NSM-E Series

NEMA TS-1
Enhanced Signal Monitor

Operations Manual

THIS MANUAL CONTAINS TECHNICAL INFORMATION FOR
THE **NSM-6E** and **NSM-12E** SERIES SIGNAL MONITOR.

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THE NSM-E SERIES SIGNAL MONITOR IS DESIGNED AND MANUFACTURED IN THE USA BY EBERLE DESIGN INC., PHOENIX, ARIZONA.

MAINTENANCE NOTE

THIS EBERLE DESIGN INC. SIGNAL MONITOR HAS BEEN CAREFULLY INSPECTED AND TESTED TO ENSURE PROPER OPERATION. IT IS RECOMMENDED THAT THE SIGNAL MONITOR UNIT BE TESTED AT LEAST ANNUALLY TO ENSURE PROPER OPERATION AND COMPLIANCE WITH FACTORY SPECIFICATIONS.

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Section 1
General

1.1 GENERAL DESCRIPTION

The NSM-E series Signal Monitors consists of two models; the NSM-6E and NSM-12E. The NSM-6E is a six channel unit and the NSM-12E is a twelve channel unit. Both models provide the same operational functions and features including advanced NEMA "plus" fault coverage, a full intersection LED display, comprehensive event logging and signal sequence reporting, and true RMS voltage measuring and reporting. A serial communications port is provided on all units that interfaces with the EDI *ECcom* Signal Monitor Communications software running on a personal computer. Where not specified otherwise, the information in this manual will apply to both models.

The NSM-E Series Signal Monitor is a device used in a Traffic Controller Assembly to accomplish the detection of, and response to improper and conflicting signals and improper operating voltages in a Controller Assembly caused by malfunctions of the Controller Unit (CU), load switches, or mis-wiring of the cabinet. The NSM-E Series also provides error sensing of two +24Vdc cabinet supplies and the controller power supplies via +24V MONITOR I, +24V MONITOR II, and Controller Voltage Monitor (CVM) inputs respectively. The Eberle Design NSM-E Series is directly interchangeable with a standard NEMA Signal Monitor and meets with or exceeds all specifications outlined in Section 6 (Conflict Monitor) of the National Electrical Manufacturers Association (NEMA) ***Standards Publication TS1-1989 R2005, Traffic Control Systems***.

1.2 ADVANCED FEATURE OVERVIEW

1.2.1 LED STATUS AND INTERSECTION FIELD DISPLAY

The NSM-E Series uses an LED display to show monitor status and full intersection field signal channel and fault status. This versatile display system provides a service technician with both detailed information regarding cabinet status and configuration, and at the same time an easily read field signal status display showing full intersection status.

1.2.2 RMS VOLTAGE REPORTING

Input voltages are measured using a true Root Mean Squared (RMS) technique. A dedicated Digital Signal Processor (DSP) RMS-Engine™ controls the analog to digital (A/D) hardware which samples each AC input voltage a minimum of 32 times per cycle. The RMS-Engine™ then calculates the true RMS voltage value producing accurate results which are very insensitive to changes in frequency, phase, wave shape, and distortion.

1.2.3 *ECCOM* SOFTWARE INTERFACE

The field proven EDI *ECcom* Signal Monitor Communications software provides a laptop computer or system interface to all information contained in the monitor. This includes detailed status, voltages, configuration, as well as historical event logs, and five thirty second Signal Sequence logs.

Event logs provide a historical record of previous fault data, ac line event data, monitor reset events, and configuration programming change events. These logs are invaluable when analyzing fault data to diagnose cabinet equipment malfunctions.

The Signal Sequence logs provide a graphical display of the signal states of all sixteen channels for up to thirty seconds prior to the fault trigger point at 50 millisecond resolution. The NSM-E Series stores these signal records for the last five fault events.

The EDI ECcom software is available at no charge from the EDI web site at **www.EDItraffic.com**.

1.3 GENERAL

The NSM-E Series is configured as a 6 channel (NSM-6E) monitor or a 12 channel (NSM-12E) when operated in a TS-1 type cabinet assembly. Each channel has the capability of monitoring a Green, a Yellow, a Red, and a Walk field signal output at the Terminals and Facilities field terminals.

A Program Card is provided for assigning permissive channels. The NSM-E Series detects the presence of conflicting Green or Yellow or Walk field signal inputs between any two or more channels not assigned to be permissive on the Program Card. The RED ENABLE input, when activated, enables the Red Fail Monitoring functions of the unit causing the monitor to trigger when it detects the absence of voltage on all three (four) of the field signal inputs of a channel. It also enables the Minimum Yellow Clearance Monitoring function which verifies that the Yellow Change Clearance interval between the end of an active Green signal and the beginning of the Red signal is proper. The monitoring circuitry is capable of detecting either full wave or positive and negative half-wave sinusoidal field signal inputs at the specified voltage levels.

When triggered by the detection of a fault condition which exists longer than the minimum period defined by the NEMA ***Standards Publication TS1-1989 R2005*** the NSM-E Series will enter the fault mode causing the OUTPUT relay to de-energize and two sets of contacts on the OUTPUT relay to transfer. The cabinet assembly should be wired such that the closure of the OUTPUT relay contacts will cause an automatic switching of the field signal outputs from normal operation to flashing operation. The NSM-E Series will then display the appropriate fault status. The loss of AC LINE will not reset the fault mode of the OUTPUT relay contacts. In the event of AC LINE loss the NSM-E Series will retain the status of all fault and channel indicators and will display the correct fault and channel status upon restoration of AC LINE.

1.4 FIELD SIGNAL TERMINALS

A GREEN, YELLOW, or WALK field signal input will be sensed as active by the unit when it exceeds the Green, Yellow, or Walk Signal Detect voltage threshold (Section 7.1.2) and a field signal input will be sensed as inactive when it is less than the Green, Yellow, or Walk Signal No-Detect voltage threshold (Section 7.1.2). Both positive and negative half wave rectified inputs will be sensed.

A RED (DON'T WALK) field signal input will be sensed as active by the unit when it exceeds the Red Signal Detect voltage threshold (Section 7.1.2) and a field signal input will be sensed as inactive when it is less than the Red Signal No-Detect voltage threshold (Section 7.1.2). Both positive and negative half wave rectified inputs will be sensed.

NOTE: When the circuit connected to the sensing input of a signal monitor exhibits high impedance characteristics such as caused by dimmers, burned out lamps, low wattage equipment, or no load, it may be necessary to place a low impedance device external to the unit between the signal monitor input and AC NEUTRAL (See Sections 5.5.3.9 and 6.2.4 of ***NEMA Standards Publication TS2-2003 v02.06, Traffic Controller Assemblies With NTCIP Requirements***).

1.4.1 *LEDGUARD™* LED FIELD SIGNAL SENSING

The Eberle Design NSM-E Series can be configured to use a technique called *LEDguard™* that is designed to better monitor the characteristics of LED based signal loads (See Section 5.4.2). Each field signal input is measured and compared to both a high threshold and a low threshold value to determine On / Off status. This differs from conventional standard Nema operation where the active threshold is picked according to the color of the field signal. Once the high and low On / Off thresholds (Section 7.1.2) have been determined using the input RMS voltage, the individual fault monitor functions use the appropriate threshold to determine if a fault condition exists.

LEDguard™	Green/Walk	Yellow	Red/Don't Walk
Conflict	Low	Low	---
Red Fail	High	High	High
Dual Indication	Low	Low	Low
Clearance	Low	Low	High

A paper with further information on the EDI *LEDguard™* function can be found in the Support section of the EDI web site at www.EDItraffic.com.

Section 2
Standard Functions

2.1 CONFLICT MONITORING

When voltages on any conflicting channels are sensed as active for more than the Conflict Fault time (Section 7.4), the NSM-E will enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and illuminate the CONFLICT indicator. The NSM-E will remain in the fault mode until the unit is reset by the RESET button or the EXTERNAL RESET input. When voltages on any conflicting channels are sensed as active for less than the Conflict No-Fault time (Section 7.4), the NSM-E will not transfer the OUTPUT relay contacts to the Fault position.

The NSM-E is fully programmable and requires the use of soldered wire jumpers on an interchangeable Programming Card to define permissive channel pairs. See Section 5.1 for Programming Card details.

2.2 RED FAIL MONITORING

When voltages on all inputs (G, Y, R, (W)) to a channel are sensed as inactive for more than the Red Fail Fault time (Section 7.4), the NSM-E will enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and illuminate the RED FAIL indicator. The NSM-E will remain in the fault mode until the unit is reset by the RESET button or the EXTERNAL RESET input. When voltages on all inputs to a channel are sensed as inactive for less than the Red Fail No-Fault time (Section 7.4), the NSM-E will not transfer the OUTPUT relay contacts to the Fault position.

Red Fail Monitoring will be disabled when the RED ENABLE input is not active.

2.3 RED ENABLE INPUT

The RED ENABLE input will be sensed as active by the NSM-E when it exceeds the Red Enable Input threshold (Section 7.1.2). The presence of the proper operating voltage at this input enables Red Fail Monitoring, Clearance Monitoring, and Dual Indication Monitoring.

The RED FAIL indicator will flash once every 2 seconds if the RED ENABLE input is not active.

2.3.1 WALK DISABLE OPTION

This option will modify the operation of Red Fail and Dual Indication Monitoring. When enabled, the Red Fail Monitoring function will not monitor the Walk field outputs. Absence of signals on the Green, Yellow, and Red field outputs of a channel will place the NSM-E into the fault mode causing the Output relay contacts to transfer. This function is enabled by the front panel option switch labeled "WALK DISABLE". See Section 5.4.2.

2.4 VOLTAGE MONITORING

2.4.1 +24VDC SUPPLY MONITORING

The +24V MONITOR I and +24V MONITOR II inputs are provided for monitoring two +24Vdc supplies in the cabinet assembly. Should loss of proper voltage occur at either of these inputs, the NSM-E will enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and illuminate the appropriate 24V-1 or 24V-2 indicator. The NSM-E will automatically reset the OUTPUT relay when the correct input voltages are restored to both of these inputs. However, the NSM-E will remain in the fault mode for at least the time determined by the Minimum Flash programming.

A voltage greater than the +24V Monitor input threshold (Section 7.1.4) applied to both of the +24V MONITOR inputs will be sensed by the NSM-E as adequate for operation of the cabinet assembly. A voltage less than the +24V Monitor input threshold (Section 7.1.4) applied to either of the +24V MONITOR inputs will be sensed as inadequate for proper operation. When a +24V MONITOR input is sensed as inadequate for more than the +24V Monitor Fault time (Section 7.4), the NSM-E will enter the fault mode and transfer the OUTPUT relay contacts to the Fault position. When a +24V MONITOR input is sensed as inadequate for less than the +24V Monitor No-Fault time (Section 7.4), the NSM-E will not transfer the OUTPUT relay contacts to the Fault position. A +24Vdc failure during the programmed Minimum Flash time or during an Power Failure will not cause a fault condition.

2.4.1.1 +24VDC MONITOR INHIBIT INPUT

A +24V MONITOR INHIBIT input is provided to inhibit the operation of the +24Vdc Monitor. Application of a logic TRUE (low) state to this input will disable the operation of the +24Vdc Monitor. The 24V-1 and 24V-2 indicators will flash once every 2 seconds if the +24V MONITOR INHIBIT input is TRUE.

2.4.1.2 +24VDC MONITOR LATCH INPUT

An Option Switch is supplied on the front panel to allow +24Vdc failures to latch in the fault condition until the unit is reset by the activation of the RESET button or the EXTERNAL RESET input. See Section 5.4.5. A +24Vdc failure during the programmed Minimum Flash time or during a Power Failure will not cause a latched fault condition.

2.4.2 CONTROLLER VOLTAGE / FAULT MONITOR INPUT

This input is to be connected to the CONTROLLER UNIT VOLTAGE MONITOR (CVM) output from the Controller Unit. When the TRUE (low) state is absent for more than the CVM Fault time (Section 7.4), the NSM-E will enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and illuminate the CVM/WATCHDOG indicator. When the TRUE (low) state is absent for less than the CVM No-Fault time (Section 7.4), the NSM-E will not transfer the OUTPUT relay contacts to the Fault position. The NSM-E will automatically reset the OUTPUT relay when the True (low) state is restored to the input. However, the NSM-E will remain in the fault mode for at least the time determined by the Minimum Flash programming. A CVM failure during the programmed Minimum Flash time or during a Power Failure will not cause a fault condition.

2.4.2.1 CVM MONITOR LATCH INPUT

An Option Switch is supplied on the front panel to allow CVM failures to latch in the fault condition until the unit is reset by the activation of the RESET button or the EXTERNAL RESET input. See Section 5.4.5. A CVM failure during the programmed Minimum Flash time or during a Power Failure will not cause a latched fault condition.

2.4.2.2 CVM LOG DISABLE

If CVM events are not related to a malfunction condition and occur on a regular basis such as Time of Day flash, the logging of these events can be disabled. See Section 5.4.7.

2.5 POWER FAILURE DETECTION

When the AC LINE voltage is below the minimum AC Line drop-out level (Section 7.1.2) for the Power Fail Respond time (7.4), the NSM-E Series will suspend all fault monitoring functions, de-energize the OUTPUT relay, and de-energize the START relay. The POWER indicator on the front panel will flash at a rate of 2Hz to indicate the low voltage status.

When the AC LINE voltage returns above the maximum AC Line restore level (Section 7.1.2) for the Power Fail Restore time (7.4), the monitor will resume normal operation and the POWER indicator on the front panel will remain illuminated. After a 2.5 $\pm$0.5 second

delay the START relay will be energized. After a programmable delay determined by the Minimum Flash programming (see Section 5.2), the OUTPUT relay will be energized.

This expanded operating voltage range for cabinet components allows the NSM-E Series to place the intersection into flash and return to normal operation in an orderly manner when the AC LINE voltage is sufficient for proper operation. The NSM-E Series should be the first component in the cabinet to sense a low voltage condition and the last component to sense a proper AC LINE operating voltage.

The AC LINE and AC NEUTRAL inputs are used to generate the internal voltage supplies required to operate the monitor. AC NEUTRAL also serves as the return for all AC signals including RED ENABLE. EARTH GROUND provides an independent connection to the chassis of the unit and is isolated from AC NEUTRAL and LOGIC GROUND. LOGIC GROUND is provided for inputs which are isolated from AC NEUTRAL (i.e. +24V Monitors, CVM, CONTROLLER WATCHDOG, EXTERNAL RESET, and 24V MONITOR INHIBIT). LOGIC GROUND may be tied to AC NEUTRAL if desired.

2.6 INTERNAL DIAGNOSTICS

The NSM-E is supplied with a resident series of self check diagnostic capabilities which monitor for correct operation of the NSM-E both at power-up and continuously during operation. Should an internal diagnostic error occur, other fault indicators that may be concurrently displayed with the DIAGNOSTIC indicator may not be valid due to the nature of these hardware and/or firmware failures.

2.6.1 MEMORY DIAGNOSTICS

On power-up, the NSM-E verifies the operation of all memory components including RAM, EPROM, and non-volatile EEPROM. During operation the NSM-E continuously performs a check sum verification of the non-volatile memory components. When either diagnostic test fails, the NSM-E will enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and illuminate the DIAGNOSTIC indicator. A Power Failure will reset the Diagnostic fault state of the monitor (see Section 2.5). Due to the nature of these hardware/firmware failures, other fault indicators that may be concurrently displayed with the DIAGNOSTIC indicator may not be valid.

2.6.2 MICROPROCESSOR MONITOR

The NSM-E contains circuitry which monitors the operation of the internal microprocessor. This monitoring circuit receives a logic transition signal from the microprocessor every 5 msec. When this logic transition is not received for 300 msec, the NSM-E will enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and illuminate the DIAGNOSTIC indicator. Due to the nature of these hardware/firmware failures, other fault indicators that may be concurrently displayed with the DIAGNOSTIC indicator may not be valid.

This type of failure is configured as latching. If the microprocessor resumes operation the unit will not return to normal operation. With latching operation, only a loss of AC Line will restore operation. If non-latching operation is desired, internal jumper E1 (Latching MPU Fault) may be removed.

2.6.3 INTERNAL I/O HARDWARE MONITOR

The NSM-E contains circuitry which verifies the operation of the internal input/output interface circuitry. On power-up, the NSM-E verifies that the circuitry which interfaces to the Programming Card, display LEDs, and front panel dip switches is functioning properly. If a malfunction is detected, the NSM-E will enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and illuminate the DIAGNOSTIC indicator. A Power Failure will reset the Diagnostic fault state of the monitor (see Section 2.5). Due to the nature of this hardware failure, other fault indicators that may be concurrently displayed with the DIAGNOSTIC indicator may not be valid.

Section 3
Extended Features

The following enhanced features are provided on the Eberle Design NSM-E Series for additional monitoring functions and to increase the reliability of the NSM-E Series monitor operation.

3.1 HARDWARE FEATURES

The NSM-E is a dual microprocessor based unit. All monitoring functions and features are firmware programmable which permits upgrades or modifications by simply replacing the EPROM device containing the firmware with the upgraded version. Thus, most changes to the NSM-E specifications may be accommodated without modifying the hardware.

Since all critical timing functions are accomplished by the microprocessor, the quartz crystal based accuracy results in very precise and repeatable measurements. This accuracy is maintained on functions from timing fault conditions to implementing a unique firmware based digital sampling and filtering algorithm. This algorithm is applied to all AC field signals to help eliminate false detection in a "noisy" AC line environment.

Input voltages are measured using a true Root Mean Squared (RMS) technique. A dedicated microcontroller RMS-Engine controls the analog to digital (A/D) hardware which samples each AC input voltage 32 times per cycle. The RMS-Engine then calculates the true RMS voltage value producing accurate results which are very insensitive to changes in frequency, phase, wave shape, and distortion. Voltage references are temperature compensated for constant voltage levels within the operating temperature range.

A nonvolatile EEPROM device is utilized to retain fault status information and event logs through an AC Line power interruption. The correct fault indications will be displayed upon restoration of AC Line power. This EEPROM device requires no battery back-up. The time of day in the NSM-E is stored in a battery-backed real time clock circuit. Should this battery fail, only current time of day and date information will be lost. No monitor configuration programming is stored under battery power.

3.2 DUAL INDICATION MONITORING

This monitoring function detects simultaneous input combinations of active Green and Yellow, Green and Red, Yellow and Red, Walk and Yellow, or Walk and Red field signal inputs on the same channel. When voltages on any two inputs of a channel are sensed as active for more than the Dual Indication Fault time (7.4), the NSM-E Series will enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and display the DUAL INDICATION status screen. The NSM-E Series will remain in the fault mode until the unit is reset by the RESET button or the EXTERNAL RESET input. When voltages on any two inputs of a channel are sensed as active for less than the Dual Indication Fault time, the NSM-E Series will not transfer the OUTPUT relay contacts to the Fault position.

Dual Indication Monitoring may anticipate and prevent a possible conflicting signal display in the intersection in the event that a proceed signal on the current phase hangs up and is constantly detected as active. An open or no load condition (i.e., burned-out bulb) may be also detected as an active signal depending on the output impedance characteristics of the load switch (i.e. load switch leakage current), and may cause a Dual Indication Fault.

Dual Indication Monitoring will be disabled when the RED ENABLE input is not active. A set of switches labeled “SSM” is provided on the NSM-E series Signal Monitor front panel to enable Dual Indication and Clearance Monitoring on a per channel basis. See Section 5.3 for the programming procedure.

3.2.1 GY ENABLE OPTION

This monitoring function detects simultaneous inputs of active Green and Yellow field signal inputs on the same channel. It can be used to monitor channels which have an unused Red field signal input tied to AC LINE such as a five section signal head resulting in the SSM switch in the Off position.

GY-Dual Indication Monitoring is enabled by the front panel option switch labeled GY ENABLE. See Section 5.4.1. When the GY-Dual Indication Monitoring option is enabled, all channels which have the front panel SSM switches OFF will be individually monitored for simultaneous active Green and Yellow field signal inputs. All channels which have the front panel SSM switches ON (i.e. enabled for Dual Indication Monitoring) will function as described above in Section 3.2.

GY-Dual Indication Monitoring will be disabled when the RED ENABLE input is not active.

3.2.2 WALK DISABLE OPTION

This option will modify the operation of Red Fail and Dual Indication Monitoring. When enabled, the Red Fail and Dual Indication Monitoring function will not monitor the Walk field outputs. Absence of signals on the Green, Yellow, and Red field outputs of a channel will place the NSM-E Series into the Red Fail fault mode causing the Output relay contacts to transfer. Presence of active signals on the Walk outputs will not cause a Dual Indication when concurrent with active Red or Yellow signals. This function is enabled by the Option Switch called "WALK DISABLE" on the front panel. See Section 5.4.4.

3.3 MINIMUM YELLOW CLEARANCE MONITORING

The NSM-E Series will verify that the Yellow Change interval is at least the Clearance Fail Fault time (7.4). The Yellow Change interval consists of the duration of time in which the Yellow field signal input is active in a sequence from Green to Yellow to Red. When this minimum interval is not satisfied the NSM-E Series will enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and display the CLEARANCE status screen. The NSM-E Series will remain in the fault mode until the unit is reset by the RESET button or the EXTERNAL RESET input.

Minimum Yellow Change Monitoring will be disabled when the RED ENABLE input is not active. A set of switches labeled “SSM” is provided on the NSM-E series Signal Monitor front panel to enable Dual Indication and Clearance Monitoring on a per channel basis.

3.4 EXTERNAL WATCHDOG MONITORING

This function monitors an optional external watchdog output from a Controller Unit or other external cabinet circuitry. If the NSM-E Series does not receive a change in state on the EXTERNAL WATCHDOG input for the External Watchdog Fault time (7.4), the NSM-E Series will enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and display the EXT WATCHDOG status screen. The NSM-E Series will remain in the fault mode until the unit is reset by the RESET button or the EXTERNAL RESET input. A Power Failure will also reset the External Watchdog fault state of the monitor (see Section 2.5).

This function is enabled by the front panel Option Switch called WD ENABLE (see Section 5.4.3). The EXTERNAL WATCHDOG input is harnessed to spare pin of the MS connector by the factory (see Section 8).

3.5 PROGRAM CARD ABSENT INDICATION

If the Program Card is absent or not seated properly in the edge connector, the NSM-E will enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and illuminate the PGM CARD indicator. The NSM-E will remain in the fault mode until the

Program Card is correctly seated and the NSM-E is reset by the RESET button or the EXTERNAL RESET input.

3.6 RESET INPUT DETECTION

Activation of the front panel RESET button or the EXTERNAL RESET input will reset the NSM-E from the fault mode and cause the START relay to energize and the OUTPUT relay to transfer to the no-fault state. Each activation of the RESET button or EXTERNAL RESET input will cause a one time reset input to the unit. A continuously activated RESET input will not prevent the NSM-E from monitoring any fault condition.

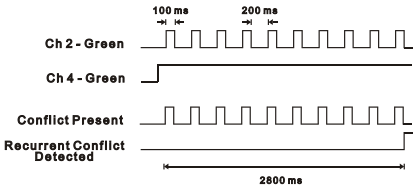
3.7 DISPLAY LED TEST

The monitor will illuminate all front panel LED indicators for a maximum of 500ms when a Reset command is issued by the front panel RESET button or EXTERNAL RESET input.

3.8 RECURRENT PULSE DETECTION

This error detection function supplements the normal Conflict, Dual Indication, and Red Fail monitoring algorithms for sensing faults which are intermittent or pulsing in nature. The RMS-Engine is designed to filter out short term transients commonly found on the electrical service and provide noise immunity against false signal detections. The Recurrent Pulse detection function is designed to respond to fault conditions which are intermittent in nature and do not meet the continuous timing requirements of the normal detection algorithms, yet may still produce improper signal displays. These input conditions are differentiated by their longer time constant and fault response times.

The figure below shows a simple example of a Recurrent Conflict fault. Channel 2 Green is detected active due to a malfunction of the load switch which caused the output to “flicker” On for 100 ms approximately every 200 ms. Since normal Conflict detection requires a continuous fault of at least 350 ms typical, this event could go undetected. The Recurrent Pulse detection algorithm will combine these pulses into one event and trigger a Conflict fault once the longer recurrent timing threshold is exceeded.



When triggered by a recurrent pulse fault condition, the NSM-E will enter the fault mode, transfer the Output relay contacts to the Fault position, and illuminate the appropriate CONFLICT, DUAL, or RED FAIL indicator along with the RP STATUS indicator. The unit will remain in the fault mode until reset by the Reset button or the External Reset input. Fault response times will vary depending on the pulse width and frequency of the recurrent inputs, but typically range from 1000 ms minimum to 10 seconds maximum. Recurrent Pulse detection can be disabled with the RP DISABLE option switch, see Section 5.4.2.

Section 4
Event logging

4.1 EDI *ECCOM* MONITOR REPORT

The EDI *ECcom* software package (Version 3.0 or greater is required) interfaces a Computer to the NSM-E. The *ECcom* program will display the Status (S), Previous Fault (PF) event log, AC Line (AC) event log, Manual Reset (MR) event log, Configuration (CF) event log, and Signal Sequence log. All events are time stamped with the time and date of the event.

Operation of the *ECcom* software package is described in ***EDI ECcom Software Operations Manual*** and will not be covered in this manual. The EDI *ECcom* software package is available free of charge at www.EDItraffic.com. The following data is available:

4.1.1 GENERAL DATA

Monitor ID#: a four digit (0000-9999) ID number may be assigned to the monitor.

Monitor Name: a thirty character name may be assigned to the monitor.

Time and Date: each event is marked with the time and date of occurrence.

Event Number: identifies the record number in the log. Event #1 is the most recent event.

4.1.2 CURRENT STATUS (S)

Fault Type: the fault type description.

Field Status: the current or latched RYGW field status and RMS voltages.

Cabinet Temperature: the current or latched temperature if the monitor.

AC Line Voltage: the current or latched AC Line voltage and frequency.

Control Input Status: the current or latched state and RMS voltage of the Red Enable input and Load Switch Flash bit.

4.1.3 PREVIOUS FAULT (PF) EVENT LOG

Fault Type: the fault type description.

Field Status: the latched field status, RMS voltages, and fault channel status at the time of the fault.

Cabinet Temperature: the latched temperature at the time of the fault.

AC Line Voltage: the AC Line voltage and frequency at the time of the fault.

Control Input Status: the latched state and RMS voltage of the Red Enable input and Load Switch Flash bit.

4.1.4 AC LINE (AC) EVENT LOG

Event Type: describes the type of AC Line event that occurred.

Power-up: AC on, monitor performed a cold start

Brown-out: AC Line < drop-out level

Restore: AC restored from AC brown-out or AC interruption, no cold start

AC Line Voltage: the AC Line voltage at the time of the event.

4.1.5 MANUAL RESET (MR) EVENT LOG

The monitor was reset from a fault by the front panel Reset button or External Reset input or non-latched fault clear.

4.1.6 CONFIGURATION (CF) EVENT LOG

Program Card Matrix: the permissive programming for each channel.

MYCD Jumpers: the Minimum Yellow Clearance Disable programming for each channel.

FC/Dual Enable Switches: the switch programming for each channel.

Option Switches: GY Enable, RP Disable, WD Enable, Walk Disable, CF Enable, CVM Log Disable.

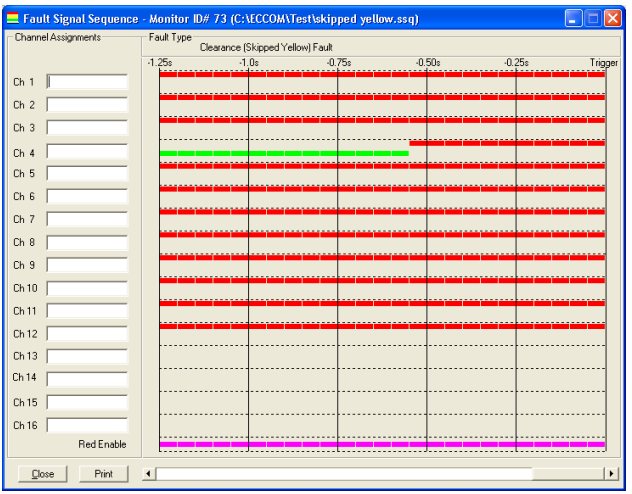
NEMA Inputs: 24V Inhibit, Type Select, Port 1 Disable.

Program Card: Minimum Flash Timing, 24V & CVM Latch Enables.

Configuration Check Value: the value of the 16 bit Check Value for the reported configuration.

4.1.7 SIGNAL SEQUENCE EVENT LOG

The Signal Sequence event log graphically displays all signal states and Red Enable state for up 30 seconds prior to the NSM-E fault trigger. These five event logs are not cleared by a Reset or power-down of the NSM-E and will remain until the unit is triggered by another fault event. This new event entry automatically overwrites the oldest event data.



Section 5
Installation

5.1 PERMISSIVE CHANNEL PROGRAMMING

The NSM-E Series Program Card contains a group of soldered wire jumper holes to set the permissive or compatible channel configuration. This programming is determined by the intersection layout and phase assignments. The card is initially supplied with 66 empty wire jumper hole pairs. This initial programming sets all channels to conflict with all other channels. To program a compatible channel pair, solder a wire jumper into the appropriate location for that channel pair as marked on the Program Card. **Make sure that any jumper leads do not make contact with any other jumper lead on the card or the monitor chassis when the Programming Card is inserted into the unit.**

Example: If channel 2 Green and Yellow is **PERMISSIVE** with channel 6 Green and Yellow, solder a jumper wire into the jumper pair labeled "2-6".

If the Program Card is absent or not seated properly in the edge connector, the NSM-E Series will enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and display the PROGRAM CARD status screen. The NSM-E Series will remain in the fault mode until the Program Card is correctly seated and the NSM-E Series is reset by the RESET button or the EXTERNAL RESET input.

5.2 MINIMUM FLASH TIME PROGRAMMING

It is recommended that the Minimum Flash Time be programmed on the NSM-E Series to facilitate an orderly start-up sequence of the Cabinet Assembly upon application or restoration of AC LINE power. The Minimum Flash Time should be long enough to ensure all cabinet components are initialized and ready before the NSM-E Series transfers the OUTPUT relay and places the intersection into signal operation.

Programming of the front panel Minimum Flash DIP switches is in a binary encoded format:

MinFlash 8	MinFlash 4	MinFlash 2	MinFlash 1	Delay Period
Off	Off	Off	Off	4 seconds
Off	Off	Off	On	4 seconds
Off	Off	On	Off	4 seconds
Off	Off	On	On	4 seconds
Off	On	Off	Off	4 seconds
Off	On	Off	On	5 seconds
Off	On	On	Off	6 seconds
Off	On	On	On	7 seconds
On	Off	Off	Off	8 seconds
On	Off	Off	On	9 seconds
On	Off	On	Off	10 seconds
On	Off	On	On	11 seconds
On	On	Off	Off	12 seconds
On	On	Off	On	13 seconds
On	On	On	Off	14 seconds
On	On	On	On	15 seconds

5.3 SSM SWITCH PROGRAMMING

The SSM switches on the NSM-E series Signal Monitor are labeled "1" to "12" ("6") corresponding to channels 1 through 12 (6), respectively. Positioning a switch in the ON position (to the right) enables a channel for Dual Indication **AND** Clearance Monitoring.

The channel SSM switch should be placed in the ON position when a channel has a Red, a Yellow, and a Green signal that turn both On and Off. The channel SSM switch should be placed in the OFF position when an unused Red field output terminal is connected to AC+ or for a channel that does not monitor the Yellow input such as an exclusive Ped channel.

5.4 UNIT OPTION PROGRAMMING

5.4.1 GY ENABLE OPTION

The GY-Dual Indication Monitoring function is **ENABLED** by setting the Option switch labeled GY ENABLE to the ON position. See Section 3.2.1.

5.4.2 RP DISABLE OPTION

The Recurrent Pulse Detection function is **DISABLED** by setting the Option switch #2 labeled RP DISABLE to the ON position. See Section 3.8.

5.4.3 EXTERNAL WATCHDOG ENABLE OPTION

The External Watchdog Monitoring function is **ENABLED** by setting Option switch labeled WD ENABLE switch to the ON state. See Section 3.4.

5.4.4 WALK DISABLE OPTION

The Walk Disable function is **ENABLED** by setting the Option switch labeled WALK DISABLE to the ON state. See Section 2.3.1.

CONTROLLER VOLTAGE MONITOR (CVM) LATCH PROGRAMMING

The CVM Latch function is **ENABLED** by setting the Option switch labeled CVM LATCH to the ON position. See Section 2.4.2.1.

24VDC MONITOR LATCH PROGRAMMING

The 24V Latch function is **ENABLED** by setting the Option switch labeled 24V LATCH to the ON position. See Section 2.4.1.2.

5.4.5 LOG CVM FAULTS OPTION

The CVM Logging function is **DISABLED** by setting the Option switch labeled LOG CVM DISABLE to the ON state. See Section 2.4.2.2.

5.4.6 *LEDGUARD*™ ENABLE OPTION

The *LEDguard*™ Monitoring function is **ENABLED** by setting Option switch labeled LEDguard to the ON state. See Section 1.4.1.

Section 6
Front Panel Description

6.1 CHANNEL STATUS DISPLAY

Forty-eight Red, Yellow, Green and Blue LEDs are provided to display the complete intersection status of the field signal inputs to the NSM-E. If the unit is operating normally without a fault condition present, the currently active field input signals will be displayed.

Once the NSM-E has been triggered by a fault the channel status display will sequence through several display modes automatically:

1. Active Signals
2. Field signals active at the time of the fault for 6 seconds.
3. Fault Channels (if applicable)
    a. The channels involved in the fault will flash their respective Green AND Yellow AND Red AND Blue indicators simultaneously at a 4 Hz rate for 2 seconds.
4. Recurrent Pulse Status (if applicable)
    a. The inputs with Recurrent Pulse Status will flash their respective indicators simultaneously with the RP STATUS indicator at a 4 Hz rate for 2 seconds.

6.2 FAULT STATUS DISPLAY

The Fault Status Display of the NSM-E displays ten fault conditions in addition AC LINE status.

1. CONFLICT Indicator

The CONFLICT indicator will be illuminated when a Conflict Fault is detected. See Section 2.1.

2. RED FAIL Indicator

The RED FAIL indicator will be illuminated when a Red Fail Fault is detected. See Section 2.2.

The RED FAIL indicator will flash once every 2 seconds if the RED ENABLE input is not active, or in the Type 16 mode, if the LOAD SWITCH FLASH bit is set to "1" in the Type 0 message from the Controller Unit.

3. CVM / WD (Controller Voltage Monitor / Watchdog) Indicator

The CVM / WD indicator will be illuminated when a Controller Voltage Monitor Fault is detected. See Section 2.4.2.

If the External Watchdog monitor option (WD ENABLE) is enabled and the NSM-E is triggered by an External Watchdog output failure, the CVM / WD indicator will be illuminated. See Section 3.2.

4. 24V-1, 24V-2 (Voltage Monitor) Indicators

These indicators will be illuminated when the NSM-E has detected a +24V MONITOR-1 or +24V MONITOR-2 failure. See Section 2.4.1.

The 24V-1 and 24V-2 indicators will flash once every 2 seconds if the +24V MONITOR INHIBIT input is TRUE.

5. CLEARANCE FAIL Indicator

The CLEARANCE FAIL indicator will be illuminated when a Minimum Yellow Change Fault is detected. See Section 3.3.

6. DUAL INDICATION Indicator

The DUAL INDICATION indicator will be illuminated when a DUAL INDICATION Fault is detected. See Section 3.2.

7. DIAGNOSTIC Indicator

The DIAGNOSTIC indicator will illuminate when the NSM-E has detected an internal diagnostic failure. Due to the nature of these hardware/firmware failures, other indicators that may also be displayed may not be valid for trouble shooting purposes. See Section 2.5.

8. PGM CARD Indicator

The PGM CARD indicator will illuminate when the Program Card is removed or not inserted fully. See Section 3.5.

9. POWER Indicator

The POWER indicator will flash at a rate of 2Hz when the AC LINE voltage is below the drop-out level. It will illuminate steadily when the AC LINE voltage returns above the restore level. See Section 2.5.

10. RECURRENT PULSE STATUS Indicator

The RP STATUS indicator will illuminate when a Conflict, Red Fail, or Dual Indication fault has been detected with Recurrent Pulse Status. The indicator will then flash at a rate of 4Hz for a 2 second interval when the Channel Status display is showing the inputs with Recurrent Pulse Status. See Section 3.8, 6.1.

11. COMM Indicator

The COMM indicator will be illuminated for a 20 msec pulse each time a message is correctly received on the EIA-232 Port.

6.3 BUTTONS

6.3.1 RESET BUTTON

Depressing the RESET button resets the NSM-E after it has been triggered by a fault. When the RESET button is depressed all front panel indicators will be illuminated for 500 msec and the OUTPUT relay and START relay energized.

Section 7
Specifications

7.1 ELECTRICAL

7.1.1 POWER REQUIREMENTS

Operating Line Voltage ..... 75 to 135 Vrms
Operating Line Frequency ..... 60 ±3Hz
Power Consumption ..... 10W (nominal)

7.1.2 AC VOLTAGE MONITORS

Nema Green Signal Inputs
- No Detect ..... less than 15 Vrms
- Detect ..... greater than 25 Vrms

Nema Yellow Signal Inputs
- No Detect ..... less than 15 Vrms
- Detect ..... greater than 25 Vrms

Nema Walk Signal Inputs
- No Detect ..... less than 15 Vrms
- Detect ..... greater than 25 Vrms

Nema Red Signal Inputs
- No Detect ..... less than 50 Vrms
- Detect ..... greater than 70 Vrms

LEDguard™ Low Threshold Signal Inputs
- No Detect ..... less than 15 Vrms
- Detect ..... greater than 25 Vrms

LEDguard™ High Threshold Signal Inputs
- No Detect ..... less than 50 Vrms
- Detect ..... greater than 70 Vrms

Red Enable Input
- No Detect ..... less than 70 Vrms
- Detect ..... greater than 89 Vrms

7.1.3 POWER FAIL MONITOR

AC Line Input
- Dropout ..... less than 92 Vrms
- Restore ..... greater than 96 Vrms

7.1.4 DC VOLTAGE MONITOR

+24 Vdc Inputs
- Fault ..... less than 18 Vdc
- No Fault ..... greater than 22 Vdc

7.1.5 LOGIC INPUTS

Controller Voltage Monitor (CVM), External Reset, +24V Monitor Inhibit, and External Watchdog Input
- True (low) ..... less than 8 Vdc
- False (high) ..... greater than 16 Vdc

7.2 MECHANICAL

Height ..... 10.5 inches
Width ..... 4.5 inches
Depth ..... 8.5 inches

7.3 ENVIRONMENTAL

Storage Temperature Range ..... -45 to +85 °C
Operating Temperature Range ..... -34 to +74 °C

Humidity Range ..... 0 to 95% Relative

7.4 TIMING FUNCTIONS

Conflict
- No Fault ..... less than 200 msec
- Fault ..... greater than 450 msec
- Typical ..... 350 msec

Red Fail
- No Fault ..... less than 700 msec
- Fault ..... greater than 1000 msec
- Typical ..... 850 msec

Controller Voltage Monitor (CVM)
- No Fault ..... less than 125 msec
- Fault ..... greater than 175 msec
- Typical ..... 150 msec

+24Vdc Monitor
- No Fault ..... less than 125 msec
- Fault ..... greater than 175 msec
- Typical ..... 150 msec

Clearance Fail
- No Fault ..... greater than 2.8 second
- Fault ..... less than 2.6 second
- Typical ..... less than 2.7 second

Dual Indication
- No Fault ..... less than 200 msec
- Fault ..... greater than 500 msec
- Typical ..... 400 msec

Power Fail
- Respond ..... greater than 500 msec
- No Response ..... less than 450 msec
- Typical ..... 475 msec

Minimum Flash ..... 4 to 15, $\pm$1 second

Start Delay ..... 2.5 $\pm$0.5 second

Section 8
Wiring Assignments

8.1 NSM-12E HARNESSING CONNECTORS

These Military Specification MIL-C-26482 connectors are interchangeable with 12 channel monitors as defined by NEMA Traffic Control Systems Specification TS1-1989 R2005, part 6. Connector MS-A will intermate with a MS 3116 22-55 SZ. Connector MS-B will intermate with a MS 3116 16-26 S.

8.1.1 NSM-12E CONNECTOR MS-A PIN TERMINATIONS

Pin	Function	I/O
A	AC Line	[I]
B	Output Relay 1 Open (Closes when fault occurs)	[O]
C	Output Relay 2 Closed (Opens when fault occurs)	[O]
D	Channel 12 Green	[I]
E	Channel 11 Green	[I]
F	Channel 10 Green	[I]
G	Channel 9 Green	[I]
H	Channel 8 Green	[I]
J	Channel 7 Green	[I]
K	Channel 6 Green	[I]
L	Channel 5 Green	[I]
M	Channel 4 Green	[I]
N	Channel 3 Green	[I]
P	Channel 2 Green	[I]
R	Channel 1 Green	[I]
S	+24 Monitor I	[I]
T	Logic Ground	[I]
U	Earth Ground	[I]
V	AC Neutral	[I]
W	Output Relay 1 Common	[I]
X	Output Relay 2 Common	[I]
Y	Channel 12 Yellow	[I]
Z	Channel 11 Yellow	[I]
a	Channel 10 Walk	[I]
b	Channel 10 Yellow	[I]
c	Channel 9 Yellow	[I]
d	Channel 8 Yellow	[I]
e	Channel 7 Yellow	[I]
f	Channel 6 Yellow	[I]
g	Channel 5 Yellow	[I]
h	Channel 3 Yellow	[I]
i	Channel 3 Walk	[I]
j	Channel 2 Yellow	[I]

Pin	Function	I/O
k	Channel 1 Yellow	[I]
m	Controller Voltage Monitor	[I]
n	+24V Monitor Inhibit	[I]
p	Output Relay 1 Closed (Opens when fault occurs)	[O]
q	Output Relay 2 Open (Closes when fault occurs)	[O]
r	Channel 12 Walk	[I]
s	Channel 11 Walk	[I]
t	Channel 9 Walk	[I]
u	Channel 8 Walk	[I]
v	Channel 7 Walk	[I]
w	Channel 5 Walk	[I]
x	Channel 4 Yellow	[I]
y	Channel 2 Walk	[I]
z	Channel 1 Walk	[I]
AA	Spare 1	[-]
BB	Reset	[I]
CC	Cabinet Interlock A	[I]
DD	Cabinet Interlock B	[O]
EE	Channel 6 Walk	[I]
FF	Channel 4 Walk	[I]
GG	Spare 2	[-]
HH	Spare 3	[-]

8.1.2 NSM-12E CONNECTOR MS-B PIN TERMINATIONS

Pin	Function	I/O
A	AC Line II	[I]
B	Start-Delay Relay Common.....	[I]
C	Start-Delay Relay Open (Closes during Start Delay period)	[O]
D	Channel 12 Red	[I]
E	Channel 11 Red	[I]
F	Channel 9 Red	[I]
G	Channel 8 Red	[I]
H	Channel 7 Red	[I]
J	Channel 6 Red	[I]
K	Channel 5 Red	[I]
L	Channel 4 Red	[I]
M	Channel 2 Red	[I]
N	Channel 1 Red	[I]
P	Spare 1	[-]
R	+24V Monitor II	[I]
S	External Watchdog (Spare 2)	[-]
T	Spare 3	[-]

Pin	Function	I/O
U	Start-Delay Relay Closed (Open during Start Delay period)	[O]
V	Channel 10 Red	[I]
W	Spare 4	[-]
X	Spare 5	[-]
Y	Spare 6	[-]
Z	Channel 3 Red	[I]
a	Red Enable	[I]
b	Spare 7	[-]
c	Spare 8	[-]

8.2 NSM-6E HARNESSING CONNECTOR

This Military Specification MIL-C-26482 connector is interchangeable with 6 channel monitors as defined by NEMA Traffic Control Systems Specification TS1-1989 R2005, part 6. Connector MS-A will intermate with a MS 3116 22-55 SY.

8.2.1 NSM-6E CONNECTOR MS-A PIN TERMINATIONS

Pin	Function	I/O
A	AC Line I	[I]
B	AC Line II	[I]
C	Output Relay 1 Open (Closes when fault occurs)	[O]
D	Output Relay 2 Closed (Opens when fault occurs)	[O]
E	Start-Delay Relay Open (Closes during Start Delay period)	[O]
F	Channel 6 Green	[I]
G	Channel 6 Red	[I]
H	Channel 5 Green	[I]
J	Channel 4 Green	[I]
K	Channel 4 Red	[I]
L	Channel 3 Green	[I]
M	Channel 2 Green	[I]
N	Channel 2 Red	[I]
P	Channel 1 Green	[I]
R	Red Enable	[I]
S	+24V Monitor I	[I]
T	Logic Ground	[-]
U	Chassis Ground	[-]
V	AC Neutral	[-]
W	Cabinet Interlock B	[-]
X	Output Relay 1 Common	[I]
Y	Output Relay 2 Common	[I]
Z	Output Relay 2 Open	[O]

Pin	Function	I/O
	(Closes when fault occurs)	
a	Start Delay Relay Common	[I]
b	Channel 6 Yellow	[I]
c	Channel 5 Yellow	[I]
d	Channel 5 Red	[I]
e	Channel 4 Yellow	[I]
f	Channel 3 Yellow	[I]
g	Channel 3 Red	[I]
h	Channel 2 Yellow	[I]
i	Channel 1 Yellow	[I]
j	Channel 1 Red	[I]
k	+24V Monitor II	[I]
m	Controller Voltage Monitor	[I]
n	+24V Monitor Inhibit	[I]
p	Cabinet Interlock A	[-]
q	Spare 1	[-]
r	Output Relay 1 Closed (Opens when fault occurs)	[O]
s	Start-Delay Relay Closed (Opens during Start Delay period)	[O]
t	Channel 6 Walk	[I]
u	Channel 5 Walk	[I]
v	Channel 4 Walk	[I]
w	Channel 3 Walk	[I]
x	Channel 2 Walk	[I]
y	Channel 1 Walk	[I]
z	Reset	[I]
AA	Spare 2	[-]
BB	Spare 3	[-]
CC	Spare 4	[-]
DD	Spare 5	[-]
EE	Spare 6	[-]
FF	Spare 7	[-]
GG	Spare 8	[-]
HH	Spare 9	[-]

8.3 EIA-232 CONNECTOR

Pin	Function	I/O
1	DCD	O
2	Tx DATA	O
3	Rx DATA	I
4	DTR	I
5	GROUND	-
6	DSR	O
7	CTS	I
8	RTS	O

Pin	Function	I/O
9	NC	-

If the monitor DTR Enable option is selected (See ***EDI ECcom Software Operations Manual***) the Data Terminal Ready (DTR) input must be in the high state (>4 Vdc) for the monitor EIA-232 port (DCE device) to be active. DCD, DSR, CTS, and RTS are provided for compatibility with Data Terminal Equipment (DTE device) control signals. If required by the Data Terminal Equipment device (Personal Computer), DCD may be driven high by inserting internal jumper E8. If the Data Terminal Equipment device uses CTS instead of DTR to control data flow, insert internal jumper E9 and remove internal jumper E7.

8.3.1 EIA-232 CABLE TO A PC

A typical cable assembly for a DB-9 connector on the PC is a straight through connection as follows:

PC DB-9		Monitor DB-9	
RX pin 2	connect to	TX pin 2	
TX pin 3	connect to	RX pin 3	
DTR pin 4	connect to	DTR pin 4	(optional)
GND pin 5	connect to	GND pin 5	

A typical cable assembly for a DB-25 connector on the PC would be as follows:

PC DB-25		Monitor DB-9	
RX pin 3	connect to	TX pin 2	
TX pin 2	connect to	RX pin 3	
DTR pin 20	connect to	DTR pin 4	(optional)
GND pin 7	connect to	GND pin 5	