



MKS Type π MFC™ Digital Mass Flow Controller Low Pressure

Preliminary Instruction Manual

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WARRANTY

Type π MFC™ Digital Mass Flow Controller Low Pressure

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**MKS Type π MFCTM Digital
Mass Flow Controller
Low Pressure**

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List of References

The documents listed below are referenced throughout this manual.

- [1] SEMI E17-00-0060 Guideline for Mass Flow Controller Transient Characteristics Tests
- [2] SEMI E56-00-1296. Test Method for Determining Accuracy, Linearity, Repeatability, Short Term Reproducibility, Hysteresis, and Dead Band of Thermal Mass Flow Controllers
- [3] SEMI E18-00-0091. Guideline for Temperature Specifications of the Mass Flow Controller
- [4] SEMI E27-00-0092. Standard for Mass Flow Controller and Mass Flow Meter Linearity
- [5] SEMI E28-00-0092. Guideline for Pressure Specifications of the Mass Flow Controller
- [6] SEMI E80-00-0299. Test Method Determining Attitude Sensitivity of Mass Flow Controllers
- [7] SEMI Standards Document E52-95. Practice for Referencing Gases and Gas Mixtures Used in Digital Mass Flow Controllers

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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 are:



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.

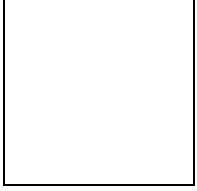
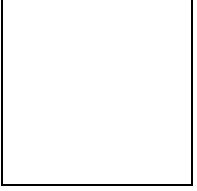
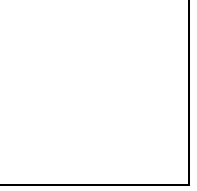
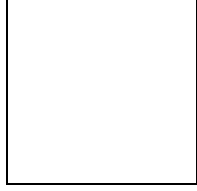
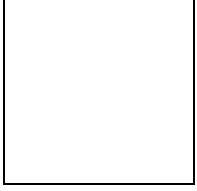
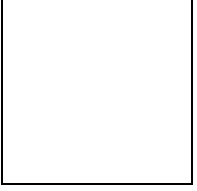
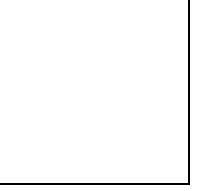
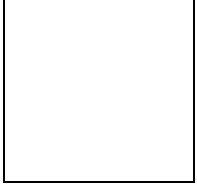
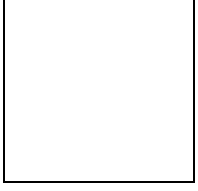
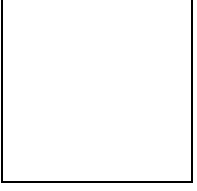
Note

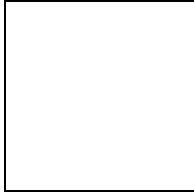
The **NOTE** sign denotes important information. It calls attention to a procedure, practice, condition, or the like, which is essential to highlight.

Symbols Found on the Unit

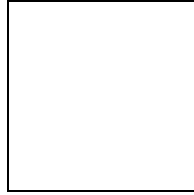
The following table describes symbols that may be found on the unit.

Table 1: Definition of Symbols Found on the Unit

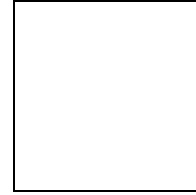
| | | | |
|---|--|--|---|
| On (Supply) IEC 417, No. 5007 |  Off (Supply) IEC 417, No. 5008 |  Earth (ground) IEC 417, No. 5017 |  Protective Earth (ground) IEC 417, No. 5019 |
|  Frame or Chassis IEC 417, No. 5020 |  Equipotentiality IEC 417, No. 5021 |  Direct Current IEC 417, No. 5031 |  Alternating Current IEC 417, No. 5032 |
|  Both Direct and Alternating Current IEC 417, No. 5033-a |  Class II 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

Safety Procedures and Precautions

Observe the following general safety precautions 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 remove instrument covers. Component replacement and internal adjustments must be made by qualified service personnel only.

KEEP AWAY FROM LIVE CIRCUITS

Do not replace components with power cable connected. Under certain conditions, dangerous voltages may exist even with the power cable removed. To avoid injuries, always disconnect power and discharge circuits before touching them.

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 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 to protect personnel. To purge this instrument properly, it must be purged in both the horizontal base down and horizontal base up configurations as defined in SEMI specification. Device has trapped volume in its sensor where gas which is lighter than air but still hazardous can accumulate.

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.

CHECK FOR LEAK-TIGHT FITTINGS

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

OPERATE AT SAFE INLET PRESSURES

This unit should never be operated 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, a suitable burst disc should be installed in the vacuum system to prevent system explosion should the system pressure rise.

KEEP THE UNIT FREE OF CONTAMINANTS

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

ALLOW PROPER WARM UP TIME FOR TEMPERATURE-CONTROLLED UNITS

Temperature-controlled unit will only meet specifications when sufficient time is allowed for the unit to meet, and stabilize at, the designed operating temperature. Do not zero or calibrate the unit until the warm up is complete.

Sicherheitshinweise für das Massenflussgerät

In dieser Betriebsanleitung vorkommende Symbole

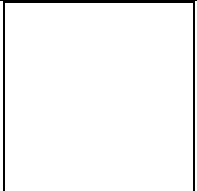

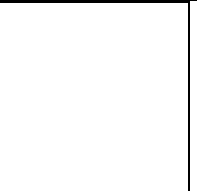
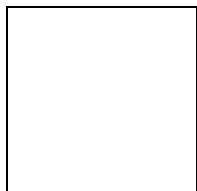
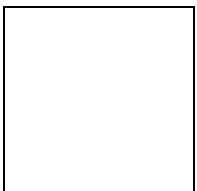
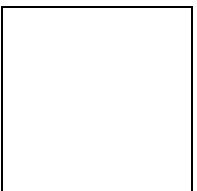
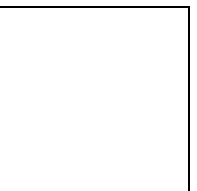
Bedeutung der mit WARNUNG!, VORSICHT! und HINWEIS gekennzeichneten Absätze in dieser Betriebsanleitung.

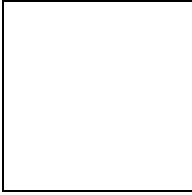
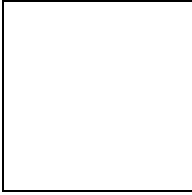
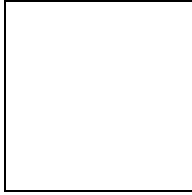
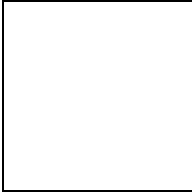
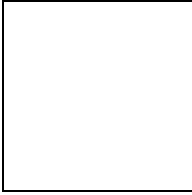
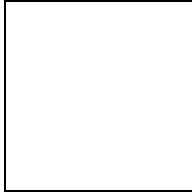
| | |
|------------------|---|
| Warnung! | Das Symbol WARNUNG! weist auf eine Gefahr für das Bedienpersonal hin. Es macht auf einen Arbeitsablauf, eine Arbeitsweise, einen Zustand oder eine sonstige Gegebenheit aufmerksam, deren unsachgemäße Ausführung bzw. ungenügende Berücksichtigung zu Verletzungen führen kann. |
| Vorsicht! | Das Symbol VORSICHT! weist auf eine Gefahr für das Gerät hin. Es macht auf einen Bedienungsablauf, eine Arbeitsweise oder eine sonstige Gegebenheit aufmerksam, deren unsachgemäße Ausführung bzw. ungenügende Berücksichtigung zu einer Beschädigung oder Zerstörung des Gerätes oder von Teilen des Gerätes führen kann. |
| Hinweis | Das Symbol HINWEIS macht auf wichtige Informationen bezüglich eines Arbeitsablaufs, einer Arbeitsweise, eines Zustands oder einer sonstige Gegebenheit aufmerksam. |

Erklärung der am Gerät angebrachten Symbole

Nachstehender Tabelle sind die Bedeutungen der Symbole zu entnehmen, die am Gerät angebracht sein können.

Tabelle 2: Bedeutung der am Gerät angebrachten Symbole

| | | | |
|---|---|--|--|
| Ein (Energie) IEC 417, No.5007 |  Aus (Energie) IEC 417, No.5008 |  Erdanschluss IEC 417, No.5017 |  Schutzleiteranschluss IEC 417, No.5019 |
|  Masseanschluss IEC 417, No.5020 |  Aquipotentialanschluss IEC 417, No.5021 |  Gleichstrom IEC 417, No.5031 |  Wechselstrom IEC 417, No.5032 |

| | | |
|--|--|---|
|  <p>Gleich- oder Wechselstrom IEC 417, No.5033-a</p> |  <p>Durchgängige doppelte oder verstärkte Isolierung IEC 417, No.5172-a</p> |  <p>Dreileiter-Wechselstrom (Drehstrom) IEC 617-2, No.020206</p> |
|  <p>Warnung vor einer Gefahrenstelle (Achtung, Dokumentation beachten) ISO 3864, No.B.3.1</p> |  <p>Warnung vor gefährlicher elektrischer Spannung ISO 3864, No.B.3.6</p> |  <p>Höhere Temperatur an leicht zugänglichen Teilen IEC 417, No.5041</p> |

Sicherheitsvorschriften und Vorsichtsmaßnahmen

Folgende allgemeine Sicherheitsvorschriften sind während allen Betriebsphasen dieses Gerätes zu befolgen. Eine Missachtung der Sicherheitsvorschriften und sonstiger Warnhinweise in dieser Betriebsanleitung verletzt die für dieses Gerät und seine Bedienung geltenden Sicherheitsstandards, und kann die Schutzvorrichtungen an diesem Gerät wirkungslos machen. MKS Instruments, Inc. haftet nicht für Missachtung dieser Sicherheitsvorschriften seitens des Kunden.

Niemals Teile austauschen oder Änderungen am Gerät vornehmen!

Ersetzen Sie keine Teile mit baugleichen oder ähnlichen Teilen, und nehmen Sie keine eigenmächtigen Änderungen am Gerät vor. Schicken Sie das Gerät zwecks Wartung und Reparatur an den MKS-Kalibrierungs- und -Kundendienst ein. Nur so wird sichergestellt, dass alle Schutzvorrichtungen voll funktionsfähig bleiben.

Wartung nur durch qualifizierte Fachleute!

Das Auswechseln von Komponenten und das Vornehmen von internen Einstellungen darf nur von qualifizierten Fachleuten durchgeführt werden, niemals vom Bedienpersonal.

Vorsicht vor stromführenden Leitungen!

Ersetzen Sie keine Komponente von Geräten, die an Netzstrom angeschlossen sind. Unter Umständen kann gefährliche Spannung auch dann bestehen, wenn das Netzanschlusskabel von der Stromversorgung entfernt wurde. Um Verletzungen vorzubeugen sollten zuerst alle Geräte von der Stromversorgung getrennt und alle Stromkreisläufe entladen werden.

Vorsicht beim Arbeiten mit gefährlichen Stoffen!

Wenn gefährliche Stoffe verwendet werden, muss der Bediener die entsprechenden Sicherheitsvorschriften genauestens einhalten, das Gerät, falls erforderlich, vollständig spülen, sowie sicherstellen, dass der Gefahrstoff die am Gerät verwendeten Materialien, insbesondere Dichtungen, nicht angreift.

Spülen des Gerätes mit Gas!

Nach dem Installieren oder vor dem Ausbau aus einem System muss das Gerät unter Einsatz eines reinen Trockengases vollständig gespült werden, um alle Rückstände des Vorgängermediums zu entfernen.

Anweisungen zum Spülen des Gerätes

Das Gerät darf nur unter einer Ablufthaube gespült werden. Schutzhandschuhe sind zu tragen.

Gerät nicht zusammen mit explosiven Stoffen, Gasen oder Dämpfen benutzen!

Um der Gefahr einer Explosion vorzubeugen, darf dieses Gerät niemals zusammen mit (oder in der Nähe von) explosiven Stoffen aller Art eingesetzt werden, sofern es nicht ausdrücklich für diesen Zweck zugelassen ist.

Anweisungen zum Installieren der Armaturen!

Alle Anschlussstücke und Armaturenteile müssen mit der Gerätespezifikation übereinstimmen, und mit dem geplanten Einsatz des Gerätes kompatibel sein. Der Einbau, insbesondere das Anziehen und Abdichten, muss gemäß den Anweisungen des Herstellers vorgenommen werden.

Verbindungen auf Undichtigkeiten prüfen!

Überprüfen Sie sorgfältig alle Verbindungen der Vakuumkomponenten auf undichte Stellen.

Gerät nur unter zulässigen Anschlussdrücken betreiben!

Betreiben Sie das Gerät niemals unter Drücken, die den maximal zulässigen Druck (siehe Produktspezifikationen) übersteigen.

Geeignete Berstscheibe installieren!

Wenn mit einer unter Druck stehenden Gasquelle gearbeitet wird, sollte eine geeignete Berstscheibe in das Vakuumsystem installiert werden, um eine Explosionsgefahr aufgrund von steigendem Systemdruck zu vermeiden.

Verunreinigungen im Gerät vermeiden!

Stellen Sie sicher, dass Verunreinigungen jeglicher Art weder vor dem Einsatz noch während des Betriebs in das Instrumenteninnere gelangen können. Staub- und Schmutzpartikel, Glassplitter oder Metallspäne können das Gerät dauerhaft beschädigen oder Prozess- und Messwerte verfälschen.

Bei Geräten mit Temperaturkontrolle korrekte Anwärmzeit einhalten!

Temperaturkontrollierte Geräte arbeiten nur dann gemäß ihrer Spezifikation, wenn genügend Zeit zum Erreichen und Stabilisieren der Betriebstemperatur eingeräumt wird. Kalibrierungen und Nulleinstellungen sollten daher nur nach Abschluss des Anwärmvorgangs durchgeführt werden.

Informations de sécurité pour appareils de mesure/contrôle de débit massique

Symboles utilisés dans ce manuel d'utilisation

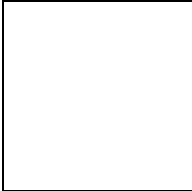
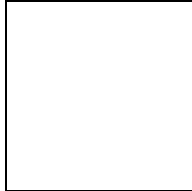
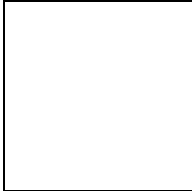
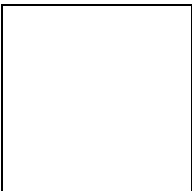
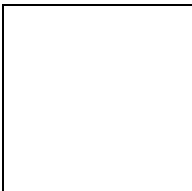
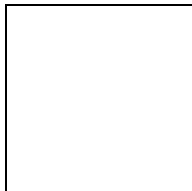
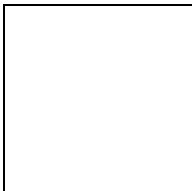
Définitions des indications AVERTISSEMENT, ATTENTION, et REMARQUE utilisées dans ce manuel.

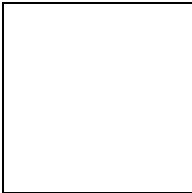
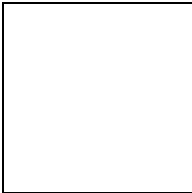
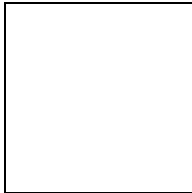
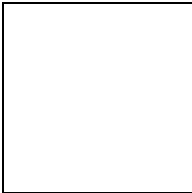
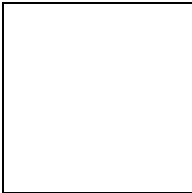
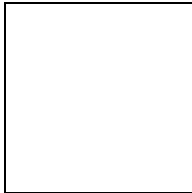
| | |
|----------------------|---|
| Avertissement | L'indication AVERTISSEMENT signale un danger pour le personnel. Elle attire l'attention sur une procédure, une pratique, une condition, ou toute autre situation présentant un risque d'accident pour le personnel, en cas d'exécution incorrecte ou de non-respect des consignes. |
| Attention | L'indication ATTENTION signale un danger pour l'appareil. Elle attire l'attention sur une procédure d'exploitation, une pratique, ou toute autre situation, présentant un risque de dégât ou de destruction partielle ou totale du produit, en cas d'exécution incorrecte ou de non-respect des consignes. |
| Remarque | L'indication REMARQUE signale une information importante. Elle attire l'attention sur une procédure, une pratique, une condition, ou toute autre situation, présentant un intérêt particulier. |

Symboles figurant sur l'unité

Le tableau suivant décrit les symboles pouvant apparaître sur l'unité.

Tableau 3: Définition des symboles sur l'unité

| | | | |
|--|---|---|--|
| Marche (sous tension) IEC 417, No.5007 |  Arrêt (hors tension) IEC 417, No.5008 |  Terre (masse) IEC 417, No.5017 |  Terre de protection (masse) IEC 417, No.5019 |
|  Masse IEC 417, No.5020 |  Equipotentialité IEC 417, No.5021 |  Courant continu IEC 417, No.5031 |  Courant alternatif IEC 417, No.5032 |

| | | |
|--|---|--|
|  Courant continu et alternatif IEC 417, No.5033-a |  Matériel de classe II IEC 417, No.5172-a |  Courant alternatif triphasé IEC 617-2, No.020206 |
|  Attention : se reporter à la documentation ISO 3864, No.B.3.1 |  Attention : risque de choc électrique ISO 3864, No.B.3.6 |  Attention : surface brûlante IEC 417, No.5041 |

Mesures de sécurité et précautions

Observer les précautions générales de sécurité suivantes pendant toutes les phases d'exploitation de cet appareil. Le non-respect des ces précautions ou des avertissements du manuel constitue une violation des normes de sécurité relatives à l'utilisation de l'appareil et peut compromettre la protection assurée par l'appareil. MKS Instruments, Inc. rejette toute responsabilité en cas de non-respect des consignes par les clients.

PAS DE REMPLACEMENT DE PIÈCES OU DE MODIFICATION DE L'APPAREIL

Ne pas installer de pièces de remplacement ni effectuer des modifications non autorisées sur l'appareil. Renvoyer l'appareil à un centre de service et de calibrage MKS pour tout dépannage ou réparation afin de garantir le l'intégrité des dispositifs de sécurité.

DÉPANNAGE UNIQUEMENT PAR DU PERSONNEL QUALIFIÉ

Le personnel d'exploitation ne doit pas essayer de sortir les composants du boîtier ou faire des réglages internes. Le dépannage est réservé au personnel qualifié.

ÉLOIGNEMENT DES CIRCUITS SOUS-TENSION

Ne pas remplacer de composants lorsqu'un câble d'alimentation est branché. Dans certaines conditions, des tensions dangereuses peuvent être présentes même après le retrait du câble d'alimentation. Pour éliminer tout risque de blessure, procéder toujours à la déconnexion et décharger les circuits avant tout contact physique.

PRÉCAUTION EN CAS D'UTILISATION AVEC DES PRODUITS DANGEREUX

Si des produits dangereux sont utilisés, l'utilisateur est responsable du respect des mesures de sécurité appropriées, de la purge complète de l'appareil quand elle s'avère nécessaire, et doit s'assurer que les produits utilisés sont compatibles avec les matériaux d'étanchéité.

PURGE DE L'APPAREIL

Après l'installation de l'unité, ou avant son retrait d'un système, purger l'unité complètement avec un gaz propre et sec afin d'éliminer toute trace du produit de flux utilisé précédemment.

UTILISATION DES PROCÉDURES APPROPRIÉES POUR LA PURGE

Cet appareil doit être purgé sous une hotte de ventilation. Le personnel doit porter des gants de protection.

PAS D'EXPLOITATION DANS UN ENVIRONNEMENT EXPLOSIF

Pour éviter toute explosion, ne pas utiliser cet appareil dans un environnement explosif, sauf en cas d'homologation spécifique pour une telle exploitation.

UTILISATION D'ÉQUIPEMENTS ET PROCÉDURES DE SERRAGE APPROPRIÉS

Tous les équipements de l'appareil doivent être conformes à ses spécifications, et compatibles avec l'utilisation prévue de l'appareil. Assembler et serrer les équipements conformément aux directives du fabricant.

VÉRIFICATION DE L'ÉTANCHÉITÉ DES CONNEXIONS

Vérifier attentivement toutes les connexions des composants pour le vide afin de garantir l'étanchéité de l'installation.

EXPLOITATION AVEC DES PRESSIONS D'ENTRÉE NON DANGEREUSES

Ne jamais utiliser des pressions supérieures à la pression nominale maximum (se reporter aux spécifications de l'unité pour la pression maximum admissible).

INSTALLATION D'UN DISQUE D'ÉCHAPPEMENT ADAPTÉ

En cas d'exploitation avec une source de gaz pressurisé, installer un disque d'échappement adapté dans le système à vide, afin d'éviter une explosion du système en cas d'augmentation de la pression.

MAINTIEN DE L'UNITÉ À L'ABRI DES CONTAMINATIONS

Ne pas laisser des produits contaminants pénétrer dans l'unité avant ou pendant l'utilisation. Des produits contaminants tels que des poussières et des fragments de tissu, de verre et de métal peuvent endommager l'unité de manière permanente.




RESPECT DU TEMPS D'ÉCHAUFFEMENT APPROPRIÉ POUR LES UNITÉS À RÉGULATION DE TEMPÉRATURE

Les unités à régulation de température sont conformes à leurs spécifications uniquement quand on leur laisse un temps suffisant pour atteindre d'une manière stable la température d'exploitation. Ne pas remettre à zéro ou calibrer l'unité tant que l'échauffement n'est pas terminé.

Medidas de seguridad del dispositivo de flujo de masa

Símbolos usados en este manual de instrucciones


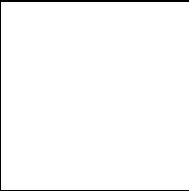
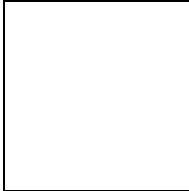
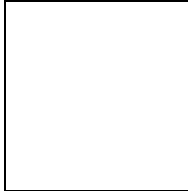
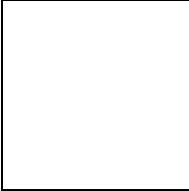
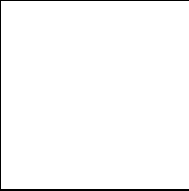
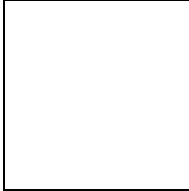
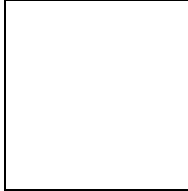
Definiciones de los mensajes de advertencia, precaución y de las notas usados en el manual.

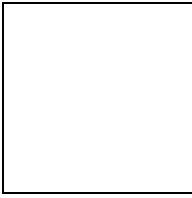
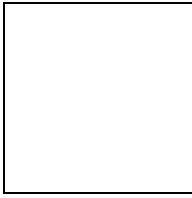
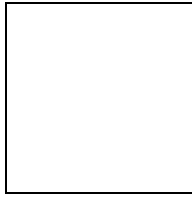
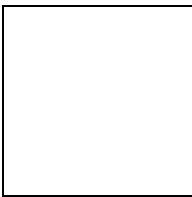
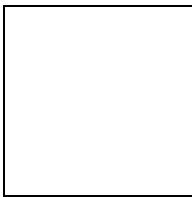
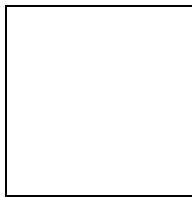
| | | |
|--|--------------------|--|
|  | Advertencia | El símbolo de advertencia indica la posibilidad de que se produzcan daños personales. Pone de relieve un procedimiento, práctica, estado, etc. que en caso de no realizarse o cumplirse correctamente puede causar daños personales. |
|  | Precaución | El símbolo de precaución indica la posibilidad de producir daños al equipo. Pone de relieve un procedimiento operativo, práctica, etc. que en caso de no realizarse o cumplirse correctamente puede causar daños o la destrucción total o parcial del equipo. |
|  | Nota | El símbolo de notas indica información de importancia. Este símbolo pone de relieve un procedimiento, práctica o condición cuyo conocimiento es esencial destacar. |

Símbolos hallados en la unidad

La tabla siguiente contiene los símbolos que puede hallar en la unidad.

Tabla 4: Definición de los símbolos hallados en la unidad

| | | | |
|--|--|--|--|
|  Encendido (alimentación eléctrica) IEC 417, N° 5007 |  Apagado (alimentación eléctrica) IEC 417, N° 5008 |  Puesta a tierra IEC 417, N° 5017 |  Protección a tierra IEC 417, N° 5019 |
|  Caja o chasis IEC 417, N° 5020 |  Equipotencialidad IEC 417, N° 5021 |  Corriente continua IEC 417, N° 5031 |  Corriente alterna IEC 417, N° 5032 |

| | | |
|--|--|---|
|  <p>Corriente continua y alterna IEC 417, N° 5033-a</p> |  <p>Equipo de clase II IEC 417, N° 5172-a</p> |  <p>Corriente alterna trifásica IEC 617-2, N° 020206</p> |
|  <p>Precaución. Consulte los documentos adjuntos ISO 3864, N° B.3.1</p> |  <p>Precaución. Riesgo de descarga eléctrica ISO 3864, N° B.3.6</p> |  <p>Precaución. Superficie caliente IEC 417, N° 5041</p> |

Procedimientos y precauciones de seguridad

Las medidas generales de seguridad descritas a continuación deben observarse durante todas las etapas de funcionamiento del instrumento. La falta de cumplimiento de dichas medidas de seguridad o de las advertencias específicas a las que se hace referencia en otras partes de este manual, constituye una violación de las normas de seguridad establecidas para el uso previsto del instrumento y podría anular la protección proporcionada por el equipo. Si el cliente no cumple dichas precauciones y advertencias, MKS Instruments, Inc. no asume responsabilidad legal alguna.

NO UTILICE PIEZAS NO ORIGINALES O MODIFIQUE EL INSTRUMENTO

No instale piezas que no sean originales ni modifique el instrumento sin autorización. Para asegurar el correcto funcionamiento de todos los dispositivos de seguridad, envíe el instrumento al Centro de servicio y calibración de MKS toda vez que sea necesario repararlo o efectuar tareas de mantenimiento.

LAS REPARACIONES DEBEN SER EFECTUADAS ÚNICAMENTE POR TÉCNICOS AUTORIZADOS

Los operarios no deben retirar las tapas del instrumento. El reemplazo de los componentes y las tareas de ajuste deben ser realizadas únicamente por personal autorizado.

MANTÉNGASE ALEJADO DE LOS CIRCUITOS ACTIVOS

No reemplace componentes con el cable de alimentación eléctrica conectado. En algunos casos, puede haber presente alto voltaje aun con el cable de alimentación eléctrica desconectado. Para evitar lesiones personales, desconecte siempre el cable y descargue los circuitos antes de entrar en contacto con los mismos.

TENGA CUIDADO CUANDO TRABAJE CON MATERIALES TÓXICOS

Cuando se utilicen materiales tóxicos, es responsabilidad de los operarios tomar las medidas de seguridad correspondientes, purgar totalmente el instrumento cuando sea necesario y comprobar que el material utilizado sea compatible con los materiales de sellado.

PURGUE EL INSTRUMENTO

Una vez instalada la unidad o antes de retirarla del sistema, purgue completamente la unidad con gas limpio y seco para eliminar todo resto de la sustancia líquida empleada anteriormente.

USE PROCEDIMIENTOS ADECUADOS PARA REALIZAR LA PURGA

El instrumento debe purgarse debajo de una campana de ventilación y deben utilizarse guantes protectores.

NO HAGA FUNCIONAR EL INSTRUMENTO EN AMBIENTES CON RIESGO DE EXPLOSIÓN

Para evitar que se produzcan explosiones, no haga funcionar este instrumento en un ambiente con riesgo de explosiones, excepto cuando el mismo haya sido certificado específicamente para tal uso.

USE ACCESORIOS ADECUADOS Y REALICE CORRECTAMENTE LOS PROCEDIMIENTOS DE AJUSTE

Todos los accesorios del instrumento deben cumplir las especificaciones del mismo y ser compatibles con el uso que se debe dar al instrumento. Arme y ajuste los accesorios de acuerdo con las instrucciones del fabricante.

COMPRUEBE QUE LOS ACCESORIOS SEAN A PRUEBA DE FUGAS

Antes de proceder con la instalación del instrumento, inspeccione cuidadosamente todas las conexiones de las tuberías para comprobar que hayan sido instaladas a prueba de fugas.

HAGA FUNCIONAR EL INSTRUMENTO CON PRESIONES DE ENTRADA SEGURAS

No haga funcionar nunca el instrumento con presiones superiores a la máxima presión nominal (en las especificaciones del instrumento hallará la presión máxima permitida).

INSTALE UNA CÁPSULA DE SEGURIDAD ADECUADA

Cuando el instrumento funcione con una fuente de gas presurizado, instale una cápsula de seguridad adecuada en el sistema de vacío para evitar que se produzcan explosiones cuando suba la presión del sistema.

MANTENGA LA UNIDAD LIBRE DE CONTAMINANTES

No permita el ingreso de contaminantes en la unidad antes o durante su uso. Los productos contaminantes tales como polvo, suciedad, pelusa, lascas de vidrio o virutas de metal pueden dañar irreparablemente la unidad.

CALIENTE ADECUADAMENTE LAS UNIDADES CONTROLADAS POR MEDIO DE TEMPERATURA

Las unidades controladas por medio de temperatura funcionarán de acuerdo con las especificaciones sólo cuando se las caliente durante el tiempo suficiente para permitir que lleguen y se estabilicen a la temperatura de operación indicada. No calibre la unidad y no la ponga en cero hasta que finalice el procedimiento de calentamiento.

Chapter One: General Information

Introduction

MKS Instruments π series digital MFCs represent state-of-the-art technology meeting the advanced process requirements of next generation toolsets. This unique device integrates thermal sensor technology together with a normally-closed proportioning control valve, through an innovative, real-time feedback control system. It is specifically designed and tested for applications with inlet pressures from 4 to 1200 torr.

The π MFC include an integrated multifunction local display and an embedded, HTML-based user interface. The device is available in standard 1.125" wide ¼" VCR™ package.

Design Features

Increases Throughput and Performance

- Accurate flow control without the need for gas specific calibrations.
- Enables better process matching through increased MFC accuracy of any process gas.
- Increases tool uptime through reduction of “No Problem Found” MFC replacements.
- Includes embedded diagnostics software that allows users to check MFC functionality without removing the MFC.
- E-diagnostics through embedded Ethernet interface.

Reduce Overall Costs

- Reduces MFC inventory through multi-gas, multi-range availability.
- Minimizes overall footprint of gas delivery module.

Easy to Integrate and Operate

- Straightforward configuration and diagnostics through Ethernet interface using a standard HTML browser with Java application plug-in – no special software required.
Includes remote MFC application.
- Easy viewing of flow rate, gas type, full scale, temperature and network IP address with bright LED display.

The design of the π MFC incorporates an advanced flow sensor, a proportional control valve, and an optimized bypass. The latest generation two-element sensing circuit provides accurate, repeatable performance for low flow applications. Temperature compensation circuitry ensures that changing ambient conditions do not affect flow measurement accuracy or control. Attitude sensitivity is completely accounted for with advanced attitude circuitry and orientation specific configuration. The optimized sensor/bypass arrangement minimizes the flow splitting error for gases with different properties, which dramatically improves measurement accuracy when gases other than the calibration gas are used.

Table 5: Definitions

| Model Number | P2A |
|-----------------|-----|
| MG(Multi Gas) | Yes |
| MR(Multi Range) | Yes |

Digital Features

The true digital calibration and valve control electronics, coupled with standard default 11 point flow calibration, provide for high flow accuracy and fast response over a wide range of setpoints to even low flow setpoints.

Reliability

To provide excellent reliability, the design contains a low mechanical and electronic components count and has successfully passed the following test:

- STRIFE, including temperature cycling and vibration (sine and random tests)

And with a metal braided, shielded cable, properly grounded at both ends:

- EMC Directive 89/336/EEC for CE Mark compliance

Cleanliness Features

The π MFCs use only metal for all external seals. The metal seals eliminate gas permeation and ensure extremely low external leakage under pressure or vacuum conditions relative to atmosphere. The internal valve control plug is Teflon, which is pure, chemically stable, and not prone to out-gassing or particle generation. The π MFCs mechanical design incorporates minimal wetted surface area and virtual leaks, assuring rapid dry-down. To further enhance its cleanliness, all internal surfaces are precision machined to a 5Ra surface finish and electro-polished. The instrument is assembled and double-packaged in a Class 100 clean room environment.

How This Manual is Organized

Before installing the device in a system and/or operating it, carefully read and familiarize yourself with all precautionary notes in the *Mass Flow Device Safety Information* 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 and Configuration*, explains the environmental requirements and describes how to mount the instrument in your system.

Chapter Three, *Ethernet Interface Setup and Configuration*, provides information on how to setup and configure the device utilizing a PC and the instrument's internal HTML browser.

Chapter Four, *Embedded Web-Based GUI and Diagnostics*, provides information on how to monitor and troubleshoot the device utilizing the instrument's internal web browser.

Chapter Five, *Overview*, provides a brief description of the instrument and its functionality. Chapter Five describes how to use the instrument and explains all the functions and features.

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

Chapter Seven, *Troubleshooting*, provides a troubleshooting chart.

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

Appendix B, *Model Code Explanation*, describes the model code.

Customer Support

Standard maintenance and repair services are available through all of the regional MKS Calibration and Service Centers.

If any difficulties arise in the use of your device, 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, then two actions must be completed before shipping: (1) a RMA (Return Material Authorization) number must be obtained and (2) a Health and Safety Form must be completed and included with the instrument.

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

Obtaining a Return Material Authorization (RMA) Number

RMA (Return Material Authorization) numbers expedite handling and ensure proper servicing of your instrument.

RMA numbers can be obtained by contacting the MKS Calibration and Service Center or through the MKS website at: <http://www.mksinst.com/service/servicehowtoorder.aspx>.

| | |
|-------------|---|
| Note | Returned instruments will not be accepted without a valid RMA number displayed on the shipping container. |
|-------------|---|

Health and Safety Form

A returned instrument will not be examined without a signed Health and Safety form indicating that the unit is free of harmful materials.

The Health and Safety form can be obtained on the last page of this manual or through the MKS website at: <http://www.mksinst.com/service/servicehowtoorder.aspx>.

| | |
|-------------|--|
| Note | Returned instruments will not be examined without a signed certificate indicating the instruments are free of harmful materials. |
|-------------|--|

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

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Chapter Two: Installation and Configuration

Unpacking

MKS has carefully packed your device 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 RMA Number (Return Material Authorization Number) from the MKS Calibration and Service Center or MKS website before shipping. Please refer to the *Customer Support* section, page 21, for additional details and the inside of the back cover of this manual for a list of MKS Calibration and Service Centers.

Opening the Package

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

1. Remove all cardboard and packaging materials. Discard before entering the garmenting room.
2. Remove the outer plastic shipping container in an ante room (garmenting room) or transfer box. Do not allow this container to enter the clean room.
3. Remove the inner bag in the clean room.
4. Inspect for any damage.
5. Pass the original calibration sheet to the appropriate personnel at your company.

Caution

Only qualified individuals should perform the installation and adjustments of the MFC. Individuals must comply with all necessary ESD 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:

- π MFC (Low Pressure)
- π MFC Instruction Manual (this book)
- Instrument calibration report

Product Location and Requirements

- Ventilation requirements include sufficient air circulation
- Ambient operating temperature range: 10° to 50° C (50° to 122° F)
- Power requirement: +15 VDC [350 mA peak current and 250 mA nominal] to 24 VDC [250 mA peak current and 200 mA nominal]
- Storage temperature range: -20° to 65° C (-4° and 149° F)
- Mount the π MFC in the orientation for which it was intended and calibrated. The orientation can be determined by the thirteenth (13th) character of the part number. “1” refers to vertical flow orientation and “2” refers to horizontal flow orientation.
- Install a separate positive shutoff valve if your system cannot tolerate any leakage through the π MFC. The internal flow control valve is not a positive shutoff valve so some leakage across the valve will occur.

| | |
|----------------|--|
| Warning | Your corporate policy on handling toxic or hazardous gases supersedes the instructions in this manual. Comply with your corporate policy. MKS assumes no liability for the safe handling of such materials. |
|----------------|--|

- Install the π MFC in a “flowing” system where gas is continually added and evacuated. Do not use the controller in a “dead-ended” system (a system which cannot remove excess mass). The π MFC can not vent excess mass to the atmosphere.
- Warm up time: 30 minutes
- Use high purity gas filters in line upstream of the device.
- Observe the pressure limits for the flow device.

Controller

- Install in accordance with flow orientation configuration specified at the time or order.
- Maximum gas inlet purge pressure is 150 psig with properly configured valve.
- Operational differential pressure is 4 to 1200 torr with vacuum (sub 500 mTorr) at the outlet.

For additional information, refer to Appendix A, *Product Specifications*, page 69.

Dimensions and Pinouts – Analog 15 pin D and 9 pin D

Refer to the applicable drawings, which follow.

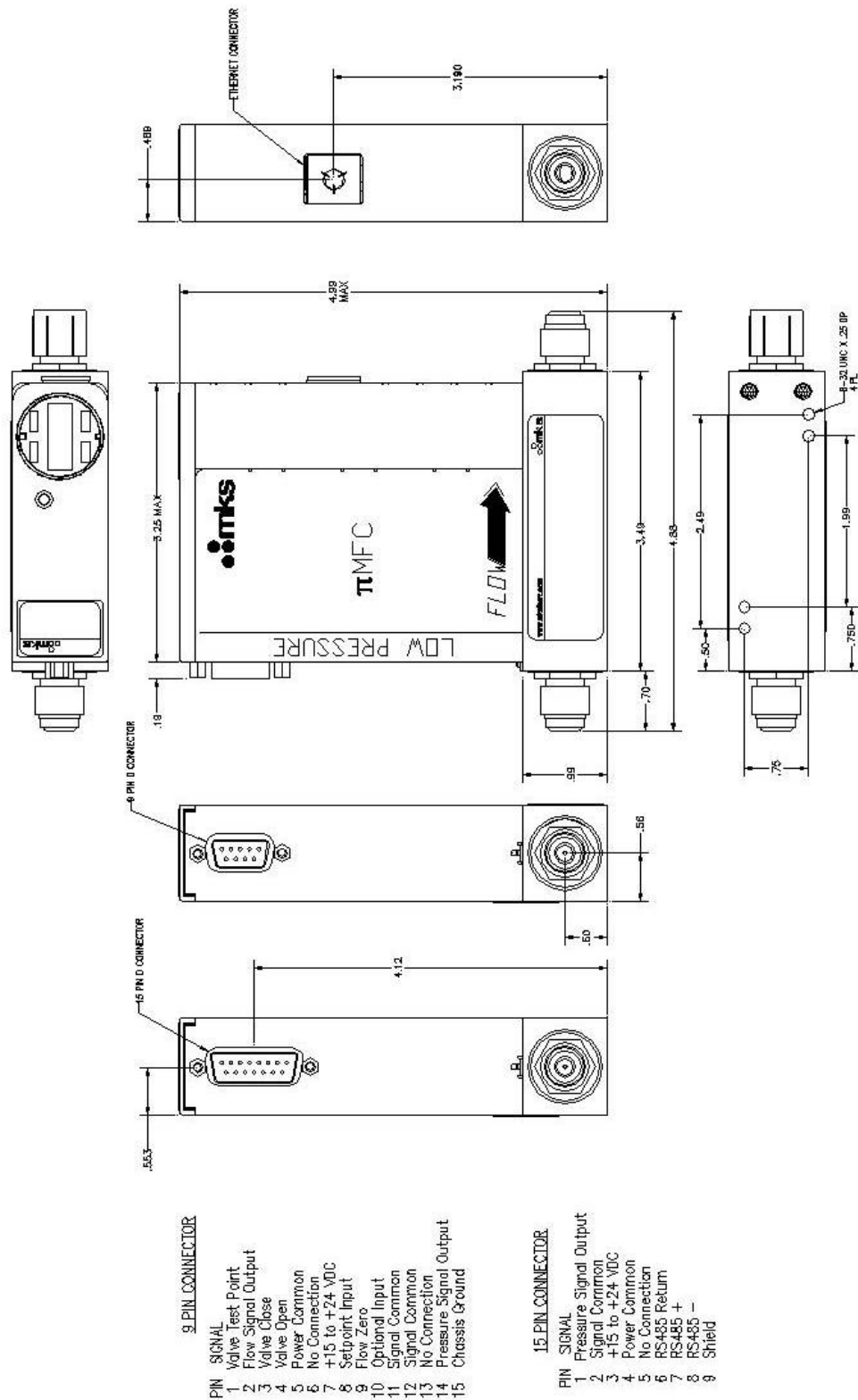
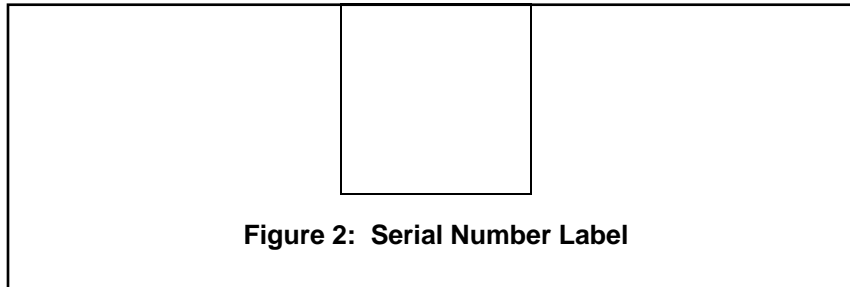


Figure 1: 4-VCR Configuration with Either 9 pin D or 15 pin D Analog I/O

Labels

Each MFC has a single large serial label on the front of the MFC. A second, small label on the top of the device shows customer gas and full scale range as the device was originally configured at time of production. The large serial label shows the date of manufacture, serial number, original shipped model number, customer gas and full scale range. Be aware that the device can be reconfigured (within limits) to control other gases and full scale flow rate ranges and thus the model number will not reflect the actual gas and/or flow rate the device is used for.



Mounting Hardware

MFCs with in-line fittings (VCR) have six threaded mounting holes located on the bottom or base of the unit: four #8-32 and two M4. Depending on the hole pattern chosen, use #8-32 UNC-2B or M4 hardware to mount the instrument. The figures beginning on page 25 show the location and dimensions of the mounting holes for standard axial fittings.

Gas Flow

The control valve is *not* a positive shutoff valve. Some leakage across the valve may occur. Refer to Appendix A, *Product Specifications*, page 69, for the leak integrity specifications (internal to external leakage and valve closed conductance leakage). If necessary, install a separate positive shutoff valve in your system.

Note Connect the MFC to your system so that the gas flows in the direction of the flow arrow on the front of the unit.

Note Install the MFC in the orientation for which it was manufactured. The orientation is specified by the thirteenth (13th) character of the part number with “1” being vertical flow and “2” being horizontal flow.

Installation Procedure

Install the MFC

Note

DO NOT make any electrical connections to the MFC until directed to do so.

1. The MFC is prepared for cleanroom installation. Follow standard cleanroom practices to ensure a clean installation:
 - Discard outer material outside of the cleanroom.
 - Remove the outer packaging in the gray area.
 - Carry the MFC into the clean area then remove the inner bag and any protective fitting covers just prior to installation.
 - Do not discard calibration sheet
2. Prepare the system into which the MFC will be installed according to your facility's gas handling procedures, including purging of the gas lines with appropriate purge gas, and notification to equipment personnel, safety engineers, environmental health and safety management, and haz/mat response teams.

PERSONAL SAFETY HAZARDS!

Gas systems can contain toxic, explosive, combustible, corrosive or other gases which can present life-threatening hazards. ALWAYS use appropriate personal protection equipment. NEVER open a gas line unless the system has been properly purged of harmful gases. Certain gas system components may contain hazardous residuals if not properly prepared. Consult with your facility safety engineers prior to working on any gas delivery system and notify all personnel in adjacent areas to take appropriate personal safety precautions BEFORE working on the equipment.

3. Prepare the MFC inlet and outlet gas connections:
 - Flow clean, dry purge gas across the fittings to minimize particle contamination during installation. Use only purge gases that are approved for your process and compatible with the wetted materials of the MFC.
 - Install the MFC and secure the MFC to the baseplate using the appropriate mounting hardware.
 - Secure the inlet and outlet fitting connections according to the fitting manufacturer's instructions. DO NOT over tighten connections.

Caution

Do not overtighten the MFC VCR connections as this can result in damage to the VCR bead surface resulting in leaks.

Caution

Do not grasp the MFC electronics enclosure to provide torque resistance while tightening the VCR connections as this can result in damage to the device.

4. Verify the power and signal pinouts for the cable leading to the MFC:

When using the built-in Ethernet interface for setup, an unshielded twisted pair CAT 5E with RJ45 males connectors wired in crossover fashion is required when the π MFC is connected directly to a PC's Ethernet port. When the π MFC is on a network with a hub interface or switch, a standard Ethernet cable should be used.

5. Power up the MFC, verify that the IP address, Gas Type and Maximum Flow Rate (Full Scale Flow Rate) match those on the calibration report sheet.

On power up, the MFC's scrolling display shows the IP address, the Gas Type, and the Maximum Flow Rate (Initial use only) and Active Gas Instance. To access other information, after 60 seconds from power up, press down on the multi-function display to toggle through the various displays. Press one time to display current measured flow. Press two times to display measured temperature. The display can be toggled to the desired display by discrete presses on the display.

6. Perform appropriate helium leak checking of your gas lines and π MFC gas line connections to verify the integrity of the gas seals. You will need to open/close appropriate pneumatic isolation valves and proportional control valves as needed to isolate and identify any leaks in the system.

Chapter Three: Ethernet Interface Setup and Configuration

The Ethernet interface is a supplemental interface that can be used for MFC setup, configuration, and diagnostics purposes. It is not used to control the π MFC during normal operation. To access the diagnostic features of the π MFC via the Ethernet port, follow Steps 1 and 2.

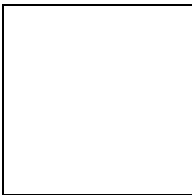
Step 1: Install the Java™ Plug-in (for single IP address)

The π MFC interface software uses a web-based Internet Explorer interface that requires a Java Technology plug-in to display real-time data plots.

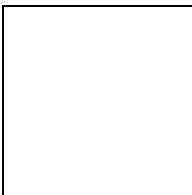
If you are installing the π MFC on a network that has web access AND you are setting up multiple IP addresses, then go to “*Option 3: For Multiple IP Address Setup*” on page 33 and skip the steps below. The “Multiple IP Address Setup” procedure enables you to access the web for download at completion.

OTHERWISE perform the following steps:

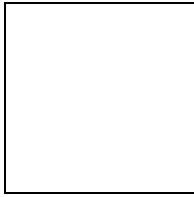
1. Download the (2) files listed below from the MKS website (www.mksinst.com/MDsw.html) by clicking on the link “piMFC java plugin file for web access.” The MKS download includes an installation script to properly load the plug-in.
 - Java installer: `jinstaller.exe`
 - Installation script: `InstallPlot.bat`
2. Copy the installer and script file to your hard drive, then double-click on the `InstallPlot.bat` file. This file connects to the Sun Microsystems download site according to the following command:
 - `jinstall.exe http://java.sun.com/update/1.4.2/1.4.2-b28.xml`
3. Follow the onscreen prompts to install the Java application.



4. Read the license agreement, select “I accept...”, click “Next” to continue installation.



5. Select the “Typical” installation option and follow the prompts to install the Java plug-in.



6. Java plug-in is now complete.

Step 2: Setup Network for Communication through Ethernet

There are three possible ways to setup your network for communication through Ethernet. Choose the correct option based on the following criteria:

Option 1 (see below) [single port/single device]

- The Java applet discussed in Step 1 on page 29 has already been installed on your computer.
- You have no need to connect to the Internet.
- You only have one IP address, i.e. 10.X.X.X, to connect with.
- If your computer has more than one network card, this option may not work. Use option 2.

Option 2 (see page 31) [single port/multiple devices]

- The Java applet discussed in Step 1 on page 29 has already been installed on your computer.
- You have no need to connect to the Internet.
- You have one or Multiple IP addresses you want to connect with, i.e. 10.X.X.X, 192.168.2.X, etc.

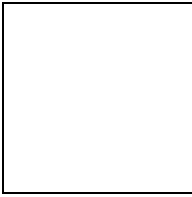
Option 3 (see page 33) [multiple ports/multiple devices]

- The Java applet discussed in Step 1 on page 29 has or has not installed on your computer.
- You need to be able connect to the Internet while connecting to one or multiple units.
- You have Multiple IP addresses to connect with, i.e. 10.X.X.X, 192.168.2.X, etc.

Option 1: Network Automatic Setup

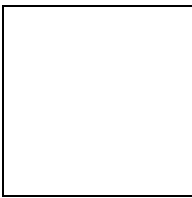
A software script allows you to rapidly create a network connection to the π MFC. Once connected a series of web-browser type windows allow you to easily monitor and configure the π MFC.

1. Logon to the MKS website (www.mksinst.com/MDsw.html) and download a copy of the IP setup script, HostIP.cmd by clicking on the HostIP.cmd link.
2. Copy the setup script HostIP.cmd to your C:\ directory. (Use Windows Explorer or similar program.)
3. Connect a **crossover** network cable to the π MFC and your laptop computer. A crossover cable is required when the π MFC is connected directly to a computer. When the π MFC is connected to a network using a hub interface, a standard Ethernet cable can be used.
4. From your computer's "Start" menu, select "Run..." then enter the word "command" and click OK.

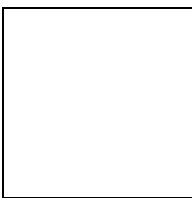


5. At the command prompt, if you find that you are not in the C-drive, then enter the command "C:". If you find yourself in a sub-directory of your C-drive, then enter the command "CD \". This will bring you to the C:\> prompt.
6. Enter the command "HostIP xx.xx.xx.xx" where the x's stand for the IP address of your Host computer, then press Enter. The system will setup a new host IP address and display it as shown in the example below:

Note The π MFC's IP Address format is 10.X.X.X. Your Host computer's IP Address must also be of the format 10.X.X.X. Remember the Host computer IP Address must be unique. A recommended IP Address for your Host computer is 10.0.0.X with a Subnet Mask of 255.0.0.0, where X is some number between 0 and 255.



To restore to a dynamic IP address, run the HostIP script with an argument of "auto" as shown below:



These commands may also be entered directly in the "Run..." window. Instead of typing "command" simply type "c:/HostIP 10.0.0.X" (without "") or "c:/HostIP auto" (without "").

7. After running the HostIP command, launch Internet Explorer, enter "http://xx.xx.xx.xx" in the address field, where xx.xx.xx.xx stands for the IP address of the π MFC you wish to connect to, then click "Go." Internet Explorer will open and display the device Monitor screen which displays the device's model code, pressure range, valve type, control direction and DeviceNet status (if applicable) for the PC90. The PC99 also includes the device's gas settings but it does not include the control direction since it is always downstream. The Serial Number can always be found in the bottom left-hand corner of the browser window.

For more information on the web-based program, go to Chapter 4 on page 39.

Option 2: Manual Setup

If you have not setup automatic network script in Option 1, a manual setup is required to access the π MFC Ethernet interface.

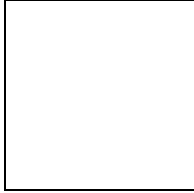
1. Connect a crossover network cable to the π MFC and your laptop computer.

A crossover cable is required when the π MFC is connected directly to a computer. When the π MFC is connected to a network using a hub interface, a standard Ethernet cable can be used.

2. Open the Local Area Connection by doing one of the following options:

Option 1:

Select **My Network Places** (On Desktop typically). Right-Click on the icon, then select **Properties**.

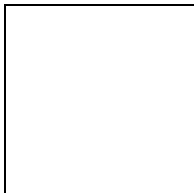


In the “Network and Dial-Up Connections” window, Double-click on “Local Area Connection.” Not all Local Area Connections have the same name, yours may have a different name.

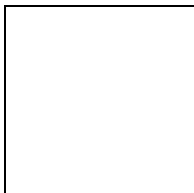
Option 2:

From your computer’s “Start” menu, select “Settings” → Network and Dialup Connections → Local Area Connections

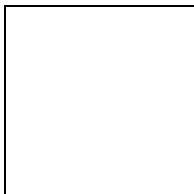
3. Select **Properties**.



4. Select **Internet Protocol (TCP/IP)**, then select **Properties**.



5. Select **Use the following IP address**.

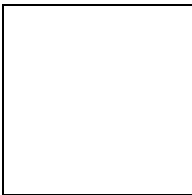


6. Enter the IP address **10.0.0.X**, where “X” is a number from 0 to 255 that is unique from any other IP address on your network. Now click in the Subnet mask field and the correct Subnet mask (**255.0.0.0**) should appear. If it doesn’t, you need to enter it. Also make sure that the “**Use the following DNS server Addresses**” is also selected. Leave this blank.

Additional IP Addresses

In the case that you need to be able to connect to more than one IP Address, simply click on the “Advanced” button at the bottom of the current window. Once the “Advanced TCP/IP Settings” window pops up, verify that you’re on the “IP Settings” tab and then click “Add” in the “IP Addresses” section. If you have a π MFC or any of the other MKS “ π ” Series products, you may also need to add the IP Address 192.168.2.X, where “X” is a number from 0 to 255 that is unique from any other IP address on your network. Now click in the Subnet mask field and the correct Subnet mask (255.255.255.0) should appear. If it doesn’t appear, you will need to enter it.

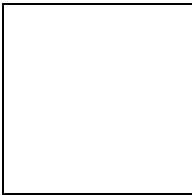
7. Close out all dialog boxes by selecting **O.K.**, **Close**, etc. as required.
8. Launch Internet Explorer (or a similar program) and enter “http://xx.xx.xx.xx” in the address field, where xx.xx.xx.xx stands for the IP address of the π MFC you wish to connect to, then click “Go.” Internet Explorer will open and display the device Monitor screen which displays the device’s model code, pressure range, valve type, control direction and DeviceNet status (if applicable) for the PC90. The PC99 also includes the device’s gas settings but it does not include the control direction since it is always downstream. The Serial Number can always be found in the bottom left-hand corner of the browser window.



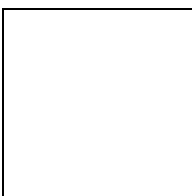
For more information on the web-based program, go to Chapter 4 on page 39.

Option 3: For Multiple IP Address Setup

1. From your computer’s “Start” menu, select “Run...” then enter the word “command” and click OK.



2. At the command prompt, if you find that you are not in the C-drive, then enter the command “C:”. If you find yourself in a sub-directory of your C-drive, then enter the command “CD \”. This will bring you to the C:\> prompt.
3. Now, before going any further it is important that you have an active network connection that allows you to connect to the Internet. If you do not have an active connection, set that up and then continue.
4. At the command prompt, enter the command “ipconfig /all” (as shown below) then press Enter.

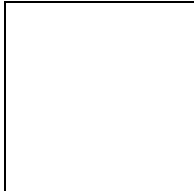


The data inside the highlighted area (lower section, between IP Address and Primary WINS Server) are what is needed for the steps below.

5. Open the Local Area Connection by doing one of the following options:

Option 1:

Select **My Network Places** (On Desktop typically). Right-Click on the icon, then select **Properties**.

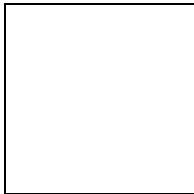


In the “Network and Dial-Up Connections” window, Double-click on “Local Area Connection.” Not all Local Area Connections have the same name, yours may have a different name.

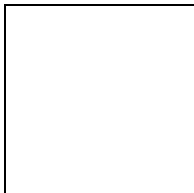
Option 2:

From your computer’s “Start” menu, select “Settings” → Network and Dialup Connections → Local Area Connections

6. Select **Properties**.

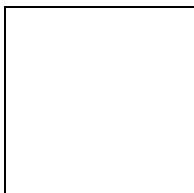


7. Select **Internet Protocol (TCP/IP)**, then select **Properties**.

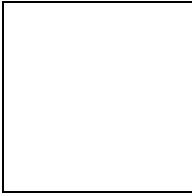


8. Select **Use the following IP address**. Now do the following to configure your computer so that it can still connect to the Internet:

- Type in the “IP address”, the “Subnet mask” and the “Default gateway” fields with values returned from the “ipconfig /all” query in the DOS command window.
- Select “Use the following DNS server addresses:”
- Type in the Preferred DNS server and the Alternate DNS server fields with values returned from the “ipconfig /all” query in the DOS command window. An example is shown below:

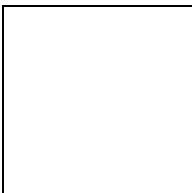


9. Click the “Advanced...” button at the bottom of the window. The following window will be displayed:

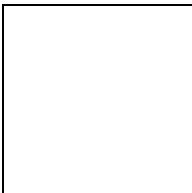


10. Verify you’re on the “IP Settings” tab and then do the following to configure your computer to talk to the π MFC and any other devices with an IP address:

- Click “Add...” in the “IP address” section and enter the IP address **10.0.0.X**, where “X” is a number from 0 to 255 that is unique from any other IP address on your network. Now click in the Subnet mask field and the correct Subnet mask (**255.0.0.0**) should appear. If it doesn’t, you need to enter it. Then click “OK.”

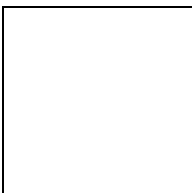


11. Now click “Add...” in the “Default gateways” group. Enter the Gateway value you will use to connect to the π MFC. Typically a gateway value will be the IP address with a (1) on the end. The Metric value should always be (1). Then click “Add.”

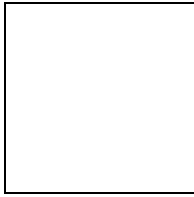


12. In the case that you need to be able to connect to more than one IP Address, i.e. not all devices on your network use a 10.X.X.X address, more addresses can be added by repeating steps 10 and 11 above. If you have a π MFC or any of the other MKS “ π ” Series products, you may also need to add the IP Address 192.168.2.X, where “X” is a number from 0 to 255 that is unique from any other IP address on your network. The Subnet mask for this IP address is 255.255.255.0, and the typical Default Gateway is 192.168.2.1.

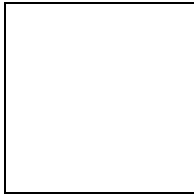
13. Click the “WINS” tab.



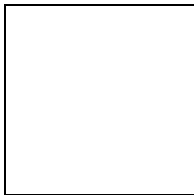
14. In the “WINS addresses, in order of use” section, click “Add...” Enter in the Primary WINS server address that was returned from the “ipconfig /all” query in the DOS command window, then click “Add.” If there were any alternate WINS servers listed in the DOS window, now enter them. If not go ahead to the next step.



Example is shown below:



15. Close out all dialog boxes by selecting **O.K.**, **Close**, etc. as required.
16. You are ready to connect to multiple IP addresses from your computer. You can connect both to the Internet and to your π MFC local network.
17. Launch Internet Explorer (or a similar program) and enter “http://xx.xx.xx.xx” in the address field, where xx.xx.xx.xx stands for the IP address of the π MFC you wish to connect to, then click “Go.” Internet Explorer will open and display the device Monitor screen which displays the device’s model code, pressure range, valve type, control direction and DeviceNet status (if applicable) for the PC90. The PC99 also includes the device’s gas settings but it does not include the control direction since it is always downstream. The Serial Number can always be found in the bottom left-hand corner of the browser window.



For the plot web page to work in the π MFC, a java plug-in has to be installed on your computer.

With the multiple IP addresses setup, if the Java plug-in has NOT already been installed, the IE browser will automatically connect to the correct web site for the downloading the first time someone connects to a π MFC and clicks on the “Plot” page. If, for some reason, this does not work please follow the Step 1 instructions (see page 29).

For more information on the web-based program, go to Chapter 4 on page 39.

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Chapter Four: Embedded Web-Based GUI and Diagnostics

Logging On to Your π MFC

Before trying to logon to your π MFC you must have your network setup correctly. To do this, complete the steps listed in Chapter Three, *Ethernet Interface Setup and Configuration*, starting on page 29.

Once you complete the steps in Chapter Three, launch Internet Explorer (or a similar program) and enter “http://xx.xx.xx.xx” in the address field, where xx.xx.xx.xx stands for the IP address of the π MFC you wish to connect to, then click “Go”. Internet Explorer will open and display the Device page in Monitor Mode.

The modes are described in detail below.

Monitor Mode

Holding true to its name, “Monitor Mode” allows the user to only *Monitor* the π MFC’s performance aside from performing diagnostics. In order to configure the MFC, i.e. zero the device, configure the PID parameters, change the IP Address, etcetera, you must enter “Setup” mode. See *Setup Mode*, page 43.

Each of the pages, i.e. tabs, in Monitor Mode are listed and described below in detail.

Device Page – Monitor Mode

This page, which contains the general information for the π MFC, is where you are initially directed once you logon to the π MFC.

What’s Displayed: P2A

The Device Page displays the device’s selected (operating) gas, Semi gas number, calibration gas, minimum and maximum full scales allowed for the device and the device’s current full scale for the selected gas.

Note The π MFC’s **serial number** can always be found in the bottom left-hand corner of the browser window.

Figure 3, next page, shows a screen capture of the Device Page for the π MFC.

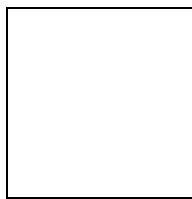


Figure 3: Embedded GUI, π MFC Device Page in Monitor Mode

Plot Page – Monitor Mode

This page enables you to plot and see real-time performance of the device. In Monitor Mode you are able to select variables to plot, the rate at which to display them, and save the data that has been plotted.

Note The Plot Page requires a java applet to use the plot program. This applet, which must be installed on the computer trying to view the page, can be downloaded by following the instructions listed on page 29.

Selecting Variables To Plot

On the right-hand side of the Plot page you should see the Variables section. Here you have the ability to select one or more variables to plot.

- *To plot one variable:* click on the variable you wish to plot.
- *To plot two or more variables:* either select the variables one-by-one while holding your keyboard's control "Ctrl" key down or select all the variables by selecting the first variable in the list and then selecting the last variable listed while holding your keyboard's "Shift" key down.

Selecting Rate

Directly below the list of variables is the Rate selection drop down menu. Here you are able to select the sampling rate at which you'd like to plot the variables. Available rates are 1, 2, 5, 10, 50 and 100 Hz.

Starting and Stopping the Plot program

Below the Rate selection is the Start/Stop button for the plot program. You must click on this button to start the plot program and click on it a second time to stop the program.

Options (*Trace Autoscroll, Rescaling Y Axis, Rescaling X Axis, Save to File*)

Below the Start/Stop button, you should see the Options section. Here you are able to start/stop the autoscrolling feature, rescale the Y-Axis, rescale the X-Axis or save the plot data to a file. These options are described in detail below:

Trace Autoscroll → unchecking this checkbox will stop the plot program from scrolling in the X-direction. This option only has an effect while the program is running. Rechecking this checkbox will enable the plot program to resume scrolling. The X-Axis scroll bar may be used for manual scrolling.

Rescaling Y-Axis → next to where it says "Y scale:" enter in the scale (Min) to (Max), and then click on the "Rescale Y-Axis" button. This option only has an effect if the "Trace Autoscroll" checkbox is unchecked or the plot program is stopped. Otherwise the Y-Axis will automatically scale itself to fit all variables being plotted.

Rescaling X-Axis → entering a value next to where it says "X scale (seconds):" adjusts the number of seconds spanned across the X-Axis, e.g. entering a value of ten seconds sets the X-Axis so that it will show ten second segments at a time. To use this feature, enter the value and then click on the "Rescale X-Axis" button. This option can be used at anytime.

Save to File → the "Save to file" option can be used at anytime once you've started the plot program. The data stored consists of the data collected from the time the Start button was pressed

to the time the “Save to file” button is pressed. The file will be saved in a (.csv) format which can be later imported into a spreadsheet for further analysis.

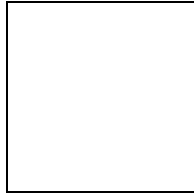


Figure 4: Embedded GUI, Plot Page in Monitor Mode

Diagnostics Page – Monitor Mode

The Diagnostics Page consists of two sections: (1) Device Diagnostics and (2) Snapshot. In the “Device Diagnostics” section the user is given the ability to run basic diagnostic tests on the flow and temperature. These tests can be run individually or all at once. The “Snapshot” section is a tool designed to help MKS diagnose a device should a problem ever occur. Both of these sections are explained in detail below.

Device Diagnostics

The tests listed in this section are designed to insure that there are no major electrical problems and that the sensors are working properly. These tests are described in detail below:

Raw Flow → this basic test is a simple diagnostic check for the flow circuit to verify that the sensor and the electronics are working properly. To run this test select the checkbox next to where it says “Raw Flow:” and then press the “Run the test” button. When the test finishes you will either see the word “Pass” or “Fail” next to the checkbox. If the test passes, then the flow circuit is good. If it fails, then there may be a problem. Please follow the instructions in the Snapshot section on page 41.

Temperature → this basic test is a simple diagnostic check for the temperature circuit to verify that the sensor and the electronics are working properly. To run this test select the checkbox next to where it says “Temperature:” and then press the “Run the test” button. When the test finishes you will either see the word “Pass” or “Fail” next to the checkbox. If the test passes, then the temperature circuit is good. If it fails, then there may be a problem. Please follow the instructions in the Snapshot section below.

Snapshot

The “Snapshot” feature is provided to help MKS diagnose any potential problems quickly so that tool downtime can be minimized. This feature will generate a file that contains the user-supplied comment and a listing of the present state of the internal device parameters. This file can then be forwarded to a MKS representative. If you ever experience a problem with your π MFC please follow the steps below:

1. Enter in a detailed description of the problem where it says “Type Description of Problem Here...”
2. Press the “Submit” button and follow the generated computer prompts. Be sure to save the file with a meaningful name and take note of where the file is saved.
3. Contact your local MKS representative to let them know the file is coming.
4. In an email, forward the file to your local MKS representative. If the problem is performance related and you were able capture the performance problem on the Plot Page, please send this information too.

Figure 5, below, shows a screen capture of the Diagnostics Page.

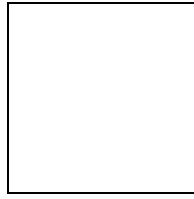


Figure 5: Embedded GUI, Diagnostics Page

Configuration Page – Monitor Mode

This page displays the TCP/IP settings and the current Firmware version for the MFC. In “Monitor Mode” you are only able to view this information. At the bottom of this page you are able to enter the password to change into “Setup Mode.” The Factory-shipped password is “config” (without the “”). Figure 6, below, shows a screen capture of the Configuration Page in “Monitor Mode.”

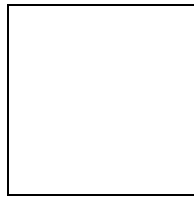


Figure 6: Embedded GUI, Configuration Page in Monitor Mode

Setup Mode

In “Setup Mode” the user is able to configure the π MFC, i.e. zero the device, change the IP address, configure the PID parameters, etc. To enter this mode, while in “Monitor Mode”, go to the “Configuration Page” and enter the Factory-shipped password “config” (without “”). Once you press the “Change Settings” button you will be directed to the “Configuration Page” in “Setup Mode.” You should now see a green banner that lines the top of the page that says, “The device is now in SETUP mode.”

Each of the pages, i.e. tabs, in “Setup Mode” are listed and described below in detail starting with the Device Page. Please note that this section will only describe in detail the features that are different from those in “Monitor Mode.” For a complete understanding of each page, also read the *Monitor Mode* section starting on page 39.

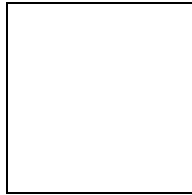


Figure 7: Setup Mode

Device Page – Setup Mode

In “Setup Mode” this page gives you the ability to modify the gas settings.

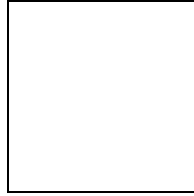


Figure 8: Embedded GUI, Device Page in Setup Mode

Gas Settings: The Device Page enables the user to change the MFC’s gas settings. To change the gas settings review the following possible operations and go to the appropriate page.

- To create a new gas instance, see page 44.
- To change the full scale range of the current gas instance, see page 44.
- To set the MFC to a different gas instance, see page 45.

Creating A New Gas Instance

(Refer to Figure 9 during the following steps.)

In the “Create A Gas” section of the Device Page:

1. Click on the “select gas” drop-down menu arrow and find the gas you’d like to create.
2. Click on the “select instance” drop-down menu arrow and find an instance that says “No Gas.” *Please note that you can write or re-write to any instance except instance 32, which is the Factory calibration.*
3. Press the “Submit” button.
4. This process typically takes under two minutes to complete. When the process is completed, the browser will display a green banner across the top of the Device Page that says, “Gas Selection Update SUCCEDED.”
5. You should now see the newly created gas and its attributes now listed in the “Gas Settings” section of the Device Page. At this point, if you want to change the full scale, then go ahead to the next section on page 44. **Otherwise you need to cycle the power to the MFC. Once you cycle the power, click on the refresh button of the browser. Once the MFC powers up, the browser will reload and start on the Device Page in Monitor Mode.**

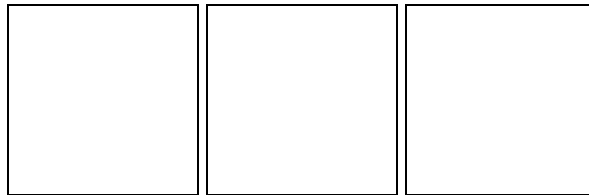


Figure 9: Embedded GUI, Creating A New Gas Instance

Changing the Full Scale Flow Range

In the “Gas Settings” section of the Device Page the user is able to change the full scale gas flow range to any number between the “Min Full Scale (sccm)” and the “Max Full Scale (sccm)” values.

To do this, enter in the desired full scale range in the “Full Scale (sccm):” field and then press the “Set” button. This operation typically takes less than one minute. **Once completed, cycle the power to the MFC. Once you cycle the power, click on the refresh button of the browser. Once the MFC powers up, the browser will reload and start on the Device Page in Monitor Mode.**

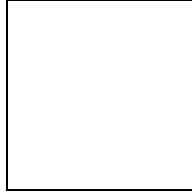


Figure 10: Changing the Full Scale Flow Range

Changing the Active Gas Instance

In the “Gas Settings” section of the Device Page the user is able to change the active gas instance.

To change the “Selected Gas”, click on the drop-down menu’s arrow and select one of the gases that have been created. *Please note that you are able to select the Factory calibration gas instance (32) but you can not change anything. Instance (1) is an exact replica of that instance if it has not been overwritten by the user on previous modifications to the gas tables.*

Once you’ve selected the instance you want press the “Set” button. The gas will change within (10) seconds. You’ll notice that the “Standard Number” and the minimum and maximum full-scale ranges will change also.

Plot Page – Setup Mode

In “Setup Mode” this page enables the user to adjust the PID settings to optimize control performance. To learn more about how to tune the π MFC to your system see page XX in the xxx section. This section only deals with setting the values.

Figure 11, below, is a screen capture of the Plot Page in “Setup Mode.” The control parameter section is located above the “Select Variables” section in the top right-hand corner of the page. This page enables you to send a setpoint to the MFC through Ethernet (see notes below), watch the MFC’s performance on the plot, and adjust the PID parameters accordingly to optimize the performance of the MFC. You should find that tuning a device has never been easier.

Note For Analog units, sending a setpoint through Ethernet will not work unless the Analog checkbox is selected. This checkbox tells the device to bypass the analog setpoint on the analog/power interface. To begin sending setpoints through the analog interface again, either uncheck the Analog checkbox or close the browser.

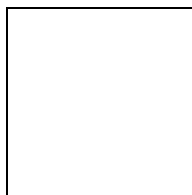


Figure 11: Embedded GUI, Plot Page in Setup Mode

Before a π MFC leaves the factory the performance is checked with Nitrogen in a typical application. During this test the control parameters are set so that the device's performance is optimized. These factory set control parameters are then saved to the device and can be restored to the device at any time by pressing the "Factory Restore" button. To change the current PID variables in the device, enter in a value for the Kp (gain), Ki (integral) and/or Kd (derivative) parameters and press the "Submit" button. For information on how to tune your π MFC for optimal performance please see *Tuning the π MFC Mass Flow Controller*.

Diagnostics Page – Setup Mode

There is no difference between this page in "Setup Mode" versus this page in "Monitor Mode." To learn more on its features, please see the *Diagnostics Page* section on page 41.

Configuration Page – Setup Mode

As was noted earlier, the Configuration Page is where you are initially directed once you've entered "Setup Mode." Here the MFC can be zeroed, the "Setup Mode" password can be changed, changes can be made to the Ethernet settings and firmware can be updated.

Caution Zeroing the flow incorrectly can cause system failure. Make sure that the "Zero Adjustment" procedure on page 60 is followed properly.

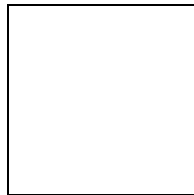


Figure 12: Embedded GUI, Configuration Page in Setup Mode

Zeroing the π MFC

For the π MFC there will be a "Zero Flow" option. Before zeroing the value make sure the "Zero Adjustment" procedure on page 60 has been followed correctly. To zero the flow, press the "Zero Flow" button. A green banner across the top of the page will tell you if the device received the command and is processing. Zeroing typically will take (10) seconds. The MFC will be unresponsive during this time.

Changing the Setup Mode Password

To change the "Setup Mode" password from the default password "config," follow the steps in the "Change Setup Password" section.

Changing the Ethernet (TCP/IP) Settings

The TCP/IP section allows you to change the IP Address, Subnet Mask, and Default Gateway for the MFC.

Caution If you are unfamiliar with setting TCP/IP settings for the MFC, please contact your company’s IT personnel or local MKS representative for help. If settings are done incorrectly, you may no longer be able to connect to the MFC over Ethernet.

To set a new IP Address, enter in the IP address and press the “Submit” button. Pressing the “Reset” button will reset the entry fields to what was in them prior to you making any changes. For the new IP address to take effect the power to the MFC must be cycled. To use the Embedded GUI, you must now change the URL to reflect the new IP address, e.g. http://xx.xx.xx.xx, where xx.xx.xx.xx is the new IP address for the MFC.

Updating Firmware

Updating firmware is the responsibility of your local MKS representative. If any updates are “necessary”, then your local representative will be in contact to set up a time to complete the upgrade. Please note that a “necessary” update is one that is deemed “Critical” by the factory.

Optional PC Page (Analog 15 pin D Devices Only)

The Optional PC page is only available in Setup Mode for Analog 15-Pin devices. Here the MFC can be setup to control to an external signal, e.g. a Baratron capacitance manometer to control pressure. The external signal full scale input voltage can be set to 10 VDC (*default*) or 5 VDC, and the TCP/IP settings can be viewed. Figure 13, below, shows a screen shot of this page.

Note Once the Optional Input is enabled, any setpoint sent to the device will cause the device to control relative to the external signal input. To set the device so that it controls to its own internal sensor the optional input must be disabled.

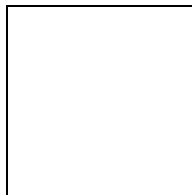


Figure 13: Embedded GUI, Optional PC Page in Setup Mode (15 pin D Analog Only)

Enabling the Optional Input

To enable the Optional Input, check the “Enable Optional Input” box and then click the “Set” button. You should now see the fields below the checkbox become enabled (text darkens). The fields are described below.

Full Scale: In this field you should enter the full scale range of the external signal. For example, if you have a Baratron capacitance manometer with a full scale of 100 Torr, then you would put a value of 100 in this field. To enter this value you must click the “Submit” button.

Optional Input: This field reports back what the optional input device is reading. Please note that this value is dependent upon the value in the Full Scale field. To refresh this value, you must refresh the browser. If you desire to watch a continuous data stream of the optional input, then you’ll need to go to the plot page. See the *Optional Input and the Plot Page* section on page 48 for more detail about this.

Optional Input Kp, Optional Input Ki, Optional Input Kd: These values are the PID parameters for Optional Input control. Typically these will be set to match the standard Kp, Ki and Kd values that are factory set before shipment. For information on how to tune your π MFC for optimal performance please see *Tuning the π MFC for Optional PC* in the following section. This section discusses tuning the standard PID values, but the same rules apply to the optional input parameters. To set any of these parameters you must click the “Submit” button. You can also set these parameters on the Plot Page. To learn more, please see the *Optional Input and the Plot Page* section on page 48.

Note A π MFC is typically used as a PI controller only. If the derivative term (Kd) is going to be used, it is recommended that you increase the value in increments of 0.001.

Changing the Optional Input Full Scale Voltage

In the Optional Input Full Scale Voltage section of the page you have the ability to tell the π MFC whether or not the Optional Input signal has a full scale voltage of 10 Volts (*default*) or 5 Volts. To change the voltage click the correct option box and then click the “Submit” button located directly above this section.

TCP/IP Info

On this page you are only allowed to view the current TCP/IP info for the π MFC. If you wish to change any of this information please see the *Configuration Page* section on page 42.

Optional PC and the Plot Page

Once you enable the Optional Input the Plot Page will include it in the variable list. A screen capture of the Plot Page with the Optional Input enabled is shown below. You can see the “Optional Input” variable listed in the variable list.

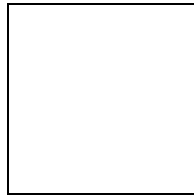


Figure 14: Embedded GUI, Plot Page with Enabled Optional Input (15 pin D Analog Only)

The Optional PID parameters are always settable on the plot page, but they will have no effect unless the Optional Input is enabled. If not already set, it is recommended that these values be set to the standard Kp, Ki and Kd values initially. The following section discusses tuning the standard PID values, but the same rules apply to the optional input parameters.

Note A π MFC is typically used as a PI controller only. If the derivative term (Kd) is going to be used, it is recommended that you increase the value in increments of 0.001.

Tuning the π MFC for Optional PC

Tuning optimizes the way the π PC unit controls your pressure system. As noted in the previous section, *How the π PC Pressure Controller Works*, the controller functions as a PID (Proportional-Integral-Derivative) controller, but the recommended use is with the Derivative term off, i.e. set to zero. Thus, in this manual, only the Proportional and the Integral term will be discussed. These values can either be adjusted through the electrical interface, if DeviceNet or RS-485, or through the Embedded GUI on the Plot Page in Setup Mode. Each method is discussed in the *Adjusting the Proportional and Integral Control* section on page 50.

Proportional Term

The proportional (P), or gain, term is used as a constant to create a valve drive signal that is proportional to the error signal. The error signal is multiplied by the proportional control setting (K_p), thus creating a proportional valve drive signal. The higher the proportional control, the greater the change in the valve drive signal. Typically, a higher proportional control setting yields a faster response. However, too high a proportional control setting will cause the pressure to oscillate around the set point. Too low a proportional control setting will result in a slow response from the controller. The following figure shows the effects of the Proportional term.

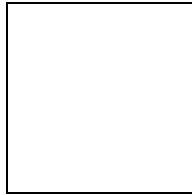


Figure 15: Effects of the Proportional Control

The proportional control setting (K_p) has a minimum value of zero but no maximum value. The factory-shipped setting is for a typical mass flow control system with Nitrogen as the process gas. The actual value depends on the configuration of the π MFC. See the *Adjusting the Proportional and Integral Control* section for an explanation of how to set the proportional control setting (K_p) using the different methods.

Integral Term

The action of the Integral (I) term creates a valve drive signal that is proportional to the magnitude and sign of the area under the error signal curve (error signal with respect to time). Therefore, as time passes, the integral term acts to position the valve to reduce the error signal to zero. A decrease in the integral control setting (K_i) increases the period of time over which the error signal is generated, and the system response gets slower. The following figure shows the effects of the Integral term.

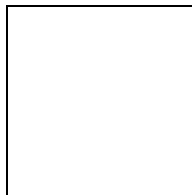


Figure 16: Effects of the Integral Control

The proportional control setting (K_i) has a minimum value of zero but no maximum value. The factory-shipped setting is for a typical mass flow control system with Nitrogen as the process gas. The actual value depends on the configuration of the π MFC. See the *Adjusting the Proportional and Integral Control* section on page 50 for an explanation of how to set the integral control setting (K_i) using the different methods.

Adjusting the Proportional and Integral Control

Over Ethernet you have the ability to view the current values for the proportional control setting (Kp) and the integral control setting (Ki) and change them. To do this, follow the steps listed below:

1. Connect to the Embedded GUI, see *Logging On to Your π MFC* on page 39.
2. Enter Setup Mode, see *Setup Mode* on page 43.
3. Go to the Plot Page. Here you are able to adjust the settings. See the Setup Mode *Plot Page* section on page 45 for further instructions.

Chapter Five: Overview

General Information

Typical Control System Configuration

The π MFC is used in a wide variety of control systems, most of which share several characteristics. The control system consists of five basic parts:

- Mass flow transducer
- Control electronics
- Control valve
- Pressure transducer (separate from MFC)
- Flow system (whose flow is being controlled by the π MFC Mass Flow Controller)

The π MFC provides the first three components. The mass flow transducer is an MKS design. The π MFC instrument contains the electronics necessary for flow control. The control valve included in the device is a proportional control valve. The flow system can be any process whose flow you need to control. In addition, the π MFC is capable of metering the mass flow of the gas during the flow control operation.

Flow Measurement Overview

The π MFC measures the mass flow rate of a gas and controls the flow rate according to a given setpoint. The accuracy from 10% to 100% of Full Scale (F.S.) is $\pm 1\%$ of Reading. For setpoints between 2% and 10%, π MFC Mass Flow Devices have an accuracy of $\pm 0.2\%$ FS.

Flow Path

Upon entering the π MFC, the gas stream passes first through the metering section of the instrument for its mass flow to be measured. The gas moves on through the control valve, which regulates the flow rate according to the given setpoint, and then exits the instrument at the established rate of flow.

The metering section consists of one of the following:

- A sensor tube for Full Scale ranges ≤ 2 sccm (N₂ equivalent)
- A sensor tube and parallel bypass for ranges > 2 sccm (N₂ equivalent)

The geometry of the sensor tube, in conjunction with the specified full scale flow rate, ensures fully developed laminar flow in the sensing region. The bypass elements are specifically matched to the characteristics of the sensor tube to achieve a laminar flow splitting ratio which remains constant throughout each range.

| | |
|-------------|--|
| Note | The π MFC must be installed in the orientation consistent with its flow configuration which is a customer specified option, either vertical or horizontal flow, at time of order. The π MFC is not warranted for operation in orientations other than that for which it was configured at time of shipment. |
|-------------|--|

Flow Control Range

The π MFC can control flow over a range of 2 to 100% of full scale flow. This means that a π MFC with a 20 sccm configuration can control flow from 0.4 to 20 sccm, whereas an instrument with a 100 sccm configuration can control flow from 2 to 100 sccm.

Measurement Technique

The flow measurement is based on differential heat transfer between temperature sensing heater elements which are attached to the flow sensor tube. This senses the thermal mass movement which is converted to mass flow via the specific heat, C_p , and other thermodynamic properties of the gas.

Control Circuitry

The controller employs the above measurement technique and utilizes a control circuit that provides drive current for the proportioning control valve. The flow controller accepts a setpoint signal, compares it to its own flow signal, and generates an error voltage. This error signal is then conditioned so that it can reposition the control valve, thus reducing the control error to zero.

In the normally closed control valve, the π MFC instrument lifts the armature and plug assembly from the seat to regulate the gas flow rate.

Control Valve

The control valve is a specially constructed solenoid valve in which the armature (moving valve mechanism) is suspended. The arrangement ensures that minimal friction is present and makes precise control possible.

How the π MFC Works

The MKS π MFC includes technology improvements in functionality and performance to help users in process industries, e.g. semiconductor fabrication, increase tool throughput and reduce overall system costs. Real-time accurate flow control is provided through advanced digital algorithms. Enabling real-time control of process gas flow, accuracy and repeatability are significantly improved over conventional PID based digital MFC's.

The π MFC compares the flow reading to the setpoint, and positions the valve to maintain, or achieve, the setpoint rate.

Example

Assume that your π MFC is positioned upstream of the process chamber. The π MFC is positioned *before* the chamber so it will regulate the flow rate of the gas entering the process chamber.

When the actual flow rate reading is *less than* the setpoint value, the π MFC opens the valve to increase the amount of gas entering the system. As the valve opens, assuming adequate differential pressure across the flow controller, gas enters the process chamber, so the flow rate rises to meet the setpoint value.

When the actual flow rate reading is *more than* the setpoint value, the π MFC closes the valve to decrease the amount of gas entering the system. As the valve closes, there is a reduced flow of gas entering the process chamber, so the flow rate decreases to meet the setpoint value.

Note The π MFC must have sufficient pressure on its inlet side to achieve the setpoint. To achieve full scale flow the pressure must be at least 4 torr with vacuum (sub 500 mTorr) at the outlet of the MFC.

Operation of the π MFC with Gases Other Than Nitrogen

The π MFC is unique in MKS flow control technology in that it does not use gas correction factors as other Mass Flow Controllers do. The operation of the π MFC is based on thermodynamic principals and multi-component functions have been developed to accurately calculate the non-linear gas flow of operating gases, with respect to the calibration gas. The current library of gases and functions is in excess of 40 in number and includes most gases in common usage. The π MFC- Low Pressure has been specifically constructed and calibrated for applications where inlet gas pressures are below 1200 torr such as Safe Delivery Source (SDS®) gases used in ion implantation. Many of the currently available SDS gases have their properties stored in the π MFC- Low Pressure's library.

When an operating gas other than the calibration gas is selected, the π MFC automatically utilizes the correct functions that calculate the flow of that gas with respect to the original calibration. This allows the MFC to report the gas flow for the gas in use immediately and with better accuracy than has previously been available. In comparison, the typical MFCs use Gas Correction factors for converting the calibration gas flow into the flow of the gas being used. This leads to inaccuracy in the flow reported to levels as high as 6-10% (of FS).

The π MFC, by using these functions for the various gases, actually reports the flow within the stated accuracy of the flow controller, for both calibration and all operating gases. The reported flow from a π MFC using Helium as the process gas, but not calibrated for Helium, will have the same accuracy for the Helium as it does for Nitrogen, the calibration gas. Traditional flow controllers and meters using a Gas Correction Factor for Helium typically have an error in the flow output of as much as 6% of FS.

Versions of the π MFC

The π MFC is available with analog communication utilizing either 9 Pin D or 15 Pin D connectors. Both the 9 and 15 pin D versions accept analog, 0-5 VDC setpoint and output signals.

Table 6: 15 Pin D Connector (Analog Interface)

| Connector Pinout – Standard Assignments (Model Code B) Pin Assignment 24 VDC Power Option | |
|--|---|
| Pin 1 | Valve Test Point |
| Pin 2 | Flow Signal Output, (0 to +5 VDC) |
| Pin 3 | Valve Close (TTL low) |
| Pin 4 | Valve Open (TTL low) |
| Pin 5 | Power Supply Common Digital Ground (see Note 4 below) |
| Pin 6 | No Connection |
| Pin 7 | +15 to +25 VDC (see Note 4 below) |
| Pin 8 | Setpoint Input (0 to +5 VDC) |
| Pin 9 | Zero Function |
| Pin 10 | Optional Input |

| | |
|--------|----------------|
| Pin 11 | Signal Common |
| Pin 12 | Signal Common |
| Pin 13 | No Connection |
| Pin 14 | No Connection |
| Pin 15 | Chassis Ground |

Notes

1. The “No Connection” pin assignment refers to a pin with no internal connection.
2. The 0 to 5 VDC flow signal output comes from pin 2 and is referenced to pin 12 (signal common).
3. Any appropriate 0 to 5 VDC input signal of less than 1K ohm source impedance referenced to pin 12 can be used to supply a setpoint signal to pin 8 or pin 10.
4. Power Ground (Pin 5) and Signal Common (Pins 11 and 12) are not internally connected within the device. The user is responsible to connect these signals at either the device or at their source.

Table 7: 9 Pin D Connector (Analog Interface)

| Connector Pinout – Standard Assignments (Model Code A) Pin Assignment 24 VDC Power Option | |
|--|-----------------------------------|
| Pin 1 | Valve Open/Close |
| Pin 2 | Flow Signal Output, (0 to +5 VDC) |
| Pin 3 | +15 to 25 VDC Power In |
| Pin 4 | Power Common |
| Pin 5 | No Connection |
| Pin 6 | Setpoint Input (0 to +5 VDC) |
| Pin 7 | Signal Common |
| Pin 8 | Signal Common |
| Pin 9 | Valve Test Point |

Notes:

1. Chassis ground is not available on a separate pin. Instead, it is carried out through the cable shielding. Be sure that the connector on the other end of the cable is properly grounded to its chassis ground.
2. The 0 to 5 VDC flow signal output comes from pin 2 and is referenced to pin 7 (signal common).
3. Use any appropriate 0 to 5 VDC input signal of less than 1K ohm source impedance referenced to pin 7 as the setpoint signal to pin 6.
4. Power Ground (Pin 3) and Signal Common (Pins 7 and 8) are not internally connected within the device. The user is responsible to connect these signals at either the device or at their source.

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 Mark 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. MKS offers a variety of interface cables, listed in Table 12, page 27.

Note

1. An overall metal braided, shielded cable, properly grounded at both ends, is required to meet CE Mark 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 1480/1485 MFC to a power supply with a 15-pin Type .D. connector, use part number CB259-5; for an overall metal braided, shielded cable use part number CB259S-5.
-

Table 8: MKS Interface Cables

| MFC End | Power Supply End | |
|---------------|--------------------|---------------|
| | 15-Pin Type "D" | Flying Leads |
| 15-pin Type D | CB147-1 CB259-5 | CB259-6 |
| 9-pin Type D | CB147-12 | Not Available |

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:

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 with direct contact to the cable 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. Ground the shield 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 to ground the shield at each such end *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 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.
5. In selecting the appropriate type and wire size for cables, consider:
 - A. Voltage ratings.
 - B. Cumulative I²R heating of all the conductors (keep them safely cool).
 - C. IR drop of the conductors, so that adequate power or signal voltage gets to the device.
 - D. Capacitance and inductance of cables that handle fast signals (such as data lines or stepper motor drive cables).
 - E. Some cables may need internal shielding from specific wires to others.

Start-Up Procedure for the Analog π MFC

1. Leak test the fittings on the unit using standard helium leak check procedures.
Do not proceed to the next step until you are certain that there is no gas leakage.
2. Plug the (un-powered) power supply/readout cable (MKS or customer-supplied) into the connector (either a 9-pin or 15-pin .D. type) located at the top of the inlet end of the device.
Plug the other end of the cable into an un-powered MKS or MKS-compatible power supply/readout unit.
3. Apply power to the device.
Once the device is sufficiently warmed-up, you can proceed to zero the device's flow output. See instructions in Section 5.

Warm Up Time

After installation and power up, allow the MKS π MFC to warm up for a minimum of 30 minutes.

Flow Zeroing Procedure

Although MKS flow devices are zeroed at the factory prior to shipment, it is normal to check the zero and re-zero them, if needed, when they are first installed on the tool. [Zeroing the MFC is done via the Embedded GUI software interface.](#)

A mass flow meter or mass flow device will provide a zero output signal under no flow gas conditions.

Zero offset from improper zeroing procedures can contribute to flow measurement inaccuracy. This is more apparent at the lower end of the device's flow range.

In order to complete a true zeroing of the device, ensure the following conditions are satisfied prior to beginning the procedure.

- Device is installed in the orientation intended for final use (i.e. horizontal base down, vertical flow up, etc.) and its defined flow configuration specified at the time of order. See Ordering Code in Appendix B.
- Device is powered at operating temperature, preferably for 30 or more minutes.
- Devices subject to ambient temperatures other than room temperature (23° C) should be zeroed under those conditions.
- Pressure drop and flow across the device is reduced to zero. Depending on the gas panel configuration, this may be done by one of the referenced procedures. See Chapter 6, *Maintenance*, page 60, for zeroing procedures.

How to Override the Control Valve

The valve override feature enables the control valve to be fully opened or closed independent of the setpoint command signal.

If the π MFC is equipped with a 9-pin Type D connector:

- To *Open* the valve, apply a TTL High to Pin 1.
- To *Close* the valve, apply a TTL Low to Pin 1 or connect Pin 1 to Signal Ground.
- Normal Setpoint operation occurs when Pin 1 is allowed to float.

If the π MFC is equipped with a 15-pin Type D connector:

- To *Open* the valve, apply a TTL low to pin 4 *or* connect pin 4 to signal ground (pins 11 or 12).
- To *close* the valve, apply a TTL low to pin 3 *or* connect pin 3 to signal ground (pins 11 or 12).

Note To control with a TTL signal, use a tri-stated device.

Priority of the Commands

The π MFC executes commands based on a hierarchical command structure. The highest priority command is Valve Open, followed by Valve Close, and Setpoint Control. Therefore, if the flow controller is operating under Setpoint Control, you can send a Valve Open command to force the valve to the full open position.

Note When both the Valve Close and Valve Open pins are pulled down, the Valve Open command takes precedence and the valve is moved to the open position.

The Optional Input (15 pin D Analog Only)

The standard 15-pin π MFC can control flow based on a 0 to 5 Volt signal from an external sensing device using the optional input feature (for a 0 to 10 Volt input range, contact the MKS Applications Department). A common application of this feature is for pressure control using input from a pressure transducer.

To use the optional input feature, route the 0-5 Volt output from the desired external device to the .optional input, pin 10. The control electronics drives the valve so that the optional input signal matches the setpoint. Use the same pin for the setpoint signal, regardless of whether you are using the optional input or the standard flow control signal.

Although controlling to the external optional input signal, the metered flow output signal is still provided on the standard output pin 2.

Note The 9-pin Type .D. connector does not support the optional input feature. This feature is only available on the 15-pin Type D connector with standard MKS pinout assignments.

Note Voltage applied to the optional input pin overrides the signal generated by the flow sensor internal to the π MFC.

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Chapter Six: Maintenance

General Information

In general, no maintenance is required other than proper installation, operation and periodic zero adjustment. The device should be inspected upon receipt for shipping damage. Any damage should be reported to the freight carrier and MKS Instruments immediately.

If a mass flow device fails to operate properly on receipt, re-check for shipping damage, and check the electrical cable for proper power, signal, ground, and shielding requirements. If there is no obvious damage, and the unit fails to operate properly through your network, obtain a RMA Number (Return Material Authorization Number) before returning the unit to MKS Instruments for service to expedite handling and ensure proper servicing of your instrument. Otherwise, periodically check for wear on the cables and inspect the enclosure for visible signs of damage during its service.

Zero Adjustment

For best accuracy and repeatability, you should check the zero output periodically and reset it, if necessary. Refer to the zero adjustment procedure below.

It is also recommended that the instrument be recalibrated annually if no other time interval has been specifically established. Refer to the inside of the back cover of this instruction manual for a complete list of MKS Calibration and Service Centers.

Note The following zeroing procedure assumes that all gas lines and fittings have been checked for leaks and that they have been verified to be leak-tight.

“Zero” the π MFC

All MFCs should be zeroed under actual installation conditions prior to use. Very slight offsets in the zero condition can contribute to flow measurement inaccuracy, especially noticed at the lower end of the device range.

Setup the MFC to the exact process conditions:

- Verify that the MFC is installed in the final equipment and orientation (base up, base down, vertical flow up, etc.) and its defined flow configuration specified at the time of order. See Ordering Code in Appendix B.
- Verify that the MFC is powered at operating temperature for at least 30 minutes.
- If the MFC will be subjected to elevated ambient temperature conditions, verify that these temperatures have been achieved and are stabilized before continuing.
- Verify that the pressure drop across the MFC is reduced to zero. Depending on the gas panel configuration, this may be done by one of the following procedures.

A) System has upstream and downstream positive shut off valves

1. Close the upstream valve.

2. Close the downstream valve.
3. Set the MFC to 100% set point.
4. Allow pressure across MFC to equilibrate as flow output approaches zero and stabilizes.
5. To ensure that actual flow remains at zero, keep downstream shut-off valve closed and provide zero setpoint to the MFC.
6. Wait one minute and adjust zero through the Embedded GUI software interface.

B) For systems with downstream valve only

1. Zero the MFC at typical operating inlet pressure.
2. Close the downstream valve.
3. Set the MFC to 100% set point.
4. Allow pressure to equilibrate across the MFC as flow output approaches zero and stabilizes. Provide zero setpoint to the MFC.
5. Wait one minute and adjust zero through the Embedded GUI software interface.

C) For systems with upstream valve only

1. MFC may be re-zeroed with downstream line under vacuum or atmosphere.
2. Close the upstream valve.
3. Set the MFC to 100% set point.
4. The MFC may be evacuated to vacuum or exposed to atmosphere on downstream side. For either case, the downstream pressure must be kept constant to insure there is no pressure drop across MFC.
5. Allow pressure to equilibrate across MFC as flow output approaches zero and stabilizes.
6. Provide zero setpoint to the MFC.
7. Wait one minute and adjust zero through the Embedded GUI software interface.

Opening and Closing the MFC Valve

There are different ways to open/close the valve depending on the electrical interface. Each electrical interface has a unique way to open/close the valve. The final way to open/close the valve is to use the embedded GUI. The instructions for this method follow the Analog section.

| | |
|--------------------|--|
| <p>Note</p> | <p>If the MFC's valve is ever opened or closed through one of the electrical interfaces and not over the embedded GUI, then it is mandatory that you set the valve back to Normal Operating Mode prior to use.</p> |
|--------------------|--|

Analog Valve Control – 15 pin D

1. To fully open the valve over Analog, tie pins (4) and (12) together.
2. To close the valve over Analog, tie pins (3) and (12) together.
3. To return the valve to Normal operation, allow pins (3) and (4) to float.

Analog Valve Control – 9 pin D

1. To fully open the valve over Analog, apply TTL high to pin (1).
2. To close the valve over Analog, apply TTL low to pin (1) or tie pins (1) and (7) together.
3. To return the valve to Normal operation, allow pin (1) to float.

Embedded GUI Valve Control

1. Log on to the embedded GUI through the Ethernet connection. For more information on how to do this, follow the instructions on page 39. Once you've logged on, you should find yourself on the "Device" page in "Monitor Mode." You need to enter "Setup Mode" so go to the "Configuration" page and enter the password "config" without quotations. *The browser will alert you when you've entered "Setup Mode."* At this point, go to the "Plot" page. Here you can enter a "Setpoint" and check the valve position (Valve Command) to make sure the valve is open.
2. Highlight the setpoint and valve command variables and then click the "Start" button. For all devices with normally closed valves, you want the valve command to equal 0.100 to 0.130 mA.

Note For Analog devices, you can not issue a setpoint over the browser unless you click the "Analog" option on the "Plot" page in "Setup Mode."

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Chapter Seven: Troubleshooting

Troubleshooting Chart

Table 9: Troubleshooting Chart

| Symptom | Possible Cause | Check/Corrective Action |
|--|--|--|
| PiMFC display does not light | No power | Check power source, measure voltage. |
| | Low power | Measure voltage. Voltage should be 15-25 VDC. |
| | Wrong cable | Check pin(s) continuity/pin-to-pin configuration. |
| | Bad cable connection | Check pin(s) continuity/pin-to-pin configuration. |
| MFC does not respond to any setpoint | Low or no power | Check power source, measure voltage. |
| | Control circuit failure | Provide setpoint, gas & pressure to device, run diagnostic using Ethernet interface. |
| | Contamination/Clogged - blocked MFC device or gas line | <p>Check inlet pressure @ PiMFC.</p> <p>Check outlet pressure MFC using pressure gauge. Verify minimum operating pressure differential is available.</p> <p>Check outlet pressure downstream of positive shut off (pneumatic) valve downstream of MFC.</p> <p>Check air line to pneumatic valve.</p> <p>Check for any restriction such as filter or check valve downstream of MFC.</p> |
| PiMFC shows 0 flow when given setpoint | Closed upstream or downstream pneumatic valves | Open valves, check inlet pressure. |
| | No gas supply | Turn on gas supply. |
| | Upstream clogged filter/component | Check flow through of components by measuring pressure drop across device. |
| | PiMFC clogged orifice | Verify MFC inlet pressure, check valve current for open valve condition. Check for gas flow downstream of MFC - If flow does not exist, possible clogged orifice. |
| | PiMFC clogged sensor | Run PiMFC diagnostics. Verify MFC inlet pressure, check valve current for open valve condition, check for gas flow downstream of MFC. If flow present, possible clogged sensor. |
| | PiMFC control circuit failure | Run PiMFC diagnostics. If error results, contact MKS service center. |
| PiMFC shows output flow > FS (overrange) | MFC valve full open | Check valve current for maximum current level (130 mA). |
| | Pressure drop across MFC > specification | Measure upstream pressure & downstream pressure. Compare to spec. |

| Symptom | Possible Cause | Check/Corrective Action |
|---|--|--|
| PiMFC shows output flow > FS (overrange) (continued) | Faulty valve control circuit/calibration | Run PiMFC diagnostics using Ethernet GUI. |
| | Possible contamination in valve assembly | Cycle-purge MFC to clear suspected contamination. |
| PiMFC output signal does not match setpoint | Contamination | Check for partial block orifice or sensor. Cycle purge MFC to clear contaminant. |
| | Inlet pressure/too low | Increase inlet pressure. |
| | Outlet pressure too high | Decrease outlet pressure. |
| | Control electronics failure, sensor failure | Run PiMFC diagnostics test. |
| MFC output signal oscillates | Inlet pressure oscillates | Check for faulty regulator. |
| | Inlet pressure too high | Lower inlet pressure |
| | MFC nameplate gas not same as actual gas | Check gas program using Ethernet GUI. Reprogram as necessary. |
| | Faulty control circuit | Run PiMFC diagnostic test. |
| PiMFC output signal matches setpoint, but actual gas flow less (as determined by transfer standard) | Contaminated bypass | Check process chamber pressure. Compare to normal or reference. |
| | MFC programmed for different gas | Compare gas programmed in MFC to actual gas used. Verify using Ethernet interface. |
| MFC cannot achieve FS flow | Inlet pressure low | Increase inlet pressure. |
| | Outlet pressure high | Decrease outlet pressure. |
| | Valve contamination | Check valve current for maximum position. |
| | Gas line blockage/contamination | Measure pressure drop across component suspected of contamination such as filter or check valve. |
| Output signal matches setpoint @ higher flows, but will not go to 0 | Device zero offset | Re-zero device with known zero flow conditions. |
| | MFC valve partial contamination | Cycle-purge device, check valve current. |
| | Faulty control valve, adjustment or electronics | Run PiMFC diagnostics. Call MKS service center. |
| | Inlet pressure too high | Decrease inlet pressure. |
| MFC has setpoint, output signal zero | Upstream and/or Downstream pneumatic valves closed | Check inlet pressure, if normal or matches regulator, check downstream valve for closed position. Open valve(s). |
| Display powers up, but MFC does not respond | Low power, power supply | Measure current and voltage from power source. |
| MFC output shows large overshoot or undershoot | Inlet pressure too high | Decrease inlet pressure. |
| | MFC not programmed for correct gas - actual gas used different | Check MFC active gas using Ethernet interface. |
| | PiMFC control parameters set incorrectly | Contact MKS service center. |

| Symptom | Possible Cause | Check/Corrective Action |
|---|------------------------|--|
| Output signal > zero with confirmed zero flow condition | MFC device zero offset | Re-zero device per instruction manual. Contact MKS service center. |

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Appendix A: Product Specifications

Performance Specifications

| | |
|---|--|
| Full Scale Flow (N2 equivalent) | 2 – 20 sccm |
| Inlet Pressure Range | 4 – 1200 torr (with vacuum (sub 50 mTorr) at the outlet) |
| Normal Operating Pressure Differential (N2 equivalent) | <10 torr at F.S. flow (with vacuum (sub 50 mTorr) at the outlet) |
| Maximum Purge Pressure | 150 psig |
| Burst Pressure | 1500 psig |
| Control Range | 2% to 100% of F.S. |
| Accuracy | ± 1% of setpoint for > 10 to 100% F.S. ± 0.2% of F.S. for 2 to 10% F.S. |
| Repeatability | ± 0.2% of F.S. |
| Resolution | 0.1% of Reading |
| Temperature Coefficients Zero Span | <0.05% F.S./°C <0.08% Reading/°C |
| Inlet Pressure Coefficient | < 0.02% of Reading./psi |
| Typical Controller Settling Time (per SEMI Guideline E17-0600) | < 2 seconds typical above 10% F.S. with inlet pressure >10 torr |
| Warm-Up Time (to within 0.2% of F.S. of steady state performance) | < 30 min. |
| Normal Operating Temperature Range | 10°C to 50°C |
| Storage Humidity | 0 to 95% Relative Humidity, non-condensing |
| Storage Temperature | -20°C to 65°C (-4°F to 149°F) |
| Temperature Display Range | 0 to 100°C |
| Temperature Readout Units | °C |
| Temperature Accuracy | ± 2°C |
| Temperature Resolution | 0.1°C |

Mechanical Specifications

| | |
|---|--|
| Fittings (compatible with) | Swagelok 4 VCR male |
| Display | 4 digits for value, 4 characters for unit |
| Leak Integrity External (scc/sec He) Through closed valve | < 1 x 10 ⁻¹⁰ < 1.0% for F.S. at 25 psig inlet to atmosphere |
| Wetted Materials Standard | 316L S.S. VAR (equivalent to 316 S.S. SCQ for semiconductor quality), 316 S.S. , nickel, KM-45, PTFE |
| Surface Finish | 5 μinches, average Ra |
| Weight | ≤ 2 lbs (0.9 kg) |

Electrical Specifications (CE Compliant to 89/336/EEC)

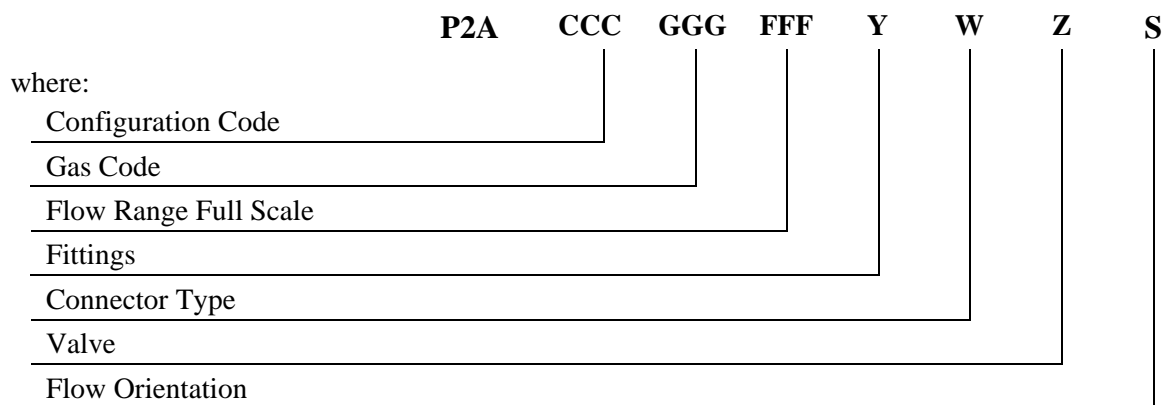
| | |
|--|---------------------------------|
| Input Voltage Required | +15 to +25 VDC |
| Max current at start-up (first 5 sec.) | 15VDC ($\pm 5\%$) @ 350 mA |
| Typical current at steady state | 15VDC ($\pm 5\%$) @ 250 mA |
| Set Point Command Signal | 0 to 5 VDC |
| Flow Output Signal | 0 to 5 VDC |
| Output Impedance | < 1 Ω |
| Connectors (Power and I/O) | 15-pin Type "D", 9-pin Type "D" |
| Connector (Ethernet Diagnostics) | RJ-45 |

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

Appendix B: Model Code Explanation

Model Code Description

The model code of the MFC defines features of the unit such as device type, flow range, fittings, valve configuration, connector type, seal material and firmware revision.



Configuration Code (CCC)

Type π MFC Mass Flow Controller – Low Pressure CCC=P2A

Gas Code (GGG)

The valve bore (the internal valve diameter) in millimeters (mm) and the type of flange is indicated by a three-character code.

| Gas | Ordering Code | Symbol |
|-------------------------|---------------|--------|
| Nitrogen | 013 | N2 |
| Arsenic Pentafluoride | 096 | AsF5 |
| Arsine | 035 | AsH3 |
| Boron Trifluoride | 048 | BF3 |
| Germanium Tetrafluoride | 099 | GeF4 |
| Hydrogen Selenide | 023 | H2Se |
| Nitrous Oxide | 027 | N2O |
| Phosphine | 031 | PH3 |
| Phosphorous Trifluoride | 062 | PF3 |
| Silicon Tetrafluoride | 088 | SiF4 |

Flow Range Full Range (FFF)

The MFC's mass flow full scale range is indicated by a three digit code.

| Mass Flow Rate | Ordering Code |
|----------------|---------------|
| 2 sccm | 200 |
| 5 sccm | 500 |
| 10 sccm | 101 |
| 20 sccm | 201 |

FittingType (Y)

The fitting options are designated by a letter code.

| Fitting Style | Ordering Code |
|---------------------|---------------|
| Swagelok VCR-4 male | R |

Connector (W)

The MFC's connector is designated by a single number code. The MFC is also available with a DeviceNet connector.

| Connector Type | Ordering Code |
|----------------------|---------------|
| 9 Pin D(Analog I/O) | A |
| 15 Pin D(Analog I/O) | B |

Valve (Z)

The seal material option is designated by a letter code. The MFCs are normally closed valve with the following seal type.

| Seal Material | Ordering Code |
|---------------|---------------|
| Teflon | T |

Flow Orientation (S)

The options for the flow orientation are indicated by a single number code.

| Flow Orientation | Ordering Code |
|------------------|---------------|
| Horizontal Flow | 2 |
| Vertical Flow | 1 |

Appendix C: Health and Safety Form



HEALTH AND SAFETY FORM

THIS FORM MUST BE COMPLETED AND RETURNED WITH EQUIPMENT OR SERVICE WILL NOT BE PERFORMED

| | |
|---|----------------------------------|
| RETURN MATERIAL AUTHORIZATION NUMBER (RMA#): | |
| RETURN TO STOCK NUMBER/RTS# (If applicable): | Trade in number (if applicable): |

| | |
|--------------------------------------|--------------------|
| Section 1: (one instrument per form) | MKS Part Number: |
| | MKS Serial Number: |

Section 2: Has this equipment been used? *(Please check appropriate boxes)*

| | |
|--------------------------|---|
| <input type="checkbox"/> | No – Still in MKS packaging |
| <input type="checkbox"/> | No – Unit unpacked, but never installed in a system. |
| <input type="checkbox"/> | Yes -- Used only with clean, dry inert gas (For Example: Air, N2, Ar, He). |
| <input type="checkbox"/> | Yes -- Used with chemicals, non-inert gases, biological or radioactive agents.) Identify all materials: |
| <input type="checkbox"/> | Yes -- Used in a Semiconductor Copper process. Equipment must be double bagged. Label outside bag and packing slip, Copper Part. Label final shipping container Copper Part and place a strip of ORANGE TAPE on the container. |
| | Has equipment been purged? <input type="checkbox"/> No <input type="checkbox"/> yes purged with what? |
| | Has equipment been flushed? <input type="checkbox"/> No <input type="checkbox"/> yes flushed with what? |
| | Has equipment been decontaminated? <input type="checkbox"/> no <input type="checkbox"/> yes, explain process: |
| | How many months in use? |

Section 3: Detailed failure information or description or required service or reason for return.

Section 4: Company or Organization (mandatory information)

| | | |
|---------------------------|------------|------|
| Company: | | |
| Address: | | |
| City: | State: | Zip: |
| Printed Name: | Signature: | |
| Date: | Phone #: | |
| Email: | Fax #: | |
| End User (if applicable): | | |

For MKS USE only:

| |
|---|
| MKS Subsidiary or Agent: |
| Contact Name: |
| Customer #: |
| Maximum Credit allowed (TBD after inspection) |

ALL PRODUCTS MUST BE RETURNED IN SEALED BAGS

MKS will not accept delivery of equipment that has been chemically, radioactively or biologically contaminated, without written evidence of decontamination or laboratory analysis. Alternately, we will require evidence that the biological process is not harmful.

FRMI 3345 Rev.E

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