LOS GATOS RESEARCH

RMT-200 Fast Methane Analyzer

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Table of Contents

Installation

The Los Gatos Research (LGR) RMT-200 Fast Methane Analyzer is comprised of several components. Be sure to check that each of the system components has arrived before beginning the installation procedure. You should have received:

- RMT-200 Fast Methane Analyzer (FMA)
- Instrument Power Cord
- FMA Users Guide (this document)
- USB Flash Drive
- Muffler for Internal Pump Exhaust

If you have not received all of these components, please contact LGR (650-965-7772 or sales@lgrinc.com).

Electrical Power Connection

In order to operate the RMT-200 Fast Methane Analyzer, it must be connected to mains power via the fused power entry module on the back of the unit. The unit can be switched from 115 VAC operation to 230 VAC operation via a voltage selection switch on the rear panel near the power entry module (Figure 1). If operation from any other voltage source or frequency is desired, please contact LGR.

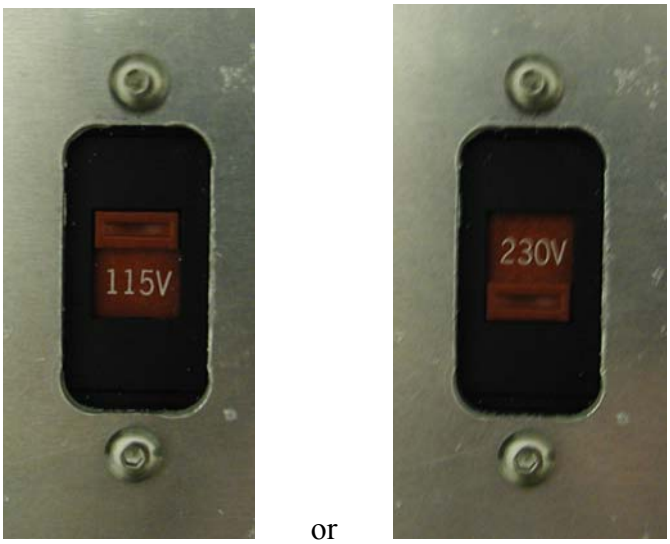

Figure 1: AC voltage selection switch**.**

Keyboard / Video / Mouse (KVM) Connections

The RMT-200 Fast Methane Analyzer has connections for an external keyboard, monitor, and mouse on the back panel (see Figure 2). A standard PS/2 mouse and keyboard should be used, and an analog monitor capable of supporting 800 x 600 pixel mode should be connected.

Figure 2: Keyboard, Video, and Mouse connections**.**

Data Interface Connections

The RMT-200 Fast Methane Analyzer has four data interface connection ports on the back panel (see Figure 3). The "USB" port is utilized for file transfer to USB memory devices. The "Serial" port is utilized for real-time measurement output directly to a computer. The "Analog Out" port provides a DC voltage that is proportional to the measured methane concentration. If this output is connected to an external device, it should be terminated into a moderate / high impedance (>1 kOhm). The "Ethernet" connection allows the instrument to be connected to a Local Area Network (LAN) and the data directory is made available as a Windows™ network shared directory. The functionality of the data interface connections is described in the relevant sections later in the manual.

Figure 3: Data interface connections**.**

Gas Inlet / Outlet Connections

The gas inlet and outlet ports of the instrument are on the rear panel (see Figure 4). The unit is shipped with all inlets and outlets plugged for protection during transit. In the normal mode of operation (internal pump), the gas to be measured should be connected to the inlet port (3/8" Swagelok), the internal pump exhaust port (1/4" Swagelok) should be open, and the outlet to the scroll pump (1/2" Swagelok) should be capped with the provided plug. The inlet gas pressure range is 0 to 20 psig. In the normal mode of operation, the internal pump draws sample through the instrument from the inlet, and the pump is exhausted through a small (1/4" Swagelok) port shown in Figure 4. This exhaust port can either be connected to the provided muffler to expel the instrument exhaust into the room air or the exhaust can be routed to an appropriate ventilation system via ¼" tubing. For high flow mode operation, the outlet to the scroll pump should be connected to a high flow dry scroll pump (LGR recommends the Iwata ISP-250B, Iwata ISP-500B, or BOC Edwards XDS-35i). These operational modes are described in more detail later in the manual.

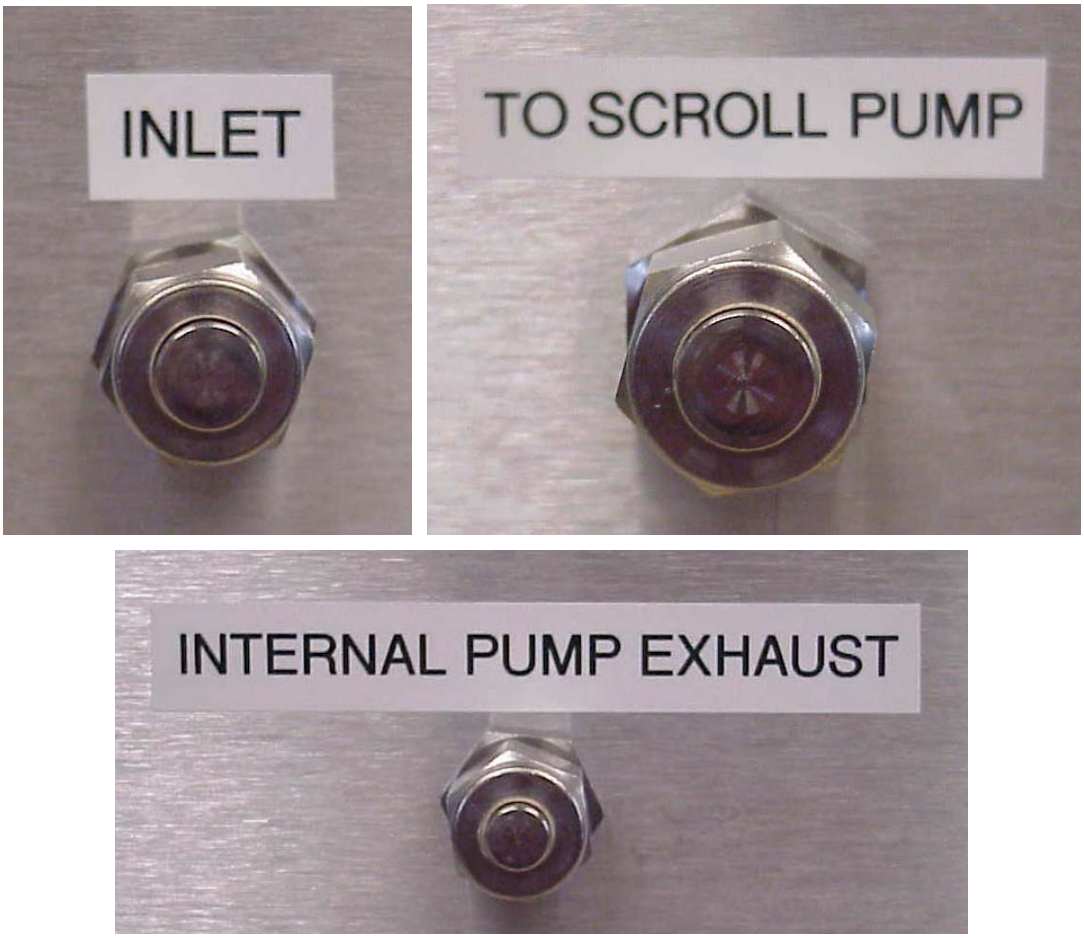

Figure 4: Gas inlet (3/8") / outlet (1/2") / internal pump exhaust (1/4") connections**.**

Instrument Startup / Shutdown

When the appropriate electrical, gas, and data connections are in place, the instrument may be started via the power switch on the front panel (make sure the switch on the rear

power entry module is in the on position - Figure 1). The internal computer will boot, and automatically load and start the instrument control software. The startup process takes approximately 1 minute. Operation of the instrument is described in the next section. Shutdown of the instrument is accomplished by exiting the operating software, waiting for the instrument to shut down, and turning off the power switch. Please refer to the more detailed Startup/Shutdown section on Pages 13-14.

Operation

The Los Gatos Research (LGR) RMT-200 Fast Methane Analyzer is easily operated via the user interface as described in this section.

Main Panel

Display Modes

When the instrument is turned on, it will automatically go through a 90-second initialization cycle with the Los Gatos Research logo and "Please Wait" message on the screen. After initialization is complete, the instrument will begin to draw in air and to display the methane concentration in the air in parts per million (ppm) mixing ratio units, as shown in Figure 5.

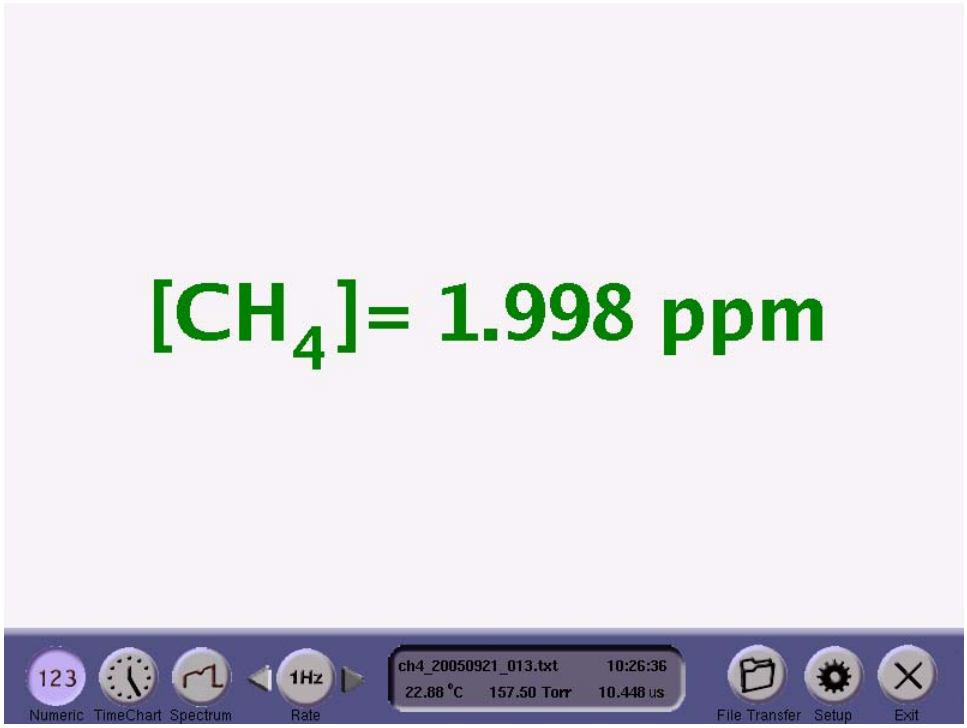

Figure 5. The methane measurement is reported in parts per million (ppm) mixing ratio units, with the measurement cell pressure in Torr, mirror ringdown time in microseconds, cell temperature in Celsius, and current data file name.

If the instrument is started in fast flux mode, the external pump power outlet will activate. NOTE: the instrument will restart in whichever mode was utilized last.

The user may select the Timechart button to see the display of methane concentration over time, as shown in Figure 6. These data are also being saved to the file indicated in the data file name box in the lower right corner of the display, along with a continuous record of the pressure, temperature, and mirror ringdown time. The user may change the rate at which data are written to the log file by selecting the Up or Down arrows next to the Rate indicator. In fast flow mode, rates from 1 Hz to 20 Hz may be selected. In normal flow mode, data will be acquired at a 1 Hz rate and averaged for a selected interval (1 to 100 seconds) before being written to the data file and plotted on the time chart. Longer averaging periods (or equivalently, slower data acquisition rates) will yield better measurement precision than shorter averaging periods; so the user may trade off precision in methane concentration for precision in time. At data rates faster than 2 Hz, the screen will not update faster than 3 Hz to maintain readability, but the data file will be written at the faster rate selected by the user.

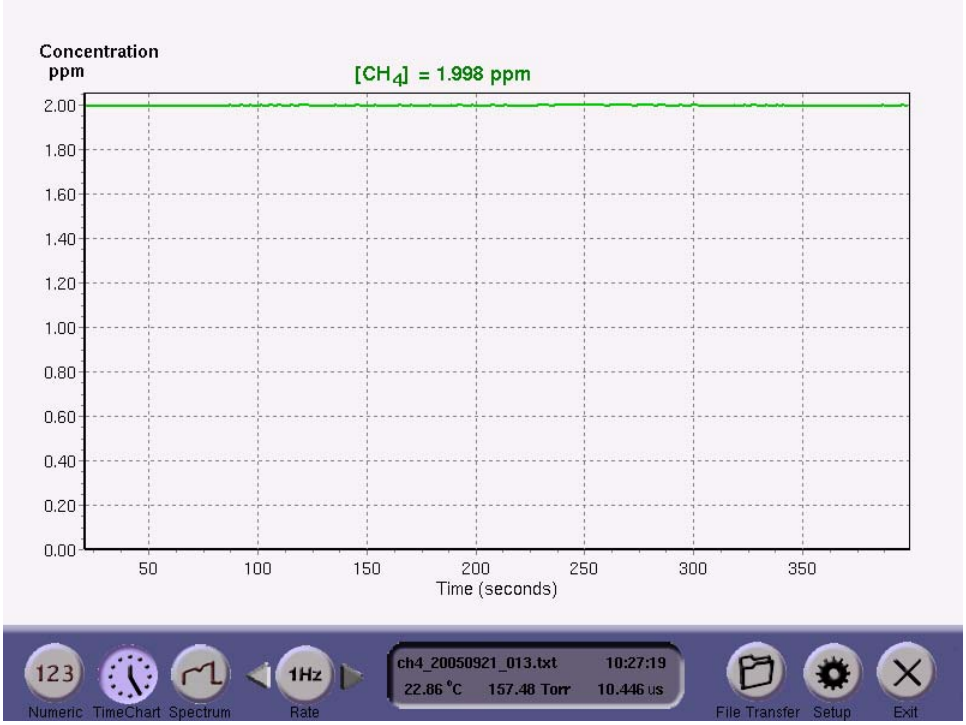

Figure 6. The time chart shows changes in the methane measurements over time.

The user may select the Spectrum button to see the laser transmission through the ICOS measurement cell (Figure 7, top frame) recorded as the laser wavelength is tuned across the selected wavelength region near 1.65 microns, and the methane absorption lineshape that results from a detailed analysis of a section of the measured transmission signal (Figure 7, bottom frame).

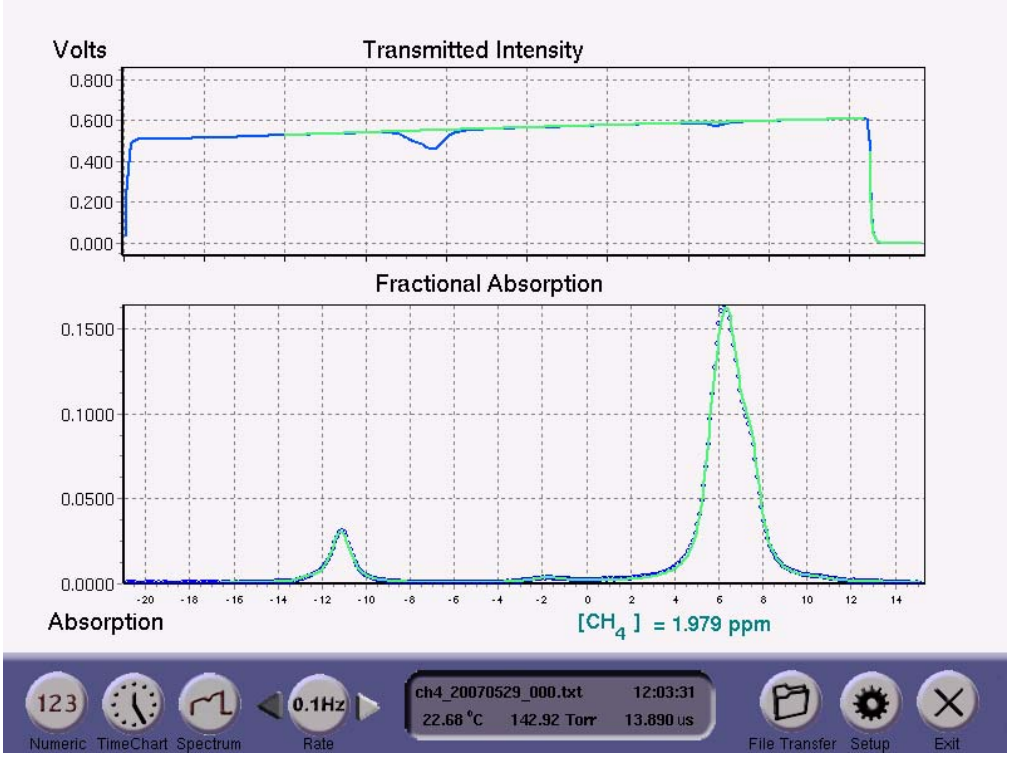

Figure 7. The top graph shows the voltage from the photodetector as the laser scans across the methane absorption feature. The bottom graph shows the optical absorption fraction due to methane in blue, and the peak fit resulting from signal analysis in green.

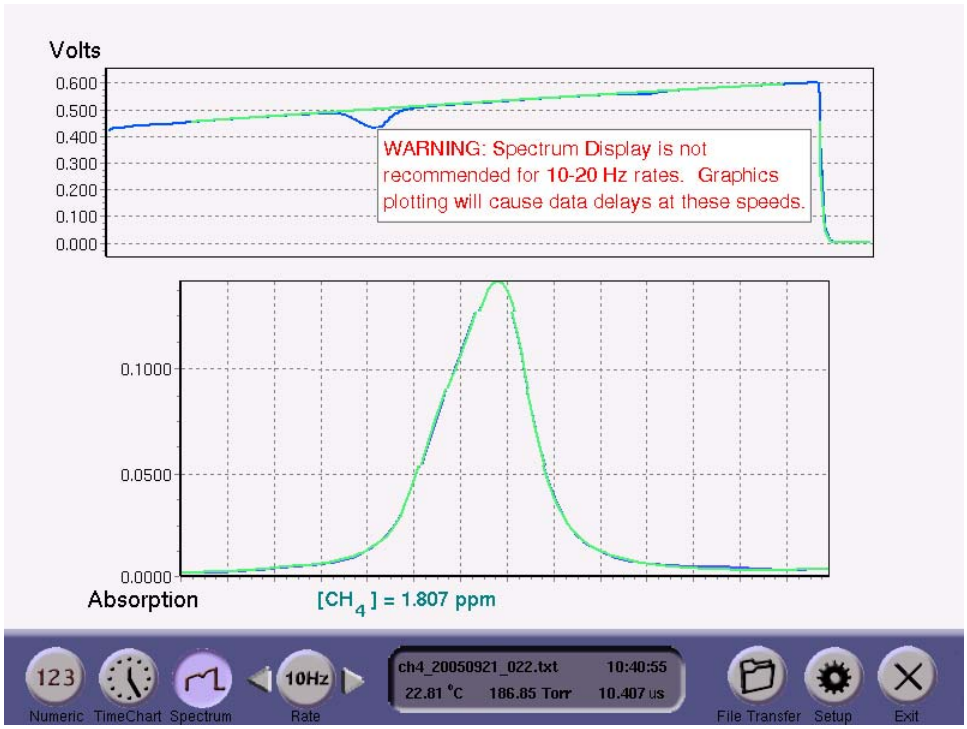

Figure 8. A warning reminds the user that the processor cannot perform both numerical analysis and graphical plotting at the requested rate of 20 Hz. The Numeric display is recommended for 10 or 20 Hz data rates. The user may hide the warning box by clicking on it.

The computationally intensive signal analysis imposes some rate limitations on the graphical display of data. As a result, measurements at 10 or 20 Hz acquisition rates while displaying the spectrum or the time chart are not recommended. Please use the Numeric display to ensure the highest signal-to-noise ratios for these fast data rates. If the user attempts to display graphics while acquiring data at 10 or 20 Hz, the display will warn the user (as shown in Figure 8) that the true data acquisition rate may be reduced due to graphical processing overhead.

File Transfer Menu

Each time the instrument is re-started, and each time the user enters and then exits the File Transfer Menu or Setup Panel, a new data file is created with a file name of the form ch4_20050601_000.txt, where the first 8 numbers are the date (yyyy/mm/dd) and the last three numbers are a serial number. The serial number counts upward to provide up to 1000 unique file names each day. If the instrument is left in continuous operation, a new data file will automatically be created every 24 hours in order to keep data file sizes manageable. The data files are written in text (ASCII) format and contain labeled columns as shown in Figure 9. The "Time" column reports seconds elapsed since the start of the data file (or since the initial start of a data file series when operating continuously). The other columns are self-explanatory, except the Calibration Flag column, which is always zero except for data sets taken during an instrument calibration with a standard gas. At the end of each data file are listings of settings used by the instrument for that data file. The settings are usually not needed, but are stored in case LGR scientists wish to re-analyze a data set to study instrument performance.

The user may transfer data files from the instrument hard disk to a USB memory device by selecting the File Transfer button. The instrument will remind the user to insert a USB memory device into the instrument USB port before proceeding (Figure 10). After pressing OK, data acquisition will halt, and the user will see two file directory windows as shown in Figure 11. The directory windows default to the local drive on the left screen and the USB memory device on the right. The directory windows can be changed by clicking the "Local Drive" or "USB Key" radio buttons. The user may use the left mouse button to highlight one or multiple files in the windows and the arrow buttons to copy the files between the directories.

The user may also navigate through folders, create directories, and delete files and directories. Files may be managed within the local drive by selecting the "Local Drive" radio button above both directory windows. Files can then be organized into directories by creating a folder, copying the desired files to that folder, then deleting the original files.

When the finished transferring files, the user must click the Exit button and wait for the "Safe to Remove USB Memory Device" message prior to removing the USB memory device to ensure proper un-mounting of the file system. WARNING: Removal of the USB memory device before prompted to do so may result in loss of data. If the user forgets to insert a USB device before entering the File Transfer mode, or if the USB

device is not recognized, the instrument will display a warning and will automatically restart data acquisition (Figure 12).

```
LGR ICOS V4.18 Trace Gas Spectrometer-- 2005 Apr 18 10:36:58
   Time_sec,    CH4_ppm, Press_Torr, Cav_T_Cels,   Cal_Flag, MirrorT_us
      1.921,     1.9665,    149.998,     20.010,          0,   8.787703
      4.144,     1.9658,    150.000,     20.019,          0,   8.787012
      6.370,     1.9658,    149.999,     20.035,          0,   8.787863
      8.610,     1.9622,    149.995,     20.040,          0,   8.788350
     10.821,     1.9643,    150.004,     20.050,          0,   8.787480
     13.042,     1.9663,    150.000,     20.067,          0,   8.787537
     … [etc.]
     …
Settings for ICOS V4.18 Data Acquisition.
       0           //Flag: 1=Hardware Simulation 2=Reprocess Data
       0           //Switch: Show Residuals + Line Area
       0           //2=SaveCoeffs,1=Spectra+Coeffs,0=None
       1           //Switch: Save Settings in Data File
   … [etc.]
```

Figure 9. The beginning of a typical data file, showing data columns with time, methane concentration, pressure, temperature, and mirror ringdown time. Instrument settings are saved after the end of the data columns.

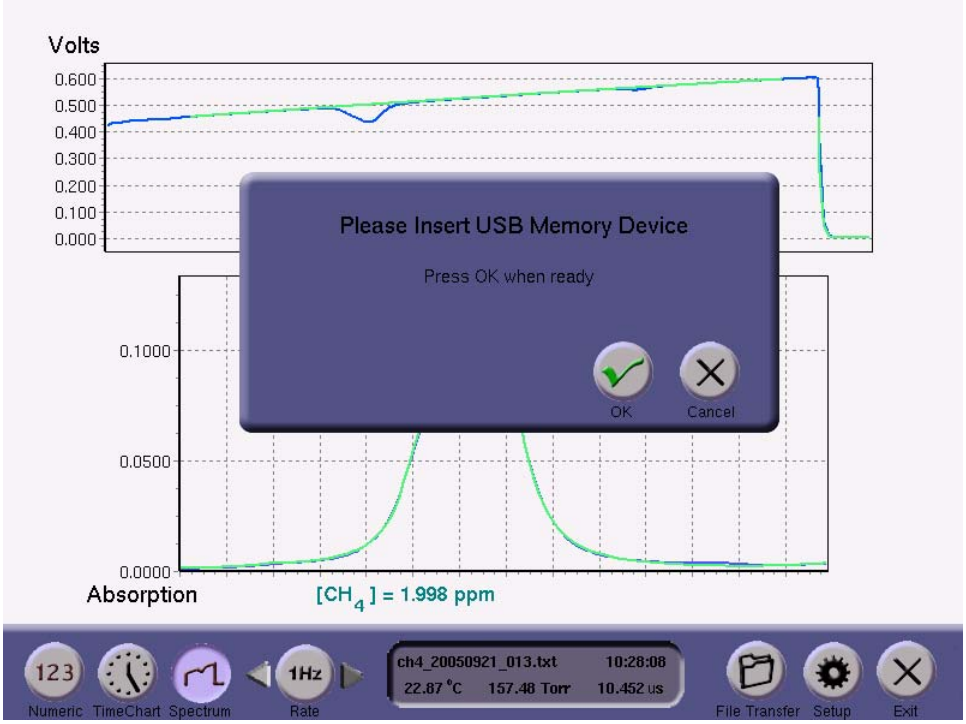

Figure 10. Reminder to insert USB memory device.

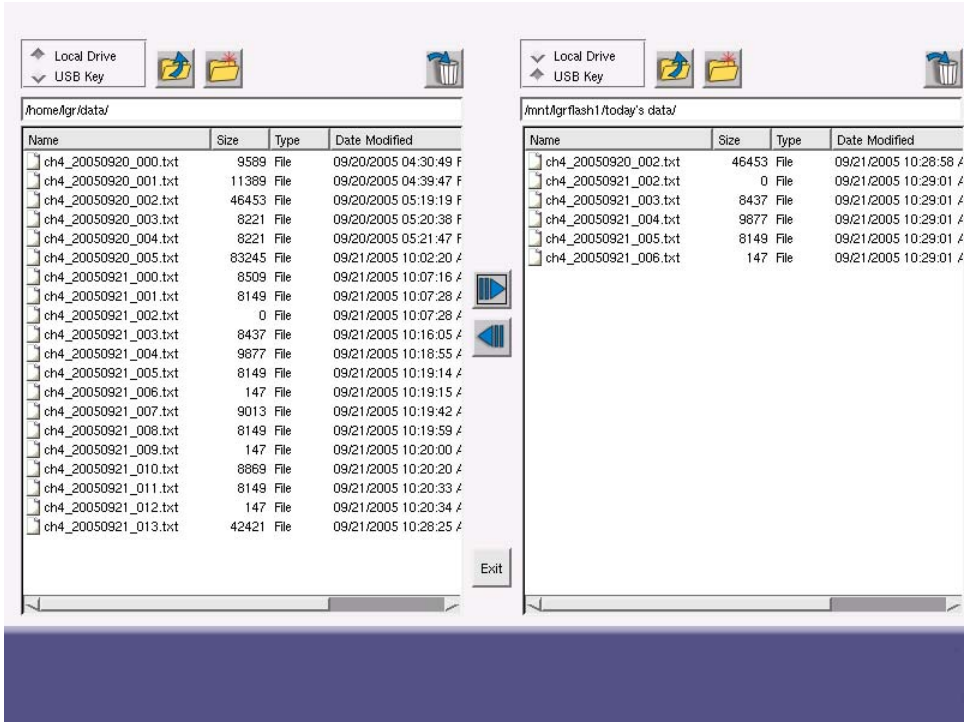

Figure 11. File transfer windows. Highlight the files to copy and click the appropriate arrow. Click the new folder icon to create directories and click the trash can to delete files.

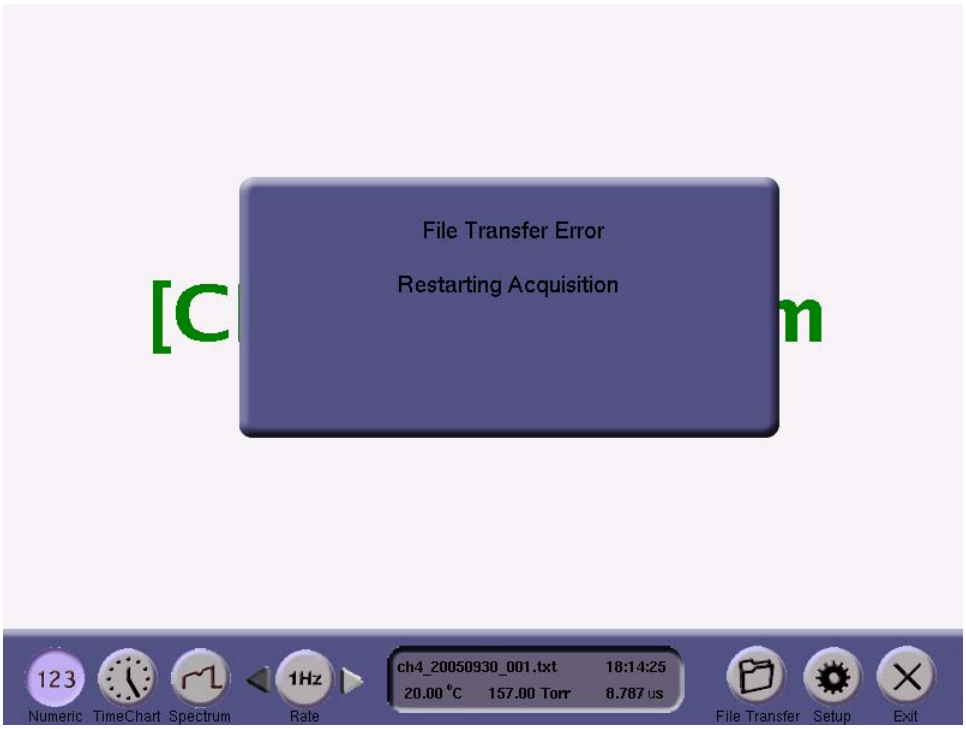

Figure 12. File Transfer Error. User forgot to insert a USB device, or the device was not recognized. Please try again with a USB device correctly inserted or with a different USB device.

Startup / Shutdown

The internal computer will boot, automatically load and start the instrument control software once the proper power connections are made and the switch is set to the ON position. The startup process takes approximately 1 minute. Once a month, the instrument automatically performs a thorough file system integrity check during bootup. The following figure appears and the instrument will take approximately 1-2 minutes to complete the integrity check before continuing with loading the software. Do not turn off the computer during this maintenance.

Figure 13: The Routine Maintenance Screen appears during bootup once a month. Normal operation will automatically continue after maintenance is complete. Please do not turn off instrument during maintenance.

The Exit button will prompt the user for verification prior to shutting down the instrument as shown in Figure 14. This prevents accidental button presses from causing interruption in data acquisition. The OK button will halt data acquisition, close the current data file, will display the shutdown screen. After the progress bar completes, the instrument will switch to a text-based output as it completes shutting down. The user must until after the "Power Down" command is displayed as shown in Figure 15 before turning off the instrument. Failure to do so may result in file system instability.

Figure 14: Instrument shutdown screen**.**

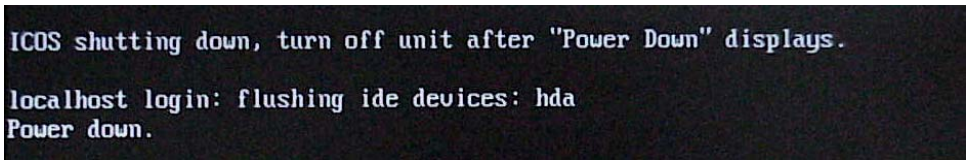

Figure 15: Final shutdown screen.

Setup Panel

The Setup button will prompt the user for verification prior to entering Setup mode as shown in Figure 16. This prevents accidental button presses from causing interruption in data acquisition. The OK button will halt data acquisition, close the current data file, and display the Setup Panel shown in Figure 17. From this panel the user may adjust the range and sensitivity of the Data Analog Output voltage, switch between fast flux and normal flow modes, re-calibrate the instrument to a local methane gas standard, configure the Serial Output, and enter the service mode.

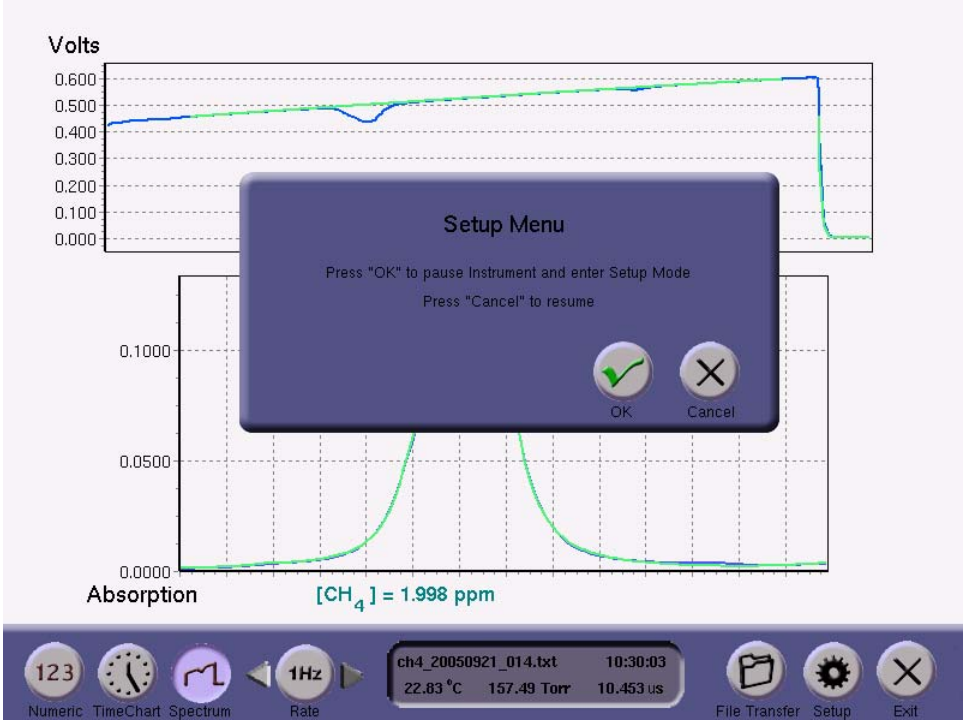

Figure 16. Pressing the Setup button prompts the user for further input.

Figure 17. The Setup Panel allows the user to change Flux Modes, configure the analog and serial outputs, calibrate the instrument, and enter the service mode.

Flux Mode

When the user presses the Flux Mode button, the instrument toggles between normal and fast flux modes and Flux Mode button text toggles between "LO" and "HI" accordingly. (An instrument internal flow schematic and adjustments to the high flow throttle valve can be found in the Appendix). In fast flux mode, the internal pump of the RMT-200 shuts off and the external pump power outlet will activate. In normal flux mode, the high-flow valve on the optical cell will close, the external pump power outlet will deactivate, and the internal pump turns back on.

Data Analog Output Menu

When the user selects the Analog Out button, the Data Analog Output Menu is displayed as shown in Figure 18. The Data Analog Output port has a voltage range from 0 to 5 volts. The user may specify a conversion between the methane ppm measurement and the analog output voltage using the two Up-Down arrow controls in the Data Analog Output box. The right arrow control allows the user to select the order of magnitude of measurement expected, from 0.01 ppm (10 ppb) to 100.0 ppm. The left arrow control allows the user to fine tune the output range by selecting 1, 2, or 5 volts. Note that the output voltage will in all cases be allowed to range from 0 to 5.0 volts; the left arrow control merely establishes the conversion factor from ppm to volts that will be transmitted to the Data Analog Output port. For example, the user may wish to set 5.0 Volts = 10.0 ppm on the expectation that the gases measured will be in the ambient range near 2 ppm, with occasional bursts up to almost 10 ppm. On the other hand, if the user wants exactly two times greater sensitivity on the analog output, with the expectation that

the concentration will not go above 5 ppm, the user may set 1.0 Volts = 1.0 ppm with a maximum signal of 5.0 volts at 5.0 ppm. If the measured concentration goes above the maximum expected value for the Data Analog Output, the on-screen displays and data files will continue to record the correct concentration, but the Data Analog Output will simply saturate at its maximum value of 5.0 volts until the concentration drops back into the expected range.

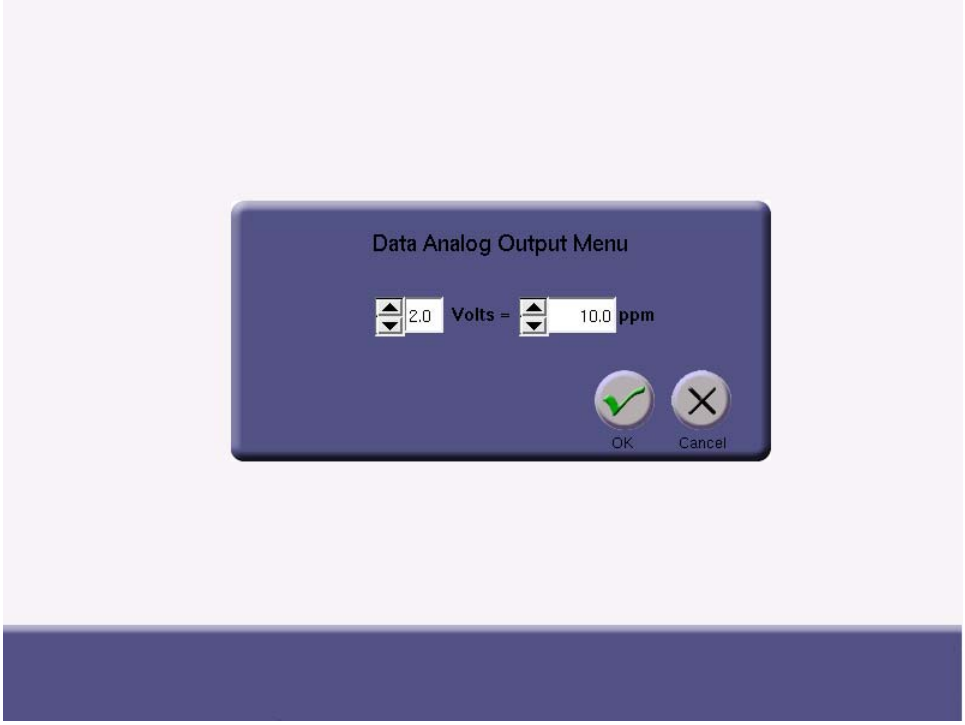

Figure 18. The Data Analog Output Menu.

Calibration Menu and Mirror Ringdown Time

In principle the RMT-200 Fast Methane Analyzer does not need external calibration, because the measured fractional absorption of light at a methane resonant wavelength is an absolute measurement of the methane density in the cell. However, it may be desirable for measurement consistency with other instruments to calibrate all instruments to a local gas standard. This can be done by attaching a tube, regulated at a pressure just slightly above ambient atmosphere, from the local gas standard to the ICOS instrument inlet. Make sure the instrument is in normal gas flow mode, not fast flux mode. Click the Calibrate button to bring up the Calibration Menu. Enter the known mixing ratio concentration in ppm of the local gas standard into the box labeled "Calibration Gas Concentration" on the Calibration Menu. When consistent flow has been established and the transfer tube is fully flushed with the calibration gas, click the Calibrate button. The Status box will update with the number of scans performed while the instrument takes data for about 2 minutes. When calibration is complete, the Status box displays the most recent calibration date, OK button reappears. The time of latest calibration is also stored in the instrument configuration files for future reference.

The mirrors of the ICOS cell are protected from contamination by interlocked valves and an inlet filter. However, it is possible over time and with continued use that the mirrors may gradually decline in reflectivity. This will not create errors in the methane measurement, because the mirror reflectivity is continually monitored and the measurement is compensated using the mirror ringdown time. However, if a significant change occurs in the mirror ringdown time (for example, greater than 20% reduction in ringdown time), the precision of the instrument may be reduced. Users should occasionally take note of the ringdown time and request instrument service (mirror cleaning) from LGR if a significant reduction in ringdown time occurs.

Figure 19. The Calibration Menu.

Serial Configuration Menu

The Serial Configuration Menu allows the user to change how the data reported at the RS-232 port is configured. Standard settings for Baud Rate, Parity, and Stop Bits are provided. The format of the Time Stamp (see table below) can be selected, the Delimiter chosen (comma, tab, space), and the Rate (1-10) specified. Note that the actual rate of serial output is equal to the Logged File Rate (i.e. 1Hz) divided by the Rate specified in the Serial Configuration Menu. NOTE: When connecting the serial port of the instrument to an external computer, a null modem type serial cable should be used.

Absolute Local American	mm/dd/yyy, hh.:mm:ss.sss
Absolute Local European	dd/mm/yyyy, hh:mm:ss.sss
Absolute GMT American	mm/dd/yyy, hh.:mm:ss.sss
Absolute GMT European	dd/mm/yyyy, hh:mm:ss.sss
Relative Seconds After Power On	ssssss.sss
Relative Seconds in Hours, Minutes, Seconds	hh:mm:ss.sss

Table 1. Available Time Stamp Formats.

Figure 20. The Serial Configuration Menu.

Service Mode Menu

A password protected Service Mode is available only for qualified technicians to make software upgrades or run instrument diagnostics.

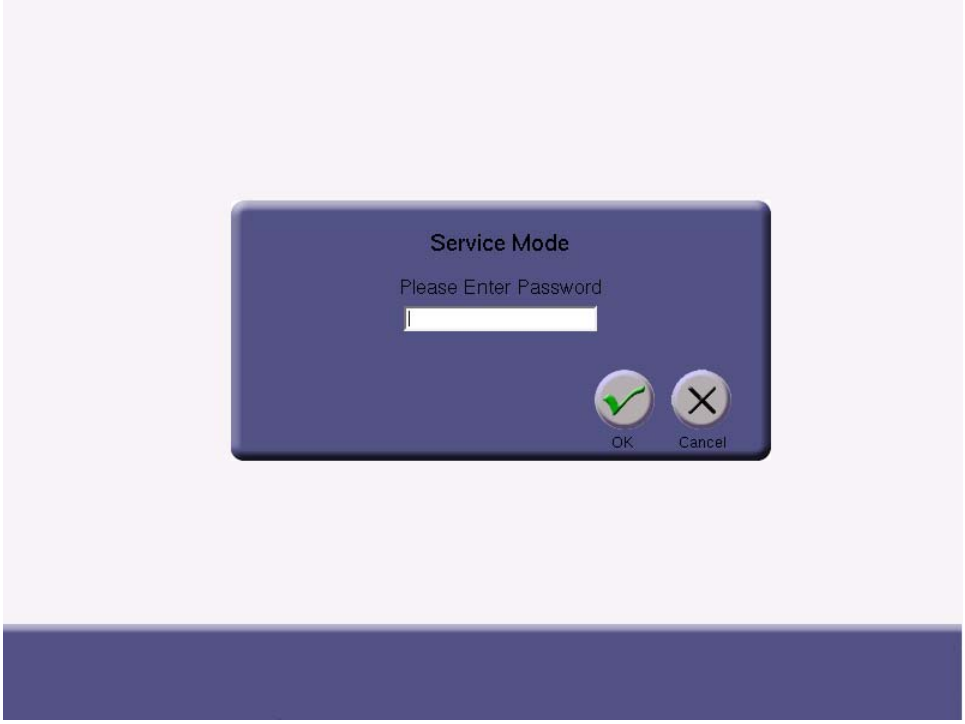

Figure 21. The Service Menu.

Appendix

The following Appendices give additional information on the instrument configuration and operation.

Appendix A - Instrument Flow Schematic

The internal flow of gas through the instrument is shown schematically below in Figure 22. Gas from the instrument inlet flows through one or both of the inlet paths shown, depending on whether the instrument is in normal flow mode or fast flow (flux) mode. In normal flow mode, the high flow solenoid valve is closed, and all of the inlet gas flows through the electronic pressure controller. This controller throttles the flow to maintain the cell at its target pressure (~142 Torr) under variable ambient inlet pressure and any variations in the pumping speed. In fast flow mode, the high flow solenoid valve opens, and the inlet gas flows through both of the inlet paths. The high flow throttle valve (whose operation is described in the Appendix B) provides coarse manual control of the flow to adjust for various external inlet configurations, and the electronic pressure control provides trim control to again maintain the target cell pressure under variable conditions. The gas exiting the cell flows through either the internal pump (in normal flow mode) or through the ½" external pump connection (in fast flow mode). Both of these outlet flow paths are isolated by check valves to prevent leakage from the flow path that is not in use. The cell "flush" time (cell volume / flowrate) is approximately 7.4 seconds while operating with the internal pump, and approximately 0.042 secondswhile operating with an external BOC Edwards XDS-35i scroll pump.

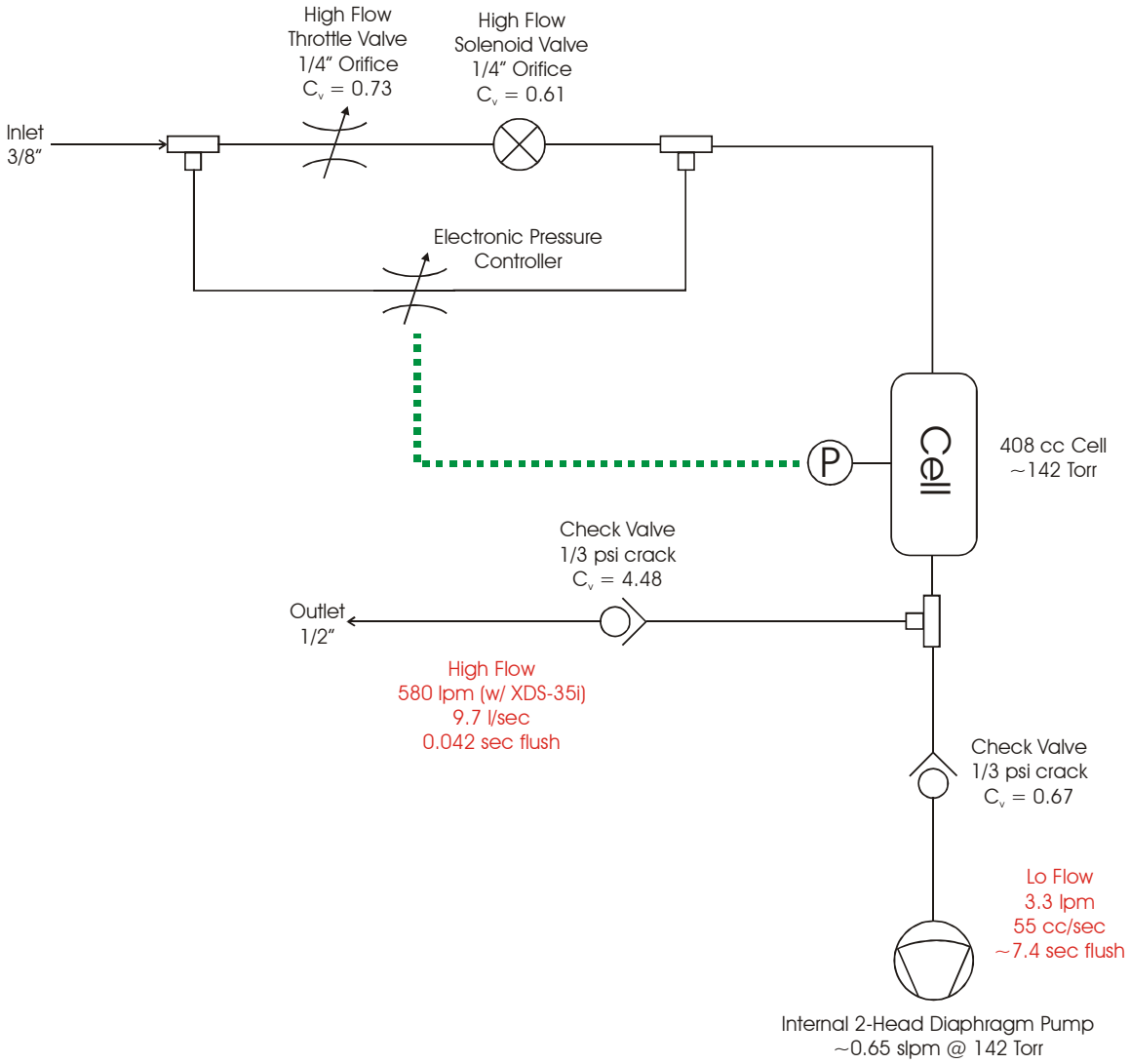

Figure 22: Internal flow schematic of the instrument.

Appendix B – High Flow Throttle Valve Operation (*Fast Flow Only*)

The function of the high flow throttle valve is to provide coarse manual control of the flow to compensate for various external inlet configurations. Depending on the pressure drop of the customer inlet system that is coupled to the instrument, this valve may have to be adjusted to allow the internal pressure controller to function properly. If the instrument is not operating at the target setpoint (approximately 142 Torr) during high flow operation, the high flow throttle valve may need to be adjusted. The high flow throttle valve is located within the instrument (and labeled), and the top of the instrument case must be removed to access and adjust the valve. *Caution should be observed when operating the instrument with the case open, as electrically active components are exposed. Touch only the black plastic high flow throttle valve during adjustment*. The operation / adjustment of the high flow throttle valve is shown schematically in Figure 23. With the instrument in operating in fast flow mode, and the high flow throttle valve nearly closed, the flow is routed primarily through the electronic pressure controller (see

Figure 22). In this condition, the electronic pressure controller is fully open but not able to pass sufficient flow to maintain the cell at its target pressure. As the high flow throttle valve is opened, a point is reached where the flow through the valve combined with the flow through the fully open pressure controller is sufficient to maintain the target cell pressure. As the high flow throttle valve is opened further (through approximately ½ more turn), the electronic pressure controller is within its control range and able to throttle down its flow to compensate for the additional flow through the valve. As the high flow throttle valve is opened even further, the electronic pressure controller is now fully closed and unable to control the cell pressure. The ideal operating point is for the high flow throttle valve to be set in the middle of the electronic pressure control range. This midpoint can be found by slowly opening and closing the high flow throttle valve while observing the reported cell pressure (5 Hz mode works well for this), and noting the points at which the control range starts and ends. This control range typically spans approximately ½ turn of the high flow throttle valve; once the range is found, set the valve position to the middle of this range. NOTE – the maximum range and reading display of the pressure transducer is approximately 155 Torr – anytime the cell pressure is above 155 Torr the display will remain locked at 155 Torr.

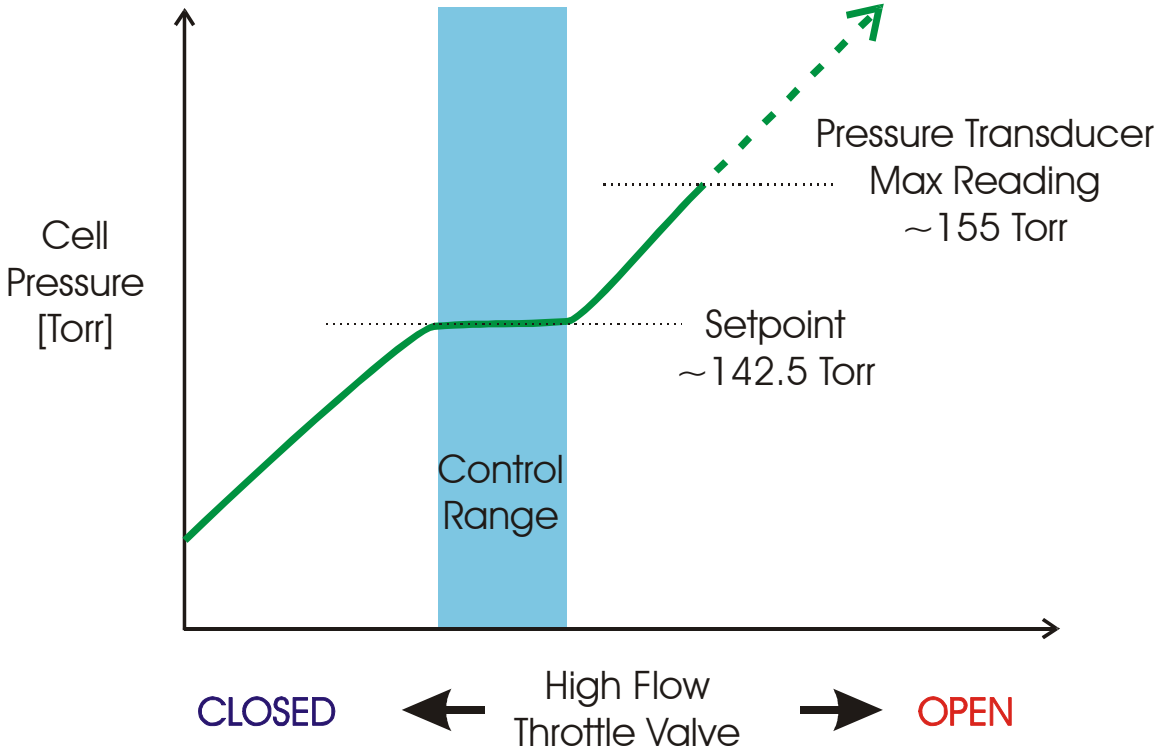

Figure 23: Operational behavior of the high flow throttle valve.

Appendix C – Accessing data via a LAN Ethernet Connection

This procedure describes how to access the analyzer data directory as a Windows™ Share via a Local Area Network (LAN) ethernet connection.

The data files stored on the internal hard disk drive of the analyzer may be accessed as a Windows™ Share via a Local Area Network (LAN) ethernet connection. The following prerequisites are necessary for this function to operate:

1. The analyzer must be connected to a Local Area Network (LAN) via the RJ-45 ethernet connection on the rear panel.
2. The analyzer must receive a response to a DHCP (Dynamic Host Configuration Protocol) request when the instrument is booted. If the analyzer does not receive a reply, it will disable the ethernet port and not attempt another DHCP request until the analyzer is restarted.

When these prerequisites are met, the data directory may be accessed via a Windows computer on the same LAN as follows:

1. Click "Start", then "Run", then type the following into the "Open" command field: \\LGR-XX-XXXX (where XX-XXXX is the serial number of the analyzer).
2. In a short time (usually between 10 and 60 seconds for the first access) a Windows share directory window will be displayed with a subdirectory named "lgrdata" displayed.
3. Double-click on the "lgrdata" directory, and you will see a listing of the data files stored on the internal hard disk drive of the analyzer. You may open or transfer any of the data files as you would with any Windows™ share drive.

ADDITIONAL NOTES:

1. The analyzer shared data directory may (or may not) be visible by "browsing" for it in the Windows "Network Neighborhood". If it is, it will be in the workgroup called "LGR" and the computer name will be "LGR-XX-XXXX" where XX-XXXX is the analyzer serial number.
2. You can open the data file that is currently being written into by the analyzer without interrupting the analyzer operation (you will see a snapshot of the file as it was when you opened it). You will notice that the current data file is only updated occasionally (every 4 kB worth of data), so a new data file will appear empty until enough data is collected and written to disk.
3. If a LAN is not available, you may plug the analyzer into a simple standalone broadband router (such as a Netgear Model RP614 – approximately $45). This will enable the analyzer to obtain a DHCP address from the router when the analyzer is started. You may then plug any Windows™ computer into the same broadband router and access the data directory.
4. A "crossover" ethernet cable will NOT allow an external computer to access the shared data directory, as the analyzer will not obtain a DHCP address at boot and will shut down its ethernet interface.
5. You may be able to access the shared analyzer data directory from computers running operating systems other than Windows™. The analyzer uses a Samba server to share the data directory, and it may be accessed by any appropriate Samba client application.

LGR Contact Information:

For questions regarding the operation of this instrument, please contact:

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