qualiflow

AFC80MD/AFC90MD

QUALIFLOW Montpellier (headquaters)
350, rue A. Nobel
BP7- 34935 MONTPELLIER
CEDEX 9
France
tel: +33 4 67 99 47 47
fax: +33 4 67 99 47 48

QUALIFLOW Inc,
24 Goose Lane
TOLLAND CT-06084
CALIFORNIA - USA
tel: +1 860.871.92.33
fax: +1 860.871.92.33

QUALIFLOW Technology Center
909 Boggs Terrace
Fremont, CA-94539
CALIFORNIA - USA
tel: +1 510 440 93 74
fax: +1 510 440 93 75

QUALIFLOW NRT Korea
10 Block-17 Lot, Namdong Ind.
CLX. #623-16n Namchon-Dong, Namdong-Ku
KOREA
tel: +82 (0)2 3401 6491
fax: +82 (0)2 3401 6493

Identification					
Reference	D-10-012	Revision	04	Date	31/05/01
Document Name		User's Manual AFC80MD/AFC90MD			
File Name		AFC80&90 Manual.doc			

Control					
Author		Verified		Approved	
Visa	Date	Visa	Date	Visa	Date
Olivier Léonel	31/05/01	P. Garnier	31/05/01	Pascal Rudent	31/05/01

History				
Author	Date	Description	Revision	Status
Olivier Léonel	25/04/00	Initial Version	00	Issued
Olivier Léonel	05/01/01	New warranty text	01	Issued
Olivier Léonel	18/01/01	New exploded view	02	Issued
Olivier Léonel	12/02/01	New section layout	03	Issued
Olivier Léonel	31/05/01	Pin layout update	04	Issued

SECTION 1 - INTRODUCTION 6
1.0 SPECIFICATIONS 6
1.1 CALIBRATION FEATURES 7
1.1.0 STANDARD CONDITIONS 7
1.1.1 MANUFACTURING ENVIRONMENT 7
1.1.2 QUALITY CONTROL 7
SECTION 2 - INSTALLATION 8
2.0 INTRODUCTION 8
2.1 UNPACKING 8
2.2 MECHANICAL INSTALLATION 8
2.2.0 GENERAL 8
2.2.1 INSTALLATION 9
2.3 ELECTRICAL INSTALLATION 10
2.3.0 GENERAL 10
2.3.1 CONNECTIONS 10
2.4 CHECKS BEFORE STARTING UP 12
2.5 DIGITAL CARD. 12
2.5.0 INTRODUCTION 12
2.5.1 A BETTER ACCURACY 12
2.5.2 AN OPTIMIZED NUMERICAL CONTROL 13
2.5.3 RAMPING 14
2.5.4 SOFT-START 14
2.5.6 IN SITU CALIBRATION 15
2.5.7 AUTO-ZERO 15
2.5.8 ADDITIONAL CAPABILITIES 15
2.6 COMMUNICATION MODES. 16
SECTION 3 – TROUBLESHOOTING 17
SECTION 4 - WARRANTY AND SERVICES 19
4.0 PRODUCT WARRANTY 19
4.1 SERVICES 20
APPENDIX A 21
Part number Description 21
APPENDIX B 22
Gas Process Number 22
APPENDIX C 23
Exploded view of the Standard AFC 80 MD and part list 23
APPENDIX D 25
GENERAL MFC OPERATIONS PRINCIPLES 25
INTRODUCTION 25
PHYSICAL DESCRIPTION 25
BYPASS 25
THE SENSOR 26
ELECTRONIC 27

SECTION 1 - INTRODUCTION

The QUALIFLOW Metal Seal Digital Mass Flow Controller AFC80.MD - AFC90.MD offer the highest degree of accuracy and reliability in controlling gas flows.
This range has been designed specifically to prevent contamination and particle deposition. It is therefore ideal when using in semiconductor and optical fiber manufacturing processes. It takes benefit from the digital technology : new features such as alarm and maintenance functions are available (with the free QUALIFLOW's PC interface digisoft). With a specially developed algorithm, the regulation is obtained without overshoot and during the transient time, the readout matches the real flow.

This manual includes the following sections :

Section 1. Introduction : contains specifications and calibration features.

Section 2. Installation : contains all the information necessary to unpack the AFC80.MD - AFC90.MD without causing contamination, install the AFC80.MD - AFC90.MD and check the installation before starting up. All data related to digital card and use of a PC with RS232 connection are developed.

Section 3.Trouble-shooting.

1.0 SPECIFICATIONS

	AFC 80 MD	**AFC 90 MD**
Flow Range	From 5 sccm to 30 slm	From 5 sccm to 30 slm
Control Range	Between 2 and 100% F.S	Between 2 and 100% F.S
Valve type	Electromagnetic	Electromagnetic
Valve Rest position	Normally Open or Close	Normally Open or Close
Accuracy	± 1% of setpoint if setpoint > 20% of F.S. ± 0.2% of F.S. if setpoint < 20% of F.S.	± 0.5% of setpoint if setpoint > 40% of F.S. ± 0.2% of F.S. if setpoint < 40% of F.S.
Linearity	± 0.2% F.S (per cal Gas)	± 0.2% F.S (per cal Gas)
Repeatability	± 0.15% F.S	± 0.15% F.S
Step Response Time	<= 1 sec (SEMI E17-91	<= 0.8 sec (SEMI E17-91
Drift	0.5% F.S. per year	0.2% F.S. per year
Temperature Range	Between 5 and 50°C	Between 5 and 50°C
Temperature Coefficient	< 0.05% F.S /°C < 0.02% F.S /°C as option	< 0.05% F.S /°C < 0.02% F.S /°C as option
Maximum Inlet Pressure	10 bar	10 bar
Minimum Differential Pressure	0.1 bar	0.1 bar
Maximum. Differential Pressure	3 bar	3 bar
Pressure Coefficient	< 0.1% F.S /bar	< 0.1% F.S /bar

Power Input Requirement	+ 15 VDC –15V ; 80mA	+ 15 VDC –15V ; 80mA
Set Point Signal	From 0 to 5 VDC	From 0 to 5 VDC
Flow Outpout Signal	From 0 to 5 VDC	From 0 to 5 VDC
Electrical Connector	Sub-D 15	Sub-D 15
Construction materials	316L stainless Steel	316L stainless Steel
Leak integrity	< 2.10^{-10} sccm/sec (He)	< 2.10^{-10} sccm/sec (He)
Standard Seals	316L Stainless Steel	316L Stainless Steel
Seals on request	Nickel, Neoprene, Viton or Kalrez	Nickel, Neoprene, Viton or Kalrez
Fittings	On request	On request
Options	Low temperature sensitivity Separated electronics Card Edge adapter Device Net or PROFIBUS RS 485/MODBUS	Low temperature sensitivity Separated electronics Card Edge adapter Device Net or PROFIBUS RS 485/MODBUS

1.1 CALIBRATION FEATURES

The Mass Flow Controllers are calibrated close to customer's process. Without customer's information, the MFCs are calibrated under standard conditions.

1.1.0 STANDARD CONDITIONS

Without special conditions specified by the customer, the MFC is calibrated under the following standard conditions :

Pressure conditions :

Pressure Outlet : Atmospheric

Delta Pressure : between 500 mbars and 3 bars (With Low DP option 30 mbars)

Dynamic adjustment : no overshoot

The mounting position (horizontal, vertical inlet up or down) should be specified by the customer to ensure the best accuracy .

1.1.1 MANUFACTURING ENVIRONMENT

The MFCs are assembled, calibrated, packaged and controlled in a class 100 cleanroom.

1.1.2 QUALITY CONTROL

Each MFC is controlled 24 hours after manufacturing on a different calibration bench. The accuracy, the dynamic response, the stability to pressure variations are double checked.

SECTION 2 - INSTALLATION

2.0 INTRODUCTION

This four part section contains all the information necessary to install the AFC80.MD - AFC90.MD mass flow controllers.

- 2.1 - UNPACKING;
- 2.2 - MECHANICAL INSTALLATION;
- 2.3 - ELECTRICAL INSTALLATION;
- 2.4 - CHECK BEFORE START UP.
- 2.5 - DIGITAL CARD.
- 2.6 - COMMUNICATION MODES.

2.1 UNPACKING

The AFC80.MD - AFC90.MD mass flow controller are manufactured under clean room conditions, and has been packed accordingly upon receipt. The cardboard packing should be checked for damage. If there is visible damage, please notify your local QUALIFLOW sales office at once. In order to minimize contamination of clean rooms, the unit has been packed in two separately sealed plastic bags. The outside bag should be removed in the entrance to the clean room. The second bag should be removed when you install the unit.

2.2 MECHANICAL INSTALLATION

2.2.0 GENERAL

Most applications will require a positive shutoff valve in line with the mass flow controller. Pressurized gas trapped between the two devices can cause surge effects, and consideration must be given to the sitting of the shutoff valve (upstream or downstream) in relation to the process sequencing. As far as the process parameters will allow this, it is recommended that you install an in-line filter upstream to the controller in order to prevent from contamination.

The AFC80.MD - AFC90.MD can be mounted in any position. The atmosphere should be clean and dry. The mounting should be free from shock or vibration. Mounting dimensions are shown in figure 2-1. Prior to installation, ensure that all the piping is thoroughly cleaned and dried. Do not remove the protective end caps until you are ready to install the controller.

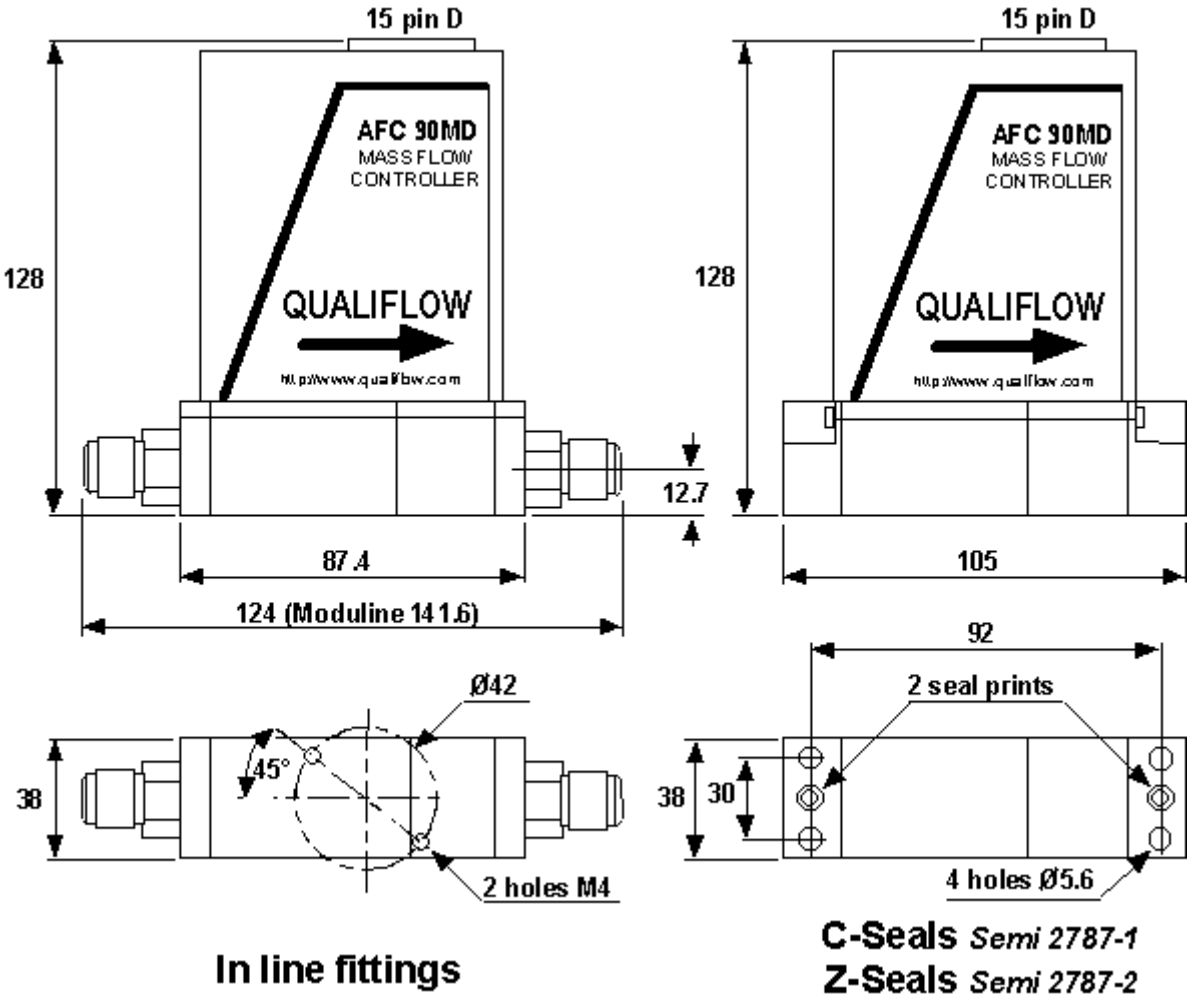


Figure 2-1 Dimensions (mm)

2.2.1 INSTALLATION

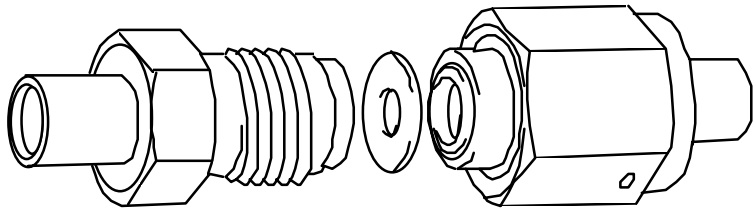
WARNING: Toxic, corrosive or explosive gases must be handled with extreme care. After installing the mass flow controller, the system should be thoroughly checked to ensure it is leak-free. Purge the mass flow controller with a dry inert gas for one hour before using corrosive gases.

IMPORTANT: When installing the mass flow controller, ensure that the arrow on the back of the unit shows the same direction as the gas-flow.

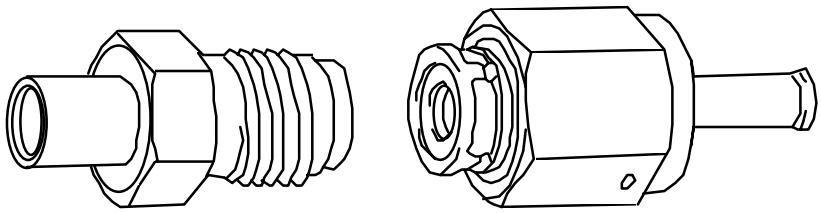
The AFC80.MD - AFC90.MD mass flow controller are normally supplied with 1/4" male VCR compatible couplings on both sides. To install the AFC, follow the steps listed below. Refer to figure 2-2.

1. Check the gland to gland space, including the gaskets.
2. Remove the plastic gland protector caps.
3.
   a) When using loose VCR "original" style gaskets, insert the gasket into the female nut.
   b) For VCR retainer gaskets, snap the gasket onto the male coupling. See figure 2-2.
4. Tighten the nuts finger tight.
5. Scribe both nut and body in order to mark the position of the nut.

6. While holding the body with a wrench, tighten the nut : 1/8 turn past finger tight for 316L stainless steel and nickel gaskets.



VCR original style gasket



VCR retainer gasket

Figure 2-2 VCR compatible couplings

2.3 ELECTRICAL INSTALLATION

2.3.0 GENERAL

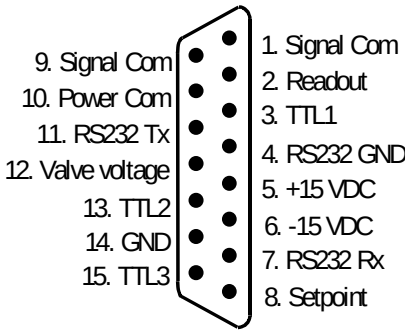
Within this section, you will find the following sub-sections:

- Connections.
- Digital functions (see Section 3 - "DIGITAL CARD").
- Pressure control.
- Ratio control.
- Communication plug (section 2.7).

2.3.1 CONNECTIONS

The electrical connections of the AFC80.MD - AFC90.MD are made through a sub D 15 connector (see figure 2-3). RS 232 adapters for use in maintenance functions are available (model 4).

Digital's card sub D 15 connector :



Note : 1. Signal Com pin is used for External Read Out Option if required

Figure 2-3 Pin arrangement for digital Card connector.

Dedicated interface connector is available to allow digital MFC connection to work with other pin arrangement, according to figure 2.4. This second pin arrangement is compatible with the

AFC 50 analog QUALIFLOW Mass Flow Controller. A card edge adapters coupled with a RS232 cable is available. The card edge connection is widespread in the industry.

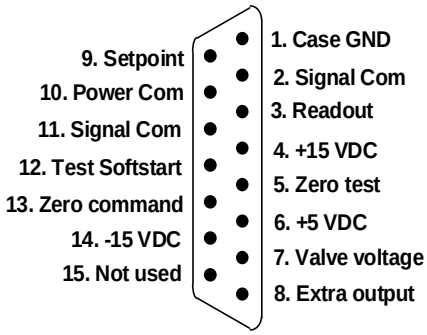
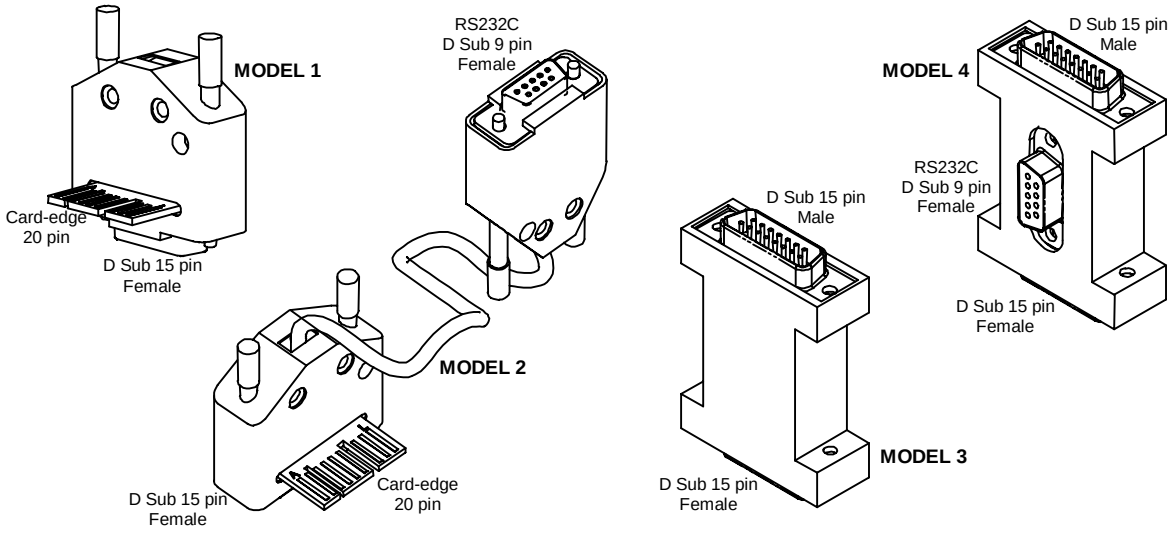


Figure 2-4 Adapters pin arrangement
(compatible with QUALIFLOW's analog MFC 50)



Connectors Conversion Adapters					
QUALIFLOW MFC / Connector		**Replaced MFC / Connector**		**Model**	**Part Number**
Analog AFC50/AFM 55	D Sub 15 pin	Main MFC's	Card-edge	1	Q201733-01
Digital All Series	D Sub 15 pin	Main MFC's	Card-edge	1 2	Q201733-07 Q201733-08
Digital All Series	D Sub 15 pin	Analog AFC50/AFM 55	D Sub 15 pin	3 4	Q201733-09 Q201733-10
Digital All Series	D Sub 15 pin	Main MFC's	D Sub 15 pin	4	Q201733-06
0-5V to 4-20mA Conversion Adapters					
MFC Type				Model	**Part Number**
QUALIFLOW Analog AFC50/AFM55				3	Q201733-05
QUALIFLOW Digital and Main MFC's with D Sub 15 pin connector				3	Q201733-15

Other Accessories	Part Number
Control and Power Supply Kit for QUALIFLOW Digital MFC's all series : When connecting individually a Digital MFC to a computer use this interface kit, which includes: • Connector conversion adapter, P/N q 2001733-06 • Power supply assy 120/230 VAC, ±15VDC, P/N Q2001733-14 • Power cord from power supply to MFC, length 1 meter, P/N Q2001733-13 • RS232C cord from MFC to computer, length 2 meters, P/N Q2001733-11	Q 2001733-12
Connecting cord for Analog AFC50/AFM55 or digital MFC's all series : • D Sub 15 pin female connector (MFC side), wires ready to weld at the other end • Length 5 meters	2990924Q

2.4 CHECKS BEFORE STARTING UP

Before operating the mass flow controller the following checks should be completed :

1. Check that tubing is leak proof.
2. Check the process sequence and proper function of all other gas components involved.
3. Check the voltage of command signals and power supply to the mass flow controller.
4. Check that the appropriate gas type is being supplied at the rated pressure.
5. Allow the mass flow controller to warm up for 20 minutes, then check the zero level output.
6. Use dry inert gas for test runs.
7. Prior to using the mass flow controller for extremely corrosive gases, purge with a dry inert gas for one hour.

2.5 DIGITAL CARD.

2.5.0 INTRODUCTION

QUALIFLOW has designed and developed a digital card for its Mass Flow Controllers (MFC) that take advantages of the full potential of digital technology. Not only enabling digital communication, these cards improve MFC accuracy and control using a numerical control algorithm. They store several calibration curves, therefore QUALIFLOW customers can reduce the number of references that they use. They also make maintenance operations easier : through alarm functions and PC diagnostic via RS232.

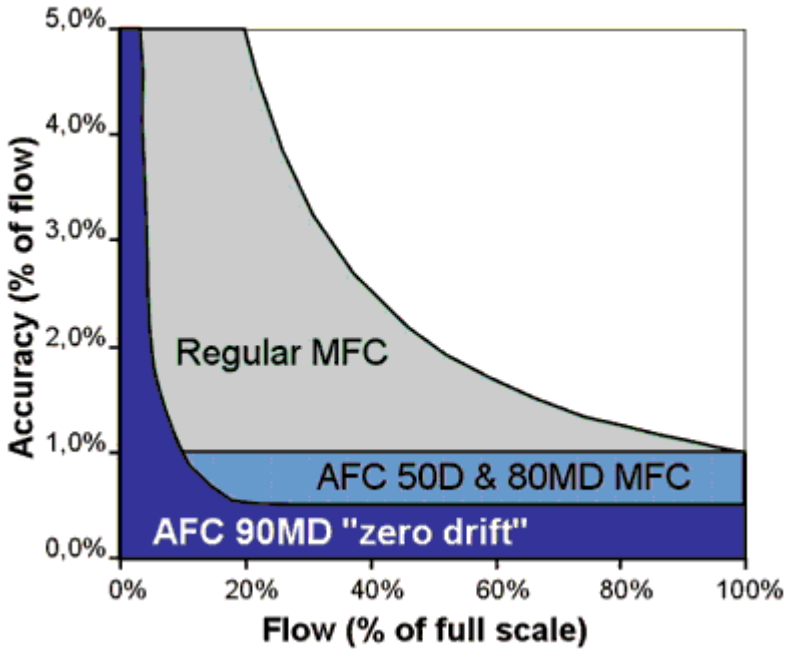
The development of the digital technology has brought great improvements in :
-Accuracy
-Control
-Additional capabilities

This new digital card is 100% compatible with previous QUALIFLOW analog Mass Flow Controllers. However the digital mode is best used for maintenance functions or in calibration mode. The RS485 communication and the device net communication allow the use in digital communication mode with standard industry protocol.

2.5.1 A BETTER ACCURACY

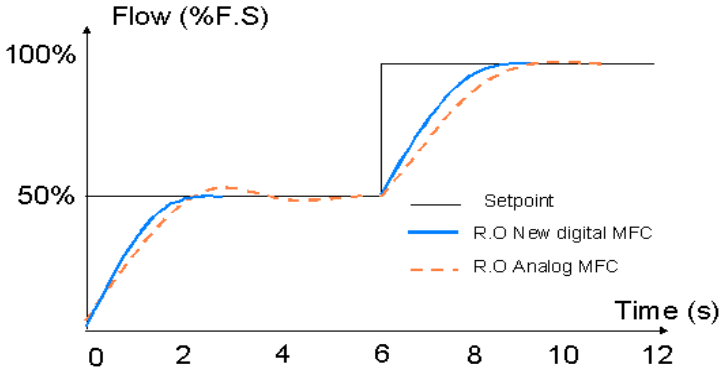
All analog MFC's are calibrated with potentiometers at three points : 2%, 50% and 100% FS to make the error at 0%, 25%, 50%, 75% under 1% FS. The numerical MFC's are calibrated at more than 6 points and the response curve is then calculated. Accuracy is ± 0.5% of setpoint if setpoint > 20% of F.S., ± 0.1% of F.S. if setpoint < 20% of F.S for the AFC 90 MD

Accuracy is ± 1% of setpoint if setpoint > 10% of F.S., ± 0.1% of F.S. if setpoint < 10% of F.S for the AFC 80 MD. So the linearity is much better at small setpoints (see the following graph).
Most of digital MFCs use linear interpolation to calculate the response curve whereas the QUALIFLOW digital board achieved better accuracy, with lower calibration points thank to polynomial interpolation.
The RS232 or RS 485 or Device net connection let you to change the calibration curve by choosing the corresponding number without disconnecting the MFC. 10 calibration curves can be stored in memory. To maintain the best accuracy the maximum factor between two full scales of two several calibrations is 3.
The set point and the measure are converted by 16 bits CAN for the best accuracy. The analog readout is converted by 12 bits CNA which does not alter the accuracy of the flow.



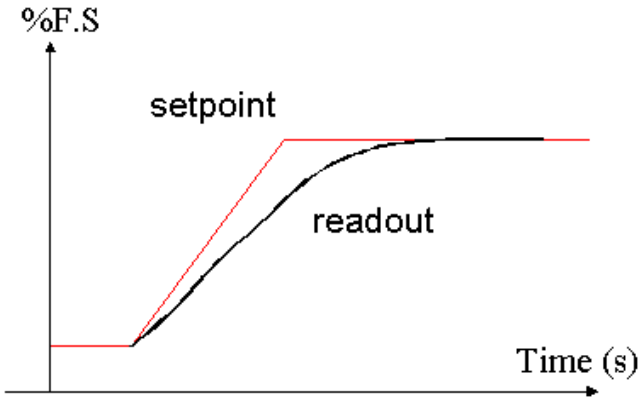
2.5.2 AN OPTIMIZED NUMERICAL CONTROL

The control of the gas flow is made by a numerical algorithm which assumes a control without overshoot at any set point. Each calibration curve is stored with its own optimised regulation parameters which are determined by calculation. An analog control is fixed by the electronic components and can not be adapted to each gas and to each full scale. For example, an analog regulation can not avoid overshoot at low flow rates whereas an algorithm gives fine control at any set point. The following typical curves compare the analog regulation with the numerical one. As the response time of the digital MFC's are more repeatable and do not depend on electronic components. So digital MFC's have closer transient behaviours, which brings a great improvement in process with mixed gases.



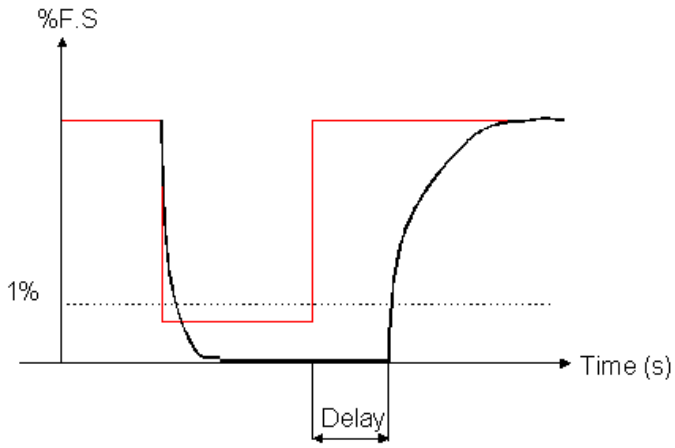
2.5.3 RAMPING

The ramping function increases linearly the set point in order to give a progressive raise in the flow. It could be used to keep stoechiometric values during transient response of a process. The increase of the set point by unit time is chosen by the user (see software manual).



2.5.4 SOFT-START

The soft start function closes the valve if the set point is lower than 1%F.S. For a new set point greater than 1%F.S, the regulation starts after a delay that is chosen by the user.
This way you can avoid big overshoots caused by pressure drop, when starting a process.

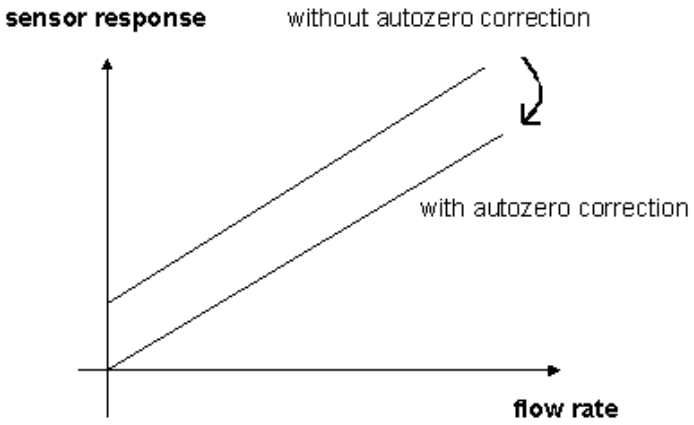


2.5.6 IN SITU CALIBRATION

The calibration can be automatically made by calibration devices with a serial communication. The calibration is made with six points without potentiometers. The QUALIFLOW software allows to calibrate the MFC from the 'Molblox' device (Caltechnics).

2.5.7 AUTO-ZERO

The function AUTO-ZERO corrects the drift of the MFC. It can be done automatically or by the user. The correction can not exceed 0.5%.



sensor response after a long-term drift

2.5.8 ADDITIONAL CAPABILITIES

Additional capabilities are customized by a free PC Interface (see the software's manual in the CD).

2.5.8.0 LED INDICATOR

The MFC contains three LEDS located on the left hand side.

The left LED is the watchdog LED. When blinking, it indicates whether the MFC is on power or not. A quick blinking (several times per second) indicates that the MFC is working on a analog mode.

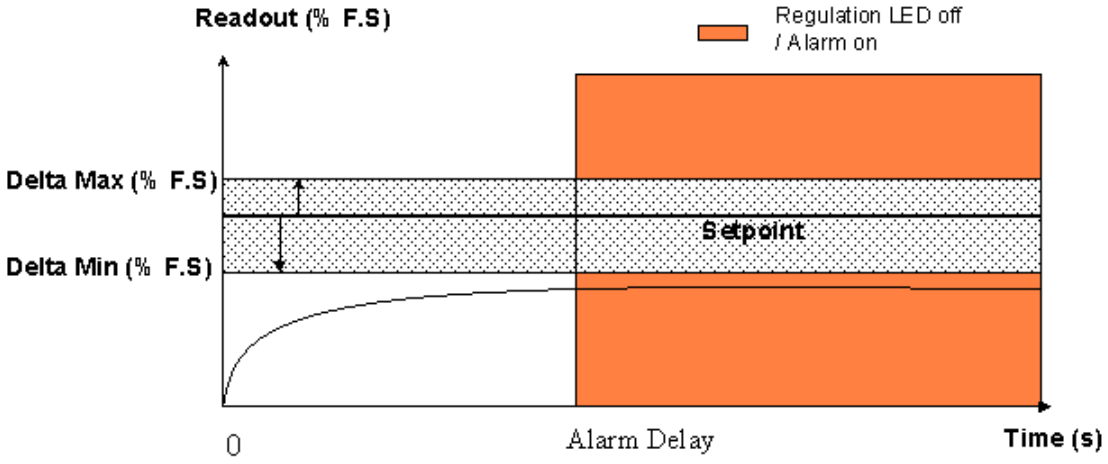
The second LED indicates whether the regulation is obtained (switched on) or not (switched off).

Switched on, the third LED indicates an error as : a sensor error
a communication error
a EEPROM error
a valve type error
a converter (A/D) error

2.5.8.1 ADJUSTABLE ALARM

The user chooses three parameters, the delta min, the delta max and the delay alarm, in order to adjust the regulation alarm. Delta min and delta max (in ‰ FS) are the maximum differences between the readout and the set point to get before the delay time. If the MFC

does not correctly control, the alarm is on until the user switches it off. For example, if the pressure is too low, the MFC could not regulate the flow The alarm signal will be generated until the user switches it off.
This alarm can be switched off by soft .



ADJUSTABLE ALARM

2.5.8.2 TOTALIZER

The totalizer indicates the cumulative flow in % FS since the last initialisation. It is useful to have a look on your gas consumption.
Example : 5000 with 20slm as FS means 1000sl total.

2.5.8.3 DATA STORING / RETRIEVING

The set point, the valve voltage and the readout are stored at a frequency of 2 times a minute during 6 hours and can be saved as an excel file. These data allow the diagnostic of sensor drift or pressure drop.
For example an increasing in valve voltage for the same set point could be due to contamination or corrosion.
Data can be scanned and retrieved at any time without interruption while the MFC runs in control mode.

2.6 COMMUNICATION MODES.

In addition to the ability to use this digital MFC on analog mode with the advantage of communication via serial RS-232C for maintenance, calibration or individual control (DB 15 connector, following options are available :

RS-485 option: can control up to 32 MFC's under MODBUS protocol (RJ11 connector).

DeviceNet or PROFIBUS option: this mode allows communication with high speed protocol.

For more information during utilization, contact QUALIFLOW, France.

SECTION 3 – TROUBLESHOOTING

The AFC80.MD - AFC90.MD will be most used as a component in complex gas handling systems. Therefore, it will often be difficult to diagnose failures correctly, since one malfunction may have a number of possible causes. For initial operation of new systems, check that the malfunction is not caused by incorrect process sequencing or other system failures. It is recommended that you perform the following checks before removing a suspect mass flow controller for bench testing:

1. Check the gas supply pressure and check that the flow-path to the mass flow controller has been opened.
2. Ensure that the power supply and command signals are correctly transmitted to the D-connector pins on the PC-board.
3. Check that the output signal matches the external reading. For pin assignments see figure 2-3.
4. Use the following table to locate the fault.

Problem 1: Output reading, without gas flow, is not zero.

Possible cause	Action
1. Gas flow is actually present	Check closure of series shutoff valve.
2. Zero reading has drift less than 1.5%	Try 'Autozero function' by the software

Problem 2: Zero reading cannot be adjusted by autozero.

Possible cause	Action
Defective sensor.	Check that sensor voltage between red and orange wires is equal to the voltage between red and blue wires. Both must be 4 to 6 volts. Contact *QUALIFLOW* for advice. If defective, the controller may need replacing.

Problem 3: Valve will not close

Possible cause	Action
1. Check the Mfc is properly connected on the gas line	Disconnect the MFC after following the procedure
2. Set-point is not zero	Check set-point voltage on PC-board pin 9
3. Incorrect solder pad connections	See the strap configuration
4. The Mfc is in digital mode and you use it with a set-point voltage	Change the control mode by the software
5. The parameters min valve (for a NC) is too high The parameters max valve (for a No) is too low	Increase or decrease one of this parameter by the software
6. Incorrect actuator voltage	Voltage across actuator wires must be : between 0V and 30V
7. Incorrect nozzle adjustment	Remove mass flow controller and readjust nozzle.
8. Plunger stuck	Remove controller and clean up.

Problem 4: Controller will not open to full scale flow

Possible cause	Action
1. Check the Mfc is connected in the good way on the gas line	Disconnect the MFC after following the procedure
2. Incorrect setpoint on PC-board (pin 8)	Check setpoint voltage.
3. Incorrect supply pressure	Check gas pressure at inlet side of mass flow controller
4. The Mfc is in digital mode and you use it with a set-point voltage	Change the control mode by the software
5. Incorrect flow reading	Check the numerical readout found by the software is correct
6. Incorrect solder pad connections	Check the strap configuration
7. The parameters max valve (for a NC) is too low The parameters min valve (for a No) is too high	Increase or decrease one of this parameter by the software
8. Incorrect actuator voltage	Voltage across actuator wires must be :between 0V and 30V

Problem 5: Unstable control

Possible cause	Action
1.Unstable pressure	Check inlet and outlet pressure stability
2. Defective electronics	Replace mass flow controller and contact *QUALIFLOW* for advice.
3. Bad Regulation parameters	Contact *QUALIFLOW*
4. Defective Mechanics	Contact *QUALIFLOW*

For any other problems, contact QUALIFLOW.

SECTION 4 - WARRANTY AND SERVICES

4.0 PRODUCT WARRANTY

1. Qualiflow products are guaranteed against defects in materials and workmanship for a period of one year from the date of shipment, if used in accordance with specifications and not subject to physical damage, contamination, alteration or retrofit.
2. Buyers undertake to check and inspect the goods and to notify Qualiflow of shipment incidents by fax, phone or e-mail as soon as possible after receipting the goods.
3. During the warranty period, products must only be repaired by authorized Qualiflow service centers; otherwise, the Qualiflow product warranty will be invalidated.
4. Repairs will be performed free of charge during the one-year warranty period. If MFCs are out of warranty, Qualiflow will notify the owner of replacement or repair costs before proceeding. Factory service and repairs are guaranteed 90 days. The warranty excludes consumable materials and wear parts (in teflon, viton, etc.).
5. No MFC will be accepted for repair or warranty without a decontamination and purge certificate.
6. Each MFC is individually checked (visual inspection of fittings, helium leak test and flow calibration). Qualiflow shall not be responsible for any damage caused by gas leakage or the use of a dangerous gas. Users are responsible for following the safety rules applicable to each gas they use. Improper use of a Qualiflow MFC will void the warranty, and MFCs that have been damaged as a result of improper use will not be replaced by Qualiflow.
7. Specific warranty requirements are as follows :
    a. Gas must be clean and particle-free, which means a filter must be fitted in the gas line upstream of the MFC.
    b. Gas must comply with the following pressure specifications:
        i. Gas pressure must never exceed 10 bars.
        ii. Differential pressure must be more than 500 mbar for full-scale flow through the MFC valve.
        iii. Differential pressure must be less than 3 bars for the MFC valve to regulate without gas-flow oscillation.
        iv. Pressure at the mass-flow inlet must be regulated by an accurate pressure regulator to prevent gas-flow oscillation.
    c. Electrical connection requirements are as follows:
        i. The system must be wired carefully: non-observance of the pinout may irreversibly damage the electronic board inside the MFC, in which case the warranty will be invalidated.
        ii. A stable power supply is required, with ripple below 5mV.
    d. Gas connections: the VCR gland must be handled carefully. Qualiflow guarantees that all glands have been individually inspected and are scratch-free.
    e. Fitting procedure: the fitting procedure set out in the manual must be followed meticulously. Specifically, the purge procedure is very important if corrosive gases or toxic gases are used.
    f. The mass-flow must not be dismounted: the MFC warranty will be invalidated if the seal between the MFC block and cover is torn.

4.1 SERVICES

QUALIFLOW Products Engineers will help you to solve your problems regarding operation, calibration, connection, gas flows, gas mixture, etc…

We deliver technical support or maintenance within 24 hours.

QUALIFLOW offers factory training on mass flow controllers.

Visit www.qualiflow.com and find your nearest repair and calibration center.

APPENDIX A

Part number Description

[t, t, t] [v] [s] [f, f] [r, r, r, r] [g, g, g] [m] - [o, o]

[t]- Type
- [100] for AFM 10
- [260] for AFC 260 or AFM 360
- [261] for AFC 261 or AFM 361
- [202] for AFC 202 or AFM 302
- [500] for AFC 50 or AFM 55
- [700] for AFC 70
- [800] for AFC 80 or AFM 85
- [900] for AFC 90 or AFM 95

[v]- Valve Configuration
- [N] for No valve (only for AFM)
- [O] for Advanced Flow Controller Normally Open
- [C] for Advanced Flow Controller Normally Close

[s]- Seals
- [V] for Viton
- [N] for Neoprene
- [K] for Kalrez
- [M] for Metal

[f, f] Inlet and Outlet Fittings
- [SB] for B-SEAL - [SC] for C-SEAL
- [SW] for W-SEAL - [SZ] for Z-SEAL

Or specify first Inlet, then Outlet.
- [F] for 1/4" VCR Female - [B] for Swagelok 1/8"
- [M] for 1/4" VCR Male - [C] for Swagelok 1/4"
- [L] for 1/4" VCR High Flow Male - [G] for Swagelok 6mm
- [N] for 1/4" VCR High Flow Female - [H] for Swagelok 3/8"
- [D] for 3/8" VCR Female - [K] for 1/8" BSPP (AFM 10 only)
- [E] for 3/8" VCR Male

[r, r, r, r]- Flow rate
Specify C for sccm, L for slm.
Example :
- 200C for 200 sccm
- 030L for 30 slm

[g, g, g]- Gas Process
See chart on the left page

[m]- Mounting Position
- [H] for Horizontal
- [U] for Vertical Inlet Up
- [D] for Vertical Inlet Down

[o, o]- Options	AFC 260 / AFM 360		AFC 261 / AFM 361		AFC 202 / AFM 302		AFC 50 / AFM 55		AFC 70/80/90 / AFM 10	AFC 70/80/90 / AFM 85/95
- [L] for Low Delta Pressure	.	.	.	.	.	.	✔	✔	.	✔
- [S] for Separated Electronics	✔	✔	✔	✔	✔	✔	✔	✔	.	✔
- [E] for External Readout	.	✔	.	✔	.	✔	.	✔	.	✔
- [D] for Digital Card	✔	✔	✔	✔	✔	✔	✔	✔	.	Standard
- If Digital [N] for DeviceNet	✔	✔	✔	✔	✔	✔	✔	✔	.	✔
[R] for RS485 / MODBUS	✔	✔	✔	✔	✔	✔	✔	✔	.	✔
[x] for nb of calibr. curves	✔	✔	✔	✔	✔	✔	✔	✔	.	✔
- [61] for AFC 50 compatible AFC 261	.	.	.	.	.	.	✔	✔	.	.
- [P] for Special Pitch	✔	✔	✔	✔	✔	✔	✔	✔	.	✔
- [T] for Low Temperature Sensitivity	.	.	.	.	.	.	.	.	.	✔
- [A] for High Accuracy	.	.	.	.	.	.	.	.	✔	.
- [B] for Brass body	.	.	.	.	.	.	.	.	✔	.
- [C] for Signal 4 to 20 mA	.	.	.	.	.	.	.	.	✔	.
- [M] for Power Supply +24 VDC	.	.	.	.	.	.	.	.	✔	✔

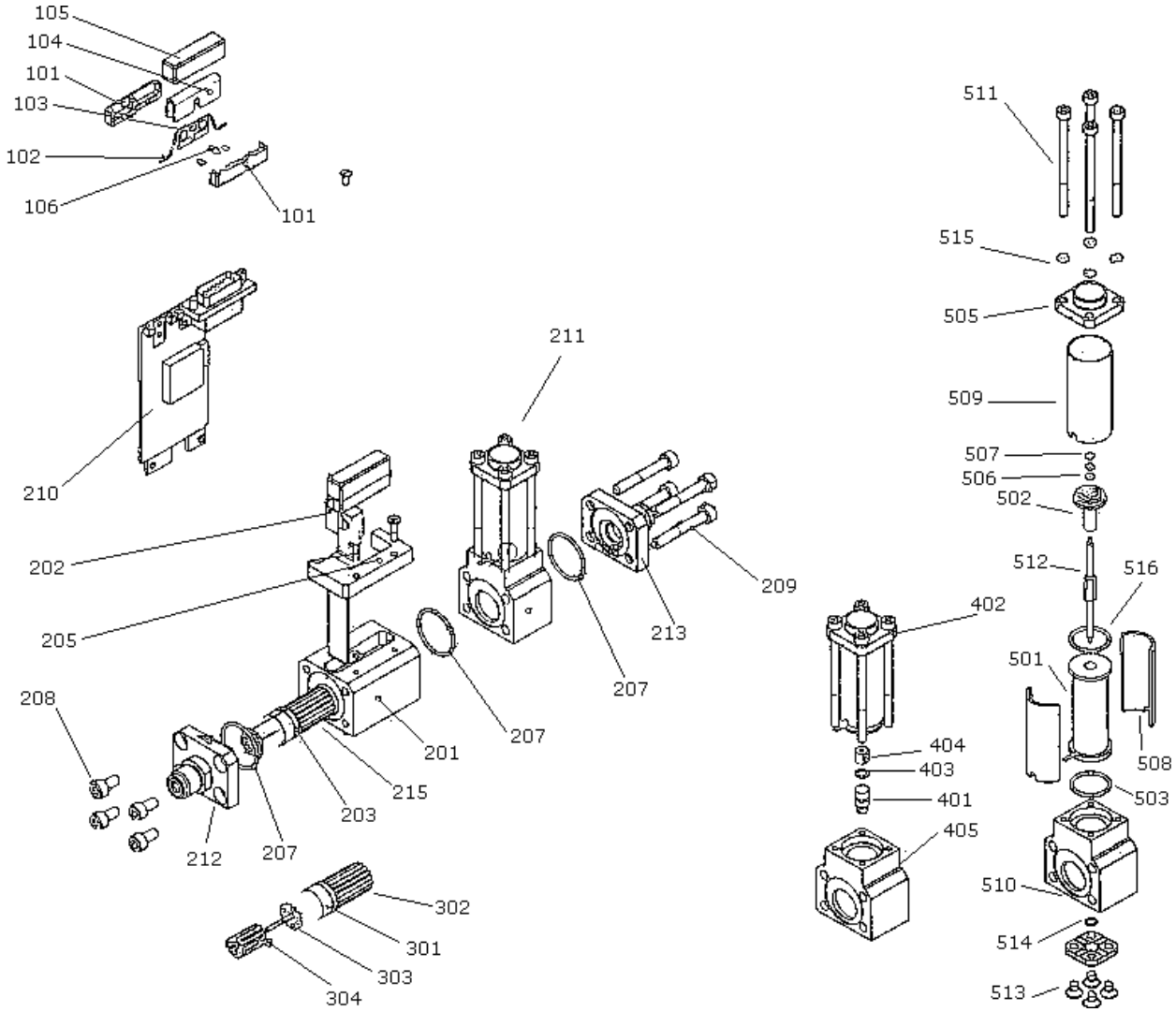
APPENDIX B

Gas Process Number

Symbol	Gas Name	Number	Density SEMI E52-0298	Sp. Heat	C [cal/g/°C]
	Air	**008**	1.2929	0.2401	1.000
NH3	Ammonia	**029**	0.7710	0.519	0.68
Ar	Argon	**004**	1.7842	0.1246	1.453
AsH3	Arsine	**035**	3.481	0.1178	0.666
BCl3	Boron Trichloride	**070**	5.26	0.130	0.40
CO	Carbon Monoxide	**009**	1.2500	0.495	1.000
CCl4	Carbon Tetrafluoride	**101**	6.86	0.141	0.309
Cl2	Chlorine	**019**	3.209	0.116	0.83
B2H6	Dibirane	**058**	1.24	0.495	0.44
SiH2Cl2	Dichlorosilane	**067**	4.54	0.141	0.43
CHF3	Fluoroform	**049**	3.125	0.173	0.506
CCl2F2	Freon-12	**084**	5.5	0.149	0.34
CF4	Freon-14	**063**	3.96	0.167	0.41
GeH4	Germane	**043**	3.423	0.138	0.58
He	Helium	**001**	0.1788	1.242	1.454
H2	Hydrogen	**007**	0.0899	3.400	1.016
HCl	Hydrogen Chloride	**011**	1.635	0.1937	0.981
C2F6	Hexafluoroethane	**118**	6.16	0.185	0.24
Kr	Krypton	**005**	3.73	0.0596	1.45
CH4	Methane	**028**	0.7166	0.528	0.722
CH3SiCl3	Methyltrichlorosilane	**183**	6.670	0.164	0.250
N2	Nitrogen	**013**	1.2503	0.2484	1.000
NO2	Nitrogen Dioxide	**026**	6.675	0.194	0.41
NF3	Nitrogen Trifluoride	**053**	3.173	0.178	0.434
N2O	Nitrous Oxide	**027**	1.98	0.206	0.206
O2	Oxygen	**015**	1.429	0.2183	0.996
O3	Ozone	**030**			
PH3	Phosphine	**031**	1.523	0.2607	0.688
C3H8	Propane	**089**	1.98	0.392	0.35
SiH4	Silane	**039**	1.438	0.3188	0.596
SiF4	Silicon Tetrafluoride	**088**	4.68	0.168	0.35
Si2H6	Disilane	**097**			
SO2	Sulphur Dioxide	**032**	2.91	0.149	0.67
SF6	Sulphur Hexafluoride	**110**	6.5	0.1590	0.27
TiCl4	Titanium Tetrachloride	**114**	8.465	0.22	0.30
C4F8	Octafluorocyclodutane	**129**			
SiHCl3	Trichlorosilane	**147**	6.047	0.130	0.348

APPENDIX C

Exploded view of the Standard AFC 80 MD and part list



Item	PN	Qty	Description
101	7740001Q-02	2	sensor half body
102	6740002Q-01	1	sensor tube
103	0230259Q-01	1	sensor binder board
104	7740002Q-01	1	sensor thermal screen
105	7740003Q-01	1	sensor cap
106	4140303	2	pin
201	7730010Q-01	1	sensor body
202	673800S80-STD	1	sensor assy
203	6750003Q-01	1	bypass assy
204	Q2048310-02	1	cover
205	7730008Q-01	1	cover&card base
207	4290005Q	3	metal seal HNV
208	4180521	4	screw M5-10
210	Q5180001-3	1	digital board
211	6730004Q-01	1	assy magnetic valve
212	6720003Q-01.C.	1	inlet fitting
213	7720006Q-01.C.	1	outlet fitting
301	7750002Q-01	1	bypass ring
302	Q2001911-xx	1	bypass tube
303	Q808017489	1	bypass plug
304	7750001Q-01	1	bypass clamp
401	Q2001696-xx	1	nozzle
402	7730022Q-01	1	magnetic valve
403	Q808092064	2	V-ORING 5.0X1.0
404	Q2001882-02	1	Assy'nut actuator valve Viton (stem stip)
405	7730023Q-01	1	Valve body assy
501	6730002Q-01	1	assy'spool
502	6730003Q-01	1	assy'spool head
503	4290004Q	2	metal seal HNV
504	Q2001814-01	1	actuator assy
505	7730004Q-01	1	cap magnetic valve
506	4190251	1	washer M 2.5
507	4200201	2	nut h M2
508	7730007Q-01	2	spool spacer
509	7730009Q-01	1	magnetic valve body
510	7730006Q-01	1	magnetic valve base
511	4180463	4	screw chcM 4-60
512	7730005Q-01	1	plug plate
513	4180458	4	screw fhc M 4-6
514	4290006Q	1	C seal
515	4190403	4	washer grower M 4
516	4290004Q	1	helicoflex seal

APPENDIX D

GENERAL MFC OPERATIONS PRINCIPLES

INTRODUCTION

This section includes the following sections:

- physical description
- bypass
- sensor tube
- electronics

PHYSICAL DESCRIPTION

The AFC80.MD - AFC90.MD belong to a modular range of Metal Seal Mass Flow Controller. The central feature of the AFC80.MD - AFC90.MD is surrounded by a series of bypass tubes or a wire mesh screen for high flow rates. A small fraction of the gas flow will also passes through the sensor tube. The bypass has been designed in such a way that there will always be laminar flow in the bypass tubes and the sensor tube under all flow conditions. Consequently, there is a direct relationship between the flow in the sensor tube and the flow in the bypass tubes. This means that the total flow through the mass flow controller can be determined by measuring the flow through the sensor tube.

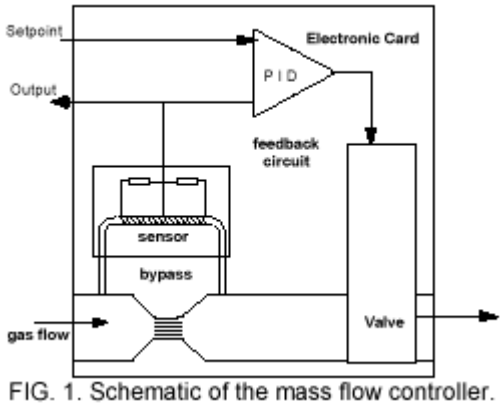


FIG. 1. Schematic of the mass flow controller.

BYPASS

The bypass unit is a series of tubes that are held in a special bypass ring. The ring fits around the body and may hold up to 24 tubes. The number of tubes and their diameter depends on the customer's specification of gas type and flow range. For high flow rates the bypass tubes are replaced by a screen bypass.

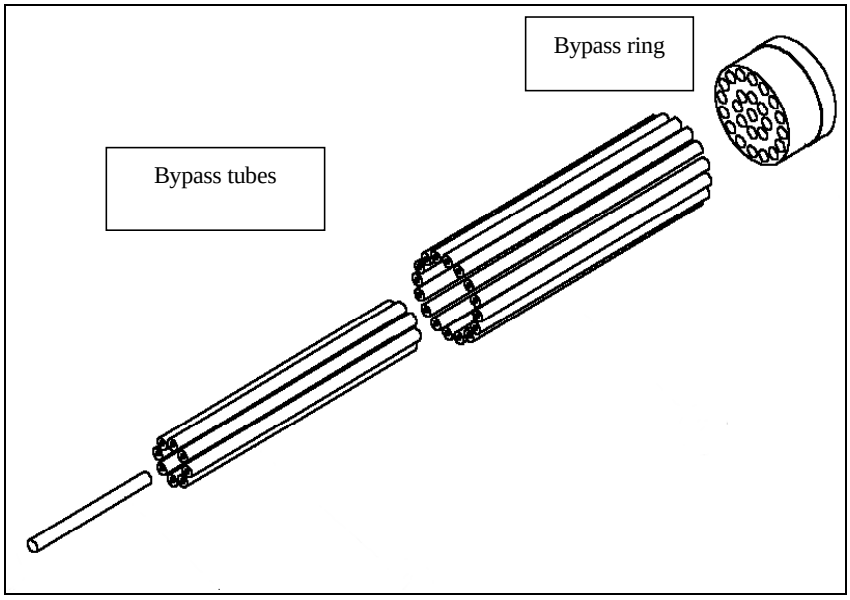


Figure 1-1 Bypass tubes

THE SENSOR

THE AFC 80 SENSOR

The sensor tube is a thin-walled tube with two symmetrical windings made from very thin resistor wires.

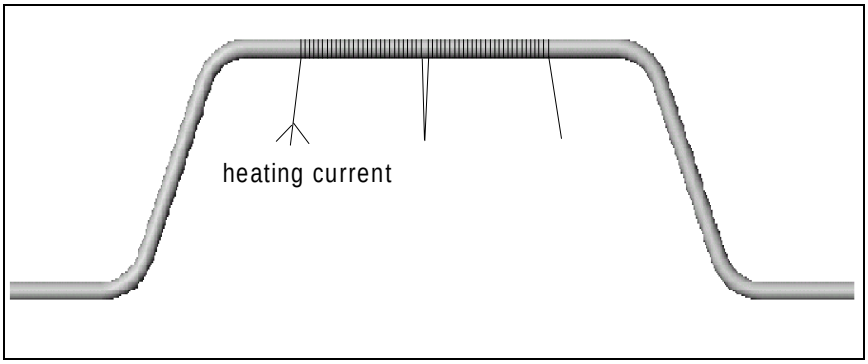


Figure 1-2 Sensor tube

The windings are heated electrically to 80°C above the ambient temperature. Gas entering the sensor tube will cool the first winding and heat the second winding. The difference in resistance between the two windings is measured electronically and this signal, which represents the total gas flow, is used to control the actuator position. Special insulating materials and a double permanently-sealed cover protect the sensor from external temperature influences.

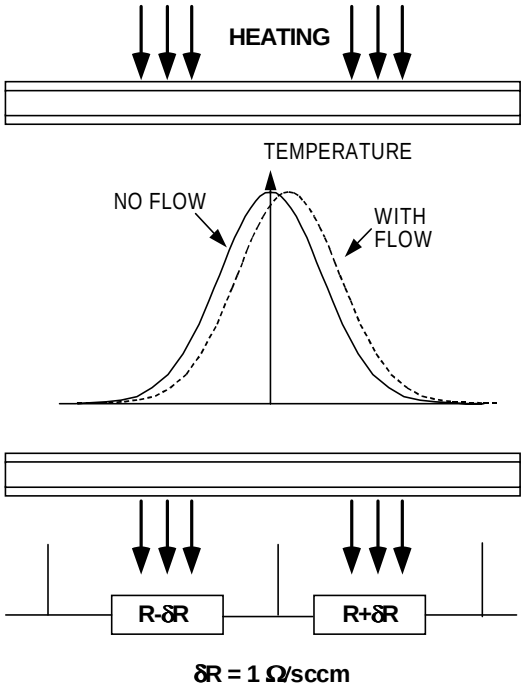


Figure 1-3 Sensor temperature profile

THE AFC 90 SENSOR (patent pending)

The tube has the same shape as the AFC 80. The heating and measuring functions are separated ; a constant resistive wire heats the tube with a constant power and two Platinum resistances sense the tube temperature. A first insulating layer is deposited directly upon the tube. With this technology the specifications of the AFC are improved : the constant time and the long term drift are significantly reduced.

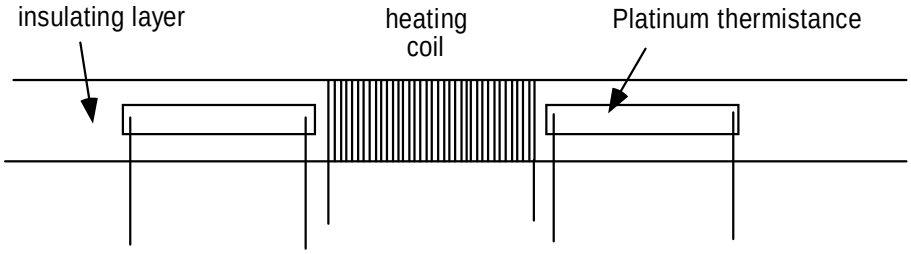


Figure 1.4 : straight part of the thin films sensor

Patent #97403185.8 for Europe #09/028,745 for the USA.

ELECTRONIC

The electronic is mounted on one digital PC-board located inside the top cover. The board contains a current source, the signal handling circuits and a power amplification section. The grounded cover of the mass flow controller shields the electronics from external interference.