OPERATING BULLETIN
PROFIBUS

Thank you for your purchase. This document is a companion to your device's manual, which contains information essential to the proper use and care of your device.

Contact Information

Alicat Scientific
World Headquarters
7641 N Business Park Dr., Tucson, AZ 85743 USA

info@alicat.com • alicat.com • +1 888-290-6060

India

india@alicat.com
M/s Halma India Pvt. Ltd.
C/O Avire India Pvt. Ltd.
Plot #A-147, Rd. #24
Wagale Ind. Estate, Thane
(West) 400604,
Maharashtra, India
+1 888-290-6060

China & SE Asia

info-cn@alicat.com
alicat.com.cn
2nd Floor, Block 63, No.
421, Hong Cao Rd,
Shanghai, PRC 200233
+86-21-60407398 ext. 801

Europe

europe@alicat.com
Geograaf 24
6921 EW Duiven
The Netherlands
+31 (0) 26 203.1651

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 European Union's Waste Electrical & Electronic Equipment (WEEE) Directive 2002/96/EC

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Contents

Introduction

Alicat L series, P series, and M series instruments can be ordered with a PROFIBUS communication interface. This turns an Alicat instrument into a PROFIBUS DP-V0 compatible slave device suitable for use on a PROFIBUS DP network.

This manual is a supplement which explains how to configure and control an Alicat instrument equipped with a PROFIBUS interface. It assumes that you have already read the instrument manual for your Alicat device and that you are familiar with the PROFIBUS protocol. Digital copies of Alicat instrument manuals can be downloaded from our website at alicat.com/manuals/.

Alicat PROFIBUS instruments ordered after August 2020 use a new hardware design. This new hardware improves the performance and manufacturability of Alicat PROFIBUS devices, and allows Alicat PROFIBUS devices to use displays. Some details in this manual are specific to this new hardware. Please contact Alicat if you require a legacy manual.

Installation

EMF & Grounding considerations

PROFIBUS networks are very sensitive to wiring quality and electrical interference. If you are planning a new PROFIBUS project or modifying an old one then we recommend downloading a PROFIBUS International's *PROFIBUS Installation Guidelines for Cabling and Assembly v 1.06*. This reference is free to download from PI's website and provides a broad reference of best practices for installing a PROFIBUS network.

When planning a network with Alicat PROFIBUS devices, please consider the following:

- Alicat PROFIBUS products do not have an internal termination resistor. You will need to use terminating cable connectors to install an Alicat device at the end of a PROFIBUS network.

- Alicat PROFIBUS devices use a single common ground for power and signal. The ground is connected to the termination ground reference and to the steel flow body of each device. Mounting an Alicat device to a conductive surface will ground the device to that surface. This can create a path between separate functional and equipotential earthing systems. You can order Alicat PROFIBUS devices with an isolated ground if your system requires it.

Power & Communication Connectors

Alicat PROFIBUS devices come equipped with two connectors: a 4-pin M8 A-code connector which accepts 24 volts power and the PROFIBUS-standard standard 9-pin D-Sub connector. Instruments can also be ordered or retrofit to work with "power over PROFIBUS" systems.

The M8 connector also provides a diagnostic RS-232 serial connection. The serial interface is not required for your device to function but can adjust low level device settings. Do not connect the M8 serial pins to anything except an RS-232 serial port.

DB-9 pins 3, 5 & 8 are required for PROFIBUS. Other pin connections depend on how unit is powered and if bus termination is required.

Pin out diagrams for PROFIBUS enabled Alicat devices are shown below.

The female DB9 top connection is PROFIBUS.

DB9 Pin	Use
1	Not Connected
2	Power over Profibus Ground (optional)
3	Rx/Tx Data-P
4	Not Connected
5	Data Ground
6	Voltage Plus
7	Power over Profibus 7 to 30VDC (optional)
8	Rx/Tx Data-N
9	Not Connected
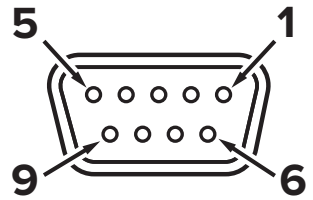
The 4-pin M8 A connection on the top is power and RS-232.

M8 A Pin	Use
1	RS-232 TX (output)
2	7 to 30VDC
3	Ground
4	RS-232 RX (input)
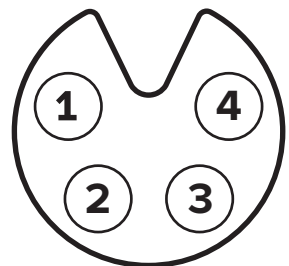
Device Commissioning

All Alicat instruments use the same PROFIBUS interface. Differences in the behavior of different instrument product lines are handled as configuration or parameter changes you provide your PROFIBUS master. These parameters and configuration options are defined in the General Station Description (GSD) file. You can download new and legacy GSD files from Alicat's website by navigating to alicat.com/profibus/ and then selecting the appropriate tab at the bottom of the page.

Alicat GSD files are forward but not backwards compatible. Networks which use a mixture of old and new devices should use the legacy GSD. The GSD file takes precedence over this document in any discrepancy.

Broadly, the steps for commissioning a new device are:

1. Power the device on and assign it a PROFIBUS slave address
2. Add the GSD File and slave address to your PROFIBUS master's configuration.
3. Change the default parameterization values the master will pass to the device (optional).
4. Select the I/O modules the master will produce/consume from the device.
5. Connect the device to the PROFIBUS network

Setting the Slave Address

New Alicat PROFIBUS instruments are preset to slave address 125. The easiest way to change this is through the front panel. The button sequence `MENU ➜ ADV SETUP ➜ COMM STATUS ➜ PROFI-BUS ➜ SLAVE ADDR` opens a menu which allows any address from 1–125 to be set at any time. Changing the address of a device while it is running will interrupt communications.

The slave address can also be changed over the PROFIBUS interface with any network provisioning tool which can act as a class 2 PROFIBUS master. Alicat devices will accept the SAP 55 set_slave_addr telegram while in the wait parameterization state only. Details of the state behavior are provided in the next section.

Any changes to the address take effect immediately and are saved to non-volatile memory.

Setting Device Parameters

Most configuration parameters are defined by the PROFIBUS standard and set automatically by the network master during normal operation. Two user-definable parameters will change the behavior of the device: The *Gas Select* parameter and the *Totalizer Rollover* parameter.

Gas Select Parameter

The default value for this parameter is "keep current" (value=30, 0x1E). This tells the instrument to use the same gas as the last time the device was powered up. Use this to keep the factory default gas. Choose any valid gas by changing this parameter. Consult the GSD file for appropriate values. "Extended gas select" is reserved for future use. After parameterization, you can still select change the selected gas using the command word as described in the next section, or with the front panel.

Totalizer Rollover Parameter

The default value for this parameter is "Rollover with Error" (0x4000). This parameter only affects Alicat flow instruments equipped with totalizers. Other valid options are: No Rollover with Error (0x0000), and Rollover with No Error (0x8000).

Setting an I/O configuration

The default I/O configuration of any instrument is:

| Module 1	"Readings"	(0x42,0xA4,0xA4,0x01)
Module 12	"Req Setpoint"	(0x82,0x83,0x83,0x0B)
Module 13	"Control Req"	(0x82,0x00,0x00,0x0C)

Choosing a custom configuration for each instrument can reduce network overhead or add control features to the device. The following pressure gauge configuration would reduce the data size from 42 bytes to 6 bytes:

Module 2	"Pressure"	(0x42,0x03,0x03,0x02)
Module 10	"Status Reg"	(0x42,0x00,0x00,0x0A)
Module 13	"Control Reg"	(0x82,0x00,0x00,0x0C)

The Cyclic I/O chapter details these functions. Once parameters and I/O configuration are set, commit your changes to your PROFIBUS masters and connect your instruments to the network. Configuration should occur automatically when the master is set to "run" mode. A green light on the top of the Alicat indicates a device was successfully configured and is exchanging data with a master.

Device States and Behavior

The Alicat PROFIBUS Interface switches between discrete states while it waits for specific configuration data from an automation system.
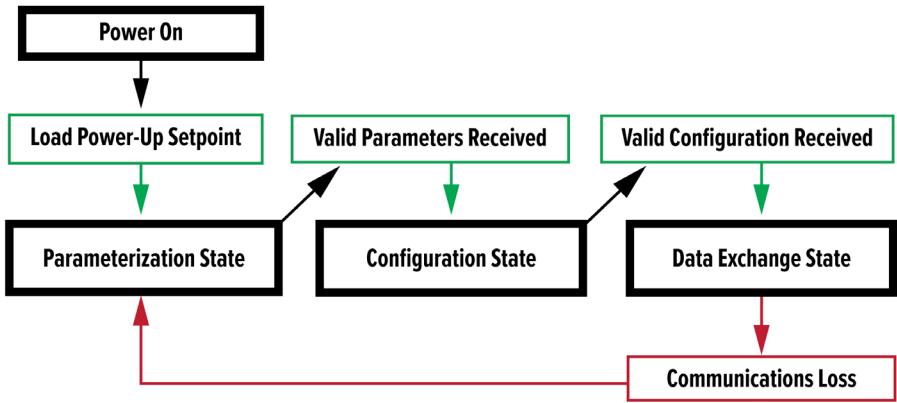
Power on state

On power up a device will attempt to detect a connected PROFIBUS network and to match the baud rate of that network. It supports all standard baud rates given in the PROFIBUS specification.

Once a baud rate is detected, the instrument switches to the wait parameterization state.

Wait Parameterization State

On entering this state the device waits for a valid SAP 61 SET_PRM telegram from a PROFIBUS master. Invalid parameterization telegrams, address changes, and most system faults will return the device to this state.

This is the only state where you can change the device's slave address over PROFIBUS by sending the SAP 55 SET_SLAVE_ADDR telegram.

Once the device receives valid parameters from a master it will switch to the wait configuration state.

Wait Configuration State

In this state the device is locked to the master which sent the parameterization telegram. The device waits until it receives a valid SAP 62 CHK_CFG telegram from its master. It will ignore configuration data from other masters.

Data Exchange State

In this state the instrument exchanges cyclic I/O data with master. If communication is lost during data exchange, the unit will return to wait parameterization mode. On re-establishing communication after an unplanned interruption it will send a diagnostic telegram.

Cyclic I/O data is grouped into 3 distinct telegrams:

- The instrument sends Input telegrams to the master
- The instrument receives output telegrams from the master
- The instrument sends diagnostic telegrams if it encounters a problem.

The "Cyclic IO" section of the manual explains how to interpret the data contained in these telegrams.

Fail Safe Behaviors

By default, when a controller leaves the data exchange state for any reason it will return to a 0 setpoint. Alternatively, you can set the device to retain the last good setpoint received from its master. This setting is accessible through the front panel by pressing: **MENU → ADV SETUP → COMM STATUS → PROFI-BUS → SETPT ON EXIT DATA EX**. This setting can also be changed using the setpoint configuration bit in the command module as documented in the next section.
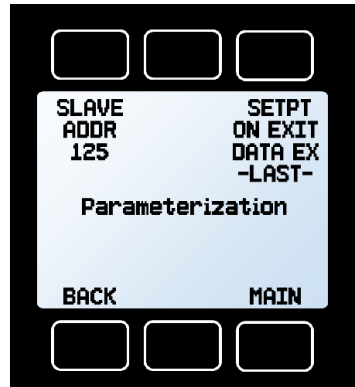
In addition to the above fail safe behavior, all controller devices will jump to a saved *power-on setpoint* when they first boot. By default this setpoint is zero, but other values can be provided. A device with a nonzero power-on setpoint will begin actively controlling from the moment it turns on, before communication has been established. You can change the power-on setpoint by using the control register.

Finally, the PROFIBUS interface does not support zero-length fail-safe telegrams from a PROFIBUS master. By convention, a PROFIBUS master transitioning to clear mode due to a fault or stoppage will send a zero setpoint to all Alicat PROFIBUS controllers.

Device Control & Data Formats

Input Telegram Structure

Input telegrams contain the modular data from the device you defined in the "Setting an I/O configuration" section. Depending on your configuration this data will contain some combination of the following:

Process Value(s)

Process values are transmitted as 4-byte IEEE 32-bit floating-point numbers. The units for any value are the engineering units of the device, usually the defaults selected when the device was ordered. You can change these units by changing the device units through the front panel, as outlined in the instrument manual for the device.

If an instrument doesn't support a reading it will output zeros.

The PROFIBUS adapter may not receive an updated process value every telegram. In these cases it will resend the previous value.

Gas String(s)

Gas strings are transmitted as 8-byte, null-terminated, alphanumeric strings. Gases with short names like H_2 will fill the unused bytes with zeros.

Status Byte(s)

Device alarms are transmitted as High bits as part of a single status byte:

Bit	7	6	5	4	3	2	1	0
Status Byte	0	R	X	Z	T	M	V	P

R: Temperature Over Range (`TOV`)

X: Overpressure Limit Exceeded (`OPL`)

Z: Totalizer Missed Out of Range Flow (`TMF`)

T: Totalizer Rollover (`OVR`)

M: Mass Flow Over Range (`MOV`)

V: Volumetric Flow Over Range (`VOV`)

P: Pressure Over Range (`POV`)

Any condition that trips one of these bits will also result in a diagnostic telegram to the master.

PID variables

All 3 PID variables are transmitted as 6-byte block of sequential, big-endian, 16-bit integers. P, then I, then D. Adding these to your I/O can be useful when sending PID values using the command structure.

Output Telegram Structure

Depending on your I/O configuration this telegram will contain some combination of **setpoint**, **control register**, and **command modules**:

Setpoint Modules

Setpoints are transmitted as 4 byte IEEE 32-bit big-endian floating-point numbers**.** The units for the setpoint are the engineering units of the device, usually the default units selected when the device was ordered. You can change these units by changing the units through the front panel.

Control Register Modules

A control register is a single byte which controls 4 different functions on an Alicat.

Register Bit Description:

Bit	7	6	5	4	3	2	1	0
Control Register	0	0	0	0	E	P	V	T

E: Save the current setpoint as the power-on setpoint

P: Tare Pressure

V: Tare Volumetric

T: Tare Totalizer

The selected function will take place when a change to the control register results in a single bit being set to '1'. Only one control bit may be set to '1' at a time. Setting multiple bits to '1' will have no effect. The control bit should be set to '0' after the function is completed.

Command Modules

Warning: Most of these commands write values to EEPROM. EEPROMs have a limited number of write cycles. Automating commands can result in rapid EEPROM writes, corrupting device settings in a very short period of time.

A Command module is four bytes long. The first two bytes select a command, and the last two bytes are the argument or data for that command. Both the command and data are 16 bit, unsigned, big-endian integers. Any change to the command or data bytes will result in the command or data being checked for validity. If valid, the command will be executed.

Writing zeros between commands is a safe way to issue the same command multiple times.

Valid Commands are:

Command	Action
0 (0x0000)	Do Nothing
21 (0x0015)	Change P in PID loop
22 (0x0016)	Change D in PID loop
23 (0x0017)	Change I in PID loop
46 (0x002E)	Change Gas Select
65 (0x0041)	Change Setpoint Configuration

For the data bytes the following are valid:

Valid Values	Data Interpretation
0 to 65535 (0x0000 to 0xFFFF)	PID Parameters
0 to 29 (0x0000 to 0x001D) 30=Keep Current (0x001E) 140 to 210 (0x008C to 0x00D2)	Gas Number*
0, 32768, or 49152 (0x0000, 0x8000, or 0xC000)	Setpoint Configuration

* Typical preloaded gas numbers. Actual preloaded gases may vary.

Setpoint Configuration Bits

Valid Values	Meaning
0 (0x0000)	Unit will go to zero setpoint upon leaving data exchange. The unit will respond to setpoints given over PROFIBUS.
32768 (0x8000)	Unit will maintain last setpoint upon leaving data exchange. The unit will respond to setpoints given over PROFIBUS.
49152 (0xC000)	Unit will maintain last setpoint upon leaving data exchange. The unit will ignore setpoints given over PROFIBUS.

Diagnostic Telegram Structure

The Alicat PROFIBUS interface sends diagnostic telegrams whenever it encounters an over-range condition. The last two bytes of this telegram contain diagnostic information. The second to last byte is the extended diagnostic octet (0x02). The last byte is a copy of the **status byte** described in the "input telegrams" section and has the same format:

Bit	7	6	5	4	3	2	1	0
Status Byte	0	R	X	Z	T	M	V	P

R: Temperature Over Range (TOV)

X: Overpressure Limit Exceeded (OPL)

Z: Totalizer Missed Out of Range Flow (TMF)

T: Totalizer Rollover (OVR)

M: Mass Flow Over Range (MOV)

V: Volumetric Flow Over Range (VOV)

P: Pressure Over Range (POV)