



Selection & Sizing of Thermal Mass Flow Meters & Mass Flow Controllers

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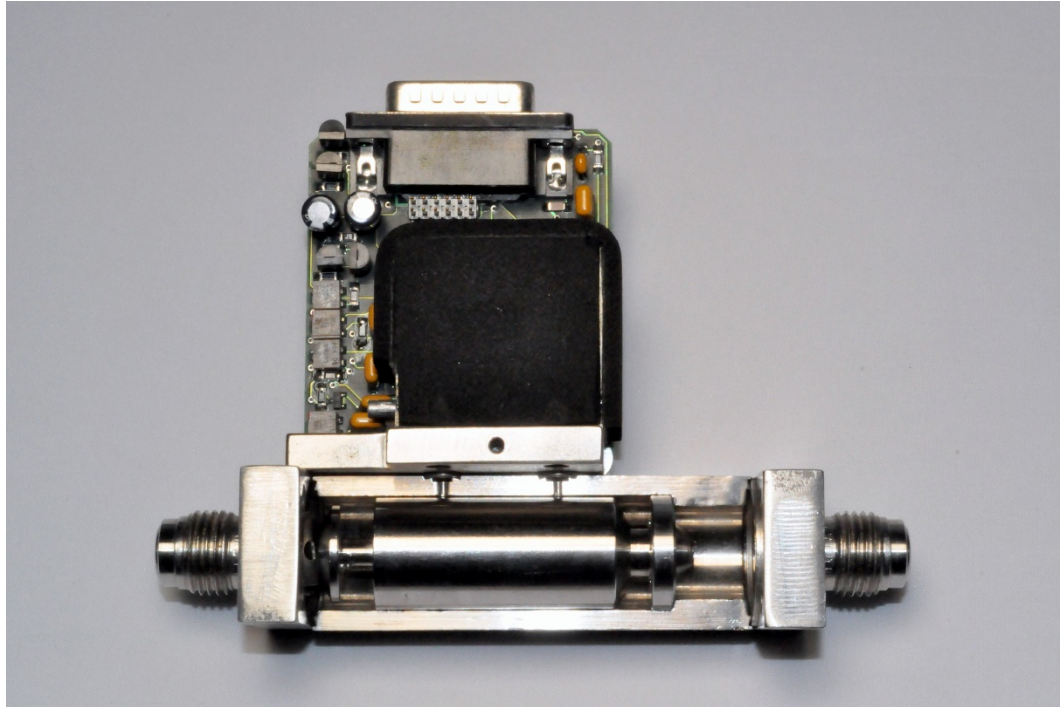


Agenda

- Basics of Mass Flow Meters
- Nitrogen Equivalent Flow
- Considerations for Selection
 - Pressure Drop
 - Environment
- Basics of Mass Flow Controllers
 - Valve Operation
 - Control Loop
- Sizing Valves
 - Flow Rates & Pressures

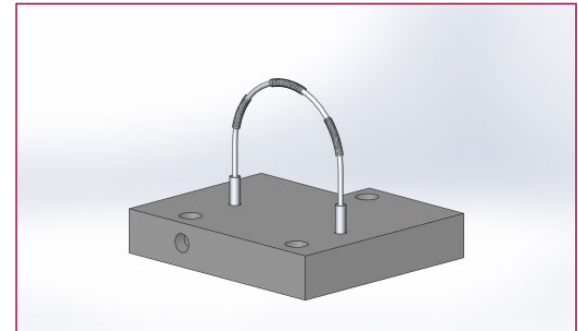
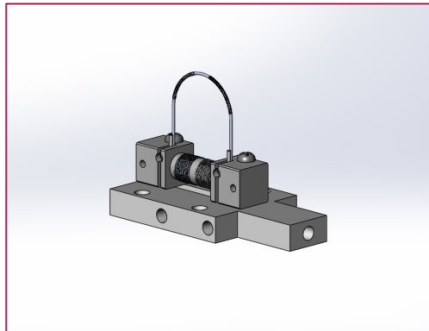
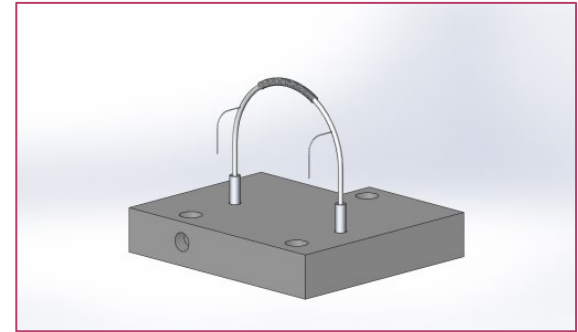


Flow Meter Cutaway



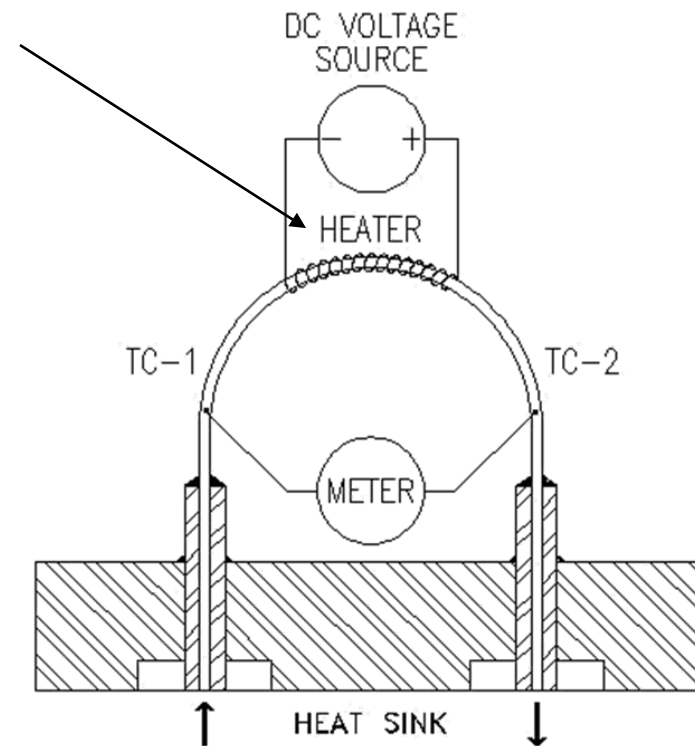
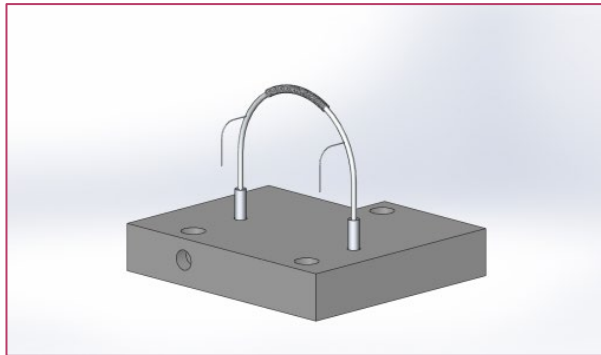
Basics of Thermal Mass Flow Meter

- Mass Flow Sensor Designs

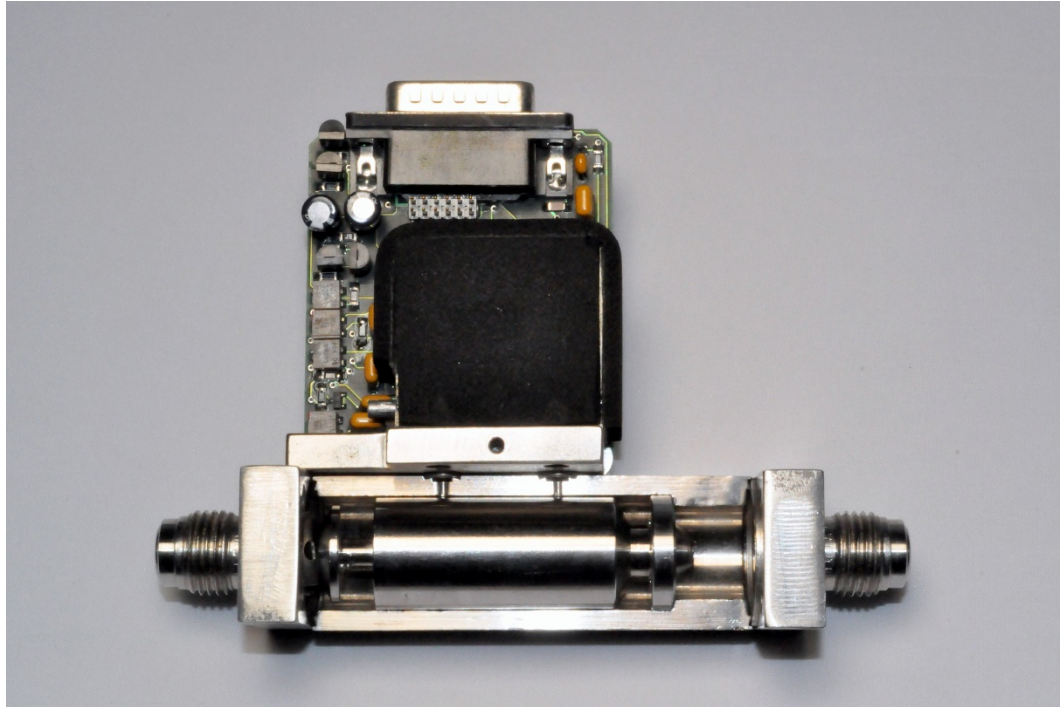


Basics of Thermal Mass Flow Meter

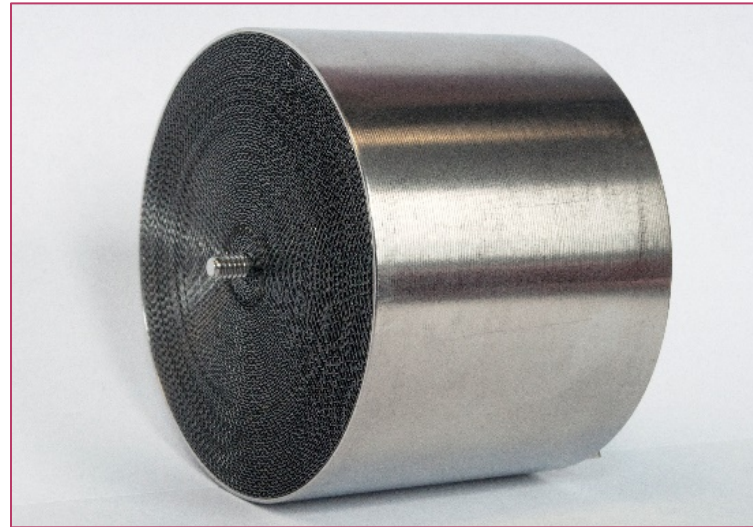
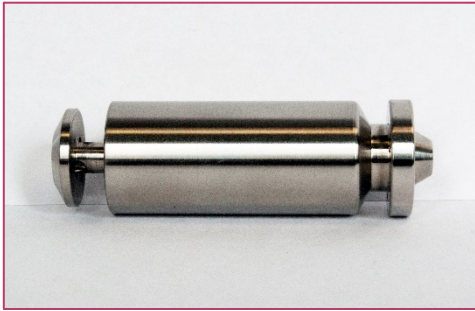
Constant temperature heater



Flow Meter Cutaway



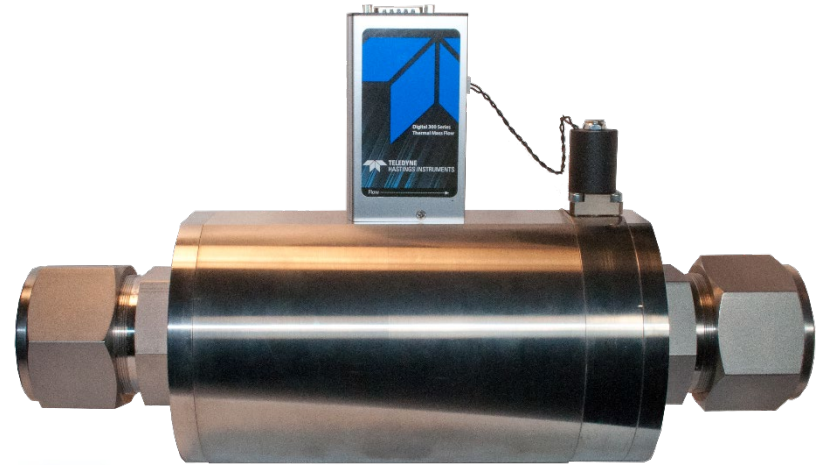
Bypass Shunt





Flow Meter Sizing





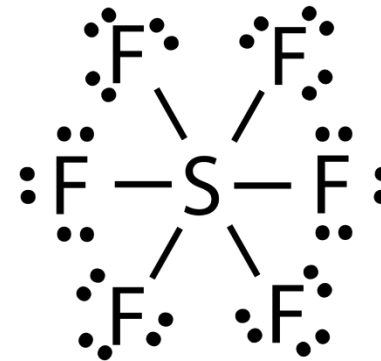
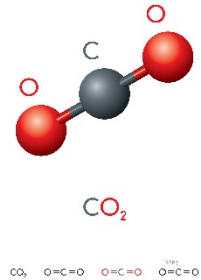
Nitrogen Equivalent Flow

- Conversion for Units

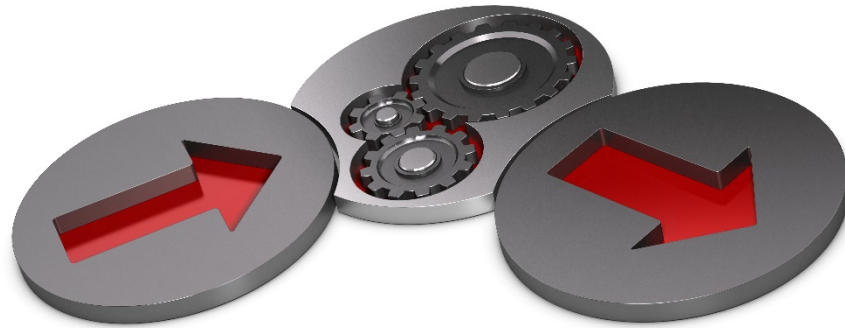
- scfm, scfh
- lbs/min, lbs/hr

- Conversion for Gas

- 1 slm He \equiv 0.713 slm N₂
- 1 slm CH₄ \equiv 1.299 slm N₂



Example: Nitrogen Equivalent Flow (nef)



Given:

300 scfh Methane

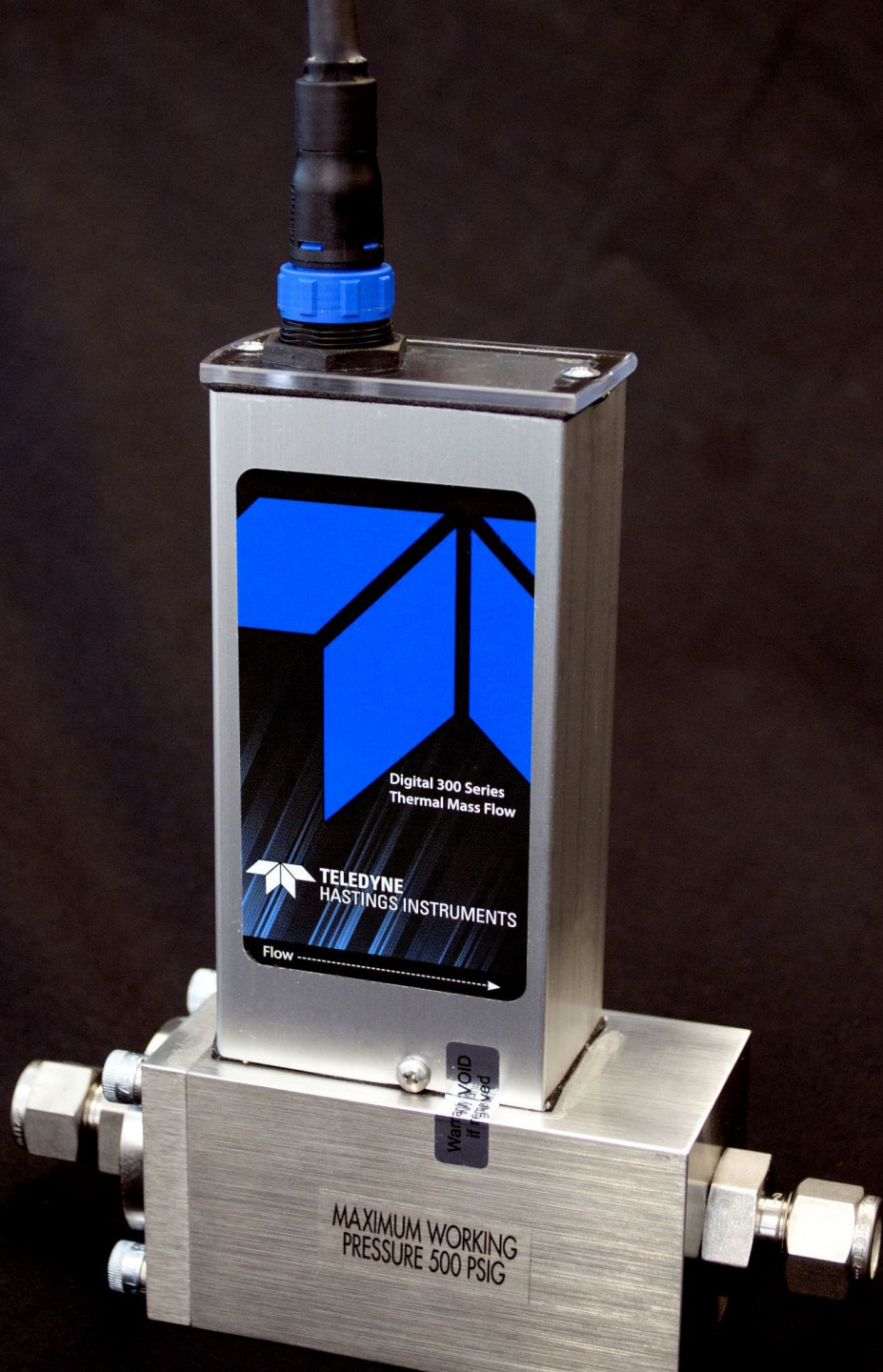
nef:

183.9 slm Nitrogen

Other Considerations

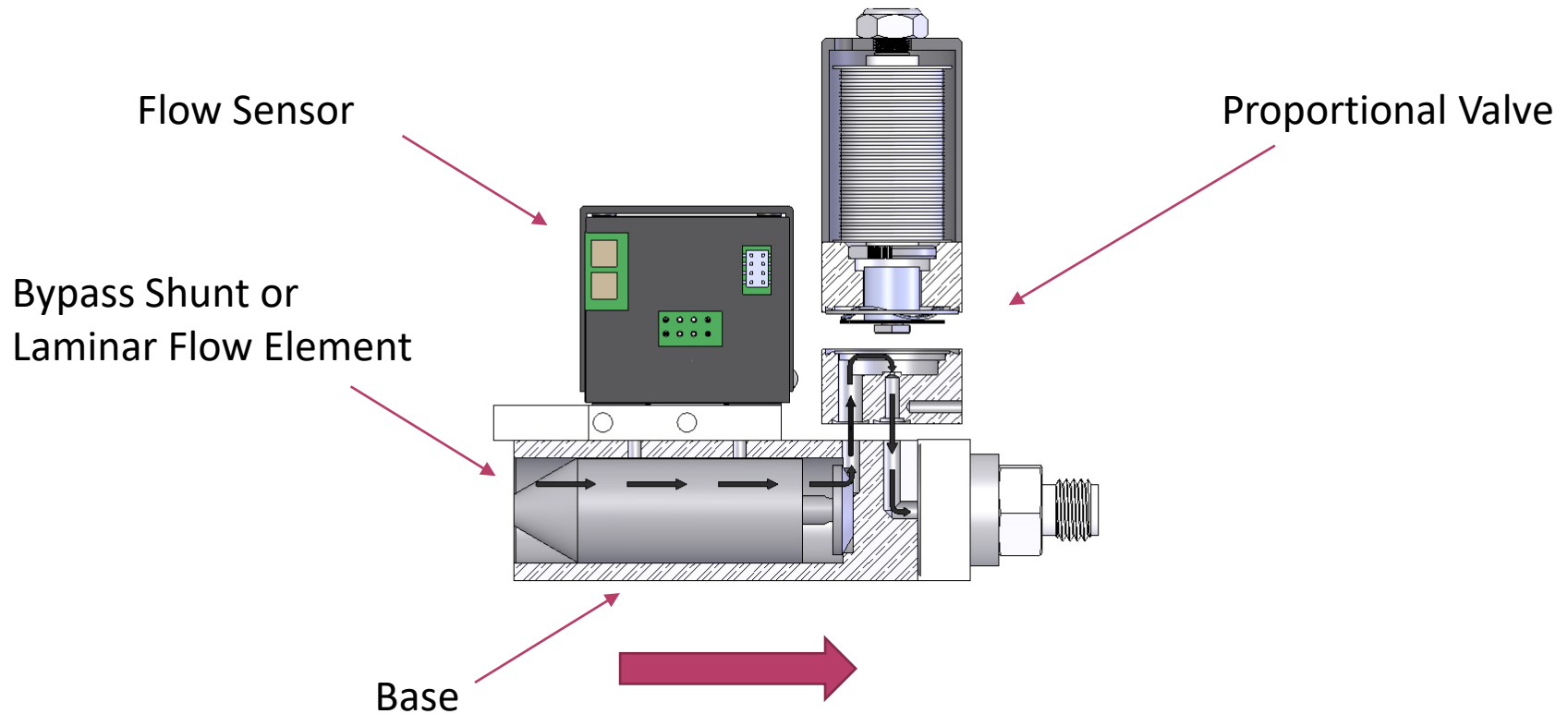
- Pressure Drop
- Installation
- Environment
- Outputs (Analog & Digital)
- Local Display



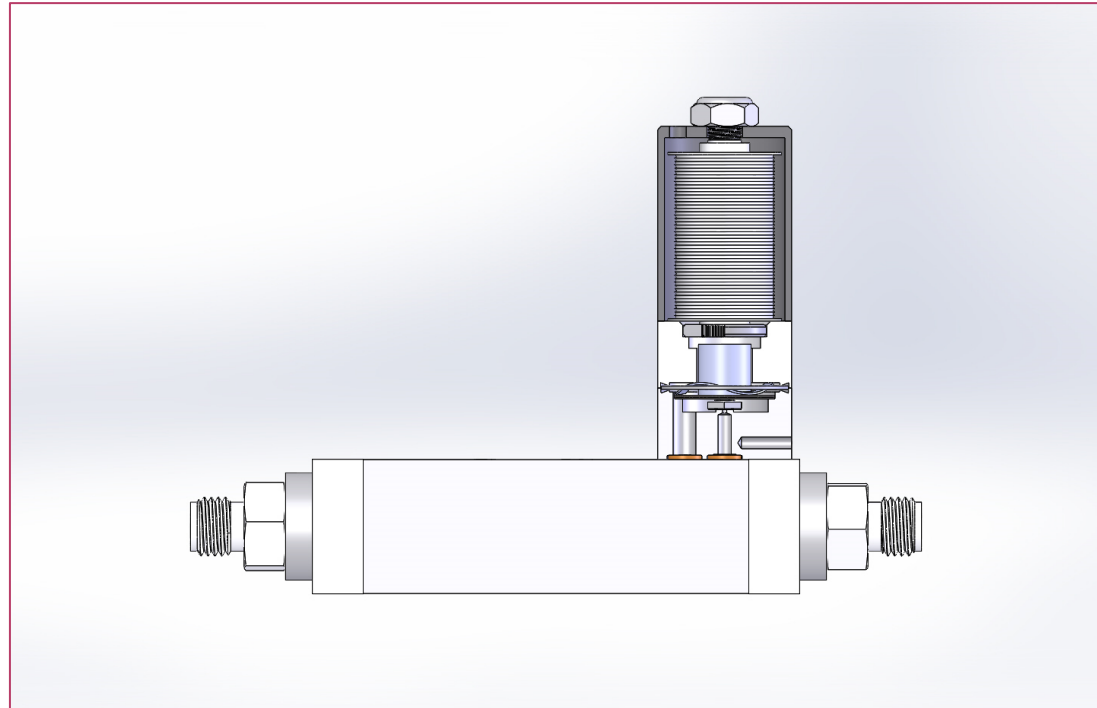


IP-67
Enclosure

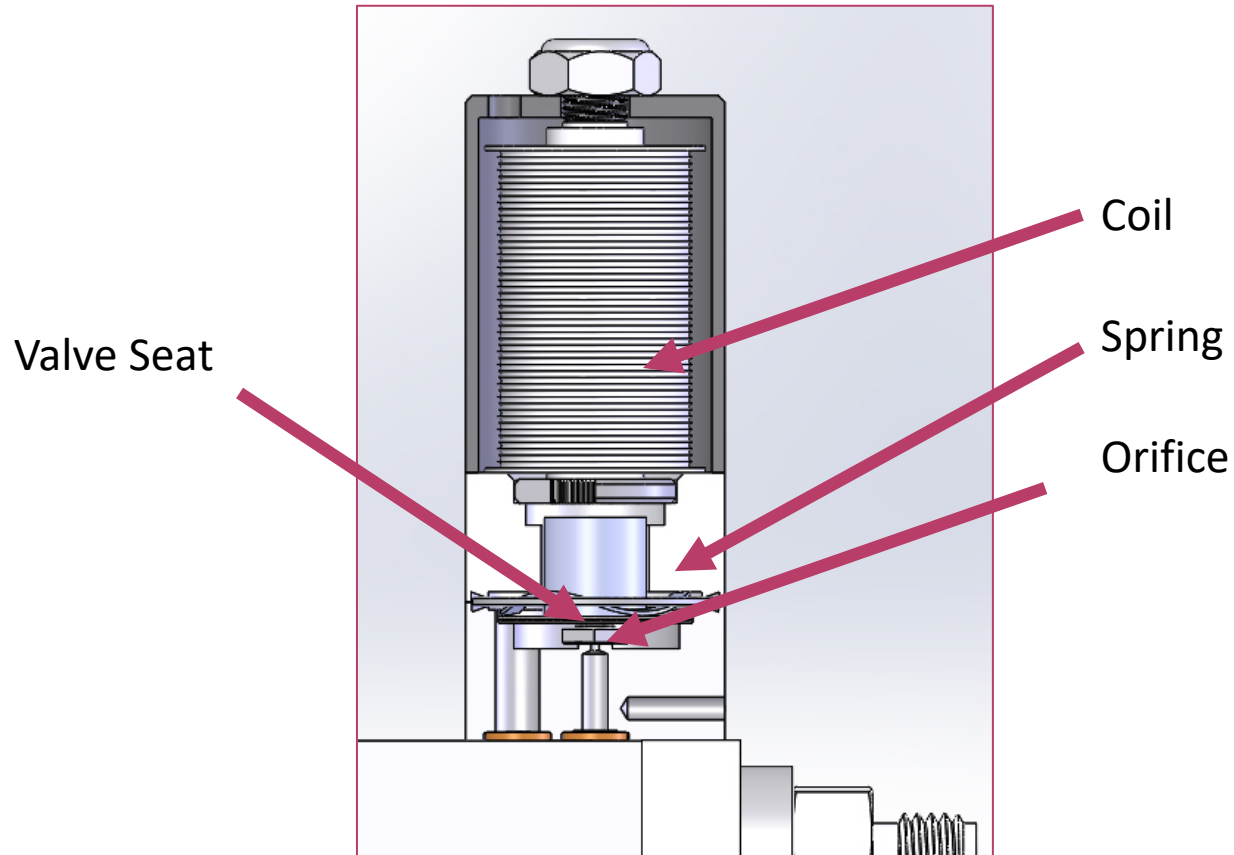
Mass Flow Controller - Overview



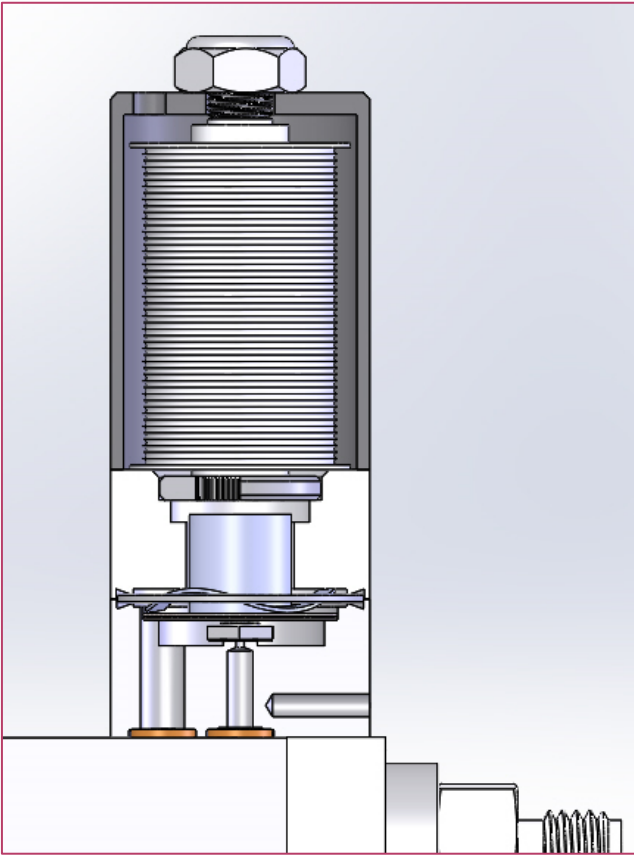
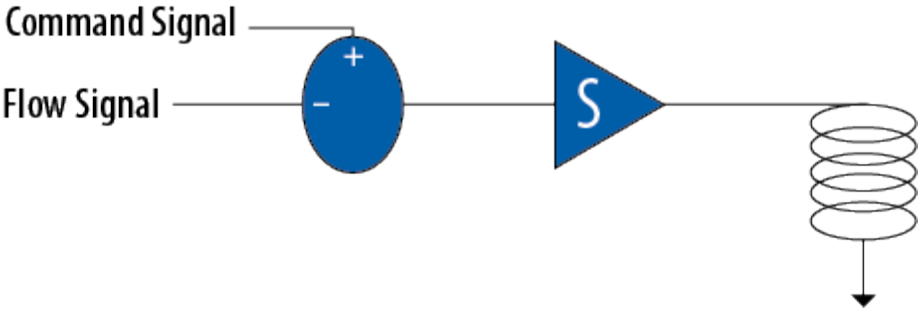
Mass Flow Controller - Valve



Mass Flow Controller - Valve



Control Loop



Orifice Equation (Simple)

$$D = \sqrt{\frac{0.0028 * \sigma * Q}{P_u}}$$

Where $P_u > 2 * P_d$

D: Orifice Diameter (inches)

σ : Specific Gravity of the gas

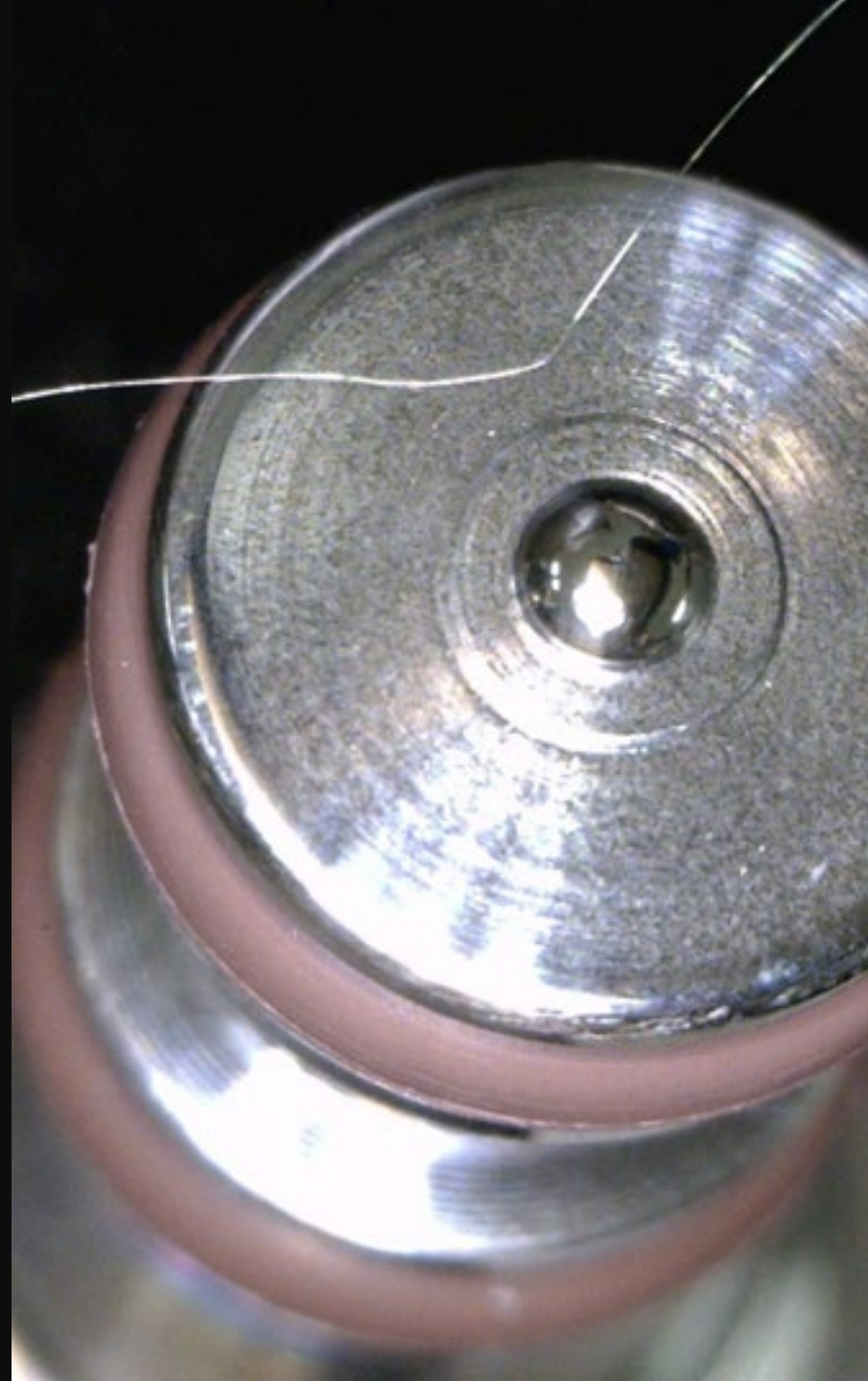
Q: Flowrate (slm)

P_u : Upstream Pressure (psia)

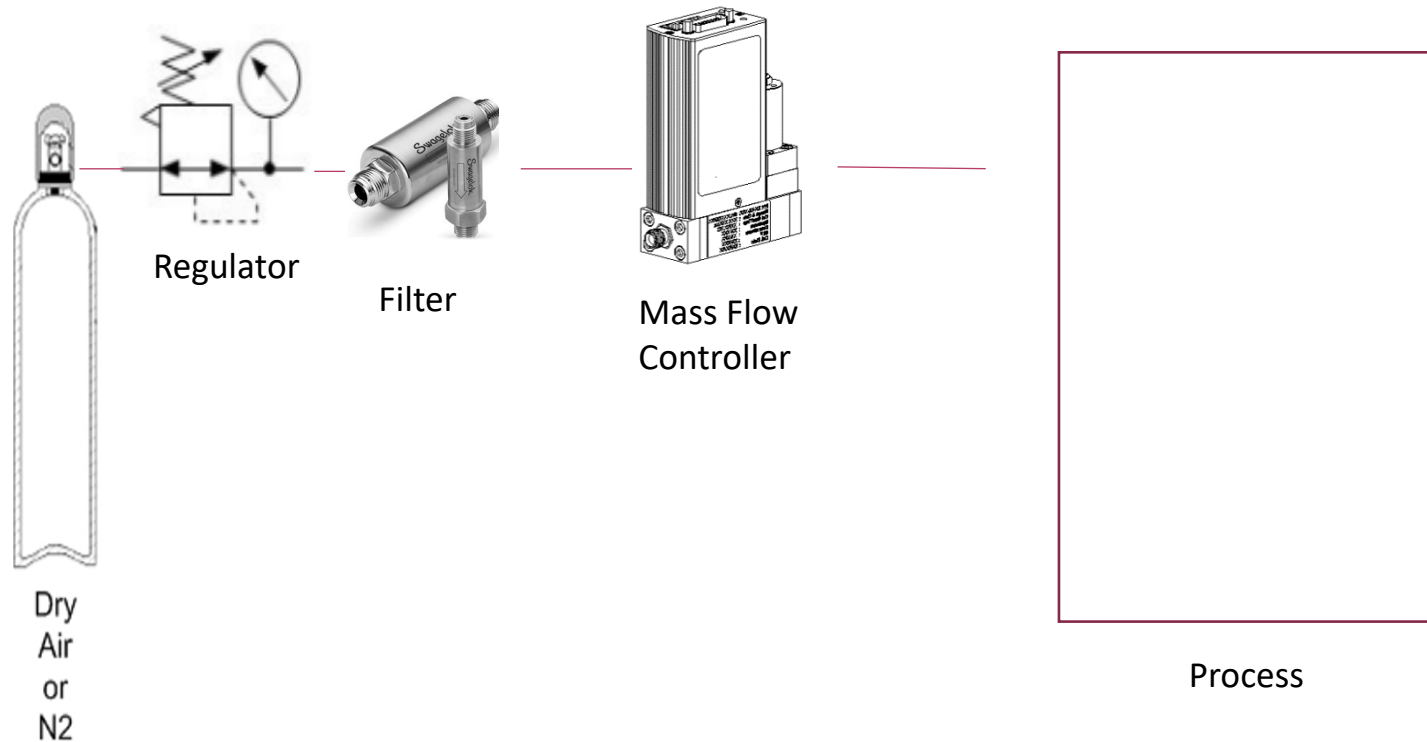
P_d : Downstream Pressure (psia)

Orifice Sizing Considerations

- Flow Rate
 - Gas Type
 - Pressures
 - Upstream
 - Downstream
 - Application
 - Downstream Regulation
 - Fill Application
-



Upstream & Downstream Pressures



Mass Flow Controller Calibration System

Maximum Upstream
Minimum Upstream



Maximum Downstream
Minimum Downstream

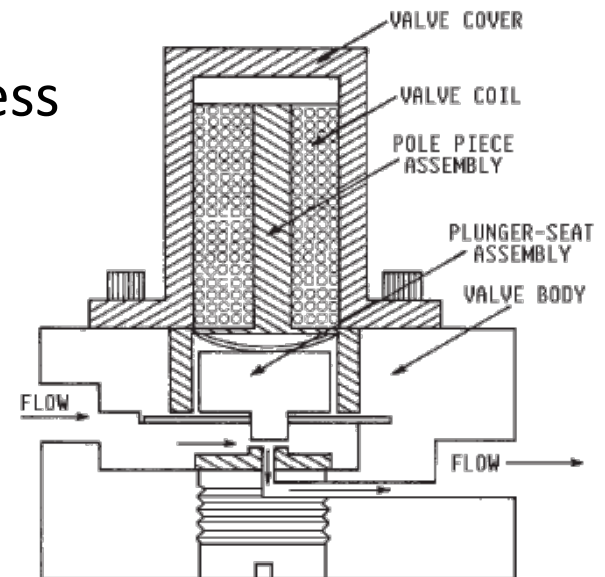


FLOW

ΔP for Valve Control

ASK US!

- Typically, Pressure Drop must be at least 15% of the Upstream Pressure
 - Some applications require more
 - Some applications can function with less
 - Ask us... we can help!



Sketch
often
helps!



Other MFC Selection Considerations

- Gas Compatibility
- Inputs/Outputs
- Power Supply
- Local Display



Material Compatibility



Interface to outside world

ANALOG INTERFACE

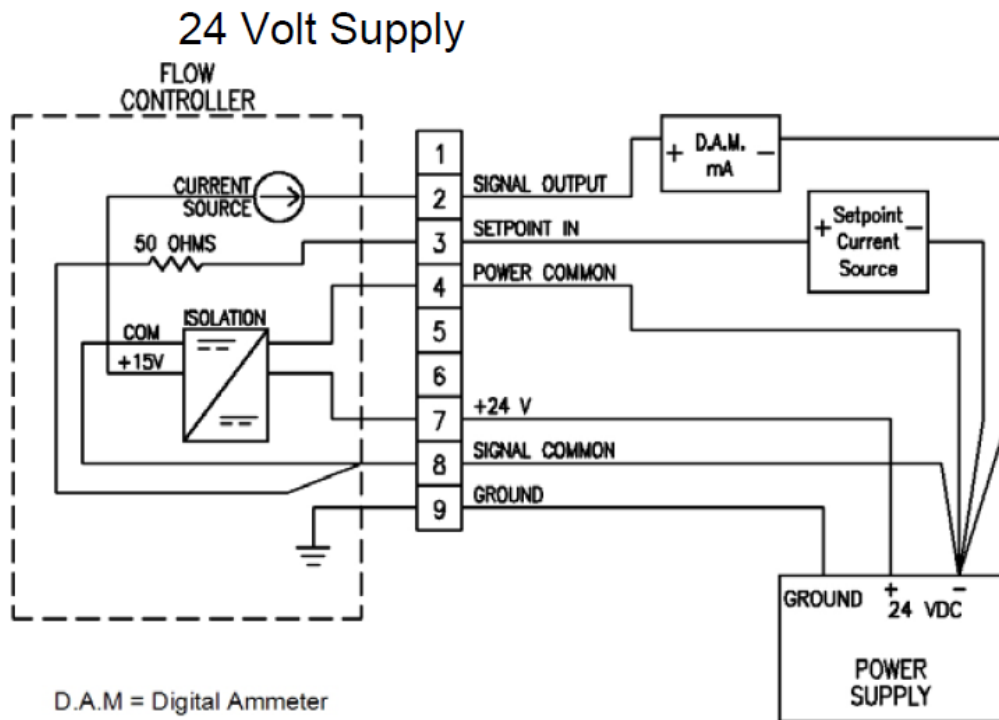
- 0 - 5 VDC / 0 – 10 VDC
- 0 – 20 mA / 4 - 20 mA

DIGITAL INTERFACE

- RS232 / RS485
- USB
- Ethernet

Certified LabVIEW Drivers

Installation/Wiring



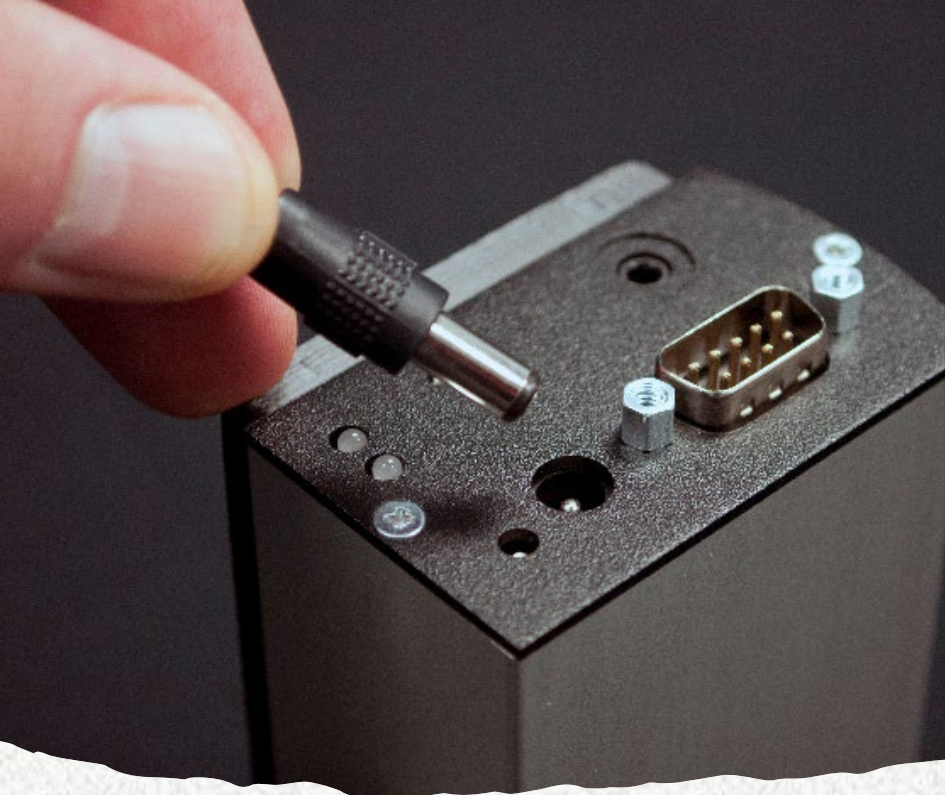
D.A.M = Digital Ammeter

Flow Signal Output is sourced from 15V Supply

Setpoint Signal Input is Sunk to Signal Common

Power Supply/Controller/Display

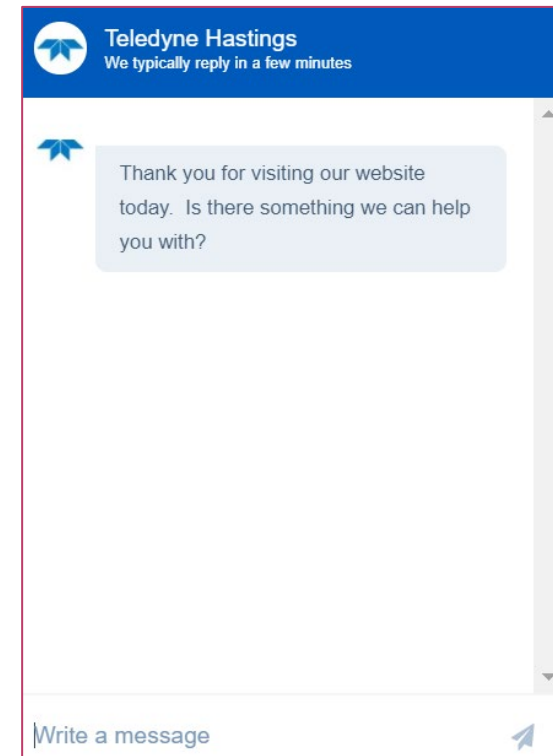




Easy!

Where to get help....

- LiveChat ww.teledyne-hi.com
- Phone 800-950-2468 (757-723-6531)
- Email: hastings_instruments@teledyne.com
- Schedule Zoom Consult



Where to get help....



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- South Korea - InfoRAD





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Lifetime Technical Support

We are always here for you. If you have questions about measurement and control of gas flow or you want to discuss a new application - we are here to help!



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