A Halma company

OPERATING MANUAL

CODA-SERIES CORIOLIS MASS FLOW DEVICES

Models K · KC · KF · KG

Thank you for purchasing your CODA-Series Coriolis mass flow device.

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This device comes with a NIST-traceable calibration certificate.

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

This device 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 device complies with the requirements of the Electrical Equipment (Safety) Regulations 2016 and the Electromagnetic Compatibility Regulations 2016 and carries the UKCA marking accordingly.

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

Contents

Getting Started

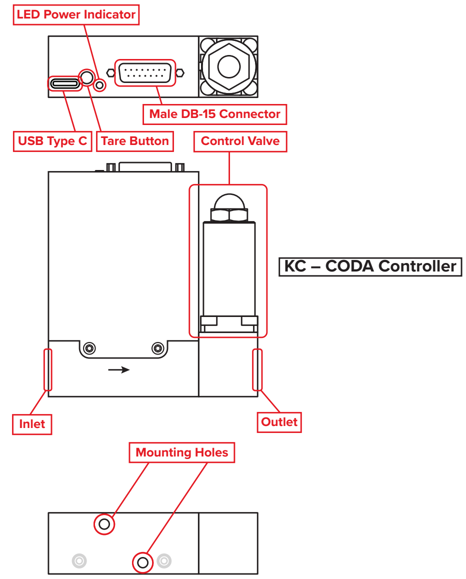
This manual is for all Coriolis meters (K), controllers (KC), pump controllers (KF), and the full coda pump system (KG).

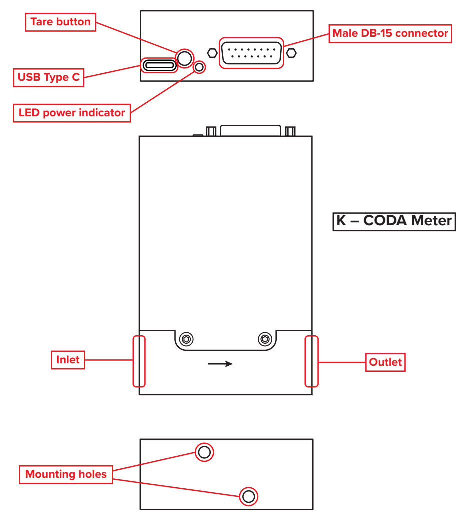
Connectors, Buttons, and LED

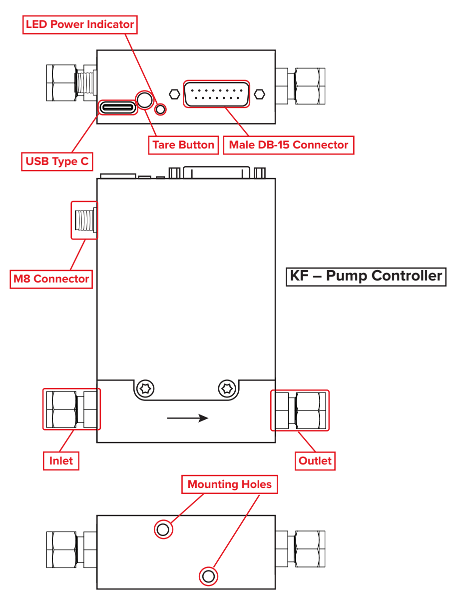
The drawings on this page represent a typical CODA-series mass flow controller, meter, and pump controller. Your device's appearance and connections may differ.

The multicolor LED indicator light displays as a steady green when power is supplied to the instrument. The LED light changes to red when transmitting or receiving through serial communication.

Controllers and meters have a single connection at the top of the device for power and communication. CODA pump controllers have two connections, one on the top and one on the side. The top connection provides power and communication to the system. The connection on the side of the device is to connect the pump to the device. This provides both power to the pump and communication between it and the device. See the power and signal connection section (page 5) for the pinouts.







Mounting

All CODA-series mass flow devices have mounting holes on the bottom for convenient attachment to flat panels. The device does not require straight run pipes upstream or downstream. The device is position insensitive and can be mounted in any orientation.

CODA pump controllers need the pump installed upstream of the controller. Installing the pump downstream of the controller may result in bubbles entering the controller body and creating inaccurate measurements.

Device Ports

Devices ship with plastic plugs seated in the process ports. To decrease the chance of contaminating the flow stream, do not remove these plugs until you are ready to install the device.

CODA devices come with different connection options that are determined at the time of production. Confirm the inlet and outlet fittings of your device and plumb them to the process appropriately.

- On fittings that require thread-sealing Teflon tape, such as NPT fittings, do not wrap the first two threads entering the device. This minimizes the possibility of getting tape into the flow stream and clogging the device.
- Face seal and compression fittings do not need Teflon tape applied to the threads.

! **Warning:** *Do not use pipe dopes or sealants on the process connections. These compounds can cause irreparable damage to the device should they enter the flow stream.*

Maximum Pressure

Each device includes a calibration sheet listing its maximum operating pressure and maximum burst pressure. Operating above these pressures, even briefly, may result in the device rupturing.

CODA controllers also have a maximum differential operating pressure that is dependent on the installed valve or pump. Pressures above the maximum differential pressure may damage the components.

When CODA pump systems are used in high-pressure processes, the outlet of the controller needs to be pressurized before the inlet. This is to protect the pump from too high of a pressure difference when it turns on.

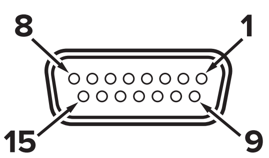
Warning: *Devices exposed to pressures above the burst pressure listed in the device's specifications sheet, even for short periods, may leak or fail catastrophically, injuring persons or equipment.*

Power and Signal Connections

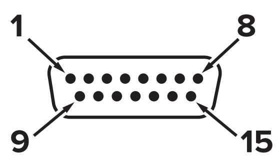
On CODA meters, the USB-C connector on top of the device can provide power and a communication interface to the meter.

CODA controllers and pump controllers require power via a DB-15, M12, or power jack connector (power jack is only available on RJ-45 units). The USB-C connection can be used to communicate with the controller. The USB-C connector is absent on devices with the M12 connector, including IP67-rated devices.

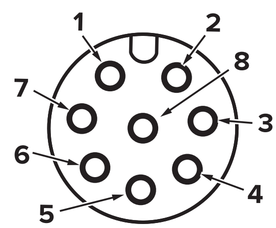
When using Modbus as the communication protocol, the USB-C connection acts as a debug port and only responds to Modbus ID 1. For more information, see the **Modbus RTU Communication** section (page 12). When using ASCII serial communication, the USB-C connection can be used with any ID.



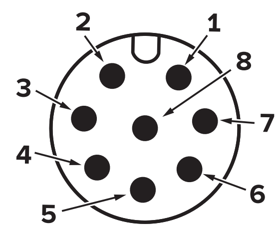
Female Connector



Male Connector



Female Connector



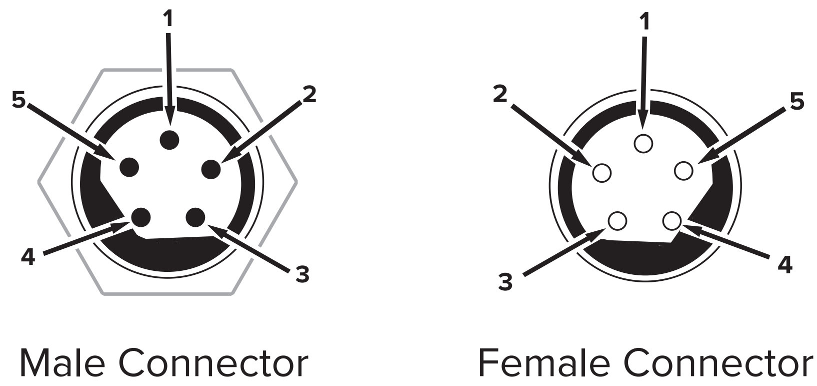
Male Connector

Pin	DB-15	M12
1	**Controllers:** Analog setpoint input **Meters:** Not connected	Analog output of mass flow rate
2	**Controllers:** Ground (analog setpoint) **Meters:** Not connected	Power in (connected to controller and pin 5 on pump controllers)
3	Analog output of mass flow rate	Serial RS-232 RX *Optional: RS-485 (–)*
4	Analog output of density	Remote tare (ground to tare)
5	Ground (analog signals)	Serial RS-232 TX *Optional: RS-485 (+)*
6	Not connected	**Controllers:** Analog setpoint input **Meters:** Analog output of density
7	Not connected	Ground (common for power and digital communications)
8	**Standard Controllers:** Direct valve drive control (0-20V) **Pump Controllers and Meters:** Not connected	**Controllers:** Ground (analog setpoint and signal) **Meters:** Ground (analog signals)
9	Power in (connected to controller and pin 5 on pump controllers)	—
10	Ground (common for power and digital communications)	—
11	Ground (common for power and digital communications)	—
12	Remote tare (ground to tare)	—
13	Ground (common for power and digital communications)	—
14	Serial RS-232 TX *Optional: RS-485 (+)*	—
15	Serial RS-232 RX *Optional: RS-485 (–)*	—

CODA Pump Side Connection

CODA pump controllers have an extra 5-pin M8 connection on the side of the device. This connection powers and controls the pump. The power for the pump runs directly from the top DB-15 or M12 connection to this M8 connection. When wiring a CODA pump device, connect the pump to the controller according to the following pinout.

! **Warning:** *Do not connect the power source directly to this connection. Use this connection to run power from the device to the pump.*



Pin	5-pin M8
1	Not connected
2	Analog pump control output
3	Not connected
4	Ground (common for power and digital communications) and analog pump control
5	Power to pump

Device Operations

Interacting with the Device

Operating a CODA device is performed by using FlowVision 2.0, ASCII serial communication, Modbus RTU, or analog communication. These options can be used for taring the device and totalizing the flow. Controllers can use these options to manage their setpoints or dispense flow in batches.

- **FlowVision 2.0:** a Windows-based software that controls the device, logs and charts data, and runs scripts. For most applications, this is the best method of operating your CODA device. To download FlowVision 2.0, visit alicat.com/flowvision. See the **FlowVision 2.0** section (page 10) for information on connecting your device to FlowVision 2.0.
- **ASCII Serial Communication:** used with either the FlowVision 2.0 terminal or the standalone Alicat Serial Terminal. The serial terminal can be downloaded from alicat.com/support/software-drivers. See the **ASCII Serial Communication** section (page 10) for more information and commands.
- **Modbus RTU:** for use with processes that already utilize the Modbus RTU protocol. See the **Modbus RTU Communication** section (page 12) for more information and commands.
- **Analog:** controllers have both input and output options to control the flow as well as receive info on the current process. CODA meters only have an output to send process information. See the **Analog Communication** section (page 16) for more information on connection to a device via an analog signal.

Taring the Device

Taring ensures accurate measurements by giving the device a zero-reference point to measure from. The taring process takes 10 seconds to complete after it begins. Prior to taring, begin flow through the device to introduce fluid to the system and then stop flow to establish a no-flow condition. For the best results, wait 15 minutes for the electronics and the flow to reach operational temperature before taring.

How to Tare

There are three ways to tare a CODA-series device.

Digitally

- **FlowVision 2.0:** a tare button is in the **Device Tab** after connecting your device (page 10)
- **ASCII serial communication:** use the tare command (*unit_id***V**).
- **Modbus RTU:** write to registers 1000 and 1001 with command ID 4 and argument 1 to start the taring process. See the **Special Commands** table of the **Modbus RTU** section (page 15).

Do not start flow again until the 10-second taring process is complete.

Analog Connection

CODA-series devices with analog connections have one pin that can be grounded to tare the device (page 5). Ground this pin for at least 5 seconds to initiate the 10-second taring process.

The Tare Button

While not recommended, the device can tare by pressing the tare button on the top of the device. To begin the taring process, press and hold the button for 5 seconds. Once the process begins, release the button and allow 10 seconds for the process to complete.

Warning: *Tare via the top button may result in an improper tare due to disturbing the process line when pressing the button.*

Note: *Devices with IP67 rating, and devices with an M12 connector do not have a tare button.*

When to Tare

- After installing the device in a different orientation.
- After a significant impact to the flow device.
- After changing fluid.
- After significant changes to the ambient conditions.

Measuring Total Flow

All CODA devices can measure the total amount of flow that has passed through the device. This is referred to as the totalizer. The flow is measured until the totalizer is reset. Once reset, the measured flow clears and begins measuring the new flow.

- **FlowVision 2.0:** the totalizer is displayed with the other measurements on the right-hand side of the device tab. To reset the totalizer, press the reset totalizer button at the top of the tab.
- **ASCII serial communication:** use the reset totalizer command, *unit_id***T** to return the totalizer to zero.
- **Modbus RTU:** write to registers 1000 and 1001 with command ID 5 and argument 0 to reset the totalizer. See the **Special Commands** table of the **Modbus RTU** section (page 15).

Using Standardized Volumetric Flow

CODA devices can measure or control the standardized volumetric flow of a process. For this, the device needs an STP density to standardize the volumetric flow. The density can either be calculated automatically by using the device's gas index or set manually.

For automatic density calculation, the CODA device needs a gas selected. The density is then calculated using the known density at the current standard temperature and standard pressure. By default, the standard temperature is 25°C and the standard pressure is 1 atmosphere (ATM).

Automatic Density Calculation (Set Gas)

There are two ways to set the gas on a CODA device.

- **ASCII serial communication:** use the **gas number ID** (**GASID**) parameter in the configure parameter command (*unit_id***CFG** *parameter_id new_parameter_value*). The *new_parameter_value* is the gas index number found in **Appendix D** (page 20).
- **Modbus RTU:** use register 1141 and write the gas index number found in **Appendix D** (page 20) as the value of the register.

Manual Density

If a gas is not found in the index it may be necessary to set the fluid density manually. There are three ways to do so.

- **FlowVision 2.0:** the STP density can be set in the **device settings**, under the **measurements** section.
- **ASCII serial communication:** use the **STP density** (**DENS**) parameter in the configure parameter command (*unit_id***CFG** *parameter_id new_parameter_value*). See the parameter command table (page 11) for more information.
- **Modbus RTU:** write the desired density in kg/m^3 to registers 1112–1113.

Managing the Setpoint Controllers

Changing the Setpoint

The setpoint is the flow rate that controllers attempt to achieve and maintain. A standard CODA controller does this by opening and closing the valve. A CODA pump controller does it by increasing and decreasing the power to the pump.

- **FlowVision 2.0:** the setpoint is managed by the field in the **device tab**.
- **ASCII serial communication:** use the setpoint command (*unit_id***S** *new_setpoint_value*) to change the setpoint to the desired setpoint value.
- **Modbus RTU:** use either registers 1010–1011 or 1012–1013 to update the setpoints. See the **Modbus Control Registers** table (page 14) for more information.
- **Analog:** Refer to the **Power and Signal Connections** (page 5) and **Analog Communication** (page 16) section for the setpoint pins and connections.

Power-Up Setpoint

It is possible to save a setpoint the controller moves to whenever it is powered on. Analog does not have a power-up setpoint option.

- **FlowVision 2.0:** in the **memory section** of the **device settings** is a setting to remember the setpoint.
- **ASCII serial communication:** use the **power-up setpoint** (**PUSP**) parameter in the configure parameter command (*unit_id***CFG** *parameter_id new_parameter_value*) to update the power-up settings. See the parameter command table (page 11) for more information.
- **Modbus RTU:** use registers 1128–1129 to set and save the setpoint. See the **Modbus Control Registers** table (page 14) for more information.

Dispensing Flow in Batches Controllers

A CODA controller can dispense fluid in a user-defined batch. Batching is a function of the totalizer on controllers. Once the batch size is defined, give the controller a setpoint to begin flowing the batch. After the desired amount of fluid passes through the controller, the controller stops the flow. Flow can be restarted by removing the batch size or repeating a batch.

- **FlowVision 2.0:** the batch size can be defined in the **device tab** underneath the setpoint.
- **ASCII serial communication:** use the batch command (*unit_id***TB 1** *batch_volume*) to define the batch size.
- **Modbus RTU:** use registers 1015–1016 to define the batch size. See the **Modbus Control Registers** table (page 14) for more information.

Repeat a Batch

After the desired batch has flowed through the controller, the flow stops. To perform another batch of the same size, reset the totalizer.

- **FlowVision 2.0:** click the **reset totalizer** button at the top of the **device tab**.
- **ASCII serial communication:** use the reset totalizer command(*unit_id***T**).
- **Modbus RTU:** Write to registers 1000 and 1001 with command ID 5 and argument 0 to reset the totalizer. See the **Special Commands** table of the **Modbus RTU** section (page 15).

Manual Bypass CODA Pump

A CODA pump system is produced with a manual bypass between the pump and the controller. This bypass provides the ability to reduce the flow range below what the pump is rated for and to help smooth flow rates.

When installing the CODA pump system, plumb the bypass to either return fluid to the reservoir or another location outside the process. The bypass should not direct flow back into the system beyond the controller as it would not be measured.

If the process requires a flow range lower than the pump allows for, open the bypass to divert flow either back to the fluid reservoir or another location.

When flow rates are fluctuating and not stabilizing, open the bypass to divert flow.

Digital Communication

FlowVision 2.0

To connect your device to FlowVision 2.0, perform the following:

1. Download and install FlowVision 2.0 from alicat.com/flowvision.
2. With the device 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 CODA device.
5. Select **Wired** for the connection type.
6. Specify the connection settings. By default, the **Device ID** is 1, and the **Baud Rate** is 19200. The **Port** is dependent on which COM port the device is connected to.
7. Specify a **Name** if desired. If the name field is left blank, FlowVision 2.0 generates a name.
8. Click **Add** to complete the process.

FlowVision 2.0 contains several features for use with your CODA device. For more detailed instructions, please see the FlowVision 2.0 manual at alicat.com/flowvision.

ASCII Serial Communication

CODA instruments can use RS-232/485 serial communication for transmitting ASCII commands and data. This can be done using the Alicat serial terminal from alicat.com/support/software-drivers/. A terminal can also be found in FlowVision 2.0.

For a more detailed explanation of Alicat ASCII commands, please see the serial primer at alicat.com/manuals.

Establishing Communication

You can access the CODA ASCII serial interface through the USB port, 15-pin, or 8-pin connectors on top of the device. Consult the pinouts on page 5 for information on how to wire a connector for CODA.

- When using a USB cable to connect your device to a Windows 10 computer, it should recognize your USB as a virtual COM port automatically. If not, please ensure the computer has the latest updates and drivers. If needed, links to USB drivers that can create virtual COM ports are found at alicat.com/support/software-drivers/.
- After physically connecting your device to a Windows PC, you can check which COM port number it uses by opening the Windows Device Manager and expanding "Ports (COM & LPT)".
- The USB-C serial interface auto-detects and accepts any rate from 9.6 kbps to 12 mbps. The 15-Pin and 8-Pin connectors come configured with a baud rate of 19.2 kbps.
- The default CODA ASCII unit ID is "A."

Multidrop Information

CODA devices that are equipped with an RS-485/RS-232 interface can operate on networks with other devices. The CODA RS-485 transceiver is a ½ unit-load transceiver. When deploying CODA devices in an RS-485 network with multiple types of devices, confirm that the total load of all devices does not exceed 32 units on an unrepeated network segment. Consult the EIA-485 standard for more information.

Command Reference

Serial Commands are not case-sensitive.

Change the unit ID:	*unit_id*@ *new_unit_id*
Poll the live data frame:	*unit_id*
Tare flow:	*unit_id*V
New setpoint:	*unit_id*S *new_setpoint_value*
Reset totalizer:	*unit_id*T
Query batch size:	*unit_id*TB 1
Set totalizer batch:	*unit_id*TB 1 *batch_volume*
Hold valve at current position:	*unit_id*H
Hold valve closed:	*unit_id*HC
Exhaust:	*unit_id*E
Resume closed loop control:	*unit_id*C
Firmware version:	*unit_id*VE
Configure parameter:	*unit_id*CFG *parameter_id* *new_parameter_value*

Parameters

When using the configure parameter command (*unit_id***CFG** *parameter_idnew_parameter_value*), use the ID from the following table in place of *parameter_id* and the desired value in place of *new_parameter_value*. For example, to change the setpoint source to digital on a device with an ID of A, use **ACFG SPS 0** as the command. The following tables outline the different possible parameters that can be used with the configure parameter command.

Parameter	ID	Read/ Write	Values
Serial number	SN	Read	Integer value
Modbus ID	MID	Read/Write	1–247 (Default is 1)
Baud rate	BAUD	Read/Write	RS-232/RS-485 baud rate 0: Auto-baud 1: 9600 2: 19200 3: 38400 4: 57600 5: 115200
Data frame	DATA	Read/Write	Configures the frame format for general query bit masks: 1: Density 2: Temperature 4: Volumetric flow rate 8: Mass flow rate 16: Setpoint (controllers only) 32: Total flow 64: Total time 128: Totalizer batch remaining (controllers only) 256: Valve drive (controllers only) 512: STP volumetric flow rate 32768: Status (see status table) By default, the parameter value starts at 33407. All statistics except for totalizer batch remaining and valve drive are enabled. If a statistic is enabled on a device that is not supported, (e.g., setpoint on a meter) the statistic is omitted from the data frame. To disable certain statistics in the data frame, subtract their value from the current parameter value (e.g., to disable total flow, subtract 64 from 33407 to obtain 33343). To enable a statistic, add its value to the current parameter value.
Power-up setpoint	PUSP	Read/Write	Floating point number: 0–100% of current control variable range
Setpoint source	SPS	Read/Write	0: Digital 1: Analog (Default)
Analog scale factor	ASF	Read/Write	0.0–5.0 (Default is 1.0)
Streaming speed	STR	Read/Write	Not applicable for RS-485 Integer ms value: 20–65535
Totalizer variable	TOTV	Read/Write	0: Mass flow rate (Default) 1: Volumetric flow rate
STP density	DENS	Read/Write	Manual density input using standard temperature and standard pressure. Floating point value.
Gas number ID	GASID	Read/Write	See Appendix D (page 20) for available gases.
P gain	PGAIN	Read/Write	Floating point: normalized gain value from 0.0–1.0
I gain	IGAIN	Read/Write	Floating point: normalized gain value from 0.0–1.0
D gain	DGAIN	Read/Write	Floating point: normalized gain value from 0.0–1.0
Valve offset	VOFF	Read/Write	Floating point: normalized gain value from 0.0–1.0
Control loop variable	LVAR	Read/Write	0: Mass flow (Default) 1: Volumetric flow 2: Standardized volumetric flow
Mass flow unit	UOMM	Read/Write	See Appendix A (page 19) for available units and their corresponding value.
Volumetric flow unit	UOMV	Read/Write	See Appendix B (page 19) for available units and their corresponding value.
Totalizer unit	UOMT	Read/Write	See Appendix C (page 19) for available units and their corresponding value.

Status Codes

Commands that return a data frame can return one or more status codes. The *unit_id***??D** command also provides the possible status codes of the firmware currently installed.

Code	Type	Description
MOV	Error	Mass flow over range. Reported mass flow value exceeds the valid range.
OVR	Warning	The totalizer rolled over or is stuck at maximum value.
TMF	Warning	Totalizer missed some flow due to flow over range. Total volume, totalizer average, and totalizer peak are not accurate.
TOV	Error	Temperature over range. The reported temperature exceeds the range in which mass flow is valid.
VOV	Error	Volumetric flow over range. The reported volumetric flow value exceeds the valid range.
ZRO	Status	Zeroing (tare) currently in progress.
DUV	Error	Density under range. Density is below measurable range.
DOV	Error	Density over range. Density exceeds measurable range.
EXH	Status	Exhaust. The controller is holding the valve open to clear the process.
HLD	Status	Valve Hold. The controller is holding the valve position and not actively controlling the process.

Modbus RTU Communication

All CODA devices come with a digital serial interface in addition to the analog interface. Modbus RTU is available on all RS-232/RS-485 CODA devices. You can read and log sensor data, switch between analog and digital control modes, adjust device settings, and control the device.

Establishing Communication

Depending on its configuration, you can access the CODA serial interface through the 15-pin or 8-pin connectors on top of the device. Consult the pinouts on page 5 for information on how to wire a connector for CODA. The USB-C port is reserved as a debug port and always has the default configuration to be used if communication to the device is lost. If connecting multiple devices to the same port, do not use the USB-C port, use the 15-Pin or 8-Pin connectors instead.

- When using a USB cable to connect your device to a Windows 10 computer, it should recognize your USB as a virtual COM port automatically. If not, please ensure it has the latest updates.
- After physically connecting your device to a Windows PC, you can check which COM port number it uses by opening the Windows Device Manager and expanding "Ports (COM & LPT)".
- **The default CODA Modbus configuration has the following settings:**
  - Data Bits: 8
  - Stop Bits: 1
  - Parity: None
  - Flow Control: None
  - Modbus ID: 1
- The 15-Pin and 8-Pin connectors come configured with a baud rate of 19.2 kbps. The USB-C serial interface auto-detects and accepts any arbitrary rate from 9.6 kbps to 12 mbps.

Multidrop Information

CODA devices equipped with an RS-232/RS-485 interface can operate on networks with other devices. The CODA RS-485 transceiver is a ½ unit-load transceiver. When deploying CODA devices in an RS-485 network with multiple types of devices, confirm that the total load of all devices does not exceed 32 units on an unrepeated network segment. Consult the EIA-485 standard for more information.

Modbus RTU Serial Protocol

Alicat uses the Modbus standard of offsetting registers by 1 from addresses, meaning register 1 is equivalent to address 0. However, some systems expect data to be mapped as 0-indexed addresses. Different Modbus control systems may refer to registers, offsets, or addresses in their documentation without clarifying their meaning. If your control system uses a 0-indexed numbering scheme, decrement all registers in this manual by 1.

If you are unsure of which addressing scheme your control system uses, perform a test read of register 1200. If the CODA instrument responds with Error code 2: “Illegal Data Address”, then your system is using the standard 1-indexed numbering system and the values in this manual can be used as-is. If the device returns a value of 0 instead of an error, decrement all registers by 1 to arrive at the correct offset.

Reading Process Data

Alicat CODA-series mass flow devices make no distinction between “Input” and “Holding” registers. Modbus function codes FC03 and FC04 can be used interchangeably to read data from the device.

Sensor and process values are stored as big-endian, 32-bit IEEE-754 floating point numbers spanning two registers. Your control system will need to chain these into a single value to interpret them correctly.

Writing Control and Configuration Information

All command and control requests to a CODA device are issued with Modbus function code FC16: “write multiple registers”.

Modbus Reading and Status Registers

Note: *All parameters in this table are read-only access.*

Register	Parameter	Data Format	Data Units
1106–1107	Full scale mass flow	Float	Uses mass flow units (register 1134)
1114–1115	Volumetric flow full scale	Float	Uses volumetric flow units (register 1135)
1116–1117	Device native range	Float	g/h
1118–1119	Standardized volumetric full-scale flow	Float	Dependent on register 1135, volumetric flow units (page 14)
1150	Major firmware revision	UINT16	N/A
1151	Minor firmware revision	UINT16	N/A
1152	Firmware revision patch	UINT16	N/A
1155–1156	Serial number	UINT32	N/A
1201–1202	Status flags	Binary Array	See the status flags table in the following section.
1203–1204	Density	Float	kg/m^3
1205–1206	Tube temperature	Float	Degrees Celsius
1207–1208	Volumetric flow	Float	Dependent on register 1135, volumetric flow units (page 14).
1209–1210	Mass flow	Float	Dependent on Register 1134, mass flow units (page 14).
1211–1212	Total flow	Float	Dependent on register 1138, total flow units (page 14).
1213–1214	Mass flow setpoint (controllers)	Float	Dependent on register 1134, mass flow units (page 14).
1215 – 1216	Totalizer time	Float	Seconds
1217–1218	Batch remaining (controllers)	Float	Dependent on the units of the control loop variable (special command 11, page 15)
1219–1220	Valve drive (controllers)	Float	0.0-1.0 (indicates the percentage of the drive's current voltage)
1229–1230	STP Volumetric Flow	Float	Dependent on register 1144, STP volumetric flow units and STP settings (page 14)
2049–2050	Mass flow percentage setpoint (controllers)	Float	% of full scale
2053	Modbus ID	UINT16	N/A (1-247 accepted)
2055	Volumetric flow over range	UINT16	0: False 1: True
2056	Mass flow over range	UINT16	0: False 1: True
2057	Temperature over range	UINT16	0: False 1: True
2058	Totalizer rollover	UINT16	0: False 1: True

Status Flags

When reading registers 1201 and 1202, the response provides a status, if one is present, and then a bit of what status is present. Refer to the following table to determine the cause of any status.

Bit	Interpretation
0	Tare in progress
1	Density under range
2	Density over range
3	Batch control active
4	Mass flow over range
5	Totalizer over range
6	Totalizer missed flow
7	Temperature over range
8	Volumetric flow over range
9	Invalid control variable
10	Valve in hold state
11-31	Reserved

Modbus Control Registers

Note: *All parameters in this table are both read and write accessible.*

Register	Parameter	Data Format	Data Units
1000–1001	Command ID & argument	UINT16	N/A (see special command results status codes table page 15)
1010–1011	Setpoint as % of full scale (controllers)	Float	Dependent on the loop control variable (special command 11, page 15) and full-scale flow.
1012–1013	Setpoint (controllers)	Float	Dependent on the loop control variable (special command 11, page 15). Uses the controlled variable's unit (register 1134 or 1135).
1015–1016	Batch size	Float	Dependent on the control variable
1018–1019	Direct valve drive	Float	0.0–1.0 (Requires direct valve drive engaged via special command 16, page 15.)
1110–1111	Single exponential filter alpha gain	Float	0.0–1.0
1112–1113	STP density	Float	kg/m^3
1120–1121	Proportional gain	Float	0.0–1.0
1122–1123	Integral gain	Float	0.0–1.0
1124–1125	Derivative gain	Float	0.0–1.0
1126–1127	Valve offset	Float	0.0–1.0
1128–1129	Power-up setpoint	Float	% of controlled loop variable full scale (0.0–100.0) Dependent on loop control variable (special command 11, page 15) and full-scale flow.
1134	Mass flow units	UINT16	N/A (Values found in Appendix A on page 19)
1135	Volumetric flow units	UINT16	N/A (Values found in Appendix B on page 19)
1137	Totalizer select	UINT16	0: Mass flow 1: Volumetric flow 2: Standardized volumetric flow
1138	Totalizer units	UINT16	N/A (Values found in Appendix C on page 19)
1139–1140	STP temp	Float	°C
1141	Gas number	UINT16	N/A (Values found in Appendix D on page 20)
1142–1143	Analog scale factor	Float	0.0–5.0 (Default is 1.0)
1144	STP volumetric flow units	UINT16	N/A (Values found in Appendix B on page 19)

Special Commands

You can access special control functions on CODA devices with an FC16 write to registers 1000 and 1001. Special commands consist of a Command ID and a Command Argument written in a single pass to these registers. Each command/argument pair transmits as a set of two 16-bit unsigned integers. Commands start by a write to register 1000. If you send a command to register 1000 without sending an argument to 1001 the CODA instrument interprets the command with a default argument of 0.

Command Name	Command ID	Command Argument	Notes
Tare flow	4	**0:** Abort tare **1:** Start tare	Tare takes about 10 seconds to complete.
Reset totalizer value	5	**0:** Reset totalizer	
Change control loop variable	11	**0:** Control mass flow **1:** Control volumetric flow **2:** Standardized volumetric flow	Volumetric flow control does not function when density reading is out of range.
Save current setpoint	12	**0:** Save setpoint	Saved setpoint is loaded on power-up.
Valve control override	16	**0:** Cancel override **1:** Close valve **2:** Open valve **3:** Hold **5:** Direct drive	
Change setpoint source	18	**0:** Digital/serial setpoint **1:** Analog setpoint	
Change Modbus ID	32767	**1–247:** New ID	Device must be power cycled for new ID to take effect.
Change serial baud rate	32768	**0:** Auto select **1:** 9600 **2:** 19200 **3:** 38400 **4:** 57600 **5:** 115200	Device must be power cycled for new baud rate to take effect.

Special Command Result Status Codes

After sending a special command to registers 1000–1001, you can perform a read of the same registers to determine the success or failure of the last command. Register 1000 stores the last command ID sent to the device and register 1001 returns a status code indicating the command result. Refer to the following table to determine the code's meaning.

Status Codes	Result
0	Success
32769	Invalid command ID
32770	Invalid setting
32771	Requested feature is unsupported

Analog Communication

CODA mass flow devices with a DB-15 connector include an analog output for both mass flow and density.

CODA controllers with an 8-pin M12 connector have a single analog output for mass flow. CODA meters with an 8-pin M12 connector have two outputs, one for mass flow and one for density (page 5).

The outputs are linear across the entire range, provided the load impedance is within the nominal values specified in the table below.

Analog I/O Electrical Characteristics

Inputs	0–5 V	0–10 V	4–20 mA
Maximum over range	+1 V	+2 V	+4 mA
Input impedance	200 kΩ	200 kΩ	250 Ω
Nominal source Impedance	<1 kΩ	< 1 kΩ	-
Nominal source voltage	—	—	0–5 V+
ADC sampling rate	50 Hz	50 Hz	50 Hz
ADC resolution	16 bit	16 bit	16 bit

Outputs	0–5 V	0–10 V	4–20 mA
Maximum over range	+1 V	+2 V	+4 mA
Minimum load impedance	>50 kΩ	>50k Ω	<500 Ω*
Output impedance	10 kΩ	10 kΩ	—
DAC update rate	50 Hz	50 Hz	50 Hz
DAC resolution	14 bit	14 bit	14 bit

* *Including sense resistor and wiring*

Analog I/O Data Ranges

Analog inputs and outputs for your device are calibrated at the factory. By default, the full-scale flow range maps 1:1 to the full scale voltage or current range of your device with a small over range allowed.

The full-scale range for density on CODA devices is 0–2000 kg/m^3. The CODA device is not sensitive enough to detect most gas densities, so it always outputs a density reading of 99 kg/m^3 or higher.

Custom analog ranges may also be set by request at the factory. Factory custom analog ranges are listed on the calibration sheet.

Note: *The density readings and accuracy are independent of mass flow readings and accuracy.*

Warning: *Do not connect this device 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.*

Analog Mass Flow Scale Factor

Analog mass flow outputs can be scaled up or down as needed. This means that the full-scale flow rates can correspond to a value above or below the maximum analog output of the device. The analog scaling factor affects the analog flow output in the following way:

$$AFO = \frac{\mathrm{MF}}{\mathrm{FSF} \times \mathrm{ASF}} MAO$$

Where AFO is the analog flow output, MF is the mass flow, FSF is the full-scale flow, ASF is the analog scale factor, and MAO is the maximum analog output.

There are two ways to modify the analog scale factor.

- **ASCII serial communication:** use the **analog scale factor** (`ASF`) parameter in the configure parameter command (`unit_idCFG parameter_id new_parameter_value`).
- **Modbus RTU:** write the desired factor to registers 1142–1143.

The analog scale factor can be any value from 0.0 to 5.0 (default is 1.0).

Maintenance

Cleaning

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

CODA mass flow devices used with gas require no periodic cleaning, provided they have been flowing clean, dry gas.

CODA mass flow devices used with liquids require some precautions to avoid contamination and/or corrosion damage. Liquid should be filtered for particulates or biological materials that may grow in the device. When removing these units from the line for any extended period, remove all liquid from the device, as deposits of calcium or other soluble minerals can affect the accuracy of the device.

Recalibration

CODA devices are calibrated to NIST-traceable standards at the time of manufacture. Due to the Coriolis technology, there is not a factory-recommended periodic recalibration cycle. Recalibration can be requested at the user's discretion/requirement by submitting a form with the device serial number at alicat.com/service.

Replacement Accessories

Accessories are available through support (**page 2**), or on our website at alicat.com/accessories.

Repair and Recycling

For repair or recycling of this product contact Alicat support (**page 2**).

Technical Specifications and Dimensional Drawings

Please visit alicat.com/specs to find complete operating specifications and dimensional drawings.

Troubleshooting

Issue: I can't communicate to the device when it's connected to my PC

Action: 1. Ensure the baud rate of the software being used matches the baud rate of the device.

2. Check the unit ID and confirm it's the expected ID. This can be done by connecting to the USB-C port as it is always Modbus ID 1.

3. Ensure you are connecting to the same COM port as the device.

4. Confirm the external serial communications device (computer, PLC, etc.) flow control settings are set to on.

5. Check the pinout of the device and confirm the correct pin is connected (page 5).

Issue: I updated the Modbus ID and now I can't communicate with the device.

Action: The ID may have been improperly updated and has a different ID than intended. Connect to the device using the USB-C connection and try to communicate with the device using ID 1. The USB-C connection always communicates on Modbus ID 1 and does not update when the ID updates.

Issue: My controller won't reach its setpoint or the readings aren't as high as I expect.

Action: This can be caused by not enough supply pressure in the system. Increase the inlet pressure to see if measurements improve.

If increasing the pressure doesn't help, check the system for a clog. Teflon tape can get trapped in the system and block flow if not applied properly. Clear out any debris that may be found and attempt the process again. If needed, a CODA device can have flow pass through it in reverse (right to left) to help diagnose a possible blockage.

Issue: My controller doesn't maintain its setpoint and may fluctuate up or down.

Action: Controllers use a PID control loop algorithm (with the D term set to 0) to reach the given setpoints. If you are familiar with PID algorithms, the parameters can be adjusted using Modbus registers 1120–1125 or in FlowVision 2.0. If you are not familiar with the algorithm, please contact Alicat support for assistance before performing any modifications (page 2).

Issue: The pump shuts off when I attempt to set a certain setpoint.

Action: The calibration of the CODA pump controller is set to a specific flow range. Attempting to create a setpoint larger than this flow range is not possible and causes the pump to shut off. Confirm that the intended setpoint is within the range of the device. If it is and the problem persists, please contact support (page 2).

Appendices

Appendix A: Mass Flow Unit Values

Mass Flow Unit	Command Value
Milligrams per second (mg/s)	17
Milligrams per minute (mg/m)	14
Grams per second (g/s)	5
Grams per minute (g/m)	2
Grams per hour (g/h)	0
Kilograms per second (kg/s)	11

Mass Flow Unit	Command Value
Kilograms per minute (kg/m)	8
Kilograms per hour (kg/h)	7
Ounces per second (oz/s)	23
Ounces per minute (oz/m)	20
Pounds per minute (lb/m)	26
Pounds per hour (lb/h)	25

Appendix B: Volumetric Flow Unit Values

Volumetric Flow Unit	Standard Volumetric Flow Unit	Command Value
Milliliters per second (mL/s)	Standard milliliters per second (SmL/s)	29
Liters per second (L/s)	Standard liters per second (SL/s)	28
Liters per minute (LPM)	Standard liters per minute (SLPM)	27
Liters per hour (L/h)	Standard liters per hour (SL/h)	0
US gallons per minute (US GPM)	Standardized US gallons per minute (Standardized US GPM)	25
US gallons per hour (US GPH)	Standardized US gallons per hour (Standardized US GPH)	24
Cubic centimeters per second (CCS)	Standard cubic centimeters per second (SCCS)	9
Cubic centimeters per minute (CCM)	Standard cubic centimeters per minute (SCCM)	8
Cubic centimeters per hour (cm3/h)	Standard cubic centimeters per hour (Scm3/h)	7
Cubic meters per minute (m3/m)	Standard cubic meters per minute (Sm3/m)	16
Cubic meters per hour (m3/h)	Standard cubic meters per hour (Sm3/h)	15
Cubic meters per day (m3/d)	Standard cubic meters per day (Sm3/d)	14
Cubic inches per minute (in3/m)	Standard cubic inches per minute (Sin3/m)	12
Cubic feet per minute (CFM)	Standard cubic feet per minute (SCFM)	10

Appendix C: Totalizer Unit Values

Mass Flow Totalizer Unit	Volumetric Totalizer Unit	Command Value
Grams (g)	Liters (L)	0
US ton (t)	US gallon (US G)	27
Milligrams (mg)	cubic centimeters (cm3)	11
Pounds (lb)	cubic meters (m3)	16
Kilograms (kg)	N/A	10

Mass Flow Totalizer Unit	Volumetric Totalizer Unit	Command Value
US ounce (US oz)	N/A	12
N/A	Cubic inches (in3)	14
N/A	Cubic feet (ft3)	13
N/A	Milliliters (mL)	34
N/A	Microliters (µL)	33

Appendix D: Gas Index

#	Short Name	Long Name
0	Air	Air (Clean Dry)
1	Ar	Argon
2	CH_4	Methane
3	CO	Carbon Monoxide
4	CO_2	Carbon Dioxide
5	C_2H_6	Ethane
6	H_2	Hydrogen
7	He	Helium
8	N_2	Nitrogen
9	N_2O	Nitrous Oxide
10	Ne	Neon
11	O_2	Oxygen
12	C_3H_8	Propane
13	nC_4H_{10}	Normal Butane
14	C_2H_2	Acetylene
15	C_2H_4	Ethylene (Ethene)
16	iC_4H_{10}	Isobutane
17	Kr	Krypton
18	Xe	Xenon
19	SF_6	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	NF_3	Nitrogen Trifluoride[2]
32	NH_3	Ammonia[2]
33	Cl_2	Chlorine[2]
34	H_2S	Hydrogen Sulfide[2]
35	SO_2	Sulfur Dioxide[2]
36	C_3H_6	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	SiH_4	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]

#	Short Name	Long Name
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

#	Short Name	Long Name
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 *Confirm device material compatibility before use.*

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.*