# MMU-16E

## NEMA TS-2
## Malfunction Management Unit

## Operations Manual

THIS MANUAL CONTAINS TECHNICAL INFORMATION FOR THE
**MMU-16E SERIES** MALFUNCTION MANAGEMENT UNIT.

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THE MMU-16E SERIES IS DESIGNED AND MANUFACTURED
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## MAINTENANCE NOTE

**THIS 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 GENERAL DESCRIPTION

The MMU-16E 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 MMU-16E 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 MMU-16E is directly interchangeable with a standard NEMA Malfunction Management Unit and meets with or exceeds all specifications outlined in Section 4 (Malfunction Management Unit) of the National Electrical Manufacturers Association (NEMA) ***Standards Publication TS2-2003 v02.06, Traffic Controller Assemblies With NTCIP Requirements*** .

The MMU-16E 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 v02.06, Traffic Controller Assemblies With NTCIP Requirements***. 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 MMU-16E 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 MMU-16E 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 specifications, the MMU-16E 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 MMU-16E 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 MMU-16E 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 MMU-16E 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 allow the Controller Unit and the MMU-16E to perform redundant checks on each other. The

Controller Unit has access to all MMU-16E 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 MMU-16E receives information from the Controller Unit which corresponds to the Controller Unit output commands to the load switches. This allows the MMU-16E to better respond to and diagnose fault situations.

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

### 1.2 FIELD SIGNAL TERMINALS

A GREEN, YELLOW, or WALK field signal input will be sensed as active by the MMU-16E when it exceeds the Green, Yellow, or Walk Signal Detect voltage threshold (Section 7.1.2) 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 7.1.2). 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 MMU-16E when it exceeds the Red Signal Detect voltage threshold (Section 7.1.2) and a field signal input will be sensed as inactive when it is less than the Red Signal No-Detect voltage threshold (Section 7.1.2). Both positive and negative half wave rectified inputs will be sensed. All unused RED (DON'T WALK) field signal inputs must be terminated to AC LINE.

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 v02.06, Traffic Controller Assemblies With NTCIP Requirements***).

#### 1.2.1 *LEDGUARD*® LED FIELD SIGNAL SENSING

The MMU-16E can be configured to use a technique called *LEDguard*® that is designed to better monitor the characteristics of LED based signal loads (See Section 5.2.7). 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 7.1.2) have been determined using the input RMS voltage, the individual fault monitor functions use the appropriate threshold to determine if a fault condition exists.

| *LEDguard*® | Green/Walk | Yellow | Red/Don't Walk |
|---|---|---|---|
| **Conflict** | Low | Low | --- |
| **Red Fail** | High | High | High |
| **Dual Indication** | Low | Low | Low |
| **Clearance** | Low | Low | High |

#### 1.2.2 TYPE SELECT INPUT

The MMU-16E will operate as a Type 16 monitor with sixteen channels when the TYPE SELECT input is at a logic True (low). The MMU-16E will operate as a Type 12 monitor with twelve channels when the TYPE SELECT input is at a logic False (high).

Type 16 - Each channel has three inputs: RED (DONT WALK), YELLOW, and GREEN (WALK).

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

The MMU-16E 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 MMU-16E monitoring functions are the same as the Type 16 mode except that Port 1 communications are disabled, Field Check Monitoring is disabled, and the Type 12 front panel indicator will be illuminated.

# Section 2
# Standard Functions

## 2.1 OUTPUT RELAY RECOVERY

Prior to the MMU-16E transferring the Output Relay contacts from the fault state to the no-fault state, a transition state with of duration 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.

## 2.2 CONFLICT MONITORING

When voltages on any conflicting channels are sensed as active for more than the Conflict Fault time (Section 7.4), the MMU-16E will enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and illuminate the CONFLICT indicator. The MMU-16E 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 (Section 7.4), the MMU-16E will not transfer the OUTPUT relay contacts to the Fault position.

The MMU-16E 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 5.1 for Programming Card details.

## 2.3 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 7.4), the MMU-16E will enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and illuminate the RED FAIL indicator. The MMU-16E 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 (Section 7.4), the MMU-16E 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 PORT 1 DISABLE input is False (high) and the LOAD SWITCH FLASH bit is set to "1" in the Type 0 message from the Controller Unit.

## 2.4 RED ENABLE INPUT

The RED ENABLE input will be sensed as active by the MMU-16E when it exceeds the Red Enable Input threshold (Section 7.1.2). The presence of the proper operating voltage at this input enables Red Fail Monitoring, Minimum Yellow Change/Red Clearance Monitoring, and Dual Indication Monitoring.

The RED FAIL indicator will flash once every 2 seconds if the RED ENABLE input is not active, or in the Type 16 mode, if the LOAD SWITCH FLASH bit is set to "1" in the Type 0 message from the Controller Unit.

### 2.4.1 WALK DISABLE OPTION

This option will modify the operation of Red Fail and Dual Indication Monitoring in the Type 12 mode only. When enabled, the Red Fail 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 MMU-16E into the fault mode causing the Output relay contacts to transfer.

This function is enabled by the front panel option switch labeled "WALK DISABLE". See Section 5.2.4.

### 2.5 VOLTAGE MONITORING

#### 2.5.1 +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 MMU-16E will enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and illuminate the appropriate 24V-1 or 24V-2 indicator. The MMU-16E will automatically reset the OUTPUT relay when the correct input voltages are restored to both of these inputs. However, the MMU-16E 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 7.1.4) applied to both of the +24V MONITOR inputs will be sensed by the MMU-16E as adequate for operation of the cabinet assembly. A voltage less than the +24V Monitor input threshold (Section 7.1.4) 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 7.4), the MMU-16E 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 (Section 7.4), the MMU-16E 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.

##### 2.5.1.1 +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. The 24V-1 and 24V-2 indicators will flash once every 2 seconds if the +24V MONITOR INHIBIT input is TRUE.

##### 2.5.1.2 +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 5.1.4 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.

#### 2.5.2 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 7.4), the MMU-16E will enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and illuminate the CVM/WATCHDOG indicator. When the TRUE (low) state is absent for less than the CVM No-Fault time (Section 7.4), the MMU-16E will not transfer the OUTPUT relay contacts to the Fault position. The MMU-16E will automatically reset the OUTPUT relay when the True (low) state is restored to the input. However, the MMU-16E 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.

##### 2.5.2.1 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 5.1.4 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.

#### 2.5.2.2 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 5.2.6. If this option is enabled it also overrides the CVM Monitor Latch Option described in Section 2.5.2.1 such that CVM events will not be logged or latched.

### 2.6 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 7.4), the MMU-16E will enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and illuminate the LOCAL FLASH indicator. When the TRUE (low) state is present for less than the Local Flash No-Fault time (Section 7.4), the MMU-16E will not transfer the OUTPUT relay contacts to the Fault position. The MMU-16E will automatically reset the OUTPUT relay when the False (high) state is restored to the input. However, the MMU-16E 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.

### 2.7 MINIMUM YELLOW CHANGE / RED CLEARANCE MONITORING

#### 2.7.1 MINIMUM YELLOW CHANGE INTERVAL

The MMU-16E will verify that the Yellow Change interval is at least the Clearance Fail Fault time (Section 7.4). 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 MMU-16E will enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and illuminate the CLEARANCE FAIL indicator. The MMU-16E will remain in the fault mode until the unit is reset by the RESET button or the EXTERNAL RESET input.

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 5.1.3 for the programming procedure.

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

#### 2.7.2 MINIMUM YELLOW PLUS RED INTERVAL

The MMU-16E 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 7.4). When this minimum interval is not satisfied the MMU-16E will enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and illuminate the Y+R CLEARANCE indicator. The MMU-16E 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.

### 2.8 MMU POWER FAILURE DETECTION

When the AC LINE voltage is below the minimum AC Line drop-out level (Section 7.1.2) for the MMU Power Fail Respond time (Section 7.4), the MMU-16E 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.

When the AC LINE voltage returns above the maximum AC Line restore level (Section 7.1.2) for the MMU Power Fail Restore time (Section 7.4), 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 5.1.2 ).

This expanded operating voltage range for cabinet components allows the MMU-16E 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 MMU-16E 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.

### 2.9 PORT 1 COMMUNICATIONS

When operating in the Type 16 mode and connected to a TS2 Controller Unit, the MMU-16E 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 v02.06***.

The information transmitted from the Controller Unit to the MMU-16E consists of the following message types: load switch driver commands (Type 0), time and date (Type 9). The information transmitted from the MMU-16E 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 8.4.

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 MMU-16E adds enhanced communications diagnostics and error handling capabilities to ensure proper communications occur.

#### 2.9.1 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 7.4), the MMU-16E will enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and illuminate the PORT 1 FAIL indicator. When receipt of a Type 0 message again occurs, the MMU-16E 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 MMU-16E 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.

### 2.9.2 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). The PORT 1 FAIL indicator will flash every 2 seconds if the TYPE SELECT input is True (low) and the PORT 1 DISABLE input is True (low) (i.e. Type 16 mode with Port 1 disabled).

### 2.9.3 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 MMU-16E to indicate the type of failure detected for extended fault monitoring capabilities of the MMU-16E. Refer to sections 3.10, 3.2, 3.2.1, 3.8, 3.2.2, and 2.7.2 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 |
| GY-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 |

## 2.10 INTERNAL DIAGNOSTICS

The MMU-16E is supplied with a resident series of self check diagnostic capabilities which monitor for correct operation of the MMU-16E 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 MMU-16E verifies the operation of all memory components including RAM, EPROM, and non-volatile EEPROM. During operation the MMU-16E continuously performs a check sum verification of the non-volatile memory components. When either diagnostic test fails, the MMU-16E 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 2.8). 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 MMU-16E 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 MMU-16E 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 I/O HARDWARE MONITOR

The MMU-16E contains circuitry which verifies the operation of the internal input/output interface circuitry. On power-up, the MMU-16E verifies that the circuitry which interfaces to the Programming Card, display LEDs, and front panel dip switches is functioning properly. If a malfunction is detected, the MMU-16E 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 2.8). Due to the nature of this hardware failure, other fault indicators that may be concurrently displayed with the DIAGNOSTIC indicator may not be valid.

The following extended features are provided on the Eberle Design MMU-16E for additional monitoring functions and to increase the reliability of the MMU-16E monitor operation.

# Section 3
# Extended Features

## 3.1 HARDWARE FEATURES

The MMU-16E is a dual microprocessor based unit. All monitoring functions and features are firmware programmable which permits upgrades or modifications by simply replacing the EPROM device containing the firmware with the upgraded version. Thus, most changes to the MMU-16E 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 which samples each AC input voltage 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 MMU-16E 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

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 7.4), the MMU-16E will enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and illuminate the DUAL INDICATION indicator. 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 MMU-16E 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 200 msec, the MMU-16E 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 bulbs, broken field wire) 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 result in a Dual Indication Fault.**

A set of switches labeled FIELD CHECK/DUAL ENABLES is provided on the MMU-16E front panel to enable Dual Indication Monitoring on a per channel basis. See Section 5.2.7 for the programming procedure.

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

### 3.2.1 GY-DUAL INDICATION MONITORING

This monitoring function detects simultaneous inputs of active Green and Yellow field signal inputs on the same channel. It can be used to monitor channels which have an unused Red field signal input tied to AC LINE such as a five section signal head. When voltages on the Green and Yellow field signal inputs of a channel are sensed as active for more than the Dual Indication Fault time (Section 7.4), the MMU-16E will enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and illuminate the DUAL INDICATION indicator. 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 MMU-16E will remain in the fault mode until the unit is reset by the RESET button or the EXTERNAL RESET input. When voltages on the Green and Yellow field signal inputs of a channel are sensed as active for less than the Dual Indication No-Fault time (Section 7.4), the MMU-16E will not transfer the OUTPUT relay contacts to the Fault position. GY-Dual Indication Monitoring may be enabled concurrently with Dual Indication Monitoring.

GY-Dual Indication Monitoring is enabled by the front panel option switch labeled GY ENABLE (see Section 5.2.1). When the GY-Dual Indication Monitoring option is enabled, all channels which have the front panel FIELD CHECK/DUAL ENABLE switches OFF will be individually monitored for simultaneous active Green and Yellow field signal inputs. All channels which have the front panel FIELD CHECK/DUAL ENABLE switches ON (i.e. enabled for Dual Indication Monitoring) will function as described above in Section 3.2.

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

#### 3.2.1.1 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. 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 front panel option switch labeled WALK DISABLE (see Section 5.2.4)

### 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 MMU-16E does not receive a change in state on the EXTERNAL WATCHDOG input for the External Watchdog Fault time (Section 7.4), the MMU-16E will enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and illuminate the CVM/WD indicator. 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 MMU-16E 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 CVM/WD fault state of the monitor (see Section 2.8).

This function is enabled by the front panel option switch labeled WD ENABLE (see Section 5.2.3). The EXTERNAL WATCHDOG input is harnessed to spare pin MSB-S on the front panel B connector by the factory.

### 3.4 CONFIGURATION CHANGE MONITORING

The MMU-16E maintains an internally calculated check value of the current configuration settings. These settings include all Program Card jumpers, FC/Dual Enable switches, Option switches, and internal jumpers. On power-up, reset, and periodically during operation, the unit will compare the current configuration settings with the previously stored

value. If the settings have changed, the MMU-16E will automatically log the new setting. This Check value can be displayed using the ECcom software.

The MMU-16E will log a change in configuration following a 30 second delay from the last change or a Reset command. This provides time to select and change multiple settings before the event is actually logged.

When the Configuration Change Fault select option (CF ENABLE) is On (see Section 5.2.5), any change in the configuration parameters will cause the MMU-16E to enter the fault mode causing the Output relay contacts to close. To indicate this fault mode the PGM CARD / CF indicator will flash at a 4 Hz rate. Depressing the Reset button for 5 full seconds will clear this fault and log the new configuration parameters. To make a change in configuration without causing a fault, the CF ENABLE switch should be in the Off position. Once the desired changes have been made, Reset the unit and restore the CF Enable switch to the On position.

If the CF ENABLE option switch is Off, the unit will not set the fault mode but will still log the configuration change.

### 3.5 PROGRAM CARD ABSENT INDICATION

If the Program Card is absent or not seated properly in the edge connector, the MMU-16E will enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and illuminate the PGM CARD / CF indicator. The MMU-16E will remain in the fault mode until the Program Card is correctly seated and the MMU-16E is reset by the RESET button or the EXTERNAL RESET input.

### 3.6 RESET INPUT DETECTION

Activation of the front panel RESET button or the EXTERNAL RESET input will reset the MMU-16E 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 MMU-16E from monitoring any fault condition. This function prevents the Cabinet Assembly from being operated with the monitor unit disabled due to a faulty RESET button or EXTERNAL RESET input.

### 3.7 DISPLAY LED TEST

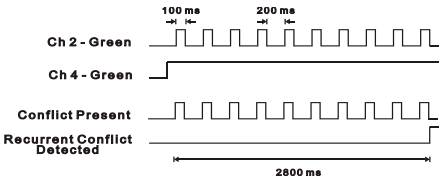
The monitor will illuminate all front panel LED indicators for a maximum of 500ms when a Reset command is issued by the front panel RESET button or EXTERNAL RESET input.

### 3.8 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. Since normal Conflict detection requires a continuous fault of at least 350 ms typical, this event could go undetected. The Recurrent

Pulse detection algorithm will combine 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 MMU-16E will enter the fault mode, transfer the Output relay contacts to the Fault position, and illuminate the appropriate CONFLICT, DUAL, or RED FAIL indicator along with the RECURRENT PULSE STATUS indicator. 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. Recurrent Pulse detection can be disabled with the RP DISABLE option switch, see Section 5.2.2.

### 3.9 TYPE FAULT

The TYPE SELECT input is used by the MMU-16E 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 1.2.1). This input is read by the MMU-16E 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 MMU-16E can only be modified when the unit is reset by the RESET button or EXTERNAL RESET input. This prevents the possibility of the MMU-16E 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 MMU-16E compares the programmed configuration mode with the state of the TYPE SELECT input. If they are different, the MMU-16E will enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, illuminate the DIAGNOSTIC indicator, and flash the TYPE 12 indicator at a 2Hz rate. The MMU-16E will remain in the fault mode until the unit is reinitialized with the TYPE SELECT input in the proper state or the MMU-16E is reset by the RESET button or the EXTERNAL RESET input.

### 3.10 FIELD CHECK MONITORING

Field Check Monitoring is an enhanced function of the Eberle Design MMU-16E made possible by the Port 1 communications between the Controller Unit and the MMU in a TS2 Cabinet Assembly. When operating in the Type 16 mode the MMU-16E 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 MMU-16E, the Type 0 message information received while the fault condition was being timed will be used by the MMU-16E to determine whether the sensed field signal input status corresponded to the Controller Unit output commands. This diagnostic information may then be used to isolate whether the fault condition was caused by a Controller Unit malfunction or a failure in the load switch and/or field wiring.

The Field Check Monitor function is enabled for each channel individually (see Section 5.2.7) and provides two modes of operation, **Field Check Fault** and **Field Check Status**.

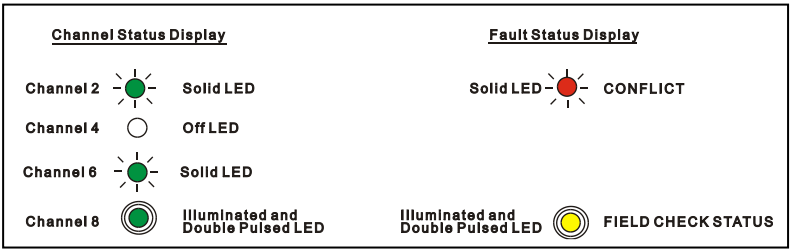
### 3.10.1 FIELD CHECK FAULT

In the **Field Check Fault** mode, when the field signal input states sensed as active or inactive by the MMU-16E do not correspond with the data provided by the Controller Unit in the Type 0 message for 10 consecutive messages, the MMU-16E will enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and illuminate the FIELD CHECK FAIL indicator. The Channel Status Display will indicate the channels on which the Field Check error was detected (see Section 6.1 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 MMU-16E 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.

### 3.10.2 FIELD CHECK STATUS

The **Field Check Status** mode works in combination with the other fault monitoring functions of the MMU-16E 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 MMU-16E, the Channel Status Display and Fault Status Display will correspond to that detected fault. If Field Check errors were detected while the fault was being timed, the FIELD CHECK STATUS indicator will also illuminate. Bit #67 (Spare Bit #1) of the Type #129 response frame will be set to indicate Field Check errors have been detected. The inputs on which the Field Check error was detected will double pulse at the same time as the FIELD CHECK STATUS indicator.

The figure below illustrates an example of the **Field Check Status** mode display. In this 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 MMU-16E will detect a Conflict Fault with Field Check Status on channel 8 Green. The CONFLICT and FIELD CHECK STATUS indicators are illuminated and the FIELD CHECK STATUS indicator is **double pulsed** every 6 seconds. Channel indicators 2, 6, and 8 are illuminated to indicate the proceed channels active at the time of the fault. Channel indicator 8 Green will **double pulse** at the same time as the FIELD CHECK STATUS indicator to indicate that the MMU-16E detected a different field signal input state than what the Controller Unit specified in the Type 0 message. This diagnostic information indicates that the malfunction was due to a field problem rather than a Controller Unit failure and directly identifies the channel and color of the faulty input.



# Section 4
# Event Logging

## 4.1 EDI *ECCOM* MONITOR REPORT

The EDI *ECcom* software package (Version 3.0 or greater is required) interfaces a Computer to the MMU-16E. 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 log. 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*** and will not be covered in this manual. The EDI *ECcom* software package is available free of charge at www.EDItraffic.com. The following data is available:

### 4.1.1 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.

### 4.1.2 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.

### 4.1.3 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.

### 4.1.4 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.

### 4.1.5 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.

### 4.1.6 CONFIGURATION (CF) EVENT LOG

Program Card Matrix: the permissive programming for each channel.

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

FC/Dual Enable Switches: the switch programming for each channel.

Option Switches: GY Enable, RP Disable, WD Enable, Walk Disable, CF Enable, CVM Log Disable.

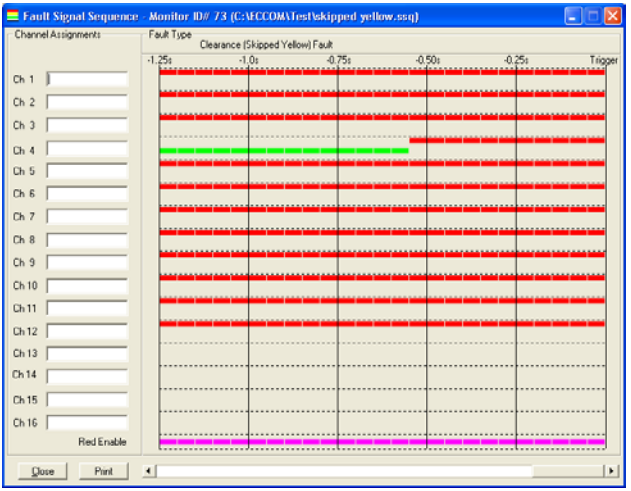
NEMA Inputs: 24V Inhibit, Type Select, Port 1 Disable.

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

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

### 4.1.7 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 MMU-16E fault trigger. These five event logs are not cleared by a Reset or power-down of the MMU-16E and will remain until the unit is triggered by another fault event. This new event entry automatically overwrites the oldest event data.



# Section 5
# Installation

## 5.1 PROGRAM CARD PROGRAMMING

The MMU-16E contains an interchangeable Programming Card which uses soldered wire jumpers to program the permissive channel pairs, Minimum Flash time, Minimum Yellow Change Disable, +24V Latch Enable, and CVM Latch Enable inputs.

### 5.1.1 PERMISSIVE CHANNEL PROGRAMMING

The MMU-16E Programming 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. **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 MMU-16E.**

Example: If channel 2 Green and Yellow is **PERMISSIVE** with channel 6 Green and Yellow, solder a jumper wire into the jumper pair labeled "2-6".

If the Program Card is absent or not seated properly in the edge connector, the MMU-16E will enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and illuminate the PGM CARD / CF indicator. The MMU-16E will remain in the fault mode until the Program Card is correctly seated and the MMU-16E is reset by the RESET button or the EXTERNAL RESET input.

### 5.1.2 MINIMUM FLASH TIME PROGRAMMING

The Programming Card also 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 MMU-16E 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 MMU-16E transfers the OUTPUT relay and places the intersection into operation.

#### 5.1.3 MINIMUM YELLOW CHANGE DISABLE PROGRAMMING

The MMU-16E Programming 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 greater than 3 seconds.

#### 5.1.4 VOLTAGE MONITOR LATCH PROGRAMMING

The MMU-16E Programming 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 MMU-16E 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.

### 5.2 OPTION SWITCH PROGRAMMING

The MMU-16E provides six independently programmed options which are controlled by the front panel DIP switch labeled OPTIONS.

#### 5.2.1 GY ENABLE OPTION

The GY-Dual Indication Monitoring function is **ENABLED** by setting the Option switch #1 labeled GY ENABLE to the ON position. See Section 3.2.1.

#### 5.2.2 RP DISABLE OPTION

The Recurrent Pulse Detection function is **DISABLED** by setting the Option switch #2 labeled RP DISABLE to the ON position. See Section 3.8.

#### 5.2.3 WD ENABLE OPTION

The External Watchdog Monitoring function is **ENABLED** by setting the Option switch #3 labeled WD ENABLE to the ON position. See Section 3.2.2.

#### 5.2.4 WALK DISABLE OPTION

The Walk Disable function is **ENABLED** by setting the Option switch #4 labeled WALK DISABLE to the ON position. See Section 2.4.1 and Section 3.2.2.

#### 5.2.5 CF ENABLE OPTION

The Configuration Change Fault function is **ENABLED** by setting the Option switch #5 labeled CF ENABLE to the ON position. See Section 3.4.

#### 5.2.6 CVM LOG DISABLE OPTION

The CVM Log function is **DISABLED** by setting the Option switch #6 labeled CVM LOG DISABLE to the ON position. See Section 2.5.2.2.

### 5.2.7 *LEDGUARD*® ENABLE OPTION

The *LEDguard*® Monitoring function is **ENABLED** by setting the Option switch #7 labeled LEDguard to the ON position. See Section 1.2.1.

### 5.3 FIELD CHECK / DUAL ENABLE SWITCH PROGRAMMING

The Field Check/Dual Enable switches are used to enable **both** Field Check Fail Monitoring (Section 3.10) and Dual Indication Monitoring (Section 3.2) for each individual channel. The dip switches are located below the Channel Status Display on the front panel and are labeled "1" to "16" corresponding to channels 1 through 16, respectively. Positioning a switch in the ON position **ENABLES** a channel for Field Check Monitoring **and** Dual Indication Monitoring.

In general, a channel monitoring a standard vehicle movement should have the Field Check/Dual Enable switch ENABLED. A channel monitoring a pedestrian movement with a load on both the Red (Don't Walk) and Yellow load switch outputs should also have the Field Check/Dual Enable switch ENABLED. In certain instances depending on the Controller Unit programming and the cabinet wiring, the Controller Unit output commands to the load switches may not correspond to the field signal inputs detected by the MMU-16E and would therefore produce a Field Check Fault. The following list describes several examples where the Field Check/Dual Enable switch for that channel 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. A channel is used as a pedestrian channel which is not monitoring the Yellow load switch output (e.g. no load on Yellow).
4. A channel is used as a pedestrian channel which is not monitoring the Don't Walk load switch output (i.e. the Red field signal input to the MMU-16E is tied to AC LINE).
5. A separate MMU-16E channel is monitoring an overlap signal which is generated in hardware from another vehicle channel load switch output.

The Field Check/Dual Enable switch for a channel must be DISABLED for those channels which have more than one input active simultaneously (Dual indication Monitoring) as in examples #1 and #4 above (see also Section 3.2.1 GY-Dual Indication Monitoring).

### 5.4 HARNESSING CONNECTORS

All field signal terminations are brought into the MMU-16E 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.

# Section 6
# Front Panel Description

## 6.1 CHANNEL STATUS DISPLAY

Forty-eight Red, Yellow, and Green LEDs are provided to display the complete intersection status of the field signal inputs to the MMU-16E. If the unit is operating normally without a fault condition present, the currently active field input signals will be displayed.

When the MMU-16 is operating in the Type 12 mode, the indicators for Green channels 13-16 are used to display Walk Channels 1-4, the indicators for Yellow channels 13-16 are used to display Walk Channels 5-8, and the indicators for Red channels 13-16 are used to display Walk Channels 9-12 respectively.

Once the MMU-16E has been triggered by a fault the channel status display will sequence through several display modes automatically:

1. Active Signals
2. Field signals active at the time of the fault for 6 seconds.
3. Fault Channels (if applicable)
    a. The channels involved in the fault will flash their respective Green AND Yellow AND Red indicators simultaneously at a 4 Hz rate for 2 seconds.
4. Field Check Status (if applicable)
    a. The inputs with Field Check Status will flash their respective indicators simultaneously with the FIELD CHECK STATUS indicator at a 4 Hz rate for 2 seconds.
5. Recurrent Pulse Status (if applicable)
    a. The inputs with Recurrent Pulse Status will flash their respective indicators simultaneously with the RECURRENT PULSE STATUS indicator at a 4 Hz rate for 2 seconds.

## 6.2 FAULT STATUS DISPLAY

The Fault Status Display of the MMU-16E displays thirteen fault conditions in addition to the Type 12 or 16 mode and AC LINE status.

**1. CONFLICT Indicator**

The CONFLICT indicator will be illuminated when a Conflict Fault is detected. See Section 2.2.

**2. RED FAIL Indicator**

The RED FAIL indicator will be illuminated when a Red Fail Fault is detected. See Section 2.3.

The RED FAIL indicator will flash once every 2 seconds if the RED ENABLE input is not active, or in the Type 16 mode, if the LOAD SWITCH FLASH bit is set to "1" in the Type 0 message from the Controller Unit.

**3. CVM / WD (Controller Voltage Monitor / Watchdog) Indicator**

The CVM / WD indicator will be illuminated when a Controller Voltage Monitor Fault is detected. See Section 2.5.2.

If the External Watchdog monitor option (WD ENABLE) is enabled and the MMU-16E is triggered by an External Watchdog output failure, the CVM / WD indicator will be illuminated. See Section 3.2.2.

**4. 24V-1, 24V-2 (Voltage Monitor) Indicators**

These indicators will be illuminated when the MMU-16E has detected a +24V MONITOR-1 or +24V MONITOR-2 failure. See Section 2.5.1.

The 24V-1 and 24V-2 indicators will flash once every 2 seconds if the +24V MONITOR INHIBIT input is TRUE.

**5. CLEARANCE FAIL Indicator**

The CLEARANCE FAIL indicator will be illuminated when a Minimum Yellow Change Fault is detected. See Section 2.7.1.

**6. Y+R CLEARANCE Indicator**

The Y+R CLEARANCE indicator will be illuminated when a Yellow Change plus Red Clearance Fault is detected. The channel(s) that caused the Y+R Clearance fail will show only the Green indicator during the Fault Channel sequence. See Section 2.7.2.

**7. DUAL INDICATION Indicator**

The DUAL INDICATION indicator will be illuminated when a DUAL INDICATION Fault is detected. See Section 3.2.

**8. PORT 1 FAIL Indicator**

The PORT 1 FAIL indicator will be illuminated when a Port 1 Failure is detected. See Section 2.9.1.

The PORT 1 FAIL indicator will flash every 2 seconds if the TYPE SELECT input is True (low) and the PORT 1 DISABLE input is True (low) (i.e. Type 16 mode with Port 1 communications disabled).

**9. FIELD CHECK FAIL Indicator**

The FIELD CHECK FAIL indicator will be illuminated when a Field Check Fault is detected. See Section 3.10.1.

**10. LOCAL FLASH Indicator**

The LOCAL FLASH indicator is illuminated when the LOCAL FLASH STATUS input is True. See Section 2.6.

**11. DIAGNOSTIC Indicator**

The DIAGNOSTIC indicator will illuminate when the MMU-16E 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 2.10.

If a Type Fault is detected the DIAGNOSTIC indicator will be illuminated and the TYPE 12 indicator will flash at a rate of 2Hz. See Section 3.9.

**12. PGM CARD / CF Indicator**

The PGM CARD / CF indicator will illuminate when the Program Card is removed or not inserted fully. See Section 3.5.

If the unit is in the Configuration Change Fault (CF) mode, the PGM CARD / CF indicator will flash at a 4 Hz rate. See Section 3.4.

**13. TYPE 12 Indicator**

The TYPE 12 indicator is illuminated when the MMU-16E is programmed for Type 12 operation. If a Type Fault is detected the DIAGNOSTIC indicator will be illuminated and the TYPE 12 indicator will flash at a rate of 2Hz. See Section 3.9.

**14. 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 Section 2.8.

**15. FIELD CHECK STATUS Indicator**

The FIELD CHECK STATUS indicator will illuminate when a fault has been detected with Field Check Status. The indicator will then flash at a rate of 4Hz for a 2 second interval when the Channel Status display is showing the inputs with Field Check Status. See Section 3.10.2, 6.1.

**16. RECURRENT PULSE STATUS Indicator**

The RECURRENT PULSE STATUS indicator will illuminate when a Conflict, Red Fail, or Dual Indication fault has been detected with Recurrent Pulse Status. The indicator will then flash at a rate of 4Hz for a 2 second interval when the Channel Status display is showing the inputs with Recurrent Pulse Status. See Section 3.8, 6.1.

**17. RECEIVE Indicator**

The RECEIVE indicator will be illuminated for a 20 msec pulse each time a Port 1 message is correctly received from the Controller Unit.

**18. TRANSMIT Indicator**

The TRANSMIT indicator will be illuminated for a 20 msec pulse each time a Port 1 message is transmitted to the Controller Unit.

**19. COMM Indicator**

The COMM indicator will be illuminated for a 20 msec pulse each time a message is correctly received on the EIA-232 Port.

## 6.3 BUTTONS

### 6.3.1 RESET BUTTON

Depressing the RESET button resets the MMU-16E 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 relay energized.

When the Configuration Change Fault select option (CF ENABLE) is On (see Section 3.4), any change in the configuration parameters will cause the MMU-16E to enter the fault mode causing the Output relay contacts to close. Depressing the Reset button for 5 full seconds will clear this fault and log the new configuration parameters.

# Section 7
# Specifications

## 7.1 ELECTRICAL

### 7.1.1 POWER REQUIREMENTS

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

### 7.1.2 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

*LEDguard*® Low Threshold Signal Inputs
- No Detect ..... less than 15 Vrms
- Detect ..... greater than 25 Vrms

*LEDguard*® 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

### 7.1.3 POWER FAIL MONITOR

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

### 7.1.4 DC VOLTAGE MONITOR

+24 Vdc Inputs
- Fault ..... less than 18 Vdc
- No Fault ..... greater than 22 Vdc

### 7.1.5 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

## 7.2 MECHANICAL

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

## 7.3 ENVIRONMENTAL

Storage Temperature Range ..... -45 to +85 $^{o}$C
Operating Temperature Range ..... -34 to +74 $^{o}$C

Humidity Range ..... 0 to 95% Relative

**7.4 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
- (Fault time depends on Type 0 message repetition rate from Controller Unit)

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
- Typical ..... 475 msec

Minimum Flash ..... 6 to 16, $\pm$1 second

Start Delay ..... 2.0 $\pm$0.5 second

# Section 8
# Connector Assignments

## 8.1 TYPE 16 TERMINATIONS

### 8.1.1 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] |

### 8.1.2 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] |

## 8.2 TYPE 12 TERMINATIONS

### 8.2.1 TYPE 12 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] |
| 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] |

| Pin | Function | I/O |
|---|---|---|
| CC | Cabinet Interlock A | [I] |
| DD | Cabinet Interlock B | [O] |
| EE | Channel 6 Walk | [I] |
| FF | Channel 4 Walk | [I] |
| GG | Spare 2 | [-] |
| HH | Type Select | [I] |

### 8.2.2 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<br>(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<br>(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.

### 8.3 HARNESSING CONNECTORS

All field signal terminations are brought into the MMU-16E 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.

### 8.4 PROGRAMMING CARD PIN CONNECTIONS

#### 8.4.1 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 |

#### 8.4.2 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

**8.5 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<br>(0 VDC = disable) |
| 11 | Rx Clock- |
| 12 | Earth Ground |
| 13 | Tx Data- |

| Pin | Function |
|---|---|
| 14 | Reserved |
| 15 | Tx Clock- |

### 8.6 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 ECcom 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 (PC), DCD may be driven high by inserting an internal jumper E8. If the Data Terminal Equipment device uses CTS instead of DTR to control data flow, insert internal jumper E10 and remove internal jumper E7.

#### 8.6.1 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 | |