

# ADVANCED COLOR LOGIC®



## *LINUX* Models 254-203 Calibration Procedure P/N 031-0214 REV. A



**CAUTION**

**Performing the following Tests and Calibration requires the operator to be near HIGH VOLTAGES and HIGH CURRENTS. Operator must be familiar with working in this environment and exercise caution during this procedure to avoid any shock hazards.**

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## 1.0 EQUIPMENT NEEDED

In addition to the ACL, other pieces of Test/Calibration tools and equipment are required. Depending on the type of calibration to be performed, LOAD BANK or LIVE ARC, different equipment and tools may be required. See images immediately following for reference.

### 1.1 LOAD BANK (load bank not provided by MK Products)

- 44 pin Test Extender Card
- Small Plastic Flathead Screwdriver
- Small Phillips Screwdriver
- 1/4" Hex Wrench
- 3/16" Hex Wrench
- Glyptol Insulating Varnish
- Certified Digital Multi-Meter (Fluke 8060A or Equivalent) and Test Leads
- 30V / 1A or higher DC External Power Supply and Test Leads

### 1.2 LIVE ARC (calibration kit provided by MK Products)

- Calibration Kit (P/N 005-0698)
- Orbital Weldhead
- Water Recirculator
- Feeler Gauge
- Wire Brush



External DC Power Supply



Digital Multi Meter - Certified



Glyptol Varnish



Calibration kit (P/N 005-0698)



1/4" Hex Driver & Small Plastic Screwdriver



44 Pin Extender Card

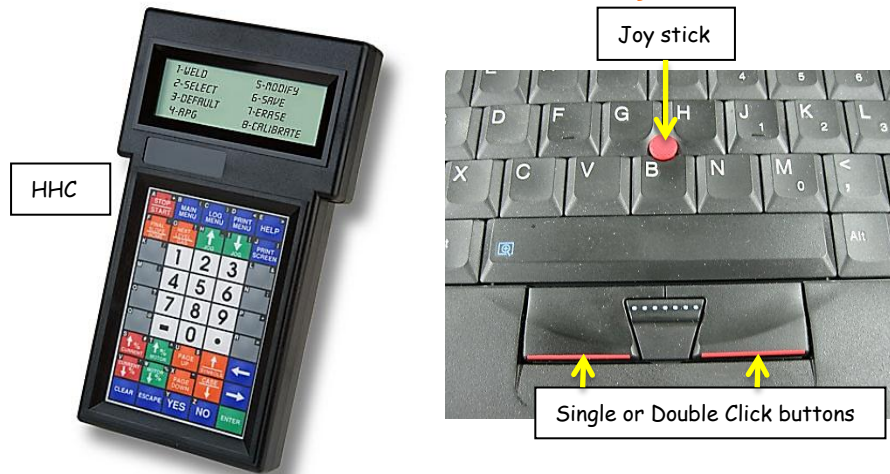


Hook and Feeler Gauge

## 2 EQUIPMENT SETUP

### 2.1 ACL SETUP

It is recommended to use 208 to 240 VAC input power for the calibration procedure. Prior to starting the calibration, the ACL should be in TEACH mode. **All commands during the calibration procedure executed using the Hand Held Control (HHC). On screen operate using key board and mouse or Joy stick combination.**



### 2.2 LIVE ARC CALIBRATION SET-UP

Adjust torch in calibration box for proper weld arc gap (**0.065"**) with feeler gauge and ensure tungsten and plate surface are clean, use wire brush if necessary. Also make sure the tungsten diameter is **3/32" OD**.

#### **CAUTION**

Before beginning final calibration, record test equipment data on the Certificate of Calibration and **VERIFY THAT ALL TEST EQUIPMENT USED HAS A CURRENT UNBROKEN CALIBRATION SEAL**. Use of uncalibrated test equipment will invalidate the calibration you are about to perform.

## 3. HARDWARE CALIBRATION

Hardware calibration is generally not recommended or required to certify the calibration of your Advanced Color Logic orbital welding power source. **Exception to this recommendation is the installation of a new servo board**. If you do routine **maintenance** the unit that you have, we recommend you to go straight to Chapter 4 and do the Software Calibration only.

#### **NOTE**

Before beginning calibration, turn the unit on and verify that it is operating normally and that the main menu is displayed with no problems. Then turn the unit off.

### 3.1 SERVO BOARD SETUP

Use the 1/4 inch Hex Wrench to remove the Low Window shield on the back of the ACL Power Supply.



**Removing Low Window Shield**

Remove the Servo Board (which is the lower of the two boards). The easiest way is to use the hook or something similar, to grab the white corner spacers of the board and ease it out. Once the Board is out, insert the Test Extender Card in its place, and then reconnect the Servo Board to the other end of the Test Extender Card.



**Remove Board with Hook**



**Insert Extender Card**



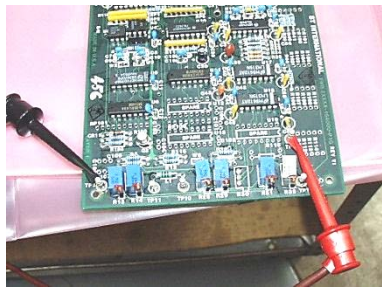
**Connect Servo Board to card**

## NOTE

Place an anti-static material beneath the Servo Board (i.e. Anti-static bag,) so that it does not rest directly on the ACL's fan. Also, the black shield can be removed from the Servo Board for easier access to components, but must be replaced before the board is placed back into the machine. It is removed in these pictures to better demonstrate the location of certain components. We recommend that you remove it, but the adjustments can be made without the cover's removal. To remove the cover, use the Small Phillips Screwdriver and the 3/16-inch Hex Wrench.

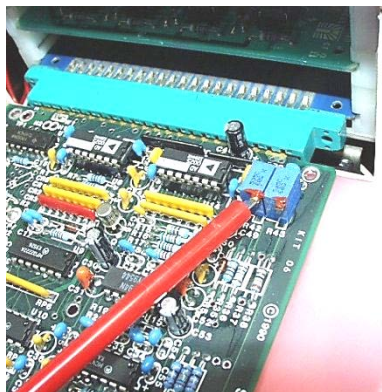
### 3.2 CURRENT OFFSET ADJUSTMENT

Place the **Meter GND (-)** lead on **TP8** (which is located on the left side near the front, directly behind the white corner spacer) and the **Meter POS (+)** lead on **TP9** (which is located slightly back from the front on the right side of the board.)



**Test Points 8 and 9**

Turn the ACL unit **ON**. Verify that the voltage across the test points is 0 (+/-2mV). If not, use the screwdriver to adjust the **R42** trim pot (located near the back of the Servo Board, second from the right) until the reading is 0 (+/-2mV).



**Adjusting R42**

### 3.3 CURRENT GAIN ADJUSTMENT

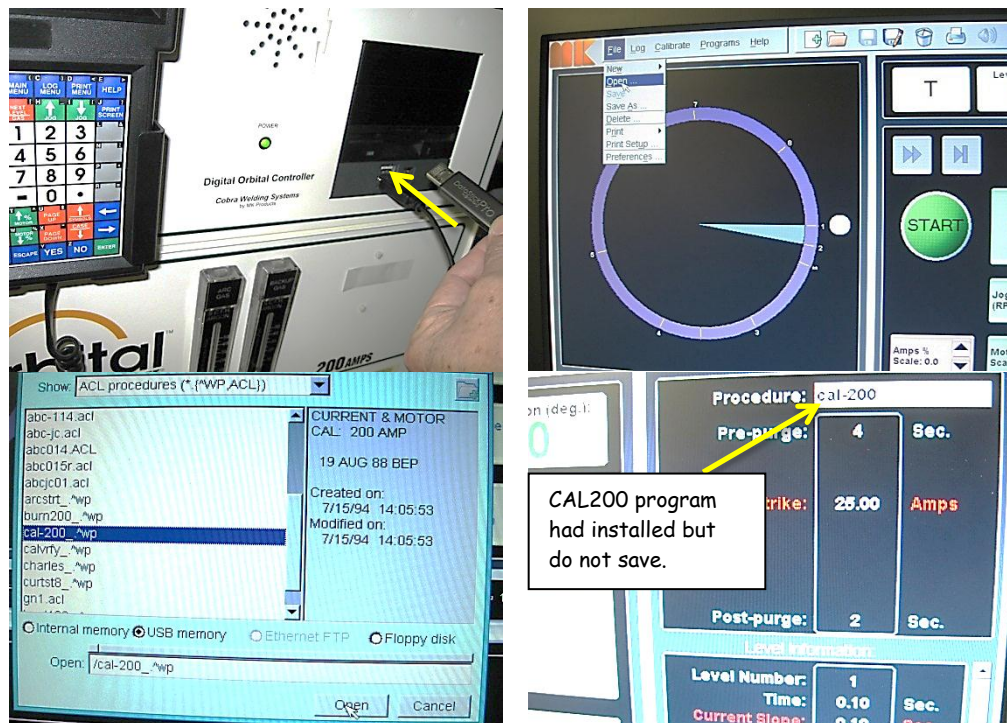
You will need to use the **CAL200** program to perform this part of the Calibration Preparation. If you do not have this program, you can request it from [mkproducts.com](http://mkproducts.com).

#### NOTE

Work as quickly as possible whenever an Arc is established, especially at high Amperage. This is necessary because the ACL does not pulse when calibrating and therefore heats up more quickly than usual. The power supply will shut off if it gets too hot. If this happens, let the machine cool down and then try again.

Assuming that you have the **CAL200** program in your flash drive.

1. First, turn on the ACL. Second, insert CAL200 flash drive into USB's slot then followed these pictures below consequently to Open **CAL200** program:
2. From File menu, open the USB Memory and select CAL200 program.



3. When CAL200 program have opened we may take the flash drive out of it slot.

**NOTE: You must run the CAL200 program for calibration, in order to complete your hardware calibration.**

## WARNING

Do not Save the CAL200 Procedure to the ACL memory. It is to be used for Calibration only and afterwards to be removed from the ACL. Failure to comply could result in serious injury.

The current calibration requires that the ACL be generating an arc. Configure the ACL with the Calibration Torch and Water Recirculator (refer to **Appendix A**). **Verify that the Water Recirculator is ON before continuing.**

Move the **Meter GND (-)** lead to **TP10** and the **Meter POS (+)** lead to **TP11** or you can simply connect the leads to the Current Shunt on the Calibration Kit Shunt Box.



**Test Points 10 and 11**

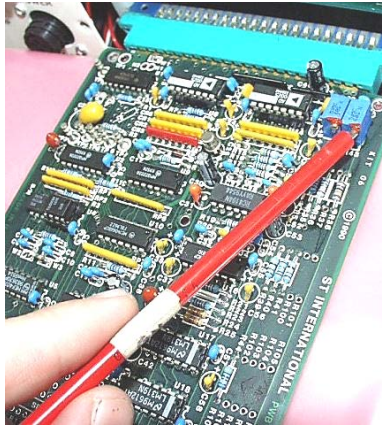
Turn on the Gas by pressing **NEXT LEVEL/GAS**. Look at the flow meter on the front of the ACL, and set the flow between 25 and 30 CFH. Set unit into **Weld** mode by using the green button on the front of the ACL.

Turn DMM off. Start the CAL200 Weld Procedure by hitting the START/STOP key. At the end of the pre-purge cycle, “touch start” the torch (may apply). Once arc is established, the DMM can be turned back on.

With a WATER COOLED calibration weld box you are able to repeat several times between ranges of 20A and 180A adjusting current gain offset to the minimum of tolerance.

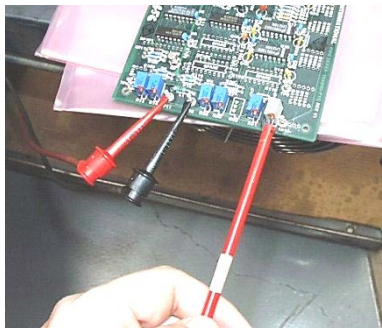
Once the arc has been established, the ACL will output approximately 180 Amps. Measure the voltage across the Current Shunt (on the box or TP10 & TP11). Multiply this voltage by 4 to obtain the “correct value” in Amps (i.e. 45mV = 180 Amps). Adjust **R43** trim pot (located near the back of the Servo Board on the right edge) until **the current reading on the current bar graph on the monitor** or hand held control display shows the calculated value (i.e. if the voltage is 43mV then the reading should be 172 Amps).





### Adjusting R43

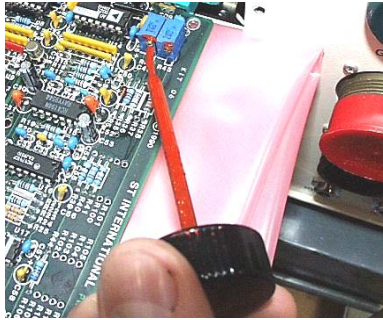
Press **NEXT LEVEL** and the output will change down to approximately 20-Amps. Measure the voltage across the current shunt (on the box or TP10 & TP11). Multiply this voltage by 4 to obtain the “correct value” in Amps (i.e. 5mV = 20 Amps). If the voltage does not match the “correct value” (i.e. 4.5mV = 18 Amps), adjust the R43 trim pot slightly to correct the reading **on the current bar graph on the monitor** or on the hand held control display to be closer to the “correct value” and then press **NEXT LEVEL** and repeat the previous step (@ 180 Amps) to **find a compromise** R43 setting that is equally apart (percentage wise) from the “correct value”. Press **NEXT LEVEL** and the output will change down to approximately 20 Amps. Adjust the R43 trim pot until the current reading on the current bar graph on the monitor or hand held control display shows 20 Amps.



### Adjusting R32

When adjustment of R43 is complete, Press **NEXT LEVEL** and the output will change to approximately 180 Amps. **Adjust R32** trim pot (located near the front of the servo board on the right) slightly to correct the current reading **on the current bar graph on the monitor** or hand held control display to be closer to 180 Amps and then press **NEXT LEVEL** and repeat the previous step (@ 20- Amps) to **find a compromise** setting that is equally apart (percentage wise) from the “correct value”. Then press Start/Stop button on HHC or Press “S” key on the key board to **Stop** the **current gain adjustment**.

When complete, all of the readings/settings should be within +/- 1% from expected values.



### Sealing R32, 42 & 43

Remove the Test Extender Card and Re-insert the Servo Board. Use hex wrench to replace Servo Board's shield and turn off the water recirculator to the calibration kit.

Hardware calibration is now complete. **A full software calibration must be performed after the hardware calibration.**

## 4.0 SOFTWARE CALIBRATION

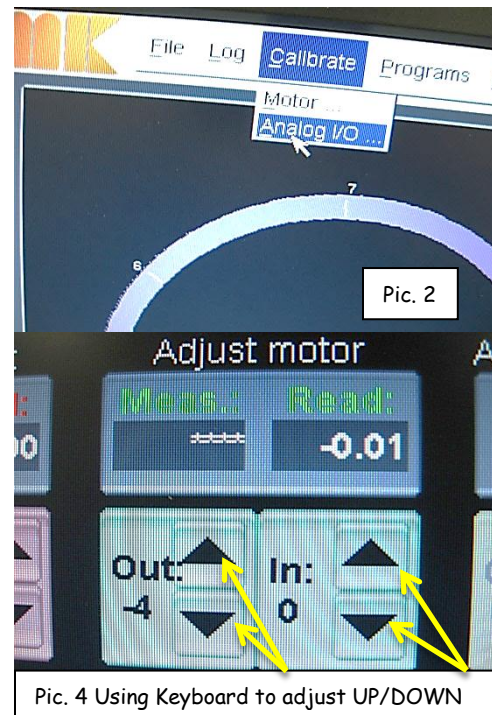
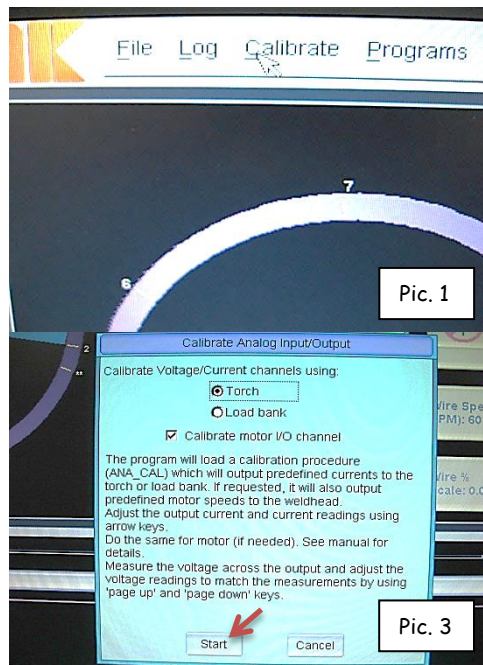
The software calibration process uses a program on your ACL Main Menu. This process does not involve removal of any boards or require any hardware adjustments. This is the only procedure for user's who wish to perform in-house calibration. If it is necessary to document the calibration data, please use the supplied "ACL Calibration Data" sheet and fill in the data during the software calibration process.

**NOTE: It is recommended that you turn the gas off at this point, because it will not be needed in this section of Calibration.**

### 4.1 MOTOR CALIBRATION

**NOTE: PERFORM PROCEDURE IN TEST MODE and Turn Gas Off.**

By using Keyboard. From Calibrate Menu, choose Analog I/O. Click on option Torch or Load bank then "mark-up" on calibrate motor I/O channel then hit Start button.



The Motor Calibration will run through procedure levels at: 0.5, 1, 2, 3, 4, 5, 6, 7, 8, 9, & 10 rpm (these are called DEMAND VALUE).

**NOTE: RPM is calibrated by using the two most recent rotations. Therefore, to obtain an accurate reading and calibration, the rotor must complete two rotations after each adjustment on the H.H.C. This will be time consuming on the lower speeds but is essential for an accurate calibration.**

Press **START/STOP**. Then if HHC is using, the **RIGHT ARROW** (for an increase) or **LEFT ARROW** (for a decrease) to adjust the “MEASURE RPM” until the “MEASURE RPM” is equal to the correct RPM DEMAND VALUE. After the “Measure RPM” equal to “RPM Demand”, use the **% MOTOR SCALE UP** (for an increase) or **% MOTOR SCALE DOWN** (for a decrease) keys to adjust the “READ RPM” until the “READ RPM” equals to the correct RPM DEMAND VALUE.

**NOTE: - You can use a mouse to adjust MOTOR MEAS. And MOTOR READING (See picture 4 on Page 11).**

Press NEXT LEVEL key to proceed to the next motor level.

Press **START/STOP** when finish with all levels. Wait for count down timing. Then using keyboard to press **CAL Save** highlight on monitor to save the calibrated data.

Press ‘Cancel’ if made error during the calibration then go over again.

#### 4.2 VOLTAGE CALIBRATION

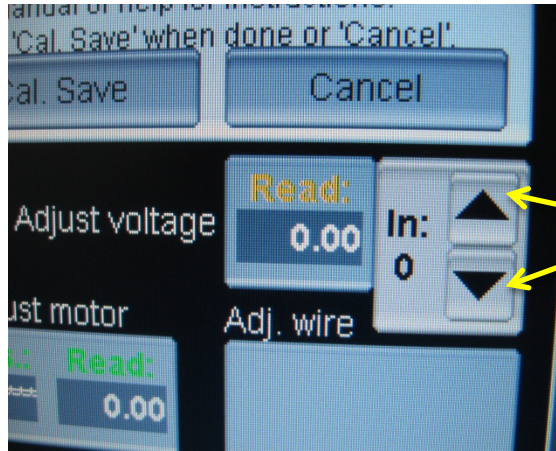
**NOTE: PERFORM PROCEDURE IN TEST MODE and Turn Gas Off.**

Connect a DC Power Supply to the Voltage Input of the Calibration Kit Shunt Box. Press **START/STOP**. Adjust input to 2VDC from the DC Power Supply.

Adjust the “ARC VOLTAGE” (displayed to the right of the Voltage Bar Graph on the monitor) by pressing **PAGE UP** or **PAGE DOWN** (on HHC) until it is the same as the supplied input voltage. Press NEXT LEVEL key for next input (4V, 6V, 8V, 10V, 12V, 14V, 16V, 18V and 20V).

Repeat Step 3.2 but input other voltages and perform the same procedure. Increase inputs: 4V, 6V, 8V, 10V, 12V, 14V, 16V, 18V and 20V.

**NOTE: - You can use a mouse for voltage calibration adjustment (See picture below).**



Press **START/STOP** when finish with all levels. Wait for count down timing then press **CAL Save** highlight on monitor to save the calibrated data.

(**Note**: - Press 'Cancel' if made error during the calibration then go over again.)  
Remove the external DC power supply.

### 4.3 CURRENT CALIBRATION

**CAUTION:**  
**PERFORM PROCEDURE IN WELD MODE and TURN GAS ON.**  
**Disconnect DC Power Supply from power source to protect from the Arc start power surge. Also turn DMM on only after the Arc has been established.**

Attach DMM leads to the Calibration Kit Current Shunt Box. Do not turn the meter on until after the arc is established.

The Current Calibration process contains 11 levels, stepping through current levels of 10, 20, 40, 60, 80, 100, 120, 140, 160, 180, and 200 Amperes.

In each level, adjustments may be made to the "Actual Output Current". This value is found by taking the reading on the DMM and multiplying by a factor of four (4). For example, if the DMM reads 2.5mV, multiply this value by four (4) to find the "Actual Output Current" (2.5 X 4 = 10 Amperes). This value needs to be adjusted to match the "Demand Current" value.

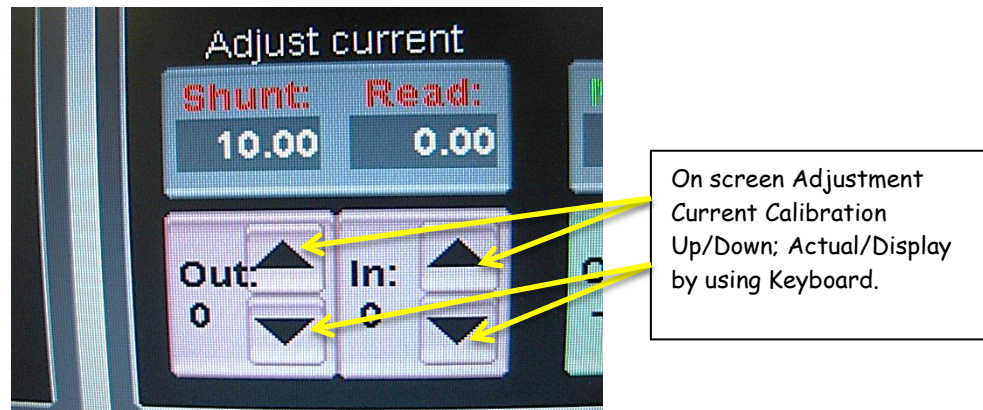
When the "Actual Output Current" value is the same with "Demand Current" value then the "Display Current" value must be adjusted to match the correct "Demand Current" value.

Calibration is as follows:

Press **START/STOP** on the HHC. Turn ON the DMM.

1. Adjust the "Actual Output Current" (found by multiplying DMM reading by four (4) to match the "Demand Current" value by pressing **UP ARROW** or **DOWN ARROW** on HHC.
2. Adjust the "Display Current (Read)" value to match the "Shunt Current" value by pressing **%CURRENT UP** or **%CURRENT DOWN** buttons.

3. Press NEXT LEVEL key to move to the next current level.
4. Repeat steps 1~3 for each level.



**NOTE:** - You can use a mouse to do these steps (See picture above).

5. Press START/STOP when finished with all levels.
6. Wait for count down timing then press **CAL Save** highlight on monitor to save the calibrated data.
7. - Press '**Cancel**' if made error during the calibration then go over again.

\* When step 6 successfully done, run Motor Calibration at **6:00 RPM/Hi** and **2:00 RPM/LO**. Create an APG along with the Weldhead been used (for previous ANACAL). Perform 3 times " Tube Weld " and there are should be " no deviation ".

\*There is a **normal** little bounce display at the Current bar graph on "**WELD**" mode at "Fit" button some-times (about 1 or 2 Amp.) cause from the **offset tolerance** in between of the ACL's controller (Top portion) and ACL's Power supply (bottom portion). Just **disable** "Fit" and **enable** "Max" button or put the power supply on "**TEST**" mode, the bounce bar graph should disappear.

## **END OF SOFTWARE CALIBRATION PROCEDURE**

If you are performing a routine calibration, you do not need to proceed further in this document. No additional calibration, hardware or software is recommended or required beyond this point.

# ACL CALIBRATION DATA

Power Supply S/N \_\_\_\_\_ Weldhead S/N \_\_\_\_\_ Software Version \_\_\_\_\_

## CURRENT CALIBRATION DATA

| <u>DEMAND</u><br>(A) | <u>SHUNT</u> (mV) | <u>ACTUAL</u><br><u>OUTPUT</u> (A) | <u>DISPLAY</u><br><u>OUTPUT</u> (A) | <u>DEMAND</u><br>(A) | <u>SHUNT</u> (mV) | <u>ACTUAL</u><br><u>OUTPUT</u> (A) | <u>DISPLAY</u><br><u>OUTPUT</u> (A) |
|----------------------|-------------------|------------------------------------|-------------------------------------|----------------------|-------------------|------------------------------------|-------------------------------------|
|                      |                   |                                    |                                     | 100                  | _____             | _____                              | _____                               |
| 10                   | _____             | _____                              | _____                               | 120                  | _____             | _____                              | _____                               |
| 20                   | _____             | _____                              | _____                               | 140                  | _____             | _____                              | _____                               |
| 40                   | _____             | _____                              | _____                               | 160                  | _____             | _____                              | _____                               |
| 60                   | _____             | _____                              | _____                               | 180                  | _____             | _____                              | _____                               |
| 80                   | _____             | _____                              | _____                               | 200                  | _____             | _____                              | _____                               |

## ARC VOLTAGE CALIBRATION DATA

|                    |       |       |       |       |       |       |       |       |       |       |
|--------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| <b>INPUT (V)</b>   | 2     | 4     | 6     | 8     | 10    | 12    | 14    | 16    | 18    | 20    |
| <b>DISPLAY (V)</b> | _____ | _____ | _____ | _____ | _____ | _____ | _____ | _____ | _____ | _____ |

## MOTOR SERVO CALIBRATION DATA

| <u>DEMAND</u><br>(RPM) | <u>ACTUAL</u><br>(RPM) | <u>DISPLAYED</u><br>(RPM) | <u>DEMAND</u> (RPM) | <u>ACTUAL</u><br>(RPM) | <u>DISPLAYED</u><br>(RPM) |
|------------------------|------------------------|---------------------------|---------------------|------------------------|---------------------------|
| 0.5                    | _____                  | _____                     | 6                   | _____                  | _____                     |
| 1                      | _____                  | _____                     | 7                   | _____                  | _____                     |
| 2                      | _____                  | _____                     | 8                   | _____                  | _____                     |
| 3                      | _____                  | _____                     | 9                   | _____                  | _____                     |
| 4                      | _____                  | _____                     | 10                  | _____                  | _____                     |
| 5                      | _____                  | _____                     |                     |                        |                           |

TECHNICIAN \_\_\_\_\_ DATE \_\_\_\_\_

## 5.0 ACL VERIFICATION (IF NEEDED)

### 5.1 CALIBRATION VERIFICATION SETUP

The unit might be verified using procedure CALVRFY (Calibration Verify). If you do not have this program, you can request it from [mkproducts.com](http://mkproducts.com).

There should NOT be a need to recalibrate or adjust any of the ACL inputs or outputs with the HHC. or Keyboard. All data will be recorded neatly and completely on the ACL Calibration Data sheet (attached to this document).

Verify that the Weld Box is set up properly. Adjust torch in load box for proper weld gap (.065~.093-inch) with feeler gauge and ensure tungsten and plate surface are clean, use wire brush if necessary. Also make sure the tungsten is 3/32 in (OD Size).

#### CAUTION:

**Before Beginning final calibration, record the test equipment data on the Certificate of Calibration and VERIFY THAT ALL TEST EQUIPMENT USED HAS A CURRENT UNBROKEN CALIBRATION SEAL. Use of uncalibrated test equipment will invalidate the calibration you are about to perform.**

### 5.2 WELDHEAD MOTOR SERVO CALIBRATION VERIFICATION

**NOTE: PERFORM PROCEDURE IN TEST MODE and Turn Gas Off. Also, motor speed is calibrated by using the two most recent rotations. Therefore, to obtain an accurate reading and calibration, the rotor must complete two rotations at each level. This will be time consuming on the lower speeds, but is essential for an accurate calibration.**

Use CALVRFY procedure to verify motor speed in RPM's.

Press **NEXT LEVEL** to step through the speeds indicated on the data sheet. Using the stop watch to record the ACTUAL for each level demand.

Also at each of the speeds, record the DISPLAYED RPM (displayed to the right and above of the Motor Speed bar graph.)

Verify that each of the recorded values equal: = the Demand Speed (+/- .05 RPM) or (Demand Speed +/- 1%) whichever is greater.

Press **START/STOP** when finished.

Run the Weldhead Calibration Menu selection for the Weldhead and printout the Calibration results and attach to test log.



### 5.3 ARC VOLTAGE CALIBRATION VERIFICATION

**NOTE: PERFORM PROCEDURE IN TEST MODE and Turn Gas Off.**

Connect the Power Supply to the Input Voltage of the Calibration Kit shunt box. Press **START/STOP**. Input the Voltage demand levels that are on the data sheet.

Record the DISPLAYED VOLTAGE (located to the right above of the Voltage Bar Graph on the monitor) onto the Data Sheet.

Verify that each level of the recorded values equal: = the Input Voltage +/- 1% VDC.

Press **START/STOP** when finished.

### 5.4 CURRENT CALIBRATION VERIFICATION

**NOTE: PERFORM PROCEDURE IN WELD MODE and TURN GAS ON. Disconnect DC Power Supply from power source to protect from the Arc start power surge. Also turn DMM on only after the Arc has been established.**

Connect **DMM** leads to the current shunt of the Calibration Kit shunt box. **Do not turn the meter on until an Arc has been established.**

Press **START/STOP** to establish an arc. Record the ACTUAL CURRENT in mV (X 4) via the current shunt, and the DISPLAY OUTPUT in Amps (displayed on the screen to the right and above the Current Bar Graph.)

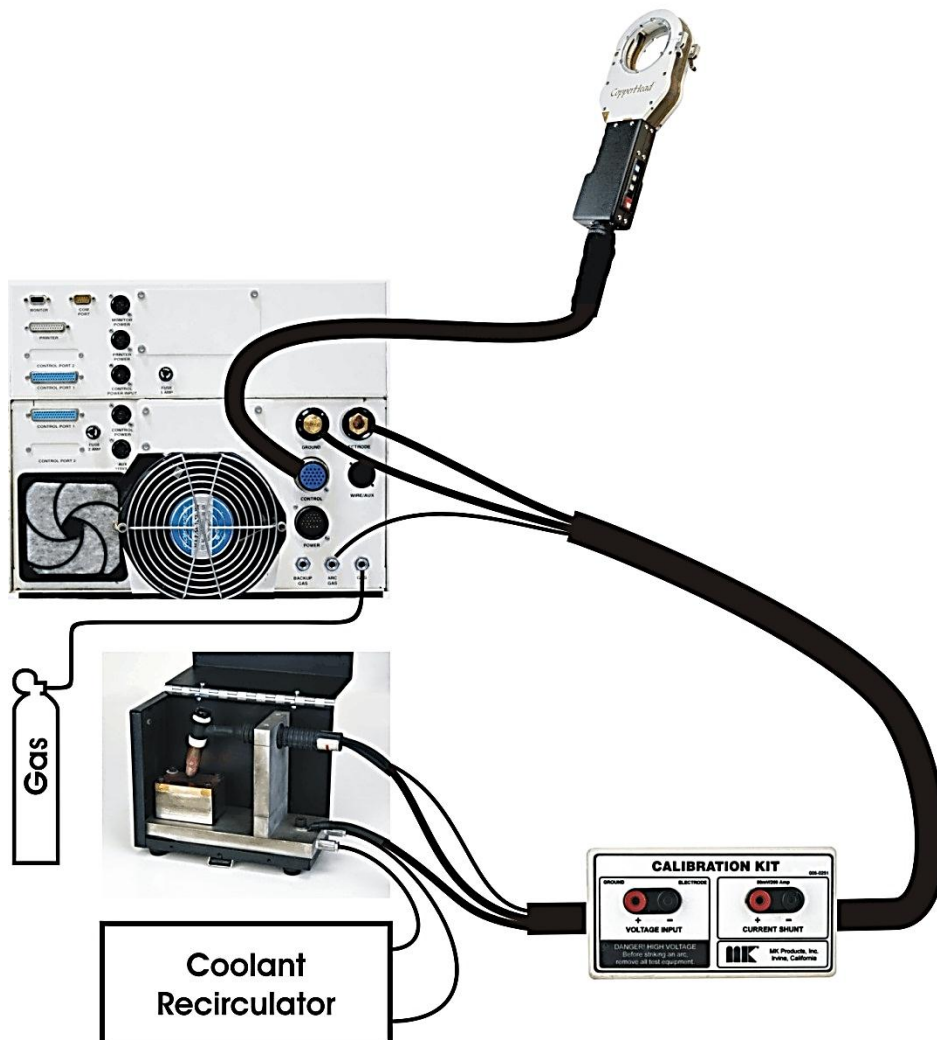
Step through all the required demand levels on the data sheet by pressing **NEXT LEVEL** and record the values for each.

Verify that each of the recorded values equal: = the Demand Current (+/- 1% Amp)

Press **START/STOP** when you verified all levels.

# Appendix A

## Diagram System Calibration Interface



# Appendix B

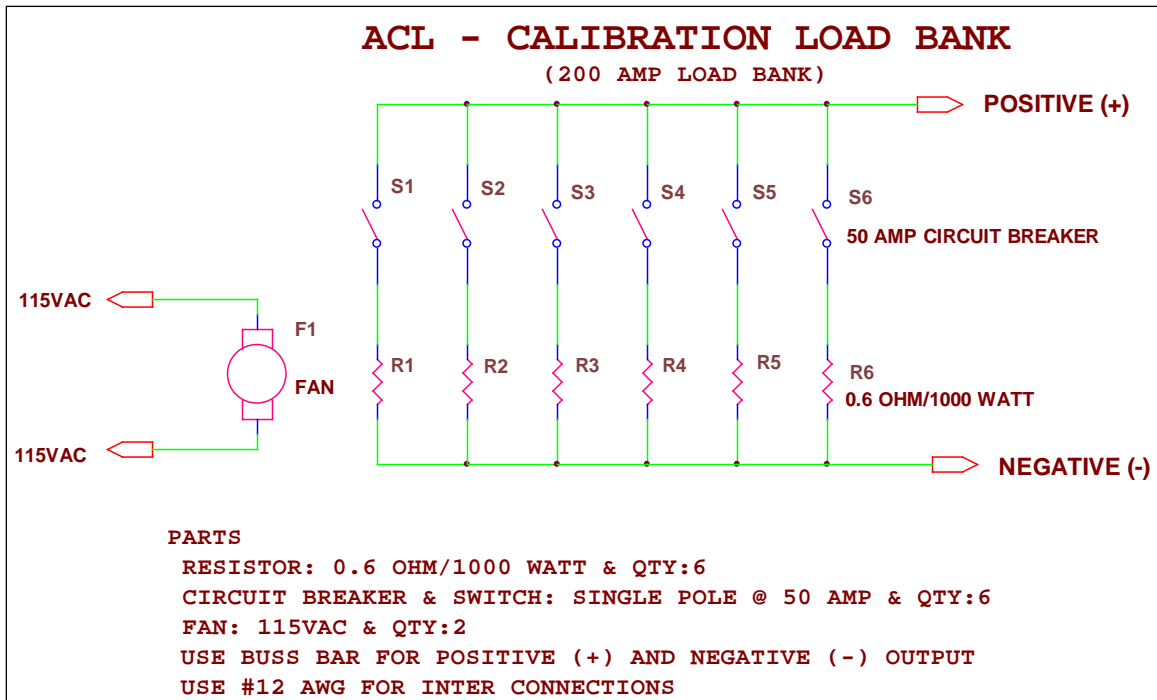
## 1. ACL CALIBRATION LOAD BANK.

Resistor: 0.6 Ohm @ 1000 Watt & QTY: 6

OHMITE Manufacture P/N PFE5KR600

Circuit breaker: Single pole @ 50 Amp & QTY: 6

E-T-A Circuit breaker P/N 8340-F110-P1M1-A0H0-50A



# Appendix B cont.

## CURRENT CALIBRATION DATA FOR RESISTOR LOAD

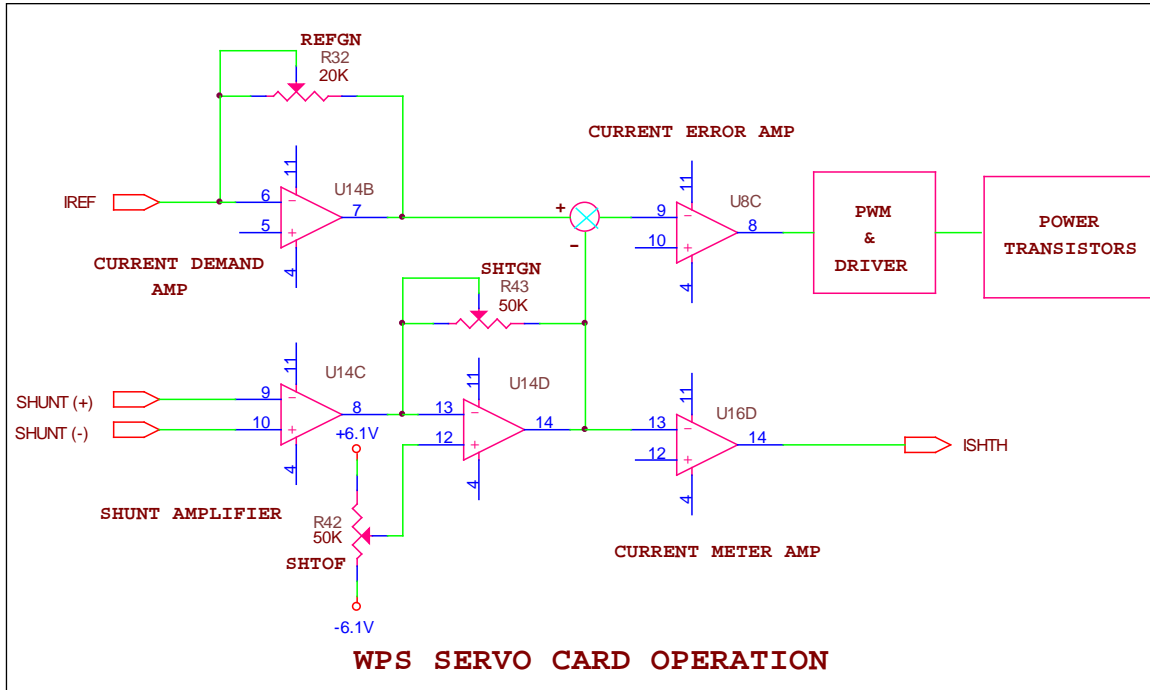
| <u>TURN ON SWITCH</u>  | <u>DEMAND (A)</u> | <u>SHUNT (mV)</u> | <u>ACTUAL OUTPUT (A)</u> | <u>DISPLAY OUTPUT (A)</u> |
|------------------------|-------------------|-------------------|--------------------------|---------------------------|
| S1                     | 10                | _____             | _____                    | _____                     |
| S1                     | 20                | _____             | _____                    | _____                     |
| S1, S2                 | 40                | _____             | _____                    | _____                     |
| S1, S2                 | 60                | _____             | _____                    | _____                     |
| S1, S2, S3             | 80                | _____             | _____                    | _____                     |
| S1, S2, S3             | 100               | _____             | _____                    | _____                     |
| S1, S2, S3, S4         | 120               | _____             | _____                    | _____                     |
| S1, S2, S3, S4         | 140               | _____             | _____                    | _____                     |
| S1, S2, S3, S4, S5     | 160               | _____             | _____                    | _____                     |
| S1, S2, S3, S4, S5     | 180               | _____             | _____                    | _____                     |
| S1, S2, S3, S4, S5, S6 | 200               | _____             | _____                    | _____                     |

**NOTE:**

Shunt is measured at TP10 and TP11 on Servo board (Section 1.3.3 - Picture)

# Appendix B cont.

## 2. ACL BLOCK DIAGRAM OF HARDWARE CALIBRATION PROCESS



### 2.1 Theory of Operation

U14B amplifies current demand from Digital controller. Weld current is measured by the shunt and amplified by U14C, U14D. These two signals are applied to Current error amplifier to regulate the weld current by using Pulse Width Modulation technique. As the pulse width output to Power Transistors increases the weld current increases and as the width decreases the weld current decreases. U16D sends actual welding current back to Digital controller for Monitor & Hand held displays or for current calibration etc. R42, R43 and R32 potentiometers are used to adjust Shunt offset shunt gain and Demand Gain respectively.

### 2.2 Potentiometer Calibrations

- Adjust R42, Shunt offset, for offset voltage to +/- 2mVDC.
- Apply 180 and 20 Amp welding currents and adjust R43, Shunt gain, such that voltage across the Shunt (converted to current in Amps) matches the current demand (180 or 20 Amps) as close as possible.
- Apply 180 and 20 Amp welding currents and adjust R32, Demand gain, such that the current reading displayed on the monitor or hand held control matches the current demand (180 or 20 Amps) as close as possible.

# Appendix C

## **Software Calibration Details**

The hardware calibration assumes that the hardware is linear in error and it calibrates only the amount and the slope of the error. When the hardware is not linear, and in most cases it is not, the software calibration tries to fine adjust the values to be even closer to the actual values.

The software divides the full range of the values (current, voltage and motor speed) into 21 smaller segments and the user calibrates these segments one at the time. Then, these calibration values are used anytime the actual value falls in a corresponding segment area. In most cases, the values will not be at the exact calibration points, so the linear interpolation is used for all of the values in between calibration points.

For example, for current, the segments are:

0-10-20-30-40-50-60-70-80-90-100-110-120-130-140-150-160-170-180-190-200 Amps

For motor speed, the segments are:

0-0.5-1-1.5-2-2.5-3-3.5-4-4.5-5-5.5-6-6.5-7-7.5-8-8.5-9-9.5-10 RPM

For voltage, the segments are:

0-1-2-3-4-5-6-7-8-9-10-11-12-13-14-15-16-17-18-19-20 Volts

To save time during calibration, the calibration is performed for every other segment and the middle segments are calculated by taking an average of the surrounding calibration values. The exception is the first point, which cannot be calibrated because its value is zero; therefore, the second point is calibrated and its calibration value is stored in the first location also.

For example, for current, the segments to be calibrated are:

10,20,40,60,80,100,120,140,160,180,200 Amps.

Then, the 10 Amps calibration value is copied to 0 Amp calibration value.

Finally, the values for:

30,50,70,90,110,130,150,170,190 Amps are calculated from the two values around them (average).

The same process is done for the output values (demand) and the input values (feedback) and the two sets are stored separately. The demand values are the ones used to tell the power supply what current to output. The feedback values are used to adjust the measured current from the shunt. The similar analogy applies to motor speed. Only voltage does not have the demand calibration because it is dependent on the physical setup and the current demand. However, the voltage feedback is calibrated and it measures the voltage across the arc gap.

Once calibrated, all of the calibration tables are stored in a non-volatile memory and are used all the time except when calibrating. Therefore, it is important to have the hardware and software calibration performed every time the hardware is changed or replaced and to have it done properly for every calibration point. Otherwise, the performance of the machine will be degraded or unacceptable.