Chemglass Life Sciences Gas Mixing Module - User Manual
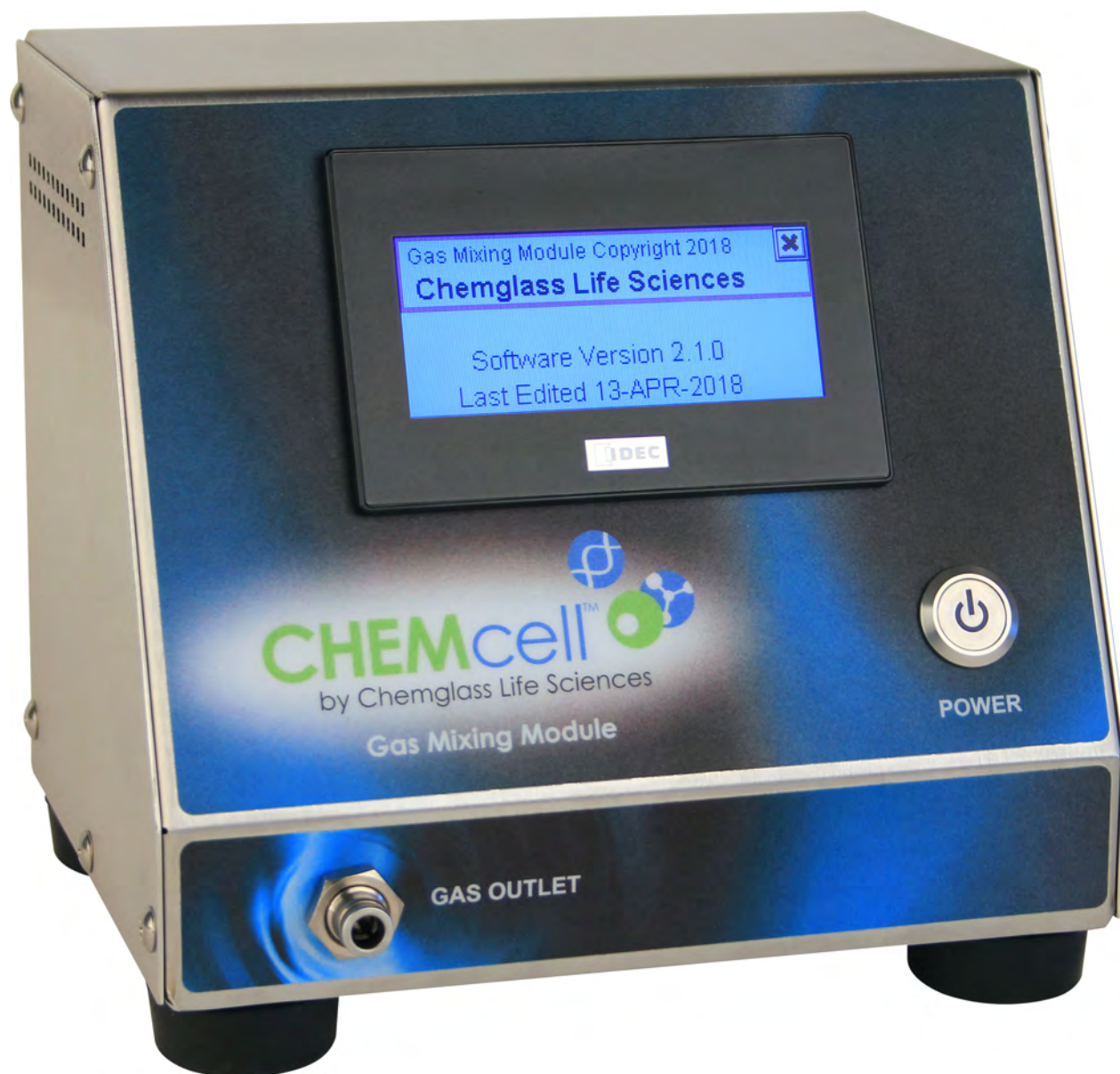
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Overview

The Chemglass Life Sciences Gas Mixing Module is used to deliver a mixture of Air and CO_2 at a controlled ratio. The Mixing Module houses built-in precision gas flow controllers that are operated through a touchscreen display. In addition to the flows, the pressure of the gas mixture is controlled within a safe limit. Gas temperatures are available for monitoring.

The following parameters can be set by the user:

1. Target total gas flow rate (SCCM = Standard Cubic Centimeters per Minute).
2. Percent CO_2 – The required percent Air is automatically calculated as (100% - %CO_2).

The following values are measured or calculated by the Gas Mixing Module:

1. Setpoint and actual CO_2 flow rate (SCCM)
2. Setpoint and actual Air flow rate (SCCM)
3. Actual total gas flow rate
4. Totalized CO_2 flow (SCC = Standard Cubic Centimeters or SL = Standard Liters)
5. Totalized Air flow (SCC or SL)
6. Temperatures of Air and CO_2 (deg C)
7. Outlet Pressure of mixed gas (PSIG)

Common Terms

The following terms are used in this document and displayed on the touchscreen displays:

Term	Description
CO_2	Carbon Dioxide gas
Ctrl	Control
Deg C	Degrees Celsius temperature
OD	Outside diameter of tubing
Press	Pressure
PSIG	Pounds per square inch of gauge pressure
SCCM	Standard Cubic Centimeters per Minute
SCC	Standard Cubic Centimeters
SL	Standard Liters

Power Button

The power button on the front of the module glows blue when on.

Figure 1 – Power Button on Gas Mixing Module (front)

Connections

The following are the connections to the Gas Mixing Module:

- CO_2 gas inlet push-on connection accepts ¼" OD flexible tubing. Gas should be filtered through a 0.2 micron filter.
  - o **Warning:** Do not exceed 20 PSIG on the CO_2 gas inlet. High pressure may damage the internal pressure sensor.
- Air gas inlet push-on connection accepts ¼" OD flexible tubing. Gas should be filtered through a 0.2 micron filter.
  - o **Warning:** Do not exceed 20 PSIG on the air gas inlet. High pressure may damage the internal pressure sensor.
- Gas outlet push-on connection accepts ¼" OD flexible tubing
- Power connection from a 100 - 240 VAC to 24 VDC power adapter which is supplied with the Mixing Module.
  - o **Warning:** Connecting a different power supply to the Mixing Module may permanently damage the internal electronic components.
  - • Data communication cable – Ethernet, RJ-485

Figure 2: Connections to the Gas Mixing Module (back)

Tubing

The gas mixer is configured for 1/4" tubing with quick-connects. Gas feed tubing is connected to the rear of the device and the output tubing to the front of the mixer by simply pushing the tubing into the quick connect fittings.

SMC 1/4" O.D. tubing such as TIUB Polyurethane Tubing or equivalent is recommended.

To remove the tubing, push and hold the outer metal ring of the quick connect IN towards the mixing box, while gently pulling out on the tubing. DO NOT force the tubing out by pulling.

Figure 3 –Tubing Connection (front)

Always make a fresh 90 degree cut before re-connecting tubing. Use a tubing cutter as displayed in the following figure.
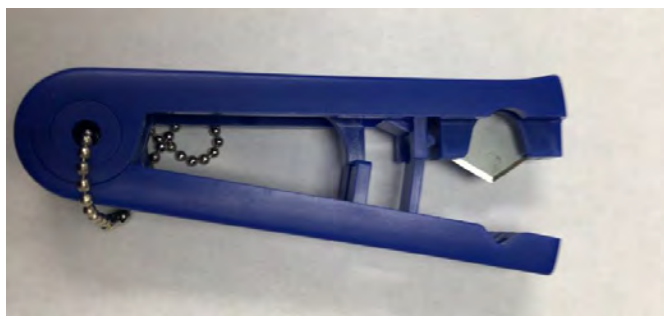

Figure 4 – Tubing Cutter

Touchscreen Display

All user interface with the Gas Mixing Module is accomplished through the touchscreen display mounted on the front.

Screen will go blank after 60 minutes of inactivity. Touching anywhere on the screen makes it come back on.

If an alarm is activated, the display will flash and a buzzer will sound. Touching the display once will stop the flashing and sound but the alarm will remain active.

On initial power up, the Gas Mixing Module starts in the RUNNING mode with the parameters set at the values entered prior to power down. The complete startup will take approximately 5 seconds. The Main page will appear on the Gas Mixing Module touchscreen display.

Main Page

The following figure shows the Main page in Running and Stopped modes of operation.
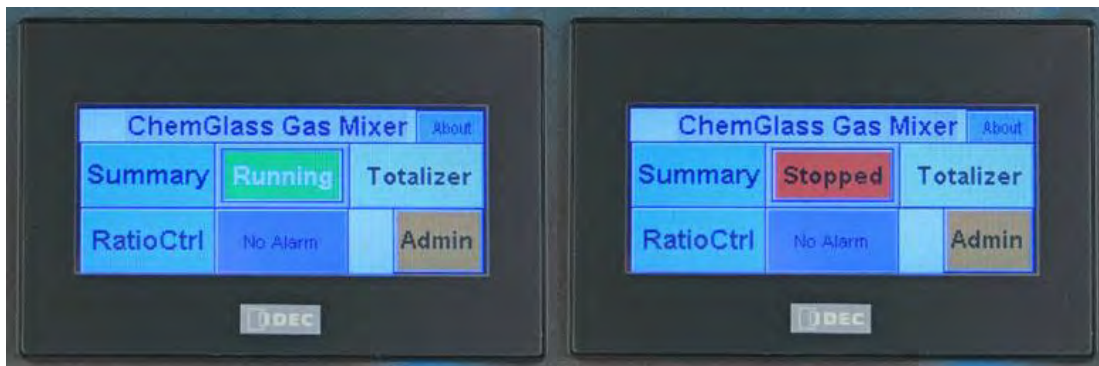
Figure 5 – Main Page – Running/Stopped

The Main page provides touch targets to the following:

- Mode of Operation: Allows toggling between modes of operation.
- Summary Page: Provides overview of the Gas Mixing Module operation.
- Ratio Ctrl Page: Allows entering of the control parameters for the Gas Mixing Module.
- Totalizer Page: Provides viewing of the current flow totals and resetting of the totalizers.

Alarm Status/Clear Alarm: Provides indication of high pressure alarm and target for clearing this alarm.

- Admin Page: For administration and maintenance use only. Not used during normal operation (see appendix).

Each of the above is described in more detail in the following sections.

Modes of Operation

Two modes of operation are available:

1. RUNNING – Gas Mixing Module will operate automatically to maintain the set operating parameters.
2. STOPPED – Gas Mixing Module shuts down and zero set points are delivered to the flow controllers.

The following touch targets allow toggling between the two modes of operation. The current mode is displayed:

Figure 6 – Operation Mode, Running or Stopped

About

The target ABOUT on the Main page brings up the software version information for the Gas Mixing Module.
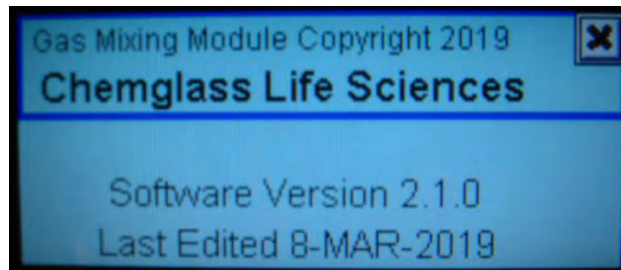
Figure 7 – Main Page - About

Summary Page

The Summary page provides an overview of the current Gas Mixing Module Operation.

Set points (SP), flows, temperatures (T Deg C), and pressure are displayed. The values are continuously updated while the Gas Mixing Module is running. Mode of operation, Run/Stop, is also displayed on the upper left corner of the Summary page.

The control range for the operating pressure (high/low) is shown at the bottom of the screen. If the actual Gas Mixing Module outlet pressure drifts outside this range, the symbols "I" or "D" are displayed to indicate that the total flow is being increased or decreased automatically to bring the pressure back to within the target control range. More information is available on Pressure Control override later in this document.

Figure 8 – Summary Page – "D" or "I" Conditions

If the maximum control pressure is exceeded, the symbol "OP" or over-pressure in red text appears on this page as well as on the Main page.

Figure 9 – Summary Page – Overpressure Condition

If the low flow alarms are enabled and active, the white text LF in red background will appear on the page.

Figure 10– Summary Page – Low Flow Alarm

If the 2-point calibration for CO2 flow is active, the text 2Pt in white with green background is shown on the upper right corner of the Summary page.

Figure 11 – Summary Page – 2Pt Calibration Active

Ratio Control Pages

Ratio Control Page 1 provides access to the user adjustable parameters for the operation of the Gas Mixing Module. Ratio Control Page 2 contains calculated values for reference.

Figure 12 – Ratio Control Page 1

Figure 13 – Ratio Control Page 2, with and without 2Pt Calibration

How to Change Parameters

1. On the Ratio Control page 1, touch the value to be changed to open the numerical entry pad.

NOTE: The CLR (clear) button will clear out the value shown at the top of the key pad screen or clear out the value that has been just entered. The CAN (cancel) button will close the key pad screen without making any changes.

Figure 14 – Numerical Entry Keypad

2. Type in the new value followed by ENT (enter). The numerical entry pad closes.
3. When all values have been changed, touch Enter on the RatioCtrl page 1 to commit the new parameter settings to the Gas Mixing Module controller. NOTE: Changes to values will NOT be sent to the controller unless Enter has been touched.

The following table lists the allowable ranges for the adjustable parameters:

Parameter	Allowable Range	Units	Limits
Percent CO_2	0 – 100	%	100 SCCM CO_2 flow
Target Total Gas Flow Rate	0 – 1100	SCCM	Flowmeter ranges and Pressure Override (see sections below for details)

The operation mode button on the Ratio Control page 1 functions exactly the same as the button on the Main page. The SUMMARY button provides a link to the Summary page.

If the Target Total Gas Flow Rate is limited by the flow meter ranges, the text MAX appears next to the value for the Total Flow in orange. The entered Target Total Gas Flow Rate is automatically reduced to the limit of the flow meters. See the section later in this document for more details.

Totalizer Pages

Total flows of CO_2 and Air are calculated and displayed in Standard Cubic Centimeters (SCC) and Standard Liters (SL). The totalizers can be reset to zero by touching the RESET buttons. Totalizers automatically reset to zero when the total reaches 999,999,999.

Figure 15 – Totalizers – Available Units

Figure 16 – Totalizers – Standard Cubic Centimeters (SCC) and Liters (SL)

Control Functionality

Ratio Control

In normal operation, the target CO_2 percentage is used to calculate the setpoints for the CO_2 flow controller and air flow controller based on the target total gas flow rate.

CO_2 flow setpoint (SCCM) = (% CO_2 / 100) * Target total flow

Air flow setpoint (SCCM) = Target total Flow – CO_2 flow

Target Total Gas Flow Limitations

The target percentage of CO_2 is the most important parameter within the Gas Mixing Module. If the combination of the requested CO_2 percentage and target gas flow rate exceed the limits of the flowmeters, the gas flow set points are automatically reduced to deliver the correct CO2 percentage. The symbol "MAX" appears next to the value on the Ratio Control page1.

For higher accuracy, the CO_2 flowmeter has a maximum limit of 100 SCCM while the Air flowmeter is limited to 1000 SCCM. The maximum total gas flow available is 1100 SCCM.

For example, if parameters of 20% CO_2 and 1000 SCCM target total flow are entered,

Requested CO_2 flow setpoint= 1000 * 0.20 = 200 SCCM (too high)

This value exceeds the 100 SCCM limit for CO_2 flow. The actual flow set points are calculated by:

Actual (limited) CO_2 flow setpoint→ 100 SCCM (max)
Actual (limited) total gas flow setpoint= 100 SCCM / 0.20 = 500 SCCM
Actual Air flow setpoint= 500 – 100 = 400 SCCM

Alternatively, if 4% CO_2 is required and a target total flow value of 1100 SCCM is entered:

Requested CO_2 flow setpoint= 1100 * 0.4 = 44 SCCM
Requested Air flow setpoint= 1100 – 44 = 1056 SCCM (too high)
Actual (limited) Air flow setpoint→ 1000 SCCM (max)
Actual CO_2 (limited) flow setpoint= (1000/0.96) * 0.04 = 41.6 SCCM
Actual (limited) total gas flow setpoint= 1000 + 41.6 = 1041.6 SCCM

Pressure Control

Maximum Pressure Shutdown

If the outlet pressure exceeds a maximum of 1.5 PSIG, the mixing module will shut down both gas flows to protect the devices downstream of the mixing module. The text "Maximum Pressure Alarm" will be displayed on the touchscreen display.

After resolving the high pressure problem, operation mode of the mixing module will have to be changed manually from Stopped to Running before automatic control can resume.

Pressure Limit Control

The Gas Mixing Module outlet pressure is normally controlled between low and high pressure control limits displayed on the Summary page. These control limits are 0.05 and 0.50 PSIG, respectively, and are based on the requirements of the receiving vessel. If pressure exceeds these limits, the gas flow rates for Air and CO_2 are automatically adjusted to bring the pressure back to the target limits.

For example, if 5% is entered for %CO_2 and 1000 SCCM for the target total gas flow, the following set points are set while the pressure is within the allowed limits:
      Calculated CO_2 flow setpoint= 1000 * 0.05 = 50 SCCM
      Calculated Air flow setpoint= 1000 - 50 = 950 SCCM

If pressure exceeds the high limit of 0.5 PSIG, both the Air and CO_2 flow rates are reduced by 10% every 10 seconds until the pressure is below 0.5 PSIG. The symbol "D" appears on the Summary page to indicate decreasing flow rates.

After the first 10-sec period, pressure above 0.5:
      Calculated CO_2 flow setpoint= 50 * 0.90 = 45 SCCM
      Calculated Air flow setpoint= 950 * 0.90 = 855 SCCM

After the second 10-sec period, pressure has dropped below 0.5:
      Calculated CO_2 flow setpoint= 45 SCCM
      Calculated Air flow setpoint= 855 SCCM

No more adjustments are made while pressure is within the allowable gap. If pressure continues to drop and falls below the low limit of 0.05 PSIG, both flow rates are increased at the rate of 10% every 10 seconds until the pressure is above 0.05 and the flow rates are back to the original target values. The symbol "I" appears on the Summary page to indicate the increasing flow rates.

After the first 10-sec period, pressure below 0.05:
      Calculated CO_2 flow setpoint= 40 * 1.10 = 44 SCCM
      Calculated Air flow setpoint= 760 * 1.10 = 836 SCCM

After second 10-sec period, pressure above 0.05, but flow rates are below original set points:

$\qquad$ Calculated CO_2 flow setpoint= 44 * 1.10 = 48.4 SCCM
$\qquad$ Calculated Air flow setpoint= 836 * 1.10 = 919.6 SCCM

After third 10-sec period, pressure between 0.05 and 0.5:

$\qquad$ Calculated (limited) CO_2 flow setpoint= 48.4 * 1.10 → 50 SCCM
$\qquad$ Calculated (limited) Air flow setpoint= 919.6 * 1.10 → 950 SCCM

No more adjustments are made since the flow rates have returned to the original set points.

Appendix I - Admin Page

The Admin page is only used during the initial setup or periodic maintenance of the Gas Mixing Module. Modifying the settings on this page can damage, disrupt the function, or affect the accuracy of the Gas Mixing Module and should only be attempted by qualified personnel.
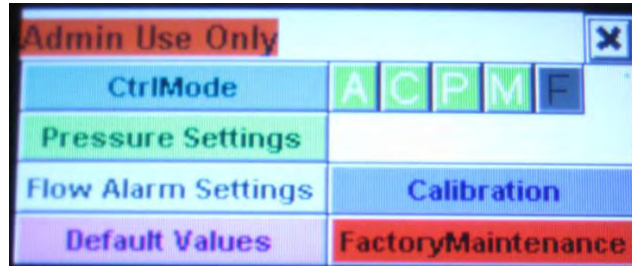

Figure 17 – Admin Main Page

The following sections describe the function of each of the buttons on the Admin page.
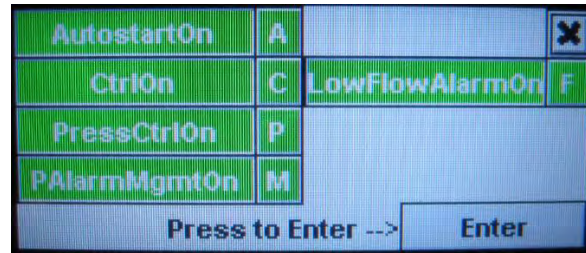
Control Modes (CtrlMode)

Figure 18 – Admin Control Modes

This displays allows activation/deactivation of the modes of control. When activated, the corresponding box next to the mode appears in green. When deactivated, the boxes appear in gray. In normal operation, all boxes should be in green. On the main Admin Page, each of the control modes appear as a single letter.

- A, Autostart – The unit will normally start in RUNNING mode when the unit is powered up. If this mode is deactivated, the unit will start in STOPPED.
- C, Ctrl – In normal operation, the unit operates in RUNNING mode. If this is deactivated, the unit will be in STOPPED mode. (The same function as the Operation Mode button).
- P, PressCtrl – In normal operation, pressure control overrides the total flow requirements to maintain the pressure within desired limits. If deactivated, pressure control will not function.
- M, PAlarmMgmt – In normal operation, when max pressure alarm is activated, gas flows stop until the pressure is back to normal range, then gas flows re-start automatically. If deactivated, automatic restart will not occur and a user must manually clear a high pressure alarm to restart the gas flows.
- F, LowFlowAlarm – If activated, alarms will be generated if either Air or CO2 measured flows fall below a certain percentage. No control action is taken.

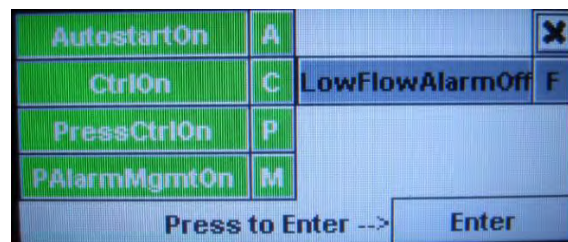The following figure shows one of the elements turned off:

Figure 19 – Control Mode Off

Pressure Settings

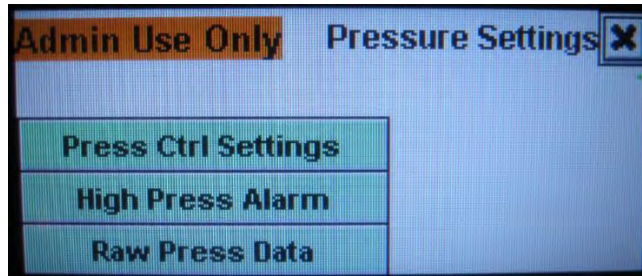Pressure settings are available through the following page.

Figure 20 – Pressure Settings Menu

Pressure Control Settings (PressCtrlSettings)

The Gas Mixing Module pressure is controlled between low and high pressure limits displayed on the Summary page. The limits can be adjusted from this display:

Figure 21 – Pressure Control Settings

The limits are based on the requirements of the receiving vessel on the outlet of the Gas Mixing Module. If pressure exceeds these limits and if pressure control mode is turned on, the gas flow rates for Air and CO_2 are automatically adjusted to bring the pressure back to the target limits. At Max Pressure Alarm, the gas flow rates are stopped and the high pressure alarm is turned on.

Note: If the high control pressure is exceeded and if pressure control mode is turned on, the system will automatically reduce the two gas flows until the pressure is between the high and low control pressures. The gas flows will not be increased unless the pressure falls below the low control pressure. If it is desirable to increase flows after a high pressure event, try increasing the low control pressure setting.

The following table summarizes the allowable ranges for these parameters:

Parameter	Allowable Range	Units	Default Value
Max Pressure Alarm	0.01 – 5.0	PSIG	1.5
High Control Pressure	0.01 – 5.0, and lower than Max Pressure Alarm	PSIG	0.5
Low Control Pressure	0.01 – 5.0, and lower than High Control Pressure	PSIG	0.05

If invalid values are entered, the following error messages can appear on the display:

Figure 22 – invalid Pressure Settings

High Pressure Alarm (High Press Alrm)

This displays allows clearing of the alarm if the Max Pressure Alarm is activated. The numerical values are for information only. When alarm is cleared, the red text becomes gray. If "P Alarm Mgmt" is turned on (default setting is on), the system will automatically try clearing the high pressure alarm if the pressure falls below the high control pressure. To clear the high pressure alarm immediately, a user can touch the "Clear Alarm" button and if the pressure is below the maximum pressure, the unit will restart gas flows.

Figure 23 – Max Pressure Alarm

Raw Pressure Data (Raw Press Data)

This display is used for troubleshooting the pressure transmitter operation. There are no adjustable parameters. The raw analog input signal should range from 0-1000.
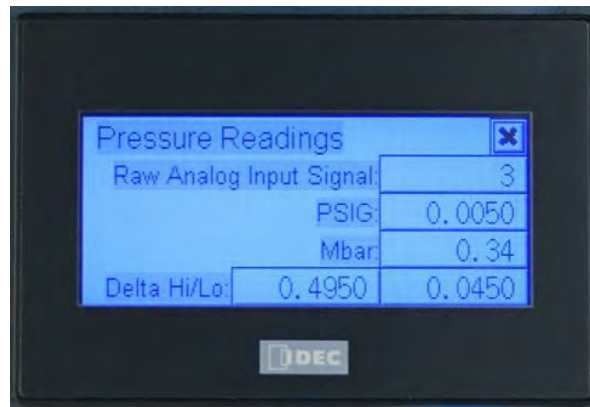

Figure 24 – Raw Pressure Data

Default Values:

This page can be reached from the Admin main page and allows the return to the default settings for the Mixing Module.

Pressing the "Enter" button does the following:

- Turns all control modes to "On"
- Sets the low and high control pressures to 0.05 and 0.50 PSIG
- Sets the maximum pressure to 1.5 PSIG
- Sets the internal control settings (which includes various control timers and control percents) to factory default settings
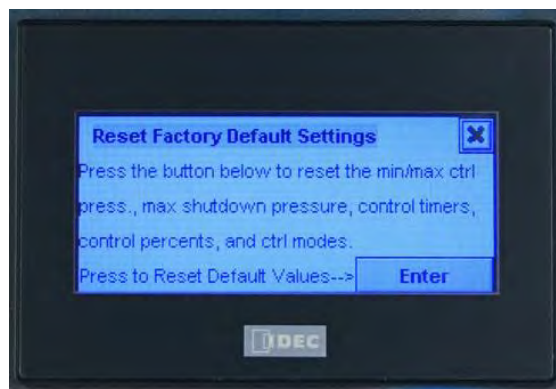

Figure 25 – Default Pressure Settings

Low Flow Alarm Settings

It is possible to add low flow alarms for both air and CO_2 flow measurements. If the flow drops below the minimum for a set time, a beeping sound will be activated and the display on the Gas Mixer will flash until touched.

Touching the anywhere on the screen acknowledgements the alarm. If the flow measurement is returned to normal before acknowledgement, the beeping and flashing will stop.

To enable the low flow alarm, ENTER values for the minimum flows as percent of setpoints and time in seconds. Then touch the BeepOff button. Alarm is enabled when the BeepON text is visible with a green background.

Figure 26 – Low Flow Alarm Setting On/Off – Page 1

Page 2 of the Low Flow Alarm Setting displays the alarm setpoints in units of flow, SCCM.
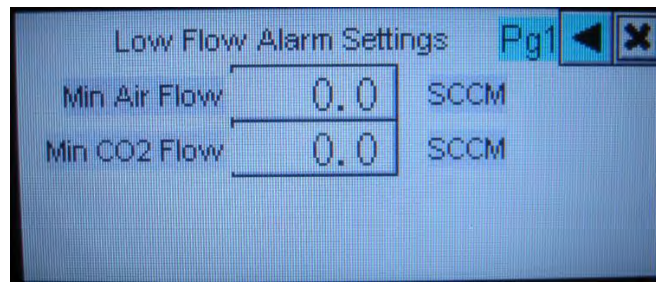

Figure 27 – Low Flow Alarm Setting – Page 2

Calibrations

Access to the calibration pages is available by logging in. User password is 9876.

Figure 28 – Calibration Login

After successful login, the following page appears with targets for the available calibration pages. Each of these pages is discussed in the following sections.
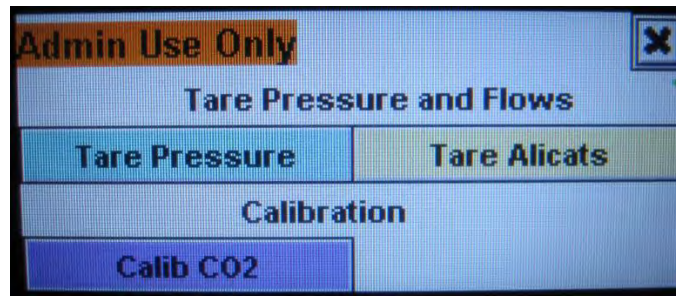

Figure 29 – Calibration Menu

Tare Pressure

The pressure transmitter is calibrated prior to installation. If it is necessary to tare (or zero) the pressure measurement, follow the steps below:

1. Remove the outlet tube in the front before taring of pressure to achieve atmospheric pressure, i.e., zero gauge pressure.
2. Make sure that the unit is in the "Stopped" mode and make sure both flow setpoints are zero.
3. On the Tare Pressure page, enter correction factor (0=no correction).
4. Touch the Tare Pressure button. Read the corrected Raw AI.
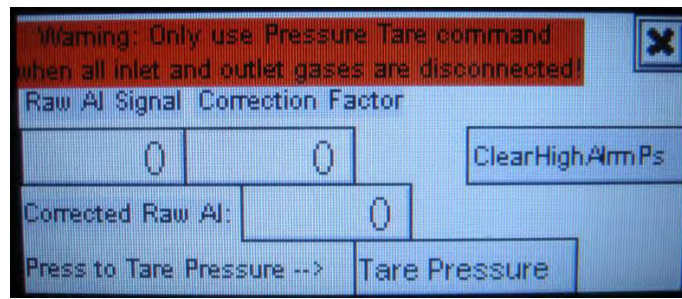5. Clear High Alrm Ps clears any existing pressure alarms.

Figure 30 – Tare Pressure Page

Tare Alicat Flow Controllers

Taring the Alicat gas flow controllers makes sure these instruments are zeroed out. This process is usually performed at the factory, but can be repeated if necessary. This procedure should only be attempted when there is no gas flow to the flow controllers and the setpoints are set to zero. Follow the procedure below:

1. On the Ratio Control page, set zero for the both CO_2 Percentage and Target Total Flow.
2. On the Tare Alicats page, push Read Tare Results. Note values for each flow meter.
3. Select flow meter by touching Tare Alicat 1 or Tare Alicat 2.
4. Touch Read Tare Results. Note values. The original values should be close to the new values.
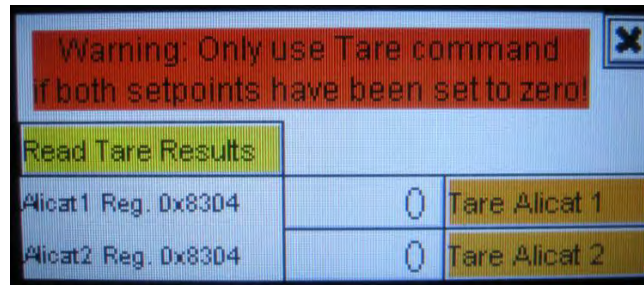5. Flow controllers have been tared. Close the page by touching X.
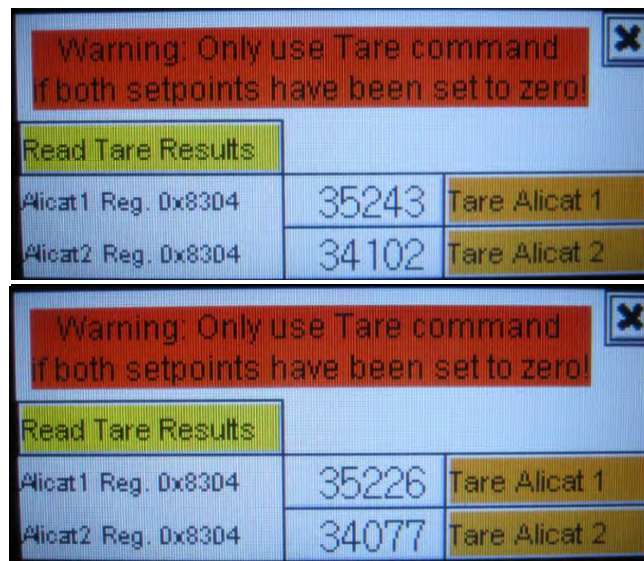

Figure 31 – Tare Alicat Page – Initial

Figure 32 – Alicat Taring Example Before and After Taring

Calibrate CO2

The Alicat flow controllers are calibrated for the particular gas at the factory. If it is necessary to re-calibrate the CO_2 flow controller, follow the procedure below:

1. Measure the actual CO_2 flow with secondary instrument.
2. On the Calib CO_2 page 1, touch the button with black text "DoNotUse2PtCalib" on gray background. When touched, the button with white text "Use2PtCalib" with green background appears.
3. If using the 2-point calibration, enter the Actual CO_2% flow and the Target CO_2 % for two measurements. One set of measurements can be left at (0,0) to use zero as the intercept or 1-point calibration.
4. Touch on the ENTER button. When values are entered correctly, the square with text "2PT" appears in white text on green background on all the pages with this symbol. Calibrated values will be used.
5. Close calibration pages by touching X.
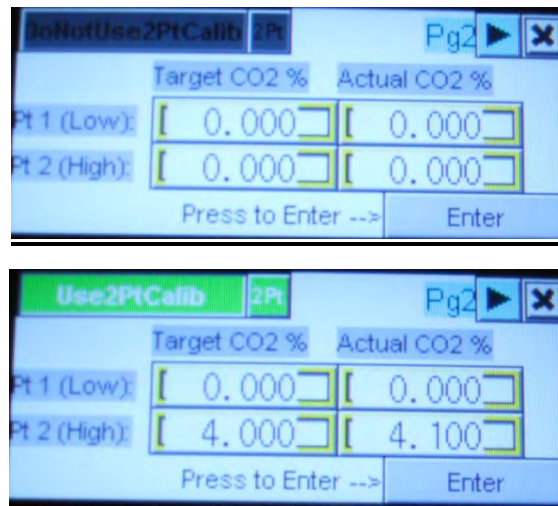
Figure 33 – Calibrate CO2 Page 1 – 2Pt Calibration Not Used/Used

On Calib CO_2 page 2, the calculated calibration values can be viewed. The values entered for Pt 1 and Pt 2 on page 1 are used for calculation of slope (m) and intercept (b) based on the $y = mx + b$ curve. The curve is then used to adjust the CO_2 raw flow measurements (x) to the calibrated values (y) that will be used for control.

Figure 34 – Calibrate CO2 Page 2

If all the entered values for the calibration are zero, a division by zero error can occur and the calibration will not be successful. In that case, the white text "Div 0" on red background will appear on page 2 and also 2 Pt Calibration will be disabled. Go back to page 1 and change at least one set of values to nonzero.
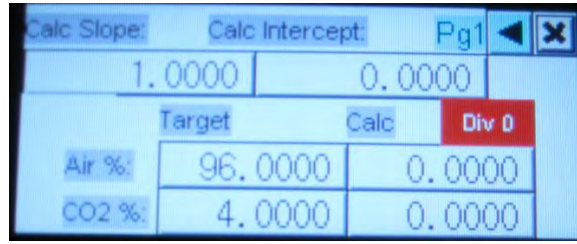

Figure 35 – Calibrate CO$_2$ Page 2 – All values zero

If both Pt1 and Pt2 values for the CO$_2$ target are set to the same value, calibration cannot proceed. In that case, the white text "x1=x2" on red background will be displayed and also 2 Pt Calibration will be disabled. Go back to page 1 and change one of the values.

Figure 36 – Calibrate CO$_2$ Page 2 – Repeated Entries

FactoryMaintenance

The FactoryMaintenance display is reserved for the factory settings and is password protected. Please contact Chemglass Life Sciences for further information.

Appendix II – Quick Setup Guide

Before connecting tubing:

1. Carefully unwrap the Gas Mixer and connect the power. Make sure there are no obstructions in the gas inlets on the rear of the device.

2. Before connecting the gas feed tubing, turn the power on.

3. On the touchscreen display, touch the "Admin" button. Then touch the "Default Values" button. Touch "Enter". Then touch the X on the top right corner to close the window and return to the Admin menu.

4. Go back to the main page by touching the "X" on the top right of the Admin page. If the "Stopped/Running" button in the top center shows Running, touch it so it shows Stopped.

5. From the main page, touch the "Admin" button and then touch the "Calibration" button. The password is 9876 on the "Calibration Login" page. Then touch "Enter".   Touch "Tare Alicats". Make sure there is no gas being fed to the device, touch the "Read Tare Results" button and record the values on the display. Then touch the "Tare Alicat 1" and then "Tare Alicat 2", then the "Read Tare Results" button once again to display the new zeroed values. The original value should be close to the new value. Although this is done in the factory, this step insures that the gas flow controllers are zeroed out. Touch X in the top right corner.

6. The gas mixer is configured for ¼" OD tubing with quick connects. You can now connect the gas feed tubing to the rear of the device and the output tubing to the front of the mixer by simply pushing the tubing into the quick connect fittings. IMPORTANT: To remove the tubing, push and hold the outer metal ring of the quick connect IN towards the mixing box, while gently pulling out on the tubing. DO NOT force the tubing out by pulling hard.

7. From the main page, touch the "RatioCtrl" button. Enter the desired CO_2 percentage and the total flow. This is typically 4.0% and 1000 SCCM. Touch the "Enter" button.

8. On the main page, touch the Stopped button to change it to Running. Touch the Summary page button to view the operation.