

# **MMU2-16LE Series**

## **SmartMonitor®**

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### **NEMA TS-2 MMU2 Enhanced Malfunction Management Unit Operations Manual**

THIS MANUAL CONTAINS TECHNICAL INFORMATION FOR THE **MMU2-16LE** and **MMU2-16LEip SmartMonitor®** SERIES MALFUNCTION MANAGEMENT UNIT.  
Firmware Version 7.4 (vXX74)

#### **- NOTE -**

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#### **MAINTENANCE NOTE**

**THIS EBERLE DESIGN INC. MALFUNCTION MANAGEMENT UNIT HAS BEEN  
CAREFULLY INSPECTED AND TESTED TO ENSURE PROPER OPERATION. IT IS  
RECOMMENDED THAT THE MALFUNCTION MANAGEMENT UNIT BE TESTED AT  
LEAST ANNUALLY TO ENSURE PROPER OPERATION AND COMPLIANCE WITH  
FACTORY SPECIFICATIONS.**

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## Section 1 General

### 1.1 DESCRIPTION

The MMU2-16LE *SmartMonitor*® series Malfunction Management Unit (MMU) is a device used in a Traffic Controller Assembly to accomplish the detection of, and response to, improper and conflicting signals and improper operating voltages in a Controller Assembly caused by malfunctions of the Controller Unit (CU), load switches, or mis-wiring of the cabinet. The MMU2-16LE *SmartMonitor*® also provides error sensing of two +24Vdc cabinet supplies and the controller power supplies via +24V MONITOR I, +24V MONITOR II, and Controller Voltage Monitor (CVM) inputs respectively.

The Eberle Design MMU2-16LE *SmartMonitor*® is directly interchangeable with a standard NEMA Malfunction Management Unit (MMU configuration) and meets with or exceeds all specifications outlined in Section 4 (Malfunction Management Unit) of the National Electrical Manufacturers Association (NEMA) ***Standards Publication TS2-2016 v03.07, Traffic Controller Assemblies With NTCIP Requirements***.

#### 1.1.1 NEMA TS-2 MMU2 (FYA) CONFIGURATION

**NEMA Standard TS2-2016** defines the operation of an MMU2 configuration that supports the Flashing Yellow Arrow (FYA) operation. FYA operation was developed under the National Cooperative Highway Research Program (NCHRP) project 3-54. 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). This MMU2-16LE *SmartMonitor*® series fully supports the requirements of the NEMA MMU2 configuration. See Section 3.11.

### 1.2 ADVANCED FEATURE OVERVIEW

#### 1.2.1 LIQUID CRYSTAL STATUS AND FIELD DISPLAY

The MMU2-16LE *SmartMonitor*® uses a programmable alpha-numeric Liquid Crystal Display (LCD) to show monitor status and two icon based LCDs to show field signal channel and fault status. This versatile back-lighted display system provides a service technician with both detailed information regarding cabinet voltages, configuration, and status, and at the same time an easily read field signal status display showing full intersection status.

#### 1.2.2 MENU DRIVEN OPERATION

The Display, Program, and Help modes of the MMU2-16LE *SmartMonitor*® are controlled using a simple menu driven user interface. The menu provides an organized scheme for displaying both current status as well as reviewing historical fault status. It also provides a mechanism for setting and reviewing the monitor enhanced-feature programming without the need for a laptop computer.

#### 1.2.3 CONTEXT SENSITIVE HELP SYSTEM

The built-in Help system provides operational guidance as well as trouble shooting advice to both the novice and expert technician. The front panel HELP button presents the requested information on the main LCD depending on the display page and context currently selected.

From start to finish, a technician can use the Set-up Wizard to accurately and quickly configure the monitor, and then use the Diagnostic Wizard to analyze the cause of a malfunction without the need for understanding complex monitor terminology and theory.

### 1.2.3.1 SET-UP WIZARD

The built-in Set-up Wizard (see Section 6.3.14) configures the monitor enhanced-feature programming using a simple series of intersection related questions. It allows a technician to accurately and completely program the MMU2-16LE *SmartMonitor*® enhanced functions without the need for understanding the complexities of monitor enhanced configuration parameters.

### 1.2.3.2 DIAGNOSTIC WIZARD

The built-in Diagnostic Wizard (see Section 3.10) is an integral part of the Help System that provides detailed diagnostic information regarding the fault being analyzed. The Wizard provides a concise view of the signal states involved in the fault, pinpoints faulty signal inputs, and provides guidance on how the technician should isolate the cause of the malfunction.

### 1.2.4 PROGRAM CARD MEMORY

All monitor enhanced-feature programming is stored in a nonvolatile memory contained on the EDI Program Card. When replacing the MMU2-16LE *SmartMonitor*® for service or test purposes, all NEMA standard and enhanced-feature programming is automatically transferred to the replacement unit when the EDI Program Card is inserted. The EDI Program Card is completely compatible with other MMU models compliant with the NEMA TS-2 Standard.

**The Program Card Memory function must be enabled before use. The factory default setting is Off.** See Section 6.3.4.6.

#### 1.2.4.1 MMU2 PROGRAM CARD MEMORY BACKWARD COMPATIBILITY

All configuration settings are compatible between previous legacy versions of the MMU-16LE *SmartMonitor*® firmware except for the Flashing Yellow Arrow parameters. When a Program Card configured with legacy FYA settings Enabled is installed into this unit, the resulting FYA settings will be set according to the table below, but only if the NEMA MMU2 FYA settings were not already enabled.

To emulate the legacy settings the following translation should be used:

Legacy FYA Mode	NEMA MMU2 Settings	
	Type 16	Type 12
FYA	Mode B	Mode A
FYAC	Mode F	Mode C

### 1.2.5 RMS VOLTAGE REPORTING

Input voltages are measured using a true Root Mean Squared (RMS) technique. A dedicated Digital Signal Processor (DSP) RMS-Engine controls the analog to digital (A/D) hardware which samples each AC input voltage a minimum of 32 times per cycle. The RMS-Engine then calculates the true RMS voltage value producing accurate results which are very insensitive to changes in frequency, phase, wave shape, and distortion.

### 1.2.6 ECCOM SOFTWARE INTERFACE

The field proven EDI *ECom* Signal Monitor Communications software provides a laptop computer or system interface to all information contained in the monitor. This



includes detailed status, voltages, configuration, as well as historical event logs, and five thirty second Signal Sequence logs.

Event logs provide a historical record of previous fault data, ac line event data, monitor reset events, and configuration programming change events. These logs are invaluable when analyzing fault data to diagnose cabinet equipment malfunctions.

The Signal Sequence logs provide a graphical display of the signal states of all sixteen channels for up to thirty seconds prior to the fault trigger point at 50 millisecond resolution. The MMU2-16LE *SmartMonitor*® stores these signal records for the last five fault events.

The EDI *ECcom* software (**Version 3.8.0 or greater is required**) is available at no charge from the EDI web site at [www.EDITraffic.com](http://www.EDITraffic.com).

### 1.2.7 NEMA TS-1 OPERATION WITH SDLC MODE

The MMU2-16LE *SmartMonitor*® can operate in a NEMA TS-1 configured cabinet with the full advantages of the Port 1 SDLC communications to the Controller Unit including Field Check monitoring and the Diagnostic Wizard. In this mode the MMU2-16LE *SmartMonitor*® channel displays operate in the twelve channel configuration displaying the Walk input status directly on the associated vehicle channels. Certain programming requirements exist but typically no cabinet wiring modifications are necessary. See Section 1.4.2.1.

### 1.2.8 FLASHING YELLOW ARROW (FYA) PROTECTED-PERMISSIVE MOVEMENT

The MMU2-16LE *SmartMonitor*® is designed to monitor an intersection with up to four approaches using the four section Flashing Yellow Arrow (FYA) movement outlined by the NCHRP Research Project 3-54 on Protected/Permissive signal displays with Flashing Yellow Arrows.

Twelve cabinet configurations are supported for the MMU2 Type 16 operation and four configurations for the MMU2 Type 12 operation depending on the number of load switches provided and the capabilities of the Controller Unit. In all modes the MMU2-16LE *SmartMonitor*® has been designed to provide the same broad fault coverage for the FYA approaches as it does for conventional protected left turn phases including Conflict, Red Fail, Dual Indication, and both Minimum Yellow and Minimum Yellow Plus Red Clearance monitoring. See section 3.11 for programming information.

## 1.3 GENERAL

The MMU2-16LE *SmartMonitor*® is normally configured as a 16 channel (Type 16) monitor when operated in a TS2 type cabinet assembly. The Type 16 MMU mode is intended for those applications in which there are three circuits per channel and the MMU channels have been wired in a one-to-one correspondence with the load switches, as defined in Section 5.5.3 paragraph 9 of the ***NEMA Standards Publication TS2-2003 (R2008) v02.06***. Each channel has the capability of monitoring a Green (Walk), a Yellow, and a Red (Don't Walk) field signal output at the Terminals and Facilities field terminals.

The MMU2-16LE *SmartMonitor*® can also be configured as a 12 channel (Type 12) monitor when operated in a NEMA TS1 type cabinet assembly. The Type 12 MMU mode is intended to provide downward compatibility with 12 channel Conflict Monitor Units (CMU) conforming to NEMA Traffic Control Systems Publication TS1-1989. Each channel has the capability of monitoring a Green, a Yellow, a Red, and a Walk field signal output at the Terminals and Facilities field terminals.

A Program Card is provided for assigning permissive channels. The MMU2-16LE *SmartMonitor*® detects the presence of conflicting Green or Yellow ( or Walk) field

signal inputs between any two or more channels not assigned to be permissive on the Program Card. The RED ENABLE input, when activated, enables the Red Fail Monitoring functions of the unit causing the monitor to trigger when it detects the absence of voltage on all three (four) of the field signal inputs of a channel. It also enables the Minimum Yellow Change/Red Clearance Monitoring function which verifies that the Yellow Change plus Red Clearance interval between the end of an active Green signal and the beginning of the next conflicting Green signal is proper. The monitoring circuitry is capable of detecting either full wave or positive and negative half-wave sinusoidal field signal inputs at the specified voltage levels.

When triggered by the detection of a fault condition which exists longer than the minimum period defined by the **NEMA Standards Publication TS2-2003 (R2008) v02.06**, the MMU2-16LE *SmartMonitor*® will enter the fault mode causing the OUTPUT relay to de-energize and two sets of contacts on the OUTPUT relay to transfer. The cabinet assembly should be wired such that the closure of the OUTPUT relay contacts will cause an automatic switching of the field signal outputs from normal operation to flashing operation. The MMU2-16LE *SmartMonitor*® will then display the appropriate fault status. The loss of AC LINE will not reset the fault mode of the OUTPUT relay contacts. In the event of AC LINE loss the MMU2-16LE *SmartMonitor*® will retain the status of all fault and channel indicators and will display the correct fault and channel status upon restoration of AC LINE.

When operating in the Type 16 mode and connected to a TS2 Controller Unit, the MMU2-16LE *SmartMonitor*® has the ability to exchange information in a standardized format with the Controller Unit in real time using Port 1. Messages are defined in the TS2 Standard which allows the Controller Unit and the MMU2-16LE *SmartMonitor*® to perform redundant checks on each other. The Controller Unit has access to all MMU2-16LE *SmartMonitor*® information including field signal input status, permissive programming, and fault status. This gives the Controller Unit the capability to provide a backup monitoring function and make enhanced event logging, remote intersection monitoring, and remote diagnostics feasible. Similarly, the MMU2-16LE *SmartMonitor*® receives information from the Controller Unit which corresponds to the Controller Unit output commands to the load switches. This allows the MMU2-16LE *SmartMonitor*® to better respond to and diagnose fault situations.

The TS2 Standard also provides for messages to be generated by the Controller Unit and the MMU2-16LE *SmartMonitor*® which extend the communications capabilities of a standard assembly. The Eberle Design MMU2-16LE *SmartMonitor*® uses these message facilities to provide enhanced application specific diagnostic reporting and monitoring.

#### 1.4 FIELD SIGNAL TERMINALS

A GREEN, YELLOW, or WALK field signal input will be sensed as active by the MMU2-16LE *SmartMonitor*® when it exceeds the Green, Yellow, or Walk Signal Detect voltage threshold (Section 8.1.2) and a field signal input will be sensed as inactive when it is less than the Green, Yellow, or Walk Signal No-Detect voltage threshold (Section 8.1.2). Both positive and negative half wave rectified inputs will be sensed.

A RED (DON'T WALK) field signal input will be sensed as active by the MMU2-16LE when it exceeds the Red Signal Detect voltage threshold (Section 8.1.2) and a field signal input will be sensed as inactive when it is less than the Red Signal No-Detect voltage threshold (Section 8.1.2). Both positive and negative half wave rectified inputs will be sensed.

**NOTE:** When the circuit connected to the sensing input of an MMU exhibits high impedance characteristics such as caused by dimmers, burned out lamps, low wattage equipment, or no load, it may be necessary to place a low impedance device external

to the unit between the MMU input and AC NEUTRAL (See Sections 5.5.3.9 and 6.2.4 of **NEMA Standards Publication TS2-2003 (R2008) v02.06**).

#### 1.4.1 LEDGUARD® LED FIELD SIGNAL SENSING

The Eberle Design MMU2-16LE *SmartMonitor*® can be configured to use a technique called *LEDguard*® that is designed to better monitor the characteristics of LED based signal loads (See Section 6.3.4.7). Each field signal input is measured and compared to both a high threshold and a low threshold value to determine On / Off status. This differs from conventional standard NEMA operation where the active threshold is picked according to the color of the field signal. Once the high and low On / Off thresholds (Section 8.1.2) have been determined using the input RMS voltage, the individual fault monitor functions use the appropriate threshold to determine if a fault condition exists.

<b>LEDguard®</b>	<b>Green/Walk</b>	<b>Yellow</b>	<b>Red/Don't Walk</b>
<b>Conflict</b>	Low	Low	---
<b>Red Fail</b>	High	High	High
<b>Dual Indication</b>	Low	Low	Low
<b>Clearance</b>	Low	Low	High

#### 1.4.2 TYPE SELECT INPUT

The MMU2-16LE *SmartMonitor*® will operate as a Type 16 monitor with sixteen channels when the TYPE SELECT input is a logic True (low). The MMU2-16LE *SmartMonitor*® will operate as a Type 12 monitor with twelve channels when the TYPE SELECT input is a logic False (high) or open circuit.

Type 16 - Each channel has three inputs: RED (DON'T WALK), YELLOW, and GREEN (WALK).

Type 12 - Each channel has four inputs: RED, YELLOW, GREEN, and WALK.

The MMU2-16LE *SmartMonitor*® is normally configured as a 16 channel (Type 16) monitor when operated in a TS2 type cabinet assembly. The Type 12 mode is intended to provide downward compatibility with 12 channel Conflict Monitor Units (CMU) conforming to NEMA Traffic Control Systems Publication TS1-1989. When operating in the Type 12 mode, the MMU2-16LE *SmartMonitor*® monitoring functions are the same as the Type 16 mode except that Port 1 communications are disabled and Field Check Monitoring is disabled. See also TYPE 12 MODE WITH SDLC Option, section 1.4.2.1.

##### 1.4.2.1 TYPE 12 WITH SDLC MODE

The MMU2-16LE *SmartMonitor*® can operate in a NEMA TS-1 configured cabinet with the full advantages of the Port 1 SDLC communications to the Controller Unit including Field Check monitoring. In this mode the MMU2-16LE *SmartMonitor*® channel displays operate in the Type 12 configuration displaying the Walk input status directly on the associated vehicle channels (2, 4, 6, and 8). Certain requirements exist for this mode to operate correctly:

1. This mode is limited to a maximum of four Ped phases which must be assigned to vehicle phases 2, 4, 6, and 8. The Walk field terminals must be wired to the MMU2-16LE *SmartMonitor*® channel inputs 2W, 4W, 6W, and 8W on MMU connector pins MSA-y, MSA-FF, MSA-EE, and MSA-u respectively. This is conventional wiring for a standard NEMA TS-1 cabinet. MMU input TYPE SELECT (pin #HH) must be "open circuit" (False).
2. The Controller Unit (CU) must be TS-2 Type 2 capable and provide the Port 1 EIA-485 communications port. The Controller Unit must be configured for

MMU operation in the following areas (terminology and procedure may vary with different brands of CU):

- a. Enable the MMU in the CU Port 1 setup.
- b. Add the Ped channels to the CU ring structure with the following assignments:

Ped Phase	MMU Channel
Phase 2 Ped	13
Phase 4 Ped	14
Phase 6 Ped	15
Phase 8 Ped	16

- c. The CU Signal Driver Output mapping may need to be modified to ensure that the CU is still driving the Ped load switches from the correct output pins: MSA-J (2W), MSB-d (4W), MSC-LL (6W), and MSC-d (8W).
3. TS-2 Controller Units provide an MMU utilization diagnostic that verifies the MMU Program Card channel compatibility to the CU Driver Group Utilization (NEMA TS-2 clause 3.9.3.1.3). Depending on the CU capabilities, jumpers may need to be added to the MMU2-16LE *SmartMonitor*<sup>®</sup> Program Card permissive matrix as if the Walk inputs were actually assigned to MMU channels 13 (2P), 14 (4P), 15 (6P), and 16 (8P).

Note that the MMU2-16LE *SmartMonitor*<sup>®</sup> will only use the channel 2, 4, 6, and 8 jumper programming for actual conflict detection. Program Card jumpers added to channels 13, 14, 15, and 16 in the Type 12 With SDLC mode are only used by the MMU2-16LE *SmartMonitor*<sup>®</sup> to satisfy the utilization diagnostic of the controller unit described above.

4. A proper Port 1 EIA-485 rated cable must be connected between the CU Port 1 and the MMU2-16LE *SmartMonitor*<sup>®</sup> Port 1.

See Section 6.3.4.9 for the Type 12 with SDLC option setting.

#### **1.4.2.2 FORCE TYPE 16 MODE**

If the cabinet is already wired for 16 channel operation but the TYPE SELECT input is not accessible due to cabinet wiring issues, the MMU2-16LE *SmartMonitor*<sup>®</sup> can be forced to the Type 16 mode by setting the FORCE TYPE 16 option in Unit Options. See Section 6.3.4.8. The FORCE TYPE 16 mode is not compatible with the TYPE 12 WITH SDLC mode (section 1.4.2.1).

## Section 2 Standard Functions

### 2.1 CONFLICT MONITORING

When voltages on any conflicting channels are sensed as active for more than the Conflict Fault time (Section 9), the MMU2-16LE *SmartMonitor*® will enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and display the CONFLICT status screen. The MMU2-16LE *SmartMonitor*® will remain in the fault mode until the unit is reset by the RESET button or the EXTERNAL RESET input. When voltages on any conflicting channels are sensed as active for less than the Conflict No-Fault time, the MMU2-16LE *SmartMonitor*® will not transfer the OUTPUT relay contacts to the Fault position.

The MMU2-16LE *SmartMonitor*® is fully programmable and requires the use of soldered wire jumpers on an interchangeable Programming Card to define permissive channel pairs. The Programming Card is used with both Type 16 and Type 12 operation. See Section 6.2.1 for Programming Card details.

### 2.2 RED FAIL MONITORING

When voltages on all inputs (G, Y, R, (W)) to a channel are sensed as inactive for more than the Red Fail Fault time (Section 9), the MMU2-16LE *SmartMonitor*® will enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and display the RED FAIL status screen. The MMU2-16LE *SmartMonitor*® will remain in the fault mode until the unit is reset by the RESET button or the EXTERNAL RESET input. When voltages on all inputs to a channel are sensed as inactive for less than the Red Fail No-Fault time, the MMU2-16LE *SmartMonitor*® will not transfer the OUTPUT relay contacts to the Fault position.

Red Fail Monitoring will be disabled when the RED ENABLE input is not active. In the Type 16 mode, Red Fail Monitoring will also be disabled if the LOAD SWITCH FLASH bit is set to "1" in the Type 0 message from the Controller Unit.

Programming is provided in the SET / VIEW CONFIG menu item to enable Red Fail Monitoring on a per channel basis. See Section 6.3.3 for the programming procedure.

#### 2.2.1 RED ENABLE INPUT

The RED ENABLE input will be sensed as active by the MMU2-16LE *SmartMonitor*® when it exceeds the Red Enable Input threshold (Section 8.1.2). The presence of the proper operating voltage at this input enables Red Fail Monitoring, Minimum Yellow Change/Red Clearance Monitoring, and Dual Indication Monitoring. In the Type 16 mode, if the LOAD SWITCH FLASH bit is set to "1" in the Type 0 message from the Controller Unit, Red Fail Monitoring will be disabled.

The main status screen will display "RED ENABLE IS OFF" if the RED ENABLE input is not active. In the Type 16 mode, if the LOAD SWITCH FLASH bit is set to "1" in the Type 0 message from the Controller Unit, the main status screen will display "CU LS-FLASH IS SET".

#### 2.2.2 WALK DISABLE OPTION

This option will modify the operation of Red Fail and Dual Indication Monitoring in the TS-1 Type 12 mode only. When enabled, the Red Fail and Dual Indication Monitoring function will not monitor the Walk field outputs. Absence of signals on the Green, Yellow, and Red field outputs of a channel will place the MMU2-16LE *SmartMonitor*® into the Red Fail fault mode causing the Output relay contacts to transfer. Presence of

active signals on the Walk outputs will not cause a Dual Indication when concurrent with active Red or Yellow signals. This function is enabled by the Unit Option called "WALK DISABLE" in the SET / VIEW CONFIG menu. See Section 6.3.4.2.

## **2.3 VOLTAGE MONITORING**

### **2.3.1 +24VDC SUPPLY MONITORING**

The +24V MONITOR I and +24V MONITOR II inputs are provided for monitoring two +24Vdc supplies in the cabinet assembly. Should loss of proper voltage occur at either of these inputs, the MMU2-16LE *SmartMonitor*® will enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and display the appropriate 24V-1 or 24V-2 status screen. The MMU2-16LE *SmartMonitor*® will automatically reset the OUTPUT relay when the correct input voltages are restored to both of these inputs. The MMU2-16LE *SmartMonitor*® will remain in the fault mode for at least the time determined by the Minimum Flash programming.

A voltage greater than the +24V Monitor input threshold (Section 8.1.4) applied to both of the +24V MONITOR inputs will be sensed by the MMU2-16LE *SmartMonitor*® as adequate for operation of the cabinet assembly. A voltage less than the +24V Monitor input threshold applied to either of the +24V MONITOR inputs will be sensed as inadequate for proper operation. When a +24V MONITOR input is sensed as inadequate for more than the +24V Monitor Fault time (Section 9), the MMU2-16LE *SmartMonitor*® will enter the fault mode and transfer the OUTPUT relay contacts to the Fault position. When a +24V MONITOR input is sensed as inadequate for less than the +24V Monitor No-Fault time, the MMU2-16LE *SmartMonitor*® will not transfer the OUTPUT relay contacts to the Fault position. A +24Vdc failure during the programmed Minimum Flash time or during an MMU Power Failure will not cause a fault condition.

#### **2.3.1.1 +24VDC MONITOR INHIBIT INPUT**

A +24V MONITOR INHIBIT input is provided to inhibit the operation of the +24Vdc Monitor. Application of a logic TRUE (low) state to this input will disable the operation of the +24Vdc Monitor.

#### **2.3.1.2 +24VDC MONITOR LATCH INPUT**

A jumper position is supplied on the Programming Card to allow +24Vdc failures to latch in the fault condition until the unit is reset by the activation of the RESET button or the EXTERNAL RESET input. See Section 6.2.4 for the programming procedure. A +24Vdc failure during the programmed Minimum Flash time or during an MMU Power Failure will not cause a latched fault condition.

#### **2.3.1.3 +24VDC MONITOR II 12VDC MODE**

The MMU2-16LE *SmartMonitor*® offers the capability of setting the threshold for the +24V MONITOR II input to levels suitable for monitoring a 12 Vdc power supply. This mode is enabled by the Unit Option called "24V-2 = 12 Vdc" in the SET / VIEW CONFIG menu. See Section 6.3.4.5.

### **2.3.2 CONTROLLER VOLTAGE / FAULT MONITOR INPUT**

This input is to be connected to the CONTROLLER UNIT VOLTAGE MONITOR (CVM) or FAULT MONITOR (FM) output from the Controller Unit. When the TRUE (low) state is absent for more than the CVM Fault time (Section 9), the MMU2-16LE *SmartMonitor*® will enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and display the CVM status screen. When the TRUE (low) state is absent for less than the CVM No-Fault time, the MMU2-16LE *SmartMonitor*® will not transfer the OUTPUT relay contacts to the Fault position. The MMU2-16LE *SmartMonitor*® will automatically reset the OUTPUT relay when the True (low) state is

restored to the input. The MMU2-16LE *SmartMonitor*<sup>®</sup> will remain in the fault mode for at least the time determined by the Minimum Flash programming. A CVM failure during the programmed Minimum Flash time or during an MMU Power Failure will not cause a fault condition.

### **2.3.2.1 CVM MONITOR LATCH INPUT**

A jumper position is supplied on the Programming Card to allow CVM failures to latch in the fault condition until the unit is reset by the activation of the RESET button or the EXTERNAL RESET input. See Section 6.2.4 for the programming procedure. A CVM failure during the programmed Minimum Flash time or during an MMU Power Failure will not cause a latched fault condition.

### **2.3.2.2 CVM LOG DISABLE**

If CVM events are not related to a malfunction condition and occur on a regular basis such as Time of Day flash, the logging of these events can be disabled. See Section 6.3.4.3.

### **2.3.3 VM MONITOR 3X/DAY LATCH**

The non-latched operation of the Voltage Monitor (CVM, 24V-I, and 24V-II) function can be configured such that after the third CVM, 24V-I, or 24V-II fault in a calendar day, the MMU2-16LE *SmartMonitor*<sup>®</sup> will remain in the fault mode until the unit is reset by the RESET button or the EXTERNAL RESET input. Loss of AC Line after the third CVM, 24V-I, or 24V-II fault will exit the fault state and reset the Voltage Monitor fail count to two. See Section 6.3.4.10.

Note that installing the Program Card jumpers to enable the CVM Monitor Latch or the 24V Monitor Latch (Section 6.2.4) will force the latch state regardless of the VM Monitor 3x/Day Latch mode setting.

## **2.4 LOCAL FLASH STATUS INPUT**

This input is to be connected to the Auto/Flash switch in the cabinet. When the TRUE (low) state is present for more than the Local Flash Fault time (Section 9), the MMU2-16LE *SmartMonitor*<sup>®</sup> will enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and display the LOCAL FLASH status screen. When the TRUE (low) state is present for less than the Local Flash No-Fault time, the MMU2-16LE *SmartMonitor*<sup>®</sup> will not transfer the OUTPUT relay contacts to the Fault position. The MMU2-16LE *SmartMonitor*<sup>®</sup> will automatically reset the OUTPUT relay when the False (high) state is restored to the input. The MMU2-16LE *SmartMonitor*<sup>®</sup> will remain in the fault mode for at least the time determined by the Minimum Flash programming. A Local Flash condition during the Minimum Flash time or during an MMU Power Failure will not cause a fault condition.

## **2.5 MINIMUM YELLOW CHANGE / RED CLEARANCE MONITORING**

### **2.5.1 MINIMUM YELLOW CHANGE INTERVAL**

The MMU2-16LE *SmartMonitor*<sup>®</sup> will verify that the Yellow Change interval is at least the Clearance Fail Fault time (Section 9). The Yellow Change interval consists of the duration of time in which the Yellow field signal input is active in a sequence from Green to Yellow to Red. When this minimum interval is not satisfied the MMU2-16LE *SmartMonitor*<sup>®</sup> will enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and display the SKIPPED Y CLEARANCE or SHORT Y CLEARANCE status screen. The MMU2-16LE *SmartMonitor*<sup>®</sup> will remain in the fault mode until the unit is reset by the RESET button or the EXTERNAL RESET input.

Minimum Yellow Change Monitoring will be disabled when the RED ENABLE input is not active.

#### 2.5.1.1 MINIMUM YELLOW CLEARANCE DISABLE

A set of soldered wire jumpers is provided on the Programming Card to disable Minimum Yellow Change Monitoring on a per channel basis. See Section 6.2.3 for the programming procedure.

#### 2.5.1.2 MINIMUM YELLOW PLUS RED INTERVAL

The MMU2-16LE *SmartMonitor*® will verify that the Yellow Change plus Red Clearance interval between the end of an active Green (or Walk) signal and the beginning of the next conflicting Green (or Walk) signal is at least the Clearance Fail Fault time (Section 9). This ensures a minimum clearance interval for channels without a true yellow signal such as pedestrian channels. When this minimum interval is not satisfied the MMU2-16LE *SmartMonitor*® will enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and display the SHORT Y+R CLEARANCE status screen. The MMU2-16LE *SmartMonitor*® will remain in the fault mode until the unit is reset by the RESET button or the EXTERNAL RESET input.

Yellow Change plus Red Clearance Monitoring will be disabled when the RED ENABLE input is not active.

#### 2.5.1.3 MINIMUM YELLOW PLUS RED CLEARANCE DISABLE

The Red + Yellow Clearance Disable Configuration screen is provided in the SET / VIEW CONFIG menu to disable Minimum Yellow Plus Red Change Monitoring on a per channel basis. Provision to disable this function is not provided for in the **NEMA Standards Publication TS2-2003 (R2008) v02.06**.

The **MUTCD Section 4D.10 Yellow Change and Red Clearance Intervals** requirement states, "A yellow signal indication shall be displayed following every CIRCULAR GREEN or GREEN ARROW signal indication". In some legacy intersection cases this requirement is not met due to the lack of a Yellow signal head on an overlap phase (channel), and signal timing that precludes what would normally be the overlap clearance interval. In this case the Minimum Yellow Plus Red Clearance monitoring function can be disabled for that channel. It should be noted that the Minimum Yellow Plus Red Clearance monitoring function is only intended to be disabled under these special conditions.

See Section 6.3.7 for the programming procedure. The default setting for Minimum Yellow Plus Red Clearance monitoring is Enabled.

### 2.6 MMU POWER FAILURE DETECTION

When the AC LINE voltage is below the minimum AC Line drop-out level (Section 8.1.3) for the MMU Power Fail Respond time (Section 9), the MMU2-16LE *SmartMonitor*® will suspend all fault monitoring functions, de-energize the OUTPUT relay, and de-energize the START relay. The POWER indicator on the front panel will flash at a rate of 2Hz to indicate the low voltage status. The main status display will indicate "AC LINE BROWNOUT" and display the current AC Line input voltage.

When the AC LINE voltage returns above the maximum AC Line restore level (Section 8.1.3) for the MMU Power Fail Restore time (Section 9), the monitor will resume normal operation and the POWER indicator on the front panel will remain illuminated. After a  $2.0 \pm 0.5$  second delay the START relay will be energized. After a programmable delay determined by the Minimum Flash programming, the OUTPUT relay will be energized (see Section 6.2.2).



This expanded operating voltage range for cabinet components allows the MMU2-16LE *SmartMonitor*® to place the intersection into flash and return to normal operation in an orderly manner when the AC LINE voltage is sufficient for proper operation. The MMU2-16LE *SmartMonitor*® should be the first component in the cabinet to sense a low voltage condition and the last component to sense a proper AC LINE operating voltage.

The AC LINE and AC NEUTRAL inputs are used to generate the internal voltage supplies required to operate the monitor. AC NEUTRAL also serves as the return for all AC signals including RED ENABLE. EARTH GROUND provides an independent connection to the chassis of the unit and is isolated from AC NEUTRAL and LOGIC GROUND. LOGIC GROUND is provided for inputs which are isolated from AC NEUTRAL (i.e. +24V Monitors, CVM, CONTROLLER WATCHDOG, EXTERNAL RESET, and 24V MONITOR INHIBIT). LOGIC GROUND may be tied to AC NEUTRAL if desired.

## 2.7 PORT 1 COMMUNICATIONS

When operating in the Type 16 mode and connected to a TS2 Controller Unit, the MMU2-16LE *SmartMonitor*® has the ability to exchange information in a standardized format with the Controller Unit using Port 1. For details on message formats refer to Section 3.3.1, ***NEMA Standards Publication TS2-2003 (R2008) v02.06***.

The information transmitted from the Controller Unit to the MMU2-16LE *SmartMonitor*® consists of the following message types: load switch driver commands (Type 0), time and date (Type 9). The information transmitted from the MMU2-16LE *SmartMonitor*® to the Controller Unit consists of the following message types: field signal status and fault status (Type 129), channel compatibility programming (Type 131). The load switch driver command (Type 0) and field signal status (Type 129) messages are exchanged approximately every 100 msec.

The electrical interface used for Port 1 conforms to the requirements of the Electronic Industries Association EIA-485 Standard. It is designed for balanced digital multipoint bus systems and provides fully differential signal operation. The baud rate used is 153.6K bit per second. The Port 1 connector intermates with a 15 pin D type connector, AMP Incorporated part number 205206-1 or equivalent. The Port 1 connector pin assignments are shown in Section 10.5.

The data and clock communications protocol used for Port 1 is a subset of the Synchronous Data Link Control (SDLC) Protocol, as defined by ***International Business Machines Corporation Document GA27-3093-3 (June 1986)***. This protocol utilizes sophisticated error checking computations to verify message integrity. In addition, the Eberle Design MMU2-16LE *SmartMonitor*® adds enhanced communications diagnostics and error handling capabilities to ensure proper communications occur.

### 2.7.1 PORT 1 TIMEOUT

When a Type 0 message from the Controller Unit has not been correctly received for the Port 1 Timeout Fault time (Section 9), the MMU2-16LE *SmartMonitor*® will enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and display the PORT 1 FAIL status screen. When receipt of a Type 0 message again occurs, the MMU2-16LE *SmartMonitor*® will exit the fault state and transfer the OUTPUT relay contacts to the normal position, except when three Port 1 faults have occurred in a calendar day.

After the third Port 1 fault in a calendar day, the MMU2-16LE *SmartMonitor*® will remain in the fault mode until the unit is reset by the RESET button or the EXTERNAL RESET

input. Loss of AC Line after the third Port 1 fault will exit the fault state and reset the Port 1 fail count to 2.

A PORT 1 timeout failure during the programmed Minimum Flash time or during an MMU Power Failure will not cause a latched fault condition.

### 2.7.2 PORT 1 DISABLE INPUT

Port 1 communications will be disabled when the PORT 1 DISABLE input is at a logic True (low) state OR the TYPE SELECT input is at a logic False (high) state (Type 12 mode). Port 1 communications will be enabled when the PORT 1 DISABLE input is at a logic False (high) state AND the TYPE SELECT input is True (low) (Type 16 mode).

### 2.8 TYPE 129 RESPONSE FRAME

Five bits designated as Spare Bit #1 through Spare bit #5 of the Type 129 response frame to the Controller Unit are used by the MMU2-16LE *SmartMonitor*<sup>®</sup> to indicate the type of failure detected for enhanced fault monitoring capabilities of the MMU2-16LE. Refer to sections 3.9, 3.2, 3.7, 3.2.1, and 2.5.1.2 of this manual for further information.

Fault Type	Bit #	NEMA Designation
Field Check Fault/Status	67	Spare Bit #1
Dual Indication Fault	68	Spare Bit #2
RP Detection Status	69	Spare Bit #3
External Watchdog Fault	70	Spare Bit #4
Yellow Plus Red Clearance	71	Spare Bit #5

### 2.9 OUTPUT RELAY RECOVERY

Prior to the MMU2-16LE *SmartMonitor*<sup>®</sup> transferring the Output Relay contacts from the fault state to the no-fault state, a transition state with duration of 500 milliseconds will occur. During the transition state the Output Relay will remain in the fault state and the Start-up Flash Call bit in the Type 129 frame will be set to 1.

### 2.10 INTERNAL DIAGNOSTICS

The MMU2-16LE *SmartMonitor*<sup>®</sup> is supplied with a resident series of self check diagnostic capabilities which monitor for correct operation of the MMU2-16LE *SmartMonitor*<sup>®</sup> both at power-up and continuously during operation. Should an internal diagnostic error occur, other fault indicators that may be concurrently displayed with the DIAGNOSTIC indicator may not be valid due to the nature of these hardware and/or firmware failures.

#### 2.10.1 MEMORY DIAGNOSTICS

On power-up, the MMU2-16LE *SmartMonitor*<sup>®</sup> verifies the operation of all memory components including RAM, EPROM, and non-volatile EEPROM. During operation the MMU2-16LE *SmartMonitor*<sup>®</sup> continuously performs a check sum verification of the non-volatile memory components. When either diagnostic test fails, the MMU2-16LE *SmartMonitor*<sup>®</sup> will enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and illuminate the DIAGNOSTIC indicator. An MMU Power Failure will reset the Diagnostic fault state of the monitor (see Section 2.6). Due to the nature of these hardware/firmware failures, other fault indicators that may be concurrently displayed with the DIAGNOSTIC indicator may not be valid.

## **2.10.2 MICROPROCESSOR MONITOR**

The MMU2-16LE *SmartMonitor*® contains circuitry which monitors the operation of the internal microprocessor. This monitoring circuit receives a logic transition signal from the microprocessor every 5 msec. When this logic transition is not received for 300 msec, the MMU2-16LE *SmartMonitor*® will enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and illuminate the DIAGNOSTIC indicator. Due to the nature of these hardware/firmware failures, other fault indicators that may be concurrently displayed with the DIAGNOSTIC indicator may not be valid.

This type of failure is configured as latching. If the microprocessor resumes operation the unit will not return to normal operation. With latching operation, only a loss of AC Line will restore operation. If non-latching operation is desired, internal jumper E1 (Latching MPU Fault) may be removed.

## **2.10.3 INTERNAL HARDWARE MONITOR**

The MMU2-16LE *SmartMonitor*® contains circuitry which verifies the operation of the many sections of the internal circuitry. Should a malfunction be detected, the MMU2-16LE *SmartMonitor*® will enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and illuminate the DIAGNOSTIC indicator. An MMU Power Failure will reset the Diagnostic fault state of the monitor (see Section 2.6). Due to the nature of this hardware failure, other fault indicators that may be concurrently displayed with the DIAGNOSTIC indicator may not be valid.

## Section 3

### Enhanced Features

The following enhanced features are provided on the Eberle Design MMU2-16LE *SmartMonitor*® for additional monitoring functions and to increase the reliability of the MMU2-16LE *SmartMonitor*® monitor operation.

#### 3.1 HARDWARE FEATURES

The MMU2-16LE *SmartMonitor*® is a dual microprocessor based unit. All monitoring functions and features are firmware programmable which permits upgrades or modifications by simply reprogramming the Flash memory device containing the firmware with the upgraded version. Thus, most changes to the MMU2-16LE *SmartMonitor*® specifications may be accommodated without modifying the hardware.

Since all critical timing functions are accomplished by the microprocessor, the quartz crystal based accuracy results in very precise and repeatable measurements. This accuracy is maintained on functions from timing fault conditions to implementing a unique firmware based digital sampling and filtering algorithm. This algorithm is applied to all AC field signals to help eliminate false detection in a "noisy" AC line environment.

Input voltages are measured using a true Root Mean Squared (RMS) technique. A dedicated microcontroller RMS-Engine controls the analog to digital (A/D) hardware that samples each AC input voltage at least 32 times per cycle. The RMS-Engine then calculates the true RMS voltage value, producing accurate results which are very insensitive to changes in frequency, phase, wave shape, and distortion. Voltage references are temperature compensated for constant voltage levels within the operating temperature range.

A nonvolatile EEPROM device is utilized to retain fault status information and event logs through an AC Line power interruption. The correct fault indications will be displayed upon restoration of AC Line power. This EEPROM device requires no battery back-up. The time of day in the MMU2-16LE *SmartMonitor*® is stored in a battery-backed real time clock circuit. Should this battery fail, only current time of day and date information will be lost. No monitor configuration programming is stored under battery power.

#### 3.2 DUAL INDICATION MONITORING

In Type 16 mode this monitoring function detects simultaneous input combinations of active Green (Walk), Yellow, or Red (Don't Walk) field signal inputs on the same channel. In Type 12 mode this monitoring function detects simultaneous input combinations of active Green and Yellow, Green and Red, Yellow and Red, Walk and Yellow, or Walk and Red field signal inputs on the same channel. When voltages on any two inputs of a channel are sensed as active for more than the Dual Indication Fault time (Section 9), the MMU2-16LE *SmartMonitor*® will enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and display the DUAL INDICATION status screen. When operating in the Type 16 mode with Port 1 communications enabled, Bit #68 (Spare Bit #2) of the Type #129 response frame will be set to indicate a Dual Indication fault has been detected. The MMU2-16LE *SmartMonitor*® will remain in the fault mode until the unit is reset by the RESET button or the EXTERNAL RESET input. When voltages on any two inputs of a channel are sensed as active for less than the Dual Indication Fault time, the MMU2-16LE *SmartMonitor*® will not transfer the OUTPUT relay contacts to the Fault position.

Dual Indication Monitoring may anticipate and prevent a possible conflicting signal display in the intersection in the event that a proceed signal on the current phase hangs up and is constantly detected as active. An open or no load condition (i.e., burned-out bulb) may be also detected as an active signal depending on the output impedance characteristics of the load switch (i.e. load switch leakage current), and may cause a Dual Indication Fault.

Programming for Dual Indication is provided in the SET / VIEW CONFIG menu item to enable Dual Indication Monitoring on a per channel basis. See Section 6.3.2 for the programming procedure.

Dual Indication Monitoring will be disabled when the RED ENABLE input is not active.

### 3.2.1 WALK DISABLE OPTION

This option will modify the operation of Red Fail and Dual Indication Monitoring in the TS-1 Type 12 mode only. When enabled, the Red Fail and Dual Indication Monitoring function will not monitor the Walk field outputs. Absence of signals on the Green, Yellow, and Red field outputs of a channel will place the MMU2-16LE *SmartMonitor*® into the Red Fail fault mode causing the Output relay contacts to transfer. Presence of active signals on the Walk outputs will not cause a Dual Indication when concurrent with active Red or Yellow signals. This function is enabled by the Unit Option called "WALK DISABLE" in the SET / VIEW CONFIG menu. See Section 6.3.4.2.

### 3.3 EXTERNAL WATCHDOG MONITORING

This function monitors an optional external watchdog output from a Controller Unit or other external cabinet circuitry. The external source should toggle the EXTERNAL WATCHDOG input logic state once every 100 msec. If the MMU2-16LE *SmartMonitor*® does not receive a change in state on the EXTERNAL WATCHDOG input for the External Watchdog Fault time (Section 9), the MMU2-16LE *SmartMonitor*® will enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and display the EXT WATCHDOG status screen. When operating in the Type 16 mode with Port 1 communications enabled, Bit #70 (Spare Bit #4) of the Type #129 response frame will be set to indicate an External Watchdog fault has been detected. The MMU2-16LE *SmartMonitor*® will remain in the fault mode until the unit is reset by the RESET button or the EXTERNAL RESET input. An MMU Power Failure will also reset the External Watchdog fault state of the monitor (see Section 2.6).

This function is enabled by a UNIT Option called EXTERN WATCHDOG in the SET / VIEW CONFIG menu (see Section 6.3.4.4). The EXTERNAL WATCHDOG input is harnessed to spare pin MSB-S on the front panel B connector by the factory.

### 3.4 PROGRAM CARD ABSENT INDICATION

If the Program Card is absent or not seated properly in the edge connector, the MMU2-16LE *SmartMonitor*® will enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and display the PGM CARD AJAR status screen. The MMU2-16LE *SmartMonitor*® will remain in the fault mode until the Program Card is correctly seated and the MMU2-16LE *SmartMonitor*® is reset by the RESET button or the EXTERNAL RESET input.

### 3.5 RESET INPUT DETECTION

Activation of the front panel RESET button or the EXTERNAL RESET input will reset the MMU2-16LE *SmartMonitor*® from the fault mode and cause the START relay to energize and the OUTPUT relay to transfer to the no-fault state. Each activation of the RESET button or EXTERNAL RESET input will cause a one-time reset input to the unit.

A continuously activated RESET input will not prevent the MMU2-16LE *SmartMonitor*® from monitoring any fault condition and/or transferring the OUTPUT relay contacts to the fault position. This function prevents the Cabinet Assembly from being operated with the monitor unit disabled due to a faulty RESET button or EXTERNAL RESET input.

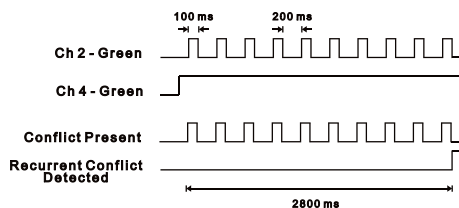
### 3.6 DISPLAY LED TEST

The monitor will illuminate all front panel LED and LCD indicators for 500ms when a Reset command is issued by the front panel RESET button or EXTERNAL RESET input. This function provides a means to check the operation of all front panel indicators.

### 3.7 RECURRENT PULSE DETECTION

This error detection function supplements the normal Conflict, Dual Indication, and Red Fail monitoring algorithms for sensing faults which are intermittent or pulsing in nature. The RMS-Engine is designed to filter out short term transients commonly found on the electrical service and provide noise immunity against false signal detections. The Recurrent Pulse detection function is designed to respond to fault conditions which are intermittent in nature and do not meet the continuous timing requirements of the normal detection algorithms, yet may still produce improper signal displays. These input conditions are differentiated by their longer time constant and fault response times.

The figure below shows a simple example of a Recurrent Conflict fault. Channel 2 Green is detected active due to a malfunction of the load switch which caused the output to “flicker” On for 100 ms approximately every 200 ms. Because normal Conflict detection requires a continuous fault of at least 350 ms typical, this event could go undetected. The Recurrent Pulse detection algorithm will process these pulses into one event and trigger a Conflict fault once the longer recurrent timing threshold is exceeded.



When triggered by a recurrent pulse fault condition, the MMU2-16LE *SmartMonitor*® will enter the fault mode, transfer the Output relay contacts to the Fault position, and display the appropriate RP CONFLICT, RP DUAL INDICATION, or RP RED FAIL status screen. The unit will remain in the fault mode until reset by the Reset button or the External Reset input. Fault response times will vary depending on the pulse width and frequency of the recurrent inputs, but typically range from 1000 ms minimum to 10 seconds maximum.

This function can be disabled by a UNIT Option called RECURRENT PULSE in the SET / VIEW CONFIG menu. See Section 6.3.4.1.

### 3.8 TYPE FAULT

The TYPE SELECT input is used by the MMU2-16LE *SmartMonitor*® to specify whether the monitor is to be configured as a Type 16 unit with 16 channels or a TS1 compatible Type 12 unit with 12 channels (see Section 1.4.2). This input is read by the

MMU2-16LE *SmartMonitor*® only during power-up initialization or when the unit is reset by the RESET button or EXTERNAL RESET input. The Type Select configuration of the MMU2-16LE *SmartMonitor*® can only be modified when the unit is reset by the RESET button or EXTERNAL RESET input. This prevents the possibility of the MMU2-16LE *SmartMonitor*® changing its configuration mode due to the failure of the cabinet TYPE SELECT jumper or the monitor TYPE SELECT input.

Once the unit is programmed by a reset command, its configuration mode (Type 16 or Type 12) is stored in non-volatile memory. During power-up initialization, the MMU2-16LE *SmartMonitor*® compares the programmed configuration mode with the state of the TYPE SELECT input. If they are different, the MMU2-16LE *SmartMonitor*® will enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and display the TYPE 12/16 FAULT status screen. The MMU2-16LE *SmartMonitor*® will remain in the fault mode until the unit is reinitialized with the TYPE SELECT input in the proper state or the MMU2-16LE *SmartMonitor*® is reset by the RESET button or the EXTERNAL RESET input.

### 3.9 FIELD CHECK MONITORING

Field Check Monitoring is an enhanced function of the MMU2-16LE *SmartMonitor*® that utilizes the Port 1 communications between the Controller Unit and the MMU in a TS2 Cabinet Assembly. When operating in the Type 16 mode the MMU2-16LE *SmartMonitor*® will receive the Type 0 message from the Controller Unit (Type 1 or Type 2 CU) which contains an image of the controller output commands to the load switches. When a fault condition triggers the MMU2-16LE, the Type 0 message information received while the fault condition was being timed will be used by the MMU2-16LE *SmartMonitor*® to determine whether the sensed field signal input status corresponded to the Controller Unit output commands. This diagnostic information is then used by the Diagnostic Wizard to isolate whether the fault condition was caused by a Controller Unit malfunction or a failure in the load switch and/or field wiring. In the latter case, the Wizard then pinpoints the faulty inputs of the channels involved in the fault condition.

The Field Check Monitor function is enabled for each channel input individually (see Section 6.3.1) and provides two modes of operation, **Field Check Fault** and **Field Check Status**.

#### 3.9.1 FIELD CHECK FAULT

In the **Field Check Fault** mode, when the field signal input states sensed as active or inactive by the MMU2-16LE *SmartMonitor*® do not correspond with the data provided by the Controller Unit in the Type 0 message for 10 consecutive messages, the MMU2-16LE *SmartMonitor*® will enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and display the FIELD CHECK FAULT status screen. The Channel Status Display will indicate the channels on which the Field Check error was detected (see Section 7.2 Channel Status Display). Bit #67 (Spare Bit #1) of the Type #129 response frame will be set to indicate a Field Check fault has been detected. The MMU2-16LE *SmartMonitor*® will remain in the fault mode until the unit is reset by the RESET button or the EXTERNAL RESET input. The Field Check Fail Monitoring function is automatically disabled in the Type 12 mode, and in the Type 16 mode with the PORT 1 DISABLE input True (low). The Field Check Fail Monitoring function is also disabled when the RED ENABLE input is not active.

#### 3.9.2 FIELD CHECK STATUS

The **Field Check Status** mode works in combination with the other fault monitoring functions of the MMU2-16LE *SmartMonitor*® to produce additional diagnostic information about the detected fault. The Field Check Monitor function will be collecting

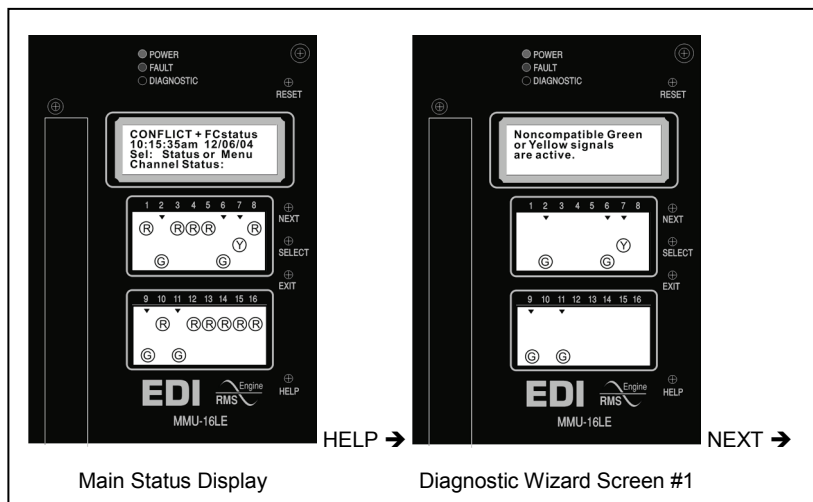
status and timing a Field Check Fault if the sensed field signal input states do not correspond to the Type 0 message data from the Controller Unit. When a Conflict, Red Fail, Clearance Fail, or Dual Indication Fail triggers the MMU2-16LE *SmartMonitor*®, the Channel Status Display and Main Status Display will correspond to that detected fault. If Field Check errors were detected while the fault was being timed, the Main Status Display will add the text “+ FCstatus” to the fault type, The FIELD CHECK STATUS screen will also be available. Bit #67 (Spare Bit #1) of the Type #129 response frame will be set to indicate Field Check errors have been detected.

In a simple example, channels 2 and 6 are set to active Green by the controller. Channel 8 Green is not permissive with channels 2 and 6 and becomes active due to a short circuit in the field wiring. The MMU2-16LE *SmartMonitor*® will detect a Conflict Fault with Field Check Status on channel 8 Green. The main fault display text will show “Conflict with FC Status”. Pressing the SELECT button will then display the actual Field Check status, which in this example would show channel 8 Green only. The MMU2-16LE *SmartMonitor*® used the Field Check function to directly pinpoint the faulty input (Channel 8 Green). Because of the Field Check status it is also known that the Controller Unit did not drive the faulty input thus was not involved in the fault.

The Diagnostic Wizard (HELP function, see Section 3.10) also uses the Field Check Status to pinpoint faulty inputs in a more direct fashion.

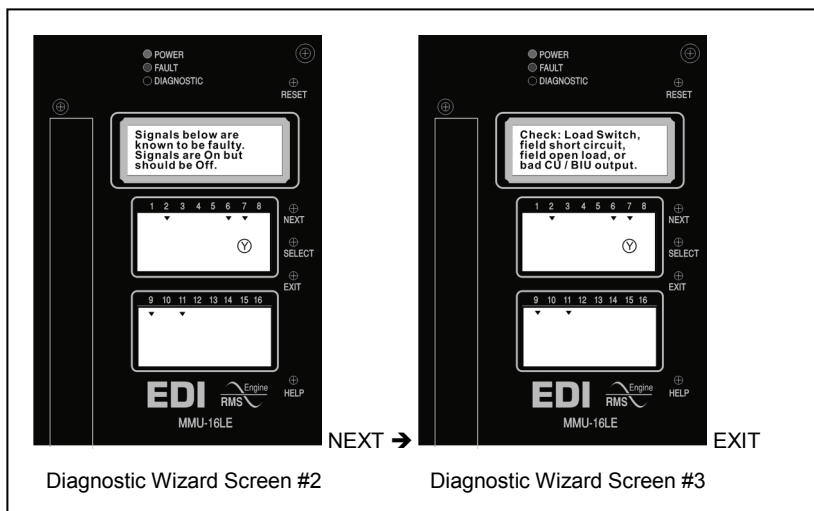
### 3.10 DIAGNOSTIC WIZARD

The built-in Diagnostic Wizard is an integral part of the Help System that provides detailed diagnostic information regarding the fault being analyzed. The Wizard provides a concise view of the signals involved in the fault, pinpoints faulty signal inputs, and provides guidance on isolating the cause of the malfunction. The Diagnostic Wizard is automatically invoked when the MMU2-16LE *SmartMonitor*® is in the fault mode and the HELP button is pressed. It is also automatically invoked when the MMU2-16LE *SmartMonitor*® is in the Previous Fail (PF) event log display and the HELP button is pressed.



The first step of the Diagnostic Wizard provides a simple definition of the fault type detected. It also filters the Channel Status display to a concise view of only the channels actually involved in the fault.





In Type 16 mode, the next steps pinpoint known faulty signals. Type 12 operation does not have the benefit of Field Checking (screen #2) unless the *Type 12 with SDLC* mode (Section 1.4.2.1) is selected, so the MMU2-16LE *SmartMonitor*® does not have enough information to actually identify the faulty signals. The last step offers the technician several suggestions for the cause of the malfunction.

Pressing the HELP button or the NEXT button will sequence the display through this series of steps. At any point the EXIT button will return the display back to the normal display mode. The figures above show a simple example of the Diagnostic Wizard screens for a Conflict fault.

### 3.11 MMU2 FLASHING YELLOW ARROW (FYA) PROTECTED-PERMISSIVE MONITORING

The MMU2-16LE *SmartMonitor*® is designed to monitor an intersection with up to four approaches using the four section Flashing Yellow Arrow (FYA) movement outlined by the NCHRP Research Project 3-54 on Protected/Permissive signal displays with Flashing Yellow Arrows, and complies with all requirements of **NEMA Standard TS-2 Amendment 4-2012 Flashing Yellow Arrow** for the MMU2 configuration.

For monitoring purposes an FYA approach is logically defined as a four input “logical channel” consisting of the solid Red Arrow, solid Yellow Arrow, flashing Yellow Arrow (permissive), and solid Green Arrow (protected). A Flashing Yellow Arrow approach is typically monitored using two load switches and two physical channels of the MMU2-16LE *SmartMonitor*®. Twelve FYA modes are supported for the Type 16 mode depending on the number of load switches provided and the capabilities of the Controller Unit (CU). Four FYA modes are supported for the Type 12 mode (A, C, G, and K).

An FYA mode should be selected based primarily on the facilities available in the cabinet.

- Modes A-D, K, and L provide straight forward assignments requiring two load switches and two MMU2 channels per FYA approach.

- Modes E, F, I, and J require the Controller Unit to remap IO to drive a signal from the Pedestrian Yellow load switch output. These modes can be considered when the cabinet facilities do not provide enough load switches. Two MMU2 channels are required for each FYA approach.
- Modes G and H require the Controller Unit to remap IO to drive a signal from the Pedestrian Yellow load switch output. These modes can be considered when the MMU2 does not provide enough channels for the intersection application. Note that modes G and H combine the permissive turn signal (flashing Yellow arrow) and the Pedestrian Walk and Don't Walk signals on the same physical load switch and monitor channel. These modes thus share the Permissive programming of the associated Pedestrian channel with the permissive turn (fYa) phase.
- Modes A through H are supported by any NEMA Controller Unit compliant to the **NEMA Standard TS-2 Amendment 4-2012 Flashing Yellow Arrow**. Modes I through L are extensions to the NEMA Standard.

- NOTE -

FYA Modes E, F, G, H, I, and J substitute an FYA signal for the Pedestrian Yellow Clearance signal. Not monitoring the Pedestrian Yellow Clearance signal prevents the MMU from detecting a Conflict condition during the full Pedestrian Clearance interval (i.e. flashing Dont Walk).

### 3.11.1 MMU2 FYA BACKWARD COMPATIBILITY

The MMU2 Flashing Yellow Arrow operation and parameters are different than previous versions of the MMU-16LE *SmartMonitor*® firmware, see also 1.2.4.1.

To emulate the legacy settings the following translation should be used:

Legacy FYA Mode	Type 16	Type 12
FYA	Mode B	Mode A
FYAC	Mode F	Mode C

### 3.11.2 MMU2 FYA CONFIGURATION MODES (A – F)

The following three clauses define the nomenclature used in this Section 3.11.2, as described in **NEMA Standard TS-2 Amendment 4-2012 Flashing Yellow Arrow** for Modes A through F.

#### 3.11.2.1 PROTECTED TURN CHANNEL

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



#### 3.11.2.2 PERMISSIVE TURN CHANNEL

The Permissive Turn Channel of the FYA channel pair is composed of the solid Red arrow (Ra), solid Yellow arrow (Ya), and the flashing Yellow arrow (fYa) indications of the FYA Signal Output Group. The flashing Yellow arrow (fYa) indication will be displayed as the Green input of the Permissive Turn Channel.



#### 3.11.2.3 OPPOSING THROUGH CHANNEL

An Opposing Through channel is also 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).

### 3.11.2.4 MMU2 FYA MODES A, B, C, D

Table 3-1 describes four modes that do not require any mapping functionality. The cabinet must provide two load switches per FYA approach. 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, 10, 11, 12 or 13, 14, 15, and 16. This accommodates cabinets that have pedestrian phases assigned to either channel group, 9-12 or 13-16.

**Table 3-1**  
**FYA Channel Configurations (Remap = No)**

	Ch: 1	3	5	7	9	12	13	16
Mode A								
	Protected Turn Channels (Ga)		Opposing Through Channels		Permissive Turn Channels (Ra, Ya, fYa)		Green Arrow Signal Driver Source	
	1			2	9		1 Green	
	3			4	10		3 Green	
Mode B								
	Protected Turn Channels (Ga)		Opposing Through Channels		Permissive Turn Channels (Ra, Ya, fYa)		Green Arrow Signal Driver Source	
	1			2	13		1 Green	
	3			4	14		3 Green	
Mode C								
	Protected Turn Channels (Ga)		Opposing Through Channels		Permissive Turn Channels (Ra, Ya, fYa)		Green Arrow Signal Driver Source	
	9			2	1		9 Green	
	10			4	3		10 Green	

**Table 3-1**  
**FYA Channel Configurations (Remap = No)**

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

### 3.11.2.5 MMU2 FYA MODES E, F

Table 3-2 describes two modes that can be used when the back panel does not provide enough load switches. These modes do require the Controller Unit to provide a mapping functionality. The cabinet must provide one load switch per FYA approach for the permissive turn overlap phase, and the protected Green arrow signal must be driven from an associated Pedestrian Yellow load switch output. Modes E and F assign the permissive turn overlap phases to channels 1, 3, 5, and 7, and the protected left turn Green arrow to either channels 9, 10, 11, 12 or 13, 14, 15, and 16. This accommodates cabinets that have pedestrian phases assigned to either channel group, 9-12 or 13-16. The MMU2-16LE *SmartMonitor*® will remap the Pedestrian Yellow load switch inputs to a logical channel group, 9-12 or 13-16.

**Table 3-2**  
**FYA Channel Configurations (Remap = Yes)**

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

### 3.11.3 MMU2 FYA CONFIGURATION MODES (G - L)

The following three clauses define the nomenclature used in this Section 3.11.2, as described in **NEMA Standard TS-2 Amendment 4-2012 Flashing Yellow Arrow** for Modes G through L.

#### - NOTE -

In Modes G-L, because the solid Yellow Arrow is assigned to the same channel as the Protected Green Arrow:

- 1) Exit Flash into Start-up in all Yellow signals is not permitted.
- 2) Time of Day flash in all Yellow signals is not permitted.

#### 3.11.3.1 PROTECTED TURN CHANNEL

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



#### 3.11.3.2 PERMISSIVE TURN CHANNEL

The Permissive Turn Channel of the FYA channel pair is composed of the flashing Yellow arrow (fYa) indication of the FYA Signal Output Group. For modes I through L, the flashing Yellow arrow (fYa) indication will be displayed as the Green input of the Permissive Turn Channel.



For modes G and H, the flashing Yellow arrow (fYa) indication will be displayed as the Yellow input of the Pedestrian channel of the associated Opposing Through Channel.



### 3.11.3.3 OPPOSING THROUGH CHANNEL

An Opposing Through channel is also 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).

### 3.11.3.4 MMU2 FYA ALTERNATE MODES G, H

Table 3-3 describes two modes that can be used when the MMU2 does not provide sufficient monitoring channels. This may occur for example when monitoring right turn overlap channels is needed beyond the 16 channels provided. These modes do require the Controller Unit to provide a mapping functionality.

The cabinet must provide one load switch per FYA approach for the protected turn phase, and the permissive flashing Yellow arrow signal must be driven from an associated Pedestrian Yellow load switch output. Modes G and H assign the protected turn phases to channels 1, 3, 5, and 7, and the permissive turn flashing Yellow arrow to either channels 9, 10, 11, 12 or 13, 14, 15, and 16. This accommodates cabinets that have pedestrian phases assigned to either channel group, 9-12 or 13-16. In this mode NO remapping is performed by the MMU2. These modes thus share the Permissive programming of the associated Pedestrian channel with the permissive turn (fYa) phase.

**Table 3-3**  
**FYA Channel Alternate Configurations (Remap = Yes)**

	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)	
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)	

### 3.11.3.5 MMU2 FYA ALTERNATE MODES I, J

Table 3-4 describes two modes that can be used when the back panel does not provide enough load switches. These modes do require the Controller Unit to provide a mapping functionality. The cabinet must provide one load switch per FYA approach for the protected turn phase, and the permissive flashing Yellow arrow signal must be driven from an associated Pedestrian Yellow load switch output. Modes I and J assign the protected turn phases to channels 1, 3, 5, and 7, and the permissive turn flashing Yellow arrow to either channels 9, 10, 11, 12 or 13, 14, 15, and 16. This accommodates cabinets that have pedestrian phases assigned to either channel group, 9-12 or 13-16. The MMU2-16LE *SmartMonitor*® will remap the Pedestrian Yellow load switch inputs to a logical channel group, 9-12 or 13-16.

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

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

**Table 3-5**  
**FYA Channel Alternate Configurations (Remap = No)**

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

### 3.11.4 CONFIGURING THE *SMARTMONITOR* FAULT PARAMETERS FOR FYA

The MMU2-16LE *SmartMonitor*® built-in Setup Wizard will automatically configure the fault configuration parameters for Red Fail, Dual Indication, Field Check, and Minimum Y+R Clearance. **The Flashing Yellow Arrow configuration settings should be applied before running the Setup Wizard.** See Section 5.2.2.3.

For an FYA channel pair the fault configuration parameters are applied to the **Primary** channel with three inputs, Ra-Ya-fYa or Ra-Ya-Ga, depending on the FYA mode selected. The fault configuration parameters programmed for the **Spars**e channel of the FYA pair with only one input, Ga or fYa, only affects the sparse channel and not the Primary channel, and should be used only when the RY INPUT option (see Section 3.11.4) is Enabled for that channel.

#### 3.11.4.1 CONFLICT

The MMU2-16LE *SmartMonitor*® will verify that no conflicting channels to the solid Yellow arrow channel (clearance) are active as determined by the Program Card compatibility programming of the solid Yellow arrow channel of the pair except during the following sequences:

##### 3.11.4.1.1 PROTECTED YELLOW CHANGE INTERVAL CONFLICT

During the Yellow change interval of the Protected Turn channel (Green arrow), the MMU2-16LE *SmartMonitor*® will verify that no conflicting channels to the solid Yellow arrow channel (clearance) are active as determined by the Program Card compatibility programming of the Protected Turn channel (Green arrow) of the pair.



#### **3.11.4.1.2 PERMISSIVE YELLOW CHANGE INTERVAL CONFLICT**

During the Yellow change interval of the Permissive Turn channel (flashing Yellow arrow), the MMU2-16LE *SmartMonitor*® will verify that no conflicting channels to the solid Yellow arrow channel (clearance) are active as determined by the Program Card compatibility programming of the Permissive Turn channel (flashing Yellow arrow).

#### **3.11.4.1.3 TIME OF DAY (TOD) FLASH**

Section 4D.20 Option 3-J of the MUTCD requires the solid Yellow arrow of the FYA signal head to flash during programmed TOD flash modes. This operation requires that the solid Yellow arrow channel be programmed permissive with the opposing through channel. Thus only FYA Modes A through F are compatible with programmed TOD Flash operation.

#### **3.11.4.2 RED FAIL**

A Red Fail fault will occur if the solid Red Arrow AND solid Yellow Arrow AND flashing Yellow Arrow AND solid Green Arrow all remain inactive for the Red Fail fault response time. The fault icon (▼) will be displayed for both channels of the FYA channel pair.

If the Red Fail function is enabled and the RY Input option is enabled for the sparse channel (Ga or fYa), then a Red Fail fault will occur if the Red AND Yellow AND Green all remain inactive on the sparse channel for the Red Fail fault response time. The fault icon (▼) will be displayed for the sparse channel of the FYA pair.

#### **3.11.4.3 DUAL INDICATION**

A Dual Indication fault will occur if any two or more of the solid Red Arrow, solid Yellow Arrow, flashing Yellow Arrow, or solid Green Arrow signal combinations are active simultaneously for the Dual Indication fault response time. The fault icon (▼) will be displayed for both channels of the FYA pair when the sparse channel input (Ga or fYa) is active.

If the RG, RY, or GY Dual Indication function is enabled and the RY Input option is enabled for the sparse channel (Ga or fYa), then a Dual Indication fault will occur if any two or more of the Red, Yellow, or Green inputs are active simultaneously on the sparse channel for the Dual Indication fault response time. The fault icon (▼) will be displayed for the sparse channel of the FYA pair.

#### **3.11.4.4 MINIMUM YELLOW CLEARANCE**

A Yellow Clearance fault will be detected if the channel pair sequences from the protected Green Arrow to the solid Red Arrow without a minimum clearance time on the solid Yellow Arrow. The fault icon (▼) will be displayed for the solid Yellow Arrow channel.

A Yellow Clearance fault will be detected if the channel pair sequences from the permissive flashing Yellow Arrow to the solid Red Arrow without a minimum clearance time on the solid Yellow Arrow. The fault icon (▼) will be displayed for the solid Yellow Arrow channel.

If the Minimum Yellow Clearance function is enabled (Section 6.2.3) and the RY Input (Section 3.11.4) option is enabled for the sparse channel (Ga or fYa), a Yellow Clearance fault will be detected if the sparse channel sequences from the Green input to the solid Red input without a minimum clearance time on the Yellow input. The fault icon (▼) will be displayed for the sparse channel (Ga or fYa).

#### **3.11.4.5 YELLOW PLUS RED CLEARANCE**

The Minimum Yellow Plus Red Clearance function is not designed to operate with Flashing Yellow Arrows. This function must be Disabled (Section 6.3.7) for the FYA channels that provide the Permissive flashing Yellow arrow (except for Modes G and

H). This allows the CU to sequence from the Permissive Left turn channel directly to the Protected Left Turn channel without a solid Yellow arrow clearance interval.

### **3.11.5 RED AND YELLOW INPUT ENABLE**

The Red and Yellow outputs of the sparse channel of an FYA channel pair are typically not loaded with a signal head and thus left floating. For example, in Mode A the Red and Yellow outputs of channels 1, 3, 5, and 7 may be deployed without signal loads connected. In these cases the Red and Yellow inputs for the sparse FYA channels can be forced to the Off state in the MMU2 by default. This simplifies the cabinet wiring such that the use of dummy cabinet loads or modifications to the monitor harness are not necessary.

If the Red and Yellow outputs of the sparse channel of an FYA channel pair are driving signal loads (such as a hard wired right turn overlap) then they must be monitored by the MMU2 at all times. The RY INPUT option should then be enabled for that channel. The fault configuration parameters programmed for this Sparse channel of the FYA pair only affects the Sparse channel and not the Primary channel, and should be enabled only when the RY INPUT option is Enabled for that channel.

#### **3.11.5.1 RED AND GREEN INPUT DISABLE (MODES G AND H)**

The Red and Green outputs of the permissive FYA channel of Modes G and H channel pair are typically loaded with a pedestrian signal head (R=DW, G=W). If a pedestrian signal head is not connected to the Red and Green outputs of the load switch then the Red and Green inputs for that FYA channel can be forced to the Off state in the MMU2. This simplifies the cabinet wiring such that the use of dummy cabinet loads or modifications to the monitor harness are not necessary.

If the Red and Green outputs of the pedestrian channel of an FYA channel pair are driving signal loads (pedestrian) then they must be monitored by the MMU2 at all times. Do not disable the RG Inputs if pedestrian signal heads are being used.

### **3.11.6 FLASH RATE DETECTION**

When the FLASHRATE FAULT option is enabled, the MMU2-16LE *SmartMonitor*<sup>®</sup> will monitor a flashing yellow arrow output for a lack of flashing operation. If any of the enabled flashing yellow arrow signals remain active for more than the FYA Flash Rate Fault time (Section 9), the MMU2-16LE *SmartMonitor*<sup>®</sup> will enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and display the FYA FLASH-RATE FAIL status screen. The MMU2-16LE *SmartMonitor*<sup>®</sup> will remain in the fault mode until the unit is reset by the RESET button or the EXTERNAL RESET input.

### **3.11.7 FYA YELLOW TRAP CONFLICT DETECTION**

When the FYA TRAP DETECT option is enabled, the MMU2-16LE *SmartMonitor*<sup>®</sup> will monitor each FYA permissive turn channel for the FYA Yellow Trap condition. The FYA Yellow Trap conflict condition occurs when the Permissive Turn channel (flashing yellow arrow) sequences to the solid yellow arrow clearance while the Opposing Through channel is still showing a green ball.

When the FYA Yellow Trap Conflict condition is detected, the MMU2-16LE *SmartMonitor*<sup>®</sup> will enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and display the "CONFtrap" fault status screen. The MMU2-16LE *SmartMonitor*<sup>®</sup> will remain in the fault mode until the unit is reset by the RESET button or the EXTERNAL RESET input.

## Section 4 *ECcom* Interface

### 4.1 EDI *ECOM* MONITOR REPORTS

The EDI *ECcom* software package (**Version 3.8.0 or greater is required**) interfaces a Computer or System to the MMU2-16LE. The *ECcom* program will display the Status (S), Previous Fault (PF) event log, AC Line (AC) event log, Manual Reset (MR) event log, Configuration (CF) event log, and Signal Sequence logs. All events are time stamped with the time and date of the event.

Operation of the *ECcom* software package is described in ***EDI ECcom Software Operations Manual*** (pn 888-1000-001) and will not be covered in this manual. The EDI *ECcom* software is available at no charge from the EDI web site at **[www.EDIttraffic.com](http://www.EDIttraffic.com)**.

#### GENERAL DATA

Monitor ID#: a four digit (0000-9999) ID number may be assigned to the monitor.

Monitor Name: a thirty character name may be assigned to the monitor.

Time and Date: each event is marked with the time and date of occurrence.

Event Number: identifies the record number in the log. Event #1 is the most recent event.

#### CURRENT STATUS (S)

Fault Type: the fault type description.

Field Status: the current or latched RYGW field status and RMS voltages.

Cabinet Temperature: the current or latched temperature if the monitor.

AC Line Voltage: the current or latched AC Line voltage and frequency.

Control Input Status: the current or latched state and RMS voltage of the Red Enable input and Load Switch Flash bit.

#### PREVIOUS FAULT (PF) EVENT LOG

Fault Type: the fault type description.

Field Status: the latched field status, RMS voltages, and fault channel status at the time of the fault.

Cabinet Temperature: the latched temperature at the time of the fault.

AC Line Voltage: the AC Line voltage and frequency at the time of the fault.

Control Input Status: the latched state and RMS voltage of the Red Enable input and Load Switch Flash bit.

#### AC LINE (AC) EVENT LOG

Event Type: describes the type of AC Line event that occurred.

Power-up: AC on, monitor performed a cold start

Brown-out: AC Line < drop-out level

Restore: AC restored from AC brown-out or AC interruption, no cold start

AC Line Voltage: the AC Line voltage at the time of the event.

## MANUAL RESET (MR) EVENT LOG

The monitor was reset from a fault by the front panel Reset button or External Reset input or non-latched fault clear.

## CONFIGURATION (CF) EVENT LOG

Program Card Matrix: the permissive programming for each channel.

MYCD Jumpers: the Minimum Yellow Clearance Disable programming for each channel.

Enhanced Programming Parameters: Unit, Field Check, Red Fail, Dual Indication, and MYRCD programming

NEMA Inputs: 24V Inhibit, Type Select, Port 1 Disable.

Program Card: Minimum Flash Timing, 24V & CVM Latch Enables.

Configuration Check Value: the value of the 16 bit Check Value for the reported configuration.

## SIGNAL SEQUENCE EVENT LOG

The Signal Sequence event log graphically displays all signal states and Red Enable state for up 30 seconds prior to the MMU2-16LE *SmartMonitor*<sup>®</sup> fault trigger for the most recent five (5) Previous Fault (PF) events.

## 4.2 CONFIGURATION PROGRAMMING

The *ECcom* software provides a method for displaying and setting the configuration programming of the MMU2-16LE. Programming functions on the NEMA Program Card are read only by the *ECcom* software. All other NEMA enhanced functions can be set directly by the software.

*ECcom* can also save the configuration setup of the MMU2-16LE *SmartMonitor*<sup>®</sup> to a disk file or retrieve a configuration from a disk file.

### 4.2.1 ECCOM CONFIGURATION SET-UP WIZARD

The Set-up Wizard in *ECcom* can be used to automatically generate all the enhanced monitor programming data for the MMU2-16LE *SmartMonitor*<sup>®</sup> in most cases without the need for understanding complex and confusing monitor terminology. It works in the same fashion as the built-in Setup Wizard (see Section 6.3.14), and configures the monitor enhanced-feature programming using a simple series of intersection related questions. The resulting output from the *ECcom* Setup Wizard can then be downloaded to the target MMU2-16LE *SmartMonitor*<sup>®</sup> unit.

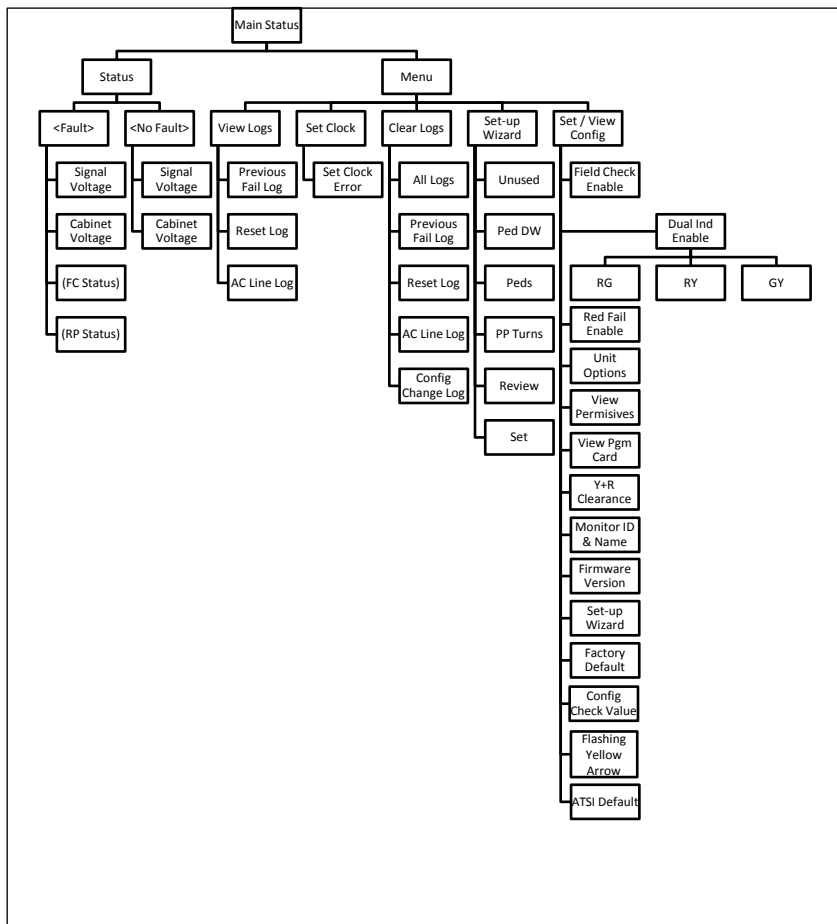
## 4.3 ETHERNET LAN PORT

The optional Ethernet port must be configured with specific network parameters such as an IP address and Subnet Mask. The network port parameters are set or changed using the EDI *ECcom* Signal Monitor Communications software. See the "*EDI ECcom Software Operations Manual*" ETHERNET LAN SETTINGS Section 3.2.1.2 for details.

## Section 5 Menu Operation

### 5.1 MAIN STATUS MENU

The menu driven user interface follows the map shown below. At the top level, the NEXT button selects whether Current Status details or the main Menu selections are displayed. The NEXT button is used to scroll through the various selections that each menu level may provide. Pressing the SELECT button will invoke the function that the cursor (►) points to. At any time the EXIT button may be pressed to back out of a menu selection.



### 5.2 TOP LEVEL MENU

The top level menu displays the current monitor status, consisting of the fault state, time and date, and the field signal states. This is the default display following a Reset. The Diagnostic Wizard (Section 3.10) is automatically invoked when the HELP button is pressed at this level if the MMU2-16LE *SmartMonitor*® is currently in the fault state.

## 5.2.1 STATUS

Pressing the SELECT button from the top level provides further details regarding the current state including Field Check status (if applicable), Recurrent Pulse Status (if applicable), Field Voltages, and Cabinet Voltages.

## 5.2.2 MENU

Pressing the NEXT button followed by the SELECT button from the top level provides the main Menu structure for selecting the following functions:

### 5.2.2.1 VIEW LOGS

This menu category provides a review of:

- Previous Failure (PF) log
- AC Line (AC) event log
- Monitor Reset (MR) log

Events are stored with #1 being the newest event in the log. Pressing the NEXT button will display the events from newest to oldest (#1 ... #n). Once the last entry is displayed pressing the NEXT button will display the events from oldest to newest (#n ... #1).

The Diagnostic Wizard is automatically invoked when the HELP button is pressed while reviewing the Previous Failure (PF) logs.

### 5.2.2.2 VIEW AND SET CONFIGURATION

This menu category provides a means to review and/or set configuration parameters:

Function	View	Set
Field Check Enable	✓	✓
Dual Indication Enable	✓	✓
Red Fail Enable	✓	✓
Unit Options	✓	✓
Permissive Channels	✓	
Program Card Options	✓	
Red+Yellow Clearance Disable	✓	✓
Monitor ID and Name	✓	
Firmware Version	✓	
Set-up Wizard	✓	✓
Set Factory Default	✓	✓
Configuration Check Value	✓	
Flashing Yellow Arrow	✓	✓

See Section 6 for details on each item.

### 5.2.2.3 SET-UP WIZARD

The built-in Set-up Wizard (see Section 6.3.14) is used to generate configuration values for the following parameters:

- Field Check Enable (Type 16 mode only)
- Red Fail Enable
- Dual Indication Enable (RG, YG, and GY)
- Minimum Yellow Plus Red Clearance

The following parameters are NOT affected by the Set-up Wizard and must be manually programmed:

- Unit Data
- Permissive Matrix (Program Card jumpers)
- Minimum Yellow Clearance Disable (Program Card jumpers)

The permissive programming on the Program Card must still be provided for Conflict monitoring. The MMU2-16LE *SmartMonitor*<sup>®</sup> will not exit the fault mode without the Program Card inserted.

- WARNING -

AFTER RUNNING THE SET-UP WIZARD ALL PARAMETERS SHOULD BE REVIEWED FOR CORRECTNESS AND CONSISTENCY WITH THE CABINET PROGRAMMING AND INTERSECTION GEOMETRY.

SOME CHANGES TO THE WIZARD RESULTS MAY BE REQUIRED DEPENDING ON CABINET WIRING OR OTHER CONSIDERATIONS.

#### **5.2.2.4 CLEAR LOGS**

This menu category provides a means to clear the following logs:

- Previous Failure (PF) log
- AC Line (AC) event log
- Monitor Reset (MR) log
- Configuration (CF) log

The ALL selection will clear all four event logs.

#### **5.2.2.5 SET CLOCK**

The built-in time of day and date clock can be set from this menu item. Note that in Type 16 mode, the Controller Unit synchronizes the clock of the MMU2-16LE *SmartMonitor*<sup>®</sup> once per second via Port 1 SDLC communications. The day and date clock will automatically adjust for Daylight Savings time. The week and month that this occurs can be programmed via the *ECcom* interface (see ***EDI ECcom Software Operations Manual***).

## Section 6 Installation

### 6.1 GENERAL

There are several ways to program the Enhanced Function configuration parameters of the MMU2-16LE *SmartMonitor*®. Regardless of the method, the basic NEMA parameters programmed on the Program Card must be set manually using soldered wire jumpers (Section 6.2). The MMU2-16LE *SmartMonitor*® will not exit the fault mode without a Program Card installed.

The most basic method to program the Enhanced Function configuration parameters is to use the front panel menu driven interface (See Section 5.2.2.2). The user should select each and every function and provide the required input.

The EDI *ECcom* software can also be used to develop the configuration parameters. This is the same process as using the front panel menu driven interface but is easier due to the personal computer interface. Once a parameter database has been developed, it can be saved to a disk file for later use or for use a template. The parameter database can then be directly downloaded to the MMU2-16LE *SmartMonitor*®.

### 6.2 PROGRAM CARD PROGRAMMING

The MMU2-16LE *SmartMonitor*® uses an interchangeable Program Card which contains soldered wire jumpers to program the permissive channel pairs, Minimum Flash time, Minimum Yellow Change Disable, +24V Latch Enable, and CVM Latch Enable inputs. The special EDI Program Card provided with the unit also has a small non-volatile memory device that contains all the enhanced configuration programming not defined by the standard NEMA jumpers.

When replacing the MMU2-16LE *SmartMonitor*® for service or test purposes, all NEMA standard and enhanced-feature programming is automatically transferred to the replacement unit when the EDI Program Card is inserted and the Unit Option, PGM CARD MEMORY, in the SET / VIEW CONFIG menu has been enabled.

The MMU2-16LE *SmartMonitor*® is compatible with both a standard NEMA defined Program Card and the special EDI Program Card. The special EDI Program Card is compatible with all other MMU units that comply with the **NEMA Standards Publication TS2-2003 (R2008) v02.06**.

#### 6.2.1 PERMISSIVE CHANNEL PROGRAMMING

The MMU2-16LE *SmartMonitor*® Program Card contains a group of soldered wire jumper holes to set the permissive or compatible channel configuration. This programming is determined by the intersection layout and phase assignments. The card is initially supplied with 120 empty wire jumper hole pairs. This initial programming sets all channels to conflict with all other channels. To program a compatible channel pair, solder a wire jumper into the appropriate location for that channel pair as marked on the Program Card. **Make sure that any jumper leads do not make contact with any other jumper lead on the card or the monitor chassis when the Programming Card is inserted into the unit.**

Example: If channel 2 Green and Yellow is **PERMISSIVE** with channel 4 Green and Yellow, solder a jumper wire into the jumper pair labeled "2-4".

If the Program Card is absent or not seated properly in the edge connector, the MMU2-16LE *SmartMonitor*® will enter the fault mode, transfer the OUTPUT relay contacts to



the Fault position, and display the PGM CARD AJAR status screen. The MMU2-16LE *SmartMonitor*® will remain in the fault mode until the Program Card is correctly seated and the MMU2-16LE *SmartMonitor*® is reset by the RESET button or the EXTERNAL RESET input.

## 6.2.2 MINIMUM FLASH TIME PROGRAMMING

The MMU2-16LE *SmartMonitor*® Programming Card contains a group of soldered wire jumper holes to set the Minimum Flashing Indication time after an MMU Power Failure. The programming of the Minimum Flash time is in a binary encoded format. The addition of a soldered wire jumper in a jumper hole pair will add that designated input value to the binary weighted sum plus 1 second (minimum period is 6 seconds). This provides a programming range from 6 seconds to 16 seconds.

b8	b4	b2	b1	Delay Period
Open	Open	Open	Open	6 seconds
Open	Open	Open	Jump	6 seconds
Open	Open	Jump	Open	6 seconds
Open	Open	Jump	Jump	6 seconds
Open	Jump	Open	Open	6 seconds
Open	Jump	Open	Jump	6 seconds
Open	Jump	Jump	Open	7 seconds
Open	Jump	Jump	Jump	8 seconds
Jump	Open	Open	Open	9 seconds
Jump	Open	Open	Jump	10 seconds
Jump	Open	Jump	Open	11 seconds
Jump	Open	Jump	Jump	12 seconds
Jump	Jump	Open	Open	13 seconds
Jump	Jump	Open	Jump	14 seconds
Jump	Jump	Jump	Open	15 seconds
Jump	Jump	Jump	Jump	16 seconds

It is recommended that the Minimum Flash Time be programmed on the MMU2-16LE *SmartMonitor*® to facilitate an orderly start-up sequence of the Cabinet Assembly upon application or restoration of AC LINE power. The amount of flash time is typically equal to the amount programmed on the Controller Unit (minimum 6 seconds). The Minimum Flash Time should be long enough to ensure all cabinet components are initialized and ready before the MMU2-16LE *SmartMonitor*® transfers the OUTPUT relay and places the intersection into operation.

## 6.2.3 MINIMUM YELLOW CHANGE DISABLE PROGRAMMING

The MMU2-16LE *SmartMonitor*® Program Card contains a group of 16 soldered wire jumper holes to disable Minimum Yellow Change Monitoring for each channel. A soldered wire jumper in a jumper hole pair will **DISABLE** Minimum Yellow Change Monitoring for that channel.

Minimum Yellow Change Monitoring requires activity on all three channel inputs (Green, Yellow, and Red) to detect a Minimum Yellow Change Fault. This function should be disabled for channels which do not provide a true Yellow Change interval equal to or greater than 3 seconds.

## 6.2.4 VOLTAGE MONITOR LATCH PROGRAMMING

The MMU2-16LE *SmartMonitor*® Program Card contains two soldered wire jumper hole pairs to cause +24V Monitor and Controller Voltage Monitor (CVM) faults to be latching. A soldered wire jumper in the jumper hole pair labeled 24V Latch Enable will **ENABLE** the latching mode for +24V Monitoring. A soldered wire jumper in the jumper hole pair labeled CVM Latch Enable will **ENABLE** the latching mode for CVM Monitoring.

If the latch mode is enabled for either of these monitoring functions, the MMU2-16LE *SmartMonitor*® will remain in the fault mode until the unit is reset by the RESET button or the EXTERNAL RESET input. Restoration of the proper input voltage or an MMU Power Failure will not reset the unit.

### 6.3 ENHANCED FUNCTION PROGRAMMING

The Program Card provides the configuration values for all required basic NEMA TS-2 functions (Section 2). The MMU2-16LE *SmartMonitor*® provides a host of additional functions that are programmed from the front panel menu interface. Alternatively, the data can be designed or downloaded from disk file using the *ECcom* software. All Enhanced Function programming values are simultaneously stored in the non-volatile memory on the EDI Program Card (see Section 6.3.4.6).

#### 6.3.1 FIELD CHECK ENABLE PROGRAMMING

Menu Path: MENU / SET VIEW CONFIG / FIELD CHECK ENABLE

The Field Check monitoring function (See Section 3.9) is enabled on a per input basis for each channel. The Field Check function must be enabled for the Diagnostic Wizard to directly pinpoint faulty channel inputs.

Typically any monitor input that is driven from a load switch output should have Field Check enabled. This would include the Red, Yellow, and Green inputs from a vehicle channel, The Yellow and Green inputs from a protected-permissive left turn channel, and the Red and Green inputs of a pedestrian channel.

The following list describes several examples where the Field Check function for that input should be DISABLED.

1. The Red field signal input of a channel is tied to AC LINE for the left turn channel of a four or five section signal head.
2. The Red field signal input of a channel is tied to AC LINE for an unused channel.
3. The Yellow field signal input of a pedestrian channel which is not monitoring the Yellow load switch output (e.g. no load on Yellow).
4. The Red field signal input of a pedestrian channel which is not monitoring the Don't Walk load switch output (i.e. the Red (Don't Walk) field signal input is tied to AC LINE).
5. A separate MMU2-16LE *SmartMonitor*® channel is monitoring an overlap signal which is generated in hardware from another vehicle channel load switch output.

#### 6.3.2 DUAL INDICATION ENABLE PROGRAMMING

Menu Path: MENU / SET VIEW CONFIG / DUAL IND ENABLE / R-G DUAL ENABLE

Menu Path: MENU / SET VIEW CONFIG / DUAL IND ENABLE / R-Y DUAL ENABLE

Menu Path: MENU / SET VIEW CONFIG / DUAL IND ENABLE / G-Y DUAL ENABLE

The Dual Indication monitoring function (See Section 3.2) is enabled on a per channel basis for each combination of Dual Indication monitoring; Red+Green, Red+Yellow, and Green+Yellow. When Dual Indication monitoring is enabled for a channel, the MMU2-16LE *SmartMonitor*® will enter the fault mode when it has detected more than one active input on that channel. Dual Indication monitoring is typically not enabled for monitor channels that are not used, or channels that have the Red input (protected / permissive left turn) tied to AC Line, or pedestrian channels with the Don't Walk (Red) input tied to AC Line.

### 6.3.3 RED FAIL ENABLE PROGRAMMING

Menu Path: MENU / SET VIEW CONFIG / RED FAIL ENABLE

The Red Fail monitoring function (See Section 2.2) is enabled on a per channel basis. When Red Fail monitoring is enabled for a channel, the MMU2-16LE *SmartMonitor*® will enter the fault mode when it does not detect at least one active input on a channel. Red Fail monitoring is typically not enabled for monitor channels that are not used, or channels that do not have an active Red input (protected / permissive left turn), or pedestrian channels with no active Yellow input.

### 6.3.4 UNIT OPTION PROGRAMMING

Menu Path: MENU / SET VIEW CONFIG / UNIT OPTIONS

The MMU2-16LE *SmartMonitor*® provides a set of independently programmed options which assist in configuring the MMU2-16LE *SmartMonitor*® to various wiring or operating conventions in the cabinet.

#### 6.3.4.1 RECURRENT PULSE OPTION

The Recurrent Pulse Detection function is **DISABLED** by setting RECURRENT PULSE to the OFF state. See Section 3.7. The Factory Default setting is ON.

#### 6.3.4.2 WALK DISABLE OPTION

The Walk Disable function is **ENABLED** by setting the by setting WALK DISABLE to the ON state. See Section 2.2.2 and . The Factory Default setting is OFF.

#### 6.3.4.3 LOG CVM FAULTS OPTION

The CVM Logging function is **DISABLED** by setting LOG CVM FAULTS to the OFF state. See Section 2.3.2.2. The Factory Default setting is ON.

#### 6.3.4.4 EXTERNAL WATCHDOG ENABLE OPTION

The External Watchdog Monitoring function is **ENABLED** by setting EXTERN WATCHDOG to the ON state. See Section 3.3. The Factory Default setting is OFF.

#### 6.3.4.5 +24V-II = 12 VDC ENABLE OPTION

Setting the +24VDC Monitor II threshold to 12 Volts DC is **ENABLED** by setting +24V-2 = 12Vdc to the ON state. See Section 2.3.1.3. The Factory Default setting is OFF.

#### 6.3.4.6 PROGRAM CARD MEMORY ENABLE OPTION

The nonvolatile memory interface on the EDI Program Card is **ENABLED** by setting PGM CARD MEMORY to the ON state. See Section 1.2.4. The Factory Default setting is OFF.

#### 6.3.4.7 LEDGUARD® ENABLE OPTION

The *LEDguard*® Monitoring function is **ENABLED** by setting LEDguard to the ON state. See Section 1.4.1. The Factory Default setting is OFF.

#### 6.3.4.8 FORCE TYPE 16 MODE ENABLE OPTION

The Force Type 16 mode can be **ENABLED** by setting FORCE TYPE 16 to the ON state. See Section 1.4.2.2. The Factory Default setting is OFF.

#### 6.3.4.9 TYPE 12 WITH SDLC MODE ENABLE OPTION

The Port 1 SDLC operation can be **ENABLED** in the TYPE 12 mode by setting TYPE 12 WITH SDLC to the ON state. See Section 1.4.2.1. The Factory Default setting is OFF.

#### 6.3.4.10 VM MONITOR 3X/DAY LATCH OPTION

The VM Monitor 3x/Day Latch function is **ENABLED** by setting VM 3X/DAY LATCH to the ON state. See Section 2.3.3. The Factory Default setting is OFF.

Note that installing the Program Card jumpers to enable the CVM Monitor Latch or the 24V Monitor Latch (Section 6.2.4) will force the latch state regardless of the VM Monitor 3x/Day Latch mode setting.

#### 6.3.5 VIEW PERMISSIVES

Menu Path: MENU / SET VIEW CONFIG / PERMISSVES

The permissive programming defined by the soldered jumpers on the Program Card can be reviewed for each Primary channel 1:15. The Main Status display will show the Primary channel number which is also indicated by the ▼ symbol on the Channel Status display. All Secondary channels programmed permissive (jumper installed) with the displayed primary channel will be indicated on the Channel Status display with their Ⓒ and Ⓐ icons illuminated. Pressing the NEXT button will increment the display to the next Primary channel.

These settings are read-only and require the Program Card jumpers to be changed.

#### 6.3.6 VIEW PROGRAM CARD OPTIONS

Menu Path: MENU / SET VIEW CONFIG / PGM CARD JUMPERS

The soldered jumper settings for Minimum Flash, 24V Latch, CVM Latch, and Minimum Yellow Change Disable defined by the soldered jumpers on the Program Card can be reviewed. The Channel Status display indicates channels that are ENABLED for Minimum Yellow Change monitoring by illuminating the Ⓢ icon.

These settings are read-only and require the Program Card jumpers to be changed.

#### 6.3.7 YELLOW PLUS RED CLEARANCE DISABLE PROGRAMMING

Menu Path: MENU / SET VIEW CONFIG / Y+R CLRANCE DISABLE

The Yellow Plus Red Clearance programming (See Section 2.5.1.3) can be reviewed and set for each channel. All channels with the Yellow Plus Red Clearance function ENABLED will be indicated on the Channel Status display with their Ⓡ and Ⓢ icons illuminated.

To change the programming of a channel, the Main Status display will show the selected channel number and the Enable / Disable status of the channel. The selected channel is also indicated by the ▼ symbol on the Channel Status display. Pressing the NEXT button will increment the display to the next channel. Pressing the SELECT button will toggle the Enable / Disable status of the selected channel.

Press the EXIT button when all channels are programmed. Select "Set" to save the current selections. Select "Cancel" to exit this mode without saving the new settings. Select "Edit" to return to the programming mode.

#### 6.3.8 VIEW MONITOR ID AND NAME

Menu Path: MENU / SET VIEW CONFIG / MONITOR ID, NAME

The monitor ID number and text name can be displayed. These settings are read-only and are set or changed using the EDI *ECcom* software.

#### 6.3.9 VIEW FIRMWARE VERSION

Menu Path: MENU / SET VIEW CONFIG / FIRMWARE VERSION

The monitor firmware version can be displayed. These settings are read-only.

### 6.3.10 RUN THE SETUP WIZARD

Menu Path: MENU / SET VIEW CONFIG / SET-UP WIZARD

Menu Path: MENU / SET-UP WIZARD

The monitor Setup Wizard can be run from either of these two menu items. See Section 6.3.14.

### 6.3.11 SET FACTORY DEFAULT PROGRAMMING

Menu Path: MENU / SET VIEW CONFIG / SET FACTORY DEFAULT

Selecting this menu item will reset all the enhanced monitor settings back to the factory default settings. **Factory default has all enhanced monitoring functions DISABLED.**

Function	Factory Default
Field Check Enable	Disabled
Dual Indication Enable	Disabled
Red Fail Enable	Enabled
Unit Options:	
Recurrent Pulse	Enabled
Walk Disable	Disabled
Log CVM Faults	Enabled
External Watchdog	Disabled
24V-2 = 12Vdc	Disabled
Program Card Memory	Disabled
LEDguard	Disabled
Force Type 16	Disabled
Flashing Yellow Arrow	Disabled
Y+R Clearance Monitor	Enabled
Monitor ID, Name	Not Affected

### 6.3.12 SET ATSI DEFAULT PROGRAMMING

Menu Path: MENU / SET VIEW CONFIG / SETUP FOR ATSI TEST

Selecting this menu item will reset all the enhanced monitor settings to a setting appropriate for testing on an ATSI PCMT tester.

Function	Factory Default
Dual Indication Enable	Enabled
Red Fail Enable	Enabled
Flashing Yellow Arrow	Disabled
Y+R Clearance Monitor	Enabled

### 6.3.13 VIEW CONFIGURATION CHECK VALUE

Menu Path: MENU / SET VIEW CONFIG / CONFIG CHECK VALUE

The Configuration Check Value can be viewed with this menu item. The Configuration Check Value is a mathematical calculation based on all programming parameters of the MMU2-16LE *SmartMonitor*® including the Program Card parameters and TYPE SELECT input. This parameter can be used to easily compare the current monitor programming to an expected value. If the Configuration Check Value is different, the monitor configuration is not the same.

### **6.3.14 FLASHING YELLOW ARROW MONITOR**

Menu Path: MENU / SET VIEW CONFIG / FLASHING YEL ARROW

#### **6.3.14.1 FYA MODE SELECTION**

A configuration mode A thru L should be selected from the menu. For Type 12 operation, only modes A, C, G, and K are provided. See Section 3.11 for FYA Mode details. For each mode the display will show the permissive and protected channel pair assignments.

#### **6.3.14.2 FYA CHANNEL PAIR ENABLES**

Select up to four channel pairs (approaches) for FYA operation. When the channel pair (e.g. 1-9, 3-14, etc) is set to ON, those two channels are configured as an FYA channel pair (protected channel and permissive channel).

#### **6.3.14.3 RED AND YELLOW INPUT ENABLES**

Select whether the Red and Yellow inputs of the MMU2 are enabled on the channel pair that has only the Green input used (sparse channel). When the channel is set to ON, the Red and Yellow inputs will be monitored. When the channel is set to OFF, the Red and Yellow inputs will be set to 0 volts regardless of the actual voltage applied at the MMU2 input. See Section 3.11.5.

##### **6.3.14.3.1 RED AND GREEN INPUT DISABLES (MODES G AND H)**

Select whether the Red and Green inputs of the MMU2 are disabled on the channel pair that has only the Yellow FYA input used. When the channel is set to OFF, the Red and Green inputs will be monitored (default). When the channel is set to ON, the Red and Green inputs will be set to 0 volts (disabled) regardless of the actual voltage applied at the MMU2 input. See Section 3.11.5.1.

#### **6.3.14.4 FYA OPTIONS**

##### **6.3.14.4.1 FLASH RATE FAULT ENABLE**

When this option is set to ON, a stuck flashing yellow arrow signal will be detected as a fault condition if the input is sensed active for more than the FYA Flash Rate Fault time (Section 9). This option affects all enabled flashing yellow arrow channels. See Section 3.11.6.

##### **6.3.14.4.2 FYA TRAP DETECT ENABLE**

When this option is set to ON, a Conflict Trap fault will be detected when the Permissive Turn channel (flashing yellow arrow) sequences to the solid Yellow Arrow clearance while the Opposing Through channel is still driving a Green Ball. This option affects all enabled flashing yellow arrow channels. See Section 3.11.7.

### **6.4 SET-UP WIZARD**

Menu Path: MENU / SET-UP WIZARD




Menu Path: MENU / SET VIEW CONFIG / SET-UP WIZARD

The built-in Set-up Wizard configures the monitor enhanced-feature programming using a series of simple intersection related questions. It allows a technician to accurately and completely program the MMU2-16LE *SmartMonitor*® enhanced functions without the need for understanding the complexities of monitor enhanced configuration parameters.

A channel is described as "OTHER" in the Wizard process until it has been assigned to a UNUSED, PED, VEH+PED, or PP-TURN function.

For applications using Flashing Yellow Arrow (FYA), the FYA parameters should be configured first before running the Set-up Wizard.

#### 6.4.1 UNUSED CHANNELS

This step selects the channels of the MMU2-16LE *SmartMonitor*® that are not connected to a load switch, that is, unused. This selection can eliminate the need to connect the Red input of an unused channel to AC+. The NEXT button moves the ▼ symbol to the next channel number. The SELECT button will toggle from the OTHER state to the UNUSED state. A channel that is selected for UNUSED is indicated by the  and  and  icons illuminated.



Designating a channel as UNUSED does not affect the Conflict programming on the Program Card.

When all UNUSED channels have been selected, the EXIT button will display the navigation choices of NEXT, CANCEL, and EDIT. The NEXT choice continues the Wizard operation with the next programming step. The CANCEL choice will exit from the Wizard operation with no changes to the configuration data base. The EDIT choice will return to the Unused Channels step.

#### 6.4.2 PEDESTRIAN CHANNELS



This step selects the channels of the MMU2-16LE *SmartMonitor*® that are connected to a pedestrian load switch that drives the Walk and Don't Walk signal display. In NEMA TS-2 Type 16 mode, the Wizard will ask if the Don't Walk signal is to be monitored. Answering YES will configure the MMU2-16LE *SmartMonitor*® to respond to a Red Fail or Dual Indication (R+G) fault if the Don't Walk signal fails.

**In NEMA TS-1 Type 12 operation, this step is not required as the Walk input is programmed to the associated vehicle monitor channel (R, Y, G, W).**

The NEXT button moves the ▼ symbol to the next channel number. The SELECT button will toggle from the OTHER state to the PED state. A channel that is selected for PED is indicated by the  (and ) icons illuminated.

When all PED channels have been selected, the EXIT button will display the navigation choices of NEXT, CANCEL, and EDIT. The NEXT choice continues the Wizard operation with the next programming step. The CANCEL choice will exit from the Wizard operation with no changes to the configuration data base. The EDIT choice will return to the Pedestrian Channels step.

#### 6.4.3 PROTECTED-PERMISSIVE TURN CHANNELS

This step selects the channels of the MMU2-16LE *SmartMonitor*® that are connected to a protected-permissive left turn channel load switch that drives only a Green and Yellow signal display. This selection can eliminate the need to connect the Red input of a protected-permissive turn channel to AC+. This selection can also include a right turn overlap that drives only a Green and Yellow signal display. The NEXT button moves the ▼ symbol to the next channel number. The SELECT button will toggle from the OTHER state to the PP-TURN state. A channel that is selected for PP-TURN is indicated by the  and  icons illuminated.

When all PP-TURN channels have been selected, the EXIT button will display the navigation choices of NEXT, CANCEL, and EDIT. The NEXT choice continues the Wizard operation with the next programming step. The CANCEL choice will exit from the Wizard operation with no changes to the configuration data base. The EDIT choice will return to the Protected-Permissive Turn Channels step.

#### 6.4.4 REVIEW CHANNEL ASSIGNMENTS

This step provides a review of all the channels assignments selected in the previous steps. The NEXT button moves the ▼ symbol to the next channel number. All channels should be described as VEHICLE, UNUSED, PED, VEH+PED, or PP-TURN function. When all channels have been reviewed for correctness, the EXIT button will display the navigation choices of SET, CANCEL, and EDIT. The SET choice completes the Wizard operation and sets the new configuration parameters. The CANCEL choice will exit from the Wizard operation with no changes to the configuration data base. The EDIT choice will return to the first Wizard step.

- WARNING -

AFTER RUNNING THE SET-UP WIZARD ALL PARAMETERS SHOULD BE  
REVIEWED FOR CORRECTNESS AND CONSISTENCY WITH THE CABINET  
PROGRAMMING AND INTERSECTION GEOMETRY.

SOME CHANGES TO THE WIZARD RESULTS MAY BE REQUIRED  
DEPENDING ON CABINET WIRING OR OTHER CONSIDERATIONS.






## Section 7


### Front Panel Description

#### 7.1 MAIN STATUS DISPLAY

The Main Status Display of the MMU2-16LE *SmartMonitor*<sup>®</sup> is used to display the current status of the MMU2-16LE *SmartMonitor*<sup>®</sup> and navigate the menu levels. When the monitor is not in the fault mode, the Main Status display will show current monitor status. When the monitor is in the fault mode, the Main Status display will show the latched monitor status at the time of the fault.

#### 7.2 CHANNEL STATUS DISPLAY

Forty-eight Red , Yellow , and Green  icons are provided to display the complete intersection status of the field signal inputs to the MMU2-16LE *SmartMonitor*<sup>®</sup>. If the unit is operating normally without a fault condition present, the currently active field input signals will be displayed.

When the MMU2-16LE *SmartMonitor*<sup>®</sup> is operating in the Type 12 mode, twelve indicators for Walk  inputs are used to display active Walk inputs.

When the MMU2-16LE *SmartMonitor*<sup>®</sup> is in the fault mode, all channels that were involved the fault will be indicated by the ▼ symbol.

#### 7.3 FRONT PANEL LED INDICATORS

##### 7.3.1 POWER INDICATOR

The POWER indicator will flash at a rate of 2Hz when the AC LINE voltage is below the drop-out level. It will illuminate steadily when the AC LINE voltage returns above the restore level. See Sections 2.6 and 8.1.3.

##### 7.3.2 FAULT INDICATOR

The FAULT indicator will be illuminated whenever the MMU2-16LE *SmartMonitor*<sup>®</sup> is in the fault mode and the OUTPUT relay has transferred to the Fault position.

##### 7.3.3 DIAGNOSTIC INDICATOR

The DIAGNOSTIC indicator will illuminate when the MMU2-16LE *SmartMonitor*<sup>®</sup> has detected an internal diagnostic failure. Due to the nature of these hardware/firmware failures, other indicators that may also be displayed may not be valid for trouble shooting purposes. See Section 2.9.

##### 7.3.4 RECEIVE INDICATOR

The RECEIVE LED indicator will be pulsed each time a Port 1 SDLC message is correctly received from the Controller Unit.

##### 7.3.5 TRANSMIT INDICATOR

The TRANSMIT LED indicator will be pulsed each time a Port 1 SDLC message is transmitted to the Controller Unit.

##### 7.3.6 COMM INDICATOR

The COMM LED indicator will be pulsed each time an *ECom* message is correctly received on the EIA-232 Port or Ethernet Port.

## **7.4 FRONT PANEL BUTTONS**

### **7.4.1 RESET BUTTON**

Depressing the RESET button resets the MMU2-16LE *SmartMonitor*® after it has been triggered by a fault. When the RESET button is depressed all front panel indicators will be illuminated for 500 msec and the OUTPUT relay and START DELAY relay energized.

### **7.4.2 MENU CONTROL BUTTONS**

#### **7.4.2.1 NEXT BUTTON**

The NEXT navigation button is used to move to the next display window in a level of the menu (down), move the cursor, or increment the parameter (channel, input, log number, etc) of the current display function. See Section 5.1. Some display modes will indicate that the NEXT button affects a parameter by displaying a "<n>" symbol. Additional screens in a sequence are indicated by the "↓" symbol displayed in the lower right corner of the Main Status display.

#### **7.4.2.2 SELECT BUTTON**

The SELECT navigation button is used once the cursor (►) has been placed next to the desired parameter to enter or toggle the selection. See Section 5.1. Some display modes will indicate that the SELECT button affects a parameter by displaying a "<s>" symbol.

#### **7.4.2.3 EXIT BUTTON**

The EXIT navigation button is used to exit from a display mode and sets the new display mode one level back up the navigation tree. Continue to press the EXIT until the top level menu item is reached. See Section 5.1.

#### **7.4.2.4 HELP BUTTON**

The HELP button activates the context sensitive Help system. When the HELP button is pressed, the display will temporarily enter the Help system mode and display a screen that offers an explanation of the current menu item. Pressing the HELP button or the NEXT button will display additional screens in the sequence if available. Additional screens in a display sequence are indicated by the "↓" symbol displayed in the lower right corner of the Main Status display.

The EXIT button is pressed to exit the Help system mode. The display mode will then return to the last selected menu display level.

##### **7.4.2.4.1 INVOKING THE DIAGNOSTIC WIZARD**

The HELP button automatically activates the Diagnostic Wizard when the display mode is currently at the top level menu (see Section 5.2) AND the unit is in the fault state. When the HELP button is pressed, the display will enter the Diagnostic Wizard mode and display a sequence of screens that help diagnose the current fault. Pressing the HELP button or the NEXT button will display additional screens in the sequence if available. Additional screens in a display sequence are indicated by the "↓" symbol displayed in the lower right corner of the Main Status display.

The HELP button also automatically activates the Diagnostic Wizard when the display mode is set to the Display Previous Failure (PF) log menu item (see Section 5.2.2.1).

The EXIT button is pressed to exit the Diagnostic Wizard mode. The display mode will then return to the last selected display level.

## Section 8 Specifications

### 8.1 ELECTRICAL

#### 8.1.1 POWER REQUIREMENTS

Operating Line Voltage.....	75 to 135 Vrms
Operating Line Frequency .....	60 $\pm$ 3Hz
Power Consumption .....	10W (nominal)

#### 8.1.2 AC VOLTAGE MONITORS

NEMA Green Signal Inputs	
No Detect .....	less than 15 Vrms
Detect.....	greater than 25 Vrms
NEMA Yellow Signal Inputs	
No Detect .....	less than 15 Vrms
Detect.....	greater than 25 Vrms
NEMA Walk Signal Inputs	
No Detect .....	less than 15 Vrms
Detect.....	greater than 25 Vrms
NEMA Red Signal Inputs	
No Detect .....	less than 50 Vrms
Detect.....	greater than 70 Vrms
<i>LEDguard</i> ® Low Threshold Signal Inputs	
No Detect .....	less than 15 Vrms
Detect.....	greater than 25 Vrms
<i>LEDguard</i> ® High Threshold Signal Inputs	
No Detect .....	less than 50 Vrms
Detect.....	greater than 70 Vrms
Red Enable Input	
No Detect .....	less than 70 Vrms
Detect.....	greater than 89 Vrms

#### 8.1.3 POWER FAIL MONITOR

AC Line Input	
Dropout .....	less than 89 Vrms
Restore.....	greater than 98 Vrms

#### 8.1.4 DC VOLTAGE MONITOR

+24V MONITOR I, +24V MONITOR II	
Fault .....	less than 18 Vdc
No Fault.....	greater than 22 Vdc
+24V MONITOR II input with “24V-2 = 12 Vdc” mode selected	
Fault .....	less than 9 Vdc
No Fault.....	greater than 11 Vdc

#### 8.1.5 LOGIC INPUTS

Controller Voltage Monitor (CVM), External Reset, +24V Monitor Inhibit, Port 1 Disable, Type Select, Local Flash, and External Watchdog Input	
True (low) .....	less than 8 Vdc
False (high) .....	greater than 16 Vdc

### 8.2 MECHANICAL

Height.....	10.5 inches
Width.....	4.5 inches
Depth .....	8.5 inches

**8.3 ENVIRONMENTAL**

Storage Temperature Range .....	-45 to +85 °C
Operating Temperature Range.....	-34 to +74 °C
Main Status LCD Operating Temperature Range .....	-20 to +74 °C
Channel Status LCD Operating Temperature Range .....	-34 to +74 °C
Humidity Range (non-condensing) .....	0 to 95% Relative

## Section 9

### Timing Functions

#### Conflict

No Fault.....	less than 200 msec
Fault.....	greater than 450 msec
Typical.....	350 msec

#### Red Fail

No Fault.....	less than 700 msec
Fault.....	greater than 1000 msec
Typical.....	850 msec

#### Controller Voltage Monitor (CVM)

No Fault.....	less than 125 msec
Fault.....	greater than 175 msec
Typical.....	150 msec

#### +24Vdc Monitor

No Fault.....	less than 125 msec
Fault.....	greater than 175 msec
Typical.....	150 msec

#### Local Flash Status

No Fault.....	less than 125 msec
Fault.....	greater than 175 msec
Typical.....	150 msec

#### Clearance Fail

No Fault.....	greater than 2.8 second
Fault.....	less than 2.6 second
Typical.....	less than 2.7 second

#### Port 1 Fail

Typical.....	300 msec
--------------	----------

#### Field Check Fail

Typical.....	1000 msec
--------------	-----------

#### Dual Indication

No Fault.....	less than 200 msec
Fault.....	greater than 500 msec
Typical.....	400 msec

#### Dual Indication (Pedestrian Channels)

No Fault.....	less than 700 msec
Fault.....	greater than 1000 msec
Typical.....	850 msec

#### MMU Power Fail

Respond.....	greater than 500 msec
No Response.....	less than 450 msec
Minimum Flash.....	6 to 16, $\pm 1$ second
Start Delay.....	2.0 $\pm 0.5$ second

#### FYA Flash Rate

No Fault.....	less than 700 msec
Fault.....	greater than 1000 msec
Typical.....	950 msec

## Section 10 Wiring Assignments

### 10.1 TYPE 16 TERMINATIONS

#### 10.1.1 TYPE 16 CONNECTOR MS-A PIN TERMINATIONS

Pin	Function	I/O
A	AC Line	[I]
B	Output Relay 1 Open (Stop Time, Closes when fault occurs)	[O]
C	Output Relay 2 Closed (FTR Drive, Opens when fault occurs)	[O]
D	Channel 12 Green	[I]
E	Channel 11 Green	[I]
F	Channel 10 Green	[I]
G	Channel 9 Green	[I]
H	Channel 8 Green	[I]
J	Channel 7 Green	[I]
K	Channel 6 Green	[I]
L	Channel 5 Green	[I]
M	Channel 4 Green	[I]
N	Channel 3 Green	[I]
P	Channel 2 Green	[I]
R	Channel 1 Green	[I]
S	+24 Monitor I	[I]
T	Logic Ground	[I]
U	Earth Ground	[I]
V	AC Neutral	[I]
W	Output Relay 1 Common (Stop Time)	[I]
X	Output Relay 2 Common (FTR Drive)	[I]
Y	Channel 12 Yellow	[I]
Z	Channel 11 Yellow	[I]
AA	Spare 1	[-]
BB	Reset	[I]
CC	Cabinet Interlock A	[I]
DD	Cabinet Interlock B	[I]
EE	Channel 14 Yellow	[I]
FF	Channel 16 Green	[I]
GG	Spare 2	[-]
HH	Type Select	[I]
a	Channel 10 Walk (Type 12 only)	[I]
b	Channel 10 Yellow	[I]
c	Channel 9 Yellow	[I]
d	Channel 8 Yellow	[I]
e	Channel 7 Yellow	[I]
f	Channel 6 Yellow	[I]
g	Channel 5 Yellow	[I]
h	Channel 3 Yellow	[I]
i	Channel 15 Green	[I]
j	Channel 2 Yellow	[I]
k	Channel 1 Yellow	[I]
m	Controller Voltage Monitor	[I]

Pin	Function	I/O
n	+24V Monitor Inhibit	[I]
p	Output Relay 1 Closed (Stop Time, Opens when fault occurs)	[O]
q	Output Relay 2 Open (FTR Drive, Closes when fault occurs)	[O]
r	Channel 12 Walk (Type 12 only)	[I]
s	Channel 11 Walk (Type 12 only)	[I]
t	Channel 9 Walk (Type 12 only)	[I]
u	Channel 16 Yellow	[I]
v	Channel 15 Yellow	[I]
w	Channel 13 Yellow	[I]
x	Channel 4 Yellow	[I]
y	Channel 14 Green	[I]
z	Channel 13 Green	[I]

### 10.1.2 TYPE 16 CONNECTOR MS-B PIN TERMINATIONS

Pin	Function	I/O
A	AC Line	[I]
B	Start-Delay Relay Common	[I]
C	Start-Delay Relay Open (Closes during Start Delay period)	[O]
D	Channel 12 Red	[I]
E	Channel 11 Red	[I]
F	Channel 9 Red	[I]
G	Channel 8 Red	[I]
H	Channel 7 Red	[I]
J	Channel 6 Red	[I]
K	Channel 5 Red	[I]
L	Channel 4 Red	[I]
M	Channel 2 Red	[I]
N	Channel 1 Red	[I]
P	Spare 1	[-]
R	+24V Monitor II	[I]
S	External Watchdog (Spare 2)	[-]
T	Channel 13 Red	[I]
U	Start-Delay Relay Closed (Open during Start Delay period)	[O]
V	Channel 10 Red	[I]
W	Channel 14 Red	[I]
X	Channel 15 Red	[I]
Y	Channel 16 Red	[I]
Z	Channel 3 Red	[I]
a	Red Enable	[I]
b	Spare 3	[-]
c	Local Flash Status	[I]

### 10.2 TYPE 12 TERMINATIONS

#### 10.2.1 TYPE 12 CONNECTOR MS-A PIN TERMINATIONS

Pin	Function	I/O
A	AC Line	[I]

Pin	Function	I/O
B	Output Relay 1 Open (Stop Time, Closes when fault occurs)	[O]
C	Output Relay 2 Closed (FTR Drive, Opens when fault occurs)	[O]
D	Channel 12 Green	[I]
E	Channel 11 Green	[I]
F	Channel 10 Green	[I]
G	Channel 9 Green	[I]
H	Channel 8 Green	[I]
J	Channel 7 Green	[I]
K	Channel 6 Green	[I]
L	Channel 5 Green	[I]
M	Channel 4 Green	[I]
N	Channel 3 Green	[I]
P	Channel 2 Green	[I]
R	Channel 1 Green	[I]
S	+24 Monitor I	[I]
T	Logic Ground	[I]
U	Earth Ground	[I]
V	AC Neutral	[I]
W	Output Relay 1 Common (Stop Time)	[I]
X	Output Relay 2 Common (FTR Drive)	[I]
Y	Channel 12 Yellow	[I]
Z	Channel 11 Yellow	[I]
a	Channel 10 Walk	[I]
b	Channel 10 Yellow	[I]
c	Channel 9 Yellow	[I]
d	Channel 8 Yellow	[I]
e	Channel 7 Yellow	[I]
f	Channel 6 Yellow	[I]
g	Channel 5 Yellow	[I]
h	Channel 3 Yellow	[I]
i	Channel 3 Walk	[I]
j	Channel 2 Yellow	[I]
k	Channel 1 Yellow	[I]
m	Controller Voltage Monitor	[I]
n	+24V Monitor Inhibit	[I]
p	Output Relay 1 Closed (Stop Time, Opens when fault occurs)	[O]
q	Output Relay 2 Open (FTR Drive, Closes when fault occurs)	[O]
r	Channel 12 Walk	[I]
s	Channel 11 Walk	[I]
t	Channel 9 Walk	[I]
u	Channel 8 Walk	[I]
v	Channel 7 Walk	[I]
w	Channel 5 Walk	[I]
x	Channel 4 Yellow	[I]
y	Channel 2 Walk	[I]
z	Channel 1 Walk	[I]
AA	Spare 1	[-]
BB	Reset	[I]
CC	Cabinet Interlock A	[I]
DD	Cabinet Interlock B	[O]



Pin	Function	I/O
EE	Channel 6 Walk	[I]
FF	Channel 4 Walk	[I]
GG	Spare 2	[-]
HH	Type Select	[I]

### 10.2.2 TYPE 12 CONNECTOR MS-B PIN TERMINATIONS

Pin	Function	I/O
A	AC Line	[I]
B	Start-Delay Relay Common	[I]
C	Start-Delay Relay Open (Closes during Start Delay period)	[O]
D	Channel 12 Red	[I]
E	Channel 11 Red	[I]
F	Channel 9 Red	[I]
G	Channel 8 Red	[I]
H	Channel 7 Red	[I]
J	Channel 6 Red	[I]
K	Channel 5 Red	[I]
L	Channel 4 Red	[I]
M	Channel 2 Red	[I]
N	Channel 1 Red	[I]
P	Spare 1	[-]
R	+24V Monitor II	[I]
S	External Watchdog (Spare 2)	[-]
T	Channel 13 Red (Type 16 only)	[I]
U	Start-Delay Relay Closed (Open during Start Delay period)	[O]
V	Channel 10 Red	[I]
W	Channel 14 Red (Type 16 only)	[I]
X	Channel 15 Red (Type 16 only)	[I]
Y	Channel 16 Red (Type 16 only)	[I]
Z	Channel 3 Red	[I]
a	Red Enable	[I]
b	Spare 3	[-]
c	Local Flash Status	[I]

Connector MS-B pins: T,W,X,Y are called out as spare pins in TS1-1989. OPEN contacts of the OUTPUT relay are the contacts which are open when the MMU is in the NO conflict state and all voltages are sufficient for proper operation of the controller assembly.

### 10.3 HARNESSING CONNECTORS

All field signal terminations are brought into the MMU2-16LE *SmartMonitor*® by means of Military Specification MIL-C-26482 connectors. These connectors are interchangeable with 12 channel monitors as defined by NEMA Traffic Control Systems Specification TS1-1989, part 6. Connector A will intermate with a MS 3116 22-55 SZ. Connector B will intermate with a MS 3116 16-26 S.

### 10.4 MMU2-16LE-RM & MMU2-16LEIP-RM RACK MOUNT CONNECTOR

The MMU main connector is a three row DIN 4161296 Header Type.

Pin	Description	Pin	Description	Pin	Description
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Pin	Description	Pin	Description	Pin	Description
A1	AC Neutral	B1	Reset	C1	Logic Ground
A2	Local Flash Status	B2	PORT1 Rx C -	C2	PORT1 Rx C +
A3	24 Volt Inhibit	B3	PORT1 Rx D -	C3	PORT1 Rx D +
A4	CVM / FM	B4	PORT1 Tx C -	C4	PORT1 Tx C +
A5	+24 Volt Monitor I	B5	PORT1 Tx D -	C5	PORT1 Tx D +
A6	+24 Volt Monitor II	B6	Reserved	C6	Port 1 Disable
A7	Channel 1 Green	B7	Channel 1 Yellow	C7	Channel 1 Red
A8	Channel 2 Green	B8	Channel 2 Yellow	C8	Channel 2 Red
A9	Channel 3 Green	B9	Channel 3 Yellow	C9	Channel 3 Red
A10	Channel 4 Green	B10	Channel 4 Yellow	C10	Channel 4 Red
A11	Channel 5 Green	B11	Channel 5 Yellow	C11	Channel 5 Red
A12	Channel 6 Green	B12	Channel 6 Yellow	C12	Channel 6 Red
A13	Channel 7 Green	B13	Channel 7 Yellow	C13	Channel 7 Red
A14	Channel 8 Green	B14	Channel 8 Yellow	C14	Channel 8 Red
A15	Channel 9 Green	B15	Channel 9 Yellow	C15	Channel 9 Red
A16	Channel 10 Green	B16	Channel 10 Yellow	C16	Channel 10 Red
A17	Channel 11 Green	B17	Channel 11 Yellow	C17	Channel 11 Red
A18	Channel 12 Green	B18	Channel 12 Yellow	C18	Channel 12 Red
A19	Channel 13 Green	B19	Channel 13 Yellow	C19	Channel 13 Red
A20	Channel 14 Green	B20	Channel 14 Yellow	C20	Channel 14 Red
A21	Channel 15 Green	B21	Channel 15 Yellow	C21	Channel 15 Red
A22	Channel 16 Green	B22	Output Relay 1 Open (Stop Time, closes during fault)	C22	Output Relay 1 Open (Stop Time, closes during fault)
A23	Channel 16 Yellow	B23	Output Relay 1 Relay Common (Stop Time)	C23	Output Relay 1 Relay Common (Stop Time)
A24	Channel 16 Red	B24	Output Relay 1 Closed (Stop Time, opens during fault)	C24	Output Relay 1 Closed (Stop Time, opens during fault)
A25	Red Enable	B25	Output Relay 2 Open (FTR Drive, closes during fault)	C25	Output Relay 2 Open (FTR Drive, closes during fault)
A26	Cabinet Interlock A	B26	Output Relay 2 Relay Common(FTR Drive)	C26	Output Relay 2 Relay Common(FTR Drive)
A27	Cabinet Interlock B	B27	Output Relay 2 Closed (FTR Drive, opens during fault)	C27	Output Relay 2 Closed (FTR Drive, opens during fault)
A28	Reserved	B28	Start Delay Relay Open (closes during start delay)	C28	Start Delay Relay Open (closes during start delay)
A29	Reserved	B29	Start Delay Relay Common	C29	Start Delay Relay Common
A30	Reserved	B30	Start Delay Relay Closed (opens during start delay)	C30	Start Delay Relay Closed (opens during start delay)
A31	Earth Ground	B31	AC Line	C31	AC Line
A32	Logic Ground	B32	AC Neutral	C32	AC Neutral

Pins A31 (Earth Ground), B32 (AC-Neutral), and C32 (AC- Neutral) pre-mate before all other pins.

## 10.5 PROGRAMMING CARD PIN CONNECTIONS

### 10.5.1 PROGRAMMING CARD P1 CONNECTOR

Pin	Row A Channel Pair	Row B Channel Pair	Row C Channel Pair
1	1-2	1-3	1-4
2	1-5	1-6	1-7
3	1-8	1-9	1-10
4	1-11	1-12	1-13
5	1-14	1-15	1-16
6	2-3	2-4	2-5
7	2-6	2-7	2-8
8	2-9	2-10	2-11
9	2-12	2-13	2-14
10	2-15	2-16	3-4
11	3-5	3-6	3-7
12	3-8	3-9	3-10
13	3-11	3-12	3-13
14	3-14	3-15	3-16
15	4-5	4-6	4-7
16	4-8	4-9	4-10
17	4-11	4-12	4-13
18	4-14	4-15	4-16
19	5-6	5-7	5-8
20	5-9	5-10	5-11
21	5-12	5-13	5-14
22	5-15	5-16	6-7
23	6-8	6-9	6-10
24	6-11	6-12	6-13
25	6-14	6-15	6-16
26	7-8	7-9	7-10
27	7-11	7-12	7-13
28	7-14	7-15	7-16
29	8-9	8-10	8-11
30	8-12	8-13	8-14
31	8-15	8-16	9-10
32	Common	Reserved	Common

### 10.5.2 PROGRAMMING CARD P2 CONNECTOR

Pin	Row A Channel Pair	Row B Channel Pair	Row C Channel Pair
1	9-11	9-12	9-13
2	9-14	9-15	9-16
3	10-11	10-12	10-13
4	10-14	10-15	10-16
5	11-12	11-13	11-14

6	11-15	11-16	12-13
7	12-14	12-15	12-16
8	13-14	13-15	13-16
9	14-15	14-16	15-16
10	MYCD-1	MYCD-2	MYCD-3
11	MYCD-4	MYCD-5	MYCD-6
12	MYCD-7	MYCD-8	MYCD-9
13	MYCD-10	MYCD-11	MYCD-12
14	MYCD-13	MYCD-14	MYCD-15
15	MYCD-16	Reserved	Reserved
16	Reserved	Reserved	Reserved
17	Reserved	Reserved	Reserved
18	Reserved	Reserved	Reserved
19	Reserved	Reserved	Reserved
20	Reserved	Reserved	Reserved
21	Minimum Flash b8	Minimum Flash b4	Minimum Flash b2
22	Minimum Flash b1	24V Latch Enable	CVM Latch Enable
23	Reserved	Reserved	Reserved
24	Reserved	Reserved	Reserved
25	Reserved	Reserved	Reserved
26	Reserved	Reserved	Reserved
27	Reserved	Reserved	Reserved
28	Reserved	Reserved	Reserved
29	Reserved	Reserved	Reserved
30	Reserved	Reserved	Reserved
31	Reserved	Reserved	Reserved
32	Common	Common	Common

NOTE—MYCD-n refers to Minimum Yellow Change Disable input for channel n

## 10.6 PORT 1 CONNECTOR

The Port 1 connector intermates with a 15 pin D type connector, AMP Incorporated part number 205206-1 or equivalent.

Pin	Function
1	Rx Data +
2	Logic Ground
3	Rx Clock +
4	Logic Ground
5	Tx Data +
6	Logic Ground
7	Tx Clock +
8	Logic Ground
9	Rx Data-
10	Port 1 Disable (0 VDC = disable)
11	Rx Clock-

Pin	Function
12	Earth Ground
13	Tx Data-
14	Reserved
15	Tx Clock-

## 10.7 EIA-232 CONNECTOR

Pin	Function	I/O
1	DCD	O
2	Tx DATA	O
3	Rx DATA	I
4	DTR	I
5	GROUND	-
6	DSR	O
7	CTS	I
8	RTS	O
9	NC	-

If the monitor DTR Enable option is selected (See ***EDI Ecom Software Operations Manual***) the Data Terminal Ready (DTR) input must be in the high state (>4 Vdc) for the monitor EIA-232 port (DCE device) to be active. DCD, DSR, CTS, and RTS are provided for compatibility with Data Terminal Equipment (DTE device) control signals. If required by the Data Terminal Equipment device (Personal Computer), DCD may be driven high by inserting internal jumper E8. If the Data Terminal Equipment device uses CTS instead of DTR to control data flow, insert internal jumper E9 and remove internal jumper E7.

### 10.7.1 EIA-232 CABLE TO A PC

A typical cable assembly for a DB-9 connector on the PC would be a straight through connection as follows:

PC DB-9		Monitor DB-9
RX pin 2	connect to	TX pin 2
TX pin 3	connect to	RX pin 3
DTR pin 4	connect to	DTR pin 4 (optional)
GND pin 5	connect to	GND pin 5

A typical cable assembly for a DB-25 connector on the PC would be as follows:

PC DB-25		Monitor DB-9
RX pin 3	connect to	TX pin 2
TX pin 2	connect to	RX pin 3
DTR pin 20	connect to	DTR pin 4 (optional)
GND pin 7	connect to	GND pin 5

## 10.8 ETHERNET LAN PORT (J2)

The optional Ethernet port must be configured with specific network parameters such as an IP address, Mask, and Port. The network port parameters are set or changed using the EDI Ecom Signal Monitor Communications software. See the "***EDI Ecom Software Operations Manual***" ETHERNET LAN SETTINGS, Section 3.2.1.2 for details.

### **10.8.1 ETHERNET LAN CABLE**

The LAN cable required is a typical Cat-5 network cable using the 8 pin RJ-45 connector. If the connection is from the monitor to a switch or hub, a standard LAN cable is needed. If the connection is from the monitor directly to a network adaptor (PC), a cross-over or patch cable is needed.