

Texas Diamond Signalized Operations

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Texas Diamond Signal Operations

- **Used exclusively for diamond interchanges with both ramps signalized.**
- **Developed at Tx DOT and refined by TTI.**
- **Two variations – 3 Phase & 4 Phase**

Texas Diamond Signal Operations

- **The “usual” ODOT method**
 - 2 signals therefore 2 controllers
- **The “sometimes” ODOT method**
 - 2 signals and 1 controller
- **Texas Diamond = 2 signals & 1 controller**
 - So what’s the big deal – why Texas Diamond?

Texas Diamond Signal Operations

- **Start with why “NOT” 2 controllers**
 - Cannot control phases being skipped or gapping out.
 - This causes traffic to enter the interchange when it’s “not supposed to”
 - Can lock up the middle
- **Cannot precisely control which phases are running at the same time at each intersection.**
- **Requires two offsets to adjust when timing plans change**

Texas Diamond Signal Operations

- **2 Intersections & 1 Controller**
 - **Can control the relationship of phases at both intersections.**
 - **Only 1 offset to adjust during timing plan changes**
 - **Basic controller/detector logic**
 - **Usually better than 2 controllers – except when you have a malfunction – both go on flash**

Texas Diamond Signal Operations

- 2 Intersections & 1 Controller (Texas Diamond)
 - Can control the relationship of phases at both intersections.
 - Very complicated detector and phase logic required.
 - Good news – the logic is “built” into the controller.
- Goal is to have heavy movements moving simultaneously.
- Travel time used to strategically start movements.
- 4 Phase can keep middle clear of cars.

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3 Phase or 4 Phase???

- **3 Phase - Most Effective When:**
 - Wide Interchanges 400' + spacing (Adequate Internal Storage). Can stop people in middle.
 - Rural Areas with Light Overall Traffic
 - Heavy Through Movements
 - Does have simultaneous arterial green at both signals

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3 Phase or 4 Phase???

- **4 Phase Most Effective When**

- Closely Spaced (less 400' or inadequate storage in middle).
- 4 phase stores ZERO cars in the middle unless over capacity.
- Heavy ramp movements.
- Only stop one time in the interchange
- **Good way to avoid widening some bridges because of storage**
- Note – does NOT have simultaneous arterial greens

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- **How do you analyze??**
 - **Passer 3: Sole purpose is to analyze Texas Diamond operations.**
 - **If coordinating interchange – figure out in Passer then input results into Synchro to include the other signals.**
 - **Synchro 7.0 has a Texas Diamond “template”**

Texas Diamond Signal Operations

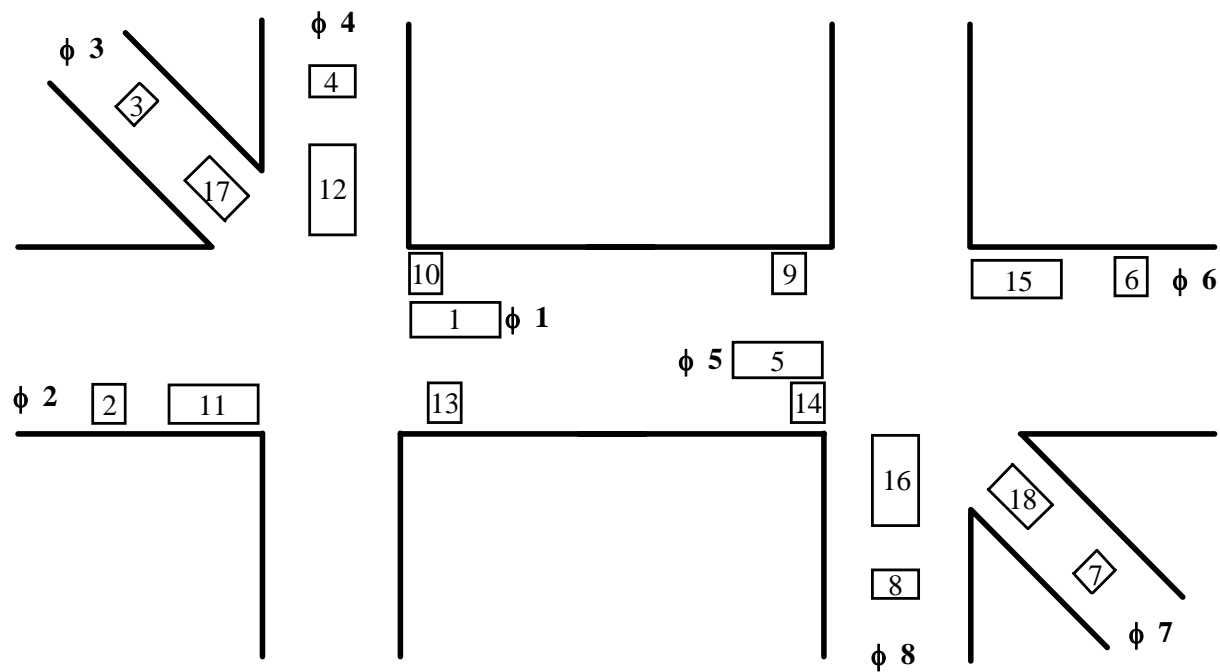
- Note – 3 Phase Texas Diamond typically has much shorter cycle lengths than 2 intersections + 2 controllers. Potential **cycle length incompatibility** for coordinated system.

Texas Diamond Signal Operations

- Loops – placement is defined by the operation.
- Detector & Phase Logic – defined by the operation.

Texas Diamond Signal Operations

Loops



Texas Diamond Signal Operations

LOOPS – 3 Phase

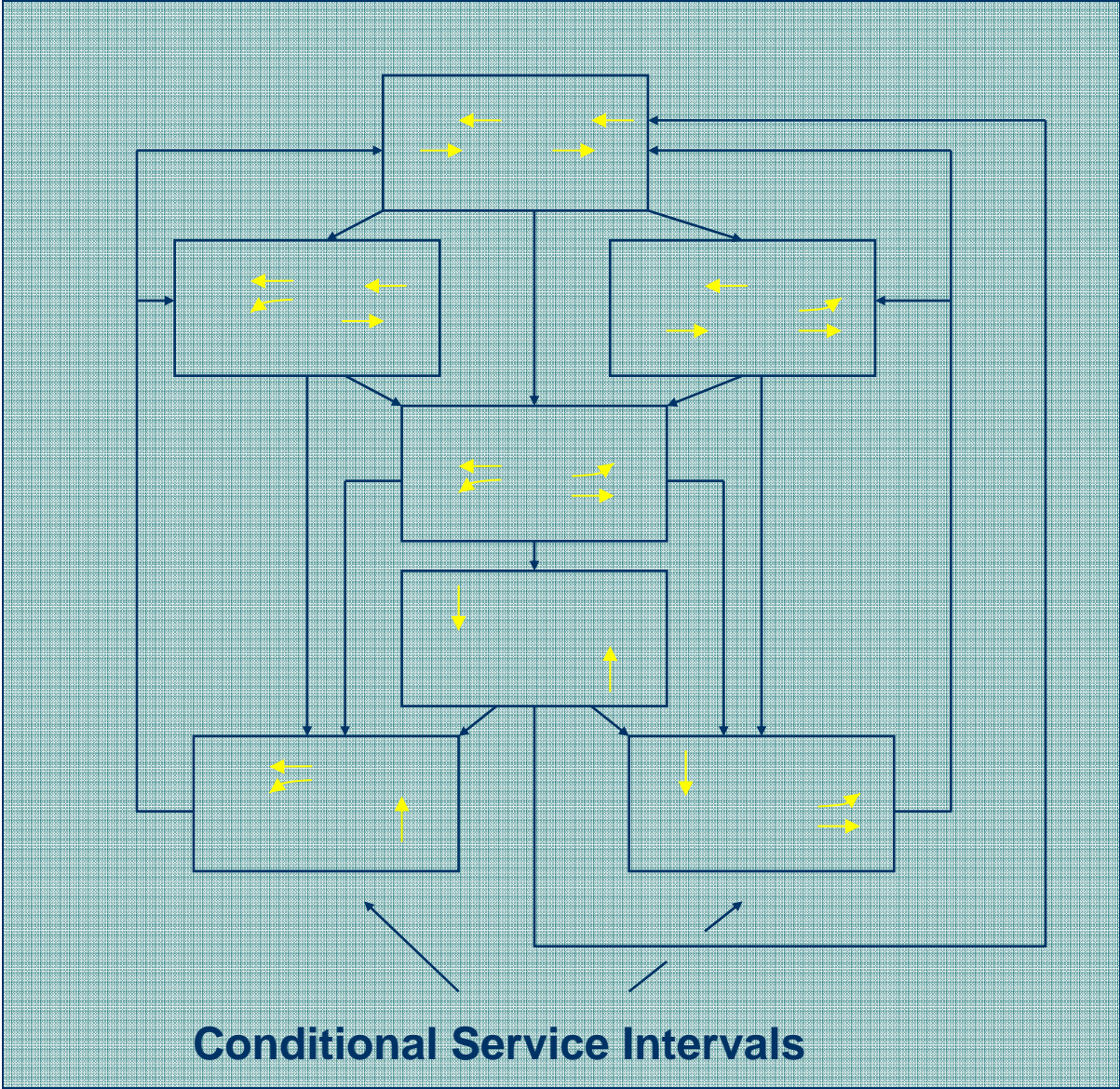
Detector Number	Associated Phase	Function
1	1	Presence detector: Calls and Extends Phase 1
2	2	Setback detector: Extends Phase 2
3	3	Setback detector: Extends Phase 3
4	4	Setback detector: Extends Phase 4
5	5	Presence detector: Calls and Extends Phase 5
6	6	Setback detector: Extends Phase 6
7	7	Setback detector: Extends Phase 7
8	8	Setback detector: Extends Phase 8
9	1	Calls phase 1 during phase 3 or 4; Extends phase 1 if phase 3 or 4 call exists
10	1	Calls phase 1 during phase 3 or 4; Extends phase 1 if phase 3 or 4 call exists
11	2	Stopbar detector: Calls Phase 2
12	4	Stopbar detector: Calls Phase 4
13	5	Calls phase5 during phase 7 or 8; Extends phase 5 if phase 7 or 8 call exists
14	5	Calls phase5 during phase 7 or 8; Extends phase 5 if phase 7 or 8 call exists
15	6	Stopbar detector: Calls Phase 6
16	8	Stopbar detector: Calls Phase 8
17	3	Stopbar detector: Calls Phase 3
18	7	Stopbar detector: Calls Phase 7

Texas Diamond Signal Operations

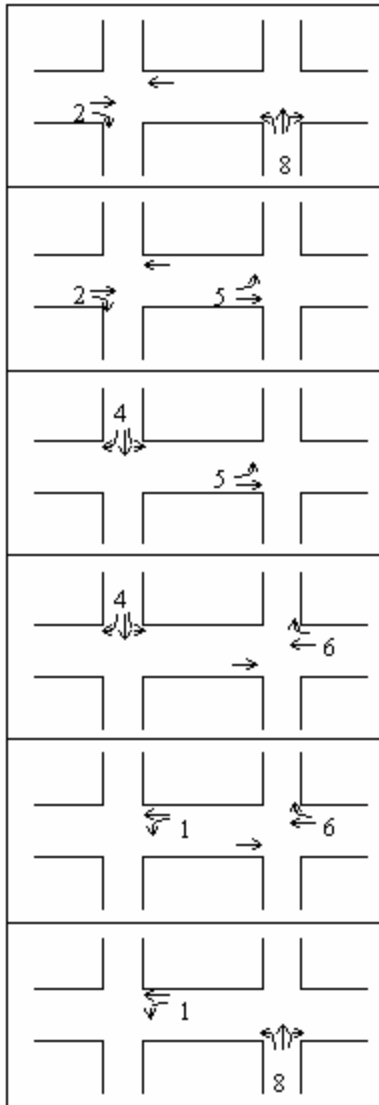
LOOPS – 4 Phase

Detector Number	Associated Phase	Function
1	1	Calls phase 6 if overlap A is not green and phase 7 or 8 is not called Extends intervals 2516B, 2517B, 2518B, 4517B, 4518B, 3517B, and 3518B
2	2	Setback detector: Extends Phase 2
3	3	Setback detector: Extends Phase 3
4	4	Setback detector: Extends Phase 4
5	5	Calls phase 2 if overlap B is not green and phase 3 or 4 is not called Extends intervals 1625B, 1635B, 1645B, 1735B, 1745B, 1835B, and 1845B
6	6	Setback detector: Extends Phase 6
7	7	Setback detector: Extends Phase 7
8	8	Setback detector: Extends Phase 8
9 / 10	1	Extends phase 2 if phase 3 or 4 is called Calls phase 6 if overlap A if not green and phase 7 or 8 is not called
11	2	Stopbar detector: Calls Phase 2
12	4	Stopbar detector: Calls Phase 4
13 / 14	5	Extends phase 6 if phase 7 or 8 is called Calls phase 2 if overlap B if not green and phase 3 or 4 is not called
15	6	Stopbar detector: Calls Phase 6
16	8	Stopbar detector: Calls Phase 8
17	3	Stopbar detector: Calls Phase 3
18	7	Stopbar detector: Calls Phase 7

3 Phase



4 Phase



Transition Interval 1+8 to 2+5 (Interval 2 + 8):

This interval begins when phase 8 gaps out or maxes out and runs for the travel time entered in the timing plan. It allows the frontage road to continue while the opposite arterial is entering the interchange, thereby not wasting green time.

Interval 2+5:

This interval is driven by the arterial (phase 2). When phase 2 gaps out or maxes out, the arterial will go through a yellow and red clear but the right interior will stay green.

Interval 4+5:

This interval is driven by the frontage road (phase 4). The setback detectors on the frontage road will allow this interval to gap out while vehicles are still a travel time away from the intersection.

Transition Interval 4+5 to 1+6 (Interval 4 + 6):

This interval begins when phase 4 gaps out or maxes out and runs for the travel time entered in the timing plan.

Interval 1+6:

This interval is driven by the arterial (phase 6). When phase 6 gaps out or maxes out, the arterial will go through a yellow and red clearance but the left interior will stay green.

Interval 1+8:

This interval is driven by the frontage road (phase 8). The setback detectors on the frontage road will allow this interval to gap out while vehicles are still a travel time away from the intersection.

Controller Logic

Sequence Control Logic:

- DUAL ENTRY PHS 2 & 6
- OMIT PHS 10 & 14
- IF PHS 5 NOT GREEN THEN OMIT PHS 9
- IF (PHS 3 ON OR PHS 4 ON) AND (PHS 6 ACTUATION OR PHS 6 CHECK) THEN OMIT PHS 9
- IF PHS 3 NOT GREEN THEN OMIT PHS 11
- IF PHS 4 NOT GREEN THEN OMIT PHS 12
- IF PHS 1 NOT GREEN THEN OMIT PHS 13
- IF (PHS 7 ON OR PHS 8 ON) AND (PHS 2 ACTUATION OR PHS 2 CHECK) THEN OMIT PHS 13
- IF PHS 7 NOT GREEN THEN OMIT PHS 15
- IF PHS 8 NOT GREEN THEN OMIT PHS 16
- IF (NOT PHS 1 ON) AND
(PHS 9 ON) OR
(PHS 11 ON) OR
(PHS 12 ON) OR
(PHS 6 ACTUATION OR PHS 6 CHECK) OR
(PHS 7 ACTUATION OR PHS 7 CHECK) OR
(PHS 8 ACTUATION OR PHS 8 CHECK) THEN
PLACE PHS 1 ACTUATION
- IF (PHS 13 ON) AND
(NOT PHS 2 CHECK) AND
(NOT PHS 3 CHECK) AND
(NOT PHS 4 CHECK) THEN
PLACE PHS 2 ACTUATION
- IF (NOT PHS 5 ON) AND
(PHS 13 ON) OR
(PHS 15 ON) OR
(PHS 16 ON) OR
(PHS 2 ACTUATION OR PHS 2 CHECK) OR
(PHS 3 ACTUATION OR PHS 3 CHECK) OR
(PHS 4 ACTUATION OR PHS 4 CHECK) THEN
PLACE PHS 5 ACTUATION
- IF (PHS 9 ON) AND
(NOT PHS 6 CHECK) AND
(NOT PHS 7 CHECK) AND
(NOT PHS 8 CHECK) THEN
PLACE PHS 6 ACTUATION
- IF (PHS 5 ON AND NOT PHSASE 9 ON) AND
(PHS 6 ACTUATION OR PHS 6 CHECK) OR
(PHS 7 ACTUATION OR PHS 7 CHECK) OR
(PHS 8 ACTUATION OR PHS 8 CHECK) THEN
PLACE PHS 9 ACTUATION
- IF (NOT PHS 6 ON) AND (PHS 6 ACTUATION OR PHS 6) CHECK THEN
PLACE PHS 11 & PHS 12 ACTUATION
- IF (PHS 1 ON AND NOT PHS 13 ON) AND
(PHS 2 ACTUATION OR PHS 2 CHECK) OR
(PHS 3 ACTUATION OR PHS 3 CHECK) OR
(PHS 4 ACTUATION OR PHS 4 CHECK) THEN
PLACE PHS 13 ACTUATION
- IF (NOT PHS 2 ON) AND (PHS 2 ACTUATION OR PHS 2 CHECK) THEN
PLACE PHS 15 & PHS 16 ACTUATION

Both the detector logic and controller logic (for both 3 & 4 phase) is “pre-programmed into the controller. Eagle currently pre-approved by Tx – Econolite is being reviewed.

Texas Diamond Signal Operations

Just fill in the timing intervals



PHASING AND DETECTOR ASSIGNMENTS

PHASING DIAGRAM

PHASE CONTROL LOGIC

- Dual entry phase 2 and phase 6
- Place phase 1 actuation if phase 1 not ON and (phase 9 ON or phase 12 ON or phase 6 actuation or phase 5 actuation)
- Place phase 2 actuation if phase 13 ON and no actuations on phase 2 and phase 4
- Place phase 5 actuation if phase 5 not ON and (phase 13 ON or phase 16 ON or phase 2 actuation or phase 4 actuation)
- Place phase 6 actuation if phase 9 ON and no actuations on phase 6 and phase 8
- Phase 9
 - Omit phase 9 if phase 5 not green
 - Omit phase 9 if phase 4 ON and phase 6 actuation
 - Place phase 9 actuation if phase 5 ON and phase 9 not ON and (phase 6 actuation or phase 8 actuation)
- Phase 12
 - Omit phase 12 if phase 4 not green
 - Place phase 12 actuation if phase 6 not ON and phase 6 actuation
- Phase 13
 - Omit phase 13 if phase 1 not green
 - Omit phase 13 if phase 8 ON and phase 2 actuation
 - Place phase 13 actuation if phase 1 ON and phase 13 not ON and (phase 2 actuation or phase 4 actuation)
- Phase 16
 - Omit phase 16 if phase 8 not green
 - Place phase 16 actuation if phase 2 not ON and phase 2 actuation

CONTROLLER INFORMATION

Ring Structure	Ring 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Phase No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
See controller notes	P	P	O	4-T6	P	P	O	8-T2	T6	O	O	T2	O	O	O	T6

Controller notes:

- O Omit phases 10 and 14; phases 3, 7, 11 and 15 are not typically used.
- Set min. and max. green times equal to 0.
- P Use green time from Passer 3 output
- T2 GR + Y + AR = travel time for phase 2, minimum and maximum greens are equal
- T6 GR + Y + AR = travel time for phase 6, minimum and maximum greens are equal
- 4-T6 Phase 4 green time from Passer 3 minus the phase 6 travel time
- 8-T2 Phase 8 green time from Passer 3 minus the phase 2 travel time

Detector Function

Detector Number	Assoc. Phase	Detector Function
1	1	Call Phase 6 when OLA is not green and Phase 8 call does not exist
2	2	Call and extend Phase 2
3	-	Not used
4	4	Call Phase 4 when Phase 4 and Phase 12 are not green Extend Phase 4 when Phase 4 is green Extend Phase 12 when Phase 12 is green
5	5	Call Phase 2 when OLB is not green and Phase 4 call does not exist
6	6	Call and extend Phase 6
7	-	Not used
8	8	Call Phase 8 when Phases 8 & 16 are not green Extend Phase 8 when Phase 6 is green
9	9	Call Phase 6 when OLA is not green and Phase 8 call does not exist
10	10	Extend Phase 2 when Phase 2 is green and Phase 4 call exists Call and extend Ph. 2, make inactive until Ph. 2 yellow if gaps out during Ph. 2 green
11	2	Call Phase 4 when Phase 4 is not green
12	4	Extend Phase 4 until Phase 6 call exists and detector gaps out, make inactive until Phase 4 yellow or Phase 8 call disappears before Phase 4 yellow
13 & 14	5	Call Phase 2 when OLB is not green and Phase 4 call does not exist Extend Phase 6 when Phase 6 is green and Phase 8 call exists
15	6	Call and extend Ph. 6, make inactive until Ph. 6 yellow if gaps out during Ph. 6 green
16	8	Call Phase 8 when Phase 8 is not green Extend Phase 8 until Phase 2 call exists and detector gaps out, make inactive until Phase 8 yellow or Phase 2 call disappears before Phase 8 yellow

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DIAMOND INTERCHANGE + PHASE (TEXAS) OPERATION
OFFICE OF TRAFFIC ENGINEERING
LAM

Texas Diamond Signal Operations

- The “RULES”:
 - If you don’t change the number of lanes OR the lane use you do NOT need to do an IMS.
 - You can extend turn lanes up to the L&D Manual maximums.
 - If you extend the existing turn lanes – you must document what you did.

Texas Diamond Signal Operations

- Summary:
 - Texas Diamond can potentially improve signalized operations at diamond interchanges.
 - Tx spec's makes programming as easy as possible (template in the controller)
 - Should use Passer 3 to analyze
 - ODOT plan insert sheets require that you only “fill in the blanks” for the timing intervals.



Texas Diamond Signal Operations



QUESTIONS???