Technical Bulletin #57

To: Coulometrics Support Personnel
From: Engineering Dept.
Date: Revised 03-2-04
Subject: Electronic Evaluation of a CM5014 Carbon Coulometer

Procedure for checking the Electronics of a CM5014 Carbon Coulometer

The following is a procedure to evaluate the electronics of a CM5014 Carbon Coulometer in the field. It requires the unit to be plugged in and turned on with no cell in the instrument. The Coulometer should be on for at least 30 minutes prior to testing to allow the electronics to stabilize.

1. Perform the Cell Setup Response test:

a. Take a clean dry empty CM5014 cell and fill the cathode compartment with 100 ml of cathode solution. Place the cell top on the cathode compartment. It is not necessary to fill the Anode compartment. Also do not connect the electrodes. The only function of the cell here is to check the transmittance of light. Make sure the electrodes are not blocking the light path. Follow the procedure in the manual for adjusting for maximum response under 'RUN CELL SETUP' of the CM5014 operation manual. Record the response obtained. The response should be between 3600-3950. Please record the reading. Leave the cell in the compartment for the next test.

Maximum Response

_____ (spec. 3600-3950)

If the value is low contact UIC (815-727-5431 ext 183 or ask operator for Technical Services department. Request a copy of Technical Bulletin #56.

2. Perform the Electronic Calibration Check:

There are two methods that can be used to perform the electronic check. One makes use of a digital multimeter and one uses the normalized reading technique. The use of a calibrated DMM with the ability to read current of 200 ma to a resolution of at least .1 is the preferred method.

For Both Methods

Set the CM5014 coulometer as follows:

Select RUN DIAGNOSTICS from the main screen.
Press '2' to Select Print Settings option to print the existing settings. Keep this for reference and to make sure the instrument is set back to these settings after the test
Press '1' to select the Change settings option.
Press '1' to select Carbon
Press 'n' to select units only
Press enter to select the default value on the on the % Difference screen.
Press enter to select the default value of 1.00 on the on the Factor screen.
Press 02 and Enter to select 2 as number of readings.
Press enter on the Interval screen to select he default of 1 min.
Press '2' to select fixed number of readings on this screen.
Press '1' to select Manual sampling method.

Press ‘1’ on the next screen to select CAL TEST PRINT OUT
Press ‘n’ to elect no to the write to disk option.
Press ‘4’ to exit diagnostics

3. If using a DMM:

a. Insert the DMM set up for current measurement in the CELL + and Negative connections. The meter will be in series with the instrument in place of the cell electrodes. Caution the Coulometer power supply develops 180 VDC. Be sure the cell switch is in the off position when connecting and disconnecting the meter.

b. Turn the meter on and set it to measure DC milliamps.
c. Turn the Cell switch to the on position.

4. If not using a DMM
   a. Turn the cell switch to the test position.

5. Select RUN ANALYIS and press enter.
6. Press F2
7. Press enter to select the default value of 01 as the number of samples.
8. Press enter on the next screen. The Coulometer will start the analysis.
9. If using a DMM record the cell current displayed on the meter as DMM current below.
10. The analysis will run for 1 minute and finish. Remove the printout. The printout will display 5 sets of numbers. They are as follows left to right:

Reading number, the time in minutes, reading in ug, the percent T, cell current

11. Record the time (in minutes) of the second reading in the table below.
12. Record the value (in ug) of the second reading as the reported reading in the table below.

TABLE FOR CALIBRATION CHECK USING A DMM

Mode	DMM Current	Time	Reported Reading	Calculated reading	Error
Carbon(C)	_____	____	_____	_____	____
Carbon Dioxide (CO2)	_____	____	_____	_____	____
Carbonate (CO3)	_____	____	_____	_____	____

11. Determine the reading as follows by using the following formula:

$$\frac{\text{Current (in amps)} * \text{time (seconds)}}{96489} * \text{Multiplier}$$

Where Multiplier is as follows: Carbon = 12.011, CO2 =44.0098, C03=60.0092

12. Repeat the test for CO2 and CO3 using the new values and multipliers. If so desired.
13. Use the printout obtained in step 2 to go back into the diagnostics and reset the coulometer to the original analytical settings.

Example calculation using a DMM:
The DMM reported 200.1 ma of current

The printout showed for reading #2

2	1.008	1505.29	99.8	199.898

The time reported is 1.008 minutes
The ug reported is 1505.29 ugc (running in C mode)

Using the formula:

$$\frac{\text{Current (in amps)} * \text{time (seconds)}}{96489} * \text{Multiplier}$$

$$\frac{.2001 * (1.008 * 60)}{96489} * 12.011 = 1506.47 \text{ ugc}$$

The instrument reported 1505.29. The Calculated value is 1506.47
The difference indicates the instrument is low 1.18 ugc

A value of +/- 1.5 ugc can be expected with a typical bench meter.

Since the example meter is limited to 1 decimal place some error is due to the meter calibration and resolution. A bench meter capable of reading 5 & ½ places is used for calibration of an instrument at UIC. In this example the actual current was 199.968ma. This means the actual value was 1505.48. The instrument error was only .19 ugc low.

If testing without a DMM in series using the Normalized reading method:

14. If not using a DMM record the readings in the table below:

TABLE FOR CALINBRATION CHECK NOT USING A DMM (Normalized approach)

Mode	Theory	Actual Time	Normalized Reading	Error (+/-)
Carbon (C)	1493.8	_____	_____	_____
Carbon dioxide (Co2)	5473.5	_____	_____	_____
Carbonate (CO3)	7463.1	_____	_____	_____

15. Normalize the reading by dividing the second actual reading by the actual time in minutes.

Example of calculation not using DMM (Normalized approach)

Instrument reported:

The printout showed for reading #2

2 1.008 1505.29 99.8 199.898

To normalize the value, simply divide the reading by the actual time in minuets from the coulometer printout. In this case the actual reading 1505.29/1.008 = normalized reading of 1493.34

The theoretical value was 1493.8 the error is -.54 ugc. The normalized approach assumes the Cell current to be the factory-calibrated value of 200.00 ma. It is possible that some drift could have occurred in the maximum cell current. If this value is not exactly 200.00 then the coulometer could still be in analytical calibration but the normalized value would indicate some error. This is why this approach is not as desirable as the use of a good DMM. The normalized approach is however, a useful tool to evaluate the instrument if a DMM is not available.