

Flashing Yellow Arrow Monitoring

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For many years, traffic signal professionals have searched for a suitable method to implement lead-lag left turn phasing while retaining the operational benefits of protected/permissive left turn (PPLT) signal displays. The topic culminated with the publication of NCHRP 3-54, *Evaluation of Traffic Signal Displays for Protected/Permissive Left-Turn Control* and the subsequent publication of the 2009 *Manual on Uniform Traffic Control Devices (MUTCD)*. Based on research results found in NCHRP 3-54, the 2009 MUTCD allows for the use of a four section left-turn signal display incorporating a red left arrow, yellow left arrow, flashing yellow left arrow and green left arrow. This method of operation is commonly referred to as "Flashing Yellow Arrow" or FYA. FYA can also be applied to right turn signal indications consistent with the requirements in MUTCD.

Implementation of FYA operation in a traffic signal controller differs from traditional industry practice in that it introduces the requirement to output and monitor a fourth signal indication. This presents the signal technician with two issues which must be resolved in order to successfully implement FYA. The first issue is where the fourth output is connected. This requires the use of an additional loadswitch output for each FYA display. These outputs may be obtained from unused

overlaps or the unused third output of the pedestrian loadswitches. The second and most critical issue is what specific indication is connected to the fourth output, the flashing yellow arrow or the green arrow and how it impacts the operation of the Malfunction Management Unit (MMU) or Monitor. While seemingly insignificant, the use of FYA introduces some yellow displays specifically allowed by 2009 MUTCD, which would normally be considered to be in conflict with one another. It is critical that the signal technician have a thorough understanding of the monitoring operation in order to avoid the display of certain indications which conflict with one another and are prohibited by MUTCD.

This document is an overview of the two current common methods for monitoring FYA (Flashing Yellow Arrow). The two current common methods for implementing FYA are: (1) Green Separate Method and (2) FYA Separate Method. The intent of this document is to provide information about specific issues that can arise when monitoring FYA with either of the two methods.

Green Separate Method: The steady red arrow, steady yellow arrow, and flashing yellow arrow indications are monitored by one channel of the Monitor. The steady green arrow indication is monitored by a separate

channel of the Monitor. The basic configuration has the steady red arrow, steady yellow arrow, and flashing yellow arrow indications in an overlap monitored by Channel 13. The steady green arrow indication is in the PLT (Protected Left Turn) monitored by Channel 1. (Refer to Table 1 and Figure 1.)

FYA Separate Method: The steady red arrow, steady yellow arrow, and steady green arrow indications are monitored by one channel of the Monitor. The flashing yellow arrow indication is monitored by a separate channel of the Monitor. The basic configuration has the steady red arrow, steady yellow arrow, and steady green arrow indications in the PLT (Protected Left Turn) monitored by Channel 1. The flashing yellow arrow indication is in an overlap monitored by Channel 13. (Refer to Table 1 and Figure 1.)

The **Green Separate Method** and the **FYA Separate Method** require an additional jumper to be soldered to the program card. This jumper configures the FYA (Channel 13) to be permissive with the opposing thru movement (Channel 2). If there is a Pedestrian movement on Channel 9 a second jumper is required to configure Channel 13 to be permissive with Channel 9. (Refer to Figure 1.)

Basic Configurations

Signal Indication	Green Separate	FYA Separate
Steady Red Arrow 	Channel 13 Red	Channel 1 Red
Steady Yellow Arrow 	Channel 13 Yellow	Channel 1 Yellow
Flashing Yellow Arrow 	Channel 13 Green	Channel 13 Yellow or Green
Steady Green Arrow 	Channel 1 Green	Channel 1 Green

Table 1

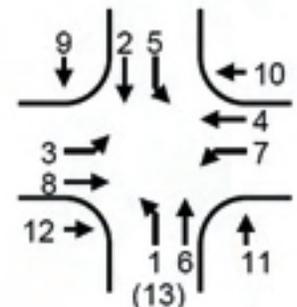


Figure 1

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GREEN SEPARATE METHOD OPERATION

To configure the FYA (Channel 13 Green) to be permissive with the opposing thru movement (Channel 2) an additional jumper must be soldered to the program card. This jumper also configures the protected left turn steady yellow arrow indication (Channel 13 Yellow) to be permissive with the opposing thru movement indications (Channel 2). The **Green Separate Method** allows the following conditions:

1. The protected left turn steady yellow arrow indication will **not be monitored for a conflict** with the opposing circular green indication.
2. When terminating a protected left turn the protected left turn steady yellow arrow indication will **not be monitored for a conflict** with the opposing thru circular yellow indication.
3. If there is a pedestrian movement, the protected left turn steady yellow arrow indication will **not be monitored for a conflict** with the pedestrian walk indication.

The above three conditions are **non-compliant** with Section 4D.05 of the 2009 MUTCD (see <http://mutcd.fhwa.dot.gov/>) which states:

MUTCD (2009 Part 4)

Section 4D.05 Application of Steady Signal Indications:

- E. A steady YELLOW ARROW signal indication:
 4. *Shall not be displayed when any conflicting vehicular movement has a green or yellow signal indication (except for the situation regarding U-turns to the left provided in Paragraph 4) or any conflicting pedestrian movement has a WALKING PERSON (symbolizing WALK) or flashing UPRAISED HAND (symbol-*

izing DONT WALK) signal indication, except that a steady left-turn (or U-turn to the left) YELLOW ARROW signal indication used to terminate a flashing left-turn (or U-turn to the left) YELLOW ARROW or a flashing left-turn (or U-turn to the left) RED ARROW signal indication in a signal face controlling a permissive left-turn (or U-turn to the left) movement as described in Sections 4D.18 and 4D.20 shall be permitted to be displayed when a CIRCULAR YELLOW signal indication is displayed for the opposing through movement.

NEMA Standards Publication TS 2-2003 v02.06

Section 4 MALFUNCTION MANAGEMENT UNIT

4.1 OVERVIEW The standards in Section 4 respond to the need for a **Malfunction Management Unit** (MMU) to accomplish the detection of, and response to, improper and conflicting signals and improper operating voltages in a Controller Assembly (CA).

Summary: *Any monitor (e.g. NEMA Type or 2070 Type) using the Green Separate Method will not comply with the 2009 MUTCD Section 4D.05.E.4. The Monitor is programmed by the user to not monitor for conflicts between the protected left turn steady yellow arrow indication and the opposing thru circular green, circular yellow and walk indications. The Monitor operation will not meet the requirements defined by the NEMA TS2 2003 v02.06 Section 4 Standard.*

FYA SEPARATE METHOD OPERATION

To configure the FYA (Channel 13 Yellow or Green) to be permissive

with the opposing thru movement indications (Channel 2) an additional jumper must be soldered to the program card. This jumper configures the flashing yellow arrow indication (Channel 13 Yellow or Green) to be permissive with the opposing thru circular green and circular yellow indications (Channel 2). The protected left turn steady yellow arrow indication (Channel 1 Yellow) conflicts with the opposing thru circular green and circular yellow indications (Channel 2). The protected left turn steady yellow arrow indication (Channel 1 Yellow) conflicts with the opposing pedestrian channel walk indication (Channel 9). (*Refer to Table 1 and Figure 1.*)

When terminating a flashing yellow arrow the MUTCD allows the protected left turn steady yellow arrow indication to be displayed with the opposing thru circular yellow indication.

MUTCD (2009 Part 4)

Section 4D.05 Application of Steady Signal Indications:

- E. A steady YELLOW ARROW signal indication:
 4. Shall not be displayed when any conflicting vehicular movement has a green or yellow signal indication (except for the situation regarding U-turns to the left provided in Paragraph 4) or any conflicting pedestrian movement has a WALKING PERSON (symbolizing WALK) or flashing UPRAISED HAND (symbolizing DON'T WALK) signal indication, *except that a steady left-turn (or U-turn to the left) YELLOW ARROW signal indication used to terminate a flashing left-turn (or U-turn to the left) YELLOW*

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ARROW or a flashing left-turn (or U-turn to the left) RED ARROW signal indication in a signal face controlling a permissive left-turn (or U-turn to the left) movement as described in Sections 4D.18 and 4D.20 shall be permitted to be displayed when a CIRCULAR YELLOW signal indication is displayed for the opposing through movement.

Summary: Any monitor (e.g. NEMA Type or 2070 Type) using the **FYA Separate Method** complies with the 2009 MUTCD Section 4D.05.E.4. Conflicts will occur in the following three conditions:

1. The protected left turn steady yellow arrow indication **will** conflict with the opposing thru circular green indication.
2. When terminating a protected left turn the protected left turn steady yellow arrow indication **will** conflict with the opposing thru circular yellow indication.
3. If there is a pedestrian movement, the protected left turn steady yellow arrow indication **will** conflict with the pedestrian walk indication.

CONCLUSION When selecting the **Green Separate Method** or the **FYA Separate Method** it is important to understand the difference between the two methods and the resulting impact on monitoring for conflicting signal displays. A Monitor that is configured using the **Green Separate Method** does not comply with Section 4D.05 of the 2009 MUTCD. A Monitor that is configured using the **FYA Separate Method** does comply with Section 4D.05 of the 2009

MUTCD. The cabinet wiring requires changes when switching between the **Green Separate Method** and the **FYA Separate Method**. Advance planning and understanding of the monitoring and safety implications is absolutely essential in order to properly implement FYA operation.

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