HSL-SM8
INSIDE SPRAY GUN CONTROL
(8 SINGLE GUN MACHINES)
User's Manual

Systems Engineering Associates, Inc.
14989 West 69th Avenue
Arvada, Colorado 80007 U.S.A.
Telephone: (303) 421-0484
Fax: (303) 421-8108
www.sea-seg.com

01/2004

HSL-SM8
INSIDE SPRAY GUN CONTROL
(8 SINGLE GUN MACHINES)
User's Manual

WARNING

To ensure the equipment described by this User Manual, as well as the equipment connected to and used with it, operates satisfactorily and safely, all applicable local and national codes that apply to installing and operating the equipment must be followed. This includes the National Electric Code in the USA and other applicable legislation, regulations, and codes in practice elsewhere. Since codes can vary geographically and can change with time, it is the user's responsibility to determine which standards and codes apply, and to comply with them.

FAILURE TO COMPLY WITH APPLICABLE CODES AND STANDARDS CAN RESULT IN DAMAGE TO EQUIPMENT AND/OR SERIOUS INJURY TO PERSONNEL.

Persons supervising and performing installation or maintenance must be suitably qualified and competent in these duties, and should carefully study this User Manual and any other manuals referred to by it prior to installation and/or operation of the equipment.

The contents of the User Manual are believed to be correct at the time of printing; however, no responsibility is assumed for inaccuracies. In the interests of a commitment to a policy of continuous development and improvement, the manufacturer reserves the right to change the specification of the product or it's performance or the contents of the User Manual without notice.

CONTENTS

CONTENTS

LIST OF FIGURES

APPENDICES

SECTION 1
GENERAL DESCRIPTION

1.1 FEATURES

- Stand alone package used to implement spray gun timer control on inside spray machines or high speed front-end upgrade package to interface with existing control system.

- HSL-SM8 package provides spray gun control for up to 8 machines each equipped with one spray gun.

- Both "on" delay timers and spray "duration" timers are built in for each gun (accurate 1 millisecond time base for both). "On" delay adjustable from 0 to 999 milliseconds. Spray "duration" time adjustable from 0 to 999 milliseconds.

- Additional control functions provided include:

    1) Number of spray cycles count and life expectancy alarm for each gun.
    2) Can Jam Detection.
    3) Sensor fail alarm.

- High speed solenoid drivers provided to minimize solenoid response time and maximize repeatability.

- Built-in 2 Line X 20 character sealed display with 24 key membrane keypad allows local viewing of collected data (coated can count, total number of spray cycles for each gun) by operator and set-up of all spray times (key switch enabled) by authorized personnel.

- Based on high performance M4500 PLC/PLS module which allows easy trouble-shooting and user customization using SYSdev (DOS-based) programming package.

SECTION 1
GENERAL DESCRIPTION

1.2 GENERAL DESCRIPTION

The HSL-SM8 spray gun control package is a stand alone package used to implement the spray timer control for up to 8 single gun spray machines. Both user adjustable "on" delay and spray "duration" timers are provided for each gun. The spray times are entered on the keypad of the M4500 and displayed on the built-in alphanumeric display. All times are adjustable from 0 to 999 milliseconds (accurate and stable crystal based time base). In addition to the spray gun timer control, the HSL-SM8 also provides spray cycle counts with a life expectancy alarm, can jam detection, a sensor fail alarm for each gun and data collection including: Total coated can count (both current shift and previous (last) shift).

The package is not a dedicated "black box", but instead based on the high performance SYSTEMS M4500 PLC which allows easy customization by either SEA or the end user. The M4500 PLC incorporates a built in keypad and 2-line by 20-character alphanumeric display and is programmed using the DOS-based SYSdev programming package. SYSdev allows the module to programmed in both Ladder and High-level (subset of C) and is used to perform on-line monitoring and trouble-shooting as well.

1.3 SPRAY GUN CONTROL

The HSL-SM8 package provides spray gun control for up to 8 single gun machines. For each gun, both an "on" delay timer and a spray "duration" timer is provided. These are adjustable from 0 to 999 milliseconds in one millisecond increments. The spray times are entered on the keypad of the M4500 and displayed in the M4500 display (see section 3.4). The basic spray gun control is implemented as follows: The "on" delay is triggered at the leading ("off"-to-"on") edge transition of the "timing" sensor only if a can has been detected by the "can" sensor.

Note: The "can" sensor must see the can prior to the leading edge of the "timing" sensor.

Once the "on" delay has timed out, the spray gun is activated "on" and is left on for the time entered in the "spray" time at which time it is de-activated.

Note: If the "on" delay is set to zero, the spray gun is activated immediately at the leading edge of the "timing" sensor.

1.4 SPRAY GUN CYCLE COUNTS AND LIFE EXPECTANCY

The number of spray cycles is accumulated for each gun and can be displayed on the M4500 display. In addition, an expected life cycle count limit can be entered by the user and is used to generate an alarm if the number of spray gun cycles exceeds the entered expected life cycle limit. This feature is used for preventative maintenance purposes to track the number of spray cycles and flag when a particular gun has exceeded it's rated life. The gun can then be changed prior to incurring spray weight problems due to a worn out gun.

1.5 CAN JAM/SENSOR FAIL ALARM

Both the "can" sensor and "timing" sensor are checked for proper operation while the spray machine is running. A "sensor check" input is provided which should be turned "on" when the machine is running and feeding cans (can stop open). With this input "on", both the "can" sensor and "timing" sensor are checked for periodic transitions. If the can sensor fails to transition "off" to "on", a "can jam" alarm is generated for that machine. If the timing sensor fails "on" or "off", a "sensor fail" alarm is generated for that machine. These alarms are displayed on the M4500 display as well as being provided as an output which can be interlocked to the spray machine control system to stop the corresponding machine when the alarm occurs.

1.6 DATA COLLECTION

The total number of coated cans is collected for both the current shift and the previous (last) shift. This data can either be viewed locally on the display by the operator or can be sent to the host PLC via RS-232 communications (MODBUS or Allen-Bradley DF1 protocols) using the optional S4516 communications board. This information is updated ("current" shift transferred to "Last" shift) based on the change of state of a discrete input. This input can be activated on an 8 or 12 hour shift basis depending on the user's preference.

SECTION 2
INSTALLATION

The standard HSL-SM8 package is provided for back-panel mounting inside the existing user's control cabinet. In addition, the HSL-SM8 can be purchased in a self contained NEMA 12 enclosure for mounting adjacent to the existing control cabinet by specifying part number HSL-SM8-ENCL.

2.1 WHAT'S INCLUDED

Depending on which package is purchased, verify that the following items are included when unpacking the HSL-SM8:

2.1.1 HSL-SM8 (for back-panel mounting)

2ea. HSL-SM8 back-panels for mounting in the existing user's control cabinet each including the following:
- 1ea. +24VDC Power Supplies
- 1ea. +15VDC Power Supplies
- 4ea. M273 High Speed Solenoid Drivers

1ea. M4500 PLC module for mounting in the user's control cabinet door.
1ea. P4500 Power Supply for mounting adjacent to M4500.
1ea. D4591 Display with ribbon cable for mounting in the existing user's control cabinet door with M4500.
1set Field wiring arms for I/O termination of M4500.
1ea. HSL-SM8 User's Manual
1ea. M4500 User's Manual
1ea. HSL-SM8 Program Disk

2.1.2 HSL-SM8-ENCL with NEMA 12 ENCLOSURE

1ea. HSL-SM8 NEMA 12 enclosure including the following:
- 1ea. M4500 PLC module
- 1ea. P4500 Power Supply
- 1ea. D4591 Display/Keypad
- 2ea. +24VDC Power Supply
- 2ea. +15VDC Power Supply
- 8ea. M273 High Speed Solenoid Drivers

1ea. HSL-SM8 User's Manual
1ea. M4500 User's Manual
1ea. HSL-SM8 Program Disk

2.1.3 HSL-SM8 OPTIONS (PURCHASED SEPARATELY)

The following items can be purchased separately as required or desired. All items are compatible with both the back-panel mountable package or the NEMA 12 enclosed package:

1ea. S4516 Data Communications Board (MODBUS and DF1 protocols)

2.2 HSL-SM8 INSTALLATION

2.2.1 POWER REQUIRED

The HSL-SM8 is powered from 115VAC 50/60HZ only. The package incorporates +24VDC and -15VDC power supplies used by the M273 solenoid drivers and a +5VDC power supply used to power the M4500 module. The total 115VAC current required for the package is 9 amps.

2.2.2 MOUNTING AND WIRING THE HSL-SM8

If installing the HSL-SM8 package mounted in the NEMA 12 enclosure, mount the HSL-SM8 NEMA 12 enclosure in proximity to the existing control cabinet.

If installing the HSL-SM8 back-panel mounted package, mount the back-panels in the existing control cabinet. Referring to the M4500 User's manual, cut a cut-out in the existing control cabinet door and mount the D4591 display in the door. Connect the ribbon cable from the M4500 module to the D4591 and mount the M4500 to the inside of the door on the back of the D4591.

With the HSL-SM8 package, the M4500 and M273 solenoid drivers are all pre-wired either in the HSL-SM8 enclosure or the back-panel, the user simply has to mount the enclosure or back-panel and wire the field devices to the terminals or fuses in the HSL-SM8. Referring to the schematic at the back of this manual, wire as follows: wire AC power to the corresponding fuses of the +24VDC, -15VDC, and P4500 power supplies. Wire spray gun solenoids to the corresponding fuses and terminals per drawing. Wire sensor check inputs to existing control system. These should go "on" when the corresponding spray machine is running and the can stop is "open".

Note: These are true high, +24VDC sourcing inputs.

Wire the sensor fail outputs to the existing control system as necessary.

Note: These are true high, +24VDC sourcing outputs, that turn "on" when a sensor fail is detected.

This should be used to stop the corresponding spray machine. Wire the spray gun "Manual On" push-buttons to the corresponding inputs.

2.3 HSL-SM8 SOFTWARE INSTALLATION

Follow the steps below to install the HSL-SM8 application program onto the IBM PC or compatible which will be used to support the HSL-SM8 package.

2.3.1 SYSdev PROGRAM DEVELOPMENT SOFTWARE INSTALLATION

The SYSdev Program Development software is used to perform program down-load, on-line trouble-shooting and program modifications to the HSL-SM8. If SYSdev was purchased with the HSL-SM8 package and is not already installed on your computer, install SYSdev onto the hard drive of your computer following the steps in section 1.5 of the SYSdev Program Development manual.

2.3.2 HSL-SM8 APPLICATION PROGRAM INSTALLATION

The HSLSM8 application program is a SYSdev based program which is loaded into the M4500 module and performs the HSL-SM8 logic. To install the HSLSM8 program on your computer's hard drive, perform the following steps:

1) Create one directory off the root directory of the PC for the HSLSM8 program called "HSLSM8" by typing the following at the DOS prompt:

   MD \HSLSM8<ENTER>

2) Install the disk labeled "HSL-SM8 PROGRAMS" into the A: drive. Switch to the HSLSM8 directory and install the "HSLSM8" application program by typing the following at the DOS prompt:

   CD \HSLSM8<ENTER>
   COPY A:HSLSM8.*<ENTER>
   CD \

3) Add the HSLSM8 application program to your computer's menu software by creating a selection called "HSL-SM8 PROGRAM". The DOS commands executed for this selection should be:

```
CD \
SYSDEV \HSLSM8 HSLSM8
```

4) To initiate SYSdev with the "HSLSM8" program, simply select the "HSL-SM8 PROGRAM" selection from the menu software's menu. The main development menu of SYSdev will be initiated with the HSLSM8 program. See the SYSdev Program Development manual and the M4500 Program Development manual for complete details on on-line monitoring and program development with SYSdev.

2.4 HSL-SM8 SET-UP

The HSL-SM8 is shipped from the factory with the program "HSLSM8" loaded into the M4500 module. This is the standard 4 machine by two gun spray gun control program. In addition, the following variables are set to the following values:

Mach#	Gun#	"ON" Delay	"SPRAY" time	Life Expectancy
1	1	0msec	100msec	649,999,999 cycles
2	1	0msec	100msec	649,999,999 cycles
3	1	0msec	100msec	649,999,999 cycles
4	1	0msec	100msec	649,999,999 cycles
5	1	0msec	100msec	649,999,999 cycles
6	1	0msec	100msec	649,999,999 cycles
7	1	0msec	100msec	649,999,999 cycles
8	1	0msec	100msec	649,999,999 cycles

In most cases the above variables will have to be adjusted to achieve the desired film weight and to match the rated life expectancy of the spray guns used.

Once the HSL-SM8 is installed and the package is powered up, perform the following to set-up the HSL-SM8. See section 3 for complete descriptions of the Keypad commands and menu displays.

2.4.1 SET CAN SENSOR-TO-GUN NUMBER OF INDEXES

The HSL-SM8 package supports between 0 and 3 indexes between the location of the can body sensor and the spray gun. If the Can Body sensor is located at the same station as the spray gun, the index would be set to zero. If the spray gun was located at the next station following the Can Body sensor, the index would be set to 1, and so on. See section 3.8.3 for details on setting the number of indexes.

2.4.2 SET GUN LIFE EXPECTANCY

Based on the number of cycles rating of the spray guns used, set the gun life expectancy limit for each gun (see section 3.8.1). If the number of spray cycles the gun has actually fired exceeds this limit, the "Gun Life Expectancy Exceeded" alarm will be displayed. This indicates the gun has exceeded it's rated life and should be replaced.

2.4.3 SET “ON” DELAY AND “SPRAY” DURATION TIMES

Set the desired approximate "on" delay time and "spray" duration time for each gun (see section 3.4). These will be adjusted once the machine is running to the desired film weight but some number must be entered to start with.

2.4.4 MANUALLY TEST EACH GUN

Using the "MAN SPRAY" key on the M4500 keypad or the manual spray push-buttons, manually fire each gun, one at a time, with the machine stopped. This is done to verify that the solenoids were wired correctly and that the gun itself is working properly. In this mode, pressing the "MAN SPRAY" key will fire the gun selected in the "MACH:" and "GUN:" field of the display for the time entered in the "SPRAY TIME" field for that gun. To check each gun, press the "NEXT GUN" key on the M4500 keypad to select the next gun and press the "MAN SPRAY" key to fire that gun.

2.4.5 RUN MACHINE AND VERIFY SPRAY WEIGHTS

With the machine running verify the spray weight and adjust the "spray" time (and "on" delay if necessary) to achieve the desired spray weight and coverage. Increasing the "spray" time will increase the weight, decreasing the time will decrease the weight. See section 3.4 for details on adjusting the "spray" time and "on" delay.

2.5 M4500/P4500/D4591

The following is provided as a reference. Section 2.5.4 is performed by the factory prior to shipping the HSL-SM8. These steps need only be performed in the event either the M4509 module, P4500 power supply, or D4591 display need to be replaced. Refer to the M4500 User's Manual for general details on installing the M4509, P4500, and D4591.

2.5.1 M4509 MODULE INSTALLATION

To install the M4509 module, perform the following:

1) Remove the cover from the M4509 chassis (retained with two captive screws on the lower front of the cover and two captive screws on each side of the M4500 chassis).

2) Install S4563 (SLOT0-0): Set the slot address dip switches (SW1) on the S4563 to the following positions (slot0):

   S4563: SW1 switch1 = "OFF"
   SW1 switch2 = "OFF"

   Install the S4563 in Slot0-0 (furthest left slot) of the M4500 chassis.

3) Install S4573 (SLOT0-1): Set the slot address dip switches (SW1) on the S4573 to the following positions (slot1):

   S4573: SW1 switch1 = "ON"
   SW1 switch2 = "OFF"

   Install the S4573 in Slot0-1 (slot next to S4563) of the M4509 chassis.

4) Install S4563 (SLOT0-2): Set the slot address dip switches (SW1) on the S4563 to the following positions (slot2):

   S4563: SW1 switch1 = "OFF"
   SW1 switch2 = "ON"

   Install the S4563 in Slot0-2 (slot next to the S4573) of the M4509 chassis.

5) Install S4516 (SLOT0-3) (OPTIONAL): Set the slot address dip switches (SW2) on the S4516 to the following positions (slot3):

   S4516: SW2 switch1 = "ON"
   SW2 switch2 = "ON"

   Set the RS-232/RS-422 select dip switches (SW1) on the S4516 to the following positions (RS-232 selected):

   S4516: SW1 switch1 = "ON"
   SW1 switch2 = "OFF"

   Install the S4516 in Slot0-3 (slot next to S4563) of the M4509 chassis.

6) Install S4563 (SLOT1-0) (NOT USED ON HSL-SM8/6): Set the slot address dip switches (SW1) on the S4563 to the following positions (slot0):

   S4563: SW1 switch1 = "OFF"
   SW1 switch2 = "OFF"

   Install the S4563 in Slot1-0 (slot next to the S4516) of the M4509 chassis.

7) Install the cover back over the M4509, making sure all the board connectors protrude through the slots in the cover. Tighten the two captive screws on the lower front of the cover and the two captive screws on each side of the M4509 chassis.

8) Connect the display ribbon cable to the connector on the back of the M4509 (the connector on the cable is polarized and should mate with the connector on the M4509 only one way).

9) Mount the M4509 chassis either to the HSL-SM8 back-panel using four 8-32 screws or to the back of the D4591 (depending on which package is used).

10) With power to the P4500 "off", install the P4500 power supply cable to the +5/C/+12/C/-12 connector on the M4509 (the connector on the cable is polarized and should mate with the connector on the M4509 only one way).

11) Install the respective field wiring arms on all the I/O boards of the M4509 (I/O slots0-0 thru 1-0, and MODBUS connector on USER PORT). Make sure all the field wiring connectors are fully mated in the M4509.

2.5.2 P4500 POWER SUPPLY INSTALLATION

To install the P4500, perform the following steps:

1) Mount the P4500 to the HSL-SM8 in the mounting holes next to the M4509 (left side) using two 8-32 screws.

2) With power to the P4500 "off", install the P4500 power supply cable to the +5/C/+12/C/-12 connector on the M4509 (the connector on the cable is polarized and should mate with the connector on the M4509 only one way).

2.5.3 D4591 KEYPAD/DISPLAY INSTALLATION

To install the D4591, perform the following steps:

1) With the gasket installed on the mounting studs of the D4591, install the D4591 in the cut-out either in the HSL-SM8 enclosure or the cut-out in the user's existing control cabinet. Secure the display to the enclosure using 4ea. 8-32 nuts and external lock washers.

2) Connect the display ribbon cable to the connector on the lower back of the display (the connector on the cable is polarized and should mate with connector on the M4509 only one way).

2.5.4 DOWNLOAD HSLSM8 PROGRAM TO M4500

Once the M4500/P4500/D4591 are installed, perform the following to download the HSLSM8 application program to the M4500:

1) Power up the M4500 and the IBM PC or compatible used to interface with the HSL-SM8.

2) Connect an RS-232 cable from the computer COM port to the "PROG" port on the M4500.

3) From the computer's menu program, select the "HSL-SM8 PROGRAM" selection (this was set in section 2.3.2). SYSdev will be invoked with the HSLSM8 application program.

4) From the main development menu of SYSdev, select "6: Target Board Interface".

5) Download the HSLSM8 application program to the M4500 by selecting "1: Download Program to Target Board" from the target board interface menu. A prompt will be displayed verifying the download, press the <ENTER> key to start the download. Once the download is complete, press any key to return to the target board interface menu. Return to the SYSdev main menu and then exit SYSdev.

6) Set the "on" delay and "spray" duration times as well as the can PRX-to-gun indexes and expected gun life expectancies per the steps in section 2.4.

7) The M4500 is now ready to run, loaded with HSLSM8 application program.

SECTION 2
INSTALLATION

(This Page Intentionally Left Blank)

SECTION 3
USING THE HSL-SM8 KEYPAD/DISPLAY

The spray gun times ("on" delay and "spray" time), Can Sensor-to-Gun Number of Indexes as well as the gun life expectancy limit are all set through the keypad of the M4500. The following sections describe the steps in setting these variables as well as using the M4500 keypad and display in general.

3.1 OVERVIEW OF KEYPAD AND DISPLAY

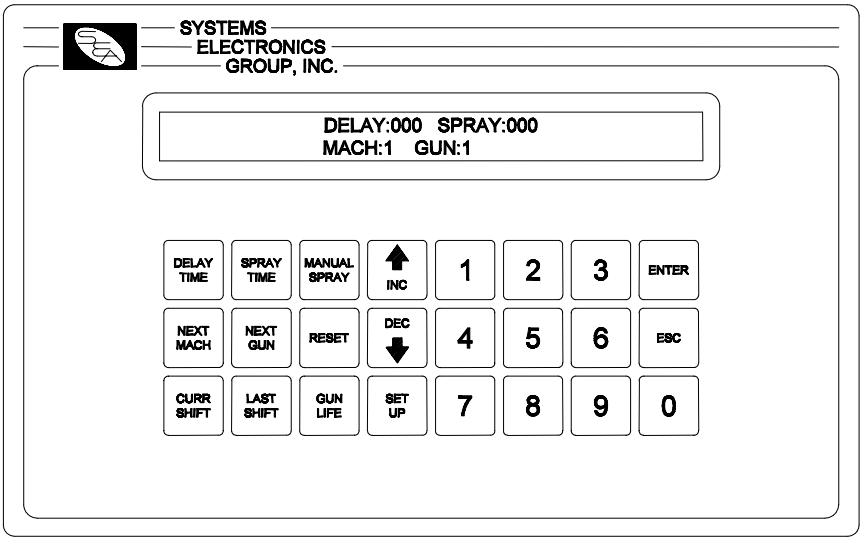

Figure 3.1 – HSL-SM8 Keypad Lay-out

The M4500 keypad is comprised of a 3 row by 8 column keypad. The group of 12 keys on the right side are used for numeric entry, which includes the "ENTER" and "ESC" keys. The group of 12 keys on the left side are defined as follows:

DELAY TIME: Used to adjust the "On" delay of for the selected gun.

SPRAY TIME: Used to adjust the "Spray" duration for the selected gun.

NEXT MACH: Used to select the next machine. Pressing this key increments the machine number by one. If the machine number was 8 when this key is pressed, the machine number will roll over to 1 again. The gun times and gun counts displayed are for the selected machine and gun number which is selected with this key.

NEXT GUN: Used to select the next gun. Pressing this key increments the gun number by one. If the machine number was 8 when this key is pressed, the gun number will roll over to 1 again. The gun times and gun counts displayed are for the selected machine and gun number which is selected with this key.

MAN SPRAY: Used to fire the selected gun when the machine is stopped for test purposes. The selected gun will fire once for the "spray" time of that gun every time this key is depressed.

RESET: Used to reset the "can jam/sensor fail" alarms and the "gun life expectancy exceeded" alarm as well as reset the gun spray counts for the selected gun.

INCR: Increment key used to increment the selected field by one. This is used to increment by one any of the following provided it is selected (the selected field is the field that contains the cursor): "on" delay, "spray" time, or any of the set-up parameters. Holding this key for one second will increment the currently selected field continuously.

DECR: Decrement key used to decrement the selected field by one. This is used to decrement by one any of the following provided it is selected (the selected field is the field that contains the cursor): "on" delay, "spray" time, or any of the set-up parameters. Holding this key for one second will decrement the currently selected field continuously.

CURR SHIFT: Used to display the number of coated cans for each machine so far into the current shift.

LAST SHIFT: Used to display the total number of coated cans for the previous (last) shift.

GUN LIFE: Used to display the total number of spray cycles and percent of used life for each gun.

SET-UP: Initiates the set-up menu which contains the following selections:

1: Set Expected Gun Life (# of Sprays)
2: Preset or Reset # of Gun Sprays
3: Set Can PRX-to-Gun Number of Indexes (shifts)

3.2 DEFAULT SCREEN

The default screen (displayed when no other commands are active) contains the following data:

DELAY:xxx SPRAY:xxx
MACH:x GUN:x

Where "Delay" is the "on" delay time and "Spray" is the "spray" duration. "Mach" and "Gun" specify the currently selected machine and gun for which the delay and spray times are displayed. The "on" delay and "spray" duration times are adjusted from the screen be selecting the "DELAY TIME" and "SPRAY TIME" keys respectively. This screen is always returned to when no other commands are active.

3.3 SELECTING MACHINE (GUN) TO ADJUST

The "NEXT MACH" key and "NEXT GUN" key are used to select the machine/gun for adjustment of any of the following variables: "on" delay, "spray" time, gun count, gun life expectancy limit, or Can PRX-to-Gun indexes. The "NEXT MACH" key increments the machine number as displayed in the "MACH" field by one when depressed. If the previous machine number was 8, pressing "NEXT MACH" causes the machine number to roll over to 1 again. The "NEXT GUN" key also increments the machine number by one when depressed. If the previous machine number was 8, pressing the "NEXT GUN" causes the machine number to roll over to 1 again.

3.4 SETTING GUN TIMES ("ON" DELAY AND "SPRAY" TIME)

Two timers are used to control each gun; the "on" delay time or "DELAY TIME" and the "spray" duration time or "SPRAY TIME". The "on" delay time is used to delay when the gun is first fired after the spray timing flag has occurred while the "spray" time is used to control how long the gun is "on" once it is fired (see section 1.3 for a complete description of the spray gun control). The times entered for the "DELAY TIME" and "SPRAY TIME" are in milliseconds. The gun times can only be adjusted if the "SET-UP" switch is in the enable position.

The "DELAY TIME" key is used to set the "on" delay time while the "SPRAY TIME" key is used to set the "spray" duration time. To set the "on" delay time, simply press the "DELAY TIME" key. The cursor will be positioned in the "DELAY" field. Either enter the desired "on" delay time as a number between 0 and 999 and press the "ENTER" key or press the "INCR" or "DECR" key to increase or decrease the "on" delay time by one. To set the "spray" duration time, simply press the "SPRAY TIME" key. The cursor will be positioned in the "SPRAY" field. Either enter the desired "spray" duration time as a number between 0 and 999 and press the "ENTER" key or press the "INCR" or "DECR" key to increase or decrease the "spray" duration time by one.

3.5 "CURR SHIFT" KEY

The "CURR SHIFT" key is used to activate the current shift data display. The Current shift data menu displays the number of coated cans for each machine so far into the current shift. The number of coated cans is displayed for each machine one at a time for a time delay of 7 to 8 seconds each. The "NEXT MACH" key can also be used to advance to the next machine coated can count if desired. Once the count for all the machines have been displayed, the default screen is returned to.

The "Current shift" data is transferred to the "Last shift" data when the end of shift input transfers from a "0" to a "1". This can be at the end of either an 8 or 12 hour shift. This data cannot be reset by the operator, only at the end of shift input transition.

3.6 “LAST SHIFT” KEY

The "LAST SHIFT" key is used to activate the last shift data display. The Last shift data menu displays the total number of coated cans for each machine for the previous (last) shift. The number of coated cans is displayed for each machine one at a time for a time delay of 7 to 8 seconds each. The "NEXT MACH" key can also be used to advance to the next machine coated can count if desired. Once the count for all the machines have been displayed, the default screen is returned to.

3.7 “GUN LIFE” KEY

The "GUN LIFE" key is used to view the actual number of spray cycles for each gun as well as the percent of life used for each gun. When the "GUN LIFE" key is depressed, the following screen is displayed:

MACH:x GUN:x USE:xx%
SPRAYS:xxx,xxx,xxx

Where "MACH" is the currently displayed machine, "GUN" is the currently displayed gun, "USE" is the percent of gun life that has been used, and "# SPRAY" is the actual number of times the spray gun has been fired since it was installed. The display is initialized with machine 1, gun 1 when the "GUN LIFE" key is first hit. Each gun is then displayed one at a time for a time delay. The "NEXT MACH" or "NEXT GUN" key can be used to advance to the next gun as well.

The purpose of this screen is to give the operator and maintenance personnel an idea of how much use each gun has incurred. The percentage of use is calculated as: number of actual sprays divided by expected gun life (see section 3.8.1) times 100. When the actual number of sprays exceeds the expected gun life ("use" equal to or greater than 100%), the "gun life expectancy exceeded" alarm will be displayed for that particular gun, indicating that gun should be replaced.

The "RESET" key can be used to reset "# SPRAYS" for the currently displayed machine and gun. This should only be done when a new spray gun has been installed to allow collection of the total number of spray cycles for the gun. This key is disabled if the "SET-UP" switch is in the disabled position to prevent unauthorized personnel from resetting the gun counts.

3.8 “SET-UP” KEY

This selection is used to invoke the primary set-up menu. This consists of the following three selections:

1: SET EXPECTED GUN LIFE (# OF SPRAYS)
2: PRESET OR RESET # OF GUN SPRAYS
3: SET CAN PRX-TO-GUN INDEXES (SHIFTS)

The set-up menu is key switch protected such that only authorized personnel (those with the key) can activate the selection. The "Set-up Enable" input must be "on" to invoke the set-up menu. Each selection is displayed for a time delay. The "INCR" key and "DECR" key can also be used to either advance to the next selection or retard to the previous selection respectively.

When selected, each of the above selections bring up a sub-menu with the corresponding set-up parameters. The following sections describe these sub-menus and the definitions of the corresponding variables. To select the respective set-up sub-menu, simply press the corresponding numeric key (1 thru 3).

3.8.1 SET EXPECTED GUN LIFE (# OF SPRAYS)

This menu is displayed when the "1" key (SET EXPECTED GUN LIFE) is pressed while the primary set-up menu is active. The expected gun life limit is a number that is compared to the actual number of accumulated gun spray cycles. If the number of spray cycles (counts) is greater than the expected gun life limit, the "gun life expectancy exceeded" alarm is displayed on the front of the M4500 for that gun.

Note: This alarm does not stop the machine or inhibit the spray function in any way, it simply indicates the gun may be worn out and should be replaced.

The expected gun life is also used in the calculation of percent of life used which is displayed when the "GUN LIFE" key is depressed.

When this menu is activated, the following screen is displayed:

MACH:x GUN:x EXPECTD
LIFE:xxx,xxx,xxx

The menu is initialized to machine 1, gun 1. The "NEXT MACH" or "NEXT GUN" key is used to advance to the next machine. The existing expected life is displayed for each gun as the "NEXT MACH" and "NEXT GUN" keys are depressed.

To change the expected gun life for the currently selected gun, simply enter the desired gun life in counts (up to 649,999,999) and press the "ENTER" key. The next gun will then automatically be advanced to. In addition, the "INCR" and "DECR" key can be used to increment or decrement the expected life by one. The number entered for the expected life should be based on the manufactures number of cycles rating for that particular gun.

Once all gun life expectancies have been entered, press the "ESC" key to return to the primary set-up menu. The "ESC" key can also be depressed at any time to return back to the primary set-up menu without setting or viewing all the guns.

3.8.2 PRESET OR RESET # OF GUN SPRAYS

This menu is displayed when the "2" key (PRESET OR RESET # OF GUN SPRAYS) is pressed while the primary set-up menu is active. This is used to either reset the actual number of spray cycles for the currently selected gun or preset the actual spray count with a number.

When this menu is activated, the following screen is displayed:

MACH:x GUN:x ACTUAL
SPRAYS:xxx,xxx,xxx

The menu is initialized to machine 1, gun 1. The "NEXT MACH" or "NEXT GUN" key is used to advance to the next machine. The actual number of accumulated spray cycles is displayed for each gun as the "NEXT MACH" and "NEXT GUN" keys are depressed.

To reset the actual number of sprays for the currently selected gun, simply press the "RESET" key. The actual number of sprays will be reset to zero. To preset the actual number of sprays to a count, simply enter the number of sprays in counts (up to 649,999,999) and press the "ENTER" key. The next gun will then automatically be advanced to. The actual number of spray counts can be preset to a number in the case where a previously used gun is installed on the machine. When a new gun is installed, the actual number of sprays would be reset to zero.

Once all gun actual sprays are reset or preset, press the "ESC" key to return to the primary set-up menu. The "ESC" key can also be depressed at any time to return back to the primary set-up menu without resetting or viewing all the guns.

3.8.3 SET CAN PRX-TO-GUN INDEXES (SHIFTS)

This menu is displayed when the "3" key (SET CAN PRX-TO-GUN INDEXES) is pressed while the primary set-up menu is active. This is used to set the number of indexes from the Can Body sensor to the spray gun for the currently selected gun.

When this menu is activated, the following screen is displayed:

MACH:x GUN:x INDEXES
CAN PRX-TO-GUN:x

The menu is initialized to machine 1, gun 1. The "NEXT MACH" and "NEXT GUN" key is used to advance to the next machine. The number of indexes from the Can sensor to the gun is displayed for each gun as the "NEXT MACH" and "NEXT GUN" keys are depressed.

The HSL-SM8 package supports between 0 and 3 indexes between the location of the can body sensor and the spray gun. If the Can Body sensor is located at the same station as the spray gun, the index would be set to zero. If the spray gun was located at the next station following the Can Body sensor, the index would be set to 1, and so on.

To set the number of indexes for the currently selected gun, simply enter the number of indexes (0 to 3) and press the "ENTER" key. The next gun will then automatically be advanced to. In addition, the "INCR" and "DECR" key can be used to increment or decrement the number of indexes by one.

Once the indexes for all the guns have been entered, press the "ESC" key to return to the primary set-up menu. The "ESC" key can also be depressed at any time to return back to the primary set-up menu without setting or viewing all the guns.

3.9 MANUAL GUN ACTUATION

The "MAN SPRAY" key can be used to fire the currently selected gun for test purposes while the machine is stopped. Only one gun is fired (the one that is selected in the "MACH" and "GUN" field) and it is fired for the "spray" time entered for that gun. The gun is fired every time the "MAN SPRAY" key is depressed. This is generally done to verify that the gun is operating properly. The spray gun can also be fired from the respective manual spray push-button located on the operators PB station.

3.10 RESETTING ALARMS

The "can jam", "timing sensor fail", and the "gun life expectancy exceeded" alarms are reset by pressing the "RESET" key. The "can jam" alarm indicates both a legitimate can jam and a can body sensor fail. In either case, the alarm is activated when no change of state is detected at the can body sensor after the can gate has been opened. The timing sensor is activated "on" when the timing flag is in front of the sensor. The can sensor is activated "on" when the can is in front of the can sensor. Verify that both of these conditions occur and press "RESET" to clear the alarm. If the condition persists, the alarm will simply occur as soon as the machine is running with cans again.

In the case of the "gun life expectancy exceeded" alarm, the gun counts will have to either be reset to zero or the life expectancy limit increased (see sections 3.8.1 and 3.8.2) above the gun counts in order to be able to reset the alarm by pressing the "RESET" key. Of course the gun counts should not be reset unless the gun is replaced.

SECTION 4
RECOMMENDED SPARE PARTS

The following are recommended spares for the HSL-SM8. These parts are available through Systems Engineering Assoc. Inc.

Quantity	Part Number	Description
1ea.	M4508	PLC/PLS Processor/Chassis
1ea.	P4500	Power Supply
1ea.	S4563	16 Point 10-30Vdc Input Board
1ea.	S4573	16 Point 10-30Vdc Output Board
1ea.	D4591	Display/Keypad
2ea.	M273	High Speed Solenoid Drivers

SECTION 4
RECOMMENDED SPARE PARTS

(This Page Intentionally Left Blank)

APPENDIX A
MODBUS COMMUNICATIONS

The MODBUS communications driver uses the S4516 communications board to both read and write data to a MODICON PLC.

The following data is written to the MODICON PLC:

MODICON Dest 4x Address	Data Definition	M4500 Source Address
401700	Mach #1 - Coated Cans (Lo-0 to 9,999)	W1084
401701	Mach #1 - Coated Cans (Hi-10,000's)	W1086
401702	Mach #2 - Coated Cans (Lo-0 to 9,999)	W1088
401703	Mach #2 - Coated Cans (Hi-10,000's)	W1090
401704	Mach #3 - Coated Cans (Lo-0 to 9,999)	W1092
401705	Mach #3 - Coated Cans (Hi-10,000's)	W1094
401706	Mach #4 - Coated Cans (Lo-0 to 9,999)	W1096
401707	Mach #4 - Coated Cans (Hi-10,000's)	W1098
401708	Mach #5 - Coated Cans (Lo-0 to 9,999)	W1100
401709	Mach #5 - Coated Cans (Hi-10,000's)	W1102
401710	Mach #6 - Coated Cans (Lo-0 to 9,999)	W1104
401711	Mach #6 - Coated Cans (Hi-10,000's)	W1106
401712	Mach #7 - Coated Cans (Lo-0 to 9,999)	W1108
401713	Mach #7 - Coated Cans (Hi-10,000's)	W1110
401714	Mach #8 - Coated Cans (Lo-0 to 9,999)	W1112
401715	Mach #8 - Coated Cans (Hi-10,000's)	W1114
401716	Gun #1 - Total Sprays (Lo-0 to 9,999)	W1052
401717	Gun #1 - Total Sprays (Hi-10,000's)	W1054
401718	Gun #2 - Total Sprays (Lo-0 to 9,999)	W1056
401719	Gun #2 - Total Sprays (Hi-10,000's)	W1058
401720	Gun #3 - Total Sprays (Lo-0 to 9,999)	W1060
401721	Gun #3 - Total Sprays (Hi-10,000's)	W1062
401722	Gun #4 - Total Sprays (Lo-0 to 9,999)	W1064
401723	Gun #4 - Total Sprays (Hi-10,000's)	W1066
401724	Gun #5 - Total Sprays (Lo-0 to 9,999)	W1068
401725	Gun #5 - Total Sprays (Hi-10,000's)	W1070
401726	Gun #6 - Total Sprays (Lo-0 to 9,999)	W1072
401727	Gun #6 - Total Sprays (Hi-10,000's)	W1074
401728	Gun #7 - Total Sprays (Lo-0 to 9,999)	W1076
401729	Gun #7 - Total Sprays (Hi-10,000's)	W1078
401730	Gun #8 - Total Sprays (Lo-0 to 9,999)	W1080
401731	Gun #8 - Total Sprays (Hi-10,000's)	W1082
401732	Timing/Can PRX Alarms (1-8)	W36
401733	Gun Life Exceeded Alarms (1-8)	B40

APPENDIX A
MODBUS COMMUNICATIONS

The definitions of the data sent from the M4500 to the MODICON are as follows:

401700: Mach #1 - Coated Cans (Lo)
thru
401715: Mach #8 - Coated Cans (Hi)
The "Coated Can" counts for the machines are the total sprayed cans for the current shift. These are reset at the end of the shift. The (Lo) words are 0-9,999 while the (Hi) words are in 10,000's.

401716: Gun #1 - Total Sprays (Lo)
thru
401731: Gun #8 - Total Sprays (Hi)
The "Total Spray" counts for each gun are the total accumulated spray cycles for the life of the gun. These are reset when the operator changes a gun (gun worn out). The (Lo) words are 0-9,999 while the (Hi) words are in 10,000's.

The bits of the "Timing/Can PRX Alarms" (401732) are mapped as follows:

W36: PRX Alarms to MODICON (4x address 401732 in MODICON)
B36.0: Timing PRX Fail - Machine #1
B36.1: Timing PRX Fail - Machine #2
B36.2: Timing PRX Fail - Machine #3
B36.3: Timing PRX Fail - Machine #4
B36.4: Timing PRX Fail - Machine #5
B36.5: Timing PRX Fail - Machine #6
B36.6: Timing PRX Fail - Machine #7
B36.7: Timing PRX Fail - Machine #8
B37.0: Can Jam/Can PRX Fail - Machine #1
B37.1: Can Jam/Can PRX Fail - Machine #2
B37.2: Can Jam/Can PRX Fail - Machine #3
B37.3: Can Jam/Can PRX Fail - Machine #4
B37.4: Can Jam/Can PRX Fail - Machine #5
B37.5: Can Jam/Can PRX Fail - Machine #6
B37.6: Can Jam/Can PRX Fail - Machine #7
B37.7: Can Jam/Can PRX Fail - Machine #8

With the respective "Sensor Check Enable" input "on", both the "can" sensor and "timing" sensor are checked for periodic transitions. If the can sensor fails to transition "off" to "on", a "Can Jam/Can PRX Fail" alarm is generated for that machine. If the timing sensor fails "on" or "off", a "Timing PRX Fail" alarm is generated for that machine.

The bits of the "Gun Life Exceeded Alarms" (401733) are mapped as follows:

B40: Gun Life Alarms to MODICON (4x address 401733 in MODICON)
- B40.0: Life Exceeded - Gun #1
- B40.1: Life Exceeded - Gun #2
- B40.2: Life Exceeded - Gun #3
- B40.3: Life Exceeded - Gun #4
- B40.4: Life Exceeded - Gun #5
- B40.5: Life Exceeded - Gun #6
- B40.6: Life Exceeded - Gun #7
- B40.7: Life Exceeded - Gun #8

The respective "Gun Life Exceeded" alarm is set when the accumulated "Total Spray" count for that gun exceeds the "Expected Gun Life" preset. The alarm is cleared when the accumulated "Total Spray" count for the gun is reset to zero and the alarm reset is pressed.

APPENDIX A
MODBUS COMMUNICATIONS

The following data is read from the MODICON PLC:

MODICON Source 4x Address	Data Definition	M4500 Dest Address
401760	Status/Control (from MODICON)	W900
401761	Gun #1 Delay Time (Machine #1)	W902
401762	Gun #2 Delay Time (Machine #2)	W904
401763	Gun #3 Delay Time (Machine #3)	W906
401764	Gun #4 Delay Time (Machine #4)	W908
401765	Gun #5 Delay Time (Machine #5)	W910
401766	Gun #6 Delay Time (Machine #6)	W912
401767	Gun #7 Delay Time (Machine #7)	W914
401768	Gun #8 Delay Time (Machine #8)	W916
401769	Gun #1 Spray Time (Machine #1)	W918
401770	Gun #2 Spray Time (Machine #2)	W920
401771	Gun #3 Spray Time (Machine #3)	W922
401772	Gun #4 Spray Time (Machine #4)	W924
401773	Gun #5 Spray Time (Machine #5)	W926
401774	Gun #6 Spray Time (Machine #6)	W928
401775	Gun #7 Spray Time (Machine #7)	W930
401776	Gun #8 Spray Time (Machine #8)	W932
401777	Gun #1 Number of Indexes (Machine #1)	W934
401778	Gun #2 Number of Indexes (Machine #2)	W936
401779	Gun #3 Number of Indexes (Machine #3)	W938
401780	Gun #4 Number of Indexes (Machine #4)	W940
401781	Gun #5 Number of Indexes (Machine #5)	W942
401782	Gun #6 Number of Indexes (Machine #6)	W944
401783	Gun #7 Number of Indexes (Machine #7)	W946
401784	Gun #8 Number of Indexes (Machine #8)	W948
401785	Gun Life Expectancy (Lo-0 to 9,999)	W950
401786	Gun Life Expectancy (Hi-10,000's)	W952
401787	Guns Total Spray Counts Reset (bits)	W954

The definitions of the data read from the MODICON to the M4500 are as follows:

401761: thru 401776: Gun #1 Delay Time (Machine #1) thru Gun #8 Spray Time (Machine #8)
Two timers are used to control each gun; the "on" delay time or "Delay Time" and the "spray" duration time or "Spray Time". The "on" delay time is used to delay when the gun is first fired after the spray timing flag has occurred while the "spray" time is used to control how long the gun is "on" once it is fired. The times entered for the "Delay Time" and "Spray Time" are in milliseconds. Both the "Delay Time" and "Spray Time" must be in the range of 0 to 999.

401777: thru 401784: Gun #1 Number of Indexes (Machine #1) thru Gun #8 Number of Indexes (Machine #8)
The HSL-SM8 package supports between 0 and 3 indexes between the location of the can body sensor and the spray gun. If the Can Body sensor is located at the same station as the spray gun, the index would be set to zero. If the spray gun is located at the next station following the Can Body sensor, the index would be set to 1, and so on.

401786: and 401787: Gun Life Expectancy (Lo) and Gun Life Expectancy (hi)
The expected life cycle count limit is used to generate the "Gun Life Exceeded" alarm if the number of spray gun cycles exceeds the entered expected life cycle limit. This feature is used for preventative maintenance purposes to track the number of spray cycles and flag when a particular gun has exceeded it's rated life. The gun can then be changed prior to incurring spray weight problems due to a worn out gun.

Note: The above parameters (401761 thru 401786) are effective only when the "Set-Up Parameters Enable" bit (401760.1 from the MODICON) is set to a "1". Otherwise these variables are not updated in the M4500.

APPENDIX A
MODBUS COMMUNICATIONS

The bits of the Status/Control register (from the MODICON to M4500) are mapped as follows:

W900: Status/Control from MODICON (4x address 401760 in MODICON)
- B900.0: End of Shift
- B900.1: Set-Up Parameters Enable
- B900.2: Alarm Reset
- B900.3: Not Used
  thru
- B900.7: Not Used
- B901.0: Manual Spray Gun #1
- B901.1: Manual Spray Gun #2
- B901.2: Manual Spray Gun #3
- B901.3: Manual Spray Gun #4
- B901.4: Manual Spray Gun #5
- B901.5: Manual Spray Gun #6
- B901.6: Manual Spray Gun #7
- B901.7: Manual Spray Gun #8

The Status/Control bits sent from the MODICON PLC are defined as follows:

B900.0: End of Shift - Setting this bit to a "1" transfers the current shift data in the M4500 to the last shift data and clears the current shift data (to start data collection for the next shift). The current shift data in the MODICON should be saved to the last shift data stack prior to setting this bit.

B900.1: Set-Up Parameters Enable - Setting this bit to a "1" enables the set-up parameters (401761 thru 401786 in the MODICON) to be used in the M4500. If this bit is set to a "0", the values in 401761 thru 401786 in the MODICON are not used as the set-up parameters, the M4500 instead uses the values set-up thru the HSL-SM8 keypad.

B900.2: Alarm Reset - Setting this bit to a "1" resets the Timing PRX Fail alarms, Can Jam/Can PRX Fail alarms, and Gun Life Exceeded Alarms.

B901.0: Manual Spray Gun #1
thru
B901.7: Manual Spray Gun #8
"Manual Spray Gun #1" thru "#8" are used to fire the respective gun for test purposes while the machine is stopped. The gun is fired for the "spray" time entered for that gun. The gun is fired every time the respective "Manual" bit transitions from a "0" to a "1". This is generally done to verify that the gun is operating properly.

The bits of the "Guns Total Spray Counts Reset" register (from the MODICON to M4500) are mapped as follows:

W954: Counts Reset from MODICON (4x address 401787 in MODICON)
- B954.0: Reset Gun #1 Total Spray Counts (Life Expectancy)
- B954.1: Reset Gun #2 Total Spray Counts (Life Expectancy)
- B954.2: Reset Gun #3 Total Spray Counts (Life Expectancy)
- B954.3: Reset Gun #4 Total Spray Counts (Life Expectancy)
- B954.4: Reset Gun #5 Total Spray Counts (Life Expectancy)
- B954.5: Reset Gun #6 Total Spray Counts (Life Expectancy)
- B954.6: Reset Gun #7 Total Spray Counts (Life Expectancy)
- B954.7: Reset Gun #8 Total Spray Counts (Life Expectancy)

The above bits are used to reset the respective "Total Spray" counts (401716 thru 401731) for the corresponding gun. This is typically done when a gun is replaced (worn out).

The MODBUS driver uses the following data format and parameters (the MODBUS port on the MODICON PLC must be set to match these):

MODBUS Port (PLC address): 5
MODBUS Baud: 19.2K
MODBUS framing mode: RTU
Number of start bits: 1
Number of data bits: 8
Number of stop bits: 1
Parity: NONE