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112760-P1
Rev C, 3/98
Instruction Manual

MKS Type 1150C
Mass Flow Controller

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Mass Flow Controller

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Table of Contents

Mass Flow Controller Safety Information 1
Symbols Used in This Instruction Manual 1
Symbols Found on the Unit 2
Safety Procedures and Precautions 3
Chapter One: General Information 5
Introduction 5
How This Manual is Organized 6
Customer Support 6
Chapter Two: Installation 7
How To Unpack the Type 1150 Unit 7
Opening the Package 7
Unpacking Checklist 8
Product Location and Requirements 8
Operating Environmental Requirements 8
Recommended Installation 8
Setup 9
Dimensions 9
Mounting the 1150 Unit 10
Mechanical Installation 11
Electrical Installation 13
Power Requirements 13
Connectors 13
Interface Cables 15
Generic Shielded Cable Guidelines 16
Chapter Three: Overview 17
General Information 17
System Operating Temperature 17
Changing the Range of the 1150 Unit 17

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Calibration 18
Label 18
Analog Interface Signals 19

Chapter Four: Operation 21
How To Set the Temperature 22
Temperature Indications 23
How To Warm Up the 1150 MFC 23
How To Zero the 1150 MFC 24
How To Configure the Output 25
To Display the Output in SCCM 25
Cautionary Notes 27
Note 1: Customer Supplied Display Equipment 27
Note 2: MKS Supplied Power Supply/Display Equipment 27
Note 3: Set Point Command 27
Note 4: Overrange Condition 27
How To Calibrate the 1150 MFC 28

Chapter Five: Troubleshooting 29
General Information 29
Troubleshooting Chart 29
How To Check Valve Operation 31
How To Prevent Oscillation 31

Chapter Six: Maintenance 33
General Information 33
Cleaning and Repair 33

Appendix A: Product Specifications 35
System Specifications 35
Mechanical Specifications 35
Electrical Specifications 36

Appendix B: Calibration Data Sheet 37
Typical Calibration Data Sheet 37

Index 39

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List of Figures and Tables

Figures

Figure 1: Recommended Installation for the 1150 MFC 8
Figure 2: Top View of the 1150 Unit 9
Figure 3: Back View of the 1150 Unit 9
Figure 4: Side View of the 1150 Unit 10
Figure 5: Location of the Mounting Holes 10
Figure 6: Typical System Configuration 11
Figure 7: Warning Label 18
Figure 8: Example Calibration Sheet 37
Figure 9: Example Calibration Graph 38

Tables

Table 1: Definition of Symbols Found on the Unit 2
Table 2: Power (J9) Connector Pinout 13
Table 3: Signal (J15) Connector Pinout 14
Table 4: Interface Cables 15
Table 5: Operating Temperature Settings 22
Table 6: Temperature Status Indicators 23
Table 7: Gauge Factor Effect on the Display Range 26
Table 8: Troubleshooting Chart 29
Table 9: Voltage Value for the Valve Control Electronics Check 31

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Mass Flow Controller Safety Information

Symbols Used in This Instruction Manual

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

Warning 

The WARNING sign denotes a hazard to personnel. 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 to equipment. 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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Symbols Found on the Unit

The following table describes symbols that may be found on the unit.

Definition of Symbols Found on the Unit			
On (Supply) IEC 417, No.5007	 Off (Supply) IEC 417, No.5008	 Earth (ground) IEC 417, No.5017	 Protective earth (ground) IEC 417, No.5019
 Frame or chassis IEC 417, No.5020	 Equipotentiality IEC 417, No.5021	 Direct current IEC 417, No.5031	 Alternating current IEC 417, No.5032
 Both direct and alternating current IEC 417, No.5033-a	 Class ll equipment IEC 417, No.5172-a	 Three phase alternating current IEC 617-2 No.020206	
 Caution, refer to accompanying documents ISO 3864, No.B.3.1	 Caution, risk of electric shock ISO 3864, No.B.3.6	 Caution, hot surface IEC 417, No.5041	

Table 1: Definition of Symbols Found on the Unit

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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.

DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT

Do not install substitute parts or perform any unauthorized modification to the instrument. Return the instrument to an MKS Calibration and Service Center for service and repair to ensure that all safety features are maintained.

SERVICE BY QUALIFIED PERSONNEL ONLY

Operating personnel must not attempt component replacement and internal adjustments. Any service must be made by qualified service personnel only.

USE CAUTION WHEN OPERATING WITH HAZARDOUS MATERIALS

If hazardous materials are used, observe the proper safety precautions, completely purge the instrument when necessary, and ensure that the material used is compatible with the wetted materials in this product, including any sealing materials.

PURGE THE INSTRUMENT

After installing the unit, or before removing it from a system, purge the unit completely with a clean, dry gas to eliminate all traces of the previously used flow material.

USE PROPER PROCEDURES WHEN PURGING

This instrument must be purged under a ventilation hood, and gloves must be worn for protection.

DO NOT OPERATE IN AN EXPLOSIVE ENVIRONMENT

To avoid explosion, do not operate this product in an explosive environment unless it has been specifically certified for such operation.

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

Carefully check all vacuum component connections to ensure leak-tight installation.

OPERATE AT SAFE INLET PRESSURES

Never operate at pressures higher than the rated maximum pressure (refer to the product specifications for the maximum allowable pressure).

INSTALL A SUITABLE BURST DISC

When operating from a pressurized gas source, install a suitable burst disc in the vacuum system to prevent system explosion should the system pressure rise.

KEEP THE UNIT FREE OF CONTAMINANTS

Do not allow contaminants to enter the unit before or during use. Contamination such as dust, dirt, lint, glass chips, and metal chips may permanently damage the unit or contaminate the process.

ALLOW THE UNIT TO WARM UP

If the unit is used to control dangerous gases, they should not be applied before the unit has completely warmed up. Use a positive shutoff valve to ensure that no erroneous flow can occur during warm up.

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Chapter One: General Information

Introduction

The MKS Type 1150C 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. The Type 1150 MFC utilizes all-metal seals to eliminate permeation normally found with the use of elastomeric sealing materials.

Mass flow measurement and control is accomplished without the need of bubbler systems or thermal mass flow sensors. The 1150 MFC uses a Baratron® pressure transducer and an integral PID controller to control the pressure above a choked orifice. This pressure, given sonic flow, is linearly proportional to mass flow and is appropriately scaled within the 1150 MFC to a 0 to 5 VDC output signal that is equal to 0 to 100% full rated flow.

Caution 

The control valve in the 1150 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 1150 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 1150 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 1150 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 1150 unit.

Before installing your Type 1150 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, Troubleshooting, provides suggestions should you encounter a problem operating the instrument.

Chapter Six, Maintenance, contains routine maintenance tasks to keep the instrument in good working condition.

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

Appendix B, Calibration Data Sheet, defines the important information documented in this sheet.

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 1150 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 1150 Unit

MKS has carefully packed the Type 1150 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.

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.

Opening the Package

The 1150 controller is assembled, leak tested with helium, and calibrated in a clean room environment. The instrument is double-bagged in this environment to ensure maintenance of its particle free condition during shipment. It is very important to remove the bags according to clean room practices. To maintain at least a minimal level of clean room standards, follow the instructions below.

1. Remove the outer bag in an ante room (garmenting room) or transfer box.

   Do not allow this outer bag to enter the clean room.

2. Remove the inner bag in the clean room.

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Unpacking Checklist

Standard Equipment:

- Type 1150 Unit
- Type 1150 Instruction Manual (this book)

Optional Equipment:

- Electrical Connector Accessories Kit: 1150C-K1
- Interface cables; refer to *Interface Cables*, page 15, for information

Product Location and Requirements

Operating Environmental Requirements

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

Caution **The control valve in the 1150 Mass Flow Controller is *not* a positive shutoff valve. Depending upon your application, you may need to install a separate positive shutoff valve.**

Recommended Installation

The recommended installation for the 1150 MFC, shown in Figure 1, includes gas purge and vacuum lines. The dashed lines indicate which lines should be heated to the operating temperature. Refer to *Mechanical Installation*, page 11, for more information.

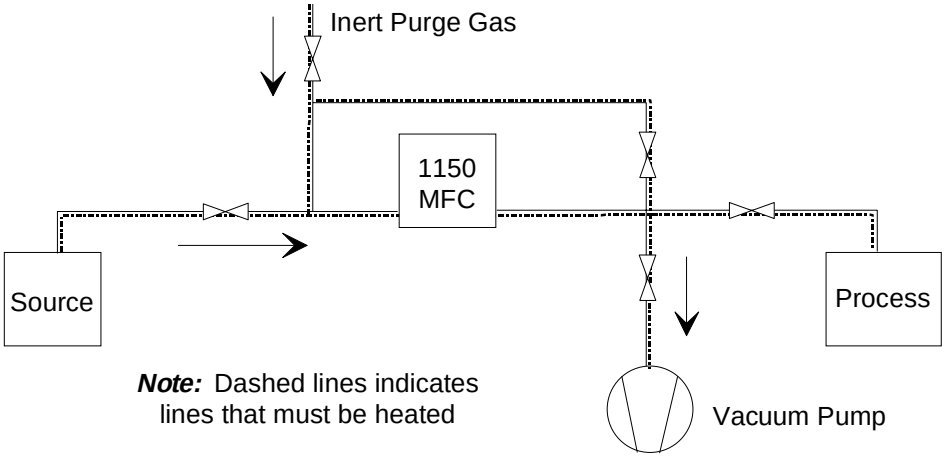


Figure 1: Recommended Installation for the 1150 MFC

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Setup

The 1150 MFC is bag packaged in a clean room environment. Keep the unit bagged prior to installation. The 1150 MFC is supplied with Swagelok® 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.

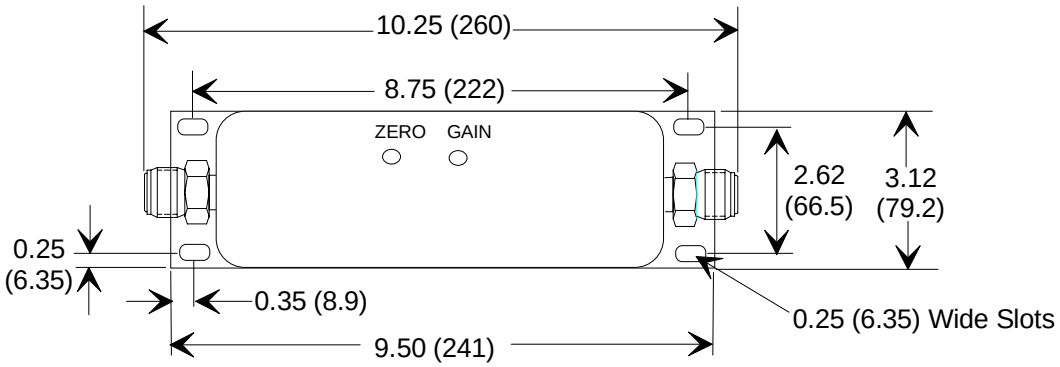


Figure 2: Top View of the 1150 Unit

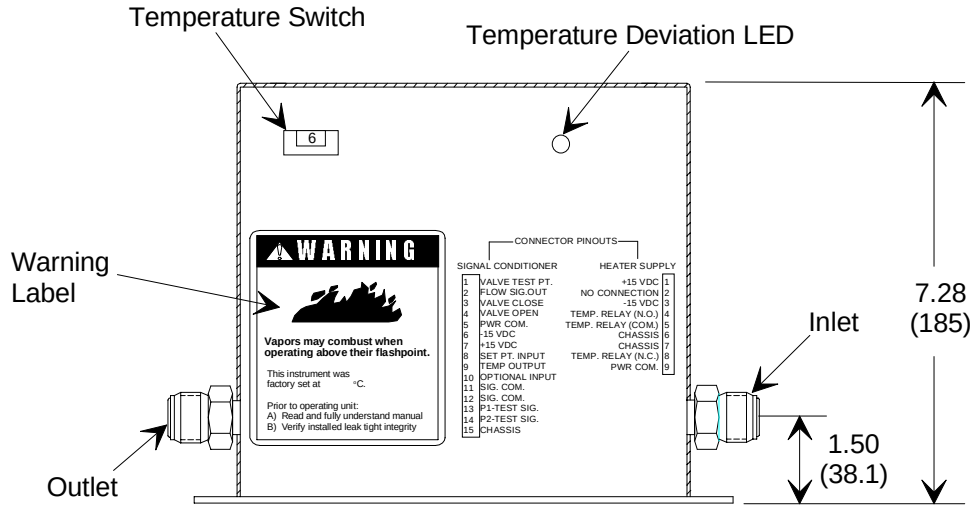


Figure 3: Back View of the 1150 Unit

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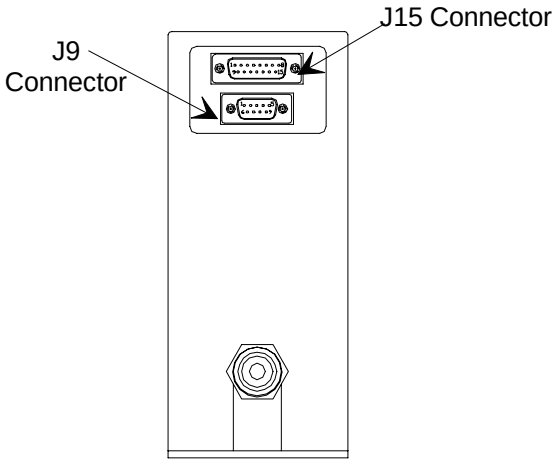


Figure 4: Side View of the 1150 Unit

Mounting the 1150 Unit

The 1150 unit has four mounting holes in its base plate as shown in Figure 5. The centers of these slots form a rectangle 8.75 inches long by 2.62 inches wide.

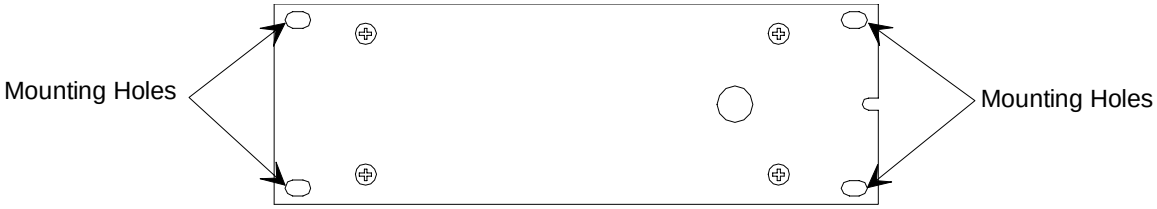


Figure 5: Location of the Mounting Holes

Follow these guidelines when mounting the 1150 unit:

Warning



Read and follow all messages in *Mass Flow Controller Safety Information,* page 1, BEFORE attempting to install the 1150 unit. Failure to adhere to these messages could result in injury to personnel.

- Close all valves between the 1150 MFC and the vapor source before installing the unit.
- Connect the input fitting on the 1150 unit to the vapor source.
- Connect the outlet fitting to the downstream side.
- 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 spontaneous combustion to occur. If possible, operate at a temperature *below* the flash point of the vapor. Refer to the Warning Label on the unit, shown in Figure 3, page 9, 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.**

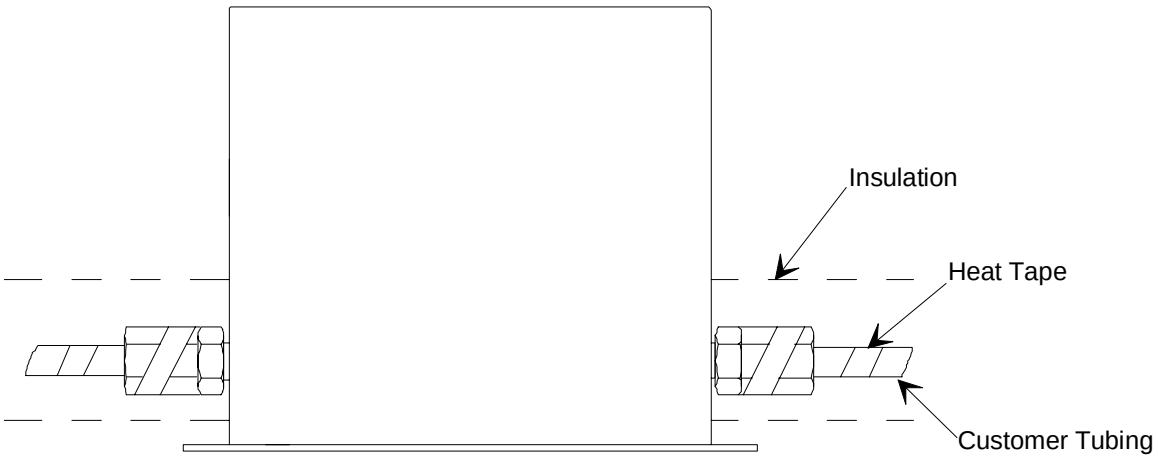


Figure 6: Typical System Configuration

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Source Feed Lines - Conductance

To minimize vapor condensation and to ensure that the 1150 unit will operate at full rated flow, **use the largest possible I.D. piping.** The 1150 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 1150 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 Installation

Power Requirements

The 1150 unit requires two ±15 VDC power supplies. One provides power to the heater and the other provides power to the Baratron 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 4, page 10.

Power 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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Interface Cables

As of January 1, 1996, most products shipped to the European Community must comply with the EMC Directive 89/336/EEC, which covers radio frequency emissions and immunity tests. In addition, as of January 1, 1997, some products shipped to the European Community must also comply with the Product Safety Directive 92/59/EEC and Low Voltage Directive 73/23/EEC, which cover general safety practices for design and workmanship. MKS products that meet these requirements are identified by application of the CE Mark.

To ensure compliance with EMC Directive 89/336/EEC, an overall metal braided shielded cable, properly grounded at both ends, is required during use. No additional installation requirements are necessary to ensure compliance with Directives 92/59/EEC and 73/23/EEC.

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 cable to connect an 1150 MFC to a 260PS-1 power supply unit, use part number CB260-3-XX, where XX designates the cable length; for a braided, shielded cable use part number CB260S-3-XX.

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 4: 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.

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Generic Shielded Cable Guidelines

Should you choose to manufacture your own cables, follow the guidelines listed below:

1. The cable must have an overall metal *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. (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).
   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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Chapter Three: Overview

General Information

The operation of the 1150 MFC based on the linear relationship between the total pressure upstream of a sonic nozzle and the mass flow through it, given choked flow; inlet to outlet pressure ratio of approximately 2:1. If this ratio drops below approximately 2:1 the flow through the sonic nozzle will not be choked and the flow may become non-linear. (For a thorough explanation of this process see: J.J. Sullivan, S. Schaffer and R.P. Jacobs. "Mass Flow Measurement and Control of Low Vapor Pressure Sources." MKS Instruments, Inc. Oct. 1988.) A Baratron pressure transducer of appropriate range measures this pressure and generates 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. The output signal and the set point 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
- 1150 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 all source lines should be greater than or equal to the 1150 operating temperature.**

Changing the Range of the 1150 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 transducer, and/or changing the nozzle size.

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

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Calibration

Each 1150 MFC is calibrated before shipment for the range and temperature 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 transducer is checked for linearity and repeatability, and adjusted as necessary. The instrument is adjusted for an output of 0.000 VDC by controlling 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 set point is applied to the instrument. The span is adjusted for a 5.000 VDC output at the equivalent nitrogen flow rate for the specified source material.

Label

The Warning label shown in Figure 7 appears on the side of the unit. A factory set temperature is listed for each unit. Refer to Figure 3, page 9, for the location of the warning label.

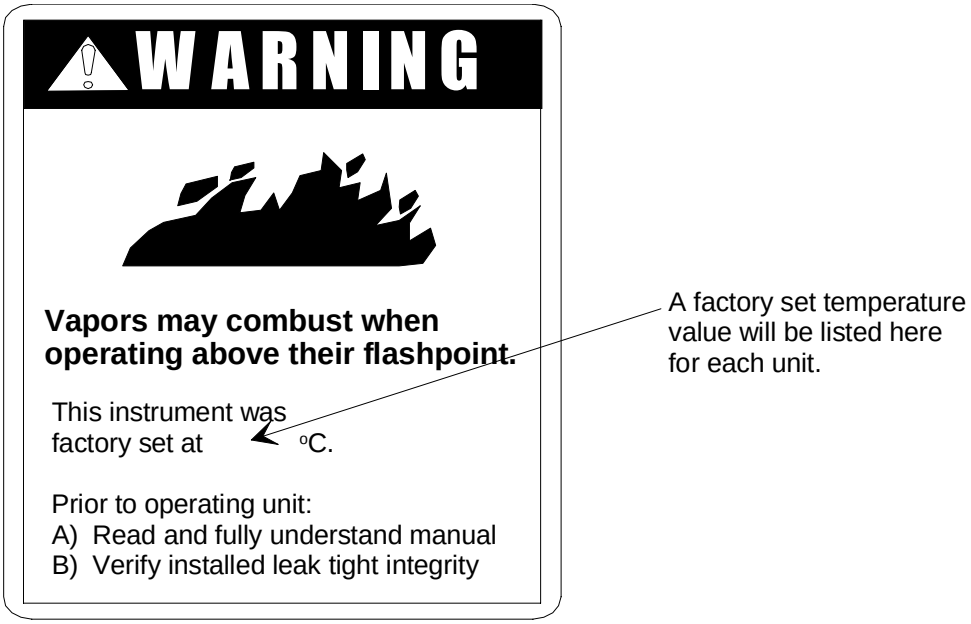


Figure 7: Warning Label

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Analog Interface Signals

The 1150 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 1150 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 1150 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 1150 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 

Before performing mass flow controller valve adjustments, you MUST purge your process equipment and the MFC with an inert gas, such as argon or nitrogen, and isolate the MFC from toxic and hazardous gases. Use an inert surrogate gas while adjusting the valve preload as a safeguard against inadvertent exposure to any toxic or hazardous gas. A release of hazardous or toxic gas could cause serious injury. If necessary, remove the MFC from the process equipment to adjust the valve.

Questions concerning the safe handling of toxic or hazardous gases 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 gases.

Warning 

Read and follow all safety messages listed in *Mass Flow Controller Safety Information,* page 1, BEFORE attempting to operate the 1150 unit. Failure to adhere to these messages could result in injury to personnel.

Caution 

Prior to operating the 1150 MFC:

1. **Thoroughly evacuate all gas lines to remove surface adsorbed water.**
2. **Ensure that all gas and electrical connections are correct.**
3. **Leak check the entire system.**

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How To Set the Temperature

The operating temperature for the 1150 MFC ranges from 30° to 100° C for the standard unit and 90 to 150° C for the high temperature option. The temperature is set using the ten position thumbwheel switch (SW-1), visible through the vent slots in the enclosure. Refer to Figure 3, page 9, for the location of SW-1. Choose the appropriate setting from Table 5, page 22.

Warning 

Operating at temperatures above the flash point of the vapor may cause spontaneous combustion to occur. If possible, operate at a temperature *below* the flash point of the vapor. Refer to the Warning Label on the unit, shown in Figure 3, page 9, 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.**

Operating Temperature Settings *(Temperatures listed in °C)*		
Switch Setting	**Standard Unit**	**High Temperature Unit**
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 1150 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 1150 MFC is indicated by both an LED and a relay. Table 6 lists the status of the LED and relays for various operating temperature ranges.

Temperature Status Indicators				
Temperature	**LED**	**Relay Contacts**		**Position**
		Pins on the External 9-pin Connector	**Pins on the Internal 3-pin Connector**	
Below Operating	Red	4 to 5	1 to 2	Closed
		6 to 5	3 to 2	Open
At Operating	Green	4 to 5	1 to 2	Open
		6 to 5	3 to 2	Closed
Above Operating	Off	4 to 5	1 to 2	Closed
		6 to 5	3 to 2	Open

Table 6: Temperature Status Indicators

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 14, 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.

How To Warm Up the 1150 MFC

The 1150 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.

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 1150 MFC

Note ***Do not*** attempt to zero the 1150 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 1150 MFC) up to the process pressure listed on the Calibration Data Sheet sent with the 1150 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 1150 MFC.

3. Adjust the ZERO pot on the 1150 until the output is zero.

   Refer to Figure 2, page 9, for the location of the ZERO pot.

Note Minor deviations in process pressure are allowable, however, any large deviation will result in the inability to zero the instrument. In such cases, contact MKS for assistance.

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How To Configure the Output

After the zero is set, the output of the 1150 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:

$$\frac{\text{Actual Output}}{\text{F.S. Output}} \times \text{F. S. Flow of the 1150 MFC} = \text{Flow of the gas used}$$

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 26, 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.

Gauge Factor Effect on the Display Range

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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 1150 MFC is now configured for use. If interrupted, follow the instructions in *How To Warm Up the 1150 MFC*, page 23.

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Cautionary Notes

Note 1: Customer Supplied Display Equipment

The controller in the 1150 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 1150 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 1150 MFC, zeroes it with the front panel zero pot, and sends it back to the controller section of the 1150 unit on pin 10 of the Signal (J15) connector.

Note 3: Set Point Command

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

Note 4: Overrange Condition

The 1150 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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How To Calibrate the 1150 MFC

To check the calibration of the instrument it is necessary to have equipment to simulate the process pressure and the vapor pressure of the source gas for which the instrument was originally calibrated.

Warning  **Read and follow all safety messages listed in *Mass Flow Controller Safety Information,* page 1, BEFORE attempting to calibrate the 1150 unit. Failure to adhere to these messages could result in injury to personnel.**

Caution  **Be sure that the 1150 MFC is free of contaminants BEFORE attempting to check its calibration.**

1. Connect the outlet port of the 1150 unit to a vacuum system.

2. Adjust the process pressure control loop to the pressure that is recorded on the Calibration Data Sheet. *Appendix B: Calibration Data Sheet,* page 37, shows a typical calibration data sheet.

3. When the pressure is stable, adjust the output of the 1150 unit to 0.000 VDC using the ZERO pot, located on the top of the unit. Read the voltage on pin 2 of the Signal (J15) connector.

   Refer to Figure 2, page 9, for the location of the ZERO pot and Table 3, page 14, for the complete pinout of the Signal (J15) connector.

4. Adjust the inlet pressure control loop to the vapor pressure of the source gas that normally will be used.

   This value is recorded on the Calibration Data Sheet.

5. Apply a set point of 5.000 VDC to the instrument, at pin 8 of the Signal (J15) connector, and measure the flow of nitrogen through the instrument as indicated on the flow standard (MKS type 258, for example).

6. Adjust the SPAN potentiometer so that the indicated flow of the flow standard is the same as the "Actual Nitrogen Flow" for an output of 5.000 VDC on the Calibration Data Sheet.

   Refer to Figure 2, page 9, for the location of the SPAN pot.

7. Check the instrument at 0.5 VDC set point increments from 0 to 5.000 VDC. The flow should be the same as that stated on the Calibration Data Sheet (± accuracy specification).

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Chapter Five: Troubleshooting

General Information

The 1150 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 *Mass Flow Controller Safety Information,* page 1, BEFORE attempting to troubleshoot the 1150 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. 2. Improper cable. 3. Valve does not open. 4. Electronics malfunctioning.	1. Check system pressure. 2. Check cable type. Also, check cable for damage. 3. Refer to *How To Check Valve Operation*, page 31. 4. Return unit to MKS for service.
Controller does not maintain set point	1. Improper zero adjustment. 2. Unstable process system pressure. 3. Insufficient delivery pressure.	1. Zero MFC output as described in *How To Zero the 1150 MFC*, page 24. 2. Stabilize system process pressure control loop. 3. Raise temperature of source material.
Controller does not function	1. Condensation. 2. Valve override function applied. 3. Electronics malfunctioning.	1. Check line temperatures. Evacuate lines overnight. 2. Disconnect. 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 1150 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 1150 MFC's on a common manifold.***
   When several 1150 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 1150 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 2, page 9, for the location of the controller gain pot.

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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 *Mass Flow Controller Safety Information,* page 1, BEFORE attempting to service the 1150 unit. Failure to adhere to these messages could result in injury to personnel.

1. Pump any condensable material out of the 1150 unit.
2. Use a dry, inert purge gas to purge 1150 unit thoroughly at operating temperature.
3. Check the calibration of the instrument.

   Refer to *How To Calibrate the 1150 MFC,* page 28, for details on calibrating the unit.
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	Swagelok 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	Inconel®, 316 SST, nickel

[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 1150 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 1150 MFC is shipped with a Calibration Data Sheet, as shown below. This sheet contains important information on the specific application for which the 1150 MFC was designed.

MKS INSTRUMENTS

1150C FLOW CALIBRATION DATA

CUSTOMER: DATE: 7/12/96

SERIAL #: MODEL: 1150C-071V

GAS: TEOS SP:

CALIBRATION GAS: N_2 OPERATING TEMPERATURE: 30°C

1150C Vout (VDC)	P3 Torr	Flow N_2 (sccm)	Theoretical Flow TEOS (sccm)
0	0.500	0.00	0.00
0.500	1.778	91.70	38.89
1.000	3.174	174.60	67.68
1.500	4.562	257.50	96.80
2.000	5.954	340.40	125.50
2.500	7.348	423.30	155.67
3.000	8.738	506.20	184.53
3.500	10.134	589.10	213.40
4.000	11.524	672.00	242.36
4.500	12.936	754.90	271.12
5.000	14.310	837.80	300.00

MFC STD: 1359C-01000RV S/N:

INLET PRESSURE: 24.00 Torr

PROCESS PRESSURE: 0.500 Torr CHECKED BY:

SM#:

Figure 8: Example Calibration Sheet

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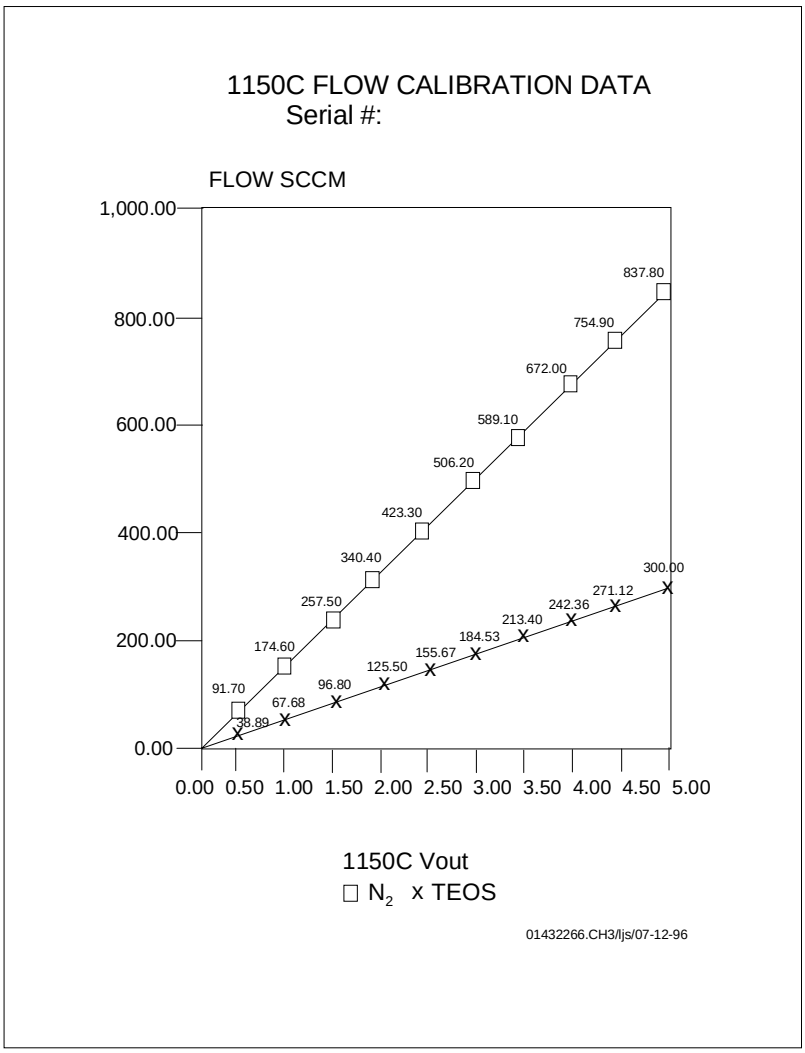


Figure 9: Example Calibration Graph

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Index

A

Accuracy, 35
Analog interface, 19

C

Cables, 8
Calibration, 18, 28
Calibration Data Sheet, 5, 24, 28, 37
CE Mark, 35
Cleaning, 33
Conductance, 12
Connectors, 13–14
Customer support, 6

D

Decomposition, 11, 22
Dimensions, 9
Display, 25, 27

E

Electrical, 13

F

Factory set temperature, 18
Fast wake up, 19
Fittings, 9
Flash point, 11, 22
Full scale range, 17

G

Gauge factor, 26

H

Heating, 11
High Temperature option, 5, 13

L

LED, 23

M

Maintenance, 33
Manual organization, 6
Mounting, 10

O

Operating temperature, 5, 17, 22–23
Oscillation, 19, 31
Output signal, 5, 17, 25
Overshoot, 23

P

PID controller, 5, 17
Plumbing, 11, 12
Power, 13

R

Readout, 25, 27
Repair, 33
Returning the product, 6, 7

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Returns, 33
RFI, 19

S

Seal material, 5
Set point, 19
Sonic flow, 5, 17
Source material, 17
Span, 28
Specifications, 35–36

T

Temperature, 5, 8, 17, 22–23
Temperature control, 11
Temperature status, 23
Troubleshooting, 29

U

Unpacking
    opening, 7

V

Valve, 31
Valve position, 17

W

Warm up, 23
Warning label, 18

Z

Zero, 24, 28

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