



Integrated Flow Control Module for Slurries and Chemicals

LFC-7000



Operating Instructions
and
Quick-Start Guide

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Introduction

The LFC-7000 Series is a line of high-performance closed-loop flow controllers designed for use in a wide variety of high-purity liquids including DI water, harsh chemicals, and CMP polishing slurries.

A typical module for high-accuracy control of ultrapure chemicals combines Malema ultrasonic flow meter, with accuracy rated at $\pm 1\%$ reading, with Malema control valve. The ultrasonic flow meter has an all PFA construction with no moving parts or seals. It sets a standard for flow measurement in terms of accuracy, repeatability, turndown, and purity. Its digital signal processing technology ensures reliable performance even with a certain degree of bubbles present in the process fluids. The high speed/precision motor actuated pinch valve (for slurries) or diaphragm valve (for chemicals) helps provide a fast, precise response with minimal "overshoot". Its all PTFE construction and minimal dead volume ensure maximum process purity and reliability.

In operation, the user inputs a flow rate "set point" via an analog signal. The flow control electronic modules continuously compares this set point value with the flow rate reported by the flow meter and provides a continuous signal to modulate the control valve to maintain the desired set point. State of the art control algorithm together with a high speed/precision flow meter and valve achieves fast, accurate, and repeatable control.

Storage and Handling

Storage conditions

Store the product under packed condition in an anti-static bag. The storage place shall be free from moisture, mechanical shock and vibration. The ambient temperature shall be between 0°C and 60°C and the humidity between 5% and 80% R.H. without condensation.

Unpacking and Product Inspection

On delivery, check the product for damage. Confirm that the model code on the label matches the specification in the purchase order.

Installation Instructions

LFC 7000 series liquid flow control modules are equipped with inlet/outlet ports with Flare or S300 Pillar connections of 1/4", 3/8" or 1/2" size. The modules are available for mounting in either the vertical or horizontal directions. The module designed for vertical mounting is not recommended to be mounted in the horizontal direction and vice-versa.

It is important to note that the mounting direction is defined based on the orientation of the flow meter inside the module. Following the specified orientation ensures no trapped air pockets during usage. The module for liquid chemicals, without abrasive particles, is assembled with a diaphragm type control valve and the module for liquid slurries is assembled with a pinch type control valve. The envelope dimensions are influenced by the type of flow control valve and also the desired mounting direction. Refer to the drawings on page 10 for envelope dimensions.

Fluid Connections

The pipe ends should be flared with the correctly sized tool and the in/out ports are connected. Choose the appropriate fittings & flare tool for the required pipe size. Make sure the inlet and outlet pipes are flared and assembled perfectly so they are leak proof. This facilitates safety while in use with corrosive chemicals. Provide a shut off valve or bypass valve to facilitate the zero reset, inspection, and maintenance as well as for positive shut-off. Avoid piping stresses and torque on the module ports. Over-tightening the nuts at the inlet and outlet may loosen the bulk head fittings.

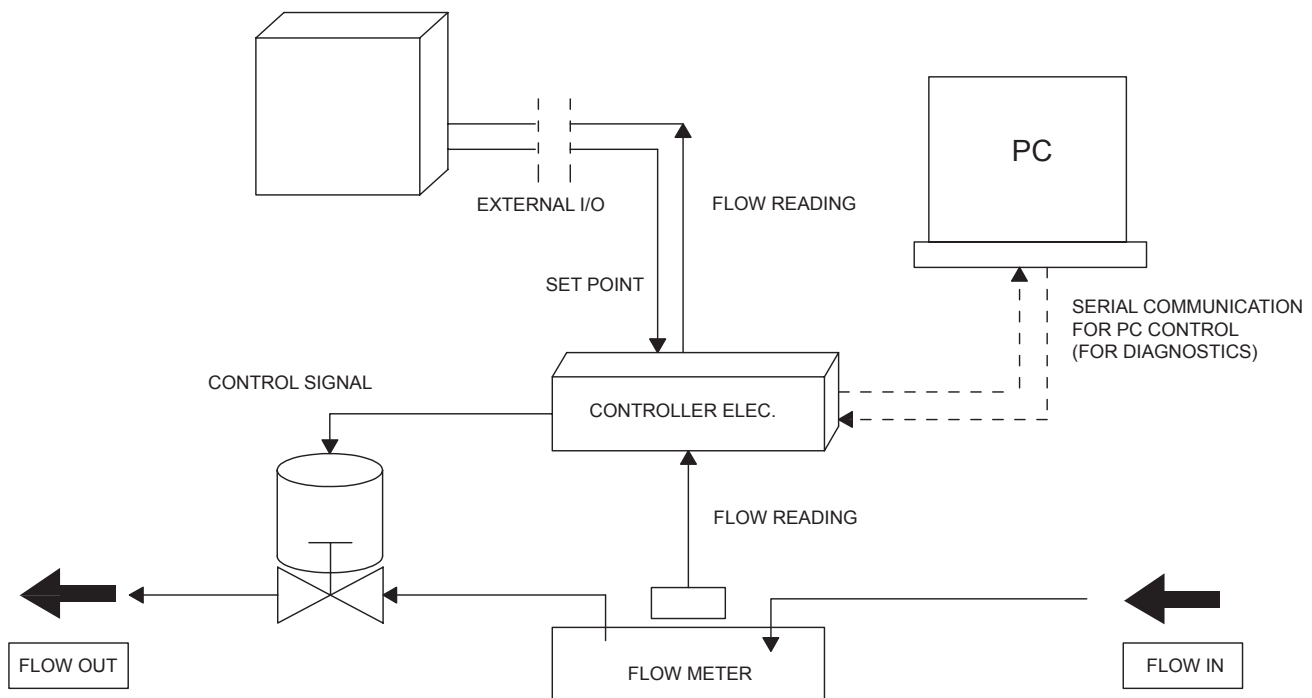
It is always recommended that the inlet port should be at a lower level than the outlet port. This eliminates air entrapment during flow measurement.

Operating Environment

Choose a location with ambient temperature 10-40°C and relative humidity value <80% RH without direct sunlight. Avoid environments with high electromagnetic noise or vibration. Make sure that the module is protected from corrosive liquid or water splashes. For Best performance avoid these environments (corrosive liquids and/or vapor) since they may degrade the performance of the electronics after a period of time. Easy access for maintenance and inspection is always recommended.

Operating Principle & Block Diagram

The user inputs a “set point” using either an analog signal or a PC GUI command. The flow control module’s electronics continuously compares the set point value with the measured flow rate and provides a continuous feedback signal to modulate the control valve in order to maintain the desired flow rate. Custom designed and user selectable control parameters insure fast response time and accuracy.



Operation

Safety: The inlet/outlet ports should be properly connected.

Parameter Setting

The parameters are preset at the factory prior to shipment as per the customer's specifications

Before Power-On

Confirm:

- a) Cables are properly connected to the terminals as per pin configuration of connectors.
- b) Supplied Voltage must be in accordance with specifications.
- c) Mounting orientation matches specifications.

After Power-On

Wait 5 minutes for the module to warm up prior to achieving the specified performance.

Zero Adjustment

Ultrasonic flow meters will show a signal error when the flow path is empty, or filled with large air pockets. The user should make sure that the flow path of the module is filled with process fluid before adjusting the zero. The fluid needs to be at rest, in order to complete an accurate zero adjust. Malema recommends using a shut off valve to bring the fluid to rest.

The Zero Adjustment is performed by momentary supplying 24 Vdc to pin#11. (Malema recommends using a momentary push button). Please make sure that the power supply to pin#11 is momentary and not continuous. It takes less than 5 seconds for zero adjustment. If this wiring setup is not adopted, the zero adjustment can be done using the Malema PC communication software. Please refer to the manual for the Malema UFM PC communication software.

It is not necessary to do a Zero Adjustment whenever the power is turned on, only when there is a change in the process fluid properties.

Confirmation of Flow Through the Module

This procedure ensures the proper functioning of the flow controller. If a set point value of 2Vdc is given to the module with 0-10Vdc input, which is equal to 20% of the full scale flow, the controller accepts the set point value and adjusts the control valve to deliver 20% of the full scale flow. After 10 seconds, observe the analog output from the module. This should be equal to 20% of the full scale flow (for example: in case of 4-20mA, 20% analog signal will be 7.2 mA). An unstable flow value or a zero may indicate that there are air bubbles present in the flow path that need to be eliminated.

Flow Controller Configuration

The LFC-7000 series flow controller is configured at the factory and calibrated with DI water. The parameters should be modified by an authorized service technician only.

The configuration of the flow controller is done by using custom communication software. This software is installed on a PC. Connect the PC to the unit using a special 6 pin communication cable (PN#: CABLE-LFC-PROG-001). The 6 pin communication port on the unit is located just below the 12 pin main electrical connector. A detailed software operations manual is available with all Malema service personnel.

Alarm Output**a) Alarm 1 - "PID Control Error Alarm"**

Controller is supposed to meet the control accuracy within 3 seconds in normal use.

In case the flow rate does not meet the set point, the control valve action with maximum torque can last for a long time, and may put unnecessary strain on the control valve. When this condition lasts for longer than the set time (configurable, default value is 15 seconds), the controller considers this situation abnormal, activates the alarm signal, and then stops controlling.

b) Alarm 2 - "Sensor Signal Strength Alarm"

This alarm signal is given when flow sensor is in "Empty Sensor" state. "Empty Sensor" means that the flow sensor does not have a qualified sound signal, e.g., the sensor is not fully filled up with fluid, namely, bubble(s) or foreign matter are in the flow sensor, or when the sensor cable is disconnected.

Inspection

Malema advises the user to inspect the flow controller periodically to ensure that there are no visible signs of leakage and electrical connections/cables are secure and damage free.

The following is a checklist to ensure all inspection points are covered.

- a) No excessive heat generation inside apparatus
- b) No excessive piping stress by bending
- c) No vibration on piping system
- d) No liquid leakage, no penetration, no condensation
- e) No air bubbles, no contamination in piping
- f) Firm wiring on all terminals
- g) No damage on electric wiring in apparatus

NOTE: Refer to the PC communication software manual of Malema UFM/LFC for more details on device operation

Performance Specifications

Standard Full Scale Range	50 mL/min
	100 mL/min
	250 mL/min
	500 mL/min
	1000 mL/min
	1500 mL/min
	2500 mL/min*
	4000 mL/min*
	8000 mL/min*
	12000 mL/min*
Accuracy ** (for room temperature DIW)	±1% of set point or ±3mL/min (whichever is larger)
Repeatability **	± 1% of set point or ± 1 mL/min (whichever is larger)
Control Repeatability	± 0.5% of set point or ± 0.5 mL/min (whichever is larger)
Flow Control Time	< 3 sec
Fluid Temperature	10 - 60 °C ***
Ambient: Temperature / Humidity	0 - 40 °C / 30 - 80% RH, without Dew
Maximum Expected Operating Pressure	50 psig
Maximum Safe Internal Pressure	70 psig
Differential Pressure Range	7 to 30 psid

* The enclosure footprint may be larger for these flow ranges to meet the pressure drop specification. The minimum differential pressure requirements can be higher for these ranges.

** Please consult with Malema for tighter accuracy/repeatability needs.

*** Consult the factory for higher temperature application

Electrical Specifications

Electrical Input	24 Vdc ±10%
Consumption	Max 500 mA
Alarm Signals	Max 30 Vdc, 200 mA NPN open collector
Control Signal In*	0 to 10 Vdc or 4 to 20 mA
Flow Signal out*	0 to 10 Vdc or 4 to 20 mA**

* Other options available

** Both Active and Passive options available

Material Specifications

Wetted parts for Modules of Slurry Application	PFA, PTFE, Pt cured Silicone*
Non wetted parts, enclosure	PPS, PEEK, Acrylic, Vinyl, PVC**

* Only used in the Slurry Module

** Flame retardant (FMET4325)

Physical Specifications

Mounting Orientation	Horizontal or Vertical
Fluid Connections	Inlet/Outlet: 1/4", 3/8", or 1/2"; Flare or Pillar
Flow Restrictions (orifice)	> 2 mm
Ingress Rating	IP64

Power and Signal Connections

It is always recommended to use a dedicated power supply with 24 Vdc ($\pm 10\%$), 500mA. The configuration of the 12 pin-connector and its mating cable is given in the table below. A communication cable with a 6 pin connector can be ordered separately to interface with the PC GUI program.

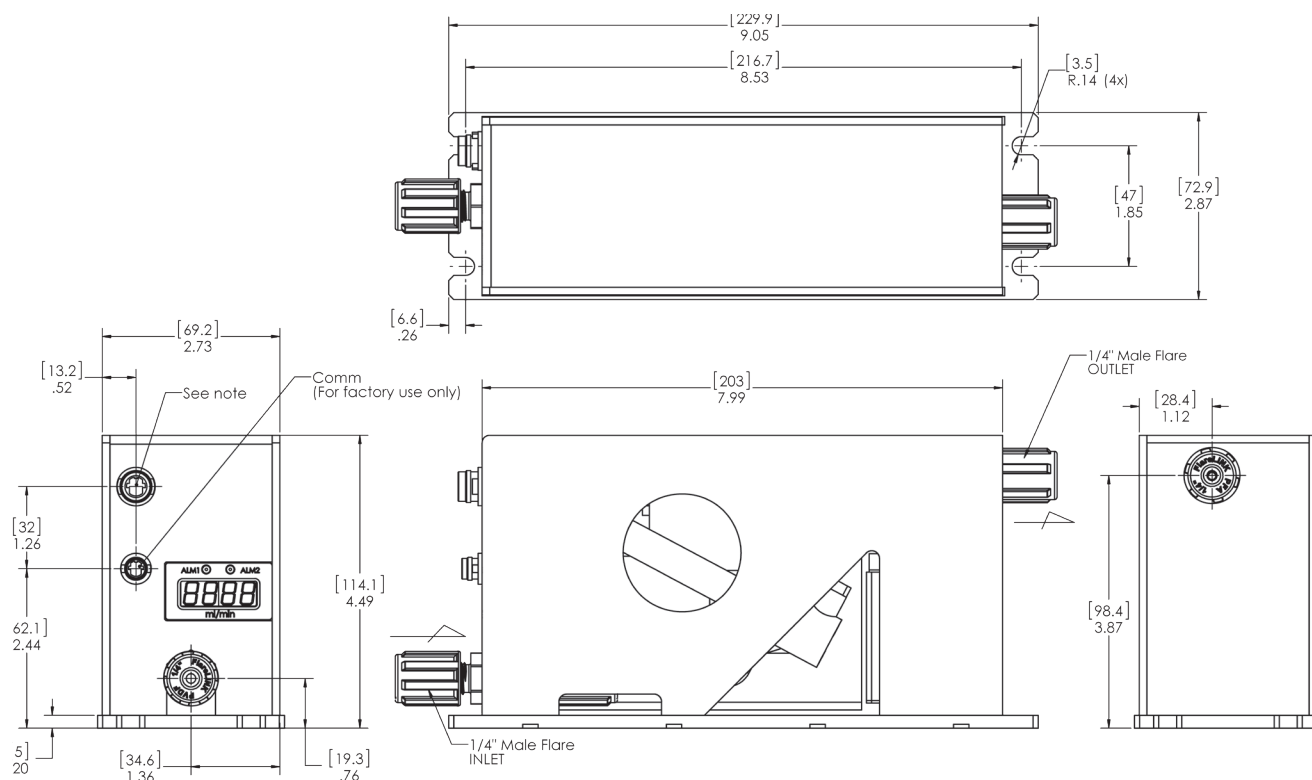
Custom pin configurations and connectors are available upon request.

12 Pin Connector Configuration				
Pin No.	Wire Color	Description	Specification	Remarks
1	Red	Power (+) 24 Vdc	24 Vdc $\pm$ 10%	
2	Black	Power (-) 0 Vdc		
3	Pink	Set Point (+)	4-20 mA or 0 - 10 Vdc	
4	Gray	Set Point (-)		
5	Blue	Flow Out (+)	4-20 mA (Max. load 900 ohm) or 0 - 10 Vdc	
6	White	Flow Out (-)		
7	Red/Black	Valve Alarm (+)	Max. rating 30 Vdc, 200 mA	Open Collector Output
8	White/Black	Valve Alarm (-) (0V)		
9	Yellow	Sensor Alarm (+)	Max. rating 30 Vdc, 200 mA	Open Collector Output
10	Brown	Sensor Alarm (-) (0V)		
11	Green	Zero Adjust*	0 Vdc: Normal operation 24 Vdc: Zero Adjust	Pull up to power supply voltage to start zero adjustment
12	Violet	No Connection		

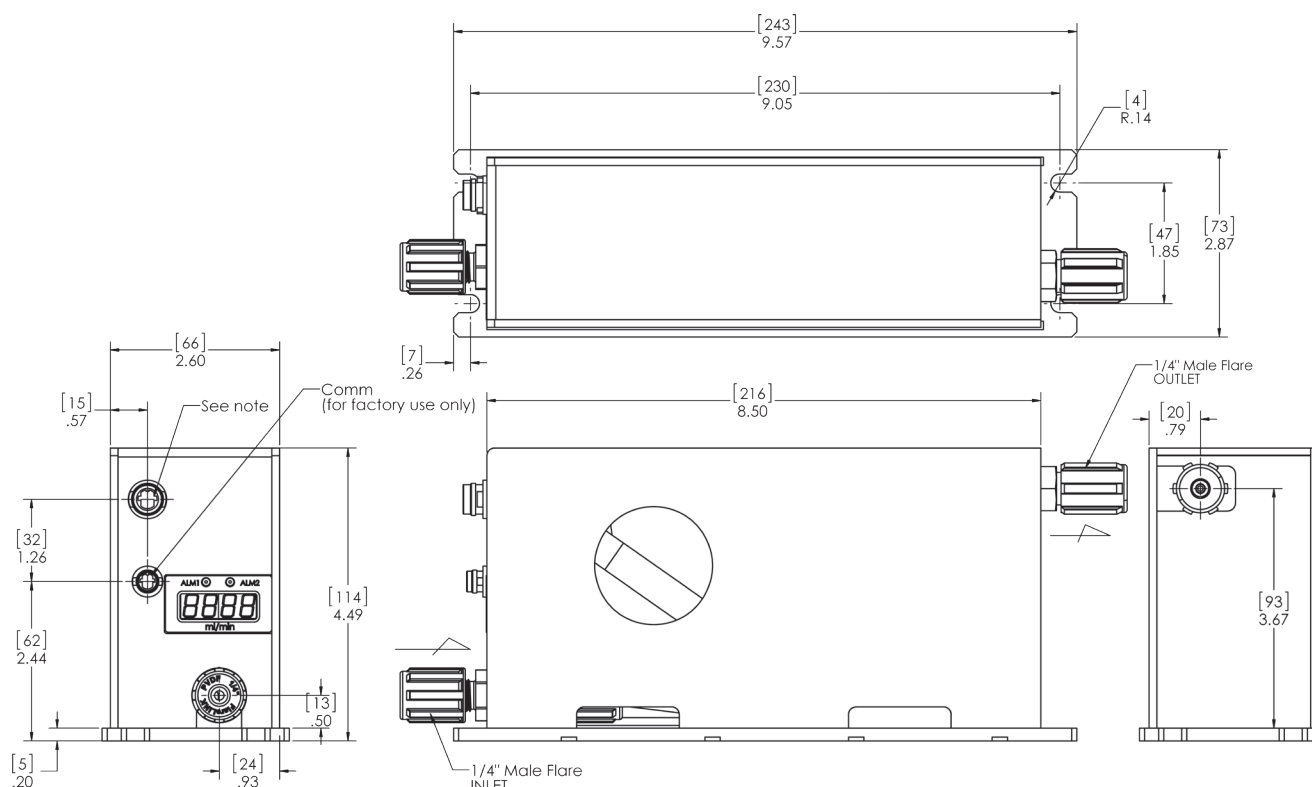
* Make sure the flow is completely stopped before zero adjust.

Dimensional Drawings (Horizontal Modules)

Chemical Version



Slurry Version



LFC-7000

Order Information

INTEGRATED FLOW CONTROL MODULE

Model Code														Description
LFC-700	*	-	*	*	*	*	*	-	*	*	*	-	***	
Alarms and Display	0													No Alarms or Display
	1													Alarms and Display on Top Panel
	2													Alarms and Display on Front Panel
		-												
Tube Size		2												1/4"
		3												3/8"
		4												1/2"
Connection Type		1												Flare Ends
		2												Super Pillar 300
Standard Full Scale Range		0												50 mL/min
		1												100 mL/min
		2												250 mL/min
		3												500 mL/min
		4												1000 mL/min
		5												1500 mL/min
		6												2500 mL/min
		7												4000 mL/min
		8												8000 mL/min
		9												12000 mL/min
Sensor / Converter		1												M-2111 (6 mm) / DSP
		2												M-2111 (4 mm) / DSP
		3												M-2111 (10 mm) / DSP
Input / Output		1												0 to 10 Vdc / 0 to 10 Vdc
		2												4 to 20 mA / 4 to 20 mA
		3												0 to 10 Vdc / 4 to 20 mA
		4												Others
		-												
Valve Type		1												Diaphragm Valve
		2												Pinch Valve
Mounting Orientation		1												Horizontal
		2												Vertical
Accessories		1												without plug connector
		2												with plug connector and cable
		-	xxx											Unique PN identifier

Warranty

Malema Sensors warrants to the buyer that its products are free from defects in materials and workmanship at the time of shipment and during the WARRANTY PERIOD. Malema Sensors obligation under this warranty is limited to the replacement of the product(s) by same product(s) manufactured by Malema Sensors or repair of the product(s) at the Malema Sensors facility. Malema Sensors products are sold with the understanding that the buyer has determined the applicability of the product(s) to its intended use. It is the responsibility of the buyer to verify acceptability of performance to the actual conditions of use. Performance may vary depending upon these actual conditions.

Warranty Period

This warranty is in effect for twelve (12) months from the date of shipment from Malema Sensors place of business.

Warranty Claim

If Malema Sensors products are found to be defective in materials or workmanship within twelve (12) months of the date of shipment, they will be repaired or replaced with same product at the discretion of Malema Sensors at its place of business at no charge to the buyer.

Service and Repair

To return the products, please obtain an RMA number for the product by contacting Malema Sensors (Corporate Office), Boca Raton at (800) 637-6418 or (561) 995-0595.

All returns of equipment must go to the following address:

Malema Sensors,
1060 S Rogers Circle
Boca Raton, FL 33487, USA