ALICAT SCIENTIFIC

A **Halma** company

OPERATION MANUAL FOR IS-MAX AND IS-PRO INTRINSICALLY SAFE INSTRUMENTS

DOC-MANUAL-IS-OPERATION

Thank you for purchasing your Alicat Instrument.

If you have any questions, or if something is not working as expected, please contact us. We are eager to help you in any way possible.

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NRTL, IECEx, and ATEX certified.

Please visit alicat.com/certifications to view Alicat's certifications.

Recalibrate your instrument every year.

Annual calibration is necessary to ensure the continued accuracy of readings, and to extend the Limited Lifetime Warranty. Fill out the Service Request Form at alicat.com/service-request, or contact us directly when it is time to send in your instrument for recalibration.

Lifetime Warranty

For information about our limited lifetime warranty, visit alicat.com/warranty.

Serial #: _____

Next Calibration: _____

NIST This instrument comes with a NIST-traceable calibration certificate.

European Directive Information

RoHS Alicat IS-Pro and IS-Max instruments with model designations beginning with the letters "IS" are intrinsically safe devices which comply with ATEX Directive 2014/34/EU, Electromagnetic Compatibility directive 2014/108/EU, and ROHS directive EU 2015/863.

CE They have been designed and evaluated according to EN IEC 60079-0:2018, EN 60079-11:2012, EN 61326-1:2013, and EN IEC 63000:2018.

These instruments are excluded from Pressure Equipment Directive (PED)2014/68/EU by complying with the ATEX directive and being categorized no higher than PED equipment category I.

This instrument complies with the requirements of the European Union's Waste Electrical & Electronic Equipment (WEEE) Directive 2002/96/EC.

DOC-MANUAL-IS-OPERATION REV 2, Nov, 2024

Contents

Introduction

For installation instructions, pinouts, safety considerations, and connection configurations, please reference the **Safety and Installation Manual for IS-Max and IS-Pro Intrinsically Safe Instruments** found at alicat.com/manuals.

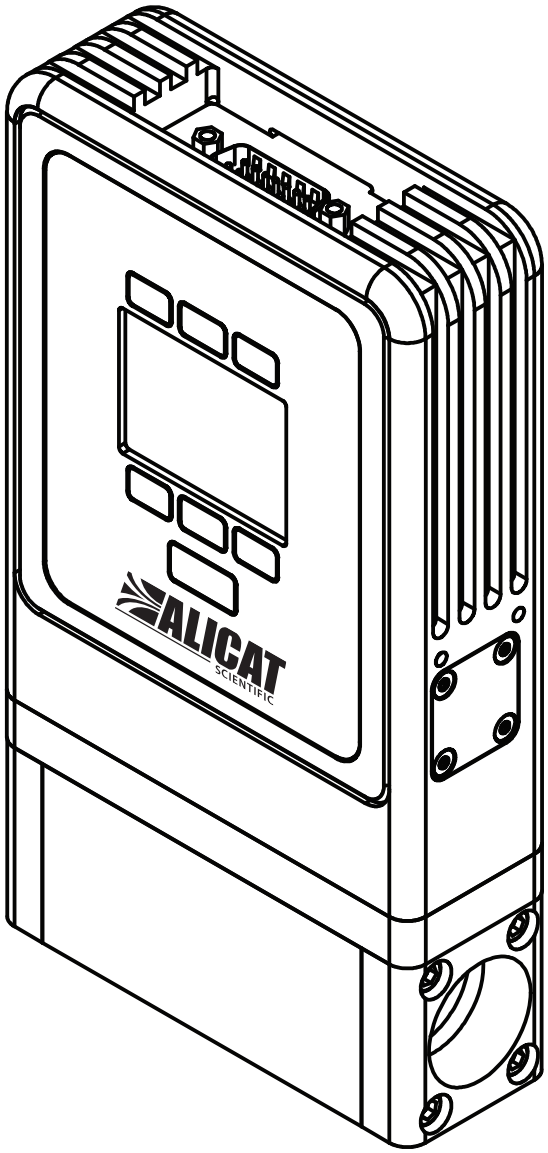
Depending on the model, Alicat instruments have a variety of features:

- **1000 readings per second** guarantees high resolution data.
- **High-accuracy performance for all your flow.** Use the mass flow instruments with any of the 98+ gases included with Gas Select™ (page 19).
- **Control pressure while monitoring flow rate.** Set the closed loop control algorithm to pressure control on your flow instrument (page 16).
- **Control either gas or liquid** with your pressure controller.
- **Monitor live pressure and temperature** in mass flow or liquid processes (page 6).
- **Monitor humidity** within the process using an optional humidity sensor that measures relative humidity, the dew point, and the percent of water vapor.
- **Backlit display with adjustable contrast** is easy to read. In dimly lit areas, press the button directly above the logo to turn on the backlight (page 6).
- **Change your STP** to match any standard temperature and pressure reference for your mass flow (page 20).
- **Log data** with a serial data connection. Control the instrument and capture data for logging and analysis (page 26).

This manual covers the IS-Max and IS-Pro intrinsically safe instruments. Please refer to the table of contents on the previous page to locate specific functions regarding your instrument.

For further support or questions regarding the use or operation of your instrument, please contact Alicat using the information on page 2.

If you have an idea for a new process or a challenging application, Alicat may be able to assist with one of our various solutions or a custom solution specifically for your needs.



Basic Operations

This section covers the most common functions of your instrument. Settings for more specialized needs can be found after this section.

Please refer to the table of contents to determine the page of your desired function. Some information found in this section may be repeated in other sections for ease of section navigation.

Viewing Live Data

The display screen has a number of options for displaying live data. There are various ways to modify the display screen functions, brightness, or orientation. Refer to **Display Setup** (page 24).

The display screen displays live data for all parameters measured by the instrument, simultaneously. Sensors measure data at 1000 Hz, and the LCD display updates at 10 Hz. The measured data is displayed in the units designated by the instrument (page 20).

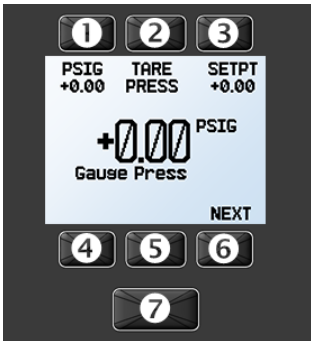
Live screen of a ***mass flow controller*** measuring the mass flow of air.

Interacting with the Instrument

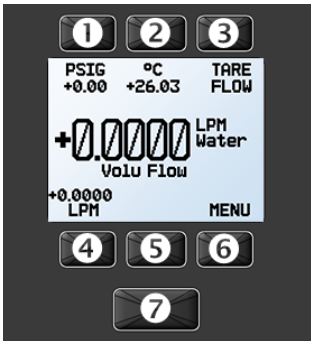
The images to the right identify the buttons of the instrument display. These images compare the differences between a mass flow controller, a pressure controller, and a liquid meter. All button functions can be performed by serial communications as well.

Below are the default button functions and their location on a given instrument. Pressing a button to highlight a reading changes what is centered in the display. If an unused button is pressed, nothing happens.

- **Highlight pressure:** all instruments use **button 1.**
- **Highlight volumetric flow:** flow instruments use **button 4**. Pressure instruments do not measure flow.
- **Highlight mass flow:** mass flow instruments use **button 5**. Pressure and liquid instruments do not measure mass flow.
- **Highlight temperature:** flow instruments use **button 2**. Pressure instruments do not measure temperature.
- **Changing the setpoint:** controllers use **button 3**. Meters and gauges do not have a setpoint function. Refer to page 8 for more information on changing the setpoint.
- **Taring the instrument:** meters and gauges use **button 3** (**TARE FLOW** for meters and **TARE PRESS** for gauges). Pressure controllers use **button 2**. Flow controllers do not have a tare button on the default display. Refer to page 7 for further information on taring.



Live screen of a ***pressure controller*** measuring gauge pressure.



Live screen of a ***liquid meter*** measuring the volumetric flow of water.

- **Enter the menu or move to the next screen:** all instruments use **button 6.**
- **Enable/Disable the backlight:** all instruments use **button 7**.

Button functions can be modified under **Display Setup** (page 24).

Status Messages

Status messages are shown above the **menu/next button**.

ADC Analog-digital converter error

EXH Exhaust mode active (Controllers)

HLD Valve hold active (Controllers)

LCK Front display is locked

MOV Mass flow over range of instrument

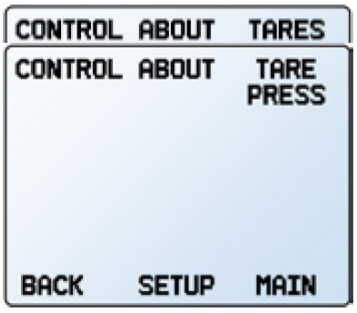
OVR Totalizer rolled over to zero or reached its max limit

POV Pressure over range of instrument

TMF Totalizer missed out-of-range flow

TOV Temperature over range of instrument

VOV Volumetric flow over range of instrument



Flow instruments have a ***TARES*** option while pressure instruments have a ***TARE PRESS*** option on the main menu.

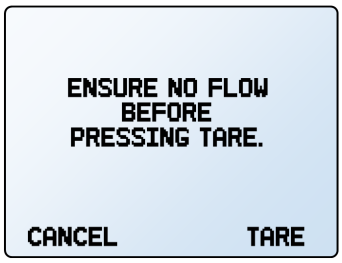
Taring the Instrument

Taring is an important practice that ensures your instrument provides its most accurate measurements. This function gives a zeroed reference point for measurements. All IS-Max and IS-Pro instruments have barometric pressure sensors, to compensate for atmospheric conditions.

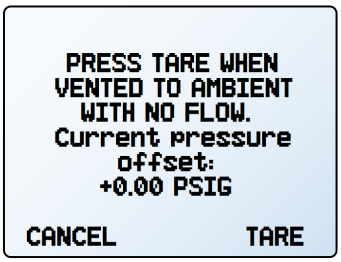
On flow meters and pressure instruments, the tare button is found on the main screen. Use **button 3** for meters and gauges and **button 2** for pressure controllers. To access taring for flow controllers, press the **MENU** button and then the **TARES** option under **button 3**.

Flow instruments provide multiple tare options. For these controllers the **TARES screen** provides the available measurements to tare.

It is also possible for controllers to autotare when the setpoint is at zero for a designated time (page 11).



Tare flow confirmation screen.



Tare pressure confirmation screen.

How to Tare

Taring Flow (Flow Instruments)

TARE FLOW *or* **MENU → TARES → TARE FLOW**

For best results, taring flow should take place at the expected process pressure with no active flow. When **Tare Flow** is pressed, a message, "**ENSURE NO FLOW BEFORE PRESSING TARE**" displays. Press **TARE** to confirm taring the flow.

Taring Pressure (All Instruments)

TARE PRESS *or* **MENU → TARES → TARE PRESS**

Taring pressure requires the instrument to be open to atmosphere, allowing for absolute pressure to be tared. When pressed, a message, "**PRESS TARE WHEN VENTED TO AMBIENT WITH NO FLOW. Current pressure offset:**" displays. Press **TARE** to confirm taring the pressure.

When to Tare

- After significant changes in temperature or pressure.
- After dropping or bumping the instrument.
- After changing the instrument's orientation.

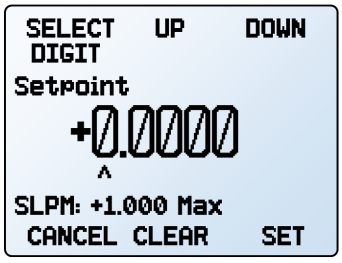
Changing the Setpoint (Controllers)

The setpoint is the target flow or pressure that a controller attempts to match by opening or closing the controller's valves. Pressing the setpoint button from the main screen (**button 3**) moves the screen to the setpoint configuration screen.

The setpoint configuration screen indicates the engineering units and maximum allowable setpoint (e.g., **SLPM: +1.000 Max**). To establish a setpoint, enter the desired value and press **SET**. The instrument immediately begins to control the flow or pressure.

To give a zero setpoint, press **CLEAR** and then **SET**.

For more detailed options and settings, including setpoint ramping, see page 13.



Setpoint configuration screen.

Selecting the Process Gas (Mass Flow Instruments)

MENU → SETUP → Active Gas

In most cases, mass flow instruments are physically calibrated at the factory using air. Gas Select™ can reconfigure the instrument to flow and measure different gases without any need to send it back for a physical recalibration.

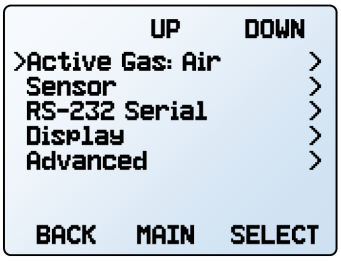
The gas selection is in the setup menu. To access it, press **MENU**, **SETUP**, then **Active Gas**.

Within this menu, there are a variety of categories, recent selections, and COMPOSER™ mixes. Each category lists a subset of available gases and preconfigured mixtures. Note that not all gases are available on all instruments. Corrosive gases and refrigerants are only available on the anti-corrosive line of IS-Max mass flow instruments.

As soon as you press **SET** from the gas list, the instrument reconfigures its flow rate calculations to the newly selected gas properties. There is no need to restart the instrument or perform any other action.

The current gas selection appears just below the unit's indicator on the right side of the main display.

It is also possible to program the instrument to calculate the mass flow of a custom gas mixture (COMPOSER™ mixes). The instrument can have up to twenty of these mixtures saved at a time. For more information and instructions on creating custom gas mixing, see the COMPOSER™ section (page 19).



Setup menu.

Data Screens

Your instrument has access to three types of data screens that relay different information based on your needs.

Further settings for the data screens can be found on page 24.

Live Screen (Main Screen)

The live screen is the default data screen of the instrument. This provides access to the multiple different measurements that an instrument may be taking.

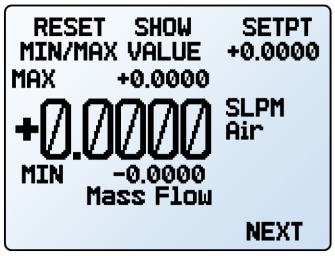
For more information, see the **Viewing Live Data** section under the **Basic Operations** on page 6.

Min/Max Screen

The min/max screen displays the current selected measurement value as well as the minimum and maximum measurement of that value since the last reset. Enabling the totalizers can be done in the **Display Setup** section (page 24).

On the min/max screen are four options:

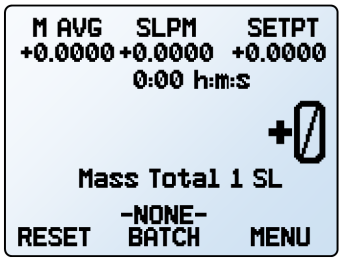
- **RESET MIN/MAX** erases the current measured minimum and maximum and sets them to the current flow value.
- **SHOW VALUE** provides possible measurements to display on the screen, along with their minimum and maximum values.
- **SETPT** is only available on controllers. It displays the current setpoint. Press to set or clear a setpoint. See page 11 for setpoint instructions.
- **NEXT** moves to the totalizer screen (if enabled) or **MENU** opens the instrument menu.



Min/Max screen.

Totalizer Screen (Flow Instruments)

Flow instruments have optional totalizers. These display the total amount of mass or volume that has flowed through the instrument since its last reset. It also enables batch dispensing for controllers (page 13). To enable the totalizers and activate other options see the **Totalizer Options** section (page 21).



Totalizer displaying a mass flow average without a batch.

The totalizer screen comes with a number of options:

- **M AVG** or **V AVG** shows totalizer mass or volumetric averaging, displaying average flow rate since last reset, updated live.
- **SLPM** (or another measurement of flow) displays the live flow rate.
- **SETPT** displays the current setpoint. Press to set or clear a setpoint (page 11).
- **BATCH** selects the quantity to be dispensed in each batch. **–NONE–** appears if the batch mode is off. Only available on flow controllers. Batching information can be found under the **Control** section (page 13)
- **RESET** clears all totalized data and immediately resets the timer to 0. Starts a new batch immediately, if set.
- **MENU** enters the main menu.
- **NEXT** moves to the second totalizer (if enabled).

Instrument Information

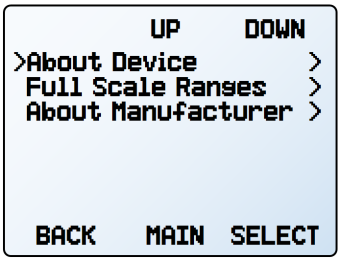
The **ABOUT menu** (**MENU ABOUT**) contains information for setup, configuration, and troubleshooting.

Basic Instrument Information

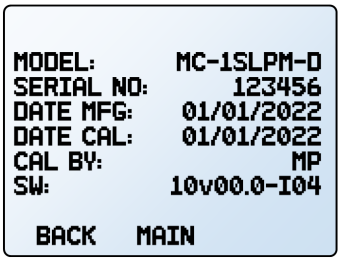
ABOUT → About Instrument

This includes information on the following:

- **MODEL:** Instrument model
- **SERIAL NO:** Serial number
- **DATE MFG:** Manufacturing date
- **DATE CAL:** Most-recent calibration date
- **CAL BY:** Initials of the person who calibrated the instrument
- **SW:** Firmware version



About menu.



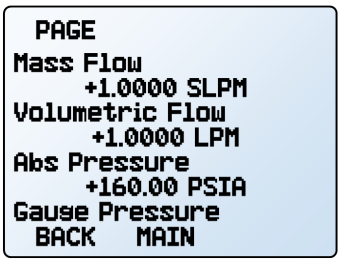
About instrument screen.

Instrument Full Scale Ranges

ABOUT → Full Scale Ranges

This displays the maximum calibrated range of available flow and pressure readings.

- **Mass flow instruments** include mass flow, volumetric flow, and pressure.
- **Liquid instruments** contain volumetric flow and pressure.
- **Pressure instruments** include the various pressures that it can measure, and always includes barometric pressures.



Full scale ranges screen.

Manufacturer Information

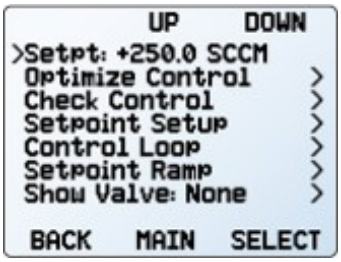
ABOUT → About Manufacturer

About Manufacturer includes:

- Manufacturer name
- Web address
- Phone number
- Email address

Control (Controllers)

For a controller to regulate the flow or pressure, it needs to have a setpoint established. The setpoint is the amount of flow or the pressure that the controller attempts to achieve in a process line.



Control menu.

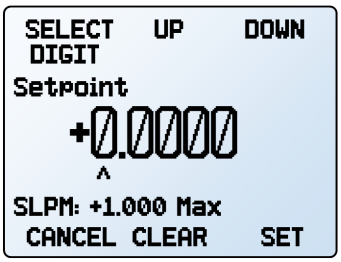
Setpoint

SETPT *or* **MENU CONTROL Setpt**

The **setpoint configuration screen** indicates the engineering units and maximum allowable setpoint (e.g., **SLPM: +1.000 Max**). To establish a setpoint, enter the desired value and press **SET**. The instrument immediately begins to control the flow or pressure.

To give a zero setpoint, press **CLEAR** and then **SET**.

If the setpoint has an analog source, **SETPOINT SOURCE IS ANALOG** will be displayed.



Setpoint configuration menu.

Setpoint Options

The setpoint can be configured with a few options to better control your process based on your needs. Below are various setpoint options and functions.

Autotare and Zero Setpoint Options

MENU CONTROL → Setpoint Setup → Zero Setpoint

A controller can automatically tare itself when it has a zero setpoint. Once the setpoint is given, the instrument waits a specified amount of time before taring. **Delay Before Tare** manages how much time the controller waits before taring. Make sure the delay provides enough time for the process to stop flow and settle.

Caution: *Autotare typically is not recommended for pressure controllers.*

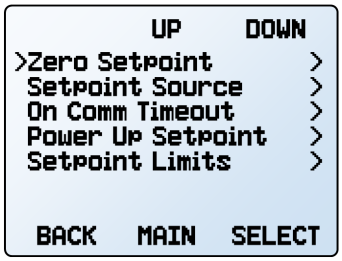
Ramp controls whether the instrument honors setpoint ramping (page 13) or immediately goes to the zero setpoint. If set as **Honor ramp to 0**, the controller moves to a zero setpoint at the specified ramp rate. If set as **Instantly to 0**, the controller immediately moves the setpoint to zero when a zero setpoint is given.

Setpoint Source

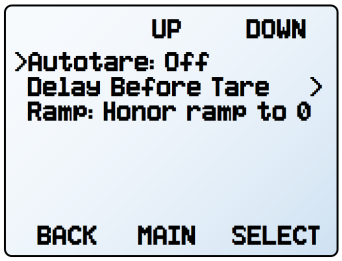
MENU CONTROL → Setpoint Setup → Setpoint Source

Controllers with RS-232 or RS-485 communication accept setpoints from the front panel and serial commands (page 26). Alternatively, an analog source can be used.

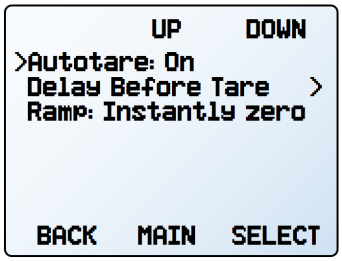
- When the source is set to **Serial/Front Panel**, the controller accepts input from either the front panel or an RS-232/RS-485 connection. Neither source is a slave of the other, and the controller accepts the most recent command from either source.
- When the source is set to **Analog**, the instrument ignores serial setpoint commands and prevents setpoint input from the front panel.



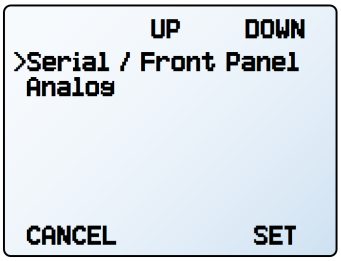
Setpoint setup menu.



Zero setpoint (autotare) ***menu*** with autotare off.



Zero setpoint (autotare) ***menu*** with autotare on.



Setpoint source menu.

Idle Connection Response

MENU CONTROL → Setpoint Setup → On Comm Timeout

If the connection is timed out, the controller can either set a zero setpoint, or maintain the last setpoint given. The timeout time is infinite by default and can be manually defined (page 23).

Setpoint on Power-Up

By default, the controller remembers its last setpoint across power cycles, but it can move to a specific setpoint each time its powered on and also following the instrument ramp rate.

Power Up Setpoint Value

MENU CONTROL → Setpoint Setup → Power Up Setpoint → Value

By selecting **Fixed Setpoint** and entering a value, the instrument moves to the same setpoint every time after power up, ignoring whatever the setpoint was before being powered off.

If the setpoint is digitally provided more often than every few minutes, use a fixed setpoint on power-up. This avoids wearing out non-volatile memory in the instrument.

Power Up Setpoint with Ramping

MENU CONTROL → Setpoint Setup → Power Up Setpoint → Ramp

This designates if the instrument ramps up or not after powering on. The instrument can either honor the ramp rate and ramp up (**Honor from 0**) or jump immediately to the power up setpoint (**Jump from 0**) .

Setpoint Limits

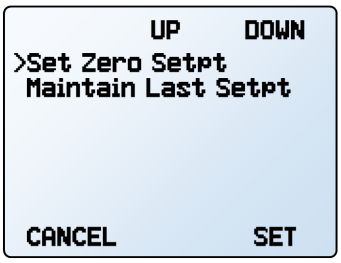
MENU CONTROL → Setpoint Setup → Setpoint Limits

The **setpoint limits menu** configures upper and lower limits for selecting a flow or pressure control setpoint. By default, the limits are the controller's measuring range, but more strict limits may be beneficial in certain applications.

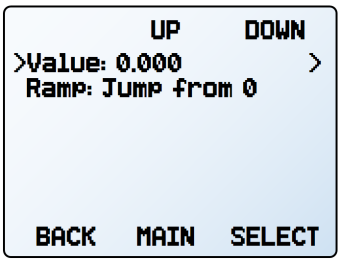
Over a serial connection, the controller rejects requests of a setpoint outside the limit and an error is returned. When using an analog setpoint signal, setpoints that are outside of the setpoint limits are treated as if they were at the nearest limit. For example, if you request a setpoint via analog that is below the lower limit, the controller sets the setpoint at the lower limit.

Caution: *Flow controllers that have non-zero lower setpoint limits cannot be set to stop flow until the lower limit has been cleared.*

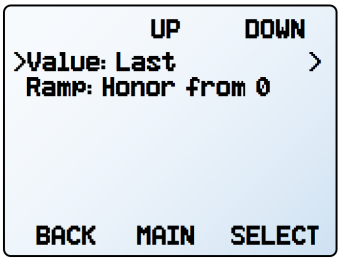
Note: *When changing from one control loop variable to another, the flow controller remembers setpoint limits as percentages of full scale. For example, a 10-SLPM limit on a 20-SLPM controller (50% of full scale) will become a limit of 80 PSIA (50% of 160 PSIA) if the control loop is changed to absolute pressure.*



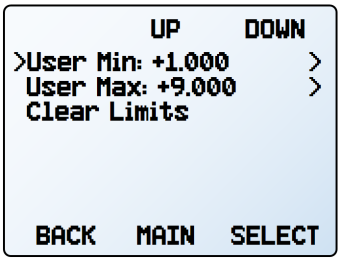
Communication timeout menu.



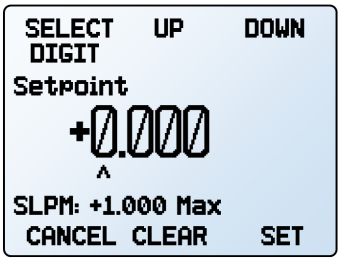
Power-up setpoint menu with jump from zero selected.



Power-up setpoint menu with honor from zero selected.



Setpoint limits menu.



Setting a minimum setpoint.

Setpoint Ramping

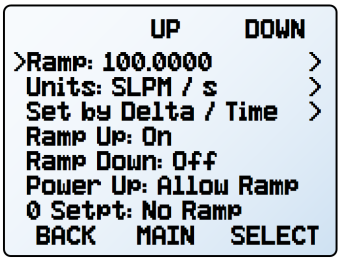
MENU CONTROL Setpoint Ramp

Setpoint ramping regulates how quickly the controller reaches the flow or pressure setpoint. It is often used to prevent bursts of pressure or flow from damaging delicate instruments at the start of a process.

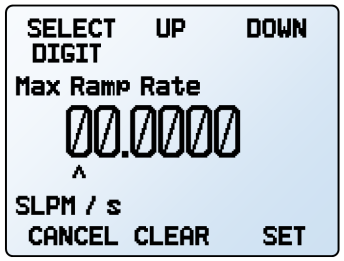
To activate setpoint ramping, set a maximum ramp rate and configure when to enable the ramping function.

Ramp Rate

- **Ramp** changes the maximum rate of change.
- **Units** changes the engineering units used.
- **Set By Delta / Time** allows for more detailed control of the ramp rate including changing the value of the time period.



Setpoint ramping menu



Setting a maximum ramp rate.

Ramping Options

Ramping options control when ramping occurs. This can be when the setpoint changes, when the instrument powers on, or when setting a zero setpoint.

- **Ramp Up** can toggle between on and off. When off, the ramp rate will not be honored when increasing flow to reach a given setpoint.
- **Ramp Down** can toggle between on and off. When off, the ramp rate will not be honored when decreasing flow to reach a given setpoint.
- **Power Up** toggles between **Allow Ramp** and **No Ramp**. If set to **No Ramp**, the instrument ignores the ramp rate just after powering on, otherwise it honors the ramp rate starting at a zero setpoint.
- **0 Setpt** determines if the controller ramps down when a zero setpoint is set. If this setting is set to **No Ramp** when given a zero setpoint, the controller immediately drops to the zero setpoint. Otherwise, the controller ramps down at the selected rate.

Note: *Setpoint ramping can be used with flow or pressure setpoints, depending on the control loop selected. Ramping for pressure control sets a rate at which pressure can change before reaching the setpoint. To limit flow rates directly while controlling pressure, see* page 17.

Batch Dispensing (Flow Controllers)

BATCH *or* **MENU** → **CONTROL** → **Batch 1** *or* **Batch 2**

Batch dispensing flows a set volume of gas. Once that volume of gas flows through the controller, the valve closes and flow stops. You can repeat batches by pressing reset, or by controlling the batch through serial communications.

To utilize batching, at least one totalizer must be enabled (page 21). Batch sizes can be defined by using the **BATCH** button on the totalizer screen or from the **CONTROL** menu. In the **CONTROL** menu, **Batch 1** is for totalizer 1 and **Batch 2** is for totalizer 2. If both batches are programmed, flow stops as soon as either batch size is reached.

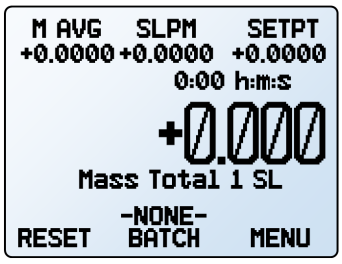
Start a Batch

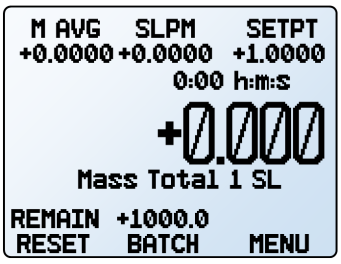
1. Choose the total quantity to be dispensed in each batch. Press **SET** to accept the new batch size.
2. Once a batch size has been set, give the controller a setpoint (page 11). Flow begins as soon as you press **SET**.

Note: *Batch dispensing requires an active batch size and a non-zero setpoint. If your controller already has a non-zero setpoint, batching begins as soon as you press SET from the batch size screen.*

While a new batch is being dispensed, the **BATCH** button on the totalizer screen changes to show the quantity that remains to be dispensed. When the batch size has been achieved, the **BATCH** button displays **–DONE–** and flow stops automatically. The setpoint is not cleared and remains the same.

The batch size can be changed while a batch is in progress. If the new batch size is larger than the current totalized flow, then flow continues until the new value is reached. If the new batch size is smaller than the current totalized flow, then the flow stops immediately. Press **RESET** to start the new batch.





Totalizer display for a mass flow average without a batch, with a batch in progress, and with a finished batch.

Repeat a Batch

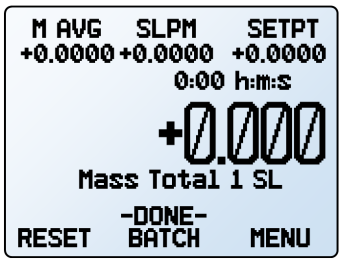
- For an identical batch, press **RESET**. Flow begins immediately.
- For a new batch of a different size, press **BATCH**, and select the new batch size. If there is a non-zero setpoint, flow will begin as soon as **SET** is pressed.

Pause or Cancel a Batch

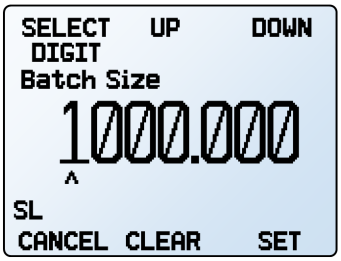
- To pause flow while a batch is in progress, change the setpoint to 0 by pressing **SETPT** → **CLEAR** → **SET** within the **totalizer menu**. This does not stop the timer. To resume, change the setpoint to a non-zero set point.
- To remove a batch setting, press **BATCH** → **CLEAR** → **SET**. Deleting the batch does not affect the setpoint. Flow will continue at the setpoint rate.

Warning: *Flow resumes immediately at the current setpoint when batch dispensing is turned off.*

Note: *The controller retains batch size across power cycles. The batch size must be manually cleared to remove it.*



A finished batch.



Selecting a batch size of 1000 SL.

Valve Drive Percentage Display

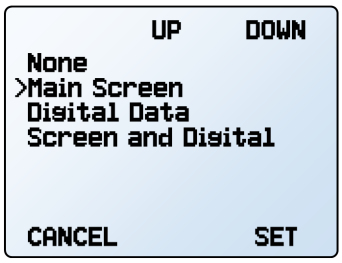
MENU → **CONTROL** → **Show Valve**

The valve drive is represented as a percentage of the total possible voltage driven to the valve. While drive percentage does not directly correlate with percentage open, a drive percentage of 0% indicates the valve is not open.

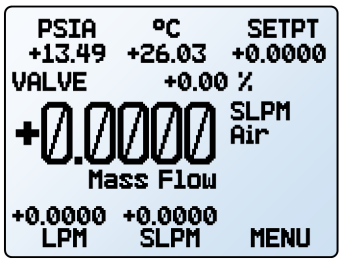
Viewing the valve drive percentage can be helpful for trouble-shooting. An increase in percentage over time likely indicates a blockage in the system where more voltage is required to drive the valve to attain the same amount of flow.

This information may be displayed on the **main display** and/or as part of transmitted serial data. There are four valve display options:

- **None:** No valve information is displayed.
- **Main Screen:** Only on the main display.
- **Digital Data:** Only in the serial data frame.
- **Screen and Digital:** Both the main display and serial data frame.



Valve display menu



Valve percentage on the ***live screen***, above the large numbers.

Optimize Control (Autotune) Flow Controllers

MENU → CONTROL → Optimize Control

Alicat instruments are set up at the factory to perform well over a range of expected conditions. If conditions change dramatically, or if the instrument needs to perform in a very specific way, then it may be beneficial to optimize the response.

The Autotune (**Optimize Control**) function automatically adjusts the control gains to improve response time for the current process and conditions. It is a much faster approach than manual tuning, and does not require extensive knowledge of control parameters and methodology.

Autotuning is recommended:

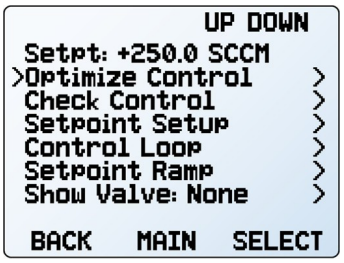
- at installation, to match current process conditions
- when the process changes significantly, as when a dramatically different pressure is required, or when switching to a process gas with very different properties
- when the physical system changes significantly, as when adding a large restriction or volume
- when incorporating the instrument into a different process or lab experiment
- when an exact response is required, or when multiple instruments need to provide the same response
- when flow control has degraded due to process changes over time.

During autotuning, the instrument moves to a series of setpoints. For each setpoint change, the instrument determines system properties and optimizes control parameters. The absolute pressure and maximum flow will be reported throughout the process.

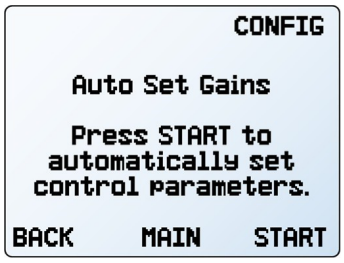
When complete, the instrument response is adjusted to the optimal settings, and the instrument reports the overshoot, dead time, time constant, and bandwidth of a typical response with the final settings.

For most instruments, autotuning is completed in 30–90 seconds. Ultra-low flow instruments (roughly 50 SCCM and below) may require longer; 0.5 SCCM instruments may take up to 15 minutes.

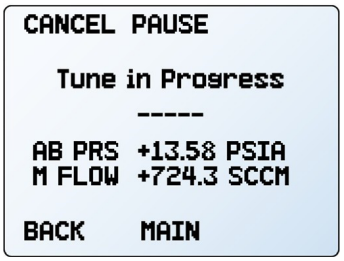
Note: *During autotuning, the instrument will move to various setpoints, some of which may exceed the current setpoint. If the maximum flow needs to be limited to protect the process, adjust the* **Max Flow** *setting (see* **Max Flow** *in the following section).*



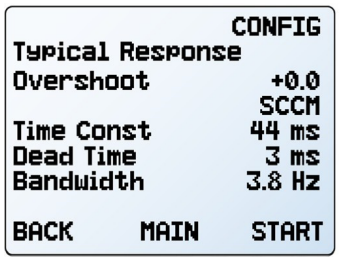
Optimize Control.



Press START to optimize control.



Optimize Control in progress.



Optimization results.

Optimization Recommendations

Autotuning will provide the best results when following these recommendations:

- Use process conditions that maximize the pressure delta across the valve(s). The instrument will perform best if it is operated at a pressure delta or common mode pressure equal to or less than the optimization value.
- Autotuning is more sensitive to fluctuations in the environment than normal closed loop control. Most fluctuations will result in control loop gains that are smaller than they might otherwise be, as it is difficult to separate the effects of the disturbance from the response of the system. Large fluctuations may preclude optimization. Ultra-low flow and other slowly responding instruments will be more sensitive to fluctuations.
- During autotuning, setpoint ramps are mostly honored. For autotuning, the instrument should be configured with the fastest setpoint ramp that will be used.
- Some valves will act significantly differently when they have not been opened for some time. Operating the valve prior to autotuning can minimize the potential impact.

Advanced Configuration Options

MENU → CONTROL → Optimize Control → Config

For most situations, the autotune function will determine the best response time using factory defaults. The function can, however, be further configured to support atypical process requirements or specific control goals.

Speed

The **Speed** setting determines how the function will address the tradeoff between speed and the ability to handle a range of process variability:

- **FAST:** the default option, which balances speed and versatility for most situations.
- **FASTEST:** maximizes response speed (i.e., minimizes the control loop response time). A small amount of overshoot is allowed.
- **VERSATILE:** accommodates a wider range of conditions, but with the tradeoff of slower response time. The system may not be able to respond to quickly changing conditions.
- **MOST VERSATILE:** accommodates an even wider range of conditions, but with slower response time.
- **GOAL:** enables advanced users to achieve a particular response profile or tune multiple instruments to an exact response. The function will attempt to achieve the response time goal. When the goal is impossible to meet (e.g., if it is set to 0), the nearest possible time constant will be used (which is equivalent to the **FASTEST** option).

Max Flow

This setting limits the maximum flow during autotuning to protect delicate processes. In unusual circumstances the maximum flow may still be exceeded; however, the instrument will attempt to minimize the duration.

Loop Type

The autotuning function will use the best control loop based on the process. The **AUTOMATIC** option is, therefore, the default, and recommended, setting.

If required, either the PD2I or PDF closed loop algorithm can be specified for use during optimization (see page 16).

Control Loop

The control loop manages which parameter a controller controls, as well as how the controller reacts to changes within the system.

Controlled Variable

CONTROL → Control Loop → Control

The controlled variable is the measurement the controller attempts to regulate to the given setpoint. Controllers can only control one measurement at a time, but they still measure the other variables during that time.

Mass Flow Controllers: Mass flow, volumetric flow, absolute pressure, gauge pressure, valve drive

Liquid Controllers: Volumetric flow, absolute pressure, gauge pressure, valve drive

Pressure Controllers: Absolute and gauge pressure—or differential pressure—and valve drive.

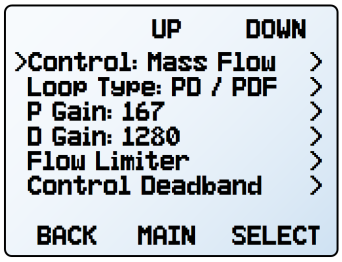
Note: *When pressure is the selected variable, all controllers with upstream valves control the outlet pressure. Those with downstream valves control upstream back pressure, but these instruments must be configured for this type of control.*

Warning: *When changing the control loop, the PID settings may need adjusting for optimal stability and speed of response.*

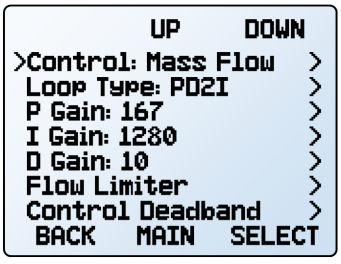
PD/PDF or PD²I Control Algorithms

CONTROL → Control Loop → Loop Type

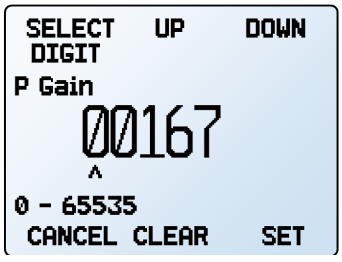
Your controller uses an electronic closed loop controller to determine how to actuate its valve(s) in order to achieve the commanded setpoint. These settings are tuned at the factory for your specific operating conditions, but changes sometimes require on-site adjustments to maintain optimal control performance. Fine-tuning your closed loop control may help correct issues with control stability, oscillation, or speed of response.



Control loop menu in PD/PDF control mode.



Control loop menu in PD²I control mode.



Setting a P Gain.

For most applications, the PD/PDF algorithm is recommended. When controlling pressure with a dual valve controller, the PD²I algorithm is recommended.

Tuning the PD/PDF Control Algorithm

The controller's default control algorithm (PD) employs pseudo-derivative feedback (PDF) control, which uses two editable variables:

- The larger the **D** gain, the faster the controller changes the process value. This is equivalent to the **P** variable in common PDF controllers.
- The larger the **P** gain, the faster the controller will correct for offsets based on the size of the errors and the amount of time they have occurred. This is equivalent to the **I** variable in common PDF controllers.

✓ **Note:** *The D and P variables in the PD/PDF control algorithm are more typically referred to as P and I, respectively, in PDF controllers.*

Tuning the PD²I Control Algorithm

PD²I usually provides a faster response in dual-valve flow and pressure controllers. This algorithm uses typical PI terms and adds a squared derivative term (D):

- The larger the **P** gain, the more aggressively the controller will correct errors between the commanded setpoint and the measured process value.
- The larger the **I** gain, the faster the controller will correct for offsets based on the size of the errors and the amount of time they have occurred.
- The larger the **D** gain, the faster the controller will predict needed future corrections based on the current rate of change in the system. This slows the system down to minimize overshoot and oscillations.

Troubleshooting Valve Performance with PID Tuning

The following issues may be resolved by adjusting the PID gain values for your controller. An **Optimize Control** feature in the **Control Menu** can autotune your valve. Principles for this are:

Fast oscillation around the setpoint:

- **PD:** Reduce the **P** gain in decrements of 10%.
- **PD²I:** Increase the **P** gain in increments of 10%, and then adjust the **I** gain to fine-tune.

Overshot setpoint:

- **PD:** Reduce the **P** gain in decrements of 10%.
- **PD²I:** If **D** is not 0, increase the **P** gain in increments of 10%.

Delayed or Unattained Setpoint:

- **PD:** Increase the **P** gain in increments of 10%, and then decrease the **D** gain by small amounts to fine-tune.
- **PD²I:** Increase the **P** gain in increments of 10%, and then increase the **I** gain to fine-tune.

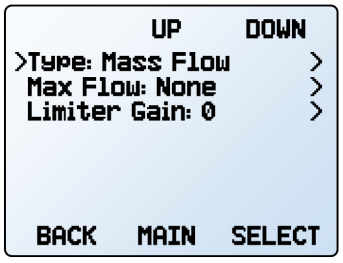
✓ *Valve tuning can be complex. We recommend employing "Optimize Control (Autotune) Flow Controllers" on page 15. More detailed information is available at alicat.com/pid.*

Flow Rate Limit while Controlling Pressure (Flow Controllers)

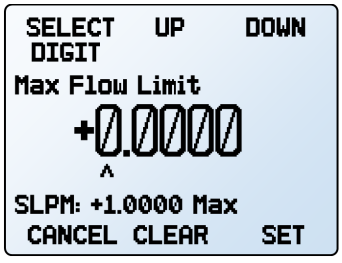
`CONTROL` → `Control Loop` → `Flow Limiter`

Limiting the flow rate while controlling pressure can help to avoid exceeding the measurable range of the instrument as well as prevent damage of sensitive instruments later in the process. To limit flow:

1. Choose either mass flow or volumetric flow to limit by pressing **Type**.
2. Set the maximum value of flow rate desired by pressing `Max Flow` and entering the maximum value in the engineering units displayed.
3. Set the `Limiter Gain` to 500 and adjust as needed. `Limiter gain` determines how aggressively the proportional control function corrects the error when the flow rate exceeds the maximum flow setting. A higher value corrects more aggressively, but is also more likely to oscillate near the flow limit.



Flow limiter menu.



Setting a maximum flow limit.

✓ **Note:** *If both flow limiting and pressure setpoint ramping are active when controlling pressure, the more restrictive function regulates the controller's operation as it attempts to attain the setpoint.*

Gas Adjust (Flow Controllers)

`MENU` → `CONTROL` → `Control Loop` → `Gas Adjust`

Enabling **`Gas Adjust`** will change the control loop gains to keep the control response time more consistent as the gas is changed. Choose **`On`** to enable the feature, **`Off`** to disable, or **`Until Set Gain`** to use gas adjust to get more consistent performance.

Control Deadband for Pressure Control

CONTROL → Control Loop → Control Deadband

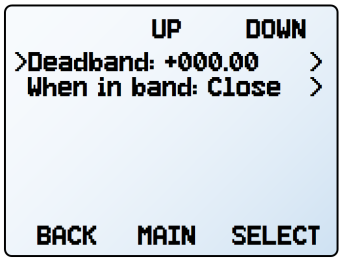
The control deadband is designed to minimize the amount of gas exhausted and improve stability. There is no active control while pressure is within the deadband.

Note: *A control deadband cannot be set when the instrument is configured to control flow (the* ***Control*** *menu item within the* ***control loop menu*** *(page 16). If control is set to mass flow, the error* ***Only active when controlling pressure*** *displays instead of the* ***deadband menu****.*

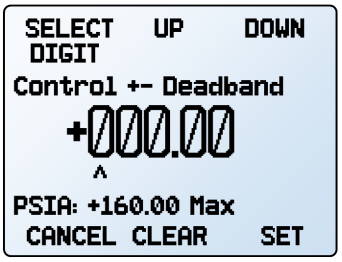
To turn on the control deadband, enter a non-zero value in **CONTROL Control Deadband Deadband**. The controller must first reach the setpoint for the deadband to activate. If the difference between the process value and the setpoint becomes larger than the deadband limit (due to either a setpoint change or process drift, active control resumes until the setpoint is reached again.

The controller can be set to either hold the current valve position or close the valve(s) in **CONTROL Control Loop Control Deadband When in Band**. It is recommended to hold the current position on single valve controllers and close valves for dual valve controllers.

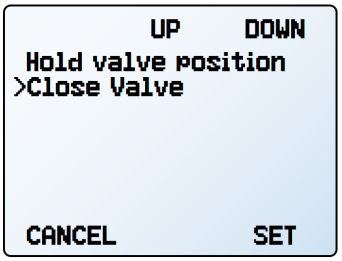
Caution: *Single valve controllers do not have an exhaust valve to reduce pressure when pressure exceeds the deadband.*



Deadband menu.



Choosing deadband size.



Choosing deadband options.

Setup

Gas Selection (Mass Flow Instruments)

In most cases, your mass flow instrument was physically calibrated at the factory using air. Gas Select™ is a feature that allows you to reconfigure the instrument to flow a different gas without any need to send it back for a physical recalibration. The instrument is also able to be programmed with—and measure—custom mixtures of gases.

Gas Select™

MENU → SETUP → Active Gas

Within this menu, there are a variety of categories (such as **Standard**, **Chromatography** and **Welding**), as well as recent selections, and COMPOSER™ mixes. Each category lists a subset of available gases and preconfigured mixtures.

As soon as you press **SET** from the gas list, your instrument reconfigures its flow rate calculations to the newly selected gas's properties. There is no need to restart the instrument.

Your current gas selection appears just below the units of measure indicator on the right side of the main display (see page 6).

Category and Gas List Controls

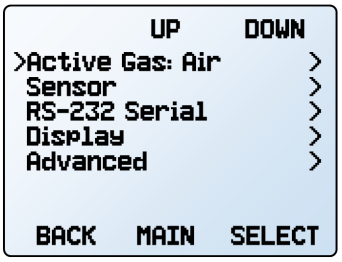
- **PAGE** advances the view to the next page of categories or gases.
- **SELECT** (in the category list) opens a list of gases in that category.
- **SET** (in the gas list) immediately loads the gas measurement properties and exits to the **setup menu**.

COMPOSER™ Gas Mixes

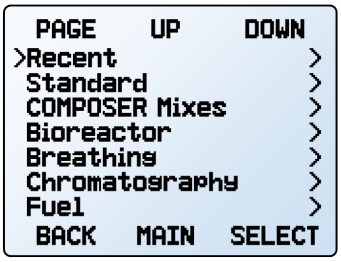
SETUP → Active Gas → COMPOSER Mixes

To remain accurate, your mass flow instrument needs to reference the viscosity of the gas you are flowing through it. The more closely you can define your actual gas composition, the more accurate your flow readings will be. COMPOSER™ is an included feature of Gas Select™ that lets you define new mixed gas compositions to reconfigure your flow controller on the fly.

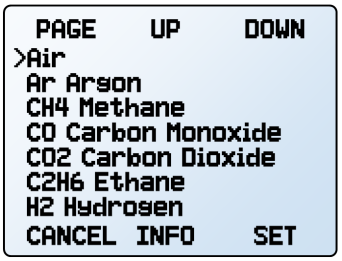
Wilke's semi-empirical method is used to define a new gas mixture based on the molar (volumetric) ratios of the gases in the mixture. You can define these gas compositions to within 0.01% for each of up to five constituent gases in the mixture. Once you define and save a new COMPOSER™ gas mix, it becomes part of the Gas Select™ system and is accessible under the gas category **COMPOSER User Mixes**. You can store up to 20 COMPOSER™ gas mixes on your flow controller.



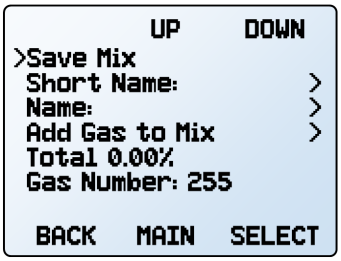
Setup menu.



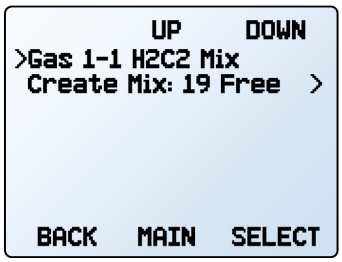
First page of the Gas Select™ category list.



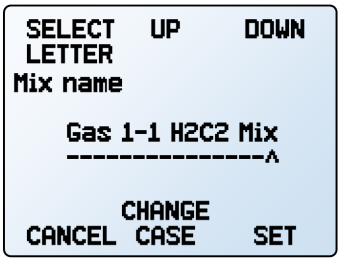
Gas Select™ standard gas list.



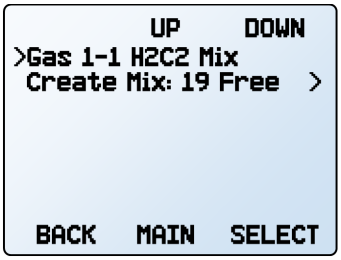
Mix settings menu.



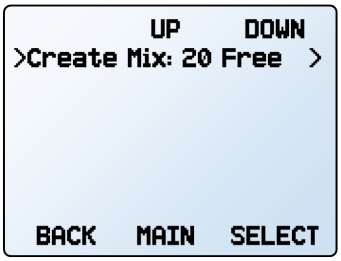
COMPOSER™ menu with the new custom mix.



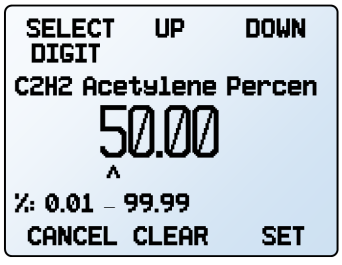
Defining a mixture's long name.



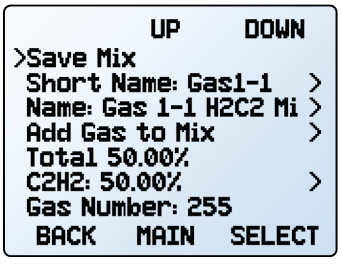
COMPOSER™ menu with the new custom mix.



COMPOSER™ menu without existing mixes.



Setting the percentage of a constituent gas C_2H_2.



Results of adding of C_2H_2.

Note: *The* COMPOSER™ *is instrument firmware, and does not physically mix gases. It only configures the instrument's calculations to report flow readings more accurately based on the constituent gases of your defined mixture.*

Select any existing mix and press **SET** to immediately configure your instrument to measure that gas mixture. To create new mixes, see the next section.

Creating New Mixes in COMPOSER™

SETUP → Active Gas → COMPOSER Mixes → Create Mix

Give the Mix a Short and Long Name

UP/DOWN changes the character. Valid characters include A–Z, 0–9, punctuation (**. , -**), and space. **CANCEL** exits to the **mix settings menu**. **SET** accepts the name.

Note: *Using a space in the short name can cause the serial data frame to be read incorrectly by some programs.*

Define the Mix

- **Add Gas to Mix** enters the Gas Select™ category listing. Once you find the correct gas, press **SET**. Enter the composition percentage and press **SET**.
- As gases are added, the total used percentage updates on the **mix settings menu**.
- Once gases have been added, COMPOSER™ can change the gas percentage to fill the remaining portion to 100% by selecting the component gas, then selecting **Set % to Balance**.
- The sum percentage of gases must total 100% to select **Save Mix**. Selecting **BACK** will permanently discard the mix.
- Mixes that contain several gases push the menu to a second page; use the **PAGE** button to see the remaining list.

Viewing, Deleting, and Creating Similar Mixes

SETUP → Active Gas → COMPOSER Mixes → [Select mix] → INFO

The current configuration of any existing COMPOSER™ mix can be viewed by selecting **INFO** instead of **SET** in the mix list. It will show:

- Options to delete the mix.
- Create a similar mix.
- Short and long names.
- The gas number.
- The composition, which may extend to a second page. Pressing the **PAGE** button will move to the next page.

Sensor Setup

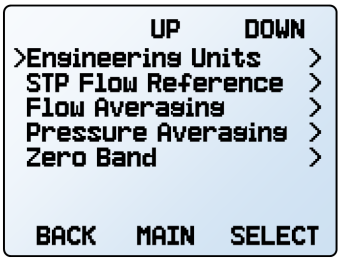
MENU → SETUP → Sensor

Sensor setup controls how measurements are calculated and communicated by the instrument. These are factors like what engineering units are used and the standard or normal reference points for flow.

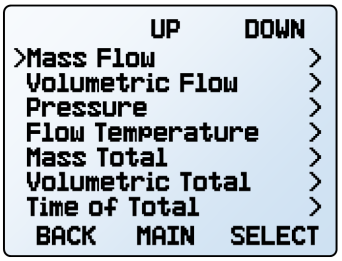
Engineering Units

SETUP → Sensor → Engineering Units

Changing engineering units alters both the display and the data frame. Choose the parameter whose unit you want to change, and then choose an engineering unit, confirming the change on the last screen.



Sensor setup menu.



Engineering units menu,

STP/NTP Reference Values (Mass Flow Instruments)

SETUP → Sensor → STP Flow Ref *or* NTP Flow Ref

A mass flow instrument references a given temperature and pressure combination to calculate flow. Standard mass flow uses an STP (standard temperature and pressure) reference point and normal mass flow uses an NTP (normal temperature and pressure) reference point. Depending on the engineering units selected, either STP or NTP will be editable from this menu. For example, if SLPM (Standard liters per minute) is selected, STP is editable. If NLPM (normal liters per minute) is selected, NTP is editable.

Reference options:

- **Stan T:** Standard Temperature
- **Stan P:** Standard Pressure
- **Norm T:** Normal Temperature
- **Norm P:** Normal Pressure
- **Ref temp units** changes the temperature units used for STP and NTP calculations.
- **Ref pressure units** changes the pressure units used for STP and NTP calculations

Unless otherwise requested, your flow controller ships with a default STP of 25°C and 1 atm (which affects flow units beginning with "S"), and an NTP of 0°C and 1 atm (which affects flow units beginning with "N").

Caution: *Changes to STP or NTP references alters your mass flow readings.*

Flow and Pressure Averaging

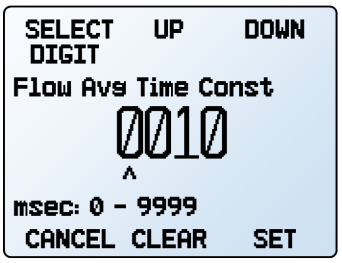
SETUP → Sensor → Flow Averaging
SETUP → Sensor → Pressure Averaging

Averaging the flow or pressure over a longer time may be useful in smoothing fluctuating readings. This menu changes the time constants of the geometric running averages for flow and pressure. Values are the time constant (in milliseconds) of the averaged values. Higher numbers generate a greater smoothing effect. The instrument is capable of a maximum 9999 ms time constant.

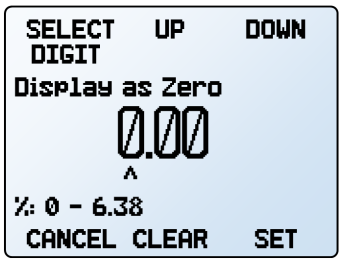
Zero Band

SETUP → Sensor → Zero Band

The zero band threshold is an amount of flow under which flow values are displayed as 0. The maximum zero band is 6.38%. For example, a 20 SLPM controller with a zero band value of 0.25% displays as 0 SLPM for all readings below 0.05 SLPM. This function also applies to gauge and differential pressure readings.



Adjusting the flow averaging time constant.



Configuring the zero band.

Totalizer Options (Flow Instruments)

The totalizer measures the total flow over a given time and is one of the main displays. For more information on the totalizer display, see page 9.

Enable Totalizer

MENU → SETUP → Sensor → Totalizer → Totalizer 1 *or* **Totalizer 2 → Totalize:**

To enable a totalizer, a flow reading must be selected.

- **None:** Disable the totalizer.
- **Mass Flow:** Totalize the mass flowreading (mass flow instruments only).
- **Volumetric Flow:** Totalize the volumetric flow reading.

Totalizer Mode

MENU → SETUP → Sensor → Totalizer → Totalizer 1 *or* **Totalizer 2 → Mode**

The totalizer mode manages how the instrument counts flow.

- **Positive Flow Only:** The totalizer only counts flow that passes left to right through the flow body of the instrument. If any negative flow (right to left) moves through the system, it is not counted.
- **Reset After No Flow:** When flow is completely stopped, the totalizer holds the current value of the measured flow until flow begins again. Once flow begins, the totalizer resets to zero. **Note:** This is not available on bidirectional instruments.

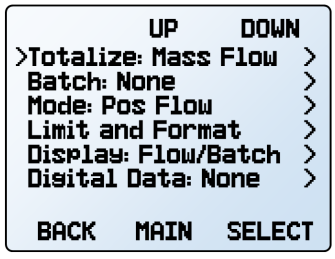
Totalizer Digits and Limit

MENU → SETUP → Sensor → Totalizer → Totalizer 1 *or* **Totalizer 2 → Limit and Format**

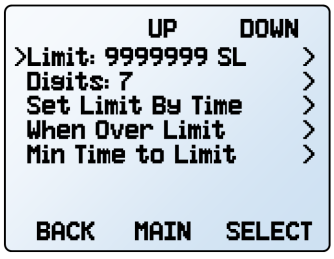
The totalizer can report up to a maximum of 10 digits. By default, it uses 7 digits and has one less digit after the decimal place than the live screen. It is possible to configure the number of digits in such a way that the max totalizer count cannot be reached for over 100 years.

The limit of the totalizer sets where the decimal is placed in the total amount of measured flow. Most instruments can be configured to measure to the hundredths position.

The set limit by time guarantees the totalizer does not reach the max limit for at least that amount of time at full-scale flow. How the totalizer reacts is based on the settings for when the totalizer reaches its limit.



Totalizer options.



Totalizer limits screen.

Totalizer Limit

There are 4 options for how the totalizer reacts when it reaches its limit:

- **Zero and Set OVR:** Totalizer resets to zero and continues once the maximum count is reached. The **OVR** status message is active to indicate maximum count has been reached (page 7).
- **Set to Zero:** Totalizer resets and continues counting from zero once the maximum count is reached. No error status is displayed.
- **Hold and Set OVR:** Totalizer stops counting at max count until it is reset manually. Displays **OVR** status message to indicate maximum count has been reached (page 7).
- **Hold:** Totalizer stops counting at max count until it is reset manually. No error is displayed.

The totalizer also calculates the minimum time the totalizer will run before it reaches the totalizer limit. Once all the settings have been confirmed, selecting **Min Time to Limit** shows how long the totalizer can run at full flow before the limit is reached. Increasing the number of digits and moving the decimal to the right will increase this time.

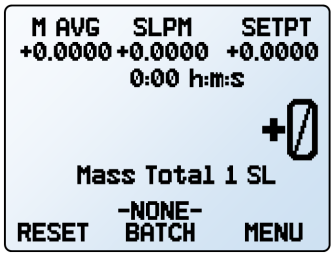
The elapsed time counter has a maximum value of over 100 years.

Totalizer Display

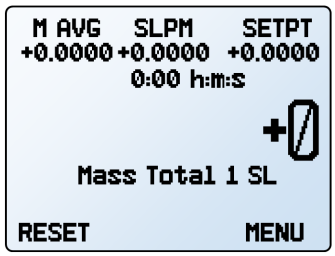
MENU → SETUP → Sensor → Totalizer → Totalizer 1 *or* **Totalizer 2 → Display**

Totalizers have 3 options for display.

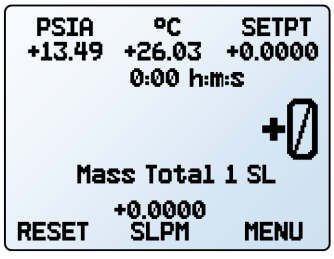
- **Flow and Batch (Default):** View as described above with options for batching, flow averaging, and set point.
- **Detailed Flow:** Similar to Flow and Batch, but without batching. Provides information focuses more on flow rates, total flow, and average flow.



Totalizer ***Flow and Batch*** view.



Totalizer ***Detailed Flow*** view.



Totalizer ***Multivariable*** view.

- **Multi-variable:** Screen that resembles the main display (page 6).

Totalizer Digital Data

MENU → SETUP → Sensor → Totalizer → Totalizer 1 *or* **Totalizer 2 → Digital Data**

Enabling this function adds the totalizer value to the data frame when the instrument is polled by a serial command (page 26). There are two options available:

- **None:** The totalizer value is not displayed when the instrument is polled.
- **Volume:** The totalizer reports the current value of the totalized volume when the instrument is pulled.

Restore Totalizer Value on Power Up

MENU → SETUP → Sensor → Totalizer → Power Up Restore

Turning this option on sets the instrument to save the totalized value every minute. When power is restored, the instrument continues to count from its most recent saved amount.

If this setting is off, the totalizer resets when the instrument is powered off.

Totalizer while Controlling Pressure

If there is an abrupt pressure change, the flow rate may exceed the maximum measurable flow (128% of full scale). In this case, the totalized value flashes and the **TMF** error appears. The **TMF** error indicates that the totalizer missed flow data and the totalized volume may be inaccurate. Reset the totalizer to clear the error message.

Setting an upper flow limit (page 17) within the readable range prevents this error, but the flow limit would be given preference over reaching the pressure setpoint.

Batches (Flow Controllers)

BATCH *or* **MENU → CONTROL → Batch 1** *or* **Batch 2**

Batching is only possible when a totalizer is enabled and works in concert with the setpoint. For more information on batching flow, see the batch section on page 13.

Serial Communications Configurations

MENU → SETUP → RS-232 Serial *or* RS-485 Serial

You can operate your instrument via its data connection for easy streaming and logging of all data. Before establishing serial communications, ensure that it is ready to communicate by checking the options in this menu.

For more on how to issue commands over serial communications, see page 26.

Unit ID

SETUP → RS-232 Serial *or* RS-485 Serial → Unit ID

The unit ID is the identifier that a computer uses to distinguish your instrument from other, similar instruments when it is connected to a network. Using the unit ID letters **A–Z**, you can connect up to 26 instruments to a computer at the same time via a single COM port. This is called **polling mode** (page 26). Unit ID changes take effect when you select **SET**.

If you select "**@**" as the Unit ID, the instrument enters **streaming mode** (page 26).

Modbus RTU Address

SETUP → RS-232 Serial *or* RS-485 Serial → Modbus Address

The Modbus address is the identifier that a computer or programmable logic computer (PLC) uses to distinguish your instrument from other instruments when connected to a Modbus network. Values of 1–247 are available for use. The default ID, set at the factory, is 1.

Baud Rate

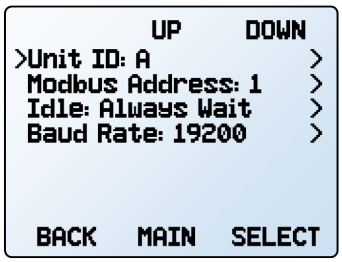
SETUP → RS-232 Serial *or* RS-485 Serial → Baud Rate

Baud rate is the speed at which digital instruments transfer information. The instrument has a default baud rate of 19200 baud (bits per second). If your computer or software uses a different baud rate, you must change the instrument's baud rate in the **BAUD menu** to ensure they match. Alternatively, you can change your computer's baud rate in Windows® Instrument Manager. Baud rate changes take effect once you press **SET**, but you may need to restart any software for it to recognize the change.

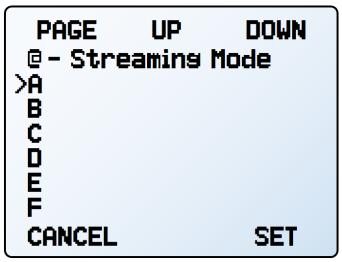
Manage Setpoint when Connection is Idle

SETUP → RS-232 Serial *or* RS-485 Serial → Idle

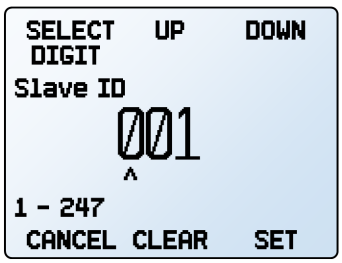
If a connection is idle for a specified amount of time, the controller can either move to a zero setpoint, or maintain the previous setpoint. The idle time will be infinite by default and can be set in seconds up to 99999.9 seconds (1 day, 3 hours, 46 minutes, 39.9 seconds).



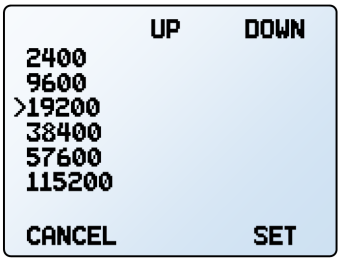
Serial communication menu.



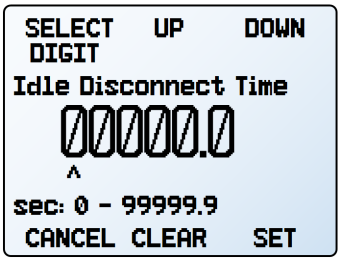
Choosing a unit ID, or streaming.



Modbus address menu.



Baud rate options.



Setting an idle disconnect time.

Display Setup

MENU → SETUP → Display

The options in the **display setup menu** adjust the contrast/brightness of the display and enable screen rotation.

Data Screens

SETUP → Display → Data Screens

The data screens menu provide options for the various screens of the instrument. For more information on the contents of the screens and their functions, see the **Data Screens** section (page 9).

Main Screen

SETUP → Display → Data Screens → Main:

To select which screen displays when **MAIN** is pressed, select from one of the options in this menu. Only screens that have been enabled are available for selection. If the live screen is not selected, it can be reached by pressing **NEXT** on the main screen.

Live Screen Options

SETUP → Display → Data Screens → Live Screen

- **Any Key Press** changes what happens when any of the parameter buttons on the **main display** (page 6) are pressed (pressure or temperature, for example). By default, these buttons highlight their measurement in the center of the display. If this option is set to **Show Actions Menu**, an option to change that parameter's engineering units is shown, as well as an option to highlight the parameter.
- **Show Valve Drive** shows or hides the valve's drive percentage. See page 14.
- **Top Left Key Value** configures which type of pressure (barometric, gauge, absolute) is displayed.

Enable Min/Max Screen

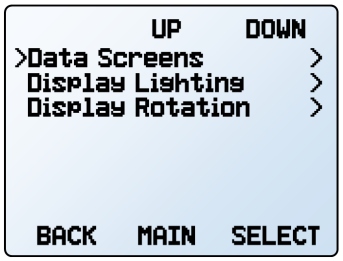
SETUP → Display → Data Screens → Min/Max Screen

- **Show** enables the min/max screen.
- **Hide** disables the min/max screen.

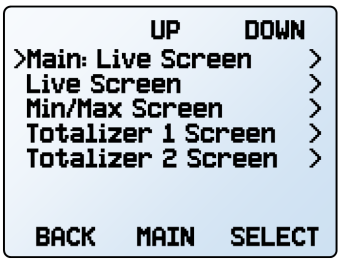
Totalizer 1 and Totalizer 2 Screen Options

SETUP → Display → Data Screens → Totalizer 1 or Totalizer 2

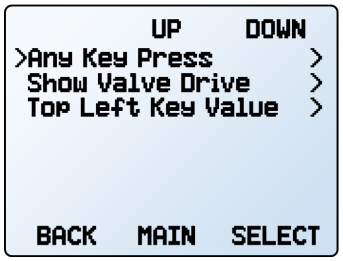
The totalizer screen options behave in the same manner as outlined in the **Totalizer Display** section (page 22). Performing changes in this menu performs the same change in the totalizer display menu. The opposite is true as well where changes in the totalizer display menu is reflected in this menu.



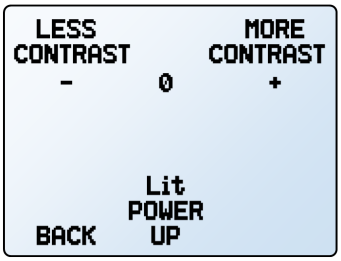
Display setup menu.



Data screens menu.



Options for pressing buttons on the live screen.



Monochrome contrast menu.

- **Flow and Batch (Default):** View as described above with options for batching, flow averaging, and set point.
- **Detailed Flow:** Similar to Flow and Batch, but without batching. Provides information focuses more on flow rates, total flow, and average flow.
- **Multi-variable:** Screen that resembles the live screen (page 6).

Screen Lighting

SETUP → Display → Screen Lighting

- Press **LESS CONTRAST** or **MORE CONTRAST** to adjust the contrast levels and move the contrast indicator left or right. **POWER UP Lit** or **Dark** toggles whether the backlight of the unit will be on when the instrument powers on.

Display Rotation

SETUP → Display → Display Rotation

The instrument has the option of inverting (flipping) the screen upside-down, as configured in this menu.

Advanced Setup

MENU → SETUP → Advanced

The **advanced setup menu** contains settings and detailed information that are useful when troubleshooting with customer support.

Factory Restore

SETUP → Advanced → Factory Restore

If something is not acting as expected, please contact an applications engineer prior to doing a **Factory Restore** to help confirm a restore is necessary.

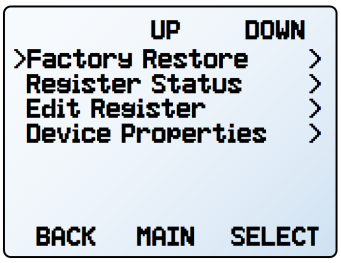
✓ *Disconnect the instrument from the system before selecting* Factory Restore.

This immediately prompts a confirmation screen. Upon confirmation, all settings and registers are returned to their default settings.

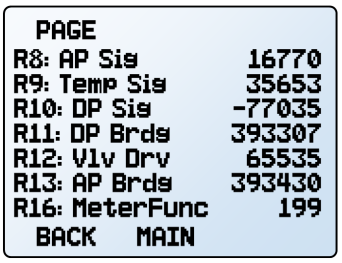
Register Status

SETUP → Advanced → Register Status

The **Register Status** screen displays live values for the internal instrument registers. Many of these values can help an applications engineer diagnose operational issues during technical support. Some register values clearly distinguish between hardware and operational problems, which speeds up the troubleshooting process.



Advanced setup menu.



Register status list.

Edit Register and Instrument Properties

SETUP → Advanced → Edit Register
SETUP → Advanced → Instrument Properties

Editing registers and instrument properties is used during technical support to fine tune functions that may not be working as expected. These functions are best left alone and used only when working with Alicat to diagnose or correct an issue. If your instrument is not functioning as expected, please contact Alicat support for assistance (page 2).

! **Caution:** *Editing these settings may cause the instrument to become inoperable. Do not modify them without working with an applications engineer.*

Serial ASCII Communication

Connecting your instrument to a computer allows you to log the data that it generates. The instrument communicates digitally through its communications connector and a cable using a real or virtual COM port on your computer. Refer to the *Safe Installation Manual*. Manuals can be found at alicat.com/manuals

This section of the manual shows you how to operate the instrument using ASCII commands.

Establishing Communication

After connecting to your instrument using a IS safety certified DB15 communications cable, you will need to establish serial communications through a real or virtual COM port on your computer or programmable logic computer (PLC).

- If you connect your instrument to a serial port, note its COM port number, which can be found in the Windows® Instrument Manager program.
- If you use a USB cable to connect your instrument to your computer, then in most cases it will recognize your USB as a virtual COM port. If it does not, download the appropriate USB instrument driver at alicat.com/drivers and note the COM port number as found in Windows® Instrument Manager.

The instrument has the following default settings:

- **Unit ID:** A
- **Baud:** 19200 (by default; others can be used if the computer, software, and the instrument are all set to the same rate)
- **Data bits:** 8
- **Parity:** none
- **Stop bits:** 1
- **Flow control:** none

Alicat's Serial Terminal Application

Alicat's Serial Terminal is a preconfigured program for serial communications. It functions much like the older Windows® HyperTerminal with plain text in a command-line format.

Download Serial Terminal for free at alicat.com/drivers. Once downloaded, simply run SerialTerminal.exe. Enter the COM port number to which your instrument is connected and the baud rate of the instrument. The default baud rate is 19200, but this is adjustable in the **RS-232 Serial menu** on your instrument (page 23).

Note: *In the following, ↵ indicates an ASCII carriage return (decimal 13, hexadecimal D). For many instruments, this is the same as hitting the Enter key. Serial commands are not case-sensitive.*

Polling Mode

Your instrument was shipped in polling mode with a unit ID of **A**, unless requested otherwise. Polling the instrument returns a single line of data each time you request it. To poll your instrument, simply enter its unit ID.

Poll the instrument: *unit_id*↵
Example: **A**↵ (polls unit A)

You can change the unit ID of a polling instrument by typing:

Change unit ID: *current_unit_id***@=***desired_unit_id*↵
Example: **A@=B**↵ (changes unit A to unit B)

This can also be achieved via the instrument's front panel menu (page 23). Valid unit IDs are letters A–Z, and up to 26 instruments may be connected at any one time, as long as each unit ID is unique.

Streaming Mode

In streaming mode, your instrument automatically sends a line of live data at regular intervals. Only one unit on a given COM port may be in streaming mode at a time. To put your instrument into streaming mode, type:

Begin streaming: *unit_id***@=@**↵
Example: **A@=@**↵
(sets instrument A to streaming mode)

This is equivalent to changing the unit ID to "**@**". To take the instrument out of streaming mode, assign it a unit ID by typing:

Stop streaming: **@@=***desired_unit_id*↵
Example: **@@=A**↵
(stops and assigns unit ID of A)

When sending a command to an instrument in streaming mode, the flow of data will not stop while the user is typing. This may make the commands you type unreadable. If the instrument does not receive a valid command, it will ignore it. If in doubt, press Backspace a number of times, then ↵, and start again.

The default streaming interval is 50 ms. This can be increased by using the set streaming interval command:

Set interval: *unit_id***NCS***number_of_ms*↵
Example: **ANCS 500**↵
(streams new data every 500 ms)

Taring Commands

Before collecting flow data, be sure to tare your instrument. If auto-tare is enabled, this can be accomplished by providing a setpoint of 0 for at least 2 seconds.

Manual taring can be accomplished through a few separate commands for flow and pressure. Taring flow sets the zero flow reading and must be done when *no flow is passing through the instrument*:

Tare flow: *unit_id*V↵
Example: AV↵

Taring a gauge or differential pressure sensor must be performed when the instrument is *open to atmosphere.*

Tare pressure: *unit_id*P↵
Example: AP↵

Taring an absolute pressure sensor must be done with the instrument *open to atmosphere*:

Tare absolute pressure: *unit_id*PC↵
Example: APC↵

Data Collection

Collect live flow data by typing the *unit_id* ↵ command or by setting your instrument to streaming. Each line of data for live measurements appear in a format similar to below. Check your instrument as it may have different options The measurements present are dictated by the type of instrument. Meters and gauges do not have setpoint nor valve drive.

Mass Flow Meter

A	+13.54	+0.00	+13.542	+24.57	+16.667	+15.444	+00017.32	N2
ID	Absolute Press.	Gauge Press.	Barometric Press.	Temperature	Volumetric Flow	Mass Flow	Totalizer	Gas

Gauge Pressure Controller

A	+33.52	+20.00	+13.542	+20.00	+063.44
ID	Absolute Press.	Gauge Press.	Barometric Press.	Setpoint	Valve Drive

Liquid Controller

A	+28.24	+14.70	+13.542	+24.57	+02.004	+02.004	+041.89	+00009.75
ID	Absolute Press.	Gauge Press.	Barometric Press.	Temperature	Volumetric Flow	Setpoint	Valve Drive	Totalizer

Single spaces separate each parameter, and each value is displayed in the chosen instrument engineering units (page 20). You can query the engineering units of the serial data frame by typing:

Query live data info: *unit_id* ??D*↵
Example: A??D*↵ (returns the data frame descriptions)

Additional columns, including status codes (page 7), may be present to the right of the gas label column. The unit ID appears in the data frame only when the instrument is in polling mode.

Setpoint (Controllers)

Before attempting to send a setpoint to your controller serially, confirm that its setpoint source is set to **`Serial/ Front Panel`** (page 11).

New setpoint: *unit_id*`S` *new_setpoint*↵
Example: `AS 15.44`↵ (setpoint of +15.44 SLPM)

When using a bidirectional or negative range instrument, negative setpoints are sent by adding a hyphen for the minus sign (-):

Example: `as -15.44`↵ (setpoint of −15.44 SLPM)

Note: *Negative setpoints are only possible on flow meters and pressure meters, but not flow controllers or pressure controllers)*

When a setpoint is given to an instrument, the data frame returns the new setpoint value when it has been accepted as a valid setpoint.

Gas Select™ and COMPOSER™ (Mass Flow)

To reconfigure your mass flow instrument to flow a different gas, look up its gas number (page 35). For more information on how Gas Select™ and COMPOSER™ work, see page 19. Here are the commands:

Choose a gas: *unit_id*`G` *gas_number*↵
Example 1: `AG 8`↵ (reconfigures to flow nitrogen)
Example 2: `AG 206`↵ (reconfigures to flow P-10)

User mixes are selected in the same way. All COMPOSER™ gas mixes have a mix number between 236 and 255.

Choose a user mix: *unit_id*`G` *gas_number*↵
Example: `AG 255`↵
(reconfigures for user mix 255)

Defining a new COMPOSER™ gas mix is faster using serial commands than using the front panel. The basic formula for this is:

unit_id`GM` *mix_name mix_number gas1_% gas1_number gas2_% gas2_number...*↵

mix_name Use a maximum of 6 letters (upper and/or lower case), numbers and symbols (period or hyphen only). This is equivalent to the short name when creating a mix via the front panel (page 19).

mix_number Choose a number from 236 to 255. *If a user mix with that number already exists, it will be overwritten.* Use the number `0` to assign the next available number to your new gas. Gas numbers are assigned in descending order from 255. *gas1_% gas1_number...* For each gas, enter its percentage of the mixture up to 2 decimal places, then its gas number (page 35). 2–5 gases are required, and the sum of all gas constituent percentages must equal 100.00%. After creating a mix, the controller will confirm the new gas:

Example 1: Create a mix of 71.35% helium, 19.25% nitrogen, and 9.4% carbon dioxide as Gas 252, called "MyGas1".

```
Command: AGM MyGas1 252 71.35 7 19.25 8 9.4 4↵
Response:    A 252 71.35% He 19.25% N2 9.40% CO2
```

Example 2: Create a mix of 93% methane, 3% ethane, 1% propane, 2% nitrogen, and 1% CO2, using the next available gas number, called "MyGas2".

```
Command: AGM MyGas2 0 93 2 3 5 1 12 2 8 1 4↵
Response:    A 253 93.00% CH4 3.00% C2H6 1.00% C3H8 2.00% N2 1.00% CO2
```

Quick Command Guide

Serial commands are not case-sensitive

General Commands for All Instruments

Change the unit ID:	*unit_id* **@=** *desired_ID*↵
Tare flow:	*unit_id* **V**↵
Tare gauge/differential pressure:	*unit_id* **P**↵
Tare absolute pressure:	*unit_id* **PC**↵
Poll the live data frame:	*unit_id*↵
Begin streaming data:	*unit_id* **@=@**↵
Stop streaming data:	**@@=** *desired_unit_id*↵
Set streaming interval:	*unit_id* **NCS** *#_of_ms*↵
Query live data info:	*unit_id* **??D***↵
Manufacturer info:	*unit_id* **??M***↵
Firmware version:	*unit_id* **VE**↵
Lock the front display:	*unit_id* **L**↵
Unlock the display:	*unit_id* **U**↵

Controller Commands

New setpoint:	*unit_id* **S** *new_value*↵
Hold valve(s) at current position:	*unit_id* **HP**↵
Hold valve(s) closed:	*unit_id* **HC**↵
Cancel valve hold:	*unit_id* **C**↵

Mass Flow Gas Select™ and COMPOSER™ Commands

Query gas list info:	*unit_id* **??G***↵
Choose a different gas:	*unit_id* **G** *gas_number*↵
New COMPOSER mix:	*unit_id* **GM** *mix_name mix_# gas1_% gas1_# gas2_% gas2_#...*↵
Delete COMPOSER mix:	*unit_id* **GD** *mix_#*↵

If you require more advanced serial communication commands, please download the serial primer at alicat.com/drivers.

Modbus RTU Communication

Modbus RTU can be used to read and log sensor data, switch between analog and digital control modes, adjust instrument settings, and control the instrument.

MODBUS is an application-layer messaging protocol that formats data for communications over serial RS-232 or RS-485. The instrument supports MODBUS RTU protocol, with data transmitted through the IS safety certified DB15 communications cable.

MODBUS RTU can be used to control:

- taring
- data collection
- setpoint control
- totalizer
- batch dispensing
- changing the gas
- in-instrument optimization (Autotune)
- control loop adjustment.

For more information on MODBUS RTU communication commands, please see the MODBUS FAQ at alicat.com/documentation/faq-modbus/ and the MODBUS RTU manual at alicat.com/manuals.

Troubleshooting

If you run into trouble with installation or operation, get in touch with support (page 2).

General Use

Issue: ***The buttons do not work, and the screen shows*** **LCK.**

Action: The instrument buttons were locked out via a serial command (*unit_ID*1↵). Press and hold all four outer buttons to unlock the interface. Can also be unlocked using a serial command the ASCII instructions (page 26) or the Modbus manual at alicat.com/manuals.

Issue: ***I can't read the display easily.***

Action: During the day, you can increase the visibility of the display by increasing the contrast or brightness (page 24). In low-light conditions, push the bottom central button (located below the display) to turn on the backlight.

Issue: ***How often do I need to calibrate my instrument?***

Action: Annual recalibration is recommended. Check your instrument's last calibration date by selecting **MENU ABOUT About Instrument**. If it is time to recalibrate, request a recalibration from customer support (page 2).

Issue: ***I dropped my instrument. Is it OK?***

Action: Dropping the instrument onto a hard surface from a height greater than 1' (300mm) may compromise the safety-critical leak integrity of the enclosure. If the instrument sustains any significant impact, inspect it for visible damage, distortion, cracks, or warping of the connector, display membrane, or metal joints. If there is any visible damage, return the instrument to Alicat for inspection.

If there is no visible damage, confirm the flow accuracy and leak integrity of the instrument before placing it into service.

Issue: ***Can I use my instrument with other gases or liquids?***

Action: Mass flow instruments can be used with any gas or combination of gases included in the Gas Select™ of the instrument. Before flowing a different gas, select the new gas with Gas Select™ or use COMPOSER™ to create the correct mix of preloaded gases.

Liquid instruments are designed specifically to work with only one liquid, typically water. For use with a different liquid, the instrument requires recalibration. Please contact customer support for assistance (page 2).

Pressure instruments can be used with any gas or liquid that is chemically and mechanically compatible with the wetted materials in the instrument. The amount of flow available with the valve(s) in the instrument may vary significantly with the viscosity of the process fluid. Please contact customer support for any assistance in determining what is compatible with your instrument (page 2).

Issue: ***How can I see readings in different units?***

Action: From the main menu, select **SETUP Sensor Engineering Units**. From this menu, you can adjust any variable's units. For more information, see page 20.

Issue: ***My controller won't reach its setpoint.***

Action: The flow rate is related linearly to the pressure drop across the instrument. If there isn't enough of a pressure difference between the inlet and outlet, the controller may not be able to reach setpoint. Often, increasing the inlet pressure will fix this issue.
If increasing the pressure doesn't help, check to see if there is a clog.

Teflon tape can often get stuck in the flow channel and block flow. Make sure to clean out any loose Teflon tape and never tape the first two threads entering the instrument to help avoid this issue.

If erratic control, or no control, continues after you have verified the supply pressure and that the valve is not clogged, please consult Appendix B (page **38**) for details on how to troubleshoot the valve power limit circuit.

Issue: ***The pressure exceeded the maximum allowable pressure.***

Action: The sensor may have been damaged and may no longer provide accurate readings. Remove the instrument from the process and check it against a known working instrument.

Over-pressuring the instrument may also damage the safety-critical leak integrity of the instrument. Check the instrument for any leaks.

If measurements are inaccurate or the instrument is leaking, contact Alicat for to perform a repair (page 2).

Flow Readings

Issue: ***The live flow readings won't settle down.***

Action: The instrument is very fast, so it can detect subtle variations in flow that may go unnoticed by your other instruments. This sensitivity can help detect problems with pumps or flow controllers. You can lessen this sensitivity by increasing the flow averaging (page 21). Controllers use PD or PD²I control loop algorithms to reach the setpoint given. These parameters are adjustable in the field. See page 16 for a quick guide on tuning.

Issue: ***My flow readings are negative.***

Action: Stop the flow and let the process settle. Under no flow conditions, a negative flow reading can indicate a poor tare. Perform a manual tare (page 7). On controllers, ensure that auto tare is enabled and give the controller a zero setpoint for at least 2 seconds.

If readings are still negative after a tare, the sensor may be damaged. Please contact support for further assistance (page 2).

Issue: ***My flow readings are not what I expect them to be (either higher or lower than expected).***

Action: Remove the instrument from the line and confirm there is no leak present within the instrument. If no leak is found in the instrument, there may be a leak in the line. Check the process line for further leaks and repair as needed.

Pressure Readings

Issue: ***My pressure readings are negative.***

Action: If a negative reading is not expected, your instrument may need to be tared (page 7). Ensure pressure is at zero, and tare it.

If readings are still negative after a tare, the sensor may be damaged. Please contact support for further assistance (page 2).

Issue: ***My pressure readings jump to zero when pressures are low.***

Action: Your instrument is equipped with a programmable zero band that is preset at the factory. Reduce your deadband threshold by selecting **SETUP → Sensor → Zero Band**.

Issue: ***My pressure reading disagrees with another instrument I have in line.***

Action: Pressure instruments can normally be compared against one another provided there are no leaks between the two instruments. Another possibility is an improper tare error (page 7).

If a tare does not resolve the issue, remove the instrument from the line and confirm there are no leaks. If leaks are found or if the issue persists, contact support for assistance (page 2).

Serial Communications

Issue: *I can't communicate to the instrument when it is connected to my PC.*

Action: **1.** Make sure the baud rate your software and COM port required is the one your instrument is using (**`MENU SETUP RS-232 Serial`** *or* **`RS-485 Serial Baud Rate`**).

2. Check the unit ID (**`MENU SETUP RS-232 Serial`** *or* **`RS-485 Serial Unit ID`**) or Modbus address (**`SETUP`** → **`RS-232 Serial`** *or* **`RS-485 Serial`** → **`Modbus Address)`** to make sure you are addressing it properly with your commands.

3. Check the pinout in the **Safety and Installation Manual for IS-Pro and IS-Max Intrinsically Safe Instruments** found at alicat.com/manuals.

4.Make sure the serial port (com port in windows) that is selected in the software matches with the hardware used to connect to the instrument.

5. On the external serial communications instrument (computer, PLC, *etc.*), be sure that the flow control (handshaking) settings are set as on page 26.

Still experiencing issues? Please contact support. See page 2.

Appendix A. Reference Information

Engineering Units

See the **Engineering Units** section under **Sensor Setup** for more on how to implement the following tables (page 20).

Pressure Units

Absolute or Barometric	Gauge	Notes
PaA	PaG	Pascal
hPaA	hPaG	Hectopascal
kPaA	kPaG	Kilopascal
MPaA	MPaG	Megapascal
mbarA	mbarG	Millibar
barA	barG	Bar
g/cm²A	g/cm²G	Gram force per square centimeter†
kg/cm²A	kg/cm²G	Kilogram force per square centimeter*
PSIA	PSIG	Pound force per square inch
PSFA	PSFG	Pound force per square foot
mTorrA	mTorrG	Millitorr
torrA	torrG	Torr
mmHgA	mmHgG	Millimeter of mercury at 0°C
inHgA	inHgG	Inch of mercury at 0°C
mmH_2OA	mmH_2OG	Millimeter of water at 4°C (NIST conventional)†
mmH_2OA	mmH_2OG	Millimeter of water at 60°C†
cmH_2OA	cmH_2OG	Centimeter of water at 4°C (NIST conventional)†
cmH_2OA	cmH_2OG	Centimeter of water at 60°C†
inH_2OA	inH_2OG	Inch of water at 4°C (NIST conventional)†
inH_2OA	inH_2OG	Inch of water at 60°C†
atm		Atmosphere
m asl		Meter above sea level
ft asl		Foot above sea level
V		Volt
%	%	Percent of full scale

Temperature Units

Label	Notes
°C	Degrees Celsius
°F	Degrees Fahrenheit
K	Kelvin
°R	Degrees Rankine

Flow Units

Volumetric	Standard	Normal	Notes
µL/m	SµL/m	NµL/m	Microliter per minute‡
mL/s	SmL/s	NmL/s	Milliliter per second
mL/m	SmL/m	NmL/m	Milliliter per minute
mL/h	SmL/h	NmL/h	Milliliter per hour
L/s	SL/s	NL/s	Liter per second
LPM	SLPM	NLPM	Liter per minute
L/h	SL/h	NL/h	Liter per hour
US GPM			US gallon per minute
US GPH			US gallon per hour
CCS	SCCS	NCCS	Cubic centimeter per second
CCM	SCCM	NCCM	Cubic centimeter per minute
cm³/h	Scm³/h	Ncm³/h	Cubic centimeter per hour†
m³/m	Sm³/m	Nm³/m	Cubic meter per minute†
m³/h	Sm³/h	Nm³/h	Cubic meter per hour†
m³/d	Sm³/d	Nm³/d	Cubic meter per day†
in³/m	Sin³/m		Cubic inch per minute†
CFM	SCFM		Cubic foot per minute
CFH	SCFH		Cubic foot per hour
CFD	SCFD		Cubic foot per day
	kSCFM		1000 cubic feet per minute
%	%	%	Percent of full-scale

True Mass Flow Units

Label	Notes
mg/s	Milligram per second
mg/m	Milligram per minute
g/s	Gram per second
g/m	Gram per minute
g/h	Gram per hour
kg/m	Kilogram per minute
kg/h	Kilogram per hour
oz/s	Ounce per second
oz/m	Ounce per minute
lb/m	Pound per minute
lb/h	Pound per hour

Time Units

Label	Notes
h:m:s	Hours:Minutes:Seconds
ms	Milliseconds
s	Seconds
m	Minutes
hour	Hours
day	Days

Total Units

Label	Notes
µL	MicroLiter‡
mL	MilliLiter
L	Liter
US GAL	US gallon
cm³	Cubic centimeter†
m³	Cubic meter†
in³	Cubic inch†
ft³	Cubic foot†
µP	Micropoise, a measure of viscosity*
mg	Milligrams
g	Grams
kg	Kilograms
oz	US ounces
lb	US pounds

** Displayed as kg/cmA and kg/cmG.*
† Superscript and subscript numerals are displayed as lining (normal) numerals.
‡ Instances of µ are displayed as a lower-case u.

Gas List by Number

To use any of these gases in your instrument, use Gas Select™ (page 19).

#	Short	Long Name
0	Air	Air (Clean Dry)
1	Ar	Argon
2	CH4	Methane
3	CO	Carbon Monoxide
4	CO2	Carbon Dioxide
5	C2H6	Ethane
6	H2	Hydrogen
7	He	Helium
8	N2	Nitrogen
9	N2O	Nitrous Oxide
10	Ne	Neon
11	O2	Oxygen
12	C3H8	Propane
13	nC4H10	Normal Butane
14	C2H2	Acetylene
15	C2H4	Ethylene (Ethene)
16	iC4H10	Isobutane
17	Kr	Krypton
18	Xe	Xenon
19	SF6	Sulfur Hexafluoride[1]
20	C-25	25% CO_2, 75% Ar
21	C-10	10% CO_2, 90% Ar
22	C-8	8% CO_2, 92% Ar
23	C-2	2% CO_2, 98% Ar
24	C-75	75% CO_2, 25% Ar
25	He-25	25% He, 75% Ar
26	He-75	75% He, 25% Ar
27	A1025	90% He, 7.5% Ar, 2.5% CO_2
28	Star29	Stargon CS (90% Ar, 8% CO_2, 2% O_2)
29	P-5	5% CH_4, 95% Ar
30	NO	Nitric Oxide[2]
31	NF3	Nitrogen Trifluoride[2]
32	NH3	Ammonia[2]
33	Cl2	Chlorine[2]
34	H2S	Hydrogen Sulfide[2]
35	SO2	Sulfur Dioxide[2]
36	C3H6	Propylene[2]
80	1Buten	1-Butylene[2]
81	cButen	Cis-Butene (cis-2-Butene)[2]
82	iButen	Isobutene[2]
83	tButen	Trans-2-Butene[2]
84	COS	Carbonyl Sulfide[2]
85	DME	Dimethylether (C_2H_6O)[2]
86	SiH4	Silane[2]
100	R-11	Trichlorofluoromethane (CCl_3F)[2,3]
101	R-115	Chloropentafluoroethane (C_2ClF_5)[2,3]
102	R-116	Hexafluoroethane (C_2F_6)[2]
103	R-124	Chlorotetrafluoroethane (C_2HClF_4)[2,3]
104	R-125	Pentafluoroethane (CF_3CHF_2)[2,3]
105	R-134A	Tetrafluoroethane (CH_2FCF_3)[2,3]
106	R-14	Tetrafluoromethane (CF_4)[2]
107	R-142b	Chlorodifluoroethane (CH_3CClF_2)[2,3]
108	R-143a	Trifluoroethane ($C_2H_3F_3$)[2,3]
109	R-152a	Difluoroethane ($C_2H_4F_2$)[2]
110	R-22	Difluoromonochloromethane ($CHClF_2$)[2,3]
111	R-23	Trifluoromethane (CHF_3)[2,3]
112	R-32	Difluoromethane (CH_2F_2)[2,3]
113	R-318	Octafluorocyclobutane (C_4F_8)[2]
114	R-404A	44% R-125, 4% R-134A, 52% R-143A[2,3]
115	R-407C	23% R-32, 25% R-125, 52% R-143A[2,3]
116	R-410A	50% R-32, 50% R-125[2,3]
117	R-507A	50% R-125, 50% R-143A[2,3]
140	C-15	15% CO_2, 85% Ar
141	C-20	20% CO_2, 80% Ar
142	C-50	50% CO_2, 50% Ar
143	He-50	50% He, 50% Ar
144	He-90	90% He, 10% Ar
145	Bio5M	5% CH_4, 95% CO_2
146	Bio10M	10% CH_4, 90% CO_2
147	Bio15M	15% CH_4, 85% CO_2
148	Bio20M	20% CH_4, 80% CO_2
149	Bio25M	25% CH_4, 75% CO_2
150	Bio30M	30% CH_4, 70% CO_2
151	Bio35M	35% CH_4, 65% CO_2
152	Bio40M	40% CH_4, 60% CO_2
153	Bio45M	45% CH_4, 55% CO_2
154	Bio50M	50% CH_4, 50% CO_2
155	Bio55M	55% CH_4, 45% CO_2
156	Bio60M	60% CH_4, 40% CO_2
157	Bio65M	65% CH_4, 35% CO_2
158	Bio70M	70% CH_4, 30% CO_2
159	Bio75M	75% CH_4, 25% CO_2
160	Bio80M	80% CH_4, 20% CO_2
161	Bio85M	85% CH_4, 15% CO_2
162	Bio90M	90% CH_4, 10% CO_2
163	Bio95M	95% CH_4, 5% CO_2
164	EAN-32	32% O_2, 68% N_2
165	EAN-36	36% O_2, 64% N_2
166	EAN-40	40% O_2, 60% N_2
167	HeOx20	20% O_2, 80% He
168	HeOx21	21% O_2, 79% He
169	HeOx30	30% O_2, 70% He
170	HeOx40	40% O_2, 60% He
171	HeOx50	50% O_2, 50% He
172	HeOx60	60% O_2, 40% He
173	HeOx80	80% O_2, 20% He
174	HeOx99	99% O_2, 1% He
175	EA-40	Enriched Air-40% O_2
176	EA-60	Enriched Air-60% O_2
177	EA-80	Enriched Air-80% O_2
178	Metab	Metabolic Exhalant (16% O_2, 78.04% N_2, 5% CO_2, 0.96% Ar)
179	LG-4.5	4.5% CO_2, 13.5% N_2, 82% He
180	LG-6	6% CO_2, 14% N_2, 80% He
181	LG-7	7% CO_2, 14% N_2, 79% He
182	LG-9	9% CO_2, 15% N_2, 76% He
183	HeNe-9	9% Ne, 91% He
184	LG-9.4	9.4% CO_2, 19.25% N_2, 71.35% He
185	SynG-1	40% H_2, 29% CO, 20% CO_2, 11% CH_4
186	SynG-2	64% H_2, 28% CO, 1% CO_2, 7% CH_4
187	SynG-3	70% H_2, 4% CO, 25% CO_2, 1% CH_4
188	SynG-4	83% H_2, 14% CO, 3% CH_4
189	NatG-1	93% CH_4, 3% C_2H_6, 1% C_3H_8, 2% N_2, 1% CO_2
190	NatG-2	95% CH_4, 3% C_2H_6, 1% N_2, 1% CO_2
191	NatG-3	95.2% CH_4, 2.5% C_2H_6, 0.2% C_3H_8, 0.1% C_4H_{10}, 1.3% N_2, 0.7% CO_2
192	CoalG	50% H_2, 35% CH_4, 10% CO, 5% C_2H_4
193	Endo	75% H_2, 25% N_2
194	HHO	66.67% H_2, 33.33% O_2
195	HD-5	LPG: 96.1% C_3H_8, 1.5% C_2H_6, 0.4% C_3H_6, 1.9% n-C_4H_{10}
196	HD-10	LPG: 85% C_3H_8, 10% C_3H_6, 5% n-C_4H_{10}
197	OCG-89	89% O_2, 7% N_2, 4% Ar
198	OCG-93	93% O_2, 3% N_2, 4% Ar
199	OCG-95	95% O_2, 1% N_2, 4% Ar
200	FG-1	2.5% O_2, 10.8% CO_2, 85.7% N_2, 1% Ar
201	FG-2	2.9% O_2, 14% CO_2, 82.1% N_2, 1% Ar
202	FG-3	3.7% O_2, 15% CO_2, 80.3% N_2, 1% Ar
203	FG-4	7% O_2, 12% CO_2, 80% N_2, 1% Ar
204	FG-5	10% O_2, 9.5% CO_2, 79.5% N_2, 1% Ar
205	FG-6	13% O_2, 7% CO_2, 79% N_2, 1% Ar
206	P-10	10% CH_4 90% Ar
210	D-2	Deuterium

1 *Sulfur hexafluoride is a highly potent greenhouse gas monitored under the Kyoto Protocol.*

2 *Corrosive-resistant units only*

3 *Under the Montreal Protocol and Kigali Amendment, the production and consumption of these ozone-depleting substances (ODS) is being or has been phased out. It is recommended you ensure compliance with this universally ratified treaty before attempting to use these gases, in addition to R113, R-123, and R-141b.*

Gas List by Category

See previous page for Gas Select™ index numbers.

Pure Non-Corrosive Gases
Acetylene (C_2H_2)
Air (clean, dry)
Argon (Ar)
Isobutane (i-C_4H_{10})
Normal Butane (n-C_4H_{10})
Carbon dioxide (CO_2)
Carbon monoxide (CO)
Deuterium (D_2)
Ethane (C_2H_6)
Ethylene (Ethene) (C_2H_4)
Helium (He)
Hydrogen (H_2)
Krypton (Kr)
Methane (CH_4)
Neon (Ne)
Nitrogen (N_2)
Nitrous Oxide (N_2O)
Oxygen (O_2)
Propane (C_3H_8)
Sulfur Hexafluoride (SF_6)[1]
Xenon (Xe)

Breathing Gases
Metabolic Exhalant
EAN-32
EAN-36
EAN-40
EA-40
EA-60
EA-80
Heliox-20
Heliox-21
Heliox-30
Heliox-40
Heliox-50
Heliox-60
Heliox-80
Heliox-99

Bioreactor Gas Mixes
5%–95% CH_4/CO_2 in 5% increments

Refrigerants[2]
R-11[3]
R-14
R-22[3]
R-23[3]
R-32[3]
R-115[3]
R-116
R-124[3]
R-125[3]
R-134a[3]
R-142b[3]
R-143a[3]
R-152a
R-318
R-404A[3]
R-407C[3]
R-410A[3]
R-507A[3]

Welding Gases
C-2
C-8
C-10
C-15
C-20
C-25
C-50
C-75
He-25
He-50
He-75
He-90
A 1025
Stargon CS

Chromatography Gas Mixes
P-5
P-10

Oxygen Concentrator Gas Mixes
89% O_2, 7.0% N_2, 4.0% Ar
93% O_2, 3.0% N_2, 4.0% Ar
95% O_2, 1.0% N_2, 4.0% Ar

Stack/Flue Gas Mixes
2.5% O_2, 10.8% CO_2, 85.7% N_2, 1.0% Ar
2.9% O_2, 14% CO_2, 82.1% N_2, 1.0% Ar
3.7% O_2, 15% CO_2, 80.3% N_2, 1.0% Ar
7.0% O_2, 12% CO_2, 80% N_2, 1.0% Ar
10% O_2, 9.5% CO_2, 79.5% N_2, 1.0% Ar
13% O_2, 7.0% CO_2, 79% N_2, 1.0% Ar

Laser Gas Mixes
4.5% CO_2, 13.5% N_2, 82% He
6.0% CO_2, 14% N_2, 80% He
7.0% CO_2, 14% N_2, 79% He
9.0% CO_2, 15% N_2, 76% He
9.4% CO_2, 19.25% N_2, 71.35% He
9.0% Ne, 91% He

Fuel Gas Mixes
Coal Gas 50% H_2, 35% CH_4, 10% CO, 5% C_2H_4
Endothermic Gas 75% H_2, 25% N_2
HHO 66.67% H_2, 33.33% O_2
LPG HD-5 96.1% C_3H_8, 1.5% C_2H_6, 0.4% C_3H_6 , 1.9% n-C_4H_{10}
LPG HD-10 85% C_3H_8, 10% C_3H_6, 5% n-C_4H_{10}

Natural Gases
93.0% CH_4, 3.0% C_2H_6, 1.0% C_3H_8, 2.0% N_2, 1.0% CO_2
95.0% CH_4, 3.0% C_2H_6, 1.0% N_2, 1.0% CO_2
95.2% CH_4, 2.5% C_2H_6, 0.2% C_3H_8, 0.1% C_4H_{10}, 1.3% N_2, 0.7% CO_2

Synthesis Gases
40% H_2, 29% CO, 20% CO_2, 11% CH_4
64% H_2, 28% CO, 1.0% CO_2, 7.0 CH_4
70% H_2, 4.0% CO, 25% CO_2, 1.0% CH_4
83% H_2, 14% CO, 3.0% CH_4

Pure Corrosive Gases[2]
Pure Corrosive Gases[2]
Ammonia (NH_3)
Butylene (1-Buten)
Cis-Butene (c-Buten)
Isobutene (i-Buten)
Trans-Butene (t-Buten)
Carbonyl Sulfide (COS)
Chlorine (Cl_2)
Dimethylether (DME)
Hydrogen Sulfide (H_2S)
Nitrogen Trifluoride (NF_3)
Nitric Oxide (NO)
Propylene (C_3H_6)
Silane (SiH_4)
Sulfur Dioxide (SO_2)

1 *Sulfur hexafluoride is a highly potent greenhouse gas monitored under the Kyoto Protocol.*

2 *Corrosive-resistant units only*

3 *Under the Montreal Protocol and Kigali Amendment, the production and consumption of these ozone-depleting substances (ODS) is being or has been phased out. It is recommended you ensure compliance with this universally ratified treaty before attempting to use these gases, in addition to R113, R-123, and R-141b.*

Instrument Environmental Conditions

The IS-Max and IS-Pro are designed for use in the following environmental conditions:

- **Indoor or outdoor** (see special conditions of use)
- **Maximum installation altitude:** 5000m
- **Ambient temperature:** -20°C to 70°C
- **Relative humidity:** 0–95%
- **Overvoltage Category I**
- **Wet or dry locations**
- **Pollution degree 4**
- **Ingress protection:** IEC 60529
  IP66, CAN/CSA-C22.2 Type 4

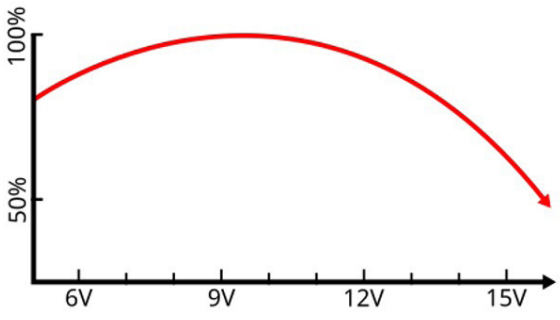
Appendix B. Valve Circuit

Troubleshooting

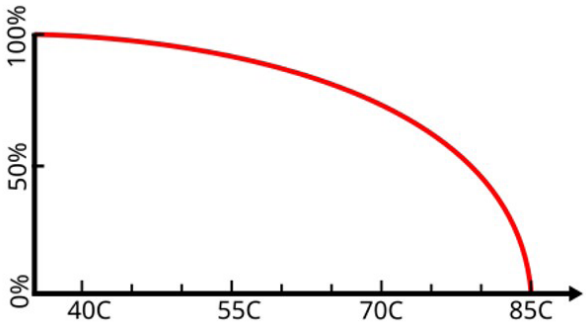
As noted on the control drawing (see DOC-IS-MANUAL-SAFEINSTALLATION), the valve power circuit has an internal power limit when supplied by a barrier or power supply operating below 15 volts. This limit is set by infallibly rated and redundant hardware on the instrument's circuit board and will always operate independent of any software state.

The valve power limiting hardware is not a simple resistive circuit. It will limit, power cycle, and even completely disable power to the valve control circuit if it detects excess current draw or circuit temperature. The current which will trip this limit decreases with increasing input voltage and circuit temperature.

The shape of this limit is approximated by the following graphs at a constant temperature or voltage, respectively:



hard power limit vs input voltage



hard power limit vs electronics temperature

In normal operation, the instrument will smoothly increase and decrease the power delivered to the valve solenoid ("valve drive") to open the valve and reach a target setpoint. If the valve drive exceeds the hardware power limits, the protection circuit will cut power to the solenoid and the instrument will not control flow normally. Instruments are designed so that the valve drive will not exceed the hardware power limit when the instrument is used with recommended barriers in the 9–12V range, but using the instrument outside this limit may require adjusting settings to prevent a loss of control.

A separate, configurable software valve drive limit is available on the instrument. This valve drive limit is temperature-dependent and can force the instrument to reduce the maximum valve drive as the electronics temperature increases. This "valve drive thermal limit" feature allows a device connected to a non-recommended barrier to avoid tripping the hardware power limit.

Valve Power Troubleshooting:

The following issues are the most likely issues that you may experience related to the valve drive circuit power and thermal limits.

Issue 1: The valve is closing and opening approximately every half second.

Cause: The power limiting hardware has detected excessive current draw for the current operating conditions and is cutting power to the valve to prevent an unsafe temperature rise.

Solution 1: Select a barrier with an input voltage in the nominal 9–12V range.

The valve circuit is designed to allow peak power between 9 and 12 volts. Voltages between 6 and 9 volts or 12 and 15 volts may still work at reduced power by adjusting the maximum drive current %, adjusting the supply pressure, and reducing the operating temperature.

Solution 2: Reduce the operating temperature of the instrument.

Power limits increase with reduced temperature at any given voltage. Verify that the local temperature around the instrument is below the Tamb maximum of 70°C. Lower temperatures may be required if operating outside the nominal barrier voltage range of 9-12 Volts.

Solution 3: Adjust operating pressure and the *valve drive thermal limit* software setting.

The software-based "Valve Drive Thermal Limit" can be adjusted using the interface described on page **40**. This setting will force the instrument to command a lower maximum current to the valve solenoid as the temperature increases.

The "set by supply volts" menu or **VLVT** command (both described on page **40**) are the easiest ways to set this limit and should be the starting point for adjustments. When making manual adjustments, small adjustments may have large effects: a reduction in the maximum current both prevents the instrument from attempting to exceed the hardware current limit and increases the hardware current limit by reducing self-heating of the electronics.

Lower solenoid drive current will always decrease the flow coefficient of the valve and decrease the maximum inlet pressure that the valve can open against. When adjusting the valve drive thermal limit, always adjust the supply pressure to ensure that full-scale flow can be reached. An optimum supply pressure will allow the instrument to reach full scale flow or control pressure at 50% valve drive. Running PID auto-tune (page **16**) after changing supply pressure is recommended.

If the behavior occurs only at high operating temperature, verify that the local temperature of the instrument is below the 70°C maximum ambient rating.

If the current limit is triggered at ambient operating conditions or adjusting the above settings do not allow control, return the instrument to Alicat for diagnosis. All Alicat instruments have a lifetime warranty against malfunction and can be reconfigured for a nominal charge if a larger valve is required for a given set of process conditions.

Issue 2: The valve will not open, or no flow is indicated despite the instrument having a setpoint.

Solution: It is possible that a damaged component on the PCB could trigger the protection circuit and disable power to the valve. This can be confirmed by ruling out other causes for the valve not opening.

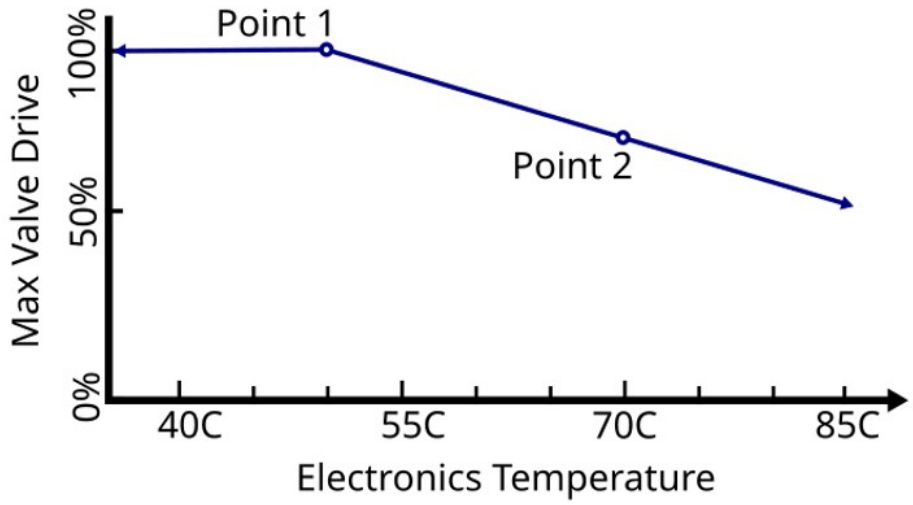
1. Verify that the instrument is commanding the valve to open by checking the valve drive percent on the display or in the serial data frame.
2. Verify that inlet pressure to the instrument is high enough to overcome the internal pressure drop of the instrument. Pressure drop information can be found on the specification sheet for your instrument.
3. Verify that the circuit is correctly wired with sufficient power supplied to the (red(+)/brown(-) twisted pair.

If the above checks do not identify any problems, there may be mechanical damage or blockage in the valve, or the input circuitry may be damaged. Please contact Alicat (page **2**) for further information on returning the instrument for repair or replacement.

Software Valve Drive Thermal Limit Function

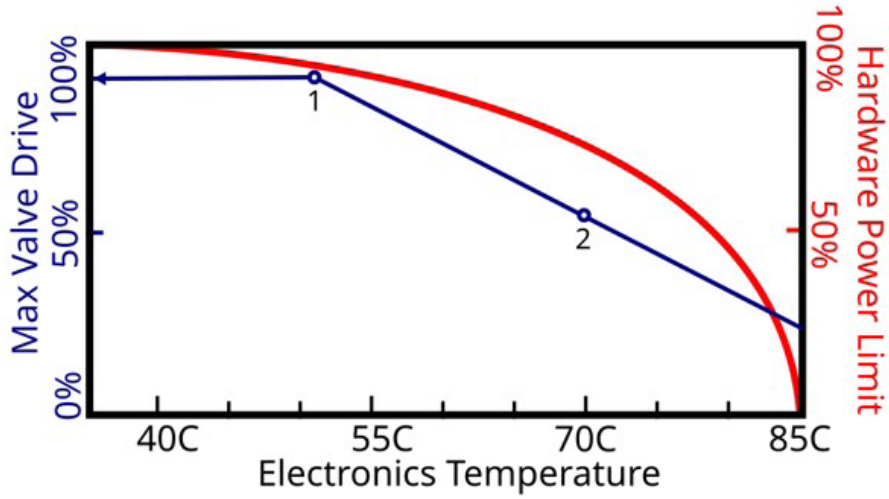
As described in the previous section, you can adjust the software valve drive thermal limit to avoid tripping the hardware power limit. Understanding how this limit works is important when adjusting the limit or your operating pressure after changing these settings.

The software limit is defined by two temperature points and a % limit. Point 1 is the temperature below which valve drive is limited to 100%. Point 2 is fixed at 70 °C and is set to a valve drive between 0–100%. At temperatures higher than Point 1, the instrument limits its valve drive % to a value defined by a line between these two points.



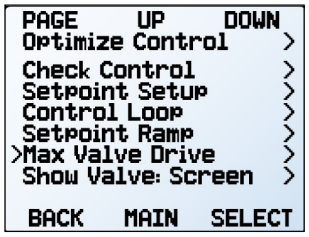
If the first temperature is greater than the second temperature, or if the maximum drive is set to 100%, the valve drive is unlimited. Both points are set automatically when using the **VLVT** command or the **Set by Voltage** menu. Always verify that the supply pressure is sufficient to reach the target flow rates below this limit.

The instrument is designed so that it will not trigger these limits in normal operation, because the power consumed at 100% valve drive is less than the hardware limit across most of the temperature range. Overlaying the power vs temperature graph (page **38**) and the maximum valve drive graph shows how adjusting the valve drive thermal limit can avoid tripping the power limit.



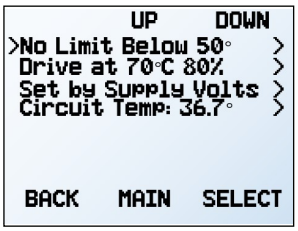
Display Menus

A menu has been added to the instrument to adjust the valve drive thermal limit using the front panel and display. This menu is accessed by navigating through **MAIN > CONTROL > Max Valve Drive**.



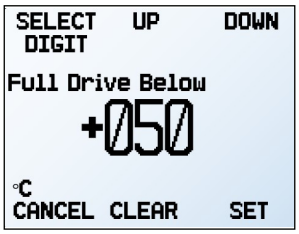
Max Valve Drive

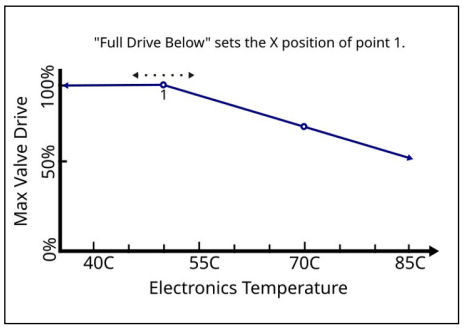
The **Max Valve Drive** menu provides a summary of the valve drive limiting configuration. Each of the four items is described in more detail below. Note that all temperatures are in °C; this is not configurable.



No Limit Below

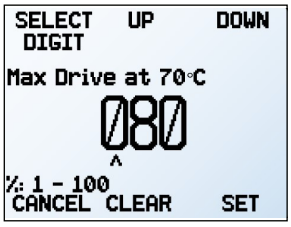
Valve drive is not limited below this temperature.

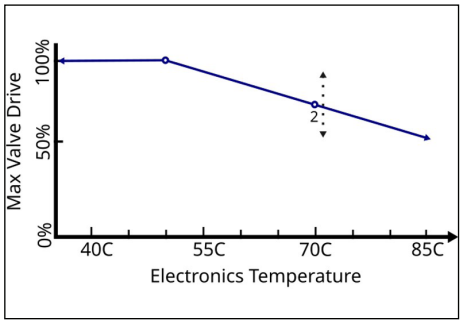




Drive at <max temp>

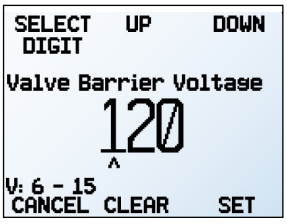
This sets the maximum valve drive at 70°C, adjusting the slope of the limiting curve.





Set by Supply Volts

This setting calculates an optimum “full drive below” and “Max drive at” setting based on your barrier’s output voltage. This should be set using the output voltage under load for the best results.



Circuit Temp

This is the temperature measured by a sensor on the device’s circuit board. All valve drive % limits are calculated using this value. This value will be higher than your device’s ambient temperature due to self-heating of the electronics.

Valve Management

Valve Drive Thermal Limit (VLT)

Added in 10v19.0. Only available on IS boards.

InstrumentID **VLT** *[driveAtMaxTemp [limitTemp]*]

Query or set the thermal limit for the IS valve drive circuit. If no parameters are given, this is a query for the currently configured parameters.

Parameters

driveAtMaxTemp: The maximum drive, in percent of full drive (1–100%), that the IS valve drive circuit is allowed to use at the maximum specified temperature.

limitTemperature: The temperature, -999–999 °C, below which the IS valve drive circuit is allowed to use the full configured drive level. If no temperature is given but a maximum drive is specified, -999 °C will be used to achieve the most consistent power level possible across all temperatures.

Response

The current temperature and the valve limiting configuration is returned:

deviceID currentTemp limitTemp driveAtMaxTemp maximumTemp

deviceID: The id of the instrument.

currentTemp: The current temperature, a floating-point value in °C, used to determine the limit on the IS valve drive.

limitTemp: The temperature below which the full IS valve drive can be used, a floating-point value in °C.

driveAtMaxTemp: The maximum drive, in percent of full drive (1–100%), that the IS valve drive circuit is allowed to use at the maximum specified temperature.

maximumTemp: The maximum specified temperature for this instrument, a floating-point value in °C.

Set Valve Drive Thermal Limit by Voltage (VLTV)

Added in 10v19.0. Only available on IS boards.

device ID **VLTV** *[valveBarrierVolts]*

Query or set the thermal limit for the IS valve drive circuit; the configuration is set by using Alicat recommendations for a voltage supplied by the valve barrier. If no parameters are given, this is a query for the currently configured parameters.

Parameters

valveBarrierVolts: The voltage of the barrier supplying power to the valve, a floating-point value in volts (6 – 15). Using the voltage of the barrier when under the maximum load of the valve circuitry will give higher performance than using the voltage under a no load or lightly loaded condition.

Response

The current temperature and the valve limiting configuration is returned:

instrumentID currentTemp limitTemp driveAtMaxTemp maximumTemp

instrumentID: The id of the instrument.

currentTemp: The current temperature, a floating-point value in °C, used to determine the limit on the IS valve drive.

limitTemp: The temperature below which the full IS valve drive can be used, a floating-point value in °C.

driveAtMaxTemp: The maximum drive, in percent of full drive (1–100%), that the IS valve drive circuit is allowed to use at the maximum specified temperature.

maximumTemp: The maximum specified temperature for this instrument, a floating-point value in °C.

Hardware

Maximum Temperature for Unlimited Valve Drive

Added in 10v19.0. Only available on IS boards.

Command ID: 76

Query or set the temperature below which the valve drive is not limited by power constraints. This value, when combined with the Maximum Valve Drive at Maximum Instrument Temperature, define the thermal valve drive limits.

Argument

maxTemperature: An unsigned integer. If at least 2000, this is a query for the current temperature limit. If less than 2000, this is the desired temperature limit in °C + 1000. For example, 1000 counts = no valve limit when the temperature is below 0 °C. Similarly, specifying 1025 counts will begin to limit the valve at temperatures above 25 °C.

Completion Status

SUCCESS: The current temperature limit is available in the return value.

UNSUPPORTED: Instrument is not an IS product.

Return Value

The current temperature used to limit the IS valve drive offset by 1000, an unsigned integer in °C. 1000 counts = 0 °C valve drive limit, 1025 counts = 25 °C valve drive limit.

Maximum Valve Drive at Maximum Instrument Temperature

Added in 10v19.0. Only available on IS boards.

Command ID: 77

Query or set the maximum valve drive that can be used at the maximum specification temperature of the instrument. This value, when combined with the Maximum Temperature for Unlimited Valve Drive, define the thermal valve drive limits.

Argument

maxDrive: An unsigned integer. If 0, this is a query for the current maximum valve drive. Otherwise, this is the maximum valve drive allowed at the maximum specified temperature for the instrument, in percent.

Completion Status

SUCCESS: The current maximum valve drive is available in the return value.

INVALID_ARGUMENT: The argument is less than 0 or greater than 100.

UNSUPPORTED: Instrument is not an IS product.

Return Value

The maximum valve drive available at the instrument's maximum specified temperature, an integer percentage from 1 – 100.

Limit Maximum Valve Drive by Barrier Voltage

Added in 10v19.0. Only available on IS boards.

Command ID: 78

Limit the valve drive that can be used, from the voltage of the valve barrier. Query Maximum Valve Drive at Maximum Instrument Temperature and Maximum Temperature for Unlimited Valve Drive to see the resulting limits.

Argument

barrierVoltage: The voltage of the barrier supplying power to the valve, am integer in 0.1 volts. The minimum is 6 volts (60 counts), the maximum is 15 volts (150 counts). Using the voltage of the barrier when under the maximum load of the valve circuitry will give higher performance than using the voltage under a no load or lightly loaded condition.

Completion Status

SUCCESS: The valve drive limit has been set.

INVALID_ARGUMENT: The argument is less than 60 or greater than 150.

UNSUPPORTED: Instrument is not an IS product.

Current Valve Drive Limit Temperature

Added in 10v19.0. Only available on IS boards.

Command ID: 79

Query the current temperature used by the thermal valve drive limit algorithm.

Argument

unused: This should always be 0.

Completion Status

SUCCESS: The current temperature is available in the return value.

INVALID_ARGUMENT: The argument was not 0.

UNSUPPORTED: Instrument is not an IS product.

Return Value

The current temperature used to limit the IS valve drive, an integer in degrees °C.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