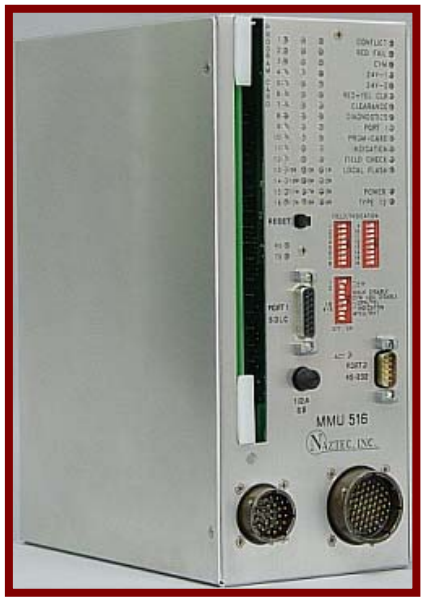
Naztec Operations Manual

For

Model MMU-516E

TS2 MMU
(Malfunction Management Unit)



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1. OVERVIEW

The Naztec MMU-516E Malfunction Management Unit monitors the traffic signal indications from its location in a Traffic Controller Cabinet Assembly. Conflicting signal indications, improper sequencing of signals, incorrect timing and improper signal voltage levels are all checked by the MMU-516E. The MMU-516E Malfunction Management Unit is fully compliant with the National Electrical Manufacturers Association (NEMA) Standard TS2-1998, Section 4, for 16 Channel Malfunction Management Units for use in traffic control systems. The MMU-516E is also capable of operating in older TS1 type cabinets, and is compatible with 12 Channel Conflict Monitor Units (CMU) conforming to the NEMA Standard TS1-1989.

1.1 Monitoring

The MMU-516E will operate in a TS2 type cabinet with up to sixteen Channels consisting of three 115 Volt AC input circuits each, denoted by: Green/Walk, Yellow, and Red/Don't Walk. The MMU-516E will also operate in a TS1 type cabinet with twelve Channels consisting of four 115 Volt AC input circuits each, denoted by: Green, Yellow, Red, and Walk. These two operating modes of the MMU, denoted by Type 16 and Type 12, are configured by the voltage applied to the DC Input **Type Select**. The MMU will operate in the Type 16 mode when the Type Select Input is at a logic True state. The MMU will operate in the Type 12 mode when the Type Select Input is at a logic False state (no connection to pin), and will illuminate the TYPE 12 LED on the front panel.

When installed in a traffic control cabinet, the MMU-516E monitors the voltages applied to conflicting channels for occurrences of proceeding indications active at the same time. Each channel is also monitored for "dark" or "red failure" conditions due to absence of voltage on all input circuits. Another monitoring function checks the duration of the yellow indication on each channel for being either too short, or skipped completely. The time from the termination of a green indication on each channel until the start of a green indication on any conflicting channel (yellow plus red clearance) is also checked. The Red Enable Input is frequently monitored for proper voltage level, and the AC Line monitoring for being above brown-out level is also performed as part of the NEMA specification.

Two DC Inputs, +24 Volt I and +24 Volt II, are carefully monitored to be sure the cabinet and/or Controller Unit power supplies are providing the proper voltage. Several DC logic level inputs are also checked. The DC logic level input Controller Voltage Monitor is sampled to be sure it is in a logic level True state (low). The Type Select, +24 Volt Monitor Inhibit and Port 1 Disable Inputs are checked to determine the proper operating mode, the Local Flash Input is checked, and the Reset Input (same as Reset Switch) is also sampled frequently.

The MMU-516E performs a check on all RAM circuits at power-up, and both the non-volatile data memory and program memory are continually sampled during operation, and compared to previously computed check sum values. The microprocessor is monitored by a watch dog timer circuit that can override the microprocessor in the event of a failure and transfer the output relay to the fault state. When operating in the Type 16 mode, the frequency of Port 1 message activity is also compared to acceptable standards in the NEMA TS2 specifications.

The MMU-516E includes enhanced monitoring features not addressed in the NEMA TS1 standard. The first of these is monitoring for invalid combinations of multiple active outputs, or indications, on a channel; such as green and red being active at the same time. Green - Yellow dual indication monitoring can be enabled for common groups of channels, even when an individual channel has dual indication monitoring disabled. A diagnostic check is frequently made to verify that the Programming Card is properly inserted into its mating connectors. When operating in the Type 16 mode in a TS2 cabinet, the MMU-516E is able to compare the Channel Inputs with the SDLC Channel data from the Controller Unit, and respond to any discrepancies found.

1.2 Relay Outputs

If any of the monitored items are outside of normal operating conditions, the monitor transfers its output relay to the "fault" state. This DPDT relay is normally wired in the controller assembly so that when it is in the fault state, the signals are transferred to a flashing indication. In addition to fault conditions, the output relay is held in the "fault" or non-operating state for a short period after AC power is applied to the malfunction management unit. This period is called the Minimum Flash Time, and it is programmed with soldered wire jumpers on the Programming Card.

A second relay, the Start Delay Relay, is provided with SPDT contacts, and transfers to the normal operating state 2.0 seconds after power-up of the monitor. This relay transfers to the power-down state if AC line voltage drops below brown-out level for more than 500 milliSeconds. The Start Delay Relay is normally used to control the power-up sequence of equipment in the controller cabinet assembly.

1.3 Front Panel

All connectors, indicators and operator controls are located on the front panel of the MMU-516E unit. Channel and control input signals and relay output connections are made through two Military Specification MIL-C-26482 connectors, and the SDLC Port is an A size, 15 contact, D shell connector. The Port 2 connector is an E size, 9 pin D shell connector. The Programming Card and the AC Line fuse are easily accessed from the front panel.

1.4 Other Features

The MMU-516E provides a Reset Timeout feature to prevent a broken switch or accidental wiring fault from holding the unit in the reset state for an extended period of time. LED fault status indicators provided, beyond the TS2 specifications, include: Dual Indication Fault, Yellow plus Red Clearance Fault, Programming Card Ajar, Field Check Fault, and LED's for the second +24 Volt DC Input Fault and the CVM Input Fault. Status indicators provided include: AC Line Power, Type 12 Indicator, SDLC Transmitter Active, and SDLC Message Received.

1.5 Data Logging

The MMU-516E performs data logging of all of its inputs, and provides a report when requested over Port 2. A C Power line disturbances of all types and all faults are also recorded, and can be reported over Port 2. All program card information and front panel switch selections are also available in a program status report. For operator convenience, the intersection Station Number and a verbal description of the location appear at the top of each report.

2. OPERATION DESCRIPTION

2.1 STANDARD MONITORING

2.1.1 Channel Inputs

When operated in the Type 12 mode, the MMU-516E has twelve Channels with four input circuits per channel, designated as: Green, Yellow, Walk and Red. When operated in the Type 16 mode, the MMU-516E has sixteen Channels with three input circuits per channel, designated as: Green, Yellow and Red. A channel is considered active if the Green, Yellow, or Walk Input circuit has greater than 25 Volts AC applied. The channel is inactive if the Green, Yellow, or Walk Input circuit has less than 15 Volts AC applied. The Red Input circuit of a channel is ON when the measured voltage is greater than 70 Volts AC; also the Red Input is considered OFF when the measured voltage is less than 50 Volts AC.

2.1.2 Conflict

A conflict occurs when two channels which are not permitted to be active at the same time become so. Two channels that are permitted to be active simultaneously are called compatible or permissive. Channels not allowed together are termed conflicting. Permissive channels are programmed in pairs by soldering jumper wires in the Programming Card. If there are no jumper wires installed, each channel conflicts with all others. The Programming Card is used for both Type 12 and Type 16 operation.

A conflict occuurs when conflicting channels are active together for 450 milliSeconds or longer. If the conflicting channels are active for less than 200 milliSeconds, no conflict occurs.

Once a conflict is detected, the Output Relay transfers to the fault state and maintains or “latches” this state until the Reset Button is pressed, or the External Reset Input is active. Since a conflict fault is latched, it can not be cleared by removing power to the MMU-516E and then applying power again.

2.1.3 Red Failure and Red Enable Input

The MMU-516E is capable of monitoring channels for the absence of voltage (channel inactive plus Red Input circuit OFF) on a channel. This feature is enabled by AC voltage (greater than 89 Volts AC) being present on the Red Enable Input. The Red Enable Input being inactive (less than 70 Volts AC) is the only condition necessary to inhibit Red Fail monitoring. A Red Failure occurs when there are no active (input ON) inputs on a channel for greater that 1000 milliSeconds. No active inputs on a channel for less than 700 milliSeconds is not recognized as a fault. A Red Failure is a latched fault and requires the Reset Button to be pressed to reset the fault. When the MMU-516E is operating in the Type 16 mode, Red Fail monitoring is also disabled when the LOAD SWITCH FLASH bit in the SDLC Type 0 message from the Controller Unit is set to 1.

2.1.4 Skip Yellow Failure

Skip yellow monitoring checks for the omission of the yellow clearance interval in the cycling of the indications of a channel. If the active inputs of a channel move from green to red without an intervening yellow, then a skip yellow fault is declared, and the Output Relay transfers to the latched fault state. To avoid nuisance faulting due to transients and noise on the channel inputs, the green and red inputs must have been active for about 330 milliSeconds before being ON for the purposes of declaring a skipped yellow indication. The Reset Button must be pressed, or an active External Reset signal applied to reset the faulted state.

Skip yellow monitoring will be disabled for a channel when a jumper wire is soldered in the channel’s Minimum Yellow Change Channel Disable position on the Programming Card. Skip yellow monitoring will also be disabled when the Red Enable Input is inactive. When the unit is operating in the Type 16 mode, skip yellow monitoring is also disabled when the LOAD SWITCH FLASH bit in the SDLC Type 0 message from the Controller Unit is set to 1.

2.1.5 Minimum Yellow Failure

Minimum Yellow monitoring checks for yellow indication intervals that are shorter than the Minimum Yellow time of 2.7 seconds. If the active inputs of a channel move from green to red in less than 2.7 seconds, then a minimum yellow fault is declared, and the Output Relay transfers to the latched fault state. The green and red inputs must have been active for about 330 milliSeconds before being ON to avoid nuisance faulting due to transients and noise on the channel inputs. The Reset Button must be pressed, or an active External Reset signal applied to reset the faulted state.

Minimum yellow monitoring will be disabled for a channel when a jumper wire is soldered in the channel's Minimum Yellow Change Channel Disable position on the Programming Card, or when the Red Enable Input is inactive. When the unit is operating in the Type 16 mode, minimum yellow monitoring is also disabled when the LOAD SWITCH FLASH bit in the SDLC Type 0 message from the Controller Unit is set to 1.

2.1.6 Minimum Yellow Change Plus Red Clearance Failure

Minimum Yellow Change plus Red Clearance Interval monitoring checks the elapsed time between the end of an active green indication on a channel and the beginning of an active green indication on a conflicting channel. If the time interval is less than 2.7 seconds, a minimum yellow change plus red clearance fault is declared. The Reset Button must be pressed, or an active External Reset signal applied to reset the faulted state.

Minimum Yellow Change plus Red Clearance Interval monitoring will be disabled when the Red Enable Input is inactive. When the unit is operating in the Type 16 mode, minimum yellow change plus red clearance monitoring is also disabled when the LOAD SWITCH FLASH bit in the SDLC Type 0 message from the Controller Unit is set to 1.

2.1.7 +24 Volt DC I & II Inputs

Two +24 Volt DC inputs are monitored for ensuring adequate supply voltage in the controller assembly. If the voltage at either input falls below 18 volts DC, the output relay transfers to the fault state for the duration of the low voltage condition. 24 Volt I & II faults are normally not latched; therefore, when the voltage at both inputs returns to the nominal value, the output relay returns to the non-fault state. A reset is not required to return to normal monitoring for a non-latched fault.

As a programmable option on the Programming Card, 24 Volt I & II faults may be latched. If this option is enabled by soldering a jumper wire in the +24 Volt Latch Enable position on the Programming Card, then any 24 volt faults will be latched and an operator or remote reset is required to clear the fault. A +24 Volt DC fault condition during Minimum Flash Time or during a power brown-out will not be latched.

+24 Volt monitoring may be disabled by placing a logic true voltage at the **+24 Volt Monitor Inhibit** Input. A logic true voltage is a level less than 8 VDC. A voltage of greater than 16 VDC at the 24 Volt Monitor Inhibit input, or if the input is left unconnected, enables monitoring at the +24 VDC I and II inputs.

2.1.8 Controller Voltage Monitor Input

The MMU-516E monitors an input called the Controller Voltage Monitor input for an active "True" logic level of less than 8 VDC. If a low level is not detected, a "CVM" fault is recognized and the output relay is transferred to the fault state. Normally, CVM is a non-latched fault and the monitor returns to normal operation when a low level is sensed at the CVM input. In this case, a reset is not required to restore normal monitoring. The CVM input is intended to be connected to a traffic signal controller and provides a means for the controller to indicate that it is ready to operate the signals.

As a programmable option, CVM faults may be latched. If this option is enabled by soldering a jumper wire in the CVM Latch Enable position on the Programming Card, then any CVM faults will be latched and an operator or remote reset is required to clear the fault. A CVM fault condition during Minimum Flash Time or during a power brown-out will not be latched.

2.1.9 Port 1 Disable Input

Port 1 is used only when the MMU-516E is operating in the Type 16 mode, and thus is disabled when operating in the Type 12 mode (Type Select Input at high level). A low level on the Port 1 Disable Input will disable Port 1 (such as when a port disable plug is connected) when operating in the Type 16 mode. When Port 1 is disabled and the unit is operating as a Type 16 MMU, the PORT 1 LED will flash every two seconds.

2.1.10 Local Flash Input

The Local Flash input is monitored to determine when the cabinet is placed in the local flash state. An inactive "False" logic level of greater than 16 VDC is the normal input, but when a high level is not detected, a "Local Flash" fault is recognized and the output relay is transferred to the fault state.

2.1.11 AC Line Voltage

AC line voltage is continuously monitored for being present at an adequate level to allow proper operation of the controller assembly. If line voltage is too low for a long enough time, the MMU-516E transfers the output and start delay relays in response to a power-down condition. The MMU-516E recognizes "brown-out" at about 92 VAC. Hysteresis of about 4 VAC is used to prevent the MMU-516E from cycling in and out of brownout when the line voltage is near the brownout threshold. Therefore, return to monitoring from power interruption occurs when line voltage reaches 96 VAC.

Note that the MMU-516E operates internally at much lower line voltages than the power interruption thresholds described in the previous paragraph.

2.1.12 Power-up Sequencing

After an AC Line power loss of 500 milliSeconds or longer, the MMU-516E operates the Start Delay and Output relays in the following manner. Following the restoration of AC Line voltage, the Start Delay Relay is energized 2.0 seconds later. The Output Relay is held in the de-energized (or fault) state for the duration of the Minimum Flash Time. If the power-up diagnostic tests disclose no problems, no latched faults existed before loss of power, and all non-latched inputs are at satisfactory levels, the Output Relay is energized; otherwise, the Output Relay stays in the fault state. Although Port 1 monitoring is disabled while timing Minimum Flash, Port 1 communication must be established during this time (if operating in the Type 16 mode) to prevent a very rapid return to the fault state.

2.2 DIAGNOSTIC MONITORING

The MMU-516E performs many diagnostic tests on a continuous basis during all operating modes. All memory elements, the microprocessor, operating voltages and critical circuitry are checked.

2.2.1 Programming Card Monitoring

The Programming Card monitoring functions include checking for a missing or improperly connected Programming Card and checking the card interface circuits. Any detected problems result in a latched Programming Card fault. After the problem has been corrected, the Reset Button must be pressed, or an active External Reset signal applied to reset the faulted state.

2.2.2 RAM Test

As part of the power-up and initialization sequence of the MMU, the data storage memory is tested by writing and then reading back several patterns in each memory location. Any problems encountered in this test will cause a non-latched fault. The Reset Button cannot normally be used to reset this type of fault.

2.2.3 EPROM Monitoring

Each program memory location for the microprocessor is read and used to calculate a check value. The finished calculation of the check value is compared to a preprogrammed value. A difference in the two values will cause a non-latched fault. This calculation is performed at a rate exceeding 1024 bytes sampled per second. The Reset Button cannot normally be used to reset this type of fault.

2.2.4 EEPROM Monitoring

Each non-volatile data memory location is read and used to calculate a check value. The finished calculation of the check value is compared to the first calculated value made following the last write to non-volatile memory. A difference in the two values will cause a non-latched fault. This test is also performed at a very high sampling rate. The Reset Button cannot normally be used to reset this type of fault.

2.2.5 Microprocessor Monitoring

The MMU-516E has circuitry independent from the microprocessor to monitor the microprocessor's operation. If the microprocessor does not signal the monitor circuit for 200 milliSeconds, a fault will be generated and the Output Relay will transfer to the fault state. Because of the severity of a problem of this nature, the status indicators and Reset Button may not function properly.

2.3 ENHANCED MONITORING

Enhanced monitoring features are discussed in this section. These features describe MMU-516E features that are not included in the TS2 specifications.

2.3.1 Indication Failure

An indication failure is one in which an invalid combination of signal voltages is present on the inputs of a channel. Invalid combinations are any that include more than one of the Green, Yellow, or Red Inputs being active at the same time. Also, when operating in the Type 12 mode, a single Walk indication on a channel and all dual indications involving Walk with a color are invalid, except a Green & Walk dual indication is allowed.

An indication failure situation that persists for greater that 1000 milliSeconds is declared a fault and latches the Output Relay in the fault state. An indication failure situation that persists for less that 700 milliSeconds is not recognized as a fault. The Reset Button must be pressed, or an active External Reset signal applied to reset the faulted state.

The Indication Monitoring feature must be enabled on an individual channel basis by setting the front panel Enhanced Monitoring Enable Switches. Indication Monitoring will be disabled when the Red Enable Input is inactive. When the unit is operating in the Type 16 mode, dual indication monitoring is also disabled when the LOAD SWITCH FLASH bit in the SDLC Type 0 message from the Controller Unit is set to 1.

2.3.2 Field Check Failure

Field Check fault monitoring is a feature that is available when the MMU-516E is operating in the Type 16 mode with Port 1 communications with the Control Unit. A field check failure situation occurs when the active channel indications at the Channel Inputs do not match the SDLC Type 0 message data from the Control Unit. When a field check failure situation exists for a time duration of about 800 milliSeconds, a fault is declared and the Output Relay latches in the fault state. The Reset Button must be pressed, or an active External Reset signal applied to reset the faulted state.

The status of the Field Check fault monitoring is tested whenever the MMU-516E has triggered due to a conflict, red failure, short or skipped yellow clearance fault, or dual indication fault. If a field check fault situation existed at the time the monitor tripped, the field check diagnostic display feature will blink the FIELD CHECK LED and also the offending channel LED(s).

The Field Check Monitoring feature must be enabled on an individual channel basis by setting the front panel Enhanced Monitoring Enable Switches. Field Check Monitoring will be disabled when the Red Enable Input is inactive. When the unit is operating in the Type 16 mode, field check monitoring is also disabled when the LOAD SWITCH FLASH bit in the SDLC Type 0 message from the Controller Unit is set to 1.

3. STATUS INDICATORS

3.1 Monitor Status

The front panel of the MMU-516E has eighteen Monitor Status LEDs arranged primarily in three groups; the large group of thirteen LEDs indicate the fault status, two LEDs are used to indicate SDLC Port 1 activity, a pair of indicators are for the AC Line Power and the Type 12 operating mode of the monitor, and the remaining LED is for Port 2 activity.

POWER Indicator
The POWER Indicator LED is on when the AC Line voltage is above brown-out level and the internal DC voltages are at proper levels. The POWER Indicator LED blinks when the AC Line voltage is below brown-out level, and turns off upon power loss (even though it can still operate for a short time) to help diagnose cabinet power problems.

TYPE 12 Indicator
The TYPE 12 Indicator is on when the MMU-516E is operating in the Type 12 mode with twelve channels of four input circuits each.

CONFLICT Indicator
The CONFLICT Indicator is on when Green, Yellow or Walk indications were detected on conflicting channels and caused a Conflict Fault. The Channel Status LEDs show the Channel Inputs that were active at the time of the fault.

RED FAIL Indicator
The RED FAIL Indicator is on when no monitored (Walks may be excluded by the Walk Disable Option Switch) inputs were active on one or more channels, and caused a Red Failure. The Channel Status LEDs show the channels that had the failure. If there is not a latched Red Fail Fault, and the Red Enable Input is inactive, the RED FAIL Indicator flashes every 2 seconds to indicate that the Red Enable Input is in the False state.

+24 Volt I Indicator
The +24 Volt I Indicator is on when the voltage at the +24 Volt I Input is below the threshold level. The +24 Volt I Indicator is also on when a +24 Volt Fault has been latched (Programming Card Latch 24 Volt Fault Enable jumper installed), even if the +24 Volt I Input has returned to the the proper voltage. The Channel Status LEDs show the channels that had active indications at the time of the fault. If there is not a +24 Volt Fault and the +24 Volt Monitor Inhibit Input is in the active state, the +24 Volt I Indicator flashes every 2 seconds to indicate that the +24 Volt Monitor Inhibit Input is in the True state.

+24 Volt II Indicator
The +24 Volt II Indicator is on when the voltage at the +24 Volt II Input is below the threshold level. The +24 Volt II Indicator is also on when a +24 Volt Fault has been latched (Programming Card Latch 24 Volt Fault Enable jumper installed), even if the +24 Volt II Input has returned to the proper voltage. The Channel Status LEDs show the channels that had active indications at the time of the fault. If there is not a +24 Volt Fault and the +24 Volt Monitor Inhibit Input is in the active state, the +24 Volt II Indicator flashes every 2 seconds to indicate that the +24 Volt Monitor Inhibit Input is in the True state.

CVM/WDT Indicator
The CVM/WATCHDOG Indicator is on when the CVM Input is inactive, or in the false state. The CVM/WATCHDOG Indicator is also on when a CVM Fault has been latched (Programming Card Latch CVM Fault Enable jumper installed), even if the CVM Input has returned to the proper voltage. The Channel Status LEDs show the channels that had active indications at the time of the fault.

CLEARANCE Fail Indicator
The CLEARANCE Fail Indicator is on when the duration of a yellow interval was too short, or was skipped completely, creating a fault. The CLEARANCE Fail Indicator is also on when the time elapsed between the termination of a Green indication on a channel or channels, and a Green indication occurring on one or more conflicting channels occurs before the minimum clearance time, creating a fault. The Channel Status LEDs show the channel(s) that had the short interval.

RED + YEL CLEARANCE Indicator
The RED + YEL CLEARANCE Indicator blinks when the time elapsed between the termination of a Green indication on a channel or channels, and a Green indication occurring on one or more conflicting channels occurs before the minimum clearance time, creating a fault. The Channel Status LEDs blink to show the sequence in which the channels caused the fault.

PORT 1 FAULT Indicator
The PORT 1 FAULT Indicator is on when the time elapsed between SDLC Type 0 mesages being correctly received causes a fault. The Channel Status LEDs show the channels that had active indications at the time of the fault. The PORT 1 FAULT Indicator flashes every 2 seconds when the MMU-516E is operating in the Type 16 mode and the Port 1 Disable Input is active (low).

DIAGNOSTIC Indicator
The DIAGNOSTIC Indicator is on when any of several internal diagnostic tests have failed. These tests include the RAM test at powerup, the non-volatile program memory and data memory tests, internal voltage checks, and other diagnostic tests. The Channel Status LEDs show the channels that had active indications at the time of the fault.

PRGM-CARD Indicator
The PROGRAM CARD AJAR Indicator blinks when the Programming Card is not properly seated in its connectors, or is missing. The DIAGNOSTIC Indicator will be on steady when the unit has a Programming Card fault. The Programming Card Diagnostic test will also give this indication when a failure of the Programming Card input circuitry occurs.

INDICATION Indicator
The INDICATION Indicator is on when an invalid combination of active inputs detected on one or more channels has generated a fault. The Channel Status LEDs show the Channel Input(s) that caused the fault.

FIELD CHECK Indicator
The FIELD CHECK Indicator is on when a discrepancy between the SDLC message Type 0 and the measured indications on the channel inputs were in disagreement long enough to cause a fault. The Channel Status LEDs show the Channel Input(s) that caused the failure. If Field Check differences occurred during the timing of a Conflict, Red Failure, Yellow Clearance Fault, or Dual Indication Fault, the FIELD CHECK Indicator will blink; as will the Channel Input LED's associated with the Field Check failure.

LOCAL FLASH Indicator
The LOCAL FLASH Indicator is on when the Local Flash Switch in the cabinet is in the on position.

PORT 1 RX Indicator
The PORT 1 RX Indicator blinks when a message is present on the TS2 SDLC communication bus.

PORT 1 TX Indicator
The PORT 1 TX Indicator blinks when a message is answered by the MMU-516E.

PORT 2 ACT Indicator
The PORT 2 Activity Indicator blinks when a message is present on the Port 2 communication bus, and also blinks when the MMU-516E transmits a response over the Port 2 bus.

3.2 Channel Status

The MMU-516E has forty-eight Channel Status LEDs on the front panel that illuminate during normal operation to show the status of each channel. Sixteen each red, yellow and green LEDs indicate the channel status when the MMU is operating in the Type 16 mode, and the top twelve rows of LEDs indicate the input color status for the Type 12 mode, with the bottom four rows of LEDs indicating the status of the Walk inputs. The non-red LEDs (except 9-12 Walk) show which channels are active. A channel that senses the Green, Yellow, or Walk Input of the channel as active is considered ON.

If the unit has faulted due to a +24 Volt Input Fault, CVM Fault, Port 1 Fault,Program Card Fault, or Diagnostic Fault (any non AC Channel Input Faults), the Channel Status indicators will retain the status of all 48 channel inputs at the time of the occurrence of the fault.

If the unit has faulted due to a Conflict, Red Fail ,short or missing Yellow Clearance Failure, Red plus Yellow Clearance Failure, Dual Indication Fault, or Field Check Fault (any AC Channel Input Faults), the Channel Status indicators will cycle through one, two, or three display blinking intervals (as needed) of 3 seconds duration, followed by a 6 second display of the channel inputs at the time of the occurrence of the fault.

The first 3 second blinking interval for a Conflict, blinks the LEDs for the active inputs on the conflicting channels and the Conflict Status Indicator LED together at a 4 Hz rate. If the Field Check Monitor was timing a Field Check Fault, a second blinking interval will follow, blinking the Field Check Channel Inputs in error along with the Field Check Indicator LED. The Conflict Indicator LED will be on steady during this second interval.

The first 3 second blinking interval for a Red Fail, blinks all the LEDs for the failed channel (the Walk LED.will be included when operating in the Type 12 mode only if the Walk Disable Option Switch is in the OFF position) and the Red Fail Indicator LED together at a 4 Hz Rate. If the Field Check Monitor was timing a Field Check Fault, a second blinking interval will follow, blinking the Field Check Channel Inputs in error along with the Field Check Indicator LED. The Red Fail Indicator LED will be on steady during this second interval.

The first 3 second blinking interval for a Dual Indication Fault, blinks the LEDs for the active inputs on the faulted channel and the Indication Status Indicator LED together at a 4 Hz rate. If the Field Check Monitor was timing a Field Check Fault, a second blinking interval will follow, blinking the Field Check Channel Inputs in error along with the Field Check Indicator LED. The Indication Indicator LED will be on steady during this second interval.

The first 3 second blinking interval for a Yellow Clearance Fault blinks all the LEDs for the failed channel and the Clearance Indicator LED together at a 4 Hz Rate. If the Field Check Monitor was timing a Field Check Fault, a second blinking interval will follow, blinking the Field Check Channel Inputs in error along with the Field Check Indicator LED. The Clearance Indicator LED will be on steady during this second interval.

The first 3 second blinking interval for a Yellow Change plus Red Clearance Failure blinks all the LEDs for the failed channel and the Red + Yel Clearance Indicator LED together at a 4 Hz Rate. The second 3 second blinking interval blinks the Green LED(s) for the channel(s) that became active following the short interval, along with the Red + Yel Clearance Indicator LED. If the Field Check Monitor was timing a Field Check Fault, a third blinking interval will follow, blinking the Field Check Channel Inputs in error along with the Field Check Indicator LED. The Red + Yel Clearance Indicator LED will be on steady during this third interval.

The 3 second blinking interval for a Field Check Fault only (no other Channel Faults) blinks the Field Check Channel Inputs in error along with the Field Check Indicator LED.

4. SETUP AND USE

The setup of the MMU-516E malfunction monitor consists of soldering the appropriate wire jumpers in the Programming Card, installing the card, setting the enhanced monitoring feature switches and individual channel enhanced monitoring switches, and resetting a latched fault if necessary. The features programmed on the card include: Permissive Channels, Minimum Flash Time, Minimum Yellow Change Channel Disables, and 24 Volt and Controller Voltage Monitor Latch Enables.

4.1 Programming Card

Features are programmed by soldering wire jumpers into the pair of holes provided for each function. There are 120 Permissive Channel jumper locations, 16 Minimum Yellow Change Channel Disable jumper locations, 4 Minimum Flash Time jumper locations, and one jumper location each for 24 Volt Latch Enable and Controller Voltage Monitor Latch Enable. The Programming Card complies with the NEMA TS2-1992 standard for Malfunction Management Units, and is therefore interchangeable with compliant cards from other manufacturers.

If the Programming Card is missing or not fully seated in its connector, the MMU-516E will enter the fault mode, transfer the Output Relay contacts, and illuminate the DIAGNOSTIC LED (constant on) and blink the PRGM-CARD LED.

4.1.1 Permissive Channel Jumpers

The absence of a soldered wire jumper in a Permissive Channel Pair location means that any combination of proceeding signal indications of that pair of channels is not compatible or permissive. Simultaneous indications of Green - Green, Green - Yellow, or Yellow - Yellow on a non-permissive channel pair for typically 350 mSec. will cause the MMU to enter the fault mode, transfer the Output Relay contacts, and illuminate the CONFLICT LED.

To program channels 1 and 5 (for example) to be permissive, simply solder a wire jumper in the hole pair at row one, position five.

4.1.2 Minimum Flash Time Jumpers

The Programming Card has four jumper hole pairs for selecting the Minimum Flash Time following a power failure or non-latched fault. The four jumper hole pairs (labeled b1, b2, b4, and b8), encode the Minimum Flash Time by summing their respective Flash Times (1 Sec., 2 Sec., 4 Sec., and 8 Sec.), and adding 1 Sec. to their total (but also subject to a minimum time of 6 Sec.). To program a Minimum Flash Time of 6 seconds (for example), no soldered wire jumpers are needed. To program othertimes, see the following table, where an x means a soldered jumper wire is installed.

Minimum Flash Time	b1	b2	b4	b8
6 Sec.				
7 Sec.	x	x		
8 Sec.	x	x	x	
9 Sec.			x	
10 Sec.	x			x
11 Sec.		x		x
12 Sec.	x	x		x
13 Sec.			x	x
14 Sec.	x		x	x
15 Sec.		x	x	x
16 Sec.	x	x	x	x

4.1.3 Minimum Yellow Change Channel Disable Jumpers

The Programming Card has sixteen jumper hole pairs for disabling the Minimum Yellow Change monitoring for each channel. Minimum Yellow Change monitoring will be **disabled** for a channel when a wire jumper is soldered in that channel's hole pair. Minimum Yellow Change monitoring finds a fault if the channel went directly from a Green indication to a Red indication (skipped Yellow), or the duration of the Yellow indication was less than 2.7 seconds.

4.1.4 Latch +24 Volt Fault Jumper

The Programming Card has a jumper hole pair to enable the latching of +24 Volt DC faults on both of the +24 Volt monitor inputs.

4.1.5 Latch CVM Fault Jumper

The Programming Card has a jumper hole pair to enable the latching of Controller Voltage Monitor faults.

4.2 Enhanced Monitoring Enable Switches

Sixteen pencil switches are provided, one for each channel, which activate both Dual Indication fault checking and Field Check monitoring for a difference between the Control Unit or Bus Interface Unit output and the actual load switch output. Setting a switch to the "ON" position activates enhanced monitoring for its corresponding channel. Dual Indications checked when a channel enable switch is on, include simultaneous combinations of: Green & Yellow, Yellow & Red, and Green & Red. Additional simultaneous Dual Indications checked when the unit is operating in the Type 12 mode include: Green & Walk and Yellow & Walk. Note that these switches, when on, enable Green & Yellow Dual Indication monitoring for the corresponding channel, regardless of the Green & Yellow Dual Indication Option Switch that includes the corresponding channel.

4.3 Option Switches

Switches 1 and 2, the Enhanced Frame Formats Switches (Labeled EFF), govern the response of the MMU-516E to requests received on Port 2. For on site operator inquiry from a laptop computer or terminal, both EFF switches should be in the OFF position. For system operation where the monitor is connected to the intersection controller, the top EFF switch should be in the ON position and the second switch should be OFF.

Switch 3 (third from top) controls whether the Walk Inputs are excluded from Red Fail monitoring.

Switch 4 (fourth from top) controls whether CVM Input faults are excluded from being entered into the Fault Log. This allows CVM to be used as a control signal (rather than a fault signal) for Time of Day control for intersection flashing mode operation.

The MMU-516E has two Green & Yellow Dual Indication Enable Switches (Switches 5 and 6) that control the option on a range of sequential channels. One switch enables green & yellow dual indication monitoring for channels 1 through 8 inclusive, the other switch enables monitoring for channels 9 through 16. Note that these switches, when on, enable Green & Yellow Dual Indication monitoring for the corresponding channels, regardless of the Field Check/Dual Indication Channel monitoring switches.

Switch 7 (second from bottom) controls whether the Minimum Yellow plus Red Clearance testing is controlled by the Minimum Yellow Change Channel Disable Jumper for each channel. When this switch is in the ON position, both the Minimum Yellow and the Minimum Yellow plus Red Clearance tests are controlled by the Minimum Yellow Change Channel Disable Jumpers. When Switch 7 is OFF, only the Minimum Yellow testing is controlled by the MYCCD Jumpers.

4.4 Reset Pushbutton

Latched faults are manually reset by pressing the Reset Button on the front panel. A fault condition may be overridden for a very short time by holding down the Reset Button; however, after 4 seconds, a continuous reset is no longer recognized. To reactivate reset, the button must be released and pressed again. This reset time-out feature is provided to protect against malfunction or misuse of the monitor reset.

5. REMOTE/LOCAL ACCESS PORT 2

The MMU-516E is equipped with an EIA-232 communications port which can be connected to a laptop computer in the field for setup and maintenance monitoring functions, or may be connected to the Timer for Remote Monitoring.

5.1 Data Logging Setup

Port 2 on the MMU-516E is an asynchronous EIA-232 port operating at 2400 Baud, one start bit and one stop bit, 8 data bits and no parity. A 'dumb' terminal or laptop computer running a terminal emulation program should be connected to the monitor by a 'null modem' cable for setup of the Station Number and Intersection Location fields for the reports.

Since the monitor has no Real Time Clock, the date and time must be initialized. This can be done manually, (see the Help Menu) or occurs automatically when the monitor is operating in a TS2 cabinet and receives the Type 9 message from the Timer. When the monitor is installed in a TS1 cabinet, the date and time can still be set automatically if the monitor's Port 2 is connected to the Timer, and the Timer periodically transmits a date and time message.

5.2 Remote Access

The MMU-516E supports remote requests for transmitting reports. These requests are received through Port 2, and consist of an escape sequence of four characters. The top Enhanced Frame Formats Switch should be in the ON position and the second switch should be OFF. The following table identifies the remote report request command sequences:

Command Sequence	Description
ESC X ESC 1	Programming Report Request
ESC X ESC 2	History Report Request (Fault and Power Log Reports)
ESC X ESC 3	Trace Report Request
ESC X ESC 4	Fault Report Request
ESC X ESC 5	Power Report Request
ESC X ESC 6	All Reports Request
ESC X ESC 7	Present Fault Report Request
ESC X ESC F	Present Fault Report Request
ESC X ESC I	Analyzer (Trace) Report Request
ESC X ESC R	History Report Request
ESC X ESC V	Firmware Version Request

The monitor accepts the Status Requests ESC X ESC C, ESC X ESC L, and ESC X ESC S. These reports are not formatted ASCII data.

The monitor also accepts a date & time message of 10 characters from the Timer in the following format: e,{, tenths of seconds, seconds, minutes, hour, day of week, day of month, month, year.

The device issuing the report request to the monitor may use the flow control characters DC1 (X-ON) and DC3 (X-OFF) to divide the report into segments if required because of device limitations.

5.3 Help Menu

The MMU-516E Help Menu is intended to assist operators who are locally accessing information from the monitor. The Help Menu is output in response to typing [H], [M], or [HM] followed by the [ENTER] or [RETURN] key (do not press either the [or] keys). Be sure to have both of the Enhanced Frame Formats Switches in the OFF position. The Help Menu is:

```
  HELP MENU
Command             Format followed by [Enter]
Code
HELP MENU             HM
Set Station #         SS  NNN
Set Location          LO  description of location
Set Day of Week       SW W (1=Sun thru 7=Sat)
Set Daylight          SF SM,SW,FM,FW spring
  Savings Time           month, week of month,
                         fall month, week of month
Programming           PR
Set Date              SD  MM  DD  YY
Set Time              ST  HH : MM
Present Fault         PF
Fault Log             FL
Power Log             PL
Trace Log             TR
Fault&Power Log       FP
All Logs              AL
Voltmeter             VM
Clear Fault Log       CF
Clear Power Log       CP
```

The following notes and examples should explain the data fields:

NNN	a three digit number from 0 to 999
description of location	a text string of 36 or less characters ie. LO Main Street @ Second Avenue
MM DD YY	numeric month day year ie. for June 8, 2000 enter SD 06 08 00 or SD 6 8 00
ST HH:MM	numeric hour minute ie. for 2:40 PM enter ST 14:40

5.4 Reports

The following reports are available from the MMU-516E: Programming Report of all the Programming Card jumpers installed and all front panel switch settings, Power Log Report of all the AC Power line disturbances and anomalies, Fault Log Report of both the present fault (if any) and the previous faults, and the Trace Log Report of the status of all inputs to the monitor.

5.4.1 Programming Report

The Programming Report details the status of all the Permissive Channel pair jumpers, Minimum Yellow Change Channel Disable jumpers, Initial Flash Delay Time jumpers, and the CVM and +24 Volt Latch Fault jumpers on the Programming Card, as well as the Field Check/Dual Indication switches, the Include Yellow + Red Clearance with the Minimum Yellow Change Channel Disable switch, and the Green-Yellow Dual Indication Enable switches on the front panel. The report is initiated by entering PR followed by {ENTER]. The following example shows the format for an MMU-516E operating in the Type 16 mode (a P in the Permissive Jumpers table indicates the presence of a jumper wire).

```
 MMU 516 v3.0
MALFUNCTION MONITOR
Copyright (c)
1999 NAZTEC, Inc.

  Station #  772
  Main Street @ Second Avenue

Initial Flash Delay Time:  6.0 Sec.

Minimum Yellow Change Channel Disable
#  1 OFF #  2 OFF #  3 OFF #  4 OFF
#  5 OFF #  6 OFF #  7 OFF #  8 OFF
#  9 ON. # 10 OFF # 11 ON. # 12 OFF
# 13 OFF # 14 OFF # 15 OFF # 16 OFF

Include Yellow + Red Clearance
 with MYCCD OFF

Green-Yellow Dual Indication Enable
#  1- 8 ON
#  9-16 ON

Exclude Walk from Red Fail Test OFF

CVM Log Disable for TOD Flash OFF

Indication/Field Check Monitor Enable
#  1 ON  #  2 ON  #  3 ON  #  4 ON
#  5 ON  #  6 ON  #  7 ON  #  8 ON
#  9 OFF # 10 OFF # 11 OFF # 12 OFF
# 13 ON  # 14 ON  # 15 ON  # 16 ON

Latch CVM Fault OFF
Latch 24V Fault OFF

Permissive Jumpers
```

```
          1111111
 1234567890123456
 1-...PP.........
 2.-..PP.........
 3..-...PP.......
 4...-..PP.......
 5....-..........
 6.....-.........
 7......-........
 8.......-.......
 9........-......
10.........-.....
11..........-....
12...........-...
13............-..
14.............-.
15..............-
```

5.4.2 Power Log Report

The Power Log Report gives a history of each AC Power line disturbance seen by the MMU-516E. A maximum of 30 previous power events relating to incoming AC line voltage are logged by the monitor. The type of power event and the date and time of its occurrence are logged. For momentary power events, or disturbances, the length of the disturbance is recorded in number of 60 Hz AC line cycles. The types of power events that are logged are:

PROC START: The processor started from its internal hardware reset. This is the normal type of power-up, one from no voltage to full

Voltage occurring quickly, such as applying power by activating a switch or circuit breaker. An internal hardware reset is active until the processor +5 VDC power is stable. This event means that the AC line voltage was in normal range at the time the +5 VDC became stable.

BROWN-UP: Power-up occurred from a brown-out or low voltage condition. This may occur in two ways. First, if power is increased slowly, the processor may start before there sufficient voltage to allow the cabinet to operate. In this case, there would be a PROC START event followed by a BROWN-UP.

The second case is a return to operating voltage following a brown-out (but not a full power outage). In this case, the PWR-UP event follows a POWER-DOWN event without an intervening PROC START.

POWER-DOWN: A Power Down event indicates that the AC line voltage fell below the brown-out threshold and remained so for longer than 475 milliSeconds. This could be due to a complete loss of AC line or due to a brownout. If the event following a POWER-DOWN is a Processor Start, then there was a loss of AC line. If the next event is a BROWN-UP, then there was not a complete loss of AC line voltage.

DROPOUT: A dropout is a loss of AC line voltage for less than 475 milliSeconds. The monitor does not go through a power-down/up cycle, but simply records the event.

DIP: A “dip” is a reduction in AC line voltage to below the brown-out threshold for less than 475 milliSeconds. The only action taken by the monitor is to log the event.

SURGE: A surge is an increase in AC line voltage above 135 volts for less than one second. The only action taken by the monitor is to log the event.

DIP/SURGE: A dip/surge is a momentary disturbance that is a combination of some low voltage cycles and some high voltage ones. The only action taken is to log the event.

OVERVOLTAGE: An overvoltage condition is a line voltage above 135 volts for more than one second. The only action taken by the monitor is to log the event.

NORMAL: The AC line voltage has returned to normal after an overvoltage condition. The only action taken by the monitor is to log the event.

In the following example Power Log Report, note that the most recent event is printed first and the Event Number is 1:

```
==================================

  POWER REPORT       Date: 01-22-99
    Station:   12    Time: 13:51:51
 State Hwy 36 @ Lincoln Rd

   # Date/Time  Event Type   Cycles
  -- ---------  ----------   --------

   1 01-22-99   PROC START
     13:34:55
   2 01-22-99   POWER-DOWN
     13:32:28

   3 01-22-99   PROC START
     12:41:50

   4 01-18-99   POWER-DOWN
     10:35:50

   5 01-18-99   BROWN-UP
     04:33:45

   6 01-18-99   PWR-DOWN
     04:33:31

  =========  End of Report  =========
```

5.4.3 Fault Log Report

The Fault Log Report begins with the Present Fault (if the MMU-516E is in a faulted state at the time the report is requested), and continues with the previous faults (up to a maximum of 20). The previous faults are numbered from the most recent to the oldest with the most recent being assigned number 1.

Faults are identified as one of the following types:

Fault Type	Description
CONFLICT	Non permissive channels active at the same time
RED FAIL	No input to a channel
INDICATION	Multiple, invalid inputs active on a channel
CLEARANCE	Yellow active time was skipped or too short on a channel
YEL + RED CLR	The time interval between active green inputs on conflicting channels was too short.
FIELD CHECK	Channel inputs do not match Controller SDLC message data. This only occurs with other channel faults.
PORT 1	The time interval between SDLC Type 0 messages was too great.
24 VOLT I	+24 Volt DC Monitor #1 voltage too low
24 VOLT II	+24 Volt DC Monitor #2 voltage too low
CVM	Controller Voltage Monitor from Timer in fault state
LOCAL FLASH	The cabinet Local Flash Switch is on.
PROGRAM CARD	The Program Card has changed or is not inserted
FIELD CK MON	Non fault combination of active channel inputs that do not match the Controller SDLC message data

A Fault Log Report example for an MMU-516E operating as a Type 16 follows:

```
There is no present fault.

  ==================================

  FAULT REPORT       Date:  9/20/99
    Station: 739      Time: 13:04:09
  Avenue D. @ First St.

  ----------------------------------

  Fault #  1    Type:  YEL+RED CLR

               Date      Time
             --------  --------
  Occurred:   9/19/99  22:14:47
     Ended:   9/20/99   8:40:34

             ---- Channel ----
                       1111111
             12345678 90123456
             -------- --------
   Faulted:  F......F ........
  Previous:  .......X ........
       Red:  .RRRRRRR RRRRRRRR
    Yellow:  ........ ........
     Green:  G.......  ........

Fault #  2    Type:  CONFLICT

               Date      Time
             --------  --------
  Occurred:   7/17/99  21:55:40
     Ended:   7/18/99  .9:01:51

             ---- Channel ----
                       1111111
             12345678 90123456
             -------- --------
   Faulted:  .F...FF. ........
  Field Ck:  ......X. ........
       Red:  R.RRR.RR RRRRRRRR
    Yellow:  ......Y. ........
     Green:  .G...G.. ........

  =========  End of Report  =========
```

In the previous example, the report was requested after the fault had been cleared. When the monitor is in a faulted state when the Fault Log Report is requested, the Present Fault Report precedes the Fault Log Report.

5.4.4 Trace Log Report

The MMU-516E records a “snapshot” or monitor state record of all the monitor’s inputs each time an input changes. Each record is time stamped, just like the other logs, except that tenths of seconds are also recorded for the Trace Log. Upon the occurrence of a fault, these monitor state records are written into the Trace Log. These state records are output as numbered trace records, starting with the most recent (number 1) printing first.

5.5 Miscellaneous Reports & Commands

In addition to the above mentioned reports, the MMU-516E also has the Present Fault Report, AC Line Voltmeter Function, Clear Power Log Function, and Clear Fault Log Function.

5.5.1 Present Fault Report

The Present Fault Report output is identical to the formal of the Fault Log, except there is only one event labeled **`PRESENT FAULT`**, instead of numbered faults. Just type PR[ENTER] to get the report.

5.5.2 AC Line Voltmeter Function

The MMU-516E continuously measures the AC Line voltage. The command VM[ENTER] gives a typical response such as: **`AC Line Voltage 115`**

5.5.3 Clear Power Log Function

The Power Log may be cleared of all stored power events or unitialized data by the command CP[ENTER]. The response is: **`Power Log Cleared.`**

5.5.4 Clear Fault Log Function

The Fault Log may be cleared of all stored faults or unitialized data by the command CF[ENTER]. The response is : **`Fault Log Cleared.`**

6. APPENDIX A

6.1 CONNECTOR PINOUTS

6.1.1 Type 16 Connector A

Pin	Signal	Pin	Signal
A	AC Line	f	Channel 6 Yellow
B	Output Relay 1 Open (closes when fault occurs)	g	Channel 5 Yellow
		h	Channel 3 Yellow
C	Output Relay 2 Closed (opens when fault occurs)	i	Channel 15 Green
		j	Channel 2 Yellow
D	Channel 12 Green	k	Channel 1 Yellow
E	Channel 11 Green	m	Controller Voltage Monitor
F	Channel 10 Green	n	+24 V Monitor Inhibit
G	Channel 9 Green	p	Output Relay 1 Closed (opens when fault occurs)
H	Channel 8 Green		
J	Channel 7 Green	q	Output Relay 2 Open (closes when fault occurs)
K	Channel 6 Green		
L	Channel 5 Green	r	Channel 12 Walk (Type 12 only)
M	Channel 4 Green	s	Channel 11 Walk (Type 12 only)
N	Channel 3 Green	t	Channel 9 Walk (Type 12 only)
P	Channel 2 Green	u	Channel 16 Yellow
R	Channel 1 Green	v	Channel 15 Yellow
S	+24 V Monitor I	w	Channel 13 Yellow
T	Logic Ground	x	Channel 4 Yellow
U	Earth Ground	y	Channel 14 Green
V	AC Neutral	z	Channel 13 Green
W	Output Relay 1 Common		
X	Output Relay 2 Common	AA	Spare 1
Y	Channel 12 Yellow	BB	Reset
Z	Channel 11 Yellow	CC	Cabinet Interlock A
		DD	Cabinet Interlock B
a	Channel 10 Walk (Type 12 only)	EE	Channel 14 Yellow
b	Channel 10 Yellow	FF	Channel 16 Green
c	Channel 9 Yellow	GG	Spare 2
d	Channel 8 Yellow	HH	Type Select
e	Channel 7 Yellow		

6.1.2 Type 16 Connector B

Pin	Signal
A	AC Line
.B	Start Delay Relay Common
C	Start Delay Relay Open (closes during start delay period)
D	Channel 12 Red
E	Channel 11 Red
F	Channel 9 Red
G	Channel 8 Red
H	Channel 7 Red
J	Channel 6 Red
K	Channel 5 Red
L	Channel 4 Red
M	Channel 2 Red
N	Channel 1 Red
P	Spare 1
R	+24 V Monitor II
S	Spare 2
T	Channel 13 Red
U	Start Delay Relay Closed (open during start delay period)
V	Channel 10 Red
W	Channel 14 Red
X	Channel 15 Red
Y	Channel 16 Red
Z	Channel 3 Red
a	Red Enable
b	Spare 3
c	Spare 4

6.1.3 Type 12 Connector A

Pin	Signal	Pin	Signal
A	AC Line	f	Channel 6 Yellow
.B	Output Relay 1 Open (closes when fault occurs)	g	Channel 5 Yellow
		h	Channel 3 Yellow
C	Output Relay 2 Closed (opens when fault occurs)	i	Channel .3 Walk
		j	Channel 2 Yellow
D	Channel 12 Green	k	Channel 1 Yellow
E	Channel 11 Green	m	Controller Voltage Monitor
F	Channel 10 Green	n	+24 V Monitor Inhibit
G	Channel 9 Green	p	Output Relay 1 Closed (opens when fault occurs)
H	Channel 8 Green		
J	Channel 7 Green	q	Output Relay 2 Open (closes when fault occurs)
K	Channel 6 Green		
L	Channel 5 Green	r	Channel 12 Walk
M	Channel 4 Green	s	Channel 11 Walk
N	Channel 3 Green	t	Channel 9 Walk
P	Channel 2 Green	u	Channel 8 Walk
R	Channel 1 Green	v	Channel 7 Walk
S	+24 V Monitor I	w	Channel 5 Walk
T	Logic Ground	x	Channel 4 Yellow
U	Earth Ground	y	Channel 2 Walk
V	AC Neutral	z	Channel 1 Walk
W	Output Relay 1 Common		
X	Output Relay 2 Common	AA	Spare 1
Y	Channel 12 Yellow	BB	Reset
Z	Channel 11 Yellow	CC	Cabinet Interlock A
		DD	Cabinet Interlock B
a	Channel 10 Walk	EE	Channel 6 Walk
b	Channel 10 Yellow	FF	Channel 4 Walk
c	Channel 9 Yellow	GG	Spare 2
d	Channel 8 Yellow	HH	Type Select
e	Channel 7 Yellow		

6.1.4 Type 12 Connector B

Pin	Signal
A	AC Line
.B	Start Delay Relay Common
C	Start Delay Relay Open (closes during start delay period)
D	Channel 12 Red
E	Channel 11 Red
F	Channel 9 Red
G	Channel 8 Red
H	Channel 7 Red
J	Channel 6 Red
K	Channel 5 Red
L	Channel 4 Red
M	Channel 2 Red
N	Channel 1 Red
P	Spare 1
R	+24 V Monitor II
S	Spare 2
T	Channel 13 Red (Type 16 only)
U	Start Delay Relay Closed (open during start delay period)
V	Channel 10 Red
W	Channel 14 Red (Type 16 only)
X	Channel 15 Red (Type 16 only)
Y	Channel 16 Red (Type 16 only)
Z	Channel 3 Red
a	Red Enable
b	Spare 3
c	Spare 4

6.1.5 Port 1 Connector

Pin	Signal
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
11	Rx Clock -
12	Earth Ground
13	Tx Data -
14	Reserved
15	Tx Clock -

6.1.6 Port 2 Connector

Pin	Signal
.1	Rx Data
2	Tx Data
.5	Logic Ground

6.1.7 Programming Card Connector P1

Pin	Permissive Channels	Pin	Permissive Channels	Pin	Permissive Channels
1a	1- 2	1b	1- 3	1c	1- 4
2a	1- 5	2b	1- 6	2c	1- 7
3a	1- 8	3b	1- 9	3c	1-10
4a	1-11	4b	1-12	4c	1-13
5a	1-14	5b	1-15	5c	1-16
6a	2- 3	6b	2- 4	6c	2- 5
7a	2- 6	7b	2- 7	7c	2- 8
8a	2- 9	8b	2-10	8c	2-11
9a	2-12	9b	2-13	9c	2-14
10a	2-15	10b	2-16	10c	3- 4
11a	3- 5	11b	3- 6	11c	3- 7
12a	3- 8	12b	3- 9	12c	3-10
13a	3-11	13b	3-12	13c	3-13
14a	3-14	14b	3-15	14c	3-16
15a	4- 5	15b	4- 6	15c	4- 7
16a	4- 8	16b	4- 9	16c	4-10
17a	4-11	17b	4-12	17c	4-13
18a	4-14	18b	4-15	18c	4-16
19a	5- 6	19b	5- 7	19c	5- 8
20a	5- 9	20b	5-10	20c	5-11
21a	5-12	21b	5-13	21c	5-14
22a	5-15	22b	5-16	22c	6- 7
23a	6- 8	23b	6- 9	23c	6-10
24a	6-11	24b	6-12	24c	6-13
25a	6-14	25b	6-15	25c	6-16
26a	7- 8	26b	7- 9	26c	7-10
27a	7-11	27b	7-12	27c	7-13
28a	7-14	28b	7-15	28c	7-16
29a	8- 9	29b	8-10	29c	8-11
30a	8-12	30b	8-13	30c	8-14
31a	8-15	31b	8-16	31c	9-10
32a	Common	32b	Common	32c	Common

6.1.8 Programming Card Connector P2

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

7. APPENDIX B

7.1 SPECIFICATIONS

7.1.1 ELECTRICAL

A. POWER

Line Voltage	75 to 150 Volts AC, RMS
Line Frequency	57 to 63 Hz., 60 Hz nominal
Power Consumption	10 Watts, typical
Fuse	0.5 Amp, Slow Blow

AC Line Monitoring Voltage:

Pickup	96 ±1 Volts AC, RMS
Dropout	91 ±1 Volts AC, RMS
Hysteresis	4 ±1 Volts AC, RMS

B. AC INPUTS

Green, Yellow and WalkChannel	OFF	0 to 15 Volts AC, RMS
	ON	greater than 25 Volts AC, RMS
Red Channel	OFF	0 to 50 Volts AC, RMS
	ON	greater than 70 Volts AC, RMS
Red Enable	OFF	0 to 70 Volts AC, RMS
	ON	greater than 89 Volts AC, RMS

Both positive and negative half cycles are measured for Green, Yellow, Red and Walk Channel inputs.

C. DC INPUTS

+24 Volt I & II	OFF	less than +18 Volts DC
	ON	Greater than +22 Volts DC

Controller Voltage Monitor (CVM),
+24 Volt Monitor Inhibit, External
Reset, Port 1 Disable, Type Select,

True	less than +8 Volts DC
False	greater than +16 Volts DC or OPEN (not connected)

D. RELAY OUTPUTS

Fault	Two sets of isolated Form C contacts, rated 3 Amps maximum at 135 VAC
Start Delay	One set of Form C contacts, rated 3 Amps maximum at 135 VAC

E. COMMUNICATION PORT 1

Interface	EIA-485
Protocol	SDLC
Data Rate	153,600 bits / second

F. REMOTE ASYNCHRONOUS PORT 2

Interface	EIA-232
Protocol	Xon/Xoff
Data Bits	8
Start Bits	1
Stop Bits	1
Parity	None
Data Rate	2400 Baud

7.2 TIMING FUNCTIONS

Conflict	
No Fault	less than 200 milliSeconds
Fault	greater than 450 milliSeconds
Red Failure	
No Fault	less than 700 milliSeconds
Fault	greater than 1000 milliSeconds
+24 Volt I & II	
No Fault	less than 125 milliSeconds
Fault	greater than 175 milliSeconds
Controller Voltage Monitor (CVM)	
No Fault	less than 125 milliSeconds
Fault	greater than 175 milliSeconds
Yellow Clearance	
No Fault	greater than 2.8 Seconds
Fault	less than 2.6 Seconds
Yellow + Red Clearance on conflicting Channels	
No Fault	greater than 2.8 Seconds
Fault	less than 2.6 Seconds
Dual Channel Indication	
No Fault	less than 700 milliSeconds
Fault	greater than 1000 milliSeconds
MMU Power Interruption	
No response	less than 450 milliSeconds
Respond	greater than 500 milliSeconds
Port 1 Failure	
Nominal	300 milliSeconds
Field Check Failure	
Nominal	800 milliSeconds
Start Delay	2.0 $\pm$ 0.5 Seconds
Minimum Flash	
Programmable from	6.0 $\pm$ 0.5 Seconds
to	16 $\pm$ 0.5 Seconds
in 1 Second increments	

7.3 CONNECTORS

Connector A	Mates with MS 3116 22-55 SZ
Connector B	Mates with MS 3116 16-26 S
Port 1 Connector	Mates with DA-15P
Port 2 Connector	Mates with DE-9S

7.4 SIZE

Height	10.5 inches
Width	4.45 inches
Depth	8.25 inches (add 2.5 inches for connector harness assembly)

7.5 ENVIRONMENTAL

Operating Temperature Range	-34°C to +74°C
Storage Temperature Range	-45°C to +85°C
Relative Humidity	less than 95% non-condensing