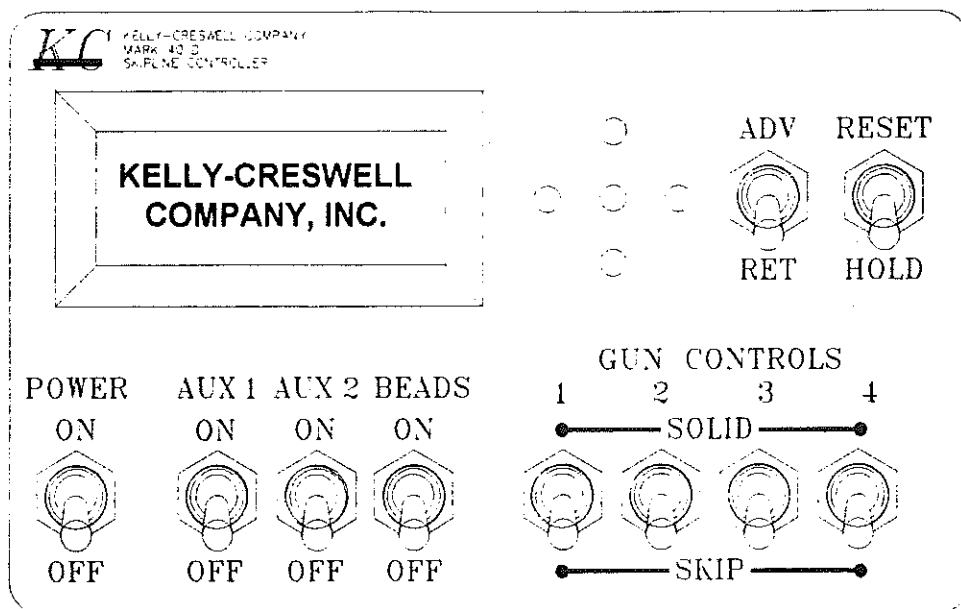


OPERATING INSTRUCTIONS

MARK 40-D SKIPLINE CONTROLLER



KELLY-CRESWELL COMPANY, INC.

Before operating this unit, please read these instructions completely

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INTRODUCTION

1.1 PRODUCT OVERVIEW

The MARK 40-D is a durable, highly reliable solid state skipline control unit. In addition, the small size makes it ideal for compact installations. All connections are made through a single 14 conductor cable, which makes installation neat and easy.

The controller uses the latest in solid state technology, and innovative techniques to create one of the most advanced skipline control units available today.

The enclosure is rugged water resistant die cast aluminum. The finish is a heavy epoxy based enamel to resist scratching and the painting solvents. Electrical connections are made to the rear of the unit, using Amphenol 97 series connectors. Mounting is accomplished by a "U" bracket, which not only allows positioning to any viewing angle, it also allows easy removal for safe keeping when not in use.

The display is organized as two lines of 16 characters. This organization allow presentation of easily readable messages, requiring a minimum number of abbreviations. The display utilizes LCD (liquid crystal display) technology with LED (light emitting diode) backlight to remain visible in the brightest of sunlight or dim evening light.

The toggle switches meet military specification (MIL-S-83731) featuring, large heavy duty lever, silicone rubber lever seal to prevent entry of contaminants, silver to silver contacts for high reliability and plated metal parts for corrosion resistance.

The push button switches are also high reliability featuring, rubber button seal to prevent entry of contaminants and silver to silver contacts for high reliability.

The menu flow is organized as a tree structure to allow the user to easily move to the items of interest while avoiding items that are of no concern at the moment.

INTRODUCTION

1.2 SPECIFICATIONS

Power requirements:

Voltage: 11 - 16 Volts DC (nominal 12V DC)

Current: MARK 40-D .1 Ampere Typical

Solenoids:

Type: Momentary

Voltage: 12 Volts DC

Current: Nominal 1 ampere

Fuse: 10 Ampere Maximum

Compatible Motion Sensors:

Type:

Generator:

Magnetic:

Interrupter:

Accuracy:

Plus or minus one half of one sensor pulse.

Calibration Range:

Five to fifteen pulses per foot of ground travel.

Cable:

18 AWG, 15 Conductor

SETUP

2.1 INSTALLATION

The MARK 40-D has threaded inserts on each side to facilitate mounting. Using the supplied "U" bracket, find a suitable mounting location. The mounting location should be free from vibration and should not be exposed to excessive heat or water. The enclosure is water resistant but is not intended to be waterproof.

Using the wiring diagrams found in Appendix A connect a length of #14 gauge wire from the vehicle power source (+12 Volt DC) the MARK 40-D's terminal strip. Using another length of #14 gauge wire connect the vehicle ground to the terminal strip.

Again using the diagrams found in Appendix A connect one side of each gun solenoid to the solenoid output circuits at the terminal strip. Connect the other wire from each solenoid to the 12 volt out supplied by the MARK 40-D at the terminal strip.

NOTE: be sure the solenoids you are using are rated for 12 Volt DC continuous operation.

If you will be using the LIFT circuit refer to the diagram in Appendix A-2 and connect the lift solenoid as shown.

If the motion sensor you are using with the MARK 40-D is the 2 wire type refer to Appendix A-3 and connect the sensor as shown. If your sensor is the 3 wire type refer to Appendix A-4 and connect it as shown

2.2 SELFTEST

The MARK 40-D has the unique ability to perform a self diagnostic to aid in trouble shooting and repair. This is also a great confidence builder for new installations. To enter diagnostic mode press and hold two or more buttons while power switch is turned on.

In addition to the diagnostic mode the current supplied to the gun solenoids is continuously monitored by the MARK 40-D. If a solenoid should become defective or a solenoid wire would become damaged and create a short circuit. The defective circuit will be turned off immediately and a message will be briefly display to alert the operator of the trouble.

SETUP

SOFTWARE REVISION

The software revision number will be the first display after entering the diagnostic mode. When calling for any information regarding the operation of the MARK 40-D, this number must be available.

SOLENOID OPEN CIRCUIT

The open circuit test is performed immediately after the software revision number is displayed. This test will identify any gun solenoid wire that does not show a connection. This is useful for isolating bad solenoids, broken wires, or bad connections. This display will only appear once each time diagnostic mode is entered.

SWITCH and BUTTON

The switch and button diagnostic routine is entered immediately after the open circuit test has completed. This test consists of activating each switch or button one at a time. The display will show each switch name as it is operated. This will help to isolate switches and buttons should they become defective.

2.3 CALIBRATION

The calibration procedure is required to allow the MARK 40-D to work with a wide variety of motion sensors. This procedure will count the number of pulses received over a measured distance, then calculate the calibration numbers required to accurately create the line patterns requested. We recommend a course length of 1000 feet or more, the longer the course the less effect any error will have of the calibration. The calibration limits are 100.0 feet to 6500.0 feet.

Upon entering the calibration mode the message "CALIBRATION MODE, CENTER = BEGIN" will be displayed. Position the vehicle at the beginning of the calibration course and press the center button. Best results will be obtained if you place a wheel on the line marking the beginning of the course.

While driving the course length, the message "DRIVE THE COURSE, CENTER = END" will be displayed. When you have traveled to the end of the course, press the center button again. As before you should stop with a wheel on the line marking the end of the course.

The message "LENGTH OF COURSE, XXXX.X FEET" will be displayed. Use the UP and DOWN buttons to set the actual length of your calibration course into the

SETUP

display, and press the CENTER button.

After the course length has been set, the MARK 40-D will calculate the calibration numbers. If the values are in range, the message "CALIBRATION OK" will be displayed. If the values are not in range, the message "CALIBRATION BAD" will be displayed. In either case the unit will return to the main display after a short delay.

OVERALL CYCLE

After you have completed the calibration procedure, you are ready to check the overall cycle length. Set the RESET/RUN/HOLD switch to HOLD, then set one GUN switch for SKIP. With the vehicle traveling at painting speed, move the RESET/RUN/HOLD to RUN. Allow two skip cycles to complete, then return to the HOLD position. Now measure the distance from the beginning of the first skip line to the beginning of the second skip line. The distance should be the MARK 40-D's cycle length setting. If this distance is not correct, the unit should be re-calibrated. DO NOT proceed to the next step until the OVERALL CYCLE is correct.

BEAD ALIGNMENT

Bead alignment is only necessary if your installation is equipped with the timed beads option. The first step for setting bead alignment will be to set the "BEAD DISTANCE" (see section 4). This is the distance between the paint guns and the bead guns. This refers to the distance between the spot where the paint and the beads hit the ground, not the physical mounting distance of the guns on the gun carriage.

Set the RESET/RUN/HOLD switch to HOLD, then set one GUN switch for SKIP. With the vehicle traveling at painting speed, move the RESET/RUN/HOLD to RUN. Allow one skip cycle to complete, then return to the HOLD position. If the bead coverage starts before the paint line, then you must set the "BEAD ON DELAY" (see section 4). If the bead coverage starts after the paint line, you must set the "PAINT ON DELAY". In either case, use the table found in Appendix C to set the correct delay. The object is to have paint and beads begin together.

PAINT LENGTH

The paint length must be set to allow for the electro air solenoids on and off response time differences. Set the RESET/RUN/HOLD switch to HOLD, then set one GUN switch for SKIP. With the vehicle traveling at painting speed, move the RESET/RUN/HOLD to RUN. Allow one skip cycle to complete,

SETUP

then return to the HOLD position. If the paint line is too short, you must increase the "PAINT OFF DELAY" (see section 4). If the paint line is too long, you must increase both the "PAINT ON DELAY" and the "BEAD ON DELAY" (if equipped) by the same amount.

BEAD LENGTH

The final step is to set the bead length. If your bead coverage is too long, you will need to increase "PAINT ON DELAY", "PAINT OFF DELAY" and the "BEAD ON DELAY" all three by the same amount. If the bead coverage is too short, you need only increase the "BEAD OFF DELAY".

OPERATION

3.1 TOGGLE SWITCHES

POWER ON/OFF

The power switch will discontinue all power to the MARK 40-D skipline control unit. When power is discontinued the MARK 40-D will automatically save all operator setup, foot counter values and the odometer value. The power switch however will not affect the operation of the LIFT switch.

RESET/RUN/HOLD

This is a three position switch. The up position is RESET, and is spring return to the center(RUN). When held in the RESET position, all guns set for skip are held in the off state. The skip cycle counter is reset, ready to begin a new cycle. Any guns set for solid will continue to paint.

The center position is RUN, this is the normal position the MARK 40-D will be operated in.

The down position is HOLD; this is the master guns OFF switch. Any time the paint guns need to be turned off or on simultaneously (e.g. moving through an intersection) this is the switch to use. When this switch is returned to the center(RUN) position, the paint cycle is restarted and the paint guns are once again allowed to follow their individual gun switch settings.

ADVANCE/RETARD

This is a three position switch. Both up(ADVANCE) and down(RETARD) positions are spring return to the center. The ADVANCE position will move the pattern forward by .1 foot each time it is activated. The pattern may also be moved forward by about 1 foot per second if it is held in the advance position.

The RETARD position will move the pattern backward by .1 foot each time it is activated. The pattern may also be moved backward by about 1 foot per second if it is held in the retard position.

LIFT/AUX 1

This is a two position switch. It is intended to control the air solenoid used to provide air for lifting the gun carriage. This switch will operate independently of the MARK 40-D's other controls.

OPERATION

AUX 2

This is a two position switch. It will allow switching between two preset skip patterns. The down position is the normal pattern, while the up position is the alternate skip pattern.

BEADS

This is a two position switch. The up position instructs the MARK 40-D to activate the solenoids used to control the application of glass beads. The down position instructs the MARK 40-D not to activate these solenoids.

GUN SWITCHES

These are three position switches. The center (OFF) position instructs the MARK 40-D not to activate the solenoid associated with that paint gun. The up (SOLID) position instructs the MARK 40-D to activate the solenoid until it is again turned off by the operator. The down(SKIP) position instructs the MARK 40-D to turn the solenoid on and off to form the selected skip cycle.

3.2 PUSHBUTTON SWITCHES

UP and DOWN

The UP and DOWN buttons are used primarily for changing values and selecting options. They are also used together during the foot counter display to reset the counter.

LEFT and RIGHT

The LEFT and RIGHT buttons are used primarily for navigating through the menu structure.

CENTER

The CENTER button is used to answer YES, when a yes or no answer is required. It is also required to keep a modified value during a menu selection.

MENU SELECTIONS

4.1 MAIN DISPLAY

This will be the display from which you will normally be operating. This screen presents the operator with the information needed for normal operation of the MARK 40-D. The "PAINT" length is displayed on the first line, followed by the vehicle speed. The second line shows the "CYCLE" length, followed by the skip cycle status "P" indicating the paint portion of the cycle. The last character position of the second line is a flashing period ".", indicating pulses are being received from the motion sensor. The last item of interest on this display will be an "*" following the "PAINT" or the "CYCLE" length. This indicates the setting of the "START CYCLE OPTION".

4.2 CONTRAST ADJUSTMENT

The nature of an LCD (liquid crystal display) is to change contrast with temperature, viewing angle and other factors. The MARK 40-D is equipped with a contrast adjustment. This will allow you to compensate for these factors. While viewing the main display, pressing the UP or the DOWN button will change the contrast. Depending on the conditions affecting the display, it may go completely dark or it may go completely white. If this happens, don't be alarmed. Continue pressing the button until the display returns to the desired contrast level.

4.3 QUICK EDIT FEATURE

The MARK 40-D has a unique quick edit feature. This feature will allow changing the current "PAINT" or "CYCLE" length without going through the menu structure. To invoke the quick edit function, simply press the CENTER button. The "PAINT" length will begin to flash. You may change the length by using the UP or the DOWN button, or if you desire. The "CYCLE" length may be changed. Pressing the LEFT or the RIGHT button will cause the "CYCLE" length to begin flashing, again use the UP or the DOWN button to change the length. Pressing the CENTER button again will exit the quick edit mode, or the edit function will terminate after 15 seconds.

4.4 MENU NAVIGATION

The MARK 40-D has an elaborate menu structure, but every effort has been made to make navigating through it simple and easy. The Left or the RIGHT buttons will move you from the main display to a branch on the menu tree (see appendix B). The CENTER button will allow entry to the displayed branch. After entering the selected branch, the LEFT and RIGHT buttons move backward and forward through the items along that branch. The UP and the DOWN buttons will change the setting. The CENTER button will select the new setting. The LEFT or RIGHT button will move on without changing the setting.

MENU SELECTIONS

4.5 FOOTAGE COUNTERS

The MARK 40-D will record the total distance traveled, and the length of the lines painted by each gun. These values are stored each time power to the unit is turned off. The values are restored each time the power is re-applied.

TOTAL DISTANCE

The MARK 40-D has a built in odometer. This counter records the number of feet traveled from the last time it was reset. The odometer may be reset at any time it is displayed by simply pressing the UP and DOWN buttons together. Once the counter has been reset there is no way to recover the previous value.

GUN COUNTERS

The MARK 40-D has built in gun counters. These counters record the number of feet painted by each gun from the last time they were reset. A selected gun counter may be reset at any time it is displayed by simply pressing the UP and DOWN buttons together. Once the counter has been reset there is no way to recover the previous value.

4.6 SKIP CYCLE SET UP

This branch of the menu tree will allow the setting of values that makeup the skip cycle. Both the normal and the alternate skip cycle lengths may be set here. To enter this branch simply press the CENTER button. The first setting will be the "PAINT" length. The next will be the "CYCLE" length, then the "ALTERNATE PAINT" length and so on. Remember to change settings use UP or DOWN. To select the new settings, you must use the CENTER button. To move on use LEFT or RIGHT.

4.7 SETUP OPTIONS

This branch of the menu tree will allow the setting of various options that affect the operation of the MARK 40-D.

UNITS SETTING

The MARK 40-D has the ability to work in "ENGLISH" or "METRIC" units. If you desire distances may be displayed in meters in which case the "METRIC" option should be selected. If the "METRIC" is to be used, it must be selected before calibrating the MARK 40-D.

MENU SELECTIONS

START CYCLE OPTION

The start cycle option allows the operator to begin a new cycle with PAINT or SKIP. A new cycle is considered to be the first cycle after returning the RESET/RUN/HOLD to the RUN position. If the cycle is to begin with PAINT the main display will show an "*" after the PAINT length. If the cycle is to begin with SKIP the display will show an "*" after the CYCLE length.

POSI-CYCLE FEATURE

The posi-cycle feature will track the operation of the ADVANCE/RETARD switch when enabled. If the ADVANCE switch is activated three times in a row, with no intervening RETARD actions, the cycle length will be lengthened by .1 feet. Likewise if the RETARD switch is activated three times in a row with no intervening ADVANCE actions, the cycle length will be shortened by .1 feet. In this way the MARK 40-D will adjust the cycle length to match the painted lines you are retracing.

PATTERN CHANGE OPTIONS

The MARK 40-D has four options to aid in changing from one paint pattern to another. The first option is "IMMEDIATE". This option instructs the MARK 40-D to change the paint pattern as you change the GUN switches.

The second option is "SMART". This option instructs the MARK 40-D to wait until the paint portion of the cycle, then invoking any GUN switch changes.

The third option is "TRIGGERED". This option instructs the MARK 40-D to wait until the trigger button is pressed then invoke any GUN switch changes. When this option is selected, the trigger spray options will be disabled.

The fourth option is "TRIGGERED/RESET". This option is the same as option three, except when the trigger button is pressed and gun switch changes are invoked the skip cycle is also reset to the beginning. This way you will always begin your new pattern with a complete cycle. As above when this option is selected, the trigger spray option is disabled.

NOTE: When using option 2, 3 or 4 CAUTION must be exercised. Turning off a GUN switch will not stop the paint flow, until the key event. When using these options, always start and stop the paint flow with the RESET/RUN/HOLD switch, **not** the GUN switches.

TRIGGER SPRAY SETTINGS

MENU SELECTIONS

The trigger spray feature will aid in retracing non-uniformly spaced skip patterns. The MARK 40-D has two settings to choose from.

The first option is "CONTINUOUS". When selected any GUN switches set in the SKIP position may be controlled by the TRIGGER button. When the trigger button is pressed, paint guns set in the SKIP position will paint until the trigger button is released.

The second option is "CYCLE". When selected any GUN switches set in the SKIP position will paint one line. Only one paint line will be applied regardless of the trigger button. To paint another simply press the trigger button again. When the TRIGGER SPRAY option is selected, Triggered pattern changes will be disabled.

4.8 SETTING DELAYS

The MARK 40-D delays branch of the menu tree is used to set the ON and OFF delay values. This will allow you to compensate for the reaction time of the electro air solenoids. This menu will also be used to set the distance between the paint and bead guns.

ON DELAYS

The on delay value for both paint and beads may be used to shorten the associated line. If the line being applied is too long, the greater the ON value the shorter the line.

OFF DELAY

The off delay value for both paint and beads may be used to lengthen the associated line. If the line being applied is too short, the greater the OFF value the longer the line.

NOTE: IF both the ON and the OFF delay are changed an equal amount, the associated line will be moved. The length will remain the same.

BEAD DISTANCE

The bead distance must be set to specify the distance between the spot where the paint and the beads hit the ground. The MARK 40-D uses this setting to delay the proper distance after paint is turned on, before turning on the beads.

MENU SELECTIONS

4.8 CALIBRATION

Calibration is the procedure required to inform the MARK 40-D of the motion sensor configuration. The MARK 40-D counts the number of pulses produced by the sensor as the vehicle moves over the road. After setting the distance traveled the calibration numbers are calculated.

REQUIREMENTS

The requirements for a successful calibration, center primarily around the motion sensor. The MARK 40-D uses an electronic buffer/filter circuit to condition the sensor signals. This in turn will allow a wide variety of motion sensor styles to be used. The MARK 40-D also contains the calibration techniques to allow a wide range of pulses per foot to be used. This simplifies the sensor mounting configuration.

The most important single factor influencing the calibration success, is the physical sensor mounting. This mounting must be rigid enough to prevent vibration. A vibrating sensor will give non-uniformly spaced pulses. One way to insure the sensor is producing uniform pulses, would be to drive the calibration course more than once. The number displayed with the message "COURSE LENGTH, XXXX.X FEET", should be very close each time you drive the course. If this is not the case, check your sensor installation again.

PROCEDURE

Please refer to the calibration procedure found in Section 2 under SETUP.

CANCELING

Pressing the LEFT or the RIGHT button at any time will cancel the calibration. When canceled the previous calibration numbers are not changed. The message "CALIBRATION, CANCELED" will be displayed then the MARK 40-D will return to normal operation.

ADJUSTMENT

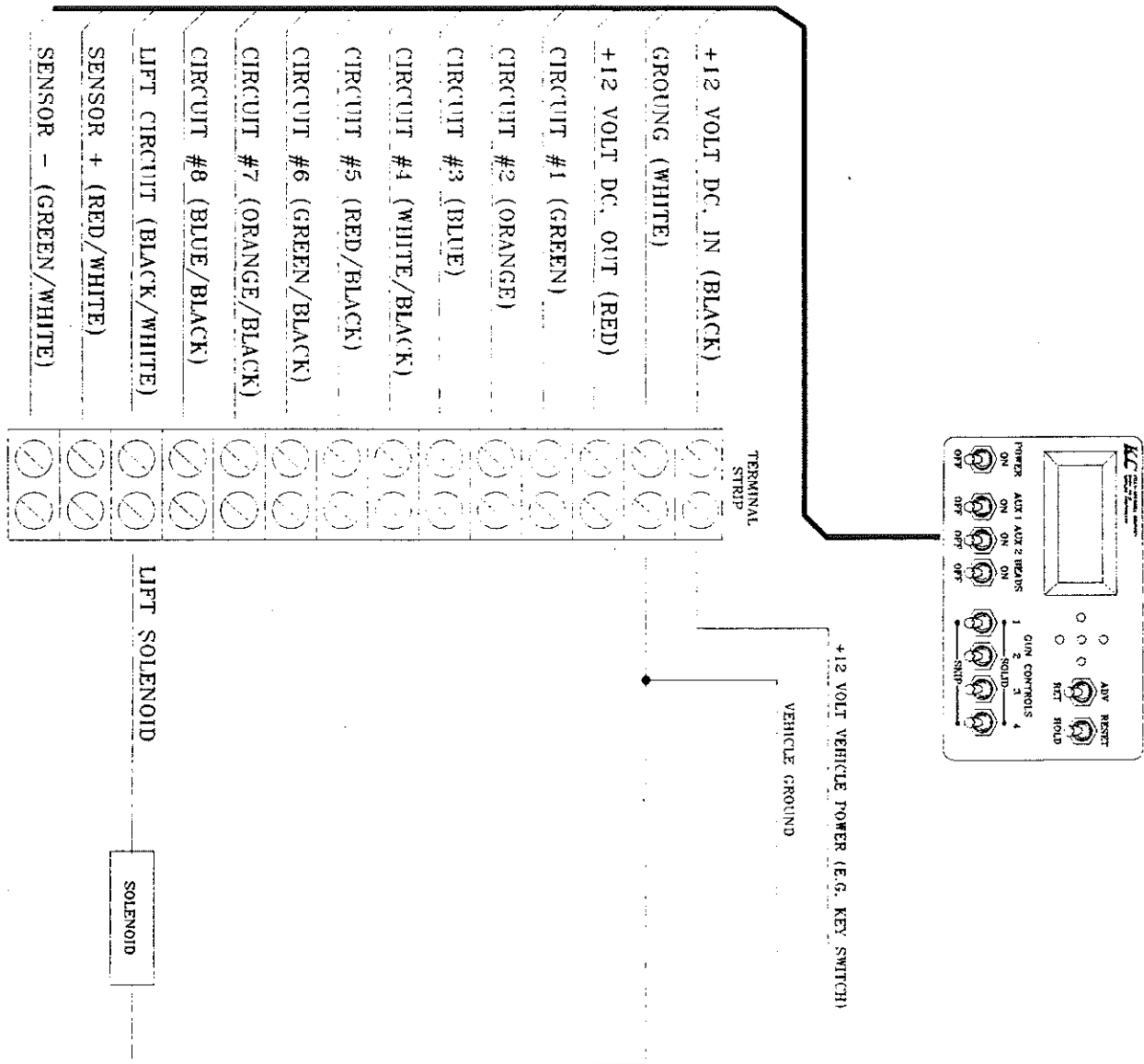
The nature of the calibration requires the vehicle be moving. Therefore if the vehicle did not move the MARK 40-D assumes you would like to adjust the earlier calibration numbers. In this case the MARK 40-D will present the pulses accumulated before, and allow you to change them. Next you will be presented with the distance traveled during the earlier calibration and allow

MENU SELECTIONS

you to change it. Remember only the UP and the DOWN buttons may be used to change the values and the CENTER button must be pressed to select your modified value. The LEFT or the RIGHT button will cancel the calibration.

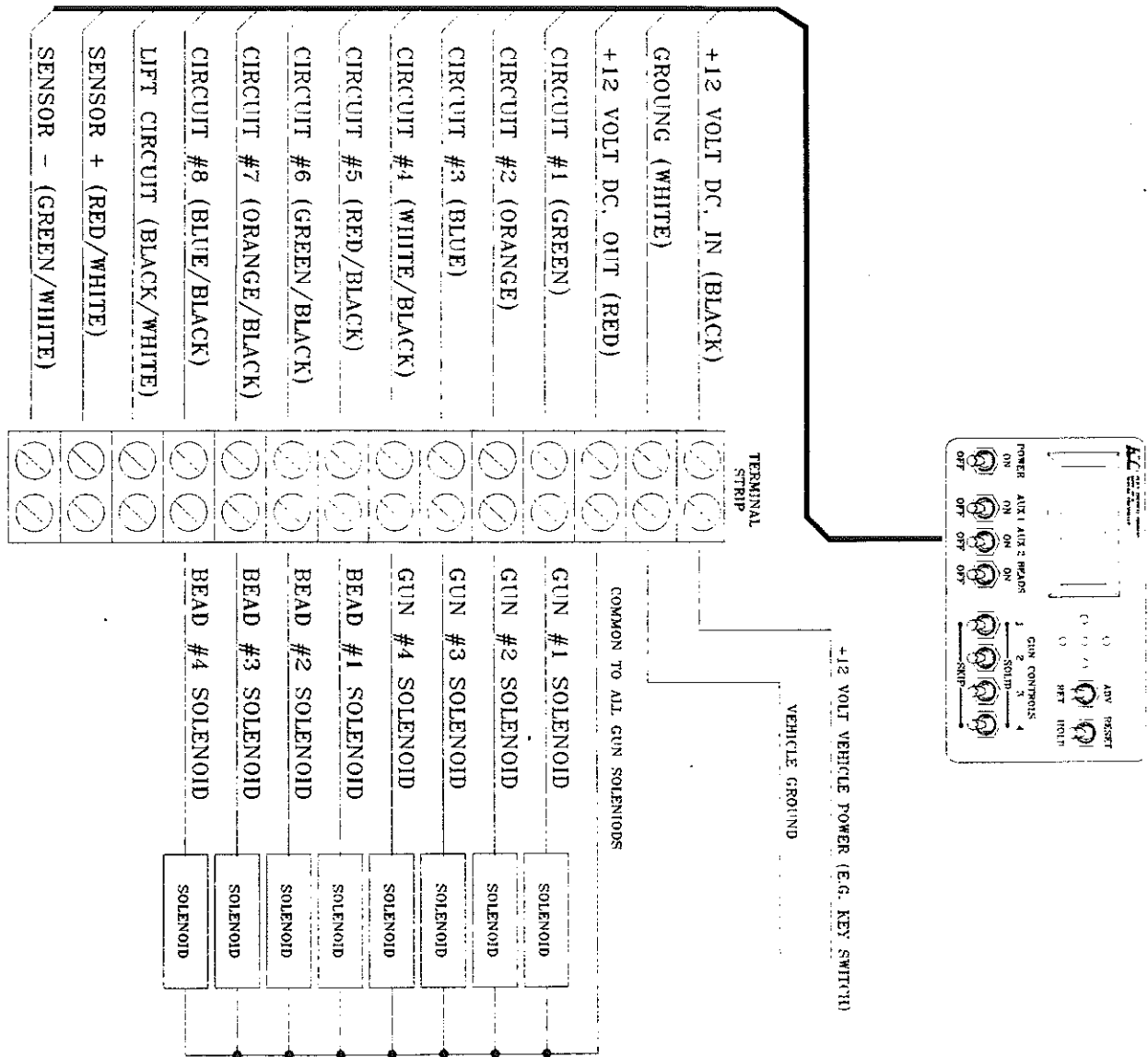
APPENDIX A

LIFT SOLENOID INSTALLATION WIRING



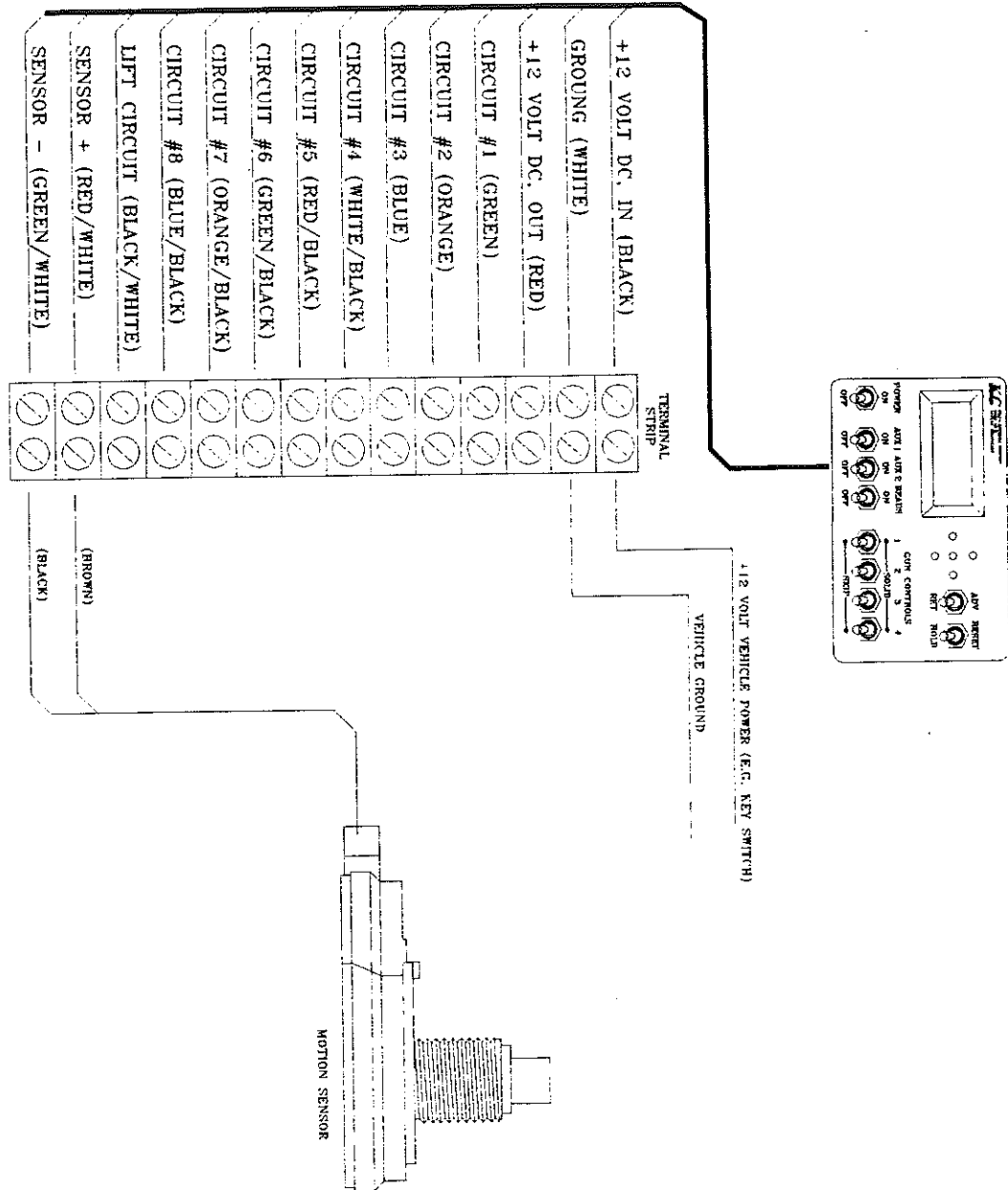
APPENDIX A

GUN SOLENOID INSTALLATION WIRING



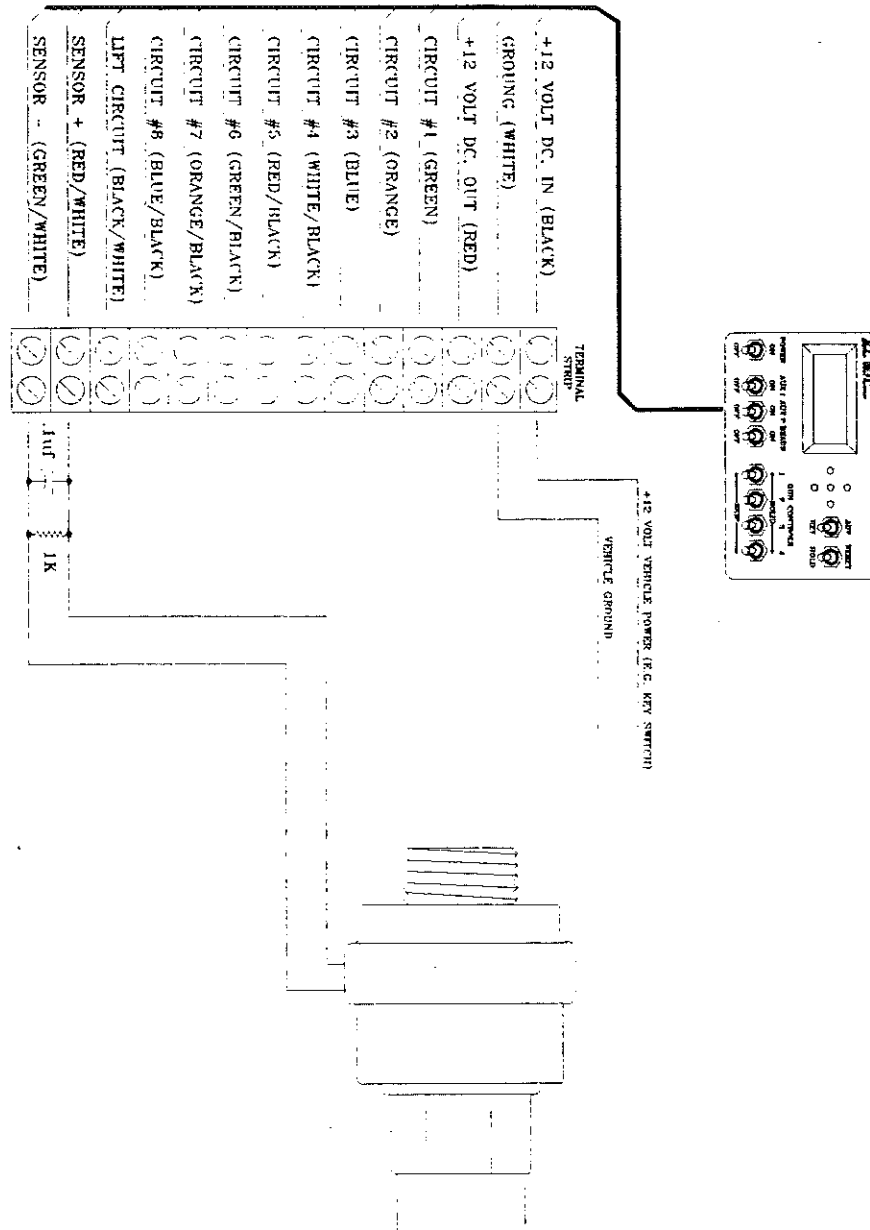
APPENDIX A

TWO WIRE MOTION SENSOR INSTALLATION WIRING



APPENDIX A

TWO WIRE MOTION SENSOR TRANSMISSION STYLE INSTALLATION WIRING

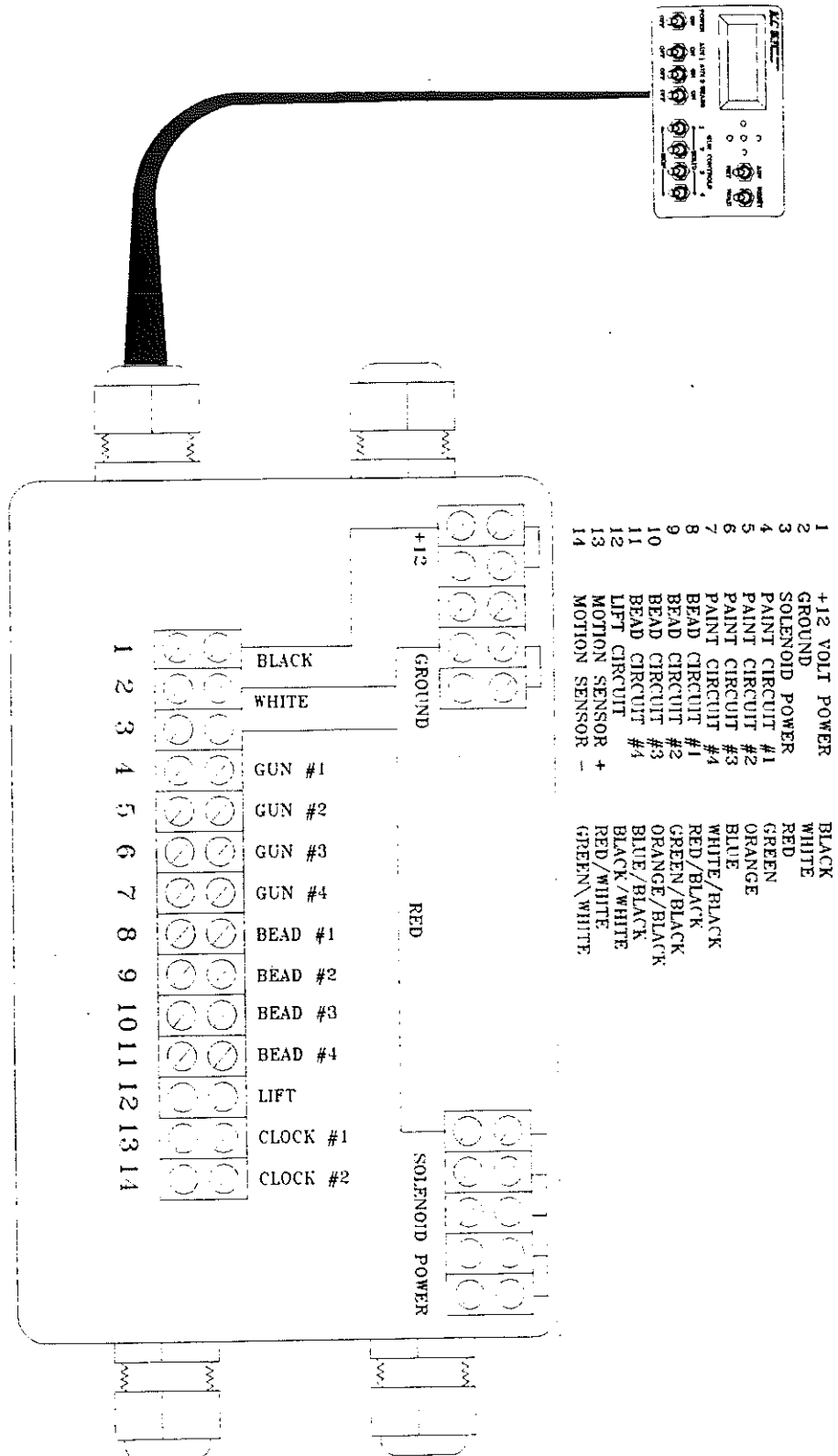


SINGLE ENDED MOTION SENSOR INSTALLATION WIRING



APPENDIX A

WIRING JUNCTION BOX LAYOUT



APPENDIX A

MARK 40-D CONNECTOR WIRING

MAIN CONNECTOR:

Amphenol MS-3106A2027S

C1

A:	BLACK,	+12 VDC IN
B:	WHITE,	GROUND
C:	RED,	+12 VDC OUT
D:	GREEN,	PAINT #1
E:	ORANGE,	PAINT #2
F:	BLUE,	PAINT #3
G:	WHITE/BLACK,	PAINT #4
H:	RED/BLACK,	BEAD #1
I:	GREEN/BLACK,	BEAD #2
J:	ORANGE/BLACK,	BEAD #3
K:	BLUE/BLACK,	BEAD #4
L:	BLACK/WHITE,	LIFT CIRCUIT
M:	RED/WHITE,	SENSOR +
N:	GREEN/WHITE,	SENSOR -

TRIGGER CONNECTOR:

Amphenol MS-3106A-10SL-3S

C2

A:	BLACK,	MANUAL TRIGGER SWITCH
B:	WHITE,	GROUND
C:		NC

APPENDIX A

PORTABLE WIRING HARNESS

When installed on a portable paint machine a special wiring harness is used, it is assembled with three individual cables leading from the Main connector. Each of the three cables is associated with a particular section of the machine. The black two wire cable is for power and ground. The gray three wire cable will carry the gun solenoid signals. The gray two wire cable will route the clock signal back to the control unit. The chart below will describe the cable and their functions.

MAIN CONNECTOR:

Amphenol MS-3106A2027S

Pin #	Wire Color	Cable Type	Description
A:	Black	2 Wire Cable (Black)	+12 volt in
B:	White	"	Ground
C:	Red	3 Wire Cable (Gray)	+12 (Solenoid
D:			No Connection
E:	Black	3 Wire Cable (Gray)	Left Paint Gun
F:	White	3 Wire Cable (Gray)	Right Paint Gun
G:			No Connection
H:			No Connection
I:			No Connection
J:			No Connection
K:			No Connection
L:			No Connection
M:	Black	2 Wire Cable (Gray)	Clock #1
N:	White	2 Wire Cable (Gray)	Clock #2

MENU FLOW DIAGRAM



APPENDIX C

SOLENOID DELAY TABLES

This chart should be used to find the proper solenoid delay value. To find the delay value find the error distance in inches along the top of the chart. Find the vehicle speed on the left side of the chart. Find at the intersection of the error (top) and the speed (left). This is the solenoid delay value.

If the line is too long add to the ON delay value. If the line is too short add to the OFF delay value. If the ON and OFF delay values are changed by the same amount. The position of the line will move with respect to the other.

		DISTANCE IN INCHES									
		1	2	3	4	5	6	7	8	9	10
S P E E D M P H	5	.012	.022	.034	.046	.056	.068	.080	.090	.102	.114
	6	.010	.018	.028	.038	.048	.056	.066	.076	.086	.094
	7	.008	.016	.024	.032	.040	.048	.056	.064	.072	.082
	8	.006	.014	.022	.028	.036	.044	.050	.056	.064	.070
	9	.006	.012	.018	.026	.032	.038	.044	.050	.056	.064
	10	.004	.012	.018	.022	.028	.034	.040	.046	.052	.056



APPENDIX D

MARK 40-D SETUP VALUES

MARK 40-D SERIAL #

SOFTWARE REVISION

DATE OF PURCHASE

SKIPCYCLE

PAINT LENGTH 10.0 PAINT 30.0 SKIP

CYCLE LENGTH 40.0

ALTERNATE PAINT LENGTH

ALTERNATE CYCLE LENGTH

OPTIONS

UNITS (ENGLISH/METRIC)

START CYCLE (PAINT/SKIP)

POSI-CYCLE (ON/OFF)

PATTERN CHANGE (IMMEDIATE/SMART/TRIG./TRG.-RESET)

TRIGGER SPRAY (OFF/CONTINUOUS/CYCLE)

DELAYS

PAINT ON DELAY

PAINT OFF DELAY

BEADS ON DELAY

BEADS OFF DELAY

BEAD DISTANCE

CALIBRATION

CALIBRATION DISTANCE 1000.0 FT

CALIBRATION PULSE COUNT 9498

NOTE: See Section 4 Calibration Adjustment for a detailed description on obtaining the calibration values.

TRUCK SPEED BEST AT 6 MPH