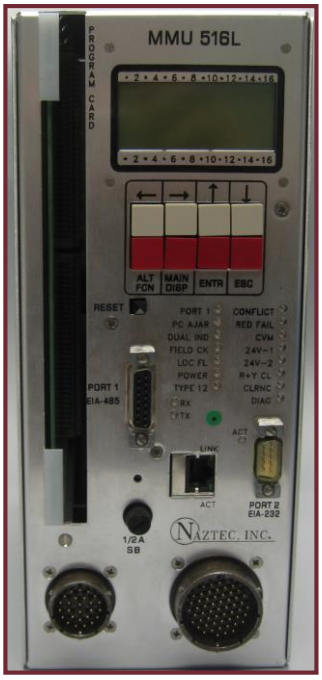
Trafficware

Operations Manual

For

Model MMU-516L-E

TS2 MMU RS232 and Ethernet (Malfunction Management Unit)



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522 Gillingham
Sugar Land, Texas 77478
Phone: (281) 240-7233
Fax: (281) 240-7238

Engineered by Naztec

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1.0 OVERVIEW

The Trafficware MMU-516L-E 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-516L-E Malfunction Management Unit complies with the National Electrical Manufacturers Association (NEMA) Standard TS2-1998, Section 4, for 16 Channel Malfunction Management Units. The MMU-516L-E 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-516L-E 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-516L-E 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 less than 8 VDC (connection to cabinet Logic Ground) is applied to the **Type Select** input (logic state *True*). The Type 12 mode is selected when at least 16 VDC (no connection to pin) is present at 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-516L-E 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 sec. 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 sec.

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-516L-E 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 AC power is applied 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 2 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-516L unit. All inputs and relay output connections are terminated using two Military Specification MIL-C-26482 connectors. In addition, the Type 16 mode interfaces to 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.

All features are programmable using the keypad and 16 column by 4 line LCD display. See section 6.0 for more information on the operation of the keypad and display.

1.5 Other Features

The MMU-516L-E 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.

The MMU-516L provides for remapping unused Yellow Inputs to a fourth input on other Channels for the purpose of Flashing Yellow Arrows or Walks (in Type 16 mode). A maximum of four Yellow Inputs may be mapped.

1.6 Data Logging

The MMU-516L-E 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. MONITORING

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 "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-516L and then applying power again.

2.1.3 Red Failure and Red Enable Input

The MMU-516L-E 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-516L-E 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. The Minimum Yellow
Transition time may be set to more than 2.7 seconds on a per channel basis through the Min Yellow configuration menu.

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-516L-E 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 green on a conflicting channel 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 **+24 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 disables +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-516L-E 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 16 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-516L transfers the *Output Relay* and *Start Delay* Relays through a power-down sequence.

A 4 VAC threshold is used to prevent the MMU-516L 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-516L 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-516L-E 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.

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

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

After the Minimum Flash Time, the MMU-516L-E 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-516L-E 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-516L-E 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 FLASH Monitoring

The MMU-516L-E program resides in FLASH (a type of EEPROM or Electrically Erasable Programmable Read-Only Memory). A checksum reference is calculated by summing the value of each FLASH 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 FLASH 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-516L-E 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 extend 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 are 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 without the Green, 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 Dual Indication Monitoring for each Channel (Selection #2 under the Configuration Menu). The initialized state (following Init EEPROM) is ON for all Channels.

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-516L-E 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 field signal terminals 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 MMU-516L-E uses a special monitoring algorithm for field checking a Flashing Yellow Arrow Input signal. The failure of the input to follow the controller unit's commands for 1.8 seconds results in a latched fault. 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.

The *Field Check* Monitoring feature must be enabled on an individual channel through the Field Check Configuration Menu. *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.

2.4 Enhanced Connectivity

The MMU-516L-E Enhanced Connectivity feature implements two types of re-assignment of otherwise unused Yellow inputs typically encountered on Ped monitoring channels. These two types of re-mapping are Flashing Yellow Arrow (FYA) and Yellow Mapped Walk. The entry display for remapping yellow inputs includes a mode selection, which determines whether the remapped yellow is assigned to a FYA channel or as a walk input. The two features are explained separately below.

2.4.1 Flashing Yellow Arrow

The FYA feature of the MMU-516L-E allows monitoring of up to four FYA channels. An FYA channel includes four indications: 1) solid red arrow, 2) solid yellow arrow, 3) flashing yellow arrow, and 4) solid green arrow. The four-section FYA movement is described in the NCHRP Research Project 3-54. It is used in protected/permitted left-turn lane situations. The flashing yellow arrow section indicates a permissive movement and the solid green arrow a protected movement.

This feature may be implemented in both Type 12 and Type 16 operating modes. See Section 7.2.4.11 for keypad data entry information.

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WARNING

THE FLASHING YELLOW ARROW MOVEMENT IS BEING DEVELOPED BASED UPON RESEARCH PERFORMED IN NCHRP PROJECT 3-54. THIS PROGRAM IS AUTHORIZED BY THE FEDERAL HIGHWAY ADMINISTRATION AND IS CURRENTLY IN AN EXPERIMENTAL PHASE.

Trafficware, Inc. does not provide any guidelines, warrants, or recommendations for the use of protected/permissive left-turn phasing. The underlying assumption is that the traffic engineer has decided that flashing yellow arrow protected/permissive control is the most appropriate left-turn treatment. It is also assumed that the deploying agency has made all necessary considerations regarding this control method and has determined that it is consistent with relevant traffic engineering standards and practices. Please note that the operation of this feature is subject to change pending actions by the regulating standards organizations.

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Setting up an FYA channel consist of entering the following information per yellow-mapped channel:

1) Set the “Type”, or Mode, to FYA

2) Identify the input channel that will be the 4-section FYA channel. This is the channel to which the remapped yellow will be added, thereby creating the logical 4-section FYA channel.

3) Enter the channel *from which* the mapped yellow input will be taken. This may be an unused channel, or, more typically, the unused yellow input of a pedestrian channel.

4) Enter additional permissive channels for the flashing yellow arrow interval of the FYA channel. Since the FYA indication is active during otherwise conflicting phases, these entries allow the specific permissive movements to be identified. The monitor does not register a conflict if these FYA permissive movements are active while the FYA indication is active. The solid green arrow and solid yellow arrow (unless it follows a FYA) of the FYA channel do not include the additional FYA permissives.

Corresponding Controller Set-up -- The Trafficware controller may be configured to output FYA signals on unused yellow outputs of pedestrian channels. It may also output them on the yellow outputs of unused channels. The yellow mapping of unused pedestrian output channels in the controller must correspond to the remapped unused yellow inputs of pedestrian channels in the MMU.

Please Refer to Appendix C at the end of this manual for two examples of programming the MMU and Trafficware controller for four FYA left-turn movements. The first example applies when channels 9-12 are assigned to pedestrian movements. The second example applies when pedestrian movements are on channels 13-16.

Note that this mapping ability of unused pedestrian yellow signals allows all sixteen channels of a 16-position load bay to be used when four of them are 4-section FYA channels. In such case, the channel assignments might be:

- Phases 2, 4, 6, 8 on channels 2, 4, 6, 8
- FYA overlaps on channels 1, 3, 5, 7
- Ped 2, 4, 6, 8 on channels 9-12
- Other phases or overlaps on channels 13-16

2.4.2 FYA Monitoring

1. ***Conflict*** – channel conflicts are determined based upon the permissive programming jumpers on the Program Card. For the flashing yellow arrow interval, and the solid yellow arrow interval immediately following an FYA interval, the additional permissives entered for the FYA channel are also included. This allows the FYA interval to be active during the permissive channel (e.g. phase 1 left-turn FYA and phase 2 thru).

2. ***Red Fail*** – a Red Fail fault occurs when all four sections of the logical FYA channel are inactive for the Red Fail fault time. A fault will not be declared during the dark half cycle of the FYA input; but instead, when the flashing yellow arrow input transitions to the active half of the flashing cycle. This recognizes the fact that during the inactive portion of the flashing cycle, it cannot be known whether the input has turned off, or not. Red Fail monitoring is disabled when the **Red Enable** input is inactive.

3. ***Dual Indication*** – a Dual Indication fault occurs if any two sections of the logical 4-section FYA channel are active simultaneously for the Dual Indication fault time. A Dual Indication fault will not be declared during the inactive half cycle of the flashing yellow arrow input; but instead, when the flashing yellow arrow input transitions to the active half of the flashing cycle.

Dual Indication monitoring must be enabled on a channel-by-channel basis by setting the Dual Indication Monitoring for each Channel (Selection #2 under the Configuration Menu), and monitoring is disabled when the **Red Enable** input is inactive.

4. ***Clearance*** – a Clearance fault occurs when a channel moves from green to red, or flashing yellow arrow to red without an intervening yellow clearance interval. A Clearance fault also occurs when the duration of the yellow clearance interval was less than the programmed Minimum Yellow Transition time, or 2.7 seconds, whichever is greater. Clearance monitoring is disabled when the **Red Enable** input is inactive. The Program Card jumpers Minimum Yellow Change Disable are used to disable clearance monitoring on a per channel basis.

5. ***Flash Rate*** – an FYA Flash Rate fault occurs when the arrow on time exceeds 750 milliSeconds, or is less that 250 milliSeconds. A FYA Flash Rate fault also occurs when the arrow off time is less than 250 milliSeconds. Due to the asynchronous nature of traffic cabinet signals, the first and last arrow on occurrence during an FYA indication is not checked for shortened pulses. This fault will illuminate the Indication fault indicator.

As a flashing yellow arrow movement is not a protected movement, a clearance interval of less than 2.7 seconds from the termination of FYA on a channel and start of green on a conflicting channel does not result in a Yellow Plus Red Clearance fault.

2.4.3 Yellow Mapped Walk

Yellow-Mapped Walk is the second mode of operation of yellow-mapped channels (the first being Flashing Yellow Arrow which is discussed in the preceding paragraphs). YMW is a feature that allows an unused yellow input, typically from an input Ped-monitoring channel, to be re-assigned as a Walk input associated with a vehicle channel. This causes the associated channel to become, logically, a four section channel (Red, Yellow, Green, and Walk). The logical 4-section channel operates the same as a Type-12 Mode MMU channel.

YMW is used to expand the number of channels monitored to beyond 16 when the MMU is in Type 16 mode. For example, if 18 channels of monitoring were needed, and four of those were peds, the MMU-516L-E could accomplish this as follows:

> Two input channels would be used to monitor two of the pedestrian movements. Say, for example, pedestrian movements for phases 2 and 6. The unused yellow of these two channels would be mapped, using the YMW feature, to the two vehicle channels associated with the other two pedestrian movements (e.g. walk for phases 4 and 8). This makes the input channels that would normally be used for peds 4 and 8 available for other use; for example, load switches 17 and 18. The YMW walk inputs for channels 4 and 8 would be monitored as Walk inputs are for Type 12 operation. In this example, the Don't Walk signals of channels 4 and 8 would not be monitored just as they are not monitored in Type 12 operation.

3. STATUS INDICATORS

3.1 Monitor Status

Monitor status is provided using fifteen LED's located on the front panel of the MMU-516L-E. 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-516L 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 Fault Status line on the LCD Display indicates 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 Fault Status line on the LCD Display indicates which channel(s) 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. 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. 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	CVM 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 Fault Status line on the LCD Display shows 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 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 Fault Status line on the LCD Display shows 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. PORT 1 FAULT flashes every 2 seconds when the MMU-516L is in the Type 16 mode and the **Port 1 Disable** input is active (low).
DIAGNOSTIC	DIAGNOSTIC indicates when any 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.
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 Fault Status line on the LCD Display shows the channel(s) that caused the fault. A Flashing Yellow Arrow flashing rate that deviates too far from the nominal half second on and half second off will illuminate this indicator.
FIELD CHECK	FIELD CHECK indicates when a discrepancy exists between the SDLC message Type 0 and the measured channel indications. The Fault Status line on the LCD Display indicates 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 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-516L-E provides a Channel Status screen indicating which channels are currently active. Separate rows on the display will show which channels are active with which colors. A channel that senses the **Red**, **Green, Yellow, or Walk** input of the channel as active is considered active or "ON" and a corresponding letter will be displayed on the LCD.

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

Fault Condition	Channel Status LCD Display
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.
Field Check Fault	Displays the channel or channels on which the fault occurred. If the MMU-516L-E 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 Field Check LED will blink.
Flashing Yellow Arrow Flash Rate Failure	Displays the channel or channels that were not flashing properly Note that the display shows the faulted channel as the FYA channel, and not the PED channel that drives the Flashing Yellow Arrow.

4. PROGRAMMING CARD

4.1 Setup

The MMU-516L-E features are programmed by soldering wire jumpers into the pair of holes associated with each function on the *Programming Card*. The program card jumpers allow 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-516L-E will enter the "fault" mode, transfer the *Output Relay* contacts, illuminate the DIAGNOSTIC LED (constant on), and blink the PRGM-CARD LED.

The LCD and keypad can be used to selectively enable and disable the following enhanced features:

- Red monitoring inhibit
- Dual indication
- Field check
- Program card fault latching
- Power disturbances logging
- Yellow plus green dual indication
- Red + yellow clearance
- Minimum Yellow time
- Red fail less walk
- CVM logging disable

More information on configuration using the LCD and keypad can be found in section 6.0.

4.2 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.

4.3 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.

4.4 *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 the minimum time of 2.7 seconds or the time specified in the minimum yellow configuration screen.

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.

4.5 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.

4.6 Latch *CVM Fault* Jumper

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

5. 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 Button*.

6. LCD AND KEYPAD

The keypad for the 516L-E Monitor is formatted as shown in Figure 3.

The keys work the same as the Series 900 controller except there are no numeric keys. Data is entered by scrolling through the selected fields with the ↑↓ arrows. In the case of numeric data the digits 0 through 9 will scroll to the next or previous number with the ↑ or ↓ arrows in a circular fashion. If the field selected has specific values such as ON or OFF, those values will be scrolled instead of numeric data.

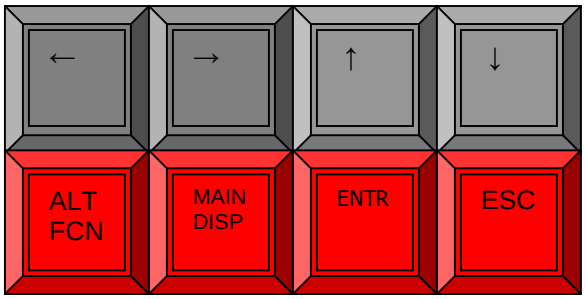


Figure 3

To enter data entry mode move the cursor to the field to be changed and select the ENTR key. The cursor will change from blinking to non-blinking when data entry mode is enabled. Use the ↓↑ arrows to select the specific value for the field or in the case of numeric data the current digit. If only one field is to be changed the ENTR key will save the data selected and exit data entry mode. The cursor will return to blinking mode and the new data entered will be shown in the field changed. For multiple digit numeric data, the ← → arrow keys will move the cursor to the digit to be changed. When the desired value is reached the ENTR key will save the data and the new data will be displayed in the field. The cursor will change back to a blinking state when the data is saved. If an error beep is sounded and the cursor does not return to a blinking state, then the value entered is invalid. If ESC is hit and the data has not been saved, an error screen will pop up.

As in the 900 series controller ALT FCN + ↑ or ↓ are page-up and page-down respectively.

The following example shows the key sequences used to enter a new date (06-10-05):

First move the cursor to the “NEW:” date field

```
Date:        06-01-05
New:         06-01-05
Time:        08:00:00
New:    ▼    08:00
```

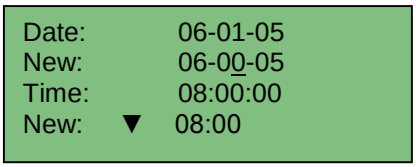
Hit the ENTR key to switch to data entry mode, which stops the cursor blinking.

```
Date:        06-01-05
New:         06-01-05
Time:        08:00:00
New:    ▼    00:00
```

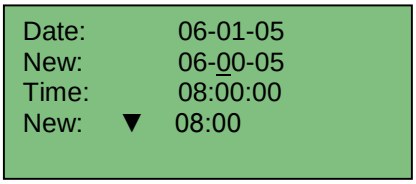
Use the ← arrow key to move the cursor to the first digit to be changed.

```
Date:        06-01-05
New:         06-01-05
Time:        08:00:00
New:    ▼    08:00
```

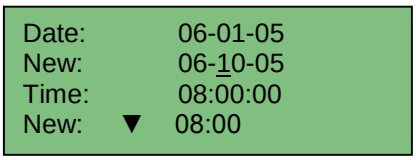
Use the ↑↓ arrows to scroll until a “0” is displayed.



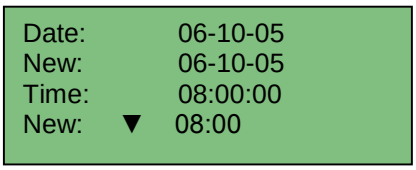
Use the ← arrow key to move to the next digit to change.



Use the ↑↓ arrows to scroll until a “1” is displayed.



Now use the ENTR key to save the data. The new data will be saved and the cursor will go back to a blinking state.



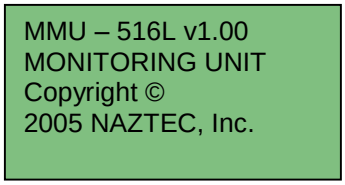
7. OPERATION

The operation of the keypad and LCD screen are described in this section. The keypad operates similar to the series 900 controller except it has no numeric keys.

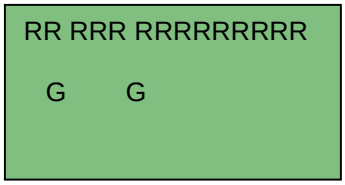
7.1 Default Status Screens

Upon application of power, the monitor displays the current, real-time status of the monitor or of the channel inputs. During start delay, the sign-on screen is displayed.

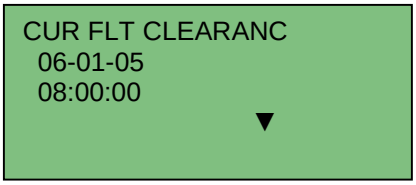
During the initial flash interval following the start delay, a message is displayed indicating that initial flash is underway. Following initial flash, real-time status of the channel inputs are continuously presented. If the controller is in the faulted state when powered up, the type of fault is displayed along with the time it occurred and the channels causing the fault. When faults are detected during operation, the channel status is replaced with the fault status screen.



Sign-on screen

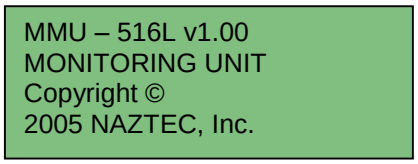


Channel Status screen

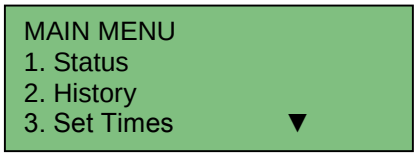


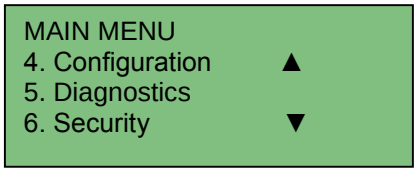
Fault Status screen

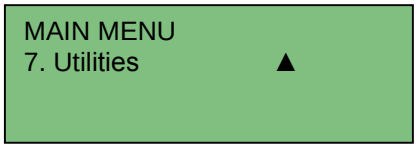
Selecting the MAIN/DISP or ESC keys will display the sign-on screen.



Hit ENTR or MAIN/DISP to bring up the Main Menu.
Select menu items by scrolling with the ↓↑ arrow keys
to the item desired and hitting ENTR to select the item.
ALT/FCN and the ↓↑ arrow keys will page up and down.
If no keys are pressed for a time that is user-programmable,
the console will return to the default status mode.







7.2 Menus and Screens

The information presented or programmed on the various screens in the monitor is shown below. They are presented in the order that they appear on menus and sub-menus.

7.2.1 Status Menu

STATUS MENU 1. Fault 2. Channel 3. Sys Inputs ▼	STATUS MENU 4. Permissives ▲ 5. AC Line 6. Input Voltage

7.2.1.1 Fault Status

Displays information of the currently active or most recent fault. "CUR FLT" is displayed in the upper left corner of the display that identifies the screen as the Current Fault Status.

Three pages of information are available by using the ALT/FCN ↓↑ arrow keys. The first page shows the type of fault, the date and time of occurrence, and the faulted channels.

```
CUR FLT CLEARANC
 06-01-05
 08:00:00
              ▼
```

The second page shows the status of the Red, Yellow, Green and Walk inputs for each channel at the time of the fault. The active inputs are displayed with capital letters “R”, “Y”, and “G”. On a Field Check fault the Red, Yellow, and Green inputs can also show the inputs from the controller for the faulted channels in lower case letters “r”, “y”, and “g”. A capitol letter “D” represents a channel that was a dark input to the MMU, but the controller indicated it was on. The third page shows the date and time that the fault was reset or cleared. CUR FLT and the fault type are displayed again on the third page for user convenience.

7.2.1.2 Channel Status

```
RR  RRR  RRRRRRRRR

  G      G
```

This one-page display shows the current, real-time status of the inputs on all channels. Each channel occupies one column on the display. Each input color is assigned to a row. Active inputs are indicated by displaying the first letter of the input color (R, Y, G or W) in the appropriate row and column location. A blank (space) indicates an inactive input.

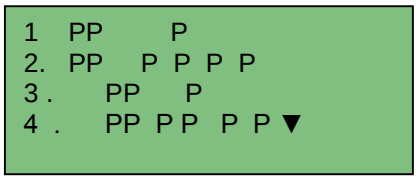
7.2.1.3 System Status

This multi-page display shows the real-time status of non-channel inputs. The following table describes the information displayed.

Identifier	Values	Description
Red Enable		**Red Enable**
	OFF	Input < 60 VAC
	ON	Input > 60 VAC
CVM		**Controller Voltage Monitor**
	OFF	Input > 16 VDC
	ON	Input < 8 VDC
+24V MI		**+24 Volt Monitor Inhibit**
	OFF	Input > 16 VDC
	ON	Input < 8 VDC

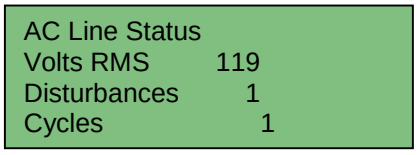
```
System Inputs
CVM              ON
Red Mon Enable   ON
  +24 MI         OFF▼
```

7.2.1.4 Permissives



The Permissives screen shows the permissives map which was most recently read from the program card. These are the permissives that are used for determining conflict faults. The map is presented in the form of a matrix where each position represents a jumper location on the program card. Each "P" on the display indicates an installed jumper on the program card.

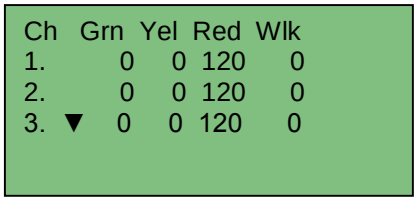
7.2.1.5 AC Line Status



The AC line status screen shows the real-time value of the line voltage in AC RMS volts. The range of voltage is from 0 to 135 volts, although the monitor operates on voltages as high as 160 VAC.

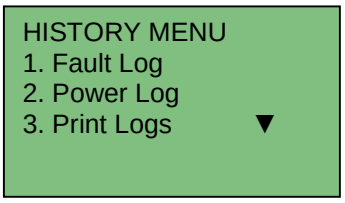
Also presented is the number of momentary disturbances in AC line voltage detected by the monitor since the last time the monitor was powered up. "Momentary" disturbances include voltage dropouts, dips, surges, and over voltage conditions. These are described in the AC power logging section later in this document. A maximum of 30 disturbances are recorded.

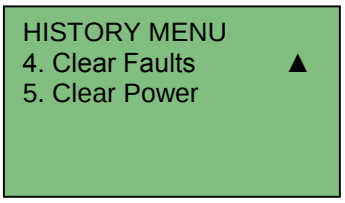
7.2.1.5 Input Voltage



The AC input voltage for each color is displayed for the current fault. Data is only valid if there is a current fault.

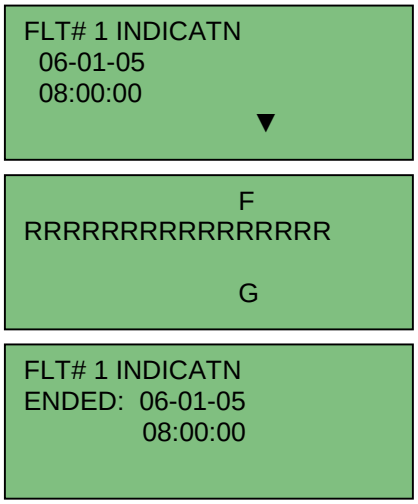
7.2.2 History Menu





7.2.2.1 Fault Log

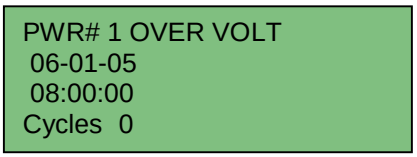
This three-page display shows the same information as the Current Fault Status screen but for previous faults. Up to 20 of the most recent previous faults are stored. The faults are numbered from most recent to oldest with the most recent being assigned number 1. As usual, the ALT/FCN ↓↑ arrow keys are used to move among the various pages of information for each fault. When the fault log is selected from the menu, fault #1 is displayed.



Faults are identified as one of the following types:

Fault Type	Description
CONFLICT	Conflict
RED FAIL	Red Failure
INDICATN	Indication Failure (multiple, invalid indications on a channel)
MIN YEL	Minimum Yellow
MIN GRN	Minimum Green
SEQ FAIL	Sequence Failure (yellow skipped)
24V I	+24 Volt DC Monitor #1
24V II	+24 Volt DC Monitor #2
CVM	Controller Voltage Monitor
PRGM CARD	Program Card has changed or is ajar
YEL+RED CLR	Yellow + Red Clearance
CLEARANCE	Clearance
FIELD CHECK	Field Check
PORT 1	Port 1 SDLC failure
LOCAL FLASH	Local Flash
FIELD CK MON	Field Check Monitor

7.2.2.2 Power Log



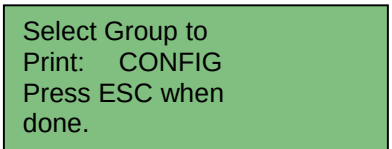
Up to 30 previous power events relating to incoming AC line voltage are logged by the monitor. A single page screen shows the event number (1 being most recent) and the date and time the event occurred. The type of power event is displayed in the upper, right-hand corner of the display. For momentary 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:

EVENT	DESCIPTION
PROC STRT	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 and logic DC power is stable. This event means that the AC line voltage was in normal range at the time the processor and logic DC power became stable.
BROWN-UP	Power-up from 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 STRT 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 PWR-DOWN event without an intervening PROC STRT.
PWR-DOWN	A Power Down event indicates that AC line voltage fell below the brown-out threshold and remained so for longer than 475 ms. This could be due to a complete loss of AC or due to a brownout. If the event following a PWR-DOWN is a Processor Start, then there was a loss of AC. 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 ms. 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 brownout threshold for less than 475 ms. 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 is to log the event
DIP/SURGE	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 over voltage condition is a line voltage above 135 volts for more than one second. The only action taken is to log the event.
NORMAL	The line voltage has returned to normal operating range after an Over voltage condition. The only action taken is to log the event.

Momentary disturbance logging may be turned on or off using the "Pwr Distrb" entry on the Latching screen. The latching screen is selected from the Configuration Menu.

7.2.2.3 Print Logs

This screen is used to print reports to an attached printer.



There are four reports available that may be printed singly or in two combinations. The print selections that are available are as follows:

Selection	Report(s)	Description
CONFIG	Configuration	All operator programmable entry screens and program card permissives
HISTRY	History	Fault Log and Power Log
TRACE	Trace Log	
FAULT	Fault Log	
POWER	Power Log	
ALL	All Reports	Configuration, Fault, Power, Trace Reports

7.2.2.4 Clear Faults

The fault log may be cleared of all stored faults or uninitialized data by using this screen.

```
Press Enter to
Clear the
Fault Log …
        In-Progress…
```

7.2.2.5 Clear Power

The power log may be cleared of all stored power events or uninitialized data by using this screen.

```
Press Enter to
Clear the
Power Log …
        Complete.
```

7.2.3 Set Times Menu

```
SET TIMES MENU
1. Date/Time
2. Flash Delay
3. Daylight Save
```

7.2.3.1 Date/Time

The date and time are set using this screen. When setting either of these values, leading zeros must be entered. The Date is entered in a single, six-digit field (dashes are not entered). A four-digit field is provided to enter hours and minutes for setting the time.

```
Date:        06-01-05
New:         00-00-00
Time:        08:00:00
New:   ▼     00:00
```

The seconds field of the time is automatically set to 00 at the instant the ENTR key is pressed. This feature allows setting the time to within one second of the desired time by waiting until the "top of the minute" before pressing the ENTR key.

```
Time:  ▲     08:00:00
New:         00:00
Day:         MON
New:
```

7.2.3.2 Flash Delay

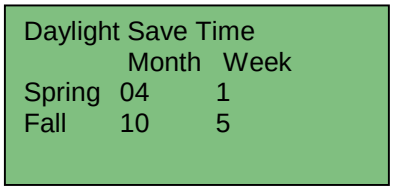
The flash delay is programmable from 6 to 16 seconds in second increments. This is programmed by soldered jumpers on the Program Card. This screen is used only to view the setting.

```
Flash Delay

Time:  6.0
```

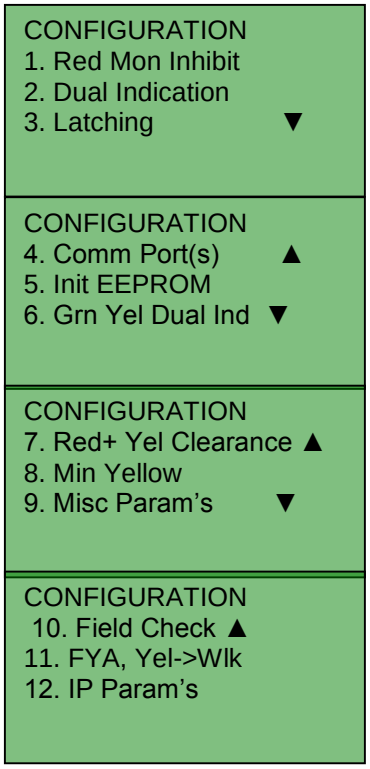
7.2.3.3 Daylight Save

Daylight savings time updates can be set to automatically change the time during a certain week of a specific month. A leading zero is necessary on the month (Jan. thru Sept.) for the date to be accepted.



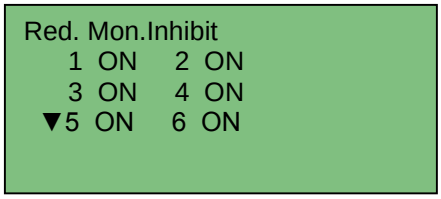
7.2.4 Configuration Menu

The Configuration Menu has 12 selections to control monitoring and various other configuration parameters.



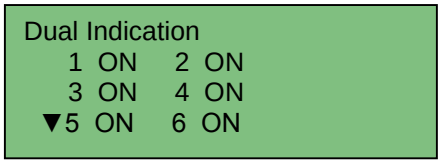
7.2.4.1 Red Monitoring Inhibit

Red Fail Monitoring may be inhibited on a per channel basis through this screen. Setting a channel "ON" inhibits monitoring on that channel. Use the arrow keys to select the channel to be changed. Hit the ENTR key to switch to data entry mode. Use the ↑↓ arrows to select either "ON" or "OFF". Hit the ENTR key to save the selection.



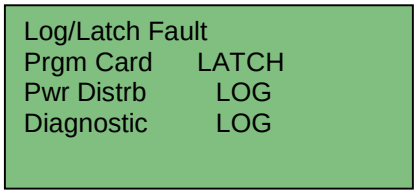
7.2.4.2 Dual Indication

The Dual Indication menu provides control over monitoring of the condition on a per channel basis. Indication faults (section 2.3.1) include simultaneous combinations of Green + Yellow, Yellow + Red, and Green + Red. Setting a channel "ON" enables monitoring of the condition. Use the arrow keys to select the channel to be changed. Hit the ENTR key to switch to data entry mode. Use the ↑↓ arrows to select either "ON" or "OFF". Hit the ENTR key to save the selection.



7.2.4.3 Latching

Standard treatment of system faults (Program Card Ajar and Power disturbances) is for the monitor to activate the fault output relay only for the period that the fault exists; in other words, the fault is not "latched". The monitor provides programmable options that allow system faults to be logged and to be latched. The Latching screen is used to enable these options. The entry fields and available selections are described below.



SELECTIONS

Selection	Description
OFF	Normal NEMA TS-1 operation, non-latched
LOG	Log faults only, do not latch
LATCH	Latch and Log faults (i.e. treat as channel faults)

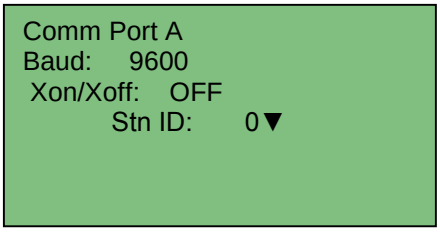
ENTRY FIELDS

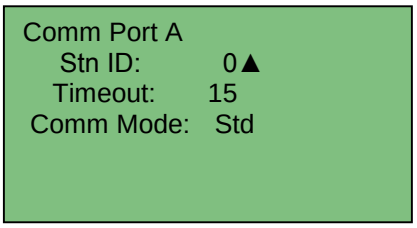
Field	Description and (selections)
Prgm Card	Program Card Ajar or Change (OFF, LATCH)
Pwr Distrb	Power Disturbances (not including Processor Start, Brown-up, or Power- down) (OFF, LOG)
Diagnostic	Internal diagnostics for RAM, ROM, EEPROM, and Program Card. Factory diagnostic test for serial ports, RAM, ROM, and Program Card. (OFF, LOG, LATCH)

Program Card selections affect monitoring in the following way. If latching is OFF, then the program card is read continuously and monitoring performed accordingly. If the card is removed or replaced during operation, then the new permissives are used for determining fault conditions. For the time that the card is removed, there are no permissives. The program ajar sensor is not monitored.

If program card latching is set to LATCH, then the program card is monitored for any change in its program after being read during power-up or following monitor Reset (either from the Reset pushbutton or NEMA input). If a change is detected or the card is removed, the monitor will latch a program card fault.

7.2.4.4 Comm Port(s) (Configure Communications Port)





Five entries are provided on the Configure Communications screen. These are:

Prompt	Entries/Selections	Description
Baud:	300, 600, 1200, 2400, 4800, 9600	Determines the Async Baud Rate of the serial port
Xon/Xoff:	OFF, ON	Enables or disables the use of X-ON and X-OFF characters for flow control. [Note: X-ON,X-OFF is the only protocol provided at this time. This setting should be ON].
Stn ID:	0 to 9999	Station Identification Number that is printed on reports
Timout:	15 to 255	Number of seconds to wait before aborting a transmission; usually due to an X-OFF or disconnected comm cable.
Comm Mode	Std, Sys	Std for local access with a laptop, Sys for access through the controller.

To communicate with the monitor, the async parameters of the device being communicated with should be set to:

Data Characters:	8 bit
Start Bits:	1
Stop Bits:	1
Parity:	None

7.2.4.5 Init EEPROM

The default settings of all configuration parameters that are stored in non-volatile memory (EEPROM) may be restored to their factory settings using this screen.

```
Press Enter to
Restore Default
Program …
```

The default values are:

Parameter	Default Setting
Min Yellow	2.7 seconds, all channels
Red Fail Monitor Inhibit	OFF, all channels Enabled
Dual Indication Monitoring	ON, all channels
Green + Yellow Dual Indication	ON, all channels
Field Check Enable	ON, all channels
Red Fail Less Walk	OFF
Red + Yellow Clearance	ON
System Fault Latching	LOG for CVM, 24V I & II; OFF for Program Card
Power Disturbance Logging	OFF
Console timeout	2 min.
Tone Enable	ON
Comm Baud	9600
Xon/Xoff	OFF
Station ID	0
Timeout	30 Seconds
Comm mode	System
Security Codes	None entered
Access Levels	None, all users
Diagnostic Latching	LATCH

7.2.4.6 Green and Yellow Dual Indication

The MMU-516L-E provides Green & Yellow *Dual Indication Enable* control on a per channel basis. These selections enable green & yellow *Dual Indication* monitoring separately for all 16 channels regardless of the settings for Field Check/Dual Indication Channel monitoring. Setting a channel "ON" enables monitoring.

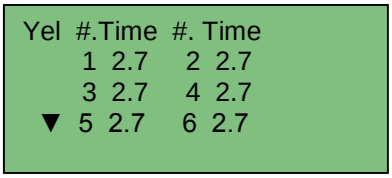
```
Grn Yel Dual Ind
   1  ON    2  ON
   3  ON    4  ON
▼5  ON    6  ON
```

7.2.4.7 Red Plus Yellow Clearance

```
Red+Yel Clearance
Enable: ON
```

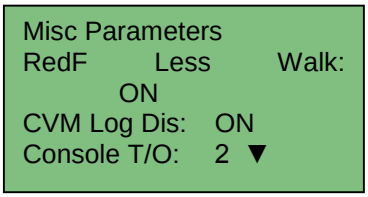
Controls whether the Minimum Yellow Change *Channel Disable* jumper on the program card for each channel controls the Minimum Yellow plus Red Clearance testing. When this selection is in the "ON" position, both the Minimum Yellow and the Minimum Yellow plus Red Clearance tests are controlled by MYCCD jumpers on the *Programming Card*. When it is "OFF", only the *Minimum Yellow* testing is controlled by the MYCCD jumpers.

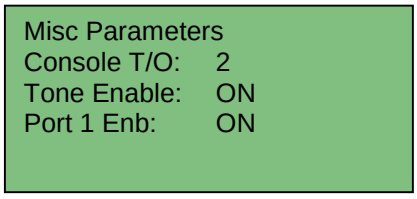
7.2.4.8 Minimum Yellow Time



The minimum yellow interval is programmable on a per channel basis. Any full yellow interval that is shorter than the programmed minimum for the channel will cause a latched fault. A "full" interval is one that is preceded by a green interval on the channel. This feature prevents false minimum yellow faults from occurring on cabinets wired such that the controller continues to run when the signals are turned off.
Also required for minimum yellow interval monitoring to be enabled is that the Red Enable input be active. This feature provides a method to prevent minimum interval failures that might otherwise occur as a cabinet is manually placed on flash or the signal head power is turned off using cabinet controls.

7.2.4.9 Miscellaneous Parameters





7.2.4.9.1 Red Fail Less Walk
When set "ON" the walk inputs are excluded from Red Fail testing.

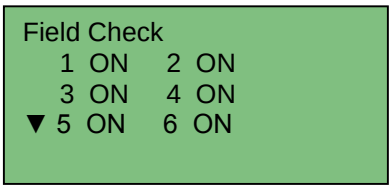
7.2.9.2 CVM Logging Disable
Controller Voltage Monitor logging. "ON" to log events.

7.2.4.9.3 Console Timeout
Time before console reverts back to status screen from menu screens.

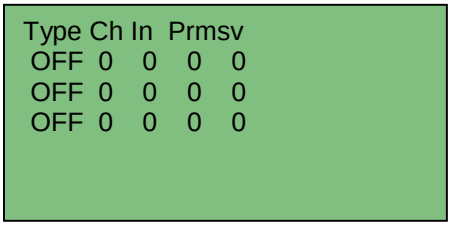
7.2.4.9.4 Tone Enable
User interface confirmation tones are enabled.

7.2.4.9.5 Port 1 Enable
Set to "OFF" to disable the SDLC port. The PORT 1 fault LED will blink when the port is disabled.

7.2.4.10 Field Check
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.
Setting a channel "ON" enables monitoring of the condition. Use the arrow keys to select the channel to be changed. Hit the ENTR key to switch to data entry mode. Use the ↑↓ arrows to select either "ON" or "OFF". Hit the ENTR key to save the selection.



7.2.4.11 FYA, Yel->Wlk
Flashing Yellow Arrow and Yellow Mapped Walk screen entries reassign unused Yellow Inputs on Ped or unused Channels to either a Flashing Yellow Arrow (fourth input on Vehicle Channel), or a Walk on another channel. An unused Yellow Input such as on a Ped Channel, also may be inhibited on this Screen.



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WARNING

THE FLASHING YELLOW ARROW MOVEMENT IS BEING DEVELOPED BASED UPON RESEARCH PERFORMED IN NCHRP PROJECT 3-54. THIS PROGRAM IS AUTHORIZED BY THE FEDERAL HIGHWAY ADMINISTRATION AND IS CURRENTLY IN AN EXPERIMENTAL PHASE.

Trafficware, Inc. does not provide any guidelines, warrants, or recommendations for the use of protected/permissive left-turn phasing. The underlying assumption is that the traffic engineer has decided that flashing yellow arrow protected/permissive control is the most appropriate left-turn treatment. It is also assumed that the deploying agency has made all necessary considerations regarding this control method and has determined that it is consistent with relevant traffic engineering standards and practices. Please note that the operation of this feature is subject to change pending actions by the regulating standards organizations.

==========

Press the ENTR key when the cursor is positioned on one of the Type entries, and then press the ↑ key to select FYA, YMW, or INH, followed by pressing ENTR again. For a Flashing Yellow Arrow (FYA) entry, enter the Channel the arrow is assigned in the Channel(Ch) column. Enter the Input Monitoring Channel (Channel that the Yellow Input is removed from) in the "In" column. Lastly, enter one or two Channels that the Flashing Yellow Arrow is to be permissive with under the Permsv heading.

For a Yellow Mapped Walk assignment, select YMW for the Type, enter the Channel that the Walk is added to (Ch), and the Channel that the Walk is monitored on (In). For an Inhibited Yellow Input entry, set Type to INH, and enter the channel affected in the "In" column. No other entries are required.
A maximum of four mappings may be entered in this screen. Any combination of Flashing Yellow Arrows, Yellow Mapped Walks, and Inhibited Yellow Inputs may be entered.

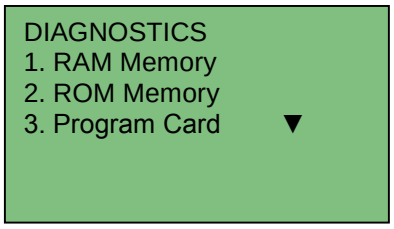
7.2.4.12 IP Parameters Configuration

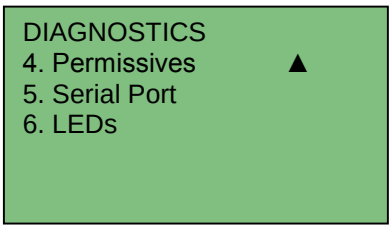
The IP Parameters Configuration screen allows the operator to enter the IP Address, Subnet Mask, Gateway, two Host IP Addresses, the Port Number, and the Port Reset upon Inactivity Timeout (Reset Time), which is entered in hours. The IP Address and Subnet Mask are for the monitor, and two Host Addresses may be configured for the central system. The Gateway is an optional parameter that may be required for your network configuration.
The IP Enable line indicates whether the Ethernet Port is Enabled (ON), or Disabled (OFF). The parameters entered in this entry screen are transferred from the screen to the IP circuitry upon changing IP Enable from OFF to ON. There is a time lag associated with this transfer, and it is shown on the Status line below IP Enable. A display of OK means the last parameters entered are currently used, OFF follows IP Enable turnoff, and INIT'G indicates that the new settings are being processed, i.e.(initializing).

IP Enable: ON Status: OK Device Addr,Mask 192.168.100. 47▼	Device Addr,Mask 192.168.100. 47 255.255.255. 0 Host Addr 1, 2▼
Host Addr 1, 2 192.168.100. 1 0. 0. 0. 0 Gateway Addr ▼	Gateway Addr▲ 0. 0. 0. 0 Port #:5001 Reset Time: 168

Anytime you change the IP settings from menu MM->4->12, you should toggle IP Enable OFF then ON to cause changes in the IP settings to take effect.

7.2.5 Diagnostics Menu

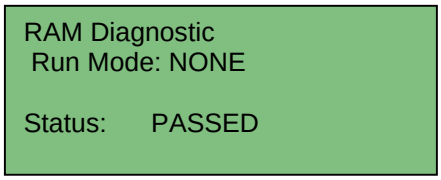




NOTE: Diagnostics can be disruptive and are meant to be used for production testing. Latching and Logging of the test results can be controlled through the Diagnostic latch in the configuration menu under latching.

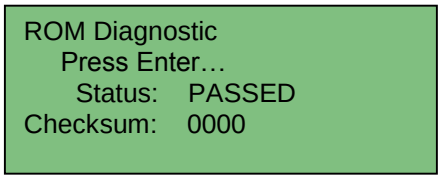
7.2.5.1 RAM Memory

The RAM diagnostic verifies that all RAM locations may be written and read with a variety of data patterns. Change the Run Mode to either “ONCE” or “CONT” to perform the tests. The status field will display PASSED or FAILED on completion of the tests.



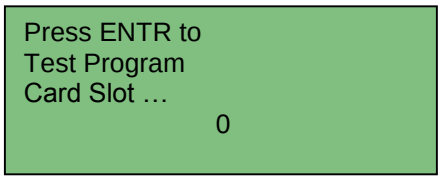
7.2.5.2 ROM Memory

The ROM diagnostic calculates a checksum of the entire program memory. The result of the checksum is displayed as PASSED or FAILED. The calculated checksum is also displayed.



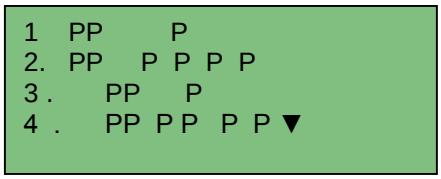
7.2.5.3 Program Card

This factory diagnostic uses an external test fixture to verify that each input of the program card slot is functioning and that there are no short circuits between any of them. It is a production-time diagnostic.



7.2.5.4 Permissives

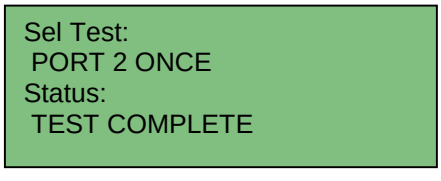
The Permissives screen shows the permissives map which was most recently read from the program card. These are the permissives used for determining conflict faults. This screen may also be used with multiple program cards to verify that the program card slot is functioning properly. When used in this way, four or more cards should be used, each with a different set of program jumpers installed. The jumpers on any card should be equally spaced; for example, every fourth jumper if four cards are used, or every fifth if there are five cards.



If all cards are read properly, it is unlikely that the program card circuitry is malfunctioning. The more cards that are used (with fewer jumpers installed per card), the less likely it will be that an error goes undetected.

7.2.5.5 Serial Port

Use this screen and a "loopback" connector to execute the internal self-test of the serial port. The loopback connector should be wired with pins 1 and 4, 2 and 3, and 7 and 8 connected in pairs.



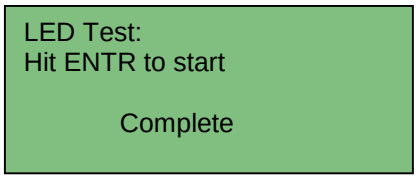
To execute the self-test, install the loopback connector on the port to be tested. Then select the port and test to be run below the prompt "Sel Test:". The status will be displayed during the test and the results when it is complete. If "PORT 2 CONT" is selected, the test will be run continuously. In this case, a successful test is one that continues to display a status of "RUNNING". If the "PORT 2 ONCE" test is selected, a successful test displays "TEST COMPLETE". An

unsuccessful test will result in one of the following messages: TRANSMIT ERROR, RECEIVE ERROR, TIMEOUT ERROR or MESSAGE ERROR.

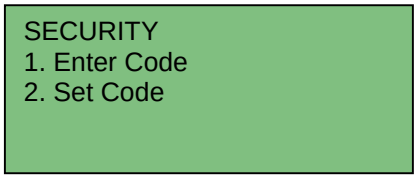
Setting the Console Timeout value to 255 will prevent the status screen from over-writing the test screen.

7.2.5.6 LEDs

The LEDs on the display board will cycle through one at a time. Once the test is done, the display will be updated to show a complete status. Hit ESC to exit test or ENTR to restart.

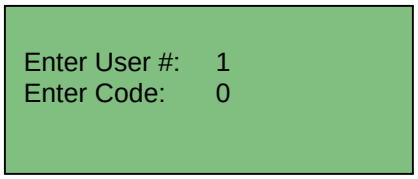


7.2.6 Security Menu



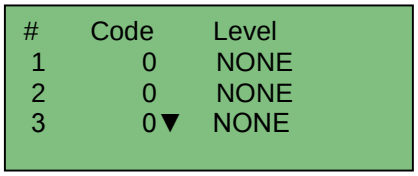
Access to data entry screens may be limited through the use of access codes. Each user may be assigned one of five access levels. Up to 64 users, each assigned a unique access code and level, are maintained by the monitor. Since operation of the security system in Series 500 monitors is the same as that of Series 900 NEMA Traffic Controllers, only one set of access codes and levels is required for both pieces of equipment.

7.2.6.1 Enter Code



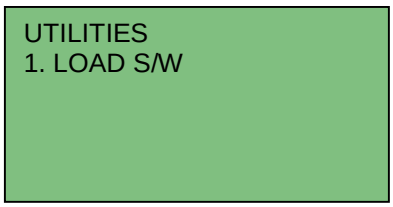
If security is setup in the monitor, this screen allows a user to enter his/her user number and access code.

7.2.6.2 Set Code

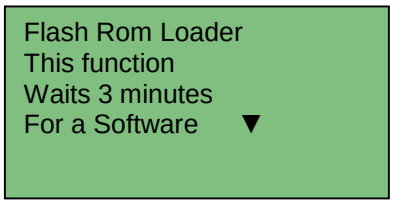


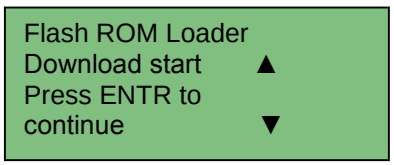
This screen is used to set access codes and levels for users. SECUR(e) is the maximum level of access and is required to gain access to this screen once any users are established. Therefore, the security administrator must be setup first with an access level of SECUR to be able to regain access to this screen.

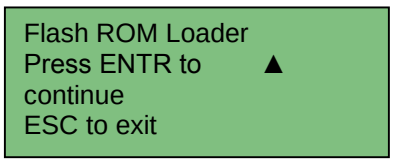
7.2.7 Utilities Menu



7.2.7.1 Flash Rom Loader Utility







The MMU-516L-E contains an internal Flash ROM which can be updated by selecting the “LOAD S/W” utility and accepting the warning displayed on the LCD. StreetWise Partner software is used to download the new firmware to the controller using the serial port. If the firmware download is not started before the 3-minute timeout, the MMU will restart. After the firmware download has completed a checksum will be performed to verify the download. The status of the checksum will be displayed along with the checksum. If the checksum fails the flash ROM loader will restart and wait for the StreetWise Partner software to initiate a new firmware download.

8. REMOTE/LOCAL ACCESS WITH DATA PORT 2

The MMU-516L-E communications Port 2 allows data logs stored within the MMU to be uploaded to a field device (laptop computer) or through the system which is 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.

8.1 Data Port 2 Interface

The MMU-516L-E provides an asynchronous EIA-232 data port (Port 2) operating at 300 to 19,200 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-516L-E 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-516L-E 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.

8.2 Remote Access

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

The Comm Mode should be set to Sys (System) Mode to allow the MMU-516L-E 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.

8.3 Help Menu

The MMU-516L-E *Help Menu* is accessed by typing [H], [M], or [HM] followed by the [ENTER] or [RETURN] key. **Be sure to have the Comm Mode set to "Std" (Standard Mode).** 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 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 so enter `ST 14:40`

8.4 Reports

The following reports are available from the MMU-516L:

- 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)

8.4.1 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 programmed settings:

- Field Check/*Dual Indication* monitoring on a per Channel basis
- Include Yellow + Red Clearance with *Minimum Yellow Change Channel Disable* jumpers
- Green-Yellow *Dual Indication* monitoring enabled on a per Channel basis

The report is initiated by entering PR followed by {ENTER]. The following example shows the format for an MMU-516L 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 516L v2.01
MALFUNCTION MONITOR
Copyright (c)
2005 TRAFFICWARE, Inc.

  Station #  386
  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 ON   # 11 ON   # 12 ON
# 13 OFF  # 14 OFF  # 15 OFF  # 16 OFF

Include Yellow + Red Clearance
 with MYCCD ON

Exclude Walk from Red Fail Test ON

CVM Log Disable for TOD Flash OFF

Green-Yellow Dual Indication Enable
#  1 ON  #  2 ON  #  3 ON  #  4 ON
#  5 ON  #  6 ON  #  7 ON  #  8 ON
#  9 ON  # 10 ON  # 11 ON  # 12 ON
# 13 ON  # 14 ON  # 15 ON  # 16 ON

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

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

Latch CVM Fault OFF
Latch 24V Fault OFF

Minimum Yellow Time(seconds)
#  1 2.7 #  2 2.7 #  3 2.7 #  4 2.7
#  5 2.7 #  6 2.7 #  7 2.7 #  8 2.7
#  9 2.7 # 10 2.7 # 11 2.7 # 12 2.7
# 13 2.7 # 14 2.7 # 15 2.7 # 16 2.7
```

Red Fail Monitor Inhibit

# 1 OFF	# 2 OFF	# 3 OFF	# 4 OFF
# 5 OFF	# 6 OFF	# 7 OFF	# 8 OFF
# 9 OFF	# 10 OFF	# 11 OFF	# 12 OFF
# 13 OFF	# 14 OFF	# 15 OFF	# 16 OFF

Flashing Yellow Arrow &/OR Yellow Mapped Walk

Type	Chan	Input	Permissive(s)
FYA	1	9	2 9
FYA	3	10	4 10
FYA	5	11	6 11
FYA	7	12	8 12

Permissive Jumpers

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

8.4.2 Power Log Report

The MMU-516L-E Power Log Report stores the last 30 power line disturbances and records the type of power event and the date and time the even 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 processor and logic DC power 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  =========
```

8.4.3 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-516L-E operating as a Type 16 follows:

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

  PRESENT FAULT      Date:  9/24/07
    Station: 386      Time: 18:12:18

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

       Fault Type:  YEL+RED CLR

                Date      Time
              --------  --------
  Occurred:   9/24/07  18:02:01

              ---- Channel ----
                        1111111
              12345678 90123456
              -------- --------
    Faulted:  F..F...F ........
        Red:  RRR.RRR. RRRRRRRR
     Yellow:  ........ Y.......
      Green:  ...G...G ........
  Yel Arrow:  A....... ........

 Mapped to :  ........ 1.5.....
      Type :  A...A... ........

Channel  Green  Yellow   Red
    1        0       0   121
    2        0       0   123
    3        0       0   121
    4      123       0     0
    5        0       0   121
    6        0       0   123
    7        0       0   123
    8      121       0     0
    9        0     121   121
   10        0       0   122
   11        0       0   122
   12        0       0   123
   13        0       0   121
   14        0       0   121
   15        0       0   122
   16        0       0   121

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

```
==================================
  FAULT REPORT       Date:  9/24/07
    Station: 386      Time: 18:12:20
  Avenue D. @ First St.
----------------------------------
  Fault #  1    Type:  INDICATION

              Date      Time
             --------  --------
  Occurred:   9/24/07  16:00:42
     Ended:   9/24/07  17:01:15

              ---- Channel ----
                        1111111
              12345678 90123456
              -------- --------
    Faulted:  ....F... ........
        Red:  ..RR.RRR RRRRRRRR
     Yellow:  ........ Y.Y.....
      Green:  .G..G... ........
  Yel Arrow:  A...A... ........

 Mapped to :  ........ 1.5.....
      Type :  A...A... ........

  Fault #  2    Type:  INDICATION

              Date      Time
             --------  --------
  Occurred:   9/24/07  14:56:23
     Ended:   9/24/07  15:58:29

              ---- Channel ----
                        1111111
              12345678 90123456
              -------- --------
    Faulted:  ......F. ........
        Red:  RR.RRR.R RRRRRRRR
     Yellow:  ......Y. ........
      Green:  ..G...G. ........
  Yel Arrow:  ........ ........

 Mapped to :  ........ 1.5.....
      Type :  A...A... ........

=========  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.

8.4.4 Trace Log Report

The MMU-516L-E 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.

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

```
==================================
  TRACE REPORT       Date:  7/ 5/05
    Station:   0      Time: 15:37:05
----------------------------------
  Trace #  1        ---- Channel ----
                              1111111
    7/ 5/05         12345678 90123456
   14:46:04.61      -------- --------
              Red: ........ ........
           Yellow: ........ ........
            Green: ........ ........


     Input    Status    Input  Status
  ----------- ------   ------- ------
   Red Enable:  ON      24V #1:  OK
         CVM:  ON      24V #2:  OK
  24V Mon Inh:  OFF    AC Line:  OK
  Local Flash:  OFF       Type:  16
   Port 1 Dis:  OFF
  ----------------------------------
  Trace #  2        ---- Channel ----
                              1111111
    7/ 5/05         12345678 90123456
   14:46:04.11      -------- --------
              Red: R.RR.RRR RRRRRRRR
           Yellow: ....Y... ........
            Green: .G...... ........


     Input    Status    Input  Status
  ----------- ------   ------- ------
   Red Enable:  ON      24V #1:  OK
         CVM:  ON      24V #2:  OK
  24V Mon Inh:  OFF    AC Line:  OK
  Local Flash:  OFF       Type:  16
   Port 1 Dis:  OFF
  ----------------------------------
```

8.5 Miscellaneous Reports & Commands

The MMU-516L-E 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.

8.5.1 Present Fault Report

The Present Fault Report output is identical to the formal 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].

8.5.2 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
```

8.5.3 Clear Power Log Function

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

```
Power Log Cleared
```

8.5.4 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 created:

```
Fault Log Cleared
```

9. APPENDIX A - CONNECTOR PINOUTS

9.1 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		

9.2 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

9.3 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		

9.4 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

9.5 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 -

9.6 Port 2 Connector

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

9.7 Ethernet Connector

1	Tx Data +
2	Tx Data -
3	Rx Data +
4	E Power+
5	E Power+
6	Rx Data -
7	E Power-
8	E Power-

9.8 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

9.9 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

10. APPENDIX B - SPECIFICATIONS MMU-516L-E

10.1 ELECTRICAL

10.1.1 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

10.1.2 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.

10.1.3 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)

10.1.4 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

10.1.5 COMMUNICATION PORT 1

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

10.1.6 REMOTE ASYNCHRONOUS PORT 2

Interface	EIA-232
Protocol	Xon/Xoff
Data Bits	8
Start Bits	1
Stop Bits	1
Parity	None
Data Rate	300, 600, 1200, 2400, 4800, or 9600 Baud

10.1.7 ETHERNET PORT

Interface	IEEE 802.3
Protocol	UDP Serial
Physical Layer	10/100 Mbit Base-T
Connector	RJ-45

10.2 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)	
FYA Flash Rate Failure	
Nominal On / Off time	less than 250 milliSeconds
	greater than 750 milliSeconds

10.3 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
Ethernet Connector	Mates with RJ-45 Plug

10.4 SIZE

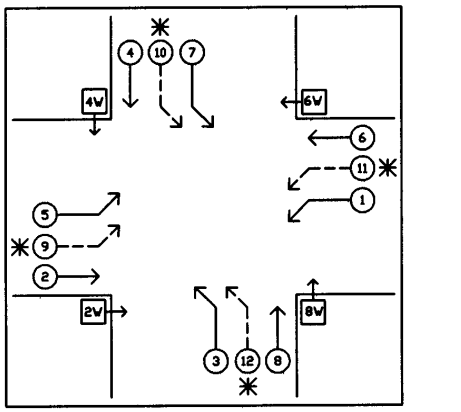
Height	10.5 inches
Width	4.45 inches
Depth	8.25 inches (add 2.5 inches for connector harness assembly)

10.5 ENVIRONMENTAL

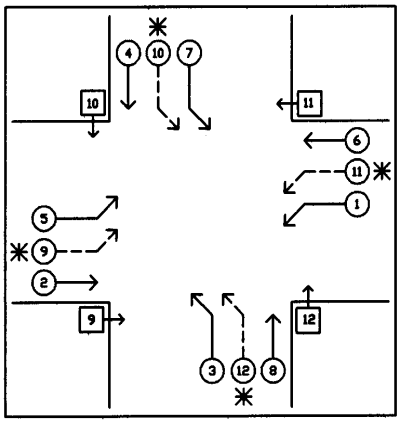
Operating Temperature Range	-34°C to +74°C
Storage Temperature Range	-45°C to +85°C
Relative Humidity	less than 95% non-condensing to +43°C

11. Appendix C – Flashing Yellow Arrow Examples

For both examples please refer to the diagrams and Display Character legend as shown below:



* Yellow Output of FYA-Assigned Channel
TS2-Type 12
Channel Assignments (Example)



* Unused Yellow of Ped Channel
TS2-Type 16
Channel Assignments (Example)

Display Character Legend

1 General - Upper case is active input and SDLC message agrees (if SDLC is active)
- Lower case, input is active but SDLC message does not agree
- 'C' indicates that an input is not active but the SDLC message from the Controller disagrees

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
		R	R			R	R	R	R	R	R	R	R	R	R
								1	3	5	7				
	G				G										
A		:		A		:									

	Row	Meaning
R, r	Red	
Y, y	Yel	
G, g	Grn	
A, a	Walk/FYA	FYA is Active
W, w	Walk/FYA	YMWalk active
:	Walk/FYA	FYA not active
^	Walk/FYA	YMWalk not active
C	All	Controller indicates active, input is not active.
M	Walk/FYA	Replaces C for FYA; C is used for YMW on this row. 'M' implies SDLC Message
1-9, a-g	Yel	Yel input mapped to channel shown (a=10, …, g=16)

11.1 Channels 9-12 Pedestrian Movement Assignment Example

Please refer to the Diagram labeled TS2 Type 12 Channel assignments at the beginning of this Appendix

FYA Programming **4 Left Turns, Peds on 9 - 12**
8/30/2007

CONTROLLER

	Controller Channel Assignments															
Channel	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
Type	OLP	VEH	OLP	VEH	OLP	VEH	OLP	VEH	PED	PED	PED	PED	OLP	OLP	OLP	OLP
#	2	2	4	4	6	6	8	8	2	4	6	8	9	9	9	9

Controller FYA Overlap Setup								
Overlap		**2**		**4**		**6**		**8**
Olp Included		1		3		5		7
Olp Modifier		2		4		6		8
FYA out on Chan		9		10		11		12
OLP Type		R-T/OTH		R-T/OTH		R-T/OTH		R-T/OTH
OLP Type+		FLYel-4		FLYel-4		FLYel-4		FLYel-4

Notes

1 Assign only Even-numbered overlaps as FYA. Odd-numbered overlaps one less than FYA must remain unassigned b/c the yellow is used as an alternate way output the FYA signal.

MMU-516L

MMU FYA Setup								
FYA #	**1**		**2**		**3**		**4**	
Type	FYA		FYA		FYA		FYA	
FYA Channel	1		3		5		7	
Yel Input Chan	9		10		11		12	
Permissive 1	2		4		6		8	
Permissive 2	9		10		11		12	

Please note that the Channel numbers in parentheses are not programmed on the Program Card.
Their FYA functionality is entered on the FYA Setup Screen as indicated above.

MMU Prog Card

Channel	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
1		(2)			5	6			(9)		11					
2					5	6			9		11					
3				(4)			7	8		(10)		12				
4							7	8		10		12				
5						(6)			9		(11)					
6									9		11					
7								(8)		10		(12)				
8										10		12				
9											11					
10												12				
11																
12																
13																
14																
15																

11.2 Channels 13-16 Pedestrian Movements Assignment Example

Please refer to the Diagram labeled TS2 Type 16 Channel assignments at the beginning of this Appendix.

FYA Programming **4 Left Turns, Peds on 13-16**
8/30/2007

CONTROLLER

	Controller Channel Assignments															
Channel	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
Type	OLP	VEH	OLP	VEH	OLP	VEH	OLP	VEH	OLP	OLP	OLP	OLP	PED	PED	PED	PED
#	2	2	4	4	6	6	8	8	9	9	9	9	2	4	6	8

Controller FYA Overlap Setup								
Overlap		**2**		**4**		**6**		**8**
Olp Included		1		3		5		7
Olp Modifier		2		4		6		8
FYA out on Chan		13		14		15		16
OLP Type		R-T/OTH		R-T/OTH		R-T/OTH		R-T/OTH
OLP Type+		FLYel-4		FLYel-4		FLYel-4		FLYel-4

Notes

1 Assign only Even-numbered overlaps as FYA. Odd-numbered overlaps one less than FYA must remain unassigned b/c the yellow is used as an alternate way to get the FYA output.

MMU-516L

MMU FYA Setup								
FYA #	**1**		**2**		**3**		**4**	
Type	FYA		FYA		FYA		FYA	
FYA Channel	1		3		5		7	
Yel Input Chan	13		14		15		16	
Permissive 1	2		4		6		8	
Permissive 2	13		14		15		16	

Please note that the Channel numbers in parentheses are not programmed on the Program Card.
Their FYA functionality is entered on the FYA Setup Screen as indicated above.

MMU Prog Card

Channel	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
1		(2)			5	6							(13)		15	
2					5	6							13		15	
3				(4)			7	8						(14)		16
4							7	8						14		16
5						(6)							13		(15)	
6													13		15	
7								(8)						14		(16)
8														14		16
9																
10																
11																
12																
13															15	
14																16
15																

12. APPENDIX D - Monitor Setup for Testing FYA

The Flashing Yellow Arrow functionality of the MMU-516L-E may be tested with either of the programming examples shown in Appendix C. Select FYA Mode G from the Optional Tests selection on the tester when you are using PED Channels 9 through 12, and select FYA Mode H from the Optional Tests when you are using PED Channels 13 through 16. All four arrows must be enabled for the tests, and the tester requires that the Red monitoring for the PED channels be inhibited for the test. When the Soft Permissives are programmed as in the Appendix C examples, it is not necessary to program any jumpers on the Program Card used in the test.

For the Certification Test with Optional test FYA Mode G, you must first prepare for the Certification Test by changing the Flash Mode to OFF for all four FYA entries. Be sure that the Red Monitoring is enabled for PED Channels 9 through 12. At the conclusion of the standard tests, you will be prompted to make the changes for the FYA Mode G test. Disable Red Monitoring for PED Channels 9 through 12 and select FYA for the Flash Mode on all four FYAs. At the conclusion of the test, be sure to restore Red Monitoring on the PED Channels.

For the Certification Test with Optional test FYA Mode H, you must first prepare for the Certification Test by changing the Flash Mode to OFF for all four FYA entries. Be sure that the Red Monitoring is enabled for PED Channels 13 through 16. At the conclusion of the standard tests, you will be prompted to make the changes for the FYA Mode H test. Disable Red Monitoring for PED Channels 13 through 16 and select FYA for the Flash Mode on all four FYAs. At the conclusion of the test, be sure to restore Red Monitoring on the PED Channels.