

Basic Coordination



Keys to Coordination

- Engineer is grouping intersections together to create traffic flows to move platoons
- Always favors the Arterial (Coord Phase) movement
- Side road vehicles are willing to wait to get in that “main-line” platoon

Coordination Minimizes Delays

- Traffic signals have different traffic flows, and often have different phasing
 - The amount of green time available to the coordinated approaches varies along a coordinated route.
 - The result is that some traffic in the platoon is stopped somewhere along the coordinated route.
- The trick is to minimize the number and duration of delays

Green time will be reduced as the Platoon moves through the system

- It is necessary to start the green period on the coordinated route sufficiently in advance of the arrival of the platoon to allow any queues of traffic stopped at the downstream traffic signals to clear.
- The advance times accumulate for subsequent traffic signals along the route, progressively reducing the green-time available for the original platoon.

Coordination improves overall Capacity

- Coordination **cannot improve** the capacity of an intersection above that it would have under independent operation.
- Coordination **can improve** the capacity of intersections that are closely spaced and therefore have strongly interacting traffic queues.

Coordination is directional

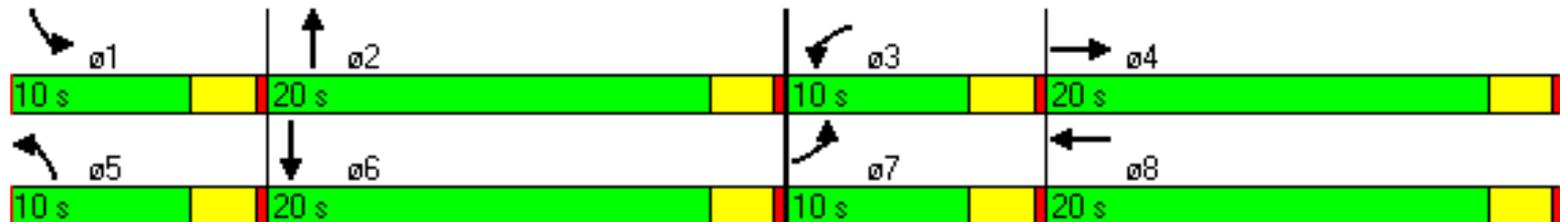
- Outside periods of strong “tidal” traffic flow (i.e. outside peak hours) traffic along arterial roads is typically balanced, so two-directional coordination is required.
- It is extremely rare that intersection green times, spacing and travel time align to allow for complete two-way coordination.
- Typically a compromise plan is selected which minimizes delays.

Cycle Length

- Each intersection has a unique cycle length based on traffic demands for that moment in time
- Get cycle length by adding time for each phase including clearances
- Can vary cycles throughout the day to reflect in inbound, outbound and off-peak traffic patterns and even evacuation routes
- Must also choose when to start the cycle
 - In our example the cycle will start at the beginning of the artery (coord) phases yellow clearance

Splits

- Split Phases
 - Phases that are designated to normally run together
- Split Time
 - Time the above phases are designated in the cycle (includes clearance of previous phases)



Offset time

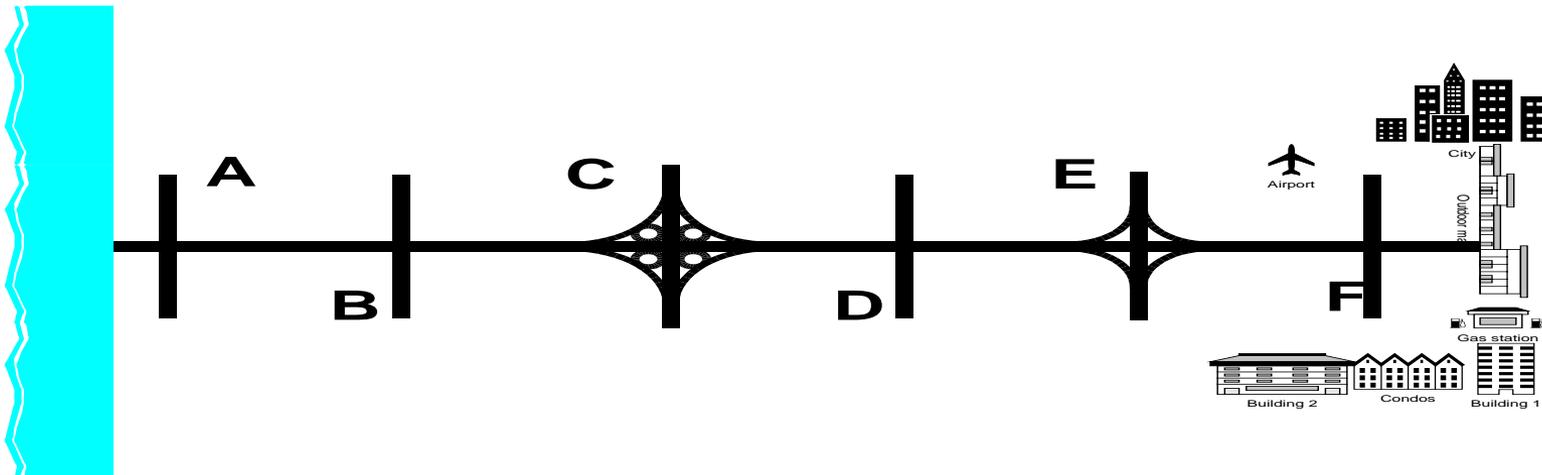
- Offset time at the “Master” intersection is normally set to 0
- Offset time is then added to the cycle length for intersections after the “Master”
- Offset time is subtracted from the cycle length for intersections before the “Master”

Traffic Mix affects Offsets

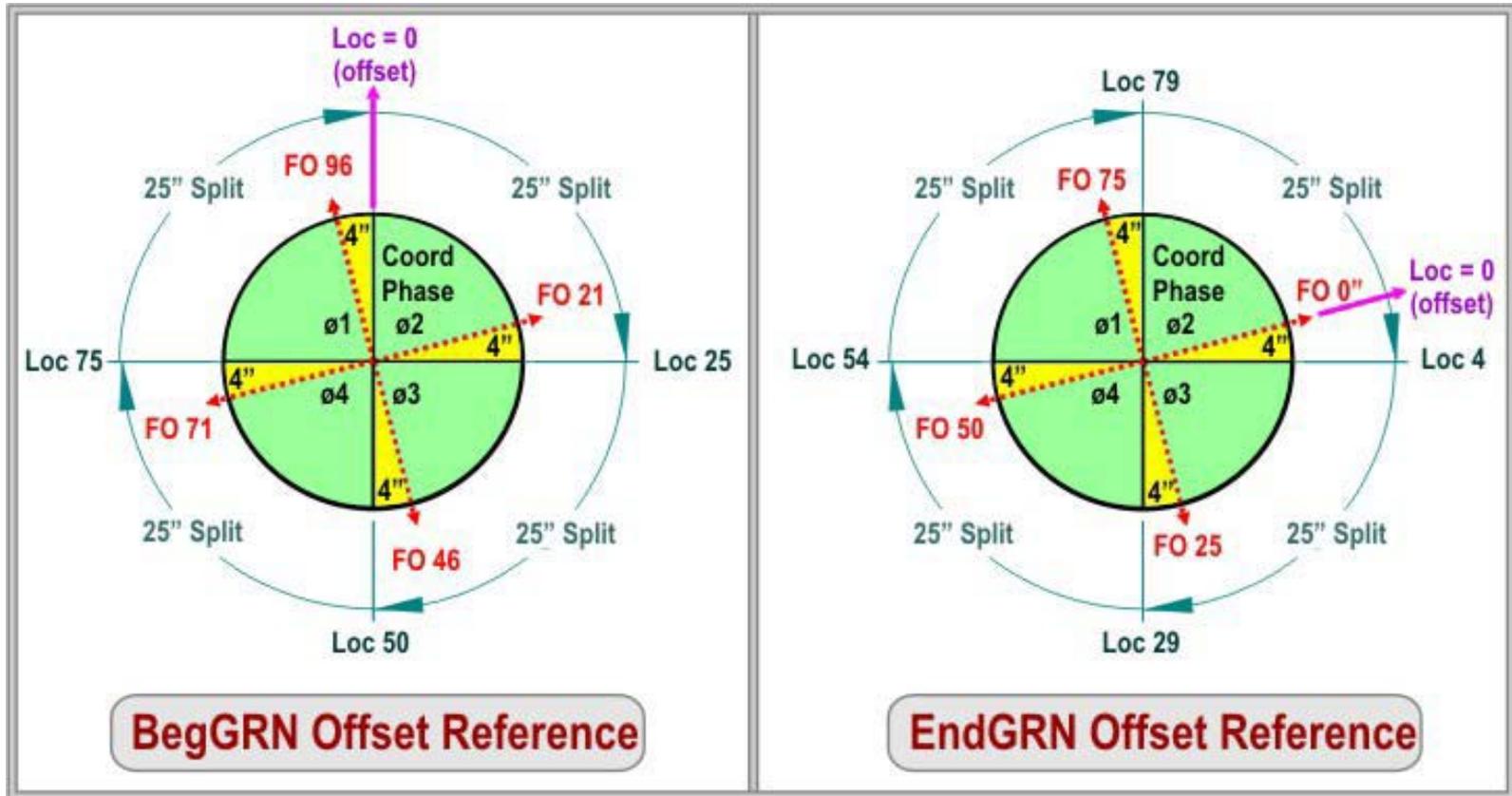
- Large trucks take longer to accelerate than passenger cars, so offsets that are ideal for passenger cars may result in heavy trucks being stopped at the next set of traffic signals.
- If the offset is set for heavy traffic this would result in additional traffic congestion, thereby adding delay for all traffic (including heavy traffic).
- Selecting offsets for Major freight routes should be done to compromise the offsets that are not ideal for either passenger cars or heavy trucks.

Offsets

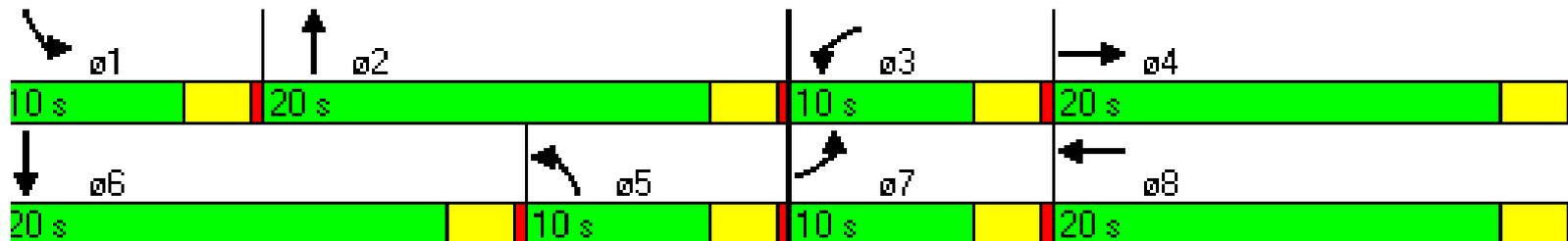
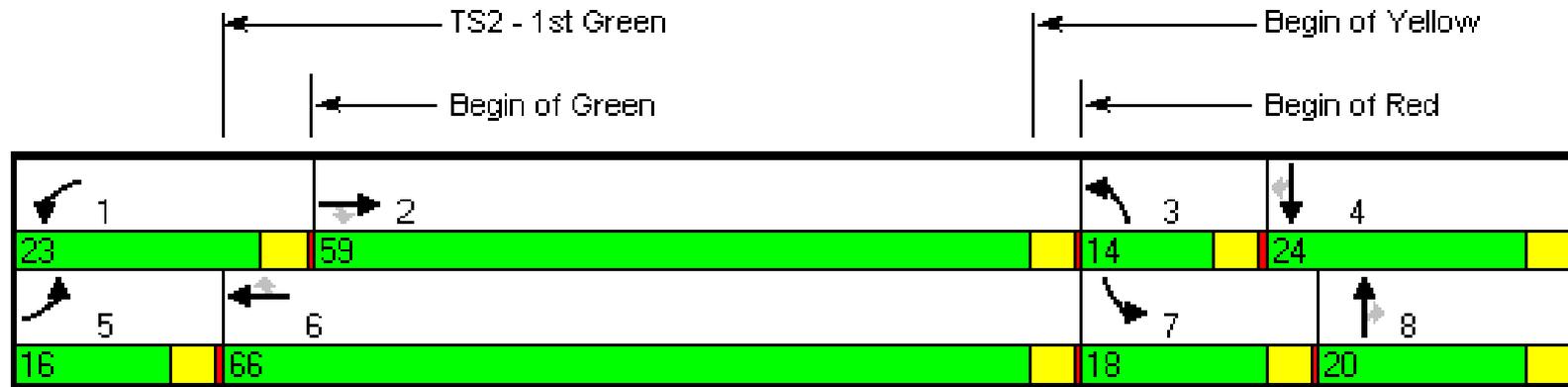
- Intersection “C” has been designated as our Master controller
- If intersection “C” goes to Clearance, cars will run the light
 - We would like to keep them in their platoon so we need to keep the next light green throughout the clearance period of “C”
 - This time is based on the speed of the vehicles and the distance between the intersections
 - The time between intersection “C” turning yellow and “D” turning yellow is known as the offset time.



Offset Reference



Offset Reference



NTCIP Coordinator

- Is always active
 - Even in Free & Flash Mode
- The NTCIP definitions are defined in the table below

Pattern#	Coord	FreeStat	Active State of the Coordinator
0	FREE	PATTERN	Coordinator has selected default free pattern# 0 by time-of-day
1 - 48	ACTIVE	CoorActv	Coordinator is running one of the 48 patterns under coordination
1 - 48	FREE	COMMAND	Coordinator is running one of the 48 patterns in free operation
254	FREE	COMMAND	Coordinator is running the NTCIP Free Pattern# 254
255	FREE	COMMAND	Coordinator is running the NTCIP Flash Pattern# 255

Note: Other Conditions are also reflected in FreeStat such as Plan, cycle, offset and split errors and external overrides such as preemptions and manual control.

Coordination Modes

- Determine the Force Off method
- Determine the offset correction used during transition
- Determine the maximum settings that are applied or inhibited during coordination
- Applies to all coordination patterns
- May not be modified by Time-of day

Test Op Mode (Operational Mode)

- Allows the operator to manually override the active pattern in the Coordination module.

```
Coordination Modes ->
Test OpMode 0      Force-off FIXED
Correction SHORT/LONG
Maximum MAX_INH   FlshMode VOLT-MON
```



Test OpMode Data

- **0: Automatic or Standby Mode(default)**
 - Active pattern is determined by
 - Internal Time based scheduler
 - External interconnect
 - Closed loop master
 - Central control system
- **1-48: Manual pattern override**
 - Operator selectable pattern
- **254: Manual Free**
- **255: Manual Flash**

Transitions

- **Short-Way**
 - Short time the split (guaranteeing the minimum greens and clearances) to get in step
- **Long Way**
 - Lengthen the time in the splits to get in step
- **Dwell**
 - Stay in the dwell phases you are in until the cycle catches up
- You can choose your method or the controller can choose for you (**Short/Long**)
- Transitions are effected by many variables including pedestrian times, various cycle lengths, alternate timings, etc.

Maximum Mode

Coordination Modes		->
<u>Test OpMode</u> 0	<u>Force-Off</u> FIXED	
<u>Correction</u> SHORT/LONG		
<u>Maximum</u> MAX_INH	<u>FlashMode</u> VOLT-MON	

- Determines which Maximum green time is active
- Or if Maximum green time is inhibited during Coordination
- Doesn't apply to FLOAT Force-off mode
 - Float sets the max time to the split time to insure extra time is applied to the coord phases

Maximum Mode

- MAX_1 allows Max 1 phase timing to terminate a phase during FIXED or OTHER modes
- MAX_2 allows Max 2 phase timing to terminate a phase during FIXED or OTHER force off modes
- MAX_INH inhibits Max 1 or Max 2 from terminating a phase during FIXED or OTHER force off modes— Controller will time max to “0” but will stay in phase till forced off. Don’t use under FLOAT!

Force off methods

– Fixed:

- Phases are forced off at fixed points in the cycle. (Allows unused split time left ,if the current phase completes prior to its force off, to revert to next phases in the sequence, thus giving them additional time to be serviced)

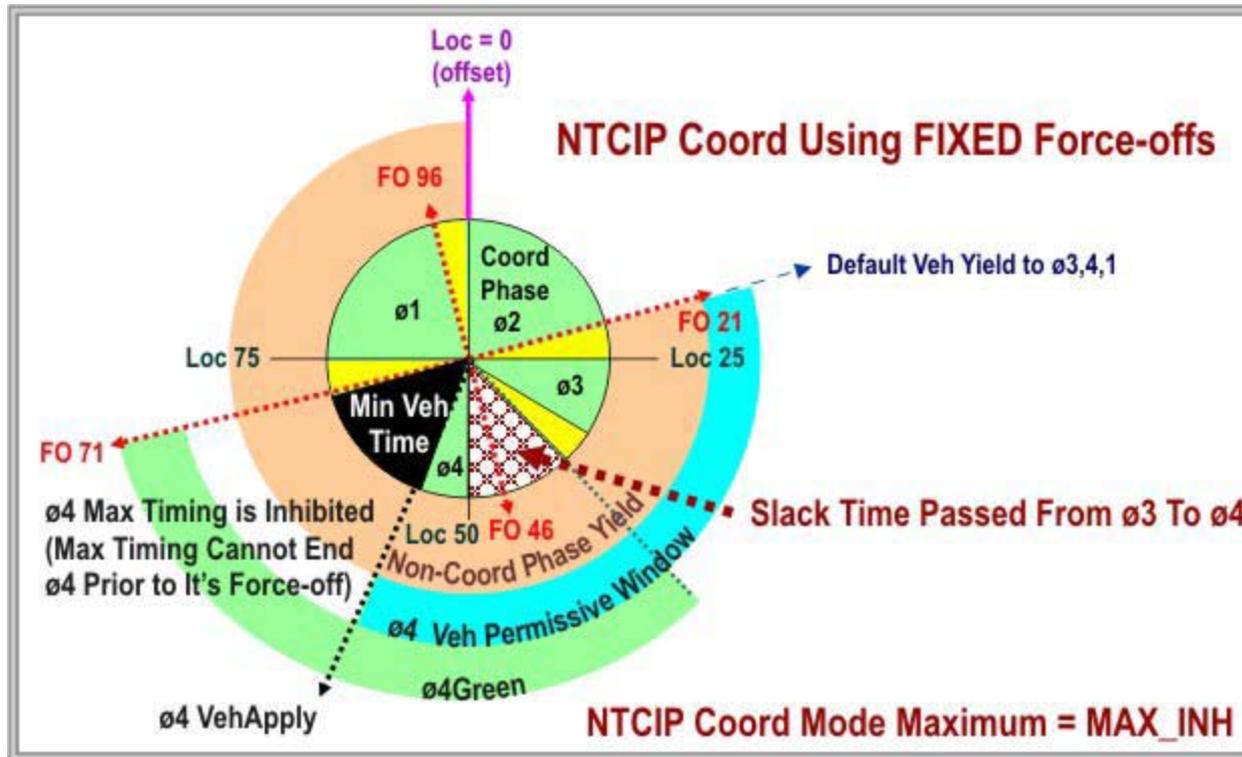
– Float:

- Non-Artery Phases are only active during their assigned split time. (Unused split time, if a phase times out prior to its force off, reverts to the artery (coord) phases)--**Many Agencies use this**

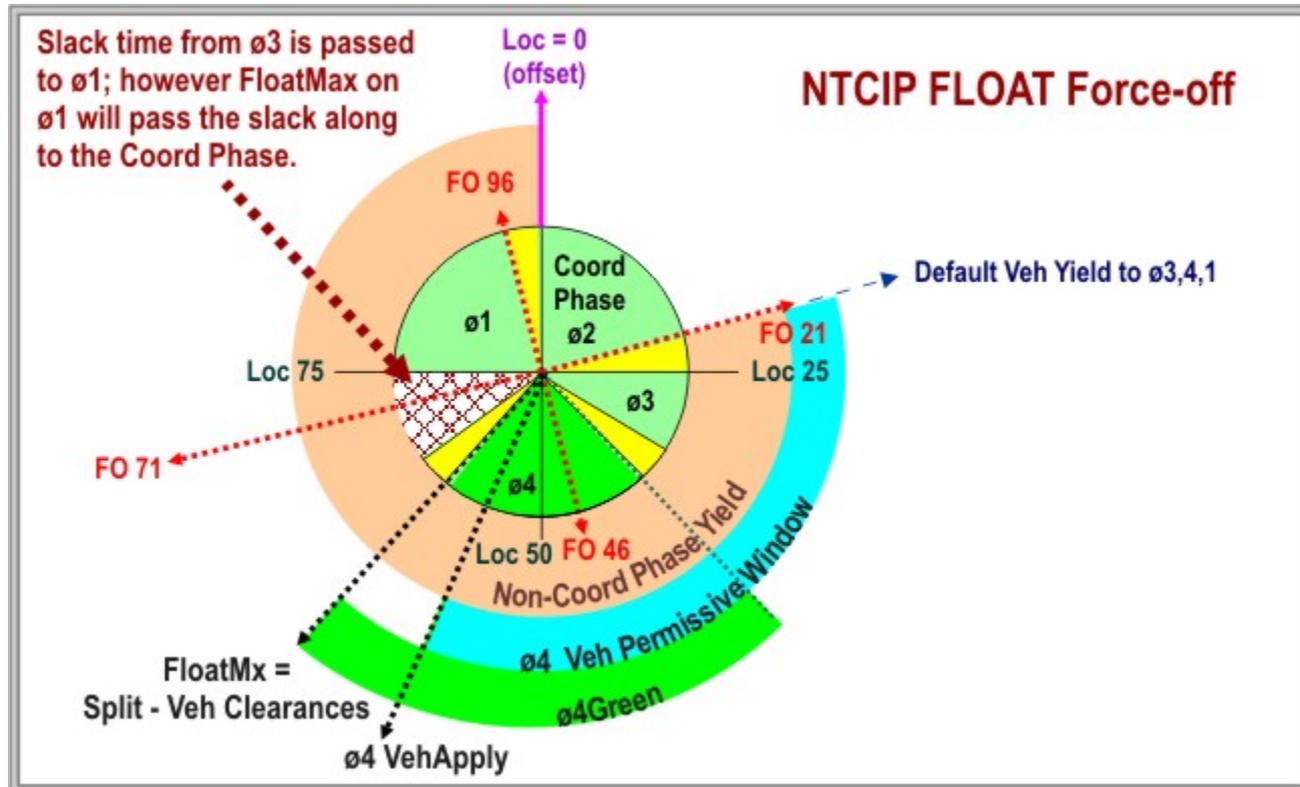
– Other:

- Coord is determined by programmed parameters (*Force-Off+ and Easy Float*)

Fixed Force off methods



Floating Force Off Methods

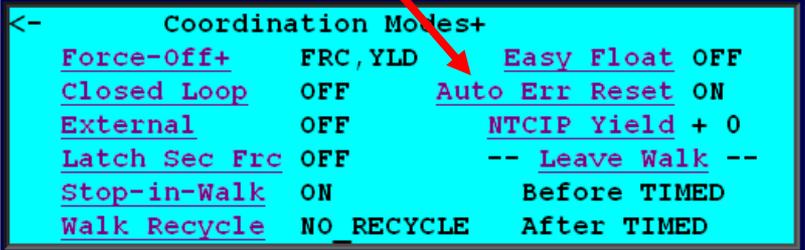


Auto Error Reset

- Each time the coordinator goes to a new pattern a check is made to see if the controller failed coordination during the previous pattern

– Failures include

- Veh or ped call is not serviced for 3 cycles
- Max cycle counter is exceeded
- ON: the next pattern will reset the failure
- OFF: The failure will not be reset



Coordination Modes+		
<u>Force-Off+</u>	FRC, YLD	<u>Easy Float</u> OFF
<u>Closed Loop</u>	OFF	<u>Auto Err Reset</u> ON
<u>External</u>	OFF	<u>NTCIP Yield</u> + 0
<u>Latch Sec Frc</u>	OFF	-- <u>Leave Walk</u> --
<u>Stop-in-Walk</u>	ON	Before TIMED
<u>Walk Recycle</u>	NO RECYCLE	After TIMED

Stop in Walk

```

<-      Coordination Modes+
Force-Off+      FRC, YLD      Easy Float OFF
Closed Loop     OFF          Auto Err Reset ON
External        OFF          NTCIP Yield + 0
Latch Sec Frc  OFF          -- Leave Walk --
Stop-in-Walk   ON           Before TIMED
Walk Recycle   NO_RECYCLE   After TIMED
  
```

- Stop-in-Walk allows the controller to get back in step quickly
- Used when the split times in a pattern are shorter than the ped minimums (walk + ped clearance + veh clearance).

Stop in Walk = OFF

- OFF: the user must provide adequate split time to service the walk & Ped Clearance times
 - The Coord diagnostic will fail if user fails to put in adequate time

Stop in Walk = ON

- ON: disables the coord diagnostic
 - The local counter will “STOP” at the force-off and suspend till the end of Ped Clearance
 - The local cycle timer will begin again at the end of Ped Clearance
 - The coordinator will begin correcting the offset using short-way transitioning if specified for the pattern

Stop in Walk

- Use it only when ped actuations are infrequent
- Under Short-way offset correction
 - the coordinator can usually resynch the offset within one cycle if the ped clearance extends 5-10 seconds beyond the force-off
- If program Rest-in Walk for a phase it will defeat Stop-in-Walk (treat it is “OFF”)

No Added Initial

- Disables added initial functionality when coordinator is active

Pattern Table

MM→2→4

- Total of 50 Patterns
- 48 Coordinated Patterns accessed via above entry MM→2→4
- Other Patterns defined in NTCIP:
 - Pattern # 254 – Free
 - Pattern#255- Flash

Pat#	Cycle	Offset	Split	Seqnc
1	100	50	32	1
2	0	0	2	16
3	0	0	1	1
...				
48	0	0	1	1

Pattern Data

Cycle Time

- Cycle Time (0-255 sec)
 - Declares Cycle length in seconds
 - Typically equals the sum of the split times en each ring
 - Free pattern has a cycle length of 0
 - Allows coordination features to be run when pattern is selected

Pattern Data Offset Time

- Offset Time (0-255 sec)
 - Time the local counter (LOC) lags behind the system time Base (TBC) for the pattern
 - System Timer is referenced to midnight & offset is referenced to that
- Programming Offset \geq cycle length will force controller to Free

Pattern Data

Split & Sequence Numbers

- Split Number (1-32)
 - Must designate a split table
 - Split Tables are interpreted differently based on the Force-off method
- Sequence Number (0-16)
 - Can choose specific Phase sequence to use
 - 8 phases per ring for each of the 4 rings
 - Sequence of “0” is defaulted to seq # 1

Recommend practice

- Naztec recommends that you program Pattern # 1-24 with Split # 1-24 so there is a one to one relationship between Pattern number and Split number. This will make it easier to manage your system, because if you can easily reference the correct Split Table # given the Pattern number.

Split Definitions

NTCIP coord modes provide:

- Split time for each phase (in seconds)
- Specified coord phase
- Recall mode or omit per phase

Split Tables

MM→2→7

Split Menu	Coord.Modes
1.Split Table	Force FIXED
2.Plus Features	Force+ FRC , YLD

- Next few slides Slides reflect the Split programming for the NTCIP Modes for FIXED and FLOAT
- NTCIP modes FIXED and FLOAT will specify the split time for each phase in seconds and let the controller calculate all force-off and yield points in the pattern
- NTCIP mode OTHER allows NAZTEC to provide 7 other coord modes and ways to program force-offs and yield points.

MM→2→7→1

Enter Split # _

then press ENTER

```
Spl-32 0..1...2...3...4...5...6...7..8 ->
Time    20   20   20   20   20   20   20   20
Coor-0   .   X   .   .   .   .   .   .
Mode     NON  MAX  NON  NON  NON  MAX  NON  NON
```

- Choose MM→2→7→1 and a screen will prompt you to enter the Split number that you would like to program then you will get the split programming screen.

Split Time

- Split Time (0-255 sec)
 - Sets the maximum time allocated to each phase during the cycle
 - Split time must be designated for all phases permitted-up to 16 phases
 - Split Time for each Phase must be sufficient to service Minimum, Vehicle Clearance, and all Red

Spl-32	0	1	2	3	4	5	6	7	8	->
Time	20	20	20	20	20	20	20	20	20	
Coor-Ø	.	X	.	.	.	.	.	.	.
Mode	NON	MAX	NON	NON	NON	MAX	NON	NON		

Split Time

- Under Fixed Force-Off method
 - Unused Split time (slack time) goes to the next phase in the sequence
- Under Float Force-Off mode
 - Unused Split time (slack time) goes to the Coord Phases

Coordinated Phase

Spl-32	Ø	1	2	3	4	5	6	7	8	->
Time	20	20	20	20	20	20	20	20	20	
Coord-Ø	.	X	.	.	.	.	.	.	.
Mode	NON	MAX	NON	NON	NON	MAX	NON	NON		

- Choose only one Phase as the coordinated Phase
- It is the Offset Reference
- Don't reference more than one Phase as the Coord Phase
 - The coordinator can't reference the offset if the phases don't end or begin at the same point in the cycle
 - This can happen if reference more than one phase
- Set the Coord Ø mode to Max to guarantee split time is allocated to the coordinated movement.

Coordinated Phase Modes

Sp1-32	Ø	1	2	3	4	5	6	7	8	->
Time	20	20	20	20	20	20	20	20	20	
Coor-Ø	.	X	.	.	.	.	.	.	.
Mode	NON	MAX	NON	NON	NON	MAX	NON	NON		

- Overrides base recall settings programmed in Phase Options (MM→1→1→2) when the Split table is active
- **NON**: don't override base settings
- **MIN**: Min Recall
- **MAX**: Max Recall
- **PED**: Ped Recall
- **MxP**: Maximum and Ped Recalls
- **OMT**: Omit this Phase when running this split
- **Enb**: Enable this phase during this split if not enabled in phase options (MM→1→1→2)

Easy Calcs For NTCIP Modes

MM→2→8→2

Spl-32	∅	1	2	3	4	5	6	7	8	->
Time	20	20	20	20	20	20	20	20	20	
Coor-∅	.	X	.	.	.	.	.	.	.
Mode	NON	MAX	NON	NON	NON	MAX	NON	NON		

- Cycle Times are allocated by programming the Split Times for each Phase
- Controller automatically calculates the internal Force-off and Yield Points given the split times and pattern sequence and places calculations in status screen at MM→2→8→2)

Easy	∅	1	2	3	4	5	6	7	8	->
<u>PrimFrc</u>	37	7	17	27	37	7	17	27		
<u>SecdFrc</u>	37	7	17	27	37	7	17	27		
<u>Veh Yld</u>	7	17	7	7	7	17	7	7		
<u>VehAply</u>	34	0	12	20	32	0	12	20		
<u>Ped Yld</u>	7	17	7	7	7	17	7	7		
<u>PedAply</u>	32	2	12	22	32	2	12	22		
<u>FloatMx</u>	7	7	7	7	7	7	7	7		
<u>PedLeav</u>	37	37	17	17	37	37	17	17		

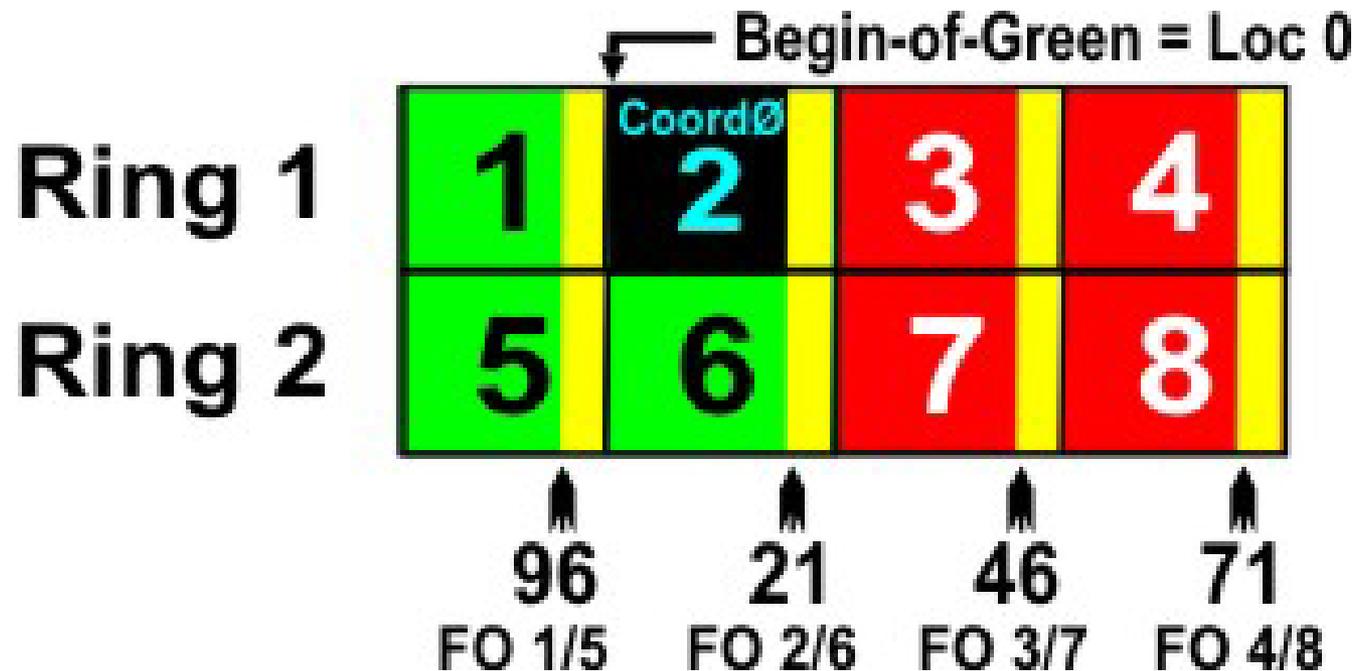
Easy Calcs

- PrimFrc (Primary Force-off) and SecdFrc (Secondary Force-off) are the force off points for each phase and are the same with FIXED or FLOAT. They can be different under OTHER.
- Veh Yld (Vehicle Yield) and Ped Yld (Pedestrian Yield) is the begin permissive period for vehicles or peds

Easy Calcs

- VehAply (Vehicle Apply) and PedAply (Pedestrian Apply) close the permissive periods
- FloatMx (Float Max Time) used with FLOAT mode
 - Insures that a phase is never serviced longer than it's programmed split and shifts any slack time developed in the actuated phases to the coordinated phase
- PedLeav (Pedestrian Rest-in Walk exit time) defines the end of the Rest-in Walk period.

Easy Calcs



Permissive Period

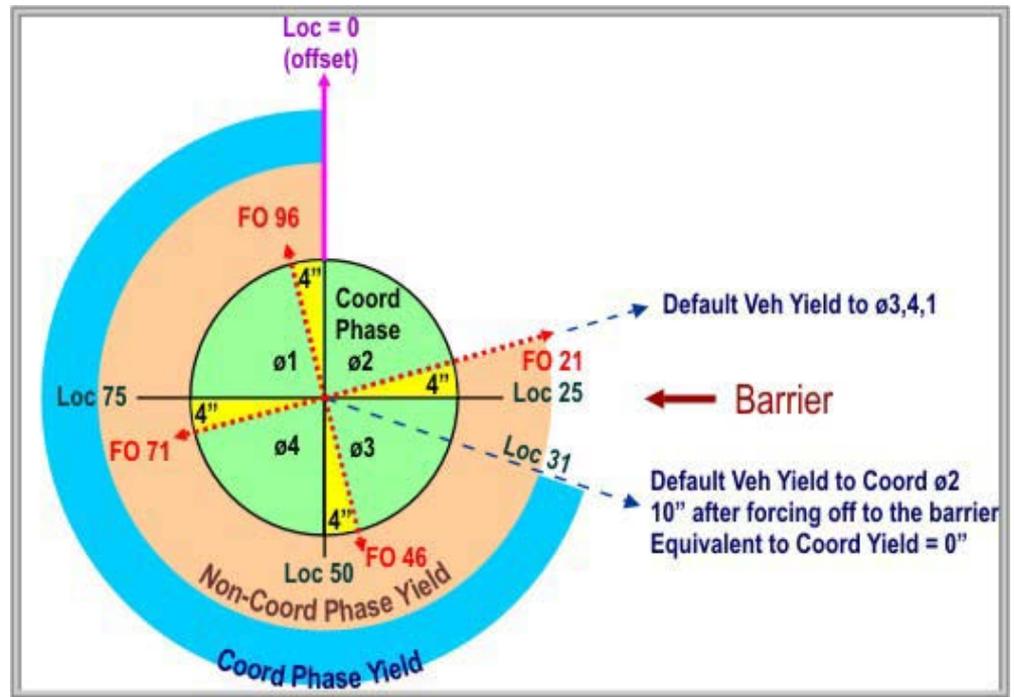
- The vehicle permissive period is defined as the portion of the cycle during which vehicle calls can be serviced if there is a vehicle call on the phase. The permissive period begins at the *VehYield* point and ends at the *VehApply* point that inhibits vehicle calls from being serviced until the next signal cycle.

Yield & Apply Point

- The yield point is the “open window of opportunity” to service calls for each phase.
- The apply point is the closing of this window.

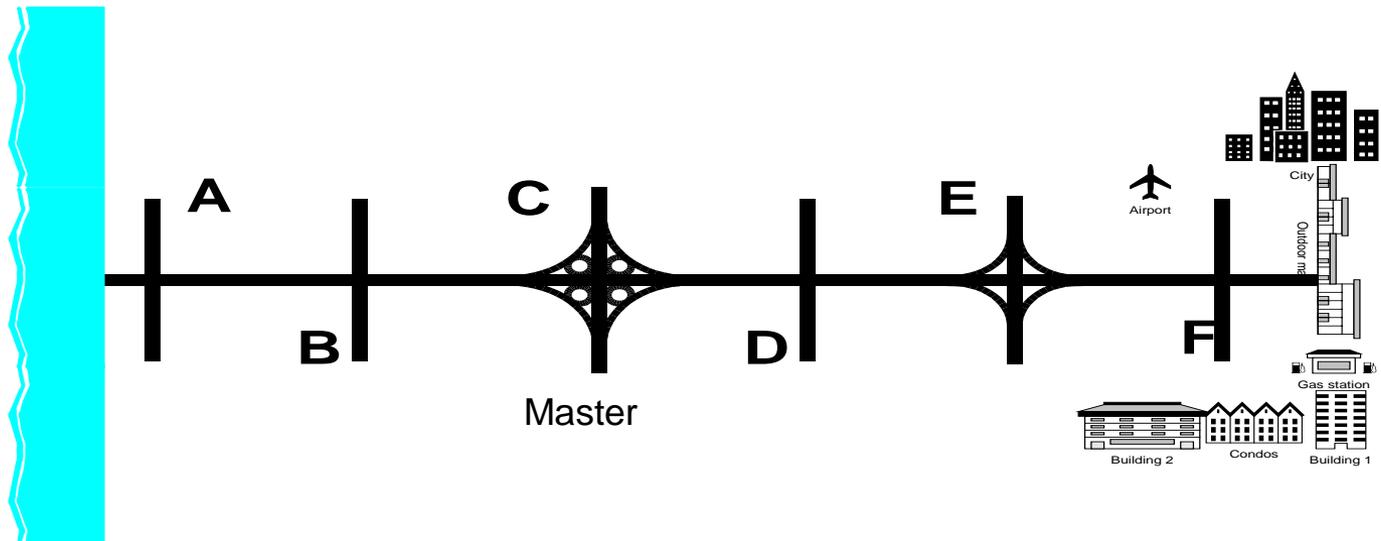
Yield & Apply Point

The default *VehYield* points for the 100" cycle example are illustrated to the right. The FIXED and FLOAT coord modes set the *Yield* points for all non-coordinated phases at the force-off of the coord phase. The default *Yield* point of the coord phase and the "pseudo" coord phase is set 10" later. This allows the controller to service the non-coordinated phases immediately at the end of the coordinated phase. However, if no calls exist on the non-coordinated phases at the barrier, the controller will dwell in the coord phase for 10" before it is reserviced. The default yield points delay the permissive period for the coord phase to allow "late" side street to be serviced after the barrier.



Master Controller

- Normally the engineer designates a “Master” intersection to coordinate the other sections from
- This is the point that all intersections will be referenced to



Transitions

- The controller must get to the true synch by transitioning to it
- Must program the type of transition, the number of cycles or the percentage of time the controller can time or dwell in the current phases

Correction Mode

Coordination Modes		->
<u>Test OpMode</u> 0	<u>Force-Off</u>	FIXED
<u>Correction</u> SHORT/LONG		
<u>Maximum</u> MAX_INH	<u>FlashMode</u>	VOLT-MON

- Synchronizes offsets during coordination.
- Valid data
 - Long
 - Transitions to new offset by increasing split times by the long way% value programmed at MM→2→5
 - Short/Long
 - Selects the quickest transition method by lengthening split times using the long way % value or shorting split times using the Short way % value programmed at MM→2→5

Coordination Modes+

- These are NAZTEC Enhancements
- Use Modes+ to select
 - Other Force Off+ methods
 - Determine if controller is operating as a secondary controller in a closed loop system
 - Determine if a controller is using external coordination
 - Modify Ped features as related to coordination

```

<-      Coordination Modes+
Force-Off+      FRC , YLD      Easy Float OFF
Closed Loop    OFF          Auto Err Reset ON
External       OFF          NTCIP Yield + 0
Latch Sec Frc  OFF          -- Leave Walk --
Stop-in-Walk  ON           Before TIMED
Walk Recycle  NO RECYCLE   After TIMED
  
```

MM→2→8→1or MM→7→2

Status screen

- Will display the current Operational mode Source that is on based on the hierarchy of the previous and next slide

```
OpModes.Src-SYS      Cycle      ofst  07:44:35
Sys-   8  Actv-   8  Loc-   20  Actu:  59  ACTIV
Tbc-  10  Next-   8  Tbc-   81  Err:+  45
Ext-   0  Remo-   0  Prog-140  Prog:  14  SHORT
Tod-  10  Test-   0  Alt:.Opt.Time.Det.CIR
                                0    1    0    0
```

Transition, Coord Ø+ MM→2→5

Pat#	Trans:	Short	Long	Dwell	No.Short.Ø	->		
1		0	17	0	1	5	0	0
2		12	22	0	0	0	0	0
3		0	0	60	0	0	0	0
.....								
48		0	17	0	0	0	0	0

<-	#	<u>ErlyYld</u>	<u>Offset</u>	<u>RetHld</u>	<u>Flt</u>	<u>MinPermV/P</u>
	1	0	BegGRN	X	.	. .
	2	25	EndGRN	.	.	. .
	3	0	BegGRN	.	.	. .
					
	48	0	BegGRN	.	.	. .

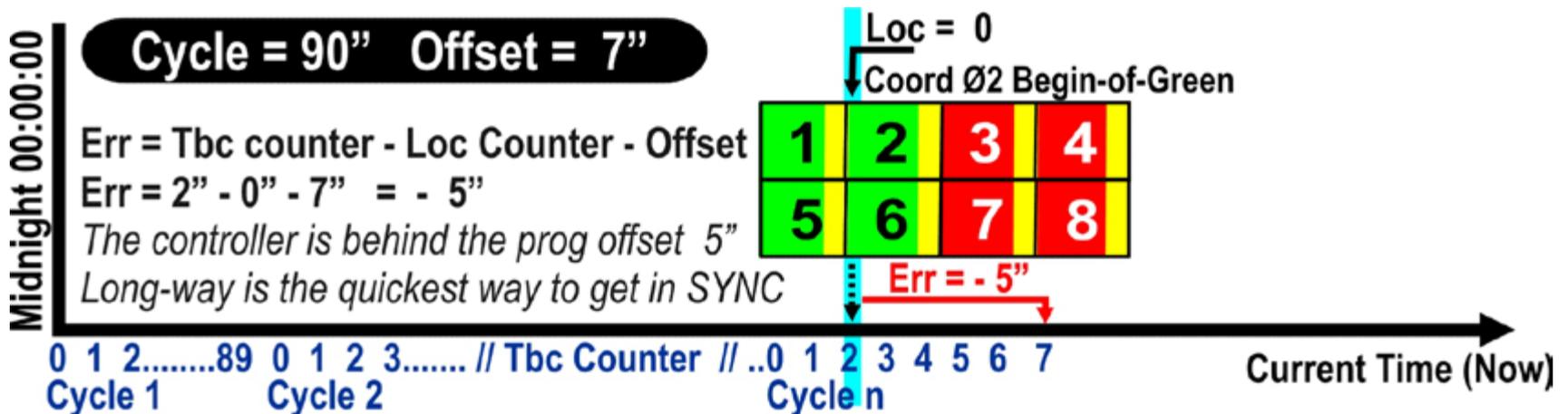
- Top Menu: All 48 Patterns can specify the % of the cycle that is allocated to short-way, long-way or dwell
- Bottom Menu: relates to the Coord Phase parameters for each pattern which controls the sync point during coordination

Transitions

- **Short:** % Reduction applied to each split time in the Split Table during short-way transition.
 - Values: 0%-24%
 - Value of 0 disables short-way
 - Force controller to use Long by setting value to 0
- **Long:** % Extension applied to each split time in the Split Table during short-way transition.
 - Values:0-99%
- If program Transition as SHORT/LONG the recommended % for Short & Long are 10% & 24 %

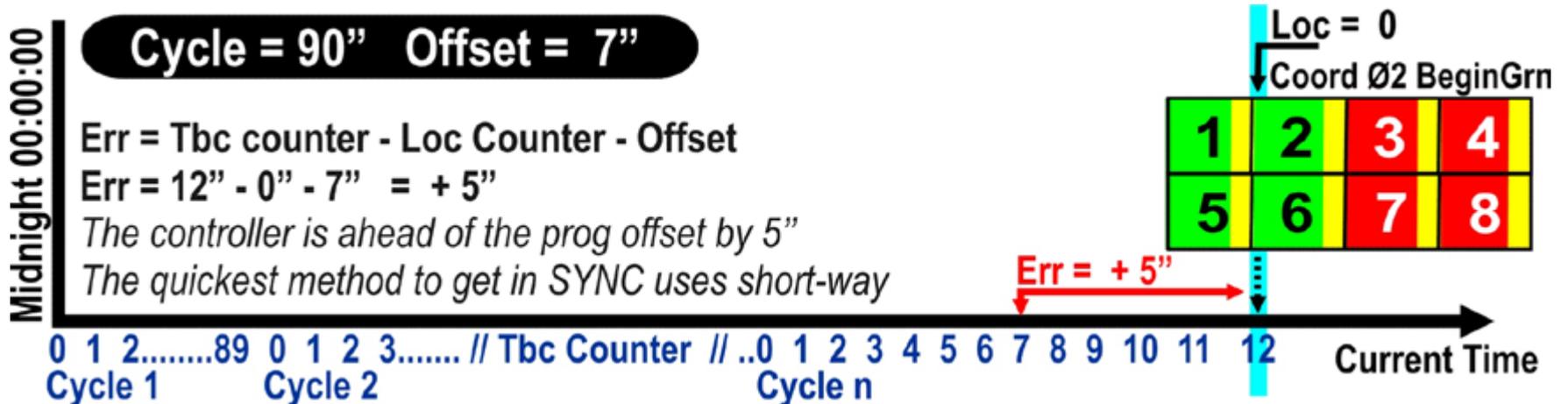
Transitions

Long Way Seeking

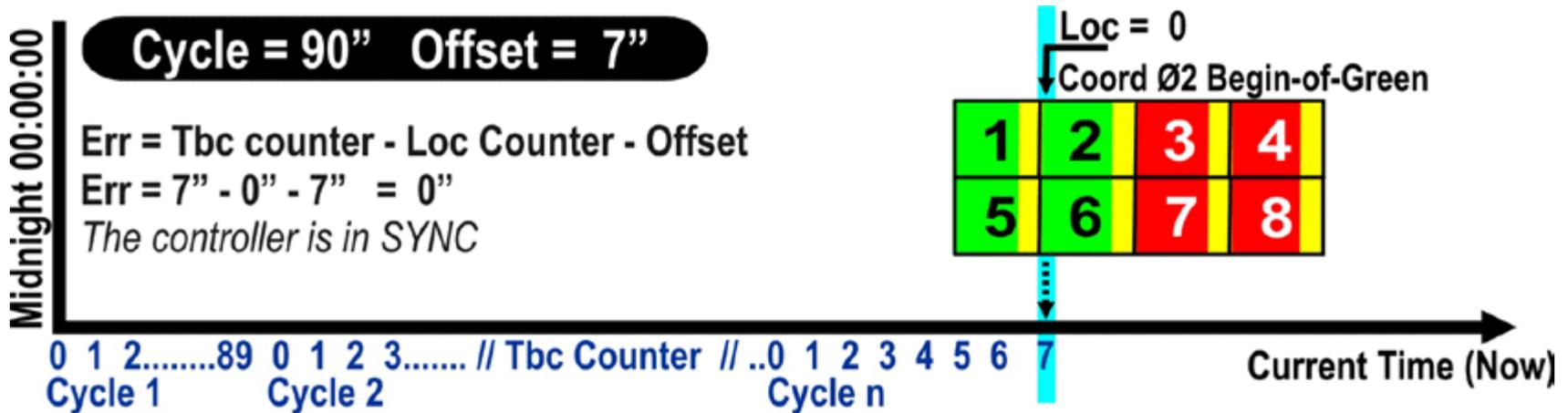


Transitions

Long Way Seeking



Transitions In Sync



Transitions

- **Dwell:** Dwell corrects the offset by resting at the end of the Coord Phase until the desired offset is reached or dwell timer has expired.
 - Increasing the dwell time will reduce the number of cycles to reach coordination but will queue traffic on other phases.
- **No Short \emptyset 's:** Excludes up to 4 phases to be excluded from short-way transitions
 - Used to override phases if coordination diagnostics fails due to split times that can't serve the phase minimums during the short-way transition.

Yield Point Adjustments, Return Hold & Offset Reference

- **Offset:** synchronizes the offset to
 - BegGRN: Beginning of artery (coord) Green
 - References to the Synchro “TS2 1st Green” offset
 - EndGRN: End of artery (coord) Green
 - References to the Synchro “Begin Yellow” offset
- **RetHold:** Return Hold - FIXED & FLOAT only
 - Enabling RetHold holds coord phase till it is forced off
 - Disabling RetHold allows controller to gap out of the coord phase to service another phase
 - NAZTEC Recommends you normally enable this

Yield Point Adjustments, Return Hold & Offset Reference

- **Flt:** Overrides the FIXED force-off method programmed at MM→2→1 to FLOAT, on a pattern by pattern basis
- **MinPermV/P:** Enable the Minimum Permissive Window for vehicles or pedestrians on a pattern by pattern basis
 - Prevents a “late” vehicle or Ped call to be serviced if the call occurs the force-off of the preceding phase.

Alternate Tables+

MM→2→6

Pat#	Alt:	<u>ØOpt</u>	<u>ØTime</u>	<u>DetGrp</u>	<u>Call/Inh</u>	->
1		0	0	0	0	
2		8	3	3	2	
3		0	0	0	0	
4		0	0	0	0	
5		0	0	0	0	
6		0	0	0	0	
7		0	0	0	0	
.....						
48		0	0	0	0	

<- Pat#	<u>olp.off:12345678</u>	<u>CIC</u>	<u>CNA1</u>	<u>Max2</u>	<u>Dia</u>
1	0	.	.	DFT
2	2	.	.	4Ø
3	3	.	.	3Ø
.....					
48	4	.	.	SEP

Alternate Tables+ Left Menu

- Attaches any Alternate Phase Program (MM→1→1→6) or Alternate Detector Programs (MM→5→5) to any pattern
- Total of
 - 8 Alternate Phase Option Programs
 - 3 Alternate Phase Time Programs
 - 3 Alternate Detector
 - 2 Call/Inhibit Program

Pat#	Alt:	Opt	Time	DetGrp	Call/Inh	->
1		0	0	0	0	
2		8	3	3	2	
3		0	0	0	0	
4		0	0	0	0	
5		0	0	0	0	
6		0	0	0	0	
7		0	0	0	0	
....						
48		0	0	0	0	

Alternate Tables+ Right Menu

- Allows Overlaps 1-8 to be individually enabled or disabled by pattern
- Critical Intersection Control (CIC) can be enabled or disabled by pattern
- Call to Non-Actuated 1 (CNA1) can be enabled for specific patterns
 - Set on a Per-Phase basis at MM→1→1→2
 - Used with P

Pat#	<u>olp.off</u> :12345678	<u>CIC</u>	<u>CNA1</u>	<u>Max2</u>	<u>Dia</u>
1	0	.	.	DFT
2	2	.	.	4Ø
3	3	.	.	3Ø
.....					
48	4	.	.	SEP

Alternate Tables+ Right Menu

- Max2 can be enabled or disabled for each pattern
 - If enabled-it will override Max setting
- DIA: Pertains to DIAMOND mode only
 - DFT: Default
 - 4P - 4 phase
 - 3P - 3 phase
 - SEP -

<- Pat#	olp.off:12345678	CIC	CNA1	Max2	Dia
1	0	.	.	DFT
2	2	.	.	4Ø
3	3	.	.	3Ø
.....					
48	4	.	.	SEP