

OPERATIONS MANUAL
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NSM & SSM-E SERIES
RMS SIGNAL MONITOR

THIS MANUAL CONTAINS TECHNICAL INFORMATION FOR THE **NSM-6, NSM-12, SSM-6E, AND SSM-12E** RMS SIGNAL MONITORS. INCLUDED ARE GENERAL DESCRIPTION, OPERATIONAL DESCRIPTION, INSTALLATION, AND SPECIFICATIONS.

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

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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 be tested at least annually to ensure proper operation and compliance with both NEMA and factory specifications.

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1 NEMA TS1 STANDARD FUNCTIONS

1.1 Introduction

This manual covers the equipment usage and design considerations of the NSM and SSM-E series Signal Monitor. It provides the user with a general understanding of the operating principles necessary to install and maintain the NSM and SSM-E series Signal Monitor.

1.2 Model Description

The NSM and SSM-E series Signal Monitors consists of four models; the NSM-6, NSM-12, SSM-6E, and SSM-12E. These units are built on the same platform with differences comprising hardware and software features. The model NSM-12 (-6) is the base unit. The model SSM-12E (-6E) unit is equivalent to the NSM-12 (-6) but includes Dual Indication and Clearance monitoring. Where not specified otherwise, the information in this manual will apply to all models.

1.3 Standard Functions

The NSM and SSM-E series Signal Monitor is a device used in a traffic controller assembly to monitor traffic signals at an intersection for conflicting proceed indications or the absence of voltage on all of the field signal outputs of a channel caused by malfunctions of the controller, load switches, or miswiring of the cabinet. The NSM and SSM-E series Signal Monitor also provides error sensing of two +24VDC supplies and the controller power supplies via +24V-1, +24V-2, and Controller Voltage Monitor (CVM) inputs respectively. The NSM and SSM-E series Signal Monitor is directly interchangeable with a standard NEMA Signal Monitor and meets with or exceeds all specifications outlined in Chapter 6 (Conflict Monitors) of the NEMA Traffic Control Systems Specifications (TS1-1989).

The NSM-12 and SSM-12E series Signal Monitor is a twelve-channel Monitor. The NSM-6 and SSM-6E series Signal Monitor is a six-channel Monitor. Each channel has the capability of monitoring a Green, a Yellow, a Red, and a Walk field signal output at the field terminals. A Program Card is provided for assigning conflicting channels. The NSM and SSM-E series Signal Monitor detects the presence of conflicting Green or Yellow or Walk signals on the AC field terminations between any two or more channels assigned to conflict on the Program Card. The Red Enable input activates the Red Monitoring capabilities of the unit causing the monitor to trigger when it detects the absence of voltage on all four of the field signal outputs of a channel. The monitoring circuitry is capable of detecting either full wave or positive and negative half-wave field signal outputs at the specified RMS voltage levels.

When triggered by the detection of a fault condition which exists longer than the minimum period defined by the NEMA Traffic Control Systems Specifications (TS1-1989, part 6), the NSM and SSM-E series Signal Monitor 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 transfer of the signal monitor Output relay contacts will cause an automatic switching of the field signal outputs from normal operation to flashing operation. The NSM and SSM-E series Signal Monitor will then display the appropriate fault status along with the proceed indications active at the time of the fault. The NSM and SSM-E series Signal Monitor will remain in the Conflict, Red Fail, Dual Indication, or Clearance Fail fault mode until a reset command is issued via the front panel RESET button or External Test Reset Input. The loss of AC+ power will not reset the fault mode of the Output relay contacts. In the event of AC+ power loss the NSM and SSM-E series Signal Monitor will retain the status of all fault and channel indicators and will display the correct fault and channel status upon restoration of AC+ power.

1.3.1 Conflict Monitoring

When voltages on any conflicting channels are sensed as active for more than 450 msec, the NSM and SSM-E series Signal Monitor will enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and illuminate the CONFLICT indicator. The NSM and SSM-E series Signal Monitor 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 200 msec, the NSM and SSM-E series Signal Monitor will not transfer the OUTPUT relay contacts to the Fault position.

The NSM and SSM-E series Signal Monitor is fully programmable and requires the use of soldered wire jumpers on an interchangeable Programming Card to define permissive channel pairs. See Section 3.1 for Program Card details.

1.3.2 Red Fail Monitoring

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When voltages on all inputs (G, Y, R, W) to a channel are sensed as inactive for more than 1000 msec, the NSM and SSM-E series Signal Monitor will enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and illuminate the RED FAIL indicator. The NSM and SSM-E series Signal Monitor 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 700 msec, the NSM and SSM-E series Signal Monitor 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.

1.3.2.1 Red Enable Input

The RED ENABLE input will be sensed as active by the NSM and SSM-E series Signal Monitor when it exceeds 89 volts RMS AC and will be sensed as inactive when it is less than 70 volts RMS AC. 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 two seconds if the RED ENABLE input is not active.

1.3.2.2 Walk Disable Option (SSM-E series Only)

This option will modify only the operation of Red Fail Monitoring in the SSM-E series Signal Monitor. 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 SSM-E series Signal Monitor 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 3.4.4.

1.3.3 +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 and SSM-E series Signal Monitor 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 and SSM-E series Signal Monitor will automatically reset the OUTPUT relay when the correct input voltages are restored to both of these inputs. The NSM and SSM-E series Signal Monitor will remain in the fault mode for at least the time determined by the Minimum Flash programming.

A voltage greater than +22 volts DC applied to both of the +24V MONITOR inputs will be sensed by the NSM and SSM-E series Signal Monitor as adequate for operation of the cabinet assembly. A voltage less than +18 volts DC 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 175 msec, the NSM and SSM-E series Signal Monitor 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 125 msec, the NSM and SSM-E series Signal Monitor will not transfer the OUTPUT relay contacts to the Fault position. A +24Vdc failure during the programmed Minimum Flash time or during a Power Failure will not cause a fault condition.

1.3.3.1 +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.

1.3.3.2 +24Vdc Monitor Latch Option

A switch position is provided 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 3.4.5. A +24Vdc failure during the programmed Minimum Flash time or during a Power Failure will not cause a latched fault condition.

1.3.4 Controller Voltage / Fault Monitor Input

This input is to be connected to the CONTROLLER VOLTAGE MONITOR (CVM) output from the Controller Unit. When the TRUE (low) state is absent for more than 175 msec, the NSM and SSM-E series Signal Monitor will enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and illuminate the CVM indicator. When a the TRUE (low) state is absent for less than 125 msec, the NSM and SSM-E series Signal Monitor will not transfer the OUTPUT relay contacts to the Fault position. The NSM and SSM-E series Signal Monitor will automatically reset the OUTPUT relay when the TRUE (low) state is restored to the input. However, the NSM and SSM-E series Signal

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Monitor 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.

1.3.4.1 CVM Monitor Latch Option

A switch position 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 3.4.6. A CVM failure during the programmed Minimum Flash time or during a Power Failure will not cause a latched fault condition.

2 EXTENDED FEATURES

The following extended features are provided on the Eberle Design NSM and SSM-E series Signal Monitor for enhanced monitoring functions, diagnostic functions, and to increase the reliability of the monitor operation.

2.1 Hardware Features

The NSM and SSM-E series Signal Monitor 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 and SSM-E series Signal Monitor 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 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.

2.2 AC+ Brown-out/Interruption Detection

When the AC+ line voltage is below the drop-out level for 475 msec (± 25 msec) the NSM and SSM-E series Signal Monitor 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 brown-out status.

When the AC+ line voltage returns above the restore level for 100 msec (± 16 msec) the monitor will resume normal operation and the POWER indicator on the front panel will remain illuminated. After a 2.5 second (± 1 second) delay the Start relay will be energized. After a programmable delay determined by the minimum flash function switches on the front panel the Output relay will be energized.

The AC+ and AC- inputs are used to generate the internal voltage supplies required to operate the monitor. AC- also serves as return for all AC signals including Red Enable. Chassis Ground provides an independent connection to the chassis of the unit and is isolated from AC- and Logic Ground. A Logic Ground input is provided for functions which are isolated from AC- (i.e. +24V monitors, CVM, Ext Reset, and 24V Inhibit). Logic Ground may, however, be tied to AC- if desired.

2.3 Dual Indication Monitoring (SSM-E series Only)

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 500 msec, the SSM-E series Signal Monitor will enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and illuminate the DUAL INDICATION indicator. The SSM-E series Signal Monitor 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 200 msec, the SSM-E series Signal Monitor will not transfer the OUTPUT relay contacts to the Fault position.

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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 (e.g. burned-out bulb, open field connection) 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.

A set of switches labeled “SSM” is provided on the SSM-E series Signal Monitor front panel to enable Dual Indication Monitoring on a per channel basis. See Section 3.3 for the programming procedure.

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

2.3.1 **GY-Dual Indication Monitoring** (SSM-E series Only)

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. When voltages on the Green and Yellow field signal inputs of a channel are sensed as active for more than 500 msec, the SSM-E series Signal Monitor will enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and illuminate the DUAL INDICATION indicator. The SSM-E series Signal Monitor will remain in the fault mode until the unit is reset by the RESET button or the EXTERNAL RESET input. When voltages on the Green and Yellow field signal inputs of a channel are sensed as active for less than 200 msec, the SSM-E series Signal Monitor will not transfer the OUTPUT relay contacts to the Fault position. GY-Dual Indication Monitoring may be enabled concurrently with Dual Indication Monitoring.

GY-Dual Indication Monitoring is enabled by the front panel option switch labeled GY ENABLE. See Section 3.4.1. 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 2.3.

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

2.4 **External Watchdog Monitoring** (SSM-E series Only)

This function monitors an optional external watchdog output from a Controller Unit or other external cabinet circuitry. The external source should toggle the EXTERNAL WATCHDOG input logic state once every 100 msec. If the SSM-E series Signal Monitor does not receive a change in state on the EXTERNAL WATCHDOG input for 1500 ± 100 msec, the SSM-E series Signal Monitor will enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and illuminate the CVM/WD indicator. The SSM-E series Signal Monitor 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 CVM/WD fault state of the monitor.

This function is enabled by the front panel option switch labeled WD ENABLE. See Section 3.4.3. The SSM-12E EXTERNAL WATCHDOG input is harnessed to spare pin MSB-S on the front panel B connector by the factory. The SSM-6E EXTERNAL WATCHDOG input is harnessed to spare pin MSA-q on the front panel connector by the factory.

2.5 **Clearance (Short or Absent Yellow) Monitoring** (SSM-E series Only)

This function detects the absence of a minimum 2.7 second period of an active Yellow field signal output during a Red to Green to Yellow to Red sequence. A Clearance (short or absent Yellow) fault condition will place the SSM-E series Signal Monitor into the fault mode causing the Output relay contacts to transfer. This occurs when a Red input signal to a channel is active following the termination of an active Green input signal when the Yellow input signal was less than 2.7 seconds in duration, including zero seconds.

A set of switches labeled “SSM” is provided on the SSM-E series Signal Monitor front panel to enable Clearance Monitoring on a per channel basis. See Section 3.3 for the programming procedure.

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

2.6 **Non-Volatile Fault Memory**

The loss of AC+ power to the monitor will not reset a Conflict, Dual Indication, Red Failure, Clearance fault condition.

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The loss of AC+ power to the monitor will not reset a or a +24 Volt Monitor or CVM Fault if the Latch option is enabled. A Controller Watchdog fault will be reset by an AC+ brownout or dropout condition. The NSM and SSM-E series Signal Monitor stores the fault and channel indicator status into a non-volatile EEPROM memory device. Should an AC+ power interruption occur while the monitor is in the fault mode, then upon restoration of AC+ power, the correct fault and channel information will be displayed. This latched fault mode is maintained until the monitor receives a reset command from the RESET button or the External Test Reset input.

2.7 Program Card Absent Indication

If the Program Card is absent or not seated properly in the edge connector, the NSM and SSM-E series Signal Monitor will enter the fault mode causing the Output relay contacts to transfer. The PROGRAM CARD indicator will illuminate to indicate this condition. A manual or external Reset is required after the Program Card is properly seated.

2.8 Reset Input Detection

Activation of the front panel RESET button or the EXTERNAL RESET input will reset the NSM and SSM-E series Signal Monitor 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 and SSM-E series Signal Monitor from monitoring any fault condition and/or transferring the OUTPUT relay contacts to the fault position.

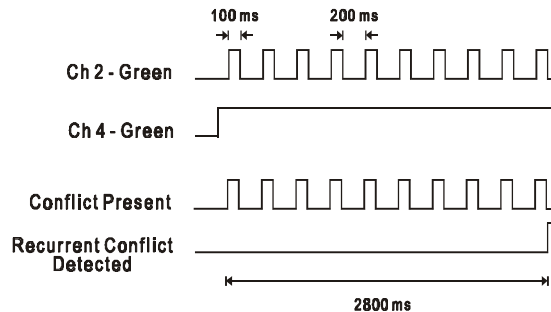
2.9 Display LED Test

The monitor will illuminate all front panel LED indicators for a period of 500ms when a Reset command is issued by the front panel RESET button or EXTERNAL RESET input. This function provides a means to check the operation of all front panel indicators.

2.10 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 an 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.



Recurrent Pulse Conflict Detection Example

When triggered by a recurrent pulse fault condition, the NSM and SSM-E series Signal Monitor will enter the fault mode, transfer the Output relay contacts to the Fault position, and illuminate the appropriate CONFLICT, DUAL (SSM-E series only), 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 3.4.2.

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2.11 Internal Diagnostics

The NSM and SSM-E series Signal Monitor is supplied with a resident series of self check diagnostic capabilities which monitor for correct operation of the unit 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.

2.11.1 Memory Diagnostics

On power-up, the NSM and SSM-E series Signal Monitor verifies the operation of all memory components including RAM, EPROM, and non-volatile EEPROM. During operation the NSM and SSM-E series Signal Monitor continuously performs a check sum verification of the non-volatile memory components. When either diagnostic test fails, the NSM and SSM-E series Signal Monitor will enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and illuminate the DIAGNOSTIC indicator. A Power Failure may reset the Diagnostic fault state of the monitor. 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.

2.11.2 Microprocessor Monitor

The NSM and SSM-E series Signal Monitor contains control circuitry which monitors the operation of the internal microprocessor. This control circuit receives a logic transition signal from the microprocessor every 5 msec. When this logic transition is not received for 300 msec, the NSM and SSM-E series Signal Monitor 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, an internal jumper (Latching MPU Fault) may be removed.

2.11.3 Internal I/O Hardware Monitor

The NSM and SSM-E series Signal Monitor contains circuitry which verifies the operation of the internal input/output interface circuitry. On power-up, the unit verifies that the circuitry which interfaces to the Programming Card, display LEDs, and front panel switches is functioning properly. If a malfunction is detected, the NSM and SSM-E series Signal Monitor 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. Due to the nature of these hardware failures, other fault indicators that may be concurrently displayed with the DIAGNOSTIC indicator may not be valid.

2.12 Diagnostic Display Mode

The NSM and SSM-E series Signal Monitor provides two means of displaying the individual Red, Yellow, Green, and Walk field status. The No Fault Diagnostic Display mode shows the individual colors while the monitor is not in the fault mode (intersection operating). The Fault Diagnostic Display mode shows the individual colors which were active at the time the monitor triggered to the fault mode (intersection in flash).

2.12.1 No Fault Diagnostic Display

When the NSM and SSM-E series Signal Monitor is not in the fault state, the unit can display the active Red, Yellow, Green, and Walk field status individually. To enter this display mode depress and hold the Reset button. Each time the Reset button is activated and held, the next set of colors will be displayed on the channel status indicators. The display will continue to show the selected color as long as the Reset button is activated. This mode only affects the monitor display and normal fault processing will continue to occur. The sequence is as follows:

<u>Reset</u>	<u>Fault Status LEDs</u>	<u>Channel Status LEDs</u>
#1	(R) CONFLICT LED flashes	Red field status
#2	(Y) RED FAIL LED flashes	Yellow field status
#3	(G) CVM LED flashes	Green field status
#4	(W) 24V-1 LED flashes	Walk field status
...	(repeats back to top)	

2.12.2 Fault Diagnostic Display

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Once the NSM and SSM-E series Signal Monitor has been triggered by a fault, the Red, Yellow, Green, and Walk field input status active at the time of the current fault may be displayed individually. This status is not reset by an AC Line power interruption. To enter this display mode remove the Program Card. The sequence is as follows:

<u>Reset</u>	<u>Fault Status LEDs</u>	<u>Channel Status LEDs</u>
--	Current Fault Type	Current Fault Status
#1	(R) CONFLICT LED flashes	Red field status
#2	(Y) RED FAIL LED flashes	Yellow field status
#3	(G) CVM LED flashes	Green field status
#4	(W) 24V-1 LED flashes	Walk field status
...	(repeats back to top)	

To enter this display mode remove the Program Card. Depressing the Reset button advances the display mode from the normal mode to the Red field input display. The (R) CONFLICT LED will pulse ON at 4Hz to indicate this mode. The channel display LEDs will show the Red channels active at the time of the fault.

Depressing the Reset button again advances the display mode from the Red display mode to the Yellow field input display. The (Y) RED FAIL LED will pulse ON at 4Hz to indicate this mode. The channel display LEDs will show the Yellow channels active at the time of the fault.

Depressing the Reset button again advances the display mode from the Yellow display mode to the Green field input display. The (G) CVM LED will pulse ON at 4Hz to indicate this mode. The channel display LEDs will show the Green channels active at the time of the fault.

Depressing the Reset button again advances the display mode from the Green display mode to the Walk field input display. The (W) 24V-1 LED will pulse ON at 4Hz to indicate this mode. The channel display LEDs will show the Walk channels active at the time of the fault.

Depressing the Reset button again advances the display mode from the Walk display mode back to the current fault display mode. To exit this display mode, replace the Program Card. If the Program Card is removed while the unit has **not** been triggered by a fault, the fault status display mode will show the Red, Yellow, Green, and Walk channels active when the Program Card was removed.

3 **INSTALLATION**

3.1 **Program Card Programming**

This universal card provides the means to assign conflicting proceed channels. It is designed to the NEMA Traffic Control Systems Specifications (TS1-1989, part 6) and therefore is interchangeable between other units complying with the NEMA standard. The card is initially supplied with 66 empty wire jumper locations on the card. This defaults 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 combination on the program card. **Make sure that any leads do not make contact with any other lead on the card or the cabinet chassis when the program card is inserted into the slot of the front panel.**

Example: If channel 2 Green or Yellow or Walk is permissive with channel 6 Green or Yellow or Walk, solder a wire jumper into the jumper pair labeled "2-6".

If the Program Card is removed or not seated properly in the edge connector, the NSM and SSM-E series Signal Monitor will enter the fault mode causing the Output relay contacts to transfer. The PROGRAM CARD indicator will illuminate to indicate this condition. A manual RESET or External Test Reset is required after the Program Card is properly seated.

3.2 **Minimum Flash Switch Programming**

It is recommended that the Minimum Flash Time be programmed on the NSM and SSM-E series Signal Monitor to exceed the initialization time of all cabinet assembly components following an AC+ restoration. The amount of flash time is typically equal to the amount programmed on the controller, so that if the controller fails to execute a minimum flash period, the signal monitor will serve as a backup to provide the minimum flash time.

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Programming of the minimum flash period is in a binary encoded format:

<u>MIN FLASH 8</u>	<u>MIN FLASH 4</u>	<u>MIN FLASH 2</u>	<u>MIN FLASH 1</u>	<u>DELAY PERIOD</u> (seconds)
OFF	OFF	OFF	OFF	4
OFF	OFF	OFF	ON	4
OFF	OFF	ON	OFF	4
OFF	OFF	ON	ON	4
OFF	ON	OFF	OFF	4
OFF	ON	OFF	ON	5
OFF	ON	ON	OFF	6
OFF	ON	ON	ON	7
ON	OFF	OFF	OFF	8
ON	OFF	OFF	ON	9
ON	OFF	ON	OFF	10
ON	OFF	ON	ON	11
ON	ON	OFF	OFF	12
ON	ON	OFF	ON	13
ON	ON	ON	OFF	14
ON	ON	ON	ON	15

3.3 **SSM Switch Programming** (SSM-E series only)

The SSM switches on the SSM-E series Signal Monitor are labeled "1" to "12" ("6") corresponding to channels 1 through 12 (6), respectively. These switches determine whether a channel will be individually monitored for Dual Indications **AND** Clearance Faults. Positioning a switch in the ON position (to the right) enables a channel for Dual Indication **AND** Clearance Monitoring. **The corresponding channel SSM switch must be placed in the OFF position (to the left) when an unused Red field output terminal is connected to AC+.**

3.4 **Option Switch Programming**

These features are activated by placing the respective switch of the "OPTIONS" switch in the ON position (to the right). The name of the Option switch is the function that is performed when in the ON position.

3.4.1 **GY Enable Option** (SSM-E series only)

The GY-Dual Indication Monitoring function is **ENABLED** by setting the Option switch labeled GY ENABLE to the ON position. See Section 2.3.1.

3.4.2 **RP Disable Option**

The Recurrent Pulse Detection function is **DISABLED** by setting the Option switch labeled RP DISABLE to the ON position. See Section 2.10.

3.4.3 **WD Enable Option** (SSM-E series only)

The External Watchdog Monitoring function is **ENABLED** by setting the Option switch labeled WD ENABLE to the ON position. See Section 2.4.

3.4.4 **Walk Disable Option** (SSM-E series only)

The Walk Disable function is **ENABLED** by setting the Option switch labeled WALK DISABLE to the ON position. See Section 1.3.2.2.

3.4.5 **24V Latch Option**

The 24V Latch function is **ENABLED** by setting the Option switch labeled 24V LATCH to the ON position. See Section 1.3.3.2.

3.4.6 **CVM Latch Option**

The CVM Latch function is **ENABLED** by setting the Option switch labeled CVM LATCH to the ON position. See Section 1.3.4.1.

3.5 **Harnessing Connectors**

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All field terminations are brought into the NSM and SSM-E series Signal Monitor by means of MIL-C-26482 type connectors. The outside harnesses are not interchangeable between any of the monitors as defined by NEMA Traffic Control Systems Specification (TS1-1989, part 6), i.e., a 12 channel harness assembly will not mate with a 6 channel signal monitor.

4 FRONT PANEL DESCRIPTION

4.1 Fault Status Display

4.1.1 (R) CONFLICT Indicator

The CONFLICT indicator will be illuminated when a conflicting proceed signal fault is detected. The Channel Status display will show the active proceed signals (Green or Yellow or Walk) for each channel involved in the conflict at the time of the fault. If the unit is in the Diagnostic Display mode the CONFLICT indicator will flash ON at 4Hz to indicate the Channel Status display is showing active Red channel status.

4.1.2 (Y) RED FAIL Indicator

The RED FAIL indicator will be illuminated when an absence of signal (dark signal head) is detected on a channel(s). The Channel Status display will show all channels on which the fault occurred. If the Red Enable input is not active the RED FAIL indicator will flash once every two seconds to indicate that Extended Monitoring functions are disabled. If the unit is in the Diagnostic Display mode the RED FAIL indicator will flash ON at 4Hz to indicate the Channel Status display is showing active Yellow channel status.

4.1.3 (G) CVM / WD Indicator

The CVM/WD indicator will be illuminated when unit detects a CVM fault or External Watchdog fault (SSM-E series Only). The Channel Status display will show the active proceed signals (Green or Yellow or Walk) for each channel at the time of the voltage fault condition. If the unit is in the Diagnostic Display mode the CVM/WD indicator will flash ON at 4Hz to indicate the Channel Status display is showing active Green channel status.

4.1.4 (W) 24V-1 Indicator

The 24V-1 indicator will be illuminated when unit detects a 24V-1 fault. The Channel Status display will show the active proceed signals (Green or Yellow or Walk) for each channel at the time of the voltage fault condition. If the unit is in the Diagnostic Display mode the 24V-1 indicator will flash ON at 4Hz to indicate the Channel Status display is showing active Walk channel status. If the 24V INHIBIT input is active the 24V-1 and 24V-2 indicators will flash once every two seconds to indicate that 24V Monitoring functions are disabled.

4.1.5 24V-2 Indicator

The 24V-2 indicator will be illuminated when unit detects a 24V-2 fault. The Channel Status display will show the active proceed signals (Green or Yellow or Walk) for each channel at the time of the voltage fault condition. If the 24V INHIBIT input is active the 24V-1 and 24V-2 indicators will flash once every two seconds to indicate that 24V Monitoring functions are disabled.

4.1.6 RP DETECT Indicator

The RP DETECT indicator will illuminate when the Recurrent Pulse detection function has triggered a Conflict, Dual Indication, or Red Fail fault. See Section 2.10.

4.1.7 DIAGNOSTIC Indicator

The DIAGNOSTIC indicator will illuminate when an internal monitor failure is detected. This indicator is used to inform the service technician of a monitor hardware and/or firmware failure. Due to the nature of these hardware/firmware failures, other fault indicators that may be concurrently displayed may not be valid for trouble shooting purposes.

4.1.8 PROGRAM CARD Indicator

The PROGRAM CARD indicator will illuminate if the program card is absent or not seated properly in the edge connector. A manual Reset is required after the program card is properly seated.

4.1.9 DUAL INDICATION Indicator (SSM-E series only)

The DUAL INDICATION indicator will be illuminated on the SSM-E series Signal Monitor when a Dual Indication fault

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is detected on a channel(s). The Channel Status display will show all channels on which the fault occurred.

4.1.10 CLEARANCE FAIL Indicator (SSM-E series only)

The CLEARANCE FAIL indicator will be illuminated on the SSM-E series Signal Monitor when no Yellow or a short (less than 2.7 seconds) Yellow signal is detected on a channel(s) during a Red to Green to Yellow to Red sequence. The Channel Status display will show all channels on which the fault occurred.

4.1.11 POWER Indicator

The POWER indicator will flash at a rate of 2Hz when the AC+ line voltage goes below the drop-out level. It will illuminate steadily when the AC+ line voltage returns above the brown-out restore level. The indicator will extinguish when the AC+ line voltage is less than 75 Vrms.

4.2 Channel Status Display

4.2.1 Channel Status Indicators

During no-fault operation the Channel Status indicators will display all active proceed signals (Green or Yellow or Walk). In the fault mode the Channel Status indicators will display the proceed signals active at the time of a conflicting signal fault (Conflict), voltage monitoring fault (CVM, 24V-1, or 24V-2), or Watchdog fault (CVM/WATCHDOG). In the event of a Red Failure, Dual Indication fault, or Clearance fault, only the channels on which the fault occurred will be displayed. The monitor retains this display until a Reset command is issued via the front panel Reset button or External Test Reset Input.

4.3 Buttons

4.3.1 RESET Button

Depressing the Reset button resets the NSM and SSM-E series Signal Monitor after it has been triggered by a fault. The monitor remains in the reset mode only if the fault condition has been restored to normal. The RESET button also controls the Diagnostic Display Mode. See Section 2.12.

In the event of a monitor hardware or firmware fault (DIAGNOSTIC indicator is illuminated) the Reset button may not reset the monitor.

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5 SPECIFICATIONS

5.1 Electrical

Power Requirements

Operating Line Voltage	75 to 135 VAC RMS
Operating Line Frequency	60 \pm 3Hz
Power Consumption	10W (nominal)

AC Voltage Monitors

Green Signal Inputs	(no detect)	less than 15 Vrms
	(detect)	greater than 25 Vrms
Yellow signal Inputs	(no detect)	less than 15 Vrms
	(detect)	greater than 25 Vrms
Walk Signal Inputs	(no detect)	less than 15 Vrms
	(detect)	greater than 25 Vrms
Red 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

AC Line Voltage Monitor

(drop-out)	less than 92 \pm 2 Vrms
(restore)	greater than 96 \pm 2 Vrms

DC Voltage Monitor

+24 VDC Inputs	(inactive)	less than +18 VDC
	(active)	greater than +22 VDC

Logic Inputs

Controller Voltage Monitor, External Reset, +24V Monitor Inhibit	(active)	less than +8 VDC
	(inactive)	greater than +16 VDC

5.2 Timing Functions

Conflict	(no fault)	less than 200 milliseconds
	(fault)	greater than 450 milliseconds
	(typical)	350 milliseconds
Red Fail	(no fault)	less than 700 milliseconds
	(fault)	greater than 1000 milliseconds
	(typical)	850 milliseconds
Controller Voltage Monitor, +24V Monitors	(no fault)	less than 125 milliseconds
	(fault)	greater than 175 milliseconds
	(typical)	150 milliseconds

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Dual Indication	(no fault)	less than 200 milliseconds
	(fault)	greater than 450 milliseconds
	(typical)	400 milliseconds
Clearance Fail		
Short Yellow	(fault)	less than 2.6 seconds
	(no fault)	greater than 2.8 seconds
AC+ Interruption (disable)		greater than 475 milliseconds \pm 25 milliseconds
Minimum flash after disable		4 to 15 seconds \pm 1 second
Start Delay Relay timer		2.5 seconds \pm 1 second

5.3 Mechanical

Dimensions

Height	10.5 inches
Width	4.5 inches
Depth	11.0 inches

5.4 Environmental

Storage Temperature Range	-55 to +90 °C
Operating Temperature Range	-37 to +74 °C
Humidity Range	0 to 95% Relative

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6 WIRING ASSIGNMENTS

6.1 NSM-12 and SSM-12E Monitor Unit Connector A

<u>PIN</u>	<u>FUNCTION</u>	<u>PIN</u>	<u>FUNCTION</u>
A	AC+ INPUT	i	CHANNEL 3 WALK
B	OUTPUT RELAY 1 OPEN	j	CHANNEL 2 YELLOW
C	OUTPUT RELAY 2 CLOSED	k	CHANNEL 1 YELLOW
D	CHANNEL 12 GREEN	m	CONTROLLER VOLTAGE MONITOR
E	CHANNEL 11 GREEN	n	+24V MONITOR INHIBIT
F	CHANNEL 10 GREEN	p	OUTPUT RELAY 1 CLOSED
G	CHANNEL 9 GREEN	q	OUTPUT RELAY 2 OPEN
H	CHANNEL 8 GREEN	r	CHANNEL 12 WALK
J	CHANNEL 7 GREEN	s	CHANNEL 11 WALK
K	CHANNEL 6 GREEN	t	CHANNEL 9 WALK
L	CHANNEL 5 GREEN	u	CHANNEL 8 WALK
M	CHANNEL 4 GREEN	v	CHANNEL 7 WALK
N	CHANNEL 3 GREEN	w	CHANNEL 5 WALK
P	CHANNEL 2 GREEN	x	CHANNEL 4 YELLOW
R	CHANNEL 1 GREEN	y	CHANNEL 2 WALK
S	+24V MONITOR I	z	CHANNEL 1 WALK
T	LOGIC GROUND	AA	SPARE 1
U	CHASSIS GROUND	BB	RESET
V	AC-	CC	CABINET INTERLOCK A
W	OUTPUT RELAY 1 COMMON	DD	CABINET INTERLOCK B
X	OUTPUT RELAY 2 COMMON	EE	CHANNEL 6 WALK
Y	CHANNEL 12 YELLOW	FF	CHANNEL 4 WALK
Z	CHANNEL 11 YELLOW	GG	SPARE 2
a	CHANNEL 10 WALK	HH	SPARE 3
b	CHANNEL 10 YELLOW		
c	CHANNEL 9 YELLOW		
d	CHANNEL 8 YELLOW		
e	CHANNEL 7 YELLOW		
f	CHANNEL 6 YELLOW		
g	CHANNEL 5 YELLOW		
h	CHANNEL 3 YELLOW		

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6.2 NSM-12 and SSM-12E Monitor Unit Connector B

<u>PIN</u>	<u>FUNCTION</u>
A	AC+ II INPUT
B	START DELAY RELAY COMMON
C	START DELAY RELAY OPEN
D	CHANNEL 12 RED
E	CHANNEL 11 RED
F	CHANNEL 9 RED
G	CHANNEL 8 RED
H	CHANNEL 7 RED
J	CHANNEL 6 RED
K	CHANNEL 5 RED
L	CHANNEL 4 RED
M	CHANNEL 2 RED
N	CHANNEL 1 RED
P	SPARE 1
R	+24V MONITOR II
S	EXTERNAL WATCHDOG (SSM-E series Only)
T	SPARE 3
U	START DELAY RELAY CLOSED
V	CHANNEL 10 RED
W	SPARE 4
X	SPARE 5
Y	SPARE 6
Z	CHANNEL 3 RED
a	RED ENABLE
b	SPARE 7
c	SPARE 8

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6.3 NSM-6 and SSM-6E Monitor Unit Connector A

<u>PIN</u>	<u>FUNCTION</u>	<u>PIN</u>	<u>FUNCTION</u>
A	AC+ INPUT 1	h	CHANNEL 2 YELLOW
B	AC+ INPUT 2	i	CHANNEL 1 YELLOW
C	OUTPUT RELAY 1 OPEN	j	CHANNEL 1 RED
D	OUTPUT RELAY 2 CLOSED	k	+24V MONITOR II
E	START DELAY RELAY OPEN	m	CVM
F	CHANNEL 6 GREEN	n	+24V MONITOR INHIBIT
G	CHANNEL 6 RED	p	CABINET INTERLOCK A
H	CHANNEL 5 GREEN	q	EXTERNAL WATCHDOG (SSM-E series Only)
J	CHANNEL 4 GREEN	r	OUTPUT RELAY 1 CLOSED
K	CHANNEL 4 RED		
L	CHANNEL 3 GREEN	s	START DELAY RELAY CLOSED
M	CHANNEL 2 GREEN	t	CHANNEL 6 WALK
N	CHANNEL 2 RED	u	CHANNEL 5 WALK
P	CHANNEL 1 GREEN	v	CHANNEL 4 WALK
R	RED ENABLE	w	CHANNEL 3 WALK
S	+24V MONITOR I	x	CHANNEL 2 WALK
T	LOGIC GROUND	y	CHANNEL 1 WALK
U	CHASSIS GROUND	z	EXTERNAL RESET
V	AC-	AA	SPARE 2
W	CABINET INTERLOCK B	BB	SPARE 3
X	OUTPUT RELAY 1 COMMON	CC	SPARE 4
Y	OUTPUT RELAY 2 COMMON	DD	SPARE 5
Z	OUTPUT RELAY 2 OPEN	EE	SPARE 6
a	START DELAY RELAY COM.	FF	SPARE 7
b	CHANNEL 6 YELLOW	GG	SPARE 8
		HH	SPARE 9
c	CHANNEL 5 YELLOW		
d	CHANNEL 5 RED		
e	CHANNEL 4 YELLOW		
f	CHANNEL 3 YELLOW		
g	CHANNEL 3 RED		

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6.4 Program Card Connector

<u>PIN</u>	<u>CHANNEL (JUMPER SIDE)</u>	<u>PIN</u>	<u>CHANNEL (BOTTOM SIDE)</u>
1	1-2	2	1-3
3	1-4	4	1-5
5	1-6	6	1-7
7	1-8	8	1-9
9	1-10	10	1-11
11	1-12	12	2-3
13	2-4	14	2-5
15	2-6	16	2-7
17	2-8	18	2-9
19	2-10	20	2-11
21	2-12	22	3-4
23	3-5	24	3-6
25	3-7	26	3-8
27	3-9	28	3-10
29	3-11	30	3-12
31	4-5	32	4-6
33	4-7	34	4-8
35	4-9	36	4-10
37	4-11	38	4-12
39	5-6	40	5-7
41	5-8	42	5-9
43	5-10	44	5-11
45	5-12	46	6-7
47	6-8	48	6-9
49	6-10	50	6-11
51	6-12	52	7-8
53	7-9	54	7-10
55	7-11	6	7-12
57	8-9	58	8-10
59	8-11	60	8-12
61	9-10	62	9-11
63	9-12	64	10-11
65	10-12	66	11-12
67	SPARE	68	SPARE
69	COMMON	70	COMMON
71	SPARE	72	SPARE

The Program Card mates with a 36/72 pin double sided edge card connector having 0.125" centers.