

NSM-3E

NEMA TS-1 Enhanced Signal Monitor Operations Manual

THIS MANUAL CONTAINS TECHNICAL INFORMATION FOR THE **NSM-3E** SERIES
SIGNAL MONITOR UNIT.

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THE NSM-3E SERIES MONITORS ARE DESIGNED AND MANUFACTURED IN THE USA
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MAINTENANCE NOTE

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

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Section 1 Standard Functions

1.1 INTRODUCTION

The NSM-3E 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-3E 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. This unit is directly interchangeable with a standard NEMA 3-channel Signal Monitor and meets with or exceeds all specifications outlined in Chapter 6 (Conflict Monitors) of the National Electrical Manufacturers Association (NEMA) ***Standards Publication TS-1-1989 R2005, Traffic Control Systems***.

The NSM-3E Signal Monitor is a 3 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. The NSM-3E Signal Monitor detects the presence of conflicting Green or Yellow or Walk signals on the AC field terminations between any two or more channels. The Red Enable input, when active, enables the Red Monitoring and Dual Indication capabilities of the monitor causing the unit to trigger when it detects the absence of voltage on all four of the field signal inputs of a channel or more than one input color active simultaneously. The monitoring circuitry can detect either full wave or positive and negative half-wave field signal outputs 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 Traffic Control Systems Specifications (TS-1, part 6), the NSM-3E 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 closure 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-3E Signal Monitor will then display the appropriate fault status along with the proceed indications active at the time of the fault. The NSM-3E Signal Monitor will remain in this 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-3E 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.

1.2 CONFLICT MONITORING

The NSM-3E Signal Monitor is capable of monitoring 3 channels. Each channel monitors a Red, Yellow, Green, and Walk field signal output at the field terminals. The NSM-3E Signal Monitor detects the presence of conflicting Green or Yellow or Walk signals on the AC field terminations between any two or more channels. The monitoring circuitry is capable of detecting either full wave or positive and negative half-wave field signal outputs at the specified voltage levels. Upon detecting a Conflict fault, the NSM-3E Signal Monitor will enter the fault mode, de-energize the Output relay contacts to the Fault position, and illuminate the CONFLICT indicator.

1.3 RED FAILURE MONITORING

When voltages on all inputs (R, Y, G, and W) to a channel are sensed as inactive for more than 1000 msec, the NSM-3E Signal Monitor will enter the fault mode, de-energize the Output relay contacts to the Fault position, and illuminate the RED FAIL indicator. The unit 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 unit will not transfer the Output relay contacts to the Fault position.

Red Failure Monitoring is disabled when the Red Enable input is not active.

1.3.1 WALK DISABLE (RED MONITORING)

This option will modify the operation of Red Monitoring on the NSM-3E Signal Monitor. When enabled, the Red 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-3E 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 also section 2.2.2.

1.4 VOLTAGE MONITORING

Inputs are provided for monitoring two +24VDC supplies and the Controller Voltage Monitor (CVM) output from the controller. Should loss of proper signal occur at any of these inputs, the NSM-3E Signal Monitor will de-energize the Output Relay causing the two sets of contacts to transfer and will illuminate the appropriate front panel indicator(s). The Monitor will automatically reset when the correct input signals are restored to these inputs if the unit had not already been triggered by a previous fault condition. A 24V Monitor Inhibit input is provided to facilitate the use of these monitors with pre-timed mechanical controller installations.

1.4.1 VOLTAGE MONITOR FAULT LATCH

When the 24V Latch option is enabled by the front panel switch labeled "24V LATCH", the absence of the proper voltage level at either of the two 24VDC inputs (24V-I & 24V-II) will place the NSM-3E Signal Monitor into the fault mode causing the Output relay contacts to transfer. The 24V-2 and / or the 24V-1 indicator(s) will be displayed on the Fault Status Display along with the field output signals active at the time of the voltage fault. Restoration of the voltage levels will not reset the fault state of the Monitor. Only a Manual Reset or External Test Reset command will reset the Monitor.

1.4.2 CVM FAULT LATCH

When the CVM Latch option is enabled by the front panel switch labeled "CVM LATCH", the absence of the True state at the CVM Input will place the NSM-3E Signal Monitor into the fault mode causing the Output relay contacts to transfer. The CVM indicator will be displayed on the Fault Status Display along with the field output signals active at the time of the voltage fault. Restoration of the True state will not reset the fault state of the Monitor. Only a Manual Reset or External Test Reset command will reset the Monitor.

1.5 AC+ BROWN-OUT / INTERRUPTION DETECTION

When the AC+ line voltage is below the drop-out level for 475 msec (± 25 msec) the NSM-3E 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.

Section 2

Extended Features

The following extended features are provided on the NSM-3E Signal Monitor for additional monitoring functions, and to increase the reliability of the NSM-3E Signal Monitor operation.

2.1 HARDWARE FEATURES

The NSM-3E Signal Monitor is a microprocessor based unit. All monitoring functions and features are firmware programmable which permits upgrades or modifications by simply reprogramming the flash memory containing the firmware with the upgraded version. Thus, most changes to the NSM-3E 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 microprocessor based 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 virtually 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 is utilized to retain fault status information in the event of an AC Line power interruption. The correct fault indications will be displayed upon restoration of AC Line power. This EEPROM nonvolatile memory requires no battery back-up. No monitor configuration programming is stored under battery power.

2.2 DUAL INDICATION MONITORING

This monitoring function detects simultaneous indications of active Green, Yellow, Walk, and Red field signal outputs on the same channel on the NSM-3E Signal Monitor. A Dual Indication fault places the NSM-3E Signal Monitor into the fault mode causing the Output relay contacts to transfer. Dual Indication Monitoring is enabled concurrently with Clearance Monitoring on a per channel basis via the front panel SSM switches.

Dual Indication Monitoring is disabled when the Red Enable input is not active.

NOTE: An open or no load condition (i.e., open field wire) may be detected as an active signal depending on the output impedance characteristics of the load switch, and may cause a Dual Indication fault.

2.2.1 GY-DUAL INDICATION MONITORING

This monitoring function detects a simultaneous indication of active Green and Yellow field signal outputs on the same channel. It can be used to monitor channels which have an unused Red field signal output tied to AC+ (i.e. five section signal head) and is enabled by placing the front panel option switch labeled "GY ENABLE" in the ON position. A GY-Dual Indication fault places the NSM-3E Signal Monitor into the fault mode causing the Output relay contacts to transfer. GY-Dual Indication Monitoring may be enabled concurrently with Dual Indication Monitoring. When GY-Dual Indication Monitoring is enabled, ALL channels which have NOT been selected for Dual Indication Monitoring via the front panel SSM switches will be individually monitored for simultaneous indications of active Green and

Yellow field signal outputs. Any channels which have been selected for Dual Indication Monitoring by the SSM switches will function as described above in Section 2.2.

GY-Dual Indication Monitoring is disabled when the Red Enable input is not active.

2.2.2 WALK DISABLE (DUAL INDICATION MONITORING)

This option will modify the operation of Dual Indication Monitoring on the NSM-3E Signal Monitor. When enabled, the Dual Indication monitoring function will not monitor the Walk field outputs. This function is enabled by the front panel option switch labeled "WALK DISABLE". See also Section 1.3.1.

2.3 CLEARANCE (SHORT OR ABSENT YELLOW) MONITORING

This function detects the absence of a minimum 2.7 second period of an active Yellow field signal output during a Green to Yellow to Red signal sequence. Clearance Monitoring is enabled concurrently with Dual Indication Monitoring on a per channel basis via the front panel SSM switches.

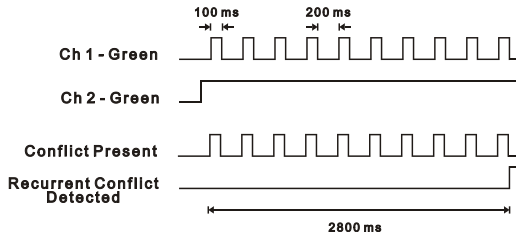
Clearance Monitoring is disabled when the Red Enable input is not active.

A Clearance (short or absent Yellow) fault condition will place the NSM-3E Signal Monitor into the fault mode causing the Output relay contacts to transfer.

2.4 RECURRENT PULSE DETECTION (RP STATUS)

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 diagram below shows an example of a recurrent Conflict fault. Channel 1 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 malfunction 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 fault condition, the NSM-3E Signal Monitor will enter the fault mode causing the Output relay contacts to transfer and illuminate the appropriate CONFLICT, DUAL INDICATION, 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 will range from 1000 ms minimum to 10.4 seconds

maximum. Recurrent Pulse detection can be disabled with the RP DISABLE option switch, see Section 3.4.

2.5 LEDGUARD® LED FIELD SIGNAL SENSING

The NSM-3E Signal Monitor can be configured to use a technique called *LEDguard*® that is designed to better monitor the characteristics of LED based signal loads. Each field signal input is measured and compared to both a high threshold and a low threshold value to determine Active / Not Active status. This differs from conventional operation where the active threshold is picked according to the color of the field signal. Once the high and low On / Off thresholds (Section 5.1) 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/Dont Walk
Conflict	Low	Low	---
Red Fail	High	High	High
Dual Indication	Low	Low	Low
Clearance	Low	Low	High

2.6 NON-VOLATILE FAULT MEMORY

The loss of AC+ power to the monitor will not reset a fault condition (Conflict, Dual Indication, Red Failure, Clearance or a Voltage Monitor Fault if the 24V Latch or CVM Latch options are enabled). The NSM-3E Signal Monitor stores the fault and channel indicator status into non-volatile EEPROM memory. Should an AC+ power interruption occur while the monitor is in the fault mode, then upon restoration of AC+ power, the Output relay will remain in the fault mode and the correct fault and channel information will be displayed. This fault mode is maintained until the monitor receives a reset command from the RESET button or the External Test Reset input.

2.7 RESET INPUT DETECTION

This function prevents the cabinet controller from being operated with the monitor disabled due to a faulty Reset button or External Reset input. The NSM-3E Signal Monitor monitors the state of the front panel Reset button and the External Reset input. When a Reset command is detected from either input, the NSM-3E Signal Monitor will enter the reset mode with all indicators illuminated, the Output and Start relays energized, and monitoring functions disabled. The monitor will then automatically enter the normal mode and begin monitoring functions.

2.8 DISPLAY LED TEST

The monitor will illuminate all front panel LED indicators for 1000ms when a Reset command is issued by the front panel RESET button. This function provides a way to check the operation of all front panel indicators.

Section 3 Installation

3.1 HARNESSING CONNECTORS

All field terminations are brought into the NSM-3E Signal Monitor by means of MIL-C-26482 connectors. The outside harnesses are not interchangeable between any of the 6, 12, or 18 channel monitors as defined by NEMA Traffic Control Systems Specification (TS-1, part 6), i.e., a 6 channel harness assembly will not mate with a 3 channel signal monitor.

3.2 MINIMUM FLASH DIP SWITCH PROGRAMMING

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

It is recommended that the Minimum Flash Time be programmed on the NSM-3E 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.

3.3 SSM DIP SWITCH PROGRAMMING

The SSM dip switches are labeled "SSM 1", "SSM 2", and "SSM 3". Positioning a switch in the ON position (to the right) enables a channel for Dual Indication AND Clearance Monitoring. The corresponding channel dip 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 DIP SWITCH PROGRAMMING

The NSM-3E Signal Monitor provides seven independently programmed options:

3.4.1 GY ENABLE

Set this switch to the ON position to enable Green / Yellow Dual Indication monitoring. See Section 2.2.1.

3.4.2 RP DISABLE

Set this switch to the ON position to Disable Recurrent Pulse monitoring, only if needed. See Section 2.4.

3.4.3 WALK DISABLE

Set this switch to the ON position to remove the Walk inputs from Red Fail and Dual Indication monitoring. See Sections 1.3.1 and 2.2.2

3.4.4 CVM LATCH

Set this switch to the ON position to change a CVM fault to the latched state. See Section 1.4.2.

3.4.5 24V LATCH

Set this switch to the ON position to change a 24V-1 or 24V-2 fault to the latched state. See Section 1.4.1.

3.4.6 LEDGUARD

Set this switch to the ON position to Enable the LEDguard function. See Section 2.5

3.4.7 OPTION A

This DIP switch is currently not assigned.

Section 4

Front Panel Description

4.1 STATUS DISPLAY

4.1.1 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 below approximately 70 Vrms.

4.1.2 CONFLICT INDICATOR

The CONFLICT indicator will be illuminated when a conflicting proceed signal fault is detected. The Channel Status display will show the active signals for each channel at the time of the fault and the channels involved in the fault.

4.1.3 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 the active signals for each channel at the time of the fault and the channels involved in the fault.

If the Red Enable input is not active the RED FAIL indicator will flash once every two seconds to indicate that Extended Monitoring functions (Red Fail, Dual Indication, and Clearance) are disabled.

4.1.4 CVM INDICATOR

The CVM indicator will be illuminated when a Controller Voltage Monitor Fault is detected. The Channel Status display will show the active signals for each channel at the time of the fault.

4.1.5 24V-1, 24V-2 VOLTAGE MONITOR INDICATORS

These indicators will be illuminated if the corresponding voltage input is below the minimum specified level. The Channel Status display will show the active signals for each channel at the time of the fault.

If the 24V INHIBIT input is active the 24V-1 and 24V-2 indicators will flash once every two seconds to indicate that Voltage Monitor functions are disabled.

4.1.6 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.

4.1.7 RP STATUS INDICATOR

The RP STATUS indicator will illuminate when the Recurrent Pulse detection function has triggered a Conflict, Dual Indication, or Red Fail fault. See Section 2.4.

4.1.8 DUAL INDICATION INDICATOR

The DUAL INDICATION indicator will be illuminated when a Dual Indication fault is detected on a channel(s). The Channel Status display will show the active signals for each channel at the time of the fault and the channels involved in the fault.

4.1.9 CLEARANCE INDICATOR

The CLEARANCE indicator will be illuminated when no Yellow or a short (less than 2.7 seconds) Yellow signal is detected on a channel during a Red to Green to Yellow to Red sequence. The Channel Status display will show the active signals for each channel at the time of the fault and the channels involved in the fault.

4.2 NO FAULT CHANNEL DISPLAY

When the NSM-3E is not in the fault state, the unit will continuously display the active Green, Yellow, Walk and Red field status simultaneously on a four color LED full intersection display.

4.3 FAULT CHANNEL DISPLAY

Once the NSM-3E has been triggered by a fault, the channel status display will alternate between the field signals active at the time of the fault for 6 seconds, and the channels which were involved in the fault (fault status) for 2 seconds. The channels involved in the fault will flash their respective Green, Yellow, Walk and Red indicators simultaneously at a 4 Hz rate for the 2 second fault status interval.

If the fault displayed is a Recurrent Pulse Conflict, Recurrent Pulse Dual Indication, or a Recurrent Pulse Red Fail, the RP STATUS indicator will then flash simultaneously at a 4 Hz rate with the input(s) that had Recurrent Pulse status for an additional 2 seconds following the fault channel display.

4.4 RESET BUTTON

Depressing the Reset button resets the NSM-3E 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. In the event of a monitor hardware or firmware fault (DIAGNOSTIC indicator is illuminated) the Reset button may not reset the monitor.

Section 5 Specifications

5.1 ELECTRICAL

5.1.1 POWER REQUIREMENTS

Operating Line Voltage.....	75 to 135 VAC RMS
Operating Line Frequency	60 + \pm 3Hz
Power Consumption	5W (nominal)

5.1.2 AC VOLTAGE MONITORS (POSITIVE OR NEGATIVE HALF WAVE INPUT)

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 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

AC Line Voltage Monitor

Drop-out.....	less than 92 + \pm 2 Vrms
Restore	greater than 96 + \pm 2 Vrms

5.1.3 DC VOLTAGE MONITOR

+24 VDC Inputs	Inactive	less than +18 Vdc
	Active.....	greater than +22 Vdc

5.1.4 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

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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
Dual Indication	No Fault less than 200 milliseconds
	Fault.....greater than 500 milliseconds
	Typical 400 milliseconds
Clearance Fail	
Short Yellow	Fault..... less than 2.6 seconds
	No Faultgreater than 2.8 seconds
	Typical 2.7 seconds

AC+ Interruption (disable)..... greater than 475 milliseconds +/- 25 milliseconds
Minimum Flash after disable..... 4 to 15 seconds +/- 1 second
Start Delay Relay timer..... 2.5 seconds +/- 1 second

5.3 MECHANICAL

Height..... 6.5 inches
Width..... 3.0 inches
Depth (including MS connector)..... 7.6 inches

5.4 ENVIRONMENTAL

Storage Temperature Range 55 to +90 oC
Operating Temperature Range 37 to +74 oC
Humidity Range..... 0 to 95% Relative

Section 6

Wiring Assignments

6.1 NSM-3E MONITOR UNIT CONNECTOR A

The NSM-3E Connector mates with a "MS 3116 20-41S" plug.

<u>TAG#</u>	<u>PIN#</u>	<u>Function</u>
1	A	AC+ I
2	B	AC+ II
3	C	OUTPUT RELAY 1 COMMON
4	D	OUTPUT RELAY 1 OPEN
5	E	OUTPUT RELAY 2 COMMON
6	F	OUTPUT RELAY 2 CLOSED
7	G	START DELAY RELAY COMMON
8	H	START DELAY RELAY OPEN
9	J	CHANNEL 3 GREEN
10	K	CHANNEL 3 YELLOW
11	L	CHANNEL 2 GREEN
12	M	CHANNEL 2 YELLOW
13	N	CHANNEL 1 GREEN
14	P	CHANNEL 1 YELLOW
15	R	CHANNEL 1 WALK
16	S	+24V MONITOR II
17	T	CONTROLLER VOLTAGE MONITOR
18	U	+24V MONITOR
19	V	LOGIC GROUND
20	W	CHASSIS GROUND
21	X	AC-
22	Y	CABINET INTERLOCK A
23	Z	OUTPUT RELAY 1 CLOSED
24	a	OUTPUT RELAY 2 OPEN
25	b	START DELAY RELAY CLOSED
26	c	CHANNEL 3 WALK
27	d	CHANNEL 3 RED
28	e	CHANNEL 2 WALK
29	f	CHANNEL 2 RED
30	g	CHANNEL 1 RED
31	h	RESET
32	i	RED ENABLE
33	j	+24V MONITOR INHIBIT
34	k	SPARE 1
35	m	CABINET INTERLOCK B
36	n	SPARE 2
37	p	SPARE 3
38	q	SPARE 4
39	r	SPARE 5
40	s	SPARE 6
41	t	SPARE 7