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TecNote 1101 – NTCIP Coordination By Example

This TecNote provides examples that let you practice running NTCIP coordination on Naztec controllers. There are 11 distinct coordination modes in the Naztec 970 and 980/981 series controllers; however, only the NTCIP fixed and floating force-off modes are discussed here. The Naztec controller database provides a one-to-one match with the NTCIP object definitions in NEMA specification TS 3.5. The names chosen for the various coordination options follow the syntax from TS 3.5, section 2.5 - Coordination Parameters. Therefore, if you take the time to work through these exercises, you will gain a good understanding of NTCIP coordination.

We use a step-by-step approach to explore the basic concepts and subtleties of coordination and relate these concepts to the Synchro software package currently used by most of our customers to develop coordination patterns. These exercises are designed to point out the importance of referencing offsets so the offset in the controller agrees with the offset reference in Synchro. Once you gain an understanding of the various coordination modes, you will typically standardize these modes as defaults for your own desired method of coordination.

The user is encouraged to enter these examples into the controller through the keyboard. A shortcut notation is provided for all key sequences - for example, the notation (MM->1) calls for the 1 key to be entered at the Main Menu. A good way to approach these exercises is to complete Steps 1 through 5 below and then take a break. Afterwards, explore the examples using the controller data you entered to gain an understanding of signal coordination. With practice, you will gain insights into the features of the Naztec controller and avoid many of the pitfalls associated with NTCIP coordination.

Step 1 - Build the Controller Base Data

It is important to create a base controller data set to achieve the same results as the examples and to familiarize yourself with basic timings and options that affect coordination. To initialize the controller database and build a controller data file for these examples, please click here.

Step 2 - Set the Coordination Modes

NTCIP coordination allows you to use the FIXED or FLOATING force-off mode of coordination. All examples in this TecNote use FIXED force-offs. To set the Coordination Modes for these examples, please click here.

Step 3 - Enter the Coordination Patterns

The coordination patterns (or timing plans) should be entered into a controller so that you can manually execute these patterns using the Test OpMode discussed in Step 2. Pre-entering the coordination patterns in this step will allow you concentrate on the coordination concepts presented below without getting bogged down with the programming. To set the Coordination Patterns used in these examples are please click here.

Step 4 - Check Patterns Using Controller Diagnostics

The Naztec controller provides diagnostics that allow you to isolate and correct faults your coordination patterns. You should get in the habit of checking every coordination pattern you enter. We have intentionally added errors to the coordination patterns you entered in Step 3 to help familiarize you with the Naztec diagnostics checks. To correct these errors and learn how to use the Naztec Diagnostics please click here.

Step 5 - Save Your Work in StreetWise

You will want to save your work by uploading the controller data, so create a new controller and assign an ID in StreetWise. Then change the "Station ID" (MM->6->1) of the controller you've been working on to this new StreetWise ID, upload the data file and save the upload file to the standard and permanent file under the "Utilities" menu.

If you are having difficulty programming the controller for these examples, you may download the controller data file here. Just save this file as your standard and permanent data file for the controller ID you created in StreetWise (980 TS2 Secondary 50.x controller type). However, you will not gain as much from this exercise if you do not program the controller by hand and work through Steps 1 through 5.

Now let's explore NTCIP coordination using the example data you entered into the controller.

Concept 1 - What is a *Coordination Pattern*?

A Coordination Pattern in NTCIP is defined by a :

- **cycle length** (in seconds)

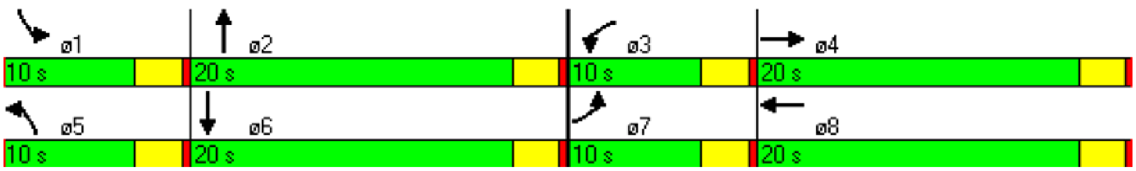
- **offset** (in seconds)
- **split number**
- **sequence number**

Go ahead and take a second look at the Pattern Table you entered in Step 3 under MM->2->4.

The sequence number refers to the phase sequences you entered under MM->1->2->4. Most agencies develop standard phase sequence chart to select the sequence number desired for the pattern.

The split number references the split table that you entered under MM->2->7.

The following timing plan was generated by Synchro



You have already programmed this plan as **Pattern #1** in the controller:

Sequence #1	Ring1: 1 2 3 4 Ring2: 5 6 7 8
Pattern #1	Pat# Cycle Offset Split Seqnc 1 60 0 1 1
Split #1	Spl- 1 ø..1...2...3...4...5...6...7...8 -> Time 10 20 10 20 10 20 10 20 Coor-ø . X . . . . . . Mode MAX MAX MAX MAX MAX MAX MAX MAX

Notice that only phase 2 is specified as the Coor-ø (coordination phase) rather than both phase 2 and 6. Only one Coor-ø (coordination phase) phase should be specified because the main street phases may not begin or end together and you can only reference the offset at one point.

All of the patterns in these examples except Patterns 7, 8, 9 and 12 use BegGRN as the offset reference (verify this by going to MM->2->5 and scrolling to the right screen). The following notation for the dual ring sequence in Pattern #1 below is used throughout this TecNote. The "<" and ">" symbols (in red) reference the offset (in seconds) for the begin or end of the coord phase (C).

Pattern #1 - 60" cycle / 0" Offset Referenced to Phase 2 Begin-of-Green

1 / 10"	<0"(C) 2 / 20"	3 / 10"	4 / 20"
5 / 10"	6 / 20"	7 / 10"	8 / 20"

Concept 2 - Exploring Coordination With the Timing Status Screen

Run Coordination Pattern #1 by entering MM->2->1->1 ENTER

Go to the Timing Status Screen (MM->7->1) and observe the controller cycling through the phases for this pattern. The sequence number is shown on this screen as well as the current phases being timed in each ring. The active vehicle (Veh) and pedestrian (Ped) calls are shown for each phase along with the phases which are Active and Next (A/N). The Loc (Local) counter is the cycle counter which resets to zero at the offset point in the coordination cycle.

Fixed-time Operation

Notice that each phase is being forced off under coordination because of the MAX calls placed in the split table for Plan #1. Term Fof is displayed at the end of the split time for each phase and the controller is operating in a "fixed-time" mode with MAX calls applied to each phase.

Also notice how the Loc (Local) counter resets to zero at the beginning of the coord phase (phase 2). With BegGRN (beginning-of-green) set, the beginning of phase 2 is the the offset reference point where Loc (Local) counter resets to zero.

Semi-actuated Operation

Now, change the MAX calls on phases 1, 3, 4, 5, 7 and 8 to MIN calls in Split #1 (MM->2->7->1). Leave the MAX calls on phases 2 and 6 and consider these the main street through phases. Then go back to the Timing Status Screen (MM->7->1) and observe the termination point of each phase. All phases other than 2 and 6 are actuated and terminate with a Term Gap because there are no detector actuations to extend the phases beyond the min time. "Slack time" from each phase is passed along to the next phase in sequence. The "slack time" eventually gets passed to phase 2 and 6 which now begin approximately 20" sooner than the fixed-time example. Note that the Loc counter resets to zero 20" after the beginning of green of phase 2.

This operation is termed **"semi-actuated"** because the cycle is fixed and the main street phases pick up the "slack time" from the actuated phases until they are forced off. A **"fixed-time"** controller guarantees a maximum split time for each phase within a fixed cycle time. A **"fully-actuated"** controller does not have a coord phase or a fixed cycle time, and each phase is serviced on a first-come, first-served basis.

Begin-of-green Vs. End-of-Green

The beginning of the coord phase is variable for "semi-actuated" controllers because the actuated phases are allowed to gap out and transfer a variable amount of "slack time" to the beginning of the coord phase.

Go ahead and change the offset reference for Pattern #1 to EndGRN (right screen under MM->2->5) and compare the "semi-actuated" and "fixed-time" examples you observed with the offset reference set to begin-of-green.

Pattern #1 - 60" cycle / 0" Offset Referenced to Phase 2 End-of-Green

1 / 10"	(C)0"> 2 / 20"	3 / 10"	4 / 20"
5 / 10"	6 / 20"	7 / 10"	8 / 20"

End-of-green insures that the offset is set to the end of the coord phase. The Loc (Local) counter resets to zero at the end of the coord phase no matter how much slack time is passed to the beginning of the phase. In other words, end-of-green coordination insures that your offset always "hits" when the coord phase goes to amber clearance. Many users prefer end-of-green for this reason, because the offsets can be easily observed in the field when the through phases on the main street go to clearance.

PASSER 2 Offset References

PASSER 2 references the offset to the beginning of the first arterial phases at intersection #1 (intersection in the lower left-hand corner of the time-space diagram). Therefore, make sure you adjust the offset from PASSER 2 so it agrees with the BEGIN or END of the coordinated phase you specify in the split table.

Here's an output from PASSER 2 for Intersection #1 (Master Intersection).

```
E Bear Val PE Bear Valley
MAST INT = 0 SYS INT = 0 SYS OFFSET = .0 REF MOVMNT = 0 REF PNT = BEGIN

INTRSC 1 : Cottonwood COORD PHASE : 0 OFFSET : .0 SEC : 0.%
*-[MASTER INTERSECTION]
DUAL-RING PHASE #     5       6       1       2       3       4       7       8
PHASE SPLIT (SEC)    17.1    53.9    17.1    53.9    18.8    24.3    24.2    18.9
PHASE SPLIT (%)      15.%    47.%    15.%    47.%    16.%    21.%    21.%    17.%
PHASE REVERSAL        --      --      --      --      4       3       --      --
LEFT TURN            LEAD     --     LEAD     --     LAG      --     LEAD     --
```

In this example, the PASSER 2 offset is referenced to the beginning of phases 1 + 5 (LEAD LEAD sequence). If you designate phase 2 as the coordinated phase in the controller, make sure you adjust the PASSER 2 offset to sync the offset at the beginning of the coord phase, not the beginning of 1+5. The controller's offset should be 0" + 17" or 17" in this case. Failing to reference the controller offset is a common mistake and leads to poor results when PASSER's output is misinterpreted.

PASSER 4 Offset References

PASSER 4 allows you to reference the system offsets to any intersection in the data set (called the Master Intersection). You can specify the offset of the Master Intersection, the coordinated direction (north, south, east or west) and whether the master offset is referenced to the beginning or end of the coordinated direction. All offsets calculated by PASSER 4 are adjusted to this master offset reference as shown below.

Here's an output of PASSER 4 offsets referenced to the beginning of each phase:

```
========= MOVEMENT-WISE MEASURES OF EFFECTIVENESS =============
NEMA PHASE        1     2      3     4     5     6     7     8
---------------------------------------------------------------
SPLITS (SEC)     32.6  38.6   15.0  33.8  15.0  56.2  15.0  33.8
PHASE REVERSAL    \___Y__/    \___N__/     \___N__/     \___N__/
OFFSET(%) TO BEG 42.8  10.6   70.0 82.5    10.6 23.1   70.0 82.5
```

Here's an output of the same PASSER 4 offsets referenced to the end of each phase.

```
========= MOVEMENT-WISE MEASURES OF EFFECTIVENESS ==============
NEMA PHASE        1     2     3     4      5      6     7     8
----------------- ---------------------------------------------
SPLITS (SEC)     32.6 38.6   15.0 33.8    15.0 56.2   15.0 33.8
PHASE REVERSAL    \___Y__/   \___N__/      \___N__/    \___N__/
OFFSET(%) TO END  30.0 2.8   42.5 70.6     83.1 30.0   42.5 70.6
```

PASSER 4's output is helpful to our application. Just select the offset that corresponds with the BEGIN or END of the coordinated phase you specify in the split table. You can also use PASSER 4's splits if you have been careful to maintain a one-to-one relationship between the phase numbers in the controller and the phase numbers in the controllers modeled with PASSER 4.

Concept 3 - Exploring Coordination With the Coordination Status Screen

Pattern #2 is identical to Pattern #1 in our last example. We had you call up a new pattern rather than go back and reset all the changes you made to Pattern #1 in the previous exercise.

Pattern #2 - 60" cycle / 0" Offset Referenced to Phase 2 Begin-of-Green

1 / 10"	<0"(C) 2 / 20"	3 / 10"	4 / 20"
5 / 10"	6 / 20"	7 / 10"	8 / 20"

Run coordination Pattern #2 by entering MM->2->1->2 ENTER.

Now, quickly go to the Coordination Status Screen (MM->7->2) and look for Active-1 and Next-2 which indicate the active pattern running in the controller and the pattern scheduled next. If the controller is in phases 2/6 or 3/4/7/8, you will see the Active plan change to 2 when the controller crosses the barrier between phases 3/4/7/8 and moves to phases 1/2/5/6. In this example, notice that the beginning of phase 2 and the offset are the same because a MAX call is applied to each phase and no "slack time" is passed to the beginning of phase 2.

OpModes, Src-TEST tells you that the controller is running in TEST mode, rather than TBC (time-base coordination or time-of-day mode). You can put the controller in TBC mode by entering MM->2->1->0 ENTER. You can also manually force the controller into free operation by entering a value of 254 or flash operation by entering a value of 255 as a test mode. (These values follow the NTCIP definitions for free and flash in TS 3.5 section 2.5.1 Coord Operational Mode Parameters).

Notice the two columns on the Coordination Status Screen labeled Cycle and Ofst: .

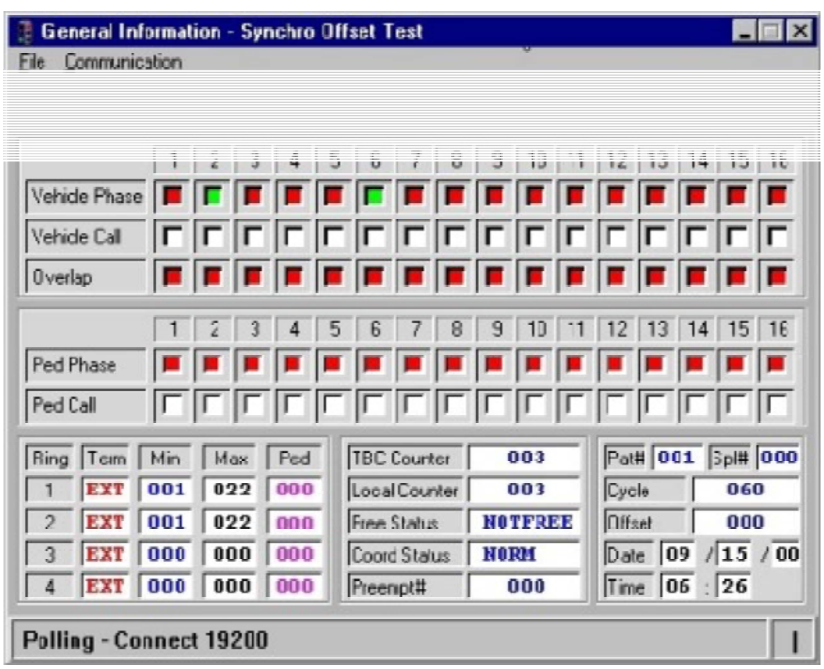
The Cycle column shows the Loc and Tbc cycle counters and the current cycle length (Prog- 60).

The Ofst column shows the actual (Actu:) offset, the current offset error (Err:) and the current programmed (Prog:) offset. The error is the difference between the actual offset and the programmed offset you specified for the pattern.

The controller will transition to the programmed offset using short-way, long-way or dwell offset correction (you specified this as a coordination mode in Step 2). Once the controller achieves coordination, the actual and programmed offsets are the same, the offset error is zero and you will see SYNC displayed in the bottom right hand corner of the display. The interpretation of the Coordination Status Screen will become obvious as you work through the transition examples.

Concept 4 - What is Time Base Coordination?

Call up the controller ID in StreetWise that you saved in Step 5 above and observe the coordination using the "General Information" screen. This display allows you to view most of the information on the controller timing and coordination status screens.



Time-base coordination uses midnight as a time reference to calculate the offset for the controller. All coordinated signal systems maintain a time-base reference by zeroing the cycle counter at midnight and accumulating cycle times to the current time. You can confirm this for the examples covered so far because a 60" cycle length resets the "TBC Counter" each minute. Just watch the "General Information" screen and observe that the "TBC Counter" reaches zero on the even minute. The "TBC Counter" provides the synchronization for all controllers in a coordinated system given that each controller's clock and the cycle length are the same.

The pattern *offset* is essentially an adjustment added to the "TBC Counter" to reference the beginning or end of the coordinated phase when the "Local Counter" reaches zero. The "Local Counter" maintains the synchronization of the coordinated phase relative to the begin or end-of-green of the coordinated phase.

When the offset is 0", the "TBC Counter" and the "Local Counter" are identical. In our next example, Pattern #3 calls for a 45" offset and you will observe that the "TBC Counter" and the "Local Counter" remain exactly 15" apart once the controller is out of transition. If you use Microsoft Explorer, check out the Time-base Coordination Calculator to get a better understanding of the Tbc and Loc counters in the controller (this Javascript program only works with the Microsoft browser, not Netscape).

Just remember that the "Local Counter" is used to reference the beginning or end of the coord phase and the offset is used to adjust the "Local Counter" relative to the "TBC Counter" which is referenced to midnight. If you understand this concept, then you understand time-base coordination.

Concept 5 - Short-way, long-way and dwell transition

This concept illustrates some of the concerns related to the Correction value chosen as a Coordination Mode in Step 2. The controller is still running Pattern #2 from our last example (60" cycle with a 0" offset). Now, change to Pattern #3 (60" cycle and 45" offset) by issuing the key sequence MM->2->1->3 ENTER.

After you force the controller to Pattern #3, look at the Coordination Status Screen (MM->7->2) and note that the Active plan is 2 and the Next plan is 3. If the controller is in phases 2/6 or 3/4/7/8, you will see the Active plan change to 3 when the controller crosses the barrier between phases 3/4/7/8 and moves to phases 1/2/5/6. During the transition, you will see the word SHORT in the bottom right hand corner indicating short-way transition. Watch the offset error change from +15" to 0" as the controller moves to the new offset in Plan #3.

Under short-way transition, the controller shortens each phase split time by 12% (the amount you specified under MM->2->5). A 12% correction each cycle moves the offset from the 0" offset under Plan #2 "backwards in time" 15" to the new 45" offset specified in Plan #3. The controller is in coordination under Plan #3 when the offset error is zero and you see SYNC in the bottom right corner of the screen.

Pattern #3 - 60" cycle / 45" Offset Referenced to Phase 2 Begin-of-Green

1 / 10"	<45"(C) 2 / 20"	3 / 10"	4 / 20"
5 / 10"	6 / 20"	7 / 10"	8 / 20"

Now go back to Pattern #2 (60" cycle and 0" offset) by using the key sequence MM->2->1->2 ENTER.

Notice that LONG (or long-way) transition is used because you are moving "forward in time" from a 45" offset in Plan #3 to a 0" offset in Plan #2. The controller lengthens each phase split by 22% (the amount you specified in MM->2->5) to move the offset forward 15" to make this correction. The controller will always use the quickest method, short-way (shortening the cycle) or long-way (lengthening the cycle) to make the offset correction.

A Common Pitfall When Using Short-way / Long-Way Transition

Pattern #4 calls for the same split table, sequence and offset as Pattern #3 (compare Pat# 4 with Pat # 3 in the Pattern Table under MM->2->4). Both patterns use begin-of-green to reference offsets and both patterns call for short-way / long-way transition (MM->2->1 Correction SHORT/LONG).

Pattern #4 - 60" cycle / 45" Offset Referenced to Phase 2 Begin-of-Green

1 / 10"	<45"(C) 2 / 20"	3 / 10"	4 / 20"
5 / 10"	6 / 20"	7 / 10"	8 / 20"

Run Pattern #4 and observe the Coordination Status Screen (MM->7->2). Instead of seeing SHORT in the bottom right corner of the screen, you will see the word DWELL indicating that the controller is attempting to correct the offset by extending the coord phase each cycle. However, the controller never achieves coordination and continues to DWELL with an offset error of -45" indefinitely.

This condition occurs because when you initialized the controller in Step 1 the transition values for short-way, long-way and dwell in table MM->2->5 were initialized to zero. The controller defaults to dwell correction when short and long-way values zero. This is true even if the correction mode on screen MM->2->1 is set to SHORT/LONG rather than LONG . The controller will remain in DWELL correction indefinitely as long as the dwell value is 0" and will continue to time the cycle, splits and sequence correctively, but the offset will always be -45" out of step.

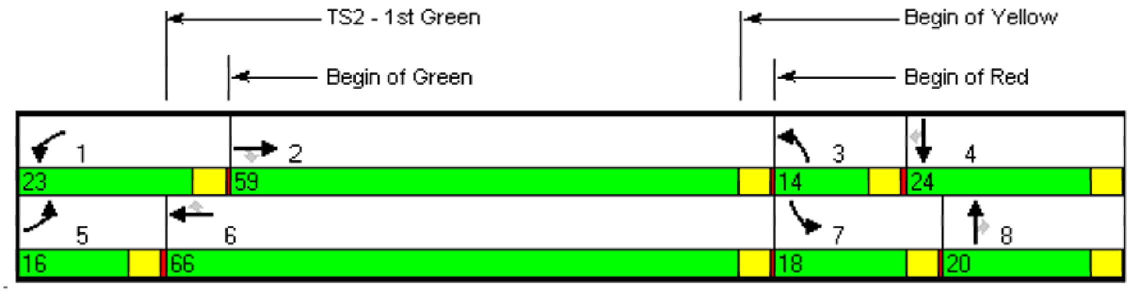
Correct this problem by changing the Dwell value for Pattern #4 on screen MM->2->5 to 60". Then observe the offset correction on the Coordination Status Screen (MM->7->2). The controller will continue to show DWELL with an offset error of -45" until the beginning of the coord phase (in this case phase 2). When the beginning of the coord phase is reached, the controller will "freeze" the Loc counter for the dwell time specified or until the offset error is reduced to zero. When the offset error is reduced to zero, the DWELL indication changes to SYNC as before with short-way and long-way correction.

Dwell transition is the fastest way to correct offsets. A dwell time equal to or greater than the cycle length always guarantees that the correction is made in one cycle by dwelling in the coordinated phase. The downside of dwell correction is that the minor phases are forced to wait up to one cycle while the controller dwells in the coordinated phase.

The Naztec controller allows you to use short-way and long-way for some patterns and dwell for others. Many users prefer to run short-way and long-way for patterns with long cycle lengths and dwell correction for shorter (off-peak) patterns.

Concept 6 - Know where your offset hits

Pattern #5 was taken from the following sequence given in the Synchro help file::



In this example, phase 2 and 6 are the main street phases which do not begin together because more split time is required for phase 1 than for phase 5. Beginning-of-green can reference either phase 6 (TS2 - 1st Green) or phase 2 (Begin of Green). If the offset is referenced to end-of-green, either main street phase may be specified because phase 2 and 6 end together. The general rule to follow is:

Specify one coord phase and make the begin or end of this phase references the offset correctly that you generated with Synchro or one of the other timing models

Left-turns First Examples

Our next two controller patterns illustrate the difference between Synchro's "TS2-1st Green" and "Begin-of-Green" offset reference when the main street phases are staggered. Run Pattern #5 using the key sequence MM->2->1->5 ENTER and observe that after Pattern #5 is active, the Loc counter resets to zero at the beginning of phase 2.

Pattern #5 - 120" cycle / 0" Offset Referenced to Phase 2 Begin-of-Green

1 / 23"	<0" (C) 2 / 59"	3 / 14"	4 / 24"
5 / 16"	6 / 66"	7 / 18"	8 / 20"

Now, run Pattern #6 using the key sequence MM->2->1->6 ENTER and observe that after Pattern #6 is Active, the Loc counter resets to zero at the beginning of phase 6. Remember, your offset is the point in the cycle when the Loc counter resets to zero.

Pattern #6 - 120" cycle / 0" Offset Referenced to Phase 6 Begin-of-Green (TS-2 1st Green)

1 / 23"	2 / 59"	3 / 14"	4 / 24"
5 / 16"	6 / 66" <0" (C)	7 / 18"	8 / 20"

If Synchro and the controller do not use the same offset reference, your controller offset in this example can be as much as 7" from the offset calculated by Synchro (23" - 16"). If end-of-green was used instead of begin-of-green, it would not matter if phase 2 or 6 were specified as the coord phase because 2 and 6 end together. You can avoid these type of errors by using end-of-green rather than begin-of-green to reference the offset to the coordinated phase. The next example proves that the offset is the same when end-of-green is used no matter if phase 2 or phase 6 is selected as the coord phase.

Run Pattern #7 with the offset referenced to the end of phase 2. Then change the coord phase in the split table (MM->2->7->7 ENTER 1) from phase 2 to phase 6 and verify that the offset "hits" at the end of either phase

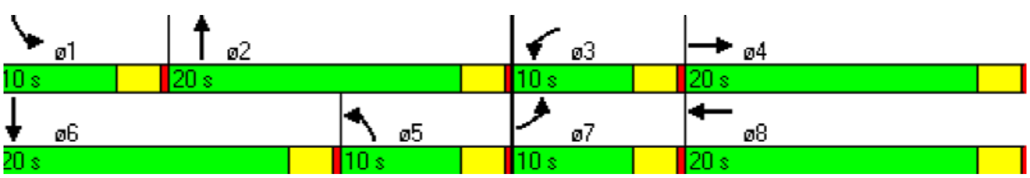
Pattern #7 - 120" cycle / 0" Offset Referenced to Phase 2 End-of-Green

1 / 23"	(C)0"> 2 / 59"	3 / 14"	4 / 24"
5 / 16"	6 / 66"	7 / 18"	8 / 20"

When the phase sequence is left-turns-first, it is always easier to specify end-of-green for the offset reference because either main street phase (phase 2 or 6 in this example) may be chosen to reference the offset. This avoids the pitfall of insuring that the coord phase agrees with Synchro's "TS2 - 1st Green" or the "Begin-of-Green". The next example illustrates another pitfall when end-of-green is used with a lead/lag left-turn sequence.

Lead/Lag End-of-Green Example

We will now look at two lead/lag patterns using the following Synchro output. Note that ring sequence number 2 given in MM->2->4 provides the lead/lag sequence called for in this example. All other examples so far have used sequence number 1 which is left-turns first.



Pattern #8 - 60" cycle / sequence 6 / 0" Offset Referenced to Phase 2 End-of-Green

1 / 10"	(C)0"> 2 / 20"	3 / 10"	4 / 20"
6 / 20"	5 / 10"	8 / 20"	7 / 10"

Pattern #9 - 60" cycle / sequence 6 / 0" Offset Referenced to Phase 6 End-of-Green

1 / 10"	2 / 20"	3 / 10"	4 / 20"
6 / 20" (C)0">	5 / 10"	8 / 20"	7 / 10"

Run patterns 8 and 9 and observe that the coord phases are different for each plan. You must insure that the offset reference for the end-of-green coord phase agrees with the Synchro offset reference, otherwise the controller will not run the offset calculated in the Synchro model.

Synchro calls EndGRN the "Begin-of-Yellow" after the term used to reference offsets in the 170 controller. Synchro defines the "Begin-of-Yellow" offset reference as "the beginning of the first main street phase to turn yellow" which is Pattern #9 in this example. If phase 2 is designated as the coord phase, the Synchro offset reference and the controller offset reference will vary by 10".

Concept 7 - Make Sure to Set Return Hold

The left-turns first examples under Concept 6 illustrated the advantage of using EndGRN when the leading left-turns are staggered because either through phase can be specified as the coord phase. When BegGRN is used and the leading left-turns are staggered, you need to make sure the coord phase agrees with the Syncro offset reference (TS-2-1st-Green or Begin-of-Green). Otherwise, with BegGRN as the offset reference, the controller will not implement the Synchro pattern as intended. This is not a problem for EndGRN because both through phase end together and either one can be specified as the coord phase. However, during lead/lag operation, the through phases do not begin or end together, so even with EndGRN selecting the correct coord phase is important.

Begin-of-Green Offset Reference

The next two examples reference the offset (and the sequence change) at the "TS-2 Start of Green".
Pattern #10 - 60" cycle / sequence 6 / 0" Offset Referenced to Phase 6 Begin-of-Green

1 / 10"	2 / 20"	3 / 10"	4 / 20"
6 / 20" <0"(C)	5 / 10"	8 / 20"	7 / 10"

Pattern #11 - 60" cycle / sequence 11 / 40" Offset Referenced to Phase 2 Begin-of-Green

<30"(C) 2 / 20"	1 / 10"	4 / 20"	3 / 10"
5 / 10"	6 / 20"	7 / 10"	8 / 20"

Go ahead and change patterns from #10 to #11 and back to Pattern #10. Observe the "General Information" screen in StreetWise and the Coordination Status Screen on the controller (MM->7->2).

These are the most difficult pattern changes that any controller has to deal with because the sequence changes on both sides of the barrier and the offset adjustment is almost a half cycle out of step.

Notice on that the sequence change occurs when the Loc counter resets to zero and the pattern becomes Actv (Active) on the Coordination Status Screen. The offset will begin to adjust immediately when you change patterns; however, the sequence change does not occur until the Loc counter resets to zero.

Notice that when the sequence changes from Pattern #10 to Pattern #11, that several of the main street phases are skipped. After this sequence change, the controller steps through the new sequence correctly without skipping any phases.

Pattern 10	-> -> ->	Pattern 11
3+8		
4+8		
4+7		
1+6 coord ø = 6	Sequence Change	
		4+7
		4+8
		3+8

A similar sequence change is observed when the controller transitions from Pattern #11 to Pattern #10:

Pattern 11	-> -> ->	Pattern 10
4+7		
4+8		
3+8		
2+5 coord ø = 2	Sequence Change	
		3+8
		4+8
		4+7

There is not a problem with the controller, you just don't have your Return Holds set correctly. Let's set the Return Holds and then go back and toggle between Pattern #10 and Pattern #11.

Go to MM->2->5 and use your right arrow key to toggle to the screen to the right. Set RetHold for Pat#10 and Pat#11. Then go back and watch the sequence change between plans. This corrects the problem observed earlier and no phases are skipped changing patterns.

<-Pat#	Coor.P:	EarlyYld	Offset	RetHold
1		0	BegGRN	X
2		0	BegGRN	X
3		0	BegGRN	X
4		0	BegGRN	X
5		0	BegGRN	X
6		0	BegGRN	X
7		0	EndGRN	X
8		0	EndGRN	X
9		0	EndGRN	X
10		0	BegGRN	.
11		0	BegGRN	.
12		0	EndGRN	X
13		0	BegGRN	X

Remember!!! always, always set the RetHold for any pattern running coordination!

End-of-Green Offset Reference

Concept 6 noted that Synchro's "Begin- of- Yellow" is the same as EndGRN for the ***first*** through phase to turn yellow. Synchro does not have an output that references the ***last*** through phase to turn yellow. Therefore, all EndGRN lead/lag examples in this exercise (other than Pattern #8) reference the ***last*** through phase to turn yellow.

Now toggle between Pattern #9 and Pattern #12 which reference offsets at the end-of-green. These two patterns are identical to the last two examples except that the sequence change will now be made at the end of the coordinated phase instead of at the beginning. You already have Return Hold set for these patterns, so you won't see any problems when the sequence changes.

Pattern #9 - 60" cycle / sequence 6 / 0" Offset Referenced to Phase 6 End-of-Green

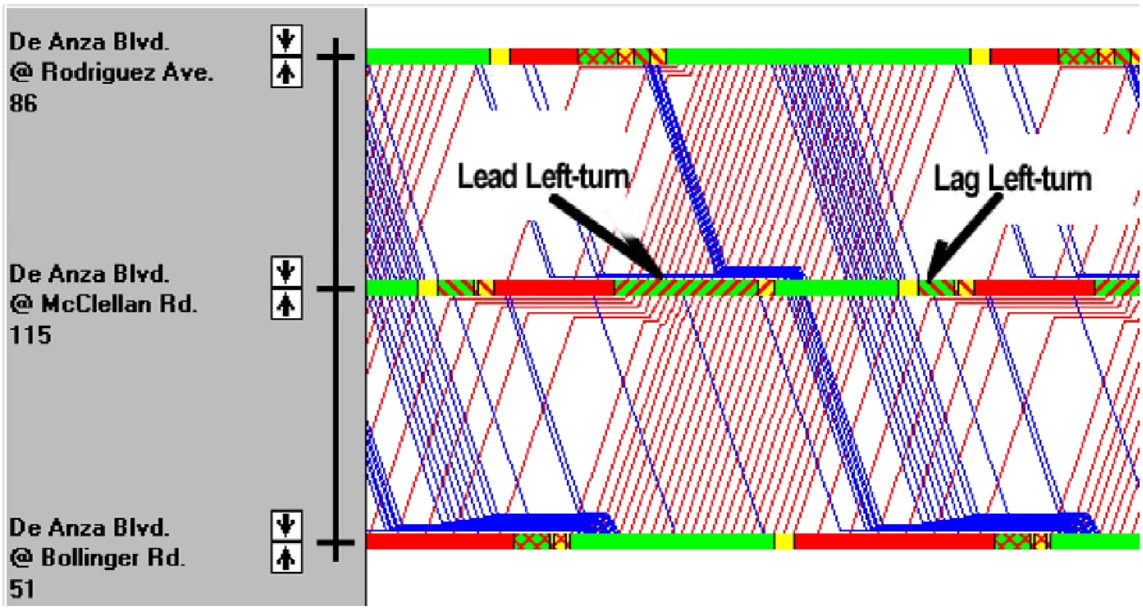
1 / 10"	2 / 20"	3 / 10"	4 / 20"
6 / 20" (C)0">	5 / 10"	8 / 20"	7 / 10"

Pattern #12 - 60" cycle / sequence 11 / 40" Offset Referenced to Phase 2 End-of-Green

(C)40"> 2 / 20"	1 / 10"	4 / 20"	3 / 10"
5 / 10"	6 / 20"	7 / 10"	8 / 20"

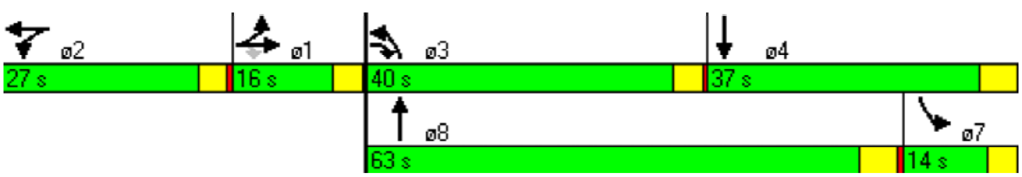
Concept 8 - Making Sure the Progression Phases Do Not Gap Out

Consider the following time-space diagram from Naztec's StreetWise system in Cupertino, CA.



In this real-world example, the lead/lag left-turn sequence at McClellan Blvd improves the bandwidth and two-way progression on DeAnza Blvd. But what would happen if the through movement phases on DeAnza were allowed to gap out to the next phases? The progression bands would not be guaranteed since a gap-out could occur just prior to the arrival of a platoon. This exercise illustrates how MAX calls in the split table can be used to insure that the green bands in the time-space diagram are fully developed.

So, here's the phase sequence and split for DeAnza Blvd @ McClellan Rd. from the Synchro output:



The offset calculated from Synchro is 115" for this pattern.

The "Reference Phase" in Synchro is set to "4+8 - SBT NBT".

The Synchro "Reference Style" is "Begin of Green", so the controller should reference the offset to the beginning of phase 4. If "TS-2 1st Green" is specified in Synchro, the offset would need to be referenced to the beginning of phase 8. If "Begin-of-Yellow" was specified, the offset would need to be referenced to the end of phase 8.

Pattern #13 - 120" cycle / 115" Offset Referenced to Phase 4 Begin-of-Green

2 / 27"	1 / 16"	3 / 40"	<115"(C) 4 / 37"
		8 / 63"	7 / 14"

Notice that only phase 4 and 8 are shaded green indicating MAX calls placed on these progression phases in the split table. All of the examples for Patterns 1 - 12 placed MAX calls on every phase (fixed-time mode) so you could observe the force-offs applied to each phase. In real-world applications, you want the actuated phases to gap-out and return "slack time" to the progression phases (semi-actuated mode). You also want to insure that the progression phases do not gap-out by placing MAX calls on these phases in the split table.

Suppose a MIN recall was used for phase 8 rather than a MAX recall. Can you visualize what would happen to the north-bound green band in the time-space diagram above if phases 3 and 8 gapped out after 15 seconds and the controller went to phase 7? Without a MAX call on phase 8, the northbound progression band could be reduced 75% by this gap-out condition.

Concept 7 stressed the need to set Return Hold for all coordination patterns Return Hold only guarantees that the coord phase does not gap out. Phase 8 is not a coord phase, so you still need to program a MAX call to guarantee that the phase 8 does not gap-out. To keep things simple, we suggest that you apply a MAX call to both progression phases in addition to using RetHold .

Go ahead and program Pattern #13 for this Synchro timing plan.

Sequence #8

```
Ring1: 2   1   3   4
Ring2: 6   5   8   7
```

Pattern #13

```
Pat#  Cycle  Offset  Split   Seqnc
 13    120    115     13       8
```

Split #13

```
Spl- 1  ø..1...2...3...4...5...6...7...8 ->
Time      16  27  40  37  16  27  14  63
Coor-ø     .   .   .   X   .   .   .   .
Mode      NON NON NON MAX NON NON NON MAX
```

The Mode setting for all phases other than the progression phases is NON which implies "None" - (the recall options under MM->1->1->2 apply). The split times specified for progression phases 4 and 8 are guaranteed by the MAX settings while phase 4 is used as the Coor-ø to reference the offset to Synchro's "Begin of Green".

Notice how split time is provided for phases 5 and 6 which do not actually exist in the Synchro timing plan. Split time must be provided for phases 5 and phase 6 because the controller diagnostic checks to make sure that the sum of the splits for each ring equals the cycle length. "Dummy split time" must be entered for phase 5 and 6 even though these phases may not be enabled in the controller (MM->1->1->2) otherwise the controller diagnostics will fail the plan.

Naztec Recommendations for NTCIP Coordination

NTCIP offers a tremendous amount of flexibility when developing coordination plans for semi-actuated controllers. The following general recommendations should be considered to improve operations and avoid several pitfalls when the coordination modes and options are not set correctly.

Under Coordination Modes+ (MM->2->1)

1. Set Correction to SHORT/LONG coordination mode
2. Set Maximum to MAX_INH to avoid leaving a phase because of a max setting before the split times out
3. Set Force-Off to FIXED or FLOAT (the difference will be discussed in another TecNote)
4. Set Auto Err Reset to ON to allow a failed plan to recover during the next time-of-day change
5. Set Stop-on-Walk to ON to allow pedestrian times to extend past the split time specified. If pedestrian movements are serviced frequently, you can always guarantee the ped time in your split

Under Transition, Coord ø+ (MM->2->5)

1. Always provide a short and long transition value or a dwell value - don't leave these values zero
2. Use EndGreen to reference the offset to avoid the problems discussed with staggered left-turns first
3. Always, always set RetHold

Under the Split Tables (MM->2->7)

1. Make sure your splits passes the diagnostic checks before you put your plan on the street
2. Use one coord phase and make sure your offset is referenced correctly with your timing model
3. If your coord phase is part of a lead/lag sequence, select the through phase that ends first as your coord phase to agree with Synchro's "Begin-of-Yellow" offset reference
4. Put MAX calls on all of your progression phases