Computer Weld Technology, Inc.

10702 Old Bammel N Houston Rd.
Houston, TX 77086
Phone: (713) 462-2118
Fax: (713) 462-2503
Email: cwt@cweldtech.com

MWC™

Modular Weld Control

Operation / Installation Manual

Manual Part Number: T8M5008
Revised: February 20, 2009

Table of Contents

1.0 INSTALLATION GUIDE

1.1 MWC ENCLOSURE

Figure 1-1 shows the dimension and mounting pattern for the MWC. Locate the MWC in a suitable enclosure. Figure 1-2 shows the terminal block locations on bottom of MWC Enclosure. Allow access to the bottom terminal block panel and operational visibility of the top panel.

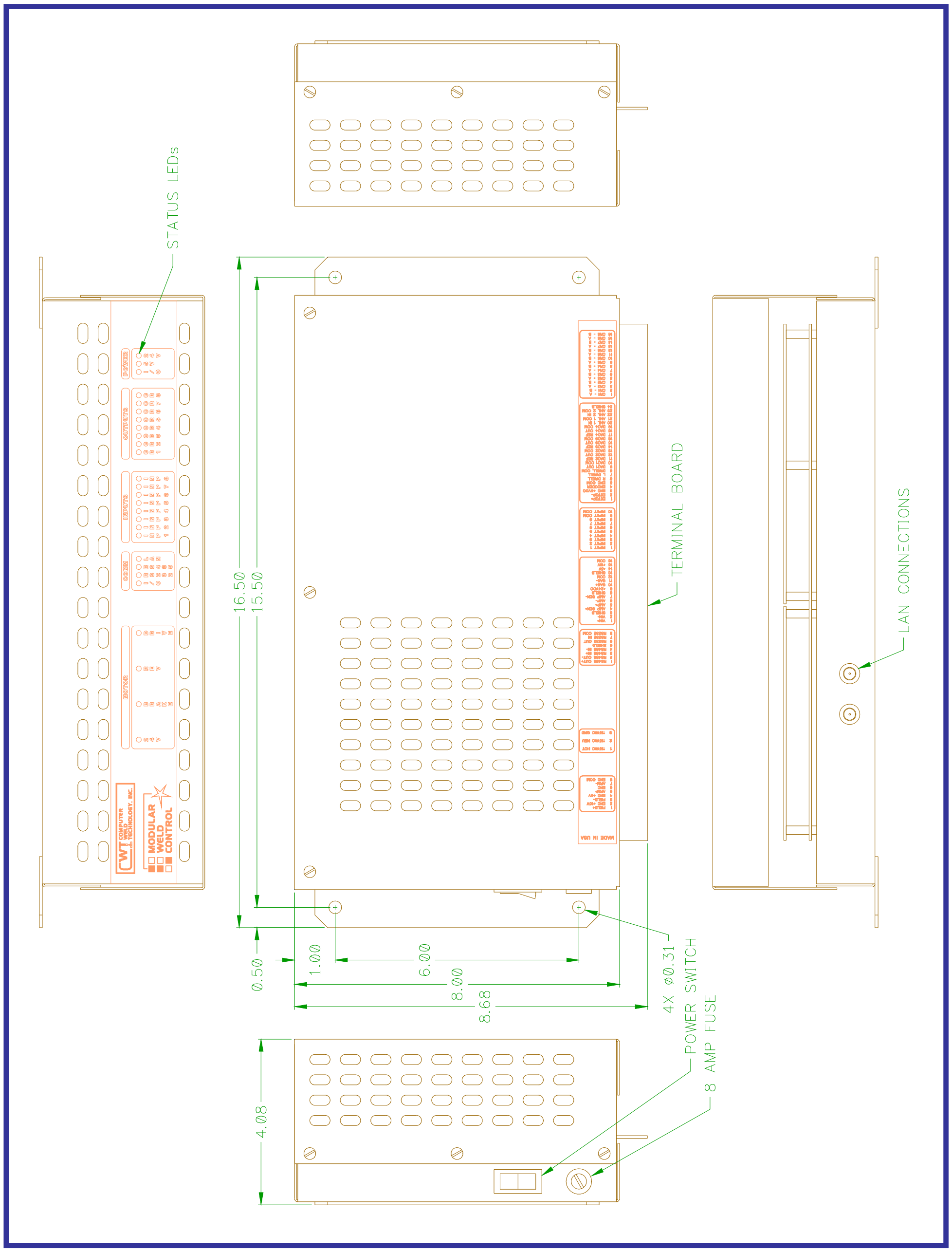


FIGURE 1-1
MWC Dimensional Outline

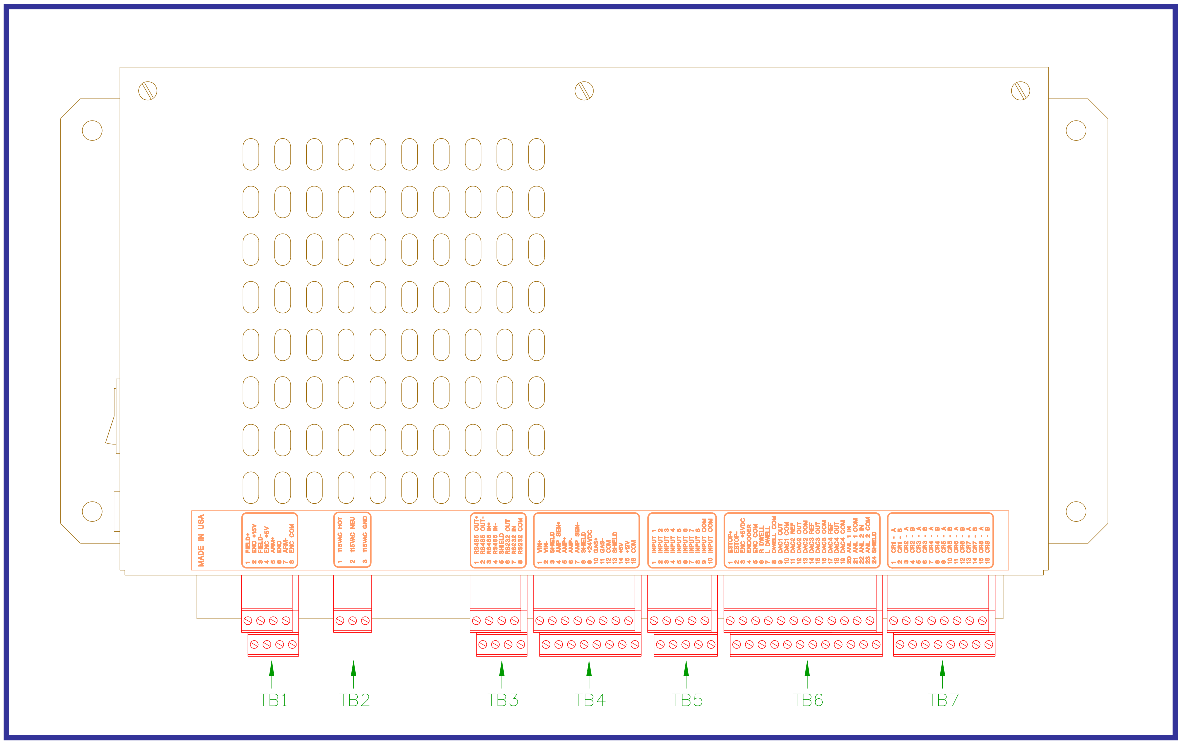


FIGURE 1-2
Rear View of MWC Enclosure

1.2 CONTROL WIRING PANEL

Locate the Control Wiring Panel, Figure 1-3, on the side of the enclosure so as to provide reasonable access to the connectors. Figure 1-4 shows the dimensional cutout for the connector panel. Route the control cables from the Control Wiring Panel to the MWC controller. Keep the MWC control cables away from any power control lines or cables. It is recommended that the cables be placed in a wiring duct independent of other high voltage control solenoid or motor wiring. Refer to Figure 1-5 or Table 1-1 and connect the control cables to the indicated terminal block connections. The cables should be trimmed to the correct length before installation. Do not coil any excess cable. Connect a suitable source of 115-vac power to the MWC to TB2. Connect a ground wire from TB2-3 to chassis ground.

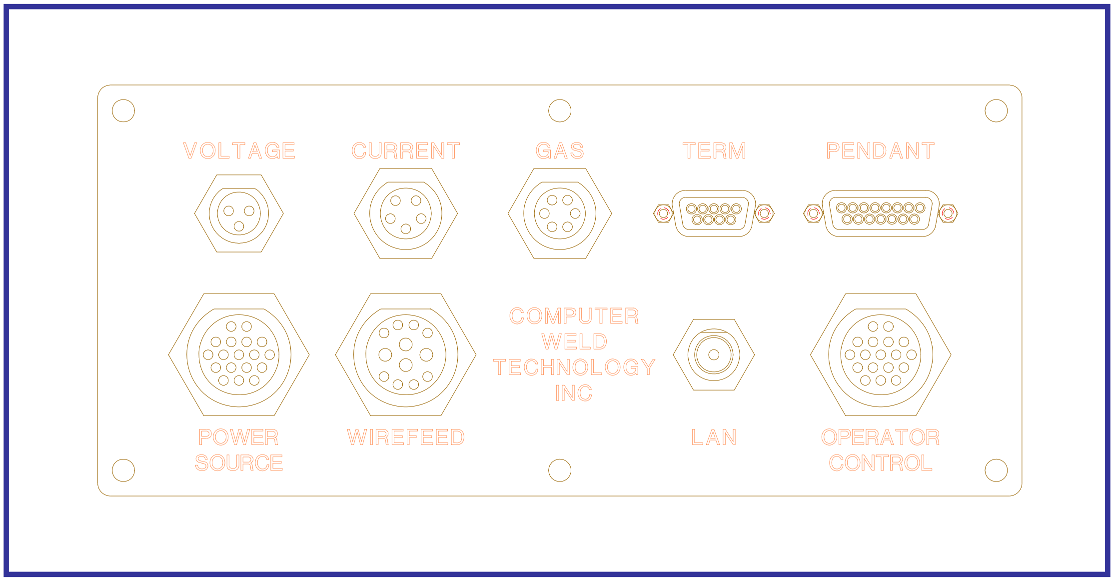


FIGURE 1-3
Control Wiring Panel

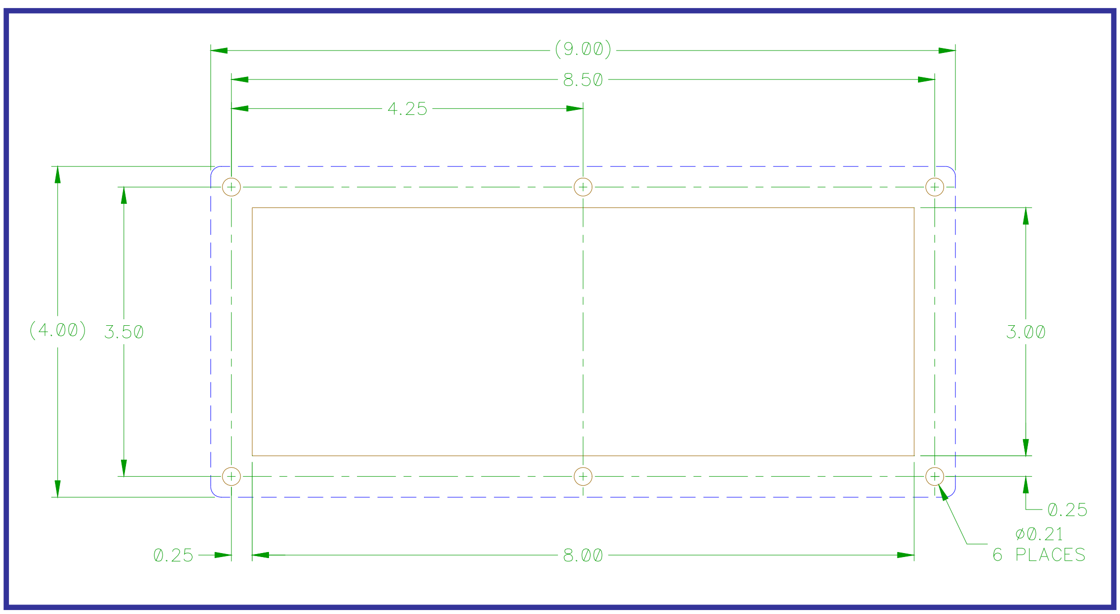


FIGURE 1-4
Panel Cutout for Control Wiring Panel

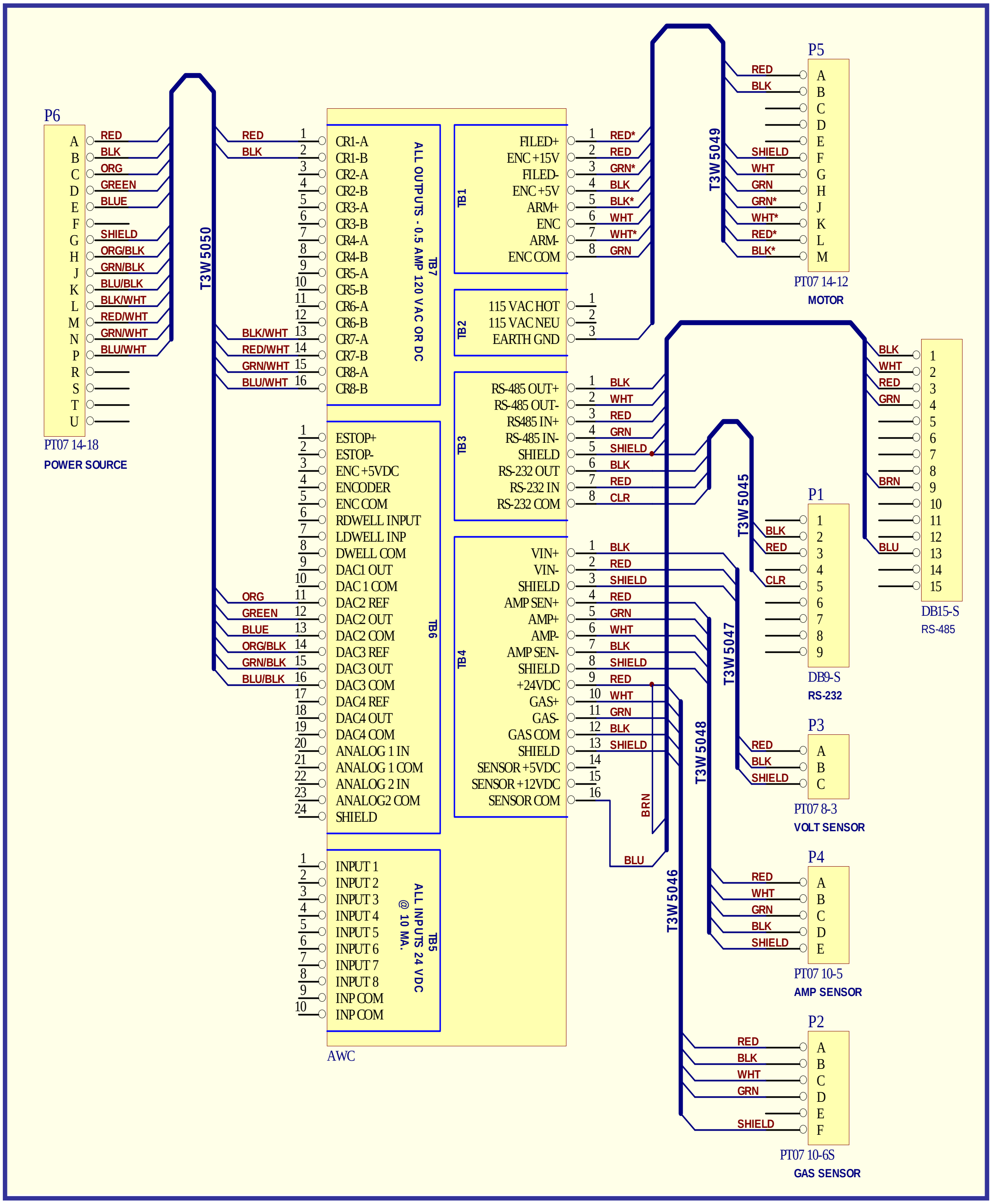


FIGURE 1-5
MWC External Cable Connection Schematic

FROM	TO	CABLE	COLOR	FUNCTION
P1-2	TB3-6	T3W5045	BLACK	RS-232 RECEIVE DATA INPUT
P1-3	TB3-7	T3W5045	RED	RS-232 TRANSMIT DATA OUTPUT
P1-5	TB3-8	T3W5045	CLEAR	RS-232 SIGNAL COMMON
	TB3-5	T3W5045	SHIELD	RS-232 CABLE SHIELD
P2-A	TB4-9	T3W5046	RED	GAS FLOW SENSOR +24 VDC OUTPUT
P2-B	TB4-12	T3W5046	BLACK	GAS FLOW SENSOR POWER COMMON
P2-C	TB4-10	T3W5046	WHITE	GAS FLOW SENSOR OUTPUT SIGNAL
P2-D	TB4-11	T3W5046	GREEN	GAS FLOW SENSOR OUTPUT SIGNAL COMMON
P2-F	TB4-13	T3W5046	SHIELD	GAS FLOW SENSOR CABLE SHIELD
P3-A	TB4-2	T3W5047	BLACK	VOLTAGE SENSOR SIGNAL INPUT (+)
P3-B	TB4-1	T3W5047	RED	VOLTAGE SENSOR SIGNAL INPUT (-)
P3-C	TB4-3	T3W5047	SHIELD	VOLTAGE SENSOR CABLE SHIELD
P4-A	TB4-4	T3W5048	RED	CURRENT SENSOR EXCITATION OUTPUT (+)
P4-B	TB4-6	T3W5048	WHITE	CURRENT SENSOR SIGNAL (-) INPUT
P4-C	TB4-5	T3W5048	GREEN	CURRENT SENSOR SIGNAL (+) INPUT
P4-D	TB4-7	T3W5048	BLACK	CURRENT SENSOR EXCITATION OUTPUT (-)
P4-E	TB4-8	T3W5048	SHIELD	CURRENT SENSOR CABLE SHIELD
P5-A	TB1-2	T3W5049	RED	WIRE FEED MOTOR ENCODER +15 VDC OUTPUT
P5-B	TB1-4	T3W5049	BLACK	WIRE FEED MOTOR ENCODER +5 VDC OUTPUT
P5-F	TB2-3	T3W5049	SHIELD	WIRE FEED ENCODER CABLE SHIELD
P5-G	TB2-6	T3W5049	WHITE	WIRE FEED ENCODER PULSE INPUT
P5-H	TB2-8	T3W5049	GREEN	WIRE FEED ENCODER COMMON
P5-J	TB2-3	T3W5049	GREEN	16 AWG – MOTOR FIELD OUTPUT (-)
P5-K	TB2-7	T3W5049	WHITE	16 AWG – MOTOR ARMETURE OUTPUT (-)
P5-L	TB2-1	T3W5049	RED	16 AWG – MOTOR FIELD OUTPUT (+)
P5-M	TB2-5	T3W5049	BLACK	16 AWG – MOTOR ARMETURE OUTPUT (-)
P6-A	TB7-1	T3W5050	RED	WELD CONTACTOR OUTPUT RELAY CR1-A
P6-B	TB7-2	T3W5050	BLACK	WELD CONTACTOR OUTPUT RELAY CR1-B
P6-C	TB6-11	T3W5050	ORANGE	REMOTE DAC2 OUTPUT REFERANCE HIGH
P6-D	TB6-12	T3W5050	GREEN	REMOTE DAC2 OUTPUT WIPER
P6-E	TB6-13	T3W5050	BLUE	REMOTE DAC2 OUTPUT REFERANCE LOW
P6-G	TB6-24	T3W5050	SHIELD	WELD REMOTE CONTROL CABLE SHIELD
P6-H	TB6-14	T3W5050	ORG/BLK	REMOTE DAC3 OUTPUT REFERANCE HIGH
P6-J	TB6-15	T3W5050	GRN/BLK	REMOTE DAC3 OUTPUT WIPER
P6-K	TB6-16	T3W5050	BLU/BLK	REMOTE DAC3 OUTPUT REFERANCE LOW
P6-L	TB7-13	T3W5050	BLK/WHT	SPARE CR7-A RELAY OUTPUT
P6-M	TB7-14	T3W5050	RED/WHT	SPARE CR7-B RELAY OUTPUT
P6-N	TB7-15	T3W5050	GRN/WHT	SPARE CR8-A RELAY OUTPUT
P6-P	TB7-16	T3W5050	BLU/WHT	SPARE CR8-B RELAY OUTPUT

TABLE 1-1
MWC Connector Panel Cable Wire List

1.3 ESTOP CONTROL INPUTS

The MWC has an ESTOP control input which must be active before the MWC can be used. The ESTOP input disconnects the I/O power and places the control processor in a reset condition. To deactivate the ESTOP function connect an external 24-vdc ESTOP signal to TB6-1 and the ESTOP common to TB6-2.

Note: *The ESTOP signal must be active for the MWC to function*.

The ESTOP signal should be opened in the event of an operator ESTOP command. This will reset the MWC outputs and halt all serial communications and reset the MWC PLC functions. After clearing the ESTOP input the MWC will restart the PLC at sequence 1 and reset the MWC weld sequence controller. During an ESTOP the I/O power LED will be "OFF".

Note: *If an external ESTOP signal is not available connect the TB6-1 (ESTOP+) to TB4-9 (+24) and connect TB6-2 (ESTOP-) to TB4-16 (COM).*

Connect a suitable power source control cable from the MWC connector panel P6 to the user supplied welding power supply. The MWC is designed to interface to any solid-state power source that has remote control capabilities. The following table provides functional description for the P6 connector:

PIN NO.	FUNCTIONAL DESCRIPTION
A	WELD CONTACTOR OUTPUT (N.O.) RELAY CONTACT FROM CR1-A
B	WELD CONTACTOR OUTPUT (COM) RELAY CONTACT FROM CR1-B
C	DIGITAL POT HIGH INPUT FROM POWER SOURCE REMOTE CONTROL TO DAC 2 REFERENCE
D	DIGITAL POT WIPER OUTPUT FROM DAC2 TO POWER SOURCE WIPER INPUT
E	DIGITAL POT LOW INPUT FROM POWER SOURCE REMOTE CONTROL TO DAC 2 COMMON
F	NO CONNECTION
G	REMOTE CONTROL CABLE SHIELD
H	SPARE DIGITAL POT HIGH INPUT TO DAC 3 REFERENCE INPUT
J	SPARE DIGITAL POT WIPER FROM DAC 3 OUTPUT
K	SPARE DIGITAL POT LOW INPUT TO DAC 3 COMMON INPUT
L	SPARE RELAY 1 OUTPUT (N.O) FROM CR7-A
M	SPARE RELAY 2 OUTPUT (COM) FROM CR7-B
N	SPARE RELAY 2 OUTPUT (N.O.) FROM CR8-A
P	SPARE RELAY 2 OUTPUT (COM) FROM CR8-B
R	NO CONNECTION
S	NO CONNECTION
T	NO CONNECTION
U	NO CONNECTION

Table 1-2
P6 welding power source connector pin out

To interface to specific power sources refer to the manufacture manual and connect P6-A and P6-B to the weld contactor remote control input. Connect P6-C to the remote control level reference high output. Connect P6-D to the remote level control wiper input. Connect P6-E to the remote control level low output.

The following table shows an example of connecting the MWC to a miller power source:

MWC P6 PIN	MILLER MS20-27P REMOTE CONNECTOR
A	A
B	B
C	C
D	D
E	E

Table 1-3
Miller 14 Pin Remote Control Pin Out

Connect a suitable wire feed motor control cable from the MWC connector panel P5 to the user supplied wire feed motor. The MWC is designed to interface to wire feed drive motors that use a 90-vdc-armature voltage. The following table provides functional description for the P5 motor connector:

PIN NO.	FUNCTIONAL DESCRIPTION
A	MOTOR ENCODER +15 VDC OUTPUT
B	MOTOR ENCODER +5 VDC OUTPUT
C	NO CONNECTION
D	NO CONNECTION
E	NO CONNECTION
F	ENCODER CONTROL CABLE SHIELD
G	MOTOR ENCODER PULSE INPUT SIGNAL
H	MOTOR ENCODER POWER COMMON OUTPUT
J	MOTOR FIELD (-) NEGATIVE OUTPUT
K	MOTOR ARMATURE (-) NEGATIVE OUTPUT
L	MOTOR FIELD (+) POSITIVE OUTPUT
M	MOTOR ARMATURE (+) POSITIVE OUTPUT

Table 1-4
Wire Drive Motor Connector Pin Out

1.4 CURRENT SENSOR INSTALLATION

The Current Sensor assembly consists of a Hall-Effect clamp-on device and a cable assembly for connection to the unit. <u>The Current Sensor must be installed around the work piece ground lead from the power supply. The two “RED DOTS” on the sensor must be oriented toward the most positive potential</u>. The location of the sensor is not critical and the welding cables may be as long as required for the application. Refer to Figure 1-6 for details.

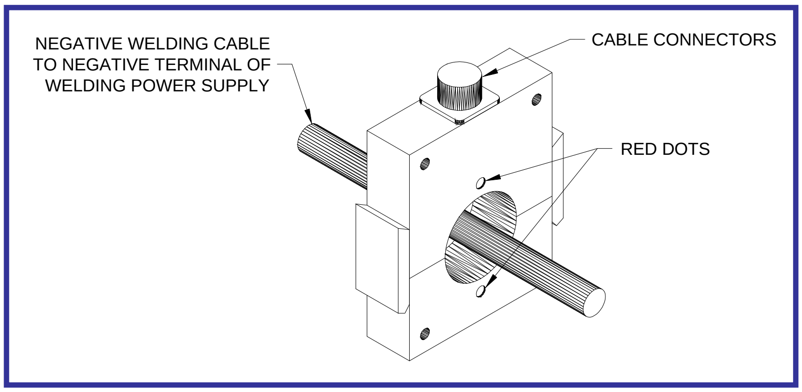


FIGURE 1-6
Current Sensor Installation

Refer to Figure 1-7 and install the arc current sensor (P/N X3Q5010). The current sensor can be mounted by installing 1/4-20 bolts through the holes provide on the outside of the sensor.

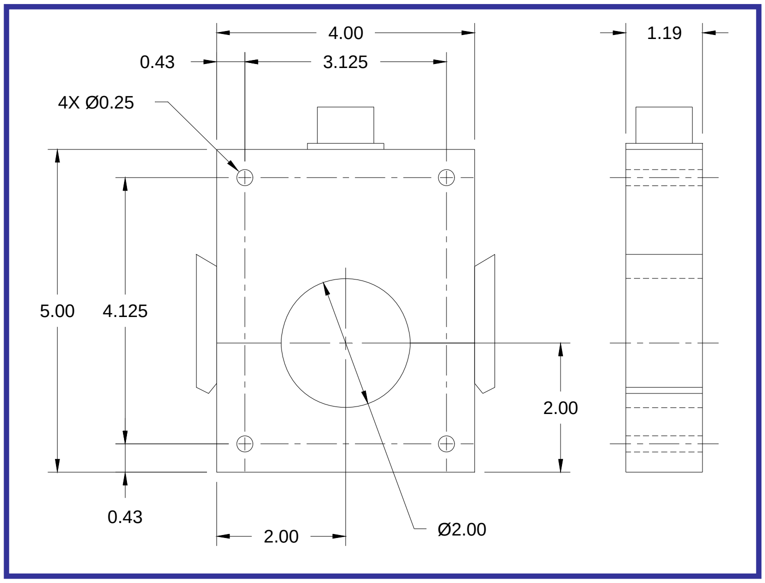


FIGURE 1-7
Current Sensor Dimensions

The Current Sensor Cable (P/N S3W5045) is a 25-foot cable. To connect the sensor cable to the unit, locate the port labeled “CURRENT” on the Control Wiring Panel. Next connect one end of the cable labeled “CURRENT” to the “CURRENT” port connector on the Control Wiring Panel and the other end connects to the Current Sensor. Refer to Figure 1-8 for cable installation.

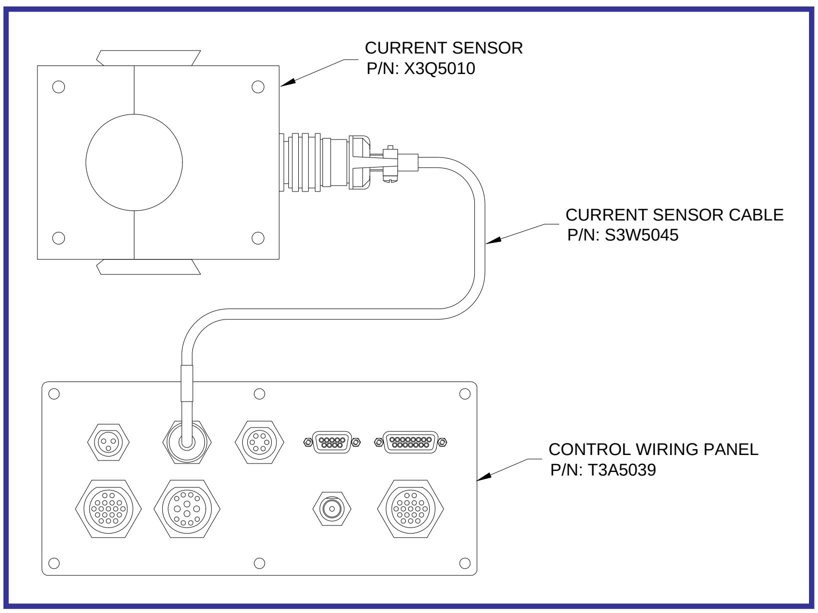


FIGURE 1-8
Current Sensor Cable Installation

1.5 VOLTAGE SENSOR INSTALLATION

The Voltage Sensor assembly consists of a probe device and a cable assembly for connection to the unit. The in-line arc voltage probe has two permanently attached leads, one RED and one BLACK, to facilitate the connection of the sensor to the welding system. Connect the RED / BLACK leads as close to the welding torch as possible in order to assure proper measurement. Connect the leads to the appropriate location indicated in the table below. If the connections provided on the leads are not suitable, any appropriate connector can be used. If the lead lengths are not the required lengths, they may be shortened or lengthened using the appropriate wire type.

APPLICATION	RED (+) LEAD	BLACK (-) Lead
GMAW	Electrode	Work
P-GMAW	Electrode	Work
GTAW	Work	Electrode
P-GTAW	Work	Electrode
SMAW (Reverse Polarity)	Electrode	Work
SMAW (Straight Polarity)	Work	Electrode
FCAW	Electrode	Work
PAW	Work	Electrode
P-PAW	Work	Electrode
SAW	Electrode	Work

Refer to Figure 1-9 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 MWC 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.

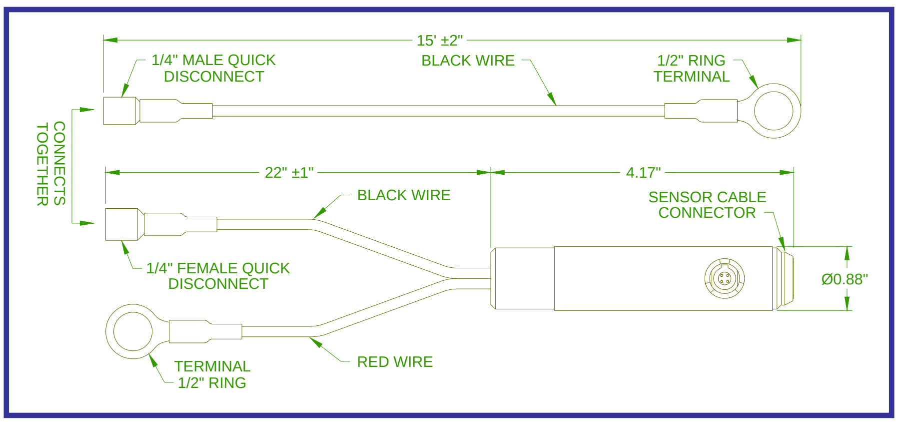


FIGURE 1-9
Voltage Sensor Installation

The Voltage Sensor Cable (P/N S3W5044) is a 25-foot cable. To connect the sensor cable to the unit, locate the port labeled “VOLTAGE” on the Control Wiring Panel. Next connect one end of the cable labeled “VOLTAGE” to the “VOLTAGE” port connector on the Control Wiring Panel and the other end connects to the Voltage Sensor. Refer to Figure 1-10 for cable installation.

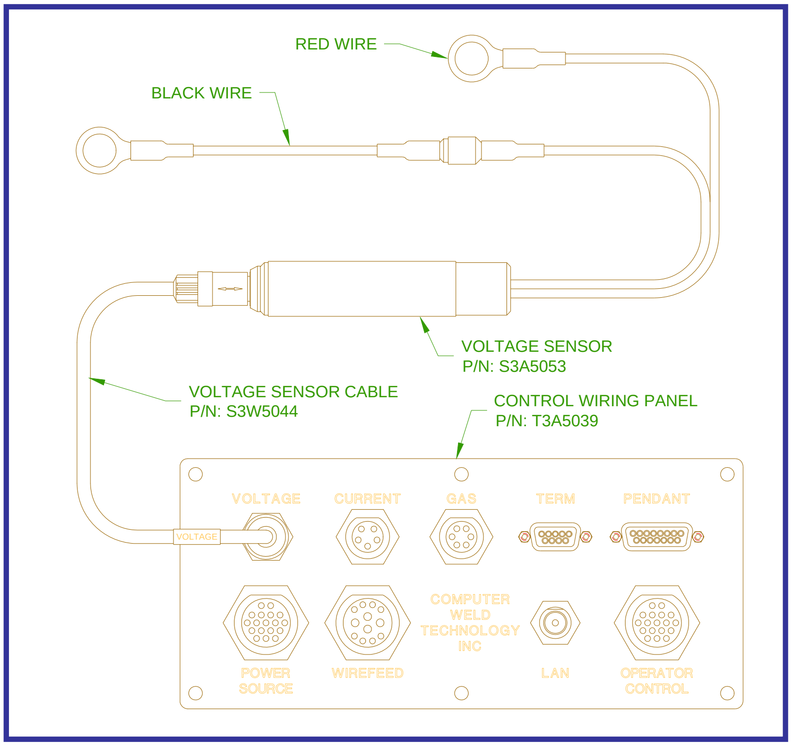


FIGURE 1-10
Voltage Sensor Cable Installation

1.6 GAS FLOW SENSOR INSTALLATION

The Gas Flow option (P/N: S0A5024) consists of a transducer assembly and a sensor cable. Refer to Figure 1-11 for mounting dimensions.

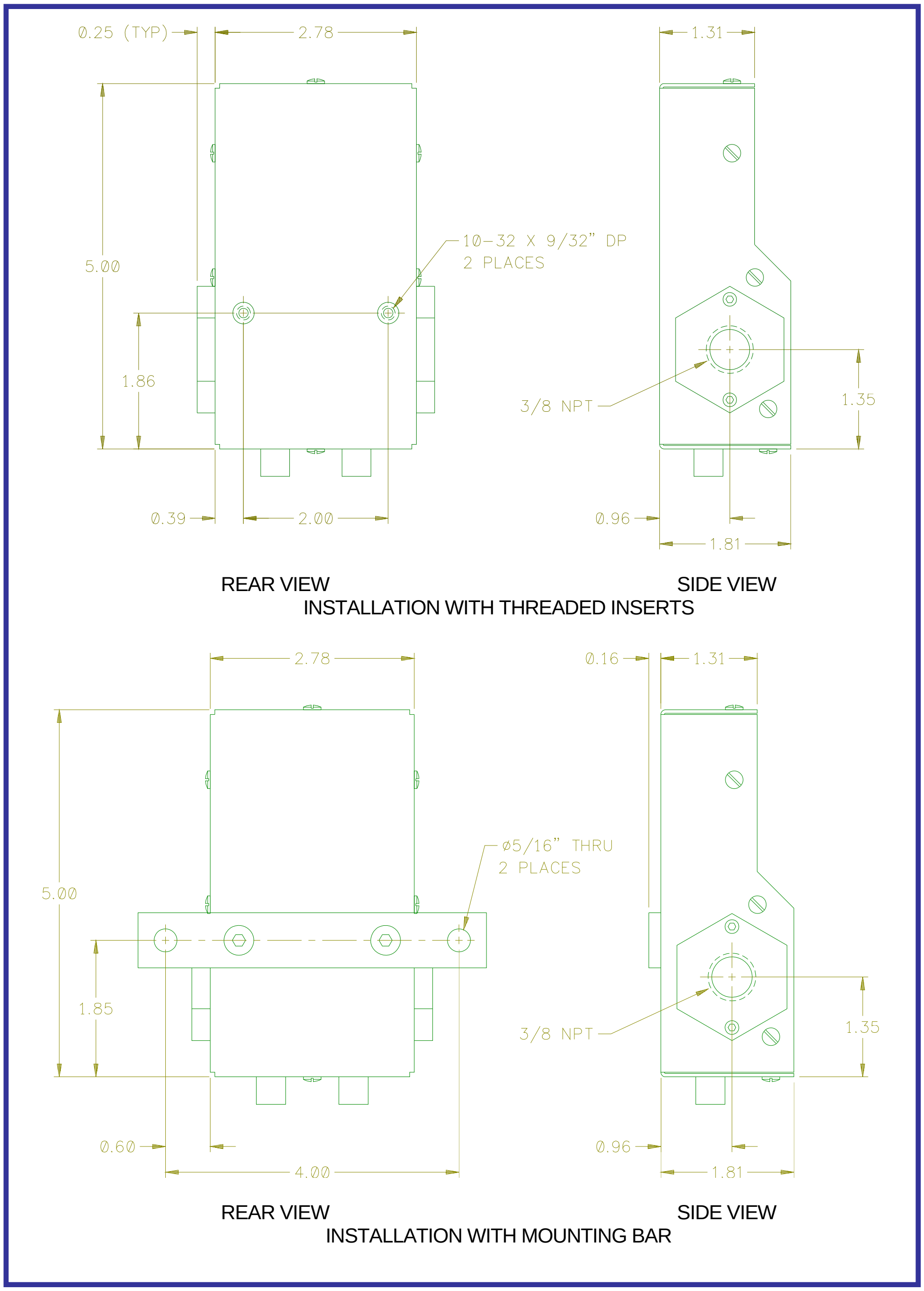


FIGURE 1-11
Gas Flow Sensor Installation

The unit is designed to measure gas flow with a maximum inlet pressure of 50 psi. The transducer should be installed with supplied fittings in the welding shielding gas lines, on the outlet side of the gas control solenoid valve. The unit should be located as close to the welding torch as practical. The transducer should be placed as far as possible from any source of high frequency interference, such as a GTAW welding power supply.

NOTE: *To avoid damage to the transducer assembly, do not use any type of pipe dope when making the connection.*

The Gas Flow Cable (P/N: S3W5046) is a 25-foot cable. To connect the sensor cable to the unit, locate the port labeled “GAS” on the Control Wiring Panel. Next connect one end of the cable labeled “GAS” to the “GAS” port connector on the Control Wiring Panel and the other end connects to the Gas Flow Sensor. Refer to Figure 1-12 for cable installation.

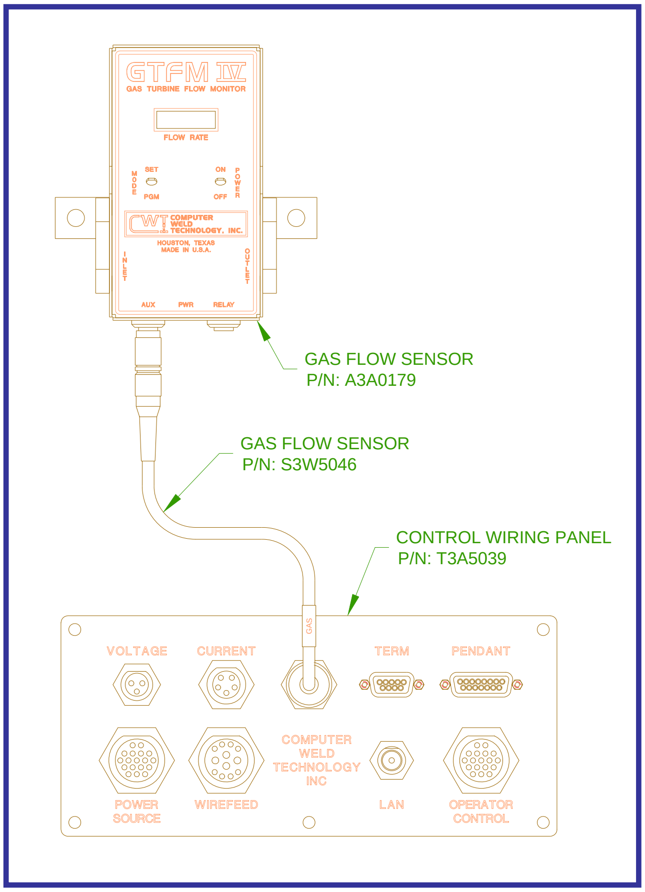


FIGURE 1-12
Gas Flow Sensor Cable Installation

1.7 TERM CABLE INSTALLATION

The Term Cable (P/N S3W5050) is to be used for communications between MWC and a personal computer. Refer to Figure 1-13 for cable installation.

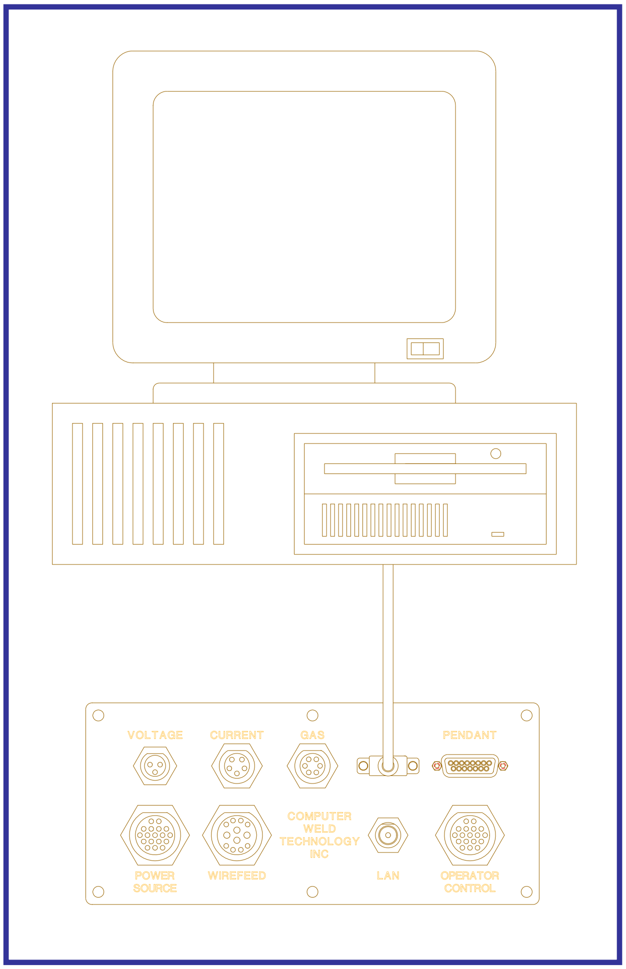


FIGURE 1-13
Term Cable Installation

1.8 REMOTE PENDANT INSTALLATION

The Remote Pendant Cable (P/N S3W5048) is to be used for communications between the MWC and the WRP-1000 Weld Remote Pendant (P/N: S3A5025). Refer to Figure 1-14 for cable installation.

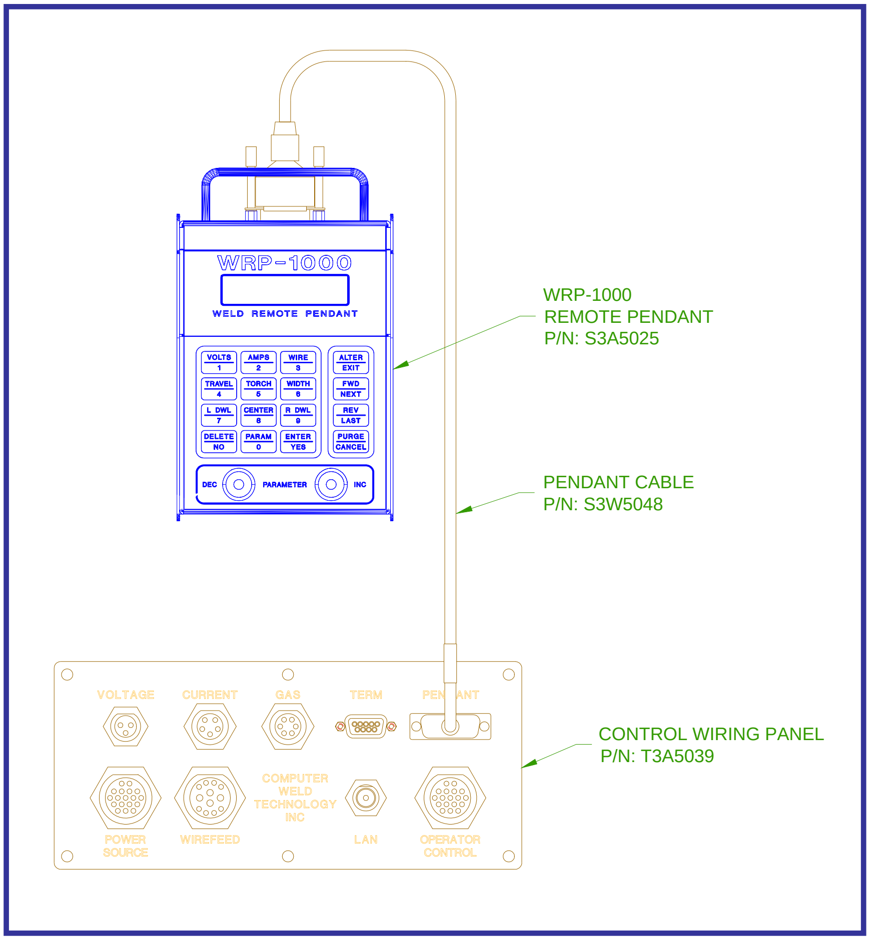


FIGURE 1-14
Pendant Cable Installation

2.0 FUNCTIONAL DESCRIPTION

2.1 GENERAL DESCRIPTION

The Modular Weld Control (MWC) is a microprocessor based weld sequence controller comprised of a MWC controller and optional wire drive motor controller. The MWC is the main controller module and provides all control and communication functions and also controls an internal wire drive motor controller. The MWC provides all external Input / Output control interface and electrical connections to user supplied components. The MWC provides eight (8) optically isolated DC inputs, eight (8) solid state relay outputs, two (2) analog 0 -10 vdc inputs, one (1) analog 0 -10 vdc output (dedicated to internal wire drive controller), three (3) isolated self calibrating analog outputs and one (1) TTL level pulse accumulator input. The following is the system general specification:

Dimensions	3.25"h x 8.77"w x 13.30"l (83mm x 223mm x 330mm)
Weight	5.2lbs (2.36kgm)
Power Input	110 - 240 vac 50/60 hz @ 0.2kw
Operating Temp	-10 ° F to +140° F (-23°C to +60°C)
Relay Outputs	115 vac/vdc 0.5 amps 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	OUT2 - 3 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. OUT1, 0 - 10 vdc output isolated 12 bit resolution (2.5 mv). 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.

2.2 CONTROL SYSTEMS

The MWC consist of two (2) major control systems (Figure 2-1). 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 using the RS-232 Terminal serial port and the PLC 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, and compare and branch functions.

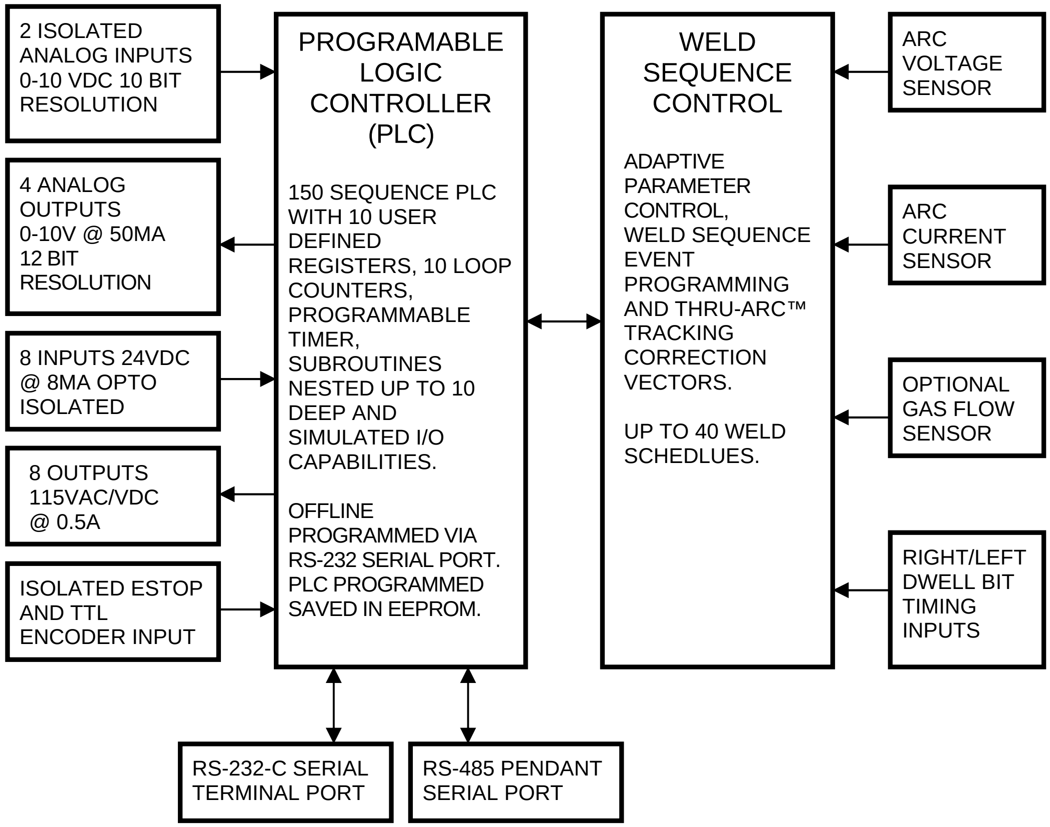


Figure 2-1
Modular Weld Control Block Diagram

The PLC is programmed via the RS-232 serial port. Section 4.0 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 MWC control functions. Section 3.0 describes the serial port protocol, the various parameters that can be programmed and their specific function.

The WSC control provides all of the weld control functions. If the tracking modes are enabled it will also provide Thru-Arc™ seam tracking. All of the WSC parameters are programmed via the RS-232 or RS-485 serial ports.

2.3 WELD SEQUENCE EVENTS

The WSC provides the user with ten (10) programmable events that comprise the weld cycle. Setting the corresponding time to zero (0) can disable individual events. Figure 2-2 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.

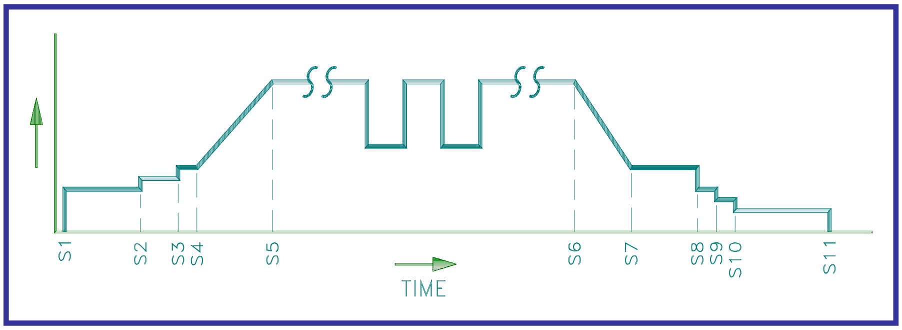


Figure 2-2
Weld Sequence Timed Events

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

2.4 Closed Loop Control

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. The user can disable the pulsation of any single parameter.

3.0 MWC RS-232 Serial Terminal Port Protocol

3.1 TERMINAL PORT PROTOCOL

The MWC terminal port is used to off-line program the PLC sequence and weld parameters. It is also used to configure the operating parameters for the MWC. 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*

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 MWC to the Host controller. If the host is up loading data to the MWC 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 MWC:

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

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

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

3.2 TERMINAL COMMANDS

The following is a summary of the Terminal Commands supported by the MWC:

COMMAND	**DESCRIPTION**
A1 – A30	Read and write MWC 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 - Actual Arc Voltage meter reading
(3 hz averaged arc voltage)
A17 - Actual Arc Current meter reading
(3 hz average arc current)
A18 – Actual wire feed meter reading
A19 – Actual Gas flow meter reading
A20 – Current sensor excitation current value
(1ma resolution i.e. 200 = 200ma)
A21 – PLC Register 11
A22 – PLC Register 12
A23 – PLC Register 13
A24 – PLC Register 14
A25 – PLC Register 15
A26 – PLC Register 16
A27 – PLC Register 17
A28 – PLC Register 18
A29 – PLC Register 19
A30 – PLC Register 20
******** Version 2.98 and Higher *********
A31 – Axis 1 Position
A32 – Axis 2 Position
A33 – Axis 3 Position
A34 – Axis 4 Position
A35 – Axis 5 Position
A36 – Axis 6 Position
A37 – Axis 7 Position
A38 – Axis 8 Position
A39 – Torch Position Locator Search Speed

C0 - C5 Set Analog Calibration values:

C0 - Current sensor excitation current value
C1 - 5.12-volt 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 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 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 -	Activate Wire Feed Forward
I2 -	Activate Wire Feed Reverse
I3 -	Activate Gas Solenoid
I4 -	Activate Travel Forward
I5 -	Activate Travel Reverse
I6 -	Not defined
I7 -	Binary Select Input Bit Mask

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** Sets 1/10 steps/step mode with Set Sine/Cosine motor current profile to optimize motor torque (Default Mode).
- **O=1** Sets 1/10 steps/step mode with Set Sine/Cosine motor current profile to optimize motor position.
- **O=2** Set 1/4 steps/step mode with torque compensated Sine/Cosine motor current profile.
- **O=3** Sets 1/2 steps/step mode with torque compensated Sine/Cosine motor current profile.
- **O=4** Disable Inverted motion control commands
- **O=5** Enable Inverted motion control.
- **O=6** Enable Home limit search mode.
- **O=7** Disable Home limit search mode.
- **O=8** Enable PWM brake drive control.
- **O=9** Disable PWM brake drive control and apply full brake power.

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 weld control function output relays. The value parameter specifies the relay that will be active for the defined function. Selected keys on the WRP-1000 remote pendant can also activate the Gas, Travel and Wire functions. 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 4.0 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 3 *(Version. ≥ 2.98 - TPL Sensor Reference Voltage)*
V44 = Spare 4 *(Version ≥2.98 - TPL Trigger Level ± Volts)*
V45 = Spare 5 *(Version ≥2.98 - TPL Torch Offset ± Position)*
V46 = Spare 6 *(Version ≥2.98 - TPL Maximum Search ±Distance)*
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)

In addition to the terminal commands the MWC 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 MWC will respond with an ASCII "CR". The following is a summary of the special control character function supported by the MWC:

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

4.0 MWC Programmable Sequence Protocol

4.1 COMMAND SEQUENCE

The MWC programmable sequence consists of a 3-byte command. The first byte is the command byte followed by a 2-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 may be separated by a colon (":"). The colon will cause the MSB and LSB byte to concatenate to form a single 2-byte value.

4.2 COMMAND 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 MWC: **S4=1,2561**
Optional Command format: **S4=1,10:1**

4.3 RELAY OUTPUTS AND SWITCH INPUTS

When Setting / Resetting the relay outputs the individual relays are selected by setting the corresponding data bits in the LSB byte. To set multiple 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 MWC: **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

4.4 AVAILABLE COMMANDS

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 the end of the weld cycle. If MSB 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 a subroutine.

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 without 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 clockwise (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 clockwise (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 clockwise (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 clockwise (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.***
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 their 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***

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

Example:S20=96,1 ***Set Weld mode to simulate***

97 **SET RELAY AND WAIT FOR INPUT -** Set the Relay output specified by the [LSB]. Wait for the Input specified by the [MSB] then increment to the next sequence.

Example:S20=97,2:2 ***Set output CR2 and wait for Input INP2***

98 **COMPARE REG[MSB] TO REG[LSB] -** Compare Register specified by the [MSB] to the Register specified by the {LSB] and set the CCR then increment to the next sequence. (CCR = REG[MSB] – REG[LSB])

Example:S20=98,8:2 ***Compare REG[8] to REG[2] REM: (REG[8] – REG[2])***

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

Example:S20=95,2:6 ***Load the Value in REG[6] to DAC 2***

(Note: The following commands are only available in EEPROM Version 2.87 and higher.)

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 CR 4 [LSB] when Input 5 [MSB] is set and wait for reset***

(Note: The following commands are only available in EEPROM Version 2.92 and higher.)

102 **SCALE 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 **LOAD VARIABLE [LSB] TO AN AXIS SPEED [MSB] –** 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].***

105 **DWL_INPUT _ON –** If [LSB] Dwell Bit (1=L-DWL, 2=R-DWL) OFF jump to sequence specified in [MSB]. If [LSB] Dwell Bit active move to next sequence. If [MSB] equal 0 wait for [LSB] Dwell Bit input active.

Example: S20=105,25:1 ***If L – DWL Bit [LSB] active move to next sequence. If L-DWL Bit [LSB] inactive jump to Sequence 25 [MSB].***
S20=105,0:1 ***Wait for L-DWL Bit Active.***

(Note: The following commands are only available in EEPROM Version 2.97 and higher.)

106 **SET_TPL –** Set TPL Sensor height using the vertical slide, *V43 -TPL Voltage Reference*, the absolute value of the *V46 - TPL Maximum Search Distance* and *A31 - TPL Search Speed* to establish the TPL sensor height level prior to a TPL Scan. If successful the PLC will increment to the next sequence. If level is not found in the specified

Example: S20=106,25:0 ***Move Vertical slide to set TPL sensor. If Fail jump to SEQ 25***

107 **TPL_SCAN –** Scan TPL sensor using the actual TPL sensor voltage, *V46 - TPL Maximum Search Distance* and *V44 - TPL Trigger Voltage* to establish the TPL sensor trigger level and scan direction prior to a horizontal seam search. If successful the Horizontal slide will be positioned from the point of detection to an offset position specified by *V45 – Torch Offset Position*. The sign of the *V45 – Torch Offset* determines the direction of the offset. The PLC will then increment to the next sequence. The sign of the V46 search distance determines the direction of the horizontal search. The sign of the V44 trigger value will determine sensor trip level. If trigger level is not detected in specified search distance the PLC will jump to sequence specified in [MSB]. If [MSB] = 0 then increment to next sequence.

Example: S20=107,25:0 ***Move Horizontal slide to detect TPL sensor trigger level. If Fail jump to SEQ 25***

(Note: The following commands are only available in EEPROM Version 3.03 and higher.)

108 **DWL_INPUT_OFF -** If [LSB] Dwell Bit (1=L-DWL, 2=R-DWL) ON jump to sequence specified in [MSB]. If [LSB] Dwell Bit OFF move to next sequence. If [MSB] equal 0 wait for [LSB] Dwell Bit input OFF.

Example: S20=108,25:1	***If L – DWL Bit [LSB] OFF move to next sequence. If L-DWL Bit [LSB] ON jump to Sequence 25 [MSB].***
S20=105,0:1	***Wait for L-DWL Bit OFF***

4.5 EXAMPLE PLC PROGRAM

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 decrements and if the value is not zero the above process is repeated.

After the desired number of welds are 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=101         ; 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
```

5.0 MWC Thru-Arc™ Tracking Setup

5.1 OVERVIEW

The MWC 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 MWC 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.

5.2 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 (i.e. the torch dives into the part or the torch loses the seam and wanders all over the welding surface).

5.3 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

5.4 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.

5.5 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:

5.5.1 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 MWC. 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 MWC. 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 Plus™ 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 MWC. 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

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.

5.5.2 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 MWC. 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 schedul*e.***

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.

5.5.3 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 MWC. 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 schedul*e.***

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.

5.5.4 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 MWC. 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 schedul*e.***

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.

5.5.5 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 MWC. 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 schedul*e.***

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.

6.0 Torch Position Locator (TPL) Setup (FIRMWARE V 2.98 or Higher)

6.1 OVERVIEW

The Torch Position Locator (TPL) technology combines advanced programming coupled with a RF Proximity sensor to provide torch-to-work height and seam location/identification. The MWC reads the 0 – 10 VDC signal from the RF Sensor and compares it to a reference value to determine the height of the sensor from the part and a seam trigger reference value to determine the location of the seam. The Values that are used to determine torch-to-work distance and to identify the seam location are user defined and are set using the WELDSEQ Plus™ Terminal Program schedule editor or by using individual parameter terminal commands.

6.2 Torch Position Locator (TPL) Terms and Definitions

In order to set up the Torch Position Locator (TPL) the operator should be familiar with the following terms and their use:

TPL Reference (V43)

Definition:

The Analog Voltage value used to provide Torch Height Position: i.e. If the TPL Reference is set to 8.00 the MWC, when placed in the height search mode, will move the vertical slide down in a search pattern until the Analog value generated by the sensor is Less-Than the TPL Reference value stored in V43 ($V_{sensor} < V43$).

Purpose

The purpose of this parameter is to establish the proper TPL Sensor flying height over the part for seam location/identification and to set contact tip-to-work distance of the torch.

TPL Trigger (V44)

Definition

The voltage change required, above or below, the actual Analog Voltage from the sensor generated by the Torch Height position search. When the sensor is scanned over the seam the sensor will detect changes in height that will be reflected in analog voltage value. When the amount of analog voltage change is Greater-Than or Equal-To the TPL Trigger reference the MWC will halt the seam search routine. (i.e. Seam Trigger Level = V43 $\pm$ V44)

Purpose

The purpose of this parameter is to locate a feature change on a part to indicate seam location.

TPL Torch Offset (V45)

Definition

Used to position the electrode over the seam when the sensor and torch cannot be aligned. The TPL Torch Offset is the distance the torch will move to the left or right after the seam has been located. A positive value will move the torch away from the Home Position. A negative value will move the torch toward the Home position. A value of 0(zero) will disable this function.

Purpose

The purpose of this parameter is to offset the torch after a feature has been found by the sensor when required.

TPL Max Search (V46)

Definition

The maximum distance the system is allowed to search to find the torch-to-work distance (TPL Reference) or to find a seam (TPL Trigger). This limit is applied to the actual search starting position of the Vertical and Horizontal slide. If a limit is reached a search fail PLC routine can be executed. The signed value is used to set the direction of the horizontal search. A positive value will cause the Torch to move away from the horizontal slide Home Position. A negative value will cause the Torch to move toward the horizontal slide Home Position. The sign of the value is ignored in the Vertical Torch Height search. This search is always down, away from the Home Position.

Purpose

The purpose of this parameter is to limit the maximum search distance of the system and to generate a search fault output.

OSC Center (V27)

Definition

This is the user-defined position for the horizontal slide that is set by schedule. This position determines the location of the torch on the Horizontal Slide and is measured in 0.000-inch increments from the Home position of the slide. Home Position is located at the motor.

Purpose

The purpose of this parameter is to set the horizontal position of the weld gun prior to a seam search. This position may also be used to locate the gun over the seam if you do not wish to use the seam search routine.

Torch Speed (V26)

Definition

The speed the slide moves when performing the Height and seam search. The value is programmed in (in/sec)

Purpose

This parameter is used to control the speed the slides move when moving from one position to the next.

Torch Up (V28)

Definition

This is the user-defined position for the vertical slide that is set by schedule. This position determines the location of the torch on the Vertical Slide and is measured in 0.000-inch increments from the Home position of the slide. Home Position is the slide in the up most position.

Purpose

The purpose of this parameter is to have a programmable starting position for the Vertical Slide and provides the user with the ability to move the torch up away from the tooling to provide ease of part loading and unloading.

Torch Weld (V31)

Definition

This is the position the vertical slide moves to from the Torch Up position and is the start of the torch height search routine.

Purpose

The purpose of this parameter is to have a programmable position to start a search prior to welding or to move to a welding position at the start of a weld if a search is not required.

6.3 Torch Position Locator (TPL) SET UP

The following is a sequence for set up and operation of the Torch Position Locator (TPL) sensor. These procedures should be utilized during initial sensor set up, after replacement of the torch or if a new sensor is installed.

Step 1 – Select the desired schedule.

Step 2 - Set Torch to the Torch Up Position. The Torch Up Position is a location that the vertical slide moves to when not welding (the Torch Up Position is not the Slide Home Position. The Torch Up is a location determined by a measurement in inches and a limit switch located inside the slide determines the Slide Home Position). The Torch Up position should be high enough to provide ease of part removal and installation but not so high as to add to machine cycle time. The vertical slide will return to the Torch Up position every time a weld is completed. To set this position perform the following:

NOTE: The Vertical Slide maintains position in measurements of inches. The Slide Home position is located at the upper most position of the slide and represents 0.001 inches. To move the slide to 1 inch from the home position you would enter a value of 1.000.

Using the WELDSEQ Terminal Program type these commands. Some of these commands will cause the Vertical Slide to move. Make sure that the slide and torch are free to move.

Type V28=1<enter> This will set the Torch Up position to the Home Position
W5=1<enter>
W4=1<enter> The Vertical will move to the Home Position.

Insert a part into the fixture and using a tape measure, measure the distance from the torch to the part. Subtract 0.750 from the measurement and write the value down. This will become the Torch Weld Position for the start of the Torch Height search. (Example: If the distance from the torch to the part is 5 inches then subtract 0.750. 5.000-0.750=4.250) Remove the part from the fixture. To establish a starting Torch Up Position, divide the distance measured from the torch to the part by 2. (5/2=2.500)

EXAMPLE:
Type V28=2500<enter>
W5=1<enter>
W4=1<enter> The torch will move down to the new position or 2.5 inches from the Home Position

Step 3 – Set Torch Weld Position. Before a search can begin you will need to determine a Torch Weld Position. When the Search Mode is enabled the MWC will move the torch to the Torch Weld Position and then start the search routine. If the Torch Weld Position is too high the system will fault prior to reaching the desired torch height and if the position is too low the torch will hit the part. Enter the Torch Weld Position that was calculated in Step 2 by typing the following:

EXAMPLE:
Type V31=4250<enter>
W5=1<enter>
W4=1<enter>

<u>Step 4</u> - Set Sensor in the down position. The sensor down position is the position that the sensor will be at when a search routine is initiated.

<u>Step 5 –</u> Open the WELDSEQ terminal program and click on the “Sched” button. When the Schedule Editor window opens click on the “Misc” tab. Locate the Weld Schedule box and enter the schedule number for the current active schedule. Click on the “Read” button. After the schedule is read from the MWC check the values loaded into the TPL Reference, TPL Trigger, TPL Torch Offset and TPL MAX Search. If this is a new system set the TPL Reference to 8.00, the TPL Trigger to 0.50, the TPL Torch Offset to 0 and the TPL Max Search to 0.500. Once you have reviewed the numbers in the schedule, click the “Write” button. After the schedule is written to the MWC type the following terminal command: W4=1<enter>.

<u>Step 6 –</u> Loosen the Torch in the bracket and remove it or move it up out of the way. Install a part into the fixture.

<u>Step 7 –</u> Select or execute the Set Torch Height routine and let the TPL find the correct height for the Vertical slide. The Vertical slide will move to the Torch Weld position of 4.250 and start the search routine. The maximum distance it can search is 0.500 inches. If the sensor cannot find the TPL Reference for height it will fault. If a fault occurs, move the torch back to the Torch Up location, verify all settings, make any desired adjustments and try the search again.

<u>Step 8 –</u> Once the sensor has set the torch height, insert the torch and adjust the torch to the correct contact-tip-to-work distance from the part and lock the torch in place.

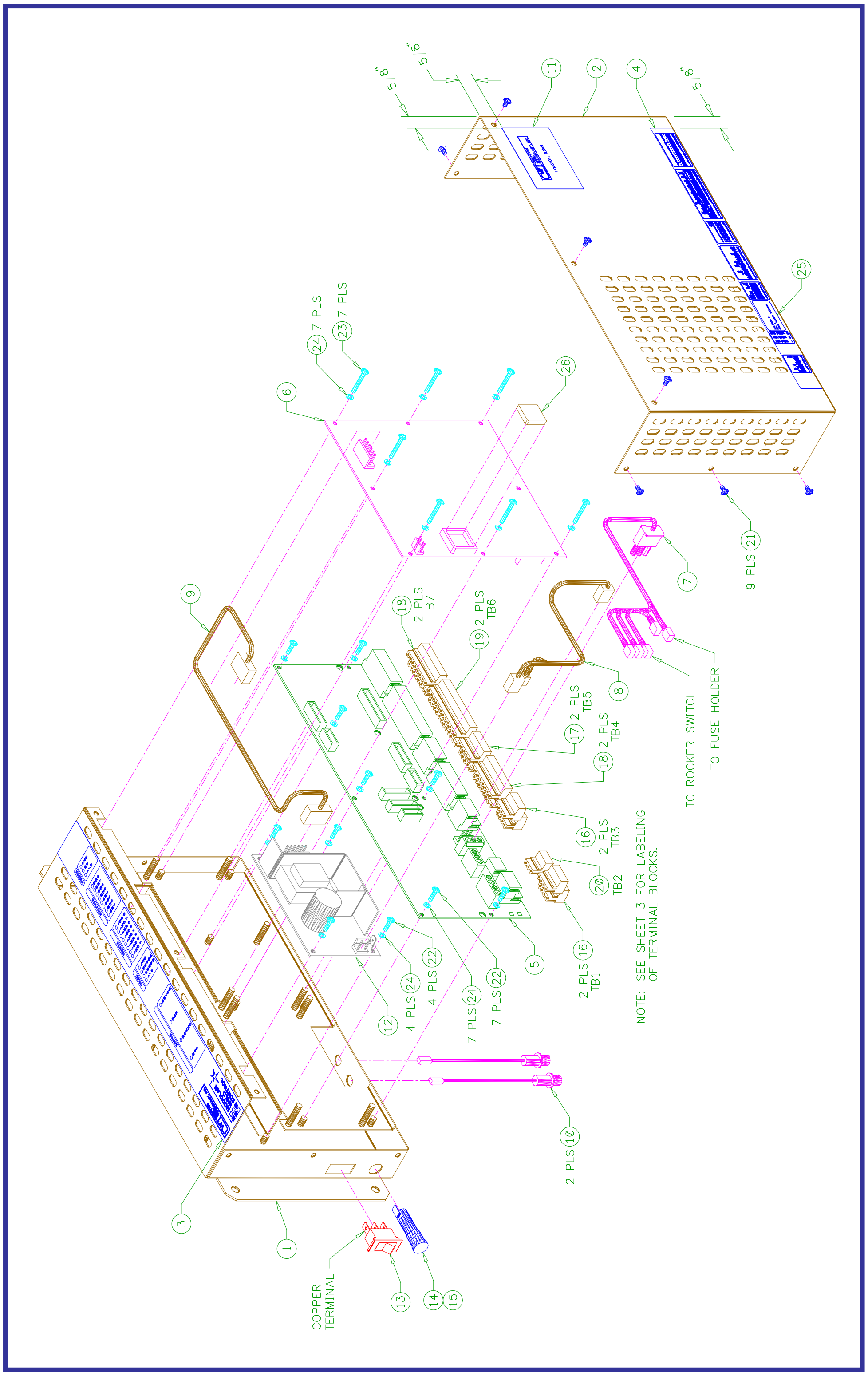
<u>Step 9 –</u> Verify the torch height position by selecting the Torch Up routine and the Set Torch Height Routine. When the search routine is complete the torch will be at the contact-tip-to-work set in Step 8 above.

<u>Step 10 –</u> After the Torch Height has been set by the TPL, select the Find Seam routine. Let the Horizontal slide move the sensor until it stops. If the sensor moves past the seam and faults reduce the TPL Trigger value by ½ and run the search routine again. If the sensor trips before it gets to the seam then add 20 to the TPL Trigger until the sensor stops in the desired location. Keep in mind that you only have 0.500 inches to search and find the seam. If the sensor finds the seam and you need to move the torch a little more to the left or right put a distance in inches for the TPL Torch Offset. The MWC will move the torch that distance after the seam has been found by the sensor. If the TPL Torch Offset is zero then the torch will not perform an offset move. To enter a 0.25” offset move toward the Home Position you would enter a –0.250. To enter a 0.25” offset move away from the Home Position you would enter 0.250.

<u>Step 11 –</u> Save all changes. To save the changes from the WELDSEQ program type the following command: W5=1(enter)

APPENDIX A ASSEMBLY DRAWINGS

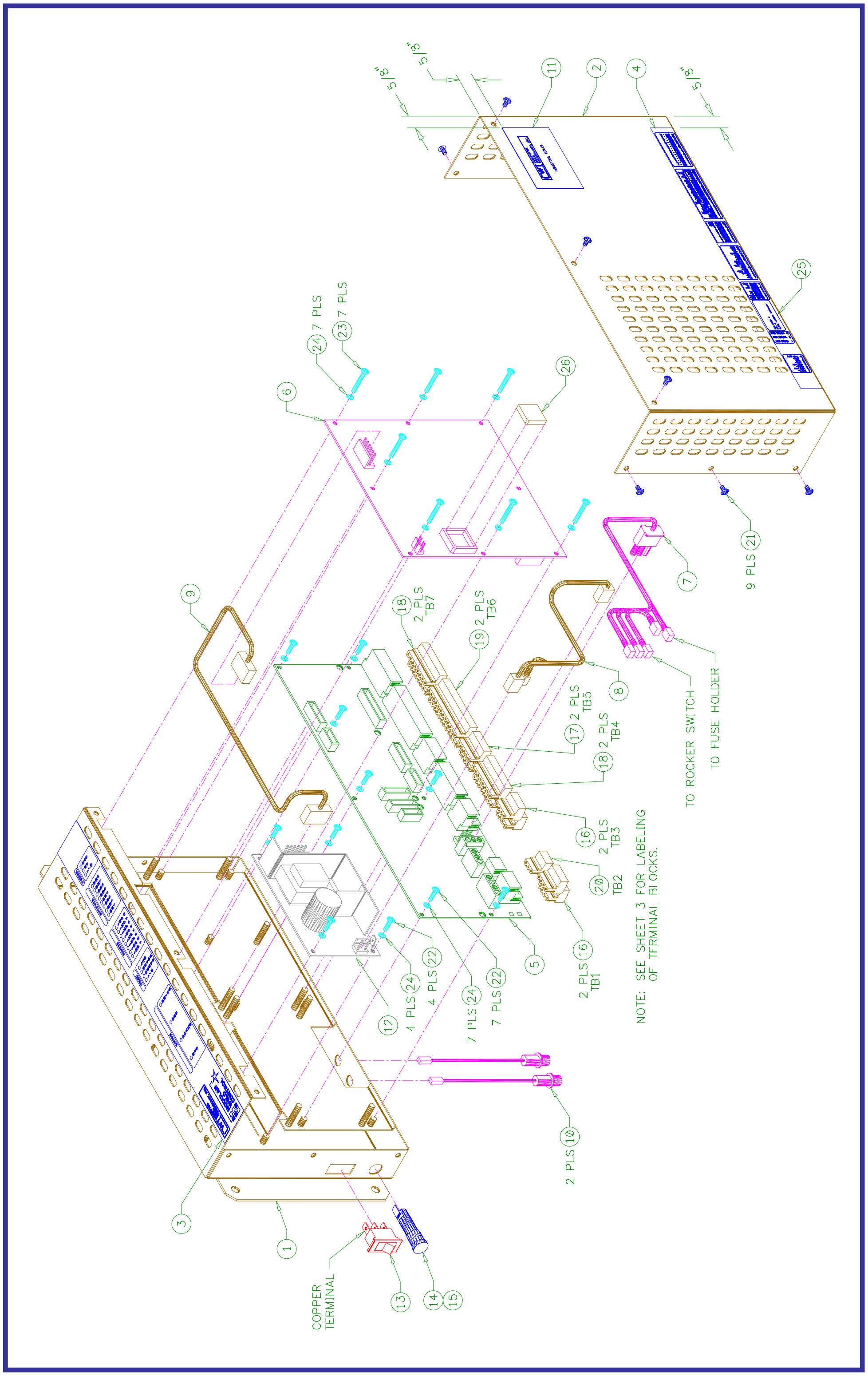
110VAC MWC ENCLOSURE ASSEMBLY P/N: T3A5047



PARTS LIST

ITEM	QTY.	PART NUMBER	DESCRIPTION
1	1	T3E5028	Enclosure
2	1	T3E5029	Cover
3	1	T3E5030	Status Overlay
4	1	T3E5023	Rear Overlay
5	1	T5A5019	Terminal PCB Assembly
6	1	T5A5015	CPU PCB Assembly
7	1	T3W5044	Switch and Fuse Cable
8	1	T3W5042	110V Power Cable
9	1	T3W5063	24V Power Cable
10	2	S3W5075	Lan Cable
11	1	S3E5050	2” x 3” CWT Label
12	1	X3T5067	24V Power Supply
13	1	X3S5078	110VAC Rocker Switch
14	1	X3C5025	Fuse Holder
15	1	X3C5026	8 Amp 3AG Fuse
16	4	X3P5643	4 Circuit Terminal Block Plug
17	2	X3P5644	5 Circuit Terminal Block Plug
18	4	X3P5645	8 Circuit Terminal Block Plug
19	2	X3P5646	12 Circuit Terminal Block Plug
20	1	X3P5709	3 Circuit Terminal Block Plug
21	9		#6-32 x 1/4" Long Pan Head Screw w/ Washer
22	11		#6-32 x 3/8" Long Pan Head Screw
23	17		#6-32 x 1" Long Pan Head Screw
24	18		#6 Internal Lock Washer
25	1		Serial Number Label
26	1	T5I5009	MWC Processor

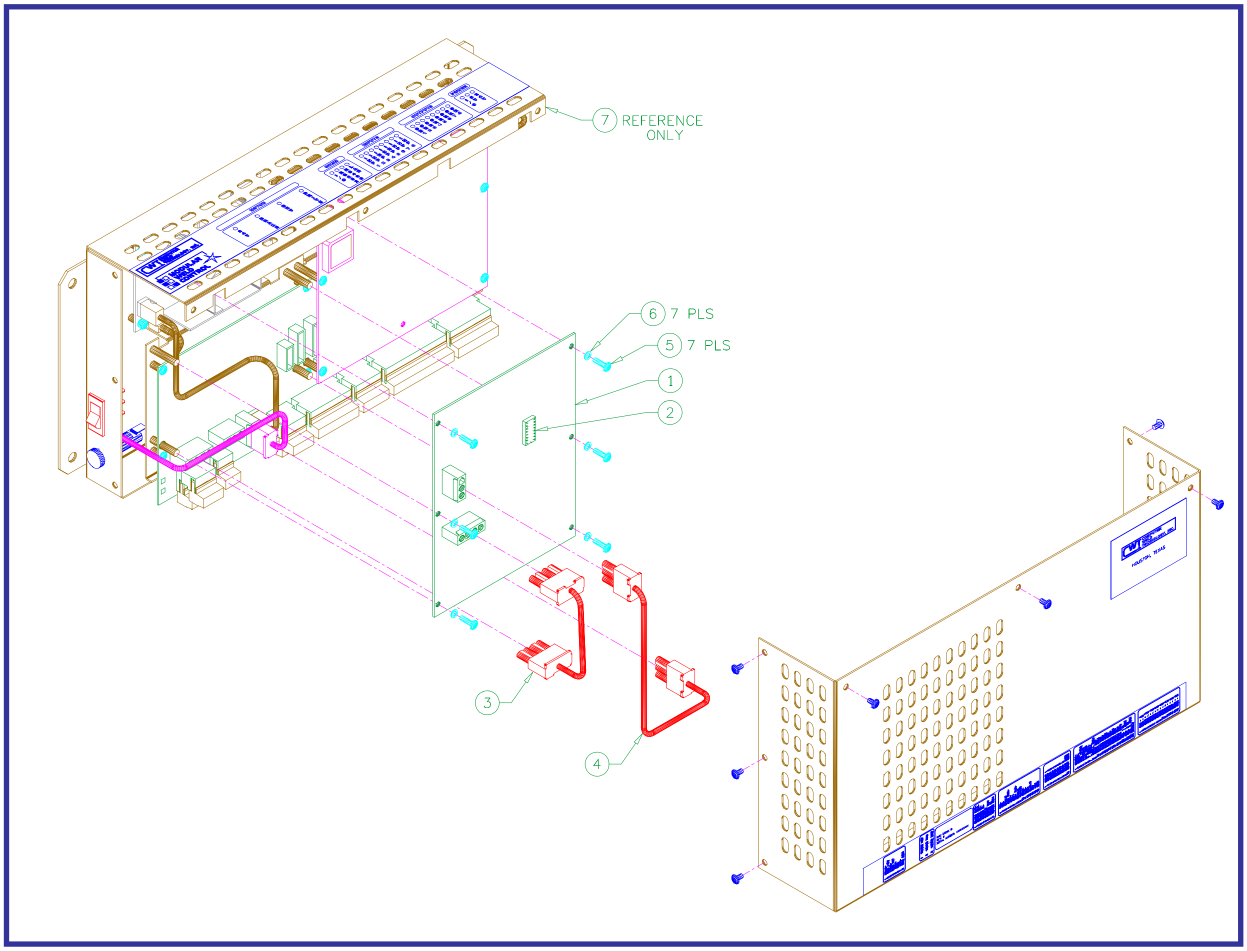
220VAC MWC ENCLOSURE ASSEMBLY P/N: T3A5075



PARTS LIST

ITEM	QTY.	PART NUMBER	DESCRIPTION
1	1	T3E5028	Enclosure
2	1	T3E5029	Cover
3	1	T3E5030	Status Overlay
4	1	T3E5023	Rear Overlay
5	1	T5A5019	Terminal PCB Assembly
6	1	T5A5015	CPU PCB Assembly
7	1	T3W5044	Switch and Fuse Cable
8	1	T3W5042	110V Power Cable
9	1	T3W5063	24V Power Cable
10	2	S3W5075	Lan Cable
11	1	S3E5050	2” x 3” CWT Label
12	1	X3T5067	24V Power Supply
13	1	X3S5090	220VAC Rocker Switch
14	1	X3C5025	Fuse Holder
15	1	X3C5026	8 Amp 3AG Fuse
16	4	X3P5643	4 Circuit Terminal Block Plug
17	2	X3P5644	5 Circuit Terminal Block Plug
18	4	X3P5645	8 Circuit Terminal Block Plug
19	2	X3P5646	12 Circuit Terminal Block Plug
20	1	X3P5709	3 Circuit Terminal Block Plug
21	9		#6-32 x 1/4" Long Pan Head Screw w/ Washer
22	11		#6-32 x 3/8" Long Pan Head Screw
23	17		#6-32 x 1" Long Pan Head Screw
24	18		#6 Internal Lock Washer
25	1		Serial Number Label
26	1	T5I5009	MWC Processor

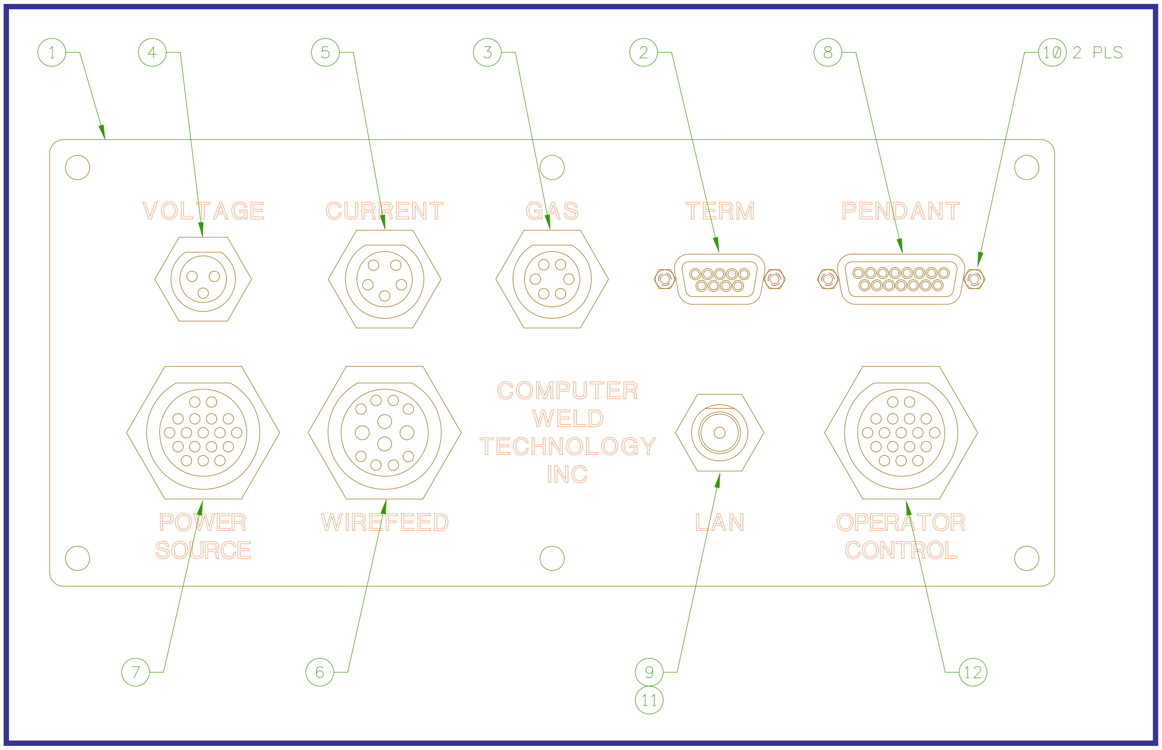
110VAC DMC WIRE FEED MOTOR CONTROL P/N: T0A5022



PARTS LIST

ITEM	QTY.	PART NUMBER	DESCRIPTION
1	1	T5A5016	110VAC MWC DMC PCB Assembly
2	1	S5I5013	DMC SCR Processor
3	1	T3W5040	MWC DMC Motor Cable
4	1	T3W5041	MWC DMC Power Cable
5	6		#6-32 x 3/8" Long Pan Head Screw
6	6		#6 Internal Lock Washer
7	REF		MWC Model B Enclosure Assembly

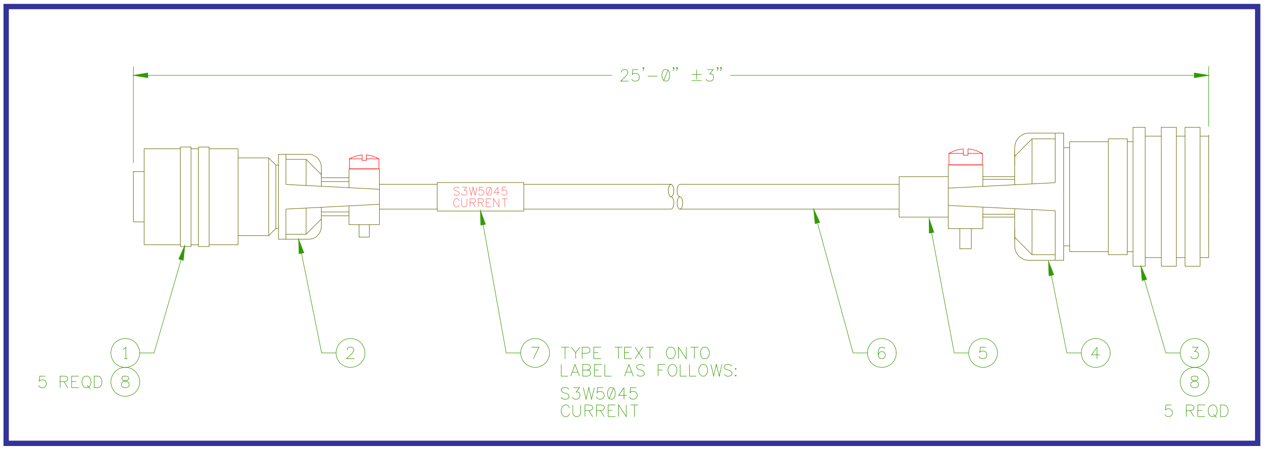
CONTROL WIRING PANEL P/N: T3A5039



PARTS LIST

ITEM	QTY.	PART NUMBER	DESCRIPTION
1	1	T3E5022	Control Wiring Plate
2	1	T3W5045	Term Cable
3	1	T3W5046	Gas Flow Cable
4	1	T3W5047	Volt Cable
5	1	T3W5048	Amp Cable
6	1	T3W5049	Wire Feed Cable
7	1	T3W5050	Power Source Cable
8	1	T3W5058	Pendant Cable
9	1	T3W5059	Lan Cable
10	2	X3Z5027	Screwlock Kit
11	1	X3P5734	Conn., BNC Bulkhead
12	1	T3W5061	Operator Control Cable

CURRENT SENSOR CABLE P/N: S3W5045



PARTS LIST

ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	X3P5584	"BENDIX" CONN., PLUG 5 CIRCUIT #PT06A-10-5P
2	1	X3P5588	"AMPHENOL" CLAMP, CABLE #97-3057-1004
3	1	X3P5124	"AMPHENOL" CONN., PLUG 5 CIRCUIT #MS3106A-14S-5P
4	1	X3P5126	"AMPHENOL" CLAMP, CABLE #97-3057-1007
5	1	X3P5519	"AMPHENOL" BOOT, CABLE CLAMP #9779-513-6
6	25'	X3W5025	"BELDEN" CABLE, 3 COND. W/ SHIELD #8871
7	1		"BRADY" LABEL, CABLE WRAP #THT-75-427-3
8	8		TUBING, HEAT SHRINK 1/8" DIA X 3/8" LONG

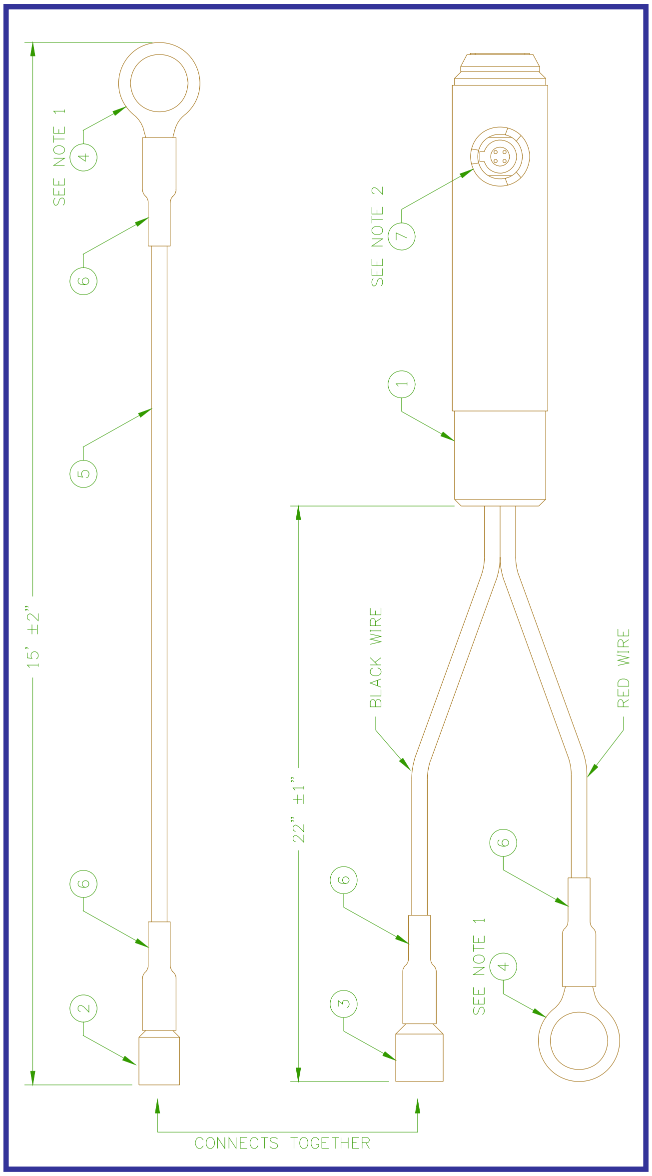
WIRE LIST

WIRE COLOR	FROM	TO	REFERENCE
RED	ITEM 1 PIN A	ITEM 3 PIN D	+SEN
WHITE	ITEM 1 PIN B	ITEM 3 PIN B	+AIN
GREEN	ITEM 1 PIN C	ITEM 3 PIN A	-AIN
BLACK	ITEM 1 PIN D	ITEM 3 PIN C	-SEN
SHIELD	ITEM 1 PIN E	ITEM 3 PIN E	EARTH GND

NOTES:

1 - Install heat shrink tubing (item 8) on all wires soldered to terminals of both connectors (items 1 & 3).

VOLTAGE SENSOR ASSEMBLY P/N: S3A5053



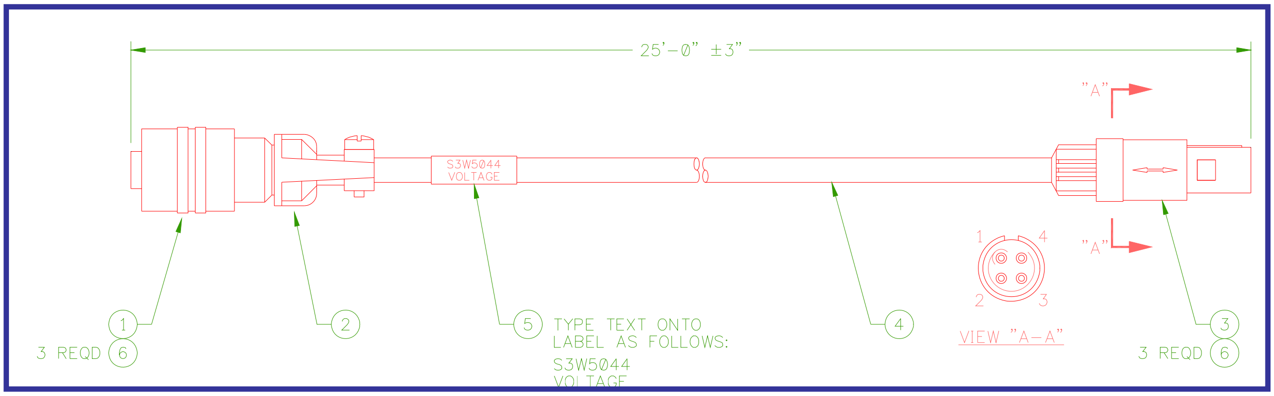
PARTS LIST

ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	T3A5042	VOLTAGE SENSOR PROBE SUB ASSEMBLY
2	1	X3P5419	“PANDUIT” TERMINAL, FEMALE COUPLER ¼”
3	1	X3P5717	“PANDUIT” TERMINAL, MALE COUPLER ¼”
4	2	X3P5718	“AMP” TERMINAL, RING ½”
5	18’		18 AWG BLACK CSA TYPE TEW WIRE
6	4		¼” DIAMETER X 1” LONG HEAT SHRINK TUBING
7	1		SERIAL NUMBER LABEL

NOTES:

1 - Ring terminals (Items 4) are to be crimped then soldered onto red and black wires.

VOLTAGE SENSOR CABLE P/N: S3W5044



PARTS LIST

ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	X3P5583	"BENDIX" CONN., PLUG 3 CIRCUIT #PT06A-8-3S
2	1	X3P5587	"AMPHENOL" CLAMP, CABLE #97-3057-1003
3	1	X3P5543	"REDEL" CONN., PLUG 4 CIRCUIT GRAY #PAG-M04-GLAC52C
4	25'	X3W5025	"BELDEN" CABLE, 3 COND. W/ SHIELD #8871
5	1		"BRADY" LABEL, CABLE WRAP #THT-75-427-3
6	6		TUBING, HEAT SHRINK 1/8" DIA X 3/8" LONG

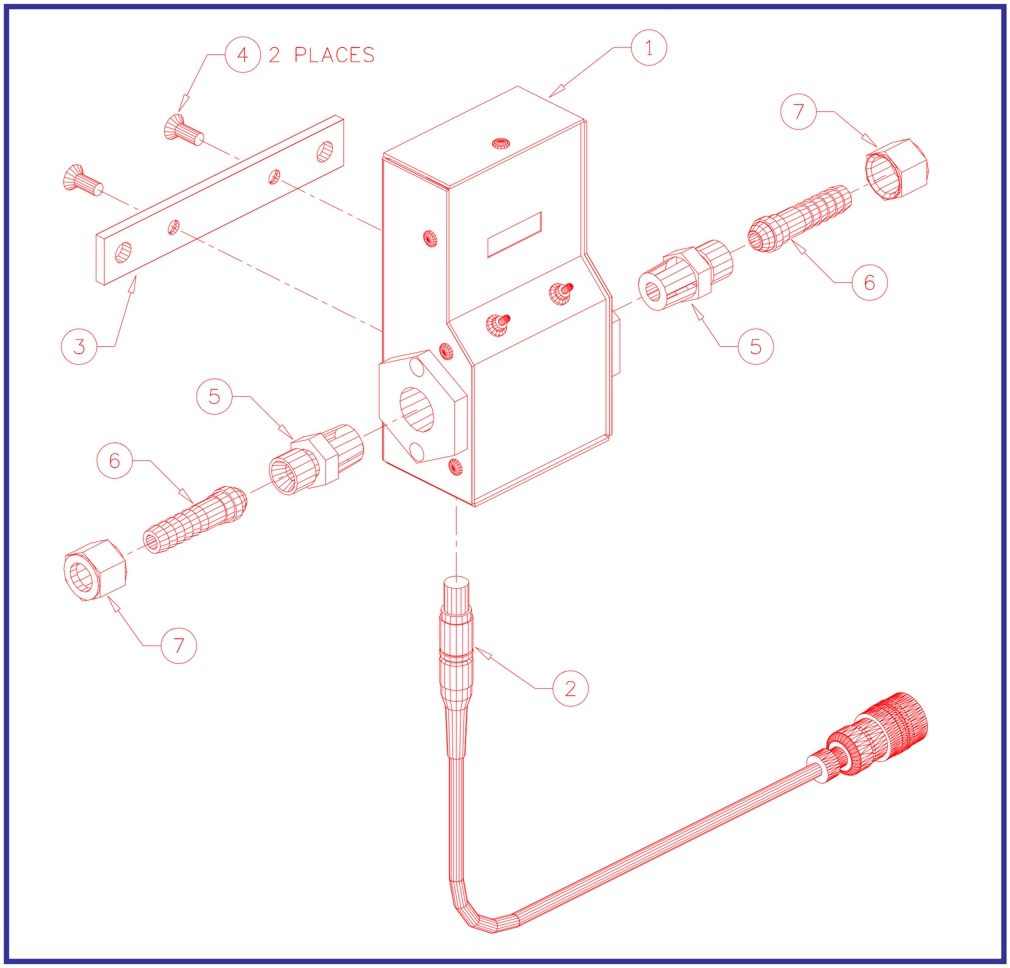
WIRE LIST

WIRE COLOR	FROM	TO	REFERENCE
RED	ITEM 1 PIN A	ITEM 3 PIN 1	VIN+
BLACK	ITEM 1 PIN B	ITEM 3 PIN 3	VIN-
SHIELD	ITEM 1 PIN C	ITEM 3 PIN 4	EARTH GND

NOTES:

1 - Install heat shrink tubing (item 6) on all wires soldered to terminals of both connectors (items 1 & 3).

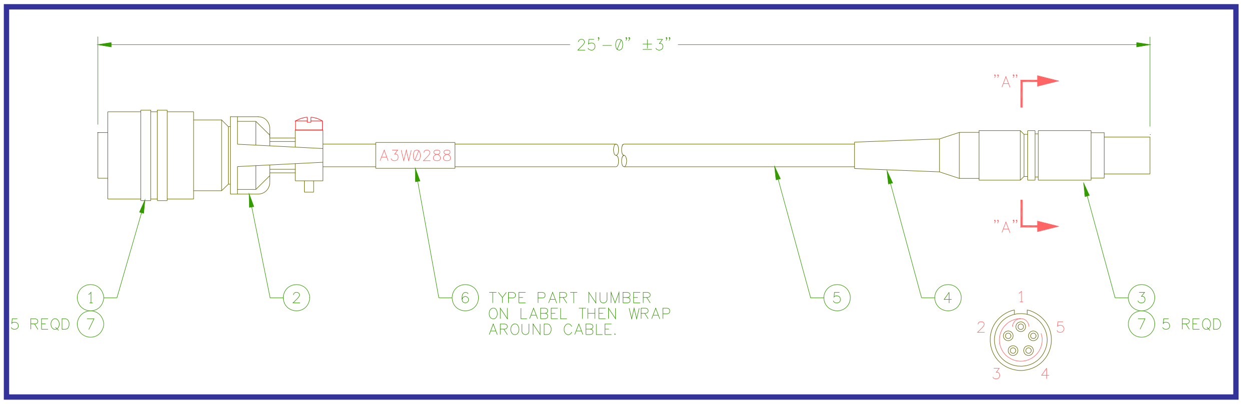
GAS FLOW SENSOR P/N: S0A5024



PARTS LIST

ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	A3A0179	GTFM4 ENCLOSURE ASSEMBLY
2	1	S3W5046	GAS FLOW CABLE
3	1	A3E0104	GTFM4 MOUNTING BAR
4	2		#10-32 X 1/2" LG. SOCKET FLAT HD. SCREW
5	2	X6F5093	ADAPTOR FITTING
6	2	X6F5094	BARB FITTING
7	2	X6F5094	“B” SIZE NUT

GAS FLOW SESNOR CABLE P/N: S3W5046



PARTS LIST

ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	X3P5606	"BENDIX" CONN., PLUG 6 CIRCUIT #PT06A-10-6P
2	1	X3P5588	"AMPHENOL" CLAMP, CABLE #97-3057-1004
3	1	X3P5628	"LEMO" CONN., PLUG 5 CIRCUIT #FGG-1B-305-CLAD52Z
4	1	X3P5629	"LEMO" RELIEF, STRAIN YELLOW #GMA-1B-054-DJ
5	25'	X3W5037	"BELDEN" CABLE, 4 COND. W/ SHIELD #9940
6	1		"BRADY" LABEL, CABLE WRAP #THT-75-427-3
7	10		TUBING, HEAT SHRINK 1/8" DIA X 3/8" LONG

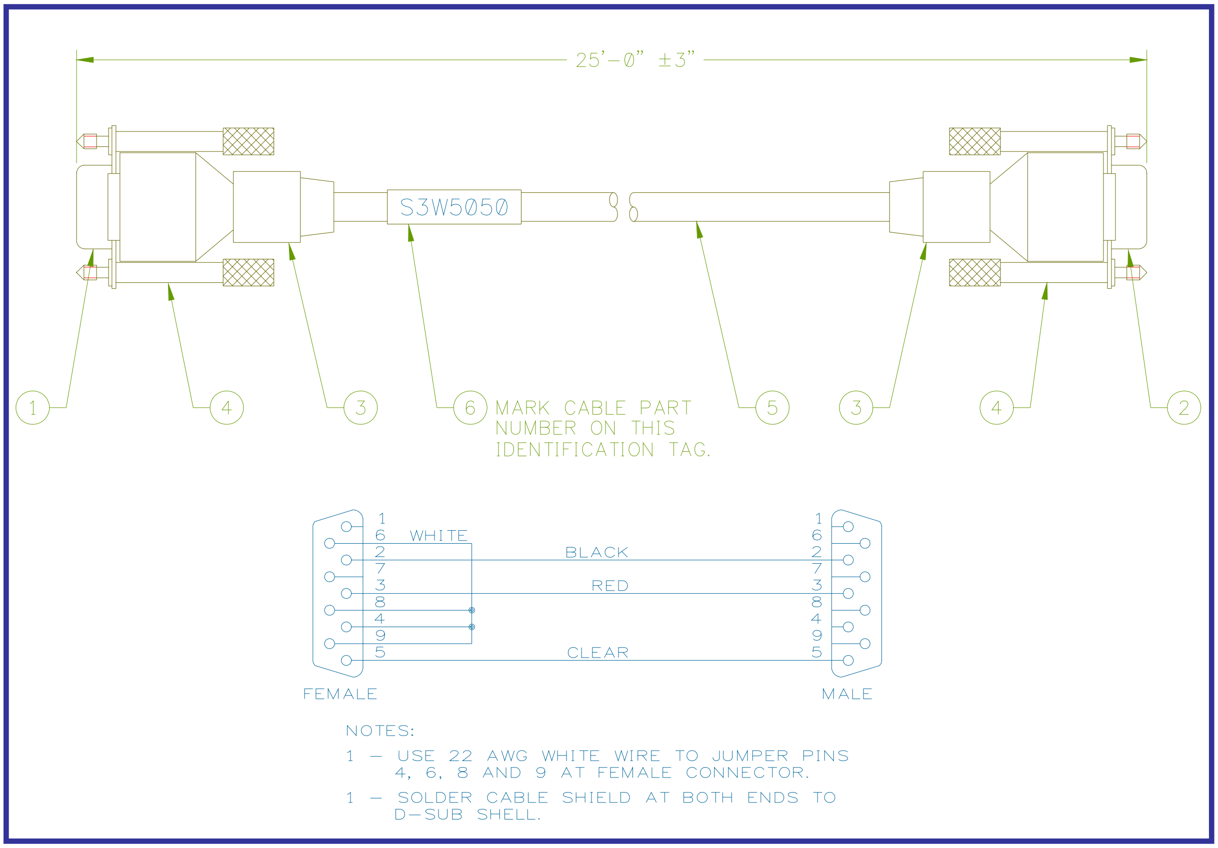
WIRE LIST

WIRE COLOR	FROM	TO	REFERENCE
RED	ITEM 1 PIN A	ITEM 3 PIN 1	+12VDC
BLACK	ITEM 1 PIN B	ITEM 3 PIN 4	DGND
WHITE	ITEM 1 PIN C	ITEM 3 PIN 2	GAS+
GREEN	ITEM 1 PIN D	ITEM 3 PIN 3	GAS-
SHIELD	ITEM 1 PIN E	ITEM 3 PIN 5	EARTH GND

NOTES:

1 - Install heat shrink tubing (item 7) on all wires soldered to terminals of both connectors (items 1 & 3).

TERM CABLE P/N: S3W5050



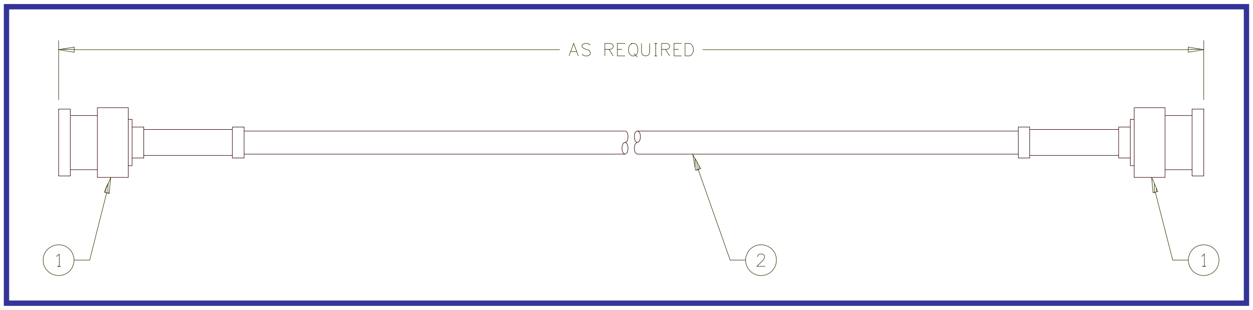
PARTS LIST

ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	X3P5484	"AMP" CONNECTOR, FEMALE 9 CIRCUIT D-SUB #747905-2
2	1	X3P5479	"AMP" CONNECTOR, MALE 9 CIRCUIT D-SUB #747904-2
3	2	X3Z5081	"3M" SHELL, D-SUB #3357-9209
4	2	X3Z5084	"3M" KIT, THUMB SCREW #3341-7
5	25'	X3W5025	"BELDEN" CABLE, 3 COND. W/ SHIELD #8771
6	1		"BRADY" LABEL, CABLE WRAP #THT-75-427-3
7	3"		WIRE, 22 AWG WHITE

WIRE LIST

WIRE COLOR	FROM	TO	TO	TO	REFERENCE
BLACK	ITEM 1 PIN 2	ITEM 2 PIN 2			TD
RED	ITEM 1 PIN 3	ITEM 2 PIN 3			RD
CLEAR	ITEM 1 PIN 5	ITEM 2 PIN 5			COM
WHITE	ITEM 1 PIN 4	ITEM 1 PIN 6	ITEM 1 PIN 8	ITEM 1 PIN 9	
SHIELD	ITEM 1 SHELL	ITEM 2 SHELL			EARTH GND

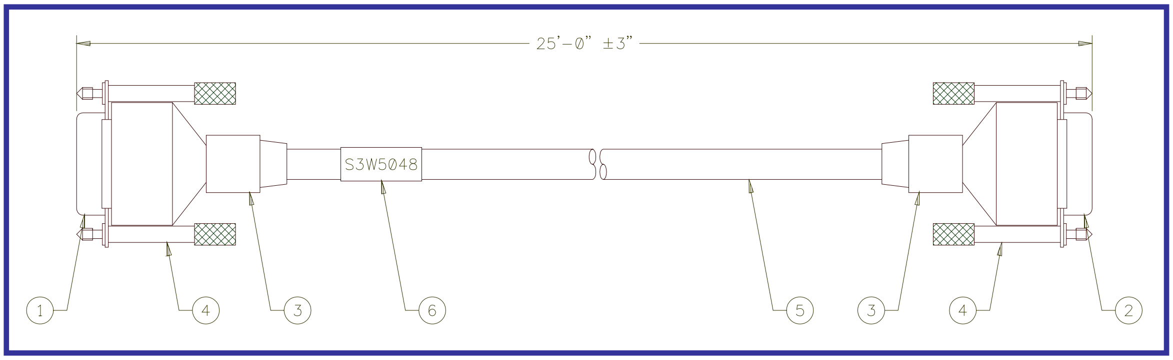
LAN CABLE P/N: S3W5049



PARTS LIST

ITEM	QTY	PART NO	DESCRIPTION
1	2	X3P5619	“Amp” Connector, BNC #5-225395-7
2	A/R	X3W5076	“Belden” Cable, Coaxial #9252

PENDANT CABLE P/N: S3W5048



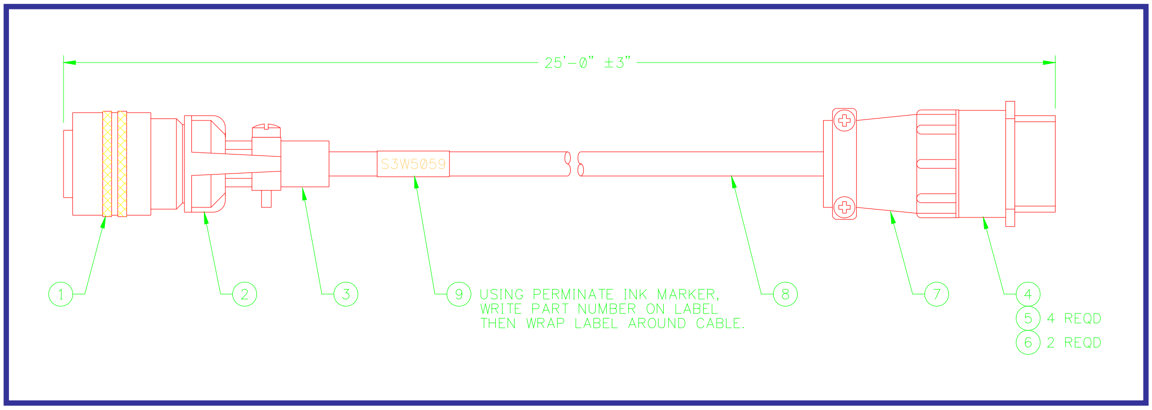
PARTS LIST

ITEM	QTY	PART NO	DESCRIPTION
1	1	X3P5506	"Amp" Connector, D-sub 15 Circuit #747908-2
2	1	X3P5485	"Amp" Connector, D-sub 15 Circuit #747909-2
3	2	X3Z5082	"3M" Shell, D-sub #3357-9215
4	2	X3Z5084	"3M" Kit, Thumb Screw D-sub #3341-7
5	25'	X3W5072	"Belden" Cable, 10 Conductor 22 AWG Shielded #9946
6	1		Tag, Identification

WIRE LIST

WIRE COLOR	FROM	TO	REFERENCE
BLACK	ITEM 1 PIN 1	ITEM 2 PIN 1	+TDP
WHITE	ITEM 1 PIN 2	ITEM 2 PIN 2	-TDP
RED	ITEM 1 PIN 3	ITEM 2 PIN 3	-RDP
GREEN	ITEM 1 PIN 4	ITEM 2 PIN 4	+RDP
GREEN/BLACK	ITEM 1 PIN 9	ITEM 2 PIN 9	+24V
ORANGE/BLACK	ITEM 1 PIN 10	ITEM 2 PIN 10	+24V
BLUE/BLACK	ITEM 1 PIN 11	ITEM 2 PIN 11	+24V
RED/WHITE	ITEM 1 PIN 13	ITEM 2 PIN 13	COMMON
GREEN/WHITE	ITEM 1 PIN 14	ITEM 2 PIN 14	COMMON
BLUE/WHITE	ITEM 1 PIN 15	ITEM 2 PIN 15	COMMON
SHIELD	ITEM 3	ITEM 3	EARTH GROUND

MILLER A1D4 WIRE FEED MOTOR CABLE P/N: S3W5059



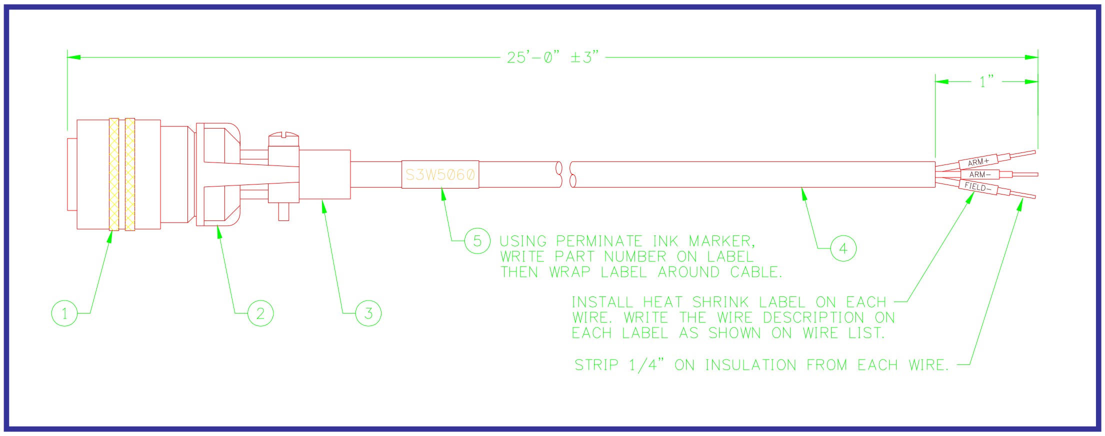
PARTS LIST

ITEM	QTY	PART NO	DESCRIPTION
1	1	X3P5586	"Bendix" Connector, Rcpt 12 Circuit #PT06A-14-12P
2	1	X3P5589	"Amphenol" Clamp, Cable #97-3057-1008
3	1	X3P5505	"Amphenol" Boot, Cable Clamp #9779-513-8
4	1	X3P5516	"Amp" Connector, Rcpt 14 Circuit #206043-3
5	4	X3P0303	"Amp" Socket 22 awg #66105-1
6	2	X3P0302	"Amp" Socket 18 awg #66601-1
7	1	X3Z5054	"Amp" Clamp, Cable #206070-1
8	25'	X3W5020	"Belden" Cable, 6 cond. #8446
9	1		Tag, Identification

WIRE LIST

WIRE COLOR	FROM	TO	REFERENCE
22 AWG RED	ITEM 1 PIN A	ITEM 4 PIN 7	+15V
22 AWG GREEN	ITEM 1 PIN F	ITEM 4 PIN 5	EARTH GROUND
22 AWG BLUE	ITEM 1 PIN G	ITEM 4 PIN 9	ENC
22 AWG BROWN	ITEM 1 PIN H	ITEM 4 PIN 8	COM
18 AWG BLACK	ITEM 1 PIN M	ITEM 4 PIN 1	ARM+
18 AWG WHITE	ITEM 1 PIN K	ITEM 4 PIN 3	ARM-

STANDARD W/O TACH WIRE FEED MOTOR CABLE P/N: S3W5060



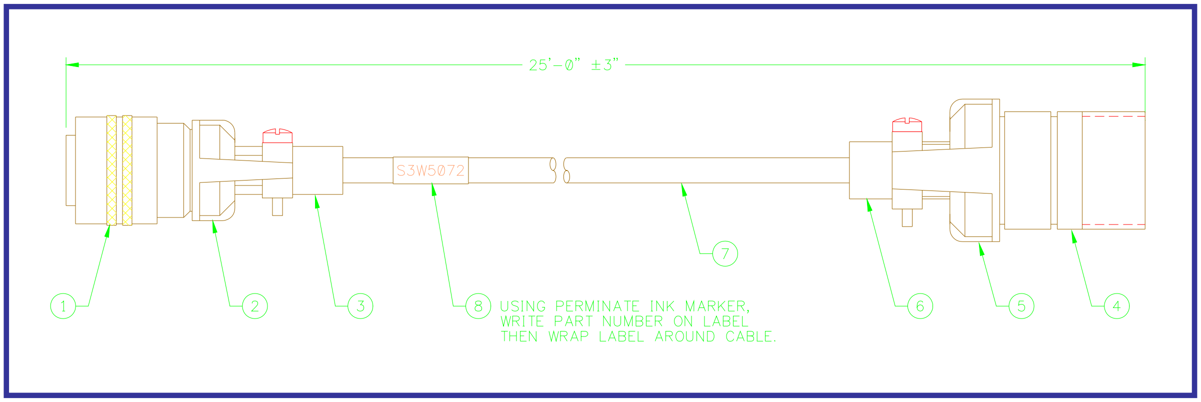
PARTS LIST

ITEM	QTY	PART NO	DESCRIPTION
1	1	X3P5586	"Bendix" Connector, Rcpt 12 Circuit #PT06A-14-12P
2	1	X3P5589	"Amphenol" Clamp, Cable #97-3057-1008
3	1	X3P5505	"Amphenol" Boot, Cable Clamp #9779-513-8
4	25'	X3W5079	"Belden" Cable, 4 Conductor 16 AWG #8620
5	1		Tag, Identification

WIRE LIST

WIRE COLOR	FROM	REFERENCE
16 AWG RED	ITEM 1 PIN M	ARM+
16 AWG BLACK	ITEM 1 PIN K	ARM-
16 AWG GREEN	ITEM 1 PIN J	FIELD-
16 AWG WHITE	ITEM 1 PIN L	FIELD+

LINCOLN NA5 WIRE FEED MOTOR CABLE P/N: S3W5072



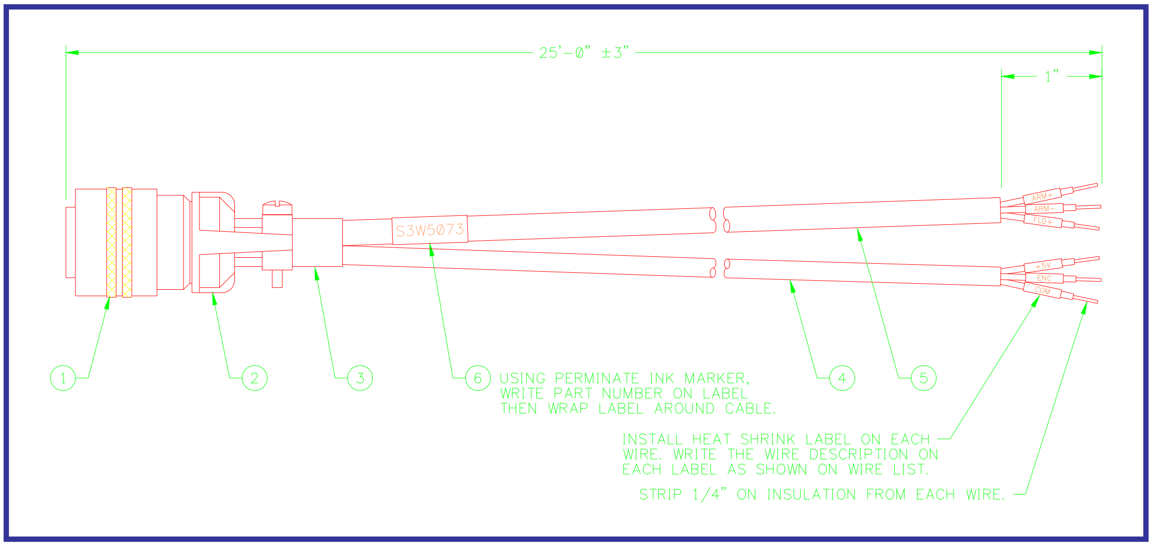
PARTS LIST

ITEM	QTY	PART NO	DESCRIPTION
1	1	X3P5586	"Bendix" Connector, Rcpt 12 Circuit #PT06A-14-12P
2	1	X3P5589	"Amphenol" Clamp, Cable #97-3057-1008
3	1	X3P5505	"Amphenol" Boot, Cable Clamp #9779-513-8
4	1	X3P5663	"Amphenol" Connector, Plug 6 Circuit #MS3101A-18-12S
5	1	X3P5503	"Amphenol" Clamp, Cable #97-3057-1010
6	1	X3Z5085	"Amphenol" Boot, Cable Clamp #9779-513-10
7	25'	X3W5079	"Belden" Cable, 4 cond. 16 awg #8446
8	1	X3W5020	Tag, Identification

WIRE LIST

WIRE COLOR	FROM	TO	REFERENCE
16 AWG RED	ITEM 1 PIN M	ITEM 4 PIN A	ARM+
16 AWG BLACK	ITEM 1 PIN K	ITEM 4 PIN B	ARM-
16 AWG GREEN	ITEM 1 PIN J	ITEM 4 PIN C	FIELD-
16 AWG WHITE	ITEM 1 PIN L	ITEM 4 PIN D	FILED+

STANDARD WITH TACH WIRE FEED MOTOR CABLE P/N: S3W5073



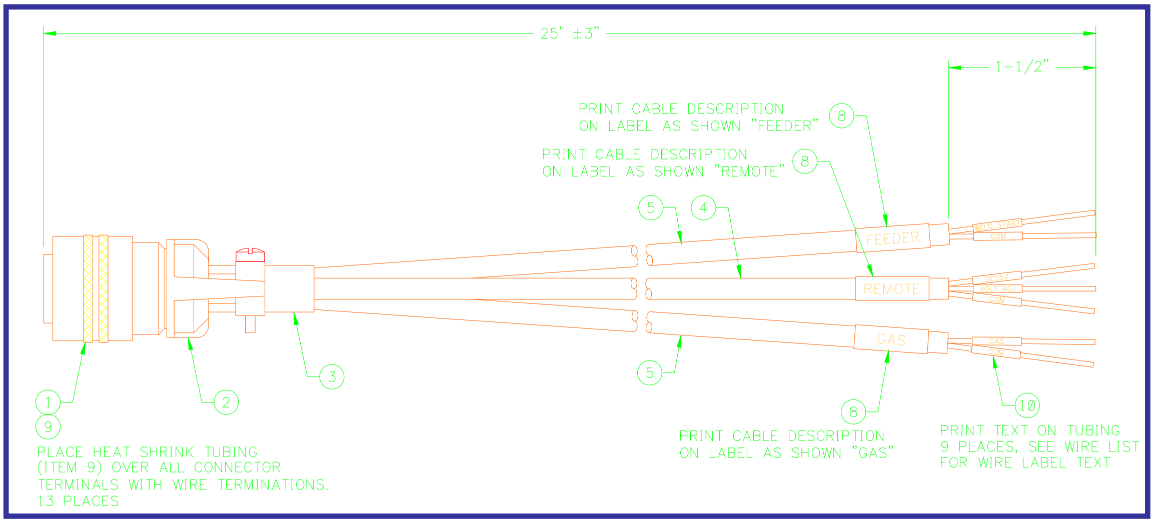
PARTS LIST

ITEM	QTY	PART NO	DESCRIPTION
1	1	X3P5586	"Bendix" Connector, Rcpt 12 Circuit #PT06A-14-12P
2	1	X3P5589	"Amphenol" Clamp, Cable #97-3057-1008
3	1	X3P5505	"Amphenol" Boot, Cable Clamp #9779-513-8
4	25'	X3W5025	"Belden" Cable, 3 Conductor 22 AWG Shielded #8771
5	25'	X3W5079	"Belden" Cable, 4 Conductor 16 AWG #8620
6	1		Tag, Identification

WIRE LIST

WIRE COLOR	FROM	REFERENCE
ITEM 4 - 22 AWG RED	ITEM 1 PIN B	+5V
ITEM 4 - SHIELD	ITEM 1 PIN F	GROUND
ITEM 4 - 22 AWG CLEAR	ITEM 1 PIN G	ENC
ITEM 4 - 22 AWG BLACK	ITEM 1 PIN H	COM
ITEM 5 - 16 AWG RED	ITEM 1 PIN M	ARM+
ITEM 5 - 16 AWG BLACK	ITEM 1 PIN K	ARM-
ITEM 5 - 16 AWG GREEN	ITEM 1 PIN J	FIELD-
ITEM 5 - 16 AWG WHITE	ITEM 1 PIN L	FIELD+

PANASONIC POWER SOURCE CABLE P/N: T3W5060



WIRE LIST

CABLE TYPE	CABLE LABEL	WIRE TYPE	WIRE LABEL	FROM	TO	TO	JUMPERED CONNECTIONS
ITEM 5	FEEDER	RED	WELD START	ITEM 1 PIN A			
		BLACK	COM	ITEM 1 PIN B			
		SHIELD		ITEM 1 PIN G			
ITEM 4	REMOTE	RED	DC15V	ITEM 1 PIN C			
		WHITE	VOLT ADJ	ITEM 1 PIN D			
		BLACK	COM	ITEM 1 PIN E			
		BROWN	OUTPUT ADJ	ITEM 1 PIN J			
		GREEN	WIRE INCH	ITEM 1 PIN L			
		SHIELD		ITEM 1 PIN G			
ITEM 5	GAS	RED	GAS	ITEM 1 PIN N			
		BLACK	COM	ITEM 1 PIN P			
		SHIELD		ITEM 1 PIN G			
ITEM 6		RED		ITEM 1 PIN C	ITEM 1 PIN H		
ITEM 7		BLACK		ITEM 1 PIN E	ITEM 1 PIN K	ITEM 1 PIN M	

PARTS LIST

ITEM	QTY	PART NO	DESCRIPTION
1	1	X3P5607	"Bendix" Connector, Rcpt 18 Circuit #PT06A-14-18P
2	1	X3P5589	"Amphenol" Clamp, Cable #97-3057-1008
3	1	X3P5505	"Amphenol" Boot, Cable Clamp #9779-513-8
4	25'	X3W5069	"Belden" Cable, 5 Conductor 22 AWG Shielded #9941
5	50'	X3W5025	"Belden" Cable, 3 Conductor 22 AWG Shielded #8771
6	2"		22 AWG Red CSA Type TR-64 Wire
7	4"		22 AWG Black CSA Type TR-64 Wire
8	13		Cable Wrap Label
9	13		1/8" Dia. x ½" Long Black Heat Shrink Tubing
10	9		1/16" Dia. x ½" Long White Heat Shrink Tubing