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112802-P1
Rev C, 4/97
Instruction Manual

MKS Type 1152C
Mass Flow Controller

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MKS Instruments, Inc. (**MKS**) warrants that the equipment described above (the "equipment") manufactured by **MKS** shall be free from defects in materials and workmanship for a period of one year from date of shipment and will for a period of two years from the date of shipment, correctly perform all date-related operations, including without limitation accepting data entry, sequencing, sorting, comparing, and reporting, regardless of the date the operation is performed or the date involved in the operation, provided that, if the equipment exchanges data or is otherwise used with equipment, software, or other products of others, such products of others themselves correctly perform all date-related operations and store and transmit dates and date-related data in a format compatible with **MKS** equipment. THIS WARRANTY IS **MKS'** SOLE WARRANTY CONCERNING DATE-RELATED OPERATIONS.

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Mass Flow Controller

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Safety Procedures and Precautions

The following general safety precautions must be observed during all phases of operation of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of intended use of the instrument and may impair the protection provided by the equipment. MKS Instruments, Inc. assumes no liability for the customer's failure to comply with these requirements.

Warning 

Questions concerning the safe handling of toxic or hazardous gases or liquids with low flashpoints, may be answered by consulting your corporate policy, a government agency such as OSHA or NIOSH, or experts familiar with your process gas.

MKS assumes no liability for safe handling of toxic or hazardous substances.

Warning 

Follow your corporate policy for handling toxic or hazardous materials, or liquids with low flashpoints. Your corporate policy on handling these liquids *supersedes* the instructions in this manual. MKS assumes no liability for the safe handling of such materials.

USE CAUTION WHEN OPERATING WITH HAZARDOUS MATERIALS

If hazardous materials are used, users must take responsibility to observe the proper safety precautions, completely purge the instrument when necessary, and ensure that the material used is compatible with sealing materials.

PURGE THE INSTRUMENT

After installing the unit, or before its removal from a system, be sure to purge the unit completely with a clean dry gas. All traces of the previously used flow material must be removed.

USE PROPER FITTINGS AND TIGHTENING PROCEDURES

All instrument fittings must be consistent with instrument specifications, and compatible with the intended use of the instrument. Assemble and tighten fittings according to manufacturer's directions.

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CHECK FOR LEAK-TIGHT FITTINGS

Before proceeding to instrument setup, carefully check all plumbing connections to the instrument to ensure leak-tight installation.

ENSURE THAT MATERIAL IS COMPATIBLE WITH THE SEAL MATERIAL

It is the user's responsibility to ensure that the material used is compatible with the seal material in the instrument

PRODUCT LABELS

The labels on the instrument must not be removed! If labels are missing or illegible, contact MKS Service department for replacement. . Figure 4, page 10, shows the Warning label.

Definitions of WARNING, CAUTION, and NOTE messages used throughout the manual.

Warning 

The WARNING sign denotes a hazard. It calls attention to a procedure, practice, condition, or the like, which, if not correctly performed or adhered to, could result in injury to personnel.

Caution 

The CAUTION sign denotes a hazard. It calls attention to an operating procedure, practice, or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of all or part of the product.

Note 

The NOTE sign denotes important information. It calls attention to a procedure, practice, condition, or the like, which is essential to highlight.

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Chapter One: General Information

Introduction

The MKS Type 1152C Mass Flow Controller (MFC) is designed for precise and repeatable mass flow control of most low vapor pressure liquid or solid source materials into low pressure processes such as Low Pressure Chemical Vapor Deposition (LPCVD), Metal Organic Molecular Beam Epitaxy (MOMBE), and others. Mass flow measurement and control is accomplished without the need of bubbler systems or thermal mass flow sensors. The 1152 MFC uses a pair of absolute pressure sensors and an integral PID controller to control the mass flow rate. For viscous laminar flow, the product of the average absolute pressure (P_{AVE}), and the differential pressure (ΔP), is linearly proportional to the mass flow rate. The 1152 unit calculates this product and appropriately scales the result to a 0 to 5 VDC output signal that is equal to 0 to 100% full rated flow for the calibrated gas and temperature.

Caution 

The control valve in the 1152 Mass Flow Controller is *not* a positive shutoff valve. Depending upon your application, you may need to install a separate positive shutoff valve.

The instrument is temperature controlled, and it is supplied with a computer generated Calibration Curve and Calibration Data Sheet for the application specified when the unit was ordered.

Note 

The 1152 MFC is optimized at the factory for the application parameters specified when the unit was ordered. Contact the MKS Applications group for a new calibration curve if your application parameters change.

The standard 1152 MFC is available with the factory set operating temperature range from 30° to 100° C. The high temperature option provides an operating temperature range of 90° to 150° C.

The 1152 MFC is bag packaged in a clean room environment.

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How This Manual is Organized

This manual is designed to provide instructions on how to set up, install, and operate a Type 1152 unit.

Before installing your Type 1152 unit in a system and/or operating it, carefully read and familiarize yourself with all precautionary notes in the *Safety Messages and Procedures* section at the front of this manual. In addition, observe and obey all WARNING and CAUTION notes provided throughout the manual.

Chapter One, *General Information*, (this chapter) introduces the product and describes the organization of the manual.

Chapter Two, *Installation*, explains the environmental requirements and describes how to mount the instrument in your system.

Chapter Three, *Overview*, gives a brief description of the instrument and its functionality.

Chapter Four, *Operation,* describes how to use the instrument and explains all the functions and features.

Chapter Five, *Maintenance,* lists any maintenance required to keep the instrument in good working condition.

Chapter Six, *Troubleshooting*, provides a checklist for reference should the instrument malfunction.

Appendix A, *Product Specifications*, lists the specifications of the instrument.

Appendix B, *Calibration Data Sheet,* shows an example of the Calibration Data Sheet that is shipped with each unit.

Customer Support

Standard maintenance and repair services are available at all of our regional MKS Calibration and Service Centers, listed on the back cover. In addition, MKS accepts the instruments of other manufacturers for recalibration using the Primary and Transfer Standard calibration equipment located at all of our regional service centers. Should any difficulties arise in the use of your Type 1152 instrument, or to obtain information about companion products MKS offers, contact any authorized MKS Calibration and Service Center. If it is necessary to return the instrument to MKS, please obtain an ERA Number (Equipment Return Authorization Number) from the MKS Calibration and Service Center before shipping. The ERA Number expedites handling and ensures proper servicing of your instrument.

Please refer to the inside of the back cover of this manual for a list of MKS Calibration and Service Centers.

Warning  **All returns to MKS Instruments must be free of harmful, corrosive, radioactive, or toxic materials.**

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Chapter Two: Installation

How To Unpack the Type 1152 Unit

MKS has carefully packed the Type 1152 unit so that it will reach you in perfect operating order. Upon receiving the unit, however, you should check for defects, cracks, broken connectors, etc., to be certain that damage has not occurred during shipment.

Note Do *not* discard any packing materials until you have completed your inspection and are sure the unit arrived safely.

If you find any damage, notify your carrier and MKS immediately. If it is necessary to return the unit to MKS, obtain an ERA Number (Equipment Return Authorization Number) from the MKS Service Center before shipping. Please refer to the inside of the back cover of this manual for a list of MKS Calibration and Service Centers.

Note The 1152 MFC is supplied with Cajon® 8-VCR® male fittings. Be sure to keep the MFC bagged with the sealing surfaces protected to ensure safe, leak-free installation and operation.

Caution **Only qualified individuals should perform the installation and any user adjustments. They must comply with all the necessary ESD and handling precautions while installing and adjusting the instrument. Proper handling is essential when working with all highly sensitive precision electronic instruments.**

Unpacking Checklist

Standard Equipment:

- Type 1152 Unit
- Type 1152 Instruction Manual (this book)

Optional Equipment:

- Electrical Connector Accessories Kit - 1152C-K1
- Interface cables

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Interface Cables

As of January 1, 1996, all products shipped to the European Community must comply with the EMC Directive 89/336/EEC, which covers radio frequency emissions and immunity tests. MKS products that meet these requirements are identified by application of the CE Mark.

This MKS product meets CE requirements, per EMC Directive 89/336/EEC. To ensure compliance when installed, an overall metal braided shielded cable, properly grounded at both ends, is required during use.

Standard Cables

Standard cabling is available to interface the 1152 unit with both the display set point electronics and the power supply. Refer to Table 1 for a list of cables to attach to other MKS equipment.

Note

1. An overall metal braided shielded cable, properly grounded at both ends, is required during use to meet CE specifications.
2. To order an overall metal braided shielded cable, add an "S" after the cable type designation. For example, to order a standard connection cable to connect the 1152 MFC to a 260PS-1 power supply, use part number CB260-3-10; for an overall metal, braided, shielded cable use part number CB260S-3-10.

Interface Cables		
To Connect To . . .	**Standard Cable**	**Metal Braided, Shielded Cable**
246, 247	CB259-5-10	CB259S-5-10
647	CB147-1-10	CB147S-1-10
260PS-1/260PS-3	CB260-3-10	CB260S-3-10

Table 1: Interface Cables

For a Flow System Using All MKS Equipment

When you purchase a complete mass flow control system, specifying all companion MKS equipment at the time of purchase, MKS will provide the appropriate cable(s) in standard lengths for a nominal cost.

For a Flow System Using Non MKS Equipment

A shielded cable assembly, (part number CB259S-6) in a nominal 10 foot (3 m) length, with a Type "D" connector on one end and terminated in "flying leads" (pigtail) fashion on the other end are available from MKS.

Note Units with flying leads are not CE compliant.

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Generic Shielded Cable Description

MKS offers a full line of cables for all MKS equipment. Should you choose to manufacture your own cables, follow the guidelines listed below to ensure CE compliance:

1. The cable must have an overall *braided* shield, covering all wires. Neither aluminum foil nor spiral shielding will be as effective; using either may nullify regulatory compliance.

2. The connectors must have a metal case which has direct contact to the cable's shield on the whole circumference of the cable. The inductance of a flying lead or wire from the shield to the connector will seriously degrade the shield's effectiveness. The shield should be grounded to the connector before its internal wires exit.

3. With very few exceptions, the connector(s) must make good contact to the device's case (ground). "Good contact" is about 0.01 ohms; and the ground should surround all wires. Contact to ground at just one point may not suffice.

4. For shielded cables with flying leads at one or both ends; it is important at each such end, to ground the shield *before* the wires exit. Make this ground with absolute minimum length. Refer to Figures 1 and 2, page 8. (A ¼ inch piece of #22 wire may be undesirably long since it has approximately 5 nH of inductance, equivalent to 31 ohms at 1000 MHz). After picking up the braid's ground, keep wires and braid flat against the case. With very few exceptions, grounded metal covers are not required over terminal strips. If one is required, it will be stated in the Declaration of Conformity or in the instruction manual.

5. In selecting the appropriate type and wire size for cables, consider:
   A. The voltage ratings;
   B. The cumulative I^2R heating of all the conductors (keep them safely cool);
   C. The IR drop of the conductors, so that adequate power or signal voltage gets to the device;
   D. The capacitance and inductance of cables which are handling fast signals, (such as data lines or stepper motor drive cables); and
   E. That some cables may need internal shielding from specific wires to others; please see the instruction manual for details regarding this matter.

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Example 1: Preferred Method To Connect Cable
(shown on a transducer)

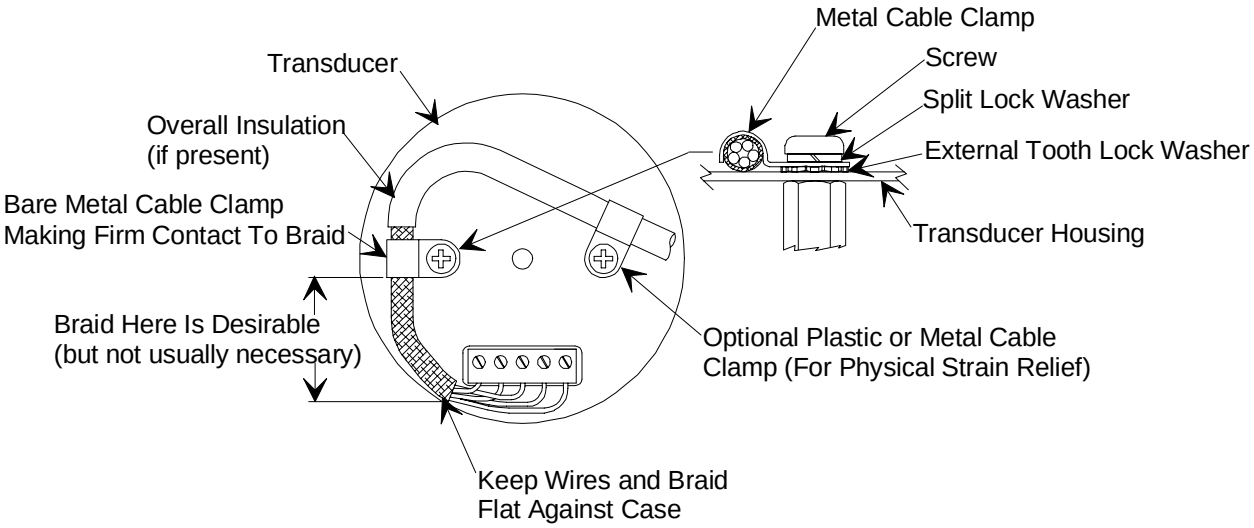


Figure 1: Preferred Method to Connect an Overall Metal Braided Shielded Cable

Example 2: Alternate Method To Connect Cable
(shown on a transducer)

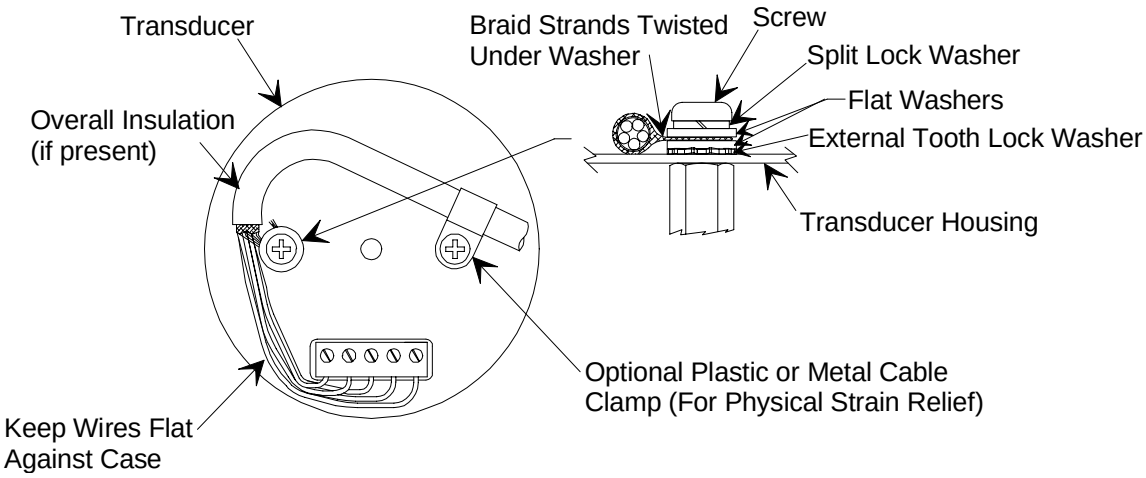


Figure 2: Alternate Method To Connect an Overall Metal Braided Shielded Cable
Use this method when cable clamp is not available

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Product Location and Requirements

Operating Environmental Requirements

- Ambient Operating Temperature: 0° C to 50° C (32° F to 122° F)
- Ventilation requirements include sufficient air circulation

Caution **The control valve in the 1152 Mass Flow Controller is *not* a positive shutoff valve. Depending upon your application, you may need to install a separate positive shutoff valve.**

Setup

The 1152 MFC is bag packaged in a clean room environment. Keep the unit bagged prior to installation. The 1152 MFC is supplied with Cajon 8-VCR type male fittings. It is important to protect the fitting seal surfaces since damaged seal surfaces may leak. Always follow the manufacturer's recommended installation instructions.

Dimensions

Note All dimensions are listed in inches with millimeters referenced in parentheses.

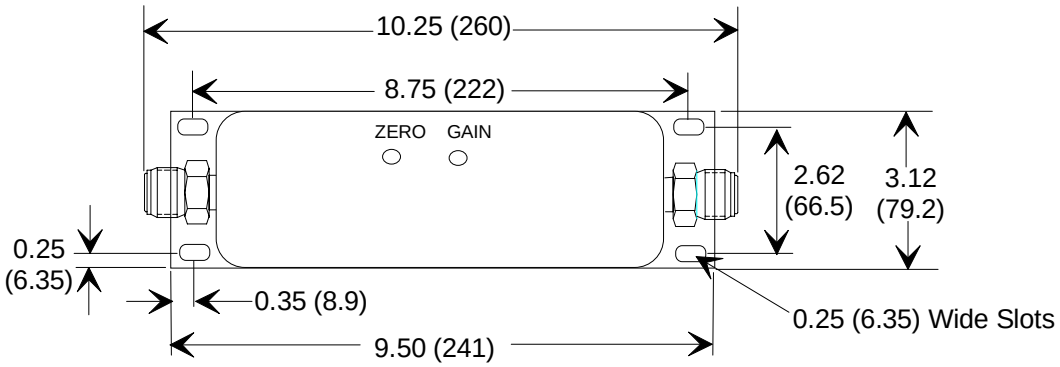


Figure 3: Top View of the 1152 Unit

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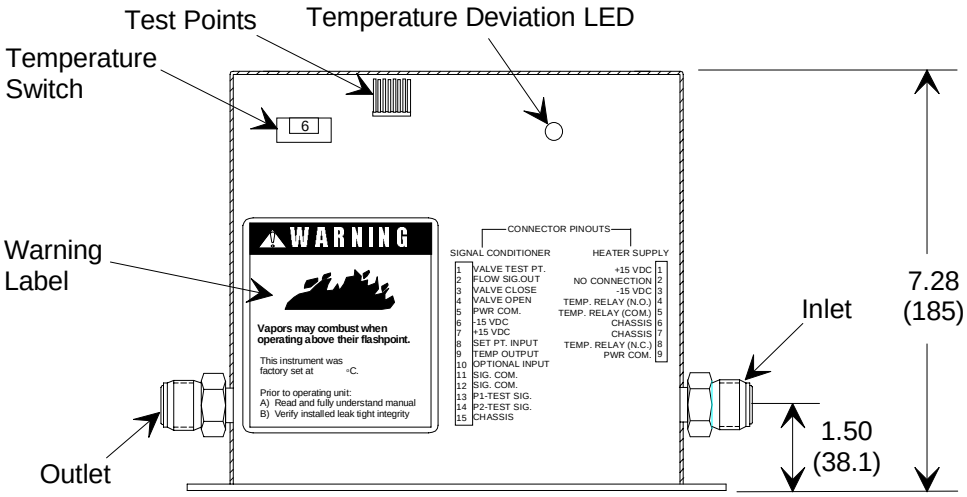


Figure 4: Back View of the 1152 Unit

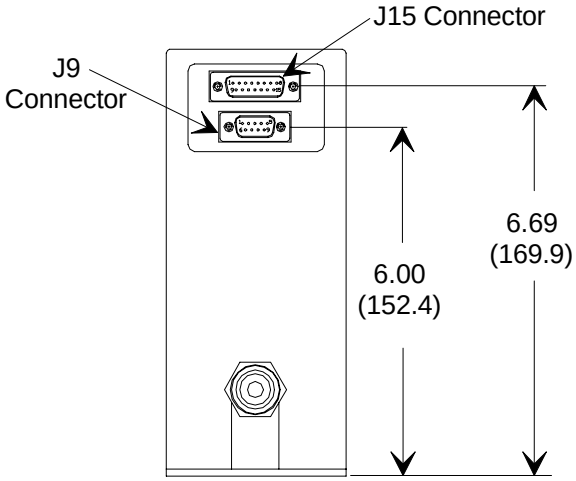


Figure 5: Side View of the 1152 Unit

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Mounting

The 1152 unit has four mounting holes in its base plate as shown in Figure 6. The centers of these slots form a rectangle 8.75 inches long by 2.62 inches wide.



Figure 6: Location of the Mounting Holes

Follow these guidelines when mounting the 1152 unit:

Warning

Read and follow all messages in *Safety Procedures and Precautions,* page1, BEFORE attempting to install the 1152 unit. Failure to adhere to these messages could result in injury to personnel.

1. Close all valves between the 1152 MFC and the vapor source before installing the unit.
2. Connect the input fitting on the 1152 unit to the vapor source.
3. Connect the outlet fitting to the downstream side.
4. Allow clearance to provide access to the connectors and the ZERO and GAIN pots.

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Mechanical Installation

Source Feed Line Temperature

It is critically important for consistent system operation that the source feed lines be adequately heated and insulated. **Remember, the coolest point in the system must be the source.** The up- and down-stream shutoff valves must also be heated and insulated, since they are integral parts of the feed lines.

Warning 

Operating at temperatures above the flash point of the vapor may cause combustion to occur if a leak to atmosphere is present. Refer to the Warning Label on the unit, shown in Figure 4, page 10, for the temperature the unit was set to at the factory.

Caution 

1. **The system temperature must not exceed the decomposition temperature of the vapor source material.**
2. **Failure to heat to all parts of the system may cause condensation, which is detrimental to proper operation.**

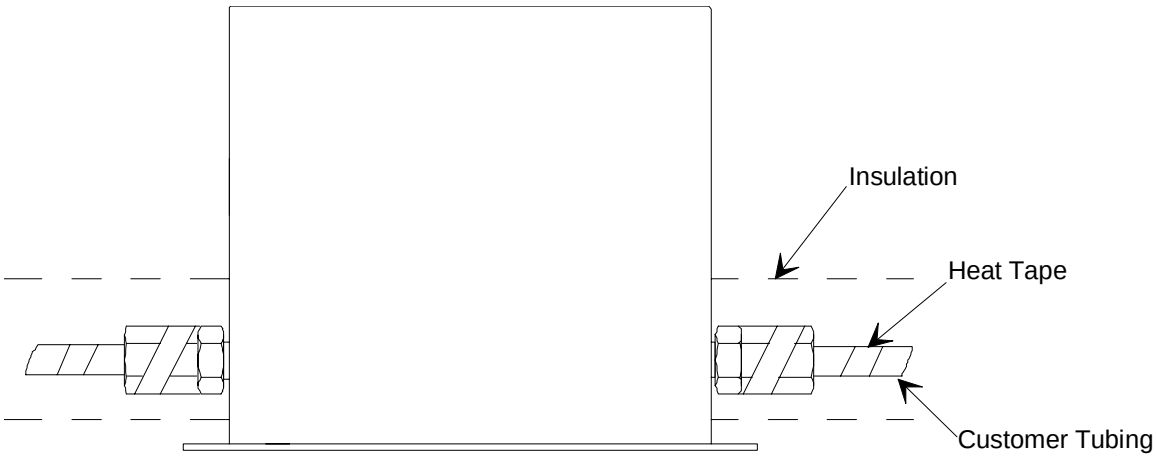


Figure 7: Typical System Configuration

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Source Feed Lines - Conductance

To ensure that the 1152 unit will operate at full rated flow, **use the largest possible I.D. piping.** The 1152 unit is equipped with 8-VCR type male fittings to be used with ½ inch tubing. This diameter is adequate (ID ≥0.40") for most installations. If ½ inch tubing is used, shutoff valves should be of the highest available conductance. Examples are ball valves or barstock type valves such as the NUPRO® SS8BK.

Caution 

Ensure that the operating conditions closely match the configuration specified at the time the 1152 unit was ordered. If there are any deviations in the configuration, contact the factory before operating the unit.

Note 

Be sure that the downstream conductance matches the conductance stated at time of order. Decreasing downstream conductance may reduce performance of the instrument.

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Electrical Information

Power Requirements

The 1152 unit requires two ±15 VDC power supplies. One provides power to the heater and the other provides power to the pressure transducer and valve control circuitry. We recommend the MKS 260PS-1 (MKS 260PS-3 for the high temperature option) combined with the MKS 246 Single Channel Power Supply/Readout. The current drawn from the 260PS-1/260PS-3 supply is directly related to the selected operating temperature. The maximum current drawn is 1.5 Amperes from the 260PS-1 (3.0 Amperes from the 260PS-3) power supply and 0.28 Amperes for the readout supply. This MFC is designed to accept a 0 to 5 VDC set point signal as an input and provides a linear 0 to 5 VDC mass flow feedback signal as an output.

Connectors

The interface connectors are located on the side of the unit, as shown in Figure 5, page 10.

Heater Supply Connector

The Power connector (J9) is a 9-pin male Type "D" connector. It includes pins for the power supply and the temperature relay.

Power (J9) Connector Pinout	
Pin Number	**Assignment**
1	+15 VDC
2	No Connection
3	-15 VDC
4	Temperature Relay (N.O.)*
5	Temperature Relay Common
6	Chassis
7	Chassis
8	Temperature Relay (N.C.)*
9	Power Common
* *Normal Operation*	

Table 2: Power (J9) Connector Pinout

Note A "No Connection" pin assignment indicates that the pin has no internal connection.

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Signal Connector

The Signal Conditioner connector (J15) is a 15-pin male Type "D" connector. This connector contains the set point input, valve test point, and manual valve position pins.

Signal (J15) Connector Pinout	
Pin Number	**Assignment**
1	Valve Test Point
2	Flow Signal Output
3	Valve Close Override
4	Valve Open Override
5	Power Common
6	-15 VDC
7	+15 VDC
8	Set Point Input
9	Temperature Output
10	Optional Input
11	Signal Common
12	Signal Common
13	P1 Test Signal
14	P2 Test Signal
15	Chassis

Table 3: Signal (J15) Connector Pinout

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Test Points

The test points are located on the back of the unit, as shown in Figure 4, page 10.

Test Point Signals	
Test Point	**Assignment**
1	Pressure 1
2	Pressure 2
3	Reserved
4	Reserved
5	Reserved
6	Valve Test Point
7	Reserved
8	Flow Output

Table 4: Test Point Signals

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Chapter Three: Overview

General Information

The operation of the 1152 MFC is based on the linear relationship between the mass flow rate and the product of the average absolute pressure and the differential pressure across a laminar flow element. A pair of Baratron® pressure sensors, of appropriate range, measure the upstream and downstream pressures and generate an output voltage which is appropriately scaled to give a 0 to 5 VDC output equal to 0 to 100% Full Scale flow rate of the specified material at the factory set temperature. The output signal and the setpoint signal are compared in an integral PID control circuit. An error signal is generated, and after further signal conditioning, a drive current for the proportioning flow control valve is generated which opens the valve to the correct position for the desired flow rate.

The stability and accuracy of the delivery system depends heavily on the proper system integration. The system consists of:

- Source heater
- Source feed lines
- 1152 MFC

System Operating Temperature

Select a system operating temperature that is high enough to prevent condensation of the vaporized source and lower than its decomposition temperature.

Caution 

To prevent condensation of the vaporized source provide a positive temperature gradient to the process. The temperature of the source lines to the 1152 unit should be less than or equal to the 1152 operating temperature. The temperature of the lines from the 1152 unit to the process should be greater than or equal to the temperature of the 1152 unit.

Changing the Range of the 1152 Unit

MKS does ***not*** recommend that the Full Scale range of the instrument be changed in the field. This procedure requires disassembly of the instrument and may require replacement of the pressure transducers, the flow control valve, and/or the laminar flow element.

Consult the MKS Applications group if you need to change the range of the unit.

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Calibration

Each 1152 MFC is calibrated before shipment for the range and the temperature that are marked on the identification tag. Power is applied to the internal heater circuit of the instrument, and it is allowed to stabilize at its operating temperature. The pressure transducers are checked for linearity and accuracy, and adjusted as necessary. The instrument is adjusted for an output of 0.000 VDC at zero flow and the customer specified process pressure at the outlet of the instrument. The vapor pressure of the source material is simulated at the inlet port, and a 5.000 VDC setpoint is applied to the instrument. The span is adjusted for a 5.000 VDC output at the equivalent nitrogen flowrate for the specified source material.

Label

The Warning label shown in Figure 8 appears on the side of the unit. Refer to Figure 4, page 10, for the location of the label. It lists the factory set temperature of the unit. It is very important to compare the factory set temperature and the flash point of the material being used since combustion could occur.

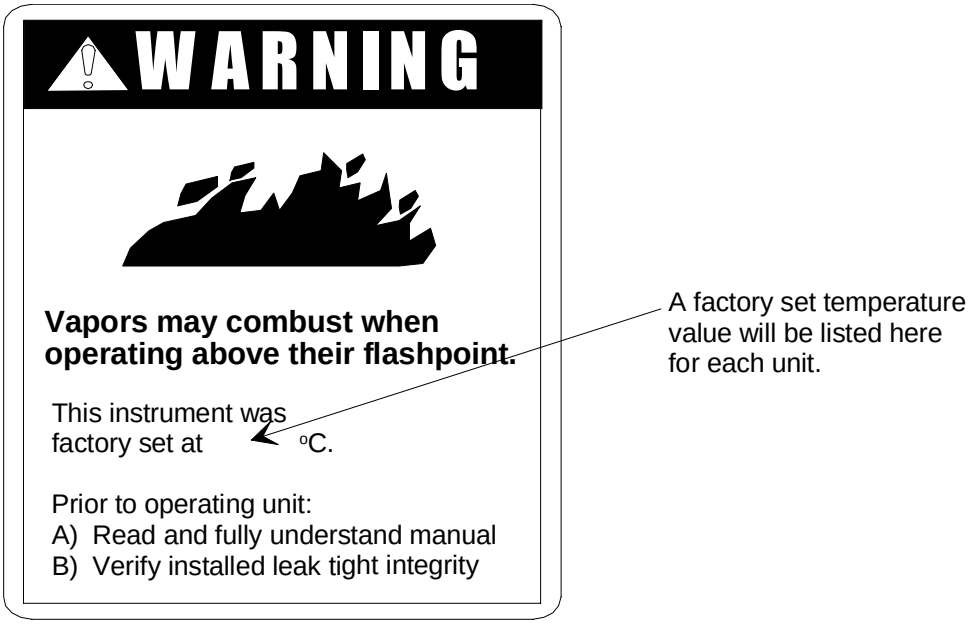


Figure 8: The Warning Label

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Analog Interface Signals

The 1152 MFC uses the analog set point input to provide "smart" features that otherwise would require separate signal lines and associated output control devices.

1. When the set point input is less than +10 mV the valve will be driven fully closed. This condition is similar to pulling the "CLOSE" line to ground which will also close the valve. Note that the 10 mV threshold is determined at the MFC. If there are voltage errors caused by ground currents or improper grounding between the MFC and the device generating the set point input, these will add (or subtract) from the threshold to establish the "close" condition.

2. The 1152 MFC has a *fast wake up* feature that allows the flow rate to quickly rise to the set point value. This feature is most noticeable when a low percentage set point is commanded. With such a low drive signal most competitive MFCs will require several seconds (up to 30) to turn on the control valve. At set point initiation (when the set point exceeds 10 mV) the 1152 MFC will quickly increase the drive current to the control valve. The current will continue to increase until the flow reading exceeds 50 mV. Exceeding this threshold turns the fast wake up feature off and the normal control parameters are used to maintain the current flow rate.

   The fast wake up will remain off until the set point signal drops below 10 mV and the flow signal drops below 50 mV.

3. The 1152 MFC has R.F. bypass capacitors on the incoming lines to reduce the susceptibility to stray high frequency signals. The capacitor on the set point input line may cause oscillations in the amplifier used to generate the set point voltage. These oscillations will occur if the amplifier is not designed to operate with capacitive loads. To prevent oscillation, install a resistor of 150 to 1000 ohms in series with the set point input line.

   Suspect oscillation if the flow rate does not follow the set point.

Note  Improper grounding can also cause discrepancies between the flow rate and the set point.

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Chapter Four: Operation

Warning 

Read and follow all safety messages listed in *Safety Procedures and Precautions,* page 1, BEFORE attempting to operate the 1152 unit. Failure to adhere to these messages could result in injury to personnel.

Caution 

Prior to operating the 1152 MFC:

1. **Thoroughly evacuate all gas lines to remove surface adsorbed water. Evacuate all gas lines and the 1152 MFC, before introducing any air or water sensitive material.**
2. **Ensure that all gas and electrical connections are correct.**
3. **Leak check the entire system.**

How To Set the Temperature

The operating temperature for the 1152 MFC ranges from 30° to 100° C for the standard unit and 90° to 150° C for the high temperature option. The temperature switch is a ten position thumbwheel switch (SW-1), visible through the vent slots in the enclosure. Refer to Figure 4, page 10, for the location of the temperature switch (SW-1). Choose the appropriate setting from Table 6, page 22.

Warning 

Operating at temperatures above the flash point of the vapor may cause combustion to occur if a leak to atmosphere is present. Refer to the Warning Label on the unit, shown in Figure 4, page 10, for the temperature the unit was set to at the factory.

Caution 

1. **The system temperature must not exceed the decomposition temperature of the vapor source material.**
2. **Failure to heat to all parts of the system may cause condensation, which is detrimental to proper operation.**

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Operating Temperature Settings		
Switch Setting	**Standard Unit (° C)**	**High Temperature Unit (° C)**
0	100	100
1	Heater Off	110
2	Heater Off	120
3	30	130
4	40	140
5	50	150
6	60	Heater Off
7	70	Heater Off
8	80	Heater Off
9	90	90

Table 5: Operating Temperature Settings

Note 

The 1152 MFC is calibrated at a temperature specified at the time the unit was ordered. If the operating temperature must change, contact the MKS Applications group for a new set of calibration data.

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Temperature Indications

The temperature status of the 1152 MFC is indicated by both an LED and a relay. Table 6 lists the status of the LED and relay for various operating temperature ranges. The relay status is available on the 9-pin Power connector (J9). Refer to Table 2, page 14, for the complete pinout of the Power connector.

Temperature Status Indicators		
Temperature	**LED Color**	**Relay Status***
Below Operating Temperature	Red	De-Energized
At Operating Temperature	Green	Energized
Above Operating Temperature	Off	De-Energized
** Refer to Table 2, page 14, for the relay pin assignments*		

Table 6: Temperature Status Indicators

Temperature Output Signal

In addition to the LED and contact relay, the temperature status may be monitored on pin 9 for the Signal connector (J15). Refer to Table 3, page 15, for the entire pinout of this connector. The actual temperature of the MFC is measured by a direct reading sensor. The output of the sensor is 10 mV per ° C. For example, an output of 0.500 VDC indicates a temperature of 50° C.

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How To Warm Up the 1152 MFC

The 1152 MFC requires approximately five (5) hours to warm up. During the warm up period the temperature of the MFC may overshoot the set point temperature by a few degrees. Therefore, both the temperature indicating LED and the relay may indicate an "above operating temperature status" for several minutes.

When power is first applied, the flow signal output may be +7.5 VDC. This is because the pressure transducer is at atmospheric pressure and is reading an overrange condition. When the process chamber is brought to process pressure, the output will be near zero. The ambient heater takes 4 to 5 hours to reach control temperature. Check zero periodically to ensure maximum accuracy.

Caution 

Be sure that all gas lines and the 1152 MFC have been fully evacuated before introducing any air or water sensitive material. Failure to do so may damage the equipment.

Note 

MKS recommends that the instrument be powered at all times. Continuous power to the unit eliminates the need to allow 4 to 5 hours for the unit to reach the operating temperature.

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How To Zero the 1152 MFC

Warning 

Read and follow all safety messages listed in *Safety Procedures and Precautions,* page 1, BEFORE attempting to zero the 1152 unit. Failure to adhere to these messages could result in injury to personnel.

Caution 

Be sure that the 1152 MFC is free of contaminants BEFORE attempting to zero the unit.

Note 

Do not attempt to zero the 1152 MFC until it has completed the five (5) hour warm up period. The warm up period is necessary to stabilize the operating temperature of the unit.

1. Bring the process chamber (located at the outlet of the 1152 MFC) up to the process pressure listed on the Calibration Data Sheet sent with the 1152 MFC.

   For example, many TEOS systems operate at a process pressure of 500 mTorr. In that case, bring the process chamber to 500 mTorr. *Appendix B: Calibration Data Sheet*, page 37, shows a typical calibration data sheet.

2. Once the process chamber has reached the process pressure, verify that there is no flow (close any upstream isolation valves) through the 1152 MFC.

3. Adjust the ZERO pot on the 1152 until the output is zero.

   Refer to Figure 3, page 9, for the location of the ZERO pot.

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How To Configure the Output

After the zero is set, the output of the 1152 MFC will be a 0 to 5 VDC signal corresponding to a 0 to 100% full scale flow of calibrated gas. In addition, you can display the output in sccm (standard cubic centimeters per minute).

To Display the Output in SCCM

Use the equation below to calculate the direct readout in sccm:

$$\frac{\text{Actual Output}}{\text{F.S. Output}} \times \text{F. S. Flow of the 1152 MFC} = \text{Flow of the gas used}$$

For example, if you are using:

Actual Output	=	3.22 VDC
Full Scale Flow	=	300 sccm TEOS
F.S. Output	=	5.000 VDC

The equation becomes:

$$\frac{3.22\ \text{V}}{5.000\ \text{V}} \times 300\ \text{sccm} = 193\ \text{sccm TEOS}$$

Using an MKS Readout

1. Determine the rated Full Scale flow rate of the instrument.
2. Refer to Table 7, page 27, to determine the appropriate value to set on the gauge factor pot on the readout unit.

   Note the location of the decimal point, shown in the “Display Range” column. Refer to the readout instruction manual for information on changing the decimal point location.

Note To configure a readout device without a gauge factor adjustment, to display sccm, an input divider may be used. Please note that MKS Types 112, 147, 246, and 247 have a gauge factor adjustment.

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Gauge Factor Effect on the Display Range		
Full Scale Flow Rate	**Gauge Factor Pot Range**	**Full Scale Display Range**
1.000 - 1.999	1.00 - 1.99	1.000 - 1.999
2.00 - 9.99	0.20 - 0.99	2.00 - 9.99
10.00 - 19.9	1.00 - 1.99	10.00 - 19.99
20.0 - 99.9	0.20 - 0.99	20.0 - 99.9
100.0 - 199.9	1.00 - 1.99	100.0 - 199.9
200. - 999.	0.20 - 0.99	200. - 999.
1000. - 1999.	1.00 - 1.99	1000. - 1999.

Table 7: Gauge Factor Effect on the Display Range

To interpret the proper method of setting the gauge factor pot, the number to the *left* of the decimal point is the number that is set in the window of the pot, and the numbers to the right are set on the dial of the pot.

Example: If the instrument being used has a rated Full Scale flow rate of 300 sccm of TEOS, the gauge factor pot would be set to 0.30 and the rightmost decimal point on the display would be turned on. When the set point pot is set to 100%, (10.0 on the dial) Full Scale flow, the readout would show a flow rate of 300 sccm.

The 1152 MFC is now configured for use. If interrupted, follow the instructions in *How To Warm Up the 1152 MFC,* page 24.

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Cautionary Notes

Note 1: Customer Supplied Display Equipment

The controller in the 1152 unit compares its own flow signal with the set point signal, and positions the valve to reduce this error to zero. Therefore, it is necessary to zero the MFC's output, using its zero potentiometer rather than offsetting a non-zero signal with an equal and opposite signal in the readout equipment if it is so equipped. Failure to properly zero the MFC will result in a disparity between set point and flow signals equal to the zero offset.

Note 2: MKS Supplied Power Supply/Display Equipment

When the 1152 MFC is used with an MKS Type 147, 246, or 247C, Note 1 does not apply. The 147, 246, or 247C takes the flow signal from the 1152 MFC, zeroes it with the front panel zero pot, and sends it back to the controller section of the 1152 unit on pin 10 of the Signal (J15) connector. Refer to Table 3, page 15, for the pinout of the Signal connector (J15).

Note 3: Set Point Command

Use of a set point voltage source of low impedance (<20K ohm) is necessary for concurrence between set point and flow signal output.

Note 4: Overrange Condition

The 1152 MFC uses an absolute pressure transducer for flow measurement. If the outlet of the MFC is at ambient (atmospheric) pressure, the pressure transducer will produce a high level output. It will appear as an overrange condition (Example : 7.5 VDC on a 0 to 5 VDC range). This may trip safety interlocks that may be present on the process system even though there is no actual flow through the MFC.

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Chapter Five: Troubleshooting

General Information

The 1152 MFC is optimized at the factory for specific application parameters. Consult the MKS Applications group if your application changes.

Warning 

Read and follow all safety messages listed in *Safety Procedures and Precautions,* page 1, BEFORE attempting to troubleshoot the 1152 unit. Failure to adhere to these messages could result in injury to personnel.

Troubleshooting Chart

Troubleshooting Chart		
Symptom	**Possible Cause**	**Remedy**
No output	1. System pressure too high.	1. Check system pressure.
	2. Improper cable.	2. Check cable type. Also, check cable for damage.
	3. Valve does not open.	3. Refer to *How To Check Valve Operation*, page 31.
	4. Electronics malfunctioning.	4. Return unit to MKS for service.
Controller does not maintain set point	1. Improper zero adjustment.	1. Zero MFC output as described in *How To Zero the 1152 MFC*, page 25.
	2. Unstable process system pressure.	2. Stabilize system process pressure control loop.
	3. Insufficient delivery pressure.	3. Raise temperature of source material.
Controller does not function	1. Condensation.	1. Check line temperatures. Evacuate lines overnight.
	2. Valve override function applied.	2. Disconnect the valve override function. Refer to Table 3, page 15, for the pin assignments.
	3. Electronics malfunctioning.	3. Return unit to MKS for service.

Table 8: Troubleshooting Chart
(Continued on next page)

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Troubleshooting Chart *(Continued)*		
Symptom	**Possible Cause**	**Remedy**
Unit produces large pressure drop or will not pass full flow	1. Clogged orifice and/or valve.	1. Purge unit; refer to *Chapter Six: Maintenance*, page 33, for specific information.
Unable to zero unit, or unit is non-linear, or has erratic flow	1. Condensation.	1. Check line temperatures. Evacuate overnight.
	2. Electronics malfunctioning.	2. Return unit to MKS for service.
	3. Improper cable.	3. Check cable type. Also, check cable for damage.
	4. System pressure too high.	4. Check that the system pressure matches the value listed on the Calibration Data Sheet.
	5. Limited downstream conductance.	5. Reconfigure downstream plumbing (shorten length or increase inside diameter).
	6. Oscillation	6. Adjust controller gain pot. Refer to *How To Prevent Oscillation*, page 31.
Indicated flow rate when no flow exists	1. High downstream pressure.	1. Check system configuration.
Oscillation	1. Incorrect controller settings.	1. Refer to *How To Prevent Oscillation*, page 31.

Table 8: Troubleshooting Chart

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How To Check Valve Operation

If the valve does not appear to be functioning properly, use this procedure to check the valve control electronics. If the electronics are functioning normally, the voltage at pin 1 of the Signal (J15) connector will correspond to the value in Table 9.

Voltage Value for the Valve Control Electronics Check	
Valve Position	**Voltage at Pin 1**
Fully Open	≈ - 13 VDC
Fully Closed	≈ + 12 VDC
Controlling at Full Rated Flow Rate	≈ - 7 VDC to + 6 VDC

Table 9: Voltage Value for the Valve Control Electronics Check

How To Prevent Oscillation

Generally, the 1152 MFC is a very stable and fast acting instrument, however some conditions may cause oscillation. The following are conditions that have been encountered:

1. ***Downstream pressure control may fight the flow controller.***
   This may be caused by improperly set gain and phase lead of the pressure loop, placing it very close to oscillation. Re-stabilize the pressure loop with the flow on.
2. ***Mounting several 1152 MFC's on a common manifold.***
   When several 1152 MFC's are mounted with their downstream fittings connected to a common manifold without regard to pressure developed, oscillations have occurred. Back pressure may cause an MFC that has no flow to read a flow rate. This may be stopped by reducing the back pressure generated or, preferably, connecting the flow to a manifold of sufficient diameter. The manifold adds significant damping volume.
3. ***Incorrect controller gain setting.***
   Flow instability may result because of incorrect controller gain setting in the 1152 MFC. This is set correctly at the factory, but because of an unforeseen system configuration, a decrease may be necessary. The potentiometer is accessed through a slot in the top cover, and turning the adjuster counter clockwise will reduce the control loop gain setting. Refer to Figure 3, page 9, for the location of the controller gain pot.
4. ***Supply pressure too high.***
   The 1152 MFC is designed to operate at the supply pressure specified in the model code. Be careful not to exceed this pressure, particularly during purge or test cycles, when using an inert gas, such as nitrogen.

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Chapter Six: Maintenance

General Information

Periodically check for wear on the cables and inspect the enclosure for visible signs of damage. Otherwise, no maintenance is required on the instrument for normal use. However, when used in a harsh environment, use the following procedure to determine if any compromise in performance or seal integrity has occurred. The following procedure should be carried out prior to returning the unit for service to prevent any unnecessary return of the instrument.

Warning 

Read and follow all safety messages listed in *Safety Procedures and Precautions,* page 1, BEFORE attempting to service the 1152 unit. Failure to adhere to these messages could result in injury to personnel.

1. Pump any condensable material out of the 1152 unit.
2. Use a dry, inert purge gas to purge 1152 unit thoroughly at operating temperature.
3. Check the calibration of the instrument.

   Refer to *How To Zero the 1152 MFC*, page 25, for details on setting the zero.
4. Check control response and stability of the instrument.

Cleaning and Repair

If, after performing the checks listed above, it is determined that cleaning is necessary, disassembly of the instrument will be required. You must send the unit back to MKS for disassembly and cleaning. Prior to any return, the instrument MUST be purged of all contaminants.

Warning 

All returns to MKS Instruments must be free of harmful, corrosive, radioactive, or toxic materials.

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Appendix A: Product Specifications

System Specifications

Accuracy (includes linearity and hysteresis)	±5% F.S.
CE Compliance Electromagnetic Compatibility[1]	 EMC Directive 89/336/EEC
Control Range	5 to 100% F.S.
Factory Set Operating Temperature Range Standard Unit High Temperature Unit	 30° to 100° C (86 to 212° F) 90° to 150° C (194 to 302° F)
Repeatability	±0.2% F.S.
Resolution	±0.1% F.S.
Settling Time	1 second to within ±2% of set point

Mechanical Specifications

Connectors (RFI/EMI shielded) Power (J9) Signal (J15)	 9-pin Type “D” 15-pin Type “D”
Fittings	Cajon 8-VCR, male
Leak Rate to atmosphere	$<1 \times 10^{-9}$ scc He/sec
Maximum Closed Conductance Through the Valve	<1% F.S. or 1 sccm, whichever is greater[2]
Maximum Line Pressure	35 psia
Mounting Position	Attitude insensitive[3]
Process Wetted Materials Optional	Inconel®, 316 SST, nickel Viton®, Kalrez®

[1] An overall metal braided shielded cable, properly grounded at both ends, is required during use.

[2] Contact MKS Applications group for information on specific applications.

[3] The 1152 MFC may be mounted in any position, however, MKS does not recommend mounting it in an upside-down position.

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Weight	7.9 lbs (3.59 kg)

Electrical Specifications

Heater Supply	
Power	±15 VDC (±2%) @1.5 Amp maximum; @ 3.0 Amp for the optional high temperature unit
Regulation	
Line	0.1%
Load	1.0%
Ripple	50 millivolts (peak-to-peak)
Signal Conditioner	
Power	±15 VDC (±2%) @ 0.28 Amp maximum
Regulation	
Line	0.1%
Load	0.2%
Ripple	50 millivolts (peak-to-peak)
Inputs	
Command Signal (Set Point)	0 to 5 VDC from <20K ohm source[4]
Set Point Override (Close)	TTL (Active Low)
Set Point Override (Open)	TTL (Active Low)
Outputs	
Flow Output	0 to 5 VDC into > 10K ohms
Relay Contact Ratings	2 Amp @ 28 VDC 1 Amp @ 120 VAC Resistive

Due to continuing research and development activities, these product specifications are subject to change without notice.

[4] Although the DC input impedance of the set point circuit is very high (meg ohms) we recommend a relatively low set point drive signal impedance (1000 ohms or less) for good noise immunity when the equipment is used in high RFI or EMI environments.

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Appendix B: Calibration Data Sheet

Typical Calibration Data Sheet

Each 1152 MFC is shipped with a Calibration Data Sheet, as shown below. This sheet contains important information on the specific application for which the 1152 MFC was designed.

MKS INSTRUMENTS

1152C FLOW CALIBRATION DATA

CUSTOMER: DATE: 11/01/96

SERIAL #: MODEL: 1152C-804K

GAS: DIBUTYLETHER SP:

CALIBRATION GAS: N_2 OPERATING TEMPERATURE: 50°C

1152C Vout (VDC) DIBUTYETHER (SCCM)	P1 TORR	P2 TORR	Flow N_2 (sccm)	Theoretical Flow
0	4.814	4.974	0.00	0.00
0.500	5.114	4.974	0.19	0.40
1.000	5.364	4.974	0.42	0.80
1.500	5.590	4.976	0.63	1.20
2.000	5.822	4.984	0.86	1.60
2.500	6.038	4.988	1.08	2.00
3.000	6.260	4.988	1.31	2.40
3.500	6.450	4.994	1.53	2.80
4.000	6.650	4.998	1.74	3.20
4.500	6.828	5.008	1.97	3.60
5.000	7.056	5.014	2.20	4.00

MFC STD: 1359C-00010RV S/N:

INLET PRESSURE: 24.00 Torr

PROCESS PRESSURE: 5.000 Torr CHECKED BY:

SM#:

Figure 9: Example Calibration Sheet

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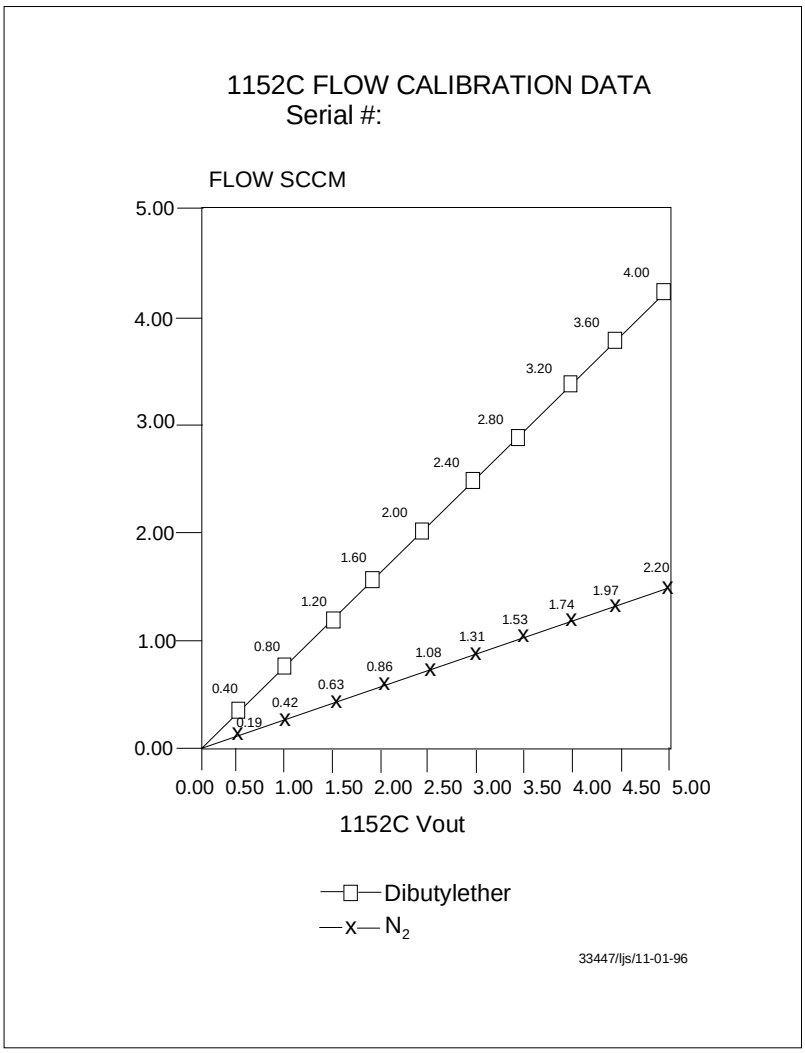


Figure 10: Example Calibration Graph

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