements

At most intersections right turning traffic that has opposing movements will be provided for by installing a separate signal display, giving the right turning motorist a protected turn at some time in the phasing sequence. However, under strict criteria filter turn movements may be permitted in order to improve intersection efficiency.

Whilst the provision of filter turns may improve efficiency, it reduces the potential safety as conflicting movements may now occur. The phasing design must consider a balance between safety and efficiency. When considering allowing filtering, safety must be given a higher weighting in the decision process.

The phasing design at adjacent intersections should also be considered to provide consistency along a corridor and preferably throughout the region.

The operation of such movement should be designed and implemented with prior consultations with the TTOC.

### Repeat Right Turn Phases

A repeat right turn is where the right turn movement is introduced for a second time within the same phase cycle. Repeat right turns can be provided at any site with a right turn phase. Generally the controller logic will have two phases with exactly the same movements (i.e. for a T-intersection B and D) with one phase only introduced when a special facility signal is activated (normally B using the Z+ flag).

Repeat right turn phasing can only be used under Masterlink or Flexilink control modes (not in isolated mode) and is generally provided at peak times. It is unusual to have a repeat right turn phase operating 24 hours a day.

Repeat right turn phasing is normally used where the single right turn phase does not provide sufficient capacity within a cycle for specific flow periods, or it is necessary for progression within a coordinated system.

A typical use is where a right turn bay is too short to cope with the number of right turning vehicles that can arrive within the cycle which results in the right turn queue extending into and blocking the through traffic lane. This reduces the capacity for the through movement and increases the risk of nose to tail type crashes occurring. The use of the repeat right turn is particularly important, under these circumstances, where there is only one through lane.

Repeat right turn phasing should only be considered under the above mentioned conditions. Generally, where vehicles may queue outside of the through lane (i.e. on a painted median), it is more efficient to provide a longer single right turn phase than two short phases. Installation of queue detection loops to be considered in the design.

### Pedestrian Control

The hierarchy of signalised pedestrian control strategies range from providing full pedestrian protection through to partial protection during the early stages of the crossing movement. They fit broadly into the following range:

1. Exclusive pedestrian phase with full protection and all vehicle traffic stopped. Also known as Barnes Dance. This is only used where pedestrian numbers are high, in CBD.
2. Full protection for the whole Walk and Clearance using red arrow.
3. Partial protection for part of the Walk and Clearance using red arrow and individual push button inputs. Red arrow on a minimum of 6 seconds for one direction and the other direction to be calculated to the last crossing lane using 1.5m per second (this can be reduced on site as required)
4. Full protected staggered or staged pedestrian movements.

The method of control adopted at any specific site is based on location, traffic volumes, pedestrian volumes and type (i.e. age or disability), intersection layout combined with the aim to provide safe, efficient movement for all users. However, when selecting control options, it is important to ensure, whenever possible, that a consistent approach is adopted within any given corridor. This may result in a more conservative approach being adopted at some intersections to maintain uniformity throughout that corridor.

At signalised intersections, near schools, where there is a high pedestrian demand at the same time each day, the signal operation should be adjusted to cater for the reoccurring demand. This will generally be achieved by increasing the Walk’ and/or clearance times.

It is preferable to have all pedestrian push button inputs wired and configured in the CIS individually to enhance pedestrian protection.

MSS bits to be used for every push button to enhance the variation options in Scats. (All non-loop detectors shall have an MSS assigned for each unit for additional Scats variation options and monitoring options).

### Cyclists

Cycle lanes are being progressively introduced along some of the main corridors. Cyclists are features managed as part of the ‘traffic mix’ and there are currently limited special facilities for them at signalised intersections. These facilities are generally in the form of advance boxes or hook turn boxes and do not require special traffic signal control. Where cyclists may be on a side road or one that is not reverted to during phase sequence then detectors may be required to demand the phase for the cyclist.

Cycle detector loops are numbered in sequential order as part of the first circuit of vehicle detectors. Cycle call buttons are external inputs and numbered in descending order after the pedestrian inputs, e.g. W1=32, W2=31, C1=30.

Special care and attention to the detector position, type and detector alarm to be used in the cycle lane and / or cycle box. TTOC have designed different sizes and style for cycle detection, these can be added to the drawings following consultation.

Where cycle boxes are used they shall always be behind the traffic signal primary pole.

Consultation with the TTOC is required at an early stage so we can consult the users groups.

Bus Lanes

Bus priority is becoming more common and requires the allocation of a signal group to each approach using the same convention as above for individual sites. If the bus signal group is demanded then the controller puts in a pre-specified delay to the through movement signal group. Where bus loops are installed these are numbered as part of the first circuit of vehicle detectors in sequential order. Where a separate signal group is provided for bus movements, these are numbered last, after all other vehicle signal groups.

# Standard Types

## Midblock Pedestrian Crossing

### Required Signal Groups

#### Vehicle

* SG 1 Main road through movement clockwise from the controller
* SG 2 Main road through movement opposite to SG 1.

#### Pedestrian

The midblock crossing will normally have one pedestrian and can be catered for with a much smaller controller than would otherwise be required.

* Pedestrian Movement 1 – At a right angle to the main vehicle flow (e.g. SG 4, 8, 12 or 16) but typically SG4.

Note

Staggered / two stage pedestrian crossings require an additional signal group as the walk phases are normally split.

## Staggered Pedestrian Crossing

The configuration of a staggered pedestrian crossing should be left to right. Although this may not be practical, this requirement is so pedestrians are walking towards the main traffic flow. Careful consideration for poles and access would be required in the design.

### Required Signal Groups

#### Vehicle

* SG 1 - Main road through movement clockwise from the controller
* SG 2 - Main road through movement opposite to SG1.

#### Pedestrian

* Pedestrian Movement 1 – At a right angle with SG1 (e.g. SG 4, 8, 12 or 16) but typically SG4
* Pedestrian Movement 2 – At a right angle with SG2 (e.g. SG 3, 7, 11 or 15) but typically SG3.

## T-Intersections

### Required Signal Groups

#### Vehicle

* SG 1 - Main Road through movement adjacent to main road right turn
* SG 2 - Main Road through movement conflicting with main road right turn
* SG 3 – Right turn from main road
* SG 4 – Right turn or right and left turn from side road.

#### Pedestrian

* Pedestrian Movement 1 – across side road (i.e. parallel with SG2)
* Pedestrian Movement 2 – across main road and to the left of the side road.

### Optional Signal Groups

Where provided use next available signal group in order below.

#### Vehicle

* Left turn from main road into side road
* Left turn from side road into main road.

#### Pedestrian

If an existing controller has eight signal groups and more than four vehicle groups then it may be necessary to renumber the pedestrian signal groups.

* + Pedestrian movement across controlled left turn slip lane from main road
  + Pedestrian movement across controlled left turn slip lane from side road.

Phasing

Normal Phase Sequence = A : C : D

Alternative phase sequence A : B : C : D

A Phase – SG’s 1, 2 and Pedestrian Movement 1.

May also include left turn movement into side road from main road if controlled by a separate signal group.

Note : Where considered safe the right turn movement may be permitted to FILTER turn. Filtering will be controlled through the introduction of the Z- flag. Filtering enabled under Flexilink or Masterlink only. If filtering is enabled, the main road left turn signal group (if provided) shall be in the OFF state.

B Phase – SG’s 1 and 3.

May also include left turn from side road into main road if controlled by a separate signal group.

Note : B Phase introduction is controlled through introduction of Z+ flag in Flexilink or Masterlink only.

C Phase – SG 4 and Pedestrian Movement 2.

May also include the left turns into and out of the side road, if controlled by separate signal groups.

D Phase – SG’s 1 and 3.

May also include left turn from side road into main road if controlled by a separate signal group.

## Split Side Road Phases

### Required Signal Groups

#### Vehicle

* SG 1 - Main road through movement clockwise from the controller
* SG 2 - Main road through movement opposite to SG 1.
* SG 3 - Right turn adjacent to SG 1
* SG 4 - Right turn adjacent to SG 2
* SG 5 - Side road movements to the left of SG 1 (clockwise from SG 1)
* SG 6 - Side road movements to the left of SG 2 (clockwise from SG 2).

#### Pedestrian

* Pedestrian Movement 1 – parallel to SG 1 (e.g. SG 16)
* Pedestrian Movement 2 – parallel to SG 2 (e.g. SG 15)
* Pedestrian Movement 3 – pedestrian on the left of the C phase side road (e.g. SG 14)
* Pedestrian Movement 4 – pedestrian on the left of the D phase side road (e.g. SG 13).

### Optional Signal Groups

Where provided use next available signal group in order below.

#### Vehicle

* Right turn adjacent to SG 5 (red arrow only for pedestrian protection)
* Right turn adjacent to SG 6 (red arrow only for pedestrian protection)
* Left turn adjacent to SG 1
* Left turn adjacent to SG 2
* Left turn from C phase side road
* Left turn from D phase side road.

#### Pedestrian

* Pedestrian across controlled left turn slip lane from main road and parallel to SG 1
* Pedestrian across controlled left turn slip lane from main road and parallel to SG 2
* Pedestrian across controlled left turn slip lane from D phase side road
* Pedestrian across controlled left turn slip lane from E phase side road.

Phasing

Normal Phase Sequence = A : D : E : F

A Phase – SG’s 1, 2, Pedestrian Movements 1 and 2.

May also include left turn movements into side road from main road if controlled by separate signal groups.

Note: Where considered safe the right turn movements may be permitted to filter turn. Filtering shall be permitted on the AB (SG1) approach under the following conditions:

* The mode of operation is Masterlink or Flexilink AND XSF 1 bit is set and there is Z- flag present
* Filtering shall be permitted on the AC (SG2) approach under the following conditions:
* The mode of operation is Masterlink or Flexilink AND XSF 2 bit is set and there is Z- flag present.

Note: If filtering is enabled, the main road left turn signal groups (if provided) shall be in the “OFF” state.

B Phase – SG’s 1, 3, Pedestrian Movement 1.

May also include left turn parallel to SG1 and from D phase side road if controlled by separate signal groups

C Phase – SG5, Pedestrian Movement 3.

May also include left turn parallel to SG2 and from D phase side road if controlled by separate signal groups

D Phase (least busiest side road movement) –SG 6 and Pedestrian Movement 4.

May also include left turn from main road parallel to SG 1 if controlled by a separate signal group.

### Single Diamond Overlap with Split Side Road Phases

4.18.5.1 Required Signal Groups

Vehicle

* SG 1 Main road through movement clockwise from the controller
* SG 2 Main road through movement opposite to SG 1.
* SG 3 – Right turn adjacent to SG 1
* SG 4 – Right turn adjacent to SG 2
* SG 5 – Side road movements to the left of SG 1 (clockwise from SG 1)
* SG 6 – Side road movements to the left of SG 2 (clockwise from SG 2).

Pedestrian

* Pedestrian Movement 1 – parallel to SG 1 (e.g. SG 16)
* Pedestrian Movement 2 – parallel to SG 2 (e.g. SG 15)
* Pedestrian Movement 3 – pedestrian on the left of the D phase side road (e.g. SG 14)
* Pedestrian Movement 4 – pedestrian on the left of the E phase side road (e.g. SG 13).

4.18.5.2 Optional Signal Groups

Where provided use next available signal group in order below.

Vehicle

* Left turn adjacent to SG 1
* Left turn adjacent to SG 2
* Left turn adjacent to SG 5 (red arrow only for pedestrian protection)
* Left turn adjacent to SG 6 (red arrow only for pedestrian protection).

Pedestrian

* Pedestrian across controlled left turn slip lane from main road and parallel to SG 1
* Pedestrian across controlled left turn slip lane from main road and parallel to SG 2
* Pedestrian across controlled left turn slip lane from D phase side road
* Pedestrian across controlled left turn slip lane from E phase side road.

4.18.5.3 Phasing

Normal Phase Sequence = A : D : E : F

A Phase – SG’s 1, 2, Pedestrian Movements 1 and 2.

May also include left turn movements into side road from main road if controlled by separate signal groups.

Note: Where considered safe the right turn movements may be permitted to filter turn. Filtering shall be permitted on the AB (SG 1) approach under the following condition:

* The mode of operation is Masterlink or Flexilink AND XSF 1 bit is set and there is no Z+ flag present (i.e. C phase is not permitted to run)

Filtering shall be permitted on the AC (SG 2) approach under the following condition:

* The mode of operation is Masterlink or Flexilink AND XSF 2 bit is set and there is no Z- flag present (i.e. B phase is not permitted to run)

Note: If filtering is enabled, the main road left turn signal groups (if provided) shall be in the OFF state i.e. filtering also.

B Phase – SG’s 1, 3, Pedestrian Movement 1.

May also include left turn parallel to SG 1 and from E phase side road if controlled by separate signal groups

Note : Phase introduction controlled through introduction of Z- flag in Flexilink or Masterlink only.

C Phase – SG’s 2, 4, Pedestrian Movement 2.

May also include left turn parallel to SG 2 and from D phase side road if controlled by separate signal groups

Note : Phase introduction controlled through introduction of Z+ flag in Flexilink or Masterlink only.

D Phase (least busy side road movement) – SG 5 or SG 6 and Pedestrian Movement 3 or 4.

May also include left turn from main road parallel to SG 1 if controlled by a separate signal group.

E Phase – SG 5 or SG 6 and Pedestrian Movement 3 or 4.

May also include left turn from main road parallel to SG 2 if controlled by a separate signal group.

F Phase – SG’s 3 and 4.

May also include left turn movements from side roads, if controlled by separate signal groups.

F1 Phase – SG’s 1, 3 and Pedestrian Movement 1.

May also include left turn parallel to SG 1 and from E phase side road if controlled by separate signal groups.

F2 Phase – SG’s 2, 4 and Pedestrian Movement 2.

May also include left turn parallel to SG 2 and from D phase side road if controlled by separate signal groups.

### Single Diamond Overlap with Combined Side Road Phase

4.18.6.1 Required Signal Groups

Vehicle

* SG 1 - Main road through movement clockwise from the controller
* SG 2 - Main road through movement opposite to SG 1
* SG 3 - Right turn adjacent to SG 1
* SG 4 - Right turn adjacent to SG 2
* SG 5 - Side road to the left of SG1
* SG 6 - Side road to the left of SG2.

Pedestrian

* Pedestrian Movement 1 – parallel to SG 1 (e.g. SG 16)
* Pedestrian Movement 2 – parallel to SG 2 (e.g. SG 15)
* Pedestrian Movement 3 – parallel and to the left of SG 5 (e.g. SG 14)
* Pedestrian Movement 4 – parallel and to the left of SG 6 (e.g. SG 13)

4.18.6.2 Optional Signal Groups

Where provided use next available signal group in order below.

Vehicle

* Right turn adjacent to SG 5 (red arrow only for pedestrian protection)
* Right turn adjacent to SG 6 (red arrow only for pedestrian protection)
* Left turn adjacent to SG 1
* Left turn adjacent to SG 2
* Left turn adjacent to SG 5 (red arrow only for pedestrian protection)
* Left turn adjacent to SG 6 (red arrow only for pedestrian protection).

Pedestrian

* Pedestrian across controlled left turn slip lane from main road and parallel to SG 1
* Pedestrian across controlled left turn slip lane from main road and parallel to SG .

4.18.6.3 Phasing

Normal Phase Sequence = A : D : E

A Phase– SG’s 1, 2, Pedestrian Movements 1 and 2.

May also include left turn movements from main road if controlled by a separate signal group.

Note: Where considered safe the right turn movements may be permitted to filter turn. Filtering shall be permitted on the AB (SG 1) approach under the following condition:

* The mode of operation is Masterlink or Flexilink AND XSF 1 bit is set and there is no Z+ flag present (i.e. C phase is not permitted to run)

Filtering shall be permitted on the AC (SG 2) approach under the following condition:

* The mode of operation is Masterlink or Flexilink AND XSF 2 bit is set and there is no Z- flag present (i.e. B phase is not permitted to run).

Note: If filtering is enabled, the main road left turn signal groups (if provided) shall be in the OFF state.

B Phase – SG’s 1, 3, Pedestrian Movement 1.

May also include left turn adjacent to SG 1 if controlled by a separate signal group.

Note : Phase introduction controlled through introduction of Z- flag in Flexilink or Masterlink only.

C Phase – SG’s 2, 4, Pedestrian Movement 2.

May also include left turn adjacent to SG 2 if controlled by a separate signal group

Note : Phase introduction controlled through introduction of Z+ flag in Flexilink or Masterlink only.

D Phase – SG 5, 6, Pedestrian Movements 3 and 4.

E Phase – SG’s 3 and 4.

E1 Phase – SG’s 1, 3 and Pedestrian Movement 1.

May also include left turn adjacent to SG 1 if controlled by a separate signal group.

E2 Phase – SG’s 2, 4 and Pedestrian Movement 2.

May also include left turn adjacent to SG 2 if controlled by a separate signal group.

### Double Diamond Overlap

4.18.7.1 Required Signal Groups

Vehicle

* SG 1 Main road through movement with stretched phase, clockwise from the controller
* SG 2 Main road through movement opposite to SG 1
* SG 3 – Right turn adjacent to SG 1
* SG 4 – Right turn adjacent to SG 2
* SG 5 Side road through movement clockwise from SG 1
* SG 6 Side road through movement clockwise from SG 2
* SG 7 – Right turn adjacent to SG 5
* SG 8 – Right turn adjacent to SG 6.

Pedestrian

* Pedestrian Movement 1 – parallel to SG 1 (e.g. SG 16)
* Pedestrian Movement 2 – parallel to SG 2 (e.g. SG 15)
* Pedestrian Movement 3 – parallel to SG 5 (e.g. SG 14)
* Pedestrian Movement 4 – parallel to SG 6 (e.g. SG 13).

4.18.7.2 Optional Signal Groups

Where provided use next available Signal Group in order below.

Vehicle

* Left turn adjacent to SG 1
* Left turn adjacent to SG 2
* Left turn adjacent to SG 5
* Left turn adjacent to SG 6.

Pedestrian

* Pedestrian across controlled left turn slip lane from main road and adjacent to SG 1
* Pedestrian across controlled left turn slip lane from main road and adjacent to SG 2
* Pedestrian across controlled left turn slip lane from main road and adjacent to SG 5
* Pedestrian across controlled left turn slip lane from main road and adjacent to SG 6.

4.18.7.3 Phasing

Normal Phase Sequence = A : D : E : G.

A Phase– SG’s 1, 2, Pedestrian Movements 1 and 2.

May also include left turn movements from main road if controlled by separate signal groups.

Note : Where considered safe the right turn movements may be permitted to FILTER turn. Filtering shall be permitted on the A-B (SG 1) approach under the following condition:

* The mode of operation is Masterlink or Flexilink AND XSF 1 bit is set and there is no Z+ flag present (i.e. C phase is not permitted to run)

Filtering shall be permitted on the AC (SG 2) approach under the following condition:

* The mode of operation is Masterlink or Flexilink AND XSF 2 bit is set and there is no Z- flag present (i.e. B phase is not permitted to run)

Note: If filtering is enabled, the main road left turn signal groups (if provided) shall be in the OFF state.

B Phase – SG’s 1, 3, Pedestrian Movement 1.

May also include left turn parallel to SG 1 and left turn parallel to SG 6 if controlled by separate signal groups

Note : Phase introduction controlled through introduction of Z- flag in Flexilink or Masterlink only.

C Phase– SG’s 2, 4, Pedestrian Movement 2.

May also include left turn parallel to SG 2 and left turn parallel to SG 5 if controlled by separate signal groups.

Note : Phase introduction controlled through introduction of Z+ flag in Flexilink or Masterlink only.

D Phase – SG’s 7 and 8.

May also include left turn movements from main road, if controlled by separate signal groups.

D1 Phase – SG’s 5, 7 and Pedestrian Movement 3.

May also include left turn parallel to SG 1 and left turn parallel to SG 5 if controlled by separate signal groups.

D2 Phase – SG’s 6, 8 and Pedestrian Movement 4.

May also include left turn parallel to SG 2 and left turn parallel to SG 6 if controlled by separate signal groups.

E Phase – SG’s 5, 6, Pedestrian Movements 3 and 4.

May also include left turn movements from side road to main road if controlled by separate signal groups.

Note: Where considered safe the right turn movements may be permitted to FILTER turn. Filtering shall be permitted on the D1-E-F1 (SG 5) approach under the following condition:

* The mode of operation is Masterlink or Flexilink AND XSF 3 bit is set and there is no XSF 6 bit present (i.e. F2 phase is not permitted to run)

Filtering shall be permitted on the D2-E-F2 (SG 6) approach under the following condition:

* The mode of operation is Masterlink or Flexilink AND XSF 3 bit is set and there is no XSF 5 bit present (i.e. F1 phase is not permitted to run).

Note: If filtering is enabled, the main road left turn signal groups (if provided) shall be in the OFF state.

F1 Phase – SG’s 5, 7 and Pedestrian Movement 3.

May also include left turn parallel to SG 6 if controlled by a separate signal group.

Note: Phase introduction controlled through introduction of XSF 5 Bit in Flexilink or Masterlink only.

F2 Phase – SG’s 6, 8 and Pedestrian Movement 4.

May also include left turn parallel to SG 5 if controlled by a separate signal group.

Note: Phase introduction controlled through introduction of XSF 6 Bit in Flexilink or Masterlink only.

G Phase – SG’s 3 and 4.

May also include left turn movements from side roads, if controlled by a separate signal group.

G1 Phase – SG’s 1, 3 and Pedestrian Movement 1.

May also include left turn parallel to SG 1 and left turn parallel to SG 6 if controlled by a separate signal groups.

G2 Phase – SG’s 2, 4 and Pedestrian Movement 2.

May also include left turn parallel to SG 2 and left turn parallel to SG 5 if controlled by a separate signal groups