2014 IMSA Annual Conference

Technical Advances in Signal Monitors

NEMA Standard

Flashing Yellow Arrow

July 28, 2014

Scott Evans

VP of Engineering

Eberle Design Inc.
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 TS-2 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 November 2012 as:
    \[NEMA\ TS-2\ Amendment\ \#4-2012\]
    
- 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.
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.
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 Two MMU channels and Two 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.
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
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
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.

<table>
<thead>
<tr>
<th>Mode</th>
<th>Ch:</th>
<th>1</th>
<th>3</th>
<th>5</th>
<th>7</th>
<th>9</th>
<th>12</th>
<th>13</th>
<th>16</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>E</strong></td>
<td>Ch:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ch:1</td>
<td></td>
<td>9</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>5</td>
<td>7</td>
<td>13</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10</td>
<td>4</td>
<td>3</td>
<td>14</td>
<td>5</td>
<td>7</td>
<td>15</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>11</td>
<td>6</td>
<td>5</td>
<td>14</td>
<td>6</td>
<td>7</td>
<td>15</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12</td>
<td>8</td>
<td>7</td>
<td>13</td>
<td>8</td>
<td>7</td>
<td>16</td>
<td>16</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mode</th>
<th>Ch:</th>
<th>1</th>
<th>3</th>
<th>5</th>
<th>7</th>
<th>9</th>
<th>12</th>
<th>13</th>
<th>16</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>F</strong></td>
<td>Ch:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ch:1</td>
<td></td>
<td>13</td>
<td>2</td>
<td>1</td>
<td>9</td>
<td>5</td>
<td>7</td>
<td>13</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>14</td>
<td>4</td>
<td>3</td>
<td>10</td>
<td>5</td>
<td>7</td>
<td>11</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>15</td>
<td>6</td>
<td>5</td>
<td>10</td>
<td>6</td>
<td>7</td>
<td>11</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>16</td>
<td>8</td>
<td>7</td>
<td>11</td>
<td>8</td>
<td>7</td>
<td>12</td>
<td>16</td>
</tr>
</tbody>
</table>
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 troubleshoot.
- Modes I and J would be used when there are not enough load switches provided in the back panel.
- Retrofit would be easier.
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.

- 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
**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.

<table>
<thead>
<tr>
<th>Mode</th>
<th>Protected Turn Channels (Ra, Ya, Ga)</th>
<th>Opposing Through Channels</th>
<th>Permissive Turn Channels (fYa)</th>
<th>Flashing Yellow Arrow Signal Driver Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mode K</td>
<td>1</td>
<td>2</td>
<td>9</td>
<td>9 Green</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>4</td>
<td>10</td>
<td>10 Green</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>6</td>
<td>11</td>
<td>11 Green</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>8</td>
<td>12</td>
<td>12 Green</td>
</tr>
<tr>
<td>Mode L</td>
<td>1</td>
<td>2</td>
<td>13</td>
<td>13 Green</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>4</td>
<td>14</td>
<td>14 Green</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>6</td>
<td>15</td>
<td>15 Green</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>8</td>
<td>16</td>
<td>16 Green</td>
</tr>
</tbody>
</table>
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.
MMU2-16LE 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.
Second step is to Enable a channel pair for each approach.

For each pair enabled the display will show the channel assignments.
MMU2-16LE 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.
MMU2-16LE FYA Programming

Last FYA step is to Enable the stuck flashing yellow arrow fault detection, and FYA Yellow Trap fault detection.

Now run the built-in Setup Wizard to set the remaining MMU2 configuration parameters:

- Field Check Enable
- Red Fail Enable
- Dual Indication Enable
- Y+R Clearance Enable
MMU2-16LE(ip) FAQ

• What is the difference between the MMU2-16LE and the MMU-16LE?
  – The units are functionally the same except for the FYA operation. The MMU2-16LE complies with the new NEMA standard. The MMU-16LE is provided for backward compatibility with existing FYA installations.
  – 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?
  – No, it will only be changed to MMU2-16LE firmware if requested.
EDI FYA Product Plans

• NEMA published the FYA Standard in November 2012.
  – Requirements were amended in November 2013. Final publication as part of NEMA TS2-2014 Standard revision.

• NEMA FYA functionality has been released as the MMU2-16LE(ip) product in December 2012.
  – 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 will continue with the basic FYA and FYAc modes of operation.

• The EDI MMU2-16LE SmartMonitor will provide an additional four FYA modes beyond the NEMA standard for a total of 12 modes.

• EDI SSM-LE (TS-1), ATCC v2 CMU, and 2010ECL (332/336) product firmware updates will follow.
Conclusion

• 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.
Contact Information

Scott Evans
VP of Engineering
Eberle Design Inc.
Phone: (480) 968-6407
Email: sevans@EDItraffic.com

Setting the Standard for Quality and Reliability

Eberle Design Inc.
www.EDItraffic.com