Naztec Operations Manual

For

TS2 Malfunction Management Unit

Model MMU-516

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Table Of Contents

1. Overview

The Naztec MMU-516 Malfunction Management Unit monitors the traffic signal indications for conflicting signal indications, improper sequencing of signals, incorrect timing and improper signal voltage levels.

The MMU-516 Malfunction Management Unit complies with the National Electrical Manufacturers Association (NEMA) Standard TS2-1998, Section 4, for 16 Channel Malfunction Management Units. The MMU-516 is also compatible with TS1 cabinets, and emulates 12 Channel Conflict Monitor Units (CMU) conforming to the NEMA Standard TS1-1989.

1.1 TS1 and TS2 Modes of Operation

The MMU-516 Type 16 mode monitors three 115 Volt AC input circuits (Green/Walk, Yellow, and Red/Don't Walk) for up to 16 load switch "Channels".

The MMU-516 Type 12 mode monitors four 115 Volt AC input circuits (Green, Yellow, Red and Walk) for up to 12 load switch "Channels".

These two operating modes of the MMU (Type 16 and Type 12) are selected using the external **Type Select** input to the monitor. The Type 16 mode is selected when at least 16 VDC is applied to the **Type Select** input (logic state *True*). The Type 12 mode is selected when less than 8 VDC is applied to the **Type Select** input (logic state *False*). The current mode is indicated by the TYPE 12 LED (illuminated if the Type 12 mode is selected).

1.2 Monitoring

The MMU-516 provides the following monitoring functions to insure that the terminal facility is operating properly:

1. Active channels are monitored for conflicting indications as defined by the *Programming Card* permissive channel jumpers.

2. Each channel is monitored for "red failure" when all channel outputs are "dark" for more than 0.7 seconds.

3. Yellow intervals are monitored to guarantee at least 2.7" of yellow clearance. The time interval from the termination of green until the start of green on the next conflicting channel is also checked to insure that yellow plus red clearance is at least 2.7".

4. The **Red Enable** input and **AC Line** input are constantly monitored as required by the NEMA TS2 specification.

5. The **+24 Volt I** input and **+24 Volt II** input are monitored to insure that cabinet and/or controller power supplies are operating at the proper voltage.

6. Checks to insure that no more than one indication is present on a single channel.

7. Green + Yellow indication monitoring (if enabled).

8. Check for *Programming Card* not inserted properly.

9. Channel inputs agree with SDLC controller data (Type 16 TS2 mode).

In addition, the following inputs are constantly monitored to insure proper operation of the terminal facility:

- **Voltage Monitor** input
- **Type Select** input
- **+24 Volt Monitor Inhibit** input
- **Port 1 Disable** input
- **Local Flash** input
- **Reset** input (same as Reset Switch)

The MMU-516 also monitors the internal hardware within the unit to insure that the unit is operating properly. The MMU performs a check sum on non-volatile (data) and program memory at power up and performs periodic RAM diagnostics to insure proper operation of the unit. A watchdog timer circuit monitors the microprocessor and will override the MMU and set the *Output Relay* to the “fault” state if the microprocessor fails. In Type 16 mode, the frequency of valid Port 1 messages is checked to insure that data is being received properly from the controller.

1.3 Relay Outputs

When the MMU detects a fault condition, the *Output Relay* is placed in the "fault" state placing the cabinet in flash. This DPDT *Output Relay* is also held in the "fault" state during the *Minimum Flash Time* after when AC power is to the MMU. The *Minimum Flash Time* is programmed using soldered wire jumpers on the *Programming Card*.

The *Start Delay* Relay controls the power-up sequence of equipment in the controller cabinet assembly. This SPDT relay transfers the cabinet to normal operation two seconds after the MMU powers up and moves to the power-down state if an AC brownout occurs.

1.4 Front Panel

All connectors, indicators and operator controls are located on the front panel of the MMU-516 unit. All inputs and relay output connections are terminated using two Military Specification MIL-C-26482 connectors. In addition, the Type 16 mode interfaces the terminal facility through the SDLC Port 1 D shell connector (A size, 15 contact). The *Programming Card* and the AC Line fuse are also easily accessed from the front panel.

1.5 Other Features

The MMU-516 provides a *Reset Timeout* feature to prevent a broken switch or accidental wiring fault from holding the **Reset** input for an extended period of time.

The following LED fault status indicators extend the minimum TS2 requirements:

- *Dual Indication* Fault
- Yellow plus Red Clearance Fault
- *Programming Card* Ajar
- *Field Check* Fault
- LED's for the second +24 Volt DC Input Fault
- CVM Input Fault

The MMU also provides the following LED status indicators:

- AC Line Power

- Type 12 Indicator
- SDLC Transmitter Active
- SDLC Message Received

1.6 Data Logging

The MMU-516 logs the status of all inputs, and provides a data log report when requested by StreetWise ATMS over communications Port 2. This log provides a date and time stamp record of all AC power line disturbances, MMU faults and program card and front panel programming. The intersection Station ID and text description of the location appear at the top of each report.

2. Operation Description

2.1 Standard Monitoring

2.1.1 Channel Inputs

Type 16 mode monitors **three 115 Volt AC** input circuits (Green/Walk, Yellow, and Red/Don't Walk) for up to 16 load switch "Channels".

Type 12 mode monitors **four 115 Volt AC** input circuits (Green, Yellow, Red and Walk) for up to 12 load switch "Channels".

A channel is considered active if a **Green**, **Yellow**, or **Walk** input circuit is greater than 25 Volts AC. The channel is inactive if the circuit is less than 15 Volts AC.

The channel **Red** input is ON when the measured voltage is greater than 70 Volts AC. The **Red** input is considered OFF when the measured voltage is less than 50 Volts AC.

2.1.2 Conflict

Permissive channels for Type 12 and Type 16 operation are programmed via jumper settings on the *Programming Card*. Conflicting channels are defined as two or more channels not defined as permissive channels. If no jumpers are installed on the *Programming Card*, then each channel conflicts with all others and the MMU will detect a constant *Conflict Fault.*

A conflict occurs when two or more conflicting channels are active for 450 milliseconds. 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 becomes active. Since a *Conflict Fault* is latched, it cannot be cleared by removing power to the MMU-516 and then applying power again.

2.1.3 Red Failure and Red Enable Input

The MMU-516 monitors for *Red Failure* on inactive channels. *Red Failure* is defined as the absence of voltage applied to all circuits of a channel. A *Red Failure* occurs when there are no active channel inputs for 1000 milliseconds. The fault is ignored if all channel outputs are dark for less than 700 milliseconds. A *Red Failure* is a latched fault and requires the *Reset Button* to be pressed to reset the fault.

Applying an AC voltage greater than 89 Volts AC to the **Red Enable** input enables *Red Failure*. Applying less than 70 Volts AC to the **Red Enable** input disables the feature.

In Type 16 mode, *Red Fail* monitoring is also disabled when the LOAD SWITCH FLASH bit in the SDLC Type 0 message from the controller is set to 1.

2.1.4 Skip Yellow Failure

Skip Yellow Failure occurs when the channel moves from green to red without an intervening yellow clearance interval. This condition forces the *Output Relay* to the latched "fault" state placing the cabinet into flash. The *Reset Button* must be pressed, or the **External Reset** input applied to reset this condition.

The MMU ignores faults from power transients by requiring the green and red inputs to be active for at least 330 milliseconds.

This feature may be disabled on a channel basis by jumpering the *Minimum Yellow Change Channel Disable* position on the *Programming Card*. *Skip Yellow* monitoring is also disabled if the **Red Enable** input is inactive.

In Type 16 mode, *Skip Yellow Failure* is also disabled when the LOAD SWITCH FLASH bit in the SDLC Type 0 message from the controller is set to 1.

2.1.5 Minimum Yellow Failure

The MMU-516 insures that the 2.7-second minimum yellow clearance required by NEMA is provided each time the channel transitions from green to red. If the transition from green to red is less than 2.7 seconds, then a *Minimum Yellow Fault* is declared and the *Output Relay* transfers to the latched "fault" state. The *Reset Button* must be pressed, or the **External Reset** input applied to reset this condition.

The MMU ignores faults from power transients by requiring the green and red inputs to be active for at least 330 milliseconds.

This feature may be disabled on a channel basis by jumpering the *Minimum Yellow Change Channel Disable* position on the *Programming Card*. *Minimum Yellow* monitoring is also disabled if the **Red Enable** input is inactive.

In Type 16 mode, Minimum Yellow Failure is also disabled when the LOAD SWITCH FLASH bit in the SDLC Type 0 message from the controller is set to 1.

2.1.6 Minimum Yellow Change Plus Red Clearance Failure

The MMU-516 also insures that the minimum yellow clearance plus red clearance is at least 2.7 seconds. If the elapsed time between the end of green and the beginning of red is less than 2.7 seconds, a *Minimum Yellow Change Plus Red Clearance Fault* is declared and the *Output Relay* transfers to the latched "fault" state. The *Reset Button* must be pressed, or the **External Reset** input applied to reset this condition.

Disabling the **Red Enable** input disables this feature. In 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 is set to 1.

2.1.7 +24 Volt DC I & II Inputs

The **+24 Volt DC I** input and **+25 Volt DC II** input are monitored to insure that an adequate supply voltage is provided to the controller unit and terminal facility. If the voltage for 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 DC faults may be *latched* or *non-latched*. A *non-latched* fault allows the *Output Relay* to reset to the "non-fault" state when the monitored voltage level returns to 18 volts. A reset is not required for a non-latched fault. A *latched* fault does not reset the *Output Relay* and requires pressing the *Reset Button* or applying the **External Reset** input to return the terminal facility to normal operation.

Normally, +24 Volt DC faults are not latched and the monitor returns to normal operation when the monitored input returns to 18 volts. In this case, a reset is not required to restore normal operation.

Latching is programmed via the +24 Volt Latch Enable jumper position on the *Programming Card*. A +24 Volt DC fault condition during *Minimum Flash Time* or during a power brownout will not be latched regardless of the jumper setting.

Grounding the **+24 Volt Monitor Inhibit** input may disable +24 Volt DC monitoring. Any logic true voltage less than 8 VDC applied to this input disables +24 Volt DC monitoring. Any voltage greater than 16 VDC applied to this input enables monitoring of the **+24 VDC I** input and **+24 VDC II** input.

2.1.8 Controller Voltage Monitor Input

The MMU-516 monitors the **CVM** input (Controller Voltage Monitor) from the controller unit. During normal operation, the **CVM** input remains at a "True" logic low level of less than 8 VDC. A *CVM Fault* is detected when the **CVM** input exceeds 16 VDC. This moves the *Output Relay* to the "fault" state.

Recovery from a *CVM Fault* depends on whether the fault is latched or non-latched. CVM faults may be *latched* or *non-latched*. A *non-latched* fault allows the *Output Relay* to reset to the "non-fault" state automatically when the monitored **CVM** input returns to 8 VDC. A reset is not required for a non-latched fault. A *latched* fault does not reset the *Output Relay* and requires pressing the *Reset Button* or applying the **External Reset** input to return the terminal facility to normal operation.

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 manual reset or external reset is not required to restore normal operation.

Latching is programmed via the *CVM Latch Enable* jumper position on the *Programming Card*. A *CVM Fault* condition during *Minimum Flash Time* or during a power brownout will not be latched regardless of the jumper setting.

2.1.9 Port 1 Disable Input

The **Port 1 Disable** input allows the MMU to be used in a TS1 or TS2 (Type 2) cabinet configuration without the SDLC Port 1 interface.

MMU Port 1 is disabled for Type 12 operation by applying a logic low signal (less than 8 VDC) to the **Port 1 Disable** input. MMU Port 1 is enabled for Type 16 operation by applying a logic high signal (greater than 16 VDC) to the **Port 1 Disable** input.

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

A hardware switch mounted in the terminal facility is used to set the **Local Flash** input and place the terminal facility in "cabinet flash". The MMU constantly monitors this input to switch the cabinet between normal stop-and-go operation (**Local Flash** input greater than 16 VDC) and "cabinet" flash (**Local Flash** input less than 8 VDC).

When the **Local Flash** input falls below 8 VDC, the *Output Relay* is transferred to the "fault" state and remains in this state until the **Local Flash** input exceeds 16 VDC.

2.1.11 AC Line Voltage

The AC line voltage is continuously monitored to insure that the supply voltages for the terminal facility are adequate. A "brownout" occurs if line voltage drops below 92 VAC for 500 milliseconds. During a brownout, the MMU-516 transfers the *Output Relay* and *Start Delay Relays* through a power-down sequence.

A 4 VAC threshold is used to prevent the MMU-516 from cycling in and out of a "brownout" condition when the line voltage hovers near 92 VAC. This threshold dampens the return from a "brownout" until the line voltage reaches 96 VAC.

The MMU-516 will continue to operate internally at a much lower line voltage than 92 VAC to allow the unit to log power interruption events.

2.1.12 Power-up Sequencing

A power failure is defined by NEMA as a continuous interruption of AC power for 500 milliseconds or longer. The MMU-516 restores the terminal facility to normal operation after a power failure by operating the *Start Delay Relay* and *Output Relay*s in the following manner:

1. The *Start Delay Relay* is energized 2.0 seconds after the AC line voltage returns (exceeds 92 VAC).

2. The *Output Relay* is held in the de-energized (or fault) state for the duration of the Minimum Flash Time.

3. After the Minimum Flash Time, the MMU-516 energizes the *Output Relay*. If the power-up diagnostics fail or if any latched or non-latched failure condition is present, the *Output Relay* will remain in the fault state. Also, if the MMU-516 is operating in the Type 16 mode, the Port 1 communications must also be established during the Minimum Flash period to return from the fault state.

2.2 Diagnostic Monitoring

The MMU-516 performs many diagnostic tests on a continuous basis to insure that the *Programming Card* is inserted, that internal memory and microprocessor are operating properly and that the proper operating voltages are present.

2.2.1 Programming Card Monitoring

The MMU insures that the *Programming Card* is present and inserted properly and that all interface circuits are functional. Any detected problem results in a latched *Programming Card* fault. After the problem has been corrected, the *Reset Button* must be pressed, or the **External Reset** input applied to reset the faulted state.

2.2.2 RAM Test

When the MMU is powered up (or initialized), a memory diagnostic is executed to test 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

The MMU-516 program resides in EPROM (Electrically Programmable Read-Only Memory). A checksum reference is calculated by summing the value of each EPROM memory location. This checksum is updated at a rate exceeding 1024 bytes per second and used to compare a preprogrammed value to verify that the EPROM memory has not been altered. A difference in these two checksum values will result in a non-latched fault. The *Reset Button* cannot normally be used to reset this type of fault.

2.2.4 EEPROM Monitoring

Non-volatile memory resides in EEPROM (Electrically Erasable Programmable Read-Only Memory). A checksum reference is calculated by summing the value of each EEPROM memory location. This checksum is also performed at a very high sampling rate to compare a preprogrammed value and verify that the EEPROM memory has not been altered. A difference in these two checksum values will cause a non-latched fault. The *Reset Button* cannot normally be used to reset this type of fault.

2.2.5 Microprocessor Monitoring

The MMU-516 provides circuitry independent of the microprocessor to monitor the microprocessor operation. If the microprocessor does not signal the monitor circuit after 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 extending the minimum requirements of the TS2 specifications are discussed in this section.

2.3.1 Indication Failure

An *Indication Failure* occurs when an invalid combination of signal voltages is present on a channel. This failure includes the situation when more than one input (Green, Yellow, or Red) is active on a channel at the same time. Another *Indication Failure* results in Type 12 mode when the Walk indication is ON with the Yellow or Red indications of the channel.

An *Indication Failure* greater that 1000 milliseconds is declared as a fault and latches the *Output Relay* in the "fault" state. An *Indication Failure* less than 700 milliseconds is ignored as a fault condition. The *Reset Button* must be pressed, or the **External Reset** input applied to reset the faulted state.

Indication Failure monitoring must be enabled on a channel-by-channel basis by setting the Enhanced Monitoring Enable Switches on the front of the MMU-516.

Indication Failure monitoring is disabled when the **Red Enable** input is inactive. When the unit is operating in the Type 16 mode, *Indication Failure* is 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 monitoring is only available when the MMU-516 is operating in the Type 16 mode and SDLC Port 1 communication is provided with the controller unit. A *Field Check* failure occurs when the active channel indications measured at the load switch do not match the SDLC Type 0 message data from the controller.

When a *Field Check* failure exists for 800 milliseconds, a fault is declared and the *Output Relay* latches in the "fault" state. The *Reset Button* must be pressed, or the **External Reset** input applied to reset this condition.

The status of the *Field Check* fault is monitored during a conflict or *Red Failure* fault, a short or skipped yellow clearance fault or *Dual Indication* fault. If a *Field Check* fault exists when the monitor trips due to some other fault condition, the *FIELD CHECK* LED will blink along with the offending channel LED(s).

The *Field Check* Monitoring feature must be enabled on an individual channel basis by setting the Enhanced Monitoring Enable Switches on the front of the MMU-516. *Field Check* Monitoring is 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

Monitor status is provided using sixteen LED's located on the front panel of the MMU-516. The cause of each status indication is provided below.

Indicator	Condition
POWER	POWER indicates when the AC Line voltage is above brownout level and the internal DC voltages are at proper levels. The POWER indicator LED blinks when the AC Line voltage is below brownout level, and turns OFF during a power outage. The indication will continue to display for a short time after a power outage to help diagnose the cabinet power condition.
TYPE 12	TYPE 12 indicates when the MMU-516 is operating in the Type 12 mode with twelve channels of four input circuits each.
CONFLICT	CONFLICT indicates a *Conflict Fault* when Green, Yellow or Walk indications are detected on conflicting channels. The Channel Status LED's indicate the active channels at the time of the *Conflict Fault*.
RED FAIL	*RED FAIL* indicates a *Red Fail* Fault when all inputs are inactive on one or more channels. The Channel Status LED's indicate which channels caused the Red Fail fault. 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	+24 Volt I indicates when the **+24 Volt I DC** input is below the acceptable operating value. The Channel Status LED's display the active channel status at the time of the fault. If the *Programming Card* Latch 24 Volt Fault Enable is jumpered, this indication will continue to display even if the **+24 Volt I DC** input has returned to the proper voltage.
+24 Volt II	+24 Volt II indicates when the **+24 Volt DC II** input is below the acceptable operating value. The Channel Status LED's display the active channel status at the time of the fault. If the *Programming Card* Latch 24 Volt Fault Enable is jumpered, this indication will continue to display even if the **+24 Volt DC II** input has returned to the proper voltage.
CVM / WDT	CVM/WATCHDOG indicates a *CVM Fault*. The Channel Status LED's show the channels that had active indications at the time of the fault.

	If the *Programming Card* Latch CVM Fault Enable is jumpered, this indication will continue to display even if the **CVM** input has returned to the proper voltage.
CLEARANCE	CLEARANCE indicates when a yellow clearance interval is shorted or was skipped entirely. The Channel Status LED's show the channel(s) that had the short interval.
RED + YEL CLEARANCE	RED + YEL CLEARANCE indicates when a yellow plus all-red clearance interval is shorted or skipped entirely. The Channel Status LED's show the channel(s) that had the short interval. The 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 LED's blink to show which channel(s) had a green indication and caused the conflict.
PORT 1 FAULT	PORT 1 FAULT indicates when the time elapsed between valid SDLC Type 0 messages is exceeded. The Channel Status LED's show the active channel indications at the time of the fault. PORT 1 FAULT flashes every 2 seconds when the MMU-516 is in the Type 16 mode and the **Port 1 Disable** input is active (low).
DIAGNOSTIC	DIAGNOSTIC indicates when any of the internal diagnostic tests have failed. These tests include a RAM test executed at power up, non-volatile program memory and data memory tests, internal voltage checks, and other diagnostics. The Channel Status LED's show the channels that had active indications at the time of the fault.
PRGM-CARD AJAR	PROGRAM CARD AJAR blinks when the *Programming Card* is missing or is not properly seated in its connectors. The DIAGNOSTIC indicator is ON when the unit has a *Programming Card* fault. The *Programming Card* diagnostic test will also show this indication when a failure of the *Programming Card* input circuitry occurs.
INDICATION	INDICATION shows when an invalid combination of active inputs is detected on one or more channels. The Channel Status LED's show the channel(s) that caused the fault.
FIELD CHECK	*FIELD CHECK* indicates when a discrepancy exists between the SDLC message Type 0 and the measured channel indications. The Channel Status LED's indicate which channel(s) caused this failure. If the *Field Check* fault occurs during a Conflict, Red Failure, Yellow Clearance Fault, or *Dual Indication* Fault, the *FIELD CHECK* indicator and Channel LED's associated with the *Field Check* failure will blink.
LOCAL FLASH	LOCAL FLASH indicates when the Local Flash Switch in the cabinet is in the on position.

3.2 Channel Status

The MMU-516 provides sixteen Channel Status LED's on the front panel indicating which channels are currently active. A channel that senses the **Green, Yellow, or Walk** input of the channel as active is considered active or "ON".

If the unit has faulted, the Channel Status indicators will display the following:

Fault Condition	Channel Status LED Displays
Conflict +24 Volt Input Fault CVM Fault Port 1 Fault External Watchdog Fault	Displays the channels that were active at the time of the fault
Red Fail Short or missing Yellow Clearance *Dual Indication* Fault	Displays the channel or channels which caused the fault
Minimum Yellow Change plus Red Clearance Failure	Displays the channel or channels that did not meet the minimum clearance time (the conflicting green channel indication which caused the fault will be blinking).
Field Check Fault	Displays the channel or channels on which the fault occurred. If the MMU-516 is timing a *Field Check* Status Fault at the time of a Conflict, Red Failure, short or missing Yellow Clearance Failure or *Dual Indication* Fault, the channel or channels involved will blink.

4. Setup and Use

The MMU-516 setup procedure consists of soldering wire jumpers on 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 Disable*s
- 24 Volt and Controller Voltage Monitor Latch Enables

4.1 Programming Card

Features are programmed by soldering wire jumpers into the pair of holes associated with each function on the *Programming Card*. This allows the user to define the permissive channel indications and customize the following functions:

- 120 Permissive Channel jumper locations
- 16 *Minimum Yellow Change Channel Disable* jumper locations
- 4 *Minimum Flash Time* jumper locations
- 24 Volt Latch Enable jumper
- Controller Voltage Monitor Latch Enable jumper

The *Programming Card* complies with NEMA TS2-1992 for Malfunction Management Units and is interchangeable with compliant cards from other manufacturers.

If the *Programming Card* is missing or not fully seated in its connector, the MMU-516 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 implies that any combination of signal indications of that channel pair is incompatible and non-permissive. Any two active channels not programmed as permissive result in the *Conflict Fault* defined in section 2.1.2.

Simultaneous indications of Green + Green, Green + Yellow, or Yellow + Yellow on two non-permissive (or conflicting) channel pairs will fault the MMU after 350 milliseconds, activate the *Output Relay* contacts, and illuminate the CONFLICT LED.

For example, to program channels 1 and 5 as permissive on the *Programming Card,* simply solder a wire jumper in the hole pair at row one, position five.

4.1.2 Minimum Flash Time Jumpers

The *Minimum Flash Time* controls the duration of “cabinet flash” when power is restored to the terminal facility. The *Programming Card* provides four jumper hole pairs (labeled b1, b2, b4, and b8), to program the *Minimum Flash Time* as the summation of the values associated with each jumper (1 Sec., 2 Sec., 4 Sec., and 8 Sec.). One additional second is added to this total to arrive at the *Minimum Flash Time*. In addition, the *Minimum Flash Time* cannot be less than 6 seconds.

For example, to program a *Minimum Flash Time* of 7 seconds, solder the jumper positions labeled b2 and b4 for a total of 2 Sec. + 4 Sec. + 1 additional second supplied by the calculation.

4.1.3 Minimum Yellow Change Channel Disable Jumpers

A *Minimum Yellow Change* fault occurs when the channel indications move directly from Green to Red (skipped Yellow), or the duration of the Yellow indication is less than 2.7 seconds.

The *Programming Card* provides sixteen jumper hole pairs for disabling the *Minimum Yellow Change* monitoring for each channel. *Minimum Yellow Change* monitoring is **disabled** when a jumper is soldered in that hole pair associated with a channel.

4.1.4 Latch +24 Volt Fault Jumper

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

4.2 Enhanced Monitoring Enable Switches

Sixteen pencil switches are provided to enable *Dual Indication* monitoring and *Field Check* monitoring for each channel. The ON position activates enhanced monitoring for the corresponding channel. Indication faults (section 2.3.1) include simultaneous combinations of Green + Yellow, Yellow + Red, and Green + Red.

Field Check Monitoring (section 2.3.2) only applies to the Type 16 mode and insures that the load switch outputs agree with the SDLC Port 1 messages from the controller.

4.3 Option Switches

The MMU-516 provides three Green & Yellow *Dual Indication Enable* switches that control the operation for a range of sequential channels. These switches enable green & yellow *Dual Indication* monitoring separately for channels 1 – 8, 9 – 12 and 13 – 16 regardless of the setting of the Field Check/Dual Indication Channel monitoring switches.

The Enhanced Frame Formats (EFF) switches govern the response of the MMU to Port 2 requests. Both EFF switches should be set to the OFF position for field access using a laptop computer. For system operation (when the monitor is interfaced with the controller, the top EFF switch should be in the ON position and the second switch should be OFF.

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

4.4 Reset Pushbutton

Pressing the *Reset Button* on the front panel manually resets latched faults. 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 not recognized until the reset is released and activated again. This reset time-out feature is provided to protect against malfunction or misuse of the monitor reset.

5. Remote/Local Access With Data Port 2

The MMU-516 communications Port 2 allows data logs stored within the MMU to be uploaded to a field device (laptop computer) or through the system which interfaced to the controller. This section provides a review of the various data logs generated by the monitor that record fault conditions and power interruptions.

5.1 Data Port 2 Interface

The MMU-516 provides an asynchronous EIA-232 data port (Port 2) operating at 2400 Baud with one start bit, one stop bit, 8 data bits and no parity. The data port interfaces the MMU with the system or a laptop computer running a terminal program. A 'null modem' cable connects these devices.

The date and time stored in the MMU-516 may be updated manually from the keyboard or from an external computer connected to Port 2. Time and date is automatically updated if Port 2 of the MMU-516 is interfaced with the Aux-232 port of the controller. Date and time is also automatically updated in a Type 16 (TS2 type 1) configuration when the monitor receives a Type 9 SDLC message from the controller.

5.2 Remote Access

The MMU-516 forwards internal data logs and reports based on a request message issued by an external device over Port 2.

The top Enhanced Frame Formats Switch should be in the ON position and the second switch should be OFF to allow the MMU-516 to respond to these requests.

The following remote requests consist of an escape sequence of four characters.

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

The monitor also accepts a date & time message of 10 characters from the controller Aux-232 port in the following format: tenths of seconds, seconds, minutes, hour, day of week, day of month, month, year.

The device issuing the report request may use 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-516 *Help Menu* is accessed by typing [H], [M], or [HM] followed by the [ENTER] or [RETURN] key. **Be sure to have both of the Enhanced Frame Formats Switches in the OFF position.** The *Help Menu* is:

HELP MENU

Command Code	Format followed by [Enter]
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 Savings Time	SF SM, SW, FM, FW spring 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 i.e. LO Main Street @ Second Avenue	
MM DD YY	numeric month day year i.e. June 8, 2000	enter SD 06 08 00 or SD 6 8 00
ST HH:MM	numeric hour minute i.e. 2:40 PM	enter ST 14:40

5.4 Reports

The following reports are available from the MMU-516:

- Programming Report (*Programming Card* jumpers and switch settings)
- Power Log Report (all AC Power line disturbances and anomalies)
- Fault Log Report (current fault and any previous faults)
- Trace Log Report (status of all inputs to the monitor during a fault)

5.4.1 Programming Report

The Programming Report provides the current jumper status on the *Programming Card*:

- Permissive Channel pair jumpers
- *Minimum Yellow Change Channel Disable* jumpers
- Initial Flash Delay Time jumpers
- CVM jumper
- +24 Volt Latch Fault jumpers

The Programming Report also provides the following external switch positions:

- Field Check/*Dual Indication* switches
- Include Yellow + Red Clearance/*Minimum Yellow Change Channel Disable* switch
- Green-Yellow *Dual Indication* Enable switch

The report is initiated by entering PR followed by [ENTER]. The following example shows the format for an MMU-516 operating in the Type 16 mode. The "P" symbol in the Permissive Jumper table indicates the presence of a jumper wire at each location.

MMU 516 v2.3
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
9-12 OFF
13-16 ON

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 OFF # 14 OFF # 15 OFF # 16 OFF

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 MMU-516 Power Log Report stores the last 30 power line disturbances and records the type of power event and the date and time the event occurred. Power line disturbances are typically very short in duration, so the length of each disturbance is recorded in the number of 60 Hz AC line cycles. The types of power events that are logged are:

PROC START — This event records when the processor initializes after an internal hardware reset or after power is restored. Normal power is restored from a no voltage condition to a full voltage condition (power activated by a switch or circuit breaker).

An internal hardware reset is active until the processor +5 VDC power becomes stable. This event records when the AC line voltage was in the normal operating range at the time the +5 VDC source within the MMU becomes stable.

BROWN-UP — This event records when power is restored after a brownout or low voltage condition. This may occur in two ways. First, if power is increased slowly, the processor may start before there is 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 brownout threshold for at least 475 milliseconds.

This fault can result from a complete loss of AC power or from a brownout condition. If PROC START follows the POWER-DOWN event, then AC power was lost. If BROWN-UP follows the POWER DOWN event, this indicates a brownout because the AC line voltage was not completely lost.

DROPOUT	The DROPOUT event records a loss of AC line voltage less than 475 milliseconds. The monitor does not go through a power-up sequence, but simply records the event.
DIP	The DIP event records a reduction in AC line voltage below the brownout threshold for less than 475 milliseconds. Like the DROPOUT condition, the monitor does not go through a power-up sequence, but simply logs the event.
SURGE	The SURGE event logs 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	The DIP/SURGE event records a momentary disturbance combining a low voltage and high voltage condition. The only action taken is to log the event.
OVERVOLTAGE	The OVERVOLTAGE event logs a line voltage above 135 volts for more than one second. The only action taken by the monitor is to log the event.
NORMAL	NORMAL indicates that the AC line voltage has returned to the normal operating range after an over voltage 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 records any Present Fault and the last 20 MMU fault conditions. The previous faults are numbered sequentially beginning with the most recent fault condition.

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-516 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 (“There is no Present Fault”). If the MMU was in a faulted state when the Fault Log Report was requested, the Present Fault Report would precede the Fault Log Report.

5.4.4 Trace Log Report

The MMU-516 records a trace record of each monitor input change following a fault condition. Each trace event record is time stamped in tenths of a second following the occurrence of the fault and recorded in the Trace Log. These trace event records are numbered sequentially starting with the most recent event.

5.5 Miscellaneous Reports & Commands

The MMU-516 provides several miscellaneous reports accessed by a keyboard command as described in this section. These reports include 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 format of the Fault Log, except only the present fault is displayed instead of a listing of the last 20 faults. This report is accessed from the MMU keyboard by pressing PR[ENTER].

5.5.2 AC Line Voltmeter Function

A real-time status display of the AC line voltage may be accessed using the command VM[ENTER]. This following status display indicates the current AC line voltage:

AC Line Voltage 115

5.5.3 Clear Power Log Function

The Power Log may be cleared of all stored power events and unitialized data by the command CP[ENTER]. This following display is issued after the log is cleared.

Power Log Cleared

5.5.4 Clear Fault Log Function

The Fault Log may be cleared and initialized using the command CF[ENTER]. The following display is issued after the Fault Log is cleared:

Fault Log Cleared

Appendix A

CONNECTOR PINOUTS

Type 16 Connector A

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

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

Type 12 Connector A

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

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

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 -

Port 2 Connector

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

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

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

Appendix B - Specifications

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 Walk Channel	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, External Watchdog Input

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

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 ± 0.5 Seconds
Minimum Flash	
Programmable from	6.0 ± 0.5 Seconds
to	16 ± 0.5 Seconds
(in 1 Second increments)	

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

4. SIZE

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

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 to +43°C