MMU–1600D

Malfunction Management Unit

Firmware Version 01.07.23

Operations Manual

NEMA TS 2-2003 Malfunction Management Unit

This manual contains technical information for the
MMU-1600D series Malfunction Management Unit

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MAINTENANCE NOTE

IT IS AN EBERLE DESIGN, INC. RECOMMENDATION THAT EACH UNIT BE TESTED AT LEAST ANNUALLY TO ENSURE COMPLIANCE WITH FACTORY SPECIFICATIONS AND MEETS PROPER OPERATIONAL STANDARDS. THE RESULTS OF THIS TESTING WILL BE DOCUMENTED.

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Section 1 General Description

This product manual was written for people installing, operating, and maintaining the Reno A&E Model MMU-1600D Malfunction Management Unit (monitor).

The Reno A&E MMU-1600D monitor was designed to meet or exceed the standards defined in Section 4 of the NEMA Standards Publication TS 2-2003. Section 4 responds to the need for a monitor to accomplish the detection of, and response to, improper and conflicting signals and improper operating voltages in a Controller Assembly (CA). This standard provides interchangeability between units of different manufacturers and downward compatibility to NEMA Standards Publication TS 1-1989.

The monitor detects the presence of voltage on conflicting field connection terminals, the absence of proper voltages on all of the signal field connection terminals of a channel, and monitors for the presence of satisfactory operating voltages within the Controller Unit (CU) and the monitor itself. If any of these conditions exist or are out of tolerance for the minimum time defined in Section 4 of the NEMA Standards Publication TS 2-2003, the Output relay's normally open contacts will transfer from the no fault state (relay energized) to the fault state (relay de-energized). The closure of the Output relay contacts will cause the transfer of the traffic signals to Flashing Operation. The fault is recorded by the monitor and displayed on the appropriate LED indicators.

The monitor will operate in one of two modes depending on the signal level on the Type Select input. If the Type Select input is at Logic Ground potential, the monitor will operate as a Type 16 monitor with sixteen channels, otherwise it will operate as a Type 12 monitor with twelve channels.

Type 16 - Each of the sixteen channels monitors three 120 volt AC outputs; Green / Walk, Yellow, and Red / Don't Walk.

Type 12 - Each of the twelve channels monitors four 120 volt AC outputs; Green, Yellow, Walk, and Red.

For TS 2 type operation the monitor is usually configured as a Type 16 monitor. The Type 16 monitor is intended for those applications in which there are three circuits per channel and the monitor channels have been wired in a one-to-one correspondence with the load switches, as defined in Section 5.5.3 of the NEMA Standards Publication TS 2-2003. The Type 12 monitor is intended to provide downward compatibility with a 12 channel conflict monitor unit (CMU) conforming to TS 1-1989.

The signal monitor portion of the monitor is capable of checking for the presence of voltage on conflicting field connection terminals in the Controller Assembly. For the purpose of conflict determination, a signal on any of the Green, Yellow, or Walk inputs associated with a channel shall be considered as that channel being active.

The signal monitor portion of the monitor is also capable of checking for the absence of any required signal voltage on each channel at the field connection terminals in the Controller Assembly. For this purpose a signal on the Green, Yellow, Walk, or Red/Don't Walk inputs associated with a channel shall be considered as that channel being active.

The voltage monitor portion of the monitor is capable of checking the Controller Unit Voltage Monitor output that indicates satisfactory operating voltage in the Controller Unit and the +24 volt direct current inputs.

The monitor is fully programmable. An interchangeable programming card is provided to allow the assignment of permissive or compatible channels. Programming is accomplished through the use of soldered wire jumpers on the Program Card. The programming card may be used in a monitor operating in either Type 16 or Type 12 mode. The Program Card can be inserted into the monitor through a slot in the front panel. The Program Card also contains a serial EEPROM. This device is used to store programming information not set by the wire jumpers. Features stored in the serial EEPROM include Flashing Don't Walk Monitoring, Co-Channel Childs, Per Channel Red Enable, Location, Unit ID, Agency ID, IP Address, and others.
When configured in the Type 16 mode and connected to a TS 2 Controller Unit, the monitor has the ability to exchange information in a standardized format with the Controller Unit in real time through the Port 1 interface. The monitor and the Controller Unit perform redundant checks on each other through messages defined in the TS 2 Standard. The Controller Unit can access monitor information including field signal input status, permissive programming, and fault status. This gives the Controller Unit the capability to function as a backup monitor and make enhanced event logging, remote intersection monitoring, and remote diagnostics possible. Likewise, the monitor receives information from the Controller Unit corresponding to Controller Unit output commands to the various load switches. Access to this information allows the monitor to more accurately respond to and diagnose fault situations.

Requirements outlined in the TS 2 Standard provide for messages to be generated by the Controller Unit and the monitor, which effectively extend the communications capabilities of a standard assembly. The monitor utilizes these message facilities to provide the highest level of enhanced application specific diagnostic reporting and monitoring.

The Model MMU-1600D Series is comprised of the following monitors:

Model MMU-1600D (Reno USA)	For applications calling for a NEMA TS 2-2003 compliant Malfunction Management Unit with DIP switch settings and LED display.
Model MMU-1600D (Reno Canada)	For applications calling for a NEMA TS 2-2003 compliant Malfunction Management Unit with DIP switch settings and LED display and Canadian Fast Flash monitoring.
Model MMU-1600DE (Reno USA)	For applications calling for a NEMA TS 2-2003 compliant Malfunction Management Unit with DIP switch settings and LED display and optional Ethernet network connector.
Model MMU-1600DE (Reno Canada)	For applications calling for a NEMA TS 2-2003 compliant Malfunction Management Unit with DIP switch settings and LED display and Canadian Fast Flash monitoring and optional Ethernet network connector.

Section 2 General Characteristics

2.1 INPUTS

2.1.1 AC LINE
The over-current protected side of 120 volt AC 60 hertz source. This input (Connector A - Pin A) is used to generate the voltages required to operate the monitoring logic. The monitor has a front panel mounted over-current protection device in the 120 volt AC input to the unit. This fuse is a 1/4 AMP SLO-BLOW and should only be replaced with a fuse of the same type and value.

Typical Connection: Cabinet AC Line power source.

2.1.2 AC NEUTRAL
The unfused and unswitched return side of the 120 volt AC 60 hertz power source. This input (Connector A - Pin V) is the referenced signal for all field terminal voltage sensing inputs. This input is not connected to Logic Ground or Earth Ground within the unit.

Typical Connection: Cabinet AC Neutral.

2.1.3 EARTH GROUND
The monitor has an input terminal (Connector A - Pin U) providing an independent connection to the chassis of the unit. This input is not connected to Logic Ground or AC Neutral within the unit.

Typical Connection: Cabinet Earth Ground.

2.1.4 FIELD TERMINALS (REDS, YELLOWS, GREENS, AND WALKS)
The field terminal inputs are where the Red, Yellow, Green, and Walk indications are connected to the monitor. The inputs used and how they are used is determined by the state of the Type Select input (See Section **2.1.11**).

Type 16: Three inputs are provided for each channel to permit the monitoring of voltages at the Green, Yellow, and Red signal field terminals. If the channel is used to monitor pedestrian indication, they are connected Don't Walk to Red, Pedestrian Clearance to Yellow, and Walk to Green.

Type 12: Four inputs are provided for each channel to permit the monitoring of voltages at the Green, Yellow, Red, and Walk signal field terminals.

The thresholds used to determine the ON and OFF states of the field terminals can be modified from the standard (incandescent) thresholds to ones more appropriate for LED field displays. The LED thresholds are more restrictive than the standard thresholds. This means that any fault that would have been caught using the standard thresholds would be caught when using the LED thresholds.

In the Standard Mode (Incandescent Field Displays):

A Green, Yellow, or Walk signal input is sensed as ON when it exceeds $25V_{RMS}$ and a signal input is sensed as OFF when it is less than $15V_{RMS}$. Signals between $15V_{RMS}$ and $25V_{RMS}$ may be in either state.

A Red signal input is sensed as ON when it exceeds $70V_{RMS}$ and a signal input is sensed as OFF when it is less than $50V_{RMS}$. Signals between $50V_{RMS}$ and $70V_{RMS}$ may be in either state.

In the LED mode (LED Field Displays):

For the purpose of testing for Conflicts, Multiple Indications, and Flashing Don't Walk Monitoring, a Green, Yellow, Red, or Walk signal input is sensed as ON when it exceeds $25V_{RMS}$ and a signal input is sensed as OFF when it is less than $15V_{RMS}$. Signals between $15V_{RMS}$ and $25V_{RMS}$ may be in either state.

For the purpose of testing for Red Fails, Co-Channel Childs, Short Yellows, and Short Clearance, a Green, Yellow, Red, or Walk signal input is sensed as ON when it exceeds $70V_{RMS}$ and a signal input is sensed as OFF when it is less than $50V_{RMS}$. Signals between $50V_{RMS}$ and $70V_{RMS}$ may be in either state.

When the load connected to the sensing input of the monitor exhibits high impedance characteristics such as those caused by some LED signal displays or burned out lamps, it may be necessary to place a low impedance device (load resistor) external to the unit between the unit input and AC Neutral. See Section 6.2.4 of NEMA Standards Publication TS 2-2003.

Typical Connections: Field terminals for channel Reds, Yellows, Greens, and Walks as appropriate.

2.1.5 RED ENABLE
The presence of the proper voltage at this terminal (Connector B - Pin a) enables the monitor to detect the absence of voltage on all field signal inputs of a channel. The absence of the proper voltage inhibits the detection of the absence of voltage on all field signal inputs of a channel. This input is considered enabled when the input voltage exceeds $89V_{RMS}$ at the Red Enable input. This function is considered not enabled when the input voltage is less than $70V_{RMS}$ at the Red Enable input.

The presence of the proper voltage at this terminal also enables Minimum Yellow Change / Red Clearance Interval Monitoring and Field Check / Dual Indication Monitoring. The absence of the proper voltage at this terminal inhibits Minimum Yellow Change / Red Clearance Interval Monitoring.

The monitor will not recognize state changes of the Red Enable input while AC power is not valid. This ensures that short power interruptions do not cause unintended state changes of the Red Enable input.

Typical Connection: Control point that has 120VAC when the cabinet is in normal operation.

2.1.6 LOGIC GROUND

A voltage reference point and current return for the Reset input, Controller Voltage Monitor input, +24V Monitor I input, +24V Monitor II input, Type Select input, +24V Monitor Inhibit input, Local Flash Status input, and Port 1 Disable input as well as the Port 1 SDLC communications signals. This termination (Connector A - Pin T) is not connected to either the AC Neutral or Earth Ground within the unit.

Typical Connection: Power Supply DC Common and/or Controller Logic Ground.

2.1.7 +24V MONITOR I

+24V Monitor I (Connector A - Pin S) is monitored to assure a proper +24 volt DC level.

Typical Connection: Power Supply +24VDC or Controller +24VDC Output.

2.1.8 +24V MONITOR II

+24V Monitor I (Connector A - Pin S) is monitored to assure a proper +24 volt DC level.

Typical Connection: Power Supply +24VDC or Controller +24VDC Output.

2.1.9 24V MONITOR INHIBIT

+24V Monitor Inhibit input (Connector A - Pin n) is a logic level input used to disable monitoring of the +24V Monitor I and +24V Monitor II inputs. Application of a True (Low) state to this input inhibits the operation of the +24 Volt Monitor and sets the +24 Volt Monitor Inhibit bit (bit 60) of the Type 129 Frame to 1.

Typical Connection: Unterminated or tied to +24VDC.

2.1.10 CONTROLLER VOLTAGE MINTOR (CVM)

The Controller Voltage Monitor input (Connector A - Pin V) is a logic level input. This input must stay in a low state (nominal 0 volts) for normal signal operation. When high or floating, the monitor will be in the fault condition. This input is sometimes used by controllers to perform time of day flash operations. In this case, the 24V Latch jumper on the program card cannot be installed for proper operation.

Typical Connection: Controller CVM Output

2.1.11 TYPE SELECT

The monitor operates as a Type 16 monitor with sixteen channels when the Type Select input (Connector A - Pin HH) is at logic True (Low) state; otherwise it operates as a Type 12 monitor with twelve channels.

Type 16: When configured for Type 16 operation, each channel has the capability of monitoring a Green (Walk), a Yellow, and a Red (Don't Walk) field signal output at the Terminals and Facilities field terminals. Type 16 operation is intended for those applications in which there are three circuits per channel and the monitor channels have been wired in a one-to-one correspondence with the load switches, as defined in Section 5.5.3 of the NEMA Traffic Controller Assemblies Standards Publication TS 2-2003.

Type 12: When configured for Type 12 operation, each channel has the capability of monitoring a Green, a Walk, a Yellow, and a Red field signal output at the Terminals and Facilities field terminals. Type 12 operation is intended for those applications in which downward compatibility with 12 channel Conflict Monitor Units (CMU) conforming to NEMA Traffic Control Systems Publication TS 1-1989 is required. All Port 1 communications errors are ignored when the monitor is configured to operate as a Type 12 monitor.

Typical Connection: Logic Ground for Type 16 operation. Unterminated or tied to +24VDC for Type 12 operation.

2.1.12 LOCAL FLASH STATUS

The Local Flash Status input (Connector B - Pin c) is a logic level input. When this input is in the low state (nominal 0 volts), the monitor will transfer the Output Relay contacts to the fault state and set the Local Flash Status bit (bit 79) in the Type 129 Frame to 1. At all other times, the Local Flash Status bit of the Type 129 Frame is set to 0.

Typical Connection: Police Panel flash switch and/or inside cabinet flash switch

2.1.13 PORT 1 DISABLE

The Port 1 Disable input (Port 1 SDLC Connector - Pin 10) is a logic level input. When this signal is in the low state (nominal 0 volts), the monitor will ignore Port 1 SDLC communications errors. Port 1 SDLC communications errors are always ignored during type 12 operation.

Typical Connection: Unterminated when Port 1 SDLC communications will be used. Logic Ground when Port 1 SDLC communications are not used in Type 16 operation.

2.1.14 RESET

The Reset input (Connector A - Pin BB) is a logic level input. When this input transitions to the low state (nominal 0 volts), a fault reset is performed.

Typical Connection: Unterminated or tied to +24VDC. Should be used only for automated testing.

2.1.15 CABINET INTERLOCK

The monitor has two terminals internally connected to indicate the presence of the unit to external circuitry. These terminals are identified as Cabinet Interlock A (Connector A - Pin CC) and Cabinet Interlock B (Connector A - Pin DD).

Typical Connection: Interlock circuitry that will not allow the cabinet to operate normally with the monitor removed.

2.2 OUTPUTS

2.2.1 OUTPUT RELAY

The Output relay of the monitor has two sets of isolated Form C contacts. These relay contacts are capable of switching all loads in the range from two milliamps at 18 volts DC to three amperes at $135V_{RMS}$ AC.

The Normally Open (N.O.) contacts of the Output relay are the contacts that are open when the unit is in the No Fault state and all voltages are sufficient for proper operation of the Controller Assembly. The relay coil is energized in the No Fault state.

Prior to the monitor transferring the Output relay contacts from the Fault state to the No Fault state, a Transition state with a duration of 500 milliseconds occurs. During the Transition state the Output relay contacts are the same as the Fault state and the monitor sets the Start-Up Flash Call bit (bit 80) of the Type 129 Frame to 1. At all other times the Start-Up Flash Call bit of the Type 129 Frame is set to 0.

Typical Connection: One set of contacts is used to control the flash transfer relays the other is usually used to apply stop timing to the controller.

2.2.2 START DELAY RELAY

The Start-Delay relay has one set of Form C relay output contacts. These relay contacts are capable of switching all loads in the range from 2 milliamps at 18 volts DC to 3 amperes at $135V_{RMS}$ AC.

The monitor includes a means of detecting a loss of AC Line power. Upon restoration of AC Line following a monitor power loss, the Start-Delay relay maintains continuity between its Common and Normally Open contacts for a period of 2.0 ±0.5 seconds. Following this 2.0 second time period, the Start-Delay relay enables continuity to occur between its Common and Normally Closed contacts.

The operation of the Start-Delay relay normally results in the initiation of a start-up sequence within the Control Unit by interrupting the AC Line input to the Control Unit.

Typical Connection: The Common and Normally Closed contacts are used to route AC power to the controller.

2.3 PROGRAMMING CARD

This monitor uses a standardized programming card for channel compatibility (permissives), minimum flash time, per channel Minimum Yellow Change Disable, CVM latch, and 24 volt monitor latch. Programming of this card is accomplished through the use of soldered wire jumpers. The programming card plugs into the monitor through a slot in the front panel. The monitor is constructed with card guides to ease the insertion of the programming card. The programming card includes card ejectors to ease removal of the programming card. The edge of the programming card is flush with the surface of the front panel when it is properly seated in the programming card slot of the monitor. The **PRGM CARD** LED will illuminate if the programming card is not properly seated while power is applied.

Programming cards supplied by Reno A&E have an integral serial EEPROM which can store the other settings for the monitor which are not programmed using soldered jumpers.

See Section **3.5** for programming card connector pin assignments.

2.3.1 CHANNEL COMPATABILITY (PERMISIVES)

The monitor requires programming action to provide compatibility between channels.

The programming card has 120 pairs of holes for channel compatibility programming jumpers. The 120 jumper hole pairs are logically labeled for easy identification of the jumper holes by channel pairs. A soldered wire jumper in a jumper hole pair defines a pair of channels as permissive or compatible.

2.3.2 MINIMUM FLASH
The programming card has four pairs of holes for minimum flash programming jumpers. The four jumper hole pairs are logically labeled for easy identification of the jumper holes in binary weighted fashion. A soldered wire jumper in a jumper hole pair adds that designated input value to the binary weighted sum. Per the NEMA TS 2 standard, the actual value used is the binary weighted sum plus one.

2.3.3 MINMUM YELLOW CHANGE CHANNEL DISABLE
The programming card has sixteen pairs of holes for Minimum Yellow Change Disable programming jumpers. The sixteen jumper hole pairs are logically labeled for easy identification of the channel numbers. A soldered wire jumper in a jumper hole pair disables Minimum Yellow Clearance monitoring for that channel. Typically, all pedestrian channels should have these jumpers installed.

2.3.4 VOLTAGE MINTOR LATCH
The programming card has two pairs of holes for latch programming jumpers. The two jumper hole pairs are logically labeled for easy identification of the +24 Volt Latch and CVM Latch. A soldered wire jumper in a jumper hole pair causes that fault condition to be latched.

2.3.5 SERIAL EEPROM
The programming card contains a serial EEPROM. This device is not called for in the NEMA TS-2 specification and is only compatible with other Reno A&E monitors. The programming card is interchangeable with other manufacturer's programming cards for the programming of the standard features. Reno A&E has provided the serial EEPROM as a way of copying the other programming settings from one monitor to another monitor. Using a non-Reno A&E programming card in this monitor will result in the monitor not being able to store the other programming settings for copying to other Reno A&E monitors. See Section **2.4.10** for additional information on how data stored in the serial EEPROM is used.

2.4 FEATURES

2.4.1 MONITOR POWER FAILURE
The monitor responds to a Power Failure by entering a non-latching flash state. The monitor responds to a Power Failure whether it is the result of the over-current protection device operation, failure of the monitor power supply, or absence of proper operating AC Line voltage as defined below.

The operating AC Line input is considered to be On if the voltage level is greater than $98V_{RMS}$ AC and it is considered to be Off if the voltage level is less than $89V_{RMS}$ AC. The hysteresis from the Off state to the On state or vice versa is at least $3V_{RMS}$ AC.

The monitor responds to Power Failure as follows:

1) If the AC Line input is Off for 450 milliseconds or less, the monitor continues to operate as though the AC Line had remained On. The Output relay contacts do not transfer to the fault condition during this interval. The Start-Delay relay maintains continuity between its Common and Normally Closed contacts.
2) If the AC Line input is Off for 500 milliseconds or more, the monitor transfers the Output relay contacts to the fault condition. The Start-Delay relay enables continuity between its Common and Normally Open contacts. The time interval from the start of the AC Line input being Off and the transfer of both relays to these states does not exceed 525 milliseconds. Both relays maintain these states for the duration of the Power Failure.

2.4.2 MINIMUM FLASH INDICATION
The monitor includes internal logic to enforce a user definable Minimum Flash time. Once the monitor has transferred the Output relay contacts to the fault condition, the state of the Output relay contacts is maintained for the Minimum Flash time before normal operation can resume.

All monitor initiated flash conditions will start the Minimum Flash timer. The monitor will not return to normal operation until this timer has expired unless it is terminated by use of the front panel reset pushbutton or reset input command which will cause an immediate transfer to the no fault state.

The duration of the Minimum Flash time is adjustable between the limits of 5 seconds and 15 seconds with an incremental adjustment of one second and is programmed using jumpers on the Program Card. The NEMA TS-2 specification requires that the monitor add one second to whatever value is programmed on the program card and that the value on the program card cannot be set to less than five seconds. This creates a useable range of 6 seconds to 16 seconds.

2.4.3 RESET
Activation of the front panel reset pushbutton or the reset input causes the Output relay contacts to transfer to the no fault condition. The monitor remains in the no fault condition only if there are no existing faults and all input voltages are at the proper operating levels. If the Minimum Flash timer is active, activation of the either reset will zero the timer and transfer to the no fault condition.

Each activation of the front panel reset pushbutton or the reset input causes a one-time reset input to the monitor. A continuously activated front panel reset or reset input will not prevent the monitor from checking any fault conditions and/or transferring the Output relay contacts to the fault condition. The front panel reset or reset input must be removed and reapplied to activate a new reset input to the monitor. Activation of either reset will cause all of the front panel LEDs to turn on for 300 milliseconds.

The only intended purpose of the reset input is to facilitate automated testing of the monitor.

2.4.4 TYPE 16 ONLY MODE

This feature if useful in cabinets where the user is retrofitting a TS 2 monitor into a TS 1 cabinet and wants to use the Type 16 mode, but the existing Connector A harness does not have a wire for Pin HH (Type Select). Activating this feature forces the monitor to operate in the Type 16 mode regardless of the logic level on the Type Select input. While this feature is on, the **TYPE 12** LED will show the Function Disabled indication (50 milliseconds on, once every two seconds).

2.4.5 COM PORT

The monitor has a front panel mounted DB-9, RS-232 communications port that can be used with Reno A&E's RaeComM software to view / modify configuration settings, view current status and voltages, view logs, and download firmware upgrades. The COM port supports the standard baud rates from 300 to 57600 with one or two stop bits and parity of odd, even, or none. The factory default is 57600, no parity, and one stop bit. The most current version of the RaeComM software can be found on the Reno A&E web site www.editraffic.com under support / monitor support / software. Also see Application Note AN-002 for an introduction to the RaeComM software. This application note can be found on the web site under support / monitor support / application notes.

The monitor was designed to use a standard DB-9 extension cable (male to female, straight through) for connecting to a laptop or computer. This port does not support handshaking signals. On the MMU-1600DE, both the COM port and the optional Ethernet port can be used at the same time. See Section **3.4** for connector pin assignments.

2.4.6 ETHERNET PORT

The MMU-1600DE has an optional high speed, 10BASE-T / 100BASE-TX Ethernet network jack that can be used for communications with Reno A&E's RaeComM software to view / modify configuration settings, view current status and voltages, view logs, and download firmware upgrades.

To use this port an IP Address and port number must be set in the monitor. Contact your network administrator for addresses valid for your network. The factory default is an IP Address of 0.0.0.0 (which is an unusable address) and port 10001 (this is the recommended value). The Ethernet settings must be configured through the COM port using the RaeComM software.

In order to prevent the accidental writing of information to an unintended monitor, the Ethernet port is read-only on power up. To make the Ethernet port read-write, press the **RESET** pushbutton on the front of the monitor. This will unlock the monitor for a period of 15 minutes.

2.4.7 TEMPERATURE SENSOR

The monitor is capable of measuring the temperature inside of the cabinet. The temperature sensor is capable of measuring temperatures in the range of -40° F to +214° F (-40° C to +101° C). The internal cabinet temperature is included in the data logged into the Prior Faults Log when a fault occurs. If the actual temperature inside the cabinet is below -40° F (-40° C) at the time the fault occurs, the temperature is logged as -40° F (-40° C). If the actual temperature inside the cabinet is above +214° F (+101° C) at the time the fault occurs, the temperature is logged as +214° F (+101° C).

2.4.8 REAL TIME CLOCK

The monitor has a Real Time Clock (RTC) that is used as a reference for all date and time stamped events that are logged by the monitor. The Real Time Clock is initialized to local Pacific Standard Time when the unit is undergoing final test. In addition, the Daylight Saving Time user option is set to Off.

The Real Time Clock is preprogrammed to recognize Leap Years and Daylight Saving Time events through the year 2099. Currently, per U.S. Federal standards, Daylight Saving Time is observed in the United States from 2:00 A.M. on the second Sunday in March until 2:00 A.M. on the first Sunday in November.

The update priority of any time setting that affects the Real Time Clock is as follows:

1. Controller Time - The Real Time Clock is programmed with the time setting received from the Controller. This information is received via the PORT 1 SDLC connector on the front of the monitor. If the Real Time Clock setting differs from the Controller Time setting by more than two (2) seconds, The Real Time Clock will be synchronized to the Controller clock. In the event that the Real Time Clock setting differs from the Controller Time setting by five (5) or more seconds, the Real Time Clock will be synchronized to the Controller clock and an entry will be made to the Time Change Log.

2. External Time Source (i.e. laptop computer) - The Real Time Clock setting can be modified through the use of the RaeComM software. Connection to the laptop computer is made via the COMM PORT serial connector or optional Ethernet connector on the front of the monitor. NOTE: Whenever the monitor is

connected to an operational SDLC bus, any time setting entered via the serial port will be overwritten by the Controller Time setting.

3. Front Panel - The Real Time Clock setting can be modified through the front panel. NOTE: Whenever the monitor is connected to an operational SDLC bus, any time setting entered via the front panel will be overwritten by the Controller Time setting.

If it is necessary to change the Real Time Clock setting in a monitor that is being used in a NEMA TS 2 Cabinet Assembly, change the time setting on the cabinet controller. The time change will be broadcast to the monitor through the SDLC port.

2.4.9 UP TIME ACCUMULATOR

The monitor has an Up Time Accumulator that keeps track of the total amount of time that the monitor has been powered up since it was manufactured. It is saved in the format of Years, Months, Days, Hours, Minutes, and Seconds. The monitor warranty coverage is valid for a total accumulated Monitor Up Time of two (2) years. Tracking and recording the total time that the unit was in service provides an accurate means of validating any potential warranty claims.

2.4.10 CONFIGURATION MONITORING (BEEPING MONITOR)

The monitor checks all configuration settings for changes once each second. If a change is found, an audible buzzer will start beeping to indicate that a configuration setting has changed. If the change is undone, the beeping will stop. No fault monitoring configuration changes are implemented until the front panel reset pushbutton is pressed and held for five (5) seconds. At that time five quick confirmation beeps will be heard, the new settings will be implemented, and a Configuration Change log entry made.

The following configuration settings are monitored: Programming Card jumpers, Type Select input, Factory Options, Dual Indication / Field Check, Per Channel Red Enables, Flashing Don't Walk Monitoring, Flashing Yellow Arrow Left Turns, Co-Channels, Thresholds, Logging Enables, Disable Local Flash, Modified CVM Latch, External Watchdog Enable, Type 16 Only, and Buzzer Disable.

On power up and any time the program card is changed the configuration stored on the program card is compared to the configuration stored in the monitor. If they do not match the user is prompted to choose which data set to use. If the program card is selected, the configuration settings on the card will be copied into the monitor. If the monitor is selected, the configuration settings on the program card are overwritten with the current monitor configuration. All user information (Ethernet settings, Location, Location ID, and Agency ID) as well as fault monitoring settings are copied. See Section **4.5** for front panel display during selection of configuration source.

2.4.11 FACTORY SETTINGS

The monitor is configured at the factory during final test. Data set at the factory includes: Model Number, Serial Number, Manufacture Date, Real Time Clock setting, Support for Flashing Greens, Enhanced Support of Econolite Controllers, Support for a Diagnostic LCD. The Up Time Accumulator is initialized to zero prior to final testing. Changes to Support for Flashing Greens, Enhanced Support of Econolite Controllers, and Support for a Diagnostic LCD are logged in the configuration log.

2.4.12 USER UNIT INFORMATION

The monitor has non-volatile memory that can be used to store the following user unit information: 40 character Location ID, 4 character Unit ID, and 5 character Agency ID. All of these IDs can consist of any alpha-numeric characters. Upper and lower case characters can be used.

2.5 FAULT MONITORING

2.5.1 CONLFICT MONITORING

Configuration: The jumpers installed on the Program Card determine permissive (non-conflicting) channels. A jumper in the row labeled "2" and the jumper hole pair labeled "6" would make Channels 2 and 6 permissive with each other. This is a two-way relationship. If channel 2 is programmed as permissive with channel 6 then channel 6 is automatically permissive with channel 2. The testing defaults for this feature are determined by the jumpers installed on the program card. Typically no jumpers are installed during automated testing.

Test Preformed: While a channel has a Green, Walk, or Yellow display active, the channel is tested to see if a non-permissive channel has a Green, Walk, or Yellow display active at the same time. If concurrently active conflicting displays are detected a conflict timer is started. If the conflict goes away the conflict timer is stopped (it is not cleared) and a non-conflict timer is started. If the conflict reappears the non-conflict timer is reset to zero and the conflict timer continues timing from its prior value. If the conflict timer reaches 300 milliseconds or more the monitor will latch a conflict fault. If the non-conflict timer reaches 666 milliseconds the conflict timer is reset to zero and the conflict is ignored. The normal voltage thresholds for this test are: Reds – ON when above $70V_{RMS}$ and OFF when below $50V_{RMS}$, Greens / Yellows / Walks – ON when above $25V_{RMS}$ and OFF when below $15V_{RMS}$.

Fault Action: The monitor transfers the Output relay contacts to the fault condition (continuity between the Normally Open and Common contacts), illuminates the **CONFLICT** indicator on the front panel, and sets the

Conflict bit (bit 65) of the Type 129 Frame to 1. The Signal Sequence log and the Prior Faults log will record this fault.

Resetting the Fault: The monitor remains in this fault condition until the unit is reset by the activation of the front panel reset pushbutton or the activation of the reset input. Power loss or power interruption will not reset this fault. The Reset log will record the resetting of this fault.

Modifying Inputs: None

Feature Interactions:

Flashing Don't Walk Monitoring: When Flashing Don't Walk Monitoring is enabled and channels have programmed as active for this feature, a flashing red on a channel with this feature active will be included in the displays checked for conflicts. A conflict with a flashing red must exist for 1500 milliseconds to create a conflict fault.

Flashing Yellow Arrow Left Turns: When Flashing Yellow Arrow (FYA) is enabled and FYA Ignore Yellow Conflict is enabled and a Channel has an FYA checked as a child channel that conflicts with this channel a Yellow in the parent channel and a Yellow in the child channel being active at the same time will be ignored as a conflict when the Yellow of the parent channel is terminating a flashing Yellow arrow. Also, when Flashing Yellow Arrow (FYA) is enabled and Per Channel Red Enables is enabled and the channel Red Enable is disabled and Dual Indication / Field Check for the channel is disabled and Minimum Yellow Change Disable for the channel is not jumpered on the Program Card and the channel has the actual flashing yellow arrow display the monitor will ignore the unused Green or Yellow of that channel for conflict tests.

LED Thresholds: When LED Thresholds

2.5.2 RED FAIL MONITORING

Configuration: All channels will be monitored for the red fail fault unless the Per Channel Red Enables feature is enabled. When Per Channel Red Enables are enabled only channels that have been programmed as active for this feature will be included in the displays checked for red fail. The per channel settings can only be modified through the RaeComM software. The testing defaults for this feature are Per Channel Red Enables is disabled and all channels enabled for red fail testing.

Test Preformed: When a channel has no displays active (Red, Yellow, Green, or Walk) a red fail timer is started. If a display turns on for the channel the red fail timer is stopped (it is not cleared) and a non-red fail timer is started. If the no active display condition returns the non-red fail timer is reset to zero and the red fail timer continues timing from its prior value. If the red fail timer reaches 800 milliseconds or more the monitor will latch a red fail fault. If the non-red fail timer reaches 300 milliseconds the red fail timer is reset to zero and the red fail is ignored. The normal voltage thresholds for this test are: Reds – ON when above $70V_{RMS}$ and OFF when below $50V_{RMS}$, Greens / Yellows / Walks – ON when above $25V_{RMS}$ and OFF when below $15V_{RMS}$.

Fault Action: The monitor transfers the Output relay contacts to the fault condition (continuity between the Normally Open and Common contacts), illuminates the **RED FAIL** indicator on the front panel, and sets the Red Failure bit (bit 66) of the Type 129 Frame to 1. The Signal Sequence log and the Prior Faults log will record this fault.

Resetting the Fault: The monitor remains in this fault condition until the unit is reset by the activation of the front panel reset pushbutton or the activation of the reset input. Power loss or power interruption will not reset this fault. The Reset log will record the resetting of this fault.

Modifying Inputs:

Red Enable: All red fail testing will be disabled when this input is below $70V_{RMS}$.

Load Switch Flash bit (bit 112) of the Type 0 Frame: All red fail testing will be disabled when this bit is set to one.

Feature Interactions:

Per Channel Red Enables: When Per Channel Red Enables are enabled only channels that have been programmed as active for this feature will be included in the displays checked for red fail.

LED Thresholds: When LED Thresholds is enabled the Greens, Yellows, Reds, and Walks are sensed as ON when their voltage is above $70V_{RMS}$ and OFF when below $50V_{RMS}$ for the red fail test.

Flashing Greens (also known as Canadian Fast Flash): When Flashing Greens are enabled the timer thresholds are changed from 800 milliseconds to 1500 milliseconds for fault detection and from 300 milliseconds to 200 milliseconds for the reset of the fault timer.

Co-Channels: When Per Channel Red Enables are enabled and Flashing Yellow Arrow (FYA) Left Turns are not enabled and a Channel has one of its child channels checked, then the Green of the child channel will be

included in the red fail test for that channel. If Co-Channel Includes Yellow is also enabled then the Green and the Yellow of the child channel will be included in the red fail test for that channel.

Flashing Yellow Arrow Left Turns: When Flashing Yellow Arrow (FYA) Left Turns are enabled and a Channel has an FYA setting with a green border for one of its child channels, then the Green of the child channel will be included in the red fail test for that channel. If a Channel has an FYA setting with a yellow border for one of its child channels, then the Yellow of the child channel will be included in the red fail test for that channel.

2.5.3 DUAL INDICATION MONITORING

Configuration: All channels with a setting of "ON" for Dual Indication / Field Check switches will be monitored for the dual indication fault. The testing defaults for this feature are all channels enabled for dual indication testing.

Test Preformed: When operating in the Type 12 mode the following dual indications are checked for: Yellow + Red, Green + Red, Walk + Red, Green + Yellow, and Walk + Yellow. When operating in the Type 16 mode the following dual indications are checked for: Yellow + Red, Green + Red, and Green + Yellow. When a channel has multiple displays active a dual indication timer is started. If one of the indications turns off the dual indication timer is stopped (it is not cleared) and a single indication timer is started. If both of the indications turn off the dual indication timer is stopped (it is not cleared) and a no indication timer is started. If the dual indication condition returns the single indication and no indication timers are stopped (not cleared) and the dual indication timer continues timing from its prior value. If the dual indication timer reaches 600 milliseconds or more the monitor will latch a dual indication fault. If the single indication timer reaches 1000 milliseconds the dual indication timer, the single indication timer, and the no indication timer are reset to zero and the dual indication is ignored. If the no indication timer reaches 300 milliseconds the dual indication timer, the single indication timer, and the no indication timer are reset to zero and the dual indication is ignored. The normal voltage thresholds for this test are: Reds – ON when above $70V_{RMS}$ and OFF when below $50V_{RMS}$, Greens / Yellows / Walks – ON when above $25V_{RMS}$ and OFF when below $15V_{RMS}$.

Fault Action: The monitor transfers the Output relay contacts to the fault condition (continuity between the Normally Open and Common contacts), illuminates the **DUAL IND** indicator on the front panel, and sets the Spare Bit #2 bit (bit 68) of the Type 129 Frame to 1. The Signal Sequence log and the Prior Faults log will record this fault.

Resetting the Fault: The monitor remains in this fault condition until the unit is reset by the activation of the front panel reset pushbutton or the activation of the reset input. Power loss or power interruption will not reset this fault. The Reset log will record the resetting of this fault.

Modifying Inputs:

Red Enable: All dual indication testing will be disabled when this input is below $70V_{RMS}$.

Load Switch Flash bit (bit 112) of the Type 0 Frame: All dual indication testing will be disabled when this bit is set to one.

Feature Interactions:

Field Check: Enabling dual indication monitoring will also enable field check monitoring.

Minimum Yellow Change Disable Jumpers: When Minimum Yellow Change Disable is jumpered for a channel the Red + Yellow reset timing threshold for the single indication timer is changed from 1000 milliseconds to 400 milliseconds.

Flashing Greens (also known as Canadian Fast Flash): When Flashing Greens are enabled the no indication timer thresholds for the Green + Red and Green + Yellow fault conditions are changed from 300 milliseconds to 100 milliseconds.

Flashing Yellow Arrow Left Turns: When Flashing Yellow Arrow (FYA) Left Turns are enabled and a Channel has an FYA setting with a green border for one of its child channels, then the Green of the child channel will be included in the dual indication test for that channel. If a Channel has an FYA setting with a yellow border for one of its child channels, then the Yellow of the child channel will be included in the dual indication test for that channel. This will effectively add the following dual indication tests: Red + FYA, Yellow + FYA, and Green + FYA. Also the timing thresholds are different for dual indications involving an FYA. The dual indication timer threshold is 1500 milliseconds, single indication timer threshold is 1000 milliseconds, and the no indication timer threshold is 300 milliseconds.

LED Thresholds: When LED Thresholds is enabled the monitor senses Greens, Yellows, Reds, and Walks as ON when their voltage is above $25V_{RMS}$ and OFF when below $15V_{RMS}$ for the dual indication test.

2.5.4 GY-DUAL INDICATION MONITORING

Configuration: Green-Yellow Monitoring Enabled is used to enable monitoring for this fault. When enabled all channels will have a minimum of Green + Yellow dual indication monitoring. All channels with a setting of "ON"

for Dual Indication / Field Check switches will be monitored for all dual indication fault combinations (See Section **2.5.3** for fault combinations). The testing default for this feature is disabled.

Test Preformed: When a channel has a Green and a Yellow display active a dual indication timer is started. If one of the indications turns off the dual indication timer is stopped (it is not cleared) and a single indication timer is started. If both of the indications turn off the dual indication timer is stopped (it is not cleared) and a no indication timer is started. If the dual indication condition returns the single indication and no indication timers are stopped (not cleared) and the dual indication timer continues timing from its prior value. If the dual indication timer reaches 600 milliseconds or more the monitor will latch a dual indication fault. If the single indication timer reaches 1000 milliseconds the dual indication timer, the single indication timer, and the no indication timer are reset to zero and the dual indication is ignored. If the no indication timer reaches 300 milliseconds the dual indication timer, the single indication timer, and the no indication timer are reset to zero and the dual indication is ignored. The normal voltage thresholds for this test are: Reds – ON when above $70V_{RMS}$ and OFF when below $50V_{RMS}$, Greens / Yellows / Walks – ON when above $25V_{RMS}$ and OFF when below $15V_{RMS}$.

Fault Action: The monitor transfers the Output relay contacts to the fault condition (continuity between the Normally Open and Common contacts), illuminates the **DUAL IND** indicator on the front panel, and sets the Spare Bit #2 bit (bit 68) of the Type 129 Frame to 1. The Signal Sequence log and the Prior Faults log will record this fault.

Resetting the Fault: The monitor remains in this fault condition until the unit is reset by the activation of the front panel reset pushbutton or the activation of the reset input. Power loss or power interruption will not reset this fault. The Reset log will record the resetting of this fault.

Modifying Inputs:

Red Enable: All Green + Yellow dual indication testing will be disabled when this input is below $70V_{RMS}$.

Load Switch Flash bit (bit 112) of the Type 0 Frame: All Green + Yellow dual indication testing will be disabled when this bit is set to one.

Feature Interactions:

Flashing Greens (also known as Canadian Fast Flash): When Flashing Greens are enabled the no indication timer threshold for the Green +Yellow fault condition is changed from 300 milliseconds to 100 milliseconds.

LED Thresholds: When LED Thresholds is enabled the monitor senses Greens, Yellows, Reds, and Walks as ON when their voltage is above $25V_{RMS}$ and OFF when below $15V_{RMS}$ for the dual indication test.

2.5.5 SHORT YELLOW MONITORING

Configuration: Minimum Yellow Change Disable (MYCD) jumpers on the program card disable short Yellow monitoring for a channel. Typically pedestrian only channels will have MYCD jumpers installed. The testing defaults for this feature are determined by the jumpers installed on the program card. Typically no jumpers are installed during automated testing.

Test Preformed: When a channel has a Green or Walk that turns off, a Yellow must follow it and it must stay on for at least 2.7 seconds. When each Green or Walk turns off a 2.7 second timer is started. A Yellow must start within 1 second of the Green or Walk turning off. If the Red turns on before the Yellow, a short Yellow fault will be generated to show that the Yellow was skipped. When a Yellow turns on for at least 100 milliseconds another 2.7 second timer is started and must reach zero before the yellow turns off or a short Yellow fault will be generated. The normal voltage thresholds for this test are: Reds – ON when above $70V_{RMS}$ and OFF when below $50V_{RMS}$, Greens, Walks, and Yellows – ON when above $25V_{RMS}$ and OFF when below $15V_{RMS}$.

Fault Action: The monitor transfers the Output relay contacts to the fault condition (continuity between the Normally Open and Common contacts), illuminates the **SHORT YEL** indicator on the front panel, and sets the Minimum Clearance Failure bit (bit 74) of the Type 129 Frame to 1. The Signal Sequence log and the Prior Faults log will record this fault.

Resetting the Fault: The monitor remains in this fault condition until the unit is reset by the activation of the front panel reset pushbutton or the activation of the reset input. Power loss or power interruption will not reset this fault. The Reset log will record the resetting of this fault.

Modifying Inputs:

Red Enable: All short Yellow testing will be disabled when this input is below $70V_{RMS}$.

Load Switch Flash bit (bit 112) of the Type 0 Frame: All short Yellow testing will be disabled when this bit is set to one.

Feature Interactions:

LED Thresholds: When LED Thresholds is enabled the monitor senses Greens, Yellows, Reds, and Walks as ON when their voltage is above $70V_{RMS}$ and OFF when below $50V_{RMS}$ for the short Yellow test.

Flashing Yellow Arrow Left Turns: When Flashing Yellow Arrow (FYA) Left Turns are enabled and a Channel has an FYA setting with a green or yellow border for one of its child channels, then the Yellow of the Channel will be used for terminating the Yellow or Green of the child channel and will be checked for short yellow and skipped yellow. Also, when Flashing Yellow Arrow (FYA) is enabled and Per Channel Red Enables is enabled and the channel Red Enable is disabled and Dual Indication / Field Check for the channel is disabled and Minimum Yellow Change Disable for the channel is not jumpered on the Program Card and the channel has the actual flashing yellow arrow display the monitor will not include the unused Green or Yellow of that channel in the short yellow tests.

2.5.6 SHORT CLEARNACE MONITORING

Configuration: All channels will be monitored for a short clearance fault.

Test Preformed: When a channel has a Green or Walk that turns off, a conflict channel cannot display a Green, Walk, or Yellow for at least 2.7 seconds. When each Green or Walk turns off a 2.7 second timer is started. If a conflicting Green, Walk, or Yellow turns on for at least 100 milliseconds the 2.7 second timer must have reached zero or a fault will be generated. The normal voltage thresholds for this test are: Reds – ON when above $70V_{RMS}$ and OFF when below $50V_{RMS}$, Greens, Walks, and Yellows – ON when above $25V_{RMS}$ and OFF when below $15V_{RMS}$.

Fault Action: The monitor transfers the Output relay contacts to the fault condition (continuity between the Normally Open and Common contacts), illuminates the **SHORT CLR** indicator on the front panel, and sets the Minimum Clearance Failure bit (bit 74) and Spare Bit #5 (bit 71) of the Type 129 Frame to 1. The Signal Sequence log and the Prior Faults log will record this fault.

Resetting the Fault: The monitor remains in this fault condition until the unit is reset by the activation of the front panel reset pushbutton or the activation of the reset input. Power loss or power interruption will not reset this fault. The Reset log will record the resetting of this fault.

Modifying Inputs:

Red Enable: All short clearance testing will be disabled when this input is below $70V_{RMS}$.

Load Switch Flash bit (bit 112) of the Type 0 Frame: All short clearance testing will be disabled when this bit is set to one.

Feature Interactions:

LED Thresholds: When LED Thresholds is enabled the monitor senses Greens, Yellows, Reds, and Walks as ON when their voltage is above $70V_{RMS}$ and OFF when below $50V_{RMS}$ for the short Yellow test.

Flashing Yellow Arrow Left Turns: When Flashing Yellow Arrow (FYA) Left Turns are enabled and a Channel has an FYA setting with a green or yellow border for one of its child channels, then that child will be checked for short clearance. Also, when Flashing Yellow Arrow (FYA) is enabled and Per Channel Red Enables is enabled and the channel Red Enable is disabled and Dual Indication / Field Check for the channel is disabled and Minimum Yellow Change Disable for the channel is not jumpered on the Program Card and the channel has the actual flashing yellow arrow display the monitor will not include the unused Green or Yellow of that channel in the short clearance tests.

2.5.7 FIELD CHECK MONITORING

Configuration: All channels with a setting of "ON" for Dual Indication / Field Check switches will be monitored for a field check fault. The testing defaults for this feature are all channels enabled for field check testing.

Test Preformed: This monitoring function combines information about active field inputs with information received through the Port 1 communications between the Controller Unit and the monitor in a TS 2 Cabinet Assembly. The monitor will receive a Type 0 Frame from the Controller Unit (Type 1 or Type 2 CU) that contains an image of the controller output commands to the load switches. When the field signal input states detected as active or inactive by the monitor do not correspond with the information received from the Controller Unit in the Type 0 Frame for 10 consecutive 100 millisecond periods a fault will be generated. The normal voltage thresholds for this test are: Reds – ON when above $70V_{RMS}$ and OFF when below $50V_{RMS}$, Greens, Walks, and Yellows – ON when above $25V_{RMS}$ and OFF when below $15V_{RMS}$.

Fault Action: The monitor transfers the Output relay contacts to the fault condition (continuity between the Normally Open and Common contacts), illuminates the **FIELD CHK** indicator on the front panel, and sets the Spare Bit #1 bit (bit 67) of the Type 129 Frame to 1. The Signal Sequence log and the Prior Faults log will record this fault.

Resetting the Fault: The monitor remains in this fault condition until the unit is reset by the activation of the front panel reset pushbutton or the activation of the reset input. Power loss or power interruption will not reset this fault. The Reset log will record the resetting of this fault.

Modifying Inputs:

Red Enable: All field check testing will be disabled when this input is below $70V_{RMS}$.

Port 1 Disable: All field check testing will be disabled when this input is below $8V_{DC}$.

Feature Interactions:

Dual Indication: Enabling field check monitoring will also enable dual indication monitoring.

Per Channel Red Enables: When Per Channel Red Enables are enabled, only channels that have been programmed with a Per Channel Red Enable setting of checked will be included in the channels checked for a field check fault.

Flashing Don't Walk Monitoring: When channels have programmed with Flashing Don't Walk Monitoring active, the yellow of the active channels will not be checked for a field check fault. This does not require that the Flashing Don't Walk Enable be set to ON.

2.5.8 PORT 1 FAIL MONITORING

Configuration: If operating in the Type 16 mode, Port 1 timeouts will always be checked for unless Port 1 Disable (SDLC Connector - Pin 10) is low. The testing default for this feature is determined by the Port 1 Disable pin.

Test Preformed: If the monitor has not received a Type 0 Frame from the Controller Unit through the Port 1 SDLC communications bus for 300 milliseconds (three consecutive frame periods) a Port 1 fault will be generated. A Port 1 Timeout failure during the programmed Minimum Flash time or during a monitor Power Failure shall not cause a fault.

Fault Action: The monitor transfers the Output relay contacts to the fault condition (continuity between the Normally Open and Common contacts), illuminates the **PORT 1 FAIL** indicator on the front panel, and sets the Port 1 Timeout bit (bit 75) of the Type 129 Frame to 1. The Signal Sequence log and the Prior Faults log will record this fault.

Resetting the Fault: When receipt of 10 consecutive valid Type 0 Frames occurs, the monitor will transfer the Output relay contacts to the No Fault state unless three Port 1 timeouts have occurred in a calendar day. The monitor will not exit this third timeout state without user interaction (activation of the front panel reset pushbutton or activation of the reset input) or AC power being removed and reapplied. A user interaction will reset Port 1 Timeout counts to zero. AC power interruptions will not reset this count. When the monitor's clock passes through midnight, the count will be reset to zero. The Reset log will record the resetting of this fault.

Modifying Inputs:

Port 1 Disable: Port 1 failures will be ignored when this input is below $8V_{DC}$.

Type Select: Port 1 failures will be ignored when this input is in the Type 12 mode (Unterminated or above $16V_{DC}$).

Feature Interactions: None

2.5.9 +24 VOLT MONITOR I

Configuration: The 24V Latch jumper on the Program Card determines whether this fault is a latched fault. The testing default for this feature is determined by the jumper installed on the program card. Typically no jumper is installed during automated testing.

Test Preformed: A voltage greater than $+22V_{DC}$ applied to the +24 Volt Monitor I input is recognized as adequate for proper operation. A voltage of less than $+18V_{DC}$ is recognized as inadequate for proper operation. When the +24 Volt Monitor I input is detected as inadequate for more than 175 milliseconds, the monitor generates a fault. A +24V Monitor I failure during the programmed Minimum Flash time or during a monitor Power Failure shall not cause a fault.

Fault Action: The monitor transfers the Output relay contacts to the fault condition (continuity between the Normally Open and Common contacts), illuminates the **24V-1** indicator on the front panel, and sets the +24 Volt Monitor I bit (bit 58) of the Type 129 Frame to 1. The Signal Sequence log and the Prior Faults log will record this fault.

Resetting the Fault: Restoration of proper voltage to the +24V Monitor I input will reset this fault. Once tripped to the fault state, the minimum flash time must time before normal operation can be restored. The Reset log will record the resetting of this fault.

If the 24V Latch jumper is installed on the Program Card, the monitor remains in this fault condition until the unit is reset by the activation of the front panel reset pushbutton or the activation of the reset input. Power loss or power interruption will not reset this fault.

Modifying Inputs:

+24V Monitor Inhibit: +24V Monitor I failures will be ignored when this input is below $8V_{DC}$.

Feature Interactions: None

2.5.10 +24 VOLT MONITOR II

Configuration: The 24V Latch jumper on the Program Card determines whether this fault is a latched fault. The testing default for this feature is determined by the jumper installed on the program card. Typically no jumper is installed during automated testing.

Test Preformed: A voltage greater than $+22V_{DC}$ applied to the +24 Volt Monitor II input is recognized as adequate for proper operation. A voltage of less than $+18V_{DC}$ is recognized as inadequate for proper operation. When the +24 Volt Monitor II input is detected as inadequate for more than 175 milliseconds, the monitor generates a fault. A +24V Monitor II failure during the programmed Minimum Flash time or during a monitor Power Failure shall not cause a fault.

Fault Action: The monitor transfers the Output relay contacts to the fault condition (continuity between the Normally Open and Common contacts), illuminates the **24V-2** indicator on the front panel, and sets the +24 Volt Monitor II bit (bit 59) of the Type 129 Frame to 1. The Signal Sequence log and the Prior Faults log will record this fault.

Resetting the Fault: Restoration of proper voltage to the +24V Monitor II input will reset this fault. Once tripped to the fault state, the minimum flash time must time before normal operation can be restored. The Reset log will record the resetting of this fault.

If the 24V Latch jumper is installed on the Program Card, the monitor remains in this fault condition until the unit is reset by the activation of the front panel reset pushbutton or the activation of the reset input. Power loss or power interruption will not reset this fault.

Modifying Inputs:

+24V Monitor Inhibit: +24V Monitor II failures will be ignored when this input is below $8V_{DC}$.

Feature Interactions:

24V-2 To 12VDC: When this feature is enabled the voltage thresholds used are changed from greater than $+22V_{DC}$ being valid to greater than $+11.5V_{DC}$ and a voltage of less than $+18V_{DC}$ being invalid to less than $+10.75V_{DC}$.

2.5.11 CONTROLLER VOLTAGE MONITOR

Configuration: The CVM Latch jumper on the Program Card determines whether this fault is a latched fault. The testing default for this feature is determined by the jumper installed on the program card. Typically no jumper is installed during automated testing.

Test Preformed: A voltage of less than $8V_{DC}$ is recognized as proper operation. A voltage greater than $16V_{DC}$ is recognized as improper operation. When the CVM input is detected as improper for more than 175 milliseconds, the monitor generates a fault. A CVM failure during the programmed Minimum Flash time or during a monitor Power Failure shall not cause a fault.

Fault Action: The monitor transfers the Output relay contacts to the fault condition (continuity between the Normally Open and Common contacts), illuminates the **CVM / WD** indicator on the front panel, and sets the Controller Voltage Monitor bit (bit 57) of the Type 129 Frame to 1. The Signal Sequence log will record this fault. The Prior Faults log will record this fault if Log CVM Events is enabled.

Resetting the Fault: Restoration of proper voltage to the CVM input will reset this fault. Once tripped to the fault state, the minimum flash time must time before normal operation can be restored. The Reset log will record the resetting of this fault.

If the CVM Latch jumper is installed on the Program Card, the monitor remains in this fault condition until the unit is reset by the activation of the front panel reset pushbutton or the activation of the reset input. Power loss or power interruption will not reset this fault.

Modifying Inputs: None

Feature Interactions:

Modified CVM Latch: When this feature is enabled and the CVM Latch jumper is installed the monitor will not latch a CVM fault until the CVM input has been valid (Low) for more than 175 milliseconds. This feature is useful in cabinets where the CVM input may not always be valid within the programmed Minimum Flash time and where latched CVM failures is desired.

Log CVM Events: When this feature is enabled the Prior Faults log will record this fault. Disabling this feature is useful when the intersection uses the CVM input to provide time of day flash. This will keep the Prior Faults log from filling up with normal flash operations.

2.5.12 LOCAL FLASH

Configuration: None

Test Preformed: A voltage of less than $8V_{DC}$ (low) is recognized as a request for Local Flash. A voltage greater than $16V_{DC}$ (or floating) is recognized as normal operation. When the Local Flash input is detected as low for more than 175 milliseconds, the monitor generates a fault. A Local Flash request during the programmed Minimum Flash time shall not cause a fault.

Fault Action: The monitor transfers the Output relay contacts to the fault condition (continuity between the Normally Open and Common contacts), illuminates the **LOC FLASH** indicator on the front panel, and sets the Local Flash bit (bit 79) of the Type 129 Frame to 1. The Signal Sequence log will record this fault. The Prior Faults log will record this fault if Log Local Flash Events is enabled.

Resetting the Fault: Restoration of a voltage greater than $16V_{DC}$ (or floating) to the Local Flash input will reset this fault. Once tripped to the fault state, the minimum flash time must time before normal operation can be restored. The Reset log will record the resetting of this fault.

Modifying Inputs: None

Feature Interactions:

Disable Local Flash: When this feature is enabled and the Local Flash input will be ignored.

Log Local Flash Events: When this feature is enabled the Prior Faults log will record this fault. Disabling this feature is useful when the intersection uses the Local Flash input to provide time of day flash. This will keep the Prior Faults log from filling up with normal flash operations.

2.5.13 EXTERNAL WATCHDOG MONITORING

Configuration: The setting of External Watchdog Enable determines if this feature is active. The testing default for this feature is disabled.

Test Preformed: The External Watchdog input is connected to Pin S on Connector B (Spare 2). A voltage of less than $8V_{DC}$ is recognized as a low and a voltage greater than $16V_{DC}$ is recognized as a high. The input must change states at least once every 1500 milliseconds or the monitor generates a fault. An External Watchdog fault during the programmed Minimum Flash time or during a monitor Power Failure shall not cause a fault.

Fault Action: The monitor transfers the Output relay contacts to the fault condition (continuity between the Normally Open and Common contacts), flashes the **CVM / WD** indicator on the front panel, and sets the Spare Bit #4 (bit 70) of the Type 129 Frame to 1. The Signal Sequence log will record this fault. The Prior Faults log will record this fault if Log Local Flash Events is enabled.

Resetting the Fault: The monitor remains in this fault condition until the unit is reset by the activation of the front panel reset pushbutton or the activation of the reset input. Power loss or power interruption will not reset this fault. The Reset log will record the resetting of this fault.

Modifying Inputs: None

Feature Interactions: None

2.5.14 PROGRAMMING CARD ABSENT MONITORING

Configuration: None

Test Preformed: If the programming card is not present or not seated properly in the connectors the monitor generates a fault.

Fault Action: The monitor transfers the Output relay contacts to the fault condition (continuity between the Normally Open and Common contacts), illuminates the **PRGM CARD** indicator on the front panel. The Signal Sequence log and the Prior Faults log will record this fault.

Resetting the Fault: Proper insertion of a Program Card is required before the fault can be reset. The monitor remains in this fault condition until the unit is reset by the activation of the front panel reset pushbutton, activation of the reset input, power loss, or power interruption. The Reset log will record the resetting of this fault.

Modifying Inputs: None

Feature Interactions: None

2.6 TESTING MODIFIERS

2.6.1 FLASHING DON'T WALK MONITORING

Configuration: The setting of Flashing Don't Walk Enabled determines if this feature is active. All channels with a setting of checked for Flashing Don't Walk Monitoring will include a flashing red on that channel in the displays

checked for conflicts. The per channel settings can only be modified through the RaeComM software. The testing defaults for this feature are all channels disabled for Flashing Don't Walk Monitoring testing and Flashing Don't Walk Enabled set to no.

Tests Modified:

Conflict: Normal conflict testing checks active Green, Walk, and Yellow displays for being permissive. With this feature active, any channel with a setting of checked will have a flashing Red included in the channels checked as permissive. A flashing input is defined as an input that stays ON for at least 200 milliseconds and no longer than 600 milliseconds and is OFF for at least 200 milliseconds and no longer than 600 milliseconds. A Flashing Don't Walk conflict must exist for 1500 milliseconds to be detected as a fault. This time allows the monitor sufficient time to detect transitions from the flashing state to the solid on state and not falsely trip.

Typical Use: This feature is used to provide additional fault checking for Flashing Don't Walk displays. Without this feature a flashing Red input is never checked for conflicts.

2.6.2 CO-CHANNEL MONITORING

Configuration: The setting of Per Channel Red Enables determines if this feature is active. All channels with a setting of checked for a Co-Channel Child setting will include the Green (and Walk if in Type 12 mode) on the child channel with the displays of that channel when checking for red fail. If Co-Channel Childs Includes Yellow is enabled the Yellow of the child channel is included as well as the Green (and Walk if in Type 12 mode). Co-Channel monitoring is disabled when the RED ENABLE input is not active. The per channel settings can only be modified through the RaeComM software. The testing defaults for this feature are all Co-Channel Childs disabled and Per Channel Red Enables set to OFF.

When a channel is programmed as a child of another channel, it is a one way relationship. Therefore, if channel 9 is assigned as a child of channel 2 there is no implied reverse relationship of channel 2 being a child of channel 9. If this operation is desired, it must be explicitly programmed as such.

Tests Modified:

Red Fail: Normal red fail testing ensures that at least one display is active for a channel. With this feature active, any channel with a setting of checked for a child channel will have the Green (and Walk if in Type 12 mode) of the child channel included when checking for a red fail. If Co-Channel Childs Includes Yellow is enabled the Yellow of the child channel is included as well as the Green (and Walk if in Type 12 mode).

Typical Use: This feature is useful when the monitor has a channel that may have all outputs off while another channel's output is on for the movement of traffic. Overlaps and Protected / Permitted applications with four and five section signal heads are common examples. Under normal operation, the Red Enable input would have to be deactivated during the time that channel would have no output to keep a Red Fail fault from occurring. The Co-Channel monitoring feature allows the user to select other channels that will be tested along with the parent channel such that a Red Fail fault will only occur if the parent channel has no outputs on and the Green, Walk, and optionally the Yellow of the child channels have no output on.

2.6.3 FLASHING YELLOW ARROW MONITORING

Configuration: The Flashing Yellow Arrow (FYA) left turn configuration consists of four different settings. See Reno A&E Application Note AN-005 for more information and detailed examples.

FYA Enable - Turning this feature ON will activate the other FYA features (FYA Childs, FYA Ignore Yellow Conflict, and FYA Driver is Yellow) and also disables the Co-Channel features.

FYA Ignore Yellow Conflict - Turning this feature ON will force the monitor to ignore Yellow-Yellow conflicts between the parent FYA channel and any conflicting child channel. This setting can only be modified through the RaeComM software.

FYA Driver is Yellow - Turning this feature ON tells the monitor that the flashing yellow arrow display is driven by a yellow output. When this feature is OFF, the monitor assumes that the display is driven by a green output. This setting can only be modified through the RaeComM software.

FYA Childs - When a child channel is selected, the monitor will determine if the child is permissive or conflicting with the parent channel based on the Program Card. If permissive, the child will have a "G" (Green) indication or a "Y" (Yellow) indication based on the setting of FYA Driver is Yellow. If conflicting, the child will have an "R" (Red) indication. These settings can only be modified through the RaeComM software.

The testing defaults for this feature are FYA Enable disabled, FYA Ignore Yellow Conflict disabled, FYA Driver is Yellow set to no, and all FYA Childs disabled.

Tests Modified:

Conflict: Normal conflict testing checks active Green, Walk, and Yellow displays for being permissive. With FYA Enable set to ON and FYA Ignore Yellow Conflict set to ON, the monitor will ignore a Yellow-Yellow conflict between a parent channel yellow and its conflicting child yellow (channel marked with a red border) when the

Yellow of the parent channel is terminating a flashing Yellow arrow. With FYA Enable set to ON, any channel check box with a green or yellow border for a child channel will have the appropriate display (Green or Yellow) of the child channel monitored for a flashing condition. A flashing input is defined as an input that stays ON for at least 200 milliseconds and no longer than 600 milliseconds and is OFF for at least 200 milliseconds and no longer than 600 milliseconds. If the input does not flash (stays on solid) the monitor will create a conflict with the conflicting child (channel marked with a red border) even though the two channels are usually jumpered as permissive. Also, when Flashing Yellow Arrow (FYA) is enabled and Per Channel Red Enables is enabled and the channel Red Enable is disabled and Dual Indication / Field Check for the channel is disabled and Minimum Yellow Change Disable for the channel is not jumpered on the Program Card and the channel has the actual flashing yellow arrow display the monitor will ignore the unused Green or Yellow of that channel for conflict tests.

Red Fail: Normal red fail testing ensures that at least one display is active for a channel. With this feature active, any channel with a checked box with a green or yellow border for a child channel will have the appropriate display (Green or Yellow) of the child channel included when checking for a red fail.

Dual Indication: Normal dual indication testing ensures that only one display for a channel is active at a time. With FYA Enable set to yes, any channel with a child check box with a green or yellow border will have the appropriate display (Green or Yellow) of the child channel included when checking for a dual indication.

Short Yellow Monitoring: When Flashing Yellow Arrow (FYA) Left Turns are enabled and a Channel has an FYA setting with a green or yellow border for one of its child channels, then the Yellow of the Channel will be used for terminating the Yellow or Green of the child channel and will be checked for short yellow and skipped yellow. Also, when Flashing Yellow Arrow (FYA) is enabled and Per Channel Red Enables is enabled and the channel Red Enable is disabled and Dual Indication / Field Check for the channel is disabled and Minimum Yellow Change Disable for the channel is not jumpered on the Program Card and the channel has the actual flashing yellow arrow display the monitor will not include the unused Green or Yellow of that channel in the short yellow tests.

Short Clearance Monitoring: When Flashing Yellow Arrow (FYA) Left Turns are enabled and a Channel has an FYA setting with a green or yellow border for one of its child channels, then that child will be checked for short clearance. Also, when Flashing Yellow Arrow (FYA) is enabled and Per Channel Red Enables is enabled and the channel Red Enable is disabled and Dual Indication / Field Check for the channel is disabled and Minimum Yellow Change Disable for the channel is not jumpered on the Program Card and the channel has the actual flashing yellow arrow display the monitor will not include the unused Green or Yellow of that channel in the short clearance tests.

Typical Use: The intended field wiring connections for this feature are the Red, Yellow, and Green arrows connected to the same channel and the flashing Yellow arrow connected to the Green or Yellow of another channel. If channel 1 is the protected left turn and will have a FYA display driven by the channel 9 green and the yellow of channel 1 will be ON at the same time as the yellow of channel 2 to terminate a flashing yellow arrow, the configuration would be: FYA Enable should be ON, Channel 1 will have childs of channel 2 and channel 9, FYA Driver is Yellow should be OFF, and FYA Ignore Yellow Conflict should be ON.

Care should be taken to insure that the possible phase sequencing does not allow the flashing Yellow arrow to terminate while its opposing through is still green. Be sure to check pre-emption sequencing as well.

2.6.4 LED THRESHOLDS

Configuration: The setting of LED Thresholds determines if this feature is active. The testing default for this feature is LED Thresholds to no.

Tests Modified:

Conflict: Normal conflict testing senses Greens, Yellows, and Walks as ON when their voltage is above $25V_{RMS}$ and OFF when below $15V_{RMS}$. Reds are ON when their voltage is above $70V_{RMS}$ and OFF when below $50V_{RMS}$. With LED thresholds, the monitor senses Greens, Yellows, Reds, and Walks as ON when their voltage is above $25V_{RMS}$ and OFF when below $15V_{RMS}$.

Red Fail: Normal red fail testing senses Greens, Yellows, and Walks as ON when their voltage is above $25V_{RMS}$ and OFF when below $15V_{RMS}$. Reds are ON when their voltage is above $70V_{RMS}$ and OFF when below $50V_{RMS}$. With LED thresholds, the monitor senses Greens, Yellows, Reds, and Walks are sensed as ON when their voltage is above $70V_{RMS}$ and OFF when below $50V_{RMS}$.

Dual Indication: Normal dual indication testing senses Greens, Yellows, and Walks as ON when their voltage is above $25V_{RMS}$ and OFF when below $15V_{RMS}$. Reds are ON when their voltage is above $70V_{RMS}$ and OFF when below $50V_{RMS}$. With LED thresholds, the monitor senses Greens, Yellows, Reds, and Walks as ON when their voltage is above $25V_{RMS}$ and OFF when below $15V_{RMS}$.

Short Yellow: Normal short Yellow testing senses Greens, Yellows, and Walks as ON when their voltage is above $25V_{RMS}$ and OFF when below $15V_{RMS}$. Reds are ON when their voltage is above $70V_{RMS}$ and OFF when below $50V_{RMS}$. With LED thresholds, the monitor senses Greens, Yellows, Reds, and Walks are sensed as ON when their voltage is above $70V_{RMS}$ and OFF when below $50V_{RMS}$.

Short Clearance: Normal short Yellow testing senses Greens, Yellows, and Walks as ON when their voltage is above $25V_{RMS}$ and OFF when below $15V_{RMS}$. Reds are ON when their voltage is above $70V_{RMS}$ and OFF when below $50V_{RMS}$. With LED thresholds, the monitor senses Greens, Yellows, Reds, and Walks are sensed as ON when their voltage is above $70V_{RMS}$ and OFF when below $50V_{RMS}$.

Field Check: Normal field check testing senses Greens, Yellows, and Walks as ON when their voltage is above $25V_{RMS}$ and OFF when below $15V_{RMS}$. Reds are ON when their voltage is above $70V_{RMS}$ and OFF when below $50V_{RMS}$. With LED thresholds, the monitor senses Greens, Yellows, Reds, and Walks as ON when their voltage is above $25V_{RMS}$ and OFF when below $15V_{RMS}$.

Typical Use: Once any LED field displays are installed, using LED Thresholds will provide better fault checking by using voltage thresholds that are specifically suited to each type of test being performed.

2.6.5 PER CHANNEL RED ENABLE

Configuration: The setting of Per Channel Red Enables determines if this feature is active. When active all channels with a setting of checked for a Per Channel Red Enable setting will perform normal red fail (See Section **2.5.2**) and field check (See Section **2.5.7**) testing. Per Channel Red Enable is disabled when the RED ENABLE input is not active. The per channel settings can only be modified through the RaeComM software. The testing defaults for this feature are all Per Channel Red Enables enabled and Per Channel Red Enables set to no.

Tests Modified:

Red Fail: Normal red fail testing ensures that at least one display is active for a channel. With this feature active, any channel unchecked for a Per Channel Red Enable will not be tested for red fail faults.

Field Check: Normal field check testing ensures that the at least one display is active for a channel. With this feature active, any channel unchecked for a Per Channel Red Enable will not be tested for field check faults.

Typical Use: This feature is useful when the user wants to monitor a display that may not be directly controlled by the controller but still wants to have Dual Indication testing for the channel. A typical application is an advance warning sign. The user may want to ensure that both indications are not on at the same time and that neither is on during specific times. The Per Channel Red Enable feature gives the user the ability to permanently disable the Red Enable function and Field Check for specific channels. The Dual Indication function will still operate according to setting of the Dual Indication / Field Check enables. For the purpose of the Conflict function and the Short Clearance functions, a dark channel is treated as if it were Red.

2.6.6 MODIFIED CVM LATCH

Configuration: The setting of Modified CVM Latch determines if this feature is active. This feature only has an effect if the CVM Latch jumper is installed on the programming card. The testing default for this feature is set to no.

Tests Modified:

CVM: Normal CVM testing checks for the CVM input being low. When this feature is enabled and the CVM Latch jumper is installed the monitor will not latch a CVM fault until the CVM input has been valid (Low) for more than 175 milliseconds.

Typical Use: This feature is useful in cabinets where the CVM input may not always be valid within the programmed Minimum Flash time and where latched CVM failures is desired.

2.6.7 12 VOLT DC MONITORING

Configuration: The setting of 24V-2 to 12VDC determines if this feature is active. A low on the +24V Monitor Inhibit input inhibits the operation of the +12 Volt Monitor. The testing default for this feature is set to no.

Tests Modified:

+24 Volt Monitor II: Normal +24 Volt Monitor II testing checks for the +24V Monitor II (Connector B - Pin R) input being greater than $+22V_{DC}$. When this feature is enabled, a voltage greater than $+11.5V_{DC}$ applied to the +24 Volt Monitor II input is recognized as adequate for proper operation. A voltage of less than $+10.75V_{DC}$ applied to the +24 Volt Monitor II input is recognized as inadequate for proper operation.

Typical Use: This feature can be very useful in TS 2 cabinets with 12 VDC supplies. The monitor can now monitor a +12 VDC supply as well as a +24 VDC supply. The operation of the input is the same as if it were the +24V Monitor II; except the voltage levels are changed.

2.6.8 DISABLE LOCAL FLASH

Configuration: The setting of Disable Local Flash determines if this feature is active. The testing default for this feature is set to no.

Tests Modified:

Local Flash: Normal intersection operation requires that the Local Flash input (Connector B - Pin c) be greater than $+22V_{DC}$. When this feature is enabled, the Local flash input is ignored and normal intersection operation is allowed.

Typical Use: This feature is useful when it is desirable to ignore a command to begin flash operation of the intersection. This may come from a Time Clock or an output of the Controller that is controlled by Time Of Day, Coordination, a System Master, or Police Panel.

2.6.9 FLASHING GREEN (CANADIAN FAST FLASH)

Configuration: This is a factory option and cannot be changed by the user. If this function is required but it is not active, contact Reno A&E Technical Support for assistance. This feature is set to OFF for units sold in the United States and set to ON for units shipped to Canada.

Tests Modified:

Please refer to Reno A&E Application Note AN-004 in the Support section of the Reno A&E web site (renoae.com) under Monitor Support / Application Notes for a detailed description of how these tests are modified.

Red Fail: Red Fail Fault time is changed from 800 milliseconds to 1.5 seconds. Red Fail Reset time is changed from 300 milliseconds to 200 milliseconds.

Dual Indication: Green-Yellow Dual Indication Reset time is changed from 300 milliseconds to 100 milliseconds. Green-Red Dual Indication Reset time is changed from 300 milliseconds to 100 milliseconds

Typical Use: This feature is intended to support the use of flashing Green indications as used in Canada.

2.6.10 CHANNELS WITH PEDESTRIAN DISPLAYS

Configuration: The setting of Channels with Pedestrian Displays determines if this feature is active on a per channel basis. The per channel settings can only be modified through the RaeComM software. The testing default for this feature is set to no channels active.

Tests Modified:

Red Fail: **Affects Type 12 operation only**. Normal red fail testing ensures that at least a red, yellow, green, or walk display is active for a channel. Any channel with a setting of "Y" for Channels with Pedestrian Displays will not include the walk display in the testing for red fail faults on that channel.

Dual Indication: Normal dual indication testing uses 600 milliseconds as the fault time for Yellow + Red dual indications. Any channel with a setting of "Y" for Channels with Pedestrian Displays will use 800 milliseconds as the fault time for Yellow + Red dual indications.

Typical Use: In Type 12 mode of operation, this feature allows vehicle displays to be checked for a dark head even though a walk for the channel may be active. In Type 16 mode of operation, this feature allows for a longer Yellow + Red dual indication fault time to deal with some controllers that have a slight overlap between the pedestrian clearance interval and the don't walk interval of a pedestrian channel.

2.7 EVENT LOGGING

Six different Event Logs provide detailed, date and time stamped documentation of selected events recorded by the monitor. This data is useful in troubleshooting and provides an accurate historical record of cabinet operation. When the date and time are not available through Port 1, the monitor will use its internal Real Time Clock as a date / time stamp for events.

2.7.1 TIME CHANGE LOG

The Time Change Log records the 50 most recent time changes. Data recorded: Original Date / Time Stamp, New Date / Time Stamp, and Up Time Accumulator.

2.7.2 MONITOR RESET LOG

The monitor Reset Log records the 20 most recent resets. Data recorded: Date / Time Stamp, Faults at Time of Reset, and Source of Reset (Front Panel, External, or Power Loss).

2.7.3 CONFIGURATION EVENT LOG

The Configuration Event Log records the 10 most recent configuration changes. Data recorded: Date / Time Stamp, Programming Card Jumpers, Type Select, Factory Options set through RaeComM, and User Options set through RaeComM.

2.7.4 PRIOR FAULTS LOG

The Prior Faults Log records the 20 most recent faults. Data recorded: Date / Time Stamp; Cabinet Temperature; Faults Reported; Status of all Greens, Yellows, Reds, and Walks; Status of all DC Inputs; Status of Red Enable; Entire Front Panel Fault Display; AC Line Voltage; and Red Enable Voltage.

2.7.5 AC LINE LOG

The AC Line Log records the 50 most recent changes in AC line status. Data recorded: Date / Time Stamp, Event Type (Power Up / Reset, Low Voltage, Low Voltage Recovery, Shutdown, Low Voltage Alarm, Low Voltage Alarm Recovery, High Voltage Alarm, and High Voltage Alarm Recovery), and AC Line Voltage.

Through RaeComM, the user can adjust the High Voltage Alarm point and the Low Voltage Alarm point. These alarm points have a fixed, three volt hysteresis. Therefore, setting the High Voltage Alarm point to 135 volts will cause the recovery point to be set to 132 volts. Likewise, setting the Low Voltage Alarm point to 105 volts will cause the recovery point to be 108 volts. The factory defaults for these alarm points are 105 volts for the low alarm point and 135 volts for the high alarm point. NOTE: The log will only record when these points are crossed. The minimum and maximum voltages seen are not recorded.

2.7.6 SIGNAL SEQUENCE LOG (LOGS LAST 13 FAULURES)

The Signal Sequence Log can be configured to record events occurring prior to a fault in one of two different modes.

Event Mode: The Signal Sequence Log records the 60 most recent events preceding the failure. An event is defined as an instance when any AC or DC signal changes state. The monitor checks all inputs for changes in state every 33 milliseconds for the purpose of accumulating data for this log. Data recorded: Time Prior to Fault; Status of all Greens, Yellows, Reds, and Walks; RMS Voltages of all Greens, Yellows, Reds, and Walks; Status of all DC inputs; Status of Red Enable; AC Line Voltage; Red Enable Voltage; and DC Input Voltages.

Time Mode: The Signal Sequence Log records the 2 seconds preceding the failure. The monitor records all inputs every 33 milliseconds for the purpose of accumulating data for this log. Data recorded: Time Prior to Fault; Status of all Greens, Yellows, Reds, and Walks; RMS Voltages of all Greens, Yellows, Reds, and Walks; Status of all DC inputs; Status of Red Enable; AC Line Voltage; Red Enable Voltage; and DC Input Voltages.

2.7.7 LOGGING OPTIONS

2.7.7.1 LOG FIELD CHANGES

When this feature is enabled the monitor will make entries in the Signal Sequence log only when an input has changed state. All inputs (AC and DC) are checked every 33 milliseconds for a change in state. If any input changed state, a new entry is placed in the Signal Sequence log. If this feature is disabled the monitor will make a new entry in the Signal Sequence log every 33 milliseconds. The disabled mode is typically the most useful mode for this feature but the Signal Sequence log can only record two seconds prior to the fault is this mode. However, when troubleshooting Short Yellow or Short Clearance faults, it may be desirable to record a longer Signal Sequence log. With this feature enabled the Signal Sequence log will typically record 40 to 50 seconds prior to the fault. This setting can only be modified through the RaeComM software. The factory default for this feature is disabled.

2.7.7.2 LOG LOCAL FLASH EVENTS

When this feature is enabled the monitor will record Local Flash events in the Prior Faults log. Disabling this feature is useful when an intersection is normally put into Local Flash (time of day, etc) and you do not want to fill up the Prior Faults log with non-fault events. This setting can only be modified through the RaeComM software. The factory default for this feature is enabled.

2.7.7.3 LOG CVM EVENTS

When this feature is enabled the monitor will record CVM events in the Prior Faults log. Disabling this feature is useful when an intersection is normally put into flash using CVM (time of day, etc) and you do not want to fill up the Prior Faults log with non-fault events. This setting can only be modified through the RaeComM software. The factory default for this feature is enabled.

2.8 DIAGNOSTICS

The monitor is provided with a series of resident self-check diagnostics capabilities. When a fault is detected, the monitor transfers the Output relay contacts to the fault condition and illuminates the front panel **DIAG FAIL** LED. The channel LEDs will also begin to flash a binary representation of the diagnostic code. Diagnostic failures are latched in the fault condition until the unit is reset by the activation of the front panel reset pushbutton or activation of the reset input. A diagnostic failure is not reset by a monitor Power Failure.

Failure of any of these diagnostics will result in the monitor Diagnostic Failure bit (bit 73) of the Type 129 Frame being set to 1. NOTE: Port 1 communications may not be possible during certain diagnostic failures.

2.8.1 MEMORY

The monitor verifies all memory elements on power up or upon reset of a Diagnostics failure. A failure of any of the memory tests will generate a diagnostics failure.

RAM Diagnostics: Test patterns are written to every byte of RAM in the monitor. After each write a read is performed to verify that the pattern is correct.

Flash ROM Diagnostics: A checksum is calculated for all of the ROM in the monitor. The calculated value is compared to a preprogrammed value stored in the ROM.

EEPROM Diagnostics: A checksum is calculated for all of the internal EEPROM in the monitor. The calculated value is compared to a preprogrammed value stored in the internal EEPROM.

Programming Card EEPROM Diagnostics: A checksum is calculated for all of the EEPROM on the programming card. The calculated value is compared to a preprogrammed value stored in the programming card EEPROM.

The monitor continues to verify the RAM, Program Flash, Storage Flash, and Programming Card EEPROM during normal operation. Checksums are calculated for the Program Flash and Storage Flash at a rate of at least 1024 bytes per second. Checksums are calculated for the entire Programming Card EEPROM once per second.

2.8.2 MICROPROCESSOR MONITOR

The monitor continuously checks the operation of its microprocessor. The monitoring circuit receives a signal or logic state transition at least once every 33 milliseconds from the microprocessor. When the signal or logic state transition is not received for more than 50 milliseconds a diagnostics fault is generated.

2.8.3 INTERNAL VOLTAGE MONITORS

The monitor checks the voltage levels of the internal DC power supplies. The +12 volt, +5 volt, digital +3.3 volt, analog +3.3 volt, and analog -3.3 volt power supplies are all monitored for proper voltage levels. When any of these voltage levels is invalid for more than 125 milliseconds a diagnostics fault is generated. These faults will not be logged by the monitor, as any one of these voltages being invalid will immediately place the monitor in a diagnostic failure mode with the microprocessor held in reset. This prevents any false faults or missed faults due to an internal power supply malfunction.

2.8.4 DIAGNOSTIC CODES

When a fault is detected, the monitor transfers the Output relay contacts to the fault condition and illuminates the front panel DIAG FAIL LED. The channel LEDs will also begin to flash a binary representation of the diagnostic code. The diagnostic code may be viewed with RaeComM on the Real Time Status display.

FAULT	CHANNEL	CODE	DESCRIPTION OF FAULT
Code Checksum	1	0001h	The checksum calculated for the main code no longer matches the stored value.
Configuration Checksum	2	0002h	The checksum calculated for the configuration and logging data does not match the stored value.
Flash Write Error	3	0004h	A write to Flash memory did not complete normally.
RAM Error	4	0008h	A RAM location failed to read back the test pattern written to it.
Boot Loader Checksum	5	0010h	The checksum calculated for one or both of the boot loaders does not match the stored value.
DSP Timeout	6	0020h	The DSP did not respond to a request for data in the required amount of time.
Ethernet Port Error	7	0040h	The interface hardware for the Ethernet port is not functioning properly.
DC Processor Timeout	8	0080h	The DC processor did not respond to a request for data in the required amount of time.
Shift Chain Error	9	0100h	One of the shift chains could not shift a bit through the entire chain.
Task Watchdog Timeout	10	0200h	One or more of the tasks did not complete in its allotted time.
Program Card Read	11	0400h	The program card could not be read reliably. Bad solder joints on the program card jumpers commonly cause this error.
PC Memory Checksum	12	0800h	The checksum calculated for the program card memory does not match the stored value.
PC Memory Timeout	13	1000h	The program card memory did not respond to a request for data in the required amount of time.
Temperature Timeout	14	2000h	The temperature sensor did not respond to a request for data in the required amount of time.
DSP Diagnostic Error	15	4000h	The DSP is indicating that it has a diagnostic error.
During the Boot Process	16	8000h	The fault identified above was found during the boot process.

Section 3 Specifications

3.1 PHYSICAL

WEIGHT: 75.2 oz. (2132 gm).

SIZE: 10.50 inches (26.67 cm) high x 4.50 inches (12.60 cm) wide x 11.00 inches (27.94 cm) deep including connectors and card ejectors.

STORAGE TEMPERATURE: -50° F to +185° F (-45° C to +85° C).

OPERATING TEMPERATURE: -30° F to +165° F (-34° C to +74° C).

HUMIDITY RANGE: 0 to 95% (relative).

CIRCUIT BOARDS: Printed circuit boards are 0.062 inch thick NEMA FR-4 glass epoxy with 2 oz. copper on both sides and plated through holes. Circuit boards and components are conformal coated with polyurethane.
CONNECTORS: (See Section **3.4** for connector pin assignments.)

CONNECTOR A: Intermates with a MS 3116 22-55 SZ.

CONNECTOR B: Intermates with a MS 3112 16-26 S.

PORT 1 SDLC CONNECTOR: DB-15, 15 pin, metal shell, D subminiature receptacle with gold plated female contacts and latching blocks.

COMM PORT CONNECTOR: DB-9, 9 pin, metal shell, D subminiature receptacle with gold plated female contacts and nuts for retaining screws.

ETHERNET CONNECTOR: High speed, 10Base-T / 100Base-TX - RJ-45 network jack (optional).

3.2 ELECTRICAL

POWER: 80 to 135 VAC, 60 Hz ±3Hz, 6 watts (nominal).

AC VOLTAGE INPUTS (NORMAL THRESHOLDS):		
Green Signal Inputs:	OFF .....< 15 V_{RMS}	ON..... > 25 V_{RMS}
Walk Signal Inputs:	OFF .....< 15 V_{RMS}	ON..... > 25 V_{RMS}
Yellow Signal Inputs:	OFF .....< 15 V_{RMS}	ON..... > 25 V_{RMS}
Red Signal Inputs:	OFF .....< 50 V_{RMS}	ON..... > 70 V_{RMS}
AC VOLTAGE INPUTS (LED DISPLAY THRESHOLDS):		
THRESHOLDS FOR CONFLICT AND MULTIPLE INDICATION TESTS:		
Green Signal Inputs:	OFF .....< 15 V_{RMS}	ON..... > 25 V_{RMS}
Walk Signal Inputs:	OFF .....< 15 V_{RMS}	ON..... > 25 V_{RMS}
Yellow Signal Inputs:	OFF .....< 15 V_{RMS}	ON..... > 25 V_{RMS}
Red Signal Inputs:	OFF .....< 15 V_{RMS}	ON..... > 25 V_{RMS}
THRESHOLDS FOR RED FAIL, SHORT YELLOW, AND SHORT CLEARANCE TESTS:		
Green Signal Inputs:	OFF .....< 50 V_{RMS}	ON..... > 70 V_{RMS}
Walk Signal Inputs:	OFF .....< 50 V_{RMS}	ON..... > 70 V_{RMS}
Yellow Signal Inputs:	OFF .....< 50 V_{RMS}	ON..... > 70 V_{RMS}
Red Signal Inputs:	OFF .....< 50 V_{RMS}	ON..... > 70 V_{RMS}
POWER FAIL:		
AC Line Input:	Dropout.....< 89 V_{RMS}	Restore..... > 98 V_{RMS}
DC VOLTAGE INPUTS:		
+24 VDC Inputs:	Fault.....< +18 V_{DC}	No Fault.....> +22 V_{DC}
+12 VDC Input:	Fault.....< +10.75 V_{DC}	No Fault.....> +11.5 V_{DC}
LOGIC INPUTS:		
CVM:	True .....< +8 V_{DC}	False .....> +16 V_{DC}
External Reset Input:	True .....< +8 V_{DC}	False .....> +16 V_{DC}
+24V Monitor Inhibit Input:	True .....< +8 V_{DC}	False .....> +16 V_{DC}
Port 1 Disable Input:	True .....< +8 V_{DC}	False .....> +16 V_{DC}
Type Select Input:	True .....< +8 V_{DC}	False .....> +16 V_{DC}
Local Flash Input:	True .....< +8 V_{DC}	False .....> +16 V_{DC}
External Watchdog Input:	True .....< +8 V_{DC}	False .....> +16 V_{DC}

RESET: Meets and/or exceeds NEMA TS 2-2003 specifications. The monitor can be manually reset by depressing the **RESET** pushbutton on the front panel.

3.3 TIMING FUNCTIONS

START DELAY:	..... 2.0 sec (±0.5 sec)		
MINIMUM FLASH:	..... 6 to 16 sec (±1 sec)		
PORT 1 FAIL:			Typical.....300 msec
FIELD CHECK FAIL:			Typical.....1000 msec
CONFLICT:	No Fault.....< 200 msec	Detect .....> 450 msec	Typical.....300 msec
RED FAIL:	No Fault.....< 700 msec	Detect .....> 1000 msec	Typical.....800 msec
CVM FAULT:	No Fault.....< 125 msec	Detect .....> 175 msec	Typical.....150 msec
+24 VDC MONITOR:	No Fault.....< 125 msec	Detect .....> 175 msec	Typical.....150 msec
CLEARANCE FAIL:	No Fault.....< 2.8 sec	Detect .....> 2.6 sec	Typical.....2.7 sec
DUAL INDICATION:	No Fault.....< 300 msec	Detect .....> 800 msec	Typical.....500 msec
MONITOR POWER FAIL:	Ignore .....< 450 msec	Respond.....> 500 msec	Typical.....483 msec
FLASHING DON'T WALK:	Flashing if state changes are > 200 msec and < 600 msec		Typical.....500 msec
	No Fault.....< 1400 msec	Respond.....>1600 msec	Typical.....1500 msec

3.4 CONNECTOR PIN ASSIGNMENTS

Connector A

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

Connector B

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

PORT 1 SDLC Connector

Pin	Function
1	RX Data +
2	Logic Ground
3	RX Clock +
4	Logic Ground
5	TX Data +
6	Logic Ground
7	TX Clock +
8	Logic Ground
9	RX Data -
10	Port 1 Disable (0 VDC = Disable)
11	RX Clock -
12	Earth Ground
13	TX Data -
14	Reserved
15	TX Clock -

COMM PORT Connector

Pin	Function
1	No Connection
2	TX Data
3	RX Data
4	No Connection
5	Ground
6	No Connection
7	No Connection
8	No Connection
9	No Connection

3.5 PROGRAMMING CARD PIN ASSIGNMENTS

Connector P1

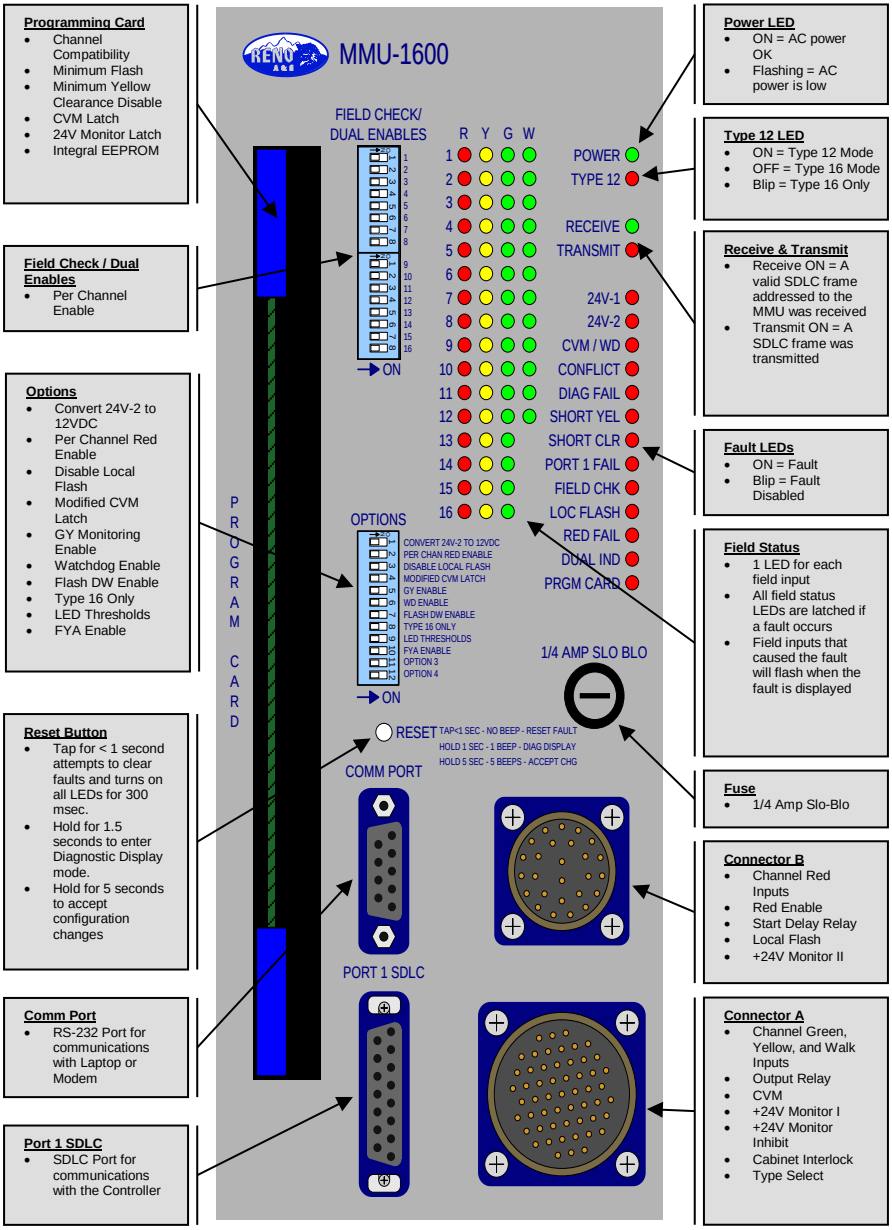
Pin	Row A Channel Pair	Row B Channel Pair	Row C Channel Pair
1	1-2	1-3	1-4
2	1-5	1-6	1-7
3	1-8	1-9	1-10
4	1-11	1-12	1-13
5	1-14	1-15	1-16
6	2-3	2-4	2-5
7	2-6	2-7	2-8
8	2-9	2-10	2-11
9	2-12	2-13	2-14
10	2-15	2-16	3-4
11	3-5	3-6	3-7
12	3-8	3-9	3-10
13	3-11	3-12	3-13
14	3-14	3-15	3-16
15	4-5	4-6	4-7
16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

Connector P2

Pin	Row A Channel Pair	Row B Channel Pair	Row C Channel Pair
1	9-11	9-12	9-13
2	9-14	9-15	9-16
3	10-11	10-12	10-13
4	10-14	10-15	10-16
5	11-12	11-13	11-14
6	11-15	11-16	12-13
7	12-14	12-15	12-16
8	13-14	13-15	13-16
9	14-15	14-16	15-16
10	MYCD-1	MYCD-2	MYCD-3
11	MYCD-4	MYCD-5	MYCD-6
12	MYCD-7	MYCD-8	MYCD-9
13	MYCD-10	MYCD-11	MYCD-12
14	MYCD-13	MYCD-14	MYCD-15
15	MYCD-16	Reserved	Reserved
16	Reserved	Reserved	Reserved
17	Reserved	Reserved	Reserved
18	Reserved	Reserved	Reserved
19	Reserved	Reserved	Reserved
20	Reserved	Reserved	Reserved
21	Minimum Flash	Minimum Flash	Minimum Flash
22	Minimum Flash	24V Latch	CVM Latch
23	Reserved	Reserved	Reserved
24	Reserved	Reserved	Reserved
25	Reserved	Reserved	Reserved
26	Reserved	Reserved	Reserved
27	Reserved	Reserved	Reserved
28	Reserved	Reserved	Reserved
29	Reserved	Reserved	Reserved
30	+5 VDC	Reserved	EEPROM WP
31	EEPROM Data	Reserved	EEPROM Clock
32	Common	Common	Common

3.6 PROGRAMMING CARD MINIMUM FLASH PROGRAMMING

Position 8	Position 4	Position 2	Position 1	Delay Time (Seconds)
Open	Open	Open	Open	6
Open	Open	Open	Jumper	6
Open	Open	Jumper	Open	6
Open	Open	Jumper	Jumper	6
Open	Jumper	Open	Open	6
Open	Jumper	Open	Jumper	6
Open	Jumper	Jumper	Open	7
Open	Jumper	Jumper	Jumper	8
Jumper	Open	Open	Open	9
Jumper	Open	Open	Jumper	10
Jumper	Open	Jumper	Open	11
Jumper	Open	Jumper	Jumper	12
Jumper	Jumper	Open	Open	13
Jumper	Jumper	Open	Jumper	14
Jumper	Jumper	Jumper	Open	15
Jumper	Jumper	Jumper	Jumper	16



Programming Card
- Channel Compatibility
- Minimum Flash
- Minimum Yellow Clearance Disable
- CVM Latch
- 24V Monitor Latch
- Integral EEPROM

Field Check / Dual Enables
- Per Channel Enable

Options
- Convert 24V-2 to 12VDC
- Per Channel Red Enable
- Disable Local Flash
- Modified CVM Latch
- GY Monitoring Enable
- Watchdog Enable
- Flash DW Enable
- Type 16 Only
- LED Thresholds
- FYA Enable

Reset Button
- Tap for < 1 second attempts to clear faults and turns on all LEDs for 300 msec.
- Hold for 1.5 seconds to enter Diagnostic Display mode.
- Hold for 5 seconds to accept configuration changes

Comm Port
- RS-232 Port for communications with Laptop or Modem

Port 1 SDLC
- SDLC Port for communications with the Controller

Power LED
- ON = AC power OK
- Flashing = AC power is low

Type 12 LED
- ON = Type 12 Mode
- OFF = Type 16 Mode
- Blip = Type 16 Only

Receive & Transmit
- Receive ON = A valid SDLC frame addressed to the MMU was received
- Transmit ON = A SDLC frame was transmitted

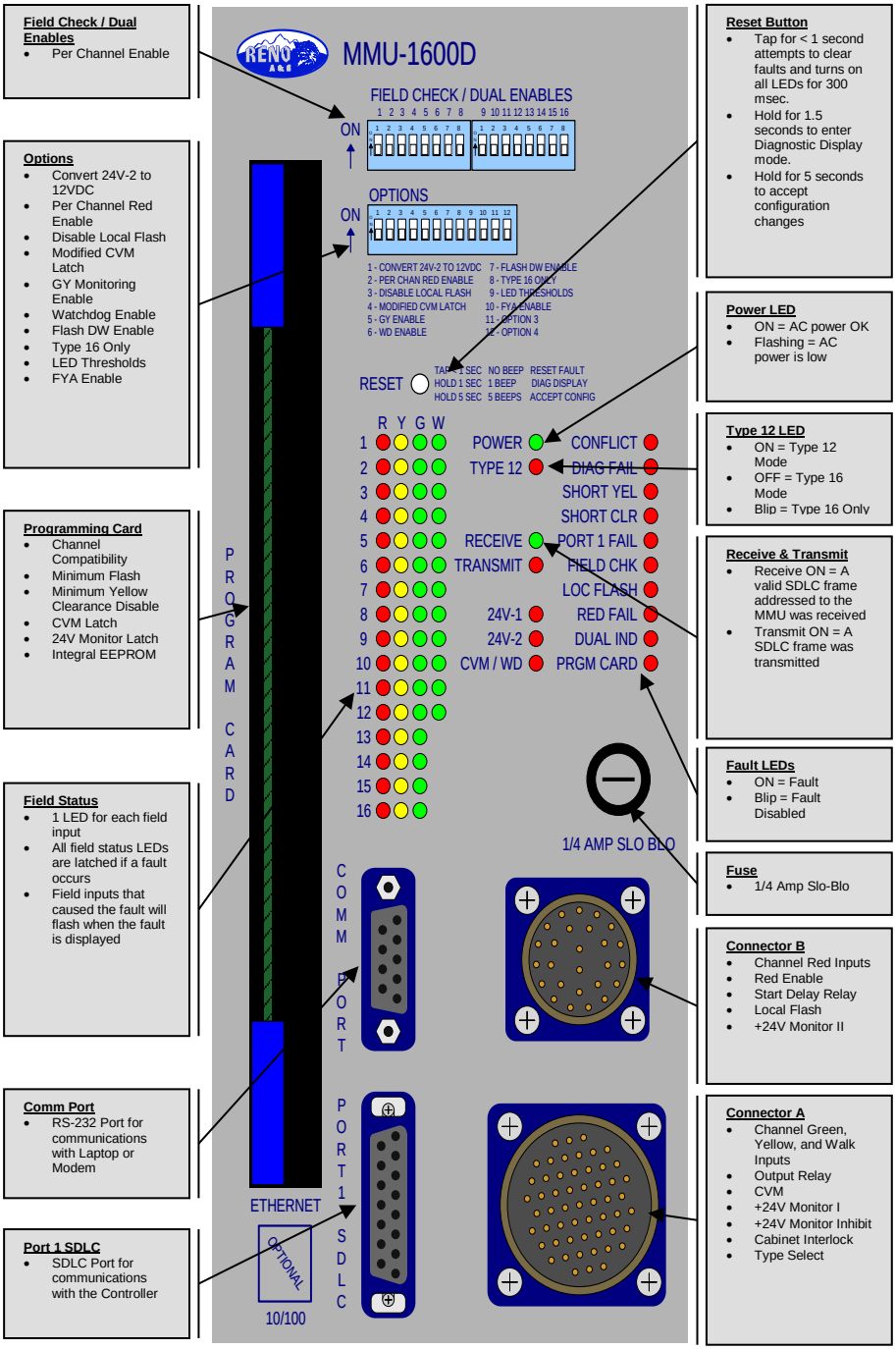
Fault LEDs
- ON = Fault
- Blip = Fault Disabled

Field Status
- 1 LED for each field input
- All field status LEDs are latched if a fault occurs
- Field inputs that caused the fault will flash when the fault is displayed

Fuse
- 1/4 Amp Slo-Blo

Connector B
- Channel Red Inputs
- Red Enable
- Start Delay Relay
- Local Flash
- +24V Monitor II

Connector A
- Channel Green, Yellow, and Walk Inputs
- Output Relay
- CVM
- +24V Monitor I
- +24V Monitor Inhibit
- Cabinet Interlock
- Type Select


Field Check / Dual Enables
Per Channel Enable
Options
Convert 24V-2 to 12VDC
Per Channel Red Enable
Disable Local Flash
Modified CVM Latch
GY Monitoring Enable
Watchdog Enable
Flash DW Enable
Type 16 Only
LED Thresholds
FYA Enable
Programming Card
Channel Compatibility
Minimum Flash
Minimum Yellow Clearance Disable
CVM Latch
24V Monitor Latch
Integral EEPROM
Field Status
1 LED for each field input
All field status LEDs are latched if a fault occurs
Field inputs that caused the fault will flash when the fault is displayed
Comm Port
RS-232 Port for communications with Laptop or Modem
Port 1 SDLC
SDLC Port for communications with the Controller
MMU-1600D
FIELD CHECK / DUAL ENABLES
ON
OPTIONS
ON
1 - CONVERT 24V-2 TO 12VDC
2 - PER CHAN RED ENABLE
3 - DISABLE LOCAL FLASH
4 - MODIFIED CVM LATCH
5 - GY ENABLE
6 - WD ENABLE
7 - FLASH DW ENABLE
8 - TYPE 16 ONLY
9 - LED THRESHOLDS
10 - FYA ENABLE
11 - OPTION 3
12 - OPTION 4
RESET
TAP < 1 SEC NO BEEP RESET FAULT
HOLD 1 SEC 1 BEEP DIAG DISPLAY
HOLD 5 SEC 5 BEEPS ACCEPT CONFIG
R Y G W
POWER
CONFLICT
TYPE 12
DIAG FAIL
SHORT YEL
SHORT CLR
RECEIVE
PORT 1 FAIL
TRANSMIT
FIELD CHK
LOC FLASH
24V-1
RED FAIL
24V-2
DUAL IND
CVM / WD
PRGM CARD
PROGRAM CARD
1/4 AMP SLO BLO
COMM PORT
PORT 1 SDLC
ETHERNET
OPTIONAL
10/100
Reset Button
Tap for < 1 second attempts to clear faults and turns on all LEDs for 300 msec.
Hold for 1.5 seconds to enter Diagnostic Display mode.
Hold for 5 seconds to accept configuration changes
Power LED
ON = AC power OK
Flashing = AC power is low
Type 12 LED
ON = Type 12 Mode
OFF = Type 16 Mode
Blip = Type 16 Only
Receive & Transmit
Receive ON = A valid SDLC frame addressed to the MMU was received
Transmit ON = A SDLC frame was transmitted
Fault LEDs
ON = Fault
Blip = Fault Disabled
Fuse
1/4 Amp Slo-Blo
Connector B
Channel Red Inputs
Red Enable
Start Delay Relay
Local Flash
+24V Monitor II
Connector A
Channel Green, Yellow, and Walk Inputs
Output Relay
CVM
+24V Monitor I
+24V Monitor Inhibit
Cabinet Interlock
Type Select

4.1 FRONT PANEL DIP SWITCHES

4.1.1 FIELD CHECK / DUAL INDICATIONS ENABLES

There are 16 DIP switches on the front panel that enable, on a per channel basis, Field Check monitoring and Dual Indication monitoring. When a switch is OFF, neither Field Check monitoring or Dual Indication monitoring will occur for that channel. For details on Field Check monitoring see Section **2.5.7**. For details on Dual Indication monitoring see Section **2.5.3**.

4.1.2 CONVERT 24V-2 TO 12VDC

When ON, the +24V Monitor II input thresholds will be modified to monitor 12VDC. The new voltage threshold will be 11.5VDC and above, sensed as valid; 10.75VDC and below, sensed as invalid. Voltages between these thresholds may be sensed as valid or invalid. See Section **2.6.7** for more information.

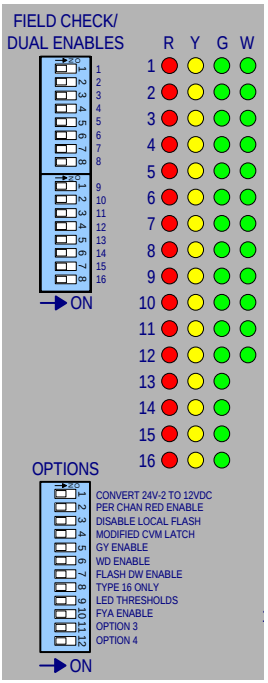
4.1.3 PER CHANNEL RED ENABLE (& CO-CHANNEL ENABLE)

When ON, the MMU will only perform Red Fail and Field Check monitoring for channels that have been enabled for this feature when the Red Enable input is active. The factory defaults for the channel settings for this option is all channels enabled. These channel settings can only be modified through the use of the RaeComM software.

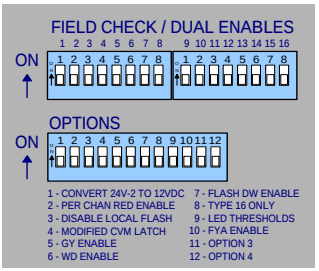
Only the Red Fail and Field Check monitoring are affected by this feature. Other monitoring normally controlled by the Red Enable input (Short Yellow, Short Clearance, and Dual Indication) still operate as defined and are not affected in any way by the activation of this feature. See Section **2.6.5** for more information.

This option switch also activates the Co-Channel feature. The Co-Channel feature allows the user to modify the Red Fail test for each channel to include the Green, Yellow, and Walk displays from other channels. The factory defaults for the channel settings for this option is all channels have no childs enabled. These channel settings can only be modified through the use of the RaeComM software.

MMU-1600 Series



MMU-1600D Series



To view the channels that will have Red Fail and Field Check monitoring enabled when this feature is activated, perform the following steps:

1. Press and hold the front panel **RESET** switch until 1 beep is heard to activate Diagnostic Display.
2. Tap the **RESET** switch one time to get to the C1 (Configuration Screen 1) display.
3. Red channel LEDs will display an ON for channels with this feature enabled.
4. Press and hold the front panel **RESET** switch until 1 beep is heard to return to normal operation.

***NOTE**: The MMU will continue to operate normally while in the diagnostic display mode. Any fault detected while in this mode will be displayed correctly when returned to normal operation.*

4.1.4 DISABLE LOCAL FLASH

When ON, the MMU will ignore the LOCAL FLASH input. The LOC FLASH indicator will show this function as disabled (50 milliseconds on, once every two seconds) when this feature is active. See Section **2.6.8** for more information.

4.1.5 MODIFIED CVM LATCH

When ON and the CVM Latch Enable jumper is installed on the Programming Card, the CVM input will not latch a CVM failure until the CVM input has been valid for more than 175 milliseconds. This feature basically requires that CVM be valid before a CVM fault will be latched. This feature is used when there may be times that the controller will not place CVM in the valid state before the minimum flash time has timed out and the CVM Latch Enable jumper is installed on the program card. See Section **2.6.6** for more information.

4.1.6 GY ENABLE

When ON, the MMU will monitor for simultaneously active Green and Yellow field signal inputs on the same channel. This feature is active on all channels when selected and is not active if the RED ENABLE input is not active.

The GY Enable can be used in conjunction with the FIELD CHECK / DUAL ENABLES switches on the front panel. Channels which have their FIELD CHECK / DUAL ENABLES switches ON will perform Dual Indication monitoring as described in Field Check / Dual Indication (See Section **2.5.3**). Channels, which have their switches OFF, will perform the GY Dual Indication monitoring (See Section **2.5.4**).

4.1.7 WD ENABLE

When ON, the MMU will monitor an optional external watchdog output from a Controller Unit or other external cabinet device. The external source should toggle the EXTERNAL WATCHDOG input logic state at least once every 1000 milliseconds. See Section **2.5.13** for more information.

The EXTERNAL WATCHDOG input is connected to pin "S" (Spare 2) on connector B.

4.1.8 FLASH DW ENABLE

When ON, the MMU will monitor flashing Don't Walk displays to not conflict with other greens, yellows, or walks at the intersection. In order to use this feature the RaeComM software must be used to set the channels that this feature is enabled for. The factory default for this feature is no channels enabled.

When a fault is detected due to this feature, it is displayed as a CONFLICT and the channel with a flashing RED input that was involved in the detected fault will be flashing its RED LED. See Section **2.6.1** for more information.

To view the channels that will have flashing Don't Walk monitoring enabled, perform the following steps:

1. Press and hold the front panel **RESET** switch until 1 beep is heard to activate Diagnostic Display.
2. Tap the **RESET** switch two times to get to the C2 (Configuration Screen 2) display.
3. Red channel LEDs will display an ON for channels with this feature enabled.
4. Press and hold the front panel **RESET** switch until 1 beep is heard to return to normal operation.

***NOTE**: The MMU will continue to operate normally while in the diagnostic display mode. Any fault detected while in this mode will be displayed correctly when returned to normal operation.*

4.1.9 TYPE 16 ONLY

When ON, the MMU will ignore the TYPE SELECT input pin ("HH") and force the MMU to always operate in the Type 16 mode. This feature if useful in cabinets where the user is retrofitting a TS 2 monitor into a TS 1 cabinet and wants to use the Type 16 mode, but the existing Connector A harness for the MMU does not have a wire for pin "HH" (Type Select). While this feature is on, the **TYPE 12** LED will show the Function Disabled indication (50 milliseconds on, once every two seconds).

4.1.10 LED THRESHOLDS

The monitor can use the standard incandescent field display thresholds or enhanced LED field display thresholds. The active threshold is selected with Option switch 9. When Option switch 9 is OFF the standard incandescent field display thresholds are selected. When Option switch 9 is ON the enhanced LED field display thresholds are selected. For a detailed description of the difference in these two thresholds see Section **2.6.4**.

4.1.11 FYA ENABLE (FLASHING YELLOW ARROW LEFT TURNS)

When ON, the MMU will activate special internal logic to properly monitor a Flashing Yellow Arrow Protected/Permissive Left Turn.

The channel that will display the solid Red arrow, Yellow arrow, and Green arrow is the parent channel. It is necessary to define the conflicting through and the channel where the flashing Yellow arrow itself will be connected. See Section **2.6.3** for more information.

To view the Flashing Yellow Arrow settings for each channel perform the following steps:

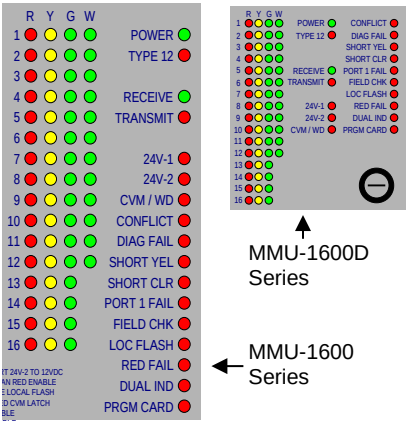
1. FYA Enable (Option switch 10) must be ON.
2. Press and hold the front panel **RESET** switch until 1 beep is heard to activate Diagnostic Display.
3. Tap the **RESET** switch two times to get to the C2 (Configuration Screen 2) display.
4. Press and hold the front panel **RESET** switch until 2 beeps are heard to activate FYA sub menu display.
5. Tap the **RESET** switch until the desired channel is displayed.
6. The displayed channel will have its Red, Yellow, and Green LEDs flashing. A solid Red LED indicates the conflicting channel (normally the opposing through channel). A solid Yellow or Green LED indicates where the Flashing Yellow Arrow should be connected. See Section **4.4.3.1** for more information.
7. Press and hold the front panel **RESET** switch until 1 beep is heard to return to normal operation.

***NOTE**: The MMU will continue to operate normally while in the diagnostic display mode. Any fault detected while in this mode will be displayed correctly when returned to normal operation.*

4.2 FRONT PANEL LED INDICATORS

The monitor has 77 light emitting diodes (LEDs) that are used to convey information to the user. These LEDs are color coded to increase viewability and enhance the intuitiveness of the display. The LEDs are extremely bright to allow viewing of the front panel indicators in direct sunlight. The front panel display is updated every 16 milliseconds.

The front panel display is broken up into four logical groups: Field Status, Power / Type, Transmit / Receive, and Fault.



4.2.1 FIELD STATUS INDICATORS

There are 60 field status indicators, one for each field input defined by the TS 2 specification for Type 16 and Type 12. The display is logically organized into four columns and sixteen rows. The columns are labeled **R** for Red, **Y** for Yellow, **G** for Green, and **W** for Walk. The rows are numbered from **1** to **16**, corresponding to the channel numbers for Type 16 and Type 12.

The indicator for a field input will be on if the RMS voltage over the last 33 milliseconds (two cycles of AC power) is above the threshold for that type of input. (See Section **3.2** for the voltage levels for each type of input.)

When a fault is detected, the field status is latched and the field input involved in the detected fault will flash at a 5 Hz rate. The following table lists the information displayed on the Field Status indicators during the various fault conditions.

FAULT CONDITION	FIELD STATUS INDICATION
24V-1 **24V-2** **CVM / WD** **PORT 1 FAIL**	***ON*** - Field inputs that were ON for at least 33 milliseconds at the time of the fault.
CONFLICT	***ON*** - Field inputs that were ON for at least 33 milliseconds at the time of the fault. ***FLASHING*** - Field inputs that were ON and were the cause of the fault.
DIAG FAIL	***FLASHING*** – The binary coded value of the diagnostic error code with channel 1 being the least significant bit and channel 16 the most significant bit. **NOTE: This may be incorrectly displayed depending on the type of diagnostic failure being experienced.**
SHORT YEL	***ON*** - Field inputs that were ON for at least 100 milliseconds at the time of the fault. ***FLASHING*** - The Yellow field inputs on which a Short Yellow was detected.
SHORT CLR	***ON*** - Field inputs that were ON for at least 33 milliseconds at the time of the fault. ***FLASHING*** - The Green field inputs that were not OFF for at least 2.7 seconds before a conflicting channel was detected as active.
FIELD CHK	***ON*** - Field inputs that were ON for at least 33 milliseconds at the time of the fault. ***FLASHING*** - The field inputs that did not agree with the load switch commands from the CU.
LOC FLASH **PRGM CARD**	Current field status. (NOT LATCHED)
RED FAIL	***ON*** - Field inputs that were ON for at least 100 milliseconds at the time of the fault. ***FLASHING*** - All field inputs for the channel(s) that had no display.
DUAL IND	***ON*** - Field inputs that were ON for at least 100 milliseconds at the time of the fault. ***FLASHING*** - Field inputs that were ON and were the cause of the fault.

4.2.2 POWER / TYPE INDICATORS

The **POWER** indicator is on continuously when the AC line voltage is above $98V_{RMS}$. When the AC line voltage is below $89V_{RMS}$, the indicator will flash at a 1 Hz rate to indicate low line voltage. While the AC line voltage is low, all field status indicators will be off. Any active fault indicators will stay on.

The **TYPE 12** indicator is on continuously when the monitor is operating in the Type 12 mode. This occurs when the Type Select input (Connector A - Pin HH) is not at a True (Low) logic level. This indicator will have a disabled indication if the monitor is configured to operate in Type 16 only mode.

4.2.3 TRANSMIT / RECEIVE INDICATORS

The **RECEIVE** indicator turns on for 50 milliseconds every time a valid SDLC frame addressed to the monitor is received.

The **TRANSMIT** indicator turns on for 50 milliseconds every time a SDLC frame is transmitted.

4.2.4 FAULT INDICATORS

When the monitor Output relay contacts are transferred to the fault condition and the monitor is not timing Minimum Flash, a fault indicator will be illuminated to identify the source of the fault.

There are two fault indicators with dual function capability. One is the **CVM / WD** indicator. If the fault is a CVM fault, the **CVM / WD** indicator will be on solid. If the fault is a WD (External Watchdog) fault, the **CVM / WD** indicator will flash at a 5 Hz rate. The other fault indicator with dual function capability is the **PRGM CARD** indicator. The **PRGM CARD** indicator will be on solid if the programming card is not properly seated while power is applied. The **PRGM CARD** indicator will flash at a 5 Hz rate if a Reno A&E supplied programming card that has a defective serial EEPROM is inserted in the programming card slot.

Any monitoring function that is disabled for any reason will display a Function Disabled indication.

4.2.5 FUNCTION DISABLED INDICATION

When a function has been disabled, the associated indicator will turn on for 50 milliseconds once every two seconds.

Functions may be disabled for one of several different reasons:

INDICATOR	DISABLE CONDITION
TYPE 12	The monitor is configured to operate in Type 16 Only mode.
24V-1	The +24V Monitor Inhibit input (Connector A - Pin n) is at a logic TRUE (Low) state.
24V-2	The +24V Monitor Inhibit input (Connector A - Pin n) is at a logic TRUE (Low) state.
SHORT YEL	The Red Enable input (Connector B - Pin a) is below 70VAC.
SHORT CLR	The Red Enable input (Connector B - Pin a) is below 70VAC.
PORT 1 FAIL	The Port 1 Disable input (Port 1 Connector - Pin 10) is at 0 VDC. Port 1 communications are not active during Type 12 operation.
FIELD CHK	The Port 1 Disable input (Port 1 Connector - Pin 10) is at 0 VDC. The Red Enable input (Connector B - Pin a) is below 70VAC. The LOAD SWITCH Flash bit is set to 1 in the Type 0 frame from the Controller Unit.
LOC FLASH	The monitor is configured to operate with the Disable Local Flash feature enabled.
RED FAIL	The Red Enable input (Connector B - Pin a) is below 70VAC. The LOAD SWITCH Flash bit is set to 1 in the Type 0 frame from the Controller Unit.
DUAL IND	The Red Enable input (Connector B - Pin a) is below 70VAC.

4.3 AUDIBLE BUZZER

The monitor is equipped with an audible buzzer. This buzzer is used to bring important events to the attention of the user. The buzzer can be disabled for pending configuration notifications only. This can only be done through the RaeComM software.

4.3.1 CRITICAL FAILURE

When the monitor main microprocessor is held in the reset state due to a critical hardware failure, the buzzer will stay on constantly. There is no way to disable this indication, as it is an indication that the monitor is not operational.

4.3.2 CONFIGURATION CHANGE

Configuration changes can originate from several sources. They are the front panel, the Com port, the Ethernet port (on MMU-1600DE), and the program card. The monitor checks for configuration changes once each second. If a configuration change is identified, the audible buzzer will start to beep at a one second rate. This beeping is an indication that a change to the current configuration has been identified and is pending. The monitor does not implement any configuration changes until the front panel **RESET** pushbutton is pressed and held for five seconds. At that time the monitor will give 5 confirmation chirps and the buzzer will stop beeping. If the configuration parameters that were changed are restored to their original states (undone), the buzzer will stop beeping.

*NOTE: If power is removed from the monitor prior to the configuration changes being accepted by pressing the **RESET** pushbutton the pending changes will be lost and the original settings will be used on power up.*

4.4 DIAGNOSTIC DISPLAY MODE

The monitor supports a diagnostic display mode that allows the user to view the current line voltage, active configurations settings, and past faults. This information is viewed on the field status indicators and the fault indicators. The display identifier will be displayed for 0.5 seconds followed by the data for 2.5 seconds. This display sequence will be repeated as long as the diagnostic display mode is active.

To display the Ethernet IP address, press and hold the front panel **RESET** pushbutton for more than 3 seconds but less than 5 seconds. The buzzer will emit a single chirp when 1.5 seconds have elapsed and two chirps when 3 seconds have elapsed. This is an audible cue to release the **RESET** pushbutton to view the Ethernet IP address. To exit the diagnostic display mode, repeat the procedure used to enter the mode.

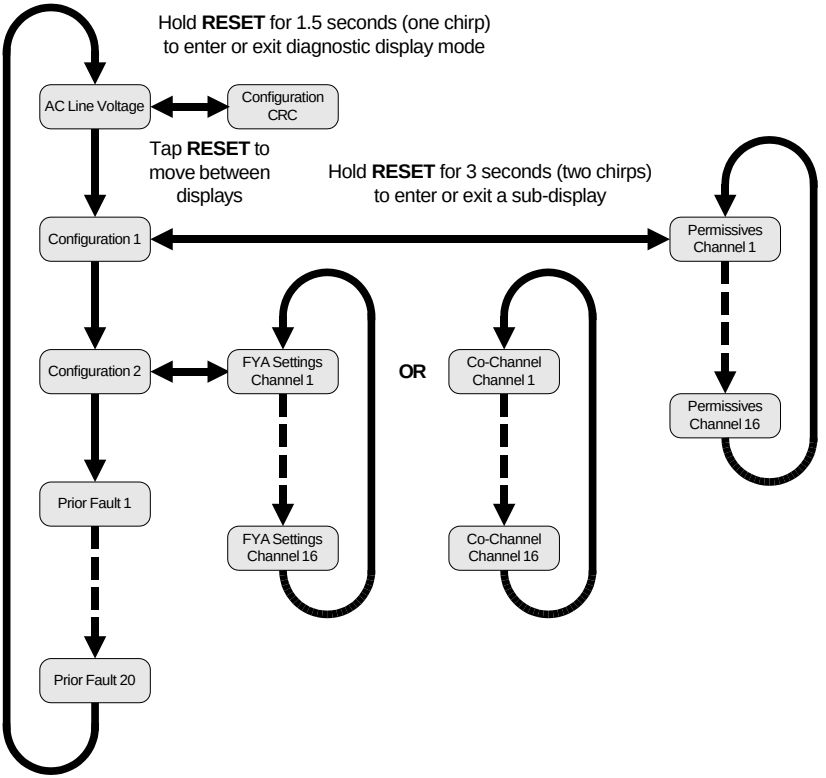
To enter the diagnostic display mode, press and hold the front panel **RESET** pushbutton for more than 1.5 seconds but less than three seconds. The buzzer will emit a single chirp when 1.5 seconds have elapsed. This is an audible

cue to release the **RESET** pushbutton to enter the diagnostic display mode. To exit the diagnostic display mode, repeat the procedure used to enter the mode.

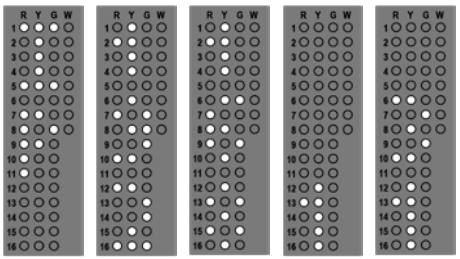
While the monitor is in the diagnostic display mode all monitoring functions are still being performed. Any fault that occurs while in this mode will be displayed once this mode is exited. It is not possible to accidentally reset a fault while in the diagnostic display mode.

While in the diagnostic display mode, a short press of the front panel **RESET** pushbutton will advance to the next diagnostic display.

The diagnostic display sequence is:



4.4.1 ETHERNET IP ADDRESS

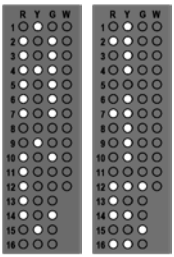


The left display is the ID Display (IP).

The other displays that are sequenced through are the IP address.

In the example shown, the current Ethernet IP address is 192.168.1.31

4.4.2 AC LINE VOLTAGE

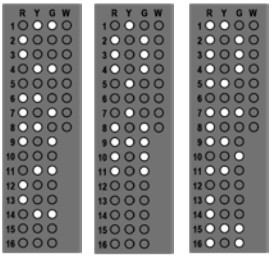


The left display is the ID Display (AC).

The right display is the Data Display. The Data Display shows the current AC Line Voltage. The line voltage is updated once per second.

In the example shown, the current AC Line Voltage is 115 VAC.

4.4.2.1 CONFIGURATION CRC



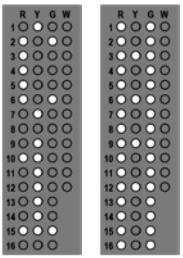
The left display is the ID Display (CRC).

The middle display is the first two digits of the CRC for the current configuration,

The right display is the last two digits of the CRC for the current configuration. There is lower case “h” added to the end of the CRC to show that it is displayed in hexadecimal format and that it is the second half of the value display.

In the example shown, the CRC for the current configuration is 0AD5h.

4.4.3 CONFIGURATION DISPLAY 1



The left display is the ID Display (C1).

The right display is the Data Display. On the Data Display:

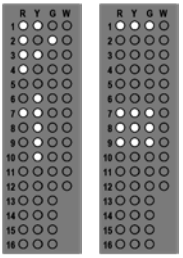
R - Shows the active Per Channel Red Enables.

Y - Shows the active Minimum Yellow Change Disable jumpers on the Program Card.

G - Shows the active Dual Indication / Field Check channels.

In the example shown, Per Channel Red Enable is enabled for all channels, Channels 3, 6, 9, and 12 have Minimum Yellow Change Disable jumpers installed; and Dual Indication / Field Check is enabled for all channels.

4.4.3.1 PERMISSIVE DISPLAYS



The left display is the ID Display (P1).

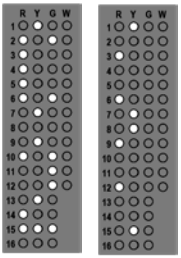
The right display is the Data Display. On the Data Display:

FLASHING - The channel with the flashing **R**, **Y**, and **G** is the channel whose permissives are being displayed.

SOLID - Channels that are permissive with the flashing channel according to the jumpers on the Programming Card.

In the example shown, the Permissives for Channel 1 are being viewed and the Permissives are Channel 7, Channel 8, and Channel 9.

4.4.4 CONFIGURATION DISPLAY 2



The left display is the ID Display (C2).

The right display is the Data Display. On the Data Display:

R - Shows the active Flashing Don't Walk Monitoring channels.

Y - Shows the active Features.

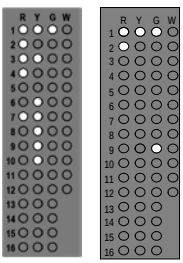
1 = Type 16 Only feature.
2 = Flashing Don't Walk Monitoring feature.
3 = External Watchdog feature.
4 = Green / Yellow Monitoring feature.
5 = Modified CVM Latch feature.
6 = Disable Local Flash feature.
7 = Per Channel Red Enable / Co-Channel feature.
8 = 24V-2 to 12VDC feature.
9 through 14 are reserved for future features.
15 = Flashing Yellow Arrow Monitoring feature.
16 = LED Thresholds feature.

G - Shows User Options and Factory Setup Options.

1 = User Option Log Field Changes.
2 = User Option Log Local Flash Events.
3 = User Option Log CVM Events.
4 = User Option Flashing Yellow Arrow Ignore Yellow Conflict.
5 = User Option Co-Channel Childs Include Yellow or Flashing Yellow Arrow Driver is Yellow.
6 = User Option Programming Card Memory Usage.
7 = User Option Disable Buzzer.
8 = User Option Daylight Saving Time.
9 = Factory Setup Option Flashing Greens.
10 = Factory Setup Option Econolite Frames.
11 through 15 are reserved for future features.
16 = Factory Setup Option Diagnostic LCD Display.

In the example shown, Channels 3, 6, 9, and 12 are programmed for Flashing Don't Walk Monitoring but the feature is not enabled; Type 16 Only mode is enabled; the Per Channel Red Enable / Co-Channel feature is enabled; the 24V-2 To 12VDC feature is enabled; and Flashing Yellow Arrow Monitoring is enabled.

4.4.4.1 FLASHING YELLOW ARROW DISPLAYS



The left display is the ID Display (F1).

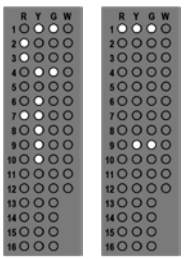
The right display is the Data Display. On the Data Display:

FLASHING - The channel with the flashing **R**, **Y**, and **G** is the channel with the solid arrows for the Red, Yellow, and Green for a Flashing Yellow Arrow display.

SOLID - Channels that are programmed as involved in the Flashing Yellow Arrow display monitoring. If the **R** is on, the channel is the conflicting through channel. If the **Y** or **G** is ON, the channel is where the Flashing Yellow Arrow indication is connected to the monitor and the color input that will be monitored.

In the example shown, Channel 1 is the solid arrows, Channel 2 is the conflicting through channel, and Channel 9 Green is where the Flashing Yellow Arrow indication is connected.

4.4.4.2 CO-CHANNEL DISPLAYS



The left display is the ID Display (C1).

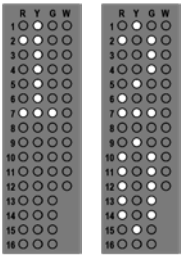
The right display is the Data Display. On the Data Display:

FLASHING - The channel with the flashing **R**, **Y**, and **G** is the channel whose Co-Channel Childs are being displayed.

SOLID - Channels that are programmed as childs of the flashing channel are indicated by a **G**. If the **Y** is ON then the Co-Channel Childs Include Yellow user option is ON.

In the example shown, Channel 9 is a Co-Channel Child of Channel 1 and the Co-Channel Childs Include Yellow user option is ON.

4.4.5 PRIOR FAULTS

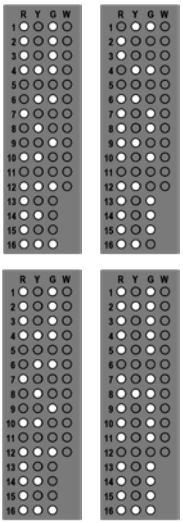


There are 20 possible Prior Faults ID Displays (1 through 20). ID Displays 1 and 20 are shown.

The Data Display for each ID Display will be the front panel status as it was when it was actually displaying the fault. All LEDs are displayed in the same state as they were when the prior fault occurred.

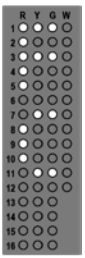
If the display reverts back to AC Line Voltage while trying to access a particular prior fault, it means that the monitor does not have a prior fault saved for the prior fault being accessed.

4.5 PROGRAM CARD CHANGE DISPLAY



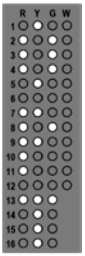
When a program card with different configuration than the one currently stored in the monitor is inserted, the monitor will require that the user select whether it is to use the configuration data on the program card or the configuration data in the monitor.
Tap the **RESET** pushbutton to toggle the selection between Program Card (CRD) and MMU (MMU). Then press and hold the **RESET** pushbutton for 5 seconds. There will be five quick confirmation beeps to confirm that the selection has been accepted. All user information (Ethernet settings, Location, Location ID, and Agency ID) as well as fault monitoring settings are copied.
The text on the field status LEDs is provided to create a consistent user interface with other Reno A&E monitors.
This feature allows a monitor to be replaced without the need for a laptop even if the replacement monitor is another Reno A&E monitor but not the same model (MMU-1600, MMU-1600G, MMU-1600GE, MMU-1600D, or MMU-1600DE).
If MMU is selected and confirmed, the monitor will copy all of its settings to the program card, overwriting all stored settings.
If the Program Card is selected and confirmed, the monitor may indicate that some of the front panel switches (Field Check/Dual Indication Enables and/or Options) need to be changed. This would indicate that the configuration that was stored on the Program Card and now transferred to the monitor requires different front panel switch settings than currently selected. See Section **4.6** for more information

4.6 SWITCH CHANGE DISPLAY



The monitor compares the stored configuration settings with the front panel switches every second. When there are differences, for the Field Check / Dual Enables switches, the field status will alternate between showing the text “FC” and the state of the 16 switches on the Red LEDs. For the Options switches, the field status will alternate between showing the text “OPT” and the state of the 12 option switches on the Green LEDs. A channel flashing at a rate of 5 Hz denotes a switch that is different from the current configuration in the monitor (Ch 1 Red LED flashing means Field Check / Dual Enables switch 1 is different). If both the Field Check / Dual Enables and Options switch settings do not match the current configuration, the field status will alternate between the two displays. When the stored configuration matches the front panel switches the display will return to normal operation and the buzzer will quit beeping.

There are two ways in which differences can occur:



First, a switch position is changed intentionally or accidentally. If intentionally, simply press and hold the **RESET** switch for 5 seconds. There will be five quick confirmation beeps to confirm that the selection has been accepted. If accidental, the display will identify the switch that needs to be changed to match the stored configuration.

Second, the stored configuration was changed and no longer matches the front panel switches. This can only occur if a Program Card change occurred and Use Program Card was selected. See Section **4.5** for more information. If the configuration that was stored on the Program Card requires different front panel switch settings, the monitor will display the appropriate screens identifying the switches that need to be changed to match the configuration that was stored on the Program Card. If it is determined that the current switch states are the desired settings, pressing and holding the **RESET** switch for 5 seconds will use the current switch settings.

Section 5 Firmware Upgrade

The firmware for the main microprocessor in the monitor can be upgraded via the front panel COM port or Ethernet port (on the MMU-1600DE). The most current version of firmware is available on the Reno A&E web site (www.renoae.com) in the support section. Firmware upgrades to the monitor are accomplished through the use of the RaeComM software, version 3.0.6 or greater.

There are three separate firmware files that can be upgraded for the main microprocessor in the monitor.

Main Code: This is the code (firmware) that runs the monitor under normal conditions. In most cases, this is the only file that must be upgraded and ends with BOOTCODE.RAE if more that one file is in the downloaded file.

Secondary Boot Loader: This is the code that is responsible for allowing firmware upgrades if the main code (boot code) is corrupt or becomes corrupt during the programming process and ends with BOOTLD2.RAE.

Primary Boot Loader: This is the code that is responsible for allowing firmware upgrades if the secondary boot loader is corrupt and ends with BOOTLD1.RAE. This file can only be upgraded by a user with factory level privileges.

The two boot loaders exist to allow the monitor to recover from problems during the upgrade process (power fail during programming, computer crash during programming, etc.). They should not need to be upgraded, but provisions to do so have been made in case they need to be upgraded.

To upgrade the main code:

1) Ensure that RaeComM version 3.0.6 or greater is installed on the computer to be used during the upgrade process.
2) Download the latest main code file for the monitor to be upgraded from the Reno A&E web site (www.renoae.com).
3) Connect the monitor to the computer through the **COMM PORT** or **ETHERNET 10/100** port (on the MMU-1600DE).
4) Start the RaeComM program.
5) Ensure that the RaeComM software can communicate with the monitor to be upgraded by clicking on **IDENTIFY** in the menu and observing that the monitor is correctly identified by the program.
6) On the **CONFIG** menu choose **UPGRADE FIRMWARE**.
7) On the Code Loader form that appears, click on the file folder icon after the file name.
8) Select the file that was just downloaded from the Reno A&E web site. If more than one file was in the downloaded file, select the one ending with BOOTCODE.RAE.
9) If the file you selected is the correct file for the attached monitor, the Upgrade Firmware form will show the current version of firmware in the monitor and the version that is about to be transferred.
10) If this is correct, click on the **UPGRADE FIRMWARE** button and the process will begin.
11) If an error is encountered once the transfer has begun, RaeComM will automatically retry the transfer process up to five times. Do not cycle power to the monitor if an error is encountered. Attempt the transfer again by closing the Upgrade Firmware form and repeating Steps 6 through 10.
12) Wait a few seconds to ensure that the RaeComM software does not automatically start another upgrade process (this will happen if the boot loaders need to be upgraded and is automatic). Once the transfer is complete, cycle power to the monitor to begin running the new code.

IMPORTANT Do not interrupt power to the monitor during the programming process. This will corrupt the firmware being transferred!

Each firmware file is encrypted and contains information identifying what model monitor it can be used in and what type of firmware it is. This ensures that the user cannot inadvertently upgrade a monitor with the incorrect firmware and that the firmware file has not been tampered with.