



## MMU2-16LEip FYA Overview NEMA Flashing Yellow Arrow Standard



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## Flashing Yellow Arrow

- Need for FYA
  - FHWA issued Interim Approval for use in March of 2006, dropping the experimental status
  - Allows protected-permitted left-turns and lead-lag phasing without the “Yellow Trap”.
  - Extremely flexible allowing protected-only or permitted-only by Time of Day or Queue
  - Has Good Driver Understanding
  - The array of phasing and detection combinations allows the engineer to maximize capacity at an intersection



## Flashing Yellow Arrow Milestones

- NCHRP 3-54 Report 2003
- First FYA capable monitor deployed in 2005 by EDI
- MUTCD formal release in 2009
  - Defines Signal operation
- NEMA TS2-2016 Standard
  - Includes FYA Amendment #4 November 2012
  - Defines Equipment operation



## NEMA TS-2 FYA Amendment

- Defines both CU and MMU2 operation
  - Devices conformant to the NEMA Standard will be interoperable and interchangeable.
  - An MMU conformant to the NEMA FYA Standard is labeled an "MMU2".
- Development Cycle
  - Project started in Q1-2009
  - Completed in August 2011
  - Publication in 2012 as *NEMA TS2 FYA Amendment #4*
  - Publication in 2016 as *NEMA TS2-2016*
- Compliant to MUTCD 2009



## NEMA Controller Section

- NEMA Definitions
  - Four output groups with four output states
  - Uses an Overlap concept to control the permissive phases
- FYA Signal Output Group
  - Red Arrow assigned to Overlap Red
  - Solid Yellow Arrow assigned to Overlap Yellow
  - Flashing Yellow Arrow assigned to Overlap Green
  - Green Arrow assigned to LT Protected movement
- NTCIP object definitions are still needed



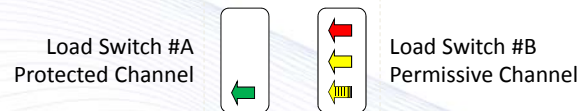
## NEMA MMU2 Section

- Definitions – “MMU2”
  - Permissive Turn Channel
  - Protected Turn Channel
  - Opposing Through Channel
  - Paired Channels
- The NEMA Standard does not define a method of programming the MMU2.
  - Interchangeability is achieved when MMU2 units are configured to produce the same functional operation.



## NEMA MMU2 Paired Channels

- The MMU2 uses two paired channels to monitor the four outputs of the FYA Signal Output Group.



- Each FYA approach typically requires two load switches and two MMU channels.
- Unused Red and Yellow outputs of the Protected channel can be disabled.



## MMU2 Paired Channel Modes

- The NEMA Standard provides for a minimum of 8 modes.
  - Four modes require no remapping
    - Two load switches and two MMU channels per approach
  - Two modes remap the Ped Yellow outputs
    - One+ load switch and two MMU channels per approach
  - Two *alternate* modes
    - One+ load switch and one+ MMU channel per approach
- Preconfigured modes simplify the cabinet and MMU2 setup and follow typical phase to channel assignment conventions in use.
- Choose a mode based on cabinet resources and level of remapping to be tolerated.



## How to Choose a Mode

Assume each FYA approach needs 2x MMU channels and 2x load switches.

- If the cabinet can provide two MMU channels and two load switches for each FYA approach then use Modes A-D.
  - Simple configuration with No mapping.
- If the cabinet can provide two MMU channels but does not have an additional load switch for each FYA approach then use Modes E-F.
  - For example, a 12 position back panel.
  - CU mapping and MMU mapping required, adds programming and trouble shooting complexity.
  - Monitoring of Pedestrian Yellow Clearance interval for Conflicts is sacrificed.
- If the cabinet does not have any additional MMU channels or load switches then use Modes G-H.
  - For example, 4 thru + 4 Ped + 4 OLPs + 4 FYA.
  - CU mapping required, adds programming and trouble shooting complexity.
  - Restricts FYA permissive programming to be the same as the parent Ped phase programming.
  - MMU display combines the flashing Yellow Arrow icon with the Ped Walk and Don't Walk icons.
  - Monitoring of Pedestrian Yellow Clearance interval for Conflicts is sacrificed.



## Modes A-B (No Mapping)

- Modes A and B assign the Protected turn phases to channels 1, 3, 5, and 7, and the Permissive turn overlap phases to either channels 9-12 or 13-16.
- This accommodates cabinets that have pedestrian phases assigned to either channel group; 9-12 or 13-16

	Ch:1	3	5	7	9	12	13	16
Mode A								
	Protected Turn Channels (Ga)				Opposing Through Channels		Permissive Turn Channels (Ra, Ya, fYa)	
	1	2	9	1 Green	3	4	10	3 Green
	3	4	11	5 Green	5	6	12	7 Green
	5	6	12	7 Green	7	8		
	7							
Mode B								
	Protected Turn Channels (Ga)				Opposing Through Channels		Permissive Turn Channels (Ra, Ya, fYa)	
	1	2	13	1 Green	3	4	14	3 Green
	3	4	15	5 Green	5	6	16	7 Green
	5	6			7	8		
	7							



## Modes C-D (No Mapping)

- Modes C and D assign the Protected turn phases to either channels 9-12 or 13-16. Channels 1, 3, 5, and 7, are the Permissive turn overlap phases.
- This accommodates cabinets that have pedestrian phases assigned to either channel group, 9-12 or 13-16

	Ch:1	3	5	7	9	12	13	16
Mode C								
	Protected Turn Channels (Ga)				Opposing Through Channels		Permissive Turn Channels (Ra, Ya, fYa)	
	9		2		1		9 Green	
	10		4		3		10 Green	
	11		6		5		11 Green	
12		8		7		12 Green		
Mode D								
	Protected Turn Channels (Ga)				Opposing Through Channels		Permissive Turn Channels (Ra, Ya, fYa)	
	13		2		1		13 Green	
	14		4		3		14 Green	
	15		6		5		15 Green	
16		8		7		16 Green		



## Modes E-F (Ped-Y Mapping)

- Modes E and F have the Ped-Y outputs remapped to drive the Protected turn phases.
  - Mapping adds a level of difficulty to trouble shoot.
- Modes E and F would be used when there are not enough load switches provided in the back panel.

	Ch:1	3	5	7	9	12	13	16
Mode E								
	Protected Turn Channels (Ga)				Opposing Through Channels		Permissive Turn Channels (Ra, Ya, fYa)	
	9		2		1		13 Yellow (Ped)	
	10		4		3		14 Yellow (Ped)	
	11		6		5		15 Yellow (Ped)	
12		8		7		16 Yellow (Ped)		
Mode F								
	Protected Turn Channels (Ga)				Opposing Through Channels		Permissive Turn Channels (Ra, Ya, fYa)	
	13		2		1		9 Yellow (Ped)	
	14		4		3		10 Yellow (Ped)	
	15		6		5		11 Yellow (Ped)	
16		8		7		12 Yellow (Ped)		



## Modes I-J (Ped-Y Mapping)

- Modes I and J have the Ped-Y outputs remapped to drive the Permissive turn phases.
  - Mapping adds a level of difficulty to trouble shoot.
- Modes I and J would be used when there are not enough load switches provided in the back panel.
- Retrofit would be easier.

	Ch:1	3	5	7	9	12	13	16
Mode I	Protected Turn Channels (Ra, Ya, Ga)		Opposing Through Channels		Permissive Turn Channels (fYa)		Flashing Yellow Arrow Signal Driver Source	
	1		2		9		13	Yellow (Ped)
	3		4		10		14	Yellow (Ped)
	5		6		11		15	Yellow (Ped)
	7		8		12		16	Yellow (Ped)
Mode J	Protected Turn Channels (Ra, Ya, Ga)		Opposing Through Channels		Permissive Turn Channels (fYa)		Green Arrow Signal Driver Source	
	1		2		13		9	Yellow (Ped)
	3		4		14		10	Yellow (Ped)
	5		6		15		11	Yellow (Ped)
	7		8		16		12	Yellow (Ped)



## Modes G-H (Alternate, Mapping)

- Modes G and H have the Ped-Y outputs remapped to drive the Permissive turn phases.
  - Permissive turn channels assume compatibility programming and display of the associated Ped phases.
  - Startup in Yellow or TOD Flash in Yellow is not supported.
- Modes G and H are used when there are not enough load switches and/or channels provided.
  - Simplify retrofits & use only one MMU channel per pair.
  - Leaves four channels available for normal overlap uses. For example, 4 thru + 4 ped + 4 OLPs + 4 FYA

	Ch:1	3	5	7	9	12	13	16
Mode G	Protected Turn Channels (Ra, Ya, Ga)		Opposing Through Channels		Permissive Turn Channels (fYa)		Flashing Yellow Arrow Signal Driver Source	
	1		2		9		9	Yellow (Ped)
	3		4		10		10	Yellow (Ped)
	5		6		11		11	Yellow (Ped)
	7		8		12		12	Yellow (Ped)
Mode H	Protected Turn Channels (Ra, Ya, Ga)		Opposing Through Channels		Permissive Turn Channels (fYa)		Flashing Yellow Arrow Signal Driver Source	
	1		2		13		13	Yellow (Ped)
	3		4		14		14	Yellow (Ped)
	5		6		15		15	Yellow (Ped)
	7		8		16		16	Yellow (Ped)



## Modes K-L (Alternate, No Mapping)

- Modes K and L assign the Permissive turn phases to either channels 9-12 or 13-16. Channels 1, 3, 5, and 7, are the Protected turn phases.
- Retrofits would be easier, but this assignment does not follow the NEMA overlap definition.

	Ch:1	3	5	7	9	12	13	16
Mode K								
	Protected Turn Channels (Ra, Ya, Ga)		Opposing Through Channels		Permissive Turn Channels (fYa)		Flashing Yellow Arrow Signal Driver Source	
	1	3	5	7	9	10	11	12
	2	4	6	8	9 Green	10 Green	11 Green	12 Green
Mode L								
	Protected Turn Channels (Ra, Ya, Ga)		Opposing Through Channels		Permissive Turn Channels (fYa)		Green Arrow Signal Driver Source	
	1	3	5	7	13	14	15	16
	2	4	6	8	13 Green	14 Green	15 Green	16 Green



## Additional FYA Functions

- Dynamic Clearance Conflict Detection
  - During Permissive clearance interval, the solid Y arrow is compatible with the opposing thru phase.
  - During Protected clearance interval, the solid Y arrow is conflicting with the opposing thru phase.
- Flashing Yellow output is monitored for a stuck-on malfunction.
- Protected channel R and Y inputs can be disabled if not utilized.



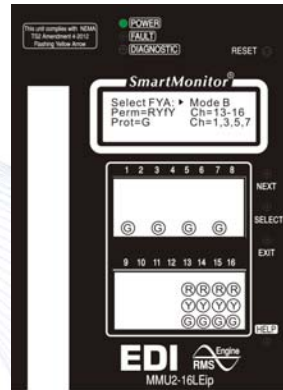


## MMU2-16LEip FYA Programming

First step is to select the Mode, A-L.

For each mode selected the display will show the channel assignments.

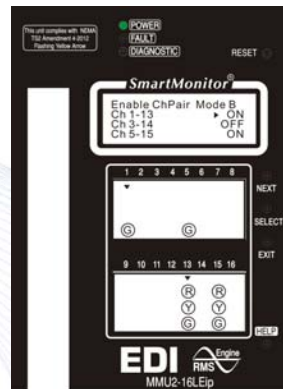
For Type 12 operation only modes A, C, G, and K are provided.



## MMU2-16LEip FYA Programming

Second step is to Enable a channel pair for each approach.

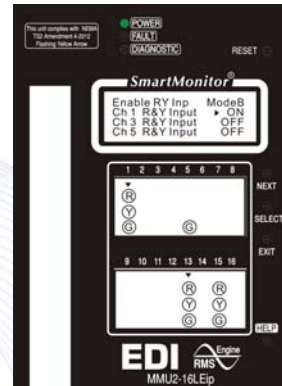
For each pair enabled the display will show the channel assignments.



## MMU2-16LEip FYA Programming

Third step is to Enable the use of the Red and Yellow input of the sparse channel (G only) if needed.

Typically, the R&Y input is disabled, and the MMU will ignore any voltage on the inputs and set them to Off. This eliminates the need to use a dummy resistor on the unused Red and Yellow load switch outputs.

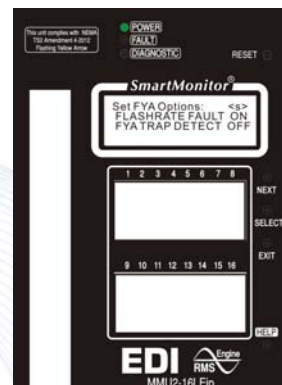


## MMU2-16LEip FYA Programming

Final step is to select the FYA Options.

The *FlashRate Fault* option will set a fault if the flashing Yellow Arrow stops flashing.

The *FYA Trap Detect* option will set a fault if the permissive turn channel (fYa) clears to solid Yellow while the opposing thru phase is Green.



## EDI FYA Product Plans

- NEMA published the FYA Standard in November 2012.
- NEMA FYA functionality will be released as the MMU2-16LE(ip) product.
  - The MMU2-16LE(ip) is functionally the same as the MMU-16LE(ip) but includes the NEMA FYA compliant operation.
  - The MMU-16LE(ip) product line is discontinued. It provided only the basic FYA and FYAc modes of operation.
- The EDI MMU2-16LEip *SmartMonitor* will provide an additional four FYA modes beyond the NEMA standard for a total of 12 modes.



## FAQ

- What is the difference between the MMU2-16LE(ip) and the MMU-16LE(ip)?
  - The units are functionally the same except for the FYA operation. The MMU2-16LE complies with the new NEMA standard.
  - NEMA Mode B is equivalent to the MMU-16LE “FYA” mode.
  - NEMA Mode F is equivalent to the MMU-16LE “FYAC” compact mode.
- Is there any price difference?
  - No.
- Can EDI update the MMU-16LE firmware to the MMU2-16LE?
  - Yes
- Can a user reflash the MMU-16LE with MMU2-16LE firmware?
  - Yes, consult the factory for details and firmware files.
- If an MMU-16LE is returned for factory repair and needs a firmware update, will it be automatically updated to MMU2-16LE level?
  - Yes, it will be changed to MMU2-16LE firmware with a label indicating the update.



## Advances in Signal Monitoring

- Be aware of new technology advancements.
- Keep equipment specifications up to date.
  - You are likely not using the same cell phone or TV that you used even 5 years ago.
- Technicians must learn to be more productive and more effective to keep up.
- New applications such as Flashing Yellow Arrow provide opportunities to move more vehicles and in a safer manner.



## MMU2-16LE FYA Overview NEMA Flashing Yellow Arrow Standard

Setting the Standard  
for  
Quality and Reliability

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