310 - Calibration Procedures

The 310 is a precision instrument which has two separate and isolated power supplies. One is utilized by the constant current source and one is utilized by the voltage measurement.
The tester can only give good results if the current is constant over the complete range on which it is testing.
The tester give the result R=U/I on the LCD.
The microprocessor control the dots, the indicators and read the rotary switch as well as control the multipliers.
It is important to verify the working voltage before proceeding with the calibration.
Ensure that the selected voltage on the board is the same as the voltage you are going to use for this instrument.
At factory calibration, use the same voltage as the one specified by the customer for this product.

Current Source Calibration

How it work:
The power supply is +5V1, 0V, -5V2 and supply 5 volts positive and 5 volts negative to the current source. Measure this supply if a problem occur.
Basically, the VR4 adjust the reference voltage from the IC4 voltage reference.
That voltage reference is compared to the voltage measured on the shunt R21 and amplified by IC3a.
For 100mA, the amplification is 1 because the 100mA x R21 = 1V
For 10mA, the amplification is 10 because the 10mA x R21 x 10 = 1V
For 1mA, the amplification is 100 because the 1mA x R21 x 100 = 1V
So the voltage reference should be 1V adjusted by VR4, to do that, because of the tolerance of the shunt and components, we will measure the current of the voltage source, for 100mA, then adjust VR4, then use the x10 amplifier to adjust 10mA (using VR3) then adjust VR2 for 1mA.
The adjustments take into account any components errors and therefore the current source will be independent of components errors.

How to adjust it and calibrate it:

1- **Short Circuit C1 and C2 terminals via a digital amp-meter to measure the DC current of the constant current source. To do so, use a calibrated digital amp-meter with the Com connected to C2, and the +mA connected to C1.**
2- **Rotate rotary switch selection to 200.0m ohm selection. (that will select the 100mA current source)**
3- **Start test.**
4- **Adjust VR4 for exactly 100.00mA**
5- **Rotate rotary switch selection to 2000m ohms. (that will still select the 100mA current source)**
6- **Start test.**
7- **Verify that the 100.00mA is stable and fine adjust VR4 if need be.**
8- **Rotate rotary switch selection to 20.00 ohms. (That will select the 10mA current source)**
9- **Start test.**
10- **Adjust VR3 for exactly 10.000mA.**
11- **Rotate rotary switch selection to 200.0 ohms. (That will also select the 10mA current source)**
12- **Start test.**
13- **Verify that the 10.000mA is stable and fine adjust VR3 if need be.**
14- **Rotate rotary switch selection to 2000 ohms. (That will select the 1mA current source).**
15- **Start test.**
16- **Adjust VR2 for exactly 1.0000mA**
17- **Check and verify the three current range again.**

Voltage Measurement Calibration

How it work:
The A/D chip (IC10) need a stable reference (IC8). That voltage reference simulate the constant current source. The A/D does the ratio. That ratio is displayed as being 1000(V+in), so if the voltmeter input of the A/D shows 1000, that mean that the voltage is 1000mV on it's pin 31.

The voltage power supply measuring circuit is supplied by +5V3, Com and –5V4.
If any problem, check these voltages.

The voltage at P1 and P2 is amplified by IC6, a precision op-amp.
The gain can be x1, x10 and x100.
So when measuring at 1mA, on 2000 ohms, the voltage does not need to be amplified because 2000 x 0.001 = 2V for 2000 counts.
Etc…
For 1mA and 2000 ohms, it does not need amplification (x1)
For 10mA and 200.0 ohms, it does not need amplification either (x1).
For 10mA and 20.00 ohms, it need x10 amplification.
For 100mA and 2.000 ohms, it need x 10 amplification too.
For 100mA and 200.0m ohms, it need x 100 amplification.

How to adjust it and calibrate it:

There are two possibilities to adjust the voltage measurement.
One is to use a precision voltage source and the other method is to use precision low resistance (4 wires).

Before proceeding with any method, the op-amp offset must be as low as possible. If the display does not indicate + 000 or – 000 on all the ranges (specially on the 200.0m ohms range) when P1 and P2 are shorted, it mean that the op-amp has too much offset.
Only Lower the offset using copper as explained by the lab engineer. Do not use variable resistors to lower he offset. The Chip IC6 should have an offset lower than 5 micro volts, so x 100, it will be lower than 500 micro volt, so lower than one point on the display (one point is 1mV). The ICL 7650S is capable of very low offset. If this is not the case, that mean that the PCB layout is responsible for the error.

Method using the voltage precision source:

1- **Select 2000 ohms or 200.0 ohms (these two positions use x1 multiplication on IC6).**
2- **Connect 1.99800V on P1 and P2**
3- **Start test to make sure the HOLD is not shown.**
4- **Adjust VR7 finely (voltage reference) until you read 1998 on the display.**
5- **Repeat step 2 to 4 using the 200.0 ohm position.**
6- **Changing polarity between P1 and P2 brings the – sign so you see –1998 on the display.**
7- **Select 20 ohm (this position use x 10 multiplication on IC6).**
8- **Connect 0.199800V on P1 and P2.**
9- **Start Test.**
10- **Adjust VR6 finely (multiplicator by 10) until you read 1998 on the display.**
11- **Repeat step 8 to 10 using the 2000m ohms position.**
12- **Changing polarity between P1 and P2 brings the – sign so you see –1998 on the display.**
13- **Select 200.0m ohms position (this position use voltage x 100 multiplication on IC6)**
14- **Connect 0.0199800V on P1 and P2.**
15- **Start test.**
16- **Adjust VR5 finely until the display shows 1998.**
17- **Repeat 14 to 16 until satisfied.**
18- **Now check all the precision resistors values using the Quality Control Procedure chart.**
19- **Record where it's wrong to analyze and adjust which pot is wrong.**

Method using the Precision Resistors:

1- **Select 2000 ohms on the rotary switch.**
2- **Use a Calibrated resistors of 1900 ohms.**
3- **Inject current into the resistor using C1 and C2 on the extremity of the resistor.**
4- **Connect P1 and P2 very close to the body of the calibrated resistor.**
5- **Now press start.**
6- **On this position, the voltage measurement is not amplified and the precision voltage source must be adjusted to have the display showing exactly 1900 on the display. Use VR7 to adjust the display to 1900.**
7- **Select 200.0 ohms on the rotary switch.**
8- **Use a Calibrated resistors of 190.0 ohms.**
9- **Inject current into the resistor using C1 and C2 on the extremity of the resistor.**
10- **Connect P1 and P2 very close to the body of the calibrated resistor.**
11- **Now press start.**
12- **On this position, the voltage measurement is not amplified and the precision voltage source must be adjusted to have the display showing exactly 1900 on the display. Use VR7 to adjust the display to 1900.**
13- **Select 20.00 ohms on the rotary switch.**
14- **Use a Calibrated resistors of 19.00 ohms.**
15- **Inject current into the resistor using C1 and C2 on the extremity of the resistor.**
16- **Connect P1 and P2 very close to the body of the calibrated resistor.**
17- **Now press start.**
18- **On this position, the voltage measurement is amplified by 10 and the amplification factor must be adjusted to have the display showing exactly 19.00 on the display. Use VR6 to adjust the display to 19.00.**
19- **Select 2000m ohms on the rotary switch.**
20- **Use a Calibrated resistors of 1.900 ohms.**

21- Inject current into the resistor using C1 and C2 on the extremity of the resistor.
22- Connect P1 and P2 very close to the body of the calibrated resistor.
23- Now press start.
24- On this position, the voltage measurement is amplified by 10 and the amplification factor must be adjusted to have the display showing exactly 1900 on the display. Use VR6 to adjust the display to 1900.
25- Select 200.0m ohms on the rotary switch.
26- Use a Calibrated resistors of 190.0m ohms.
27- Inject current into the resistor using C1 and C2 on the extremity of the resistor.
28- Connect P1 and P2 very close to the body of the calibrated resistor.
29- Now press start.
30- On this position, the voltage measurement is amplified by 100 and the amplification factor must be adjusted to have the display showing exactly 190.0 on the display. Use VR5 to adjust the display to 190.0.
31- Now check all the precision resistors values using the Quality Control Procedure chart.

Record where it's wrong to analyze and adjust which pot is wrong.