



# CompRatio™ system for Volumetrics™ - User's Guide

Computer Assisted *Compression Ratio* Measurement

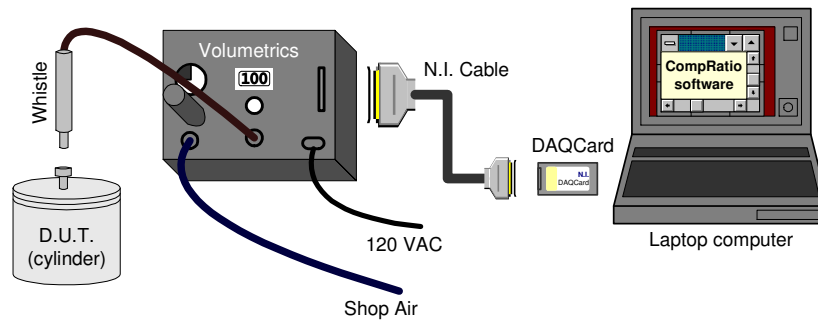
## 1. Introduction:

**CompRatio™** is a system for measuring the volume of an engine's combustion chamber, and to calculate the corresponding compression ratio.

The system consists of a portable **Volumetrics™** Instrument, combined with a data acquisition card inside a laptop computer, and custom software. These additional components, with proper calibration, perform signal processing to improve the volume measurement accuracy to a fraction of a cubic centimeter (cc).

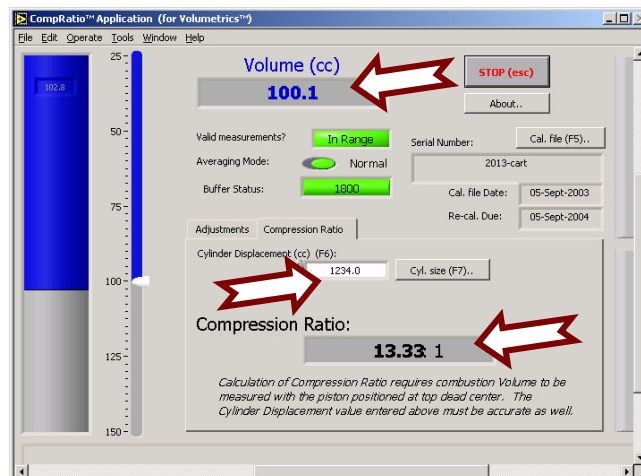
A critical part of the instrument is its transducer probe, referred to as the "whistle assembly". Please treat this delicate, calibrated device with care.

Connection Diagram:



**Compression Ratio** is the measured [*Combustion-*] Volume (cc), divided by the sum of this volume and the *Cylinder Displacement*. The *Cylinder Displacement* value is manually entered into the software, and is typically calculated from bore and stroke dimensions.

Volume (measured), Cylinder Displacement (pre-determined), and Compression Ratio (calculated):



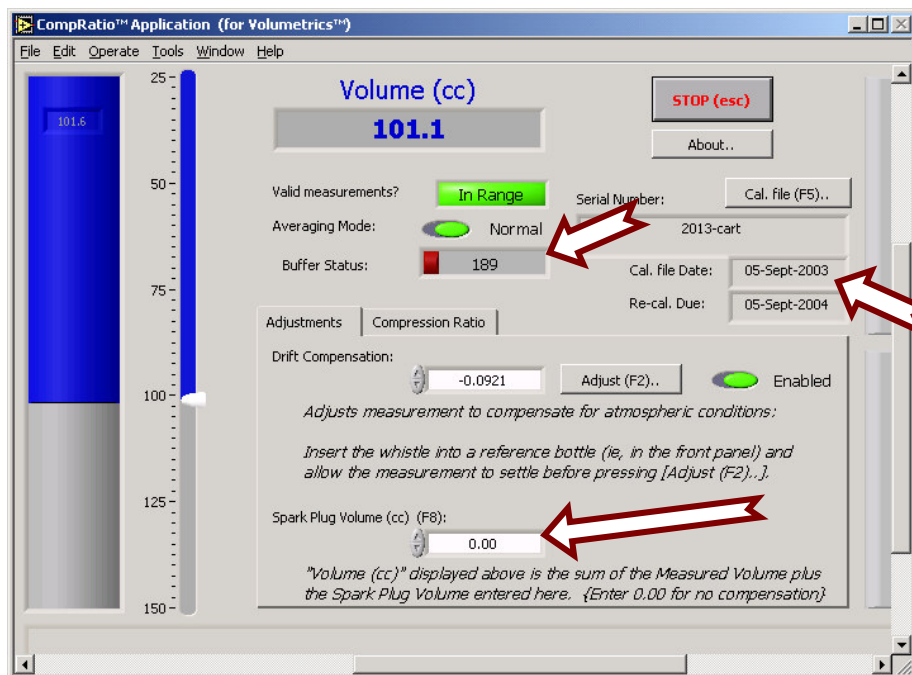
## 2. Setup and Operation:

It may be helpful to first watch the Video Demonstration, available at this Internet address (or from the CompRatio™ software setup CD): <http://www.MichSciMfd.com/volumetrics/>

- 2.1 Connect the Volumetrics™ instrument into shop air. *The shop air supply should be clean: An inline filter and a water trap are recommended.*
- 2.2 Plug both the instrument and the laptop computer into A/C power. *(Refer to step "A.4" about grounding issues.)*
- 2.3 Plug in the whistle assembly that is labeled with the same serial number as the Volumetrics™ instrument, and turn on the instrument's power switch.
- 2.4 Connect the cable between the Volumetrics™ instrument and the DAQCard. Make sure the DAQCard is plugged into the laptop's PCMCIA (or "PC-Card") slot.
- 2.5 Turn on the laptop computer, and log on. *(When delivered, the default password is "MSC", all capital letters and no quotation marks.)*
- 2.6 Start the "CompRatio™ Application (for Volumetrics™)" program, either from the desktop icon, or from the Windows [Start] button.
- 2.7 It is important to check that the software is using the correct Calibration File. This is a **REQUIRED** step, and must not be skipped. *If the correct Cal. file is loaded, the software will display the same Serial Number as engraved on the Volumetrics™ instrument's panel, and the Cal. File Date displayed will be less than one year old.*
- 2.8 **Insert the whistle completely into the built-in CAL VOLUME**, or another reference bottle of known internal volume.
- 2.9 Turn the air *FLOW* regulator until the gauge reads *30 cfh*. The box should be allowed to warm up for several minutes: 15 minutes (with air flowing) is recommended. **Re-adjust the regulator whenever necessary to maintain 30 cfh.**
- 2.10 **After the warm-up time, and once** the on-screen measurement of the reference volume has **settled, perform drift compensation: Press the [Adjust (F2)..] button** on the "Adjustments" tab, then enter the actual volume of the reference bottle. The **CAL VOLUME** built into the front panel is *100.0 cc* unless labeled otherwise.  
*(This calculates the correct compensation number and turns on the Enable button. For best accuracy, compensate using a reference that is close in size to the [combustion-] volume to be measured.)*  
*This software button replaces the front panel CAL ADJ knob, which only affects the accuracy of the LCD panel meter, and not the results generated by the CompRatio™ software. In fact, to avoid confusion, the panel knob and LCD meter have been completely removed from recently built "-CART" systems.*
- 2.11 Compensation for the volume displaced by the spark plug may be made.  
*If the "Spark Plug Volume" (SPV) correction value is known, click on the "Adjustments" tab on the data screen and enter this value at the bottom. **If the SPV is not known** (or not significant), **enter "0.00"**.*  
*The large blue Volume (cc) displayed is the sum of the SPV and the whistle's measurement.*  
*Note: the SPV is the difference between the spark plug's crevice volume and its projection volume: When the crevice is larger than the projection, the SPV is a positive number.*
- 2.12 Click on the "Compression Ratio" tab on the data screen and enter the proper cylinder displacement value. *Use the displacement of a single cylinder, expressed in cubic centimeters (cc). The [Cyl. Size (F7)..] button may be helpful.*

- 2.13 To most accurately measure Compression Ratio, readjust the *FLOW* regulator often to maintain 30 *cfh*. Plug the whistle into the engine, using the appropriate spark plug thread adaptor. *Allow the hose coming out of the whistle to fall slack, for best consistency.*
- 2.14 Turn the engine until the piston reaches “Top Dead Center” (TDC). This occurs when the combustion volume measurement is minimized. Note that there is a delay until the numerical Volume measurement stabilizes. Larger volumes produce longer delays.
- Setting the [Averaging Mode] button on the screen to "Fast" reduces settling time, which may make it easier to find the TDC position. Switch back to "Normal" before recording the measurement, to get the best stability.*
- Use the digital volume display on the computer screen to locate TDC, because the LCD display (when included on the VOLUMETRICS panel) shows less resolution. Rotate the crankshaft very slowly while nearing TDC to ensure that an accurate minimum volume reading is obtained.*
- 2.15 Ensure that there are no extra openings, by closing the cylinder’s valves. The whistle measures the volume of air that is confined within the combustion chamber.
- 2.16 Occasional “??” (*out of range*) readings are expected. Wait until the number has stabilized before recording the measured value. *(To obtain a settled reading, allow the “Buffer Status” indicator to turn green and fill all the way to the right.)*
- 2.17 Ambient temperature fluctuations do affect the system’s accuracy. For best results, operate the instrument in a controlled environment, to keep its temperature from rapidly varying.

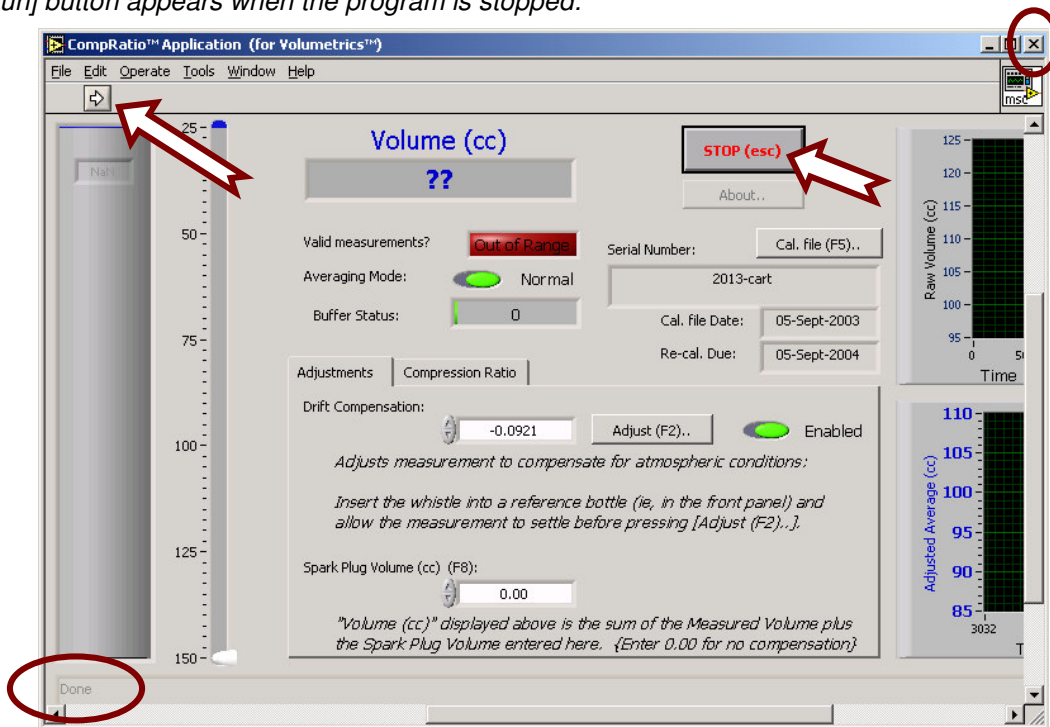
Software shows which “Cal. file” is loaded, and “Spark Plug Volume (cc)” compensation. Buffer Status indicates that the measurement has not yet stabilized:



### 3. Shutting Down:

- 3.1 To stop running the CompRatio™ program, either press [Esc] on the keyboard, or click on the [STOP (esc)] button. *(This step is required due to a limitation in LabVIEW, the software used to develop the CompRatio™ program.)*
- 3.2 If the program is stopped by mistake, restart it by pressing the [Run] button that appears at the top left of the screen.
- 3.3 There are occasional conflicts between the Windows operating system's power management and its PCMCIA support. The data acquisition card is not properly restarted after the laptop has been restored from *Suspend* or *Hibernate* modes. A full shut down and restart is a reliable fix in these conditions. *(Alternatively, to avoid the shut down, run the National Instruments "Measurements & Automation" program and press [F5].)* Keeping A/C power connected will prevent the laptop from entering these power savings modes.

The [Run] button appears when the program is stopped:



### 4. Volumetrics™ Support Contacts:

Information is available on our web site at:

<http://www.MichSciMfd.com/volumetrics/>

To be notified of updates, or for support, please email:

[Volumetrics@MichSciMfd.com](mailto:Volumetrics@MichSciMfd.com)

To speak to an engineer, phone our Milford lab at (248) 685-3939. Ask for Doug Kane (ext. 137) or Jim Thane (ext. 120).

## A. Troubleshooting Suggestions:

Try checking these items if the instrument is not operating as expected. For example, if the whistle is plugged into the internal “100.0 cc” reference volume, and the computer display indicates “105.9 cc”.

- A.1 The volume being measured should be as clean as possible. It must be free of volatile contaminants.

*For example, if even a few drops of gasoline are added to a reference bottle, the volume cannot be measured correctly! Measurement error will be significant until the bottle (or engine cylinder) is purged of the contaminant vapors. Compressed air may be helpful in this purging.*

- A.2 Is the whistle inserted completely into the reference volume port (or into the spark plug adaptor in the **Device Under Test (DUT)**)?

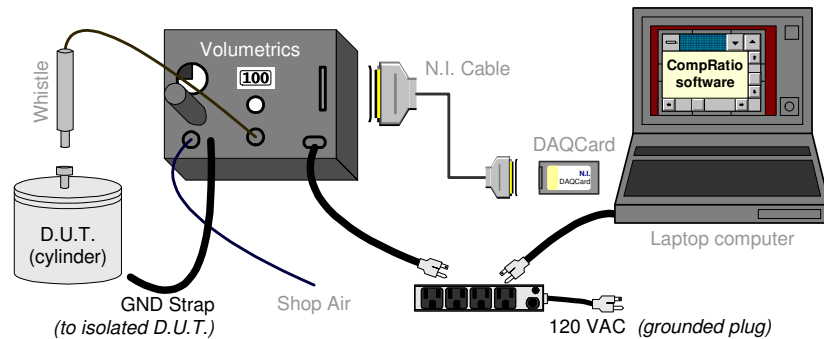
- A.3 Ensure all electrical connections are secure, such as where the whistle assembly attaches to the VOLUMETRICS panel.

- A.4 Connecting a “ground-strap” between the front panel and the DUT may be helpful.

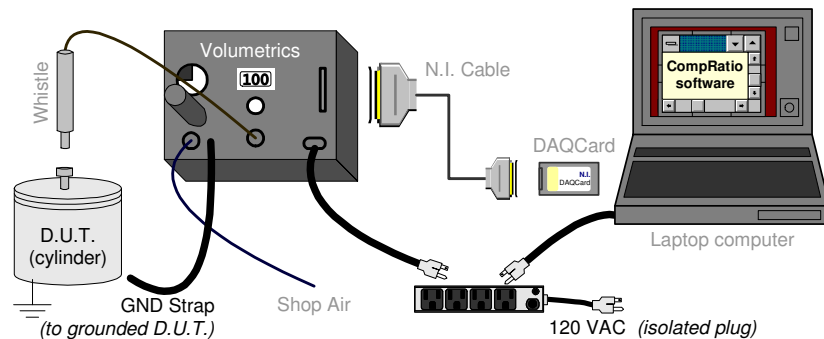
*For a more stable measurement, either the instrument or the DUT should be isolated from external electrical connections (except for the ground-strap between them). This prevents electrical “ground loop noise” current from flowing through the whistle assembly.*

*It is recommended that a **SINGLE** point in the system be connected to earth ground for safety. Typically, if the DUT is isolated, this is done by plugging (both the Volumetrics™ instrument and the laptop) into the same filtered outlet strip. That strip is then plugged into a grounded power outlet.*

*Either ground the instrument (if DUT is isolated)...:*



*...or the DUT, but not both. (In this case, plug instrument into isolated A/C power source):*



A.5 Whistles and calibration files are not interchangeable. The whistle, the Volumetrics™ instrument, and the cal. file used by the CompRatio™ software must all have **matching serial numbers**.

Use the most recent calibration file available for that serial number instrument.

A.6 The VOLUMETRICS **panel's temperature must be stable, not rapidly varying.**

*To minimize measurement uncertainties, try to operate the instrument at room temperature.*

A.7 Allow sufficient warm up and settling times. *(During warm-up, it is best to have the air flowing and the whistle plugged into the volume under test. This allows the system to reach a steady state, since the temperature of the compressed shop air may be different than ambient.)*

A.8 Air flow should be checked often, and adjusted as needed to make the panel gauge indicate "30".

A.9 In the software, make sure the "Spark Plug Volume" compensation is set to 0.0 cc. *(Or, subtract the SPV compensation from the indicated volume to get the actual measured value.)*

A.10 Hose orientation can cause some variation in the measurement. *(The instrument was calibrated at Michigan Scientific with the instrument standing upright, so the whistle was inserted horizontally into the test volume, and the whistle's hose was left hanging slack. See photo on pg. 1.)*

A.11 If a second Volumetrics™ system is available, try using both systems to measure each other's built in reference volumes. This can help identify whether the reference volume has been altered.

A.12 If possible, check the system against another reference volume.

**If these checks do not resolve the problem, the system may require factory servicing or re-calibration. Please contact Michigan Scientific (see section 4).** *(For example, there are components within the whistle that could have been unintentionally moved or damaged. Power surges or static electricity could damage electrical components. Cables and connectors can wear out, or debris in the shop air could damage or clog internal airways...).*