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WSC-1000 ™
WELD SEQUENCE CONTROLLER

Operation / Installation Manual

Manual Part Number: S8M5001
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1.0 GENERAL DESCRIPTION

1.1 SYSTEM DESCRIPTION

The WSC-1000 is a microprocessor based weld sequence controller comprised of a WSC-1000 controller and a WRC-1000 weld remote interface. The WSC-1000 is the main controller module and provides all control and communication functions and can also program external motion control axis via the Local Area Network (LAN) port. The controller can support up to four (4) stepper motor controlled axis, using the MSC-1000 Micro-Step Controller, and four (4) DC servo controls, using the DMC-1000 DC Servo Controller. The WRC-1000 provides all external Input/Output control interface and electrical connections to user-supplied components. The WRC-1000 provides eight (8) optically isolated DC inputs, eight (8) relay outputs, two (2) analog 0 -10 vdc inputs, four (4) analog 0 -10 vdc isolated self calibrating analog outputs and one (1) TTL level pulse accumulator input. The following is the system general specification:

WSC-1000 Weld Sequence Control:

Dimensions:	4.0"h x 6.5"w x 11"l (102mm x 165mm x 280mm)
Weight:	5.5lbs (2.49kgm)
Power Input:	110 - 240 vac 50/60 hz @ 0.2kw
Operating Temp:	-10 ° F to +140° F (-23°C to +60°C)

WRC-1000 Weld Remote Control:

Dimension:	2.0"h x 6.5"w x 11"l (1-1mm x 165mm x 280mm)
Weight:	1.3lbs (0.589kgm)
Power Input:	24vdc @ 1.0 amp (Supplied by WSC)
Operating Temp:	-10°F to +140°F (- 23°C to +60°C)
Relay Outputs:	115/220 vac 8 amps 1/8 hp normally Open contact
Switch Inputs:	5 - 24 vdc @ 1.0 - 8.0 ma.
Analog Inputs:	0 - 10 vdc unipolar, 10k ohm input impedance with 10 BIT resolution (10 mv).
Analog Output:	DAC1–DAC4 0 -10 vdc user defined reference input. 12-bit resolution (Vin / 4095). Isolated Reference and analog input. 10-vdc precision reference output. Maximum output current 10 ma. Output is short circuit protected.
Encoder Input:	Pulse accumulator input 5.0 vdc TTL level with 4.7K pull-up. Maximum input frequency 15 khz.

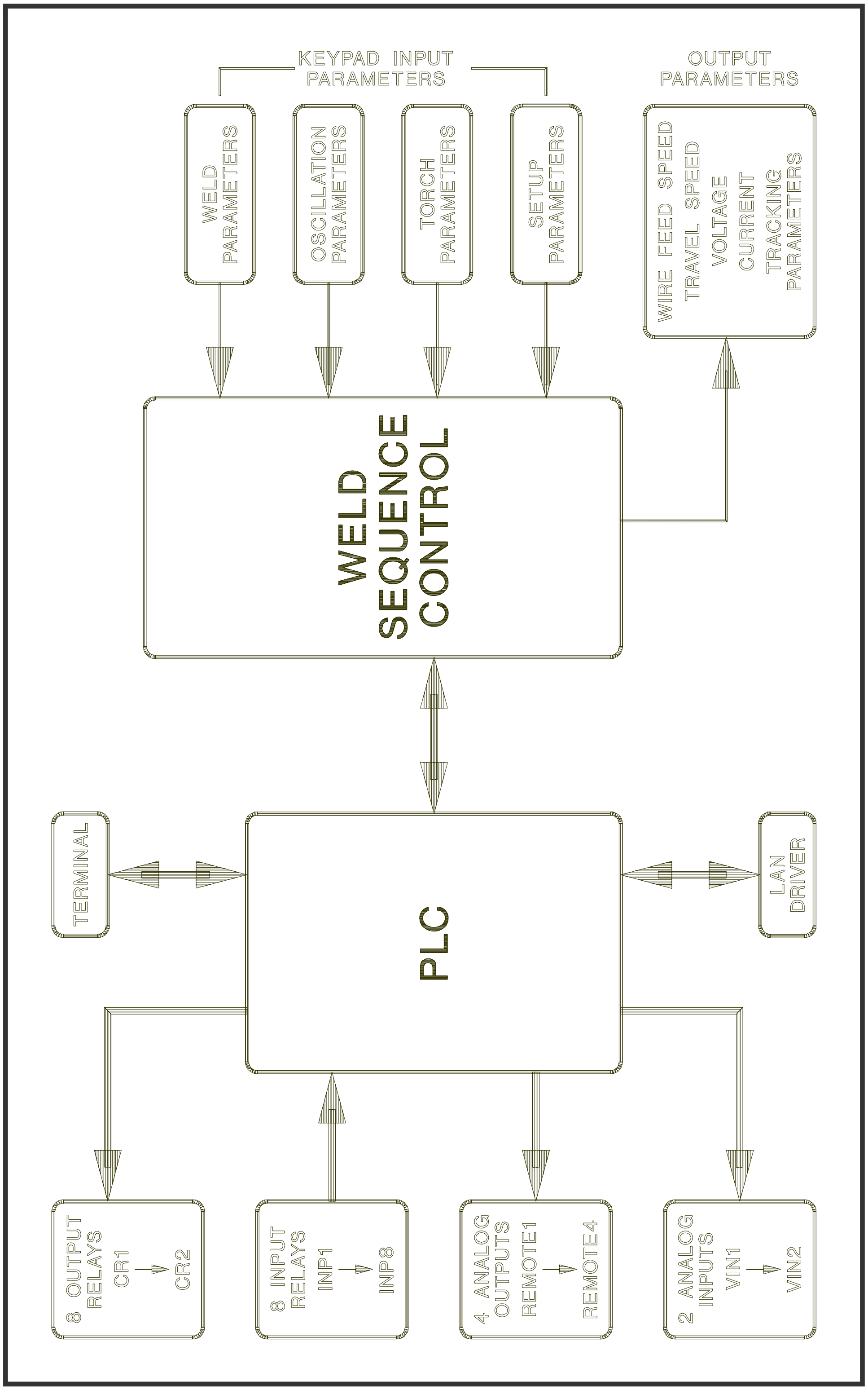


Figure 1
WSC-1000 Control System Diagram

The WSC-1000 consists of two (2) major control systems (Figure 1). The first control system is a Programmable Logic Controller or PLC and the second system is the Weld Sequence Control or WSC. The PLC is the main controlling element and provides the interface between the WSC and the external I/O functions. The PLC is configured by using the Terminal serial port and the PLC serial command language. The user can define up to 150 sequences that will be executed by the specified switch inputs. The PLC is also used to activate a weld sequence and control external devices such as relays or solenoids and the PLC can provide time delay, event counting, relay/solenoid sequencing, analog output level control, analog input measurements and switch input compare functions. The PLC provides the user with 10 Timers, 10 Cycle counters, 10 nested subroutines, 11 compare and branch test functions and external axis control functions. The PLC can only be programmed by using the WSC-1000 terminal RS-232 serial port. Section 5.0 describes the PLC protocol and command structure. The Terminal port can also be used to upload or down Load welding parameters and to configure the WSC-1000 control functions. Section 4.0 describes the serial port protocol, the various parameters that can be programmed and their specific function. The PLC also controls an Local Area Network, or LAN, port. This LAN allows the PLC and WSC to control up to four (4) external axis drives and four (4) external DC servo drives. The external axis and drives can be used to control torch position or other motion control devices.

1.2 SYSTEM PARAMETERS

The WSC control provides all of the weld control functions. If two external axis, vertical and horizontal, are enabled it will also provide Thru-the-Arc seam tracking. The WSC is programmed via the sixteen (16) key keypad. There are two (2) Menu screens that allow the user to program the required welding and configuration parameters. They are as follows:

WELD PARAMETERS - Allows the user to set the various welding parameters.

SETUP PARAMETERS - Allow the user to configure the WSC configuration parameters.

Depending on the type of external axis enabled the WSC additional menu screens will be enabled they are as follows:

WEAVE PARAMETERS - Allows the user to set the oscillation (Horizontal) parameters.

TORCH PARAMETERS - Allows the user to configure torch-to-work (Vertical) parameters.

The WSC provides the user with ten (10) programmable events that comprise the weld cycle. Individual events can be disabled by setting the corresponding time to zero (0). Figure 2 shows the various weld cycle events. In conjunction with the weld events the user can specify a pulse mode of operation. In this mode the WSC will provide a synchronized pulse of the remote power supply, Wire feeder and Travel speed. The user can disable any individual pulse output function.

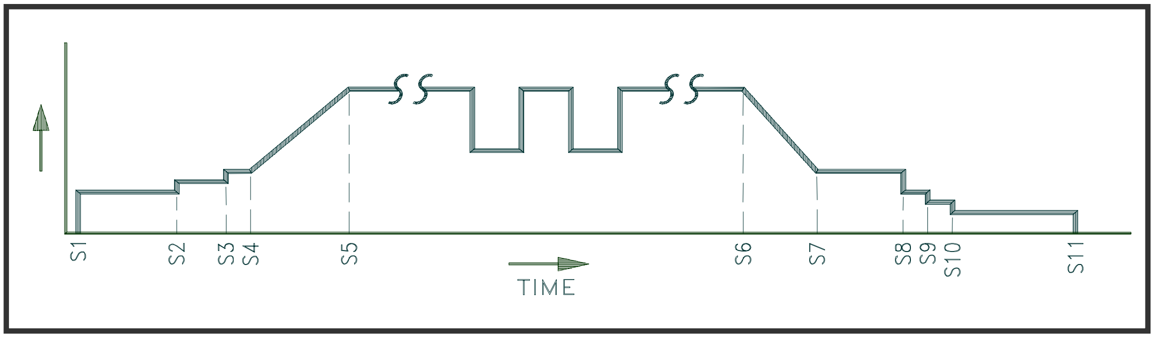


Figure 2
Weld sequence timed events

Weld Sequence Events:

S1	=	Cycle Start
S1 - S2	=	Event 1 - Prepurge Gas Flow Time
S2 - S3	=	Event 2 - Arc Start Parameter Time
S3 - S4	=	Event 3 - Arc Active Delay Time
S4 - S5	=	Event 4 - Ramp Up Time
S5 - S6	=	Event 5 - Weld Time (spot or manual)
S6 - S7	=	Event 6 - Ramp Down Time
S7 - S8	=	Event 7 - Crater Fill Parameter Time
S8 - S 9	=	Event 8 - Wire Retract Time
S9 - S10	=	Event 9 - Burn Back Time
S10 - S11	=	Event 10 - Post Purge Time

The WSC provides closed loop control for voltage and current values and will adjust the external welding devices to regulate and obtain the programmed values. The WSC provides programmable control for Arc Voltage, Arc Current, Wire Feed Speed, Travel Speed and Event Time. Setting the event time to zero will disable the specific event. In addition to the specific weld events the user can specify a pulse mode of operation. In this mode the WSC will pulse the Arc Voltage, Arc Current, Wire Feed speed and Travel speed. If an external oscillator (horizontal) axis is enabled, the user can synchronize the pulse mode to an oscillation pattern. The user can disable the pulsation of any single parameter.

2.0 INSTALLATION GUIDE

2.1 CONTROL ENCLOSURE INSTALLATION

Figure 3 and Figure 4 show the dimension and mounting pattern for the WSC-1000 and WRC-1000. Locate the WSC-1000 to allow access to the front panel. The WRC-1000 can be located up to 75ft (22.8 m) from the WSC-1000 and should be located at or near the welding power supply and fixture controller. Refer to Figure 5 and connect the Remote I/O cable (P/N S3W5047) as shown. Connect the AC power cable (P/N S3W5043) to the WSC and a suitable AC supply.

2.2 CURRENT SENSOR INSTALLATION

Refer to Figure 6 and install the arc current sensor (P/N X3Q5010). Install the current sensor around the welding ground cable. The sensor is a split shell design and the top of the sensor can be removed by releasing two (2) side-mounted latches. Make sure to orientate the two red dots on the sensor so they point toward the welding power supply. Pass the welding cable through the opening and reinstall the top half of the sensor. Make sure that the top and bottom half of the sensor are properly aligned and clamp the side latches. The current sensor can be mounted by installing 1/4-20 bolts through the holes provide on the outside of the sensor. The welding cable must pass through the center of the sensor. Connect the current sensor cable (P/N S3W5045 to the current sensor and to the WSC-1000.

2.3 VOLTAGE SENSOR INSTALLATION

Refer to Figure 6 and install the arc voltage sensor. The voltage sensor should be installed as close as possible to the welding torch. The location of this sensor is important as the WSC-1000 is a closed loop controller and the voltage being measured should be as close to the arc as possible. This will reduce the voltage drop caused by the welding current. Connect the voltage cable (P/N S3W5044) to the voltage sensor and to the rear of the WSC-1000.

2.4 GAS FLOW SENSOR INSTALLATION

If the optional gas flow sensor (P/N A3A0143) is being used Refer to figure 6 and install the sensor per the installation manual. Connect the gas sensor cable (P/N S3W5046) to the gas flow sensor (GTFM) and to the rear of the WSC-1000.

2.5 LAN INSTALLATION

If optional external axis or DC drives are being used refer to Figure 7 and install the Local Area Network (LAN) communication cable from the rear of the WSC to the various axis drives. The LAN is a high-speed serial communication link and is daisy chained to the various external devices. There are two BNC connectors on the rear of the WSC and external axis drives. The BNC connectors are paralleled and the LAN cable can be connected to either BNC connector. Route the LAN cable to the AXIS drive and then route the LAN cable from the first axis drive to the next axis drive, if required. It does not matter as to the sequence in which the external axis drives are connected to the LAN. The LAN will address the selected drive via an internally set axis ID value.

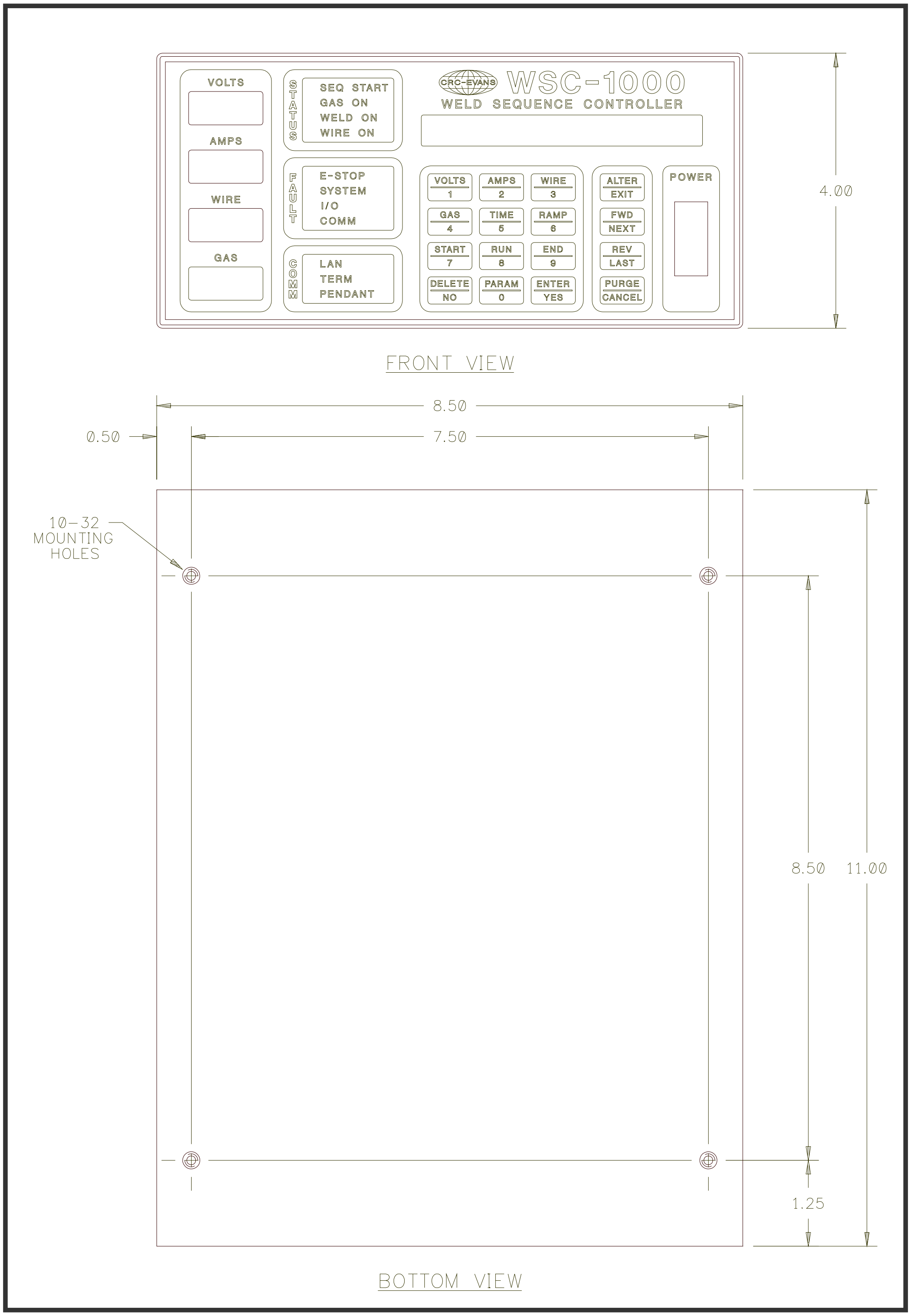


Figure 3
WSC-1000 Enclosure Installation

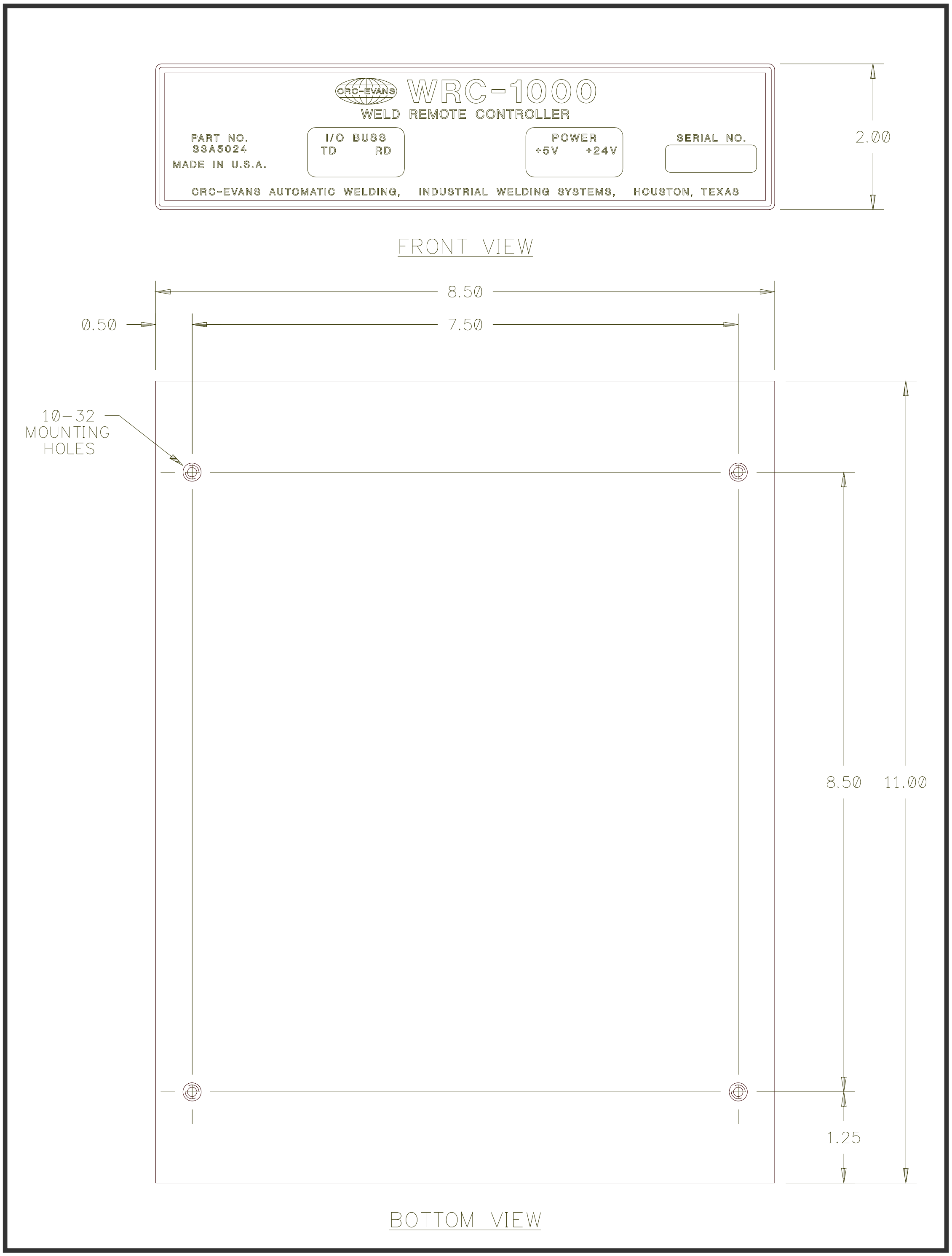


Figure 4
WRC-1000 Enclosure Installation

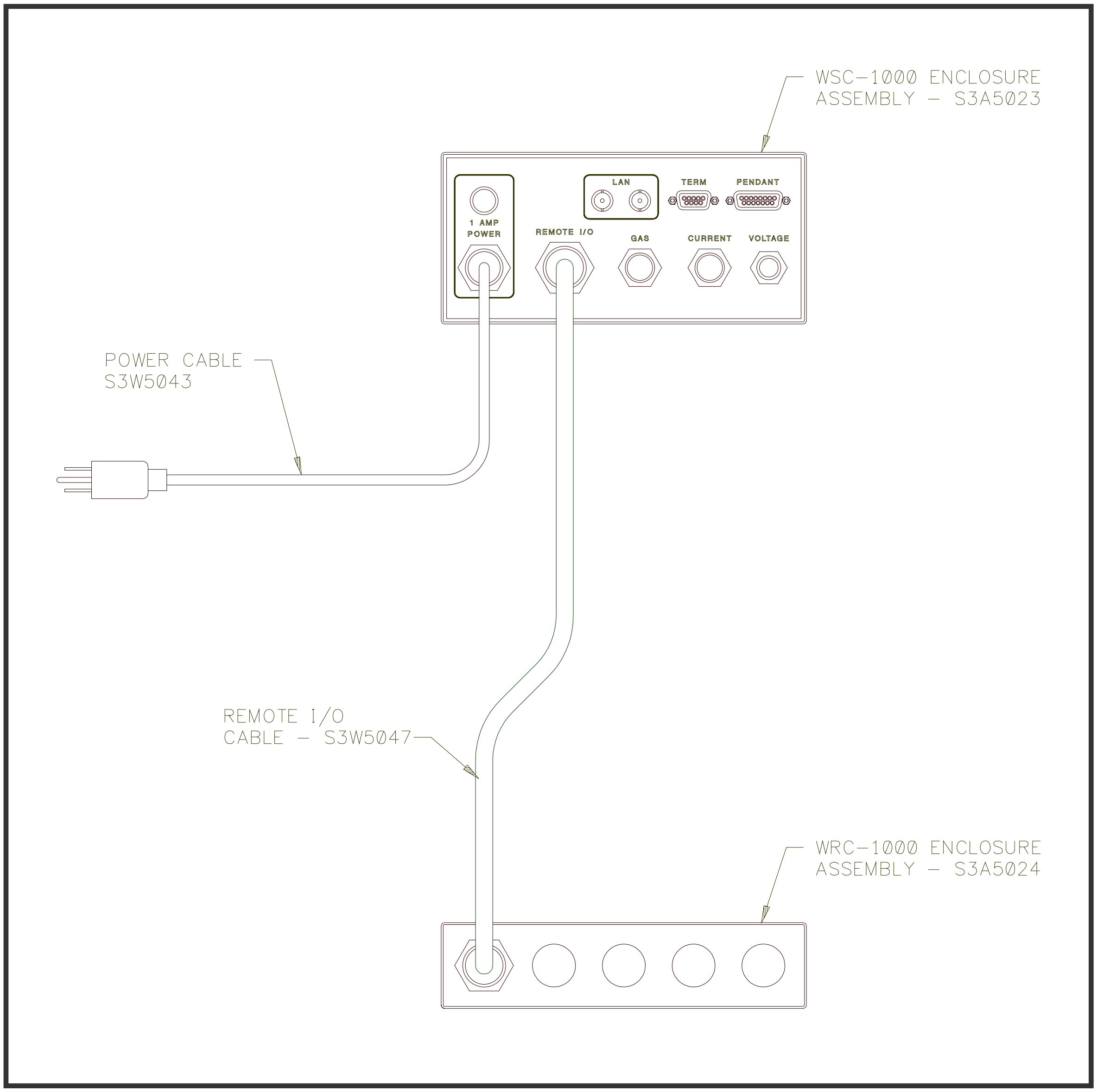


Figure 5
WSC-1000 Remote I/O (WRC-1000) Installation

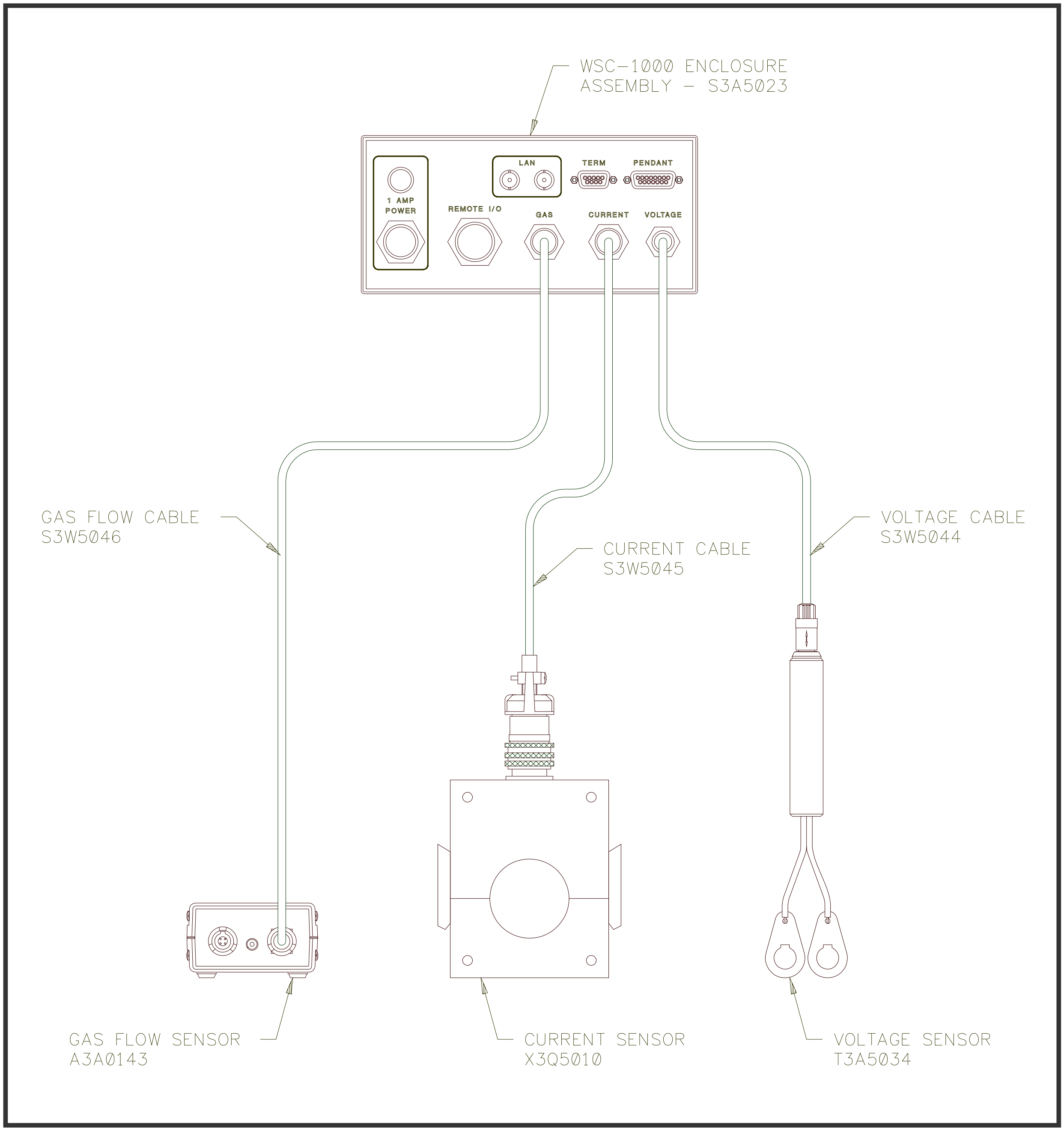


Figure 6
WSC-1000 Sensor Installation

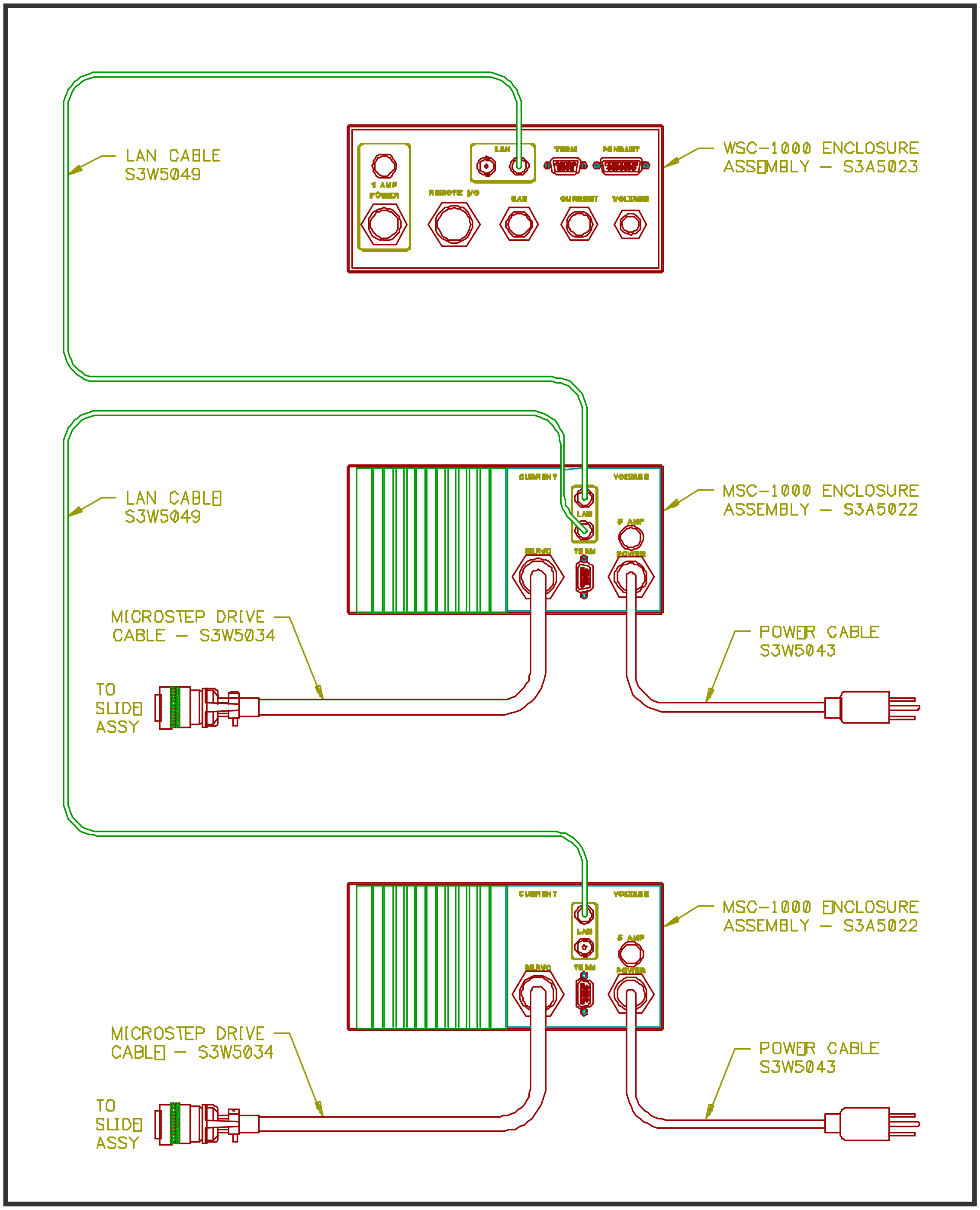


Figure 7
WSC-1000 LAN and Servo (MSC-1000) Installation

2.6 WELD REMOTE PENDANT INSTALLATION

An optional Weld Remote Control (WRP-1000) pendant can be used with the WSC-1000. This pendant allows the operator to program and control various WSC parameters. To install the WRP-1000 reference Figure 8 and connect the pendant cable (P/N S3W5048) to the WRP-1000 and to the rear of the WSC-1000.

2.7 SERIAL CABLE INSTALLATION

To setup and program the PLC control sequences the user must connect a P.C. or terminal to the WSC-1000 serial port. Section 4.0 and 5.0 describe the parameters and PLC commands that can be programmed by the P.C. or terminal. To connect the P.C. reference Figure 9 and connect the serial cable (P/N S5A5050) to a suitable serial communications port on the P.C. and connect the other end to the terminal port on the WSC-1000.

2.8 EXTERNAL CONTROL CABLE INSTALLATION

The user must provide the necessary external control cables to interface the WRC-1000 to the welding power source, wire feeder, travel speed control and external fixture controls. All of these connections are made in the WRC-1000 enclosure. A screw terminal barrier strip is provided for all external connections. Refer to Section 6 for sample interface examples and default functions. The WRC-1000 has four (4) 1/2" conduit knockouts that can be used to install cord grips or cable clamps to secure the external user supplied cables.

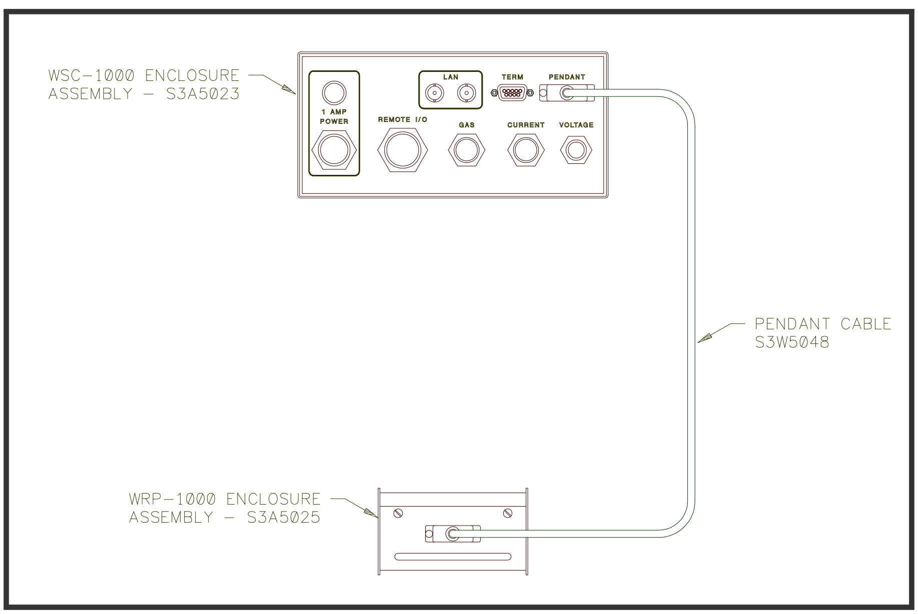


Figure 8
WSC-1000 Remote Pendant (WRP-1000) Installation

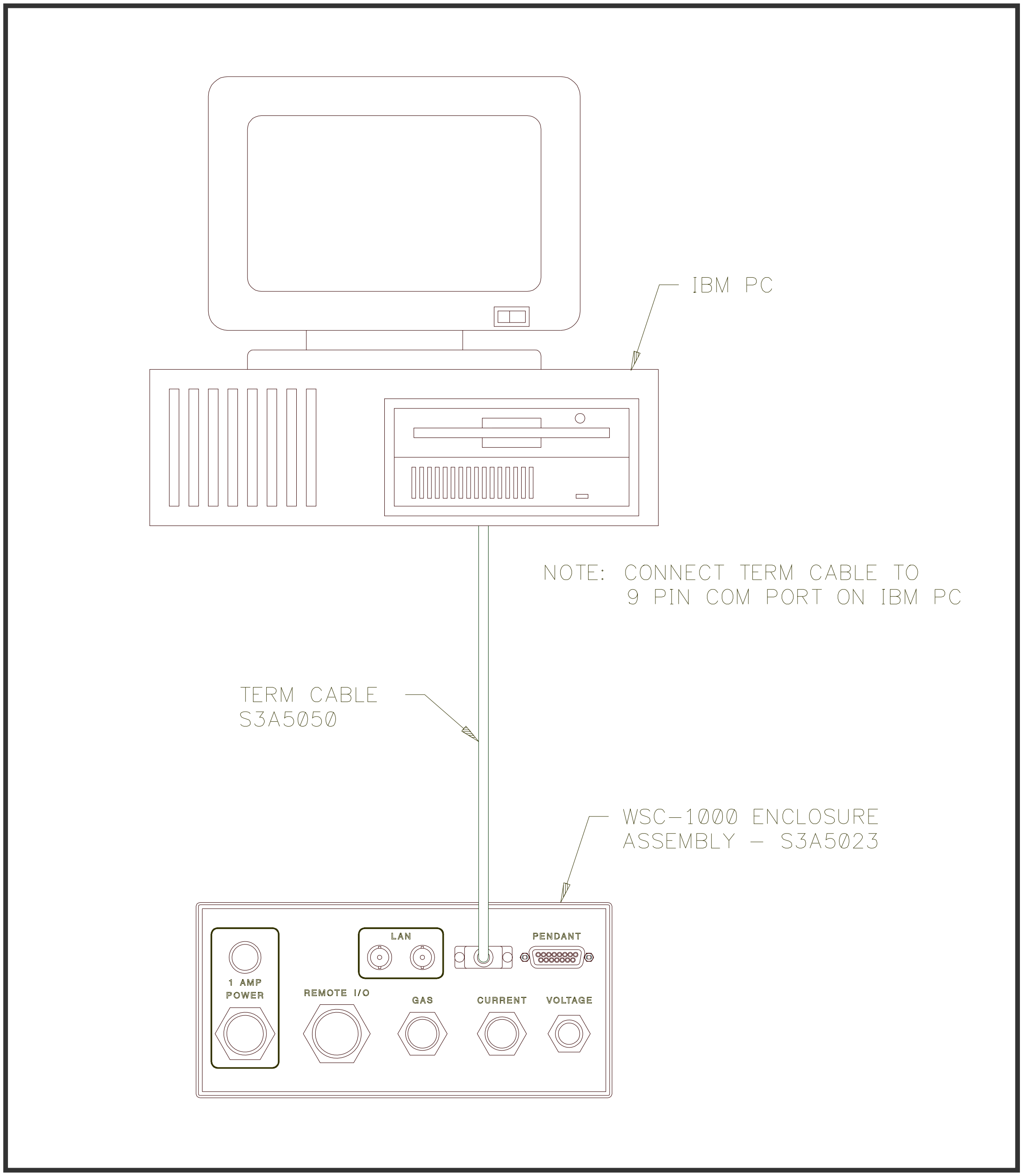


Figure 9
WSC-1000 Terminal Installation

3.0 OPERATION AND PROGRAMMING

3.1 POWER UP TEST

To activate the WSC-1000 turn the power switch to the "ON" position. If External axis drives are being used apply power to each drive prior to activating the WSC-1000. Upon applying power the WSC-1000 will perform a series of self-tests. The following Message will be displayed:

" POWER UP TEST "

3.2 LAN RESET

During the power up self-test routine the WSC-1000 will display the test being performed in meter windows. The "STATUS" and "FAULT" LED's will indicate the result of the test. The green "STATUS" LED will be illuminated if the test passed. The red "FAULT" LED will be illuminated if the test failed and an error message will be displayed indicating the fault condition. After completing the self-test the WSC-1000 will initialize the external axis that are enabled. The following message will be displayed:

" LAN RESET DEV=## "

Where: ## is the axis drives address being enabled.

If an enabled external axis drive is not responding the WSC-1000 will continue to initialize the drive. The WSC will not begin the PLC sequence program until it has successfully initialized the enabled external drives. After initializing the axis drives the WSC-1000 will start executing the PLC sequence program and the following will be displayed:

" SEQ ###=CC, DDD "

Where:	###	= The PLC sequence number being executed.
	CC	= The PLC sequence command code being executed.
	DDD	= The PLC sequence command value being executed.

3.3 PLC PROGRAMMING

All of the PLC sequence commands are programmed by using the terminal port and a suitable terminal or PC using a terminal emulation program. Section 4.0 describes the setup and configuration parameters that can be programmed. Section 5.0 describes the PLC command protocol and PLC commands that are available. The PLC sequence commands are stored in non- volatile RAM memory. An additional copy is stored in EEPROM. During power up the WSC-1000 will compare the stored EEPROM program to the program stored in RAM. If an error is detected the WSC-1000 will load the programmed stored in EEPROM and the following messages will be displayed:

First Message:	***" ERROR: RAM FAIL"***
Second Message:	***"LOADING EEPROM!"***

After programming the PLC configuration parameters or Sequence commands the user must write the new configuration and sequence data to the EEPROM. The new data can be written to the EEPROM by sending the WSC-1000 a "^W " ASCII command (Press the "CTRL" and "W "key on the PC keyboard at the same time) the RAM data will then be written to EEPROM.

Note: The Welding data programmed via the WSC-1000 keypad is not stored in the EEPROM. The welding data is saved as a weld schedule in the nonvolatile RAM. Changes in the welding data do not have to be saved in EEPROM.

3.4 KEYPAD LAYOUT AND FUNCTIONS

All of the weld sequence parameters can be programmed via the 16 key key-pad (reference Figure 10).

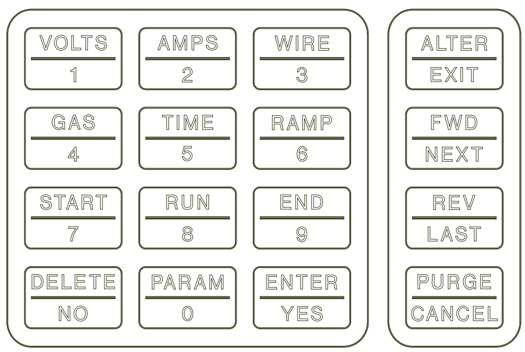


Figure 10 WSC-1000 keypad layout

The WSC-1000 keys have various functions that are selected based on the mode of operation. The WSC-1000 has four modes of operation. The first is the Normal Mode. In this mode the WSC-1000 will display the PLC sequence and selected keys will jog the wire and travel outputs and activate the gas solenoid. The second mode is the Menu Select Mode and is used to select parameter menus it is selected by pressing the ALTER/EXIT key while in the Normal Mode. The third mode is the Parameter Select Mode, and is used to select a specific parameter from the various menu options. This mode is selected by pressing the ENTER/YES key while viewing a menu selection in the Menu Select Mode. The fourth mode is the Weld Parameter Mode, and is used to move directly to a specific welding parameter. This mode is only functional from the Normal Mode. While in the Normal mode press the START, RUN or END key then press the desired welding parameter.

Note: This mode places the WSC-1000 into the WELD PARAMETER menu and selects the specified parameter. To exit this mode, press the ALTER/EXIT key.

3.5 WSC-1000 MENU SCREENS

The following is a functional description of the keypad:

KEY	**FUNCTION**
ALTER/EXIT	Used to enter or exit the parameter menu select program.

FWD/NEXT When in the Menu/Parameter select mode scrolls forward through the menus. In normal mode provides wire inch forward control.

REV/LAST When in the Menu/Parameter select mode scrolls backwards through the parameters/menus. In the normal mode provides wire inch reverse control.

PURGE/ CANCEL When in the Parameter select mode will cancel the current operation and return to the menu select mode. In normal operation will activate the Gas solenoid output.

ENTER/YES When in the Menu mode selects the displayed menu function. When in the Parameter mode selects the displayed function and enters any value entered via the keypad. If a Yes/No parameter is selected press this key will enter a "YES" response to the parameter. In normal operation provides a jog travel forward output.

PARAM/0 In the parameter entry mode enters 0 into the parameter value.

DELETE/NO When in the Parameter data entry mode pressing this key will delete the previously enter numbers. In the normal operation provides a jog travel reverse output.

VOLTS/1 In Parameter entry mode enters 1 into the selected parameter value. In the Weld parameter select mode selects the START/RUN/END voltage parameter.

AMPS/2 In Parameter entry mode enters 2 into the selected parameter value. In the Weld parameter select mode selects the START/RUN/END amp parameter.

WIRE/3 In Parameter entry mode enters 3 into the selected parameter value. In the Weld parameter select mode selects the START/RUN/END wire parameter.

GAS/4 In Parameter entry mode enters 4 into the selected parameter value. In the Weld parameter select mode selects the START/END gas parameter.

TIME/5 In Parameter entry mode enters 5 into the selected parameter value. In the Weld parameter select mode selects the START/RUN/END time parameter.

RAMP/6 In Parameter entry mode enters 6 into the selected parameter value. In the Weld parameter select mode selects the START/END ramp time parameter.

START/7 In Parameter entry mode enters 7 into the selected parameter value. In the normal mode selects the START group of the Weld parameters.

RUN/8 In Parameter entry mode enters 8 into the selected parameter value. In the normal mode selects the RUN (weld) group of the Weld parameters.

END/9 In Parameter entry mode enters 9 into the selected parameter value. In the normal mode selects the END (crater fill) group of the Weld parameters.

The WSC-1000 has several menus that allow the user to program the various welding parameters and configuration parameters. The basic weld menus are ***"WELD PARAMETERS"*** and ***"SETUP PARAMETERS"***. If an external horizontal axis drive (Oscillator) is enabled then an addition ***"WEAVE PARAMETERS" menu*** will appear. If an external vertical axis (Torch VC/ACC control) is enabled then and additional "***TORCH PARAMETERS"*** menu will appear. To modify a specific welding parameter perform the following steps:

STEP 1: From the normal mode press the ALTER/EXIT key. Select the desired menu by pressing the FWD/NEXT to scroll forward or the REV/LAST to scroll in reverse.

STEP 2: While viewing the desired menu press the ENTER/YES key. The first parameter for the selected menu will be displayed. Select the desired parameter by pressing the FWD/NEXT to scroll forward or the REV/LAST to scroll in reverse.

STEP 3: To modify a parameter value, press the ENTER/YES or a 0-9 key to load a new value. Press the enter key to save the value. If an error is made during data entry, press the delete key and enter a new value. If the selected parameter is a "YES/NO" function press the ENTER/YES key to clear the display and select the function. Then press the ENTER/YES or DELETE/NO key to set the desired function. To exit and not change the value, press the PURGE/CANCEL key and the old value or status will be displayed.

STEP 4: To select another parameter from the same menu, press the FWD/NEXT or REV/LAST key then repeat STEP 3. To select another menu press the PURGE/CANCEL key and select another menu by pressing the FWD/NEXT or REV/LAST key then repeat STEP 2 and STEP 3. To return to the normal mode press the ALTER/EXIT key and the WSC-1000 will return to the normal mode and redisplay the current PLC executing sequence.

The following is an example of how to modify the start wire feed speed and set it to 300 ipm:

STEP 1: From the normal mode press the ALTER/EXIT key. Select the "WELD PARAMETERS" menu by pressing the FWD/NEXT to scroll forward or the REV/LAST to scroll in reverse. While viewing the menu press the ENTER/YES key.

STEP 2: Select the ***"START WIRE=   "*** parameter by pressing the FWD/NEXT to scroll forward or the REV/LAST to scroll in reverse. While viewing the parameter press the 3 key, the 0 key, the 0 key again then press the ENTER/YES key to save the new value.

STEP 3: To exit the parameter mode, press the ALTER/EXIT key. The WSC will return to the Normal Mode and display the currently executing PLC command.

Another way to change a specific welding parameter is to use the Weld Parameter Mode. To set the start wire feed speed, while in the normal mode, press the START/7 key the WSC-1000 will display ***"SELECT START PAR" message***. Press the WIRE/3 key then enter the new value by pressing the number keys and ENTER/YES to accept the new value. To exit this function, press the ALTER/EXIT key. To select another welding parameter press the FWD/NEXT or REV/LAST key.

All of the WSC-1000 menus and parameters conform to the above methods of data entry. The following lists the parameters screens and the specific function for each of the four possible menus:

First Menu: **PARAMETER**		***"WELD PARAMETERS"*** **FUNCTION**
"PREPURGE =	***"***	Gas Flow Prepurge Time (seconds).
"START VOLT =	***"***	Hot Start Voltage reference (vdc).
"START AMPS=	***"***	Hot Start Current reference (adc).
"START WIRE =	***"***	Start wire feed speed (ipm).

"START TVS=	***"***	Start travel speed (ipm or mm/s).
"START TIME=	***"***	The amount of time to use the start parameters.
"ARCON TIME=	***"***	The time to wait, after detecting an valid arc, to set the arc active relay output.
"RAMP UP=	***"***	Time to ramp all parameters from start condition to weld condition (seconds).
"WELD VOLT =	***"***	Weld cycle Voltage reference (vdc).
"WELD AMPS=	***"***	Weld cycle Current reference (adc).
"WELD WIRE =	***"***	Weld cycle wire feed speed (vdc).
"WELD TVS=	***"***	Weld cycle Travel speed (ipm or mm/s).
"WELD TIME=	***"***	Spot-weld time if enabled (seconds).
"RAMP DOWN=	***"***	Time to ramp all parameters from weld condition to end or crater fill condition (seconds).
"END VOLT =	***"***	End or Crater fill cycle Voltage reference (vdc).
"END AMPS=	***"***	End or Crater fill cycle Current reference (adc).
"END WIRE =	***"***	End or Crater fill cycle wire feed speed (ipm).
"END TVS=	***"***	End or Crater fill cycle Travel speed (ipm or mm/s).
"END TIME=	***"***	End or Crater fill time (seconds).
"REV WIRE=	***"***	Reverse Wire feed speed used for GTAW applications (ipm or mm/s).
"REV TIME=	***"***	Reverse Wire feed speed time used for GTAW applications (seconds).
"BURN BACK=	***"***	Burn back time for GMAW applications (seconds).
"POST PURGE=	***"***	Post gas purge time (seconds).

Note: *The following menu items are only available if the pulse mode is active*

"BKG VOLT =	***"***	Pulse mode background Voltage reference (vdc) for GTAW mode.
"BKG AMPS=	***"***	Pulse mode background Current reference (adc) for GTAW mode.
"BKG WIRE =	***"***	Pulse mode background wire feed speed (vdc) for GTAW mode.
"BKG TVS=	***"***	Pulse mode background Travel speed (ipm or mm/s) for GTAW mode.
"BKG TIME=	***"***	Pulse mode background time (seconds) for GTAW mode.

Second Menu:		***"SETUP PARAMETERS"***
PARAMETER		**FUNCTION**
"SPOT WELD?	***"***	Enables/Disables spot weld mode uses Weld time parameter if enabled.
"PULSE WELD?	***"***	Enables/Disables pulse weld mode uses BKG and WELD parameters if enabled. The WELD parameters are set during pulse peak and the BKG parameters are used during background time. Enable this function for GTAW applications.
"WELD SCHED=	***"***	The weld schedule number currently being used.
"JOG TRAVEL=	***"***	The travel speed that will be set after a completed weld cycle (ipm, mm/s).
"JOG WIRE=	***"***	The wire speed that will be set after a completed weld cycle (ipm, mm/s).

Third Menu: ***"WEAVE PARAMETERS"***

PARAMETER		FUNCTION
"OSC WIDTH=	***"***	Sets oscillator weave width (inch) if horizontal external axis enabled.
"OSC SPEED=	***"***	Sets oscillator weave velocity (inch/sec) if horizontal external axis enabled.
"RIGHT DWELL=	***"***	Sets oscillator right position dwell time (seconds) if horizontal external axis enabled.
"LEFT DWELL=	***"***	Sets oscillator left position dwell time (seconds) if horizontal external axis enabled.
"CENTER POS=	***"***	Sets oscillator weave center position (inch) if horizontal external axis enabled.
"OSC JOG=	***"***	Sets oscillator jog distance (inch) if horizontal external axis enabled.
"OSC POWER?	***"***	Enable/Disable oscillator servo power. Disabling and enabling servo power will restart the horizontal axis drive.
"OSCILLATOR?	***"***	Enable/Disable the oscillator or weave function if horizontal external axis enabled.
"AUTO CENTER?	***"***	Enable auto centerline tracking. Only functional if oscillator is enabled. This provides oscillation centerline joint tracking.

Forth Menu: ***"TORCH PARAMETERS"***

PARAMETER		FUNCTION
"TORCH UP=	***"***	Sets the vertical torch up position (inch) used by the PLC command 27.
"TORCH WELD=	***"***	Sets the vertical torch weld position (inch) used by PLC command 26.
"TORCH SPD=	***"***	Sets the vertical torch axis velocity (inch/sec).
"TORCH JOG=	***"***	Sets the vertical torch jog step size (inch) for incremental motion.
"TORCH POWER?	***"***	Enable/Disable vertical torch servo power. Disabling and enabling servo power will restart the vertical axis drive.
"TORCH TRACK?	***"***	Enable auto torch to work tracking. This provides torch to work height control (ACC or AVC).

4.0 WSC-1000 OFF LINE SERIAL TERMINAL PORT PROTOCOL

4.1 OFF-LINE PROGRAMMING

The WSC-1000 terminal port is used to off-line program the WSC -1000 sequence and weld parameters. It is also used to configure the operating parameters for the WSC. The Protocol is a simple ASCII command string that allows the user to upload or down load the various parameters. The serial port is configured for the follow data format:

Baud Rate:	*9600, Full Duplex*
Word Length:	*8 Data Bits, One Stop and no parity*
Hand Shaking:	*None*

4.2 COMMAND STRINGS

The Protocol consists of a command string and optional data bytes. The command string is an Alpha character an option number followed by a "=" or "?" followed by optional data and terminated with an ASCII "cr" (0dh) . The "=" will indicate that data is being sent to the select parameter by the host controller. The "?" will indicate a request for data from the WSC to the Host controller. If the host is up loading data to the WSC the data will be placed after the "=" character and will be an ASCII string terminated with an ASCII "cr" (0dh). The following is an example of sending a new start wire feed speed to the WSC-1000:

V4=1000(cr) *- Sent from Host*

To read the WSC start wire feed speed send the following command:

V4?(cr)	*- Sent from Host*
1000(cr)	*- Received from WSC*

4.3 TERMINAL COMMANDS

The following is a summary of the Terminal Commands supported by the WSC-1000:

COMMAND **DESCRIPTION**

A1 – A25 Read and write WRC-1000 Analog Inputs/Outputs and set scaling for welding parameter DAC outputs. The welding parameters (Wire feed, Travel speed, Voltage, Current) can be scaled to provide proper DAC outputs for the selected parameters. The DAC scaling is a MX + B straight-line equation. The M and B values are user defined for each welding parameter. The M value is the slope of the line from minimum to the maximum control output value and the B value is the minimum offset value. The following equations can be used to calculate the M and B values for voltage and travel speed:

M = 4095/ (Max - Min) *B = -10 x MIN*

Example - Welding Machine maximum Output is 38.0 volts, Minimum Output is 14.0 volts. Calculate the M and B values for voltage DAC scaling:

Voltage M = 4095/(38.0v - 14.0v) = 170
Voltage B = -(14.0 x 10) = -140

For the Wire feed and Current DAC's use the following equations for M and B values:

M = 40950 / (Max - Min)   B = -Min

The following is a summary of the analog command functions:

A1 - DAC output 1 (max value 4095)
A2 - DAC output 2 (max value 4095)
A3 - DAC output 3 (max value 4095)
A4 - DAC output 4 (max value 4095)
A5 - Read Analog 1 input (max value 1024)
A6 - Read Analog 2 input (max value 1024)
A7 - Wire Feed Speed DAC Slope M
A8 - Travel Speed DAC Slope M
A9 - Current Control DAC Slope M
A10 - Voltage control DAC Slope M
A11 - Wire Feed Speed DAC offset B
A12 - Travel Speed DAC Offset B
A13 - Current Control DAC offset B
A14 - Voltage Control DAC offset B
A15 - External encoder input pulse accumulator (max value 65535)
A16 – Programmable Register 11
A17 – Programmable Register 12
A18 – Programmable Register 13
A19 – Programmable Register 14
A20 – Programmable Register 15
A21 – Programmable Register 16
A22 – Programmable Register 17
A23 – Programmable Register 18
A24 – Programmable Register 19
A25 – Programmable Register 20

C0 – C5 Analog Calibration Values where:

C0 = Current sensor excitation current value
C1 = 5.12 voltage reference calibration value
C2 = Arc Current gain value
C3 = Arc Current zero value
C4 = Arc Voltage gain value
C5 = Arc Voltage zero value

D1 - D4 Select WRC-1000 DAC output to be used for welding parameters where:

Value = 0 *No output*
Value = 1 *Set selected output to DAC 1*
Value = 2 *Set selected output to DAC 2*
Value = 3 *Set selected output to DAC 3*
Value = 4 *Set selected output to DAC 4*
Value = 5 *Set selected output to LAN device 5*
Value = 6 *Set selected output to LAN device 6*
Value = 7 *Set selected output to LAN device 3*
Value = 8 *Set selected output to LAN device 4*

D1 - Set Wire feed speed output to DAC specified by value.
D2 - Set Travel speed output to DAC specified by value.
D3 - Set Welding current output to DAC specified by value.
D4 - Set Welding Voltage output to DAC specified by value.

I0 - I7 Define WRC-1000 switch inputs. The value parameter specifies the switch control function that will be activated by the selected input. Setting the bit to a 1 will activate the input. Setting the bit to zero will deactivate the input. The following is the value bit definition for input switch selection:

BIT 0 = Input INP1
BIT 1 = Input INP2
BIT 2 = Input INP3
BIT 3 = Input INP4
BIT 4 = Input INP5
BIT 5 = Input INP6
BIT 6 = Input INP7
BIT 7 = Input INP8

The following is the allowable control switch command values:

I0 - Weld On Switch input
I1 - Not defined
I2 - Not defined
I3 - Not defined
I4 - Not defined
I5 - Not defined
I6 - Not defined
I7 - Not defined

L1 - L8 Send external axis command string to specified LAN device. Where the number following the L is the selected device. The string following the "=" will be sent to the selected axis drive. The following is a summary of the axis commands:

example: ***L1=M=1.000*** (cr) Move horizontal axis to 1.000 inch from home position.

^S Save current axis configuration to axis EEPROM and use as default.
^L Load default axis EEPROM data.
^Q Terminate current axis move command.
M= Move to position specified by value.
A= Set output current to value specified.
V= Set velocity to value specified.
H Reset control and move to Home position.
C Move to center position based on measured slide width.
I Inhibit drive output power.
S Set auto sequence parameter S1 - S150 to specified move, velocity or delay parameter.
EXAMPLE: *S1=M1000, set sequence 1 to move to position 1000 from home position.*
G Start axis drive auto sequence routine.
Q Quit axis drive auto sequence routine.
Z Clear all axis drive auto sequence parameters.
E Enable axis drive power output.

R= Jog center position right by specified value.
L= Jog center position left by specified value.
U= Set axis drive acceleration constant to value specified.
T Calculate total slide width.
W= Set oscillation width to value specified. Set auto sequence values for oscillation pattern.
| Set slide to center position.
p= Set center position to specified value.
O= Sets operational mode for MSC-1000 drive control
O=0 Selects 1/10 step drive control with maximized torque profile.
O=1 Selects 1/10 step drive with optimized position profile.
O=2 Selects 1/4 step drive with optimize torque profile.
O=3 Selects 1/2 step drive with optimized torque profile.
F= Sets scale factor Steps/Step. Default = 1.

M0 - M5 Set system control mode functions:

M0 - Set programmable sequence number to value.

M1 - Read Switch input status (1 = on, 0 = off)
BIT 0 = Switch INP1 (1)
BIT 1 = Switch INP2 (2)
BIT 2 = Switch INP3 (4)
BIT 3 = Switch INP4 (8)
BIT 4 = Switch INP5 (16)
BIT 5 = Switch INP6 (32)
BIT 6 = Switch INP7 (64)
BIT 7 = Switch INP8 (128)

M2 - Set output relays CR1 - CR8 (1=on, 0=off).

BIT 0 = Relay CR1 (1)
BIT 1 = Relay CR2 (2)
BIT 2 = Relay CR3 (4)
BIT 3 = Relay CR4 (8)
BIT 4 = Relay CR5 (16)
BIT 5 = Relay CR6 (32)
BIT 6 = Relay CR7 (64)
BIT 7 = Relay CR8 (128)

M3 - Enable Weld Simulation mode (1=Simulate, 0=Normal).

M4 - Enable external axis drives (1 = Enabled, 0 = Disabled).
BIT 0 = Axis 1 Horizontal oscillator slide
BIT 1 = Axis 2 Vertical torch to work slide
BIT 2 = Axis 3 Stepper motor spare drive 1
BIT 3 = Axis 4 Stepper motor spare drive 1
BIT 4 = DC Servo Drive 1
BIT 5 = DC Servo Drive 2
BIT 6 = DC Servo Drive 3
BIT 7 = DC Servo Drive 4

M5 - Set Horizontal axis drive ID (1-4) number (Default = 1).

M6 - Set Vertical axis drive ID (1-4) number (Default = 2).

M7 - Encoder Scale factor – Default = 1 (Version 2.74 or Greater only).

M8 - Disable adaptive voltage/current control (1 = Disable, 0 = Enable)

M9 - Disable automatic weld schedule save function (1 = Disable, 0 = Enable)

R0 - R7 Define WRC-1000 weld control function output relays. The value parameter specifies the relay that will be active for the defined function. The Gas, Travel and Wire functions can also be activated by selected keys on the WSC-1000 and the WRP-1000 remote pendant. Pressing these keys will activate the assigned relay outputs. The keys are only active while not welding. The following is selected relay output functions.

R0 - Gas Solenoid Relay output	- ***"PURGE/CANCEL"*** key
R1 - Weld Contactor Relay output	
R2 - Travel Forward Relay output	- ***"ENTER/YES"*** key
R3 - Travel Reverse Relay output	- ***"DELETE/NO"*** key
R4 - Wire Feed Forward Relay output	- ***"FWD/NEXT"*** key
R5 - Wire Feed Reverse Relay output	- ***"REV/LAST"*** key
R6 - Arc Active Relay Output	
R7 - Pulse On output Relay	

To assign a weld control function to a relay output type the command ***"R#=Value"***. Where # equals the command number 0 - 7 and Value is the relay output decimal number. The following is the command value definition for the relay outputs:

Relay CR1 (value= 1)
Relay CR2 (value= 2)
Relay CR3 (value= 4)
Relay CR4 (value= 8)
Relay CR5 (value= 16)
Relay CR6 (value= 32)
Relay CR7 (value= 64)
Relay CR8 (value= 128)

S1 - S150 Programmable Sequence Commands - See Section 5.0 for description of programmable sequence commands and data format.

V1 - V48 Write/Read Welding variables:

V1 = Pre Purge Time
V2 = Start Arc voltage
V3 = Start Arc Current
V4 = Start Wire Feed Speed
V5 = Start Travel Speed
V6 = Hot Start Time
V7 = Arc Active Delay Time
V8 = Ramp Up time
V9 = Weld Time Arc voltage
V10 = Weld Time Arc Current
V11 = Weld Time Wire Feed Speed
V12 = Weld Time Travel Speed
V13 = Spot Weld Time
V14 = Ramp Down time

V15 = Crater Fill Time Arc voltage
V16 = Crater Fill Time Arc Current
V17 = Crater Fill Time Wire Feed Speed
V18 = Crater Fill Time Travel Speed
V19 = Crater Fill Time
V20 = Reverse Wire Feed Speed
V21 = Reverse Wire Feed Time
V22 = Burn Back Time
V23 = Post Gas Flow Time
V24 = Oscillator Width
V25 = Oscillator speed
V26 = Torch to work Vertical slide speed
V27 = Oscillator center position
V28 = Torch to Work Up position
V29 = Oscillator Left Dwell Time
V30 = Oscillator Right Dwell Time
V31 = Torch to Work Down Position
V32 = Oscillator jog distance
V33 = Torch to Work jog distance
V34 = Spare schedule parameter 1 (Not used)
V35 = Spare schedule parameter 2 (Not used)
V36 = Cross Seam Tracking Gain
V37 = Torch to Work Tracking Gain
V38 = Arc Active voltage reference
V39 = Arc Active current reference
V40 = Weld Schedule Number
V41 = Wire Inch Speed
V42 = Travel jog speed
V43 = Spare schedule parameter 3 (Not used)
V44 = Spare schedule parameter 4 (Not used)
V45 = Spare schedule parameter 5 (Not used)
V46 = Spare schedule parameter 6 (Not used)
V47 = Pulse background voltage
V48 = Pulse background current
V49 = Pulse background wire feed speed
V50 = Pulse background Travel speed
V51 = Pulse background time (10m sec)
V52 = Percent depth of side wall penetration for tracking (% x 10)
V53 = Delay oscillator sweep counter for start of adaptive fill routine.
V54 = Minimum Oscillation width for adaptive width control tracking.
V55 = Maximum Oscillation width for adaptive width control tracking.
V56 = Minimum Arc Voltage operator control limit for weld schedule.
V57 = Maximum Arc Voltage operator control limit for weld schedule.
V58 = Minimum Arc Current operator control limit for weld schedule.
V59 = Maximum Arc Current operator control limit for weld schedule.
V60 = Minimum Wire Feed Speed operator control limit for weld schedule.
V61 = Maximum Wire Feed Speed operator control limit for weld schedule.
V62 = Minimum Travel speed for adaptive width control tracking and operator limit.
V63 = Maximum Travel speed for adaptive width control tracking and operator limit.
V64 = PLC arithmetic result register 0
V65 = PLC Programmable Register 1
V66 = PLC Programmable Register 2
V67 = PLC Programmable Register 3
V68 = PLC Programmable Register 4

V69 = PLC Programmable Register 5
V70 = PLC Programmable Register 6
V71 = PLC Programmable Register 7
V72 = PLC Programmable Register 8
V73 = PLC Programmable Register 9
V74 = PLC Programmable Register 10
V75 = Maximum Torch correction vector limit
V76 = Maximum Cross seam correction vector limit

W0 - W7 Set Weld Mode control options: (1=Enable, 0=Disable)

W0 - Enable/Disable spot-weld mode
W1 - Enable / disable centerline tracking.
W2 - Enable / disable torch to work tracking.
W3 - Enable / disable torch oscillation.
W4 - Load weld schedule specified by schedule number
W5 - Save weld parameters to weld schedule specified by weld schedule number.
W6 - Enable/Disable upload of tracking data.
W7 - Select Thru-Arc (tm) Tracking Mode of operation (0 - 6)

0 = Weld joint Centerline tracking
(Constant width centerline tracking both side walls).
1 = Adaptive width control tracking with fill height control
(Variable width tracking).
2 = Right side centerline weld joint tracking
(Constant width single side tracking).
3 = Left side centerline weld joint tracking
(Constant width single side tracking).
4 = Automatic Voltage Control (AVC) for torch height control only for GTAW.
5 = Automatic Current Control (ACC) for torch height control only for GMAW.

W8 - Enable/ Disable pulse tig weld mode
W9 - Torch to Work Sample time (10 - 255, 10 msec increments)

4.4 CONTROL KEY FUNCTIONS

In addition to the terminal commands the WSC-1000 supports several special control key functions. These functions are used to save the programmed data in the EEPROM and to clear any pending terminal commands. Pressing the “CTRL” and specified letter key generate the following commands. When sending any of the following control codes, the WSC-1000 will respond with an ASCII "CR". The following is a summary of the special control character function supported by the WSC-1000:

Control Code	Command Function
^W	Save current parameters and sequence values to WSC-1000 EEPROM
^C	Reset the terminal serial port and clear any pending terminal commands.
^S	Up Load stored sequence commands from WSC to terminal.
^R	Load sequence commands from EEPROM to RAM

5.0 WSC-1000 PROGRAMMABLE SEQUENCE PROTOCOL

5.1 WSC PROGRAMMABLE SEQUENCE

The WSC programmable sequence consists of a 3-byte command. The First byte is the command byte followed by a two-byte value:

{byte1}, {Byte2 (MSB)(:)Byte3 (LSB)}

The value bytes must be set even if not required by the command. The value bytes may be branch addresses or real data passed to the selected function. A comma must separate the command and value. The MSB byte and LSB byte of the value maybe separated by a colon (":"). The colon will cause the MSB and LSB byte to concatenate to form a single two-byte value.

5.2 MSB AND LSB FUNCTIONS

When setting MSB and LSB bytes for specific command function the MSB and LSB byte may be separated by a ":" or the total value may be specified by the decimal equivalent of the two bytes. To set the decimal value for the MSB and LSB bytes use the following equation:

Decimal Value = (MSB x 256) + LSB

The following is an example of how to set sequence 4 to the "SWITCH ON" command (1) and branch to sequence number 10 when "OFF" (MSB) and to test switch input 1 (LSB):

Decimal Value = (MSB x 256)+LSB = (10 x 256)+1 = 2561

Decimal Command sent to WSC: **S4=1,2561**
Optional Command format: **S4=1,10:1**

5.3 RELAY SETTING

When Setting / Resetting the relay outputs the individual relays are selected by setting the corresponding data bits in the LSB byte. To set multiply relays with the same command add the decimal value for each relay and use the result as the value for the command. The following is an example of programming sequence 5 to set relay CR1 and CR6 using the "SET RELAY" command (3):

Decimal Value for CR1 = 1 and CR6 = 32
Decimal Value = 1 + 32 = 33
Command sent WSC: **S5=3,33**

The following is the decimal value for individual bits used for the relay outputs and switch inputs:

BIT NUMBER	*DECIMAL*	*RELAY SWITCH*	*INPUT SWITCH*
BIT 0	*1*	*CR1*	*INP1*
BIT 1	*2*	*CR2*	*INP2*
BIT 2	*4*	*CR3*	*INP3*

BIT 3	*8*	*CR4*	*INP4*
BIT 4	*16*	*CR5*	*INP5*
BIT 5	*32*	*CR6*	*INP6*
BIT 6	*64*	*CR7*	*INP7*
BIT 7	*128*	*CR8*	*INP8*

5.5 COMMAND DESCRIPTIONS

The following is summary of the available commands and the required values:

COMMAND **DESCRIPTION**

0 **NOP -** No Operation increment to next sequence

Example: *S20=0,0* *Skip sequence - No operation.*

1 **SWITCH ON** - LSB selects switch input MSB is branch to sequence number if switch is "OFF". If MSB is zero, function will wait for switch "ON" condition then increment to next sequence.

Example 1: *S20=1,0:1* *Wait for input 1 "ON".*
Example 2: *S20=1,40:1* *If input 1 is "OFF" branch to SEQ40. If "ON" increment to next sequence*

2 **SWITCH OFF -** LSB selects switch input, MSB is the branch to sequence number if switch is "ON". If MSB is zero, function will wait for switch "OFF" condition then increment to next sequence.

Example 1: *S20=2,0:1* *Wait for input 1 "OFF".*
Example 2: *S20=2,40:1* *If input 1 is "ON" branch to SEQ40. If "OFF" increment to next sequence*

3 **SET RELAY -** Activate relay(s) set by LSB byte.

Example 1: *S20=3,2* *Set CR2 relay output.*
Example 2: *S20=3,3* *Set CR1 and CR2 relay output*

4 **RESET RELAY -** Deactivate relay(s) selected by LSB byte.

Example 1: *S20=4,2* *Reset CR2 relay output.*
Example 2: *S20=4,3* *Reset CR1 and CR2 relay output*

5 **TIME DELAY** - Set Delay Sequence Timer. Value is specified in 10 msec increments. After program time has expired the function will increment to next sequence.

Example: *S20=5,20* *Delay for 0,20 seconds.*

6 **SET DAC 1 -** Load value to analog remote output 1 then increment to next sequence.

Example: *S20=6,1024* *Set DAC 1 output to 1/4 full scale.*

7 **SET DAC 2 -** Load value to analog remote output 2 then increment to next sequence.

Example: *S20=7,2048* *Set DAC 2 output to 1/2 full scale.*

8 **SET DAC 3** - Load value to analog remote output 3 then increment to next sequence.

Example:	*S20=8,3072*	*Set DAC 3 output to 3/4 full scale.*

9 **SET DAC 4** - Load value to analog remote output 4 then increment to next sequence.

Example:	*S20=9,4095*	*Set DAC 4 output to full scale.*

10 **START WELD** - Start weld sequence with weld schedule specified by LSB byte then Increments to next sequence.

Example 1:	*S20=10,0*	*Start weld sequence with current active schedule.*
Example 2:	*S20=10,4*	*Start weld sequence with schedule 4*

11 **WAIT FOR ARC ON CONDITION** - Wait for valid arc condition defined by variable "V38=(Arc On Voltage)" and "V39=(Arc on Current)" variables. If MSB byte is set the function will branch to the selected sequence number while the ARC ON Flag is clear. If the LSB is set and the "ARC ON" flag is set the function will branch to the specified sequence. If the LSB is zero the function will increment to next sequence.

Example 1:	*S20=11,0*	*Wait for Arc Active.*
Example 2:	*S20=11,40:60*	*If Arc is not active branch to SEQ 40. If Arc is active branch to SEQ 60*

12 **WAIT FOR WELD END** - Wait for end of weld cycle. If LSB byte is set the function will branch to the selected sequence number while the weld cycle is not complete. If weld cycle is complete and the LSB is not zero the function will branch to the specific sequence number. If the LSB is zero the function will increment to next sequence.

Example 1:	*S20=12,0*	*Wait for End of WSC weld sequence.*
Example 2:	*S20=12,40:6*	*Is weld cycle complete? No - Branch to SEQ 40. Yes – branch to SEQ 60.*

13 **JUMP TO SEQUENCE** - Jump to new sequence number specified by LSB bye of value.

Example:	*S20=13,100*	*Jump to SEQ 100.*

14 **MOVE AXIS 1 TO POSITION** - Send move position command to axis 1 drive control - Horizontal Drive. Value equal new move position.

Example:	*S20=14,1000*	*Move Axis 1 (Horizontal) to 1.000 inch*

15 **MOVE AXIS 2 TO POSITION** - Send move position command to axis 2 drive control - Vertical Drive. Value equal new move position.

Example:	*S20=15,1000*	*Move Axis 2 (Vertical) to 1.000 inch*

16 **MOVE AXIS 3 TO POSITION** - Send move position command to axis 3 drive control. Value equal new move position.

Example:	*S20=16,1000*	*Move Axis 3 to 1.000 inch*

17 **MOVE AXIS 4 TO POSITION** - Send move position command to axis 4 drive control. Value equal new move position.

Example:	*S20=17,1000*	*Move Axis 4 to 1.000 inch*

18 **SET AXIS 1 SPEED -** Send new velocity to axis 1 drive and increment to next sequence.

Example:	*S20=18,1000*	*Set Axis 1 (Horizontal) speed to 1.000 inch/sec*

19 **SET AXIS 2 SPEED -** Send new velocity to axis 2 drive and increment to next sequence.

Example:	*S20=19,1000*	*Set Axis 2 (Vertical) speed to 1.000 inch/sec*

20 **SET AXIS 3 SPEED -** Send new velocity to axis 3 drive and increment to next sequence.

Example:	*S20=20,1000*	*Set Axis 3 speed to 1.000 inch/sec*

21 **SET AXIS 4 SPEED -** Send new velocity to axis 4 drive and increment to next sequence.

Example:	*S20=21,1000*	*Set Axis 4 speed to 1.000 inch/sec*

22 **AXIS 1 MOVE COMPLETE -** Has axis 1 completed the last move command? If the MSB byte is set the function will jump to the selected sequence number if the move is not complete. If the LSB byte is zero the function will wait for the move to be completed then increment to the next sequence or branch to the sequence number set by the LSB.

Example 1:	*S20=22,0*	*Wait for AXIS 1 move complete*
Example 2:	*S20=22,40:0*	*Is AXIS 1 move complete? No - Branch to SEQ 40*

23 **AXIS 2 MOVE COMPLETE -** Has axis 2 completed the last move command? If the MSB byte is set the function will jump to the selected sequence number if the move is not complete. If the LSB byte is zero the function will wait for the move to be completed then increment to the next sequence or branch to the sequence number set by the LSB.

Example 1:	*S20=23,0*	*Wait for AXIS 2 move complete*
Example 2:	*S20=23,40:0*	*Is AXIS 2 move complete? No - Branch to SEQ 40*

24 **AXIS 3 MOVE COMPLETE -** Has axis 3 completed the last move command? If the MSB byte is set the function will jump to the selected sequence number if the move is not complete. If the LSB byte is zero the function will wait for the move to be completed then increment to the next sequence or branch to the sequence number set by the LSB.

Example 1:	*S20=24,0*	*Wait for AXIS 3 move complete*
Example 2:	*S20=24,40:0*	*Is AXIS 3 move complete? No - Branch to SEQ 40*

25 **AXIS 4 MOVE COMPLETE -** Has axis 4 completed the last move command? If the MSB byte is set the function will jump to the selected sequence number if the move is not complete. If the LSB byte is zero the function will wait for the move to be completed then increment to the next sequence or branch to the sequence number set by the LSB.

Example 1:	*S20=25,0*	*Wait for AXIS 4 move complete*
Example 2:	*S20=25,40:0*	*Is AXIS 4 move complete? No - Branch to SEQ 40*

26 **MOVE TORCH TO WELD POSITION** - Move the torch to the weld position as set byte the "TORCH WELD=" parameter. After sending the move torch command the routine will increment to the next sequence.

Example:	*S20=26,0*	*Move AXIS 2 (Vertical) to WSC "TORCH WELD" position.*

27 **MOVE TORCH TO UP POSITION** - Move the torch to the weld position as set byte the "TORCH UP=" parameter. After sending the move torch command the routine will increment to the next sequence.

Example:	*S20=27,0*	*Move AXIS 2 (Vertical) to WSC "TORCH UP" position.*

28 **SET LOOP COUNTER** - Load selected loop counter (0-9) with starting value. MSB byte is the value to load and the LSB byte is the selected counter. There are 10 Loop counters available.

Example:	*S20=28,25:1*	*Load Loop counter 1 with a value of 25.*

29 **DECREMENT LOOP COUNTER** - Decrement the selected counter (0 - 9) and set the condition code register. The LSB byte selects the loop counter to decrement.

Example:	*S20=29,1*	*Decrement Loop Counter 1 and set Condition Code Register.*

30 **CLEAR LOOP COUNTER** - Clears the selected loop counter (0 - 9). The LSB byte selects the desired loop counter to be cleared and sets the condition code register.

Example:	*S20=30,1*	*Clear Loop Counter 1 and set Condition Code Register.*

31 **JUMP SUBROUTINE** - Jump to specified sequence number subroutine. The sequence subroutine must be terminated with a return from subroutine command (32). The WSC allows nesting of up to 10 subroutines. All commands may be used in subroutines.

Example:	*S20=31,80*	*Jump to sequence subroutine at SEQ 80.*

32 **RETURN FROM SUBROUTINE** - Returns the sequence counter to the "jump subroutine " sequence number plus 1. If a return subroutine command is executed with out a "jump subroutine " the sequence counter will be incremented to the next sequence.

Example:	*S85=32,0*	*Return from sequence subroutine.*

33 **READ ANALOG VALUES** - Reads selected analog value and stores the result in the Result Register. The value is selected by the LSB byte of the command (0 - 5). The following is a summary of the values read as specified by the LSB byte:

LSB	*Value Read*
0	*Welding Voltage*
1	*Welding Current*
2	*Wire Feed Speed*
3	*Welding Gas Flow Rate*
4	*WRC-1000 Analog Input 1*

5	*WRC-1000 Analog Input 2*

Example: *S20=33,4* *Read WRC analog input 1.*

34 **COMPARE STORED VALUE** - Compares the value measured by the READ ANALOG VALUES function to the value specified by the command value (MSB, LSB) and sets the condition code register. The comparison is a subtraction of the stored value from the command value (STORED VALUE - COMMAND VALUE). The stored value is unchanged as a result of the command. Only the condition code register is set.

Example: *S20=34,400* *Compare Read Analog value to 400 and set condition code register.*

35 **COMPARE SWITCH INPUT** - Compares the current WRC-1000 switch inputs to the binary value specified in the LSB byte (SWITCH - VALUE) and sets the condition code register.

Example: *S20=35,3* *Compare input to 3 (Input 1 and 2 active) and set condition code register.*

36 **COMPARE LOOP VALUE** - Compares the loop counter specified by the LSB byte to the value specified in the MSB byte and sets the condition code register (COUNTER - VALUE).

Example: *S20=36,10:1* *Compare Loop counter 1 to 10 and set condition code registers.*

37 **COMPARE WELD CYCLE** - Compares the value specified in the LSB byte to the current WSC-1000 weld sequence number and sets the condition code register (CYCLE - VALUE). The following is a summary of the WSC weld sequence numbers and there associated functions:

CYCLE	*FUNCTION*
0	*Weld cycle off*
1	*Pre gas flow time*
2	*Hot Start time*
3	*Arc active test and delay time*
4	*Ramp up time*
5	*Weld cycle time*
6	*Ramp down time*
7	*Crater fill time*
8	*Reverse wire feed time*
9	*Burn Back time*
10	*Post Purge gas flow time*

Example: *S20=37,5* *Compare Weld cycle to 5 (Weld Time) and set condition code register.*

38 **BRANCH NOT EQUAL** - Branch to sequence specified by LSB byte as a result of the previous parameter value not being equal to command value or not equal zero. As specified by the condition code register. If not zero increment to next sequence number.

Function: (Parameter != Compare) then Branch to Seq #

Example: *S20=38,40* *If comparison parameter is not equal to value branch to SEQ 40.*

39 **BRANCH IF LOWER** - Branch to sequence specified by LSB as a result of the previous parameter value being less then the command value. As specified by the condition code register. If not less then stored value increment to next sequence number.

Function: Parameter < Compare then Branch to Seq #

Example: *S20=39,40* *If comparison parameter < value branch to SEQ 40.*

40 **BRANCH IF HIGHER** - Branch to sequence specified by LSB byte as a result of the previous parameter value being greater then the command value. As specified by the condition code register. If not greater then parameter value increment to next sequence number.

Function: Parameter > Compare then Branch to Seq #

Example: *S20=40,40* *If comparison parameter > value branch to SEQ 40.*

41 **BRANCH IF EQUAL** - Branch to sequence specified by LSB byte as a result of the previous parameter value being equal to the command value (Note: result of comparison is zero). As specified by the condition code register. If not equal to parameter value increment to next sequence number.

Function: Parameter = Compare then Branch to Seq #

Example: *S20=41,40* *If comparison parameter = value branch to SEQ 40.*

42 **BRANCH IF HIGHER OR EQUAL** - Branch to sequence specified by LSB byte as a result of the previous parameter value being greater then or equal to the command value. As specified by the condition code register. If not greater then command value increment to next sequence number.

Function: Parameter >= Compare then Branch to Seq #

Example: *S20=42,40* *If comparison parameter >= to value branch to SEQ 40.*

43 **BRANCH IF LESS THEN OR EQUAL** - Branch to sequence specified by LSB byte as a result of the previous parameter value being less then or equal to the command value (Note: result of comparison is zero). As specified by the condition code register. If not equal to parameter value increment to next sequence number.

Function: Parameter <= Compare then Branch to Seq #

Example: *S20=43,40* *If comparison parameter <= to value branch to SEQ 40.*

44 **CLEAR PULSE ACCUMULATOR** - Clear external encoder pulse accumulator. Resets the accumulator count to zero.

Example: *S20=44,0* *Clear external encoder pulse accumulator value.*

45 **COMPARE PULSE ACCUMULATOR** - Compare the contents of the pulse accumulator to the value store in register specified by the LSB byte and set the condition code register.

Example:	*S20=45,1*	*Compare Encoder count to register 1 and set condition code register.*

46 **SET PULSE ACCUMULATOR DIRECTION** - Set the accumulator direction flag to increment or decrement the count, in the accumulator, as a result of the incoming pulses. Setting the LSB byte to 1 will cause the accumulator to decrement by one for each incoming pulse. Setting the LSB to 0 will cause the accumulator to be incremented by one for each incoming pulse.

Example 1:	*S20=46,0*	*Set encoder pulse accumulator to count up.*
Example 2:	*S20=46,1*	*Set encoder pulse accumulator to count down.*

47 **SAVE CENTER POSITION** - Read and Save the horizontal oscillator center position.

Example:	*S20=47,0*	*Save Horizontal center position.*

48 **RESTORE CENTER POSITION** - Restore and move the horizontal oscillator center position to the previously saved value.

Example:	*S20=48,0*	*Restore Horizontal center position and move axis to position.*

49 **INDEX AXIS 3 CW** - Index the axis 3 servo drive by the number of steps specified by the value parameter in the clock wise (CW) direction.

Example:	*S20=49,1000*	*Index AXIS 3 1000 steps in the CW direction*

50 **INDEX AXIS 4 CW** - Index the axis 4 servo drive by the number of steps specified by the value parameter in the clock wise (CW) direction.

Example:	*S20=50,1000*	*Index AXIS 4 1000 steps in the CW direction.*

51 **INDEX AXIS 3 CCW** - Index the axis 3 servo drive by the number of steps specified by the value parameter in the counter clock wise (CCW) direction.

Example:	*S20=51,1000*	*Index AXIS 3 1000 steps in the CCW direction.*

52 **INDEX AXIS 4 CCW** - Index the axis 4 servo drive by the number of steps specified by the value parameter in the counter clock wise (CCW) direction.

Example:	*S20=52,1000*	*Index AXIS 4 1000 steps in the CCW direction.*

53 **JOG TORCH POSITION RIGHT** - Move the torch position to the right (Oscillator drive) by the number of steps specified by the "JOG OSC=   " parameter. Modifies the "CENTER POS=   " parameter.

Example:	*S20=53,100*	*Jog oscillator center .100 inch to the right.*

54 **JOG TORCH POSITION LEFT** - Move the torch position to the left (Oscillator drive) by the number of steps specified by the "JOG OSC=   " parameter. Modifies the "CENTER POS=   " parameter.

Example:	*S20=54,1000*	*Jog oscillator center 0.100 inch to the left.*

55 **JOG TORCH POSITION UP** - Move the torch weld position up (Vertical drive) by the number of steps specified by the "JOG TORCH=   " parameter.

Loads the vertical drive with the torch weld position and modifies the "TORCH WELD=   " parameter.

Example:	*S20=55,1000*	*Jog "TORCH WELD" position up 0.100 inch.*

56 **JOG TORCH POSITION DOWN** - Move the torch weld position down (Vertical drive) by the number of steps specified by the "JOG TORCH=   " parameter. Loads the vertical drive with the torch weld position and modifies the "TORCH WELD=   " parameter.

Example:	*S20=56,1000*	*Jog "TORCH WELD" position down 0.100 inch.*

57 **LAN6 TRAVEL SERVO RUN/STOP** - Start/Stop the LAN 6 travel control servo. The following are the allowable values and there function:

VALUE	*FUNCTION*
0	*Stop the travel servo LAN drive*
1	*Start the Travel servo in the "FORWARD" direction using the preset travel speed.*
2	*Start the Travel servo in the "REVERSE" direction using the preset travel speed.*

Example 1:	*S20=57,0*	*Stop Travel speed servo LAN6.*
Example 2:	*S20=57,1*	*Start Travel speed servo (LAN6) forward at programmed speed.*
Example 3:	*S20=57,2*	*Start Travel speed servo (LAN6) reverse at programmed speed.*

58 **LAN COMMAND** - Send LAN device command, specified by the "LSB" byte to LAN controller specified by the "MSB" byte. Allowable range for LAN command ("LSB") is 1 - 11.

COMMAND	*FUNCTION*
1	*Set servo to Home position.*
2	*Set servo velocity as specified in the following variables:* ***AXIS 1*** *- Horizontal drive velocity variable V25.* ***AXIS 2*** *- Vertical drive velocity variable V26.* ***AXIS 3*** *- Axis 3 velocity variable V43.* ***AXIS 4*** *- Axis 4 velocity variable V44.*
3	*Read current Servo drive position.*
4	*Move Axis to position stored in move registers.*
5	*Disable axis drive power.*
6	*Read axis status.*
7	*Halt current move command.*
8	*Set Axis acceleration to value specified by the following variables:* ***AXIS 1*** *- Horizontal drive acceleration variable V34.* ***AXIS 2*** *- Vertical drive velocity variable V35.* ***AXIS 3*** *- Axis 3 velocity variable V45.* ***AXIS 4*** *- Axis 4 velocity variable V46.*
9	*Send ASCII string to Lan device.*
10	*Index Axis in CW direction.*
11	*Index Axis in CCW direction.*

Example:	*S20=58,2:1*	*Send AXIS2 (Vertical) to "HOME" position.*

59 **END WELD CYCLE** - End the current weld cycle and start ramp down and end weld routines. This will cause the WSC to terminate a non-spot weld routine independent of the current weld switch status.

Example: *S20=59,0* *Terminate current weld cycle and start ramp down.*

60 **SUBTRACT REGISTERS -** Subtract register specified by the LSB from the register specified by the MSB. Save result in register zero and set condition code register.

Register 0 = Register(MSB) - Register(LSB)

Example: *S20=60,1:4* *Subtract Reg[4] from REG[1] and save result in REG[0].*

61 **ADD REGISTERS -** Add register specified by the MSB to the register specified by the LSB. Save result in register zero and set condition code register.

Register 0 = Register(LSB) + Register(MSB)

Example: *S20=61,1:4* *Add Reg[1] to REG[4] and save result in REG[0].*

62 **SAVE PULSE ACCUMULATOR VALUE IN REGISTER -** Save the current pulse accumulator value in register pointed to by the LSB byte.

Example: *S20=62,4* *Save encoder pulse accumulator value in REG[4].*

63 **LOAD REGISTER 1 -** Load register 1 with value specified by MSB and LSB.

Example: *S20=63,500* *Load Reg[1] with a value of 500.*

64 **LOAD REGISTER 2 -** Load register 2 with value specified by MSB and LSB.

Example: *S20=64,500* *Load Reg[2] with a value of 500.*

65 **LOAD REGISTER 3 -** Load register 3 with value specified by MSB and LSB.

Example: *S20=65,500* *Load Reg[3] with a value of 500.*

66 **LOAD REGISTER 4 -** Load register 4 with value specified by MSB and LSB.

Example: *S20=66,500* *Load Reg[4] with a value of 500.*

67 **LOAD REGISTER 5 -** Load register 5 with value specified by MSB and LSB.

Example: *S20=67,500* *Load Reg[5] with a value of 500.*

68 **LOAD REGISTER 6 -** Load register 6 with value specified by MSB and LSB.

Example: *S20=68,500* *Load Reg[6] with a value of 500.*

69 **LOAD REGISTER 7 -** Load register 7 with value specified by MSB and LSB.

Example: *S20=69,500* *Load Reg[7] with a value of 500.*

70 **LOAD REGISTER 8 -** Load register 8 with value specified by MSB and LSB.

Example:	*S20=70,500*	*Load Reg[8] with a value of 500.*

71 **LOAD REGISTER 9 -** Load register 9 with value specified by MSB and LSB.

Example:	*S20=71,500*	*Load Reg[9] with a value of 500.*

72 **LOAD REGISTER 10 -** Load register 10 with value specified by MSB and LSB.

Example:	*S20=72,500*	*Load Reg[10] with a value of 500.*

73 **INCREMENT LOOP COUNTER -** Increment loop counter value specified by LSB (0 - 9).

Example:	*S20=73,2*	*Increment Loop counter 2.*

74 **START WELD SEQUENCE -** Start the weld sequence using the value in loop counter as weld schedule. The LSB byte specifies the loop counter value to be used as a weld schedule number.

Example:	*S20=74,2*	*Start Weld sequence with weld schedule number in loop counter 2.*

75 **READ PARAMETER TO REGISTER -** Load WSC weld schedule Parameter to selected PLC register. The Parameter is specified by the "MSB" and the register is specified by the "LSB" value.

REG[LSB] = V[MSB]

Example:	*S20=75,10:5*	*Read Weld schedule programmed run current value (V10) into REG[5].*

76 **WRITE REGISTER TO PARAMETER -** Load selected PLC register to WSC weld schedule parameter. The Parameter is specified by the "MSB" and the register is specified by the "LSB" value.

V[MSB] = REG[LSB]

Example:	*S20=76,10:5*	*Write REG[5] to weld schedule run current value (V10).*

77 **DELAY BY REGISTER VALUE -** Delay PLC operations by value in PLC register. Register value is specified by "LSB" value (Range 1 - 10).

Example:	*S20=77,3*	*Delay PLC execution by the value stored in REG[3] (10 msec increments).*

78 **SET NEW WELD SCHEDULE -** Load a new weld schedule into the weld sequence control. "LSB" value selects the new weld schedule number. Allowable range 1 - 40.

Example:	*S20=78,20*	*Load weld schedule 20 into active schedule.*

79 **LOAD REGISTER TO DAC SCALE PARAMETER -** Load selected PLC register to selected WSC DAC scaling parameter. The DAC scale Parameter is specified by the "MSB" and the PLC register is specified by the "LSB" value.

SCALE[MSB] = REG[LSB]

MSB	*FUNCTION*
0	*Wire feed slope (M) value.*
1	*Travel speed slope (M) value.*
2	*Current slope (M) value.*
3	*Voltage slope (M) value.*
4	*Wire feed offset (B) value.*
5	*Travel speed offset (B) value.*
6	*Current offset (B) value.*
7	*Voltage offset (B) value.*

Example: *S20=79,1:2* *Load REG[2] into Travel speed DAC slope parameter (A8).*

80 **MOVE AXIS BY REGISTER VALUE -** Send register value selected by the "LSB" byte to the LAN axis drive specified by the "MSB" byte. Allowable MSB value 1 - 8. Allowable LSB value 0 - 10.

Example: *S20=80,2:1* *Move AXIS 2 (Vertical Drive) to position in REG[1].*

81 **RESET ADAPTIVE FILL HEIGHT DELAY SWEEP COUNTER -** Reset the adaptive fill height delay counter to value specified by "LSB" byte. Resetting this adaptive delay counter will allow the WSC to recalculate a new fill height base on current welding parameters. The calculation will occur when the delay sweep counter makes the transition from one to zero. The value specified by the "LSB" byte is the number of oscillation cycles completed before the fill height is calculated.

Example: *S20=81,20* *Reset adaptive sweep counter to 20 and recalculate new fill height.*

82 **SET WELD SCHEDULE -** Set WSC weld schedule to the value specified by the selected WRC I/O bits. The "LSB" byte is used to mask the unused input bits and the "MSB" byte is used to right justify the remaining schedule input bits. If the "MSB" byte is set the PLC will shift the masked input bits to the right by the number locations specified in the "MSB" byte.

Example: *S20=82,2:28* *Use input 3-5 to select weld schedule 1-8*

83 **SET WELD SCHEDULE TO REGISTER VALUE -** Set WSC weld schedule to the value set in the selected Register. The "LSB" byte is used to specify the Register.

Example: *S20=83,4* *Set the weld schedule to the value in REG[4]*

84 **IF INPUT JUMP TO SEQUENCE -** Compare the switch input to the value specified by the "LSB" byte. If equal branch to sequence specified by the "MSB" byte. If the value is not equal the program will increment to the next PLC Sequence.

Example: *S20=84,100:3* *If switch input = 3 then branch to SEQ 100*

85 **IF INPUT JUMP TO SUBROUTINE -** Compare the switch input to the value specified by the "LSB" byte. If equal jump to the subroutine specified by the "MSB" byte. If the value is not equal the program will increment to the next PLC Sequence.

Example:	*S20=85,100:3*	*If switch input = 3 then jump to subroutine SEQ 100*

86 **LOAD LOOP COUNTER WITH REGISTER -** Load the LOOP counter specified by the "MSB" byte with the value in the register selected by the "LSB" byte.

Example:	*S20=86,1:3*	*Load the Loop Counter 1 with the value in REG[3]*

87 **SET AXIS OPTION PARAMETER -** Load the AXIS specified by the "MSB" byte with the option value specified by the "LSB" byte. Refer to the specific Axis servo control manual for defined operational modes.

Example:	*S20=87,1:3*	*Set AXIS 1 (Horizontal) to 1/4 step mode*

88 **SET VERTICAL AND HORIZONTAL AXIS -** Set the Vertical axis to the LAN ID specified by the "MSB" byte and the Horizontal axis to the LAN ID with the value specified by the "LSB" byte. If the MSB or LSB byte is 0 the current assigned LAN ID will not be changed.

Example:	*S20=88,2:1*	*Set Vertical motion to AXIS 2 and Horizontal motion to AXIS 1*

89 **LOAD CURRENT AXIS POSITION -** Load the current AXIS position specified by the "MSB" byte to the register specified by the "LSB" byte. Before reading the position data the user must request the current axis position from the desired AXIS by using the PLC command 58,[AXIS]:3 (LAN COMMAND).

Example:	*S20=58,3:3*	*Read AXIS 3 current position.*
Example:	*S21=89,3:1*	*Load axis 3 current position into REG[1].*

90 **HOME EXTERNAL AXIS DRIVES-** Initialize the external LAN AXIS drives specified by the [LSB] byte. Invoking this PLC command will cause the external AXIS drives to initialize to there "HOME" positions. The [LSB] byte specifies the AXIS drive LAN ID number. If the [LSB] byte is set to 0 all activated LAN axis drives will be initialized to there home position.

Example:	*S20=90,0*	*Initialize all external axis drives.*
Example:	*S20=90,1*	*Initialize AXIS 1 (horizontal) external drive.*

91 **SET WELD SCHEDULE TO LOOP COUNTER VALUE -** Set WSC weld schedule to the value set in the selected loop counter. The "LSB" byte is used to specify the loop counter (range = 0 - 9).

Example:	*S20=91,4*	*Set the weld schedule to the value in loop counter 4.*

92 **AXIS MOVE COMPLETE -** Has axis [LSB]] completed the last move command? If the [MSB] byte is set the function will jump to the selected sequence number if the move is not complete. If the [MSB] is zero the function will wait for the move to be completed then increment to the next sequence.

Example 1:	*S20=92,4*	*Wait for AXIS 4 move complete*
Example 2:	*S20=92,40:4*	*Is AXIS 4 move complete? No - Branch to SEQ 40*

93 **ENABLE AXIS AUTO EXECUTE -** Start the Auto execute PLC routine for the axis [LSB] specified then increment to the next sequence.

Example:	*S20=93,4*	*Start Auto PLC execute routine for axis 4*

94 **SET DAC OUTPUT -** Set the DAC [LSB] specified to the control output function specified by the [MSB] then increment to the next sequence.

Example:	*S20=94,2:5*	*Set travel speed output to AXIS 5*

95 **SET RELAY OUTPUT -** Set the Weld control Relay [LSB]output specified to the relay output specified by the [MSB] then increment to the next sequence.

Example:	*S20=95,2:2*	*Set travel forward output to CR2*

**** The following commands are only available in Firmware Version 2.74 or greater.**

96 **SET/RESET WELD SIMULATE -** Set the Weld/Weld Simulate mode to the specified by the [LSB] then increment to the next sequence. (1 = Simulate Weld Enabled, 0 = Simulate Weld disabled)

Example:	*S20=96,1*	*Enable weld simulation*
Example:	*S20=96,0*	*Disable weld simulation*

97 **SET RELAY AND WAIT FOR INPUT -** Set the Weld control Relay[LSB] output specified then wait for Input [MSB]. When Input [MSB] is active reset Relay [LSB] and increment to next sequence.

Example:	*S20=95,2:2*	*Set CR2 output and wait for input 2 active then reset CR2*

98 **COMPARE REG [MSB] TO REG[LSB] -** Compare REG specified by the [MSB] to the REG specified by the [LSB] and set the condition code register then increment to the next sequence.

Example:	*S20=98,1:2*	*Compare REG[1] to REG[2] (REG[1] - REG[2])*

99 **LOAD REG [LSB] TO DAC [MSB] -** Load the REG value specified by the [LSB] to the DAC specified by the [LSB] then increment to the next sequence.

Example:	*S20=98,1:2*	*Write the value in REG[2] to DAC 1*

**** The following commands are only available in Firmware Version 3.03 or greater.**

100 **MOVE TRAVEL TO REG [LSB] –** Move TRAVEL to encoder location designated in the Register specified by the [LSB] then increment to next sequence.

Example:	*S20=100,1*	*Move Travel to encoder value stored in REG 1*

101 **SET OUTPUT [LSB] BY INPUT [MSB] –** Set Output [LSB]by Input [MSB] and wait for Input Off. When Input [MSB] is asserted the specified Output [LSB] is set and will remain set until Input [MSB] is removed. The PLC will wait for Output [LSB] reset then increment to next sequence.

Example:	*S20=101,16:8*	*Set CR4 [LSB] when Input 5 [MSB] is set and wait for reset*

102 **SALE VARIABLE [MSB] USING DAC [LSB] SCALE –** Scale Weld Variable specified by [MSB] using Command DAC Scaling specified by [LSB] and the new scaled value is stored in [REG 0].

Example:	*S20=102,44:2*	*Scale Weld Variable 44 [MSB] using established Scale numbers for Travel DAC Command - D2 [LSB]. Value stored in [Reg 0]*

103 **SET AXIS SPEED [MSB] BY VARIABLE [LSB] –** Load SPEED specified in the Weld Schedule VARIABLE [LSB] to the AXIS specified in the [MSB].

Example:	*S20=103,2:43*	*Set AXIS 2 [MSB] speed to the number stored in V43 [LSB]*

104 **MOVE AXIS [MSB] TO LOCATION STORED IN VARIABLE [LSB] –** Move the AXIS specified in the [MSB] to the location specified in the Weld Schedule Variable [LSB].

Example:	*S20=104,2:43*	*Move AXIS 2 [MSB] to the location number stored in V43 [LSB]*

5.6 STITCH WELD EXAMPLE

The following is an example PLC program, which is used to provide multiple stitch welds. The WSC-1000 starts executing the PLC program at SEQ 1. Upon power up the PLC program will initialize the position of the welding carriage to the end of the travel carriage. The fixture has a limit switch at the end of the travel carriage. S120 is a initialization routine that will drive the carriage to the end limit, back off the limit switch and initialize the travel position encoder. It will then move the travel carriage to location specified by register 2 (REG [2]). When the weld cycle switch is active the PLC calls the weld subroutine S80. This routine sets the total number of welds to be made in loop counter 1. The weld is started and the program calls a position subroutine S115. The travel position is monitored until the travel carriage position specified by REG [0] is reached (REG[0]=REG[10]+REG[4]). When the length has been reached the weld cycle is terminated. The weld-offset distance is added to the current travel carriage position and the carriage is moved to the next weld starting position. The weld number counter is decremented and if the value is not zero, the above process is repeated.

5.6 WELD SCHEDULE REGISTERS

After the desired number of welds is made the PLC will reinitialize the travel carriage to the start position. The following weld schedule registers are used to specify the weld length, skip distance and travel positions:

```
==================== PLC Register Values ===================
              V61=80               ; REG[1] = Travel Deceleration value
              V62=606              ; REG[2] = Start location on Table (101 Pulse/Inch).
              V63=1   01           ; REG[3] = Skip Weld distance (101 Pulses/Inch).
              V64=202              ; REG[4] = Weld length ( 101 Pulses/Inch).

==================== Power Up Routine =====================
              S1=31,120            ; Jump to Initialize sub routine 120 - Resets carriage to end.

==================== Weld switch "ON" routine ================
              S2=5,30              ; Delay .3 seconds
              S3=1,1               ; Is weld switch "ON"? No - wait for switch "on"
              S4=26,0              ; Yes - move torch down to weld position
              S5=5,20              ; Delay for 0.20 seconds
              S6=23,0              ; Wait for torch move complete
              S7=47,0              ; Save oscillator center position
              S8=31,80             ; Jump to weld Subroutine SEQ80 - Skip Weld Routine
              S9=2,3:1             ; Wait for Weld switch "OFF"
              S10=48,0             ; Restore old center position
              S11=23,0             ; Wait for move complete.
              S12=13,2             ; Jump to SEQ 2

============= Skip Weld Sequence Subroutine 80 ================
              S80=28,10:1          ; Set Loop counter 1 with Number of welds in MSB byte
              S81=62,10            ; Save current position in REG [10]
              S82=61,4:10          ; Add length REG [4] to Current position REG [10]- Sets
                                   REG [0]
              S83=10,0             ; Start Weld Cycle with default schedule.
              S84=31,115           ; Jump to Move position subroutine SEQ 115
              S85=59,0             ; End Weld cycle
              S86=0,0              ; For normal operation
              S87=12,0             ; Wait for end of weld cycle.
              S88=27,0             ; Move Torch up.
              S89=23,0             ; Wait for torch move complete.
              S90=29,1             ; Decrement Loop counter 1 (Number of total welds)
              S91=41,101           ; If loop counter is zero - Reset Travel position to start
              S92=1,101:1          ; Is weld switch still "ON"? - No Branch to End Subroutine
              S93=62,10            ; Read current position into REG [10]
              S94=61,3:10          ; Add skip distance REG [3] to REG [10] - Sets REG [0]
              S95=3,16             ; Set Travel relay to forward direction
              S96=31,115           ; Jump to Move to new position subroutine SEQ115
              S97=4,16             ; Reset Travel forward relay
              S98=26,0             ; Yes - move torch down to weld position
              S99=23,0             ; Wait for torch move complete
              S100=13,81           ; Jump to SEQ 81 and perform next weld.
              S101=31,120          ; When Cycle complete Reset to Start Position
              S102=32,0            ; Return from subroutine.

========== Index Carriage to new Position set by REG [0] ===========
              S115=1,118:1         ; Is cycle switch still "ON"
              S116=45,0            ; Yes - Compare travel position encoder count to REG [0].
              S117=43,115          ; Is position = to REG [0]?  No - branch to SEQ 115.
              S118=32,0            ; Return from subroutine
```

```
============== Table initialization sub routine 120 ================
S120=90,0         ; Initialize all external axis drives.
S121=15,10        ; Move torch to Up position
S122=23,0         ; Wait for torch move complete
S123=4,255        ; Clear All relay outputs
S124=6,4000       ; Set DAC 4 (Travel speed ) to maximum
S125=3,32         ; Set reverse travel relay CR6
S126=1,128        ; Wait for reverse limit switch to open
S127=4,32         ; Reset travel reverse relay CR6
S128=5,20         ; Delay .20 seconds
S129=6,500        ; Set DAC 4 (Travel speed) to minimum
S130=3,16         ; Set forward travel relay CR5
S131=2,128        ; Wait for reverse limit switch to close
S132=4,16         ; Reset travel forward relay CR5
S133=5,50         ; Delay .50 seconds
S134=6,4000       ; Set speed to maximum
S135=46,0         ; Set travel encoder count direction
S136=44,0         ; Clear travel encoder accumulator
S137=60,2:1       ; Calculate Deceleration Position (REG [0] = REG [2] –
                  REG [1]
S138=3,16         ; Set forward travel relay on CR5
S139=45,0         ; Compare travel position encoder count to REG [0].
S140=43,139       ; Wait for position to be reached (No - branch to SEQ 138)
S141=6,500        ; Set DAC 4 (Travel speed) to 12.0 IPM
S142=45,2         ; Compare travel position encoder to REG [2]
S143=43,142       ; Wait for position to be reached (No - Branch to SEQ 141)
S144=4,16         ; Reset travel forward relay CR5
S145=32,0         ; Return from subroutine
```

6.0 PLC PROGRAMMING AND I/O INSTALLATION

6.1 PLC DESCRIPTION

The WSC PLC allows the user to configure and control the operation of the user defined hardware system. Before the WSC can be used, the user must configure the WSC-PLC to the external hardware attached to the system. The PLC provides the hardware interface for the Weld Sequence and adaptive control functions. The WSC control system provides the user with eight (8) relay outputs, eight (8) 24 vdc inputs, four (4) isolated analog outputs, two (2) isolated analog inputs, one (1) incremental 5vdc TTL encoder input, 24 vdc ESTOP control input and a 24 vdc power supply. The PLC controls all of the operational functions of the WSC.

Figure 6.1 shows the electrical connections provided by the WRC-1000 control enclosure. The WRC has four (4) terminal block assemblies that allow the user to interface to external hardware. The terminal blocks are grouped based on control functions.

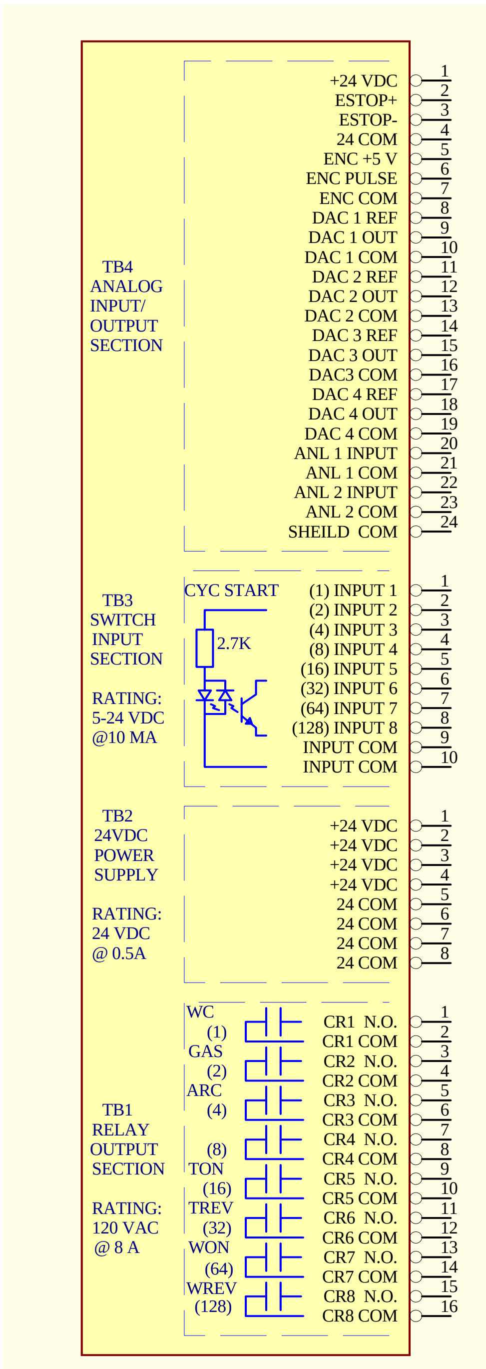


Figure 6-1

6.2 RELAY OUTPUT INTERFACE

TB1 provides the relay output interface. Each relay is a dry relay contact rated at 8 amps and 120 vac. The WSC-1000, as shipped from the factory, has several of the relays defined for specific output functions. The following is a summary of the default relay functions:

CR1 *- Weld contactor output.*
CR2 *- Gas solenoid output.*
CR3 *- Weld Arc active output.*
CR4 *- Not defined.*
CR5 *- Travel drive on output.*
CR6 *- Travel drive reverse output.*
CR7 *- Wire feeder drive on output.*
CR8 *- Wire Feeder reverse output.*

The user can redefine the relay functions by using the "R" commands and setting the output functions to the desired relay decimal number.

Note: *the number in parenthesis is the decimal value of the selected input/output device.*

6.3 24VDC POWER OUTPUT INTERFACE

TB2 provides the 24-vdc-power output for peripheral device interface. The 24-vdc supply can provide up to 0.5 amps of output current. The output is protected from overload by a solid-state fuse. The solid-state fuse will reset automatically when power is removed from the WRC-1000. To reset the fuse, turn the power off on the WSC-1000 control enclosure. The 24-vdc output can be used to power the 24-vdc inputs when using external manual switch or relays.

6.4 24VDC INPUT CONTROL INTERFACE

TB3 provides the 24 vdc input control interface. The input circuit is an optically isolated input and is not polarity sensitive. The input can be configured for "Pull-Up" or "Pull-down". With no input applied the PLC input will be off "0". When voltage is applied the PLC input will be on "1". The input operating voltage range is from 5.0 to 24 vdc @ 10 ma. Only if one of the default input is defined. INP1 is configured as a weld "Cycle Start" input.

6.5 ANALOG INPUT AND OUTPUT INTERFACE

TB4 provides the analog input and output interface. There are four (4) analog outputs (DAC1 - DAC4) which can be used to interface external equipment to the WSC. Each output is isolated and can be used as a 10-vdc output or as a self-referencing digital potentiometer. To enable the 10-vdc-output mode place the jumper located on the WRC PCB assembly on terminals 3-4 for the desired DAC output. To enable the digital pot mode place the jumper on terminal 1-2 for the desired DAC output. The maximum input reference voltage for any DAC output is 15 vdc. To use the DAC output as a digital pot connect the reference input to the most positive (High) terminal on the existing pot. Connect the wiper wire to the DAC output.

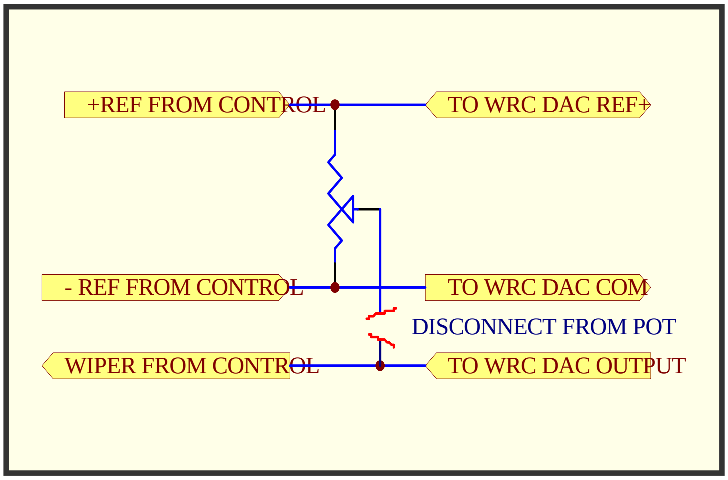


Figure 6-2

Connect the DAC common to the remaining (Low) terminal on the existing pot. Each basic welding parameter can be assigned to any of the four DAC outputs. In order for the WSC to correctly set the Digital Pot Connection DAC output based on real world values, the user must set the slope and offset values for each DAC output used. This allows the WSC to correctly set the outputs based on real welding parameter values. Refer to section 4.0 for explanation of setting the DAC slope and offset values.

6.6 ISOLATED ANALOG INPUTS

Two (2) uni-polar isolated analog inputs are also provided. The input range is 0 - 10 vdc and provides a 10 mv resolution. The inputs are filtered and provide a 1khz roll-off. These inputs can be used by the PLC to measure external sensors. The results of these measurements can be used by the PLC and read via the RS-232 terminal port and external PC.

6.7 ENCODER INTERFACE

A TTL incremental encoder input and 5-vdc-power supply is provided and can be used for encoding position information. The PLC controls the operation of the encoder input. Results of the incremental input can be used by the PLC. The PLC can clear the incremental counter and set direction of the incremental counter. The maximum count input is 65,535. The input has a maximum pulse input rate of 10 khz.

6.8 EMERGENCY INPUT INTERFACE

An emergency (ESTOP) input is provided and can be used for emergency conditions. The ESTOP input uses a normally closed input and must be present for the WSC control to operate. If this input is not used install a jumper from TB4-1 to TB4-2 and a jumper from TB4-3 to TB4-4. Activating an ESTOP condition will cause the WSC to open all output relays, disable all LAN drive motors and halt the PLC execution. Once the ESTOP has been cleared the operator must press the "CANCEL" key on the WSC control enclosure. The WSC will perform a power-up reset and the PLC will resume execution from sequence 0.

6.9 WRC-1000 INTERFACE

Before installing the WRC-1000 control enclosure determine what devices will be controlled by the PLC. The WRC-1000 provides four (4) 1/2" conduit holes, which will accept 1/2" conduit cord grips. To use the conduit holes remove the plastic hole plug and insert the cord grip. Route the external cable through the cord grip and terminate the cable to the desired input terminals. All input cables should be shielded to reduce the possibility of external interference. Number 22 awg cable can be used for switch inputs, analog outputs, analog inputs, encoder and ESTOP. The wire size for the output relays will be determined by the current requirement for the external devices.

After installing the external peripheral wiring the user must configure the WRC controller and write the required PLC software. The Weld Sequence Controller has a series of outputs that can be used to automatically control the external hardware. When a weld cycle is started the Weld Sequence Control will activate the various relay output functions. The user must associate these relay output functions to their respective hardware relay outputs. The control outputs are defined using the Terminal ***"R0 - R7"*** commands. The following is a summary of the Relay commands:

R0 - Gas Solenoid Relay output	- ***"PURGE/CANCEL"*** key
R1 - Weld Contactor Relay output	
R2 - Travel Forward Relay output	- ***"ENTER/YES"*** key
R3 - Travel Reverse Relay output	- ***"DELETE/NO"*** key
R4 - Wire Feed Forward Relay output	- ***"FWD/NEXT"*** key
R5 - Wire Feed Reverse Relay output	- ***"REV/LAST"*** key
R6 - Arc Active Relay Output	
R7 - Pulse On output Relay	

In addition to the weld sequence relay control functions pressing the specific keys on the WSC control panel also activates several of the outputs. These keys will be active during the non-weld cycle period. Refer to Section 4 for an explanation of how to set the relay outputs.

6.10 WELDING PARAMETER INTERFACE

The welding parameters Wire feed, Travel speed, Voltage and Current can be scaled to provide proper DAC outputs for the selected parameters. The DAC scaling is a MX ± B straight-line equation. The M and B values are user defined for each welding parameter. The M value is the slope of the line from minimum to the maximum control output value and the B value is the minimum offset value. The following equations can be used to calculate the M and B values for voltage and travel speed:

M = 4095/ (Max - Min)   B = 10 x MIN

Example - Welding Machine Output maximum is 38.0 volts, Minimum Output is 15.0 volts. Calculate the M and B values for voltage DAC scaling:

Voltage M = 4095/(38.0v - 14.0v) = 170
Voltage B = 14.0 x 10 = 140

For the Wire Feed and Current DACs use the following equations for M and B values:

M = 40950 / (Max - Min)   B = Min

The user must calculate and set the scaling for each welding parameter DAC

Output.

The following is a summary of the analog command functions:

A1 - DAC output 1 (max value 4095)
A2 - DAC output 2 (max value 4095)
A3 - DAC output 3 (max value 4095)
A4 - DAC output 4 (max value 4095)
A5 - Read Analog 1 input (max value 1024)
A6 - Read Analog 2 input (max value 1024)
A7 - Wire Feed Speed DAC Slope M
A8 - Travel Speed DAC Slope M
A9 - Current Control DAC Slope M
A10 - Voltage control DAC Slope M
A11 - Wire Feed Speed DAC offset B
A12 - Travel Speed DAC Offset B
A13 - Current Control DAC offset B
A14 - Voltage Control DAC offset B
A15 - External encoder input pulse accumulator (max value 65535)

7.0 WSC-1000 THRU-ARC™ TRACKING SETUP

7.1 OVERVIEW

The WSC-1000 provides a Thru-Arc Tracking option that allows the system to perform automatic torch height control and cross-seam tracking. To enable this option the WSC-1000 must have a vertical and horizontal slide and two MSC-1000 micro-step controllers. To provide only torch height control only a vertical slide and an MSC-1000 are required. To provide cross-seam control only a horizontal slide and an MSC-1000 are required.

7.2 OPERATIONAL CONDITIONS

The first step in establishing Thru-Arc Tracking is to set up good stable welding parameters that prevent harsh arc conditions to include the arc start and end of weld. The technology requires table arc conditions to derive proper correction vector information. This may include having to set ramp-up and ramp-down conditions in the weld process. If the welding conditions are not under control the system will respond to the adverse conditions produced by an unstable welding process rather than to the actual conditions required for tracking and torch height control. If there are drastic changes in the weld process (instability) the system will react in a drastic manor (ie. the torch dives into the part or the torch loses the seam and wanders all over the welding surface).

7.3 TRACKING MODES

The user will need to understand that there are several tracking Modes and Variables as well as understanding their relationship within the tracking process. The weld tracking Modes are:

W7=0 Enables **Centerline and Torch Height** tracking control mode. This will provide both horizontal and vertical correction vectors to maintain the proper torch path. If the vertical slide is not available then only horizontal vectors will be generated. The oscillation width is fixed and the oscillation center will move based on tracking information from the welding arc. The center position is corrected at each oscillator extreme. The torch height will be measured at the center of the oscillation pattern. The torch vertical position is corrected at the oscillator extreme. The following variables are used in this mode:

V36 – Cross-seam (horizontal) Correction Gain
V37 – Torch Height (vertical) Correction Gain
V75 – Max Torch Correction Limit Oscillation Cycle
V76 – Max Cross-seam Correction Limit per side

W7=1 Provides **Adaptive Width Control** and can provide constant volume fill if the WSC has control of the torch travel speed. This mode uses the Depth-of-Penetration value to determine arc position as related to the sidewall position. The sidewall position is determined by a percent change in arc impedance with respect to the oscillation center position. This method allows the oscillation width to increase/decrease to obtain the specified penetration value. The following variables are used with this mode:

V36 – Cross-seam (horizontal) Correction Gain
V37 – Torch Height (vertical) Correction Gain
V52 – % Depth of sidewall penetration
V54 – Minimum Oscillation Width

V55 – Maximum Oscillation Width
V62 – Minimum Travel Speed
V63 – Maximum Travel Speed
V75 – Max Torch Correction Limit Oscillation Cycle
V76 – Max Cross-seam Correction Limit per side

W7=2 Provides **Right Side Centerline** weld joint tracking with constant width, single side tracking. In this mode, the Depth-of-Penetration control is used to determine the location of the right side wall. The oscillator will move to the right to obtain the depth-of-penetration that is established by the Variable V52. This percent change is based on the centerline impedance. When a new sidewall position is determined the mode will determine the left position by subtracting the oscillation width from the new right most position. This mode is used for bead stacking or overlay applications. The following variables are used in this mode:

V36 – Cross-seam (horizontal) Correction Gain
V37 – Torch Height (vertical) Correction Gain
V52 – % Depth of sidewall penetration
V75 – Max Torch Correction Limit Oscillation Cycle
V76 – Max Cross-seam Correction Limit per side

Note: *The Right is determined by looking at the horizontal slide from the front. Larger values in "OSC CENTER" position represent a movement to the Right (away from the location of the motor on the slide).*

W7=3 Provides **Left Side Centerline** weld joint tracking with constant width, single side tracking. This mode uses the Depth-of-Penetration control method to determine the location of the Left sidewall position. This mode allows the oscillator to move to the left to obtain the depth-of-penetration that is established by the Variable V52. This percent change is based on the centerline impedance. When a new sidewall position is determined the mode will determine the Right position by adding the oscillation width from the new left most position. This mode is used for bead stacking or overlay applications. The following variables are used in this mode:

V36 – Cross-seam (horizontal) Correction Gain
V37 – Torch Height (vertical) Correction Gain
V52 – % Depth of sidewall penetration
V75 – Max Torch Correction Limit Oscillation Cycle
V76 – Max Cross-seam Correction Limit per side

Note: *The Left is determined by looking at the horizontal slide from the front. Smaller values in "OSC CENTER" position represent a movement to the Left (toward the location of the motor on the slide).*

W7=4 **Automatic Voltage Control (AVC)** for torch height control only for GTAW. This mode is used to provide torch height control when no oscillation is required. The vertical corrections are generated on a time basis. The weld mode parameter W9 specifies the time, in 10msec increments, between vertical correction vectors. This mode is used for GTAW and PAW applications. The following variables are used in this mode:

V37 – Torch Height (vertical) Correction Gain
W9 – Torch-to-Work sample time in 10 msec increments
V75 – Max Torch Correction Limit per correction cycle

W7=5 **Automatic Current Control (ACC)** for torch height control only for GMAW. This mode is used to provide torch height control when no oscillation is required. The vertical corrections are generated on a time basis. The weld mode parameter W9 specifies the time, in 10msec increments, between vertical correction vectors. This mode uses the voltage and current to calculate the arc impedance and to generate the torch height correction vector. This mode is used for GMAW and SAW applications.

V37 – Torch Height (vertical) Correction Gain
W9 – Torch-to-Work sample time in 10 msec increments
V75 – Max Torch Correction Limit per correction cycle

7.4 TRACKING PARAMETERS

There are several weld schedule variables that affect the way the system responds to the welding conditions as well. These variables are loaded with the Weld Schedule. If a weld schedule change is made and these variables are different from one schedule to another, then the way the system tracks will be affected. These variables are:

V36 Cross-Seam Tracking Gain – The recommended starting value is 15. This gain is used to increase or decrease the response of the Cross-Seam (Horizontal) Tracking. The lower the number the slower the system will respond to a change of seam direction. This variable impacts the stability of weld bead center. If the weld bead center position is oscillating (snake shape weld bead) decrease this parameter. If the center position is slow to respond to a change in the center position, increase this parameter. This value normally increases with a larger wire diameter.

V37 Torch-to-Work Tracking Gain – The recommended starting value is 30. This gain is used to increase or decrease the response of the Torch Height (Vertical) tracking. The lower the number the slower the system will respond to changes to the work surface or geometry. This variable impacts the stability of torch height. If the torch position is oscillating (moving up and down constantly) decrease this parameter. If the torch position is slow to respond to a change in position, increase this parameter. This value normally increases with a larger wire diameter.

V52 Percent Depth of Penetration – This variable is only used in Mode 1, Mode 2 and Mode 3. This variable set's the percent change from the weld bead center that the WSC will use to detect arc movement into a sidewall position. The percent change from center will determine the new extreme oscillation position for each oscillation cycle. The unit of measure is in 0.1% increments (i.e. V52=10 equals 1.0% change). Increasing this value will cause the arc to move harder into the sidewall. Decreasing this value will move the arc away from the sidewall.

V75 Maximum Torch Correction Vector Limit – The default value is 250. This parameter is used to set the maximum distance, in .001-inch increments, the torch can move per correction cycle. The default value of 250 is the maximum distance (0.250) the torch could move per correction cycle.

V76 Maximum Cross-Seam Correction Vector Limit – The default value is 20. This vector is used to set the maximum distance the horizontal center position can move per correction generated by the system. The default value of 20 is the physical distance, in .001-inch increments, the oscillator center position will move per correction cycle.

W9 Torch-to-Work sample Time – This weld variable is only used with Tracking Mode 4 and 5. The sample time is used to generate torch correction vectors with out oscillating the torch. At the end of this time delay the WSC will calculate a new Torch correction vector. The unit of measure for this variable is 0.01 seconds. The default value of 20 will produce a torch correction vector every 0.2 seconds for a correction rate of 5 Hz.

7.5 GETTING STARTED

The first thing that the user must do is establish and stabilize the Torch Height Control Tracking function. If the Torch Height Tracking is not stable then Cross-Seam will not function correctly. To configure the system for proper seam tracking here are a few basic steps to follow:

7.5.1 TORCH HEIGHT TRACKING

STEP 1 Set welding conditions for proper bead shape and weld specifications using the initial oscillation parameters derived from the following equations.

OSC WIDTH = 1.5 x Wire Dia
OSC SPEED = 420 x Width/Travel Speed in inches per minute
R/L DWELL = .01

Adjust the oscillation and weld parameters to provide acceptable bead appearance.

STEP 2 Observe the Weld Voltage and Current for stable arc condition during the weld. Note the Apparent Average Volt and Current reading.

STEP 3 Enter the observed values into the “RUN VOLT” and “RUN AMP” parameters of the Weld Schedule by pressing the ALTER key from the front of the WSC-1000. The Weld Parameters Menu screen will appear. Press the ENTER key. Using the FWD key, scroll through the screens until the “RUN VOLTS” screen is displayed. Using the numeric keypad, enter the noted value for Volts. Press the ENTER key. Scroll forward to the “RUN AMPS” screen. Enter the noted value and press the ENTER key. Press the ALTER key to exit the menu screen.

STEP 4 Enable “TORCH TRACKING” by pressing the ALTER key on the WSC-1000. Use the FWD key to scroll to the Torch Parameters menu. Press the ENTER key. Use the FWD key to scroll to the “Torch Power?” and set it to “Yes”. Scroll FWD and set the “Torch Track?” to “Yes”. Press the ALTER key.

STEP 5 From the WELDSEQ Terminal Program set the Torch Gain V37 to 30, set the Maximum Torch Correction Limit V75 to 20 then type W5=1 <enter>.

STEP 6 Enable the Oscillator by pressing the ALTER key on the front of the WSC-1000. Press the FWD key to scroll through the menus until the Weave Parameters menu appears. Press the ENTER key. Use the FWD key to scroll to the "OSC Power?" and set it to "YES". Press FWD key to display the "Oscillator?" and set to "YES". From the terminal set Mode W1 to 0 (type W1=0 <enter>).

STEP 7 Enable Tracking data upload by entering the following terminal command, W6=1(enter). When in this mode, the tracking data will be uploaded to the terminal screen. The data is displayed in column format. From left to right the columns are: Horizontal Center, Vertical Position (Torch Height), Oscillator Width, Arc Volts, Arc Amps and Travel Speed.

STEP 8 Make a weld and observe the torch motion. The torch will move some. If the torch is correcting its position in small increments it is operating correctly. If the torch is oscillating Up and Down or moves only in one direction (UP or DOWN) reduce the Torch Gain V37.

STEP 9 The first column of data uploaded to the terminal is the oscillator center position. The second column is the torch height position. The torch position should be moving slowly from sample to sample and the direction should change slowly.

STEP 10 Make several welds to assure torch stability.

7.5.2 CENTERLINE TRACKING MODE 0 - W7=0

STEP 1 Make sure that the Torch Height tracking is set up correctly. If the Torch Height Controls have not been set up, the system will not produce stable cross-seam tracking. To set the Tracking Mode to 0, from the WELDSEQ Program terminal, type **W7=0***(enter)*.

STEP 2 After obtaining stable torch height tracking set the cross seam Gain V36 to ½ of the value used for torch height (i.e. V37=20 then V36=10).

STEP 3 Set the Cross-seam Correction Vector Limit V76 to ½ the value of the Cross-seam Gain (V36) value (i.e. V36=10 then V76=5) then type **W5=1** *<enter>.*

STEP 4 Enable Cross-seam tracking by pressing the ALTER key on the WSC-1000. Use the FWD key to scroll to the" WEAVE PARAMETERS" menu. Press the ENTER key. Use the FWD key to scroll to the "AUTO CENTER?" parameter and set it to "YES". Press the ALTER key to exit. To enable the cross seam tracking from the WELDSEQ terminal Program type **W1=1** *<enter>* then type **W5=1** *<enter>* to save the change to the current schedule*.*

STEP 5 Enable Tracking data upload by entering the following terminal command, **W6=1***(enter)*. When in this mode, the tracking data will be uploaded to the terminal screen. The data is displayed in column format. From left to right the columns are Horizontal Center, Vertical Position (Torch Height), Oscillator Width, Arc Volts, Arc Amps and Travel Speed.

STEP 6 Make a weld and observe the torch motion, both height and center position. The torch will move some on both axes. If the torch is correcting its position in small increments it is operating correctly. If the torch is oscillating Up and Down reduce the Torch Gain V37. If the center position is oscillating (snaking the bead) reduce the Cross-seam Gain V36. If the torch moves up and out of the joint, as if it has lost the seam, the ARC may be riding in the weld pool and unable to locate a wall or side of the joint. To correct this situation, increase Oscillator width and/or modify the weld procedure to improve weld bead contour. Joint geometry will affect tracking ability. Take a look at the uploaded tracking data. The first column of data uploaded to the terminal is the oscillator center position. The second column is the torch height position. The Torch and Center position should be moving slowly from sample to sample and the direction should change slowly.

7.5.3 WIDTH CONTROL TRACKING MODE 1 - W7=1

STEP 1 Make sure that the Torch Height tracking is set up correctly. If the Torch Height Controls have not been set up, the system will not produce stable cross-seam tracking. To set the Tracking Mode to 1, from the WELDSEQ Program terminal, type **W7=1***(enter)*.

STEP 2 After obtaining stable torch height tracking set the cross seam Gain V36 to ½ of the value used for torch height (i.e. V37=20 then V36=10). Set the Cross-seam Correction Vector Limit V76 to ½ the value of the Cross-seam Gain (V36) value (i.e. V36=10 then V76=5). Set the Oscillation width limits by setting the variable V54 to some value equal to the minimum width for the weld joint opening and the variable V55 to a value equal to the maximum weld joint opening. Set the Depth-of-Penetration (V52) to a value of 10. Lock the adaptive travel speed by setting variable V62 and variable V63 to the same speed set in the weld travel speed parameter.

STEP 3 Enable Cross-seam tracking by pressing the ALTER key on the WSC-1000. Use the FWD key to scroll to the" WEAVE PARAMETERS" menu. Press the ENTER key. Use the FWD key to scroll to the "AUTO CENTER?" parameter and set it to "YES". Press the ALTER key to exit. To enable the cross seam tracking from the WELDSEQ terminal Program type **W1=1** <*enter*> then type **W5=1** <*enter*> to save the change to the current schedule.

STEP 4 Enable Tracking data upload by entering the following terminal command, **W6=1***(enter)*. When in this mode, the tracking data will be uploaded to the terminal screen. The data is displayed in column format. From left to right the columns are Horizontal Center, Vertical Position (Torch Height), Oscillator Width, Arc Volts, Arc Amps and Travel Speed.

STEP 5 Make a weld and observe the torch motion, both height and center position. The torch will move some on both axes. If the torch is correcting its position in small increments it is operating correctly. If the torch is oscillating Up and Down reduce the Torch Gain V37. If the center position is oscillating (snaking the bead) reduce the Cross-seam Gain V36. If the width decreases to the minimum width set in V54 and is not reaching the sidewalls, increase the depth of penetration V52. If the width increases to the maximum width or the arc is riding to high on the sidewalls, decrease the Depth-of-Penetration value V52. If the torch moves up and out of the joint, as if it has lost the seam, the arc may be riding in the weld pool and unable to locate a wall or side of the joint. To correct this situation, increase Oscillator width and/or modify the weld procedure to improve weld bead contour. Joint geometry will affect tracking ability. Review the uploaded tracking data. The first column of data uploaded to the terminal is the oscillator center position. The second column is the torch height position. The Torch and Center position should be moving slowly from sample to sample and the direction should change slowly.

7.5.4 RIGHT SIDE TRACKING MODE 2 – W7=2

STEP 1 Make sure that the Torch Height tracking is set up correctly. If the Torch Height Controls have not been set up, the system will not produce stable cross-seam tracking. To set the Tracking Mode to 2, from the WELDSEQ Program terminal, type **W7=2***(enter)*.

STEP 2 After obtaining stable torch height tracking set the cross seam Gain V36 to ½ of the value used for torch height (i.e. V37=20 then V36=10). Set the Cross-seam Correction Vector Limit V76 to ½ the value of the Cross-seam Gain (V36) value (i.e. V36=10 then V76=5). Set the Depth-of-Penetration (V52) to a value of 10.

STEP 3 Enable Cross-seam tracking by pressing the ALTER key on the WSC-1000. Use the FWD key to scroll to the" WEAVE PARAMETERS" menu. Press the ENTER key. Use the FWD key to scroll to the "AUTO CENTER?" parameter and set it to "YES". Press the ALTER key to exit. To enable the cross seam tracking from the WELDSEQ terminal Program type **W1=1** <*enter*> then type **W5=1** <*enter*> to save the change to the current schedule*.*

STEP 4 Enable Tracking data upload by entering the following terminal command, **W6=1***(enter)*. When in this mode, the tracking data will be uploaded to the terminal screen. The data is displayed in column format. From left to right the columns are Horizontal Center, Vertical Position (Torch Height), Oscillator Width, Arc Volts, Arc Amps and Travel Speed.

STEP 5 Make a weld and observe the torch motion, both height and center position. The torch will move some on both axes. If the torch is correcting its position in small increments it is operating correctly. Note the location of the weld bead and verify that it is tracking the right side or right wall of the joint. If the torch climbs the wall or walks out of the joint, decrease the Depth-of-Penetration value V52. If the arc is tracking low on the sidewall increase the Depth-of-Penetration value V52. Make small adjustments by increasing or decreasing the value until the torch tracks correctly. If the center position is oscillating (snaking the bead) reduce the Cross-seam Gain V36.

STEP 6 The first column of data uploaded to the terminal is the oscillator center position. The second column is the torch height position. The torch and center position should be moving slowly from sample to sample and the direction should change slowly.

7.5.5 LEFT SIDE TRACKING MODE 3 – W7=3

STEP 1 Make sure that the torch height tracking is set up correctly. If the Torch Height Controls have not been set up, the system will not produce stable cross-seam tracking. To set the Tracking Mode to 3, from the WELDSEQ Program terminal, type **W7=3***(enter)*.

STEP 2 After obtaining stable torch height tracking set the cross seam Gain V36 to ½ of the value used for torch height (i.e. V37=20 then V36=10). Set the Cross-seam Correction Vector Limit V76 to ½ the value of the Cross-seam Gain (V36) value (i.e. V36=10 then V76=5). Set the Depth-of-Penetration (V52) to a value of 10.

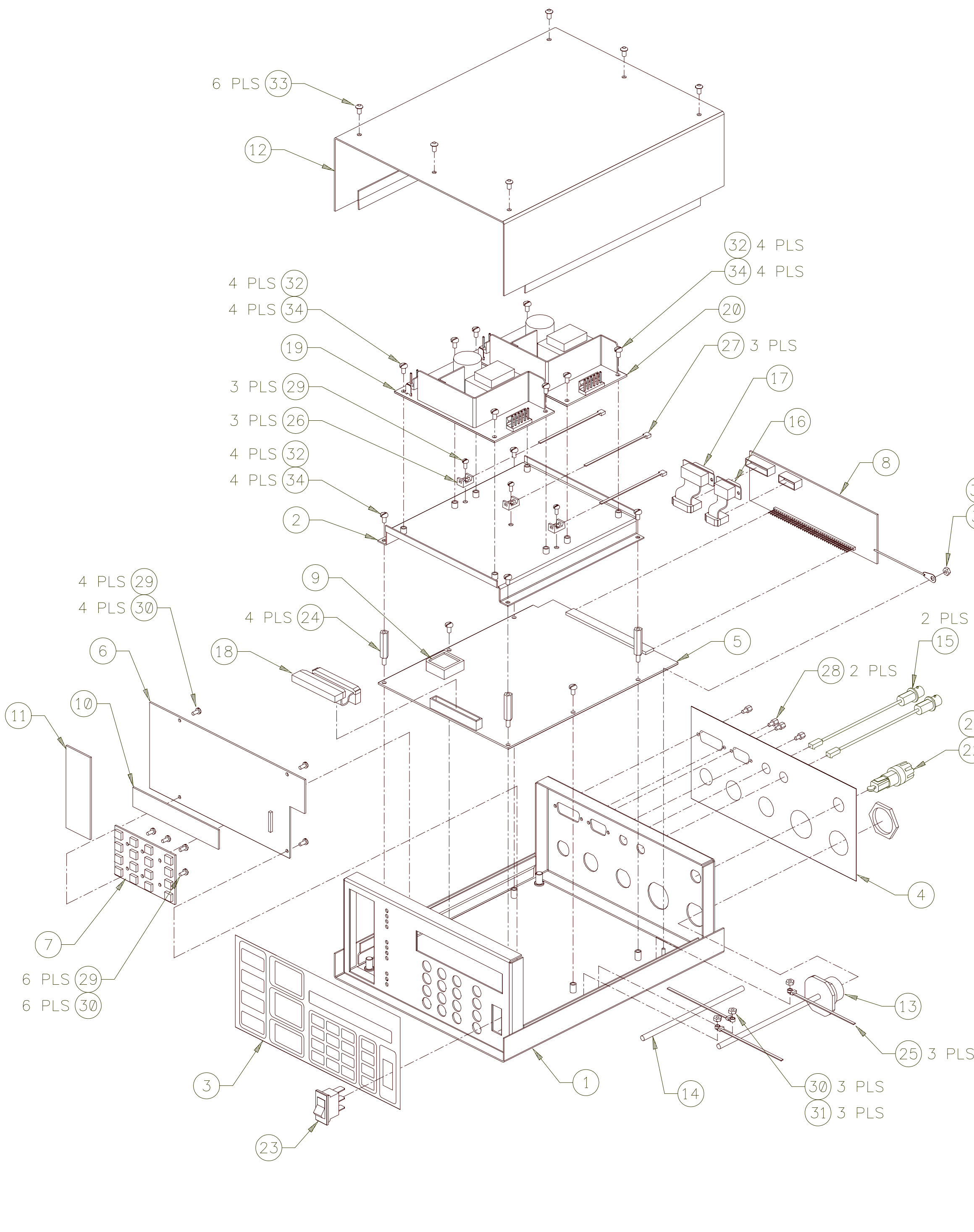
STEP 3 Enable Cross-seam tracking by pressing the ALTER key on the WSC-1000. Use the FWD key to scroll to the" WEAVE PARAMETERS" menu. Press the ENTER key. Use the FWD key to scroll to the "AUTO CENTER?" parameter and set it to "YES". Press the ALTER key to exit. To enable the cross seam tracking from the WELDSEQ terminal Program type **W1=1** <*enter*> then type **W5=1** <*enter*> to save the change to the current schedule.

STEP 4 Enable Tracking data upload by entering the following terminal command, **W6=1***(enter)*. When in this mode, the tracking data will be uploaded to the terminal screen. The data is displayed in column format. From left to right the columns are Horizontal Center, Vertical Position (Torch Height), Oscillator Width, Arc Volts, Arc Amps and Travel Speed.

STEP 5 Make a weld and observe the torch motion, both height and center position. The torch will move some on both axes. If the torch is correcting its position in small increments it is operating correctly. Note the location of the weld bead and verify that it is tracking the left side or left wall of the joint. If the torch climbs the wall or walks out of the joint, decrease the Depth-of-Penetration value V52. If the arc is tracking low on the sidewall increase the Depth-of-Penetration value V52. Make small adjustments by increasing or decreasing the value until the torch tracks correctly. If the center position is oscillating (snaking the bead) reduce the Cross-seam Gain V36.

STEP 6 The first column of data uploaded to the terminal is the oscillator center position. The second column is the torch height position. The torch and center position should be moving slowly from sample to sample and the direction should change slowly.

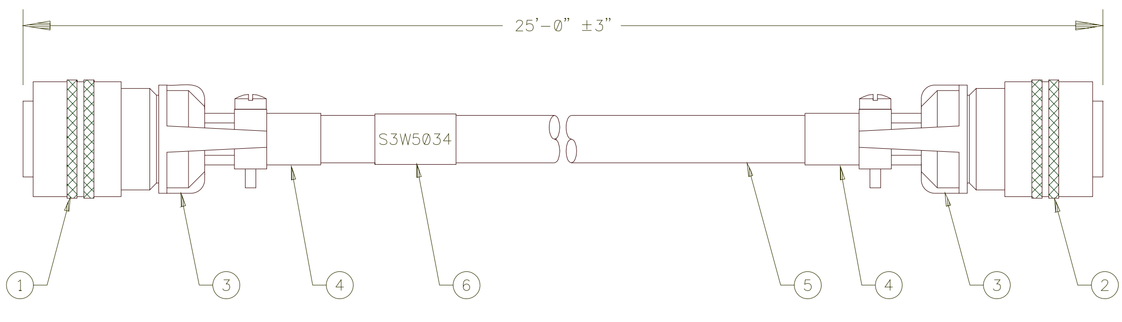
A-1 WSC-1000 ENCLOSURE P/N: S3A5023

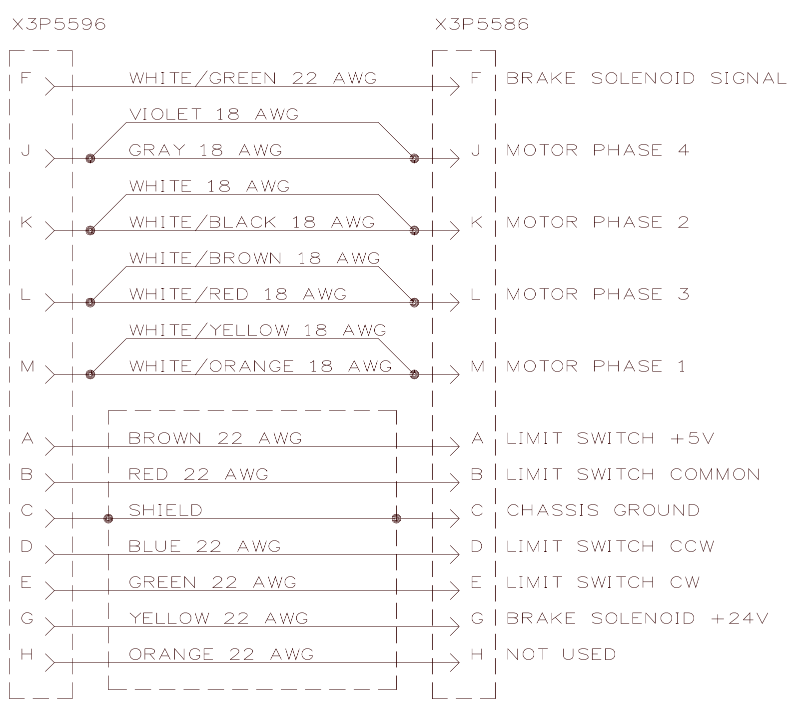


ITEM	QTY	PART NO	DESCRIPTION
1	1	S3E5039	Enclosure
2	1	S3E5040	Power Supply Plate
3	1	S3E5041	Front Overlay
4	1	S3E5042	Rear Overlay
5	1	S5A5021	CPU P.C.B. Assembly
6	1	S5A5022	Display P.C.B. Assembly
7	1	S5A5023	Keypad P.C.B. Assembly
8	1	S5A5024	Connector P.C.B. Assembly
9	1	S5I5011	Eprom
10	1	S2M5080	Control Display Lens
11	1	S2M5081	Sensor Display Lens
12	1	S3E5035	Cover
13	1	S3W5037	AC Wiring Harness
14	1	S3W5038	DC Wiring Harness
15	2	S3W5039	Lan Cable
16	1	S3W5040	Term Cable
17	1	S3W5041	Pendant Cable
18	1	S3W5042	Front Panel Cable
19	1	X3T5067	Triple Voltage Power Supply
20	1	X3T5065	Single Voltage Power Supply
21	1	X3C5014	Fuse, 1 amp 3ag
22	1	X3C0003	Fuse Holder
23	1	X3S5078	Rocker Switch
24	4	X6S5051	Spacer
25	3	X3Z5090	Cable Tie
26	3	X6Z5022	Cable Tie Mount
27	3	X6Z5034	Cable Tie
28	2	X3Z5027	Female Screwlock Kit
29	11		#4-40 x 1/4" Pan Hd Screw
30	13		#4 Internal Lock Washer
31	2		#4-40 Hex Nut
32	14		#6-32 x 5/16" Pan Hd Screw
33	6		#6-32 x 1/4" Button Hd Screw
34	14		#6 Internal Lock Washer

A-2 MICROSTEP DRIVE CABLE P/N: S3W5034

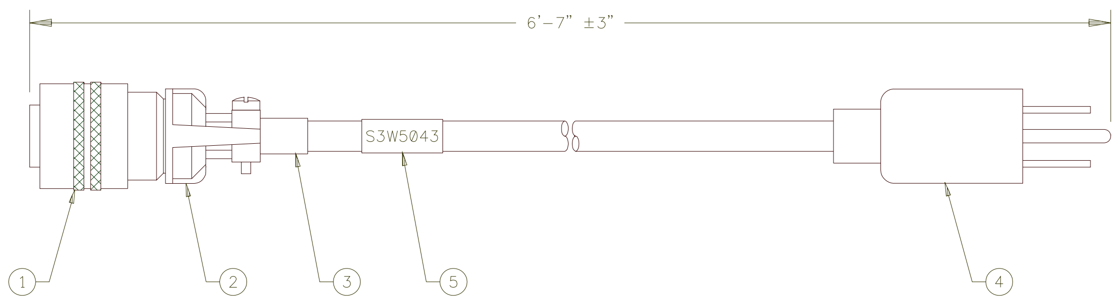
ITEM	QTY	PART NO	DESCRIPTION
1	1	X3P5596	Connector, Plug 12 Circuit
2	1	X3P5586	Connector, Plug 12 Circuit
3	1	X3P5589	Clamp, Cable
4	2	X3P5505	Boot, Cable Clamp
5	25'	X3W0077	Cable, Series 1000
	1	X3Z5089	Tag, Identification





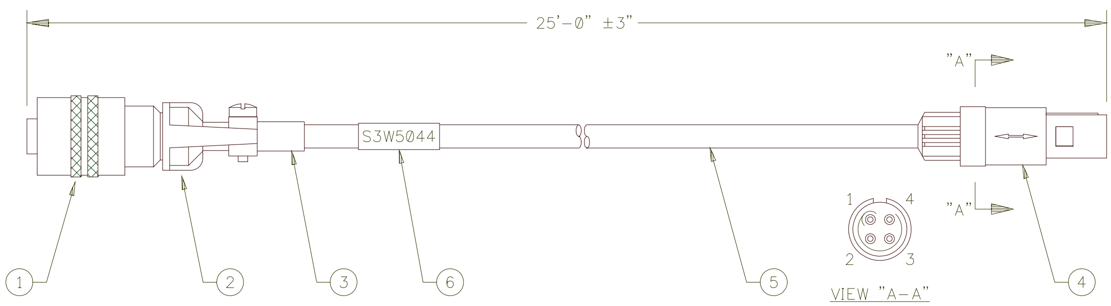
A-3 POWER CABLE P/N: S3W5043

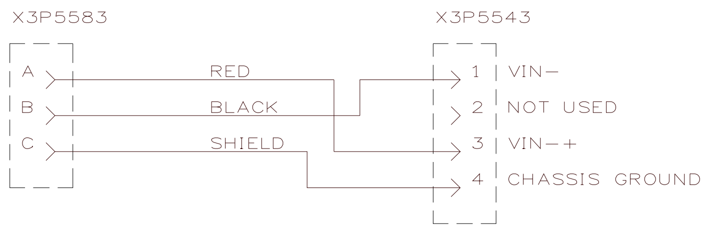
ITEM	QTY	PART NO	DESCRIPTION
1	1	X3P5585	Connector, Plug 3 Circuit
2	1	X3P5126	Clamp, Cable
3	1	X3P5519	Boot, Cable Clamp
4	1	X3W5022	Cable, Power
5	1	X3Z5089	Tag, Identification



A-4 VOLTAGE SENSOR CABLE P/N: S3W5044

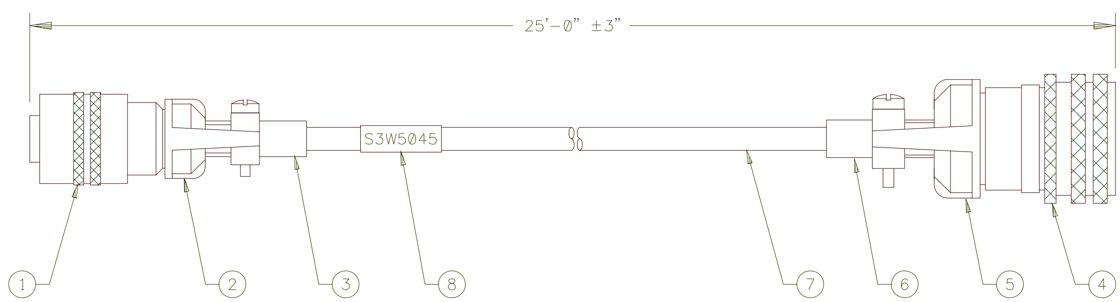
ITEM	QTY	PART NO	DESCRIPTION
1	1	X3P5583	Connector, Plug 3 Circuit
2	1	X3P5587	Clamp, Cable
3	1	X3P5618	Boot, Cable Clamp
4	1	X3P5543	Connector, Plug 4 Circuit Gray
7	25'	X3W5025	Cable, 3 Conductor 22 AWG Shielded
8	1	X3Z5089	Tag, Identification

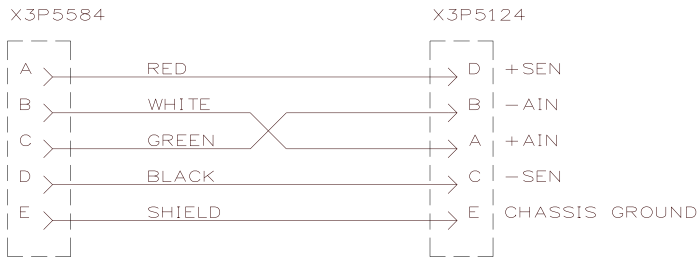




A-5 CURRENT SENSOR CABLE P/N: S3W5045

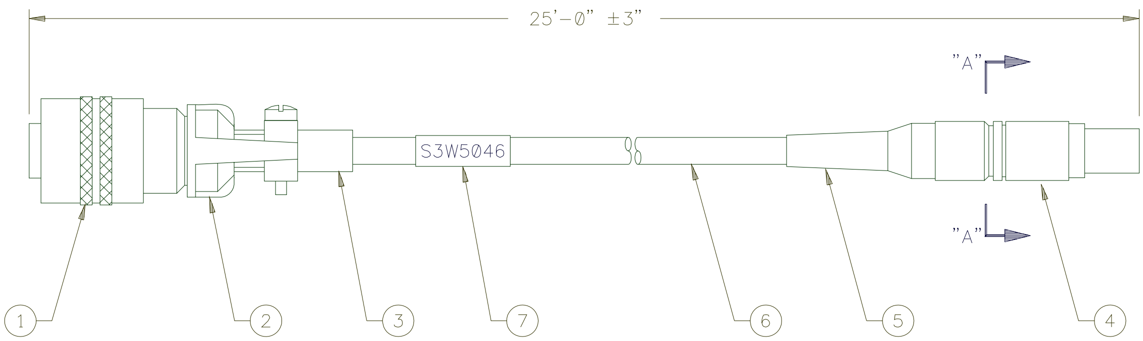
ITEM	QTY	PART NO	DESCRIPTION
1	1	X3P5584	Connector, Plug 5 Circuit
2	1	X3P5588	Clamp, Cable
3	1	X3Z5001	Boot, Cable Clamp
4	1	X3P5124	Connector, Plug 5 Circuit
5	1	X3P5126	Clamp, Cable
6	1	X3P5519	Boot, Cable Clamp
7	25'	X3W5037	Cable, 4 Conductor 22 AWG Shielded
8	1	X3Z5089	Tag, Identification

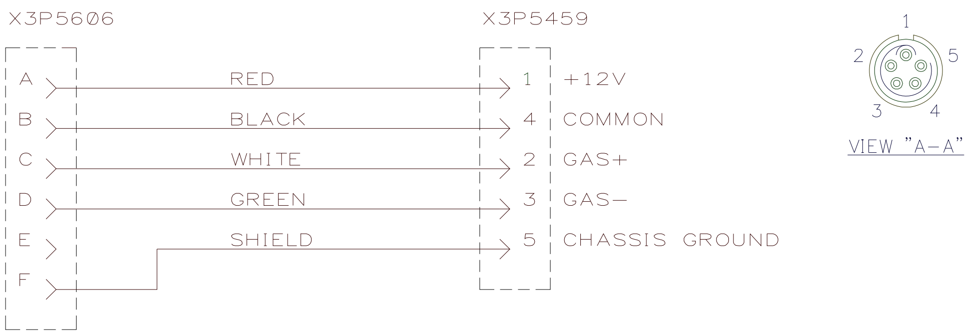




A-6 GAS FLOW SENSOR CABLE P/N: S3W5046

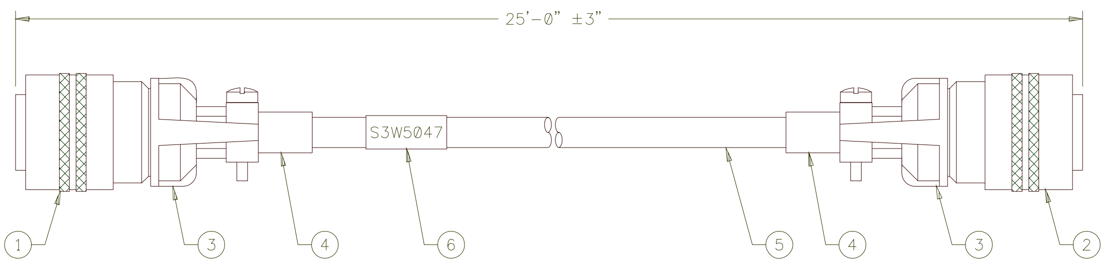
ITEM	QTY	PART NO	DESCRIPTION
1	1	X3P5606	Connector, Plug 6 Circuit
2	1	X3P5588	Clamp, Cable
3	1	X3Z5001	Boot, Cable Clamp
4	1	X3P5628	Connector, Plug 5 Circuit
5	1	X3P5629	Relief, Strain Yellow
6	25'	X3W5037	Cable, 4 Conductor 22 AWG Shielded
7	1	X3Z5089	Tag, Identification

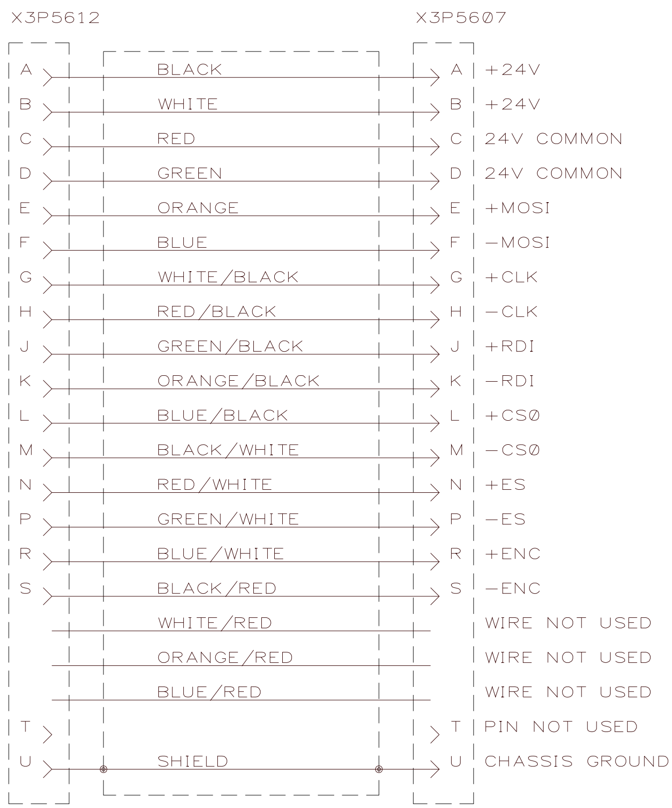




A-7 REMOTE I/O CABLE P/N: S3W5047

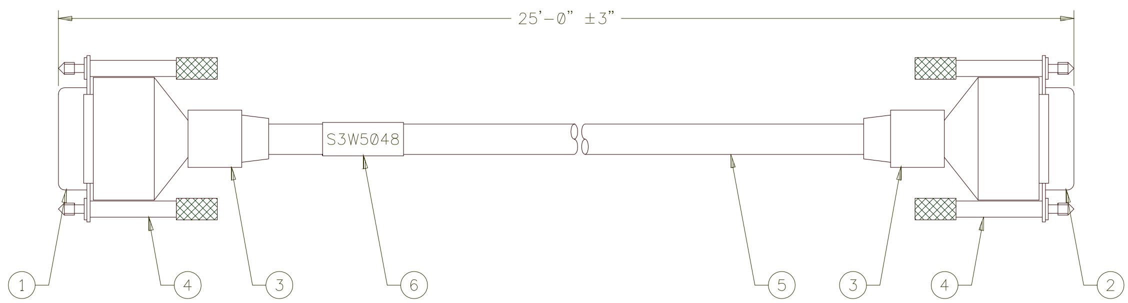
ITEM	QTY	PART NO	DESCRIPTION
1	1	X3P5612	Connector, Plug 18 Circuit
2	1	X3P5607	Connector, Plug 18 Circuit
3	2	X3P5589	Clamp, Cable
4	2	X3P5505	Boot, Cable Clamp
5	25'	X3W5050	Cable, 25 Conductor 22 AWG Shielded
6	1	X3Z5089	Tag, Identification

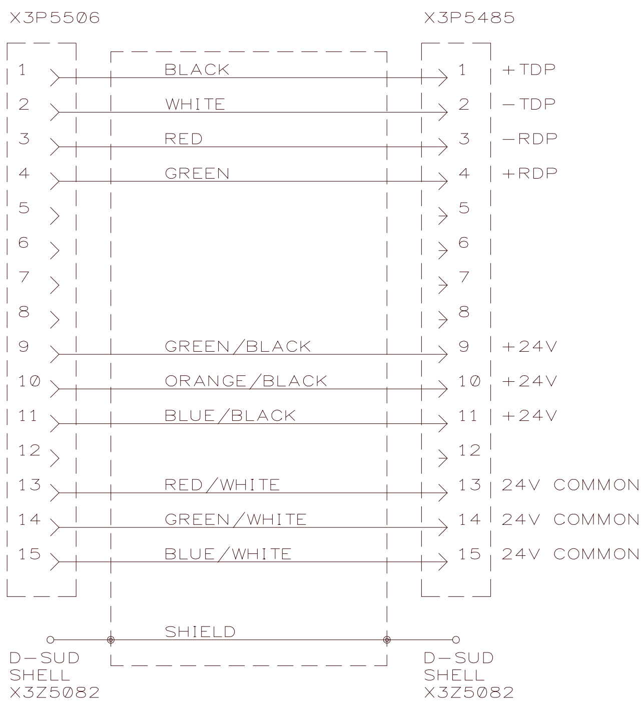




A-8 PENDANT CABLE P/N: S3W5048

ITEM	QTY	PART NO	DESCRIPTION
1	1	X3P5506	Connector, D-sub 15 Circuit
2	1	X3P5485	Connector, D-sub 15 Circuit
3	2	X3Z5082	Shell, D-sub
4	2	X3Z5084	Kit, Thumb Screw D-sub
5	25'	X3W5072	Cable, 10 Conductor 22 AWG Shielded
6	1	X3Z5089	Tag, Identification

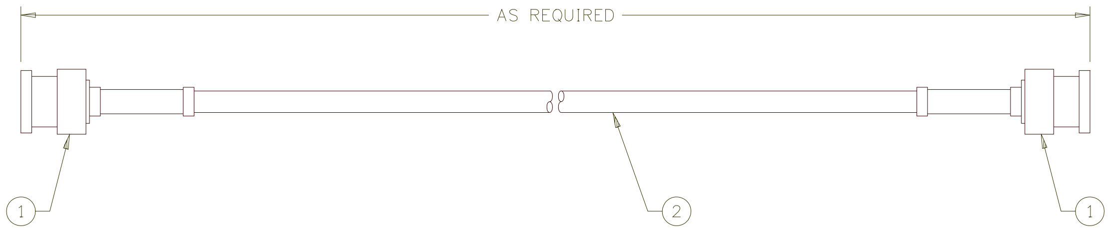




NOTE: SOLDER BOTH ENDS OF CABLE
SHIELD TO D-SUB SHELL.

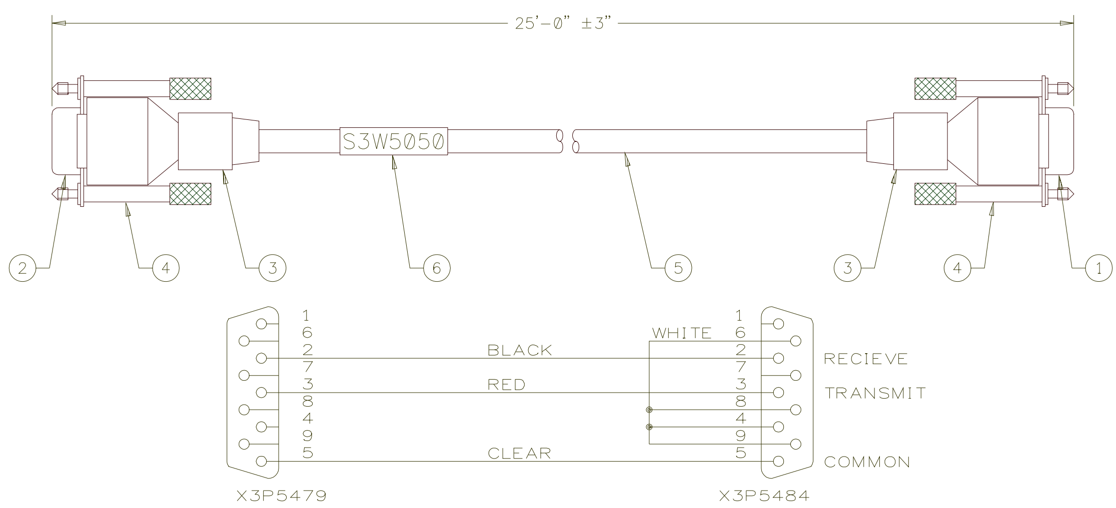
A-9 LAN CABLE P/N: S3W5049

ITEM	QTY	PART NO	DESCRIPTION
1	2	X3P5619	Connector, BNC
2	A/R	X3W5076	Cable, Coaxial



A-10 TERM CABLE P/N: S3W5050

ITEM	QTY	PART NO	DESCRIPTION
1	1	X3P5484	Connector, D-sub 9 Circuit
2	1	X3P5479	Connector, D-sub 9 Circuit
3	2	X3Z5081	Shell, D-sub
4	2	X3Z5084	Kit, Thumb Screw D-sub
5	25'	X3W5025	Cable, 3 Conductor 22 AWG Shielded
6	1	X3Z5089	Tag, Identification
7	0.2'		Wire, 22 AWG White Teflon Coated



NOTES:

1 – USE 22 AWG WHITE WIRE TO JUMPER PINS 4, 6, 8 AND 9 AT FEMALE CONNECTOR.

1 – SOLDER CABLE SHIELD AT BOTH ENDS TO D-SUB SHELL.

B-1 TOOLS NEEDED

You will need a #2 Phillips screwdriver, a small Flat tip screwdriver, a 5/64 Hex head driver, a Digital Volt Meter (DVM) and an external terminal (computer) connected to the RS-232 port of the WSC, with the WSC-1000 programming screen displayed.

B-2 PROCEDURES

STEP 1 Make sure that the voltage probe and current sensor are connected to the WSC-1000. With the power switch “ON”, read and record the current calibration values for your WSC-1000. To do this type “C0?” and record the value on the terminal screen. Do this for each of the calibration values (C0 – C5) located on page 4-2 0f this manual.

NOTE: *Each WSC is factory calibrated and the values are recorded on the board by the EPROM PLCC socket or on the inside of the WSC cover. Use these values if you suspect that the WSC is out of tolerance for factory calibration. If you need to recalibrate the WSC to your specific needs or to reset the factory values, follow the procedures below.*

STEP 2 Power down the WSC-1000 Weld Sequence Control and remove the cover mounting screws and cover. Remove the four, power supply mounting screws. Without unplugging the power supply, lay the power supply upside down on a suitable insulating material. Make sure that the power supply is not in contact with enclosure or any external conductive material. Using a small blade screwdriver set switch 1 of the dip switch to the "ON" or “CLOSED” position. The dip switch is located close to the EPROM PLCC socket. Power up the WSC controller by turning the power switch "ON". The WSC will display the following Message:

S5I5011 VER #.##
WSC CALIBRATION

Perform the following steps to calibrate the WSC analog inputs:

STEP 3 With the power source “ON” (make sure the current sensor is connected to the WSC and installed correctly) read the value displayed on the WSC WIRE DISPLAY meter. The value displayed is your CURRENT SENSOR EXCITATION VALUE. Match this value with the value that you recorded for **“C0”** in STEP 1. To change the value type **“C0= ###”** and enter (the ### equals the value displayed on the WSC WIRE DISPLAY). Once the two values match, turn the **WSC OFF**. Set **DIP SWITCH 1** back to the **OPEN** position. Carefully replace the power supply and it’s four screws and reinstall the cover. Turn the WSC back ON.

NOTE: *C0 – C5 are digital pots with a MIN/MAX value of 0 – 255.*

STEP 4 Using the terminal key board adjust the WSC Analog calibration value, **“C3”** (ARC CURRENT ZERO VALUE), by increasing or decreasing the value until the WSC AMPS Display Meter reads “0”.

STEP 5 Using a calibrated welding power source with a load bank, place a load on the power source and note the current value of the power source. The load value should close to MAX power for calibration purposes. Using the terminal key board adjust the WSC Analog calibration value, **“C2”** (ARC CURRENT GAIN VALUE), by increasing or decreasing the value until the WSC AMPS Display Meter matches the value of the power source. After you have set the gain value go back and check the zero value. Adjust these two values until desired results are attained.

STEP 6 Using the terminal key board adjust the WSC Analog calibration value, **“C5”** (ARC VOLTAGE ZERO VALUE), by increasing or decreasing the value until the WSC VOLTS Display Meter reads “0”.

STEP 7 Using a 0 – 90 vdc power supply connect the voltage probe to the supply and adjust the supply for 90.0 volts output. Using the terminal key board adjust the WSC Analog calibration value, **“C4”** (ARC VOLTAGE GAIN VALUE), by increasing or decreasing the value until the WSC VOLTS Display Meter matches the value of the power source. After you have set the gain value go back and check the zero value. Adjust these two values until desired results are attained.

STEP 8 After all adjustments are made, enter a **^W** (Control W) command by pressing the Ctrl and W keys at the same time to save the values to the WSC memory.