

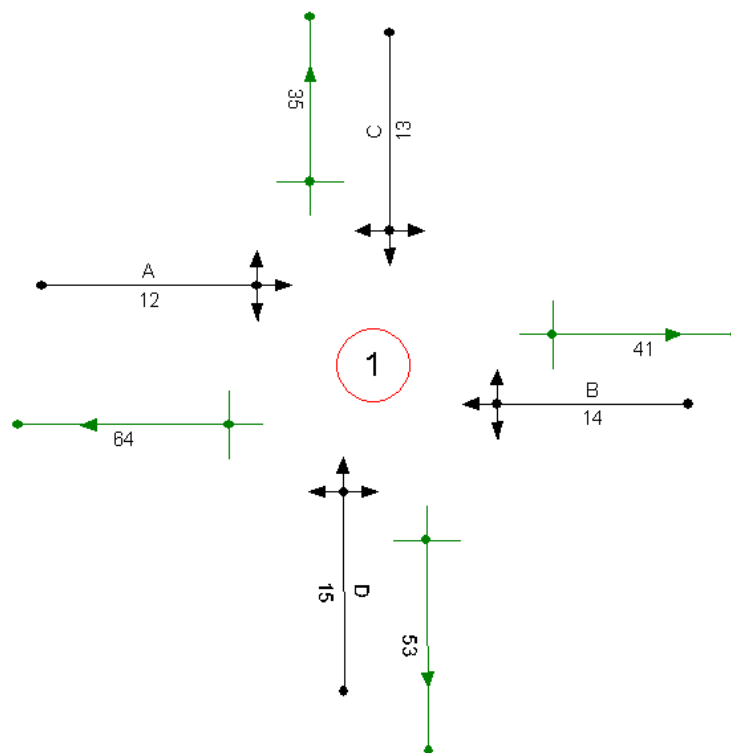
## TranEd – Phase Intergreen Conversion Tool

### 1. Introduction

To speed up the process of transferring Intergreens from phases to Links and to reduce errors, a Converter Tool has been written for TranEd. If Intergreens are to be calculated initially on a link to link basis, then the Converter Tool will not be required. However, there are many examples where a TRANSYT model is prepared from LINSIG models or directly from controller specifications which are both phase based. In any event, a design will need phase Intergreens to be calculated for the controller configuration and it makes sense to carry out these calculations first.

### 2. The Conversion Tool

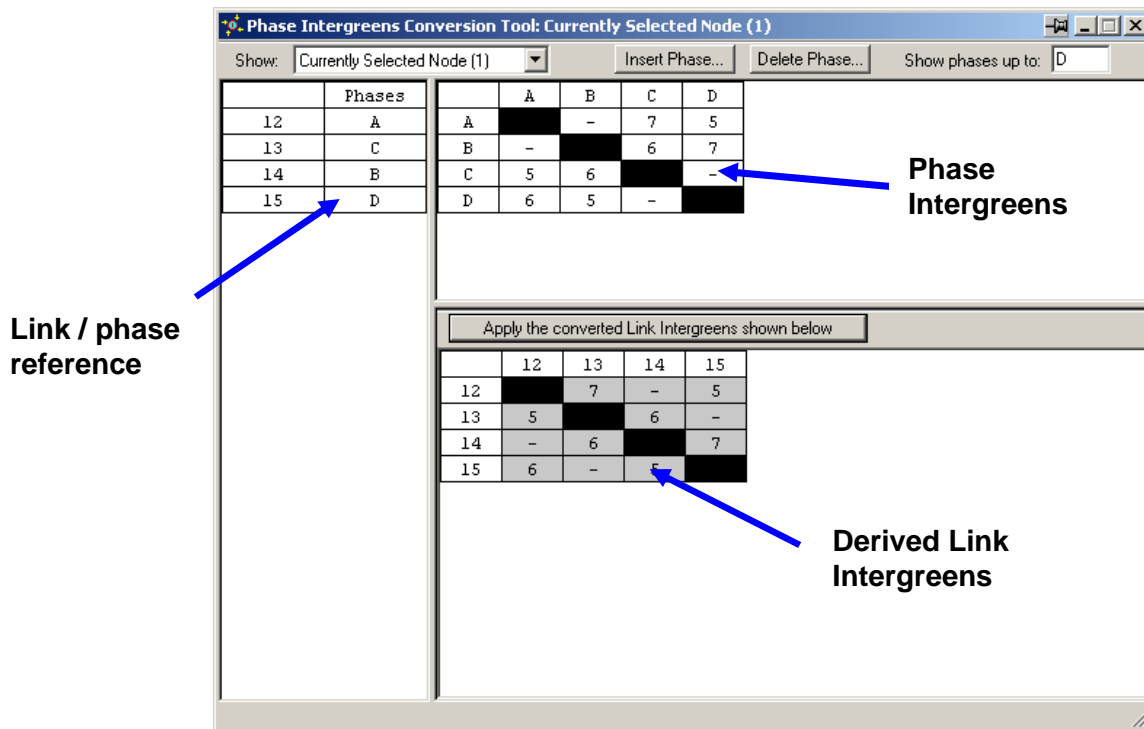
The Converter Tool functions as a specific view in TranEd and can be divided into three elements. A table showing the phase Intergreens, a table which allows each link to be cross referenced with a controlling phase and a link Intergreen matrix which shows what the link Intergreens would be if the conversion is activated. Take the example of a simple cross roads controlled by 4 phases.



**Fig 1 – Link and Phase Allocation in TranEd**

The Link allocation and the controlling Phase is shown in Fig 1; the Phase Conversion Tool is shown in Fig 2. The Phases can be added by specifying that there are 4 phases to show in the top right hand corner of the View. The Phase Intergreens are entered in the matrix created in the top right of the view, and the association between each link in TranEd and the controlling phase is made in the left hand side of the view. As this information is added,

corresponding link intergreens are derived in the Link Intergreen matrix at the bottom right of the view. It should be noted that these values are 'read only' and can only be changed by editing the information in the other two areas of the view.



**Fig 2 – Phase Conversion Tool**

Once this has been completed, select the 'Apply the Link Intergreens shown below' button to transfer the Intergreens into the Link Intergreens View. There are circumstances where this may not be allowed (see Section 5). If Intergreens need to be changed in the future, the Phase Intergreens can be updated and the 'Apply the converted Link Intergreens...' button used again to update the Link Intergreens.

### 3. Conversion Logic

If each phase is only referenced to one link, then the conversion is a simple one to one relationship. Where a phase can control more than one link, then a single phase intergreen will be copied to number of link intergreens. However, when multiple phases control a link, (i.e. when filter arrows and indicative arrows are involved in the signalling) the situation becomes more complicated.

In TranEd and LINSIG, Intergreens are used for two purposes. Whilst the Intergreen matrix shows the minimum period of separation between any pair of phases, a blank in the matrix also indicates that phases are not in conflict. Generally speaking conflicts / intergreens away from filter arrows are not required because a Filter Phase would be associated with a full green phase. However, TranEd cannot make this distinction and as such it is important that all conflicts are entered into the Phase Intergreen matrix; in particular those from a filter phase which might normally be omitted.

The second complication arises from the situation where the Intergreen between two links can take a value from more than one pair of phases. Again, this could easily arise with the use of a filter where the traffic movement would have an Intergreen to a filter and another to

the full green phase. In practice, if the Intergreens have been correctly calculated, the values should be the same. However, a set of rules has been derived to make this conversion quick and easy to use. They are defined as follows:-

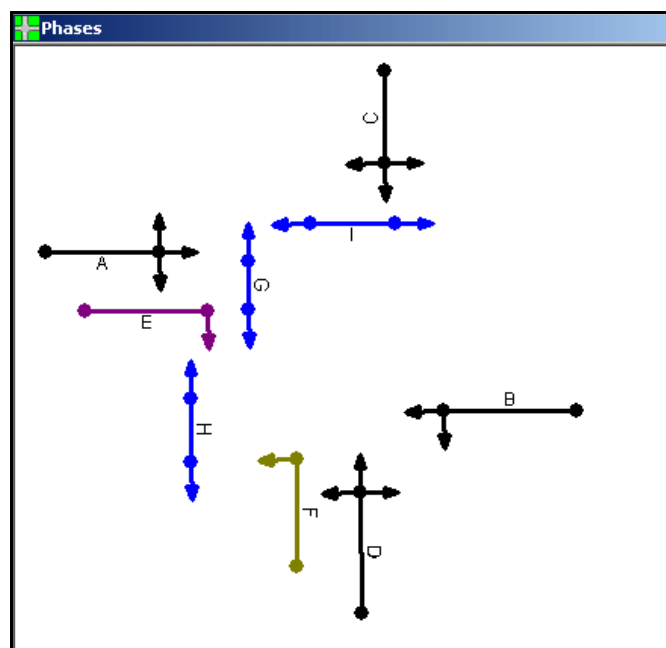
- (a) If a pair of links are matched to Intergreens which are all non conflicting, then the conversion tool will select the links to be also non conflicting.
- (b) If a pair of links are matched to Intergreens which are all conflicting, then the conversion tool will select the links to be also conflicting using the highest Intergreen (for safety reasons).
- (c) If a pair of links are matched to Intergreens in which at least one Intergreen is non conflicting (n/c), then the conversion tool will select the links to be also not conflicting on the basis that the least onerous phase will be controlling the link.

An explanation of the operation and modelling of single aspect phases (filters and indicative arrows) is given in Appendix A.

Examples explaining the application of the rules and in particular with reference to single aspect phases are given below.

#### 4. Worked Example in using the phase Converter Tool

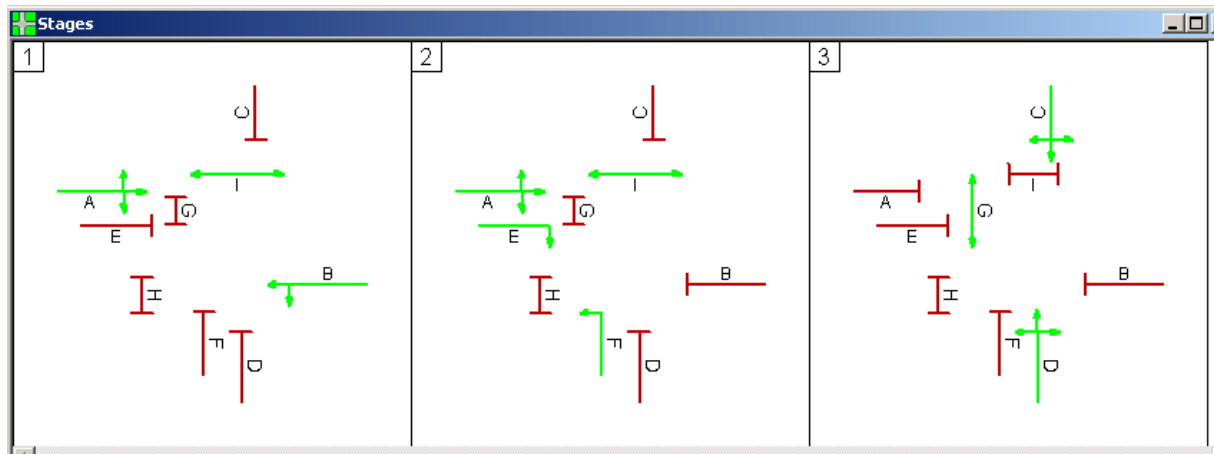
To explain the use of the phase Converter Tool, and the logic behind it, consider the example below which represents a simple crossroads with parallel pedestrian facilities. The phase structure (Fig 3) has one traffic phase per approach (A to D), an indicative arrow for right turning traffic on the main road (E), a left filter arrow for left turners out of the side road (F) and three parallel pedestrian phases (G, H and I). The phase Intergreens (Fig 4) and the stage structure (Fig 5) have all been taken from LINSIG for convenience. The stages selected for analysis run the main road (stage 1) the early cut off (stage 2) and the side road (stage 3). The Pedestrian phase H is not active in this sequence.



**Fig 3 – Phase Structure**

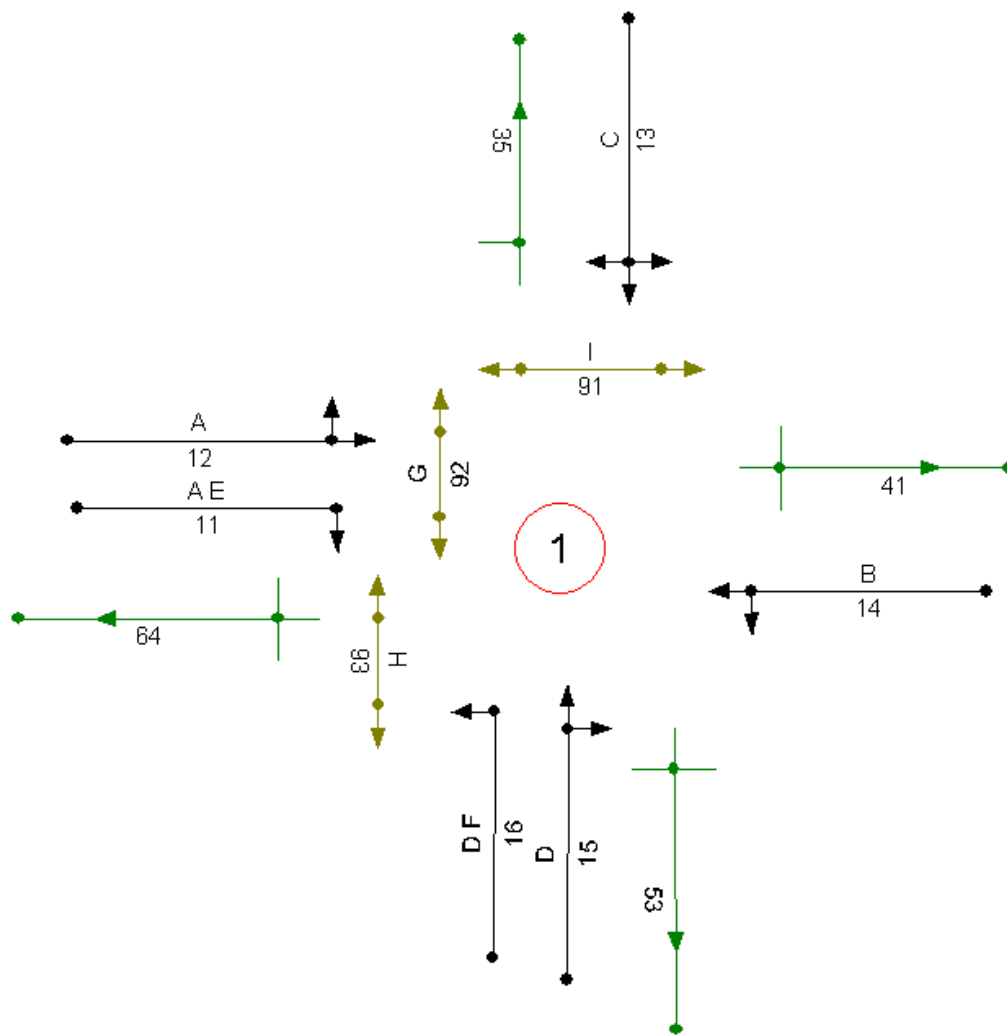
Intergreen Matrix									
	A	B	C	D	E	F	G	H	I
A		-	7	5	-	-	5	-	-
B	-		6	7	3	7	-	8	-
C	5	6		-	5	5	-	9	5
D	6	5	-		6	-	-	7	8
E	-	5	7	5		-	5	-	-
F	-	-	-	-	-		-	-	-
G	8	-	-	-	8	-		-	-
H	-	8	8	8	-	8	-		-
I	-	-	12	12	-	-	-	-	

**Fig 4 – Phase Intergreens**

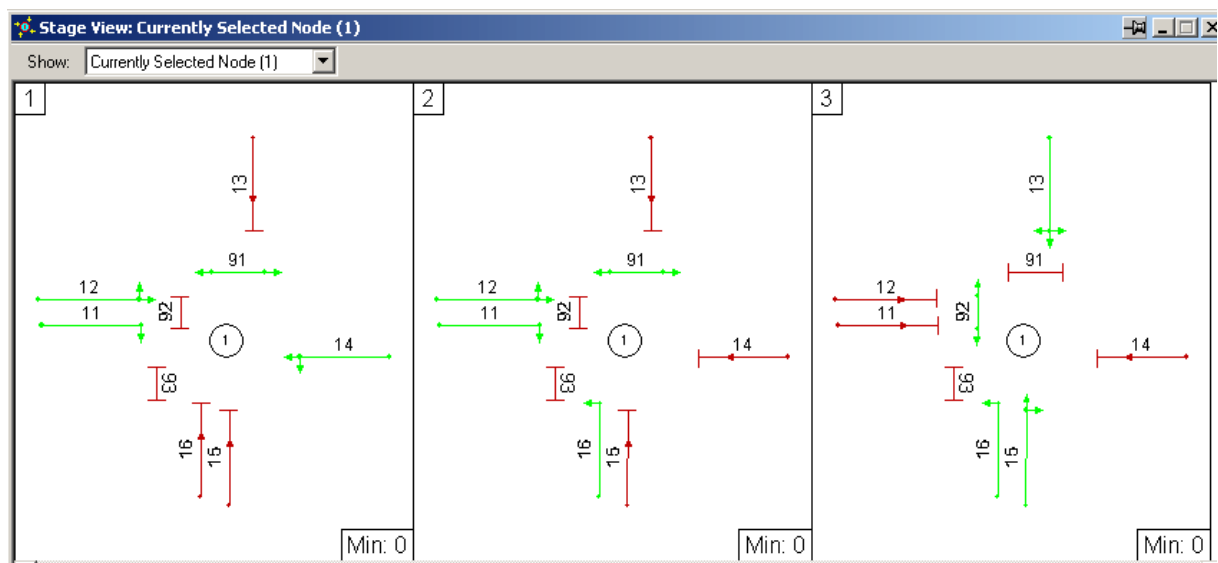


**Fig 5 – Stage Structure**

A TranEd model of the above junction is shown in Fig 6. In this view, the link text format has been changed to show the controlling phase(s) (above) and the link number (below). TRANSYT and indeed TranEd, only need to know when a link is receiving a 'green' signal. It does not know what type of phase is providing that green signal. However, these 'arrow' phases cannot be simply ignored because we are going to use their Intergreens to determine link Intergreens and conflicts. For example, in the case of filters it is likely that the left turn traffic movement controlled by phases F and D will have fewer conflicts than the adjacent ahead movement controlled by phase D and as such the opportunity for a green signal will be increased. In the example below, if phase F were to be ignored, then link 16 would not be green in stage 2 (Fig 7).



**Fig 6 – Junction in TranEd Network View**



**Fig 7 – Stages and Link configuration in TranEd**

## Entering Data into the Phase Converter Tool

The phase Converter Tool (Fig 8) is set up to transfer the phase Intergreens (Fig 4) into Link Intergreens specified in the TranEd network (Fig 6). The right hand side of the View shows two Intergreen Tables. The top table shows the phase Intergreens which have been copied manually from the Phase Data (Fig 3). The Table below shows what the link Intergreens will be if the converted link intergreens are transferred to the TranEd model. Note that at this point the converter is not allowing any conversion to take place; you will notice that the box which says 'Apply the converted Link Intergreens shown below' is inactive.

The Converter Tool will not allow the implementation of converted Intergreens to take place under either of the following two conditions:-

- (a) if the phase Intergreen matrix is not symmetrical
- (b) if there are stages already constructed which would cause a conflict.

In this example, it is if the former which applies and is explained further in 'Conversion 5'. The later case is explained later under Conflict Errors preventing Transfer.

Phase Intergreens Conversion Tool: Currently Selected Node (1)										
Show:	Currently Selected Node (1)		Insert Phase...	Delete Phase...	Show phases up to:	I				
	Phases	A	B	C	D	E	F	G	H	I
11	A,E	A	-	7	5	-	-	5	-	-
12	A	B	-	6	7	3	7	-	8	-
13	C	C	5	6	-	5	5	-	9	5
14	B	D	6	5	-	6	-	-	7	8
15	D	E	-	5	7	5	-	5	-	-
16	D,F	F	-	-	-	-	-	-	-	-
91	I	G	8	-	-	8	-	-	-	-
92	G	H	-	8	8	8	-	8	-	-
93	H	I	-	-	12	12	-	-	-	-
Apply the converted Link Intergreens shown below										
	11	12	13	14	15	16	91	92	93	
11	-	-	7	-	5	-	-	5	-	
12	-	-	7	-	5	-	-	5	-	
13	5	5	-	6	-	-	5	-	9	
14	-	-	6	-	7	7	-	-	8	
15	6	6	-	5	-	-	8	-	7	
16	-	-	-	-	-	-	-	-	-	
91	-	-	12	-	12	-	-	-	-	
92	8	8	-	-	-	-	-	-	-	
93	-	-	8	8	8	8	-	-	-	

Fig 8 – Phase Converter Tool

### Conversion 1 – Link 12 to 13

Link 12 is controlled by phase A; Link 13 by phase C (Fig 6).  
Hence the Intergreen from Link 12 to 13 will take the value A to C which will be 7 seconds (Fig 4). The TranEd computed link Intergreen is shown below (Fig 9).

Apply the converted Link Intergreens shown below									
	11	12	13	14	15	16	91	92	93
11		-	7	-	5	-	-	5	-
12	-		7	-	5	-	-	5	-
13	5	5		6	-	-	5	-	9
14	-	-	6		7	7	-	-	8
15	6	6	-	5		-	8	-	7
16	-	-	-	-	-		-	-	-
91	-	-	12	-	12	-		-	-
92	8	8	-	-	-	-	-		-
93	-	-	8	8	8	8	-	-	

**Fig 9 – Link Intergreen from 12 to 13 (not yet converted)**

### Conversion 2 – Link 12 to 14

Link 12 is controlled by phase A; Link 14 by phase B (Fig 6).  
Hence the Intergreen from Link 12 to 14 will take the value A to B which will be n/c (non conflicting) (Fig 4). TranEd will therefore take the link Intergreen to be non conflicting by putting a dash in the cell.

Apply the converted Link Intergreens shown below									
	11	12	13	14	15	16	91	92	93
11		-	7	-	5	-	-	5	-
12	-		7	-	5	-	-	5	-
13	5	5		6	-	-	5	-	9
14	-	-	6		7	7	-	-	8
15	6	6	-	5		-	8	-	7
16	-	-	-	-	-		-	-	-
91	-	-	12	-	12	-		-	-
92	8	8	-	-	-	-	-		-
93	-	-	8	8	8	8	-	-	

**Fig 10 – Link Intergreen from 12 to 14 (not yet converted)**

### Conversion 3 – Link 11 to 14

Link 11 is controlled by phases A and E, Link 14 by phase B. phases A and B are full traffic phases whilst phase E is an indicative arrow.  
Hence the Intergreens which affect these links are as follows:-

phase A to B Intergreen which is n/c  
phase E to B Intergreen which is 3 seconds

Hence TranEd will compute the Intergreen from Link 11 to 14 to be n/c. In TRANSYT this is the correct scenario because Link 11 will be green at the same time as 14, irrespective of the operation of the indicative arrow (Fig 11).

Apply the converted Link Intergreens shown below									
	11	12	13	14	15	16	91	92	93
11		-	7	-	5	-	-	5	-
12	-		7	-	5	-	-	5	-
13	5	5		6	-	-	5	-	9
14	-	-	6		7	7	-	-	8
15	6	6	-	5		-	8	-	7
16	-	-	-	-	-		-	-	-
91	-	-	12	-	12	-		-	-
92	8	8	-	-	-	-	-		-
93	-	-	8	8	8	8	-	-	

**Fig 11 – Link Intergreen from 11 to 14 (not yet converted)**

#### Conversion 4 – Link 16 to 11

Link 16 is controlled by phases D and F, Link 11 by phases A and E. phases A and D are full traffic phases, E is an indicative arrow and F is a left Filter. The Intergreens which affect these links are as follows:-

phase D to A Intergreen which is 6 seconds  
phase D to E Intergreen which is 6 seconds  
phase F to A Intergreen which is n/c  
phase F to E Intergreen which is n/c

Hence, TranEd will compute the Intergreen from Link 16 to 11 to have a value n/c. In TRANSYT, this is the correct scenario because Link 16 will be green at the same time as Link 11 in stage 2 (Fig 12).

Apply the converted Link Intergreens shown below									
	11	12	13	14	15	16	91	92	93
11		-	7	-	5	-	-	5	-
12	-		7	-	5	-	-	5	-
13	5	5		6	-	-	5	-	9
14	-	-	6		7	7	-	-	8
15	6	6	-	5		-	8	-	7
16	-	-	-	-	-		-	-	-
91	-	-	12	-	12	-		-	-
92	8	8	-	-	-	-	-		-
93	-	-	8	8	8	8	-	-	

**Fig 12 – Link Intergreen from 16 to 11 (not yet converted)**



## Conversion 5 – Link 16 to 14

Link 16 is controlled by phases D and F, Link 14 by phase B. phases B and D are full traffic phases, F is a left Filter. The Intergreens which affect these links are as follows:-

phase D to B Intergreen which is 5 seconds

phase F to B Intergreen which is n/c

According to conversion rules, the converter will calculate the Intergreen from Link 16 to 14 to be n/c. Clearly, this is incorrect because the Intergreen should be 5 seconds since Link 16 can never run with Link 14. The error has occurred because in the original Intergreen matrix, there were no Intergreens away from the Filter. This is because in LINSIG and indeed when configuring TR2210A forms, the rules regarding filter terminations mean that the filter is normally terminated with the full green or in some cases continues to run with the full green. However, TranEd/TRANSYT cannot check for this scenario because phases are not part of the data structure and are unable to check for this. Hence, for the Converter Tool to work correctly, the user must specify conflicts away from the Filter phase. This is the reason why the Converter Tool will not allow the Intergreens to be converted. To resolve the problem, look for green coloured squares in the phase Intergreen table which indicates cells which have no matching pair (not symmetrical) and therefore should be the ones to check first. The absolute value of the Intergreen is not strictly critical since the Converter Tool will take the highest Intergreen to the filter or full green anyway. Since, in practice, these two Intergreen values should be the same, an entered value of zero or one will suffice.

Phase Intergreens Conversion Tool: Currently Selected Node (1)										
Show:	Currently Selected Node (1)	Insert Phase...	Delete Phase...	Show phases up to:						
	Phases	A	B	C	D	E	F	G	H	I
11	A,E		-	7	5	-	-	5	-	-
12	A	-		6	7	3	7	-	8	-
13	C	5	6		-	5	5	-	9	5
14	B	6	5	-		6	-	-	7	8
15	D	-	5	7	5		-	5	-	-
16	D,F	-	0	0	-	-		-	0	-
91	I	8		-	8	-				-
92	G	-	8	8	8	-	8			-
93	H	-	-	12	12	-	-	-		

Apply the converted Link Intergreens shown below										
	11	12	13	14	15	16	91	92	93	
11		-	7	-	5	-	-	5	-	
12	-		7	-	5	-	-	5	-	
13	5	5		6	-	-	5	-	9	
14	-	-	6		7	7	-	-	8	
15	6	6	-	5		-	8	-	7	
16	-	-	-	5	-		-	-	7	
91	-	-	12		12	-		-	-	
92	8	8	-	-	-	-	-		-	
93	-	-	8	8	8	8	-	-		

Fig 13– Calculated Link Intergreens (ready for conversion)

To summarise, the Converter Tool will not transfer Intergreens into TranEd unless the phase matrix is completely symmetrical (i.e. no green coloured cells). This ensures that the user checks for missing conflicts before making the transfer. Providing the conditions for the conversion are met, the button 'Apply the converted Link Intergreens shown below' will be activated (Fig 13). Clicking the button will transfer the Intergreens (Fig 13) into the Link Intergreen View (Fig 14).

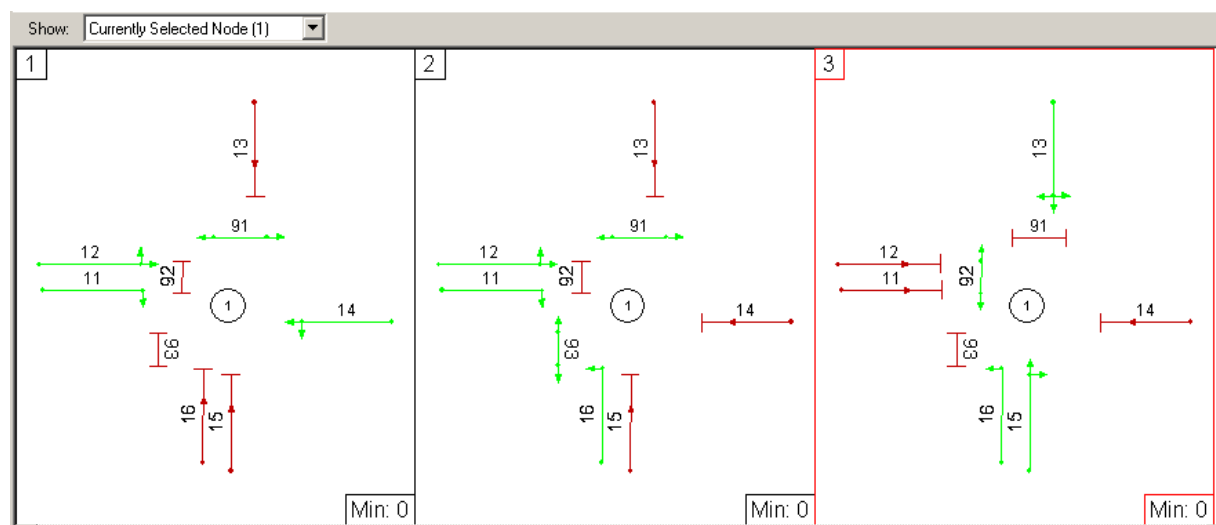
Link Intergreens View: Currently Selected Node (1)									
Show:	Currently Selected Node (1)								
	11	12	13	14	15	16	91	92	93
11		-	7	-	5	-	-	5	-
12	-		7	-	5	-	-	5	-
13	5	5		6	-	-	5	-	9
14	-	-	6		7	7	-	-	8
15	6	6	-	5		-	8	-	7
16	-	-	-	5	-		-	-	7
91	-	-	12	-	12	-		-	-
92	8	8	-	-	-	-	-		-
93	-	-	8	8	8	8	-	-	

**Fig 14 – Link Intergreen matrix (after conversion)**

## 5. Conflict Errors preventing Transfer

Generally speaking, if you use TranEd to construct a network in a particular order (e.g. phase Intergreens, link Intergreens then stage construction), then a problem will not arise. However, under different circumstances, particularly if Intergreens are being added to a TranEd file for checking purposes, then the Converter Tool will not permit the transfer of an Intergreen if it would cause a conflict.

For example, consider the following stages (Fig 15) set up in error (an easy mistake in TRANSYT since conflicts are determined indirectly). Note that the left filter (link 16) is in conflict with the pedestrians (link 93) in stage 2.



**Fig 15 – Stages Generated in Error without Link Intergreens**

Phase Intergreens Conversion Tool: Currently Selected Node (1)										
Show: <span>Currently Selected Node (1)</span>		Insert Phase...		Delete Phase...		Show phases up to: <span>1</span>				
	Phases	A	B	C	D	E	F	G	H	I
11	A, E		-	7	5	-	-	5	-	-
12	A	-		6	7	3	7	-	8	-
13	C	5	6		-	5	5	-	9	5
14	B	6	5	-		6	-	-	7	8
15	D	-	5	7	5		-	5	-	-
16	D, F	-	0	0	-	-		-	0	-
91	I	8	-	-	-	8	-		-	-
92	G	-	8	8	8	-	8	-		-
93	H	-	-	12	12	-	-	-	-	
Apply the converted Link Intergreens shown below										
	11	12	13	14	15	16	91	92	93	
11		-	7	-	5	-	-	5	-	
12	-		-	-	5	-	-	5	-	
13	5	5		6	-	-	5	-	9	
14	-	-	6		7	7	-	-	8	
15	6	6	-	5		-	8	-	7	
16	-	-	-	5	-		-	-	7	
91	-	-	12	-	12	-		-	-	
92	8	8	-	-	-	-	-		-	
93	-	-	8	8	8	8	-	-		

**Fig 16 – Converter Tool showing why Transfer is prohibited**

If the phase Intergreens are now added to the Converter Tool, the table of link Intergreens in the lower half of the Tool show two blue coloured cells. This indicates that the conversion cannot be carried out because there is a conflict between link 16 and 93 which is not compatible with the stage View. To correct the error, either link 16 or link 93 must be made inactive in stage 2.

## Appendix A – Use of Single Aspect Phases in TRANSYT

This is intended as a guide on how indicative arrows and filter phases operate, how this is represented in a TRANSYT model and how this is simplified when using the phase converter tool in TranEd.

### (a) Filter Arrows

Consider the signal arrangement below (Fig A1), which shows a full green phase (D) and a left filter phase (F). Traffic turning left will be controlled initially by the Filter (phase F) then by the full green (phase D). Modelling this scenario in LINSIG requires the user to specify that the left turn traffic movement is controlled by phases F and D. In TRANSYT the user will need to specify the stage in which phase F runs and the stage in which phase D runs. In TranEd, when using the phase Converter, the situation will be similar to LINSIG in that the user simply specifies that the left turn traffic movement is referenced to both phase F and D.

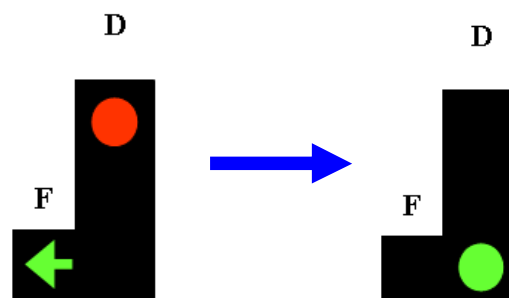


Fig A1 – Use of Filter Arrows

### (b) Indicative Arrows

Consider the signal arrangement shown below (Fig A2), which shows a full green phase (A) and an Indicative Arrow phase (E). Traffic turning right will be controlled initially by the full green (phase A) and the movement will be opposed. When the opposing traffic is stopped, right of way is given to the right turn by use of the Indicative Arrow (phase E). Modelling this scenario in LINSIG requires the user to specify that the right turning traffic is controlled by phases A and E. In TRANSYT the user will need to specify the stages in which traffic can turn right. In TranEd, when using the phase Converter, the situation is again similar to LINSIG in that the user simply specifies that the right turning traffic is referenced to both phases A and E.

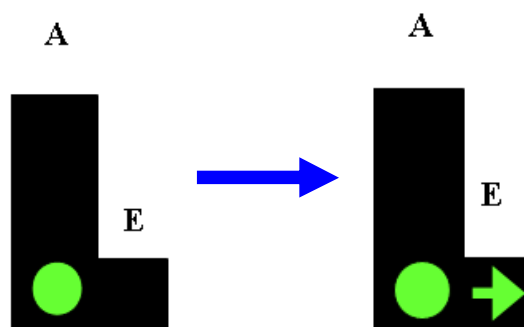


Fig A2 – Use of an Indicative Arrow