

# MALFUNCTION MANAGEMENT UNIT SPECIFICATION

The following specification describes the minimum acceptable requirements for a sixteen (16) channel MALFUNCTION MANAGEMENT UNIT (MMU).

The MMU shall meet or exceed NEMA TS-1 and TS-2 specifications. In addition to meeting or exceeding NEMA TS-1 and TS-2 specifications, the MMU shall also meet the specific features defined in this detailed specification.

The MMU shall be designed using a front panel that includes programming switches, a series of seventy-seven (77) light emitting diodes (LEDs), a RS-232 communication port, a Port 1 SDLC interface connector, two (2) MS type connectors, a replaceable fuse, and a card slot capable of accepting a user configurable program card.

The manufacturer of the MMU shall provide full warranty coverage for a period of at least two (2) years. The warranty period shall be based on the actual usage time of the MMU unit. The MMU shall include an Up Time Accumulator to track usage.

The MMU shall be manufactured by an ISO 9001 registered company. A copy of the manufacturer's ISO 9001 registration certificate shall be included with any bid submission.

The MMU shall be a Model MMU-1600 manufactured by Reno A & E or an approved equal. Approved equals shall not be allowed unless approved prior to bid submission.

## **The following describes the specific extended features of the Malfunction Management Unit:**

**Hardware Features:** The MMU unit shall have circuitry dedicated to monitoring internal voltages and diagnostic signals from all microcontrollers and the main microprocessor. This circuitry will hold the rest of the system in the reset state until the AC Line voltage and all supply voltages have been verified as being within operational ranges.

The MMU is to be entirely connectorized internally with the exception of allowing two (2) wires to the front panel fuse.

The MMU shall incorporate an internal buzzer that indicates when the main processor is not running or when configuration changes occur.

The communication port baud rate shall be configurable between 300 and 57,600 baud. MMU power up with the front panel reset switch depressed shall temporarily force the communications port setting to 9,600 baud.

**Dual Indication Monitoring:** This monitoring feature shall function in the following manner. It monitors for simultaneously active inputs of Green (Walk), Yellow, or Red (Don't Walk) on the same channel. A set of switches on the front panel labeled FIELD CHECK / DUAL ENABLES is to be provided to allow Dual Indication monitoring to be enabled on a per channel basis.

**Type 12 Mode:** When the MMU is operating in this mode; Dual Indication monitoring shall detect simultaneously active inputs of Green and Yellow, Green and Red, Yellow and Red, Walk and Yellow, or Walk and Red on the same channel. When any two inputs of a channel are sensed as active for more than 1,000 milliseconds, the MMU will transfer the Output relay contacts to the fault condition and illuminate the DUAL IND indicator.

**Type 16 Mode:** When the MMU is operating in this mode; Dual Indication monitoring shall detect simultaneously active inputs of Green and Yellow, Green and Red, or Yellow and Red on the same channel. When any two inputs of a channel are sensed as active for more than 1,000 milliseconds, the MMU will transfer the Output relay contacts to the fault condition, illuminate the DUAL IND indicator, and set the Spare Bit #2 bit (bit 68) of the Type 129 Frame to 1.

Dual Indication monitoring will be disabled when the Red Enable input is not active or if the Load Switch Flash bit (bit 112) of the Type 0 Frame is set to 1.

The MMU shall remain in this fault condition until the unit is reset by the activation of the front panel reset switch or the activation of the Reset input. An MMU Power Failure will not reset the MMU when it has been triggered by detection of Dual Indications on a channel prior to the MMU Power Failure.

**GY-Dual Indication Monitoring:** This monitoring function shall detect simultaneously active inputs of Green and Yellow field signal inputs on the same channel. When the Green and Yellow inputs of a channel are sensed as active for more than 1,000 milliseconds the MMU will transfer the Output relay contacts to the fault condition, illuminate the DUAL IND indicator, and set the Spare Bit #2 bit (bit 68) of the Type 129 Frame to 1.

The MMU shall remain in this fault condition until the unit is reset by the activation of the front panel reset switch or the activation of the Reset input. An MMU Power Failure will not reset the MMU when it has been triggered by detection of GY-Dual Indications on a channel prior to the MMU Power Failure. GY-Dual Indication Monitoring may be enabled concurrently with Dual Indication Monitoring.

GY-Dual Indication Monitoring is to be enabled by the use of the front panel option switch labeled GY ENABLE. When the GY-Dual Indication Monitoring option is enabled, all channels which have the front panel FIELD CHECK/DUAL ENABLE switches set to OFF will be individually monitored for simultaneously active Green and Yellow inputs. All channels that have the front panel FIELD CHECK/DUAL ENABLE switches set to ON will function as described above in Dual Indication Monitoring.

GY-Dual Indication monitoring is to be disabled when the Red Enable input is not active or if the Load Switch Flash bit (bit 112) of the Type 0 Frame is set to 1.

**Field Check Monitoring:** This monitoring function shall combine information about active field inputs with information received through the Port 1 SDLC communications between the Controller Unit and the MMU in a TS2 Cabinet Assembly. The MMU will receive a Type 0 Frame from the Controller Unit 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 MMU do not correspond with the information received from the Controller Unit in the Type 0 Frame for ten (10) consecutive 100 millisecond periods, the MMU will enter the fault mode, transfer the Output relay contacts to the Fault position, illuminate the FIELD CHK indicator, and set the Spare Bit #1 bit (bit 67) of the Type 129 Frame to 1.

The MMU will remain in this fault condition until the unit is reset by the activation of the front panel reset switch or the activation of the Reset input. An MMU Power Failure will not reset the MMU when it has been triggered by detection of Field Check fault prior to the MMU Power Failure.

Field Check Monitoring is to be enabled for each channel, individually, through the use of front panel switches labeled FIELD CHECK / DUAL ENABLES. Field Check Monitoring will be disabled when the RED ENABLE input is not active. Field Check Monitoring is to be enabled concurrently with Dual Indication Monitoring

**External Watchdog Monitoring:** This monitoring function shall detect 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 1,000 milliseconds. If the MMU does not receive a change in state on the EXTERNAL WATCHDOG input for 1500 milliseconds, the MMU will transfer the Output relay contacts to the Fault position, flash the CVM/WD LED on the front panel, and latch the state of all inputs. When operating in the Type 16 mode, Bit 70 (Spare Bit #4) of Frame 129 shall be set to indicate an External Watchdog fault has been detected.

The MMU will remain in this fault condition until the unit is reset by the activation of the front panel reset switch or the activation of the Reset input. An MMU Power Failure will not reset the MMU when it has been triggered by the detection of an External Watchdog fault prior to the MMU Power Failure.

This monitoring function is to be enabled by use of the front panel option switch labeled WD ENABLE. The EXTERNAL WATCHDOG input is connected to pin "S" on Connector B (Spare 2).

**Program Card Absent Monitoring:** If the Program Card is not present or not seated properly in the connectors, the MMU unit will enter the fault mode, transfer the Output relay contacts to the Fault position, and illuminate the PRGM CARD indicator on the front panel. The MMU will remain in this fault condition until the program card is properly inserted and the unit is reset by the activation of the front panel reset switch or the activation of the Reset input. An MMU Power Failure will reset the MMU when it has been triggered by the detection of a Program Card fault prior to the MMU Power Failure.

**Display LED Test:** Pressing the front panel reset switch or activating the Reset input shall cause all of the LEDs on the front panel shall be illuminated. When the reset switch is pressed or the Reset input activated, all of the LEDs will illuminate for 300 milliseconds. This feature will allow the user to insure that all displays are functioning correctly.

**12 Volt DC Monitoring:** This feature shall convert the +24V Monitor II (Connector B - pin "R") to a +12V Monitor. This feature is intended to allow use of the MMU in TS2 cabinets with 12 VDC supplies. The MMU can monitor a +12VDC supply as well as a +24 VDC supply. The operation of the input is to be the same as if it were the +24V Monitor II; except for the fact that the voltage levels are changed.

A voltage greater than +11.5 volts DC applied to the +24 Volt Monitor II input will be recognized by the MMU as adequate for proper operation of the Controller Assembly (CA). A voltage of less than +10.75 volts DC applied to the +24 Volt Monitor II input will be recognized by the MMU as inadequate for proper operation of the CA.

When the +24 Volt Monitor II input is detected as inadequate for more than 175 milliseconds, the MMU will transfer the Output relay contacts to the fault condition and set the +24 Volt Monitor II bit (bit 59) of the Type 129 Frame to 1. The time interval between the beginning of the inadequate voltage level and the transfer of the Output relay contacts to the fault condition shall not exceed 450 milliseconds.

Restoration of proper voltage level shall reset the +24V Monitor II portion of the MMU. A failure during the programmed Minimum Flash time or during an MMU Power Failure will not cause a fault condition.

A method of programming is to be provided on the programming card which will cause the +24 volt DC failures to latch in the fault condition until the unit is reset by the activation of the front panel reset switch or activation of the Reset input. This will also apply when the +24V Monitor II input has been converted to a +12V Monitor. A latched +12 volt DC failure will not be reset by an MMU Power Failure.

Application of a True (Low) state to the +24V Monitor Inhibit input shall inhibit the operation of the +12 Volt Monitor.

This monitoring function is to be enabled by a front panel option switch labeled CONVERT 24V-2 TO 12VDC.

**Modified CVM Latch:** This feature is intended to allow use of the MMU in cabinets where the CVM input may not always be valid within the programmed Minimum Flash time and where latched CVM failures may be desired. In the modified mode of operation, the MMU will not latch a CVM failure until the CVM input has been valid for more than 175 milliseconds.

This function is to be enabled by a front panel option switch labeled MODIFIED CVM LATCH. This feature will only have an effect if the CVM Latch jumper is installed on the programming card.

**Type 16 Only Mode:** This feature is intended to allow use of the MMU 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 will force the MMU 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).

**Event Logging:** Six (6) different Event Logs shall provide detailed, date and time stamped documentation of events that occur in the cabinet. This data is intended to be used in troubleshooting and will provide an accurate historical record of cabinet operation. In the event date/time information is not available, the time stamp of the Up Time Accumulator will be used.

**Time Change Log:** The Time Change Log shall record the thirty (30) most recent time changes. Data to be recorded: original date/time stamp, new date/time stamp, and MMU Up Time Accumulator time stamp.

**MMU Reset Log:** The MMU Reset Log shall record the twenty (20) most recent resets. Data to be recorded: date/time stamp, faults at time of reset, and source of reset (front panel, External, or Power Loss).

**Configuration Event Log:** The Configuration Event Log shall record the ten (10) most recent configuration changes. Data to be recorded: date/time stamp, program card jumpers, all front panel DIP switch settings, MMU type mode, and factory option settings.

**Prior Faults Log:** The Prior Faults Log shall record the twenty (20) most recent faults. Data to be recorded: date/time stamp; faults reported; status of all Greens, Walks, Yellows, and Reds; status of all DC inputs; status of Red Enable; entire front panel fault display; AC line voltage; and Red Enable voltage.

**AC Line Log:** The AC Line Log shall record the fifty (50) most recent changes in AC line status. Data to be recorded: date/time stamp, event type (power up/reset, low voltage, low voltage recovery, or shutdown), actual AC line voltage, and AC line frequency.

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

**Event Mode:** The Signal Sequence Log will record the sixty (60) most recent events preceding the failure. An event is defined as an instance when any AC or DC signal changes state. The MMU will check all inputs for changes in state every 100 milliseconds for the purpose of accumulating data for this log. Data to be recorded: time prior to fault; status of all Greens, Walks, Yellows, and Reds; RMS voltages of all Greens, Walk, Yellows, and Reds; 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 will record the events occurring in the six (6) seconds preceding the failure. The MMU will record all inputs every 100 milliseconds for the purpose of accumulating data for this log. Data to be recorded: time prior to fault; status of all Greens, Walks, Yellows, and Reds; RMS

voltages of all Greens, Walk, Yellows, and Reds; status of all DC inputs; status of Red Enable; AC line voltage; Red Enable voltage; and DC input voltages.

**SPECIFICATIONS (PHYSICAL):**

**Weight:** shall not exceed 90 oz. (2268 gm.).

**Size:** not to exceed 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, card ejectors and harness.

**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 Board:** shall be 0.062 inch thick NEMA FR4 glass epoxy material with 2 oz. copper on both sides and plated through holes. The circuit board and components shall be conformal coated with a polyurethane material.

**Connectors:**

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

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

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

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

**SPECIFICATIONS (ELECTRICAL):**

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

**AC Voltage Inputs:**

<b>Green Signal Inputs:</b>	OFF..... < 15 VRMS	ON..... > 25 VRMS.
<b>Walk Signal Inputs:</b>	OFF..... < 15 VRMS	ON..... > 25 VRMS.
<b>Yellow Signal Inputs:</b>	OFF..... < 15 VRMS	ON..... > 25 VRMS.
<b>Red Signal Inputs:</b>	OFF..... < 50 VRMS	ON..... > 70 VRMS.
<b>Red Enable Input:</b>	OFF..... < 70 VRMS	ON..... > 89 VRMS.

**Power Fail:**

<b>AC Line Input:</b>	Dropout .... < 89 VRMS	Restore .... > 98 VRMS.
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**DC Voltage Inputs:**

<b>+24 VDC Inputs:</b>	Fault..... < +18 VDC	No Fault ... > +22 VDC.
<b>+12 VDC Input:</b>	Fault..... < +10.75 VDC	No Fault ... > +11.5 VDC.

**Logic Inputs:**

<b>CVM:</b>	True ..... < +8 VDC	False ..... > +16 VDC.
<b>External Reset Input:</b>	True ..... < +8 VDC	False ..... > +16 VDC.
<b>+24 V Monitor Inhibit Input:</b>	True ..... < +8 VDC	False ..... > +16 VDC.
<b>Port 1 Disable Input:</b>	True ..... < +8 VDC	False ..... > +16 VDC.
<b>Type Select Input:</b>	True ..... < +8 VDC	False ..... > +16 VDC.
<b>Local Flash Input:</b>	True ..... < +8 VDC	False ..... > +16 VDC.
<b>External Watchdog Input:</b>	True ..... < +8 VDC	False ..... > +16 VDC.

**Reset:** Meets and/or exceeds NEMA TS 2-1998 specifications. The MMU can be manually reset by depressing the RESET switch on the front panel.

**SPECIFICATIONS (TIMING FUNCTIONS):**

<b>Start Delay:</b>			2.0 s (±0.5 s).
<b>Minimum Flash:</b>			6 to 16 s (±1 s).
<b>Port 1 Fail:</b>			Typical..... 300 ms.
<b>Field Check Fail:</b>			Typical..... 1,000 ms.
<b>Conflict:</b>	No Fault..... < 200 ms	Detect ..... > 450 ms	Typical..... 350 ms.
<b>Red Fail:</b>	No Fault..... < 700 ms	Detect.....> 1,000 ms	Typical..... 850 ms.
<b>CVM Fail:</b>	No Fault..... < 125 ms	Detect.....> 175 ms	Typical..... 150 ms.
<b>+24 VDC Monitor:</b>	No Fault..... < 125 ms	Detect.....> 175 ms	Typical..... 150 ms.
<b>Clearance Fail:</b>	No Fault..... < 2.8 s	Detect.....> 2.6 s	Typical..... 2.7 s.
<b>Dual Indication:</b>	No Fault..... < 700 ms	Detect.....> 1,000 ms	Typical..... 850 ms.
<b>MMU Power Fail:</b>	No Fault..... < 450 ms	Detect.....> 500 ms	Typical..... 483 ms.

**SPECIFICATIONS (OPERATIONAL):**

**Front Panel DIP Switches:**

**Field Check / Dual Enables:** There shall be sixteen (16) DIP switches on the front panel that will enable, on a per channel basis, Field Check monitoring and Dual Indication monitoring. When a switch is not ON, neither Field Check monitoring or Dual Indication monitoring will occur for that channel.

**Convert 24 V-2 to 12 VDC:** When ON, the +24V Monitor II input thresholds shall 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.

**Disable Local Flash:** When ON, the MMU shall ignore the LOCAL FLASH input. The LOC FLASH indicator will show this function as disabled.

**GY Enable:** When ON, the MMU shall monitor for simultaneously active Green and Yellow field signal inputs on the same channel. This feature is to be active on all channels when selected and is not active if the RED ENABLE input is not active.

The GY Enable shall have the capability of being 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. Channels, which have their switches OFF, will perform the GY Dual Indication monitoring.

**WD Enable:** When ON, the MMU shall 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 1,000 milliseconds.

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

**Front Panel Indicators:** The MMU shall have seventy-seven (77) LEDs that will be used to convey information to the user. These LEDs are to be color coded to enhance viewability and intuitiveness of the display. The LEDs used are to be ultra-bright to allow viewing of the front panel indicators in direct sunlight. The front panel display will be updated every sixteen (16) milliseconds by the MMU.

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

**Field Status Indicators:** There shall be sixty (60) field status indicators, one for each field input defined by the TS 2 specification for Type 16 and Type 12. The display is to be logically organized into four (4) columns and sixteen (16) rows. The columns are to be labeled R for Red, Y for Yellow, G for Green, and W for Walk indicators. The rows are to be numbered from 1 to 16, corresponding to the channel numbers for Type 16 and Type 12.

The indicator for a field input shall be on if the RMS voltage over the last thirty-three (33) milliseconds (two cycles of AC power) is above the threshold for that type of input.

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

Fault Condition	Field Status Indications
CVM / WD 24V-1 24V-2 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	ON – Field inputs that were ON for at least 33 milliseconds at the time of the fault. 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 which 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 Controller Unit.
LOC FLASH PRGM CARD	Current field status. (NOT LATCHED).
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.
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.

**Power / Type Indicators:** The POWER indicator shall be on continuously when the AC line voltage is above 98 VAC RMS. When the AC line voltage is below 89VAC 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 shall be on continuously when the MMU is operating in the Type 12 mode. This will occur 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 front panel switch labeled TYPE 16 ONLY is ON.

**Transmit / Receive Indicators:** The RECEIVE indicator shall turn on for 50 milliseconds every time a valid SDLC frame addressed to the MMU is received.

The TRANSMIT indicator shall turn on for 50 milliseconds every time a SDLC frame is transmitted.

**Fault Indicators:** When the MMU Output relay contacts are transferred to the fault condition and the MMU is not timing Minimum Flash, a fault indicator shall be illuminated to identify the source of the fault.

The only fault indicator to have a dual function will be the CVM/WD indicator. If the fault is a CVM fault, the indicator will be on solid. If the fault is a WD (External Watchdog) fault, the indicator will flash at a 5 Hz rate.

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

**Function Disabled Indication:** When a function has been disabled, the associated indicator shall turn on for 50 milliseconds once every two seconds. Functions may be disabled for one of several different reasons:

- TYPE 12:** The front panel switch labeled TYPE 16 ONLY is ON.
- 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 or the Red Enable input (Connector B – Pin “a”) is below 70VAC. Port 1 communications are not active during Type 12 operation.
- LOC FLASH:** The front panel switch labeled LOCAL FLASH DISABLE is ON.
- 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.