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SERIES 400

Description and Instructions

for

VERSION V7.025 and higher
31 Sequences and
99 Weld Schedules

WTC Corporation
150 East St. Charles Road
Carol Stream, IL 60188
Phone (630) 462-8250 and FAX (630) 462-8259

V7.014 6/20/95 Added bits 374 and 375 and fixed Bus Fault.
V7.016 12/25/95 Changed Regulator Speed to % heat changes.
V7.017 3/25/96 Added link steppers 370-372, E.Stop in sequence only, CLEAR “pilot”.
V7.018 6/19/96 Added bits #368-369 and instructions #88-89, fixed window math bug.
V7.022 9/17/98 Added cal password, AVC list, boost, Nachi fixes, HFDC & DeviceNet.
V7.024 4/29/99 Added 40 gun table, Tip force and Network commands #43-44.
V7.025 9/24/99 Enhanced view weld data and stepper commands for Robohost V3.2.1

Instruction Book 710240 a.k.a. M-050002

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1.0 Definitions and Features

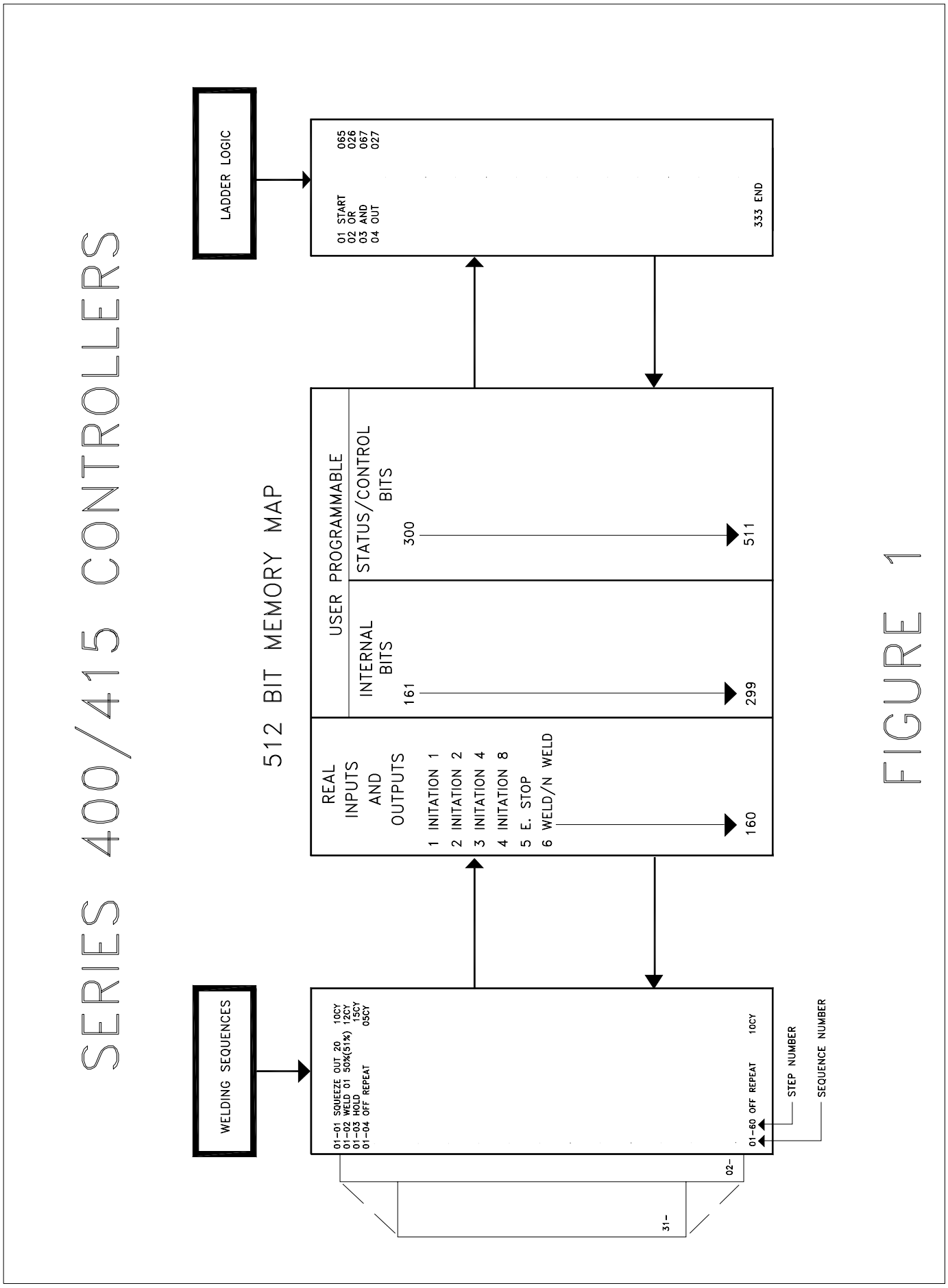
This section defines and provides a overview of the Series 400 weld control. Its propose is to be **completely modular** in both hardware and software. Hardware modules are chosen and grouped into a back plane or "rack" arrangement. Rack size varies from 2 to 12 slots, and may contain a single welding system or multi-systems. Program instructions are chosen from two "lists" and inserted into two distinct style of controllers which are contained in the CPU/Timer module.

1.1 Sequencer

The sequencer offers 3069 programmable sequential logic steps. They are divided into 31 sequences of 99 steps each. Sequences are binary pilot or internal PLC initiated. Each sequence may be freely programmed using a list of 83 English labeled or code entered instructions. Ninety-nine programmable Weld Schedules are possible. Weld schedules may be defined as a binary I/O selectable programmable weld subroutines. The sequencer works with a memory map of 512 bits of which the first 160 bits are possible real I/O. They may be user defined as input, output or used internally. I/O bits are assigned in groups of 8 through slots to ports in I/O modules. 113 memory map bits are sequencer status or control bits, 231 are user defined internal status bits. All bits may be examined and most may be manipulated. Instructions are available for weld heat control, timing, decision-making and branching, looping and sub-routines. The sequencer and its instruction set is so powerful almost all-complex spot welding and sequential machine control applications are possible. The sequencer is ideally suited to control the "automatic" mode of any off line welding tool limited to 160 I/O.

1.2 PLC Controller

The PLC (programmable logic controller) or ladder logic controller is a random logic one bit "scanning" type controller. The maximum program size is 999 logic steps, which are scanned at a rate of about 100 instructions per line cycle (16.66MS). The program may employ 32 registers for any combination of timers or counters. The ladder logic controller may be programmed to run concurrently and hand shake with, or run separately of any sequencer program. Ladder logic is used to customize welding I/O definitions, "steer" sequential welding programs, provide custom user faults, provide time and heat data from remote thumbwheels, monitor and change the fault status, control separate portions of a machine or control other machines, interface with Allen Bradley® RIO system, control a Static Controls Corp® display, interface with robots employing the Nadex® SRIO system and help interface with a networked welding control host workstation. Ladder logic is ideally suited to provide the "manual control" of any off line welding tool limited to 160 I/O. The PLC section shares the memory map with the sequencer, therefore it has access to all 512 bits used by the sequence controller. Interface between ladder logic and sequential logic programs are via the shared memory map. For a overall pictorial view see FIGURE 1 following.


SERIES 400/415 CONTROLLERS
512 BIT MEMORY MAP
LADDER LOGIC
01 START 065
02 OR 026
03 AND 067
04 OUT 027
333 END
USER PROGRAMMABLE
STATUS/CONTROL BITS
300
511
INTERNAL BITS
161
299
REAL INPUTS AND OUTPUTS
1 INITATION 1
2 INITATION 2
3 INITATION 4
4 INITATION 8
5 E. STOP
6 WELD/N WELD
160
WELDING SEQUENCES
01-01 SQUEEZE OUT 20 10CY
01-02 WELD 01 50%(51%) 12CY
01-03 HOLD 15CY
01-04 OFF REPEAT 05CY
01-60 OFF REPEAT 10CY
STEP NUMBER
SEQUENCE NUMBER
02-
31-
FIGURE 1

1.3 Current Monitoring and Control

Through the use of a primary current transformer (**CT**) and/or secondary toroid coil, combined with sequential AVC percent of available current and/or constant current, windowing and transformer turns ratio instructions and through View Data and Set-Up functions the following features may be implemented:

-Directly monitor, display, report and/or control Primary or Secondary current in AVC or constant current measurements are made on a 1/2 cycle basis.

-Control the welding process in full cycle or half cycle mode. In half cycle mode, the polarity of firing may be chosen at all times. The speed of the control process may also be adjusted. See 5.1 bits 415, 416, 380, 381 and 382 and 11.7 Regulator Speed.

-Display Primary instantaneous 1/2 cycle current readout.

-Provide primary 1/2 cycle over current check (SCR protection). A safety value is checked against all heat instructions in all schedules. If any ½ cycle is over the programmable Set-Up value a primary overcurrent fault will occur.

-Provide a minimum primary average RMS weld current check. A minimum average current value is checked upon the closing any current window. If under a programmable Set-Up value a low primary current fault will occur.

-Provide a false current check. A primary instantaneous non-weld current safety value is checked against all non-heat instructions in all schedules. If over the programmable Set-Up value a false current fault will occur.

-Provide constant current welding functions and be mixed with percent of available current (AVC) welding functions in the same sequential program.

-Program primary or secondary AVERAGE RMS current windows, which frame any, heat function or set of functions. Branching, custom faulting, read-out, annunciation, re-welding, network report and other programmable actions may be accomplished upon missing a high or low window parameter. As many as 200 custom AVERAGE RMS windows may be programmed.

1.4 Mode Control

The selection of one of three programming modes exists on any data entry panel. Any one of a CPU/Timers three modes may be set from two different types of DEPs; directly connected and networked connected. Both styles of DEP may be connected to and address a CPU/Timer at the same time. Because the modes are hierarchical, #1 PROGRAM, #2 ON-LINE and #3 RUN, one style DEP cannot override the others higher set mode. To help the user understand which style DEP has called for the mode set, the DEP style will be displayed in parentheses next to the mode. In the examples below, both styles are calling for the mode. The modes are:

PROGRAM Displayed: (DIRECT) PROGRAM MODE (NETWORK)

If the control is not sequencing, it will not sequence regardless of input. All outputs will be disabled. The PLC program if any, will not be scanned.

If the control is sequencing and the program mode is entered, it will finish the sequence, disable outputs and not sequence again regardless of inputs. All outputs will be disabled. The programmer may review and reprogram any function in the controller. These include sequence instructions, PLC instructions, all data and control configuration. Review of a programmed weld sequence will show the entire sequence; welding, I/O and machine instructions all steps, one at a time. Reviewing of the ladder logic program will show all steps one at a time. Programming features the use of a "LIST" key which presents to the programmer the list of instructions for review and selection.

ON LINE DATA CHANGE Displayed: (DIRECT) ON-LINE MODE (NETWORK)

Control executes the sequence program upon command and the programmable logic program is scanned. Data changes may be made during operation in both the sequencer and the PLC programs. The operator may review any sequence and/or special functions on the controller. The operator may reprogram any data associated with any instruction the programmer chose to display at this time. These instructions may be Squeeze, Weld and Hold ONLY out of hundreds of other instructions in the sequence program.

RUN Displayed: SERIES 400 WELD CONTROL V7.025

The control will execute a sequencer program at the command of its initiation input and the programmable logic program will be scanned at the rate of 100 instructions per power line cycle. The operator may review any sequence or special function in the controller but cannot enter any instructions or data. When reviewing a sequence program will only certain instructions will be viewable. Only the instructions, which were selected by the programmer for viewing, may be seen, the remainder is hidden from view.

1.5 Data Entry Panels

There are four variations of programming and Data Entry Panels (DEP) available. They are divided into two major groups. Data entry panels that connect directly into a single CPU/Timer and DEP’s that are on a network of CPU/Timers. Listed by ascending features, cost and complexity they are:

CHARACTERS	DISPLAY AND DEP TYPE	PART NUMBER
32	LCD DIRECT ONLY	503-4-0318-02
32	FLUORESCENT DIRECT ONLY	503-4-0319-01
40	LCD DIRECT OR NETWORKED	503-4-0328-02
600 X 800 VGA COLOR	P5 MASTER WORK STATION W/16 MEG RAM & 1.2 GIG HARD DRIVE	810-0-0116-01

1.5.1 32 Character Direct DEPs

The 32 character single line LCD DEP measures 8.5 X 6.5 X 2 and the FLUORESCENT style DEP measures 10 X 6.5 X 2 inches. They are identical units except for display type and width. Both are capable of being remotely mounted. Normally the DEP is mounted on the outside of the cabinet door and connected to a single CPU/Timer with a 5 foot cable. With longer cables remote connections up to 100 foot are possible. The cable provides circuits for +12VDC power and full duplex RS422 at 9.6 KBaud. Without a DEP attached, the CPU/Timer will still operate according the last mode programmed prior to the DEPs removal. Normally a DEP may be plugged into a CPU/Timer during operation, especially if it is the LCD style because it draws very little current. BUT, depending on the power supply module employed and the rack system load applied, plugging in a DEP during operation might cause the power supply module to reset and momentarily shut down the CPU/Timer. This happens when the surge current demanded by the DEP exceeds the automatic current limit shut down feature of the switcher supply employed. If the quiescent current demand is not over the supplies limit the CPU/Timer will recover. System resets usually occur when plugging in a fluorescent style DEP because of its large start up surge.

In addition to the single line 32 character display there are two LED's that annunciate "In sequence" and "Welding". There is a total of 24 keys with 4 keys LED annunciated. Two different programming keys are available for a 3 position key lock they are:

-Operators key (T002) 333-0-078-00 allows the operator to change certain displayed functions data only. The program position is not accessible, functions cannot be programmed.

-Master programmers key (T001) 333-0-078-01 allows both on line data change and program modes. All features, program functions and data may be programmed or changed.

See 6.0 for enhanced hardware description of the keyboard board. A simple generalized keyboard results from menu driven software system.

1.5.2 40 Character LCD Direct and Networked DEP

The single line 40 character LCD DEP is the same size, looks and acts like the 32 character LCD DEP. Differences are:

-8 more characters for a networked CPU/Timer address connection.

-Three LED annunciated mode keypads replace the three-position dual key lock switch. A single position key lock that locks and unlocks the three mode keypads in the state they are in at the time of lockout. When in lockout, set-up changes under the local key are not possible.

-A LOCAL button is added to display the DEP’s local set up menu.

-A 9 pin DB serial port is available for up and down loading programs from a lap top or any other DOS based PC.

In addition to the direct mode connection the DEP may be connected as one of 64 drops on a network (secondary). When set up as a secondary, the DEP must be assigned an address on the network. The address must be a number 1 through 64 and NOT 0. Afterward connection to any other address on the network may be made. All connections are made through a primary host controller, which must exist on the network.

The DEP may also be set up as a primary host controller. If set up as a primary, up to 16 CPU/Timers may be accessed. A network system cannot tolerate two primary controllers. If two exist, the network will lock up. Therefore it is important to consider which of the three modes will be employed before connection to any network is made. If the connection is secondary, make sure a unique network ID is assigned to the DEP and the address is NOT 0. If the connection is primary make sure it is the only primary on the system and its network ID is 0.

The DEP mode set-up is accomplished under local screens found under the LOCAL key. The word LOCAL reminds the user that they are in the local set-up mode in the DEP, and not connected to a CPU/Timer on the network. The keyswitch on the bottom of the DEP locks out set-up changes made under LOCAL. After pressing the LOCAL key selections are viewed by pressing the DOWN ARROW or UP ARROW keys. After all selections are made pressing EXIT SCREEN causes all selections to be made. Assuming the DOWN ARROW key is used, the screens are:

LOCAL TIMER NETWORK ID XX TOOL NAME

In this screen the address of a networked CPU/Timer is entered. If a tool name has been entered under the Edit Tool Name screen and ENTER is pressed the tool name will appear. After the address is entered and the EXIT SCREEN key is pressed, the connection to the CPU/Timer is made through the network. Another form of this screen will appear by pressing the LIST key. By pressing the UP or DOWN ARROW key one may scroll through the list of timer numbers with their tool names if they exist. Pressing EXIT SCREEN causes connection via the network of the timer viewed.

LOCAL DEP NETWORK ID XX

In this screen the address of the DEP is entered. If the DEP is a primary controller the address must be 0. There must not be any other primary network controllers on the network. If it is a secondary it must have a address that does not conflict with any other drop on the network and cannot be 0. CAUTION: If the choice is primary the serial connection to the network must be made via the black 5 pin connector on the 473-0-0419 network connector board. If secondary, use a green connector on the board.

DEP MODE (0=DIRECT, 1=NETWORK) X

Under this screen the DEP may be set up to connect directly to a single CPU/Timer or networked on a system of many timers.

RESPONSE TIME (SECONDS) X.X

If connected as a secondary, the DEPs constant polling through the primary will slow down the network. With this screen the response time may be adjusted. The user should program the quickest response time the network will stand without the overall network seeming to slow.

TIMEOUT (MINUTES) XXX

Timeout provides a means of automatically disconnecting from the remote device to reduce network activity. Time out of 999 disables the timeout feature remaining connected permanently.

NETWORK DATA ENTRY PANEL V1.006

This screen displays the version of firmware installed.

CHECKSUM = 28434

This screen displays the check sum of the firmware installed in base 10.

EDIT TOOL NAME XX TOOL NAME1

Under this screen each of the 64 timers may be given a unique 10 character name. The CPU/timers network address may be entered when the cursor is flashing at XX or the UP/DOWN ARROW key may be used to find the network address of interest. Afterwards the RIGHT/LEFT and UP/DOWN ARROW keys are used to record CPU/Timers tool name slot machine style.

CAUTION

If a timer is placed in **PROGRAM** mode when the DEP is connected **DIRECT** and left in program mode then connected **NETWORK**, the timer will not respond to a change to **RUN** mode. Please read 1.4 carefully.

ALWAYS place the timer in **RUN** mode before changing the DEPs mode from **DIRECT** to **NETWORK** or from **NETWORK** to **DIRECT**.

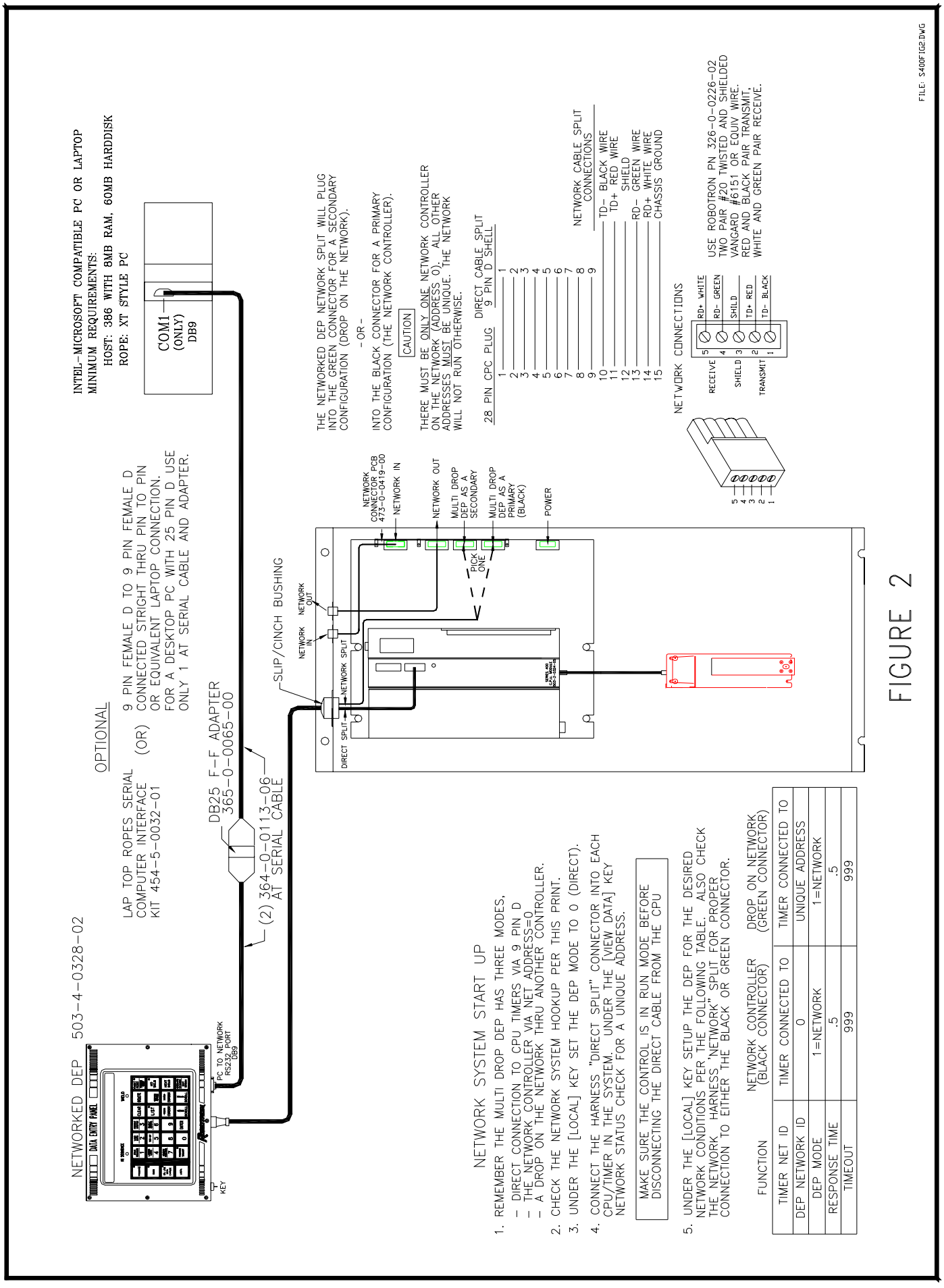

INTEL-MICROSOFT COMPATIBLE PC OR LAPTOP
MINIMUM REQUIREMENTS:
HOST: 386 WITH 8MB RAM, 60MB HARDDISK
ROPE: XT STYLE PC
COM1 (ONLY) DB9
OPTIONAL
LAP TOP ROPES SERIAL COMPUTER INTERFACE KIT 454-5-0032-01
(OR)
9 PIN FEMALE D TO 9 PIN FEMALE D CONNECTED STRIGHT THRU PIN TO PIN OR EQUIVALENT LAPTOP CONNECTION. FOR A DESKTOP PC WITH 25 PIN D USE ONLY 1 AT SERIAL CABLE AND ADAPTER.
DB25 F-F ADAPTER 365-0-0065-00
(2) 364-0-0113-06 AT SERIAL CABLE
SLIP/CINCH BUSHING
NETWORKED DEP 503-4-0328-02
PC TO NETWORK RS232 PORT J3B9
KEY
NETWORK SYSTEM START UP
1. REMEMBER THE MULTI DROP DEP HAS THREE MODES,
– DIRECT CONNECTION TO CPU TIMERS VIA 9 PIN D
– THE NETWORK CONTROLLER VIA NET ADDRESS=0
– A DROP ON THE NETWORK THRU ANOTHER CONTROLLER.
2. CHECK THE NETWORK SYSTEM HOOKUP PER THIS PRINT.
3. UNDER THE [LOCAL] KEY SET THE DEP MODE TO 0 (DIRECT).
4. CONNECT THE HARNESS "DIRECT SPLIT" CONNECTOR INTO EACH CPU/TIMER IN THE SYSTEM. UNDER THE [VIEW DATA] KEY NETWORK STATUS CHECK FOR A UNIQUE ADDRESS.
MAKE SURE THE CONTROL IS IN RUN MODE BEFORE DISCONNECTING THE DIRECT CABLE FROM THE CPU
5. UNDER THE [LOCAL] KEY SETUP THE DEP FOR THE DESIRED NETWORK CONDITIONS PER THE FOLLOWING TABLE. ALSO CHECK THE NETWORK HARNESS "NETWORK" SPLIT FOR PROPER CONNECTION TO EITHER THE BLACK OR GREEN CONNECTOR.
FUNCTION
NETWORK CONTROLLER (BLACK CONNECTOR)
DROP ON NETWORK (GREEN CONNECTOR)
TIMER NET ID | TIMER CONNECTED TO | TIMER CONNECTED TO
DEP NETWORK ID | 0 | UNIQUE ADDRESS
DEP MODE | 1=NETWORK | 1=NETWORK
RESPONSE TIME | .5 | .5
TIMEOUT | 999 | 999
DIRECT SPLIT
NETWORK SPLIT
NETWORK IN
NETWORK OUT
NETWORK CONNECTOR PCB 473-0-0419-00
NETWORK IN
NETWORK OUT
MULTI DROP DEP AS A SECONDARY
MULTI DROP DEP AS A PRIMARY (BLACK)
PICK ONE
POWER
THE NETWORKED DEP NETWORK SPLIT WILL PLUG INTO THE GREEN CONNECTOR FOR A SECONDARY CONFIGURATION (DROP ON THE NETWORK).
- OR -
INTO THE BLACK CONNECTOR FOR A PRIMARY CONFIGURATION (THE NETWORK CONTROLLER).
CAUTION
THERE MUST BE ONLY ONE NETWORK CONTROLLER ON THE NETWORK (ADDRESS 0). ALL OTHER ADDRESSES MUST BE UNIQUE. THE NETWORK WILL NOT RUN OTHERWISE.
DIRECT CABLE SPLIT
28 PIN CPC PLUG
9 PIN D SHELL
NETWORK CABLE SPLIT CONNECTIONS
TD- BLACK WIRE
TD+ RED WIRE
SHIELD
RD- GREEN WIRE
RD+ WHITE WIRE
CHASSIS GROUND
NETWORK CONNECTIONS
RECEIVE
SHIELD
TRANSMIT
RD+ WHITE
RD- GREEN
SHILD
TD+ RED
TD- BLACK
USE ROBOTRON PN 326-0-0226-02 TWO PAIR #20 TWISTED AND SHIELDED VANGARD #6151 OR EQUIV WIRE. RED AND BLACK PAIR TRANSMIT, WHITE AND GREEN PAIR RECEIVE.
FILE: S400FIG2.DWG

FIGURE 2

1.5.3 ROBOHOST Master Workstation and Gateways

Industrial computerized master workstation with a minimum of 32 meg RAM and a 3.0 gig hard drive and a 15 inch SVGA monitor, (printer optional) and Windows95. If the Robohost Master Workstation stands alone (i.e. no Gateways), it includes 4 channels X 16 (64 drop) network controller housed in a sealed industrialized Ice Station® enclosure. For bulk data storage and good network speed, Gateway PC(s) running RoboServer software are connected via Ethernet to the Robohost Master Workstation. The Gateways are necessary when:

1. Networking with multiple Workstations
2. More then 64 controls must be networked
3. SPC and/or Footprint data is collected
4. Timer program automatic backup system is employed
5. Fault archiving is desirable

Robohost (Graphical User Interface) application software was designed by Weltronic to network Weltronic Series 400/415/435/3050 weld controls. Robohost is Windows 95 and Windows NT 4.0 compatible. See instruction book 328-0-0648-00 for more detail.

Robohost features:

1. Robohost is capable of monitoring a larger number of controls over a Ethernet network. Every 64 controls are networked to a Weltronic Gateway. Robohost can monitor up to 40 Gateways. (2560 controls).

2. Multiple workstations monitoring the entire or partial network of controls.

3. Robohost can network different types of controls, Series 400, 415, 435, 3050 or Ethernet groups Gateways of these controls.

4. Copying programs from/to any workstation on the network to any control.

5. Copying programs from a control to any similar control on the network.

6. The ability to use long names for programs and storing them at any work station on the network.

7. On line data change where the user can change multiple values in sequences, steppers and smart steppers while the timer is running.

8. Resetting one or multiple steppers in one selected control.

8. Resetting one or multiple steppers in a range of selected controls on a Gateway.

10. On line last weld data monitoring.

11. On line timer digital I/O map and register monitoring.

12. On line fault monitoring for all controls connected on the network.

13. Off line programming (ROPE) for all controls.

14. Diagnostic tools to help understand and fixing of faults.

15. Resetting one or multiple faults in one selected control.

16. Resetting all faults in a range of selected controls on a Gateway.
17. Remote monitoring and changing DEP programming key switch status.
18. Secured access to system configuration and copying functions.
19. Touch screen computer system support.
20. SPC and FOOTPRINT data collection in ASCII format (Gateway only).
21. Controls schedule backup according to a preset calendar data and time (Gateway only).
22. Remote viewing of the weld/no weld status.
23. Remote setting of one or multiple controls to Weld/No Weld mode.

1.6 I/O Bit/Rack/Slot/Port Definition

The Series 400 has a memory map of 512 bits of which the first 160 bits may be addressed as real inputs or real outputs. Linking the memory map bits to I/O is done in the Set-up menu. It is accomplished by assigning the bits in groups of 8 CONTIGUOUS bits to a "slot" which contains a I/O module and then to "ports" within these modules. Modules are plugged into a "rack" type arbitrated bus system. Any combination of Series 400 CPU/Timers (6 maximum) and I/O modules (32 total maximum) may be on the arbitrated bus. Any or all CPU/Timers may "read" any input port, but only one CPU/Timer may "write" to any one output port. See 11.0 for set up detail.

There are two types of slots, *physical* and *logic* slots. In physical slots 1 through 12 which modules may be inserted, it is possible to address 16 eight-bit ports. Ports 0 through 3 are defined as inputs and 4 through 7 outputs. Their definition CANNOT be changed, ports 8 through 15 as of this writing are not defined.

The Port definition for I/O Modules is as follows:

PORT 0 - 8 INPUTS
PORT 1 - 8 INPUTS
PORT 2 - 8 INPUTS
PORT 3 - 8 INPUTS

PORT 4 - 8 OUTPUTS
PORT 5 - 8 OUTPUTS
PORT 6 - 8 OUTPUTS
PORT 7 - 8 OUTPUTS

PORT 8 - 8 FUTURE
PORT 9 - 8 FUTURE
PORT 10- 8 FUTURE
PORT 11- 8 FUTURE

PORT 12- 8 FUTURE
PORT 13- 8 FUTURE
PORT 14- 8 FUTURE
PORT 15- 8 FUTURE

Because of physical constraints, I/O modules with physical I/O are limited to a maximum of 32 I/O (4 ports). Therefore a 32 input module would respond only to ports 0, 1, 2 and 3. A 32-output port module would respond to ports 4, 5, 6, and 7. A 16 input module would respond to ports 0 and 1. A 16-output module, ports 4 and 5. Logic slots 16 and 17 provide a portal for "Blue Hose" remote I/O. Slot 16 also provides 16 ports but ALL are INPUTS. Slot 17 ALL 16 ports are OUTPUTS. The same holds true for slots 18 and 19 respectively, except the connection is not via the backplane but via P2 the serial port to Kawasaki® robots. Any I/O device that carries logical slot numbers, reflect those numbers no matter what physical slot or they may occupy. Various combination of I/O are available see 2.4 and 3.2 for more detail.

As mention above there is a maximum of 32 "rack slots" possible in the arbitrated bus system. The division between physical and logical slots is at slot 15. At this writing a 10 slot back plane is available, with the possibility of 12 slot in the future. They are defined as follows:

Rack Slot	Definition
0-15	Possible physical backplane hardware slots. Access to the I/O hardware plugged into these slots is provided by bus interface hardware included in each CPU/Timer and I/O module.
15	The 503-7-0324-XX Cascade Steering Panel(s) may be permanently configured for slot 15 no matter what physical slot(s) they are plugged into, or they may be made to assume the physical slot number they are plugged into. Assignment is made via the SL15 or SLTA headers. See Section 4 for more detail.
16	Logical slot providing sixteen eight-bit ports or 128 Allen Bradley® Remote I/O and DeviceNet INPUT bits. Input from A-B RIO through RIO Module regardless of the actual slot the module is plugged into. See Section 3 for more detail.
17	Logical slot providing sixteen eight-bit ports or 128 Allen-Bradley® Remote I/O and DeviceNet OUTPUT bits. Outputs to A-B RIO through RIO Module regardless of the actual slot the module is plugged into. See Section 3 for more detail.
18	Logical slot providing 128 Kawasaki®/Nachi®robots and PLC Direct/KOYO® PLC Remote I/O INPUT bits. Input from RS422/485 port P2 on front of timer and placed into memory map input bits programmed.
19	Logical slot providing 128 Kawasaki®/Nachi® robots and PLC Direct/KOYO® PLC Remote I/O OUTPUT bits. Output to RS422/485 port P2 on front of timer from memory map output bits programmed.
20-31	Reserved for future interface.

See 11.19 **I/O bit to slot to port set up.**

1.7 Networking Features

It is possible to network up to 64 Series 400 controls to a single work station, and/or connect a RS485 serial RIO connection to a Nadex® protocol I/O link or Static Controls Corp® (SCC) Model 1040 display. Connection to the network is via a 5 pin connector on the backplane, through the back plane to a CPU/Timer module, to the network coupling transformers T1 and T2 on the 473-0-0414-01 CPU/Timer card. The network address may be set in two ways, first via hardware binary selector switch S1 or by software in the Setup menu. The Robot (Nadex) or SCC link is via the RS485 COM. P2 port on the front of the CPU/Timer. Where P2 pin 7 is + data and pin 8 is - data. The robot ID is set by software only. See 11.11 and 2.1.1.

SW1-1 through 8	ACTION
0000000<-LSD SW1-8	Off line, direct DEP entry only
1 through 64	Hardware set network address (binary)
65 through 99	Software set network address via Set-Up See 11.10 and 2.1.1
SW1-1	Closed=Robot (Nadex) RIO link Open=SCC Display

On the 473-0-0414-01 board a HC16 16 bit micro-processor (U1) and firmware (U7 and U8) features:

-Connection to the Network Via T1 T2 a 4 wire transformer coupled duplex at 19.2Kb. The data link is controlled by a Weltronic Network Controller using a form of HDLC-NRM protocol and ISO-3309/4435 bit sequence, synchronous, non-ASCII communication.

-The collection and consolidation of Statistical Process Control data (SPC). 99 Weld SPC history buckets and 16 Weld footprint buckets per network board. Weld SPC sample size may be programmed under set-up, Foot Print sample size is not programmable and set to five samples. Frequency of samples is defaulted to 100 but may be changed via the work station under Off Line Programming (ROPE). Buckets 1 through 16 may be set with a different frequency, but buckets 17 through 99 will always equal 16's frequency. Each of the 115 buckets contents will contain the following data:

1. Normalized RMS Current
2. Low Line voltage
3. Power factor
4. ACDC Stepper Sensitivity (Nugget resistance 9.1)
5. Sample size and frequency

After the proper frequency and sample size an Average, Range Standard Deviation and Variation for each of the above will be reported to the Host work station. It will happen upon the next poll from the Network controller. This local concentration of data greatly reduces the network activity.

Other data reported to the Host workstation include:

1. Faults, custom faults with custom text
2. Last Weld Data
3. Status of the timers I/O map
4. Data from all 32 Registers
5. SPC of Last Weld Data

1.8 Electrical Specifications

LINE VOLTAGE RANGE:	115-240VAC and 240-600VAC versions, control transformer tap selection,-25 +20% each tap selection.
LOGIC SUPPLY: (4 Styles)	Input: 120VAC (85-264VAC 0-50C) 47-63HZ. 20A inrush @110VAC, Emission-FCC/VDE "B"
	Output Triple: +5V/5A, +12V/3A, -12V/.7A Weltronic P/N 343-0-0141-00 IDP 45 Watt Model SRW-45-3001
	Output Quad: +5V/5A, +12V/2A, -12V/2A, 24V/1A Weltronic P/N 343-0-0142-00 IDP 65-Watt Model SRW-65-4003
	Output Triple: +5V/12A, +12V/4A, -12V/2A Weltronic P/N 343-0-0144-00 IDP 115 Watt Model SRW-115-3001
	Output Quad: +5V/12A, +12V/4A, -12V/2A, 24V/1A Weltronic P/N 343-0-0145-00 IDP 115 Watt Model SRW-115-4002
HEAT CONTROL:	20-99% available RMS line current or constant current at +-2% 50 or 60HZ. Power factor and current corrections are programmable. Automatic Line Voltage or constant current compensation, will correct to 18 degrees maximum forward firing angle and 140 degrees minimum retarded angle. See 10.8 bits 377-382 for programmable current control features.
SCR GATING SUPPLY TO FIRING CARD:	+2A @100uSec transformer coupled (1:1) pulse from a +32VDC supply (C03) in the SCR firing module.
MAXIMUM FIRING MODULE SEPARATION LENGTH:	75 feet.
DATA ENTRY PANEL	Display re-freshed twice per second. via RS422 at 9.6KB. +12VDC regulated to +5VDC at data entry panel.
MAXIMUM DEP CABLE LENGTH:	100 ft, exits door or top of cabinet lockable remote mounting kit available.
SEQUENCER TIMING:	Absolute to line frequency in cycles, 50 or 60 Hertz.
MAXIMUM SEQUENCER PROGRAM STEPS:	Matrix of 3069 cells. All programmed cells and data stored in EEPROM
MAXIMUM NUMBER OF PRE SET SEQUENCES:	31 sequences at 99 steps each or 99 Weld Schedules at 10 steps each
MAXIMUM NUMBER OF WELD SCHEDULES BY PROGRAM:	99+ (depends on schedule contents and method of implementation)
PLC SCAN RATE:	100 program instructions each 8.33MS if not interrupted by data entry. If in RUN mode program is executed 8.5 seconds after power is applied.
PLC TIMERS:	Up to 32. Timing in Tenths of a second.

PLC COUNTERS:	Up to 32. Count of 0 to 65535
MAXIMUM INSTRUCTIONS PER PLC PROGRAM RUNG:	999 instructions.
MAXIMUM PLC PROGRAM SPACE:	2000 bytes at 2 bytes per instruction except timers and counters @ 5 bytes. Not to exceed 999 program steps. Program and data stored in EEPROM.
DATA STORAGE:	Stepper programs actual count, keyswitch position and memory retented I/O bits PLC latched bits in battery backed RAM. All other program and data is stored in EEPROM. Therefore user programs may be transferred between CPU/Timers by exchanging EEPROMS (U17 X28C256). Caution use anti-static precautions.
PILOT RESPONSE:	If binary inputted through a pilot port, within 3 line cycles. If via bits 507-511, 3 line cycles plus PLC program scan time. If via strobe pilot method, within the next half cycle but only if recognized before 160°.
DATA ENTRY MODES:	LCD or florescent DEP data entry, remote thumbwheels, Multi-drop DEPs, floppy disk drive connections to Weltronic Offline Programming Environment (ROPENET). Networked host workstation. (HOST 64 nodes). See 1.5.
SCR CONTACTORS:	150 through 5000 AMPS. Contact Weltronic sales for details.

I/O:

All I/O logic voltage is 5VDC. See specific vendor specifications for more detail, large voltage, current and time variations are available. Slight variations occur between brands. Brands available are WRC®, Gordos®, P-B and Opto22.

INPUTS:

24VAC/DC	@7.2MA 20MS response	WRC 1781-IA5SE or Gordos SM-IAC5E	359-0-0293-00
120VAC/DC	@4.2MA 20MS response	WRC 1781-IA5S or Gordos SM-IAC5	359-0-0292-00
24VDC	@48MA 50uS response	WRC 1781-IT5S or Gordos SM-IDC5F	359-0-0320-00

OUTPUTS:

12-120VAC @3.5AMP (100AMP for 1 cycle) 3.0MArms max off state leakage 8.33MS (next zero cross on and off) WRC 1781-OAC5S or Gordos SM-OAC5	359-0-0255-00
24-240VAC @3.5AMP (100AMP for 1 cycle) 6.0MArms max off state leakage 8.33MS (next zero cross on and off) WRC 1781-OM5S or Gordos SM-OAC5A	359-0-0255-01
24VDC (5-150VDC) @1AMP (5AMPS for 1SEC non repetitive) 2MA max off state leakage 100uS turn on 750uS turn off WRC 1781-OC5S or Gordos SMODC5A	359-0-0294-00

RELAY MODULE:

5AMP 120 VAC contacts 5VDC coil 100K @5A, +1 MEG @.050A operations	473-0-0369-01

2.0 Architecture

The basic architecture for the Series 400 contains six major components:

2.1 CPU/Timer module 503-2-0324-05
2.2 Back plane assembly 419-1-044X-01 (X=number of slots)
2.3 SCR Firing Module 454-0-0028-01
2.4 I/O Modules 503-1-0324-XX
2.5 Power Supply Module 503-0-0324-XX
1.5 Data Entry Panel (see 1.5)

2.1 CPU/Timer Module 503-2-0324-05 consists of:

Printed circuit board 473-0-0477-01 Weld controller board in an aluminum frame and cover. This module is plugged into a back plane assembly through P1 for connections to power, discrete I/O, Robonet network, Allen Bradley® RIO, DeviceNet and SCR Cascading Panels. At the top a 15 pin "D" shell plug P2 labeled “SERIAL PORT” provides a RS485 or RS422 connection. The port supports robot I/O, message display, and printer connections. Below P2 is a 9 pin "D" socket J1 labeled “DATA ENTRY PANEL” for serial connections to a local data entry panel (if used). Below J1 is a green CPU status LED. On the bottom of the module a 25 pin "D" socket J2 for connections to the SCR firing module. The CPU/Timer may be plugged into any firing module connected to any phase. HC16 processor U1 with its firmware U7 and U8 control all control functions, sequencing, current control and monitoring, ladder logic, data entry, network and SPC control. All program functions and data are stored in EEPROM U7. IF **ANTI-STATIC** PRECAUTIONS ARE CAREFULLY OBSERVED, stored programs in one board may be transferred to another by exchanging EEPROMs. Stepper program counts and latched bits are stored in RAM U13 and U15 via pin 32 (+5B) a 3.6 Volt battery B1. Networking is through T1 and T2 a 4 wire transformer coupled duplex at 19.2 KBaud. Connections between the CPU and a Data Entry Panel are via U5A, U6A RS422 at 9.6KB through J1-5 through 8. Connections between the CPU and the serial communications port P2 is through U11, U5D and U6B RS422 or 485 (W4 and W5) at user specified baud rate (W3).

Once a CPU/Timer is plugged into a slot and programmed, it memorizes the slot number with the program and will refuse to run in another slot unless the RESET key is pressed. The program should be reviewed for conformance to this new slot before resetting. A warning message (not a fault), is displayed:

"CONFIRM SLOT SETUP & RESET"

A master bus arbitrator makes I/O connections between all CPU/Timer modules and I/O modules. Any CPU/Timer, A-B RIO module or DeviceNet module may act as the master bus arbitrator. The master bus arbitrator assumes its role in Slot 0, therefore there must be a master installed in slot 0. There cannot be any empty slots or I/O modules between the master and any other CPU/Timer(s), A-B RIO modules or DeviceNet modules. There may be empty slots between the last CPU/Timer, A-B RIO or DeviceNet module and any discrete I/O or SCR cascade modules.

2.1.1 "W" Jumpers and SW1 Description

On the Series 400 HC16 CPU/Timer PC board 473-0-0477-01 there are 26 .1 "W" jumpers. In the following list (normal) indicates where the jumper is installed at shipment.

JUMPER — DESCRIPTION

W3 P2 Serial port baud rate

1-2 19200 Baud (Nadex interface)
3-4 9600 Baud (normal) (Johnson Controls® interface)
5-6 4800 Baud
7-8 2400 Baud

W4 P2 Serial port transmission full/half duplex control
(Note two jumpers necessary to complete assignment)

1-2 FDX (Full Duplex 4 wire normal) #1->o o
2-3 HDX (Half Duplex 2 wire) o o
4-5 FDX (Full Duplex 4 wire normal) #3->o o<-#6
5-6 HDX (Half Duplex 2 wire)

W5 P2 Serial port transmission RD/CTS control
(Note two jumpers necessary to complete assignment)

1-2 RD (Receive Data normal) #1->o o
2-3 CTS (Clear to Send) o o
4-5 RD (Receive Data normal) #3->o o<-#6
5-6 CTS (Clear To Send)

W6 Software Features

1-2 Enable local DEP lockswitch (normal)
3-4 Enable writing to LIBRARY programs (see 13.2).
Also enables “unlock” to a ROPEs DEP locked out

W12 Battery

1-2 Ship
2-3 Run (normal)

W13 1-2 Secondary toroid coil range
W14 1-2 <--Jumper positions and pins are arranged as shown.
Recalibration is necessary whenever the range is changed.
See Setup 11.9.

RANGE	W13	W14	MAXIMUM CURRENT
0	ON	ON	16KA
1	OFF	ON	20KA (normal)
2	ON	OFF	50KA
3	OFF	OFF	100KA

W15 EEPROM Size (jumper not installed)

1-2 Defaulted in foil for 32K part
2-3 Future 64K or 128K part

W16 EEPROM Size (Jumper not installed)

1-2 Defaulted in foil for 32K part
2-3 Future 64K or 128K part

W18 RAM Size

1-2 256K part
2-3 64K part (normal)
4-5 256K part
5-6 64K part (normal)

SW1 SW1-2 through 8, Robonet network address switches, binary coded and a **closed switch provides its binary weight**. Switch settings 64 and lower sets network address (hardware coded). Switch settings above 64 provides a software set address under SET-UP 11.10. Switch setting 0000000 keeps the control off line and can only be accessed by data entry panel. SW-1 controls the Nadex® SIO protocol or SCC® Display link. The robot address is set under Setup Robot ID 11.11.

SW1-1 Nadex® SIO/SSC® display link:
open=SCC® Corp Display
closed=Nadex®/Kawasaki®/Nachi® robots and PLC Direct/KOYO® PLC SIO
(check W3 1-2 for 19.2 KBaud)

SW1-2 binary 64
SW1-3 binary 32
SW1-4 binary 16
SW1-5 binary 8
SW1-6 binary 4
SW1-7 binary 2
SW1-8 binary 1

2.1.2 Green CPU Status LED

The status LED displays the status of CPU on the 473-0-0477-01 Weld Controller board. It also indicates relationship of other CPU/Timers on the bus:

ON	The uProcessor is running okay and this (slot). This Timers uProcessor is not asserting a bus fault. See 12.4.
BLINKING	The uProcessor is not running properly. Observe the main status screen. This CUP/Timer is asserting a bus fault.
OFF	The Weld uProcessor did not make it through power up initialization and is not running or running properly. This card is most likely asserting a bus fault.

2.2 Back Plane Bus Assembly

The Back Plane Bus assembly is part number 419-0-044X-01, where X=number of user slots. It contains a printed circuit board 473-0-040X-01 where X=number of user slots plus 1 slot to accept certain styles of power supply modules (-01 through -03). The back plane bus assembly contains high speed bus termination, power up reset circuitry and two wire harnesses to accept a new style power supply module (-11 through -17). Any combination of CPU/Timers and I/O modules may be plugged into the back plane. Once a CPU/Timer is plugged into a slot and programmed, it memorizes the slot number with the program and will refuse to run in another slot unless the RESET key is pressed. The program should be reviewed for conformance to this new slot before resetting. A warning message (not a fault), is displayed:

"CONFIRM SLOT SETUP & RESET"

2.2.1 Master Bus Arbitrator

Any CPU/Timer, A-B Remote I/O or DeviceNet Interface Module may act as the master bus arbitrator. The master assumes its role in Slot 0, therefore a master module must be installed in slot 0. There cannot be any empty slots between the master in slot 0 and any other masters. There may be empty slots between masters and I/O modules.

General rules:

A. **Never install or move any module with the power on**. It is possible to damage the I/O interface logic. (U38, U39, U40, and/or U29 see schematic 473-0-0477-01 sheet 4 of 9)

B. **There must be a CPU device in slot 0 capable of bus arbitration**. CPU/Timer, ABRIO or DeviceNet module.

C. **There cannot be a gap between CPU modules.** No empty slots, I/O or cascade modules between CPU’s. There may be empty slots between the group of CPU modules on the left and I/O cascade modules on the right.

D. **ALWAYS review the program of a CPU/Timer occupying a new slot**. When CPU/Timers are moved from slot to slot or installed from another system, bus faults will occur upon power up. This is because a CPU has memorized the slot it last occupied and could be dangerous to run in another slot. To reset the bus fault a data review should be made in the CPU/Timers new slot and the Fault Reset key pressed while viewing the message "CONFIRM SLOT SETUP & RESET". Bus fault logic is "wired OR'd" through P1-13 U37 pin 22 OUTPUT to the backplane and U27 pin 11 INPUT from backplane. Therefore all CPU/Timers with bus faults or the slot setup warning message must be reset before the master bus arbitrator in slot 0 will permit operation.

2.3 SCR Firing Module

The 454-0-0028-01 SCR firing module contains printed circuit board 473-0-0370-01. On this board are circuits for SCR firing T1, overtemp monitoring and firing power supply D1 and C3 and contactor feedback status U1 and U3. Line voltage (phase and amplitude) U1, and firing pulse-indicating LEDs. The connections to the SCR are made via labeled stab terminals. Once the SCR is properly hooked up connection to the CPU/Timer is made via a 25-pin RS232 extension cable (shielded 25 plug/socket wired pin to pin). Weltronic part number 402-0-1051-XX where XX=length in feet. This cable plugs between J2 on the CPU/Timer and CNTH on the Firing Module. Connections between any CPU/Timer modules to any SCR firing module, on any phase may be made.

CAUTION:

Turn OFF power before changing connections. Also make sure the green wire on the module is attached to the cabinet ground.

2.4 I/O Module 503-1-0324-XX

This basic I/O module provides 10 inputs, 16 outputs and 2 SFCR (safety relay) status bits. The module consists of printed circuit board 473-0-0337-XX in an aluminum frame and cover.

The module is plugged into a back plane assembly through card edge BKPL for connection to power and the arbitrated I/O system for high speed connections to CPU/Timer modules. Connection to the inputs and outputs are make through a 38 terminal edge connector TS1. Voltage for the inputs and outputs must be user supplied. TS1-1 (Input X2) TS1-2 through 4 for common input power (X1) 24VAC (-11) or 120VAC (-12), and TS1-15, 16, 21, 26, 31, 33, 35 and 37 for X1 output power.

-NOTICE-

THE USER MUST SUPPLY TERMINATION FOR X2 CONNECTIONS FOR OUTPUTS. THE OUTPUT X2 MAY BE MADE COMMON WITH INPUT X2 (TS1-1) OR REMAIN ISOLATED. THE USERS OUTPUT X2 SHOULD BE CONNECTED TO EARTH FOR SAFETY.

CAUTION: IF 120 VOLTS IS APPLIED TO 24V VERSION DAMAGE WILL OCCUR TO THE INPUT MODULES AND RELAYS ESCR, SFCR. ESCR AND SFCR ARE SOLDERED IN PLACE AND VERY DIFFICULT TO REMOVE. IF 24 VOLTS IS APPLIED TO THE 120 VOLT VERSION ERRATIC OR NO OPERATION MAY RESULT.

SFCR is a pilot safety relay which protects outputs 1 through 4 if the user applies output X1 power to terminal TS1-15. SFCR will remove the X1 power from these outputs unless a pilot is applied to one of the first four inputs. Therefore, outputs 1 through 4 are failsafe, they cannot output at rest if they become shorted. SFCR becomes energized through a diode DO1 through DO4 when a pilot is applied, the user must either keep one of these inputs applied (hands on the initiation), or program one of the failsafe outputs on to "latch" in SFCR through a diode DO7 through 10. If latching is desired, the latching output should not be programmed on until it is safe to do so. If safety is not a issue, simply apply X1 power to TS1-16 and insert jumper J5. If more then 4 ports must be failsafe, TS1-15 and 16 may be used for X1 power to other outputs but only if J5 is inserted. Also notice a N.O. & N.C. set of contacts of SFCR are available for the users view. They may be viewed through the 11th and 12th bit respectively of the programmed memory bits to slot setup (see 11.19). The users program may examine these bits to determine if SFCR is energized, i.e. the initiation is still applied.

The ports to I/O set-up for modules are:

INPUTS

Port 0 Inputs 1 through 8
Port 1 Inputs 9 and 10 (bits 11 and 12 reflect SFCR status and bits 13 through 16 CANNOT be used on -0324-xx modules.)

Port 2 Inputs 17 through 24 (Used on 32 bit input modules only)
Port 3 Inputs 25 through 32 (Used on 32 bit input modules only)

OUTPUTS

Port 4 Outputs 1 through 8 (possible safety relay latch output)
Port 5 Outputs 9 through 16
Port 6 Outputs 17 through 24 (Used on 32 bit output modules only)
Port 7 Outputs 25 through 32 (Used on 32 bit output modules only)

The overlay on the face of the modules show the Port number, I/O status LED (the number in the I/O status window), I/O schematic and terminal number. It is important that the user fill in the memory mapped bit number on the inside and the terminal mnemonic on the outside of the terminal cover. Lack of good documentation will cause frustration at start up and increase down time in the future.

2.4.1 I/O Module Charts

The following charts display Series 400 I/O modules that are available. They show features, part numbers and layout. The column labeled SAFE displays the output that is jumpered safe. See 14.0 foldout schematics for more detail:

10 INPUTS AND 16 OUTPUPS WITH SAFETY RELAY MODULES

INPUTS	OUTPUTS	SAFE PORT	SFCR RELAY	ESCR RELAY	MODULE AND BOARD NUMBER
10 120VAC 3590029200	16 120VAC 3590025500	#17	YES 3040062000	YES 3040062200	5031032411 4730037300
10 24VAC 3590029300	16 120VAC 3590025500	#17	YES 3040061700	YES 3040062100	5031032412 4730037300
10 120VAC 3590029200	6 120VAC 3590025500 10 RELAY 4730039601	#17	YES 3040062000	YES 3040062200	5031032413 4730037300 17-20, 29, 32 120VAC
10 24VDC 3590029300	16 120VAC 3590025500	#17	YES 3040061700	YES 3040061700	5031032414 4730037300
10 24VDC 3590029300	16 120VAC 3590025500	#20	YES 3040061700	YES 3040061700	5031032415 4730037300
10 24VDC 3590029300	16 RELAY 4730039601	#17	YES 3040061700	YES 3040061700	5031032416 4730037300
10 24VAC 3590029300	15 120VAC 3590025500 1 RELAY 4730039600	#17	YES 3040061700	YES 3040062100	5031032417 4730037300 RELAY IN OUT #32
10 24VDC 3590029300	16 24DC** 3590029400	N/A sinking	YES 3040061700	YES 3040061700	5031032418 pend.*layout
10 120VAC 3590029200	12 120VAC 21 THRU 24 4-20MALOOP	#17 #18	YES 3040062000	YES 3040062200	5031032419 4730037300 4730041601
10 24VDC 3590029300	16 120VAC 3590025500	#17 #20	YES 3040061700	YES 3040061700	5031032420 4730037300
10 24VDC 3590029300	16 120VAC 3590025500	NONE	YES 3040061700	YES 3040061700	5031032421 4730037300
10 120VAC 3590029200	16 120VAC 3590025500	#17 #18	YES 3040062000	YES 3040062200	5031032422 4730037300
10 120VAC 3590029200	10 RELAY 4730039601 6 120VAC 3590025500	#17	YES 3040062000	YES 3040062200	5031032423 4730037300

*SOURCING **SINKING

32 INPUTS OR 32 OUTPUTS MODULES

INPUTS	OUTPUTS	SAFE PORT	SFCR RELAY	ESCR RELAY	MODULE AND BOARD NUMBERS
32 120VAC 3590029200	NONE	NONE	NONE	NONE	5031032501 4730037801
32 24VACDC 3590029300	NONE	NONE	NONE	NONE	5031032502 4730037801
4 24VDC 3590032000 4 120VAC 3590029200 8 24VDC 3590032000 16 24VACDC 3590029300	NONE	NONE	NONE	NONE	5031032503 4730037801 4DCF PORT 0 4AC PORT 0 8DCF PORT 1 8AC PORT 2 8AC PORT 3
16 24VDC 3590032000 16 120VAC 3590029200	NONE	NONE	NONE	NONE	5031032504 4730037801 DCF PORT 0&1 AC PORT 2&3
NONE	32 120VAC 3590025500	NONE	NONE	NONE	5031032601 4730037901
NONE	32 24VDC * 3590029400	NONE	NONE	NONE	5031032602 4730037901
NONE	16 24VDC * 3590029400 16 120VAC 3590025500	NONE	NONE	NONE	5031032603 4730039701 DC PORT 4&5 AC PORT 6&7

*SOURCING **SINKING

16 INPUTS AND 16 OUTPUTS MODULES

INPUTS	OUTPUTS	SAFE PORT	SFCR RELAY	ESCR RELAY	MODULE AND BOARD NUMBERS
16 120VAC 3590029200	16 120VAC 359025500	NONE	NONE	NONE	5031032701 4730041501
16 24VACDC 3590029300	16 120VAC 3590025500	NONE	NONE	NONE	5031032702 4730041501
16 24VDC 3590032000	16 24DC* 3590029400	NONE	NONE (In fast)	NONE	5031032703 4730041501
16 24VACDC 3590029300	16 24VDC* 3590029400	NONE	NONE (In slow)	NONE	5031032704 4730041501
16 24VACDC 3590029300	16 24VDC** 3590029400	NONE	NONE (In slow)	NONE	5031032705 4730043001
15 24VDC 3590029300 1 LOGIC IN PRESSURE ACHIEVED	10 24DC* 3590029400 2 120VAC 3590025500 4-20ma	NONE	NONE (In slow)	NONE	5031032706 4730041501 4730044801 4-20ma PRESS CONTROL
15 120VAC 3590029200 1 LOGIC IN PRESSURE ACHIEVED	12 120VAC 3590025500 1 4-20ma	NONE	NONE	NONE	5031032707 4730041501 4730044801 4-20ma PRESS CONTROL
16 120VAC 3590029200	16 24DC* 3590029400	NONE	NONE	NONE	5031032708 4730041501

*SOURCING **SINKING

Part Number	Description
304-0-0617-00	Relay Guardian® 1315P-4C-24D W/PC Pins
304-0-0621-00	Relay Guardian® 1310P-4C-24A W/PC Pins
304-0-0622-00	Relay Guardian® 1310PVS-120A Sealed W/PC Pins
304-0-0620-00	Relay Guardian® 1315PS-110D
359-0-0255-00	Gordos® SMOAC5 120VAC TRAIC Output, 5V logic input
359-0-0255-01	Gordos® SMOAC5A 240VAC TRAIC Output, 5V logic input
359-0-0292-00	Gordos® SM-IAC5 120VAC/DC Input, 5V logic output
359-0-0293-00	Gordos® SM-IAC5E 24VAC/DC Input, 5V logic output
359-0-0294-00	Gordos® SM-ODC5 3-60VDC Output, 5V logic input
359-0-0320-00	Gordos® SM-IDC5F 2-30VDC fast Input, 5V logic out
473-0-0396-01	Relay Output PC board 5A contacts 5VC coil uses:
304-0-0624-00	Relay Guardian® 1675-DC 5V

2.5 Power Supply Module 503-3-0324-XX

The power supply module supplies +5VDC, +24VDC, and -12VDC to the backplane to power modules and supply optional +24VDC power for DC I/O. Connections to the backplane are made with two harnesses via "in line" connectors. The 36 pin PC edge connector on the backplane below the power supply is no longer used. The connector received power from a earlier power supply module design which is no longer available. Connection for the optional +24VDC I/O power is made through a white 6-pin connector at the bottom of the module. See 1.8 for detailed electrical specifications. Power supply modules are sized to a rack by the total module "weight" in that rack where:

```
                  CPU/Timer = 1
           ABRIO I/O Module = 1
         SCR Cascade module = 1
        Discreet I/O Module = .5
Fluorescent Data Entry Panel = .5
 All other Data Entry Panels = Included
```

Simply sum up the rack weight and choose from the following chart. For a system weight over 9 call Weltronic. The Power Supply Module will be 503-3-0324-XX where XX=

-21 Supports a system weight up to 3. It features a IDP 45 watt Model SRW-45-3001 outputting +5V/5A, +12V/3A, -12V/.7A. Weltronic part number 343-0-0141-00.

-22 Supports a system weight up to 3. It features a IDP 65 watt Model SRW-65-4003 outputting +5V/5A, +12V/2A, -12V/2A, and 24V/1A for DC I/O option. Weltronic part number 343-0-0142-00.

-23 Supports a system weight up to 9. It features a IDP 115 watt Model SRW-115-3001 outputting +5V/12A, +12V/4A, -12V/2A. Weltronic part number 343-0-0144-00.

-24 Supports a system weight up to 9. It features a IDP 115 watt Model SRW-115-4002 outputting +5V/12A, +12V/4A, -12V/2A, and 24V/1A for DC I/O option. Weltronic part number 343-0-0145-00.

-26 Supports a system weight up to 5. It features a IDP 115 watt Model SRW-115-3001 outputting +5V/12A, +12V/4A, -12V/2A. Weltronic part number 343-0-0144-00.

-27 Supports a system weight up to 5. It features a IDP 115 watt Model SRW-115-4002 outputting +5V/12A, +12V/4A, -12V/2A, and 24V/1A for DC I/O option. Weltronic part number 343-0-0145-00.

-CAUTION-

A first sign of insufficient power is the resetting of a CPU/Timer upon plugging a data entry panel into the CPU with power applied. The reset action may cause memory errors and erratic operation and could be a safety hazard. If CPU resetting occurs, the next size power supply module must be installed. If resetting occurs using the -23 or -24 modules consult WTC.

Shorting or injecting foreign I/O power into the +24VDC may destroy a switcher supply.

3.0 Options

In addition to various Data Entry mode choices, cabinet size, SCR and Circuit Breaker sizes and future I/O module options, other options are available:

3.1 SCR Cascade Module
3.2 Allen Bradley® Remote I/O Module
3.3 Remote Sequence Selector
3.4 Remote Thumbwheels
3.5 Kawasaki®/Nachi®/PLC Direct®/KOYO® SIO Interface
3.6 Static Controls Corp® Display
3.7 DeviceNet Remote I/O Accessory
3.8 Data Export
3.9 In Sequence On Line Data Changes
3.10 Keyboard Override Options

3.1 SCR Cascade Module (503-7-0324-xx)

By employing 503-7-0324-xx cascade module(s) (up to 4) one CPU/Timer control can address up to sixteen SCR contactors in a cascade system. The SCRs are hooked up in groups of four SCRs per steering module. There may be more then one cascade system per rack, but only one CPU/timer per cascade system. A 503-7-0324-01 steering module can address SCRs installed on the same phase only, but the 503-7-0324-02 module can address SCRs installed on any phase. Each steering module in the SAME system MUST receive the SAME steering DATA but have a DIFFERENT GROUP NUMBER selected by the GPXX jumpers inside the modules. If there is only one cascade module in a system jumper J1 must be jumpered LAST, if there is more then one, the last module must be jumpered LAST and all proceeding modules jumpered MORE. After proper hook up each SCR contactor may be selected and fired in cascade mode (ONLY) by employing the "Contactor Select yy" instruction code #51. After the contactor is selected a one cycle delay and delayed firing is automatically implemented after which any other function may be executed. A new contactor in any order may then be called and the process repeated. See Section 2 and 4, "Contactor Select yy" and schematic drawing 473-0-0374-01 for more detail. If there is more then one Cascade module in a rack, it is very important for the user to mark each modules configuration. This may done in pencil in the boxes provided on the front of each module.

Failure to mark configuration could cause problems in the future especially if there is more then one system in a rack and steering modules are substituted.

3.2 Allen Bradley® Remote I/O Interface Module (454-0-0033-05 & 454-0-0034-01)

The Weltronic® Series 400 ABRIO Interface Module provides a serial "Blue Hose" I/O link between a Weltronic Series 400 rack and Allen-Bradley® PLC5 or SLC remote rack system. To the A-B system the ABRIO Module looks like a full Allen-Bradley® remote rack which is plugged into the Weltronic Series 400 rack system. This interface between systems is accomplished by Allen-Bradley® AB 1771-NAK1 Node Adapter Chip Set.

The ABRIO module is plugged into the Weltronic Series 400 rack system and is interconnected to the A-B PLC5 Programmable Controller.
The connection is made via REM I/O plug/terminals on each unit. Only one ABRIO module may be used per Series 400 rack. It may be plugged into any slot. The ABRIO module will not reflect the physical slot number it is plugged into, but assumes logical slots 16 and 17. Any Series 400 CPU/Timer plugged into the same rack may address slots 16 and 17.

This is done in the Set-Up of each timer by addressing the internal bits of each CPU/Timer to Slot 16 IN (inputs from AB's outputs) or Slot 17 OUT (outputs to AB's inputs). See 11.18 for more set-up detail. In the following description the term INPUT refers to inputs into a Series 400 CPU/Timer and OUTPUT refer to outputs from a Series 400 CPU/Timer.

If the AB system is set up for a full rack, logic slot 16 provides sixteen 8 bit input ports (128 inputs from AB's outputs). Logic slot 17 sixteen 8 bit output ports (128 outputs to AB's inputs). Any (or all) CPU/Timer(s) may read any single port in slot 16, but only one CPU/Timer may write to any one 8 bit port in slot 17. Another way of visualizing the above is that any or all CPU/Timers can listen to any input port without quarreling. But only one timer may write to one single output port. If two or more try, contention will surely arise between the CPU/Timers on what is to be outputted to the port. By DIP switch SW3 the first two 8 bit output ports writing to A-B may be real AB local inputs. And the first two input port from A-B may be outputted as real local outputs. This I/O may be considered as Allen Bradley® I/O and is addressed and displayed in the normal AB addressing system. The inputs are 24VAC/DC and the outputs are 120VAC. In the case of the first two input ports (from A-B), if they are routed to the local outputs via SW3, they may also be read by any CPU/Timer. But if SW3 is set to route the local inputs to A-B and a CPU/Timer also writes to the same output ports, the local A-B inputs will always write over the CPU/Timers. There is no argument in this case, the local inputs will always override the CPU/Timer. The CPU/Timers output will be lost. See See Section 3 for more detail.

3.3 **Remote Sequence Selector** (519-1-0358-01)

An externally mounted box which contains hexadecimal thumbwheel switches. The box may be used for 1 to 15 sequence selection. The box may also be used for 1 to 15 Weld Schedule selection using a port controlled instruction #59 Call Weld Schedule and the subroutine header #49 Weld Schedule pp. The switches are for 24V operation only.

3.4 **Remote Thumbwheels**

Single Remote heat	(550-5-0235-01)
Weld and Percent Heat	(550-5-0236-01)
Five Function Thumbwheel Set	(550-5-0237-01)

With the use of instructions #27, 28, 29, 88, 89, memory map control bits 368 and 369 and through ladder logic instruction #18 any combination if remote **BCD thumbwheel pairs** (up to 16) may be read. The incoming BCD data may be inserted into any sequential program, timing, heat, current or both. See 10.1.18 and section 2 for more detail. The five function thumbwheel set is available labeled Squeeze, Weld, Hold, Off, and Percent Heat or unlabeled for user's custom thumbwheel assignments. The user must supply any other combination of thumbwheels.

3.5 Kawasaki®/Nachi®/PLC Direct®/KOYO® SIO Interface

A Nadex® Protocol RS485 multi-drop (15 max) half duplex serial remote I/O interface to Kawasaki®/Nachi® robots and PLC Direct®/KOYO® PLCs may be made through serial port (P2). All weld controls on the network are slaves to the Robot or PLC master and will transmit only when polled. Up to 128 inputs, (16 Ports of 8) may be received through logical slot 18. Also 128 outputs (16 Ports of 8) may be sent to the robot through logical slot 19. The master upon power up transmits the actual number of 8 bit I/O ports to the control. The Series 400 responds to the set up and displays it under View Data. The weld controls address on the robots I/O network is set under Set Up. Simply SET-UP memory map bits 1-8 (or any other bits) to Slot 18 IN for initiation, emergency stop and Weld/No weld control. Outputs to the robot must be setup Slot 19 OUT. The robot will receive them contiguously. Fault codes may be dispatched from memory map bits 400 through 407 through any desired output bits.

Electrical hookup (402-0-1048-02):

SERIES 415 P2 DB PIN#	SHIELDED TWISTED PAIR	KAWASAKI® ROBOT IAS BOARD TERM#
D+ 7	White	5 S+
D- 8	Black	7 S-
GND 9	Shield	6 GND

SERIES 415 P2 DB PIN#	SHIELDED TWISTED PAIR	NACHI® ROBOT UM873 TERM#
D+ 7	Blue	14 S+
D- 8	Clear	15 S-
GND 9	Shield	OPEN

SERIES 415 P2 DB PIN#	SHIELDED TWISTED PAIR	PLC DIRECT® REMOTE I/O MASTER TERM#
D+ 7	White	1 S+
D- 8	Black	2 S-
GND 9	Shield	3 GND

Hardware setup:

SW1-1 **CLOSED** (See 2.1.1)
W3 19200 Baud 1-2
W4 HDX (Half Duplex) 2-3 & 5-6
W5 RD (Receive Data normal) 1-2 & 4-5

Please read 1.6, 2.1.1, 5.1, 5.4, 8.2, 11.11, 11.12, 11.17 and 11.18 In 2.1.1 observe carefully W4 and W5 pin arrangement.
Also see Schematic #473-0-0477-01 Sheet 1 of 2.

3.6 Static Controls® Corp Display (SCC)

The Series 415 supports transmission of BCD fault "Messages" or "Data" to a SCC display through the serial port (P2) on the front of the CPU/Timer. Messages/data will be dispatched from memory map bits 400 through 407 by PLC program. See 2.1.1, 10.1.20 through 10.1.23, 5.0, 5.4 memory map bits 396 through 407. Reception of data by the Series 415 is not supported at this time therefore P2 pins 7 and 8 may be ignored.

Electrical hookup:

```
SERIES 415                  SHIELDED                        SCC
P2 DB PIN#                TWISTED 2 PAIR                  TERM#

 T+ 5------------------------Red---------------------->10 COMM1+
 T- 6------------------------Black---------------------->9 COMM1-
GND 9------------------------Shield--------------------6 COMM GND
 R+ 7<-----------------------White---------------------8 COMM2+
 R- 8<-----------------------Green---------------------7 COMM2-
```

Hardware setup:

SW1-1 OPEN
W3 19200 Baud 1-2
W4 FDX (Full Duplex) 1-2 & 4-5
W5 RD (Receive Data normal) 1-2 & 4-5

3.7 DeviceNet Remote I/O Module (452-0-0035-01)

The Series 400 DeviceNet Remote I/O module provides a serial DeviceNet **slave** I/O link between a S400 rack and any DeviceNet **master**. To the S400 rack the interface looks like 64 inputs through logical slot 16 ports 0-7 and 64 outputs through logical slot 17 ports 0-7. The I/O is presented to the backplane for use by any CPU/Timer module in the rack. There is also 16 24VAC inputs and 16 120VAC 1 AMP outputs available on the module to any CPU/Timer in the rack or the DeviceNet master. Interface is accomplished via 82C250 CAN chip and Motorola HC16 microprocessor on the 473-0-0453-01 S415 DeviceNet Accessory board. The microprocessor (U10) interfaces through P1 plugged into J2 on the 473-0-0454-01 Bus Interface board. The Bus Interface board which also has a HC16 microprocessor (U8) can play the role of master bus arbitrator making the I/O available via slot 16 and 17 to any CPU/Timer in the rack running V7.021 or higher. The following DeviceNet I/O interface with extensive network diagnostics will be featured:

DeviceNet Type	GENERIC	Master/Scanner	NO
Explicit Peer to Peer Messaging	NO	I /O Slave Messaging	NO
I/O Peer to Peer Messaging	NO	Bit Strobe	NO
Configuration Consistency Value	NO	Polling	YES
Faulted Node Recovery	NO	Cyclic	NO
Baud Rates	125K, 250K, 500K	Change of State (COS)	NO
Vendor Number	289	Input/Output byte size	8 each
Product Name	S400DN	Product Code	1

See DeviceNet instruction book 328-0-0654-00 for more detail.

3.8 Data Export

Four types of data may be sent via RS422 through P2, they are:

1. Print Time and Date (see 15.0 code 71)
2. Print Weld Data (see 8.6, 15.0 code 70
3. Print Report (see 13.6)
4. Print ACDC Data (see 5.1 bit 433, 10.8)

Data used by the ACDC Stepper feature and the Current Regulator for constant current control is buffered for up to 15 seconds if continuous. Each time a new sequence is executed the buffer is refreshed. Print out of the buffer may be controlled by the Print report function. The data is very useful for quality control and current control analyses. The example below shows ACDC data, Print View weld data and Print Time and Date. The header above the dashed line will not be printed.

```
HT ==uSEC==       ==uSEC==      CY  PK     AV   ==uSEC==    Line     Primary
CY Fire Hang      Fire Hang     IN  PF SEN PF   Line Clk   Voltage   Current
AC  FT+  HT+  PF+ FT-  HT-  PF- SEQ CU CU  CU   ZC+  ZC-   V+   V-   I+  I-
-------------------------------------------------------------------------------
 1 7447 1525  65 6629 1842  67   1   0   0 166 10012 10001 117 117   56  112
 2 5969 2008  68 5729 2084  66   2   0   0 169 10020  9998 117 117  164  181
 3 5482 2128  68 5359 2180  67   3   0   0 171 10010  9991 117 117  198  211
 4 5283 2185  67 5332 2195  65   4 170   0 170 10014  9992 117 117  218  215
 1  1 117VL 117V   211A .66PF     5C <--(Weld Data see 8.6, first screen only)
 09:13  04/17/95 <--(Time and Date see 13.5 also Section 2 Page 141)
```

TERMS:

1. HT CY AC — Heat Cycle After Cool (reset every cool instruction).
2. Fire FT+ — Firing angle Time (lead from zero cross) in microseconds
3. Fire HT+ — Hang over Time (lead from zero cross) in microseconds
4. PF+ PF- — Power Factor for lead and trail cycle
5. Fire FT- — Firing angle Time (trail from zero cross) in microseconds
6. Fire HT- — Hang over Time (trail from zero cross) in microseconds
7. CY IN SEQ — Cycle In the Sequence (256 max number, 256 repeated)
8. PK PF CU — Peak Power Factor in Computer Units used in ACDC stepper
9. SEN CU — Sensitivity in Computer Units (Power factor drop from peak)
10. AV PF CU — Average Power Factor in Computer Units
11. ZC+ ZC- — Line Clock (zero cross) lead and trail in microseconds
12. V+ V- — Line Voltage lead and trail in volts
13. I+ I- — Line amperes lead and trail in amperes

Electrical hookup (402-0-1048-02):

```
SERIES 415        BLACK BOX® 485<->232 CONVERTER       PC COM1
P2 DB15 Pin#           485 IN    232 OUT (25DB)       PORT DB9 Pin#

 D+ 7-------White-------->RXB---->DB7--------------->5 Signal GND
 D- 8-------Black-------->RXA---->DB3--------------->2 Receive Data
GND 9-------Shield------OPEN
```

Hardware setup:(402-0-1048-02):

15DB female connector necessary for P2 connection
RS485 to RS232 Converter for PC interface
SW1-1 OPEN
W3 19200 Baud 1-2 (or user choice)
W4 HDX (Half Duplex) 2-3 & 5-6
W5 RD (Receive Data normal) 1-2 & 4-5
Set bit #433 for ACDC Stepper data (See 10.8)
See 15.0 sequential instructions codes 70 and 71

3.9 In Sequence On line Data Changes (359-0-0336-00)

Normally all programs and data is stored in EEPROM U4. Because EEPROMS are slow during data write all data changes are made between sequence runs. Hence the message displayed "Waiting For End Of Sequence". If Part number 359-0-0336-00 DS 1230AB-200 256K Nonvolatile SRAM is installed in U4 data changes will be accepted immediately during sequence.

3.10 Keyboard Override Options

The control offers keyboard options that will override conditions that might be considered a dilemma or hazardous.

3.10.1 "Pilot Not Clear" Message

If a sequence has ended in the Off Single instruction and at that time the pilot is applied, the control will refuse to repeat the sequence (anti-repeat). The message “Pilot Not Clear” will be displayed. To repeat the sequence the pilot must be removed and reapplied. Or if the pilot cannot easily be removed and reapplied, the anti-repeat condition may be overcome by pressing the FUNCTION SELECT then CLEAR keys. **CAUTION:** The sequence will **immediately** run again! In firmware version V8.016 and earlier the FUNCTION SELECT then RESET keys must be pressed.

3.10.2 Forcing Program Mode

The control will normally finish a sequence before it enters Program Mode. If the keyswitch is placed in Program mode during a sequence that will never end, such as WAIT for XXX True instruction and XXX is never satisfied, the sequence may be ended by first placing the control in PROGRAM Mode, then pressing the FUNCTION SELECT then RESET keys. **CAUTION:** The control will go into program mode and end the sequence, but the machine may now be "Out of Sync" and damage may occur upon re-initation.

4.0 Current Control Features

There are two modes of current control, *percent of available current* and *constant current*. Current mode control is accomplished by executing current control instructions in the users program, of any mode at any time in any order.

4.1 Percent Available Current Mode

By employing sequential current control instructions ranging from codes #3 through #41, 20-99% percent of available RMS current will be delivered to a welding transformer primary. The current delivered depends upon line voltage and the secondary impedance with automatic power factor compensation through a range of.3 to .98. Automatic Voltage compensation (AVC) may be included by programming a AVC set point in Set-up. Automatic Voltage Compensation is accomplished by reading voltage and dividing into the programmed AVC set point value then multiplying by the called for percent current in the instruction. If possible the new percent value is displayed in parenthesis. If the results of the calculation is greater then 99% the COMPENSATION OVER 99% fault is indicated. If the results of this calculation become less then 20% heat output, the COMPENSATION UNDER 20% fault is indicated.

Delayed firing at 87 1/2 degrees is automatically applied at 99% heat. Delayed firing is also automatically "pulled back" at lesser heats and "reverted back" to during pulsation in a way that prevents weld transformation saturation. This Weltronic patented feature allows pulsation welding employing a wound core welding transformer to a degree never before possible. The delayed firing feature may be removed by setting bit 382. A HEAT RESET instruction which forces the heat control to 87 1/2 degree firing at any time is available. See instruction number 52.

4.2 Constant Current Modes

By employing instruction codes #80 through #87 a constant current at +-3% will be delivered to the weld transformer. There are two modes of constant current control, read and regulate *primary*, read *secondary* and regulate primary. Primary mode regulation is accomplished via a current transformer pick-up placed in the primary. And by program a turns ratio if 1-200 is placed in a Trans Turns Ratio instruction which is placed ahead of constant current instruction(s). If no transformer turns ratio instruction is entered, or if so and the ratio is 1, the current requested in the constant current instructions that follow will be in primary amperes. If a proper transformer turns ratio is entered, then secondary current may be entered, in amperes, ranging from 1000 to 65000A in the constant current instructions that follow.

Secondary mode regulation is accomplished via a toroidal pick-up placed in the secondary. The user must enter a transformer turns ratio 0 in a Trans Turns Ratio instruction placed in front of the constant current instructions that follow. The requested secondary current is entered, in amperes, ranging from 1000 to 65000A.

The current transformer and/or toroid pickups are connected to the 454-0-0028-01 firing module. Proper selection is accomplished via the data in the Trans Turns Ratio instruction. Where Trans Turns of 1-200 causes the heat control to read (and multiply the reading by the ratio number for display purposes) and regulate primary current. Transformer Turns Ratio of 0 reads secondary directly and regulates the primary current to the proper secondary current requested.

4.3 Current Control Regulation Speed

There are two types of welding transformers; stacked EI iron core which are physically large per KVA size and "C" core which are much smaller per KVA size. Stacked Iron transformers are, by nature, forgiving in terms of flux density and unbalance and therefore are hard to magnetically saturate. "C" core transformers, because of size, operate near magnetic flux saturation and under certain conditions will saturate easily. Saturation will be detected by a rumbling, barking or thud noise coming from the transformer. When the transformer saturates primary current will be very high and secondary current low, often circuit breakers will trip. Some common causes are; operating the transformer at voltage near or over its rating and while doing pulsation welding. Stepper program boosting the primary voltage over the transformers primary voltage rating. Unbalanced firing between lead and trail half cycles. No first half cycle delayed firing. Also by changing the firing angle between half cycles to quickly.

Because of the algorithm employed and the nature of the process, transformer saturation in "C" core transformers during percent of available current mode seldom occurs. Because constant current is a dynamic process and many "C" core transformers are rated at 440VAC certain restrictions are placed on the control process. These restrictions result in a control process that is slowed down appearing to "slope" between current changes. In most welding cases this slow algorithm is not a problem and will never be noticed. If the user needs a faster process and the transformer can tolerate the increase in speed, it may be increased. The process is controlled by setting control bits 378, 380, 381, and 382 in the memory map, and also by controlling the regulator speed (see 11.17). The bits control feedback and regulation speed and also enable and disable the current control features employed on "C" core weld transformers. Any bit, combination of bits or all bits may be set. A properly selected stacked iron transformer will probably offer no protest to all four bits set. A complex current waveform will be very crisp. If a stacked iron welding transformer is NOT employed and/or the user does NOT fully understand the features listed below, the bits should NOT be set. If "C" core transformers are used, **NEVER** set bit #382 or saturation **WILL** occur. Most 480VAC rated "C" core transformers running under 80% available current will accept bit 380. If pulsation is not used bit 381 will probably also be accepted and the results viewed on a weld scope very noticeable.

378 Enables regulation speed control, 0=3 cycle response. See 11.17
380 Feedback speed. 1=Half Cycle (fast), 0=Full Cycle (slow)
381 1=Inhibits Firing Angle Amortization (built in 1 cycle slope)
382 1=Inhibits firing angle pullback during cool times, deletes the 2/3 way logic and the first 1/2 cycle delayed firing. Employs the .99 P.F. curve @ heat requested for the first half cycle.

The control bits listed above may be set on, or reset off, in any combination during sequence with sequential instructions #16 Output xxx On and #17 Output xxx Off. The bits may be also set logically or permanently on via Ladder Logic program. (see 10.0.) The control bits have been arranged in a manner so that in almost all cases of SPOT welding and most cases of SEAM welding, NO programming action is necessary. If SEAM welding at constant current and at a high rate of speed, setting bit #378 and slowing the regulation speed can prevent a uneven heat pattern, regulating speed very slow may cause hunting. Stitch seaming at high speed will improve by setting bit #382 disabling of delayed firing and pull back, and/or 380 half cycle feedback. CAUTION: Only on stacked iron transformers.

See Section 2 SEAM instructions #37, 38, 85 and 86 for more detail.

5.0 Inputs and Outputs

The I/O map contains 512 bits. These bits are divided into four types.

1. 160 possible real I/O, programmable as inputs (IN) or outputs (OUT) or internal (XXX). They are programmable in groups of 8 through *slots* to *ports* which contain real I/O paths. The first group of 8 bits have assigned default functions, but these functions may be re-assigned to any other group of 8 bits or removed totally. See 11.17. NEVER write to a bit assign as INPUT port even if no hardware is connected to the assignment. NEVER write to a output port that is assigned to another CPU/Timer module in any way. Any or all CPU/Timers in a rack may read any input port.

2. 230 spare internal bits, which have no unassigned function. In addition, any real I/O bits which are programmed XXX internal are considered unassigned. These bits appear as X's in the Set-Up menu (See 11.18). They are used as ladder logic and sequential logic internal use, or as interfacing bits between the ladder logic sequence programs.

3. 113 status and control bits which are pre-assigned to represent the Series 415s' present operating status and provide control of special features. Some bits are set by the control itself by faults and other conditions; they may be examined for special action. Others are reset and control bits, which the users programs may set for special effects and features. By examining these bits a programmer may control the users program by the over all control status. The programmer may monitor, display or reset fault conditions remotely. DO NOT write to a status bit, it is to be considered a INPUT written to by the Series 415 software.

   Example: Bit 431 (IN) the control is in the no weld mode, only the control can input to this bit. But bit #430 (OUT) may be written to by the users program putting the control in No Weld mode.

4. 8 Host workstation control bits are used to serially interface Series 415s on a network to the workstation for status and program control purposes. DO NOT write to these bits, they are written to by the Host workstation.

5.1 512 bit I/O map

00 constant 1 when in run mode and the PLC is running.

----------Physical I/O----------

01 Binary pilot 1
02 Binary pilot 2 **THIS GROUP OF 8 BITS WILL**
03 Binary pilot 4 **HAVE THESE ATTRIBUTES ONLY**
04 Binary pilot 8 **IF "PILOT PORT STARTING AT"**
05 Emergency Stop **IS SET TO 1. SEE 11.18**
06 Weld/No weld
07 Pilot Strobe **only if #412 strobe pilots=1. If 0, spare input**
08 Binary pilot 16 **only if #379=1. If 0, Spare input** (See bit 511)

09 through 16 (8) user defined in, out or internal.

17 through 24 (8) user defined in, out or internal
(Squeeze out defaults to bit 17)
(MC Contactor defaults to bit 18)
(Forge Delay defaults to bit 19)
(End of Hold defaults to bit 20)
(Water valve defaults to bit 21)

25 Thru 32 (8) user defined in, out or internal
33 through 40 (8) user defined in, out or internal
41 through 48 (8) user defined in, out or internal
49 through 56 (8) user defined in, out or internal
57 through 64 (8) user defined in, out or internal
65 through 72 (8) user defined in, out or internal
73 through 80 (8) user defined in, out or internal
81 through 88 (8) user defined in, out or internal
89 through 96 (8) user defined in, out or internal
97 through 104 (8) user defined in, out or internal
105 through 112 (8) user defined in, out or internal
113 through 120 (8) user defined in, out or internal
121 through 128 (8) user defined in, out or internal
129 through 136 (8) user defined in, out or internal
137 through 144 (8) user defined in, out or internal
145 through 148 (4) binary contactor select outputs (145 LSB)
-or-
145 through 152 (8) user defined if instruction #51 is not used.
153 through 159 (7) Call Weld Schedule binary inputs (153 LSB),
-or-
153 through 160 user defined if instruction #59 is not used

---------- Spare Internal ----------

161 through 299 (139) user defined internal bits (OUT)

---------- Status and Control Bits ----------

CAUTION - DO NOT WRITE TO (IN), YOU MAY WRITE TO (OUT). TO RESET ANY FAULT, MOMENTARY SET THE RESET BIT.

```
300 Bus fault status     (IN)
301 Reset Bus fault      (OUT)<-------------|
                                            |
302 User fault 1 status  (IN)               |
303 Reset User fault 1   (OUT)              |
                                            |
304 User fault 2 status  (IN)               |
305 Reset User fault 2   (OUT)              |
                                            |
306 User fault 3 status  (IN)               |
307 Reset User fault 3   (OUT)              |
                                            |
308 User fault 4 status  (IN)           also see
309 Reset User fault 4   (OUT)     bits #436 through 443
                                            |
310 User fault 5 status  (IN)               |
311 Reset User fault 5   (OUT)              |
                                            |
312 User fault 6 status  (IN)               |
313 Reset User fault 6   (OUT)              |
                                            |
314 User fault 7 status  (IN)               |
315 Reset User fault 7   (OUT)              |
                                            |
316 User fault 8  status (IN)               |
317 Reset User fault 8   (OUT)<-------------|

318 Stepper Compensation fault status (IN)
319 Reset Stepper Compensation fault  (OUT)

320 A Stepper Program has ended       (IN)
321 Reset all Stepper Programs        (OUT)

322 A Stepper Program is in step 9    (IN)
323 Reset Stepper Program in 9 fault  (OUT)

324 Primary Overcurrent status        (IN)
325 Reset Primary Overcurrent fault   (OUT)

326 False Current fault status        (IN)
327 Reset False current fault         (OUT)

328 Emergency Stop fault status       (IN)
329 Reset Emergency stop fault        (OUT)

330 Compensation Over 99% fault status (IN)
331 Reset Compensation Over 99% fault (OUT)

332 Compensation Under 20% fault status (IN)
333 Reset Compensation Under 20% fault (OUT)

334 Contactor Over Temperature status (IN)
335 Reset Contactor Over Temperature  (OUT)

336 Half Cycling fault status         (IN)
337 Reset Half cycling fault          (OUT)

338 Contactor Fault status            (IN)
339 Reset Contactor fault             (OUT)

340 Tip Touch fault status            (IN)
341 Reset Tip Touch fault             (OUT)

342 Tips Stuck fault status           (IN)
343 Reset Tip Stuck fault             (OUT)
```

344 Low Battery fault status (IN)
345 Reset Low Battery fault (OUT)

346 Memory Error fault status (IN)
347 Reset Memory Error fault (OUT)

348 Sequencer fault status (IN)
349 Reset Sequencer fault (OUT)

350 Line Clock fault status (IN)
351 Reset Line Clock fault (OUT)

352 Low Primary Current fault (IN)
353 Reset Low Primary Current fault (OUT)

354 thru 362 Internal bits reserved for future faults and flags. May be used as internal memory. But if they are used, future Series 415 software versions may obsolete the users program.

363 Set by a active guns ID bit if programmed in the gun table (LSB) (IN)
364 Set by a active guns ID bit if programmed in the gun table (IN)
365 Set by a active guns ID bit if programmed in the gun table (IN)
366 Set by a active guns ID bit if programmed in the gun table (MSB) (IN)
367 1=1ink all Stepper programs counting and reset (OUT)

368 and 369 control bits are used to configure the PLC MUX instruction. The bits must be set in binary fashion where:

Bit #368	Bit #369	
0	0	Capability mode (V8.017 or prior) Slow scan, %heat and time are 2 digits each, constant current instructions are 3 digits.
1	0	Fast scan, %heat and time are 2 digits each, constant current instructions are 3 digits.
0	1	Fast scan, %heat and time are 2 digits each, constant current instructions are 4 digits.
1	1	Fast scan, %heat and time are 2 digits each, constant current instructions are 5 digits.

370 1=Link Stepper programs 11 to 15 counting and reset (OUT)
371 1=Link Stepper programs 6 to 10 counting and reset (OUT)
372 1=Link Stepper programs 1 to 5 counting and reset (OUT)
373 Set to 1 for 1 PLC scan when CLEAR button is pressed (IN)
374 Set to 1 for 1 PLC scan when FAULT RESET is pressed (IN)
375 1=Fault codes outputted BCD format, 0=Binary format (OUT)
376 1=Sequencer is in sequence. 0=NOT in Sequence. (IN)
377 1=Digital Line Clock Filter. 0=Via 0 cross hardware interrupts
378 1=Enable regulator speed control (See 11.17) (OUT)
379 1=Enable 31 Sequences on bit 8 (IN=binary 16) (OUT)
380 Feedback speed. Half Cycle (fast), 0=Full Cycle (slow) (OUT)
381 1=Inhibits Firing Angle Amortization (built in 1 cycle slope)
382 1=Inhibits firing angle pullback during cool times and (OUT)
deletes delayed firing and 2/3 way logic (3-1/2 cycle slope)
(uses the .99 P.F. curve for the first half cycle)

CAUTION:

380 though 382 are used to control feedback speed and to enable and disable current control features employed on "C" core weld transformers. If a stacked iron welding transformer is NOT employed and/or the user does NOT fully understand these features, the bits should NOT be set. Setting of these bits may cause transformer saturation. If "C" core transformers are used NEVER set bit #382. Please read 4.3, 10.8, 11.17

```
383 Gate Power Supply Fault  ---------------------------------|
384 Ground fault detected          Bits 383 through 394       |
385 Gross over current fault       are used when a HFDC       |
386 DC bus voltage low fault       Contactor is employed      |
387 Device fault                   and Weld mode = HF.        |
388 Spare                          (Series 400 V6.202 only)   |
389 Spare                          They are set for HF        |
390 Spare                          contactor faults and       |
391 DC volt charge up fault        may be transferred to      |
392 Over voltage fault             user faults via ladder     |
393 Discharge resistor open        logic programming.         |
394 Load resistor open fault ---------------------------------|

395 Reset all faults
396 Send Message/Data to SCC Display  1=send 0=No action
397 Send "Data" To SCC display   1="Data" 0="Message Number"
       (See 10.1.20 for more detail on bits 396 & 397)
398 Pilot Not Clear (1=Not clear, 0=Clear)
399 Kawasaki® Robot Link established (1=established)

400 through 407 are set in binary to the assigned priority number of a
               fault.  See 12.0, 5.4, also bits 375 & 396.

400 Fault code binary 01
401 Fault code binary 02
402 Fault code binary 04
403 Fault code binary 08
404 Fault code binary 16
405 Fault code binary 32
406 Fault code binary 64
407 Fault code binary 128

--------------- Status and Control Bits -----------------

CAUTION - DO NOT WRITE TO (IN), YOU MAY WRITE TO (OUT)

408 1=All Steppers are Reset                  (IN)
409 1=Tips Touched 0=Open                     (IN)
410 1=Tips are Stuck 0=Open                   (IN)
411 1=Bad Re-weld 0=OK                        (IN)
412 1=Strobed Pilots enable 0=Debounced Pilots(OUT)
413 1=Software Pilot Strobe, on 0 -> 1 Strobes(OUT)
414 1=Software force to Emergency Stop        (OUT)
415 1=in Lead 1/2 cycle, 0=in Trail 1/2 cycle (IN)
416 1=Enable 1/2 cycle timing mode            (OUT)
      (ALL timing in half cycles 8.333ms)
417 1=Remote I/O link is established          (IN)

418 through 425 8 Host control bits inputted  (IN)
                  by the Robonet network for
                  DOS host control of programs
426 Major Fault has occurred                  (IN)
427 Minor Fault has occurred                  (IN)
428 Stepper End (No longer used)              (OUT)
429 1=Sequencer instruction timeout           (IN)
430 1=Force No Weld mode                      (OUT)
431 1=In No Weld mode                         (IN)
432 1=Force sequencer to Off        (MOMENTARY OUT)
433 1=ACDC Stepper Data Printout (see 3.8)    (OUT)
434 1=Host Up and running                     (IN)
435 1=Network Controller Up and Running       (IN)
```

```
436 1=Set User Fault #1            (MOMENTARY OUT)<------|
437 1=Set User Fault #2            (MOMENTARY OUT)       |
438 1=Set User Fault #3            (MOMENTARY OUT)     also
439 1=Set User Fault #4            (MOMENTARY OUT)   see bits
440 1=Set User Fault #5            (MOMENTARY OUT) #302 through #317
441 1=Set User Fault #6            (MOMENTARY OUT)       |
442 1=Set User Fault #7            (MOMENTARY OUT)       |
443 1=Set User Fault #8            (MOMENTARY OUT)<------|
444 1=Reset Stepper 1/101          (MOMENTARY OUT)
445 1=Reset Stepper 2/102          (MOMENTARY OUT)
446 1=Reset Stepper 3/103          (MOMENTARY OUT)
447 1=Reset Stepper 4/104          (MOMENTARY OUT)
448 1=Reset Stepper 5/105          (MOMENTARY OUT)
449 1=Reset Stepper 6/106          (MOMENTARY OUT)
450 1=Reset Stepper 7/107          (MOMENTARY OUT)
451 1=Reset Stepper 8/108          (MOMENTARY OUT)
452 1=Reset Stepper 9/109          (MOMENTARY OUT)
453 1=Reset Stepper 10/110         (MOMENTARY OUT)
454 1=Reset Stepper 11/111         (MOMENTARY OUT)
455 1=Reset Stepper 12/112         (MOMENTARY OUT)
456 1=Reset Stepper 13/113         (MOMENTARY OUT)
457 1=Reset Stepper 14/114         (MOMENTARY OUT)
458 1=Reset Stepper 15/115         (MOMENTARY OUT)
```

459 through 474 Internal bits reserved for future stepper resets. May be used as internal memory. But if they are used, future Series 400/415 software versions may obsolete the users program.

```
475 Advance Stepper 1              (MOMENTARY OUT)
476 Advance Stepper 2              (MOMENTARY OUT)
477 Advance Stepper 3              (MOMENTARY OUT)
478 Advance Stepper 4              (MOMENTARY OUT)
479 Advance Stepper 5              (MOMENTARY OUT)
480 Advance Stepper 6              (MOMENTARY OUT)
481 Advance Stepper 7              (MOMENTARY OUT)
482 Advance Stepper 8              (MOMENTARY OUT)
483 Advance Stepper 9              (MOMENTARY OUT)
484 Advance Stepper 10             (MOMENTARY OUT)
485 Advance Stepper 11             (MOMENTARY OUT)
486 Advance Stepper 12             (MOMENTARY OUT)
487 Advance Stepper 13             (MOMENTARY OUT)
488 Advance Stepper 14             (MOMENTARY OUT)
489 Advance Stepper 15             (MOMENTARY OUT)
```

490 through 506 Internal bits reserved for future stepper advances. May be used as internal memory. But if they are used, future Series 400/415 software versions may obsolete the users program.

```
507 Internal Pilot 1                          (OUT)
508 Internal Pilot 2                          (OUT)
509 Internal Pilot 4                          (OUT)
510 Internal Pilot 8                          (OUT)
511 Internal Pilot 16 (Bit 379 may=1 or 0)    (OUT)
```

Bits 507 through 511 are used to binary execute sequences with a Ladder Logic program. These bits are logically ORed with memory map bits 1 through 4 (and bit 8 if 379=1) respectively. Therefore setting bit 507 with a Ladder Logic program or setting bit 1 with a real input will execute sequence 1. This is true only if "Pilot Port Starting At" is set to 1 and bits 1 through 8 are configured as inputs, if they are configured as outputs or internal (XXX) then only bits 507 through 511 are able to initiate sequences. Also read 11.18 and 11.19

5.2 Dedicated Inputs

There are seven inputs that by default are dedicated to certain functions. The dedication starts at the beginning of the I/O area, bits 1-8. This dedication may be removed by setting up the bits to be outputs or internal or changing to a different pilot port memory map area (See 11.18). Dedication as follows:

5.2.1 Bits 1,2,3,4 binary inputs for 15 sequence select
5.2.2 Bits 5 Sequence Reset/Emergency stop
5.2.3 Bits 6 External Weld No weld
5.2.4 Bit 7 Strobe Pilots
5.2.5 Bit 8 Binary 16 for 31 Sequences

5.2.1 Bits 1 through 4 binary pilots

Select the sequence (1-15) to be executed. (Bit 8 may be included for binary 16 for 1-31). Upon a binary input combination, the control will memorize the pattern. After 2 line cycles (33.3 ms) the pattern is re-checked, if the pattern has not changed the control will recognize this pattern as a valid pilot and execute the first instruction of that sequence. If the pattern changes, the new pattern is memorized and re-checked after 2 line cycles. If the pattern is "0" the control will abort and re-sample. In any case it will take two consecutive samples of the same pattern to execute the sequence. After executing the first instruction bits 1 through 4 may be re-examined and provide programmable control (on an individual basis) throughout the remaining sequence. At the end of off time, (Off-Repeat) if the pilot pattern memorized at the start of the sequence is recognized again, the control will repeat the sequence. If the pattern is "0" it will abort sequence.

If the pilot pattern has changed and it is a valid pilot for a sequence, it will execute the sequence commanded. If in Off-Single and the BCD pattern is "0" the control will reset and re-scan for a new initiation.

If any BCD pilot is applied at Off-Single, the control will display "PILOT IS NOT CLEAR" and wait for BCD "0" then reset. In either case, single or repeated from "0" reset or from a new (non-bounced) pilot the control will recognize and sequence within 3 line cycles (50ms). If upon power up, if any pilot port is true, the control will not sequence but display "PILOT NOT CLEAR" and wait for BCD "0" to reset, or the user may press the FUNCTION SELECT then CLEAR keys thereby forcing the applied pilot.

Another method of sequence initiation is to use a strobed pilot method. This method allows pilots to be applied at all times and are "strobed" in by bit 7 or 413 for pilot acceptance, the 2 cycle denounce time will NOT occur. The "PILOT NOT CLEAR" rules above apply to the strobe bit if it is used.

To employ this method a ladder logic program must be written which first permanently sets bit 412 for strobe mode:

STEP	INSTRUCTION	COMMENT
1.	Start 00	;Always a one in run and online.
2.	Output 412	;sets control to strobe mode.
3.	Start xxx	;Input xxx 0=>1 transition
4.	Output 413	;strobes in pilot pattern on ports ;1 through 4 or on bits 507 through 511.

If input 7 is used as the strobe, steps 3 and 4 are not necessary.

5.2.2 Bit 5 Sequence Reset/Emergency Stop

If bit 5 (unless redefined, see 11.18) is zero at the start of or went to zero during a sequence, the Emergency Stop Fault will occur (see 12.11). The bit is checked every half line cycle. When zero all sequencing will stop and programmed outputs will be removed. But the PLC program, if any, will **not stop** nor its programmed outputs removed. The control may be forced to emergency stop at any time by outputting bit #414 in a ladder logic rung.

5.2.3 Bit 6 Weld/No Weld control

Upon executing each half cycle of weld, the bit is checked to be true. If true that half cycle will be fired. If not true it will not be fired, and the no weld light on the no weld keypad will turned on. See 6.11 for more detail.

5.2.4 Bit 7 Strobe Pilots

If bit #412 is set 1 which enables strobe pilot mode and bit 7 goes from a 0 to 1, the binary pattern on bits 1-8 or 507-511 will start sequence on the next half line cycle. If bit #412 equals 0, then bit 7 is a spare. Please read 5.2.1

5.2.5 Bit 8 Binary 16 for 31 Sequence

If bit #379 is set setting bit 8 will equal binary select 16. This enables 31 sequences. Bit 8 is logically **or'ed** with bit 511, but bit 511 remains active as binary 16 even if bit 379 is not set. If bit #379 is not set, bit 8 is user defined.

5.3 Dedicated Outputs

There are no hard dedicated outputs in the Series 400. But there are outputs that are dedicated under certain conditions. Bits 145 (LSB), 146, 147 and 148 (MSB) are set when instruction #51, Contactor Select is executed. These bits are set in a binary pattern by the instruction and are outputted to and used by a SCR Cascade Modules to select SCRs in a cascade system. See instruction #51 for more detail.

Bits 17 through 21 are defaulted to as outputs when certain instructions are programmed. The default bit may be changed by the programmer. The instructions are:

1. All Squeeze out default to bit 17
2. MC Contactor out defaults to bit 18
3. Forge Delay out defaults to bit 19
4. End of Hold out defaults to bit 20
5. Water Valve out defaults to bit 21

5.4 Fault Code Bits

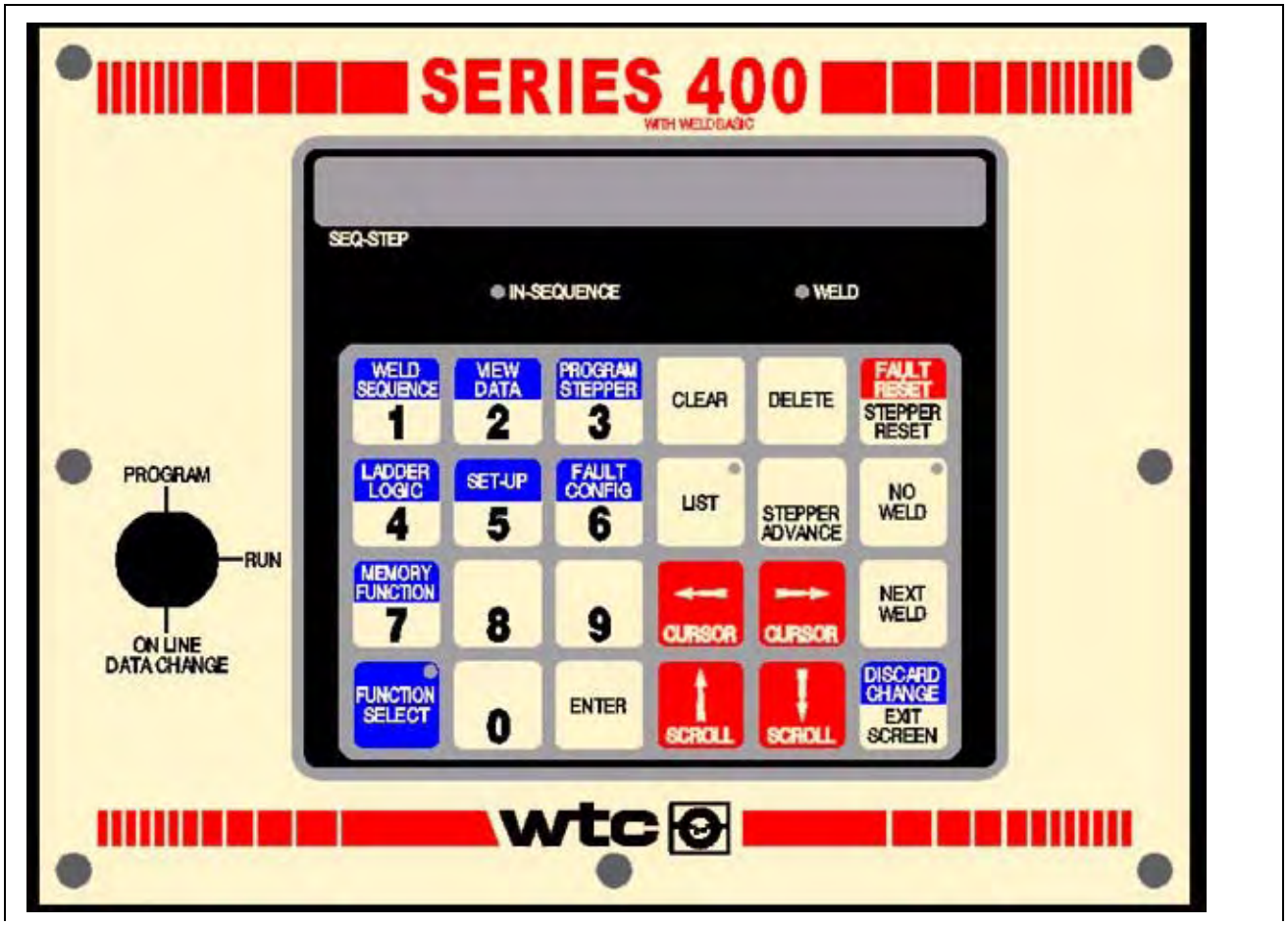
Bits 400 through 407 are set in binary (by the firmware) to the priority number of any fault when the fault occurs. If bit #375 is set the bits will be set in BCD format (Binary Coded Decimal). If a fault priority number is programmed zero, no fault bits will be set therefore the fault will not be outputted. See 12.3

If a Kawasaki®/Nachi®/PLC Direct®/KOYO® Robot SIO Interface is employed, the fault code is automatically transmitted to the device that is connected to P2. Therefore it is important to program the Series 400 fault priority numbers to match the fault code of the receiving device. See 3.0

If Static Controls Corp® display is connected to P2 the fault code will only be outputted when bit #396 is set and #397 is not set. See 3.6 and 10.1.20.

To transfer fault code bits to I/O use ladder logic, see 10.7.

6.0 Keyboard Layout and Description



6.1 Numerical keys 0 to 9. These keys are used to key in the following information:

1. Menu selections
2. Instruction codes
3. Sequence numbers
4. Sequence data
5. Alarm windows
6. Port Assignments

6.2 Up scroll

This key is used to scroll upward through the following lists:

1. The Main menu
2. Menu Selections
3. Users Welding Sequence instructions
4. List of Sequence instructions
5. Users Ladder Logic Program
6. List of Ladder logic instructions

After each depression of the key, the previous item in the accessed list is displayed. Each list has its own unique pointer. The pointer is defined as being the currently displayed register of a list. When the top of any list is reached, the scroll wraps to the bottom of the list. The control will remember the last item accessed by the key and use it as the item for the next use of scroll in that list.

6.3 Down Scroll

The same function as item 6.2 except depressing this key will cause the next item in the list to be displayed.
When the bottom of the list is reached, the scroll wraps to the top of the list.

6.4 List Key

This key is used only in the PROGRAM mode. If not in program mode and an attempt is made to use the key, "NOT IN PROGRAM" will be displayed. After a sequence is selected and scrolled through to the first step (NOT PROGRAMMED displayed) or to a position of interest, the LIST key may be used. If an instruction occupies this step, when the LIST key is pressed the instruction is automatically moved down to the next step. Pressing the LIST key and then either UP SCROLL or DOWN SCROLL displays the instruction list, displaying an instruction pointed to by a list pointer. If the programmer wishes to leave the list of instructions, pressing the list key again will do so. Hence entering and leaving the instruction lists is accomplished in "toggle form". An LED on the keypad will annunciate current status. If lit the list is displayed. If not lit the users program is displayed.

The general format of the display appears as follows:

```
                         1111111111222222222333
               12345678901234567890123456789012
               03-03 xxxxxxxxxxxxxxxxxxxxxxx nn
```

Where characters 1 to 5 show the sequence number and program step number. Characters 7 to 29 show the instruction description Characters 31 and 32 show the instruction code number.

By pressing either the up scroll or down scroll key the appropriate instruction is selected. The selection may be entered into the users program by pushing the ENTER key. At this point, any data for the entered instruction may be addressed by using the RIGHT POSITION CURSOR or LEFT POSITION CURSOR keys. The instructions in the Sequential list are outlined in section 7.4.

6.5 Right Position Data Cursor Key

This key is used to position the cursor to a data item of interest. This key may be used in all modes and at all times. The cursor is defined as the position of flashing display. If no old data or instruction is available to flash the underline mark "_____" is used to show position. Each time this key is pressed the flashing cursor may be moved one position at a time until the right-most position is reached. If pressed one more time the cursor will wrap around and move to the sequence number which is the first position on the left.

Entry of a new sequence number, and pressing the ENTER key will call up that sequence and step number with its first data field flashing. The programmer may choose to enter a new step number, if so the control will go

to that step number and it will be displayed as programmed with its first data field flashing.

Upon entering a new instruction into a program, its first data field will flash. New data may be entered, or the cursor key may be used to step through the data fields until the last position is reached. Again if pressed the cursor will wrap around to the sequence number. Simply stated, the right cursor key moves the cursor to the right. One position per stroke to each item of interest. Changes may be made and entered at any time at which the control will respond. The ENTER key does not have to be pressed each time data is changed.

6.6 Left Position cursor key

Same as 6.5 except this key moves the cursor to the left.

6.7 Enter Key

This key is used to enter the selected program instruction from a LIST into the users program. It also may be used to enter the data viewed, then automatically move the cursor to the next field for the another data change.

6.8 Function Select Key

This key is used to enhance the 1 through 7, ENTER, EXIT SCREEN, and RESET keys. If the Function Select key is pressed causing its LED to be illuminated, it will enhance the 1 through 7 keys to become "hot keys". Pressing one of these keys causes automatic entry, at any time from any place, the menu selection listed above each key. It will cause the saving any data changes made prior to the "hot exit/entry". See 7.9 for more detail on "saving".

If the FUNCTION SELECT key is pressed before the ENTER key a grand enter or SAVE will be accomplished. The entire edited buffer will be entered into the run buffer and saved. It is especially useful to SAVE data under the ON LINE DATA CHANGE mode. The control will keep its place and not EXIT to the main status screen after the buffer SAVE. See 7.9 for more detail. For safety reasons FUNCTION SELECT then ENTER is used to execute all functions under Memory Function.

If FUNCTION SELECT is pressed before the DISCARD CHANGES key, the entire edited buffer with any attempted changes will be erased and made like the current run buffer was before any data or function changes were made. This DISCARD CHANGES action must happen BEFORE the exit of the function. Remember the entire buffer, all CHANGED functions and data will be DISCARDED. See 7.9 for more detail.

If the key switch is changed from RUN to PROGRAM mode while in sequence, and FUNCTION SELECT then the FAULT RESET keys are pressed, any sequence waiting for some action may be made to recognize the key switch change to program mode. i.e. reset to program mode, the control jumps to OFF and recognizes program mode.

6.9 Delete Key

This key is used to delete instructions from a program. Upon deletion, all remaining instructions will be re-numbered automatically. CAUTION! Branches out of a sequence WILL NOT be re-numbered and must be re-numbered by the programmer. CAUTION!

6.10 Fault/Stepper Reset Key

This key is used to reset a fault displayed on the main status screen. The key is annunciated with a red LED. If this LED is lit, a fault or faults have been encountered. If there is more then one fault they will be displayed in order of their programmed priority. This order may be set by the user, see 12.0. The fault queue may be scanned and all faults viewed via the use of the Down Scroll key. Each fault must be reset one at time, only the fault viewed will be reset. In the case of a stepper program end, to FULLY reset one must view the steppers history screen. That is in Program Stepper, Edit Stepper X Current step 9, then when the reset key is pressed that viewed steppers program will be FULLY reset. Confirmation of the reset is viewing current step 1. See 9.2 for more detail.

6.11 No Weld Key

This key is annunciated with a red LED. If this LED is lit, the control is in the no weld mode (bit #431=1). The control will sequence but **will not weld**. If the LED is not lit, the control is in the weld mode and when sequencing will weld. Each time this key is pressed the control will alternately switch from weld to no weld modes. This action will happen only if the external weld/no weld is true (usually bit #6, also see 11.17). If not true the control will remain in no weld with the LED lit. OR If bit #430 is a 1 the control will be placed in the no weld mode, the LED will remain lit, and the control will not weld.

Therefore there are three ways to place a control into a no weld mode:

1. By opening the circuit on input 6 making bit 6 a zero. This is true only if pilot port is set to 1. If pilot port is not set to 1, then the sixth bit of the group of 8 bits that it is set to. If the pilot port is set to zero then the control cannot be placed in no weld by this method. See #3 below and 11.19.

2. Toggling the NO WELD key.

3. Forcing a one in bit #430 via a PLC program. See 10.8.

Also note two ways to observe NO WELD mode:

1. By observing the lit LED on the NO WELD keypad.

2. By observing via a PLC program bit #431, if it is 1 the control is in NO WELD mode. Consider a ladder logic program rung setting a user fault labeled " IN NO WELD MODE" which is set MINOR and SELF RESETTING. See 12.0 and 12.5.

6.12 Next Weld Key

In the Series 400 Weld functions may be identified by a programmable two digit number to the right of any Weld function. It is the users responsibility to supply this number after each Weld function. If the number is not provided the next weld key will not show the next weld because it scans on this data. Upon power up and if the next weld key is depressed, "Show Next Weld 1" will appear. If a Weld 1 is programmed, it will appear when ENTER key is pressed. If some other weld is of interest simply enter that weld number and press ENTER. Any Programmed Weld number may be found in any sequence, from any location in any menu selection at any time.

6.13 Clear Key

This key is used to clear any data from the current position of the cursor. If the user makes an error when keying in data, this key may be pressed and new data keyed in. It is possible to "write over" mis-keyed data, but it may also be cleared.

6.14 Stepper Advance Key

If the keyswitch is in PROGRAM mode and the control is in Program Stepper, Edit Stepper X Current step X, and the Stepper Advance key is pressed that viewed steppers program will be advanced.

7.0 Programming and Data Entry

It would be helpful to view, while reading the following description, the 314-0-0823-04 Instruction Summery Card. On the back of the card is listed in block form the 7 Menu selections listed in the Series 400. The card is shipped in the print pocket of every control. If using a Series 400 to explore the menu selections, only three keys are necessary for exploration:

1. EXIT SCREEN moves to the top block, Main Status.
2. DOWN SCROLL moves down through any viewed list
3. ENTER enters any function viewed

7.1 Main Status Screen (Press EXIT Screen Key)

After power up "Series 400 Version 7.XXX" will be displayed on the main status screen. This display will appear only when no pilot is present. If in sequence, running conditions are displayed. If the sequence is held up by some condition not satisfying the program in progress, it will be displayed.

Example: INPUT 6 = 0

If faults are present they will be displayed as outlined in a section 12.0. Running sequence XX is displayed during a weld. Below is a listed other possible messages which may appear when viewing the main status screen:

CHECKSUM=XXXXX
SERIES 400 WELD CONTROL V 7.XXX
RUNNING SEQUENCE XXX
PROGRAM MODE
ON LINE DATA CHANGE MODE
INPUT XXX = 0
INPUT XXX = 1
INPUT XXX AND INPUT XXX = 0
INPUT XXX OR INPUT XXX = 0
LINE LESS THAN XXX VOLTS
SECOND STAGE OPEN
PRESSURE SWITCH OPEN
PILOT NOT CLEAR
WAITING FOR END OF SEQUENCE
CONFIRM SLOT SETUP & RESET
EXTERNAL RESET
POWER UP RESET
SOFTWARE WATCHDOG RESET
HALT MONITOR RESET
ACCESS DENIED

Pressing the up or down scroll keys while more then one fault is active will scroll through the fault queue. The EXIT SCREEN key will set the display to the highest active fault. Faults may be reset by first clearing the problem, placing the keyswitch in program mode, viewing the fault in this screen, then pressing the FAULT RESET key. See 12.0 for more detail.

7.2 Main Menu

Pushing the down or up scroll, (or any numbered key except 1, 2, 3, 4, 6, or 7 which enters a menu choice directly), from the main status display level will display the main menu. Displaying the first choice WELDING SEQUENCES, allowing the operator to ENTER this choice if he wishes. If he does not wish to enter, he may scan through the menu with the up or down arrow keys until the item of interest is viewed. Pressing the ENTER key enters this choice. Another and much easier method of entering a menu selection from the main status screen is to simply press the menu selection printed on the numbered keys 1 through 7. If a directly entered choice is inadvertently pressed and a wrong selection is made, pressing the FUNCTION SELECT key then the proper function key will enter the proper choice. The main menu choices are:

1 Welding Sequences
2 View Data
3 Program Stepper
4 Ladder Logic
5 Set-Up
6 Fault Configuration
7 Memory Management

7.3 Welding Sequences

Typical 32 position display:

```
                        11111111112222222222333
                123456789012345678901234567890 12
                01-01 ####################  ----
```

where columns:

1-2 Are the sequence number
4-5 Program step number
7-32 Instruction and data description.

The operator may program up to 31 sequences of 99 sequential instructions each for a total of 3069 programmable sequential steps. The instructions may be programmed in any order to solve almost any sequential control problem. Residing in PROM is a list of all WELDBASIC sequential instructions. To access this list for programming a sequence the following steps must be accomplished:

1. The control must be in program mode, and in the Welding Sequences menu selection (1).

2. The sequence and user program step number of interest must be displayed.

3. The WELDBASIC instruction list will appear by pressing the LIST key and then one of the scroll keys (up or down arrow). Scrolling up or down through the instruction list is now permitted. Pressing the ENTER key at this time will enter any viewed instruction into the users program at the step displayed. Pressing the LIST key again will leave the list displaying the users program.

7.4 Sequential Instruction List

A more detailed explanation and typical applications for each of the sequential instructions can be found in the second half of this instruction book. Please review Section 2.
Meaning of lower case letters used in the following instructions:

aa-aa Sequence/Step address:
First (aa) is sequence number 0-15.
Second (aa) is the program step number 1-99.
bb Multiplex buffer location, 1-99 (3 bytes each)
cc Time number 00 to 99
ccc Time number from 000 to 999
ddddd Digital number 0 to 65535
hh Heat percentage 20 to 99 (percent of available current)
iiiii Current in Amperes
mm A value displayed only, or the real value derived
nn Optional assigned instruction position 0 to 99
rr Register number 1-32. (one of the PLC timer/counters)
rrr Transformer turns ratio 1-200
pp Two digit number 0 to 99
ppppp Register preset value 0 to 65535
ss Stepper number 0 to 32
vvv Voltage 000 to 999
xxx I/O Map 0 to 512
yy contactor number 1-16
& Logical AND
^ Logical OR
zz Hex valve 0 to 15

CODE	INSTRUCTION DESCRIPTION	IN RUN & ON LINE DATA DISPLAYED
01	INIT SQUEEZE OUT xxx ccCY	YES
02	SQUEEZE OUT xxx ccCY	YES
03	PREHEAT nn hh% (mm%) ccCY	YES
04	COOL nn hh% (mm%) ccCY	YES
05	SLOPE I-hh% F-hh% ccCY	YES
06	WELD nn hh% (mm%) ccCY	YES
07	POSTHEAT nn hh% (mm%) ccCY	YES
08	HOLD ccCY	YES
09	OFF REPEAT MODE ccCY	YES
10	OFF SINGLE MODE	YES
11	WAIT FOR ccCY	NO
12	WAIT xxx TRUE	NO
13	WAIT xxx NOT TRUE	NO
14	WAIT xxx & xxx TRUE	NO
15	WAIT xxx ^ xxx TRUE	NO
16	OUTPUT xxx ON	NO
17	OUTPUT xxx OFF	NO
18	OUTPUT xxx IF xxx&xxx TRUE	NO
19	OUTPUT xxx IF xxx^xxx TRUE	NO
20	WATER VALVE OUT xxx cc SEC	YES
21	PRESSURE OUT xxx-x ZZ% (zz%)	YES
22	WINDOW HI iiiii LO iiiii	YES
23	PRECOMPRESSION OUT xxx ccCY	YES
24	MC CONTACTOR OUT xxx cccSEC	YES
25	pp PULSE @ ccCOOL to -xx	YES
26	HEAT UNTIL xxx hh% cccCY	YES
27	REM HEAT bb mm% (mm%) ccCY	YES
28	REM HTT bb mm% (mm%) mmCY	YES
29	REM WTT bb mmCY	YES
30	PRESSURE SWITCH INPUT xxx	YES
31	Second STAGE INPUT xxx	YES
32	NEMA SECOND STAGE INPUTxxx	YES
33	SQUEEZE DELAY OUT xxx ccCY	YES
34	FLASH HT INP xxx hh% cccCY	YES

35	UPSET HT INP xxx hh% ccCY	YES
36	DELAY cccCY	YES
37	SEAM-BEAT hh% HT cc CL cc	YES
38	SEAM NONBT hh% HT cc CL cc	YES
39	FORGE DELAY OUT xxx ccc CY	YES
40	QUENCH ccCY	YES
41	TEMPER nn hh% (mm%) ccCY	YES
42	EOH OUT xxx DLY cc DWL cc	YES
43	INDEX OUT xxx ccCY	YES
44	PRODUCTION COUNT rr ddddd	YES
45	ASSIGN STEPPER #ss select	YES
46	p REWELDS @ aa RWrr BWRrr	YES
47	TIPTOUCH iiiA cccMAX rrCOUNT	YES
48	TIPSTICK TEST iiA ccCY DLY	YES
49	WELD SCHEDULE pp	YES
50	NO OPERATION	NO
51	CONTACTOR SELECT yyy	NO
52	HEAT RESET	NO
53	HEAT FAULTS ON	NO
54	HEAT FAULTS OFF	NO
55	WAIT FOR vvv VOLTAGE^cccCY	NO
56	COUNTER rr ddddd	NO
57	TRANS TURNS RATIO rrr	NO
58	WINDOW COMPARE HIiiiii LOiiiii	NO
59	CALL WELD SCHEDULE mm DEPmm	YES
60	GOTO a-aa	NO
61	IF xxx TRUE GOTO aa-aa	NO
62	IF xxx NOT TRUE GOTO aa-aa	NO
63	IF xxx & xxx GOTO aa-aa	NO
64	IF xxx ^ xxx GOTO aa-aa	NO
65	CALL aa-aa	NO
66	RETURN	NO
67	LOOP COUNT rr = ppppp	NO
68	REPEAT rr a-aa	NO
69	FUTURE ASSIGNMENT (BRANCHING)	
70	PRINT WELD DATA	NO
71	PRINT TIME AND DATE	NO
72	SPC WELD DATA nn	NO
73	FOOTPRINT WELD DATA nn	NO
74	WINDOW HI hh% LO hh%	YES
75	RESET STEPPER xx TO STEP y	YES
76	MF ffff TF PPPP (####)	YES
77	FUTURE ASSIGNMENT	
78	FUTURE ASSIGNMENT	
79	FUTURE ASSIGNMENT	
80	PREHEAT nn iiiii ccCY	YES
81	SLOPE IiiiiiA FiiiiA ccCY	YES
82	WELDnn iiiiiA (mmmmm) ccCY	YES
83	POSTHEAT nn iiiiiA ccCY	YES
84	HEATUNTILxxx iiiiiA cccCY	YES
85	SEAMBEAT iiiiiA ccHT ccCL	YES
86	SEAM NBT iiiiiA ccHT ccCL	YES
87	TEMPER iiiiiA (iiiii) ccCY	YES
88	REMInn iiiiiA (iiiii) ccCY	YES
89	REMITnn iiiii (iiiii) ccCY	YES
90	FUTURE ASSIGNMENT	NA
91	FUTURE ASSIGNMENT	NA
92	FUTURE ASSIGNMENT	NA
93	FUTURE ASSIGNMENT	NA
94	FUTURE ASSIGNMENT	NA
95	FUTURE ASSIGNMENT	NA
96	FUTURE ASSIGNMENT	NA
97	FUTURE ASSIGNMENT	NA
98	FUTURE ASSIGNMENT	NA
99	FUTURE ASSIGNMENT	NA

7.5 Code Programming

This mode of programming is used to speed up the process of programming by not having to scroll through the long list of instructions. Instead of scrolling, the programmer lists on paper his program in code form, presses the list key to obtain a blank step and keys in the two digit code for the instruction of interest. Note the machine is looking for two keystrokes, hence instruction #1 may be entered by stroking keys 0 then 1 or 1 then ENTER. The instruction is entered into that step automatically and is receptive to data entry immediately. Pressing the down arrow scroll key makes the next program step blank and another code may be entered. At any time he may scroll through the list called to obtain a instruction, and it may be entered. Simply stated, instructions are inserted in a program by their code number. This code number is either entered by the programmer because it is known or it is obtain from the list by pointing to by name because it is not known.

Note: When ever a code is entered the LIST pointer is updated to match the entered code.

7.6 Inserting Instructions

The first thing that should be done when attempting to write a new program is to delete all old instruction or residual instructions which may occupy any of the 99 steps in a sequence. This may be accomplished by viewing the sequence of interest at step number one and holding down the delete key for 30 seconds. One may watch this process as each instruction is brought up from the following step and deleted. When all steps are blank there will be no changes in the message "STEP NOT PROGRAMMED". Another way to delete is by using Memory Management, Clear All Memory. CAUTION the exercise of this memory function CLEARS ALL MEMORY.

Assume the program pointer points to “STEP NOT PROGRAMMED”.
The sequence number, and step number 1 and "STEP NOT PROGRAMMED is displayed. Call the list by pressing LIST key. The STEP NOT PROGRAMMED" is removed and replaced with a blinking instruction cursor. Upon pressing one of the scroll keys, the display shows the instruction pointed to by the list pointer. The last two digits following the instruction is the code number. Continue to press the scroll key until the instruction of interest entered into the blank step #1 with the first data field flashing. The instruction code is removed. Data may now be entered with the number keys in the flashing area. If data does not appear as expected, reinsert the data. If the ENTER is pressed the data cursor moves right to the next position and it now begins flashing. If the CURSOR RIGHT key is used the same action happens. If the CURSOR LEFT key is used, the position to the left flashes. If the data is entered with the CURSOR RIGHT key and is in the extreme right position the cursor will wrap around to the right and the sequence number on the extreme left will flash. After all data fields have been programmed, the next instruction may be programmed in the next step by pressing the DOWN ARROW key. After pressing the DOWN arrow key a second time the instruction list will appear again and the UP/DOWN arrow keys may be used to find the next instruction of interest. Pressing enter will enter this instruction in the next step. The data entry processed may be then repeated. Remember at any time an instruction code number may be used to insert the instruction directly.

When inserting in an existing list of instructions, upon pressing the LIST key, the instruction displayed is moved down to the next step. The display will display the sequence number, the step number and the instruction cursor. Listing of instructions will follow by the pressing of one of the scroll keys. The desired instruction may be then entered.

When inserting or deleting the remaining instructions will be re-numbered accordingly.

7.7 Deleting Instructions

If in the LIST (LED on) the programmer enters an instruction and does not finish entering data then decides it is the wrong instruction, one may press the DELETE key. This will delete the wrong instruction. By pressing DOWN arrow the list will re-appear and a new choice may be made. If not in the LIST (LED off), instructions may be deleted by scrolling to the step which is to be deleted and pressing DELETE.

7.8 Program Review

Review of the user programmed steps may be accomplished via the up or down scroll keys. Note: The control must not be in a list mode (list key LED off) or scrolling of the instruction list will occur. If the down scroll key is depressed at the last step, the pointer will go back to step #01. If the up scroll key is pressed it will step back to the proceeding step. Each time one of the scroll keys is depressed, one step is accomplished; if held depressed scrolling will be fast but at a comfortable rate. The list pointer will remain where it was last pointing in the list after leaving that list. The instruction lists have been arranged so the next instruction is sequentially of interest. Hence scanning of the instruction lists will be minimized.

7.9 Saving Programs or Data Changes

In order to accomplish on line data changes, i.e. data changes during program execution, the Series 400 has two copies of all programs and configurations. The copies are kept in two separate buffers. A run buffer for the Processor to "Run" on, and a "Edit" buffer for user changes. The user CANNOT VIEW DIRECTLY the run buffer, and the processor does not run on the edit buffer. Pressing FUNCTION SELECT then ENTER keys makes the RUN buffer just like the EDIT buffer, and Pressing FUNCTION SELECT then DISCARD CHANGES makes the EDIT buffer just like the RUN buffer destroying any previous attempted changes. These two actions are called GRAND enters or DISCARDS.

It is not necessary to execute a grand enter. After changes are made and the keyswitch is changed from on line or program to run or if the menu selection is exited the run buffer will be updated automatically. There is a time where a GRAND enter is helpful, that is when the user wishes not to exit the present menu function. The control will accept the change and remain where it is.

8.0 View Data

In addition to controlling the weld process and sequence, the control has the ability to monitor various processes and assist the user. These aids are available to the user via the VIEW DATA menu.

View Data menu contains:

8.1 Network Status/Version
8.2 Robot Interface Status
8.3 Heat Processor Status/Version
8.4 Remote I/O Processor Status/Version
8.5 GM Version
8.6 View Welding Data
8.7 Instantaneous Current
8.8 View Digital I/O

8.1 Network Status/Version

This screen displays helpful network data as viewed looking through the weld controller, through the network controller/concentrator and finally at the Host workstation. It is a very helpful diagnostic tool for network connections as far viewing Host communications. When entering this screen one of two messages will be displayed:

```
          11111111112222222222333
12345678901234567890123456789012
NETWORK=xx V7.xxx  6648 NET HOST
```

Item	Position	Description
A	1-7	Screen description
B	9-10	Assigned Network address see section 11.10
C	12-17	Version number of the local network software
D	19-23	Checksum of the local network software EPROM
E	25-27	Timer has recognized the network controller, DOES NOT mean network controller recognized the CPU.
F	29-32	The timer is in communication with Host software.

8.2 Robot Interface Status

This screen displays helpful Robot serial RIO link data as viewed looking through the weld controller. It is a helpful diagnostic tool for Robot Link connections. The display is as follows:

```
          11111111112222222222333
12345678901234567890123456789012
ROBOT=x PORTS IN ii OUT oo LINK
```

Item	Position	Description
A	1-5	Screen description
B	7	Assigned Network address. See 11.12
C	18-19	Number of input ports set by the Robot
D	25-26	number of output ports set by the robot
E	28-31	LINK if link is established. (if blank, thee is no communication with the robot)

8.3 Heat Processor Status/Version

This screen simply displays the Heat processors Version number if communications is established between the main CPU and the Heat CPU. If the heat CPU is down "Heat Processor not active" will be displayed:

```
          11111111112222222222333
12345678901234567890123456789012
HEAT PROCESSOR V7.001  6648
```

Item	Position	Description
A	1-14	Screen description
B	16-21	Version number
C	23-27	Checksum of the EPROM

8.4 Remote I/O Processor Status/Version

This screen simply displays the Remote I/O processors Version number if employed and communications is established between the main CPU and the Remote I/O CPU. If the Remote CPU is down or not installed in the back plane "Remote I/O Processor not Active" will be displayed:

```
          11111111112222222222333
12345678901234567890123456789012
RIO PROCESSOR VX.XXX  46385
                         or
REMOTE I/O PROCESSOR NOT ACTIVE
```

Item	Position	Description
A	1-13	Screen description
B	15-20	Version number
C	23-27	Checksum of the RIO software

8.5 GM Version

At this writing the Series 400 V7.025 meets General Motors Welding control specification Version RWC1 Rev 0.

8.6 View Welding Data

This function has four screens. The screens display welding data of the last “windowed” weld. The second screen displays one of two modes, a weld made in percent of available current or constant current mode. The screens are updated about one second after the compare instruction is executed. The displays will read:

```
First screen report:            1111111111222222222333
                                12345678901234567890123456789012
                                ss vvvVL vvvV iiiiiA ffPF cccccC

                    (Pressing the Down Scroll Key)

Second screen report:           1111111111222222222333
                                12345678901234567890123456789012
                     AVC mode-  ws vm% avcAVC  sssSTP-stp    mul
Constant current mode-  ws spspsSP eh% sssSTP-stp    mul

                    (Pressing the Down Arrow Key)

Third screen report:            1111111111222222222333
                                12345678901234567890123456789012
                                BST +bb% TOTAL ttttt WELDS wwwww

                    (Pressing the Down Arrow Key)

Fourth screen report:            1111111111222222222333
                                12345678901234567890123456789012
                                R29=rrr29 R30=rrr30 R31=rrr31
```

Meaning of lower case letters:

avc	AVC set point (See 11.2)
bb	Stepper +/-boost (See 9.0)
eh%	Equivalent % available current used to obtain the requested constant current
mul	Last stepper multiplier used (See 9.0)
rrr29	contents of register 29 (See 10.0)
rrr30	contents of register 30
rrr31	contents of register 31
sss	Stepper program number if assigned
stp	Current Stepper program step
ss	Last sequence executed. (1-15)
spsps	Current set point. (current target with stepper if used)
ws	Last Weld Schedule called. (1-99) Blank if not programmed. See sequencer instructions 49 and 59 for programming detail.
vm	Percent available current AVC and/or stepper adjusted
vvvVL	Lowest voltage read during sequence.
vvvV	Present line voltage
ttttt	Total welds in the stepper program
wwwww	Welds made
iiiii	Average RMS Current for all functions between the last WINDOW HIiiii LOiiiii an WINDOW COMPARE instructions. INCLUDING ALL NON CURRENT FUNCTIONS. If the TRANS TURNS RATIO instruction is present, this value will be in secondary amps 10-65535A. See note below.
ff	The average natural power Factor for all heat instructions between WINDOW HIiiiii LOiiiiii and WINDOW COMPARE. See note below.
ccccc	The number of cycles that iiiii is averaged. i.e. the number of cycles between WINDOW and WINDOW COMPARE instructions.

Note:

Values iiiii, ff and ccccc are determined between WINDOW HI LO and WINDOW COMPARE. If these instructions are not present, the values reported will be determined over the **entire** sequence. Also note, updating the DEP requires one second, if "WINDOWS" are reported too quickly, simply increase the time between reports.

8.7 Instantaneous Primary Current Display

This function displays instantaneous primary weld current only. Upon entry, the display will react as a current meter updated twice each second. The data displayed will be the primary current value at the time of reading. Readings are taken as fast as possible. It is important to remember that this functions simply as a meter and is used to obtain reasonable numbers to set current window values. If functions like preheats, slopes and postheats are present in the sequence, chances are readings will be taken on these functions and reported. If the reader cannot distinguish readings between functions, the functions of non-interest will have to be removed from the sequence for the reading of the function of interest. It is possible to set primary current values for safety reasons. See 11.3, 11.4, 11.5, 12.9, 12.10 and 12.23

8.8 View Digital I/O

This function displays status (1 or 0) of the entire 512 bit I/O map. View digital I/O is arranged for view with the following displays:

```
I/O  0-15   xxxx xxxx xxxx xxxx
I/O  16-31  xxxx xxxx xxxx xxxx
I/O  32-47  xxxx xxxx xxxx xxxx
                          .
                          .
I/O 480-495 xxxx xxxx xxxx xxxx
I/O 496-511 xxxx xxxx xxxx xxxx
```

It should be remembered that the display is updated at a rate of twice each second, hence bits changing value at a rapid rate will not be displayed on time.

9.0 Programming a Counting Stepper

A counting stepper program maintains consistent welding heat by increasing the percent of available current or the constant current over a programmable number of welds. This increase in current compensates for tip mushrooming by maintaining current density. The Series 400 has fifteen 10-step, ramp or staircase, multiplying steppers. Each step may be programmed for a weld count of 0 to 65535. Only the first weld current function in a sequence increments the assigned steppers count; they are not incremented by any other function.

All heat functions used in a sequence control the same set of mushrooming tips. Therefore, a stepper should affect all currents in that sequence (preheats, pulses, slopes, postheats, pressures and windows) for the tips. Hence, **one stepper** program is used for **one set of tips**, and all heat functions and windows involved with those tips should be increased, not just welding current. In the case of a robot where different stack ups may occur, multiple stepper heat curves may be necessary. A group of stepper programs may be "linked" in their counting and resetting. See 5.1 bits #367, 370, 371 and 372. Links will exist with all actions of the group except editing or resetting a stepper program under the PROGRAM STEPPER key. A single program may be reset or modified without affecting the group.

For proper process control, every % of available current, constant current, current window and pressure instruction encountered in the sequence will be multiplied by an "M" factor of the previous ASSIGNED STEPPER. The resultant percentage change will always be displayed in parenthesis. The BASE percent of available current or constant current, Window values and pressure are displayed without parentheses.

To determine the multiplying factor in any Stepper STEP, perform the following in Staircase Mode. See Set Up 11.14

A. Record the base heat (% of available current or constant current amperes) necessary in WELD at the start of the Stepper Step.

B. Determine the new heat or current desired in WELD to make good welds after the tips mushroom and welds become weak in that STEP.

C. Apply the formula: $\frac{\text{new heat\%}}{\text{base heat\%}}$ = Multiplying factor

Examples:

The base heat% was 50% and the new heat% required is 53%:

$\frac{\text{new heat\%}}{\text{base heat\%}} = M \qquad \frac{.53}{.50} = 1.06 \qquad M=106\%$

The base Current is 10,500A and the new Current required is 11,130A:

$\frac{\text{new Current}}{\text{base Current}} = M \qquad \frac{11,130A}{10,500A} = 1.06 \qquad M=106\%$

In both cases the "M" factor is 106%. After trying a few examples one will see that any multiplying factor under 100% lowers the base heat, any factor above 100% raises the base heat and 100% does not change the heat. The programmable range of the M factor is 1-199%.

During the welding process, increases of current, windows and pressures should be **proportional throughout** the schedule for any given set of mushrooming tips.

Most steppers, unlike Weltronic's, are "add% to WELD" and do not affect the non-weld heats, windows or pressures. The result: after a time, insufficient current density is applied to non-weld heat functions. A "add%" stepper applied to the non-weld functions would result in too much current density, probably welding in these functions, which is not desirable.

Stepper programs are applied by first assigning the program (code #45 ASSIGN STEPPER #XX) to the sequence. Make sure it is assigned ahead of all desired increases (usually step #1) and a unique stepper program number is entered. In the FUNCTION menu, PROGRAM STEPPER, enter the stepper number of interest in EDIT STEPPER #**XX** CURRENT STEP X. Using the Down scroll and cursor keys the stepper program will appear to the programmer as follows:

```
<-------- Cursor keys --------->
         1111111111222222222333
12345678901234567890123456789012<-# of character position on DEP screen (1-32)
        ALL STEPPERS RESET      <-appears only if ALL steppers are reset.
              (or)                  (and only if in PROGRAM mode)
   RESET ALL STEPPER PROGRAMS?  <-Press RESET key here to reset ALL steppers.
EDIT STEPPER #xx CURRENT STEP  X<-Enter a stepper to program or RESET it only.
      BOOST ALL STEPS BY  +0    <-Applies a +/- boost or stepper curve offset.
STEP #0 100%  Set-  250 ACT- 250
STEP #1 107%  Set-  250 ACT- 250<---From STEP #0 through STEP #9 the Up/Down
STEP #2 115%  Set-  500 ACT- 490    Arrow and Left/Right cursor keys are used
STEP #3 122%  Set- 1000 ACT-   0    to program the %change and Set- counts.
STEP #4 127%  Set- 1000 ACT-   0
STEP #5 132%  Set- 1000 ACT-   0    To exit the program, press the EXIT SCREEN
STEP #6 135%  Set- 1000 ACT-   0    key.  The control will display the area
STEP #7 137%  Set- 1000 ACT-   0    shown above this program.  Pressing the
STEP #8 140%  Set- 1000 ACT-   0    EXIT SCREEN key again will display the
STEP #9 142%  Set- 1000 ACT-   0    MAIN STATUS SCREEN.
```

NOTE--

1. This program example increases current from 100% to 142% in ten amortized or staircase style steps. Please read Set Up 11.14 and 11.15.

2. The state of the stepper program above is 490 actual weld counts into the third step of 500 counts. A total of 990 welds have been made. To accelerate or decelerate the program, the ACT (actual count) may be edited up or down or the Boost feature may be employed, offsetting everything by a percentage. With a Boost value other than 0 its sign may be toggled with the left arrow key. Boost is used to temporarily offset the whole stepper curve for some process change. Boost and ACT will be reset to 0 when the stepper program I reset.

3. In the EDIT STEPPER #xx CURRENT STEP X screen, enter a stepper number to program and press Down Arrow to display the program. **Or,** with the control in PROGRAM MODE, press the RESET key at this screen to reset **only** this displayed stepper program.

PROGRAM PROCEDURE:

1. Always start with new tips, making the best welds possible. Record the **base** %heat (current) or constant current amperes in the WELD function.

2. Assign a stepper program to the sequence ahead of all the functions to be stepped. In "Set Up", program the steppers for Staircase mode.

3. Program STEP #0 100% and SET- 65,000. The current will not change but the number of welds will be recorded in ACT.

4. Make production observing weld quality carefully. At the first sign of small welds (insufficient current density), stop production and record the ACT count of STEP #0. This will become the programmed value of SET- in STEP #0.

5. Increase current in the WELD function enough to make the best welds possible. Record the **new** %current or constant current value. Reprogram the original **base** value in the WELD function.

6. Divide the **new** by the **base** value to obtain "M" (Multiplying percent factor).

7. Program STEP #0s MMM% with "M" obtained in step 6 above.

8. Program STEP #0s SET equal to a value rounded off slightly lower than the value for ACT recorded in step 4 above.

9. Program STEP #1 MMM% with the same M factor (step #6) and its SET-65,000. Now STEP #1 will not change the current but record the number of welds to insufficient current density, as was done in step 4. Make sure WELD is programmed back to its **base** value. (step 1) The WELD parentheses should now display the multiplying percent value.

10. Resume production. At the first sign of insufficient current density, stop production and record the ACT count of STEP #1. This will become the programmed value of SET- in STEP #2.

11. Repeat step 5 above but this time change the WELD base to a value higher than the previous multiplying factor to make good welds again. Record the new Multiplying factor and continue this process until the tips are no longer useable. Program any unused Stepper STEPS with the multiplying factor last used and program the SET- values for 1 weld. Change tips and reset the stepper program.

12. In Set-up set the Steppers to Ramp Mode. (See 11.14).

9.1 Programming Automatic Current Density Control (ACDC) Stepper

Usually, a counting stepper program is used to increase current to compensate for changes in current density caused by tip mushrooming. Careful study determines the proper counts and current increases based on the rate of tip mushrooming. Then, a program is written with the accurate current increase per weld count. If conditions change in the secondary, such as shunt wear, the stepper program could be upset.

The weld study is not necessary with the ACDC steppers because these "smart steppers" are capable of adapting to changing conditions in the secondary. This is possible because of a well-accepted fact that it is better to weld "hot" than to weld "cold". When over-welding, just before expulsion of molten metal occurs, the resistance of the weld nugget changes (lowers) dramatically. By monitoring REAL power factor, one would see that this resistance is already in rapid decline, even before drastic expulsion occurs.

The ACDC system is based on this decline of secondary resistance. Simply determine the decline in power factor, or “R factor”, which is called SENSITIVITY. It may be read out under ACT (actual) and programmed under SET (set point). Three basic factors are used to increase and decrease the weld current and make the system oscillate ±1% about a point just before expulsion occurs:

1. Sensitivity- (1-20) — A number which reflects resistance drop. It is the difference in peak power factor and power factor at expulsion. The larger the number the larger the "R" drop. A practical number which reflects pre-expulsion is between 3 and 20. This number is affected by secondary impedance.

2. Expulsion-Counter (0-999) — A programmable counter that counts expulsion welds. If this counter reaches its programmable limit, heat is decreased by 1%. The counter is used to control system speed.

3. Non-expulsion Counter (0-999) — A programmable counter that counts non-expulsion. If this counter reaches its programmable limit, heat is increased by 1%. This counter is also used to control system speed.

NOTE: If either counter reaches its limit BOTH counters are reset to zero. Other programmable factors are used in the control process:

4. Blanking-Time (0-99) — The number of weld cycles to ignore before looking for expulsion. This is necessary because resistance at the start of weld is very erratic and may appear to be an expulsion event. Blanking starts at the first WELD function in the program. It should continue up to the beginning of the last 1/3 of the weld function(s).

5. Multiplier-Factor (1%-199%) — Multiplier factor effects all % heats in ALL heat functions and all current window statements. The “M” factor ALWAYS starts at 100% and is automatically stepped up or down in 1% steps. If the stepper is reset, it reverts to 100%.

6. Multiplier-Max (1%-199%) — The maximum multiplier factor after which the program ends and the stepper end status bit is set. Tips are replaced, and ACDC stepper is reset.

7. Multiplier-Min (1%-199%) — The minimum level that the multiplier factor can reach. The initial difference between Multiplier Min and Multiplier Factor is stored in the beginning (“D”). As the algorithm progresses and the Multiplier ACTUAL increases, the Multiplier Min will be increased to maintain at most a "D" difference.

The Operator interface is listed under the Program Stepper key. They are listed on the following page as they will appear to the user. Remember only one line may be viewed at any given time. Simply use the Up or Down arrow keys to view the line of interest under the stepper number of interest. The numbers above the listing is the position in the 32 character display. Also remember, the Stepper MUST be ASSIGNED in front of all heats that are to be affected by the ACDC stepper. Simply insert instruction #45 in your program. If you are not familiar with WTC’s multiplier type stepper, please re-read section 9.0. There are 15 ACDC steppers available labeled 101 through 115 (hundreds digit in front of the stepper number).

The first screen to come into view after entering Program Stepper and entering one of the ACDC steppers (101-115) is:

```
          11111111112222222222333
1234567890123456789012345678901 2
EDIT STEPPER 101 MULTIPLIER 100%
```

This screen is a history screen, and shows the current Multiplier factor "M". The "M" factor may be edited to advance or retard the stepper. Positions 14, 15 and 16 permits movement to any of the 15 ACDC stepper programs. Position 29-31 show the accumulated "M" factor. The "M" factor always starts at 100% and is increased or decreased by 1%.

The next screen to come into view after pressing the Down arrow key is:

```
          11111111112222222222333
1234567890123456789012345678901 2
EXPULSION COUNT  SET-nnn ACT-nnn
```

This is the programmable number of expulsion events (nnn) before heat is lowered. The ACTual count at any given time appears under positions 30-32. It is important to keep this number LOW as possible because expulsion causes tip wear.

The next screen to come into view after pressing the down arrow key is:

```
          11111111112222222222333
1234567890123456789012345678901 2
NON-EXPULS COUNT SET-nnn ACT-nnn
```

This is the programmable number of non-expulsion events (nnn) before heat is raised. The ACTual count at any given time appears under position 29-32. It is important to keep this number HIGH as possible to prevent tip wear.

As soon as the Expulsion OR the Non-expulsion counters reach their SET value BOTH counters are reset. By making the expulsion count low and the non-expulsion count high, most welds (all but the expulsion counter number) will be made just below the point of expulsion. This algorithm periodically tests the current density by looking for expulsion, then backs off to the non-expulsion level for the non-expulsion count. Thus ACDC, automatically keeps the current density in control as the tips mushroom.

The next screen upon pressing down arrow is:

```
          11111111112222222222333
1234567890123456789012345678901 2
SENSITIVITY      SET- nn ACT- nn
```

The ACT number reflects resistance drop of the last weld. A practical number that reflects expulsion is between 4 and 20. Steppers reporting sensitivity under 3 may become unstable, therefore a counting-type stepper should be applied. To set up the ACDC stepper, the user must first make **and record good welds**. After this step the user must "blank" the first 2/3 of the WELD function (see BLANKING). Then determine what SENSITIVITY number reflects expulsion in the system by continually increasing current or time and observing the sensitivity ACT number. As current is increased and the welds become hotter the number will increase. Simply note the number when

expulsion occurs and program a number one number less in SET. Return the WELD function back to the recorded heat and time.

PRESSURE plays an important role in the generation of the sensitivity number. HIGH pressure results in LOW numbers and LOW pressure results in HIGH numbers. It is therefore important to set pressure properly for any given weld. Set pressure for the best spot weld not the sensitivity number.

The next screen after down arrow is pressed is:

```
          1111111111222222222333
12345678901234567890123456789012
BLANKING TIME              ccCY
```

Blanking must be used because resistance is erratic in the first part of any weld. Sufficient blanking cycles must be programmed to cover at least the first 2/3 of the WELD function. **Cool** cycles between Welds are not counted and any preceding **Preheat** functions will **not be counted**.

The last screen in the ACDC stepper rotation is:

```
          1111111111222222222333
12345678901234567890123456789012
MULTIPLIER MAX-hhh  MIN-hhh(hhh)
```

When the ACDC action of increasing heat reaches this maximum value, the stepper (program) ends and must be reset to 100%. If the stepper should decrease heat to the current multiplier value minus the original difference between the minimum value programmed and 100% (which is the number in parentheses) a Stepper compensation fault will be issued and bit 318 will be set. In this case, look for false counts of expulsion caused by edge welds, low tip pressure, tips too small for applied current, loose connections, secondary arcing or insufficient blanking time.

9.2 Resetting Stepper Programs

There are four ways to reset stepper programs:

9.2.1 Resetting all Programs at Once
9.2.2 Resetting/Advancing only one Program
9.2.3 Resetting/Advancing Programs through inputs (PLC)
9.2.4 Resetting/Advancing Programs through the gun table

9.2.1 Resetting All Programs at Once

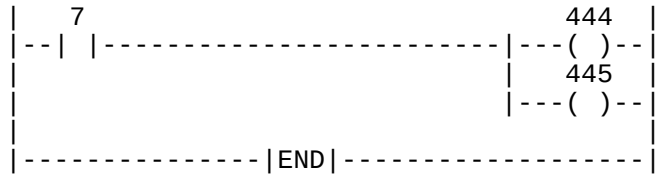
In program mode, entering the PROGRAM STEPPER menu, the user will be asked if ALL stepper programs are to be reset. Press the reset key at this time to reset ALL 30 stepper programs. To reset only one stepper program, press the Down arrow key at this time.

9.2.2 Resetting/Advancing only one Program

Pressing the down arrow key (at Step 9.2.1 above) will result in the screen "Edit Stepper XX Current Step X". Entering the Stepper Program number and pressing ENTER will display the current step of that stepper program. Pressing the reset key at this time resets the stepper to step 0. In the case of a ACDC stepper program, back to a 100% multiplier. The tips must now be replaced. If the Stepper Advance key was pressed instead of the reset, a counting stepper would be advanced to the next step. In the case of a ACDC stepper program a new multiplier must be entered to advance to a higher heat.

9.2.3 Resetting/Advancing Programs Through I/O

May be accomplished by programming the ladder logic section to reset steppers individually or all at once. Individually by forcing a one in the reset/advance bits listed in section 5.1, 444 through 458 and 475 through 489. Or all stepper programs may be reset at once by setting bit 321. Note the stepper may be configured to be reset via the PLC ONLY. See 12.2 Below is a sample program that resets Stepper 1 or 101 and 2 or 202 through a momentary closed switch wired to input number 7



PLC PROGRAM

STEP	INSTRUCTION	COMMENT
1	Start 7	Look at input #7
2	Output 444	If true reset stepper #1 or #101
3	Output 445	and Stepper program #2 or #202
4	End	End of program

9.2.4 Resetting/Advancing Programs through the Gun Table

If the Gun table is employed, the weld count for a particular gun (1-40) is stored in a table under the gun number. Therefore the first method to reset or advance stepper programs (that are used by different guns!), is the weld count for the gun **in the table**. To reset the count, press the CLEAR key with the control in PROGRAM mode and the cursor at C (count). To advance or retard the stepper, edit the weld count number up or down. A second method, is by setting Bit #321 which resets the **Active Guns** Weld Count and **ALL Stepper programs**, therefore bit #408 “All Steppers Reset” will reflect the Active Gun Weld Count. See 11.20 and 9.2.3 the stepper reset PLC program.

10.0 Ladder Logic

The ladder logic or random logic user program is accessed by entering LADDER LOGIC. The algorithm employed is what is commonly referred to as a scanning "One Bit" process. The bit is referred to as STATUS in the following detailed instruction descriptions. In this section the programmer may program 999 steps of 2 bytes of Boolean logic or 2000 bytes maximum. The program keystroke process follows the same rules as programming the Sequential logic. The only difference is, when the programmer presses the LIST key the ladder logic instruction list will be presented to the programmer. See 7.0 for keystroke detail.

It is important to remember that the ladder logic program runs independently of any sequential program, and that the program runs at all times (except PROGRAM mode). If not interrupted, the executive program executes 50 user PLC instructions every 1/2 line cycle, i.e. it "scans" at a rate of 100 instructions every 16.66 milliseconds. On Line data entry in the Ladder logic program or the Sequencer program may lower the number of instructions per half cycle. Upon power up, for safety and other reasons, scanning will start after a 7 second delay. Scanning starts less then 1 second after a mode switch from PROGRAM to RUN.

A ladder logic program can binarily "call" or pilot any sequential program via bits 507, 508, 509, 510 and possibly 511.

A ladder logic program can binarily steer any sequence to "call weld subroutine" for any one of 99 Weld Schedules via bits 153 through 160. See sequencer instructions 49 and 50 in section 2.

Any interfacing of the sequential and ladder logic programs must be accomplished via the 512 bits in the I/O map, see 5.1.

Ladder logic may be used to permanently set a Series 400 feature, see 10.8.

CAUTION!

The PLC program does not respond to the Emergency Stop/Sequence Reset. Program rungs that must respond can do so via AND NOT of bit #328 Emergency Stop Fault status.

Ladder logic instruction list:

OP CODE	1234567890123456789012345678901233	DATA DIRECTION	TOTAL BYTES
1	sss START iii	input	2
2	sss START NOT iii	input/logic	2
3	sss OUTPUT ooo	output	2
4	sss OUTPUT NOT ooo	output/logic	2
5	sss END	logic	2
6	sss NOT	logic	2
7	sss AND iii	input/logic	2
8	sss AND NOT iii	input/logic	2
9	sss OR iii	input/logic	2
10	sss OR NOT iii	input/logic	2
11	sss OUT LATCHED ooo	output	2
12	sss OUT UNLATCHED ooo	output	2
13	sss TIMERrr pppp iii	input/logic	5
14	sss TON rr pppp	logic	5
15	sss TOF rr pppp	logic	5
16	sss TOS rr pppp	logic	5
17	sss COUNTERrr pppp iii	input/logic	5
18	sss MUX OUT ooo-dd IN iii	input/output	4
19	sss HEX OUT STARTING AT ooo zz	output	3
20	sss UPDATE DISPLAY	serial output	1
21	sss COPY nn BITS FROM iii TO ooo	input/output	6
22	sss BCD2 OUT STARTING AT ooo nn	output	4
23	sss BCD ENCODE nn AT iii TO ooo	input/output	6

Where sss = Program step Number 1 to 999.
iii = I/O number 0 to 511.
ooo = I/O number 0 to 511.<==========

CAUTION !!!!
do not assign to
assigned inputs.

rr = Holding register number 0 to 31.
pppp = Register preset 0 to 65535.
aaaaa = Register actual value 0 to 65535.
dd = Number of consecutive output ports strobed, 0-99 with input data @ iii + 7 placed in data registers 1 through 99 consecutively (bb). Usable by sequential REM (remote) instructions 27,28 and 29.
zz = Hexadecimal value 0-15
nn = Decimal number 1-99

NOTE: iii reset input port on timers and counters. When iii=0 timers or counters are RESET and will not count or time. ppppp preset are in units of .1 seconds.

There are 2000 bytes of ladder program space available for the user program.

10.1 Ladder Logic Instructions

The ladder logic instruction interpreter reads and writes to the I/O space based on the logic status of a variable called "STATUS". STATUS may only be assigned the value 1 or 0, where 1 represents true or on and 0 represents false or off. Most of the instructions use and modify this variable. The individual instructions operate as follows:

10.1.1 START RUNG

The display will read: Logic symbol:

```
                                        |  iii
"  1 START        iii"                 !--| |--
                                        |
```

This instruction sets STATUS to the current value of the assigned input iii. That is, if iii is a 0 then STATUS is assigned 0, if iii is a 1 STATUS is assigned a 1. The programmer inserts the input bit number iii and presses enter. This bit may be any of the 256 bits in the memory map. The number one is the step number and is automatically assigned as the program is entered, in this case it is the first step.

10.1.2 START NOT RUNG

The display will read: Logic Symbol:

```
                                        |  iii
      " 1 START   NOT   iii"            !--|/|--
                                        |
```

This instruction sets STATUS to the complement of the current value of the assigned input iii. That is, if iii is 0 then status will be assigned 1, if iii is a 1 then STATUS will be assigned a 0. The programmer inserts the input bit number iii and presses enter. This bit may be any of the 256 bits in the memory map. The number one is the step number and is automatically assigned as the program is entered, in this case it is the first step.

10.1.3 OUTPUT

The display will read: Logic Symbol:

```
                                          ooo |
"  2  OUTPUT     ooo "               ----( )-|
                                             |
```

This instruction assigns the value of STATUS to the assigned output. That is if STATUS is a 1 then the assigned output will become a 1, true or on.
The programmer inserts the output bit number ooo and presses enter. This bit may be any of the 256 bits EXCEPT ASSIGNED INPUT BITS. The number 2 is the step number and is automatically assigned as the program is entered. In this case, step two.

10.1.4 OUTPUT NOT

The display will read: Logic Symbol:

```
                                        ooo |
"  3  OUTPUT NOT   ooo "           ----(/)-|
                                           |
```

This instruction assigns the complement of the value of STATUS to the assigned output. STATUS is NOT modified. That is, if STATUS is a 0 then the assigned output will become a 1, true or on. And STATUS will remain a 0. The programmer inserts the output bit number ooo and presses enter. This bit may be any of the 256 bits EXCEPT ASSIGN INPUTS. The number 3 is the step number and is automatically assigned as the program is entered, in this case step three.

10.1.5 END

The display will read: Logic Symbol:

```
                              |                 |
 "  4  END     "              |------[END]------|
                              |                 |
```

This instruction designates the end of the ladder program. It must be entered at the desired end and will cause the instruction interpreter to go back to step #1 and restart execution of the ladder program.

More than one END statement may be present in a ladder program, but all instructions after the first End will not be executed. This may be used to "check out" a program or to turn off a program by inserting the END instruction in step #1. The number 4 in this example is the step number.

10.1.6 NOT

The display will read: Logic Symbol:

```
" 5 NOT   "                          |   ooo
                                     |---| |---|NOT|
                                     |
```

This instruction simply inverts STATUS.
The above example shown in ladder form would be equal to "START NOT".

NOTE: No I/O is associated with this logic instruction.
The number 5 is the step number in this example.

Truth Table

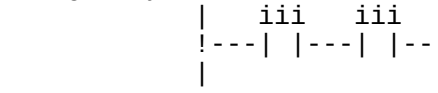
STATUS	NEW STATUS
0	1
1	0

10.1.7 AND

The display will read:

```
"  6  AND       iii "
```

Logic Symbol:



This instruction logically AND's the value of STATUS with the assigned input, then stores the result back into STATUS. That is, if STATUS is a 1 and the assigned input is a 1 then STATUS will become a 1, true or on.

Truth table:

STATUS	INPUT	NEW STATUS
0	0	0
0	1	0
1	0	0
1	1	1

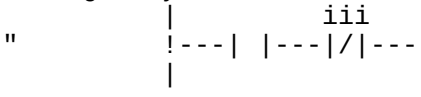
The programmer inserts the input bit number iii and presses enter. This bit may be any of the 256 bits. The number 6 is the step number and is automatically assigned as the program is entered, in this case step six.

10.1.8 AND NOT

The display will read:

```
"  7  AND   NOT   iii "
```

Logic Symbol:



This instruction logically AND's the value of STATUS with the complement of the assigned input, then stores the result back into STATUS. That is, if STATUS is a 1 and the assigned input is a 0 then STATUS will become a 1, true or on.

Truth table:

STATUS	INPUT	NEW STATUS
0	0	0
0	1	0
1	0	1
1	1	0

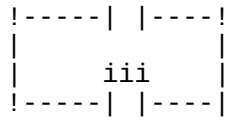
The programmer inserts the input bit number iii and presses enter. This bit may be any of the 512 bits. The number 7 is the step number and is automatically assigned as the program is entered, in this case step seven.

10.1.9 OR

The display will read:

```
"  8  OR        iii"
```

Logic Symbol:



This instruction logically OR's the value of STATUS with the assigned input. Then stores the result back into STATUS. That is, if STATUS is a 0 and the assigned input is a 1 then STATUS will become a 1, true or on.

Truth table:

STATUS	INPUT	NEW STATUS
0	0	0
0	1	1
1	0	1
1	1	1

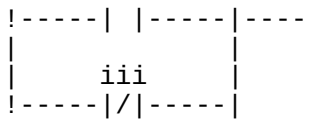
The programmer inserts the input bit number iii and presses enter. This bit may be any of the 256 bits. The number 8 is the step number and is automatically assigned as the program is entered, in this case step eight.

10.1.10 OR NOT

The display will read:

```
"  9  OR    NOT   iii"
```

Logic Symbol:



This instruction logically OR's the value of STATUS with the complement of the assigned input, then stores the result back into STATUS. That is, if STATUS is a 0 and the assigned input is a 0 then STATUS will become a 1.

Truth table:

STATUS	INPUT	NEW STATUS
0	0	1
0	1	0
1	0	1
1	1	1

The programmer inserts the input bit number iii and presses enter. This bit may be any of the 256 bits. The number 9 is the step number and is automatically assigned as the program is entered, in this case step nine.

10.1.11 OUTPUT LATCHED

The display will read: Logic Symbol:

```
                                          ooo |
" 10  OUT LATCHED   ooo "              ----(L)-|
                                               |
```

When STATUS is a 1, this instruction assigns a 1 to the assigned output. Afterwards no assignment to the assigned output takes place. This value is retained through a power failure. STATUS is not modified. The output can only be changed back to a 0 with a true out unlatch instruction. The programmer inserts the output bit number ooo and presses enter. This bit may be any of the 256 bits EXCEPT ASSIGNED INPUT BITS. The number 10 is the step number and is automatically assigned as the program is entered, in this case step ten.

10.1.12 OUTPUT UNLATCHED

The display will read: Logic Symbol:

```
                                        ooo |
" 11  OUT UNLATCHED   ooo "         ----(U)-|
                                            |
```

When STATUS is a 1, this instruction assigns a 0 to the assigned output. Afterward no assignment to the assigned output takes place. This value is retained through a power failure. STATUS is not modified. The output can only be changed back to a 1 with a true out latch instruction.

The programmer inserts the output bit number ooo and presses enter. This bit may be any of the 256 bits EXCEPT ASSIGNED INPUT BITS. The number 11 is the step number and is automatically assigned as the program is entered, in this case step eleven.

10.1.13 TIMER

The display will read: Logic Symbol: iii
ppppp
"12 TIMERrr ppppp iii (aaaaa)" ---|T|---

This instruction has two inputs, STATUS and the assigned input. The timer time base is seconds divided by 10 (ppppp = 51 = 5.1 seconds). The assigned input controls the reset of the timer as follows:

When the assigned input iii=0, the timer is set to 0, reset and will not time.

When the assigned input iii=1, the timer is not set to 0, not reset and will time.

When the timer is not being reset (iii=1) and:

When STATUS =1, the timer is enabled. However the timer cannot exceed the timer preset ppppp.

When STATUS =0, then the timer is disabled.

On exit STATUS is updated as follows:

When the timer value aaaaa is less then the timer preset ppppp STATUS will be made 0.

When the timer value aaaaa = the timer preset ppppp STATUS will be made a 1.

The programmer inserts:

One of 32 register numbers (0 to 31) and presses enter. The preset timer value, 0 to 65535, (.1 to 6553.5 seconds.[1.82 hours]) and presses enter. The input bit number iii (reset port) and presses enter. This bit may be any of the 256 bits. The number 12 is the step number and is automatically assigned as the instruction was entered, in this case step twelve. If the timer is called up during operation the actual value at that time will be displayed in aaaaa. The contents of aaaaa will be retained during a power down.

10.1.14 TON (TIMED ON)

The display will read: Logic Symbol:

```
                                                  ppppp
"13 TON rr ppppp (aaaaa)"                    --|TON|--
```

This instruction has one input, STATUS. The timer time base is seconds divided by 10 (ppppp = 51 = 5.1 sec.).

When STATUS =1, the timer is enabled. However the timer cannot exceed the timer preset ppppp.

When STATUS =0, then the timer is disabled and reset.

ON exit STATUS is updated as follows:

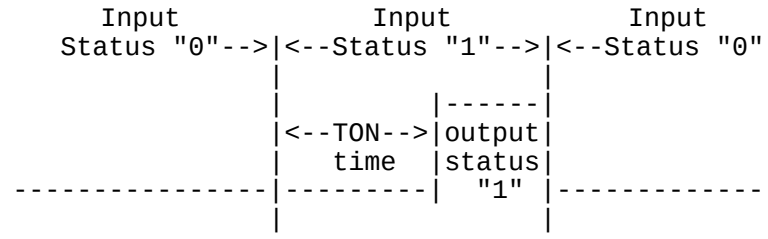
When the timer value aaaaa is less then the timer preset ppppp STATUS is made 0.

When the timer value aaaaa = the timer preset ppppp STATUS is made a 1.

The programmer inserts:

One of 32 register numbers (0 to 31) and pressed enter. The preset timer value 0 to 65535, (.1 to 6553.5 seconds.[1.82 hours]) and presses enter. The number 13 is the step number and is automatically assigned as the program is entered. If the timer is called up during operation the actual value at that time will be displayed in aaaaa. aaaaa will be reset upon power up.

Graphic example of TON



Note timing starts after input status goes from a 0 to a 1. After timeout if input status is a 1, status will remain a 1. As soon as input status goes to a 0 output status will go to a 0 re-arming the timer for the next 0 to 1 transition.

10.1.15 TOF (TIMED OFF)

The display will read: Logic Symbol:

```
                                                ppppp
"14 TOF rr ppppp (aaaaa)"                  --|TOF|--
```

This instruction has one input, STATUS. The timer time base is seconds divided by 10 (ppppp = 51 = 5.1 sec.).

When STATUS =0, then the timer is disabled and reset.

When input STATUS = 1, output STATUS will = 1 and the timer is armed but not timing.

When the input STATUS goes from 1 to 0 the timer starts timing, on exit STATUS is updated as follows:

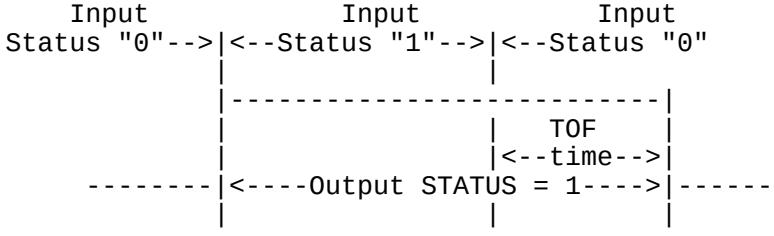
When the timer value aaaaa is less then the timer preset ppppp STATUS is made a 1.

When the timer value aaaaa = the timer preset ppppp STATUS is made a 0.

The programmer inserts:

One of 32 register numbers (0 to 31) and presses enter. The preset timer value 0 to 65535, (.1 to 6553.5 seconds.[1.82 hours]) and presses enter. The number 14 is the step number and is automatically assigned as the program is entered. If the timer is called up during operation the actual value at that time will be displayed in aaaaa. aaaaa will be reset upon power up.

Graphic example of TOF



Note output status is made a 1 as soon as input status is made a 1. Timing starts as soon as input status goes from a 1 to a 0. After time out, output status is made a 0, hence timed off.

10.1.16 TOS (TIMED ONE SHOT)

The display will read: Logic Symbol:

```
                                                ppppp
"15 TOS rr ppppp  (aaaaa)"                   --|TOS|--
```

This instruction has one input, STATUS. The timer time base is seconds divided by 10 (ppppp = 51 = 5.1 sec.).

When the input STATUS goes from 0 to 1 the output STATUS is made a 1 and remains a one until timing is over, output status then becomes a 0. If the input STATUS moves from 1 to 0 and back to 1 during the timing period, Output status will remain a 1 until movement from 0 to 1 ceases and timing is over.

On exit STATUS is updated as follows:

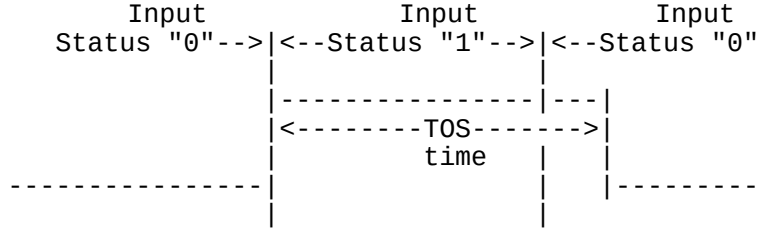
When the timer value aaaaa is less then the timer preset ppppp STATUS is made 1.

When the timer value aaaaa = the timer preset ppppp STATUS is made a 0.

The programmer inserts:

One of 32 register numbers (0 to 31) and presses enter. The preset timer value, 0 to 65535, (.1 to 6553.5 seconds.[1.82 hours]) and presses enter. The number 15 is the step number and is automatically assigned as the program is entered. If the timer is called up during operation the actual value at that time will be displayed in aaaaa. aaaaa will be reset upon power up.

Graphic example of TOS



Note: timing starts on the 0 to 1 transition. If a new transition takes place during timing, timing will be reset and start again.

10.1.17 COUNTER

The display will read: Logic Symbol: iii
ppppp
"16 COUNTERrr ppppp iii (aaaaa)" --|C|---

This instruction has two inputs, STATUS and the assigned input. The assigned input controls the reset of the counter as follows:

When the assigned input iii=0, the counter is set to 0, it is reset and will not count.

When the assigned input iii=1, the counter is not set to 0, not reset and will count.

When the counter is not being reset (iii=1) and when STATUS changes from a 0 to a 1 the counter is incremented. However the counter cannot exceed the counter preset ppppp. On exit, STATUS is updated as follows:

When the counter value aaaaa is less then the counter preset ppppp STATUS will be made a 0.

When the counter value aaaaa = the counter preset ppppp STATUS will be made 1.

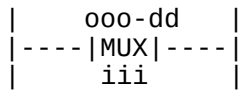
The programmer inserts:

One of 32 register numbers (rr=0 to 31) and presses enter. The preset counter value, 0 to 65535, and presses enter. The input bit number iii (reset port) and presses enter. This bit may be any of the 256 bits. The number 16 is the step number and is automatically assigned as the program is entered, in this case step sixteen. If the timer is called up during operation the actual count at that time will be displayed in aaaaa. The contents of aaaaa will be retained during power down.

10.1.18 MUX OUT

The display will read: Logic symbol:

" 17 MUX OUT ooo-dd IN @ iii"



This instruction is not a logic instruction but a ladder logic subroutine. The program outputs to up to 16 BCD thumbwheel **pairs** one at a time. Each pair will remain energized for a programmable 2 or 3 scans of the PLC program. Outputting to the thumbwheels starts at (ooo) for (dd) **consecutive** outputs each wired to a BCD thumbwheel pair. The two digit BCD data returning from the thumbwheels must be wired to 8 **consecutive** input ports where the LSD of lower BCD digit is wired to iii and up to MSD of higher digit on iii+7. The incoming two digit BCD data is placed into consecutive two digit BCD data buffers up to maximum of 16. Normally each buffer number corresponds to the output number strobed. i.e. Let us say the second output (ooo+1) strobes the second thumbwheel pair. The incoming two digit BCD data will be read on the 8 consecutive inputs and placed in buffer number 2. Buffer 2 may then be read by sequential instruction #28 for time or #88 for current. The number of BCD thumbwheel **pairs** read and the digits per buffer may be changed by setting binary control bits 368 and 369 where:

Bits #368	#369	
0	0	Compatibility mode (V8.017 or prior) Three scans, %heat and time are 2 digits each, constant current instructions look for 3 digits.
1	0	Two scans, %heat and time are 2 digits each, constant current instructions look for 3 digits.
0	1	Two scans, %heat and time are 2 digits each, constant current instructions look for 4 digits.
1	1	Two scans, %heat and time are 2 digits each, constant current instructions look for 5 digits.

The BCD data that is inserted into the programmable 2 to 5 digit buffers may be read by five different sequential instructions. It is accomplished by programming the sequential instruction to examine the two-digit buffer of interest. Bits 368 and 369 control the number of digits read out of the buffer. If bits 368 and 369 are set for an odd number of digits, then only the odd number of digits will be examined in the buffer by the sequential instruction. If an odd number of thumbwheels are used, 2K ohm pull down resistors should be added to the inputs to cover the thumbwheel that is missing in the last pair.

Noise read on the missing digit may cause debounce problems slowing down the scanning system. Also the outputs of the Series 415 have .001 bypass capacitors across them (Series 400 do not). But depending on the installed circuit and leakage (especially the diodes) the capacitors stored voltage could cause cross talk. This is true when one digit effects its another. A 10K 1W across the DC outputs to common may be necessary.

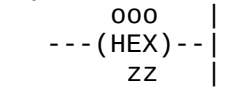
If there is only one pair of thumbwheels, 24VAC may be delivered directly to the pair and 24VAC inputs may be used, dd=1. If more than one pair are employed, 24VDC I/O must be used and dd=# of pairs. This is so even if only one thumbwheel exists in the last pair driven. For more detail see 15.0 instruction numbers 27, 28, 29, 88 and 89.

10.1.19 HEX OUT

The display will read:

" 18 HEX OUT STARTING AT ooo zz"

Logic Symbol:



This instruction assigns a hexadecimal output starting at a user assigned starting address (ooo) plus the next three consecutive bit addresses. The hexadecimal assignment will be equal to the assigned decimal number zz (0-15). That is, if STATUS is a 1 then the assigned outputs ports (ooo+1+2+3) will become the assigned hexadecimal number zz, and will remain LATCHED with that number until a NEW hexadecimal is outputted and LATCHED. The outputted number is NOT RETAINED during power down. ooo may be any memory address except real assigned inputs.

HEXADECIMAL CHART

OUTPUT zz weight	+3 8	+2 4	+1 2	(ooo) 1
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1
10	1	0	1	0
11	1	0	1	1
12	1	1	0	0
13	1	1	0	1
14	1	1	1	0
15	1	1	1	1

10.1.20 UPDATE DISPLAY

The display will read:

```
                          Logic Symbol:     |
" 19 UPDATE DISPLAY              ---(DIS)--|
                                           |
```

This output instruction is NOT logic instruction but a subroutine, which serially outputs to a Static Controls® Corporation 1000 Series display. Output is through a RS485 serial port on the top front of the CPU/Timer. The update will be send 8 bits, 1 Stop, No parity at the time this instruction is executed AND depending on the status of bits #396 and #397. This instruction does not modify or refer to STATUS. The data send is dispatched from bits #400 thru #407; therefore the instruction should be used only after bits #400-407 are set up with data by your program.

Data is sent by the following conditions:

#396=1 Causes message or data to be sent to the SCC display. Bit #396 is THEN CLEARED (0). Setting this bit to often could cause the SCC® or Series 400 buffers to overflow (loss of data).

#396=0 Causes no transmit action

Bit #397 has the following meaning only if #396 is set, Otherwise no action is performed.

#397=1 Causes the 2 digit Binary Coded Decimal value of bits #400 through #407 to be sent and displayed as "NUMERICAL DATA" on the SCC® display.

#397=0 Causes the 2 digit Binary Coded Decimal value to bits #400 through 407 to be sent as "MESSAGE NUMBER" to the SCC® Display (CYRL-Y00dd).

NOTE: Set W4 for FDX (Full duplex) and W5 RD (Receive Data). Check W3 and S1-1. See 2.1.1 for more detail.

RS485 SERIAL PORT
HOOK UP CHART

SERIES 400 DB15 PIN #	SCC® DISPLAY
+12V	+12
-GND	GND
8--(not used)	COM2-
7--(not used)	COM2+
9--(shield)	COMGND
6	COM1-
5	COM1+

10.1.21 COPY BITS

The display will read:

```
                                  Logic Symbol:
                                                  |
" 20 COPY nn BITS FROM iii TO ooo    --(COP)--|
                                                  |
```

This instruction copies nn bits starting at iii to ooo. The copy takes place only when STATUS is true. The I/O bits are not copied when STATUS is false. This instruction is useful for making a historical copy of a bit pattern or transferring data from one place in memory to another.

10.1.22 BCD2 OUT

The display will read:

```
                                  Logic Symbol:
                                                  |
 " 21 BCD2 OUT STARTING AT ooo nn     --(BC2)--|
                                                  |
```

This instruction similar to instruction #19 HEX OUTPUT however the output of this instruction writes to 8 rather than 4 consecutive bits and its format is in Binary Coded Decimal rather than Hexadecimal, nn range is from 0-99. The output occurs only when STATUS is true on entry to this instruction.

Example:

```
                                BIT#  VALUE  COMMENT
BCD2 OUT STARTING AT 11 99-->11     1    $01 bit
                             12     0    $02 bit
                             13     0    $04 bit
                             14     1    $08 bit
                             15     1    $10 bit
                             16     0    $20 bit
                             17     0    $40 bit
                             18     1    $80 bit
                              8BITS 4 SET 99 BCD
```

Eight consecutive bits are addressed (11 through 18), four bits are set for a total value of 99 (80+10+8+1=99)

10.1.23 BCD ENCODE

The display will read:

```
                                  Logic Symbol:
                                                        |
 " 21 BCD ENCODE nn AT iii TO ooo     --(BCE)--|
                                                        |
```

This instruction starts counting up to nn bits (0-99) starting at iii looking for the first true (1) bit. When it finds a bit set true, it outputs the bits value by position in Binary Coded Decimal Starting at ooo. Output occurs upon instruction entry BUT only if STATUS is true.

When nn has a value of nine or less the instruction outputs only four BCD valued bits. When nn is grater than 9, output is eight consecutive bits. Outputs always start with the Least Significant BCD Bit.

This instruction may be used to load prioritized faults into bits 400 thur 407 in proper BCD form for transmission to Kawasaki® robots or SCC Corp® Displays.

Example:

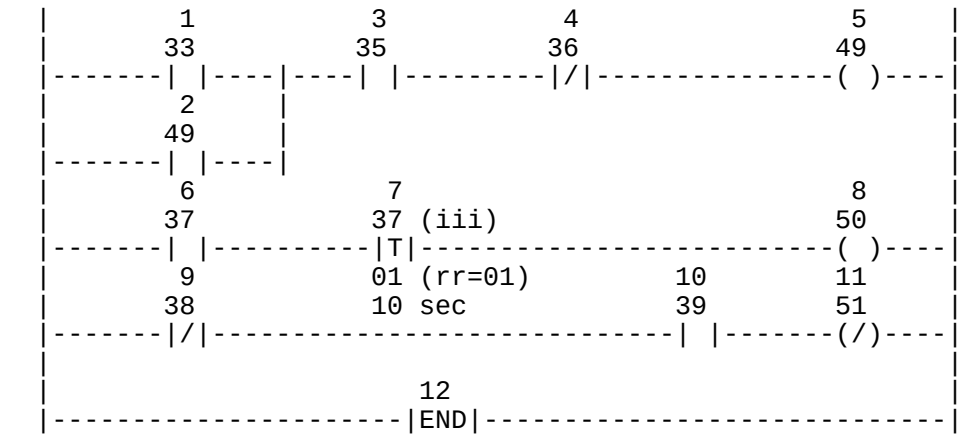
BCD ENCODE 14 AT 200 TO 400

BIT FIELD SCANNED				BCD BIT FIELD OUTPUTTED		
BIT#	VALUE	COUNT		BIT#	VALUE	COMMENT
200	0	1		400	0	bit $01
201	0	2	|------>	401	1	bit $02
202	0	3	|	402	0	bit $04
203	0	4	|	403	0	bit $08
204	0	5	|------>	404	1	bit $10
205	0	6	|	405	0	bit $20
206	0	7	|	406	0	bit $40
207	0	8	|	407	0	bit $80
208	0	9	|	2 bits set for value of 12		
209	0	10	|	(2+10=12)		
210	0	11	|			
211	1	12>	-------|			
212	0	13				
213	1	14<---Ignored because not the first bit set				

If no bit above is set then no BCD bit pattern will be outputted.

10.2 Sample Program

A sample "does nothing" program and its entry is shown below:



Program entry is as follows:

Step	Instruction	Data	Execute Keys
1	Start	33	Enter/down arrow
2	Or	49	Enter/down arrow
3	And	35	Enter/down arrow
4	And Not	36	Enter/down arrow
5	Output	49	Enter/down arrow
6	Start	37	Enter/down arrow
7	Timer 01 100	37	Enter/down arrow
8	Output	50	Enter/down arrow
9	Start Not	38	Enter/down arrow
10	And	39	Enter/down arrow
11	Output Not	51	Enter/down arrow
12	End	N/A	

10.3 Ladder Logic Program Constraints

There are very few constraints on the program flow in the Series 400. Listed below are the DO NOT'S

10.3.1 Outputting

Do not OUTPUT to a real ASSIGNED input.
Do not OUTPUT to the same port from both controllers. See 10.4

10.3.2 Sequential and Random logic handshaking

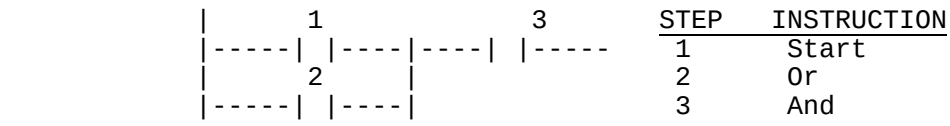
If a Ladder logic program is controlling I/O in unison with the sequential controller timing (program scanning) might become a problem. Make sure the two programs are interlocked. This can be done by making the sequence program WAIT for the ladder logic program or vis-a-vis to complete its task and then grant permission to continue, timing problems will be avoided.

10.3.3 ORing

The OR instruction always starts the logic OR from the start of the last START RUNG instruction and OR's to the point of the OR's insertion. Only one instruction may be placed in this ORed branch.

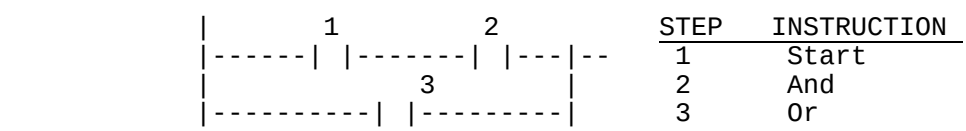
Examples:

Example 1. This is drawn and expressed properly.



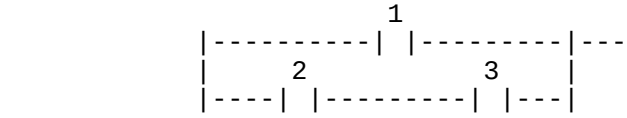
STEP	INSTRUCTION
1	Start
2	Or
3	And

Example 2. This is drawn and expressed properly.



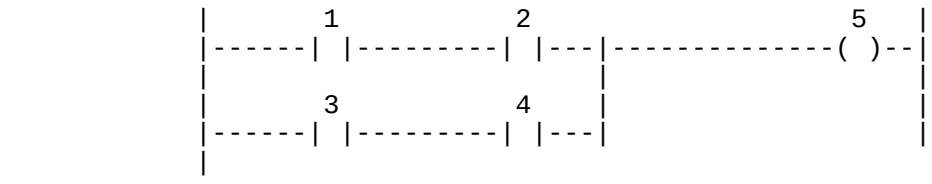
STEP	INSTRUCTION
1	Start
2	And
3	Or

Example 3. This is not drawn properly, and cannot be expressed. An attempt to express it will end up expressed like Example #1 above



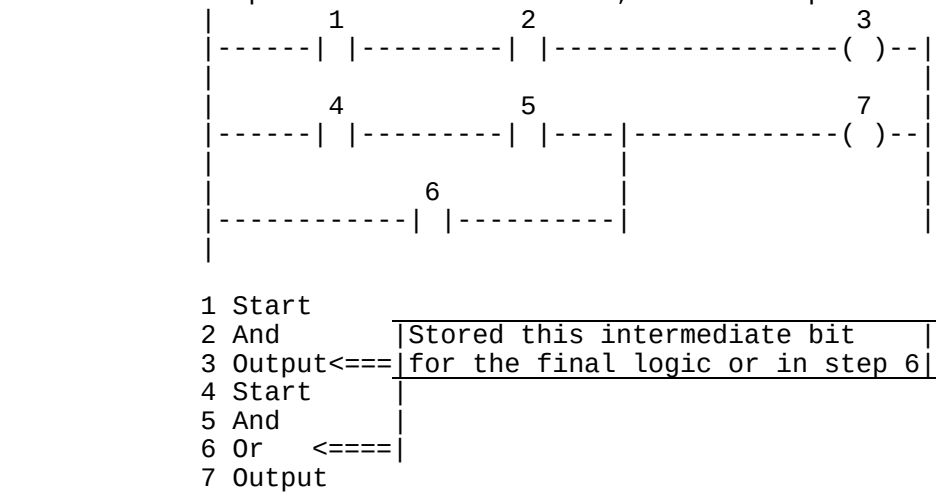
NOTE: It must be re-drawn and expressed as Example #2. Example #2 and this example are logically the same statement.

Example 4. Two elements in a OR'd branch cannot be expressed, so this example must be re-drawn and re-defined. Steps 3 and 4 must be ANDed and intermediately stored, then ORed with 1 and 2.



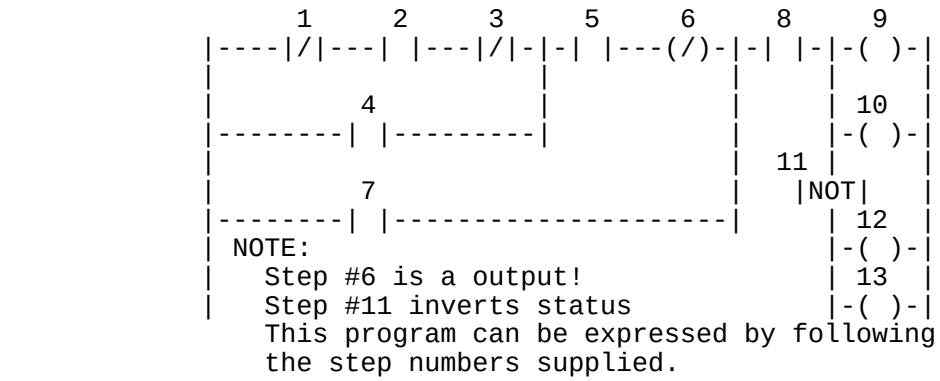
Example 5. Properly drawn and expressed. Steps 1 and 2 are stored in step 3, and OR'd in step 6. Steps 1 and 2 in this example are old steps 3 and 4 above.

Step 7 is the final result, as was step 5 above.



By the above example one can see that there is no way to express two or more AND statements and then OR them with two or more AND statements without using a intermediate store.

Example 6: This is example is ALL OK and can be expressed.



This program can be expressed by following the step numbers supplied.

10.3.4 When to and when not to use ladder logic

The purpose of the Series 400 is to provide a way to untangle the clumsy application of a separate weld or sequence controller and a random logic machine controller. If the suggestions listed below are NOT followed, the cost savings of the single control will still be there and so will the programming, de-bugging, start up and maintenance nightmares of the past. Even though your programs probably work!

If the instruction set of the sequencer is studied, one will recognize the enormous power of the Series 400. Powerful enough to control and annunciate the status of the MACHINE during the sequence. Because the WELD sequence must be included in the process and its instruction set is in English, why not include all machine control, if possible and it usually is, in the sequencer? Therefore control of the machine in AUTOMATIC MODE should be accomplished in the SEQUENCER. Reserve the ladder logic for the following tasks:

1. Controlling the machine in MANUAL MODE. See 10.4

2. Communicating with other PLC'S or other Series 400's via I/O bits or binary coded numbers.

3. Controlling OFF LINE tasks that have nothing to do with the automatic process.

4. Assist the sequencer in tasks in which it cannot easily implement. Some examples are long or parallel out of sequence timings or out of sequence output events. Simply stated, the ladder logic program should assist the sequencer program. Some reasons are:

    a. The sequencers timing is absolute. There are no “scan time” problems.

    b. There is more program space in the sequencer. 1485 sequential steps.

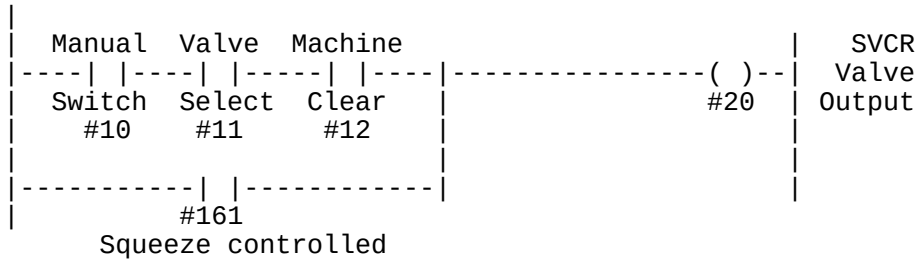
    c. The sequencers instruction set is more user friendly, powerful and more useful when starting up or troubleshooting.

10.4 Automatic and Manual modes

If automatic and manual modes are to be accomplished, and outputs are common to both the sequencer and the ladder logic sections, the outputs must be controlled from only one program. Attempts to control a single output from both programs will result in output contention and "valve chatter". What happens is the valve will be energized with the sequencer program and then de-energized with a PLC ladder rung that is logically not true. Solve this problem by simply assigning output control to the ladder logic program, then in the control of the output rung include a ORed internal bit which is controlled by the sequencer.

In the example below the Squeeze function outputs to bit #161, the ORed branch in the ladder logic section controls the SVCR Solenoid valve through output #20. A manual switch is on input port #10. A valve selector switch on input #11 and a machine clear limit switch on input #12.

Automatic and Manual SVCR control



Random logic program:

STEP	INSTRUCTION	COMMENT
1	Start 10	;If the manual switch port 10
2	And 11	;AND the selector port 11
3	And 12	;AND the machine clear on 12
4	Or 161	;or the sequencer intermediate
5	Output 20	;Energizes SVCR

Sequencer program:

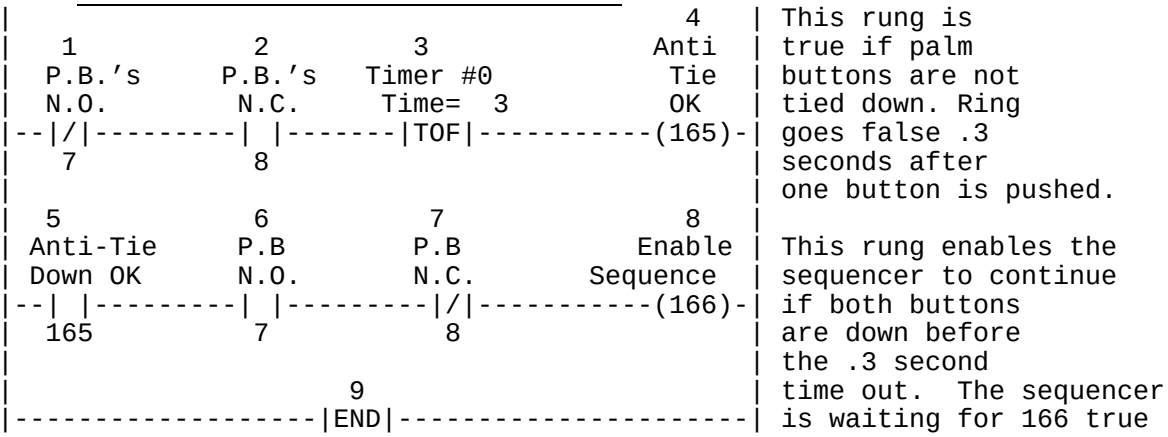
STEP	INSTRUCTION	COMMENT
1.	If 010 true Goto 005	;If in manual mode goto off single
2.	Squeeze out 161 10 cy	;Output port #161 (to PLC) and sqz.
3.	Weld 50% for 10 cycles	;Weld for 10 cycles @ 50% heat
4.	Hold 10 cy	;Hold for 10 cycles
5.	Off single	;Turns off bit #161 and through the ;PLC program ORed rung and output #20 ;turn off the Solenoid Valve

10.5 Anti-Tie Down Program

Assume two palm buttons both with a N.O. and N.C. contact each. The two N.O. contacts are wired in series and applied to input 7. The two N.O. contacts are also applied to inputs 1-4 through a binary selector switch for sequence selection and SFCR safety relay closure. The N.C. contacts are wired in series and applied to input 8. See Hookup drawing 475-0-0053-5X. The operator must press both palm buttons down fully before a .3 second timer times out. If either palm button is tied down, the program will not respond to the pressing of the second button because the TOF timer has timed out.

It is extremely important to monitor the closure of the head and apply the contact to input 9 for Second Stage operation. If the operator removes a hand from a palm button before the tips close, sequence will be aborted by Second Stage and the heads will open immediately. Also to use a head down output that is protected with a contact from the safety relay SFCR. Only the 50310324XX I/O modules have SFCR safety relays. SAFETY FIRST!

ANTI-TIE DOWN LADDER LOGIC DIAGRAM



STEP	INSTRUCTION AND BIT		CODE
1.	START NOT	7	02
2.	AND	8	07
3.	TOF rr=00 ppppp=3		15
4.	OUT	165	03
5.	START	165	01
6.	AND	7	07
7.	AND NOT	8	08
8.	OUT	166	03
9.	END	N/A	05

SEQUENCER PROGRAM

STEP	INSTRUCTION	COMMENT
1.	WAIT FOR 166 TRUE	;WAIT FOR PLC INITIATION TO CONTINUE
2.	OUTPUT 017 ON	;OUTPUT SVCR AND LATCH SFCR RELAY
3.	SECOND STAGE 009	;CONTINUE SEQUENCE ONLY IF THE HEAD IS DOWN
4.	SQUEEZE OUT 017 5CY	;SQUEEZE TIME MAY BE SHORT, HEADS ARE DOWN!
5	WINDOW Hiiii Loiiii	;OPEN WINDOW FOR CURRENT MEASUREMENT
6.	WELD nn 50% 10CY	;WELD FUNCTION
7.	WINDOW COMPARE	;CLOSE WINDOW MEASUREMENT AND COMPARE
8.	HOLD 10 CY	;HOLD FUNCTION
9.	OFF SINGLE	;END TURN OFF ALL OUTPUTS

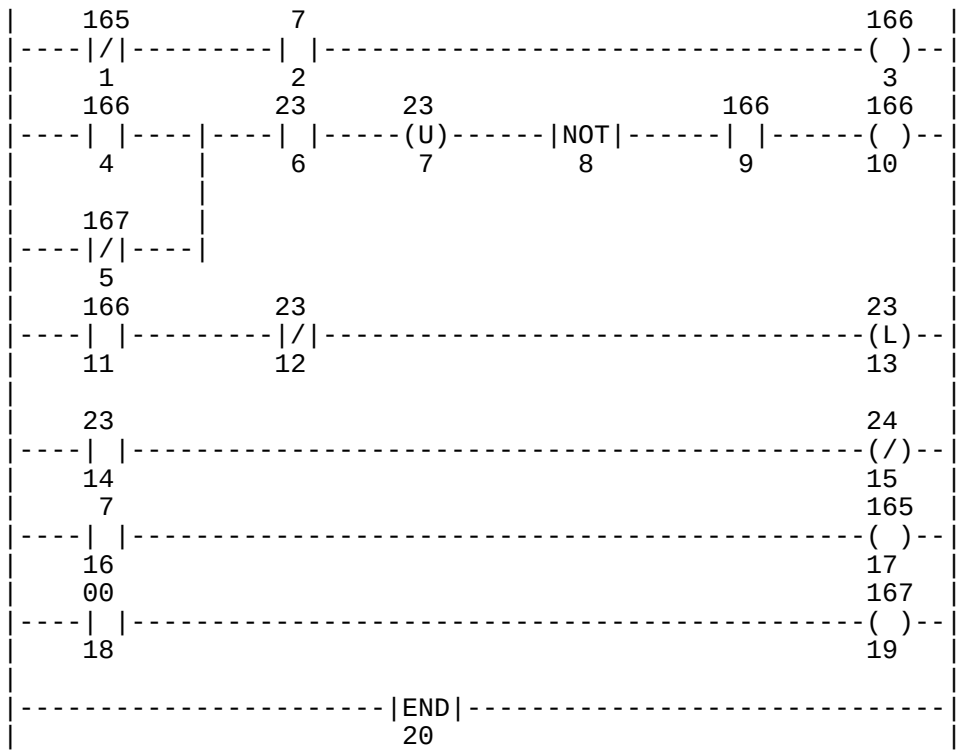
10.6 Retraction Program

Assume a single button toggled retraction solenoid. Tips Retracted with either energized or de-energized solenoid. Input on port #7 outputs 23 and 24. Remember the Series 400 provides solid-state outputs and is not fail safe. If the operator is not protected from unexpected motion this proposal cannot be used.

SEQUENCER PROGRAM:

STEP	CODE	INSTRUCTION	DESCRIPTION
1	61	IF #23 GO TO 0005	If in retraction go to off
2	02	SQUEEZE	Squeeze function
3	06	WELD	Weld function
4	08	HOLD	Hold function
5	10	OFF SINGLE	turn off valve

PLC LOGIC LADDER DIAGRAM:



PC LOGIC PROGRAM

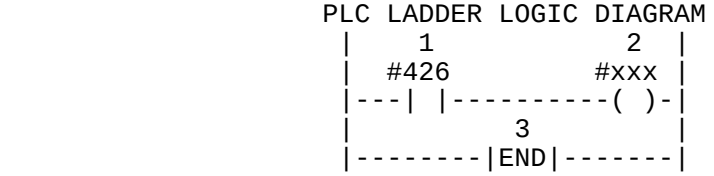
STEP	CODE	INSTRUCTION	DESCRIPTION
1	02	START NOT #165	IF #165 IS NOT SET, READY FOR ACTION
2	07	AND #7	AND THE INPUT IS TRUE, THEN
3	03	OUTPUT #166	PREPARE FOR SOME ACTION.
4	01	START #166	IF PREPARED FOR SOME ACTION
5	10	OR NOT #167	OR POWER HAS JUST BEEN TURN ON
6	07	AND #23	AND IN THE LATCHED CONDITION
7	12	OUT UNLATCHED #23	THEN UNLATCH THE RETRACT CONDITION.
8	06	NOT	TURN STATUS OVER.
9	07	AND #166	AND IF #166 IS SET THEN
10	03	OUT #166	RESET #166 SO RE-LATCH CANNOT OCCUR.
11	01	START #166	IF RETRACTION IS TO OCCUR
12	08	AND NOT #23	AND #23 IS NOT ALREADY LATCHED UP,
13	11	OUT LATCHED #23	LATCH UP RETRACTION ON PORT #23.
14	01	START #23	IF RETRACTED PROVIDE A
15	04	OUT NOT #24	INVERTED RETRACT ON PORT #24.
16	01	START #7	IF RETRACT BUTTON IS DOWN THEN
17	03	OUTPUT #165	SET #165 TO EQUAL SWITCH STATE IS OLD.
18	01	START #00	#00 IS ALWAYS A ONE, SO AFTER FIRST
19	03	OUTPUT #167	SCAN SET POWER UP RESET BIT #167 TO A
20	05	END	ONE. END OF PROGRAM START OVER AT STEP NUMBER 1.

In the analysis of the program, one must remember that all bits are set to 0 upon power up (unless latched) and that goes for bit #165. And the program must respond to the 0 to 1 transition of the retraction pilot and not a maintained pilot. Enjoy!

10.7 Fault Annunciation and Reset

The Series 400 does not have bits dedicated to fault annunciation or reset. A simple rung in ladder logic easily accomplishes outputting to any bit. Overall fault status is maintained in bits 426 (major fault has occurred), 427 (minor fault has occurred) and 320 (a stepper program has ended). To annunciate, simply transfer the bits to the output of your choice.

PLC LADDER LOGIC DIAGRAM

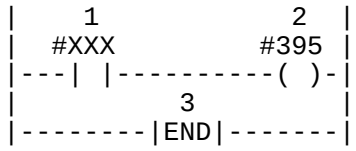


STEP	INSTRUCTION	CODE	COMMENT
1	Start 426	01	Check major fault status
2	Output xxx	03	and output the status to xxx
3	End	05	End of program, start again.

It is possible to program one rung for each type of fault outputting to three different bits, or logically OR all three fault status and output to one bit, or any combination necessary.

Faults may be reset by momentary setting bit #395 through a user input.

PLC LADDER LOGIC DIAGRAM

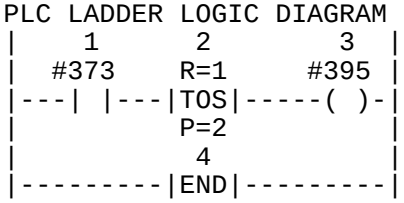


STEP	INSTRUCTION	CODE	COMMENT
1	Start XXX	01	Check fault reset bit status
2	Output 395	03	and output the status to 395
3	End	05	End of program, start again.

It is possible to program the resetting if any single fault or group of faults. Simply output to the faults reset bit of interest. See odd bit numbers 301 through 351 in section 5.1.

This program resets all faults at once by pressing the CLEAR key just once.

PLC LADDER LOGIC DIAGRAM



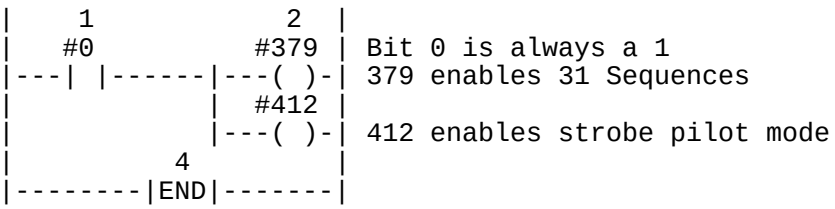
STEP	INSTRUCTION	CODE	COMMENT
1	Start 373	01	If the CLEAR key is pressed
2	TOS R=1 P=2	16	stretch the fact for .2 seconds
3	Output 395	03	Resetting all faults
4	End	05	End of program, start again.

10.8 Setting Control Bits

In the Series 400 any control bit may be set either permanently or only during execution of a sequence. Setting bits permanently is done with a single line in ladder logic, and of course during a sequence in the sequencer logic with the Output On instruction. Remember the Off Single and Off Repeat instructions will turn off all bits set in a sequence. If a sequence program has no Off instruction and is "Looping" then the bit will be set permanently. In all cases the bit will **not** be set in Program Mode.

:

EXAMPLE:



PLC LADDER LOGIC PROGRAM

STEP	INSTRUCTION	CODE	COMMENT
1	Start 000	01	Bit 0 is always a one while PLC is running
2	Output 379	03	Setting bit 379 enables 31 sequences
3	Output 412	03	Setting bit 412 enables strobe pilot mode
4	End	05	End of program, start again.

In a sequencer program, simply turn the control bit(s) on when necessary with code #16 OUTPUT XXX ON and off with code #17 OUTPUT XXX OFF. Or simply turn the bits on when required and let code #9 Off REPEAT or #10 Off SINGLE turn them off at the end of the sequence.
Control bits and the features that could be engaged by Ladder Logic:

321 1=Reset all stepper programs
368 1=Number of remote thumbwheel digits displayed. (see 10.1.18,15.0 88 & 89)
369 1=Number of remote thumbwheel digits displayed. (see 10.1.18,15.0 88 & 89)
370 1=Link Stepper programs 11 to 15 together
371 1=Link Stepper programs 6 to 10 together
372 1=Link Stepper programs 1 to 5 together
375 1=Fault codes outputted BCD format
377 1=Digital Line Clock Filter 0=Via 0 cross hardware interrupts (See 12.22)
378 1=Enable regulator speed control (See 11.17)
379 1=Enable 31 Sequences on bit 8 (See 5.2.5)
380 Feedback speed:
1=Half Cycle (fast) correction applied to next half cycle.
0=Full Cycle (slow) corrections applied lead to lead and trail to trail
381 1=Inhibits Firing Angle Amortization (built in 1 cycle slope)
382 1=Inhibits firing angle pullback during cool times. Deletes the 2/3 way logic and deletes the first 1/2 cycle delayed firing.
(uses the .99 P.F. curve for the first half cycle)
apply to seam welders with stacked iron cores only if necessary

CAUTION:

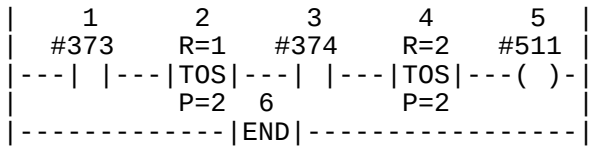
380 though 382 are used to control feedback speed and to enable and disable current control features employed on "C" core weld transformers. If a stacked iron welding transformer is NOT employed and/or the user does NOT fully understand these features, the bits should NOT be set. Setting of these bits may cause transformer saturation. If "C" core transformers are used NEVER set bit #382. Please read 4.3, 11.17

412 1=Strobed Pilots Enable 0=De-bounced Pilots (See 5.2.1 and 5.2.4)
416 1=Enable 1/2 cycle timing mode (all timing in 1/2 cycles 8.333MS)
433 1=ACDC Stepper Data Printout (see 3.8)

10.9 Sequence Initiation via DEP

A sequence may be initiated by utilizing #373 and #374 which are set for one scan of a PLC program. This program requires the operator to press quickly first the CLEAR then the RESET keys. If pressed in the right order and at the right speed sequence 16 will be initiated.

PLC LADDER LOGIC DIAGRAM



PLC LADDER LOGIC PROGRAM

STEP	INSTRUCTION	CODE	COMMENT
1	Start 373	01	If the CLEAR button is pressed
2	TOS R=1 P=2	16	stretch the fact on for .2 seconds
3	And #374	07	and the RESET button is pressed,
4	TOS R=2 P=2	16	hold the fact on for .2 seconds then
5	Output 511	03	set bit 511 calling sequence 16.
6	End	05	End of program, start again.

11.0 Set Up

The Set Up menu selection is used to set up the control to handle certain features in a user prescribed manner. The set up contains:

11.1 Global Squeeze Delay
11.2 AVC Set Point
11.3 Primary Over Current
11.4 False Current
11.5 Minimum Primary Current
11.6 Measured Line Voltage/Calibration
11.7 Primary Current Range
11.8 Measured Primary Current/Calibration
11.9 Measured Secondary Current
11.10 Network ID
11.11 Robot ID
11.12 Robot SIO Broken Link Default
11.13 SPC Sample Size
11.14 Steppers Ramp Or Staircase
11.15 Stepper Up or Up/Down
11.16 Weld Mode (AC DC or HF)
11.17 Regulator Speed
11.18 Pilot Port Starting At
11.19 I/O bit to Slot to Port set up
11.20 Gun Port Table

11.1 Global Squeeze Delay

This menu selection provides a global Squeeze Delay time that will be applied to any programmed Squeeze Delay function in any sequence program. If the global Squeeze time is zero, the programmed delay value in the Squeeze Delay function will be used. If the global value is non-zero then all Squeeze Delay functions will use and display the global value. See Section 2, Squeeze delay code 33.

11.2 AVC Set Point

This set point is the line voltage value upon which the Automatic Line Voltage Compensation feature regulates about. Upon entering this screen the display will read:

"AVC SET POINT vvv VOLTS"

In program mode and with the cursor position flashing, a value is obtained and entered from a list of voltage values. Press the **LIST** key and with the up or down arrow key choose and **ENTER** the value. If the value required is not in the list, the odd value must be downloaded via a ROPE program through Robonet. If "0" AVC volts is entered, the AVC function is disabled. The line voltage read by the control divides the AVC value used in the algorithm. Hence, the voltage measured calibration must be accurate. See 8.6 (vvvV) and 11.6. The algorithm employed is:

$$\frac{\text{AVC Set Point}}{\text{Line Voltage}} \times \%\ \text{Available Current} = (\text{Adjusted \% Available Current})$$

11.3 Primary Over Current

This function registers the programmed maximum instantaneous primary current value, which is used in the primary current fault check during all current instructions. Primary Over current is used as a safety limit to protect the SCR. The Primary Current value will be compared to the metered value reported in VIEW DATA, INSTANTANEOUS CURRENT every half cycle. See 1.3 and 12.9 for more detail. Upon entering this function the display will read:

"PRIMARY OVER CURRENT XXXXX"

11.4 False Current

This function registers the programmed maximum instantaneous **false** current value, which is used in the false current fault check. False Current is a shorted SCR or leakage test during non-heat instructions. Leakage occurs through the cooling water and through the DVDT network placed across most SCRs. The minimum detectable amount is about 10 amperes; the default value is 20 amperes. The value will be compared to the metered value reported in VIEW DATA, INSTANTANEOUS CURRENT on a half cycle basis. See 1.3 and 12.10 for more detail. Upon entering this function the display will read:

"FALSE CURRENT XXXXX"

11.5 Minimum Primary current

This function registers the programmed minimum average weld current value. The value is used whenever a "Window Compare" instruction is executed. If the value obtained at the Compare is less then the Minimum Primary Current value, "Low Primary Current Fault" is issued. The default value is 50 amps with a minimum of 10 amps possible. See instruction #58 in section 15. Upon entering this function the display will read:

"MINIMUM PRIMARY CURRENT XXXX"

11.6 Measured Line Voltage/Calibration

This function allows entry of a measured line voltage. It is used to calibrate the system to the line voltage perceived. First determine the line voltage with an accurate AC volt meter. Then in program mode, key in the measured voltage and press ENTER. "ENTER PASSWORD TO CALIBRATE" will be displayed. Enter the password and press ENTER to re-calibrate the control. The password may be obtained from the Weltronic Service Manager. The control was calibrated by Weltronic before shipment and cannot easily "lose calibration". The display simply shows the last value entered. The display will read:

"MEASURED LINE VOLTAGE xxx VAC"

11.7 Primary Current Range

This screen allows the selection of a primary current range. If the user must change range a calibration in the new range must be accomplished. Each range has a unique memory location for its calibration. Therefore, once calibrated in a range, re-calibration in that range is not necessary. See 11.8 below. Caution if a current reading is attempted above the selected range a distorted reading will result. The display will read:

"PRIM CUR (1=LO, 2=MID, 3=HI) X"

Where:
0 EXLO 150A Maximum
1 LO 1000A Maximum (normal)
2 MID 2000A Maximum
3 HI 2800A Maximum

11.8 Measured Primary Current Calibration

This Setup item is used for calibration of the PRIMARY current sensed from the PRIMARY current transformer (CT). The CT is generally located on the L1 side of the SCR. Calibration is done at the factory and is usually NOT necessary to repeat unless a current range change has been made, or the control calibration "memory" has been corrupted. Calibration is CT and burden resistor dependent. Therefore when replacing or moving CPU module(s) a variation of ±3% is possible and a re-calibration may be desirable but not necessary.

CALIBRATION PROCEDURE:

1. The Measured Primary Current value is based on the LAST "windowed weld ", the same value as would appear in the VIEW WELD DATA screen. The first step is to program a weld schedule similar to the following:

```
SEQ-STEP CODE     SEQUENCE                      COMMENT
  1- 1   24     MC CONTACTOR OUT 19 5 SEC ; If isolation contact used.
  1- 2    2     SQUEEZE OUT 20 30 CY      ; Energize SVCR & wait for gun.
  1- 3   57     TRANS TURNS RATIO 1       ; Primary current.(Change after cal for sec current)
  1- 4   22     WINDOW HI 65535 LO 0      ; Window "start".
  1- 5    6     WELD 65% 20 CY            ; % availible current, DO NOT USE CONSTANT CURRENT
  1- 6   58     WINDOW COMPARE HI 161 LO 161  ; Window "end" report value.
  1- 7    8     HOLD 30 CY                  ; Cool nugget.
  1- 8   10     OFF SINGLE MODE
```

2. Using a secondary weld current monitor, such as the Weltronic® Weldscope WS-10 or WS-25, set FIRST CYCLE = 3, LAST CYCLE = 20. This blanks out the first two cycles of current. The control is also ignoring these cycles of the weld.

3. Pilot the control for the programmed sequence and read the current.

4. Divide the Weldscope's displayed current by the transformer turns ratio. Round off the number to the nearest whole number. Choose and enter a current range under Set-Up, see 11.7.

"PRIM CUR (1=LO, 2=MID, 3=HI) X"

5. If a change was made above, reweld and enter the measured current value in

"MEASURED PRI CUR xxxxx SPAN ss%"

In program mode key in the measured current and press ENTER. "ENTER PASSWORD TO CALIBRATE" will be displayed. Enter the password and

press ENTER to recalibrate the control. If the user does not know the password, it may be obtained from the Weltronic Service Manager.

The control was calibrated by Weltronic before shipment and cannot easily "lose calibration". More then likely some other condition, such as using the wrong transformer turns ratio is the problem. Therefore re-calibration may not be a very wise thing to do.

SPAN% will be entered by the control. SPAN may be thought of as a current meter which shows the computer units range. A good SPAN% reflects a percentage somewhat less then the percent of available current requested in the weld instruction. A current range (see 11.7) should be chosen so that if 99% current was requested the span would be somewhat less then 99%. Never trust the calibration if the reported SPAN is less than 10% or more then 95%. Change the current range and try again. If after a range change and re-calibration SPAN does not change, check the current transformer and the .2 ohm burden resistor.

Pilot the control again and compare the current value in VIEW DATA with that of the WELDSCOPE device. If the values are off by more than 2% then repeat steps 3-6. Try a high and low percentage weld to check linearity.

CALIBRATION FROM THE PRIMARY SIDE

Calibration may be done on the primary side of the transformer with an accurate TRUE RMS current meter. (i.e. FLUKE®) Generally meters require 1.5 seconds (90 cycle) to stabilize. If this is all that is available, then program the turns ratio to 1 and increase the weld time to 90 cycles. Then basically follow steps 3 through 5 reading the stable reading from the meter.

11.9 Measured Secondary Current Calibration

This Setup item is used for calibration of a SECONDARY current sensed from a toroid current coil. Calibration is necessary whenever a coil is installed, current range change has been made, or the controls calibration "memory" has been corrupted. Calibration is coil dependent. Therefore variation of ±3% is possible and a re-calibration may be desirable but not necessary.

CALIBRATION PROCEDURE:

1. The Measured Secondary Current value is based on the use of trans turns ratio 0 and the LAST "windowed weld", the same value as would appear in the VIEW WELD DATA screen. The first step is to program a weld schedule similar to the following:

```
SEQ-STEP CODE      SEQUENCE                      COMMENT
  1- 1   24     MC CONTACTOR OUT 19 5 SEC  ; If isolation contact used.
  1- 2    2     SQUEEZE OUT 20 30 CY       ; Energize SVCR & wait for gun.
  1- 3   57     TRANS TURNS RATIO 0        ; For secondary current.
  1- 4   22     WINDOW HI 65535 LO 0       ; Window "start".
  1- 5    6     WELD 65% 20 CY             ; Short circuit pulse. DO NOT USE CONSTANT CURRENT
  1- 6   58     WINDOW COMPARE HI 161 LO 161; Window "end" report value.
  1- 7    8     HOLD 30 CY                 ; Cool nugget.
  1- 8   10     OFF SINGLE MODE
```

2. Using a secondary weld current monitor, such as the Weltronic® Weldscope WS-10 or WS-25, set FIRST CYCLE = 3, LAST CYCLE = 20. This will blank out the 3 half cycles of upslope which can occur in constant current mode as the control finds the correct firing angle.

3. Pilot the control for the programmed sequence and read the current.

4. Choose and install the proper W13 and W14 jumper combination for the current range, see 2.1.1.

5. If a change was made above, reweld. Enter the measured current value in:

   "MEASURED SEC CUR xxxxx SPAN ss%"

   In program mode key in the measured current and press ENTER. "ENTER PASSWORD TO CALIBRATE" will be displayed. Enter the password and press ENTER to recalibrate the control. If the user does not know the password, it may be obtained from the Weltronic Service Manager. The control was calibrated by Weltronic before shipment and cannot easily "lose calibration". More then likely some other condition, such as using the wrong transformer turns ratio is the problem. Therefore re-calibration may not be a very wise thing to do.

   SPAN will be entered by the control. SPAN may be thought of as a current meter which shows the computer units range. A good SPAN reflects a percentage somewhat less then the percent of available current requested in the weld instruction. A current range (see 11.7) should be chosen so that if 99% current was requested the span would be somewhat less then 99%. Never trust the calibration if the reported SPAN is less than 10% or more then 95%. Change the current range and try again. If after a range change and re-calibration SPAN does not change, check the toroid current coil and hookup.

   Pilot the control again and compare the current value in VIEW DATA with that of the WELDSCOPE device. If the values are off by more than 2% then repeat steps 3-6. Try a high and low percentage weld to check linearity.

11.10 Network ID

If S1, the network address switch on the 473-0-0414-01 board, is set to a value above 65 the user may enter the network address via the Data Entry Panel. If S1 is set below 65 its setting determines the network address. If S1 is set above 65, in program mode under Set Up Network ID, enter the desired address under the cursor and press ENTER. Sixty-four is the maximum number of drops on the networked system. See 2.1.1 SW1

11.11 Robot ID

If Robot SIO with Nadex® protocol is used (SW1-1 closed) the control's unique robot SIO address must be programmed. Programming 0 places the control off-line programming 1-15 establishes a unique SIO address. In program mode under setup Robot ID, enter a address and press ENTER. Fifteen is the maximum number of drops on the RS485 system.

11.12 Robot SIO Broken Link Default

If the RS485 serial link is broken, the control may be programmed to hold the last state received, or set all bits to zero. In program mode, program a 0 to clear or a 1 to hold last I/O state.

11.13 SPC Sample Size

Sample size refers to the number of consecutive welds averaged and represented as one “piece” of data. Sample size is programmed in Set Up or via the network (ROPE) next to FREQUENCY, or the number of welds "skipped" before another sample of welds is taken. The control will default to Sample Size 5.

11.14 Steppers Ramp or Staircase

This screen permits the global control of stepper programs in "Ramp" (amortized) heat application over step counts, or "Staircase" (full step) application of heat after the programmed step count is over. Simply enter a 0 for Ramp or a 1 for Staircase mode under the blinking cursor and press ENTER.

11.15 Steppers Up or Up/Down

This screen controls how a stepper program may be programmed. If 0=Up Only is chosen, an attempt to program a percentage lower than the previous step will produce "DATA RANGE TOO LOW" message until the data entry attempt is higher than the previous step. If 1=Up/Down is chosen, a message "WARNING: LOWER HEAT" will be displayed, and the data will be accepted.

11.16 Weld Mode (AC, DC or HF)

This screen is used to inform the processor what type welding transformer it is in use. The system defaults to the most common, "0" AC. If the welding transformer is DC (diodes in the secondary), enter 1. If high frequency DC, enter 2.

11.17 Regulator Speed

Regulator Speed control is used to change the speed of current regulation during **constant current high speed seam welding**. A slower regulation speed is sometimes necessary to prevent system "hunting". Current regulator hunting results in uneven heat along the seam. Hunting may be caused by current correction that is too fast **or** too slow. If a speed change is made, it will be applied to any constant current instruction. The system defaults to 5.0 with a programmable range of 0 to 25.0. The number programmed reflects the percent of available current change allowed from one half cycle to the next. Please note that speed changes are not possible unless this feature is "turned on" by setting control bit #378. When #378 is forced to a 1 the percent rate of change will be the value programmed in this screen. Bit #378 may be set and reset at any time during a sequence providing speed control changes at any point in the sequence.

A typical high speed seamer sequencer program might be:

```
STEP   INSTRUCTION                    COMMENT
1-1 Slope I-35% F-65% 5cy     ;Up slope will not burn leading edge
1-2 Output 378 On             ;Engage regulator speed control
1-3 Window HI 300 LO  200     ;Start current and time measurement
1-4 Seambeat  300A 03HT 00CL  ;Requested primary AMPS and weld time
1-5 Window Compare HI161 LO162;End measurement, report View data
1-6 Off Single                ;End of sequence
```

The weld transformer tap and requested current should be adjusted so that the percent of available current is mid-rang. 45%-65% current control permits range for regulator adjustment. See 8.6, second screen, item "eh". The seamers mechanical speed should be adjusted to the desired speed first. Then the regulator speed adjusted (if necessary) for the best seam heat pattern possible. Notice the regulator will "hunt" at some point when set to slow for machine speed and conditions.

11.18 Pilot Port Starting At

This screen permits the re-assignment of ports for Pilots, Emergency Stop, Weld/No Weld and Pilot strobe to any group of eight I/O memory bits. If memory is cleared the control will default to port 1 (the first group of 8 bits, see 5.1). Reassignment will take place by entering any bit number in the desired group of 8. Example: If the user enters any bit number between 25 and 32, pilot port assignment will be as follows:

```
25 Binary pilot 1
26 Binary pilot 2
27 Binary pilot 4
28 Binary pilot 8
29 Emergency Stop
30 Weld/No Weld
31 Strobe pilots
32 Spare Input (Or Binary 16 if 379=1)
```

If 0 is entered the above assignment will be removed totally. The functions must be programmed in ladder logic via status and control bits. See 5.1 bits 507-511, 414, 430, and 413.

11.19 I/O bit to Slot to Port set up

The first 160 bits in the Series 400 memory map are definable in groups of 8 as inputs (IN), outputs (OUT) or remain internal (XXX). Linking these bits to real I/O is done by programming them in groups of 8 contiguous "BITS" through a "SLOT" to one of the "PORTs" in the Slot. This interface may be made to other devices such as DeviceNet, Allen Bradley® remote I/O or Kawasaki® ¢obot via slots 16 through 19. See 1.6, 3.0 and 11.18

The display will read:

```
                    11111111112222222222233
           123456789012345678901234567890l2
           bbb-bbb SLOT ss PORT pp xxx
```

Where:

- bbb Is the memory map bit numbers 1 through 160 in 20 groups of eight. Each group is addressed with the UP or DOWN arrow keys.
- ss Is the slot number in the device 0 through 31.
- pp Is the port number of the device in the slot/. (0 through 19)
- xxx Is the direction; IN, OUT or XXX (internal).

Data fields are addressed by moving the cursor with the left or right arrow keys. The first step is to display the group of 8 memory map BITS of interest with the up or down arrow keys. In program mode, the cursor starts at the SLOT number, enter the proper slot number. Slots are numbered starting with slot 0 just to the right of the power supply slot which is not counted. After the slot number is entered, press the right arrow key and program the PORT number you wish the bit to appear on. The port numbers are listed with their physical connection on the front of the I/O modules. Pressing right arrow key again places the cursor at the bit DIRECTION (xxx=internal). With the cursor flashing on direction pressing the up or down arrow keys will provide three choices. You MUST move the cursor away from this field to access the next group of 8 bits.

TYPICAL SET UP FOR LOCAL I/0

```
1- 8  SLOT 1  PORT 0 IN   (Assuming the I/O module is in Slot
9-16  SLOT 1  PORT 1 IN   1 and  Pilot Port is starting at 1)
17-24 SLOT 1  PORT 4 OUT
25-32 SLOT 1  PORT 5 OUT
```

TYPICAL SET UP FOR REMOTE I/O

```
1- 8  SLOT 16 PORT 0 IN    (With Pilot Port Starting at 1)
9-16  SLOT 16 PORT 1 IN
17-24 SLOT 17 PORT 0 OUT
25-32 SLOT 17 PORT 1 OUT
```

11.20 Gun Port Starting At

V7.024 and higher supports a connection to a Gun Port and a 40 line Gun Table in which the weld guns maximum force rating, assigned stepper program and a four bit gun "features" tag may be programmed. Each line also contains a weld count register which is updated whenever the gun is active. Weld guns are connected to the control one at a time. Identification is by a unique six bit binary input code which is hard wired on a ID plug of each gun. If a Gun Port input starting address is programmed (LSB of 6 bits) the control will examine the 6 inputs and display the gun number connected. Pressing the Down Arrow key will display the Gun Table. If the ID input starting address is not programmed, the gun table will be disabled and not be displayed.

The Gun Port display will read:

```
                    11111111112222222222233
          123456789012345678901234567890l2
          GUN PORT AT iii (GG) ACTIVE = gg
```

Where:

iii The Gun ID Port starting input bit (LSB of 6 bit binary). The next six bits in the I/O map will be used to ID the gun.

GG The decimal value of the gun ID inputs (0-40) Refreshed without debounce. This field is useful for diagnosis of faulty gun input connections.

gg The decimal value of the gun ID inputs (0-40) with a one second debounced. This value is memorized during power down.

If iii above is programmed and Down Arrow is pressed the Gun table will read:

```
                    11111111112222222222233
          123456789012345678901234567890l2
          GUNgg F=ffff S=ss C=ccccc O=oooo
```

Where:

gg The Gun ID number (0-40).
A gun number may be entered in this field, or Up/Down arrow keys may be used to find the gun of interest.

ffff The maximum force of the gun. This value is used by TIP FORCE instruction #76. It is the force exerted by the gun if all outputs of the TIP FORCE instruction are on.

ss The Stepper program assigned to this gun when it is active (1-15). The stepper assignment may be overridden by assigning a stepper in the sequence with Assign Stepper #45 instruction, the new stepper program will be initialized with the count from the gun table. Providing different tip wear curves for the same gun.

ccccc The welds this gun has made. THE STEPPER IS RESET OR ADVANCED BY PROGRAMMING THIS VALUE. (0=RESET). DO NOT RESET THE STEPPER PROGRAM VIA STEPPER RESET OR PROGRAM KEYS. The value in ccccc will be inserted the next time the stepper program is used.

oooo Four output bits that may be set to identify features of a gun. The right most bit (LSD) will set memory map bit #363 to a 1 if a one is programmed on the display. Second most to the right sets bit #364, third #365 and fourth #366.

Assigning a Gun Port and a Stepper program in the Gun Table for a gun, may be thought of as applying ONE WELD COUNTER to ALL 15 Stepper programs and their associated faults for the Active Gun. When the gun is changed, the control simply reinitializes all 15 Stepper programs and their associated faults to the condition of the new guns weld counter immediately. You may LOOK at a steppers weld count and its progress under the Program Stepper screens, but do not change the stepper progress there, since each new pilot initializes the active stepper with the active guns weld count. Therefore editing a steppers progress, (advancing, retarding and resetting) must be done on the Active Guns count (C=ccccc). In addition, setting Bit #321 when Guns are Active (GUNPORT<>0) resets the ACTIVE GUN's weld count (only) and ALL STEPPERS programs. To prevent nuisance Step 9 Faults on all unused Stepper programs, when the Step 0 Counts=0 and the stepper is NOT initialized with the Guns count, the Stepper Counts will remain 0. However if a sequence is executed that ACTUALLY USES one of those steppers, the appropriate "Step 9" and "End faults are asserted at run time. Assign Stepper instruction #45 may be used to override the Active Gun Stepper assignment. When Guns are active this instruction uses the Weld count from the gun table Active Guns entry to initialize the assigned Stepper program.

When Guns are Active (GUNPORT<>0) then the following is true:

1. The Gun Table is used to assign a default Stepper and set the Weld Counts for that Stepper program when a valid pilot is received. When editing or viewing Stepper Programs the ACTUAL count therefore reflects the latest GUN Weld Count for the gun that is active.

2. Setting Bit #321 resets the Active Guns Weld Count and ALL Steppers, therefore bit #408 "All Steppers Reset" will reflect the Active Gun Weld Count. Editing the Weld Count may also reset a Guns stepper to zero. The Host workstation can use network command $44 to set any Gun Weld Count to zero. If this is done the 15 Steppers and associated faults will also be reset. Otherwise, it will take effect the next time the Gun becomes active.

3. If editing Gun Weld Counts for the Active Gun, ALL steppers are reset and the new Weld Count is used to initialize the Stepper Programs. This assures a Step 9 fault if any of the steppers are now in step 9. This also occurs if the Host uses command $44 to set Weld Count for the Active Gun. Note that although editing other (non-active) Gun Weld Counts does not reset and Initialize Steppers, the Steppers for that Gun cannot be used until the Active Gun changes, which then resets and presets the steppers.

4. ACDC Steppers (i.e. Stepper #101-115) may be assigned and used with the ASSIGN Stepper instruction #45. ACDC Steppers do not use the Active Gun Weld Count. HOWEVER in practice, smart steppers are most likely not usable in conduction with Gun operation since ALL steppers are reset when the Active Gun changes.

5. MF Pressure instruction #74 uses Max Pressure directly form the Instruction when ffff<>0. Otherwise the pressure comes from the Active Gun Table entry. In the event the table entry is zero, the pressure output is set to FULL pressure 9999 ($FF on the output port).

6. Stepper operation may be disabled by either setting Active Gun=0 or using the Assign Stepper instruction #45 and setting it to zero.

12.0 Fault Configuration

Any faults detected by the CPU/Timer are displayed directly on any data entry panel, one at a time. If more then one fault occurs the faults are stacked in a fault queue arranged by a programmable priority. The faults may be viewed by pressing the DOWN ARROW key. Each fault has associated with it a fault status word which indicates how the fault reacts with the controller, how the fault is reset and its display priority. The status words are set up by default but may be re-configured. The programmable areas are:

1. Type of fault
2. How it is reset
3. Its priority in the display que.

A typical fault status display might look like this:

MAJOR A PROGRAM 28

By the use of the CURSOR, UP/DOWN ARROW, FUNCTION SELECT and ENTER keys, each of the three categories may be changed to any combination of the following:

Type of fault	How Reset	Priority number
Major A	On line	0-99
Major B	Program	
Minor	Run	
Off	PLC only	
Retentive Major A	Self (not all faults)	
Retentive Major B		
Retentive Minor		

12.1 Type of Fault

Major A fault aborts sequence, sets major fault bit #426 on, and forces all outputs off. Will not execute any sequence until reset. When reset, major fault bit #426 is turned off. If power is lost, this fault is automatically reset.

Major B fault will finish sequence; set major fault bit #426 on, force all outputs off. Then will not sequence until reset. When reset, major fault bit #426 is turned off. If power is lost this fault is automatically reset.

Minor will finish sequence; set minor fault bit #427 on and sequence again if a pilot occurs. When the fault is reset the minor fault bit #427 is turned off. If power is lost this fault is automatically reset.

Fault Off. The fault is turned off and ignored, no action happens.

Retentive Major A is the same as Major A, except it will not be cleared by a power down cycle. It will be retained (memorized) if power is removed from the timer. It can be used with a program that trips a shunt trip type circuit breaker. Any fault of this type would automatically shut down the control but be displayed when power is returned. (Use a one shot timer in ladder logic to shunt trip or the control will just re-trip upon power up.)

Retentive Major B is the same as Major B with power down fault retention.

Retentive Minor is the same as Minor with power down fault retention.

12.2 Resetting Mode

The second item in configuration is how the fault is reset. There are six choices:

1. With the RESET key and in ON LINE DATA CHANGE mode.
   (or higher, PROGRAM and PLC modes)

2. With the RESET key and in PROGRAM mode.
   (or higher PLC mode)

3. With the RESET key and in RUN mode.
   (or higher ON LINE, PROGRAM, or PLC modes)

4. With a EXTERNAL INPUT port through a PLC program setting momentarily it's reset bit. (ONLY and not in PROGRAM mode)

5. SELF resetting when and if the condition corrects itself.
   (Not all faults have this selection)

12.3 Priority number 0 to 99

This number is pre-assigned to a default value shown in FIG 4. The number is programmable. If two or more faults occur at the same time, the number is used to determine which fault has precedence over the display. The higher the number the higher the priority. If two faults carry the same number the first encountered will take precedence. In a fault cue, a stack of fault messages will be made by priority number and presented for view as they are reset or scanned for review with the down and up arrow keys. Faults may be viewed only if the control is viewing the main status screen (Press EXIT SCREEN key twice).

When a fault occurs, bits 400 through 407 are set to the priority number of the fault. See 5.4 Fault Code Bits.

12.4 Bus fault xx

Bus fault indicates an interfacing problem between CPU/Timer module(**s**) and the I/O ports on the bus (backplane).

Terminology:

1. **Bus Fault Input** - Wired OR'd hardware input (P1-13-U27 pin #11) from the backplane.
2. **Bus Fault Output** - Wired OR'd hardware output (P1-13-U37 pin #22) to the backplane.
3. **Bus Fault nn** - Normally a software fault, See (nn) description below.

Function:

1. **Bus Fault Input** - Since all CPU's power up with its Bus Fault output asserted, this input is true on power up. Each CPU will ignore the input until the entire system is initialized (six second hold off timer).

2. **Bus Fault Output** - Asserted on power up by the backplane hardware, when initialization is complete the output is released if there are no problems with the CPU. This output is a function of:

   a. Output initialization during power up, this CPU may have other faults.
   b. System parameters checksum error during power up.
   b. "Configured for slot XX" message active. (**MOST COMMON PROBLEM read 2.1**)
   d. Bus fault 2 through 4 active, see list below.

3. **Bus fault nn** - Where:

   nn=1 This CPU received a bus fault input and is refusing to run, look at the other CPU's in the system, reset those faults before trying to reset this fault. This fault is a function of:

   a. A bus fault was inputted. **Look at other CPU's for the problem!**
   b. Not bus fault output. (a CPU ignores the input if it set the output)
   c. Power up 6 second hold off timer.

   nn=2 Configuration Checksum error. This fault is a function of the system Parameters checksum. I/O configuration is stored in system parameters. The control cannot trust the data to initialize the configured I/O ports.

   nn=3 Output Port Initialization time out. This fault is a function of Power up six second time out period and the port configuration.

   nn=4 Bus Access Time Out. This fault is a function of the bus access 1 second time out. The control could not gain access to the bus within a reasonable time. This could be a hardware or software problem.

12.5 User defined Faults 1 through 8

The Series 400 contains eight 18-character user programmable faults. Text for user faults is programmed outside the control using ROPE software or via the Host Workstation in a networked system under PROGRAM MENU, MASTER PROGRAMS. The setting, resetting, and status of these faults is controlled by manipulation of bits #302-#317 and 436-443 through a users ladder logic and/or sequence programs. The display will read:

"USERS COMMENT HERE #n aa-aa "

Where aa-aa is the sequence and step number the sequencer is in when the set user fault bit becomes a 1. If a sequence program is not active or the CPU/Timer cannot determine the sequence-step, then aa-aa becomes 00-00. This usually happens when a ladder logic program sets the fault.

12.6 Stepper Compensation Fault

Entering heat or current data in instruction or stepper step which would cause a stepper program to step beyond controllable range, a stepper compensation fault message will be displayed. The display will read:

"STEPPER nn COMPENSATION AT aa-aa"

12.7 Stepper Program End

Is indicated when any one of the 30 stepper programs end. Display will read:

" STEPPER (nnn) PROGRAM ENDED"

When a stepper program ends, the stepper program end bit #320 becomes a 1 and remains set until all programs are not ended. Only the proper use of the reset key, or forcing bit #321 or #444 through #458 by ladder logic program will reset any stepper. See 9.2 for more detail.

12.8 Stepper Is in Step 9

Is indicated when any one of the 30 stepper programs enters step 9 of their program, it is intended as a warning of the upcoming stepper program end. Display will read:

" STEPPER (nnn) IS IN STEP 9 "

When any stepper program enters step 9 of its program, the stepper in step 9 bit #322 becomes a 1 and remain set until all programs are not in step 9. Only the proper use of the reset key, or forcing bit #323 by a ladder logic program will reset this fault. See 9.2 for more detail.

12.9 Primary Overcurrent Fault

Indicates programmed primary welding current has been exceeded. The controls maximum settable limit is 65535 amps. It as a indication that the current rating of the SCR has been reached. See 11.3. The display will read:

"OVERCURRENT FAULT AT aa-aa"

Note the sequence and step number in which the fault occurred is displayed.

12.10 False Current Fault

Indicates a programmed instantaneous primary non-heat leakage current value has been reached. See 11.4. When the fault occurs the display will read:

"FALSE CURRENT FAULT AT aa-aa"

The display shows sequence and step number in which the fault occurred.

12.11 Emergency Stop/Sequence reset

Indicates the emergency stop/sequence reset input (bit #5 unless redefined, see 11.18) is zero at the start of, or went to zero during a sequence. The bit is checked every half line cycle. When zero all sequencing will stop and programmed outputs will be removed. But the PLC program, if any, will **not stop** nor its programmed outputs removed. The control may be forced to emergency stop at any time by outputting bit #414 in a ladder logic rung. The display will read:

"EMERGENCY STOP/SEQUENCE RESET"

12.12 Current Compensation Over/Under

In Set Up, AVC SET POINT vvv the user may enter a nominal line voltage operating point. The voltage entered is compared to the actual line voltage and used to advance or retard the firing angle to compensate for line voltage changes. If during a Percent of available current instruction (AVC mode), or constant current instruction (#80 through 88), the control is unable to compensate because firing angle cannot be advanced or retarded further, the CURRENT COMPEN fault will be registered. The display will read:

"CURRENT COMP OVER 99% AT aa-aa"
or
"CURRENT COMP UNDER 20% AT aa-aa"

The aa-aa displays the sequence number and step number the fault occurred.

12.13 SCR Overtemp or No 24 Volts

Indicates the SCR contactor thermal switch has opened or the 24 volt SCR firing pulse power supply is open. A DC firing supply in the firing module (D1 & C3) is applied through the thermal switch to a input port on the CPU/Timer board. The firing supply gets its power from the 24VAC winding the control transformer through F3. The port is checked to be closed before welding instructions are executed. If this circuit is open the display will read:

"SCR OVERTEMP OR NO 24VOLTS"

12.14 Half Cycling Fault

Indicates one of the pair of SCR's has failed to fire on time for three consecutive half cycles of the same polarity. This data is available after each firing pulse is delivered. Approximately 350 micro seconds after a firing pulse is issued, the contactor feed back should go low (SCR contactor should be on or shorted). Missing or late feedback, (after 350 Micro seconds) for three consecutive conductions constitutes half cycling. The display will read:

"HALF CYCLING FAULT AT aa-aa"

12.15 Contactor Fault

Indicates a SCR is shorted or voltage normally dropped across an the SCR contactor is missing. During current conduction the voltage across the SCR is very low because the contactor is nearly a short. At any other time (except near line zero) the voltage is high because the contactor is an open circuit. If the voltage is low or missing when it should be present, the contactor fault message will be displayed. The display will read:

"CONTACTOR FAULT AT aa-aa"

12.16 Tip Touch Fault

If Instruction #47 Tip Touch Test is employed and its maximum cycle limit is exceeded the instruction will issue a Tip Touchdown fault. The display will read:

" TIP TOUCHDOWN FAULT at aa-aa "

Where aa-aa is the sequence and step of the tip touchdown fault.

12.17 Tip Stuck Fault

If Instruction #48 Tip Stuck Test is employed and after its programmable delay its programmable current limit is exceeded the instruction will issue a Tip Stuck fault. The display will read:

" TIPS STUCK FAULT at aa-aa "

Where aa-aa is the sequence and step of the tip stuck fault.

12.18 Low battery

Indicates battery voltage less is then 3.6 volts on the battery backed memory card. The Lithium battery has a life expectancy of 5 years. The battery check will be done only upon power up. If low the display will read:

" LOW BATTERY "

12.19 Memory Error

Memory error indicates a checksum error has been detected in the operational data stored in RAM or EEPROM. This check is done on power up, and while the unit is running. Because of the danger of running a faulty program, the SEQUENCES, PLC, STEPPER, FAULT CONFIGURATION programs and over all SYSTEM PARAMETERS are automatically checked. Note each section above carries its own check number. If a memory error occurs in any of these programs, it must be found, data or functions re-entered, and saved before this fault can be reset and operation continued. If the control is networked a simple down load of the program will re-adjust all check sums so the fault may be then reset.

The Memory Error fault is SET by ANY of the following conditions:

1. On power up when the Memory Error fault is configured for Memory Retentive and a prior fault exists.
2. Invalid checksum of System Parameters detected on power up. The System Parameters checksum is related to ALL configurable data EXCEPT the 32 sequencer programs and the PLC program.
3. Invalid checksum of Sequence 1 through 31 detected at power up.
4. Invalid checksum of the PLC program detected at power up.
5. Invalid checksum of System Parameters detected at runtime**.
6. Invalid checksum of Sequence 1 through 31 detected at runtime**.
7. Invalid checksum of the PLC Program detected at runtime**.

** Runtime checksums are tested approximately every 10 to 20 seconds depending on system activity which may reactivate this fault. The display will read:

"MEMORY ERROR nn RELOAD PROGRAMS"

nn is the memory section containing the checksum error, where:

00	LADDER LOGIC PROGRAM
01-31	SEQUENCE PROGRAM 1 to 31
32	SYSTEM PARAMETERS, RAM Copy of Steppers, Fault I/O, Setup & Config.
33	LOCAL SYSTEM PARAMETERS, RAM Copy of Net ID, Voltage, Current Cal
34	SYSTEM PARAMETERS, EEPROM Copy
35	LOCAL SYSTEM PARAMETERS, EEPROM Copy
99	CHECKSUM DETECTED DURING POWER UP, then replaced with number above

The Memory Error fault my be cleared only when the following conditions are met:

From the KEYBOARD when:

1. ALL checksums are correct; Welding Sequences, Stepper programs, Ladder Logic program, Set-Up data, or Fault Configuration. All data and functions must be checked, corrected and saved in each memory section at fault. Make SOME FUNCTION or DATA CHANGE, then change back original data or function even if all appears proper.
2. The key switch is in the program mode.
3. The Reset key is pressed while viewing the fault on the main status screen of the display.

From the PLC:

1. ALL checksums are correct, see 1 above.
2. I/O bit #347 is set to a 1.

12.20 Sequencer Fault

This fault indicates a sequence programming error. ALL sequence steps should be reviewed for accuracy, all steps not programmed should be reviewed for unwanted data or functions. The sequencer fault is set by any of the following conditions:

1. On power up when the sequencer fault is configured for Memory Retentive and a prior fault exists.

2. Invalid checksum of Sequence 1 through 15 is detected on power up. In this case the fault will indicate the FIRST Sequence having an invalid checksum. The step number is displayed as ZERO.

3. An attempt to execute an unknown or invalid instruction in the sequence. In this case the fault will indicate the Sequence and Step of the error.

4. Waiting to long for an input, attempting to execute too many 0 time instructions, or in a tight non timed loop. In this case the fault will indicate the Sequence and Step of the error. Another example might be trying to turn off, with the OFF instruction, more then 20 bits left on at the end of a sequence. The display will read:

"SEQUENCE PGM FAULT AT aa-aa"

Where aa-aa is the sequence and step of the sequence program fault. The Sequencer fault may be cleared when the following conditions are met:

1. The fault is corrected, key switch is in the proper mode, and viewing the fault in the main status screen the reset key is pressed. Or from a PLC program when I/O bit #349 is set to 1.

12.21 Ladder Program Fault

This fault indicates a fault in the ladder logic program and will refuse to execute that program until it is corrected. The user must **REVIEW** the program for accuracy and make some **CHANGE**. Make a port or function change and then change back to the original port or function even if all appears proper. Another and easier way is to reload the program via a Load from Network. See 13.1. After reload, all faults will be resettable. The Ladder Program fault is SET by ANY of the following conditions:

1. Power up when the Ladder program Fault is configured for Memory Retentive and a prior fault exists.

2. Invalid checksum of the PLC program detected on power up.

2. Invalid checksum of the PLC program detected at runtime. Runtime checksums are tested approximately every 10 to 20 seconds depending on system activity which may reassert the fault after reset. The display will read:

"LADDER PROGRAM FAULT"

The Ladder Program fault may be cleared when the key switch is in the program mode, or in the proper position for the way the fault is configured and the RESET key is pressed when viewing the fault.

12.22 Line Clock Fault

The micro controller continually monitors line voltage to assure that it is 50 or 60 HZ and is symmetrical (line zero to line zero). Line voltage zero cross must be within 10% of 8.333MS for 60HZ or 10.0MS for 50HZ. If symmetry is not within 10% of the connected line the control will issue a line clock fault. The display will read:

" LINE CLOCK FAULT at aa-aa "

Where aa-aa is the sequence and step of the Line Clock fault.

If memory map control bit #377 is not set by the users program, zero voltage cross of the line is monitored via hardware interrupts to the HC16 uP. If bit #377 is set via a Ladder Logic rung, (see 10.8) a software digital IIR filter algorithm will be used for zero cross detection. Employment of the digital filter will permit heat control on welding buses with large “holes” in the line. The control will run in line conditions in which controls of the past would never run. Therefore setting bit #377 will greatly reduce Line Clock Faults and permit current control in hostile line conditions. Please note however, that the synthesized line zero detect will effect Power Factor measurement to a degree in which Automatic Steppers may not work properly and power factor SPC bell curves will be much wider. Bit #377 should never be set randomly or in a sequencer program, it must be set continuously or erratic current control will occur.

12.23 Low Primary Current Fault

If after any "Window Compare" instruction the average RMS value is lower then the value entered in Set-Up under Minimum Primary Current, The Low Primary Current Fault will be issued. The display will read:

"LOW PRIMARY CURRENT FAULT at aa-aa"

Where aa-aa is the sequence and step of the Window Compare instruction. The fault will never occur if there is no compare instruction.

12.24 Default Fault Configurations

On the following page, FIGURE 4 lists the default fault conditions. It is strongly suggested the user mark any changes made to the default conditions for future reference. The CPU/Timer site line voltage, current calibration and AVC set point should also be entered in the upper left hand corner of FIGURE 4 for future reference.

CAUTION

If a memory fault check sum error occurs in this area, the control will revert back to the default values shown on FIGURE 4.

SERIES 400 DEFAULT FAULT CONFIGURATION TABLE

VOLTAGE CAL _____ VAC
CURRENT CAL _____ AMPS
AVC SET POINT _____ VAC

FAULT	TYPE OF FAULT								HOW THE FAULT IS RESET						
	MAJOR A	MAJOR B	MINOR	OFF	RETENT MAJOR A	RETENT MAJOR B	RETENT MINOR	FAULT BIT	SELF	ON LINE	PROGM	RUN	PLC ONLY	RESET BIT	QUE PRIO-RITY
BUS FAULT nn	X							300	X					301	77
USER PROGRAMMABLE #1							X	302				X		303	56
USER PROGRAMMABLE #2							X	304				X		305	55
USER PROGRAMMABLE #3							X	306				X		307	54
USER PROGRAMMABLE #4							X	308				X		309	53
USER PROGRAMMABLE #5							X	310				X		311	52
USER PROGRAMMABLE #6							X	312				X		313	51
USER PROGRAMMABLE #7							X	314				X		315	50
USER PROGRAMMABLE #8							X	316				X		317	49
STEPPER COMPENSATION							X	318				X		319	69
STEPPER PROGRAM END							X	320		X				321	48
STEPPER IS IN STEP #9							X	322				X		323	47
PRIMARY OVERCURRENT					X			324		X				325	74
FALSE CURRENT					X			326		X				327	72
EMERGENCY STOP/SEQUENCE RESET	X							328		X				329	81
COMPENSATION OVER 99%			X					330				X		331	71
COMPENSATION UNDER 20%			X					332				X		333	70
CONTACTOR OVERTEMP	X							334		X				335	63
HALF CYCLING					X			336		X				337	75
CONTACTOR FAULT					X			338		X				339	76
TIP TOUCH FAULT					X			340			X			341	61
TIP STUCK FAULT					X			342			X			343	60
LOW BATTERY						X		344		X				345	68
MEMORY ERROR					X			346			X			347	78
SEQUENCER FAULT		X						348			X			349	80
LADDER PROGRAM FAULT					X			N/A			X			N/A	79
LINE CLOCK FAULT			X					350			X			351	67
LOW PRIMARY CURRENT FAULT		X						352				X		353	46

FIGURE 4

13.0 Memory Management Menu

The memory management menu contains program aids for manipulating or transferring memory one location to another. For safety reasons all function executions under this menu require two keystrokes the FUNCTION SELECT then ENTER keys.

The Memory Management menu contains:

13.1 Load from/Dump to Network
13.2 Copy Sequence
13.3 Clear all SPC Buffers
13.4 Clear All Memory
13.5 Set Clock
13.6 Print Report

13.1 Load from/Dump to Network

This function permits all sequence programs, PLC program, data, fault configuration, everything except line voltage calibration to be loaded from ROBONET. (NOT from ROPENET and the Dump to network function is disabled at this writing). It is available for quick restarts on model or CPU/timer change, data transfer or data loss. Displaying LOAD FROM/DUMP TO NETWORK In program mode, a blinking cursor may be moved between LOAD FROM and DUMP TO network. Upon pressing FUNCTION SELECT then ENTER, the control will request a file number after entering the proper number (the down load table/network address at the HOST) and pressing FUNCTION SELECT then ENTER again the action takes place. Individual sequences cannot be loaded, only a complete file can be taken from the down load table.

13.2 Copy Sequence

This function copies the instructions and data from one sequence into another. In program mode, "Copy ---------- to ----------" appears with the cursor flashing at the first position (from). The down arrow key provides 19 choices, sequence 1 through 15 and 4 default "library" programs which may be copied from. Moving the cursor to the right and using the down arrow key provides 15 choices to copy to. Pressing FUNCTION SELECT then ENTER the copy action occurs. If branching instructions are included in the copied sequences, and the branches remain in that same sequence, make sure the sequence number is 00 in that branch address.

CAUTION

If branching instructions, which branch out of a sequence or remain in the same sequence but contain the sequence number instead of 00, a faulty program will be copied. All branching address must be checked and repaired to contain the proper sequence number. Failure to comply might result in damage to the machine or possibly cause dangerous operation.
The four default "library" program choices (GM RWC1) might be:

1. LIBRARY A, single weld pulse program
2. LIBRARY B, dual weld pulse program
3. LIBRARY C, dual weld pulse with slope program
4. LIBRARY D, polypulse welding program

If W6 3-4 on the 473-0-0411-01 Weld Controller card is not jumpered the user cannot copy to these seed programs, even if the Clear All Memory function is used the programs will not be cleared. If W6 3-4 is jumpered the user may copy to these locations. It is not possible to view the stored programs without coping it to one of the 15 sequences.

13.3 Clear All SPC Buffers

If the ROBONET accessory is employed one of its features is SPC data gathering and reporting to a host computer. This function will clear all SPC buffers under control of the network interface microprocessor. After pressing FUNCTION SELECT then ENTER, press 1,2,3 to clear SPC buffers will appear. Pressing 1 then 2 then 3 clears the buffers. A message "SPC BUFFERS CLEARED" will be displayed after the process is finished.

13.4 Clear All Memory

Under Function Select, Memory Function, "Clear All Memory" will be displayed. If the user presses FUNCTION SELECT then ENTER, a message "Press 1,2,3 to clear all memory" will then be displayed. If the instruction is executed and 1, 2, and 3 are pressed, the memory will be cleared and all default values will be inserted. A message "MEMORY CLEARED" will be displayed after the process is finished.

13.5 Set clock

If the key is in program mode, the user may set a real time software clock. It is found under Special Function, Memory management, Set clock. Simply enter the current time and date, and press FUNCTION SELECT then ENTER. The display will be as follows:

```
                    11111111112222222222233
1234567890123456789012345678901
    SET CLOCK  hh:mm  MM/DD/YY
```

The real-time clock in the Series 400 is a SOFTWARE function and will continue to keep time as long as the power is kept on. If the power is removed from the control, time set will be lost and must be re-entered. However because it is software driven clock, it will constantly be updated by ROBONET if employed, therefore never needs setting and if set, it will be overwritten by ROBONET.

13.6 Print Report

If the control is in program mode, and a RS422 interface is made to a printer or personal computer which can receive at 2400 baud or higher. Simply enter selection (0-15) and press FUNCTION SELECT then ENTER. The user may print out certain reports through P2 pin 7+ and 8-, see 3.8. The display will read:

```
                    1111111112222222222333
          12345678901234567890123456789012
                    PRINT REPORT dd
```

Where dd=

0 - Prints the PLC program
1 - Prints Sequence 1 program
2 - Prints Sequence 2 program
3 - Prints Sequence 3 program
4 - Prints Sequence 4 program
5 - Prints Sequence 5 program
6 - Prints Sequence 6 program
7 - Prints Sequence 7 program
8 - Prints Sequence 8 program
9 - Prints Sequence 9 program
10- Prints Setup Data
11- Prints all programs and setup
12- Sets to top of form
13- Clear Print Buffer
14- Printer Holding (Offline but Print Buffer is active)
15- Printer Enabled (Prints Print Buffer)

NOTE:
At this writing the Series 400 does not support printout of sequence 10 through 31 or stepper programs above stepper 9.

14.0 Hook-up procedure

In some cases special I/O setups have been engineered, configured and shipped by WTC, if so this and the next step may be skipped, if not the user must perform the first two very important steps.

1. Determine the necessary number, voltage and slot position of all I/O modules. Insert the modules and connect each common for proper voltage to the ports in the modules. Failure to connect proper voltage to the I/O modules may result in over heated input modules and burnt SFCR and ESCR relay coils. Notice (See I/O module schematic 503-1-0324-XX) inputs require common voltage (BPC) and outputs will deliver common voltage out. Required voltage and X2 termination is the responsibility of the user. The WTC supplied control transformer may be used. 24VDC I/O requires a separate power supply accessory WTC part number 343-0-0119-00.

   General rules to follow are:

   A. Never install or move a module with the power on.

   B. There must be a "smart" device in slot 0 capable of bus arbitration (CPU/Timer or ABRIO module)

   C. There cannot be a gap between smart devices, no empty slots, no I/O or cascade steering modules. There may be empty slots between the smart group and I/O modules.

   D. If smart devices are moved from slot to slot, bus faults will occur when power is returned because all smart devices memorized the slot they occupy. In order to reset the bus faults a data change must be made in each smart device new slot. This does no apply to the ABRIO Module, the user cannot change data in this module.

2. Program under SET-UP the connection between the memory maps 160 I/O bits to the installed I/O modules. Set-up the memory map BITS to the proper SLOT number and its PORT number and the direction of the port (IN/OUT). The port numbers and their direction is listed on the front of the I/O modules. Recheck your set-up data. Especially the SLOT number, remember they count starting at 0 to the right of the power supply slot which is NOT counted. See 11.18 and 11.19.

-CAUTION-
IN PENCIL, MARK THE ASSIGNED MEMORY MAP BIT
ON THE INSIDE OF THE CLEAR PLASTIC TERMINAL COVER
AND THE CIRCUIT WIRE MNEMONIC ON THE OUTSIDE

3. Hook-up cooling water and check: (See RWMA Bul 5-005.04-05 for more detail)

   -Minimum flow of 1.2 GPM
   -Maximum water temperature 40^{o}C (104^{o}F).
   -To prevent condensation, water temperature should not be less than the existing dew point of the ambient air. (Approximately 70^{o}F) The combination of water, dust, 480V and a poorly grounded cabinet is very dangerous.
   -Maximum pressure 90 P.S.I.G.
   -Maintain pH between 7.0 and 8.0
   -Maximum Chloride content of 20PPM
   -Maximum Nitrate of 10PPM
   -Maximum Sulfate content of 100PPM
   -Maximum solids content of 250PPM
   -Maximum Calcium Carbonate content of 250PPM

   Also on Direct Cooled SCRs' i.e. cooling water at line potential:

   -Resistively greater then 2000 Ohm/cm at 25^{o}C (77^{o}F).
   -Hoses should be non-conductive type 3/8" ID no less then 18" long.
   -Power must be removed from the SCR within 10 minutes after water flow

stops.

Failure to remove power without water flow may cause the hoses to overheat and burst. Heating is caused by current flow through contaminants inside the hose. Very rapid heating will occur if the two specifications above are violated, less heating if the specifications are exceeded, especially hose length.

4. Make sure the cabinet has a good safety ground.

5. Hook up the welding transformer and a L2 control transformer power lead if a circuit breaker was not supplied.

6. If the first 8 memory map bits were assigned INPUTS, then on the assigned input port 0-#5 hook-up the Emergency Stop input or jumper true if not required.

7. If the first 8 memory map bits are assigned INPUTS, then on the assigned input port 0-#6 hook-up the external weld/no weld input or jumper true if not required.

8. If the first 8 memory map bits are assigned INPUTS, hook up the pilot(s) (binary) to port 0-#1 through #4.

CAUTION!

If pilot is "hand held" or Weltronic® remote sequence selector 519-0-0358-01 is used, use 24VAC or DC input voltage only.

9. Hook-up the SVCR valve to your assigned I/O module. SVCR valve is automatically assigned to bit 17 when squeeze function is programmed. If safety is an issue make sure your assignment for SVCR is made to a module with a safety relay and the first output port is used. See 2.4

10. Hook-up power, check control transformer primary connection for proper voltage jumpers and primary fuse sizing.

11. Turn on power WITH CABINET DOOR CLOSED.

12. Measure and key in line voltage. See 11.6. Record the value on FIGURE 4.

13. Set AVC set point. See 11.2. Record the value on FIGURE 4.

14. In PROGRAM mode insert your program. Pay close attention to the I/O assignment made in step #2. ALWAYS start with a percent of available current Weld instruction switching to Constant Current welds only after good welds are made. If the control is networked, down load your program from the workstation.

15. Test run your program in RUN or ON LINE mode and in No Weld. If necessary, temporarily insert Wait XXX True in your program to "Halt-and-Jog" slowly through critical steps.

16. Adjust timing and current as needed.

17. Record your program with lots of comments. Carefully list your I/O assignments with their names and functions. Draw in all I/O and label. Save your program on ROPE or make listing of your program by hand. Make sure you record any changes in fault configuration. Use FIGURE 4 to do so.

CAUTION

Failure to carefully record your program, I/O set-up, AVC set point and configuration changes will someday cause somebody serious problems. The importance of complete documentation with comments of your programs cannot be emphasized enough. Failure to DOCUMENT and/or STOCK recommended spare parts WOULD someday cause excessive down time.

14.1 Recommended spare parts

The following list is the recommended spare parts for ten units:

REQUIRED	DESCRIPTION	PART NUMBER
1	S400 CPU/TIMER MODULE	503-2-0324-03
1	S400 I/O MODULES	See 2.4.1
1	DATA ENTRY PANEL LCD	503-4-0318-01
1	DATA ENTRY PANEL FLUOR.	503-4-0319-01
1	DEP INTERCONNECT CABLE 5 FOOT	402-0-0898-05
1	FIRING CABLE 25 PIN D SHELL 3 ft.	364-0-0110-03
2	SCR TYPE IN USE (consult wtc)	356-0-00XX-00
1	SCR FIRING MODULE	454-0-0028-01
1	TESTER/SIMULATOR DEMO UNIT	518-1-0042-02
5	SPARE KEY MASTER T001	333-0-0078-01
5	SPARE KEY OPERATORS T002	333-0-0078-00
1	BATTERY LITHIUM 3.6V 1/2AA	328-0-0471-01
1	S400 INSTRUCTION BOOK V7.025	710240
3	EACH TYPE INPUT AND OUTPUT MODULE	359-0-0XXX-XX
	CHOOSE I/O MODULES PER VOLTAGE AND TYPE IN USE.	See 2.1.4
1	S400 POWER SUPPLY MODULE	See 1.8 & 2.5
	and/or choose one switcher supply below:	
1	SWITCHER SUPPLY IDP SRW 45-3001	343-0-0141-00
1	SWITCHER SUPPLY IDP SRW 65-4002	343-0-0142-00
1	SWITCHER SUPPLY IDP SRW 115-3001	343-0-0144-00
1	SWITCHER SUPPLY IDP SRW 115-4002	343-0-0145-00
5 EACH OF 3 TYPES LISTED BELOW:	SEE FUSE CHART ON DRAWING NUMBER 475-0-0053-51&52 2 OF 2 FOR FUSE SIZE PER TRANSFORMER VA SUPPLIED	
	FNQ 1 500V	321-0-0140-00
	FNQ 1.5 500V	321-0-0177-00
	FNQ 2 500V	321-0-0178-00
	FNQ 6 500V	321-0-0164-00
	CCMR-1 600V	321-0-0167-00
	CCMR-1.5 600V	321-0-0168-00
	CCMR-2 600V	321-0-0169-00
	CCMR-6 600V	321-0-0172-00
	MDL-1 1 AMP SLOBLO	321-0-0142-00
	3AG2 2A LITTLEFUSE	321-0-0025-00
	3AG3 3A SLOBLO LITTLEFUSE	321-0-0143-00
	3AG4 4A LITTLEFUSE	321-0-0055-00
	3AG6 6A LITTLEFUSE	321-0-0108-00

14.2 Series 400 Bulletin #1

DATE: 10/27/94

SUBJECT: Series 400 Cascade Module 503-7-0324-01

The Series 400 Cascade Module 503-7-0324-01 is assembled without relays CR3A through CR3D and CR4A through CR4D. The omission of these 8 relays is because they are not necessary for cascading SCRs on a single phase system. Previously J6 through J13 (labeled -01) were used to short out the contacts on the missing relays.

The jumpers may cause two problems depending on the number of SRCs and the length of the firing cables in the system:

1. Jumpers J7, J9, J11 and J13 connect all U01's in each firing module in parallel which may damage a U01. Therefore of these 4 jumpers, **ONLY** J7 should be installed. Jumpers J9, J11, and J13 should be removed to correct the potential problem.

2. Jumpers J6, J8, J10 and J12 complete a circuit for current transformers connected to each firing module in parallel. Noise pickup on the firing cables on the unused current transformer circuits will cause false current readings. The false current upsets the controls ability to regulate in constant current and possibly miss current window programs. Therefore of these 4 jumpers, **ONLY** J6 should be installed. Jumpers J8, J10 and J12 should be removed.

A third potential problem is sticking contacts of relays CR1A through CR1D. When one of these 4 relays stick, two SCR's will be gated at the same time which will cause 2 welds to be made at the same time. Relays CR1A through CR1D connect firing pulses between SCR firing modules and the CPU/Timer. The firing pulses are 2-3A at 100us. Even at this short period of time non-mercury wetted contacts of CR1 relays have welded closed. Therefore CR1A, CR1B, CR1C and CR1D should be replaced with WTC P/N 300-0503 a modified mercury wetted contact relay Sumida or Clare MSS21A12. The relay must be modified by cutting off pin 13. (This paragaraph updated on 05/24/05 by ERK)

14.3 Series 400 Bulletin #2

DATE: 6/20/96

SUBJECT: False Current Window Low Compares

All previous Series 400 and Series 415 firmware versions below V8.018 and V7.018 (Version 6.XXX excluded) contain a mathematical error. The error will occur only when a Current Window is placed around a Constant Current weld instruction and a stepper program is used. When the stepper program calls for a increase, a **non-stepped** current value is compared with the **stepped** current window values. The larger the stepper percent change the larger the percent error in window compare. Because stepper programs usually step up, the low value will be missed. The welding current is always stepped properly therefore only the compare low is usually wrong by the stepper percent current increased.

The proper Window used to frame a Constant Current weld is the Window Hi% Lo% code number 74. The percent window should **always** be used with constant current instructions and if so used the problem is resolved.

14.4 Series 400 Bulletin #3

DATE: 03/11/98

SUBJECT: Series 400 Allen Bradley® RIO System

The Series 400 Allen Bradley® Remote I/O (ABRIO) Module 503-7-0033-05) interfaces with Series 400 CPU timer modules 503-2-0324-05 via the back plane through U41 dual port RAM on the CPU timer modules. This I/O interface is high speed and interface timing is critical. If timing is improper, false local outputs may energize the Shunt Trip breaker, MC contactor, or loose Emergency stop and Weld No weld inputs and/or reset Stepper programs falsely. Two problems in this area have been observed:

1. Between June and December of 1997 dual port RAM chips were installed in U41 with the logo ISSI IS62C64-70W. The ISSI brand RAM may be defective and should be replaced with another brand such as SHARP 164A-80L or equivalent.

2. Timing intolerance between the V25 CPU in the ABRIO module, U41 dual ported RAM and U24 the RAMs PAL/GAL controller chip could falsely drive local outputs at the ABRIO module. If false outputs (shunt trip) is occurring the U24 PAL/GAL program #30167 R1 MUST be changed to #30167 R3.

PRINTS AND SCHEMATICS FOLLOW THIS PAGE

WELDBASIC SEQUENCE CONTROLLER V7.025, V8.025 & V9.006

- Series { 400 V7.025 / 415 V8.025 & 9.006
- Sequence conditions
- Faults
- Running Sequence #

Main Status Screen

Main Menu

1 Welding Sequences	3069 Programmable Steps Divided into 31 Sequences of 99 Steps Each List Key Accesses A List of 81 Sequential Weldbasic® Instructions	
2 View Data	View Weld Data 1 View Weld Data 2 Instantaneous Current View Digital I/O Network Status/Version Robot Status Heat Processor Status/Version Remote I/O Processor Status/Version GM Version	
3 Program Stepper	Reset all Steppers Edit Stepper XXX 1-15 Counting Steppers 101-115 ACDC Steppers - Current Step - Advance/Reset	
4 Ladder Logic	2000 Bytes of Program Space (~999 2Byte) Programmable Instructions List Key Accesses A List of 23 Random Logic Instructions 32 Timers/ Counters Available	
5 Set-Up	Global Squeeze Delay AVC Set Point Primary Overcurrent False Current Min. Primary Cur. Measure Line Voltage Calibration Pri. Current Range Measure Primary Current Calibration Measured Secondary Current Calibration Network ID Robot I/O Control SPC Sample Size Stepper Ramp Or Staircase Stepper Up Only Or Up/Down Weld Mode Regulator Speed Pilot Port Start I/O Bit through Slot 16 Port Conf. Gun Port Starting	
6 Fault Configuration	28 User Programmable Faults -Type of Fault -How Reset -Priority	
7 Memory Management	Load from/Dump to Network Copy Sequence Clear all SPC Buffers Clear all Memory Set Clock Print Report	

314-0-0823-06

DISPLAYED INSTRUCTIONS

WELDING

CODE	
01	Init. Squeeze Out xxx ccCY
02	Squeeze Out xxx ccCY
03	Preheat nn hh% (mm%) ccCY
04	Preheat nn hh% (mm) ccCY
05	Cool nn hh% (mm) ccCY
06	Slope I-hh% F-hh% ccCY
07	Weld nn hh% (mm%) ccCY
08	Postheat nn hh% (mm%) ccCY
09	Hold ccCY
10	Off Repeat Mode ccCY
11	Off Single Mode
20	Water Valve Out xxx cc SEC
21	Press Out xxx-d pp% (pp%)
22	Window Hi iiiii LO iiiii
23	Precompression Out xxx ccCY
24	MC Contactor Out xxx ccc SEC
25	pp Pulse @ ccCool to -xx
26	Heat Until xxx hh% cccCY
27	REM Heat bb mm% (mm%) ccCY
28	REM HIT bb mm% (mm%) mmCY
29	REM WIT bb mmCY
30	Pressure Switch Input xxx
31	Second Stage Input xxx
32	NEMA Second Stage Input xxx
33	Squeeze Delay Out xxx ccCY
34	Flash HT INP xxx hh% cccCY
35	Upset HT INP xxx hh% cccCY
36	Seam-Beat hh% HT cc CL cc
37	Seam-Nonbt hh% cc CL cc
38	Forge Delay Out xxx ccc CY
39	Quench ccCY
40	Temper nn hh% (mm%) ccCY
41	EOH Out xxx DLY cc PWL cc
42	Index Out xxx ccCY
43	Production Count rr dddd
44	Assign Stepper #ss select
45	p Reweld= @ oo RWrr BWRrr
46	TipTouch IIiA ccMAX rrCOUNT
47	Tipstick Test IIA ccCY DLY
48	Weld Schedule pp
49	Wait for vvv Voltage ^ cccCY
50	Call Weld Schedulemm OEPmm Window HHh% LOhh%
74	Reset Stepper xx To Step y
75	MF ffff TF pppp (####)
76	

HIDDEN INSTRUCTIONS

CODE	INPUT/OUTPUT
11	Wait for ccCY
12	Wait xxx True cccCy
13	Wait xxx Not True cccCy
14	Wait xxx & xxx True cccCy
15	Wait xxx ^ xxx True cccCy
16	Output xxx On
17	Output xxx Off
18	Output xxx IF xxx & xxx True
19	Output xxx if xxx ^ xxx True
50	No Operation
51	Contactor Select yyy
70	Print Weld Data
71	Print Time and Date
72	SPC Weld Data nn
73	Footprint Weld Data nn

CODE	SPECIAL
52	Heat Reset
53	Heat Faults On
54	Heat Faults Off
56	Counter rr dddd
57	Trans. Turn Ratio rr.r
58	Window Compare HIxxx LOxxx

CODE	BRANCHING
60	Goto o-oo
61	IF xxx True GOTO oo-oo
62	IF xxx Not True GOTO oo-oo
63	IF xxx & xxx GOTO oo-oo
64	IF xxx ^ xxx Goto oo-oo
65	Call oo-oo
66	Return
67	Loop Count rr=ppppp
68	Repeat rr o-oo

DISPLAYED INSTRUCTIONS

CONSTANT CURRENT

CODE	
80	Preheat nn iiiii ccCY
81	Slope IIIIIA FIIIIA ccCy
82	Weldnn iiiiiA (nnnnnn) ccCY
83	Postheat nn iiiiiA ccCY
84	Heatunitxxx iiiiiA cccCY
85	Seambat iiiiiA ccHT ccCL
86	Seam NBT iiiiiA ccHT ccCL
87	Temper iiiiiA (iiii) ccCY
88	REMnn iiiiiA (iiii) ccCY
89	REMTnn iiiiiA (iiii) ccCY

PROGRAMMABLE LOGIC CONTROLLER

CODE	INSTRUCTION	CODE	INSTRUCTION
1	Start xxx	13	Timer rr pppp xxx (ms)
2	Start Not xxx	14	TON rr pppp (ms)
3	Output xxx	15	TOF rr pppp (ms)
4	Output Not xxx	16	TOS rr pppp (ms)
5	End	17	Counter rr pppp xxx (ms)
6	Not	18	MUX Out xxx-dd IN xxx
7	And xxx	19	Hex Out Starting at xxxzz
8	And Not xxx	20	UPDATE DISPLAY
9	Or xxx	21	COPY dd Bits From xxx To xxx
10	Or Not xxx	22	BCD2 Out Starting at xxx mm
11	Out Latched xxx	23	BCD Encode dd at xxx To xxx
12	Out Unlatched xxx		

Meaning of lower case letters in instructions:

oo-oo	Sequence/Step address: Either (oo) is sequence number 0-15 and (oo) is step number 1-99 Multiple (oo)'s for Nesting (rr) is step number 1-99
bb	Time Number from 00 to 99
cc	Time Number from 000-999
dd	Weldnn number 0-65535
dddd	Heat percentage 20-99
hh	Current in Amperes
iiii	A value displayed only, or the read value derived
mm	A number 0 to 99
nn	Transformer Turn Ratio 1-200
rr	Two digit number 0 to 99
pppp	Register preset value or Tip Force
ss	Stepper number 1 to 32
vvv	Voltage 000 to 999
xxx	I/O Map 0 to 512
yyy	Contactor number 1-16
zz	Logical OR
ffff	Hex Valve 0-15
	Maximum Force

TRIM MARKS
(4) CORNERS

FOLD MARKS
FOLD DOWN AT FOLD MARKS.

PRINT ON 120 POUND CARD STOCK AND
TRIM TO 11.0 X 17.0

FILE: 314082306

DATE	REVISION	BY

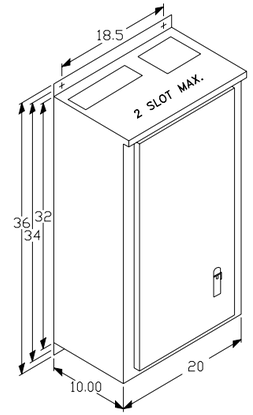
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Drawn: ERK 12/21/99 | Checked | Scale: FULL

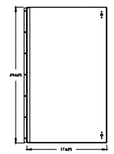
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Dwg./ Part No. 314-0-0823-06

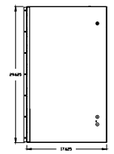
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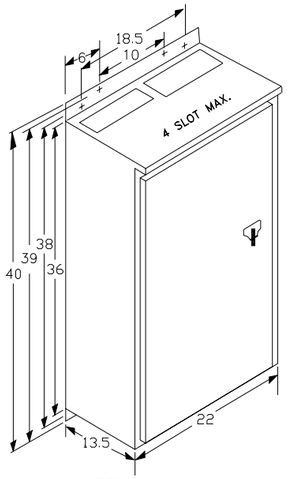
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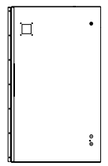
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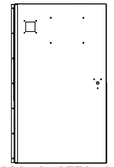
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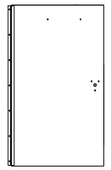
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620-0-0770-06 (STANDARD)
620-0-0770-26
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620-0-0770-28



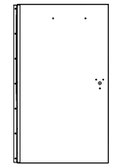
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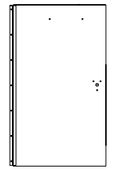
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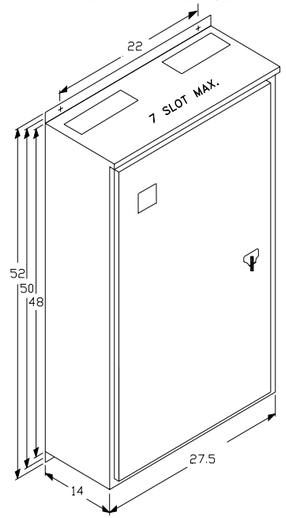


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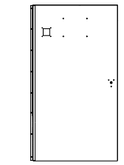


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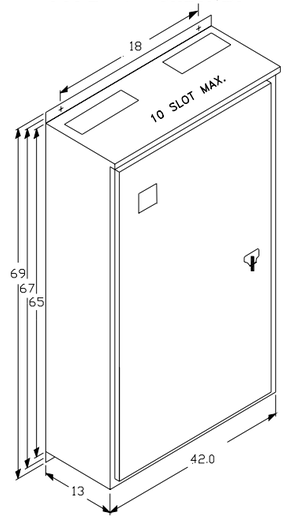
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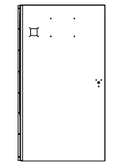
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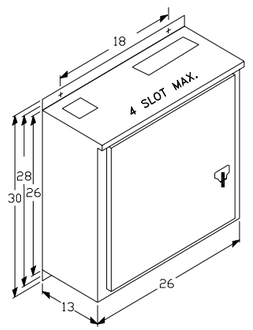
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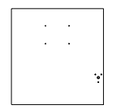
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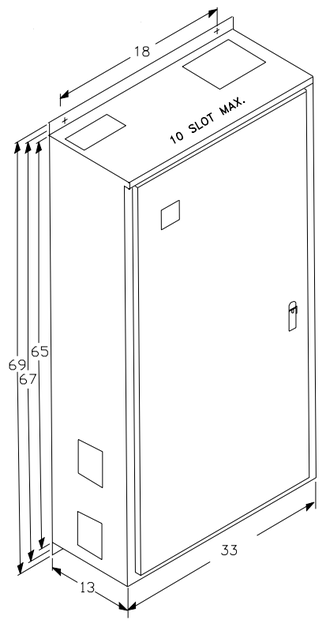


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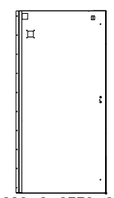


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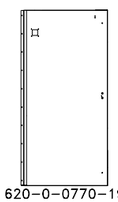
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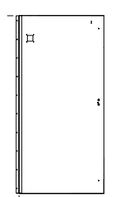
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620-0-0770-07
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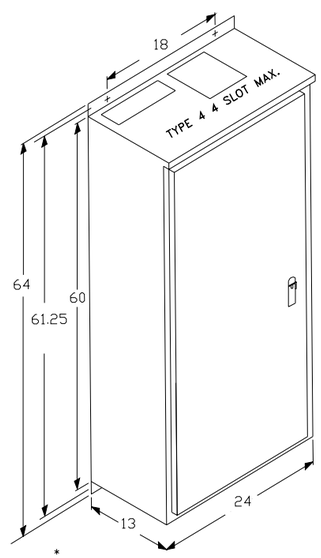
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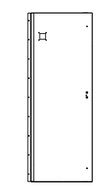
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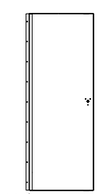
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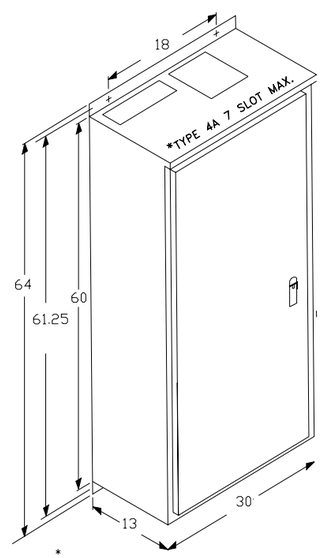
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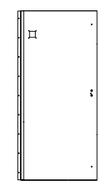
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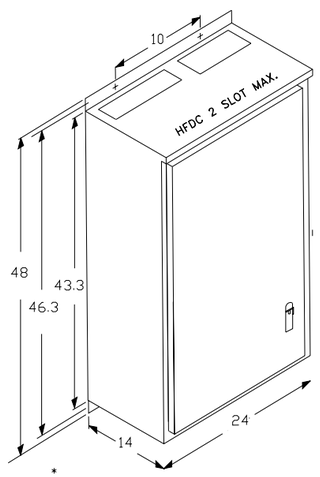
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620-0-0770-05

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HFDC CABINET



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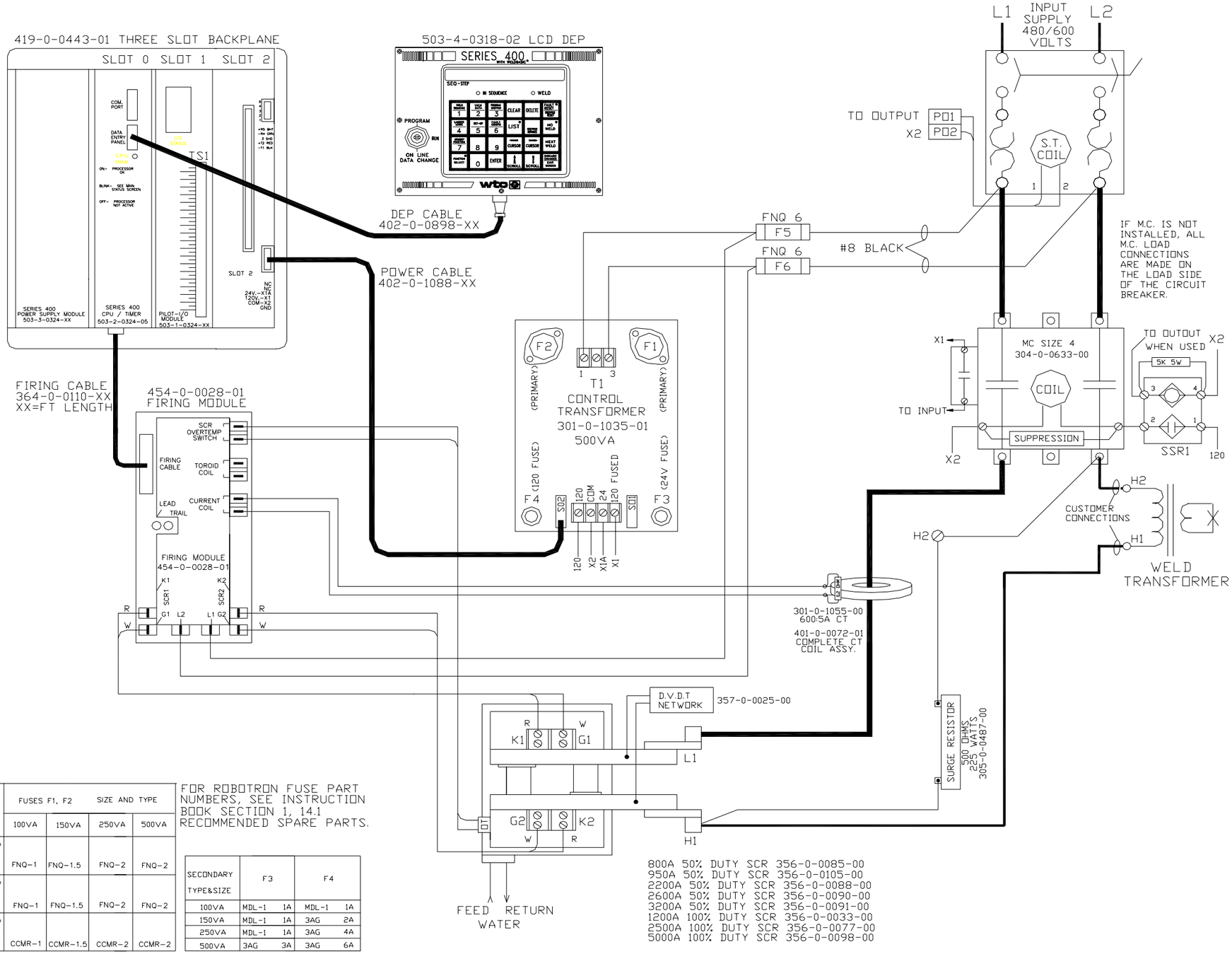


620-0-0770-16

620-0-0770-16

wtc
S400/S415 CABINET TYPES

FILE:\\skynet\weltdwgs\6200\S400CAB1.DWG



CONTROL TRANSFORMER PRIMARY CONNECTIONS		FUSES F1, F2 SIZE AND TYPE			
		100VA	150VA	250VA	500VA
240 V.	H1 H3 H2 H4 H5 L1 L2	FNQ-1	FNQ-1.5	FNQ-2	FNQ-2
480 V.	H1 H3 H2 H4 H5 L1 L2	FNQ-1	FNQ-1.5	FNQ-2	FNQ-2
600 V.	H1 H3 H2 H4 H5 L1 L2	CCMR-1	CCMR-1.5	CCMR-2	CCMR-2

FOR ROBOTRON FUSE PART NUMBERS, SEE INSTRUCTION BOOK SECTION 1, 14.1 RECOMMENDED SPARE PARTS.

SECONDARY TYPE&SIZE	F3		F4	
100VA	MDL-1	1A	MDL-1	1A
150VA	MDL-1	1A	3AG	2A
250VA	MDL-1	1A	3AG	4A
500VA	3AG	3A	3AG	6A

SYM	DATE	REVISION	BY
	05/05	Made D Size	ERK
	12/99	Changed Logo	ERK

wtc

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Description

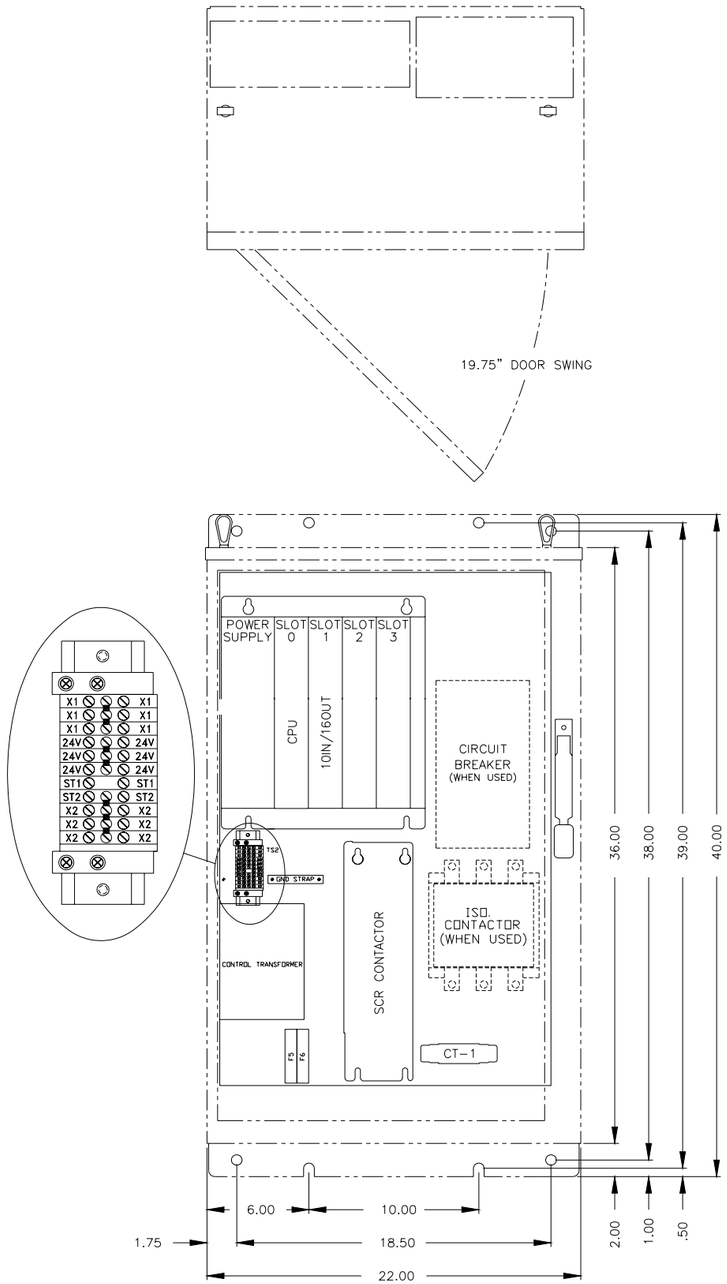
BASIC S400 PARTS AND HOOKUP.

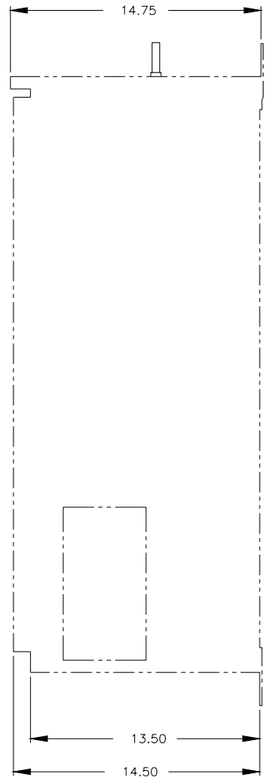
Drawn	Checked	Scale
ERK 10/14/98		NONE

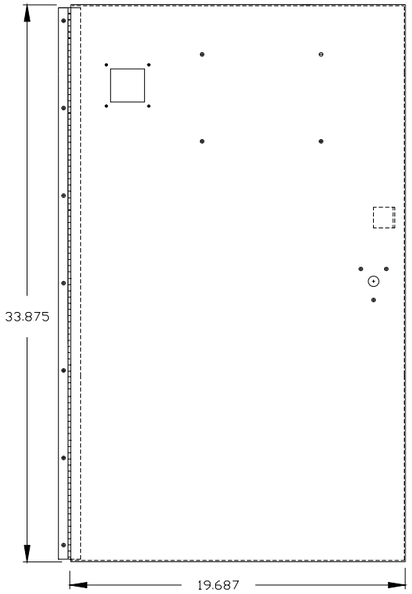
Drawing Size D | Sheet 1 of 1

Dwg./Part No. 314-0-0838-01

FILE: 31400838.dwg







Sym.	Date	Revision	By
	12/21/99	changed logo	ERK
	10/3/97	ADDED LABELS	WDD

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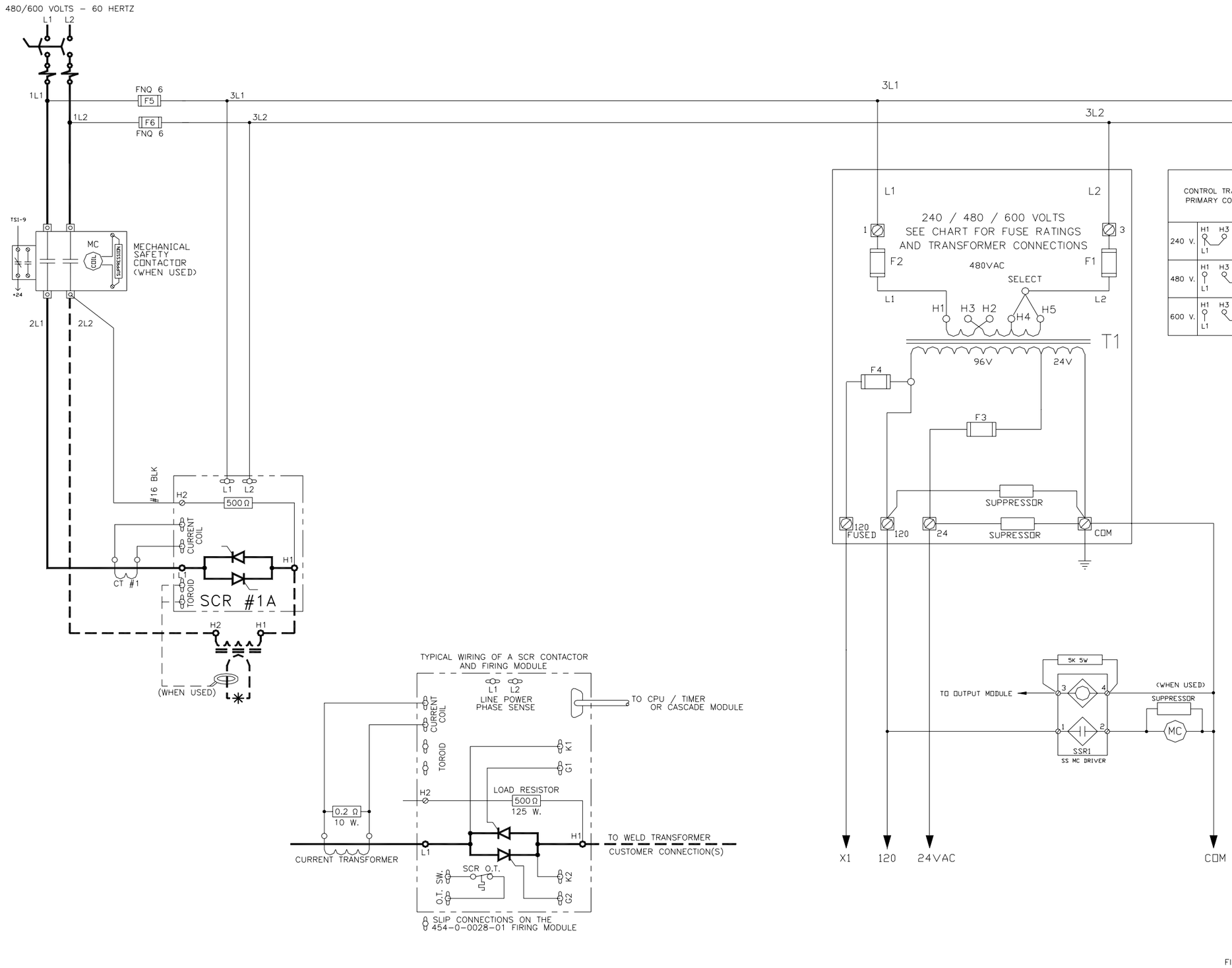
Description
Series 400 in a type 1 cabinet with a 4 slot backplane and a 10/16 I/O module 120VAC in and out.

Drawn	Checked	Scale
S.W. 8/16/93	ERK 8/16/93	1/4 = 1

Drawing Size (D) Sheet 1 of 6

Dwg./Part No. 414-0-0156-01

FILE: 015601S1.dwg



CONTROL TRANSFORMER PRIMARY CONNECTIONS		FUSES F1, F2 SIZE AND TYPE			
		100VA	150VA	250VA	500VA
240 V.	H1 H3 H2 H4 H5 L1 L2	FNQ-1	FNQ-1.5	FNQ-2	FNQ-2
480 V.	H1 H3 H2 H4 H5 L1 L2	FNQ-1	FNQ-1.5	FNQ-2	FNQ-2
600 V.	H1 H3 H2 H4 H5 L1 L2	CCMR-1	CCMR-1.5	CCMR-2	CCMR-2

SECONDARY TYPE&SIZE	F3		F4	
100VA	MDL-1	1A	MDL-1	1A
150VA	MDL-1	1A	3AG	2A
250VA	MDL-1	1A	3AG	4A
500VA	3AG	3A	3AG	6A

Sym.	Date	Revision	By
	12/21/99	Changed Logo	ERK
	10/12/98	CHANGED FUSE CHART	ERK
	3/30/98	ADDED TOROID COIL	WDD
	10/03/97	FIXED FUSES	WDD
	8/6/97	REVISED T1 WIRING	WDD
	6/23/97	CHANGED FS/F6/F7 FUSES & REWIRED T1 PRIMARY WIRES.	WDD

wtc

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Description

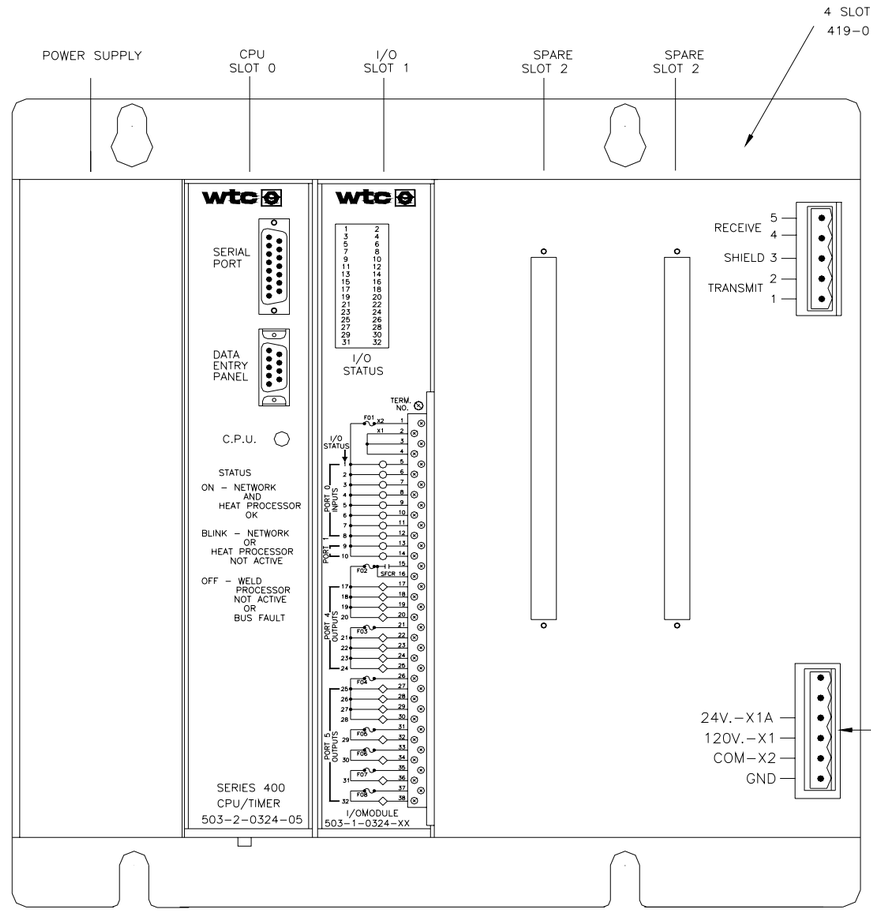
S400 T1 1SCR POWER HOOKUP

Drawn	Checked	Scale
S.W. 8/16/93	ERK 8/16/93	NONE

Drawing Size D | Sheet 2 of 6

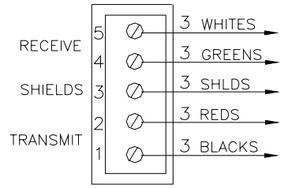
Dwg./ Part No. 414-0-0156-01

FILE: 015601S2.dwg



402-0-1088-XX POWER CABLE
CONNECTION TO CONTROL TRANSFORMER.

NETWORK CONNECTIONS



EACH TERMINAL HAS UP TO THREE WIRES, ONE FROM EACH OF THREE 2 COND. TWISTED, SHIELDED PAIRS.
THE CABLES ARE,

1. NETWORK IN
2. NETWORK OUT
3. MULTIDROP DATA ENTRY IF USED.

IF THE CONTROL IS THE LAST CONTROL ON THE NETWORK
150 OHM 1/4W RESISTOR SHOULD BE PLACED ACROSS 1-2 & 4-5

(OR)

A OPTIONAL REPEATER PC BOARD #473-0-0419-01 IS AVAILABLE FROM ROBOTRON WHICH PLUGS INTO THE BACKPLANE. SEE SECTION 1, FIGURE 2 IN THE SERIES 400 INSTRUCTION BOOK.

I/O BIT SET-UP

	CPU #1		
BIT	SLOT	PORT	TYPE
1-8	1	0	IN
9-16	1	1	IN
17-24	1	4	OUT
25-32	1	5	OUT
33-40			
41-48			
49-56			
57-64			
65-72			
73-80			
81-88			
89-96			
97-104			
105-112			
113-120			
121-128			
129-136			
137-144			
145-152			
153-160			

Sym.	Date	Revision	By
	21/21/99	Changed logos	ERK
	10/3/97	FIXED DWG	WDD

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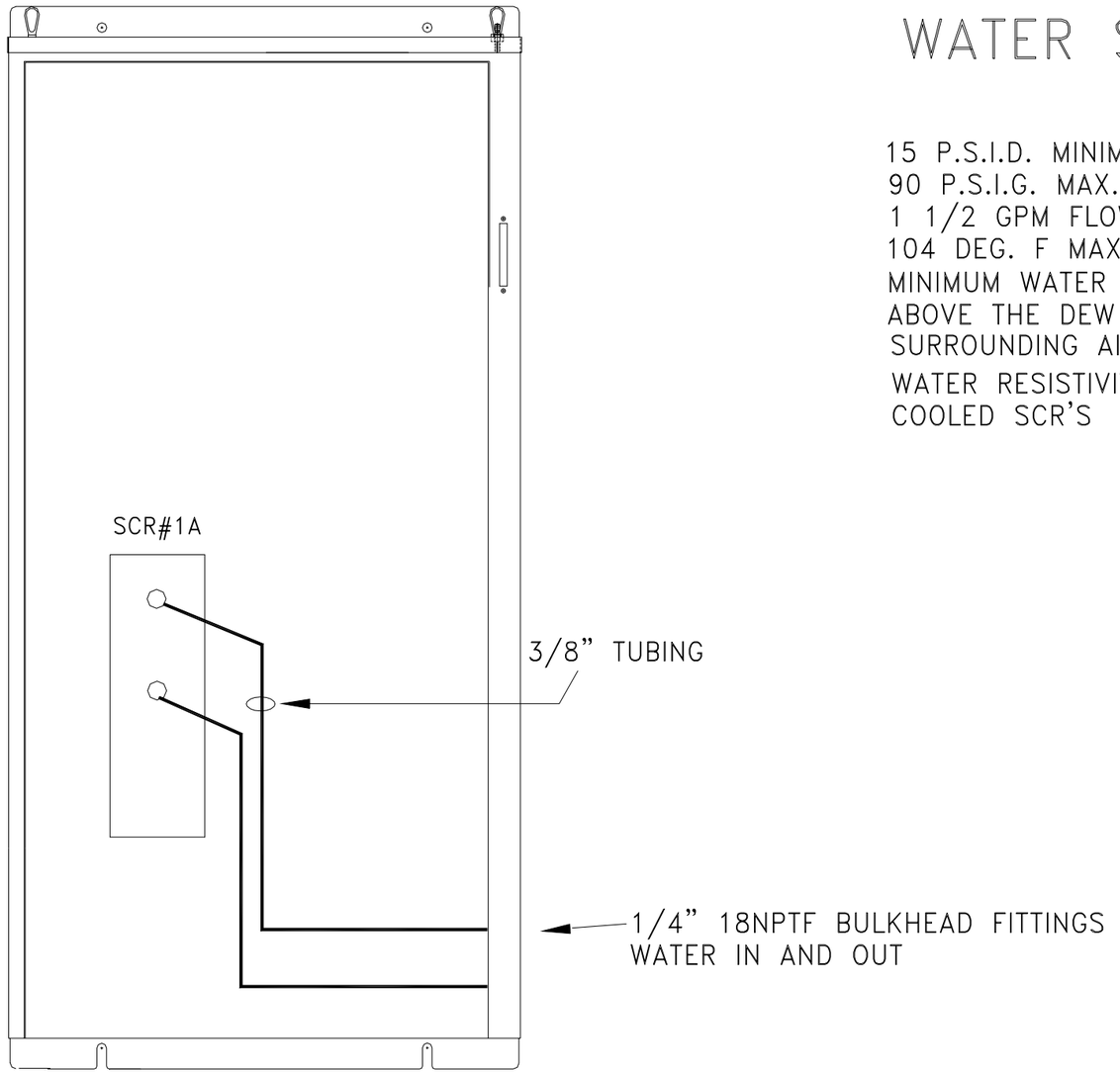
Description
S400 T1 1CPU 1SCR 10/16I/O BACKPLANE SET-UP.

Drawn	Checked	Scale
S.W. 8/16/93	ERK 8/16/93	1 = 1

Drawing Size (D) Sheet 3 of 6

Dwg./ Part No. 414-0-0156-01

FILE: 015601S3.dwg



WATER SPECIFICATIONS

15 P.S.I.D. MINIMUM BETWEEN FEED AND RETURN
90 P.S.I.G. MAX. PRESSURE
1 1/2 GPM FLOW RATE MINIMUM
104 DEG. F MAX. WATER TEMPERATURE
MINIMUM WATER TEMPERATURE IS
ABOVE THE DEW POINT OF THE
SURROUNDING AIR
WATER RESISTIVITY 5000 OHMS/CM ON DIRECT
COOLED SCR'S

SYM.	DATE	REVISION	BY
	21/21/99	Changed logo	ERK

wtc

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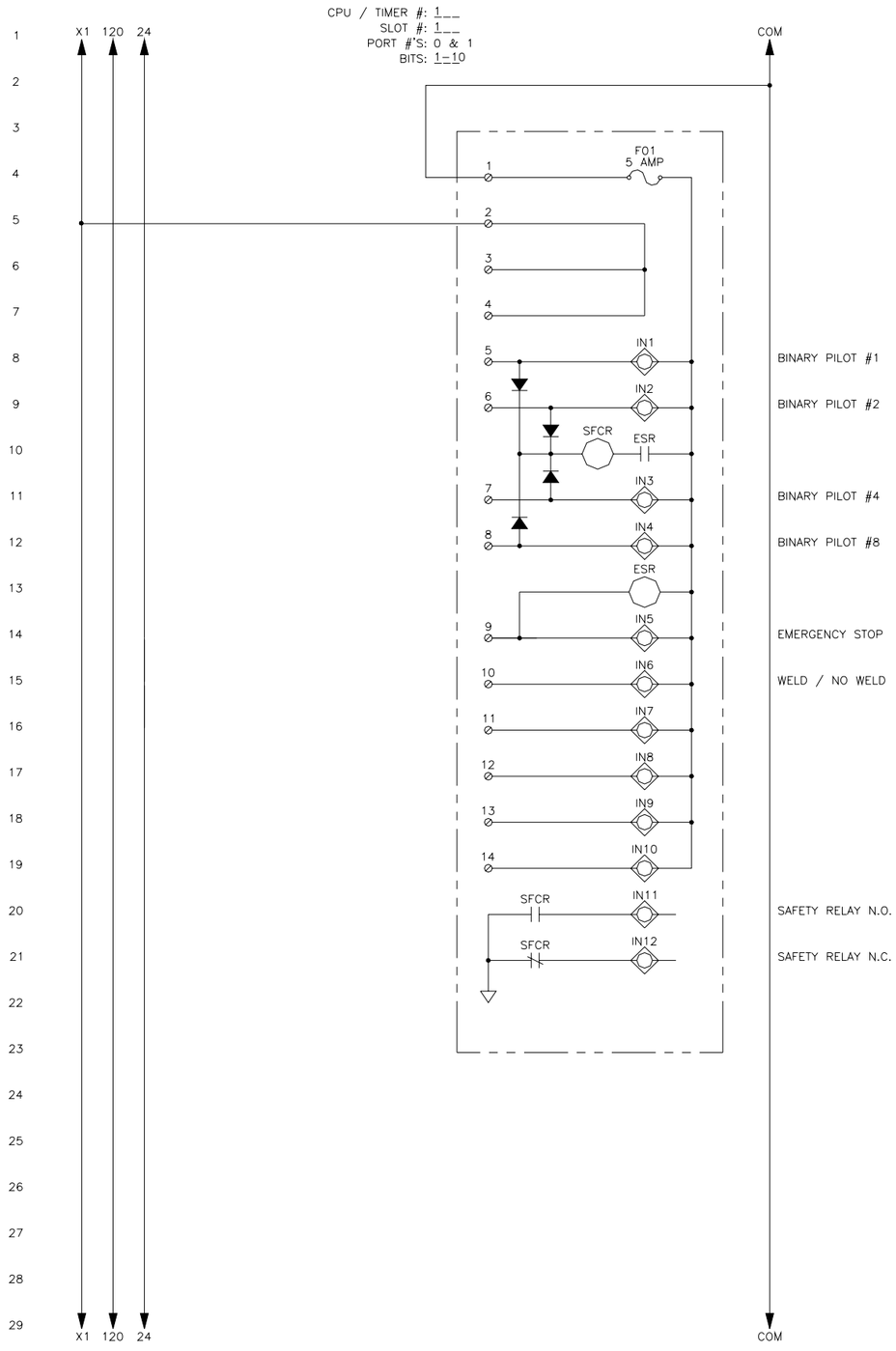
Description S400 WATER HOOK-UP AND SPECIFICATIONS FOR A TYPE 1 CABINET WITH 1 SCR CONTACTOR.

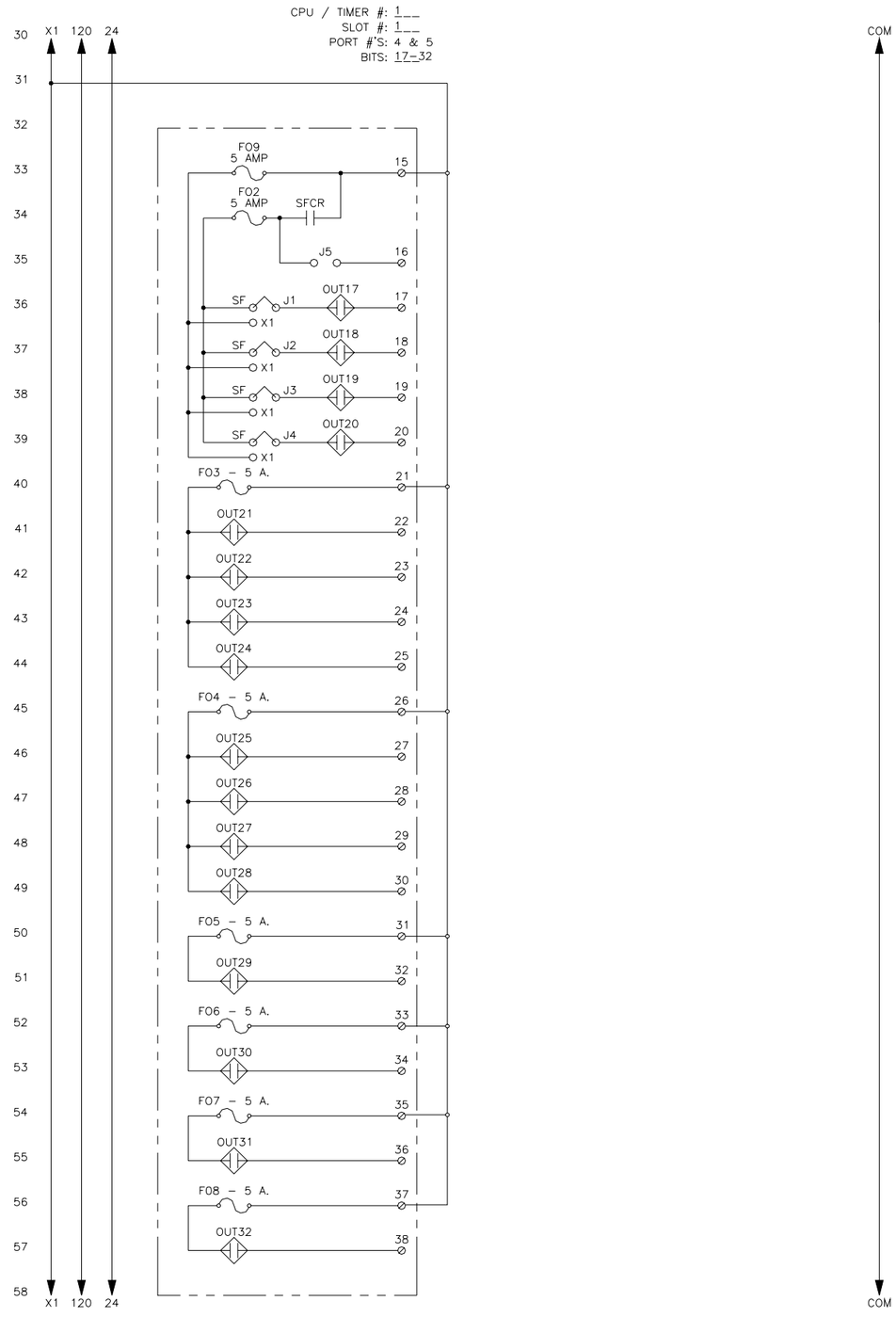
Drawn	Checked	Scale
S.W. 3/15/94	ERK 10/12/98	

Drawing Size (D) Sheet 4 Of 6

Dwg./ Part No. 414-0-0156-01

FILE: 015601S4.dwg





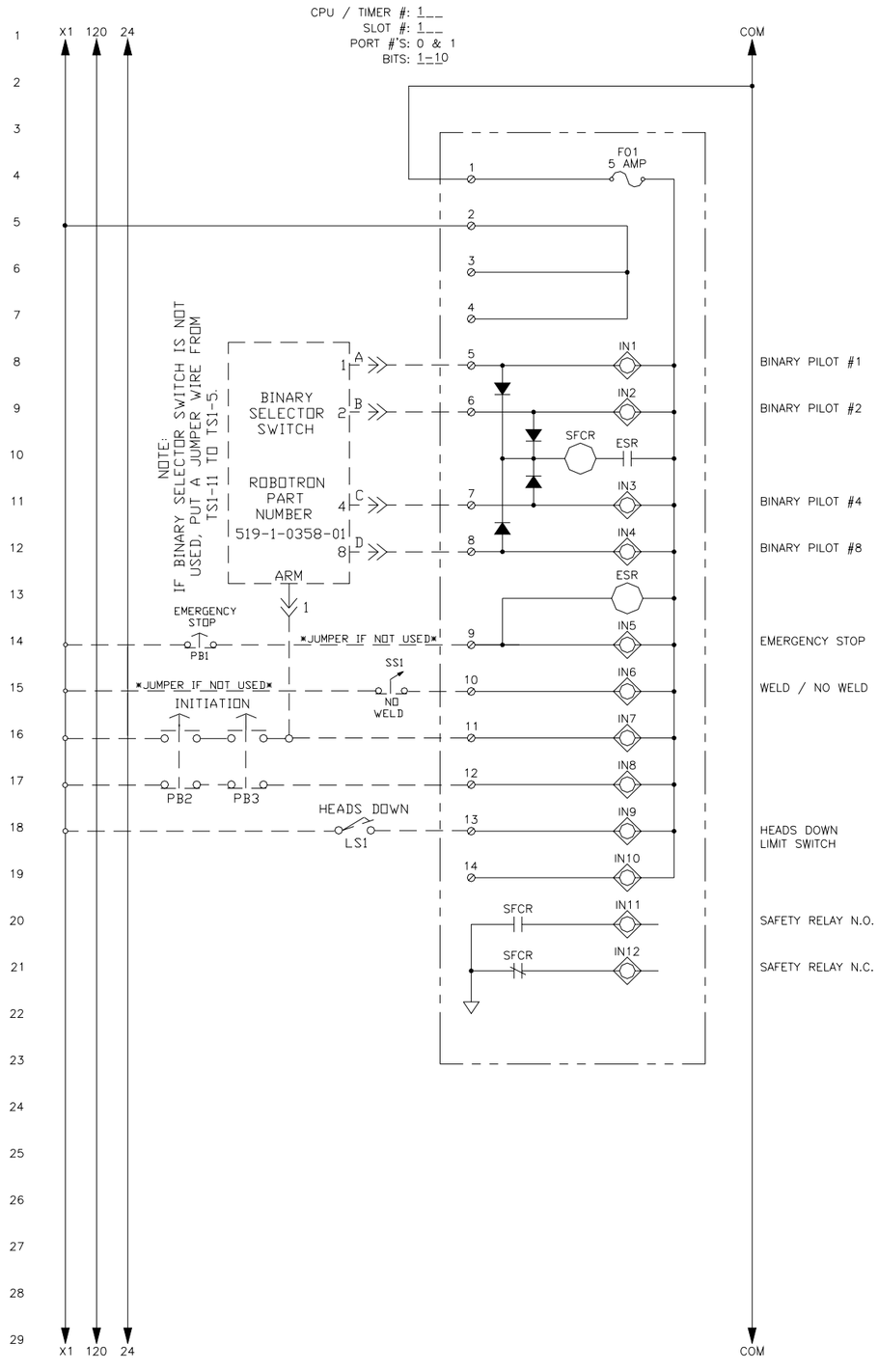
DWG FILE: 015601S5

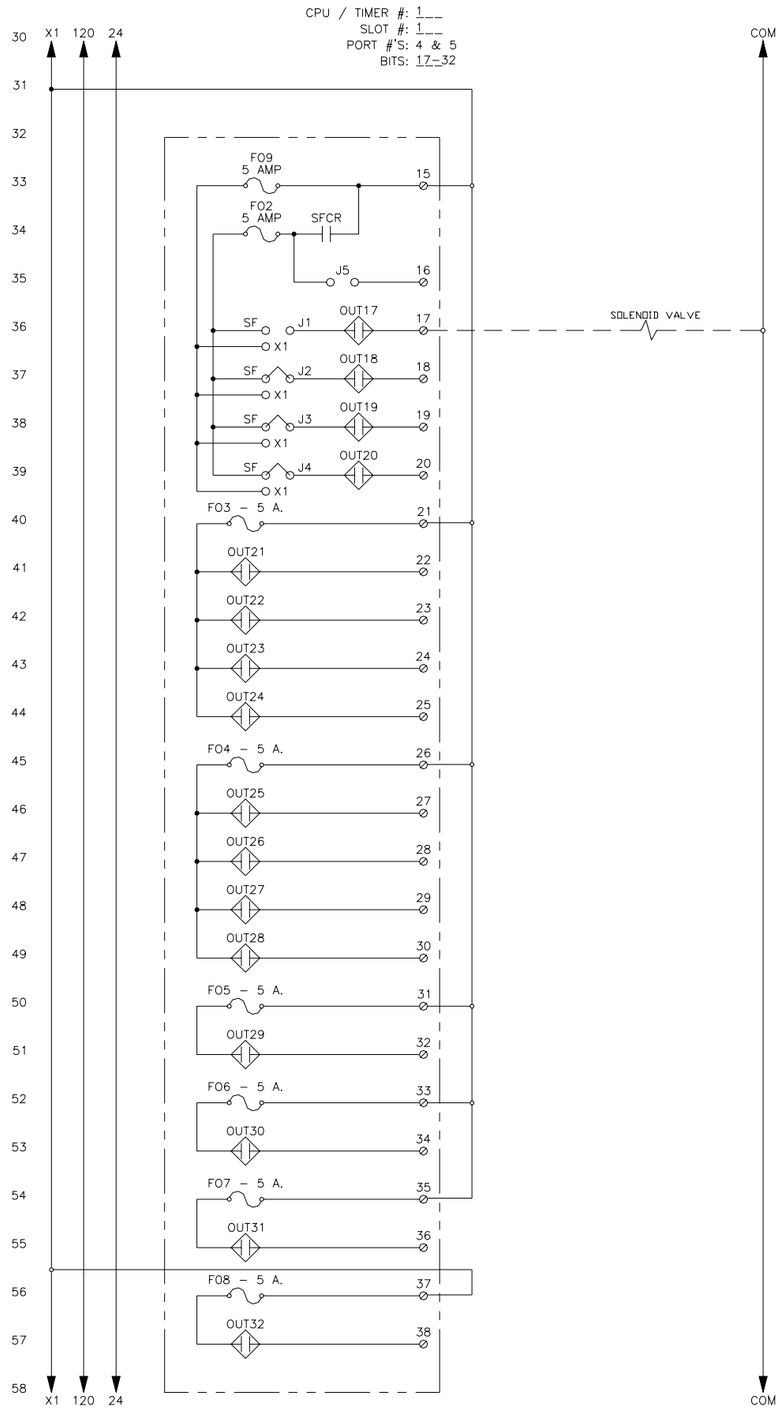
	2/21/99	Changed logo	ERK
Sym.	Date	Revision	By

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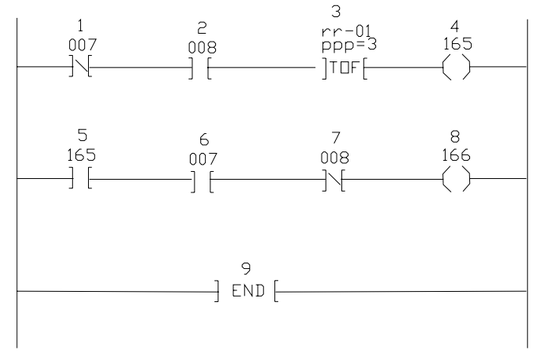
Description
S400 T1 4S 1CPU 1SCR 1I/O
WITH 120VAC IN/120VAC OUT.

Drawn FDONGON 3/30/98	Checked ERK 3/30/98	Scale NONE
Drawing Size D	Sheet 5 of 6	
Dwg./ Part No. 414-0-0156-01		





PLC PROGRAM




```
1 START NOT 007      ;N.O. BUTTONS NOT PUSHED
2 AND 008            ;AND N.C. BUTTONS CLOSED
3 TOF 01 3           ;TIMED OFF TIMER .3 SEC.
4 OUTPUT 165         ;165 TRUE AT REST
5 START 165          ;IF 165 IS STILL TRUE
6 AND 007            ;AND BOTH N.O. BUTTONS CLOSED
7 AND NOT 008        ;AND BOTH N.C. BUTTONS OPEN
8 OUTPUT 166         'OUTPUT 166
9 END                ;END OF PROGRAM START AGAIN
```

SEQUENCER PROGRAM

STEP	INSTRUCTION	COMMENTS
1	WAIT 166 TRUE	;WAIT FOR PLC INITIATION.
2	OUTPUT 017 ON	;OUTPUT SVCR AND LATCH SFCR.
3	NO OPERATION	;OUTPUT 18, 19 OR 20 HERE IF SOME OTHER VALVE IS NEEDED.
4	SECOND STAGE 009	;LATCH IN SEQUENCE, HEAD DOWN.
5	SQUEEZE OUT 017 ccCY	;SQUEEZE TIME.
6	WINDOW Hi iiii Lo iiii	;OPEN WINDOW.
7	WELD nn hh% (mm%) ccCY	;WELD FUNCTION.
8	WINDOW COMPARE Hi xxx Lo xxx	;CLOSE WINDOW.
9	HOLD ccCY	;SOLIDIFY WELD NUGGET
10	OFF SINGLE MODE	;END, TURN OFF PORTS.

DWG FILE: 015601S6

Sym.	Date	Revision	By
	12/21/99	Changed logo	ERK

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Description: S400 T1 4S 1CPU 1SCR 1I/O 120VACIN/120VACOUT WITH ANTI-TIE-DOWN OPERATION.

Drawn	Checked	Scale
FDONGON 3/30/98	ERK 3/30/98	NONE

Drawing Size: D | Sheet 6 of 6

Dwg./Part No. 414-0-0156-01

SFCR IS 300-0295
ESCR IS 300-0296
INPUT MODULES ARE 300-0406
OUTPUT MODULES ARE 300-0292

REVISIONS				
BY	REV	DESCRIPTION	DATE	APRV'D

LOW #S = LAYER 3 (COMP)
HIGH #S = LAYER 2 (SOLDER)

CNEXP1 · CNEXP2 · X2 · BPC · JUMPER · R03 · 120 VDC COIL · SFCR · ESCR · R01 5K 1W · R02 10 1/2W · C01 3uF 250V · F01 · F02 · F03 · F04 · F05 · F06 · F07 · F08 · F09 · J1 · J2 · J3 · J4 · J5 · D01 · D02 · D03 · D04 · D05 NOT USED · D06 NOT USED · D07 · D08 · D09 · D10 · LED1 LTO1 4 · LED2 LTO1 3 · LED3 LTO1 6 · LED4 LTO1 5 · LED5 LTO1 8 · LED6 LTO1 7 · LED7 LTO1 10 · LED8 LTO1 9 · LED9 LTO1 12 · LED10 LTO1 11 · LED17 LTO1 22 · LED18 LTO1 21 · LED19 LTO1 24 · LED20 LTO1 23 · LED21 LTO1 26 · LED22 LTO1 25 · LED23 LTO1 28 · LED24 LTO1 27 · LED25 LTO1 30 · LED26 LTO1 29 · LED27 LTO1 32 · LED28 LTO1 31 · LED29 LTO1 34 · LED30 LTO1 33 · LED31 LTO1 36 · LED32 LTO1 35 · I1 120 VAC · I2 120 VAC · I3 120 VAC · I4 120 VAC · I5 120 VAC · I6 120 VAC · I7 120 VAC · I8 120 VAC · I9 120 VAC · I10 120 VAC IN · O1 5 120 VAC · O2 5 120 VAC · O3 5 120 VAC · O4 5 120 VAC · O5 5 120 VAC · O6 5 120 VAC · O7 5 120 VAC · O8 5 120 VAC · O9 5 120 VAC · O10 5 120 VAC · O11 5 120 VAC · O12 5 120 VAC · O13 5 120 VAC · O14 5 120 VAC · O15 5 120 VAC · O16 5 120 VAC · INPUT 1 · INPUT 2 · INPUT 3 · INPUT 4 · INPUT 5 · INPUT 6 · INPUT 7 · INPUT 8 · INPUT 9 · INPUT 10 · 120 VAC COIL · ESCR · NOT USED · NOT USED · SFCR · SLOT IS SELECTED · SLOT ADR · BKPL · BIOSTB · BRESET · BR/W · BFAULT · LOW = WRITE · I/O DATA BUS · U01 74HC138 · U02 74HC85 · U03 74HCT245 · U04 74HC540 · U05 74HC540 · U06 · U07 · U08 74HCT04 · U09 2804 · U10 · U11 74HCT32 · U04 74HC273 · U07 74HC273 · RN01 1K · RN02 1K · RN03 1K · RN04 3.3K · RN05 3.3K · RN07 3.3K · RN09 3.3K · Q01 MPS6531 · Q02 TIP32 · R04 1K · R05 1K · R06 82 · R07 1K · C02 47uF · C03 .1uF · C04 .1uF · C05 .1uF · C06 .1uF · C07 .1uF · C08 .1uF · C09 220pF · C10 220pF · GND · Vdd · Vsw

DRAWN	HRB	10/17/91	
CHK'D	ERK	10/21/97	
ENG'R	HRB	10/17/91	
FO-AD			

WTC CORPORATION

SERIES 400 I/O
10 IN/120 VAC
16 OUT/120 VAC #17 ON SFCR

SIZE	PCB REV	DRAWING No.
	E	473-0-0373-00
SCALE		47300373.SCH

NOTE: U08-P12 TO U08-P11 IS MISSING IN FOIL
PRODUCTION BOARDS ARE JUMPERED PEND. NEXT REV.

REVISIONS

BY	REV	DESCRIPTION	DATE	APRV'D
HRB	R	INVERT BR/W	1/28/93	
HRB	R	U08 P11-P12 OPEN	3/22/93	

LOW #S = LAYER 3 (COMP)
HIGH #S = LAYER 2 (SOLDER)

TS1 PORT 1 COM 1 F01
TS1 INPUT 1 2
TS1 INPUT 2 3
TS1 INPUT 3 4
TS1 INPUT 4 5
TS1 INPUT 5 6
TS1 INPUT 6 7
TS1 INPUT 7 8
TS1 INPUT 8 9
TS1 INPUT 9 10
TS1 INPUT 10 11
TS1 INPUT 11 12
TS1 INPUT 12 13
TS1 INPUT 13 14
TS1 INPUT 14 15
TS1 INPUT 15 16
TS1 INPUT 16 17
TS1 PORT 2 COM 18 F02
TS1 19

I1 I2 I3 I4 I5 I6 I7 I8 I9 I10 I11 I12 I13 I14 I15 I16

LTO1 4 LED1, 3 LED2, 6 LED3, 5 LED4, 8 LED5, 7 LED6, 10 LED7, 9 LED8, 12 LED9, 11 LED10, 14 LED11, 13 LED12, 16 LED13, 15 LED14, 18 LED15, 17 LED16

Vdd
RN04 3.3K
RN05 3.3K
74HC540 U04 U05
D0 D1 D2 D3 D4 D5 D6 D7
OE1 CS0 OE2 19 BR/W

TS1 PORT 3 COM 20 F03
TS1 INPUT 17 21
TS1 INPUT 18 22
TS1 INPUT 19 23
TS1 INPUT 20 24
TS1 INPUT 21 25
TS1 INPUT 22 26
TS1 INPUT 23 27
TS1 INPUT 24 28
TS1 INPUT 25 29
TS1 INPUT 26 30
TS1 INPUT 27 31
TS1 INPUT 28 32
TS1 INPUT 29 33
TS1 INPUT 30 34
TS1 INPUT 31 35
TS1 INPUT 32 36
TS1 PORT 4 COM 37 F04
TS1 38

I17 I18 I19 I20 I21 I22 I23 I24 I25 I26 I27 I28 I29 I30 I31 I32

LTO1 22 LED17, 21 LED18, 24 LED19, 23 LED20, 26 LED21, 25 LED22, 28 LED23, 27 LED24, 30 LED25, 29 LED26, 32 LED27, 31 LED28, 34 LED29, 33 LED30, 36 LED31, 35 LED32
LTO1 41, LTO1 42

Vdd
RN06 3.3K
RN07 3.3K
74HC540 U06 U07
D0 D1 D2 D3 D4 D5 D6 D7
OE1 CS2 OE2 19 BR/W
OE1 CS3 OE2 19 BR/W

BKPL
BA0 62
BA1 26
BA2 61
BA3 25
BA4 60
BA5 24
BA6 59
BA7 23
74HC138 U01
CS1 CS2 CS3 CS4 CS5 CS6 CS7
BIOSTB
SLOT IS SELECTED
SLOT ADR 8 44 9 45
74HC85 U02 A<B A=B A>B
RN02 1K
RN03 1K

BRESET 49
BIOSTB 14
RN01 1K
74HCT245 U03
A8 A7 A6 A5 A4 A3 A2 A1 B8 B7 B6 B5 B4 B3 B2 B1
DIR G
I/O DATA BUS
74HCT04 U08
BR/W
LOW = WRITE
BFAULT 13

GND BKPL 34 70
16 16 20 20 20 20 20 14
U01 U02 U03 U04 U05 U06 U07 U08
8 8 10 10 10 10 10 7

C03 .1uF C04 .1uF C05 .1uF C06 .1uF C07 .1uF
C02 47uF

DRAWN	HRB	WTC CORPORATION
CHK'D		SERIES 400
ENG'R	HRB	32 INPUT BD.
FO-AD		SIZE PCB REV R — DRAWING No. 473-0-0378-00
		SCALE — 4730378.SCH SHEET

REVISIONS				
BY	REV	DESCRIPTION	DATE	APRV'D

BRESET
U04 74HCT04
U04 74HCT04
R05 1K
C06 .1uF
RN01 1K
74HCT245
BKPL
D0 D1 D2 D3 D4 D5 D6 D7
A8 A7 A6 A5 A4 A3 A2 A1
B8 B7 B6 B5 B4 B3 B2 B1
54 53 52 51 18 17 16 15
G
DIR
U03
I/O DATA BUS
LOW #S = LAYER 3 (COMP)
HIGH #S = LAYER 2 (SOLDER)
BIOSTB
BR/W
LOW = WRITE
BFAULT
Vdd
Vsw
U01
P20L10
BA0 BA1 BA2 BA3 BIOSTB MATCH BRW NC1 NC2 NC3 NC4 GND
Vdd CS0 CS1 CS2 CS3 CS4 CS5 CS6 CS7 DBEN NDIR NC5
RN02 1K???
MATCH
74HC85
A=B A<B A>B
RN03
U02
SLOT ADR
1K
C07 .1uF
R02 1K
Q02 TIP32
R03 82
Q01 MPS6531
R01 1K
R04 1K
LT01
U04 74HCT04
BFAULT
BKPL
GND
C01 47uF
C02 .1uF
C03 .1uF
C04 .1uF
C05 .1uF
C12 .1uF
C13 .1uF
C14 .1uF
C15 .1uF
74HC273
U06
C08 220pF
U10 2804
RN04 3.3K
LED1 LTO1
LED2 LTO1
LED3 LTO1
LED4 LTO1
LED5 LTO1
LED6 LTO1
LED7 LTO1
LED8 LTO1
001 002 003 004 005 006 007 008
F01
TS1
74HC273
U07
C09 220pF
U11 2804
RN05 3.3K
LED9 LTO1
LED10 LTO1
LED11 LTO1
LED12 LTO1
LED13 LTO1
LED14 LTO1
LED15 LTO1
LED16 LTO1
009 010 011 012 013 014 015 016
F02
74HC273
U08
C10 220pF
U12 2804
RN06 3.3K
LED17 LTO1
LED18 LTO1
LED19 LTO1
LED20 LTO1
LED21 LTO1
LED22 LTO1
LED23 LTO1
LED24 LTO1
017 018 019 020 021 022 023 024
F03
74HC273
U09
C11 220pF
U13 2804
RN07 3.3K
LED25 LTO1
LED26 LTO1
LED27 LTO1
LED28 LTO1
LED29 LTO1
LED30 LTO1
LED31 LTO1
LED32 LTO1
025 026 027 028 029 030 031 032
F04

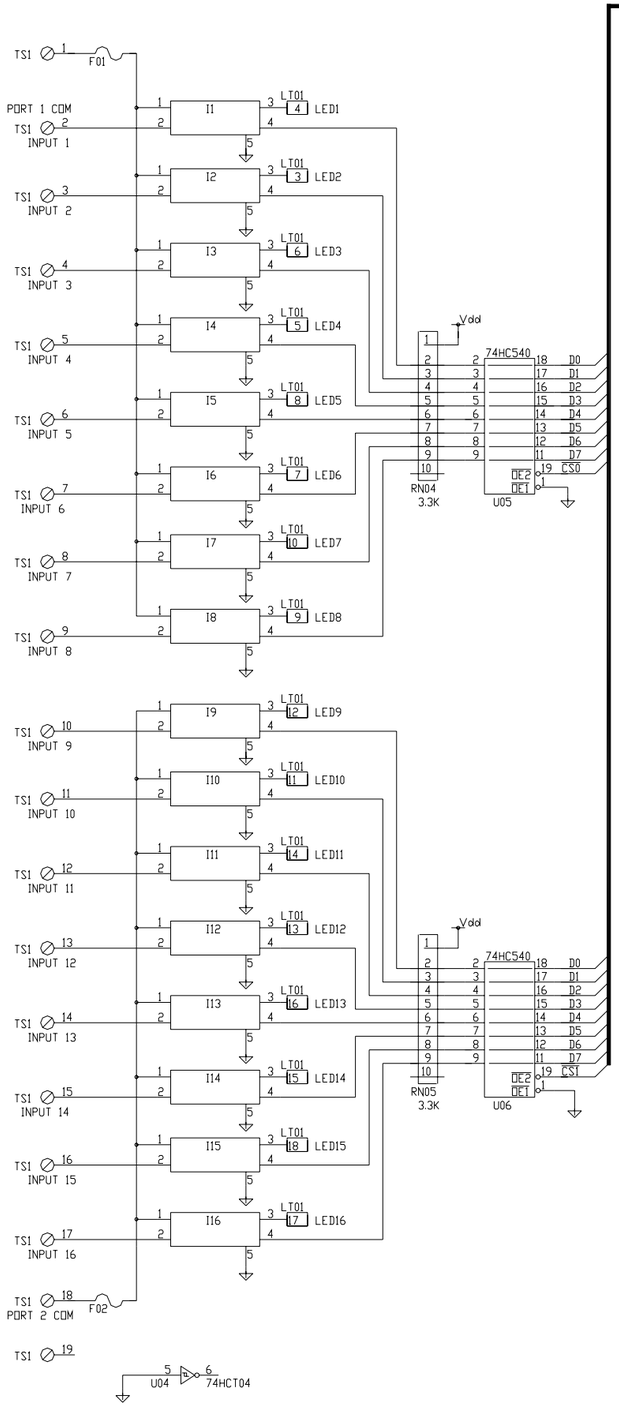
	WTC CORPORATION	
DRAWN HRB	SERIES 400	
CHK'D	32 OUTPUT MODULE	
ENG'R HRB		
PD-AD	SIZE PCB REV A	DRAWING No. 473-0-0379-XX
	SCALE	47300379.SCH SHEET

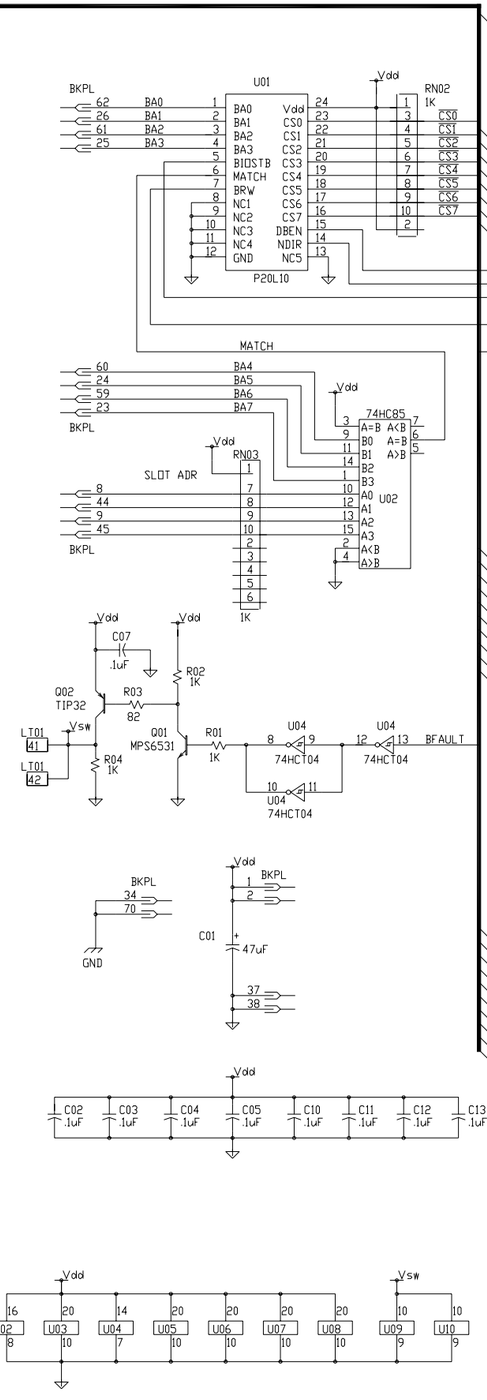
REVISIONS				
BY	REV	DESCRIPTION	DATE	APRV'D

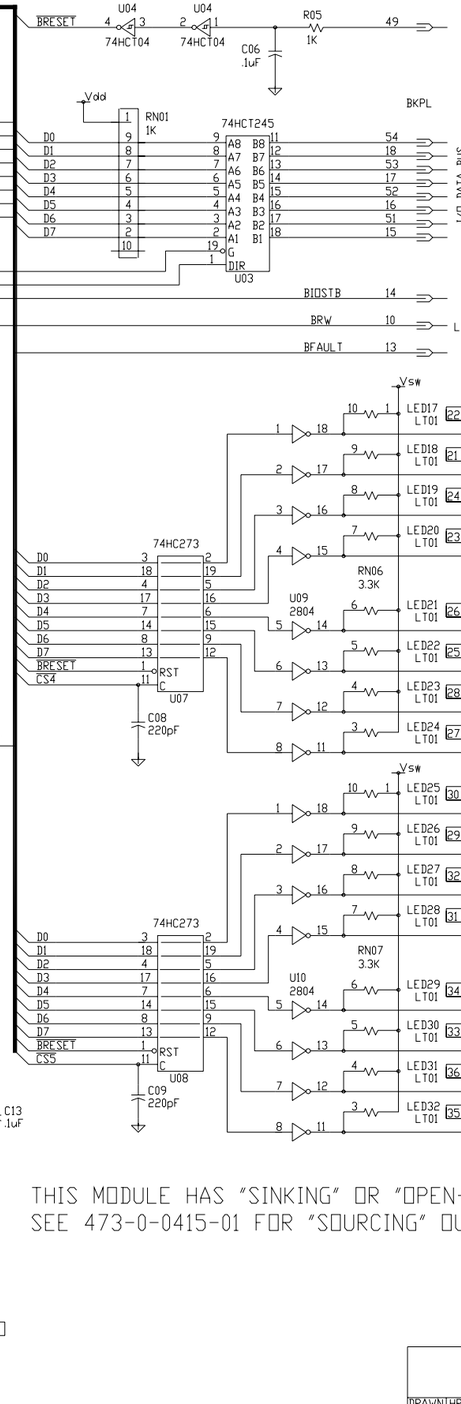
LOW #S = LAYER 3 (COMP)
HIGH #S = LAYER 2 (SOLDER)

WTC CORPORATION			
SERIES 400 16 IN/OUT MODULE			
DRAWN HRB CHK'D ENG'R HRB PD-AD	SIZE PCB REV PR	DRAWING No. 473-0-0415-01	
	SCALE	47300415.SCH	SHEET

REVISIONS				
BY	REV	DESCRIPTION	DATE	APRV'D







THIS MODULE HAS "SINKING" OR "OPEN-COLLECTOR" OUTPUTS
SEE 473-0-0415-01 FOR "SOURCING" OUTPUTS

	WTC CORPORATION	
DRAWN HRB	SERIES 400	
CHK'D	16 IN/OUT MODULE	
ENG'R HRB		
FD-AD	SIZE PCB REV PR	DRAWING No. 473-0-0430-01
	SCALE	473004 30.SCH SHEET

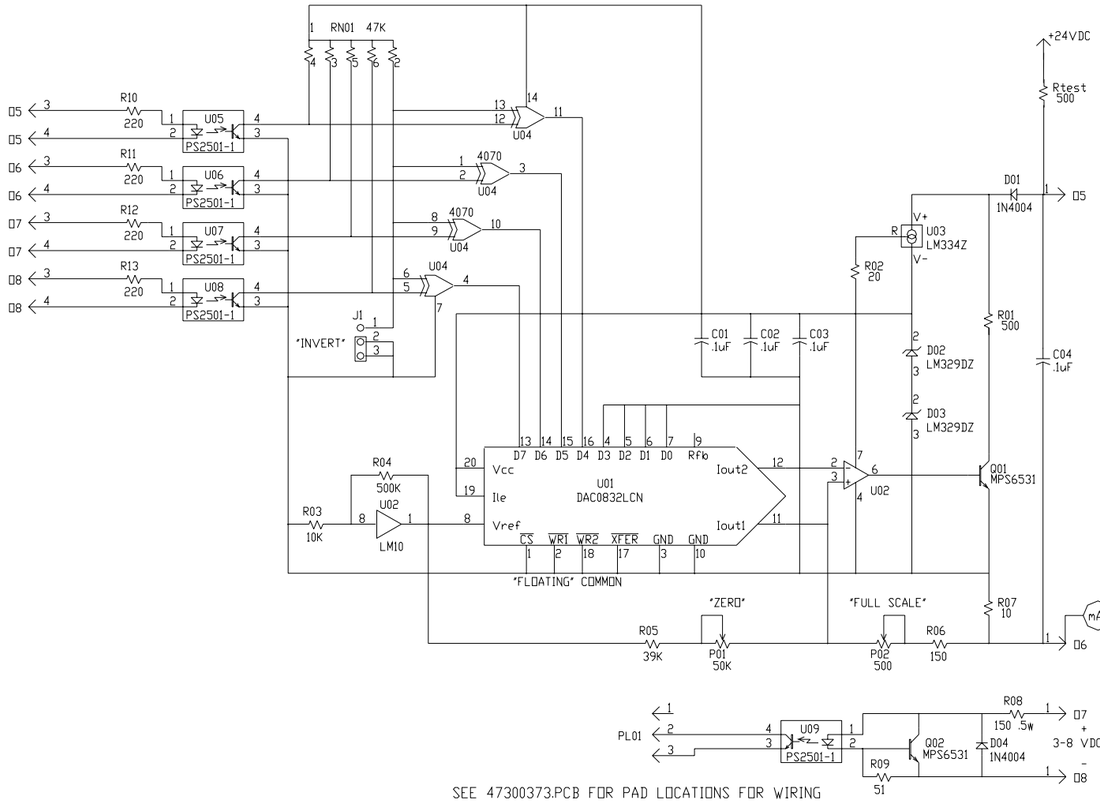
CALIBRATION:

1) SET ZERO ADJ. AND SPAN ADJ. FULLY COUNTER-CLOCKWISE
2) SET JUMPER J1 TO PINS 1 & 2. ADJUST SPAN FOR 20mA.
3) SET JUMPER J1 TO PINS 2 & 3. ADJUST ZERO FOR 4 mA.
4) REPEAT STEPS 2 AND 3 ABOVE UNTIL NO IMPROVEMENT CAN BE MADE
   READINGS SHOULD BE +.01 TO -.01 MILLIAMP
5) USE TORQUE-SEAL ON ADJUSTMENTS. LEAVE JUMPER J1 SET TO PINS 2 & 3

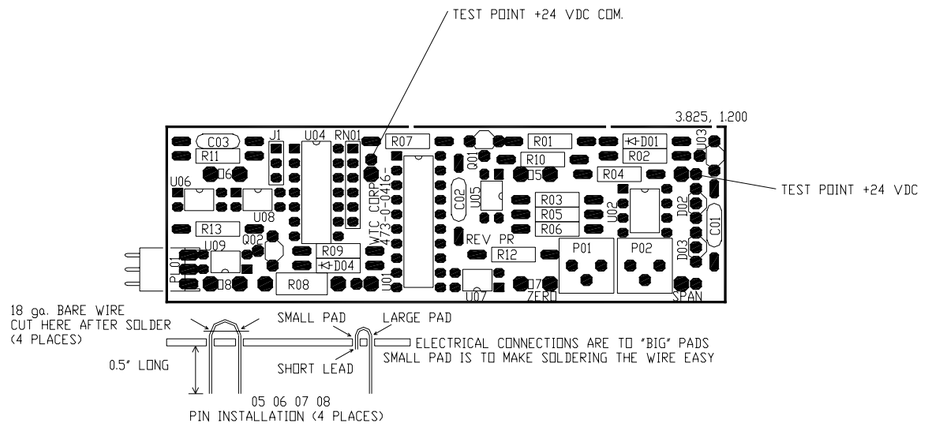
FINAL TEST:

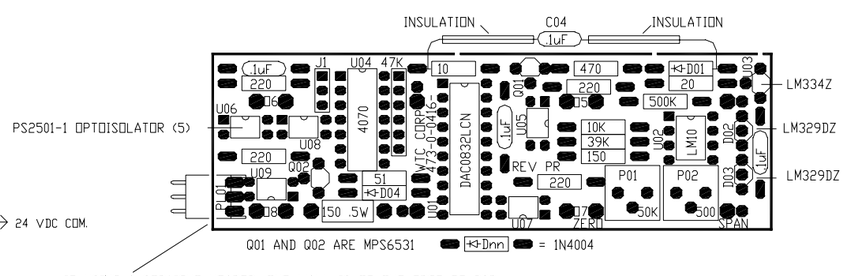
1) USE PRESSURE OUT STATEMENT TO SET ALL 16 LEVELS. OUTPUT mA. SHOULD
   4mA. AND 20mA. OUTPUTS SHOULD BE CORRECT. VERIFY THAT OTHER LEVELS
   ARE LINEAR AND MONOTONIC.
2) APPLY 3-8 VOLTS (5 VOLT NOMINAL) TO TTL INPUT. LOOK AT INPUT BIT 13
   USING THE "VIEW DATA" SCREEN.

REVISIONS				
BY	REV	DESCRIPTION	DATE	APRV'D
HRB		RN1 WAS 22K. UNIT WAS NON-LINEAR AT HIGH % PRESSURES.	070693	

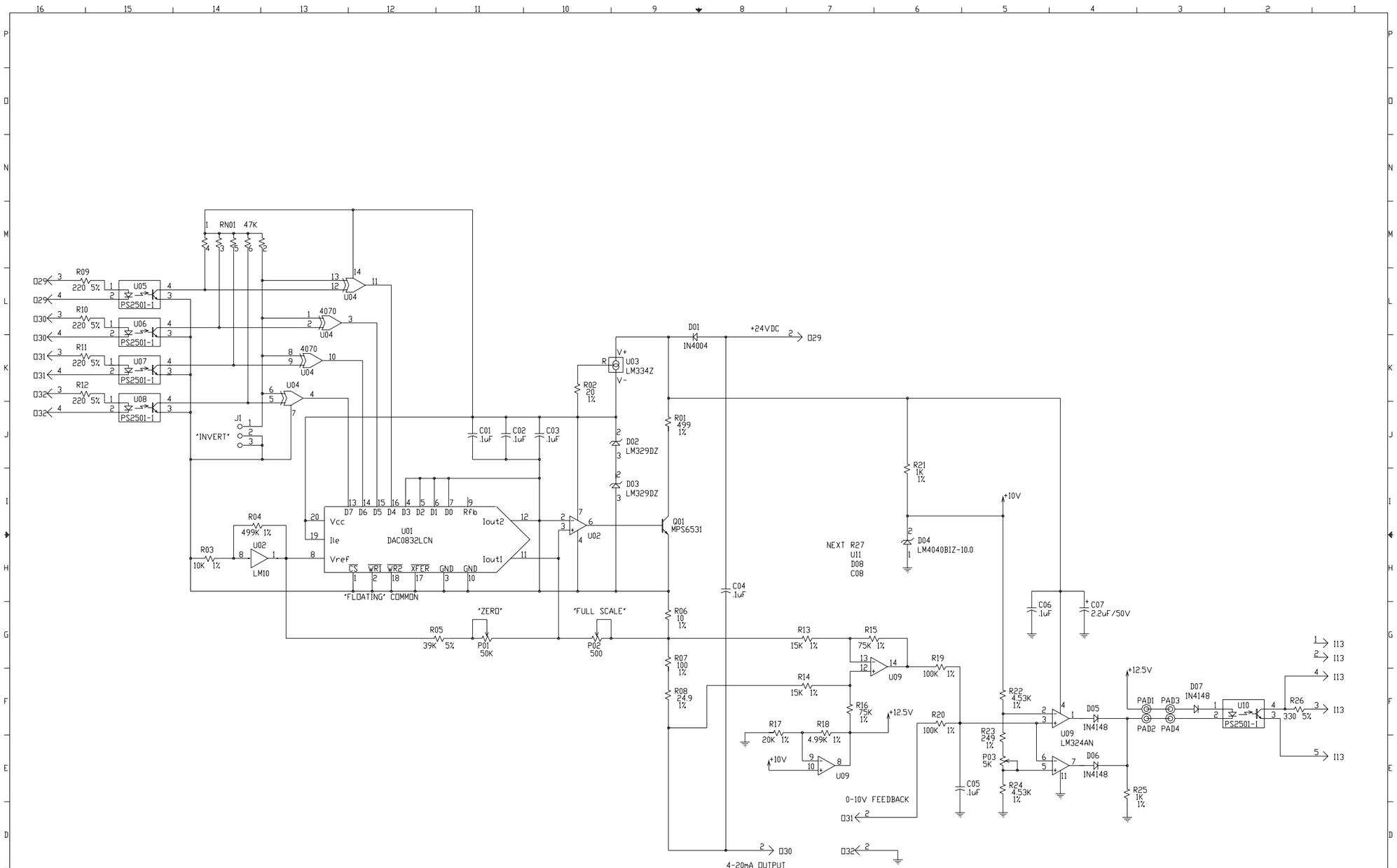


SEE 47300373.PCB FOR PAD LOCATIONS FOR WIRING





DRAWN	HRB	6/29/93	WTC CORPORATION
CHK'D	HRB		ASSEMBLY-INSPECTION-SCHEMATIC 4-20 mA. CURRENT LOOP ASSY. FOR 503-1-0324-XX I/O BOARD
ENG'R	HRB		SIZE B · PCB REV. PR · DRAWING No. 473-0-0416-XX
			SCALE Bb · 47300416.ASM · SHEET



REV	DESCRIPTION	ECR	BY	DATE	APRV
S	ADDED PAGE 3 AND CONNECTION PAD3 TO PAD1 ADDED CONNECTION PAD2 TO PAD4	16407	JJM	3/1/01	HB
R	SEE PAGE 1	13736	HB	10/25/00	JJM

WTC CORPORATION

4-20 mA CURRENT LOOP
PRESSURE SYSTEM
WITH 0-10V ANALOG FEEDBACK

prepared	HRB	1999
checked	ERK	1999
engineer	HRB	1999

size A | code id no. | drawing no. 473-0-0448-01 | REV S

scale | sheet 2 of 3

REVISIONS				
BY	REV	DESCRIPTION	DATE	APRV'D
HRB	R	SWAP NETWORK PINS	6-06-92	
HRB	A	JOIN AGND TO FG	8-19-93	

POWER SUPPLY

SLOT 0

SLOT 1

SLOT 2

SLOT 3

Vdd C56 .1uF

Vdd C57 .1uF

Vdd C58 .1uF

Vdd C59 .1uF

Vdd C55 .1uF

COMP SOLDER SO1 SO1

COMP SOLDER SO2 SO2

COMP SOLDER SO3 SO3

COMP SOLDER SO4 SO4

COMP SOLDER SO5 SO5

CP5

CGND

TLNET 1 TLNET 3

TLNET 2 TLNET 4

BRESET

AN12

AP12

AGND

SPARE_7

ACCOM

24VAC

FG

CN01

CN02

CN03

CN06

KEEP FAR AWAY FROM ALL OTHER BKPLANE TRACES

485+ 485-

TLNET 1 TLNET 2 TLNET 3 TLNET 4

SLOT1 SLOT2 SLOT4 SLOT8

BR/W BMRDY BBSY BREQ BGIN BRESET BFAULT BMEMSTB BIOSTB

BD7 BD6 BD5 BD4 BD3 BD2 BD1 BD0

BA15 BA14 BA13 BA12 BA11 BA10 BA9 BA8 BA7 BA6 BA5 BA4 BA3 BA2 BA1 BA0

SPARE_1 SPARE_2 SPARE_3 SPARE_4 SPARE_5 SPARE_6

CN01, CN02 ARE .156" JST HEADER
CN03, CN04, CN05 ARE .2" ALTECH

CN05

TLNET 4 TLNET 2 TLNET 1 TLNET 3

C53 .001uF

C54 .001uF

CN02 AND CN06 PROVIDE AC POWER TO 503-3-0324-XX (POWER SUPPLY MODULE)

CN01 PROVIDES DC POWER FROM POWER SUPPLY MODULE TO BACKPLANE 419-0-0444-01

NOT USED ON ALL MODELS

+24VDC

+-12VDC,+5VDC

TO CN06

FROM CN02

FROM CN06

RN10 1K

RN11 1K

RN1 1K

RN2 1K

RN3 1K

RN4 100

RN5 100

RN6 100

RN7 100

RN8 100

RN9 100

RN12 1K

RN13 1K

RN14 1K

RN15 100

RN16 100

RN17 100

RN18 100

RN19 100

RN20 100

C08 C06 C04 C02 C07 C05 C03 C01

C16 C14 C12 C10 C15 C13 C11 C09

C24 C22 C20 C18 C23 C21 C19 C17

C32 C30 C28 C26 C31 C29 C27 C25

C40 C38 C36 C34 C39 C37 C35 C33

C48 C46 C44 C42 C47 C45 C43 C41

D01 1N4004

R01 220K

R02 220K

R03 4.7K

R04 1K

C49 2.2uF

C50 2.2uF

C51 .01uF

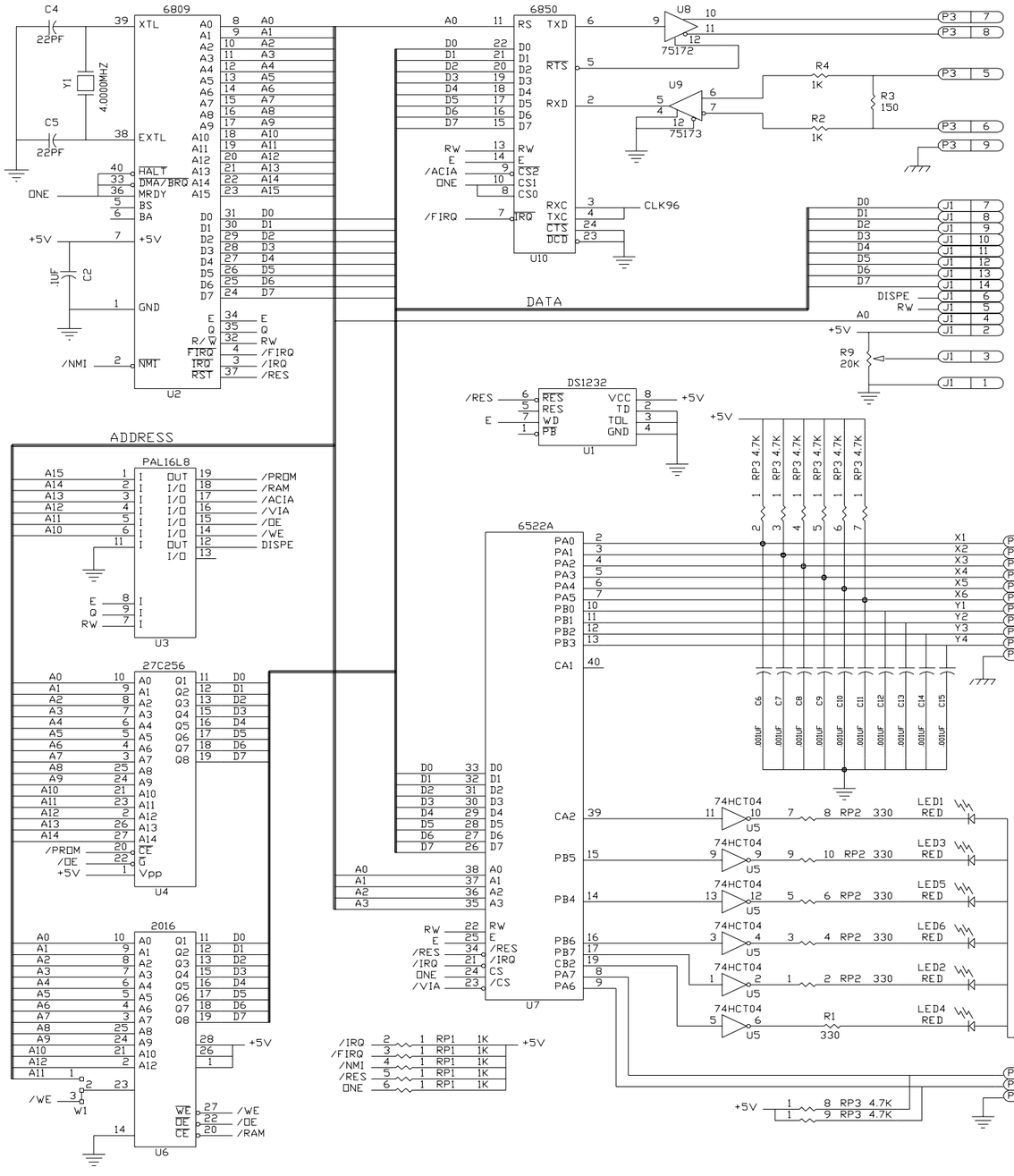
C52 .1uF

U01 555

Q01 MPS6531

BRESET

DRAWN		WTC CORPORATION	
CHK'D		S400 MOTHER BOARD - FOUR SLOT (POWER SUPPLY SLOT NOT COUNTED)	
ENG'R	HRB 5/22/92		
		SIZE B / PCB REV	DRAWING No. 473-0-0404-01
		SCALE	SHEET 1 OF 1



ACTIVE LAYERS
0
BORDER-TITLE

REV	DESCRIPTION	DATE	BY	AUTHORITY	BY
B	CHANGED TO WTC TITLEBLOCK		ERK	ENG	

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DO NOT SCALE DRAWING

MECHANICAL TOLERANCES:	ANGLES ±1/2°	PROJECTION
0.00X ±0.005	UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE	THIRD ANGLE
0.0X ±0.015	IN INCHES. IF REQUIRED, METRIC ARE SHOWN IN	
0.X ±0.03	BRACKETS [mm]. BREAK & DEBURR ALL SHARP EDGES.	

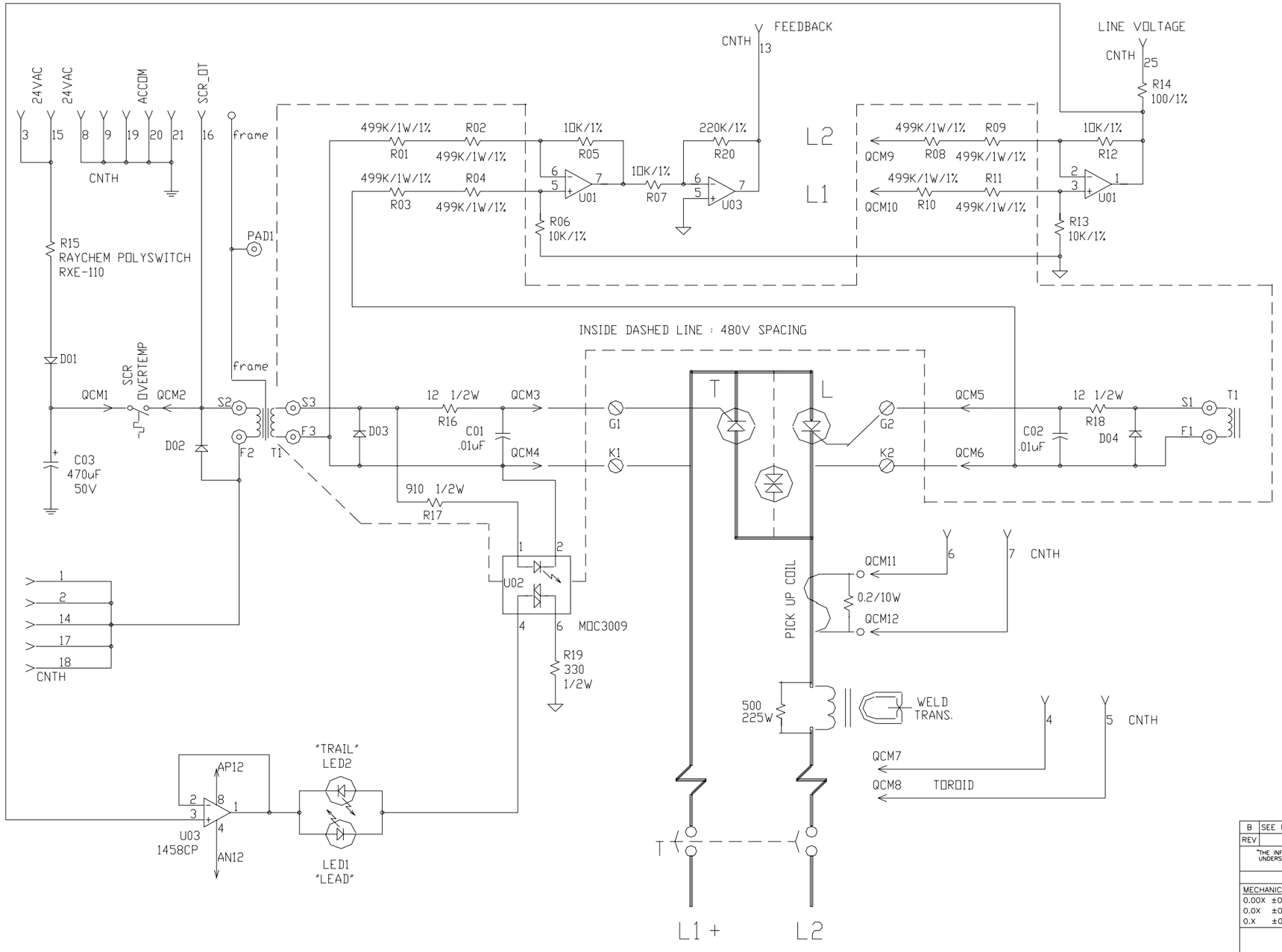
wtc

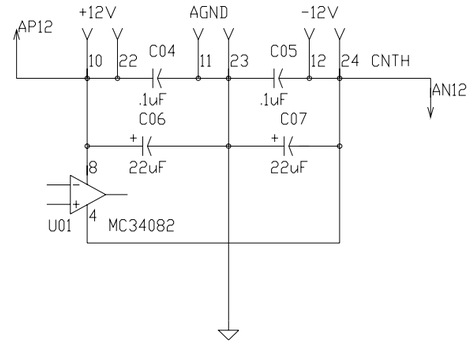
TECHNICAL CENTER
24775 CRESTVIEW COURT
FARMINGTON HILLS, MI 48335

SCHEMATIC FOR SERIES 400	DRAWN BY:	01/20/95
LCD DATA ENTRY PANEL	REQ'D BY:	
	SCALE: NONE	SIZE: D
CUSTOMER:	SALES ORDER NO.:	

PART NO.	SHEET	DRAWING NO.	REV.
4730028103	1 OF 1	028103	B

revisions				
by	ltr	description	date	appr'd
HRB	R	ADD GAIN STAGE U03	5/29/91	
HRB	A	MOVED U03-3 TO U01-1	10/2/91	
HRB	B	R15 WAS 10 OHM 5W	6/01/93	
HRB	C	C03 WAS AXIAL LEAD	12/22/99	





NOTE:

1) UNLESS OTHERWISE NOTED
ALL DIODES ARE 1N4004.
ALL RESISTORS ARE IN OHMS, 1/4W, 5%.

REV	DESCRIPTION	DATE	BY	AUTHORITY	BY
B	SEE REVISION CHART ABOVE				

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DO NOT SCALE DRAWING

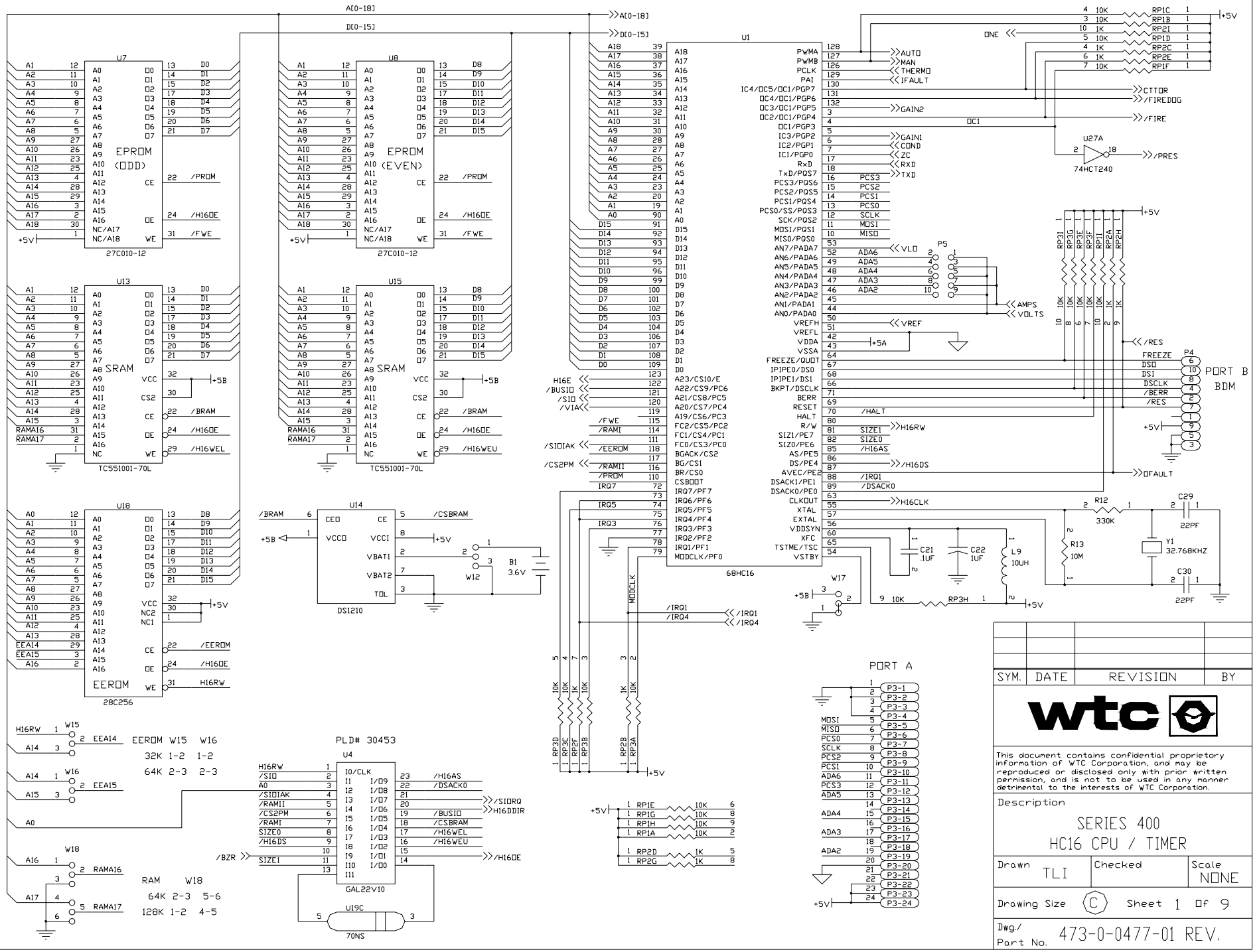
MECHANICAL TOLERANCES:	ANGLES ±1/2"	PROJECTION
0.00X ±0.005	UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE	
0.0X ±0.015	IN INCHES. IF REQUIRED, METRIC ARE SHOWN IN	
0.X ±0.03	BRACKETS [mm]. BREAK & DEBURR ALL SHARP EDGES.	THIRD ANGLE

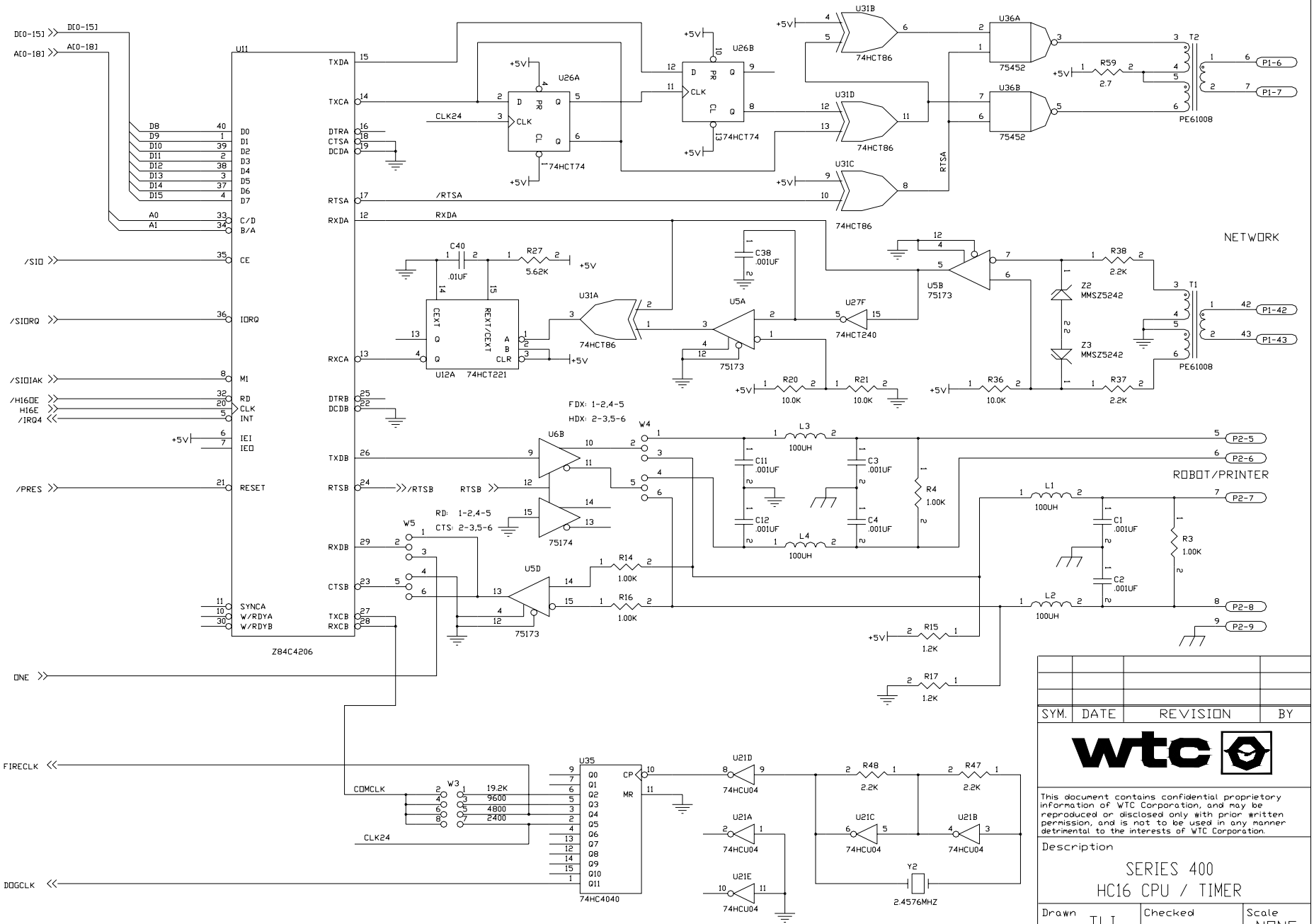
wtc
TECHNICAL CENTER
24775 CRESTVIEW COURT
FARMINGTON HILLS, MI 48335

FIRING CARD WITH FIRING LIGHTS AND ANALOG FEEDBACK SCHEMATIC	DRAWN BY: H.B.	5/29/91
	REQ'D BY:	
	SCALE: NONE	SIZE: D
CUSTOMER:	SALES ORDER NO.:	

PART NO.	SHEET	DRAWING NO.	REV.
900-S400	1 OF 1	4730037001	B

ACTIVE LAYERS
BORDER-TITLE


A[0-18]
D[0-15]
U7
EPROM (ODD)
27C010-12
U8
EPROM (EVEN)
27C010-12
U13
SRAM
TC551001-70L
U15
SRAM
TC551001-70L
U18
EEROM
28C256
U1
68HC16
U14
DS1210
U27A
74HCT240
P5
P4
PORT B
BDM
PORT A
PLD# 30453
U4
GAL22V10
U19C
70NS
B1
3.6V
Y1
32.768KHZ
L9
10UH
C21
.1UF
C22
1UF
C29
22PF
C30
22PF
R12
330K
R13
10M
W12
W15
W16
W17
W18
EEROM W15 W16
32K 1-2 1-2
64K 2-3 2-3
RAM W18
64K 2-3 5-6
128K 1-2 4-5
SYM.
DATE
REVISION
BY
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Description
SERIES 400
HC16 CPU / TIMER
Drawn TLI
Checked
Scale NONE
Drawing Size C
Sheet 1 of 9
Dwg./ Part No. 473-0-0477-01 REV.



SYM.	DATE	REVISION	BY

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Description

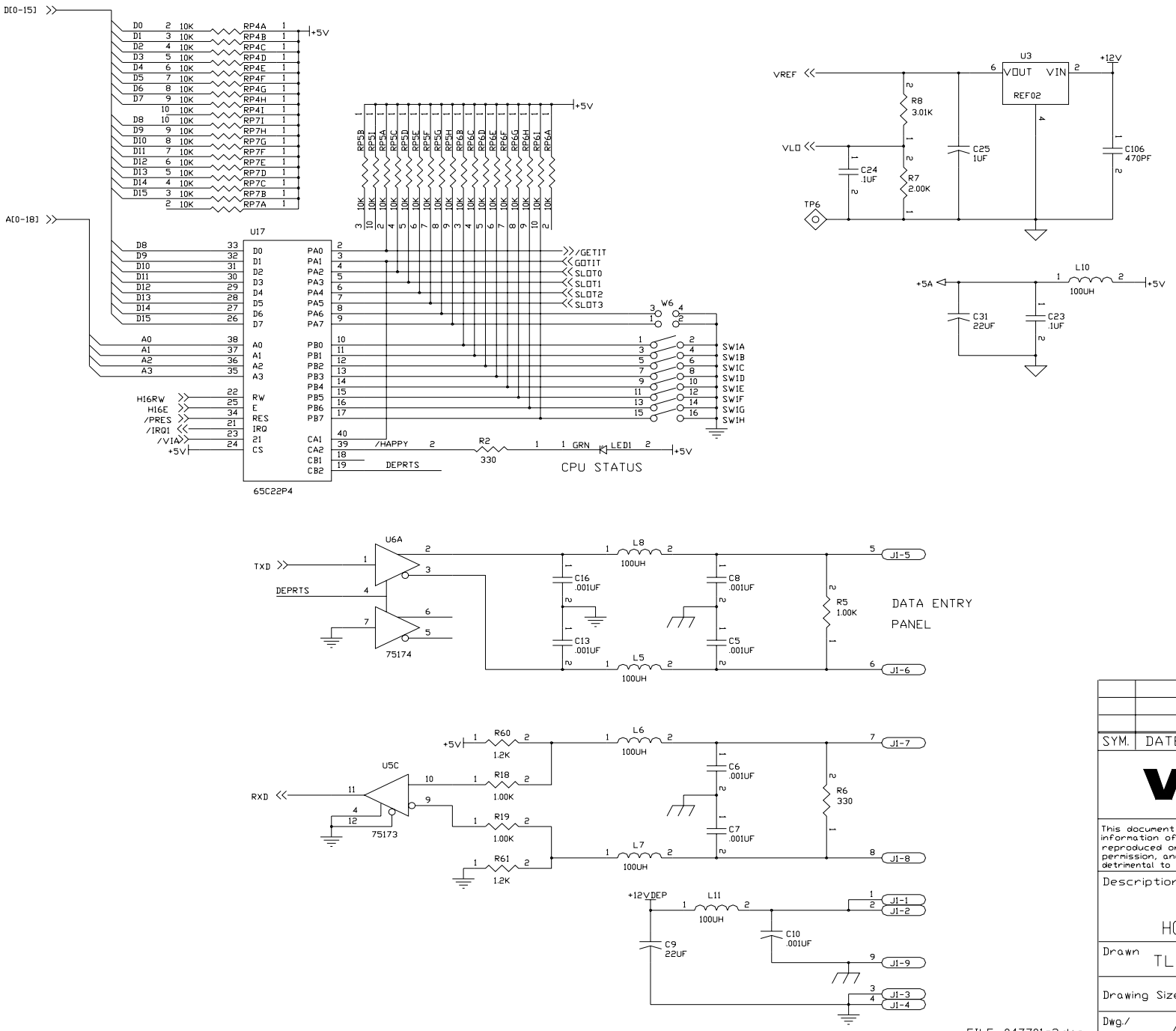
SERIES 400
HC16 CPU / TIMER

Drawn	Checked	Scale
TLI		NONE

Drawing Size C Sheet 2 of 9

Dwg./ Part No. 473-0-0477-01 REV.

FILE: 047701s2.dwg



SYM.	DATE	REVISION	BY

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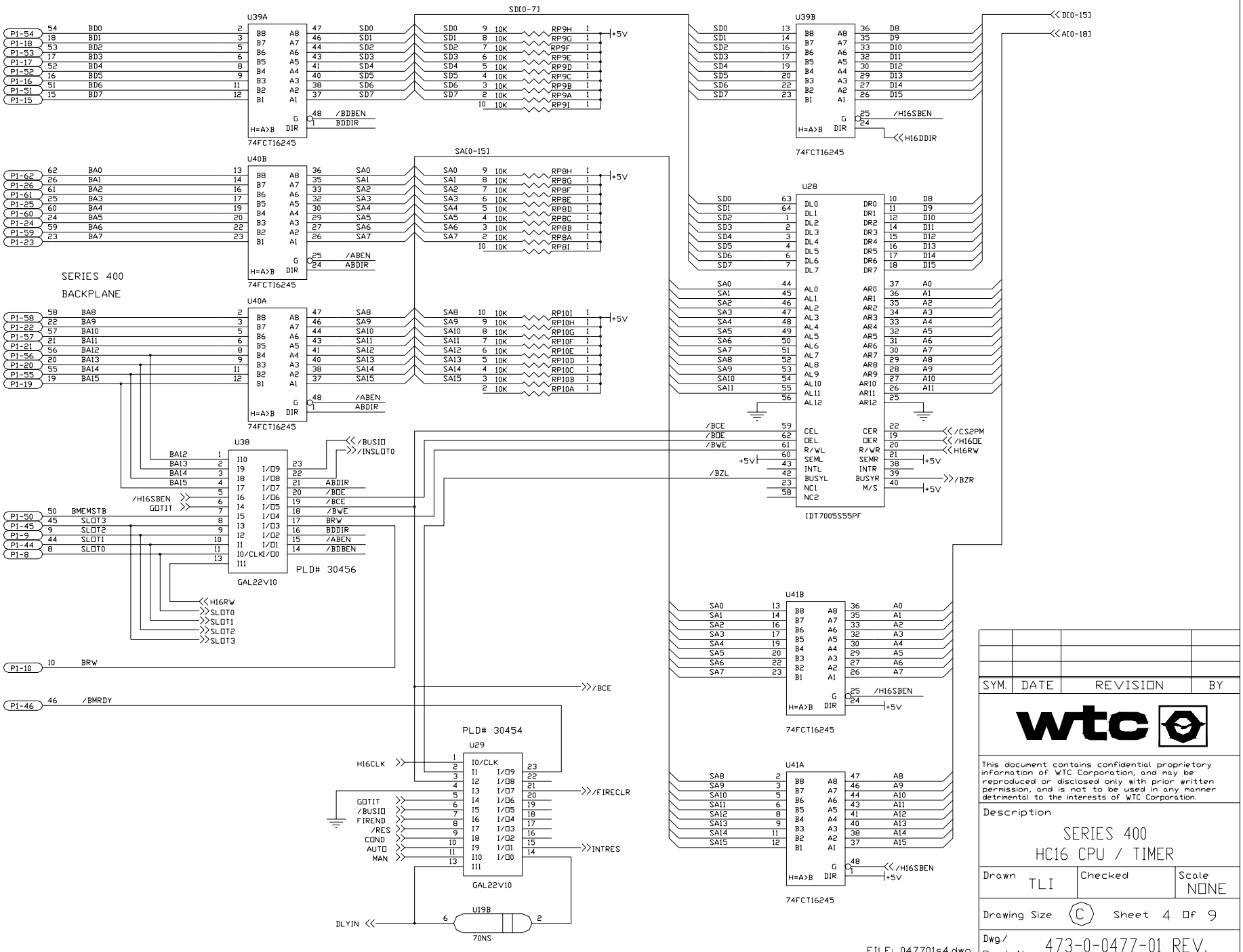
Description

SERIES 400
HC16 CPU / TIMER

Drawn	Checked	Scale
TLI		NONE

Drawing Size C Sheet 3 of 9

Dwg./ Part No. 473-0-0477-01 REV.



SYM.	DATE	REVISION	BY

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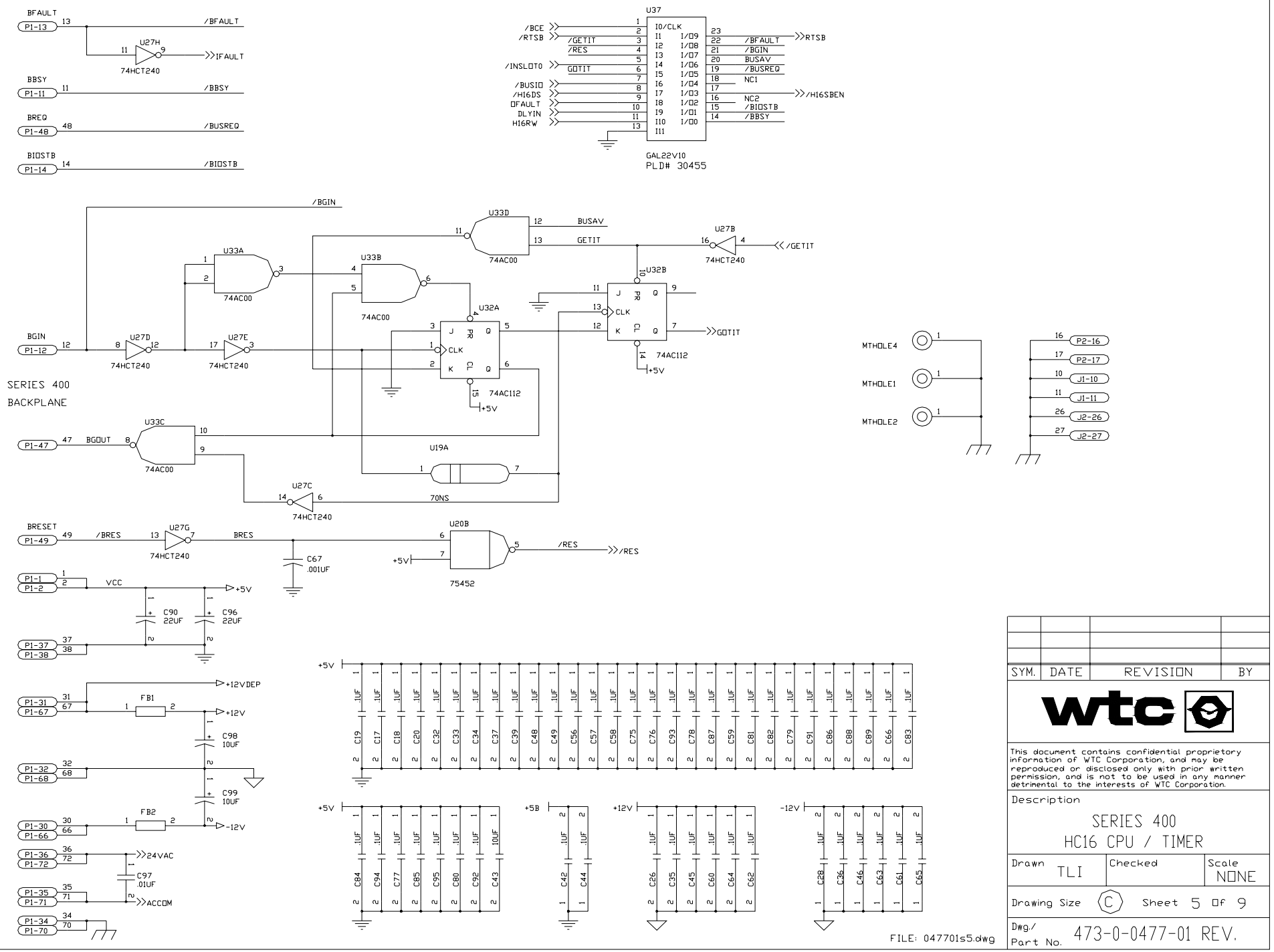
Description

SERIES 400
HC16 CPU / TIMER

Drawn	Checked	Scale
TLI		NONE

Drawing Size C Sheet 4 of 9

Dwg./ Part No. 473-0-0477-01 REV.



SYM.	DATE	REVISION	BY

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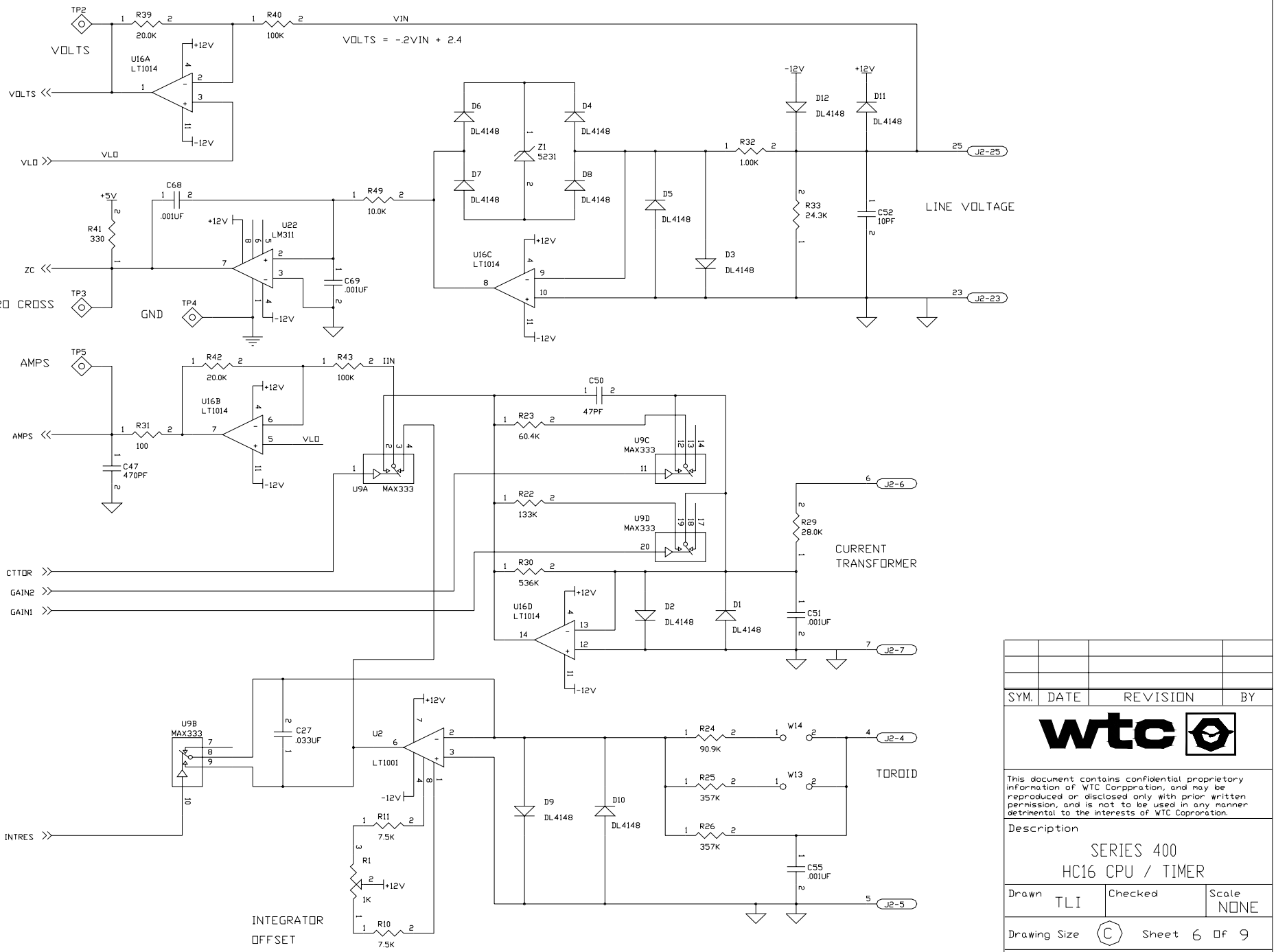
Description

SERIES 400
HC16 CPU / TIMER

Drawn	Checked	Scale
TLI		NONE

Drawing Size C Sheet 5 of 9

Dwg./ Part No. 473-0-0477-01 REV.



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Description

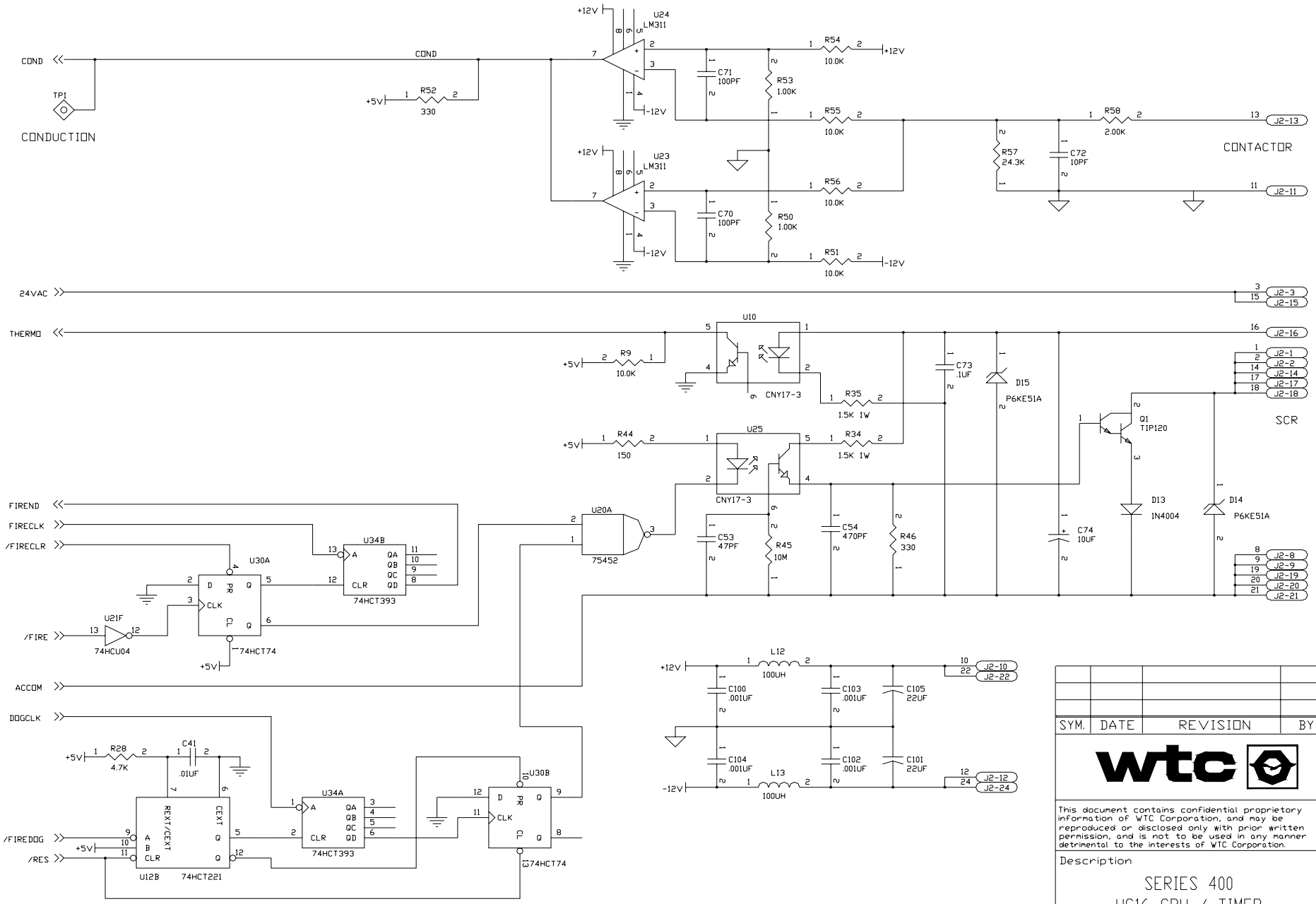
SERIES 400
HC16 CPU / TIMER

Drawn	Checked	Scale
TLI		NONE

Drawing Size C Sheet 6 Of 9

Dwg./ Part No. 473-0-0477-01 REV.

FILE: 047701s6.dwg



SYM.	DATE	REVISION	BY

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Description

SERIES 400
HC16 CPU / TIMER

Drawn	Checked	Scale
TLI		NONE

Drawing Size C Sheet 7 of 9

Dwg./ Part No. 473-0-0477-01 REV.

FILE: 047701s7.dwg

SMT COMPONENTS

ITEM	PART NUMBER	DESCRIPTION	QTY
C1-8,10-13, 16,38,51,55, 67,68,69,100, 102,103,104	SM .001UF 50V 10%	CAPACITOR, CERAMIC	23
C14,15		DO NOT INSTALL	0
C17-21,23,24, 26,28,32-37, 39,42,44-46, 48,49,56-66, 73,75-89,91-95	SM .1UF 50V 10%	CAPACITOR, CERAMIC	54
C22,25	SM 1UF 35V 20%	CAPACITOR, TANTALUM	2
C29,30	SM 22PF 50V 10%	CAPACITOR, CERAMIC	2
C40,41,97	SM .01UF 100V 10%	CAPACITOR, CERAMIC	3
C43,98,99	SM 10UF 20V 20%	CAPACITOR, TANTALUM	3
C47,54,106	SM 470PF 100V 10%	CAPACITOR, CERAMIC	3
C50,53	SM 47PF 100V 10%	CAPACITOR, CERAMIC	2
C52,72	SM 10PF 100V 10%	CAPACITOR, CERAMIC	2
C70,71	SM 100PF 100V 10%	CAPACITOR, CERAMIC	2
C90,96	SM 22UF 25V 20%	CAPACITOR, TANTALUM	2
D1-12	DL4148	DIODE, DL-35	12
L1-8,10	ISC-1812-100UH	INDUCTOR, 100UH SMT	9
L9	IMC-1210-10UH	INDUCTOR, 10UH SMT	1
R2,6,41,46,52	SM 330 OHM 1/8W 5%	RESISTOR	5
R3-5,14,16,18, 19,32,50,53	SM 1.00K 1/8W 1%	RESISTOR	10
R7,58	SM 2.00K 1/8W 1%	RESISTOR	2
R8	SM 3.01K 1/8W 1%	RESISTOR	1
R9,20,21,36, 49,51,54-56	SM 10.0K 1/8W 1%	RESISTOR	9
R10,11	SM 7.5K 1/8W 5%	RESISTOR	2
R12	SM 330K 1/8W 5%	RESISTOR	1
R13,45	SM 10M 1/8W 5%	RESISTOR	2
R15,17,60,61	SM 1.2K 1/8W 1%	RESISTOR	4
R27	SM 5.62K 1/8W 1%	RESISTOR	1
R28	SM 4.7K 1/8W 5%	RESISTOR	1
R31	SM 100 OHM 1/8W 5%	RESISTOR	1
R33,57	SM 24.3K 1/8W 1%	RESISTOR	2
R34,35	SM 1.5K 1W 1%	RESISTOR	2
R37,38,47,48	SM 2.2K 1/8W 5%	RESISTOR	4
R39,42	SM 20.0K 1/8W 1%	RESISTOR	2
R40,43	SM 100K 1/8W 1%	RESISTOR	2
R44	SM 150 OHM 1/8W 5%	RESISTOR	1
R59	SM 2.7 OHM 1/8W 5%	RESISTOR	1
U1	68HC16Z1CFC16	IC, 132 PQFP	1
U13,15	TC551001BFL-70L	IC, 32 SOP	2
U22,23,24	LM311D	IC, 8 SOP	3
U28	IDT7005S55PF	IC, 64 PQFP	1
U32	74AC112D	IC, 16 SOP	1
U33	74AC00D	IC, 14 SOP	1
U39,40,41	74FCT162245	IC, 48 SSOP	3
Y1	MC-306-32.768KHZ	CRYSTAL, 32.768KHz	1
Z1	MMSZ5231BT1	DIODE, 5.1V ZENER, SOD-123	1
Z2,3	MMSZ5242BT1	DIODE, 12V ZENER, SOD-123	2

THRU HOLE COMPONENTS

ITEM	PART NUMBER	DESCRIPTION	QTY
B1	15-51-01-410-000	BATTERY, 3.6V, 1/2AA	1
C9,31,101,105	TVX1E220M	CAPACITOR, 22UF 25V, ALUM. ELEC.	4
C27	ECQ-P1H333GZ	CAPACITOR, .033UF 50V, POLYPROP	1
C74	T350K106K050AS	CAPACITOR, 10UF 50V, TANTALUM	1
D13	1N4004	DIODE	1
D14,15	P6KE51A	DIODE	2
FB1,2	28L0138-A00	FERRITE BEAD	2
J1	745781-2 (-9)	CONN, 9 POS. 'D' RECEPTACLE	1
J2	747846-5	CONN, 25 POS. RT. ANGLE 'D'	1
LED1	HLMP-3507	LED (SEE NOTES)	1
L11-13	5250	INDUCTOR, 100UH	3
P2	747841-6 (-5)	CONN, 15 POS. 'D' PLUG	1
P3,W3-W6,W18	TSW-136-07-G-D	POST, .025 SQ., DUAL ROW	27
P4		DO NOT INSTALL	0
P5		DO NOT INSTALL	0
Q1	TIP120	TRANSISTOR, NPN	1
RP1,3-10	4310R-101-103	RESISTOR ARRAY, 10K x 9, 10P SIP	9
RP2	4310R-101-102	RESISTOR ARRAY, 1K x 9, 10P SIP	1
R1		DO NOT INSTALL	0
R22	MF 133K 1/8W 1%	RESISTOR	1
R23	MF 60.4K 1/8W 1%	RESISTOR	1
R24	MF 90.9K 1/8W 1%	RESISTOR	1
R25,26	MF 357K 1/8W 1%	RESISTOR	2
R29	MF 28.0K 1/8W 1%	RESISTOR	1
R30	MF 536K 1/8W 1%	RESISTOR	1
SW1	76SB08S	SWITCH, 8P SPST	1
TP1-6, W12,13,14	TSW-136-07-G-S	POST, .025 SQ., SINGLE ROW	13
T1,2	PE-61008	TRANSFORMER, 1:1:1	2
U2	LT1001ACNS	IC	1
U3	REF-02CN8	IC	1
U4,29,37,38	GAL22V10-15	IC (SEE NOTES)	4
U5	75173	IC	1
U6	75174	IC	1
U7,8	27C010-12	IC (SEE NOTES)	2
U9	MAX333CPP	IC	1
U10,25	CNY17-3	OPTOCOUPLER (SEE NOTES)	2
U11	Z84C4206PEC	IC (SEE NOTES)	1
U12	74HCT221	IC	1
U14	DS1210	IC	1
U16	LT1014	IC	1
U17	65C22P4	IC (SEE NOTES)	1
U18	X28C256P-25	IC (SEE NOTES)	1
U19	DS1013M-70	IC	1
U20,36	75452BP	IC	2
U21	74HCU04	IC	1
U26,30	74HCT74	IC	2
U27	74HCT240	IC	1
U31	74HCT86	IC	1
U34	74HCT393	IC	1
U35	74HC4040	IC	1
W15,16,17		DO NOT INSTALL	0
Y2	MP1-2.4576	CRYSTAL, 2.4576MHz	1

SYM.	DATE	REVISION	BY

wtc

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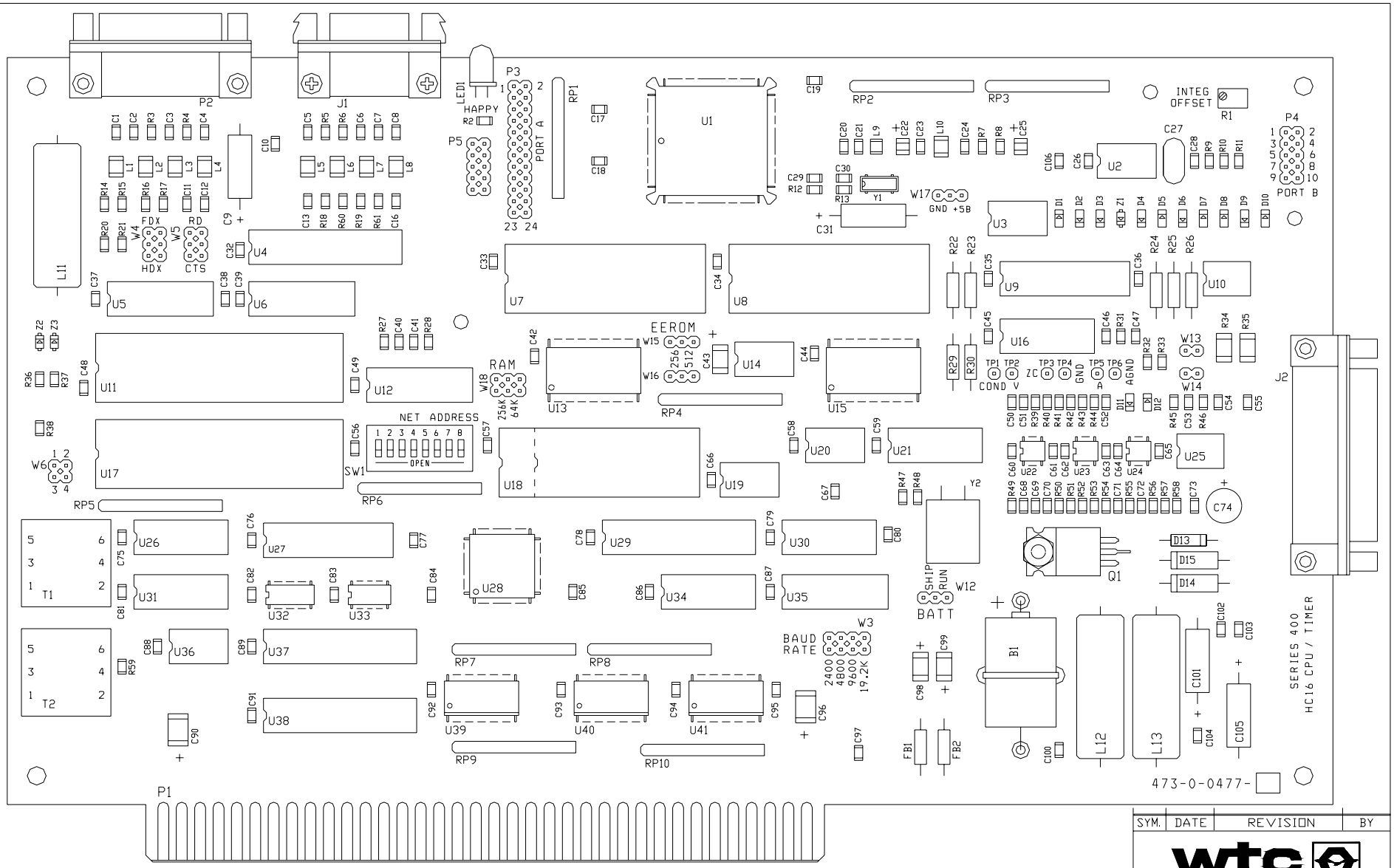
Description

SERIES 400
HC16 CPU / TIMER

Drawn	Checked	Scale
TLI		NONE

Drawing Size (C) Sheet 8 OF 9

Dwg./ Part No. 473-0-0477-01 REV.



SYM.	DATE	REVISION	BY

wtc

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Description

SERIES 400
HC16 CPU / TIMER

Drawn	Checked	Scale

Drawing Size (C) Sheet 9 of 9

Dwg./ Part No. 473-0-0477-01 REV.

15.0 Detailed Sequential Instructions

INDEX OF SEQUENTIAL INSTRUCTIONS
Sorted by code number

CODE#	INSTRUCTION	PAGE
1	Initial Squeeze	SEC 2-1
2	Squeeze	SEC 2-3
3	Preheat	SEC 2-5
4	Cool	SEC 2-7
5	Slope	SEC 2-9
6	Weld	SEC 2-11
7	Postheat	SEC 2-13
8	Hold	SEC 2-15
9	Off Repeat	SEC 2-17
10	Off Single	SEC 2-19
11	Wait for (ccc) Cycles	SEC 2-21
12	Wait for Input (xxx) to be True	SEC 2-23
13	Wait for Input (xxx) to be Not true	SEC 2-25
14	Wait for Input (xxx) and Input (xxx) to be True	SEC 2-27
15	Wait for Input (xxx) or Input (xxx) to be True	SEC 2-29
16	Output (xxx) On	SEC 2-31
17	Output (xxx) Off	SEC 2-33
18	Output (xxx) If (xxx) And (xxx) True	SEC 2-35
19	Output (xxx) If (xxx) Or (xxx) True	SEC 2-37
20	Water Valve	SEC 2-39
21	Pressure Output	SEC 2-41
22	Window High Current Low Current	SEC 2-43
23	Precompression	SEC 2-45
24	MC Contactor	SEC 2-47
25	Pulse with Cool	SEC 2-49
26	Heat Until (xxx)	SEC 2-51
27	Remote Heat	SEC 2-53
28	Remote Heat and Time	SEC 2-55
29	Remote Wait	SEC 2-57
PLC 18	Multiplex Thumbwheels	SEC 2-59
30	Pressure Switch	SEC 2-61
31	Second Stage	SEC 2-63
32	NEMA Second Stage	SEC 2-65
33	Squeeze Delay	SEC 2-67
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Sorted by code number

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43	Index	SEC 2-87
44	Production Counter	SEC 2-89
45	Assign Stepper Program	SEC 2-91
46	Reweld	SEC 2-93
47	Tip Touch Test	SEC 2-95
48	Tips Stuck Test	SEC 2-97
49	Weld Schedule	SEC 2-99
50	No Operation	SEC 2-101
51	Contactor Select	SEC 2-103
52	Heat Reset (delayed firing)	SEC 2-105
53	Heat Faults On	SEC 2-107
54	Heat Faults Off	SEC 2-109
55	Wait For Line Volts	SEC 2-111
56	Counter	SEC 2-113
57	Transformer Turns Ratio	SEC 2-115
58	Window Compare	SEC 2-117
59	Call Weld Schedule	SEC 2-119
60	Go To	SEC 2-121
61	If (xxx) True Go To (aa-aa)	SEC 2-123
62	If (xxx) Not True Go To (aa-aa)	SEC 2-125
63	If (xxx) And (xxx) Go To (aa-aa)	SEC 2-127
64	If (xxx) Or (xxx) Go To (aa-aa)	SEC 2-129
65	Call (aa-aa) (subroutine)	SEC 2-131
66	Return	SEC 2-133
67	Loop Counter	SEC 2-135
68	Repeat (a-aa)	SEC 2-137
70	Print Weld Data	SEC 2-139
71	Print Time and Date	SEC 2-141
72	SPC Weld Data	SEC 2-143
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74	Window HI hh% Lo HH%	SEC 2-147
75	Reset Stepper xx To Step y	SEC 2-149
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80	Preheat at Constant Current	SEC 2-153
81	Slope at Constant Current	SEC 2-155
82	Weld at Constant Current	SEC 2-157
83	Postheat at Constant Current	SEC 2-159
84	Heat Until Input at Constant Current	SEC 2-161
85	Seambeat at Constant Current	SEC 2-163
86	Seam-nonbeat at Constant Current	SEC 2-165
87	Temper at Constant Current	SEC 2-167
88	Remote Current (REMI)	SEC 2-169
89	Remote Current and Time (REMIT)	SEC 2-171

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65	Call (aaa) (subroutine)	SEC 2-131
59	Call Weld Schedule	SEC 2-119
51	Contactor Select	SEC 2-103
4	Cool	SEC 2-7
56	Counter	SEC 2-113
36	Delay	SEC 2-73
42	EOH (End Of Hold)	SEC 2-85
34	Flash Heat	SEC 2-69
73	Footprint Weld Data	SEC 2-145
39	Forge Valve/Delay	SEC 2-79
60	Go To	SEC 2-121
54	Heat Faults Off	SEC 2-109
53	Heat Faults On	SEC 2-107
52	Heat Reset (delayed Firing)	SEC 2-105
84	Heat Until Input at Constant Current	SEC 2-161
26	Heat Until (xxx)	SEC 2-51
8	Hold	SEC 2-15
62	If (xxx) Not True Go To (aa-aa)	SEC 2-125
61	If (xxx) True Go To (aa-aa)	SEC 2-123
63	If (xxx) And (xxx) Go To (aa-aa)	SEC 2-127
64	If (xxx) Or (xxx) Go To (aa-aa)	SEC 2-129
43	Index	SEC 2-87
1	Initial Squeeze	SEC 2-1
67	Loop Counter	SEC 2-135
24	MC Contactor	SEC 2-47
PLC 18	Multiplex Thumbwheels	SEC 2-59
32	NEMA Second Stage	SEC 2-65
50	No Operation	SEC 2-101
9	Off Repeat	SEC 2-17
10	Off Single	SEC 2-19
17	Output (xxx) Off	SEC 2-33
16	Output (xxx) On	SEC 2-31
18	Output (xxx) If (xxx) And (xxx) True	SEC 2-35
19	Output (xxx) If (xxx) Or (xxx) True	SEC 2-37
83	Postheat at Constant Current	SEC 2-159
7	Postheat	SEC 2-13
23	Precompression	SEC 2-45
80	Preheat at Constant Current	SEC 2-153
3	Preheat	SEC 2-5
21	Pressure Output	SEC 2-41
30	Pressure Switch	SEC 2-61

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Sorted by instruction name

CODE#	INSTRUCTION	PAGE
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70	Print Weld Data	SEC 2-139
44	Production Counter	SEC 2-89
25	Pulse with Cool	SEC 2-49
40	Quench	SEC 2-81
88	Remote Current (REMI)	SEC 2-169
89	Remote Current and Time (REMIT)	SEC 2-171
28	Remote Heat and Time	SEC 2-55
27	Remote Heat	SEC 2-53
29	Remote Wait	SEC 2-57
68	Repeat (a-aa)	SEC 2-137
75	Reset Stepper xx To Step y	SEC 2-149
66	Return	SEC 2-133
46	Reweld	SEC 2-93
85	Seambeat at Constant Current	SEC 2-163
37	Seam-Beat	SEC 2-75
38	Seam nonbeat	SEC 2-77
86	Seam-nonbeat at Constant Current	SEC 2-165
31	Second Stage	SEC 2-63
81	Slope at Constant Current	SEC 2-155
5	Slope	SEC 2-9
72	SPC Weld Data	SEC 2-143
33	Squeeze Delay	SEC 2-67
2	Squeeze	SEC 2-3
87	Temper at Constant Current	SEC 2-167
41	Temper	SEC 2-83
76	Tip Force	SEC 2-151
48	Tips Stuck Test	SEC 2-97
47	Tips Touch Test	SEC 2-95
57	Transformer Turns Ratio	SEC 2-115
35	Upset Heat	SEC 2-71
14	Wait for Input (xxx) and Input (xxx) to be True	SEC 2-27
15	Wait for Input (xxx) or Input (xxx) to be True	SEC 2-29
13	Wait for Input (xxx) to be Not True	SEC 2-25
12	Wait for Input (xxx) to be True	SEC 2-23
55	Wait for Line Volts	SEC 2-111
11	Wait for (ccc) Cycles	SEC 2-21
20	Water Valve	SEC 2-39
82	Weld at Constant Current	SEC 2-157
49	Weld Schedule	SEC 2-99
6	Weld	SEC 2-11
58	Window Compare	SEC 2-117
22	Window High Current Low Current	SEC 2-43
74	Window High hh% Low hh%	SEC 2-147

THIS PAGE IS INSERTED TO MAKE THE FOLLOWING PAGES SEQUENCE SO THE INSTRUCTION DESCRIPTIONS ARE ON THE LEFT AND THE ASSOCATED INSTRUCTION FLOW CHART ON THE RIGHT.

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
01	Initial Squeeze	Yes	00-99 Cycles

HEAT RANGE	COUNT	PRESET	CURRENT WINDOW CHECK
None	Once per repeated sequence.	1	No

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Only on the first pass in repeat mode	Output user assigned	Output defaults to bit #17 but may be reassigned to any output or internal bit. Initial squeeze must be programmed before squeeze in a repeat mode.

DESCRIPTION

A squeeze time at the start of a repeated sequence or the only squeeze time in a single sequence. Used to permit the initial movement of electrodes through their greater starting distance. Initial squeeze time should be greater than subsequent squeeze times in the repeated sequence.

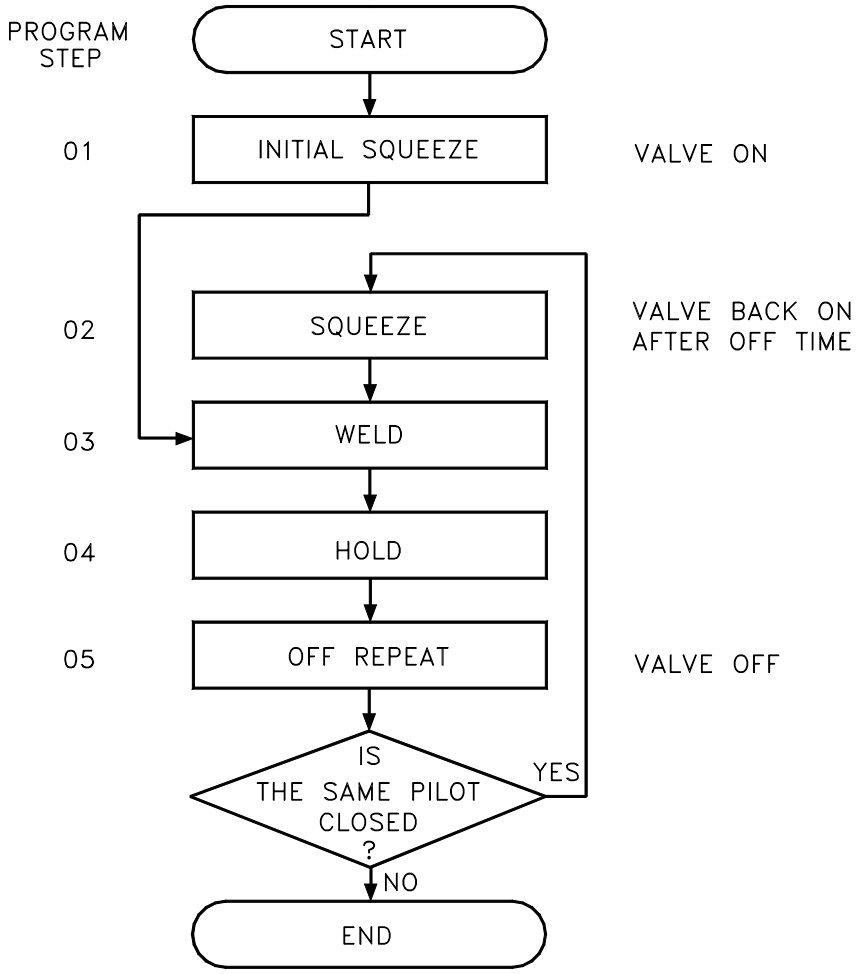
Display:

```
         1111111111222222222333
12345678901234567890123456789012
 1- 1 INIT SQUEEZE OUT xxx  ccCY
         At instruction entry 01
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 22	Instruction description
D	24, 26	User output bit assignment
E	>29, 30	Initial squeeze time 00-99 cycles

FLOW CHART EMPLOYING INITIAL SQUEEZE
IN A SIMPLE SEQUENCE PROGRAM



INITSQZ.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
02	Squeeze	Yes	00-99 Cycles

HEAT RANGE	COUNT	PRESET	CURRENT WINDOW CHECK
None	N/A	N/A	No

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass through the sequence, except first pass if Initial Squeeze is programmed.	Output user assigned	Output defaults to bit #17 but may be reassigned by the user to any output or internal bit.

DESCRIPTION

Squeeze time is the time interval between the initial application of electrode force on the work and the first application of current in a welding sequence. This delay time is to assure complete electrode movement and closure. If Squeeze time is too short, expulsion of metal may occur at the start of the weld interval.

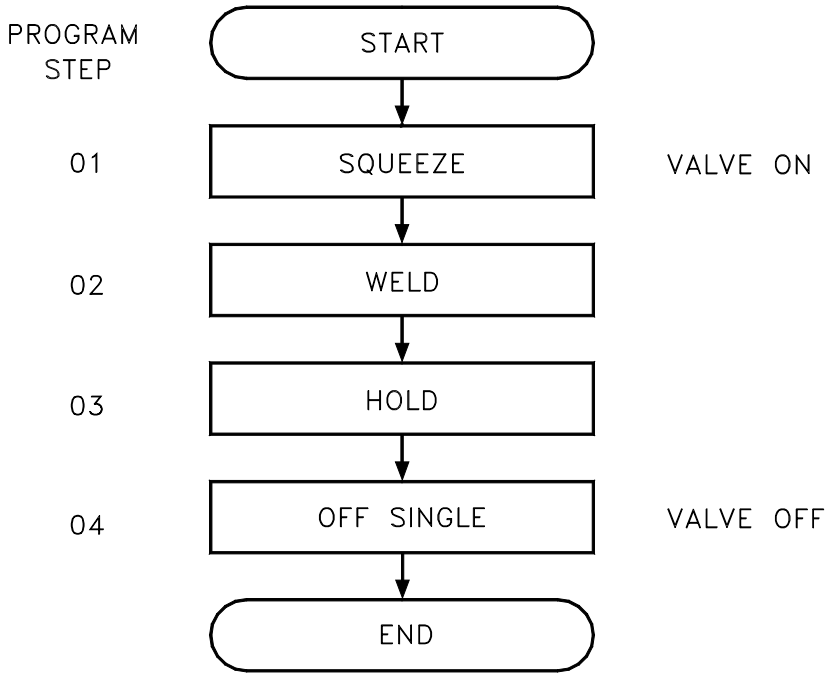
Display:

```
         1111111111222222222333
12345678901234567890123456789012
 1- 1 SQUEEZE      OUT xxx  ccCY
         At instruction entry 02
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 22	Instruction description
D	24, 26	User output bit assignment
E	>29, 30	Squeeze time 00-99 cycles

FLOW CHART EMPLOYING SQUEEZE
IN A SIMPLE SEQUENCE PROGRAM



SQUEEZE.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
03	Preheat	Yes	00-99 Cycles

HEAT RANGE	COUNT	PRESET	CURRENT WINDOW CHECK
20-99% of Available current	N/A	N/A	Yes.

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	Firing pulse for each 1/2 cycle of Preheat.	User may enter a preheat ID# in position nn, entered it remains blank. Preheat will not increment stepper programs.

DESCRIPTION

Preheat current is an impulse or series of impulses of current prior to and separate from the welding current. This current is considered preparatory and must not cause the faying surfaces to be destroyed. A simple check for over heating is to "zero out" weld time and make a weld. The parts should not be fused.

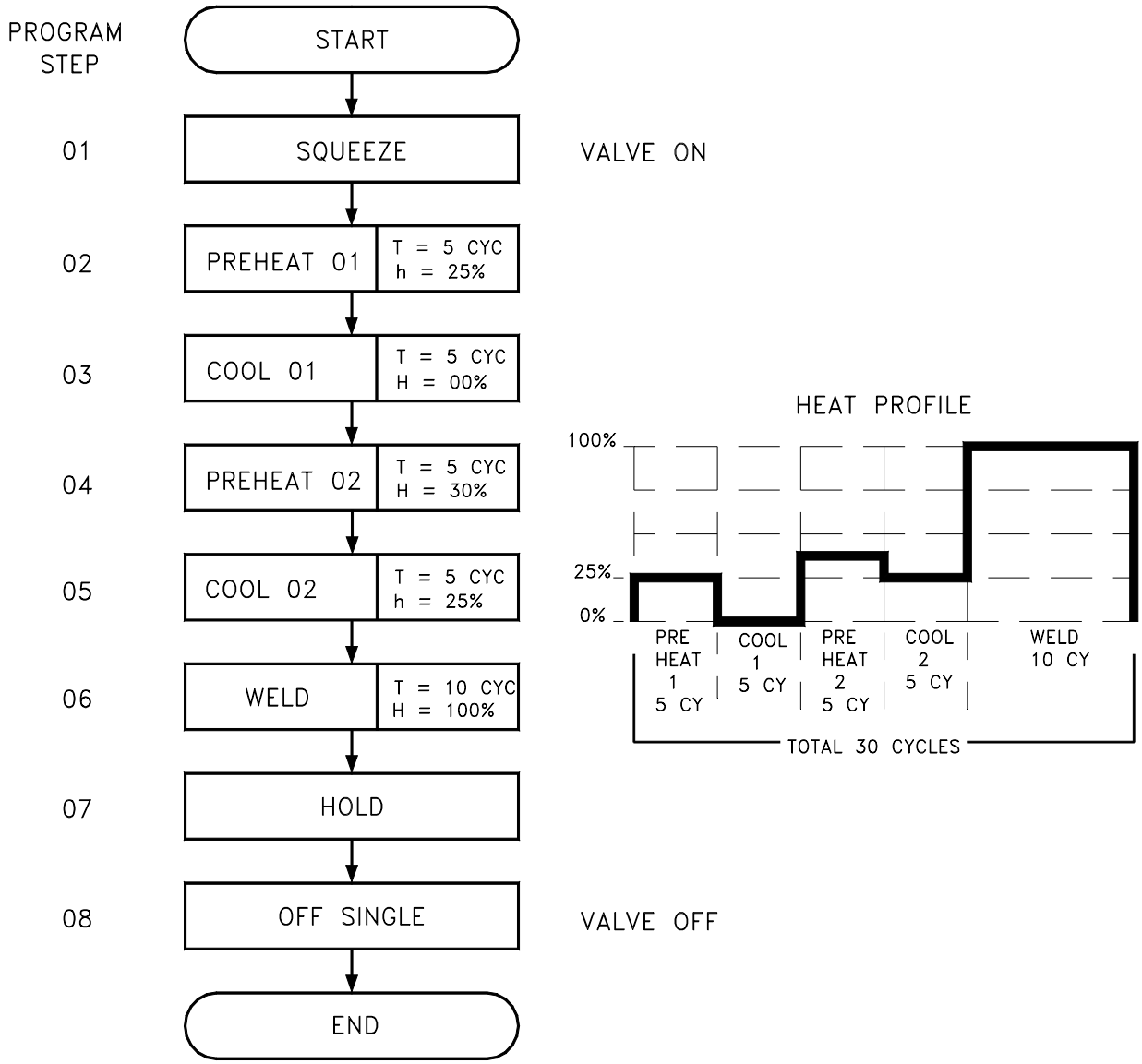
Display:

```
         11111111112222222222333
12345678901234567890123456789012
 1- 4 PREHEAT nn  hh% (mm%) ccCY
         At instruction entry 03
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 13	Instruction description
D	15, 16	User optional Preheat number
E	>19, 20	Percent of available Preheat current
F	24, 25	Preheat percent with stepper and/or AVC influence (actual heat applied to firing circuit)
G	29, 30	Preheat timing in line cycles

FLOW CHART EMPLOYING PREHEAT
IN A SIMPLE SEQUENCE PROGRAM



PREHEAT.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
04	Cool	Yes	00-99 Cycles

HEAT RANGE	COUNT	PRESET	CURRENT WINDOW CHECK
20-99% of Available current 00% = NO CURRENT	N/A	N/A	Yes

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	Firing pulse for each 1/2 cycle if programmed 20-99% heat	User may enter a Cool ID # in position nn, if not entered it remains blank. Cool will not increment stepper programs. Defaults to 00% heat.

DESCRIPTION

In multiple impulse and seam welding cool time is the time interval between successive heat times. By programming Weld (01), Cool (01), Weld (02), Cool (02), Weld (03), etc. pulsation welding may be accomplished. Also see instructions 25, 67 and 68 for other modes of pulsation.

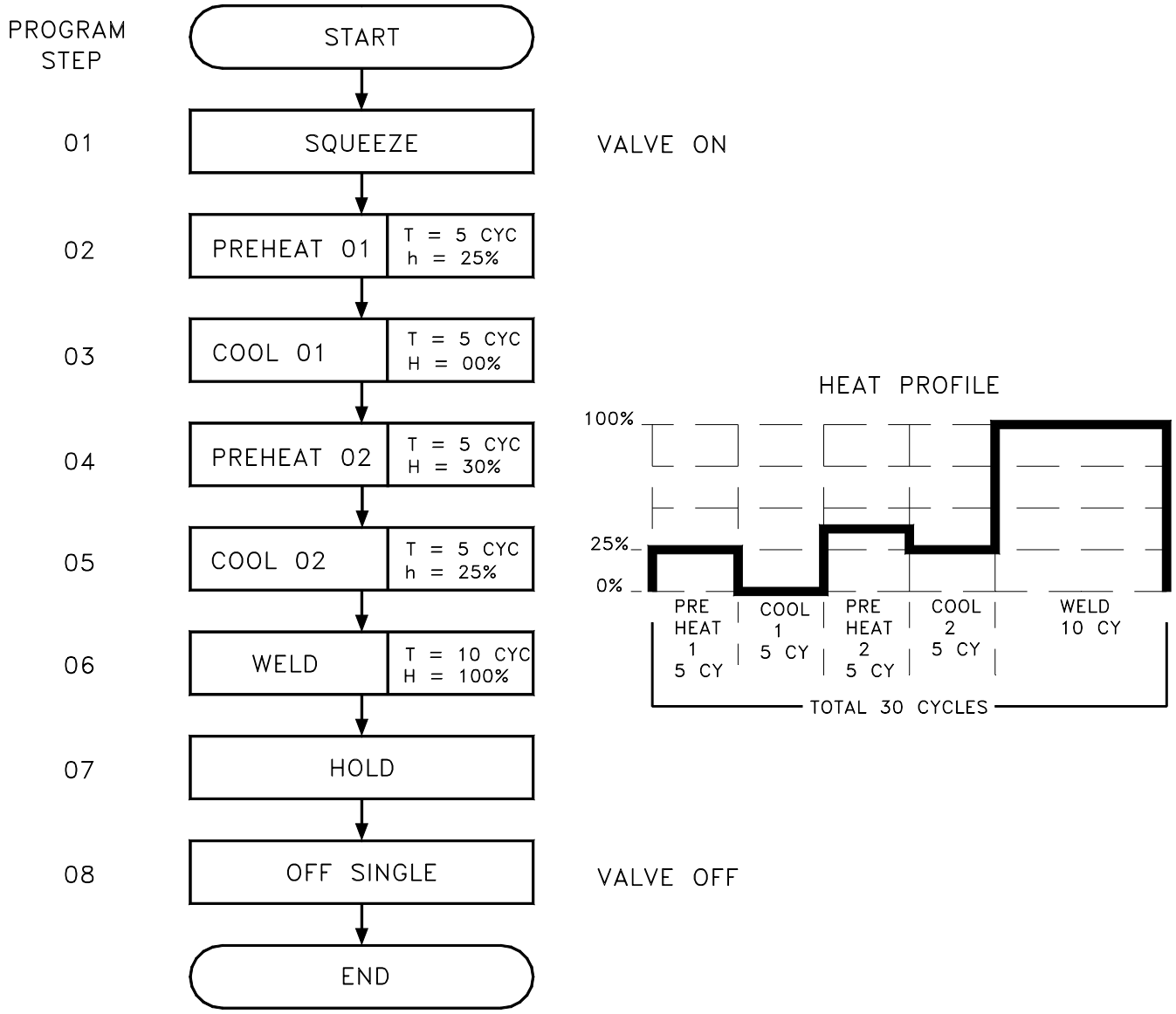
Display:

```
         1111111111222222222333
12345678901234567890123456789012
 1- 3 COOL nn hh% (mm%)     ccCY
         At instruction entry 04
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 10	Instruction description
D	12, 13	User optional Cool number
E	15, 16	Percent of available cool current
F	>29, 30	Cool timing in line cycles
G	20, 21	Cool percent with stepper and/or AVC influence (actual heat applied to firing circuit)

FLOW CHART EMPLOYING COOL IN A SIMPLE SEQUENCE PROGRAM



COOL.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
05	Slope	Yes	00-99 Cycles

HEAT RANGE	COUNT	PRESET	CURRENT WINDOW CHECK
20-99% of Available current	N/A	N/A	Yes

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	Firing pulse for each 1/2 cycle if programmed 20-99% heat	Slope may be programmed to be Up or Down slope by changing the Initial and Final percent values.

DESCRIPTION

Slope time is the time during which the percent of available welding current continuously increases or decreases. If it increases from the beginning of weld current it is considered up slope. If the current increases at the end of the weld period it is considered downslope.

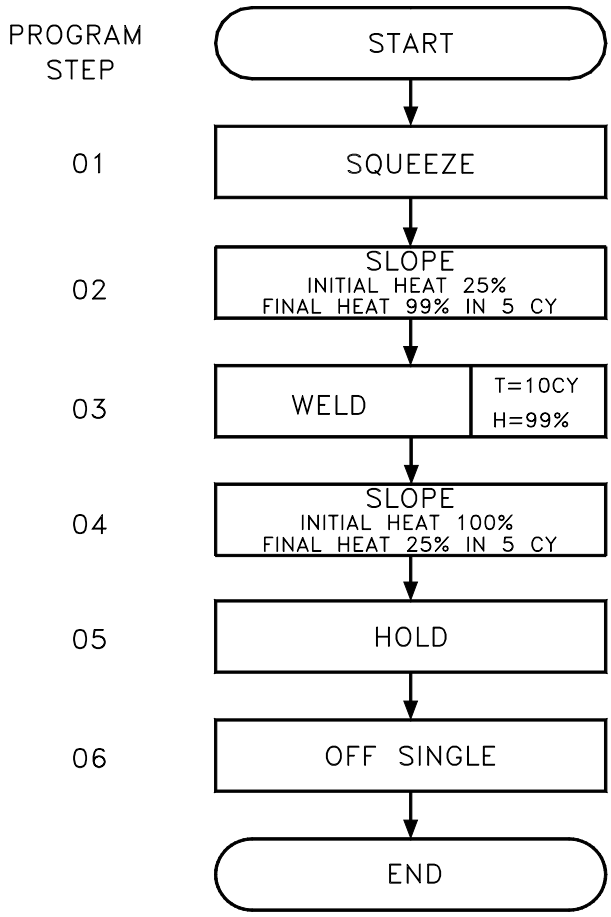
Display:

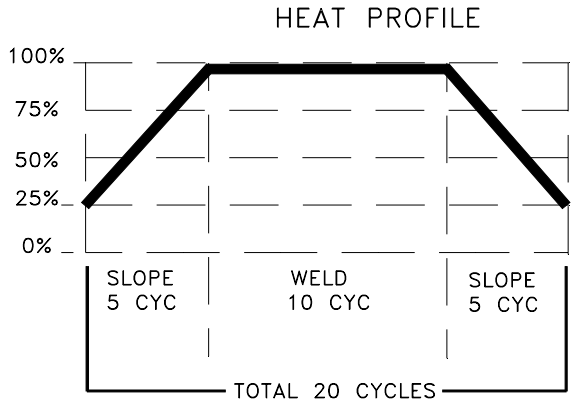
```
         1111111111222222222233
12345678901234567890123456789012
 1- 4 SLOPE I-hh% F-hh%     ccCY
         At instruction entry 05
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 11	Instruction description
D	15, 16	Percent of available Initial current
E	21, 22	Percent of available Final current
F	>29, 30	Slope time in line cycles

FLOW CHART EMPLOYING SLOPE IN A SIMPLE SEQUENCE PROGRAM





SLOPE.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
06	Weld	Yes	00-99 Cycles

HEAT RANGE	COUNT	PRESET	CURRENT WINDOW CHECK
20-99% of Available current	N/A	N/A	Yes.

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	Firing pulse for each 1/2 cycle if programmed 20-99% heat	User may enter a Weld ID # in position nn, if not entered it remains blank. Every Weld instruction will increment stepper programs applied.

DESCRIPTION

The Weld function is the time current is passed from the beginning of welding to the beginning of post heat time. It is the period of time the actual fusion of metal takes place by the application of a high current through the resistance of work pieces. Current should be applied until a point short of metal expulsion. Expulsion should never occur, it is an indication of too much weld heat or time.

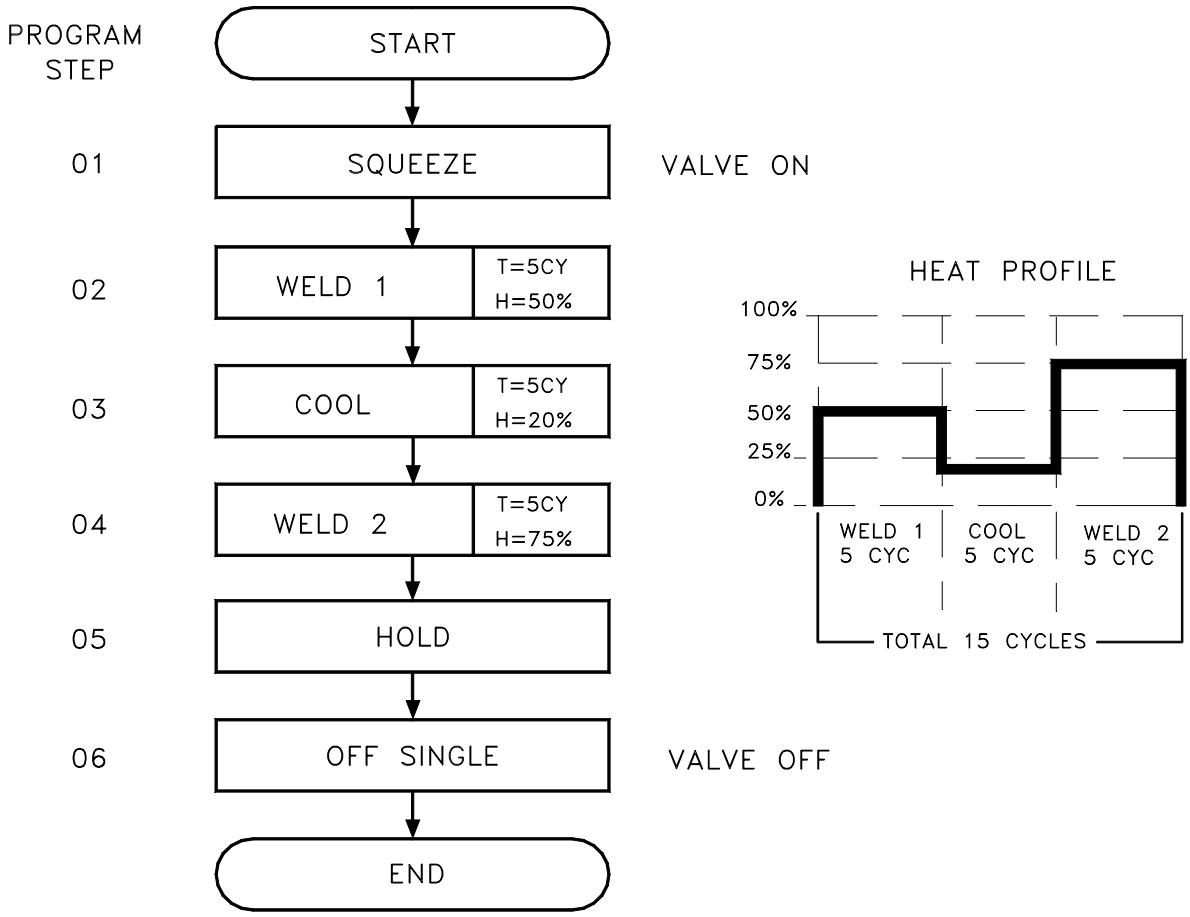
Display:

```
         1111111111222222222333
12345678901234567890123456789012
 1- 3 WELD nn hh% (mm%)     ccCY
         At instruction entry 06
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 10	Instruction description
D	12, 13	Weld number (Necessary for NEXT WELD Key to work)
E	>15, 16	Percent of available weld current
F	20, 21	Weld percent with stepper and/or AVC influence (actual heat applied to firing circuit)
G	29, 30	Weld timing in line cycles

FLOW CHART EMPLOYING WELD IN A SIMPLE SEQUENCE PROGRAM



WELD.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
07	Postheat	Yes	00-99 Cycles

HEAT RANGE	COUNT	PRESET	CURRENT WINDOW CHECK
20-99% of Available current	N/A	N/A	Yes

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	Firing pulse for each 1/2 cycle if programmed 20-99% heat	User may enter a Postheat ID # in position nn, if not entered it remains blank. Postheat will not increment stepper programs.

DESCRIPTION

Post heat is a function which applies current to the weld nugget after the weld function is over. It is used to condition the nugget by controlling the cooling process to prevent crystallization and cracking.

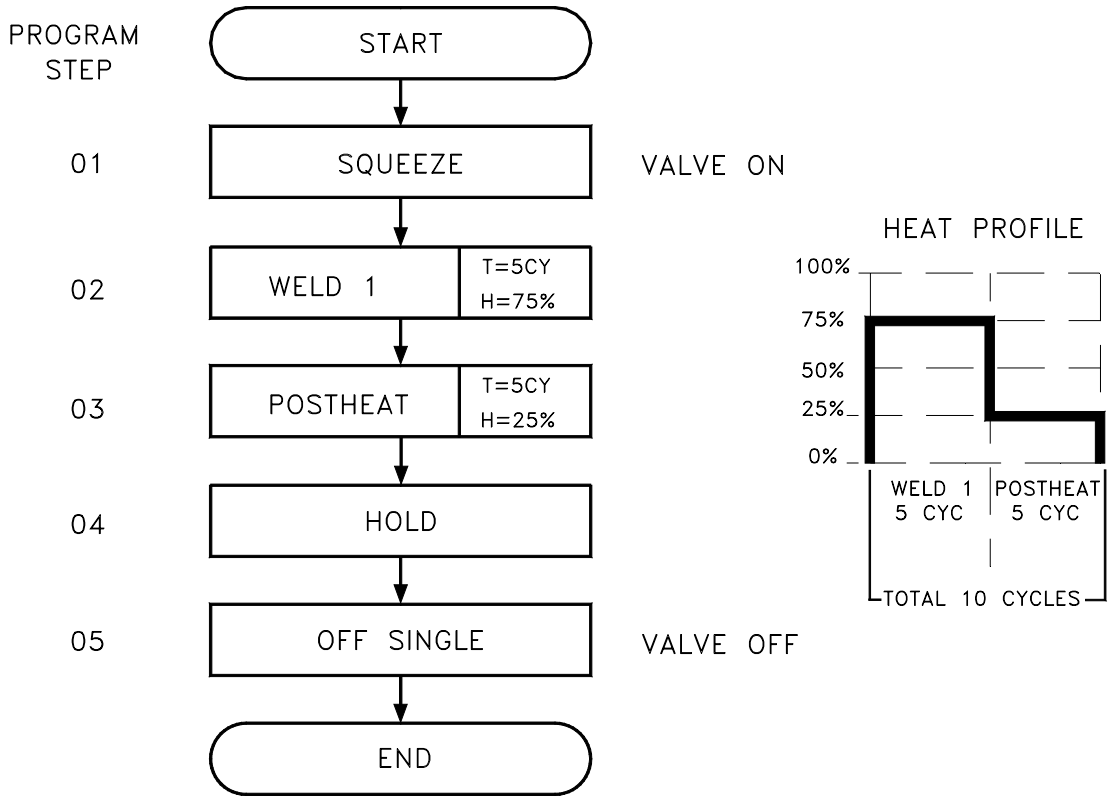
Display:

```
         1111111111222222222333
12345678901234567890123456789012
 1- 3 POSTHEAT nn hh% (mm%) ccCY
         At instruction entry 07
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 14	Instruction description
D	16, 17	User optional Postheat number
E	>19, 20	Percent of available Postheat current
F	24, 25	Postheat percent with stepper and/or AVC influence (actual heat applied to firing circuit)
G	29, 30	Postheat timing in line cycles

FLOW CHART EMPLOYING POSTHEAT
IN A SIMPLE SEQUENCE PROGRAM



POSTHEAT.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
08	Hold	Yes	00-99 Cycles

HEAT RANGE	COUNT	PRESET	CURRENT WINDOW CHECK
None	N/A	N/A	No

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	None	None

DESCRIPTION

In spot and projection welding hold time is the time during which force is applied for some time after Weld or Postheat current ceases. It is
used to cool and solidify the weld nugget.

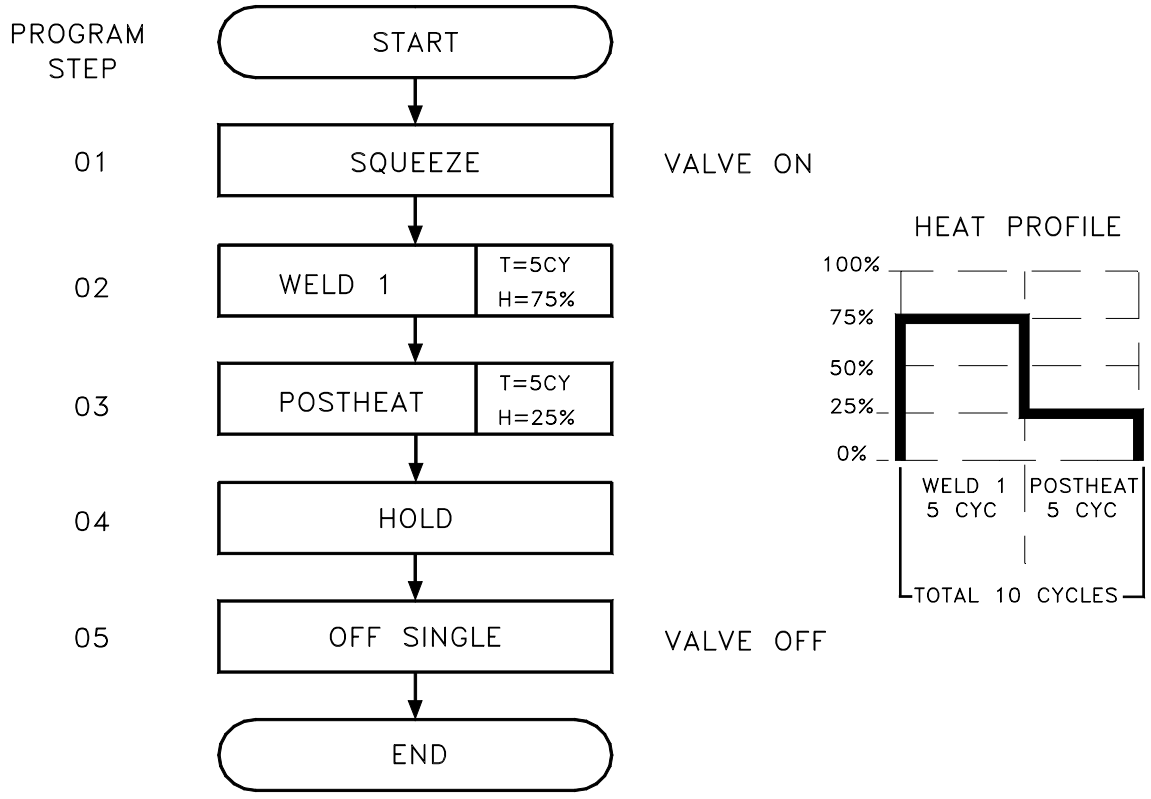
Display:

```
         1111111111222222222233
12345678901234567890123456789012
 1- 3 HOLD                  ccCY
         At instruction entry 08
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 10	Instruction description
D	>29, 30	Hold timing in line cycles

FLOW CHART EMPLOYING HOLD
IN A SIMPLE SEQUENCE PROGRAM



HOLD.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
09	Off Repeat	Yes	00-99 Cycles

HEAT RANGE	COUNT	PRESET	CURRENT WINDOW CHECK
None	N/A	N/A	No

I/O	EXECUTED	SPECIAL CONSIDERATIONS
Turns off all output bits left programmed on in the sequence program. Will not turn off bits assigned on by the ladder logic program, Water Valve, or End of Hold instructions if used.	Each Pass	Cannot turn off more then 20 bits. If attempted, sequencer fault at the Off instruction will result. If more 20 bits must be turned off use Output xxx Off for the remainder.

DESCRIPTION

Off Repeat time is the time during which the electrodes are off the work while the weld cycle is being repeated. It is used in hand held gun applications where the pilot is maintained for repetition. Off time is equal to the "stitch length" between spots as the gun is moved by the operator. This instruction first turns off all bits set at this time, then starts Off Time. After off time is over a pilot check is made. If the same pilot is made the same sequence is run again starting at step 1 (Except if Initial Squeeze). If any other valid pilot is made then that sequence is run.

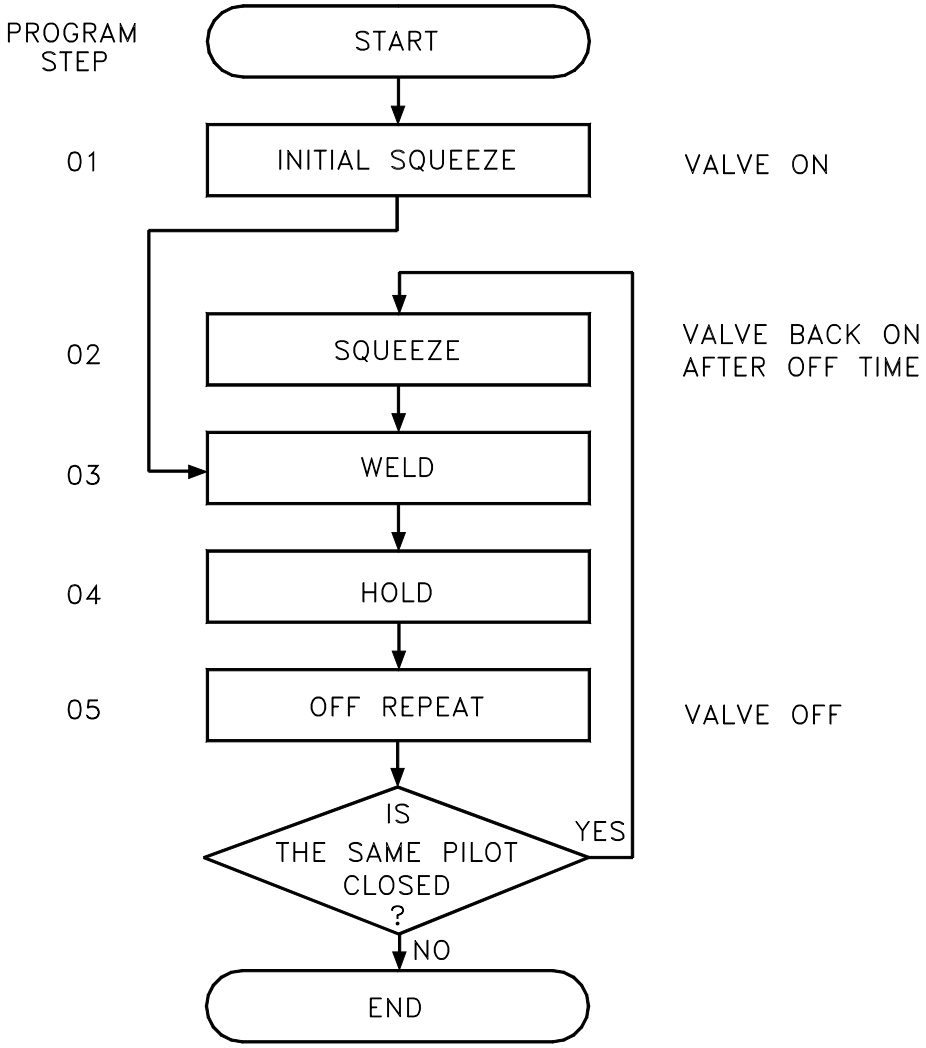
Display:

```
         1111111111222222222333
12345678901234567890123456789012
 1- 5 OFF REPEAT MODE       ccCY
         At instruction entry 09
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 21	Instruction description
D	>29, 30	Off time in line cycles

FLOW CHART EMPLOYING OFF REPEAT
IN A SIMPLE SEQUENCE PROGRAM



OFFRPT.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
10	Off Single	Yes	None

HEAT RANGE	COUNT	PRESET	CURRENT WINDOW CHECK
None	N/A	N/A	No

I/O	EXECUTED	SPECIAL CONSIDERATIONS
Turns off all output bits left programmed on in the sequence program. Will not turn off bits assigned on by the ladder logic program, Water Valve, or End of Hold instructions if used.	Each Pass	Cannot turn off more then 20 bits. If attempted, sequencer fault at the Off instruction will result. If more 20 bits must be turned off use Output xxx Off for the remainder.

DESCRIPTION

Off Single time is the time during which the electrodes are off the work. This term is generally applied where the weld cycle is NOT repetitive, hence in single no time data is applicable. Cycle repetition must be accomplished by removal and re-application of the pilot. Used in machine and robot applications.

If a pilot is applied at the off instruction, a message "Pilot not Clear" will be displayed and the control will refuse to continue. This is **not** a control fault, therefore the control will not respond to pressing the FAULT RESET key. The pilot must be removed then re-applied **or** the FUNCTION then CLEAR keys on the data entry panel may be pressed to accept the applied pilot.

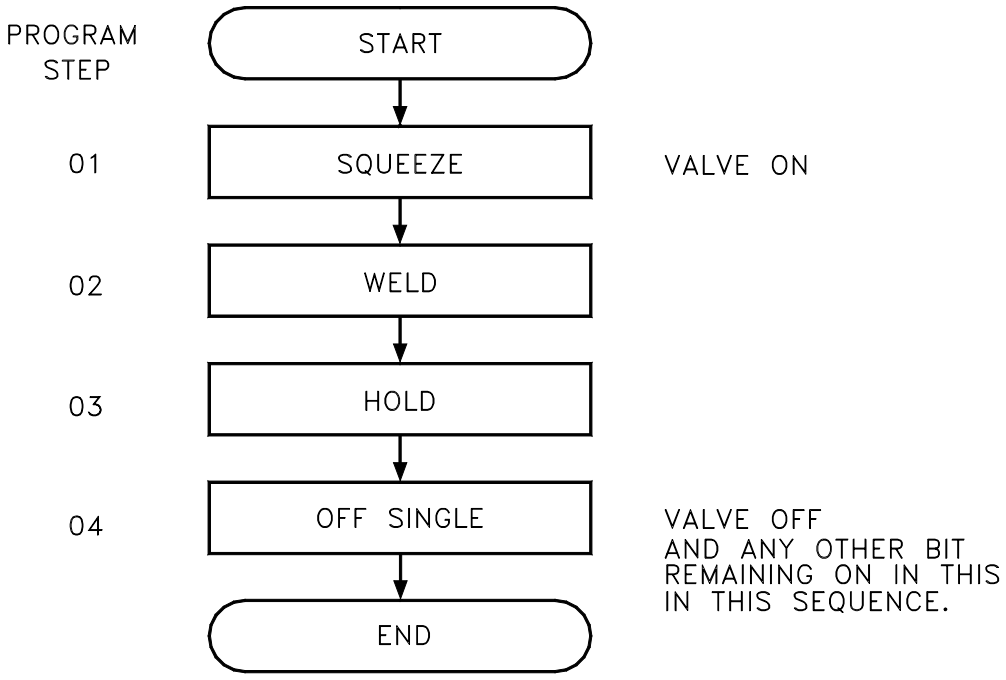
Display:

```
         11111111112222222222333
12345678901234567890123456789012
 1- 4 OFF SINGLE MODE
         At instruction entry 10
```

Data fields:

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 21	Instruction description

FLOW CHART EMPLOYING OFF SINGLE
IN A SIMPLE SEQUENCE PROGRAM



OFFSINGL.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
11	Wait	No	000-999 Cycles

HEAT RANGE	COUNT	PRESET	CURRENT WINDOW CHECK
None	N/A	N/A	No

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	None	None

DESCRIPTION

This instruction provides a simple delay of 000 to 999 line cycles.

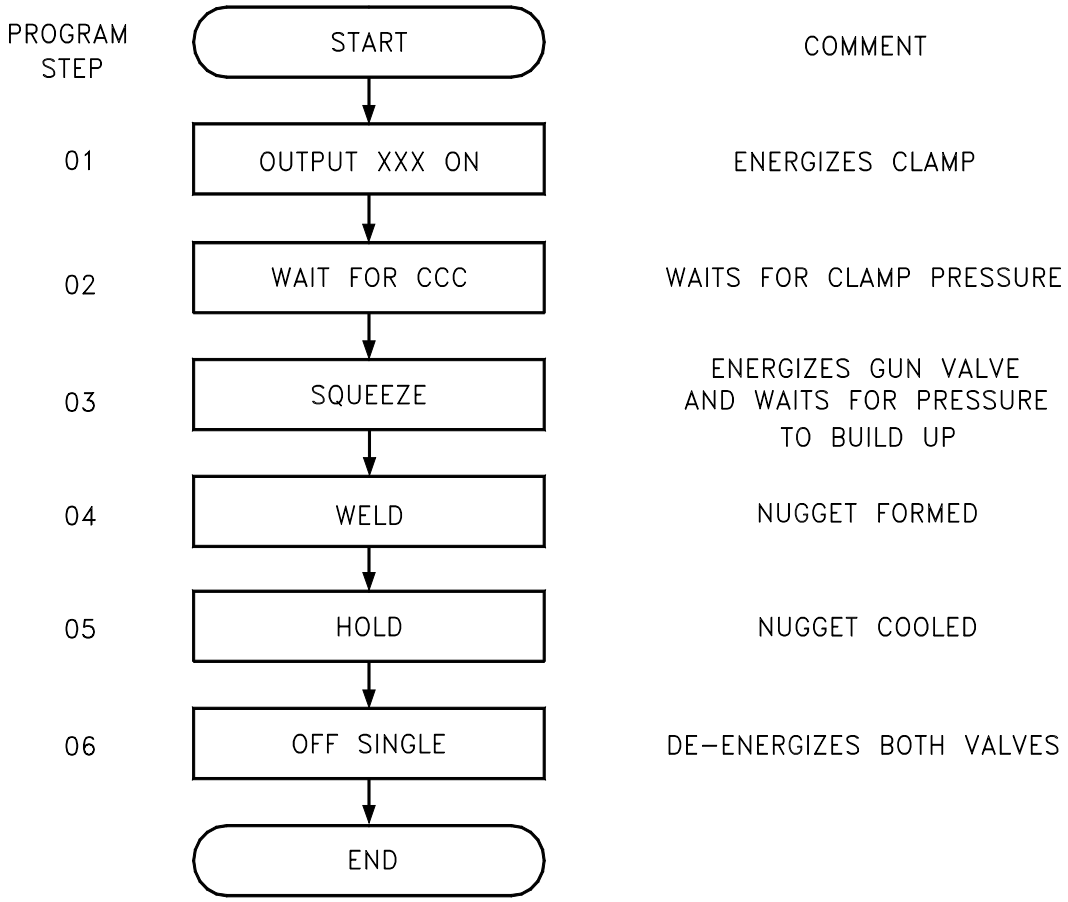
Display:

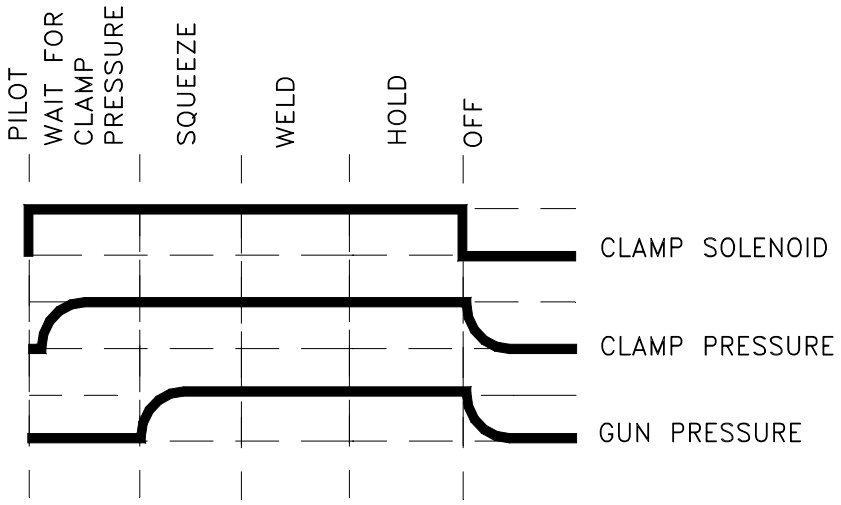
```
         11111111112222222222333
123456789012345678901234567890 12
 1- 2 WAIT FOR             cccCY
At instruction entry 11
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 14	Instruction description
D	>28, 30	Wait timing in line cycles 000-999 line cycles

FLOW CHART EMPLOYING WAIT
IN A SIMPLE SEQUENCE PROGRAM





WAIT.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
12	Wait for input xxx to be true	No	0-999 cycleoverride 0=infinity

HEAT RANGE	COUNT	PRESET	CURRENT WINDOW CHECK
None	N/A	N/A	No

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	Assignable bit	In run mode Input xxx=0 will be displayed until the bit becomes a 1 and the sequence continues.

DESCRIPTION

This instruction provides a halt in sequence flow until a programmable input is true (any bit). While waiting for the bit to become true, "Input xxx=0" will be displayed. The message will remain until the bit becomes a 1 which causes the sequence to continue to the next step. The sequence will also continue if a override time is programmed above 0 and the timeout occurs. Or if the user places the keyswitch in program mode and presses first the Function Select then the Reset keys. this causes the control to accept Program mode during sequence. The instruction may be used as a interlock between a Sequencer program and a Ladder Logic program by making the sequence "wait" for logical conditions in a ladder logic rung to become true.

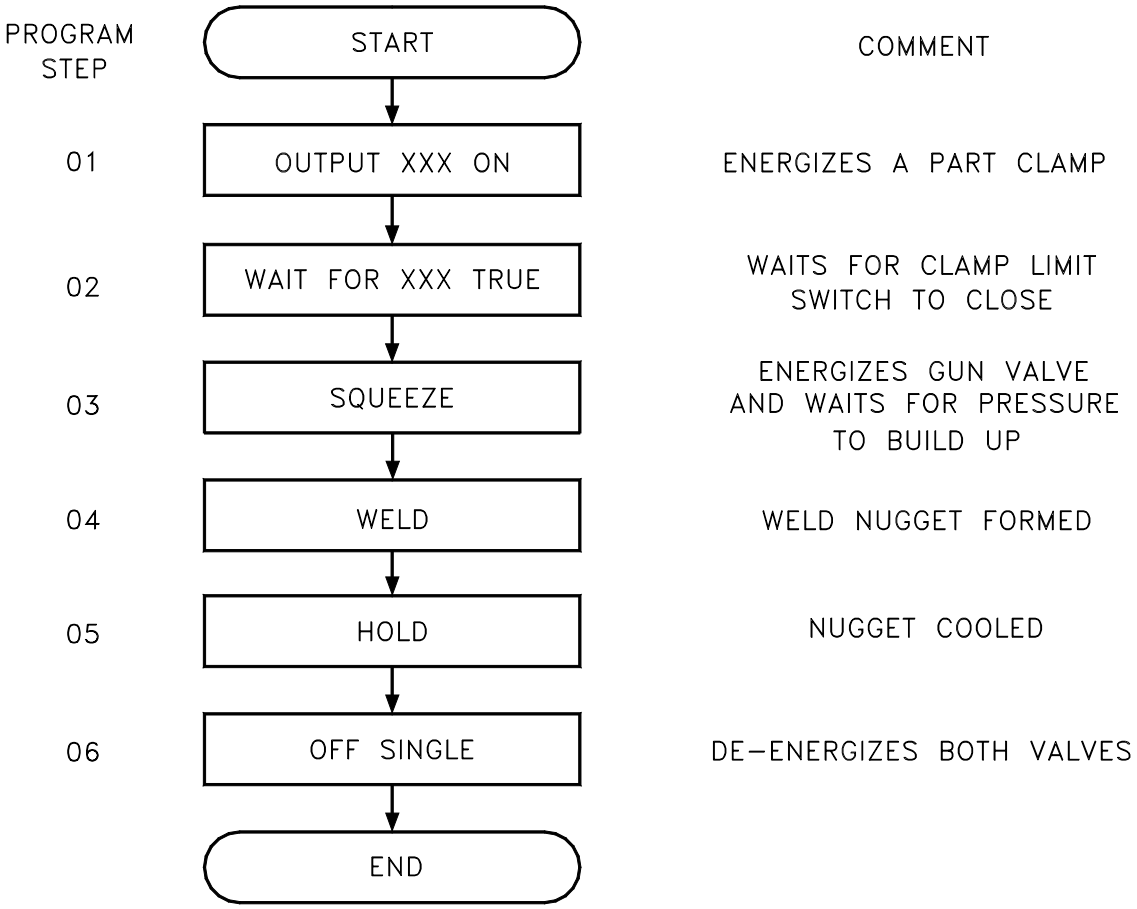
Display:

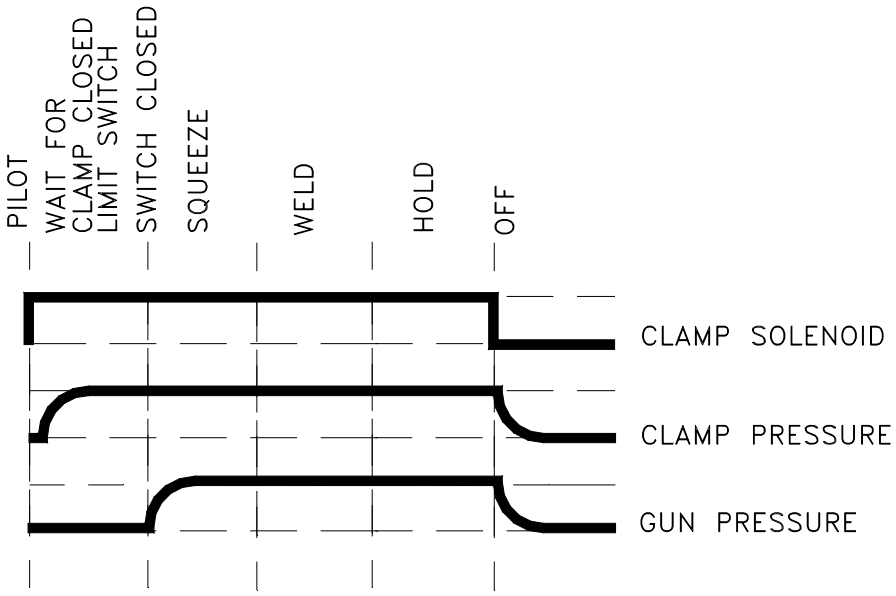
```
         1111111111222222222333
12345678901234567890123456789012
 1- 2 WAIT xxx TRUE        cccCY
         At instruction entry 12
       INPUT xxx=0 While waiting
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 19	Instruction description
D	>12, 14	Bit assignment
E	28, 30	Number of timer override cycles (0-999, 0=infinity)

FLOW CHART EMPLOYING WAIT FOR INPUT TRUE
IN A SIMPLE SEQUENCE PROGRAM





WAIT41.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
13	Wait for input xxx to be not true	No	0-999 cycle override 0=infinity

HEAT RANGE	COUNT	PRESET	CURRENT WINDOW CHECK
None	N/A	N/A	No

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	Assignable any bit 1-512	In run mode Input xxx=1 will be displayed until the bit becomes a 0 and the sequence continues.

DESCRIPTION

This instruction provides a halt in sequence flow until a programmable input bit is not true. While waiting for the bit to become false, "Input xxx=1" will be displayed. The message will remain until the bit becomes a 0, which causes the sequence to continue to the next step. The sequence will also continue if a override time is programmed above 0 and the timeout occurs. Or if the user places the keyswitch in program mode and presses first the Function Select then the Reset keys. this causes the control to accept Program mode during sequence. The instruction may be used as a interlock between a Sequencer program and a Ladder Logic program by making the sequence "wait" for logical conditions in a ladder logic rung to become not true.

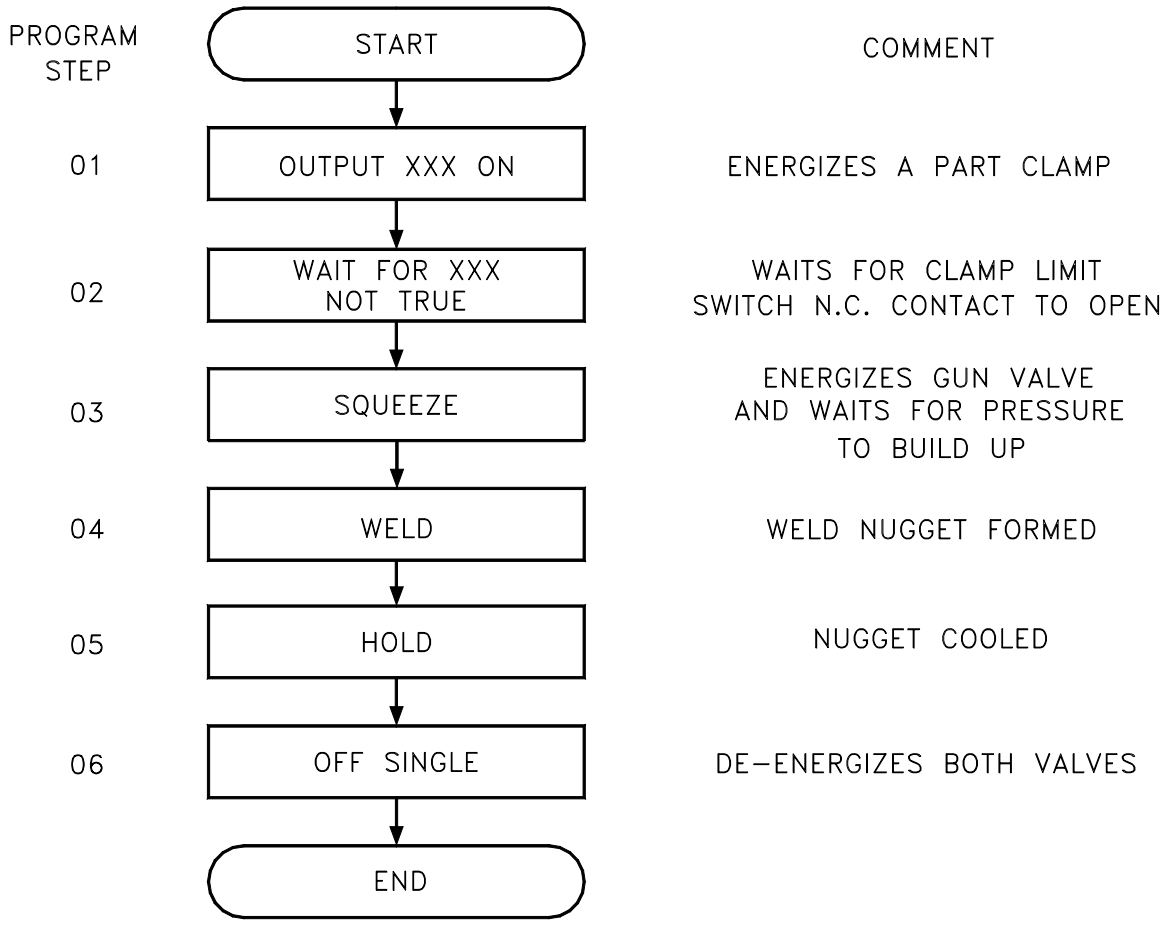
Display:

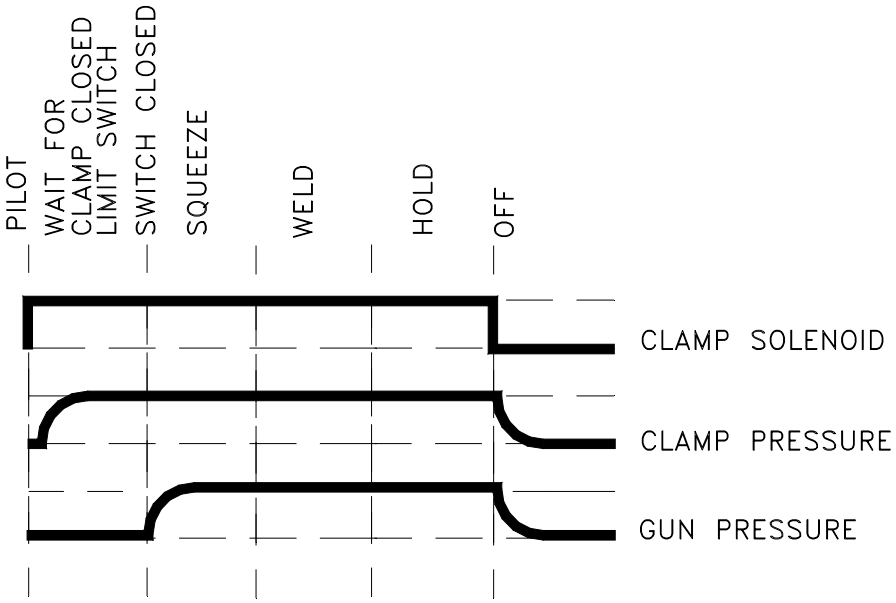
```
         1111111111222222222333
12345678901234567890123456789012
 1- 2 WAIT xxx NOT TRUE    cccCY
         At instruction entry 13
       INPUT xxx=1 While waiting
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 19	Instruction description
D	>12, 14	Bit assignment
E	28, 30	Number of timer override cycles (0-999, 0=infinity)

FLOW CHART EMPLOYING WAIT FOR INPUT NOT TRUE
IN A SIMPLE SEQUENCE PROGRAM





WAIT41N.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
14	Wait for input xxx and xxx to be true	No	0-999 cycleoverride 0=infinity

HEAT RANGE	COUNT	PRESET	CURRENT WINDOW CHECK
None	N/A	N/A	No

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	Assignable bits 0-511	In run mode Input xxx and Input xxx = 0 will be displayed until the bits both become a 1 and the sequence continues.

DESCRIPTION

This instruction provides a halt in sequence flow until two bits are logically ANDed true. While waiting for both bits to become true, "Input xxx and Input xxx = 0" will be displayed. The message will remain until the AND condition becomes true which causes the sequence to continue to the next step. The sequence will also continue if a override time is programmed above 0 and the timeout occurs. Or if the user places the keyswitch in program mode and presses first the Function Select then the Reset keys. This causes the control to accept Program mode during sequence. The instruction may be used as a interlock between a Sequencer program and a Ladder Logic program by making the sequence "wait" for logical conditions in a ladder logic rung to become not true.

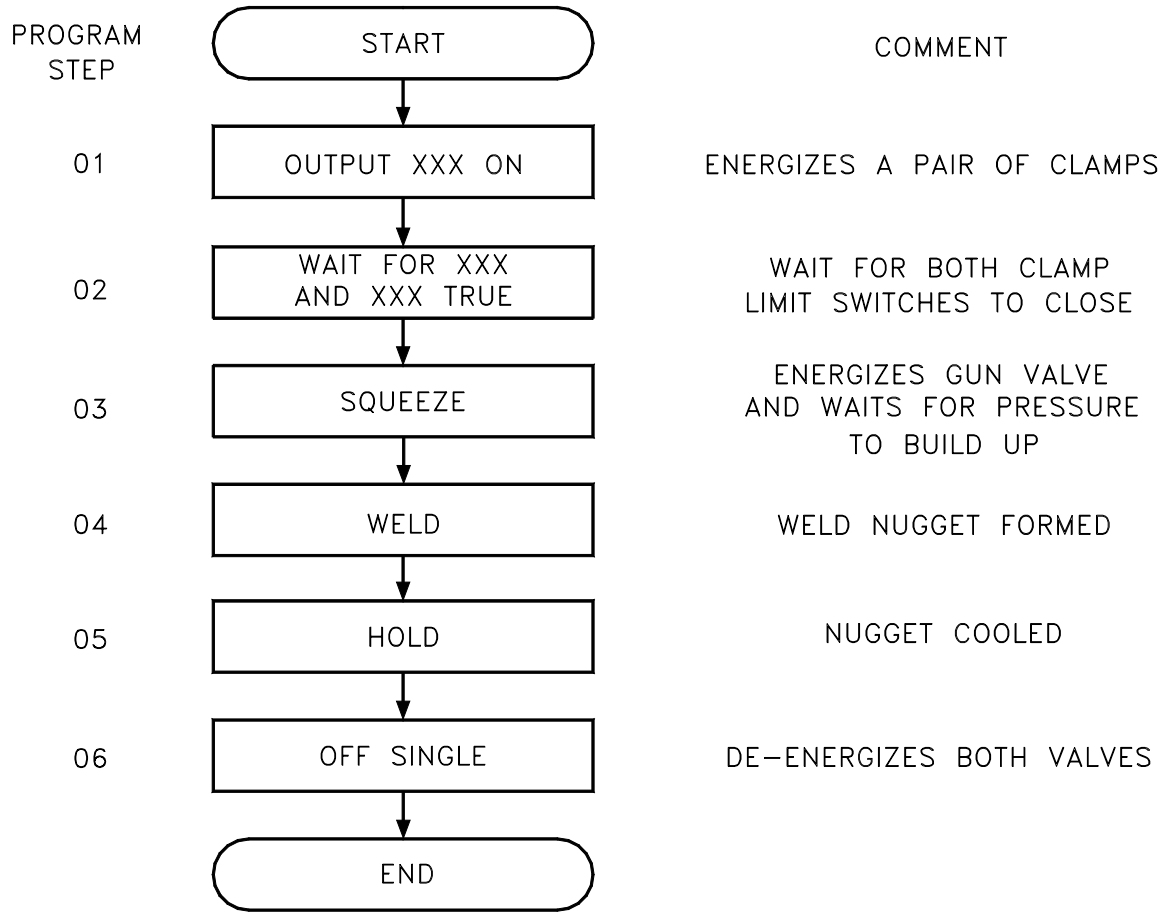
Display:

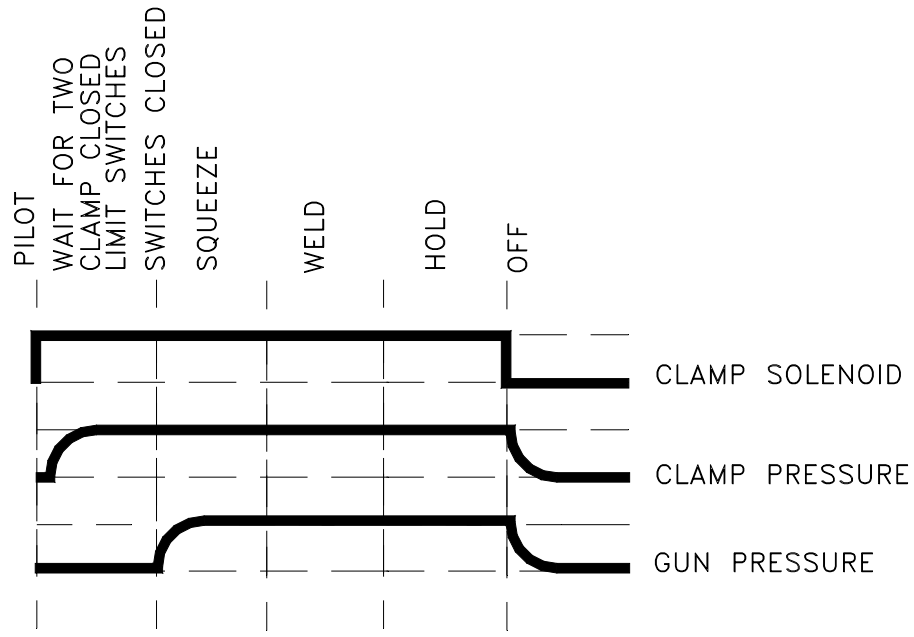
```
         1111111111222222222333
12345678901234567890123456789012
 1- 4 WAIT xxx & xxx TRUE  cccCY
         At instruction entry 14
  INPUT xxx AND INPUT xxx = 0   While waiting for AND true condition
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 19	Instruction description
D	>12, 14	Bit assignment number one
E	18, 20	Bit assignment number two
F	28, 30	Number of timer override cycles (0-999, 0=infinity)

FLOW CHART EMPLOYING WAIT FOR INPUT XXX AND XXX TO BE TRUE
IN A SIMPLE SEQUENCE PROGRAM





WAIT42A.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
15	Wait for input xxx or xxx to be true	No	0-999 cycle override 0=infinity

HEAT RANGE	COUNT	PRESET	CURRENT WINDOW CHECK
None	N/A	N/A	No

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	Assignable any bits 0-511	In run mode Input xxx ^ Input xxx = 0 will be displayed until one of the bits becomes 1 and the sequence continues.

DESCRIPTION

This instruction provides a halt in sequence flow until two bits are logically ORed true. While waiting for one or both bits to become true, "Input xxx or Input xxx = 0" will be displayed. The message will remain until the ORed condition becomes true, which causes the sequence to continue to the next step. Or if the user places the keyswitch in program mode and presses first the Function Select then the Reset keys. this causes the control to accept Program mode during sequence. The instruction may be used as a interlock between a Sequencer program and a Ladder Logic program by making the sequence "wait" for logical conditions in a ladder logic rung to become not true.

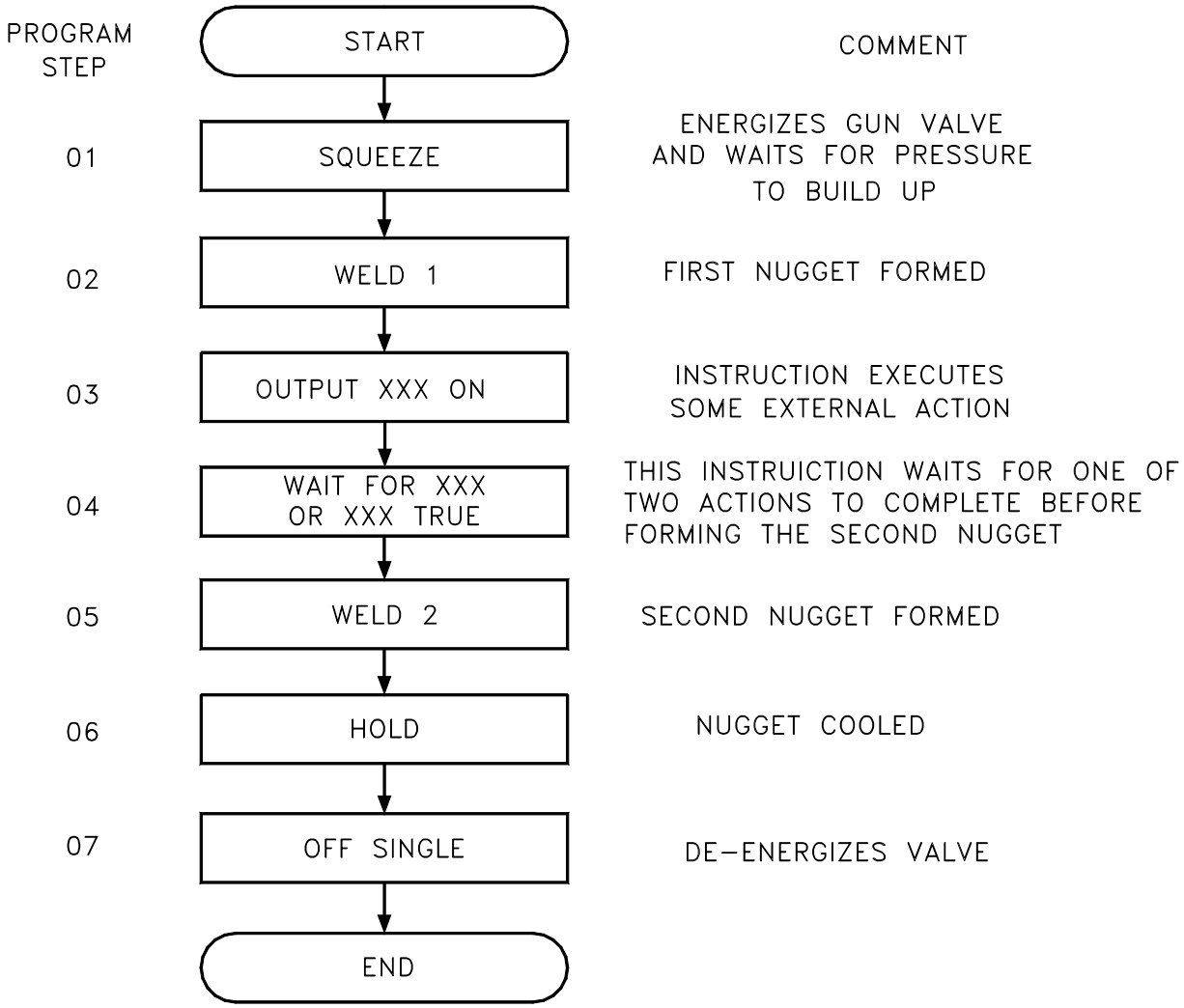
Display:

```
         11111111112222222222333
123456789012345678901234567890123
 1- 4 WAIT xxx ^ xxx TRUE  cccCY
         At instruction entry 15
   INPUT xxx OR INPUT xxx = 0   While waiting AND true condition
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 19	Instruction description
D	>12, 14	Bit assignment number one
E	18, 20	Bit assignment number two
F	28, 30	Number of timer override cycles (0-999, 0=infinity)

FLOW CHART EMPLOYING WAIT FOR INPUT XXX OR XXX TO BE TRUE
IN A SIMPLE SEQUENCE PROGRAM



WAIT420.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
16	Output xxx On	No	None

HEAT RANGE	COUNT	PRESET	CURRENT WINDOW CHECK
None	N/A	N/A	No

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	Assignable to any writeable output bit	Cannot set assigned input bits or status bits. See section 1, 5.0. MUST NOT write to a bit if a ladder logic program is writing to the same bit. See section 1, 10.4

DESCRIPTION

This instruction turns on (sets) a bit to a 1. This bit must be assigned output or unused. It will remain on through out the sequence unless turned off by the Output xxx off instruction or one of the Off instructions (see codes 9, 10 and 17). This instruction may be used as a interlock between a Sequencer program and the Ladder Logic program by controlling logical conditions in a ladder logic rung.

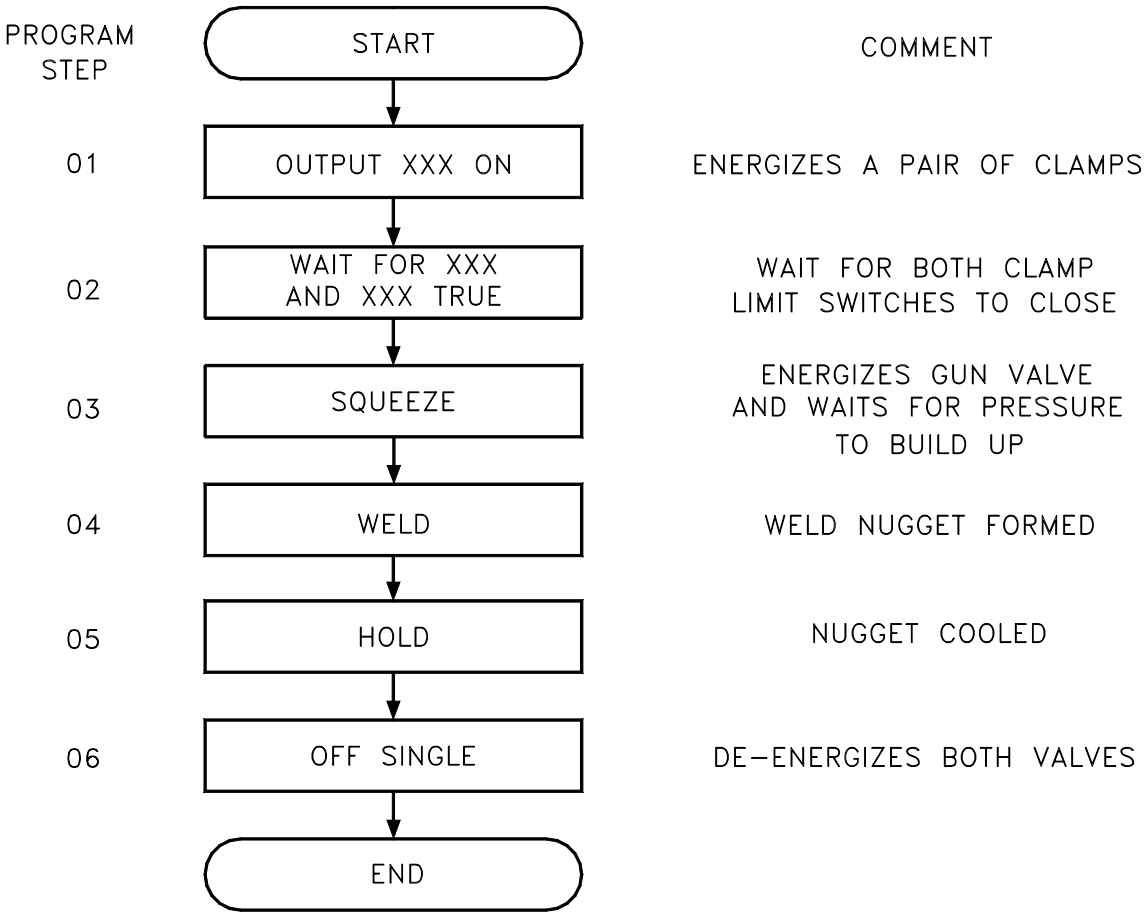
Display:

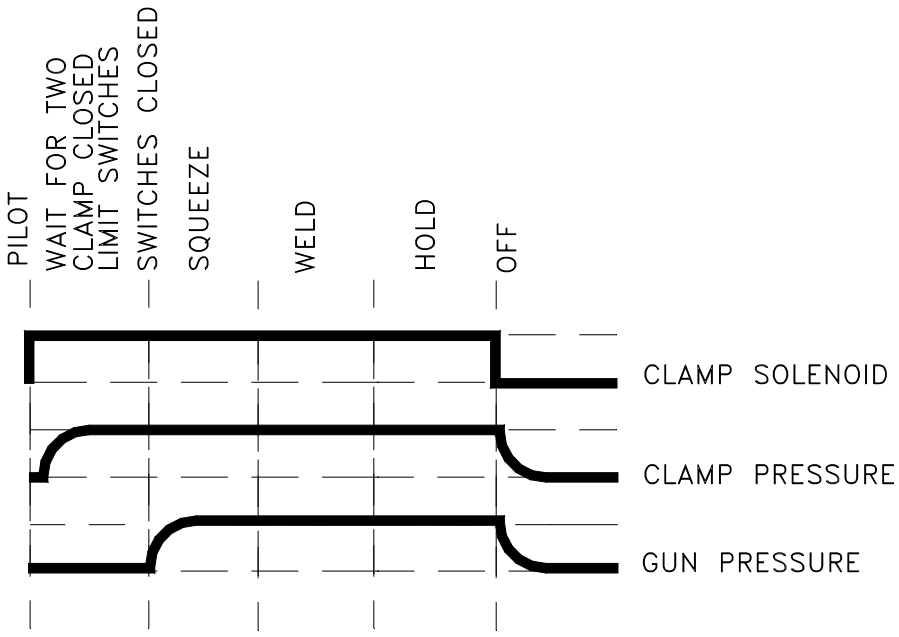
```
         1111111111222222222333
12345678901234567890123456789012
 1- 3 OUTPUT xxx ON
         At instruction entry 16
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 19	Instruction description
D	>14, 16	Bit assignment

FLOW CHART EMPLOYING OUTPUT ON
IN A SIMPLE SEQUENCE PROGRAM





OUTON.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
17	Output xxx Off	No	None

HEAT RANGE	COUNT	PRESET	CURRENT WINDOW CHECK
None	N/A	N/A	No

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	Assignable bits 1-511 Except real inputs and status bits.	Cannot set assigned input bits or status bits. See section 1, 5.0. MUST NOT write to a bit if a ladder logic program is writing to the same bit. See section 1, 10.4

DESCRIPTION

This instruction turns off (resets) a bit to a 0. This bit must be assigned output or unassigned. This instruction may be used as a interlock between a Sequencer program and the Ladder Logic program by controlling logical conditions in a ladder logic rung.

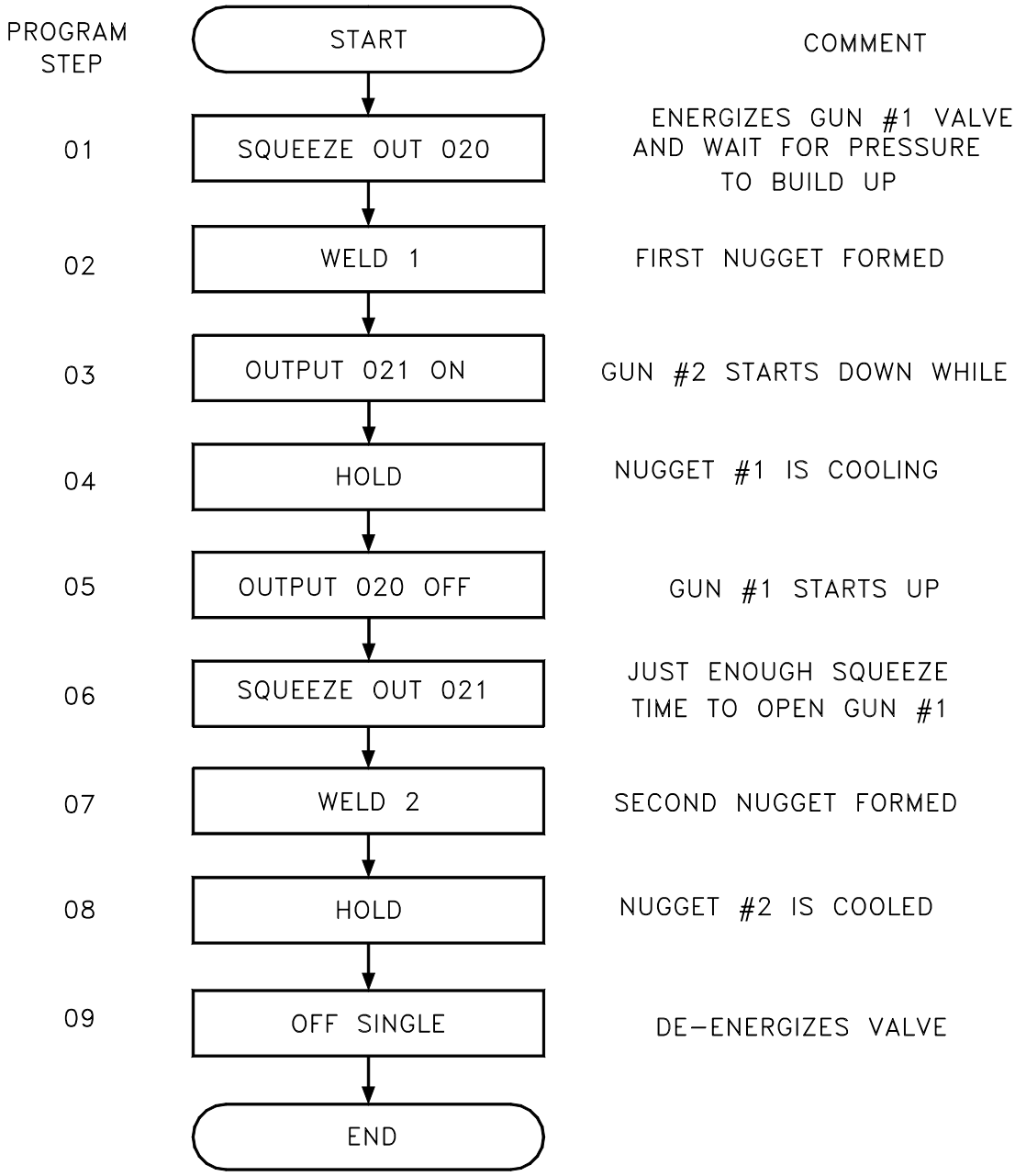
Display:

```
         1111111111222222222333
12345678901234567890123456789012
 1- 3 OUTPUT xxx OFF
         At instruction entry 17
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 19	Instruction description
D	>14, 16	Bit assignment

FLOW CHART EMPLOYING OUTPUT OFF
IN A SEQUENCE PROGRAM COMMONLY
CALLED "SEQUENTIAL GUNS"



OUTOFF.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
18	Output xxx If xxx & xxx True	No	None

HEAT RANGE	COUNT	PRESET	CURRENT WINDOW CHECK
None	N/A	N/A	No

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	Assignable output to bits 1-511 except real inputs or status bits. Any bit may be tested.	Cannot set assigned input bits or status bits. See section 1, 5.0. MUST NOT write to a bit if a ladder logic program is writing to the same bit. See section 1, 10.4

DESCRIPTION

This instruction turns on (sets) a bit to a 1 if two other bits logically ANDed are true. The outputted bit must be assigned output or unassigned. The bit will remain on throughout the sequence even if the test bits do not remain true. The outputted bit may be turned off by the Output xxx off instruction or one of the Off instructions (see codes 9, 10 and 17). This instruction may be used as a interlock between a Sequencer program and the Ladder Logic program by controlling logical conditions in a ladder logic rung.

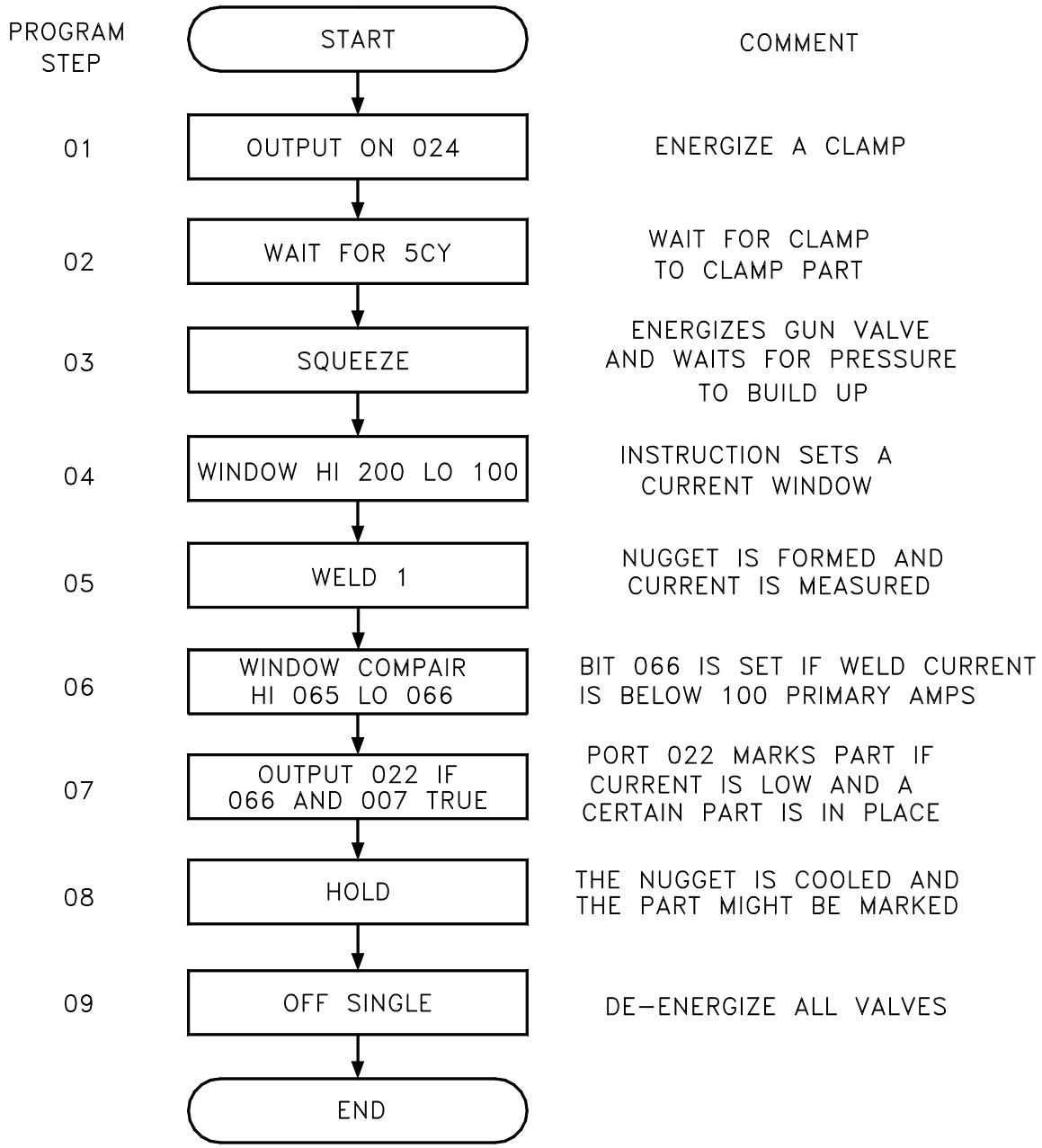
Display:

```
         1111111111222222222333
12345678901234567890123456789012
 1- 3 OUTPUT xxx IF xxx&xxx TRUE
         At instruction entry 18
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 32	Instruction description
D	>14, 16	Bit output assignment
E	21, 23	Bit test assignment number one
F	25, 27	Bit test assignment number two

FLOW CHART EMPLOYING OUTPUT IF XXX AND XXX IS TRUE
IN A SIMPLE SEQUENCE PROGRAM



OUTIF2A.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
19	Output xxx If xxx or xxx True (^=or)	No	None

HEAT RANGE	COUNT	PRESET	CURRENT WINDOW CHECK
None	N/A	N/A	No

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	Assignable out to any writable bit. Any bit may be tested.	Cannot set assigned input bits or status bits. See section 1, 5.0. MUST NOT write to a bit if a ladder program is writing to the same bit. See section 1, 10.4

DESCRIPTION

This instruction outputs (sets a bit to a 1) if one or both of two test bits logically ORed are true. The outputted bit must be outputtable (not a input bit). The bit will remain on throughout the sequence even if the test bit(s) does not remain true. The outputted bit may be turned off by the Output xxx off instruction or one of the Off instructions (see codes 9, 10 and 17). This instruction may be used as a interlock between a Sequencer program and the Ladder Logic program by controlling logical conditions in a ladder logic rung.

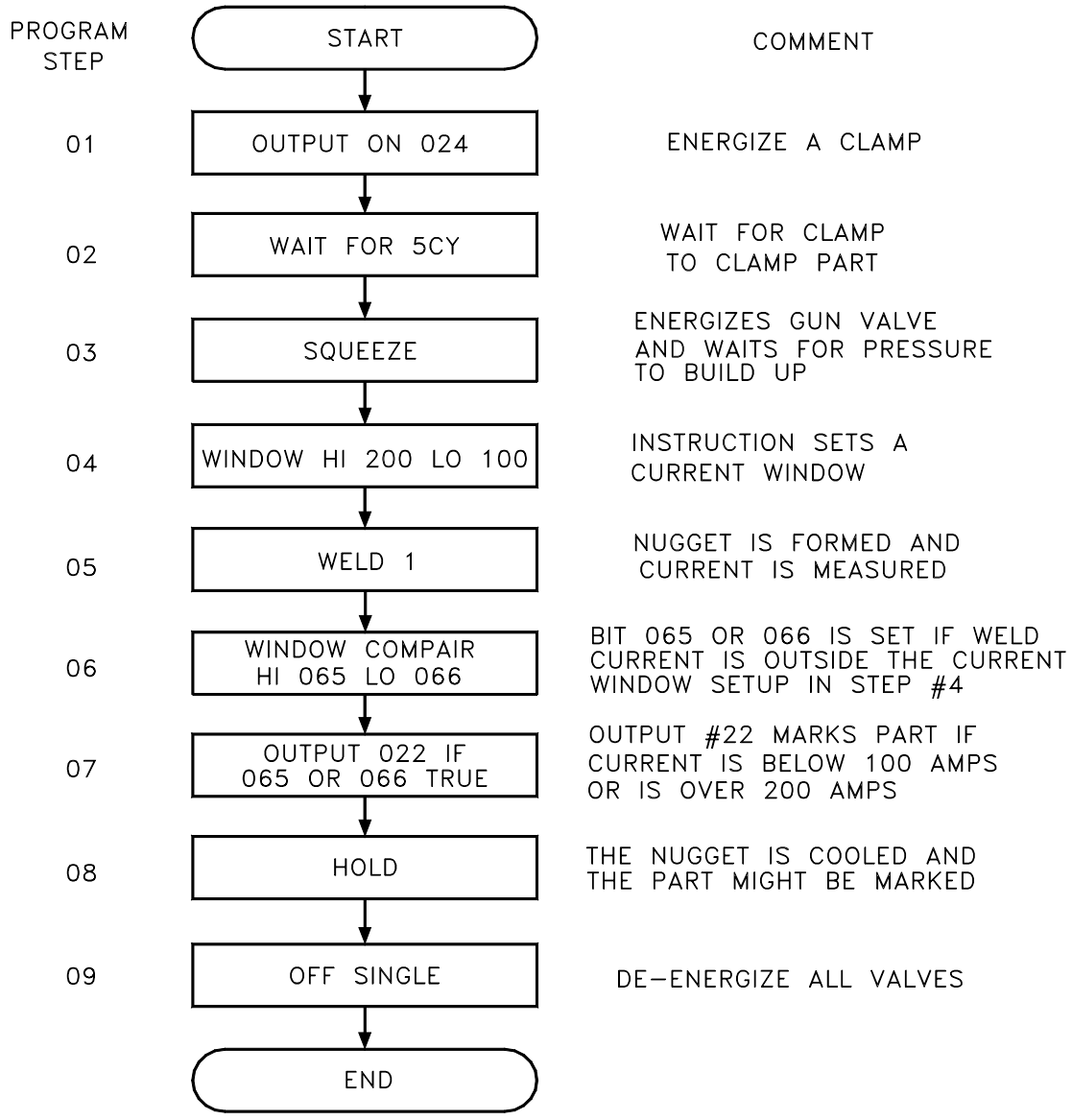
Display:

```
         11111111112222222222333
12345678901234567890123456789012
 1- 3 OUTPUT xxx IF xxx^xxx TRUE
         At instruction entry 19
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 32	Instruction description
D	>14, 16	Output bit assignment
E	21, 23	Test bit assignment number one
F	25, 27	Test bit assignment number two

FLOW CHART EMPLOYING OUTPUT IF XXX OR XXX IS TRUE
IN A SIMPLE SEQUENCE PROGRAM



OUTIF2O.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
20	Water Valve	Yes	1-99 Seconds

HEAT RANGE	COUNT	PRESET	CURRENT WINDOW CHECK
None	N/A	N/A	No

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	Assignable output bit or any unassigned bit.	Only one water valve may be assigned per sequence. Note timing is in seconds not in line cycles and is outside the sequence.

DESCRIPTION

This instruction outputs or sets a bit at the instruction interpretation. At the end of Off time, a 1 to 99 second timing (cc) starts. When the selected time period is completed, the output is made 0. This output is usually used to open a water coolant valve to cool the welding machine for some time after use. The instruction may be placed anywhere in the sequence but should be placed before the first heat instruction. Timing will not start in a repeat sequence but is initiated after the pilot is removed.

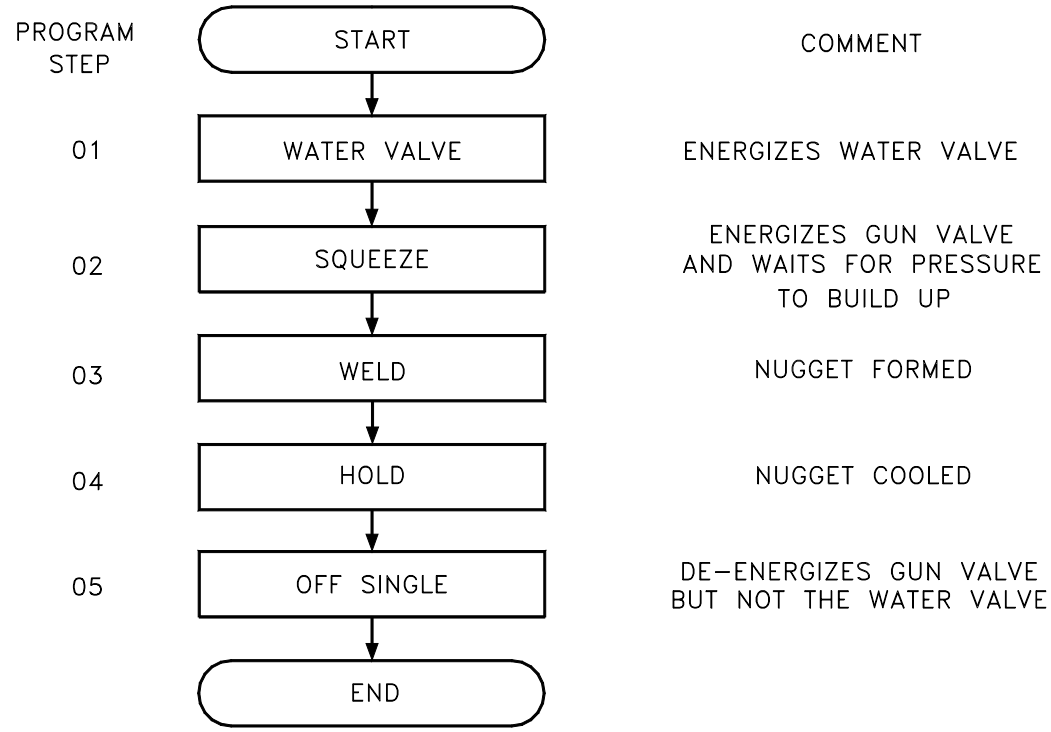
Display:

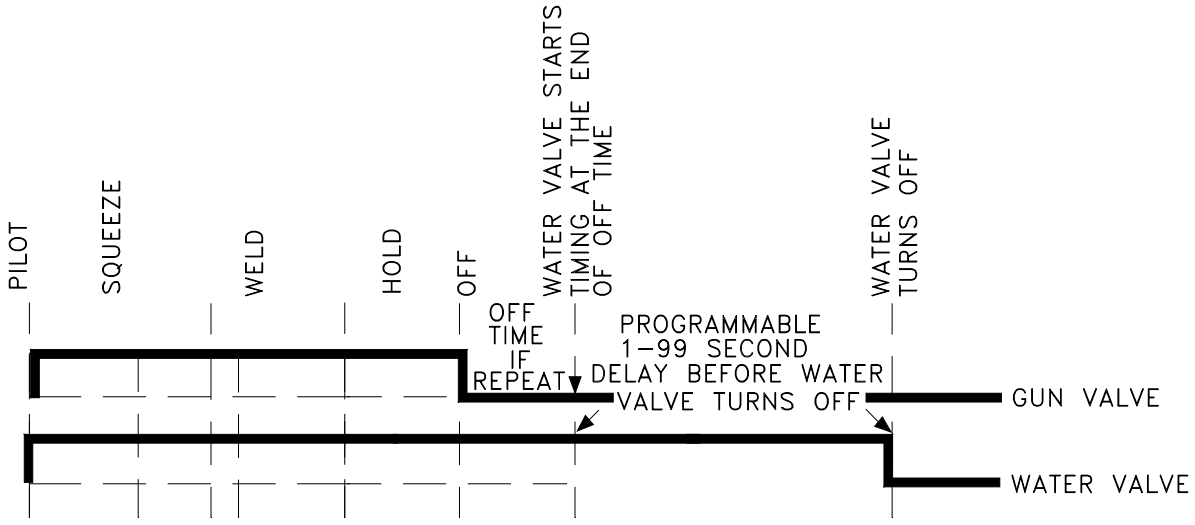
```
         1111111111222222222333
12345678901234567890123456789012
 1- 1 WATER VALVE OUT xxx cc SEC
         At instruction entry 20
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 21	Instruction description
D	>23, 25	Output bit to be set
E	27, 28	Time in seconds 1-99

FLOW CHART EMPLOYING WATER VALVE
IN A SIMPLE SEQUENCE PROGRAM





CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
21	Pressure Output	Yes	None

HEAT RANGE	COUNT	PRESET	WINDOW CHECK
None	None	None	None

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each pass	None	Output effected by any stepper program multiplier by percent.

DESCRIPTION

This instruction is used to output a binary number. The number of binary bits outputted is programmable (1-8). The outputs may be connected to a binary valve designed to deliver a pressure based upon its binary input or to any other binary device. The user supplies the output starting address (xxx LSB) and the number of consecutive binary bits required (-x). The last bit outputted will be the most significant binary digit. The binary number outputted (zz) will be the equivalent of the percent of the maximum binary number possible with the number of bits chosen to be outputted. The number supplied in parenthesis by the control is the real percentage outputted with any applied stepper multiplier influence. Which would be any stepper assigned before this instruction. See instruction #45.

See section 1 paragraph 10.1.19, ladder logic instruction HEX OUT. This instruction is very similar showing a hexadecimal chart relating input zz to the output ooo.

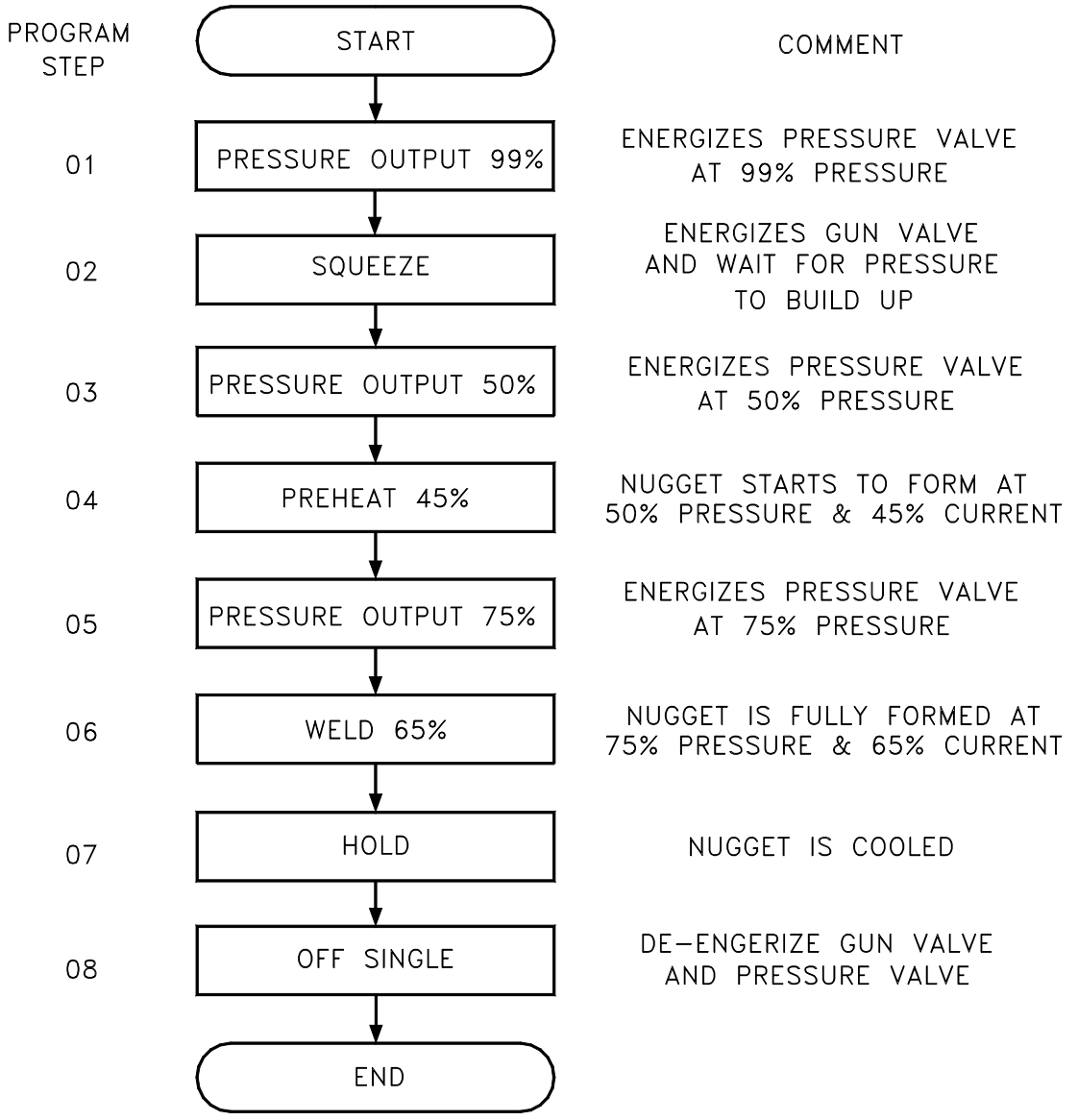
Display:

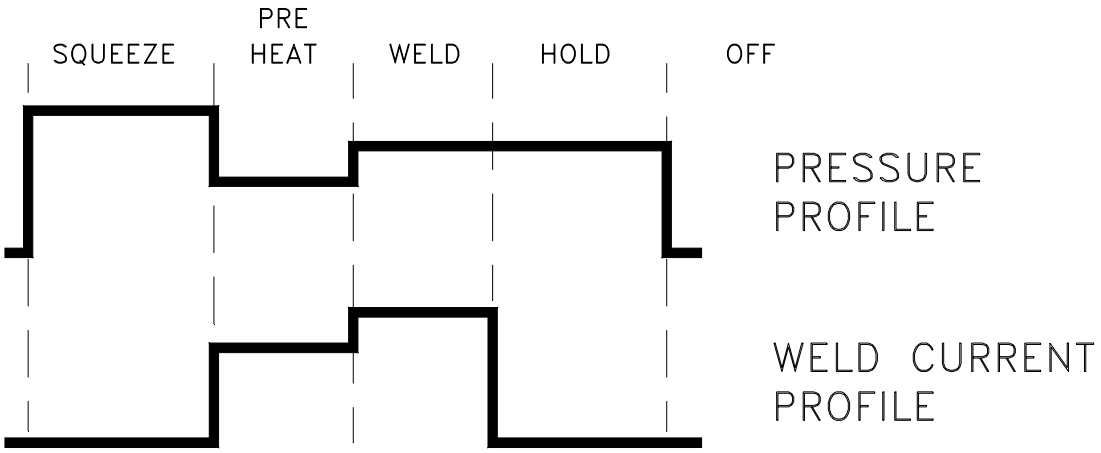
```
         1111111111222222222333
12345678901234567890123456789012
 1- 2 PRESS OUT xxx-x  zz  (zz%)
         At instruction entry 21
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 15	Instruction description (PRESSure OUTput)
D	17, 19	Output address of the first bit outputted (LSB)
E	21	The number of consecutive binary bits required (1-8)
F	>24, 25	Desired binary percentage outputted.
G	29, 30	Real binary percentage outputted with applied stepper program influence

FLOW CHART EMPLOYING PRESSURE OUTPUT
IN A SIMPLE SEQUENCE PROGRAM





PRESSOUT.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
22	Window HIiiii LOiiii	Yes	None

HEAT RANGE	COUNT	PRESET	WINDOW CHECK
None	None	None	Works with Window Compair instruction Code 58

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Before Heats	None	Must be placed before the heat statement(s) of interest.

DESCRIPTION

This instruction is placed before AVC heat instructions or any statements of interest. It is used to frame, measure, report and provide a custom current window for any AVC heat statements between it and the WINDOW COMPARE instruction. If used after a TRANS TURNS RATIO instruction all currents will be in secondary amperes. The measurement of current will be AVERAGE RMS amps and includes cool times if present. The current reported may be seen View Data. If the average RMS current value tallied at the time of the WINDOW COMPARE instruction is outside the values programmed in this instruction, one of the programmable HI or LO bits in the WINDOW COMPARE instruction will be set. These bits may then be examined to be set, and if set, any programmable action may be taken. Remember to reset these bits before continuing your program. Also see section 1, 8.6 for more detail. Note in RUN and ON Line Mode the display will show the programmed amps in parenthesis. The data shown when in Run mode will reflect the amperage "bumped" by any stepper program. Hence all current windows are proportionally changed when their heat instructions are changed by a stepper program. The user may block this influence by programming Assign Stepper 0 before this instruction. For constant current monitoring see code 74.

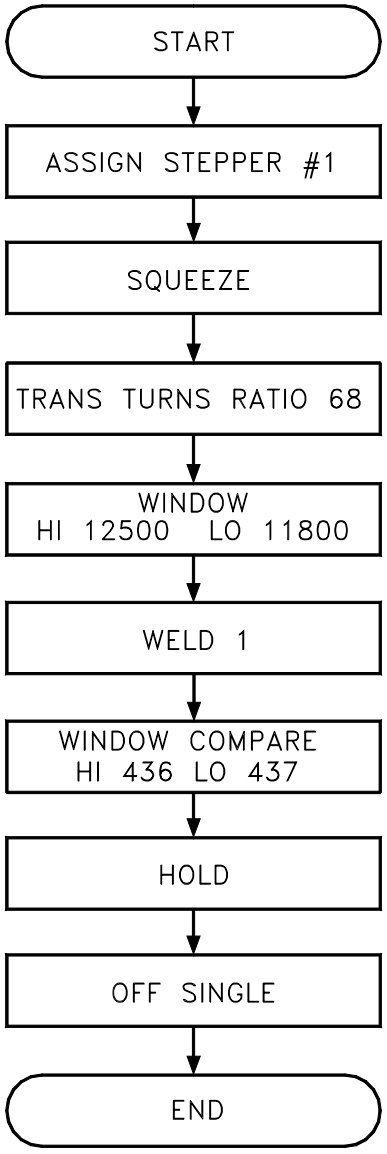
Display:

```
         11111111112222222222333
12345678901234567890123456789012
 1- 2 WINDOW HI iiiii  LO iiiii  <--Display in Program mode
 1- 2 WINDOW HI(iiiii) LO(iiiii) <--Display in Run and On Line Mode
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 15	Instruction description
D	>17, 21	Current window high value 0-65535 AMPS
E	26, 30	Current window low value 0-65535 AMPS

FLOW CHART EMPLOYING WINDOW HI LO
IN A SIMPLE SEQUENCE PROGRAM



COMMENT

STEPPER PROGRAM #1 WILL EFFECT ALL CURRENTS PROGRAMMED FROM THIS POINT UNTIL OFF SINGLE.

ENERGIZES GUN VALVE AND WAITS FOR PRESSURE TO BUILD UP

MULTIPLYES PRIMARY CURRENT BY 68 THEREBY PERMITTING PROGRAMMING IN SECONDARY AMPS. 0=TOROID PICKUP.

CURRENT WINDOW IS SET, MEASUREMENT IS STARTED AND ENDS AT COMPARE.

NUGGET IS FORMED, RMS CURRENT IS SUMMED AND AVERAGE RMS CURRENT IS CALCULATED AT THE COMPARE.

BIT 436 OR 437 IS SET IF CURRENT IS OUTSIDE THE WINDOW IN STEP #4. THIS SETS USER FAULT #1 OR #2.

NUGGET IS COOLED

DE-ENERGIZE ALL VALVES

WINDOW.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
23	Precompression	Yes	00-99 Cycles

HEAT RANGE	COUNT	PRESET	CURRENT WINDOW CHECK
None	N/A	N/A	None

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	Output bit	User must assign output bit, the bit remains true for the programmed time only.

DESCRIPTION

Precompression is the use of a higher pressure than the welding pressure for some time then decreasing to the normal welding pressure. It is used on aluminum and other softer metals to achieve a moderate degree of cold forging to prevent spitting and loss of firm electrode contact. Electrode indentation is often decreased by this means. This higher pressure before welding will also cause the gun or the work to move so that the electrodes are properly aligned if they were previously misaligned.

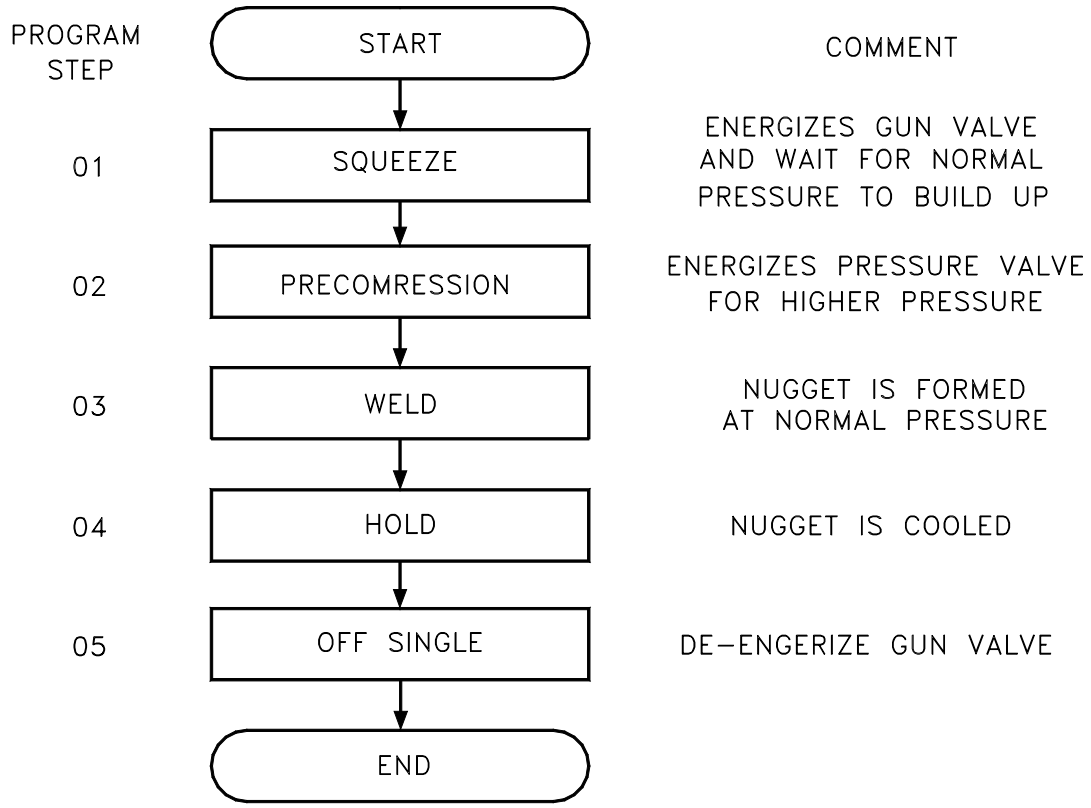
Display:

```
         1111111111222222222333
12345678901234567890123456789012
 1- 2 PRECOMPRESSION OUTxxx ccCY
         At instruction entry 23
```

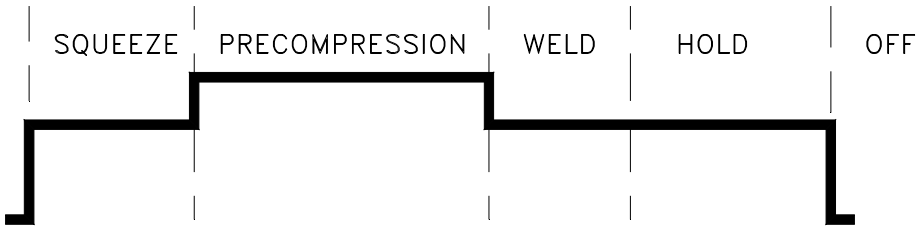
Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 24	Instruction description
D	25, 27	Output bit assignment
E	>29, 30	Precompression time

FLOW CHART EMPLOYING PRECOMPRESSION
IN A SIMPLE SEQUENCE PROGRAM



PRESSURE
PROFILE



PRECOMP.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
24	MC CONTACTOR	Yes	Preset 3 cycles in 000-999 Seconds out

HEAT RANGE	COUNT	PRESET	CURRENT WINDOW CHECK
None	N/A	N/A	Yes

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	Assignable output	Heat faults are turned off for 3 cycles during MC contact closure. Coil will not be energized if in No Weld.

DESCRIPTION

This instruction is used to close a mechanical safety contactor. MC's are installed for operator safety by completely opening the weld transformer primary when its secondary cannot be grounded. It should be the first instruction in the sequence or Heat Faults off must be programmed. For 3 line cycles the heat faults will be automatically turned off during contact closure; therefore, it will take 3 cycles for this function to complete. If Heat Faults Off was programmed prior to this instruction, then Heat Faults On should be programmed immeadiatly after. After the welding sequence is complete (in Off Single), the mechanical contactor coil may remain energized for a programmable number of seconds. This action improves contactor life during rapidly repeated single mode operations. The opening delay time should be programmed short enough so the operator cannot possibly touch ungrounded secondarys before the time delay is over. The contactor will not be energized if the control is in No Weld mode.

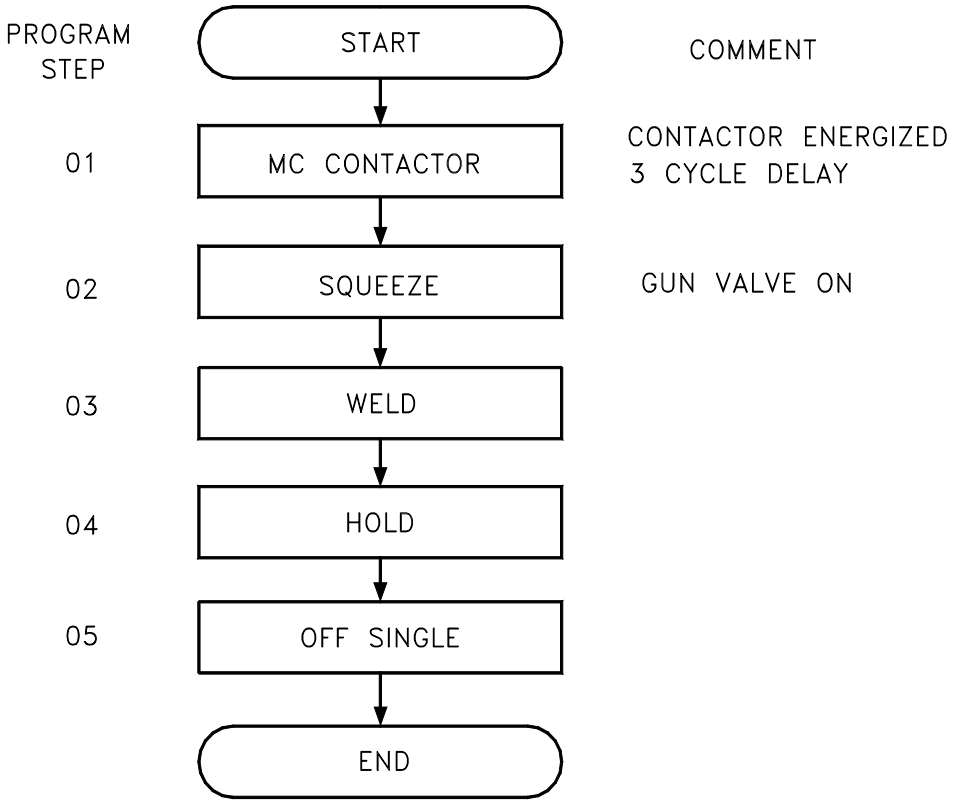
Display:

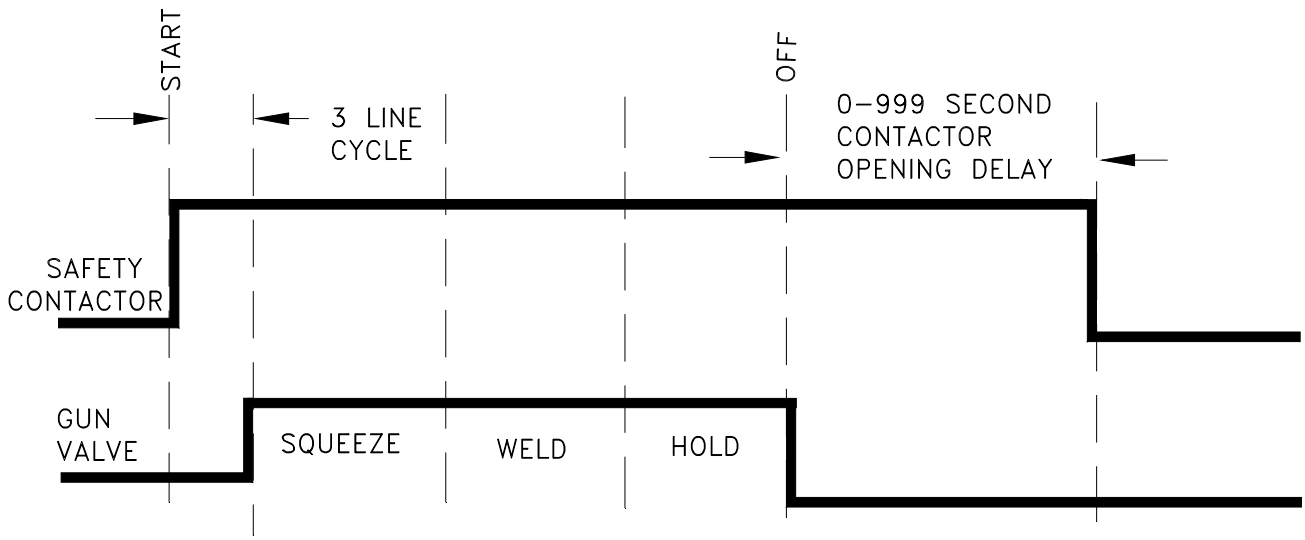
```
         11111111112222222222333
12345678901234567890123456789012
 1- 1 MC CONTACTOR OUTxxx cccSEC
         At instruction entry 24
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 22	Instruction description
D	23, 25	Output bit assignment
E	>27, 29	Contactor deenergize delay time in seconds

FLOW CHART EMPLOYING MC CONTCTOR
IN A SIMPLE SEQUENCE PROGRAM





MCCONTAC.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
25	Pulse with Cool	Yes	00-99 Cycles 1-99 Pulses

HEAT RANGE	COUNT	PRESET	WINDOW CHECK
None	None	nn	No

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Number of times entered by user.	None	Address (aa) must be supplied by the user and will only branch back in the same sequence. 1 in pp results in NO branch back. Entering 2 results in 1 branch back. nn cannot = 0

DESCRIPTION

This instruction provides what sometimes is called Pulsation welding. It is used to repeat heat-cool functions from 1 to 99 times. The user must supply the branch back step number address (aa), the number of cool cycles (cc) and the number of times to be repeated (nn). Any number of functions may be programmed between this instruction and the branch address. This function is used to weld heavy gauge metals.

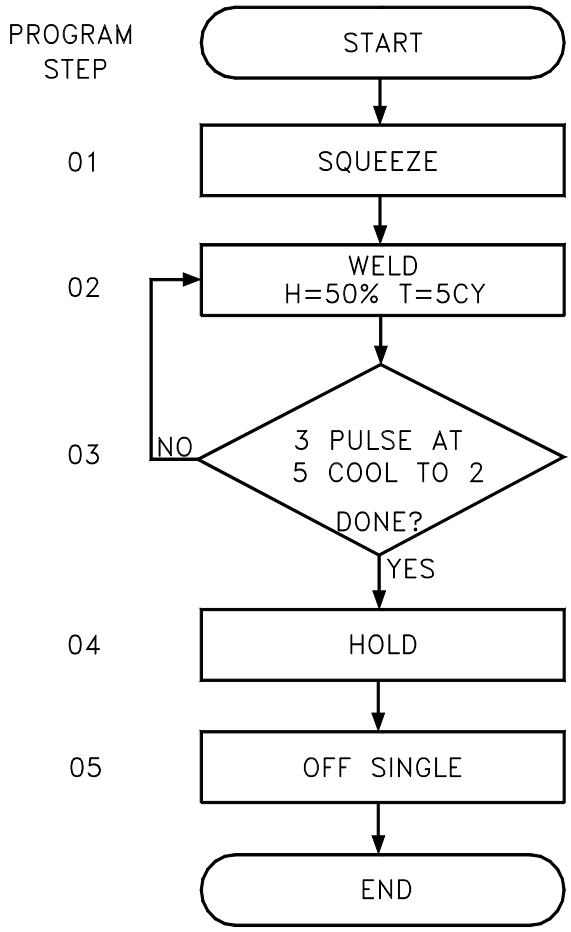
Display:

```
         11111111112222222222333
12345678901234567890123456789012
 1- 3 nn PULSE @ ccCY COOL TO aa
         At instruction entry 25
```

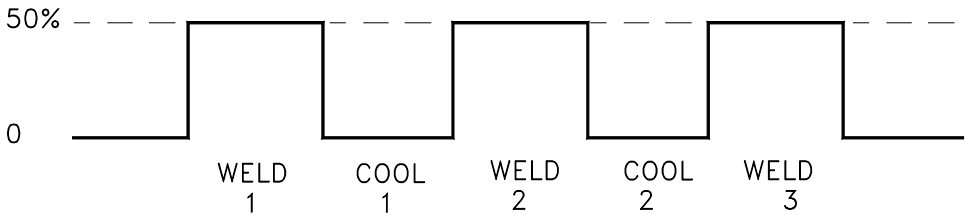
Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 1-31
B	4, 5	Program step number 01-99
C	>7, 8	Number of pulsations 01-99
D	18, 19	Number of Cool cycles 00-99
E	10, 26	Instruction description
F	31, 32	Branch back address step number

FLOW CHART EMPLOYING PULSE WITH COOL
TO OBTAIN PULSATION WELDING



WELD CURRENT PROFILE
3 PULSES OF WELD COOL



PULWCOOL.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
26	Heat Until Input	Yes	1-999 Cycles 0=Infinity

HEAT RANGE	COUNT	PRESET	CURRENT WINDOW CHECK
20-99% of available current	N/A	N/A	Yes

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	Assignable input bit or bit 1-512	If override time occurs bit #429 will be set to 1.

DESCRIPTION

This instruction is used to apply heat at a specified percent until an assigned input is made true. A override timer of 1-999 cycles may be applied, which will override the specified input at the applied time. If the timer is set to 0 the override time defaults to the global override timer which may be set to infinity. For diagnostic purposes, the user may examine bit #429 to check for a timer override condition. This may be done in the following sequence instructions or in a PLC program.

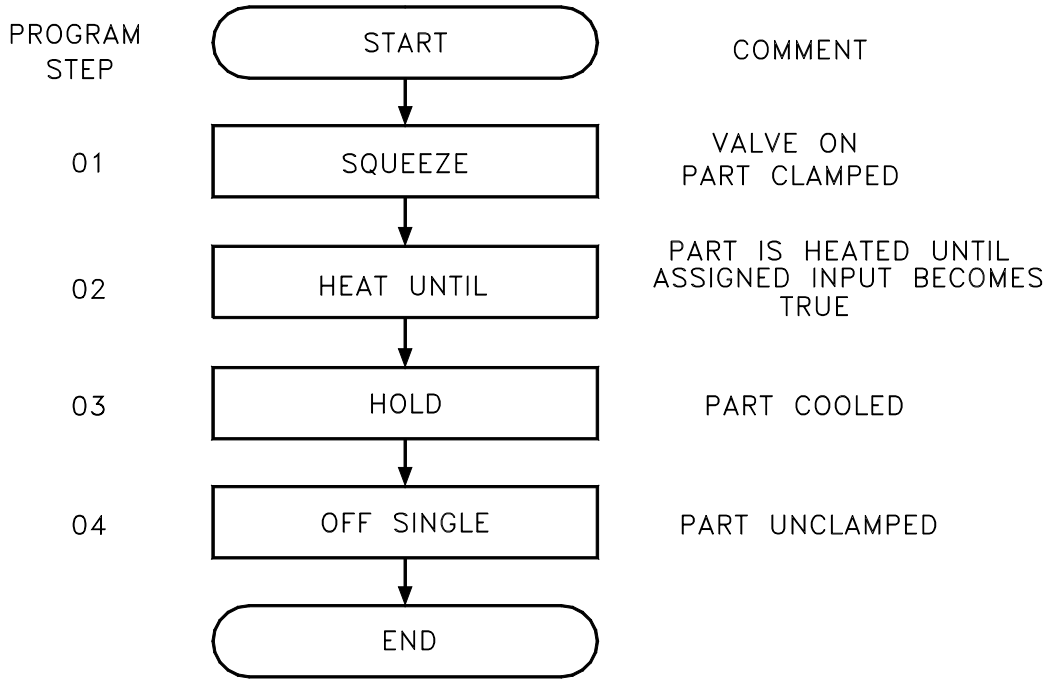
Display:

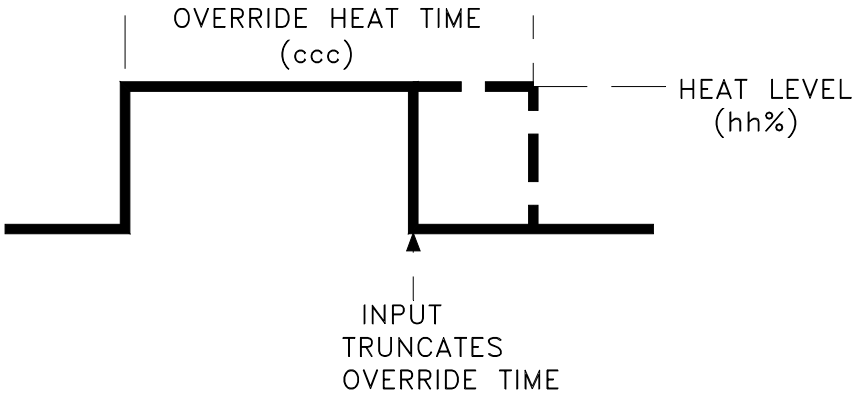
```
         1111111111222222222333
12345678901234567890123456789012
 1- 2 HEAT UNTIL   xxx hh% cccCY
         At instruction entry 26
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 16	Instruction description
D	20, 22	Input bit assignment
E	>24, 25	Percent of available current
F	28, 30	Override time

FLOW CHART EMPLOYING HEAT UNTIL INPUT
IN A SIMPLE SEQUENCE PROGRAM





HEATUNTL.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
27	Remote Heat (REM HEAT)	Yes	1-99 Cycles

HEAT RANGE	COUNT	PRESET	CURRENT WINDOW CHECK
20-99% of available current	N/A	N/A	Yes

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	Firing pulses and (bb) buffer location filled by PLC #18 MUX inst.	Entering 1-19% heat on the thumbwheels results in 20% heat, 0% provides no heat, timing only. If over 20% assigned stepper will incremented.

DESCRIPTION

This instruction is the same as instruction #6 Weld, except data for percent heat comes from a set of thumbwheels. The thumbwheels are strobed and data entered in a buffer location by PLC instruction (#18 MUX). The MUX (multiplex) instruction loads from 1 to 99 thumbwheel to buffer locations (bb). One of these buffer locations must be addressed by this instruction and is done so by supplying the buffer number if interest (bb). Proper thumbwheel/buffer correlation may be checked by observing positions 19 and 20 and comparing the data observed with the thumbwheel data. The control must be in run mode for proper operation. See PLC instruction #18 for more information on thumbwheel to buffer application.

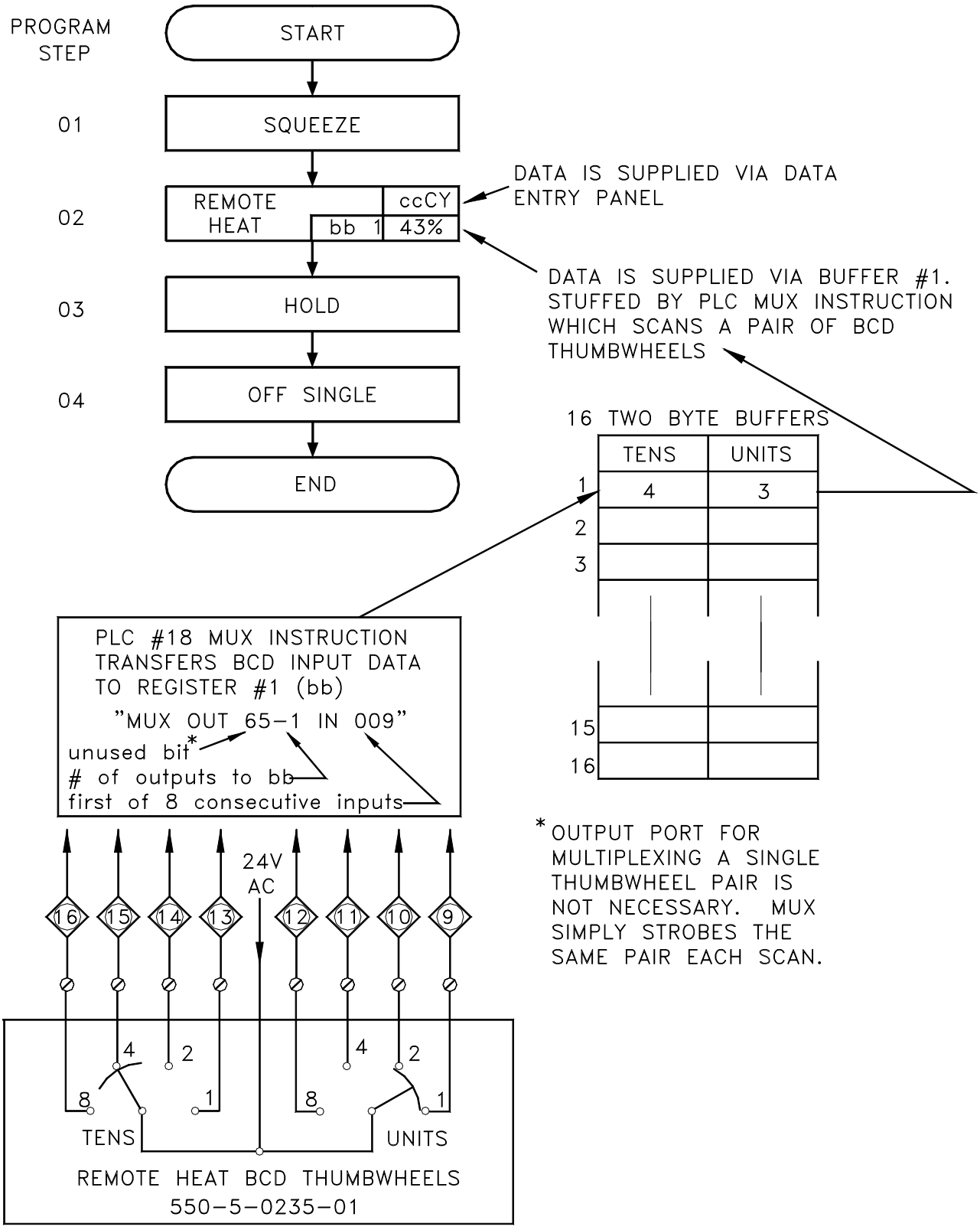
Display:

```
         11111111112222222222333
12345678901234567890123456789012
 1- 2 REM HEAT bb mm% (mm%) ccCY
         At instruction entry 27
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 14	Instruction description
D	16, 17	Buffer location. 1-16
E	19, 20	Contents of bb buffer
F	24, 25	Weld percent with stepper an/or AVC influence (actual heat applied to firing circuit)
G	>29, 30	Weld time in line cycles 00-99

FLOW CHART EMPLOYING REMOTE HEAT
IN A SIMPLE SEQUENCE PROGRAM



*OUTPUT PORT FOR MULTIPLEXING A SINGLE THUMBWHEEL PAIR IS NOT NECESSARY. MUX SIMPLY STROBES THE SAME PAIR EACH SCAN.

REMHEAT.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
28	Remote Heat and Time (REM HTT)	Yes	1-99 Cycles

HEAT RANGE	COUNT	PRESET	CURRENT WINDOW CHECK
20-99% of available current	N/A	N/A	Yes

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	Firing pulses and 2 (bb) buffer locations filled by PLC #18 MUX inst.	Entering 1-19% heat on the thumbwheels results in 20% heat, 0% provides no heat, timing only. If over 20% assigned stepper will incremented.

DESCRIPTION

This instruction is the same as instruction #6 Weld, except data for percent heat and time comes from two sets of thumbwheels. The thumbwheels are strobed and data entered in two buffer locations by PLC instruction (#18 MUX). The MUX (multiplex) instruction loads from 1 to 99 thumbwheel to buffer locations (bb). Two buffer locations are addressed by this instruction and is done so by supplying only the first buffer number if interest (bb=%heat). Proper thumbwheel/buffer correlation may be checked by observing positions 19, 20 29 and 30 and comparing the data observed with the thumbwheel data. The control must be in run mode for proper operation. See PLC instruction #18 for more information on thumbwheel to buffer application.

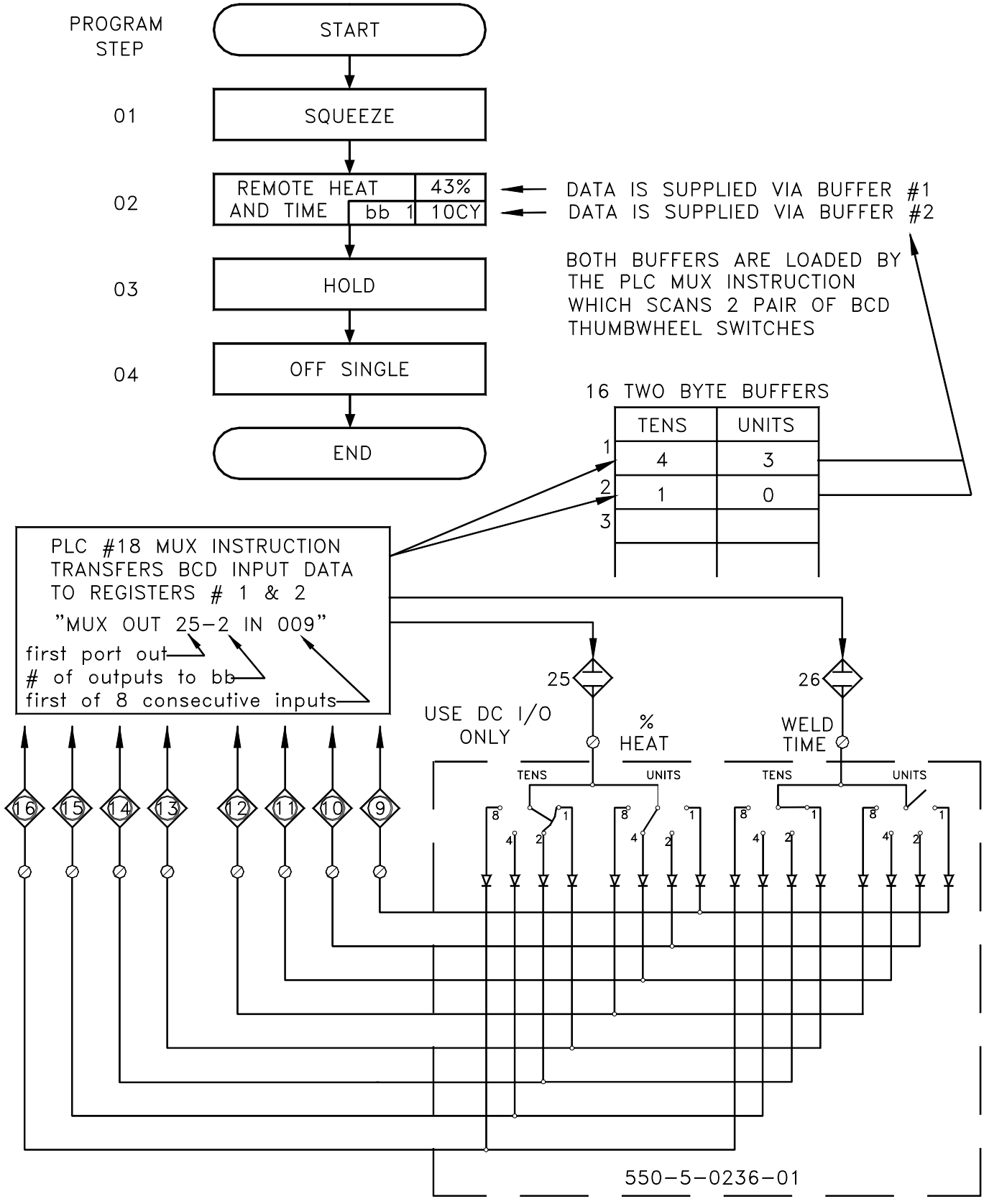
Display:

```
         11111111112222222222333
123456789012345678901234567890123
 1- 2 REM HTT bb  mm% (mm%) mmCY
         At instruction entry 28
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 13	Instruction description
D	>15, 16	First buffer location (% heat) of two buffers. 1-16
E	19, 20	Contents of first bb buffer percent of heat
F	24, 25	Weld percent with stepper an/or AVC influence (actual heat applied to firing circuit)
G	29, 30	Contents of second buffer (bb+1) weld time 00-99

FLOW CHART EMPLOYING REMOTE HEAT AND TIME
IN A SIMPLE SEQUENCE PROGRAM



REMHTT.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
29	Remote Wait (REM WTT)	Yes	1-99 Cycles

HEAT RANGE	COUNT	PRESET	CURRENT WINDOW CHECK
None	N/A	N/A	No

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	bb buffer location. The buffer location is filled by PLC #18 MUX instruction.	None

DESCRIPTION

This instruction is the same as instruction #11 Wait, except data for time comes from a set of thumbwheels. The thumbwheels are strobed and data entered in a buffer location by PLC instruction (#18 MUX). The MUX (multiplex) instruction loads from 1 to 16 thumbwheel to buffer locations (bb). One of these buffer locations must be addressed by this instruction and is done so by supplying the buffer number of interest (bb). Proper thumbwheel/buffer correlation may be checked by observing positions 19 and 20 and comparing the data observed with the thumbwheel data. The control must be in run mode for proper operation. See PLC instruction #18 for more information on thumbwheel to buffer application.

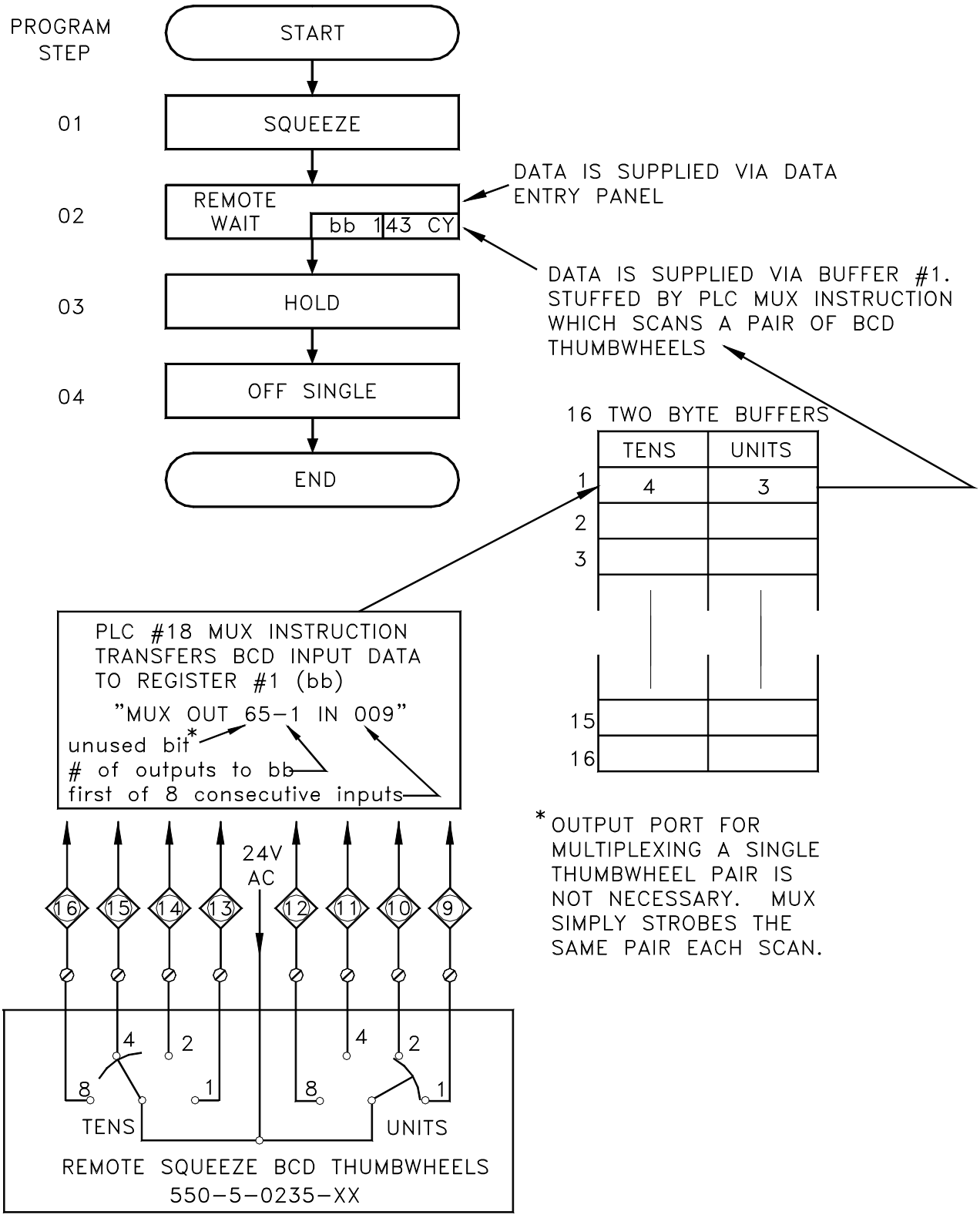
Display:

```
         11111111112222222223333
12345678901234567890123456789012
 1- 2 REM WTT bb            mmCY
         At instruction entry 29
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 13	Instruction description
D	>15, 16	Buffer location. 1-16
E	29, 30	Contents of buffer (Wait time in line cycles 00-99)

FLOW CHART EMPLOYENG REMOTE WAIT TIMED
IN A SIMPLE SEQUENCE PROGRAM



REMWTT.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
18 (PLC)	Multiplex Thumbwheels	N/A	None

HEAT RANGE	COUNT	PRESET	CURRENT WINDOW CHECK
N/A	N/A	N/A	None

EXECUTED	I/O	SPECIAL CONSIDERATIONS
As a subroutine in Ladder Logic. Executed once each scan of the program. Suggest placing in rung #1.	Selectible 1-16 outputs defaults to 16 inputs. Input data assignment starting at LSD of the units byte.	On time for each output to thumbwheels is 10MS. Therefore employ high speed DC I/O if more than one thumbwheel set is used.

DESCRIPTION

This **PLC subroutine** is used to scan up to 16 pairs of diode isolated BCD thumbwheels. The data read from the thumbwheel pairs is placed in two byte buffer locations 1 through 16 consecutively. One output and one two read per scan of the PLC program. If only one pair of thumbwheels is required, the arms of the thumbwheel pair may be connected to 24VAC. Diode isolated thumbwheels should not be used. In the MUX instruction, program the output to a unused bit or followed by -00, this will cause no output and one input per scan with the data placed in buffer number 1. If more then one pair are to be scanned, 24VDC high speed inputs and diode isolation must be used. The inputs must be connected so that IN AT xxx bit is the least significant digit of the units thumbwheel BCD byte. See Section 1 paragraph 10.1.18 MUX OUT for other options.

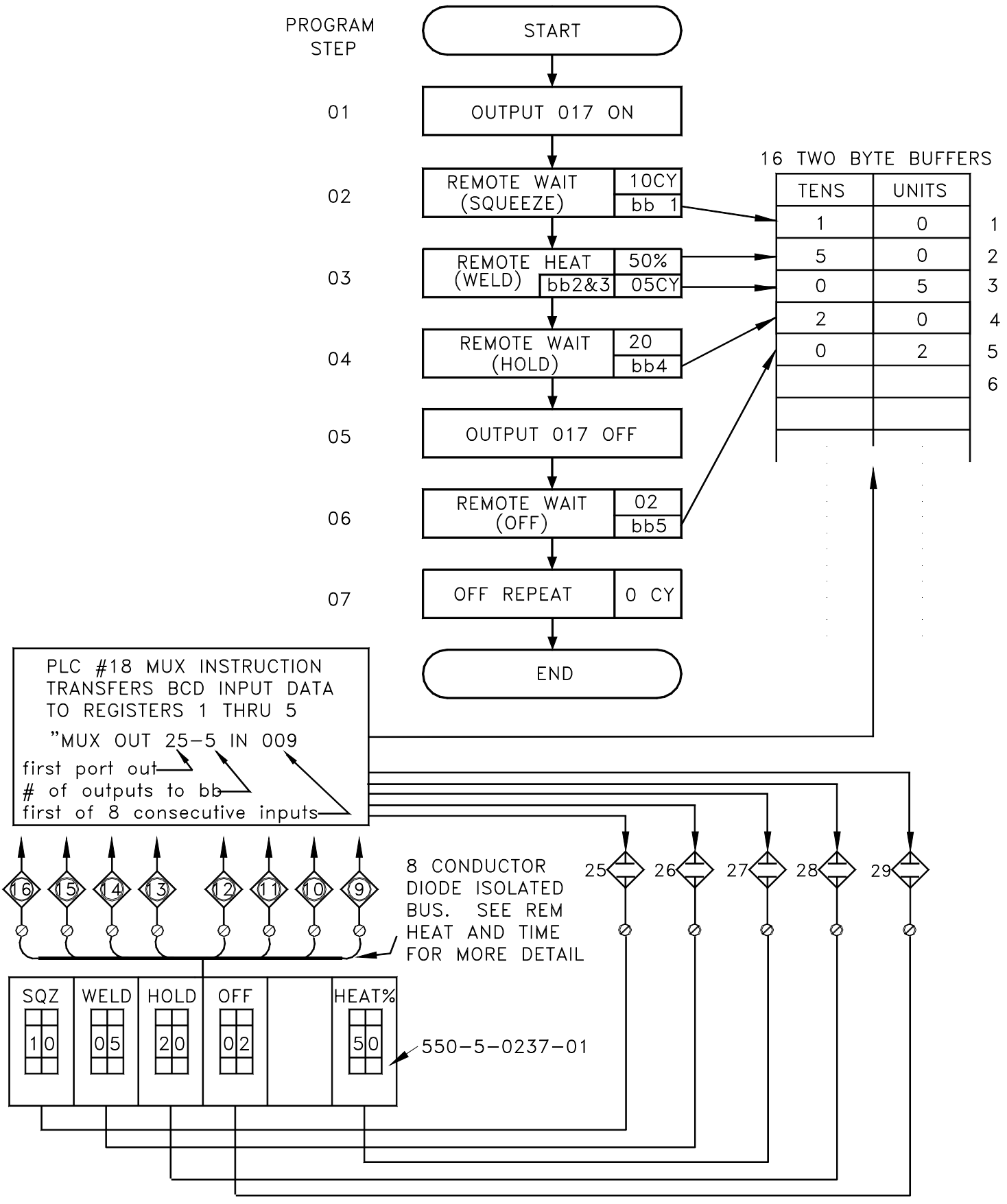
Display:

```
         11111111112222222222333
12345678901234567890123456789012
  1  MUX OUT AT xxx-dd IN AT xxx
         At instruction entry 18
```

Data fields:

ITEM	POSITION	DESCRIPTION
A	1, 3	Ladder logic step number, suggest step #1.
B	>17, 19	First output. (wired to the first thumbwheel pair)
C	21, 22	Number of outputs. (thumbwheel pairs)
E	30, 32	Starting address of the first input (LSD of units byte) Up to 16 consecutive inputs may be scanned. Each output drives a thumbwheel pair, inputs read and data placed in its corresponding buffer location.

POSSIBLE USE OF PLC #18 MUX IN A SEQUENTIAL 3B WELDING PROGRAM



MUX18.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
30	Pressure Switch xxx to be true	Yes	None

HEAT RANGE	COUNT	PRESET	CURRENT WINDOW CHECK
None	N/A	N/A	No

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	Assignable input bit 1-512	In run mode, "Pressure Switch Open" will be displayed until the assigned bit becomes true and the sequence continues.

DESCRIPTION

This instruction provides a halt in sequence flow until a programmable input (bit) is made true. While waiting for the input to become true "PRESSURE SWITCH OPEN" will be displayed. The message will remain until the input bit becomes a 1 which causes the sequence to continue to the next step or the user places the keyswitch in program mode and presses Function Select then the Reset keys which causes the control to accept Program mode during sequence. This instruction is used to assure full tip pressure before welding. It usually is placed before the Weld instruction.

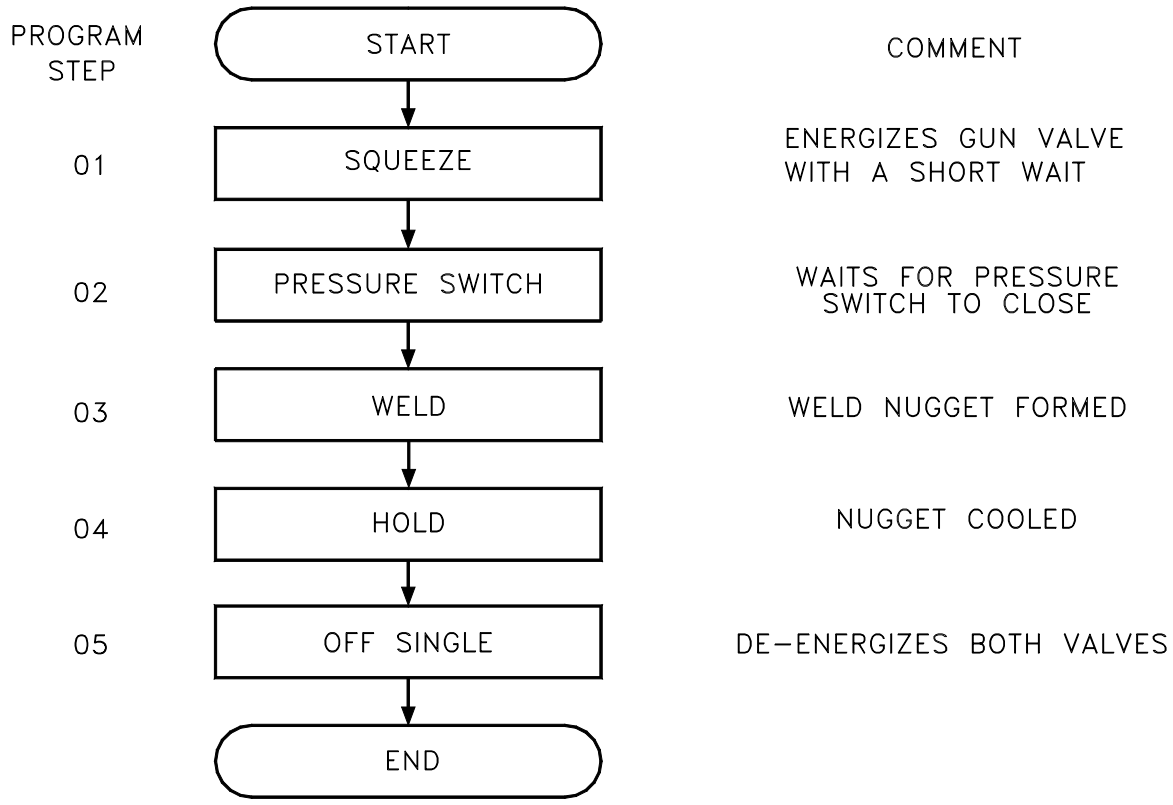
Display:

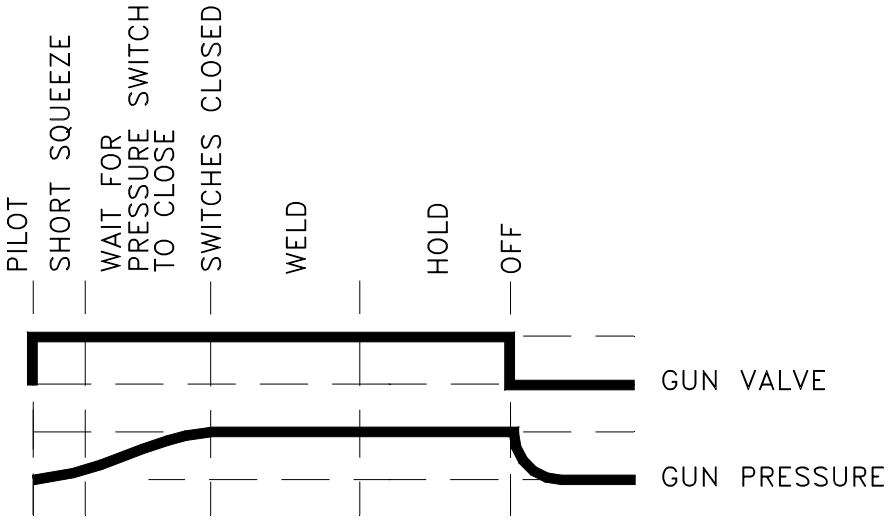
```
         11111111112222222222333
12345678901234567890123456789012
 1- 2 PRESSURE SWITCH  INPUT xxx
         At instruction entry 30
      PRESSURE SWITCH OPEN (While waiting for switch closure)
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 28	Instruction description
D	>30, 32	Input bit assignment

FLOW CHART EMPLOYING PRESSURE SWITCH
IN A SIMPLE SEQUENCE PROGRAM





PRESSW.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
31	SECOND STAGE	Yes	None

HEAT RANGE	COUNT	PRESET	WINDOW CHECK
None	None	None	None

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	Second stage input assignable	Squeeze timing starts (usually next instruction) with closure of SECOND stage INPUT.

DESCRIPTION

This instruction provides an untimed wait for an input (second stage) to become true. It also monitors the pilot (first stage input) status during the wait period and will abort the sequence and delete all sequence outputs if the first stage pilot is removed. After the second stage input is made true the sequence is locked in and executes the next instruction which usually is squeeze, initial squeeze or squeeze delay. Note the squeeze timing STARTS AFTER the second stage input is made true.

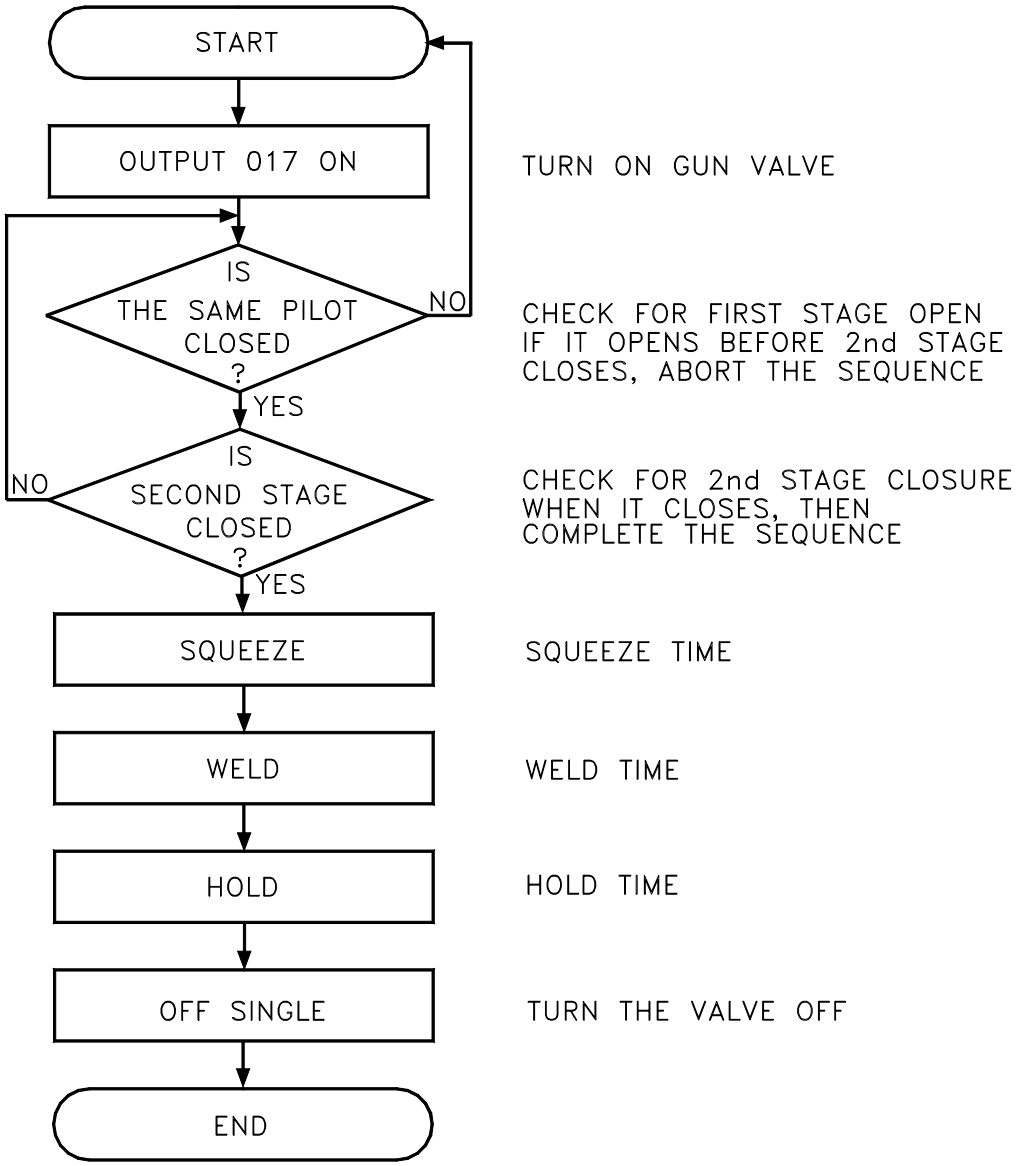
Display:

```
         1111111111222222222333
12345678901234567890123456789012
 1- 2 SECOND STAGE     INPUT xxx
         At instruction entry 31
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 28	Instruction description
D	>30, 32	Second stage input bit assignment

FLOW CHART EMPLOYING SECOND STAGE
IN A SIMPLE SEQUENCE PROGRAM



SECSTG1.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
32	NEMA SECOND STAGE	Yes	None

HEAT RANGE	COUNT	PRESET	WINDOW CHECK
None	None	None	None

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	Second stage input assignable	Must be programmed BEFORE Squeeze, Initial Squeeze, or Squeeze delay. Starts The functions timing.

DESCRIPTION

This instruction provides a parallel timed and untimed wait for an input (second stage) to become true. It STARTS the timing of the next instruction but prohibits exit even if the timing is completed. Exit to the next instruction occurs only after the second stage input is made true. The instruction monitors the pilot status (first stage) during the wait periods and will abort the sequence, delete all sequence outputs and reset the timing started if first stage input is removed. After the second stage input is made true the control is locked in sequence, Squeeze timing is FINISHED (if not finished) then executes the next instruction.

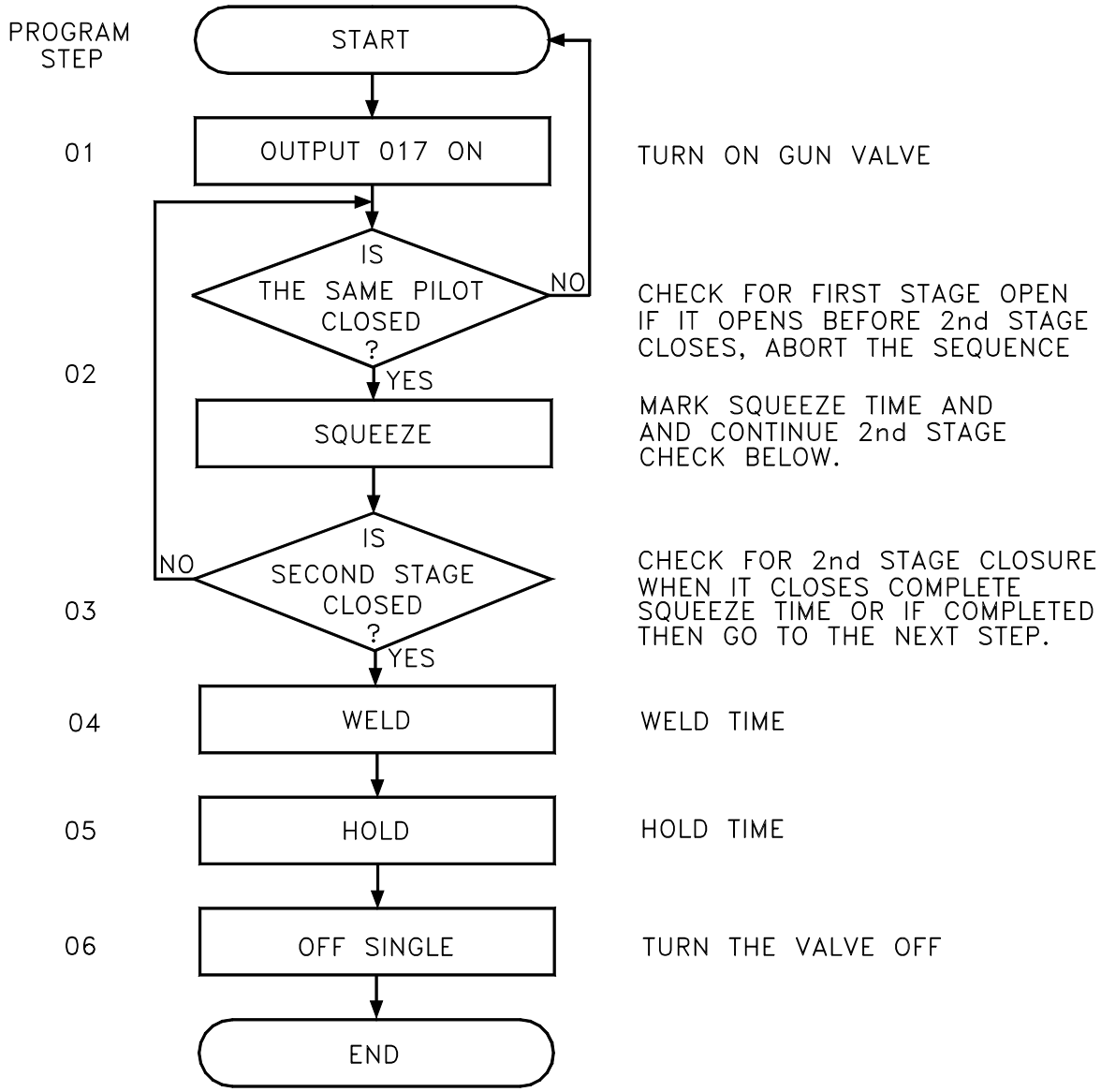
Display:

```
         1111111111222222222333
12345678901234567890123456789012
 1- 2 NEMA SECOND STAGE INPUTxxx
         At instruction entry 32
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 29	Instruction description
D	>30, 32	Second stage input bit assignment

FLOW CHART EMPLOYING NEMA SECOND STAGE
IN A SIMPLE SEQUENCE PROGRAM



SECSTG2.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
33	Squeeze Delay	Yes	00-99 Cycles

HEAT RANGE	COUNT	PRESET	CURRENT WINDOW CHECK
None	Once per repeated sequence.	1	None

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Only on the first pass in repeat mode	Output user assigned	User must assign output bit. Squeeze Delay must be assigned before Squeeze and in repeat See code 09. Global Squeeze Delay will be applied if data is programmed in Set-up

DESCRIPTION

A squeeze time added to a second squeeze time at the start of a repeated sequence. Used to permit the initial movement of electrodes through their greater starting distance. This instruction is similar to Initial Squeeze code #1. The difference in the Squeeze Delay case, is on the first pass of a repeated sequence Squeeze Delay time will be ADDED to Squeeze time. Where in the case of Initial Squeeze, Initial Squeeze time is SUBSTITUTED for Squeeze time on the first pass. A global Squeeze time is programmable under SET-UP. If Global Squeeze Delay time is zero the user may place the cursor at delay and program a value that will be used. If the Global Squeeze time is non-zero, the delay value will be placed in every programmed Squeeze Delay time. The user will not be able to place the cursor at the delay time in the function.

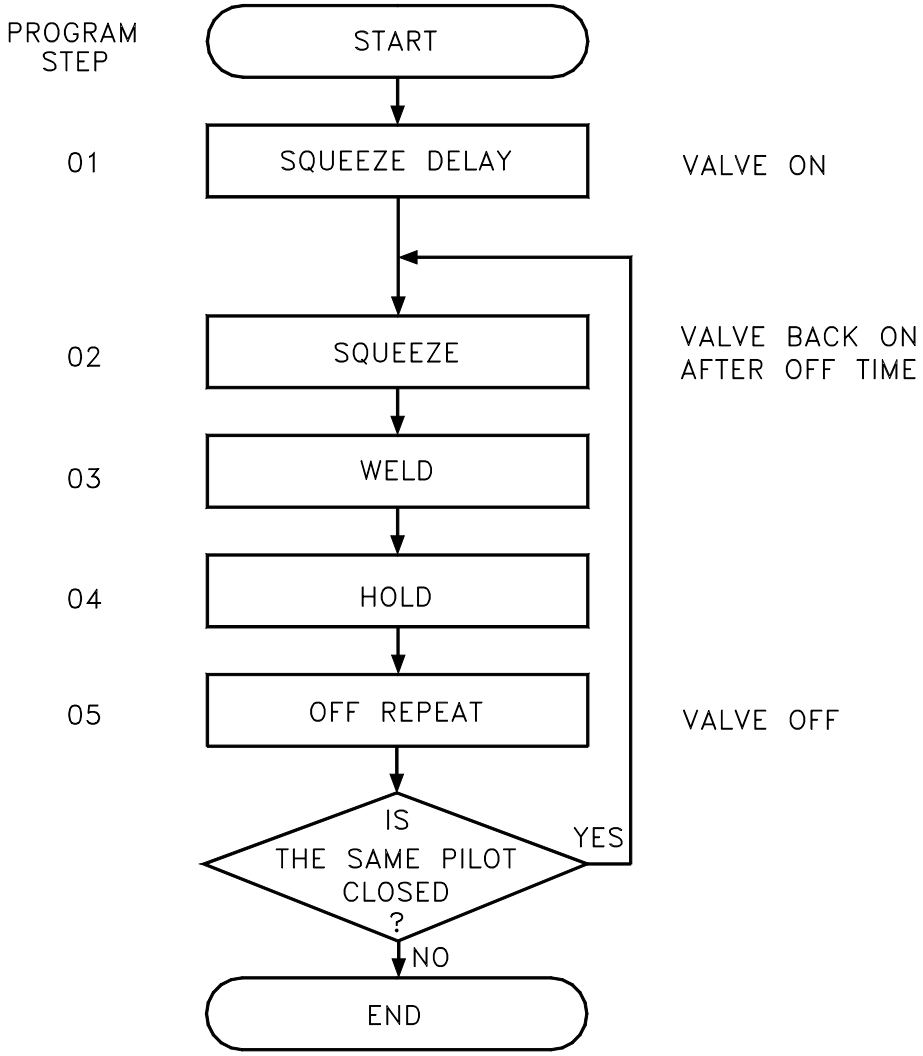
Display:

```
         1111111111222222222333
12345678901234567890123456789012
 1- 1 SQUEEZE DELAY OUT xxx ccCY
         At instruction entry 33
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 23	Instruction description
D	25, 27	Output bit assignment
E	>29, 30	Squeeze Delay time 00-99 cycles cursor position only if Global squeeze time is zero

FLOW CHART EMPLOYING SQUEEZE DELAY
IN A SIMPLE SEQUENCE PROGRAM



SQZDLY.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
34	Flash Heat	Yes	0-999 Cycles 0=Infinity

HEAT RANGE	COUNT	PRESET	CURRENT WINDOW CHECK
20-99% of Available current	N/A	N/A	Yes.

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	Firing pulse for each 1/2 cycle if programmed 20-99% heat. Controlled by user defined input bit.	Instruction completion on either input true or override timeout. If timeout occurs bit #429 will be set.

DESCRIPTION

This instruction provides welding current for some distance controlled by a limit switch, or for a timing period if the input bit never becomes true. The timing period is usually used as a override time in case of input failure. The flash function serves as a heating and cleaning (Burn Off) of the flashing parts. For diagnostic purposes the user may examine bit #429 to check for a timer override condition. This may be done in the following sequence instructions or in a PLC program.

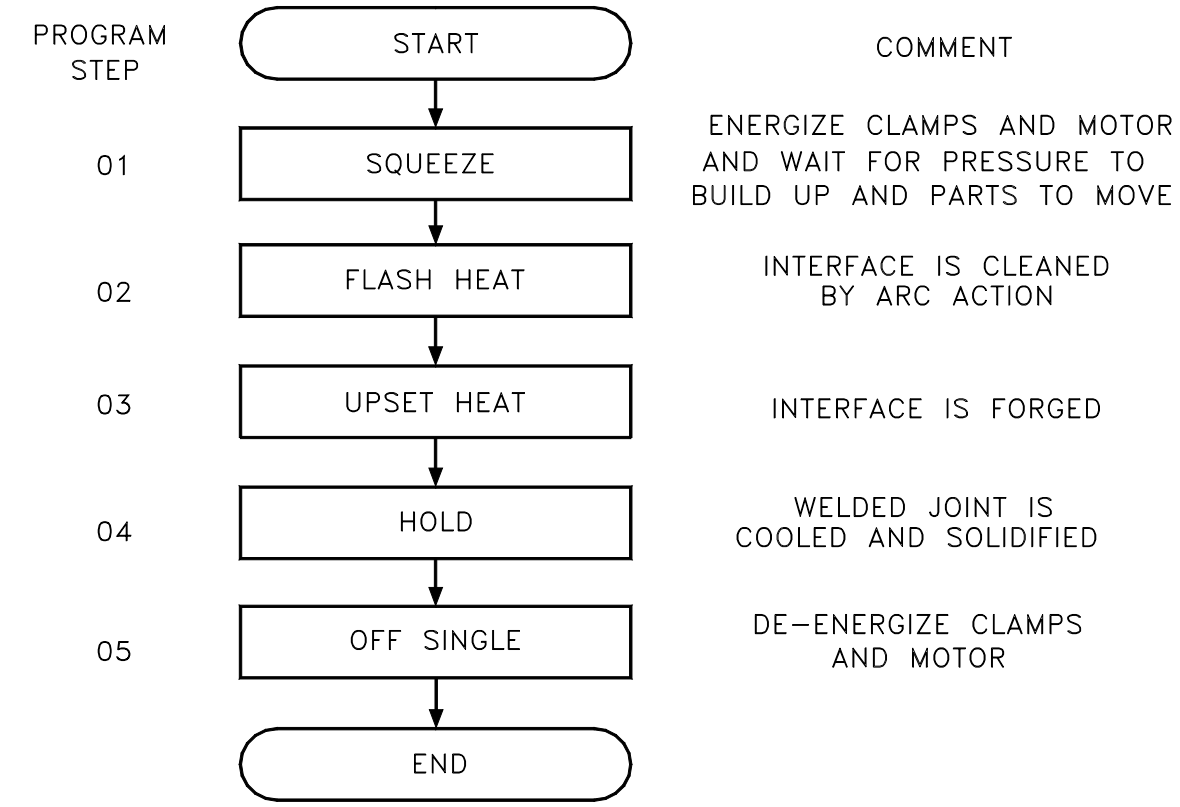
Display:

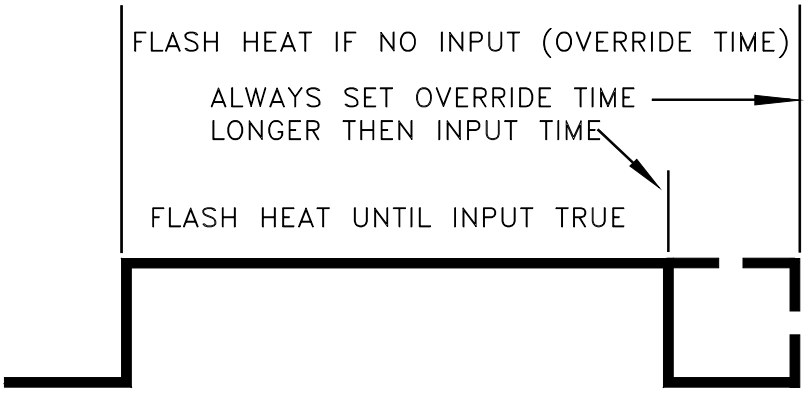
```
         1111111111222222222333
12345678901234567890123456789012
 1- 2 FLASH HT INP xxx hh% cccCY
         At instruction entry 34
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 18	Instruction description
D	20, 22	User assignable heat termination input bit
E	>24, 25	Percent of available Flashing current
F	28, 30	Override time in line cycles 000-999

FLOW CHART EMPLOYING FLASH HEAT
IN A SIMPLE SEQUENCE PROGRAM





FLASH.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
35	Upset Heat	Yes	0-999 Cycles 0=Infinity

HEAT RANGE	COUNT	PRESET	CURRENT WINDOW CHECK
20-99% of Available current	N/A	N/A	Yes.

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	Firing pulse for each 1/2 cycle if programmed 20-99% heat. Controlled by user defined input bit.	Instruction completion on either input bit true or override timeout. If timeout occurs bit #429 will be set.

DESCRIPTION

This instruction provides welding current for some distance controlled by a limit switch, or for a timing period if the input bit never becomes true. The timing period is usually used as a override time in case of input failure. The Upset heat function usually follows Flash Heat and is used to "upset" the hot metal for some distance determined by a limit switch. For diagnostic purposes the user may examine bit #429 to check for a timer override condition. This may be done in the following sequence instructions or in a PLC program.

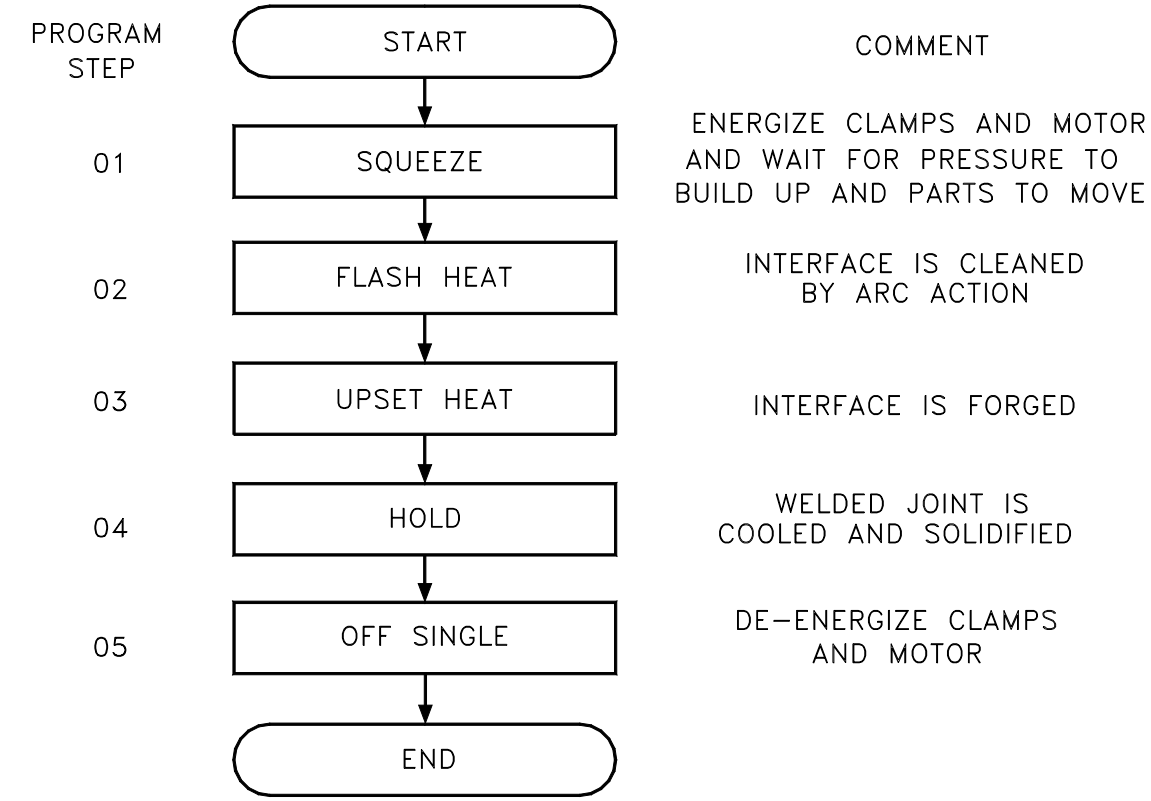
Display:

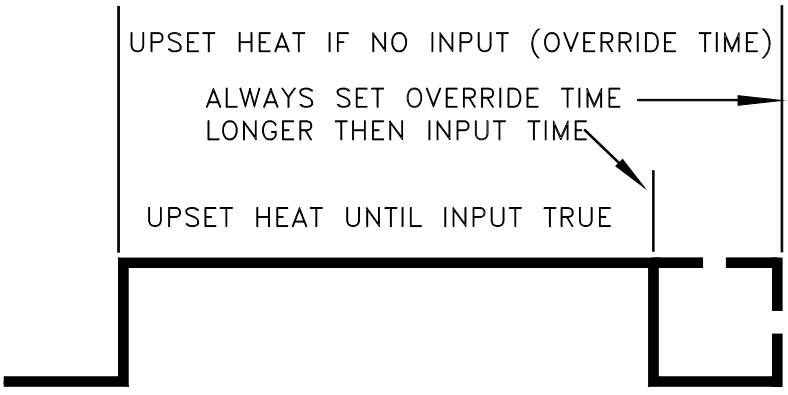
```
         1111111111222222222333
12345678901234567890123456789012
 1- 3 UPSET HT INP xxx hh% cccCY
         At instruction entry 35
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 18	Instruction description
D	20, 22	User assignable heat termination input bit
E	>24, 25	Percent of available Upset current
F	28, 30	Override time in line cycles 000-999

FLOW CHART EMPLOYING UPSET HEAT
IN A SIMPLE SEQUENCE PROGRAM





UPSET.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
36	Delay	YES	000-999 Cycles

HEAT RANGE	COUNT	PRESET	CURRENT WINDOW CHECK
None	N/A	N/A	No

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	None	None

DESCRIPTION

This instruction provides a simple delay of 000 to 999 line cycles. It is the same as instruction 11 Wait, except it defaults to displayed mode and is labeled Delay.

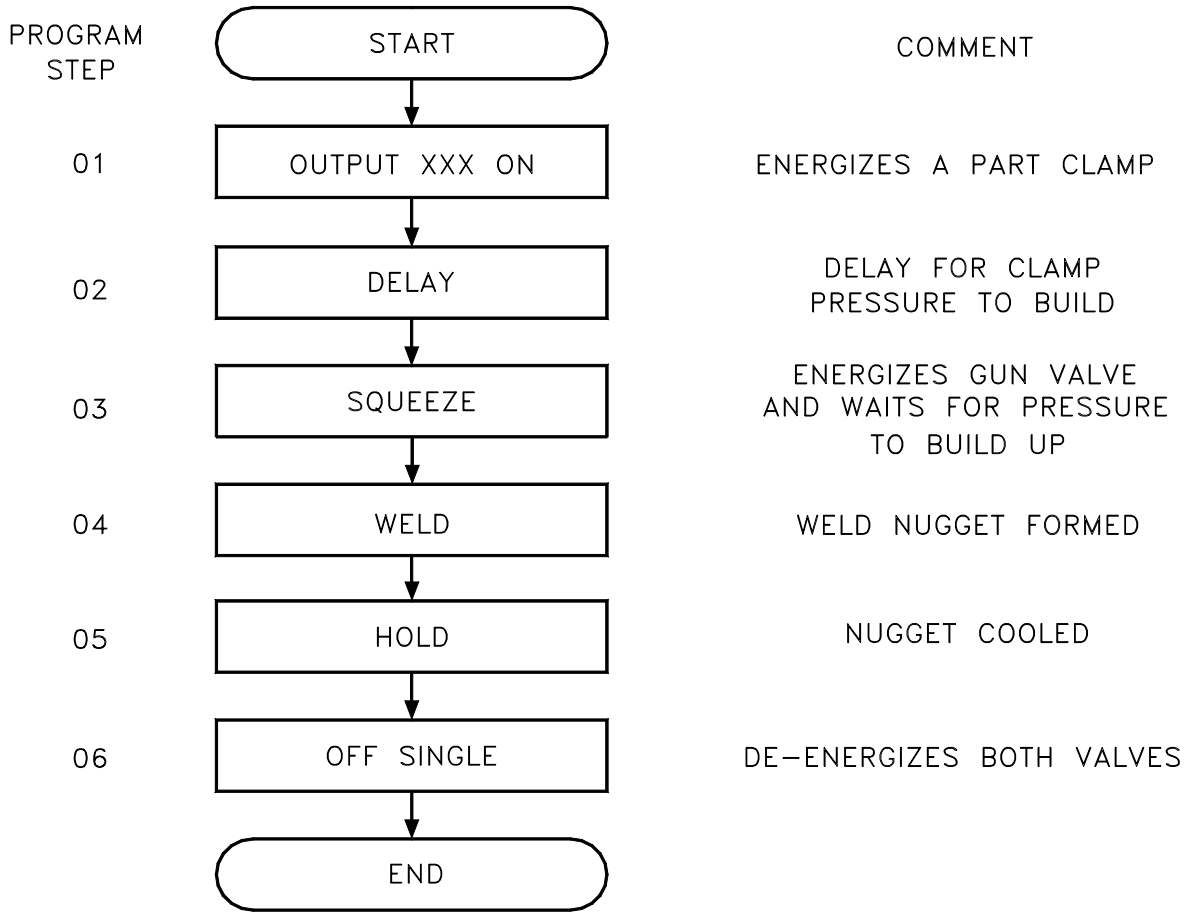
Display:

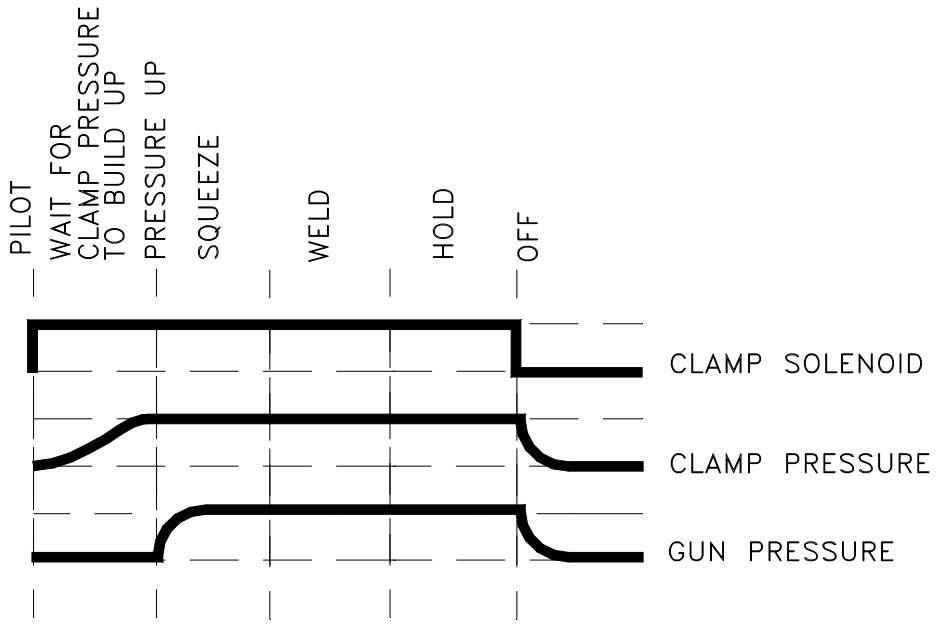
```
         11111111112222222222333
12345678901234567890123456789012
 1- 6 DELAY                cccCY
         At instruction entry 36
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 11	Instruction description
D	>28, 30	Delay timing in line cycles 000-999 line cycles

FLOW CHART EMPLOYING DELAY
IN A SIMPLE SEQUENCE PROGRAM





DELAY.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
37	Seam-Beat	Yes	0-99 Cycles Cool 1-99 Cycles Heat

HEAT RANGE	COUNT	PRESET	CURRENT WINDOW CHECK
20-99% of available current	N/A	N/A	Yes

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	Firing pulses for each half cycle until pilot made not true	If cool time is dialed to 0, Seam will be continuous.

DESCRIPTION

This instruction checks the pilot status during heat and cool periods and aborts when the pilot goes false or the pilot status changes. This may only happen when an even number of 1/2 cycles have occurred. The sequence will continue at the instruction following the seam-beat instruction.

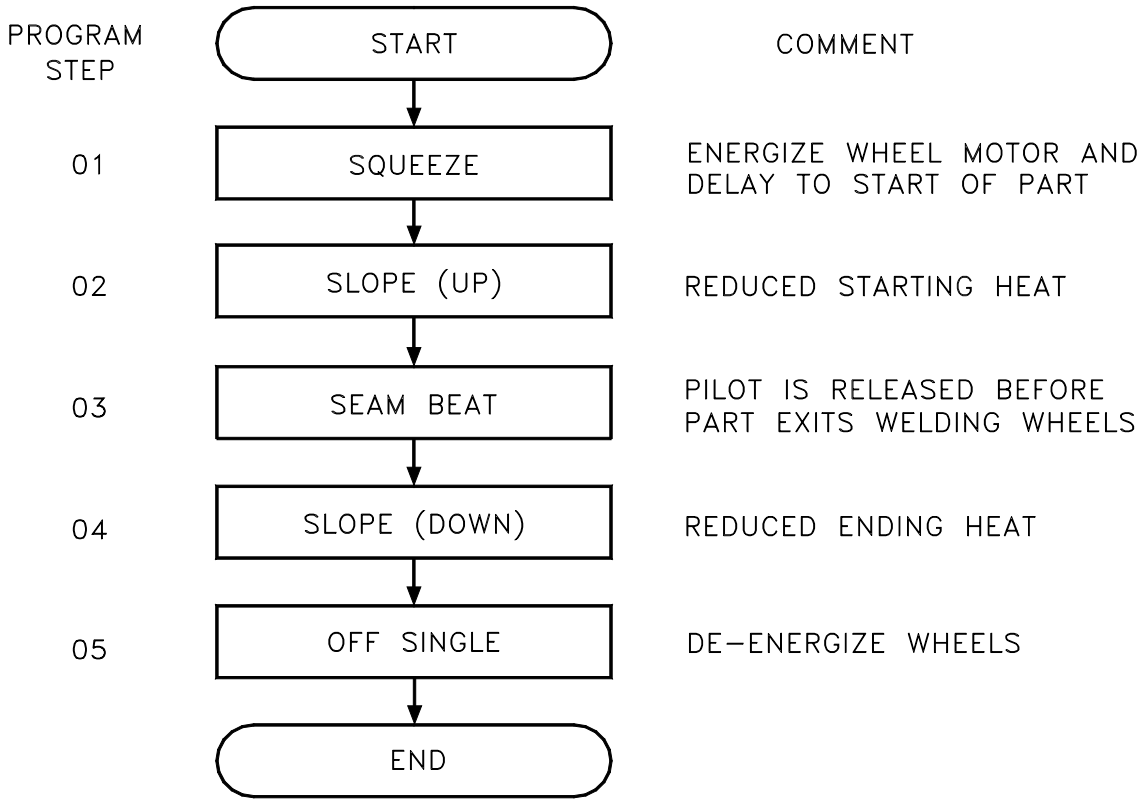
Display:

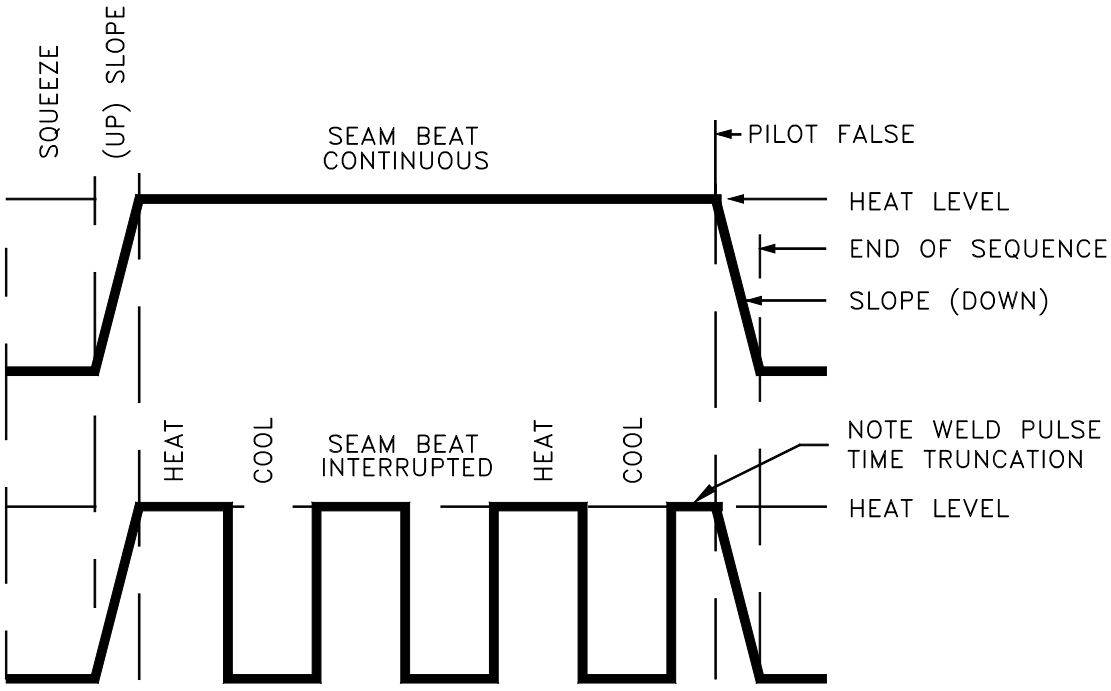
```
         1111111111222222222333
12345678901234567890123456789012
 1- 3 SEAM-BEAT hh%  HT cc CL cc
         At instruction entry 37
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 15	Instruction description
D	>17, 18	Percent of available current during heat pulses 20-99%
E	25, 26	Heat pulses time in line cycles 1-99
F	31, 32	Cool pulses time in line cycles 0-99

FLOW CHART EMPLOYING SEAM BEAT
IN A SIMPLE SEQUENCE PROGRAM





SEAMBT.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
38	Seam-nonbeat	Yes	0-99 Cycles Cool 1-99 Cycles Heat

HEAT RANGE	COUNT	PRESET	CURRENT WINDOW CHECK
20-99% of available current	N/A	N/A	Yes

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	Firing pulses for each half cycle until pilot made not true	If cool time is dialed to 0, Seam will be continues.

DESCRIPTION

This instruction checks the pilot status during heat and cool periods. If in continuous seam (no cool time) this function will abort at the first occurring even number of 1/2 cycles of heat after the pilot changes status. If in intermittent seam (cool>0) and in a cool period, the function will abort at the first occurring even number of 1/2 cycles after the pilot status changes. If in intermittent seam and in a heat period, this function will abort only after the heat time is completed. The sequence will continue at the instruction following Seam-nonbeat.

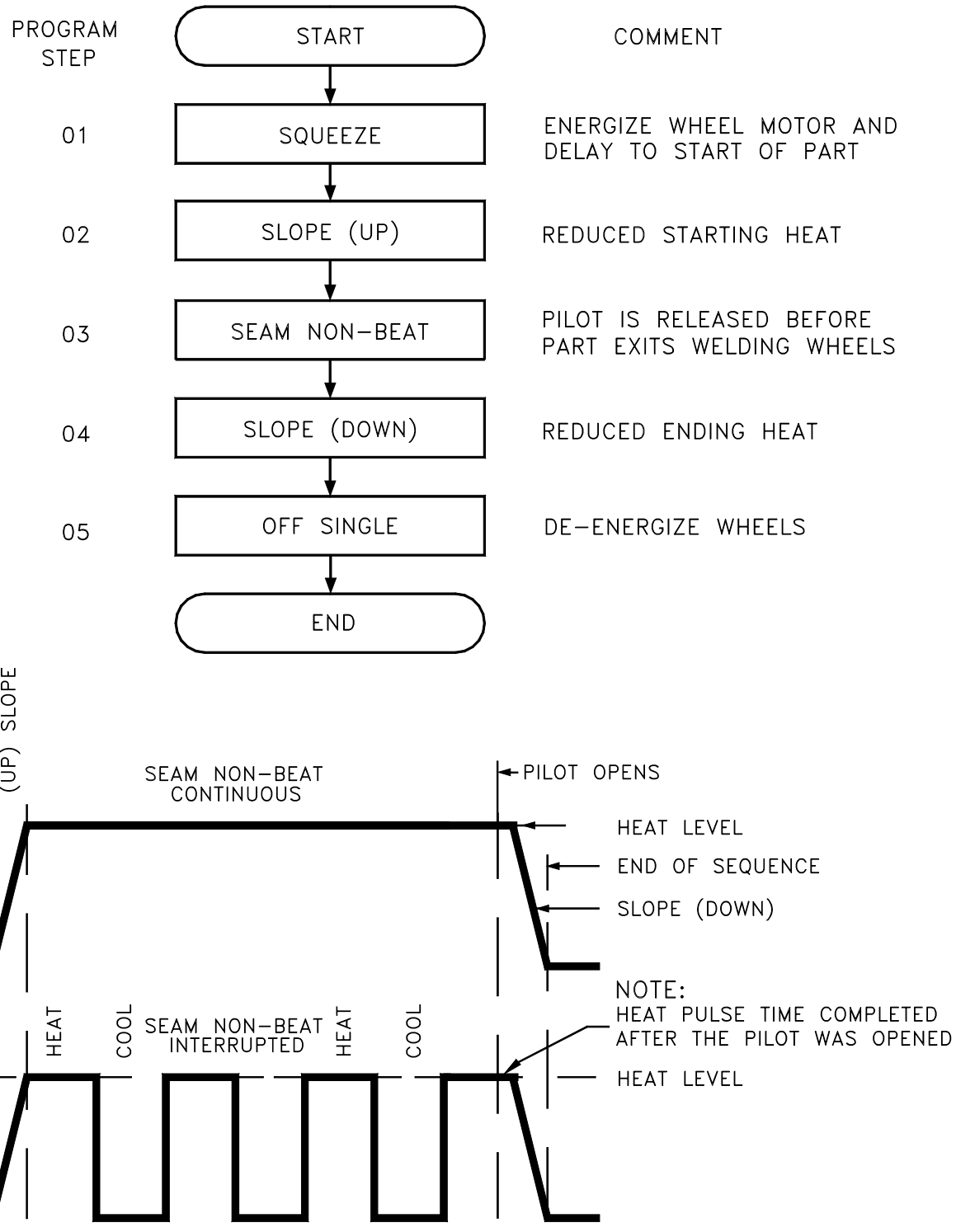
Display:

```
         11111111112222222222333
12345678901234567890123456789012
 1- 3 SEAM-NONBT hh% HT cc CL cc
         At instruction entry 38
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 16	Instruction description
D	>18, 19	Percent of available current during heat pulses 20-99%
E	25, 26	Heat pulses time in line cycles 1-99
F	31, 32	Cool pulses time in line cycles 0-99

FLOW CHART EMPLOYING SEAM NON–BEAT
IN A SIMPLE SEQUENCE PROGRAM



SEAMNBT.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
39	Forge Valve/Delay	Yes	00-999 Cycles

HEAT RANGE	COUNT	PRESET	WINDOW CHECK
None	None	None	None

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	Output Assignable	Timing runs concurrently with timed sequence functions. Only one Forge delay timer may be timing at one time. If attempted the next timer resets the first.

DESCRIPTION

This function is usually inserted before the Weld function, but may be inserted after. The instruction sets a output bit at the end of a selected delay. Delay timing starts at the position of insertion, and the output is used to change pressure to "Forge" hot metal.

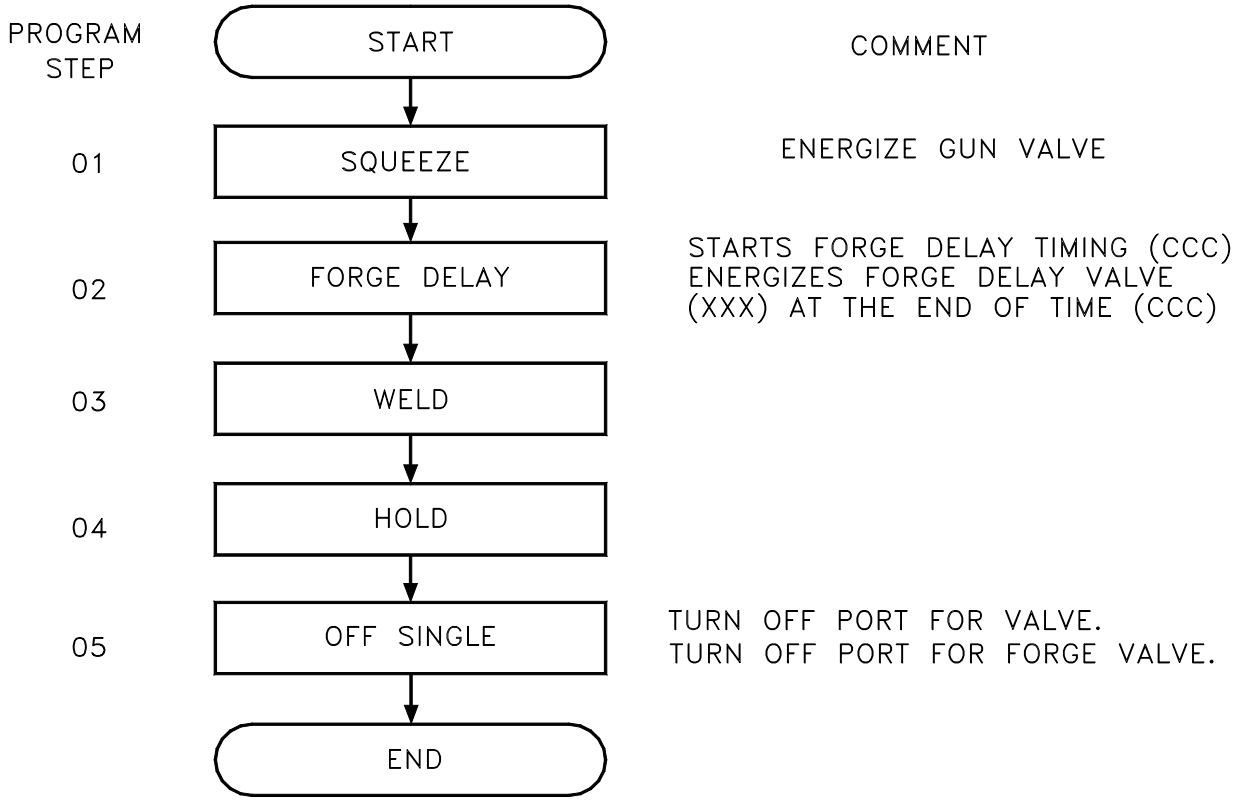
Display:

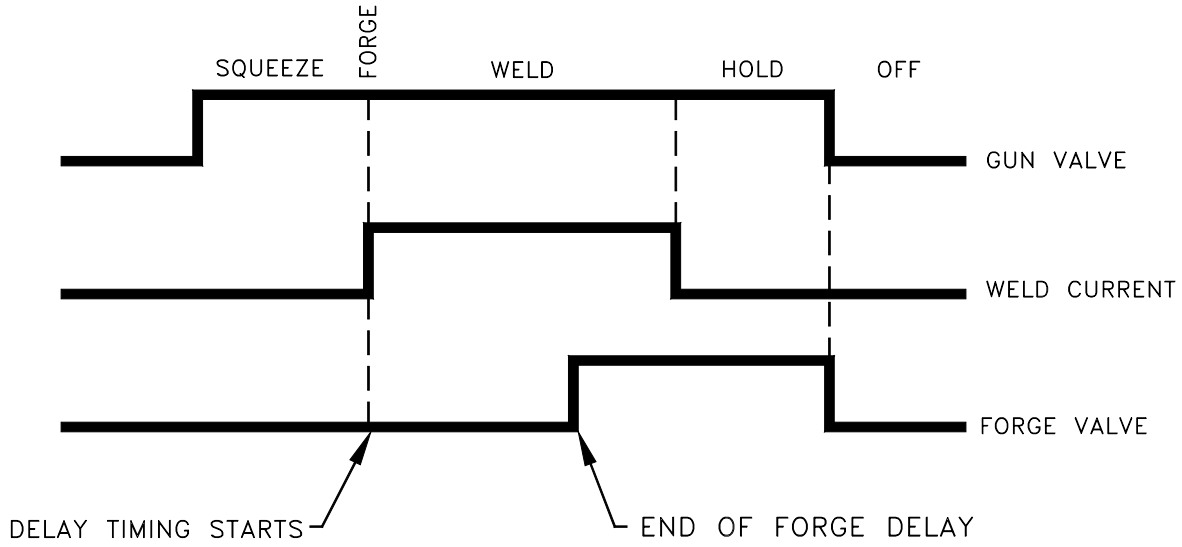
```
         11111111112222222222333
12345678901234567890123456789012
 1- 2 FORGE DELAY OUT xxx ccc CY
         At instruction entry 39
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1,2	Sequence number 01-31
B	4,5	Program step number 01-99
C	7, 21	Instruction description
D	23, 25	Assigned output bit for pressure change valve
E	>27, 29	Forge delay time 000-999 line cycles

FLOW CHART EMPLOYING FORGE VALVE/DELAY
IN A SIMPLE SEQUENCE PROGRAM





FVDELAY.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
40	Quench	Yes	00-99 Cycles

HEAT RANGE	COUNT	PRESET	CURRENT WINDOW CHECK
None	N/A	N/A	No

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	None	None

DESCRIPTION

Quench time is the time interval between the weld period and the temper period. No current is supplied during the quench period; hence, it is a cooling function.

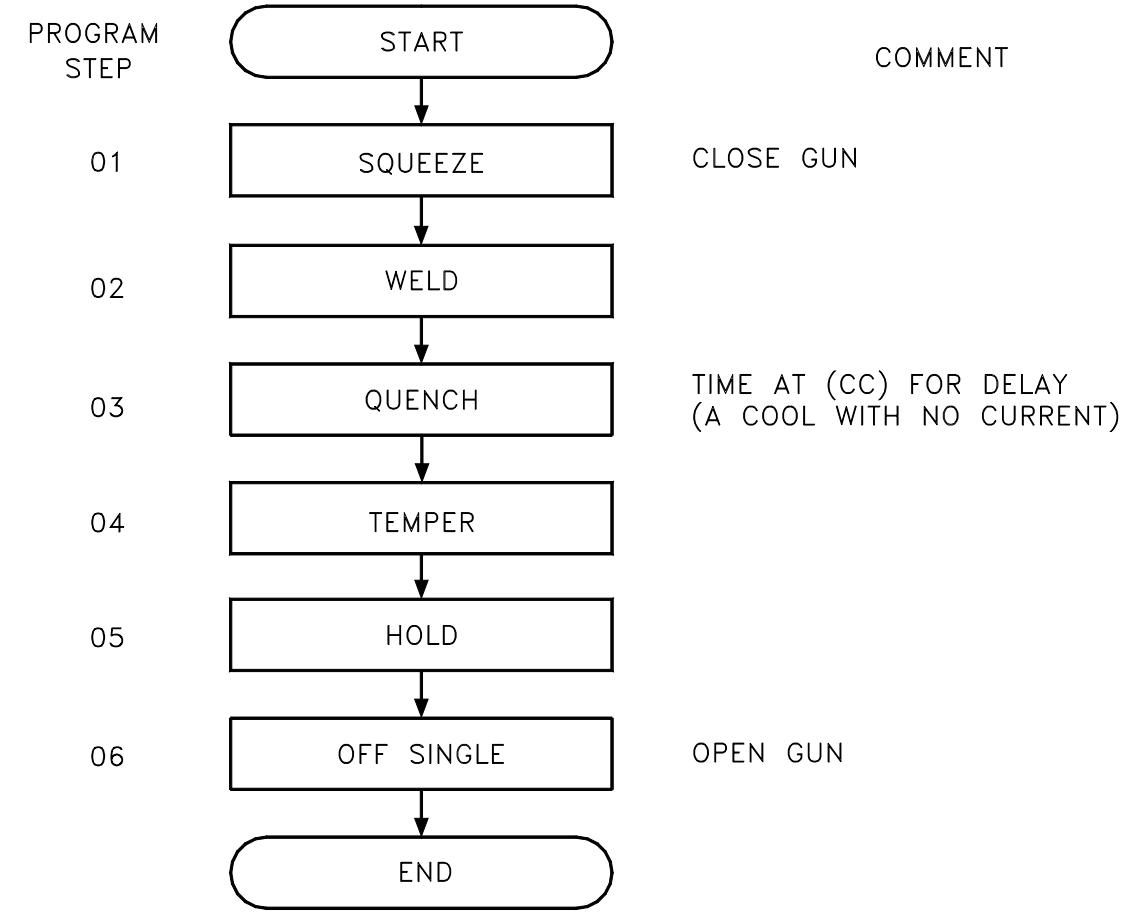
Display:

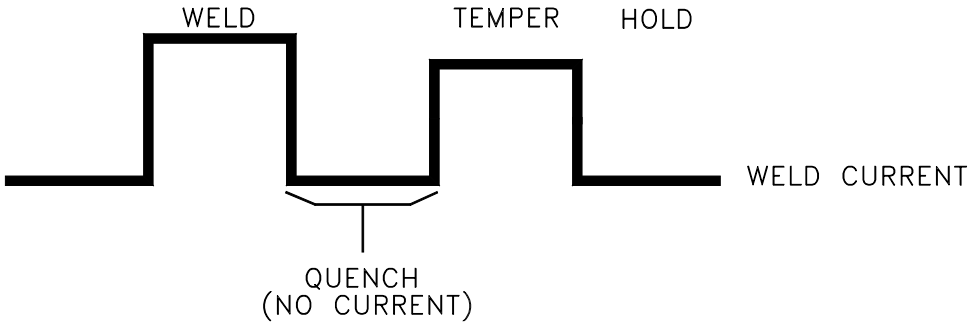
```
         1111111111222222222333
12345678901234567890123456789012
 1- 3 QUENCH                ccCY
         At instruction entry 40
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 12	Instruction description
D	>29, 30	Quench timing in line cycles 0-99

FLOW CHART EMPLOYING QUENCH
IN A SIMPLE SEQUENCE PROGRAM





QUENCH.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
41	Temper	Yes	00-99 Cycles

HEAT RANGE	COUNT	PRESET	CURRENT WINDOW CHECK
20-99% of Available current	N/A	N/A	Yes.

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	Firing pulse for each 1/2 cycle if programmed 20-99% heat	User may enter a Temper ID # in position nn, if not entered it remains blank.

DESCRIPTION

Temper current is an impulse or a series of impulses of current which occur after and separate from the weld current. It is usually used in conjunction with the Quench function. These functions are used to prevent the possible cracking and/or crystallization of the weld nugget by controlling its cooling process.

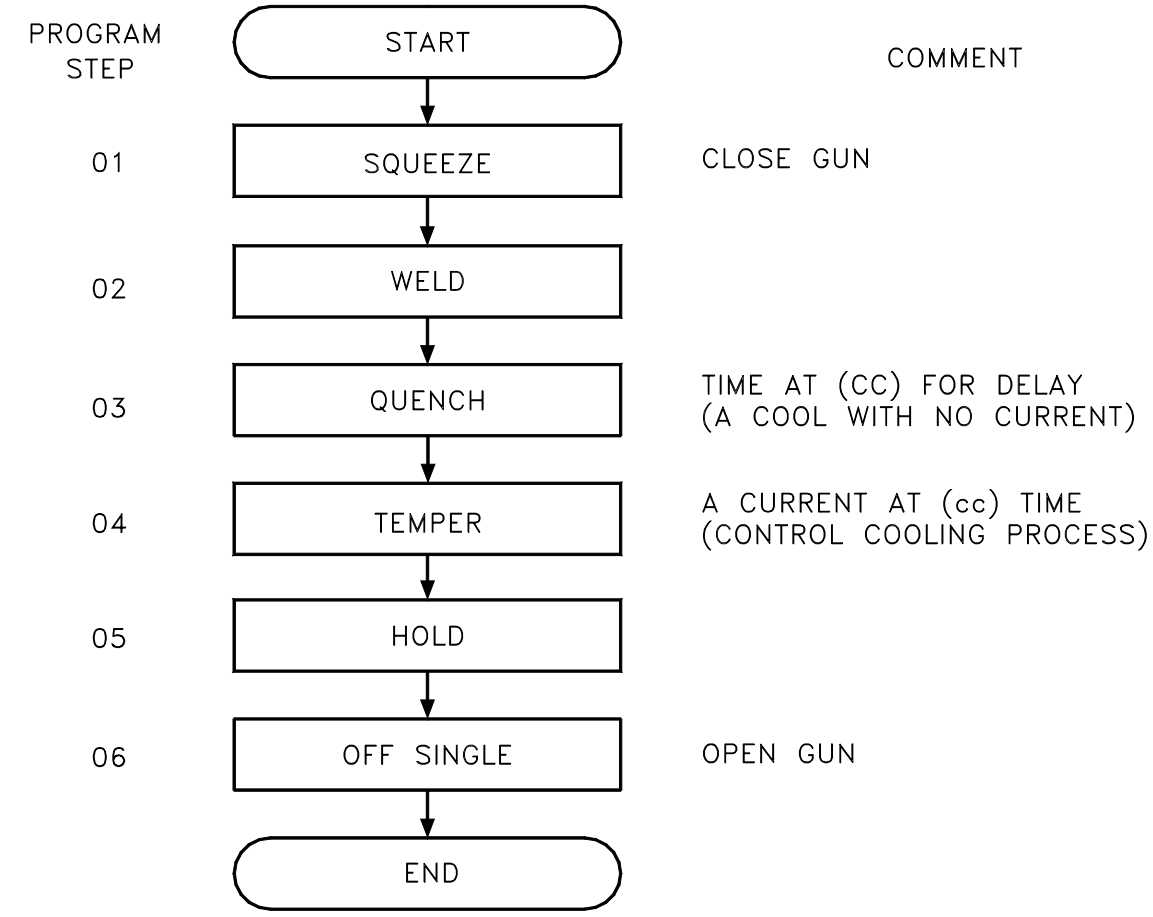
Display:

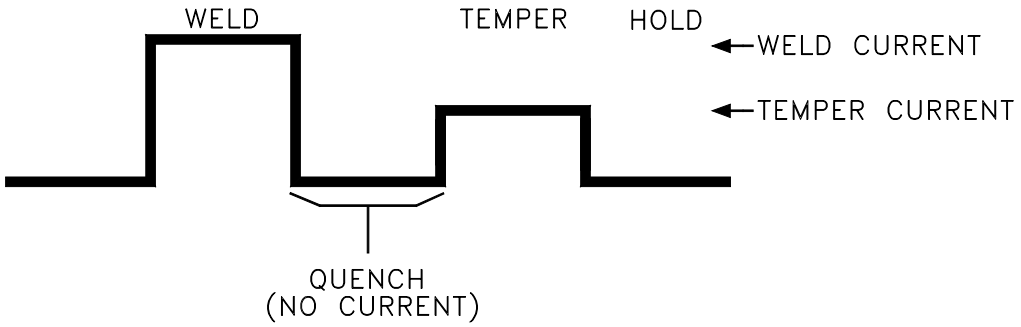
```
         1111111111222222222333
12345678901234567890123456789012
 1- 4 TEMPER nn  hh% (mm%)  ccCY
         At instruction entry 41
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 12	Instruction description
D	14, 15	User optional Temper number
E	>18, 19	Percent of available Temper current
F	23, 24	Temper percent with stepper and/or AVC influence (actual heat applied to firing circuit)
G	29, 30	Temper timing in line cycles

FLOW CHART EMPLOYING TEMPER
IN A SIMPLE SEQUENCE PROGRAM





TEMPER.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
42	EOH (End Of Hold)	Yes	00-99 Cycles

HEAT RANGE	COUNT	PRESET	CURRENT WINDOW CHECK
None	N/A	N/A	No

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	Assignable output bit	Usually inserted just before Off Single. Will not be enabled in Repeat mode. Timing outside of sequence.

DESCRIPTION

This function outputs to the assigned output bit at the end of a delay time (DLY). The duration (dwell) of this output is determined by a programmable time DWL. The pilot status is monitored during the end-of- hold period and if a new pilot is detected during the dwell time, dwell time is truncated and the end-of-hold output is deleted. EOH is used as a hand-shaking function between a spot welding robot and the weld control. Delay (DLY) time is adjusted to assure the electrodes are open before robot movement. Dwell (DWL) time is adjusted just long enough for the robot to "see" the EOH signal.

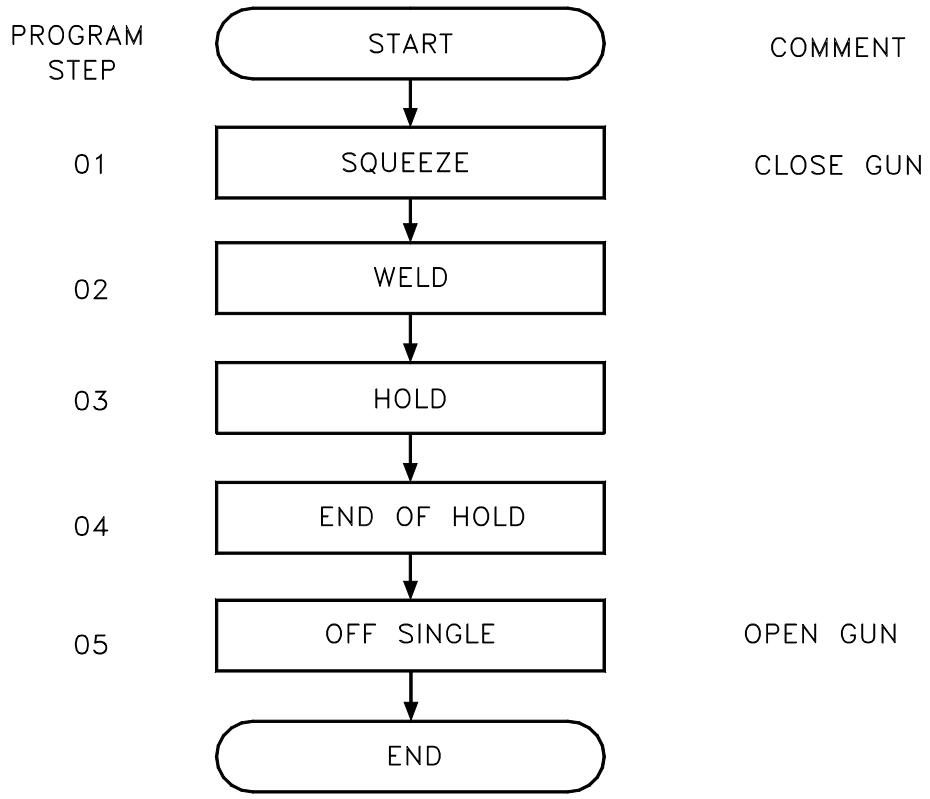
Display:

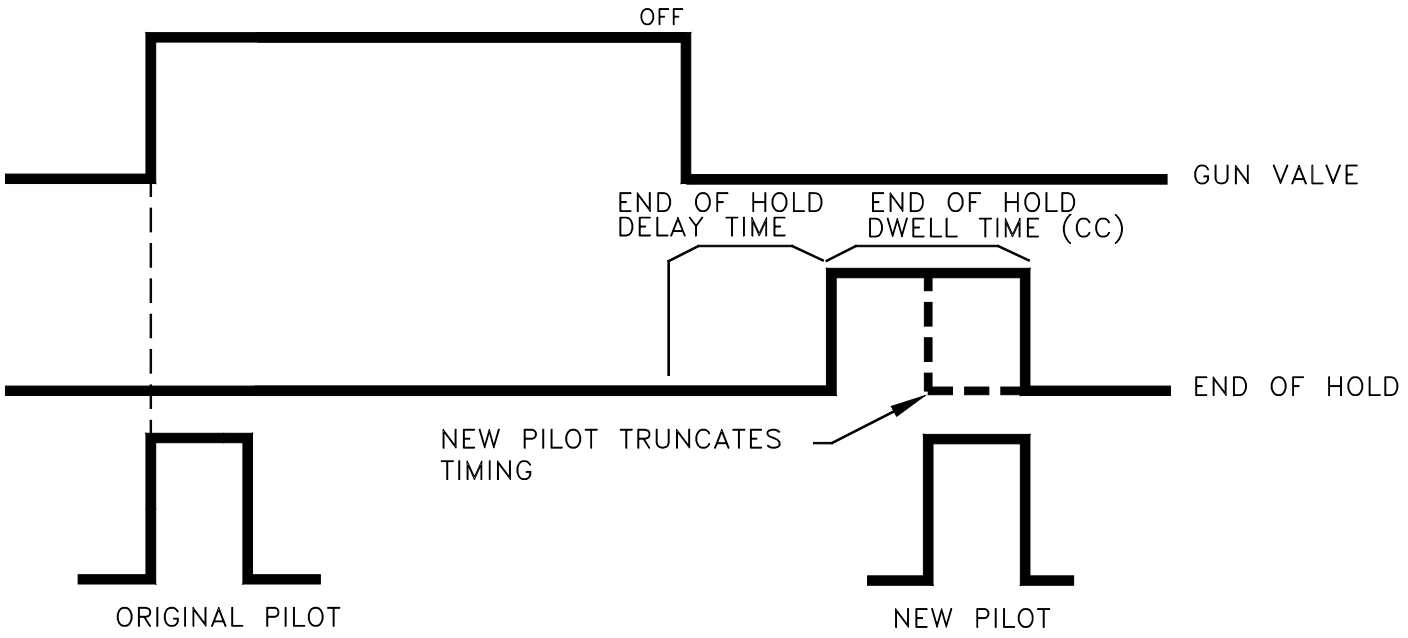
```
         1111111111222222222333
12345678901234567890123456789012
 1- 4 EOH OUT xxx DLY cc  DWL cc
         At instruction entry 42
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 13	Instruction description
D	15, 17	Programmable EOH output bit
E	>23, 24	End of Hold Delay time
F	31, 32	End of Hold Dwell (on) Time

FLOW CHART EMPLOYING EOH (END OF HOLD)
IN A SIMPLE SEQUENCE PROGRAM





NOTE: IF ORIGINAL PILOT IS MAINTAINED, END OF HOLD DWELL IS NOT TRUNCATED

EOH.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
43	Index	Yes	00-99 Cycles

HEAT RANGE	COUNT	PRESET	CURRENT WINDOW CHECK
None	N/A	N/A	None

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	Assignable output bit	User must assign output bit, the bit remains true for the programmed time only.

DESCRIPTION

Index provides a programmable output for a programmable time. It is used in a machine or part "movement" function.

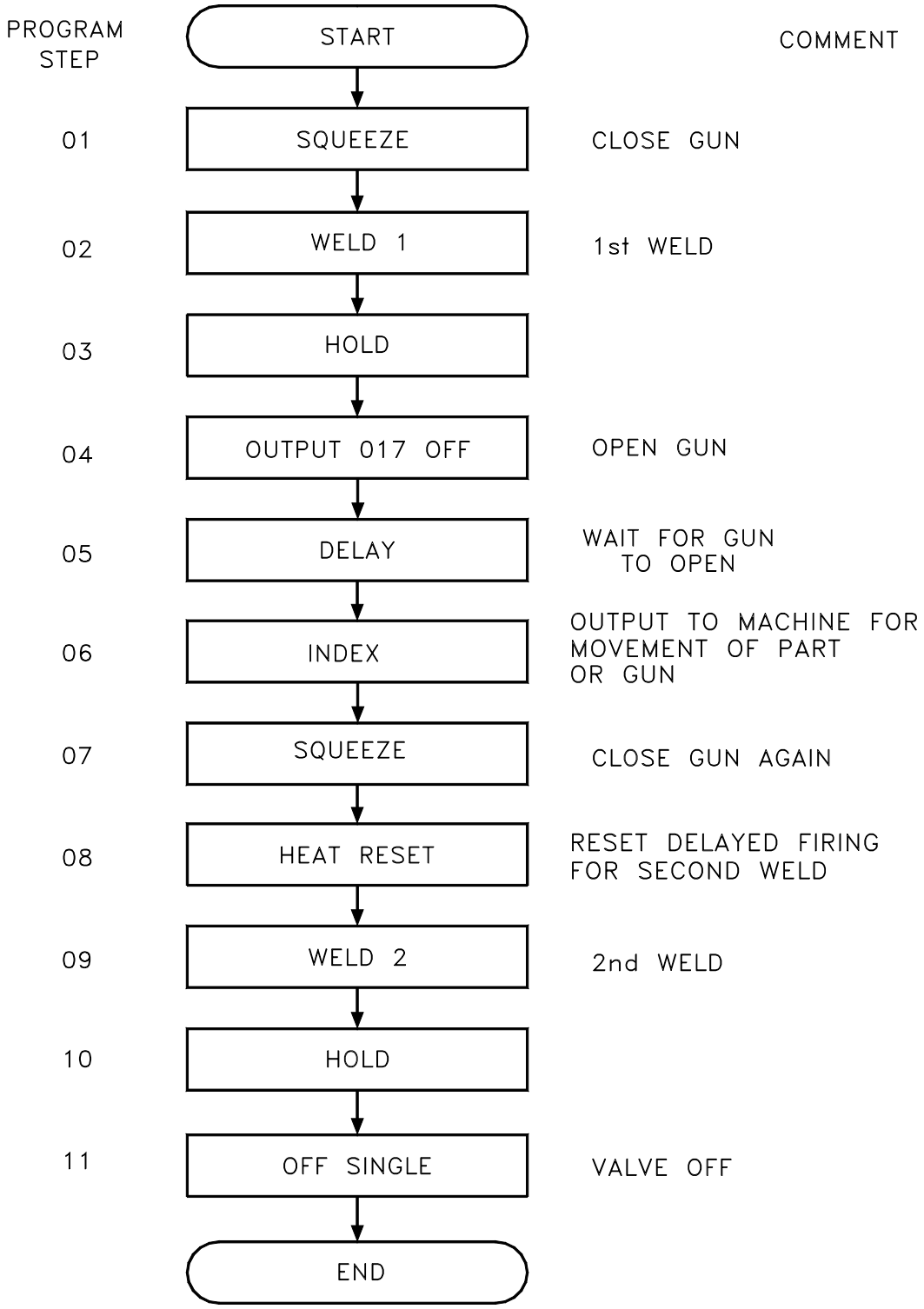
Display:

```
         11111111112222222222333
12345678901234567890123456789012
 1- 5 INDEX OUT xxx         ccCY
         At instruction entry 43
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 15	Instruction description
D	17, 19	Index output bit assignment
E	>29, 30	Index time

FLOW CHART EMPLOYING INDEX
IN A SIMPLE WELD–SHIFT–WELD PROGRAM



INDEX.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
44	Production Count	Yes	None

HEAT RANGE	COUNT	PRESET	CURRENT WINDOW CHECK
None	0-65,535	N/A	None

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	None	A register must be assigned (0-31).

DESCRIPTION

This instruction increments a register each pass through the instruction. The same register may be assigned in different steps or sequences, and also in a PLC program at the same time. The register is reset to 0 by displaying the instruction, with the control in program mode depressing the Reset keypad, or by controlling the reset bit in a Ladder Logic program.

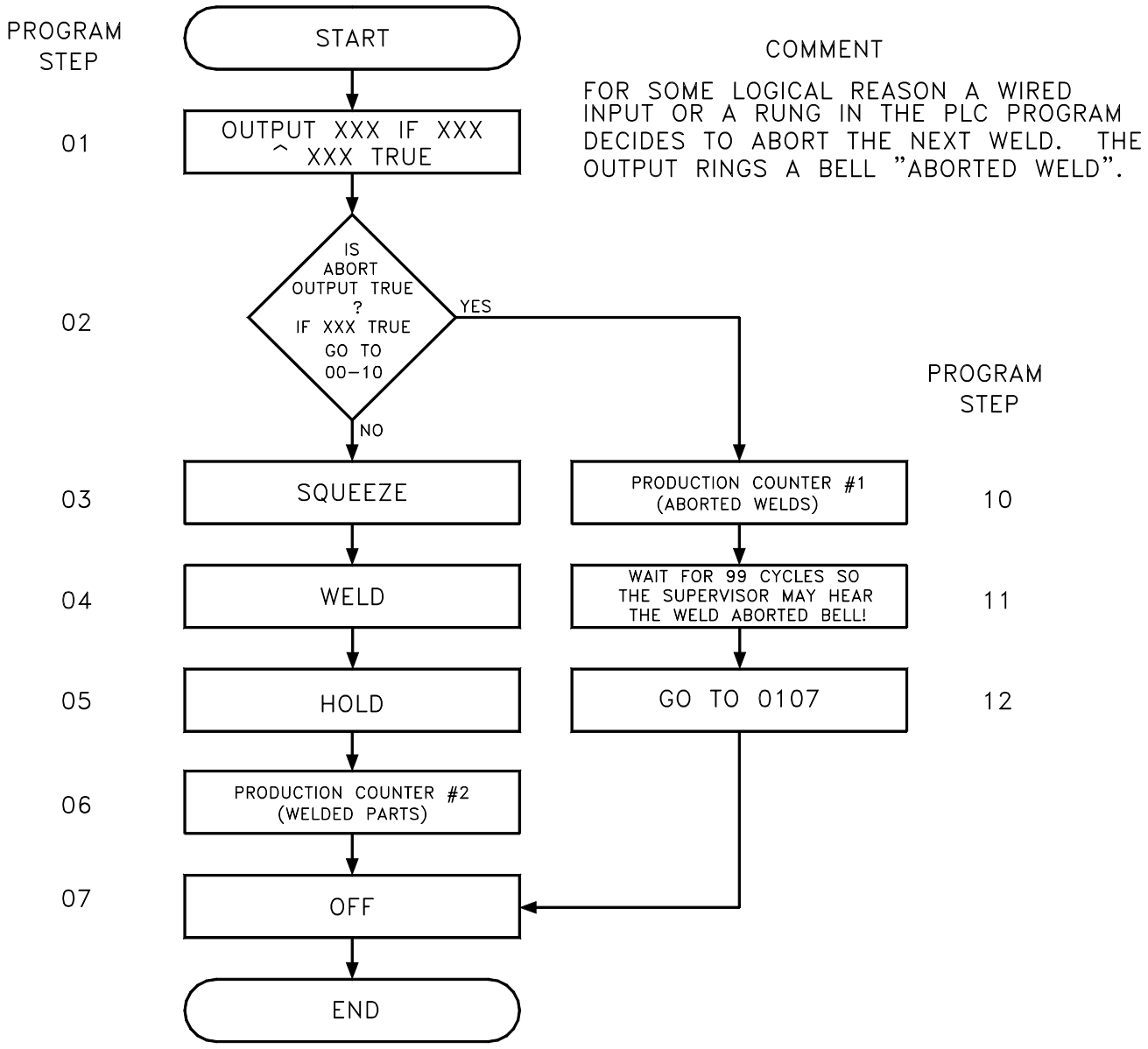
Display:

```
         111111111122222222233
12345678901234567890123456789012
 1- 6 PRODUCTION COUNT rr  ddddd
         At instruction entry 44
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 22	Instruction description
D	>24, 25	Register number
E	28, 32	Production count

FLOW CHART EMPLOYING PRODUCTION COUNTER IN A SIMPLE SEQUENCE PROGRAM



PROCOUN.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
45	Assign Stepper	Yes	None

HEAT RANGE	COUNT	PRESET	CURRENT WINDOW CHECK
None	N/A	N/A	None

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Data is applied to all instructions that follow. The counting type is incremented only by the first Weld in the sequence.	None	Instructions will "look back" and apply the last stepper multiplication factor. The look back feature can occur only in in the sequence in which the function is applied. The control cannot look back back beyond a branch instruction; hence if branching is involved, reassign the intended stepper before the instructions that follow.

DESCRIPTION

This instruction simply **assigns** one of 30 possible stepper programs. A Stepper program steps or increase current, pressure or the current window values of instructions that follow the assignment. The program may be a 10 step “counting” type or a ACDC "automatic" type. This instruction can also remove a stepper programs influence by programming Stepper #0 ahead of the instructions that are not to be stepped. The type of Stepper program chosen by entering 1-15 for one of 15 COUNTING type programs or 101-115 for one of 15 a ACDC type programs. Please remember a Stepper PROGRAM must be entered for the assignment to work. See Section 1, 9.0 and 9.1 for Stepper programming details.

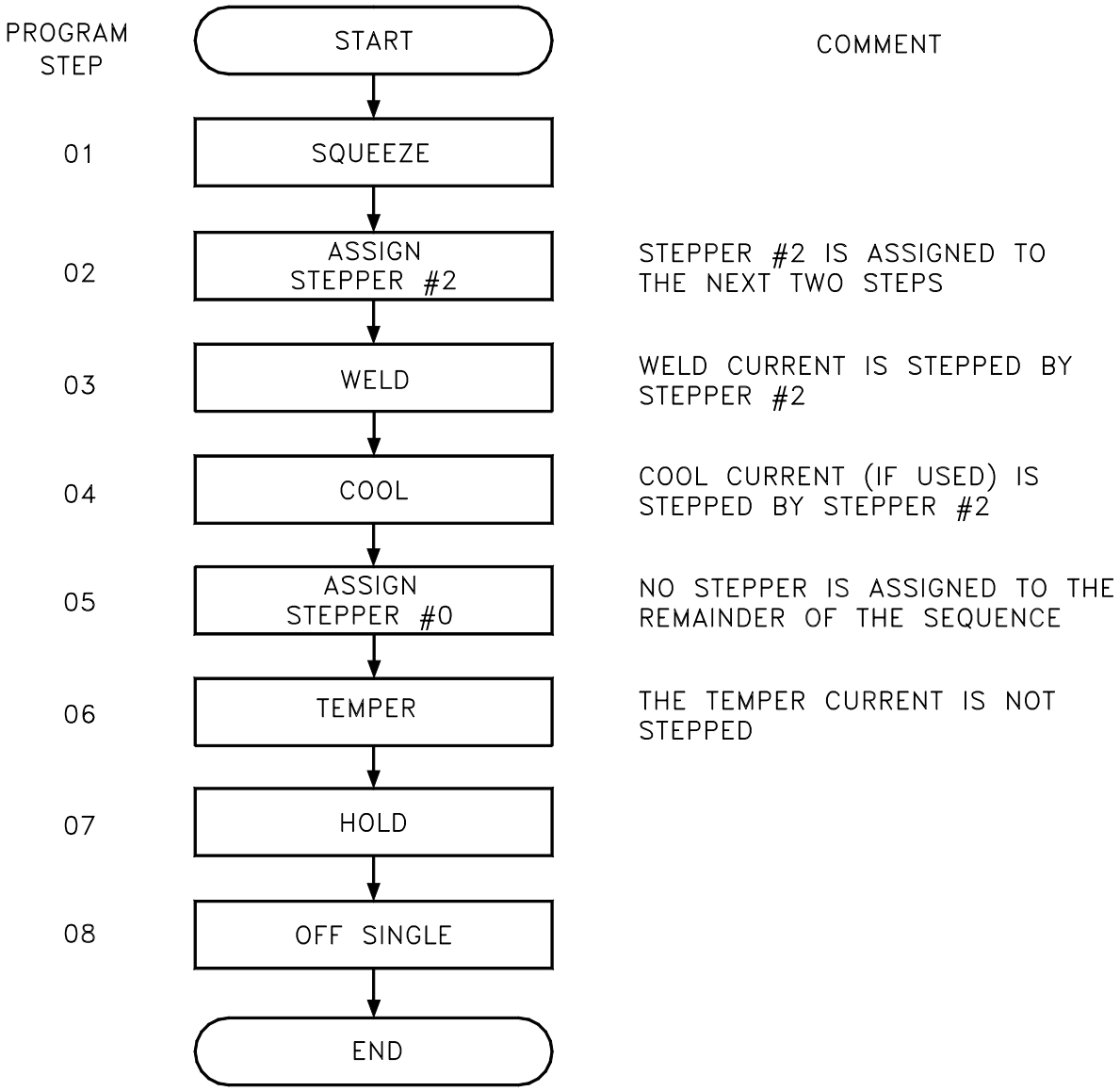
Display:

```
         11111111112222222222333
123456789012345678901234567890 12
 1- 2 ASSIGN STEPPER #sss
         At instruction entry 45
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 20	Instruction description
D	>23, 24	Stepper Program number 1-15(COUNTING) 101-115(ACDC)
E	26, 30	Type of stepper, COUNTS or ACDC (use down arrow key)

FLOW CHART EMPLOYING ASSIGN STEPPER
IN A SIMPLE SEQUENCE PROGRAM



ASNSTEP.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
46	Reweld	Yes	None

HEAT RANGE	COUNT	PRESET	CURRENT WINDOW CHECK
None	N/A	User assigned (pp) Maximum of 9	See window Compare #58

EXECUTED	I/O	SPECIAL CONSIDERATIONS
When the LOW bit in the window compare is set	None	Must be used with the Window instructions and placed after the Window Compare. Only one register will be incremented per attempt, the reweld register first and the bad reweld register thereafter.

DESCRIPTION

This instruction attempts rewelds by checking the low bit of the Window Compare instruction (see instructions 22 and 58). Therefore Reweld must always be placed after the Window Compare instruction. When the low bit is set in Compare a branch back to the user supplied address (aa) is executed for the programmable number of times (pp 1-9). The branch back address **must be** the WINDOW HI LO instruction, resetting the window for a new current measurement for the next reweld attempt. Optional registers may be assigned to count rewelds (RW) and bad rewelds (BRW). It is the users responsibility to reset the registers by ladder logic program. The registers may be viewed and/or reset by programming in ladder logic “do nothing rungs” containing the register or assigning one to register #31 and viewing it in View Weld Data. See section 1 8.6.

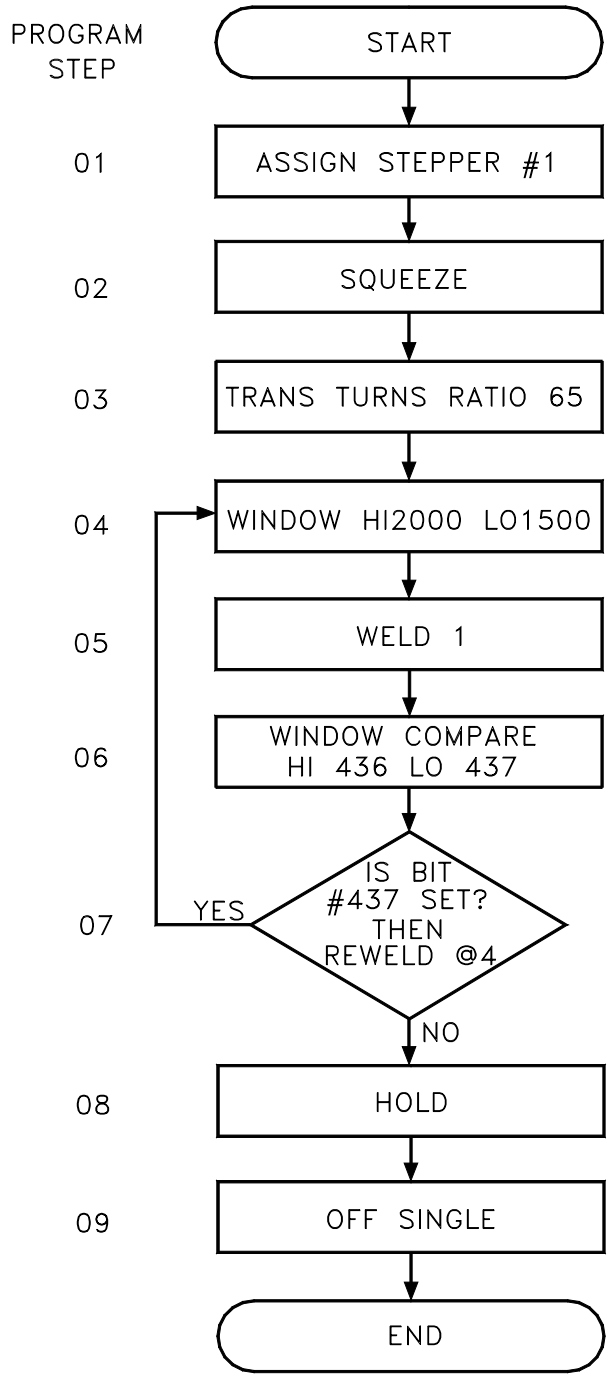
Display:

```
         1111111111222222222333
12345678901234567890123456789012
 1- 2 pp REWELDS @ aa RWrr BRWrr
         At instruction entry 46
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 1-31
B	4, 5	Program step number 1-99
C	>7, 8	Number of reweld attempts, (1-9) defaults to 1.
D	10, 18	Instruction description
E	20, 21	Step number branch back address for reweld attempt
F	25, 26	Optional register number for Reweld counter
G	31, 32	Optional register number for Bad Reweld counter RW and BRW registers default to 99, no register assignment

FLOW CHART EMPLOYING REWELD
IN A SIMPLE SEQUENCE PROGRAM



COMMENT

STEPPER PROGRAM #1 WILL EFFECT ALL CURRENTS PROGRAMMED FROM THIS POINT UNTIL OFF SINGLE.

ENERGIZES GUN VALVE AND WAITS FOR PRESSURE TO BUILD UP

MULTIPLYES PRIMARY CURRENT BY 65, THEREBY PERMITTING PROGRAMMING IN SECONDARY AMPS. 0=TOROID PICKUP.

CURRENT WINDOW IS SET, MEASUREMENT IS STARTED AND ENDS AT COMPARE.

NUGGET IS FORMED, RMS CURRENT IS SUMMED AND AVERAGE RMS CURRENT IS CALCULATED AT THE COMPARE.

BIT 436 OR 437 IS SET IF CURRENT IS OUTSIDE THE WINDOW IN STEP #4. THIS SETS USER FAULT #1 OR #2. USER #2 = "REWELDING" AND IS A MINOR FAULT SELF RESETTING.

THIS TEST MAY BE PROGRAMMED TO OCCUR UP TO 9 TIMES

NUGGET IS COOLED

DE-ENERGIZE ALL VALVES

REWELD.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
47	Tip Touch Test	Yes	01-999 Cycles

HEAT RANGE	COUNT	PRESET	CURRENT WINDOW CHECK
Fixed 10% One cycle	Optional user assigned (rr)	None	Yes

EXECUTED	I/O	SPECIAL CONSIDERATIONS
User programmable number of maximum override cycles.	Tip Touch Fault	Non-Required register assignment is used for SPC tip touching time. rr records the number of cycles to touch.

DESCRIPTION

The Tip Touch test is used to monitor the closing of the welding electrodes, it is sometimes called "Automatic Squeeze". Automatic squeeze is accomplished by energizing the weld transformer at 10% available current and testing each cycle for the increase primary current (iii) when the tips touch. If the touch time is longer then a programmable maximum time (cc cycles), the "Tip Touch Fault" will occur. Within the user register assignment (rr), the total time in line cycles for each test will be recorded. In a networked system all registers are transferred to a host workstation there by useful for SPC data, in this case Tip Closure time will be monitored. The timing register is automatically reset just before the Tip Touch test takes place. The tip touching current (iii) may be determined by measuring the current during a weld at 20% current (use View Weld Data), divide the current by 2 and subtract 15 Amps. This final amperage must be above 10 amps for consistent operation of the Tip Touch feature.

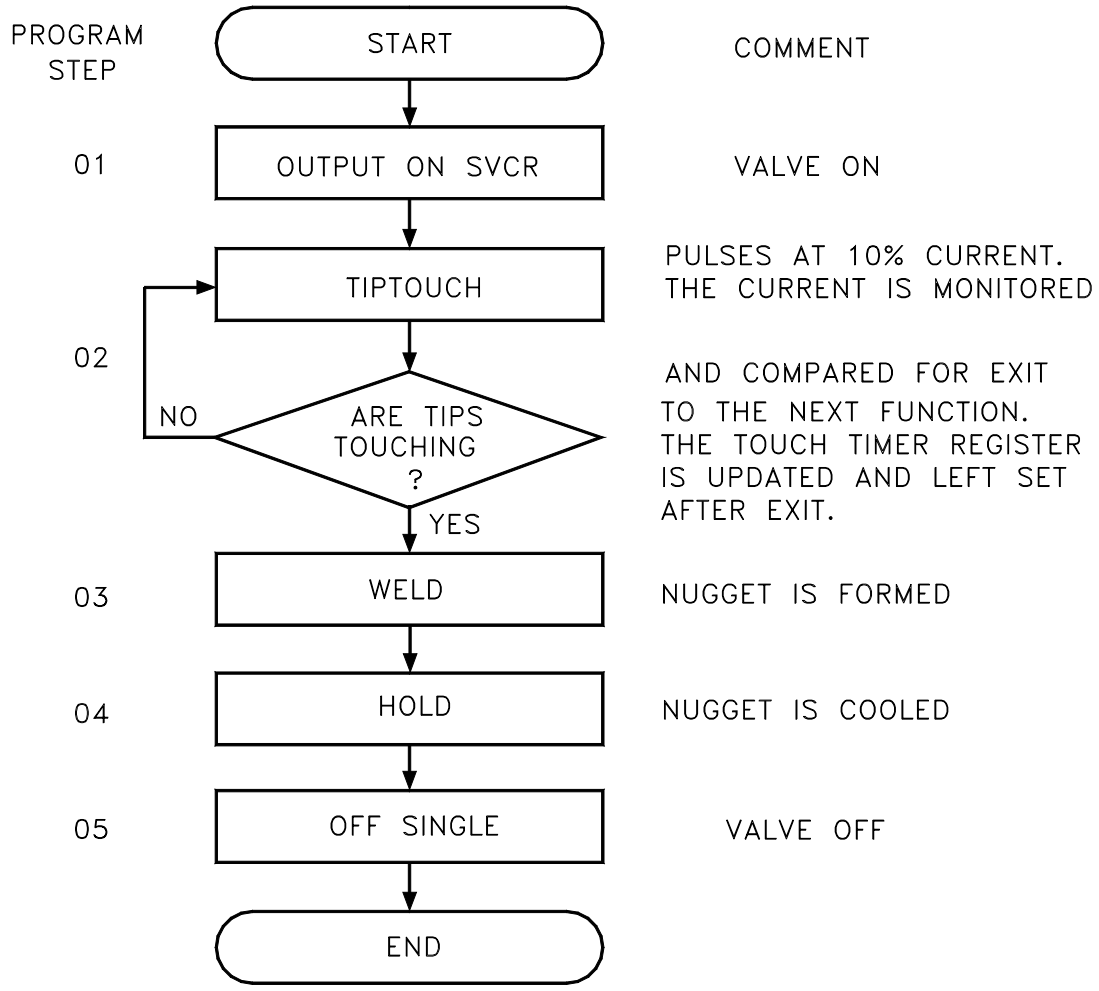
Display:

```
         1111111111222222222333
12345678901234567890123456789012
 1- 2 TIPTOUCH iiiA cccMAX rrREG
         At instruction entry 47
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 14	Instruction description
D	>16, 18	Programmable number of amperes at tip touch 10-999
E	21, 23	Programmable number of cycles before tip touch fault
F	28, 29	Register number for tip touch time record

FLOW CHART EMPLOYING TIPTOUCH
IN A SIMPLE SEQUENCE PROGRAM



TIPTEST.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
48	Tip Stuck Test	Yes	01-99 Cycles

HEAT RANGE	COUNT	PRESET	CURRENT WINDOW CHECK
Fixed 10% One cycle	None	None	Yes

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	Tip Stuck Fault	None

DESCRIPTION

The Tip stuck test is used after hold time to determine if **both tips** (only) are stuck to the work. This is accomplished by first turning off the bit which is energizing the tip solenoid with a separate output XXX off instruction. In the test instruction, program sufficient delay time (cc) to assure the tips have enough time to open before a one cycle of weld at 10% current is passed. If the programmed current (ii) or a higher current is detected, the "Tip Stuck Fault" is issued. If a lower value of current than programmed current is detected, no action takes place. The Tip Stuck fault might occur because of secondary shorting by water and/or weld "flash" deposits, frayed shunts shorting the secondary, or a sluggish cylinder, which indicates maintenance is required.

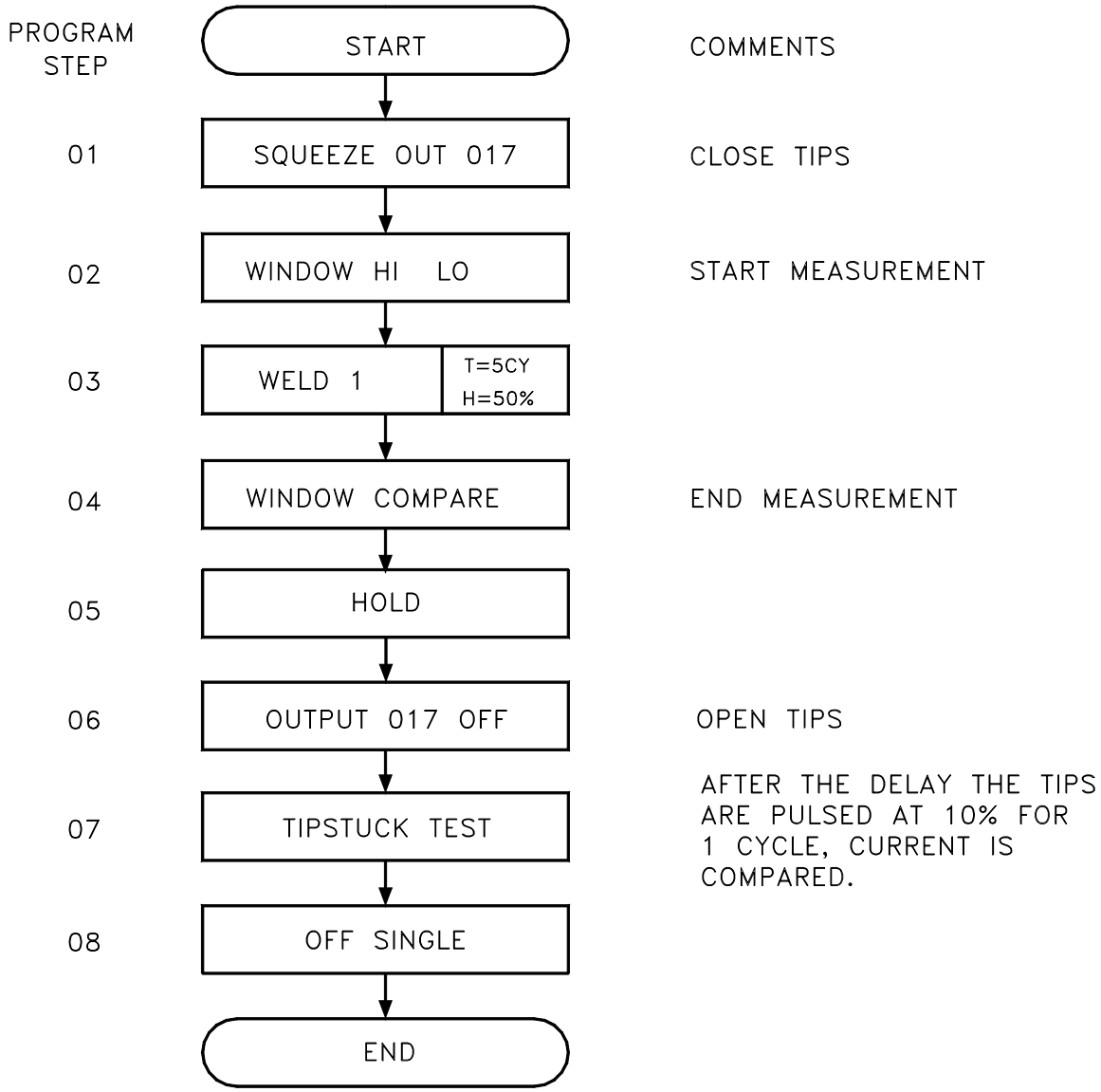
Display:

```
         1111111111222222222333
12345678901234567890123456789012
 1- 6 TIPSTUCK TEST iiA ccCY DLY
         At instruction entry 48
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 19	Instruction description
D	>21, 22	Programmable amps which determines stuck tips 10-99A
E	25, 26	Programmable delay in cycles before tip stuck test pulse occurs 01-99 line cycles

FLOW CHART EMPLOYING TIPSTUCK TEST
IN A SIMPLE SEQUENCE PROGRAM



TIPSTUCK.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
49	Weld Schedule pp	Yes	None

HEAT RANGE	COUNT	PRESET	WINDOW CHECK
None	None	None	N/A

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	None	None

DESCRIPTION

This instruction is used as a header or locator for a welding schedule or any other subroutine. It must be the first instruction in the subroutine program and may be located in any sequence. The data (pp) entered by the programmer as the subroutines location. This locator is used by instruction #59 "Call Weld Schedule mm" when mm=pp. Any number of steps may follow the instruction providing they are in the same schedule. The end of the subroutine must contain the "Return" or "Off Single" instructions. The "Return" instruction returns to next instruction after the "Call Weld Schedule mm" instruction, the "Off Single" instruction ends the program.

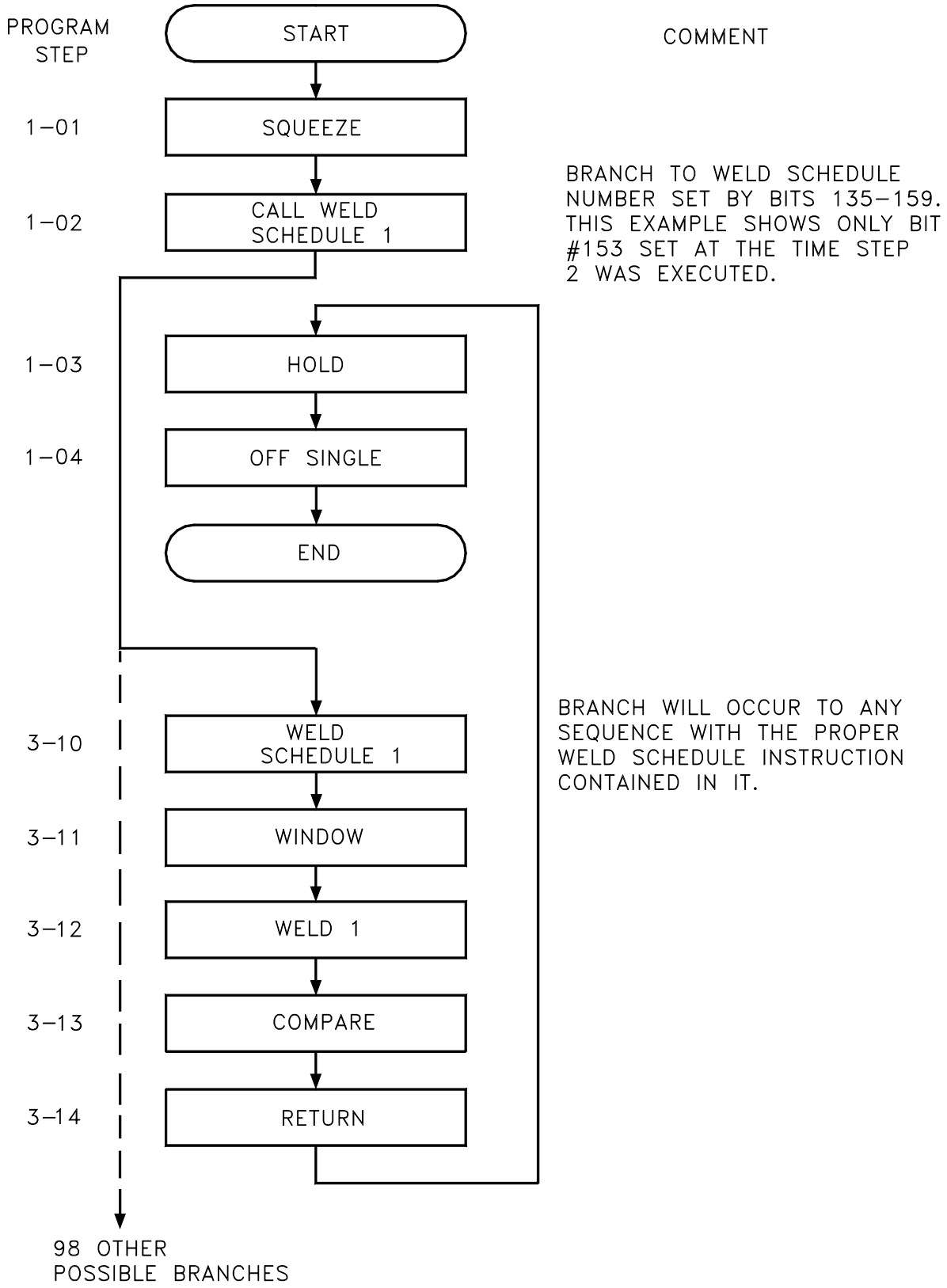
Display:

```
         11111111112222222222333
12345678901234567890123456789012
 2- 1 WELD SCHEDULE pp
         At instruction entry 49
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 19	Instruction description
D	21, 22	Programmable number 1-99

FLOW CHART EMPLOYING WELD SCHEDULE
IN A SIMPLE SEQUENCE PROGRAM



WELDSCHD.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
50	No Operation	No	None

HEAT RANGE	COUNT	PRESET	CURRENT WINDOW CHECK
None	N/A	N/A	N/A

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	None	None

DESCRIPTION

This instruction does nothing but occupy a step in the program sequence, it takes zero time to implement. It is used to occupy a step for future program changes or program tests without re-addressing the program.

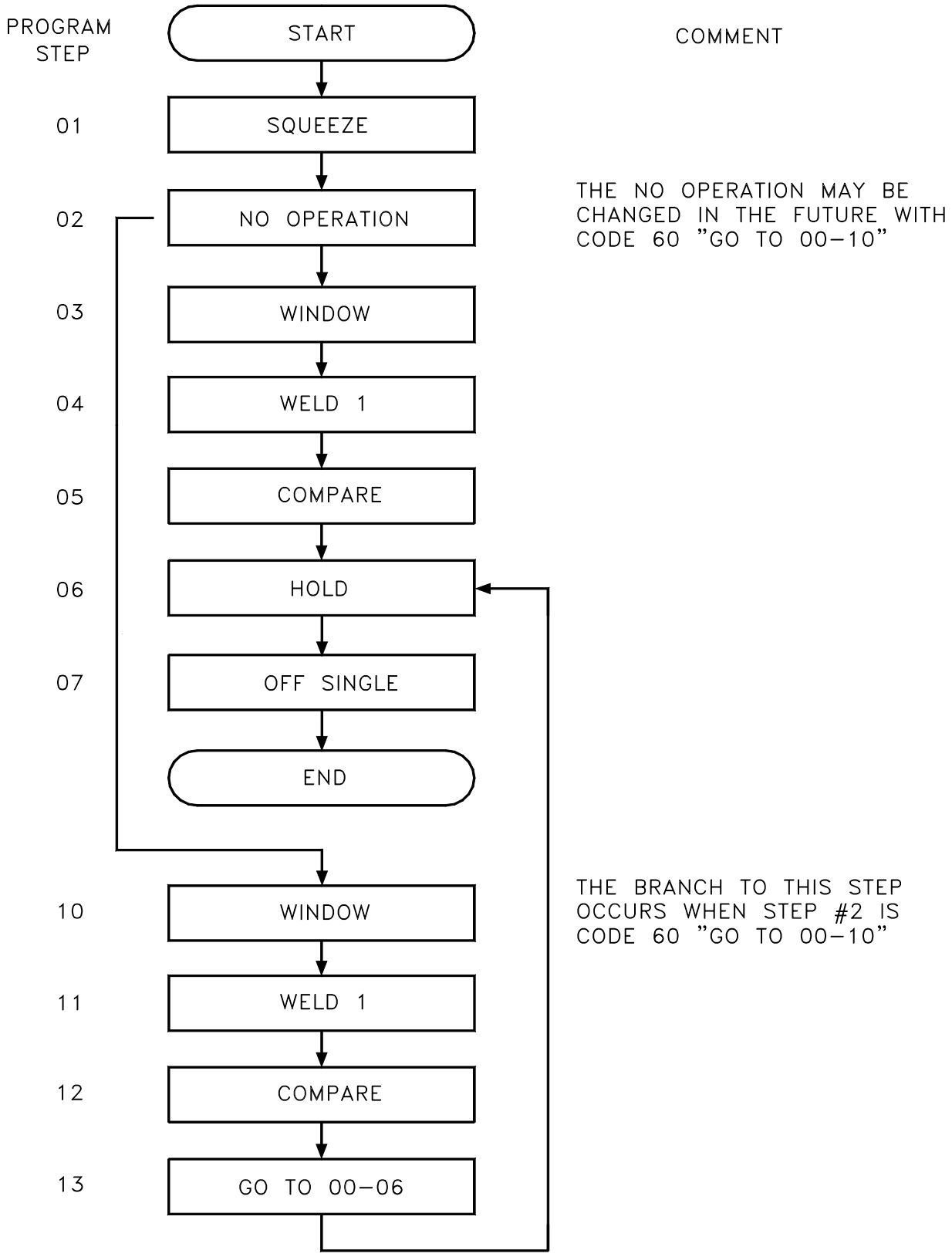
Display:

```
         11111111112222222222333
12345678901234567890123456789012
 1- 4 NO OPERATION
         At instruction entry 50
```

Data fields:

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 18	Instruction description

FLOW CHART EMPLOYING NO OPERATION
IN A SIMPLE SEQUENCE PROGRAM



NOOP.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
51	Contactor Select	No	None

HEAT RANGE	COUNT	PRESET	CURRENT WINDOW CHECK
None	N/A	N/A	N/A

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	Four bit binary output to bits 145 (LSB), 146, 147, and 148 (MSB).	Defaults to contactor #1. Upon selection of a new contactor, the control reverts to 87½ degree delayed firing and delays two line cycles before exit to the next step.

DESCRIPTION

This instruction outputs a four bit binary number equal to the user's programmed decimal number minus one (contactor select 1=0000 binary). Outputting is to I/O bits 145 through 148 with 145=LSB. The bit pattern **must** be vectored through the Slot\Port Setup to a SCR Cascade Module in the rack system, usually **Slot 15 Port 4 OUT**. The binary number is decoded by the Cascade Module which in turn connects the CUP/Timer to one of four SCR contactors. With the use of four Cascade modules, sixteen different SCR contactors may be selected by the CPU/Timer, one SCR at a time. After the SCR is connected, any program function(s) or subroutine may be executed. Because all outputs are turned off during OFF time, SCR #1 will be automatically selected and remains selected until a new SCR is selected in a new sequence. This instruction may be used in any order at any time. Because of potential phase differences between SCRs, the instruction has a two line cycle execution time.
For more detail see instruction book 328-0-0572-00.

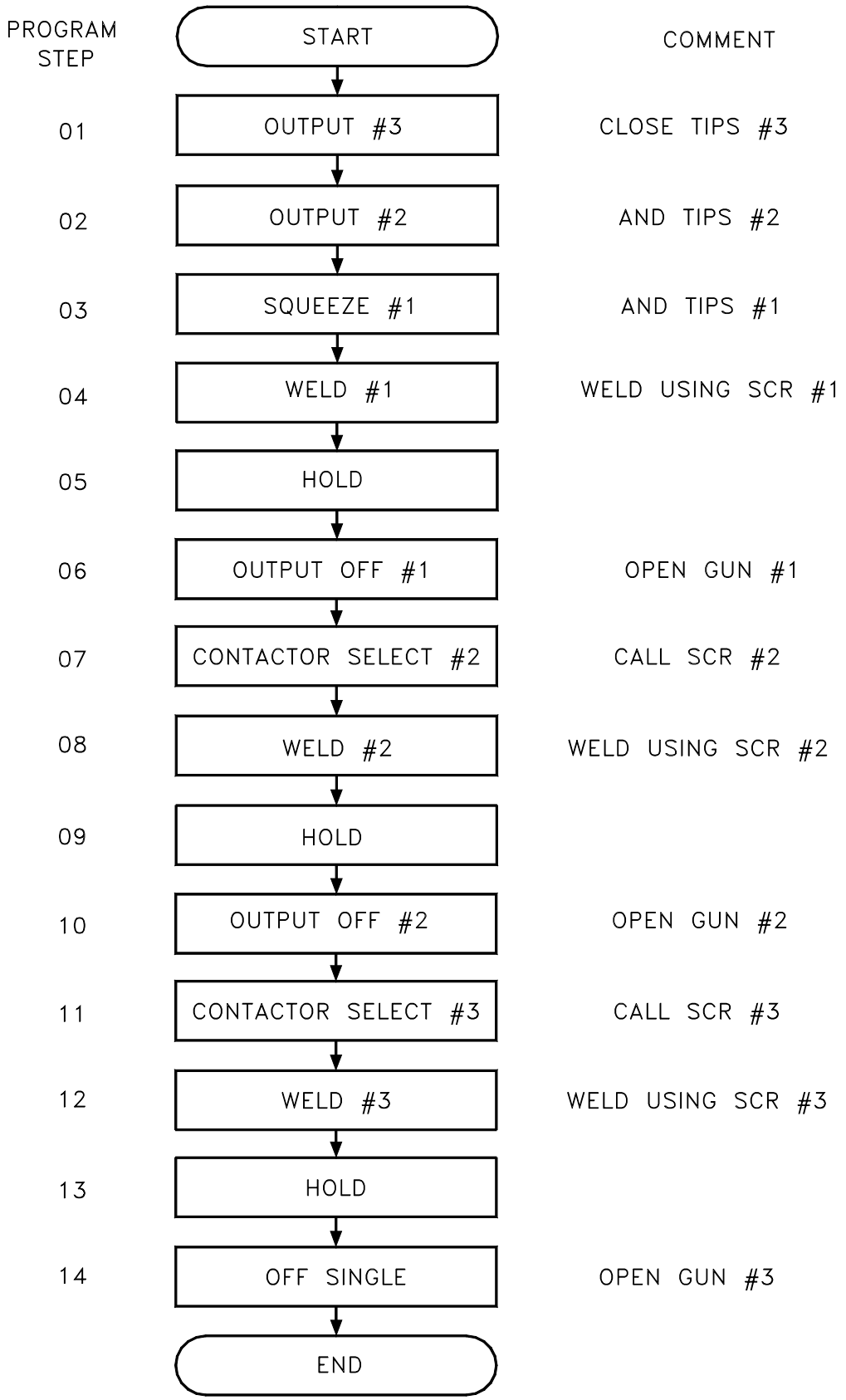
Display:

```
          1111111111222222222333
12345678901234567890123456789012
 1- 8 CONTACTOR SELECT yy
         At instruction entry 51
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 1-31
B	4, 5	Program step number 1-99
C	7, 22	Instruction description
D	>24, 25	Contactor number 1-16

FLOW CHART EMPLOYING CONTACTOR SELECT
IN A THREE CASCADE WELD



CONSEL.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
52	Heat Reset	No	None

HEAT RANGE	COUNT	PRESET	CURRENT WINDOW CHECK
None	N/A	N/A	N/A

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	None	Delayed firing is issued normally only once per sequence only on the first Weld function

DESCRIPTION

After this instruction is executed, delayed firing (87½ degree @ 99%) will occur on the heat instruction that follows. Delayed firing will not occur on subsequent heats unless the Heat Reset is present before them. The instruction should be applied if the secondary was opened between welds employing a Hypersel® type welding transformer. It should not be applied if the secondary was **not opened** between welds. The instruction is not necessary if a stacked iron type welding transformer is used or if there is only one weld per sequence.

Display:

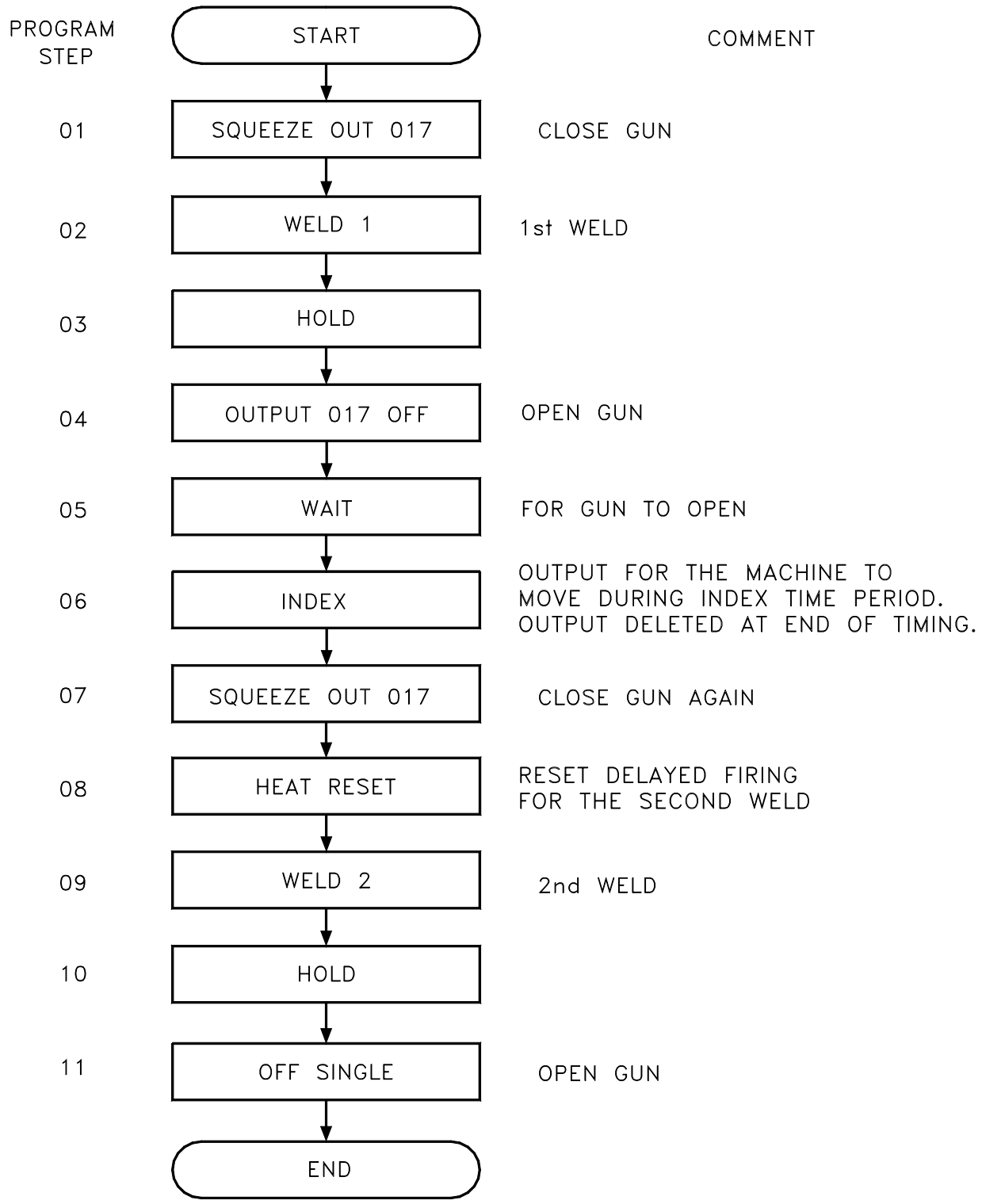
```
         1111111111222222222333
12345678901234567890123456789012
 1- 7 HEAT RESET
         At instruction entry 52
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	>4, 5	Program step number 01-99
C	7, 16	Instruction description

Section 2-105

FLOW CHART EMPLOYING HEAT RESET
IN A SIMPLE SEQUENCE PROGRAM



HTRESET.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
53	Heat Faults On	No	None

HEAT RANGE	COUNT	PRESET	CURRENT WINDOW CHECK
None	N/A	N/A	N/A

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	None	None

DESCRIPTION

This instruction causes the fault system to recognize all heat faults following this instruction in the sequence program. Heat faults (Contactor and Half cycling faults) will be recognized only if they are not programmed off individually under fault configuration (see section 12.0). Heat Faults On is used in conjunction with Heat Faults Off code 54 to selectively ignore heat faults during certain instructions in a sequence.

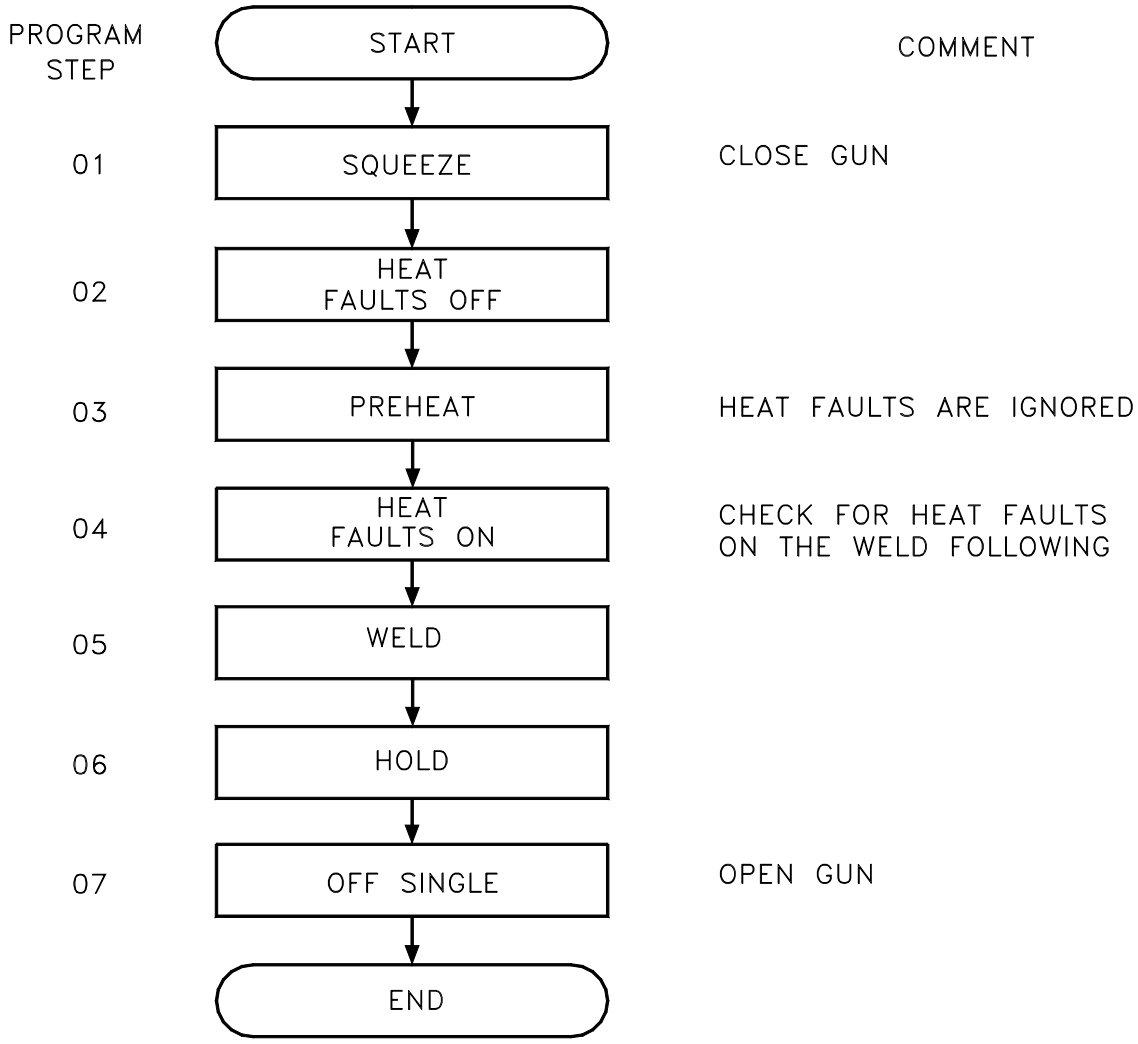
Display:

```
         1111111111222222222333
12345678901234567890123456789012
 1- 4 HEAT FAULTS ON
         At instruction entry 53
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	>4, 5	Program step number 01-99
C	7, 20	Instruction description

FLOW CHART EMPLOYING HEAT FAULTS ON
IN A SIMPLE SEQUENCE PROGRAM



HTFLTON.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
54	Heat Faults OFF	No	None

HEAT RANGE	COUNT	PRESET	CURRENT WINDOW CHECK
None	N/A	N/A	N/A

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	None	None

DESCRIPTION

This instruction causes the fault system to not recognize all heat faults following this instruction in the sequence program (Contactor and Half cycling faults). Heat faults Off is used in conjunction with Heat Faults On code 53 to selectively ignore heat faults during certain instructions in a sequence.

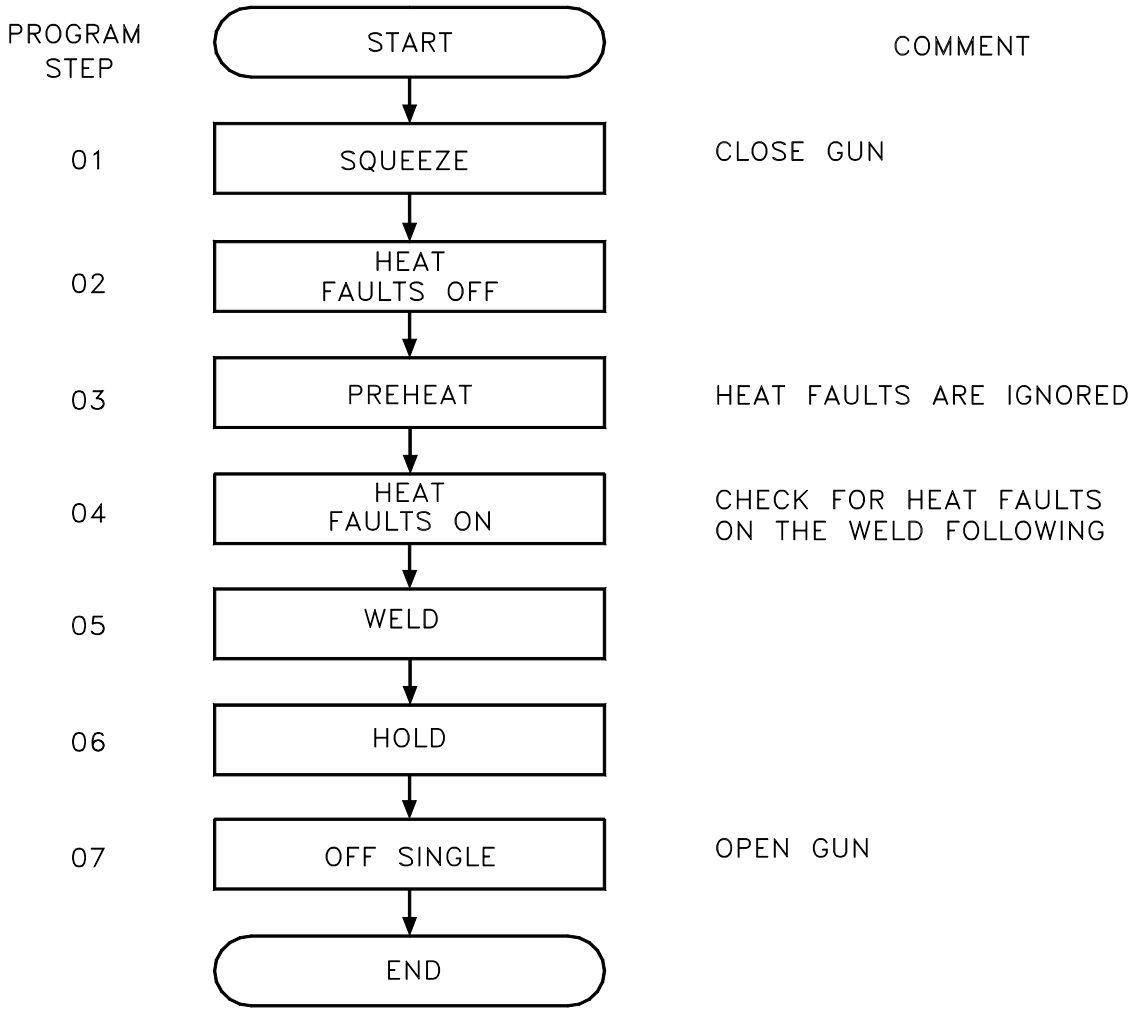
Display:

```
         1111111111222222222333
12345678901234567890123456789012
 1- 2 HEAT FAULTS OFF
         At instruction entry 54
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	>4, 5	Program step number 01-99
C	7, 21	Instruction description

FLOW CHART EMPLOYING HEAT FAULTS OFF
IN A SIMPLE SEQUENCE PROGRAM



HTFLTOF.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
55	Wait for vvv Volts or ccc Cycles	Yes	0-999 cycles 0=infinity

HEAT RANGE	COUNT	PRESET	CURRENT WINDOW CHECK
None	N/A	N/A	No

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	None	If a override condition occurs bit #429 will be set.

DESCRIPTION

This instruction provides a halt in sequence flow until the line voltage is equal to or grater than a programmed value. While waiting for proper line voltage, "LINE LESS THEN xxx VOLTS" WILL be displayed. The message will remain until the voltage is equal to or greater than the programmed value or until a programmable override time expires. For diagnostic purposes the user may examine bit #429 to check for a timer override condition. This may be done in the following sequence instructions or in a PLC program.

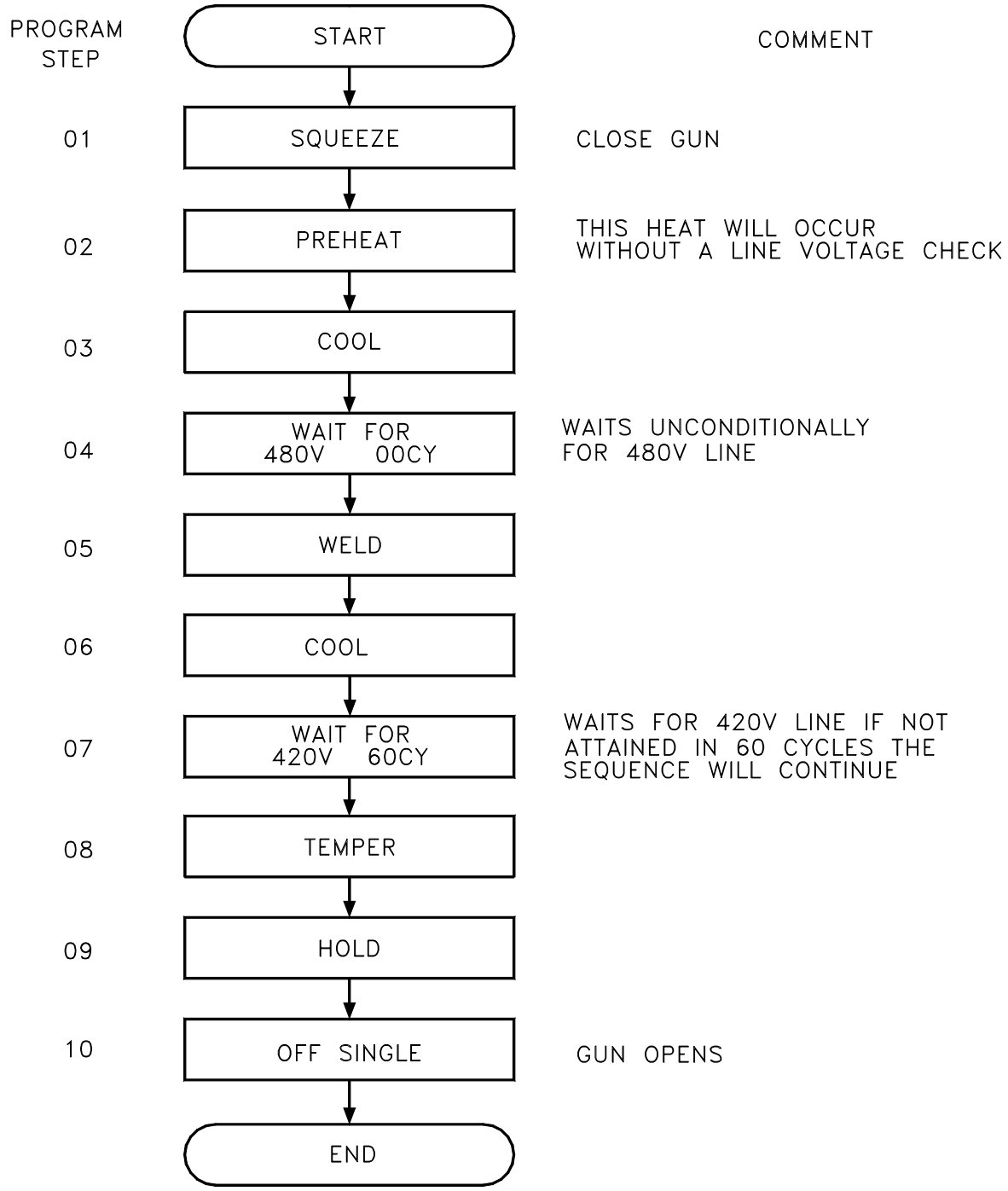
Display:

```
         1111111111222222222333
12345678901234567890123456789012
 1- 7 WAIT FOR vvv VOLTAGE cccCY
         At instruction entry 55
    LINE LESS THEN vvv VOLTS    (If waiting)
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 25	Instruction description
D	>16, 18	Programmable line voltage value
E	28, 30	Programmable override time 0-999 Cycles (0=Infinite wait)

FLOW CHART EMPLOYING WAIT FOR LINE VOLTS
IN A SIMPLE SEQUENCE PROGRAM



WT4LNVO.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
56	Counter	No	None

HEAT RANGE	COUNT	PRESET	CURRENT WINDOW CHECK
None	0-65,535	N/A	None

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	None	A register must be assigned 0-31).

DESCRIPTION

This instruction increments a register each pass through the instruction. The same register may be assigned in different steps or sequences, and also in a PLC program at the same time. The register is reset to 0 by displaying the instruction, with the control in program mode depressing the Reset keypad. Or by controlling the reset bit in a Ladder Logic program. This instruction is the same as Production Counter code #44 except it is not displayed in run and on line mode.

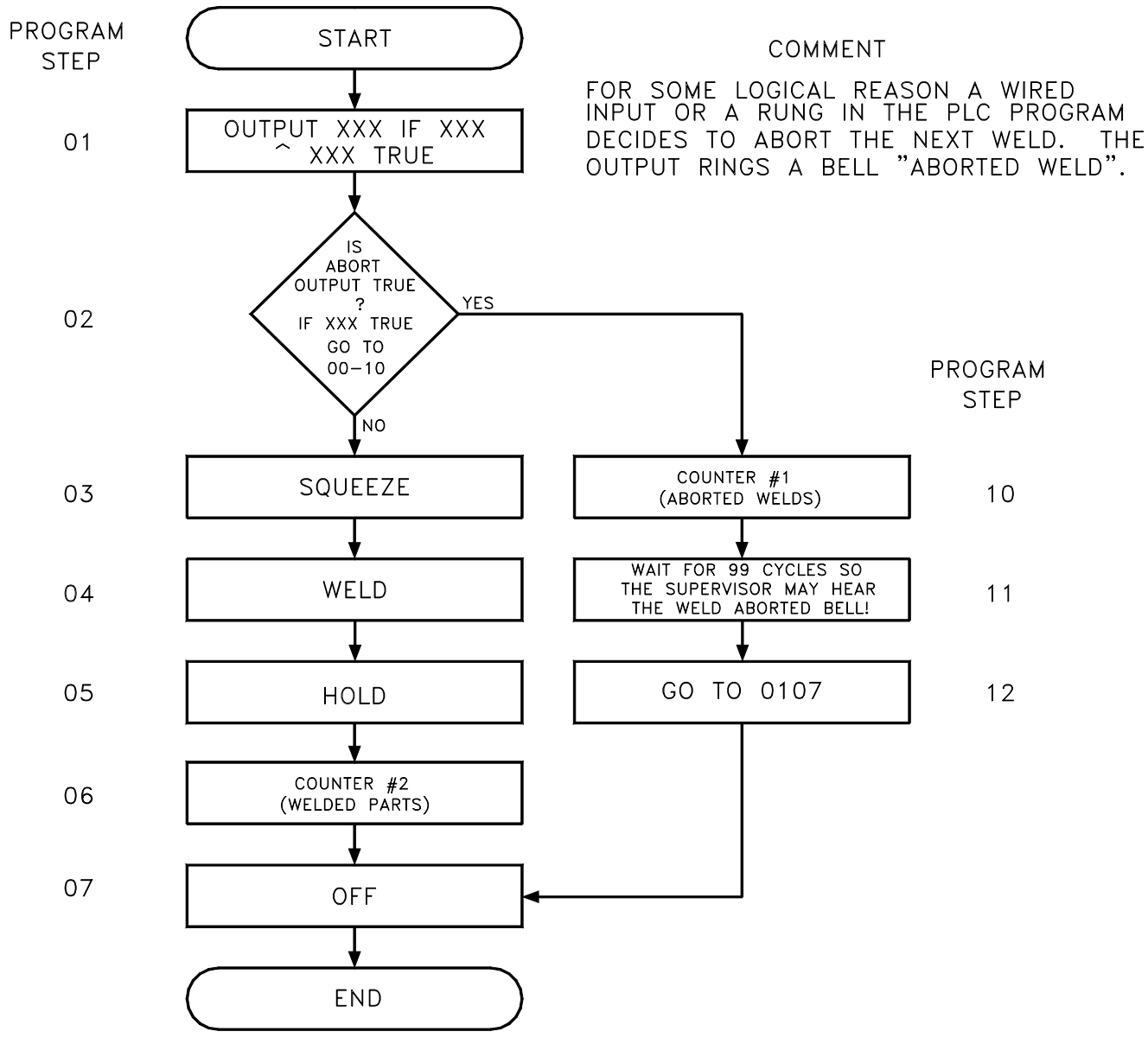
Display:

```
         1111111111222222222333
12345678901234567890123456789012
 1- 6 COUNTER rr           ddddd
         At instruction entry 44
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 13	Instruction description
D	>15, 16	Register number
E	28, 32	Accumulated count

FLOW CHART EMPLOYING COUNTER IN A SIMPLE SEQUENCE PROGRAM



COUNTER.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
57	TRANS TURNS RATIO rrr.r	No	None

HEAT RANGE	COUNT	PRESET	WINDOW CHECK
None	None	None	Modifies Window Compare and all constant current instructions that follow.

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Memorized and used on all following heat instructions	None	Must be placed before the heat statement(s) of interest. Range: 0-199.9, 1 equals primary current, 0 equals secondary current pickup.

DESCRIPTION

The Series 400/415 normally monitors primary current; therefore, at the start of each sequence, the control defaults to a turns ratio of 1. If the user wishes to program in terms of secondary current the actual transformer turns ratio must be supplied. The ratio instruction is placed before the heat statements of interest. Once it is programmed, it will be applied to all current windows and constant current instructions that follow the instruction. If a new transformer with a different ratio is addressed in the program, simply program the new ratio in front of the heat statements that address the transformer. The transformer turns ratio may be found by reading the manufacturer's label or by applying a known voltage to the primary and measuring the secondary volts of the transformer. Dividing secondary voltage into primary voltage provides the ratio. Another method is while measuring the secondary current, program different ratios until the controls View Weld Data agrees with the secondary measurements. If a trans turns ratio of 0 is programmed, the control will read a toroid pickup coil on the SECONDARY and readout will be in secondary amps. See instructions 22, 58 and 80 through 89.

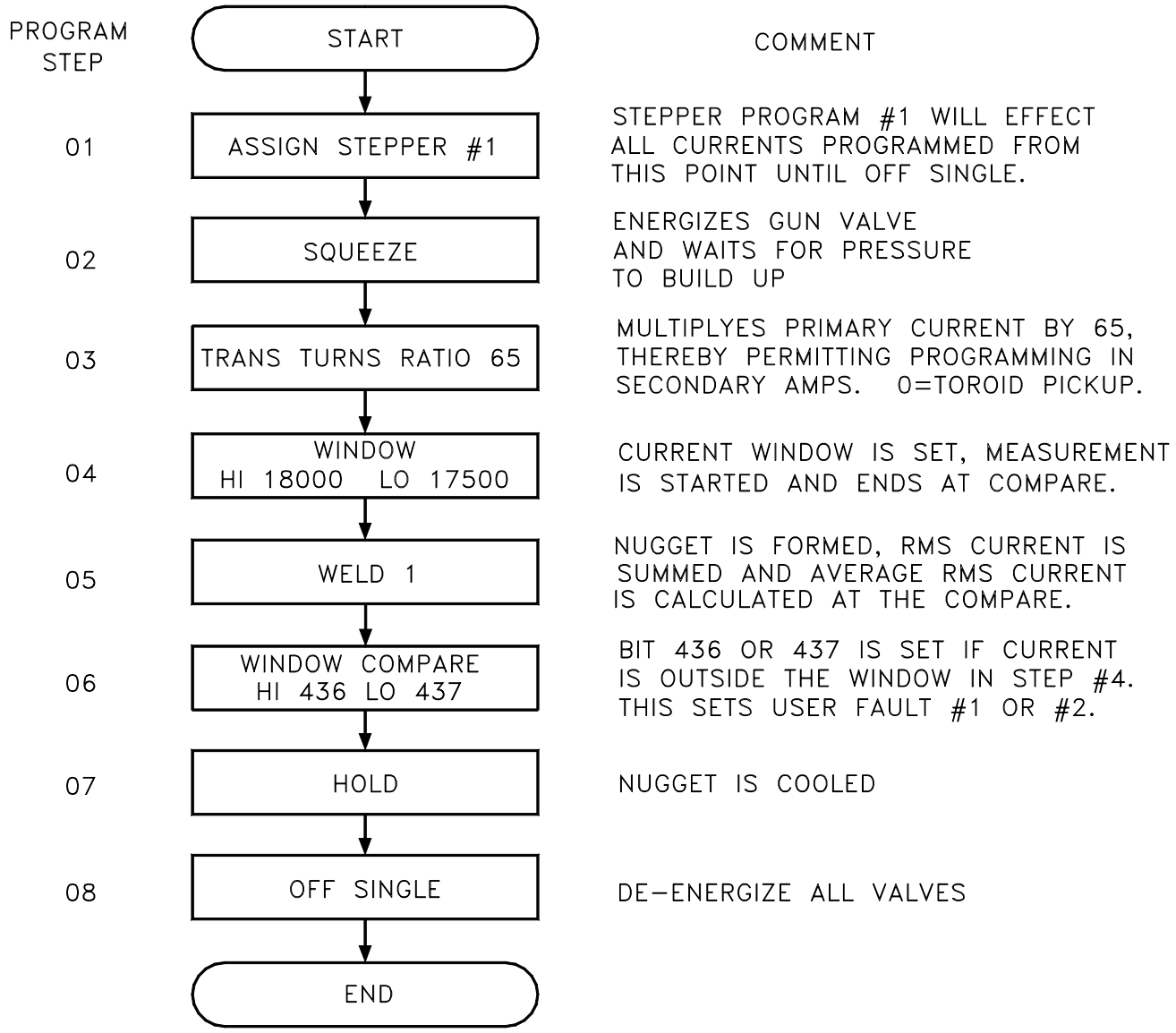
Display:

```
         1111111111222222222333
12345678901234567890123456789012
 1- 2 TRANS TURNS RATIO rrr.r
         At instruction entry 57
```

Data fields: (> Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 23	Instruction description
D	>25, 29	Welding transformer turns ratio 0-199.9

FLOW CHART EMPLOYING TRANS TURNS RATIO IN A SIMPLE SEQUENCE PROGRAM



TTRATIO.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
58	WINDOW COMPARE	No	Automatic 1 cycle

HEAT RANGE	COUNT	PRESET	WINDOW CHECK
None	None	None	Works with Window Hi/Lo instruction

EXECUTED	I/O	SPECIAL CONSIDERATIONS
After Heats	HI & LO bits programmable	Must be placed after the heat statement(s) of interest.

DESCRIPTION

This instruction is placed after the heat statement or statements of interest. It is used to frame, measure, report and provide a custom current window for any heat statements between it and the WINDOW HI LO instruction. If used after a TRANS TURNS RATIO instruction currents will be in secondary amperes. The measurement of current will be AVERAGE RMS amps (including cool times if present) and will be reported in View Weld Data. The average RMS current value is tallied and reported to memory by the WINDOW COMPARE instruction. This action takes one line cycle to execute. If the average RMS current is outside the values programmed in the WINDOW HI LO instruction, one of the programmed HI or LO bits in the WINDOW COMPARE instruction will be set. These bits may then be examined by the following program steps or by the PLC program to be set thereby any action may be taken. See section 8.6 for more detail.

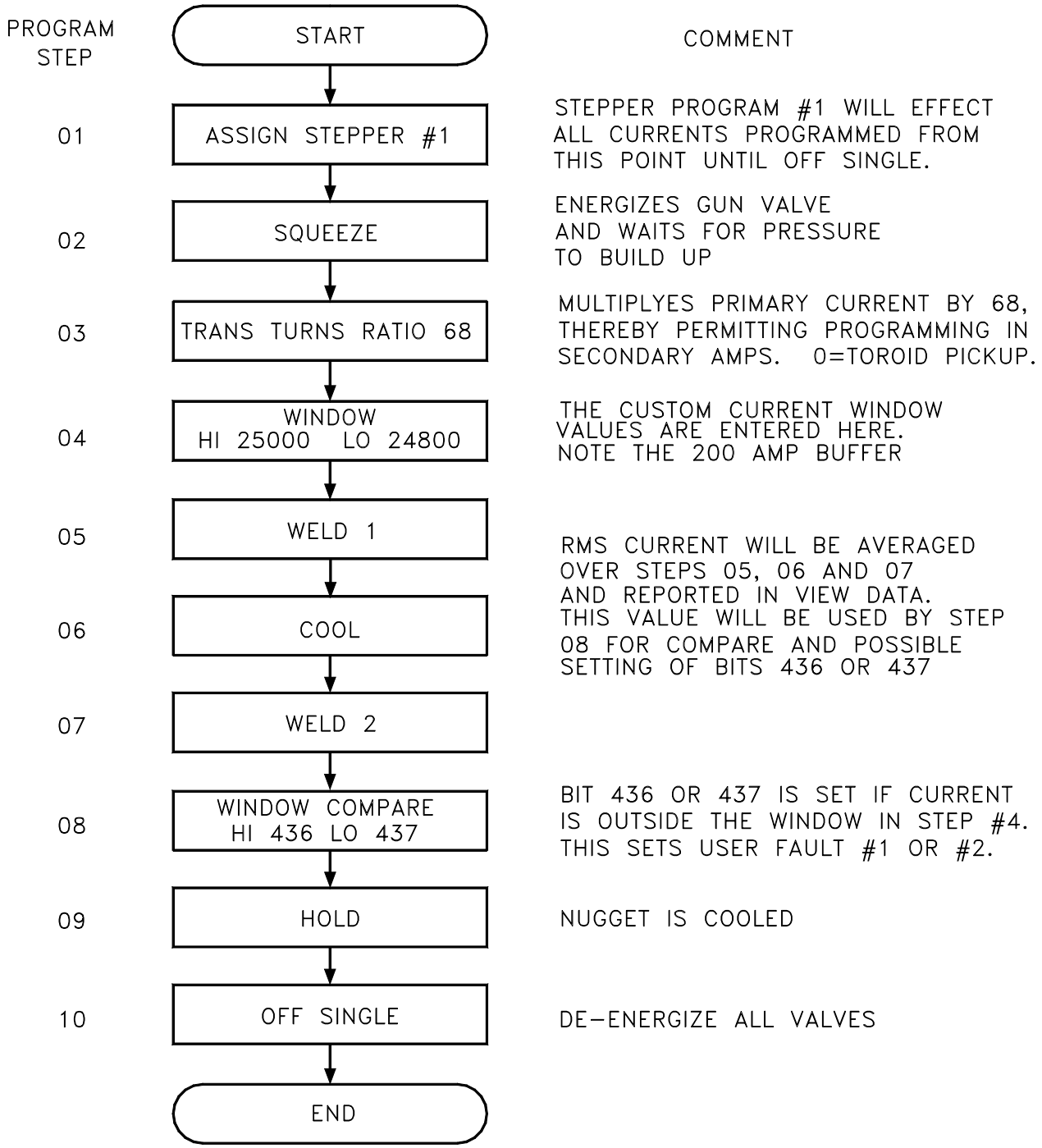
Display:

```
         1111111111222222222333
12345678901234567890123456789012
 1- 4 WINDOW COMPARE HIxxx LOxxx
         At instruction entry 58
```

Data fields: (> Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 20	Instruction description
D	>24, 26	Bit made true if current is over WINDOW HI
E	30, 32	Bit made true if current is under WINDOW LO

FLOW CHART EMPLOYING WINDOW COMPARE
IN A SIMPLE SEQUENCE PROGRAM



WINCOMP.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
59	Call Weld Schedulemm DEPmm	Yes	None

HEAT RANGE	COUNT	PRESET	WINDOW CHECK
None	None	None	N/A

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	None	None

DESCRIPTION

The instruction #59 "Call Weld Schedule mm" will run a subroutine based on the binary bit pattern set in memory map bits 153 through 159. Where bit 153=LSB (1) and 159=MSB (64). **OR** the inputs may be overridden by calling a desired weld schedule via the Data Entry Panel (DEP). Any non zero request will over ride the inputs. DEP requests may be made in ON Line mode. The decimal equivalent of the binary bit pattern or the DEP request will be inserted in mm so that the user may view the last subroutine number ran. The subroutine that will be run will be the one that follows the header instruction #49 "Weld Schedule pp" where pp=mm. Calls may be made to subroutines programmed in other sequences but the whole subroutine program must be contained in that sequence. Returns will be to the next step after the Call Weld Schedule mm. Subroutines may be ended wherever they may be by programming Off Single in place of the Return.

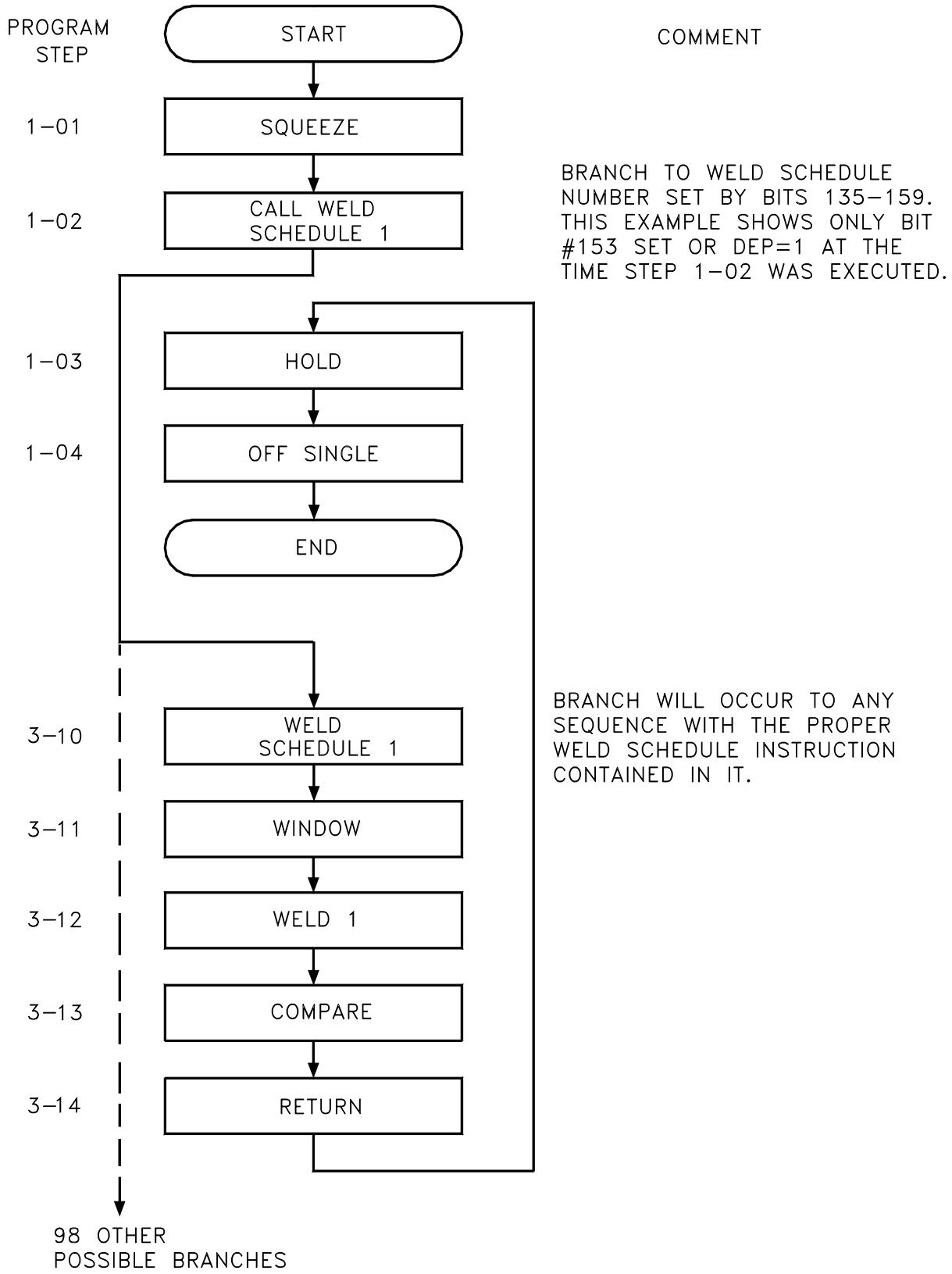
Display:

```
         11111111112222222222333
12345678901234567890123456789012
 2- 1 CALL WELD SCHEDULEmm DEPmm
         At instruction entry 59
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 24	Instruction description
D	25, 26	The number of the last schedule ran
E	31, 32	Data Entry Panel entered Weld Schedule request

FLOW CHART EMPLOYING CALL WELD SCHEDULE
IN A SIMPLE SEQUENCE PROGRAM



CALLWELD.DWG

BRANCHING INSTRUCTIONS 60 THROUGH 65

All branching instructions work as follows:

1. The default sequence-step destination of the branch is 00-99.

2. Executing the sequence 00 destination (default) will NOT change the active sequence. This provides a “sequence independent“ branch. Making it easier and much safer to COPY programs to other sequences.

3. Absolute branches to other sequences is allowed but EXTREME caution is necessary.

4. Resequencing of branch instructions is as follows:

   A. Branches pointing out of the sequence being edited are NOT re-sequenced, i.e. re-numbered when changes are made.

   B. Branches in the sequence being edited that point to PROGRAMMED instructions within the sequence are resequenced.

   This allows a programmer to enter a forward branch to a not yet programmed instruction. The editor will NOT resequence that branch until a destination instruction is programmed. The editor will then “track” the destination instruction as the programmer continues to insert or delete other instructions in the program.

5. What the above means to the programmer:

   A. When branching within a sequence it is not necessary to include the the sequence number if 00 is used. When a copy is made to a different sequence the sequence number is automatically understood.

   B. When editing a program it is not necessary to edit existing branching addresses when branching is within that sequence. BUT when branching out of sequence, it is the responsibility of the programmer to adjust branching addresses.

   C. Therefore, if possible, all branching should be kept within a given sequence. If branching out of sequence is necessary, then EXTREME caution must be applied when editing any sequence. One should not attempt to edit without a listing of all instructions involved and checking the new step numbers against branches pointers from other sequences.

THIS PAGE IS INSERTED TO MAKE THE FOLLOWING PAGES SEQUENCE SO THE INSTRUCTION DESCRIPTIONS ARE ON THE LEFT AND THE ASSOCATED INSTRUCTION FLOW CHART ON THE RIGHT.

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
60	Go To (aa-aa)	No	None

HEAT RANGE	COUNT	PRESET	WINDOW CHECK
None	None	None	N/A

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	None	None

DESCRIPTION

This instruction causes an unconditional branch to the selected step of the selected sequence. To prevent addressing problems when copying sequences, branching should remain in the same sequence if possible. If the branch can remain in the same sequence, then sequence 00 should be programmed in the branch.

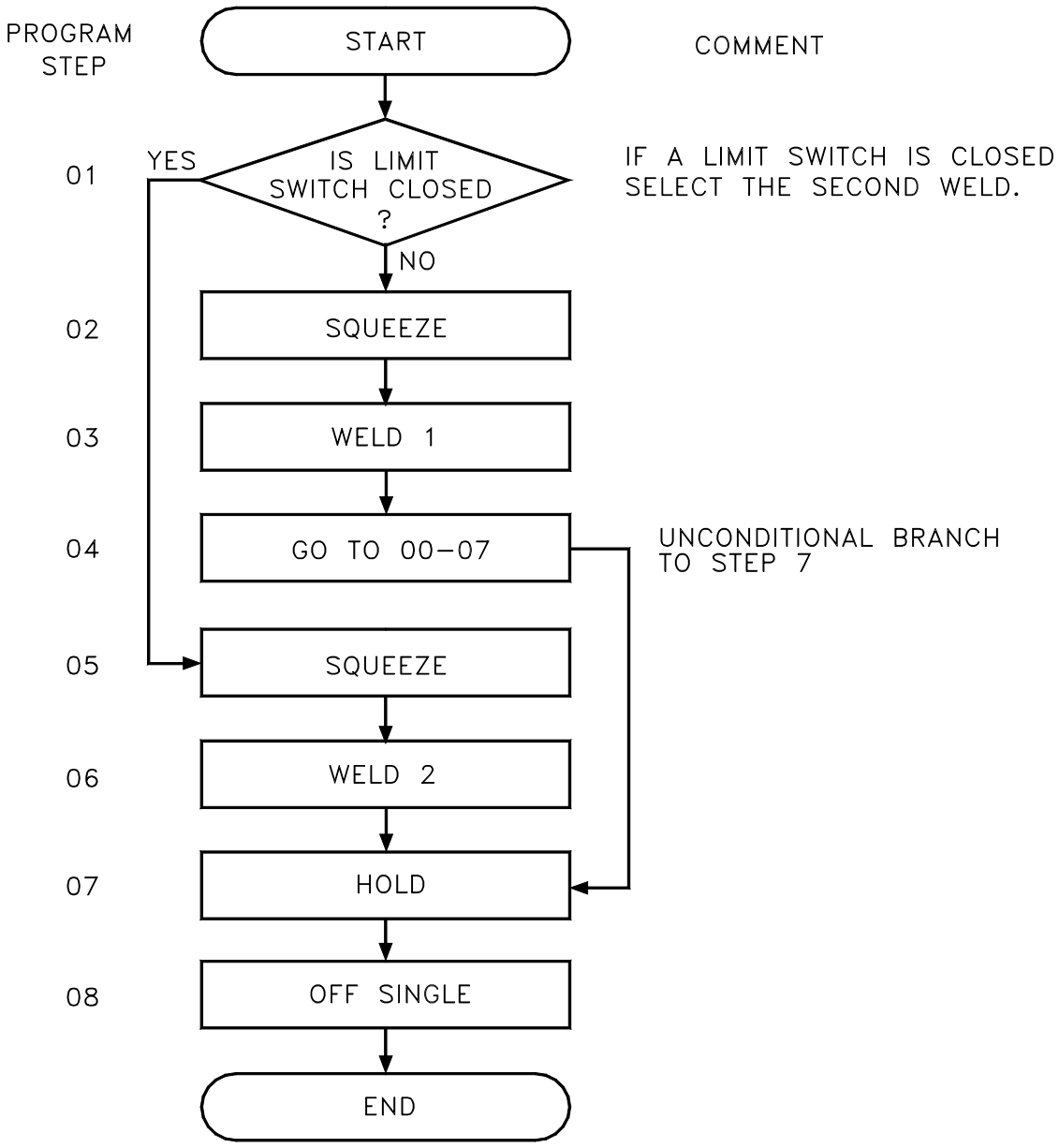
Display:

```
         1111111111222222222333
12345678901234567890123456789012
 1- 4 GOTO aa-aa
         At instruction entry 60
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 10	Instruction description
D	12, 13	Programmable Sequence 00-99
E	>15, 16	Step 01-99

FLOW CHART EMPLOYING GO TO
IN A SIMPLE SEQUENCE PROGRAM



GOTO.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
61	IF xxx TRUE GOTO aa-aa	No	None

HEAT RANGE	COUNT	PRESET	WINDOW CHECK
None	None	None	N/A

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	Assignable	None

DESCRIPTION

This instruction causes a branch to the selected step of the selected sequence if a bit is true (1). If the branch is to remain in the same sequence, then sequence 00 should be used to prevent sequence copy problems.

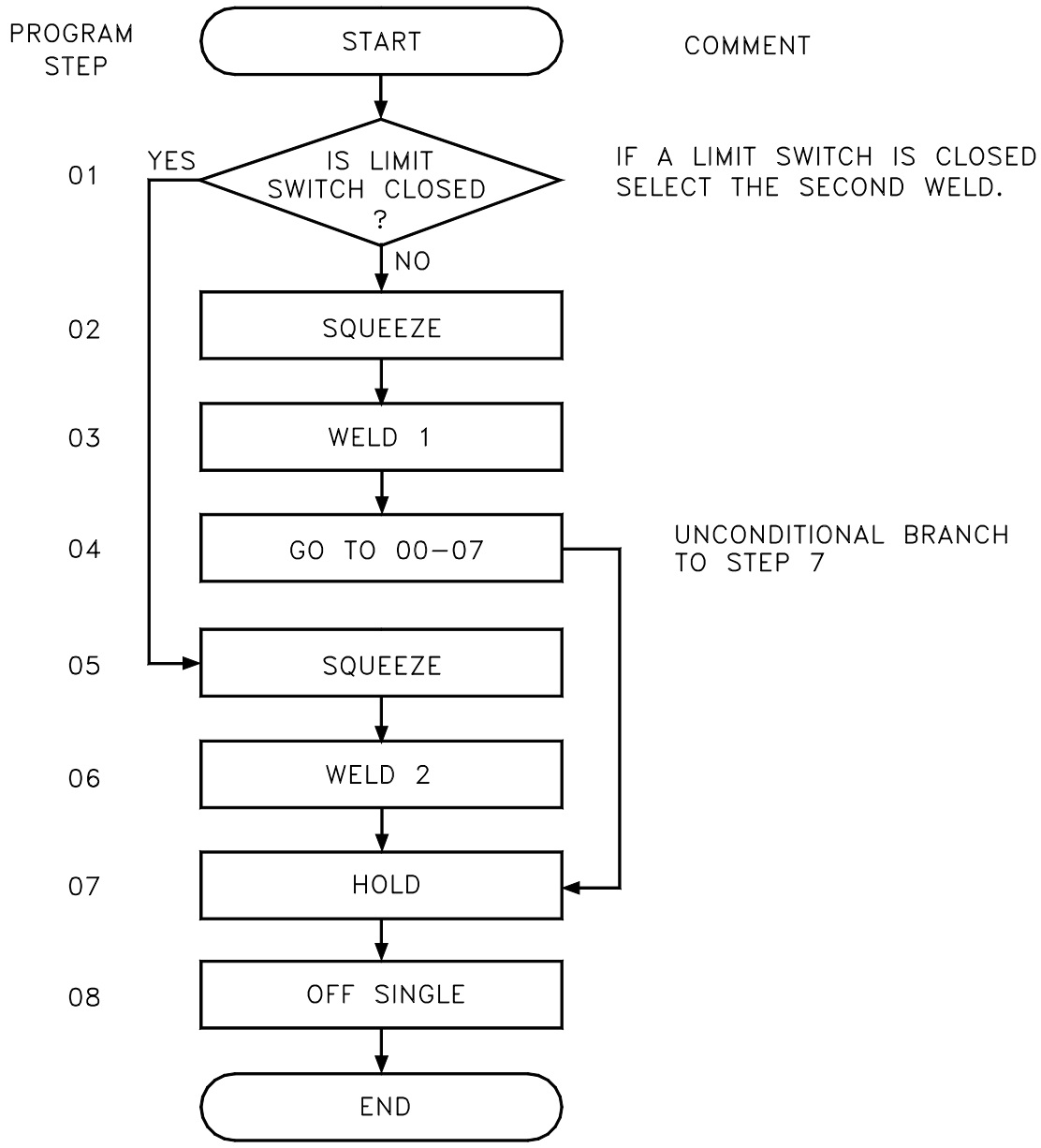
Display:

```
         11111111112222222222333
123456789012345678901234567890123
 1- 4 IF xxx TRUE GOTO aa-aa
         At instruction entry 61
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 22	Instruction description
D	>10, 12	Programmable bit 1-511
E	12, 13	Programmable sequence 00-99 (Defaults to 00 same seq)
F	15, 16	Programmable Step 01-99

FLOW CHART EMPLOYING IF TRUE GO TO
IN A SIMPLE SEQUENCE PROGRAM



IFTGOTO.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
62	IF xxx NOT TRUE GO TO aa-aa	No	None

HEAT RANGE	COUNT	PRESET	WINDOW CHECK
None	None	None	N/A

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	Assignable	None

DESCRIPTION

This instruction causes a branch to the selected step of the selected sequence if a is not true (0). If the branch is to remain in the same sequence, then sequence 00 should be used to prevent sequence copy problems.

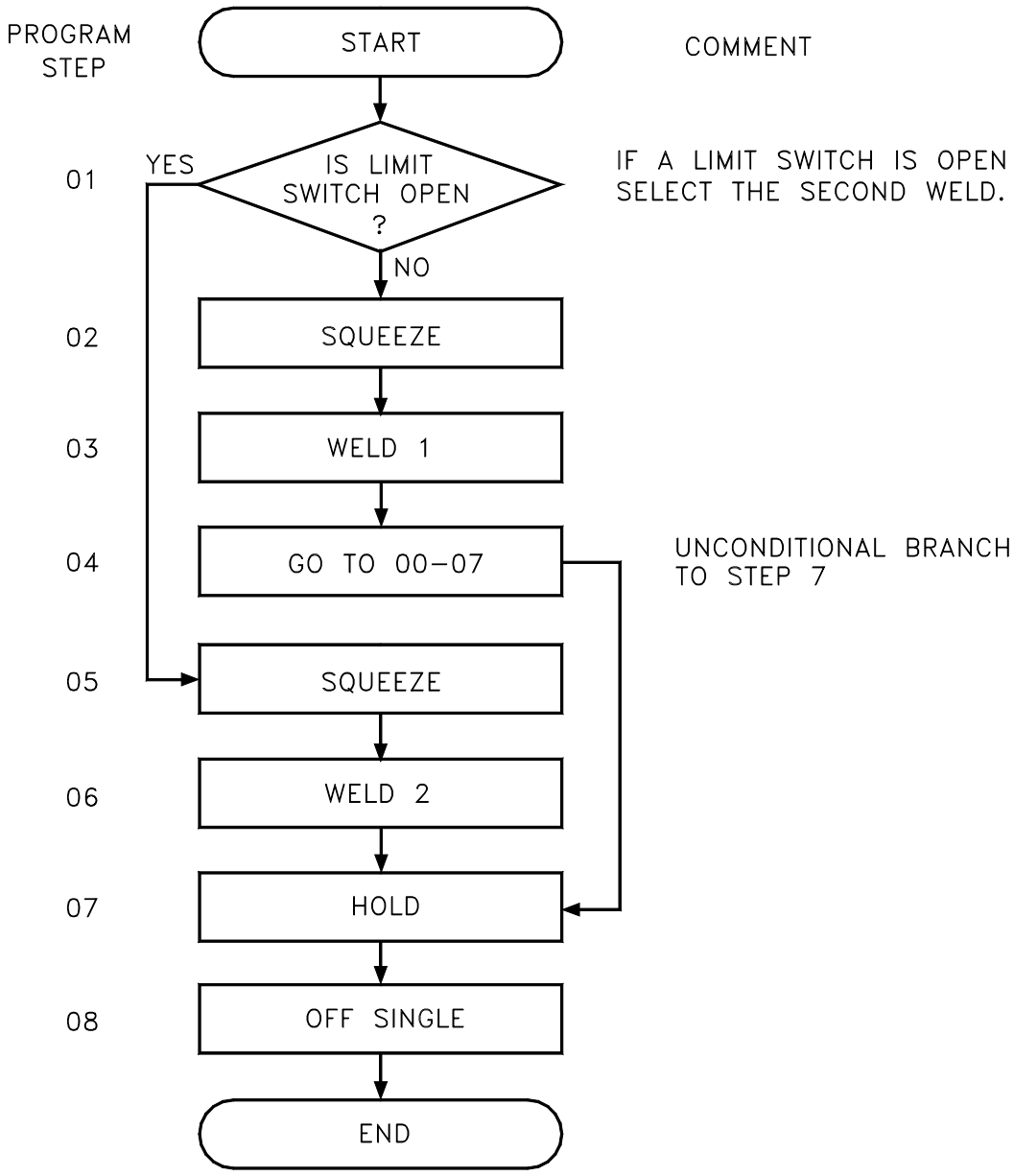
Display:

```
         1111111111222222222333
12345678901234567890123456789012
 1- 4 IF xxx NOT TRUE GOTO aa-aa
         At instruction entry 61
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 26	Instruction description
D	>10, 12	Programmable bit 1-511
E	28, 29	Programmable sequence 00-99 (Defaults to 00 same seq)
F	31, 32	Programmable Step 01-99

FLOW CHART EMPLOYING IF NOT TRUE GO TO
IN A SIMPLE SEQUENCE PROGRAM



IFNTGOT.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
63	IF xxx AND xxx GO TO aa-aa	No	None

HEAT RANGE	COUNT	PRESET	WINDOW CHECK
None	None	None	N/A

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	Assignable	None

DESCRIPTION

This instruction causes a branch to the selected step of the selected sequence if two bits logically ANDed are true (1). If the branch is to remain in the same sequence, then sequence 00 should be used to prevent sequence copy problems.

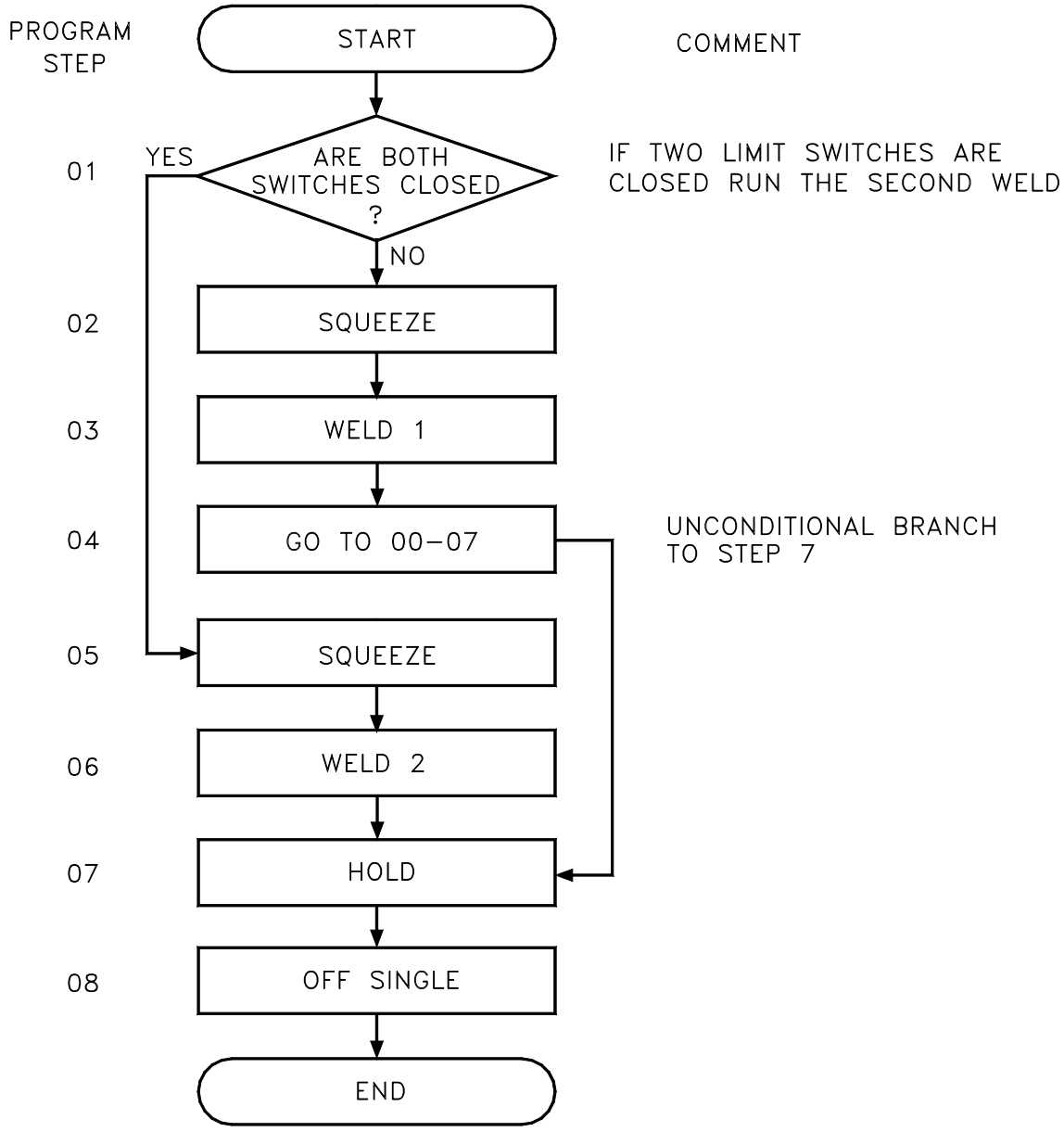
Display:

```
         1111111111222222222333
12345678901234567890123456789012
 1- 1 IF xxx & xxx GOTO aa-aa
         At instruction entry 63
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 23	Instruction description
D	>10, 12	Programmable bit 1-511
E	16, 18	Programmable bit 1-511
F	25, 26	Programmable sequence 00-99 (Defaults to 00 same seq)
G	28, 29	Programmable Step 01-99

FLOW CHART EMPLOYING IF (XXX) & (XXX) TRUE GO TO
IN A SIMPLE SEQUENCE PROGRAM



IFXGOTO.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
64	IF xxx OR xxx GO TO aa-aa	No	None

HEAT RANGE	COUNT	PRESET	WINDOW CHECK
None	None	None	N/A

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	Assignable	None

DESCRIPTION

This instruction causes a branch to the selected step of the selected sequence if one or both of two bits logically ORed are true (1). If the branch is to remain in the same sequence, then sequence 00 should be used to prevent sequence copy problems.

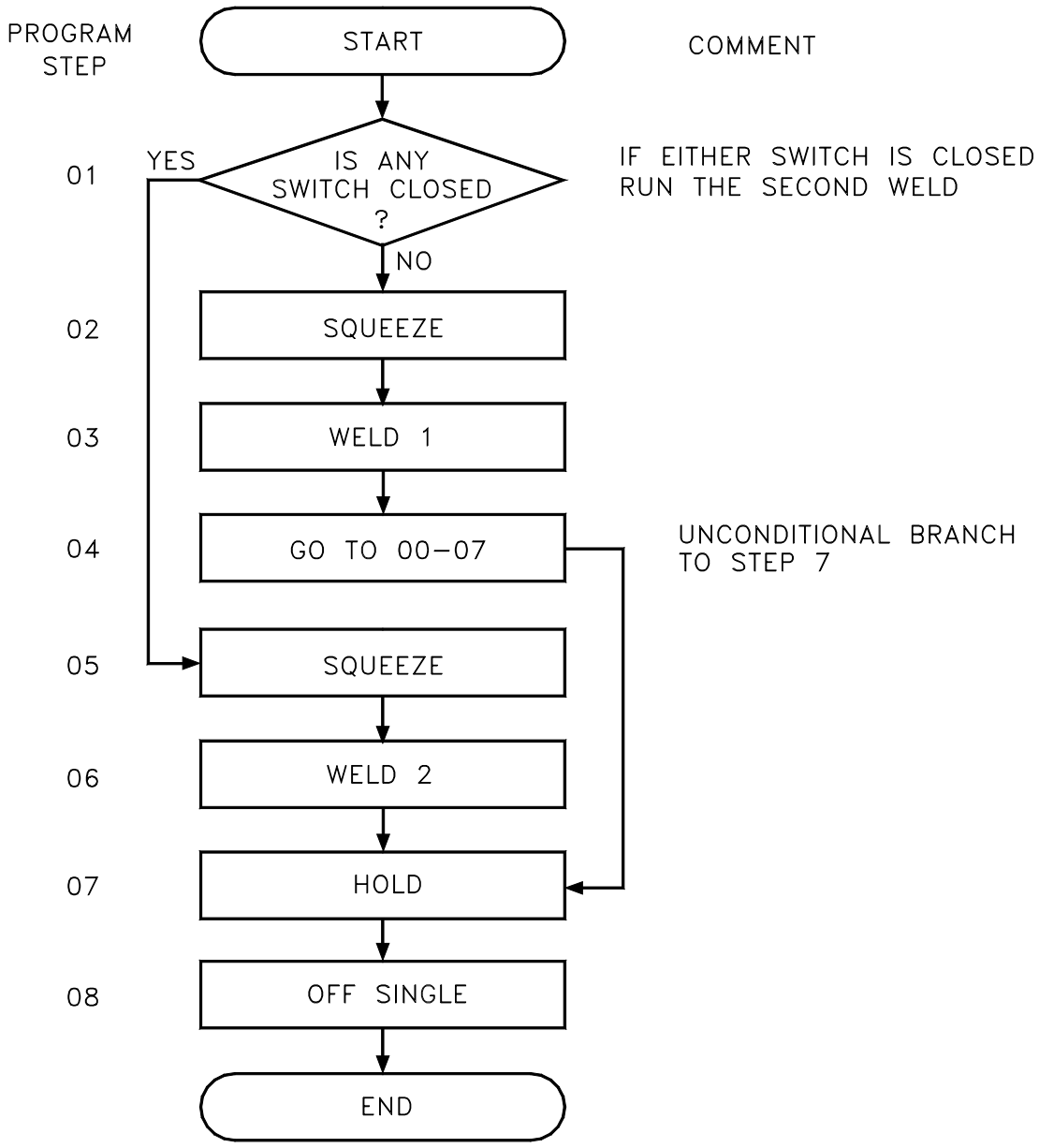
Display:

```
         1111111111222222222333
12345678901234567890123456789012
 1- 1 IF xxx ^ xxx GOTO aa-aa
         At instruction entry 63
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 23	Instruction description (position 14 ^=logical OR)
D	>10, 12	Programmable bit 1-511
E	16, 18	Programmable bit 1-511
F	25, 26	Programmable sequence 00-99 (Defaults to 00 same seq)
G	28, 29	Programmable Set 01-99

FLOW CHART EMPLOYING IF (XXX) OR (XXX) TRUE GO TO
IN A SIMPLE SEQUENCE PROGRAM



IFYGOTO.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
65	CALL aa-aa (subroutine)	No	None

HEAT RANGE	COUNT	PRESET	WINDOW CHECK
None	None	None	N/A

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	None	None

DESCRIPTION

This instruction will memorize the calling step number and branch to the programmed sequence and step number. It will continue to execute instructions until a RETURN instruction is encountered which will cause it to return to the next step after the memorized step. CALLs and RETURNs may be nested eight CALLs deep.

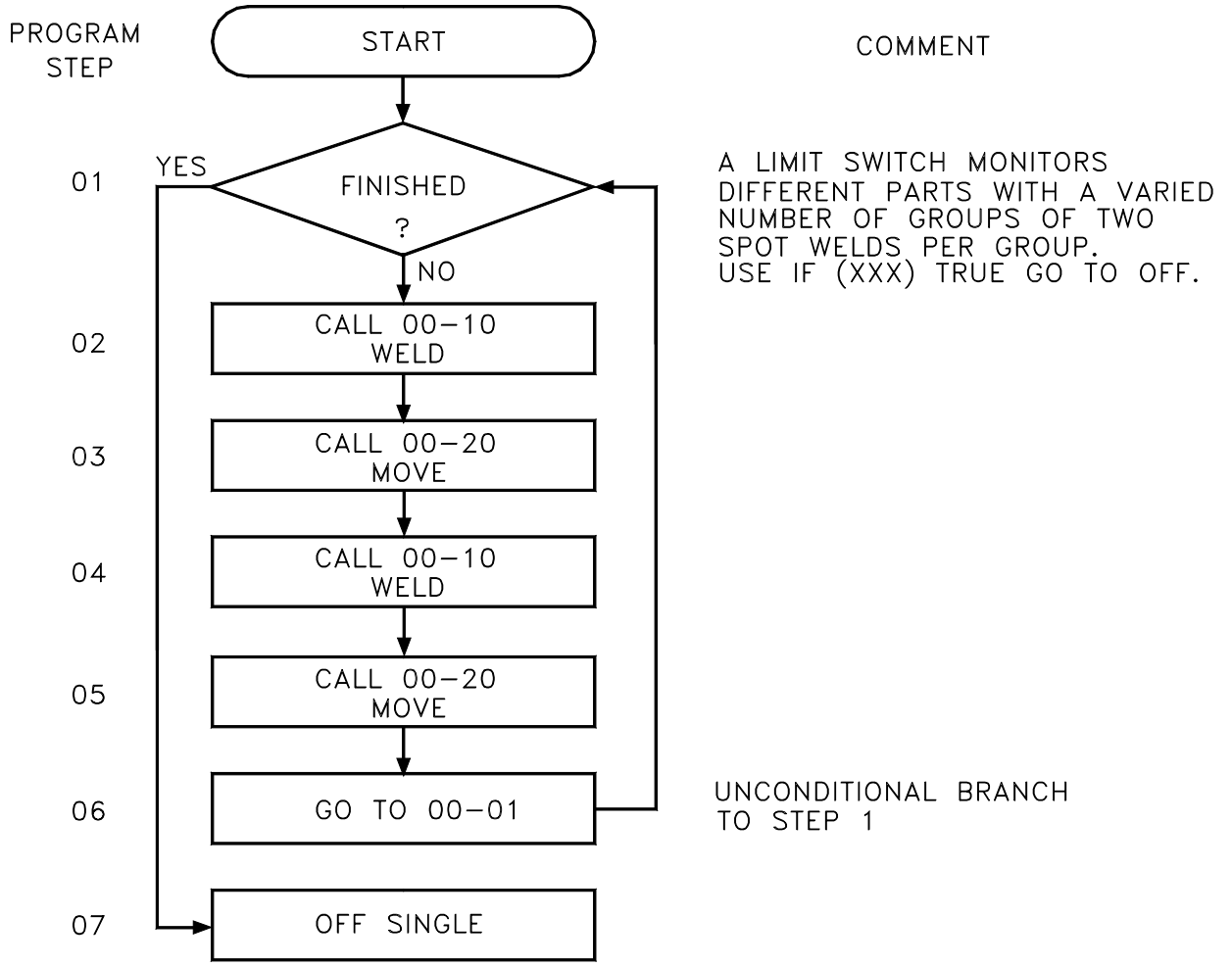
Display:

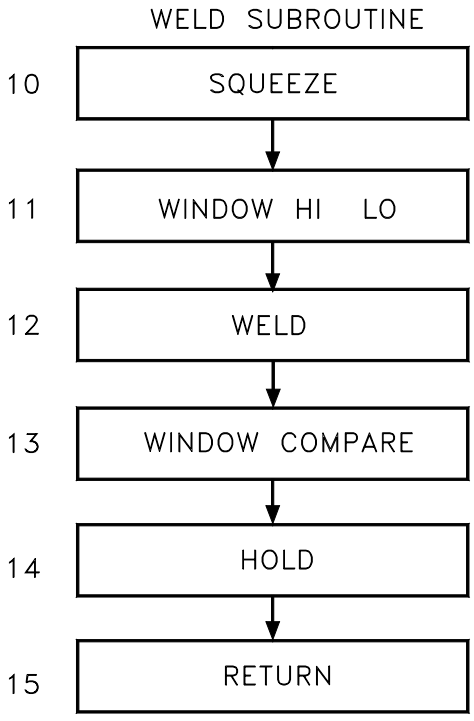
```
         1111111111222222222333
12345678901234567890123456789012
 1- 1 CALL aa-aa
         At instruction entry 65
```

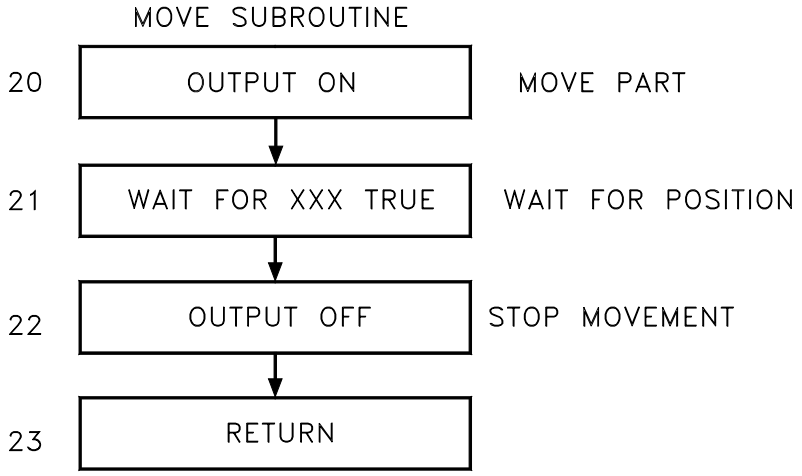
Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 10	Instruction description
D	12, 13	Programmable sequence 00-99 (Defaults to 00 same seq)
E	15, 16	Programmable Set 01-99

FLOW CHART EMPLOYING CALL
IN A SIMPLE SEQUENCE PROGRAM







CALL.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
66	RETURN (subroutine end)	No	None

HEAT RANGE	COUNT	PRESET	WINDOW CHECK
None	None	None	N/A

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	None	None

DESCRIPTION

This instruction will cause a branch back to the step after the memorize step of the last CALL. It is the last step of a CALLed subroutine. See instruction number 65.

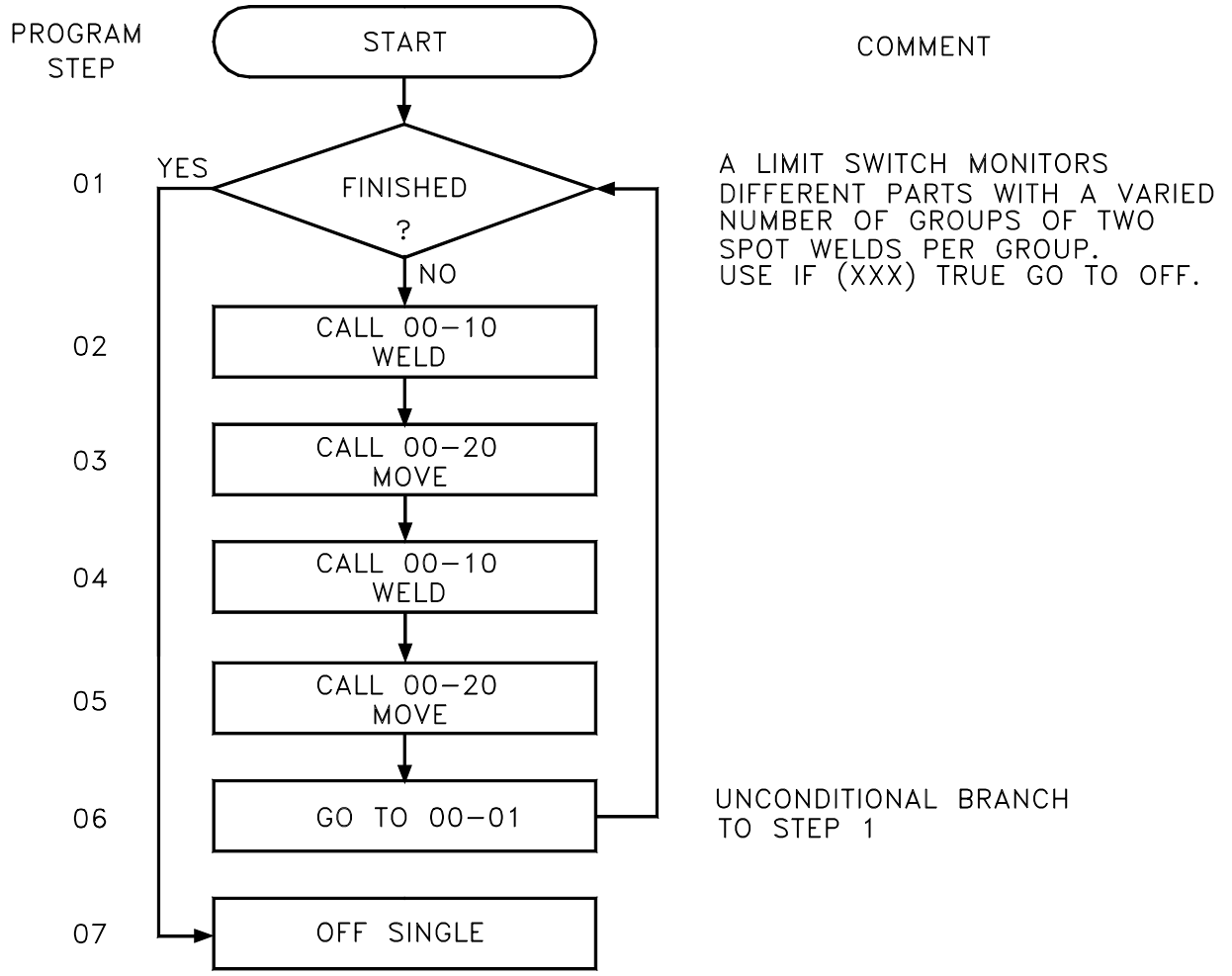
Display:

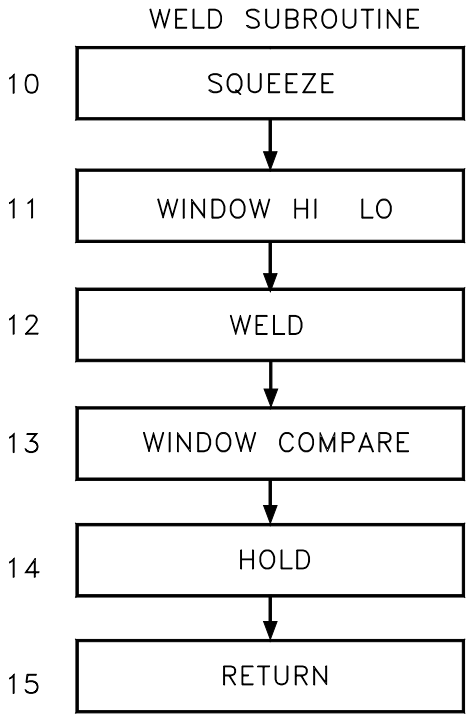
```
         1111111111222222222333
12345678901234567890123456789012
 1- 3 RETURN
         At instruction entry 66
```

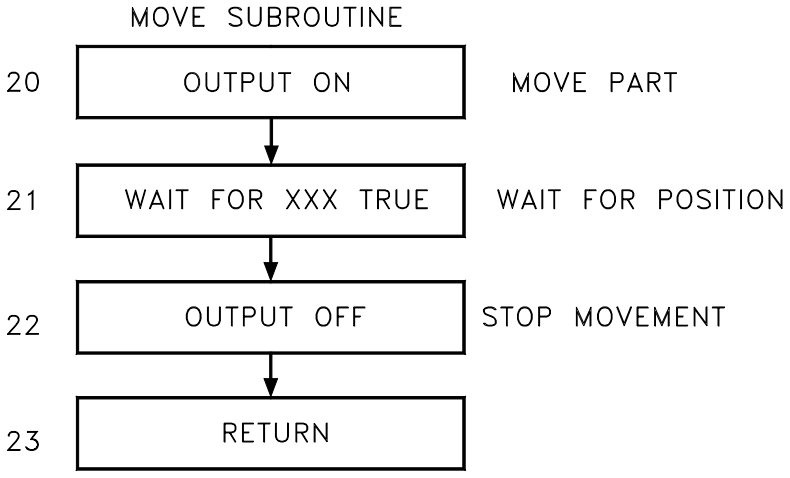
Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	>4, 5	Program step number 01-99
C	7, 12	Instruction description

FLOW CHART EMPLOYING RETURN
IN A SIMPLE SEQUENCE PROGRAM







RETURN.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
67	LOOP COUNTER	No	None

HEAT RANGE	COUNT	PRESET	WINDOW CHECK
None	None	1-65535	N/A

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each pass presets users loop count	None	Must have a Register Assignment. Must be used with REPEAT code 68 May be nested.

DESCRIPTION

LOOP COUNTER is used with REPEAT instruction code 68. These two instructions will repeat any instructions placed between them up to 65,535 times. The LOOP COUNTER instruction simply loads counter register with the preset count. The REPEAT instruction decrements the register and tests for zero at each pass through REPEAT. The register number and branch back step address must be programmed in the REPEAT. Branch back **MUST NOT** be the LOOP COUNTER step but some step between them or the loop will never end. LOOP COUNTER/REPEAT instructions may be nested 32 times.

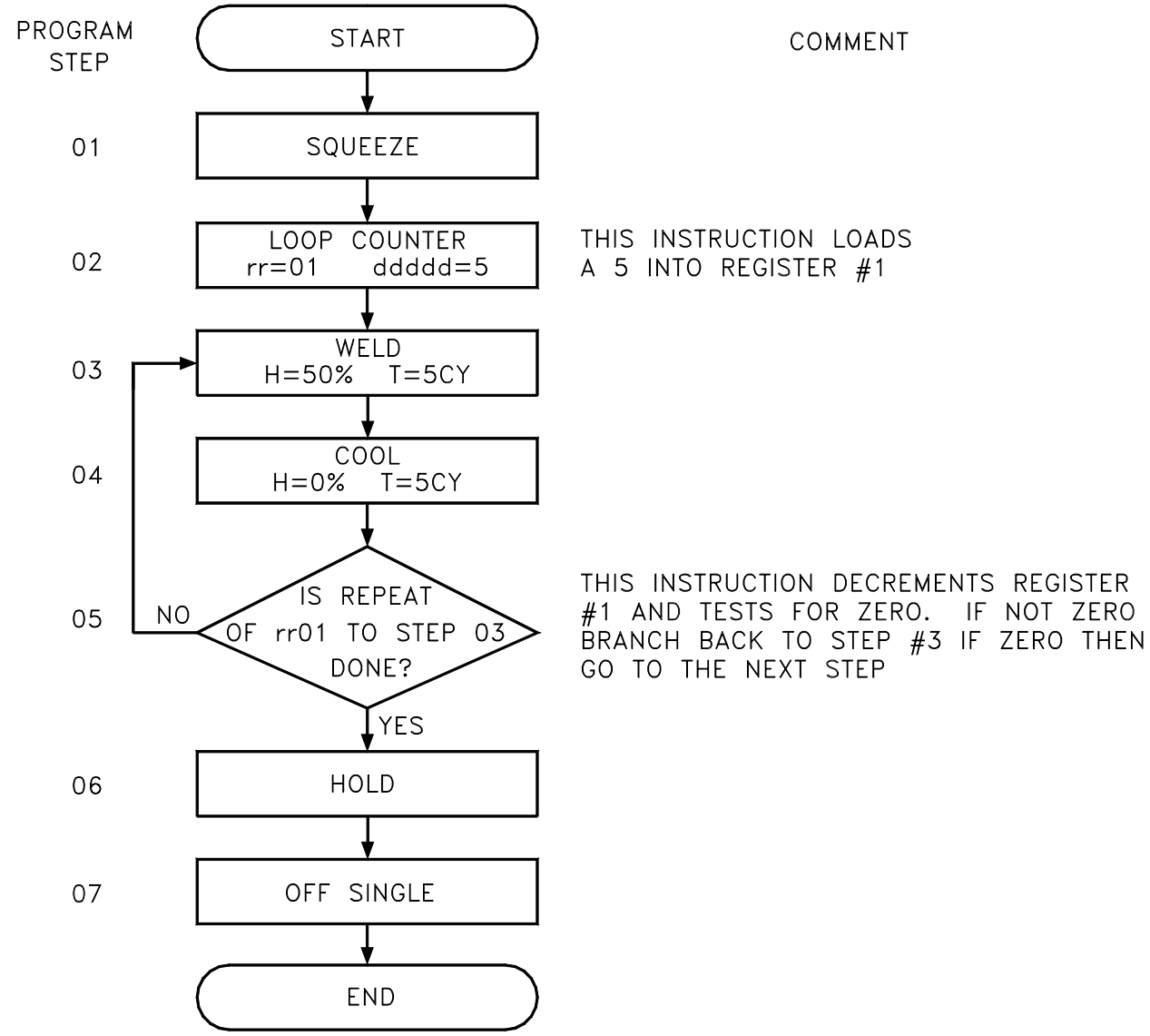
Display:

```
         11111111112222222222333
12345678901234567890123456789012
 1- 2 LOOP COUNT rr = ddddd
         At instruction entry 67
```

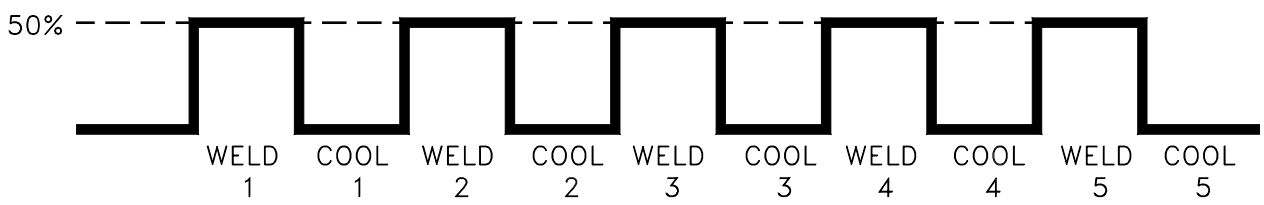
Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 16	Instruction description
D	18, 19	Register Number 0-31
E	>23, 27	Loop Count 1-65535

FLOW CHART EMPLOYING LOOP COUNTER
IN A SIMPLE SEQUENCE PROGRAM



WELD CURRENT PROFILE
5 PULSES OF WELD COOL



LOOPCTR.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
68	REPEAT aa-aa	No	None

HEAT RANGE	COUNT	PRESET	WINDOW CHECK
None	None	1-65,535	N/A

EXECUTED	I/O	SPECIAL CONSIDERATIONS
The number if times programmed in the LOOP COUNTER preset	None	Must have a Register Assignment. Must be used with REPEAT code 68 May be nested 32 times.

DESCRIPTION

REPEAT is used with LOOP COUNTER instruction code 67. These two instructions will repeat any instructions placed between them up to 65,535 times. The LOOP COUNTER instruction simply loads counter register with the preset count. The REPEAT instruction decrements the register and tests for zero at each pass through REPEAT. The register number and branch back step address must be programmed in the REPEAT. Branch back **MUST NOT** be the LOOP COUNTER step but some step between them or the loop will never end. LOOP COUNTER/REPEAT instructions may be nested 32 times.

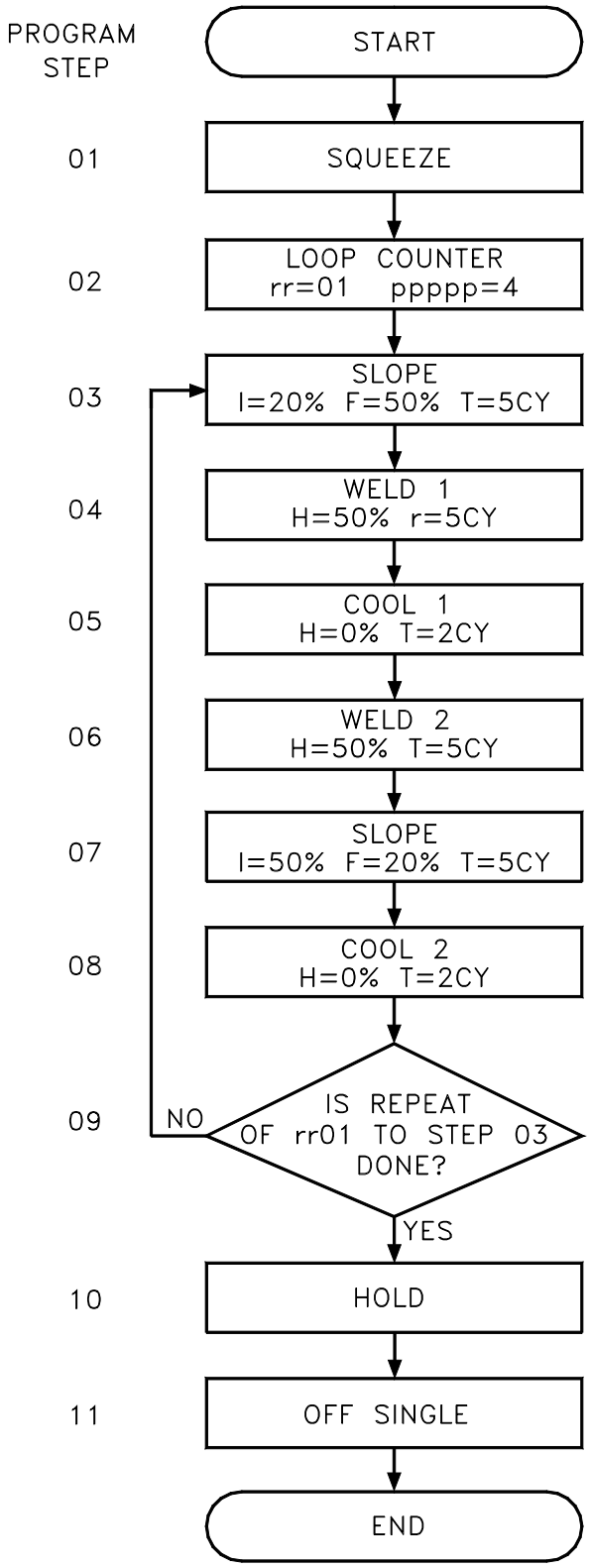
Display:

```
         11111111112222222222333
12345678901234567890123456789012
 1- 2 REPEAT rr aa-aa
         At instruction entry 68
```

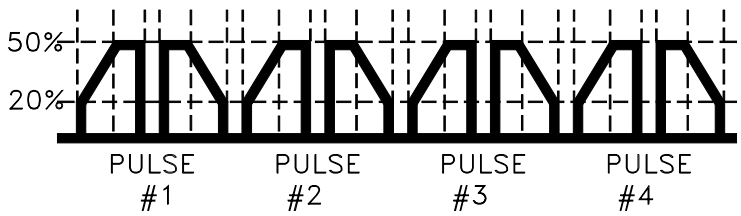
Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 1-31
B	4, 5	Program step number 1-99
C	7, 12	Instruction description
D	14, 15	Register Number 0-31
E	>17, 21	Sequence and Step number of branch back

THE USE OF LOOP COUNTER AND REPEAT TO OBTAIN PULSATION WELDING WITH UP AND DOWN SCOPE ON EACH PULSE



WELD CURRENT PROFILE OF 4 PULSES OF WELD AND COOL WITH UP/DOWN SLOPE



REPEAT.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
70	PRINT WELD DATA	No	None

HEAT RANGE	COUNT	PRESET	WINDOW CHECK
None	None	None	None

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	Serial RS485/422 on P2. Pins 7+ & pin 8-.	Minimum rate of transmission is 2400 baud. Set up HDX and RD.

DESCRIPTION

This instruction may be placed anywhere in a program, but is usually placed after a Window Compare instruction. Upon its execution the data contained in RAM for use in "View Welding Data" first line only, will be transmitted to a serial port P2. Notice the user may program a two digit number. This number may be used to identify the weld data printed out. If the weld or heats framed by the Current Window have been assigned a number by the user, this number should be programmed the same for easy reference. See section 1-3 Options, Data Export.

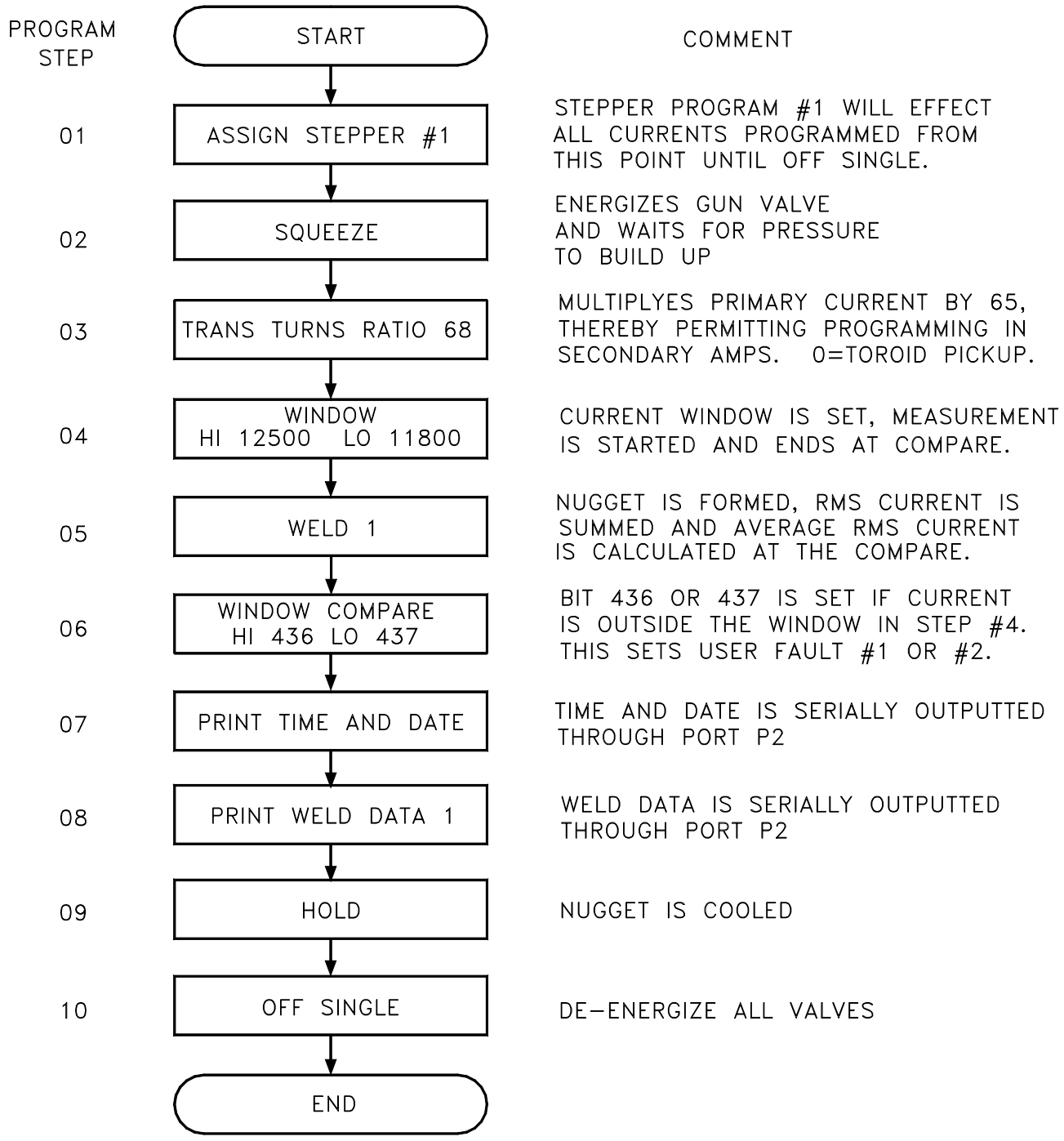
Display:

```
         1111111111222222222333
12345678901234567890123456789012
 1- 8 PRINT WELD DATA nn
         At instruction entry 70
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 1-31
B	4, 5	Program step number 1-99
C	7, 21	Instruction description
D	>23, 24	User inserted ID number for print out 1-99

FLOW CHART EMPLOYING PRINT WELD DATA
IN A SIMPLE SEQUENCE PROGRAM



PRWLDAT.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
71	PRINT TIME AND DATE	No	None

HEAT RANGE	COUNT	PRESET	WINDOW CHECK
None	None	None	None

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	Serial RS485/422 on P2. Pins 7+ & pin 8-.	Minimum rate of transmission is 2400 baud. Set up HDX and RD.

DESCRIPTION

This instruction may be placed anywhere in a program but is usually placed in front of Print Weld Data. Upon its execution the time and date which is contained in a real time software program will be serially outputted to port P2. It is used to "date stamp" the printout of any View Weld Data. Keeping track of time and date in the control is a **software function** which is continuously updated via the network from the workstation PC's real-time clock. Therefore if power is removed and the control is not networked, time and date will be lost and must be reprogrammed in Memory Management, Set Clock. See section 1-3 Options, Data Export.

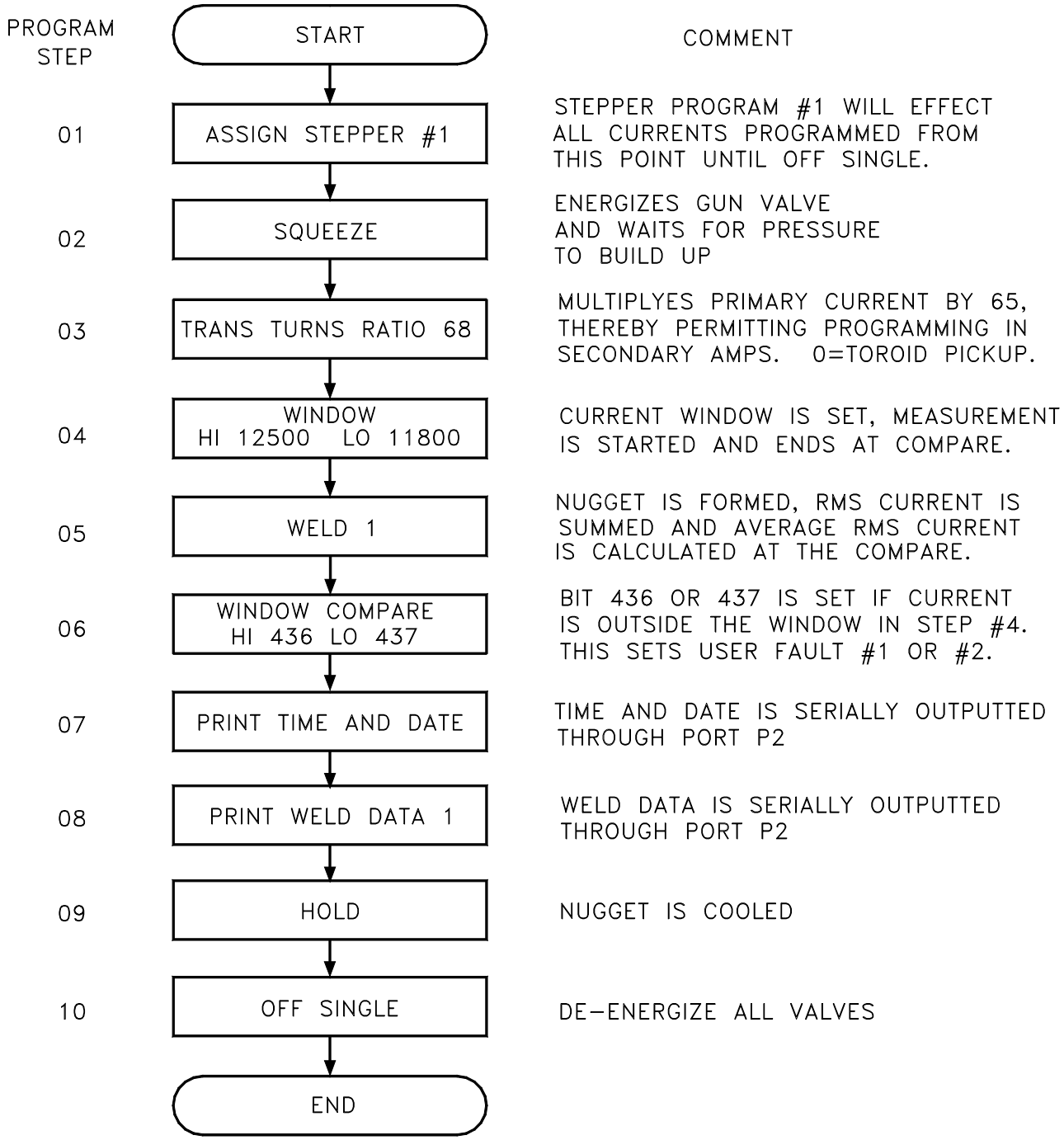
Display:

```
         11111111112222222222333
123456789012345678901234567890123
 1- 5 PRINT TIME AND DATE
         At instruction entry 71
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 1-31
B	>4, 5	Program step number 1-99
C	7, 25	Instruction description

FLOW CHART EMPLOYING PRINT TIME AND DATE IN A SIMPLE SEQUENCE PROGRAM



PRTMDATE.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
72	SPC WELD DATA yy	No	None

HEAT RANGE	COUNT	PRESET	WINDOW CHECK
None	None	None	Uses data from the last Compare for SPC bucket

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	Dual ported RAM	SPC sample size and frequency is set in ROPE. Sample size also programmable in Set Up.

DESCRIPTION

This instruction should be placed after Window Compare. Upon execution, the data used for "View Weld Data" will also be presented to an SPC algorithm. A number (1-99) must be programmed in the SPC Weld Data; this number identifies the SPC data location or “data bucket”. To avoid confusion, the WELD instruction framed by the Current Window should be assigned the same number. In operation, after the frequency and sample size has been reached, SPC math is performed. The SPC data is immediately transmitted to the workstation via Robonet and placed on the PC’s hardrive C:\robosrvr\spcdata\block0\timer#\timer#.dat&timer#.off. For file format see C:\robosrvr\spcdata\spc.file.cfg. SPC Frequency defaults to 100 but in ROPE may be reprogrammed. Buckets 1-16 frequency range is 0-999, with buckets 17-99 equaling bucket 16. There is only one programmable Sample Size per Weld Timer. Sample size defaults to 5 but may be reprogrammed 1-999 in Set Up and in ROPE.

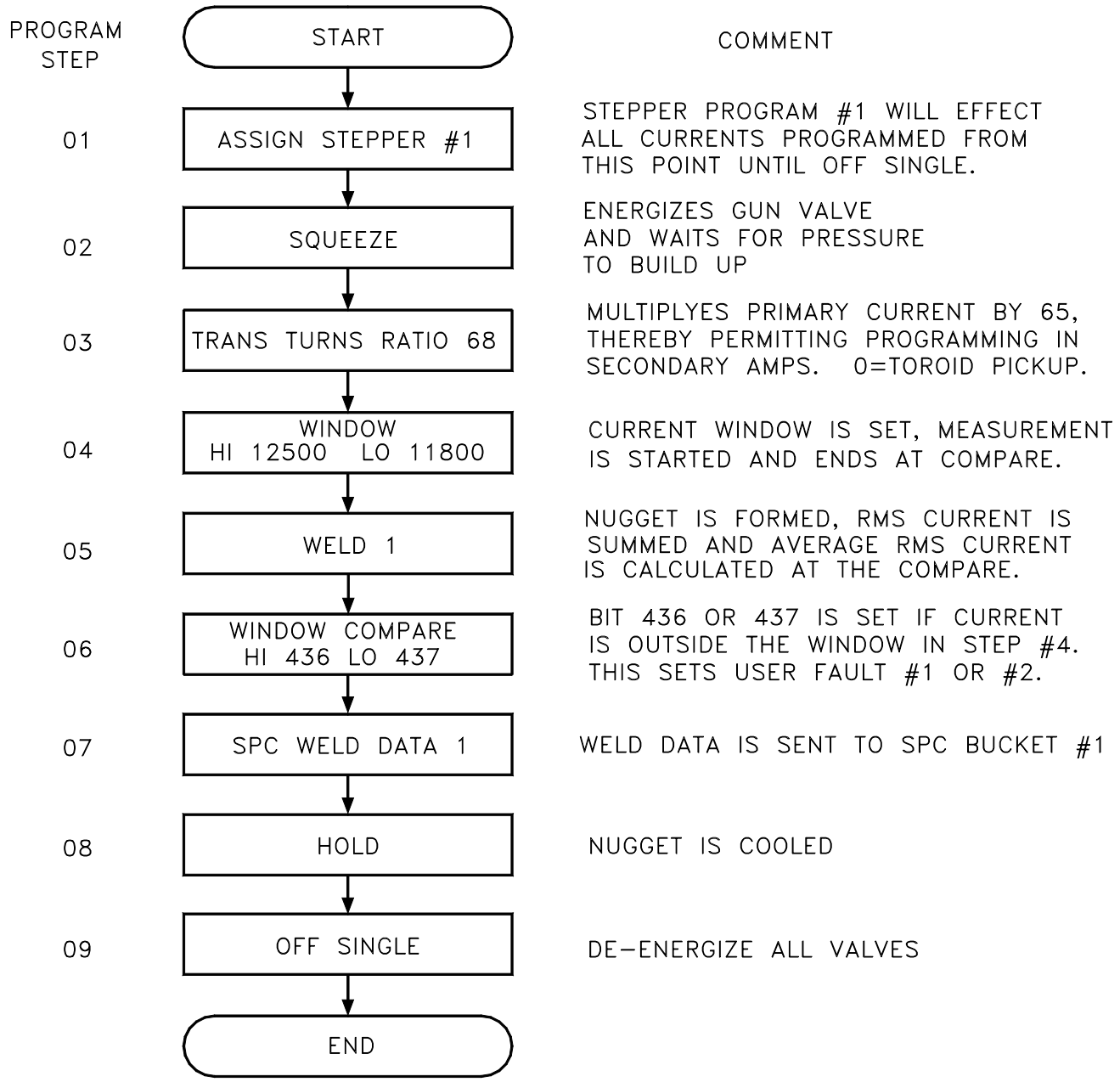
Display:

```
         1111111111222222222333
12345678901234567890123456789012
 1- 5 SPC WELD DATA yy
         At instruction entry 72
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 19	Instruction description
D	>21, 22	User inserted number used to identify SPC data bucket. (1-16 buckets)

FLOW CHART EMPLOYING SPC WELD DATA
IN A SIMPLE SEQUENCE PROGRAM



SPCDAT.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
73	FOOTPRINT WELD DATA yy	No	None

HEAT RANGE	COUNT	PRESET	WINDOW CHECK
None	None	None	None

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	none	none

DESCRIPTION

This instruction should be placed after Window Compare. Upon execution, the data used for "View Weld Data" will be transmitted immediately via RoboNet to the Workstations PC. The SPC data is placed on the hardrive C:\robosrvr\fotdata\block0\timer#\timer#.dat&timer#.off. For file format see C:\robosrvr\spcdata\spc.file.cfg. A number (1-16) must be programmed in the Footprint Weld Data, this number identifies the Footprint data location. To avoid confusion, the WELD instruction framed by the Current Window should be assigned same number. Footprint Weld Data is used to take a “Footprint” of data on a **new** machine making a **good** weld spot. The footprint sequence should be contained in a separate sequence and **never** changed through the life if the machine. It is a shame that practically every machine because of insuffient funds, poor planning or project management leaves the build house running poorly if at all. But it is a bigger shame that after finally running well on the customers floor, there is never enough time to document and make a back up copies of this valuable data!

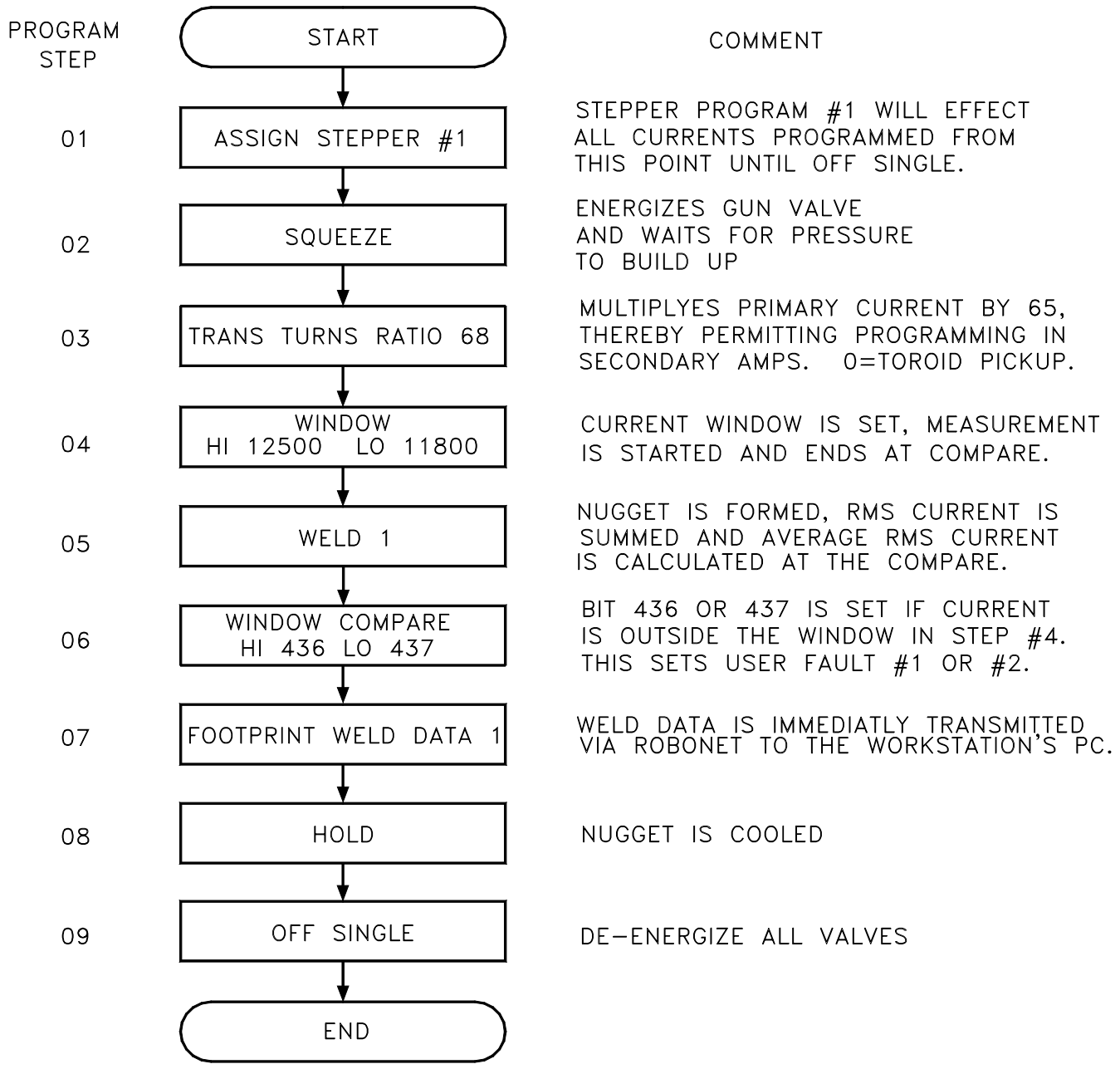
Display:

```
         1111111111222222222333
12345678901234567890123456789012
 1- 5 FOOTPRINT WELD DATA yy
         At instruction entry 73
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 25	Instruction description
D	>27, 28	User inserted number used to identify SPC
E		Footprint data bucket. (1-16 buckets)

FLOW CHART EMPLOYING FOOT PRINT DATA IN A SIMPLE SEQUENCE PROGRAM



FOTDAT.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
74	Window HI hh% LO hh%	Yes	None

HEAT RANGE	COUNT	PRESET	WINDOW CHECK
None	None	None	Works with Window Compare instruction Code 58.

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Before Heats	None	Must be placed before the heat statement(s) of interest.

DESCRIPTION

This instruction is placed before constant current heat instruction or any constant current weld operation. It is used to monitor the percent of available current during constant current heats and/or any other statements between it and the WINDOW COMPARE instruction. If during the open window the percent of heat control is forced outside the values programmed, one of the programmable HI or LO bits in the WINDOW COMPARE instruction will be set. These bits may be examined to be set and if set any programmable action may be taken. The bits may be examined by instructions following the WINDOW COMPARE or by a ladder logic program. The window is used to control the maximum and minimum heat control range of regulation and thereby provides a early warning before a compensation fault. Note in RUN or ON Line Mode the display shows the programmed percent available current in parenthesis. This data reflects the programmed percent "bumped" by any stepper program. Hence the Window percent is proportionally changed when the heat instruction is changed by a stepper program. Therefore a stepper program can not step the heat outside the programmed percent window. For AVC monitoring see code 22.

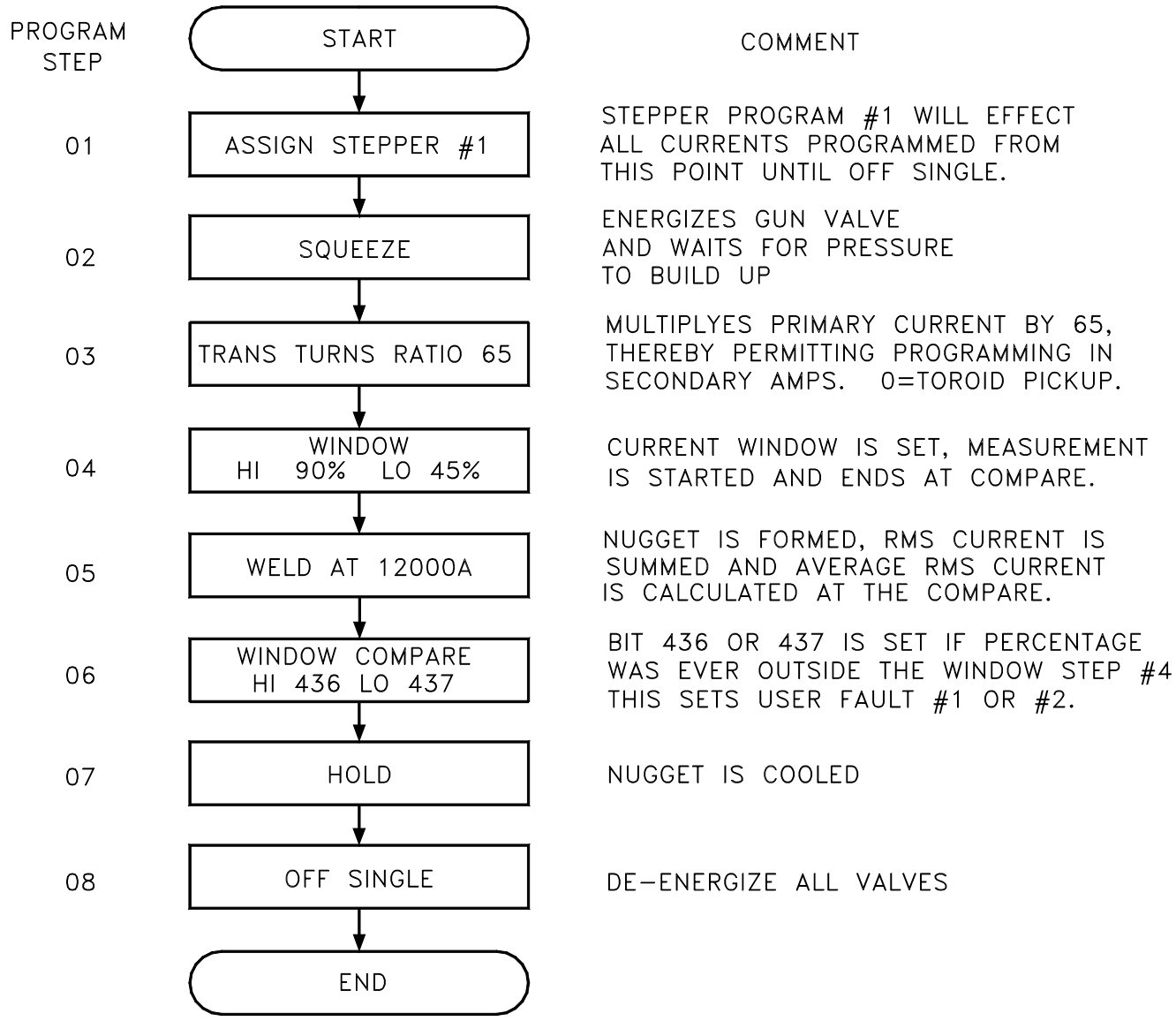
Display:

```
         1111111111222222222333
12345678901234567890123456789012
 1- 2 WINDOW HI hh%  LO hh%    <--Display in Program mode
 1- 2 WINDOW HI(hh%) LO(hh%)   <--Display in Run and On Line Mode
         At instruction entry 74
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 15	Instruction description
D	>17, 19	Percent available current high
E	25, 27	Percent available current low

FLOW CHART EMPLOYING WINDOW HI% LO%
IN A SIMPLE SEQUENCE PROGRAM



WINCENT.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
75	Reset Stepper xx To Step y	Yes	Fixed 3 Cycles

HEAT RANGE	COUNT	PRESET	WINDOW CHECK
None	None	None	None

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	None	None

DESCRIPTION

This instruction is used to reset or force to any step a counting type (1-15) Stepper program. The action happens every time the instruction is executed. It is used reset (y=0) for new tips or reset/advance (y=1) for old tips in robot automatic tip dress sequence.

If other steppers are "linked" via control bits #370-372 they also will be set to the same step in their programs. But resetting or advancing a stepper program under the PROGRAM STEPPER key will only effect that stepper in a linked system. Therefore individial stepper programs may be modified without effecting the linked group.

Although the instruction is displayed in Run and On Line mode, data may be changed only in Program mode.

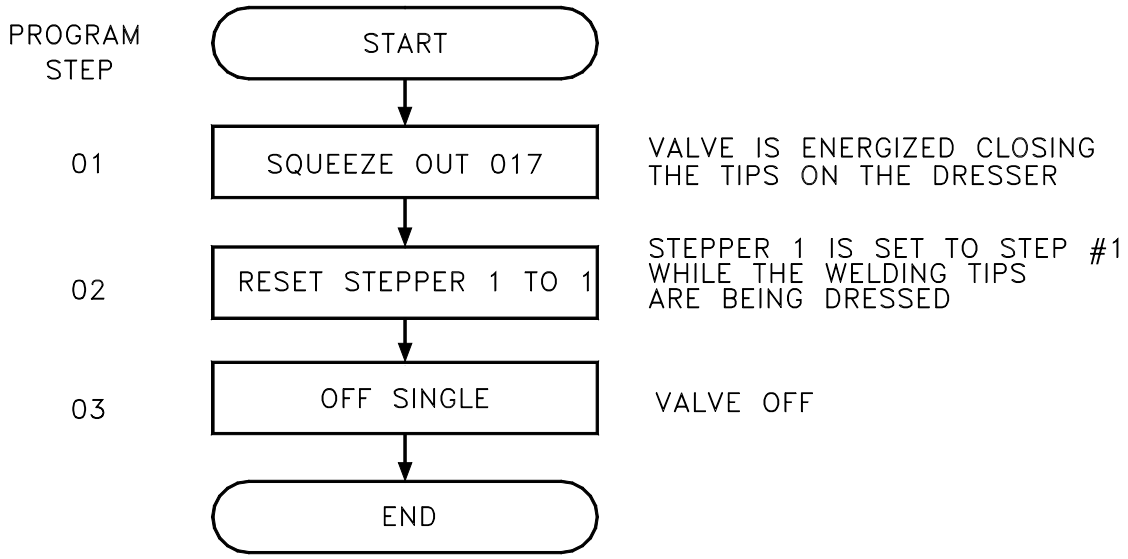
Display:

```
         1111111111222222222333
12345678901234567890123456789012
 1- 2 RESET STEPPER xx TO STEP y
         At instruction entry 75
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	>1, 2	Sequence number 01-15
B	4, 5	Program step number 01-99
C	7, 19	Instruction description
D	21, 22	Stepper number to reset
E	32	Step to reset to

FLOW CHART EMPLOYING RESET STEPPER xx TO STEP y
IN A SIMPLE ROBOT TIP DRESS PROGRAM



STPRSET.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
76	Tip Force	Yes	None

HEAT RANGE	COUNT	PRESET	WINDOW CHECK
None	None	None	None

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each pass	None	Output is effected by any stepper program. If MF=0, MF is obtained from the Gun table.

DESCRIPTION

This instruction outputs a 8 bit binary number which is used to control gun pressure. With the output starting address (ooo LSB) provided the control outputs to the next seven bits of the I/O space. With the maximum force of the gun (ffff) and the desired tip force (pppp) programmed, at instruction execution the 8 bit output will be:

$$\text{Force Outputted} = \frac{\text{TF} * \text{STEPPER \%}}{\text{MF}}$$ Clipped at 256 (8 bit binary)

This instruction will generate a Sequencer Fault if MF=0 and Gun Port=0, or MF is programmed 0 in the Gun Table (**divide by zero**). The output will remain on until a new instruction is executed or the Off instruction is reached. A number supplied by the control in parenthesis is the value with any applied stepper multiplier. See instruction #45 and 11.20.

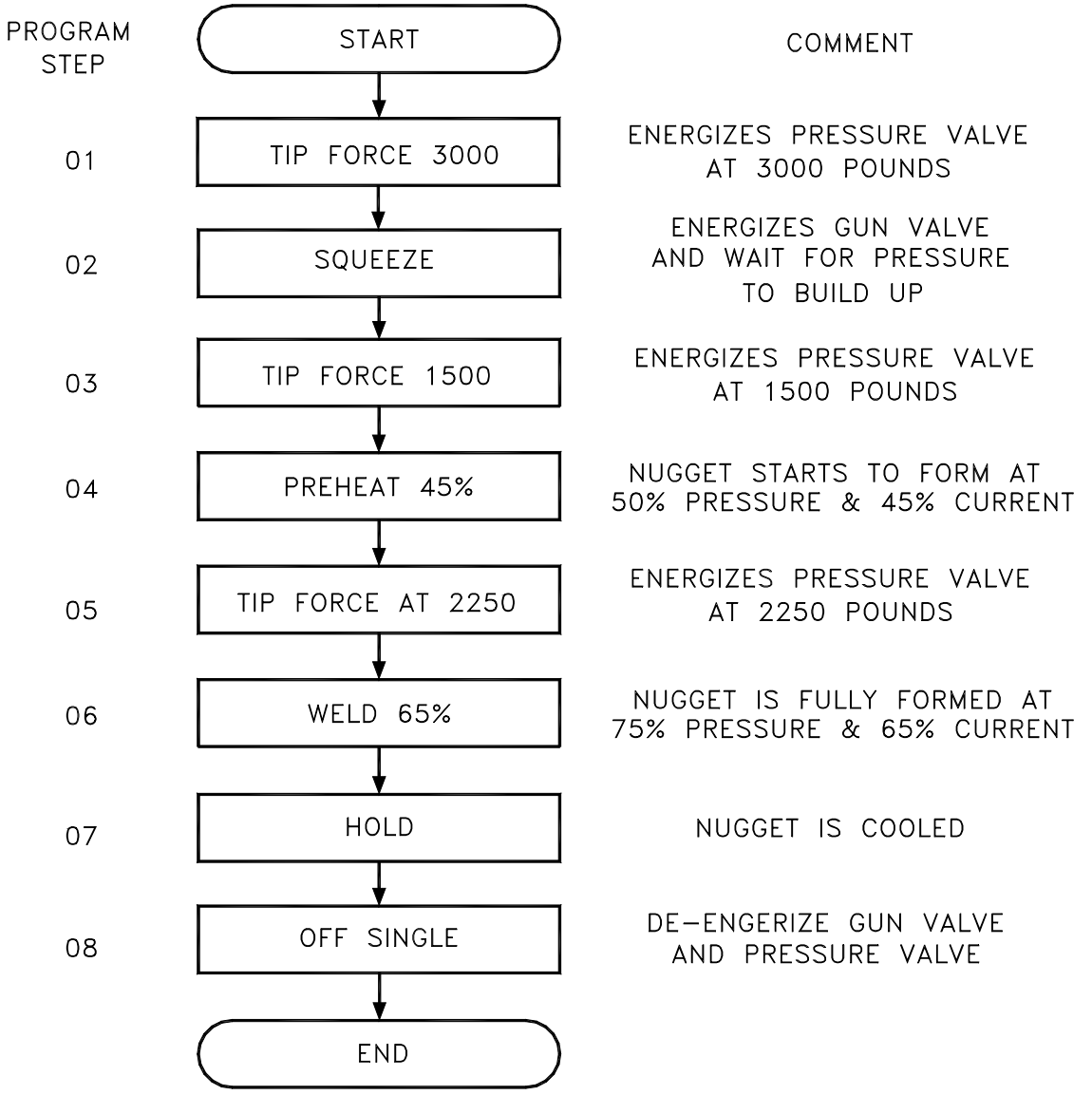
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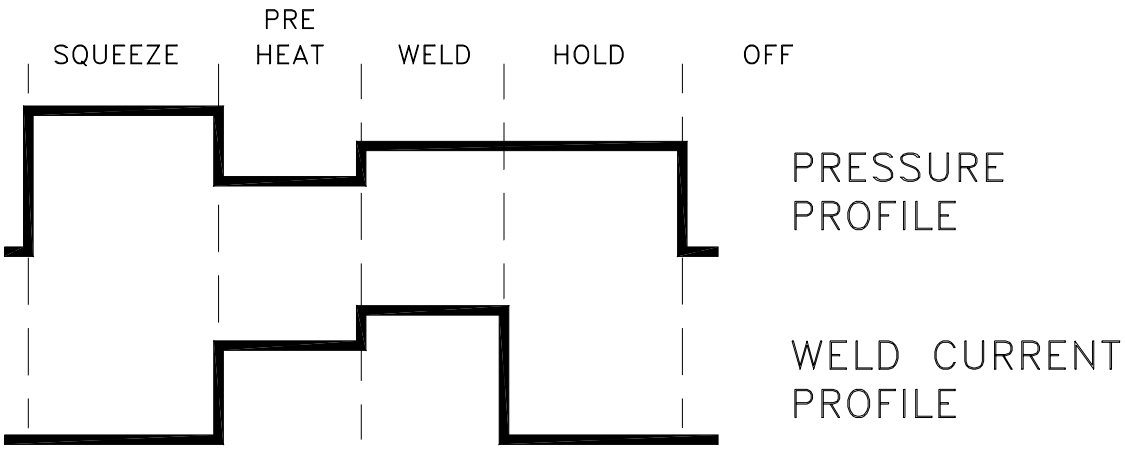
```
         11111111112222222223333
12345678901234567890123456789012
 1- 2 MF ffff TF pppp (####) ooo
         At instruction entry 76
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 1-31
B	4, 5	Program step number 1-99
C	7, 8	MF (Maximum Force)
D	10, 13	The guns maximum force. (force with all 8 bits set) If 0 the value comes from a Gun table under Set Up, if non zero the maximum force of the gun up to 9999.
E	15, 16	TF (Tip Force)
F	>18, 21	Desired tip force 1-9999, defaults to 9999
G	24, 27	Tip force applied with stepper program influence
H	30, 32	Output starting address (LSB), defaults to 161

FLOW CHART EMPLOYING TIP FORCE
IN A SIMPLE SEQUENCE PROGRAM





TIPFORCE.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
80	Preheat at Constant Current	Yes	00-99 Cycles

CURRENT RANGE	COUNT	PRESET	CURRENT WINDOW CHECK
1-65535 amperes	N/A	N/A	Yes.

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	Firing pulse for each 1/2 cycle of Preheat.	User may enter a preheat ID # in position nn, if not entered it remains blank. Preheat will not increment stepper programs. The last programmed transformer turns ratio is applied.

DESCRIPTION

Preheat current is an impulse or series of impulses of current prior to and separate from the welding current. This current is considered preparatory and must not cause the faying surfaces to be destroyed. A simple check for over heating is to "zero out" weld time and make a weld. After the "weld" is made the parts should not be fused. This instruction is the same as Preheat code 03 except it provides a constant current programmed in amperes. The control monitors primary current therefore if a trans turns ratio is NOT programmed before this instruction regulation will be in PRIMARY amperes. If a trans turns ratio instruction IS programmed, the turns ratio is applied providing regulation in SECONDARY amperes. The control will always use the last ratio programmed in the sequence. A trans turns ratio of 1 will provide primary regulation and is defaulted to at the beginning if each sequence. See instruction codes 22, 57 and 58.

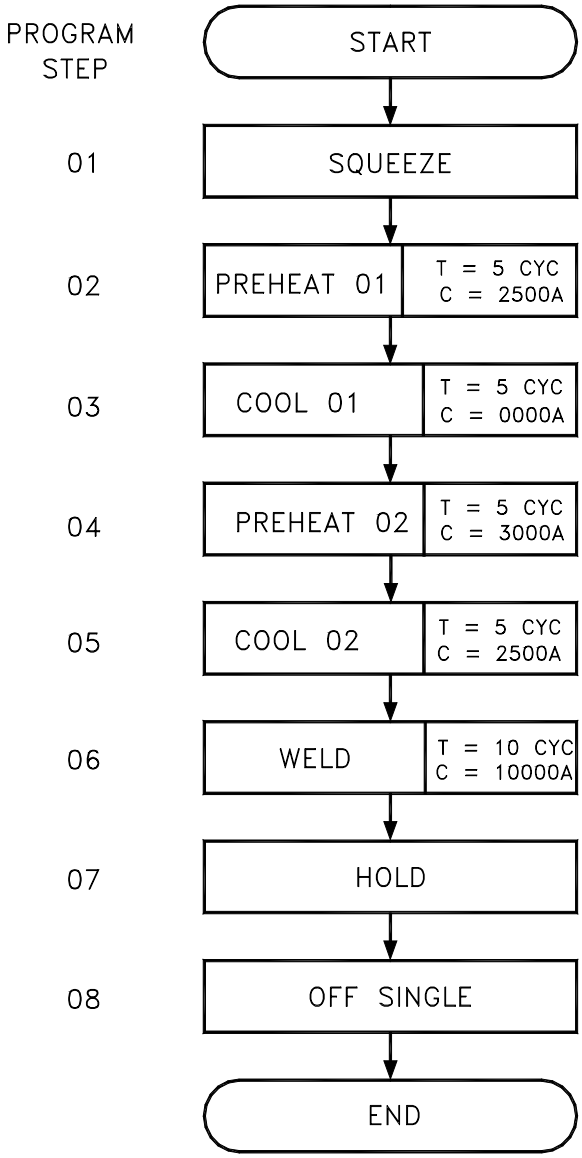
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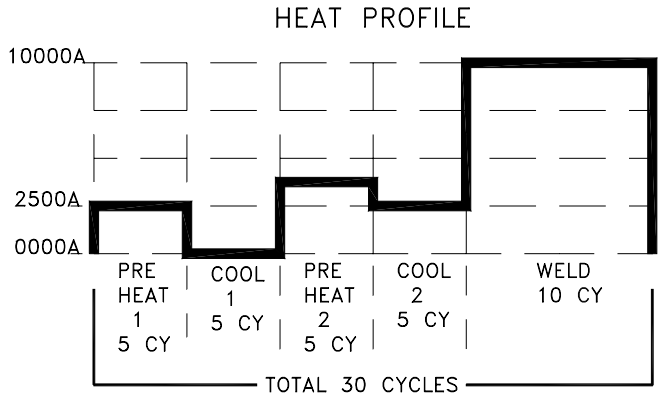
```
         1111111111222222222333
12345678901234567890123456789012
 1- 4 PREHEAT nn  iiiiiA    ccCY
         At instruction entry 80
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 13	Instruction description
D	15, 16	User optional Preheat number
E	>19, 23	Preheat current in amperes 1-65535A
F	29, 30	Preheat timing in line cycles

FLOW CHART EMPLOYING PREHEAT AT A CONSTANT CURRENT
IN A SIMPLE SEQUENCE PROGRAM





PREHTCC.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
81	Slope at Constant Current	Yes	00-99 Cycles

HEAT RANGE	COUNT	PRESET	CURRENT WINDOW CHECK
1-65535 amperes	N/A	N/A	Yes

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	Firing pulse for each 1/2 cycle if programmed current	Slope may be programmed to be Up or Down slope by changing the Initial and Final current values. The last programmed transformer turns ratio is applied.

DESCRIPTION

Slope time is the time during which the welding current continuously increases or decreases. If it increases from the beginning of weld current it is considered up slope. If the current increases at the end of the weld period it is considered downslope. This instruction is the same as Slope code 05 except it provides a constant sloping current programmed in amperes. The control monitors primary current therefore if a trans turns ratio is NOT programmed before this instruction regulation will be in PRIMARY amperes. If a trans turns ratio instruction IS programmed, the turns ratio is applied providing regulation in SECONDARY amperes. The control will always use the last ratio programmed in the sequence. A trans turns ratio of 1 will provide primary regulation and is defaulted to at the beginning if each sequence. See instruction codes 22, 57 and 58.

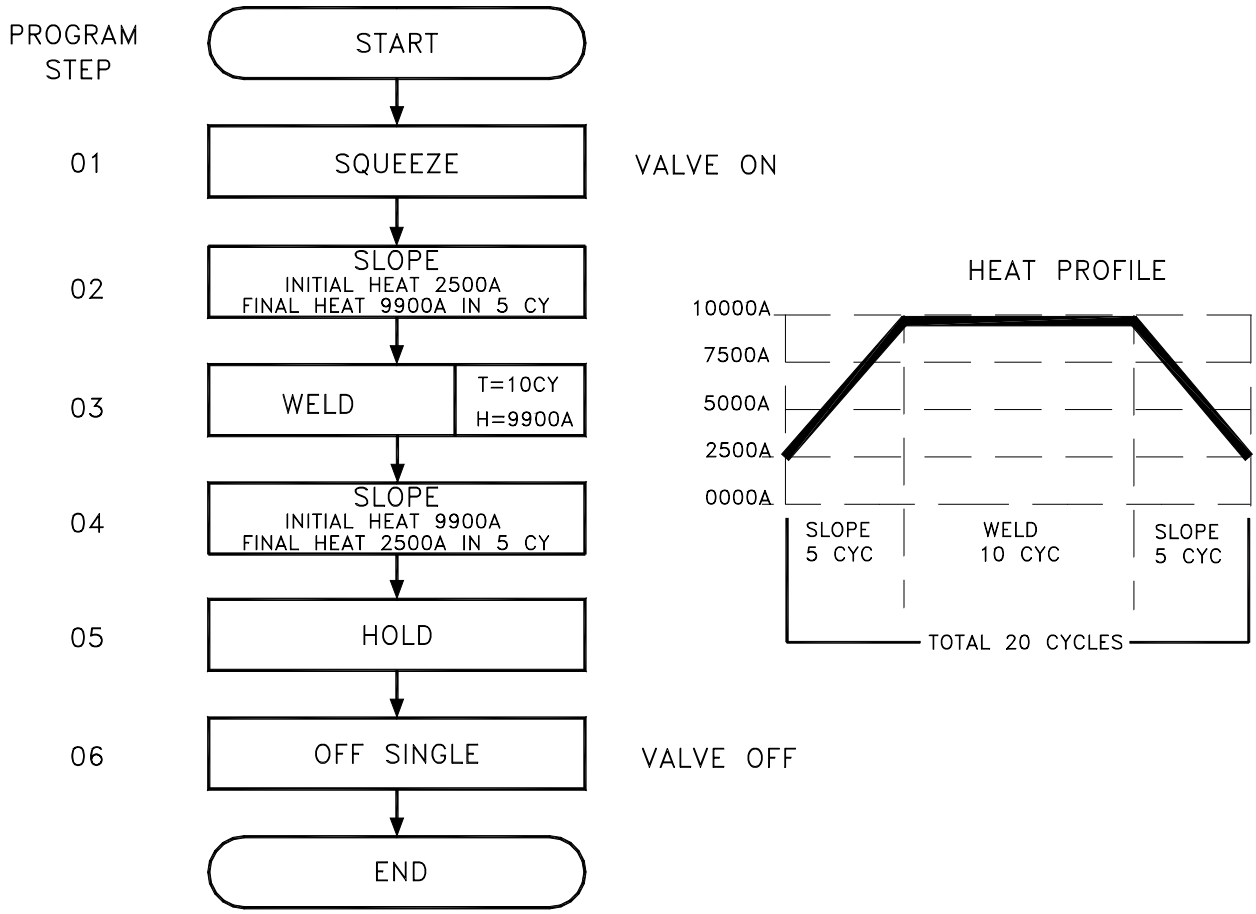
Display:

```
         1111111111222222222333
12345678901234567890123456789012
 1- 5 SLOPE IiiiiiA FiiiiiA ccCY
         At instruction entry 81
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 11	Instruction description
D	>14, 18	Initial current in amperes 1-65535
E	22, 25	Final current in amperes 1-65535
F	29, 30	Slope time in line cycles

FLOW CHART EMPLOYING SLOPE AT A CONSTANT CURRENT
IN A SIMPLE SEQUENCE PROGRAM



SLOPECC.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
82	Weld at Constant Current	Yes	00-99 Cycles

HEAT RANGE	COUNT	PRESET	CURRENT WINDOW CHECK
1-65535 amperes	N/A	N/A	Yes.

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	Firing pulse for each 1/2 cycle if programmed current	User may enter a Weld ID# in position nn, if not entered it remains blank. The last turns ratio is applied.

DESCRIPTION

The Weld function is the time current is passed from the beginning of welding to the beginning of post heat time. It is the period of time the actual fusion of metal takes place by the application of a high current through the resistance of work pieces. Current should be applied until a point short of metal expulsion. Expulsion should never occur; it is an indication of too much weld current or time. This instruction is the same as Weld code 06 except it provides a constant current programmed in amperes. The control monitors primary current; therefore, if a trans turns ratio is NOT programmed before this instruction regulation will be in PRIMARY amperes. If a trans turns ratio instruction IS programmed, the turns ratio is applied providing regulation in SECONDARY amperes. The control will always use the last ratio programmed in the sequence. A trans turns ratio of 1 will provide primary regulation and is defaulted to at the beginning if each sequence. See instruction codes 22, 57 and 58.

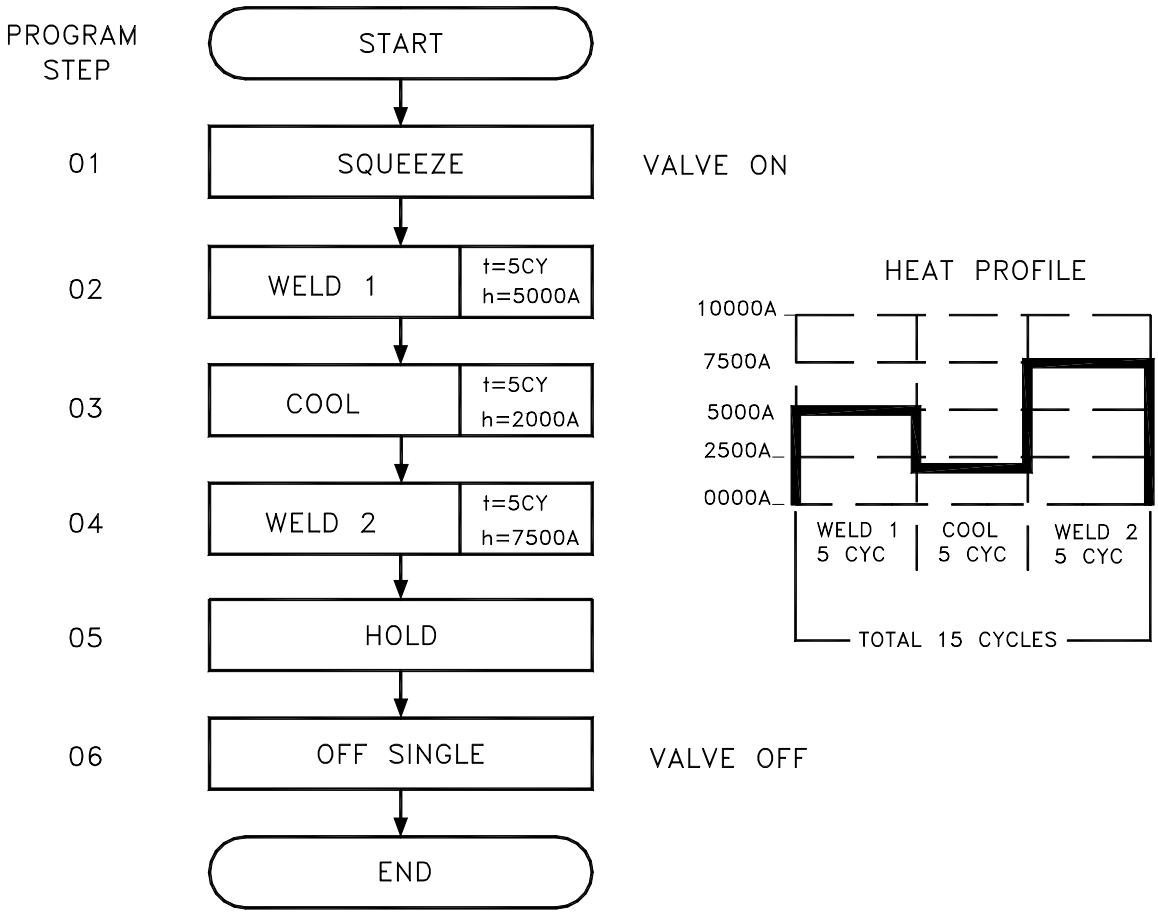
Display:

```
         1111111111222222222333
12345678901234567890123456789012
 1- 3 WELDnn iiiiiA (mmmmm) ccCY
         At instruction entry 82
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 10	Instruction description
D	11, 12	User optional Weld number
E	>14, 18	Weld current in amperes 1-65535
F	23, 26	Weld current with stepper program % influence (actual current applied)
G	29, 30	Weld timing in line cycles

FLOW CHART EMPLOYING WELD AT A CONSTANT CURRENT
IN A SIMPLE SEQUENCE PROGRAM



WELDCC.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
83	Postheat at Constant Current	Yes	00-99 Cycles

CURRENT RANGE	COUNT	PRESET	CURRENT WINDOW CHECK
1-65535 amperes	N/A	N/A	Yes

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	Firing pulse for each 1/2 cycle of Preheat.	User may enter a postheat ID # in position nn, if not entered it remains blank. Postheat will not increment stepper programs. The last programmed transformer turns ratio is applied.

DESCRIPTION

Post heat is a function which applies current to a nugget after the weld function is over. It is used to condition the nugget by controlling the cooling process there by preventing crystallizing and/or cracking of the weld spot. This instruction is the same as Post heat code 07 except it provides a constant current programmed in amperes. The control monitors primary current therefore if a trans turns ratio is NOT programmed before this instruction regulation will be in PRIMARY amperes. If a trans turns ratio instruction IS programmed, the turns ratio is applied providing regulation in SECONDARY amperes. The control will always use the last ratio programmed in the sequence. A trans turns ratio of 1 will provide primary regulation and is defaulted to at the beginning if each sequence. See instruction codes 22, 57 and 58.

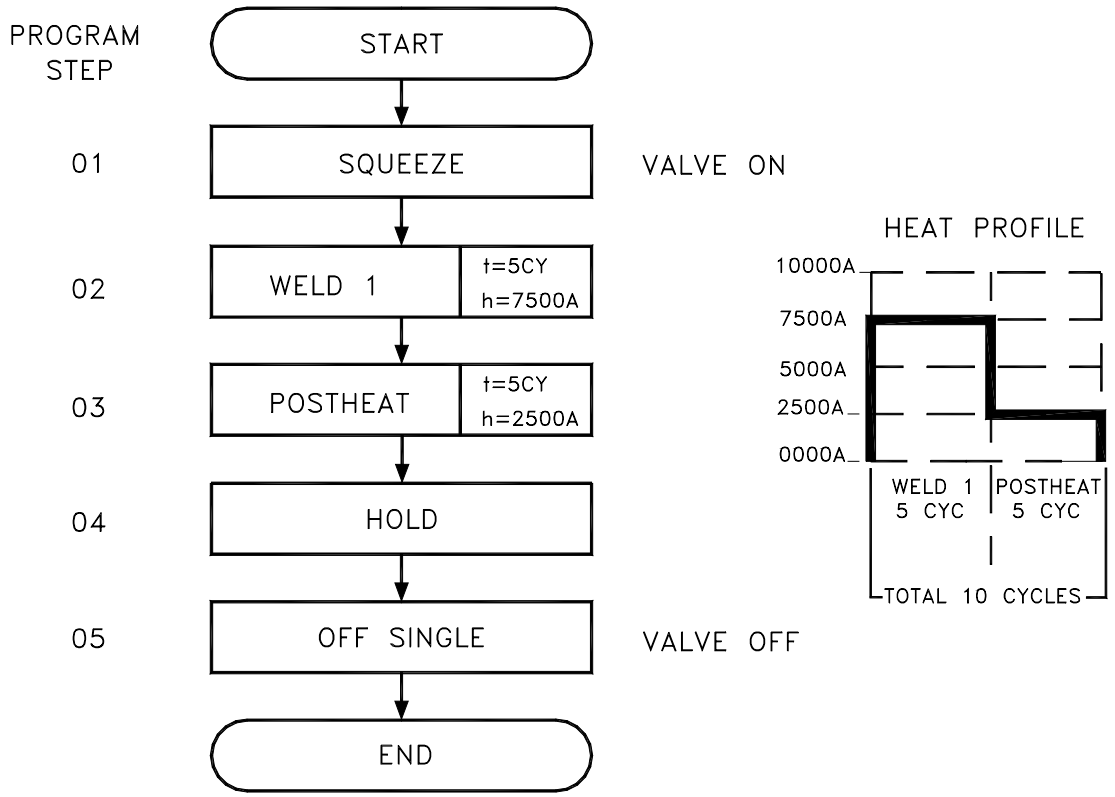
Display:

```
         1111111111222222222333
12345678901234567890123456789012
 1- 4 POSTHEATnn  iiiiiA    ccCY
         At instruction entry 83
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 13	Instruction description
D	15, 16	User optional Postheat number
E	>19, 23	Postheat current in amperes 1-65535
F	29, 30	Postheat timing in line cycles

FLOW CHART EMPLOYING POSTHEAT AT A CONSTANT CURRENT
IN A SIMPLE SEQUENCE PROGRAM



PSTHTCC.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
84	Heat Until Input at constant current	Yes	1-999 Cycles 0=Infinity

HEAT RANGE	COUNT	PRESET	CURRENT WINDOW CHECK
1-65535 amperes	N/A	N/A	Yes

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	Assignable input bit	If override time occurs bit #429 will be set to 1. The last programmed transformer turns ratio is applied.

DESCRIPTION

This instruction is used to apply heat at a specified current until an assigned input is made true. A override timer of 1-999 cycles may be applied which will override the specified input at the applied time. For diagnostic purposes the user may examine bit #429 to check for a timer override condition. This may be done in the following sequence instructions or in a PLC program. This instruction is the same as Heat Until code 26 except it provides a constant current programmed in amperes. The control monitors primary current therefore if a trans turns ratio is NOT programmed before this instruction regulation will be in PRIMARY amperes. If a trans turns ratio instruction IS programmed, the turns ratio is applied providing regulation in SECONDARY amperes. The control will always use the last ratio programmed in the sequence. A trans turns ratio of 1 will provide primary regulation and is defaulted to at the beginning if each sequence. See instruction codes 22, 57 and 58.

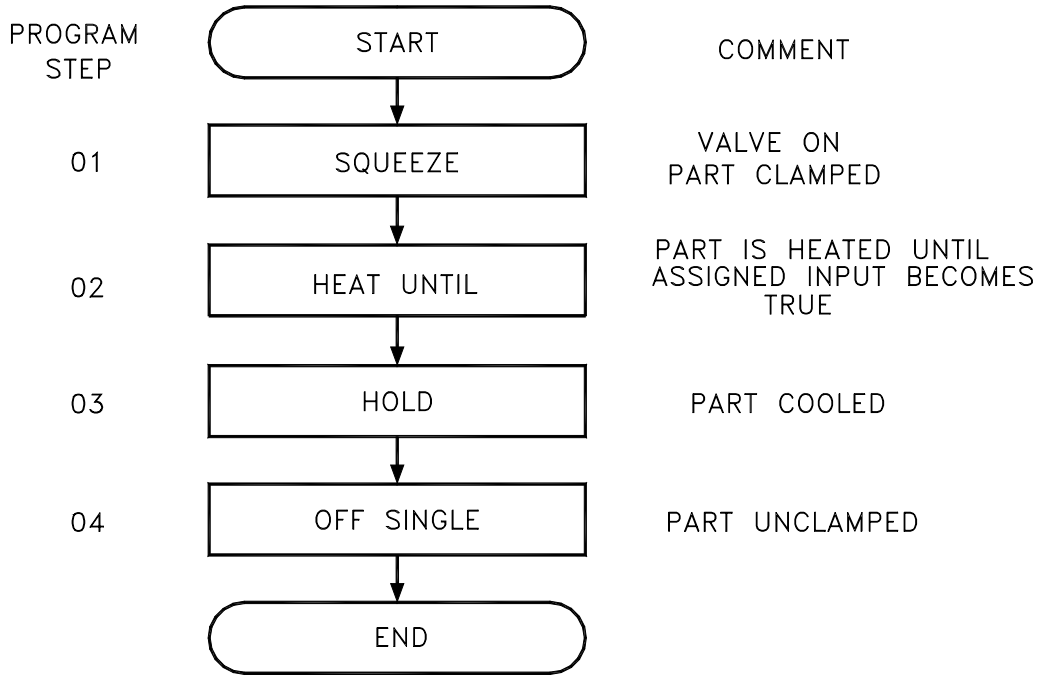
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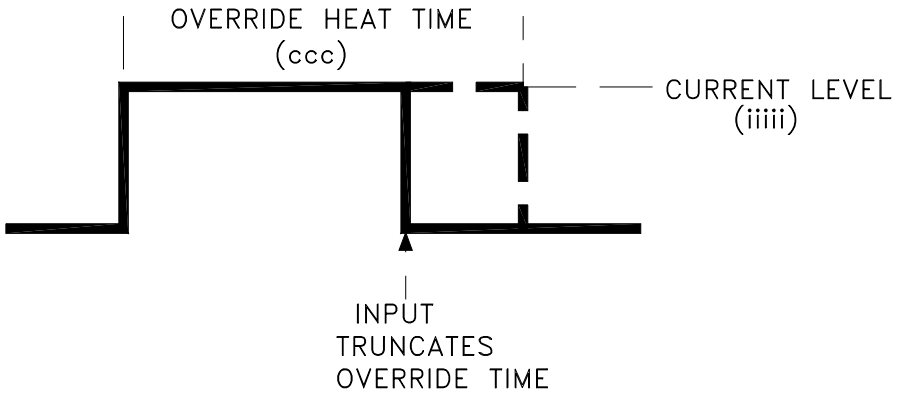
```
         1111111111222222222333
12345678901234567890123456789012
 1- 3 HEATUNTILxxx  iiiiiA cccCY
         At instruction entry 84
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 15	Instruction description
D	16, 18	Input bit number 1-511
E	>21, 25	Heating current in Kiloamperes
F	28, 30	Override time

FLOW CHART EMPLOYING HEAT UNTIL (XXX) AT A CONSTANT CURRENT
IN A SIMPLE SEQUENCE PROGRAM





HTUNTLCC.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
85	Seambeat at a Constant Current	Yes	0-99 Cycles Cool 1-99 Cycles Heat

HEAT RANGE	COUNT	PRESET	CURRENT WINDOW CHECK
1-65535 amperes	N/A	N/A	Yes

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	Firing pulses for each half cycle until pilot made not true	If cool time is dialed to 0, Seam will be continuous. The last programmed trans-turns ratio is applied.

DESCRIPTION

This instruction checks the pilot status during heat and cool periods and aborts when the pilot goes false or the pilot status changes. This may only happen when an even number of 1/2 cycles have occurred. The sequence will continue at the instruction following the seam-beat instruction. This instruction is the same as Seambeat code 37 except it provides a constant current programmed in amperes. The control monitors primary current therefore if a trans turns ratio is NOT programmed before this instruction regulation will be in PRIMARY amperes. If a trans turns ratio instruction IS programmed, the turns ratio is applied providing regulation in SECONDARY amperes. The control will always use the last ratio programmed in the sequence. A trans turns ratio of 1 will provide primary regulation and is defaulted to at the beginning if each sequence. See instruction codes 22, 57 and 58.

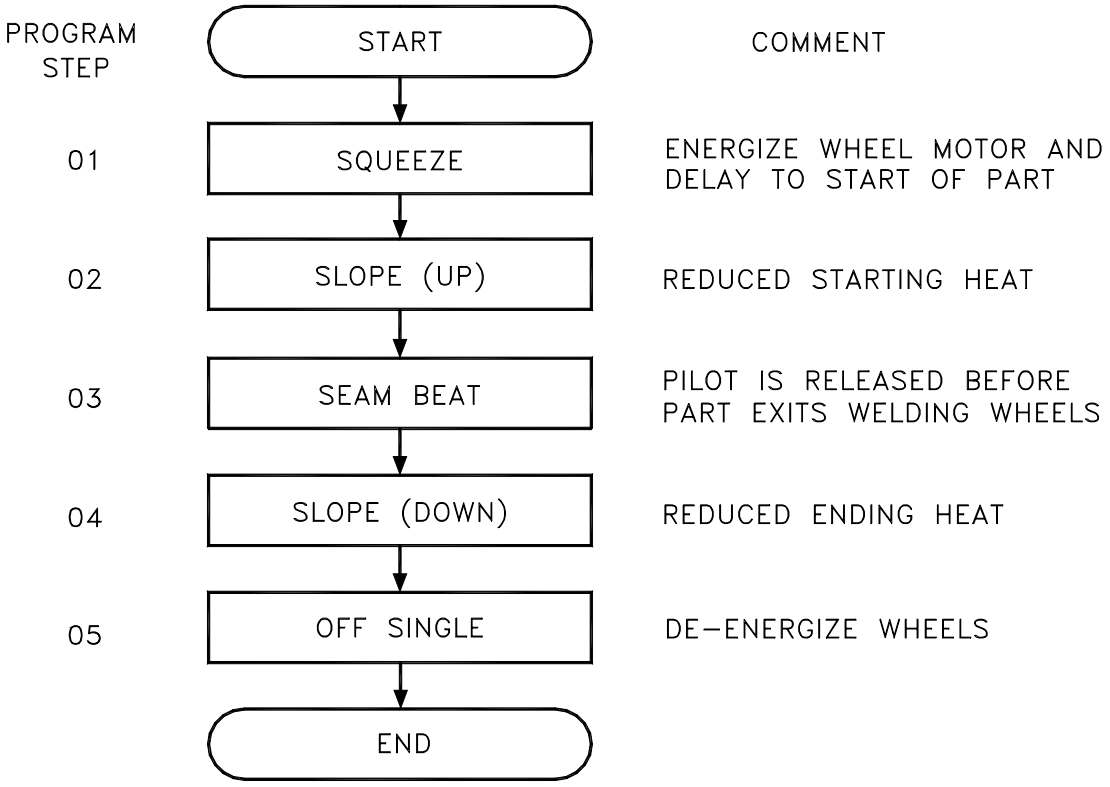
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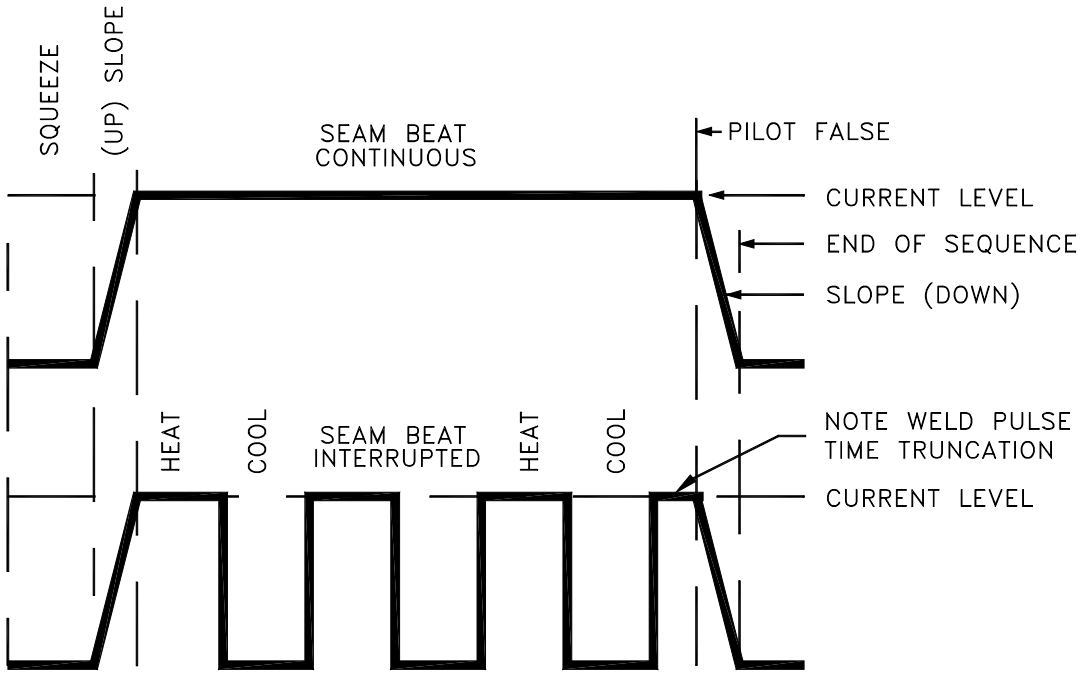
```
         1111111111222222222333
12345678901234567890123456789012
 1- 2 SEAMBEAT  iiiiiA ccHT ccCL
         At instruction entry 85
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 14	Instruction description
D	>17, 21	Current during heat pulses 1-65535 amperes
E	24, 25	Heat pulses time in line cycles 1-99
F	29, 30	Cool pulses time in line cycles 0-99

FLOW CHART EMPLOYING SEAM BEAT AT A CONSTANT CURRENT
IN A SIMPLE SEQUENCE PROGRAM





SMBTCC.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
86	Seam-nonbeat at Constant Current	Yes	0-99 Cycles Cool 1-99 Cycles Heat

HEAT RANGE	COUNT	PRESET	CURRENT WINDOW CHECK
1-65535 amperes	N/A	N/A	Yes

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	Firing pulses for each half cycle until pilot made not true	If cool time is dialed to 0, Seam will be continues. The last programmed trans-

DESCRIPTION

This instruction checks the pilot status during heat and cool periods. If in continuous seam (no cool time), this function will abort at the first occurring even number of 1/2 cycles of heat after the pilot changes status. If in intermittent seam (cool>0) and in a cool period, the function will abort at the first occurring even number of 1/2 cycles after the pilot status changes. If in intermittent seam and in a heat period, this function will abort only after the heat time is completed. The sequence will continue at the instruction following Seam-nonbeat. This instruction is the same as Seam non beat code 38 except it provides a constant current programmed in amperes. The control monitors primary current therefore if a trans turns ratio is NOT programmed before this instruction regulation will be in PRIMARY amperes. If a trans turns ratio instruction IS programmed, the turns ratio is applied providing regulation in SECONDARY amperes. The control will always use the last ratio programmed in the sequence. A trans turns ratio of 1 will provide primary regulation and is defaulted to at the beginning if each sequence. See instruction codes 22, 57 and 58.

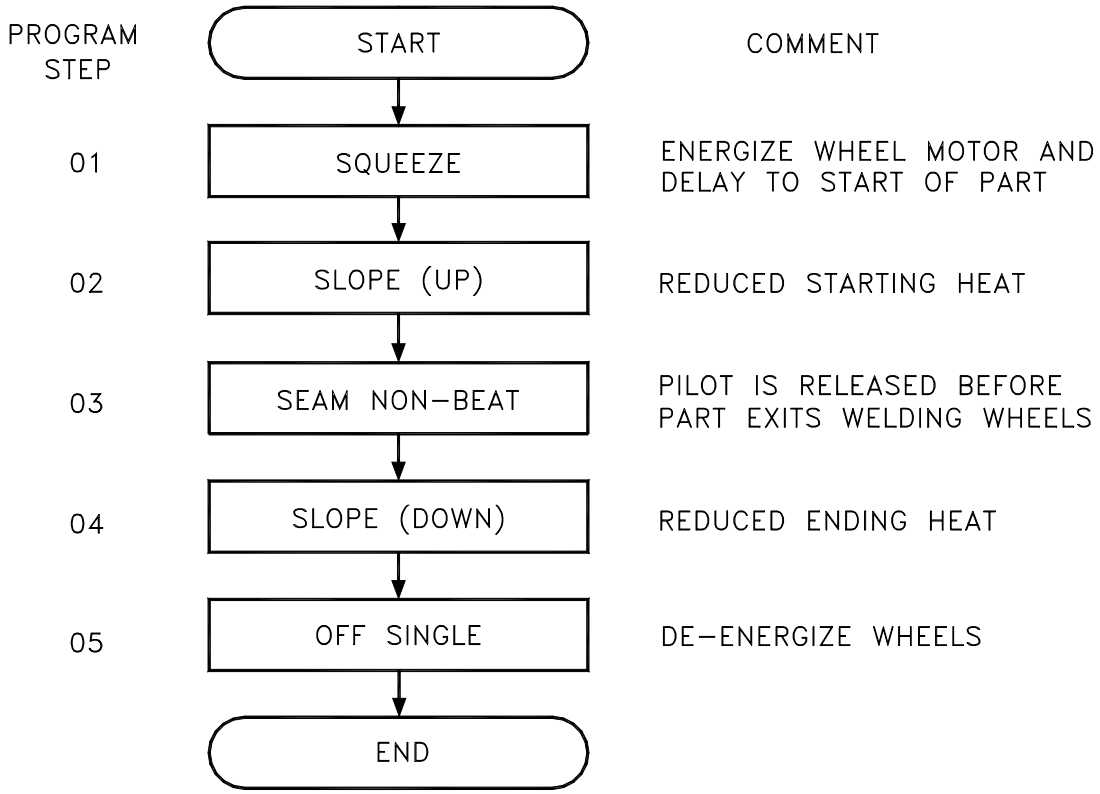
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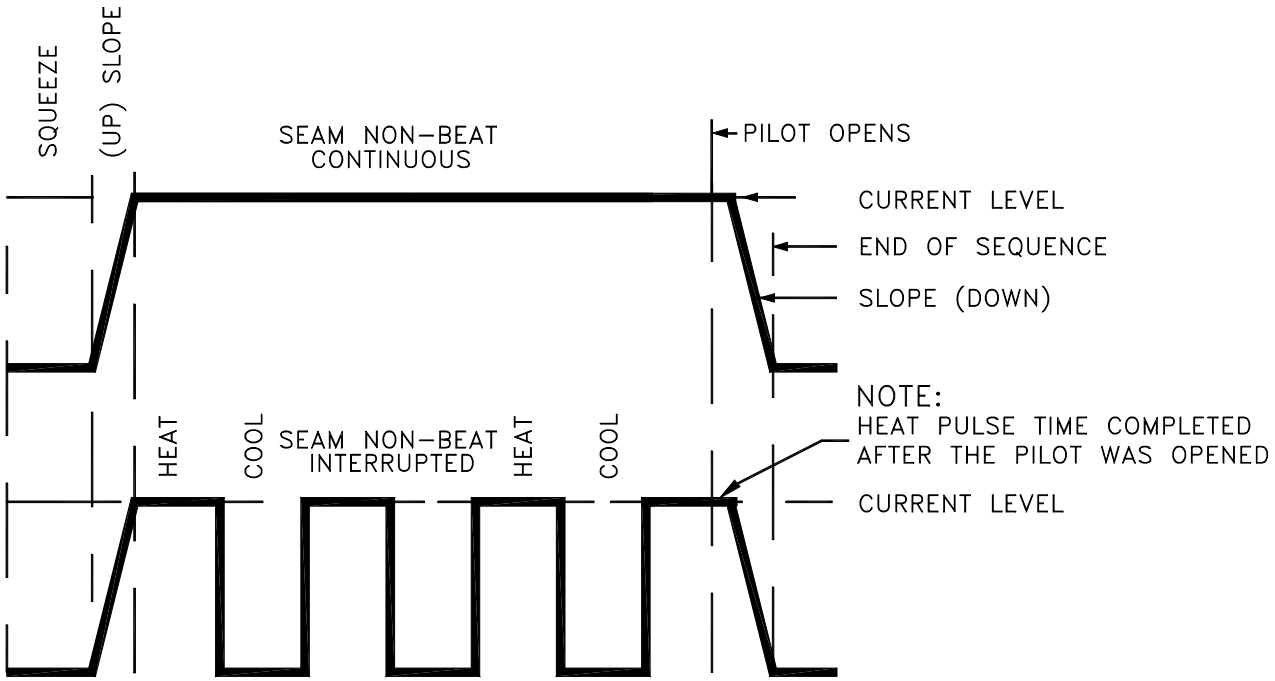
```
         1111111111222222222333
12345678901234567890123456789012
 1- 3 SEAM-NBT  iiiiiA ccHT ccCL
         At instruction entry 86
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 14	Instruction description
D	>17, 21	Current in amperes during heat pulses
E	24, 25	Heat pulses time in line cycles 1-99
F	29, 30	Cool pulses time in line cycles 0-99

FLOW CHART EMPLOYING SEAM NON–BEAT AT A CONSTANT CURRENT
IN A SIMPLE SEQUENCE PROGRAM





SMNBTCC.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
87	Temper at Constant Current	Yes	00-99 Cycles

HEAT RANGE	COUNT	PRESET	CURRENT WINDOW CHECK
1-65535 amperes	N/A	N/A	Yes.

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	Firing pulse for each 1/2 cycle if programmed current	User may enter a Temper ID # in position nn, if not entered it remains blank. The last programmed trans-turns ratio will be applied.

DESCRIPTION

Temper current is an impulse or a series of impulses of current which occur after and separate from the weld current. It is usually used in conjunction with the Quench function. These functions are used to prevent the possible cracking and/or crystallization of the weld nugget by controlling its cooling process. This instruction is the same as Temper code 41 except it provides a constant current programmed in amperes. The control monitors primary current therefore if a trans turns ratio is NOT programmed before this instruction regulation will be in PRIMARY amperes. If a trans turns ratio instruction IS programmed, the turns ratio is applied providing regulation in SECONDARY amperes. The control will always use the last ratio programmed in the sequence. A trans turns ratio of 1 will provide primary regulation and is defaulted to at the beginning if each sequence. See instruction codes 22, 57 and 58.

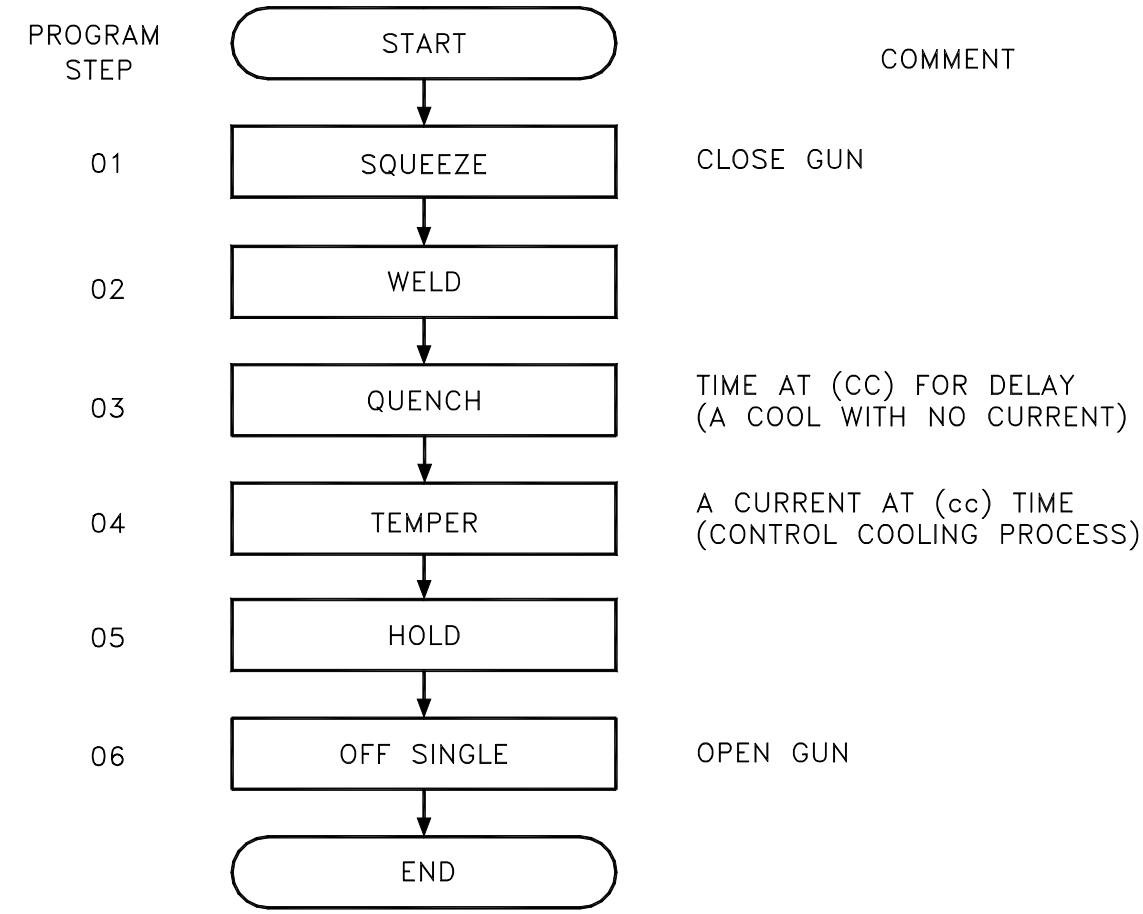
Display:

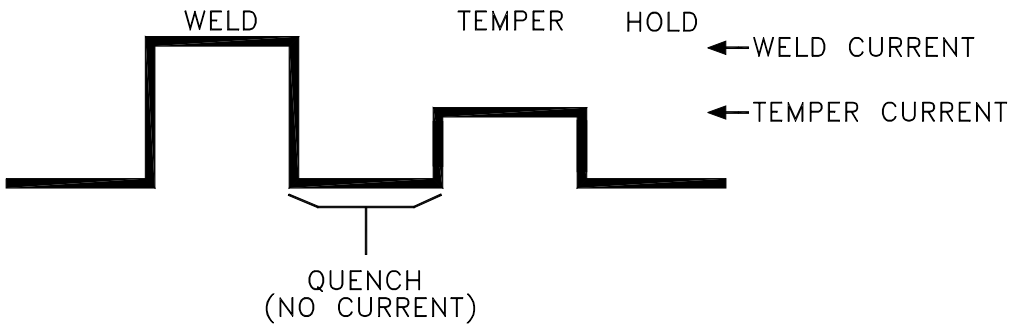
```
         11111111112222222222333
123456789012345678901234567890123
 1- 4 TEMPER iiiiiA (mmmmm) ccCY
         At instruction entry 87
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 12	Instruction description
D	>14, 18	Temper current in amperes 1-65535
E	22, 26	Temper current with stepper % influence (actual current applied)
F	29, 30	Temper timing in line cycles

FLOW CHART EMPLOYING TEMPER AT A CONSTANT CURRENT
IN A SIMPLE SEQUENCE PROGRAM





TMPRCC.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
88	Remote Current (REMI)	Yes	1-99 Cycles

RANGE	COUNT	PRESET	CURRENT WINDOW CHECK
3, 4 or 5 digits to a 65535 maximum	N/A	N/A	Yes

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass control	Firing pulses and (bb) buffer location filled by PLC #18 MUX inst.	Control bits 368 and 369 the number of digits employed. Please read section 1 10.8.

DESCRIPTION

This instruction is the same as instruction #82 Weld at a Constant Current, except the current set point data comes from sets of remote thumbwheels. The thumbwheels are strobed and data entered in buffer locations by PLC instruction (#18 MUX). One of the buffer locations must be addressed by this instruction and is done so by supplying the buffer number if interest (bb). Proper thumbwheel/buffer correlation and operation may be checked by observing positions 14 through 18 and comparing the data observed with the thumbwheels. The control must be in run mode for proper operation. See PLC instruction #18 for more information on thumbwheel to buffer application and 10.8 for digit control.

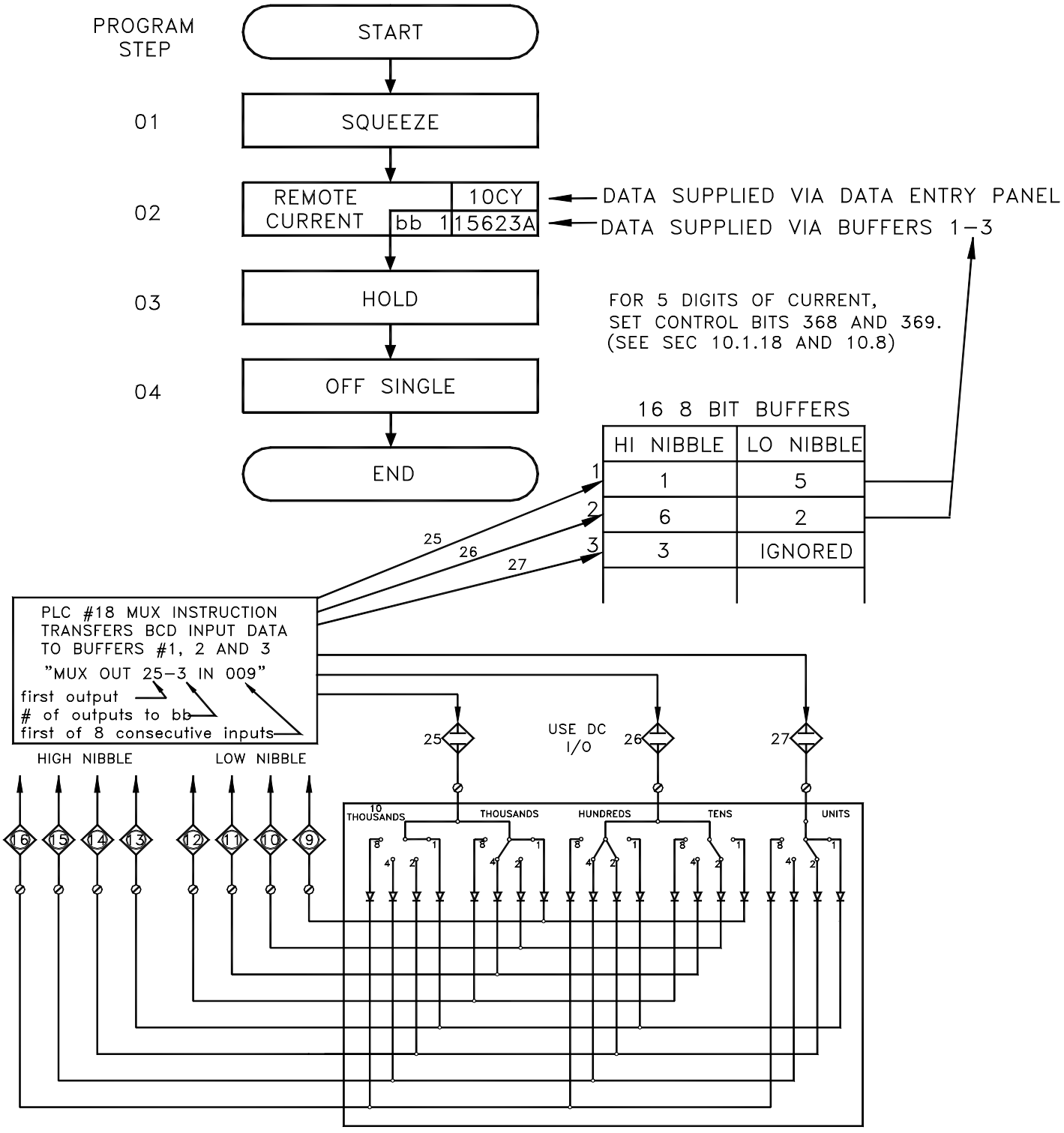
Display:

```
         1111111111222222222333
12345678901234567890123456789012
 1- 2 REMIbb iiiiiA (iiiii) ccCY
         At instruction entry 88
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 10	Instruction description
D	11, 12	Buffer location. 1-16
E	14, 18	Contents of buffers
F	22, 26	Current with any stepper influence
G	>29, 30	Weld time in line cycles 00-99

FLOW CHART EMPLOYING REMOTE CURRENT WITH 5 DIGITS OF CONSTANT CURRENT VIA THUMBWHEELS



REMI.DWG

CODE NUMBER	FUNCTION NAME	DISPLAYED IN RUN AND ON-LINE	TIMING RANGE
89	Remote Current & Time (REMIT)	Yes	1-99 Cycles

HEAT RANGE	COUNT	PRESET	CURRENT WINDOW CHECK
3, 4 or 5 digits to a 65535 maximum	N/A	N/A	Yes

EXECUTED	I/O	SPECIAL CONSIDERATIONS
Each Pass	Firing pulses and (bb) buffer locations filled by PLC #18 MUX inst.	Control bits 368 and 369 control the number of digits employed. Please read section 1 10.8

DESCRIPTION

This instruction is the same as instruction #82 Weld at a Constant Current, except the current and time set points come from sets of remote thumbwheels. The thumbwheels are strobed and data entered in buffer locations by PLC instruction (#18 MUX). Three or four buffer locations are examined by this instruction. The process is started by supplying only the first buffer number if interest. Proper thumbwheel/buffer correlation and operation may be checked by observing positions 15 through 19, 29 and 30 and comparing the data observed with the thumbwheel data. The control must be in run mode to observe the thumbwheel settings. See PLC instruction #18 for more information on thumbwheel to buffer application and 10.8 for digit control.

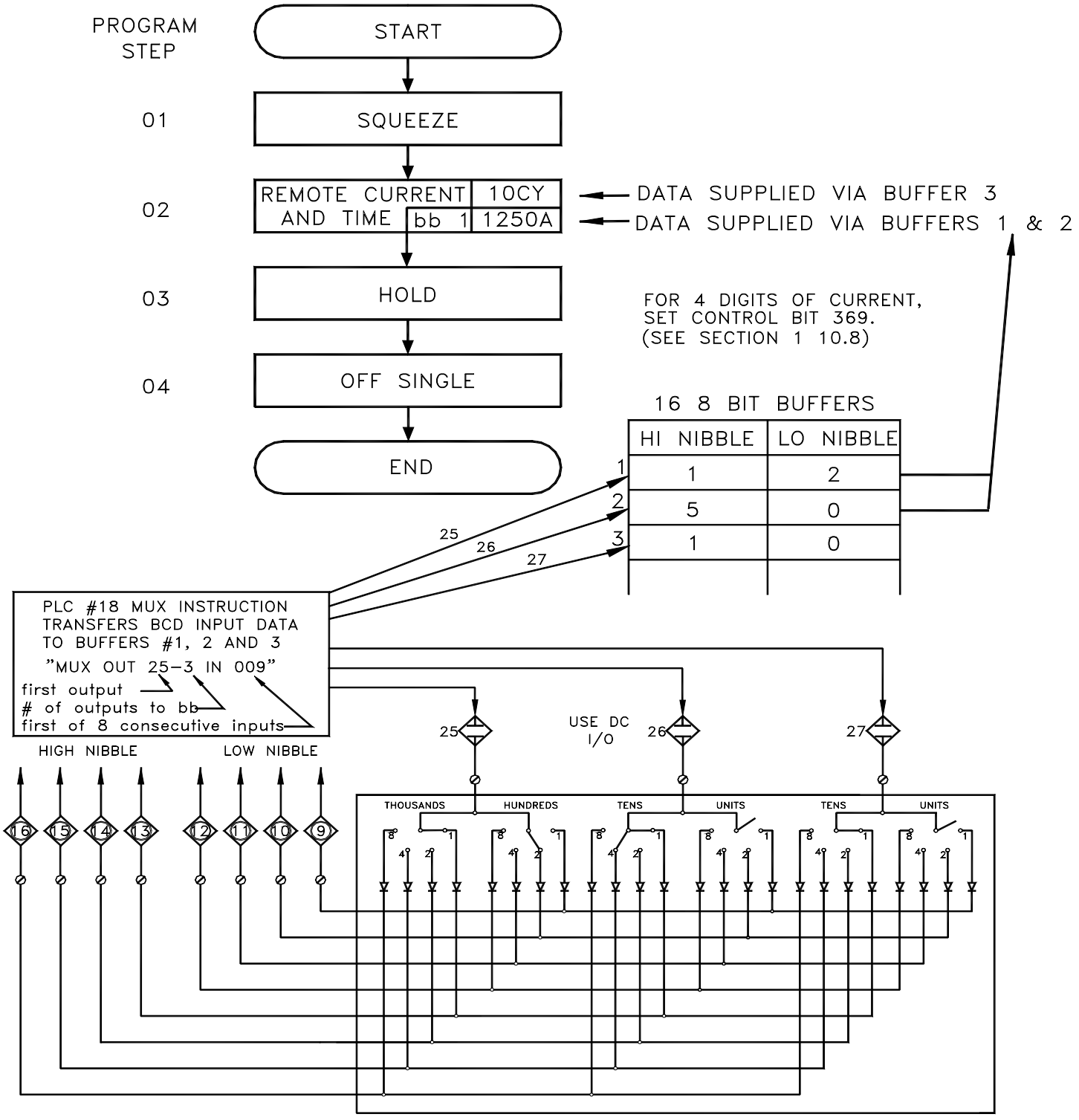
Display:

```
         11111111112222222222333
12345678901234567890123456789012
 1- 2 REMITbb iiiii (iiiii) mmCY
         At instruction entry 89
```

Data fields: (>Indicates cursor starting position)

ITEM	POSITION	DESCRIPTION
A	1, 2	Sequence number 01-31
B	4, 5	Program step number 01-99
C	7, 11	Instruction description
D	>12, 13	First buffer location. 1-16
E	15, 19	Contents of the current buffers
F	22, 26	Weld current with stepper influence
G	29, 30	Contents of time buffer

FLOW CHART EMPLOYING 6 REMOTE THUMBWHEELS, 4 DIGIT CURRENT CONTROL AND 2 DIGIT TIME



REMIT.DWG

SERIES 400

Allen Bradley Remote
I/O Interface Module
(ABRIO Module)
452-0-0034-01

Description and Instructions

Instruction Book #328-0-0570-03

Table of Contents

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3.2 AB I/O Through a Weltronic 503-1-0324-XX Module
3.3 AB I/O Routed To The ABRIO Modules Local I/O
3.4 CPU/Timer I/O Routed To The ABRIO Modules Local I/O

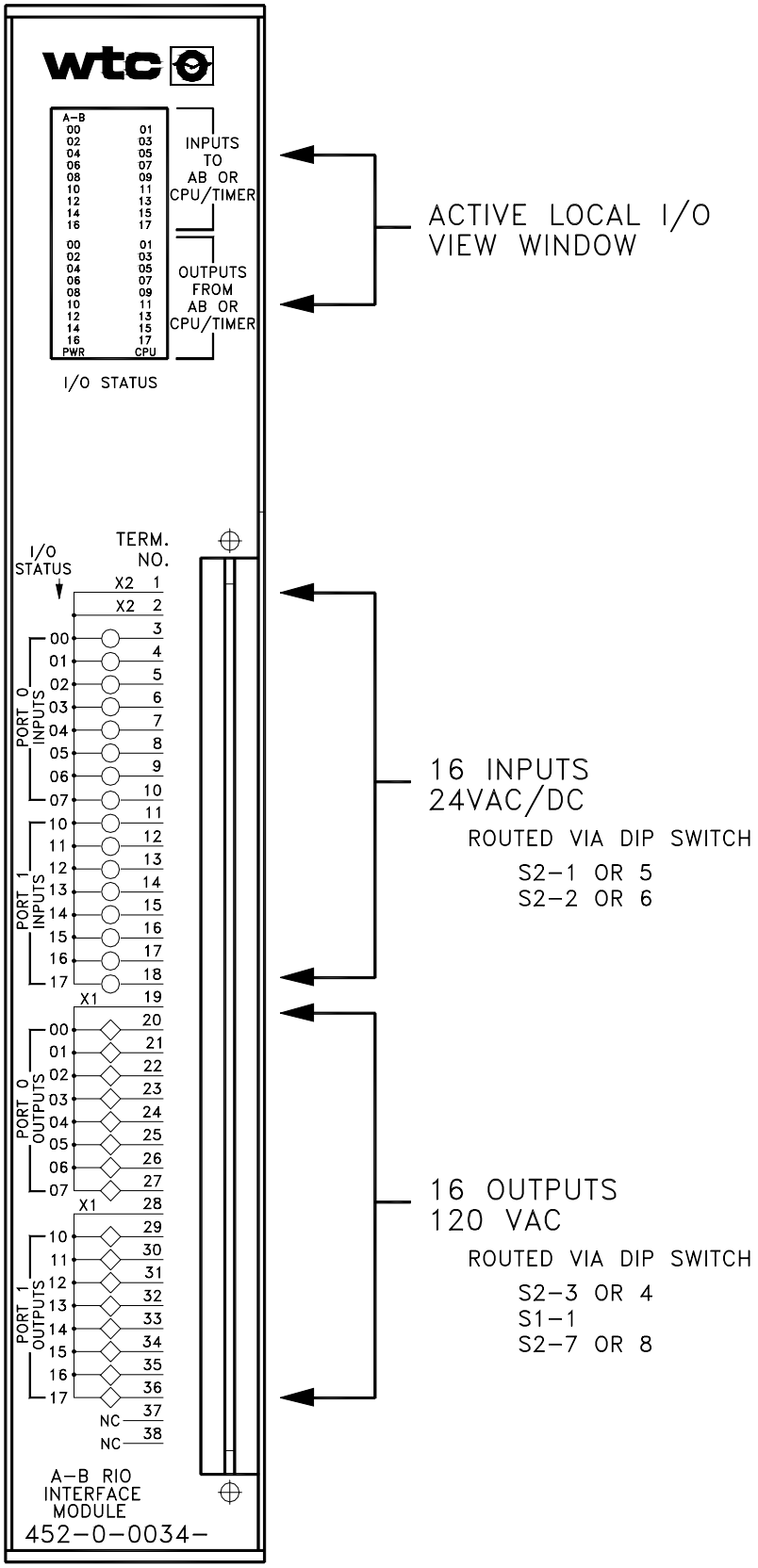
4.0 Addressing

5.0 Installation and Start Up

6.0 Diagnostic Chart

7.0 Example Interface for Three Weld Timers
7.1 Chrysler Specification for Three Weld Timers

8.0 RIO Scanner Setup Example



A-B REMOTE I/O INTERFACE MODULE

FILE: ABRIOFRONT

1.0 Definitions/Features

The WELTRONIC Series 400 ABRIO Interface Module #452-0-0034-01 provides a serial "Blue Hose" I/O link between a WELTRONIC Series 400 rack and Allen-Bradley's PLC5 and SLC remote rack system. To the A-B system the ABRIO Module looks like a full Allen-Bradley remote rack which is plugged into the Weltronic Series 400 rack ssystem. This interface between systems is accomplished by Allen-Bradleys AB 1771-NAK1 Node Adapter Chip Set.

The AB 1771-NAK1 chip set is contained in the Series 400 ABRIO Module and is licensed under patents and proprietary technology of Allen Bradley Company, Inc. Allen-Bradley Company, Inc. does not warrant or support this product. All warranty and support devices for this product are the responsibility of and provided by Weltronic Corporation.

The ABRIO Module is plugged into a WELTRONIC Series 400 rack system and is interconnected to the A-B PLC5 Programmable Controller. The connection is made via REM I/O plug/terminals on each unit. Only one ABRIO module may be used per Series 400 rack. The ABRIO module will not reflect the physical slot number it is plugged into, but assumes logical slots 16 and 17. Any Series 400 CPU/Timer plugged into the same rack may address slots 16 and 17. This is done in the Set-Up of each timer by addressing the internal bits of each CPU/Timer to Slot 16 IN (inputs from AB's outputs) or Slot 17 OUT (outputs to AB's inputs). See I/O Bit to Slot to Port Set Up in 11.0 of the Series 400 instruction book for more set-up detail. In the following description the term INPUT refers to inputs into a Series 400 CPU/Timer and OUTPUT refer to outputs from a Series 400 CPU/Timer.

If the AB system is set up for a full rack, logic slot 16 provides sixteen 8 bit input ports (128 inputs from AB's outputs). Logic slot 17 sixteen 8 bit output ports (128 outputs to AB's inputs). Any/all CPU/Timers may read any port in slot 16, but only <u>one</u> CPU/Timer may write to any <u>one 8 bit port</u> in slot 17. Another way of visualizing the above statement is that any or all CPU/Timers can listen to any input port without quarreling. But only one timer may write to a output port. If two or more try, contention will surely arise between the CPU/Timers on what is to be outputted to the port on its way to A-B inputs.

Via DIP switch S2 the first or last two 8 bit I/O ports may be routed to local I/O on the 452-0-0034-01 module and is available to any/all CPU/Timers in the rack. The local I/O may be routed only through the first two ports to A-B and will appear on the first two address ports of the starting quarter selected. All local outputs will be OR'ed therefore no output contention will occur, any device may address the local outputs. at any time. The local inputs are 24VAC/DC (ONLY), outputs are 120VAC.

2.0 Architecture

The 452-0-0034-01 ABRIO module contains two printed circuit boards. The boards and their functions are:

2.1 473-0-0424-01 Allen Bradley Interface Board
2.2 473-0-0545-01 S400 AB-RIO/Devicenet Bus Interface Board

2.1 The 473-0-0424-01 Allen Bradley Adapter board contains the AB 1771-NAK1 Node Adapter chip set and the Allen Bradley system set-up DIP switches. This board connects directly to AB, provides all AB system functions and follows all A-B rules.

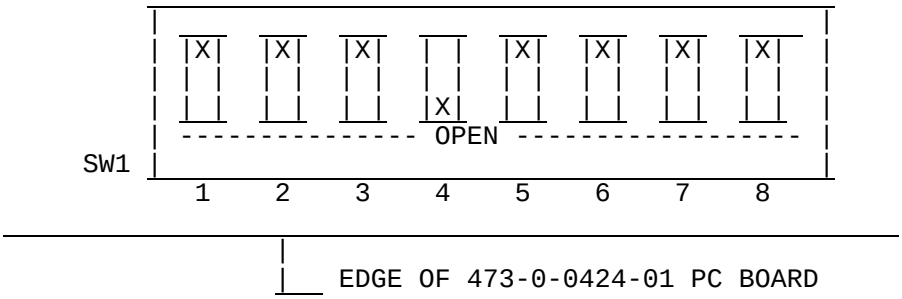
2.2 The 473-0-0454-01 bus interface board contains the HC16 microprocessor and the 473-0-0367-01 LED Status Light PC board. Its main function is to interconnect or "glue" all two boards together and make connection to the Weltronic backplane.

3.0 Set up

The 128 remote inputs and 128 remote output bits are "packed" into consecutive bytes and transferred to and from the A-B system. Thus the inputs in slot 16 show up contiguously outputted from A-B. And the outputs are packed contiguously into slot 17 and outputted to A-B as A-B inputs. From the ABRIO module looking toward A-B, the module truly emulates an A-B logical rack therefore must be set up via the typical A-B rack set up DIP switches. The rack set up switches SW1 and SW2 are located on the 473-0-0424-01 AB RIO Interface Board. Viewing the dipswitches and the fact that OPEN=1 on each switch can make proper set up very confusing. To simplify set up follow this simple rule: If the switches are the "rocker" type, then pressing the rocker down nearest the edge of the board provides the rocker switch's assigned function.

SW1 is shown below as an example, the X depicts the rocker switches pressed down. The example shows SW1 1-6 providing Rack Address 4 (cccocc) and SW1 7-8 First Quarter (cc). See DIP switch description on page 9, all four switches must be set using this chart.

A VIEW OF SW1 CONFIGURED FOR RACK ADDRESS 4 AND FIRST STARTING QUARTER



From the ABRIO Module looking toward CPU/Timer modules, set up is accomplished by each timers I/O Bit to Slot to Port Set-Up. See section 11.00 in the Series 400 instruction book for more detail. Before attempting the CPU/Timer I/O bit setup please study carefully the Slot/Port/Bit interface chart in section **4.0 Addressing** of this manual and consider the following rules:

3.1 Read/Write Rules

Any or all CPU/Timers may input or "Read" any input port in slot 16. But only one CPU/Timer may output to any one port in slot 17. Output contention will cause outputs (inputs at AB) to be unstable and seldom or never become true.

3.2 AB I/O Routed to a Weltronic 503-1-0324-XX Modules

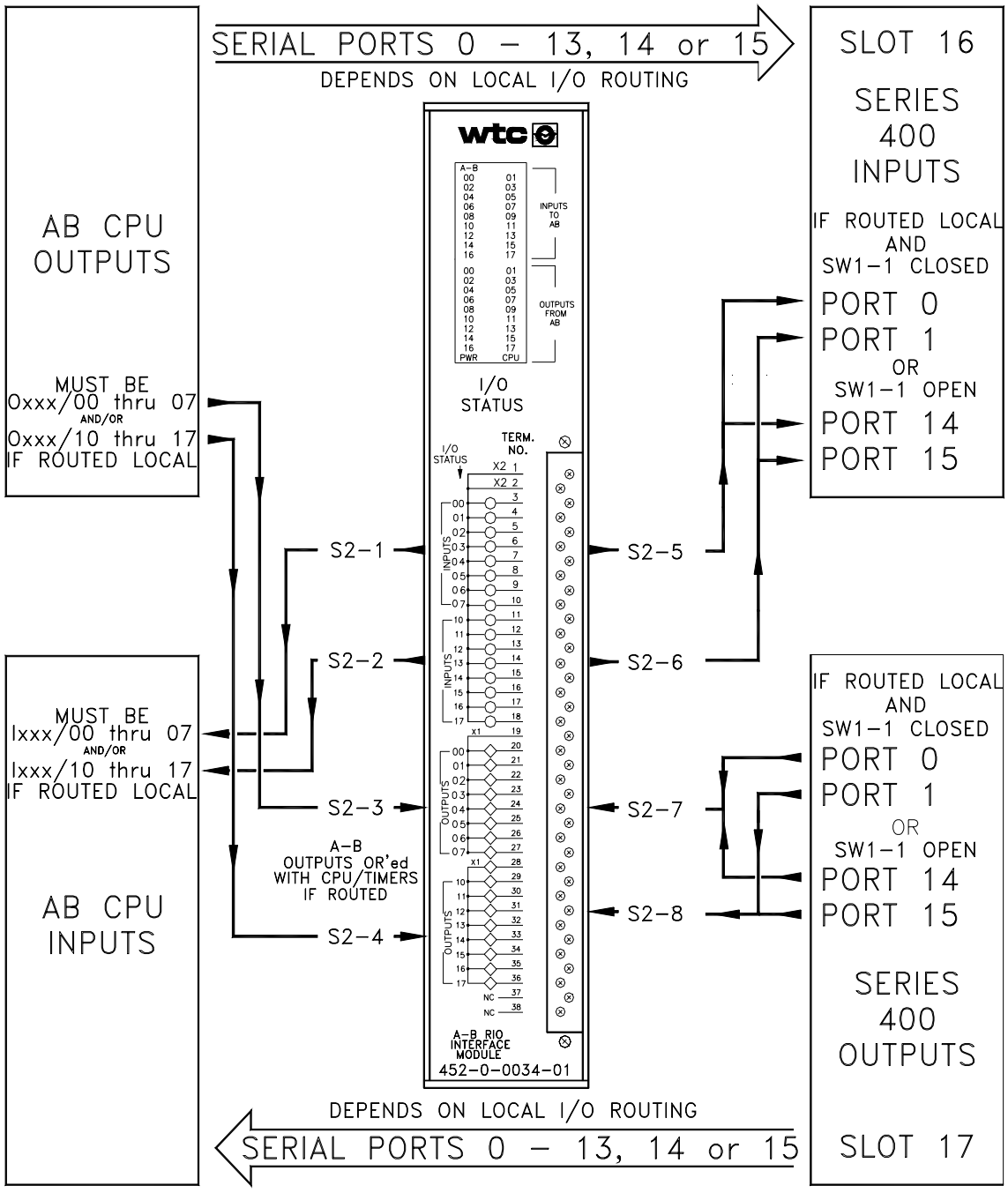
I/O to and from AB may come from or appear on a WELTRONIC 503-1-0324-xx I/O modules only by transmission through a CPU/Timer module. AB outputs are received by the CPU/Timer as inputs, then converted to outputs in a ladder logic program and sent through Set-Up to a WELTRONIC I/O module. Inputs to AB are handled in a reverse manner. Allen Bradley I/O through a WELTRONIC I/O Module should be avoided because of added scan time. The CPU/Timers ladder logic program may cause the I/O too appear slow.

3.3 AB I/O Routed to the ABRIO Module Local I/O

Eight or sixteen outputs from AB may be made to appear on the ABRIO module by routing them through S2 pin 3 & 4. Eight or sixteen inputs to AB may be read AB by routing them through S2 pin 1 & 2. Note only the first 16 consecutive I/O bits or first two ports 0 and 1 (AB address 0.00-17) of I/O may be routed. If a higher starting quarter is chosen, the local I/O will appear in the first two ports of the chosen quarter.

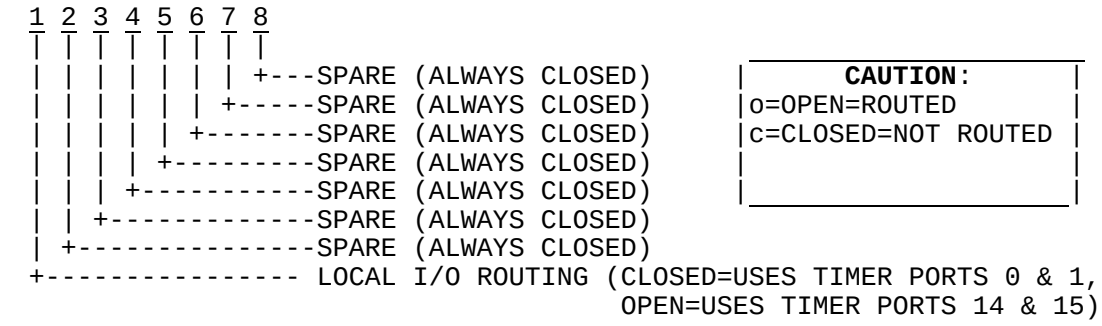
3.4 CPU/Timer I/O Routed to the ABRIO Modules Local I/O

Eight or sixteen outputs from a CPU/Timer Module may be made to appear on the ABRIO Module by routing them through S2 pin 7 & 8. Eight or sixteen inputs on a ABRIO Module may be read by a CPU/Timer by routing them through S2 pin 5 & 6. S1 pin 1 is used to select which ports the local I/O will appear through. The choice is ports 0-1 or 14-15. Local inputs may be examined by any device. Local outputs may be driven by any/all device(s) because they and are logically OR'ed out through the HC16 CPU.

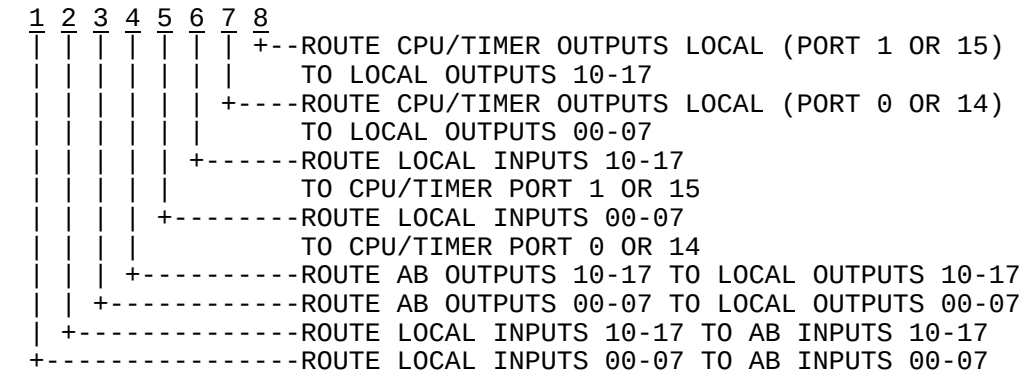

SERIAL PORTS 0 – 13, 14 or 15
DEPENDS ON LOCAL I/O ROUTING
AB CPU OUTPUTS
MUST BE Oxxx/00 thru 07 AND/OR Oxxx/10 thru 17 IF ROUTED LOCAL
MUST BE Ixxx/00 thru 07 AND/OR Ixxx/10 thru 17 IF ROUTED LOCAL
AB CPU INPUTS
S2-1
S2-2
S2-3
S2-4
S2-5
S2-6
S2-7
S2-8
A-B OUTPUTS OR'ed WITH CPU/TIMERS IF ROUTED
wtc
INPUTS TO AB
OUTPUTS FROM AB
I/O STATUS
TERM. NO.
A-B RIO INTERFACE MODULE
452-0-0034-01
SLOT 16
SERIES 400 INPUTS
IF ROUTED LOCAL AND SW1-1 CLOSED
PORT 0
PORT 1
OR
SW1-1 OPEN
PORT 14
PORT 15
IF ROUTED LOCAL AND SW1-1 CLOSED
PORT 0
PORT 1
OR
SW1-1 OPEN
PORT 14
PORT 15
SERIES 400 OUTPUTS
SLOT 17
DEPENDS ON LOCAL I/O ROUTING
SERIAL PORTS 0 – 13, 14 or 15
ABRIONEW.DWG

DIP SWITCH DESCRIPTION for V3.000

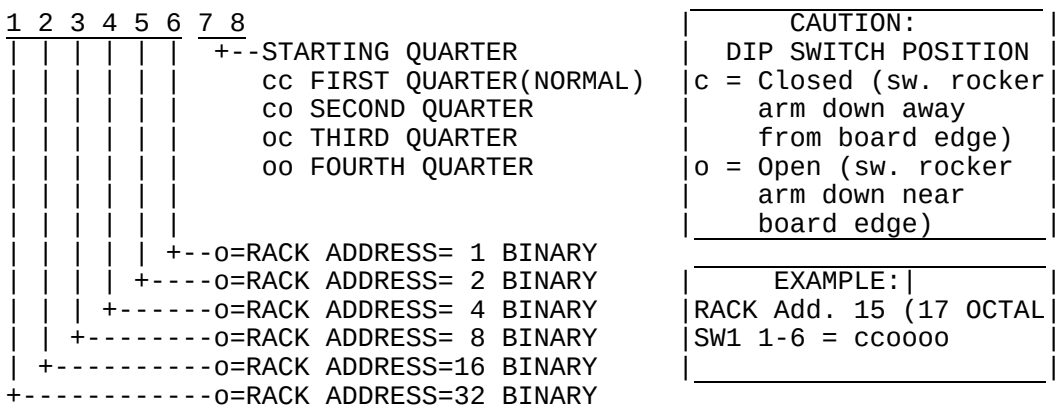
MAIN BOARD DIP SWITCH S1:



MAIN BOARD DIP SWITCH S2

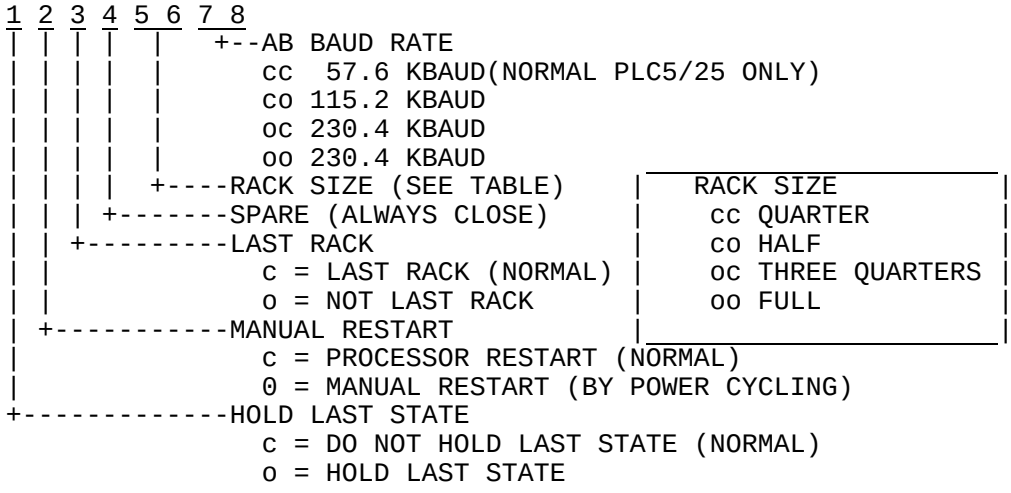


ALLEN BRADLEY RIO ACCESSORY BOARD (SW1):



(SEE MANUAL FOR RACK ADDRESS OCTAL CONVERSION CHART)

ALLEN BRADLEY RIO ACCESSORY BOARD (SW2):



BINARY-DECIMAL-OCTAL RACK ADDRESS CONVERSION CHART

	BINARY							RACK ADDRESS	
	32	16	8	4	2	1	DECIMAL	IN OCTAL	
	c	c	c	c	c	c	00	00	
	c	c	c	c	c	o	01	01	
	c	c	c	c	o	c	02	02	
	c	c	c	c	o	o	03	03	
	c	c	c	o	c	c	04	04	
	c	c	c	o	c	o	05	05	
	c	c	c	o	o	c	06	06	
	c	c	c	o	o	o	07	07	<- MAX PLC5/25-30
	c	c	o	c	c	c	08	10	
	c	c	o	c	c	o	09	11	
	c	c	o	c	o	c	10	12	
	c	c	o	c	o	o	11	13	
	c	c	o	o	c	c	12	14	
	c	c	o	o	c	o	13	15	
	c	c	o	o	o	c	14	16	
	c	c	o	o	o	o	15	17	<- MAX PLC5/40
	c	o	c	c	c	c	16	20	
	c	o	c	c	c	o	17	21	
	c	o	c	c	o	c	18	22	
	c	o	c	c	o	o	19	23	
	c	o	c	o	c	c	20	24	
	c	o	c	o	c	o	21	25	
	c	o	c	o	o	c	22	26	
	c	o	c	o	o	o	23	27	<- MAX PLC5/60
	c	o	o	c	c	c	24	30	
	c	o	o	c	c	o	25	31	
	c	o	o	c	o	c	26	32	
	c	o	o	c	o	o	27	33	
	c	o	o	o	c	c	28	34	
	c	o	o	o	c	o	29	35	
	c	o	o	o	o	c	30	36	
	c	o	o	o	o	o	31	37	
	o	c	c	c	c	c	32	40	
	o	c	c	c	c	o	33	41	
	o	c	c	c	o	c	34	42	
	o	c	c	c	o	o	35	43	
	o	c	c	o	c	c	36	44	
	o	c	c	o	c	o	37	45	
	o	c	c	o	o	c	38	46	
	o	c	c	o	o	o	39	47	
	o	c	o	c	c	c	40	50	
	o	c	o	c	c	o	41	51	
	o	c	o	c	o	c	42	52	
	o	c	o	c	o	o	43	53	
	o	c	o	o	c	c	44	54	
	o	c	o	o	c	o	45	55	
	o	c	o	o	o	c	46	56	
	o	c	o	o	o	o	47	57	
SW1	1	2	3	4	5	6	SLC	PLC5	
		POSITION					500		

4.0 Addressing

Depicted below is an example of Allen-Bradley® addressing system. Remember that it is in octal, a base 8 numbering system. And the first character is a letter that depicts direction.

ALLEN BRADLEY I/O ADDRESSING SYSTEM

```
I=Input O=Output  Rack#  Group#   Bit ##
                    |      |       |      (NOTE)
                    O  :   4   0   .  00 <---OCTAL 00-07
                                                  10-17
```

Assume dip switches on the Allen Bradley Adapter Board are set to:

-Rack address = 4
-Starting quarter = First
-Rack Size = Full
-The PLC5 program Data file #2 is set up likewise

And Remember that a possible 128 bits are contiguously transmitted BOTH ways, then a Series 400 Slot/Port to AB bit address interface would be:

SLOT 16 IN	A-B OUT	BITS#	SLOT 17 OUT	A-B IN
Port 0 Bit 0<------	O:40.00	1	Port 0 Bit 0------>	I:40.00
Port 0 Bit 1<------	O:40.01	2	Port 0 Bit 1------>	I:40.01
Port 0 Bit 2<------	O:40.02	3	Port 0 Bit 2------>	I:40.02
Port 0 Bit 3<------	O:40.03	4	Port 0 Bit 3------>	I:40.03
Port 0 Bit 4<------	O:40.04	5	Port 0 Bit 4------>	I:40.04
Port 0 Bit 5<------	O:40.05	6	Port 0 Bit 5------>	I:40.05
Port 0 Bit 6<------	O:40.06	7	Port 0 Bit 6------>	I:40.06
Port 0 Bit 7<------	O:40.07	8	Port 0 Bit 7------>	I:40.07
Port 1 Bit 0<------	O:40.10	9	Port 1 Bit 0------>	I:40.10
Port 1 Bit 1<------	O:40.11	10	Port 1 Bit 1------>	I:40.11
Port 1 Bit 2<------	O:40.12	11	Port 1 Bit 2------>	I:40.12
Port 1 Bit 3<------	O:40.13	12	Port 1 Bit 3------>	I:40.13
Port 1 Bit 4<------	O:40.14	13	Port 1 Bit 4------>	I:40.14
Port 1 Bit 5<------	O:40.15	14	Port 1 Bit 5------>	I:40.15
Port 1 Bit 6<------	O:40.16	15	Port 1 Bit 6------>	I:40.16
Port 1 Bit 7<------	O:40.17	16	Port 1 Bit 7------>	I:40.17
Port 2 Bit 0<------	O:41.00	17	Port 2 Bit 0------>	I:41.00
Port 2 Bit 1<------	O:41.01	18	Port 2 Bit 1------>	I:41.01
Port 2 Bit 2<------	O:41.02	19	Port 2 Bit 2------>	I:41.02
Port 2 Bit 3<------	O:41.03	20	Port 2 Bit 3------>	I:41.03
Port 2 Bit 4<------	O:41.04	21	Port 2 Bit 4------>	I:41.04
Port 2 Bit 5<------	O:41.05	22	Port 2 Bit 5------>	I:41.05
Port 2 Bit 6<------	O:41.06	23	Port 2 Bit 6------>	I:41.06
Port 2 Bit 7<------	O:41.07	24	Port 2 Bit 7------>	I:41.07

SLOT 16 IN	A-B OUT	BITS#	SLOT 17 OUT	A-B IN
Port 3 Bit 0<------	O:41.10	25	Port 3 Bit 0------>	I:41.10
Port 3 Bit 1<------	O:41.11	26	Port 3 Bit 1------>	I:41.11
Port 3 Bit 2<------	O:41.12	27	Port 3 Bit 2------>	I:41.12
Port 3 Bit 3<------	O:41.13	28	Port 3 Bit 3------>	I:41.13
Port 3 Bit 4<------	O:41.14	29	Port 3 Bit 4------>	I:41.14
Port 3 Bit 5<------	O:41.15	30	Port 3 Bit 5------>	I:41.15
Port 3 Bit 6<------	O:41.16	31	Port 3 Bit 6------>	I:41.16
Port 3 Bit 7<------	O:41.17	32	Port 3 Bit 7------>	I:41.17

Interface would end here if SW2 5 and 6 are set for quarter rack

Port 4 Bit 0<------	O:42.00	33	Port 4 Bit 0------>	I:42.00
Port 4 Bit 1<------	O:42.01	34	Port 4 Bit 1------>	I:42.01
Port 4 Bit 2<------	O:42.02	35	Port 4 Bit 2------>	I:42.02
Port 4 Bit 3<------	O:42.03	36	Port 4 Bit 3------>	I:42.03
Port 4 Bit 4<------	O:42.04	37	Port 4 Bit 4------>	I:42.04
Port 4 Bit 5<------	O:42.05	38	Port 4 Bit 5------>	I:42.05
Port 4 Bit 6<------	O:42.06	39	Port 4 Bit 6------>	I:42.06
Port 4 Bit 7<------	O:42.07	40	Port 4 Bit 7------>	I:42.07
Port 5 Bit 0<------	O:42.10	41	Port 5 Bit 0------>	I:42.10
Port 5 Bit 1<------	O:42.11	42	Port 5 Bit 1------>	I:42.11
Port 5 Bit 2<------	O:42.12	43	Port 5 Bit 2------>	I:42.12
Port 5 Bit 3<------	O:42.13	44	Port 5 Bit 3------>	I:42.13
Port 5 Bit 4<------	O:42.14	45	Port 5 Bit 4------>	I:42.14
Port 5 Bit 5<------	O:42.15	46	Port 5 Bit 5------>	I:42.15
Port 5 Bit 6<------	O:42.16	47	Port 5 Bit 6------>	I:42.16
Port 5 Bit 7<------	O:42.17	48	Port 5 Bit 7------>	I:42.17
Port 6 Bit 0<------	O:43.00	49	Port 6 Bit 0------>	I:43.00
Port 6 Bit 1<------	O:43.01	50	Port 6 Bit 1------>	I:43.01
Port 6 Bit 2<------	O:43.02	51	Port 6 Bit 2------>	I:43.02
Port 6 Bit 3<------	O:43.03	52	Port 6 Bit 3------>	I:43.03
Port 6 Bit 4<------	O:43.04	53	Port 6 Bit 4------>	I:43.04
Port 6 Bit 5<------	O:43.05	54	Port 6 Bit 5------>	I:43.05
Port 6 Bit 6<------	O:43.06	55	Port 6 Bit 6------>	I:43.06
Port 6 Bit 7<------	O:43.07	56	Port 6 Bit 7------>	I:43.07
Port 7 Bit 0<------	O:43.10	57	Port 7 Bit 0------>	I:43.10
Port 7 Bit 1<------	O:43.11	58	Port 7 Bit 1------>	I:43.11
Port 7 Bit 2<------	O:43.12	59	Port 7 Bit 2------>	I:43.12
Port 7 Bit 3<------	O:43.13	60	Port 7 Bit 3------>	I:43.13
Port 7 Bit 4<------	O:43.14	61	Port 7 Bit 4------>	I:43.14
Port 7 Bit 5<------	O:43.15	62	Port 7 Bit 5------>	I:43.15
Port 7 Bit 6<------	O:43.16	63	Port 7 Bit 6------>	I:43.16
Port 7 Bit 7<------	O:43.17	64	Port 7 Bit 7------>	I:43.17

Interface would end here if SW2 5 and 6 are set for half rack

SLOT 16 IN	A-B OUT	BITS#	SLOT 17 OUT	A-B IN
Port 8 Bit 0<------	O:44.00	65	Port 8 Bit 0------>	I:44.00
Port 8 Bit 1<------	O:44.01	66	Port 8 Bit 1------>	I:44.01
Port 8 Bit 2<------	O:44.02	67	Port 8 Bit 2------>	I:44.02
Port 8 Bit 3<------	O:44.03	68	Port 8 Bit 3------>	I:44.03
Port 8 Bit 4<------	O:44.04	69	Port 8 Bit 4------>	I:44.04
Port 8 Bit 5<------	O:44.05	70	Port 8 Bit 5------>	I:44.05
Port 8 Bit 6<------	O:44.06	71	Port 8 Bit 6------>	I:44.06
Port 8 Bit 7<------	O:44.07	72	Port 8 Bit 7------>	I:44.07
Port 9 Bit 0<------	O:44.10	73	Port 9 Bit 0------>	I:44.10
Port 9 Bit 1<------	O:44.11	74	Port 9 Bit 1------>	I:44.11
Port 9 Bit 2<------	O:44.12	75	Port 9 Bit 2------>	I:44.12
Port 9 Bit 3<------	O:44.13	76	Port 9 Bit 3------>	I:44.13
Port 9 Bit 4<------	O:44.14	77	Port 9 Bit 4------>	I:44.14
Port 9 Bit 5<------	O:44.15	78	Port 9 Bit 5------>	I:44.15
Port 9 Bit 6<------	O:44.16	79	Port 9 Bit 6------>	I:44 16
Port 9 Bit 7<------	O:44.17	80	Port 9 Bit 7------>	I:44 17
Port 10 Bit 0<------	O:45.00	81	Port 10 Bit 0------>	I:45.00
Port 10 Bit 1<------	O:45.01	82	Port 10 Bit 1------>	I:45.01
Port 10 Bit 2<------	O:45.02	83	Port 10 Bit 2------>	I:45.02
Port 10 Bit 3<------	O:45.03	84	Port 10 Bit 3------>	I:45.03
Port 10 Bit 4<------	O:45.04	85	Port 10 Bit 4------>	I:45.04
Port 10 Bit 5<------	O:45.05	86	Port 10 Bit 5------>	I:45.05
Port 10 Bit 6<------	O:45.06	87	Port 10 Bit 6------>	I:45.06
Port 10 Bit 7<------	O:45.07	88	Port 10 Bit 7------>	I:45.07
Port 11 Bit 0<------	O:45.10	89	Port 11 Bit 0------>	I:45.10
Port 11 Bit 1<------	O:45.11	90	Port 11 Bit 1------>	I:45.11
Port 11 Bit 2<------	O:45.12	91	Port 11 Bit 2------>	I:45.12
Port 11 Bit 3<------	O:45.13	92	Port 11 Bit 3------>	I:45.13
Port 11 Bit 4<------	O:45.14	93	Port 11 Bit 4------>	I:45.14
Port 11 Bit 5<------	O:45.15	94	Port 11 Bit 5------>	I:45.15
Port 11 Bit 6<------	O:45.16	95	Port 11 Bit 6------>	I:45.16
Port 11 Bit 7<------	O:45.17	96	Port 11 Bit 7------>	I:45.17

Interface would end here if SW2 5 and 6 are set for three quarter rack

---

SLOT 16 IN	A-B OUT	BITS#	SLOT 17 OUT	A-B IN
Port 12 Bit 0<------	O:46.00	97	Port 12 Bit 0------>	I:46.00
Port 12 Bit 1<------	O:46.01	98	Port 12 Bit 1------>	I:46.01
Port 12 Bit 2<------	O:46.02	99	Port 12 Bit 2------>	I:46.02
Port 12 Bit 3<------	O:46.03	100	Port 12 Bit 3------>	I:46.03
Port 12 Bit 4<------	O:46.04	101	Port 12 Bit 4------>	I:46.04
Port 12 Bit 5<------	O:46.05	102	Port 12 Bit 5------>	I:46.05
Port 12 Bit 6<------	O:46.06	103	Port 12 Bit 6------>	I:46.06
Port 12 Bit 7<------	O:46.07	104	Port 12 Bit 7------>	I:46.07
Port 13 Bit 0<------	O:46.10	105	Port 13 Bit 0------>	I:46.10
Port 13 Bit 1<------	O:46.11	106	Port 13 Bit 1------>	I:46.11
Port 13 Bit 2<------	O:46.12	107	Port 13 Bit 2------>	I:46.12
Port 13 Bit 3<------	O:46.13	108	Port 13 Bit 3------>	I:46.13
Port 13 Bit 4<------	O:46.14	109	Port 13 Bit 4------>	I:46.14
Port 13 Bit 5<------	O:46.15	110	Port 13 Bit 5------>	I:46.15
Port 13 Bit 6<------	O:46.16	111	Port 13 Bit 6------>	I:46.16
Port 13 Bit 7<------	O:46.17	112	Port 13 Bit 7------>	I:46.17
Port 14 Bit 0<------	O:47.00	113	Port 14 Bit 0------>	I:47.00
Port 14 Bit 1<------	O:47.01	114	Port 14 Bit 1------>	I:47.01
Port 14 Bit 2<------	O:47.02	115	Port 14 Bit 2------>	I:47.02
Port 14 Bit 3<------	O:47.03	116	Port 14 Bit 3------>	I:47.03
Port 14 Bit 4<------	O:47.04	117	Port 14 Bit 4------>	I:47.04
Port 14 Bit 5<------	O:47.05	118	Port 14 Bit 5------>	I:47.05
Port 14 Bit 6<------	O:47.06	119	Port 14 Bit 6------>	I:47.06
Port 14 Bit 7<------	O:47.07	120	Port 14 Bit 7------>	I:47.07
Port 15 Bit 0<------	O:47.10	121	Port 15 Bit 0------>	I:47.10
Port 15 Bit 1<------	O:47.11	122	Port 15 Bit 1------>	I:47.11
Port 15 Bit 2<------	O:47.12	123	Port 15 Bit 2------>	I:47.12
Port 15 Bit 3<------	O:47.13	124	Port 15 Bit 3------>	I:47.13
Port 15 Bit 4<------	O:47.14	125	Port 15 Bit 4------>	I:47.14
Port 15 Bit 5<------	O:47.15	126	Port 15 Bit 5------>	I:47.15
Port 15 Bit 6<------	O:47.16	127	Port 15 Bit 6------>	I:47.16
Port 15 Bit 7<------	O:47.17	128	Port 15 Bit 7------>	I:47.17

5.0 Installation and Start Up

5.1 If the ABRIO Module has not been installed by Weltronic, install it in a slot next to the last CPU/Timer. Make sure DIP switches S1, S2, SW1 and SW2 are set to the proper configuration for your A-B PLC5 programs Data Table #2 RIO rack configuration. If there is hook up difficulty, it probably is because this step was not properly executed. See Section 3.0 for detail.

It does not matter which slot the ABRIO Module occupies, including slot 0, as long as there is not any empty slots, or I/O modules between CPU/Timers and/or the ABRIO. General rules to follow are:

A. Never install or move a module with the power on.

B. There must be a "smart" device in slot 0 capable of bus arbitration. (CPU/Timer or ABRIO Module)

C. There cannot be a gap between smart devices, no empty slots, no I/O or cascade steering modules. There may be empty slots between the group of smart modules and I/O modules.

D. If smart devices are moved from slot to slot, bus faults will occur when power is returned because all smart devices memorized the slot they occupy. In order to reset the bus faults a data change must be made in each smart devices new slot. This does not apply to the ABRIO Module, the user cannot change data in this device.

5.2 With the PLC5 REM I/O connection NOT MADE, turn on the power to the Series 400. Observe the power (PWR LED) in the lower right of the status window, it should come on quickly when power is received. About 4 seconds later the CPU LED will come on and stay on if the AB I/O module HC16 CPU is up and running. If the CPU light remains off the AB I/O module HC16 CPU is not running. If it blinks, the CPU is running but there is a hardware fault or the CPU is not handshaking with the A-B Node Adapter chip.

Now observe the main status screen of the CPU/Timer it should be up normally if the board is functioning properly. If not then a Diagnostic/Status message is displayed "Bus Fault 1" because the ABRIO is outputting a bus fault. See Section 12.4 in the Series 400 instruction book for more bus fault detail.

5.3 At this point in the installation the CPU/Timer and the AB I/O module HC16 CPU have NOT tried to handshake. To establish this link a CPU/Timer must address Slot 16 and/or 17 by assigning some of its 160 I/O bits to the logic slots 16 (IN) and 17 (OUT). After assignment is made and if handshaking is established, the main status screen of the CPU/Timer will appear normal. If after the I/O bit assignment is made and handshaking is not established "Remote I/O Failure xx" will be displayed on the main status screen were xx is one of the following:

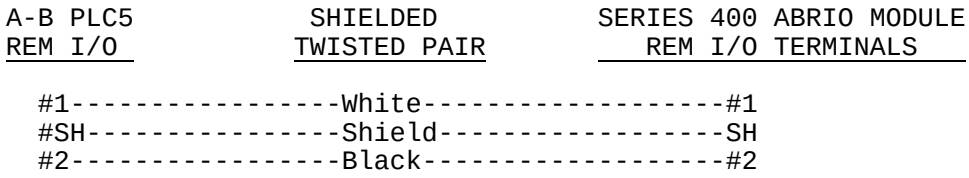
$00 = ABRIO module missing (no handshake)
$01 = Failed RAM Test FF
$02 = Failed RAM test count
$04 = Failed RAM test 00
$08 = Failed VIA test

(VIA - **V**ersatile **I**nterface **A**dapter hardware between A-B Node Adapter chip set and the AB I/O module HC16 uProcessor)

5.4 At this point ABRIO handshake has not been established between the PLC5 and the A-B Node Adapter chip set. The A-B LED light in the upper right hand corner of the I/O status window on the ABRIO Module should be off. The REM I/O COM LED on the PLC5 is RED.

Down load the PLC5 program making sure Data File 2 is properly set up to reflect the DIP switch settings on the ABRIO Module.

5.5 Hookup a shielded pair between the ABRIO Modules REM I/O and the PLC5 REM I/O connectors using the recommended A-B Hook up procedure.



If this installation is the last electrical connection install the A-B termination module as recommended.

5.6 Place the A-B PLC5 keyswitch in PROGRAM mode, then power up the PLC5. The REM I/O light on the PLC5 at this time will be RED because there is no communications from the Series 400 ABRIO Module.

5.7 Power up the Series 400. After the Series 400 Modules are up and running, the REM I/O light on the PLC5 should turn green, but the A-B LED on the ABRIO Module should be

blinking. Place the PLC5 keyswitch in RUN Mode and the A-B LED should stop blinking. Full communications have been established.

The COM and REM I/O status LED's on the PLC5 CPU and the A-B LED on the Series 400 ABRIO Module indicate the state of communications between the AB PLC5 CPU and the A-B 1771-NAK1 Node Adapter Chip. With the PLC5 in RUN mode if they are not both on solid green and the A-B LED solid on, follow the Allen-Bradley RIO trouble shooting procedures.

Connections between the A-B 1771-NAK1 Node Adapter chip and the Series 400 CPU/Timer is indicated by messages on the main status screen and its memory map bit #417. If Communications is established bit #417 "Remote I/O Link is established" will be set and no fault/status messages to the status screen will be displayed. Bit #417 should be included in the users fault program system to annunciate ABRIO communication failures.

MOST COMMON PROBLEMS

- A Series 400 CPU/Timers I/O bits not Setup to Slot 16 and or 17. More then one group of 8 output bits addressing Slot 17 from the same CPU/Timer or other CPU/Timers.

- Not addressing local I/O properly or at all because DIP switches S1, S2 and or SW2 are not set properly.

- Differences between a **PLC5** Program Status File in Data Table #2 and the corresponding DIP switch setting on the 473-0-0424-01 A-B RIO Accessory PCB or the 473-0-454-01 main I/O interface PCB.

- Connections between the REM I/O terminals. Open or swapped, Poor routing, (Blue Hose in a noisy environment) and/or not following Allen-Bradleys suggested termination procedure.

6.0 Diagnostic Chart

The diagnostic chart on the following page is divided into two sections. The first half involves the connection status between A-B PLC5 and the ABRIO Module. The status of the connections is reflected by two LEDS, COM and REMI/O found on the PLC5 Programmable Controller and the A-B LED in the I/O status window on the Series 400 ABRIO Module.

The second half of the chart involves the connection status between the Series 400 ABRIO Module and the CPU/Timer. The status of the connection is reflected by messages displayed on the status screen of the CPU/Timer.

PLC5 to ABRIO MODULE DIAGNOSTIC CHART

A-B PLC5 REM I/O	ABRIO A-B LED	NODE LINK UP STATUS BIT	POSSIBLE FAULT
green	A-B on	417=1	PLC5 in RUN or REM mode and no communications faults, but no bit transfer between controls. -Faulty program(s) -CPU/Timer not setup to Slot 16/17 -More then 1 Port assigned Slot 17 -Local AB inputs overriding Timer
Green	A-B blinking	417=1	OK, PLC5 in PROGRAM mode. Or possible REM mode. When PLC5 programming key is switched from PROGRAM to REM, COM status LED will continue to blink because the PLC5 is still in PROGRAM mode. (Switch to RUN then REM)
Red	off	417=0	No communications -Open twisted shielded pair. -Reversed terminal #1 and #2. -Baud rate not the same SW2 7-8. -Rack Address wrong on SW1 1-6 -Interface between Node Adapter chip or HC16 uProcessor PCB bad. (See status message chart below)
Flash green/ red	A-B on	417=1	Dip Switches set wrong for PLC5 RIO Data Table 2 program setup -Rack size. SW2 5-6 (OK oversize) -Starting quarter. SW1 7-8

A-B RIO MODULE TO CPU/TIMER DIAGNOSTIC CHART

S400 CPU/Timer message displayed: "REMOTE I/O FAILURE xx"

Where xx = $00 = ABRIO Module missing (no handshake)
$01 = Failed RAM Test FF
$02 = Failed RAM test count
$04 = Failed RAM test 00
$08 = Failed VIA test

If any of the above hardware tests fail the software will abort any attempt to communicate with the AB 1771-NAK1 Node Adapter. The CPU/Timer will then set status bit #417 to 0.

7.0 Example Interface for Three Weld Timers.

Only 1/4 AB rack space is necessary. In this scheme the Allen Bradley program must OR inputs I:R0.04, I:R0.14 and I:R1.04 (Call Isolation contactor Coil) and output back O:R0.07 to energize the Isolation Contactor Coil. Contactor Open status is by a PLC program in timer #1 (469-0-0008-01). Configure CPU/Timers I/O Set up and ABRIO Module DIP switches as follows:

```
Timer #1:
          1-8 Slot  0 Port 0 XXX  (De-assigns Pilots)
         9-16 Slot 16 Port 3 IN   (Weld Control IN)
        17-24 Slot 17 Port 0 OUT  (Weld Control Out)
        25-32 Slot 17 Port 3 OUT  (Iso Contactor Open)
        41-48 Slot 16 Port 14 IN  (Local MC AUX Contact IN)
      137-144 Slot 16 Port 0 IN   (Timer Initiation)

Timer #2:
          1-8 Slot  0 Port 0 XXX
         9-16 Slot 16 Port 3 IN
        17-24 Slot 17 Port 1 OUT
      137-144 Slot 16 Port 1 IN

Timer #3:
          1-8 Slot  0 Port 0 XXX
         9-16 Slot 16 Port 3 IN
        17-24 Slot 17 Port 2 OUT
      137-144 Slot 16 Port 2 IN


   ABRIO Module: S2-3 OPEN and S2-5 OPEN (Routed)
                                 S1-1 OPEN Local I/O on Ports 14 & 15
```

AB OUTPUTS/S400 INPUTS

CPU/Timer #1 Inputs

FUNCTION	S400 MAP BIT	S400 CONFG SLOT 16 IN	R=Rack# A-B OUT
Binary select 1	137	Port 0 Bit 0 <--	O:R0.00
Binary select 2	138	Port 0 Bit 1 <--	O:R0.01
Binary select 4	139	Port 0 Bit 2 <--	O:R0.02
Binary select 8	140	Port 0 Bit 3 <--	O:R0.03
Binary select 16	141	Port 0 Bit 4 <--	O:R0.04
Initiate weld	142	Port 0 Bit 5 <--	O:R0.05
Weld/No Weld	143	Port 0 Bit 6 <--	O:R0.06
Isolation contactor Coil	144/P07	Port 0 Bit 7 <--	O:R0.07

P=Port on S400 ABRIO module

CPU/Timer #2 Inputs

FUNCTION	S400 MAP BIT	S400 CONFG SLOT 16 IN	R=Rack# A-B OUT
Binary select 1	137	Port 1 Bit 0 <--	O:R0.10
Binary select 2	138	Port 1 Bit 1 <--	O:R0.11
Binary select 4	139	Port 1 Bit 2 <--	O:R0.12
Binary select 8	140	Port 1 Bit 3 <--	O:R0.13
Binary select 16	141	Port 1 Bit 4 <--	O:R0.14
Initiate weld	142	Port 1 Bit 5 <--	O:R0.15
Weld/No Weld	143	Port 1 Bit 6 <--	O:R0.16
Spare	144	Port 1 Bit 7 <--	O:R0.17

CPU/Timer #3 Inputs

FUNCTION	S400 MAP BIT	S400 CONFG SLOT 16 IN	R=Rack# A-B OUT
Binary select 1	137	Port 2 Bit 0 <--	O:R1.00
Binary select 2	138	Port 2 Bit 1 <--	O:R1.01
Binary select 4	139	Port 2 Bit 2 <--	O:R1.02
Binary select 8	140	Port 2 Bit 3 <--	O:R1.03
Binary select 16	141	Port 2 Bit 4 <--	O:R1.04
Initiate weld	142	Port 2 Bit 5 <--	O:R1.05
Weld/No Weld	143	Port 2 Bit 6 <--	O:R1.06
Spare	144	Port 2 Bit 7 <--	O:R1.07

Weld Control Inputs

FUNCTION	S400 MAP BIT	S400 CONFG SLOT 16 IN	R=Rack A-B OUT
Control Stop	9	Port 3 Bit 0 <--	O:R1.10
MC Saver Enable	10	Port 3 Bit 1 <--	O:R1.11
Stepper Reset	11	Port 3 Bit 2 <--	O:R1.12
Fault Reset	12	Port 3 Bit 3 <--	O:R1.13
Spare	13	Port 3 Bit 4 <--	O:R1.14
Spare	14	Port 3 Bit 5 <--	O:R1.15
Spare	15	Port 3 Bit 6 <--	O:R1.16
Spare	16	Port 3 Bit 7 <--	O:R1.17

CPU/Timer #1 Outputs

Function	S400 Map bit	S400 CONFG SLOT 17 Out	R=Rack A-B IN
I/O Active	17	Port 0 Bit 0 -->	I:R0.00
Weld In Progress	18	Port 0 Bit 1 -->	I:R0.01
No Faults	19	Port 0 Bit 2 -->	I:R0.02
Alert	20	Port 0 Bit 3 -->	I:R0.03
Call for Iso Cont Coil	21	Port 0 Bit 4 -->	I:R0.04
Stepper is Reset	22	Port 0 Bit 5 -->	I:R0.05
Weld Complete	23	Port 0 Bit 6 -->	I:R0.06
Ready for Weld	24	Port 0 Bit 7 -->	I:R0.07

CPU/Timer #2 Outputs

Function	S400 Map bit	S400 CONFG SLOT 17 Out	R=Rack A-B IN
I/O Active	17	Port 1 Bit 0 -->	I:R0.10
Weld In Progress	18	Port 1 Bit 1 -->	I:R0.11
No Faults	19	Port 1 Bit 2 -->	I:R0.12
Alert	20	Port 1 Bit 3 -->	I:R0.13
Call for Iso Cont Coil	21	Port 1 Bit 4 -->	I:R0.14
Stepper is Reset	22	Port 1 Bit 5 -->	I:R0.15
Weld Complete	23	Port 1 Bit 6 -->	I:R0.16
Ready for Weld	24	Port 1 Bit 7 -->	I:R0.17

CPU/Timer #3 Outputs

Function	S400 Map bit	S400 CONFG SLOT 17 Out	R=Rack A-B IN
I/O Active	17	Port 2 Bit 0 -->	I:R1.00
Weld In Progress	18	Port 2 Bit 1 -->	I:R1.01
No Faults	19	Port 2 Bit 2 -->	I:R1.02
Alert	20	Port 2 Bit 3 -->	I:R1.03
Call for Iso Cont Coil	21	Port 2 Bit 4 -->	I:R1.04
Stepper is Reset	22	Port 2 Bit 5 -->	I:R1.05
Weld Complete	23	Port 2 Bit 6 -->	I:R1.06
Ready for Weld	24	Port 2 Bit 7 -->	I:R1.07

Weld Control outputs

Function	S400 Map bit	S400 CONFG SLOT 17 Out	R=Rack A-B IN
Isolation Contactor Open	25	Port 3 Bit 0 -->	I:R1.10
Spare	26	Port 3 Bit 1 -->	I:R1.11
Spare	27	Port 3 Bit 2 -->	I:R1.12
Spare	28	Port 3 Bit 3 -->	I:R1.13
Spare	29	Port 3 Bit 4 -->	I:R1.14
Spare	30	Port 3 Bit 5 -->	I:R1.15
Spare	31	Port 3 Bit 6 -->	I:R1.16
Spare	32	Port 3 Bit 7 -->	I:R1.17

7.1 Chrysler specification interface for three weld timers - A-B ¼ Rack Addressing.

for **V3.000**

	A-B GROUP 0				A-B GROUP 1			
	PLC OUTPUTS OR'ed WITH WELD CONTROL OUTPUTS Slot 17, Port 0		PLC INPUTS or WELD CONTROL INPUTS Slot 16, Port 0		PLC OUTPUTS / WELD CONTROL INPUTS S400 Slot 16, Port 2		PLC INPUTS / WELD CONTROL OUTPUTS S400 Slot 17, Port 2	
A-B BIT	S400 Bits	S400 & Local AB Outputs	S400 Bits	S400 & Local AB Inputs	S400 Bits	Weld Timer #2 (Inputs)	S400 Bits	Weld Timer #2 (Outputs)
0	25	Iso. Contactor Coil #1	9	Iso. #1 Aux. Contact	1	Binary Select 1	17	End of Weld
1	26	Iso. Contactor Coil #2	10	Iso. #2 Aux. Contact	2	Binary Select 2	18	Major Fault
2	27	Iso. Contactor Coil #3	11	Iso. #3 Aux. Contact	3	Binary Select 4	19	Minor Fault
3	28		12		4	Binary Select 8	20	Weld / No Weld Status
4	29		13		5	Emer. Stop	21	End of Stepper
5	30		14		6	Weld / No Weld	22	Weld is Initiated
6	31	FAULT LIGHT	15		7	Initiate	23	
7	32	S400 Shunt Trip	16	EMER. STOP Contact	8	Stepper Reset	24	
	PLC OUTPUTS / WELD CONTROL INPUTS S400 Slot 16, Port 1		PLC INPUTS / WELD CONTROL OUTPUTS S400 Slot 17, Port 1		PLC OUTPUTS / WELD CONTROL INPUTS S400 Slot 16, Port 3		PLC INPUTS / WELD CONTROL OUTPUTS S400 Slot 17, Port 3	
A-B BIT	S400 Bits	Weld Timer #1 (Inputs)	S400 Bits	Weld Timer #1 (Outputs)	S400 Bits	Weld Timer #3 (Inputs)	S400 Bits	Weld Timer #3 (Outputs)
10	1	Binary Select 1	17	End of Weld	1	Binary Select 1	17	End of Weld
11	2	Binary Select 2	18	Major Fault	2	Binary Select 2	18	Major Fault
12	3	Binary Select 4	19	Minor Fault	3	Binary Select 4	19	Minor Fault
13	4	Binary Select 8	20	Weld / No Weld Status	4	Binary Select 8	20	Weld / No Weld Status
14	5	Emer. Stop	21	End of Stepper	5	Emer. Stop	21	End of Stepper
15	6	Weld / No Weld	22	Weld is Initiated	6	Weld / No Weld	22	Weld is Initiated
16	7	Initiate	23		7	Initiate	23	
17	8	Stepper Reset	24		8	Stepper Reset	24	

A-B RIO Switch Settings:

S1 -1 I/O Routing "C" use CPU/Timer Ports 0&1
-2 Spare (Always closed)
-3 " " "
-4 " " "
No, Set to "C"
-5 " " "
Yes, Set to "O"
-6 " " "
No, Set to "C"
-7 " " "
-8 " " "

S2 -1 Route Loc. Inputs 1-8 to AB as 00-07 (Prt. 0) = Yes, Set to "O"
-2 Route Loc. Inputs 9-16 to AB as 10-17 (Prt. 1) = No, Set to "C"
-3 Route AB Outputs 00-07 to Local Outputs (Prt. 0) = Yes, Set to "O"
-4 Route AB Ouptuts 10-17 to Local Outputs (Prt. 1) =
-5 Route Local Inputs 00-07 to CPU/Timer (Prt. 0) =
-6 Route Local Inputs 10-17 to CPU/Timer (Prt. 1) =
-7 Route CPU Out - Loc. Prt 0=Yes, Set to "O"
-8 Route CPU Out - Loc. Prt 1 = No, Set to "C"

SW1-1 Set for Rack # *
-2 " " " "
-3 " " " "
-4 " " " "
-5 " " " "
-6 " " " "
-7 Set to Starting ¼ Rack *
-8 " " " " "

SW2 -1 Hold Last State? = No, Set to "C"
-2 Processor Restart? *
-3 Last Rack? , "C" = Yes, "O" = No
-4 (Not Used)
-5 Set for ¼ Rack = yes, Set to "C"
-6 " " " " " " " " "
-7 Set Baud Rate *
-8 " " "

"C" = Closed, No, Not Routed "O" = Open, Yes, Routed

* = See section 3A.0 for detailed instructions.

8.0 RIO Scanner Setup Example

The following procedure was recorded in the making of a test fixture that would exchange 16 inputs and 16 outputs between a S400 ABRIO module and 16 switches and 16 lights connected to a AB SLC rack. The test fixture consisted of :

1 1746-A7 7 slot I/O Rack
1 1747-L532 SLC 5/03 CPU
1 1746-P2 120VAC Power supply
1 1746-IA16 Input Module connected to 16 toggle switches
1 1746-OA16 Output Module connected to 16 neon lights.
1 1746-SN Series B Remote I/O Scanner Module

The Software used to program the SLC was AB 9324-RL0100END RS Logix 500 Software.

A. Setting the Dip Switches

1. Set RIO Scanner baud rate SW1 to desired baud rate. Example: 230.4 Kbaud. The RIO Scanner module shows how to set the switches. After setting the switches, plug the RIO Scanner to the desired slot on the Allen-Bradley rack. DO NOT unplug or plug modules with the power on.

2. Go to the S415 ABRIO adapter card and set the DIP switches as follows:

SW1..... all switches are in the closed position.
Rack Address 0 and starting at First Quarter.

SW2..... switches 1 to 6 are closed and switches 7 & 8 are open.
Do not hold last state, processor restart, last rack,
rack size is quarter and baud rate is 230.4 KBaud.

B. Make a RIO Link Cable

1. Plug in one end of the RIO link cable to the RIO Scanner module. Install a terminating resistor (82 ohm « watt) on the end of the cable plugged into the scanner connector and install another terminating resistor at the end of the cable connected to the **last** physical device.

2. If the RIO Scanner is a Series B model, the shield drain wire must be connected to the chassis mounting bracket and not to the middle pin of the link cable connector. Solder the wire to the ring lug supplied with the scanner module. The other end of the drain wire must be connected to the middle pin of the connector plugged into the devices.

3. Plug in the other end of the link cable to the S415 ABRIO interface card.

C. Program the SLC 5/03

1. Connect a 1747-PIC interface converter from a personal computer serial communication port to the SLC 5/03 processor DH485 connector.

2. Turn on power to the SLC rack and all devices connected to it.

3. Start RSLogix® programming software.
   A. Click Comms.
   B. Choose System Comms.
   C. Click Who Active button. The Linx® screen will automatically come up and show the devices connected to the computer.
   D. When the screen shows that it found the PIC driver and the SLC processor, minimize the LINX screen.
   E. Close RSLogix window.
   F. Close System Options window.

4. Start a new project.

   A. Click File.
   B. Choose New.
   C. Enter desired Processor name. Example: SDNRIO
   D. Highlight the SLC processor being used.
   E. Choose the driver being used.
   F. Enter 10 seconds for the Reply timeout.
   G. Enter desired Processor node number.
   H. Click OK.
   I. Double click Project inside the SDNRIO window.
   J. Double click Controller under Project directory.
   K. Double click Processor Status under Controller.
   L. Click I/O tab inside the Status window. Check that all I/O slot enables and all I/O Slot Interrupt enables are all 1's.
   M. Close Status window.
   N. Double click I/O Configuration under Controller.
   O. Choose the Allen-Bradley rack being used as Rack 1. Rack 2 and 3 are not used.
   P. Click Power Supply button. Choose the power supply module used then click OK.
   Q. Find the RIO Scanner from the list of Current Cards Available. Highlight it, hold down the left mouse button then drag it to slot 1 of the rack shown on the left side of the screen. Choose Series A or B model.
   R. Choose the other modules installed on the actual rack and a assign them to their respective slots.
   S. When all modules are assign to their respective slots, highlight the RIO scanner then click the Adv Config button.
   T. In the Advanced I/O Configuration window, click the Edit G Data button.
   U. In the 1747-SN G File Configuration window, click Group 0 of Logical Rack 0, then choose Rack.

V. Click OK then in the Advanced I/O Configuration window click OK also.
W. Close the I/O Configuration window.

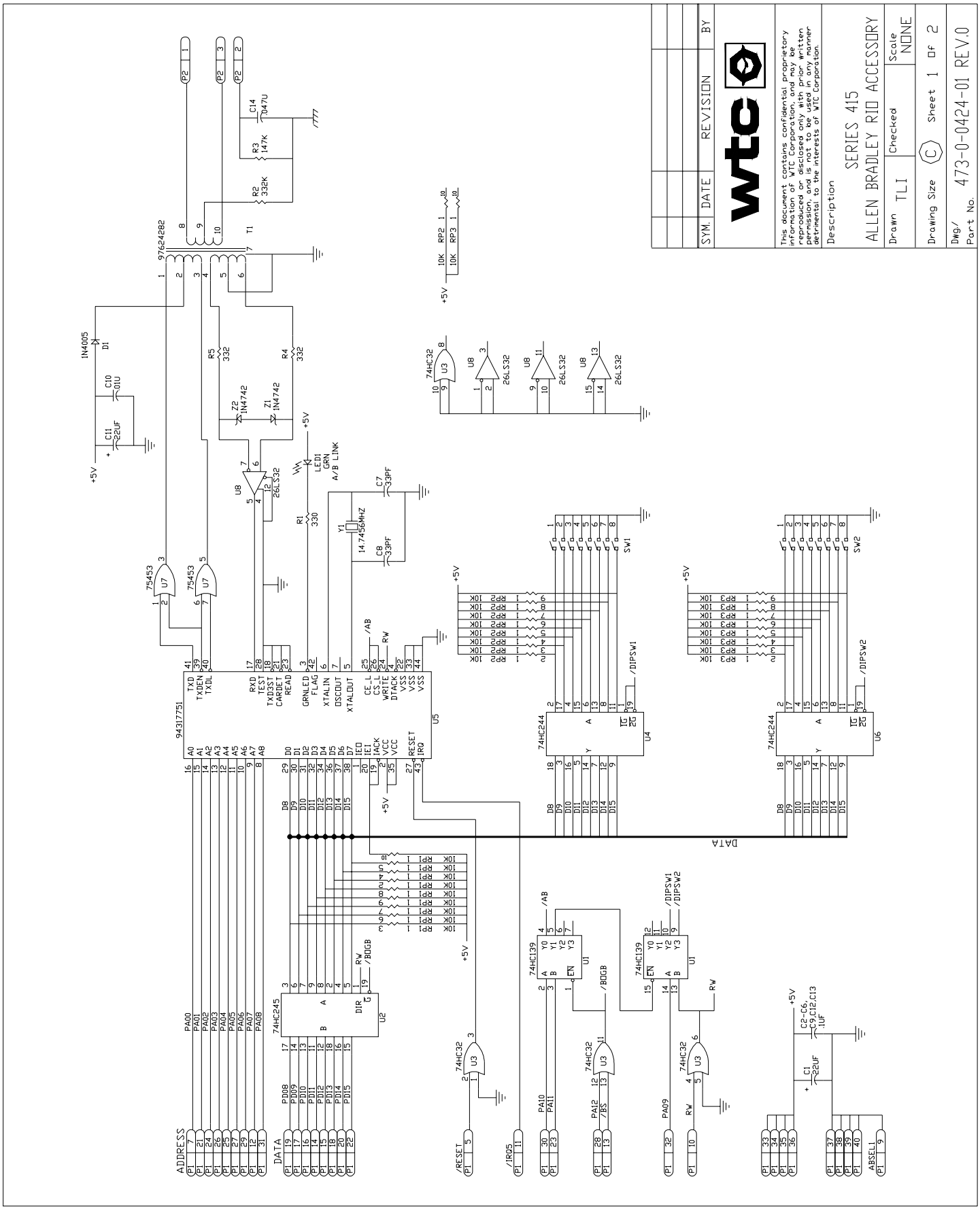
5. Make the ladder logic program using the Mask Move command that moves the inputs from the Input Module to the Outputs of the RIO sacnner module. Also using the Mask Move command to move the RIO Scanner inputs to the Output module. Save ladder logic program.

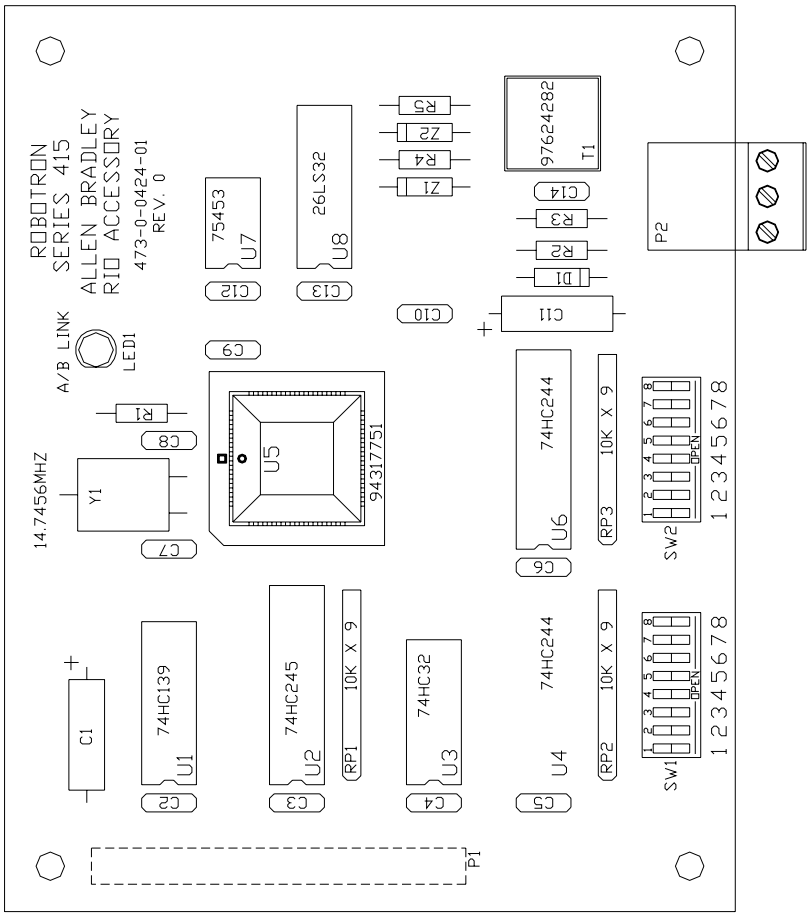
6. Download the ladder logic program to the SLC processor.

A. Click Comms menu and choose Download.
B. When Revision Note window appears, enter processor name, example: SDNRIO, click OK.
C. Put the SLC processor key switch to Program mode.
D. When the window appears asking if you want to proceed downloading, click Yes.
E. When downloading is done, click Yes to go Online.
F. Turn SLC processor switch to RUN mode. If all configurations are correct at this time, there should be no faults and the SLC processor will have solid green lights on the RUN and DH485 LEDs. The RIO Scanner will also have a solid green light on the COMM LED. The S415 ABRIO adapter card will also have a solid green light.
G. Go to S415 welding control DEP, go to Program mode and set I/O bits as follows:

1-8	Slot 16	Port 0	IN
9-16	Slot 16	Port 1	IN
17-24	Slot 17	Port 0	OUT
25-32	Slot 17	Port 1	OUT

H. Go to Run mode then initiate sequence 1 using the discrete input switch #1 from the remote Allen-Bradley® rack.


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Description
SERIES 415
ALLEN BRADLEY RIO ACCESSORY
Drawn TLI
Checked
Scale NONE
Drawing Size C
Sheet 1 of 2
Dwg./ Part No. 473-0-0424-01 REV.0
97624282
94317751
74HC245
74HC244
74HC139
74HC32
75453
26LS32
IN4005
IN4742
14.7456MHZ
ADDRESS
DATA
PA00
PA01
PA02
PA03
PA04
PA05
PA06
PA07
PA08
PD08
PD09
PD10
PD11
PD12
PD13
PD14
PD15
/RESET
/IRQ5
/AB
/BDGB
RW
/BS
/DIPSW1
/DIPSW2
A/B LINK
GRN LED1
+5V



SYM.	DATE	REVISION	BY

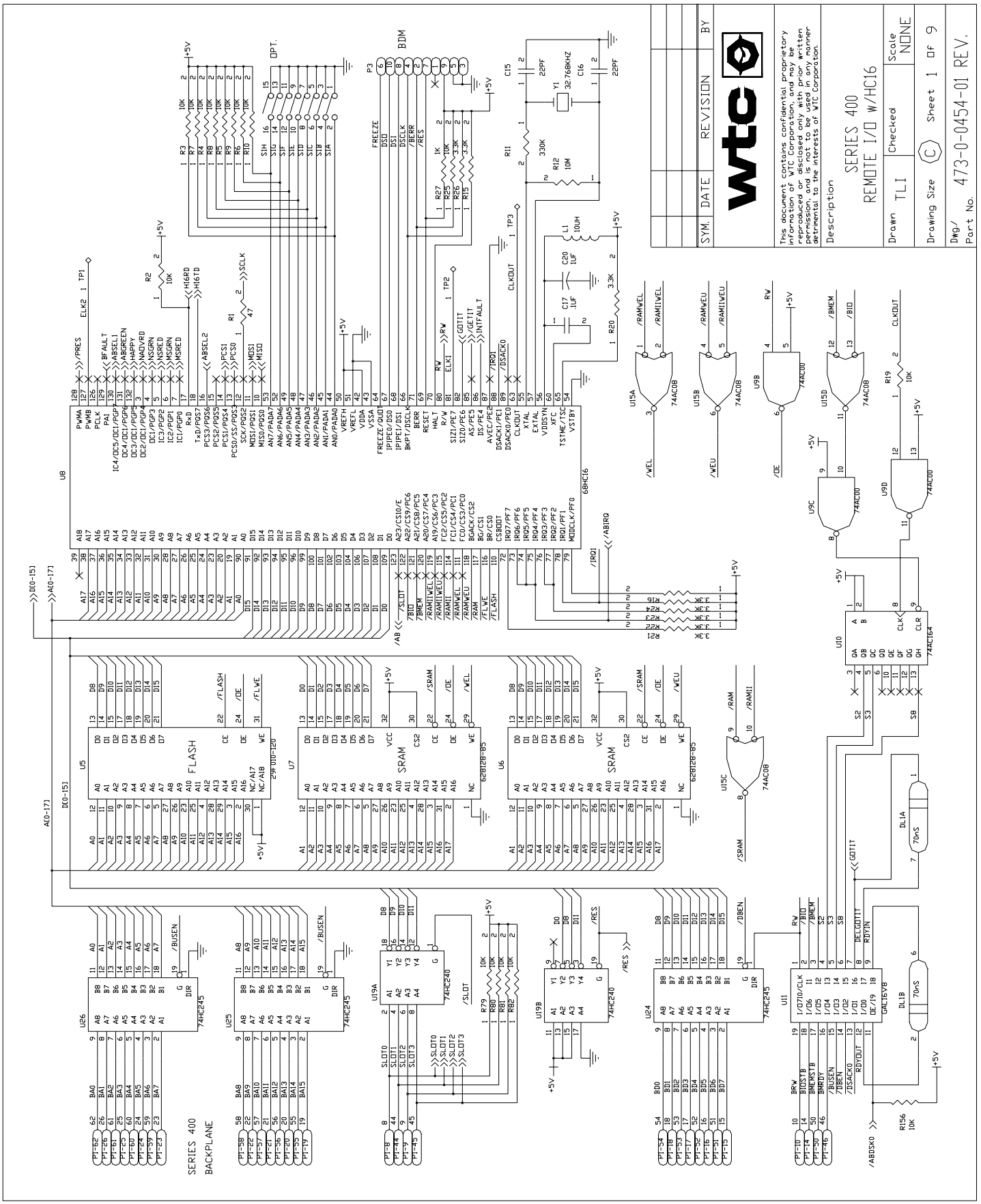
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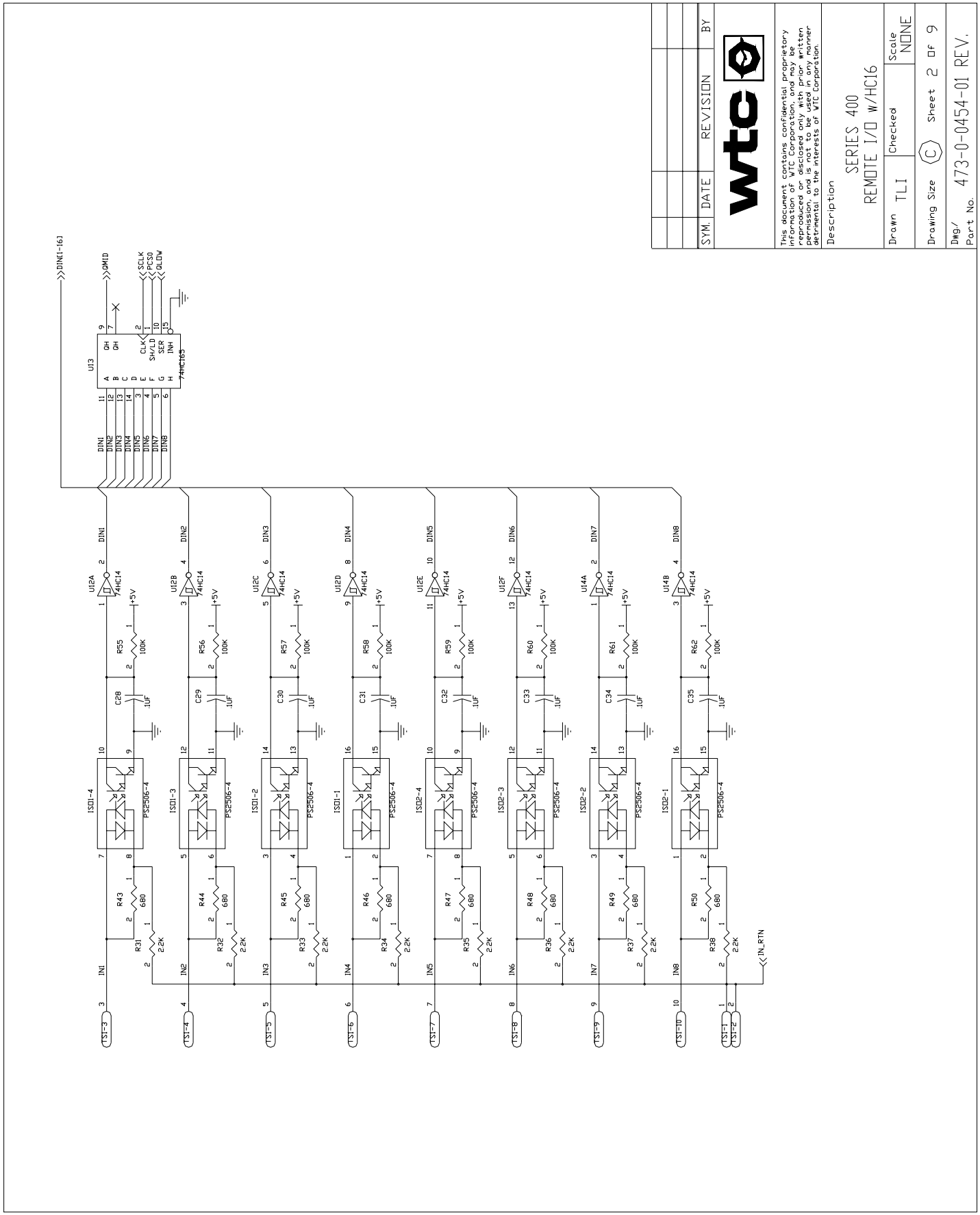
Description
SERIES 415
ALLEN BRADLEY RIO ACCESSORY

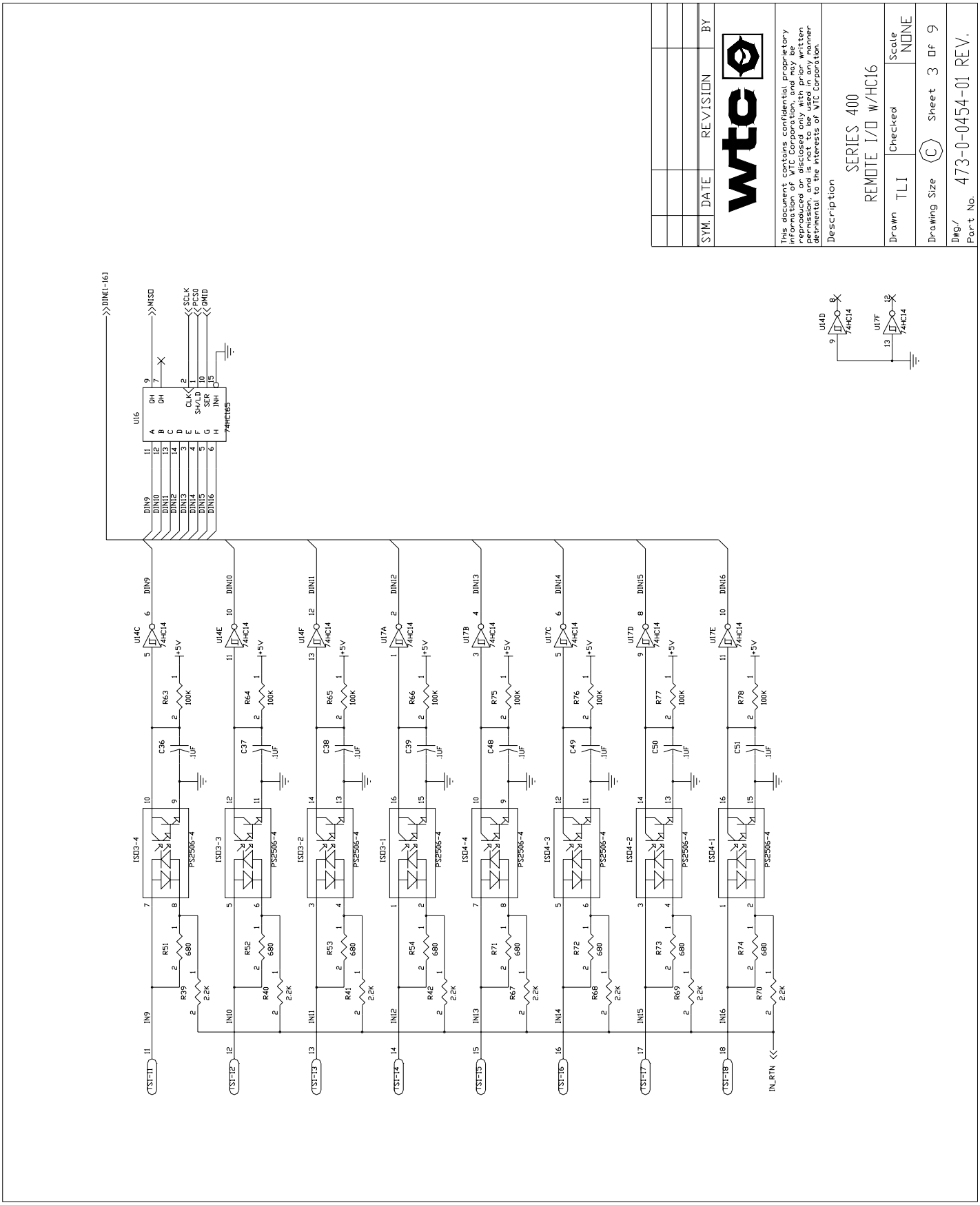
Drawn TLI | Checked | Scale 2:1

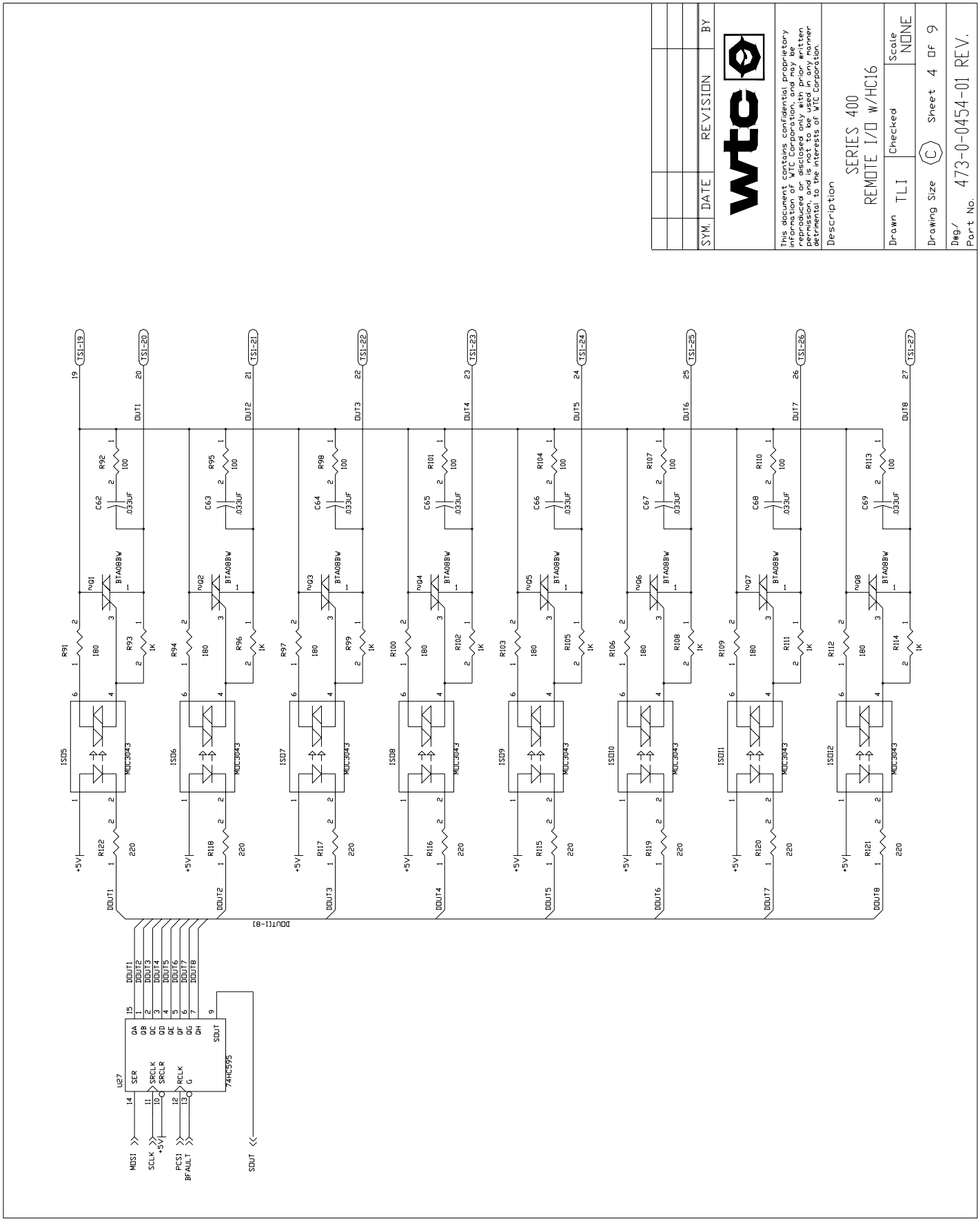
Drawing Size C | Sheet 2 Of 2

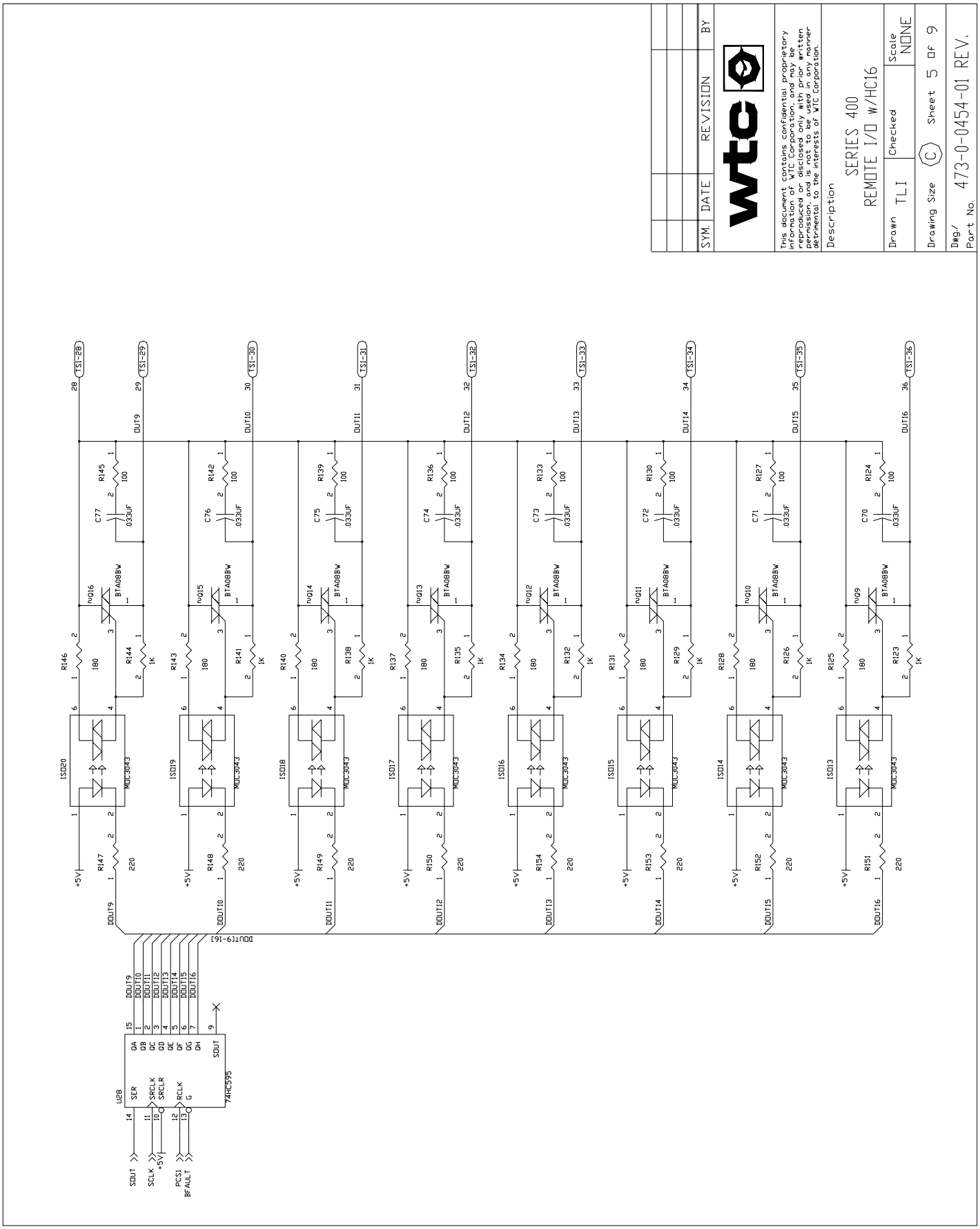
Dwg./ Part No. 473-0-0424-01 REV.0

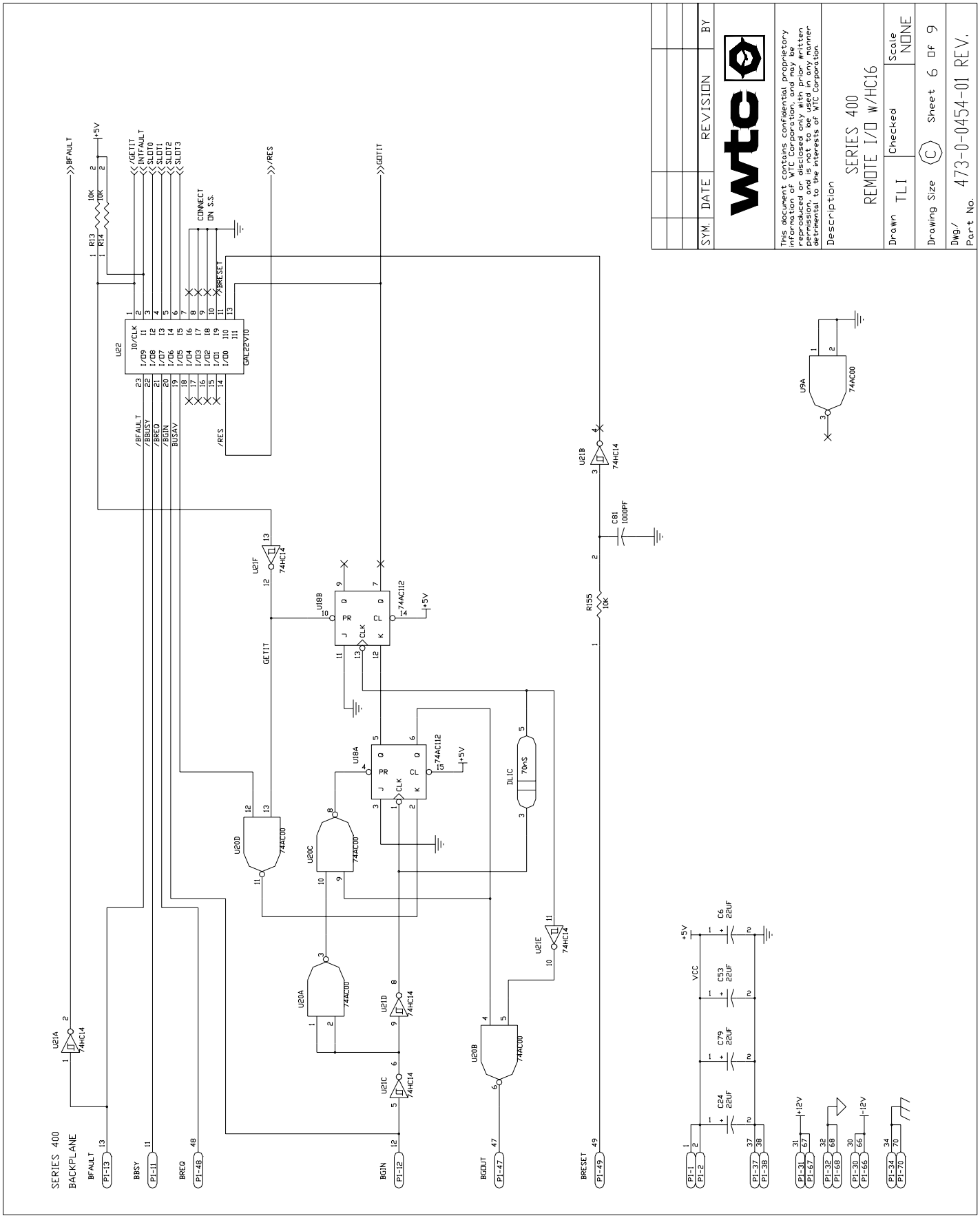

SERIES 400
REMOTE I/O W/HC16
Drawn TLI
Checked
Scale NONE
Drawing Size C
Sheet 1 OF 9
Dwg/ Part No. 473-0-0454-01 REV.
SERIES 400
BACKPLANE
FLASH
SRAM
68HC16
74HC245
74HC240
74AC164
74AC08
74AC00
GAL16V8
32.768KHZ
+5V
/RES
/SLOT
/GDTIT
/DBEN
/BUSEN
/ABDSKO

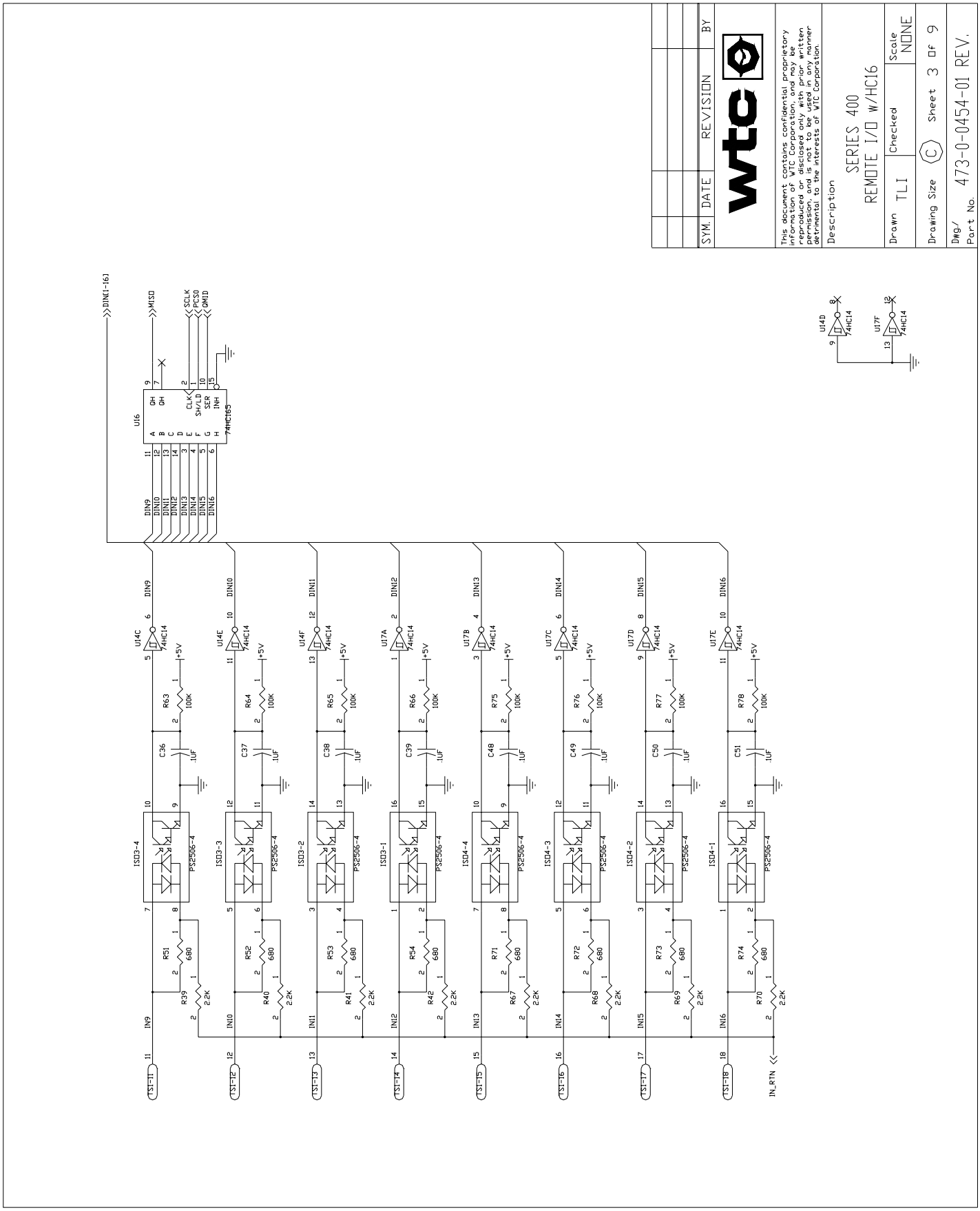

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Description
SERIES 400
REMOTE I/O W/HC16
Drawn TLI
Checked
Scale NONE
Drawing Size C
Sheet 2 of 9
Dwg/ Part No. 473-0-0454-01 REV.
DIN[1-16]
OMID
SCLK
PCS0
QLOW
U13
74HC165
DIN1
DIN2
DIN3
DIN4
DIN5
DIN6
DIN7
DIN8
U12A
U12B
U12C
U12D
U12E
U12F
U14A
U14B
74HC14
+5V
R55
R56
R57
R58
R59
R60
R61
R62
100K
C28
C29
C30
C31
C32
C33
C34
C35
.1UF
ISO1-4
ISO1-3
ISO1-2
ISO1-1
ISO2-4
ISO2-3
ISO2-2
ISO2-1
PS2506-4
R43
R44
R45
R46
R47
R48
R49
R50
680
R31
R32
R33
R34
R35
R36
R37
R38
2.2K
IN1
IN2
IN3
IN4
IN5
IN6
IN7
IN8
IN_RTN
TST-3
TST-4
TST-5
TST-6
TST-7
TST-8
TST-9
TST-10
TST-1
TST-2

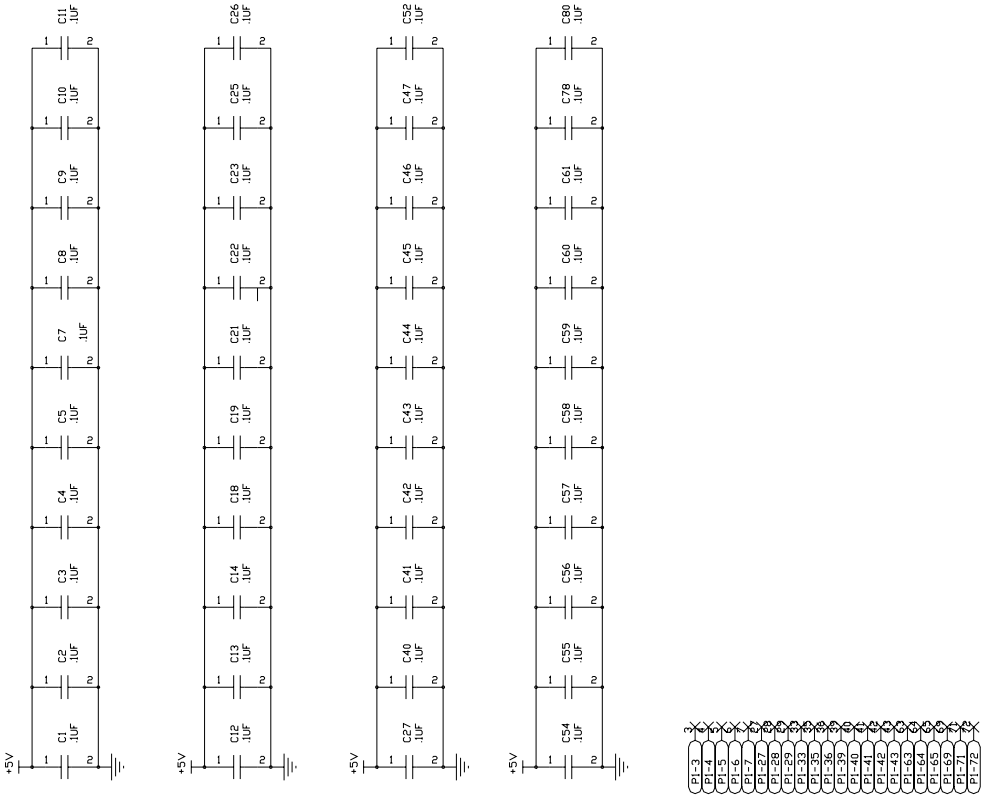

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Description
SERIES 400
REMOTE I/O W/HC16
Drawn TLI
Checked
Scale NONE
Drawing Size C
Sheet 3 of 9
Dwg./ Part No. 473-0-0454-01 REV.
DIN[1-16]
MISO
SCLK
PCS0
QMID
U16
74HC165
DIN9
DIN10
DIN11
DIN12
DIN13
DIN14
DIN15
DIN16
U14C
U14E
U14F
U17A
U17B
U17C
U17D
U17E
U14D
U17F
74HC14
+5V
R63
R64
R65
R66
R75
R76
R77
R78
100K
C36
C37
C38
C39
C48
C49
C50
C51
.1UF
ISO3-4
ISO3-3
ISO3-2
ISO3-1
ISO4-4
ISO4-3
ISO4-2
ISO4-1
PS2506-4
R51
R52
R53
R54
R71
R72
R73
R74
680
R39
R40
R41
R42
R67
R68
R69
R70
2.2K
IN9
IN10
IN11
IN12
IN13
IN14
IN15
IN16
TSI-I1
TSI-I2
TSI-I3
TSI-I4
TSI-I5
TSI-I6
TSI-I7
TSI-I8
IN_RTN


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Description
SERIES 400
REMOTE I/O W/HC16
Drawn TLI
Checked
Scale NONE
Drawing Size C
Sheet 4 of 9
Dwg./ Part No. 473-0-0454-01 REV.
TSI-19
TSI-20
TSI-21
TSI-22
TSI-23
TSI-24
TSI-25
TSI-26
TSI-27
DOUT1
DOUT2
DOUT3
DOUT4
DOUT5
DOUT6
DOUT7
DOUT8
Q1
Q2
Q3
Q4
Q5
Q6
Q7
Q8
BTA08BW
MOC3043
ISO5
ISO6
ISO7
ISO8
ISO9
ISO10
ISO11
ISO12
C62
C63
C64
C65
C66
C67
C68
C69
.033UF
R91
R92
R93
R94
R95
R96
R97
R98
R99
R100
R101
R102
R103
R104
R105
R106
R107
R108
R109
R110
R111
R112
R113
R114
180
100
1K
R121
R122
220
+5V
DOUT1
DOUT2
DOUT3
DOUT4
DOUT5
DOUT6
DOUT7
DOUT8
DOUT1-8
U27
74HC595
SER
SRCLK
SRCLR
RCLK
G
QA
QB
QC
QD
QE
QF
QG
QH
SOUT
MOSI
SCLK
PCS1
DEFAULT


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Description
SERIES 400
REMOTE I/O W/HC16
Drawn TLI
Checked
Scale NONE
Drawing Size C
Sheet 5 of 9
Dwg./ Part No. 473-0-0454-01 REV.
TSI-28
TSI-29
TSI-30
TSI-31
TSI-32
TSI-33
TSI-34
TSI-35
TSI-36
DOUT9
DOUT10
DOUT11
DOUT12
DOUT13
DOUT14
DOUT15
DOUT16
ISDI20
ISDI19
ISDI18
ISDI17
ISDI16
ISDI15
ISDI14
ISDI3
MOC3043
BTA08BW
+5V
DDUT9
DDUT10
DDUT11
DDUT12
DDUT13
DDUT14
DDUT15
DDUT16
DDUT9-16]
U28
74HC595
SER
SRCLK
SRCLR
RCLK
G
QA
QB
QC
QD
QE
QF
QG
QH
SDUT
SCLK
PCS1
DEFAULT


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Description
SERIES 400
REMOTE I/O W/HC16
Drawn TLI
Checked
Scale NONE
Drawing Size C
Sheet 6 of 9
DWG/ Part No. 473-0-0454-01 REV.
SERIES 400 BACKPLANE
BFAULT
BBSY
BREQ
BGIN
BGDUT
BRESET
/GETIT
INTFAULT
SLOT0
SLOT1
SLOT2
SLOT3
CONNECT ON S.S.
/RES
GDTIT
GETIT
+5V
+12V
-12V
VCC
U21A 74HC14
U21B 74HC14
U21C 74HC14
U21D 74HC14
U21E 74HC14
U21F 74HC14
U20A 74AC00
U20B 74AC00
U20C 74AC00
U20D 74AC00
U9A 74AC00
U18A 74AC112
U18B 74AC112
U22 GAL22V10
DL1C 70nS
R13 10K
R14 100K
R155 10K
C81 1000PF
C6 22UF
C53 22UF
C79 22UF
C24 22UF


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Description
SERIES 400
REMOTE I/O w/HC16
Drawn TLI
Checked
Scale NONE
Drawing Size C
Sheet 3 of 9
Dwg./ Part No. 473-0-0454-01 REV.
DIN1-16
MISO
SCLK
PCS0
QMID
U16
74HC165
U14C
U14E
U14F
U17A
U17B
U17C
U17D
U17E
U14D
U17F
74HC14
+5V
R63
R64
R65
R66
R75
R76
R77
R78
100K
C36
C37
C38
C39
C48
C49
C50
C51
1UF
ISO3-4
ISO3-3
ISO3-2
ISO3-1
ISO4-4
ISO4-3
ISO4-2
ISO4-1
PS2506-4
R51
R52
R53
R54
R71
R72
R73
R74
680
R39
R40
R41
R42
R67
R68
R69
R70
2.2K
IN9
IN10
IN11
IN12
IN13
IN14
IN15
IN16
TST-I1
TST-I2
TST-I3
TST-I4
TST-I5
TST-I6
TST-I7
TST-I8
IN_RTN



SYM.	DATE	REVISION	BY

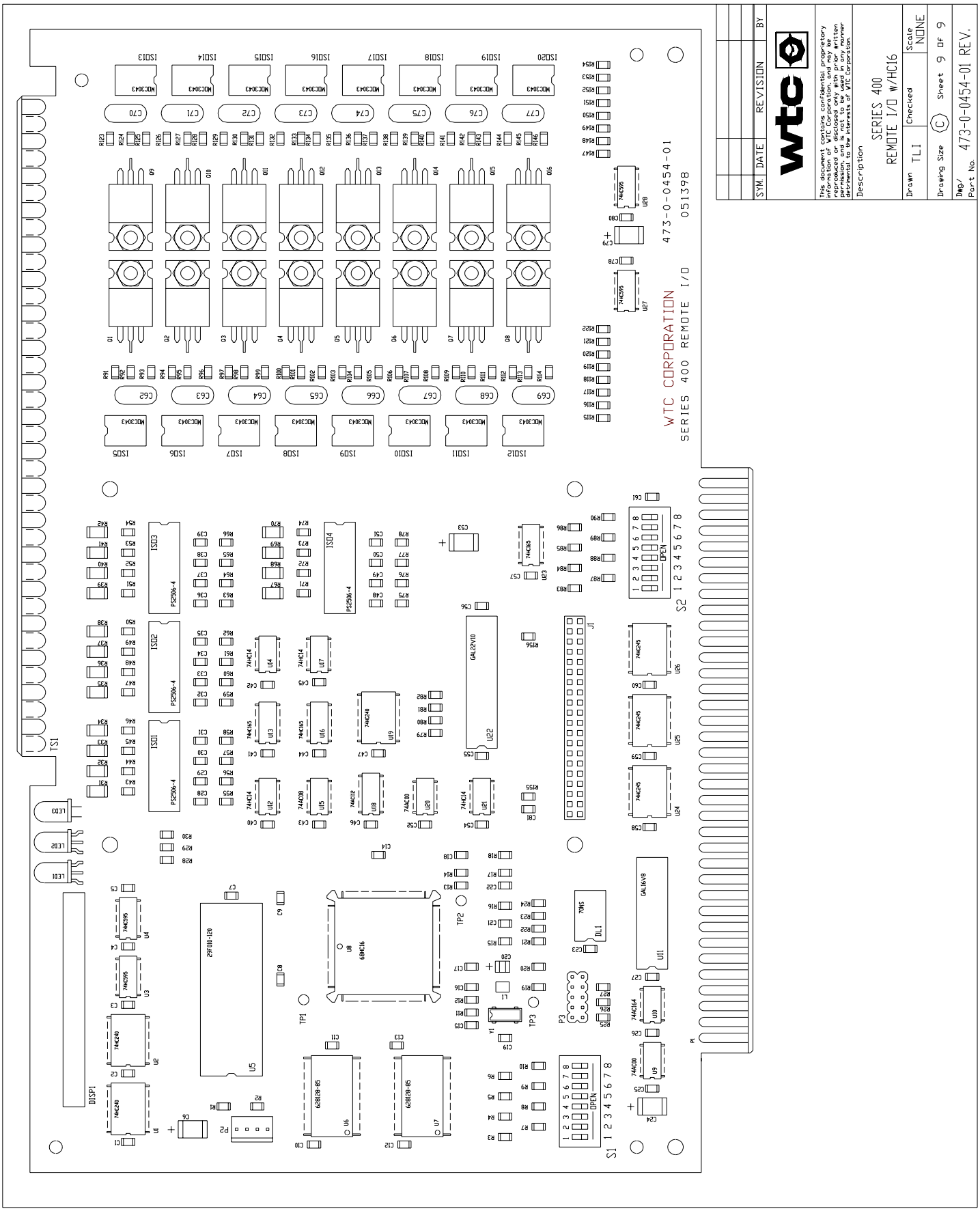
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Description
SERIES 400
REMOTE I/O W/HC16

Drawn	Checked	Scale
TLI		NONE

Drawing Size C Sheet 8 of 9

Dwg./ Part No. 473-0-0454-01 REV.


WTC CORPORATION
SERIES 400 REMOTE I/O
473-0-0454-01
051398
SERIES 400
REMOTE I/O W/HC16
Drawn TLI
Checked
Scale NONE
Drawing Size C
Sheet 9 of 9
Dwg/ Part No. 473-0-0454-01 REV.

Description and Instructions
for
Cascade SCR Steering Modules

503-7-0324-01 Single Phase
503-7-0324-02 Three Phase
503-7-0324-03 Three Phase and Secondary Monitoring

Instruction Book 328-0-0572-00

Table of Contents

I. Definition / Features

II. Single Phase vis Three Phase

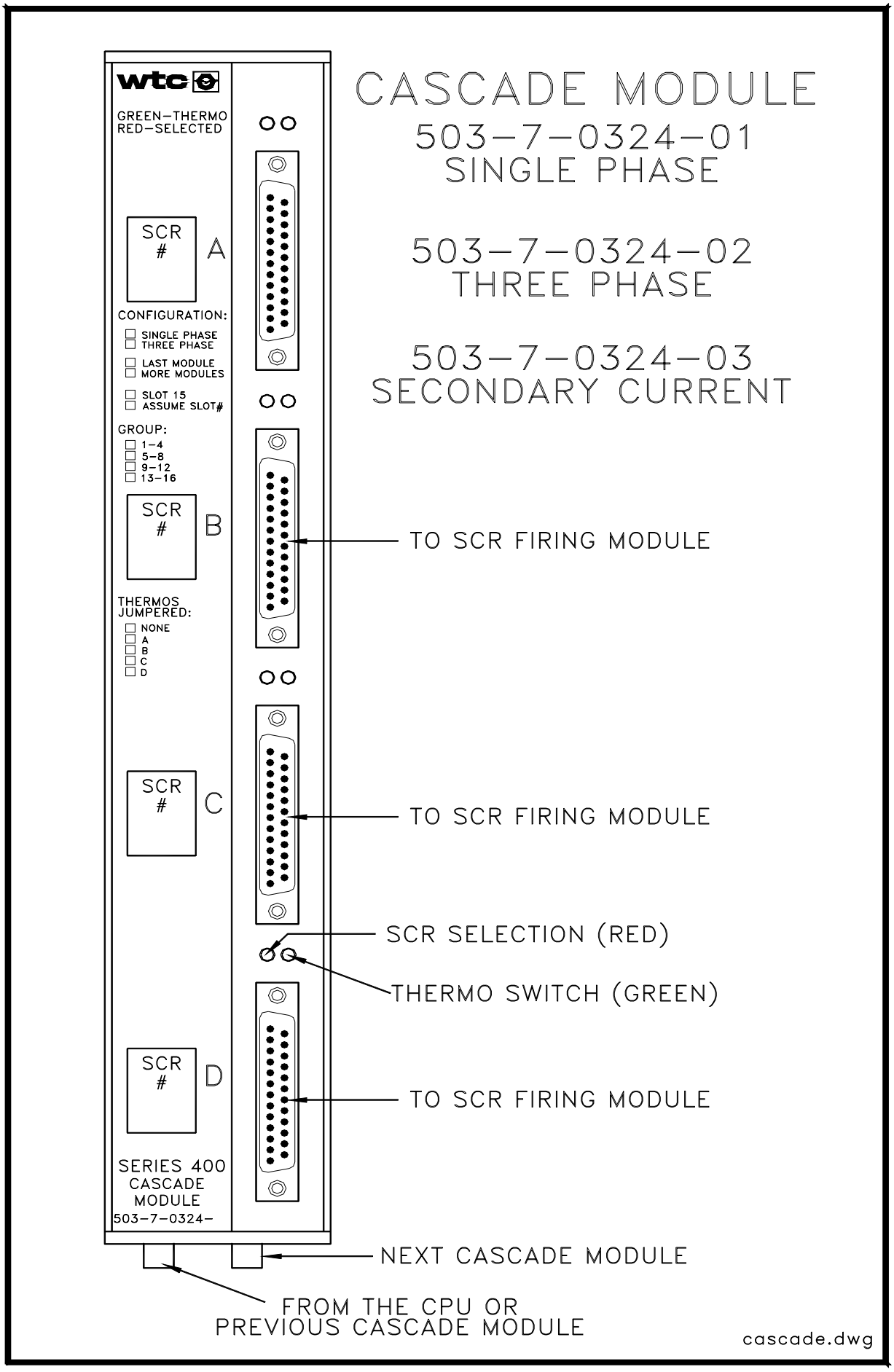
III. SCR Group Select

IV. Slot Addressing

V. Monitoring of SCR Thermoswitches

VI. SCR Selection

VII. Cascade Module Styles


CASCADE MODULE
503-7-0324-01
SINGLE PHASE
503-7-0324-02
THREE PHASE
503-7-0324-03
SECONDARY CURRENT
wtc
GREEN-THERMO
RED-SELECTED
SCR #
A
CONFIGURATION:
SINGLE PHASE
THREE PHASE
LAST MODULE
MORE MODULES
SLOT 15
ASSUME SLOT#
GROUP:
1-4
5-8
9-12
13-16
SCR #
B
THERMOS JUMPERED:
NONE
A
B
C
D
SCR #
C
SCR #
D
SERIES 400
CASCADE
MODULE
503-7-0324-
TO SCR FIRING MODULE
TO SCR FIRING MODULE
SCR SELECTION (RED)
THERMO SWITCH (GREEN)
TO SCR FIRING MODULE
NEXT CASCADE MODULE
FROM THE CPU OR
PREVIOUS CASCADE MODULE
cascade.dwg

I. Definition / Features

A Cascade Steering Module is used to *sequentially* (only) connect SCR contactors to a single CPU/Timer. The benefit of cascading is cost savings, where each SCR added to the system saves the cost of the CPU/Timer needed to service the added SCR. Therefore savings increase as the number of cascaded SCR's increase. System cost savings of up to 60% may be achieved. The only penalty of cascading is added cycle time, but by proper programming the total cycle time may be surprisingly short. The shortest time will be realized by making all cascaded welds share the squeeze and hold times and cascading only the weld times. If brittle spots occur because the first welds' hold time is too long, that gun should be released before the common hold time (after the next SCRs weld).

A single cascade module can connect up to 4 SCR contactors, but up to 4 modules may be interconnected for a total cascade system of 16 SCR's per CPU / Timer. It is possible for more then one cascade **system** to be installed in a rack but each system must have a CPU/Timer and Cascade Module. If multiple systems are employed, Assume Slot Addressing (SLTA) should be used, See IV Slot Addressing.

Each cascade system address SCRs on the same phase using Cascade Module 503-7-0324-01. A CPU/Timer cascading SCRs connected to different phase power(s) must employ Cascade Module 503-7-0324-02. The difference between the two modules is the three phase module contains two more relays per SCR which switch a copy of the AC line for the SCRs proper line clock and associated current coil. A three phase cascade steering module may be used on single phase systems.

II. Single Phase vis Three Phase

In a cascade welding system only one weld can be made at a time, hence all SCRs should be placed on the same phase. This results in cost savings through out whole the system. Load distribution is accomplished by placing each **cascade system** on a different phase. In the Series 400 rack system it is very easy to remove a SCR from a cascade system and address it with a separate CPU/Timer. If this is done, then two welds probably will be made at the same time on the same phase, overloading the phase. If the user forsees a future possibility of simultaneous welds, the system should be three phase and the components sized accordingly. If a SCR is removed from a three phase cascade system it does not have to be rewired to a different phase but simply addressed by its own CPU/Timer. A three phase cascade system is more flexible, expensive and more complex. The task of proper load distribution on **multiple** S400 three phase systems becomes very difficult if not impossible.

III. SCR Group Select

If more then one cascade module is employed in a system, each module MUST be configured for a different SCR group. If two cascade modules are configured for the same group in a system, both modules will respond and connect two SCRs to the CPU / Timer. Because the CPU / Timer provides sufficient energy to fire only one SCR, gate current will be cut in half. Also the CPU / Timer is provided with feed back data which will now come from two different SCRs. The CPU / Timer will act on the data coming in first which may cause the second SCR to be fired ahead of power factor causing half cycling. Although it is possible in some cases to fire two SCRs at the same time, it is not worth the risk and should not be attempted.

Group programming is accomplished with the group select jumper socket P/N 410-0-0079-01. When the jumper plug is installed in GP1 the module responds to a call for SCRs 1-4, GP2 SCRs 5-8, GP3 9-12, GP4 13-16.

IV. Slot Addressing

The cascade modules slot address may be jumper programmed to respond to **logical** slot 15 (SL15) or may be made to **assume** the slot address it is plugged into (SLTA). Simply plug a jumper socket P/N 410-0-0079-01 into the desired header SL15 or SLTA. If only one cascade system is used in the rack and it contains more then one cascade module, the user should choose slot 15 for all the modules in the system. If more then one cascade system is employed in the rack, **all** cascade modules should all be configured to assume the slot they occupy. If a rack contains multiple cascade systems and a system has more then one cascade panel in it, a ladder logic program must be written to address the additional modules properly. All cascade panels in a system must see the same outputs from its CPU / Timer. If the reader is not familiar with the Series 400 I/O structure please read Section 1 paragraph 1.6, 5.1 bits 145 through 148 and section 2, code #51 Contactor Select. Remember **all** Cascade modules connected to a CPU / Timer must receive the same cascade output data but respond to a different **group** of SCRs. Also one cascade system must not transmit to another systems cascade panels, this is controlled by unique **slot** addresses.

V. Monitoring of SCR thermoswitches

J1 More / Last and the Thermo / No thermo jumpers control the SCR Overtemp circuit. The More / Last jumper plug J1 must be plugged into "Last" position of the last cascade module in a system. If there is only one module it is considered last. The plug must be placed in the "More" position of all preceding cascade modules. In any SCR port that is not used its Thermo / No thermo jumper must be placed in No thermo position. In all SCR ports that are used the jumper must be in the Thermo Position. If there is a SCR thermo switch in the port and the jumper is in the No thermo position, the thermo switch will be jumpered and will not be used.

VI. SCR Selection

SCR selection may be made at any time and in any order. This is done by programming "CONTACTOR SELECT #XX" (code #51) at the desired time in your program. The instruction automatically sets memory map bits 145-148 to the binary equivalent of the decimal number programmed in the Contactor Select instruction. Bits 145-152 are possible real I/O bits. If these bits are set up as OUTPUTS PORT 4 in the Set Up menu and sent to the proper slot where the cascade module resides, (usually slot 15 PORT 4 OUT), they will be received by the (all) cascade module(s) configured for that slot. Then through the group selection decode jumper (GPx) and selected relay bank the SCR will be connected. A cascade module may be thought of as a binary I/O (0-16) module that employs only the first 4 bits of the first output port (PORT 4) to select and connect one of 4 SCR's to the CPU / Timer that addressed it. The first four incoming bits are received by U01, U02 and U03, latched in by U04 and binary to decimal decoded by U05 and U06. It is important to realize that the reception of binary 0 (no selection) automatically connects SCR 1 the CPU / Timer. Therefore at rest SCR #1 is always connected and does not have to be selected in your program.

VII. Cascade Module Styles

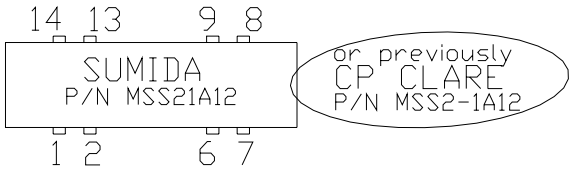
There are three styles of cascade modules 503-0-0324-01, -02 and -03. Three different functions are obtained by jumper configuration of J6 through J13, J6A through J13A and J14 on the 473-0-0374-01 REV R, A and B PC boards. REV C and D boards do not have J8 through J13 and J8A through J13A available, simply ignor any reference to them. Never install jumpers in J8 through J13 and J8A through J13A in **any board**. Please refer to item and value prints during reconfiguration.

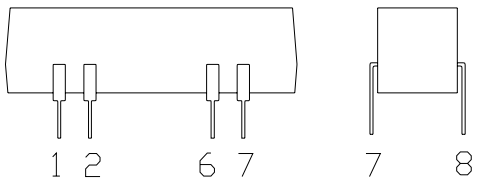
DASH #	FUNCTION	CR3 & 4 A-D	JUMPERS
-01	SINGLE PHASE	**NOT** INSTALLED	**INSTALL**: J6 AND J7 **DO NOT** INSTALL: J8, J9, J10, J11, J12, AND J13 (Not availible on REV C boards) **INSTALL:** J14 = 01-02
-02	THREE PHASE	INSTALLED	**INSTALL**: J6A and J7A **DO NOT** INSTALL: J6 THRU J13 (J8 thru J13 not available on REV C boards) **INSTALL**: J14 = 01-02
-03	1 OR 3 PHASE WITH SECONDARY TOROID COIL MONITORING SEE NOTE 1	INSTALLED	**INSTALL**: J6A and J7A **DO NOT**INSTALL: J6 THRU J13 (J8 thru J13 not available on REV C boards) **INSTALL:** J14 = -03

NOTE 1: A system employing a 503-0-0374-03 Cascade Module **MUST** employ 454-0-0028-02 Firing Modules for proper secondary current monitoring. (toroid operation)

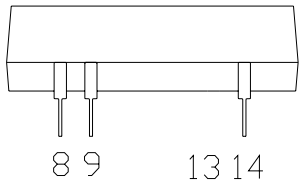
MODIFACTION OF 300-0542
TO 300-0503
RECOMMENDED RELAY FOR CR1-A, B, C AND D

ORIGINAL RELAY BEFORE MODIFACTION

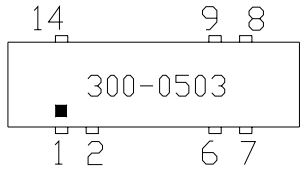




STEP ONE~
CUT OFF PIN NUMBER 13
TO MATCH DIAGRAM BELOW



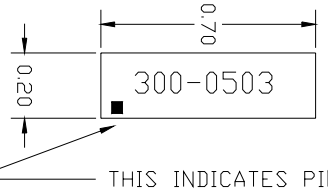
STEP TWO~
INSTALL BRADY LABEL
TO MATCH DIAGRAM BELOW



NOTE: THE SUMIDA OR CP CLARE MUST BE COMPLETELY COVERED WITH THE BRADY LABLE. INSURE THAT THE SQUARE IS OVER PIN ONE.

NOTES ON MAKING THE LABEL WITH THE BRADY MACHINE:
FONT ~ UNIVERSAL CONDENSED
FONT SIZE ~ 8 PTS
LINE THICKNESS ~ 0.010

BRADY LABEL



REV	DATE	DISCRIPTION	ECA	BY	APPRV
B	6-09-03	UPDATED VENDOR AND QANTEL P/N		ERK	
A	9-22-00	CHANGE LABEL ADD "M"	15588	JML	

GENERAL TOLERANCE FOR MECHANICAL DRAWING
0.00X ± .005
.0X ± .015 IN INCHES
.X ± .03
REMOVE ALL BURS AND SHARP EDGES UNLESS OTHERWISE SPECIFIED ON THE DRAWING

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DATE:
S.O.NO.

MODIFICATION OF SUMIDA RELAY

wtc

TB# 845036 R. A
DO NOT SCALE DWG
DO NOT SCALE DWG
SHEET 1 OF 1

DRAWING NO. 300-0503

REV. B

REVISIONS				
BY	LTR	DESCRIPTION	DATE	APRV'D
HRB	A	CISF25 GOES TO CIPE25	8/15/92	
HRB	C	ADDED J14 (-03)	4/20/94	
HRB	-	ADDED -03 NOTES	10/3/94	
ERK	D	CHANGED CR1 TO 300-0503	06/09/03	

CONTACTOR A — CISA

CONTACTOR B — CISB

CONTACTOR C — CISC

CONTACTOR D — CISD

24VAC
TORQID
FB/COM
CUR/COM
ACCOM
+12VDC
AGND
-12VDC
TIMER FIRE
TIMER FEEDBACK
TIMER THERMO
MORE THERMOS
LINE VOLTAGE
CURRENT

FIRE 1 CR1A — CURR 1 CR3A J6 -01 SEE NOTE 6 — FEEDBACK 1 CR2A — CR5A LED5 R1 330 THERM01 24VDC — SEE NOTE 4 MODULES MORE LAST J1 — CR5A J2 NO THERMO — LINE 1 CR4A J7 -01 SEE NOTE 4

FIRE 2 CR1B — CURR 2 CR3B J8 -01 SEE NOTE 6 — FEEDBACK 2 CR2B — CR5B LED6 R2 330 THERM02 24VDC — CR5B J3 NO THERMO — LINE 2 CR4B J9 -01 SEE NOTE 4

FIRE 3 CR1C — CURR 3 CR3C J10 -01 SEE NOTE 6 — FEEDBACK 3 CR2C — CR5C LED7 R3 330 THERM03 24VDC — CR5C J4 NO THERMO — LINE 3 CR4C J11 -01 SEE NOTE 4

FIRE 4 CR1D — CURR 4 CR3D J12 -01 SEE NOTE 6 — FEEDBACK 4 CR2D — CR5D LED8 R4 330 THERM04 24VDC — CR5D J5 NO THERMO — LINE 4 CR4D J13 -01 SEE NOTE 6

CIPE

SEE NOTE 6 — J14

TO TIMER IF MODULE #1 OR FROM PREVIOUS IF MORE

CISF

TO NEXT STEERING PANEL IF MORE

NOTE: PIN 26 ON DB-25 CONNECTORS IS THE SHELL GROUND

CASCADE MODULE CONFIGURATION INSTRUCTIONS

1. A CASCADE SYSTEM IS DEFINED AS ONE CPU/TIMER ADDRESSING ONE OR MORE CASCADE MODULES (4 MAXIMUM). THERE MAY BE MORE THEN ONE CASCADE SYSTEM INSTALLED IN A RACK, BUT NEVER MORE THEN ONE CPU/TIMER MODULE IN A SYSTEM.

2. IF THERE IS ONLY ONE CASCADE SYSTEM CONTROLLED BY ONE CPU/TIMER INSTALLED IN A RACK, INSERT THE MULTI-PIN SLOT SELECTOR PLUG IN "SLOTS 15". MAKE SURE IN SET-UP BITS 145 THRU 152 ARE SENT TO SLOT 15 PORT 4 OUT. IF THERE IS MORE THEN ONE CASCADE SYSTEM INSTALLED INSERT THE MULTI-PIN SLOT SELECTOR IN "SLOT ADDRESS" OF THE SECOND (AND HIGHER) SYSTEMS CASCADE MODULE(S). THESE MODULES NOW ASSUME THE SLOT NUMBER THEY ARE PLUGGED INTO. MAKE SURE EACH SYSTEMS CASCADE MODULE(S) IS ADDRESSED BY ONLY ONE CPU/TIMER MODULE AND ALL CASCADE MODULES IN THAT SYSTEM SEE THE SAME DATA.

3. INSERT THE MULTI-PIN GROUP SELECTOR JUMPER IN THE DESIRED CONTACTOR GROUP OF EACH MODULE. WHERE GROUP 1 IS SCR 1 THRU 4 GROUP 2 IS SCR 5 THRU 8, GROUP 3 SCR 9 THRU 12 AND GROUP 4 SCR 13 THRU 16. THE STEERING PANELS MAY BE CONFIGURED FOR ANY GROUP IN ANY ORDER, BUT THERE CANNOT BE MORE THAN ONE OF EACH GROUP IN ANY SYSTEM.

4. INSERT JUMPER J1 IN THE "LAST" POSITION IN THE LAST STEERING MODULE OF A SYSTEM. IF THERE IS ONLY ONE STEERING MODULE, IT IS CONSIDERED THE LAST MODULE. INSERT J1 IN THE "MORE" POSITION OF ALL STEERING MODULES PROCEEDING THE LAST MODULE.

5. INSERT JUMPER J2, J3, J4 OR J5 IN THE NO THERMO POSITION OF ANY CONTACTOR CIRCUIT PATH THAT IS NOT CONNECTED TO A SCR.

6. A) 503-7-0324-01 FOR SINGLE PHASE USE: INSERT -01 JUMPERS IN CHANNEL 1 ONLY, J6 AND J7. DO NOT INSTALL J8,J9,J10,J11,J12,J13 JUMPER J14 1-2 AND 3-4

   B) 503-7-0324-02 FOR MULTI-PHASE USE: INSERT ALL RELAYS AND JUMPERS ON -02 POSITION. JUMPER J14 1-2 AND 3-4

   C) 503-7-0324-03 FOR SINGLE OR MULTI-PHASE WITH SECONDARY MONITORING (TORQID) YOU MUST USE 454-0-0028-02 FIRING MODULES. FOLLOW A AND B ABOVE, BUT SET JUMPER J14 TO 1-3 AND 2-4.

NOTE: CR3 AND CR4 A THRU D ARE NOT USED IN THE -01 SINGLE PHASE VERSION.

INSTALL JUMPER PLUG IN DESIRED GROUP

+12 — LED1 R5 1200 — CR1A CR2A CR3A CR4A — ULN2003 U07 — R6 100K — GRP1
LED2 R7 1200 — CR1B CR2B CR3B CR4B — R8 100K — GRP2
LED3 R9 1200 — CR1C CR2C CR3C CR4C — R10 100K — GRP3
LED4 R11 1200 — CR1D CR2D CR3D CR4D — R12 100K — GRP4

4028 U05 U06 — A B C D

CNEXP1

BKPL BA0–BA3 — U01 P20L10 — BIOSTB — MATCH — RN02 — RN03 — IK

74HC245 U03 — RN01 IK — D0–D7 — I/O DATA BUS — BKPL

74HC85 U02 — BA4–BA7 — A>B A=B A<B

SLOT ADDRESS — SLTA — SLOT 15 — SL15

74HC273 U04 — RESET — RST — C11 220pF

U08 74HCT04 — R13 1K — C10 .1uF — LOW = WRITE

GNDPAD — BKPL 34 70

C12 50uF — LOGIC COMMON — BKPL 1 2 37 38

C13 50uF — AGND — BKPL 31 67 32 68

U07 ULN2003 — C07 1uF

C14 C01 C02 C03 C04 C05 C06 C08 C09 1uF

⚠1 CR1A-D PREFERRED PART 300-0503 MODIFIED SUMIDA MSS21A12 CUT OFF PIN 13

CR2A-D THRU CR4A-D 304-0-0627-00 12VDC GORODOS B3IA-5 (OR 300-0503 ABOVE)

CR5A THRU D 304-0-0603-00 24VDC GORODOS B3IA-7 DIP RELAY SPST

16 SCR CONTACTOR SYSTEM INTERCONNECT DIAGRAM

CPU/TIMER — DATA ENTRY PANEL — J3

STEERING MODULE #1 (CONFIGURED FOR GROUP #1) (SLOT 15) (J1 JUMPERED MORE)
STEERING MODULE #2 (CONFIGURED FOR GROUP #2) (SLOT 15) (J1 JUMPERED MORE)
STEERING MODULE #3 (CONFIGURED FOR GROUP #3) (SLOT 15) (J1 JUMPERED MORE)
STEERING MODULE #4 (CONFIGURED FOR GROUP #4) (SLOT 15) (J1 JUMPERED LAST)

A B C D E F — FIRING MODULE #1 … #16 — SCR #1 … #16

WTC CORPORATION			
SCHEMATIC AND HOOK-UP FOR SERIES 400 CASCADE STEERING MODULE 503-7-0324-01,02,03			
DRAWN HRB 04/23/93			
CHK'D ERK			
ENG'R ERK			
SIZE	REV.	DRAWING No.	
D	D	473-0-0374-01,02,03	
SCALE	473003743.SCH	SHEET 1 OF 1	

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