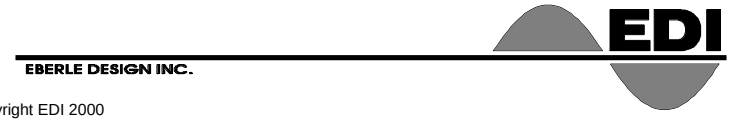
Eberle Design Inc.

MMU-16E Series

Malfunction Management Unit

- Overview -



Eberle Design Inc.
3819 East LaSalle Street
Phoenix, AZ 85040

Telephone	480-968-6407
Fax	602-437-1996
e-mail	support@editraffic.com
web site	www.editraffic.com

Scott Evans	Engineering Manager
Noel Soriano	Sr. Design Engineer
Jon Muilenberg	National Sales Manager

MMU-16E series Overview

- The signal monitor has three important tasks to perform:
  - » *Detect* improper signals / voltages
  - » *Display* cabinet status and fault status
  - » *Diagnose* with accurate information
- The EDI MMU-16E signal monitor brings state-of-the-art advancements to all 3 tasks

The EDI model MMU-16E has been completely redesigned using state-of-the-art technology which vastly improves performance and increases capabilities for the three main tasks of the signal monitor.

Reliable detection of signals has traditionally been adversely affected by changes in phase and frequency, as well as sine wave distortion. The MMU-16E uses a high speed coprocessor to measure the true RMS voltage and provide reliable detection in the on-street environment.

The front panel display has been improved to show full intersection status using Red, Yellow, and Green LEDs for each channel.

A full complement of event logging capabilities as well as the signal Trace History display helps present and document accurate status information about the events occurring at the intersection. This information is vital to the technician in repairing a cabinet malfunction and ensuring that the repair corrected the real cause of the malfunction.

Because of the high costs of malfunction maintenance calls and the increased exposure to liability, trouble shooting exercises must be done quickly and effectively. Traffic is not moving efficiently while the intersection is in flash.

Detect Improper Signals / Voltages

- EDI RMS-Engine^{tm} DSP Coprocessor
  - » Over samples each AC input at 1920S/sec using a precision Analog to Digital converter and DSP algorithms to calculate True RMS.
  - » Signal detection is virtually unaffected by changes in phase, frequency, or sine wave distortion.
  - » On / Off status is replaced with actual voltages.
  - » Accurate signal detection reduces nuisance triggering of the monitor.

The MMU-16E is based on a dual microprocessor architecture. The RMS-Engine coprocessor is dedicated to calculating true RMS analog AC input voltages.

Traditional monitors use a threshold technique which is sensitive to changes in phase, frequency, and wave form distortion. These sensitivities can shift the threshold of detection or produce erroneous results in a noisy environment such as electrical storms, ac line instabilities, etc.

The over sampling technique used in the EDI RMS-Engine produces the correct RMS voltage value regardless of the wave form. It works accurately for ac, dc, sine, triangle, distorted ac, etc. Frequency shifts experienced during power line instabilities no longer can cause detection problems.

As a diagnosis tool, the actual voltage value rather than just the On/Off status of a signal gives one more piece of information needed to home in on the actual cause of a malfunction.

Display Cabinet Status

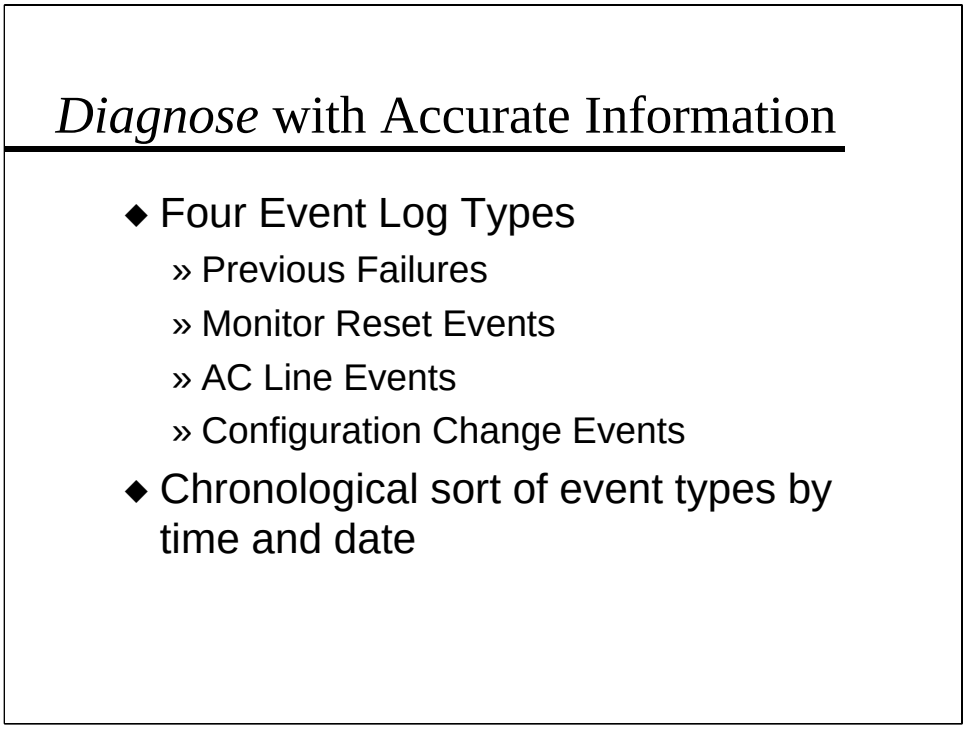
- Full R-Y-G Intersection Display
  - » Front panel Red, Yellow, and Green LEDs display the full status of the intersection simultaneously.
  - » Improper signal displays are instantly recognizable.
  - » ECcom software on a PC displays signal and control RMS voltages in real time.

One of the first tasks of trouble shooting a cabinet is to compare the expected controller outputs to what the signal monitor sensed at the time of the fault. This helps isolate the problem down to the field, the load bay, or the controller.

The full intersection display of the MMU-16E shows the actual signal status for the Red, Yellow, and Green inputs to each channel simultaneously. Improper signal displays are instantly recognizable.

This makes the comparison to the load switch input status easy. The MMU-16E display also shows which channels were involved in the fault if triggered.

ECcom software will present the complete picture if a more detailed view is required.



It is important to use the tools available to the technician to find the cause of a malfunctioning cabinet quickly, and then repair the problem with a high level of confidence that the true cause was found. Call-backs for repeated problems only multiply the effect of the problem. Besides being a source of detailed and accurate information about the state of the intersection at the time of the fault, the event logs can also help provide accurate documentation about the malfunction.

Four Event Log Types

The Previous Failure log contains a record of the field signal voltages, control signal voltages, and cabinet temperature, all time-stamped with the time and date of the event. The Monitor Reset log time-stamps when the intersection was cleared from the fault flash by a monitor reset. The entry to flash and exit from flash are now documented.

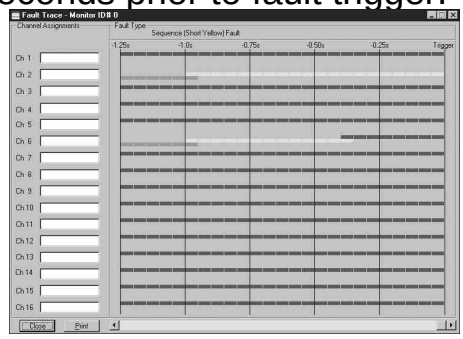
The AC Line log records any event on the AC Line which causes the monitor to transfer to flashing operation (power-down, short interrupt, or brownout), and records the actual line voltage. This helps in trouble shooting intermittent cabinet problems related to power service problems.

The Configuration Change log records any change to the monitor programming including the program card, switches, or jumper selections.

All events are then sorted according to time and date to view them in the real time line they occurred.

Diagnose with Accurate Information

- Signal Sequence History Display
  - » Graphically display signal states for 30 seconds prior to fault trigger.



Ever wonder what the signals did prior to a fault?

Did the controller execute an improper sequence to get a clearance problem or did a field malfunction cause it?

The Signal Sequence History feature of the MMU-16E will show all field signal states graphically for as much as 30 seconds prior to the monitor trigger point with 50 millisecond resolution.

This information is critical to diagnose signal sequence faults and intermittent flickering or blinking of field signals resulting in faults.

Dual Mode Operation

- TS-2: 16 Channel x RYG Mode
  - » 8 Vehicle + 4 Pedestrian + 4 Overlap
  - » Full Monitoring of Pedestrian Channels
- TS-1: 12 Channel x RYGW Mode
  - » 8 Vehicle + 4 Walk + 4 Overlap
  - » Downward Compatible with TS-1 12 Channel Monitor
  - » No Port 1 Communications

The MMU-16E operates in one of two modes depending on the state of the TYPE SELECT input. This input must be grounded in the TS-2 mode (either Type 1 or Type 2).

The main difference in the new TS-2 configuration is that the number of channels has been increased to separate pedestrian inputs from vehicle inputs as in TS-1. This increases the potential fault coverage for pedestrian channels by monitoring both Walk and Dont Walk inputs as well as the pedestrian clearance interval.

In the TS-1 mode the MMU-16E is compatible with a 12 channel monitor harness. All TS-2 mode monitoring functions still operate in this mode except Field Check Monitoring since the MMU to CU communications channel is disabled.

High Speed Communications (Port 1)

- The addition of a communications link between the CU and MMU adds improvements in cabinet monitoring and malfunction diagnosis:
  - » MMU-16E Compatibility Programming
  - » MMU-16E Field Signal Status
  - » Controller Unit Output Command Status
  - » Controller Unit Time and Date
  - » MMU-16E Fault Status

The five basic pieces of standardized information that are exchanged between the CU and MMU-16E provide new safety and diagnostic capabilities that were not possible in TS-1 cabinet systems.

This increases the likelihood that malfunctions will be accurately detected and that technicians can diagnose the cause, repair the equipment quickly, and leave with a high degree of confidence that the true cause was repaired. This greatly decreases the chance of a call-back for the same problem.

MMU-16E Compatibility Programming

- The MMU-16E programming data is sent to the Controller Unit.
- The CU is required to verify that the conflict programming of the MMU-16E is not more permissive than the CU programming.
- This prevents intersection operation with an improperly programmed MMU

The Controller Unit verifies the compatibility of its phase programming with the MMU-16E program card to limit unsafe intersection operation.

The MMU must be programmed equal to or less permissive than the CU.

If the MMU-16E programming is not compatible with the CU programming, the cabinet remains in flash (CVM).

MMU-16E Field Signal Status

- The MMU-16E reports the states of the field signals to the CU every 100ms.
- This provides the data to the CU for redundant conflict monitoring.
- It also allows the CU to check that field signals reflect the intended CU output states.

Real-time field status allows the Controller Unit to perform a redundant monitoring function should the MMU-16E or associated flash circuitry become disabled.

If the MMU-16E does not respond to a conflict condition, the CU will go to soft flash through the load switches. This acts as a backup system to detect and respond to a very dangerous intersection condition.

It also provides a continuous check that the CU output commands are being displayed properly on the signals. This is like having a tester connected to the cabinet system 24 hours a day.

CU Output Command Status

- The CU reports the states of the field signals to the MMU-16E every 100ms.
- It also allows the MMU-16E to check that field signals reflect the intended CU output states.
- This provides a continuous check of inputs versus outputs.

Real-time Controller Unit load switch command status allows the MMU-16E to report diagnostic information such as specific channel and color errors.

It also provides a continuous check that the CU output commands are being correctly displayed properly on the signals. This is like having a tester connected to the cabinet system 24 hours a day.

When a malfunction is detected, the MMU-16E can isolate whether the CU was at fault or a problem in the load bay or field caused the problem. More on this important function on later slides (Field Check Status).

MMU-16E Fault Status

- Fault status is returned to the CU for system retrieval or event logging.
- Time and date info from the CU keep the real time clock in the MMU-16E synchronized with the CU clock.

The MMU-16E fault status is available for the Controller Unit to log or transmit for remote archiving and trouble shooting.

MMU-16E event log time-stamps will be synchronized with the Controller Unit.

Future Peer to Peer diagnostics with the Controller Unit or other device. The TS-2 Standard provides a mechanism for exchanging manufacturer specific information on the SDLC Port 1.

The Controller Unit will display full MMU-16E fault status.

More automated MMU-16E and cabinet diagnostics are possible.

Expanded MMU Fault reports and event logs will be available to the CU and system software.

MMU-16E Functions Beyond TS-1

- AC Power Interruption and Low Voltage Monitoring
- Field Check Monitoring
- Dual Indication Monitoring
- Yellow Plus Red Clearance Monitoring (Green to Green)
- Yellow Clearance Monitoring (Short or Skipped Yellow)
- Program Card Configuration

1)AC Power Interruption and Low Voltage Monitoring

The MMU is the first device to recognize a low AC Line condition, placing the cabinet into flash mode. It is the last device to recognize a proper AC Line condition, placing the cabinet back into operation once all other devices are operating.

2) Field Check Monitoring

This diagnostic information can be used to isolate whether the fault condition was caused by a Controller Unit malfunction, or a failure in the load switch and/or field wiring. The channel(s) which malfunctioned are also directly identified.

3) Dual Indication Monitoring

Detects simultaneous active inputs on a channel. Adds to fault coverage; can also anticipate conflict malfunctions before they are displayed on signals.

4) Yellow plus Red Clearance Monitoring (Green to Green)

Used to ensure a minimum clearance time for pedestrian channels or channels without a true Yellow signal.

5)Yellow Clearance Monitoring (Short/Skipped Yellow)

Used to ensure a minimum clearance time for vehicle channels.

6) Program Card adds: Minimum Yellow Clearance Disable, Minimum Flash, 24V latch, and CVM Latch jumpers. All standard MMU configuration settings stay with the cabinet.

MMU-16E Field Check Monitoring

- The CU sends an image of the Load Switch Output commands to the MMU-16E every 100 ms.
  - » The data received during the fault interval will be analyzed to *isolate* whether the fault condition was caused by a CU malfunction OR a failure in the load bay or field.
  - » The channel(s) which malfunctioned will also be *directly* identified.

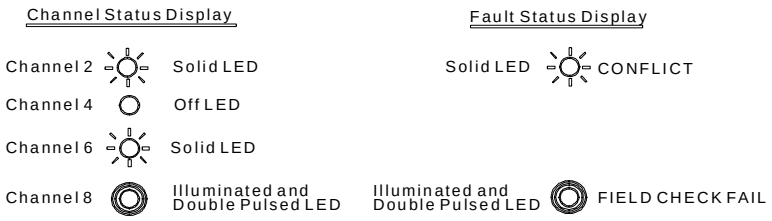
Filed Check Monitoring is probably the most significant addition to the MMU-16E Signal Monitor.

The MMU-16E gathers information sent from the CU in real time and analyzes this data during a fault condition to isolate whether a malfunction occurred as a result of a Controller Unit problem or whether the fault was caused by a Load Switch, field wiring, or load problem.

The service technician can tell at a glance whether the Controller Unit should be serviced, or if not, on which channel or channels the problem exists.

Field Check Status Mode

- Conflict Fault with Field Check Status on Channel 8 example.
  - » Channels 2 & 6 are set active by the CU.
  - » Channel 8 is sensed active due to Load Switch short.



In this example channels 2 and 6 are set to active Green by the controller. Channel 8 Green is not permissive with channels 2 and 6, and becomes active due to a short circuit in the field wiring. The MMU-16E will detect a Conflict Fault with Field Check Status on channel 8.

The CONFLICT and FIELD CHECK STATUS indicators are illuminated. The FIELD CHECK STATUS indicator is **double pulsed** when the channel display indicates the faulty channel (ch 8). Channel indicators 2, 6, and 8 Green are illuminated to indicate the proceed channels active at the time of the fault. Channel indicator 8 Green will **double pulse** at the same time as the FIELD CHECK STATUS indicator to indicate that the field signal input state did not correlate properly with the Controller Unit Load Switch Output commands.

This diagnostic information directly shows that the malfunction was due to a field problem rather than a Controller Unit failure, and the channel at fault is Channel 8 Green.

Field Check Fault Mode

- The MMU-16E sensed field input status for 1000 ms which did not correspond to the CU Load Switch Output commands.
- The field input status also did not result in a normal MMU-16E Conflict, Red Fail, Clearance Fail, or Dual Indication fault.

Field Check Fault Mode

When the field signal input states sensed as active or inactive by the MMU-16E unit do not correspond with the data provided by the Controller Unit in the Type 0 message for 10 consecutive messages, the MMU-16E unit will enter the fault mode and illuminate the FIELD CHECK FAIL indicator. The Channel Status Display will indicate the channel(s) on which the Field Check error was detected.

This type of fault is usually associated with a CU or MMU programming error.

It could also indicate a wiring problem with the MMU harness. An example might be with improper wiring on pedestrian yellow outputs.

Dual Indication Monitoring

- Detects simultaneous active inputs on a channel.
  - » Adds to potential fault coverage.
  - » Can *anticipate* Conflict malfunctions before they are displayed on the signals.
- GY Enable option works with 5 section heads and GY Overlaps.

Dual Indication Monitoring detects simultaneous active inputs on a channel. It adds to the fault coverage and can also anticipate conflict malfunctions before they are displayed on signals.

If a Green signal stays on due to a faulty Load Switch, the fault will be detected when the Yellow signal goes active and the intersection will be placed into flashing mode. Without this function, the CU would have cycled all the way to the next phase, allowing a conflict to occur before the monitor responded.

The GY Enable option provides Green-Yellow fault coverage for channels which have the Red input tied back to AC Line (five section signal head, GY overlaps, etc.).

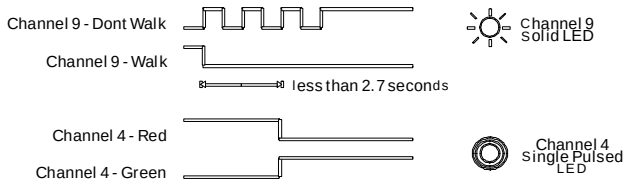
Minimum Yellow Clearance

- Ensures that minimum MUTCD Yellow clearance interval of 3.0 seconds is met for vehicles.
- Detects CU Pinwheeling, sequence malfunction, preemption error, etc..

The MMU-16E monitors the Yellow clearance interval on each selected channel during a Green to Yellow to Red sequence. This ensures that all channels have a minimum clearance period of at least 2.7 seconds.

Minimum Yellow Plus Red Clearance

- Ensures that minimum MUTCD Yellow clearance interval of 3.0 seconds is met for pedestrian and overlap phases.
- Pedestrian Clearance Fault example
  - » Ch 4 Green is active before 2.7 seconds of clearance times out on Ped Ch 9.



The MMU-16E monitors the Yellow plus Red clearance interval between conflicting phases. This ensures that channels with no true Yellow interval such as pedestrian and overlap channels, all have a minimum clearance period.

The MMU-16E measures the interval from the termination of a Green input to the start of the next conflicting Green input. This interval must exceed 2.7 seconds.

The example shows channel 4 Green going active before the pedestrian channel 9 terminated the pedestrian clearance interval. The Clearance display will indicate the channel that had the sort clearance by an ON indicator and the channel that caused the clearance fault with a single pulsed indicator.

NEMA TS-2 STANDARD

- THE NEXT GENERATION OF TRAFFIC CONTROL EQUIPMENT

Eberle Design Inc.