NEMA Standards Publication TS 2-2003 (R2008)

Traffic Controller Assemblies with NTCIP Requirements (Version 02.06)

Amendment 4-2012

Flashing Yellow Arrow (FYA) Amendment

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FOREWORD

This NEMA Standards Publication TS 2-2003, *Traffic Controller Assemblies with NTCIP Requirements*, has been developed as a design guide for traffic signaling equipment, which can be safely installed and provide operational features not covered by NEMA TS 1-1989, *Traffic Control Systems*. Within the standard, any reference to a specific manufacturer is made strictly for the purpose of defining interchangeability where there exists no nationally recognized standard covering all the requirements. The manufacturer references do not constitute a preference.

The TS 2 Standards Publication has been established to reduce hazards to persons and property when traffic signaling equipment is properly selected and installed in conformance with the requirements herein. The user's attention is called to the possibility that compliance with this standard may require use of an invention covered by patent rights. By publication of this standard, no position is taken with respect to the validity of this claim or of any patent rights in connection therewith.

Comments and suggestions for the improvement of this document are encouraged. They should be sent to:

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NEMA TS 2-2003 (R2008) Amendment 4 revises NEMA TS 2-2003 (R2008) in four places:

a) Section 3.3.1.4.2.2, Type 129 MMU Inputs/Status (Type 1 ACK) (a replacement Section 3.3.1.4.2.2, Type 129 MMU Inputs/Status (Type 1 ACK) [Amendment 4], is provided);
b) After Section 3.5.8, Overlaps, and before Section 3.6, Actuated Coordination (a new Section 3.5.8.1, Flashing Yellow Arrow (FYA) [Amendment 4], through Section 3.5.8.1.4, Operation, is added);
c) After Section 4.1.2, TS 1-1989 Compatibility, and before Section 4.2, Physical (a new Section 4.1.3, Flashing Yellow Arrow (FYA) Configurations [Amendment 4], through Section 4.1.3.1, MMU2 Programming, is added); and
d) After Section 4.5.2, Microprocessor Monitor, and before Section 5, Terminals and Facilities (a new Section 4.6, Flashing Yellow Arrow (FYA) Support MMU2 Only [Amendment 4], through Section 4.6.4.3.1, Yellow Change Interval Conflict Compatibility, is added).

Section 1
REPLACE EXISTING SECTION 3.3.1.4.2.2

1.1   DELETE EXISTING SECTION 3.3.1.4.2.2 TYPE 129 MMU INPUTS/STATUS (TYPE 1 ACK)

On pages 54 through 56 of NEMA TS 2-2003 (R2008), delete existing Section 3.3.1.4.2.2, as follows:

3.3.1.4.2.2 Type 129 MMU Inputs/Status (Type 1 ACK)

The source of these frames is the MMU. This frame type shall be transmitted only if a Type 1 Frame has been correctly received from the primary station. If a Type 1 Frame is received from the primary station with a CRC error, then this frame type shall not be issued.

If the MMU is in the no failure state and its output relay is energized, then bits 9 through 62 of the information field of this frame shall contain an exact image of the signals that are applied to the MMU front panel connectors and bits 65 through 77 shall be 0. In the event that the MMU has fewer than 16 channels, the bit positions of the nonexistent channels shall be set to 0.

If the MMU is in the failure state and its output relay is de-energized, then bits 9 through 62 of the information field of this frame shall contain an exact image of the signals that were applied to the MMU front panel connectors at the point in time of the detection of the failure, one or more of bits 65 through 75 shall be set to 1 to indicate the type of failure(s) and bits 76 and 77 shall be 1.

If the MMU is in the **failure state** and its output relay is energized, then bits 9 through 62 of the information field of this frame shall contain an exact image of the signals that are applied to the MMU front panel connectors, one or more of bits 65 through 75 shall be set to 1 to indicate the type of failure(s), bit 76 shall be **0** and bit 77 shall be **1**.

Type 129 Response Frame

Bit	Function
1	1
2	0
3	0
4	0 **Type 129 Response Frame**
5	0
6	0
7	0
8	1
9	Channel 1 Green
10	Channel 2 Green
11	Channel 3 Green
12	Channel 4 Green
13	Channel 5 Green
14	Channel 6 Green
15	Channel 7 Green
16	Channel 8 Green
17	Channel 9 Green
18	Channel 10 Green
19	Channel 11 Green
20	Channel 12 Green
21	Channel 13 Green
22	Channel 14 Green
23	Channel 15 Green
24	Channel 16 Green
25	Channel 1 Yellow
26	Channel 2 Yellow

Type 129 Response Frame

Bit	Function
27	Channel 3 Yellow
28	Channel 4 Yellow
29	Channel 5 Yellow
30	Channel 6 Yellow
31	Channel 7 Yellow
32	Channel 8 Yellow
33	Channel 9 Yellow
34	Channel 10 Yellow
35	Channel 11 Yellow
36	Channel 12 Yellow
37	Channel 13 Yellow
38	Channel 14 Yellow
39	Channel 15 Yellow
40	Channel 16 Yellow
41	Channel 1 Red
42	Channel 2 Red
43	Channel 3 Red
44	Channel 4 Red
45	Channel 5 Red
46	Channel 6 Red
47	Channel 7 Red
48	Channel 8 Red
49	Channel 9 Red
50	Channel 10 Red
51	Channel 11 Red
52	Channel 12 Red
53	Channel 13 Red
54	Channel 14 Red
55	Channel 15 Red
56	Channel 16 Red
57	Controller Voltage Monitor (1=fail)
58	+24 Volt Monitor I (1=fail)
59	+24 Volt Monitor II (1=fail)
60	+24 Volt Monitor Inhibit (1=inhibit)
61	Reset (1=reset)
62	Red Enable (1=enable)
63	Reserved
64	Reserved
65	Conflict
66	Red Failure
67	Spare Bit 1
68	Spare Bit 2
69	Spare Bit 3
70	Spare Bit 4
71	Spare Bit 5
72	Spare Bit 6
73	MMU Diagnostic Failure
74	Minimum Clearance Failure
75	Port 1 Timeout Failure
76	Fail (1=failed - Output Relay Transferred)
77	Fail (1=failed - Immediate Response To Failure)
78	Reserved
79	Local Flash Status
80	Start-Up Flash Call
81	Reserved
82	Reserved
83	Reserved
84	Reserved
85	Reserved
86	Reserved
87	Reserved
88	Reserved

When Bit 80 is set to **1** for two consecutive Type 129 transfers, the CU shall go to the beginning of the **Start-Up Flash** period/state (see 3.9.1.1) and begin timing same, except when bit 80 is set to 1 as a result of exiting the **Start-Up Flash** period/state. No input, other than the lack of AC power, shall prevent this transition to the **Start-Up Flash** period/state.

Spare fault bits are used to indicate MMU detected failures which are not defined in this document. (Authorized Engineering Information)

Note: See Section 1.2 for replacement Section 3.3.1.4.2.2, Type 129 MMU Inputs/Status (Type 1 ACK) [Amendment 4].

1.2 INSERT REPLACEMENT SECTION 3.3.1.4.2.2 TYPE 129 MMU INPUTS/STATUS (TYPE 1 ACK) [AMENDMENT 4]

On pages 54 through 56, insert Section 3.3.1.4.2.2, Type 129 MMU Inputs/Status (Type 1 ACK) [Amendment 4].

Note: Section 3.3.1.4.2.2, Type 129 MMU Inputs/Status (Type 1 ACK) [Amendment 4] reflects the following amendments:

a) In paragraphs 2, 3, and 4, the phrase "one or more of the bits 65 through 75…" is replaced with the phrase "one or more of the bits 65 through 75 <u>and 81</u>…"; and
b) In the table labeled "Type 129 Response Frame," at Bit 81, the Function entry "Reserved" is replaced by the Function entry "<u>FYA Flash Rate Failure</u>."

Insert Section 3.3.1.4.2.2, Type 129 MMU Inputs/Status (Type 1 ACK) [Amendment 4], as follows:

3.3.1.4.2.2 Type 129 MMU Inputs/Status (Type 1 ACK) [Amendment 4]

The source of these frames is the MMU. This frame type shall be transmitted only if a Type 1 Frame has been correctly received from the primary station. If a Type 1 Frame is received from the primary station with a CRC error, then this frame type shall not be issued.

If the MMU is in the no failure state and its output relay is energized, then bits 9 through 62 of the information field of this frame shall contain an exact image of the signals that are applied to the MMU front panel connectors and bits 65 through 77 <u>and 81</u> shall be 0. In the event that the MMU has fewer than 16 channels, the bit positions of the nonexistent channels shall be set to 0.

If the MMU is in the failure state and its output relay is de-energized, then bits 9 through 62 of the information field of this frame shall contain an exact image of the signals that were applied to the MMU front panel connectors at the point in time of the detection of the failure, one or more of bits 65 through 75 <u>and 81</u> shall be set to 1 to indicate the type of failure(s) and bits 76 and 77 shall be 1.

If the MMU is in the failure state and its output relay is energized, then bits 9 through 62 of the information field of this frame shall contain an exact image of the signals that are applied to the MMU front panel connectors, one or more of bits 65 through 75 <u>and 81</u> shall be set to 1 to indicate the type of failure(s), bit 76 shall be 0 and bit 77 shall be 1.

Type 129 Response Frame	
Bit	**Function**
1	1
2	0
3	0
4	0 **Type 129 Response Frame**
5	0
6	0
7	0
8	1
9	Channel 1 Green
10	Channel 2 Green
11	Channel 3 Green
12	Channel 4 Green
13	Channel 5 Green
14	Channel 6 Green
15	Channel 7 Green
16	Channel 8 Green
17	Channel 9 Green
18	Channel 10 Green
19	Channel 11 Green

Type 129 Response Frame

Bit	Function
20	Channel 12 Green
21	Channel 13 Green
22	Channel 14 Green
23	Channel 15 Green
24	Channel 16 Green
25	Channel 1 Yellow
26	Channel 2 Yellow
27	Channel 3 Yellow
28	Channel 4 Yellow
29	Channel 5 Yellow
30	Channel 6 Yellow
31	Channel 7 Yellow
32	Channel 8 Yellow
33	Channel 9 Yellow
34	Channel 10 Yellow
35	Channel 11 Yellow
36	Channel 12 Yellow
37	Channel 13 Yellow
38	Channel 14 Yellow
39	Channel 15 Yellow
40	Channel 16 Yellow
41	Channel 1 Red
42	Channel 2 Red
43	Channel 3 Red
44	Channel 4 Red
45	Channel 5 Red
46	Channel 6 Red
47	Channel 7 Red
48	Channel 8 Red
49	Channel 9 Red
50	Channel 10 Red
51	Channel 11 Red
52	Channel 12 Red
53	Channel 13 Red
54	Channel 14 Red
55	Channel 15 Red
56	Channel 16 Red
57	Controller Voltage Monitor (1=fail)
58	+24 Volt Monitor I (1=fail)
59	+24 Volt Monitor II (1=fail)
60	+24 Volt Monitor Inhibit (1=inhibit)
61	Reset (1=reset)
62	Red Enable (1=enable)
63	Reserved
64	Reserved
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66	Red Failure
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69	Spare Bit 3
70	Spare Bit 4
71	Spare Bit 5
72	Spare Bit 6
73	MMU Diagnostic Failure
74	Minimum Clearance Failure
75	Port 1 Timeout Failure
76	Fail (1=failed - Output Relay Transferred)
77	Fail (1=failed - Immediate Response To Failure)
78	Reserved
79	Local Flash Status
80	Start-Up Flash Call
81	FYA Flash Rate Failure
82	Reserved
83	Reserved
84	Reserved

Type 129 Response Frame

Bit	Function
85	Reserved
86	Reserved
87	Reserved
88	Reserved

When Bit 80 is set to **1** for two consecutive Type 129 transfers, the CU shall go to the beginning of the **Start-Up Flash** period/state (see 3.9.1.1) and begin timing same, except when bit 80 is set to 1 as a result of exiting the **Start-Up Flash** period/state. No input, other than the lack of AC power, shall prevent this transition to the **Start-Up Flash** period/state.

Spare fault bits are used to indicate MMU detected failures which are not defined in this document. (Authorized Engineering Information)

Section 2
INSERT NEW SECTION 3.5.8.1 FLASHING YELLOW ARROW [AMENDMENT 4]

2.1 INSERTION AFTER SECTION 3.5.8 OVERLAPS

On page 119 of NEMA TS 2-2003 (R2008), identify existing Section 3.5.8, Overlaps, ending with the phrase "for each overlap signal."

On page 119 of NEMA TS 2-2003 (R2008), identify existing Section 3.6, Actuated Coordination.

A new Section 3.5.8.1, Flashing Yellow Arrow (FYA) [Amendment 4], through Section 3.5.8.1.4, Operation, is inserted between existing Section 3.5.8, Overlaps, and Section 3.6, Actuated Coordination.

Note: See Section 2.2 for new Section 3.5.8.1, Flashing Yellow Arrow (FYA) [Amendment 4].

2.2 INSERT NEW SECTION 3.5.8.1 FLASHING YELLOW ARROW (FYA) [AMENDMENT 4]

On page 119 of NEMA TS 2-2003 (R2008), insert Section 3.5.8.1, Flashing Yellow Arrow (FYA) [Amendment 4], as follows:

3.5.8.1 Flashing Yellow Arrow (FYA) [Amendment 4]

All CU's shall support protected-permissive operation through the use of the four-section Flashing Yellow Arrow (FYA) following the MUTCD-recommended implementation.

3.5.8.1.1 Requirements

FYA operation was developed under the National Cooperative Highway Research Program (NCHRP) project 3-54. The results of this program were reviewed by the FHWA and an interim approval has been granted by the FHWA with definition of a recommended implementation. Per the MUTCD 2009 recommended guidance, the FYA signal head is a 4-section signal face with outputs for a: protected left turn (Green arrow); permissive left turn (flashing Yellow arrow); yellow clearance (solid Yellow arrow); and prohibited left turn (Red arrow). (Authorized Engineering Information)

NEMA TS 2-2003 (R2008) Amendment 4 defines an FYA output group to be a set of outputs from the CU, intended to control all 4 output conditions (G, FY, Y, R) for a given 4-section signal face. The FYA Load Switch Driver Group for an FYA output group requires 4 outputs, in contrast to the 3 outputs necessary for a Vehicle Load Switch Driver Group.

Note: The term and all upper-case acronym Flashing Yellow Arrow (FYA) refers to the 4-section signal face group and general output characteristics of the group. The term and mixed upper-/lower-case acronym flashing Yellow arrow (fYa) refers to the individual signal indication, similar to Red arrow (Ra), Yellow arrow (Ya), and Green arrow (Ga).

3.5.8.1.2 Signal Output Groups

The CUs shall support a minimum of 4 separate FYA signal output groups, with each group providing all 4 output states per the MUTCD-approved implementation. Only one output indication shall be active for each FYA output group at a time. When the permissive left turn is active, the flashing Yellow arrow (fYa) output shall provide an alternating **True/False** output at a 1 pulse per second (1 Hz) repetition rate, with a 50 ± 2 percent duty cycle. The other three FYA outputs shall output with a solid (non-flashing) state when active.

The permissive left turn output and Yellow clearance output shall be provided as separate outputs for each FYA output group and not implemented as a dual flashing/steady state of the same physical output.

3.5.8.1.3   Configuration

The FYA output group movements shall operate in a manner consistent with overlaps programmed for the phases, with the protected left turn (Green arrow) following the Green interval of the designated left turn phase, and the permissive left turn (flashing Yellow arrow) following the designated overlap. In support of this overlapping movement, each FYA output group shall support the following assignments:

1. Overlap Assigned: Each FYA output group shall support designation of the overlap that will control the output state of the FYA group. The designated overlap may require additional configuration with parent phases for the protected left turn as well as permissive through movement.
2. Protected (Left Turn) Phase: Each FYA output group shall support designation of the phase associated with the left turn protected movement.

3.5.8.1.3.1 Output Configuration

Each FYA group shall be output through the standard outputs of the overlap assigned as well as protected phase. The following output mapping shall be provided:

1. FYA Red Arrow: This output shall be mapped to the assigned overlap Red output.
2. FYA Solid Yellow Arrow: This output shall be mapped to the assigned overlap Yellow output.
3. FYA Flashing Yellow Arrow: This output shall be mapped to the assigned overlap Green output.
4. FYA Green Arrow: This output shall be mapped to the Green output of the left turn protected phase movement.

Within this mapping, the protected phase clearance outputs shall not be required for operation of the FYA output group.

3.5.8.1.3.2 Alternate Output Configuration

The CU shall support an alternate mapping of the FYA signal output group. This alternate mapping makes use of existent protected left turn phase field wiring and allows implementation of the FYA with focus on minimizing cabinet re-wiring for retrofit applications.

In this alternate mapping, each FYA indication shall be output through the standard outputs of the protected phase as well as overlap assigned.

1. FYA Red Arrow: Output for this indication shall be mapped to the assigned Red output of the left turn protected phase movement. This indication shall operate in a manner consistent with the assigned overlap Red indication.
2. FYA Solid Yellow Arrow: Output for this indication shall be mapped to the Yellow output of the left turn protected phase movement. This indication shall operate in a manner consistent with the assigned overlap Yellow indication.
3. FYA Flashing Yellow Arrow: Output for this indication shall be mapped to the Pedestrian Clear (Yellow) output of the assigned opposing through phase pedestrian movement.
4. FYA Green Arrow: Output for this indication shall be mapped to the Green output of the left turn protected phase movement.

Note: An intentional indirection exists between the FYA output group indication function and resultant output mapping in the # 4 alternate output configuration.

3.5.8.1.4 Operation

The CU shall support transitions from a permissive left turn into a protected left turn immediately, without clearance through the solid Yellow arrow or Red clearance intervals between the permissive and protected left turn outputs.

The CU shall support transitions from a permissive left turn into a conflicting phase movement through a programmable Yellow clearance and Red clearance interval for each FYA output group. The CU shall use the associated overlap parent phase timings for these clearance intervals or may optionally provide user-defined clearance intervals that override the overlap parent phase interval timing.

Section 3
INSERT NEW SECTION 4.1.3 CONFIGURATIONS [AMENDMENT 4]

3.1 INSERTION AFTER SECTION 4.1.2 TS 1-1989 COMPATIBILITY

On page 135 of NEMA TS 2-2003 (R2008), identify existing Section 4.1.2, TS 1-1989 Compatibility, ending with the phrase "wired to the requirements of TS 1."

On page 136 of NEMA TS 2-2003 (R2008), identify existing Section 4.2, Physical.

A new Section 4.1.3, Flashing Yellow Arrow (FYA) Configurations [Amendment 4], through Section 4.1.3.1, MMU2 Programming, is inserted between existing Section 4.1.2, TS 1-1989 Compatibility, and Section 4.2, Physical.

Note: See Section 3.2 for new Section 4.1.3, Flashing Yellow Arrow (FYA) Configurations [Amendment 4].

3.2 INSERT NEW SECTION 4.1.3 FLASHING YELLOW ARROW (FYA) CONFIGURATIONS [AMENDMENT 4]

On page 119 of NEMA TS 2-2003 (R2008), insert Section 4.1.3, Flashing Yellow Arrow (FYA) Configurations [Amendment 4], as follows:

4.1.3 Flashing Yellow Arrow (FYA) Configurations [Amendment 4]

NEMA TS 2-2003 (R2008) Amendment 4 covers Malfunction Management Unit (MMU) configurations as shown in Table 4-1. The MMU type shall be shown on the front panel of the MMU.

Table 4-1
MMU TYPES

NEMA MMU Designation	Flashing Yellow Arrow (FYA) Support
MMU	No
MMU2	Yes

The two MMU types are not keyed differently. It is the user's responsibility to ensure the correct MMU type is installed and keyed as required for the user's application. (Authorized Engineering Information)

4.1.3.1 MMU2 Programming

A method of programming the Flashing Yellow Arrow (FYA) operation and associated parameters of an MMU2 is not defined in NEMA TS 2-2003 (R2008) Amendment 4. Interchangeability of equipment can be achieved only when MMU2 units are configured to produce the same functional operation.

Section 4
INSERT NEW SECTION 4.6 FLASHING YELLOW ARROW (FYA) SUPPORT (MMU2 ONLY) [AMENDMENT 4]

4.1   INSERTION AFTER SECTION 4.5.2 MICROPROCESSOR MONITOR

On page 150 of NEMA TS 2-2003 (R2008), identify existing Section 4.5.2, Microprocessor Monitor, ending with the phrase "shall transfer the **Output** relay to the fault condition."

On page 151 of NEMA TS 2-2003 (R2008), identify existing Section 5, Terminals and Facilities.

A new Section 4.6, Flashing Yellow Arrow (FYA) Support (MMU2 Only) [Amendment 4], is inserted between existing Section 4.5.2, Microprocessor Monitor, and Section 5, Terminals and Facilities.

Note: See Section 4.2 for new Section 4.6, Flashing Yellow Arrow (FYA) Support (MMU2 Only) [Amendment 4].

4.2   INSERT NEW SECTION 4.6 FLASHING YELLOW ARROW (FYA) SUPPORT (MMU2 ONLY) [AMENDMENT 4]

On page 150 of NEMA TS 2-2003 (R2008), insert Section 4.6, Flashing Yellow Arrow (FYA) Support (MMU2 Only) [Amendment 4], as follows:

4.6   FLASHING YELLOW ARROW (FYA) SUPPORT (MMU2 ONLY) [AMENDMENT 4]

The MMU2 configuration shall support the operation of Flashing Yellow Arrow (FYA) indication in the CU as defined in NEMA TS 2-2003 (R2008) Amendment 4 Section 3.5.8.1. This operation defines an FYA Signal Output Group that requires 4 outputs in contrast to the 3 outputs necessary for a Vehicle Load Switch Driver Group.

The MMU2 configuration shall use two paired channels to monitor the 4 outputs of the FYA Signal Output Group. At a minimum, FYA support shall be provided in the Type 16 mode.

4.6.1   MMU2 Definitions

The following defines the nomenclature used in NEMA TS 2-2003 (R2008) Amendment 4 Section 4.6.1.

4.6.1.1 Protected Turn Channel

The Protected Turn Channel of the FYA channel pair shall be composed of the solid Green arrow (Ga) indication of the FYA Signal Output Group.

4.6.1.2 Permissive Turn Channel

The Permissive Turn Channel of the FYA channel pair shall be composed of the: solid Red arrow (Ra); solid Yellow arrow (Ya); and flashing Yellow arrow (fYa) indications of the FYA Signal Output Group. The MMU2 shall display the flashing Yellow arrow (fYa) indication as the Green input of the Permissive Turn Channel.

4.6.1.3 Opposing Through Channel

An Opposing Through channel shall also be associated with the FYA channel pair. The Opposing Through channel is the channel that conflicts with the FYA Protected Turn Channel and is permissive with the Permissive Turn Channel (flashing Yellow arrow).

4.6.2   Channel Configurations

The MMU2 shall provide support for the FYA paired channel assignments shown in Table 4-2 and Table 4-3. MMU2 programming shall be provided to select a configuration of # A through # F at a minimum. For a selected configuration, the MMU2 shall provide a method to enable at least four channel pairs allowing up to four FYA approaches. Other configuration mappings may be offered in addition to these.

Table 4-2
FYA Channel Configurations (Remap = No)

Configuration	Protected Turn Channels (Ga)	Opposing Through Channels	Permissive Turn Channels (Ra, Ya, fYa)	Green Arrow Signal Driver Source
A	1	2	9	1 Green
	3	4	10	3 Green
	5	6	11	5 Green
	7	8	12	7 Green
B	1	2	13	1 Green
	3	4	14	3 Green
	5	6	15	5 Green
	7	8	16	7 Green
C	9	2	1	9 Green
	10	4	3	10 Green
	11	6	5	11 Green
	12	8	7	12 Green
D	13	2	1	13 Green
	14	4	3	14 Green
	15	6	5	15 Green
	16	8	7	16 Green

Table 4-3
FYA Channel Configurations (Remap = Yes)

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

4.6.3 Functions

For the purpose of fault monitoring, the four inputs of an FYA channel pair (FYA Signal Output Group) shall be the Red (Ra), Yellow (Ya), and Green (fYa) inputs of the Permissive Turn channel and the Green input (Ga) of the Protected Turn channel.

4.6.3.1 Protected Turn Channel Red and Yellow Inputs

The MMU2 shall provide a programming means to disable the Red and Yellow inputs of each of the Protected Turn channels when they are not connected to signal loads. When the Red and Yellow inputs of a Protected Turn channel are disabled in this manner, the MMU2 shall sense them as 0 Vrms.

4.6.3.2 Red Monitoring

The MMU2 shall be capable of monitoring for the absence of voltage as described in 4.4.4, on all four of the inputs of an FYA channel pair.

4.6.3.3 Minimum Yellow Change / Red Clearance Interval Monitoring

4.6.3.3.1 Yellow Change Interval

The solid Yellow arrow shall be monitored as described in 4.4.5.2 when terminating both the Protected Turn channel (solid Green arrow) interval and the Permissive Turn channel (flashing Yellow arrow) interval.

4.6.3.3.2 Permissive Turn Yellow Plus Red Interval

As described in NEMA TS 2-2003 (R2008) Amendment 4 Section 3.5.8.1, the MMU2 shall allow a transition from a Permissive Turn channel (flashing Yellow arrow) to the Protected Turn channel (solid Green arrow) of the pair without clearance through the solid Yellow arrow or Red arrow clearance intervals.

The MMU2 shall provide a programming means to disable the Minimum Yellow plus Red interval monitoring function (see 4.4.5.1) for the Permissive Turn channel of an enabled FYA paired channel.

4.6.3.4 Yellow Change Interval Conflict Compatibility

The MMU2 shall verify that during the Yellow change interval of the Permissive Turn channel (flashing Yellow arrow), no conflicting channels to the solid Yellow arrow channel are active. These conflicting channels shall be determined by the Program Card compatibility programming of the Permissive Turn channel (flashing Yellow arrow).

During all other times, the MMU2 shall verify that no conflicting channels to the solid Yellow arrow channel are active as determined by the Program Card compatibility programming of the Protected Turn channel (solid Green arrow) of the pair.

4.6.3.5 Permissive Turn Flash Rate

The MMU2 shall be capable of monitoring for the absence of a valid flash rate for the Permissive Turn (flashing Yellow arrow) signal. When the Permissive Turn (flashing Yellow arrow) signal is active for less than 700 milliseconds, the MMU2 shall not transfer the Output relay contacts to the fault condition. When the Permissive Turn (flashing Yellow arrow) signal is active for more than 1000 milliseconds, the MMU2 shall transfer the Output relay contacts to the fault condition. When the Permissive Turn (flashing Yellow arrow) signal is active for more than 700 milliseconds but less than 1000 milliseconds, the MMU2 may or may not transfer the Output relay contacts to the fault condition. The status bit # 81 shall be set in the Type 129 Frame (see NEMA TS 2-2003 (R2008) Amendment 4 Section 3.3.1.4.2.2) and transmitted to the CU through Port 1.

When the MMU2 transfers the **Output** relay contacts to the fault condition, it shall cause continuity between the open (see 4.3.2.2) and common contacts of the **Output** relay. These contacts shall remain in this fault condition until the unit is reset by the activation of a front panel control or the activation of the **Reset** input.

The MMU2 shall provide a programming means to enable the FYA Permissive Turn Flash Rate monitoring function.

4.6.4 Alternate FYA Channel Configurations

The MMU2 shall support an alternate mapping for the FYA signal output group, as shown in Table 4-4. Other configuration mappings may be offered in addition to this list. This alternate mapping makes use of existent protected left turn phase field wiring and allows implementation of the FYA with focus on minimizing cabinet re-wiring for retrofit application. In addition, unlike standard configurations # E and # F

of Table 4-3, this mode does not require an additional MMU2 channel for each FYA channel pair by using the Pedestrian channel of the associated Opposing Through Channel for the Permissive Turn (flashing Yellow arrow) channel.

Table 4-4
FYA Channel Configurations (Alternate Map)

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

4.6.4.1 Protected Turn Channel

The Protected Turn Channel of the FYA channel pair shall be composed of the solid Red arrow (Ra), solid Yellow arrow (Ya), and solid Green arrow (Ga) indication of the FYA Signal Output Group.

4.6.4.2 Permissive Turn Channel

The Permissive Turn Channel of the FYA channel pair shall be composed of the flashing Yellow arrow (fYa) indication of the FYA Signal Output Group. The MMU2 shall display the flashing Yellow arrow (fYa) indication as the Yellow input of the Pedestrian channel of the associated Opposing Through Channel.

4.6.4.3 Alternate FYA Functions

For the purpose of fault monitoring, the four inputs of an FYA channel pair shall be the Red (Ra), Yellow (Ya), and Green (Ga) inputs of the Protected Turn channel and the Yellow (fYa) input of the Permissive Turn channel (FYA Signal Output Group). In this mode, the Permissive Turn channel shall be shared with the Pedestrian channel for the associated Opposing Through Channel.

The MMU2 shall provide the functions described in NEMA TS 2-2003 (R2008) Amendment 4 Sections 4.6.3.2, 4.6.3.3, and 4.6.3.5.

4.6.4.3.1   Yellow Change Interval Conflict Compatibility

The MMU2 shall verify that during the Yellow change interval of the Permissive Turn channel (flashing Yellow arrow), no conflicting channels to the solid Yellow arrow channel are active. These conflicting channels shall be determined by the Program Card compatibility programming of the Permissive Turn channel (Opposing Through Pedestrian).

During all other times, the MMU2 shall verify that no conflicting channels to the solid Yellow arrow are active as determined by the Program Card compatibility programming of the Protected Turn channel (solid Green arrow) of the pair.

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