FIELD MANUAL
FOR CONFIGURING TRAFFIC-RESPONSIVE CONTROL ON TxDOT CLOSED-LOOP SYSTEMS

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DISCLAIMER

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CHAPTER 1: INTRODUCTION

OVERVIEW

Closed-loop traffic control systems can be operated in either Time-of-Day (TOD) mode or Traffic Responsive Plan Selection (TRPS) mode. When properly configured, the TRPS mode has the greatest potential to provide optimal operation due to its ability to accommodate abnormal traffic conditions such as incidents, special events, and holiday traffic. Most importantly, TRPS mode can reduce the need for frequent redesign/updates to signal timing plans.

The TRPS mode is designed to continuously monitor the traffic flow pattern and select the most appropriate timing plan from a pre-programmed library. Thus, proper configuration of TRPS mode requires:

- a sufficient number of system detectors placed outside the influence of cyclic queues at the stop bar,
- a library of timing plans that can accommodate all traffic conditions possible at the selected site, and
- proper configuration of numerous TRPS parameters, which include cycle level parameters, directionality parameters, smoothing factors, and weighting factors.

If any of the above requirements is not met, the TRPS mode may select inappropriate timing plans or cause the closed-loop system to run in a continuous transitioning state.

This field manual is intended to provide a step-by-step guide for installation and operation of TRPS mode at typical TxDOT arterials consisting of three to six signalized intersections. The guide is divided into the following sections:

- Chapter 2 provides data for implementing TRPS control at ideal sites.
- Chapter 3 provides customized guidelines for four non-ideal sites.
- Chapter 4 provides steps to configure TRPS mode in Eagle systems.

CHAPTER 2: IDEAL SITE

As illustrated in Figure 1, the ideal site has 13 6×6 ft system detectors placed outside the influence of queues at the stop bar. Specifically, the site has the following characteristics:

- It carries significant non-local through traffic (in both directions with unpredictable demand).
- There are two critical signals. In this example, these signals (1 and 4) are located at the two ends. Each critical intersection has six detectors.
- One non-critical signal has significant local traffic demand on the side street. Placement of system detector 7 at this signal identifies the critical approach.
- System detectors in through lanes (detectors 1, 2, 4, 5, 7, 8, 9, 11, and 13) are located (or can be located) at least 400 feet upstream of the traffic signal in the inside lanes.
- System detectors in left-turn lanes or bays (detectors 3, 6, 10, and 12) are located 300 feet upstream of the stop bar.

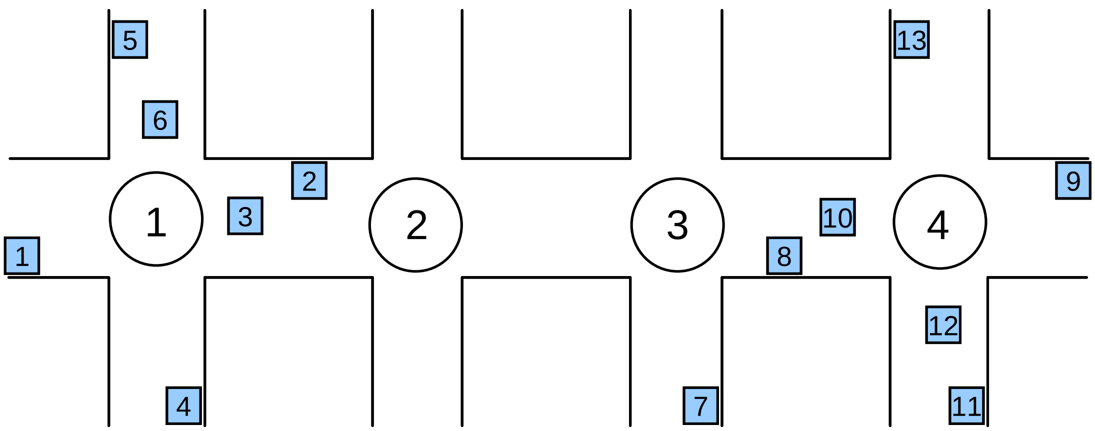


Figure 1. Ideal System Detector Locations at a Typical Site.

The ideal site may have more intersections than shown here. Table 1 provides recommended timing plans (only cycle lengths and green splits) for normal intersection operation with all eight phases. Table 2 provides recommended timing plans for intersections with side-street split phasing. Table 3 provides recommended timing plans for intersections with permissive-only phases. To apply these guidelines to a site that is not significantly different from the one shown in Figure 1 (i.e., sites with similar detector configuration but with different number of signals and with a mix of multi-phase, split- and/or permissive-only phasings on different cross streets), the appropriate timings can still be selected from these three tables. In addition, there may also be a need to adjust some splits to accommodate site specific characteristics. Finally, procedures described at the end of this chapter can be used to determine offsets and phasing sequences to provide progression. As an alternative, a signal timing optimization program (i.e., PASSER V) may also be used to accomplish this last objective. The following subsection presents an example of how these timings can be adapted for sites that are different from those shown in Figure 1.

Table 1. Recommended Timing Plans for Signals with All 8 Phases.

Timing Plan	Inter-section	Cycle	Phase							
			1	2	3	4	5	6	7	8
1	1	60	10	28	10	12	10	28	12	10
	2	60	10	30	10	10	10	30	10	10
	3	60	10	30	10	10	10	30	10	10
	4	60	10	26	11	13	13	23	11	13
2	1	100	17	29	24	30	10	36	21	33
	2	100	13	59	13	15	11	61	12	16
	3	100	10	61	13	16	14	57	13	16
	4	100	10	50	30	10	22	38	18	22
3	1	60	11	26	11	12	10	27	13	10
	2	60	10	30	10	10	10	30	10	10
	3	60	10	30	10	10	10	30	10	10
	4	60	10	26	14	10	13	23	11	13
4	1	60	10	24	12	14	10	24	12	14
	2	60	10	30	10	10	10	30	10	10
	3	60	10	30	10	10	10	30	10	10
	4	60	10	26	10	14	10	26	11	13
5	1	75	11	39	12	13	10	40	15	10
	2	75	10	45	10	10	10	45	10	10
	3	75	10	45	10	10	10	45	10	10
	4	75	10	36	14	15	11	35	13	16
6	1	60	10	30	10	10	10	30	10	10
	2	60	10	30	10	10	10	30	10	10
	3	60	10	30	10	10	10	30	10	10
	4	60	10	29	11	10	10	29	10	11
7	1	75	11	37	12	15	10	38	13	14
	2	75	10	45	10	10	10	45	10	10
	3	75	10	45	10	10	10	45	10	10
	4	75	10	40	10	15	10	40	12	13
8	1	90	12	54	11	13	10	56	14	10
	2	90	10	60	10	10	10	60	10	10
	3	90	10	60	10	10	10	60	10	10
	4	90	10	53	17	10	12	51	12	15
9	1	90	18	32	18	22	10	40	10	30
	2	90	14	46	14	16	12	48	13	17
	3	90	10	50	13	17	16	44	14	16
	4	90	10	41	10	29	23	28	18	21
10	1	75	15	27	15	18	10	32	15	18
	2	75	11	39	11	14	10	40	11	14
	3	75	10	40	11	14	13	37	11	14
	4	75	10	33	10	22	20	23	15	17
11	1	75	15	26	16	18	10	31	18	16
	2	75	11	40	11	13	10	41	11	13
	3	75	10	40	11	14	13	37	11	14
	4	75	10	33	17	15	20	23	15	17

Table 2. Recommended Timing Plans for Signals with Side-Street Split Phasing.

Timing Plan	Inter-section	Cycle	Phase							
			1	2	3	4	5	6	7	8
1	1	60	10	26	10	14	10	26	14	10
	2	60	10	30	10	10	10	30	10	10
	3	60	10	30	10	10	10	30	10	10
	4	60	10	26	11	13	13	23	13	11
2	1	100	17	29	33	21	10	36	21	33
	2	100	13	59	13	15	11	61	15	13
	3	100	10	61	16	13	14	57	13	16
	4	100	10	45	30	15	20	35	15	30
3	1	60	10	26	10	14	10	26	14	10
	2	60	10	30	10	10	10	30	10	10
	3	60	10	30	10	10	10	30	10	10
	4	60	10	24	16	10	13	21	10	16
4	1	60	10	24	14	12	10	24	12	14
	2	60	10	30	10	10	10	30	10	10
	3	60	10	30	10	10	10	30	10	10
	4	60	10	23	10	17	10	23	17	10
5	1	75	11	36	10	18	10	37	18	10
	2	75	10	45	10	10	10	45	10	10
	3	75	10	45	10	10	10	45	10	10
	4	75	10	36	14	15	11	35	15	14
6	1	60	10	27	13	10	10	27	10	13
	2	60	10	30	10	10	10	30	10	10
	3	60	10	30	10	10	10	30	10	10
	4	60	10	26	14	10	10	26	10	14
7	1	75	11	37	14	13	10	38	13	14
	2	75	10	45	10	10	10	45	10	10
	3	75	10	45	10	10	10	45	10	10
	4	75	10	36	10	19	10	36	19	10
8	1	90	12	52	11	15	10	54	15	11
	2	90	10	60	10	10	10	60	10	10
	3	90	10	60	10	10	10	60	10	10
	4	90	10	49	20	11	11	48	11	20
9	1	90	17	29	24	20	10	36	20	24
	2	90	14	46	14	16	12	48	16	14
	3	90	10	50	16	14	16	44	14	16
	4	90	10	40	21	19	23	27	19	21
10	1	75	15	26	16	18	10	31	18	16
	2	75	11	39	11	14	10	40	14	11
	3	75	10	40	14	11	13	37	11	14
	4	75	10	30	16	19	18	22	19	16
11	1	75	15	26	16	18	10	31	18	16
	2	75	11	40	11	13	10	41	13	11
	3	75	10	40	14	11	13	37	11	14
	4	75	10	33	17	15	20	23	15	17

Table 3. Recommended Timing Plans for Signals with Permissive-Only Cross-Street Phases.

Timing Plan	Inter-section	Cycle	Phase							
			1	2	3	4	5	6	7	8
1	1	60	10	28		22	10	28		22
	2	60	10	30		20	10	30		20
	3	60	10	30		20	10	30		20
	4	60	10	26		24	13	23		24
2	1	100	17	29		54	10	36		54
	2	100	13	59		28	11	61		28
	3	100	10	61		29	14	57		29
	4	100	10	50		40	22	38		40
3	1	60	11	26		23	10	27		23
	2	60	10	30		20	10	30		20
	3	60	10	30		20	10	30		20
	4	60	10	26		24	13	23		24
4	1	60	10	24		26	10	24		26
	2	60	10	30		20	10	30		20
	3	60	10	30		20	10	30		20
	4	60	10	26		24	10	26		24
5	1	75	11	39		25	10	40		25
	2	75	10	45		20	10	45		20
	3	75	10	45		20	10	45		20
	4	75	10	36		29	11	35		29
6	1	60	10	30		20	10	30		20
	2	60	10	30		20	10	30		20
	3	60	10	30		20	10	30		20
	4	60	10	29		21	10	29		21
7	1	75	11	37		27	10	38		27
	2	75	10	45		20	10	45		20
	3	75	10	45		20	10	45		20
	4	75	10	40		25	10	40		25
8	1	90	12	54		24	10	56		24
	2	90	10	60		20	10	60		20
	3	90	10	60		20	10	60		20
	4	90	10	53		27	12	51		27
9	1	90	18	32		40	10	40		40
	2	90	14	46		30	12	48		30
	3	90	10	50		30	16	44		30
	4	90	10	41		39	23	28		39
10	1	75	15	27		33	10	32		33
	2	75	11	39		25	10	40		25
	3	75	10	40		25	13	37		25
	4	75	10	33		32	20	23		32
11	1	75	15	26		34	10	31		34
	2	75	11	40		24	10	41		24
	3	75	10	40		25	13	37		25
	4	75	10	33		32	20	23		32

ADAPTING THE GUIDELINES TO A NON-TYPICAL SITE

Figure 2 shows a hypothetical site that is somewhat different from the ideal site shown in Figure 1. It has five intersections instead of four. Intersection 1 has split phasing on the cross street, intersections 2 and 4 are critical intersections with all eight phases, intersection 3 is not critical, but has all eight phases, and intersection 5 has permissive-only phasing on the cross street. It is used to illustrate how the guidelines can be adapted to some non-typical sites.

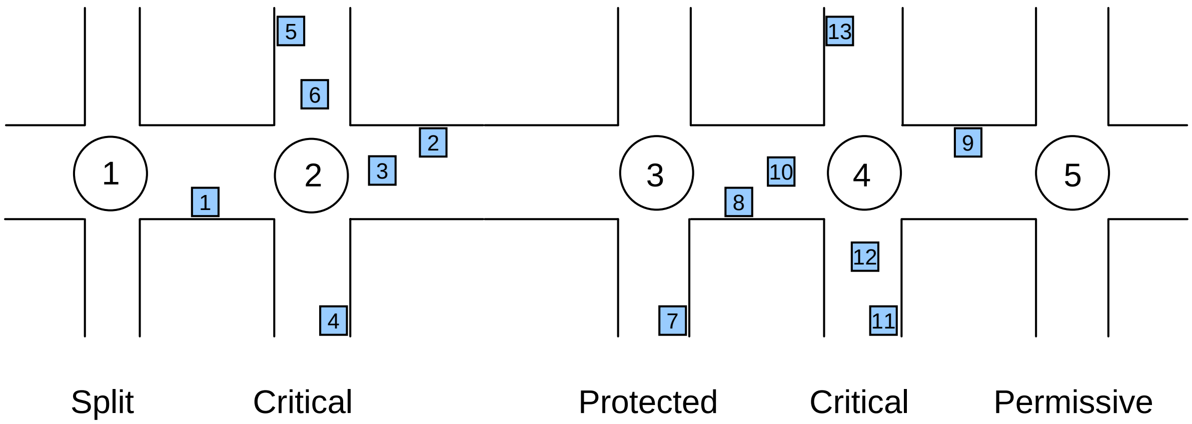


Figure 2. A Hypothetical Site with Five Intersections.

In this case, timings for each desired plan should be selected as follows:

1. For intersections 2, 3 and 4, select the timings given for signals 1, 2 or 3, and 4, respectively, in Table 1.
2. For intersection 1, select the timings corresponding to signals 2 or 3 in Table 2.
3. For signal 5, select timings given for intersection 2 or 3 in Table 3.

Repeat the above steps for all appropriate timing plans, and then determine the offsets and phasing sequences using the procedures described at the end of this chapter. It should be noted that the set of timing plans selected depends on the brand of equipment in the field. The following sections provide details for the two most common controller types.

NAZTEC CONTROLLER GUIDELINES

Of the 11 possible timing plans shown in Table 1, only nine plans are used for the Naztec configuration. Table 4 shows the nine selected plans.

Table 4. Selection of Timing Plans for Naztec Controller.

Timing Plan Number	1	4	5	6	7	8	9	10	11

The detector weights for the Naztec controller are listed in Table 5. The entering thresholds are listed in Table 6. The initial value for an exiting threshold should be set by subtracting 2 from the corresponding entering threshold until it is fine-tuned in the field. The plan table look-up entries are listed in Table 7.

Table 5. Naztec Controller Detector Weights.

Direction	Actuation	Detector												
		1	2	3	4	5	6	7	8	9	10	11	12	13
Inbound	Count	13	83	27	14	92	76	1	12	59	77	92	65	85
	Occupancy	12	21	75	9	10	52	16	52	21	25	5	26	13
Outbound	Count	98	52	22	63	91	5	1	99	44	4	6	61	1
	Occupancy	86	68	45	10	63	38	34	38	60	13	5	43	27
Cross	Count	3	53	15	79	33	1	74	10	90	10	95	79	91
	Occupancy	52	12	34	72	29	22	14	22	11	56	12	15	25

Table 6. Naztec Controller TRPS Entry Thresholds.

Level	Cycle	Offset	Split
1	11	59	34
2	12	65	41
3	19	66	

Table 7. Naztec Controller TRPS Plan Look-Up Table Entries.

Offset 1 Index

		SPLIT		
		1	2	3
CYCLE	1	6	6	8
	2	7	9	1
	3	6	11	4
	4	9	4	4

Offset 2 Index

		SPLIT		
		1	2	3
CYCLE	1	6	6	8
	2	9	9	6
	3	10	10	9
	4	6	4	4

Offset 3 Index

		SPLIT		
		1	2	3
CYCLE	1	9	9	9
	2	11	6	6
	3	10	10	4
	4	5	5	6

Offset 4 Index

		SPLIT		
		1	2	3
CYCLE	1	5	11	8
	2	11	9	7
	3	6	1	9
	4	5	7	6

Readers not familiar with the Naztec traffic responsive system should note in the above structure that the look-up table consists of four offset tables. The master selects the appropriate offset table based on real-time values of offset index. Depending on the hardware-software version, there are either four or six entries for each value of cycle and split index in an offset table. Thus, the offset tables are either 4×4 or 6×6 matrices populated with appropriate pattern numbers.

These guidelines use only four cycle entries (first four rows in each offset table) and three split entries (first three columns in each offset table). The remainder of available rows and columns will be blank. Real-time values of cycle and offset indices select the pattern identified by these values. A separate table in each secondary controller defines a cycle length, a split table (that includes splits and identification of coordinated phases), an offset, and a phasing sequence that defines each pattern. This three-dimensional architecture is extremely flexible and provides a way to populate the lookup tables with any desired combination of pattern numbers, providing a capability to select the same pattern for different traffic conditions (that is, different combinations of values for offset, cycle, and split indices).

EAGLE CONTROLLER GUIDELINES

The Eagle implementation is not as flexible as Naztec. The primary reason for this inflexibility is the way patterns (dials, splits, offset and alternate phasing sequences) are stored and selected. Readers familiar with this system will recognize that the pattern selection via any mode (manual, time-of-day, or traffic responsive) requires the selection of a dial-split-offset (D/S/O) combination. However, the data under offset (which includes three pairs of offset values and alternate phase sequence numbers) are specifically tied to each of 16 (36 in NTCIP-compatible controller) dial-split combinations. This structure allows the user to program only 16 (36 in NTCIP compatible controllers) unique patterns arranged in a two-dimensional 4×4 (6×6 in NTCIP-compatible controller) dial-split matrix. Because of this limitation, the offset index cannot be used to select a unique timing plan. Thus, only four plans are used for the Eagle configuration. Table 8 shows the four selected plans.

Table 8. Final Selection of Timing Plans for Eagle Controller.

Timing Plan Number	2	3	5	11

Table 9 lists the detector weights for the Eagle controller. The entering thresholds are listed in Table 10. The initial value for an exiting threshold should be set by subtracting 2 from the corresponding entering threshold, until it is fine-tuned in the field. Table 11 lists the plan table look-up entries. Duplicate plans will need to be entered in each controller. The user can do this using the "Coordination Copy" feature in the Eagle controller.

Table 9. Eagle Controller Detector Weights.

Direction	Detector												
	1	2	3	4	5	6	7	8	9	10	11	12	13
ART (CS1 &CS2)	94	44	6	62	80	59	43	63	83	62	9	22	95
NART	40	56	0	10	81	80	59	38	59	53	29	83	88

Table 10. Eagle Controller TRPS Entry Thresholds.

Level	Cycle	Split	Offset
1	18	56	--
2	21	59	--
3	32	60	

Table 11. Eagle Controller TRPS Plan Look-Up Table Entries.

		DIAL			
		1	2	3	4
SPLIT	1	11	2	3	3
	2	11	3	3	3
	3	11	3	11	11
	4	11	3	11	5

OFFSET AND PHASE SEQUENCE CALCULATIONS

Offset

Offset = Travel time mod cycle.

Phase Sequence

Determination of phase sequences for the signal system is performed in two steps, as shown in Figure 3. The phase sequence of the first and last intersections can be obtained from Table 12. The phase sequence for the intermediate intersection can be obtained from Table 13. In both tables, the sequence obtained can be explained as follows:

- 1: Lead-Lag (phases 2+5 start at the arterial barrier),
- 2: Lag-Lead (phases 1+6 start at the arterial barrier),
- 3: Lead-Lead (phases 1+5 start at the arterial barrier), and
- 4: Lag-Lag (phases 2+6 start at the arterial barrier).

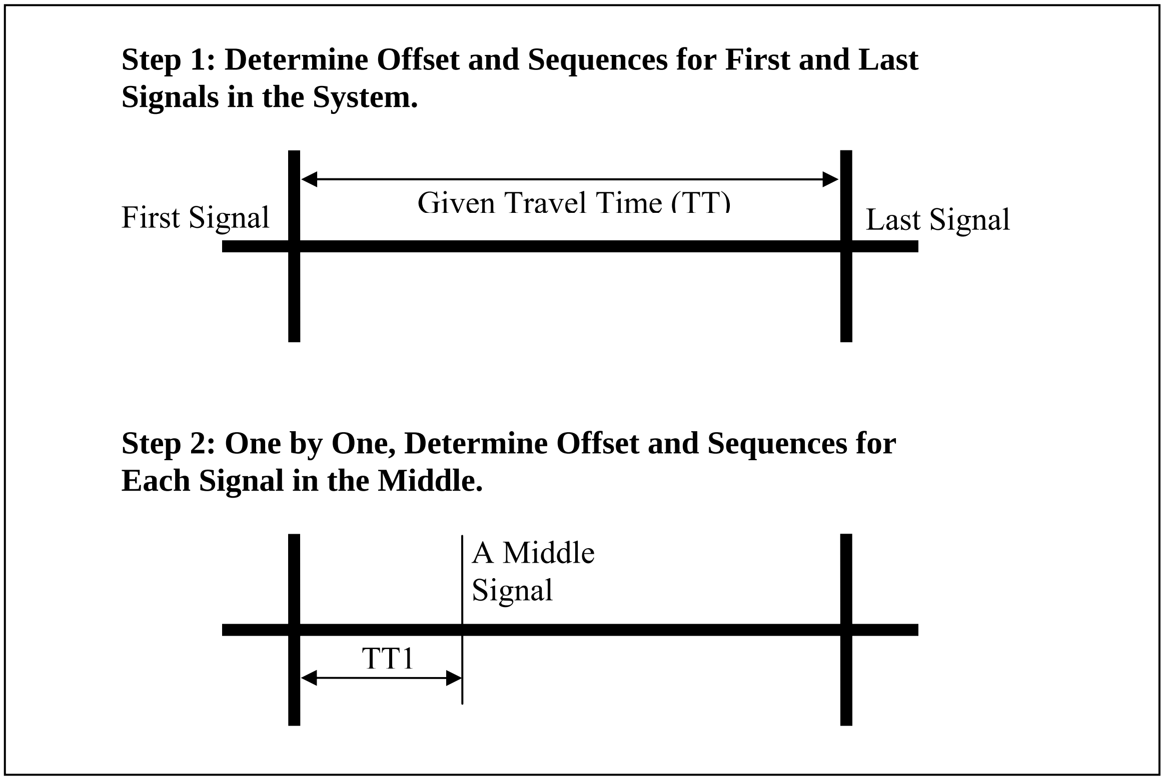


Figure 3. Optimal Selection of Offsets and Phase Sequences.

Table 12. Recommended Phase Sequence at the First and Last Signals.

(Offset × 12) / Cycle	Sequence
1	13, 14, 32, 42
2	12
3	12
4	21
5	23, 24, 31, 41
6	11, 22, 33, 34, 43, 44
7	13, 14, 32, 42
8	12
9	12
10	21
11	23, 24, 31, 41
12	11, 22, 33, 34, 43, 44

Table 13. Recommended Phase Sequence at Intermediate Signals.

(External Offset × 12) / Cycle	(Internal Offset × 12) / Cycle											
	1	2	3	4	5	6	7	8	9	10	11	12
1	2	2	1	1	1	2	2	2	1	1	3	2
2	2	1	1	1	3	2	2	1	1	1	3	2
3	2	1	1	1	3	2	2	1	1	1	3	2
4	3	2	2	2	1	1	3	2	2	2	1	1
5	3	2	2	1	1	1	3	2	2	1	1	1
6	3	2	1	1	1	2	3	2	1	1	3	2
7	2	2	1	1	1	2	2	2	1	1	3	2
8	2	1	1	1	3	2	2	1	1	1	3	2
9	2	1	1	1	3	2	2	1	1	1	3	2
10	3	2	2	2	1	1	3	2	2	2	1	1
11	3	2	2	1	1	1	3	2	2	1	1	1
12	3	2	1	1	1	2	3	2	1	1	3	2

Example Offset and Phase Sequence Calculations

For two external intersections that are 14,300 feet apart and with a design speed of 45 mph, the link travel time would be calculated as 14,300/(45 × 1.467) ≈ 217 seconds. The offset to the last intersection for a plan that has a 60-second cycle length is equal to TT mod cycle = 217 mod 60 = 37 seconds (the mod function throws away all multiples of cycle lengths and leaves only the remainder). Using Table 12 to find the appropriate sequence at the last intersection requires the calculation of the look-up term "(offset × 12)/cycle." The look-up term = 37 × 12/60 = 7.4. A value of 7 in Table 12 suggests that any of the following two sequences will work at the first and last intersections, respectively: lead-lag and lead-lead, lead-lag and lag-lag, lead-lead and lag-lead, and lag-lag and lag-lead. For an intermediate intersection 5240 feet from the first intersection, TT1 = 5240/(45 × 1.467) ≈ 79 seconds. The offset calculation for the same plan of 60-second cycle length is TT1 mod 60 = 79 mod 60 =19 seconds. From the external intersection's calculations, the first look-up factor = (External Offset × 12)/Cycle = 37 × 12/60 = 7.4. The second look-up factor = (Internal Offset × 12)/Cycle = 19 × 12/60 = 3.8. Using Table 13, the recommended sequence for the intermediate intersection is 1 (lead-lag).

CHAPTER 3: NON-IDEAL SITES

Chapter 2 provided all data needed for configuring TRPS mode of operation at an ideal site with either an Eagle or a Naztec system. It is anticipated that most candidate sites for TRPS operation will not have thirteen system detectors required for using data provided in Chapter 2. In addition, it may not be feasible to upgrade the detection system at many of these sites. If that is the case, TRPS operation may still be used.

This chapter provides information needed for configuring TRPS mode at non-ideal sites. Because each site is different from others in some respects, case studies are needed to guide the application of TRPS mode to specific sites. Towards that goal, this chapter presents TRPS configuration data for four non-ideal sites, where TRPS mode of operation was implemented and tested.

SPECIAL SITE 1

The Eagle closed-loop system shown in Figure 4 consists of three intersections only. It has 6x6 loop detectors 140 feet from the intersections on the arterial, and 6x40 stop bar detectors on the side streets. The two major differences between this site and the typical site illustrated in Figure 1 are that the side streets at this site have only 6x40 stop bar detectors, and the advance detectors on the arterial are located 140 feet from the intersections. The long stop bar detectors on the side streets are not appropriate for reliable volume data collection. Also, the length of vehicle queues on the arterials may exceed 140 feet, and in such cases volume data from the advance detectors are unreliable. Because of these differences, the general guidelines described in Chapter 2 cannot be directly applied here and customization is needed.

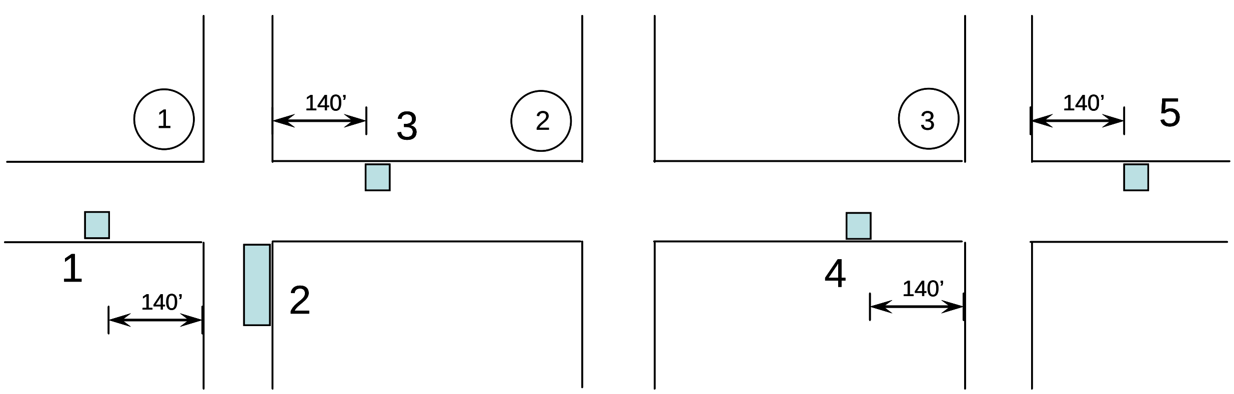


Figure 4. System Detectors at Special Site 1.

The recommended timing plans for this site are given in Table 14. Only four plans are used for this Eagle configuration. The detector weights are given in Table 15, and the entering thresholds for each timing plan are specified in Table 16. The initial value for exiting thresholds should be set 2% below the corresponding entering thresholds until they are fine-tuned in the field. Table 17 lists the plan look-up table entries. Duplicate plans will need to be entered in each controller. The user can do this using the “Coordination Copy” feature in the Eagle controller.

Table 14. Recommended Timing Plans for Special Site 1.

Timing Plan	Inter-Section	Cycle	Phase							Leading Phases on Main-Street	Offset
			1	2	3	4	5	6	8		
1	1	75	15	31		29	15	31	29	1+5	33
	2	75	15	45		15	15	45	15	2 +5	22
	3	75	13	34	15	13	16	31		1+6	28
2	1	75	15	31		29	15	31	29	1+5	33
	2	75	15	45		15	15	45	15	2+5	22
	3	75	13	32	16	14	24	21		2+6	38
3	1	150	30	61		59	30	61	59	1+5	33
	2	150	30	90		30	30	90	30	1+5	97
	3	150	14	83	28	25	32	65		1+6	99
4	1	100	20	41		39	20	41	39	1+6	33
	2	100	20	60		20	20	60	20	1+6	49
	3	100	13	51	19	17	22	42		2+5	10

Table 15. Eagle Controller Detector Weights for Special Site 1.

Direction	Detector				
	1	2	3	4	5
ART (CS1)	100	-	-	100	-
NART	-	10	100	-	100

Table 16. Eagle Controller TRPS Thresholds for Special Site 1.

Level	Cycle Select		Split Select	
	Enter	Leave	Enter	Leave
1	25	23	50	48
2	62	60	60	58
3	100	98	100	98

Table 17. Eagle Controller TRPS Plan Look-Up Table Entries for Special Site 1.

SPLIT	DIAL			
	1	2	3	4
1	2	1	3	4
2	1	1	3	4
3	2	1	3	4
4	2	1	3	4

SPECIAL SITE 2

Special site 2 shown in Figure 5 consists of four intersections. It is similar to Special Site 1, but has the following differences:

1. There is an additional signal at a non-standard, fork-shaped intersection. On the west side of the site, it has a fork. The north branch of the fork serves traffic on a major highway. In addition, this branch leads into an interchange, approximately 2000 ft to the west, which is not shown in the figure. This interchange feeds eastbound platoons of vehicles into the system. Only the eastbound traffic traveling on the north branch encounters a traffic signal. The south branch serves traffic to and from a city roadway, but the traffic is not platooned. Demand levels are comparable on both branches.
2. Only one signal, signal 2, experiences significant side-street traffic, as opposed to Site 1. Furthermore, this side street (one with a detector in the figure) has less demand than any of the side streets at Site 1.
3. Setback detectors are 110 ft from the stop bar as opposed to 140 ft at Site 1.

There are 6x6 loop detectors at 110 feet from the intersections on the arterial, and 6x40 stop bar detectors on the side streets. The long stop bar detectors on the side streets are not appropriate for reliable volume data collection. Also, vehicle queues on the arterials may easily grow beyond the locations of the advance detectors, making the volume data from these detectors also unreliable. Therefore, the general guidelines in Chapter 2 are not applicable to this site.

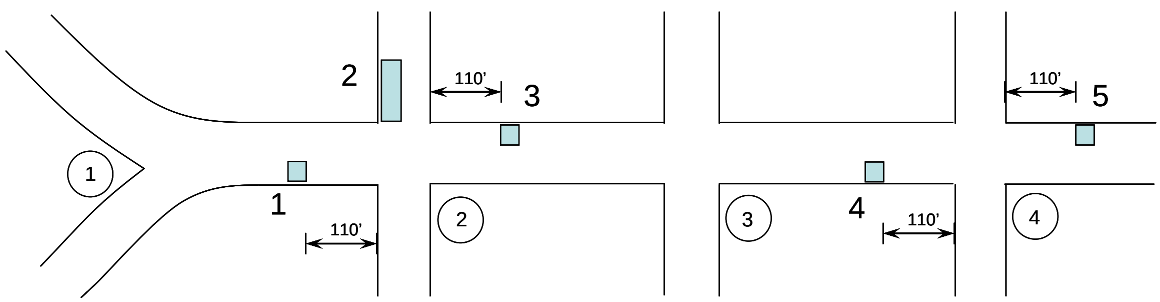


Figure 5. System Detectors at Special Site 2.

The recommended timing plans for this site are given in Table 18. Only three plans are used for this Naztec configuration. The detector weights are given in Table 19, and the entering thresholds for each timing plan are specified in Table 20. The initial value for exiting thresholds should be set 2% below the corresponding entering thresholds until they are fine-tuned in the field. Table 21 lists the plan look-up table entries.

Table 18. Recommended Timing Plans for Special Site 2.

Timing Plan	Inter-section	Cycle	Phase						Leading Phases on Main-Street	Offset
			1	2	4	5	6	8		
1	1	75		37	38		37			28
	2	75	15	30	30	11	34	30	2+6	28
	3	75	11	42	22	11	42	22	1+6	15
	4	75	11	34	30	15	30	30	2+5	59
2	1	120		60	60		60			28
	2	120	36	28	56	11	53	56	1+6	27
	3	120	23	53	44	19	57	44	1+6	30
	4	120	12	53	55	26	39	55	2+5	94
3	1	100		50	50		50			28
	2	100	24	32	44	11	45	44	1+6	13
	3	100	16	48	36	20	44	36	2+5	59
	4	100	11	42	47	28	25	47	1+5	65

Table 19. Naztec Controller Detector Weights (Count/Occupancy) for Special Site 2.

	Detector				
	1	2	3	4	5
Direction	Out	Cross	In	Out	In
Volume	50	100	50	50	50
Occupancy	100	100	100	100	100

Table 20. Naztec Controller TRPS Thresholds for Special Site 2.

Level	Cycle Select		Split Select	
	Enter	Leave	Enter	Leave
1	40	38	50	48
2	100	98	100	98

Table 21. Naztec Controller TRPS Plan Look-Up Table Entries for Special Site 2.

SPLIT	DIAL	
	1	2
1	1	2
2	1	3

SPECIAL SITE 3

The closed-loop system shown in Figure 6 consists of four intersections and uses video detection. The first intersection from the left is a T-intersection. For the system detector configuration it is assumed that the southbound approach at this T-intersection is the critical side street (i.e., it has the highest traffic demand among all side streets). The limited fields of view of video cameras typically do not allow the definition of system detectors at sufficient distances upstream of the stop lines. However, video detection makes it possible to define system detectors (additional detection zones) just downstream of the stop lines. Although the volume counts from these detectors depend on signal operation, they are not affected by vehicle queues.

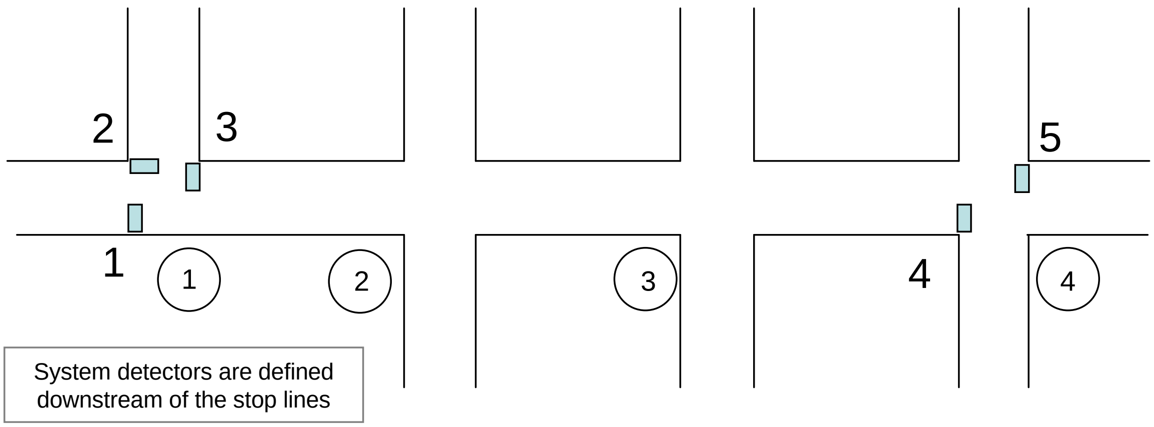


Figure 6. System Detectors at Special Site 3 Using Video Detection.

The recommended timing plans for this site are given in Table 22. Only three plans are used for this Eagle configuration. The detector weights are given in Table 23, and the entering thresholds for each timing plan are specified in Table 24. The initial value for exiting thresholds should be set 2% below the corresponding entering thresholds until they are fine-tuned in the field. Table 25 lists the plan table look-up entries.

Table 22. Recommended Timing Plans for Special Site 3.

Timing Plan	Inter-section	Cycle	Phase								Leading Phases on Main-Street	Offset
			1	2	3	4	5	6	7	8		
1	1	120		80		40	15	65			2+5	0
	2	120	26	53	21	20	15	64			1+6	119
	3	120	19	64	17	20	17	66			2+6	64
	4	120	15	46	27	32	18	43			1+6	67
2	1	120		68		52	15	53			2+5	0
	2	120	27	37	29	27	15	49			1+6	118
	3	120	21	49	23	27	22	48			2+5	52
	4	120	15	38	30	37	24	29			1+6	67
3	1	120		68		52	15	53			2+5	0
	2	120	26	42	27	25	15	53			1+6	119
	3	120	19	51	23	27	22	48			1+5	64
	4	120	15	38	30	37	24	29			1+6	67

Table 23. Eagle Controller Detector Weights for Special Site 3.

Direction	Detector				
	1	2	3	4	5
ART (CS1)	100	-	-	100	-
NART	-	10	100	-	100

Table 24. Eagle Controller TRPS Thresholds for Special Site 3.

Level	Cycle Select		Split Select	
	Enter	Leave	Enter	Leave
1	43	41	53	51
2	55	53	60	58
3	100	98	100	98

Table 25. Eagle Controller TRPS Plan Look-Up Table Entries for Special Site 3.

SPLIT	DIAL		
	1	2	3
1	1	1	2
2	3	2	2
3	1	1	2

SPECIAL SITE 4

The closed-loop system shown in Figure 7 consists of six intersections and uses video detection. The second intersection from the right is a T-intersection. For the system detector configuration it is assumed that the northbound approach of the third intersection from the right is the critical side street (i.e., it has the highest traffic demand among all side streets). The arterial system detectors are defined downstream of the two outer intersections as shown in Figure 7. This setup ensures that all traffic entering the network at the arterial system boundaries is detected and accounted for.

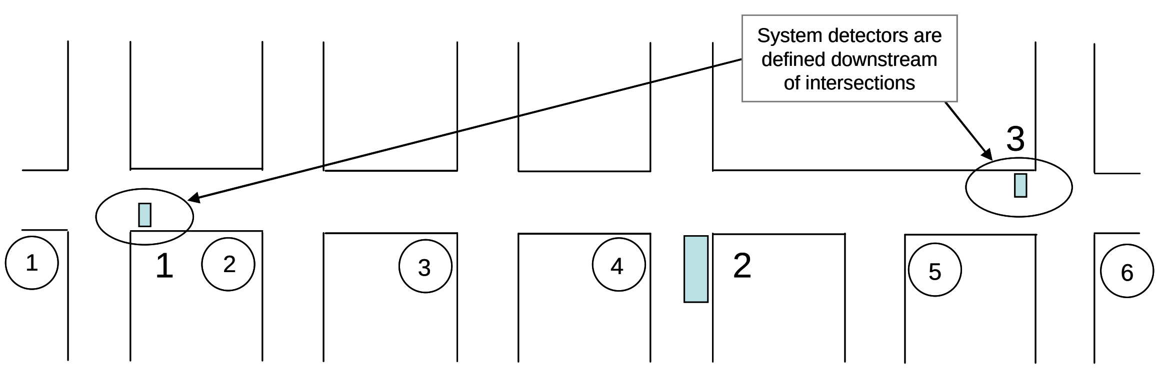


Figure 7. System Detectors at Special Site 4 Using Video Detection.

The five recommended timing plans for this site are given in Table 26. The detector weights are listed in Table 27, and the entering thresholds for each timing plan are specified in Table 28. The initial value for exiting thresholds should be set 2% below the corresponding entering thresholds until they are fine-tuned in the field. Table 29 lists the plan table look-up entries.

Note that the cross street detection uses a very long detection zone. If it were possible to define or add a short (i.e., 6X6) system detector upstream of the influence of queues, then the corresponding detector weight should be changed from 10 to 100 as for the other two detectors.

Table 26. Recommended Timing Plans for Special Site 4.

Timing Plan	Inter-section	Cycle	Phase								Leading Phases on Main-Street	Offset
			1	2	3	4	5	6	7	8		
1	1	100	15	66		19	15	66		19	1+6	0
	2	100	26	30	20	24	25	31	24	20	1+6	11
	3	100	10	68	12	10	15	63	11	11	2+6	62
	4	100	18	41	30	11	25	34			1+5	66
	5	100	15	65	10	10	14	66		20	2+6	53
	6	100	19	50		31	20	49		31	2+5	7
2	1	100	19	58		23	15	62		23	1+5	0
	2	100	16	33	20	31	25	24	26	25	1+6	10
	3	100	11	64	13	12	15	60	12	13	2+6	51
	4	100	18	41	30	11	22	37			1+5	61
	5	100	15	65	10	10	14	66		20	2+6	45
	6	100	13	50		37	24	39		37	2+5	96
3	1	100	25	43		32	15	53		32	2+5	0
	2	100	25	21	11	43	15	31	41	13	1+6	97
	3	100	14	60	14	12	15	59	12	14	2+6	47
	4	100	19	31	39	11	14	36			2+6	57
	5	100	15	65	10	10	14	70		16	2+5	29
	6	100	14	46		40	16	44		40	2+5	92
4	1	100	25	43		32	15	53		32	1+5	0
	2	100	40	21	11	28	16	45	26	13	1+6	92
	3	100	16	59	13	12	15	60	12	13	1+6	41
	4	100	32	26	28	14	14	44			1+5	49
	5	100	15	65	10	10	14	66		20	1+6	39
	6	100	25	33		42	13	45		42	2+5	0
5	1	120	30	52		38	15	67		38	1+6	0
	2	120	49	25	11	35	19	55	32	14	2+5	79
	3	120	18	72	16	14	17	73	14	16	2+5	61
	4	120	39	31	34	16	17	53			1+6	69
	5	120	15	85	10	10	17	83		20	2+5	0
	6	120	30	40		50	15	55		50	2+6	28

Table 27. Eagle Controller Detector Weights for Special Site 4.

Direction	Detector			
	1	2	3	4
ART (CS1)	100	-	-	-
NART		20	100	-

Table 28. Eagle Controller TRPS Thresholds for Special Site 4.

Level	Cycle Select		Split Select	
	Enter	Leave	Enter	Leave
1	42	39	53	51
2	54	52	61	59
3	61	59	70	68
4	100	98	100	98

Table 29. Eagle Controller TRPS Plan Look-Up Table Entries for Special Site 4.

SPLIT	DIAL			
	1	2	3	4
1	3	3	4	4
2	4	4	5	5
3	1	1	2	2
4	1	1	1	1

STEPS IN USING THE GUIDELINES

1. Identify a site that is closest to the site where you wish to implement TRPS mode.
2. Use the example provided in Chapter 2 to derive/modify green splits for your intersections. Do not forget to make any other minor changes due to characteristics specific to your site.
3. Once you have obtained the green splits for all timing plans for your site, use the steps provided in Chapter 2 to determine offsets and phasing sequences.
4. Make a backup of your existing database. This step is necessary because the implementation of the TRPS mode will require replacing some existing data, including the dial-split or pattern information. In other words, if you currently run one of three different TOD patterns, you will probably use the same schedule, but the plans activated by that schedule will most probably be replaced by new timing plans from step 2 above.
5. Make site specific modifications to detector weights. If there is a possibility to define 6x6 system detectors upstream of the influence of queues, then the corresponding detector weight can be set to 100%. However, if a system detector is defined as a long stop bar detector, then the weight will be significantly lower, such as the 10% weight for the side-street detector at Special Site 4 in the previous section.
6. Enter selected data and turn on the TRPS mode.
7. Verify new operation through field observations and by reviewing various reports generated through the master controller.
8. Make any minor adjustments to timing plans and/or thresholds, if necessary.

CHAPTER 4: TRPS CONFIGURATION IN AN EAGLE SYSTEM

The following directions assume that the user is familiar with basic programming of local and on-street master controllers.

PROGRAMMING LOCAL CONTROLLERS

Setting up each local controller requires the following steps:

1. Define alternate sequences matching.
2. Enter each unique Dial/Split/Offset data into the controller. When entering these data, ensure the following:
    a. The splits are larger than minimum requirement in the local controller. Split should be 1 second longer than the maximum of:
        i. Minimum Green + Yellow + Red Clearance, or
        ii. Walk + Pedestrian Clearance + Yellow + Red Clearance, or
        iii. Max. Initial + Yellow + Red Clearance.

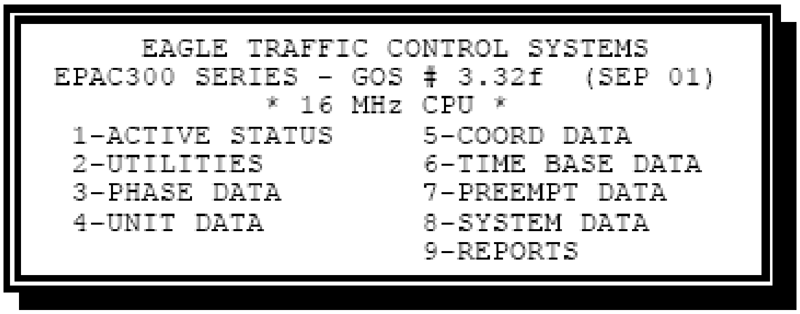
    Note: If this condition is not met, make needed modifications to splits for timing plans selected for implementation at your site.

    b. Offsets are referenced to the arterial through phase that starts first.
3. Check each unique Dial/Split/Offset data by manually forcing the controller to run it:
    a. Check Ring Status to make sure that the forced manual operation is selected, and then
    b. Check the status of Coordination timer.
4. If the same pattern is to be programmed into multiple Dial/Split/Offset locations, use the copy feature provided by the vendor.
5. Define system detectors and program associated entries.
6. Define detector for which data is to be logged (optional).
7. Create a TOD schedule. This schedule is common for all locals and the master.
8. Turn on system detector data reporting to the master.

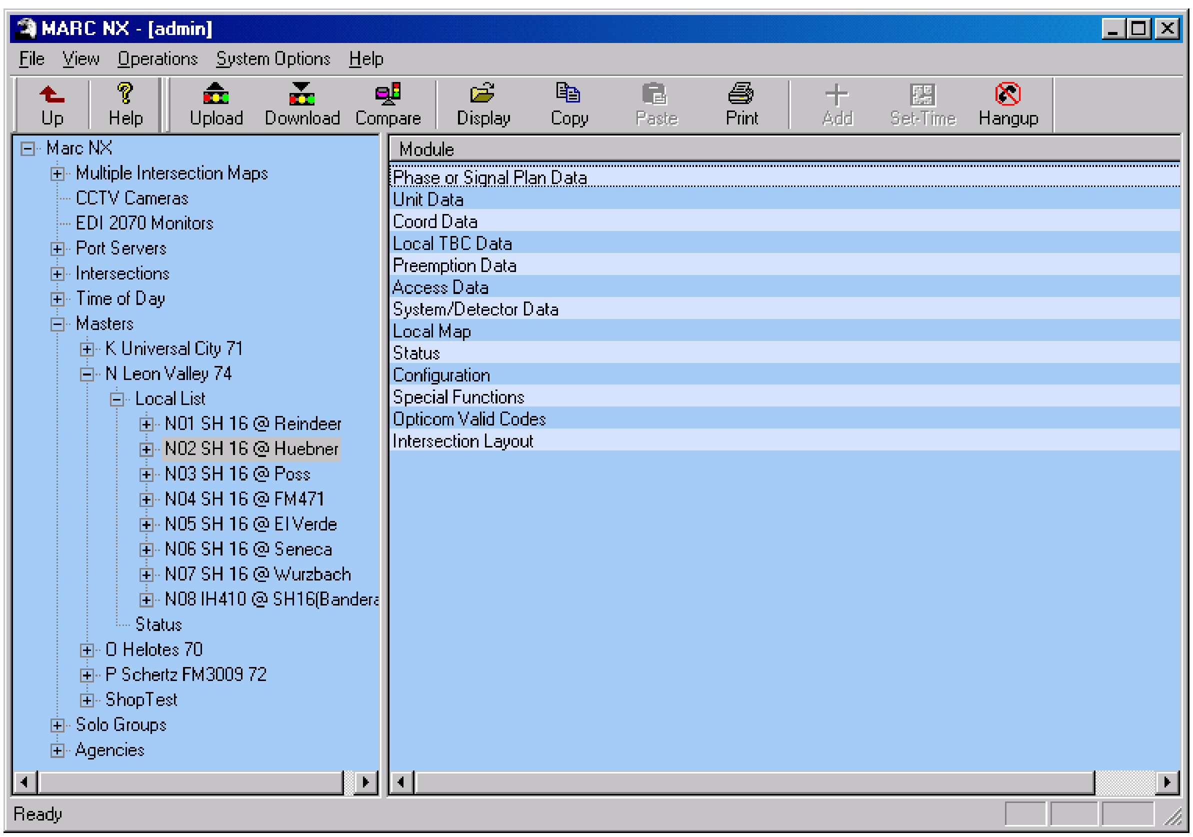
The following subsections illustrate front panel screens used for entering required data described in the above steps. The line preceding each controller screen is an instruction about how to get to that screen. For instance, MM > 1 > 2 means pressing 1 and then 2 from the main menu (MM). In addition, illustrations of corresponding screens from MARC NX© (referred to as MARC in the remainder of the document) are provided. It should be noted here that ACTRA© has the same data screen format as MARC, so there is no need to repeat screen shots for TxDOT Districts using ACTRA.

EPAC 300 Main Menu

The following is an illustration of the main menu on the controller front panel.



If you are using MARC and select one of your intersections, your main screen will look as shown below. The right side of this screen shows all major data categories. Double-clicking on any one of these will take you to the specific data screen. The bottom of each specific data screen has tabs that allow the user to view/edit specific data.



Defining Alternate Phasing Sequences

The following description assumes that you have a standard ring structure with eight phases shown below. It is further assumed that Phase 2 is assigned to one of the two main-street through phases.

Sequence 0	Barrier 1		Barrier 2	
Ring 1	1	2	3	4
Ring 2	5	6	7	8

This ring structure is defined in the controller by specifying the following:

Phase	Ring	Next Phase	Concurrent Phases	
1	1	2	5	6
2	1	3	5	6
3	1	4	7	8
4	1	1	7	8
5	2	6	1	2
6	2	7	1	4
7	2	8	3	4
8	2	5	3	4

The above ring-structure defines the default phasing sequence to be:

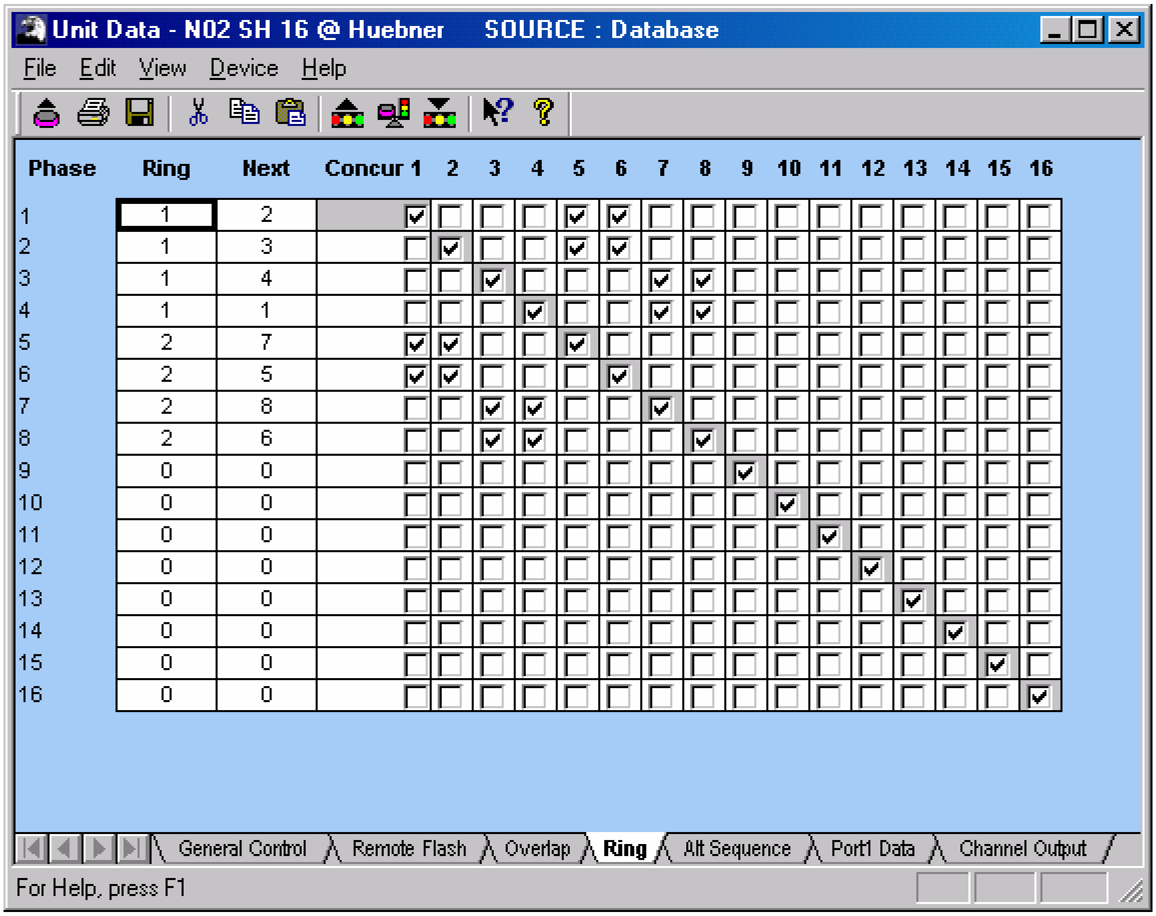
- Lead-Lead phasing on main street with left-turn phases 1 and 5 leading, and
- Lead-Lead phasing on cross street with left-turn phases 3 and 7 leading.

As illustrated in the ring diagram above, EPAC 300 controller defines this as sequence "0" (zero). The first step is to identify the default sequence in your controller to establish your base reference point. To do this, press MM > 4 > 5 on the front panel of the local controller you are programming. You will see the following screen, which shows existing phase compatibility and channel assignment data.

```
EPAC RING STRUCTURE         (0-NO/1-YES)
 PHASE: 1  RING: 1  NXT PHS: 2      .....
 CONCUR PHS: 100011000 0000000
    PHS/CHN: 123456789 0123456789 01234
 VEH CHN(S): 100000000 0000000000 00000
 PED CHN(S): 000000000 0000000100 00000

A-UP B-DN D-DspChn  E-EDIT  F-PRIOR MENU
```

Press buttons marked “A” or “B” on the controller to verify the (default) sequence 0 in the controller being programmed. If you are using MARC, you can double-click on the “Unit Data” category followed by a single click on the “Ring” tab to view the entire ring-structure as illustrated below.



Note that the EPAC 300 controller programming requires each phase to be selected as its own concurrent phase (checks in boxes along the diagonal).

In EPAC 300 controllers alternate phasing sequences are defined by specifying which phase pairs are to be reversed in the selected sequence. For example, if you want the following three sequences:

Sequence 1	Barrier 1		Barrier 2	
Ring 1	2	1	3	4
Ring 2	5	6	7	8

Sequence 2	Barrier 1		Barrier 2	
Ring 1	1	2	3	4
Ring 2	6	5	7	8

Sequence 3	Barrier 1		Barrier 2	
Ring 1	2	1	3	4
Ring 2	6	5	7	8

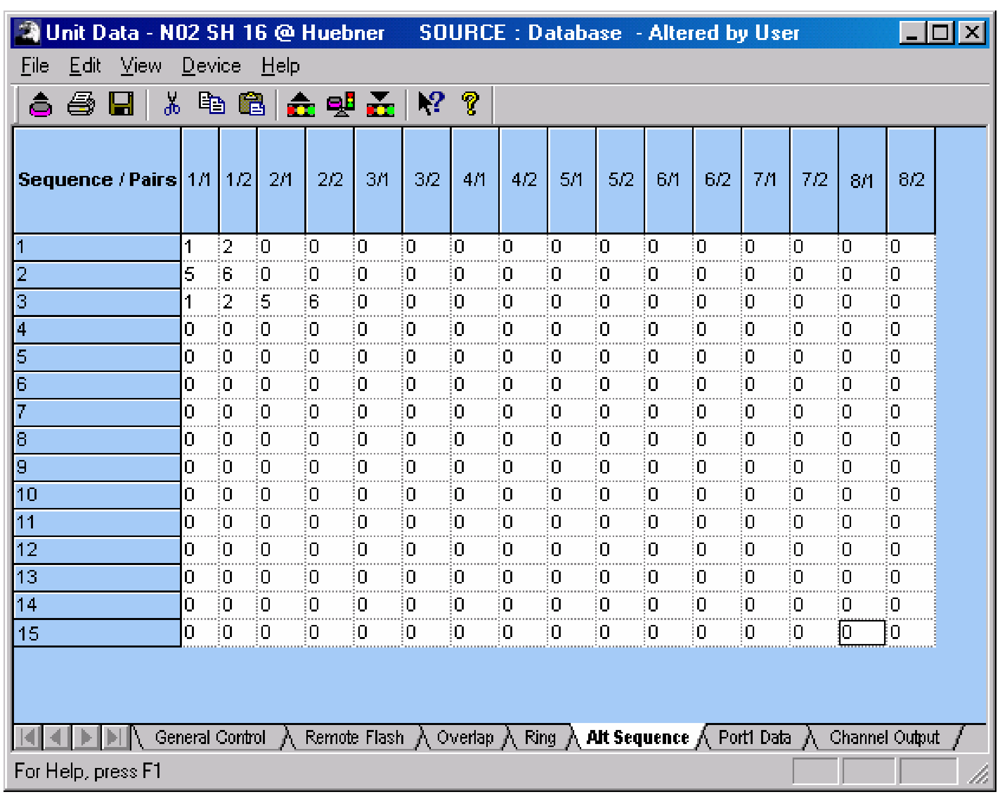
Then specify the following three alternate sequences with specified pairs to be reversed:

- Sequence 1: Reverse pair 1/2.
- Sequence 2: Reverse pair 5/6.
- Sequence 3: Reverse pairs 1/2 and 5/6.

Press MM > 4 > 6 on the front panel. Enter the values as per the following illustration.

```
EPAC ALT SEQ (PHASE PAIR TO REVERSE)
SEQ  .PP1.  .PP2.  .PP3.  .PP4.  .PP5.  .PP6.
 01  01 - 02 00-00 00-00 00-00 00-00 00-00
 02  05 - 06 00-00 00-00 00-00 00-00 00-00
 03  01 - 02 05 - 06 00-00 00-00 00-00 00-00
 04  00-00  00-00  00-00  00-00  00-00  00-00
 05  00-00  00-00  00-00  00-00  00-00  00-00
A-UP B-DN C-LT D-RT E-EDIT  F-PRIOR MENU
```

If you have MARC, clicking on “Alt Sequence” tab under “Unit Data” will allow you to define alternate sequences (as shown below).



Sequence / Pairs	1/1	1/2	2/1	2/2	3/1	3/2	4/1	4/2	5/1	5/2	6/1	6/2	7/1	7/2	8/1	8/2
1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	5	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	1	2	5	6	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Entering Coordination Pattern Data

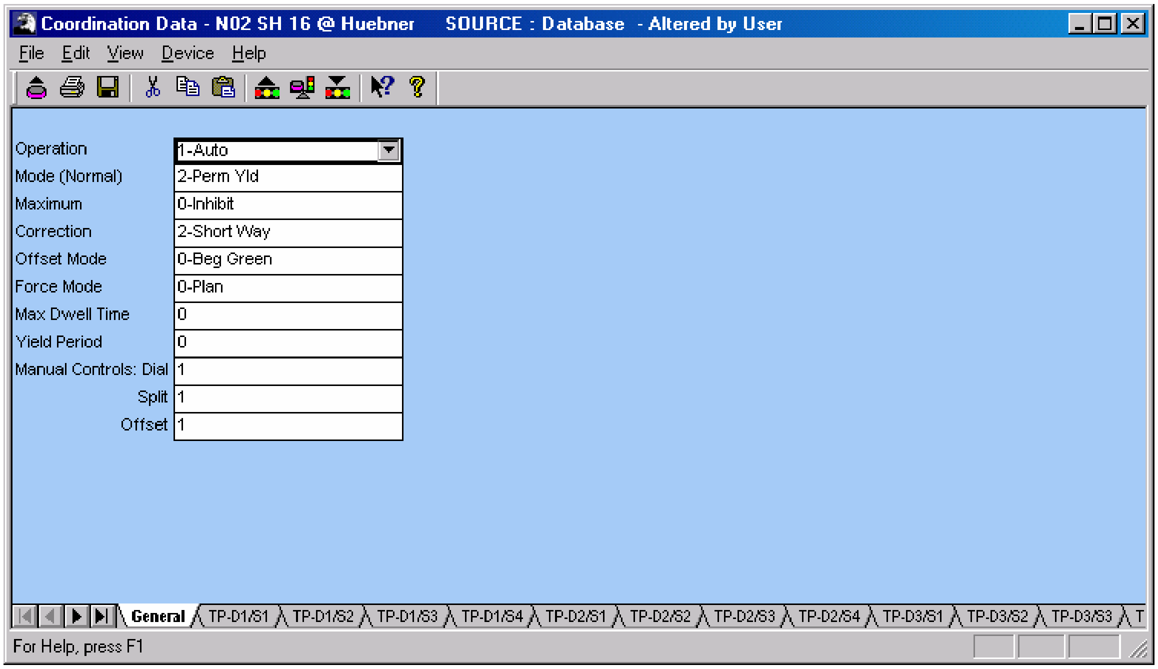
In EPAC 300, coordination data has two parts. The first part is to set up coordination setting parameters. These include specification of general coordination parameters: type (i.e., manual or automatic), mode, correction method, and method of offset referencing. If your site is already using coordinated operation, most of these parameters will not need to be changed. The second part is to enter selected coordination patterns, which are entered as Dial-Split-Offset combinations. To enter coordination settings, press MM > 5 > 1 (see illustration below).

```
EPAC COORD SETUP .0.  .1.  .2.  .3.  .4.  .5.
A-UP      OPER:0  FRE  AUT  MAN  ---  ---  ---
B-DN      MODE:0  PRM  YLD  PYL  POM  SOM  FAC
C-LT      MAX :0  INH  MX1  MX2  ---  ---  ---
D-RT      CORR:0  DWL  MDW  SWY  SW+  ---  ---
E-ENTER   OFST:0  BEG END OF GREEN
F-PRIOR   FRCE:0  PLN CYCLE TIME
  MENU    MX DWELL:000   YIELD PERIOD:000
```

The operation should always be set to “1-Auto.” The offset mode should be set to “0-Beg Green” unless you have already calculated offsets to the end of green phases.

Operation	1-Auto
Mode (Normal)	2-Prm Yld
Maximum	0-Inhibit
Correction	2-Short Way
Offset Mode	0-Beg Green
Force Mode	0-Plan
Max Dwell	0
Yield Period	0

In MARC, the same data can be entered by selecting the “General” tab under “Coordination Data” (see illustration below).



To enter offsets and phasing sequences, press MM > 5 > 3 on the control panel. You will see the following screen.

```
EPAC COORD MANUAL CONTROL

 DIAL: 1   SPLIT: 1   OFFSET: 1   SYNC: 0

  TO SET CYCLE ZERO IN MANUAL CONTROL
  ENTER "1" FOR SYNC THEN PRESS "E"

A-UP B-DN C-LT D-RT E-ENTER F-PRIOR MENU
```

On this screen, enter the numbers for desired dial and split. Then, enter a “1” for “OFFSET” to go to the screen for entering offsets and phasing sequences corresponding to the selected dial-split combination (see illustration below).

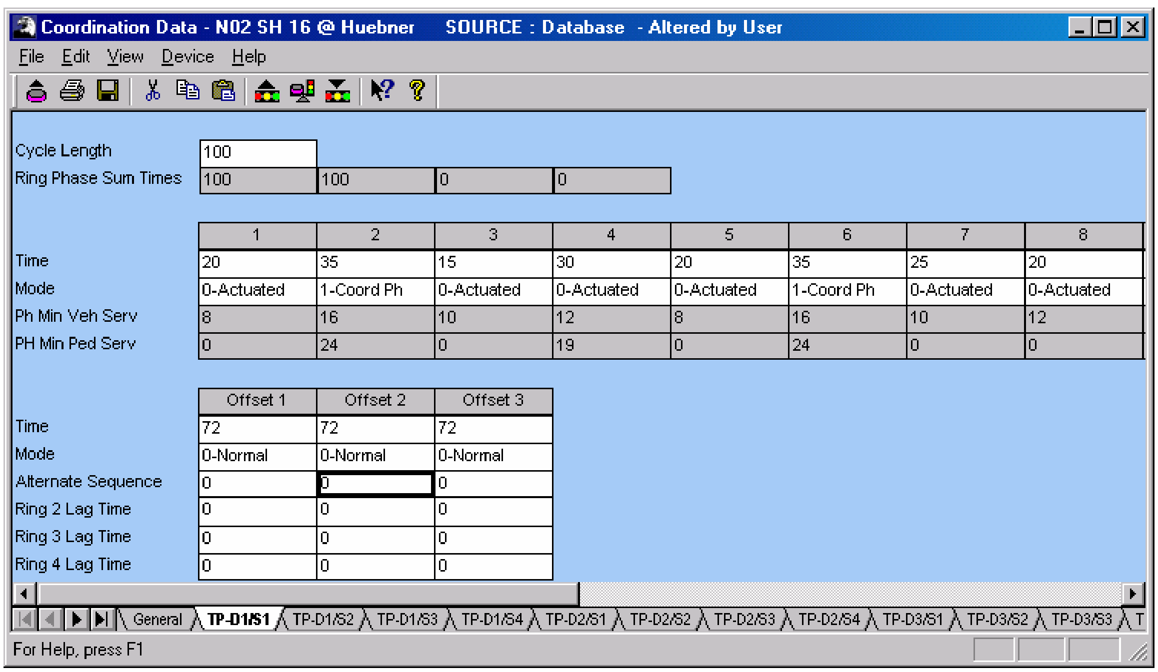
```
DIAL 1 SPLIT 1 PARAMETERS
 OFFSET TIME  ALT  PATN  R2   R3   R4
   #     SEC  SEQ  MODE  LAG  LAG  LAG
   1     000   0     0   000  000  000
   2     000   0     0   000  000  000
   3     000   0     0   000  000  000
MODE (0-6): NRM/PRM/YLD/PYL/POM/SOM/FAC
A-UP B-DN C-LT D-RT E-ENTER F-PRIOR MENU
```

The next step is to enter each unique coordination pattern in specified Dial/Split fields. To do this, first exit to the previous screen. Make sure that the same dial and split values are selected. Then, enter a value of “2” for “OFFSET.” This will take you to the screen used for entering cycle length and phase split times. After entering this data, also enter a value of “1” for the two coordinated phases (in this case, phases 2 and 6).

```
DIAL 1 SPLIT 1 PHASE PARAMETERS
PHASE......1...2...3...4...5...6...7...8
 TIME      0   0   0   0   0   0   0   0
 MODE      0   0   0   0   0   0   0   0
MODE: 0-ACTUATED   1-COORD PH   2-MIN REC
      3-MAX REC    4-PED REC    5-MX+P REC
      6-PH OMIT    7-DUAL COORD PHASE
A-UP B-DN C-LT D-RT E-ENTER F-PRIOR MENU
```

To complete data entry for a specific pattern, select the “Copy Dial/Split” option (MM > 5 > 4) and copy data to all appropriate dials and split combinations.

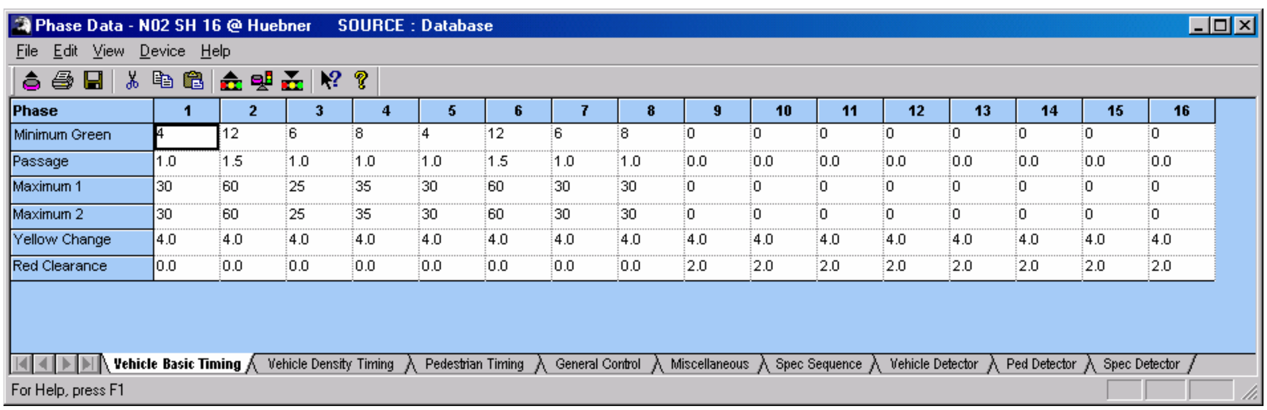
In MARC, select the appropriate Dial/Split tab under coordination data to view/enter all of above data (see illustration below). It should be noted that, like other Windows-based programs, MARC allows the user to select a set of fields, copy selected data, and paste elsewhere. This feature can be used to copy data entered for one dial-split combination to another dial-split combination.



Notice in the illustration above that the MARC data screen also shows phase and pedestrian minimum times for use as a guide when entering splits. As stated earlier, the split for a phase cannot be smaller than the larger of these two values for that phase. Before entering splits, you should make sure that this is indeed the case. If you are programming via the control panel, press MM > 3 > 1 to check splits against data entered for vehicle times (illustrated below), press MM > 3 > 3 to check splits against specified pedestrian times, and press MM > 3 > 2 to check splits against any programmed volume-density data. The following illustration shows data for vehicle times.

```
PHASE......1...2...3...4...5...6...7...8
 MIN GRN   10  15  10  15  10  15  10  15
 PASS/10   40  50  4   50  40  50  40  50
 MAX # 1   25  35  25  35  25  35  25  35
 MAX # 2   30  50  30  50  30  50  30  50
 YEL/10    40  40  40  40  40  40  40  40
 RED/10    10  10  10  10  10  10  10  10
A-UP B-DN C-LT D-RT E-ENTER F-PRIOR MENU
```

In MARC (as illustrated below), these data can be viewed under the "Phase or Signal Plan Data" option.



Phase	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Minimum Green	4	12	6	8	4	12	6	8	0	0	0	0	0	0	0	0
Passage	1.0	1.5	1.0	1.0	1.0	1.5	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Maximum 1	30	60	25	35	30	60	30	30	0	0	0	0	0	0	0	0
Maximum 2	30	60	25	35	30	60	30	30	0	0	0	0	0	0	0	0
Yellow Change	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Red Clearance	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0

Repeat the above steps for entering data for all coordination patterns you have selected for your site.

Configuring System Detectors

If there are no system detectors at the current intersection, go to the next subsection. Otherwise, configure system detectors using the following three steps:

1. Assign system detector on screen reached by pressing MM > 8 > 2 > 1 (see below).

```
EPAC SYSTEM - SYS DET ASSIGNMENT

SYS DET....1...2...3...4...5...6...7...8
 ASSIGNED  1   2   3   4   5   6   7   8
   TO ASSIGN:  VEH 01-64 enter #01-64
               SPC 01-08 enter #65-72
               PED 01-08 enter #73-80
A-UP B-DN C-LT D-RT E-ENTER F-PRIOR MENU
```

2. Assign volume occupancy parameters using MM > 8 >2 > 2 (see below).

```
EPAC SYSTEM - SYS DET V+O PARAMETERS

SYS DET....1...2...3...4...5...6...7...8
VPHRx100: 00  00  00  00  00  00  00  00
AVGT....: 00  00  00  00  00  00  00  00
CTFC/10.: 00  00  00  00  00  00  00  00
MVOL%...: 00  00  00  00  00  00  00  00
A-UP B-DN C-LT D-RT E-ENTER F-PRIOR MENU
```

3. Set reporting interval using MM > 8 > 2 > 3 (see below).

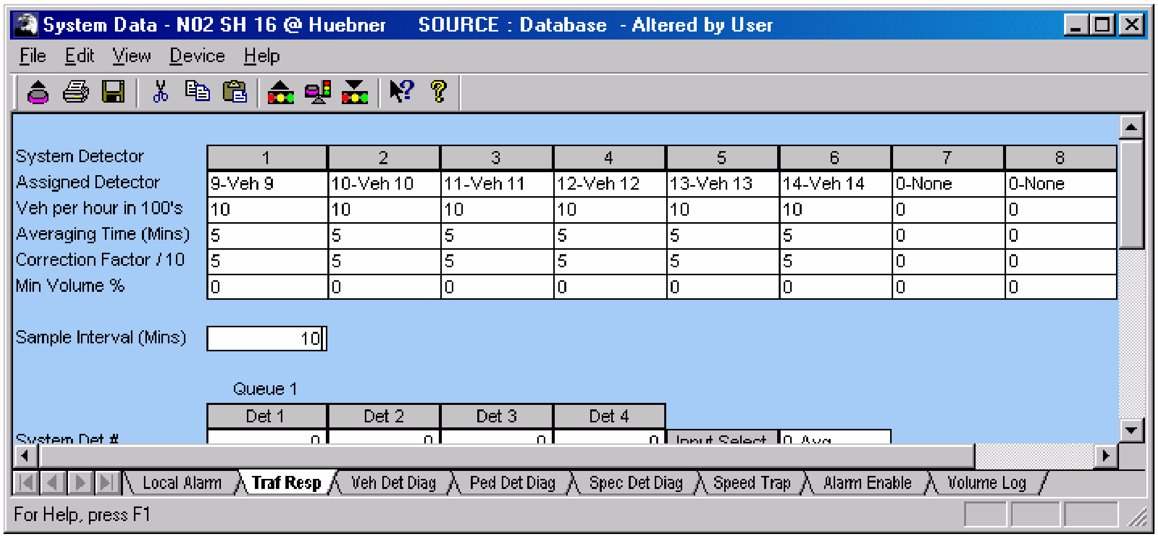
```
EPAC SYSTEM - REPORT PARAMETERS

 REPORT INTERVAL:  00  (00-99 MINUTES)


  TIME BASE AUX "D2" ENABLES REPORTING

A-UP B-DN C-LT D-RT E-ENTER F-PRIOR MENU
```

In MARC, all these data are entered by selecting the "Traf Resp" tab (see below) under the "System/Detector Data" option.



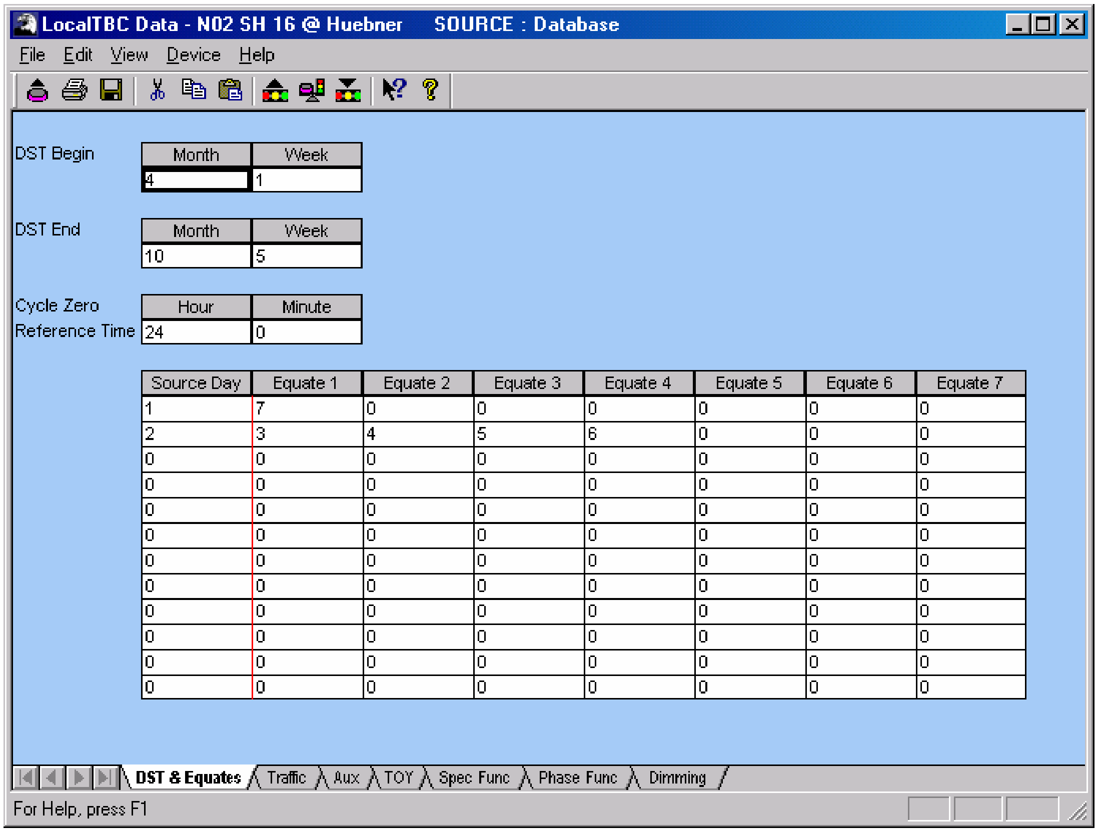
Configuring the Scheduler

Before setting up the TOD schedule, you should analyze each programmed pattern to determine which of these patterns should run at different times (i.e., AM-peak, noon-peak, PM-peak, and off-peak times) during weekdays and weekends. After you have done so, create the same TOD schedule in each controller. This is important to ensure coordination of signals should traffic-responsive operation fail due to loss of communication or bad detectors. This is done by selecting MM > 6 > 3 and then pressing "E" on the front panel.

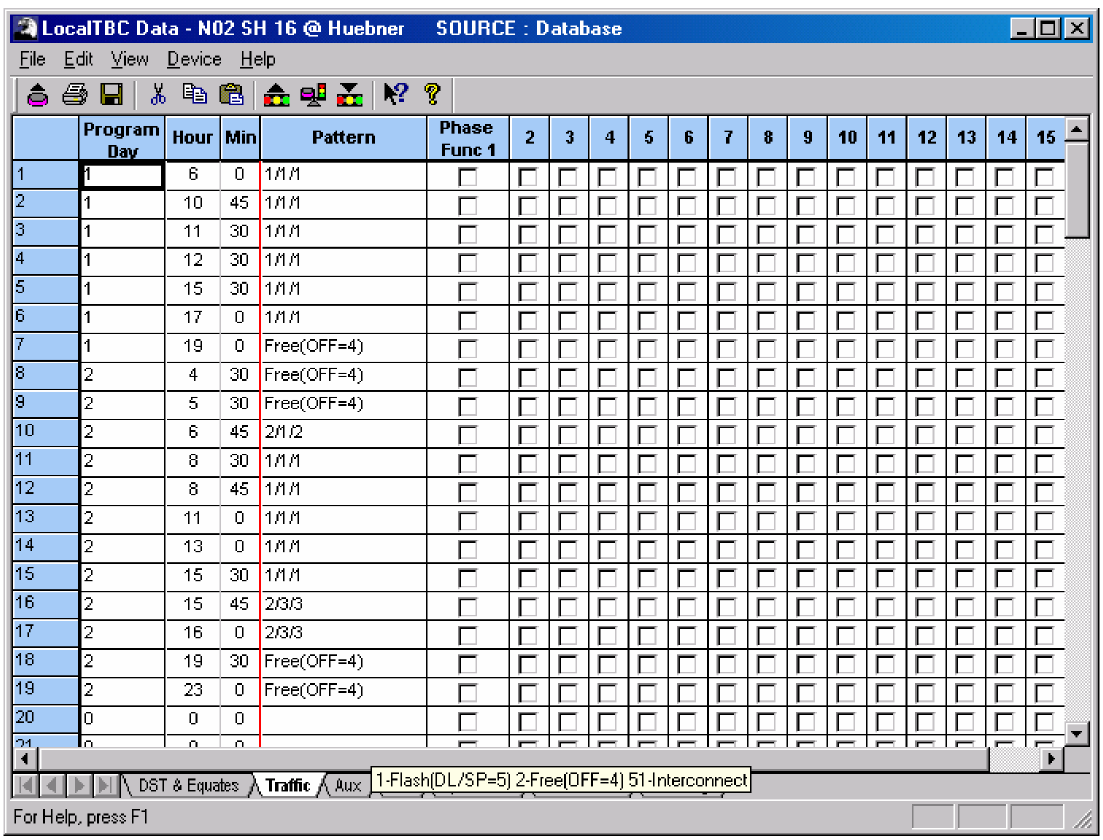
```
EPAC TIME BASE - TRAFFIC EVENTS
  DD  HH MM  DL SP OF P123456789 0123456
  01  06:00   1  1  1  .........  ......
> 01  08:00   1  2  1  .........  ......
  01  10:00   2  1  1  .........  ......
CODES........FL=DL/SP=5....FR=OF=4......
OVERWRITE ">" W/ 1-ADD  2-DELETE  3-EDIT
A-UP B-DN C-LT D-RT E-ENTER F-PRIOR MENU
```

After the schedule for a unique day (i.e., one weekday and one weekend) has been defined, select MM > 6 > 6 to copy or equate the data for this day to all other compatible days.

In MARC, the same data are defined by selecting "DST & Equates" and "Traffic" tabs (illustrated below) under "Local TBC Data" option.



Source Day	Equate 1	Equate 2	Equate 3	Equate 4	Equate 5	Equate 6	Equate 7
1	7	0	0	0	0	0	0
2	3	4	5	6	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0



	Program Day	Hour	Min	Pattern	Phase Func 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	1	6	0	1/1/1															
2	1	10	45	1/1/1															
3	1	11	30	1/1/1															
4	1	12	30	1/1/1															
5	1	15	30	1/1/1															
6	1	17	0	1/1/1															
7	1	19	0	Free(OFF=4)															
8	2	4	30	Free(OFF=4)															
9	2	5	30	Free(OFF=4)															
10	2	6	45	2/1/2															
11	2	8	30	1/1/1															
12	2	8	45	1/1/1															
13	2	11	0	1/1/1															
14	2	13	0	1/1/1															
15	2	15	30	1/1/1															
16	2	15	45	2/3/3															
17	2	16	0	2/3/3															
18	2	19	30	Free(OFF=4)															
19	2	23	0	Free(OFF=4)															
20	0	0	0																
21	0	0	0																

Turning On Reporting to the Master

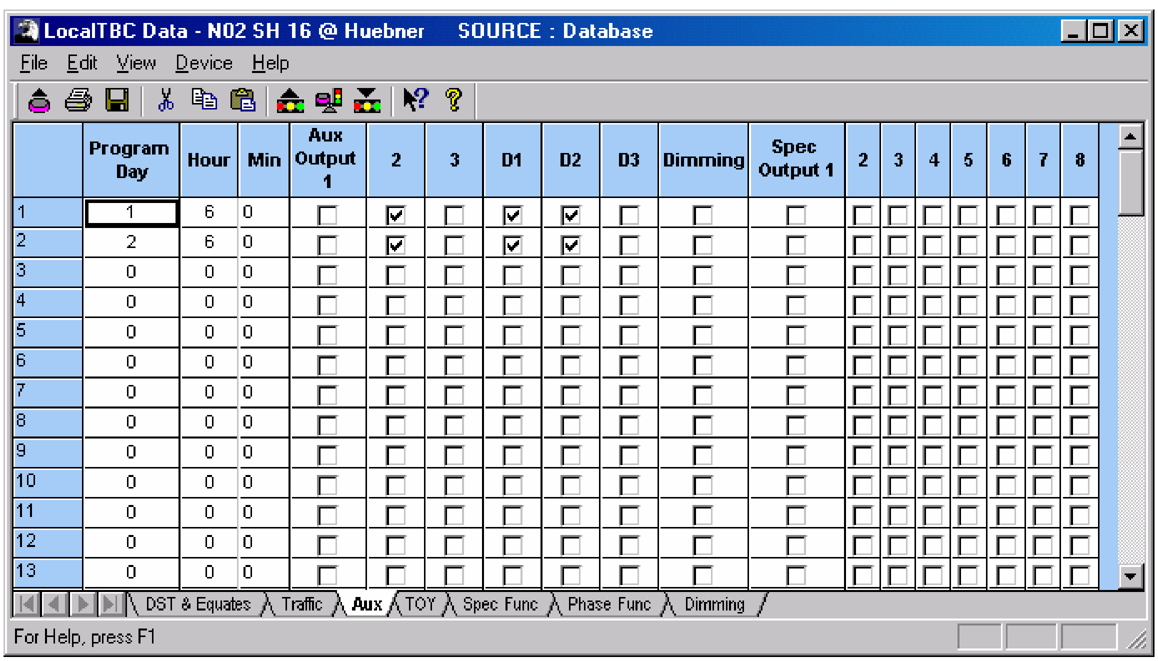
This is the last step in setting local controllers. Select MM > 6 > 4 and enter "E" to get to the screen shown below.

```
EPAC TIME BASE - AUXILIARY EVENTS
  DD  HH MM  A123  D123  DIM  S12345678
  01  06:00   100   000   0    00000000
> 01  08:00   010   000   0    00000000
  01  10:00   001   000   0    00000000
CODES........0-OFF....1-ON.............
OVERWRITE ">" W/ 1-ADD  2-DELETE  3-EDIT
A-UP B-DN C-LT D-RT E-ENTER F-PRIOR MENU
```

On this data screen:

- Select a day, specify a time at which system data needs to be reported to the master, and enter a "1" for option "D2."
- Optionally enter a "1" for option "D1" to enable reporting of detector failures.

By entering another time for the same day and putting a "0" for either "D1" or "D2" you can also specify times of day during which these options are active. Set "D2" to "1" for all days during which you wish to run traffic-responsive. As illustrated below, in MARC you can achieve this by selecting the "Aux" tab under "Local TBC Data."



PROGRAMMING ON-STREET MASTER CONTROLLER

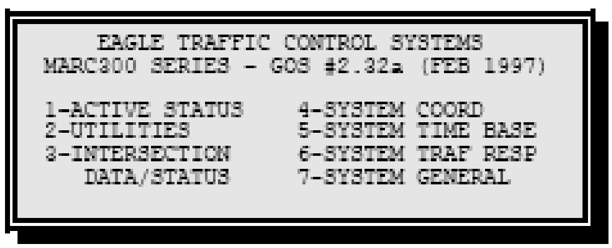
The on-street master allows up to 32 local controllers to be operated under its control. Furthermore, you can divide your system in two groups, one or both of which can be under traffic-responsive control. However, if only one group is to be operated under traffic-responsive control, it should be defined as group 1.

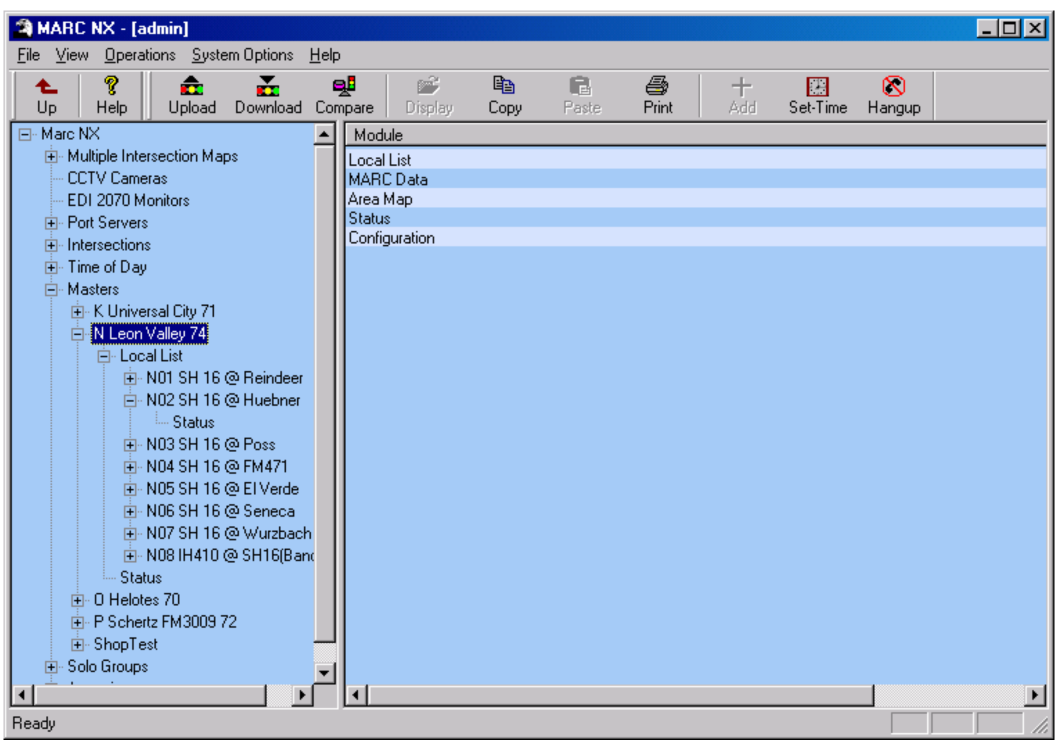
On-street master setup requires the following steps:

1. Coordination setup
2. Programming system time-base data
3. Programming sample interval
4. Programming computational channels
5. Programming pattern select parameters
6. Turning the system on

On-Street Master Controller and MARC Main Menus

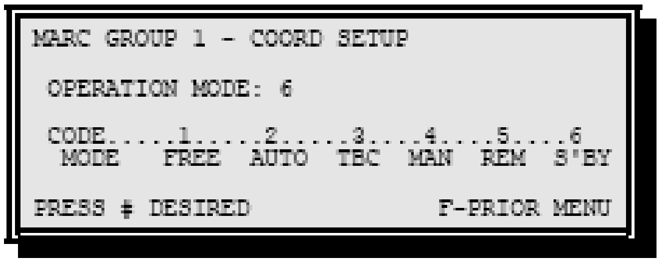
The following screens illustrate the main menus you will be using to program the master.



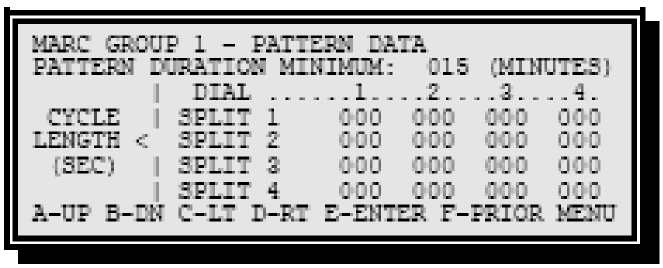


Coordination Setup

From the front panel, select MM > 4 > 1 > 1 (see illustration below), and enter "2" (Auto) for mode data.



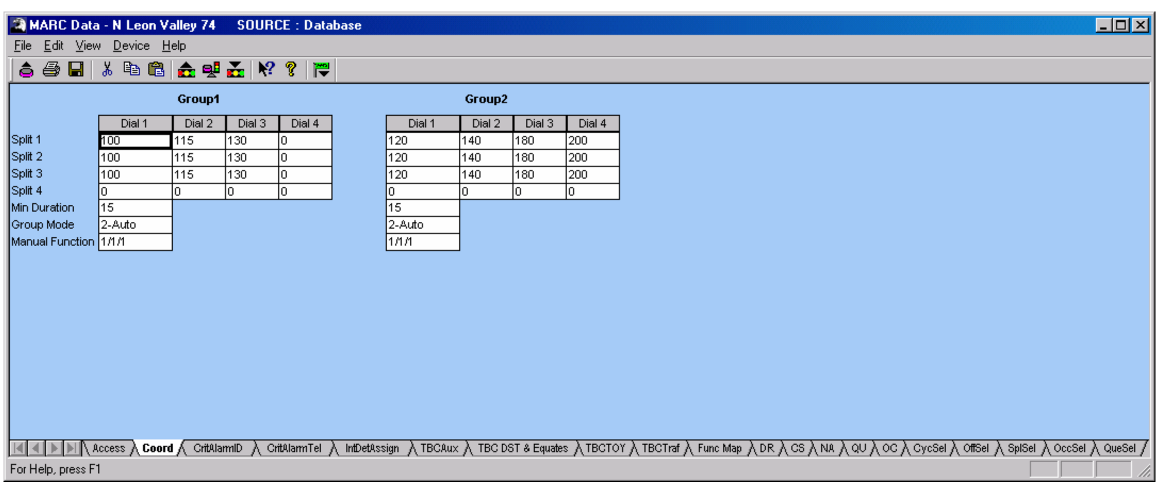
From the front panel, select MM > 4 > 1 > 1 (see illustration below).



1. Enter desired minimum duration. This is the minimum time for which the master will run a specific pattern under traffic-responsive control.
2. Enter cycle lengths for all dials and splits programmed in the local controllers. Proper entry ensures that the master sends correct coordination pulse to the local controller.

In MARC, these data can be entered by selecting the "Coord" tab under "MARC" data option (see illustration below).

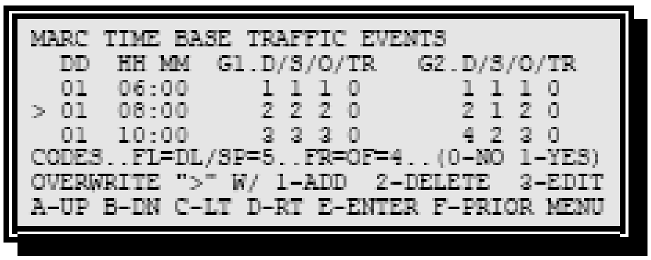
.



Programming System Time Base Data

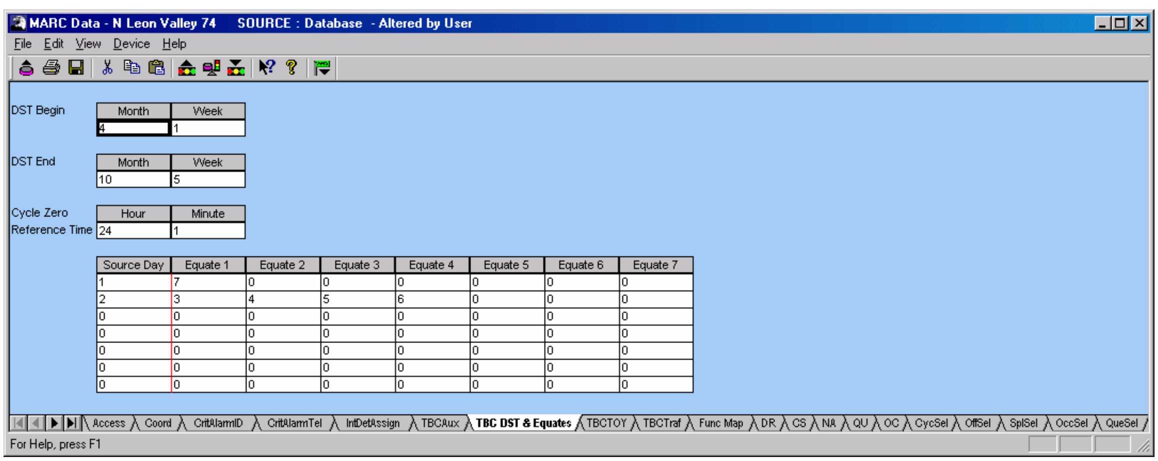
For consistency, program the same equates and TOD schedules in the master as in the local controllers.

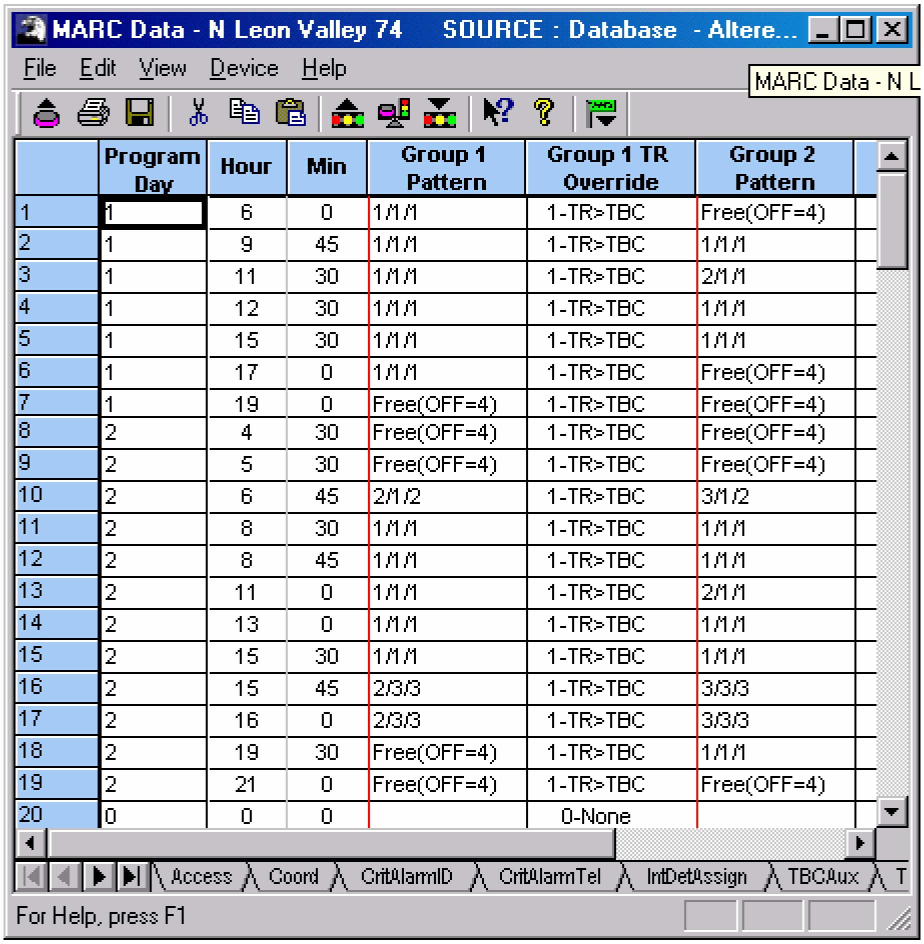
Press MM > 5 > 3 followed by "E" on the front panel to program time base data in the on-street master controller (illustrated below). You will enter program day, time, and pattern (dial/split/offset) for group 1 (G1) on this screen. This data entry is similar to local controller, except that it provides for entering data for the two groups. In addition, you will also enter a "1" for "TR" if traffic-responsive operation is to override time-base control. For day and time combinations where TOD (which could be "Free") operation is desired, the value of TR should be zero.



Once you define the schedule for all unique days (i.e., weekday and weekend), use MM > 5 > 6 to copy this data to other compatible days.

As shown in the following illustrations, these data are specified in MARC on "TBC DST & Equates" and "TBCTraf" tabs under "MARC" data.



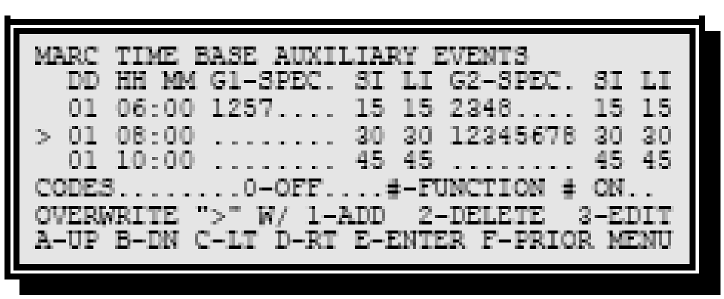


	Program Day	Hour	Min	Group 1 Pattern	Group 1 TR Override	Group 2 Pattern
1	1	6	0	1/1/1	1-TR>TBC	Free(OFF=4)
2	1	9	45	1/1/1	1-TR>TBC	1/1/1
3	1	11	30	1/1/1	1-TR>TBC	2/1/1
4	1	12	30	1/1/1	1-TR>TBC	1/1/1
5	1	15	30	1/1/1	1-TR>TBC	1/1/1
6	1	17	0	1/1/1	1-TR>TBC	Free(OFF=4)
7	1	19	0	Free(OFF=4)	1-TR>TBC	Free(OFF=4)
8	2	4	30	Free(OFF=4)	1-TR>TBC	Free(OFF=4)
9	2	5	30	Free(OFF=4)	1-TR>TBC	Free(OFF=4)
10	2	6	45	2/1/2	1-TR>TBC	3/1/2
11	2	8	30	1/1/1	1-TR>TBC	1/1/1
12	2	8	45	1/1/1	1-TR>TBC	1/1/1
13	2	11	0	1/1/1	1-TR>TBC	2/1/1
14	2	13	0	1/1/1	1-TR>TBC	1/1/1
15	2	15	30	1/1/1	1-TR>TBC	1/1/1
16	2	15	45	2/3/3	1-TR>TBC	3/3/3
17	2	16	0	2/3/3	1-TR>TBC	3/3/3
18	2	19	30	Free(OFF=4)	1-TR>TBC	1/1/1
19	2	21	0	Free(OFF=4)	1-TR>TBC	Free(OFF=4)
20	0	0	0		0-None	

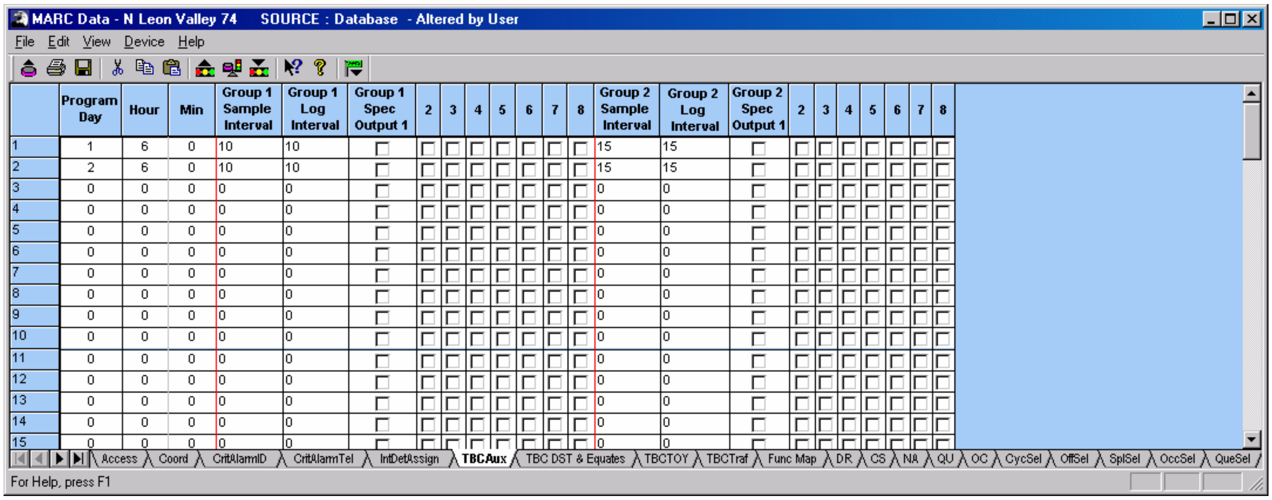
On the schedule screen (shown below), set "1-TR>TBC" for all days and times during which you wish to run traffic-responsive operation. For times during which you wish to run TOD operation, specify "none."

Programming Sample Interval

From the control panel, select MM > 5 > 4, then press "E" to specify sample and logging intervals (SI and LI) for group 1. An illustration of this screen is provided below.

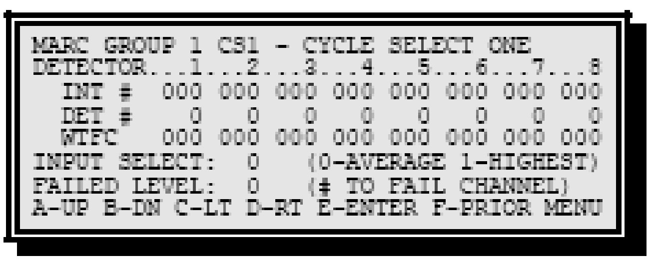


In MARC (illustrated below), this data is entered on the “TBCAux” tab under “MARC” data.



Programming Traffic Responsive Computational Channels

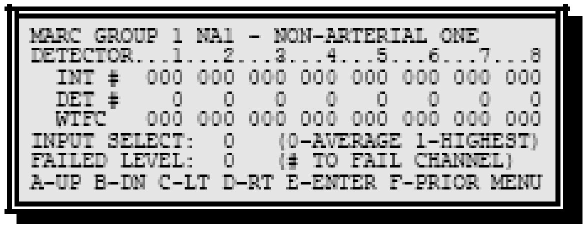
From the front panel, select MM > 6 > 1 > 1 > 2 to assign system detectors to cycle select channel 1 (CS1) for group 1 (see illustration below).



On this screen, configure specify system detector data as follows:

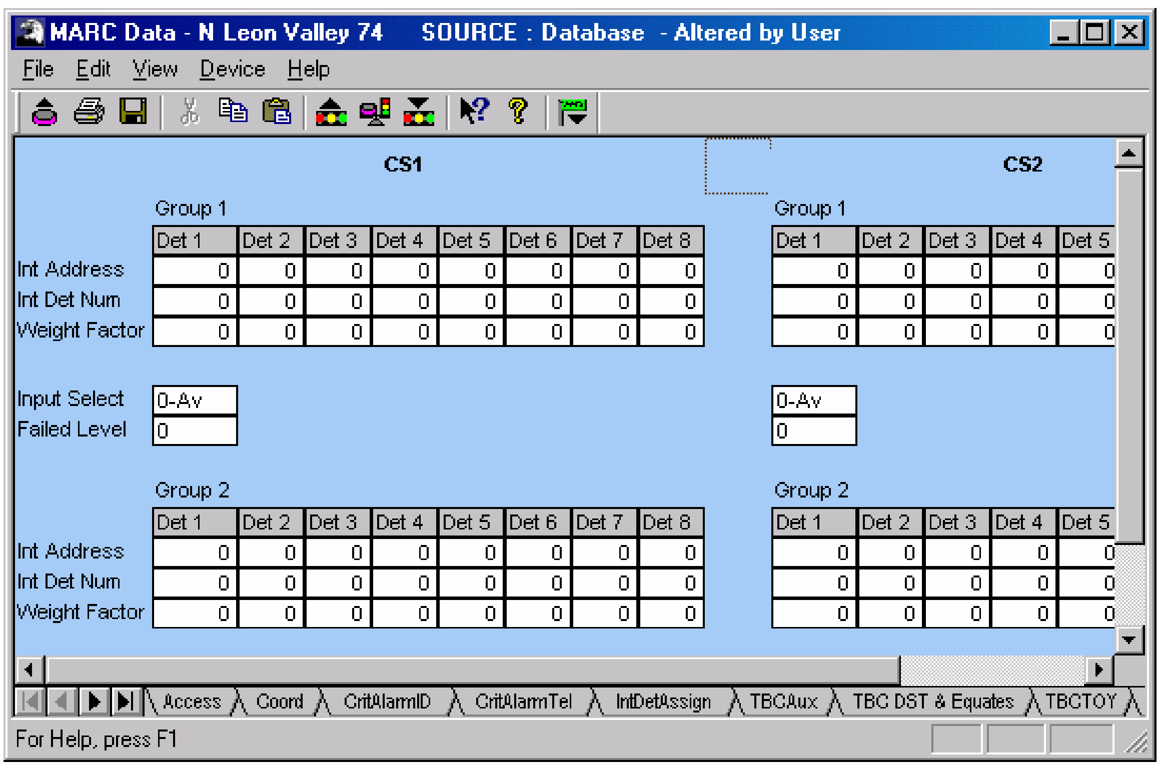
- For each system detector (starting from 1), specify the local intersection number and corresponding local system detector number.
- For each system detector, enter the weighting factor for data from each local system detector.
- For each detector, specify (Input Select) if data is to be averaged or the highest value is to be used in the calculation when two or more detectors are configured for this channel.
- Specify the “Failed Level,” which is the number of failed detectors, to indicate that sufficient data does not exist for proper calculations.

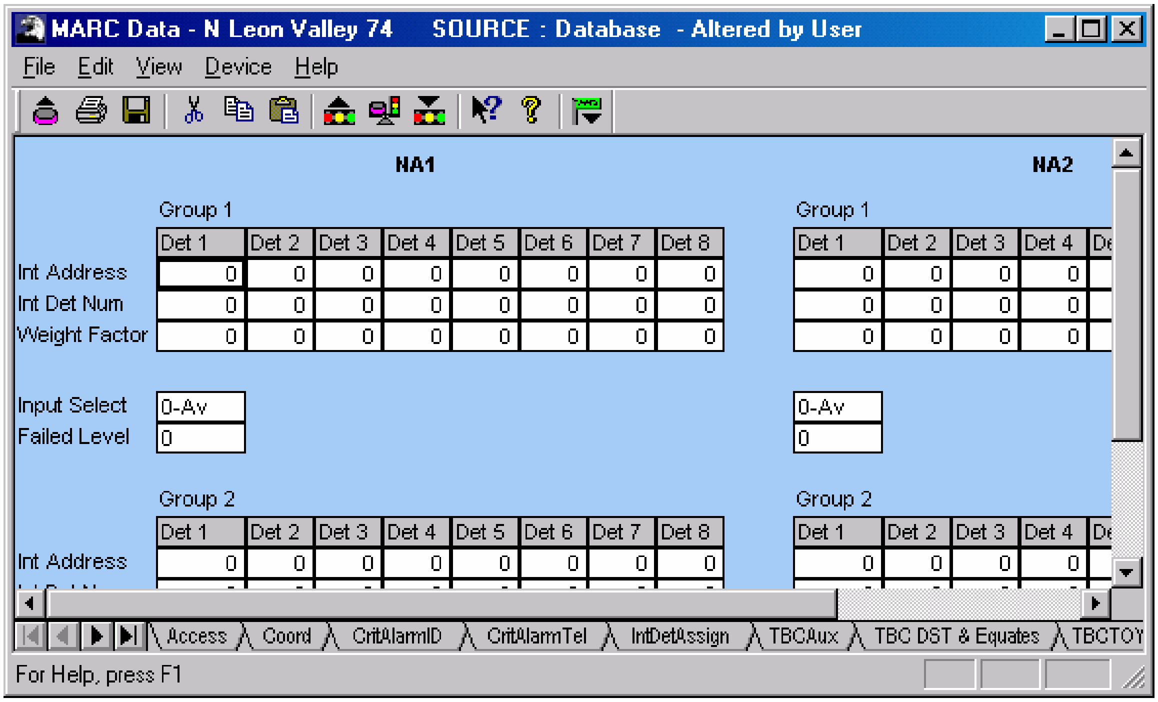
From the front panel, select MM > 6 > 1 > 1 > 4 to assign system detectors to non-arterial channel 1 (NA1) for group 1 (see illustration below).



On this screen, configure detectors for use in the calculation of NA1. This data entry is similar to the one for CS1.

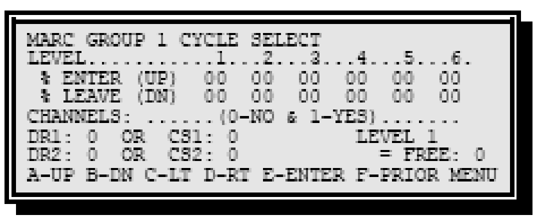
In MARC, these data are entered by selecting "CS1" and "NA1" tabs under "MARC" data. The following are illustrations.





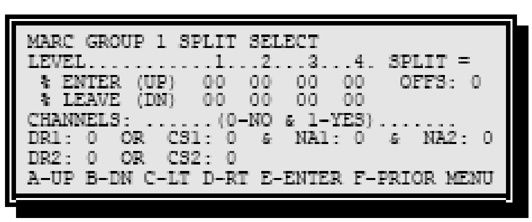
Programming Pattern Select Parameters

From the control panel, select MM > 6 > 1 > 2 > 1 to specify thresholds for cycle (Dial) select (see illustration below).



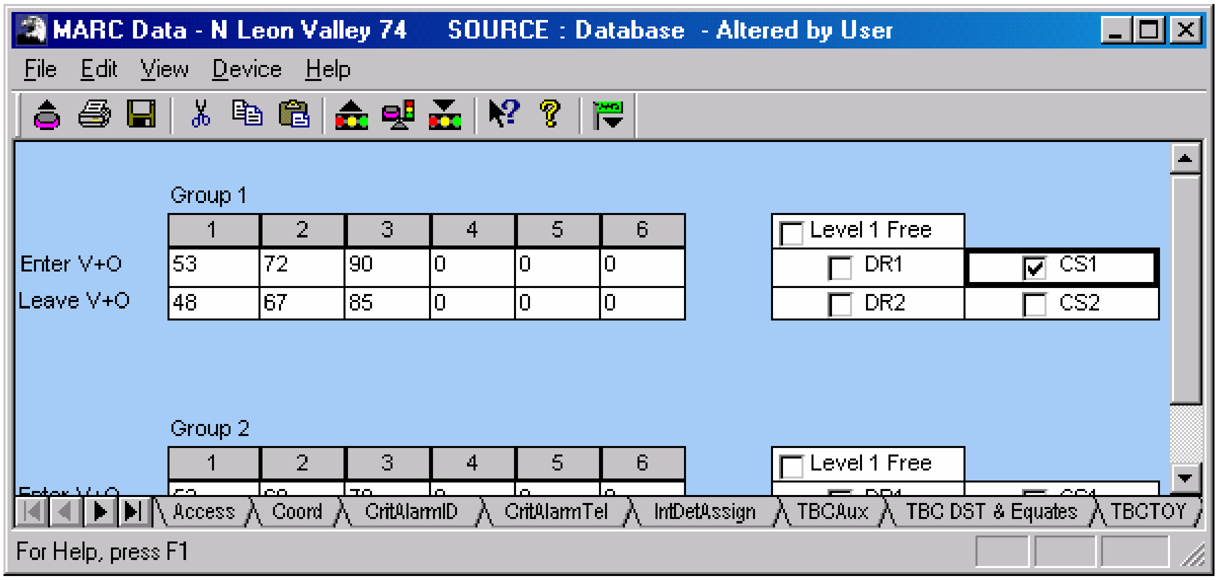
On this screen you will enter specified thresholds. By entering a "1," you will also specify the channel (CS1) for selection cycle level.

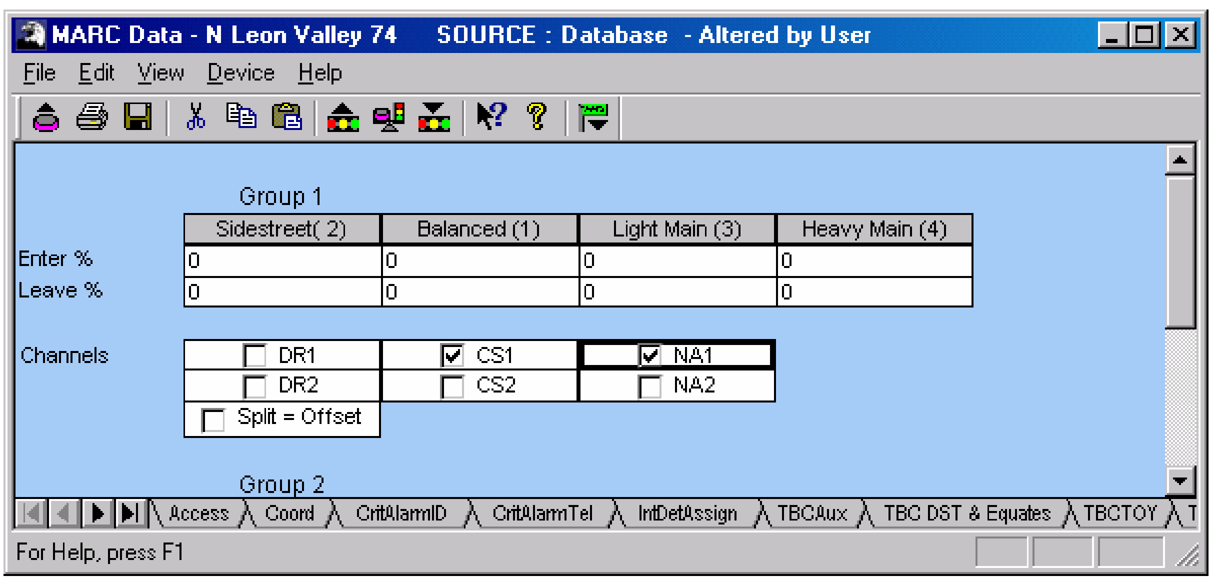
From the control panel, select MM > 6 > 1 > 2 > 1 to specify thresholds for cycle (Dial) select (see illustration below).



On this screen, you will enter "1" for CS1 and NA1 and enter the selected threshold.

In MARC, these data are entered on “CycSel” and “SplSel” tabs under “MARC” data. These screens are illustrated below.





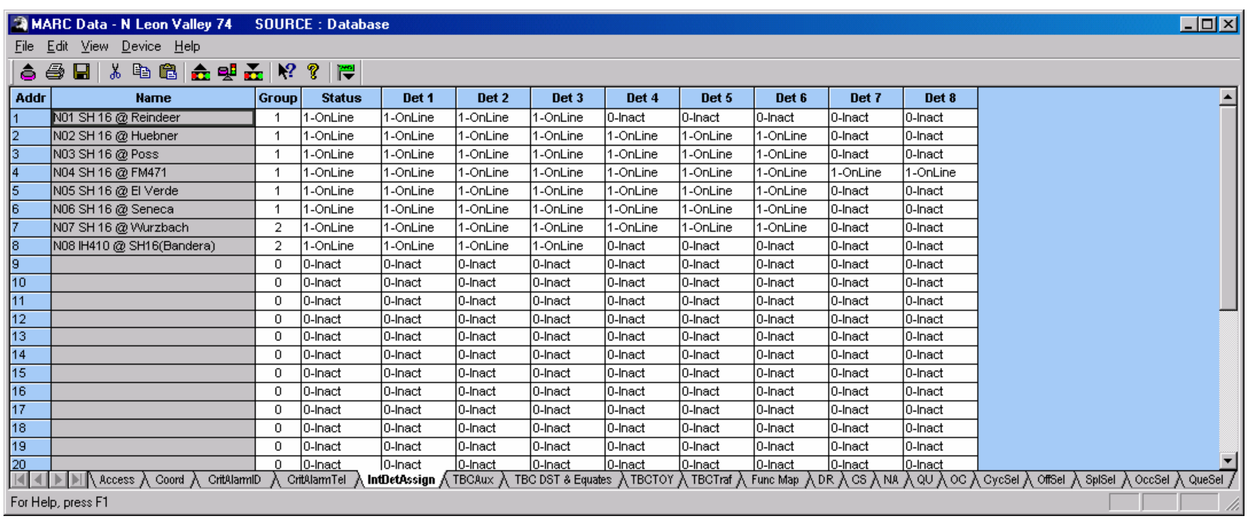
Turning the System On

The final step is to bring the system online. To do this, select MM > 7 > 1 from the front panel. On the front panel, select “1” for the first four intersections in your system, select “2” for the next four intersections, and so on (see illustration below).

```
MARC INTERSECTION ASSIGNMENTS
 INT GRP ST  DET..1..2..3..4..5..6..7..8
  01  0   0       0  0  0  0  0  0  0  0
  02  0   0       0  0  0  0  0  0  0  0
  03  0   0       0  0  0  0  0  0  0  0
  04  0   0       0  0  0  0  0  0  0  0
..0-INACT  1-ONLIN  2-CRITIC  3-STANDBY.
A-UP B-DN C-LT D-RT E-ENTER F-PRIOR MENU
```

On the above screens, enter “1” under the column labeled “ST” for all intersections in group 1. This will bring the intersection online. For each intersection, also enter a “1” for all local system detectors defined. It should be noted here that some intersections in your system may not have any system detectors. In those cases, leave the entries for system detectors to zero, but make sure that the intersection is online.

In MARC, this last step is accomplished by entering data on the “IntDetAssign” tab under “MARC” data.



Addr	Name	Group	Status	Det 1	Det 2	Det 3	Det 4	Det 5	Det 6	Det 7	Det 8
1	N01 SH 16 @ Reindeer	1	1-OnLine	1-OnLine	1-OnLine	1-OnLine	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact
2	N02 SH 16 @ Huebner	1	1-OnLine	1-OnLine	1-OnLine	1-OnLine	1-OnLine	1-OnLine	1-OnLine	0-Inact	0-Inact
3	N03 SH 16 @ Poss	1	1-OnLine	1-OnLine	1-OnLine	1-OnLine	1-OnLine	1-OnLine	1-OnLine	0-Inact	0-Inact
4	N04 SH 16 @ FM471	1	1-OnLine	1-OnLine	1-OnLine	1-OnLine	1-OnLine	1-OnLine	1-OnLine	1-OnLine	1-OnLine
5	N05 SH 16 @ El Verde	1	1-OnLine	1-OnLine	1-OnLine	1-OnLine	1-OnLine	1-OnLine	1-OnLine	0-Inact	0-Inact
6	N06 SH 16 @ Seneca	1	1-OnLine	1-OnLine	1-OnLine	1-OnLine	1-OnLine	1-OnLine	1-OnLine	0-Inact	0-Inact
7	N07 SH 16 @ Wurzbach	2	1-OnLine	1-OnLine	1-OnLine	1-OnLine	1-OnLine	1-OnLine	1-OnLine	0-Inact	0-Inact
8	N08 IH410 @ SH16(Bandera)	2	1-OnLine	1-OnLine	1-OnLine	1-OnLine	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact
9		0	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact
10		0	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact
11		0	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact
12		0	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact
13		0	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact
14		0	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact
15		0	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact
16		0	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact
17		0	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact
18		0	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact
19		0	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact
20		0	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact	0-Inact

If you programmed using the front panel, you are done with the system setup. If you programmed via MARC NX or ACTRA, you will have to download programmed data for the master and each local controller. This can be done from the central office if center-to-field communication infrastructure is in place, or by direct connection to the field hardware through a serial port.