Standard for Single Diamond Overlap Phasing

Guidelines for Developing

Roads and Traffic Authority

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Revision history

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1.1	10 Nov 2009	Correction to flowchart labelling in sections 5.4 and 5.5.

Roads and Traffic Authority of New South Wales
Traffic Management Branch
PO Box 1927
Strawberry Hills NSW 2012
Australia

Telephone: +61 2 8396 1602
Facsimile: +61 2 8396 1600

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1 Introduction

This document provides a description of single diamond overlap (SDO) phasing. It replaces the Standard for Single Diamond Overlap Design [2] and Standard for Single Diamond Overlap Phasing with Filter Option [5]. The Single Diamond tables introduced in this document are all for left turn vehicle groups, The Vehicle Group tables to be used for all the other movements in a diamond phase design should be selected from those introduced in the Specification of Vehicle Group Operation, [10].

Single diamond overlap phasing is a method of controlling two opposing right turn movements at a signalised intersection by using overlap movements, alternative phasing and repeat right turns. This enables leading and trailing right turns to be used in the same cycle.

An enhancement to this operation is the filter option, where the right turn movements from the major road may be permitted to filter during A phase by sacrificing the right turn phase in the opposing direction (i.e. B or C phase).

The filter option may be provided for either or both of the right turn movements. This standard describes the differences in operation when the filter option is provided.

The general methods to be adopted in specifying the colour sequences for a vehicle group, detector logic and pedestrian movements can be found in the specifications for Vehicle Group, Detector Logic and Pedestrian Movement operation [10], [11] and [12] respectively.

1.1 Definitions and Abbreviations

Term	Meaning
Arterial road	is the major road.
LT	Left Turn
'major road'	is the road containing the two opposing right turn movements which are allowed in the diamond phase. This is usually, but not necessarily, the road with the higher traffic flows.
'minor road'	is the road serviced by the side-street phases. That crossing the major road.
RA	Red Arrow
RT	Right Turn
RTA	Roads and Traffic Authority
SDO	Single Diamond Overlap
Signal Group	A group of signal lanterns which control either: one or more vehicle movements; or one or more pedestrian movements. Used when referring to either: both vehicle and pedestrian signal groups; or only pedestrian signal groups.
TMB	Traffic Management Branch
Vehicle group	Used when referring to Signal Groups which only control vehicle movements.

All other terms are defined in Traffic Signal Terminology [9].

1.2 References

[1] VD018-10, Standard for Detector Specification Schedule, 23 December 1988 (*also titled Standard Tables for Detector Logic, RTA Standard Personality, 24 November 1988*)

[2] VD018-5, Standard for Single Diamond Overlap Design

[3] VD018-6, Standard for Double Diamond Overlap Design

[4] VD018-8, Standard for Signal Group Displays

[5] VD018-14, Standard for Single Diamond Overlap Phasing with Filter Option

[6] TS-QA-156, Personality Standard Tables Management – Standard Operating Procedure

[7] Traffic Signals Practice, Design – RTA, February 2008

[8] RTA-TC-106, Traffic Signal Operation, Version 1.1, October 2000

[9] RTA-TC-118, Traffic Signal Terminology, Version 1.1, November 2000

1.3 Associated Documents

[10] TS-TN-019, Specification of Vehicle Group Operation – Guidelines for Developing

[11] TS-TN-020, Specification of Detector Logic Operation – Guidelines for Developing

[12] TS-TN-021, Specification of Pedestrian Movement Operation – Guidelines for Developing

[13] TS-TN-022, Specification of Ancillary Operation – Guidelines for Developing

[14] TS-TN-023, Layout of Macros for Standard Tables – Guidelines

[15] TS-TN-027, Standard for Double Diamond Overlap Phasing

[16] RTA_TC-185, RTA Standard Personality Reference Manual (Phases)

2 Format and Explanation

This section provides an explanation of the terms used when describing how a left turn arrow works for an intersection which incorporates a diamond overlap. All the examples given are based on a four road intersection.

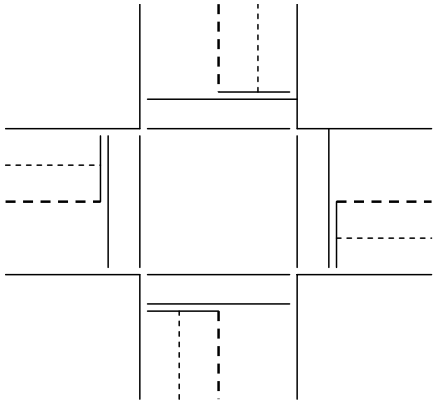


Figure 1 Example cross intersection

A through phase is one where both opposing through movements are allowed. Other non-conflicting movements can also occur while the through movements are allowed.

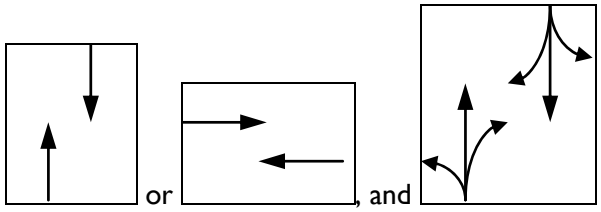


Figure 2 Through movements examples, and with other non-conflicting movements

The diamond phase refers to the phase where both opposing right turns are allowed. Other non-conflicting movements can also occur while the diamond movements are allowed.

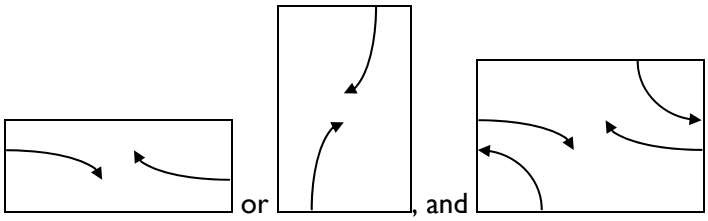


Figure 3 Diamond movements examples, and with other non-conflicting movements

For efficiency the diamond phase has two sub-phases which can be transitioned to depending on the demand for each right turn. If the demand for one right turn is erratic or non existent, the traffic signal controller has the ability to switch to a sub-phase. Other non-conflicting movements can also occur. These are shown dotted in the following diagram.

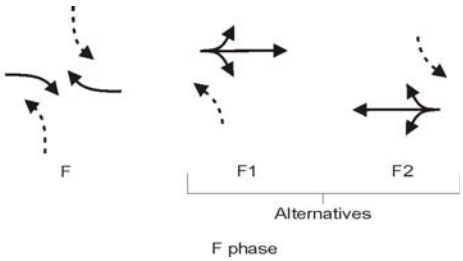


Figure 4 Diamond phase with sub-phases

The standard diamond overlap tables are valid for left turns both off and onto the arterial road. Those left turns off the arterial have been described as Adjacent left turns and left turns onto the arterial have been described as Complimentary left turns.

3 Single Diamond Overlap – Non Filter

The following sections describe in detail the operation of a non filter single diamond overlap intersection.

3.1 Application

Single diamond overlap phasing should be used when the following conditions are met:

a) The intersection has four or more legs which intersect at the same point.

b) The opposing right turns from the major road are from non-adjacent legs which are aligned opposite one another.

c) All the through movements are permitted in the major road.

d) Each of the opposing right turns from the major road has one or more exclusive right turn bays or right turn lanes and does not use any shared lanes.

e) The clearance between the swept paths of the opposing right turns from the major road is sufficient to allow both movements to turn simultaneously with safety.

f) The opposing right turns from the major road are not permitted to filter as described in section 4.

g) The right turn conditions in the minor road do not allow double diamond overlap phasing as described in the Standard for Double Diamond Overlap Phasing [15].

3.2 Phasing

The phasing for a single diamond overlap consists of:

a) a phase to permit all the through movements in the major road (A phase);

b) a phase to permit one of the right turns from the major road and its adjacent through movement (B phase);

c) a phase to permit the other right turn from the major road and its adjacent through movement (C phase);

d) a variable number of side-street phases;

e) an optional emergency service phase; and

f) a diamond phase consisting of three alternative combinations of movements.

A single diamond overlap may therefore be 4 to 7 phases depending on the number of side-street phases and whether or not an emergency service phase is provided. Regardless of the number of phases, the first three phases (i.e. A to C phases) do not change. For uniformity, B phase is the right turn phase whose right turn vehicle group is the first encountered in a clockwise direction from the controller.

The 4-phase single diamond overlap is used when there are no side-street phases. This is extremely rare. It can only occur when there are no pedestrian movements across the major road and each leg of the minor road is either:

a) a one-way road leading away from the intersection; or

b) a two-way road where all the vehicles approaching the intersection must turn left.

In case (a), there is no side-street traffic entering the intersection. In case (b), the left turn movement from the minor road can be accommodated during the right turn phases and the diamond phase (as shown in Figure 5) by providing the appropriate left turn arrow vehicle group. In both cases, a separate side-street phase is unnecessary.

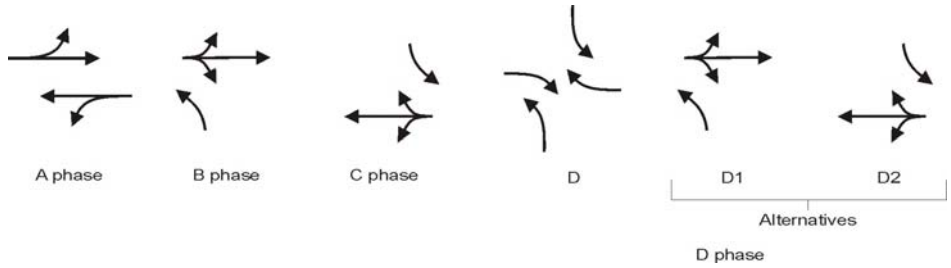


Figure 5 Example phasing for 4-phase single diamond overlap

The 5-phase single diamond overlap is used when there is one side-street phase as shown in Figure 6. If a traffic analysis proves that it is beneficial to run either of the left turn movements shown dotted, then this may be done by providing the appropriate left turn arrow vehicle groups.

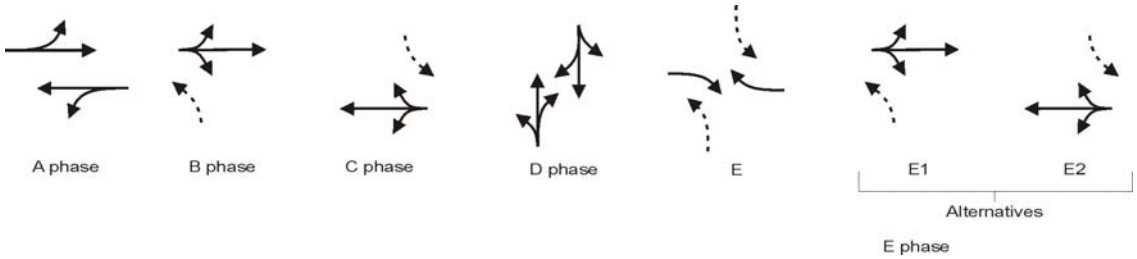


Figure 6 Example phasing for 5-phase single diamond overlap

The 6-phase single diamond overlap is used when there are two side-street phases. This includes a leading right turn as shown in Figure 7, a trailing right turn as shown in Figure 8 or split-approach phasing as shown in Figure 9. If a traffic analysis proved that it is beneficial to run any of the left turn movements shown dotted, then this may be done by providing the appropriate left turn arrow vehicle groups.

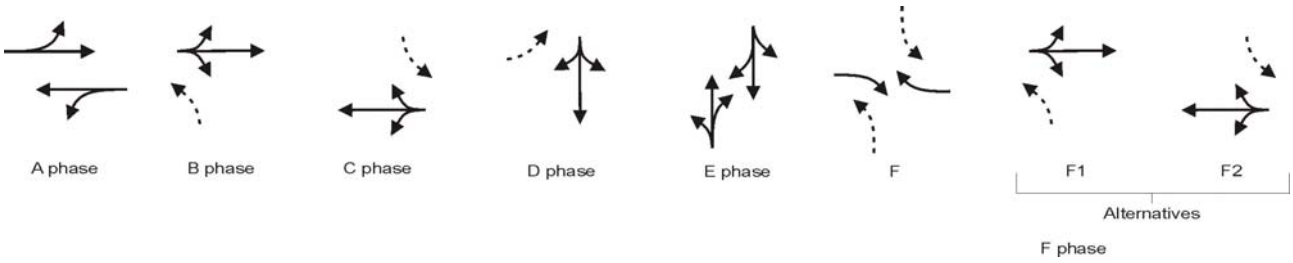


Figure 7 Example phasing for 6-phase single diamond overlap with leading right turn in the minor road

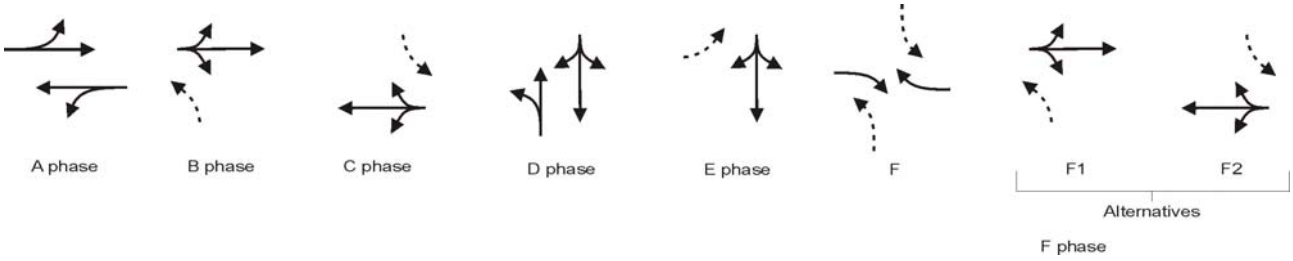


Figure 8 Example phasing for 6-phase single diamond overlap with trailing right turn in the minor road

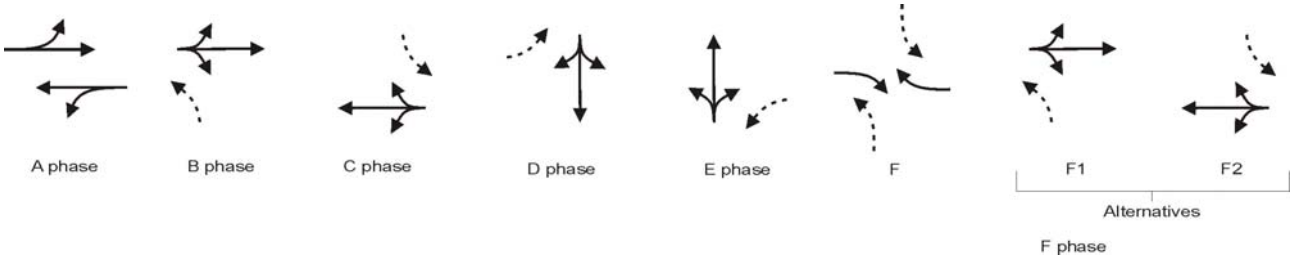


Figure 9 Example phasing for 6-phase single diamond overlap with split-approach phasing in the minor road

If an emergency service phase is required, one of the normal phases (other than the diamond phase) should be utilised for this if possible. Otherwise an emergency service phase can be added. Thus, the 4, 5, and 6-phase examples above would be increased to 5, 6 and 7 phases respectively. An example of a 7-phase

single diamond overlap with two side-street phases and an emergency service phase is shown in Figure 10. In this case, F phase is the emergency service phase.

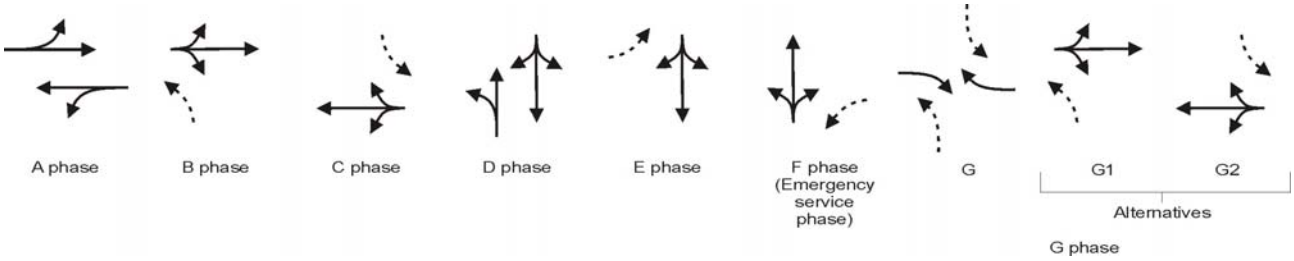


Figure 10 Example phasing for 7-phase diamond overlap with two side-street phases and an emergency service phase

The phase labelling should always be carried out in accordance with the above examples, i.e. A, B and C, followed by the side-street and emergency service phases (in any order) and the diamond phase last.

Standard personalities are available for 5-phase, 6-phase and 7-phase single diamond overlaps. Personalities for 4-phase and 7-phase single diamond overlaps may be generated by modifying the standard personalities.

The standard personalities also provide default data for phase sequence, software arterial, maximum time stealing and unused maximum time transfer. This data may be changed as described below.

As there are so many variations possible in the minor road (due to turn bans, multiple phases, shared or exclusive lanes, non-locked or presence-timed detectors, one-way streets, freeway ramps, left turn on red, left turn slip lanes, emergency service phase etc.), the operation of the minor road phasing is not considered to be part of the 'standard' single diamond overlap. Therefore, neither the standard personalities nor this document define the phasing in the minor road.

3.3 Typical Layout

The typical layout of a site with a 5-phase single diamond overlap is shown in Figure 11. For clarity, only the features defined by the standard are labelled. In the case of lanterns, only those at the stop line are shown.

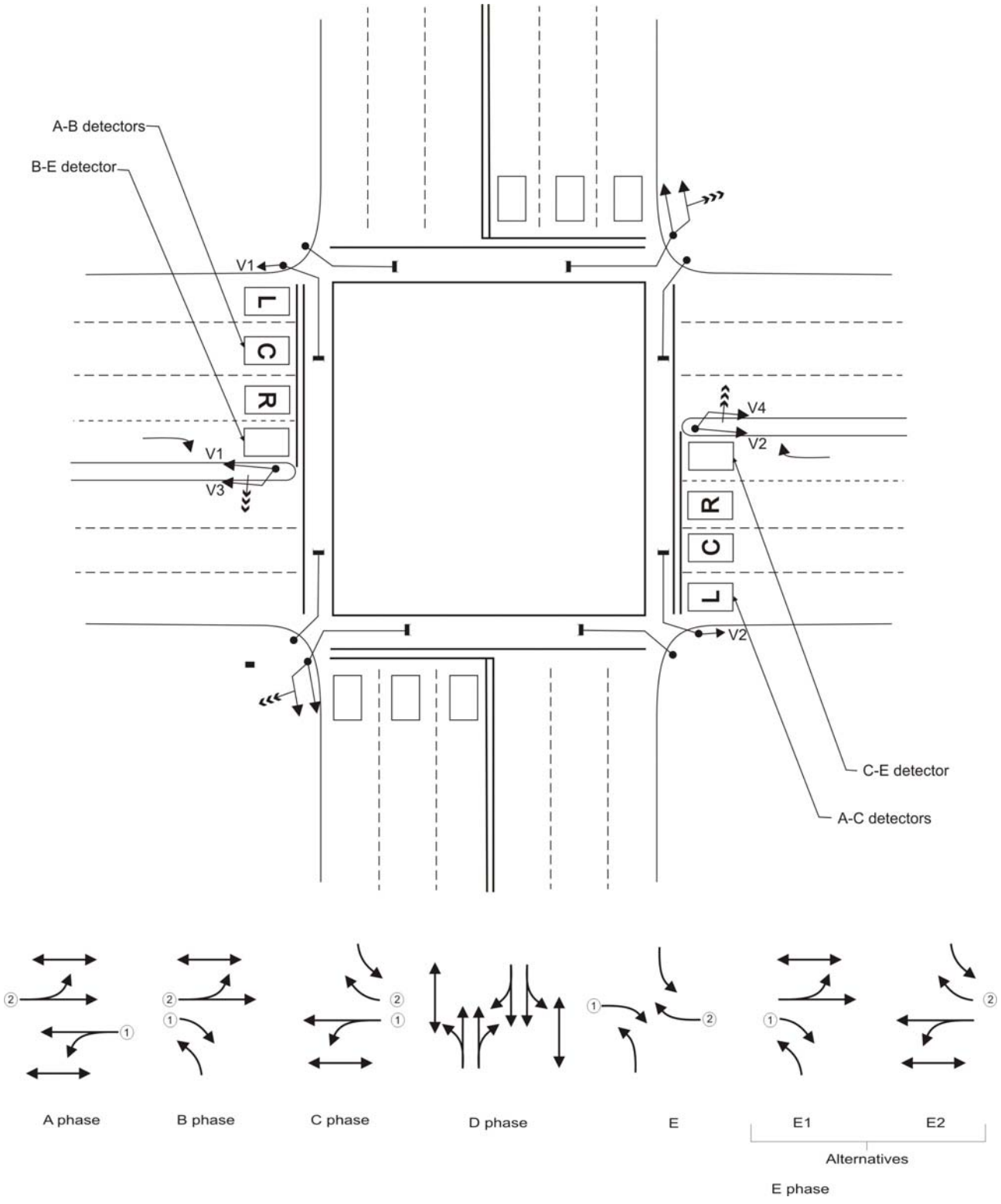


Figure 11 Example layout for 5-phase single diamond overlap

3.4 Isolated Operation

The following description is for a 5-phase single diamond overlap as shown in the typical layout of Figure 11. The same principles apply to 4, 6 and 7-phase designs.

The standard personalities have a software arterial on A phase. If it is more appropriate to have the arterial on a side-street phase, this may be done by changing the demand conditions in the personality. The arterial is not recommended on B, C or the diamond phase as the personality requires such extensive modification that a single diamond overlap is no longer appropriate.

If A phase has a software arterial, it will be introduced automatically. Otherwise it is introduced by demands from the A-B or A-C detectors or by an automatic demand placed during the diamond phase as described below.

Once A phase is introduced, it may be extended by the A-B detector (unless B phase or the E1 option of E phase is next) or by the A-C detector (unless C phase or the E2 option of E phase is next). If A phase uses its maximum green time, it may gain further green time from B and/or C phases via maximum time stealing as described in Traffic Signal Operation [8]. If it is more appropriate to allow a different phase to do the maximum time stealing, this may be achieved by changing the maximum time stealing data in the personality.

B and C phases are alternatives. Only one can run per cycle. The first to be demanded will be the one that runs. The processing of demands for B phase is handled first. Therefore, if the conditions for demanding B and C phases both occur simultaneously, only B phase will be demanded.

The intention of B and C phases is to provide a repeat right turn when traffic flows are high. A cycle timer is used to determine whether the repeat right turn can be introduced. This is a special timer loaded with special time setting 9 (S9 SCATS, B.9 keyboard) and starts timing at the start of the A phase yellow interval. If the controller rests in any phase during the cycle because there are no demands, then the cycle timer is continually reloaded with special time setting 9. When a demand occurs, the cycle timer can recommence timing.

B phase will be demanded if:

a) there is an actuation on the B-E detector; and

b) the controller is in the extension interval of A phase; and

c) a gap or waste expiry has occurred on the A-C detectors; and

d) there is no demand for C phase; and

e) the cycle timer is timed out.

If the B phase is introduced, it may be extended by the A-B detectors (unless A phase is next) or the B-E detector. Any unused maximum time from A phase is allotted to B phase via unused maximum time transfer as described in Traffic Signal Operation [8]. If this feature is not required, it may be removed by changing the unused maximum time transfer data in the personality.

C phase will be demanded if:

a) there is an actuation on the C-E detector; and

b) the controller is in the extension interval of A phase; and

c) a gap or waste expiry has occurred on the A-B detectors; and

d) there is no demand for B phase; and

e) the cycle timer is timed out.

If the C phase is introduced, it may be extended by the A-C detectors (unless A phase is next) or the C-E detector. Any unused maximum time from A phase is allotted to C phase via unused maximum time transfer as described in *Traffic Signal Operation*. If this feature is not required, it may be removed by changing the unused maximum time transfer data in the personality.

E phase is the diamond phase. There are three options within E phase i.e. E (the diamond turn), E1 (the V1 overlap) and E2 (the V2 overlap). E1 and E2 are alternatives. It is impossible for both to run in the same cycle. Therefore, E phase may consist of the E option only, the E1 option only, the E2 option only, the E option followed by the E1 option or the E option followed by the E2 option.

E phase may be demanded by the B-E or C-E detectors. However, the controller does not determine which option will run until it has started to move to E phase, i.e. at the termination of the extension green interval of the phase preceeding E phase. The option is chosen as follows:

a) If there were demands on both the B-E and C-E detectors, the E option is introduced.

b) If there was a demand on only the B-E detector, then:

i) if the controller is leaving C phase and the gap timer on the C-E detector has not expired, the E option is introduced;

ii) otherwise, the E1 option is introduced.

c) If there was a demand on only the C-E detector, then:

i) if the controller is leaving B phase and the gap timer on the B-E detector has not expired, the E option is introduced;

ii) otherwise, the E2 option is introduced.

Once the E option is running, the controller may change options or extend the option as follows:

a) If there is no gap or waste expiry on the B-E and C-E detectors, the E1 and E2 options are skipped and the E option is terminated by the maximum timer.

b) If there is a gap or waste expiry on the C-E detector only, then:

i) if A phase is next, the E option is terminated and the E1 option is introduced without resetting the gap, waste, headway or maximum timers; or

ii) if A phase is not next, the E option is not terminated but may be extended by the B-E detector.

c) If there is a gap or waste expiry on the B-E detector only, then:

i) if A phase is next, the E option is terminated and the E2 option is introduced without resetting the gap, waste, headway or maximum timers; or

ii) if A phase is not next, the E option is not terminated but may be extended by the C-E detector.

d) If a gap or waste expiry occurs simultaneously on both the B-E and C-E detectors, E phase is terminated.

Once the E1 option is running, it may be extended by the B-E detector. Similarly, once the E2 option is running, it may be extended by the C-E detector.

When the controller moves from E to E1 or E to E2, the terminating right turn vehicle group must display a green-yellow-red sequence before the opposing through vehicle group can display a green signal. The duration of the right turn yellow arrow is controlled by a special movement timer loaded with the yellow time setting for E phase. The initial duration of the right turn red arrow is controlled by the same special movement timer loaded with the all-red time setting for E phase. It is then safe for the opposing through vehicle group to display a green signal.

As the E1 or E2 options can be introduced any time during E phase (including the intergreen), E phase should be followed by A phase to ensure that the V1 or V2 vehicle groups display a green signal for a safe minimum time. This is achieved by ensuring A phase follows E phase in the sequence data and placing an artificial demand for A phase during E phase. Thus, the V1 vehicle group overlaps from E1 to A and the V2 vehicle group overlaps from E2 to A without the need for vehicle group minimum timers.

If A phase does not follow the E1 or E2 options of E phase due to incorrect sequence data, a dwell placed on another phase or the introduction of an emergency service phase, E phase is held until the V1 or V2 vehicle group has displayed a green signal for a safe minimum time. In this case, the minimum duration of the green display is determined by a special timer loaded with the minimum green time setting for E phase.

3.5 SCATS-Isolated Operation

If the controller is running in isolated mode while communicating with a SCATS regional computer (i.e. SCATS-isolated operation), then the regional computer may be used to turn the Z- and Z+ special facility signals on or off via the SCATS split plan data, time change data or variation routines.

If the Z- special facility signal is on, an actuation on the B-E detector places a locked demand for B phase. Similarly, if the Z+ special facility signal is on, an actuation on the C-E detector places a locked demand for C phase. Thus, if both the Z- and Z+ special facility signals are on, both B and C phases may be demanded and allowed to run in the same cycle. However, running B and C phases in the same cycle is not

recommended under SCATS-isolated operation because of the inefficient vehicle group sequence which results.

3.6 Flexilink Operation

Full Flexilink operation is similar to isolated operation except that the use of the software arterial, maximum timer, cycle timer, maximum time stealing and unused maximum time transfer is not applicable. The pivot phase is normally A phase unless it is more appropriate to have the pivot on one of the side-street phases. This is achieved by changing the sequence data in the personality to specify the side-street phases as the pivot phase, i.e. the first phase specified in the sequence data. Even though the pivot phase may be changed, the automatic demand for A phase is still placed during E phase.

The cycle length and duration of each phase is determined by the Flexilink plan data. This may be changed on site once the traffic signals are in service.

The Flexilink plan data may also be used to turn the Z- and Z+ special facility signals on or off. The response to the Z- and Z+ special facility signals is the same as described for scats-isolated operation. However, under Flexilink operation it is acceptable to run both B and C phases in the same cycle by running one as a leading turn and the other as a trailing turn. This is achieved by changing the sequence data in the personality to a sequence such as ABDCE and forcibly skipping E phase in the plan data. This operation allows the introduction and duration of the leading and trailing right turn movements to be fully controlled, unlike in E phase.

If the conditions for full Flexilink operation are not met (as described in *Standard Flexilink Operation*), then the controller may run in the Flexilink-isolated mode. In tis case, the operation is the same as for isolated operation except that the Flexilink plan data can still be used to turn the Z- and Z+ special facility signals on or off. Therefore, B and C phases may both be demanded and allowed to run in the same cycles as described for full Flexilink operation.

3.7 Masterlink Operation

Masterlink operation is similar to Flexilink operation except that the pivot phase and other Flexilink plan data is not applicable. The stretch phase is normally A phase, so it should have a permanent demand unless it is more appropriate to have this on one of the side-street phases. The cycle length, phase sequence and duration of each phase is determined by the SCATS split plan data. The use of the Z- and Z+ special facility signals is determined by the split plan data, time change data or variation routines. The SCATS data may be changed at any time by a qualified SCATS officer.

3.8 Pedestrian Movement Operation

The standard personalities do not currently include any pedestrian facilities. If pedestrian facilities need to be provided, these may be added to the personality via standard tables. For example, a commonly used standard table for the operation of a pedestrian movement running parallel to the V1 vehicle group works as follows:

> The push buttons associated with the pedestrian signal group demand A phase. The walk is introduced concurrently with the V1 green. If the walk is introduced at the start of A or B phase, the walk interval starts timing at the start of the phase. The walk and clearance intervals can then overlap into B or A phase. However, they are not permitted to overlap into E1 because the controller will not decide whether or not E1 will run until after the extension green interval going to E phase.
>
> Under isolated and Flexilink operation, the walk is timer terminated in A or B phase. Under Masterlink operation, the walk is pulse terminated in A or B phase.

Other variations on the operation of pedestrian movements are possible such as automatic introduction and walk for green. Reintroduction may also be permitted if there is no conflict with vehicle movements. Some of these variations are available in the standard tables.

The operation of any pedestrian movements running parallel to the side street are also governed by standard tables. Advice on the use of the standard tables may be obtained from Traffic Management Branch or any adaptive engineering staff.

All pedestrian movements should be independent and may have timed or full red-arrow protection provided where necessary, even if this means adding a single-aspect red arrow. Controlled pedestrian movements across left turn slip lanes must obviously have full red-arrow protection.

3.9 Labelling of Pedestrian Signal Groups

Each pedestrian signal group is labelled with a 'P' followed by a numeric suffix, i.e. P1, P2, P3 etc. The numbering starts at 1 and has no gaps in the sequence. The allocation of numbers is done in the following order:

a) pedestrian movements which run parallel to the major road;

b) pedestrian movements which run parallel to the minor road;

c) pedestrian movements which cross a left turn slip lane from the major road; and

d) pedestrian movements which cross a left turn slip lane from the minor road.

If there are two or more signal groups in any of the above categories, then the signal groups within that category are numbered in a clockwise direction from the V1 vehicle group. For example, if there are two pedestrian movements which run parallel to the major road, P1 is adjacent to the V1 vehicle group and P2 is adjacent to the V2 vehicle group.

3.10 Signal Group Operation

The vehicle group operation for the through and right turn vehicle groups in the major road (i.e. V1 to V4) is defined by the standard personalities and this standard. The vehicle group display sequence for any through or right turn vehicle groups in the minor roads is normally defined by the standard tables described in Specification of Vehicle Group Operation [10]. The vehicle group display sequence for any left turn vehicle groups in the major or minor roads is also defined by standard tables. Advice on the use of these tables may be obtained from Traffic Management Branch or any adaptive engineering staff.

Signal Group	Phases When Green								Standard Table	Remarks
	A	B	C	D	E	F	F1	F2		
V1	X	X					X		this document	
V2	X		X					X	this document	
V3		X				X	X		this document	
V4			X			X		X	this document	
V5				X	X				3	
V6				X					1	
V7					X				6	Timed RA protection for P4 pedestrians
V8					X				112	Timed RA protection for P1 pedestrians
V9			X	C	C	X		X	106	Timed RA protection for P3 pedestrians
V10		X				X	X		104	Timed RA protection for P4 pedestrians
P1	X	X					X		108	
P2	X		X					X	107	
P3			X	X					7	
P4			X						2	

Figure 12 Example signal group/phase chart for 6-phase single diamond overlap with trailing turn in the minor road

The design plan must include a signal group/phase chart as shown in Figure 12 to summarise the signal group operation in a concise format.

The first column (i.e. SIGNAL GROUP) lists all vehicle and pedestrian groups in numerical order.

The middle columns (i.e. PHASES WHEN GREEN) show the phases or phase options during which each signal group is green. The number of columns is varied to suit the number of phases or phase options. An 'X' indicates that the signal group is unconditional. A 'C' indicates that the vehicle group is conditional. In this case, the conditions are described in the standard table or note specified in the second last column.

The second last column (i.e. STANDARD TABLE) lists the standard table for each signal group. Where there is no standard table for a particular signal group, the entry should refer to the standard drawing where the operation is described or to a note. In the case of V1 to V4, the entry should refer to this standard. When a note is used, it should list any phase transitions where overlaps or late starts are applicable and details of any conditions, duration of pedestrian protection, vehicle group minimums etc.

The last column (i.e. REMARKS) lists any remarks necessary to help in the interpretation of the table. This column may be deleted if it is not needed.

3.11 Vehicle Detector Operation

The operation of the through and right turn detectors in the major road is defined by the standard personalities and this standard. This operation cannot be described properly in a detector specification schedule using the symbols currently available. Therefore, the operation of these detectors does not need to be described on the design plan provided that there is a reference to this standard.

A detector specification schedule should be included on the design plan to describe the operation of the detectors in the minor road and any variations to the detector operation in the major road such as presence-timed calls on the kerbside detectors.

3.12 Labelling and Numbering of Detectors

Labelling and numbering of detectors is carried out as described in *Traffic Signal Practice: Design.*

3.13 Approach Numbering

Approach timers 1 and 2 are used by the through and right turn detectors in the major road as shown in the movement diagrams of Figure 11. The use of these timers is specified in the standard personalities and should not be changed. Hence, approach timers 1 and 2 are unavailable for general use in A, B, C and the diamond phase. The remaining approach timers are allocated as described in Specification of Detector Logic Operation [11].

3.14 Plan Requirements

Any traffic signal design using single diamond overlap phasing must refer to this standard. Any variations from the standard must be described on the coordination documentation sheet. This includes changes to:

- phase sequence;
- software arterial;
- maximum time stealing; and
- unused maximum time transfer.

Any features not described in this standard must be described on the design plan. This includes the operation of:

- any left turn vehicle groups in the major road;
- any left turn detectors in the major road;
- all the vehicle groups in the minor road;
- all the detectors in the minor road;
- the emergency service phase (if provided);

- any pedestrian movements; and
- any controlled left turn slip lanes.

Most of these features will be adequately described by the design layout, movement diagrams, signal group/phase chart and detector specification schedule. Any special features need to be described by notes.

4 Application of Filter Option

Single diamond overlap phasing with filter option may be used if the conditions for a single diamond overlap are satisfied (see section 2) and it is safe for either or both of the opposing right turns from the major road to filter.

Each of the right turns from the major road should be tested separately to determine whether filtering can be permitted. The tests are briefly described in Traffic Signal Practice: Design [7].

If either of the right turns can be permitted to filter, further analysis should be carried out to determine whether the filter will provide sufficient capacity to clear the right turning vehicles (see ARRB Research Report *ARR 123 Traffic Signals: Capacity and Timing Analysis*) and what times of the day and days of the week that filtering is to be permitted. Factors to consider include traffic flows, the probability of conflicts with pedestrians (particularly school children, elderly or handicapped pedestrians), previous accident patterns and traffic management requirements. If the tests indicate that filtering can be permitted 24 hours per day and 7 days per week, then a single diamond overlap with filter option may not be appropriate and simpler phasing should be used instead.

4.1 Phasing

The phasing for a single diamond overlap with filter option is the same as for a single diamond overlap except for the addition of the filter option in A phase as shown in Figure 13. as the filter is optional, it should be shown as conditional movement in the movement diagrams.

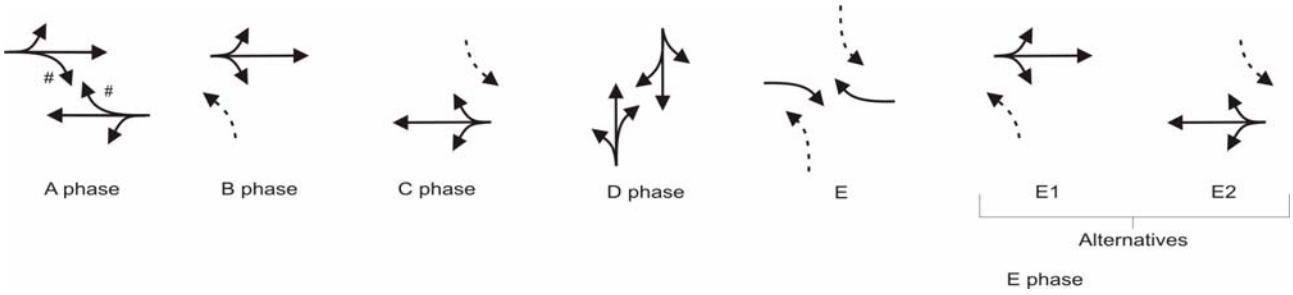


Figure 13 Example phasing for 5-phase single diamond overlap with filter option

Standard personalities are available for 5-phase, 6-phase single and 7-phase diamond overlaps with filter option. These assume that the filter option is provided on both approaches. If the filter option is only required on one approach, the personality must be changed to suit.

The filtering is enabled independently on each approach as described below.

4.2 Typical Layout

The typical layout of a site with a 5-phase single diamond overlap with filter option is shown in Figure 14. This is the same as the typical layout in Figure 11except that the filter option is provided on both approaches. The differences required on the layout are:

a) the addition of the conditional right turn movements in the movement diagram for A phase;

b) the provision of long detectors in the right turn bays or right turn lanes;

c) the use of extra approach numbers for the extension function in A phase; and

d) the change in labelling of the right turn detectors to A-B-E and A-C-E.

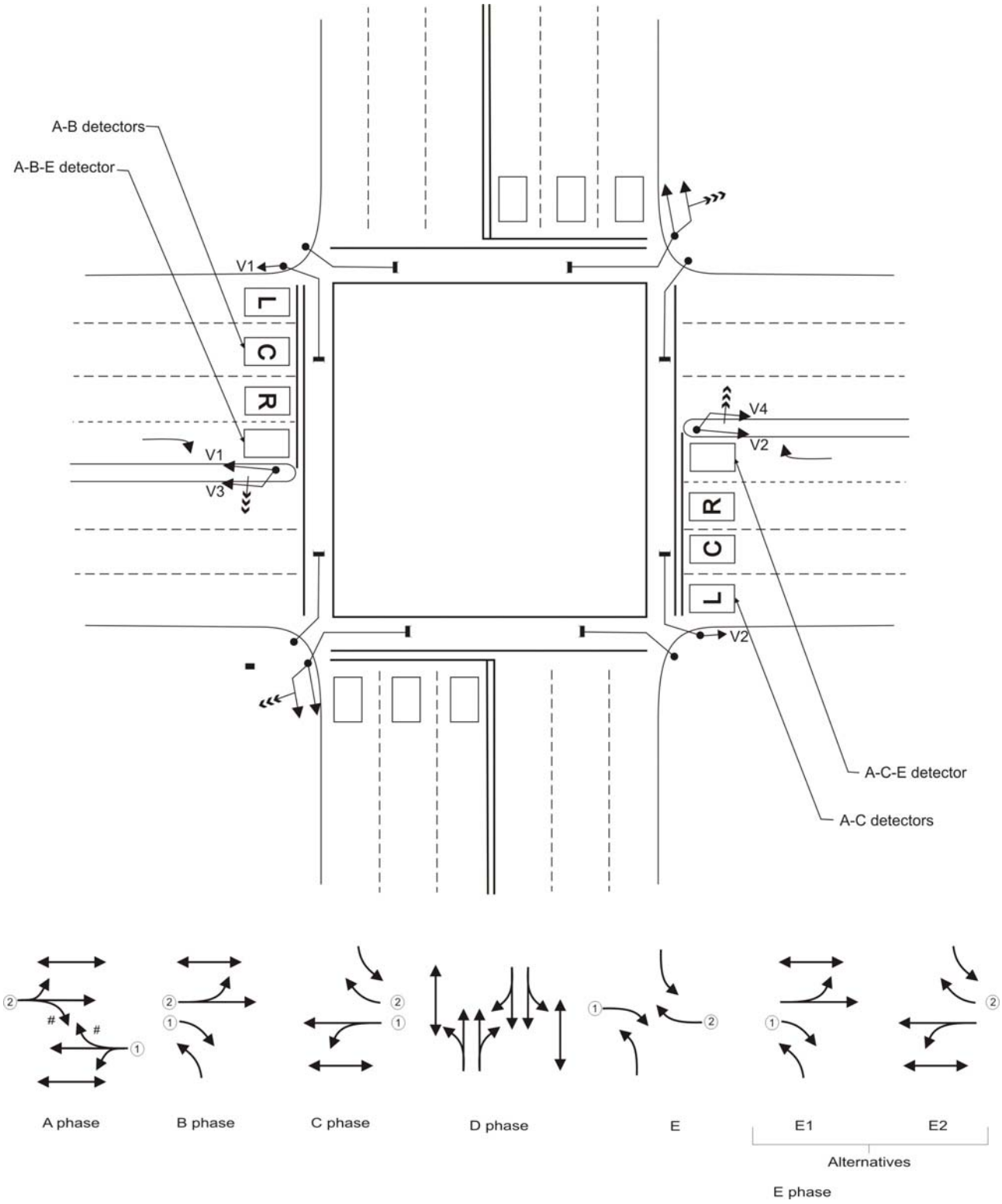


Figure 14 Example layout for 5-phase single diamond overlap with filter option on both approaches

4.3 Enabling Filter Under Isolated Operation

Under isolated operation, filtering cannot be enabled.

4.4 Enabling Filter Under Masterlink and Flexilink Operation

Under SCATS-isolated, Flexilink and Masterlink operation, filtering is enabled on the A-B approach by:

a) turning off the Z+ special facility signal so that C phase cannot be demanded; and

b) turning on bit 0 (SCATS flag 1) of the SCATS extra special facilities word (e.g. XSF=1!).

Similarly, filtering is enabled on the A-C approach by:

a) turning off the Z- special facility signal so that B phase cannot be demanded; and

b) turning on bit 1 (SCATS flag 2) of the SCATS extra special facilities word (e.g. XSF=2!).

4.5 Vehicle Group Operation

The filtering may be enabled at any point in the cycle, but the personality will not act upon it until it is safe to do so. Specifically:

a) the controller must not be in A phase;

b) the opposing through vehicle group (i.e. V1 or V2) must be red; and

c) the controller must not be in the late start interval.

If filtering is disabled on both approaches, the operation is the same as for a single diamond overlap.

When filtering is enabled on the A-B approach, the differences in operation are as follows:

a) When A phase follows B phase or any of the diamond options, the V3 vehicle group displays red for the late start interval of A phase and then displays off for the remaining green and yellow intervals to permit filtering.

b) When A phase follows C phase or any of the side-street phases, the V3 vehicle group displays off for all the green and yellow intervals of A phase to permit filtering.

c) The V2 vehicle group is not permitted to overlap from A phase to C phase because of the conflict with the right turn filter during the A-C intergreen. The personality normally prevents this transition because it ignores demands for C phase while filtering is enabled. (Remember that the Z+ special facility signal is turned on during A phase to enable demands for C phase, these demands are ignored until the controller has left A phase and filtering on the A-B approach is disabled. If the controller is forced from A phase to C phase (e.g. by a SCATS dwell, then all movements on the A-C approach are stopped and the V2 vehicle group is held for the late start interval of C phase.

d) The V2 vehicle group is not permitted to overlap from A phase to the E2 option of E phase because of the conflict with the right turn filter during the A-E2 intergreen. The personality prevents this phase transition by forcing the controller to the E option instead. If this wasn't done, it would be necessary to stop all movements on the A-C approach and hold the V2 vehicle group for the late start interval in E2.

When filtering is enabled on the A-C approach, the differences in operation are as follows:

a) When A phase follows C phase or any of the diamond options, the V4 vehicle group displays red for the late start interval of A phase and then displays off for the remaining green and yellow intervals to permit filtering.

b) When A phase follows B phase or any of the side-street phases, the V4 vehicle group displays off for all the green and yellow intervals of A phase to permit filtering.

c) The V1 vehicle group is not permitted to overlap from A phase to B phase because of the conflict with the right turn filter during the A-B intergreen. The personality normally prevents this transition because it ignores demands for B phase while filtering is enabled. (Remember that the Z- special facility signal must be off for filtering to be enabled). If the Z- special facility signal is turned on during A phase to enable demands for B phase, these demands are ignored until the controller has left A phase and filtering on the A-C approach is disabled. If the controller is forced from A phase to B phase (e.g. by a SCATS dwell), then all movements on the A-B approach are stopped and the V1 signal is held for the late start interval of B phase.

d) The V1 vehicle group is not permitted to overlap from A phase to the E1 option of E phase because of the conflict with the right turn filter during the A-E1 intergreen. The personality prevents this phase transition by forcing the controller to the E option instead. If this wasn't done, it would be necessary to stop all movements on the A-B approach and hold the V1 vehicle group for the late start interval in E1

4.6 Detector Operation

When filtering is enabled, the A-B-E and A-C-E right turn detectors operate the same as table 14 (as described in drawing No. Vd018-10). This necessitates long detectors and approach timers allocated for the extra extension functions in A phase.

4.7 Approach Numbering

If the filter option is provided on both approaches, then approach timers 3 and 4 are used by the right turn detectors as shown in the movement diagrams of Figure 14. The use of these timers is specified in the standard personalities, but can be changed to suit the numbering of other detectors if necessary. If the filter option is only provided on one approach, then that approach would normally use approach timer 3.

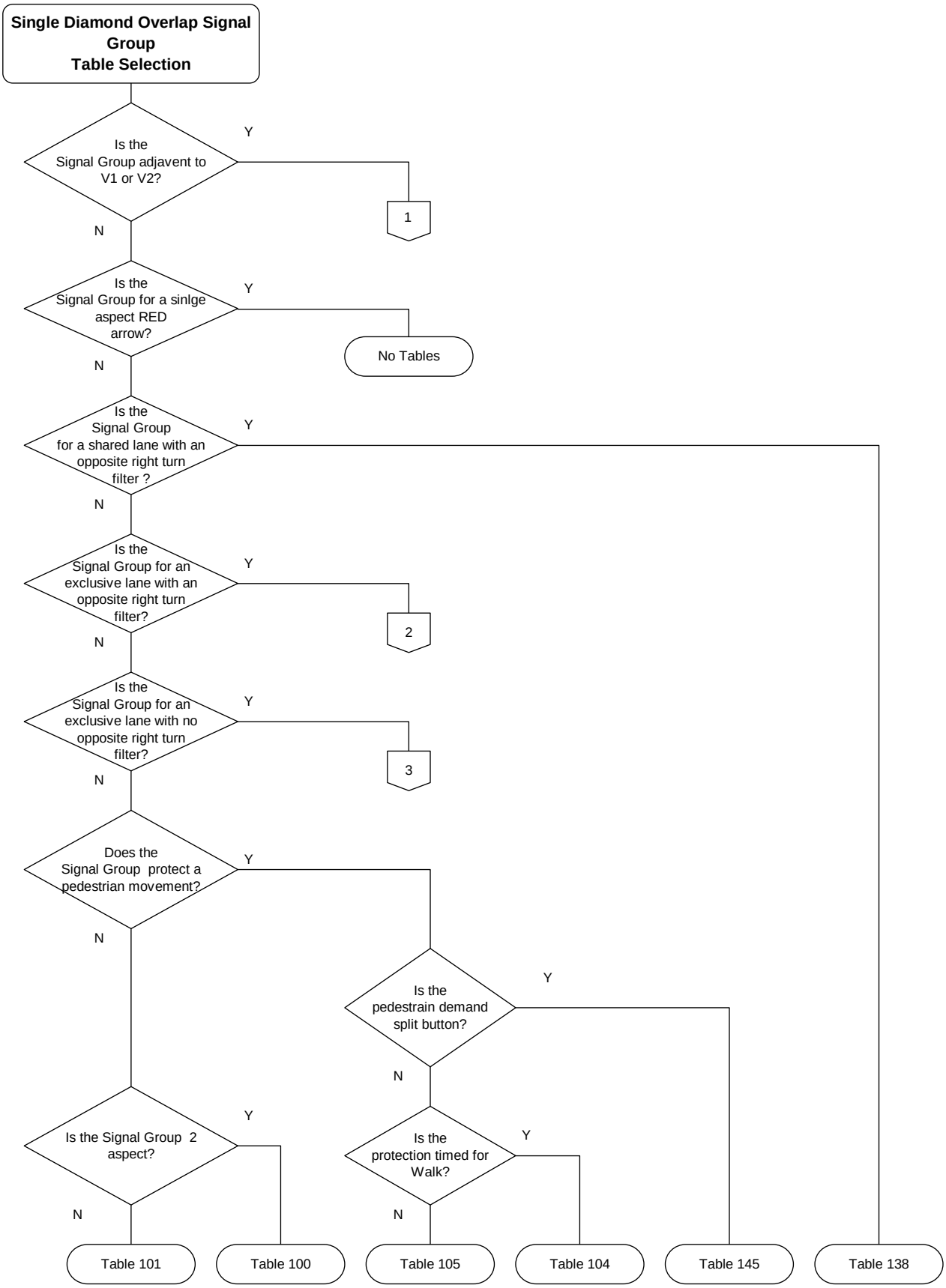
4.8 Plan Requirements

The plan requirements for a single diamond overlap with filter option are the same as VD018-5 except that the plan must refer to both VD018-5 and VD018-14.

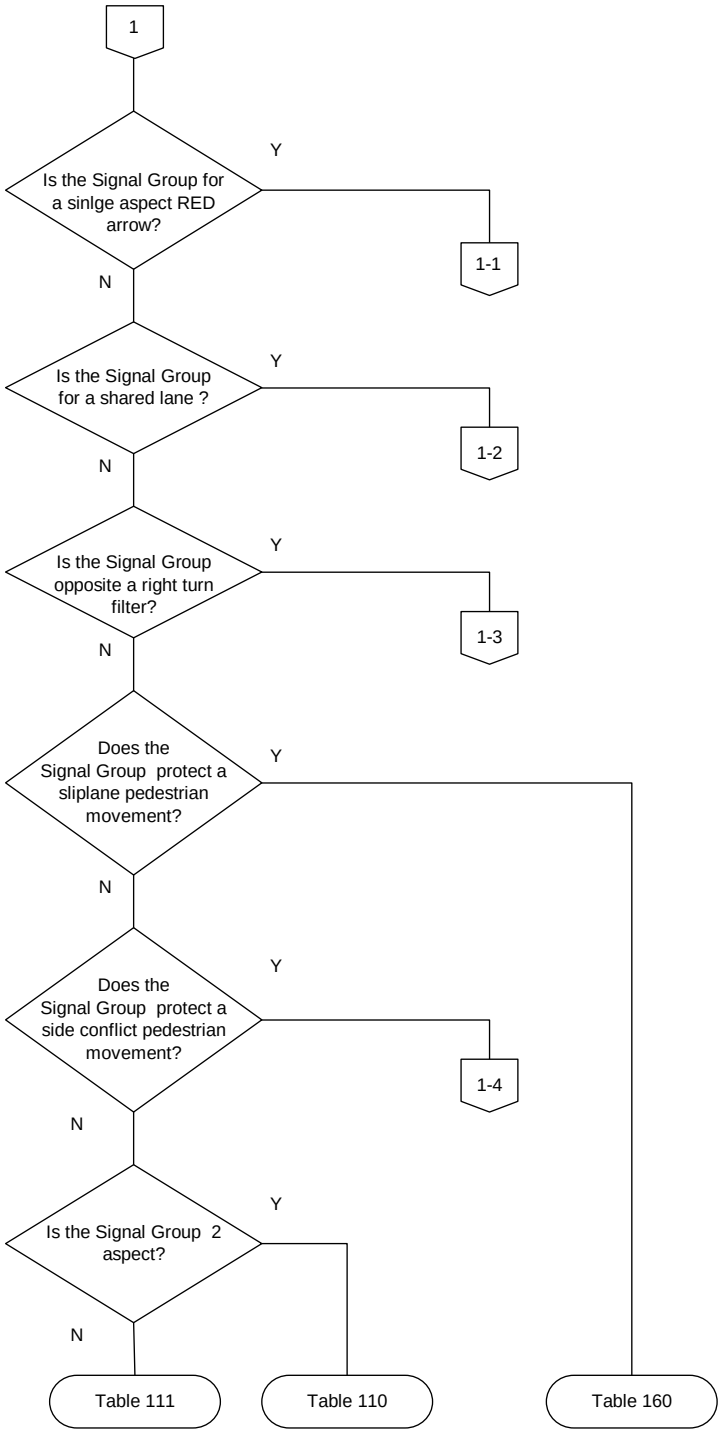
Labelling of vehicle groups, labelling and numbering of detectors, provision of signal group/phase chart etc. is carried out as described in VD018-5 or the other relevant standards.

5 Standard Table Selection Charts

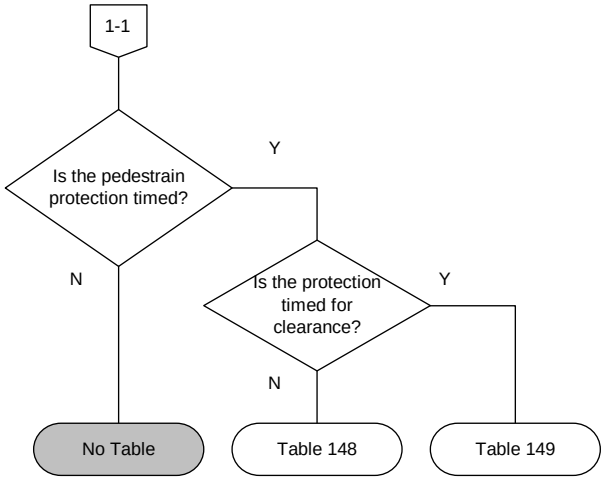
5.1 Main Selection Chart



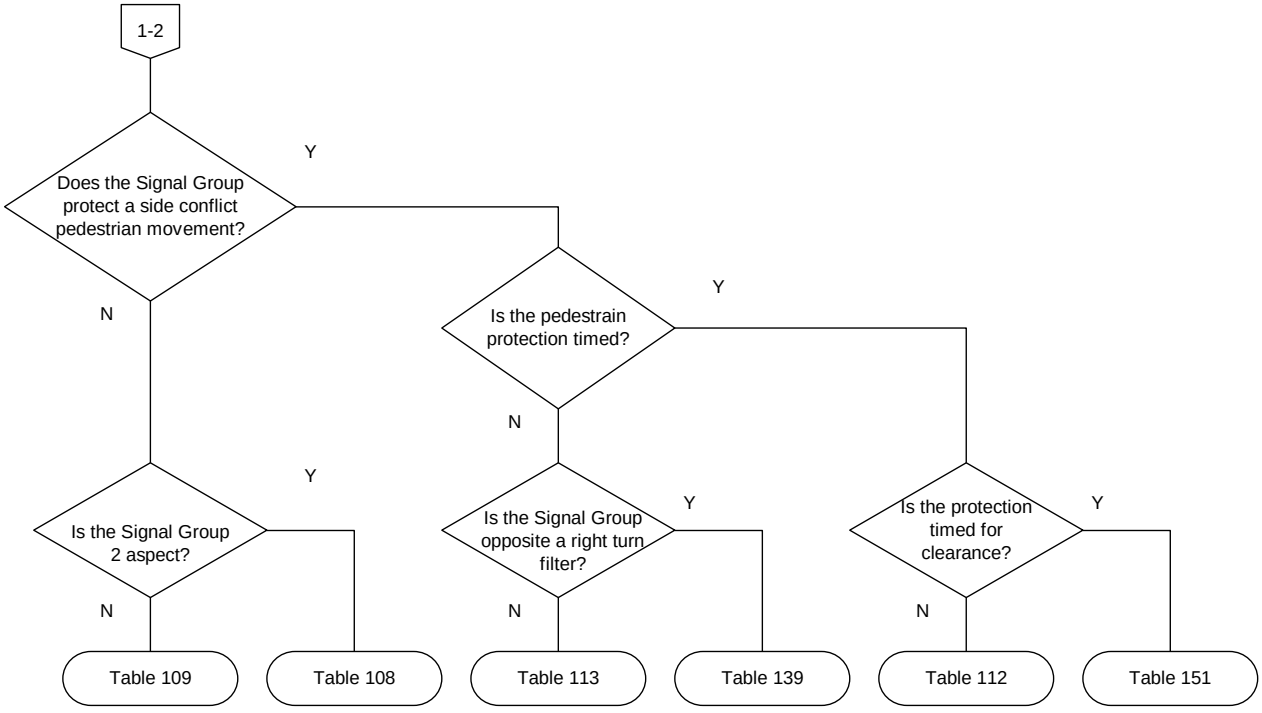
5.2 Adjacent Left Turn Selection Chart – Sheet 1



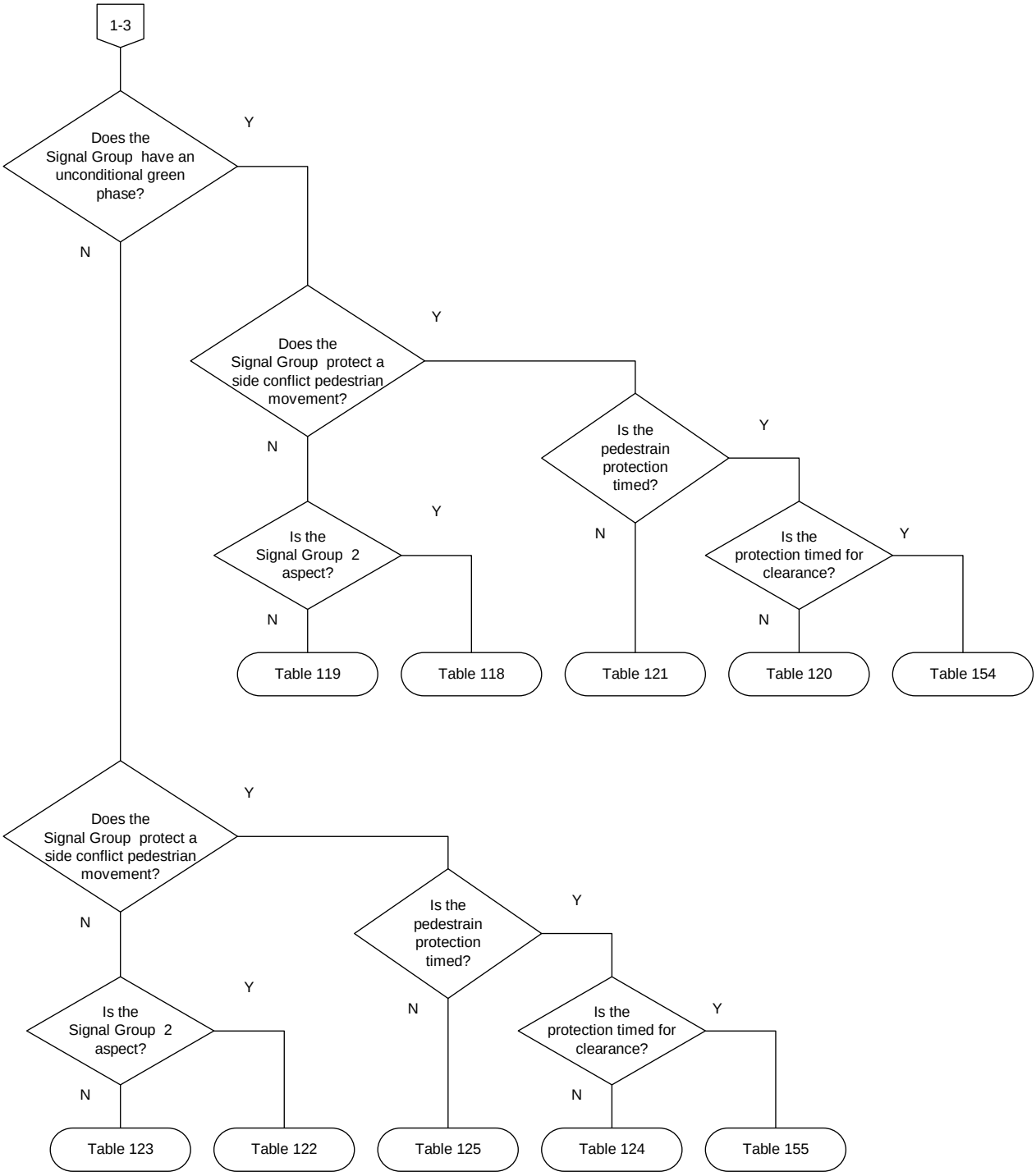
5.3 Adjacent Left Turn Selection Chart – Sheet 1-1



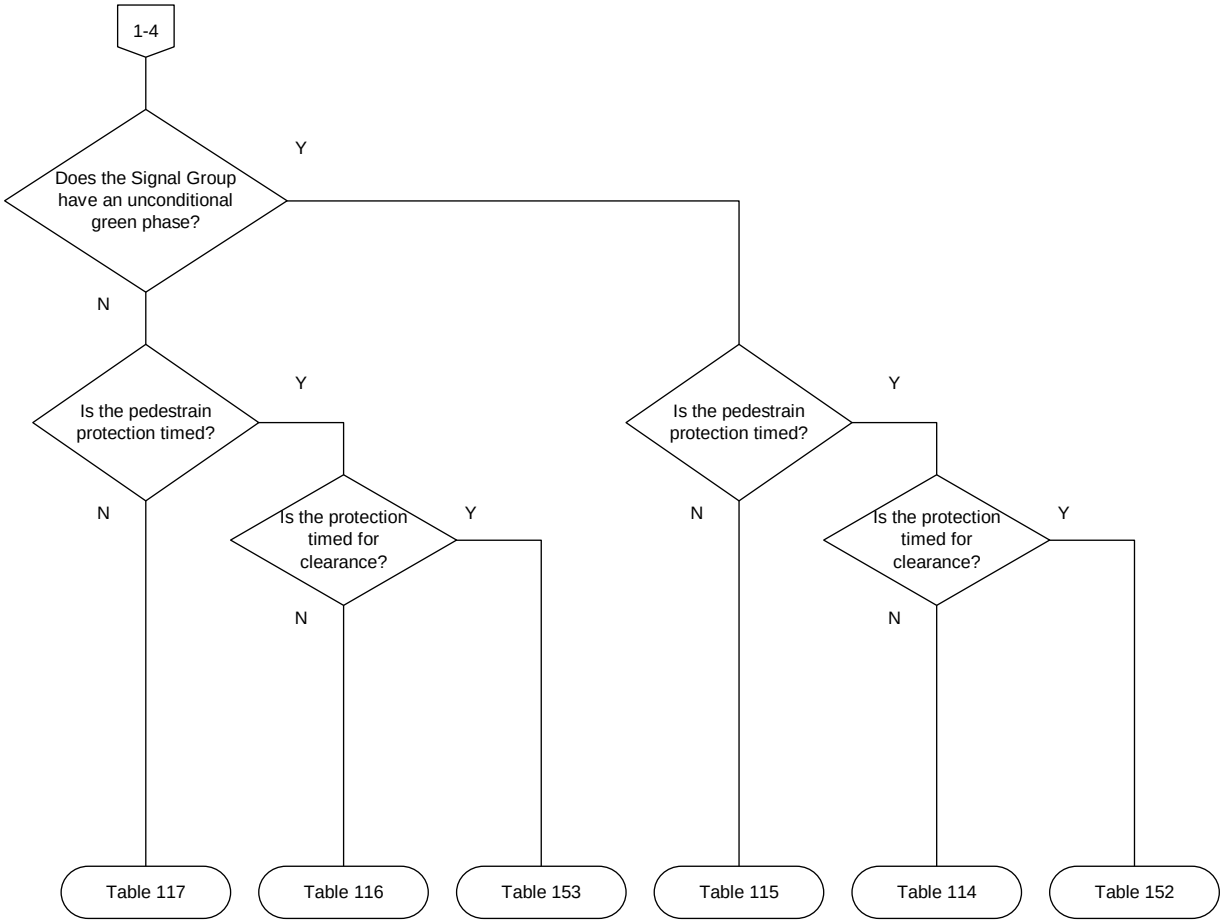
5.4 Adjacent Left Turn Selection Chart – Sheet 1-2



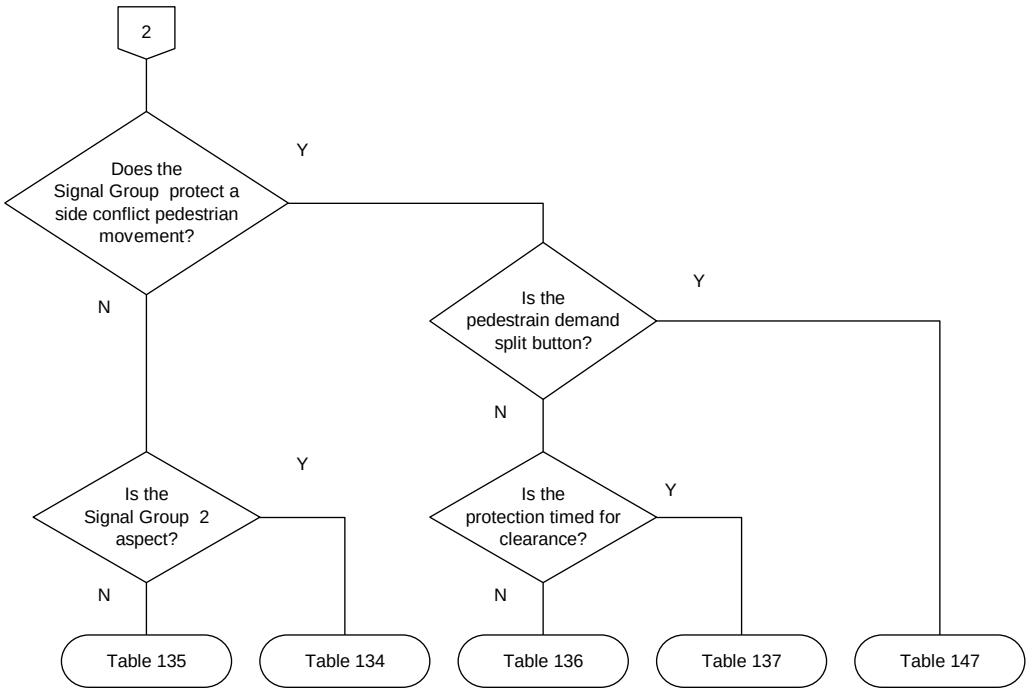
5.5 Adjacent Left Turn Selection Chart – Sheet 1-3



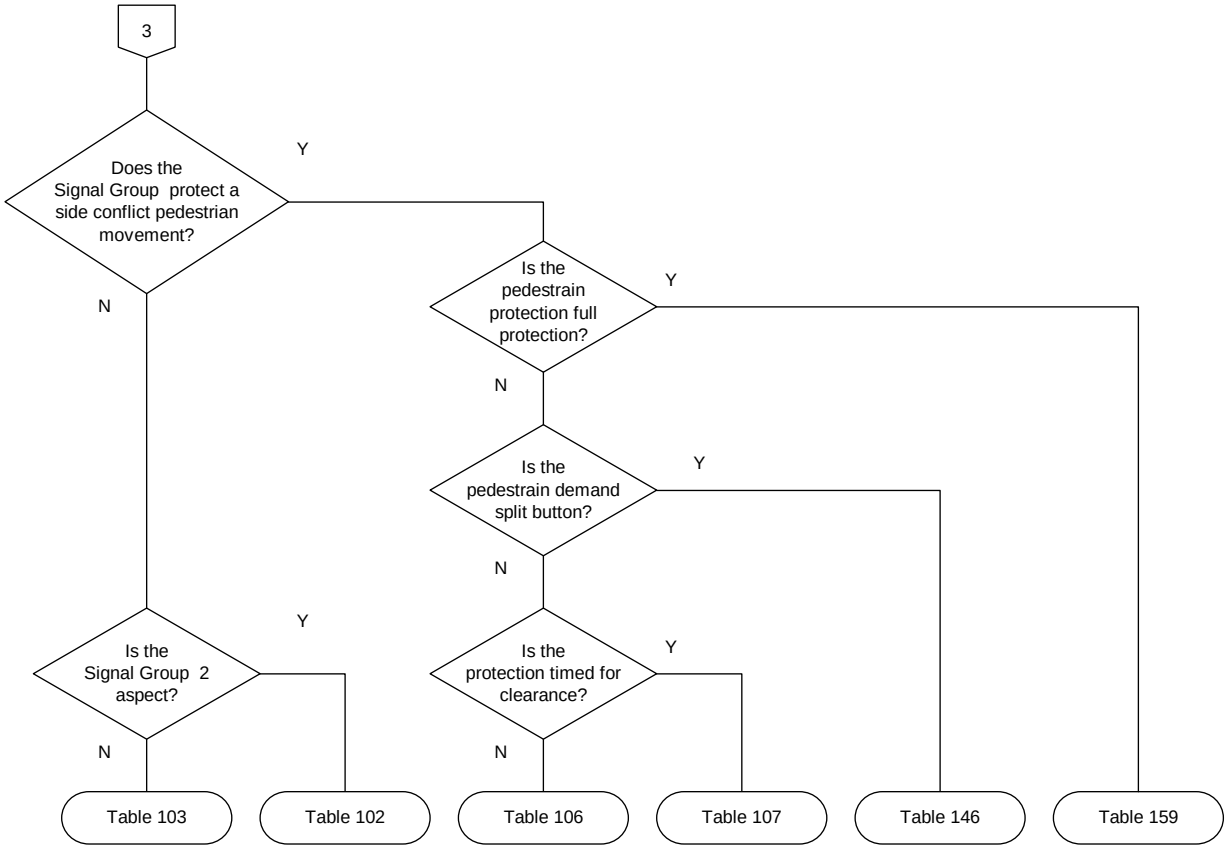
5.6 Adjacent Left Turn Selection Chart – Sheet 1-4



5.7 Complementary Left Turn Selection Chart – Sheet 2



5.8 Complementary Left Turn Selection Chart – Sheet 3



6 Standard Table Selection Guides

Each table of the Single Diamond Overlap Vehicle group Standards is covered separately, illustrating the default entries in the Vehicle group Colour Table and the associated Vehicle group Condition Table. Entries in the Vehicle group Minimum Table and the Vehicle group Special Movement Table are also shown where these are required.

The tables illustrated are for the particular case of a 5, 6 or 7 phase intersection although the tables may be extended / modified.

6.1 Adjacent to V1, V2

6.1.1 Single Aspect

Pedestrian protection timed during walk	Table 148
Pedestrian protection timed during clearance	Table 149
Pedestrian protection for walk & clearance	Table 150

6.1.2 Two Aspect

No pedestrian conflict.

Shared lane	Table 108
Exclusive lane, no opposite right turn filter	Table 110
Exclusive lane, optional opposite right turn filter – unconditional green phase	Table 118
Exclusive lane, optional opposite right turn filter – no unconditional green phase	Table 122

6.1.3 Standard Three Aspect

Slip lane pedestrian conflict.

Exclusive lane, no opposite right turn filter	Table 160

The following table should be used for a shared left turn lane.

	No Pedestrian	Pedestrian Protection		
		timed during walk	timed during clearance	for walk & clearance
No opposite right turn filter	109	112	151	113
Optional opposite right turn filter	109	112	151	139

The following table should be used for an exclusive left turn lane with no opposite right turn filter.

	No Pedestrian	Pedestrian Protection		
		timed during walk	timed during clearance	for walk & clearance
Unconditional green phase	111	114	152	115
No unconditional green phase		116	153	117

The following table should be used for an exclusive left turn lane with optional opposite right turn filter.

	No Pedestrian	Pedestrian Protection		
		timed during walk	timed during clearance	for walk & clearance
Unconditional green phase	119	120	154	121
No unconditional green phase	123	124	155	125

6.2 Adjacent to V5, V6

6.2.1 Single Aspect

Pedestrian protection timed during walk	Table 30
Pedestrian protection timed during clearance	Table 44
Pedestrian protection for walk & clearance	Table 71

6.2.2 Two Aspect

No pedestrian conflict.

Shared lane	Table 100
Exclusive lane, no opposite right turn filter	Table 102
Exclusive lane, opposite right turn filter – one filter phase	Table 100
Exclusive lane, opposite right turn filter – two filter phases	Table 134

6.2.3 Standard Three Aspect

Slip lane pedestrian conflict.

Exclusive lane, no opposite right turn filter	Table 159

The following table should be used for a shared left turn lane.

	No Pedestrian	Pedestrian Protection		
		timed during walk	timed during clearance	for walk & clearance
	101	104	145	105
Opposite right turn filter with two filter phases				138

The following table should be used for an exclusive left turn lane with no opposite right turn filter.

	No Pedestrian	Pedestrian Protection		
		timed during walk	timed during clearance	for walk & clearance
	103	106	146	107

The following table should be used for an exclusive left turn lane with opposite right turn filter.

	No Pedestrian	Pedestrian Protection		
		timed during walk	timed during clearance	for walk & clearance

One filter phase	101	104	145	105
Two filter phases	135	136	147	137

6.3 Vehicle Group Tables

The Single Diamond Overlap Tables below will work for 5, 6 and 7 Phase Single Diamond Overlap designs. The 7 phase designs, although rare may occur at such sites as Fire Stations, Train crossings etc.

The diamond phase must be E, F or G phases. Generally the diamond phase is used for the main road. To use these tables for an application where the diamond phase is to be used for the side roads care must be taken to set up the intersection to operate correctly. Attention must be given to sequence order, pivot phases, etc.

The following tables will work in 5, 6 and 7 phase Single Diamond Overlap designs:

- Tables 100 - 111 inclusive.
- Tables 116 & 117.
- Tables 122 - 125 inclusive (filter option only).

The following tables will work in 6 and 7 phase (not 5 phase) Single Diamond Overlap designs:

- Tables 112 - 115 inclusive.
- Tables 118 - 121 inclusive (filter option only).
- Table 139 (filter option only).

The following tables have been made to suit specific situations not covered by tables 100, 101, 104, and 105.

- Tables 134 - 138 inclusive.

The following tables will work in the RTA Standard Double Diamond Overlap Design see Standard for Double Diamond Overlap Phasing [15]:

- Tables 126 - 133 inclusive.
- Tables 140 - 144 inclusive (filter option only).
- Tables 156 - 158 inclusive.
- Tables 161 - 164 inclusive.