



A Halma company



# OPERATING MANUAL

## FOR MASS FLOW INSTRUMENTS

BASIS 2 METERS AND CONTROLLERS

## Thank you for purchasing your mass flow 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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**BASIS 2 GAS MASS  
FLOW INSTRUMENTS**



## Calibration

BASIS 2 instruments are factory calibrated. When operated per instructions, regular maintenance is not required. Periodic inspection and recalibration can ensure ongoing performance and accuracy. Fill out the Service Request Form at [alicat.com/service](http://alicat.com/service) or contact us directly to send in your instrument for recalibration.

For information about our limited lifetime warranty, visit [alicat.com/warranty](http://alicat.com/warranty).

Serial #:

Next Calibration:



This instrument comes with a NIST-traceable calibration certificate.



This instrument conforms to the European Union's Restriction of Use of Hazardous Substances in Electrical and Electronic Equipment (RoHS) Directive 2011/65/EU.



This instrument complies with the requirements of the Low Voltage Directive 2014/35/EU and the EMC Directive 2014/30/EU and carries the CE Marking accordingly.



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



# Introduction

Your new BASIS 2 B- or BC-Series instrument is a highly accurate mass flow device that you can control through several digital communication methods or through analog signals. Log data to your PC with a serial data connection to control the instrument and to store flow data.

This manual covers the following instruments:

- **BC-Series:** gas mass flow controllers
- **B-Series:** gas mass flow meters

For support or questions regarding the use or operation of this instrument, please contact us using the information on [page 2](#).

Alicat offers many combinations of instrument sizes, accessories, connections, and configurations. These custom solutions can meet a variety of application challenges brought forth by users pushing the boundaries of our standard offerings. If you have an idea for a new process or a challenging application, contact Alicat for specialized engineering and application support.

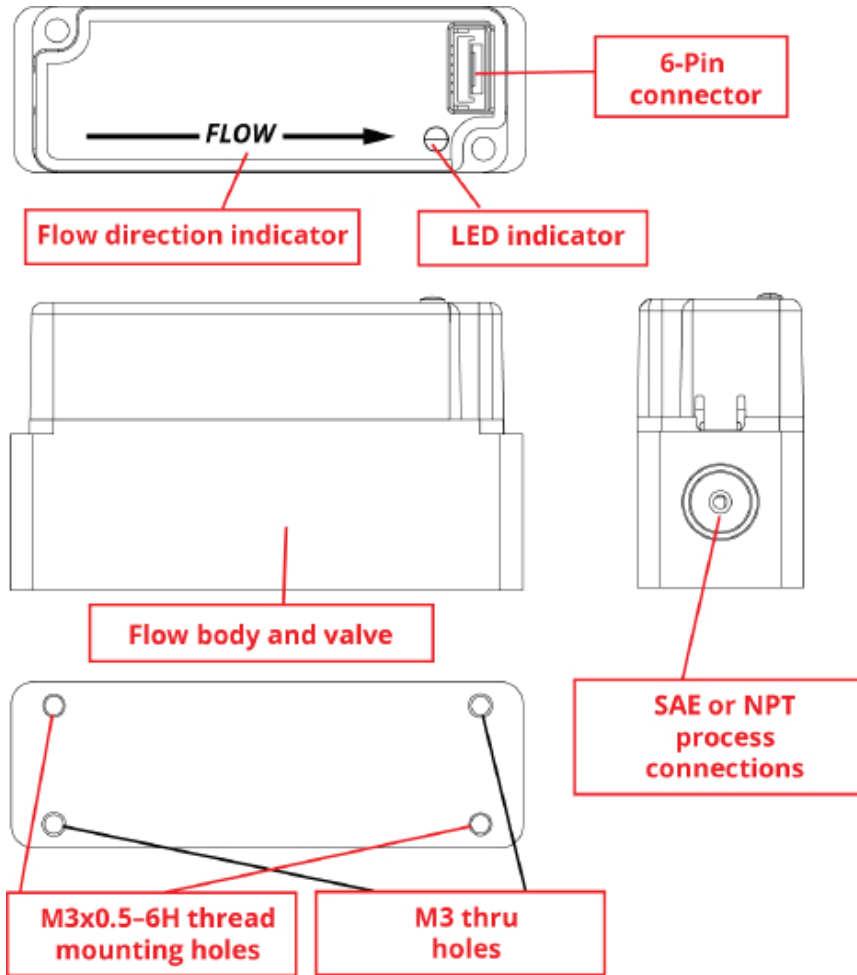
This manual covers the general operation of factory OEM instruments. Some custom setups may not be covered by this document. If you need further assistance, please contact Alicat support.

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# Getting Started

The major instrument components are shown in the diagram below.



Most communication with the instrument is completed through digital communication or analog signals, as described later in this manual. The LED on the top of the instrument provides the following feedback:

- **Solid Green:** Power is applied, no errors
- **Flashing Green:** Power is applied, serial activity is occurring
- **Fast Red Blink:** Mass overrange, temperature overrange, totalizer overrange, etc.
- **Slow Red Blink:** Valve override in effect

## Mounting

Mount the instrument so that flow passes through the flow body in the direction shown by the flow arrow. The flow body must be mounted horizontally, with the flow arrow parallel to the ground.

Use the (2) M3 threaded mounting holes on the bottom to mount the instrument to flat panels (see figure above). For dimensions see the BASIS 2 specification sheet at [alicat.com/specs](http://alicat.com/specs).

## Filters

When pressure drop is not a concern, use in-line sintered filters to prevent large particulates from entering the flow body of the controller. Suggested maximum particulate size is **50 microns** for all flow ranges.

## Gas Connections

BASIS 2 series instruments do not require straight runs of pipe upstream or downstream.

Instruments are shipped with plastic plugs seated in the processing ports. To decrease the chance of contaminating the flow stream, do not remove these plugs until you are ready to install the instrument.

After removing the plugs, immediately connect the instrument to upstream and downstream plumbing, leak-tight. Verify that the flow matches the direction indicated on the instrument body. Standard gas flow instruments have female inlet and outlet ports.

Connection options include:

Model	NPT	SAE
100 SCCM-2 SLPM	1/8"	SAE4
5 SLPM-20 SLPM	3/8"	SAE6

If you are using a fitting that does not have a face seal, use thread-sealing Teflon tape to prevent leakage around the port threads, but **do not wrap** the first two threads entering the instrument. This will minimize the possibility of tape entering the flow stream and clogging the flow path.

Face seal fittings can be installed without Teflon tape applied to the threads.



**Caution:** Pipe dopes or sealants are not recommended on the process connections. These compounds can cause permanent damage to the instrument should they get into the flow stream.

## Maximum Pressure

The maximum common mode pressure for BASIS 2 instruments is **145 PSIG**.



**Warning:** Using the flow instrument above the maximum specified pressure may permanently damage the device. If the line pressure is above these limits, use a pressure regulator upstream of the instrument to reduce the pressure.

## Power and Signal Connections

Power is supplied to the instrument through the 6-pin JST-GH connector on the top of the instrument. The table below indicates how to connect the instrument to power and communication.

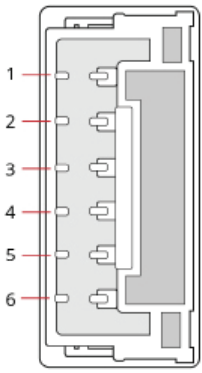
The instrument power requirement for BASIS 2 controllers is 12-24 VDC, 210 mA. The power requirement for BASIS 2 meters is 12-24 VDC, 12 mA.



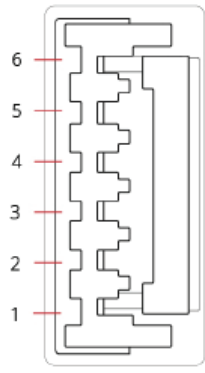
**Warning:** Only connect power to pin 4. Do not enable power to the instrument until all necessary pins have been properly connected.



*A mass flow instrument with female NPT connections.*



**Instrument**



**Cable**

Pin	Function
1	Analog Setpoint Input
2	Analog Signal Output
3	Ground
4	Power In, 12-24V
5	Serial RS-232 (Rx) or RS-485 B (+)
6	Serial RS-232 (Tx) or RS-485 A (-)

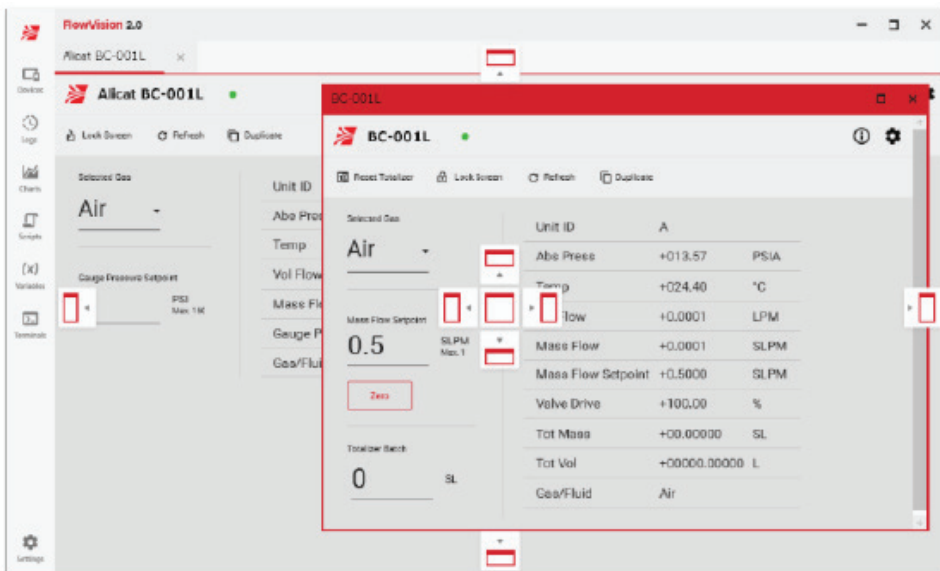
# Control

BASIS 2 Series controllers and meters can be operated using digital or analog communication. Digital communication can be performed using Alicat FlowVision™ 2.0 software, ASCII serial commands, MODBUS-RTU, or analog signals.

- FlowVision 2.0: [page 8](#)
- ASCII Serial Communication: [page 10](#)
- MODBUS-RTU: [page 18](#)
- Analog Signals: [page 28](#)

## FlowVision 2.0

FlowVision 2.0 is Windows-based software that enables easy collection and analysis of data from Alicat controllers and meters. FlowVision controls the instrument, runs scripts, and logs and charts data. It also provides easy access to the gas calibration selector and PID loop tuning to increase response speed and stability for some applications.



## Establishing Communication

To connect your instrument to FlowVision 2.0:

1. Download FlowVision 2.0 from [alicat.com/flowvision](http://alicat.com/flowvision) and install.
2. With the instrument turned on and connected to the computer, start FlowVision 2.0.
3. Click **Devices** in the top left corner.
4. Click the **green plus sign** to add your instrument.
5. Select **Wired** for the connection type.
6. Specify the connection settings. By default, the **Device ID** is A, and the **Baud Rate** is 38400. The **Port** is dependent on which COM port the instrument is connected to.
7. Specify a **Name** if desired. FlowVision 2.0 generates a name if the field is blank.
8. Click **Add** to complete the process.

Please see the FlowVision 2.0 manual at [alicat.com/flowvision](http://alicat.com/flowvision) for detailed instructions on operating your instrument through FlowVision.



Note that the following three controls differ from the FlowVision manual for BASIS 2:

1. Valve drive. The "Valve" button has the following options:
  - a. Open/exhaust
  - b. Close
  - c. Direct drive (sets the "Setpoint" entry field to use a percentage instead of a unit of measure)
  - d. Resume (clears the direct drive and returns to closed-loop control).
2. The totalizer limit mode, shown in **Instrument Settings > Totalizer**, is unique to BASIS 2 [page 15](#).
3. Setpoint ramping. The button near the "Setpoint" box will read Ramp: (disabled) or (%/msec). Clicking the button will open **Instrument Settings > Control**, where a new ramp rate can be set or cleared [page 12](#).

# Alicat ASCII Serial Communication

Alicat ASCII Serial Terminal is a pre-configured program for serial communications via the instrument's 6-pin connector. Download Serial Terminal for free at [alicat.com/drivers](http://alicat.com/drivers).

Serial commands are not case-sensitive. In the descriptions below, however, the commands are shown in uppercase while command variables are shown in lowercase to help differentiate them.

All commands must be prefixed with the `unit_id`, the unique identifier for the instrument. Instruments will also accept commands beginning with `*`, which is used as a broadcast value. The `unit_id` must be the first character after a carriage return (`↵`).

Unless otherwise noted, there must be a space between the command and any arguments.

All commands must end with a carriage return (`↵`), decimal value 13, hex value 0x0D).

After a carriage return is received, the instrument does not start acting upon or responding to a command until the serial idle timeout is reached (the time needed to transmit 3.5 bytes).

All responses are a single line terminated with a carriage return. If a new command is started before the carriage return of the response of the previously issued command has been received, the behavior of the instrument is undefined.

## Establishing Communication

Connect the instrument to a computer through a COM port or virtual COM port, noting the COM port number. Up to 26 instruments can be connected to a single COM port.

The following are the default connection settings:

- **Baud:** 38400 (see [page 17](#))
- **Data bits:** 8
- **Parity:** none
- **Stop bits:** 1
- **Unit ID:** A (see [page 16](#))

## Data Frame Format

Data can be read from the instrument as the complete data frame, or you can choose specific data to report. The complete data frame is:

```
A      +24.57 +100.0 +0021513.0 +100.0   +55.13      N2  [TOV][MOV][OVR][HLD][VTM]
unit_id temp.  flow   total    setpoint valve_drive gas Error Conditions
```

where:

<code>unit_id</code> :	The text ID of the instrument.
<code>temperature</code> :	The current temperature of the instrument, in °C.
<code>flow</code> :	The current flow reading of the instrument, in the configured units.
<code>Total</code> :	The total volume (read from the totalizer)
<code>setpoint</code> :	The current setpoint value, in the same units as flow.
<code>valve_drive</code> :	The valve drive will be reported in percent of full drive.
<code>gas</code> :	The currently selected gas.

If present, the following error condition abbreviations indicate:

<code>TOV</code>	Temperature overrange.
<code>MOV</code>	Mass flow overrange.
<code>OVR</code>	Totalizer overrange.
<code>HLD</code>	Valve hold is in use (see <a href="#">page 13</a> ).
<code>VTM</code>	Valve thermal management is active (see note below).



**Note:** Valve thermal management activates if a setpoint is given for a certain amount of time with no flow detected. To prevent the valve from getting excessively hot when driven fully, thermal management is activated, which pulses the valve open/closed until a change in flow is detected. Once the change is detected, the valve returns to normal control mode.

Single spaces separate each parameter, and each value is displayed in the chosen instrument engineering units.

## Query Full Data Frame

To read (poll) the entire data frame: `unit_id←`

The returned data will be in the format described just above.

## Query Specific Data

To read (poll) particular data: `unit_idDV specific_data←`

`specific_data` is the data to be returned, per the table below.

Value	Requested Value
+1	Current flow
+2	Current setpoint
+4	Current temperature
+8	Current valve drive
+16	Gas
+32	Total volume
+64	Current batch remaining
+128	Instrument Status

Add the table values to request multiple data, which will be returned in the order they appear in this table. The total value must be an integer from 1 to 255:

Example: `unit_idDV 12←` (returns the current temperature followed by valve drive)

## Setpoint

The setpoint (controllers only) is the flow rate that the controller attempts to achieve and maintain by proportionally changing the position of the valve.

To read the setpoint: `unit_idS←`

To set the setpoint: `unit_idS setpoint←`

`setpoint` is the desired flow rate. It is a floating-point value from 0 to the full scale of the instrument, in the selected flow units for the device. The instrument will accept up to 2.5% overrange.

Example: `aS 15.44←` (set a setpoint of +15.44 [flow units] for instrument A)

## Setpoint Source

The setpoint source is the input which will control the setpoint (controllers only).

To read the setpoint source: `unit_idLSS←`

To set the setpoint source: `unit_idLSS setpoint_source←`

`setpoint_source` determines which source will control the setpoint, per the table below:

Value	Notes
<b>a</b>	The analog input is used as the setpoint source. Digital setpoint commands are not accepted.
<b>s</b>	Saved digital. Digital setpoint commands are accepted; the most recent command will be used when the instrument is powered up. The analog input is disconnected from the setpoint.  CAUTION: If the setpoint is consistently changed more often than every few minutes, the nonvolatile memory may be damaged and may no longer correctly store the setpoint.
<b>u</b>	Unsaved digital. Setpoint changes from the digital setpoint commands are accepted but will not affect the setpoint used by the instrument on the next power up. The analog input is disconnected from the setpoint.  This setting is recommended when the setpoint will often be changed more often than every few minutes.

Example: `aLSS a↵` (the analog input will be the source for the setpoint for instrument A)

## Maximum Setpoint Ramp Rate

This value determines the maximum rate at which the setpoint can change (controllers only). It applies to both increasing and decreasing setpoints, whether the setpoint was given digitally or via the analog input.

To read the current setpoint ramp rate: `unit_idSR↵`

To set a new setpoint ramp rate: `unit_idSR max_ramp_rate time_units↵`

`max_ramp_rate` is the new maximum setpoint ramp rate. The value is a non-negative floating-point value in the default units of the loop control variable (see [page 13](#)). The instrument will use the closest available ramp rate.

`time_units` are the units for the ramp rate, per the table below:

Unit Label	Values	Notes
<b>ms</b>	3	millisecond
<b>s</b>	4	second
<b>m</b>	5	minute

Example: `aSR 600 3↵` (set the maximum ramp rate to 600 [flow units] /ms for instrument A)

To disable any limiting of the setpoint ramp rate: `unit_idSR 0↵`

## Communication Watchdog

A communication watchdog (controllers only) will force a zero setpoint and close the controller valve if no serial communication is received within a user-defined time period.



**Note:** The Communication Watchdog is only available when the setpoint is being set via MODBUS communication and the Setpoint Source is set to "unsaved digital" (see [page 11](#)). All other setpoint sources (ASCII, saved digital, analog) are not impacted by the Communication Watchdog.

To read the current watchdog: `unit_idWD↵`

Example: `aWD↵` (read watchdog time on instrument A)

To set a new watchdog: `unit_idWD watchdog_time↵`

`watchdog_time` is the desired watchdog duration, from 0–5000 milliseconds.

Example: `aWD 10` (create a watchdog with 10 ms timeout for instrument A)

**To disable the watchdog:** `unit_idWD 0`

## Hold Valve Position / Resume Flow

The controller valve can be held at any percentage of full drive (controllers only).

**To hold the valve at a particular drive percentage:** `unit_idHPUR valve_drive`

`valve_drive` is the percentage of full drive, a floating-point value from 0–100 percent.

Example: `aHPUR 10` (holds the valve for instrument A at 10% of full drive)

**To resume closed loop control:** `unit_idC`

The valve will be returned to normal closed loop flow control.

## Loop Control Gains

The loop control variables determine how the instrument will maintain the flow rate (controllers only).

**To read the closed loop control gains:** `unit_idLCG`

**To set the closed loop control gains:** `unit_idLCG pgain igain`

`pgain` is the value to use for the proportional closed loop gain. It is an integer from 0–65535. The larger the `pgain`, the faster the controller will predict necessary future corrections based on the current rate of change in the system. A larger `p gain` may result in overshoot and oscillations.

`igain` is the value to use for the integral closed loop gain. It is an integer from 0–65535. The larger the `igain`, the more aggressively the controller will correct errors between the commanded setpoint and the measured process value.

Example: `aLCG 500 5000` (sets `pgain` to 500 and `igain` to 5000 for instrument A)

## Reference Temperature

The reference temperature is used to calculate standard or normal mass flow.

**To read the temperature reference:** `unit_idRT`

**To set the temperature reference:** `unit_idRT ref_temperature`

`ref_temperature` is the reference temperature. It is a floating-point number in °C.

Example: `aRT 22` (sets the temperature reference to 22°C for Instrument A)

## Readings Averaging

Averaging smooths the reading response for a rapidly changing flow

**To read the averaging time constant for flow readings:** `unit_idDCA`

**To set the averaging time constant for flow readings:** `unit_idDCA average_tc`

`average_tc` is the averaging time constant, the time required for the reported value to reach 63.2% of the final value when there is a step change in the reading. The value is an integer from 0–2500 milliseconds.

Example: `aDCA 400` (sets the time constant to 400 ms for instrument A)

## Configure Measurement Triggering

Measurements can be triggered based on one or more events (controllers only).

**To read the current triggering mode:** `unit_idMT`

**To set the current triggering mode:** `unit_idMT mode`

`mode` determines how a measurement will be triggered, per the table below:

Mode	Description
+1	Begin a new measurement when the digital setpoint is changed.
+2	Begin a new measurement when the valve is being held and the hold percentage is changed.
+4	Begin a new measurement when the average flow of the last measurement is read.

The table values may be added together to trigger measurements based on multiple methods (the value must be an integer between 0 and 7).

Example: `aMT 3←` (triggers a measurement for instrument A when either the digital setpoint is changed or the hold percentage is changed)

## Start a Measurement

To start a new measurement: `unit_idDVAS time←`

`time` is the duration to collect data in the measurement, in milliseconds. The measurement will end when the time has elapsed.

Example: `aDVAS 4000←` (starts a measurement with 4000ms collection time)

## Measurement Averages and Ranges

The average values or the range of values can be reported over the measurement time period, for the current or most recent measurement

To return the average flow and temperature: `unit_idDVAA←`

The data returned will be:

```
unit_id  time  avg_temp  avg_flow
```

where:

`unit_id`: The text ID of the instrument.  
`time`: The elapsed time that data has been acquired, in milliseconds..  
`avg_temp`: The average temperature during the measurement, in °C.  
`avg_flow`: The average flow during the measurement.

To return the range of temperature and flow values: `unit_idDVAR←`

The data returned will be:

```
unit_id  time  min_temp  max_temp  min_flow  max_flow
```

where:

`unit_id`: The text id of the instrument.  
`time`: The elapse time data has been taken for this measurement, in milliseconds.  
`min_temp`: The minimum temperature during the measurement, in °C.  
`max_temp`: The maximum temperature during the measurement, in °C.  
`min_flow`: The minimum flow during the measurement, in instrument flow units.  
`max_flow`: The maximum flow during the measurement, in instrument flow units.

## Taring the Instrument

Taring adjusts the flow sensor offset so that the current flow value reads zero. This action gives the instrument a zero reference, ensuring that the instrument provides its most accurate flow measurements. It is recommended to tare the instrument:

- After installation
- If the instrument is hit with any significant impact
- After any significant changes to the temperature or pressure.

**To tare the instrument:** `unit_idV duration←`

`duration` is the time in milliseconds, to collect values for calculating the tare offset. The value is a positive integer from 1–32767.

Example: `aV 1000←`(tares instrument A, with the offset calculated over 1 second)

## Autotare

If autotare is enabled (controllers only), the instrument will automatically zero its measurement after being at a 0 setpoint for 2 seconds.

**To read the current autotare configuration:** `unit_idZCA←`

**To enable autotare:** `unit_idZCA 1←`

**To disable autotare:** `unit_idZCA 0←`

## Active Gas

BASIS 2 instruments are calibrated to measure any of 9 gases:

#	Short Name	Long Name
0	Air	Air (Clean Dry)
1	Ar	Argon
2	CO <sub>2</sub>	Carbon Dioxide
3	N <sub>2</sub>	Nitrogen
4	O <sub>2</sub>	Oxygen
5	N <sub>2</sub> O	Nitrous Oxide
6	H <sub>2</sub>	Hydrogen
7	He	Helium
8	CH <sub>4</sub>	Methane

**To read the active gas:** `unit_idGS←`

**To set the active gas:** `unit_idGS gas_number←`

`gas_number` is an integer from the table above.

Example: `aGS 8←` (flow methane on instrument A)

When reading or setting the active gas, the data reported will be:

`unit_id gas_number gas_name`

## Totalizer Reset

The instrument totalizer can measure the total flow that has passed through the instrument since it was powered on or since it was last reset. The totalizer value is returned as part of the data frame (see [page 10](#)). Totalizer counts are reset if power to the instrument is lost.

**To reset the total volume:** `unit_idT←`

## Totalizer Batch

Batch dispensing flows a set volume of gas, after which the valve will close and the flow will stop (controllers only).

**To read the remaining batch volume:** `unit_idDV 64←` (see [page 11](#)).

**To set the totalizer batch:** `unit_idTB batch_volume←`

`batch_volume` is a floating-point value, in instrument volume units.

**To disable the batch function:** `unit_idTB 0←`

Example: `aTB 200↵` (set the batch volume to 200 [volume units] for instrument A)

## Totalizer Configuration

To read the current totalizer configuration: `unit_idTC↵`

To set the current totalizer configuration: `unit_idTC limit_mode↵`

`limit_mode` is the action when the totalizer reaches the maximum allowed value:

Value	Description
0	Keep totalizer value at the maximum value and do not indicate an OVR error.
1	Reset totalizer value to zero and do not indicate an OVR error.
2	Keep totalizer value at the maximum value and indicate an OVR error.
3	Reset totalizer value to zero and indicate an OVR error.

Example: `aTC 1↵` (when the totalizer for instrument A reaches max, reset the total volume to zero and do not indicate an OVR error)

## Full Scale Flow

To read a full scale value: `unit_idFPF value↵`

`value` is the instrument measurement to read full scale:

Value	Requested Value
0	Full scale flow
1	Largest total volume/totalizer batch
2	Maximum temperature

Example: `aFPF 2↵` (returns the max temperature for Instrument A)

The data returned will be:

```
unit_id value units
```

where `units` is a text string indicating the units for the full scale measurement.

## Unit ID

Each instrument has a unique, single-letter ID using the standard 26-letter English alphabet (e.g., A, B, C, etc.). The default ID is "A". If more than one instrument on a COM port has the same ID, data and commands become corrupted and do not report or execute properly. When connecting multiple instruments on the same COM port, connect one instrument at a time. Provide a unit ID command for each instrument before connecting the next instrument.

To give the most recently connected instrument an unused ID:

To change the unit id: `unit_id@ new_id↵`

## Serial Number

Each instrument has a unique serial number.

To read the serial number: `unit_idSN↵`

## Version Number

Each firmware release has a unique number.

To read the firmware version number: `unit_idVE↵`

## MODBUS Address

The MODBUS address is the ID to which the instrument will respond when using MODBUS communications (see [page 18](#)).



To read the MODBUS address: `unit_idMA↵`

To set the MODBUS address: `unit_idMA address↵`

`address` is the new MODBUS address, an integer from 1–247.

## Serial Baud Rate

To read the current baud rate: `unit_idNCB↵`

To set the baud rate: `unit_idNCB baud_rate↵`

`baud_rate` is the communication rate, per the table below:

Value	Corresponding Baud Rate
0	4800
1	9600
2	19200
3	38400 (default)
4	57600
5	115200

Example: `aNCB 2↵` (changes baud rate on Instrument A to 19200)



**Note:** When changing the instrument's baud rate, the baud rate for the COM port must change in time to successfully receive the response confirming the new baud rate. If it does not, then the baud rate will change on the instrument, but the response from the serial terminal will not be understood. Since the serial terminal is set to communicate at a specific baud rate during the initial configuration, you will have to redefine the terminal baud rate to continue communications.

## Command Protocol

The instrument can be switched from BASIS Protocol 2 (described in this manual) to Protocol 1 (described in the BASIS 1 manual).

To read the current command protocol: `unit_idP↵`

To switch from Protocol 2 to 1: `unit_idP 1↵`

To switch from Protocol 1 to 2: `unit_idP2↵`



**Note:** There is a space between the command and argument when switching from protocol 2 to 1 but NOT when switching from protocol 1 to 2.

Example: `aP2↵` (switch Instrument A to be controlled through BASIS 2 protocol)

BASIS 1 ASCII commands can be found in the BASIS 1 user manual, available at [alicat.com/manuals](http://alicat.com/manuals).



**Caution:** The BASIS 1 protocol only works with flow units of SCCM, SLPM, NCCM, and NLPM. An error will be returned if you attempt to switch to BASIS 1 protocol for an instrument with different flow units.

## Load Factory Default as Current Configuration

When you reset the instrument, data from the factory area of memory is copied into the user settings area. The instrument will be completely configured to the factory-set values. Power cycling the instrument is recommended to ensure that all values are properly used.

To reset the instrument to factory defaults: `unit_idFACTORY RESTORE↵`

This command must be entered in ALL CAPITAL LETTERS and with exactly one space between the words of the command.

# MODBUS-RTU

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 Pin 6 of the 6-pin connector.

MODBUS-RTU can be used to control:

- taring
- data collection
- setpoint control
- totalizer
- batch dispensing
- changing the gas
- control loop adjustment.



**Note:** For more information on MODBUS-RTU communication commands, please see the MODBUS FAQ at [alicat.com/using-your-alicat/faq-modbus/](http://alicat.com/using-your-alicat/faq-modbus/) and the MODBUS-RTU manual at [alicat.com/manuals](http://alicat.com/manuals).

## Communicating Via MODBUS-RTU

The following MODBUS commands are supported:

- 3** Read holding register
- 6** Write single register
- 16** Write multiple registers

Use the instrument registers to interact with the instrument.

Note that the response to function code 6 (Write Single Register) will echo the value provided by the master in the write and not the value of the register after the write. For example, if the setpoint register were written to a value that is not valid for the instrument, it will be adjusted inside the register; however, the value returned will be the original setpoint value. If the real value is desired, a read of the register must be issued. This is consistent with the MODBUS specification and demanded by some MODBUS implementations.

Reading undefined registers may return 0 or a Bad Address error.

## MODBUS Address

Each instrument must have a unique address, which will be an integer from 1 to 247.

**To find the MODBUS address:** read register 45.

**To assign a MODBUS address:** write an integer from 1 to 247 to register 45.

## Changing the Baud Rate

BASIS 2 units can communicate at the baud rates shown in the table below.

Value	Corresponding Baud Rate
0	4800
1	9600
2	19200
3	38400 (default)
4	57600
5	115200

**To read the current baud rate:** read register 21.

**To change the baud rate:** write a value from the table above to register 21.



**Note:** *When changing the instrument's baud rate, the baud rate for the COM port must change in time to successfully receive the response confirming the new baud rate. If it does not, then the baud rate will change on the instrument, but the response from the serial terminal will not be understood. Since the serial terminal is set to communicate at a specific baud rate during the initial configuration, you will have to redefine the terminal baud rate to continue communications.*

## Setpoint Type

The setpoint type is the signal which will be used to define the setpoint (controllers only).

**To read the setpoint type:** read register 516. The values are detailed below.

**To change the setpoint type:** write one of the following values to register 516 to set the setpoint source:

0: Analog input.

1: Digital. The setpoint is saved in flash memory as a power up setpoint.

2: Digital. The setpoint is not saved in flash memory.

## Changing the Setpoint

The setpoint is the flow rate that a controller attempts to achieve and maintain by proportionally changing the position of the valve (controllers only).

**To read the current setpoint:** read register 2106. This is the current setpoint. It may differ from the commanded setpoint due to limited resolution on configured maximum ramping, indicated by register 524.

**To set the desired setpoint:** write the setpoint, as a signed 2-byte integer, to register 33524. The setpoint is equal to the value after formatting with the factory-set number of decimal places.

Example: if flow units are SCCM, to obtain a setpoint of 10 SCCM, write 10 to register 33524.

## Communication Watchdog

A communication watchdog (controllers only) will force a zero setpoint and close the controller valve if no serial communication is received within a user-defined time period. The time is set in milliseconds, and valid values are 0–5000. If zero, the watchdog is disabled.



**Note:** *The Communication Watchdog is only available when the setpoint is being set via MODBUS communication and the Setpoint Source is set to "unsaved digital" (see [page 11](#)). All other setpoint sources (ASCII, saved digital, analog) are not impacted by the Communication Watchdog.*

**To read the current watchdog:** read register 514.

**To set a new watchdog:** write a value from 0–5000 to register 514.

## Taring the Instrument

Taring adjusts the flow sensor offset so that the current flow value reads zero. This action gives the instrument a zero reference, ensuring that the instrument provides its most accurate flow measurements. It is recommended to tare the instrument:

- After installation
- If the instrument is hit with any significant impact
- After any significant changes to the temperature or pressure.

**To tare the instrument:** write 0xAA55 (43605) to register 39. Note that performing a tare will interrupt any currently-executing measurement.

**To enable autotare** (controllers only): write 1 to register 515. The instrument will tare flow

automatically when the setpoint had been set to 0 for at least two seconds.

**To disable autotare** (controllers only): write 0 to register 515.

## Flow Averaging

Flow averaging governs how the flow sensor reports data, an integer 0–2500 ms. A higher flow averaging setting will smooth the data, which can be useful for rapidly fluctuating flow readings.

The time constant is approximately [value] milliseconds.

**To read the current averaging:** read register 55.

**To change the averaging value:** write an integer from 0–2500 to register 55.

## Totalizer

The totalizer measures the total flow that has passed through the instrument since it was powered on or since it was last reset. Totalizer counts are reset if power is lost.

**To read the totalizer:** read registers 2104–2105. The value will be in the volume units of the instrument, scaled by the factory-set number of decimal places.

**To reset the totalizer:** write 0xAA55 (43605) to register 53.

## Batch Dispensing

Batch dispensing (controllers only) flows a set volume of gas, after which the valve closes and flow stops. You can repeat batches.

**To read the volume remaining for the current batch:** read registers 2108–2109. The value will be an integer in the current totalizer volume units, with the same scaling as the total volume (registers 2104–2105).

**To set the desired volume for the totalizer batch:** write the value to registers 521–522. The value must be an integer in the instrument's current total volume units and scale.

**To reset the batch:** write 0xAA55 (43605) to register 53.

## Changing the Gas

BASIS 2 instruments are calibrated to measure any of 9 gases:

Gas Number	Short Name	Long Name
0	Air	Air (Clean Dry)
1	Ar	Argon
2	CO <sub>2</sub>	Carbon Dioxide
3	N <sub>2</sub>	Nitrogen
4	O <sub>2</sub>	Oxygen
5	N <sub>2</sub> O	Nitrous Oxide
6	H <sub>2</sub>	Hydrogen
7	He	Helium
8	CH <sub>4</sub>	Methane

**To select a gas:** write one of the gas numbers above, as an integer, to register 2100.

## Switch Command Protocol

The unit can be switched from BASIS Protocol 2 (described in this manual) to Protocol 1 (described in the BASIS 1 manual).

**To read the command protocol:** read register 56.

0 indicates that the instrument is in BASIS 2 Protocol mode.

1 indicates that the instrument is in BASIS 1 Protocol mode.

**To set the command protocol:** write 0 or 1 to register 56.



**Caution:** The BASIS 1 protocol only works with flow units of SCCM, SLPM, NCCM, and NLPM. An error will be returned if you attempt to switch to BASIS 1 protocol for an instrument with different flow units "Changing the Setpoint" on page 28.

## User Registers

User registers can be read and written by the end user, in contrast to factory registers, which are intended only for factory use.

## Instantaneous Data Registers

These registers provide the most current measurements made by the instrument.

Data Address	R/W	Notes
2100	R/W	The selected gas, an integer representing its gas number. If a gas number is written for a gas that is not in the instrument, the selected gas remains unchanged.  <i>Added in V3.0.0.</i>
2101	R	+1: If set, there is a mass flow overrange (MOV) condition. +2: If set, there is a temperature overrange (TOV) condition. +4: If set, there is a totalizer overrange (OVR) condition. +8: If set, the valve is being frozen by the user. +16: If set, valve thermal management is active (VTM).  <i>Added in V3.0.0.</i>
2102	R	The instantaneous temperature, a signed integer. Temperature (°C) = value / 100.  <i>Added in V3.0.0.</i>
2103	R	The instantaneous flow, a signed 2-byte integer. Flow is equal to the value after formatting with the factory-set number of decimal places.  <i>Added in V3.0.0.</i>
2104–2105	R	The total volume since last power up or total reset, in the volume units of the instrument, scaled by the factory-set number of decimal places.  <i>Added in V3.0.0.</i>
2106	R	When read, this is the current setpoint, which may differ from the commanded setpoint due to limited resolution on configured maximum ramping, indicated by register 524.  <i>Added in V3.0.0.</i>
2107	R	The instantaneous valve drive. Valve drive (%) = value / 100.  <i>Added in V3.0.0.</i>

<b>2108-2109</b>	R	The volume remaining for the current batch, an integer in the current totalizer volume units with the same scaling as the total volume, registers 2104-2105.  <i>Added in V3.0.0.</i>
<b>33524</b>	R/W	The commanded setpoint, an integer 0–4095. Values less than 4 will be set to 0. Values greater than 4095 will be set to 4095. This value is ignored if the setpoint source is analog. Otherwise, setpoint = value / 4000 * full scale range.  <i>Added in V2.1.0.</i>

## Measurement Data Registers

These registers support extended measurements using multiple samples.

Data Address	R/W	Notes
<b>4200</b>	R/W	Measurement triggering (controllers only): +1: Begin a new measurement when the digital setpoint is changed. +2: Begin a new measurement when the valve is being held and the hold percentage is changed. +4: Begin a new measurement when the least significant register of the average flow of the last measurement (address 4214) is read.  <i>Added in V3.0.0.</i>
<b>4201</b>	R/W	The number of samples to take in a measurement, an unsigned integer. Each sample is taken at approximately a 2.5 msec interval. Writing to this register resets and starts a measurement; any measurement currently in progress will be canceled and the accumulated data will be moved into the last completed measurement.  <i>Added in V3.0.0.</i>
<b>4202</b>	R	The minimum temperature of the current, or most recent measurement, a signed integer. Temperature (°C) = value / 100.  <i>Added in V3.0.0.</i>
<b>4203</b>	R	The maximum temperature of the current, or most recent measurement, a signed integer. Temperature (°C) = value / 100.  <i>Added in V3.0.0.</i>
<b>4204</b>	R	The minimum flow measured of the current, or most recent measurement, a signed 2-byte integer. Flow is equal to the value after formatting with the factory-set number of decimal places. This value will not be accurate if flow range, units, gas, or calibration has been changed.  <i>Added in V3.0.0.</i>

<b>4205</b>	R	<p>The maximum flow measured of the current, or most recent measurement, a signed 2-byte integer. Flow is equal to the value after formatting with the factory-set number of decimal places. This value will not be accurate if flow range, units, gas, or calibration has been changed.</p> <p><i>Added in V3.0.0.</i></p>
<b>4206</b>	R	<p>The number of samples averaged in the current, or most recent measurement, an unsigned integer. This number will not be larger than the last value written to register 4201.</p> <p><i>Added in V3.0.0.</i></p>
<b>4207</b>	R	<p>The average temperature of the current, or most recent measurement, a signed integer. Temperature (°C) = value / 100.</p> <p><i>Added in V3.0.0.</i></p>
<b>4208</b>	R	<p>The average flow of the current, or most recent measurement, a signed 2-byte integer. Flow is equal to the value after formatting with the factory-set number of decimal places. This value will not be accurate if flow range, units, gas, or calibration has been changed.</p> <p><i>Added in V3.0.0.</i></p>
<b>4209</b>	R	<p>The instantaneous valve drive. Valve drive (%) = value / 100.</p> <p><i>Added in V3.0.0.</i></p>
<b>4210</b>	R	<p>The minimum flow measured in the previously completed measurement, a signed 2-byte integer. Flow is equal to the value after formatting with the factory-set number of decimal places. This value will not be accurate if flow range, units, gas, or calibration has been changed.</p> <p><i>Added in V3.0.0.</i></p>
<b>4211</b>	R	<p>The maximum flow measured in the previously completed measurement, a signed 2-byte integer. Flow is equal to the value after formatting with the factory-set number of decimal places. This value will not be accurate if flow range, units, gas, or calibration has been changed.</p> <p><i>Added in V3.0.0.</i></p>
<b>4212</b>	R	<p>The number of samples averaged in the previously completed measurement, an unsigned integer.</p> <p><i>Added in V3.0.0.</i></p>
<b>4213</b>	R	<p>The average temperature of the previously completed measurement, a signed integer. Temperature (°C) = value / 100.</p> <p><i>Added in V3.0.0.</i></p>
<b>4214</b>	R	<p>The average flow of the previously completed measurement, a signed 4-byte integer. Flow is equal to the value after formatting with the factory-set number of decimal places. This value will not be accurate if flow range, units, gas, or calibration has been changed.</p> <p><i>Added in V3.0.0.</i></p>

## Configuration and Function Registers

These registers affect the operation of the instrument.

Data Address	R/W	Notes
21	R/W	The baud rate: 0: 4800 1: 9600 2: 19200 3: 38400 4: 57600 Added in V2.2.2. 5: 115200 Added in V2.2.2.
25	R	The firmware version. If the version is Va.b.c, it is encoded as $256*a + 16*b + c$ .
26-31	R	The serial number of the instrument. A string of characters in MODBUS, two characters per register.
32	R	The flow sensor offset; the integer ADC reading that is defined as zero flow.
35-36	R	The full scale range of the flow, an unsigned 4-byte integer in SCCM.
39	W	Write 0xAA55 (43605) to tare instrument flow. Note that performing a tare will interrupt any currently executing measurement.
45	R/W	The MODBUS address of the instrument. An integer between 1 and 247, inclusive. If a value outside of that range is written to the register, the address will be set to 1.  <i>Added in V2.4.0.</i>
46	R/W	The text unit ID of the instrument. A byte between ASCII A and Z (decimal values 65 to 90), inclusive. If a value outside of that range is written to the register, the unit ID will be set to A (decimal 65).  <i>Added in V2.4.0.</i>
47-48	R	The full scale flow of the instrument, an unsigned 4-byte integer. Flow (flow units) = value / 1000.  <i>Added in V2.4.0.</i>



49	R	<p>The units of measure for flow:</p> <p>0: SCCM  1: NCCM  2: SLPM  3: NLPM  4: SmL/s  5: NmL/s  6: SmL/m  7: NmL/m  8: SL/h  9: NL/h  10: SCCS  11: NCCS  12: Sm<sup>3</sup>/h  13: Nm<sup>3</sup>/h  14: Sm<sup>3</sup>/d  15: Nm<sup>3</sup>/d  16: SCIM  17: SCFM  18: SCFH  19: SCFD</p> <p><i>Added more units in V3.0.0.</i></p>
51	R/W	<p>The number of samples to use when performing a flow tare, an integer 1–65535. Each sample is taken at approximately a 2.5 msec interval.</p> <p><i>Added in V2.4.0.</i></p>
52	R/W	<p>Adjust the reported flow values to this reference temperature, an integer 0–3000. Reference temperature (°C) = value / 100.</p> <p><i>Added in V2.4.0.</i></p>
53	W	<p>Write 0xAA55 (43605) to reset the total volume to 0.</p> <p><i>Added in V2.5.5.</i></p>
54	R/W	<p>The totalizer behavior when the total volume reaches the maximum limit the instrument is capable of, represented as an integer:</p> <p>0: Keep total volume at max value and do not indicate OVR error.  1: Reset total volume to zero and do not indicate an OVR error.  2: Keep total volume at max value and indicate an OVR error.  3: Reset total volume to zero and indicate an OVR error.</p> <p><i>Added in V3.0.0.</i></p>
55	R/W	<p>The averaging to use for the reported flow. An integer 0-2500. The time constant is approximately value milliseconds.</p> <p><i>Added in V3.0.0.</i></p>

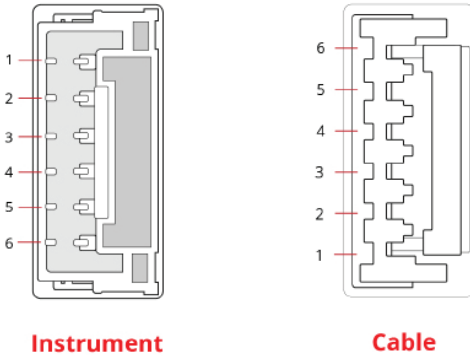
<b>56</b>	R/W	<p>Indicates if instrument is in BASIS 1 Protocol mode.</p> <p>0: Instrument is in BASIS 2 Protocol mode 1: Instrument is in BASIS 1 Protocol mode</p> <p><i>Added in V3.0.0.</i></p>
<b>80</b>	W	<p>Write 0x5214 (21012) to restore factory settings.</p>
<b>512</b>	R/W	<p>The valve control mode, an integer (controllers only):</p> <p>0: Normal closed loop flow control Nonzero: Exhaust/Hold for purge mode; drive the valve at the percentage in register 513.</p> <p><i>Added ability to drive at specified percentage in V3.0.0.</i></p>
<b>513</b>	R/W	<p>The percentage of valve drive to apply in exhaust mode. An integer where valve drive (%) = value / 100; 0 is fully closed, 10000 is maximum open.</p> <p><i>Added in V2.4.0.</i></p>
<b>514</b>	R/W	<p>Communication watchdog (controllers only), an integer 0–5000. If zero, the watchdog is disabled. Otherwise, the setpoint is set to zero if the instrument does not receive a command addressed to it within every value milliseconds.</p> <p>The Communication Watchdog is only available when the setpoint is being set via MODBUS communication and the Setpoint Source is set to "unsaved digital" (see <a href="#">page 11</a>). All other setpoint sources (ASCII, saved digital, analog) are not impacted by the Communication Watchdog.</p> <p><i>Added in V2.4.0.</i></p>
<b>515</b>	R/W	<p>Autotare enable (controllers only).</p> <p>0: The instrument never tares automatically. 1: The instrument will tare flow automatically when the setpoint had been set to 0 for at least two seconds. Writing any value other than 0 is interpreted as a 1.</p> <p><i>Added in V2.4.0.</i></p>
<b>516</b>	R/W	<p>Setpoint type (controllers only):</p> <p>0: Analog input. 1: Digital, and the setpoint is saved to flash (not recommended because the flash burns out easily). 2: Digital, and the setpoint is not saved to flash. 3: No setpoint; the instrument is a meter (the instrument cannot be set to this value, and this register is read-only when this value is present).</p> <p><i>Added in V2.4.0.</i></p>
<b>519</b>	R/W	<p>The proportional control gain in the PDF control algorithm (controllers only). This is an integer from 0–65535. Note that this register is scaled differently from legacy proportional gain registers.</p> <p><i>Added in V2.4.0.</i></p>

<b>520</b>	R/W	<p>The integral control gain in the PDF control algorithm (controllers only) This is an integer 0–65535. Note that this register is scaled differently from legacy integral gain registers.</p> <p><i>Added in V2.4.0.</i></p>
<b>521–522</b>	R/W	<p>Desired volume for the current totalizer batch (controllers only) This is an integer in the current instrument total volume units, indicated in register 49 and scale, formatted with the factory-set number of decimals.</p> <p><i>Added in V3.0.0.</i></p>
<b>524–525</b>	R/W	<p>The maximum setpoint ramp (controllers only) This is an integer where <math>100\% / \text{msec} = 1000000000</math>. If 0, all ramping is disabled; the setpoint will instantly step to the newly requested value. If nonzero, this is the maximum ramp rate of the setpoint per millisecond. The value should be the ramp in percentage of full scale per millisecond, multiplied by <math>10^7</math>.</p> <p><i>Added in V3.0.0.</i></p>

# Analog Signals

Alternatively to the digital communications methods described above, the instrument can be controlled using analog signals transmitted through the 6-pin connector.

**Warning:** Do not supply power to the instrument until all necessary pins have been properly connected.



Pin	Function
1	Analog Setpoint Input
2	Analog Signal Output
3	Ground
4	Power In
5	Serial RS-232 (Rx) or RS-485 B (+)
6	Serial RS-232 (Tx) or RS-485 A (-)

**Warning:** Connecting power to pins other than Pin 4 can permanently damage the instrument.

## Changing the Setpoint

Manage the setpoint using pin 1 (analog in) of the 6-pin connector. The voltage/current sent to the controller is proportional to the full range of the instrument. The setpoint value should correspond linearly to 0–100% of device full scale (0–5 VDC or 4–20 mA).

## Reading the Flow

The analog output signal (pin 2) is 0–5 VDC or 4–20 mA and linear over its entire range. A zero-flow condition is indicated at approximately 0.010 VDC or 4 mA. Full scale flow is indicated at 5.0 VDC or 20 mA. Ground for this signal is common on pin 3.

**Warning:** Do not connect this instrument to “loop-powered” systems, as this will destroy portions of the circuitry. If you must interface with existing loop-powered systems, always use a signal isolator and a separate power supply.

# Troubleshooting

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

**Issue:** *The analog output signal indicates values lower than expected.*

**Action:** Analog signal voltage degrades over long distances. You can minimize this effect by using wires with a heavier gauge, especially in the ground wire.

**Issue:** *I dropped my instrument. Is it OK? Do I need to recalibrate?*

**Action:** If the instrument turns on and appears to respond normally, then it is likely OK. It may or may not need recalibration. To verify, tare the instrument (see [page 14](#)) and compare it against a known good flow standard.

**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 (see [page 20](#)). Adjust the pgain and igain settings to tune the setpoint algorithm (see [page 13](#)).

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

**Action:** This is often caused by insufficient supply pressure. Increase the inlet pressure. If increasing the pressure doesn't help, check for clogs in the line or ports. Teflon tape can often get stuck in the flow channel and block flow. Clean out any loose Teflon tape. As noted on [page 6](#), never tape the first two threads entering the instrument to help avoid this issue.

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

**Action:** Negative flow readings under no flow conditions can indicate a poor tare. Set a zero setpoint to see if the flow returns to 0 after 2 seconds. If using a controller, ensure that autotare is enabled and give the controller a zero setpoint for at least 2 seconds.

**Issue:** *Can I put the flow controller on top of a vibrating instrument? Will it be accurate?*

**Action:** Yes you can. However, sensor noise will increase if the flow controller is vibrating.

**Issue:** *My flow readings won't change when flow changes.*

**Action:** If the flow readings won't change regardless of actual flow, the flow sensor may be damaged. Please contact support to troubleshoot (see [page 2](#)).

**Issue:** *Can I use the controller with other gases?*

**Action:** Your BASIS 2 flow controller is designed specifically to work with 9 preloaded gases (see [page 15](#)).

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

**Action:**

1. Make sure the baud rate for your software, COM port, and flow controller match.
2. Check the flow controller unit ID to make sure you are addressing it properly with your serial commands.
3. Check the pinout (see [page 6](#)).
4. Make sure the COM number matches the one your software is using to connect to the flow controller.
5. On the external serial communications instrument (computer, PLC, etc.), be sure that the flow control (handshaking) settings are correct.

**Still experiencing issues? Please contact support (see [page 2](#)).**

# Maintenance

## Cleaning

This instrument requires minimal maintenance. If necessary, the outside of the instrument can be cleaned with a soft dry cloth. Avoid excess moisture or solvents.

The single most important thing that affects instrument life and accuracy is the quality of the gas being measured. The instruments are designed to measure clean, dry, non-corrosive gases.



**Caution:** *If you suspect that debris or other foreign material has entered your instrument, do not take apart the flow body to clean it, as this will negate its NIST-traceable calibration. Please contact support for cleaning ([page 2](#)).*

## Recalibration

BASIS 2 instruments are calibrated to NIST-traceable standards at the time of manufacture. As an OEM instrument, there is not a factory-recommended periodic recalibration cycle. Recalibration can be requested at the user's discretion/requirement. A recalibration can be requested with your serial number at [alicat.com/service](http://alicat.com/service).

For repair, recalibration, or recycling of this product contact us ([page 2](#)) with your instrument's serial number and your contact information.

# Reference

## Engineering Units

### Flow Units

Standard	Normal	Notes
SmL/s	NmL/s	Milliliter per second
SmL/m	NmL/m	Milliliter per minute
SLPM	NLPM	Liter per minute
SL/h	NL/h	Liter per hour
SCCS	NCCS	Cubic centimeter per second
SCCM	NCCM	Cubic centimeter per minute
Sm <sup>3</sup> /h	Nm <sup>3</sup> /h	Cubic meter per hour†
Sm <sup>3</sup> /d	Nm <sup>3</sup> /d	Cubic meter per day†
SCIM		Cubic inch per minute
SCFM		Cubic foot per minute
SCFH		Cubic foot per hour
SCFD		Cubic foot per day

### Total Units

SmL	NmL	Milliliter
SL	NL	Liter
Scm <sup>3</sup>	Ncm <sup>3</sup>	Cubic centimeter†
Sm <sup>3</sup>	Nm <sup>3</sup>	Cubic meter†
Sin <sup>3</sup>	Nin <sup>3</sup>	Cubic inch†
Sft <sup>3</sup>	Nft <sup>3</sup>	Cubic foot†

### Time Units

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

### Temperature Units

°C	Degrees Celsius
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† Superscript and subscript numerals are displayed as lining (normal) numerals.