INSTRUCTION MANUAL

700194K

EN1000/EN1001 CASCADE/MULTI-VALVE SERIES CONTROLS

MICROPROCESSOR BASED
Weld Sequence Controls
With
Solid State Thyristor Contactors

	Wiring Diagrams	
Cabinet Style	**EN1000**	**EN1001**
NEMA	421214-023	421438-004
NEMA with SCR	421214-024	421438-005
NEMA with Ignitron Tube	421214-025	421438-006
Flat Plate	421214-026	421438-009

Intended for use with firmware versions 619044-002L and Higher

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ENTRON Controls, LLC.

MICROPROCESSOR BASED WELDING CONTROLS

INSTALLATION AND OPERATION MANUAL FOR:
Model Series EN1000/EN1001 CASCADE/MULTI-VALVE
NEMA Type: ALL

! CAUTION !
READ THIS MANUAL COMPLETELY BEFORE ATTEMPTING TO INSTALL OR OPERATE THIS CONTROL

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ENTRON Controls, LLC.
Greer, South Carolina 29650

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1.0 GENERAL DESCRIPTION

The EN1000/EN1001 Cascade/Multi-Valve Control is a microprocessor based welding control. It can perform Upslope, Downslope, Quench, Temper, Pulsation, Seam, and Spot, with standard eight valve outputs (and additional eight as option), all of which can be combined to provide for any possible welding schedule imaginable. It can store as many as 12 base parameters in each of 100 unique schedules. These are held in non-volatile memory for storage. In addition, schedules can be chained together to provide more complex welding sequences. Despite the seemingly complicated possible welding schedules, both the EN1000 and EN1001 Cascade/Multi-Valve Controls are simple to program and operate.

The control provides accurate, predetermined execution of welding schedules for specific numbers of cycles upon an external command. Initiation commands can be given by the closure of a normally-open switch installed as part of the welding machine. The initiation switches need not remain closed for the duration of the weld, but must be opened after the welding interval is completed in order to re-initiate the control. After a weld has been started, the control cannot be re-initiated until the previous sequence is completed.

The EN1000 and EN1001 Cascade/Multi-Valve Controls are designed to operate in conjunction with a welding transformer rated for the 60 Hz or 50 Hz output frequency. These controls can be used either on 60 Hz or 50 Hz, without any additional settings or parameter changes. These controls are not designed to operate with mid-frequency transformers with 500 Hz to 2000 Hz operating frequency rating.

The EN1001 differs from EN1000 as it has a Constant Current mode of operation – see Section 5.4.14 and Section 8.0.

1.1 STANDARD FEATURES (All Models)

DIGITAL PHASE SHIFT CURRENT CONTROL – Varies the output waveform duty cycle from 0% to 99%, adjustable in 1% steps by means of Front Panel push buttons and direct reading LED displays.

FUNCTION TIMING – Control uses Front Panel push buttons and direct reading LED displays to program parameter timing in 1 cycle steps. Timing of SQUEEZE, HOLD, and OFF are achieved by counting each cycle of the line current directly. This method of timing allows this control to be used on either 50 Hz or 60 Hz power without special adjustments.

NOTICE
NO ADJUSTMENT is required for timing to change from 60 to 50 Hz operation.

OPERATING CONDITIONS – Temperature Range: 0°C to 70°C (32°F to 158°F).

POWER SUPPLY MONITORING – Control monitors VCC power supply and, whenever this voltage goes below safe operating range, the message **d.o.u.n.** will be displayed on DATA display. After this condition, control must be reset by activating Emergency Stop input or by reapplying the power to the control.

1.1 STANDARD FEATURES (cont.)

PRESSURE SWITCH FIRING – Terminal Strip connection which allows the control to be initiated from a Pressure Switch closure. Remove the jumper from TS1-PS1 and TS1-GND and connect Pressure Switch leads. Pressure Switch is not furnished with control.

EMERGENCY STOP – Terminal Strip connection which allows all control functions to be reset upon opening of the Emergency Stop Switch. **After an Emergency Stop, the control will not re-initiate automatically upon release of the switch.** The control must be re-initiated through the initiation circuits. The display will be flashing ***E.S.*** when TS1-ES1 is open. Remove the jumper from TS1-ES1 and TS1-GND and install a normally closed switch. Emergency Stop Switch is not furnished with control.

VALVE CONTROL TRANSFORMER – Provides the necessary voltage for powering the welding machine solenoid valve(s). Input voltage may be either 240 VAC or 480 VAC, or optional 575 VAC (see Wiring Diagram). Valve transformer output is 115 VAC (optional low voltage transformer for certain operations provides a 24/48 VAC output). A 150 VA transformer is standard in all cabinets (250 VA or 500 VA transformers optional).

NOTICE
This control may be configured for external valve power. See Section 4.3 for Terminal Strip (TS10 or TS15) external valve power connection.

! CAUTION !
When external valve power is used, 24-240 VAC or 24 VDC, valve transformer must be disconnected at TS10-VL1 and TS10-VL2 (TS15-VL1 and TS15-VL2*). Caution must be used to properly insulate the wires from T8-X1 and T8-X2 leads after removing from TS10 on A/N 410322 or TS15 on A/N 410322-001. * TS15 on controls with 9-16 Valve Extension (VE) Option.

1.2 CONTROL PANEL LAYOUT

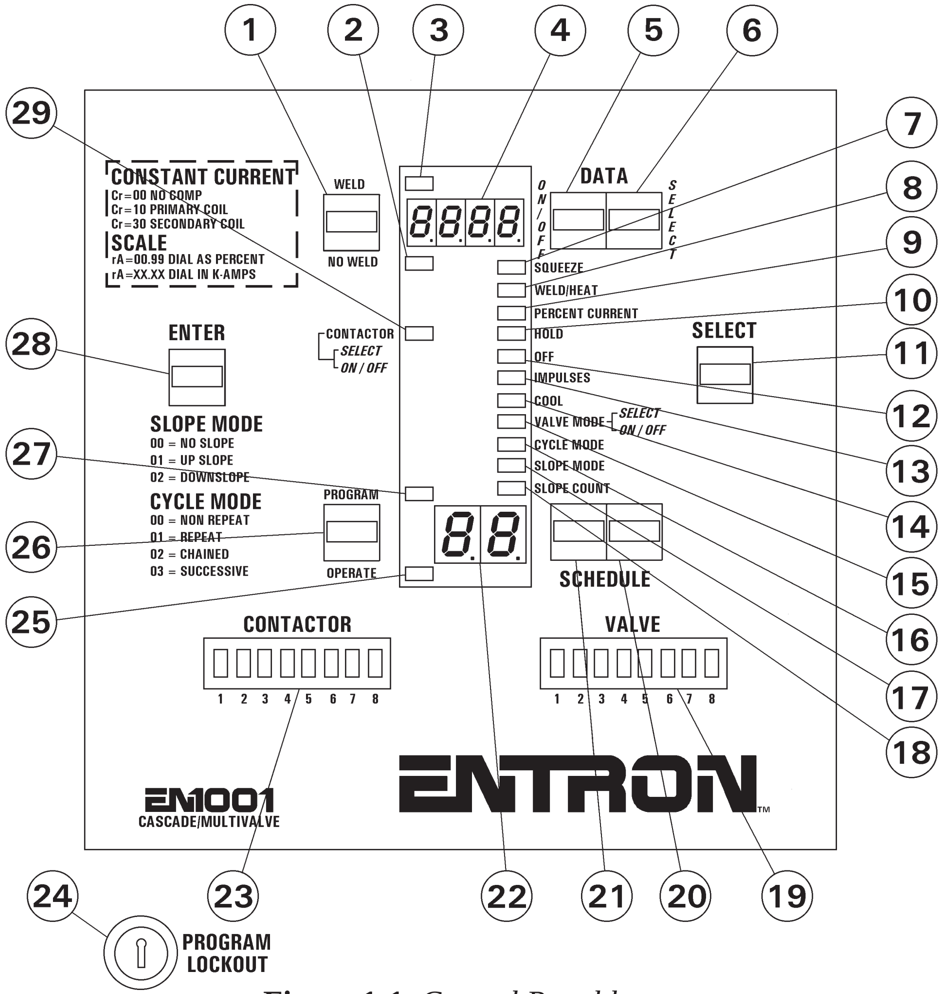


Figure 1-1. *Control Panel layout*

1 - WELD/NO WELD push button
2 - NO WELD mode indicator LED
3 - WELD mode indicator LED
4 - DATA display
5 - DATA 10s push button
6 - DATA 1s push button
7 - SQUEEZE function indicator LED
8 - WELD/HEAT function indicator LED
9 - PERCENT CURRENT function indicator LED
10 - HOLD function indicator LED
11 - SELECT push button
12 - OFF function indicator LED
13 - IMPULSES function indicator LED
14 - COOL function indicator LED
15 - VALVE MODE function indicator LED
16 - CYCLE MODE function indicator LED*
17 - SLOPE MODE function indicator LED*
18 - SLOPE COUNT function indicator LED
19 - VALVE indicator LEDs
20 - SCHEDULE 1s push button
21 - SCHEDULE 10s push button
22 - SCHEDULE display
23 - CONTACTOR indicator LEDs
24 - PROGRAM LOCKOUT key switch
25 - OPERATE mode indicator LED
26 - PROGRAM/OPERATE push button
27 - PROGRAM mode indicator LED
28 - ENTER push button
29 - CONTACTOR indicator LED

* For operator convenience, codes for SLOPE MODE and CYCLE MODE functions are printed on the left side of the Control Panel.

On **EN1000** Control Panel layout, there is no added text for CONSTANT CURRENT modes.

2.0 PROGRAMMABLE FUNCTIONS

SCHEDULES – The EN1000/EN1001 Cascade/Multi-Valve Controls can store up to 100 schedules. A weld sequence may include more than one schedule. A chain of schedules, for example, may be used to add a forge operation during a weld sequence, or add a quench and temper sequence to a schedule. In the simplest form, a weld schedule may include SQUEEZE, WELD, and HOLD only. In a more complex form, a schedule may include: SQUEEZE and PRESSURE or FORCE for the electrode, WELD time and STEPPER count, CURRENT in [%] or [kA] and HI/ LO CURRENT limits when using CONSTANT CURRENT mode, HOLD, etc. All of these features may be accessed by means of Front Panel parameters.

EXTENDED FUNCTIONS – The EXTENDED FUNCTIONS are used instead of Jumper or Dip-switch settings. They are accessible from the Front Panel by simply pressing the SELECT push button until FUNCTION indicator LED reaches SLOPE COUNT, then press once more. At this point, the top display (DATA) will show **EF**. By pressing the SCHEDULE push buttons, the EXTENDED FUNCTIONS are visible in the bottom display (SCHEDULE). For most features, such as CHAINED schedules or SUCCESSIVE initiations, it is not necessary to enable functions. For some others such as STEPPER (**S.t.**), it is necessary to just enable a Front-Panel accessible EXTENDED FUNCTION. For others, it is necessary to add optional hardware to the base control, such as the Integrated Pressure Sense Control System or Constant Current operation.

2.1 CONTROL FUNCTIONS – See Figure 1-1. *Control Panel layout*

WELD/NO WELD PUSH BUTTON (1) **–** This push button is active at all times. It puts the control in the WELD mode (enables the weld firing pulse) or NO WELD mode (disables firing). This function is accessible while in OPERATE mode or while welding with few exceptions (generally during error conditions).

WELD (3)/**NO WELD** (2) **INDICATOR LEDs –** These lights indicate the firing status of the control. The LEDs toggle whenever the WELD/NO WELD push button is pressed.

DATA PUSH BUTTONS (5) & (6) **–** The right button increments DATA display (4) by one, and the left button increments by ten. When either digit reaches the maximum, it resets to zero. For parameters which allow programming of all four digits, the right button affects the two right-hand digits – press to increment by one; press and hold to increment by ten. The left button affects the two left-hand digits – press to increment by 100; press and hold to increment by 1000. Only active in the PROGRAM mode.

FUNCTION INDICATOR LEDs (7-10, 12-18 and 29) **–** The indicator LEDs light up to indicate the active SCHEDULE parameter. They correspond to the programmable functions listed on the Control Panel as the operator presses SELECT to view function values.

SELECT PUSH BUTTON (11) **–** Use the SELECT push button to choose any SCHEDULE parameter. As the button is pressed, the corresponding LED will light up to indicate the parameter data in the DATA display. Holding the SELECT push button momentarily will reverse the direction of the LED movement when the button is released.

2.1 CONTROL FUNCTIONS (cont.) – See Figure 1-1. *Control Panel layout*

EXTENDED FUNCTIONS – One of the features found while paging through the functions by using the SELECT push button is the EXTENDED FUNCTIONS (**EF**). The EXTENDED FUNCTIONS are a second layer of parameters that apply to all the schedules and can modify or enhance the way the control operates (see Section 5.4). To view the EXTENDED FUNCTIONS, press SELECT until all LEDs are off and DATA display shows **EF**. Use SCHEDULE push buttons to scroll through **EF** parameters.

SCHEDULE DISPLAY (22) **–** The SCHEDULE display shows the number of the active schedule. The EN1000/EN1001 Cascade can store up to 100 schedules, numbered from 00 to 99.

SCHEDULE PUSH BUTTONS (20) & (21) **–** The right button increments SCHEDULE display by one, and the left button increments by ten. When either digit reaches the maximum, it resets to zero.

There are two ways to select the active schedule (see Section 5.4.3):

1. INTERNAL: Use the SCHEDULE push buttons and **select** the desired schedule. Initiation on TS1-FS3 to TS1-GND will select the schedule shown in the display.
2. EXTERNAL: Use a combination of TS1-FS7/SS1 and TS1-FS11/SS3 to **select one of four schedules**.

PROGRAM/OPERATE PUSH BUTTON (26) **–** This push button will put control in PROGRAM or OPERATE mode. PROGRAM (27) and OPERATE (25) LEDs indicate which mode control is in:

PROGRAM mode is the mode in which the individual schedules can be entered or modified. Data such as WELD time, PERCENT CURRENT, VALVE select, etc., can only be changed in the PROGRAM mode.

OPERATE mode is the normal operating mode for the control. This is the only mode in which the control can be initiated for a weld. When the control is in OPERATE mode, the control is in a Ready (to initiate) state.

PROGRAM LOCKOUT KEY SWITCH (24) (Optional) **–** A PROGRAM LOCKOUT key switch can be ordered as a factory-installed option. It may also be added later by the customer, if desired. To install the key switch, remove the key switch hole-plug from the Front Panel and mount the switch using the nut and lock-washer provided. Connect the plug from the switch onto the mating 2-prong connector (J1) on the back of the Display Circuit Board.

To put the control in **PROGRAM** mode using the PROGRAM LOCKOUT key switch:

Rotate the key 45 degrees clockwise and hold, while holding the key in this position, press and release the PROGRAM/OPERATE push button, then release the key. The OPERATE LED will now turn off and the PROGRAM LED will turn on, indicating programmability of all functions.

To put the control back in the **OPERATE** mode:

Press the PROGRAM/OPERATE push button again. The control will return to the OPERATE mode without the necessity of rotating the key.

See Section 5.4.17 for detailed information on PIN LOCKOUT mode.

2.1 CONTROL FUNCTIONS (cont.) – See Figure 1-1. *Control Panel layout*

ENTER PUSH BUTTON (28) – The ENTER push button is used to **store** the data shown **from** the DATA display **into** the non-volatile **memory** which retains data with the power off.

NOTICE
If ENTER is **not** pressed before other data is viewed (by pressing the SELECT push button) or before returning to the OPERATE mode, the data will not be stored; however, it is not necessary to press the ENTER push button to save the four-digit DATA display.

VALVE INDICATOR LEDs (19) – The LEDs under the word "VALVE" (small lower right window) indicate which valves will be used in the current schedule. VALVE LEDs will turn on either when the VALVE MODE parameter is selected or during the execution of a welding schedule. Codes for valve selection are given in Table 2-1.

NOTICE
The control can activate **any or all of eight solenoid valves** available on the standard Valve Output Board. The programming of the valves is done by choosing a schedule and then turning VALVE LEDs on. Since this is done visually, there are no codes to memorize or follow. The corresponding valves will turn on according to the pattern shown. While in the OPERATE mode, and while viewing the current VALVE setup, the DATA display will show the hexadecimal (hex) representation of the pattern seen in the VALVE display, digits 1 through 16 will show as 1 2 3 4 5 6 7 8 9 a b C d E F.

CONTACTOR INDICATOR LEDs (23) – The LEDs under the word "CONTACTOR" (small lower left window) indicate which contactor will be used in the current schedule. It will turn on either when the FUNCTION indicator LED stops at CONTACTOR while viewing parameters or at the time of firing a transformer during the execution of a weld sequence.

NOTICE
The control can activate **one of up to eight contactors** per schedule. The programming of the contactors is done by choosing a schedule and then turning the chosen CONTACTOR LED on. Since the programming is done visually, there are no codes to memorize or follow. The corresponding contactor will fire during the execution of the schedule it is assigned to. See Section 6.2.3 on CHAINED mode for cascade weld operation and Section 5.4.2 for Simultaneous Contactor Firing. While in the OPERATE mode, and while viewing the current CONTACTOR setup, the DATA display will show the hexadecimal (hex) representation of the pattern seen in the CONTACTOR display, digits 1 through 16 will show as 1 2 3 4 5 6 7 8 9 a b C d E F.

2.2 SEQUENCE TIMED PARAMETERS (Count Functions)

PARAMETER	RANGE	Factory Default Setting
SQUEEZE	00 to 99 cycles	00
WELD/HEAT	00 to 99 cycles	00
HOLD	00 to 99 cycles	00
OFF	00 to 99 cycles	00
IMPULSES	01 to 99 impulses	01
COOL	00 to 99 cycles	00
SLOPE COUNT	00 to 99 cycles	00

NOTICE

NO ADJUSTMENT is required for timing to change from 60 to 50 Hz operation.

SQUEEZE COUNT (7) – The **time duration for the electrodes to close** on the work and build up pressure **before** WELD time begins.

WELD/HEAT COUNT (8) **–** The **time during which current will flow through the welding transformer** (during one impulse in impulse welding). It **starts after SQUEEZE** or after the closure of a Pressure Switch, whichever occurs last.

HOLD COUNT (10) **–** The **time during which the electrodes will remain in contact** with the work to allow the weld nugget to congeal. It starts **after the WELD time.**

OFF COUNT (12) **–** In the REPEAT mode, the **time duration between HOLD count and SQUEEZE count** to allow the work to be repositioned.

COOL COUNT (14) **–** The **time between heat IMPULSES** (in multiple impulse welding).

SLOPE COUNT (18) **–** The **number of additional WELD cycles** during which **PERCENT CURRENT increases or decreases** to achieve SLOPE (gradual increase or decrease in current).

2.3 OTHER PROGRAMMABLE SEQUENCE PARAMETERS

IMPULSES (13) **–** The **number of heat IMPULSES** that will occur in a schedule.

PERCENT CURRENT (9) **–** The **percentage of conduction time** provided to the welding transformer primary from 0 to 99%, adjustable in 1% steps. This parameter is also used to set HIGH and LOW limits in CONSTANT CURRENT mode (see Section 8.1.1).

2.3 OTHER PROGRAMMABLE SEQUENCE PARAMETERS (cont.)

VALVE MODE (15) – The eight solenoid valves are activated based on selecting desired valves, using right DATA push button to select valve (1 to 8) to change and left DATA push button to toggle the selected valve on or off. Programmed valves will be indicated by the VALVE indicator LEDs on bottom right of Control Panel, as well as 7-segment LEDs of DATA display. Each vertical segment on upper row represents each valve 1-8 (Figure 2-1). Once all desired valves are programmed, press ENTER to save the setting. Upon pressing ENTER, the VALVE code (Table 2-1) will flash twice in the middle two digits of DATA display.

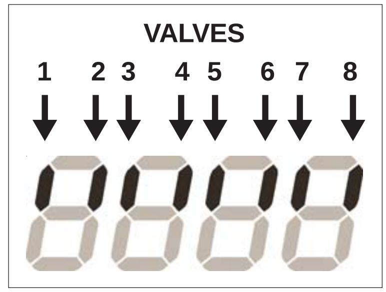


Figure 2-1. *Valve indication in DATA display*

Table 2-1. *VALVE codes*

VALVE code right digit	VALVE LED 1 2 3 4	Description	VALVE code left digit	VALVE LED 5 6 7 8	Description
0	0 0 0 0	Four valves off	0	0 0 0 0	Four valves off
1	1 0 0 0	Valve 1	1	1 0 0 0	Valve 5
2	0 1 0 0	Valve 2	2	0 1 0 0	Valve 6
3	1 1 0 0	Valves 1 & 2	3	1 1 0 0	Valves 5 & 6
4	0 0 1 0	Valve 3	4	0 0 1 0	Valve 7
5	1 0 1 0	Valves 1 & 3	5	1 0 1 0	Valves 5 & 7
6	0 1 1 0	Valves 2 & 3	6	0 1 1 0	Valves 6 & 7
7	1 1 1 0	Valves 1, 2 & 3	7	1 1 1 0	Valves 5, 6 & 7
8	0 0 0 1	Valve 4	8	0 0 0 1	Valve 8
9	1 0 0 1	Valves 1 & 4	9	1 0 0 1	Valves 5 & 8
a	0 1 0 1	Valves 2 & 4	a	0 1 0 1	Valves 6 & 8
b	1 1 0 1	Valves 1, 2 & 4	b	1 1 0 1	Valves 5, 6 & 8
C	0 0 1 1	Valves 3 & 4	C	0 0 1 1	Valves 7 & 8
d	1 0 1 1	Valves 1, 3 & 4	d	1 0 1 1	Valves 5, 7 & 8
E	0 1 1 1	Valves 2, 3 & 4	E	0 1 1 1	Valves 6, 7 & 8
F	1 1 1 1	Valves 1, 2, 3 & 4	F	1 1 1 1	Valves 5, 6, 7 & 8

NOTICE

The VALVE indicator LEDs will indicate the selected valve(s). The valve output will not be energized while in PROGRAM mode.

NOTICE

Beside the standard eight valve outputs, which are programmed as indicated in Table 2-1, there is one more valve output used for PROCESS OUTPUT (see Section 5.4.7).

2.3 OTHER PROGRAMMABLE SEQUENCE PARAMETERS (cont.)

CYCLE MODE (16) – The manner in which the control performs schedules is determined by the code programmed into this function as described in Table 2-2. See Section 6.2 for detailed information on CYCLE MODE functions.

Table 2-2. *CYCLE MODES*

CYCLE MODE	MODE	Description
00	NON-REPEAT	The control can be initiated for only one sequence (see Section 6.2.1)
01	REPEAT	After initiation, the control internally re-initiates as long as the initiation switch is maintained closed (see Section 6.2.2)
02	CHAINED	Several schedules can be chained together so that several consecutive schedules can be sequenced from one initiation (see Section 6.2.3)
03	SUCCESSIVE	Several schedules can be sequenced successively upon separate initiations (see Section 6.2.4)
04	CONDITIONAL SUCCESSIVE	Valves remain active at the end of HOLD (*this is indicated by blinking HOLD indicator LED*) until control is re-initiated and next schedule will be sequenced (see Section 6.2.5)
05	WAIT-HERE	After TS1-FS3 initiation, wait either in SQUEEZE or WELD-COOL or HOLD part of the sequence until control is re-initiated with TS1-FS7 or TS1-FS11 and schedule 20 or 40 will be sequenced (see Section 6.2.6)

SLOPE MODE (17) – Determines **direction of the ramp** with respect to programmed weld PERCENT CURRENT. See Section 6.3 for detailed information on SLOPE MODE functions.

Table 2-3. *SLOPE MODES*

SLOPE MODE	Description
00	**NO** SLOPE
01	**UP**SLOPE
02	**DOWN**SLOPE

NOTICE

The CYCLE MODE and SLOPE MODE function codes are printed on the Control Panel, adjacent to the ENTER push button, for operator convenience.

3.0 INSTALLATION

The EN1000 and EN1001 Cascade/Multi-Valve Controls can be provided in different cabinet styles with one to eight SCR Contactors.

3.1 INSTALLATION & MOUNTING DIAGRAMS – “L/H/G/U” CABINETS

Example of “G” Cabinet with six SCR Contactors is shown in Figure 3-1. See Figure 3-2 for mounting information.

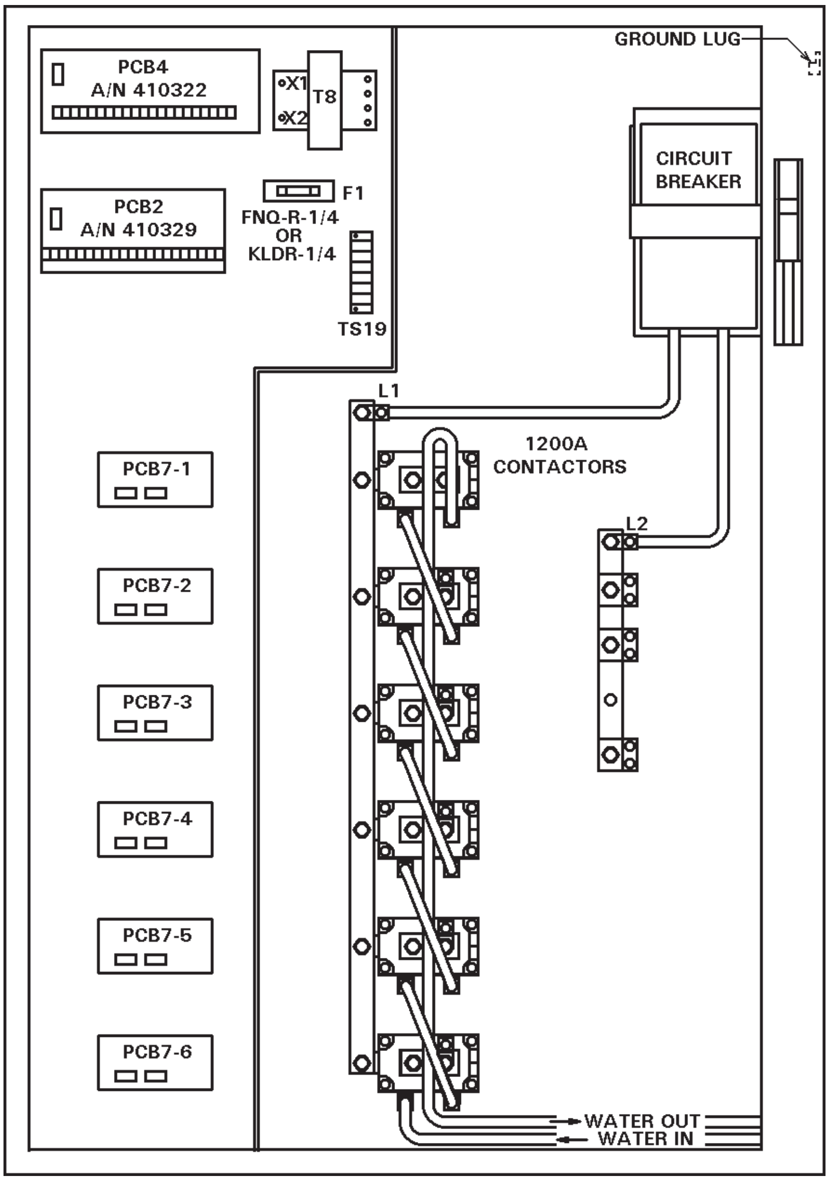


Figure 3-1. *Style “G” Cabinet – 1200A Contactors*

3.1 INSTALLATION & MOUNTING DIAGRAMS – “L/H/G/U” CABINETS (cont.)

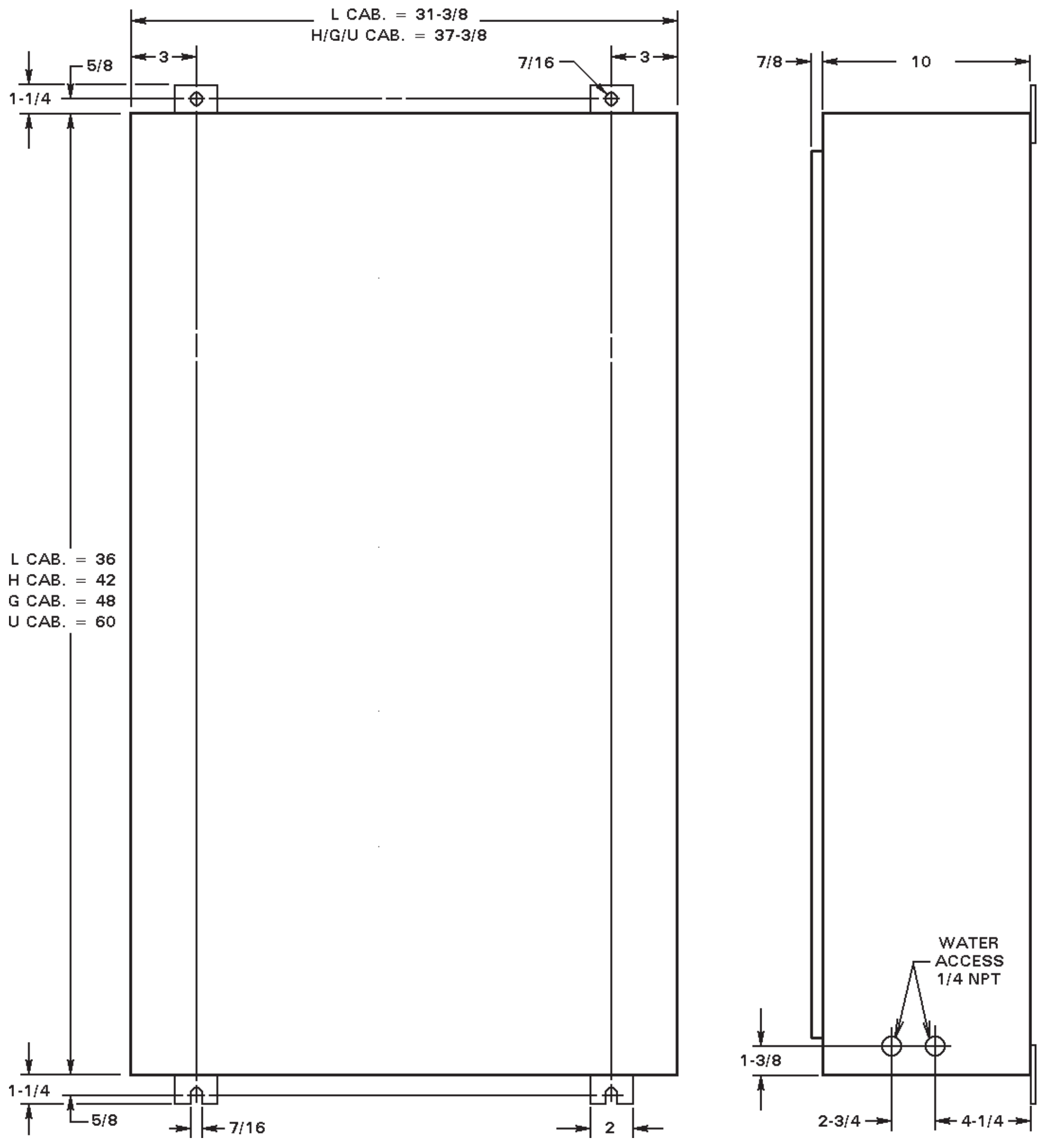


Figure 3-2. *Mechanical mounting diagram for “L/H/G/U” cabinets*

3.2 INSTALLATION & MOUNTING DIAGRAMS – FLAT PLATE

The EN1000/EN1001 Flat Plate Control is equipped with state-of-the-art microprocessor-based logic circuits, valve and control power supplies, and firing circuits for each of the existing SCRs. This model consists of three assemblies to provide easy location and mounting.

3.2.1 INDIVIDUAL COMPONENT ASSEMBLIES

FIRING BOARD ASSEMBLY

This assembly consists of a 9" x 24" plate containing from 1 to 8 individual firing board assemblies. Each individual firing board assembly is equipped with a sense transformer and surge resistors dedicated to each existing SCR. Each individual firing board has inputs for the cathode and gate connections, the temperature limit switch and 16 pin (In and Out) firing board interface sockets to cascade firing signals from the microprocessor control board. The main power input terminal strip is also located on this assembly. The power terminal strip (TS11) inputs are clearly labeled for the L1 and L2 and the various SCRs H1 connections.

INPUT/OUTPUT CONTROL POWER SUPPLY ASSEMBLY

This assembly consists of a 9" x 24" mounting plate containing a control power transformer, valve transformer, peripheral input circuit board, valve output circuit board, and control power fuse block. Power (L1 and L2) inputs to the valve transformer primary are clearly labeled. The valve output circuit board (Terminal Strip TS10) provides 8 available 120VAC outputs. The peripheral input circuit board provides connections for foot switch (initiation), Emergency Stop, Process Outputs, Pressure Switch, etc., connected via the TS1 terminal strip. Fuse (F1) is a 6/10 amp which limits current flow to the control circuits.

CONTROL DISPLAY ASSEMBLY

This assembly, a Display Mounting Plate measuring 9-9/16" x 9-9/16", consists of a microprocessor control panel display with push button programming and interface ribbon cable connector. Data entry and direct access to all schedule parameters are possible through this panel.

3.2.2 INSTALLATION

When choosing mounting location, bear in mind the wire harnesses joining the assemblies have a finite length. The various cable lengths are as follows:

J3	Control Power (from Transformer to Display Panel)	30" length
J7	Firing Signal Interface (from Display to Firing Board Panel)	38" length
J4A	Initiation Input Interface (from Display to I/O Panel)	31" length

When locating these assemblies, be aware cable routing distance must be taken into account. Provide some slack to minimize over-stressing the cable connection terminations. Locate SCRs near the Firing Board Assembly. SCR gate and cathode wires should be physically isolated from other wiring to avoid electrical transients from causing false triggering of SCRs (fusing may be required). Some SCRs have sensitive gates. In these cases, special care should be taken to isolate interconnecting wires.

3.2.2 INSTALLATION (cont.)

Use the Wiring Diagram to connect the control. When making connections from Circuit Board to Circuit Board via a 16 pin ribbon cable, be sure the red stripe (indicating pin 1) is in the correct orientation. Ribbon cable connections from Firing Board to Firing Board (In and Out) should already be installed. Customer connections are highlighted on the Wiring Diagram.

Develop a systematic method to install all customer connections.

Check to insure that no connections are omitted or connected improperly to guarantee proper operation of the control. Reference the Wiring Diagram for location of all customer connections.

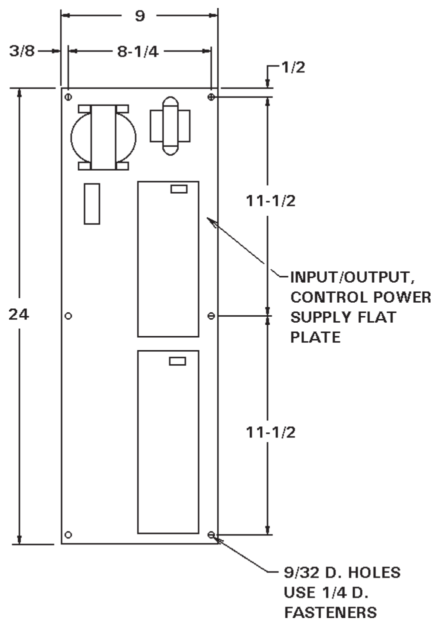


Figure 3-3. *Input/Output Assembly mounting detail*

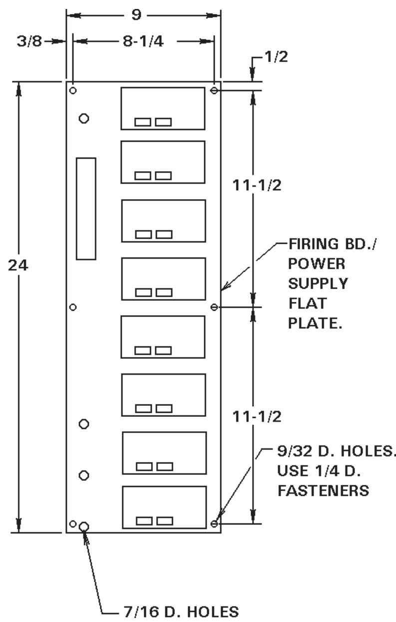


Figure 3-4. *Firing Board Assembly mounting detail*

RECOMMENDATIONS

Route initiation wires on paths isolated from any valve and transformer wiring. Isolating high voltage from low voltage wiring is essential in minimizing internal transients. Connect a solid earth ground to the control cabinet or mounting location to avoid electrical shock and insure proper control functionality. Some SCRs have sensitive gates. In these cases, special care should be taken to isolate interconnecting wires.

3.2.3 RETROFIT APPLICATION

This model can be used to retrofit any manufacturer's cascade/multiweld welding control depending on the size of the cabinet being considered. If the component assemblies' dimensions are too large, the SCR Firing Board Assembly may be altered only if the number of SCRs allows. For example, a Firing Board Assembly may only contain three Firing Boards. Removal of the unused portion of the plate will provide additional space. The retrofit configuration described within this document may, or may not, fit the layout of the cabinet being considered.

3.2.3 RETROFIT APPLICATION (cont.)

RETROFIT CABINET PREPARATION

Remove all contents of the cabinet with the exception of the SCR assemblies and welding transformer primary wiring. If the Firing Board Circuit is part of the SCR assembly, it must be isolated in order to allow firing directly from the SCR Firing Boards included on Firing Board Assembly. Install Firing Board Assembly and Input/Output Control Power Supply Assembly using existing cabinet studs wherever possible. Mount all three assemblies securely to minimize vibration.

The Display Panel plate dimensions may differ from the original equipment. It may be necessary to modify the cabinet to provide the 8" x 8" mounting holes. If possible, locate this assembly in the same space occupied by the panel being replaced.

RETROFIT TO AN ENTRON CABINET

It may be possible to retrofit this control to existing EN100, EN200, EN300 Series ENTRON Cascade/Multi-Valve Controls with NEMA Enclosures.

Remove all contents of the cabinet with the exception of the SCR assemblies and welding transformer primary wiring. When mounting the Firing Board Assembly and Input/Output Control Power Supply Assembly, panel mounting holes may line up with some mounting studs in the cabinet being fitted. The Input/Output Control Power Supply Assembly is intended to be located on the side wall of the control cabinet as shown in Figure 3-5.

NOTICE
Refer to Figure 3-6 and Mounting Detail 440450-002 for hole locations and diameter.

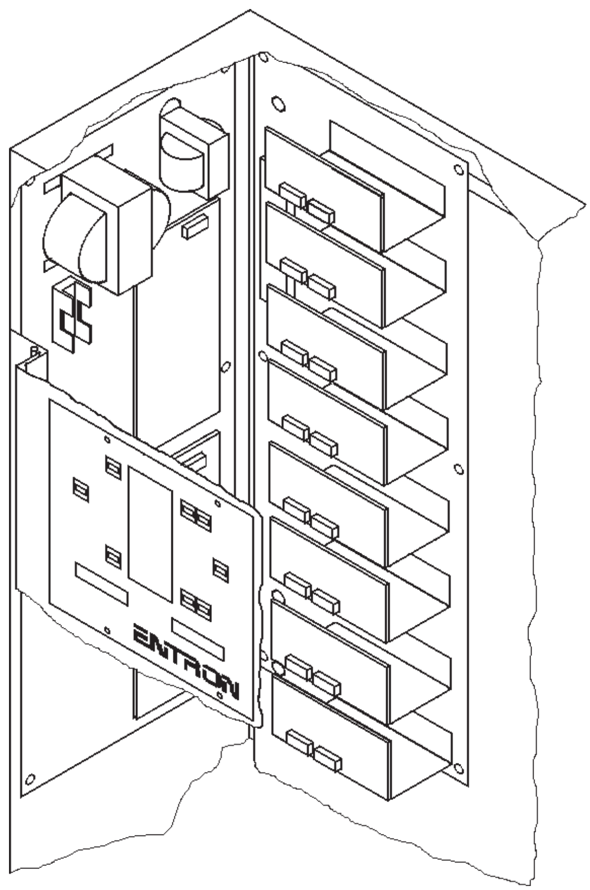


Figure 3-5. *Control Panel placement in existing enclosure*

RECOMMENDATIONS

Route initiation wires on paths isolated from any valve and transformer wiring. Isolating high voltage from low voltage wiring is essential in minimizing internal transients. Connect a solid earth ground to the control cabinet or mounting location to avoid electrical shock and insure proper control functionality. Some SCRs have sensitive gates. In these cases, special care should be taken to isolate interconnecting wires.

! WARNING !
To avoid serious bodily injury and damage to control circuitry, be sure all wiring, including SCR connections, is correct and secure prior to applying power to control.

3.2.3 RETROFIT APPLICATION (cont.)

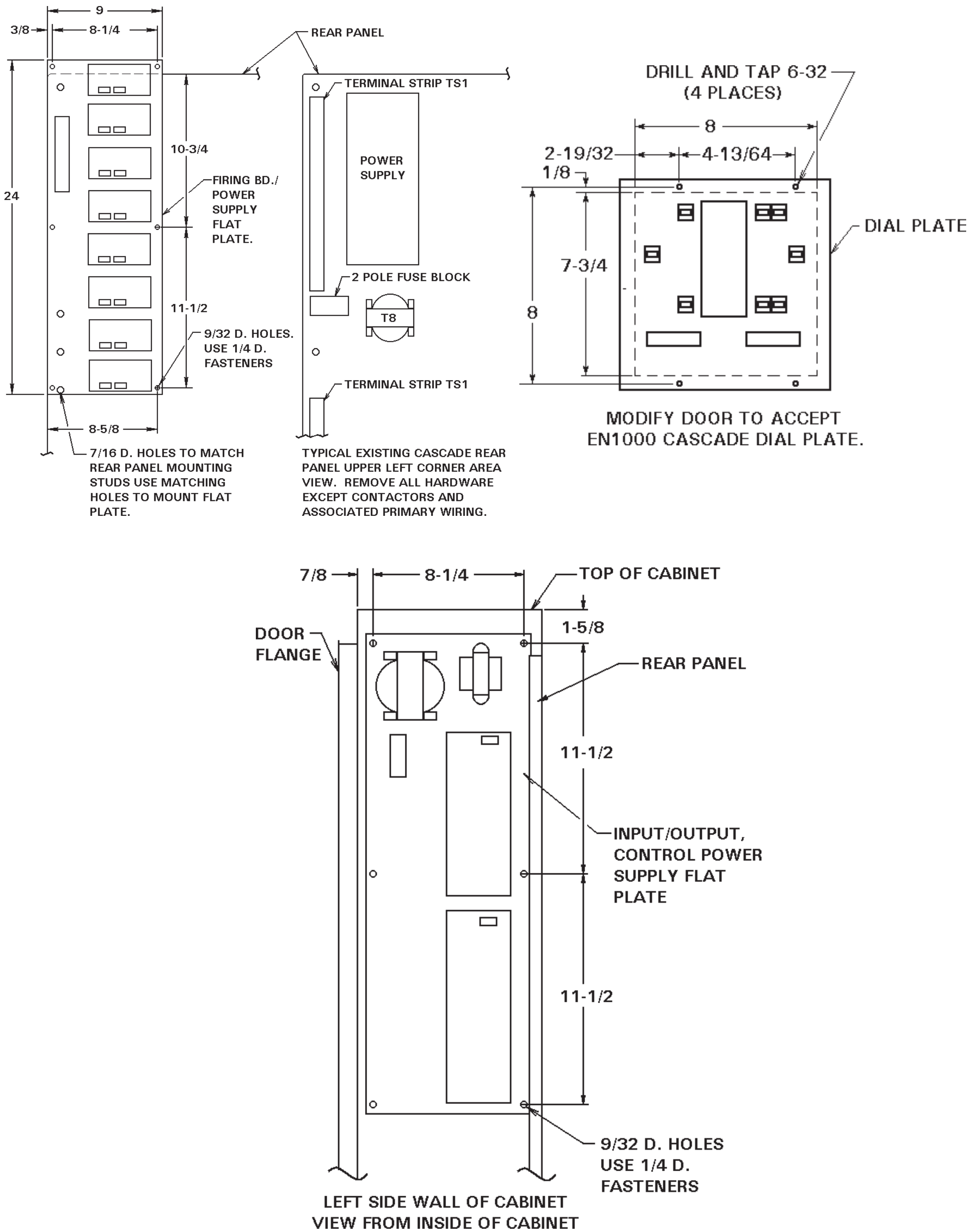


Figure 3-6. *Mounting information for Flat Plate Control in existing enclosure*

3.3 WELDING TRANSFORMER PRIMARY WIRING

SCR OR IGNITRON TUBE CONTACTORS

! DANGER !

WHEN POWER IS ON, ALL EXTERIOR SURFACES OF THE IGNITRON TUBES AND SCRS CARRY HAZARDOUS VOLTAGES.
CONTACT WITH THESE DEVICES MAY CAUSE SERIOUS OR FATAL INJURIES.

1. For your convenience, many electrical and mechanical connections have been performed at the factory. Check **ALL** electrical connections to ensure that all connections are tight. Connections may loosen during shipping.

2. Connect the L1 lead from incoming power to the L1 connection located on the contactor assembly. Connect the H1 lead from the welding transformer to the H1 connection located on the contactor assembly. Follow machine manufacturer's recommended wire size for installation. A connection from L2 must be made to TS11-H2-X/L2 to provide power to the control circuitry. Refer to appropriate Wiring Diagram for other connections.

3. When control is supplied with a circuit isolation device, L1 is factory installed and the L2 control wire is connected to TS11-H2-X/L2.

NOTICE

Connect a chassis ground to the lug provided on the right wall of the control cabinet and to an external earth ground. **A good earth ground is necessary for proper control operation.**

3.4 EXTERNAL SCR CONTACTOR WIRING

External SCR Contactor wiring is shown on Figure 3-7. Connectors J5 and J6 are mounted on Firing Board PCB7. Connector TS12 is located on EN1001 Control Board.

Table 3-1. *External SCR Contactor connections*

Terminal	Connection Description
TS11-L1	Connect to contactor L1 terminal
TS11-H1-X	Connect to contactor H1 terminal
TS11-L2	Connect to circuit isolation device L2 or H2
J5-C	Connect to the cathode of SCR1
J5-G	Connect to the gate of SCR1
J6-C	Connect to the cathode of SCR2
J6-G	Connect to the gate of SCR2
TS12-J12-B	Connect to the current coil (***EN1001 only***)
TS12-J12-W	Connect to the current coil (***EN1001 only***)

For more information, refer to appropriate Wiring Diagram for user's cabinet style.

NOTICE

Do not over tighten TS8, TS9, J5 or J6.

3.4 EXTERNAL SCR CONTACTOR WIRING (cont.)

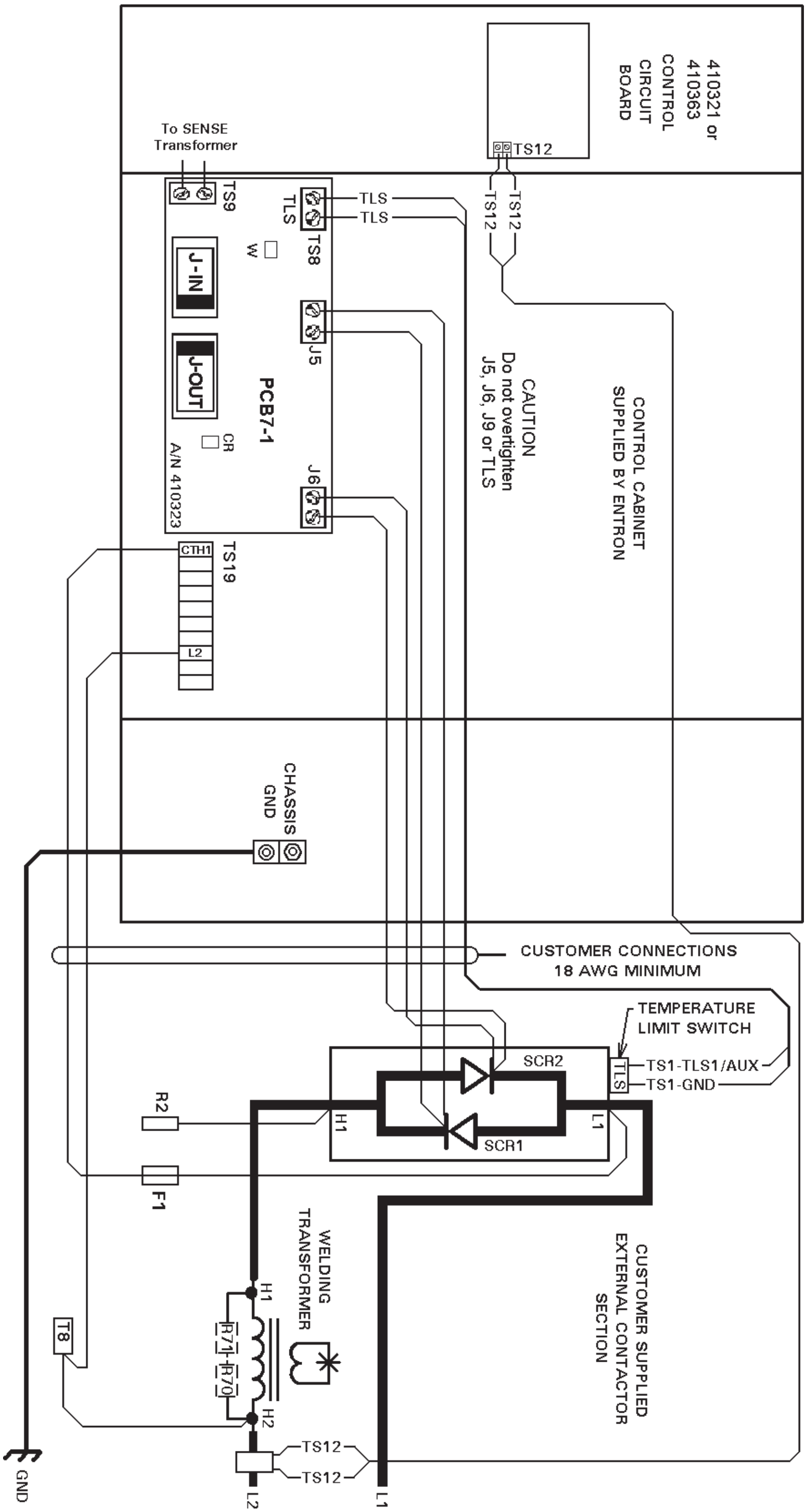


Figure 3-7. *External SCR Contactor connections*

3.5 CONTACTOR SPECIFICATIONS

To help in selecting the proper SCR contactor size for application, use the following "rule of thumb" for sizing SCR contactors for various size transformers.

$$\frac{\text{Transformer KVA x 1000}}{\text{AC Line Voltage}} \text{ x 3 = Maximum Current Demand}$$

Example 1: Using 75 KVA transformer at 230 VAC:

$$\text{Maximum Current Demand} = \frac{75 \text{ x } 1000}{230} \text{ x 3} = \mathbf{978} \text{ Amperes}$$

Example 2: Using 250 KVA transformer operating at 460 VAC:

$$\text{Maximum Current Demand} = \frac{250 \text{ x } 1000}{460} \text{ x 3} = \mathbf{1630} \text{ Amperes}$$

The multiplier factor of 3 in this formula assumes a reasonable secondary configuration of an 8" x 12" throat to a secondary of 13" to 18", with a poor power factor of about 40%, having a necessary adjustment on the welding control of greater than 50 percent current.

A multiplier factor of 2.5 may be used when a machine's power factor is 45% or better. A multiplier factor of 5 or 8 may be required for machines with large secondaries with power factors of 30% or poorer.

When applying the above "rule of thumb", two other parameters must be considered. **Conduction Time –** the time the welding transformer is energized and the **Duty Cycle –** the ratio of Conduction Time to the complete cycle time (including part handling). These are factors that can substantially alter the selection of a contactor with regard to demand current.

The shorter the Conduction Time and Percent Duty Cycle, the greater the current switching capability of a contactor. Conversely, longer Conduction time and higher Duty Cycle reduce the current switch capability of the contactor.

Figure 3-8 shows suggested relationships for Current Demand, Duty Cycle and Conduction Times. All curves on chart are shown in 30 cycle (60 Hz) conduction time. Assuming maximum 30 cycle conduction time and using Figure 3-8, following recommendations would be made for above examples:

> **Example 1:** For 75 KVA transformer operating at 230 VAC, recommended contactor size would be 1200A SCR contactor for Percent Duty Cycle of approximately 14% or less.
>
> **Example 2:** For 250 KVA transformer operating at 460 VAC, recommended contactor size would be 1200A SCR contactor for Percent Duty Cycle of approximately 20% or less.

DUTY CYCLE

Duty Cycle is the percent of the time the weld current is on. A convenient formula for calculating Duty Cycle is:

$$\text{\% Duty Cycle} = \frac{\text{Weld Time (in Cycles) x Number of welds per minute}}{36}$$

3.5 CONTACTOR SPECIFICATIONS (cont.)

Consult machine manufacturer or local resistance welding supplier for assistance in selecting the proper contactor size that fits application.

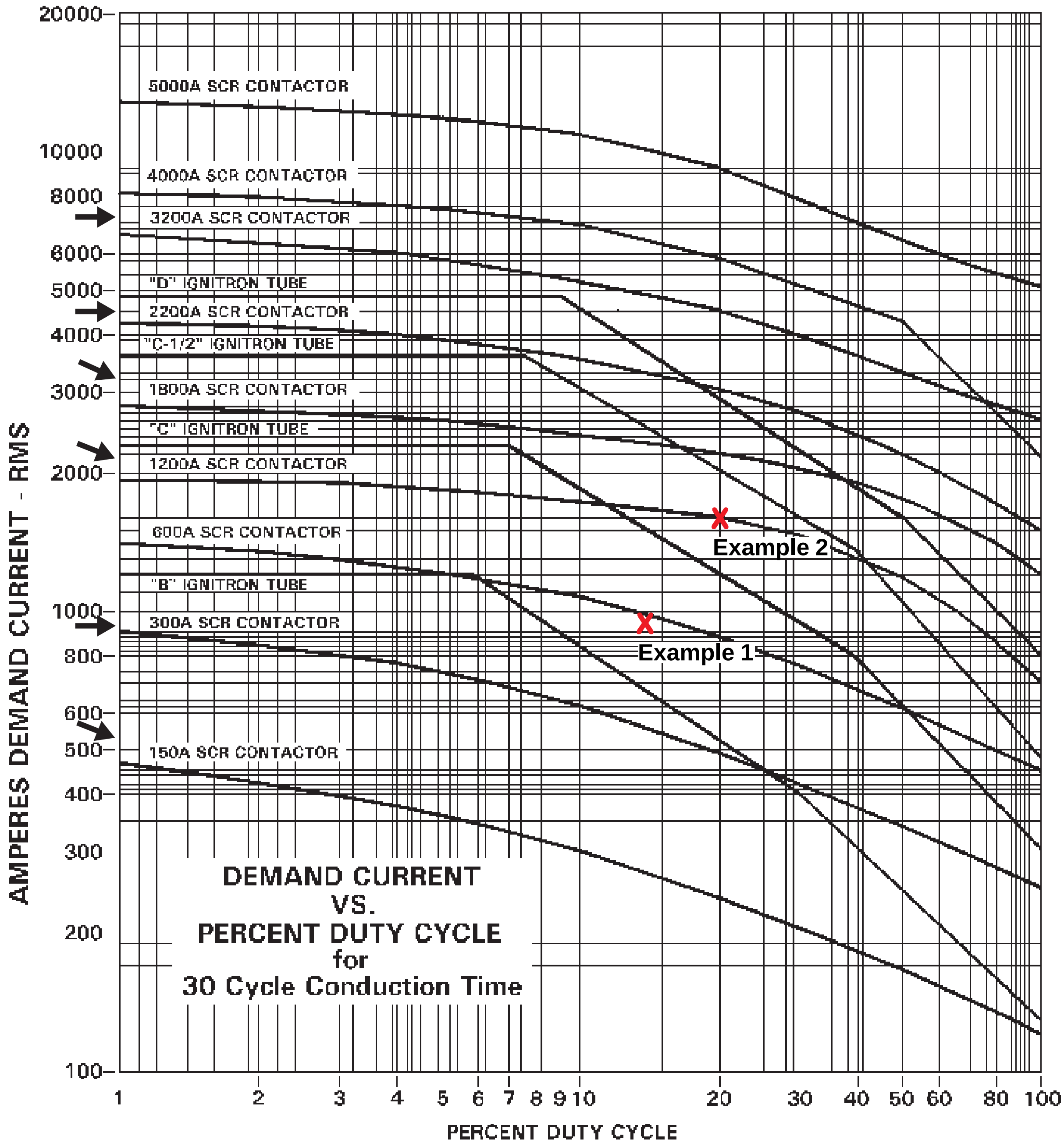


Figure 3-8. *Demand Current vs. Percent Duty Cycle*

NOTICE
Ignition tubes for reference only. SCR Contactors available for EN1000/EN1001 Cascade are: 150A, 300A, 1200A, 1800A, 2200A, and 3200A (indicated by arrows).

3.6 COOLING REQUIREMENTS FOR CONTACTORS

SOLID STATE MANUFACTURER'S COOLING RECOMMENDATIONS

600 A – SCR Solid State Contactor – ***NO LONGER AVAILABLE***
1200 A – SCR Solid State Contactor
1800/2200/3200 A – SCR Solid State Contactor

1 GPM at 104°F (40°C) maximum inlet temperature.

Be sure power to an electronic contactor is turned off when water is turned off.

With a voltage applied, most water will ionize and begin to conduct current between points of high differential voltages. This current is sufficient to heat the water past the boiling point, creating steam and possibly causing the rubber hose to burst. The water spraying over the high voltage circuit can cause considerable damage to the contactor and, most likely, the control circuitry as well. Never use metallic or other conductive tubing to plumb a water-cooled resistance welding contactor. Heater hose has a very high carbon content and should not be used for contactor plumbing. A low carbon, reinforced hose (such as the hose originally supplied with the unit), no less than 18" long, must be used to connect the Heatsinks to each other and to the bulkhead fitting on the inside wall of the cabinet (see plumbing instructions on Wiring Diagram).

The EN1000/EN1001 Cascade water-cooled SCR Contactors are electrically isolated from electrical circuit within the contactor section. No minimum length of water hose is required for electrical isolation of the contactor. It is still recommended to turn power off when control is not in use.

WATER OFF – POWER OFF
POWER ON – WATER ON

For all water-cooled Heatsinks, **be sure water is turned on** before placing welder in operation. An open drain is recommended for best operation. If a closed return system is used, be sure return line is properly sized so that back pressure will not reduce water flow below recommendations. A sight flow indicator is recommended.

4.0 GENERAL OPERATING REQUIREMENTS

4.1 OPERATING VOLTAGE

To insure the control will operate properly, it must be properly grounded. Proper grounding is not only a safety precaution, it will lessen the possibility of electrical interference being introduced into the control. Ground the control at the ground lug on the cabinet.

! CAUTION !

THIS WELDING CONTROL OPERATES ON SINGLE PHASE 208 VAC, 240 VAC, 380 VAC, 480 VAC OR 575 VAC.

When the welding control and/or welding machine is shipped, the voltage at which it was set is marked on the tag attached to the control terminal block.

! WARNING !

THIS WELDING CONTROL IS A MULTI-VOLTAGE UNIT WHICH CAN BE CHANGED FROM ONE VOLTAGE TO ANOTHER BY RE-ARRANGING JUMPERS ON THE TERMINAL STRIP FOUND INSIDE THE UNIT. IF THE CONTROL IS USED ON A VOLTAGE OTHER THAN THE ONE FOR WHICH IT IS WIRED, SERIOUS DAMAGE CAN RESULT.

It is possible to operate the EN1000 and EN1001 Cascade/Multi-Valve Controls at 208, 240, 380, 480, and 575 VAC. When a 380 or 575 VAC main is desired, please consult the factory. When the control is converted from one line voltage to another, there are three changes required:

1. **Control Transformer**: Jumpers on TS19-CTH1, TS19-CTH3, TS19-CTH2, and TS19-CTH4 must be configured to match the line voltage. For TS19 wiring, see Figure 4-1.

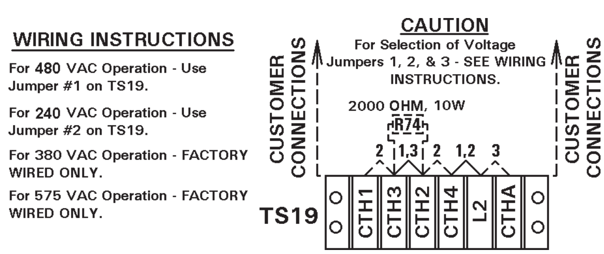


Figure 4-1. *Voltage operation jumpers settings*

2. **Sense Transformer**: Jumpers on T2-H2/H4 to R2-1 must be configured to match the line voltage. For T2-H2/H4 to R2-1 wiring, see Figure 4-2.

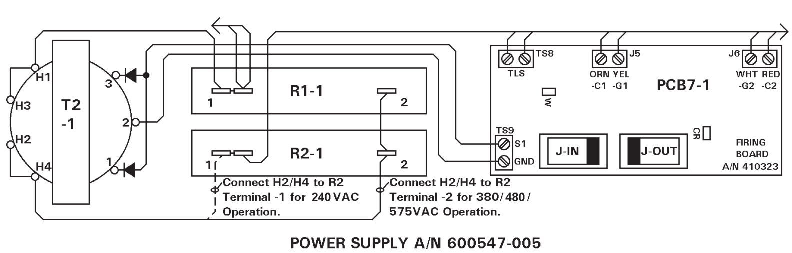


Figure 4-2. *Sense Transformer jumpers settings*

4.1 OPERATING VOLTAGE (cont.)

3. **Valve Transformer**: Jumpers on the valve transformer T8-H1, T8-H3, T8-H2, and T8-H4 must be configured to match the line voltage (see Figure 4-3). The standard Valve Transformer included with the EN1000/EN1001 (either 50 VA or 150 VA) is configured for 240 VAC or 480 VAC input; for 380 or 575 VAC operation, consult the factory.

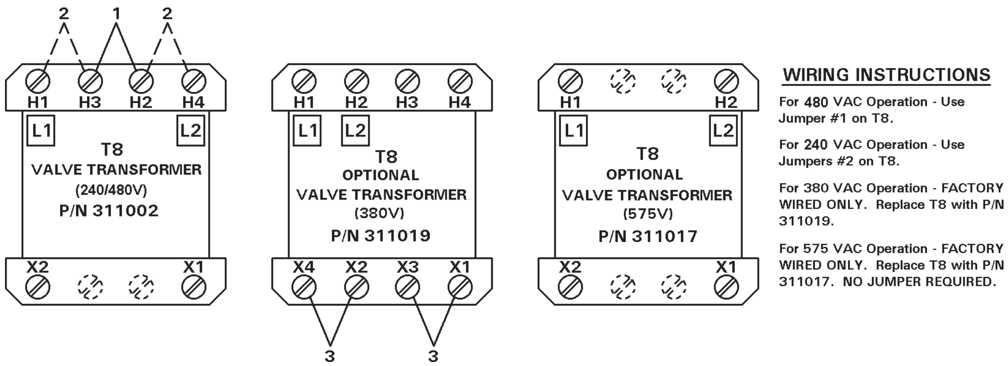


Figure 4-3. *Valve Transformer jumpers settings*

! CAUTION !
When external valve power is used (24-240 VAC), Valve Transformer MUST be disconnected at TS10-VL1 and TS10-VL2 (TS15-VL1 and TS15-VL2*). Caution must be used to properly insulate the wires from T8-X1 and T8-X2 leads after removing from TS10 on A/N 410322 or TS15 on A/N 410322-001.
* TS15 on controls with 9-16 Valve Extension (VE) Option.

NOTICE
Whether valve power is supplied by the Valve Transformer or by an external valve power supply, the maximum current that can be switched by the solid state relays on the Firing Board is maximum 1 A per valve. If more current is desired, the valve circuit should be wired to an external relay having a suitable contact rating to switch the desired valve. For more information, refer to Wiring Diagram shipped with the control.

JUMPER SETTINGS EXAMPLES:

240 Volt Operation Jumpers

Terminal Strip TS19:
- Jumper H1/H3 and H2/H4
- Jumper CTH1/CTH3 and CTH2/CTH4

Valve Transformer:
- Jumper H1/H3 and H2/H4

480 Volt Operation Jumpers

Terminal Strip TS19:
- Jumper H3/H2
- Jumper CTH3/CTH2

Valve Transformer:
- Jumper H3/H2

4.2 FUSING AND SAFE OPERATION

CONTROL FUSE — This fuse, a 1/4 A, is used to protect the control circuits. The fuse holder is located within the control, upper left section of the cabinet.

VALVE FUSES — These fuses, a 2AG 1 A, are used to protect the valve circuits. These nine fuses are located on the Terminal Strip PCB (A/N 410322) within the control.

IGNITOR FUSES — These fuses, BAF 6 A, two per contactor (supplied with ignitron tube retrofit controls only), are used to protect the ignitor circuits of the ignitron tubes. The fuse holders are located on the Ignitron Firing Board Module PCB8 (A/N 410318).

! CAUTION !
INSTALL PROPERLY SIZED FUSES IN SERVICE DISCONNECT SWITCH. CHECK WELDING MACHINE MANUFACTURER'S RECOMMENDATIONS.

! DANGER !
VOLTAGES PRESENT IN THIS CONTROL CAN CAUSE SEVERE OR FATAL INJURY. DO NOT SERVICE ANY COMPONENT WITH POWER ON. USE ONLY THE FUSE TYPE SPECIFIED TO MAINTAIN SAFE OPERATION.

Observe the **WARNING, DANGER** and **CAUTION** labels affixed to the control to maintain safe operation. Some of them are shown in Figure 4-4.

Figure 4-4. *Warning, Danger and Caution labels*

4.3 TERMINAL STRIP DIAGRAMS AND CONNECTIONS

4.3.1 TERMINAL STRIP INPUT TS1 ON PCB2 (A/N 410329)

See Wiring Diagram 421214 (all cabinet styles) for more details.

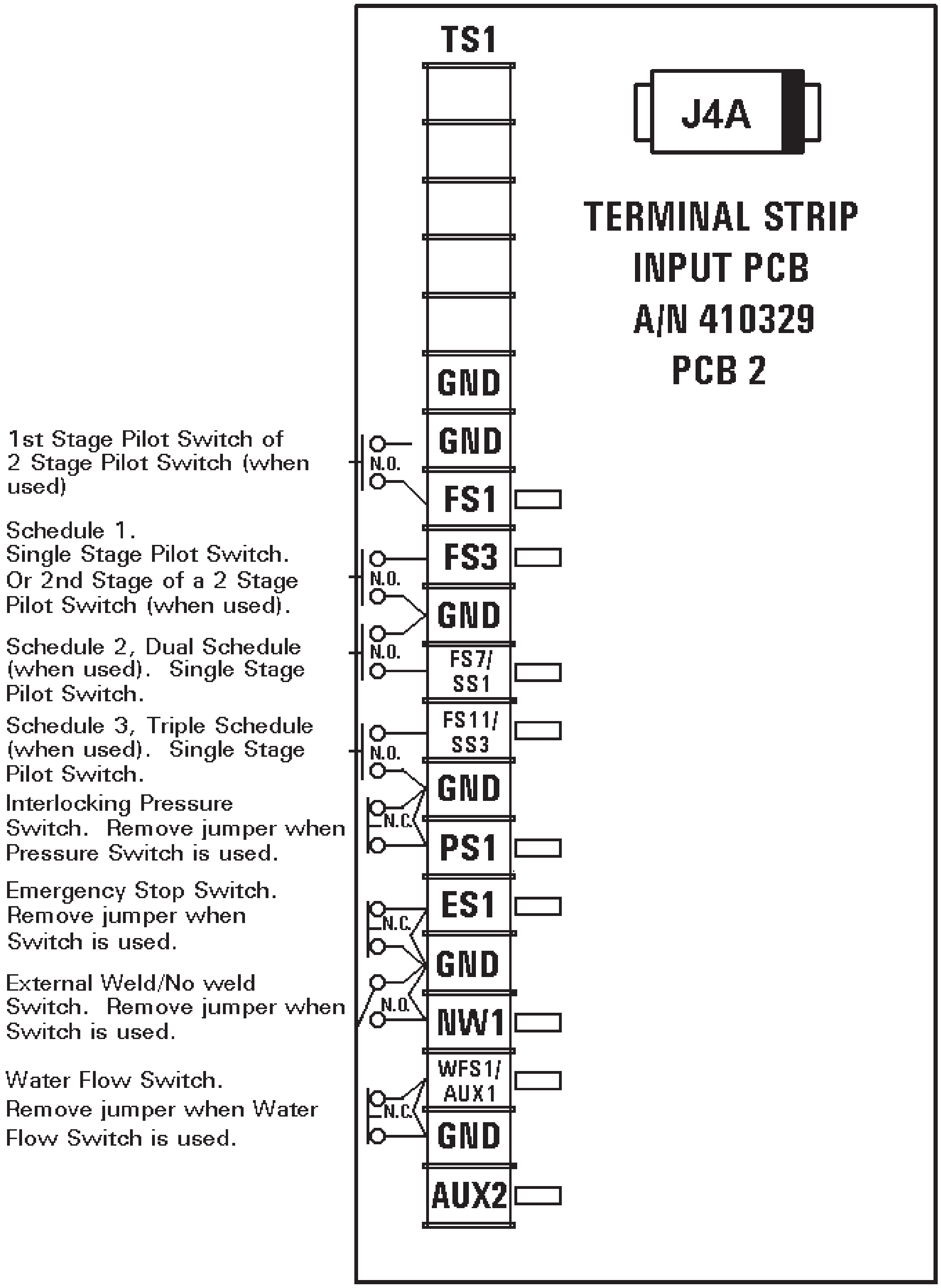


Figure 4-5. *Terminal Strip Input Board*

4.3.2 TERMINAL STRIP OUTPUT TS10 ON PCB4 (A/N 410322)

See Wiring Diagram 421214 (all cabinet styles) for more details.

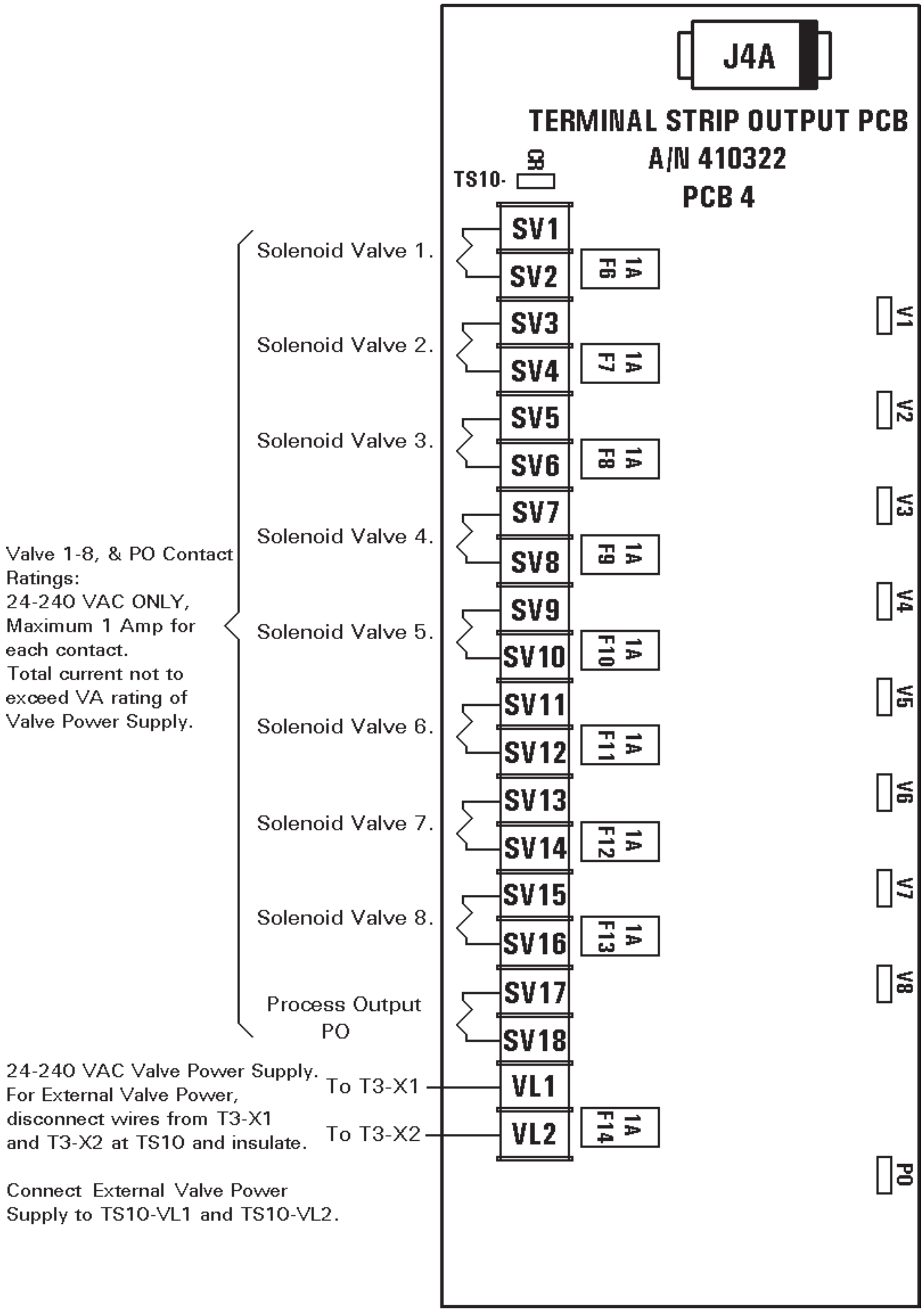


Figure 4-6. *Terminal Strip Output Board for* ***24-240 VAC***

NOTICE
An optional 9-16 Valve Expansion Board (VE Option – A/N 410322-001) can be used for an additional eight valve outputs. See Appendix D for more information.

4.3.2 TERMINAL STRIP OUTPUT TS10 ON PCB4 (A/N 410322) (cont.)

Whenever DC valves are used, standard Terminal Strip AC Output Board must be replaced with Terminal Strip DC Output Board (A/N 410322-002). See Application Note 700189 for more information.

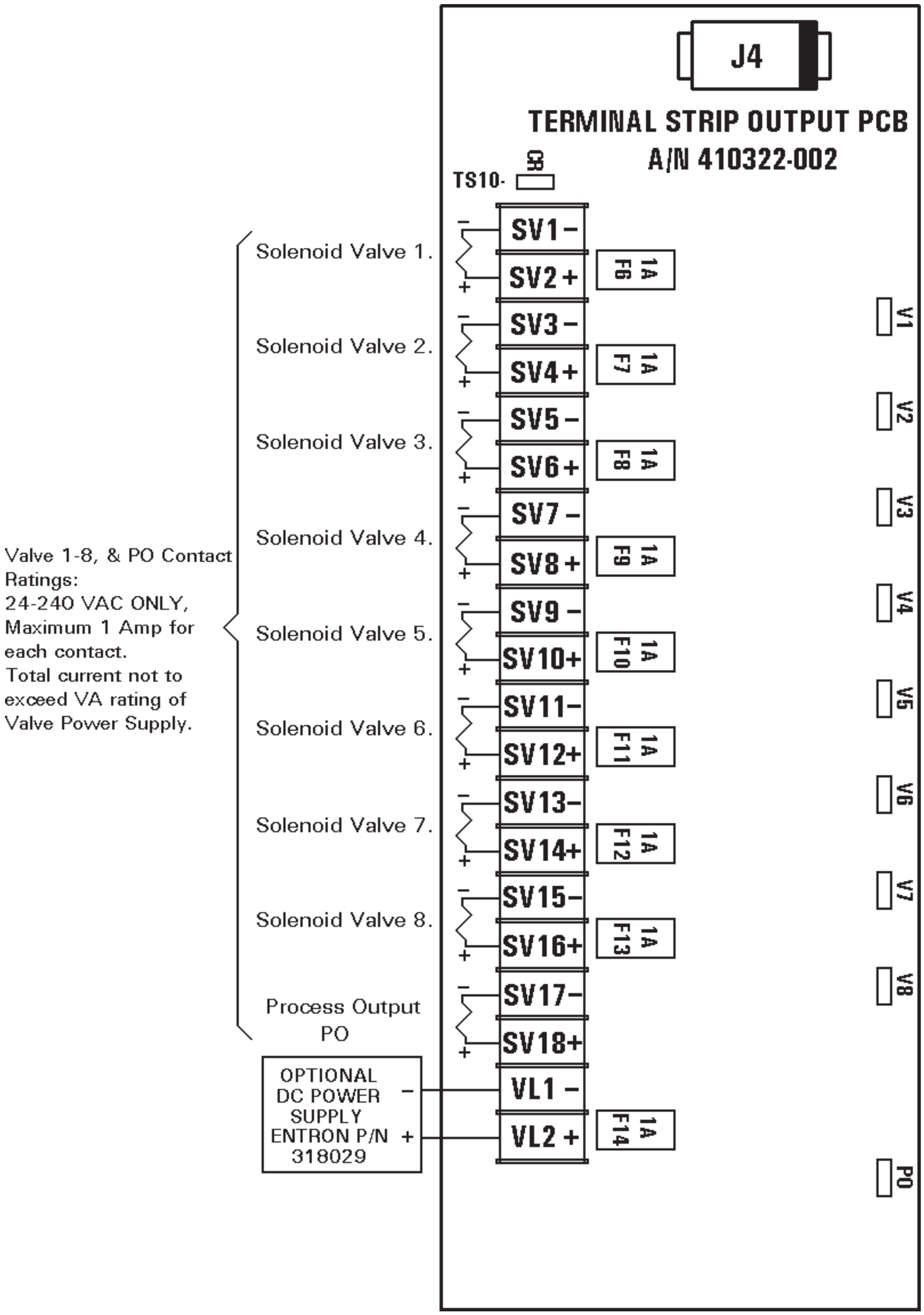


Figure 4-7. *Terminal Strip Output Board for* ***24 VDC***

NOTICE
An optional 9-16 Valve Expansion Board (VE Option – A/N 410322-003) can be used for an additional eight valve 24 VDC outputs. See Appendix D for more information.

4.3.3 TERMINAL STRIP CONNECTIONS – See Figures 4-5, 4-6 and 4-7

TS1	***Terminal Strip Connections Description***
TS1-GND	Used as the **common connection point** for all of the other Terminal Strip input connections. There are six GND terminals provided on TS1.
TS1-FS1	Used to connect one side of the **First Stage of a Two Stage Pilot Switch.** Use a single pole, normally open, momentary type switch. Connect the First Stage of a Two Stage Pilot Switch between TS1-FS1 and TS1-GND terminals.

! CAUTION !

A JUMPER IS NOT REQUIRED ON TS1-FS1 TO TS1-GND WHEN A TWO STAGE FOOT SWITCH IS NOT USED. **DO NOT CONNECT TS1-GND TO EARTH GROUND**.

TS1-FS3	Used to connect **one side of a Single Stage Pilot.** Connect a Single Stage Pilot between TS1-FS3 and TS1-GND terminals. Use a single pole, normally open, momentary type switch. –or– Used to connect **one side of a Two Stage Pilot.** Connect the Second Stage of a Two Stage Pilot between TS1-FS3 and TS1-GND terminals. Use a single pole, normally open, momentary type switch. When initiated via TS1-FS3, the weld control will begin execution at schedule actively shown in SCHEDULE display.

***NOTICE* – DUAL SCHEDULE**

TS1-FS3 is used with a Single Stage Pilot for Dual Schedule operation. Connect another Single Stage Pilot between TS1-FS7 and TS1-GND terminals. Use a single pole, normally open, momentary type switch.

TS1-FS7	When initiated via TS1-FS7/SS1, the weld control will begin execution at schedule 20. –or– Used to connect **one side of a Two Stage Pilot.** Connect the Second Stage of a Two Stage Pilot between TS1-FS7 and TS1-GND terminals. Use a single pole, normally open, momentary type switch. –or– Terminal TS1-FS7/SS1 along with TS1-FS11/SS3 can also function as **inputs to select schedules externally** when EXTENDED FUNCTION ***5.5.***=***01***. To connect for EXTERNAL SCHEDULE SELECT, use two single pole, normally open switches, one connected between TS1-FS7/SS1 and TS1-FS3, the other between TS1-FS11/SS3 and TS1-FS3. As shown in Figure 9-15, these switches can now be **used as pointers to one of four schedules.** TS1-FS3 is then used to initiate the schedule pointed to. See Table 5-1 in Section 5.4.3.

4.3.3 TERMINAL STRIP CONNECTIONS (cont.) – See Figures 4-5, 4-6 and 4-7

TS1	*Terminal Strip Connections Description* (cont.)

TS1-FS11 When initiated via TS1-FS11/SS3, the weld control will begin execution at schedule 40.

–or–

Used to connect **one side of a third Single Stage Pilot.** For initiations of a third of three pre-assigned schedules. Connect a Single Stage Pilot between TS1-FS11 and TS1-GND terminals. Use a single pole, normally open, momentary type switch.

–or–

Used to connect **one side of a Two Stage Pilot.** Connect the Second Stage of a Two Stage Pilot between TS1-FS11 and TS1-GND terminals. Use a single pole, normally open, momentary type switch. When initiated via TS1-FS11/SS3, the weld control will begin execution at schedule 40.

–or–

Terminal TS1-FS11/SS3 along with TS1-FS7/SS1 can also function as **inputs to select schedules externally** when EXTENDED FUNCTION **5.5.**=**01**. To configure for EXTERNAL SCHEDULE SELECT, use two single pole, normally open switches, one connected between TS1-FS11/SS3 and TS1-GND, the other between TS1-FS7/SS1 and TS1-GND, as shown in Figure 9-15. These switches can now be **used as pointers to one of four schedules.** TS1-FS3 is then used to initiate the schedule pointed to. See Section 5.4.3 for more information.

TS1-PS1 Used to connect **one side of a Pressure Switch.** When used, remove jumper between TS1-PS1 and TS1-GND terminals and install normally open Pressure Switch contacts.

TS1-ES1 Used to connect **one side of an Emergency Stop Switch**. When used, remove jumper between TS1-ES1 and TS1-GND terminals and install a single pole, normally closed Emergency Stop Switch. It is possible to install several Emergency Stop Switches in series. Activation of any one switch will put the control into the Emergency Stop condition.

TS1-NW1 Used to connect **one side of an External Weld/No Weld Switch.** When used, remove jumper between TS1-NW1 and TS1-GND terminals and install a single pole, normally open switch. The switch must be in the closed position to weld.

TS1-**WFS1/AUX1**

Used to connect **one side of a Water Flow Switch.** When used, remove jumper and install a normally closed Water Flow Switch between TS1-GND and TS1-WFS1/AUX1 terminals. This terminal may also be used for an auxiliary function in RETRACTION modes or for BACK-STEP mode.

4.3.3 TERMINAL STRIP CONNECTIONS (cont.) – See Figures 4-5, 4-6 and 4-7

TS1	*Terminal Strip Connections Description* (cont.)
TS1-**AUX2**	Currently not used. Reserved for future expansion.

! CAUTION !

When external valve power is used (24-240 VAC) on Terminal Strip Output PCB Board (A/N 410322 or 410322-001), internal Valve Transformer **must** be disconnected at TS10-VL1 and TS10-VL2 (TS15-VL1 and TS15-VL2*). Properly **insulate** the wires from T8-X1 and T8-X2 of the Valve Transformer.

* TS15 on controls with 9-16 Valve Extension (VE) Option.

4.4 INITIATION

The EN1000 and EN1001 Cascade/Multi-Valve Controls are equipped with four weld initiation inputs – TS1-FS1, TS1-FS3, TS1-FS7 and TS1-FS11 – as shown in Figure 4-8 (see also Section 5.4.3), and provide two basic weld initiations: Single Stage Pilot and Two Stage Pilot.

For more information about routing and wiring of initiation wires, see Section 4.6.

NOTICE

This control can be programmed to BEAT operation by programming **b.E.** parameter in EXTENDED FUNCTIONS (see Section 5.4.8). Several modes are available.

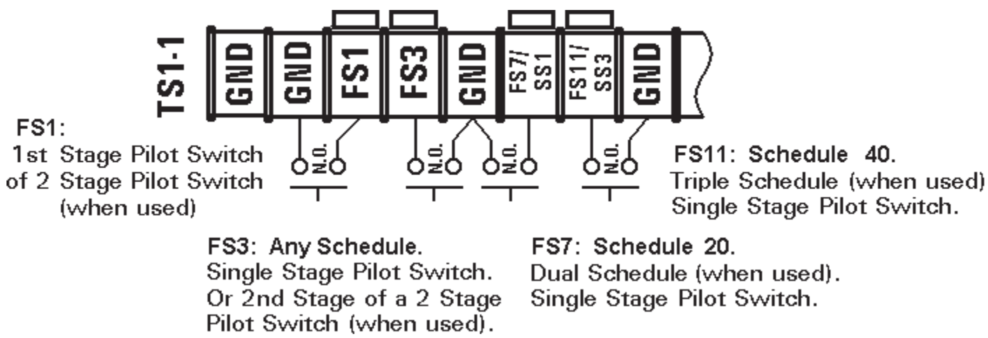


Figure 4-8. *Initiation inputs on Terminal Strip TS1*

4.4.1 SINGLE STAGE PILOT INITIATION

Connect the Pilot Switch between TS1-FS3 and TS1-GND. Once the control is initiated, the switch need not remain closed. The initiation circuit is automatically latched until the control has completed the sequence. In the REPEAT mode, the control will continue to sequence as long as the initiation remains closed. No connection is made to TS1-FS1. See Section 4.3.

4.4.2 TWO STAGE PILOT INITIATION

Connect the First Stage between TS1-FS1 and TS1-GND; then connect the Second Stage between TS1-FS3 and TS1-GND. The First Stage (FS1) activates the solenoid valves programmed in the selected schedule, and will not initiate a sequence. The Second Stage (FS3, FS7 or FS11) initiates

4.4.2 TWO STAGE PILOT INITIATION (cont.)

the sequence in the schedule associated with the chosen foot switch (FS) connection (see Section 5.4.3). It is possible to initiate three separate schedules in Two Stage configuration. Once the control is initiated via TS1-FS3, TS1-FS7 or TS1-FS11, TS1-FS1 does not need to remain closed. The initiation circuit is automatically latched to prevent re-initiation until after the control has completed its sequence. In the REPEAT mode, the control will continue to sequence as long as either stage remains closed.

4.5 OTHER TERMINAL STRIP INPUTS

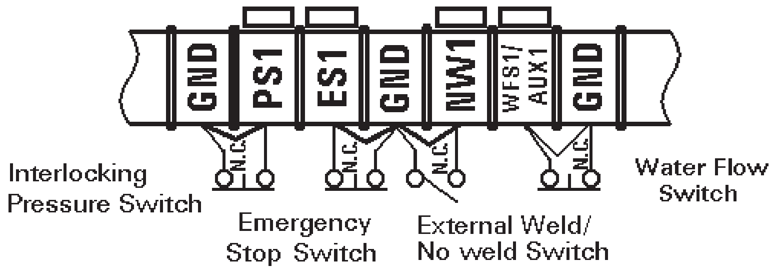


Figure 4-9. *Other inputs on Terminal Strip TS1*

PRESSURE SWITCH – This feature is used to make the control **wait** if the required pressure has not been reached while in the SQUEEZE interval as follows.

After initiation, the control advances through SQUEEZE. If the Pressure Switch is open (pressure not sufficient), the control waits, and the SQUEEZE LED flashes at the end of SQUEEZE. When the Pressure Switch closes (pressure is sufficient), the flashing stops and the control begins to WELD and completes the sequence.

If the Pressure Switch interrupts the sequence for an extended period, the display will flash ERROR CODE ***15***. This error will not terminate the sequence. Once the Pressure Switch closes, the sequence will continue on to WELD and complete the sequence. See Section 4.3.3.

NOTICE
If a Pressure Switch is not used, place a jumper (factory installed) between TS1-PS1 and TS1-GND. **Pressure Switch is not furnished with the control.**

EN1000/EN1001 Cascade/Multi-Valve Controls with PROM firmware version 619044-002**A** or later will have the following Pressure Switch function revised. As of this version, the Pressure Switch will be ignored if WELD time is set to ***00***. This allows sequences that use features such as CLAMP & WELD to only have the Pressure Switch checked for the WELD sequence. Before this version, the Pressure Switch was checked after SQUEEZE in all schedules, including CHAINED schedules.

EMERGENCY STOP SWITCH – When the Emergency Stop Switch is open, the control **stops any and all processes (all valves and firing pulses)**. While in the Emergency Stop condition, the control will flash ***E.S.*** on the DATA and SCHEDULE displays until the condition has been cleared. If the execution of a schedule was interrupted by means of the Emergency Stop Switch, the control will not re-initiate automatically (after the Emergency Stop condition is removed). Upon release of the switch, it must be re-initiated by closing the Pilot switch.

4.5 OTHER TERMINAL STRIP INPUTS (cont.)

NOTICE
If the Emergency Stop Switch is not used, place a jumper (factory installed) between TS1-ES1 and TS1-GND. **Emergency Stop Switch is not supplied with the control.**

WELD/NO WELD SWITCH and **INDICATOR LEDs –** When the control is in NO WELD, the NO WELD LED is illuminated. This allows the operator to initiate a weld sequence without passing current through the welding transformer. When the WELD LED is illuminated, the control switching circuitry will pass current through to the welding transformer during the programmed WELD time ***only*** if WELD Switch is closed. If this switch is open, the control will be in the NO WELD mode even if WELD LED is illuminated.

NOTICE
If a Weld/No Weld Switch is not used, place a jumper (factory installed) between TS1-NW1and TS1-GND. **Weld/No Weld Switch is not supplied with the control.**

WATER FLOW SWITCH or **AUXILIARY SWITCH –** This feature is used to inhibit welding if water is **not flowing**. If this input is open (no flow), the control cannot be initiated until the Water Flow Switch is closed (flowing). Also, if this input becomes open during a weld, the weld interval will continue until the end of WELD time; HOLD and OFF will execute normally but a new sequence cannot be initiated until the input switch is closed. In either of the above cases, the DATA display will show ERROR CODE ***01*** until the Water Flow Switch recovers its normally closed state; then the control will return to normal operation.

NOTICE
If the Water Flow Switch is not used, place a jumper between TS1-WFS1/AUX1 and TS1-GND terminals.

TEMPERATURE LIMIT SWITCH – TS8 terminals on SCR Firing Board – This feature is used to inhibit welding if the temperature of the SCR Heatsink is above the rated operating temperature (149°F). If this input is open (above temperature), the control cannot be initiated until the Temperature Limit Switch cools (resets/closes). Also, if this input becomes open during a weld, the weld interval will continue until the end of WELD time; HOLD and OFF will execute normally but a new sequence cannot be initiated until the Temperature Limit Switch cools and resets (closes). In either of the above cases, the DATA display will show ERROR CODE ***01*** until the Temperature Limit Switch recovers its normally closed state; then the control will return to normal operation.

NOTICE
If the Temperature Limit Switch is not used, place a jumper between TS8-TLS terminals on all SCR Firing Boards (PCB7-1 through PCB7-8).

4.6 NON-VOLATILE MEMORY ERROR

All ENTRON microprocessor based controls make extensive use of non-volatile memory devices for parameter data storage. Although safety features (control relays and opto-isolation) are in place to insure high voltage spikes do not appear on low voltage circuits, non-volatile memory devices can sometimes be affected by improper hookup, electrical disturbances generated in other equipment operating nearby, or in the welding machine itself.

When an EN1000/EN1001 Cascade/Multi-Valve Control is powered up or returns from an Emergency Stop condition, it executes a diagnostic test that reads all memory locations within the schedule storage areas. If invalid data is stored in memory, control will display a flashing **32** in DATA display and **E.r.** in SCHEDULE display alternating with schedule number where invalid data (error) is found. If invalid data is found in EXTENDED FUNCTIONS' memory area, **E.r.** alternates with EXTENDED FUNCTION parameter designation.

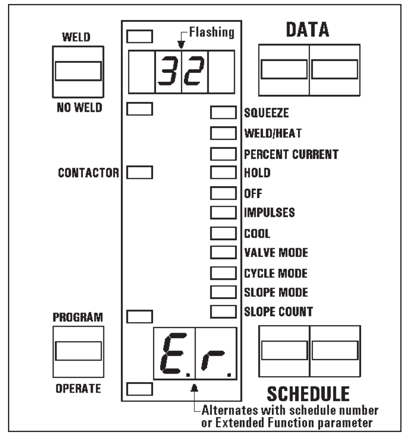


Figure 4-10.
Flashing **14** *or* **32** *Errors*

The ERROR **32** indication does not mean there has been damage to welding control. It simply means something has caused invalid data to be stored in one or more memory locations. The control will not sequence until this error has been corrected.

To recover from this condition:

1. Press SELECT push button to stop flashing.
2. Place control in PROGRAM mode.
3. The operator can use SELECT to find function containing invalid data.
4. Use DATA push buttons to correct data.
5. Press ENTER.
6. Return control to OPERATE mode.

If more than one location has been affected, it may be necessary to use CLEAR ALL command in EXTENDED FUNCTIONS to erase all memory locations and restore default settings (factory settings).

Reoccurring ERROR 32 (ERROR 14 Flashing in previous revisions)

The effects of electrical disturbances can be minimized or prevented by observing the following precautions when installing the welding control:

1. Make sure cabinet is properly grounded to power distribution system, nearby water pipe or other effective building ground with a wire adequate for its application.
2. All wires connected to the pilot input terminals on the TS1 Terminal Strip (FS1, FS3, FS7, FS11, PS1, ES1, NW1, WFS1, and their adjacent GND terminals) should be separated as much as possible from other wires connecting to solenoid valves, welding transformers, and the AC line. These pilot input wires should never be run through the same conduit with solenoid, welding transformer and AC line wires. Connection of any GND terminal to earth ground might cause ERROR **32** or even ERROR **14**.

WRONG example for wiring and routing of low and high wires in same conduit for typical EN1000/EN1001 Cascade Series Controls is shown in Figure 4-11.

4.6 NON-VOLATILE MEMORY ERROR (cont.)

L1 and H1 will radiate electromagnetic spikes onto the parallel wires bundled with it. Initiation wires are low voltage and are most vulnerable to electromagnetic spikes. Also, a short within this bundle could cause severe damage. **CAUTION:** NEVER connect Terminal Strip GND to earth ground.

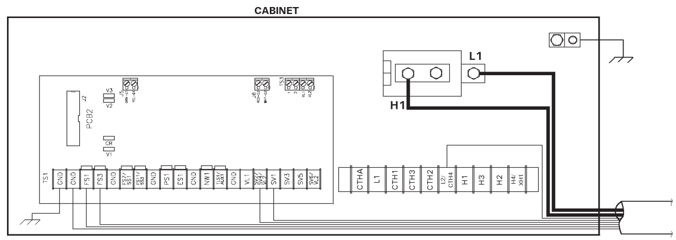


Figure 4-11.
Wrong *routing of low and high voltage wires*

BETTER example is shown in Figure 4-12. Wires are routed parallel to each other but in separate *grounded* conduits. Conduits isolate vulnerable wires and reduce noise, but often, when conduits are running parallel, wires will have some unprotected travel distance inside cabinet. This could couple some electromagnetic spikes onto more vulnerable low voltage circuits.

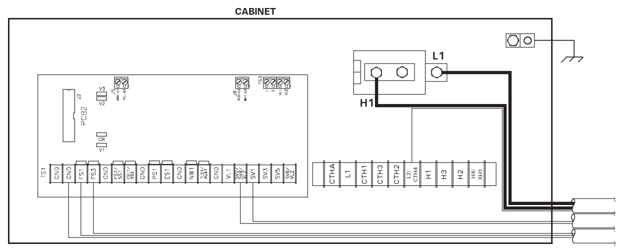


Figure 4-12.
Better *routing of low and high voltage wires*

Use **BEST** wiring method shown in Figure 4-13 to minimize introduction of induced electrical transient spikes that cause corrupt data to be stored in the control's microprocessor. Note that all low voltage initiation wires have been physically isolated from any high voltage wiring. The routing method used in example is not possible in all applications, but should be considered the best possible. It would be ideal to route and exit low voltage terminals (5-18 VDC) at least 6" or more or at opposite end of cabinet from higher voltage terminals (24-240 VAC) and (115-575 VAC).

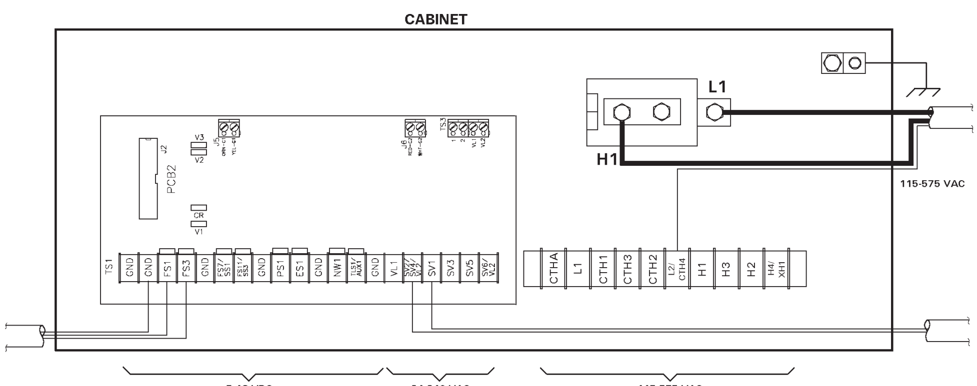


Figure 4-13. ***Recommended*** *routing of low and high voltage wires*

NOTICE
The GND designations on Terminal Strip TS1 are commons only (nominally at ground potential). These points should never be grounded externally. However, control cabinet must be properly grounded using ground lug on inside of cabinet.

NOTICE
Avoid routing high and low voltage wires parallel to each other to eliminate coupling adjacent signals which may cause irregular operation.

4.7 ISOLATION CIRCUITRY DESCRIPTION

The EN1000/EN1001 Cascade/Multi-Valve Controls are microprocessor-based resistance welding controls that incorporate circuitry designed to prevent any output from the control due to spurious or unexpected or false conditions or failure of circuit components. The intent of this section is to explain how the circuitry accomplishes this isolation.

The main isolation is provided by electro-mechanical control relay contacts that are in series with the solenoid valve voltage supply and the contactor firing circuitry. In a non-initiated state, the relay contacts are open and no output from these circuits are possible. When the control is initiated by the physical closure of a normally open set of external contacts (commonly a foot switch) across the initiation circuit, the relays are energized and their contacts close and complete the circuits to the solenoid valve and the contactor. The outputs are not actually energized, however, until the microprocessor reaches the point in the sequence at which the valve or contactor outputs are to be activated.

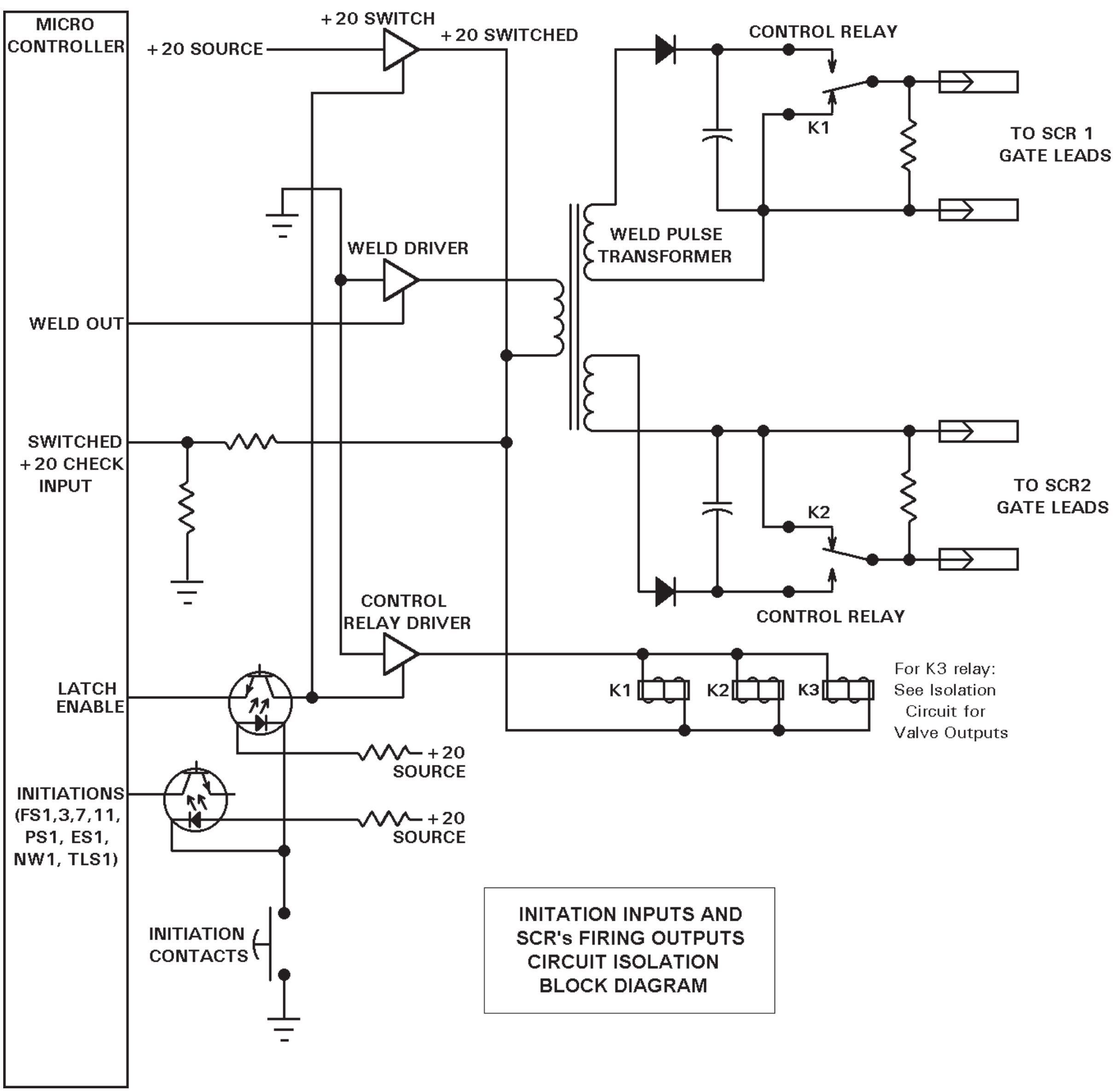


Figure 4-14. *Isolation circuit block diagram*

4.7 ISOLATION CIRCUITRY DESCRIPTION (cont.)

There is no way to guarantee that any control circuit will be immune to component failure. It is always necessary to take personal safety precautions when operating any machinery. Through a PROCESS OUTPUT system, the EN1000/EN1001 Cascade/Multi-Valve Controls can be programmed so that if the 20 volt energizing voltage for the isolation relays appears in the absence of an initiation, or if the SCR contactor conducts current at any time other than when programmed, an output voltage will appear at the PROCESS OUTPUT valve terminals. This voltage can be used to sound an alarm or operate a shunt trip breaker to remove line voltage from the machine and the control.

NOTICE
PROCESS OUTPUT valve (SV17-SV18) will not be isolated.

In addition to the relay contacts mentioned above, there are other levels of isolation. The initiation signals first pass through a circuit comprised of opto-isolators before being passed to the input circuitry of the microprocessor. The valve outputs are further isolated by the use of optically coupled triac (solid state) outputs and the weld pulses are isolated by a pulse transformer.

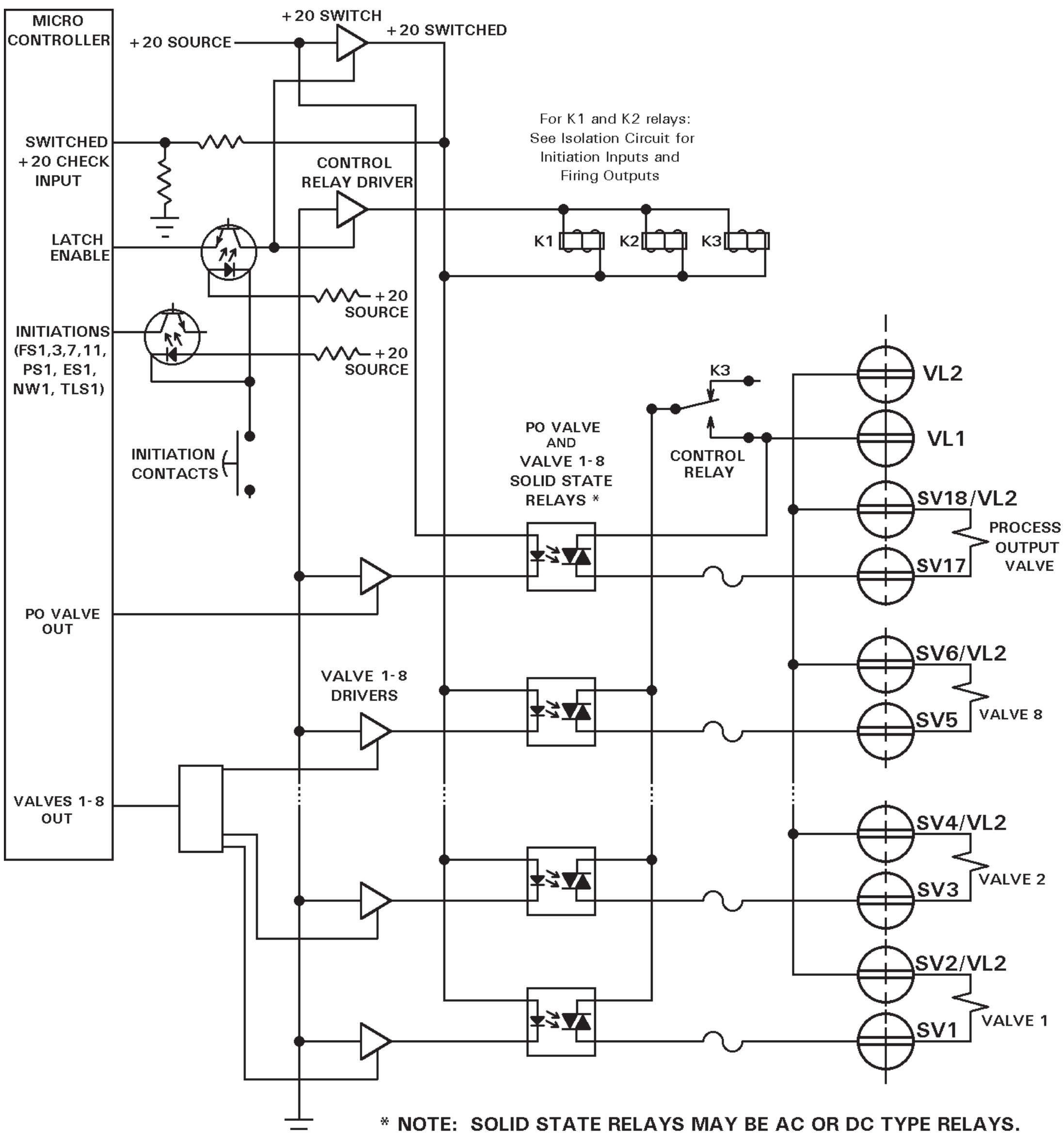


Figure 4-15. *Isolation circuit block diagram for valve outputs*

5.0 INTRODUCTION TO DATA PROGRAMMING

The EN1000 or EN1001 Cascade/Multi-Valve Control is capable of storing and accessing up to 100 unique welding schedules. This makes the EN1000 or EN1001 particularly suitable for complex welding operations, as well as automated machinery. Programming allows the operator to enter or change parameters of weld schedules and the subsequent storing of those parameters in non-volatile memory. See Appendix F for programming worksheets.

Basically, programming only requires **selecting** the function to be programmed (or modified), **changing** the data (with DATA display and push buttons) applicable to that function, and then **entering** the desired parameters into memory. For more detailed information about programming, see Appendix B, Section B-1.0.

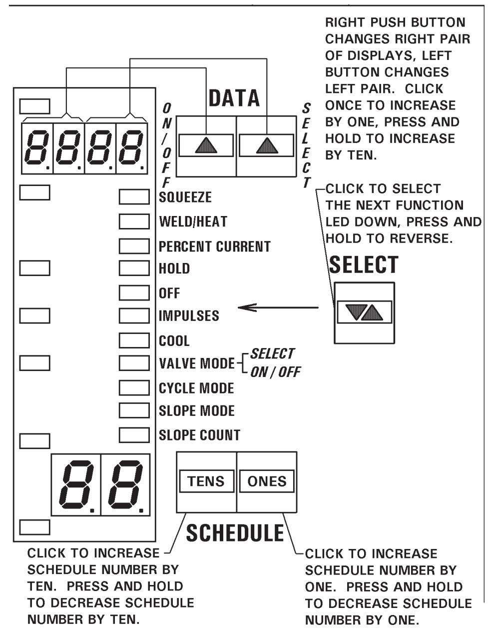


Figure 5-1. *Four-digit DATA display*

5.1 GENERAL PROGRAMMING

1. **Press and release the PROGRAM/OPERATE push button.** The PROGRAM LED will light up and the OPERATE LED will turn off. Only in the PROGRAM mode, does the control allow changes to existing data or entering new data. If an optional PROGRAM LOCKOUT key switch is installed, see Section 5.2.
2. **Select the schedule to be entered or modified by using the SCHEDULE push buttons** until the desired schedule number appears in the SCHEDULE display. The left push button increments the display by ten, and the right push button increments the display by one. When the maximum number is reached for either digit, that digit resets to zero.
3. **Press the SELECT push button to reach the required function.** Pressing and holding the SELECT push button momentarily will move to the previous parameter. The FUNCTION indicator LEDs show which function may be entered or modified, and the DATA display shows the data stored in that function. If the SELECT push button is pressed again, the FUNCTION indicator LED will advance to the next function.

NOTICE

When the FUNCTION indicator LED is advanced one position past the SLOPE COUNT function, all FUNCTION indicator LEDs will be off and the DATA display will show ***EF***. This indicates that the control is in the EXTENDED FUNCTION mode and the EXTENDED FUNCTIONS can now be altered or viewed (see Section 5.4).

4. **Use the DATA push buttons to change data.** The left button increments the data by ten, and the right button increments the data by one. When either digit reaches the maximum, that digit resets to zero. For parameters which allow programming of all four digits, the right button affects the two right-hand digits – press to increment by one; press and hold to increment by ten. The left button affects the two left-hand digits – press to increment by 100; press and hold to increment by 1000.
5. **Press the ENTER push button to store data from the DATA display into non-volatile memory**. As ENTER is pressed, the DATA display will blink and then remain steady.

5.1 GENERAL PROGRAMMING (cont.)

Repeat the steps described above as required. Any or all functions may be programmed depending on the final welding schedule or sequence required.

NOTICE
Remember to press the ENTER push button to complete a programming step. If the control is placed back in the OPERATE mode, or if a different function is selected before pressing ENTER, **the DATA shown in the display will be lost**. The previous data will remain stored in memory.

6. When all the required functions for all required schedules have been programmed, put the control in the OPERATE mode by pressing and releasing the PROGRAM/OPERATE push button, so that the OPERATE LED turns on and the PROGRAM LED turns off.

5.2 PROGRAM LOCKOUT OPTIONS

5.2.1 PROGRAM LOCKOUT KEY SWITCH OPTION

A PROGRAM LOCKOUT key switch can be ordered as a factory-installed option. It may also be added later by the customer, if desired. To install the key switch, remove the key switch hole plug from the lower left corner of the Front Panel and mount the switch using the nut and lock washer provided. Connect the plug from the switch onto the mating 2-prong connector (J1) on the back of the Display Circuit Board.

Mounting the key switch will be easier if the Front Panel Circuit Board Assembly is removed from the enclosure. Remove the four mounting screws from the Front Panel and lift it off of the enclosure.

To put the control in the PROGRAM mode using the PROGRAM LOCKOUT key switch:

Rotate the key 45 degrees clockwise and hold; while holding the key in this position, press and release the PROGRAM/OPERATE push button, and then release the key. The OPERATE LED will now turn off and the PROGRAM LED will turn on, indicating programmability of all functions.

To put the control in the OPERATE mode:

Press the PROGRAM/OPERATE push button again. The control will return to the OPERATE mode without the necessity of rotating the key.

5.2.2 USING PROGRAM LOCKOUT KEY SWITCH FOR ERROR CLEARING

Most errors except initiation, heatsink over temperature, and pressure errors (ERROR CODES from 01 to 15 and 36), may be cleared by pressing any push button on the Front Panel. However, if a PROGRAM LOCKOUT key switch is installed in the control, a key is required to clear the ERROR condition and reset the control for voltage monitoring, current monitoring and several other non-hardware related ERROR CODES (all codes from 17 to 35, 37, H. i. and L.o.).

5.3 SEQUENCE (SCHEDULE) PARAMETERS PROGRAMMING

Beside standard SCHEDULE parameters, there are several EXTENDED parameters. The associated EXTENDED SCHEDULE parameters are accessible by first using SELECT to choose the main function such as SQUEEZE, and then pressing either SCHEDULE push button to access a schedule function such as **P.r.** or **P.t.**

PARAMETER	EXTENDED	Description	MIN	MAX
SQUEEZE		SQUEEZE time in 50/60Hz cycles	00	99
* **P.r.**, **P.t.** (PSI)		PRESSURE mode: **P.C.**=**01** or **02**	00	99
F.r., **F.t.** (lb)		FORCE mode: **P.C.**=**03** or **04**	0000	9999
A.r., **A.t.** (mA)		CURRENT mode: **P.C.**=**05** or **06**	04.00	20.00
WELD/HEAT			00	99
# **0.0** to **0.9**		Stepper 0, schedule **00** to **09**		
1.0 to **1.9**		Stepper 1, schedule **10** to **19**		
2.0 to **2.9**		Stepper 2, schedule **20** to **29**	0000	9999
...continuing up to		*...continuing up to*		
9.0 to **9.9**		Stepper 9, schedule **90** to **99**		
	L.S.	LAST STEP for STEPPER **S.t.**=**01**	00	99
	L.C.	LAST COUNT for STEPPER **S.t.**=**01**	0000	9999
PERCENT CURRENT		PHASE SHIFT in [%] mode	00	99
** [%] mode	**EN1001** ***only***	CURRENT in [%] or [kA]: **C.r.**>**00**	00.00	99.99
or	**L.o.** +	LOW CURRENT limit window	00.00	99.99
[kA] mode	**H.i.** +	HIGH CURRENT limit window	00.00	99.99
HOLD			00	99
OFF			00	99
IMPULSES			01	99
COOL			00	99
VALVE MODE			00	FF hex
*** 410322-001	**E.o.**	Extended Valve Output	00	FF hex
CYCLE MODE			00	05
SLOPE MODE			00	02
SLOPE COUNT			00	99
CONTACTOR			00	FF hex

* Available only if IPSC option is present. For more information, see Instruction Manual 700178.
\# For more information about programming and using STEPPER function, see Section 7.0.
** Available only in EN1001 Controls. See Section 8.0 for Constant Current operation.
\+ See Section 8.1.1 for programming information.
*** Available only if Extended Valve option is present. See Appendix D for programming information.

Times for WELD, COOL, SLOPE COUNT and all other timed sequence parameters (SQUEEZE, HOLD, OFF) are based on 60 Hz or 50 Hz frequency.

5.3.1 PROGRAMMING VALVES AND CONTACTORS

The EN1000/EN1001 Cascade/Multi-Valve Control has been designed with versatility in mind. It features eight valve outputs on the standard Output Board. A ninth output is provided for use by control's PROCESS OUTPUTS. In addition, control can activate one of up to eight contactors as shipped from factory. Please note that control will accept programming of non-existent contactors. For example, a three Cascade Control can be programmed to fire Contactor 4. This will not affect control but care must be taken when programming only supplied contactors.

PROGRAMMING THE VALVES

This control is capable of simultaneously activating up to eight valves in any pattern for each programmed schedule.

There are two steps necessary to program VALVES before ENTER is pressed. The DATA push buttons perform dual functions. The right DATA push button labeled "SELECT" is used to select a VALVE. The left DATA push button labeled "ON/OFF" is used to turn VALVE indicator LEDs on or off. Active VALVES for a schedule are indicated by the LEDs which are on.

While in the desired schedule and in PROGRAM mode:

1. Press SELECT and move FUNCTION indicator LED to VALVE MODE.
2. Press **right** DATA push button to select a VALVE. Corresponding segment of **upper** row in DATA display (Figure 5-2) and corresponding VALVE LED will turn on.
3. Press and release **left** DATA push button and selected VALVE will turn on.

Repeat steps 2 and 3 until all needed VALVE LEDs are lit on VALVE display.

4. Press ENTER to store VALVE pattern displayed.

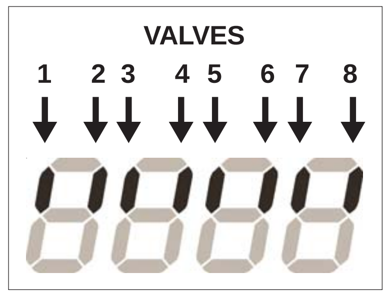


Figure 5-2. *Valve indication in DATA display*

PROGRAMMING THE CONTACTORS

The EN1000/EN1001 Cascade/Multi-Valve Control is able to activate one contactor for each programmed schedule. In order to compose a cascade function, it is necessary to chain various schedules together. This allows the operator more flexibility in firing of individual contactors, since each contactor can be fired for different lengths of time and with varying amounts of heat.

The right DATA push button labeled "SELECT" is used to select a CONTACTOR. This step is necessary to program a CONTACTOR before pressing ENTER. Since only one CONTACTOR can be selected per schedule, this step automatically turns CONTACTOR LED on (except in SIMULTANEOUS FIRING mode).

While in the desired schedule and in PROGRAM mode:

1. Press SELECT and move FUNCTION indicator LED to CONTACTOR.
2. Use **right** DATA push button to select desired CONTACTOR. Corresponding segment of **lower** row in DATA display (Figure 5-3) and corresponding CONTACTOR LED will turn on.
3. Press ENTER to store CONTACTOR displayed.

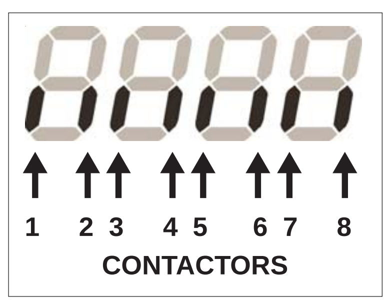


Figure 5-3. *Contactor indication in DATA display*

5.3.2 USING PROGRAMMING SHORTCUTS

TO QUICK COPY A SCHEDULE UP TO THE NEXT SCHEDULE

1. Put the control in the PROGRAM mode.
2. Press and hold ENTER.
3. Press the SCHEDULE 1s button.

The displayed schedule is copied to the next higher schedule. The new schedule is now displayed.

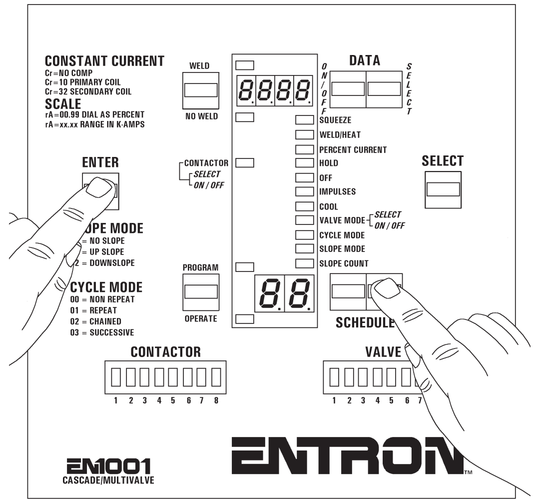


Figure 5-4. *Copy schedule up by* ***1***

TO QUICK COPY A SCHEDULE UP TEN SCHEDULES

1. Put the control in the PROGRAM mode.
2. Press and hold ENTER.
3. Press the SCHEDULE 10s button.

The displayed schedule is copied to that schedule number plus ten. The new schedule is now displayed.

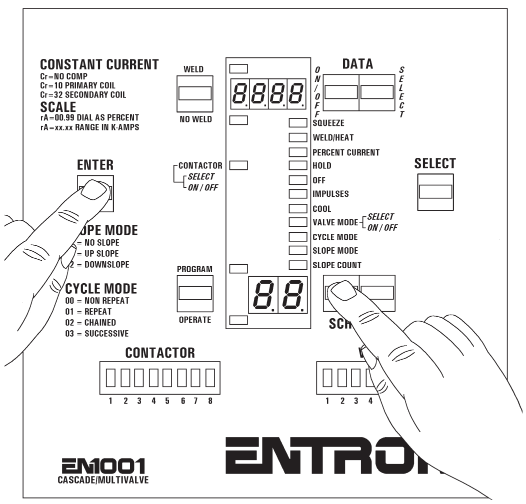


Figure 5-5. *Copy schedule up by* ***10***

TO CLEAR DATA FOR DISPLAYED SCHEDULE

1. Put the control in the PROGRAM mode.
2. Press and hold ENTER.
3. Press the PROGRAM/OPERATE button.

All SCHEDULE data for the displayed schedule has been erased.

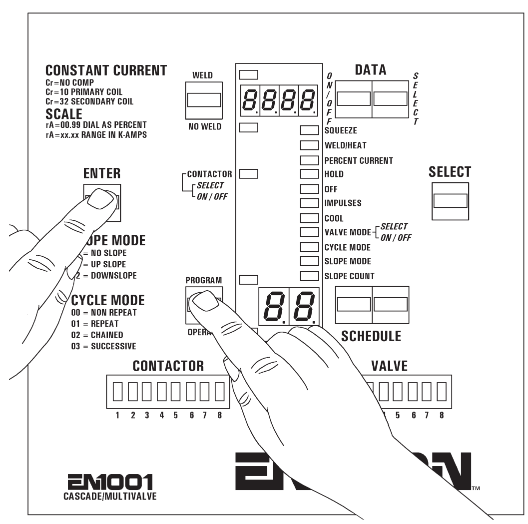


Figure 5-6. *Clear SCHEDULE data*

TO CLEAR ALL EXTENDED FUNCTIONS FROM CONTROL

1. Remove all power to the control.
2. Press and hold the PROGRAM/OPERATE push button.
3. Reapply power to the control.

All EXTENDED FUNCTIONS parameters in the control have been erased.

5.4 EXTENDED FUNCTIONS

The EN1000/EN1001 EXTENDED FUNCTIONS allow the operator to change normal operation modes and add various operating functions that are useful for special applications of the control.

The EXTENDED FUNCTIONS are used instead of Jumper or Dip-switch settings. They are accessible from the Front Panel by simply pressing the SELECT push button until FUNCTION indicator LED reaches SLOPE COUNT, then press once more. At this point, the DATA display will show EF. By pressing the SCHEDULE push buttons, the EXTENDED FUNCTIONS are visible in the SCHEDULE display. For most features, such as CHAINED schedules or SUCCESSIVE initiations, it is not necessary to enable functions. For some others such as STEPPER (S.t.), it is necessary to just enable a Front Panel-accessible EXTENDED FUNCTION. For others, it is necessary to add optional hardware to the base control, such as the Integrated Pressure Sense Control System or Constant Current operation.

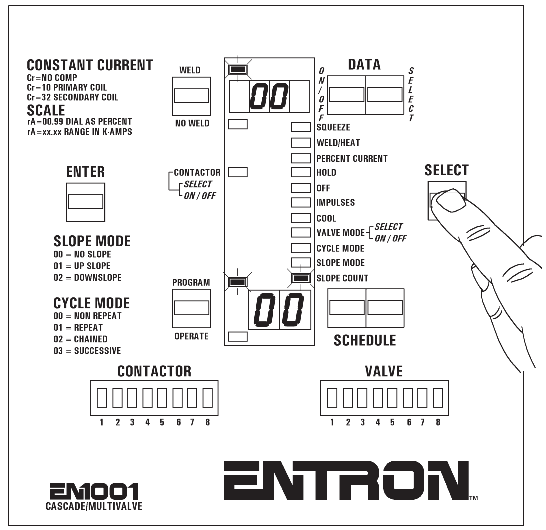


Figure 5-7. *Selecting functions*

To change settings of EXTENDED FUNCTIONS, use SELECT to step once past SLOPE COUNT.

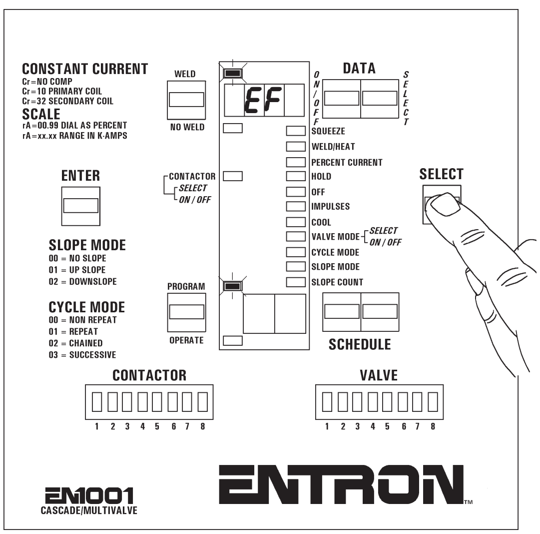


Figure 5-8. *EXTENDED FUNCTIONS mode*

At this point, all FUNCTION indicator LEDs are off and the DATA display shows EF. This indicates that the control is in the EXTENDED FUNCTION mode, and these functions can be altered or viewed.

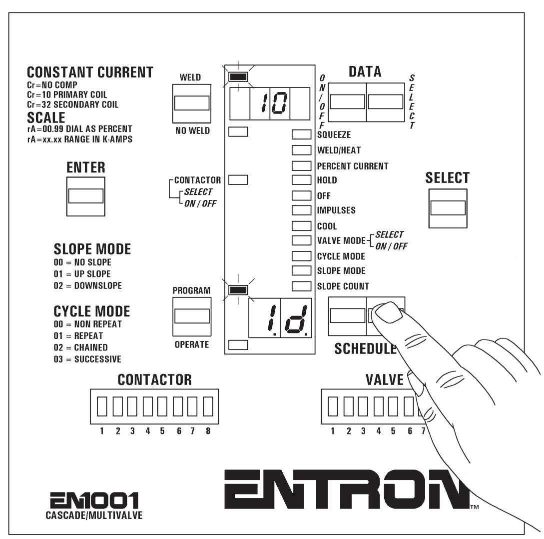


Figure 5-9. *Viewing EXTENDED FUNCTIONS*

To view EXTENDED FUNCTIONS, press the SCHEDULE push buttons and step in either direction through the available EXTENDED FUNCTIONS. When a desired parameter is shown by the SCHEDULE display, the DATA display will show the current value of that selection.

To exit the EXTENDED FUNCTION mode, press SELECT to advance the FUNCTION indicator LED one more time.

5.4 EXTENDED FUNCTIONS (cont.)

The available EXTENDED FUNCTION parameters are listed below – they are described in the indicated sections.

Designation	Description		Section
I.d.	Identification Number		5.4.1
C.S.	Simultaneous Contactor Firing		5.4.2
S.S.	Schedule Select		5.4.3
C.C.	Automatic Voltage Compensation & Monitoring		5.4.4
C.A.	Clear All Functions		5.4.5
b.S.	Back-Step / Water Flow Switch		5.4.6
P.O.	Process Outputs		5.4.7
b.E.	Beat Operation Initiation Modes		5.4.8
8.7.	87° Delay		5.4.9
P.P.	Manual Power Factor Programming		5.4.10
P.F.	Power Factor Measuring		5.4.11
S.d.	Squeeze Delay		5.4.12
b.L.	Blocking Delay (if P.O.=07 *only*)		5.4.13
C.r.	Constant Current Modes	***Available only for EN1001 using Constant Current***	5.4.14
r.A.	Range or Ratio		5.4.15
C.O.	Current Offset		5.4.16
S.t.	Stepper		7.0
P.C.	Pressure Control Mode	***Available only if IPSC hardware is present***	See Instruction Manual 700178 for IPSC
b.d.	Background Pressure		
S.I.	Sensor Input		
P.n.	PIN Lockout Mode		5.4.17

5.4.1 IDENTIFICATION NUMBER – I.d.

The EN1000/EN1001 Cascade/Multi-Valve Control may be equipped with RS485 Option to communicate to a PC or any other device with RS485 interface. The device with RS485 interface is capable of communicating with up to 64 controls on a common two-wire network. For this reason the control needs to be identified. See Instruction Manual 700171 for more information.

5.4.2 SIMULTANEOUS CONTACTOR FIRING – C.S.

The mode parameter **C.S.** allows the control to be programmed with multiple contactors within the same schedule in the EN1000/EN1001 Cascade/Multi-Valve Controls. This offers the advantage of increased productivity in plants where the higher line current demand is not a problem.

5.4.2 SIMULTANEOUS CONTACTOR FIRING – C.S. (cont.)

NOTICE
This mode applies to PCB A/N 410321 with PROM firmware version 619011-002 (Original) or later, or 619044-002**B** or later, and PCB A/N 410363 with PROM firmware version 619044-002 (Original) or later.

EXTENDED FUNCTION **C.S.** allows control to be switched to SIMULTANEOUS FIRING mode, allowing programming of more than one contactor per schedule. Simultaneously fired contactors will use PERCENT CURRENT programmed in the indicated schedule. It is not possible to fire simultaneous contactors with different percent currents.

If DATA display shows value of **00** for **C.S.** parameter, control allows selection of only one contactor per schedule. If DATA display shows **01** for **C.S.** parameter, control allows programming of multiple simultaneous contactors. The CONTACTORS are programmed using same procedure used for programming VALVES – select VALVE/CONTACTOR needed by pressing SELECT (**right** DATA push button), and turn it on or off by pressing ON/OFF (**left** DATA push button).

Switching from SINGLE CONTACTOR mode to SIMULTANEOUS CONTACTOR mode requires using memory in a different way. Therefore, CONTACTORS must be reprogrammed.

NOTICE
RECORD AND SAVE ALL SCHEDULES PROGRAMMED IN THE CONTROL. When switching to SIMULTANEOUS mode or returning to SINGLE CONTACTOR mode, the user must re-program the CONTACTORS in all the schedules used.

To enable programming of SIMULTANEOUS CONTACTORS:

1. Put the control in PROGRAM mode.
2. Press SELECT and find **EF** in the DATA display.
3. Press the SCHEDULE push buttons and find **C.S.** in the SCHEDULE display.
4. Program **01** in the DATA display and press ENTER.

To program multiple CONTACTORS:

1. Program control as normal, with the exception of the CONTACTORS.
2. Select schedule that requires more than one CONTACTOR to be fired simultaneously.
3. Select **C.S.** (CONTACTOR SELECT) parameter.
4. Select CONTACTORS by pressing **right** DATA push button to make CONTACTOR LEDs blink.
5. Form CONTACTOR pattern by pressing **left** DATA push button to turn CONTACTOR LED on.

   Repeat steps 4 and 5 until required CONTACTORS are selected (corresponding segments of lower row of DATA display and LEDs for selected CONTACTORS for this schedule will be lit – see Figure 5-10).
6. Press ENTER to store pattern in memory.

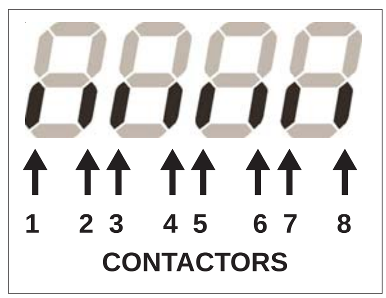


Figure 5-10. *Contactor indication in DATA display*

! WARNING !
Using simultaneous contactor firing defeats the original cascade design purpose. Cascade controls are single phase controls used to distribute power to multiple loads at different times on a single phase line. Users must take responsibility for what is programmed in control. Selecting an excessive number of contactors could cause excessive current draw. Primary wiring is sized for firing only **one** SCR Contactor at a time.

5.4.3 SCHEDULE SELECT – *S.S.*

The EN1000/EN1001 Cascade/Multi-Valve Control provides 3 modes of SCHEDULE SELECT and/or initiation – INTERNAL (panel-dialed), EXTERNAL (non-panel, FS7/FS11 select) and EXTERNAL BINARY SELECT using S99 Option (100 non-panel, external schedules). The default (factory setting) mode is INTERNAL SCHEDULE SELECT.

To program the control for desired SCHEDULE SELECT mode:

1. Put the control in PROGRAM mode.
2. Use SELECT to find ***EF***.
3. Use SCHEDULE push buttons to page through EXTENDED FUNCTIONS to find ***S.S.***
4. Enter a value for ***S.S.*** of: ***00***, ***01***, ***02***, or ***03*** using the DATA push buttons.
   Where: ***S.S.***=***00*** for INTERNAL SCHEDULE SELECT (default)
   S.S.=***01*** for EXTERNAL SCHEDULE SELECT
   S.S.=***03*** for S99 EXTERNAL BINARY SCHEDULE SELECT
5. Press the ENTER push button.

INTERNAL SCHEDULE SELECT – *S.S.=00* (default)

In this mode, the initiation inputs (TS1-FS3, TS1-FS7, TS1-FS11) are dedicated as follows.

TS1-FS3 INITIATES ON ANY DISPLAYED SCHEDULE:

1. Select a schedule using the SCHEDULE push buttons.
2. Program the selected schedule or sequence.
3. **Use TS1-FS3 to initiate ANY schedule shown on the panel.**

TS1-FS7 AUTOMATICALLY SELECTS AND INITIATES ON SCHEDULE 20:

1. Select schedule 20 using the SCHEDULE push buttons.
2. Program schedule 20 (or a sequence starting at schedule 20).
3. **Use TS1-FS7 to initiate schedule 20 (or a sequence starting at schedule 20).**

NOTICE
Regardless of what schedule the Front Panel displays, TS1-FS7 is dedicated to initiate only on schedule 20.

TS1-FS11 AUTOMATICALLY SELECTS AND INITIATES ON SCHEDULE 40:

1. Select schedule 40 using the SCHEDULE push buttons.
2. Program schedule 40 (or a sequence starting at schedule 40).
3. **Use TS1-FS11 to initiate schedule 40 (or a sequence starting at schedule 40).**

NOTICE
Regardless of what schedule the Front Panel displays, TS1-FS11 is dedicated to initiate only on schedule 40.

5.4.3 SCHEDULE SELECT – S.S. (cont.)

EXTERNAL SCHEDULE SELECT – S.S.=01

In this mode, the initiation inputs (TS1-FS3, TS1-FS7, TS1-FS11) are dedicated as follows:

1. Select one of four schedules by an external device or operator acting on TS1-FS7 and TS1-FS11 as shown in Table 5-1.
2. Initiate the selected schedule using TS1-FS3.

Table 5-1. *EXTERNAL SCHEDULE SELECT with TS1-FS7 and TS1-FS11*

SCHEDULE	TS1-FS7/SS1	TS1-FS11/SS3	INITIATION
00	**OPEN**	**OPEN**	TS1-FS3
20	***CLOSED***	**OPEN**	TS1-FS3
40	**OPEN**	***CLOSED***	TS1-FS3
60	***CLOSED***	***CLOSED***	TS1-FS3

NOTICE
In this mode, the operator cannot select schedules using the Front Panel in OPERATE mode and can only initiate using TS1-FS3. Binary selects TS1-FS7 and TS1-FS11 must be closed before initiation of TS1-FS3 and be opened after sequence is started or completed.

Dual Two-stage Foot Switches with EXTERNAL SCHEDULE SELECT

The Dual Schedule and EXTERNAL SCHEDULE SELECT functions can be combined to allow initiations by means of 2 two-stage foot switches.

Use schedule 00 for the foot switch #1 sequence and schedule 10 for the foot switch #2 sequence.

The foot switches and additional diode assembly (A/N 600573) are connected to TS1 Terminal Strip (see Figure 5-11). The diode assembly may be substituted with most any silicon diode rated 1 A at 100 V.

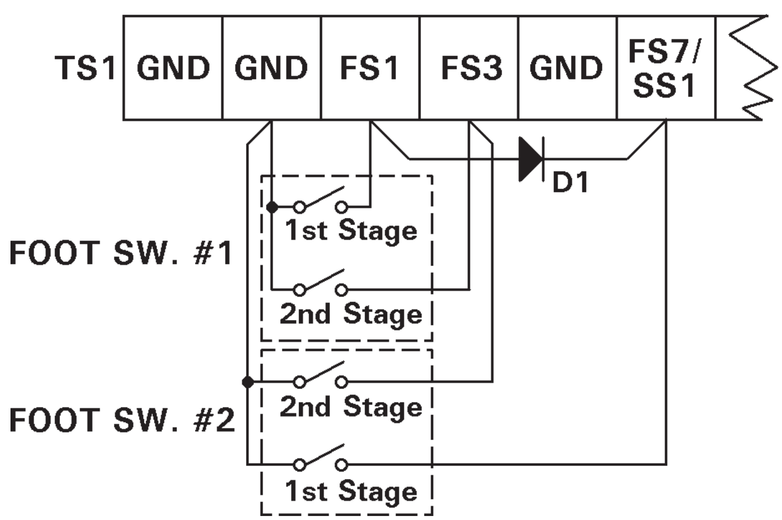


Figure 5-11. *Dual two-stage foot switch initiation*

5.4.3 SCHEDULE SELECT – S.S. (cont.)

Multiple Two-stage Foot Switches with EXTERNAL SCHEDULE SELECT

The Dual Schedule and EXTERNAL SCHEDULE SELECT functions can also be combined to allow initiations by means of multiple two-stage foot switches.

Use schedule 00 for foot switch #1 sequence, schedule 10 for foot switch #2 sequence, schedule 20 for foot switch #3 and schedule 30 for foot switch #4.*

The foot switches and additional diodes (P/N 170012) are connected to TS1 Terminal Strip as shown in Figure 5-12. The diode assembly may be substituted with most any silicon diode.

* Similar connections can be used with S99 Option (see EXTERNAL BINARY SELECT section).

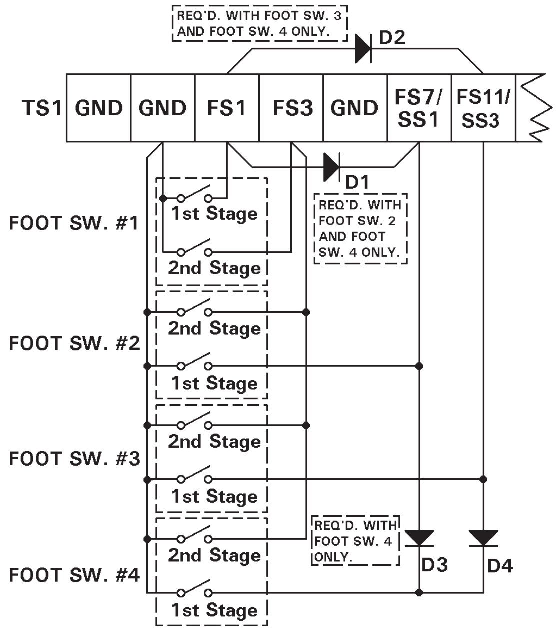


Figure 5-12. *Multiple two-stage foot switch initiation*

5.4.3 SCHEDULE SELECT – S.S. (cont.)

EXTERNAL BINARY SELECT – S99 OPTION – S.S.=03

In order to program this EXTENDED FUNCTION parameter **S.S.**=**03**, the S99 Option must be present and connected to the Control Board. The option consists of a J4 ribbon cable and an additional PCB 410329-001 with seven binary schedule select inputs (see Appendix C for installation instructions). These seven dry contact closure inputs (approximately 24 VDC) make all 100 schedules remotely available to the operator or machine process control system.

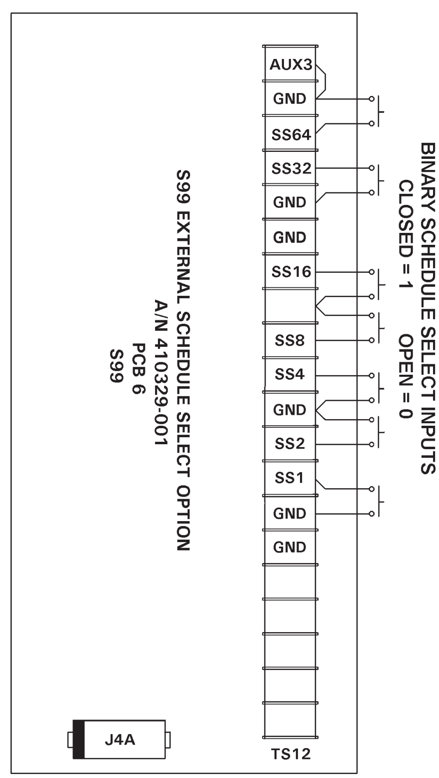


Figure 5-15. *Switch closure connections*

In this mode, the initiation input on TS1-FS3 and binary schedule select inputs on S99 Option Board TS12-SS1 through TS12-SS32 are dedicated as follows:

5.4.3 SCHEDULE SELECT – *S.S.* (cont.)

NOTICE

NOTICE

Table 5-2. *S99 EXTERNAL SCHEDULE SELECT*

DECIMAL (**SCHEDULE**) TO BINARY (TS12-SS1 through TS12-SS64)

SCH	SS1	SS2	SS4	SS8	SS16	SS32	SS64
00	0	0	0	0	0	0	0
01	1	0	0	0	0	0	0
02	0	1	0	0	0	0	0
03	1	1	0	0	0	0	0
04	0	0	1	0	0	0	0
05	1	0	1	0	0	0	0
06	0	1	1	0	0	0	0
07	1	1	1	0	0	0	0
08	0	0	0	1	0	0	0
09	1	0	0	1	0	0	0
10	0	1	0	1	0	0	0
11	1	1	0	1	0	0	0
12	0	0	1	1	0	0	0
13	1	0	1	1	0	0	0
14	0	1	1	1	0	0	0
15	1	1	1	1	0	0	0
16	0	0	0	0	1	0	0
17	1	0	0	0	1	0	0
18	0	1	0	0	1	0	0
19	1	1	0	0	1	0	0
20	0	0	1	0	1	0	0
21	1	0	1	0	1	0	0
22	0	1	1	0	1	0	0
23	1	1	1	0	1	0	0
24	0	0	0	1	1	0	0
25	1	0	0	1	1	0	0
26	0	1	0	1	1	0	0
27	1	1	0	1	1	0	0
28	0	0	1	1	1	0	0
29	1	0	1	1	1	0	0
30	0	1	1	1	1	0	0
31	1	1	1	1	1	0	0
32	0	0	0	0	0	1	0
33	1	0	0	0	0	1	0
34	0	1	0	0	0	1	0
35	1	1	0	0	0	1	0
36	0	0	1	0	0	1	0
37	1	0	1	0	0	1	0
38	0	1	1	0	0	1	0
39	1	1	1	0	0	1	0
40	0	0	0	1	0	1	0
41	1	0	0	1	0	1	0
42	0	1	0	1	0	1	0
43	1	1	0	1	0	1	0
44	0	0	1	1	0	1	0
45	1	0	1	1	0	1	0
46	0	1	1	1	0	1	0
47	1	1	1	1	0	1	0
48	0	0	0	0	1	1	0
49	1	0	0	0	1	1	0
50	0	1	0	0	1	1	0
51	1	1	0	0	1	1	0
52	0	0	1	0	1	1	0
53	1	0	1	0	1	1	0
54	0	1	1	0	1	1	0
55	1	1	1	0	1	1	0
56	0	0	0	1	1	1	0
57	1	0	0	1	1	1	0
58	0	1	0	1	1	1	0
59	1	1	0	1	1	1	0
60	0	0	1	1	1	1	0
61	1	0	1	1	1	1	0
62	0	1	1	1	1	1	0
63	1	1	1	1	1	1	0
64	0	0	0	0	0	0	1
65	1	0	0	0	0	0	1
66	0	1	0	0	0	0	1
67	1	1	0	0	0	0	1
68	0	0	1	0	0	0	1
69	1	0	1	0	0	0	1
70	0	1	1	0	0	0	1
71	1	1	1	0	0	0	1
72	0	0	0	1	0	0	1
73	1	0	0	1	0	0	1
74	0	1	0	1	0	0	1
75	1	1	0	1	0	0	1
76	0	0	1	1	0	0	1
77	1	0	1	1	0	0	1
78	0	1	1	1	0	0	1
79	1	1	1	1	0	0	1
80	0	0	0	0	1	0	1
81	1	0	0	0	1	0	1
82	0	1	0	0	1	0	1
83	1	1	0	0	1	0	1
84	0	0	1	0	1	0	1
85	1	0	1	0	1	0	1
86	0	1	1	0	1	0	1
87	1	1	1	0	1	0	1
88	0	0	0	1	1	0	1
89	1	0	0	1	1	0	1
90	0	1	0	1	1	0	1
91	1	1	0	1	1	0	1
92	0	0	1	1	1	0	1
93	1	0	1	1	1	0	1
94	0	1	1	1	1	0	1
95	1	1	1	1	1	0	1
96	0	0	0	0	0	1	1
97	1	0	0	0	0	1	1
98	0	1	0	0	0	1	1
99	1	1	0	0	0	1	1

1 = CLOSED   0 = OPEN

TS12-SS1 through TS12-SS64 require 24 VDC at 50 mA contacts

5.4.3 SCHEDULE SELECT – S.S. (cont.)

MULTIPLE PILOT OPERATION

The EN1000/EN1001 Cascade/Multi-Valve Control can be configured to allow multiple pilots to initiate multiple schedules using the S99 Option. Once the control is put into the EXTERNAL SCHEDULE SELECT mode (**S.S.**=**03**), a switch closure between TS1-FS3 and TS1-GND initiates schedule externally selected via TS12-SS1 through TS12-SS64.

Additional pilot circuits can be accomplished by the addition of diodes. Each new pilot circuit will require at least two diodes and a single pole, normally open, momentary type switch. Refer to the Multiple Pilot Switch Connections diagram (Figure 5-16) during the following discussion.

The schedule selected by each new pilot switch is determined by the diodes connected to the schedule select inputs. In Figure 5-16, SW7 initiates schedule 07. Notice there is a diode connected to SS1, SS2, and SS4; if these are added together, they equal 7 (1 + 2 + 4 = 7). SW15 will initiate schedule 15, the diodes are connected to SS1, SS2, SS4, and SS8. Any schedule (00 to 99) can be selected in this way. To select schedule 99, a diode is connected to SS1, SS2, SS32, and SS64 inputs.

These examples can be combined and thus several pilots can select several schedules. It is possible to connect more than one pilot circuit to the same schedule select terminals. Therefore, it is possible to have one pilot initiate schedule 07 (SS1, SS2, SS4) and another pilot initiate schedule 15 (SS1, SS2, SS4, SS8).

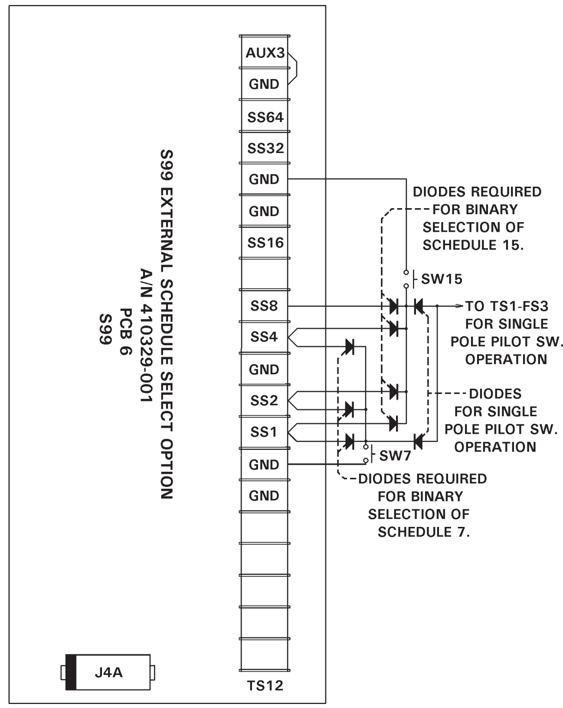


Figure 5-16. *Multiple pilot switch connections*

5.4.4 AUTOMATIC VOLTAGE COMPENSATION AND MONITORING – C.C.

In addition to the original AUTOMATIC VOLTAGE COMPENSATION (AVC), an additional series of settings are available in the EN1000 or EN1001 Cascade/Multi-Valve Controls with PROM firmware version 619044-002**A** or later. The new settings allow voltage monitoring, or compensation and monitoring.

To program AUTOMATIC VOLTAGE COMPENSATION (AVC) or VOLTAGE MONITORING (AVM):

1. Put the control in PROGRAM mode.
2. Press SELECT until the DATA display shows **EF**.
3. Press the left SCHEDULE push button until the SCHEDULE display shows **C.C.**
4. Use DATA push buttons and Tables 5-3 and 5-4 to program the desired value.
5. Press ENTER.

Original AVC settings are shown in Table 5-3. These settings are available on all controls, but they can be used only for compensation, not for monitoring.

Table 5-3. *Original AVC values*

AVC parameter C.C.	Line Voltage in VAC
00	AVC **disabled**
01	110
02	230
03	380
04	460
05	575

Additional AVC and AVM settings are shown in Table 5-4. These settings are available only on controls with PROM firmware version 619044-002**A** or later.

Table 5-4. *AVC parameter values*

AVC parameter C.C.		
MONITORING & COMPENSATION	MONITORING ONLY	THRESHOLD
10	11	+/- 3%
12	13	+/- 5%
14	15	+/- 10%
16	17	+/- 15%
18	19	+/- 20%
20	21	+/- 25%
22	23	+/- 30%
24	25	+/- 35%
26	27	+/- 40%
28	29	+/- 45%
30	31	+/- 50%

The AUTOMATIC VOLTAGE COMPENSATION uses a nominal set point value to determine whether the line voltage is changing during idle periods (between welds). The AVC (**C.C.**) values must be set during a time in which the line voltage is at this nominal value. For example, if the steady state line voltage is approximately 480 VAC, do not program **C.C.** until the line voltage is as close to 480 VAC as possible.

5.4.4 AUTOMATIC VOLTAGE COMPENSATION & MONITORING – *C.C.* (cont.)

If nominal set point value is too low or too high compared to nominal voltage level, the control will display one of the following errors:

E.r.=17	AVC nominal set point voltage is too low compared to nominal voltage level
E.r.=18	AVC nominal set point voltage is too high compared to nominal voltage level

To clear these errors, simply press any push button. If either of these two errors occur during ***C.C.*** programming, the control will not enable AVC; i.e., ***C.C.*** will remain zero.

If AVC is enabled, the control monitors relative line voltage changes from the nominal set point. If the control detects line voltage changes, it will average these values. When the control is initiated to weld, it compares nominal relative voltage and measured average values to make a correction in the firing angle used for the weld; i.e., to compensate for any line voltage changes.

For ***C.C.*** values of ***10*** to ***31***, the threshold values determine a window within which error messages are not triggered. These values are valid for any voltage level from 110 VAC to 575 VAC, since the control uses nominal set point. Any time when ***C.C.*** is reprogrammed, nominal voltage set point will be reset.

If the line voltage surpasses the threshold, the control will display an error announcing that the line voltage threshold has been exceeded. If measured average voltage is lower than low window (nominal set points minus threshold), or higher than high window (nominal set points plus threshold), the control will display one of the following errors:

E.r.=19	average voltage is below low window (below nominal set point minus threshold)
E.r.=20	average voltage is above high window (above nominal set point plus threshold).

To clear these errors, simply press any push button.

Several PROCESS OUTPUTS may be programmed for AVC and AVM. If either ERROR ***19*** or ***20*** occurs, the control will continue or stop the sequence depending on ***P.O.*** value:

P.O.=12	Display error for 30 cycles (0.5 seconds) and **continue** with sequence. PO Valve is **off**.
P.O.=10, ***13***, or ***17***	Display error, turn **on** PO Valve for 30 cycles (0.5 seconds) and **continue** with sequence.
P.O.=14	Display error, turn **on** PO Valve, and **stop** the sequence.

5.4.5 CLEAR ALL FUNCTIONS – C.A.

It is sometimes desirable to CLEAR ALL previous SCHEDULES and EXTENDED FUNCTIONS from the memory and return the programmed parameters to factory defaults.

To use the CLEAR ALL feature:

1. Put the control in PROGRAM mode.
2. Use SELECT to find **EF**.
3. Use the SCHEDULE push buttons to find **C.A.**
4. Enter a value for **C.A.** of **01**.
5. Press the ENTER push button to clear all SCHEDULE data.
6. Enter a value for **C.A.** of **02**.
7. Press the ENTER push button to clear EXTENDED FUNCTIONS data.
8. Press PROGRAM/OPERATE push button to return the control to OPERATE mode.

NOTICE
ONCE THE CLEAR ALL FUNCTION IS EXECUTED, ERASED DATA *CANNOT* BE RESTORED.

SHORTCUT TO CLEAR DATA FOR DISPLAYED SCHEDULE

1. Put the control in PROGRAM mode.
2. Press and hold ENTER.
3. Press the PROGRAM/OPERATE button.

All SCHEDULE data for the displayed schedule will be erased.

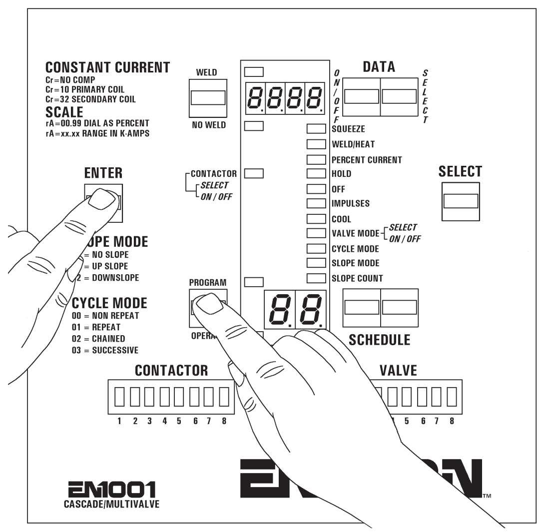


Figure 5-17. *Clear SCHEDULE data*

SHORTCUT TO CLEAR ALL EXTENDED FUNCTIONS FROM CONTROL

1. Remove all power to the control.
2. Press and hold the PROGRAM/OPERATE push button.
3. Reapply power to the control.

All EXTENDED FUNCTIONS parameters in the control have been erased.

NOTICE
After firmware updates in the field, a one-time CLEAR ALL is required when upgrading to a new version of firmware on **ALL** older Control Boards.

5.4.6 BACK-STEP / WATER FLOW SWITCH – b.S.

The BACK-STEP function is designed to add flexibility while welding with SUCCESSIVE schedules. While active, **b.S.** steps back to the previous schedule, and allows the operator to initiate on that schedule again while in the middle of a SUCCESSIVE sequence.

As an example, suppose the control executes a sequence and automatically advances the schedule number and flashes schedule **03**. But the operator has executed the sequence in the NO WELD mode. In this case, the operator must use the BACK-STEP switch to step back from schedule **03**, put the control in the WELD mode and re-initiate on schedule **02**.

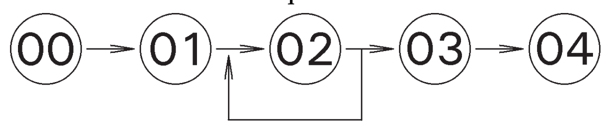


Figure 5-18. *BACK-STEP sequence example*

To connect the control for BACK-STEP operation, use a normally open switch between TS1-WFS1/AUX1 and TS1-GND on the Terminal Strip as a BACK-STEP input.

To program the control for BACK-STEP operation:

1. Put the control in PROGRAM mode.
2. Use SELECT to find **EF**.
3. Use the SCHEDULE push buttons to find **b.S.**
4. Enter a value for **b.S.** of **01** using the DATA push buttons.
5. Press the ENTER push button.

When in the BACK-STEP mode of operation, the switch connected between TS1-WFS1/AUX1 and TS1-GND must be open for normal operation, and momentarily closed to BACK-STEP one schedule. If left closed, the DATA display will show ERROR CODE **06** and the SCHEDULE display will show **E.r.** The control has configured TS1-WFS1/AUX1 to TS1-GND as an input which looks for a momentary closure.

NOTICE
If BACK-STEP remains active for more than 1.5 seconds, it will cause the control to return to the first schedule of either a SUCCESSIVE or CHAINED series and display a flashing **E.r.**=**06**; ERROR CODE will remain while BACK-STEP contact is held closed.

To restore the control for WATER FLOW SWITCH operation (default setting):

1. Put the control in PROGRAM mode.
2. Use SELECT to find **EF**.
3. Use the SCHEDULE push buttons to find **b.S.**
4. Enter a value for **b.S.** of **00** using the DATA push buttons.
5. Press the ENTER push button.

NOTICE
If PROCESS OUTPUT **11** has been selected, the PO output (SV17-SV18) will become energized when switching back to WATER FLOW SWITCH mode. If the control is using the RETRACTION PROCESS OUTPUT (**P.O.**=**08**), terminal TS1-WFS1/AUX1 is used as an input, thus BACK-STEP is not available.

5.4.6 BACK-STEP / WATER FLOW SWITCH – b.S. (cont.)

USING BOTH WATER FLOW SWITCH AND BACK-STEP FUNCTION

If a Water Flow Switch is being used, it can be connected to TS1-NW1 and TS1-GND. This is the External Weld/No Weld input. If this switch is open, control will be in a NO WELD condition.

NOTICE
The Back-Step Switch replaces the Water Flow Switch (WFS) operation. Alternatively, the Water Flow Switch should be connected in series with the Temperature Limit Switch (TLS) or connect the Water Flow Switch to the External Weld/No Weld input (NW1) while using the BACK-STEP option.

5.4.7 PROCESS OUTPUTS – P.O.

The EN1000 and EN1001 Cascade/Multi-Valve Controls provide an output that can be useful when the operator or the system needs feedback from specific parts of the welding sequence, such as: major or minor error conditions to machine controls, shunt trips, or indicator lamps. Some PROCESS OUTPUTS may result in changes of the control sequence, status, fault, or major or minor error conditions. These changes are intentional with the objective of providing designers with complete flexibility. See Table 5-5 for the data codes available.

To use any PROCESS OUTPUT mode:

1. Put the control in PROGRAM mode.
2. Use SELECT to find **EF**.
3. Use the SCHEDULE push buttons to find **P.O.**
4. Use Table 5-5 as a guide for the necessary PROCESS OUTPUT code.
5. Press the ENTER push button.

The PO Valve may be connected to the shunt trip of a circuit breaker. Under certain conditions as listed below, when a shunt trip breaker is tripped, it is the same as removing power from the control. Most breakers can be equipped with a 110 VAC input shunt trip device. Refer to Section 4.3 and the appropriate Wiring Diagram.

! WARNING !
Exercise caution when PO Valve is programmed – the result of its activation could cause a personnel hazard. The Valve Control Relay normally incorporated in the standard operation of 1-8 valves is bypassed for PO Valve.

Table 5-5 summarizes all PROCESS OUTPUT codes. Detailed descriptions of each PROCESS OUTPUT follow the table.

5.4.7 PROCESS OUTPUTS – P.O. (cont.)

Table 5-5. *PROCESS OUTPUT codes and descriptions*

CODE	PROCESS OUTPUT DESCRIPTION
00	PROCESS OUTPUT disabled
01	ON during WELD
02	ON during WELD and HOLD
03	ON during HOLD
04	ON during OFF
05	ON after OFF until initiation is removed
06	ON for 0.5 seconds after EOS (END OF SEQUENCE)
07	Special AIR OVER OIL RETRACTION
08	RETRACTION mode
09	HALF CYCLE WELD mode
10	ON during any ERROR ***or*** control in NO WELD ***or*** control in PROGRAM mode ***or*** control in Emergency Stop ***or*** in CONSTANT CURRENT mode if current out of limit window
11	ON when Temperature Limit Switch or Water Flow Switch is OPEN (E.r.=01)
12*	Flash H. i./L.o. if current out of limit window
13*	Flash H. i./L.o. and PO Valve ON for 0.5 seconds if current out of limit window
14	– reserved –
15	ON for HARDWARE ERROR ***or*** CONTROL RELAY ERROR
16	ON for shorted SCR ***or*** L2 missing ERROR (E.r.=26)
17	ON for: TLS ERROR, Memory ERROR, AVC ERRORS, END OF STEPPER, etc.
18	ON when SCR full conduction is detected (E.r.=13)
19	ON during WELD only in WELD mode and closed NW1-GND input on TS1
20	– reserved –
22*	Send HI/LO and current after out of limit window weld or last weld in sequence with RS232 or RS485 Option
23*	Send HI/LO and current if current out of limit window with RS232 or RS485 Option
24	– reserved –
25	– reserved –
26*	Flash H. i./L.o., stop sequence and turn PO Valve ON if current out of limit window
27	– reserved –
28	– reserved –
29	– reserved –
30	ON if ERROR 36 (IPSC or IPS error) occurs
31	ON if ERROR 36 (IPSC or IPS error) occurs at the end of weld
33	ON during any ERROR or control in NO WELD or control in PROGRAM mode or control in Emergency Stop. Also flash H. i./L.o., stop sequence and Valve ON for 0.5 seconds if current out of limit window
34	Flash H. i./L.o., stop sequence and turn PO Valve ON for 0.5 seconds if current out of limit window

* **ONLY** available with EN1001 Controls.

5.4.7 PROCESS OUTPUTS – *P.O.* (cont.)

P.O.=00 **PROCESS OUTPUT disabled –** No PROCESS OUTPUT programmed.

P.O.=01 **ON during WELD –** PO Valve output will be **ON during WELD time** part of the sequence, regardless whether the control is in WELD or NO WELD mode.

P.O.=02 **ON during WELD and HOLD –** PO Valve output will be **ON during application of WELD CURRENT and the programmed HOLD time.**

P.O.=03 **ON during HOLD –** PO Valve output will be **ON during the programmed HOLD time.**

P.O.=04 **ON during OFF –** PO Valve output will be **ON during the programmed OFF time** (only valid in REPEAT sequences).

P.O.=05 **ON after OFF until INITIATION is removed –** PO Valve output will turn **ON after the programmed OFF time** has elapsed **and remain ON until the initiation is removed** from TS1-FS3, TS1-FS7 or TS1-FS11.

P.O.=06 **ON for 0.5 seconds after EOS (END OF SEQUENCE) –** PO Valve output will turn **ON after the sequence is complete and remain ON for 0.5 seconds.**

P.O.=07 **Special AIR OVER OIL RETRACTION –** The operator can access additional EXTENDED FUNCTIONS parameter **BLOCKING DELAY** (*b.L.*).

P.O.=08 **RETRACTION mode –** PO Valve output will **toggle if TS1-WFS1/AUX1 is momentarily closed** to TS1-GND. The control will not initiate if this output is off.

P.O.=09 **HALF CYCLE WELD mode –** When *P.O.=09* and WELD=*01*, the control will operate in HALF CYCLE mode.

P.O.=10 **ON during ANY ERROR *or* control in NO WELD *or* control in PROGRAM mode *or* control in Emergency Stop *or* in CONSTANT CURRENT mode if current out of HIGH/LOW limit window –** PO Valve output will turn **ON under several conditions: 1) if any error is detected, 2) if control is in a NO WELD condition, 3) if control is in PROGRAM mode, or 4) in the event an Emergency Stop** condition is detected. May be useful when an automated machine is unattended. Under any circumstances, if there is an ERROR to be displayed by the control, PO Valve output will be energized concurrently with the error message, or in STEPPER modes during END OF STEPPER message. This way, the control can advise an operator or a master PLC that an error has occurred. Also, an un-welded part cannot be fed into the machine following the welder if the PLC receives this signal and halts the subsequent process. Note that this signal will be active if the control is in NO WELD or in PROGRAM mode.

In addition, when using PROM firmware version 619044-002**C** or later in CONSTANT CURRENT mode with this PROCESS OUTPUT, PO Valve will be **ON during HOLD time if current out of HIGH/LOW limit window ERROR** occurs in any schedule of a welding sequence.

5.4.7 PROCESS OUTPUTS – P.O. (cont.)

P.O.=11 **ON when Temperature Limit Switch or Water Flow Switch is OPEN –** PO Valve output will be **ON when Water Flow Switch input WFS1 is open (E.r.=01** detected**)**.

P.O.=12 **Flash H. i./L.o. if current out of limit window** (EN1001 *ONLY)* – DATA display will **flash H. i. or L.o. when the control is unable to keep the current constant within the programmed HIGH/LOW limit window**.

P.O.=13 **Flash H. i./L.o. and PO Valve ON if current out of limit window** (EN1001 *ONLY)* – DATA display will **flash H. i. or L.o. when the control is unable to keep the current constant within the programmed HIGH/LOW limit window**. In addition, PO Valve output will turn **ON for 0.5 seconds**.

P.O.=15 **ON for HARDWARE/CONTROL RELAY ERROR –** PO Valve output will turn **ON if a Control Board ERROR is detected.**

P.O.=16 **ON for shorted SCR or L2 missing ERROR –** PO Valve output will turn **ON if shorted SCR or L2 missing ERROR (E.r.=26) is detected.**

P.O.=17 **ON for: TLS ERROR/Memory ERROR/AVC ERRORS, END OF STEPPER, etc. –** PO Valve output will turn **ON if following errors are detected:** TLS ERROR, EEPROM ERROR, AVC ERRORS, during END OF STEPPER message in STEPPER modes, etc.

P.O.=18 **ON when SCR full conduction is detected –** PO Valve output will be **ON if full SCR conduction error (E.r.=13) is detected.**

P.O.=19 **ON during WELD only in WELD mode and closed NW1-GND input on TS1 –** PO Valve will be **ON during the WELD time of the sequence, only in WELD mode and closed NW1-GND input on TS1.** This PROCESS OUTPUT is the same as **P.O.=01**, except that PO Valve will not be ON if control is in NO WELD mode or if NW1-GND input on TS1 is open.

P.O.=22 **Send HI/LO and CURRENT after out of limit window weld or last weld in sequence with RS232 or RS485 Option** (EN1001 *ONLY)* – Will **send data for out of limit window weld in sequence or last weld only in completed sequence to master on ENBUS or to serial printer**. Display will flash **H. i.** or **L.o.** and measured CURRENT if out of limit window.

P.O.=23 **Send HI/LO and CURRENT if current out of limit window with RS232 or RS485 Option** (EN1001 *ONLY)* – Will **send data after weld if current is out of limit window to master on ENBUS or to serial printer**. Display will flash **H. i.** or **L.o.** and measured CURRENT.

P.O.=26 **Flash H. i./L.o., stop sequence and turn PO Valve ON if current out of limit window** (EN1001 *ONLY)* – Uses PO Valve to indicate HIGH or LOW current errors and stop the sequence until the error is cleared. PO Valve will be ON until error is cleared either by pressing any push button or Emergency Stop input activation and will do a start up initialization.

5.4.7 PROCESS OUTPUTS – P.O. (cont.)

P.O.=30 **ON if ERROR 36 (IPSC or IPS error) occurs –** When the control includes the IPSC or IPS option, the control may be programmed to turn PO Valve **ON to indicate whenever any PRESSURE error is detected.**

P.O.=31 **ON if ERROR 36 (IPSC or IPS error) occurs at end of weld –** When the control includes the IPSC or IPS option and uses this PROCESS OUTPUT, the control reads the sensor output **after** the WELD portion of the weld sequence and turns PO Valve **ON if the TRIGGER value for PRESSURE/FORCE/CURRENT is not reached**. The TRIGGER values must be programmed within a valid range.

P.O.=33 **ON during any ERROR *or* control in NO WELD *or* control in PROGRAM mode *or* control in Emergency Stop; also flash H. i./L.o., stop sequence, turn PO valve ON for 0.5 seconds if current out of limit window –** PO Valve output will turn **ON under several conditions: 1) if any error is detected, 2) if control is in a NO WELD condition, 3) if control is in PROGRAM mode, or 4) in the event an Emergency Stop** condition is detected. The PO Valve output will turn **ON for 0.5 seconds if the control is unable to keep the current constant within HIGH/ LOW limit window**. Also the control will stop a REPEAT or CHAINED sequence and flash **H. i./L.o.** If the sequence is interrupted, the Front Panel will flash **H. i./L.o.** until ENTER button is pressed.

P.O.=34 **Flash H. i./L.o., stop sequence, turn PO Valve ON for 0.5 seconds if current out of limit window –** PO Valve output will turn **ON for 0.5 seconds if the control is unable to keep the current constant within HIGH/LOW limit window**. Also the control will stop a REPEAT or CHAINED sequence and flash **H. i./L.o.** If the sequence is interrupted, the Front Panel will flash **H. i./L.o.** until ENTER button is pressed.

5.4.8 BEAT OPERATION INITIATION MODES – b.E.

The EN1000/EN1001 Cascade/Multi-Valve Controls can provide several INITIATION modes:

- NON-BEAT INITIATION
- BEAT INITIATION DURING SQUEEZE
- BEAT INITIATION DURING SQUEEZE AND WELD
- BEAT INITIATION DURING WELD USING NW1 INPUT

NON-BEAT INITIATION – b.E.=00

The default (factory setting) mode is NON-BEAT. In the NON-BEAT mode, once a sequence is initiated by a momentary switch closure, it cannot be stopped unless the Emergency Stop is opened.

To program the control for the default (factory setting) NON-BEAT mode:

1. Put the control in PROGRAM mode.
2. Use SELECT to find **EF**.
3. Use the SCHEDULE push buttons to find **b.E.**
4. Use the DATA push buttons and make **b.E.**=**00**.
5. Press ENTER.

BEAT INITIATION DURING SQUEEZE – b.E.=01

BEAT DURING SQUEEZE is typically used with transgun applications. Generally, these applications may require that the operator or an external source terminate SQUEEZE time before entering the WELD period. This allows the operator to check tip placement before welding. If the placement is not correct, the initiation can be interrupted and the sequence can be terminated; the operator can then reposition the tip.

NOTICE
If initiation is opened during the WELD or HOLD period, the sequence will not be interrupted.

To program the control for BEAT DURING SQUEEZE:

1. Put the control in PROGRAM mode.
2. Use SELECT to find **EF**.
3. Use the SCHEDULE push buttons to find **b.E.**
4. Use the DATA push buttons and make **b.E.**=**01**.
5. Press ENTER.

NOTICE
To emulate a Two Stage Pilot, a Single Stage Pilot may be used in this mode of non-interlocked SQUEEZE time. If the Pilot is opened during SQUEEZE, the control will immediately stop the sequence.

Once the WELD time begins, however, the control interlocks the pilot circuit and completes the sequence. Allow enough SQUEEZE time for the operator to check alignment during SQUEEZE and open the pilot circuit before WELD time begins. This will allow the operator time to reposition the part if the alignment is not proper.

5.4.8 BEAT OPERATION INITIATION MODES – b.E. (cont.)

BEAT INITIATION DURING SQUEEZE AND WELD – b.E.=02

BEAT DURING SQUEEZE AND WELD is typically used for brazing applications. It provides the same functions as provided by BEAT DURING SQUEEZE; in addition the weld sequence can be terminated before WELD time has elapsed. If the operator opens the initiation during WELD time, the WELD time is interrupted and the control immediately advances to HOLD time. If the initiation switch remains closed, however, the control will weld normally until the end of the programmed schedule.

This flexibility is required for brazing parts with differing characteristics that require different weld times. The WELD time must be set for the longest time required to bring the parts to the required brazing temperature.

To program for BEAT DURING SQUEEZE AND WELD:

1. Put the control in PROGRAM mode.
2. Use SELECT to find ***EF***.
3. Use the SCHEDULE push buttons to find ***b.E.***
4. Use the DATA push buttons and make ***b.E.***=***02***.
5. Press ENTER.

b.E. MODE – b.E.=03 *

In this mode, control will have faster response time after Emergency Stop or power-up, without redundant checking schedule data validity. It will eliminate all self-checking delays as well. This mode was added in PROM firmware version 619044-002**A**. It does not affect initiation and control will operate, after closing initiation, exactly the same as in default NON-BEAT mode (***b.E.***=***00***), except that control will be ready for initiation much faster. Faster initialization after closing Emergency Stop input may be very useful when light curtain is used.

When ***b.E.*** is set to ***03***, the control will run a faster internal self-check after reset. This will reduce the time the control requires to go from an Emergency Stop condition to a Ready To Operate condition. This time will range from 30ms to 60ms maximum. To accomplish this reduced time, the redundant schedule data checking has been removed in this mode. The schedule data is still checked before use in a schedule when the weld sequence is initiated. The main reason for this addition is for machine control systems that use the TS1-ES1 and TS1-GND terminals to disable the weld control between initiations.

The standard recovery time of 200ms could add to machine cycle time if ***b.E.*** is not set to ***03***. Before PROM firmware version 619044-002**A**, recovery time was around 500ms. This is especially apparent when light curtains, as shown in Figure 5-19, are used to activate the Emergency Stop circuit.

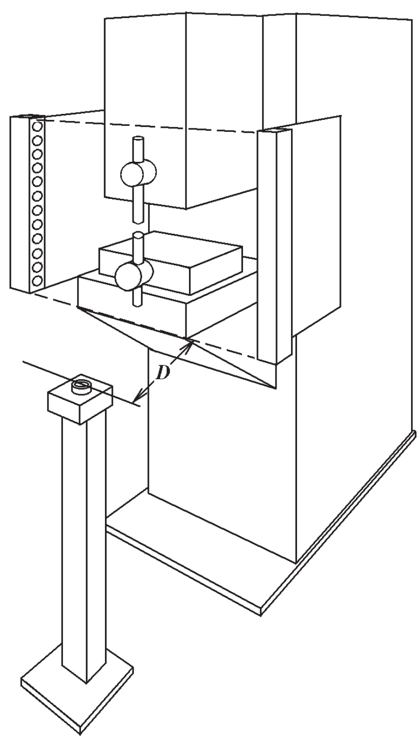


Figure 5-19. *Using light curtain*

* This mode will not affect BEAT operation.

5.4.8 BEAT OPERATION INITIATION MODES – b.E. (cont.)

How far (D) would the initiation button need to be for reliable initiation? Using the following times:

1. Weld control EMERGENCY STOP response = 60 ms
2. Typical light curtain response = 50 ms
3. Typical speed of travel of hand used in calculations for light curtains is 63″/second

Distance (D) is calculated as follows:

$$D = \frac{63''}{1000 \text{ ms}} \text{ x } 110 \text{ ms} = 6.93''$$

This is an estimate based on typical values and does not include switch de-bounce times.

BEAT INITIATION DURING WELD USING NW1 INPUT – b.E.=04

BEAT DURING WELD USING NW1 INPUT is enabled if **b.E.**=**04** is programmed. In this mode, when Weld/No Weld input (NW1-GND) is open, the control will stop welding and jump immediately to HOLD without executing the rest of the WELD part of the sequence.

b.E. MODE – b.E.=05 *

In this mode, the control will allow programming of CYCLE MODE **05**. This mode was added in PROM firmware version 619044-002**C**. It does not affect initiation and control will operate, after closing initiation, exactly the same as in default NON-BEAT mode **b.E.**=**00**. See Section 6.2.6 for more details.

b.E. MODE – b.E.=06 *

This mode is used for External Stepper Reset with momentary push button-type switch connected between TS1-ES1 and TS1-GND input. This mode was added in PROM firmware version 619044-002**E**. See Section 7.5.3 for more details.

* This mode will not affect BEAT operation.

5.4.9 87° DELAY – 8.7.

The 87° DELAY helps to prevent the build-up of a DC component in the welding transformer. A DC component may be damaging. To program this function:

1. Put the control in PROGRAM mode.
2. Use SELECT to find **EF**.
3. Use the SCHEDULE push buttons to find **8.7.**
4. Use the DATA push buttons and make **8.7.**=**00** or **01**.
   Where: **00** = 87° DELAY is disabled
   01 = 87° DELAY is enabled – default (factory setting)
5. Press ENTER.

NOTICE
87° DELAY ENABLE or DISABLE is only operational in MANUAL POWER FACTOR mode of operation (see Section 5.4.10).

5.4.10 MANUAL POWER FACTOR PROGRAMMING – *P.P.*

If required, the EN1000/EN1001 Cascade/Multi-Valve Control can be placed in the MANUAL POWER FACTOR mode as follows:

1. Place the control in the PROGRAM mode.
2. Use SELECT to find ***EF***.
3. Use the SCHEDULE push buttons to find ***P.P.***
4. Use the DATA push buttons to enter the machine's POWER FACTOR as measured following steps outlined in Section 5.4.11.

   Where: ***P.P.***=***00*** Control is in AUTOMATIC POWER FACTOR mode (default).
   P.P.=**[*xx*]** If ***xx*** is not 00, control is in MANUAL POWER FACTOR mode and the programmed POWER FACTOR is ***xx***.
5. Press ENTER.

5.4.11 POWER FACTOR MEASURING – *P.F.*

The EN1000/EN1001 Cascade/Multi-Valve Control is in the AUTOMATIC POWER FACTOR mode when shipped from the factory. Calibration of the automatic power factor circuit is not required. This has two benefits:

1. It is not necessary to make manual adjustments when installing the control, to match its circuitry to the POWER FACTOR of the welding machine;
2. It assures that maximum welding current, for any welding transformer tap switch setting, will occur when the selected PERCENT CURRENT is 99%.

If desired, for some applications, the AUTOMATIC mode can be disabled and the machine POWER FACTOR can be set manually (see Section 5.4.10). Machine's POWER FACTOR can be determined when in the AUTOMATIC POWER FACTOR mode as follows:

1. Use SELECT to find ***EF***.
2. Use the SCHEDULE push buttons to find ***P.F.***
3. Make a weld.

At this point, after the weld is complete, the machine's POWER FACTOR will be shown in the DATA display (see Section 5.4.10).

NOTICE
When measuring the POWER FACTOR, the displayed POWER FACTOR corresponds to the last weld made by the control.

5.4.12 SQUEEZE DELAY – S.d.

SQUEEZE DELAY is a pre-squeeze which energizes the scheduled valves for the programmed interval of time. SQUEEZE DELAY occurs **after** initiation and immediately **before** the first SQUEEZE is executed (a form of retraction to position electrodes closer to the work in a REPEAT sequence).

The length of time added to SQUEEZE time measured in cycles (60 cycles = 1 second).

After initiation on any of the Pilot switches (TS1-FS3, etc.), the control's display will dim slightly indicating the control is in SQUEEZE DELAY and return to regular intensity for the programmed SQUEEZE time.

NOTICE
SQUEEZE DELAY occurs only before the first SQUEEZE time when in REPEAT mode.

5.4.13 BLOCKING DELAY – b.L.

This output enables the user of an air-over-oil gun to have a programmed partial retraction in the middle of a sequence. The output may be turned off by momentarily opening Emergency Stop terminals TS1-ES1 and TS1-GND.

BLOCKING DELAY is an interval of time that occurs **immediately before** (overlapping) the programmed OFF time interval.

When **P.O.**=**07** and delays have been programmed properly, PO Valve output will turn on during the programmed OFF time, starting at the end of BLOCKING DELAY time. It will remain on after the current sequence until the next initiation occurs.

If the programmed OFF interval is shorter than the programmed BLOCKING DELAY interval, the programmed OFF will not occur.

If the programmed OFF interval is longer than BLOCKING DELAY, resulting OFF time will be programmed OFF time minus BLOCKING DELAY time (see Figure 9-14). This means that BLOCKING DELAY overlaps OFF (after HOLD, coincident with OFF time) which happens only in a sequence of schedules ending with a CYCLE MODE = **00**, **01** or **03**.

5.4.14 CONSTANT CURRENT MODES – C.r. (EN1001 *only*)

This parameter is used to select desired CONSTANT CURRENT mode and Current Sensor. The EN1001 Cascade/Multi-Valve Constant Current Control can be programmed for CONSTANT CURRENT operation and two basic modes:

1. Compensation (both monitoring and compensation)
2. Monitoring (only monitoring, no compensation)

CONSTANT CURRENT operation is possible with two different types of Current Sensors:

- Primary sensing with Current Transformer
- Secondary sensing with calibrated Rogowski Coil

To program the control for CONSTANT CURRENT operation:

1. Put the control in PROGRAM mode.
2. Use SELECT to find **EF**.
3. Use the SCHEDULE push buttons to find **C.r.**
4. Use DATA push buttons to select desired CONSTANT CURRENT code from Table 5-6.
5. Press the ENTER push button.

Table 5-6. *CONSTANT CURRENT modes*

C.r.	CONSTANT CURRENT		MODE	RANGE
00	disabled CONSTANT CURRENT		—	—
Primary Current Transformer: PT2, PT5, PT10, or PT20				
10	Primary Compensation	any	max. range	
11	Primary Monitoring	any	max. range	
12	Primary Compensation	PT2	ratio	200 A
13	Primary Monitoring	PT2	ratio	200 A
14	Primary Compensation	PT5	ratio	500 A
15	Primary Monitoring	PT5	ratio	500 A
16	Primary Compensation	PT10	ratio	1000 A
17	Primary Monitoring	PT10	ratio	1000 A
18	Primary Compensation	PT20	ratio	2000 A
19	Primary Monitoring	PT20	ratio	2000 A
Secondary Rogowski Coil: S6 or S10				
30	Secondary Compensation		max. range	up to 100 kA
31	Secondary Monitoring		max. range	up to 100 kA
32	Secondary Compensation		desired range	2 to 100 kA
33	Secondary Monitoring		desired range	2 to 100 kA

EN1001 Cascade/Multi-Valve Controls in CONSTANT CURRENT mode can access **H. i.** and **L.o.** EXTENDED parameters to set specific current limits (see Section 8.1.1).

5.4.15 RATIO OR RANGE – r.A. (EN1001 *only*)

This parameter is used in CONSTANT CURRENT mode to program:

1. **RATIO** of the welding transformer for monitoring and compensation with Primary Current Sensor in RATIO mode; i.e., for C.r.=12 through 19.
2. Operating **RANGE**, either in [%] mode, r.A.=00.99, or in [kA] mode where r.A. is maximum RMS CURRENT for desired range or transformer tap.

To program the **RATIO** or **RANGE** on the EN1001 Control in CONSTANT CURRENT modes:

1. Put the control in PROGRAM mode.
2. Use SELECT to find EF.
3. Use the SCHEDULE push buttons to page through the EXTENDED FUNCTIONS and find r.A.
4. Enter a value for r.A. from Table 5-7, using the DATA push buttons.
5. Press ENTER.

The control can be programmed in PERCENT CURRENT steps from 00.00 to 00.99, or the control can be programmed in steps proportional to a maximum measured CURRENT on the secondary of the welding transformer.

Table 5-7. *RATIO or RANGE for CONSTANT CURRENT modes*

C.r.	CONSTANT CURRENT	r.A. MODE	[%]	[kA]	rA_{WT} *
00	disabled		—	—	—
	Primary Current Transformer: PT2, PT5, PT10, or PT20				
10	Primary Compensation	max. range	00.99	*xx.xx*	—
11	Primary Monitoring	max. range	00.99	*xx.xx*	—
12,14,16,18	Primary Compensation	ratio	—	—	up to 0125
13,15,17,19	Primary Monitoring	ratio	—	—	up to 0125
	Secondary Rogowski Coil: S6 or S10				
30	Secondary Compensation	max. range	00.99	*xx.xx*	—
31	Secondary Monitoring	max. range	00.99	*xx.xx*	—
32	Secondary Compensation	desired range	—	*xx.xx*	—
33	Secondary Monitoring	desired range	—	*xx.xx*	—

* Welding Transformer Ratio is: $rA_{WT} = U_{PRIMARY} / U_{SECONDARY} = I_{SECONDARY} / I_{PRIMARY}$

NOTICE

When entering **RATIOS** in the r.A. parameter, the RATIO should be entered as a whole number (if the ratio is 115.5, enter 0115). When entering **RANGE** in [kA] mode, only numbers representing maximum values should be entered as [kA] (12500 A enter as 12.50).

5.4.16 CURRENT OFFSET – C.O.

The EXTENDED FUNCTION parameter CURRENT OFFSET (**C.O.**) provides current adjustment in either [kA] or [%] in OPERATE mode without going into PROGRAM mode. With this parameter, an adjustment limit window is set within which the weld CURRENT can be changed. Only weld CURRENT can be changed this way and all other SCHEDULE parameters remain unchanged. There are two CURRENT OFFSET modes – CURRENT OFFSET FOR SINGLE DISPLAYED SCHEDULE and CURRENT OFFSET FOR ALL SCHEDULES.

1. **CURRENT OFFSET FOR SINGLE DISPLAYED SCHEDULES**
   Changing the CURRENT for a schedule only affects the displayed schedule. This is useful when a change is needed because of an individual part change.
2. **CURRENT OFFSET FOR ALL SCHEDULES**
   Changing the CURRENT for any individual schedule, within the CURRENT OFFSET window, will affect ***all*** schedules programmed in the control. Offsetting of all schedules may be useful when a machine function (i.e., a shunt) increases in resistance, affecting all weld schedules.

CURRENT OFFSET PROGRAMMING FOR SINGLE DISPLAYED SCHEDULES

To program the CURRENT OFFSET limits for SINGLE DISPLAYED SCHEDULES:

1. Put the control in PROGRAM mode.
2. Use SELECT to find **EF**.
3. Use SCHEDULE push buttons to find **C.O.**
4. Use the DATA push buttons to program the desired values.
   Where: **C.O.**=**00** CURRENT OFFSET is disabled
   C.O.=**01** to **19** CURRENT OFFSET is enabled ONLY for SINGLE DISPLAYED SCHEDULE
5. Press ENTER.

For a SINGLE DISPLAYED SCHEDULE, the CURRENT OFFSET may be any value from 01 to 19 in units of percent [%]. This value will set maximum and minimum OFFSET limits for programmed CURRENT. CURRENT can be changed within these limits without going into PROGRAM mode.

CURRENT OFFSET PROGRAMMING FOR ALL SCHEDULES

To program the CURRENT OFFSET limits for ALL SCHEDULES:

1. Put the control in PROGRAM mode.
2. Use SELECT to find **EF**.
3. Use SCHEDULE push buttons to find **C.O.**
4. Use the DATA push buttons to program the desired values.
   Where: **C.O.**=**20** CURRENT OFFSET is disabled
   C.O.=**21** to **39** CURRENT OFFSET is enabled for ALL SCHEDULES
5. Press ENTER.

5.4.16 CURRENT OFFSET – C.O. (cont.)

When CURRENT OFFSET FOR ALL SCHEDULES is used, **C.O.** can have a value from 20 to 39 as indicated below:

C.O.	= 20	CURRENT OFFSET is disabled
	= 21	CURRENT OFFSET FOR ALL SCHEDULES ±1%
	= 22	CURRENT OFFSET FOR ALL SCHEDULES ±2%
	= . . .	
	= 38	CURRENT OFFSET FOR ALL SCHEDULES ±18%
	= 39	CURRENT OFFSET FOR ALL SCHEDULES ±19%

On Control Boards with four-digit DATA display, the first digit will be **S.** if **C.O.**=01 to 19 or **A.** if **C.O.**=21 to 39.

USING CURRENT OFFSET

This feature is very useful when a PROGRAM LOCKOUT key switch is used. An operator may change the CURRENT without changing any other welding parameters and without going into PROGRAM mode. The operator may increase the operating PERCENT CURRENT only up to BASE CURRENT plus CURRENT OFFSET, or decrease the operating PERCENT CURRENT down to BASE CURRENT minus CURRENT OFFSET.

To change programmed CURRENT, within the OFFSET limits in [%] or [kA], in OPERATE mode:

1. Press SELECT until FUNCTION indicator LED stops at PERCENT CURRENT.
2. Use the DATA push buttons to increase or decrease the PERCENT CURRENT by pressing or holding either DATA push button.
3. Press ENTER ***only*** for CONSTANT CURRENT mode in [kA]. For CONSTANT CURRENT mode in [%] or for NON-CONSTANT CURRENT mode, data will be stored immediately after pressing either DATA push button.

NOTICE
If a value greater than allowed by maximum OFFSET is programmed, the control will store and display maximum PERCENT allowed. Similarly, if a value lower than allowed by minimum OFFSET is programmed, the control will store and display minimum PERCENT allowed.

CURRENT OFFSET FOR SINGLE DISPLAYED SCHEDULES – C.O.=01 to 19: New weld PERCENT CURRENT will be only for that schedule.

CURRENT OFFSET FOR ALL SCHEDULES – C.O.=21 to 39: PERCENT CURRENT will be increased or decreased with the same OFFSET in percent in all schedules.

CHANGING BASE CURRENT

To change BASE PERCENT CURRENT, simply program the schedule as done normally by switching to the PROGRAM mode and following normal programming procedures. In PROGRAM mode, the display will flash between BASE CURRENT and OFFSET CURRENT value. PERCENT CURRENT is the only weld schedule parameter that is changed whenever a CURRENT OFFSET value is used.

5.4.16 CURRENT OFFSET – C.O. (cont.)

CURRENT OFFSET INDICATION

In the PROGRAM mode, when the PERCENT CURRENT is displayed, the control will flash if the CURRENT OFFSET is active. The programmed BASE CURRENT is indicated simultaneously with the schedule number. The OFFSET CURRENT is indicated simultaneously with **C.O.** in the SCHEDULE display plus either **S.** (**S**ingle Displayed) or **A.** (**A**ll) in the DATA display (NON-CONSTANT CURRENT mode) along with the OFFSET CURRENT value used.

The ENTER push button can be depressed while either of the two values are displayed. Pressing ENTER will move the OFFSET CURRENT value into the BASE PERCENT CURRENT value. BASE CURRENT value also may be changed by pressing or holding DATA push buttons and then pressing ENTER.

CURRENT OFFSET EXAMPLES

1. **C.O.**=**00** — CURRENT OFFSET is disabled. The CURRENT cannot be changed in OPERATE mode.

2. **C.O.**=**05** or **C.O.**=**S.05** [%] mode — CURRENT OFFSET is +/-5%. For SINGLE DISPLAYED SCHEDULE, the CURRENT can be changed in OPERATE mode within 10% window; i.e., up to +/-5% from original BASE value programmed in PROGRAM mode.
   For example: For an original BASE CURRENT value of 70%, a new value may be from 65% to 75%.

3. **C.O.**=**25** or **C.O.**=**A.25** [%] mode — CURRENT OFFSET is +/-5%. For ALL SCHEDULES, the CURRENT can be changed in OPERATE mode within 10% window; i.e., up to +/-5% from original BASE value programmed in PROGRAM mode.
   For example: For an original BASE CURRENT value of 70%, a new value may be from 65% to 75%.

4. **C.O.**=**05** or **C.O.**=**S.05** [kA] mode — CURRENT OFFSET is +/-5%. For SINGLE DISPLAYED SCHEDULE, the CURRENT can be changed in OPERATE mode within 10% of maximum RMS CURRENT window; i.e., up to +/-5% from original value programmed in PROGRAM mode.
   For example: For an original BASE CURRENT value of 14.00 kA and maximum RMS is 20.00 kA, a new value may be from 13.00 kA to 15.00 kA (because 5% of 20.00 kA is 01.00 kA).

5.4.17 PIN LOCKOUT MODE – P.n.

This feature has been added in PROM firmware version 619044-002**A** and does not require any hardware change or additional option. Operation of the hardware PROGRAM LOCKOUT key switch, when used, has not been changed.

ENABLING PIN LOCKOUT

To enable PIN LOCKOUT mode, a 4-digit PIN number must be programmed:

1. Put the control in PROGRAM mode.
2. Use SELECT to find **EF**.
3. Scroll through EXTENDED FUNCTIONS using the right SCHEDULE push button until the SCHEDULE display shows **P.n.**
4. Use the DATA push buttons to program desired PIN from **0001** to **9999**.
5. Press ENTER.
6. Program all other desired SCHEDULE or EXTENDED FUNCTION parameters.
7. Put the control back in PROGRAM mode. After PROGRAM/OPERATE push button is released, the control will flash **L.o.c.** on DATA display, which will indicate that PIN LOCKOUT mode is enabled.

After the last step, control will be locked from going into PROGRAM mode. To unlock control, entering correct PIN is required or use of PROGRAM LOCKOUT key switch when used.

UNLOCKING CONTROL USING PIN

In order to go in PROGRAM mode when control is locked, correct PIN must be entered:

1. Use SELECT to find **EF**.
2. Scroll through EXTENDED FUNCTIONS using the right SCHEDULE push button until the SCHEDULE display shows **P.n.** On DATA display, control will show **0000** as programmed PIN is hidden.

NOTICE
Whenever PROGRAM/OPERATE push button is pressed while control is locked with PIN, the control will flash **P. i.n.** for 0.5 seconds on DATA display and PROGRAM LED will flash as well, and control will go immediately to EXTENDED FUNCTION parameter **P.n.**

3. Use the DATA push buttons to enter PIN.
4. Press ENTER. After this push button is released:
   – if correct PIN is entered, the control will flash **u.L.o.c.** on DATA display and it will go immediately into PROGRAM mode;
   – if incorrect PIN is entered, the control will flash **O.o.P.S.** on DATA display.
5. After programming all desired SCHEDULE or EXTENDED FUNCTION parameters, new PIN may be entered or the current PIN will be applied when control is put back in OPERATE mode.

DISABLING PIN LOCKOUT

To disable PIN LOCKOUT mode or delete PIN, simply clear all EXTENDED FUNCTIONS data by entering **C.A.=02**, or press and hold PROGRAM/OPERATE push button during power-up or after Emergency Stop reset. This may be also very useful whenever the PIN is lost.

NOTICE
The control is shipped from the factory in the **disabled** PIN LOCKOUT mode.

6.0 GENERAL OPERATING INSTRUCTIONS

For customer's convenience, many electrical and mechanical connections have been performed at the factory. Refer to Wiring Diagram for other connections.

Be sure **ALL** electrical connections are properly made and that all fittings are securely tightened. Loose electrical connections can cause faulty or erratic operation of the control or welding machine.

If the machine is air operated, turn on the air supply to the machine. Set air pressure in accordance with the machine manufacturer's recommendations.

Be sure that the welding machine heads are fully retracted. Turn on main power. The SCHEDULE and DATA displays will turn on at this time.

Place the control in NO WELD. Use either the Front Panel's WELD/NO WELD switch or the External Weld/No Weld Switch connected to Terminal Strip between TS1-NW1 and TS1-GND.

6.1 WELD SEQUENCE EXAMPLE

Program a simple single SPOT schedule into the control as follows:

SQUEEZE count	30 to 60 cycles
WELD/HEAT count	12 to 25 cycles
PERCENT CURRENT	50 to 60%
HOLD count	10 to 15 cycles
OFF count	00 cycles
IMPULSES	01 (NO IMPULSES)
COOL count	00 cycles
VALVE MODE	01 (VALVE 1)
CYCLE MODE	00 (NON-REPEAT)
SLOPE MODE	00 (NO SLOPE)
SLOPE COUNT	00 cycles
CONTACTOR SELECT	01 (SCR 1)

1. Initiate the control. On installations with a Two Stage Pilot switch, depress the First Stage only. The programmed valve will activate. The control will not sequence through SQUEEZE, WELD, HOLD and OFF. Be sure that the electrodes have closed together prior to depressing the Second Stage.
2. The control will sequence but will not weld, and then the head or arms will retract. On Single Stage operation, closure of the Pilot switch will cause the control to sequence. On foot-operated machines only, a switch on the mechanical linkage of the machine will initiate the sequence.

! CAUTION !
KEEP HANDS, ARMS, OTHER PORTIONS OF THE BODY, CLOTHING, AND TOOLS AWAY FROM THE MOVING PARTS OF THE MACHINE.

6.1 WELD SEQUENCE EXAMPLE (cont.)

3. Program the schedule for the part to be welded. Place the work in the machine and set the WELD/NO WELD switch (both on Control Panel and any External Weld/No Weld Switches) to the WELD position. The machine is ready to weld.
4. If no standards have been set, it is recommended to use a short WELD count for initial setup and welding. WELD count can be increased, the PERCENT CURRENT can be adjusted, and welding transformer tap (if applicable) can be increased for the best weld. The most efficient use of the control and welding machine will generally be made at the lowest welding transformer tap, the highest PERCENT CURRENT setting, and the shortest WELD count.
5. For REPEAT operation, program CYCLE MODE to **01**, and program OFF count to allow sufficient time to reposition the part for subsequent welds.

6.2 CYCLE MODES

The EN1000/EN1001 Cascade/Multi-Valve Control can be programmed to operate in several CYCLE MODES. Each of the 100 possible schedules has a CYCLE MODE parameter that dictates the sequence of events that will follow an initiation.

The CYCLE MODE are as follows:

00 = NON-REPEAT
01 = REPEAT
02 = CHAINED
03 = SUCCESSIVE
04 = CONDITIONAL SUCCESSIVE
05 = WAIT-HERE

The CYCLE MODE parameter is entered into a schedule when the control is in PROGRAM mode with CYCLE MODE indicator LED illuminated.

6.2.1 NON-REPEAT – CYCLE MODE=00

When any of the 100 possible schedules, having a CYCLE MODE setting of **00**, is initiated by a Pilot switch, the sequence executes as shown in Figure 6-1 (depending on the programmed parameters).

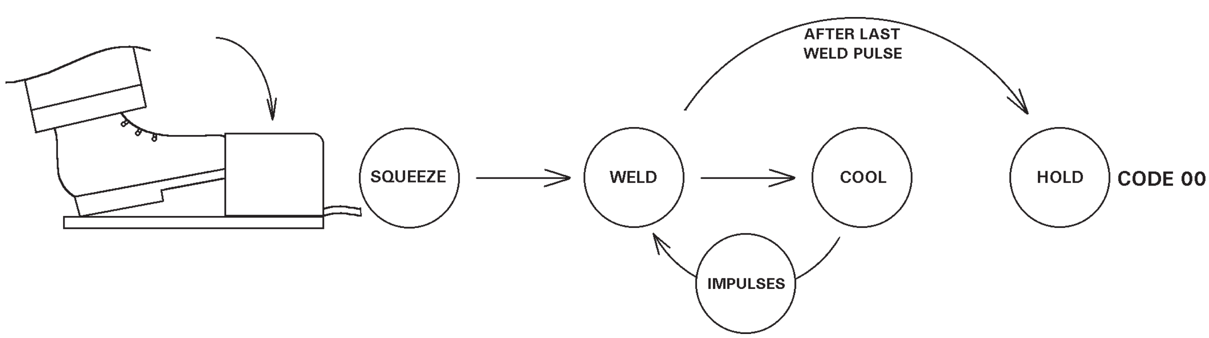


Figure 6-1. *NON-REPEAT sequence*

6.2.1 NON-REPEAT – CYCLE MODE=00 (cont.)

Upon initiation, the programmed valve is energized at the beginning of SQUEEZE. If the Pressure Switch is open, the control counts through SQUEEZE time but does not begin counting WELD time until the Pressure Switch closes. If the Pressure Switch remains open, the SQUEEZE LED will flash. Once the Pressure Switch closes, WELD time begins. Weld current is then supplied to the welding transformer at a value programmed by the PERCENT CURRENT for a duration programmed in WELD.

In this example, PULSATION is shown after COOL, until the number of IMPULSES has elapsed, then moving to HOLD. HOLD time is when the electrodes are closed with no current present, but the selected valve will still be energized. Since this is a NON-REPEAT sequence, there is no OFF time mentioned. The valve will automatically de-energize at the end of the programmed HOLD time.

6.2.2 REPEAT – CYCLE MODE=01

When any of the 100 possible schedules, having a CYCLE MODE setting of **01**, is initiated by a Pilot switch, the sequence is as shown in Figure 6-2.

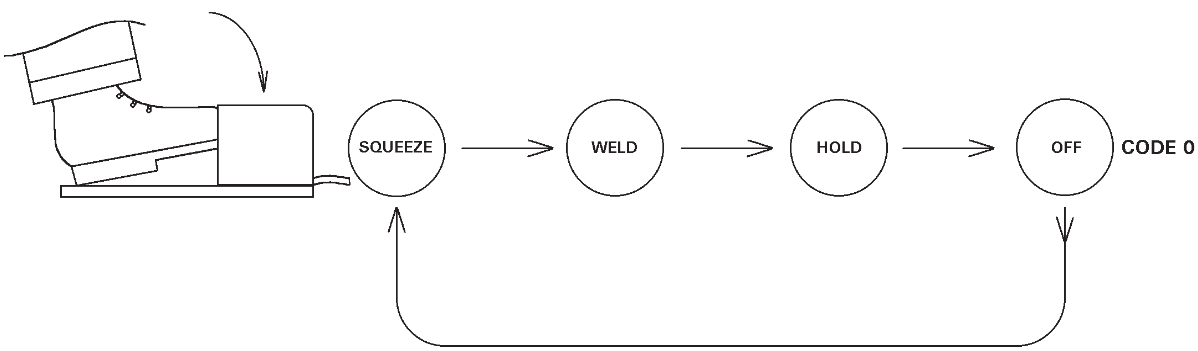


Figure 6-2. *REPEAT sequence*

In this example, the sequence is much the same as the previous example with the exception of no IMPULSE welding. If the initiation (foot switch) is held closed until after the OFF time, the control will move to the beginning of SQUEEZE time and REPEAT the scheduled sequence.

Each individual sequence intended to REPEAT must be programmed separately for CYCLE MODE **01** to perform a REPEAT function.

6.2.3 CHAINED – CYCLE MODE=02

Scheduled sequences may be CHAINED, resulting in a weld sequence made up of several schedules in length. A CHAINED sequence can be programmed by entering **02** in CYCLE MODE. The last scheduled sequence must be a CYCLE MODE value of **00** (NON-REPEAT), **01** (REPEAT), or **03** (SUCCESSIVE).

If CYCLE MODE **01** is used in the last schedule of a CHAINED sequence, the entire chain will be repeated if the initiation is held closed.

6.2.3 CHAINED – CYCLE MODE=*02* (cont.)

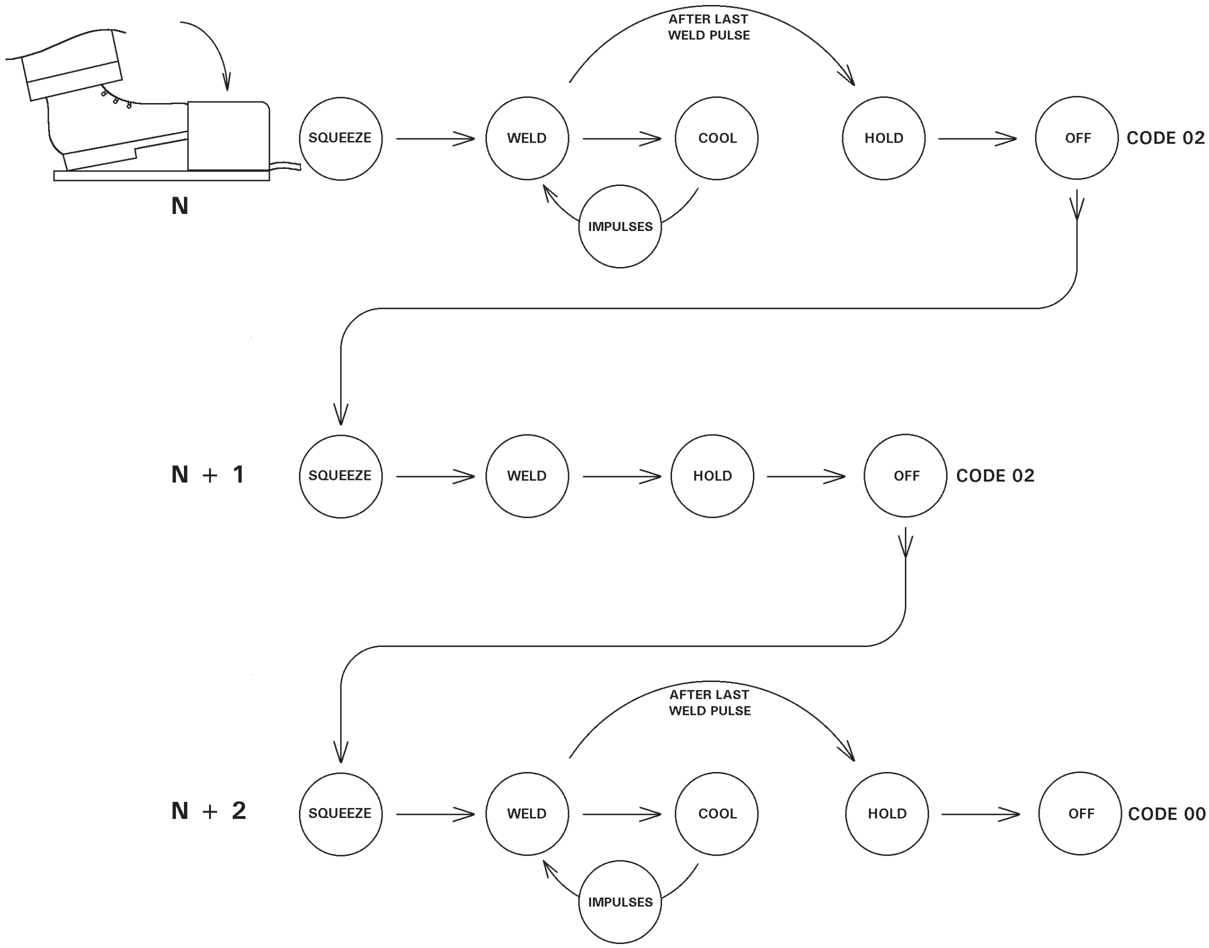


Figure 6-3. *CHAINED sequence*

The first schedule of a CHAINED sequence can be any of the 100 possible. In CYCLE MODE ***02***, a scheduled sequence is CHAINED immediately to the next schedule (numerically 23, 24, 25, etc.). When initiated (foot switch), the sequence takes place as shown in Figure 6-3. The first schedule of the CHAINED sequence is called *N*.

While schedule *N* is sequencing, the times and parameters will be in accordance with those stored in schedule *N*. When schedule *N* has finished, the sequence jumps to schedule *N*+1. Schedule *N*+1 is then performed and so on until the sequence encounters a ***00***, ***01***, or ***03*** in the CYCLE MODE function.

Within the CHAINED sequence, the control will encounter schedules programmed with the following CYCLE MODES and will react as follows:

***00* NON-REPEAT**: The sequence will end in NON-REPEAT mode. The SCHEDULE display will then return to the first initiated sequence.

***01* REPEAT**: The sequence will start over at the initiated sequence and continue as explained in CHAINED mode.

***02* CHAINED**: The SCHEDULE display will increment by one and continue as explained in CHAINED mode.

6.2.3 CHAINED – CYCLE MODE=02 (cont.)

03 SUCCESSIVE: The sequence will end as if it were in NON-REPEAT mode. The SCHEDULE display would then be incremented by one to next schedule as in SUCCESSIVE mode but not start that sequence until the next initiation. By using **03** at the end of CHAINED sequences, extremely complicated sequences can be generated. The SCHEDULE display will display the schedule number of the last schedule performed + 1.

04 CONDITIONAL SUCCESSIVE: The sequence will start over at the initiated sequence.

05 WAIT-HERE: The sequence will wait for TS1-FS7 or TS1-FS11 initiation input.

When HOLD and OFF in the first schedule of a CHAINED sequence and SQUEEZE in the second of the CHAINED sequence are all programmed to 00 cycles, the sequence will jump directly from the end of WELD time of the first schedule to the beginning of WELD time in the following schedule, without any interval between the two WELD times (continuous weld current). This sequence allows two different weld currents to be introduced with one immediately following the other.

The schedule number displayed at the end of a CHAINED sequence depends on the EXTENDED FUNCTION SCHEDULE SELECT (**S.S.**). If it was programmed in the EXTERNAL mode, the schedule number displayed will be controlled by the combination of TS1-FS7/SS1 and TS1-FS11/SS3 (see Section 2.1). If it was programmed to the INTERNAL mode, the schedule number will be the last number entered using SCHEDULE push buttons. The number displayed need not be the first number in a sequence of CHAINED schedules. For example, if schedules 01, 02, 03 and 04 are CHAINED together and we select schedule 02, after initiation the sequence would be as follows: schedule 02, 03, 04 and at the completion of schedule 04, the SCHEDULE display would read 02, and not the first schedule 01. See Section 5.4.3.

6.2.4 SUCCESSIVE – CYCLE MODE=03

SUCCESSIVE mode can be thought of as a CHAINED schedule being initiated one link (or step) at a time. When the first schedule of a SUCCESSIVE series is initiated, it will sequence as in NON-REPEAT. At the completion of the schedule, the SCHEDULE display will be incremented by one and the control will return to the Ready state.

For example, if the control is programmed with a SUCCESSIVE series consisting of the schedules 01, 02, and 03 (01 and 02 being programmed as SUCCESSIVE schedules and 03 being programmed as a NON-REPEAT schedule) and the SCHEDULE display is manually set to 01 and the control is initiated, the sequence of events will be as follows: the control will sequence through schedule 01 and then increment the SCHEDULE display to 02 (flashing) and wait for the next initiation. An initiation at this point would start schedule 02. After schedule 02 was completed, the SCHEDULE display would then increment to schedule 03 (flashing). After the next initiation, schedule 03 will be completed and the SCHEDULE display will again show schedule 01.

6.2.4 SUCCESSIVE – CYCLE MODE=03 (cont.)

When the EXTENDED FUNCTION SCHEDULE SELECT is programmed to the EXTERNAL mode, the SUCCESSIVE series will start with the externally selected schedule and will automatically return to that schedule once the series is completed (see Section 5.4.3).

The BACK-STEP function can be used to return to the previous schedule *N*-1 without continuing through the rest of the SUCCESSIVE schedules. A momentary closure of the BACK-STEP (TS1-WFS1/AUX1) switch will cause the control to return the previous schedule. This can be repeated until the first schedule of a series is reached. A maintained closure (approximately 1.5 seconds) will cause the control to return the first schedule in the series. If the BACK-STEP switch is maintained after the control reaches the first schedule, an ERROR CODE **E.r.=06** will flash in the DATA display. See Section 5.4.6.

6.2.5 CONDITIONAL SUCCESSIVE – CYCLE MODE=04

The CONDITIONAL SUCCESSIVE mode has been implemented to complement CHAINED and SUCCESSIVE sequences with a third type that combines the benefits of both.

The control will execute the given schedule, and at the end of HOLD will maintain the schedule valves active. At this point, the control will wait in this state and indicate the state by blinking the Front Panel HOLD LED. If the control is initiated a second time, when the initiation input closes, the control will continue by selecting the next schedule and executing it as programmed.

NOTICE
If a momentary initation was used to begin the current schedule, the control will wait until a new initation is asserted. If the initiation was held closed until this point, the control will wait until the initiation is opened and a new initiation is asserted.

EXAMPLE: PART LOCATOR & CLAMP

In some cases fixturing may require a locating pin be extended to accurately locate a part before welding. The following shows how six schedules can be programmed using various CYCLE MODES to accomplish this function.

Step 1 – Locate
Schedule 00 is programmed to energize Valve 1 in order to actuate a part locator. Initially, the valve is active for 60 cycles, 40 cycles of SQUEEZE and 20 cycles of HOLD (one second). At the end of this time, the control blinks the HOLD LED and waits for further input; i.e., for re-initiation.

SCHEDULE	SQUEEZE	WELD/ HEAT	PERCENT CURRENT	HOLD	OFF	IMPULSES	COOL	VALVE MODE*	CYCLE MODE	SLOPE MODE	SLOPE COUNT
00	40	00	00	20	00	01	00	01	04	00	00

At this point, the operator can load a part and initiate the next sequence by opening and closing the foot switch.

* See Table 2-1 for description of this code.

6.2.5 CONDITIONAL SUCCESSIVE – CYCLE MODE=04 (cont.)

Step 2 – Clamp
When the operator closes the foot switch again, the control activates the following CHAINED schedule immediately. During the second schedule, the control adds a second valve to the first, the clamp valve.

SCHEDULE	SQUEEZE	WELD/ HEAT	PERCENT CURRENT	HOLD	OFF	IMPULSES	COOL	VALVE MODE*	CYCLE MODE	SLOPE MODE	SLOPE COUNT
01	40	00	00	20	00	01	00	03	02	00	00

Step 3 – Cascade Welds
The third and fourth schedules (02 and 03) execute a SQUEEZE, WELD and HOLD using Valve 3. Valves 1 and 2 are still active (position and clamp).This sequence adds Valve 3 which closes a pair of guns connected to each of the two welding transformers. After the control executes a weld on Contactor 1, the sequence continues onto schedule 03, where the control makes a similar weld using Contactor 2.

The fifth and sixth schedules (04 and 05) execute another SQUEEZE, WELD and HOLD using Valve 4. In this sequence, Valve 3 is de-energized. Valve 4 activates a second pair of guns connected to the two transformers. Again, the control welds using Contactor 1 and chains to Contactor 2 to execute the third and fourth welds.

SCHEDULE	SQUEEZE	WELD/ HEAT	PERCENT CURRENT	HOLD	OFF	IMPULSES	COOL	VALVE MODE*	CYCLE MODE	SLOPE MODE	SLOPE COUNT	CONTACTOR SELECT
02	40	10	70	05	00	01	00	07	02	00	00	01
03	00	10	70	05	00	01	00	07	02	00	00	02
04	40	10	70	05	00	01	00	0B	02	00	00	01
05	00	10	70	05	00	01	00	0B	00	00	00	02

Variations in the above sequence can be accomplished using other CYCLE MODES and VALVE MODES. Since VALVE codes are in *binary* form, valve assignments are clarified in Table 6-1 in Section 6.4.

6.2.6 WAIT-HERE – CYCLE MODE=05

! CAUTION !

Use WAIT-HERE function (CYCLE MODE=05) with full understanding of machine and control operation. Enabling of b.E.=05 has been added to help ensure this operation is **really** required.

This CYCLE MODE has been implemented to satisfy additional requirements for more complicated machine sequencing.

NOTICE

The control will allow programming of CYCLE MODE 05 ***only*** if EXTENDED FUNCTION parameter BEAT mode is already programmed to b.E.=05.

If a schedule is programmed with CYCLE MODE 05 and, if initiated by TS1-FS3 initiation, the control will execute the schedule sequence, wait either in SQUEEZE or WELD/COOL or HOLD

* See Table 2-1 for description of this code.

6.2.6 WAIT-HERE – CYCLE MODE=05 (cont.)

part of the sequence, depending on programmed data in the given schedule, and maintain the schedule valves active indefinitely. At this point, the WAIT-HERE part of the sequence can be stopped by activating Emergency Stop or Temperature Limit Switch input, or it can be continued with TS1-FS7 or TS1-FS11 initiation. When the TS1-FS7 or TS1-FS11 initiation input closes, the control will continue by selecting schedule 20 or 40, respectively, and executing it as programmed whether it is a SPOT or REPEAT or CHAINED sequence.

In order to determine where control will wait in CYCLE MODE **05**, corresponding SCHEDULE parameter must be programmed to 99. The control will wait on SQUEEZE if SQUEEZE is programmed to 99, or WELD/COOL if IMPULSES is 99, or HOLD if HOLD is 99.

The following sequence illustrates an example of how to use this CYCLE MODE.

SCHEDULE	SQUEEZE	WELD/ HEAT	PERCENT CURRENT	HOLD	OFF	IMPULSES	COOL	VALVE MODE*	CYCLE MODE	SLOPE MODE	SLOPE COUNT
00	30	00	00	00	00	01	00	01	02	00	00
01	20	00	00	10	00	01	00	03	04	00	00
02	30	00	00	00	00	01	00	03	02	00	00
03	10	20	60	10	00	99	06	07	05	00	00

After welding sequence is started with TS1-FS3, the control will execute a chain on schedule 00, wait for re-initiation on schedule 01, execute chain on schedule 02 and then it will weld indefinitely on schedule 03 (because CYCLE MODE=**05** and IMPULSES=**99**). It will continue to weld until one of two conditions occur: 1) Emergency Stop or Temperature Limit Switch is open causing sequence to be stopped or 2) TS1-FS7 or TS1-FS11 is activated causing the control to jump to schedule 20 or 40, respectively, and execute whatever sequence is programmed there. In this case for schedule 03, SQUEEZE time must be less than 99 cycles, otherwise the control will wait on SQUEEZE. In order to wait on HOLD, both SQUEEZE and IMPULSES must not be programmed to 99.

! WARNING !

By definition, use of this CYCLE MODE can cause control to latch up with programmed valves or welds for an indeterminate time. Welding sequence cannot be stopped by releasing TS1-FS3 initiation in this mode. Only either TS1-FS7 or TS1-FS11 input can be used to jump to sequences on schedules 20 or 40, respectively, or Temperature Limit Switch or Emergency Stop inputs can be used to stop the sequence.

! CAUTION !

Use WAIT-HERE function (CYCLE MODE=05) with full understanding of machine and control operation. Enabling of **b.E.**=**05** has been added to help ensure this operation is **really** required.

* See Table 2-1 for description of this code.

6.3 SLOPE MODES

The EN1000/EN1001 Cascade/Multi-Valve Controls offer UPSLOPE and DOWNSLOPE as standard features for applications that require their use.

UPSLOPE/DOWNSLOPE function provides a means of gradually increasing or decreasing weld current. How gradual the increase or decrease occurs is determined by the SLOPE bottom current and the number of SLOPE cycles programmed in SLOPE COUNT. The number programmed into SLOPE COUNT will determine the rate at which the control will reach the programmed weld current. SLOPE COUNT is programmable from 01 to 99 (in ms at 1000 Hz).

When SLOPE MODE is used, its function is to change current gradually. The UPSLOPE mode causes current to start from a low level and increase for a predetermined number of cycles. When DOWNSLOPE is in use, the reverse is true. Current will start to decrease to low level for a predetermined number of cycles.

The number of SLOPE cycles is automatically added to the number of WELD cycles. If 14 cycles of UPSLOPE are programmed in SLOPE COUNT, for SLOPE MODE ***01*** or ***02***, and the number of WELD cycles is 21, the total amount of WELD time is 35 cycles.

The ENTRON UPSLOPE and DOWNSLOPE functions are sequential. The UPSLOPE COUNT and DOWNSLOPE COUNT setting and the WELD count times are independent of each other. Adjusting either of the SLOPE COUNTS or WELD count does not affect the setting or operation of the other switch setting. No arithmetic is involved in setting the SLOPE COUNT.

6.3.1 NO SLOPE – SLOPE MODE=*00*

When ***00*** is programmed, SLOPE is disabled. The output of the welding transformer may look like a natural UPSLOPE waveform. The welding transformer secondary load characteristics will affect the rate at which this natural UPSLOPE occurs.

6.3.2 UPSLOPE – SLOPE MODE=*01*

When ***01*** is selected and the control initiated, UPSLOPE will occur before WELD. If the control sequence is REPEAT mode or PULSATION mode, the UPSLOPE will only occur before the first weld impulse. If in INTERMITTENT or CONTINUOUS SEAM mode, UPSLOPE will only occur when first initiated.

When a single schedule is used to program UPSLOPE and WELD as a part of weld sequence (schedule 10 in example), starting current by default is equal to one quarter of PERCENT CURRENT. In this example, starting current is: 60%/4 = 15%; and PERCENT CURRENT increment is: (60% - 15%)/09 = 5%.

SCHEDULE	SQUEEZE	WELD/ HEAT	PERCENT CURRENT	HOLD	OFF	IMPULSES	COOL	VALVE MODE*	CYCLE MODE	SLOPE MODE	SLOPE COUNT
10	10	26	60	20	00	01	00	01	00	01	09

* See Table 2-1 for description of this code.

6.3.2 UPSLOPE – SLOPE MODE=01 (cont.)

Schedules 11 and 12 are used to show how two CHAINED schedules can be used to program UPSLOPE and WELD parts of the weld sequence with any other values for starting PERCENT CURRENT. In this example, starting current is 30%; and PERCENT CURRENT increment is: (75% - 30%)/15 = 3%.

SCHEDULE	SQUEEZE	WELD/ HEAT	PERCENT CURRENT	HOLD	OFF	IMPULSES	COOL	VALVE MODE*	CYCLE MODE	SLOPE MODE	SLOPE COUNT
11	10	00	30	00	00	01	00	01	02	01	15
12	00	20	75	20	00	01	00	01	00	00	00

6.3.3 DOWNSLOPE – SLOPE MODE=02

When 02 is selected and the control initiated, DOWNSLOPE will occur after WELD. If the control is in REPEAT mode or PULSATION mode, DOWNSLOPE will only occur after the last weld impulse. For example, if the schedule has programmed 10 cycles of DOWNSLOPE and 25 cycles of WELD, DOWNSLOPE will start after WELD. The complete WELD and DOWNSLOPE time would add to 35 cycles. If in INTERMITTENT or CONTINUOUS SEAM mode, DOWNSLOPE will only occur when the last initiation, with a programmed DOWNSLOPE, is removed.

Schedule 20 is used to show how DOWNSLOPE and WELD parts of the sequence are programmed in a single schedule. The bottom current by default is equal to one quarter of PERCENT CURRENT. In this example, starting current is 80%; bottom current is: 80%/4 = 20%; and PERCENT CURRENT increment is: (80% - 20%)/10 = 6%.

SCHEDULE	SQUEEZE	WELD/ HEAT	PERCENT CURRENT	HOLD	OFF	IMPULSES	COOL	VALVE MODE*	CYCLE MODE	SLOPE MODE	SLOPE COUNT
20	10	25	80	20	00	01	00	01	00	02	10

Schedules 21 and 22 are used to show how two CHAINED schedules can be used to program WELD and DOWNSLOPE parts of the weld sequence with any desired values for bottom current of last DOWNSLOPE pulse. The bottom current is 10%; and PERCENT CURRENT increment is: (75% - 15%)/15 = 4%.

SCHEDULE	SQUEEZE	WELD/ HEAT	PERCENT CURRENT	HOLD	OFF	IMPULSES	COOL	VALVE MODE*	CYCLE MODE	SLOPE MODE	SLOPE COUNT
21	10	20	75	00	00	01	00	01	02	02	15
22	00	00	15	20	00	01	00	01	00	00	00

* See Table 2-1 for description of this code.

6.4 VALVE MODES

Each programmed schedule can have any one of the eight valve outputs (or none) enabled during its schedule. The eight solenoid valves are activated based on the VALVE MODE programmed as shown in Table 6-1.

When in PROGRAM mode and selection of VALVE MODE is being made, the VALVE indicator LEDs will indicate the selected valve(s). The valve output(s) will not be energized while in PROGRAM mode.

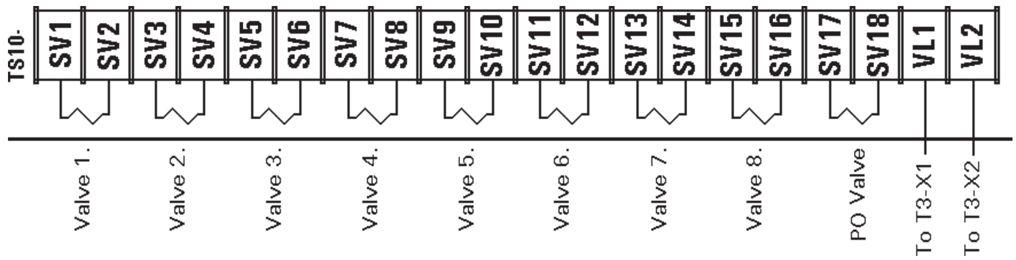


Figure 6-4. *Terminal Strip TS10 valve outputs*

NOTICE
The VALVE codes shown in Table 6-1 are the same for Valves 9-16 on PCB 410322-001. Refer to Appendix D for further information on the use of Cascade 9-16 Valve Extension (VE) Option.

Table 6-1. *VALVE MODES and valve outputs*

VALVE code right digit	VALVE LED 1 2 3 4	Description	VALVE code left digit	VALVE LED 5 6 7 8	Description
0	0 0 0 0	Four valves off	0	0 0 0 0	Four valves off
1	1 0 0 0	Valve 1	1	1 0 0 0	Valve 5
2	0 1 0 0	Valve 2	2	0 1 0 0	Valve 6
3	1 1 0 0	Valves 1 & 2	3	1 1 0 0	Valves 5 & 6
4	0 0 1 0	Valve 3	4	0 0 1 0	Valve 7
5	1 0 1 0	Valves 1 & 3	5	1 0 1 0	Valves 5 & 7
6	0 1 1 0	Valves 2 & 3	6	0 1 1 0	Valves 6 & 7
7	1 1 1 0	Valves 1, 2 & 3	7	1 1 1 0	Valves 5, 6 & 7
8	0 0 0 1	Valve 4	8	0 0 0 1	Valve 8
9	1 0 0 1	Valves 1 & 4	9	1 0 0 1	Valves 5 & 8
a	0 1 0 1	Valves 2 & 4	a	0 1 0 1	Valves 6 & 8
b	1 1 0 1	Valves 1, 2 & 4	b	1 1 0 1	Valves 5, 6 & 8
C	0 0 1 1	Valves 3 & 4	C	0 0 1 1	Valves 7 & 8
d	1 0 1 1	Valves 1, 3 & 4	d	1 0 1 1	Valves 5, 7 & 8
E	0 1 1 1	Valves 2, 3 & 4	E	0 1 1 1	Valves 6, 7 & 8
F	1 1 1 1	Valves 1, 2, 3 & 4	F	1 1 1 1	Valves 5, 6, 7 & 8

7.0 STEPPER ON EN1000/EN1001 SERIES CONTROLS

Up to **ten** steppers may be programmed on the EN1000/EN1001 Cascade/Multi-Valve Control.

The weld stepper may be used to compensate the gradual deformation of a welding machine's electrodes. This deformation occurs because of the repeated application of heat and pressure to the relatively soft electrode material, resulting in a broadening of the electrode face (mushrooming) with continued usage. The increasing face diameter results in a decreasing current density, which eventually reaches a point where satisfactory welds can no longer be made. At this time, the weld current setting must be adjusted upwards or the electrodes must be re-dressed before further use.

The weld stepper increases the number of satisfactory welds that can be made without re-dressing the electrodes, by increasing the welding current in steps as the mushrooming progresses. This action maintains the current density fairly constant for a relatively large number of welds. The stepper can be programmed to not only change the weld current, but also the weld time, and even the complete welding schedule if desired.

Each of the steppers may have up to maximum of ten steps, and each step may be programmed from 0000 to 9999 welds.

The stepper can also be programmed to provide an electrical output after the LAST STEP to sound an alarm to alert the operator that the electrodes need to be re-dressed or replaced. After end of LAST STEP, stepper can be reset manually or automatically.

The stepper may be useful when welding complex multiple spot sequences. On a large welded assembly for example, several welds may require a given time and current setting and then several more welds may require a different time and current setting, continuing in this manner through several changes in welding parameters.

Each of the steppers may also be used as simple weld count down-counter.

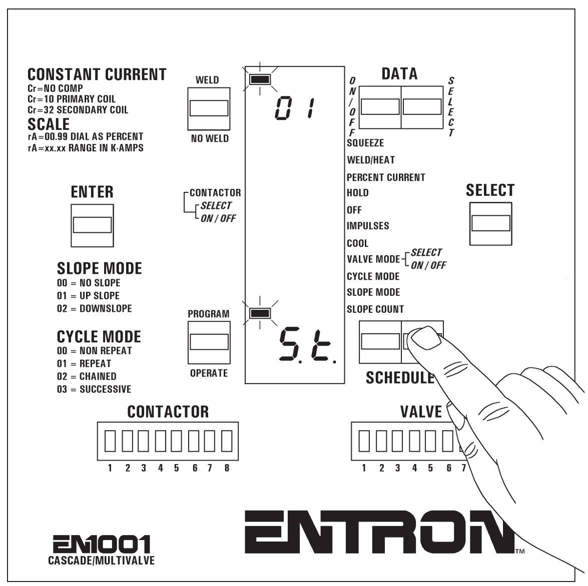


Figure 7-1. *STEPPER enabling*

NOTICE
In PROM firmware version 619044-002**B**, a new STEPPER mode was added – **S.t.**=**02**, for single stepper counter with multiple steps and any possible schedule sequence combination.

Stepper counter will be decremented during welding sequence only if weld was made; i.e., WELD time and weld CURRENT must be programmed, and control must be in the WELD mode (External Weld/No Weld Switch, if used, must be closed and Front Panel WELD/NO WELD indicator LED must be in WELD mode).

7.1 SCHEDULE MAP

Since up to ten steps may be programmed per stepper in STEPPER mode **01**, ten schedules are assigned for each stepper, as illustrated in Table 7-1.

Table 7-1. *Schedule map used for STEPPER programming*

STEPPER	SCHEDULES	WELD STEPS STEP	 COUNT	LAST STEP	LAST COUNT	INITIATION
0	00 01 02 03 04 05 06 07 08 09	0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9	0000 to 9999	L.S. 00 to 09	L.C. 0000 to 9999	FS3
1	10 11 12 13 14 15 16 17 18 19	1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9	0000 to 9999	L.S. 10 to 19	L.C. 0000 to 9999	FS3
2	20 21 22 23 24 25 26 27 28 29	2.0 2.1 2.2 2.3 2.4 2.5 2.6 2.7 2.8 2.9	0000 to 9999	L.S. 20 to 29	L.C. 0000 to 9999	FS3 or FS7
continuing up to…	*continuing up to…*		*continuing up to…*	*continuing up to…*	L.C. 0000 to 9999	Stepper 3 FS3 Stepper 4 FS3 or FS11 Stepper 5-8 FS3
9	90 91 92 93 94 95 96 97 98 99	9.0 9.1 9.2 9.3 9.4 9.5 9.6 9.7 9.8 9.9	0000 to 9999	L.S. 90 to 99	L.C. 0000 to 9999	FS3

For STEPPER mode **02**, the same schedule map is used as in mode **01**, except that only **one** stepper counter exists with all schedules from 00 to 99, with maximum of 100 steps.

7.2 STEPPER PROGRAMMING

7.2.1 EXTENDED FUNCTION PROGRAMMING

STEPPER ENABLE (**S.t.**) EXTENDED FUNCTION parameter is used to **enable** STEPPER.

1. Press the SELECT push button until SLOPE COUNT is reached, then press once more.
2. Press the SCHEDULE push buttons to find **S.t.** in the SCHEDULE display.
3. Program the required value according to Table 7-2.
4. Press ENTER.

See Section 7.2.5 for quick setup instructions.

Table 7-2. *STEPPER codes*

S.t.	STEPPER	Description
00	disable	STEPPER operation is disabled
01	enable	Multiple steppers with maximum 10 steps per stepper
02	enable	Single stepper counter with multiple steps

7.2.2 WELD SEQUENCE PROGRAMMING

1. Put the control in PROGRAM mode by pressing PROGRAM/OPERATE push button.
2. Using standard programming procedure, program all weld sequence parameters for first schedule for desired stepper.
3. Using ***copy schedule*** Front Panel shortcuts (i.e., press ENTER and right SCHEDULE push button in PROGRAM mode), copy current schedule to the next one and repeat as many times as number of steps needed for that stepper.
4. PERCENT CURRENT or WELD/HEAT must be adjusted in each step after the first one.
5. Put the control in OPERATE mode by pressing PROGRAM/OPERATE push button.

7.2.3 STEP COUNTS PROGRAMMING

1. Using the SCHEDULE push buttons, set the **first** schedule for desired stepper; e.g., for stepper **0**, first schedule is **00**.
2. Put the control in PROGRAM mode by pressing PROGRAM/OPERATE push button.

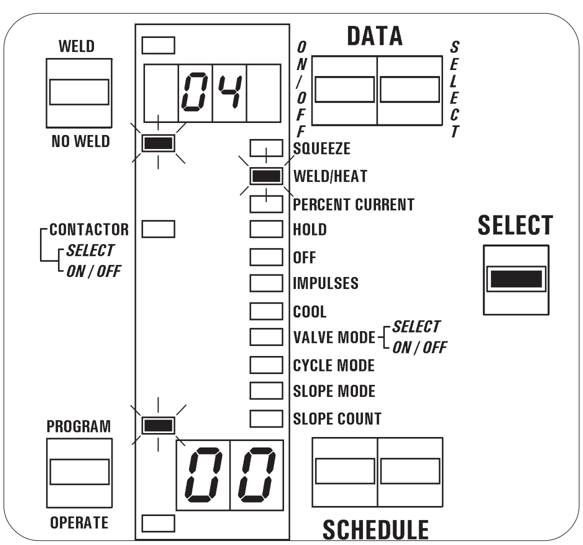


Figure 7-2. *Select WELD/HEAT*

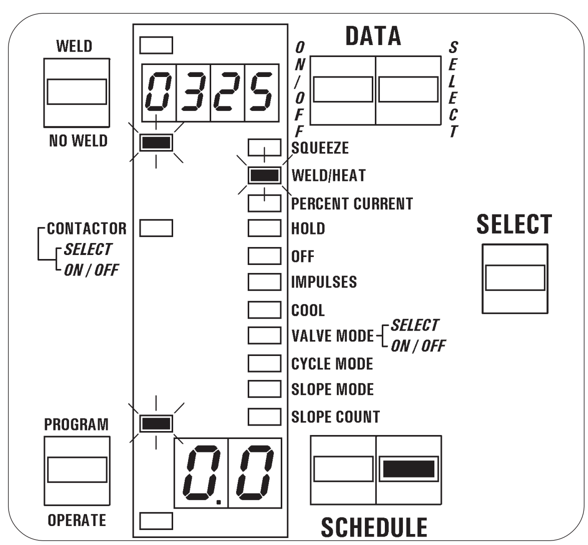


Figure 7-3. *Program WELD COUNT*

7.2.3 STEP COUNTS PROGRAMMING (cont.)

3. Press the SELECT push button until WELD/HEAT parameter is reached (Figure 7-2).
4. Program the required WELD time for the weld sequence; e.g., **04** cycles.
5. Press the SCHEDULE push buttons to find ***0.0*** in the SCHEDULE display (Figure 7-3).
6. Program the required WELD COUNT for this step; e.g., **0325** welds.
7. Press SELECT push button to find PERCENT CURRENT and program the required CURRENT in [%] or [kA] for this step of the weld sequence.
8. Put the control in OPERATE mode by pressing PROGRAM/OPERATE push button.
9. For programming all other steps from ***0.1*** to ***0.9***, increase the schedule number and repeat Steps 2 through 8.

7.2.4 LAST STEP AND LAST COUNT PROGRAMMING

1. Dial any schedule from schedule map for desired stepper. For example, for STEPPER mode ***01*** and stepper **0**, any schedule from **00** to **09**; for stepper **1**, any schedule from **10** to **19**; etc. For STEPPER mode ***02***, dial any schedule.
2. Put the control in PROGRAM mode.
3. Press the SCHEDULE push buttons to find ***L.S.*** in the SCHEDULE display, as shown in Figure 7-4.
4. Program the desired LAST STEP for this stepper; e.g., for stepper **0**, LAST STEP in STEPPER mode ***01*** may be any number from **00** to **09** (Figure 7-4), but in STEPPER mode ***02***, it may be any schedule number from **00** to **99**. In fact, this value will be first step at beginning of the weld sequence. This value will be reset or reprogrammed after resetting the stepper.
5. Press the SCHEDULE push buttons to find ***L.C.*** in the SCHEDULE display, as shown in Figure 7-5.
6. Program the desired LAST COUNT for this stepper; e.g., for stepper **0**, LAST COUNT may be any number from **0000** to **9999**, as shown in Figure 7-5. In fact, this value will be first count at beginning of the weld sequence. This value will be reset or reprogrammed after resetting the stepper.
7. Put the control back in OPERATE mode.

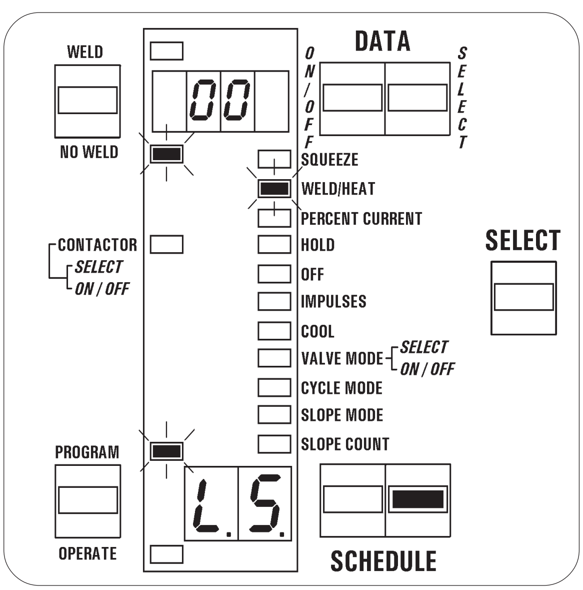


Figure 7-4. *Program LAST STEP*

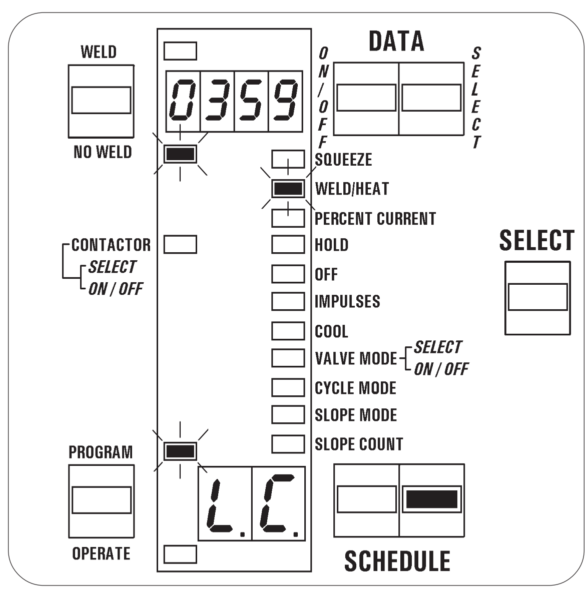


Figure 7-5. *Program LAST COUNT*

7.2.5 QUICK SETUP INSTRUCTIONS FOR STEPPER

For basic schedule welding where weld time and/or percent current need to increase after a given quantity of welds, follow these steps:

1. Put control in **PROGRAM** mode.

2. Program all SCHEDULE parameters – SQUEEZE, WELD/HEAT, PERCENT CURRENT, CONTACTOR, VALVE, HOLD, etc.

3. Repeat programming schedules for the number of times STEPPER is needed with the increase in WELD/HEAT and/or PERCENT CURRENT.

4. In EXTENDED FUNCTIONS (**EF**), set **S.t.** = **02**.

5. Press SELECT push button, moving indicator LED to WELD/HEAT parameter.

6. Select first weld step for each schedule by pressing SCHEDULE push buttons until desired weld step is displayed:
   If using schedule 00, select weld step **0.0**
   If using schedule 10, select weld step **1.0**
   If using schedule 25, select weld step **2.5**
   If using schedule 34, select weld step **3.4**
   If using schedule 46, select weld step **4.6**

7. Program required WELD COUNT for this schedule as follows:
   Press and hold left DATA push button to enter 1000s digit.
   Press and release quickly left DATA push button to enter 100s digit.
   Press and hold right DATA push button to enter 10s digit.
   Press and release quickly right DATA push button to enter 1s digit.
   Press ENTER when done and then press SELECT push button.

8. Repeat steps 6 and 7 for the first weld step of each schedule.

9. Return to starting schedule. Reset stepper by pressing and holding ENTER and pressing both DATA push buttons simultaneously.

10. Put control in **OPERATE** mode and begin welding.

11. Return to the first starting schedule.

    After all weld steps are complete, control will stop and display **S.t. E.n.d.**

NOTICE
For **S.t.**=**01** with multiple steppers, follow Quick Setup Instructions above. **All steppers must be reset individually**. Repeat step 9 to reset each stepper as needed. Control must be in **PROGRAM** mode for step 9.

7.3 SEQUENCE (SCHEDULE) INITIATION IN STEPPER MODE

7.3.1 SCHEDULE SELECT OPTIONS FOR STEPPER MODE S.t.=01

Since the stepper requires certain specific starting schedules, the SCHEDULE SELECT (**S.S.**) options with STEPPER mode ***01*** are described in the following sections.

INTERNAL SCHEDULE SELECT – S.S.=00

As shown in Table 7-1, each of the ten steppers can be initiated with the TS1-FS3 initiation switch. This is possible only if any of the ten possible schedules for desired stepper is dialed on the SCHEDULE display.

Besides TS1-FS3 initiation, steppers 2 and 4 can be initiated with TS1-FS7 and TS1-FS11 initiation switches. TS1-FS7 is dedicated to initiate only stepper **2** (schedule 20 to 29) regardless of what schedule is dialed on SCHEDULE display. TS1-FS11 is dedicated to initiate only stepper **4** (schedule 40 to 49) regardless of what schedule is dialed on SCHEDULE display.

EXTERNAL SCHEDULE SELECT – S.S.=01

In this mode, only four steppers can be initiated with the TS1-FS3 initiation switch. This is possible only if TS1-FS7 and TS1-FS11 are used for stepper selection, as shown in Table 7-3.

Table 7-3. *Stepper selection using TS1-FS7 and TS1-FS11*

STEPPER	SCHEDULE	TS1-FS7/SS1	TS1-FS11/SS3	INITIATION
0	00	**OPEN**	**OPEN**	TS1-FS3
2	20	***CLOSED***	**OPEN**	TS1-FS3
4	40	**OPEN**	***CLOSED***	TS1-FS3
6	60	***CLOSED***	***CLOSED***	TS1-FS3

EXTERNAL BINARY SELECT WITH S99 OPTION – S.S.=03

In this mode, any of seven steppers can be initiated with TS1-FS3 initiation switch. The stepper selection is possible with closing one of the SS terminals as shown in Table 7-4.

Table 7-4. *Stepper selection using S99 Option*

STEPPER	SCHEDULE	SS1	SS2	SS4	SS8	SS16	SS32	SS64	INITIATION
0	00	0	0	0	0	0	0	0	TS1-FS3
1	10	1	0	0	0	0	0	0	TS1-FS3
2	20	0	1	0	0	0	0	0	TS1-FS3
3	30	0	0	1	0	0	0	0	TS1-FS3
continuing up to…	…	…	…	…	…	…	…	…	TS1-FS3
7	70	0	0	0	0	0	0	1	TS1-FS3

7.3.2 SCHEDULE SELECT OPTIONS FOR STEPPER MODE S.t.=02

NOTICE

Stepper counter will be decremented ***only*** if TS1-FS3 is used for initiation.

When either TS1-FS7 or TS1-FS11 is used for initiation in STEPPER mode ***02***, stepper counter will not be decremented, and control will execute welding sequence starting with schedule 20 or 40, respectively. But, when S99 Option is used for EXTERNAL BINARY SELECT (**S.S.**=**03**) after TS1-FS7 initiation, control will execute any selected schedule, instead of schedule 20.

7.4 STEPPER OPERATION

7.4.1 OPERATION ALGORITHM FOR STEPPER MODE S.t.=01

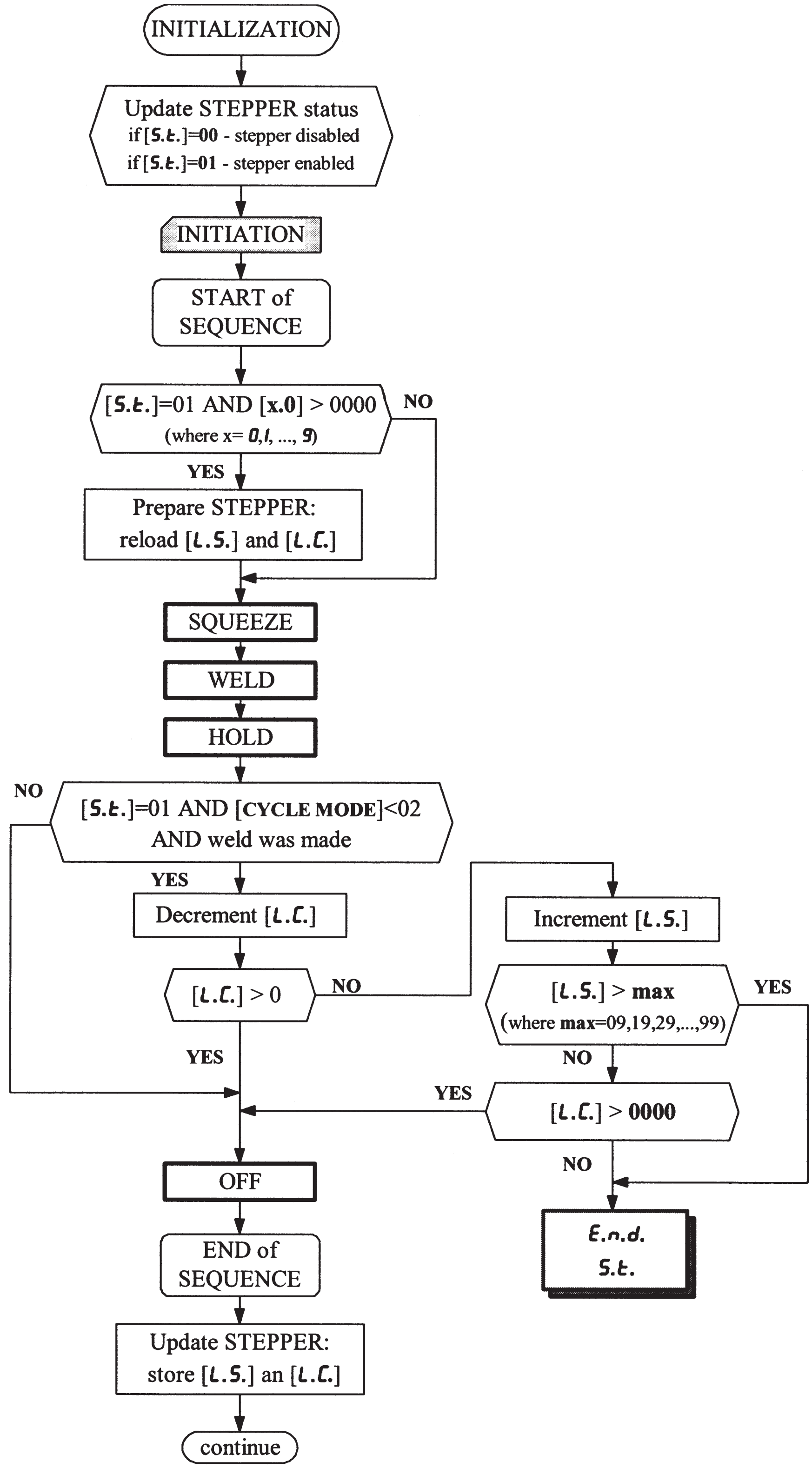


Figure 7-6. *Stepper Operation Algorithm*

7.4.2 STEPPER OPERATION FOR STEPPER MODE S.t.=02

In this mode, the maximum number of steps is 100, which is possible only if a single schedule is used per step. If more CHAINED schedules are required in a welding sequence, the number of steps is determined by the number of CHAINED schedules used in each step.

The algorithm is almost identical to the one for STEPPER mode 01 (see Figure 7-6), except that only **one** stepper counter is used and when LAST STEP is incremented, control will check if that number is greater than maximum number of schedules, 99 in this case, and then show END OF STEPPER message, if necessary. Also, stepper counter will be decremented only if TS1-FS3 is used for initiation.

Table 7-5 demonstrates this mode with five CHAINED schedules per step or welding sequence. WELD COUNT **must** be programmed in the first schedule of the CHAINED sequence. Following the LAST STEP, the next schedule should be empty, in this example schedule 17. If WELD COUNT in that schedule is 0000, this will indicate END OF STEPPER – **S.t.=E.n.d.**

Table 7-5. *Programming for STEPPER mode* **02**

SCHEDULE	SQUEEZE	WELD/ HEAT	WELD STEPS STEP	WELD STEPS COUNT	PERCENT CURRENT	HOLD	OFF	IMPULSES	COOL	VALVE MODE*	CYCLE MODE	SLOPE MODE	SLOPE COUNT	XTOR
first step: LAST STEP is L.S.=00 and LAST COUNT L.C. will be from 0325 to 0000														
00	40	00	0.0	0325	00	20	00	01	00	81	02	00	00	01
01	10	25	0.1	*xxxx*	60	10	00	01	00	83	04	00	00	01
02	10	00	0.2	*xxxx*	00	00	00	01	00	81	02	00	00	01
03	30	20	0.3	*xxxx*	50	10	00	01	00	03	03	00	00	01
04	10	00	0.4	*xxxx*	00	00	00	01	00	07	00	00	00	01
second step: LAST STEP is L.S.=05 and LAST COUNT L.C. will be from 0250 to 0000														
05	40	00	0.5	0250	00	20	00	01	00	81	02	00	00	01
06	10	25	0.6	*xxxx*	65	10	00	01	00	83	04	00	00	01
07	10	00	0.7	*xxxx*	00	00	00	01	00	81	02	00	00	01
08	30	20	0.8	*xxxx*	55	10	00	01	00	03	03	00	00	01
09	10	00	0.9	*xxxx*	00	00	00	01	00	07	00	00	00	01
third step: LAST STEP is L.S.=10 and LAST COUNT L.C. will be from 0195 to 0000														
10	40	00	1.0	0195	00	20	00	01	00	81	02	00	00	01
11	10	25	1.1	*xxxx*	70	10	00	01	00	83	04	00	00	01
12	10	00	1.2	*xxxx*	00	00	00	01	00	81	02	00	00	01
13	30	20	1.3	*xxxx*	60	10	00	01	00	03	03	00	00	01
14	10	00	1.4	*xxxx*	00	00	00	01	00	07	00	00	00	01
fourth step: LAST STEP is L.S.=15 and LAST COUNT L.C. will be from 0150 to 0000														
15	30	20	1.5	0150	75	10	20	01	00	07	01	00	00	01
fifth step: LAST STEP is L.S.=16 and LAST COUNT L.C. will be from 0001 to 0000														
16	30	00	1.6	0001	00	00	00	01	00	C0	00	00	00	01
17	00	00	1.7	0000	00	00	00	01	00	00	00	00	00	00

NOTICE

If STEPPER RESET is performed by holding ENTER and pressing both DATA push buttons at the same time, the LAST STEP will be L.S.=00 in this example, and LAST COUNT L.C.=0325, no matter which schedule is dialed on Front Panel display.

* See Table 2-1 for description of this code.

7.5 STEPPER RESET

7.5.1 MANUAL STEPPER RESET

1. Dial any schedule from schedule map for desired stepper. For example, in STEPPER mode 01 for stepper **0**, dial any schedule from **00** to **09**; in STEPPER mode 02, dial any schedule.
2. Put the control in PROGRAM mode.
3. Press and hold the ENTER push button. While holding ENTER, press both DATA push buttons at the same time and hold momentarily. After this, LAST STEP L.S. and LAST COUNT L.C. parameters will be initialized with appropriate values programmed for first step; e.g., for stepper **0**, LAST STEP will now be L.S.=00, and LAST COUNT L.C.=0325. The stepper will be reset only if all three push buttons are properly pressed. After reset, both initialized parameters will be displayed on the SCHEDULE and DATA displays for a short period of time. These two parameters may be reprogrammed by entering desired values and pressing ENTER, at any time, without resetting stepper using all three push buttons.
4. Put the control back in OPERATE mode.

NOTICE
STEPPER RESET may be performed not only by holding ENTER and pressing both DATA push buttons at the same time, but also by manual programming of LAST STEP L.S. and LAST COUNT L.C. for corresponding stepper.

7.5.2 AUTOMATIC STEPPER RESET

When necessary, the stepper can be automatically reset by adding the RESET command using an additional schedule after LAST STEP. The RESET command is simply an empty schedule – no valves, no other parameters except for OFF time. If the stepper counter reaches zero on LAST STEP, the control will read the next schedule. If it finds the RESET command, it will reload the stepper automatically. Any new sequence will start again on the first step.

To enable automatic STEPPER RESET:
1. Display the next schedule after the last schedule from schedule map for desired stepper.
2. Put the control in PROGRAM mode.
3. Clear all parameters for that schedule. In PROGRAM mode, the ***delete*** shortcut may be used by holding ENTER and pressing the PROGRAM/OPERATE push button.
4. Make sure that the WELD COUNT is 0000 for this step.
5. Program the OFF time to 99 cycles.
6. Put the control back in OPERATE mode.

If necessary, a warning signal may be added just before the RESET command. Simply add an additional step with a very low WELD COUNT (for example 0010 welds). This schedule may contain an additional valve output which may be used to warn the operator by means of light or some other alarm device.

SCHEDULE	...	WELD STEPS STEP	COUNT	...	OFF	...	VALVE MODE*	DESCRIPTION
00		0.0	0325				01	Step 1
01		0.1	0400				01	Step 2
02		0.2	0450				01	Step 3
03		0.3	0010				03	Pre-warning step, adding Valve 2 output
04		0.4	0000		99		00	RESET command (all other parameters=00)

* See Table 2-1 for description of this code.

7.5.3 STEPPER RESET USING EXTERNAL SWITCH INPUT

Since PROM firmware version 619044-002**E**, it is possible to use an External Reset switch (normally closed) connected between TS1-ES1 and TS1-GND to cause STEPPER RESET. To enable EXTERNAL RESET, EXTENDED FUNCTION ***b.E.*** must be programmed to ***06***. Whenever momentary switch is activated (open), control will automatically reset active stepper.

7.6 USING STEPPER AS A COUNTER

The stepper counter may be used as a down-counter. It is simply necessary to load a schedule stepper counter with a value to count down from. The maximum allowable value is 9999. This function may be used in a single weld schedule, such as 00, 10, 20, 30, or 40, or any welding sequence starting with those schedules.

1. Select schedule to be used.
2. Put the control in PROGRAM mode.
3. Enable STEPPER by programming ***S.t.***=***01*** or ***02***.
4. Program weld schedule as required.
5. Select WELD/HEAT parameter again.
6. Find ***0.0***, ***1.0***, etc., by pressing the right SCHEDULE push button.
7. Program desired COUNT from ***0000*** to ***9999*** in the DATA display and press ENTER.
8. Reset STEPPER by pushing ENTER and the two DATA push buttons simultaneously.
9. Put the control back in OPERATE mode.

NOTICE
If necessary, the message ***S.t. E.n.d.*** may be shown at the end of the countdown. Select the next schedule and clear it by using the ***clear data*** shortcut (see Section 5.4.5). Program a WELD time of 01 cycles and return to OPERATE mode.

7.7 DISPLAYING STEPPER COUNT DURING OPERATION

The stepper count may be displayed during operation if necessary. Since this is not a principal WELD function, the access to the display requires the following:

1. Select schedule to be used.
2. Put the control in PROGRAM mode.
3. Select the WELD/HEAT parameter.
4. Find ***L.C.*** by pressing the right SCHEDULE push button.
5. Put the control back in OPERATE mode.

The LAST COUNT will be shown after end of each welding sequence.

7.8 END OF STEPPER

When LAST STEP is reached, control will flash message ***S.t. E.n.d.*** on displays. This message can be cleared by pressing any Front Panel push button or by activating Emergency Stop.

To avoid resetting the counter value, use the External Switch input (see Section 7.5.3).

If ***P.O.*** is programmed to ***10*** or ***11***, PO Valve will be active as long as message ***S.t. E.n.d.*** is flashing on displays.

8.0 CONSTANT CURRENT OPERATION (EN1001 *only*)

To operate the control with CONSTANT CURRENT, it is necessary to be familiar with the operation of the control in NON-CONSTANT CURRENT mode.

The function of the Current Compensation feature of the EN1001 Cascade/Multi-Valve Controls is that of maintaining the welding current constant at the preset level, despite influencing factors which could otherwise make the current vary. With the Current Compensation feature in operation, the current remains substantially constant regardless of line voltage variations, changes in machine power factor caused by movement of ferrous metal within the secondary, changes in the size or shape of the secondary, changes in material resistance, or any combination of these factors.

The Current Compensation feature **should not be expected to correct for electrode wear, improper electrode size or force**, or other problems caused by improper machine setup and maintenance.

CONSTANT CURRENT operation is possible with two different types of Current Sensors:

1. Primary sensing with Current Transformer
2. Secondary sensing with calibrated Rogowski Coil

8.1 INTRODUCTION TO CONSTANT CURRENT OPERATION

For EN1001 Cascade/Multi-Valve Constant Current Controls, there are two basic modes:

[%] mode If ***r.A.***=***00.99***, CURRENT is programmable in percent steps from ***0000*** (0%) to ***0099*** (99%);

[kA] mode CURRENT is programmable in [kA] from ***00.00*** (0 A) to ***99.99*** (99,990 A), using the four-digit DATA display.

For parameters which allow programming of all four digits, the right DATA push button affects the two right-hand digits – press to increment by one; press and hold to increment by ten. The left DATA push button affects the two left-hand digits – press to increment by 100; press and hold to increment by 1000 (see Figure 5-1).

Based on Current Sensor and desired CONSTANT CURRENT mode, program one of the modes from Table 5-6 or Table 5-7. For more detailed information on programming and setup, see Appendix B, Section B-2.0.

8.1.1 SETTING LIMIT WINDOW FOR CONSTANT CURRENT

The default (factory setting) current limit window is set at $\pm$10% of PERCENT CURRENT. If specific HIGH or LOW limits different from the default are needed, follow these steps:

1. Put the control in PROGRAM mode.
2. Select desired schedule.
3. Press SELECT push button until FUNCTION indicator LED is at PERCENT CURRENT.
4. Press the right SCHEDULE push button once and SCHEDULE display will show ***L.o.*** to indicate LOW limit.

8.1.1 SETTING LIMITS FOR CONSTANT CURRENT (cont.)

5. Use the DATA push buttons to enter your LOW limit and push ENTER to save setting.
6. Press the right SCHEDULE push button once and and SCHEDULE display will show **H. i.** to indicate HIGH limit.
7. Use the DATA push buttons to enter your HIGH limit and push ENTER to save setting.
8. Press the PROGRAM/OPERATE push button to return control to OPERATE mode.

8.1.2 SHOW CURRENT ON DISPLAY AFTER WELD

It is not necessary to program any special function or PROCESS OUTPUT to display CURRENT after the weld. Simply use the SELECT push button to indicate PERCENT CURRENT before initiation. The control will display the measured CURRENT at the end of the sequence.

Before initiation of the sequence, select PERCENT CURRENT using the SELECT push button. After the end of sequence, the DATA display may show average RMS CURRENT in [kA] or [%]. If necessary, the control will display the range or tap indicator (**t.-UP** or **t.-dn**) messages. The display may be toggled between CURRENT in [kA] and real PHASE SHIFT PERCENT firing in [%] by pressing the DATA push buttons as follows:

- Pressing DATA 1s push button will show PERCENT;
- Pressing DATA 10s push button will show last measured CURRENT in [kA];
- Pressing any other push button will clear the display.

The following messages are readily available at the end of the sequence.

Average RMS CURRENT in [kA] – Shown on the display if the control is operating in the proper mode and a weld has been made. A valid operating mode for [kA] display is any mode that allows programming the control in [kA] in the weld schedule.

PHASE SHIFT in [%] – Selectable only if RMS CURRENT is displayed at the end of a weld. To show PERCENT, simply press the DATA 1s push button. This is useful to determine if the control has enough headroom to compensate for current losses whenever needed.

Toggle between RMS CURRENT in [kA] and PHASE SHIFT in [%] – RMS CURRENT in [kA] and PHASE SHIFT in [%] are selectable only if average RMS CURRENT is displayed at the end of a weld. To show PERCENT, simply press the DATA 1s push button. To show last measured RMS CURRENT in [kA], simply press the DATA 10s push button. To clear display, press any other push button.

Tap UP (or Range DOWN) indicator (**t-UP**) – Shown at the end of a weld sequence if the weld control is unable to compensate and maintain the programmed CURRENT. In this case, moving the tap selector, if exists, to a higher setting will allow the control to maintain the current constant. If machine is already at the highest tap setting, the maximum current range of machine is much lower than the programmed range in **r.A.** In this case, choose a lower current range from Table 8-2 and program the corresponding value in **r.A.**

PHASE SHIFT in [%] and RMS CURRENT in [kA] are also available during this condition. To show PERCENT while **t-UP** is displayed, simply press the DATA 1s push button. To show the RMS CURRENT in [kA], simply press the DATA 10s push button. To clear display, simply press any other push button.

8.1.2 SHOW CURRENT ON DISPLAY AFTER WELD (cont.)

Tap DOWN (or Range UP) indicator (**t-dn**) – Shown at the end of a weld sequence if the weld control is unable to compensate and maintain the programmed CURRENT. In this case, moving the tap selector, if exists, to a lower setting will allow the control to maintain the current constant. If machine is already at the lowest tap setting, the maximum current range of machine is higher than the programmed range in **r.A.** In this case, choose a higher current range from Table 8-2 and program the corresponding value in **r.A.**

PHASE SHIFT in [%] and RMS CURRENT in [kA] are also available during this condition. To show PERCENT while **t-dn** is displayed, simply press the DATA 1s push button. To show the RMS CURRENT in [kA], simply press the DATA 10s push button. To clear display, simply press any other push button.

8.1.3 USING CONSTANT CURRENT PROCESS OUTPUTS

The EN1001, while in any CONSTANT CURRENT mode, can be programmed to always provide a weld current readout at the end of any weld sequence, no matter what is shown on display before beginning of sequence. Several CONSTANT CURRENT PROCESS OUTPUTS function as defined in Section 5.4.7 and can be programmed to function as explained below.

To obtain an **End of Sequence Readout**, find **P.O.** in EXTENDED FUNCTIONS and program a value of **P.O.**=**12**. While in CONSTANT CURRENT mode, control will measure the value of current maintained during the weld and show this value on DATA display at the end of the sequence. If limit window is being monitored for HI/LO range, the value shown on the display will be the CURRENT maintained by control if it can maintain this value. If the control cannot maintain the set CURRENT value, **the control will flash L.o. or H. i.** (depending on the case).

To obtain an **End of Sequence Readout and PO Valve alarm output**, find **P.O.** in EXTENDED FUNCTIONS and program a value of **P.O.**=**13**. While in CONSTANT CURRENT mode, control will measure the value of current maintained during the weld and show this value on DATA display at the end of the sequence. If limit window is being monitored for HI/LO range, the value shown on the display will be the CURRENT maintained by control if it can maintain this value. If the control cannot maintain the set CURRENT value, **the control will flash L.o. or H. i.** (depending on the case). In addition, **the control will turn PO Valve ON for 0.5 seconds** (30 cycles).

To **interrupt a REPEAT sequence or stop at the end of a weld** , find **P.O.** in EXTENDED FUNCTIONS and program a value of **P.O.**=**14**. While in CONSTANT CURRENT mode, control will measure the value of current maintained during the weld and show this value on DATA displays at the end of the sequence. If limit window is being monitored for HI/LO range, the value shown on the display will be the CURRENT maintained by control if it can maintain this value. If the control cannot maintain the set CURRENT value, **the control will display L.o. or H. i. permanently**. In addition**, the control will stop a REPEAT sequence if in REPEAT mode or stop the control from any further initiations.** In order to re-enable initiations, it is necessary to simply press any Front Panel push button to clear **H. i./ L.o.** ERROR.

8.1.3 USING CONSTANT CURRENT PROCESS OUTPUTS (cont.)

To obtain a **Weld Current Readout without monitoring HI/LO limit window**, program EXTENDED FUNCTION parameter ***P.O.***=***12***. Program a value in WELD CURRENT parameter ***Hi***=***00.99*** or ***Hi***=[***xx.xx***], where ***xx.xx*** is close to the maximum available current. Program a value in WELD CURRENT parameter ***Lo***=***00.10***. Do not leave these values at zero. If they are left at zero, control uses default limit window of CURRENT value+10% for ***Hi*** and CURRENT value-10% for ***Lo***, and monitors default limit window as described above.

If any other **NON-CONSTANT CURRENT PROCESS OUTPUT** must be used, simply use the SELECT push button to indicate PERCENT CURRENT before weld initiation, as explained in previous section.

8.1.4 SETTING UP CURRENT REGULATOR (for Primary Sensor or Secondary Coil with Auto Range selection *only*)

1. The control must be initiated using a TS1-FS3 initiation switch connected between TS1-FS3 and TS1-GND. If the machine does not have permanent initiations using this terminal, temporarily connect a switch to TS1-FS3.
2. Make sample welds with CONSTANT CURRENT off (***C.r.***=***00***) to determine proper welding transformer tap switch setting. PERCENT CURRENT should be between 70% and 80%* and WELD time should be the recommended number of cycles for material being welded.
   * In order for the control to adapt to changing conditions, it must be able to adjust current. If weld is made around 75%, the control can move up to 99% or down to 20% if necessary to maintain current constant when the control is in CONSTANT CURRENT mode.
3. Put the control in PROGRAM mode.
4. Select EXTENDED FUNCTION ***C.r.*** and program ***10*** or ***30***, depending on current sensing option.
5. Select EXTENDED FUNCTION ***r.A.*** and program:
   00.99 for operating in [%] mode, or
   [***xx.xx***] for operating in [kA] mode (***xx.xx*** is maximum RMS CURRENT in [kA]).
6. Select EXTENDED FUNCTION ***C.A.***, program ***04*** on the DATA display, and press ENTER. This presets schedules 90 to 97 with specific setup parameters, including 30 cycles of SQUEEZE time, 99 cycles of SQUEEZE DELAY time, and Valve 1 output. The control will remain in PROGRAM mode. The most important part here is that there is one schedule per contactor. For example, for five Cascade Control, a setup must be run on each of the five SCRs (welding transformers).
7. At this point, each of the eight schedules can be modified for the application. SQUEEZE time and VALVES may be changed to adapt to the application. Traditional cascade applications normally use one valve for all contactors. Once the one valve closes all electrodes, contactors are fired in cascade. Do not change any parameters other than SQUEEZE time or VALVE MODE. The setup must be run using the contactors as assigned.

NOTICE
If necessary, SQUEEZE time or VALVE output may be changed to match machine requirements. Switch to PROGRAM mode, change the SQUEEZE time or VALVE and press ENTER. Return to OPERATE mode.

8. Delete the schedule following the last available SCR. In a two Cascade Control, schedule 92 (corresponding to Contactor 3) must be deleted. In PROGRAM mode, simply select schedule 92, hold the ENTER push button and press the PROGRAM/OPERATE push button.

8.1.4 SETTING UP CURRENT REGULATOR (cont.)

9. Select EXTENDED FUNCTION **C.A.**, program **05** in the DATA display, and press ENTER. This prepares the control to run a setup on each of the available SCRs (welding transformers). The DATA display will flash **S.E.t.** to indicate setup is ready to run.
10. Using the same material already welded**, insert it between the machine electrodes, initiate a weld sequence and hold initiation switch TS1-FS3 closed. The machine electrodes will close and the control will sequence through a preset test schedule. When setup is complete, the control counts down on the display, returns to schedule 00, and displays [0] or [ ] on the DATA display.

    ** While in setup, the control makes multiple welds using 4 cycle pulses. If the part being welded cannot support weld times of 4 cycles without expulsion or distortion, the parameters measured may not provide correct setup data. In this case, run the setup with no material between the electrodes.
11. Release the initiation switch. The control is now set up and ready to operate. Sequence parameter CURRENT must be reprogrammed now as a four-digit number (example: 80% = **0080**, or 15.7 kA = **15.70**). Return to OPERATE mode.

NOTICE
Before running setup, make sure jumper on back side of Control Board is set in proper position (see Figure 8-1).

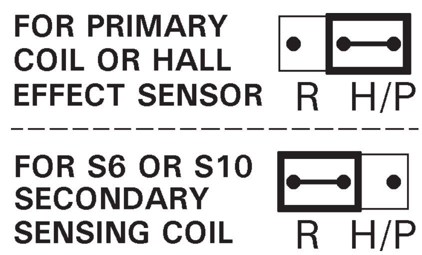


Figure 8-1. *Jumper settings*

Schedules programmed in CONSTANT CURRENT mode require a PERCENT CURRENT entered in a four-digit DATA display. Since the CONSTANT CURRENT operation depends on the contactor assigned to the given schedule, the PERCENT CURRENT should be reasserted after programming the contactor. To insure correct operation, select each cascade weld schedule, put the control in PROGRAM mode and press ENTER for each of the PERCENT CURRENTS programmed to reassert this value after the contactor has been selected.

8.1.5 QUICK SETUP SUMMARY

1. Put the control in PROGRAM mode.
2. Program **C.r.**=**10**.
3. Program **C.A.**=**04**.
4. Delete the first schedule following the last contactor (controls with less than eight contactors).
5. Adjust schedule to requirements (VALVE outputs and SQUEEZE times).
6. Program **C.A.**=**05**.
7. Close TS1-FS3 and maintain initiation until control shows dash [-] signaling that setup is complete.
8. Reprogram PERCENT CURRENT in each of the schedules used. For example, **0055** and press ENTER.
9. Return control to OPERATE mode.

8.2 CONSTANT CURRENT OPERATION WITH PRIMARY SENSOR

In addition to **[%]** mode, the EN1001 Cascade/Multi-Valve Control in CONSTANT CURRENT mode with a Primary Current Transformer (Figure 8-2) allows two **[kA]** modes of operation: RANGE (or proportional) mode and RATIO mode. Choose and program one of the modes from Table 5-6 or Table 5-7, described in Sections 5.4.14 and 5.4.15.

Figure 8-2. *Primary Sensor – P5*

8.2.1 RANGE OR PROPORTIONAL MODE

In this mode, a learning type setup is required. This mode should be used in [%] mode with ***r.A.***=***00.99***, or [kA] mode with ***r.A.*** as maximum RMS secondary current entered at the end of setup procedure (in this case an external weld monitor may be used to measure maximum RMS current that could be entered as maximum RANGE).

1. Put the control in PROGRAM mode.
2. Press SELECT until the DATA display shows ***EF***.
3. Press the left SCHEDULE push button until the SCHEDULE display shows ***C.r.***
4. Use the DATA and ENTER push buttons to program:
   C.r.=***10*** for Compensation and Monitoring, or
   C.r.=***11*** for Monitoring only.
5. Press the right SCHEDULE push button until the SCHEDULE display shows ***r.A.***
6. Use the DATA and ENTER push buttons to program:
   r.A.=***00.99*** for program and display CURRENT in [%], or
   r.A.=[***xx.xx***] for program and display CURRENT in [kA],
   where ***xx.xx*** is maximum RMS CURRENT, may be any number except ***00.99***.
7. Follow instructions from Section 8.1.4 for setting up Current Regulator.

After programming ***C.r.*** and ***r.A.*** EXTENDED FUNCTION parameters, control is ready for setup procedure. After setup is done, parameter ***r.A.*** in [kA] mode should hold approximately the maximum RMS CURRENT in [kA] for the used transformer tap. If weld monitor is available, exact maximum RMS CURRENT could be used for reprogramming parameter ***r.A.*** To obtain maximum RMS measurement with weld monitor, put control in NON-CONSTANT CURRENT mode and make weld with 99%, if possible.

8.2.2 RATIO MODE

In this mode, setup is **not** required, since the control is already calibrated in the factory by using standard calibration procedures for the gain calibration on the Control Board. However, the welding transformer RATIO must be programmed in order to use secondary current in [kA] and show measured CURRENT on DATA displays. Also, Primary Current Sensor must be selected.

1. Put the control in PROGRAM mode.
2. Press SELECT until the DATA display shows ***EF***.
3. Press the left SCHEDULE push button until the SCHEDULE display shows ***C.r.***

8.2.2 RATIO MODE (cont.)

4. Use the DATA and ENTER push buttons to program:
   C.r.=***12***, ***14***, ***16***, or ***18*** for Compensation and Monitoring, or
   C.r.=***13***, ***15***, ***17***, or ***19*** for Monitoring only, as shown in Table 8-1.
5. Press the left SCHEDULE push button until the SCHEDULE display shows ***r.A.***
6. Use the DATA and ENTER push buttons to program ***r.A.***=[***xxxx***],
   where ***xxxx*** is welding transformer ratio $rA_{WT} = U_P / U_S = I_{SECONDARY} / I_{PRIMARY}$
   or any number from 0001 to maximum of 0435, 0174, 0087, or 0043 for PT2, PT5, PT10 or PT20, respectively.
7. Press the SELECT push button and select CURRENT [%] or [kA].
8. Program desired CURRENT in [%] (Monitoring mode) or in [kA] (Compensation and Monitoring mode) for the dialed schedule.
9. Put the control back in the OPERATE mode.

Table 8-1. *CONSTANT CURRENT RATIO modes with Primary Sensor*

PT designation	Coil Ratio	RANGE	$rA_{WT\,MAX}$	C.r.	
				Compensation	Monitoring
PT2	200:5 A/A	200 A	0435	12	13
PT5	500:5 A/A	500 A	0174	14	15
PT10	1000:5 A/A	1000 A	0087	16	17
PT20	2000:5 A/A	2000 A	0043	18	19

All Monitoring modes (***C.r.***=***13***, ***15***, ***17***, or ***19***) have following exceptions:

CURRENT – CURRENT in [%] from ***0000*** (0 %) to ***0099*** (99%);
L.o. – **LOW** current limit window in [kA] from ***0000*** (0 kA) to ***99.99*** (99.99 kA);
H. i. – **HIGH** current limit window in [kA] from ***0000*** (0 kA) to ***99.99*** (99.99 kA).

See Section 8.1.1 for information on setting HIGH/LOW limit window.

Also, in these Monitoring modes, RMS CURRENT in [kA] will always be shown on DATA display after end of the sequence, which may be useful for setting HI/LO limit window.

NOTICE

For ***r.A.***=***0010***, schedule parameter CURRENT will be programmed in **primary Amps** and control will show primary CURRENT in [A] on display. This may be useful if welding transformer ratio is unknown.

8.2.3 SET POINT SETUP FOR PRIMARY COMPENSATION MODE

Since setup is not required in RATIO mode, the control will use calibrated gain to operate and show CURRENT on the display. But, depending on the size of the welding transformer, the size of the primary current transformer and maximum operating range of the machine, upslope or overshoot during the first several cycles of the weld could happen ***only*** in Compensation mode. This may happen because the control does not know the correlation between the percentage of phase shift and the measured current in [kA] before the weld. In order to eliminate or minimize the effect of upslope or overshoot during compensation, the following simple set point setup procedure is recommended (but not required).

8.2.3 SET POINT SETUP FOR PRIMARY COMPENSATION MODE (cont.)

1. Put the control in PROGRAM mode.
2. Program one of the Monitoring modes: **C.r.**=**13**, **15**, **17**, or **19**.
3. Program desired CURRENT in [%] (**0060** for 60% for the dialed schedule), along with other SCHEDULE parameters like SQUEEZE, WELD or HOLD time.
4. Put the control back in the OPERATE mode.
5. Before sequence initiation, select PERCENT CURRENT using the SELECT push button.
6. Make sample welds with chosen schedule to determine proper welding transformer tap switch setting. WELD time should be the recommended number of cycles for material being welded. PERCENT CURRENT should be high enough in order to achieve desired secondary current. After end of weld and releasing initiation switch, CURRENT in [kA] will be shown on DATA display.
7. At this point, press and hold ENTER push button and **S.E.t.A.** message will appear on DATA display. While ENTER is held, press SELECT push button to store this **set point**, which represents correlation between PHASE SHIFT in [%] and CURRENT in [kA], into EEPROM memory of the control.
8. After this, the control can be reprogrammed back to one of the corresponding Compensation modes: **C.r.**=**12**, **14**, **16**, or **18**.
9. **Calibration of CURRENT display –** Once Compensation mode **12**, **14**, **16**, or **18** is selected, the turns ratio needs to be adjusted so that displayed secondary CURRENT value matches value displayed on weld analyzer or other equipment capable of displaying secondary current.
   a) Start with the original **r.A.** settings.
   b) Make a weld and compare displayed CURRENT on the control with current reading on the weld analyzer.
   c) If displayed CURRENT is less than current on the weld analyzer, increase **r.A.** proportionally, re-program the desired CURRENT in [%] (Monitoring mode) or [kA] (Compensation and Monitoring mode) for the dialed schedule. Repeat this until secondary current value matches.
   d) Otherwise, if CURRENT is greater, decrease **r.A.** proportionally and re-program the desired CURRENT in [%] (Monitoring mode) or [kA] (Compensation and Monitoring mode) for the dialed schedule. Repeat this until secondary current value matches.

8.3 CONSTANT CURRENT OPERATION WITH SECONDARY ROGOWSKI COIL

The EN1001 Cascade/Multi-Valve Control in CONSTANT CURRENT mode with a Secondary Rogowski Coil (Figure 8-3) as Current Sensor, allows two modes of operation: Auto Range Selection and Manual Range Selection. The simplest and quickest to use is Manual Range Selection.

Figure 8-3. *Secondary Sensor – S6*

8.3.1 AUTO RANGE SELECTION

In this mode, a learning type setup is required, as described in Section 8.1.4. This mode should be used ***only*** when the secondary current range is not known. This mode is similar to CONSTANT CURRENT with Primary Sensing.

1. Put the control in PROGRAM mode.
2. Press SELECT until the DATA display shows ***EF***.
3. Press the left SCHEDULE push button until the SCHEDULE display shows ***C.r.***
4. Use the DATA and ENTER push buttons to program:
   C.r.=***30*** for Compensation and Monitoring, or
   C.r.=***31*** for Monitoring only.
5. Press the left SCHEDULE push button until the SCHEDULE display shows ***r.A.***
6. Use the DATA and ENTER push buttons to program:
   r.A.=***00.99*** for program and display CURRENT in [%], or
   r.A.=[***xx.xx***] for program and display CURRENT in [kA],
   where ***xx.xx*** may be any number except ***00.99***.
7. Follow instructions in Section 8.1.4 for setting up Current Regulator.

After programming ***C.r.*** and ***r.A.*** EXTENDED FUNCTION parameters, control is ready for setup procedure. This procedure is the same as setup procedure for EN1001 Cascade/Multi-Valve Controls with Current Transformer. The only difference is that after setup is performed in this way in [kA] mode, the parameter ***r.A.*** will hold approximately the maximum RMS CURRENT in [kA] for the used transformer tap.

After finishing setup, the control is in CONSTANT CURRENT mode and ready to operate. Original value for PERCENT CURRENT used in NON-CONSTANT CURRENT mode is no longer available.

8.3.2 MANUAL RANGE SELECTION

In this mode, setup is **not** required, since the control is already calibrated in the factory by using two independent calibration procedures for the Control Board and Secondary Coil. However, the control must be programmed for the desired CURRENT range in which the machine will operate. In this mode, CURRENT is programmed and displayed only in [kA], except in Monitoring mode ***C.r.***=***33***.

1. Put the control in PROGRAM mode.
2. Press SELECT until the DATA display shows ***EF***.
3. Press the left SCHEDULE push button until the SCHEDULE display shows ***C.r.***
4. Use the DATA push buttons to program:
   C.r.=***32*** for Compensation and Monitoring, or
   C.r.=***33*** for Monitoring only.
5. Press ENTER.
6. Press the left SCHEDULE push button until the SCHEDULE display shows ***r.A.***
7. Use the DATA push buttons to program:
   r.A.=[***xx.xx***] to operate in desired range,
   where ***xx.xx*** must correspond to desired range, as shown in Table 8-2.
8. Press ENTER.

8.3.2 MANUAL RANGE SELECTION (cont.)

9. Press the SELECT push button and select CURRENT [%] or [kA].
10. Program the desired CURRENT in [kA] for the dialed schedule.
11. Press ENTER.
12. Put the control back in the OPERATE mode.

Table 8-2. *Operating Ranges for Manual Range Selection with Rogowski Coil*

Current Range in **kA**	RANGE Parameter **r.A.**	Current Range in **kA**	RANGE Parameter **r.A.**
0 to 2	02.00	0 to 30	30.00
0 to 3	03.00	0 to 40	40.00
0 to 4	04.00	0 to 50	50.00
0 to 5	05.00	0 to 60	60.00
0 to 6	06.00	0 to 70	70.00
0 to 8	08.00	0 to 80	80.00
0 to 10	10.00	0 to 90	90.00
0 to 20	20.00	0 to 100	99.99

The weld control will sequence and fire SCRs according to operating range defined with **r.A.**

NOTICE

C.r. must be equal to **32** or **33** before changing operating range!

Monitoring mode **C.r.**=**33** has following exceptions:

CURRENT – CURRENT in [%] from **0000** (0 %) to **0099** (99%);
L.o. – **LOW** current limit window in [kA] from **00.00** (0 kA) to **99.99** (99.99 kA);
H. i. – **HIGH** current limit window in [kA] from **00.00** (0 kA) to **99.99** (99.99 kA).
See Section 8.1.1 for information on setting HIGH/LOW limit window.

Also in this mode, RMS CURRENT in [kA] will be shown on DATA display after end of the sequence, which may be useful for setting HI/LO limit window.

8.3.3 CHOOSING A RANGE

The desired range should be as close as possible to the maximum operating range of the welding machine. If the programmed range is far below or above operating range, after any weld, the RMS current may be far above or far below desired RMS values, or with **P.O.**=**12** the control will display ERROR **H. i.** or **L.o.** In such cases, the range has to be changed by programming lower or higher **r.A.**, otherwise the transformer tap has to be moved up or down, if that is possible.

If the operating range of the welding machine is unknown, running the setup procedure is recommended. After running the setup for **C.r.**=**30** and **r.A.** equal to any value except **00.99**, the approximate maximum RMS value will be stored in **r.A.** Once that value has been determined for the tap setting necessary for a good weld, go to Table 8-2 and determine the RANGE parameter **r.A.** closest to the value determined by the setup and use that value when reprogramming **r.A.** in the Manual Range mode with **C.r.**=**32** or **33**.

8.4 SENSOR SELECTION JUMPER SETTINGS

Proper jumper settings for the different types of sensors are shown in Figure 8-4 (for Primary Sensor) and Figure 8-5 (for Secondary Rogowski Coil). See also Figure 8-1 for further clarification.

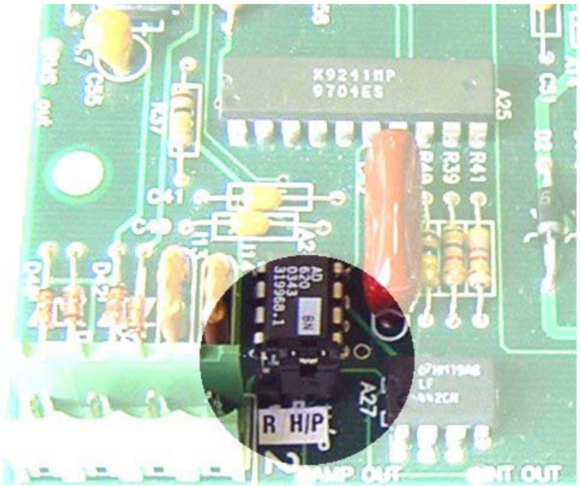


Figure 8-4. *Jumper setting:*
Primary Sensor
(two pins on the right)

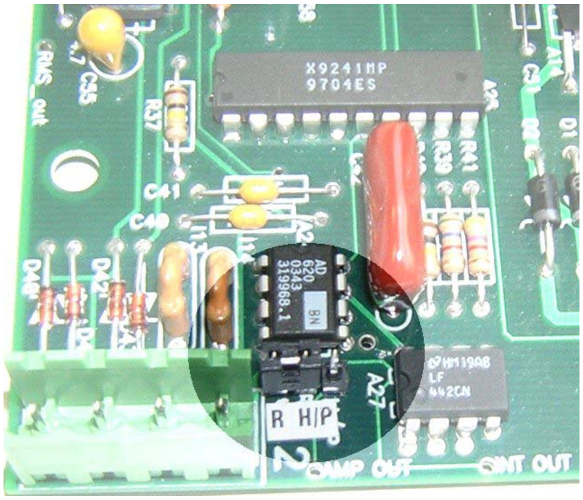


Figure 8-5. *Jumper setting:*
Secondary Sensor – Rogowski Coil
(two pins on the left)

9.0 APPLICATIONS AND PROGRAMMING EXAMPLES

The EN1000/EN1001 Cascade/Multi-Valve Controls can be programmed for numerous welding applications, but only few of them are highlighted here.

The schedules shown are for demonstration purposes. In order to easily follow visually the schedules as they progress, the individual times in each one have been made longer than they would be for an actual machine operation.

9.1 SPOT MODE EXAMPLES

9.1.1 SPOT WITH REPEAT MODE

Schedule 00 is a SPOT schedule in the REPEAT mode. Momentary initiation results in one sequence only. If the initiation is held closed, the sequence will continue repeating. Valve 2 output is used.

SCHEDULE	SQUEEZE	WELD/ HEAT	PERCENT CURRENT	HOLD	OFF	IMPULSES	COOL	VALVE MODE*	CYCLE MODE	SLOPE MODE	SLOPE COUNT
00	40	30	60	10	15	01	00	02	01	00	00

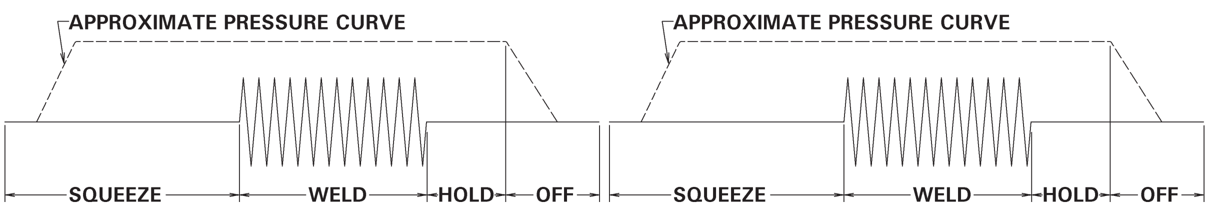


Figure 9-1. *SPOT with REPEAT mode*

9.1.2 PULSATION WITH SUCCESSIVE MODE

Schedule 01 and 02 are PULSATION and SPOT schedules combined in the SUCCESSIVE mode. Schedule 01 is initiated first. When it is completed, schedule 02 will flash to indicate that it is ready to be initiated. After it is completed, the SCHEDULE display will return to 01. Schedule 01 uses Valve 1, schedule 02 uses Valve 2.

SCHEDULE	SQUEEZE	WELD/ HEAT	PERCENT CURRENT	HOLD	OFF	IMPULSES	COOL	VALVE MODE*	CYCLE MODE	SLOPE MODE	SLOPE COUNT
01	20	10	60	10	10	03	06	01	03	00	00
02	25	30	60	10	10	01	00	02	00	00	00

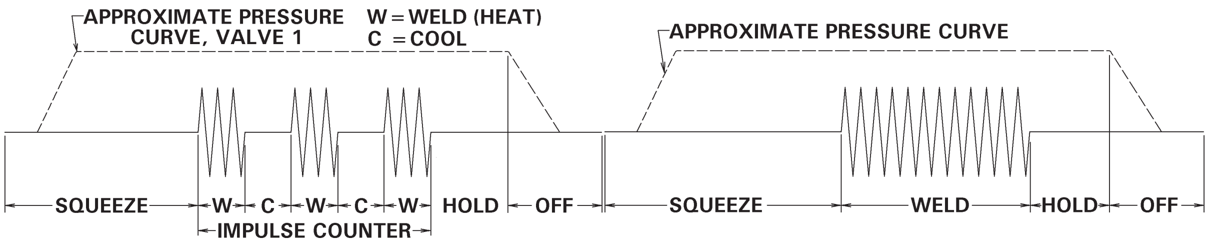


Figure 9-2. *PULSATION with SUCCESSIVE mode*

* See Table 2-1 for description of this code.

9.1.3 QUENCH-TEMPER WITH CHAINED MODE

Schedules 03 and 04 are CHAINED together to illustrate QUENCH-TEMPER operation. Schedule 03 performs the SQUEEZE, WELD and QUENCH functions (using HOLD for QUENCH), and schedule 04 performs the TEMPER and HOLD functions (using WELD for TEMPER). Valve 3 output is used. The WELD light gives a visual indication of the relative amplitude and duration of CURRENT during WELD and TEMPER times.

SCHEDULE	SQUEEZE	WELD/ HEAT	PERCENT CURRENT	HOLD	OFF	IMPULSES	COOL	VALVE MODE*	CYCLE MODE	SLOPE MODE	SLOPE COUNT
03	40	35	60	35	10	01	00	04	02	00	00
04	00	30	40	20	10	01	00	04	00	00	00

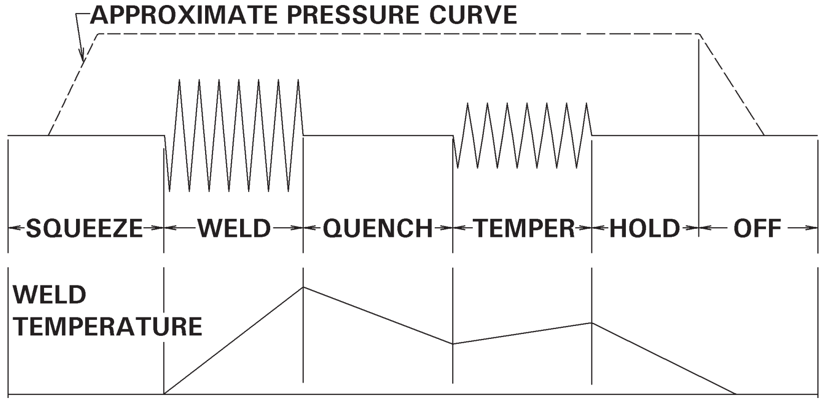


Figure 9-3. *QUENCH-TEMPER with CHAINED mode*

9.1.4 UPSLOPE AND DOWNSLOPE WITH CHAINED MODE

Schedules 05, 06, 07 and 08 are CHAINED together to illustrate UPSLOPE/DOWNSLOPE operation. Schedule 05 performs SQUEEZE function and establishes PERCENT CURRENT at which UPSLOPE will begin (bottom current). Schedule 06 performs WELD function and sets UPSLOPE time. Schedule 07 sets DOWNSLOPE time and PERCENT CURRENT it starts from. Schedule 08 establishes PERCENT CURRENT at which DOWNSLOPE will end, and performs HOLD function. The number in the SCHEDULE display will change as the sequence progresses from one schedule to the next. Valve 1 output is used for this example.

SCHEDULE	SQUEEZE	WELD/ HEAT	PERCENT CURRENT	HOLD	OFF	IMPULSES	COOL	VALVE MODE*	CYCLE MODE	SLOPE MODE	SLOPE COUNT
05	40	00	10	00	00	01	00	01	02	00	00
06	00	20	60	00	00	01	00	01	02	01	20
07	00	00	60	00	00	01	00	01	02	02	22
08	00	00	05	20	10	01	00	01	00	00	00

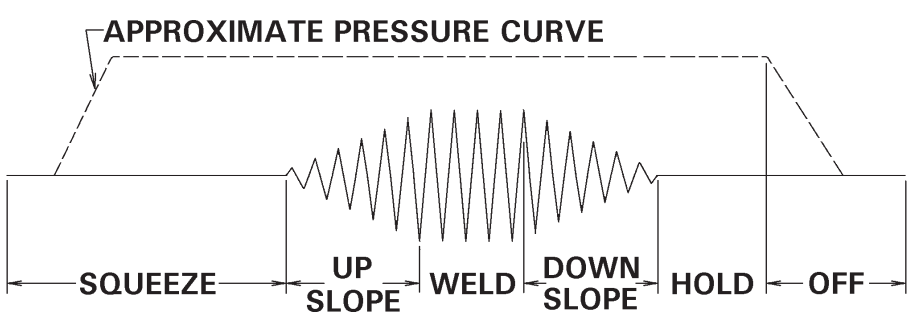


Figure 9-4. *UPSLOPE and DOWNSLOPE with CHAINED mode*

* See Table 2-1 for description of this code.

9.1.5 BUTT WELD WITH CHAINED MODE

Schedules 11 and 12 are CHAINED together to perform a BUTT welding sequence. Schedule 11 contains only SQUEEZE time with Valve 1 output, and is used as the CLAMP function. Schedule 12 follows the CLAMP function with a normal SQUEEZE, WELD, HOLD sequence with Valve 2 output. Both valve outputs turn off at the end of HOLD time.

SCHEDULE	SQUEEZE	WELD/ HEAT	PERCENT CURRENT	HOLD	OFF	IMPULSES	COOL	VALVE MODE*	CYCLE MODE	SLOPE MODE	SLOPE COUNT
11	20	00	00	00	00	01	00	01	02	00	00
12	20	10	50	10	10	01	00	03	00	00	00

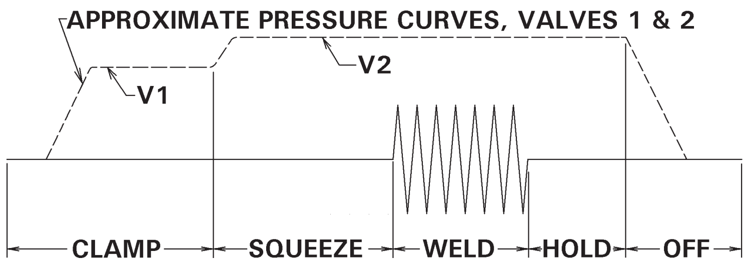


Figure 9-5. *BUTT weld with CHAINED mode*

9.1.6 FORGE DELAY WITH CHAINED MODE

The forging process is most often used when working with hard-to-weld materials such as aluminum. The weld is usually started at one force, followed by the application of a higher force during weld or hold time. This action may refine the weld zone, and provide a more homogeneous weld nugget. Timing of the application of forging force is critical. If applied too soon, the welding current may be insufficient for the higher force. If applied too late, the weld will have solidified and the forging force will do no good.

FORGE DELAY is defined as the delay from the beginning of the weld to the activation of the forging solenoid valve. To accomplish FORGE DELAY operation on EN1000/EN1001 Cascade/ Multi-Valve Controls, it is necessary to CHAIN together two or more schedules as follows:

1. Program the first schedule with the amount of WELD time desired before the activation of the forging valve. Use any one of the eight solenoid valve outputs.
2. For FORGE during WELD, program the second schedule with remaining WELD time and program an unused valve output. This second valve output activates the forging valve.

NOTICE

For continuous CURRENT from the first schedule to the second schedule, do not program any HOLD time into the first schedule or SQUEEZE time into the second schedule.

3. For FORGE after WELD, program the number of cycles of time between WELD time and the activation of the forge valve into HOLD time of the first schedule or into SQUEEZE time of the second schedule.

SCHEDULE	SQUEEZE	WELD/ HEAT	PERCENT CURRENT	HOLD	OFF	IMPULSES	COOL	VALVE MODE*	CYCLE MODE	SLOPE MODE	SLOPE COUNT
00	*xx*	*xx*	*xx*	00	00	01	00	02	02	00	00
01	00	*xx*	*xx*	*xx*	00	01	00	06	00	00	00

* See Table 2-1 for description of this code.

9.1.6 FORGE DELAY WITH CHAINED MODE (cont.)

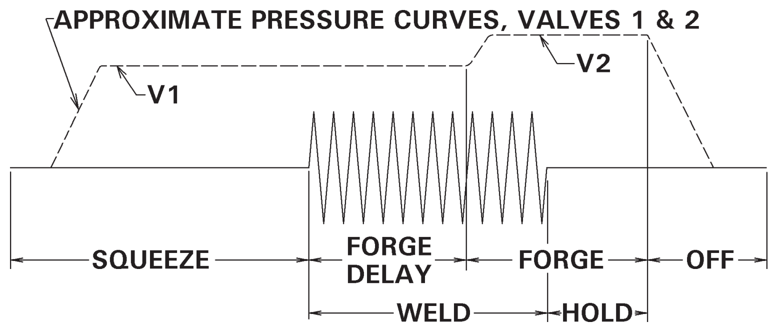


Figure 9-6. *FORGE DELAY with CHAINED mode*

In the next example, Valve 1 will be the standard valve and Valve 2 will be the forging valve. The total WELD time is 15 cycles at 95 PERCENT CURRENT with the forging valve activated after 10 cycles.

SCHEDULE	SQUEEZE	WELD/ HEAT	PERCENT CURRENT	HOLD	OFF	IMPULSES	COOL	VALVE MODE*	CYCLE MODE	SLOPE MODE	SLOPE COUNT
00	20	10	95	00	00	01	00	01	02	00	00
01	00	05	95	20	00	01	00	03	00	00	00

For FORGE during WELD, it is possible to select a PERCENT CURRENT for the second schedule different from that of the first schedule.

Other combinations of weld schedules may be combined to create other forging schedules. For example, it would be possible to use UPSLOPE in the first sequence and PULSATION in the second sequence.

9.2 SEAM MODE EXAMPLES

By definition Cascade Controls are not designed for SEAM mode applications, but after adding CYCLE MODE **05** (WAIT-HERE) in PROM firmware version 619044-002**C**, some types of SEAM mode are possible (for TS1-FS3 initiation only) on these controls.

SEAM mode operation is possible by using WAIT-HERE mode (CYCLE MODE **05**). The control is only enabled for this mode by programming EXTENDED FUNCTION **b.E.** to **05**. After this, CYCLE MODE must be programmed to **05** and IMPULSES to **99**. Welding sequence must be initiated with TS1-FS3 initiation input, and, after SQUEEZE time, the control will start to weld. In order to stop or break welding part of sequence, either TS1-ES1 or TS1-WFS1/AUX1 must be activated or initiation inputs TS1-FS7 or TS1-FS11 will continue to execute sequence beginning with schedule 20 or 40, respectively.

NOTICE
Refer to Section 6.2.6 for more information about WAIT-HERE – CYCLE MODE **05**.

* See Table 2-1 for description of this code.

9.2.1 CONTINUOUS SEAM MODE WITH CYCLE MODE 05

Schedule 13 is a WAIT-HERE mode (CYCLE MODE **05**). To disable this mode in dialed schedule, reprogram the CYCLE MODE to any other values from **00** to **04** or change number of IMPULSES.

SCHEDULE	SQUEEZE	WELD/ HEAT	PERCENT CURRENT	HOLD	OFF	IMPULSES	COOL	VALVE MODE*	CYCLE MODE	SLOPE MODE	SLOPE COUNT
13	30	10	40	10	10	99	00	01	05	00	00

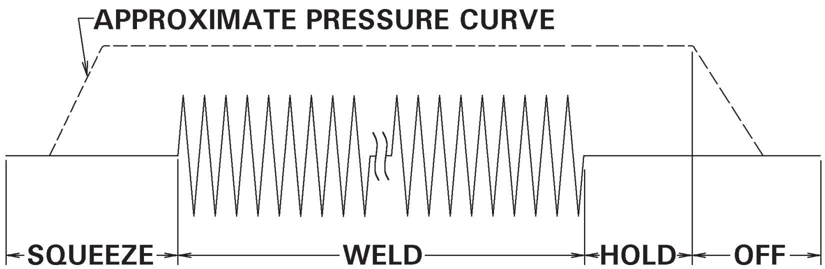


Figure 9-7. *CONTINUOUS SEAM mode*

9.2.2 INTERMITTENT SEAM MODE WITH CYCLE MODE 05

Schedule 14 is an INTERMITTENT SEAM mode. INTERMITTENT operation is accomplished by programming a value other than **00** for COOL into the schedule. To disable this mode in dialed schedule, reprogram the CYCLE MODE to any other values from **00** to **04** or change number of IMPULSES.

SCHEDULE	SQUEEZE	WELD/ HEAT	PERCENT CURRENT	HOLD	OFF	IMPULSES	COOL	VALVE MODE*	CYCLE MODE	SLOPE MODE	SLOPE COUNT
14	10	20	50	10	10	99	08	01	05	00	00

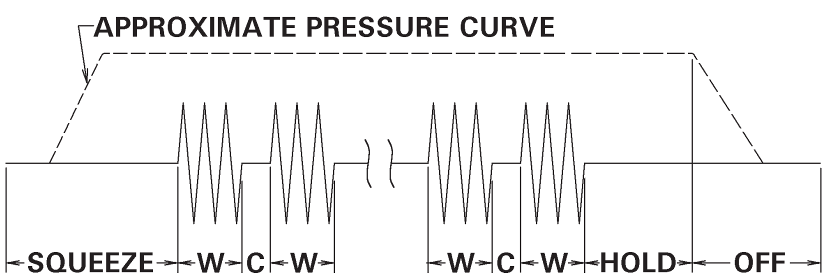


Figure 9-8. *INTERMITTENT SEAM mode*

* See Table 2-1 for description of this code.

9.3 BRAZING APPLICATION

Brazing operations differ from spot welding operations in that a much longer heating time may be required. This is because a much larger area must be raised to the melting temperature of the brazing material. Depending on the mass of the parts to be brazed, this time may vary from several cycles to several seconds. The EN1000/EN1001 Cascade/Multi-Valve Controls can be operated in two BRAZING modes: AUTOMATIC for short brazing times and MANUAL which is most useful for long brazing times.

9.3.1 AUTOMATIC BRAZING MODE

For the AUTOMATIC BRAZING mode, the EN1000/EN1001 Cascade/Multi-Valve Control is initiated in the same manner as SPOT welding. However, it must be programmed through EXTENDED FUNCTIONS for BEAT DURING SQUEEZE AND WELD initiation, as explained in Section 5.4.8. For convenience, the instructions are repeated here.

To program for BEAT DURING SQUEEZE AND WELD:

1. Put the control in PROGRAM mode.
2. Use SELECT to find ***EF***.
3. Use the SCHEDULE push buttons to find ***b.E.***
4. Use the DATA push buttons and make ***b.E.***=***02***.
5. Press ENTER.

In this mode, the initiation must be held closed for the time required to bring the parts to the required brazing temperature. If this time is longer than 99 cycles, two or more schedules must be CHAINED together. If the operator then opens the initiation, the brazing current turns off immediately and the sequence advances to HOLD time, and after HOLD time the electrodes retract. The control will terminate the weld sequence normally at the end of the programmed schedule if the initiation switch remains closed.

9.3.2 MANUAL BRAZING MODE

For the MANUAL BRAZING mode, BEAT INITIATION DURING SQUEEZE AND WELD is also programmed as above. In addition, set WELD/HEAT and IMPULSES to ***99***, PERCENT CURRENT and VALVE MODE in accordance with job requirements, and all other parameters to ***00***. Initiation switches are connected to TS1 as shown in Figure 9-9.

Operation in this mode is as follows: When First Stage is closed, brazing electrodes close on the work. When Second Stage is closed, brazing current comes on. If Second Stage is opened, brazing current stops, but electrodes stay closed. Current may be turned on and off in this manner as many times as desired by operator. When First Stage is opened, electrodes retract.

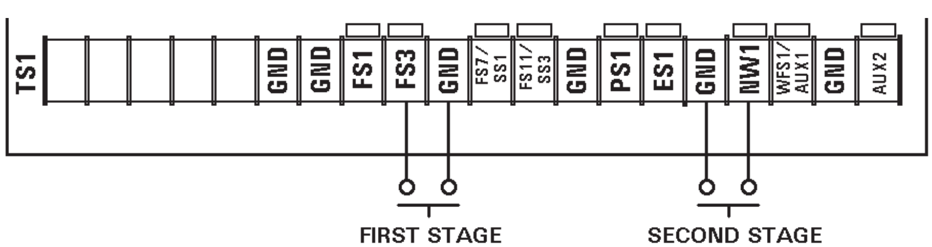


Figure 9-9. *Using Two Stage initiation in BRAZING mode*

9.4 SQUEEZE DELAY APPLICATION

Some applications require the welder arms be opened wide to allow the electrodes to access areas to be welded. SQUEEZE DELAY was designed for use with welding guns and stationary machines incorporating standard air cylinders and valves without retraction features. The additional time provided by the SQUEEZE DELAY will allow the electrodes to travel a greater distance and simulate the retraction function. SQUEEZE DELAY is only active in the first schedule in a REPEAT sequence.

9.4.1 SQUEEZE DELAY OPERATION

Setting the control for SQUEEZE DELAY will provide additional time before the programmed SQUEEZE time in all schedules. The SQUEEZE indicator LED on the Control Panel will dim slightly during the programmed SQUEEZE DELAY time. SQUEEZE DELAY time occurs only during the first SQUEEZE of a series of repeated welding sequences (REPEAT mode).

SQUEEZE DELAY will be present in all schedules even if no other data has been entered.

SQUEEZE DELAY is not intended for use with SEAM modes of operation. If not required, set **S.d.** to **00**.

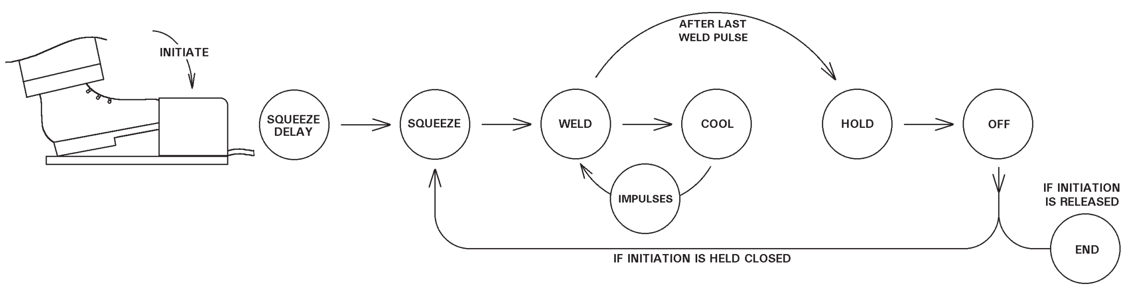


Figure 9-10. *SQUEEZE DELAY operation*

9.4.2 SQUEEZE DELAY PROGRAMMING

1. Press SELECT push button repeatedly until FUNCTION indicator LED has advanced past SLOPE COUNT to enter data in EXTENDED FUNCTIONS (**EF**).
2. Scroll through the EXTENDED FUNCTIONS until **S.d.** appears in SCHEDULE display.
3. Press PROGRAM/OPERATE push button to place the control in PROGRAM mode.
4. Press DATA push buttons until desired SQUEEZE DELAY time (time=number of cycles) is displayed in DATA display.
5. Press ENTER push button to store the desired data.
6. Select and enter CYCLE MODE=**01** (REPEAT).
7. Adjust SQUEEZE and OFF times to allow the electrodes to open only a short distance between repeated welding sequences.
8. Press PROGRAM/OPERATE push button to put the control in OPERATE mode.

9.5 RETRACTION APPLICATION

Retraction is used for welding guns and stationary machines with cylinders and valves configured for retraction operation. Retraction can be accomplished by de-energizing a valve solenoid, allowing the electrode arms to separate further than normal to allow large parts to be placed between welding electrodes.

The retraction valve can be activated by a ***momentary*** (**P.O.=08**) switch closure that toggles the electrodes between the retracted and non-retracted state or a ***maintained*** (**b.S.=09**) closure. AIR OVER OIL RETRACTION (**P.O.=07**) is used on welding guns and stationary welders that incorporate special air over oil cylinders

9.5.1 MOMENTARY CLOSURE – P.O.=08

While the RETRACTION PROCESS OUTPUT is enabled, the TS1-WFS1/AUX1 terminal is configured as a retraction input. The Water Flow Switch, if connected to terminal TS1-WFS1/AUX1, could be moved to TS1-NW1. A momentary closure from TS1-WFS1/AUX1 to TS1-GND will toggle the retraction valve from the On to the Off state. These contacts are normally tied to a momentary type switch that is independent from the initiation switch. When the valve is off and the gun is in a fully retracted state, the control cannot initiate a weld sequence and an ERROR **E.r.**=**27** message will appear on the display if initiation is attempted. Only when the valve is on and the electrodes are in the welding position will the initiations be enabled.

The valve output (Process Output valve) between TS10-SV17 and TS10-SV18 is enabled by toggling the TS1-WFS1/AUX1 to TS1-GND switch. This output remains on during and after a weld as long as the switch is not activated.

SUCCESSIVE schedules can be used with MOMENTARY RETRACTION.

When the retraction valve is on, the control may not be placed into PROGRAM mode. The TS1-WFS1/AUX1 (retraction input) must be momentarily activated.

If the TS1-WFS1/AUX1 input switch is held **closed** for a long period of time, ERROR **E.r.**=**06** message will be displayed, but the error condition is abandoned and the valve output **will be toggled** upon the opening of TS1-WFS1/AUX1 from TS1-GND. The Control Panel indication of Process Output valve (retraction valve) will not indicate the status of PROCESS OUTPUT.

! WARNING !

PROCESS OUTPUT valve terminals are on Terminal Strip TS10 on Terminal Strip Ouput Board 410322 (see Figure 9-11).

For this valve, the Valve Control Relay, which normally prevents valve activation until a weld sequence is initiated, is bypassed. Since this valve may now be activated without energizing the Control Relay, care MUST be taken to insure safe operation.

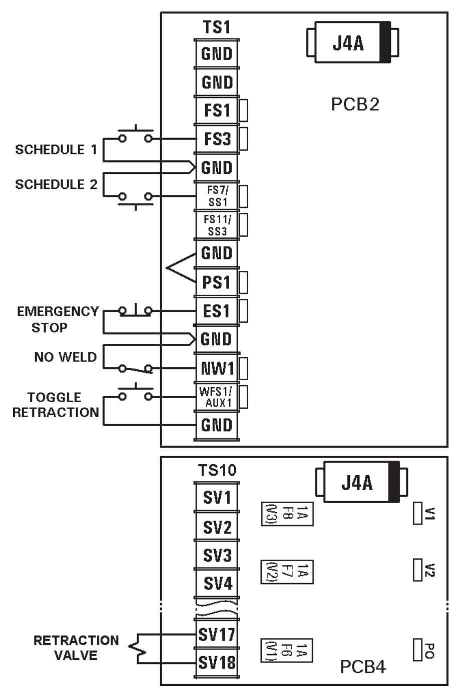


Figure 9-11. *Momentary Retraction connections*

9.5.1 MOMENTARY CLOSURE – *P.O.=08* (cont.)

PROGRAMMING MOMENTARY RETRACTION

1. Provide a constant closure of TS1-WFS1/AUX1 to TS1-GND.
2. Press SELECT push button repeatedly until FUNCTION indicator LED has advanced past SLOPE COUNT to enter data in EXTENDED FUNCTIONS (*EF*).
3. Scroll through the EXTENDED FUNCTIONS until *P.O.* appears in SCHEDULE display.
4. Press PROGRAM/OPERATE push button to place the control in PROGRAM mode.
5. Use the DATA push buttons to display *08* in DATA display.
6. Press ENTER push button to store the data.
7. Open the retraction switch held closed in Step 1.
8. Press PROGRAM/OPERATE push button to put the control in OPERATE mode.

9.5.2 MAINTAINED CLOSURE – *b.S.=09*
(THREE STAGE FOOT-SWITCH RETRACTION ADDITION)

Once *b.S.* is set to *09*, the control will enter the Maintained Closure RETRACTION mode. This RETRACTION implementation is different from *P.O.*=*07* or *P.O.*=*08* in that it uses one foot switch that has a maintained/latched contact that the control uses to turn on the retraction output PO Valve. The software has a power-on interlock of the PO valve output to block PO Valve from turning on with power on. This feature, simple as its operation may be, will help users implement this type of retraction without putting high voltage on one pole and/or in the same conduit as the low voltage foot switch wiring.

The valve output between TS10-SV17 and TS10-SV18 is enabled by closing the TS1-WFS1/AUX1 to TS1-GND switch. This output remains on during and after a weld as long as the switch remains closed.

SUCCESSIVE schedules can be used with MAINTAINED CLOSURE RETRACTION.

When the retraction valve is on, the control may not be placed into PROGRAM mode.

The Control Panel indication of the PO valve output (retraction valve) will not indicate the status of PROCESS OUTPUT.

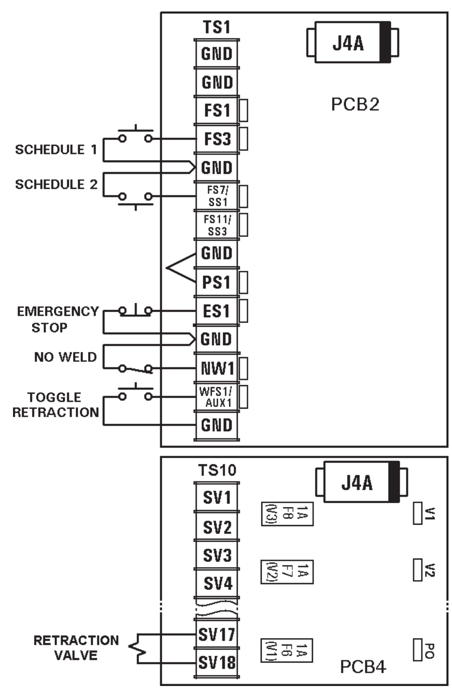


Figure 9-12. *Maintained Closure Retraction connections*

! WARNING !
PROCESS OUTPUT valve terminals are on Terminal Strip TS10 on Terminal Strip Output Board 410322 (see Figure 9-12).   **For this valve, the Valve Control Relay, which normally prevents valve activation until a weld sequence is initiated, is bypassed. Since this valve may now be activated without energizing the Control Relay, care MUST be taken to insure safe operation.**

9.5.2 MAINTAINED CLOSURE – b.S.=09 (cont.)

PROGRAMMING MAINTAINED CLOSURE RETRACTION

1. Provide a constant closure of TS1-WFS1/AUX1 to TS1-GND.
2. Press SELECT push button repeatedly until FUNCTION indicator LED has advanced past SLOPE COUNT to enter data in EXTENDED FUNCTIONS (**EF**).
3. Scroll through the EXTENDED FUNCTIONS until **b.S.** appears in SCHEDULE display.
4. Press PROGRAM/OPERATE push button to place the control in PROGRAM mode.
5. Use the DATA push buttons to display **09** in DATA display.
6. Press ENTER push button to store the data.
7. Open the retraction switch held closed in Step 1.
8. Press PROGRAM/OPERATE push button to put the control in OPERATE mode.

9.5.3 AIR OVER OIL RETRACTION – P.O.=07

Air over Oil Retraction is used on welding guns and stationary welders that incorporate special air over oil cylinders.

This feature requires the use of three solenoid valve outputs. The first output (Valve 1) is assigned to the *extend* solenoid. When the control is initiated, the *extend* valve is turned on, and the electrodes will approach the work under low pressure. The *intensify* valve (Valve 2) is then turned on once the electrodes reach the work and welding pressure is applied. The control continues onto WELD time and HOLD time. At the end of HOLD time, both the *extend* and *intensify* valves are shut off and a BLOCKING DELAY timer is then started. At the end of BLOCKING DELAY, the *blocking* valve (PO Valve) is turned on. This valve is connected to the *extend* port of the cylinder and when energized or closed, the return stroke can be halted before the gun completely opens. Initiating the *extend* valve will de-energize the *blocking* valve.

AIR OVER OIL RETRACTION is available through EXTENDED FUNCTION **P.O.**=**07**.

Because of the longer time that is required for the electrodes to go from the fully retracted state to the closed state, a SQUEEZE DELAY time is necessary. The SQUEEZE DELAY time is in addition to any scheduled SQUEEZE time. The control will only go through SQUEEZE DELAY when initiated from a fully retracted state. If the control is initiated when the *blocking* valve is on, the control will not go through SQUEEZE DELAY.

RETRACTION TOGGLE

When the control is programmed for AIR OVER OIL RETRACTION, TS1-FS1 can be used as an input to advance/retract the gun. When extending, the gun will advance during the programmed SQUEEZE DELAY time (using Valve 1). Valve 1 will de-energize and ADVANCE STOP will begin. PO Valve will turn on immediately after the programmed ADVANCE STOP time (programmed OFF time on schedule 00 in Figure 9-14).

The following steps assume that a *blocking* valve is connected between TS10-SV17 and TS10-SV18 (PO Valve output):

1. Connect a normally open momentary close type switch between TS1-FS1 and TS1-GND.
2. Program SQUEEZE DELAY to time the advance of the gun to a ready position.

9.5.3 AIR OVER OIL RETRACTION – P.O.=07 (cont.)

3. Program an OFF time in the first of the two schedules composing the weld sequence. This OFF time is designated as ADVANCE STOP time. This time will only occur during the TS1-FS1 toggle activation. It will not affect an actual weld sequence, since the first schedule is a non-welding part of the sequence.

NOTICE
The timing of SQUEEZE DELAY (Step 2) and OFF/ADVANCE STOP (Step 3) is counted in half cycle increments in order to double adjustment resolution.

To advance the electrodes, a momentary closure of TS1-FS1 will energize Valve 1.

The *blocking* valve will turn on immediately at the end of a programmed ADVANCE STOP time. Travel distance will depend on SQUEEZE DELAY plus ADVANCE STOP. In addition, inertia of the gun, oil pressure, etc., may influence travel distance.

While the *blocking* valve is energized, the Control Panel will indicate this status by blinking the PO VALVE LED. In this state, the control does not allow programming changes.

To return the electrodes to a fully retracted state, a momentary closure of TS1-FS1 will de-energize PO Valve. The Emergency Stop input may also be used to retract the electrodes. The PO Valve output will remain off after the Emergency Stop is activated.

In REPEAT sequences when programmed OFF time is shorter than or equal to BLOCKING time, only BLOCKING DELAY time takes place. When OFF time is greater than BLOCKING time, the *blocking* valve will turn on at the end of BLOCKING DELAY time and the control will continue through an OFF time that is equal to OFF time minus BLOCKING time.

When the control is in sequence and is in SQUEEZE DELAY or in BLOCKING DELAY time periods, the SQUEEZE and OFF indicator LEDs (respectively) will dim to half their intensity while the control continues through these times.

When **P.O.**=**07** is enabled, SQUEEZE DELAY time and BLOCKING DELAY time are in place for all 100 schedules.

SUCCESSIVE schedules can be used with AIR OVER OIL RETRACTION.

BEAT DURING SQUEEZE (**b.E.**=**01**) by definition will not work well with PROCESS OUTPUT **07** as the electrodes will completely open and the *blocking* valve will not turn on.

! WARNING !

PROCESS OUTPUT valve terminals are on Terminal Strip TS10 on Terminal Strip Output Board 410322 (see Figure 9-13).

For this valve, the Valve Control Relay, which normally prevents valve activation until a weld sequence is initiated, is bypassed. Since this valve may now be activated without energizing the Control Relay, care MUST be taken to insure safe operation.

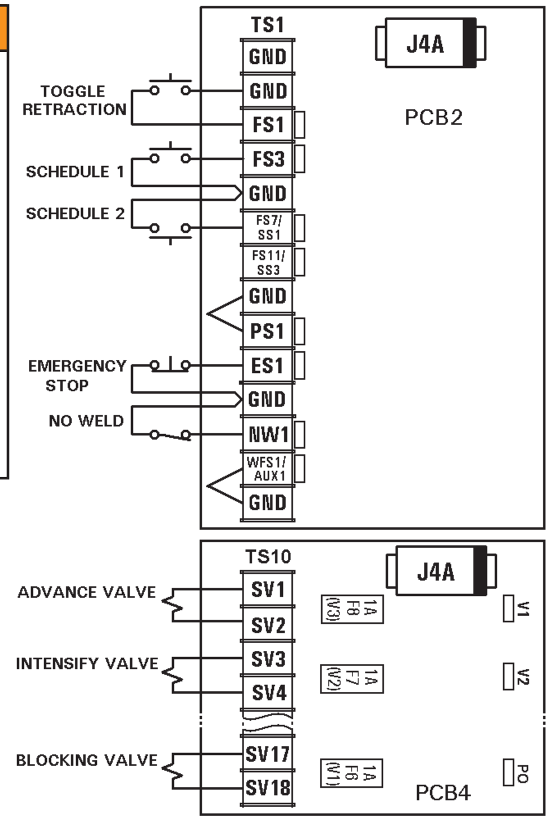


Figure 9-13.
Air over Oil Retraction connections

PROGRAMMING AIR OVER OIL RETRACTION

1. Press SELECT push button repeatedly until FUNCTION indicator LED has advanced past SLOPE COUNT to enter data in EXTENDED FUNCTIONS (**EF**).
2. Scroll through the EXTENDED FUNCTIONS until **P.O.** appears in the SCHEDULE display.
3. Press PROGRAM/OPERATE push button to place the control in the PROGRAM mode.
4. Use the DATA push buttons to display **07** in DATA display.
5. Press ENTER push button to store the data.
6. Scroll through the EXTENDED FUNCTIONS until **S.d.** appears in the SCHEDULE display.
7. Press the DATA push buttons until the desired SQUEEZE DELAY time is displayed in the DATA display (time = number of cycles).
8. Press ENTER push button to store the data.
9. Press SCHEDULE push buttons to advance SCHEDULE display to **b.L.** (BLOCKING DELAY).

NOTICE

EXTENDED FUNCTION b.L. can only be accessed when P.O.=07 is programmed.

10. Press DATA push buttons until desired BLOCKING DELAY time appears in DATA display.
11. Press ENTER push button to store the data.
12. Using the example below, enter CHAINED schedules that will control the *extend* (schedule 00) and *intensify* (schedule 01) valve sequencing.

NOTICE

Schedule 00 uses Valve 1 to activate the *extend* valve for 20 cycles.

SCHEDULE	SQUEEZE	WELD/ HEAT	PERCENT CURRENT	HOLD	OFF	IMPULSES	COOL	VALVE MODE*	CYCLE MODE	SLOPE MODE	SLOPE COUNT
00	20	10	00	00	05	01	00	01	02	00	00
01	10	15	85	10	00	01	00	03	00	00	00

* See Table 2-1 for description of this code.

9.5.3 AIR OVER OIL RETRACTION – P.O.=07 (cont.)

TIMING CHART ANALYSIS

Detailed sequencing of the cylinder can be better understood by studying sequence timing charts (see Figure 9-14) which are discussed in the following sections.

Section A

Section A details a basic sequence and how it may begin. The *blocking* valve may be on or off and will be cleared by an Emergency Stop. TS1-FS3 is then initiated and schedule 00 is started.

Since the *blocking* valve is off, the sequence begins with SQUEEZE DELAY (if programmed) and then proceeds into SQUEEZE time (EXTEND). A VALVE MODE of **01** is selected to turn on Valve 1 only. Schedule 00 is CHAINED to schedule 01. Schedule 01 begins and enters into SQUEEZE time (INTENSIFY), WELD time, and HOLD time. A VALVE MODE of **03** is selected to enable both Valve 1 (*extend*) and Valve 2 (*intensify*). After HOLD time is complete, the BLOCKING DELAY (if programmed) begins. When this DELAY is complete, Valve 3 (*blocking*) turns on. The control then waits for the next initiation, leaving the *blocking* valve on.

Section B

Section B is the same as Section A but, since Valve 3 (*blocking*) is on, the sequence skips SQUEEZE DELAY and immediately begins schedule 00 with SQUEEZE time (EXTEND).

Section C

Section C illustrates how a sequence can be terminated by an Emergency Stop. When Emergency Stop is detected, the sequence is aborted and all valves and weld output are turned off. As can be seen, when Emergency Stop is closed, the *blocking* valve is not turned back on.

Section D

Section D shows a single sequence similar to Section A, followed by a REPEAT sequence. Since OFF time is less than BLOCKING time, the sequence will REPEAT when the BLOCKING time has ended.

Section E

Section E illustrates that different schedules may be selected having common SQUEEZE DELAY and BLOCKING times.

Section F

Section F shows how a momentary switch attached to TS1-FS1 can toggle the gun from retracted to non-retracted mode or vice-versa. After a momentary closure of TS1-FS1, SQUEEZE DELAY is followed by ADVANCE STOP before BLOCKING occurs.

9.5.3 AIR OVER OIL RETRACTION – P.O.=01 (cont.)

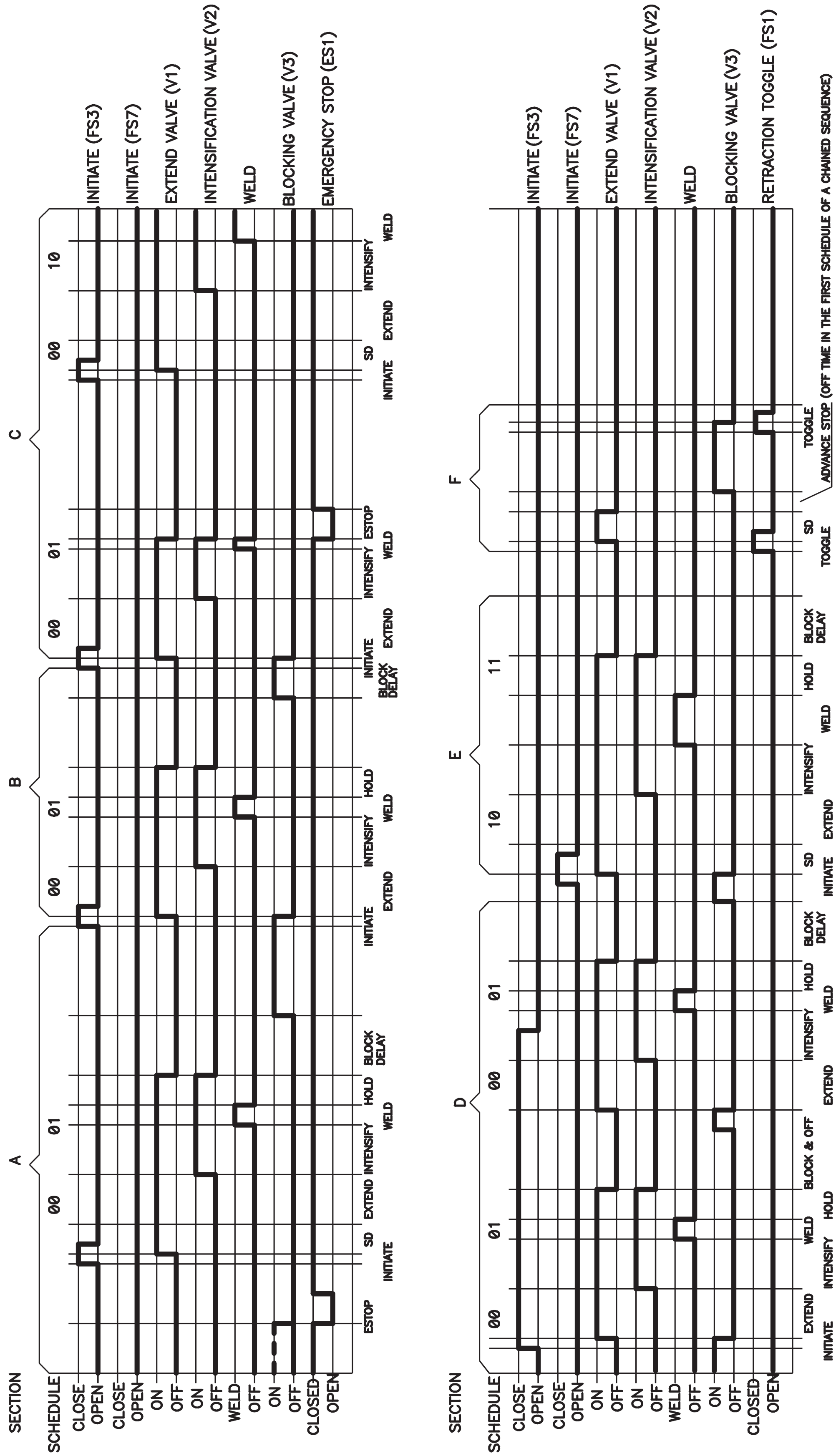


Figure 9-14. *Air Over Oil Retraction timing diagrams*

9.6 MULTIPLE SCHEDULE OPERATION

There are applications where it is advantageous to make more than one variety of welded assembly on a single Cascade welding machine where each assembly may require different WELD count and PERCENT CURRENT settings. The flexibility of the EN1000/EN1001 Cascade/Multi-Valve Control, with its 100 programmable schedules, allows for programming many combinations of schedules to meet these requirements.

For operating convenience it is sometimes desirable to select schedules from an operator's position, remote from the programming panel. This may be done in several ways.

9.6.1 MULTIPLE INITIATION SWITCHES

TRIPLE COUNT/TRIPLE CURRENT or 3C/3C can be accomplished on the EN1000/EN1001 Cascade/Multi-Valve Controls. Up to three individual cascaded schedule combinations can be selected by multiple initiation switch contacts.

EXTENDED FUNCTION **S.S.** must be set to INTERNAL SCHEDULE SELECT mode (**S.S.**=**00**). In this mode:

1. A switch closure between TS1-FS3 and TS1-GND will initiate any schedule shown in the SCHEDULE display.
2. A switch closure between TS1-FS7 and TS1-GND will initiate schedule 20.
3. A switch closure between TS1-FS11 and TS1-GND will initiate schedule 40.

An example of programming for a two Cascade Control with three schedule combinations is shown here.

SCHEDULE	SQUEEZE	WELD/ HEAT	PERCENT CURRENT	HOLD	OFF	IMPULSES	COOL	VALVE MODE*	CYCLE MODE	SLOPE MODE	SLOPE COUNT	CONTACTOR SELECT
00	30	05	50	00	00	01	00	01	02	00	00	01
01	00	05	50	10	00	01	00	01	00	00	00	02
20	30	03	60	00	00	01	00	01	02	00	00	01
21	00	03	60	10	00	01	00	01	00	00	00	02
40	30	06	70	00	00	01	00	01	02	00	00	01
41	00	06	70	15	00	01	00	01	00	00	00	02

9.6.2 EXTERNAL SCHEDULE SELECT OR SINGLE INITIATION SWITCH WITH REMOTE SCHEDULE SELECTION

Up to four individual cascaded schedule combinations can be selected remotely by using the EXTENDED FUNCTION **S.S.** The control is initiated at TS1-FS3 for any one of the four schedule combinations.

Schedule numbers can be externally selected in the EXTERNAL SCHEDULE SELECT mode with use of EXTENDED FUNCTION **S.S.**=**01**. In this mode:

1. TS1-FS7/SS1 and TS1-FS11/SS3 become binary schedule selects, and can point to one of four schedules – 00, 20, 40, 60.
2. The control is then initiated via TS1-FS3 for any one of the four schedules.

* See Table 2-1 for description of this code.

9.6.2 EXTERNAL SCHEDULE SELECT OR SINGLE INITIATION SWITCH WITH REMOTE SCHEDULE SELECTION (cont.)

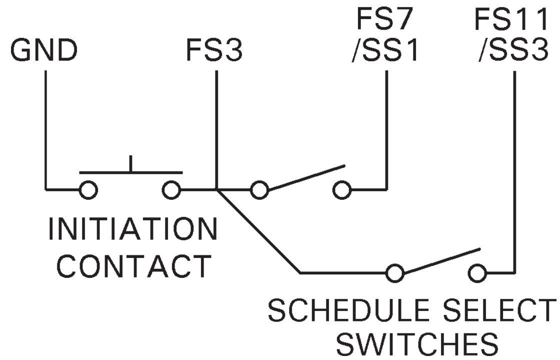


Figure 9-15. *SCHEDULE SELECT*

Table 9-1. *EXTERNAL SCHEDULE SELECT with TS1-FS7 and TS1-FS11*

SCHEDULE	TS1-FS7/SS1	TS1-FS11/SS3	INITIATION
00	**OPEN**	**OPEN**	TS1-FS3
20	***CLOSED***	**OPEN**	TS1-FS3
40	**OPEN**	***CLOSED***	TS1-FS3
60	***CLOSED***	***CLOSED***	TS1-FS3

The control is factory configured for INTERNAL SCHEDULE SELECT mode (***S.S.***=***00***) or TRIPLE SCHEDULE (3C/3C) operation. See Section 5.4.3 for more information about SCHEDULE SELECT options.

Examples of programming are similar to those shown for remote multiple initiation switches in Section 9.6.1.

9.6.3 COMPLEX CASCADE SCHEDULE PROGRAMMING

In some cascade welding operations, the current and time requirements may vary from one weld to another within a given set of welds made on a single welded assembly. This could be necessary because of different metal thicknesses or types of metal being welded. Also it may be necessary to close electrodes sequentially as the welds progress.

In this example, for a three cascade welding process, weld #1 requires a WELD time of 4 cycles at 60% CURRENT. Weld #2, because one part is galvanized steel, requires 3 PULSATIONS, and weld #3 requires UPSLOPE because one part is aluminum. It is also necessary to close the electrodes for welds #1 and #2 simultaneously, and then release them before closing the electrodes for weld #3. The programming would be as follows:

SCHEDULE	SQUEEZE	WELD/ HEAT	PERCENT CURRENT	HOLD	OFF	IMPULSES	COOL	VALVE MODE*	CYCLE MODE	SLOPE MODE	SLOPE COUNT	CONTACTOR SELECT
01	20	04	60	00	00	01	00	03	02	00	00	01
02	00	06	70	10	00	03	04	03	02	00	00	02
03	20	03	90	10	00	01	00	04	00	01	05	04

* See Table 2-1 for description of this code.

9.6.4 MULTI-VALVE PROGRAMMING

In addition to cascading multiple SCR contactors for energizing multiple welding transformers, the EN1000/EN1001 Cascade/Multi-Valve Controls can be programmed to cascade multiple solenoid valves which operate multiple electrodes operating from the secondary or a single welding transformer. This system is more economical because only one SCR contactor and one welding transformer are required. It has the disadvantage of being a slower process, because a SQUEEZE and HOLD time must be programmed between each weld.

An example of programming for a four multi-valve sequence is as follows:

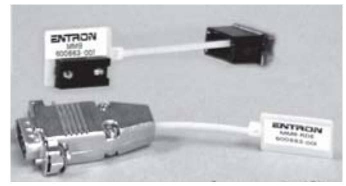
SCHEDULE	SQUEEZE	WELD/ HEAT	PERCENT CURRENT	HOLD	OFF	IMPULSES	COOL	VALVE MODE*	CYCLE MODE	SLOPE MODE	SLOPE COUNT	CONTACTOR SELECT
01	30	03	70	10	00	01	00	01	02	00	00	01
02	30	06	80	10	00	01	00	02	02	00	00	01
03	30	05	75	10	00	05	02	04	02	00	00	01
04	30	04	90	10	00	01	00	08	00	01	03	01

* See Table 2-1 for description of this code.

10.0 OPTIONS ON EN1000/EN1001 CASCADE CONTROLS

The following optional devices can be used with EN1000 or EN1001 Cascade/Multi-Valve Controls. Consult factory or sales representatives for details.

10.1 MM8 MEMORY MODULE



The MM8 Memory Module is designed as a backup device for any EN1000/EN1001 Cascade/Multi-Valve Control. There are two versions of this device: **MM8-RDE** for controls with RDE option and **MM8** for all other controls. The only difference between these two versions is the connection to the control. The MM8-RDE is designed to plug into a 9 pin D-Subminiature connector; the MM8 is designed to plug directly into the J4 connector on the Control Board. See Instruction Manual 700202 for additional information.

10.2 INTEGRATED PRESSURE SENSE AND CONTROL SYSTEM (IPSC)

See Instruction Manual 700178 for further details regarding the options for IPSC System.

PRESSURE SENSOR

The Pressure Sensor accurately measures air pressure and converts measurement to an electrical signal. The electrical output is a linear ratio of the sensed pressure. The Sensor is connected to the IPSC or IPS board through TS13. The signal from the Sensor is converted by IPSC or IPS Board and data is sent to the weld Control Board.

The pressure may be displayed by the weld control if EXTENDED FUNCTION parameter ***S.I.*** is selected. The pressure reading depends on the location of the Sensor.

PRESSURE CONTROL

The Integrated Pressure Sense Control System is designed for any application that requires automatic selection of a pre-programmed pressure, or automatic switching between different pressure settings. Weld control schedules may be chained to obtain sequential pressure changes. The benefits of the system depend on the application. The ENTRON IPSC or IPC System allows for sequencing of multiple pressures with one initiation. The flexibility of operation is only limited by the number of weld schedules. An IPSC or IPC System may be used to remove the worry of pressure settings from the operator. Also, the IPSC or IPC System may be used to reduce electrode wear by programming “soft set-down” during SQUEEZE. The IPSC or IPC System may eliminate multiple valves to simplify forging operations. Another application may serve to eliminate many valves when multiple pressures are required for selecting different pressure regulators.

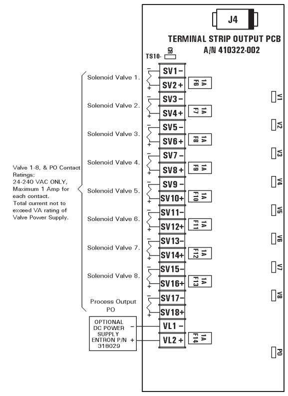
4-20 mA CONTROL AND/OR SENSE

The IPSC, IPS or IPC Board could be used for any 4-20 mA sensor input or 4-20 mA for regulated output for different applications. For example, the IPS Board can be successfully used for the welding parts detection.

10.0 OPTIONS ON EN1000/EN1001 CASCADE CONTROLS (cont.)

10.3 24 VDC VALVE OUTPUTS

Optional Valve Output Boards A/N 410322-002 or A/N 410322-003 with 24 VDC output. See Application Note 700189 for additional information.

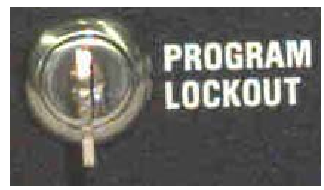


10.4 CURRENT SENSORS

Primary Coil and Secondary Rogowski Coils (6″ and 10″) are available for Constant Current operation on EN1001 Cascade/Multi-Valve Series Controls. See Section 8.0 for further details.

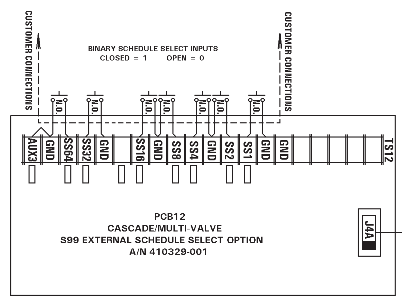
10.5 PROGRAM LOCKOUT KEY SWITCH

A PROGRAM LOCKOUT key switch prohibits unauthorized editing of control parameters. It can be ordered as a factory installed option or ordered separately and field installed by the customer. See Section 2.1 for more details.



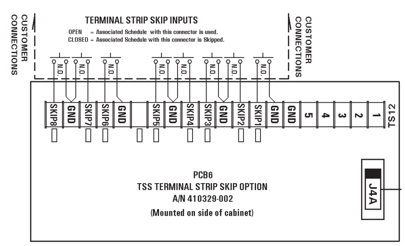
10.6 SCHEDULE SELECT S99 OPTION

The S99 Option adds seven binary select inputs to the EN1000/EN1001 Cascade/Multi-Valve Controls. Through the use of these added inputs, the user can select any one of 100 schedules to begin a sequence. This option is typically tied to a PLC or PC that selects the required schedule. Section 5.4.3, Appendix C and Application Note 700115 provide additional details.



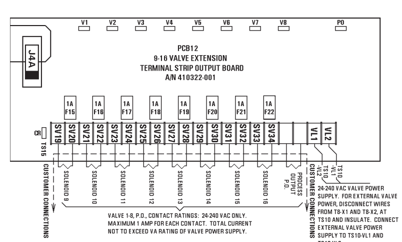
10.7 TERMINAL STRIP SKIP OPTION

The Terminal Strip Skip (TSS) Option adds eight binary select inputs on the EN1000/EN1001 Cascade/Multi-Valve Controls which allows the user the ability to skip (deactivate) any schedule associated with a selected SCR contactor using an external switch. A single pole contact connection is necessary for each contactor being skipped. This option is typically tied to a PLC or PC that skips the required SCR contactor. See Appendix E and Application Note 700138 for more information.



10.8 9-16 VALVE EXTENSION OPTION

The Cascade 9-16 Valve Extension (VE) Option adds eight additional valve outputs on EN1000/EN1001 Cascade/Multi-Valve Controls. Appendix D and Application Note 700146 provide more information.



10.0 OPTIONS ON EN1000/EN1001 CASCADE CONTROLS (cont.)

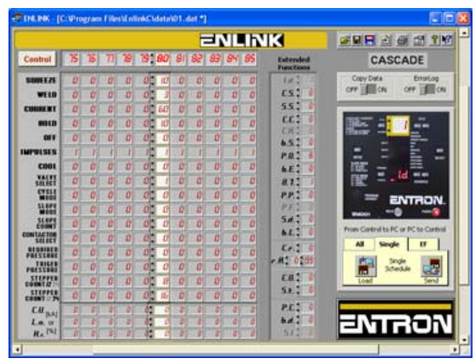
10.9 RS485 OPTIONS

Controls with RS485 Option can communicate with Remote Terminal RT4jr., PC or other devices with RS485 interface, over two-wire RS485 network (ENBUS network). Enables use of ENLINK 1000/1001 Cascade Software. Instruction Manual 700171 further explains this option.

The non-proprietary ENBUS protocol defines a message format that controls will recognize and use, regardless of who is the host – either RT4jr. or other devices. It describes the process which a host uses to request access to different controls, how the host will respond to request from the controls, and how errors will be detected and reported. This protocol provides an internal standard which hosts and controls use for parsing messages.

During communication on a ENBUS network, the protocol determines how each host and control will know its address (Identification Number), recognize a message addressed to it, determine which action will be taken, and extract any data or other information contained in the message.

10.10 ENLINK 1000/1001 CASCADE SOFTWARE



ENLINK 1000/1001 Cascade software is available for use with any EN1000 or EN1001 Cascade/Multi-Valve Control. It offers the ability to upload, download, store, retrieve, monitor and backup weld schedules to and/or from control using PC connected via RS232 or RS485 converters. Software is available on CDROM and works with Microsoft Windows™.

10.11 REMOTE TERMINAL RT4jr.

The Remote Terminal RT4jr. is designed as master device for communication with EN1000 or EN1001 Cascade/Multi-Valve Controls through RS485 two-wire network, allowing access to multiple controls. RT4jr. Control Panel provides programming and monitoring capabilities.

10.12 ISOLATED ADAPTERS – S485 AND U485

ENTRON offers two isolated adapters which can be used on PC to communicate with EN1000 and EN1001 Cascade/Multi-Valve Controls. S485 Serial Adapter with power supply is RS232 to RS485 converter. U485 USB Adapter is USB to RS485 converter.

10.13 RS232 OPTIONS

ENTRON RS232 interface is full duplex and operates in ASCII mode with specified RS232 Command/Response protocol. Using ASCII (American Standard Code for Information Interchange) mode, each eight-bit byte in a message is sent as two ASCII characters. The main advantage of this mode is allowing time intervals to occur between characters without causing errors. The protocol also uses short ASCII commands and an interactive mode. Can be used with ENLINK 1000/1001 Cascade Software. See Instruction Manual 700140 for more details.

11.0 ERROR CODES AND TROUBLESHOOTING

Please refer to other manual pages and Wiring Diagrams for location of fuses, terminal strips, etc.

11.1 ERROR CODES

ERROR	POSSIBLE CAUSE	REMEDY
Data/Schedule Display E.r.=01	Error Code #01 Temperature Limit Switch open or overheated.	Wait for the Temperature Limit Switch to cool or check for open circuit. **See Section 4.3, 4.5, and 5.4.6**.
Data/Schedule Display E.r.=02	Error Code #02 TS1-FS1 AND TS1-FS7 both closed.	Two Stage Operation not allowed with TS1-FS7. **See Section 4.3 and 4.4.**
Data/Schedule Display E.r.=03	Error Code #03 TS1-FS1 AND TS1-FS11 both closed.	Two Stage Operation not allowed with TS1-FS11. **See Section 4.3 and 4.4.**
Data/Schedule Display E.r.=04	Error Code #04 Attempt to weld in PROGRAM mode.	Return to OPERATE mode. **See Section 2.1 and 6.0.**
Data/Schedule Display E.r.=05	Error Code #05 TS1-FS1,FS3,FS7,FS11 closed to GND before power on or before Emergency Stop is re-closed after being opened.	Initiations must be open at power on or after an Emergency Stop. **See Section 1.1, 4.3, and 4.4**.
Data/Schedule Display E.r.=06	Error Code #06 Back-step or Retraction is closed too long or at start of sequence.	Open TS1-WFS1/AUX1. **See Section 4.3, 4.5, and 5.4.6**.
Data/Schedule Display E.r.=07	Error Code #07 TS1-FS1 initiated while another sequence active.	Open TS1-FS1. **See Section 4.3, 4.5, 5.4.3, and 9.6.**
Data/Schedule Display E.r.=08	Error Code #08 TS1-FS3 initiated while another sequence active.	Open TS1-FS3. **See Section 4.3, 4.5, 5.4.3, and 9.6**.
Data/Schedule Display E.r.=09	Error Code #09 TS1-FS7 initiated while another sequence active.	Open TS1-FS7. **See Section 4.3, 4.5, 5.4.3, and 9.6.**
Data/Schedule Display E.r.=10	Error Code #10 TS1-FS11 initiated while another sequence active.	Open TS1-FS11. **See Section 4.3, 4.5, 5.4.3, and 9.6.**
Data/Schedule Display E.r.=11	Error Code #11 Control Board. Control Relay problem.	Replace Control Board.
Data/Schedule Display E.r.=12	Error Code #12 Control Board. Hardware error.	Replace Control Board.
Data/Schedule Display E.r.=13	Error Code #13 Full conduction detected.	Change to higher welding transformer tap. **See Section 5.4.10.**

11.1 ERROR CODES (cont.)

ERROR	POSSIBLE CAUSE	REMEDY
Data/Schedule Display E.r.=14 (Flashing)	Error Code #14 EEPROM error. Memory corrupt due to electrical transients or bad EEPROM memory chip.	1. Clear all SCHEDULES and EXTENDED FUNCTIONS. 2. Re-route wiring in cabinet. Replace Control Board, if necessary. **See Section 4.6, 5.4.5.**
Data/Schedule Display E.r.=15	Error Code #15 Pressure Switch open too long.	1. Close Pressure Switch 2. Check wiring for open. **See Section 1.1, 4.3, and 4.5**.
Data/Schedule Display E.r.=17 or E.r.=18	Error Code #17 or 18 Nominal AVC reading too low or too high.	1. Reprogram nominal setting. 2. Check C.C. value. **See Section 5.4.4.**
Data/Schedule Display E.r.=19 or E.r.=20	Error Code #19 or 20 AVC reading too low or too high.	1. AVC could not compensate. 2. Change tap or PERCENT. **See Section 5.4.4.**
Data/Schedule Display E.r.=22	Error Code #22 +18 VDC out of range. High line voltage.	1. Line voltage too high. 2. Wrong voltage jumper settings. **See Section 4.1.**
Data/Schedule Display E.r.=23 or E.r.=24	Error Code #23 or 24 Manual Power Factor error.	1. Full conduction reached. 2. Set Automatic Power Factor. **See Section 5.4.10.**
Data/Schedule Display E.r.=26	Error Code #26 SCR Contactor short detected.	1. Check Contactor for short. 2. Check Firing Board.
Data/Schedule Display E.r.=27	Error Code #27 Retraction valve is not ON.	Turn ON retraction valve via TS1-WFS1/AUX1. **See Section 4.5, 5.4.7.**
Data/Schedule Display E.r.=28	Error Code #28 PROCESS OUTPUT 10 error.	Attempting to weld in NO WELD with P.O.=10 or 33. **See Section 5.4.7.**
Data/Schedule Display E.r.=32 (Flashing)	Error Code # 32 Schedule data out of range or invalid data in memory or EEPROM memory corrupt due to electrical transients.	Clear SCHEDULE with corrupted data or clear EXTENDED FUNCTIONS. See E.r.=14 remedy. **See Section 4.6, 5.4.5.**
Data/Schedule Display E.r.=37 (*EN1001 only*)	Error Code # 37 Calibration data out of range.	1. Change to Auto Range mode. 2. Run in Manual Range w/o correct RMS current values. 3. Return Control Board to factory for re-calibration. **See Section 8.3.**

For list of all Error Codes, refer to Appendix A (Application Note 700158).

11.2 TROUBLESHOOTING

Please refer to other manual pages and Wiring Diagrams for location of fuses, terminal strips, etc.

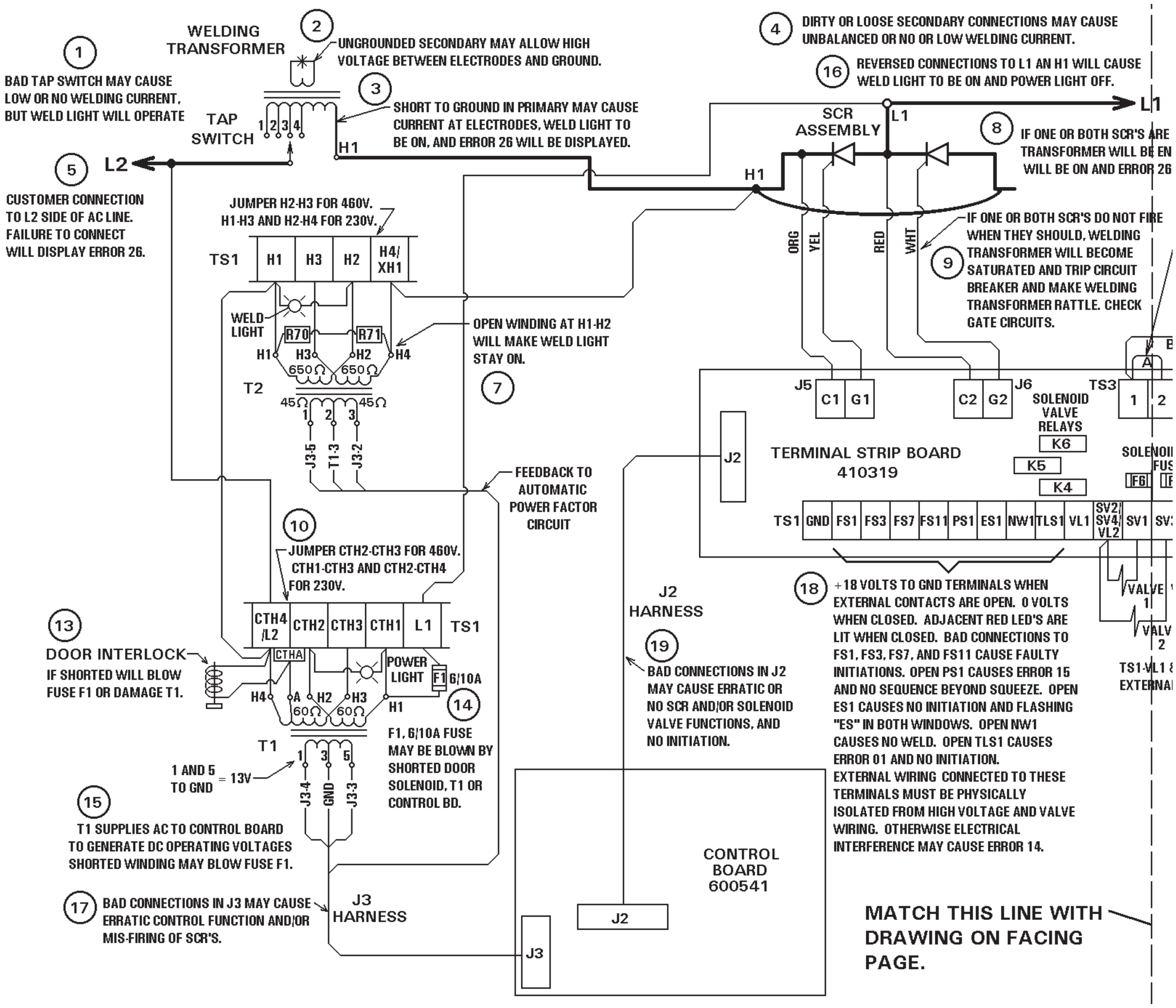
It is very easy to press a SCHEDULE push button and select a different schedule accidentally. This causes no problem when initiating on TS1-FS7 or TS1-FS11. However, when initiating on TS1-FS3, always verify that the schedule to be initiated is displayed prior to initiation. Conversely when the default setting of ***S.S.***=***00*** is used, TS1-FS7 and TS1-FS11 will select schedule 20 and 40 respectively. The control may display any schedule at any time. Foot switch (FS) connections and EXTENDED FUNCTION ***S.S.*** determine which schedule will be executed. Use care when programming to be sure operating parameters are stored in the schedule to be initiated.

TROUBLE	POSSIBLE CAUSE	REMEDY
Power Switch ON but no display.	1. Fuse F1, type KLDR 1/4 or FNRQ 1/4, control fuse blown. 2. Defective Circuit Breaker. 3. Defective Control Board.	1. Check that control is being powered by all phases. 2. Replace Circuit Breaker. 3. Replace Control Board.
Control will not initiate.	1. Initiation switch(es) defective. 2. Loose or broken wire(s) at initiation switch(es). 3. Fuses F6 - F8 valve fuses blown. 4. Defective Control/Display or Terminal Strip/Firing PCB.	1. Replace switch(es). 2. Check for loose or broken wire(s) at initiation switch(es) and at Terminal Strip (FS1, FS3, etc.). 3. Check valve solenoid coil. 4. Replace board with another board stamped with same A/N.
Control initiates, valve light comes on, but electrodes ***do not*** close.	1. Solenoid valve circuit mis-wired or broken wires. 2. Hydraulic (or air) line blocked.	1. Check terminals VL1, SV1 and SV2, and associated wiring (see Wiring Diagram). 2a) Check pressure. 2b) Repair or replace air accessories.
Control does not initiate, but welder head or arms close.	1. Mis-wired for Single Stage operation. 2. Second Stage Pilot switch open. 3. Defective Control/Display or Terminal Strip/Firing PCB.	1. Check Pilot switch wiring. 2. Check for proper operation of Pilot switch. Be sure First Stage closes before Second Stage. 3. Replace board with another board stamped with same A/N.
Control initiates, but stays in SQUEEZE.	1. Pressure Switch not closing. 2. Defective Control/Display or Terminal Strip/Firing PCB.	1a) Check for defective or malfunctioning Pressure Switch connected to PS1 & GND. 1b) If no Pressure Switch is used, jumper PS1 & GND. 2. Replace board with another board stamped with same A/N.

11.2 TROUBLESHOOTING (cont.)

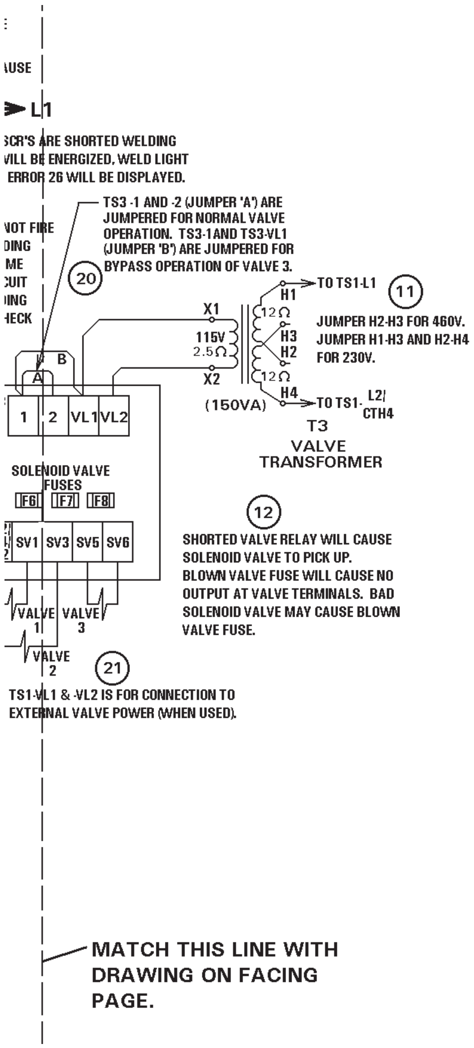
TROUBLE	POSSIBLE CAUSE	REMEDY
Control initiates and sequences properly, but solenoid valve chatters.	1. Solenoid valve coil. 2. Defective Control/Display PCB. 3. Defective Terminal Strip/Firing Board.	1a) Check that valve supply voltage is not varying below tolerance, -15%. 1b) Check if valve coil is proper voltage. 1c) Insufficient air pressure. 1d) Loose connections in valve wiring. 2. Replace board with another board stamped with same A/N. 3. Replace board. See Wiring Diagram for correct A/N.
Control sequences but will not weld.	1. External Weld/No Weld Switch or WELD/NO WELD switch on Front Panel of control. 2. Welding transformer not connected. 3. Welding transformer secondary open. 4. Defective Terminal Strip/Firing PCB. 5. Defective Control/Display PCB. 6. Excessive ripple in secondary.	1a) Check both for proper operation and/or loose wires on NW1 & GND. 1b) If no external Weld/No Weld Switch is used, put jumper across NW1 & GND. 2. Connect H1 and H2 to lugs in the control. 3. Check corroded or open connections. Be sure welding electrodes close on work. 4. Replace board. See Wiring Diagram for correct A/N. 5. Replace board with another board stamped with same A/N. 6. Check for missing phase.
Weld too cool.	1. Line voltage drop. 2. Excessive pressure at electrodes. 3. WELD count too short. 4. Excessive tip “mushrooming”.	1. KVA demand for welding transformer too high for input power line. Check line voltage. 2. Check air system regulator. 3. Increase WELD count duration. 4. Properly dress tips.
Weld too small.	1. PERCENT CURRENT too low. 2. Electrode face too small.	1. Increase PERCENT CURRENT. 2. Select correct electrode face diameter.
“HOT” Welds	1. Insufficient air pressure. 2. WELD count set too high. 3. PERCENT CURRENT set too high. 4. Electrode diameter too small.	1. Check air supply and accessories. 2. Reduce WELD count duration. 3. Decrease PERCENT CURRENT. 4. Dress or replace tip with proper size.
Inconsistent Welds	1. Varying air pressure. 2. Work not square with electrodes. 3. Poor part fit-up. 4. Dirty material to be welded. 5. Loose connection.	1. Check air supply and accessories. 2. Check welding fixtures setup or electrode alignment. 3. Check parts for proper fit-up. 4. Work should be free from excessive dirt, paint and oxides. 5. Check all terminal and/or lug connections inside the cabinet.

11.3 TROUBLESHOOTING GUIDE



NOTICE
This Troubleshooting Guide was originally created to help troubleshoot the EN1000 Series Controls; it may be useful to troubleshoot EN1000/EN1001 Cascade/Multi-Valve Controls.

11.3 TROUBLESHOOTING GUIDE (cont.)

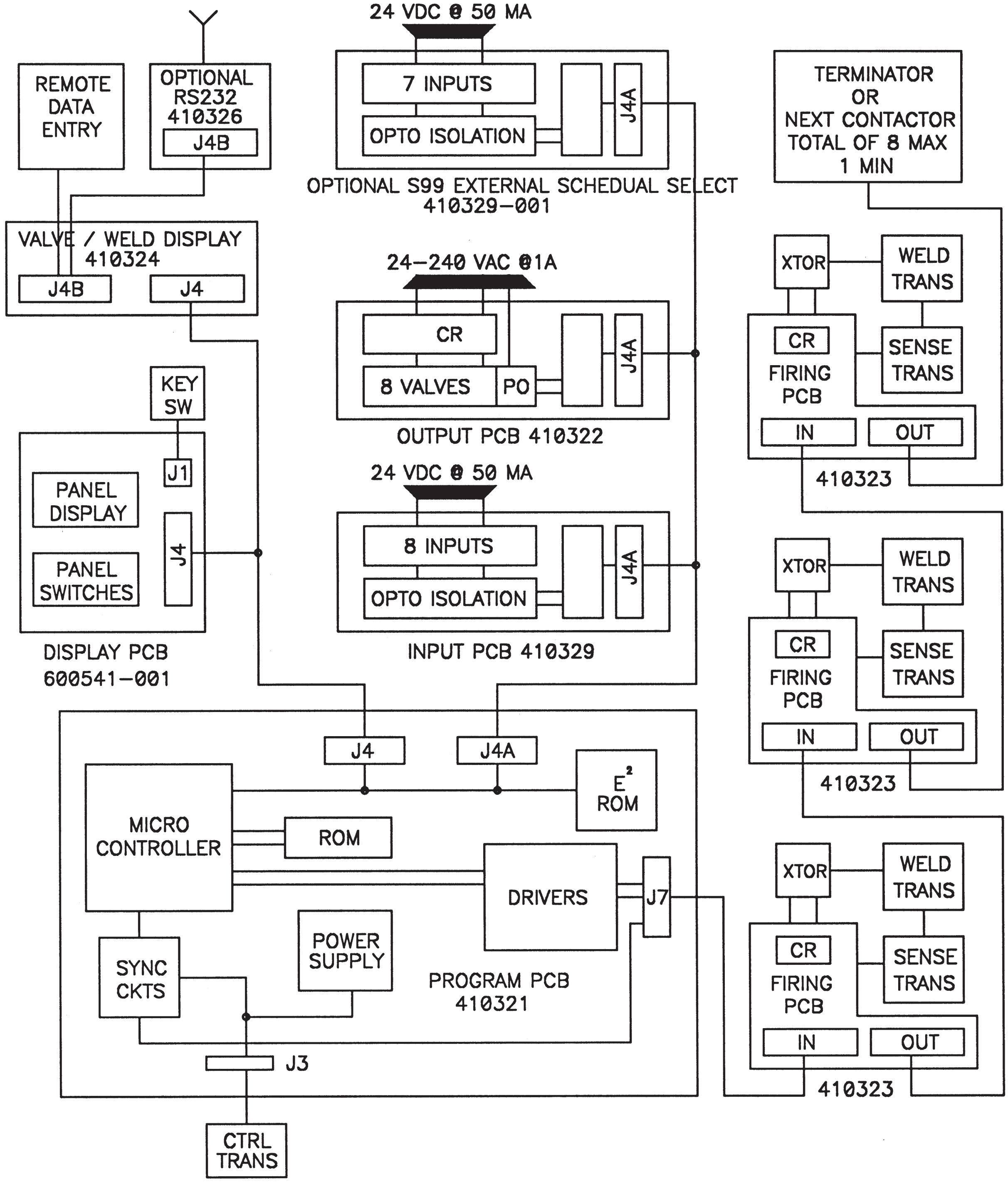


	TROUBLE SYMPTOM	SEE NOTE (#)
A.	Power Light Off	14
B.	Power Light Off, Weld Light On	16
C.	Weld Light On	8, 3, 7
D.	One or more Solenoid Valves Energized	12
E.	Blowing fuse F1	10, 13, 14, 15
F.	No Initiation	18, 19
G.	Control goes through sequence but electrodes do not close.	11, 12, 19
H.	Control and machine go through sequence but there is no current and Weld Light does not come on.	18, 19
J.	Control and machine go through sequence but there is no weld current. Weld light comes on.	1, 4
K.	Blowing Valve Fuses	12
L.	Tripping Circuit Breaker	9, 17, 19
M.	High Voltage between Welding Electrodes and Ground.	2
N.	Welding Current occasionally drops to a low level.	1, 4
P.	Erratic Sequence or Valve operation	17, 19
R.	Sequence will not advance beyond Squeeze. (Electrodes remain closed, no Weld Current)	18
S.	Error 26 displayed immediately when power is turned on.	3, 5, 8
T.	Error 14 displayed on Front Panel.	18
U.	Jumper A on TS3-1 to -2. Provides normal operation of Valve 3. Jumper B provides bypass operation of Valve 3, some EF's and PO's will not work without Jumper B in place.	20
V.	When external valve power source (24-240 VAC) is used it connects here. Remove and insulate connections to TS3-VL1 and -VL2.	21

TROUBLE SHOOTING GUIDE
EN1000-SERIES CONTROLS

451014 A

11.4 WELD CONTROL WITH OPTIONS BLOCK DIAGRAM



12.0 ENTRON LIMITED WARRANTY AND FACTORY SERVICE

ENTRON Controls, LLC., warrants that all ENTRON control panels, **EXCEPT** Mid-frequency Inverter controls, silicon controlled rectifiers (SCRs), insulated gate bipolar transistors (IGBTs), SCR and IGBT assemblies, circuit breakers, and electro-mechanical contactors, are free of manufacturing defects for a period of **TWO YEARS** from the date of original purchase and, in the event of a manufacturing defect, ENTRON will repair or replace, at its discretion, the defective part without any cost for parts or labor.

All silicon controlled rectifiers, SCR and IGBT assemblies, circuit breakers and electro-mechanical contactors in ENTRON control panels are covered by **a limited warranty from the original manufacturer**. If these parts fail because of a manufacturing defect, they will not be repaired or replaced by ENTRON, but will be returned by ENTRON to the original manufacturer in accordance with said manufacturer's warranty.

ENTRON Controls, LLC., warrants that all Mid-frequency Inverter controls are free of manufacturing defects for a period of **ONE YEAR** from the date of original purchase and, in the event of a defect, ENTRON will repair or replace, at its discretion, the defective part without any cost for parts or labor.

To obtain repairs or replacement parts under this warranty, the defective part must be returned, prepaid, to ENTRON Controls, LLC., 1402 S. Batesville Road, Greer, SC 29650. Please send your repair to the attention of "Service" with a description of the problem you are experiencing, contact person and phone number.

EXCLUSIONS: This warranty does not cover damage by accident, misuse, unauthorized repair or modification to any control assembly by the customer.

IMPORTANT NOTE: The warranty period is considered from the date of shipment and is tracked by a serial number code.

USE OF OUT OF WARRANTY REPAIR SERVICE:
To obtain service for any printed circuit board assembly or welding control after the warranty period, send assembly or control, prepaid, to ENTRON Controls, LLC., and ENTRON will repair printed circuit board assembly or control and return it to you without further warranty. Additional service charges will be invoiced at time of shipment.

Your ENTRON Controls, LLC., Original Equipment Manufacturers (OEMs), Dealers and Distributors are your first response contact to secure technical assistance on control or welding problems. Should they be unable to assist you, please contact your ENTRON sales representatives or the factory directly. Contact the factory at 864-416-0190.

APPENDIX A

APPLICATION NOTE 700158K
ERROR CODES*

ERROR CODE	Reason or Cause
01	Temperature limit exceeded (TLS open). / Incorrect **b.S.** or **P.O.** programmed.
02	FS1 & FS7 are both active.
03	FS1 & FS11 are both active.
04	Weld initiated while in PROGRAM mode.
05	FS1, FS3, FS7, or FS11 is active upon power up.
06	BACK-STEP is active too long. / Input switch closed. / Incorrect **b.S.** or **P.O.** programmed.
07	FS1 still active after weld.
08	FS3 still active after weld.
09	FS7 still active after weld.
10	FS11 still active after weld.
11	Control Relay still active after weld.
12	Hardware error is detected.
13	Full conduction is detected.
14	EEPROM error is detected (refer to Application Note 700127).
14 - **flashing**	Invalid data in EEPROM (refer to Application Note 700127).
15	Pressure Switch is open too long.
16	Emergency Stop is active.
17	Nominal AVC reading is too low.
18	Nominal AVC reading is too high.
19	AVC reading is too low.
20	AVC reading is too high.
21	+5 VDC is out of range.
22	+18 VDC is out of range.
23	Maximum firing angle exceeded during AVC correction.
24	Minimum firing angle exceeded during AVC correction.
25	Power factor measured as zero.
26	Sense input active while not welding. / Shorted SCRs. / Incorrect wiring or missing L2.
27	Retraction not active upon initiation.
28	Front Panel NO WELD switch is active for **P.O.**=**10** or for *EN1000/EN1001 Cascade only* **P.O.**=**33**.
29	Schedule out of range for **S.S.**=**03** when using S49 or S99 option.
30	Over current (*EN1200 and EN1201 only*).
31	IIC Error.
32 - **flashing**	Invalid data in EEPROM (refer to Application Note 700127).
33	MM2 is not found. Memory Module required.
34	Downloading data from MM2 Checksum Error.
35	Copy data to MM2 Checksum Error.
36	Pressure Sense input is too low or too high.
37	Calibration data out of range (*EN1001 only*).
38	DC bus voltage is too low (*EN1200 and EN1201 only*).
39	DC bus voltage is too high (*EN1200 and EN1201 only*).
40	Control with programmed ID not found on the RS485 network (*RT4jr. only*).
41	Message is not received from the control (*RT4jr. only*).
42	Communication Error (*RT4jr. only*).
43	Checksum Error in data bytes (*RT4jr. only*).
44	DC bus voltage is too high. Send signal to Circuit Breaker Shunt Trip (*EN1200 and EN1201 only*).
45	One or two of the three phases are missing (*EN1200 and EN1201 only*).
46	Setup failed. Control failed to adjust for signal level *(EN1001/EN1001 Cascade only).*
47	Over current from Primary Current Sensor (*EN1200 and EN1201 only*).
48	SCR's Firing Board is not ready for weld (*EN1200 and EN1201 only*).
90	Error Output from control to ENLINK, High.
91	Error Output from control to ENLINK, Low.
d.o.u.n.	VCC power supply voltage below safe operating range (see Section 1.1).
H. i. or L.o.	Flashing on DATA display if control is unable to correct and maintain constant current during weld. Generally shown after weld for **P.O.**=**12**, **13**, **14**, **22**, **23**, **24** or **25** (*EN1001 and EN1201 only*).
E.S. - **flashing**	Emergency Stop is active (see Section 1.1).

*These ERROR CODES affect controls in Series EN1000, EN1001, EN1000B, EN1003, EN1000/EN1001 Cascade, EN1200, EN1201, EN1280, TW1280, EN1380, EN1500 and EN1501.

APPENDIX B PROGRAMMING AND SETUP

B-1.0 INTRODUCTION TO PROGRAMMING EN1000/EN1001 CASCADE CONTROLS

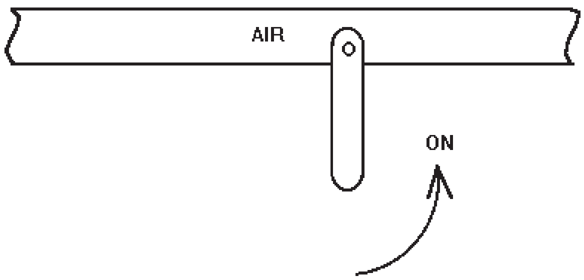


Figure B1. *Turn* **ON** *air supply to machine*

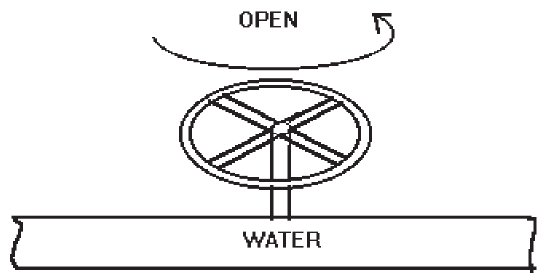


Figure B2. *Turn* **ON** *water supply to machine*

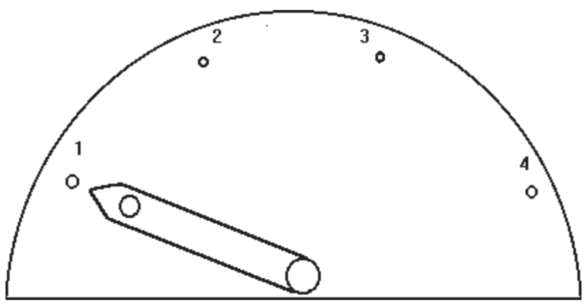


Figure B3. *Set welder switch* **LOW**

Be sure welder head or arms are fully retracted!

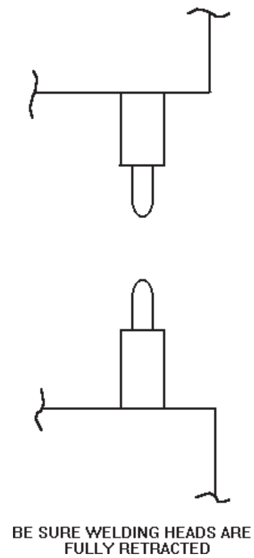


Figure B4. *Retracted head or arms*

Figure B5. *Turn* **ON** *power to control*

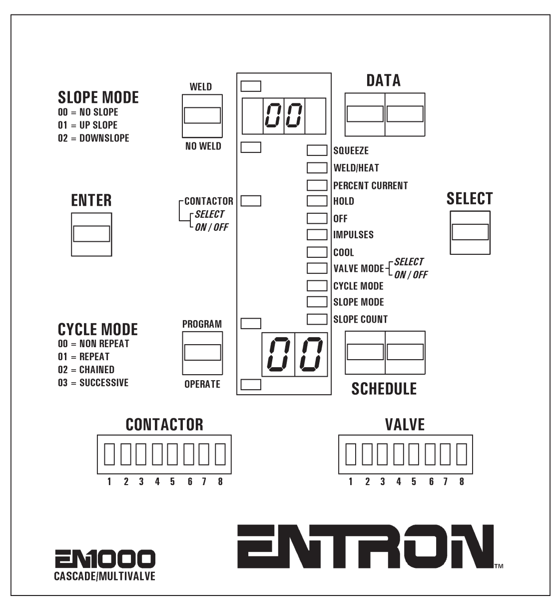


Figure B6. **POWER ON** *light indicator*

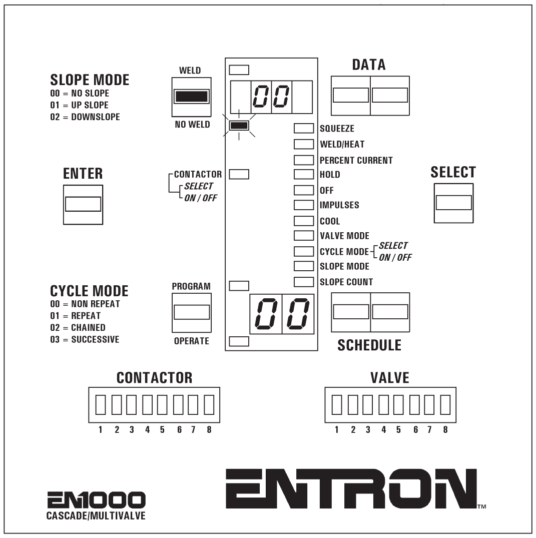


Figure B7. *Put control in* **NO WELD**

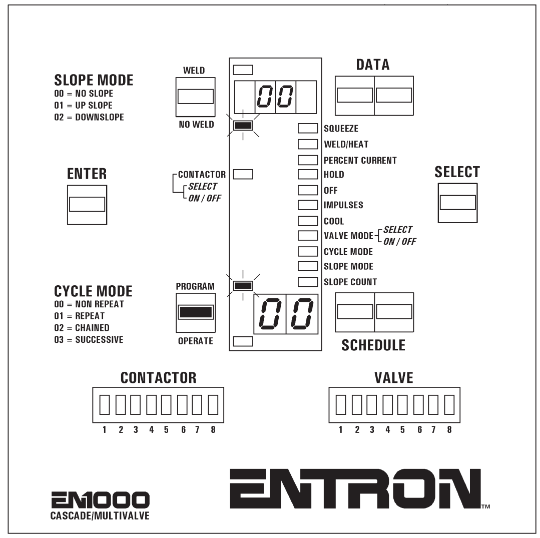


Figure B8. *Put control in* **PROGRAM** *mode*

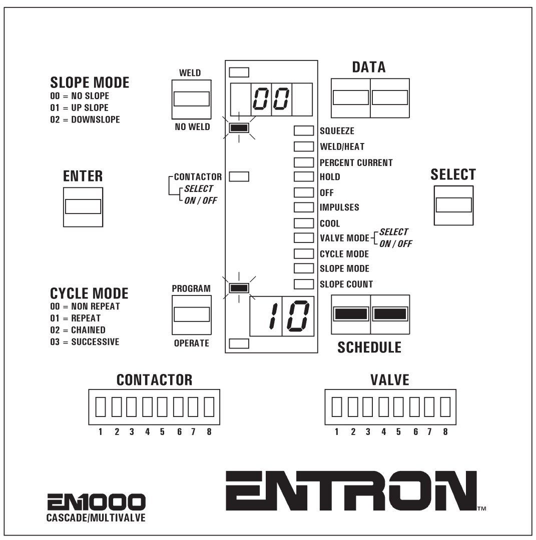


Figure B9. *Choose* **SCHEDULE** *to program*

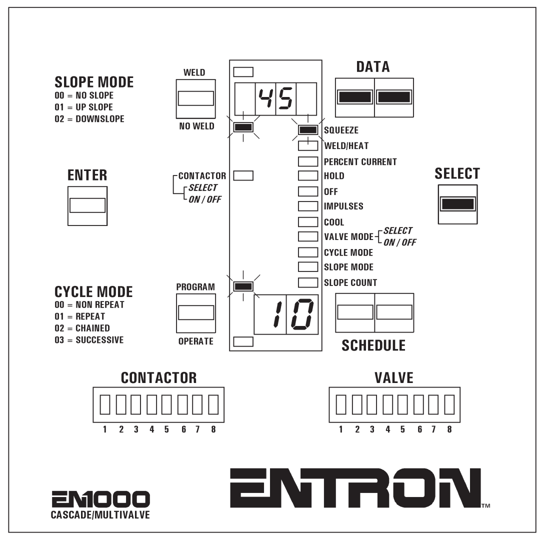


Figure B10. **SELECT** **SQUEEZE** *and program 30 to 60 cycles*

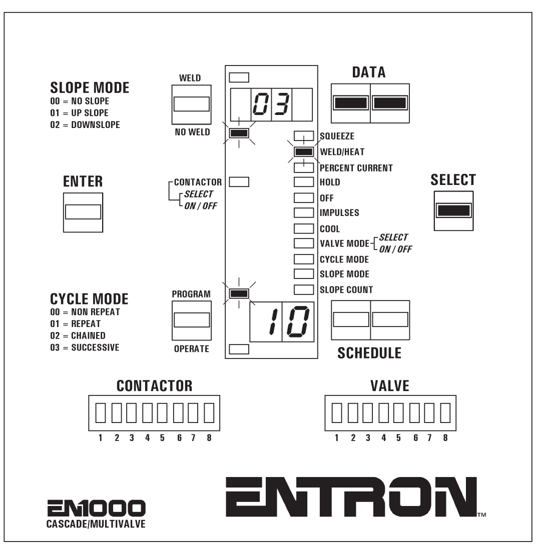


Figure B11. **SELECT** **WELD/HEAT** *and program 2 to 3 cycles*

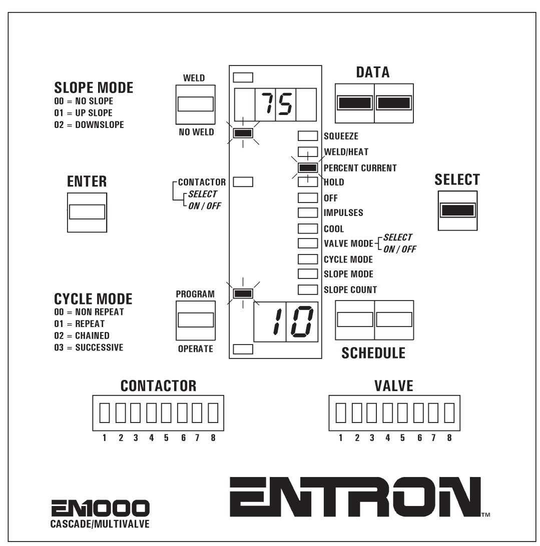


Figure B12. **SELECT** **PERCENT CURRENT** *and program 70% to 80%*

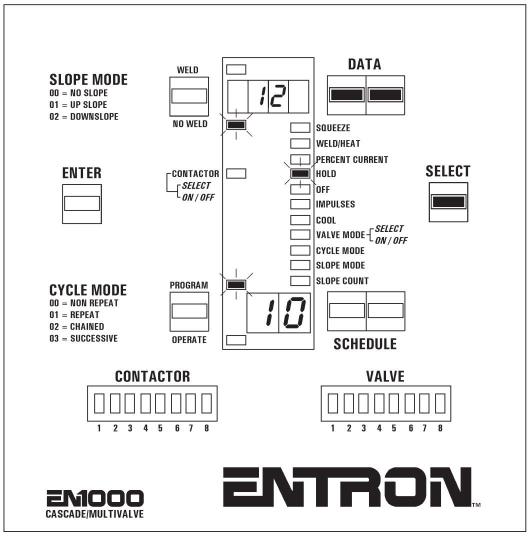


Figure B13. **SELECT HOLD** *and program 10 to 15 cycles*

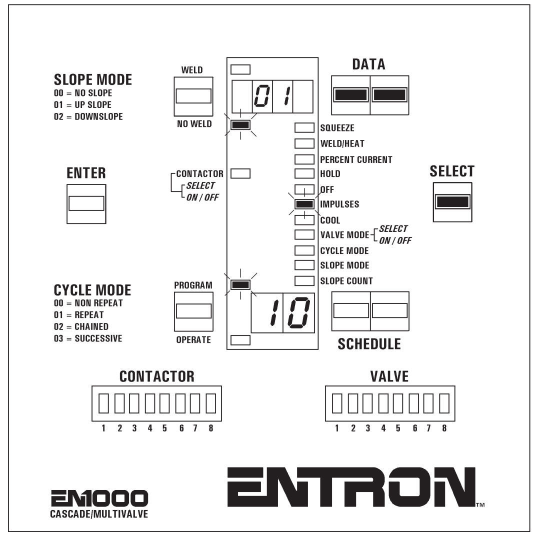


Figure B14. **SELECT IMPULSES** *and program* **01** *(one pulse)*

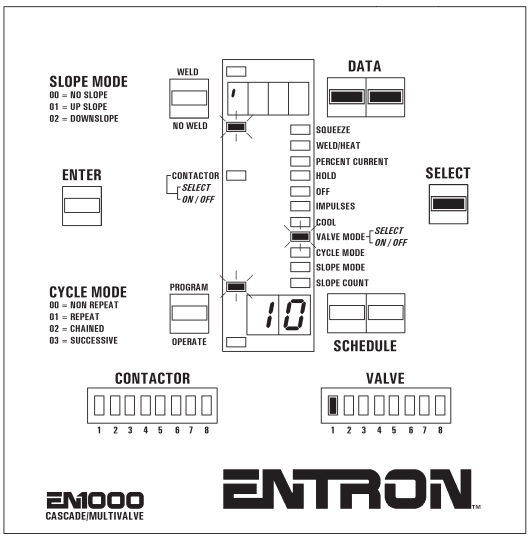


Figure B15. **SELECT VALVE MODE** *and program* **01** *(Valve 1)*

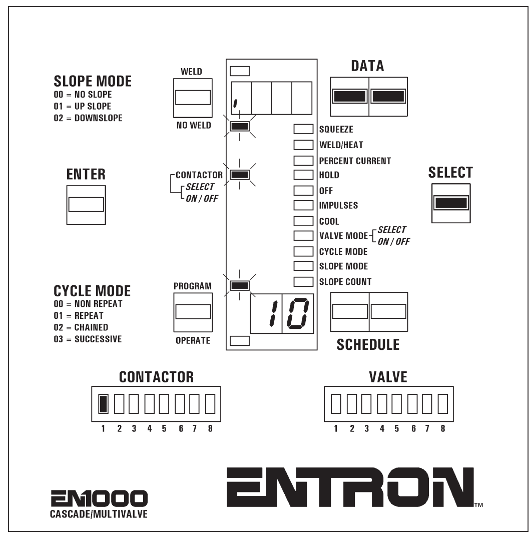


Figure B16. **SELECT CONTACTOR** *and program* **01** *(Contactor 1)*

Press **ENTER** whenever new values for any parameter are programmed.

Make sure that all unnecessary parameters are set to **00** before going to **OPERATE** mode.

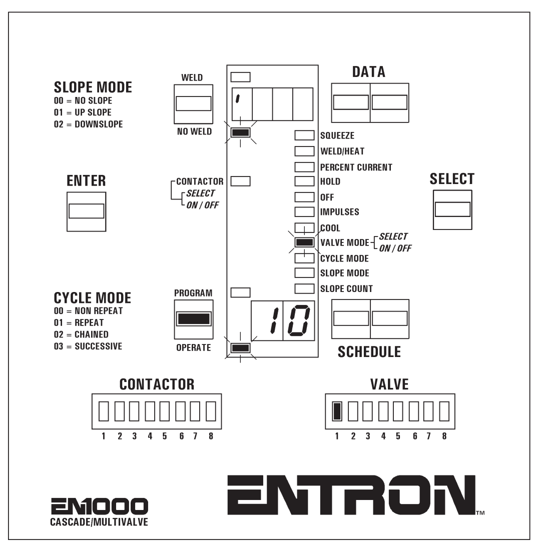
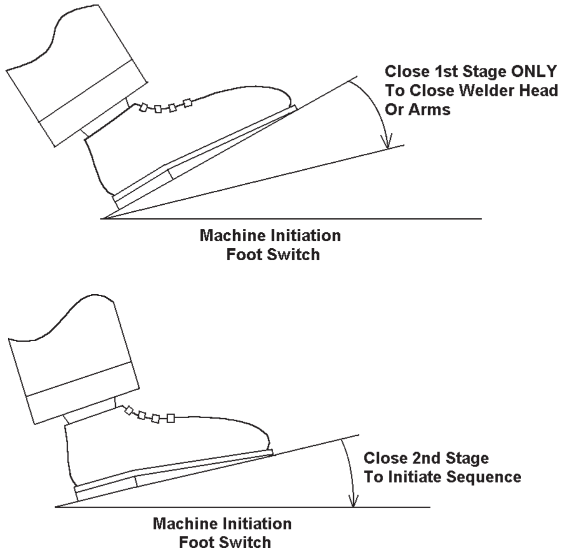


Figure B17. *Put control in* **OPERATE** *mode*



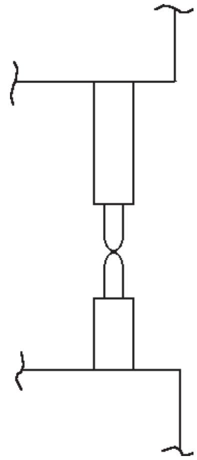


Figure B18. *Closed head or arms*

Make sure machine head (or arms) closes properly. (On machines with Single Stage initiation, depressing the foot switch will sequence the control but will not weld.)

Machine will sequence but **will not weld**, then the head (or arms) will retract.

Put the control in WELD mode (see Figure B19).

Place sample parts to be welded between electrodes, and initiate weld sequence again.

Machine head (or arms) will close on parts to be welded. (On machines with Single Stage initiation, depressing the foot switch will sequence the machine and weld.)

Machine will go through sequence, and **weld**, then the head (or arms) will retract.

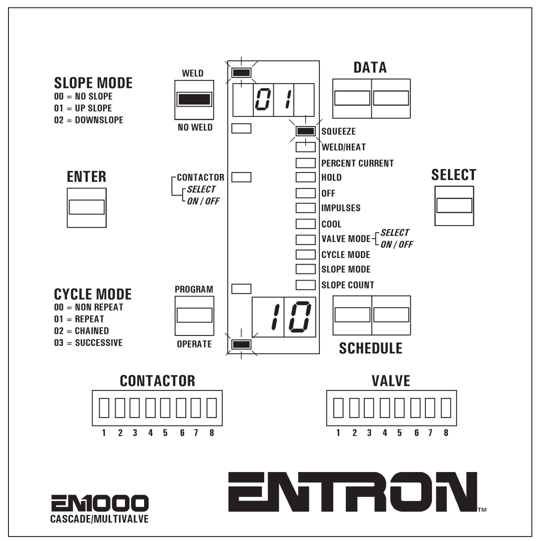
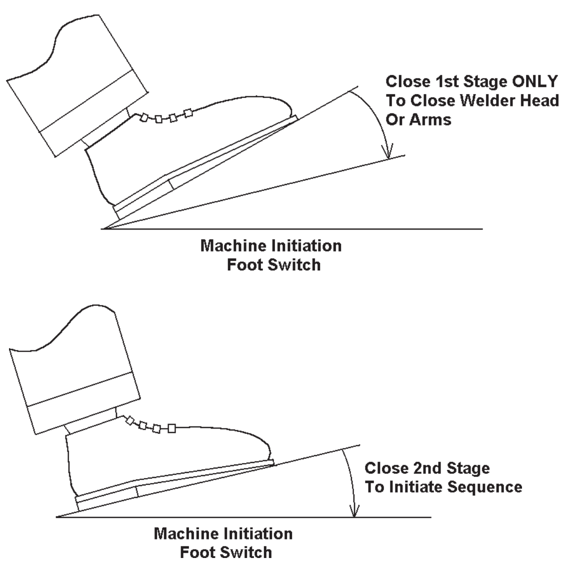


Figure B19. *Put control in* **WELD** *mode*



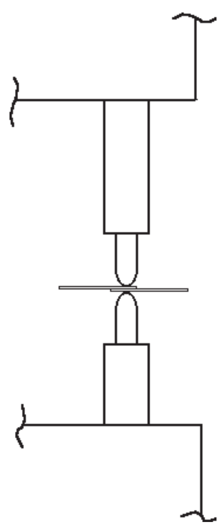


Figure B20. *Welding the sample part*

Before running production quantities of welded parts, ENTRON recommends destructive testing of the welds. Set the welding machine to RWMA recommended standards. Weld the parts. Then clamp one end of the welded part in a vise and **PEEL** the other side back against the weld. Ideally, in low carbon steel, the weld will pull a hole through one or the other parent materials.

To make the best possible weld for the material to be welded, use:

1. The **LOWEST** transformer tap setting,
2. The **HIGHEST** PERCENT CURRENT setting, and
3. The **SHORTEST** WELD count setting.

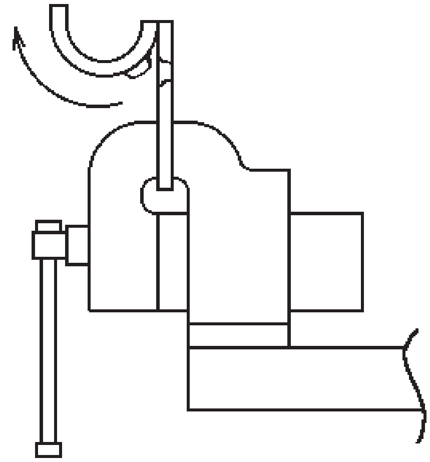


Figure B21. *Destructive test*

B-2.0 CONSTANT CURRENT PROGRAMMING AND SETUP (EN1001 only)

Put control in PROGRAM mode, as shown in Figure B8. Find the EXTENDED FUNCTIONS by pressing the SELECT push button until EF appears in the DATA display. Use SCHEDULE push buttons to scroll through the EXTENDED FUNCTIONS.

Based on Current Sensor and desired CONSTANT CURRENT mode, program C.r. and r.A. to enable CONSTANT CURRENT. For C.r.=32 or 33, only [kA] mode is possible, and r.A. must be programmed according to desired RANGE (see Table 8-2). Programming [%] mode is shown in Figure B22, and programming RANGE of 30 kA for [kA] mode is shown in Figure B23.

For programming four-digit data parameters, the two DATA push buttons are used as follows: Press right DATA push button to increase by one, press and hold to increase by ten. Press left DATA push button to increase by 100, and press and hold to increase by 1000.

After selecting and programming desired CONSTANT CURRENT mode, run setup if necessary.

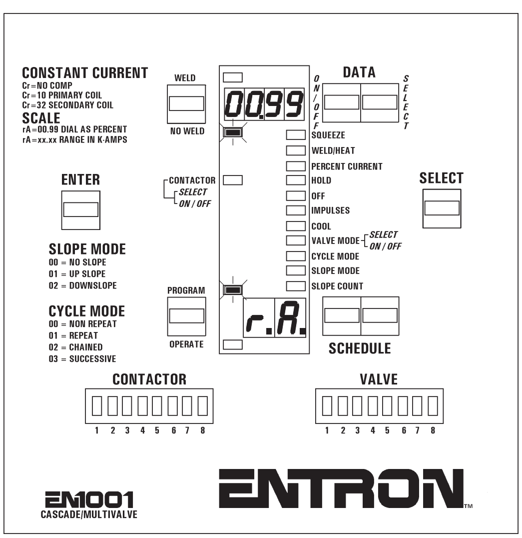


Figure B22. *Program RANGE for [%] mode*

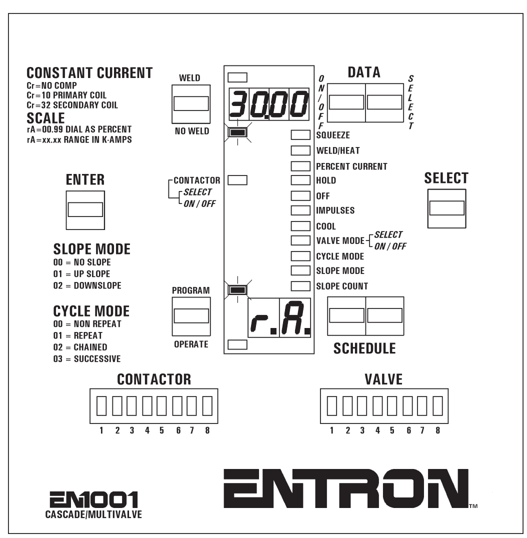
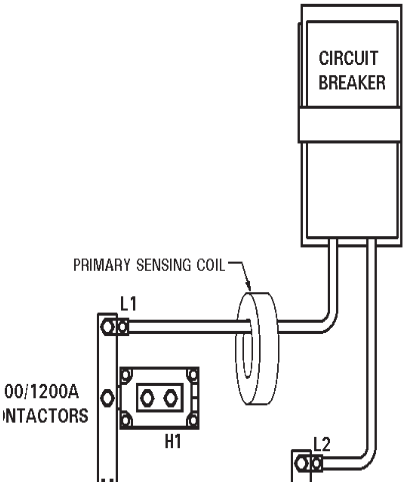


Figure B23. *Program RANGE for [kA] mode*

APPENDIX B PROGRAMMING AND SETUP (cont.)

For Primary Coil Sensing,
program 10 through 19.



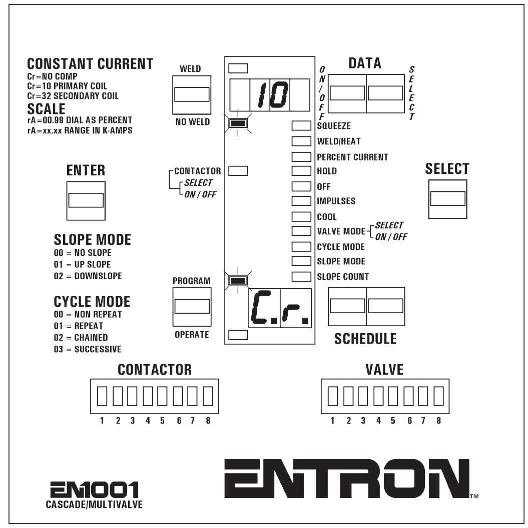
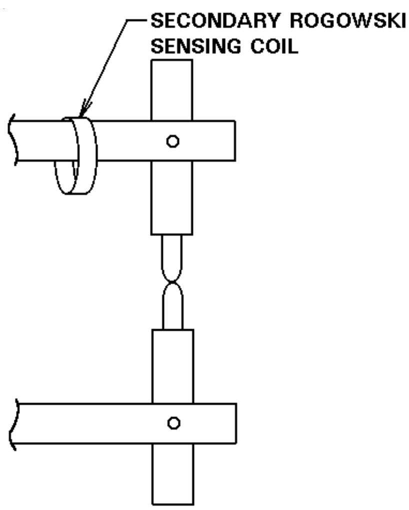


Figure B24. *For **Primary** Coil Sensing*

For Secondary Rogowski Coil Sensing,
program 30, 31, 32, or 33.



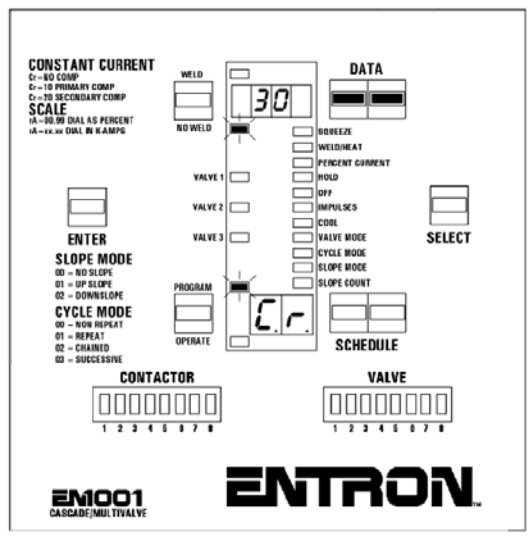


Figure B25. *For **Secondary** Rogowski Coil*

APPENDIX B PROGRAMMING AND SETUP (cont.)

In order to self-adjust gains for Current Sensor signal, control must automatically perform setup procedure, as described in Section 8.1.4. This setup procedure is necessary only for following CONSTANT CURRENT modes:

- **C.r.**=**10** or **11** – for Primary Coil
- **C.r.**=**30** or **31** – for Secondary Rogowski

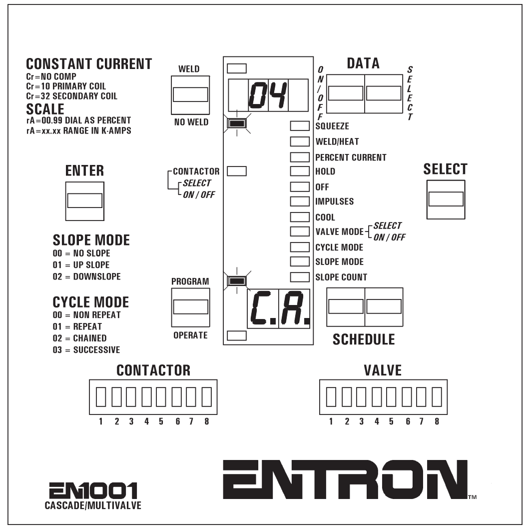


Figure B26. *Prepare control for* ***setup***

After programming **C.A.**=**04** and **05**, as shown on Figure B26, follow the setup procedure described in Section 8.1.4.

Initiate the control using TS1-FS3 terminal input ONLY. Bring the heads together on a previously welded part. Hold the initiation contacts closed while the machine sets up the CONSTANT CURRENT parameters. When a Primary Sensing Coil is used, this initiation will cause the control to fire several times then count down on the Dial Plate from **99** (**99**, **98**, **97**,..., to **20**). The display will switch to schedule 00 when the CONSTANT CURRENT routine has completed successfully.

APPENDIX C S99 SCHEDULE SELECT OPTION INSTALLATION

C-1.0 CUSTOMER INSTALLATION OF S99 SCHEDULE SELECT OPTION In an existing “L”, “H”, “G” or “U” Cabinet

	600624-001 Door Mtd.	600624-002 Side Mtd.	PARTS LIST	
	QUANTITY		PART NO.	DESCRIPTION
	1	1	410329-001	Assembly, PCB, S99 Schedule Select Board
	1	1	510236	Assembly, PCB, Mounting Plate
	1		322356	Harness Assembly, J4A-J4A-J4A-J4A
		1	322357	Harness Assembly, J4A-J4A-J4A-J4A
	4	4	555031	Spacer, 6-32 x 1/2, 1/4 Hex Brass, Brite
	3	3	557003	6-32 x 1/4 PHSMS, Phil, Brite
	4	4	557006	6-32 x 3/8 PHSMS, Phil, Brite
or	1	1	421214-034	Wiring Diagram, EN1000-Series/S99
	1	1	421438-019	Wiring Diagram, EN1001-Series/S99
	1	1	700115	Application Note, S99 Option

1. Remove **ALL** power to control. Open door.
2. Remove J4A-J4A-J4A harness from Program Board/Terminal Strip Output Board/Terminal Strip Input Board.
3. Remove four (4) screws holding Terminal Strip Input Board (A/N 410329) to its mounting bracket. Rotate Board 180° (so terminal strip is at the top), plug J4A-J4A-J4A-J4A harness into its jack and route harness **under** PCB and re-mount Board using same four (4) screws.
4. Drill and tap rear panel per Figure C1, be sure to vacuum or otherwise remove ALL metal chips before assembling PCB Mounting Plate (A/N 510236) to rear panel using three (3) 6-32 x 1/4 PHSMS, Phil., Brite. Add extra spacer (P/N 555031) to each existing spacer (4 places) to offset PCB 1″ from panel.
5. Mount S99 Option PCB (A/N 410329-001) to Mounting Plate (A/N 510236) using four (4) #6-32 x 3/8 PHSMS, Phil., Brite (see Figure C1).
6. Connect J4A-J4A-J4A-J4A Harness (A/N 322356 or 322357) per Cascade Wiring Diagram included with this kit.

NOTICE

On Wiring Diagram, dark band on connectors indicates stripe on ribbon harness. Harness **MUST** be installed with ribbon harness stripe oriented correctly.

7. Close door. Reapply power.

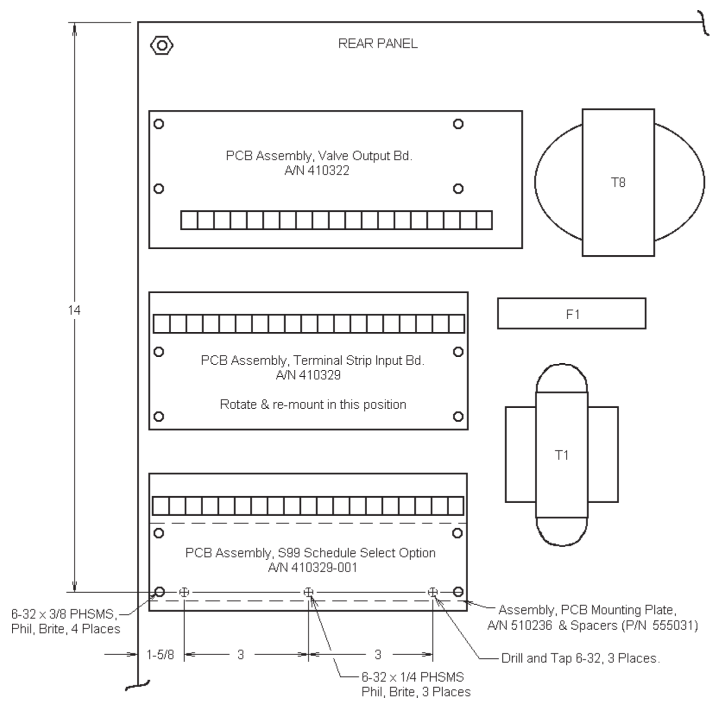


Figure C1. *Mounting detail for “L”, “H”, “G”, or “U” Cabinet*

C-2.0 CUSTOMER INSTALLATION OF S99 SCHEDULE SELECT OPTION In an existing “T” or “D” Cabinet

600624-003 "T" Cabinet	600624-004 "D" Cabinet	PARTS LIST	
QUANTITY		PART NO.	DESCRIPTION
1	1	410329-001	Assembly, PCB, S99 Schedule Select Board
1		322356-001	Harness Assembly, J4A-J4A-J4A-J4A
	1	322357-001	Harness Assembly, J4A-J4A-J4A-J4A
8	8	555031	Spacer, 6-32 x 1/2, 1/4 Hex Brass, Brite
4	4	557003	6-32 x 1/4 PHSMS, Phil, Brite
4	4	557006	6-32 x 3/8 PHSMS, Phil, Brite
1	1	421214-034	Wiring Diagram, EN1000-Series/S99
1	1	421438-019	Wiring Diagram, EN1001-Series/S99
1	1	700115	Application Note, S99 Option

or

1. Remove **ALL** power to control. Open door.
2. Remove J4A-J4A-J4A harness from Program Board/Terminal Strip Output Board/Terminal Strip Input Board.
3. Remove the four (4) screws mounting the Terminal Strip Input Board (A/N 410329) to the Cabinet. Rotate the Board 180° (so the terminal strip is at the top), plug J4A-J4A-J4A-J4A harness into its jack and route the harness **under** the PCB and re-mount the Board using the same four (4) screws.
4. Drill and tap the left side of the cabinet per Figure C2, be sure to vacuum or otherwise remove ALL metal chips before installing four (4) 6-32 x 3/8 PHSMS, Phil., Brite from outside the cabinet. On the inside of the cabinet, mount two (2) 6-32 x 1/2 spacers (P/N 555031) on each exposed thread (4 places) to offset PCB 1″ from cabinet wall.
5. Mount S99 Option PCB (A/N 410329-001) to spacers using four (4) 6-32 x 1/4 PHSMS, Phil., Brite (see Figure C2).
6. Connect J4A-J4A-J4A-J4A Harness (A/N 322356-001 for “T” Cabinets, A/N 322357-001 for “D” Cabinets) per Cascade Wiring Diagram included with this kit.

NOTICE

On the Wiring Diagram, the dark band on connectors indicates stripe on ribbon harness. Harness **MUST** be installed with ribbon harness stripe oriented correctly.

7. Close door. Reapply power

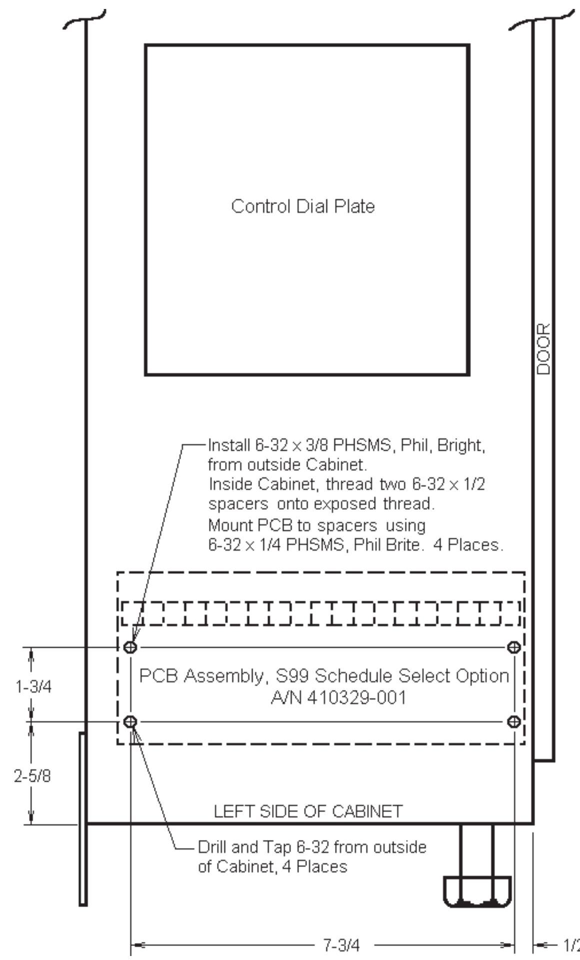


Figure C2. *Mounting detail for “T” or “D” Cabinet*

C-3.0 CUSTOMER INSTALLATION OF S99 SCHEDULE SELECT OPTION In an existing “L”, “H”, “G”, or “U” Cabinet with pre-existing RS232

	600624-005 Door Mtd.	600624-006 Side Mtd.	PARTS LIST	
	QUANTITY		PART NO.	DESCRIPTION
	1	1	410329-001	Assembly, PCB, S99 Schedule Select Board
	1		322356-001	Harness Assembly, J4A-J4A-J4A-J4A
		1	322357-001	Harness Assembly, J4A-J4A-J4A-J4A
	8	8	555031	Spacer, 6-32 x 1/2, 1/4 Hex Brass, Brite
	4	4	557003	6-32 x 1/4 PHSMS, Phil, Brite
	4	4	557006	6-32 x 3/8 PHSMS, Phil, Brite
or	1	1	421214-013 – ***Obsolete***	Wiring Diagram, EN1000-Series/S99-232 460V
	1	1	421214-014 – ***Obsolete***	Wiring Diagram, EN1000-Series/S99-232 230V
	1	1	700115	Application Note, S99 Option

1. Remove **ALL** power to control. Open door.
2. Remove J4A-J4A-J4A harness from Program Board/Terminal Strip Output Board/Terminal Strip Input Board.
3. Remove the four (4) screws mounting the Terminal Strip Input Board (A/N 410329) to the Cabinet. Rotate the Board 180° (so the terminal strip is at the top), plug J4A-J4A-J4A-J4A harness into its jack and route the harness **under** the PCB and re-mount the Board using the same four (4) screws.
4. Drill and tap the left side of the cabinet per Figure C3, be sure to vacuum or otherwise remove ALL metal chips before installing four (4) 6-32 x 3/8 PHSMS, Phil., Brite from outside the cabinet. On the inside of the cabinet, mount two (2) 6-32 x 1/2 spacers (P/N 555031) on each exposed thread (4 places) to offset PCB 1″ from cabinet wall.
5. Mount S99 Option PCB (A/N 410329-001) to spacers using four (4) 6-32 x 1/4 PHSMS, Phil., Brite (see Figure C3).
6. Connect J4A-J4A-J4A-J4A Harness (A/N 322356-001 or A/N 322357-001) per Cascade Wiring Diagram included with this kit.

NOTICE

On the Wiring Diagram, the dark band on connectors indicates stripe on ribbon harness. Harness **MUST** be installed with ribbon harness stripe oriented correctly.

7. Close door. Reapply power

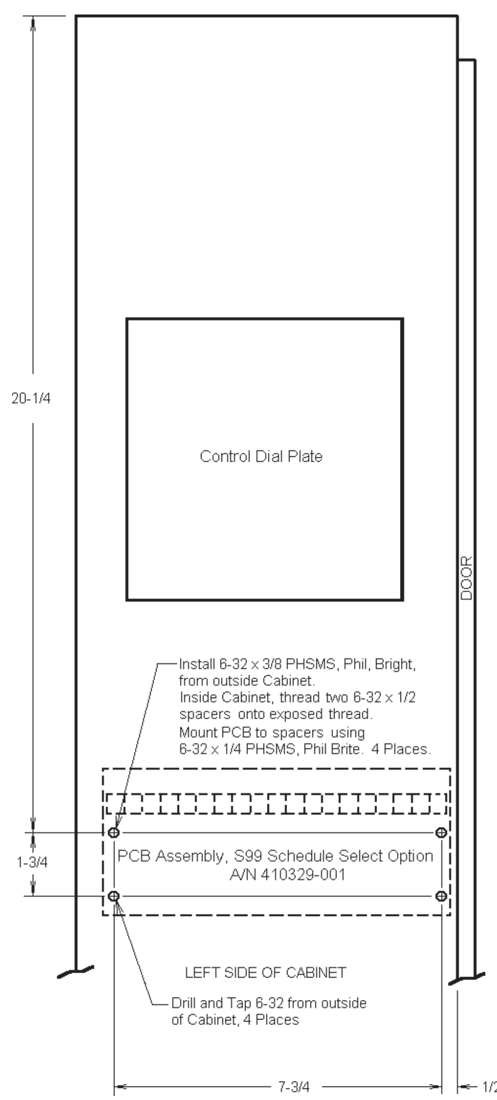


Figure C3. *Mounting detail for “L”, “H”, “G”, or “U” Cabinet with RS232*

C-4.0 CUSTOMER INSTALLATION OF S99 SCHEDULE SELECT OPTION On an existing Flat Plate Cascade Control

600624-007	PARTS LIST	
QUANTITY	**PART NO.**	**DESCRIPTION**
1	410329-001	Assembly, PCB, S99 Schedule Select Board
1	322446	Harness Assembly, J4A-J4A-J4A-J4A
4	557006	6-32 x 3/8 PHSMS, Phil, Brite
1	421214-020 – ***Obsolete***	Wiring Diagram, EN1000-Series/S99-FP 460V
1	700115	Application Note, S99 Option

1. Remove **ALL** power to control.
2. Remove J4A-J4A-J4A harness from Program Board/Terminal Strip Output Board/Terminal Strip Input Board.
3. Mount S99 Option PCB (A/N 410329-001) to existing spacers using four (4) 6-32 x 3/8 PHSMS, Phil., Brite (see Figure C4).
4. Connect J4A-J4A-J4A-J4A Harness (A/N 322446) per Cascade Wiring Diagram included with this kit.

   NOTICE

   On the Wiring Diagram, the dark band on connectors indicates stripe on ribbon harness. Harness **MUST** be installed with ribbon harness stripe oriented correctly.
5. Reapply power.

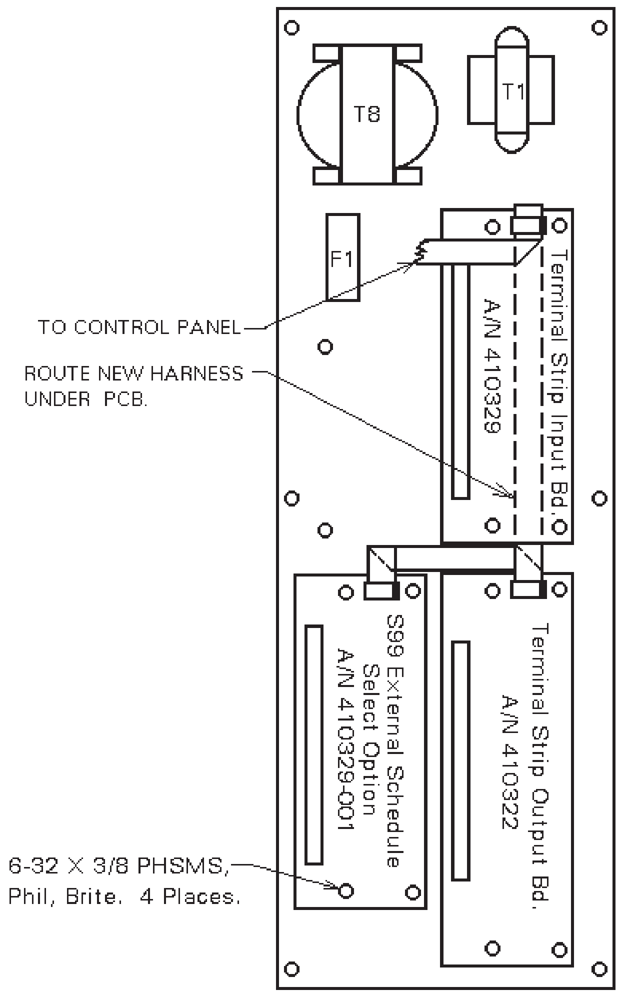


Figure C4. *Mounting detail for Flat Plate Cascade*

C-5.0 CUSTOMER INSTALLATION OF S99 SCHEDULE SELECT OPTION AND 9-16 VALVE OUTPUT OPTION In an existing “L”, “H”, “G” or “U” Cabinet

	600765-001 Door Mtd.	600765-002 Side Mtd.	PARTS LIST	
	QUANTITY		PART NO.	DESCRIPTION
	1	1	410322-001	Assembly, PCB, 9-16 Valve Extension Board, 24-240VAC
	1	1	410329-001	Assembly, PCB, S99 Schedule Select Board
	1	1	510236	Assembly, PCB, Mounting Plate
	1	1	322435	Harness Assembly, TS10 to TS15
	1		322456	Harness Assembly, J4A-J4A-J4A-J4A-J4A
		1	322457	Harness Assembly, J4A-J4A-J4A-J4A-J4A
	12	12	555031	Spacer, 6-32 x 1/2, 1/4 Hex Brass, Brite
	7	7	557003	6-32 x 1/4 PHSMS, Phil, Brite
	8	8	557006	6-32 x 3/8 PHSMS, Phil, Brite
or	1	1	421214-042	Wiring Diagram, EN1000-Series/VE/S99
	1	1	421438-020	Wiring Diagram, EN1001-Series/VE/S99
	1	1	700146	Application Note, VE Option
	1	1	700115	Application Note, S99 Option

1. Remove **ALL** power to control. Open door.
2. Remove J4A-J4A-J4A harness from Program Board/Terminal Strip Output Board/Terminal Strip Input Board.
3. Remove the four (4) screws mounting the Terminal Strip Input Board (A/N 410329) to the cabinet. Rotate the Board 180° (so the terminal strip is at the top) and re-mount the Board using the same four (4) screws.
4. Drill and tap the left side of the cabinet per Figure C5, be sure to vacuum or otherwise remove ALL metal chips before installing four (4) 6-32 x 3/8 PHSMS, Phil., Brite from outside of cabinet. On the inside of the cabinet, mount two (2) 6-32 x 1/2 spacers (P/N 555031) on each exposed thread (4 places) to offset PCB 1″ from cabinet wall.
5. Mount S99 PCB (A/N 410329-001) to spacers using four (4) 6-32 x 1/4 PHSMS, Phil., Brite. See Figure C5.

(Instructions continued on following page)

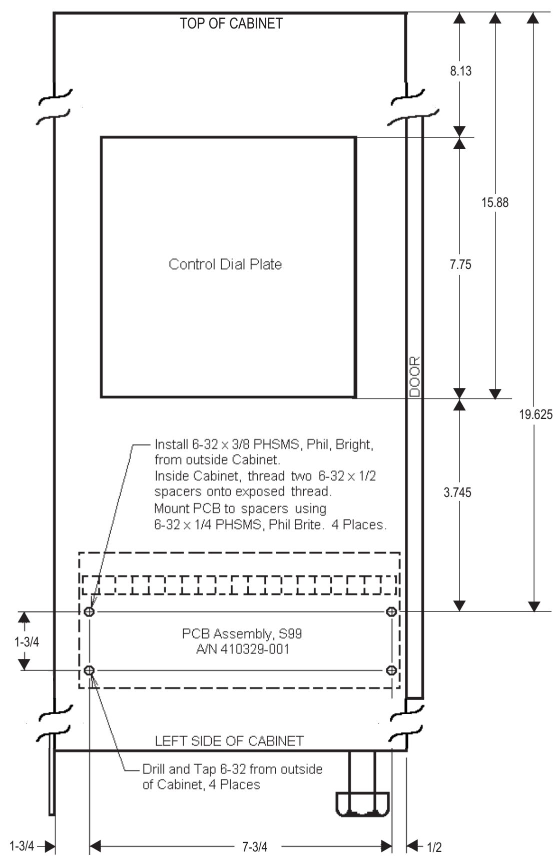


Figure C5. *S99 Mounting detail for “L”, “H”, “G”, or “U” Cabinet*

C-5.0 CUSTOMER INSTALLATION OF S99 SCHEDULE SELECT OPTION AND 9-16 VALVE OUTPUT OPTION In an existing "L", "H", "G" or "U" Cabinet (cont.)

6. Drill and tap rear panel per Figure C6, be sure to vacuum or otherwise remove ALL metal chips before adding Mounting Plate (A/N 510236) to rear panel using 3 ea. 6-32 x 1/4 PHSMS, Phil Brite. Add extra spacer (P/N 555031) to each existing spacer (4 places) to offset PCB 1″ from panel.
7. Mount 9-16 Valve Extension PCB (A/N 410322-001) to bracket (P/N 510236) using four (4) 6-32 x 3/8 PHSMS, Phil., Brite. See Figure C6.
8. Connect J4A-J4A-J4A-J4A-J4A Harness (A/N 322456 for Door Mounted Cabinets or 322457 for Side Mounted Cabinets) and Harness Assembly TS10 to TS15 (A/N 322435) per Wiring Diagram included with this kit.

NOTICE
On the Wiring Diagram, the dark band on connectors indicates stripe on ribbon harness. Harness **MUST** be installed with ribbon harness stripe oriented correctly.

9. Close door. Reapply power.

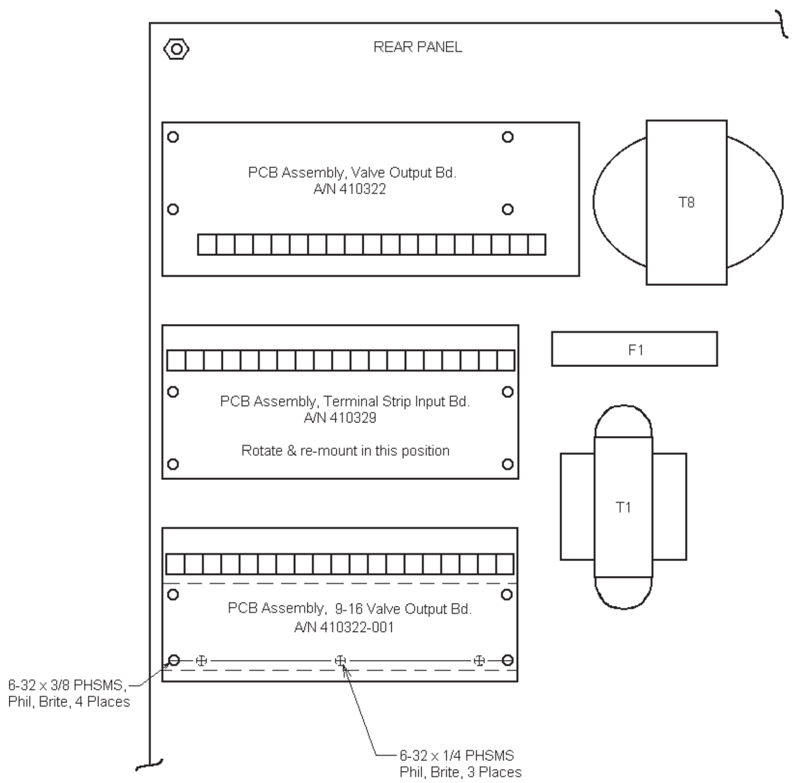


Figure C6. *9-16 Valve Extension Mounting detail for "L", "H", "G", or "U" Cabinet*

APPENDIX D 9-16 VALVE EXTENSION (VE) OPTION

The 9-16 VALVE EXTENSION (VE) option allows an EN1000 or EN1001 Cascade/Multi-Valve Control to use a total of 16 valves. The required software for this option is integrated within the control. The 9-16 VALVE EXTENSION option may be added to a standard EN1000 or EN1001 Cascade/Multi-Valve Control, if there is no physical interference with other options (i.e., RS232, S99, or TSS). This option can be ordered with 24-240 VAC valve outputs (A/N 410322-001) or 24 VDC valve outputs (A/N 410322-003) – see Application Note 700189 for information on DC Valves.

NOTICE
Please contact factory before ordering this option, particularly when multiple options are used.

D-1.0 PROGRAMMING AND HARDWARE REQUIREMENTS FOR EN1000 CASCADE CONTROLS BUILT AFTER JUNE 2000 AND ALL EN1001 CASCADE CONTROLS

D-1.1 HARDWARE REQUIREMENTS

or
(1) 410322-001 – 9-16 Valve Extension Terminal Strip Output Board – 24-240 VAC valve output
(1) 410322-003 – 9-16 Valve Extension Terminal Strip Output Board – 24 VDC valve output

(1) 410321 (EN1000) or 410363 (EN1001) – Cascade/Multi-Valve Program Board (with PROM firmware version 619011-002 **ORIG** or later or 619044-002 **ORIG** or later)
(1) Application Note 700146 – 9-16 Valve Extension Option

D-1.2 PROGRAMMING

To access the EXTENDED VALVES 9 to 16:

1. Put the control in PROGRAM mode.
2. Use SELECT and stop at VALVE MODE.
3. Use the SCHEDULE push buttons and select ***E.o.*** (EXTENDED OUTPUT).
4. Program the VALVES as normally done with the first 8 VALVES.
5. Press ENTER.

No further programming is required. Since the firmware revision which resulted in PROM firmware version 619011-002 (June 2000), the weld control detects the Extended Output board automatically if the option is present in the control and is properly connected.

All Cascade Controls with EXTENDED VALVE option used in controls built prior to June 2000 (controls with PROM firmware version 619011-001) must follow the instructions in Section D-2.0.

D-2.0 PROGRAMMING AND HARDWARE REQUIREMENTS FOR EN1000 CASCADE CONTROLS BUILT PRIOR TO JUNE 2000

D-2.1 HARDWARE REQUIREMENTS

(1) 410321 – Cascade/Multi-Valve Program Board (after 1-98; before 1-98, PCB Assembly 410321-003 was used)

D-2.2 PROGRAMMING VALVES 1 to 16 (before PROM firmware version 619011-002)

1. Select an EVEN numbered schedule to begin initiation (for the example, schedule 20).
2. Program the desired weld parameters in the EVEN numbered schedule only (i.e., SQUEEZE, WELD, PERCENT CURRENT, HOLD, OFF, IMPULSES, COOL).
3. Program VALVES 1 through 8 in the EVEN numbered schedule (for the example, schedule 20).
4. Program *04* in CYCLE mode in the EVEN numbered schedule.
5. Advance to the next consecutive schedule (for the example, schedule 21).
6. Program VALVES 9 through 16 in the ODD numbered schedule (schedule 21).

PROGRAM EXAMPLE

SCHEDULE 20		SCHEDULE 21	
SQUEEZE	00 - 99 CYCLES	SQUEEZE	00
WELD	00 - 99 CYCLES	WELD	00
PERCENT CURRENT	00 - 99 PERCENT	PERCENT CURRENT	00
HOLD	00 - 99 CYCLES	HOLD	00
OFF IMPULSES	01 TO 99 IMPULSES	OFF IMPULSES	01
COOL	00-99 CYCLES	COOL	00
VALVE MODE	**VALVES 1 TO 8**	**VALVE MODE**	**VALVES 9 TO 16**
CYCLE MODE	***** 04 *****	**CYCLE MODE**	**** 00, 01, 02, 03, 04 ****
SLOPE MODE	00 - 02 UP/DOWN	SLOPE MODE	00
SLOPE COUNT	00 - 99 CYCLES	SLOPE COUNT	00
CONTACTOR	00-08	CONTACTOR	00

NOTICE

In a CHAINED sequence, all even schedules **MUST** be programmed with CYCLE mode *04*, even though the last schedule may not require VALVES 9 to 16.

D-3.0 OPERATION WITH 9-16 VALVE EXTENSION OPTION

D-3.1 FIRST STAGE INITIATION (FS1 to GND)

Upon an FS1 to GND foot switch closure, First Stage initiation will activate any programmed VALVES **(1 through 16)** if initiation **on an EVEN numbered schedule**. First Stage initiation will activate any programmed VALVES **(9 through 16)** when initiating **on an ODD numbered schedule**.

Initiation of the First Stage allows for testing of the valves during programming.

D-3.2 SECOND STAGE INITIATIONS (FS3 to GND or FS7 to GND or FS11 to GND)

For sequences using VALVES 9 through 16, it is necessary to use two schedules. The first schedule stores the weld parameters and valve data only for VALVES 1 through 8. **The first schedule of any sequence MUST be an EVEN numbered schedule.** The second (ODD) schedule should contain only valve data for VALVES 9 through 16.

The easiest way to avoid errors with the EVEN-ODD rule on initiations is to program your schedules beginning on schedule 20 or 40. This way, the machine can be initiated using FS7 or FS11. These initiations select schedule 20 or 40 respectively before initiating them.

To sequence a schedule to completion, the CYCLE mode ***04*** will allow the EVEN numbered schedule to select VALVES 9 through 16 on the NEXT consecutive schedule (21 in our example) and activate them simultaneously with the first 8 VALVES.

D-3.3 CYCLE MODE PROGRAMMING

The most important thing to remember is that in order to use 16 valves, two schedules must be used in an EVEN-ODD sequence and the first schedule must have a CYCLE mode of ***04***.

CHAINING

If schedule 21 is programmed with a CYCLE mode of ***04***, it will be chained to schedule 22. In this case, repeat the steps used in programming schedules 20 and 21 for schedules 22 and 23, and so on if more schedules are necessary.

REPEAT AND SUCCESSIVE

The ODD numbered schedule can also be programmed with a CYCLE mode of ***01*** for REPEAT sequences or ***03*** for SUCCESSIVE sequences.

D-4.0 VALVE EXTENSION OUTPUT BOARDS

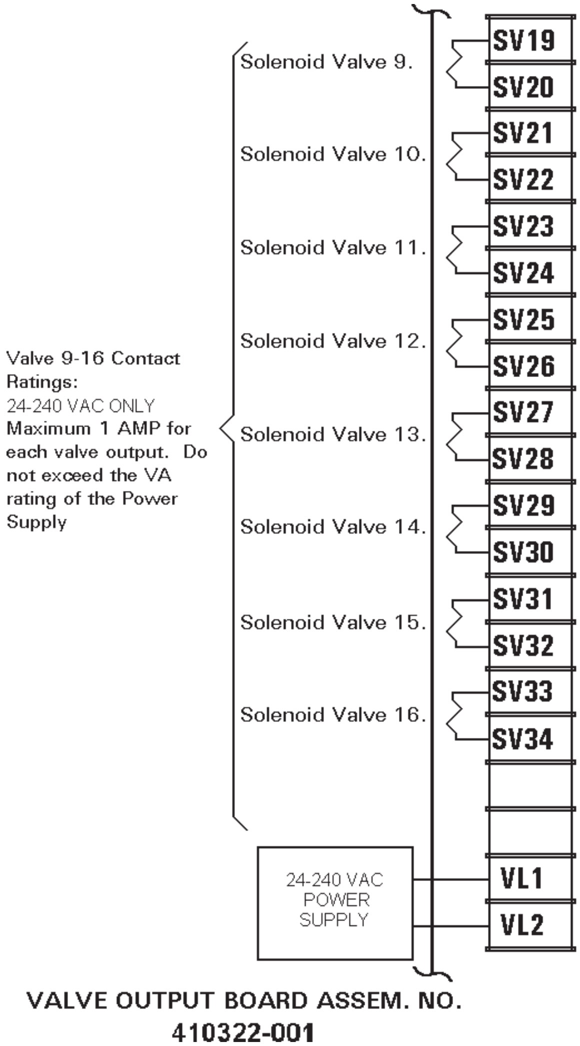


Figure D1. *24-240 VAC Valve Output Board diagram*

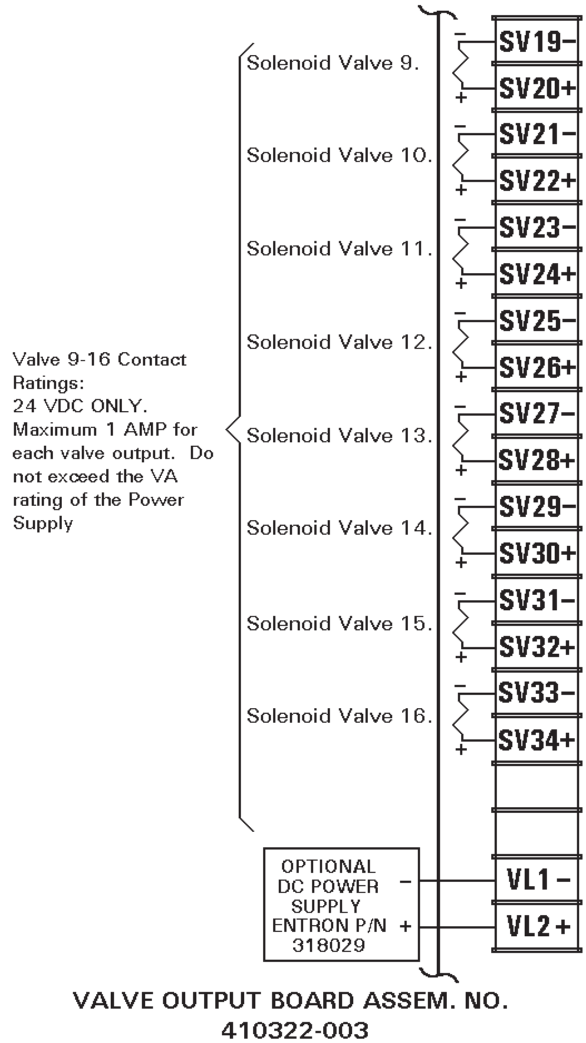


Figure D2. *24 VDC Valve Output Board diagram*

D-5.0 INSTALLATION INSTRUCTIONS

D-5.1 CUSTOMER INSTALLATION OF 9-16 VALVE OUTPUT OPTION In an existing "L", "H", "G" or "U" Cabinet

	600764-001 VAC Valves	600764-002 VDC Valves	PARTS LIST – Side Mounted Control Panel	
	QUANTITY		PART NO.	DESCRIPTION
	1		410322-001	Assembly, PCB, 9-16 Valve Extension Board, 24-240VAC
		1	410322-003	Assembly, PCB, 9-16 Valve Extension Board, 24VDC
	1	1	510236	Assembly, PCB, Mounting Plate
	1	1	322435	Harness Assembly, TS10 to TS15
	1	1	322436	Harness Assembly, J4A-J4A-J4A-J4A
	4	4	555031	Spacer, 6-32 x 1/2, 1/4 Hex Brass, Brite
	3	3	557003	6-32 x 1/4 PHSMS, Phil, Brite
	4	4	557006	6-32 x 3/8 PHSMS, Phil, Brite
or	1	1	421214-035	Wiring Diagram, EN1000-Series/VE
	1	1	421438-007	Wiring Diagram, EN1001-Series/VE
	1	1	700146	Application Note, VE Option

1. Remove **ALL** power to control. Open door.
2. Remove J4A-J4A-J4A harness from Program Board/Terminal Strip Output Board/Terminal Strip Input Board.
3. Remove the four (4) screws holding the Terminal Strip Input Board (A/N 410329) to its mounting bracket. Rotate the board 180° (so the terminal strip is at the top) and re-mount the board using the same four (4) screws.
4. Drill and tap rear panel per Figure D3, be sure to vacuum or otherwise remove ALL metal chips before adding Mounting Plate (A/N 510236) to rear panel using 3 ea. 6-32 x 1/4 PHSMS, Phil Brite. Add extra spacer (P/N 555031) to each existing spacer (4 places) to offset PCB 1″ from panel.
5. Mount 9-16 Valve Extension PCB (A/N 410322-001 or -003) to bracket (P/N 510236) using four (4) #6-32 x 3/8 PHSMS, Phil, Brite. See Figure D3.

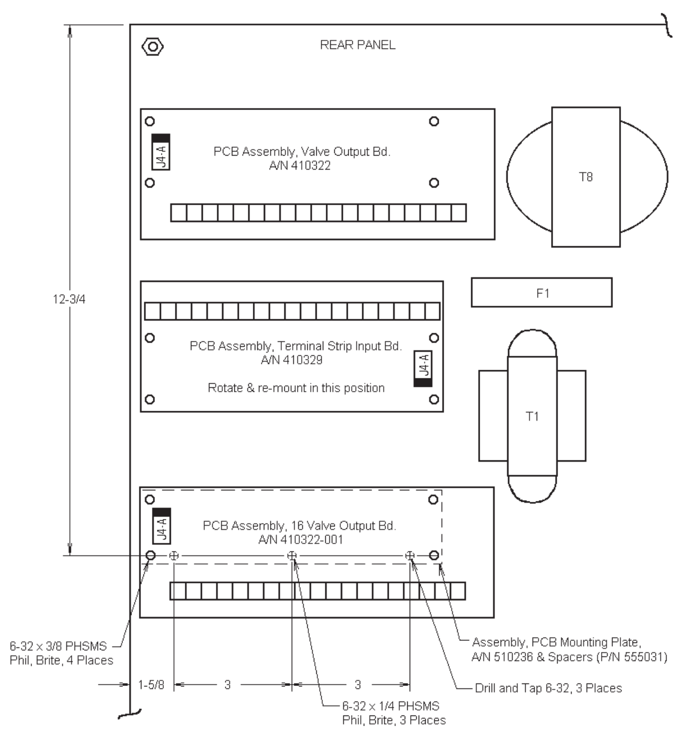


Figure D3. *Mounting detail for "L", "H", "G", or "U" Cabinet*

6. Connect J4A-J4A-J4A-J4A Harness (A/N 322436) and Harness Assembly TS10 to TS15 (A/N 322435) per Wiring Diagram included with this kit.

NOTICE
On the Wiring Diagram, the dark band on connectors indicates stripe on ribbon harness. Harness **MUST** be installed with ribbon harness stripe oriented correctly.

7. Close door. Reapply power.

D-5.2 CUSTOMER INSTALLATION OF 9-16 VALVE OUTPUT OPTION In an existing "T/D" Cabinet

	600764-003 VAC Valves	600764-004 VDC Valves	PARTS LIST – Side Mounted Control Panel	
	QUANTITY		PART NO.	DESCRIPTION
	1		410322-001	Assembly, PCB, 9-16 Valve Extension Board, 24-240VAC
		1	410322-003	Assembly, PCB, 9-16 Valve Extension Board, 24VDC
	1	1	322435	Harness Assembly, TS10 to TS15
	1	1	322357-001	Harness Assembly, J4A-J4A-J4A-J4A
	12	12	555031	Spacer, 6-32 x 1/2, 1/4 Hex Brass, Brite
	4	4	557003	6-32 x 1/4 PHSMS, Phil, Brite
	4	4	557006	6-32 x 3/8 PHSMS, Phil, Brite
or	1	1	421214-035	Wiring Diagram, EN1000-Series/VE
	1	1	421438-007	Wiring Diagram, EN1001-Series/VE
	1	1	700146	Application Note, VE Option

	600764-005 VAC Valves	600764-006 VDC Valves	PARTS LIST – Door Mounted Control Panel	
	QUANTITY		PART NO.	DESCRIPTION
	1		410322-001	Assembly, PCB, 9-16 Valve Extension Board, 24-240VAC
		1	410322-003	Assembly, PCB, 9-16 Valve Extension Board, 24VDC
	1	1	322435	Harness Assembly, TS10 to TS15
	1	1	322356-001	Harness Assembly, J4A-J4A-J4A-J4A
	12	12	555031	Spacer, 6-32 x 1/2, 1/4 Hex Brass, Brite
	4	4	557003	6-32 x 1/4 PHSMS, Phil, Brite
	4	4	557006	6-32 x 3/8 PHSMS, Phil, Brite
or	1	1	421214-035	Wiring Diagram, EN1000-Series/VE
	1	1	421438-007	Wiring Diagram, EN1001-Series/VE
	1	1	700146	Application Note, VE Option

1. Remove **ALL** power to control. Open door.
2. Remove J4A-J4A-J4A harness from Program Board/Terminal Strip Output Board/Terminal Strip Input Board.
3. Remove the four (4) screws and Terminal Strip Input Board (A/N 410329) from rear panel of cabinet.
4. Drill and tap the left side of the cabinet per Figure D4, be sure to vacuum or otherwise remove ALL metal chips before installing four (4) 6-32 x 3/8 PHSMS, Phil, Brite from outside of cabinet. On the inside of the cabinet, mount two (2) 6-32 x 1/2 spacers (P/N 555031) on each exposed thread (4 places) to offset PCB 1″ from cabinet wall.
5. On rear panel, add extra spacer (P/N 555031) to each standoff if needed (spacing should not exceed 1″). Mount 9-16 Valve Extension PCB (A/N 410322-001 or -003) to the four standoffs on the rear panel using four (4) 6-32 x 1/4 PHSMS, Phil, Brite, rotate board as shown in Figure D4.
6. Move Terminal Strip Input PCB (A/N 410329) to spacers on left side of cabinet using four (4) screws previously removed. See Figure D4.
7. Connect J4A-J4A-J4A-J4A Harness (A/N 322356-001 for "T" Cabinets, A/N 322357-001 for "D" Cabinets) and Harness Assembly TS10 to TS15 (A/N 322435) per Wiring Diagram included with this kit.

(Instructions continued on following page)

D-5.2 CUSTOMER INSTALLATION OF 9-16 VALVE OUTPUT OPTION In an existing "T/D" Cabinet (cont.)

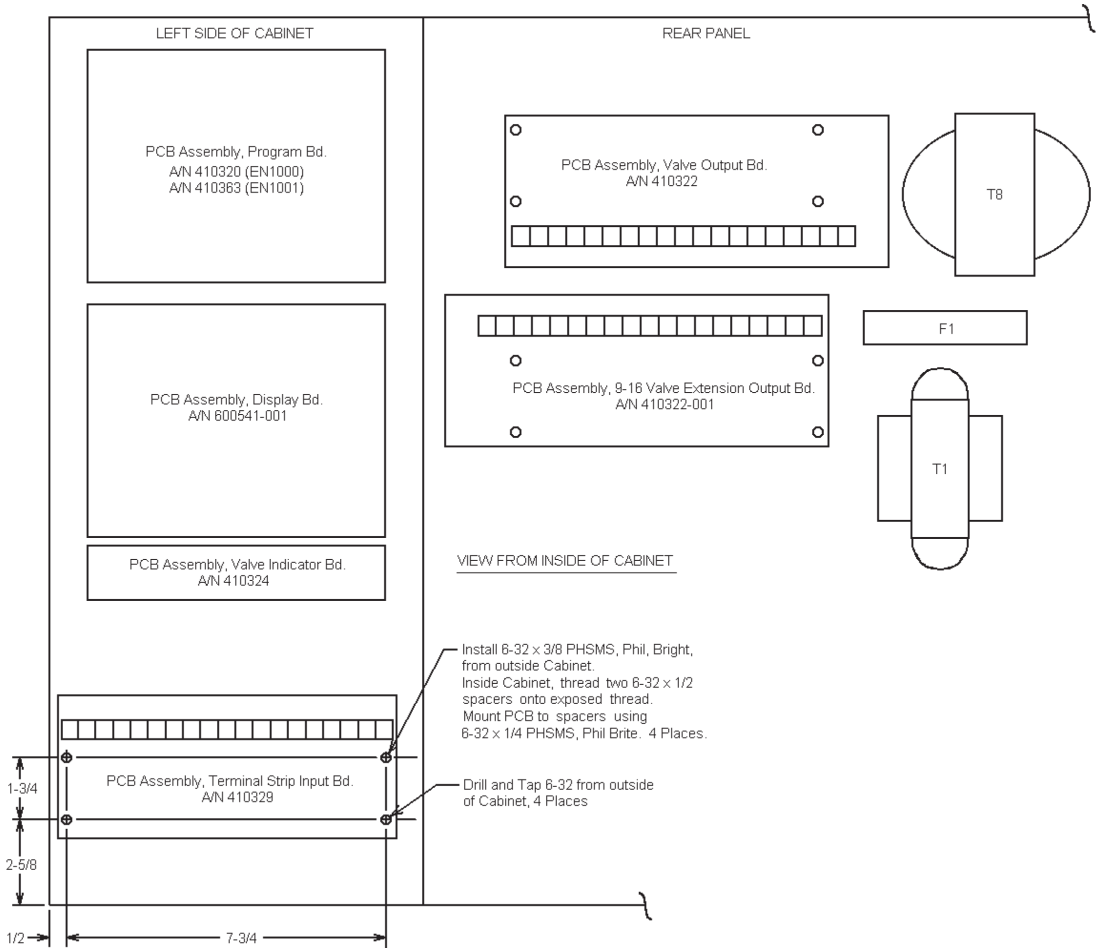


Figure D4. *Mounting detail for "T/D" Cabinet*

NOTICE
On the Wiring Diagram, the dark band on connectors indicates stripe on ribbon harness. Harness **MUST** be installed with ribbon harness stripe oriented correctly.

8. Close door. Reapply power

D-5.3 CUSTOMER INSTALLATION OF 9-16 VALVE OUTPUT OPTION AND S99 SCHEDULE SELECT OPTION In an existing "L", "H", "G" or "U" Cabinet

	600765-001 Door Mtd.	600765-002 Side Mtd.	PARTS LIST	
	QUANTITY		PART NO.	DESCRIPTION
	1	1	410322-001	Assembly, PCB, 9-16 Valve Extension Board, 24-240VAC
	1	1	410329-001	Assembly, PCB, S99 Schedule Select Board
	1	1	510236	Assembly, PCB, Mounting Plate
	1	1	322435	Harness Assembly, TS10 to TS15
	1		322456	Harness Assembly, J4A-J4A-J4A-J4A-J4A
		1	322457	Harness Assembly, J4A-J4A-J4A-J4A-J4A
	12	12	555031	Spacer, 6-32 x 1/2, 1/4 Hex Brass, Brite
	7	7	557003	6-32 x 1/4 PHSMS, Phil, Brite
	8	8	557006	6-32 x 3/8 PHSMS, Phil, Brite
or	1	1	421214-042	Wiring Diagram, EN1000-Series/VE/S99
	1	1	421438-020	Wiring Diagram, EN1001-Series/VE/S99
	1	1	700146	Application Note, VE Option
	1	1	700115	Application Note, S99 Option

1. Remove **ALL** power to control. Open door.
2. Remove J4A-J4A-J4A harness from Program Board/Terminal Strip Output Board/Terminal Strip Input Board.
3. Remove the four (4) screws mounting the Terminal Strip Input Board (A/N 410329) to the cabinet. Rotate the Board 180° (so the terminal strip is at the top) and re-mount the Board using the same four (4) screws.
4. Drill and tap the left side of the cabinet per Figure D5, be sure to vacuum or otherwise remove ALL metal chips before installing four (4) 6-32 x 3/8 PHSMS, Phil., Brite from outside of cabinet. On the inside of the cabinet, mount two (2) 6-32 x 1/2 spacers (P/N 555031) on each exposed thread (4 places) to offset PCB 1″ from cabinet wall.
5. Mount S99 PCB (A/N 410329-001) to spacers using four (4) 6-32 x 1/4 PHSMS, Phil., Brite. See Figure D5.

(Instructions continued on following page)

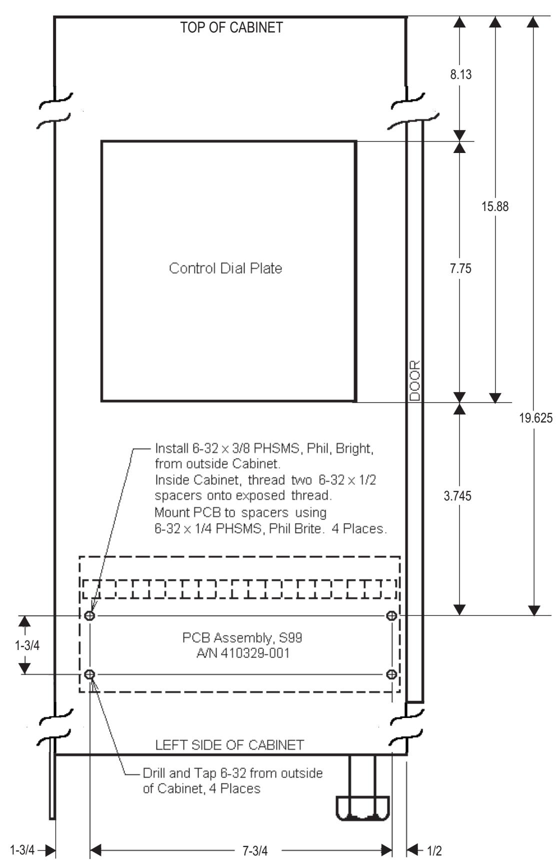


Figure D5. *S99 Mounting detail for "L", "H", "G", or "U" Cabinet*

D-5.3 CUSTOMER INSTALLATION OF 9-16 VALVE OUTPUT OPTION AND S99 SCHEDULE SELECT OPTION
In an existing “L”, “H”, “G” or “U” Cabinet (cont.)

6. Drill and tap rear panel per Figure D6, be sure to vacuum or otherwise remove ALL metal chips before adding Mounting Plate (A/N 510236) to rear panel using 3 ea. 6-32 x 1/4 PHSMS, Phil Brite. Add extra spacer (P/N 555031) to each existing spacer (4 places) to offset PCB 1″ from panel.
7. Mount 9-16 Valve Extension PCB (A/N 410322-001) to bracket (P/N 510236) using four (4) 6-32 x 3/8 PHSMS, Phil., Brite. See Figure D6.
8. Connect J4A-J4A-J4A-J4A-J4A Harness (A/N 322456 for Door Mounted Cabinets or 322457 for Side Mounted Cabinets) and Harness Assembly TS10 to TS15 (A/N 322435) per Wiring Diagram included with this kit.

NOTICE
On the Wiring Diagram, the dark band on connectors indicates stripe on ribbon harness. Harness **MUST** be installed with ribbon harness stripe oriented correctly.

9. Close door. Reapply power.

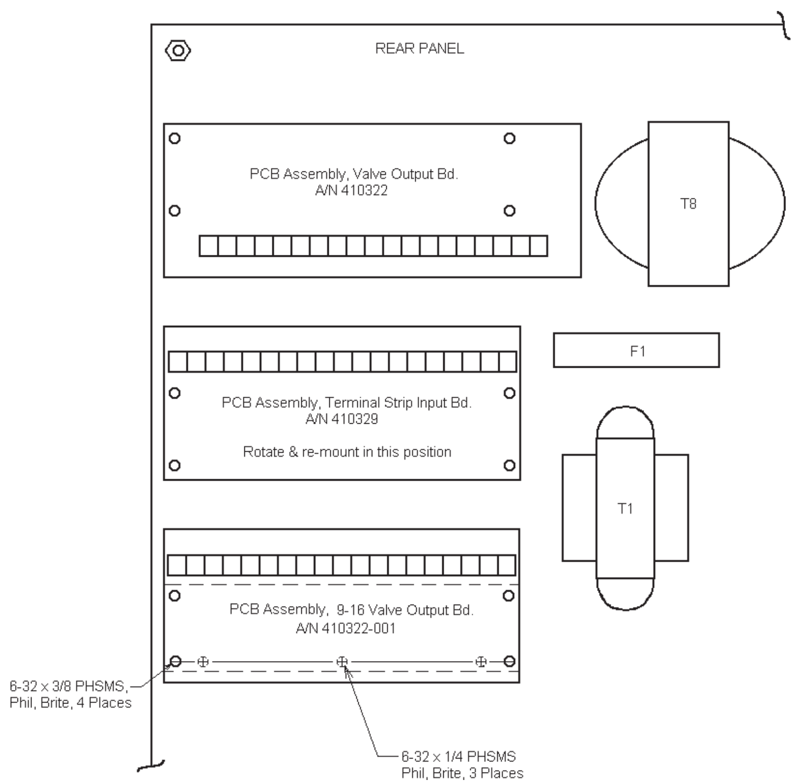


Figure D6. *9-16 Valve Extension Mounting detail for “L”, “H”, “G”, or “U” Cabinet*

D-6.0 LIST OF WIRING DIAGRAMS (available as of 6-14)

421214-035	Wiring Diagram, EN1000/VE-(1-8) Series, 230/380/460/575V
421214-041	Wiring Diagram, EN1000/VE/TSS-(1-8) Series, 230/380/460/575V, with DC Valve Output
421214-042	Wiring Diagram, EN1000/VE/S99-(1-8) Series, 230/380/460/575V, with DC Valve Output
421214-048	Wiring Diagram, EN1000/VE/485-(1-8) Series, 230/380/460/575V
421214-049	Wiring Diagram, EN1000/VE-(SCR), 230/380/460/575V
421438-007	Wiring Diagram, EN1001/VE-(1-8) Series, NEMA Cabinet, 230/380/460/575V
421438-013	Wiring Diagram, EN1001/VE/485-(1-8) Series/SP, NEMA Cabinet, 230/380/460/575V, SP=J4B for MM8
421438-020	Wiring Diagram, EN1001/VE/S99-(1-8) Series, 230/380/460/575V

APPENDIX E TERMINAL STRIP SKIP (TSS) OPTION

The TERMINAL STRIP SKIP (TSS) option allows the ability to deactivate (skip) any schedule associated with selected Contactor using an external switch. A single pole contact connection is necessary for each Contactor being skipped. This feature requires setting SCHEDULE SELECT **S.S.** in EXTENDED FUNCTIONS to **04** when used **without an S99 option**; set to **03** when using this option in conjunction **with an S99 option**. For more information, see Section 5.4 Extended Functions.

External connections to TERMINAL STRIP SKIP option circuit board are shown in Figure E1. With switches in the state shown, all Contactors selected in a programmed schedule will be active. Any closure will disable the Contactor indicated by the Terminal Strip designation and corresponding LED.

A single pole contact (relay or switch) is necessary for each Contactor being skipped. Switches are **NOT** supplied.

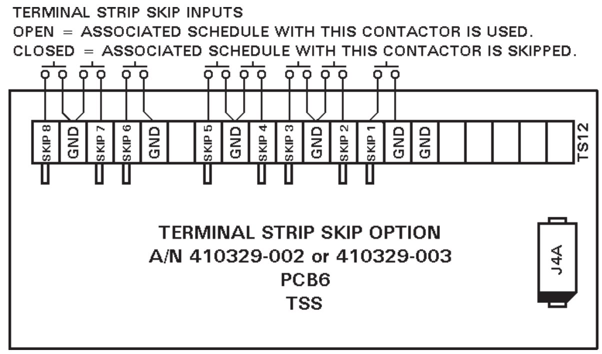


Figure E1. *TSS Circuit Board connections*

To retrofit an existing EN1000 Cascade Control with a TERMINAL STRIP SKIP option, the PROM (Integrated Circuit) on Cascade/Multi-Valve PCB (A/N 410321) **MUST** be P/N firmware version 619011-001**F** (or later), 619011-002 **ORIG** (or later) or 619044-002 **ORIG** (or later). If control was manufactured on or after January 1, 1998, it includes PROM firmware version 619011-001**F** (or later), 619011-002 **ORIG** (or later) or 619044-002 **ORIG** (or later). If control was manufactured before January 1, 1998, you must replace PROM on PCB 410321 with PROM included with retrofit kit. If control has PROM firmware version 619011-998 on 410321, replace it with current PROM firmware version.

For the retrofit application of TERMINAL STRIP SKIP in a Cascade Control **with S99** in an "L", "H", "G", or "U" Cabinet, substitute PCB 410329-003 for 410329-002. For TERMINAL STRIP SKIP to work with S99, PROM on PCB A/N 410321 must be firmware version 619011-001**K** (or later), 619011-002 **ORIG** (or later) or 619044-002 **ORIG** (or later). Also for Harness Assembly J4A-J4A-J4A-J4A-J4A, substitute A/N 322456 for 322356 in Door Mounted Controls and substitute A/N 322457 for 322357 in Side Mounted Controls.

NOTICE
Please contact Factory for available option combinations.

E-1.0 WIRING DIAGRAMS (available as of 5-14)

421214-030	Wiring Diagram, EN1000/S99/TSS-(1-8) Series, NEMA Cabinet, 460VAC
421214-040	Wiring Diagram, EN1000/TSS-(1-8) Series, 230/380/460/575V
421214-041	Wiring Diagram, EN1000/VE/TSS-(1-8) Series, 230/380/460/575V, with DC Valve Output
421214-046	Wiring Diagram, EN1000/TSS-(1-8)FP(SCR), 230/380/460/575V
421438-021	Wiring Diagram, EN1001/TSS-(1-8) Series, 230/380/460/575V

E-2.0 CUSTOMER INSTALLATION OF TERMINAL STRIP SKIP OPTION In an existing “L”, “H”, “G” or “U” Cabinet

600618-001 Door Mtd.	600618-002 Side Mtd.	PARTS LIST	
QUANTITY		PART NO.	DESCRIPTION
1	1	619044-002	EPROM, 64K x 8, Programmed
1	1	410329-002	Assembly, PCB, Terminal Strip Skip
1	1	510236	Assembly, PCB, Mounting Plate
1		322356	Harness Assembly, J4A-J4A-J4A-J4A
	1	322357	Harness Assembly, J4A-J4A-J4A-J4A
4	4	555031	Spacer, 6-32 x 1/2, 1/4 Hex Brass, Brite
3	3	557003	6-32 x 1/4 PHSMS, Phil, Brite
4	4	557006	6-32 x 3/8 PHSMS, Phil, Brite
1	1	421214-040	Wiring Diagram, EN1000/TSS-(1-8) Series
1	1	700138	Application Note, TSS Option

1. Remove **ALL** power to control. Open door.
2. Remove J4A-J4A-J4A harness from Program Board/Terminal Strip Output Board/Terminal Strip Input Board.
3. Remove the four (4) screws holding Terminal Strip Input Board (A/N 410329) to its mounting bracket. Rotate Board 180° (so the terminal strip is at the top) and re-mount Board using same four (4) screws.
4. Drill and tap rear panel per Figure E2, be sure to vacuum or otherwise remove ALL metal chips before assembling PCB Mounting Plate (A/N 510236) to rear panel using 3 ea. 6-32 x 1/4 PHSMS, Phil., Brite. Add extra spacer (P/N 555031) to each existing spacer (4 places) to offset PCB 1″ from panel.
5. Mount External Terminal Strip Skip PCB (A/N 410329-002) to bracket (P/N 510236) using four (4) #6-32 x 1/4 PHSMS, Phil., Brite. See Figure E2.

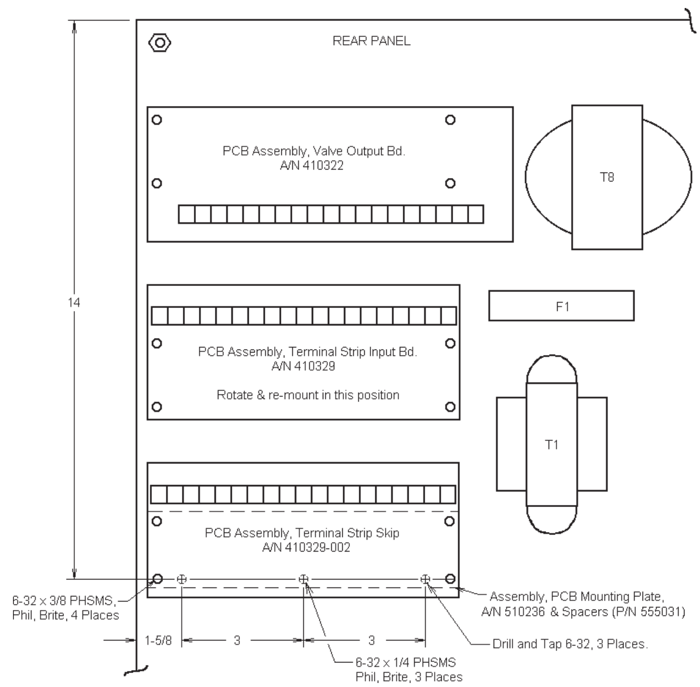


Figure E2. *Mounting detail for “L”, “H”, “G” or “U” Cabinet*

6. Connect J4A-J4A-J4A-J4A Harness (A/N 322356 or 322357) per Cascade Wiring Diagram included with this kit.

> **NOTICE**
>
> On the Wiring Diagram, the dark band on connectors indicates stripe on ribbon harness. Harness **MUST** be installed with ribbon harness stripe oriented correctly.

7. Close door. Reapply power.

> **NOTICE**
>
> EN1000 Cascade/Multi-Valve Controls in “L”, “H”, “G”, or “U” Cabinets with RS232 Driver Board **CANNOT** be modified for External Terminal Strip Skip Option (TSS).

E-3.0 CUSTOMER INSTALLATION OF TERMINAL STRIP SKIP OPTION In an existing "T" or "D" Cabinet

600618-003 "T" Cabinet	600618-004 "D" Cabinet	PARTS LIST	
QUANTITY		PART NO.	DESCRIPTION
1	1	619044-002	EPROM, 64K x 8, Programmed
1	1	410329-002	Assembly, PCB, Terminal Strip Skip
1		322356-001	Harness Assembly, J4A-J4A-J4A-J4A
	1	322357-001	Harness Assembly, J4A-J4A-J4A-J4A
8	8	555031	Spacer, 6-32 x 1/2, 1/4 Hex Brass, Brite
4	4	557003	6-32 x 1/4 PHSMS, Phil, Brite
4	4	557006	6-32 x 3/8 PHSMS, Phil, Brite
1	1	421214-040	Wiring Diagram, EN1000/TSS-(1-8) Series
1	1	700138	Application Note, TSS Option

1. Remove **ALL** power to control. Open door.
2. Remove J4A-J4A-J4A harness from Program Board/Terminal Strip Output Board/Terminal Strip Input Board.
3. Remove the four (4) screws mounting Terminal Strip Input Board (A/N 410329) to the Cabinet. Rotate Board 180° (so terminal strip is at the top) and re-mount Board using same four (4) screws.
4. Drill and tap left side of the cabinet per Figure E3, be sure to vacuum or otherwise remove ALL metal chips before installing four (4) 6-32 x 3/8 PHSMS, Phil., Brite from outside the cabinet. On inside of the cabinet, mount two (2) 6-32 x 1/2 spacers (P/N 555031) on each exposed thread (4 places) to offset PCB 1″ from cabinet wall.
5. Mount External Terminal Strip Skip PCB (A/N 410329-002) to spacers using four (4) 6-32 x 1/4 PHSMS, Phil., Brite. See Figure E3.
6. Connect J4A-J4A-J4A-J4A Harness (A/N 322356-001 for "T" Cabinets, A/N 322357-001 for "D" Cabinets) per Cascade Wiring Diagram included with this kit.

NOTICE

On the Wiring Diagram, the dark band on connectors indicates stripe on ribbon harness. Harness **MUST** be installed with ribbon harness stripe oriented correctly.

7. Close door. Reapply power.

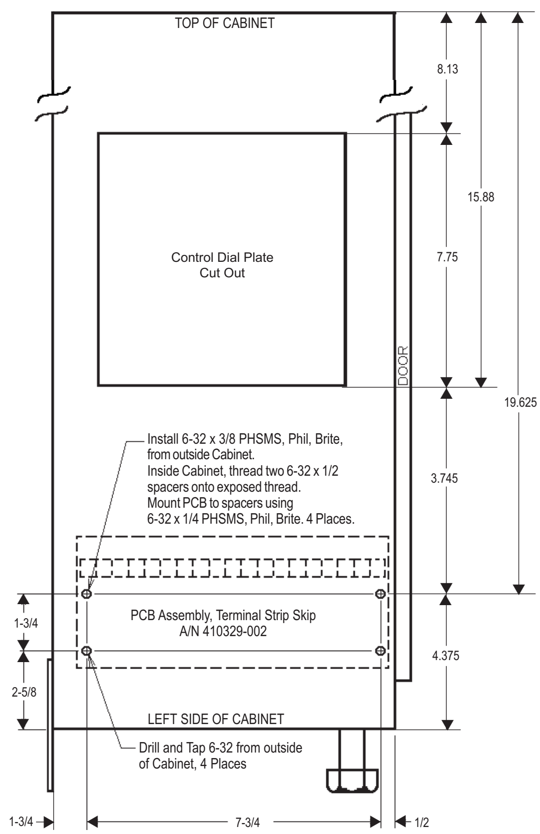


Figure E3. *Mounting detail for "T" or "D" Cabinet*

NOTICE

EN1000 Cascade/Multi-Valve Controls in "T" or "D" Cabinets with RS232 Driver Board **CANNOT** be modified for External Terminal Strip Skip Option (TSS).

E-4.0 CUSTOMER INSTALLATION OF TERMINAL STRIP SKIP OPTION On an existing Flat Plate Cascade Control

PARTS LIST FOR ASSEMBLY NO. 600618-005		
QTY	**PART NO.**	**DESCRIPTION**
1	619044-002	EPROM, 64K x 8, Programmed
1	410329-002	Assembly, PCB, Terminal Strip Skip
1	322446	Harness Assembly, J4A-J4A-J4A-J4A
4	557006	6-32 x 3/8 PHSMS, Phil, Brite
1	421214-046	Wiring Diagram, EN1000/TSS-(1-8)FP(SCR)
1	700138	Application Note, TSS Option

1. Remove **ALL** power to control.
2. Remove J4A-J4A-J4A harness from Program Board/Terminal Strip Output Board/Terminal Strip Input Board.
3. Mount External Terminal Strip Skip PCB (A/N 410329-002) to existing spacers using four (4) 6-32 x 3/8 PHSMS, Phil., Brite. See Figure E4.
4. Connect J4A-J4A-J4A-J4A Harness (A/N 322346) per Cascade Wiring Diagram included with this kit.

NOTICE

On the Wiring Diagram, the dark band on connectors indicates stripe on ribbon harness. Harness **MUST** be installed with ribbon harness stripe oriented correctly.

5. Reapply power.

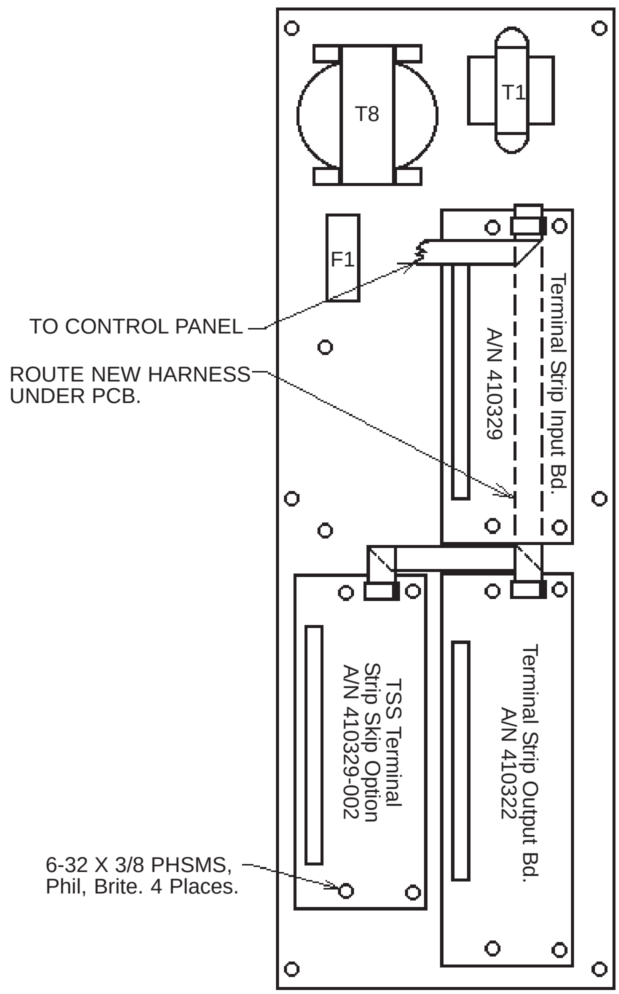


Figure E4. *Mounting detail for Flat Plate Cascade*

E-5.0 CUSTOMER INSTALLATION OF TERMINAL STRIP SKIP OPTION In existing “L”, “H”, “G” or “U” Cabinet with S99 Option

600618-006 Door Mtd.	600618-007 Side Mtd.	PARTS LIST	
QUANTITY		PART NO.	DESCRIPTION
1	1	619044-002	EPROM, 64K x 8, Programmed
1	1	410329-003	Assembly, PCB, Terminal Strip Skip
1		322456	Harness Assembly, J4A-J4A-J4A-J4A-J4A
	1	322457	Harness Assembly, J4A-J4A-J4A-J4A-J4A
12	12	555031	Spacer, 6-32 x 1/2, 1/4 Hex Brass, Brite
4	4	557003	6-32 x 1/4 PHSMS, Phil, Brite
4	4	557006	6-32 x 3/8 PHSMS, Phil, Brite
1	1	421214-030	Wiring Diagram, EN1000/S99/TSS-(1-8) Series
1	1	700138	Application Note, TSS Option

1. Remove **ALL** power to control. Open door.
2. Remove J4A-J4A-J4A-J4A harness from Program Board/Terminal Strip Output Board/Terminal Strip Input Board.
3. Remove the four (4) screws mounting the Terminal Strip Input Board (A/N 410329) to the Cabinet. Rotate the Board 180° (so the terminal strip is at the top) and re-mount the Board using the same four (4) screws.
4. Drill and tap the left side of the cabinet per Figure E5, be sure to vacuum or otherwise remove ALL metal chips before installing four (4) 6-32 x 3/8 PHSMS, Phil., Brite from outside the cabinet. On the inside of the cabinet, mount two (2) 6-32 x 1/2 spacers (P/N 555031) on each exposed thread (4 places) to offset PCB 1″ from cabinet wall.
5. Remove S99 PCB (A/N 410329-001) from bracket on rear panel, retaining 4 screws to mount TSS PCB in Step 6. Move S99 PCB to spacers on left side of cabinet; mount using four (4) 6-32 x 1/4 PHSMS, Phil., Brite. See Figure E5.

(Instructions continued on following page)

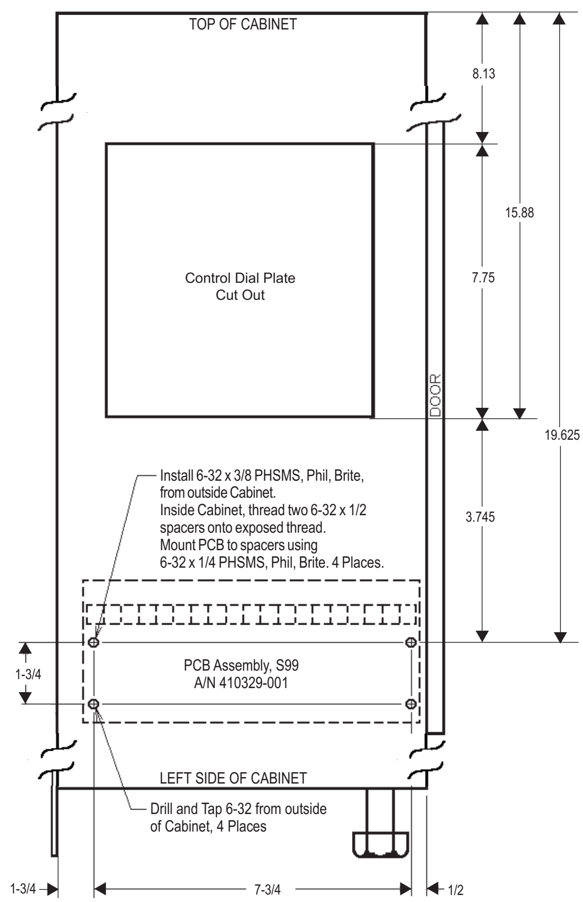


Figure E5. *Mounting detail for “L”, “H”, “G” or “U” Cabinet with S99*

E-5.0 CUSTOMER INSTALLATION OF TERMINAL STRIP SKIP OPTION In existing "L", "H", "G" or "U" Cabinet with S99 Option (cont.)

6. Add extra spacer (P/N 555031) to each existing spacer (4 places) to offset PCB 1″ from panel. Mount External Terminal Strip Skip PCB (A/N 410329-003) to existing bracket (P/N 510236) using four (4) screws retained from S99 PCB. See Figure E6.
7. Connect J4A-J4A-J4A-J4A-J4A Harness (A/N 322456 for Door Mounted Cabinets or 322457 for Side Mounted Cabinets) per Cascade Wiring Diagram included with this kit.

NOTICE
On the Wiring Diagram, the dark band on connectors indicates stripe on ribbon harness. Harness **MUST** be installed with ribbon harness stripe oriented correctly.

8. Close door. Reapply power.

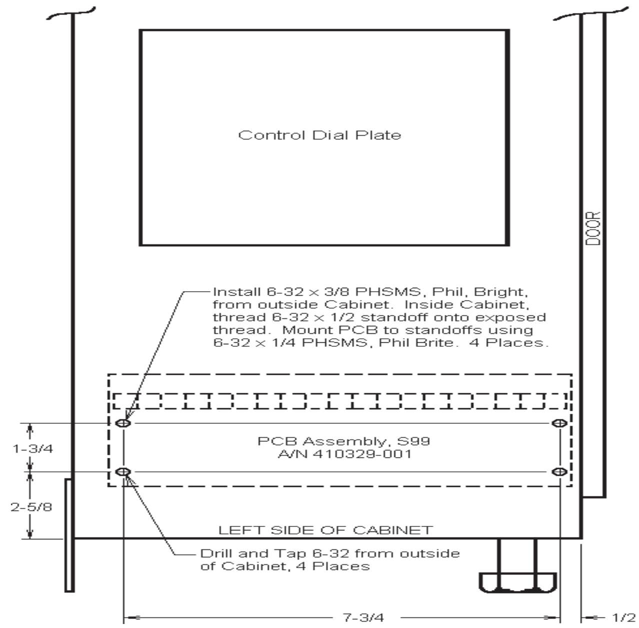


Figure E6. *External TSS Mounting detail for "L", "H", "G" or "U" Cabinet*

NOTICE
EN1000 Cascade/Multi-Valve Controls in "L", "H", "G", or "U" Cabinets with RS232 Driver Board **CANNOT** be modified for External Terminal Strip Skip Option (TSS).

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EN1000/1001 CASCADE SCHEDULE WORKSHEET

SCHEDULE # ☐

CHAINED OR SUCCESSIVE TO SCHEDULE # ☐

☐ SQUEEZE

☐ WELD/HEAT

☐ PERCENT CURRENT

☐ HOLD

☐ OFF

☐ IMPULSES

☐ COOL

☐ VALVE MODE (HEX CODE)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

9-16 Valve Extension Option

☐ CYCLE MODE

00 = NON REPEAT
01 = REPEAT
02 = CHAINED
03 = SUCCESSIVE

☐ SLOPE MODE

00 = NO SLOPE 01 = UPSLOPE 02 = DOWNSLOPE

☐ SLOPE COUNT

☐ CONTACTOR (HEX CODE)

1	2	3	4	5	6	7	8

COMMENTS

____

____

____

____

______ TAP SETTING _______ WELDING PRESSURE ____________________ MACHINE

EN1000/1001 CASCADE SCHEDULE WORKSHEET

SCHEDULE # ☐

☐	I.d.	Identification Number – 01-64
☐	C.S.	Simultaneous Contactor Firing – 00=Single Contactor; 01=Multiple Contactors
☐	S.S.	Schedule Select – 00=Internal; 01=External; 03=External Binary
☐	C.C.	Auto Voltage Compensation/Monitoring (See Manual 700194) ______
☐	b.S.	Back-Step / Water Flow Switch – 00=Water Flow Switch; 01=Back-Step
☐	P.O.	Process Outputs (See Manual 700194) ______
☐	b.E.	Beat Mode – 00=Non-Beat; 01=Beat during Squeeze; 02=Beat during Squeeze & Weld
☐	8.7.	87° Delay – 00=Off; 01=On
☐	P.P.	Manual Power Factor Programming – 00=Automatic; 01-99=Manual
☐	S.d.	Squeeze Delay – 00-99
☐	b.L.	Blocking Delay – 00-99
☐	C.r.	Constant Current Modes (See Manual 700194) ______
☐	r.A.	Range or Ratio (See Manual 700194) ______
☐	C.O.	Current Offset – 00=Off Single; 01-19=On Single; 20=Off All; 21-39=On All
☐	S.t.	Stepper (See Manual 700194) ______
☐	P.C.	Pressure Control Mode (See Manual 700178) ______
☐	b.d.	Background Pressure (See Manual 700178) ______
☐	S.I.	Sensor Input (See Manual 700178) ______
☐	P.n.	PIN # of Control

EN1000/1001 CASCADE 100 SCHEDULE WORKSHEET

SCHEDULE	SQUEEZE	WELD/ HEAT	PERCENT CURRENT	HOLD	OFF	IMPULSES	COOL	VALVE MODE [1]	CYCLE MODE [2]	SLOPE MODE [3]	SLOPE COUNT	XTOR [4]	COMMENT
00													
01													
02													
03													
04													
05													
06													
07													
08													
09													
10													
11													
12													
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58													
59													

[1] **VALVE MODE:** Hex equivalent
[2] **CYCLE MODE:** 00=NON REPEAT, 01=REPEAT, 02=CHAINED, 03=SUCCESSIVE
[3] **SLOPE MODE:** 00=NO SLOPE, 01=UPSLOPE, 02=DOWNSLOPE
[4] **CONTACTOR:** Hex equivalent

APPENDIX F PROGRAMMING WORKSHEETS (cont.)

EN1000/1001 CASCADE 100 SCHEDULE WORKSHEET

SCHEDULE	SQUEEZE	WELD/ HEAT	PERCENT CURRENT	HOLD	OFF	IMPULSES	COOL	VALVE MODE[1]	CYCLE MODE[2]	SLOPE MODE[3]	SLOPE COUNT	XTOR[4]	COMMENT
60													
61													
62													
63													
64													
65													
66													
67													
68													
69													
70													
71													
72													
73													
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92													
93													
94													
95													
96													
97													
98													
99													

[1] **VALVE MODE:** Hex equivalent
[2] **CYCLE MODE:** 00=NON REPEAT, 01=REPEAT, 02=CHAINED, 03=SUCCESSIVE
[3] **SLOPE MODE:** 00=NO SLOPE, 01=UPSLOPE, 02=DOWNSLOPE
[4] **CONTACTOR:** Hex equivalent

EXTENDED FUNCTIONS			
	ID NUMBER	I.d.	01-64
	CONTACTOR FIRING	C.S.	00=SINGLE CONTACTOR, 01=MULTIPLE CONTACTORS
	SCHEDULE SELECT	S.S.	00=INTERNAL, 01=EXTERNAL, 03=EXTERNAL BINARY
	AVC	C.C.	SEE MANUAL 700194
	BACK-STEP/WFS	b.S.	00=WATER FLOW SWITCH, 01=BACK-STEP
	PROCESS OUTPUT	P.O.	SEE MANUAL 700194
	BEAT MODE	b.E.	00=NON-BEAT, 01=BEAT DURING SQUEEZE, 02=BEAT DURING SQUEEZE&WELD
	87 DEGREE	8.7.	00=OFF, 01=ON
	PF Programming	P.P.	00=AUTOMATIC, 01-99=MANUAL POWER FACTOR
	SQUEEZE DELAY	S.d.	00-99
	BLOCKING DELAY	b.I.	00-99
	CONSTANT CURRENT	C.r.	00=OFF, 10=PRIMARY COIL, 32=SECONDARY COIL
	RANGE or RATIO	r.A.	SEE MANUAL 700194
	CURRENT OFFSET	C.O.	00=OFF SINGLE, 01-19=ON SINGLE, 20=OFF ALL, 21-39=ON ALL
	STEPPER	S.t.	SEE MANUAL 700194
	PRESSURE CONTROL	P.C.	SEE MANUAL 700178
	BACKGROUND PRESSURE	b.d.	SEE MANUAL 700178
	SENSOR INPUT	S.I.	SEE MANUAL 700178
	PIN # OF CONTROL	P.n.	