



# Phasing Options for Traffic Signals

An Online Continuing Education Course for Engineers

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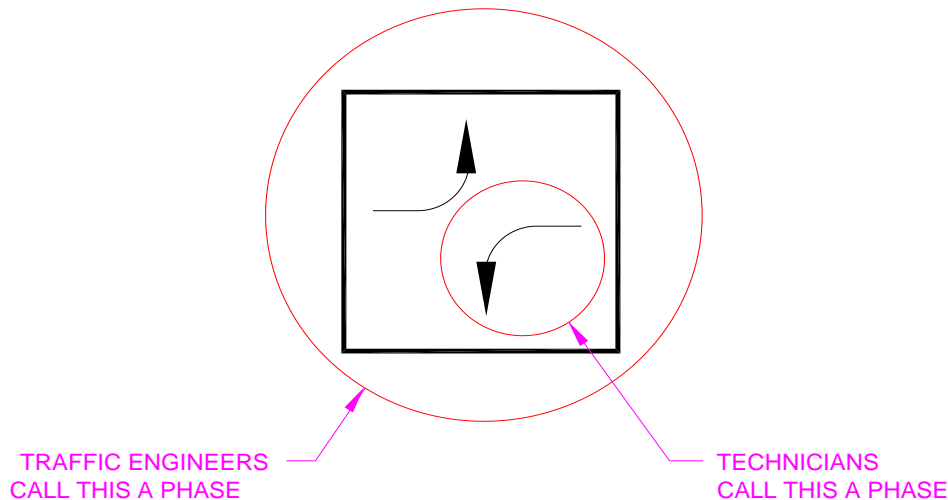
# PHASING OPTIONS FOR TRAFFIC SIGNALS

Jeffrey W. Buckholz, PE, PhD, PTOE

This Traffic Signal Design course presents information regarding phasing sequences used for traffic signal control. The material is intended to provide a practical overview of traffic signal phasing and its proper application. Since fully actuated controller operation demonstrates the most sophisticated features and capabilities with respect to signal phasing, the explanation of phasing concepts centers on this mode of controller operation. However, many of the concepts are similar for pre-timed or semi-actuated controller operation. This is not an introductory course and a basic knowledge of traffic signal operation is assumed.

Traffic engineers and traffic technicians use the word "phasing" a little differently, so confusion can occur. Technicians typically have in mind the individual vehicle movements (or NEMA phases) when they speak of phasing, whereas traffic engineers are typically referring to a specific combination of phases, or what one might call a phase set. For example, when opposing main street left turns go green together, the engineer would say that the lead left turn phase (or more precisely, the lead left turn phase set) has started, whereas the technician would say that phases 1 and 5 have begun concurrent operation.

## DUAL DEFINITION OF PHASING

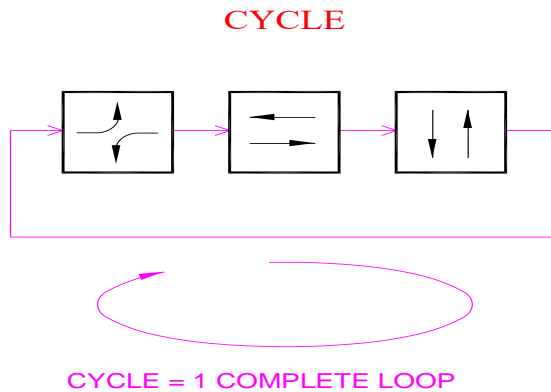


To maintain clarity, this course defines a **phase** as any traffic signal display with its own set of timings that controls an individual vehicle or pedestrian movement. Examples would be a westbound left turn phase, a northbound thru phase, or a northbound pedestrian phase. A **phase set**

is defined as any unique combination of vehicle or pedestrian phases that occur at the same time. Examples of a phase set would be opposing northbound/southbound left turns or east/west thru movements with concurrent east/west pedestrian movements.

## SIGNAL CYCLES

A traffic signal **cycle** is one complete set of signal phase sets. The following illustration provides an example traffic signal cycle with six phases and three phase sets:

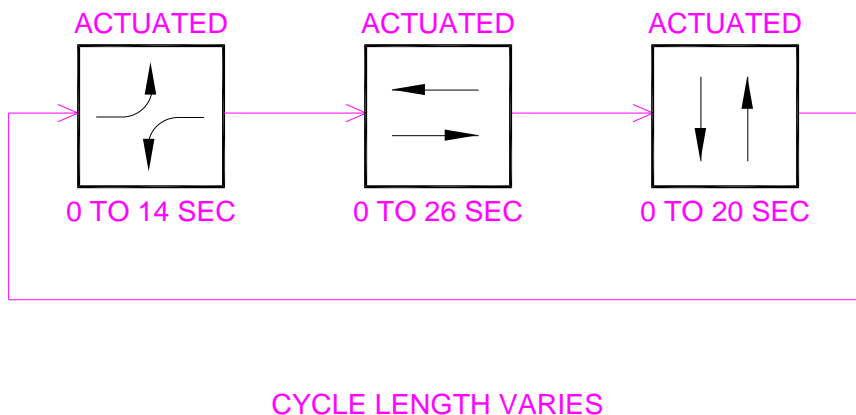


Each arrow represents a phase and each box represents a phase set.

The time it takes to complete one cycle is known as the **cycle length**. If each of the above phase sets were 30 seconds in length then the cycle length would be 90 seconds.

A **traffic actuated** signal is a signal having phase times that vary each cycle depending on the amount of vehicular demand:

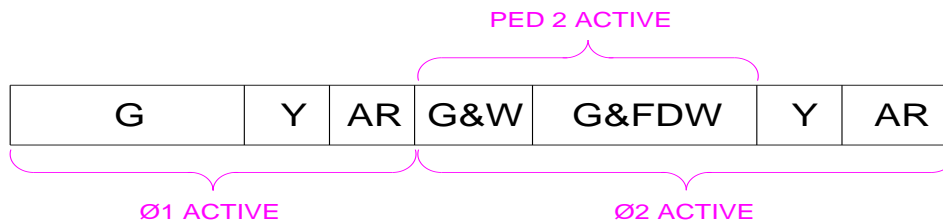
## FULLY-ACTUATED SIGNAL EXAMPLE



The maximum cycle length of 60 seconds for the above phasing scheme occurs when all phase sets are timed to their maximum value.

A vehicle phase is **serviced** when it becomes active and displays a green (G) indication. A vehicle phase remains active thru its subsequent yellow (Y) interval and all-red interval (R). A pedestrian phase is serviced when it becomes active and displays a walk (W) indication. A pedestrian phase remains active thru its subsequent flashing don't walk (FDW) interval, which is also referred to as the pedestrian clearance interval.

### PHASE SERVICE

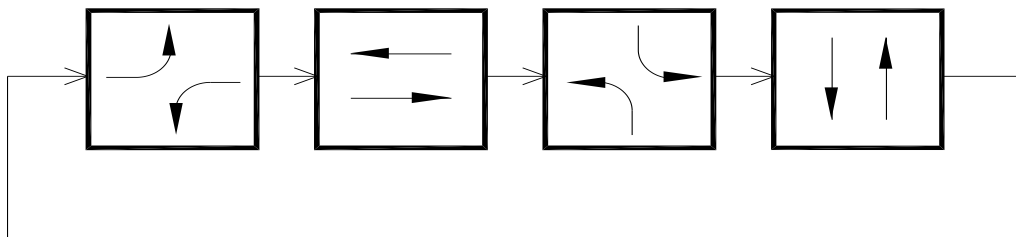


For a phase to be serviced it must first receive a call for service. A **vehicle call** is a demand for the green interval of a vehicle phase while a **pedestrian call** is a demand for the walk interval of a pedestrian phase. Vehicle calls typically occur when vehicles are detected by a vehicle sensor, such as an inductance loop embedded in the pavement or a video detection camera mounted overhead. Pedestrian calls typically occur when an individual pushes a pedestrian button. However, calls can be placed on phases by other means, such as thru **recall** settings programmed into the controller.

### PHASE ROTATION

Two phases which must not have green indications at the same time are referred to as **conflicting phases**. Conversely, two phases that can have the green at the same time are called non-conflicting or **concurrent phases**. When calls are present on two or more conflicting phases, **conflicting calls** are said to be present at the intersection. When there are conflicting calls at an intersection then the intersection will service the calls in a predetermined order called the **phase rotation**.

### PHASE ROTATION



The phase rotation (also called the phasing sequence) is the order in which the various phases are served. Phases are numbered and, in typical operation, phases are served in increasing numerical order. Use of a predetermined phase rotation guarantees that the green indication is displayed to motorists in a logical order and having properly selected maximum green times programmed for each phase ensures that no motorist has to wait an unreasonably long period of time to receive the green - although sometimes it may seem like it!

If it is the appropriate time in the phase rotation for a particular phase to be served, yet there is no demand for that phase (and the phase has not been placed on recall), then the phase will be **skipped**. The ability of a modern actuated controller to avoid serving phases when no demand is present is a very beneficial feature that increases the efficiency of the traffic signal by eliminating wasted green time.

## RECALLS

**Vehicle recall** is a demand for the green indication that does not require a vehicle to be present while **pedestrian recall** is a demand for the walk indication that does not require pushing of the pedestrian button. One or more phases can be placed on recall through programming of the signal controller. When recall has been activated for a phase, a call will be placed on the phase only when the phase does not currently have the green. The following three types of vehicle recall are typically available:

- Minimum Recall
- Maximum Recall
- Soft Recall

The following timing chart shows that minimum recall is active for NEMA phases 2 and 6 at this signalized intersection:

### RECALL

DESCRIPTION	PHASE							
	1	2	3	4	5	6	7	8
MIN Recall		X				X		
MAX Recall								
PED Recall								
Soft Recall								
CNA 1		X				X		
CNA 2								
Flashing Walk								
Phase Omit			X				X	
Ped Omit	X		X		X		X	
Non-Locking								

**Minimum recall** places a call on a phase and then keeps the phase green for at least as long as the initial (or minimum) setting programmed in the signal controller. The phase's green interval may be longer than the initial if actual vehicles continue to activate the vehicle detector and extend the green, but it will never be less than the initial setting.

**Maximum recall** places a call on a phase and then keeps the phase green for a time equal to the maximum setting programmed in the signal controller. Unless there is no other demand at the intersection, the green interval for the phase on maximum recall will exactly equal the maximum setting, it will not be any less or any greater. If there is no other conflicting demand at the intersection once the maximum interval has fully timed, the green time will continue to be displayed to the recall phases until such demand occurs. In this case, the green time experienced by the recall phases will be longer than their maximum green setting. Phases are said to **rest in green** during the period when the actual green time is longer than the maximum green time.

**Soft recall** is almost identical to maximum recall, but it will discontinue its call for a phase if there is no vehicle demand. The phase will be serviced if there is demand for the recall phase. If there is no demand, the phase is always serviced even if there is no demand.

In addition to vehicle recalls, there are **pedestrian recalls** (often referred to as **pedestrian calls**) for pedestrian service on a phase. These will be serviced through the recall mechanism.

## VEHICLE PHASE NUMBERING

NEMA (the National Electrical Manufacturers Association) is the industry accepted procedure for numbering the eight signal phases. The phases are commonly referred to as NEMA signal phasing. The odd numbers are used to designate the left turn phases and the even numbers are used to designate the thru phases. A maximum of four left turn phases and four thru phases can be designated using NEMA phasing:

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