MKS Type πPC™
PCA & P99A
Digital Pressure Controller

Instruction Manual

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Revision A, 3/08
Instruction Manual

WARRANTY

Type πPC™ Equipment

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

For the period commencing with the date of shipment of this equipment and ending one year later, **MKS** will, at its option, either repair or replace any part which is defective in materials or workmanship or with respect to the date-related operations warranty without charge to the purchaser. The foregoing shall constitute the exclusive and sole remedy of the purchaser for any breach by **MKS** of this warranty.

The purchaser, before returning any equipment covered by this warranty, which is asserted to be defective by the purchaser, shall make specific written arrangements with respect to the responsibility for shipping the equipment and handling any other incidental charges with the **MKS** sales representative or distributor from which the equipment was purchased or, in the case of a direct purchase from **MKS**, with the **MKS** home office in Wilmington, Massachusetts, USA.

This warranty does not apply to any equipment which has not been installed and used in accordance with the specifications recommended by **MKS** for the proper and normal use of the equipment. **MKS** shall not be liable under any circumstances for indirect, special, consequential, or incidental damages in connection with, or arising out of, the sale, performance, or use of the equipment covered by this warranty.

MKS recommends that all **MKS** pressure and flow products be calibrated periodically (typically every 6 to 12 months) to ensure accurate readings. When a product is returned to **MKS** for this periodic re-calibration it is considered normal preventative maintenance not covered by any warranty.

THIS WARRANTY IS IN LIEU OF ALL OTHER RELEVANT WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING THE IMPLIED WARRANTY OF MERCHANTABILITY AND THE IMPLIED WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE, AND ANY WARRANTY AGAINST INFRINGEMENT OF ANY PATENT.

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List of References

The documents listed below are referenced throughout this manual.

[1] "DeviceNet Specification, Volume I: DeviceNet Communication Model and Protocol", Open DeviceNet Vendors Association, Inc. Release 2.0. ERRATA 4.0

[2] "DeviceNet Specification, Volume II: DeviceNet Profiles and Object Library", Open DeviceNet Vendors Association, Inc. Release 2.0. ERRATA 4.0

[3] "Sensor/Actuator Network Common Device Model", SEMI Standards Document E54.1-0097.

[4] "Sensor/Actuator Network Communications Standard for DeviceNet", SEMI Standards Draft Document E54.4-0097.

[5] "Sensor/Actuator Network Specific Device Model for Mass Flow Devices", SEMI Standards Draft Document #2253C.

[6] "Sensor/Actuator Network Standard", SEMI Standards Document E54-0097.

[7] SEMI Standards Document E52-95.

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Pressure Transducer Safety Information

Symbols Used in This Instruction Manual

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

Warning	**The WARNING sign denotes a hazard to personnel. It calls attention to a procedure, practice, condition, or the like, which, if not correctly performed or adhered to, could result in injury to personnel.**
Caution	**The CAUTION sign denotes a hazard to equipment. It calls attention to an operating procedure, practice, or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of all or part of the product.**
Note	The NOTE sign denotes important information. It calls attention to a procedure, practice, condition, or the like, which is essential to highlight.

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 attempt component replacement and internal adjustments. Any service must be made by qualified personnel only. Removing instrument covers voids the warranty for the device.

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 the wetted materials in this product, including any sealing materials.

PURGE THE INSTRUMENT

After installing the unit, or before removing it from a system, purge the unit completely with a clean, dry gas to eliminate all traces of the previously used flow material. Purge on install should involve pulling a vacuum on the system to remove the previous gas (air), flooding with process gas.

USE PROPER PROCEDURES WHEN PURGING

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

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

INSTALL A SUITABLE BURST DISC

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

KEEP THE UNIT FREE OF CONTAMINANTS

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

ALLOW PROPER WARM UP TIME FOR TEMPERATURE-CONTROLLED UNITS

Temperature-controlled units 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 den Druckmeßumformer

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

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. Bei Entfernung von Geräteabdeckungen erlischt die Garantie.

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 im Gerät verwendeten medienberührenden 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. Für die Spülung bei der Installierung wird ein Vakuum an das System angelegt, um das (die) vorherige Gas (Luft) zu entfernen und das System mit Prozessgas zu füllen.

Anweisungen zum Spülen des Gerätes
Das Gerät darf nur unter einer Ablufthaube gespült werden. Schutzhandschuhe sind zu tragen. Um eine korrekte Spülung des Gerätes vorzunehmen, müssen Sie dieses in den beiden Konfigurationen horizontale Standfläche nach unten und horizontale Standfläche nach oben entsprechend den SEMI-Spezifikationen spülen. Im Druckfühler des Gerätes befindet sich ein Einschlussvolumen, in dem sich Gase, die leichter als Luft, aber dennoch gefährlich sind, ansammeln können.

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!
Vor der Installierung des Gerätes, überprüfen Sie sorgfältig alle Geräteanschlüsse an Rohrleitungen 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 relatives à la sécurité concernant le transducteur de pression

Symboles utilisés dans ce manuel d'utilisation

Définitions des indications AVERTISSEMENT, MISE EN GARDE, et REMARQUE utilisées dans ce manuel.

Avertissement	**Un 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 de blessures pour le personnel, en cas d'exécution incorrecte ou de non-respect des consignes.**
Attention	**Une MISE EN GARDE signale un danger pour l'appareil. Elle attire l'attention sur une procédure d'emploi, 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	Une 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	Borne de protection (masse) IEC 417, No.5019
Masse IEC 417, No.5020	Équipotentialité 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	3~ Courant alternatif triphasé IEC 617-2, No.020206	
Mise en garde : se reporter à la documentation ISO 3864, No.B.3.1	Mise en garde : risque de choc électrique ISO 3864, No.B.3.6	Mise en garde : surface brûlante IEC 417, No.5041	

Mesures de sécurité et précautions

Observer les précautions générales de sécurité suivantes pendant toutes les phases du fonctionnement de cet appareil. Le non-respect de 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. dénie toute responsabilité en cas de non-respect des consignes par les clients.

NE PAS SUBSTITUER DE PIÈCES NI MODIFIER L'APPAREIL

Ne pas susbstituer des pièces ni effectuer des modifications non autorisées sur l'appareil. Renvoyer l'appareil à un centre de réparation et de calibrage MKS pour toute intervention ou réparation afin de garantir l'intégrité des dispositifs de sécurité.

FAIRE RÉPARER UNIQUEMENT PAR DU PERSONNEL QUALIFIÉ

Le personnel d'exploitation ne doit pas tenter de remplacer des composants ou d'effectuer des réglages internes. Toute intervention ne doit être effectuée que par du personnel qualifié. Le retrait des couvercles de l'appareil annule la garantie du dispositif.

FAIRE PREUVE DE PRUDENCE EN CAS D'UTILISATION AVEC DES MATIÈRES DANGEREUSES

Si des matières dangereuses sont utilisées, l'utilisateur doit prendre des précaution appropriées, purger complètement l'appareil lorsque cela est nécessaire et s'assurer que les produits utilisés sont compatibles avec les composants humidifiés de cet appareil, y compris les matériaux d'étanchéité.

PURGER 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 débit usagé. La purge après l'installation devrait consister en une mise sous vide du système afin d'éliminer le gaz précédent (air), pour que puisse s'écouler à la place le gaz utilisé.

UTILISER LES PROCÉDURES APPROPRIÉES POUR LA PURGE

Cet appareil doit être purgé sous une hotte de ventilation. Il faut porter des gants de protection. Pour purger correctement l'appareil, ce dernier doit être purgé tant dans les configurations à base inférieure qu'à base supérieure, tel que le stipule la spécification SEMI. Un certain volume peut être emprisonné dans le capteur de pression de l'appareil où du gaz, plus léger que l'air mais quand même dangereux, peut s'accumuler.

NE PAS FAIRE FONCTIONNER DANS UN ENVIRONNEMENT EXPLOSIF

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

UTILISER LES BONS RACCORDS ET PROCÉDURES DE SERRAGE

Tous les raccords de l'appareil doivent être conformes à ses spécifications et compatibles avec l'usage prévu de l'appareil. Assembler et serrer les raccords conformément aux directives du fabricant.

VÉRIFIER L'ÉTANCHÉITÉ DES RACCORDS

Avant de procéder au montage de l'appareil, vérifier avec soin tous les raccordements à l'appareil afin de garantir l'étanchéité de l'installation.

UTILISER À DES PRESSIONS D'ADMISSION SÛRES

Ne jamais faire fonctionner l'appareil à des pressions supérieures à la pression nominale maximale (se reporter aux spécifications de l'unité pour la pression maximale permise).

INSTALLER UN DISQUE D'ÉCHAPPEMENT ADAPTÉ

Lors du fonctionnement avec une source de gaz sous pression, installer un disque de rupture adapté dans le système à vide, afin d'éviter l'explosion du système en cas d'augmentation de la pression.

GARDER L'UNITÉ LIBRE DE TOUT CONTAMINANT

Ne pas laisser des contaminants pénétrer dans l'unité avant ou pendant l'utilisation. Les contaminants tels que la poussière, la saleté, les peluches, les petits éclats dde verre et de métal peuvent endommager l'unité d'une manière permanente ou contaminer le processus.

RESPECT DU TEMPS D'ÉCHAUFFEMENT APPROPRIÉ POUR LES UNITÉS Á TEMPÉRATURE CONTRÔLÉE

Les unités à température contrôlée n'atteignent leurs spécifications que lorsqu'on leur laisse suffisamment de temps pour atteindre d'une manière stable leur température de fonctionnement. Ne pas remettre à zéro ou calibrer l'unité tant que l'échauffement n'est pas terminé.

Medidas de seguridad del transductor de presión

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
Corriente continua y alterna IEC 417, N° 5033-a	Equipo de clase II IEC 417, N° 5172-a	3 Corriente alterna trifásica IEC 617-2, N° 020206	
Precaución. Consulte los documentos adjuntos ISO 3864, N° B.3.1	Precaución. Riesgo de descarga eléctrica ISO 3864, N° B.3.6	Precaución. Superficie caliente IEC 417, N° 5041	

Procedimientos y precauciones de seguridad

Las medidas generales de seguridad descritas a continuación deben observarse durante todas las etapas de funcionamiento del instrumento. La fMFC 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 intentar reemplazar los componentes o realizar tareas de ajuste en el interior del instrumento. Las tareas de mantenimiento o reparación deben ser realizadas únicamente por personal autorizado. Si se retiran las tapas del instrumento, quedará anulada la garantía del dispositivo.

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 humedecidos del instrumento e inclusive, con todos 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. El purgado de la instalación supondrá la creación del vacío en el sistema para eliminar el gas (aire) previo, inundándolo con gas procesado.

USE PROCEDIMIENTOS ADECUADOS PARA REALIZAR LA PURGA

El instrumento debe purgarse debajo de una campana de ventilación y deben utilizarse guantes protectores. Para purgar adecuadamente este instrumento, se debe purgar con las configuraciones de base horizontal hacia abajo y de base horizontal hacia arriba, según se define en la especificación SEMI. El dispositivo tiene un volumen atrapado en el sensor de presión, donde se puede acumular el gas que es más ligero que el aire, pero aún así peligroso.

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 LAS CONEXIONES SEAN A PRUEBA DE FUGAS

Antes de poner en marcha el sistema, inspeccione cuidadosamente las conexiones de tubos con el instrumento 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 o contaminar el proceso.

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 active pressure controllers (πPC) represent state-of-the-art technology meeting the advanced process requirements of next generation toolsets. This unique device integrates MKS Baratron® technology with a normally-closed or normally-open proportioning control valve, *(optional)* integrated flow meter, and closed-loop control electronics through an innovative, real-time feedback control system.

The πPCs include an integrated multifunctional local display, Ethernet connectivity, and an embedded, web-based user interface that offers E-diagnostics. The device is available in either standard 1.125" C-seal and W-seal surface mount or ¼" VCR™ process connections.

Design Features

Increases Throughput and Performance

- Integral Baratron® capacitance manometer technology provides accuracy, reliability and rangeability from 2% to 100% full scale.
- Available with Full Scale pressure ranges as low as 100 Torr for use in low-pressure processes.
- Available as an upstream system backpressure or downstream controller.
- Increases tool uptime through reduction of "No Problem Found" πPC replacements.
- Includes embedded diagnostics software that allows users to check πPC functionality without removing the device.
- E-diagnostics through embedded Ethernet interface.
- Programmable high and low limit alarm and warnings for process limit control.

Reduce Overall Costs

- Reduces overall system cost while saving valuable rack space through minimized footprint.
- Reduce inventory through multi-gas, multi-range availability for units with *optional* integrated flow meter.

Easy to Integrate and Operate

- Straightforward configuration and diagnostics through Ethernet interface

  Uses HTML 2.0 compatible web browser – no special software required.

  Includes remote πPC application.
- Easy viewing of device configuration, full-scale pressure, *(optional)* full-scale flow rate and gas type, and Ethernet IP address with big LED display.

Model Name(Part Number)	PC90 (PCA0)	PC99 (P99A)
Absolute Pressure	Yes	Yes
Control Direction	Upstream and Downstream	Downstream Only
Integrated Flow Meter	No	Yes
MG(Multi Gas) Flow	N/A	Yes
MR(Multi Range) Flow	N/A	Yes

The design of the πPC PC99 incorporates an advanced flow sensor and an optimized bypass. The latest generation two-element sensing circuit provides accurate, repeatable flow measurement performance even in low flow ranges (as low as 10sccm full-scale range). A low temperature effect from ambient temperature change and a low attitude sensitivity effect are also ensured. Attitude sensitivity is completely accounted for with advanced attitude circuitry. The optimized sensor/bypass arrangement minimizes the flow splitting error when gases other than the calibration gas are used; dramatically improving measurement accuracy.

Digital Features

The DeviceNet interface ensures interoperability in any DeviceNet pressure control application. In addition, the true digital calibration and valve control electronics, coupled with default 11 point pressure calibration, provide for high pressure accuracy over a wide range of setpoints and fast response to even low 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 πPCs 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 or sapphire, which are pure, chemically stable, and not prone to out-gassing or particle generation. The πPCs mechanical design incorporates minimal wetted surface area assuring rapid dry-down. Its construction minimizes trapped volume enhancing product safety and eliminating troublesome virtual leaks. To further enhance its cleanliness, all internal surfaces are precision machined and electropolished to a 5Ra surface finish. 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 *Pressure Transducer 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 this 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 explains how to prepare your computer network to talk to a πPC using the Ethernet interface. It also explains how to use the web-base browser interface to setup, configure and run diagnostics on your πPC.

Chapter Four: Embedded Web-Based GUI and Diagnostics takes a detailed look at the Embedded Web-Based Graphical User Interface (GUI) and its features, specifically E-Diagnostics.

Chapter Five: Overview provides a brief description of the instrument and its functionality, describes how to use the instrument, explains all the functions and features and also provides instruction on tuning the device.

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

Chapter Seven: Troubleshooting provides a reference should the instrument appear to malfunction.

Appendix A: Product Specifications for the PC90 Model lists the specifications of the instrument.

Appendix B: Model Code Explanation for the PC90 Model describes the PC90 model code.

Appendix C: Product Specifications for the PC99 Model lists the specifications of the instrument.

Appendix D: Model Code Explanation for the PC99 Model describes the PC99 model code.

Appendix E: Valve Orifice Selection describes how to select the correct orifice for the πPC.

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 purged so it is free of harmful, corrosive, radioactive, or toxic materials.**

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. The device has trapped volume in the pressure sensor where gas lighter than air but still HAZARDOUS can accumulate.

Obtaining a 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.

Chapter Two: Installation and Configuration

Unpacking the πPC

MKS has carefully packaged 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, please refer to the *Customer Support* section of Chapter 1 on page 12 for instructions on obtaining a RMA (Return Material Authorization) number and details on the Health and Safety form that is required with every return.

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(s) to the appropriate personnel at your company.
6. For surface mount πPCs, remove the Ethernet kit and adapter cable (RS-485 and Analog only) from the inner container and DO NOT take into clean room.

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

Unpacking Checklist

Standard Equipment:

- πPC
- πPC Instruction Manual (this book)
- Ethernet Kit (Surface Mount πPCs only)
- Adapter cables for 9 pin RS-485 and 15 pin analog devices (Surface Mount πPCs only)

- Pressure calibration sheet (Type PC90 & PC99)
- Flow calibration sheet (Type PC99 only)

Optional Equipment:

- RS-485 Connector Accessory
- Interface cables

Product Location and Requirements

- Ventilation requirements include sufficient air circulation with 0.25" on each side of the device to allow convection cooling of internally generated valve heat.
- Ambient operating temperature range: 10° to 50° C (50° to 122° F)
- Power requirement:

    1. Analog & RS-485: +15.0 to +24.0 VDC @ 350mA max
    2. DeviceNet: +11.0 to +25.0 VDC [320 mA maximum current @ 11 VDC
       146 mA @ 24 VDC nominal]

- Storage temperature range: -20° to 80° C (-4° and 176° F)
- Mount the πPC in an upright position if possible for easy viewing of the display during configuration, although any mounting orientation is satisfactory during normal operation. The local display can be rotated 270° so that it can be easily read in any orientation.
- Install a separate positive shutoff valve if your system cannot tolerate any leakage through the πPC. The internal proportional control valve is not a positive shutoff valve so some leakage across the valve may 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 πPC 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 πPC can not vent excess mass to the atmosphere.
- Verify that your pressure system can withstand pressure equal to the full scale range of the transducer. Your pressure system may be exposed to the full scale pressure since the πPC controller will control over the entire full scale range of the transducer. As a precaution, you may choose to install a safety valve in your system to vent excess pressure.
- Take care not to expose the transducer to pressures above its full scale range. Pressures exceeding twice the full scale pressure may cause zero-drift or damage the transducer. Pressures exceeding the full scale range can cause loss of calibration and NIST traceability.
- For a PC99 *Only*, the control valve inside the PC99 is rated for a maximum gas inlet pressure of 150 psig. Ensure that the inlet pressure is consistent with the differential pressure limit of the pressure transducer.

Caution **Exposing the pressure transducer to pressures exceeding twice the full scale pressure for extended periods of time may cause zero drift or damage the pressure transducer. Sub-atmospheric sensors must not be exposed to pressures greater than one atmosphere.**

- Warm up time and zeroing:

    1. πPC and Pressure sensor warm up: After installation and power up, allow the πPC to warm up for a minimum of 30 minutes while under vacuum. This will require opening the device's process control valve. Refer to the *Opening & Closing the πPC's Process Control Valve* section of Chapter 6 on page 82 for instructions on opening the valve.
    2. Zeroing: After the warm up is complete, the πPC needs to be zeroed. Refer to the *Zero Adjustment* section of Chapter 6 on page 79 for more on the zeroing procedure.

- Use high purity gas filters in line upstream of the device to prevent contamination of precision flow orifices and proper bypass operation (for PC99).
- For additional information on the PC90 refer to Appendix A, *Product Specifications for the PC90 Model*, on page 91.
- For additional information on the PC99 refer to Appendix C, *Product Specifications for the PC99 Model*, on page 99.

Dimensions

Refer to the applicable drawings, which follow.

Note Height dimensions are given for a πPC with a Normally Closed (N.C.) valve and a πPC with a Normally Open (N.O.) valve. To determine if the πPC has a Normally Open valve view the back side of the device. Directly above the pinout information you will see the text "NORMALLY OPEN VALVE".

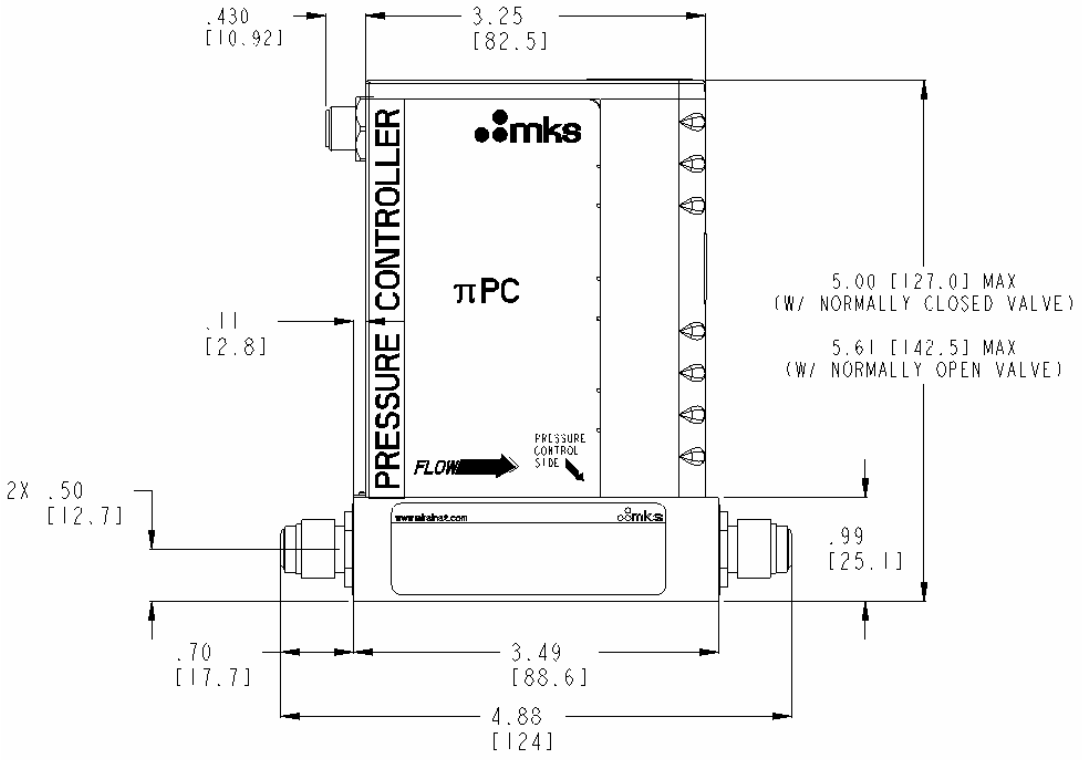


Figure 1: 4-VCR Front View – DeviceNet

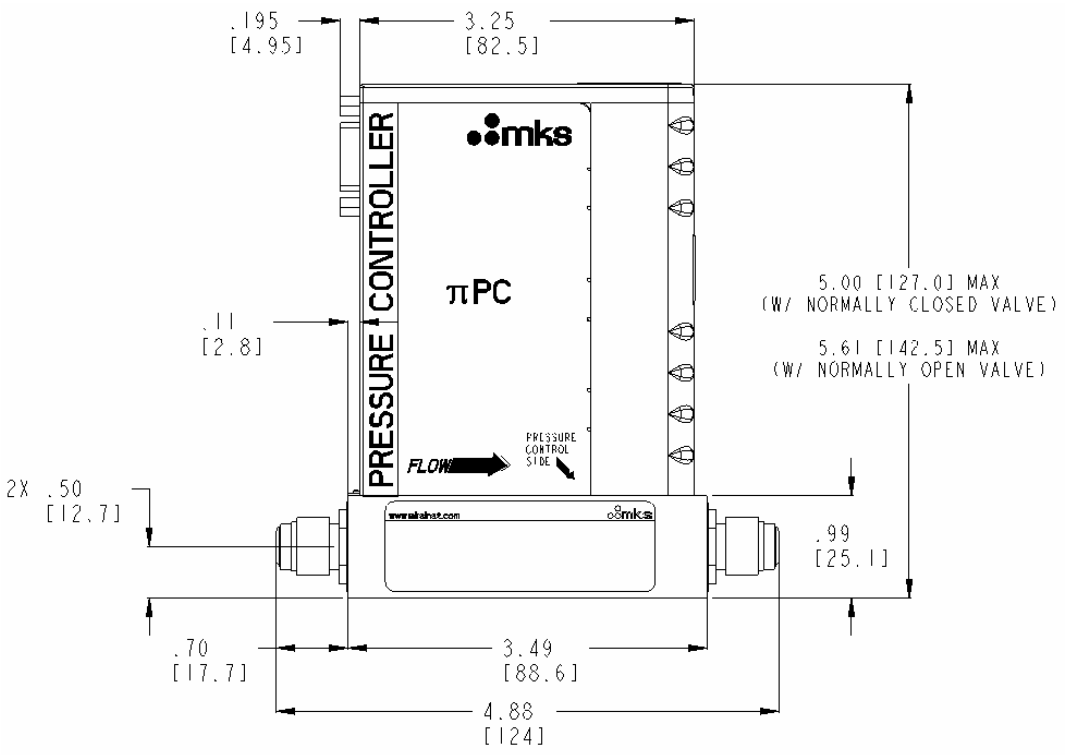


Figure 2: 4-VCR Front View – 9-Pin D RS-485

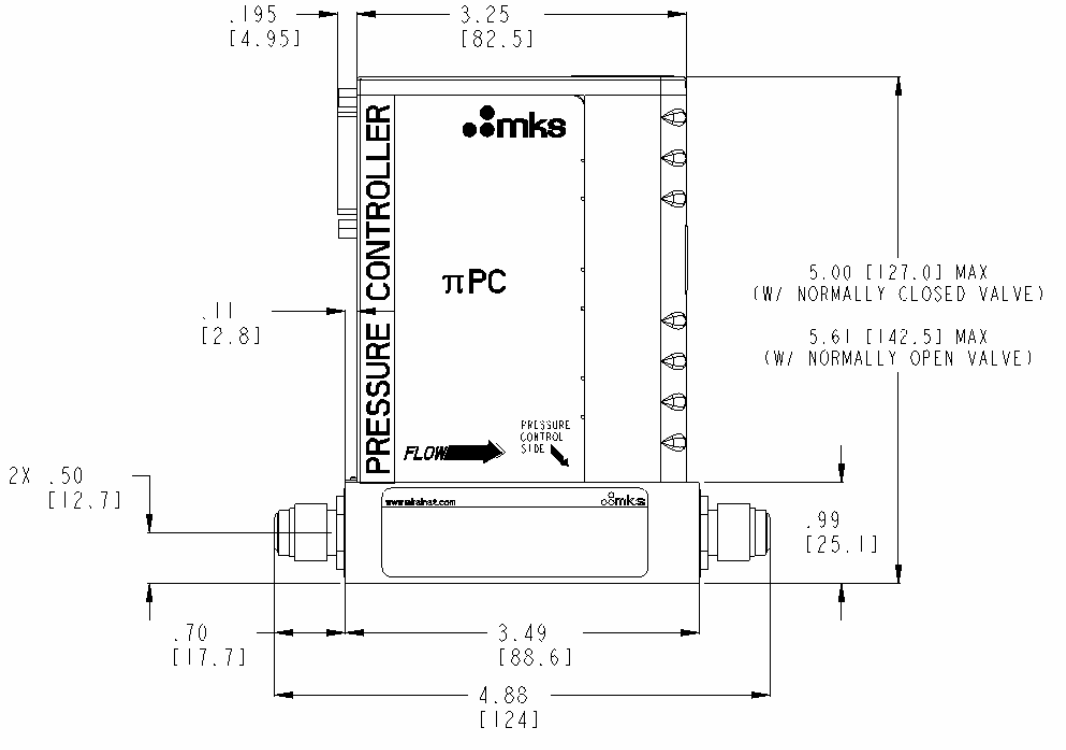


Figure 3: 4-VCR Front View – 15-Pin D Analog

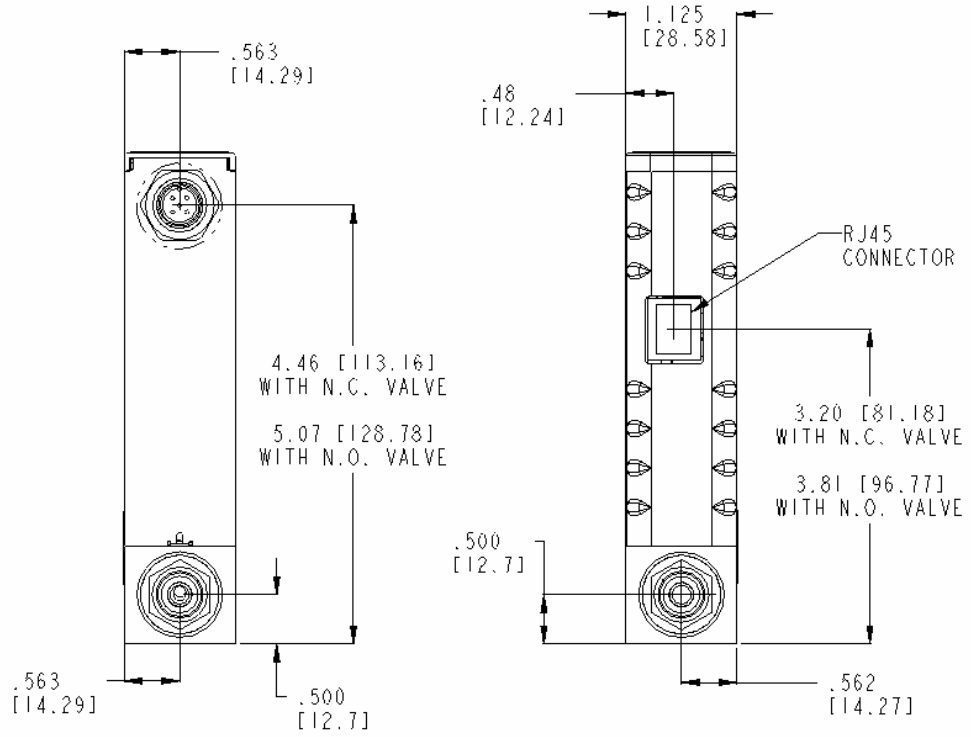


Figure 4: 4-VCR Left and Right Side Views – DeviceNet

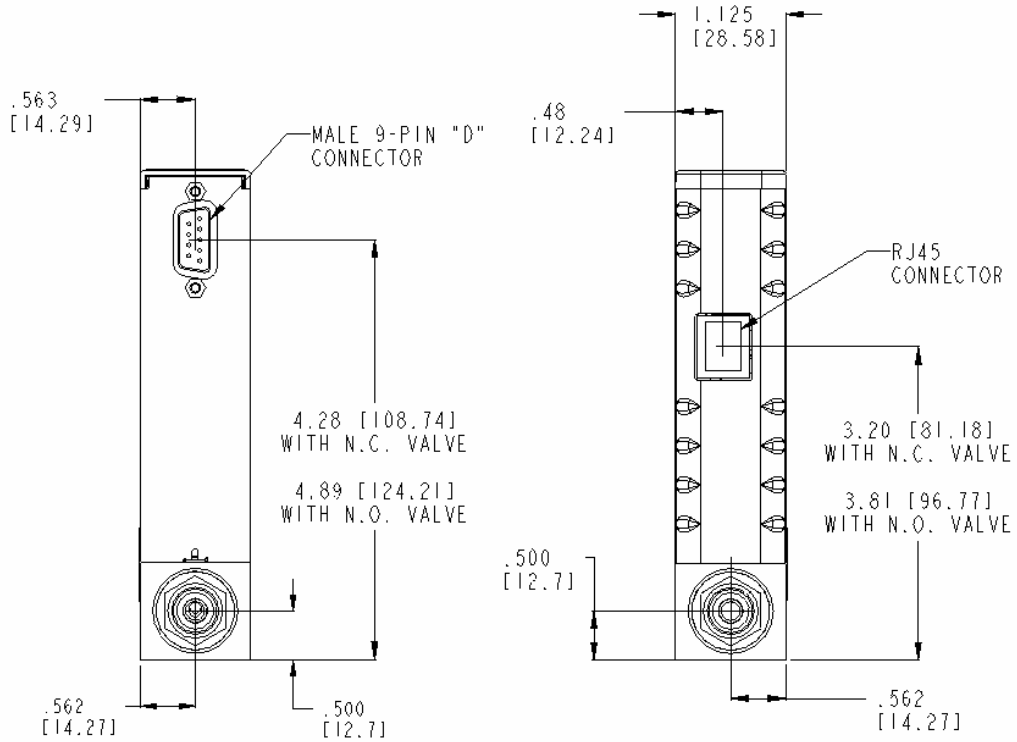


Figure 5: 4-VCR Left and Right Side Views – 9-Pin D RS-485

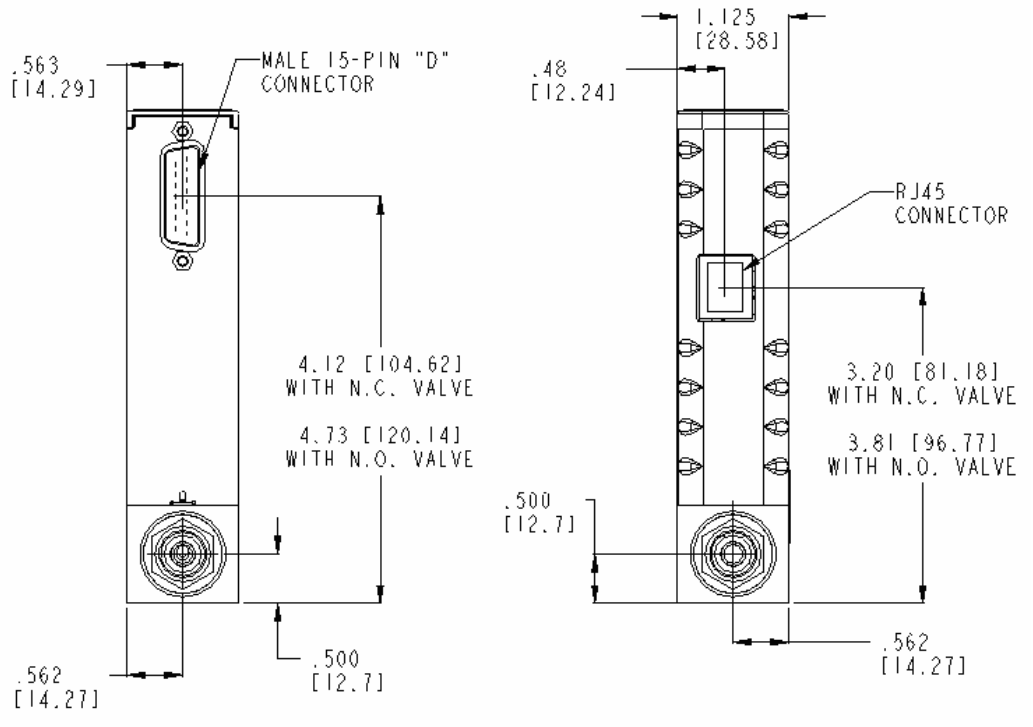


Figure 6: 4-VCR Left and Right Side Views – 15-Pin D Analog

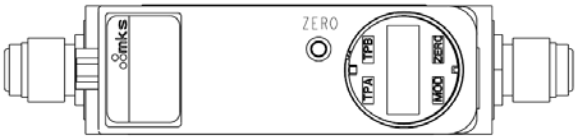


Figure 7: 4-VCR Top View (15-Pin D Analog Shown)

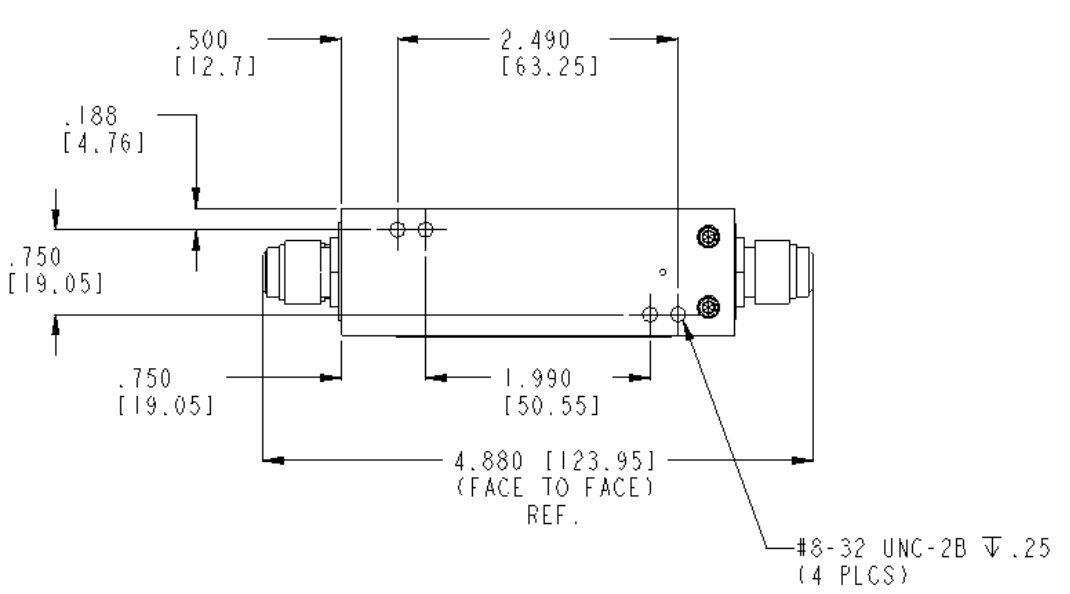


Figure 8: 4-VCR Bottom View

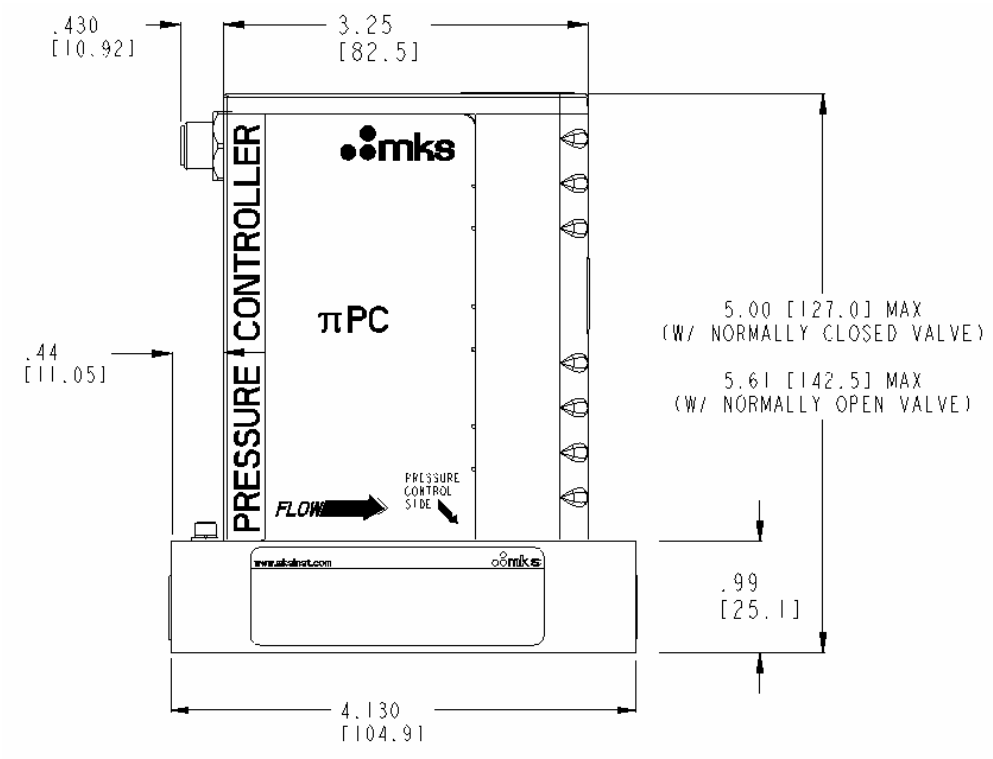


Figure 9: C or W Seal Front View – DeviceNet

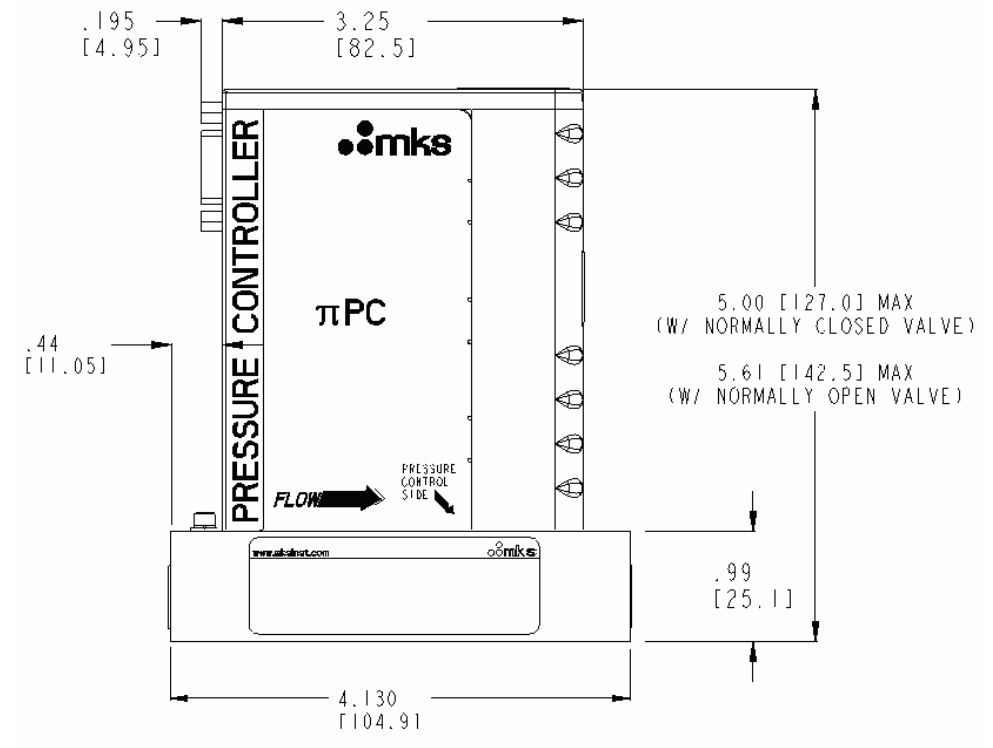


Figure 10: C or W Seal Front View – 9-Pin D RS-485

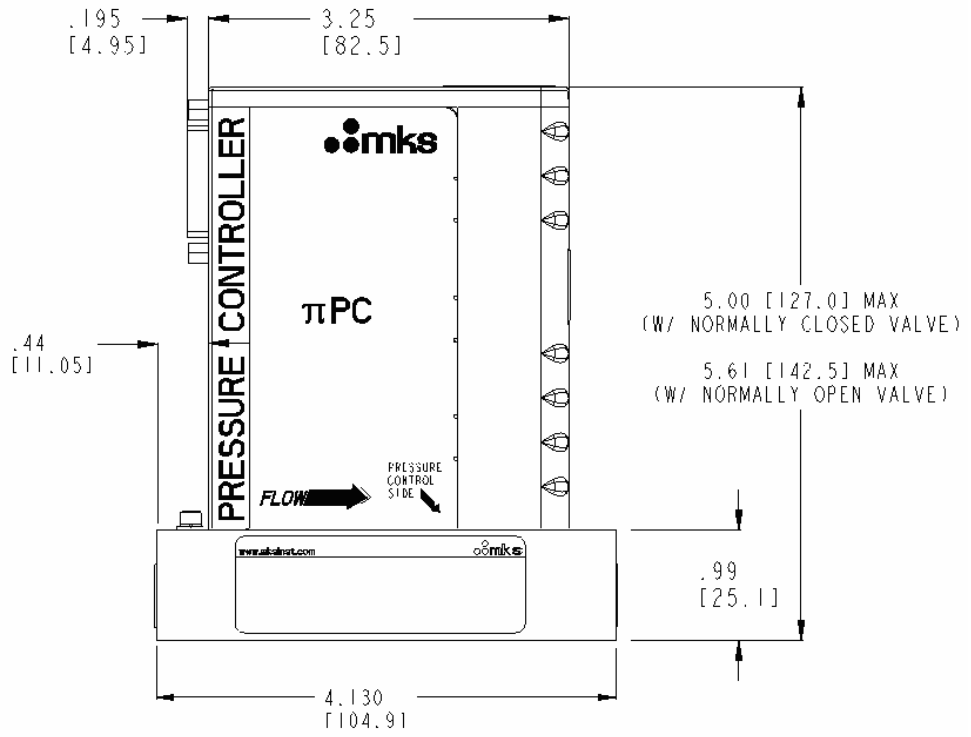


Figure 11: C or W Seal Front View – 15-Pin D Analog

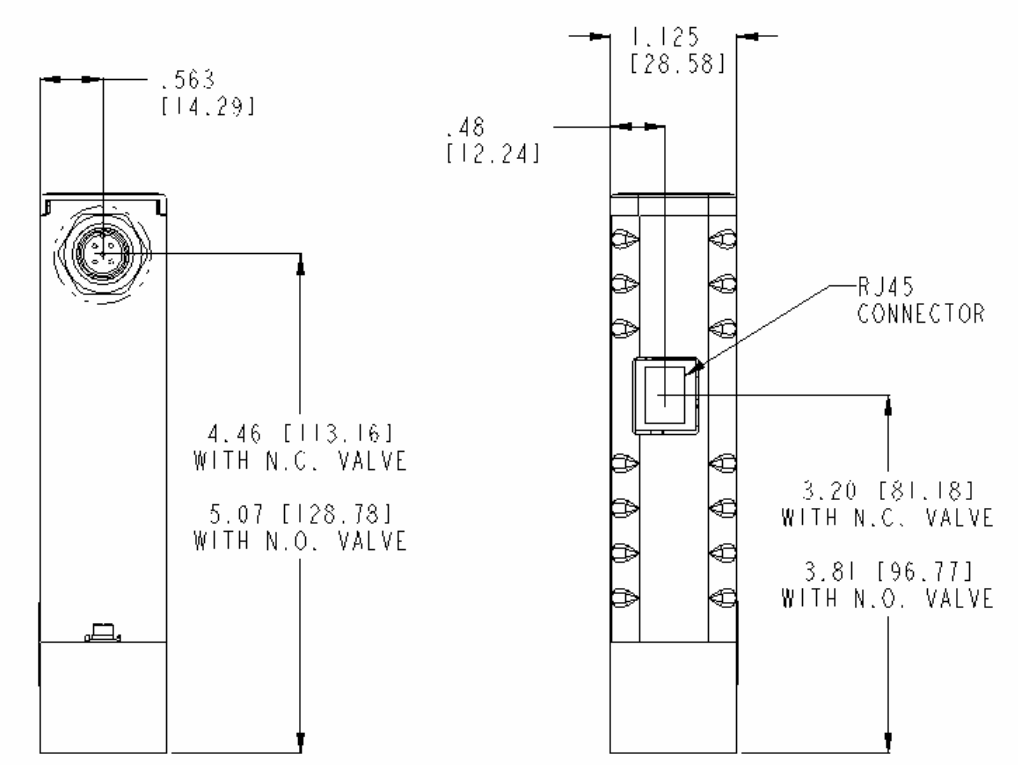


Figure 12: C or W Seal Left and Right Views – DeviceNet

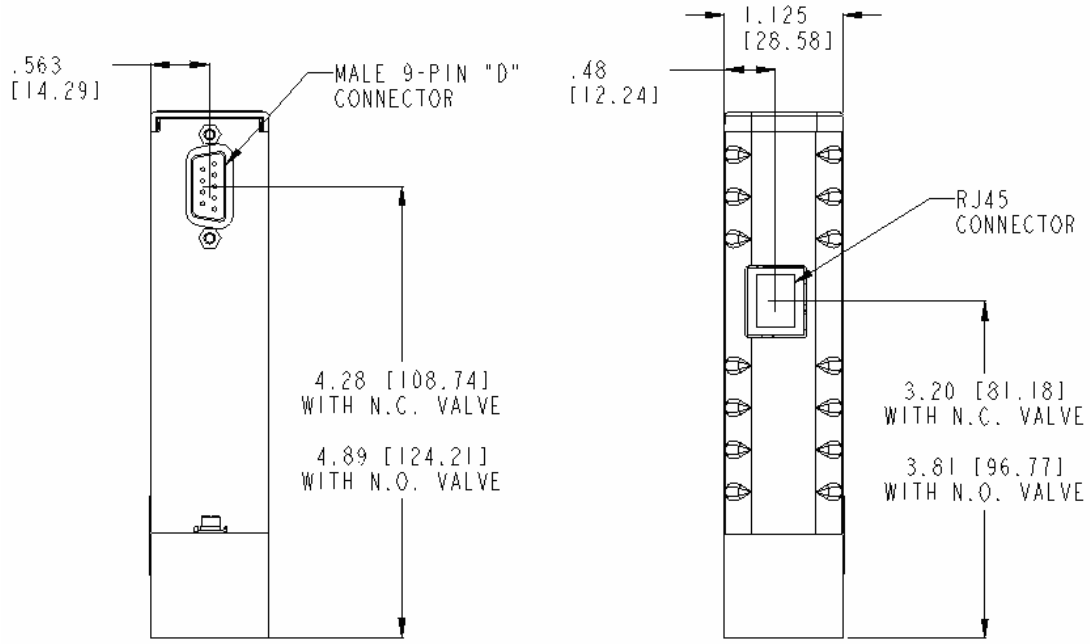


Figure 13: C or W Seal Left and Right Side Views – 9-Pin D RS-485

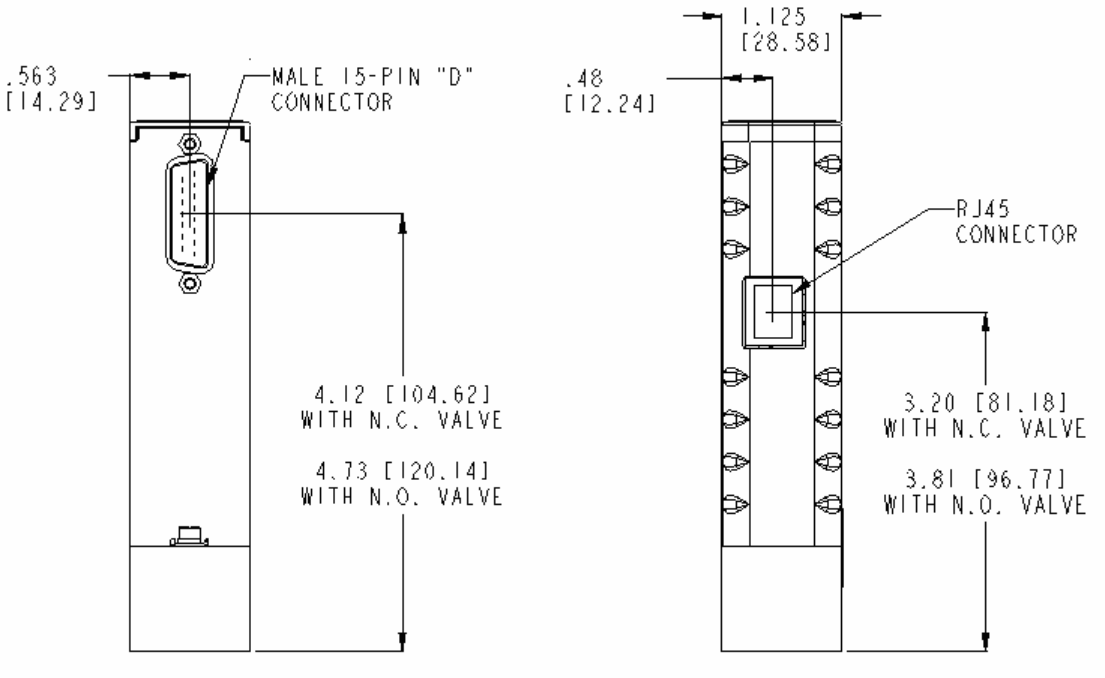


Figure 14: C or W Seal Left and Right Side Views – 15-Pin D Analog

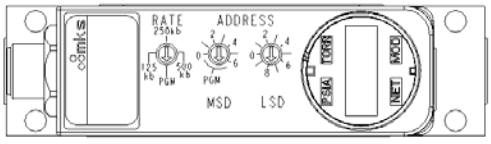


Figure 15: C and W Seal Top View (DeviceNet Shown)

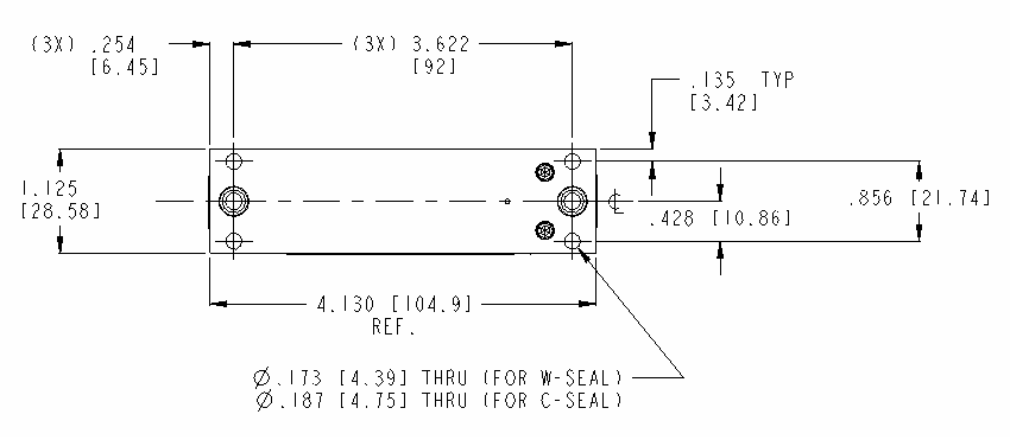


Figure 16: C and W Seal Bottom View

Device Information (*Labels, Display, Communication, Mounting, Leak Integrity*)

Labels

Each πPC has three labels, two of which are located on the device itself and one that's located on the packaging. Figure 17, below, shows all three of these labels. The three on the left are for a PC99 and the three on the right are for a PC90. Going from top to bottom: the first label is located on the top of each πPC and displays the model number and pressure range. The second label is located on the side of the flowbody and displays device specific information, i.e. serial number, model number, pressure range, gas type (PC99 only), the flow full scale range (PC99 only). This label also contains the CE Mark, which indicates compliance with European directives. The third and final label is located on the outer packaging of a πPC and it contains the model number, serial number and the date code.

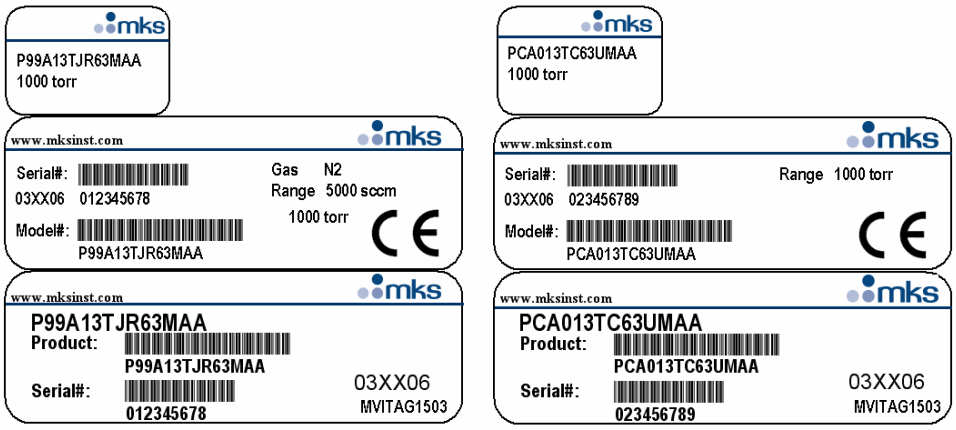


Figure 17: Labels for the πPC (PC99 and PC90)

Caution **For PC99's, the gas and range are only for the factory shipped configuration. It may not reflect the configuration of the device during troubleshooting. Always verify current gas full scale and type.**

The Local Display

Each πPC has a fully integrated local display on the top panel of the device, which includes a four-character dot matrix LED readout and four LED indicator lights that are used for various purposes. Its features, which are described in detail below, include the scrolling display, the ability to be rotated 270° from its default position and the ability to be toggled to display various readouts.

Scrolling Display

After applying power to the πPC, the local display will begin scrolling important information about the device. For all πPCs it is important to note the pressure full scale range and the IP Address. For the πPC PC99 model, you should also take note of the gas type and the flow full scale range.

Note The πPC's scrolling display differs in the information it shows depending on whether or not the device is a PC90 or a PC99. In this order, the PC90 scrolls the Model Type (PC90), pressure full scale, and the IP address. In this order, the PC99 scrolls the Model Type (PC99), pressure full scale, flow full scale, gas type, IP address, and the instance number (1 to 31).

Rotating Feature

The local display was designed so that it could be easily read in any mounting orientation by rotating it to one of four possible positions. The default position is set for a vertical inlet up mounting position. To change the position the display should be rotated in the clockwise direction.

Push-Button Feature

The local display was designed with a push-button feature that enables the user to toggle between various readouts. After being powered for about two minutes, the user is able to toggle the display from the scrolling display to the system pressure in PSI or Torr (depending on the pressure full scale range ordered), the system pressure in KPA, the gas flow rate (PC99 only) and the πPC's temperature in degrees Celsius (see Figure 18 below). Toggling the display once more will bring you back to the scrolling display.

Figure 18: Push Button Display Readouts

LED Indicator Lights

Surrounding the four-character dot matrix LED readout, there are four LED indicator lights; (2) above and (2) below. These lights serve different purposes depending on the electrical configuration ordered. Each of the configurations is described in detail below.

Analog πPC LED Indicator Lights

From top to bottom, left to right, the LEDs are labeled TPA, TPB, MOD and ZERO for an Analog πPC. TPA and TPB are the trip point LEDs. TPA will illuminate solid red when Trip Point A has been activated and TPB will illuminate solid red when Trip Point B has been activated. For more on the trip points, please see *The Trip Points* section of Chapter 5 on page 74. MOD is the module LED. For Analog πPCs it's used as a general status LED. If no problems are found it will be solid green. ZERO is the Zeroing status LED. This LED illuminates solid red when the zero push-button on the top panel of the πPC has been pressed. This LED will stay lit until the pressure zero function has been completed.

DeviceNet πPC LED Indicator Lights

From top to bottom, left to right, the LEDs are labeled PSI or TORR, KPA, NET and MOD for a DeviceNet πPC. PSI / TORR and KPA illuminate solid red if the push button display has been toggled once or twice, respectively. NET is the network status LED and it indicates the status of the communications link. If no problems are detected, the network status LED illuminates solid green. A red, dark, or flashing green network status LED indicates a fault condition on the network. Table 5 summarizes the four possible states of this LED. MOD is the module status LED. The LED will illuminate solid green once the device has been successfully powered.

Table 5: DeviceNet Network Status LED Indicators

LED Status	Meaning
Solid Green	Communications link is OK. The device is online and connections are established.
Flashing Green	The device is online but no connections are established. The device has passed the Dup_MAC_ID test and is online, but has no established connections to other nodes.
Solid Red	Critical link failure. The device has detected an error that prevents network communication (Duplicate MAC_ID or bus-off.).
Dark	Not powered / Not online. The device has not completed the Dup_MAC_ID test, or the device is not powered; check the module status LED.

RS-485 πPC LED Indicator Lights

From top to bottom, left to right, the LEDs are labeled PSI or TORR, KPA, NET and MOD for a RS-485 πPC. PSI / TORR and KPA illuminate solid red if the push button display has been toggled once or twice, respectively. NET is the network status LED and it indicates the device's status on the network. The LED will illuminate solid green if there are no problems. MOD indicates the status of the communications link. If no problems are detected the Module Status LED will flash red as it receives commands and processes them. A solid red Module Status LED indicates a fault condition. Table 6 below indicates the three possible states of this LED.

Table 6: RS-485 Module Status LED Indicators

LED Status	Meaning
Flashing Red	The device is online and functioning properly. The Module Status LED flashes red when receiving commands from Host.
Solid Red	Critical link failure. The device has detected an error that prevents network communication (Duplicate MAC_ID or bus-off.)
Dark	Not powered / Not online. The device is offline or the device is not powered; check the network status LED.

Digital Communication

Baud Rate and MAC ID Switches for Digital πPCs

For DeviceNet: The baud rate and MAC ID (node address) for your device can be set through software commands using standard DeviceNet protocol over the network or manually using the rotary switches located on the top panel of the device. The baud rate and MAC ID switches allow you to easily configure units without an operational network, or to network multiple units quickly.

The baud rate and MAC ID rotary switches support an assigned *network* position, labeled on the device as "PGM" to indicate software operation.

If the rotary switch is in the network PGM position at power-up, the baud rate or address is read from the non-volatile memory. Any changes to the values must be made over the network; any changes in the rotary switch positions after power-up are ignored.

If the rotary switch is *not* in the network PGM position at power-up, the baud rate or address is read directly from the switches.

Note The DeviceNet General Error Codes are listed in the ODVA DeviceNet Specification, Volume 1 [1].

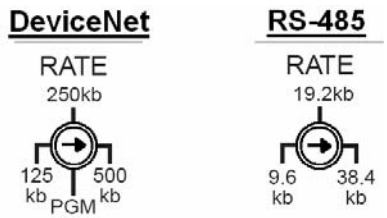
For RS-485: Unlike the DeviceNet πPC, the baud rate and MAC ID (node address) switches are the *only* way to configure an RS-485 πPC.

Baud Rate Switch

For DeviceNet*:* The 4-position rotary switch is used to select the DeviceNet baud rate. The choices are: PGM (the baud rate is read from the non-volatile memory), 125, 250, and 500 Kb. *Factory default is 500 Kb.*

For RS-485: The 3-position rotary switch is used to select the RS-485 baud rate. The choices are: 9.6, 19.2, and 38.4 Kb. *Factory default is 38.4 Kb.*

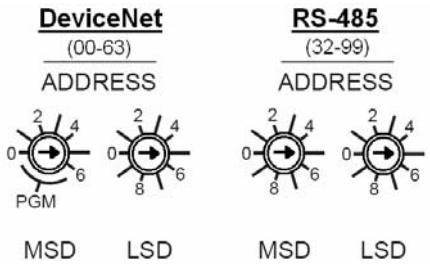
The switch positions are numbered in a clockwise direction, to correspond to the increasing address values.



MAC ID (Node Address) Switches

Two 10-position rotary switches, shown below, are used to set the MAC ID (node address).

The MAC ID is an integer identification value assigned to each node on the DeviceNet or RS-485 network.



For DeviceNet*:* The valid MAC ID switch positions are 0 to 63. *Factory Default is 55.* Use the switch on the left to set the Most Significant Digit (MSD), that is, the factor of ten (10, 20, 30...60). Use the switch on the right to set the Least Significant Digit (LSD), that is, the increments of one (1, 2, 3...9). The switch positions are numbered in a clockwise direction, to correspond to the increasing address values.

Note Setting the MAC ID address to a value greater than 69 will disable the rotary switches and allow the internal software setting of the MAC ID. The software setting defaults to the last hardware setting stored in non-volatile memory. MAC ID addresses 64 to 69 are unused and, if selected will default to 63. The rotary switches are only read during power up.

Note The MAC ID switch on the top of the device must be set to the network PGM position before power up in order for changes to be made over the network. Any changes in the rotary switch positions after power up are ignored.

For RS-485*:* The valid MAC ID switch positions are 32 to 99. *Factory Default is 55.* Use the switch on the left to set the Most Significant Digit (MSD), that is, the factor of ten (10, 20, 30...60). Use the switch on the right to set the Least Significant Digit (LSD), that is, the increments of one (1, 2, 3...9). The switch positions are numbered in a clockwise direction, to correspond to the increasing address values.

Mounting Hardware

πPCs with in-line fittings (VCR) have four #8-32 threaded mounting holes located on the bottom or base of the unit. Use #8-32 UNC-2B hardware to mount the instrument. Minimum hardware length should be the thickness of the mounting plate plus 0.125" and the maximum should be the thickness of the mounting plate plus 0.25". For example, a 0.060" thick plate would require a hardware length of 0.185"–0.310". The figures beginning on page 15 show the location and dimensions of the mounting holes for standard axial fittings.

The C-Seal and W-Seal downmount fittings are designed for device mounting using four M5-0.8 x 30 mm long socket head cap screws. In addition, C-Seal units may be mounted using 10-32 UNF x 1.25" long socket head cap screws if your mounting substrate requires.

Leak Integrity

The control valve is *not* a positive shutoff valve. Some leakage across the valve may occur. Refer to Appendix A, *Product Specifications for the PC90 Model,* on page 91 or Appendix C, *Product Specifications for the PC99 Model,* on page 99 for the leak integrity specifications. If necessary, install a separate positive shutoff valve in your system.

Installation and Startup Procedure

Install the πPC

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

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

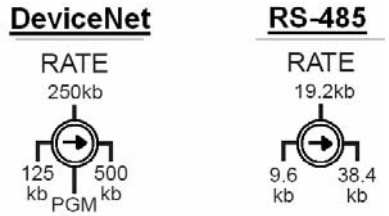
1. The πPC is prepared for cleanroom installation.
   Follow standard cleanroom practices to ensure a clean installation:
2. Remove all cardboard and packaging materials. Discard before entering the garmenting room.
3. Remove the outer plastic shipping container in an ante room (garmenting room) or transfer box. Do not allow this container to enter the clean room.
4. Carry the πPC into the clean room then remove the inner bag and any protective fitting covers just prior to installation. If the device is a surface mount, then remove the plastic ethernet kit from inner plastic and adapter cable (RS-485 and Analog only). DO NOT take the ethernet kit or the adapter cable into the clean room.
5. Inspect for any damage.
6. Pass the original calibration sheet(s) to the appropriate personnel at your company.
7. Prepare the system according to your facility's gas handling procedures, including purging of the gas lines with appropriate purge gas, and notification to equipment personnel and haz/mat 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.

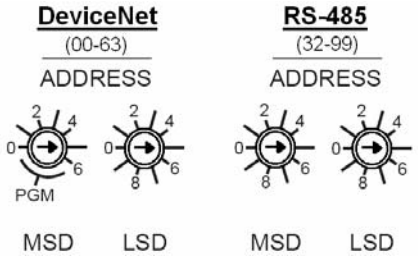
8. Prepare the connections fittings:
   - Flow clean, dry purge gas across the fittings to minimize particle contamination during installation. Use only purge gases that are approved for your process.
   - Install the πPC and secure according to the fitting manufacturer's instructions. DO NOT overtighten connections.
9. Before powering the device, for DeviceNet and RS-485 πPCs, remember to set the Baud Rate and MAC ID (node address) switches located on top of the device to acceptable values. **All settings are read on power up, so they must be set prior to applying power to the device.**

BAUD RATE



- For DeviceNet → set the baud rate switch for communications: PGM (the baud rate is read from the non-volatile memory), 125, 250, or 500 Kb. *Factory default is 500 Kb.*
- For RS-485 → set the baud rate switch for communications: 9.6, 19.2, or 38.4 Kb. *Factory default is 38.4 Kb.*

MAC ID (node address)



- For DeviceNet → The valid MAC ID switch positions are 0 to 63. Use the switch on the left to set the Most Significant Digit (MSD), that is, the factor of ten (10, 20, 30...60). Use the switch on the right to set the Least Significant Digit (LSD), that is, the increments of one (1, 2, 3...9). Setting the MAC ID address to a value greater than 69 will disable the rotary switches and allow the internal software setting of the MAC ID. The software setting defaults to the last hardware setting stored in non-volatile memory. MAC ID addresses 64 to 69 are unused and, if selected will default to 63. The rotary switches are only read during power up. *Factory default is 55.*
- For RS-485 → The valid MAC ID switch positions are 32 to 99. Use the switch on the left to set the Most Significant Digit (MSD), that is, the factor of ten (10, 20, 30...60). Use the switch on the right to set the Least Significant Digit (LSD), that is, the increments of one (1, 2, 3...9). *Factory default is 55.*

10. Before connecting to the πPC, verify the power and signal pinouts for the cable leading to the πPC:
    - For DeviceNet, confirm connections to:
      1 = Drain, 2 = V+, 3 = V-, 4 = Can_H, 5 = Can_L
    - For Analog, 15-Pin D Male, see pinout information on page 68 for a PC90, page 69 for PC99.
    - For RS-485, 9-Pin D Male, see pinout information on page 70.

Note All analog "signal common" pins including the RS-485 analog signal common must be electronically connected with the power common pin at the tool controller end of the cable.

Note For Analog units, make sure that you are using an MKS or MKS-compatible power supply/readout unit along with the proper power supply/readout cable. See the *Interface Cables for Analog I/O* section of Chapter 5 on page 71 for details on cables and MKS power supply/readout units.

Note When using Ethernet interface for setup, a crossover cable (similar to null modem) is required when the πPC is connected directly to a computer. When the πPC is on a network with a hub interface, a standard Ethernet cable should be used.

11. Power up the πPC, then record the IP address and the pressure full scale from the scrolling display. For a PC99, you should also take note of the gas type and maximum flow rate (full scale flow range).

Note The πPC's scrolling display differs in the information it shows depending on whether or not the device is a PC90 or a PC99. In this order, the PC90 scrolls the Model Type (PC90), pressure full scale, and the IP address. In this order, the PC99 scrolls the Model Type (PC99), pressure full scale, flow full scale, gas type, IP address, and the instance number (1 to 31).

12. Perform appropriate helium leak checking of your gas lines and πPC connections to verify the integrity of the gas seals. You will need to open all pneumatic and mass flow control valves in addition to the πPC valve.

    Opening the πPC valve can be done by one of the following:

    - For DeviceNet πPC's: You can open the valve by using the following explicit command:
      ***Service** 0x10, **Class** 0x32, **Instance** 1, **Attribute** 0x05, **Service Data** 0x02*

      You can set the valve back to normal operation by using the following explicit command:
      ***Service** 0x10, **Class** 0x32, **Instance** 1, **Attribute** 0x05, **Service Data** 0x00*

    - For RS-485 πPC's: You can open the valve by using the "Set Actuator Mode" message.
      To open the valve, send the following message from the Host to the πPC:
      ***MAC ID (**πPC MAC ID**), **STX** 0x02, **Command Code** 0x81, **Packet Length** 0x04, **Class ID** 0xAA, **Instance ID** 0x01, **Attribute ID** 0x02, **Actuator Mode** 0x02, **Pad** 0x00, **Checksum** 0x36*

      To set the valve back to normal operation by sending the following message from the Host to the πPC:
      ***MAC ID (**πPC MAC ID**), **STX** 0x02, **Command Code** 0x81, **Packet Length** 0x04, **Class ID** 0xAA, **Instance ID** 0x01, **Attribute ID** 0x02, **Actuator Mode** 0x00, **Pad** 0x00, **Checksum** 0x34*

    - For Analog πPC's: You can open the valve by pulling the Valve Open pin (Pin 4) low.

13. After the device has been successfully powered and the helium leak test of your gas lines has been completed then you need to zero the πPC before operation.

Warm Up and Zero the πPC

Although MKS 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.

A pressure controller will provide a zero output signal while under vacuum. For the PC99, the mass flow meter will provide a zero output signal under no flow gas conditions.

Zero offset from improper zeroing procedures can contribute to pressure and flow measurement inaccuracy. This is more apparent at the lower end of the device range in both cases.

To complete the warm up and zeroing of your πPC follow the steps listed in the *Zero Adjustment* section of Chapter 6 on page 79.

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Chapter Three: Ethernet Interface Setup and Configuration

The Ethernet interface is a supplemental feature that can be used for setup, configuration, and running diagnostics. It is not used to control the πPC. To access the diagnostic features of the πPC via the Ethernet port, follow Steps 1 and 2.

Step 1: Install the Java™ Plugin (for single IP address)

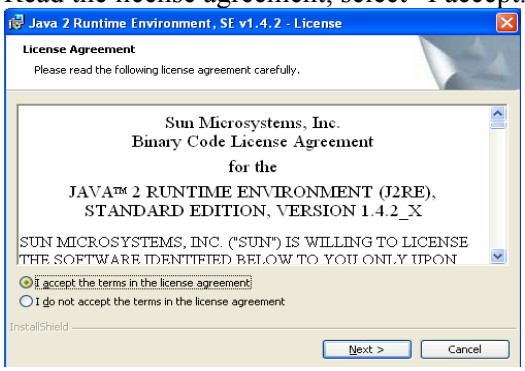
The πPC interface software uses a web-based Internet Explorer interface that requires a Java Technology plug-in to display real-time data plots.

If you are installing the πPC 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 36 and skip the steps below. The "Multiple IP Address Setup" procedure enables you to access the web for download at completion.

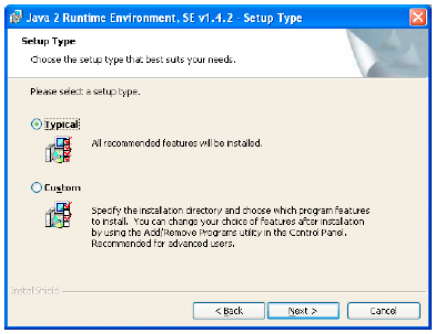
OTHERWISE perform the following steps:

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.xm
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:

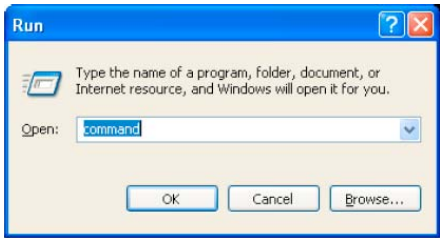
- Option 1 *(See Below)*
  - ❑ The Java applet discussed in Step 1 on page *31* has already been installed on your computer.
  - ❑ You have no need to connect to the Internet and the device GUI at the same time.
  - ❑ You only have one IP address, i.e. 10.X.X.X, to connect with.
  - ❑ If your computer has more than one network card, this option may not work. Use option 2.
- Option 2 *(See page 34)*
  - ❑ The Java applet discussed in Step 1 on page *31* has already been installed on your computer.
  - ❑ You have no need to connect to the Internet and the device GUI at the same time.
  - ❑ 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 36)*
  - ❑ The Java applet discussed in Step 1 on page *31* has or has not been 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 πPC. Once connected a series of web-browser type windows allow you to easily monitor and configure the πPC.

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

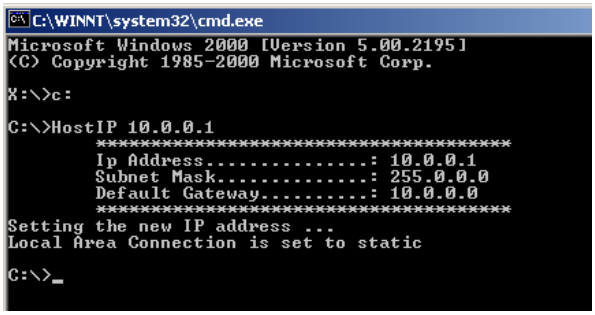
4. From your computer's "Start" menu, select “Run...” then enter the word “command” and click OK.



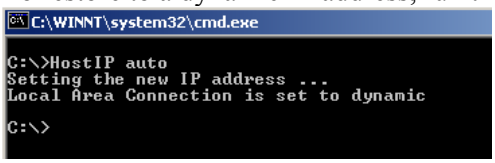
5. At the command prompt, if you find that you are not in the C-drive, then enter the command “C:”. If you find yourself in a sub-directory of your C-drive, then enter the command “CD \”. This will bring you to the C:\> prompt.

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 πPC’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 254.



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 πPC 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 41.

Option 2: Manual Setup

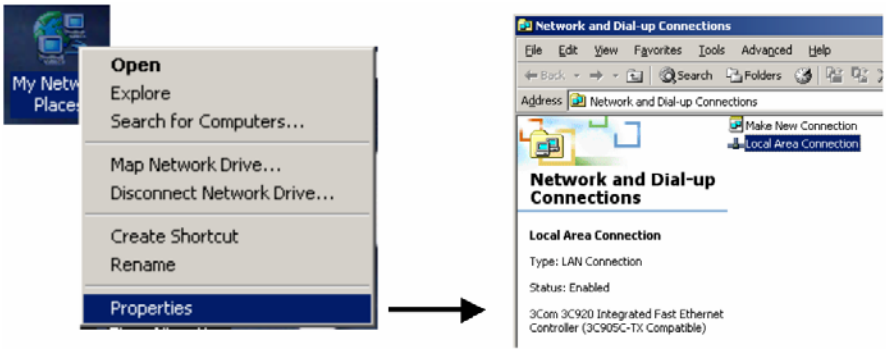
If you have not setup automatic network script in Option 1, a manual setup is required to access the πPC Ethernet interface.

1. Connect a crossover network cable to the πPC and your laptop computer.
   A crossover cable is required when the πPC is connected directly to a computer. When the πPC 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**.

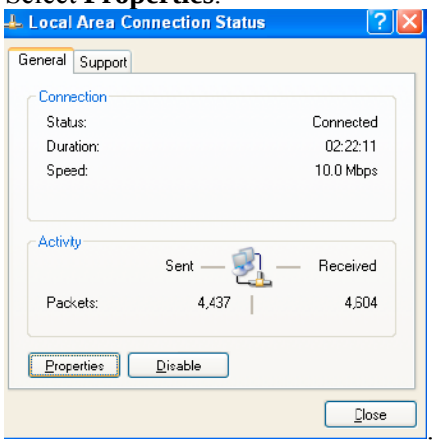


   In the "Network and Dial-Up Connections" window, Double-click on "Local Area Connection". Not all Local Area Connections have the same name, yours may have a different name.

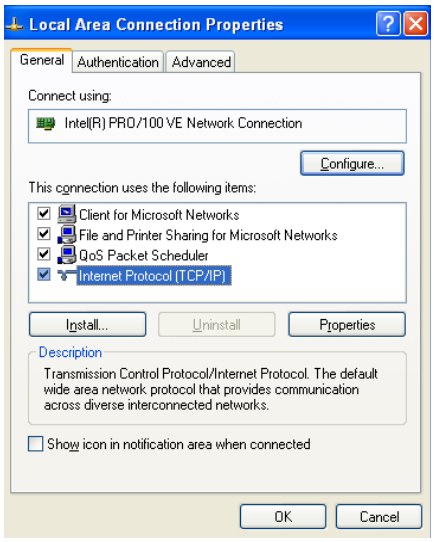
   Option 2:

   From your computer's "Start" menu, select "Settings" →Network and Dialup Connections → Local Area Connections

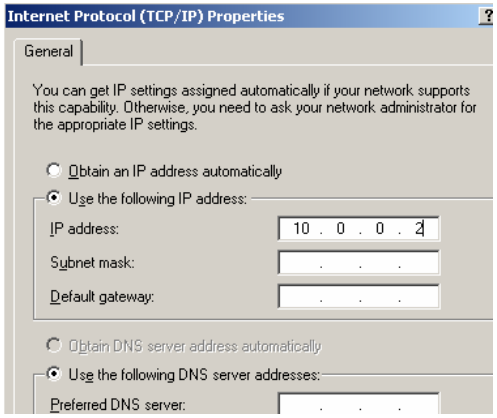
3. Select **Properties**.



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 254 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 appears, verify that you're on the "IP Settings" tab and then click "Add" in the "IP Addresses" section. If you have a πMFC 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 254 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.

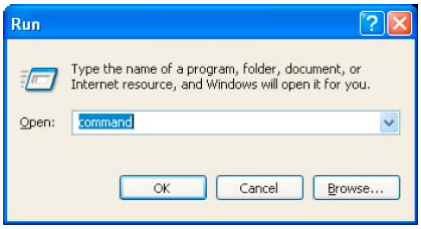
7. Close out all dialog boxes by selecting **O.K**., **Close**, etc. as required.

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 πPC 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 41.

Option 3: For Multiple IP address setup

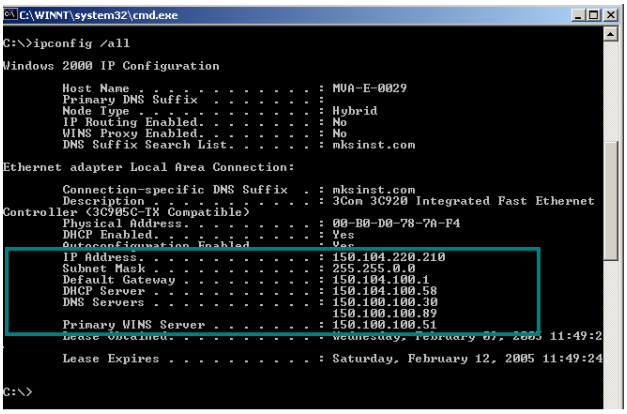
1. From your computer's "Start" menu, select “Run...” then enter the word “command” and click OK.



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.

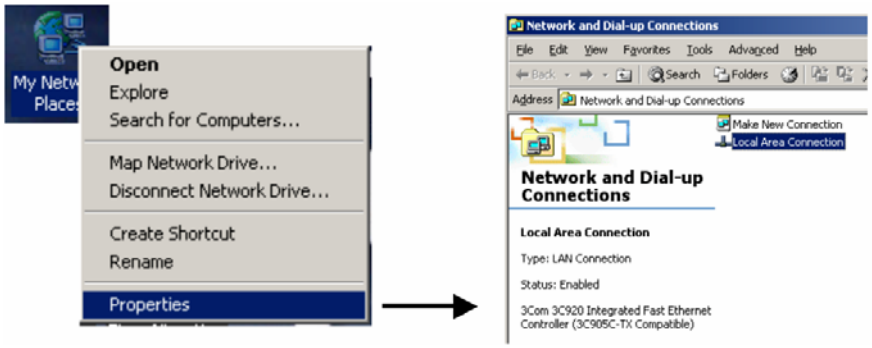


The data inside the hilighted area (lower section, between IP Address and Primary WINS Server) are what is needed for the steps below.

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**.



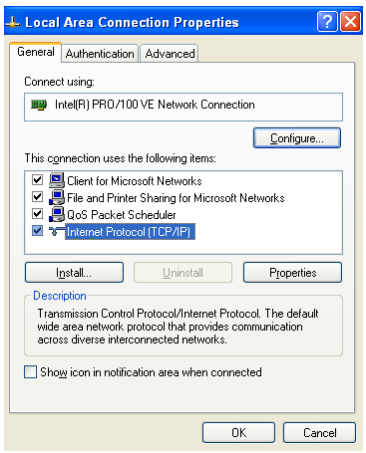
   In the "Network and Dial-Up Connections" window, Double-click on "Local Area Connection". Not all Local Area Connections have the same name, yours may have a different name.

   Option 2:

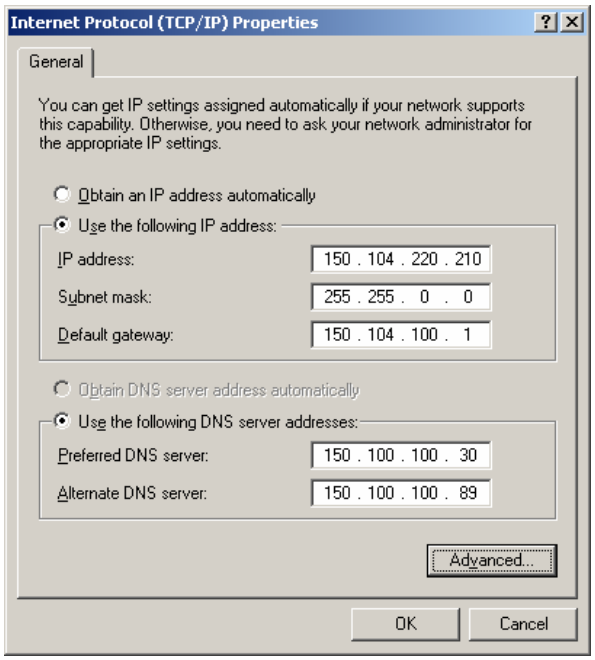
   From your computer's "Start" menu, select "Settings" →Network and Dialup Connections → Local Area Connections

6. Select **Properties**.

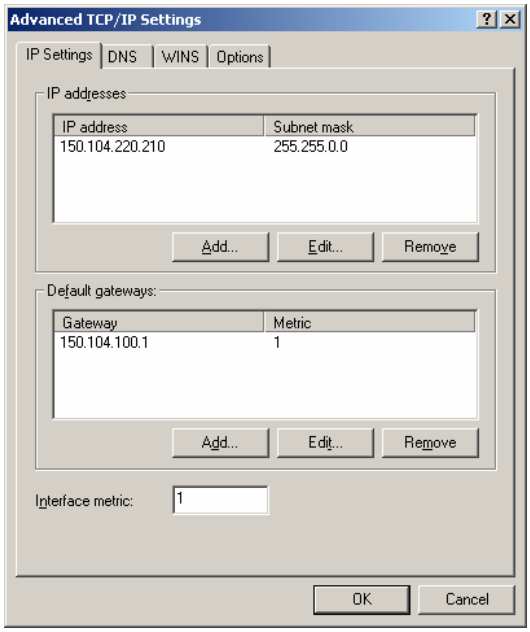
7. Select **Internet Protocol (TCP/IP)**, then select **Properties**.



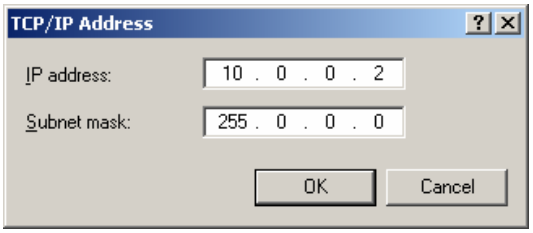
8. Select **Use the following IP address**. Now do the following to configure your computer so that it can still connect to the Internet:
   - Type in the "IP address", the "Subnet mask" and the "Default gateway" fields with values returned from the “ipconfig /all” query in the DOS command window.
   - 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:



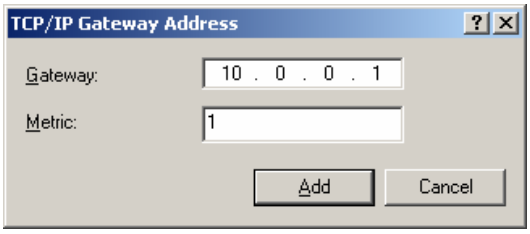
9. Click the “Advanced…” button at the bottom of the window. The following window will be displayed:



10. Verify you're on the "IP Settings" tab and then do the following to configure your computer to talk to the πPC 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 254 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".

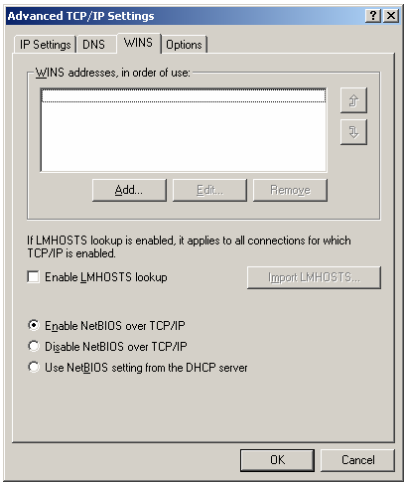


11. Now click "Add…" in the "Default gateways" group. Enter the Gateway value you will use to connect to the πPC. Typically a gateway value will be the IP address with a (1) on the end. The Metric value should always be (1). Then click "Add".

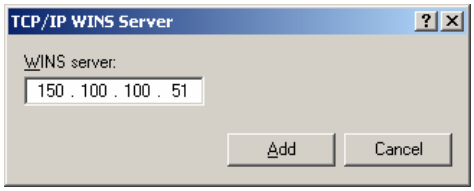


12. In the case that you need to be able to connect to more than one IP Address, i.e. not all devices on your network use a 10.X.X.X address, more addresses can be added by repeating steps 10 and 11 above. If you have a πMFC or any of the other MKS "π" Series products, you may also need to add the IP Address 192.168.2.X, where "X" is a number from 0 to 254 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.

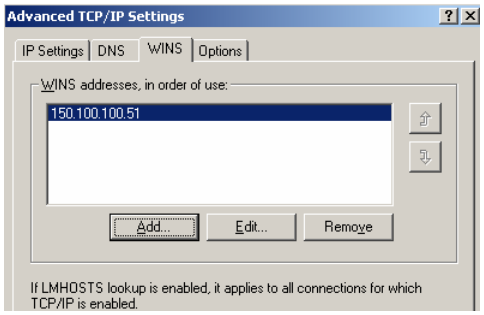
13. Click the “WINS” tab.



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, enter them now. 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 πPC 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 πPC you wish to connect to, then click "Go". Internet Explorer will open and display the Device Page in Monitor Mode, 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 πPC, a java plugin has to be installed on your computer.

With the multiple IP addresses setup, if the plugin 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 πPC and clicks on the "Plot" page. If, for some reason, this does not work please follow the Step 1 instructions (see page 31).

For more information on the web-based program, go to Chapter 4 on page 41.

Chapter Four: Embedded Web-Based GUI and Diagnostics

Logging On To Your πPC

Before trying to log on to your πPC 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 31.

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 πPC you wish to connect to and 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 πPC's performance aside from performing diagnostics. In order to configure the πPC, i.e. zero the device, configure the PID parameters, change the IP Address, etcetera, you must enter "Setup" mode. See "Setup Mode" on page 46.

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

Device Page

This page, which contains the general information for the πPC, is where you are initially directed once you log on to the πPC. The information displayed is dependent on the type of πPC, i.e. PC90 or PC99, and the electrical interface.

What's Displayed: PC90

For a PC90, the Device Page displays the device's model code, pressure range, valve type, control direction and DeviceNet status (if applicable).

What's Displayed: PC99

For a PC99, the Device Page displays the device's model code, pressure range, valve type, current gas settings and DeviceNet status (if applicable). It does not include the control direction since it is always downstream and cannot change.

Note The πPC's serial number can always be found in the bottom left-hand corner of the browser window.

Figures 19 and 20, next page, show a screen capture of the Device Page for a DeviceNet PC90 and PC99, respectively.

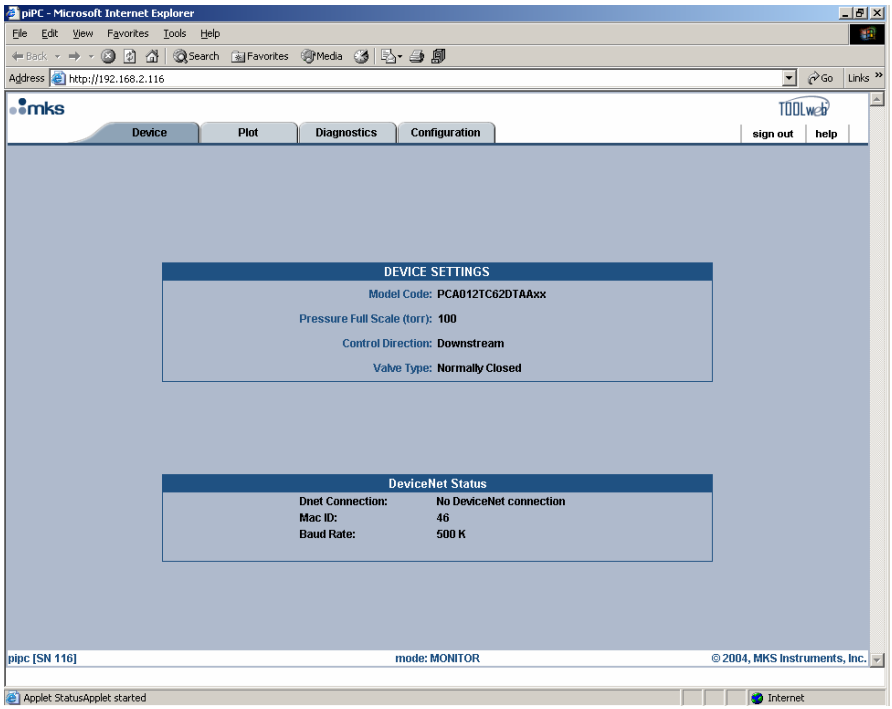


Figure 19: Embedded GUI, Device Page in Monitor Mode (DeviceNet PC90 shown)

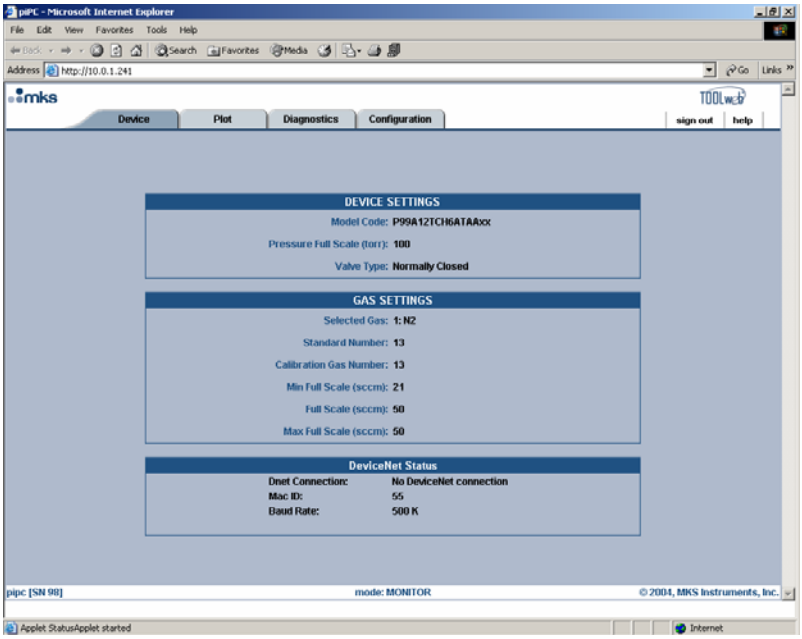


Figure 20: Embedded GUI, Device Page in Monitor Mode (DeviceNet PC99 shown)

Plot Page

This page enables you to 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 31.

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 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. Please note that there is not a software imposed time limit for data collection. The data is written to the computer, so it is computer dependent.

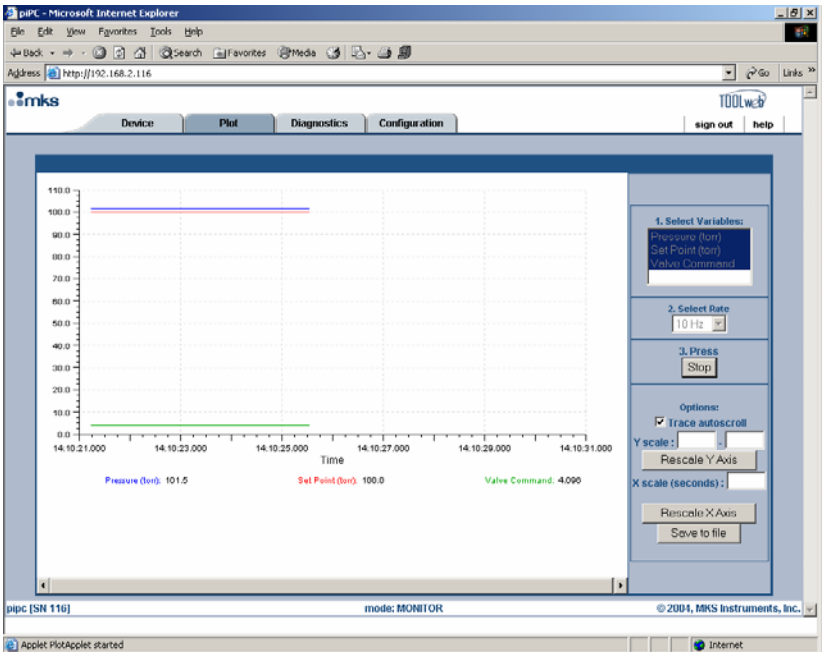


Figure 21: Embedded GUI, Plot Page in Monitor Mode (PC90 shown)

Diagnostics Page

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 pressure, temperature and flow circuit (if applicable). 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 Pressure* → this basic test is a simple diagnostic check for the pressure circuit to verify that the sensor and the electronics are working properly. Please note that if your πPC has a sub-atmospheric full scale pressure range, then your device must be under vacuum prior to running the test. To run this test select the checkbox next to where is says "Raw Pressure:" and then press the "Run the test" button.

Note If your πPC has a sub-atmospheric full scale pressure range, then the the πPC must be under vacuum prior to running the "Raw Pressure" diagnostic test or it will fail.

When the test finishes you will either see the word "Pass" or "Fail" next to the checkbox. If the test passes, then the pressure circuit is good. If it fails, then there may be a problem. Please follow the instructions in the Snapshot section on page 45.

- *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.
- *Raw Flow* → (PC99 Only) 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 below.

Snapshot

The "Snapshot" feature was added 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 πPC 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 22, below, shows a screen capture of the Diagnostics Page for a PC99.

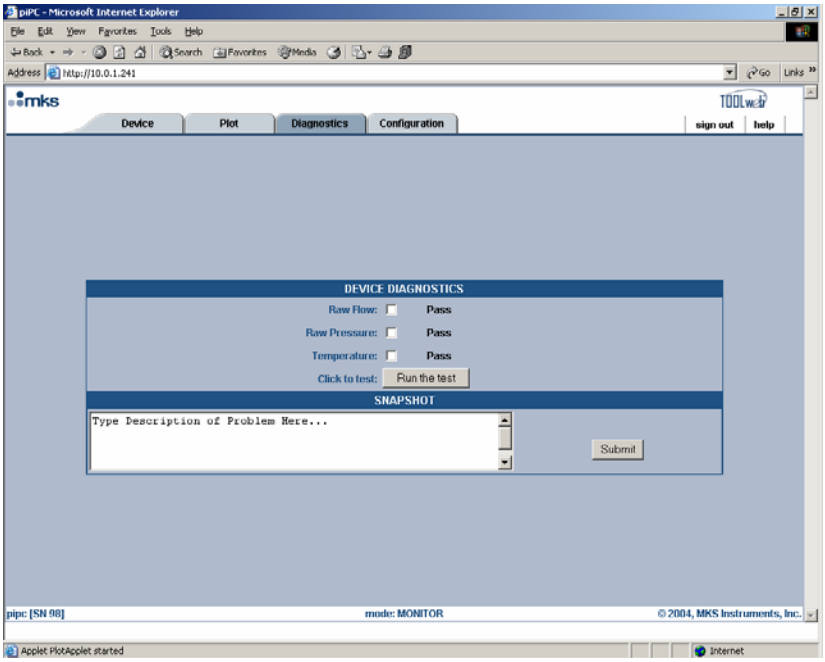


Figure 22: Embedded GUI, Diagnostics Page (PC99 shown)

Configuration Page

This page displays the TCP/IP settings and the current Firmware version for the πPC. 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 parentheses. Figure 23, below, shows a screen capture of the Configuration Page in "Monitor Mode".

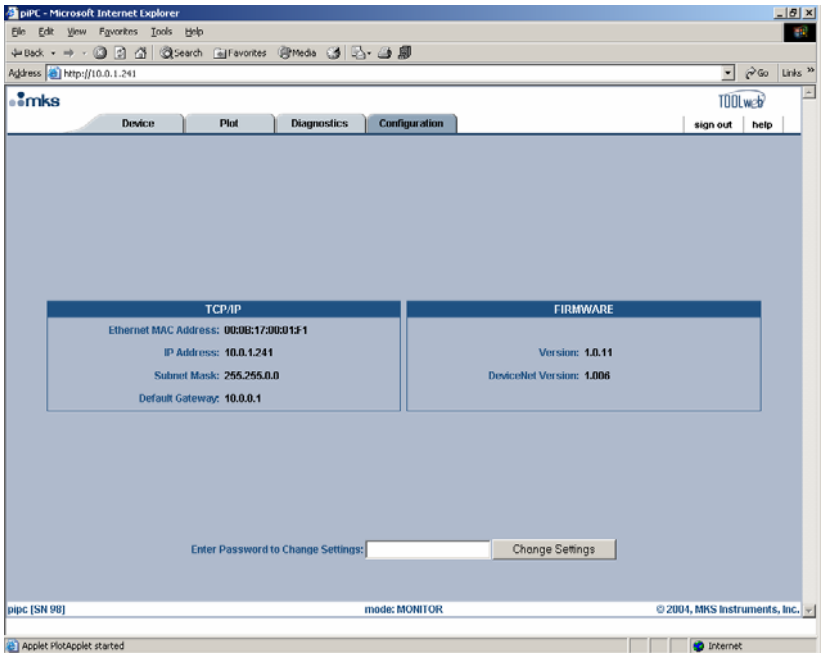


Figure 23: Embedded GUI, Configuration Page in Monitor Mode (DeviceNet πPC shown)

Setup Mode

In "Setup Mode" the user is able to configure the πPC, 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 tabs, i.e. pages, 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 41.

Device Page

In "Setup Mode" this page gives you the ability to change the local display setting and modify the gas settings (PC99 only).

Local Display: All πPC's allow the user to change what's displayed on the local display through the use of the pull-down menu in the "Display Settings" section as is shown in Figure 24. The default setting represents "push-button", which allows you to toggle the display by pushing down on the display itself. Changing the display to any other configuration will disable the "push-button" aspect of the display.

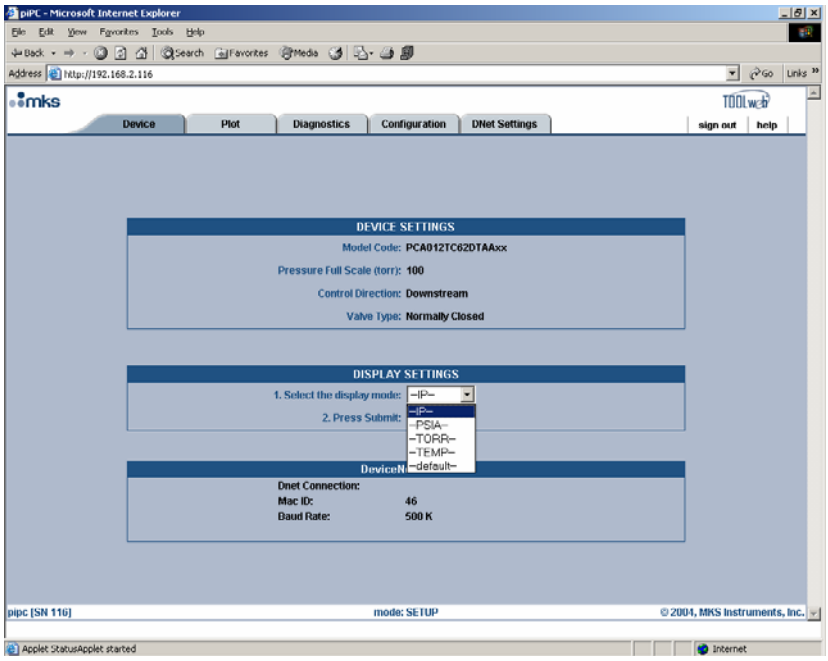


Figure 24: Embedded GUI, Device Page in Setup Mode (DeviceNet PC90 shown)

Gas Settings: If your device is a PC99, then the Device Page also enables the user to change the πPC'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 48.
- To change the full scale range of the current gas instance, see page 49.
- To set the πPC to a different gas instance, see page 49.

Figure 25, next page, shows a screen capture of the Device Page for a DeviceNet PC99.

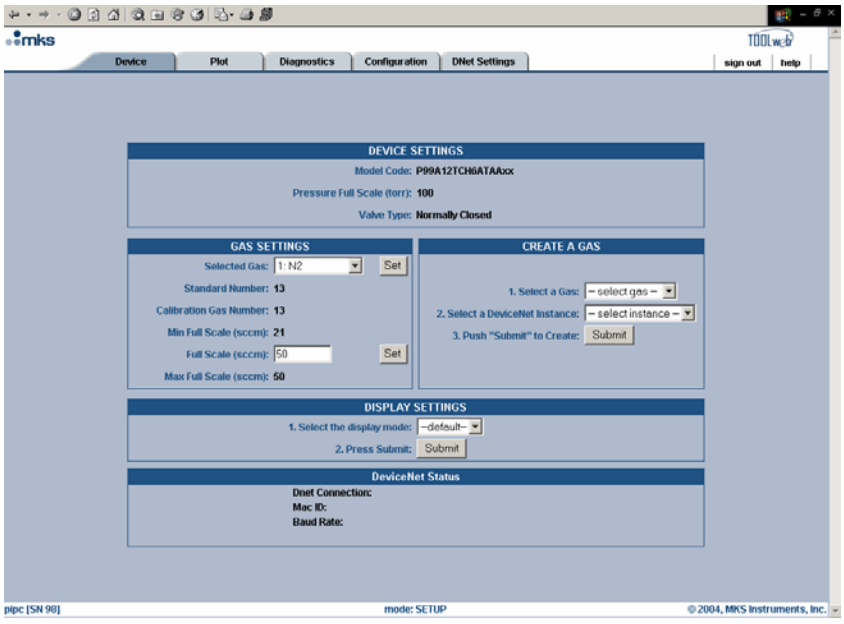


Figure 25: Embedded GUI, Device Page in Setup Mode (DeviceNet PC99 shown)

Creating A New Gas Instance (PC99 only)

In the "Create A Gas" section of the Device Page: *(Refer to Figure 26a during the following steps)*

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 SUCCEEDED".
5. You should now see the newly created gas and its attributes 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 49. **Otherwise you need to cycle the power to the πPC.** Once you cycle the power, click on the refresh button of the browser. Once the πPC powers up, the browser will reload and start on the Device Page in Monitor Mode.

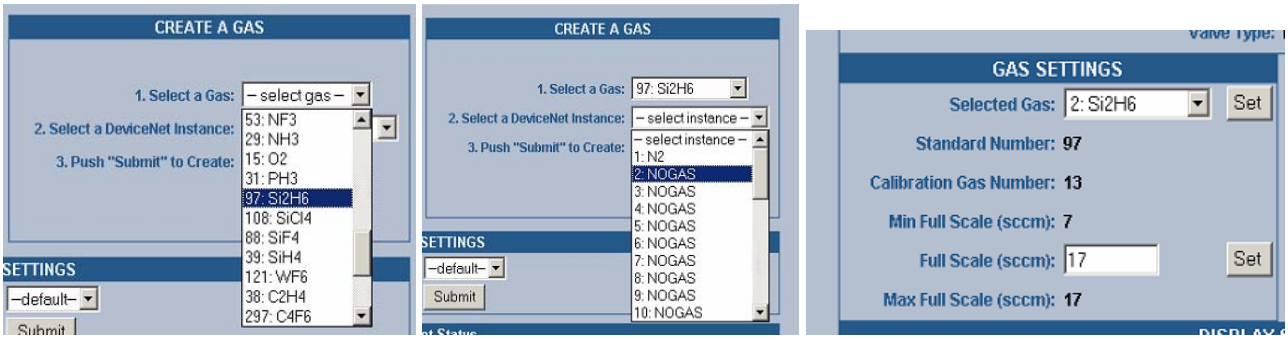


Figure 26a: Embedded GUI, Multi Gas, Creating A New Gas Instance (PC99 only)

Changing the Full Scale Flow Range (PC99 only)
In the "Gas Settings" section of the Device Page (see Figure 25b below) you are 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 πPC**, then click the refresh button of the browser. Once the πPC powers up, the browser will reload and start on the Device Page in Monitor Mode.

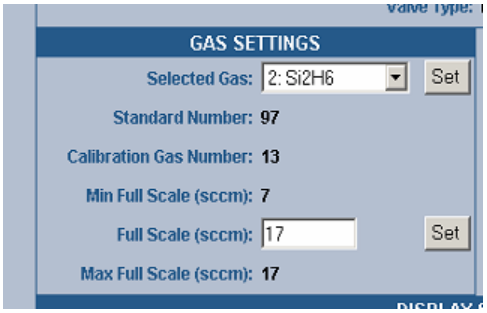


Figure 25b: Embedded GUI, Multi Range, Changing the Full Scale Flow Range (PC99 only)

Changing the Active Gas Instance (PC99 only)
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 the factory setting.*

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

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 πPC to your system refer to *Tuning the πPC Pressure Controller* on page 61. This section only deals with setting the values.

Figure 27, next page, 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 πPC through Ethernet (see notes below), watch the πPC's performance on the plot, and adjust the PID parameters accordingly to optimize the performance of the πPC. You should find that tuning a device has never been easier.

Note For DeviceNet units, sending a setpoint through Ethernet will not work if the πPC has been connected to your DeviceNet network and brought online. Either setpoint commands must be processed through DeviceNet protocol or the πPC must be taken off the network and the power must be cycled so that the Ethernet setpoint will work.

Note For Analog units, sending a setpoint through Ethernet will not work unless the "Digital" optionbox is selected. The optionbox is located above the setpoint input as shown in Figure 28. This checkbox tells the device to bypass the analog setpoint. To begin sending setpoints through the analog interface again, either check the "Analog" optionbox or close the browser.

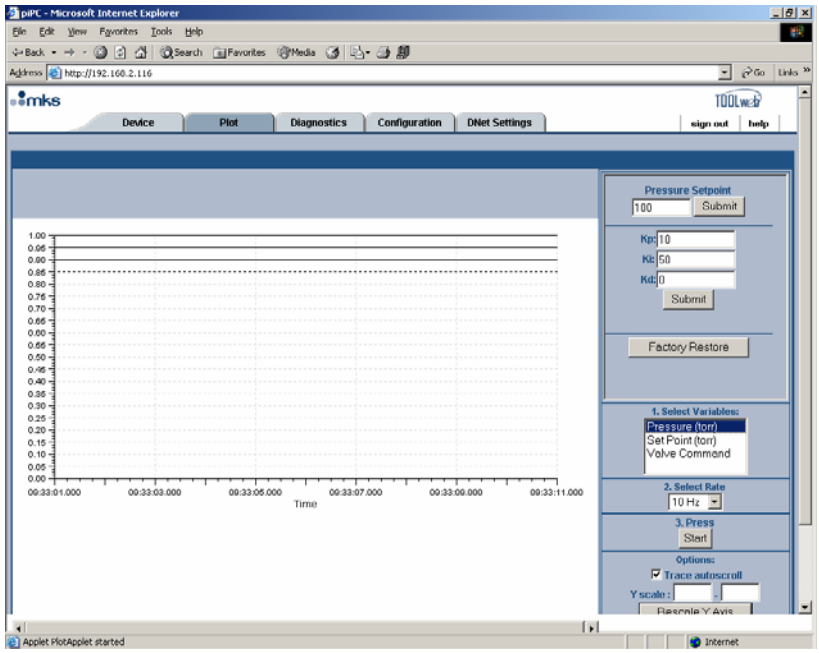


Figure 27: Embedded GUI, Plot Page in Setup Mode (DeviceNet PC90 shown)

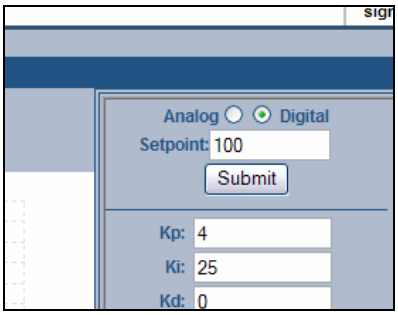


Figure 28: Embedded GUI, Plot Page in Setup Mode (Analog)

Before a πPC 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 πPC for optimal performance please see *Tuning the πPC Pressure Controller* on page 61.

Note

A πPC 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.

Diagnostics Page

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 44.

Configuration Page

As was noted earlier, the Configuration Page is where you are initially directed once you've entered "Setup Mode". Here the πPC can be zeroed, the "Setup Mode" password can be changed, changes can be made to the Ethernet settings and firmware can be updated. For the Analog interface you are able to adjust Trip Points and the Pressure Output Switch, which adjusts the Full Scale input/output voltage of the device from 0-10 VDC (*default)* to 0-5 VDC. The RS-485 electrical interface allows you to change the Pressure Output Switch. This switch adjusts Full Scale output voltage of the device from 0-10 VDC (*default)* to 0-5 VDC.

Caution **Zeroing the pressure incorrectly can cause system failure. Make sure that the "Zero Adjustment" procedure on page 79 is followed properly.**

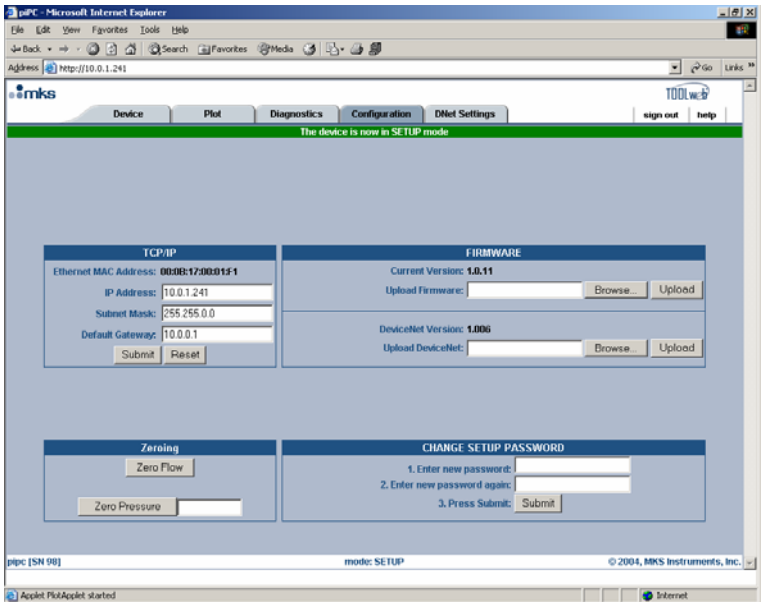


Figure 29: Embedded GUI, Configuration Page in Setup Mode (DeviceNet PC99 shown)

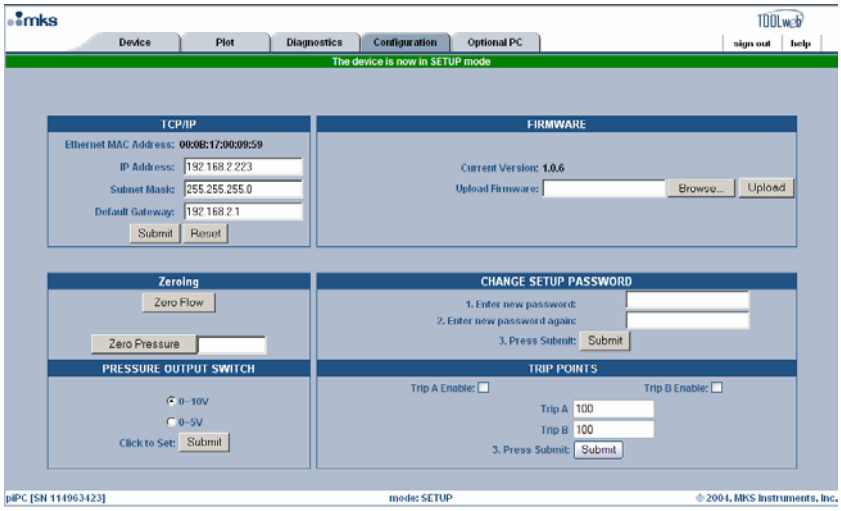


Figure 30: Embedded GUI, Configuration Page in Setup Mode (Analog PC99 shown)

Zeroing the πPC

Depending on the type of πPC there will either be a "Zero Pressure" option (PC90) or a "Zero Pressure" and a "Zero Flow" option (PC99). **Before zeroing either value make sure the "Zero Adjustment" procedure on page 79 has been followed correctly.** To zero the flow, press the "Zero Flow" button. To zero the pressure, enter the system base pressure, i.e. minimum pressure the system pumps down to, in the field next to the "Zero Pressure" button and then press the "Zero Pressure" 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) to (15) seconds. The πPC will be unresponsive during this time.

Note To zero the pressure transducer to zero pressure the adjustment ***must*** be made at a pressure less than the pressure transducer's resolution (0.01% of Full Scale).

Changing the Setup Mode Password

To change the "Setup Mode" password from the default password "config", enter the new password in the "Change Setup Password" section. Re-enter the password and then press the "Submit" button.

Changing the Ethernet (TCP/IP) Settings

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

Caution **If you are unfamiliar with setting TCP/IP settings, please contact your local MKS representative for help. If settings are done incorrectly, you may no longer be able to connect to the πPC 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 πPC must be cycled.** To use the Embedded GUI, you must now change the URL to reflect the new IP address, i.e. http://xx.xx.xx.xx, where xx.xx.xx.xx is the new IP address for the πPC.

Updating Firmware

Updating firmware can only be done by your local MKS representative. If updates are necessary, then your local representative will be in contact to set up a time to complete the upgrade.

Pressure Output Switch (Analog15-Pin and RS-485 only)

This option allows you to change the Full Scale input/output voltage for your πPC from the default setting of 0-10 VDC to 0-5 VDC. For the RS-485 interface this option will only change the pressure output signal since there is only an Analog output.

Trip Points (Analog 15-Pin only)

By default the analog trip points, i.e. Trip Point A and Trip Point B, are disabled. To enable either one or both check or uncheck the trip point(s) as desired. The setting for each is in percent of full scale (%FS). Type in the trip point value(s) and then click submit. When a trip point is "tripped", the trip point's respective LED (Red) will light up. Please note that Trip Point A will be tripped while the pressure is at or above its respective value. Trip Point B will be tripped while the pressure is at or below its respective value. This can be easily remembered by thinking "A" for above and "B" for below.

Optional PC Page

The Optional PC page is only available in Setup Mode for Analog 15-Pin devices. Here the πPC can be setup to control to an external signal, e.g. a Baratron, 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 31, below, shows a screen shot of this page.

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

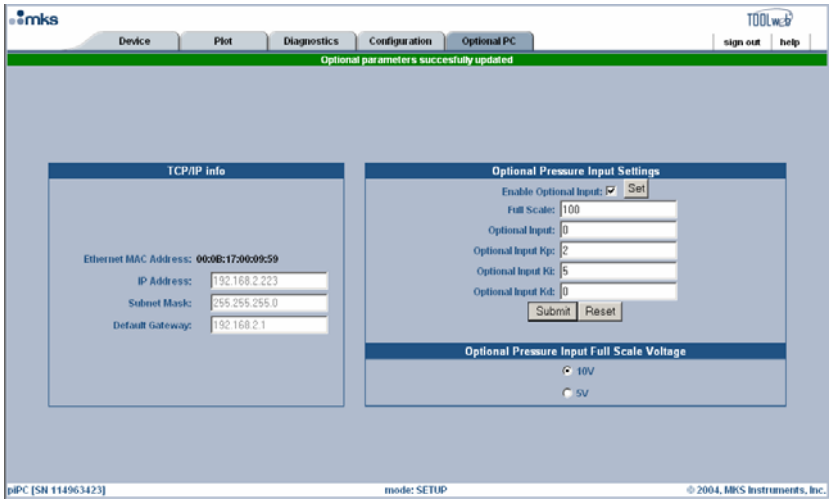


Figure 31: Embedded GUI, Optional PC Page in Setup Mode (Analog πPC Only)

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. 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 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 54 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 πPC for optimal performance please see *Tuning the πPC Pressure Controller* on page 61. 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 54.

Note A πPC 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 πPC 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 πPC. If you wish to change any of this information please see the *Configuration Page* section on page 51.

Optional Input 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.

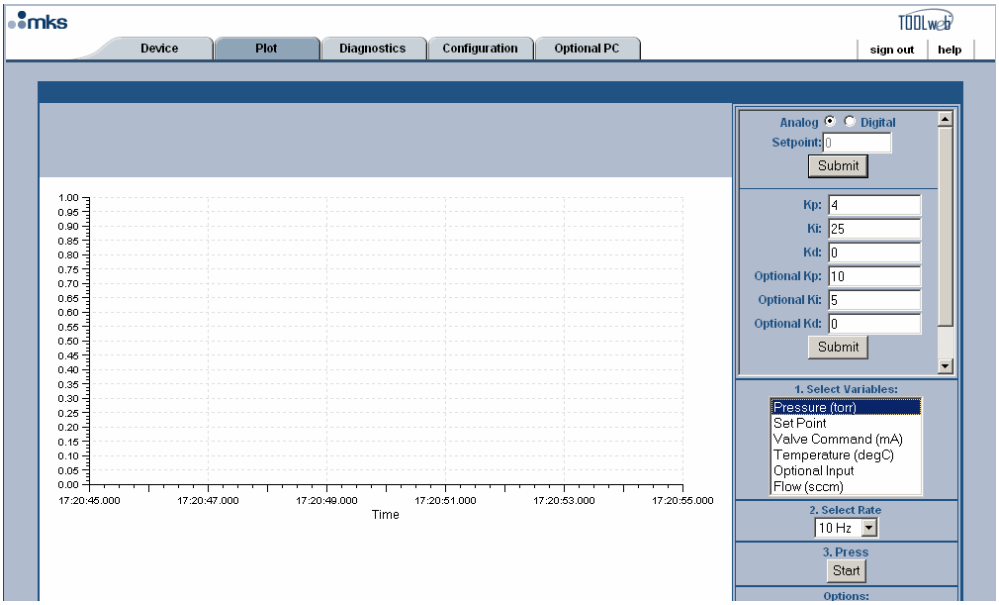


Figure 32: Embedded GUI, Plot Page with Enabled Optional Input (Analog PC99 Shown)

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. For information on how to tune your πPC for optimal performance please see *Tuning the πPC Pressure Controller* on page 61. This section discusses tuning the standard PID values, but the same rules apply to the optional input parameters.

Note A πPC 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.

DNet Settings Page

As the name suggests, this page only applies to πPC's with a DeviceNet interface. Here you are able to view the πPC's current DeviceNet settings for Flow (PC99 only), Pressure, Temperature, and a few miscellaneous parameters. Among these parameters you will find such things as the πPC's alarm/warning settings, full scale parameters, and actuator settings. This page is intended for viewing purposes only.

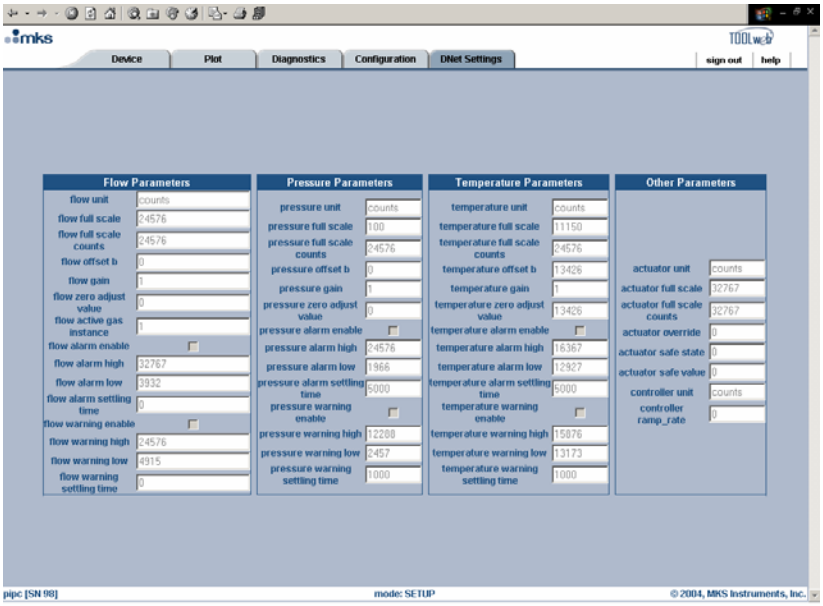


Figure 33: Embedded GUI, DNet Settings Page in Setup Mode (PC99 shown)

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Chapter Five: Overview

General Information

Typical Control System Configuration

The πPC can be used in a wide variety of control systems, most of which share several characteristics. Typically, a control system consists of four basic parts:

- Pressure transducer
- Control electronics
- Control valve
- Pressure system (whose pressure is being controlled by the πPC Pressure Controller)

The πPC provides the first three components with the PC90 and PC99 models. The PC99 model offers the additional ability to measure flow rate through the system.

- The pressure transducer is an MKS Baratron capacitance manometer.
- The electronics are what is necessary for pressure control.
- The control valve included within the πPC is a proportional control valve.
- The PC99 model's flow transducer is an MKS design.

The pressure system can be any process requiring pressure control.

Pressure Measurement Overview

The πPC measures the pressure and controls the pressure under flowing conditions within the operating envelope for the device according to a given setpoint. The PC90 model offers the ability to control the pressure either upstream or downstream of the device depending on the configuration ordered. The PC99 model only controls pressure downstream. For more on this, see *How the πPC Pressure Controller Works*, on page 59.

Flow Path

Upon entering the πPC, the flow path through the instrument differs depending on the model type and the device configuration.

πPC, PC90 model, upstream control configuration: the gas stream flows first through the metering system, which consists of the pressure transducer, next through the control valve, and then exits the instrument.

πPC, PC90 model, downstream control configuration: the gas stream flows first through the control valve, next through the metering system, which consists of the pressure transducer, and then exits the instrument.

πPC, PC99 model: the gas stream flows first through the flow metering section for its mass flow to be measured. Next the gas moves on through the control valve, then the pressure metering section, which consists of the pressure transducer, and finally it exits the instrument.

The flow metering section consists of a sensor tube and parallel bypass for all ranges offered. The geometry of the sensor tube, in conjunction with the specified bypass range, 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. See Appendix D, *Model Code Explanation for the PC99 Model*, on page 105 for a list of available flow metering, i.e. bypass, ranges.

Pressure Control Range

The πPC can control pressure over a range of 2 to 100% of full scale. This means that a πPC with a 1000 Torr transducer can control pressure from 20 to 1000 Torr, whereas an instrument with a 100 Torr transducer can control pressure from 2 to 100 Torr.

Measurement Technique

The pressure measurement is based on MKS Baratron technology that uses capacitance to determine pressure. Baratron capacitance manometers − well known for their percent of Reading accuracy, stability, and resolution − provide precise measurements at lower pressures and over wider dynamic ranges than strain gage transducers. Furthermore, Baratron capacitance manometers have no silicone oil fill which can result in hysteresis and can slow the controller time response.

The flow measurement (PC99 only) is based on differential heat transfer between temperature sensing heater elements which are attached to the sensor tube. This senses the thermal mass movement which is converted to mass flow via the specific heat, C_p, of the gas.

Control Circuitry

The controller employs the above pressure measurement technique and utilizes a control circuit that provides drive current for the proportioning control valve. The pressure controller accepts a setpoint signal, compares it to its own pressure 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.

Control Valve

The control valve is a specially constructed solenoid valve in which the armature (moving valve mechanism) is suspended. The arrangement ensures that no friction is present and makes precise control possible. For the πPC the control valve is either Normally Closed or Normally Open.

In the Normally Closed control valve, the πPC instrument lifts the armature and plug assembly from the seat to regulate the pressure. In the Normally Open control valve, the πPC instrument works in reverse, starting in a fully open position it moves the armature and plug assembly towards the fully closed position to regulate the pressure.

How the πPC Pressure Controller Works

The MKS πPC pressure controller can control pressure upstream or downstream of the device depending on the configuration ordered. Both configurations are described in detail below, but in general the controller compares the pressure reading to the setpoint and positions the valve to maintain, or achieve, the set point pressure. 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. These values are adjustable through the electrical interface, if DeviceNet or RS-485, or through the embedded GUI on the Plot Page in Setup Mode. These methods are described in detail in the *Tuning the πPC Pressure Controller* section on page 61.

Note The control configuration can be determined by examining the pressure control side directional arrow on the front of the πPC. If the arrow points away from the electrical connector, then the device is configured for a downstream pressure control configuration.

Downstream Pressure Control Configuration

For a downstream PC90 or a PC99 configuration, the controlled pressure volume is positioned *after* the πPC controller so the controller will regulate the amount of gas entering the pressure system.

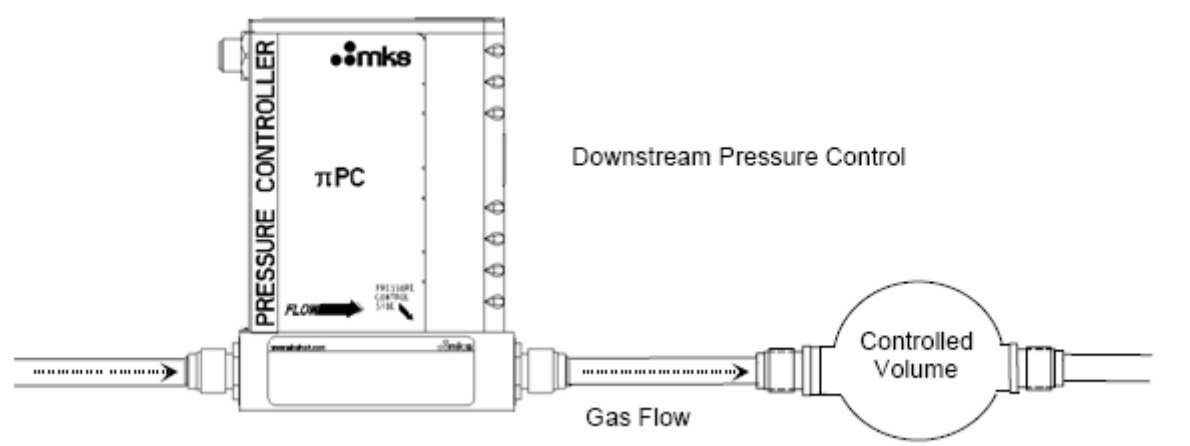

Figure 34: πPC Controller in Downstream Control Position (PC90 or PC99)

When the actual pressure reading is *less than* the setpoint value, the πPC opens its control valve. As the valve opens, assuming adequate differential pressure across the pressure controller, gas enters the pressure system, so the pressure rises to meet the setpoint value.

When the actual pressure reading is *more than* the setpoint value, the πPC closes its control valve. As the valve closes, assuming adequate vacuum, there is a reduced flow of gas entering the pressure system, so the pressure decreases to meet the setpoint value.

Note The πPC must have sufficient pressure on its inlet side to achieve the setpoint.

Caution **For this mode of pressure control, closed conductance leak across the πPC will cause downstream pressure to rise slightly for a zero pressure setpoint unless a positive shutoff valve is used for discrete sequenced operation.**

Caution **In a continuously flowing system a transducer situated downstream of the πPC may show an offset between its reading and the πPC's due to pressure drops in the gas line.**

Upstream Pressure Control Configuration

For an upstream PC90 configuration, the controlled pressure volume is positioned *before* the πPC controller so the controller will regulate the amount of gas exiting the pressure system.

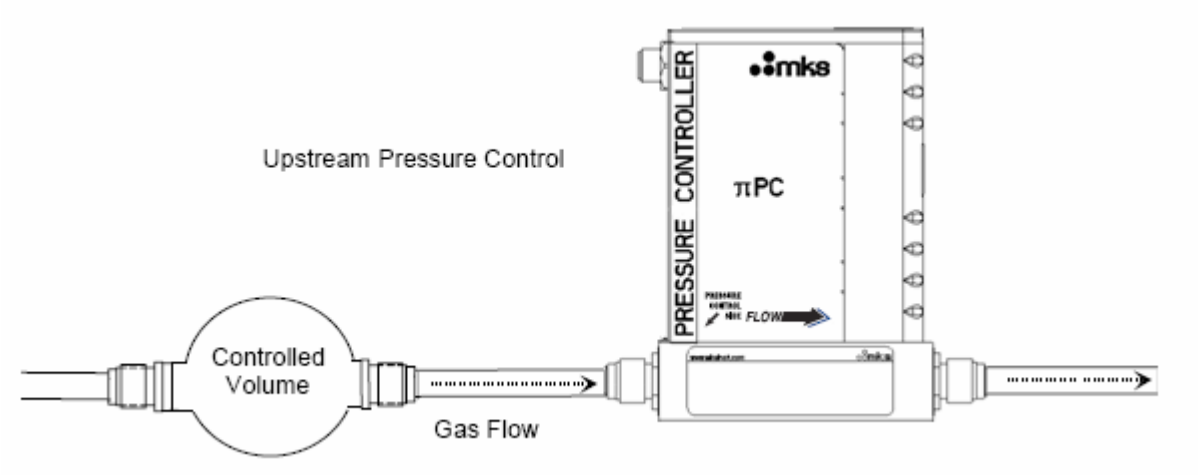

Figure 35: πPC Controller in Upstream Control Position (PC90 only)

When the actual pressure reading is *less than* the setpoint value, the πPC closes its control valve. As the valve closes, there is a reduced flow of gas exiting the pressure system, thus the pressure rises to meet the setpoint value.

When the actual pressure reading is *more than* the setpoint value, the πPC opens its control valve. As the valve opens, there is an increase in the amount of gas exiting the pressure system, so the pressure decreases to meet the setpoint value.

Caution **In a continuously flowing system a transducer situated upstream of the πPC may show an offset between its reading and the πPC's due to pressure drops in the gas line.**

Tuning the πPC Pressure Controller

Tuning optimizes the way the πPC unit controls your pressure system. As noted in the previous section, *How the πPC 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, 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 62.

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 (Kp), 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. Figure 36 shows the effects of the Proportional term.

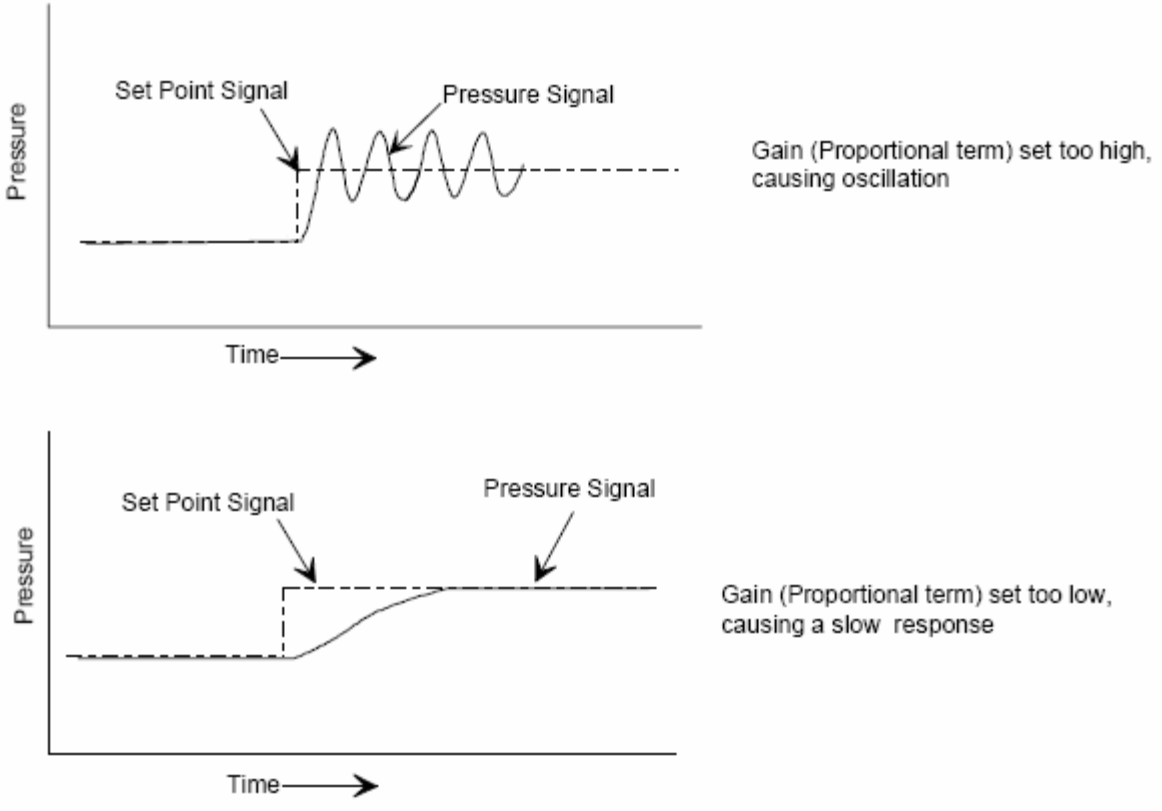

Figure 36: Effects of the Proportional Control

The proportional control setting (Kp) has a minimum value of zero but no maximum value. The factory-shipped setting is for a typical pressure system with Nitrogen as the process gas. The actual value depends on the configuration of the πPC. See the *Adjusting the Proportional and Integral Control* section on page 62 for an explanation of how to set the proportional control setting (Kp) 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 (Ki) increases the period of time over which the error signal is generated, and the system response gets slower. Figure 37 shows the effects of the Integral term.

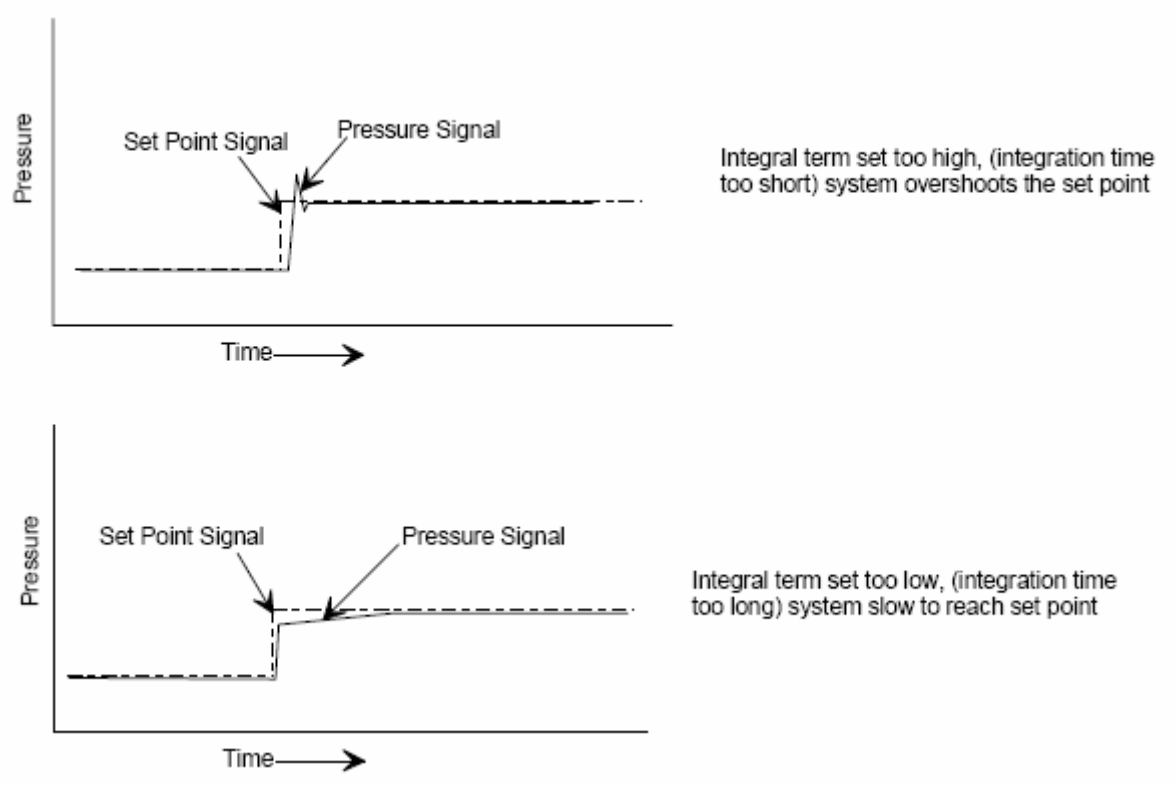

Figure 37: Effects of the Integral Control

The integral control setting (Ki) has a minimum value of zero but no maximum value. The factory-shipped setting is for a typical pressure system with Nitrogen as the process gas. The actual value depends on the configuration of the πPC. See the *Adjusting the Proportional and Integral Control* section on page 62 for an explanation of how to set the integral control setting (Ki) using the different methods.

Adjusting the Proportional and Integral Control

As noted at the beginning of this section, both the proportional control setting (Kp) and the integral control setting (Ki) can be set over the electrical interface if the interface is DeviceNet or RS-485 or they can be set through the Embedded GUI. All methods are described below.

Note For more information on commands for DeviceNet, please see the DeviceNet supplement, MKS P/N 1005676-001. For more information on commands for RS-485, please see the RS-485 supplement, MKS P/N 1005677-001.

Over DeviceNet you have the ability to get and set both the proportional control setting (Kp) and the integral control setting (Ki) through the S-Single Stage Controller Object by using the following DeviceNet commands:

Get Kp → **Service** 0x0E**, Class** 0x33**, Instance** 1**, Attribute** 94

Set Kp → **Service** 0x10**, Class** 0x33**, Instance** 1**, Attribute** 94**, (New value in Real data type)**

Get Ki → **Service** 0x0E**, Class** 0x33**, Instance** 1**, Attribute** 93

Set Ki → **Service** 0x10**, Class** 0x33**, Instance** 1**, Attribute** 93**, (New value in Real data type)**

Over RS-485 you have the ability to query and set both the proportional control setting (Kp) and the integral control setting (Ki) by sending the following messages to the πPC pressure controller.

Query Kp → **Message sent from Host to πPC:**

MAC ID (πPC MAC ID**), STX** 0x02, **Command Code** 0x80**, Packet Length** 0x03**,**
Class ID 0x69**, Instance ID** 0x01**, Attribute ID** 0xA5**, Pad** 0x00**,**
Checksum (Sum of all bytes excluding the MAC ID**)**

πPC response to Host: (*Response is a 4-byte floating point number***)**

ACK 0x06**, MAC ID (**host controller**), STX** 0x02**, Command Code** 0x80**,**
Packet Length 0x07**, Class ID** 0x69**, Instance ID** 0x01**, Attribute ID** 0xA5**,**
Kp Byte #1 (LSB**), Kp Byte #2, Kp Byte #3, Kp Byte #4 (**MSB**), Pad** 0x00**,**
Checksum (Sum of all bytes excluding ACK and MAC ID**)**

Set Kp → **Message sent from Host to πPC: (***Kp is a 4-byte real value***)**

MAC ID (πPC MAC ID**), STX** 0x02, **Command Code** 0x81**, Packet Length** 0x07**,**
Class ID 0x69**, Instance ID** 0x01**, Attribute ID** 0xA5**, Kp Byte #1 (**LSB**),**
Kp Byte #2, Kp Byte #3, Kp Byte #4 (MSB**), Pad** 0x00**,**
Checksum (Sum of all bytes excluding the MAC ID**)**

Query Ki → **Message sent from Host to πPC:**

MAC ID (πPC MAC ID**), STX** 0x02, **Command Code** 0x80**, Packet Length** 0x03**,**
Class ID 0x69**, Instance ID** 0x01**, Attribute ID** 0xA6**, Pad** 0x00**,**
Checksum (sum of all bytes excluding MAC ID**)**

πPC response to Host: (*Response is a 4-byte floating point number***)**

ACK 0x06**, MAC ID (**host controller**), STX** 0x02**, Command Code** 0x80**,**
Packet Length 0x07**, Class ID** 0x69**, Instance ID** 0x01**, Attribute ID** 0xA6**,**
Ki Byte #1 (LSB**), Ki Byte #2, Ki Byte #3, Ki Byte #4 (**MSB**), Pad** 0x00**,**
Checksum (Sum of all bytes excluding ACK and MAC ID**)**

Set Ki → **Message sent from Host to πPC: (***Ki is a 4-byte real value***)**

MAC ID (πPC MAC ID**), STX** 0x02, **Command Code** 0x81**, Packet Length** 0x07**,**
Class ID 0x69**, Instance ID** 0x01**, Attribute ID** 0xA6**, Ki Byte #1 (**LSB**),**
Ki Byte #2, Ki Byte #3, Ki Byte #4 (MSB**), Pad** 0x00**,**
Checksum (Sum of all bytes excluding the MAC ID**)**

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 πPC* on page 41.
2. Enter Setup Mode, see *Setup Mode* on page 46.
3. Go to the Plot Page. Here you are able to adjust the settings. See the Setup Mode *Plot Page* section on page 49 for further instructions.

Optimizing the Response of the πPC

Tuning the πPC controller involves adjusting the Proportional and Integral control terms to optimize the response of the controller *in your system*. Since every system is different, the optimum settings for the Kp and Ki terms will vary. Also, the response of the system to increasing and decreasing pressures may vary. Tune the system to provide the best response in the direction of pressure change that you anticipate.

The following graphs show the response of the πPC controller to changes in the setpoint. The setpoint changed from 100 Torr to 500 Torr, and back again. The pressure response was tracked using the Embedded GUI's Plot Page.

Note

The following three graphs were generated on a system consisting of a πPC controller configured for upstream control, with a 1000 Torr transducer, 500 sccm flow of Nitrogen gas, and a 500 cm^3 system volume. Tuning with nitrogen may not offer maximum performance if another gas is used for processing. Gases with lighter densities, for example, may require a reduction in the Kp value.

The same Kp and Ki term values may not create the same effect in your system.

Controller Response with the Initial Values:

The initial values (Kp = 25; Ki = 50) yielded:

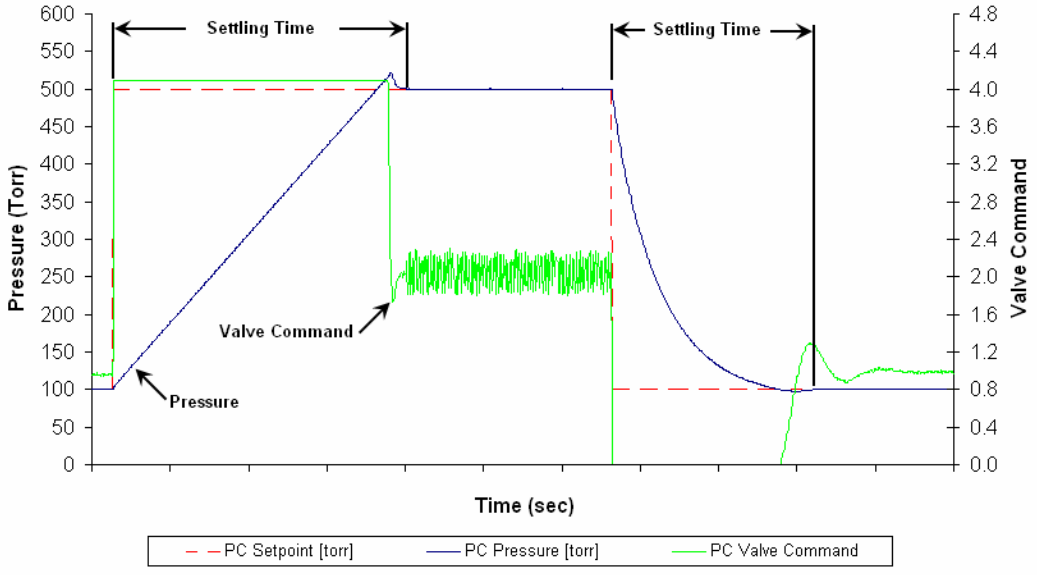

Figure 38: Controller Response with Initial Kp and Ki term values

The controller response reaches the setpoint without a problem, however, there is oscillation once the controller reaches setpoint. This is very apparent when looking at the Valve Command, which is a variable that has a direct correlation to the electrical current being applied to the valve. A good rule of thumb is that when oscillation occurs, cut the Kp value in half. The next graph shows an over compensation by decreasing the Kp value to five.

Controller Response with Decreased Kp Term

The new values (Kp = 5; Ki = 50) yielded:

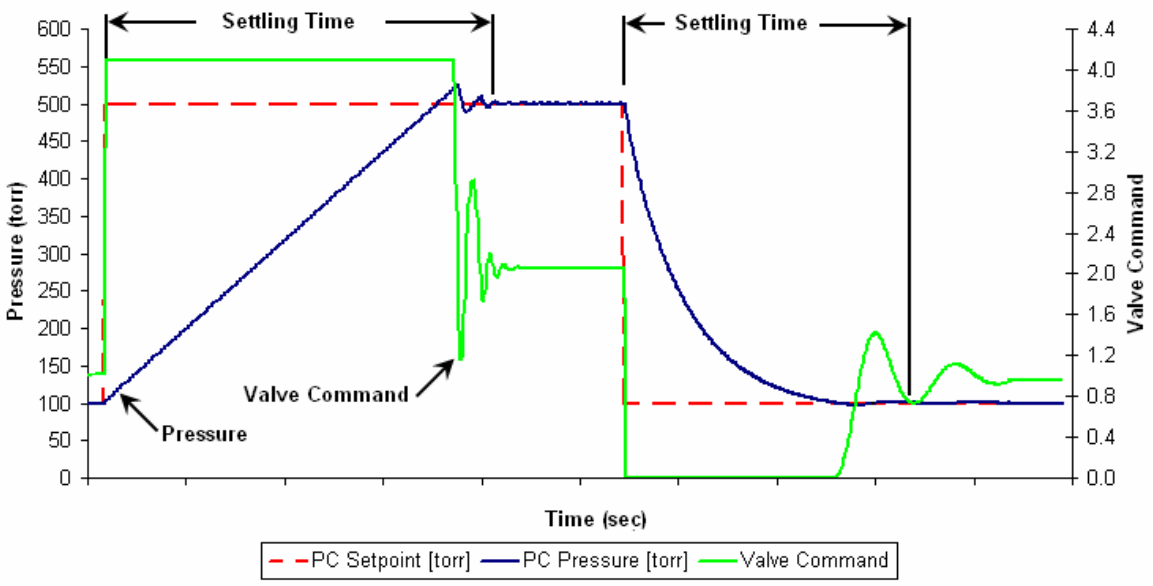

Figure 39: Controller Response with New Kp and Ki term values

The controller response, once again, reaches the setpoint without a problem. The noticeable changes are: (1) the oscillation starts initially and then stops and (2) the controller has more of an undershoot when the valve responds to bring the pressure to 500 Torr. The best way to fix both of these problems would be to reduce the Ki term. This would slow the response time, thus reducing the oscillation and undershoot. A good rule of thumb when reducing the Ki term is to start by cutting the Ki value in half, and then increase or decrease the value as needed. However, in this case, it was important to consider the typical use of an upstream pressure controller which uses two volumes, one large and one small. Tests using the small volume, which is approximately 0.5 cm^3, showed the Ki term with a value of 50 was good. Ultimately, after trying different Kp and Ki values with both volumes, the best values were with Kp set to seven and Ki set to fifty. Figure 40 on the next page shows the controller response with these settings using the 500 cm^3 volume.

Controller Response with Optimized Terms

The new values (Kp = 7; Ki = 50) yielded:

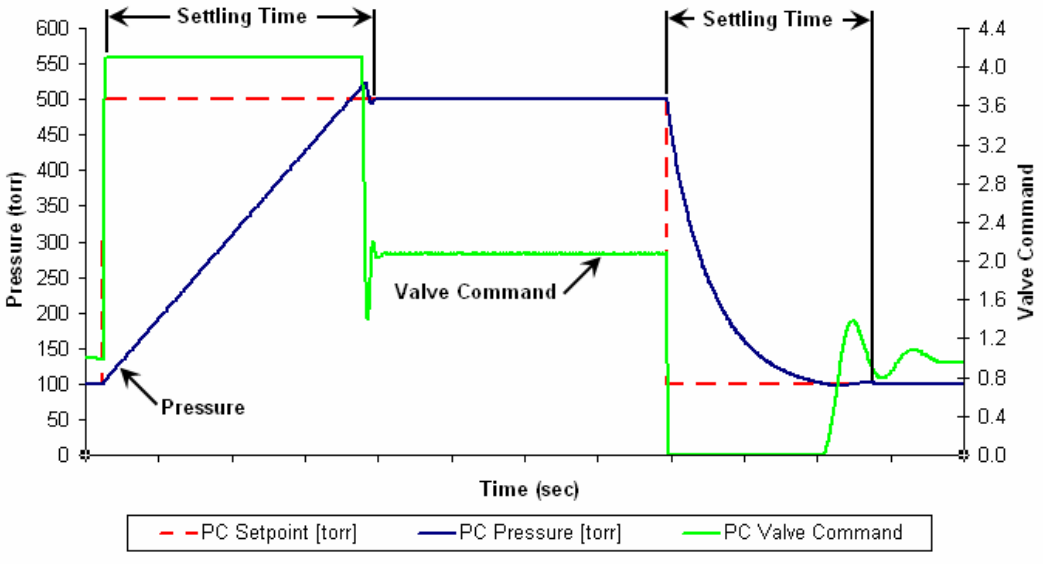

Figure 40: Controller Response with New Kp and Ki term values

This time the controller reaches the setpoint without a problem. The valve does not oscillate and the settling time has improved. This combination of the Kp and Ki settings yields the best control for our example system.

Operation of the πPC PC99 Model with Gases other than Nitrogen (Multi Gas)

The πPC PC99's flow metering capability which does not use gas correction factors, is a unique feature shared by very few Mass Flow Meters (MFM). The operation of the PC99's flow metering is based on thermodynamic principles and multi-component functions that have been developed to accurately calculate the non-linear gas flow of many gases, with respect to the calibration gas. The current library of gases and functions covers virtually all gases used in the semi conductor industry and can be expanded to cover more gases. Please contact Applications Engineering for questions regarding any specific gas.

When a gas other than the calibration gas is selected, the PC99 automatically pulls up the correct functions that calculate the flow of that gas with respect to the original calibration. This allows the πPC to report the flow of the gas in use immediately and with better accuracy than previous MFMs that use Gas Correction Factors.

The PC99, by using these functions for the various gases, reports the flow within the stated accuracy of the flow meter, but for non-calibration gases. For example, the reported flow from a PC99 using Helium as the process gas, but calibrated for Nitrogen, will have the same accuracy both gases. Traditional flow meters using a Gas Correction Factor for Helium typically have a higher error.

Unless specially ordered, all PC99's are shipped with Nitrogen as the default gas, but all offer the ability for the user to create a gas instance with any of the numerous gases we offer through the use of the Embedded GUI. To do this, follow the steps listed below:

1. Connect to the Embedded GUI, see *Logging On To Your πPC* on page 41.
2. Enter Setup Mode, see *Setup Mode* on page 46.
3. Go to the Device Page. Here you are able to create a new gas instance and use the Multi Range feature. See the Setup Mode *Device Page* section on page 47 for further instructions.

Versions of the πPC (Electrical Interface Related, i.e. Pinouts, cables, etc.)

The πPC is available in three communications versions: the 15 Pin D analog communications version, the DeviceNet digital communications version, and the RS-485 digital communication version using a 9 pin D connector. The 15 pin D version accepts analog 0-10 VDC setpoint signals and produces 0-10 VDC output signals by default, but it is user-switchable to 0-5 VDC through the Embedded GUI (see page 51). The DeviceNet version uses only DeviceNet digital communications for routine control.

15 Pin D Male Connector (Analog I/O Interface) for PC90 Model

Connector Pinout – Standard Assignments (Model Code "B")

Table 7: Pinout, PC90 Model, 15 Pin Analog I/O

Pin Number	Signal Description
Pin 1	Valve Test Point, 0 to 5 VDC
Pin 2	Pressure Signal Output, 0 to 10 VDC (default), 0 to 5 VDC (user-switchable). (See Note 2 below)
Pin 3	Valve Close (TTL low)
Pin 4	Valve Open (TTL low)
Pin 5	Power Supply Common Ground (See Note 4 below)
Pin 6	No Connection (See Note 1 below)
Pin 7	+15 to +24 VDC (See Note 4 below)
Pin 8	Setpoint Input, 0 to 10 VDC (default), 0 to 5 VDC (user-switchable) (See Note 3 below)
Pin 9	No Connection (See Note 1 below)
Pin 10	Optional Input, 0 to 10 VDC (default), 0 to 5 VDC (user-switchable)
Pin 11	Signal Common
Pin 12	Signal Common (See Note 5 below)
Pin 13	Trip Point A
Pin 14	Trip Point B
Pin 15	Chassis Ground

Notes:

1. The No Connection pin assignment refers to a pin with no internal connection.
2. The pressure signal output (pin 2) is referenced to signal common (pin 12).
3. Any appropriate 0 to 10 VDC input signal of less than 1K ohm source impedance referenced to pin 11 can be used to supply a setpoint signal to pin 8.
4. The power signal input (pin 7) is referenced to power common (pin 5).
5. The signal common (pin 12) must be referenced to power common (pin 5) at the tool-end of the cable.

15 Pin D Male Connector (Analog I/O Interface) for PC99 Model

Connector Pinout – Standard Assignments (Model Code "B")

Table 8: Pinout, PC99 Model, 15 Pin Analog I/O

Pin Number	Signal Description
Pin 1	Valve Test Point, 0 to 5 VDC
Pin 2	Pressure Signal Output, 0 to 10 VDC (default), 0 to 5 VDC (user-switchable). (See Note 2 below)
Pin 3	Valve Close (TTL low)
Pin 4	Valve Open (TTL low)
Pin 5	Power Supply Common Ground (See Note 5 below)
Pin 6	No Connection (See Note 1 below)
Pin 7	+15 to +24 VDC (See Note 5 below)
Pin 8	Setpoint Input, 0 to 10 VDC (default), 0 to 5 VDC (user-switchable) (See Note 4 below)
Pin 9	Flow Signal Output, 0 to 5 VDC (See Note 3 below)
Pin 10	Optional Input, 0 to 10 VDC (default), 0 to 5 VDC (user-switchable)
Pin 11	Signal Common
Pin 12	Signal Common (See Note 6 below)
Pin 13	Trip Point A
Pin 14	Trip Point B
Pin 15	Chassis Ground

Notes:

1. The No Connection pin assignment refers to a pin with no internal connection.
2. The pressure signal output (pin 2) is referenced to signal common (pin 12).
3. The flow signal output (pin 9) is referenced to signal common (pin 12).
4. Any appropriate 0 to 10 VDC input signal of less than 1K ohm source impedance referenced to pin 11 can be used to supply a setpoint signal to pin 8.
5. The power signal input (pin 7) is referenced to power common (pin 5).
6. The signal common (pin 12) must be referenced to power common (pin 5) at the tool-end of the cable.

9 Pin D Male Connector (RS-485 Digital I/O)

Connector Pinout – Standard Assignments (Model Code "5")

Table 9: Pinout, πPC, RS-485, 9 Pin Digital I/O

Pin Number	Signal Description
Pin 1	Pressure Signal Output, 0 to 10 VDC (default), 0 to 5 VDC (user-switchable). (See Note 2 below)
Pin 2	Signal Common (See Note 4 below)
Pin 3	+15 to +24 VDC (See Note 3 below)
Pin 4	Power Supply Common Ground (See Note 3 below)
Pin 5	No Connection (See Note 1 below)
Pin 6	RS-485 Return
Pin 7	RS-485 +
Pin 8	RS-485 -
Pin 9	Shield

Notes:

1. The No Connection pin assignment refers to a pin with no internal connection.
2. The pressure signal output (pin 1) is referenced to pin 2 (signal common).
3. The power signal input (pin 3) is referenced to power common (pin 4).
4. The signal common (pin 2) must be referenced to power common (pin 4) at the tool-end of the cable.

DeviceNet Connector

Connector Pinout – Standard Assignment (Model Code "6")

The πPC has one 5-pin, male DeviceNet connector that provides the communications interface with the DeviceNet network, electrical power from the network bus, and shielding for the instrument signals.

Table 10: DeviceNet Connector Pinout

Pin Number	Signal Description
Pin 1	Drain
Pin 2	V+
Pin 3	V-
Pin 4	CAN_H
Pin 5	CAN_L

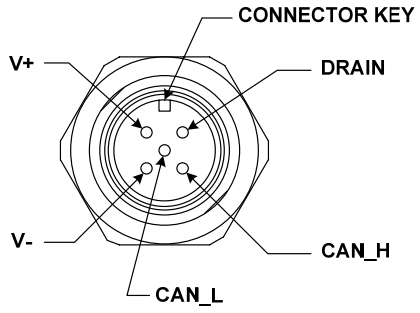

Figure 41: DeviceNet Connector Pin Diagram

Interface Cables for Analog I/O

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 11 below.

Note An overall metal braided, shielded cable, properly grounded at both ends, is required to meet CE Mark specifications.

Note To order an overall metal, braided, shielded cable, add an "S" after the cable type designation. For example, to order a standard cable to connect the πPC 15-Pin Analog I/O device to a MKS Type 246 Power Supply/Readout unit, use part number CB259-5-xx, where xx indicates the length. To order an overall metal braided shielded cable, use part number CB259S-5-xx.

Table 11: Interface Cables

πPC End	Power Supply End	
	15-pin Type D Male	Flying Leads
15-pin Type D Female, *for PC90*	CB259-5-xx or CB147-1-xx (see Notes 1 & 2 below)	CB259-6-xx
15-pin Type D Female, *for PC99*	CB649-1-xx (see Note 3 below)	Not Available

Notes:

1. CB259-5-xx can be connected to the following:
   - MKS Type 246, 247, or 113 set point/display module
2. CB147-1-xx can be connected to the following:
   - MKS Type 647 or 167 set point/display module (includes open and close lines)
3. CB649-1-xx can be connected to the following:
   - MKS Type 246 or 247 set point/display module
   - MKS Type 647 set point/display module (includes open and close lines)

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 devices 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:
   - Voltage ratings.
   - Cumulative I^2R heating of all the conductors (keep them safely cool).
   - IR drop of the conductors, so that adequate power or signal voltage gets to the device.
   - Capacitance and inductance of cables that handle fast signals (such as data lines or stepper motor drive cables).
   - Some cables may need internal shielding from specific wires to others.

Overview of the Analog πPC Operation

Power Requirements

The πPC requires an input voltage of +15.0 to +24.0 VDC @ 350mA max. The input voltage is introduced to the pressure controller through the 15-Pin Male D connector located on side of the instrument. For more information on the connector see the pinout information on page 68 for a PC90, page 69 for a PC99.

How To Override the Valve

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

Open the valve by applying a TTL low to pin 4 *or* connect pin 4 to signal ground (pins 11 or 12).

Override a setpoint to the controller and c*lose* the valve by applying 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 πPC executes commands based on a hierarchical command structure. The highest priority command is Valve Closed, followed by Valve Open and Setpoint Control. Therefore, if the pressure controller is operating under Setpoint Control to maintain a desired pressure, and the Valve Open pin (pin 4) is pulled low, the valve will move to the fully open position. Since the Valve Closed command has the highest priority, if both the Valve Open and Valve Close commands are issued, the valve will move to the fully closed position.

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

The Optional Input

The standard 15-pin πPC has an optional input (pin 10), which can be used to re-introduce another signal, such as zero corrected pressure signal or an external Baratron signal into the control circuitry of the πPC pressure controller. Please note that the signal introduced into pin 10 will only override the signal generated by the pressure transducer internal to the πPC if the Optional Input is enabled. See the *Optional PC* section on page 53 for information on how to enable the optional input. The Optional Input is disabled by default.

Note The signal introduced into pin 10 will only override the signal generated by the pressure transducer internal to the πPC if the Optional Input is enabled. See the *Optional PC* section on page 53 for information on how to enable the optional input.

Once the Optional Input is enabled the control electronics will drive the valve so that the optional input signal matches the setpoint. You will use the same pin (Pin 8) for the setpoint signal, regardless of whether you are using the optional input or the standard pressure control signal.

Please note that although controlling to the external optional input signal, the πPC's pressure output signal is still provided on the standard output pin 2.

The Trip Points

The πPC pressure controller offers two alarm trip points; Trip Point A and Trip Point B. Each trip point has an LED on the local display. When a trip point is on, the LED for the respective trip point will light solid red. When the trip point is off, the LED will not be lit.

The trip points can be set from 0 to 100% of full scale by adjusting the appropriate trip point value located in the embedded GUI on the "Configuration" page in "Setup Mode", see page 51 for more information.

Use the appropriate trip point output signal to control a relay or another piece of equipment, such as a valve, or as a digital input to a computer. The trip point signal is pulled to ground when the trip point is on. Both trip points are open collector transistors.

By default, both trip points are disabled. Refer to *Trip Points*, page 52, for more on the trip points.

Warm Up and Zero the πPC

After installation and power up, allow the πPC to warm up for a minimum of 30 minutes while under vacuum. Refer to the *Zero Adjustment* section of Chapter 6 on page 79 for more on the warm up and the zeroing procedure of the πPC.

Overview of πPC DeviceNet Digital Operation

Your πPC DeviceNet Pressure Controller complies with Volume 1 of the ODVA DeviceNet Specification, Release 2 and the associated SEMI-SIG requirements. A detailed software attribute summary pertaining to the DeviceNet communications is provided in the πPC DeviceNet, Instruction manual (MKS P/N 1005676-001).

Power Requirements

The πPC requires an input voltage of +11.0 to +25.0 VDC with <500 mA max @ 11 VDC (230 mA @ 24 VDC, nominal). The input voltage, provided by the DeviceNet network, is introduced to the pressure controller through the 5-pin micro-style connector located on side of the instrument. For more information on the connector see the *DeviceNet Connector* section on page 70.

DeviceNet Controls and Indicators

The local display on the top panel of the πPC contains several DeviceNet controls and indicators.

The device has two standard bi-color (green/red) DeviceNet status LEDs, (Module Status LED and Network Status LED) located on top of the instrument. The power-up sequence of these LEDs conforms to the requirements in the ODVA DeviceNet Specification, Volume 1 [1].

Unrecoverable Fault Condition

A hardware problem with the EEPROM, or a memory problem with the RAM are major unrecoverable faults. This fault condition sets its exception status bit, and the Module Status LED illuminates solid red, complying with Volume I of the DeviceNet Specification.

Note A major unrecoverable fault prevents operation because the device cannot communicate on the network. Contact MKS Instruments, Inc. for assistance.

Power Up

At power-up, the device performs checks on its communications link and internal diagnostic checks of the EEPROM and RAM. The results of these checks are indicated by the color (green or red) and condition (solid or flashing) of the status LEDs on top of the instrument. The following LED sequence occurs when the πPC is powered up (times are approximate):

1. The Module Status LED flashes first GREEN for ¼ second, then RED for ¼ second, then turns OFF.
2. The Network Status LED flashes first GREEN for ¼ second, then RED for ¼ second, then turns OFF.
3. The Module Status LED flashes from GREEN to RED for five seconds while the device is initializing. The Network Status LED remains OFF.
4. The Module Status LED illuminates solid GREEN when initialization is complete.
5. When the device establishes communication with other devices on the network, the Network Status LED illuminates GREEN.

Note If the power up LED sequence does not function properly, contact MKS for assistance.

See *Network and Module Status LED (NET & MOD)*, page 24, for more information on the operation of the Network Status LED and the Module Status LED.

Warm Up and Zero the πPC

After installation and power up, allow the πPC to warm up for a minimum of 30 minutes while under vacuum. Refer to the *Zero Adjustment* section of Chapter 6 on page 79 for more on the warm-up and the zeroing procedure of the πPC.

DeviceNet Protocol

Use this manual with the ODVA DeviceNet Specification Volume I and Volume II [1, 2], and the SEMI Standards Common and Specific Device Models [3, 4]. Refer to those documents for a complete functional description of the πPC Pressure Control device.

See πPC DeviceNet Manual, MKS part number 1005676-001 for specific commands and command structures.

Overview of πPC RS-485 Digital Operation

A detailed software attribute summary pertaining to the RS-485 communications is provided in the πPC RS-485, Instruction manual (MKS P/N 1005677-001).

Power Requirements

The πPC requires an input voltage of +15.0 to +24.0 VDC @ 350mA max. The input voltage is introduced to the pressure controller through the 9-Pin Male D connector located on side of the instrument. For more information on the connector see the *RS-485 Connector* section on page 70.

RS-485 Controls and Indicators

The local display on the top panel of the πPC contains the RS-485 controls and indicators.

The device has two standard bi-color (green/red) RS-485 status LEDs, (Module Status LED and Network Status LED) located on top of the instrument.

Unrecoverable Fault Condition

A hardware problem with the EEPROM, or a memory problem with the RAM are major unrecoverable faults. This fault condition sets its exception status bit, and the Module Status LED illuminates solid red.

Note A major unrecoverable fault prevents operation because the device cannot communicate on the network. Contact MKS Instruments, Inc. for assistance.

Power Up

At power-up, the device performs checks on its communications link and internal diagnostic checks of the EEPROM and RAM. The results of these checks are indicated by the color (green or red) and condition (solid or flashing) of the status LEDs on top of the instrument.

When the device establishes communication with the Host, the Module Status LED blinks RED.

Note See *Network and Module Status LED (NET & MOD)*, page 25, for more information on the operation of the Network Status LED and the Module Status LED.

Warm-Up and Zero the πPC

After installation and power up, allow the πPC to warm up for a minimum of 30 minutes while under vacuum. Refer to the *Zero Adjustment* section of Chapter 6 on page 79 for more on the warm-up and the zeroing procedure of the πPC.

RS-485 Protocol

See πPC RS-485 Manual, MKS part number 1005677-001 for specific commands and command structures.

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Chapter Six: Maintenance

General Information

In general, no maintenance is required other than proper installation and operation. Periodically check for wear on the cables and inspect the enclosure for visible signs of damage. If a pressure control device fails to operate properly on receipt, check for shipping damage, and check the electrical cable for proper power supply. Any damage should be reported to the freight carrier and MKS Instruments immediately. If there is no obvious damage, and the unit fails to operate properly through your network, obtain a RMA (Return Material Authorization) number before returning the unit to MKS Instruments for service to expedite handling and ensure proper servicing of your instrument. Refer to the *Customer Support* section of Chapter 1 on page 12 for more information on returns.

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 Procedure for the πPC Pressure and Flow (PC99 Only)

All devices should be zeroed under actual installation conditions prior to use. Very slight offsets in the zero condition can contribute to pressure and flow (PC99 only) measurement inaccuracy, especially noticeable at the lower end of the device range.

1. Verify that the πPC is installed in the final equipment orientation (Horizontal Base Down, Vertical Inlet Up, etc.).
2. Warm-up the πPC by doing the following:
    a. Apply power to the device for a minimum of 30 minutes.
    b. Fully open the πPC's valve and subject the device to vacuum for a minimum of 30 minutes. Please note that failing to do this may cause the device to experience significant zero-drift since the pressure sensor was not given adequate time to warm-up. For instructions on how to open the device's valve, see the "*Opening & Closing the πPC's Process Control Valve*" section on page 82.
3. If the πPC will be subjected to elevated ambient temperature conditions, verify that these temperatures have been achieved before continuing.
4. After the warm-up is complete it is recommended that the πPC be set to control to the average pressure that your process requires for 10 minutes before zeroing. If controlling pressure at this point is not desired, then note the extra requirements in Step 5.

5. The final step prior to zeroing the πPC is to setup your gas panel configuration correctly. This may be done by one of the following procedures:
    a. For systems with upstream and downstream positive shut-off valves
        i. Close the upstream valve. (While the system pressure is at "zero")
        ii. Close the downstream valve.
        iii. Close the πPC valve. If the pressure was not controlled in step 4, then it is recommended that you close the valve and wait for (5) minutes before moving on to step 6. To close the πPC's valve, see the "*Opening & Closing the πPC's Process Control Valve*" section on page 82.
        iv. Follow steps 6 and 7 for the zeroing procedure for both pressure and flow (PC99).
    b. For systems with a downstream valve only
        i. Keep the downstream valve open.
        ii. If it is possible to stop gas flow to the πPC by some means, then do so. Once the gas flow has stopped and the system has been pumped down, close the πPC valve. If the pressure was not controlled in step 4, then it is recommended that you close the valve and wait for (5) minutes before moving on to step 6. To close the πPC's valve, see the "*Opening & Closing the πPC's Process Control Valve*" section on page 82.
        iii. If the device is a PC99, after zeroing the pressure, close the downstream valve and allow the pressure to equilibrate across the device. When the pressure has equilibrated the flow output will stop changing. You can verify that the flow output has stopped changing by either toggling the "Push-Button" display until it shows flow or highlighting the browser variable on the plot page and clicking the "Start" button to track the flow output. Once the value stops changing, close the πPC valve and verify that the reading continues to stay steady. To close the πPC's valve, see the "*Opening & Closing the πPC's Process Control Valve*" section on page 82.
        iv. Follow steps 6 and 7 for the zeroing procedure for both pressure and flow.
    c. For systems with an upstream valve only
        i. Close the upstream valve.
        ii. With the πPC valve open, verify that the line pressure is zero and then close the πPC valve. If the pressure was not controlled in step 4, then it is recommended that you close the valve and wait for (5) minutes before moving on to step 6. To close the πPC's valve, see the "*Opening & Closing the πPC's Process Control Valve*" section on page 82.
        iii. If the device is a PC99, after zeroing the pressure, verify that the flow output has stopped changing by either toggling the "Push-Button" display until it shows flow or highlighting the browser variable and clicking the "Start" button to track the flow output. Once the value stops changing, close the πPC valve and verify that the reading continues to stay steady. To close the πPC's valve, see the "*Opening & Closing the πPC's Process Control Valve*" section on page 82.
        iv. Follow steps 6 and 7 for the zeroing procedure for both pressure and flow.

Note To zero the pressure transducer to zero pressure the adjustment ***must*** be made at a pressure less than the pressure transducer's resolution (0.01% of Full Scale).

6. To zero the pressure transducer to zero pressure your system must be able to pump down to a pressure less than the pressure transducer's resolution (0.01% of Full Scale). See Table 12 below for a listing of what the highest pressure can be for a proper zero adjustment. If your system can not achieve these pressures, then the πPC allows you to zero the pressure transducer to the lowest pressure your system can pump down to. So for example, if your system could only pump down to one Torr, then you can enter one Torr in the zero data field.

Table 12: Highest Pressures Suggested for Proper Zero Adjustment

Full Scale Range	Highest Pressure for Proper Zero Adjustment
100 Torr	1×10^{-2} Torr
1000 Torr	1×10^{-1} Torr
2000 Torr	2×10^{-1} Torr
1000 Psia	1×10^{-2} Psia

7. For DeviceNet devices, you may zero the πPC over DeviceNet by following the "*DeviceNet Zeroing Commands*" section on page 83. For RS-485 devices, you may zero the πPC over RS-485 by following the "*RS-485 Zeroing Commands*" section on page 84. For Analog devices, you can zero the pressure by pressing the zero-button on top of the device. To zero flow (if PC99), you must use the browser. For All devices, you may use the browser to zero both pressure and flow (PC99 only). Go to the "Configuration" page in "Setup Mode". *To log into "Setup Mode", follow the instructions on page 46.* Once you get to the page, you should see the "Zeroing" section in the bottom left-hand corner of the page. To zero the pressure for gas panel configuration A, B or C follow step 7a unless you are unable to pump your system down to zero due to pump strength. In this case, follow step 7b. To zero flow, follow step 7c.

   a. To zero the pressure enter the value (0), without parentheses, in the text box next to the "Zero Pressure" button. Then click the "Zero Pressure" button. The device will now proceed to zero out the pressure and then save the adjustment. This will take approximately (20) seconds for a small zero-offset. If the device has a large zero-offset, then it can take a few minutes. The browser will alert you once the zero has been issued. Refresh the browser after this.

   b. In the case that the system can not be pumped down to zero, take the value from a standard and use that as your base pressure. To zero the pressure, enter your base pressure in the text box next to the "Zero Pressure" button. Then click on the "Zero Pressure" button. The device will now proceed to zero out the pressure and then save the adjustment. This will take approximately (20) seconds for a small zero-offset. If the device has a large zero-offset, then it can take a few minutes. The browser will alert you once the zero has been issued. Refresh the browser after this.

   c. To zero the flow, click on the "Zero Flow" button. The device will now proceed to zero out the flow and then save the adjustment. This usually takes less than one minute.

Opening & Closing the πPC's Process Control Valve

There are different ways to open/close the πPC's process control valve depending on the electrical interface. Each electrical interface has a unique way to open/close the valve and these are listed below.

Note If the πPC's process control valve is ever opened or closed through one of the electrical interfaces, then it is mandatory to set the valve back to Normal Operating Mode prior to use.

DeviceNet Valve Control

The πPC must be in the executing state before you can open/close the valve. The following assumes explicit messaging only using the DeviceNet communication protocol.

1. Place the device in the Executing State through the S-Device Supervisor Object. Note the response Status: Success. The following DeviceNet command places the device in executing.

   Service 0x0E**, Class** 0x30**, Instance** 1

2. Verify you are in executing through the S-Device Supervisor Object. Note the response Data (hex): 04 means you are in executing. The following DeviceNet command is used to verify you are in executing. You should get response data 0x04.

   Service 0x0E**, Class** 0x30**, Instance** 1**, Service Data (attribute)** 0x0B

3. To fully open the valve through the S-Analog Actuator Object, use the following DeviceNet command:

   Service 0x10**, Class** 0x32**, Instance** 1**, Attribute** 0x05**, Service Data** 0x02

4. To close the valve through the S-Analog Actuator Object, use the same DeviceNet command as is used in step (3) above except with **Service Data** = 0x01.

5. To set the valve back to Normal operation through the S-Analog Actuator Object, use the same DeviceNet command as is used in step (3) above except with **Service Data** = 0x00.

RS-485 Valve Control

You are able to control the valve over RS-485 by using the "Set Actuator Mode" message.

1. To fully open the valve using the "Set Actuator Mode" message, send the following message from the Host to the πPC:

   MAC ID (πPC MAC ID**), STX** 0x02, **Command Code** 0x81**, Packet Length** 0x04**, Class ID** 0xAA**, Instance ID** 0x01**, Attribute ID** 0x02**, Actuator Mode** 0x02**, Pad** 0x00**, Checksum** 0x36

2. To close the valve using the "Set Actuator Mode" message, send the same message from the Host to the πPC as is sent in step (1) above except with **Actuator Mode** = 0x01 and the **Checksum** = 0x35.

3. To set the valve back to Normal operation using the "Set Actuator Mode", send the same message from the Host to the πPC as is sent in step (1) above except with **Actuator Mode** = 0x00 and the **Checksum** = 0x34.

Analog Valve Control

1. To fully open the valve over Analog pull the Valve Open pin, pin 4, low.

2. To close the valve over Analog pull the Valve Close pin, pin 3, low.

3. To return the valve to Normal operation, allow pins 3 and 4 to float.

DeviceNet Zeroing Commands

The πPC must be in the executing state before you can zero the pressure and flow (if applicable). The following assumes explicit messaging only using the DeviceNet communication protocol.

1. Place the device in the Executing State through the S-Device Supervisor Object. Note the response Status: Success. The following DeviceNet command places the device in executing.

   Service 0x0E**, Class** 0x30**, Instance** 1

2. Verify you are in executing through the S-Device Supervisor Object. Note the response Data (hex): 04 means you are in executing. The following DeviceNet command is used to verify you are in executing. You should get response data 0x04.

   Service 0x0E**, Class** 0x30**, Instance** 1**, Service Data (attribute)** 0x0B

3. To zero the pressure, you must use the Zero Adjust Service through the S-Analog Sensor Object Instance 1 (Pressure).

   Service 0x4B**, Class** 0x31**, Instance** 1**, Service Data (**Target Value**)**

   The "Target Value" must be an integer if you don't change the data type. Integer is the default "Data Type" (Attribute 0x03), but you have the option to change it to Real. The DeviceNet command for changing the data type to Real is:

   Service 0x4B**, Class** 0x31**, Instance** 1**, Attribute** 0x03**, Service Data** 0xCA

   To change the data type back to Integer, the DeviceNet command is:

   Service 0x4B**, Class** 0x31**, Instance** 1**, Attribute** 0x03**, Service Data** 0xC3

   The "Target Value", whether Integer of Real must be your "base pressure" (*the minimum pressure to which your vacuum can pump the system down to*). In most cases, this value will be zero.

4. To zero the flow, you must use the Zero Adjust Service through the S-Analog Sensor Object Instance 4 (Flow). The flow zeroing procedure usually takes several seconds to perform. You can perform an Autozero for flow by using the following DeviceNet command:

   Service 0x0E**, Class** 0x31**, Instance** 4**, Attribute** 0x1C**, Service Data** 0x01

   Attribute 0x1C is the Autozero status. The attribute's service data will equal "1" while zeroing is in progress and "0" when the zeroing has completed. *Keep in mind that no flow should be going through the device. If a flow greater than or equal to 15% of the full scale range is detected by the πPC, then zeroing will not occur.*

RS-485 Zeroing Commands

The πPC must be in the executing state before you can zero the pressure or flow (if applicable).

1. To zero the pressure, you must use the "Requested Pressure Zero Enable" message. Send the following message from the Host to the πPC:

   MAC ID (πPC MAC ID**), STX** 0x02, **Command Code** 0x81**, Packet Length** 0x07**,**
   Class ID 0x68**, Instance ID** 0x01**, Attribute ID** 0xBA**, Target Value(**Byte 1−LSB**),**
   Target Value(Byte 2**), Target Value(**Byte 3**), Target Value(**Byte 4−MSB**), Pad** 0x00**,**
   Checksum (Sum of all bytes excluding the MAC ID**)**

   The "Target Value" is a (4) byte floating point number. The actual number used must be your "base pressure" (*the minimum pressure to which your vacuum can pump the system down to*). In most cases, this value will be zero.

2. To zero the flow (if applicable), you must use the "Requested Flow Zero Enable" message.

   MAC ID (πPC MAC ID**), STX** 0x02, **Command Code** 0x81**, Packet Length** 0x04**,**
   Class ID 0x68**, Instance ID** 0x02**, Attribute ID** 0xBA**, Enable(**1**), Pad** 0x00**,**
   Checksum (Sum of all bytes excluding the MAC ID**)**

Chapter Seven: Troubleshooting

Troubleshooting Chart

Table 13: Troubleshooting Chart

Symptom	Possible Cause	Check/Corrective Action
Cannot Connect to unit through Ethernet	Network not setup correctly	Go through the Manual Network setup instructions in Chapter 3 of this manual.
	Incorrect cable	If connecting to the device directly from a computer, you must be using a crossover cable. If connecting through a Hub/Switch, then you must use a standard Ethernet cable.
	Internet securities too high	Through a command window, type the following command through the c: drive: "ping xx.xx.xx.xx" where xx.xx.xx.xx is the device's IP address. If the connection doesn't time out then check your internet settings.
Local display does not light	No power	Check power source
	Low power	Measure voltage 11-25 VDC (DNet)
	Wrong cable	Obtain correct cable
	Bad cable connection	Check pin(s) continuity
Does not respond to setpoint	Low or no power	Check power source, measure voltage
	If DeviceNet, incorrect connection	Verify correct DNet I/O instance
	Control circuit failure	Provide setpoint, gas & pressure to device, run diagnostic using Ethernet GUI. If error results, contact MKS service center.
	Contamination/Clogged - blocked πPC device or gas line	Check inlet pressure @ πPC. Check outlet pressure @ πPC using pressure gauge. Make sure adequate vacuum. Check air line to pneumatic valves if applicable. Check for any restriction such as filter or check valve downstream / upstream of πPC.

Display shows (0) pressure when given setpoint	Closed upstream pneumatic valve	Open valve
	Closed or faulty regulator	Check regulator for proper operations
	Upstream clog	Check for gas flow to the πPC.
	No gas supply	Turn on gas source
	πPC fault pressure transducer output	Run πPC diagnostics using Ethernet GUI. If error results, contact MKS service center.
	Downstream valves open to vacuum, upstream valves closed	Check status of pneumatic valves air lines & solenoid valves & system pump

Display shows (0) flow **PC99 Only**	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
	πPC clogged orifice	Verify πPC inlet pressure, check valve current for open valve condition. Check for gas flow downstream of πPC - If flow does not exist, possible clogged orifice
	πPC clogged sensor	Run πPC diagnostics using Ethernet GUI. If error results, contact MKS service center. Verify πPC inlet pressure, check valve current for open valve condition, check for gas flow downstream. If flow present, possible clogged sensor
	πPC control circuit failure	Run πPC diagnostics using Ethernet GUI. If error results, contact MKS service center.

πPC shows output pressure overrange	πPC valve fully open	Check valve current for maximum condition
	Pressure drop across πPC is greater than specification	Measure upstream pressure & downstream pressure. Compare to spec.
	Faulty valve control circuit/calibration	Run πPC diagnostics using Ethernet GUI. If error results, contact MKS service center.
	Possible contamination in valve assembly	Cycle-purge πPC to clear suspected contamination

πPC output signal does not match setpoint	Contamination	Check for partial block orifice or sensor. Cycle purge πPC to clear contaminant
	Inlet pressure too low	Increase inlet pressure
	Outlet pressure too high	Decrease outlet pressure
	Control electronics failure, sensor failure	Run πPC diagnostics using Ethernet GUI. If error results, contact MKS service center.

πPC output signal oscillates	kP and/or kI values not adjusted correctly	Check / readjust values through Ethernet GUI. Follow Tuning instructions on page 61.
	Inlet pressure too high	Lower inlet pressure
	Inlet pressure oscillates	Check for faulty regulator
	Faulty control circuit	Run πPC diagnostics using Ethernet GUI. If error results, contact MKS service center.

πPC flow output signal matches setpoint, but actual gas flow is less (as determined by transfer standard) ** PC99 Only **	Contaminated bypass	Check process chamber pressure. Compare to normal or reference.
	πPC programmed for different gas	Compare gas programmed in πPC to actual gas used. Verify using DNet or Ethernet interface.

πPC cannot achieve FS pressure ** For Downstream Controllers **	Inlet pressure low	Increase inlet pressure >>be sure not to exceed 45 psi(d)
	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
	Flow through control volume is not restricted enough. Vacuum force pulls flow out to quickly to build up to FS pressure.	Adjust flow restriction.

πPC cannot achieve FS pressure ** For Upstream Controllers **	Inlet pressure low	Increase inlet pressure >>be sure not to exceed 45 psi(d)
	Possible contamination in valve assembly	Check valve current for minimum position. Cycle-purge πPC to clear suspected contamination
	Gas line blockage/contamination	Measure pressure drop across component suspected of contamination such as filter or check valve
	Closed Conductance through valve too high	Check valve current for minimum position and measure flow through device with 25 psig on the inlet.

Display powers up, but πPC doesn't respond** For DeviceNet πPC's **	Bad DeviceNet (DNet) connection	Check status DNet polled connection, check network LED
	Incorrect MAC ID Address	Check MAC ID on device / tool host
	Incorrect baud rate setting	Check baud rate on device / tool host
	Incorrect DNet I/O Instance Setting	Check I/O setting using DNet commissioning tool/software
	Low power, power supply	Measure current & voltage from power source

πPC output shows large overshoot or undershoot	Inlet pressure too high	Decrease inlet pressure
	kP and/or kI values not adjusted correctly	Check / readjust values through Ethernet GUI. Follow Tuning instructions on page 61.

Output signal > zero with confirmed zero pressure condition	Insufficient warm-up time for pressure sensor.	Allow device to be under vacuum for a minimum of 30 minutes prior to zeroing. Refer to zeroing instructions on page 79.
	MFC device zero offset	
	Fault in valve adjustment, gap between plug & orifice	Contact MKS service center

Pressure output signal different than confirmed line pressure	Zero offset in pressure transducer	Re-zero pressure transducer using known pressure standard & Ethernet GUI

LED INDICATOR (COLOR)	STATE	INDICATION
DNET Network status LED		
Solid Green	Link OK, On-line, Connected	The device in on-line and has connection in the established state.
Flashing Green	On-line, Not Connected	Device is on-line but has no connection in the established state. The device has passed The Dup_MAC_ID test, is on-line, but has no established connections to other nodes. For a Group 2 only device it means that this device is not allocated to a master.
Solid Red	Critical Link Failure	Failed communication device. The device has detected an error that has rendered it incapable of communicating on the network (Duplicate MAC ID, or Bus-off)
Flashing Red	Connection Time-Out	One or more I/O Connections are in the Timed-Out state.
Flashing Red & Green	Communication Faulted and Received an Identify Comm Fault Request - Long Protocol	A specific Communication Faulted device. The device has detected a Network Access error and is in the Communication Faulted state. The device has subsequently received and accepted an Identify Communication Faulted Request - Long Protocol message.
Off	Not Powered/Not On-Line	Device is not on-line
		The device has not completed The Dup_MAC-ID test yet
		The device may not be powered, look at Module Status LED.
DNET Module Status LED		
Green	Device operational	The device is operating in a normal condition
Flashing Green	Device in Standby (The Device Needs Commissioning)	The device needs commissioning due to configuration missing, incomplete or incorrect.
Red	Unrecoverable Fault	The device has an unrecoverable fault; may need replacing.

Flashing Red	Minor Fault	Recoverable Fault

Flashing Red & Green	Device Self Testing	The Device is in Self Test. Reference the Identity Object in Volume II for Device states.

Off	No power	There is no power applied to the device

Appendix A: Product Specifications for the PC90 Model

Physical Specifications

Pressure Type	Absolute
Pressure Full Scale Ranges	100 Torr, 1000 Torr, 2000 Torr, 100 Psi
Transducer Over Pressure Limit	2x Full Scale for all ranges
Orifice Full Scale Ranges[1]	(sccm) 50, 200, 1000, 5000, 10000, 20000, 30000, 50000
Maximum Differential Pressure	45 Psid
Burst Pressure	1500 Psig
Control Mode	Upstream or Downstream
Valve Options	
Type	Normally Closed or Normally Open
Seal Material	PTFE (Teflon) or Sapphire (Metal)

Performance Specifications

Pressure Reading

Accuracy[2]	± 1.0% of Reading (for >2 to 100% of Full Scale)
Temperature Coefficients	
Zero	± 0.02% of Full Scale / °C
Span	± 0.04% of Reading / °C
Pressure Readout Units	(For all Torr Full Scale ranges) Torr, kPa; (For Psi Full Scale Range) Psi, kPa
Pressure Resolution	0.1 Torr for 0 to 100 Torr, 1 Torr for >100 Torr. 0.1 Psi for 0 to 100 Psi

Pressure Control

Accuracy[2]	± 0.2% of Full Scale (< 10% full scale); ± 1.0% of reading (≥ 10% full scale)
Range	>2 to 100% of Full Scale
Typical Response Time[3]	< 1.0 second

Temperature Reading

Temperature Display Range	0 to 100°C
Temperature Readout Units	°C
Temperature Accuracy	± 2°C
Temperature Resolution	0.1°C

[1] Orifice Full Scale ranges are Nominal Full Scale flow rates for Nitrogen with 15 Psig on the inlet and atmosphere on the outlet side.

[2] Accuracy includes linearity, hysteresis, and repeatability.

[3] Typical response time is excluding system time constant.

Environmental Specifications

Operating Temperature Range	10° to 50°C (50° to 122°F)
Storage Temperature Range	-20° to 80°C (-4° to 176°F)
Storage Humidity Range	0 to 95% Relative Humidity, non-condensing

Mechanical Specifications

Fittings	Swagelok 4 VCR Male, 1-1/8" surface mount (C-seal, W-seal)
Display	4 digits for value, 4 characters for unit
Leak Integrity External (scc/sec He) Through closed valve	 $< 1 \times 10^{-10}$ < 1.0% for Full Scale (Nitrogen at 25 psig on inlet to atmosphere)
Wetted Materials Standard Optional (Valve Seal)	 316L S.S. VAR (equivalent to 316 S.S. SCQ for semiconductor quality), 316L S.S., 316 S.S., Elgiloy, KM-45, Inconel 718, 825 Incoloy PTFE (Teflon) or Sapphire (Metal)
Surface Finish	5 µinches, average Ra
Weight	≤ 3 lbs (1.36 kg)

Electrical Specifications

Analog I/O

Input Power Required	+15 to +24 VDC @ 350mA max
Pressure Set Point Command / Output Signal	0 to 10 VDC (Default), 0 to 5 VDC (User Switchable)
Valve Test Point Signal	0 to 5 VDC
Trip Points Rated Current State Hysteresis Status LEDs	Two open collector transistors, adjustable from 0 to 100% of Full Scale. 30VDC / 250mA On, above, or below trip point 3% of Full Scale (factory set) Red when the transistor is on
Output Impedance	< 1 Ω
Connector	15-pin Type "D" Male
Electromagnetic Compatibility	CE Compliant

Digital I/O (DeviceNet)

Input Power Required	+11 to +25 VDC per DeviceNet specification (@ <3.5 watts)
Data Rate Switch	4 positions: 125, 250, 500K (*Default*), PGM (programmable over the network)
Data Rate / Network Length	Data Rate (User Selectable) 125 Kbps, 500 meters (1,640 feet) 250 Kbps, 250 meters (820 feet) 500 Kbps, 100 meters (328 feet)
MAC ID Switches	2 switches, 10 positions; 0,0 to 6,3 are hardware ID numbers: 7,0 to 9,9 are software ID numbers; (6,4 to 6,9 are unused and, if selected will default to hardware ID number 6,3)
Network Size	Up to 64 nodes
Network Topology	Linear (trunkline/dropline) power and signal on same network cable
Visual Communication Indicators	LED network status (green/red) LED module status (green/red) Scrolling LED displays(πPC Type, Pressure Full Scale, IP address) Push-Button Display toggles between (Pressure in TORR & KPA or PSI & KPA, Temperature and Scrolling display)
Level of Filtering	User software adjustable
Digital Functions (pressure)	Select units: counts (*Default*), torr, psi, kpa Remote Zero Set/read control pressure Monitor πPC status – valve drive level and trip points (alarm for high pressure, alarm for low pressure, warning for high pressure, warning for low pressure) Reset factory defaults Set PID control parameters Set/Get Actuator Mode, Safe State Change user tags and device address Device Identification Storage includes manufacturer information, model and serial number, original factory calibration, software and hardware revision numbers.
Digital Functions (temperature)	Set units Read temperature Alarm enable, Warning enable Alarm settling time, Warning settling time Alarm trip point high, Warning trip point high Alarm trip point low, Warning trip point low
Electromagnetic Compatibility	CE Compliant

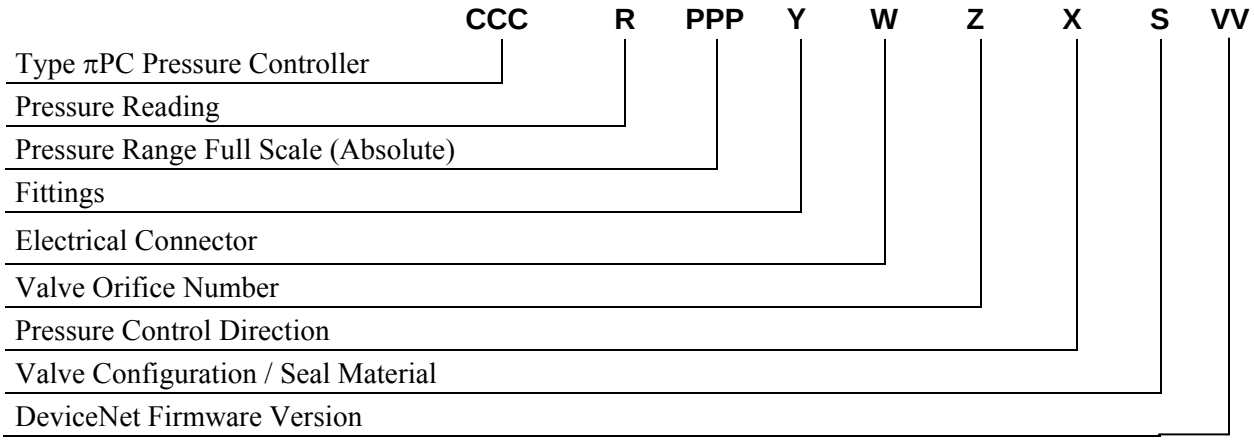
Digital I/O (RS-485) with Analog Pressure Out

Input Power Required	+15 to +24 VDC @ 350mA max
Connector	9-pin Type "D" Male
Analog Pressure Output Signal	0 to 10 VDC (Default), 0 to 5 VDC (User Switchable)
Data Rate Switch	3 positions: 9.6, 19.2, 38.4K (*Default*)
Data Rate / Network Length	Data Rate (User Selectable) 9.6 Kbps, 1200 meters (4,000 feet) 19.2 Kbps, 1200 meters (4,000 feet) 38.4 Kbps, 1200 meters (4,000 feet)
MAC ID Switches	2 switches, 10 positions; 0,0 to 9,9. Available MAC ID's are 3,2 to 9,9.
Network Size	Up to 32 nodes
Network Topology	A Host controller acts as a master device on an RS-485 multi-drop bus. It controls all transactions on the bus. The pressure controller acts as a slave device on the RS-485 multi-drop bus. It will continually look for transaction requests from the Host controller, process requests addressed to it, and send replies as needed.
Visual Communication Indicators	LED network status (green/red) LED module status (green/red) Scrolling LED displays(πPC Type, Pressure Full Scale, IP address) Push-Button Display toggles between (Pressure in TORR & KPA or PSI & KPA, Temperature and Scrolling display)
Communication Parameters	BAUD rate: 9.6, 19.2, 38.4 Kbps (*Default*) Data bits: 8 Start bit: 1 Stop bit: 1 Parity: none Byte order: LSB first MAC (Address) assignment: → Host Controller: 0x00 → Available MAC ID range: 0x20(32) – 0x63(99) → Broadcast packet address: 0xFF(255) → Addresses 0x01(01) to 0x1F(31) are reserved for bus control characters * ACK — 0x06 * ACK — 0x16
Digital Functions (pressure)	Set/Query control pressure Set/Query PID parameters Set/Query Actuator Mode, Safe State, Valve Drive Level Remote Zero Device Identification Storage includes manufacturer information, model and serial number, original factory calibration, software revision numbers.
Digital Functions (temperature)	Query Temperature
Electromagnetic Compatibility	CE Compliant

Appendix B: Model Code Explanation for the PC90 Model

Model Code Description

This model code is for the πPC, type PC90 model. It defines features of the unit such as device type, pressure range, fittings, electrical connector type, valve configuration, seal material and firmware revision.



Type πPC Pressure Controller (CCC)

The πPC, type PC90 pressure controller is indicated by a three letter code.

πPC Type	Ordering Code (CCC)
Pressure controller	PCA

Pressure Reading (R)

The πPC, type PC90 pressure controller is indicated by a single digit code. Currently, only an absolute reading (PC90) is available.

Pressure Reading	Ordering Code (R)
Absolute, Type PC90	0

Pressure Range Full Scale (PPP)

The πPC's pressure range full scale is indicated by a three character alphanumeric code. All pressure full scale ranges are absolute scale only.

Pressure Range Full Scale	Ordering Code (PPP)
100 Torr (mmHg)	12T
1000 Torr (mmHg)	13T
2000 Torr (mmHg)	23T
100 psi	12P

Fittings (Y)

The fitting options are designated by a single letter code. All options are for a 1.125" foot print.

Fitting Style	Ordering Code (Y)
Swagelok VCR-4 male	R
Downport, 1.125" C-Seal	C
Downport, 1.125" W-Seal	H

Electrical Connector (W)

The πPC's connector is designated by a single letter code or a single digit code.

Connector Type	Ordering Code (W)
DeviceNet	6
Digital RS-485, 9-Pin D	5
15 Pin D(Analog I/O)	B

Valve Orifice Number (Z)

The valve orifice number is designated by a single letter code or a single digit code. The flow rates given are with 15 psig of Nitrogen on the inlet and atmosphere on the outlet.

Valve Orifice Number	Ordering Code (Z)
50 sccm	A
200 sccm	1
1,000 sccm	2
5,000 sccm	3
10,000 sccm	4
20,000 sccm	5
30,000 sccm	6
50,000 sccm	7

Control Direction (X)

The control direction is designated by a single letter code.

Connector Type	Ordering Code (X)
Downstream	D
Upstream	U

Valve Configuration / Seal Material (S)

The seal material option is designated by a single letter code. The letter code also designates whether or not the valve is normally open or normally closed. Currently, the normally open valve is only available with Teflon, and the Metal valve is only available for orifice sizes of 5,000 sccm and below.

Configuration / Seal Material	Ordering Code (S)
Normally Closed, Teflon	T
Normally Open, Teflon	P
Normally Closed, Metal	M (10 sccm to 5,000 sccm orifice sizes only)

Firmware Version (VV)

The firmware version options are designated by a two digit code.

Example: The release of firmware version 1.0 = 10

Firmware Version	Ordering Code (VV)
DeviceNet Only	(leave blank)

Note The default order code is to leave this position blank. This means that the devices shipped will have the latest firmware. However if a specific version of firmware is desired, be sure to include that part in the model code when you order.

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Appendix C: Product Specifications for the PC99 Model

Physical Specifications

Pressure Type	Absolute
Pressure Full Scale Ranges	100 Torr, 1000 Torr, 2000 Torr, 100 Psi
Flow Full Scale Ranges (*N_2 Equivalent*)	(sccm) 10, 20, 50, 100, 200, 500, 1000, 2000, 5000, 10000, 20000, 30000
Transducer Over Pressure Limit	2x Full Scale for all ranges
Orifice Full Scale Ranges[1]	(sccm) 50, 200, 1000, 5000, 10000, 20000, 30000
Maximum Differential Pressure	45 Psid
Burst Pressure	1500 Psig
Control Mode	Downstream
Valve Options Type Seal Material	 Normally Closed or Normally Open PTFE (Teflon) or Sapphire (Metal)

Performance Specifications

Pressure Reading

Accuracy[2]	± 1.0% of Reading (for >2 to 100% of Full Scale)
Temperature Coefficients Zero Span	 ± 0.02% of Full Scale / °C ± 0.04% of Reading / °C
Pressure Readout Units	(For all Torr Full Scale ranges) Torr, kPa; (For Psi Full Scale Range) Psi, kPa
Pressure Resolution	0.1 Torr for 0 to 100 Torr, 1 Torr for >100 Torr. 0.1 Psi for 0 to 100 Psi

Pressure Control

Accuracy[2]	± 0.2% of Full Scale (< 10% full scale); ± 1.0% of reading (≥ 10% full scale)
Range	>2 to 100% of Full Scale
Typical Response Time[3]	< 1.0 second

[1] Orifice Full Scale ranges are Nominal Full Scale flow rates for Nitrogen with 15 Psig on the inlet and atmosphere on the outlet side.

[2] Accuracy includes linearity, hysteresis, and repeatability.

[3] Typical response time is excluding system time constant.

Flow Reading

Measurement Range	2 to 100% of Full Scale
Accuracy[4]	± 1.0% of Reading for > 10% of Full Scale ± 0.21% of Full Scale for 2 to 10% of Full Scale
Repeatability	± 0.2% of Full Scale
Resolution	0.1% of Full Scale
Temperature Coefficients Zero Span	 ± 0.05% of Full Scale / °C ± 0.08% of Reading / °C
Pressure Coefficient	< 0.02% of Reading / psi
Meter Response Time	< 100 msec

Temperature Reading

Temperature Display Range	0 to 100°C
Temperature Readout Units	°C
Temperature Accuracy	± 2°C
Temperature Resolution	0.1°C

[4] Accuracy includes non-linearity, hysteresis and non-repeatability referenced to 760 Torr and 0°C

Environmental Specifications

Operating Temperature Range	10° to 50°C (50° to 122°F)
Storage Temperature Range	-20° to 80°C (-4° to 176°F)
Storage Humidity Range	0 to 95% Relative Humidity, non-condensing

Mechanical Specifications

Fittings	Swagelok 4 VCR Male, 1-1/8" surface mount (C-seal, W-seal)
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 Full Scale (Nitrogen at 25 psig on inlet to atmosphere)
Wetted Materials Standard Optional (Valve Seal)	 316L S.S. VAR (equivalent to 316 S.S. SCQ for semiconductor quality), 316L S.S., 316 S.S., Elgiloy, KM-45, Inconel 718, 825 Incoloy PTFE (Teflon) or Sapphire (Metal)
Surface Finish	5 µinches, average Ra
Weight	≤ 3 lbs (1.36 kg)

Electrical Specifications

Analog I/O

Input Power Required	+15 to +24 VDC @ 350mA max
Pressure Set Point Command / Output Signal	0 to 10 VDC (Default), 0 to 5 VDC (User Switchable)
Flow Output Signal	0 to 5 VDC
Valve Test Point Signal	0 to 5 VDC
Trip Points Rated Current State Hysteresis Status LEDs	Two open collector transistors, adjustable from 0 to 100% of Full Scale. 30VDC / 250mA On, above, or below trip point 3% of Full Scale (factory set) Green when the transistor is on
Output Impedance	< 1 Ω
Connector	15-pin Type "D" Male
Electromagnetic Compatibility	CE Compliant

Digital I/O (DeviceNet)

Input Power Required	+11 to +25 VDC per DeviceNet specification (@ <3.5 watts)
Data Rate Switch	4 positions: 125, 250, 500K (*Default*), PGM (programmable over the network)
Data Rate / Network Length	Data Rate (User Selectable) 125 Kbps, 500 meters (1,640 feet) 250 Kbps, 250 meters (820 feet) 500 Kbps, 100 meters (328 feet)
MAC ID Switches	2 switches, 10 positions; 0,0 to 6,3 are hardware ID numbers: 7,0 to 9,9 are software ID numbers; (6,4 to 6,9 are unused and, if selected will default to hardware ID number 6,3)
Network Size	Up to 64 nodes
Network Topology	Linear (trunkline/dropline) power and signal on same network cable
Visual Communication Indicators	LED network status (green/red) LED module status (green/red) Scrolling LED displays(πPC Type, Pressure Full Scale, IP address) Push-Button Display toggles between (Pressure in TORR & KPA or PSI & KPA, Temperature and Scrolling display)
Level of Filtering	User software adjustable

Digital Functions (pressure)	Select units: counts (*Default*), torr, psi, kpa Remote Zero Set/read control pressure Monitor πPC status – valve drive level and trip points (alarm for high pressure, alarm for low pressure, warning for high pressure, warning for low pressure) Reset factory defaults Set PID control parameters Set/Get Actuator Mode, Safe State Change user tags and device address Device Identification Storage includes manufacturer information, model and serial number, original factory calibration, software and hardware revision numbers.
Digital Functions (flow)	Select units: counts (*Default*), sccm, slm, % of Full Scale Remote Zero Read flow Monitor πPC status – trip points (alarm for high pressure, alarm for low pressure, warning for high pressure, warning for low pressure) Create New Gas Table Rerange Gas Table Change Gas Instance
Digital Functions (temperature)	Set units Read temperature Alarm enable, Warning enable Alarm settling time, Warning settling time Alarm trip point high, Warning trip point high Alarm trip point low, Warning trip point low
Electromagnetic Compatibility	CE Compliant

Digital I/O (RS-485) with Analog Pressure Out

Input Power Required	+15 to +24 VDC @ 350mA max
Connector	9-pin Type "D" Male
Analog Pressure Output Signal	0 to 10 VDC (Default), 0 to 5 VDC (User Switchable)
Data Rate Switch	3 positions: 9.6, 19.2, 38.4K (*Default*)
Data Rate / Network Length	Data Rate (User Selectable) 9.6 Kbps, 1200 meters (4,000 feet) 19.2 Kbps, 1200 meters (4,000 feet) 38.4 Kbps, 1200 meters (4,000 feet)
MAC ID Switches	2 switches, 10 positions; 0,0 to 9,9. Available MAC ID's are 3,2 to 9,9.
Network Size	Up to 32 nodes
Network Topology	A Host controller acts as a master device on an RS-485 multi-drop bus. It controls all transactions on the bus. The pressure controller acts as a slave device on the RS-485 multi-drop bus. It will continually look for transaction requests from the Host controller, process requests addressed to it, and send replies as needed.

Visual Communication Indicators	LED network status (green/red) LED module status (green/red) Scrolling LED displays(πPC Type, Pressure Full Scale, IP address) Push-Button Display toggles between (Pressure in TORR & KPA or PSI & KPA, Temperature and Scrolling display)
Communication Parameters	BAUD rate: 9.6, 19.2, 38.4 Kbps (*Default*) Data bits: 8 Start bit: 1 Stop bit: 1 Parity: none Byte order: LSB first MAC (Address) assignment: → Host Controller: 0x00 → Available MAC ID range: 0x20(32) − 0x63(99) → Broadcast packet address: 0xFF(255) → Addresses 0x01(01) to 0x1F(31) are reserved for bus control characters * ACK — 0x06 * ACK — 0x16
Digital Functions (pressure)	Set/Query control pressure Set/Query PID parameters Set/Query Actuator Mode, Safe State, Valve Drive Level Remote Zero Device Identification Storage includes manufacturer information, model and serial number, original factory calibration, software revision numbers.
Digital Functions (flow)	Query flow reading Set/Query Actuator Active Gas Instance Create New Gas Table Remote Zero
Digital Functions (temperature)	Query Temperature
Electromagnetic Compatibility	CE Compliant

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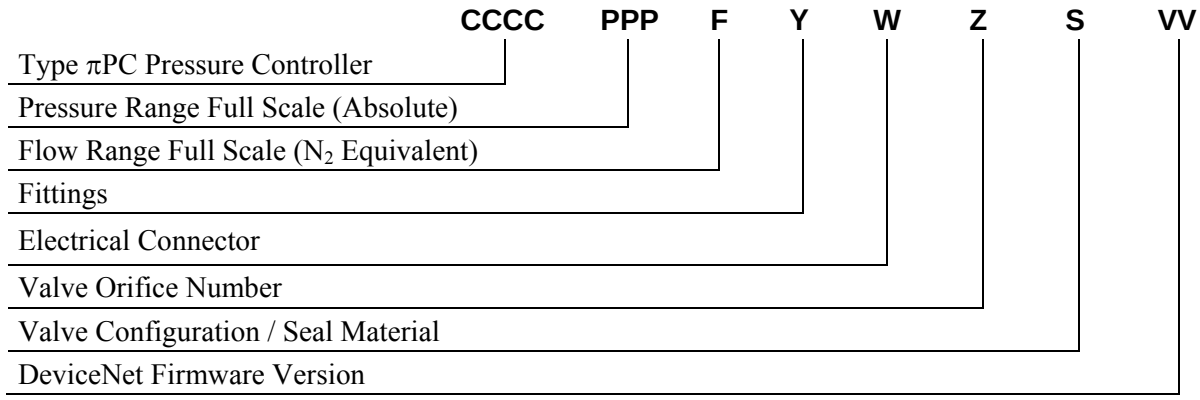
Appendix D: Model Code Explanation for the PC99 Model

Model Code Description

This model code is for the πPC, type PC99 model. It defines features of the unit such as device type, pressure range, flow range, fittings, electrical connector type, valve configuration, seal material and firmware revision.



Type πPC Pressure Controller (CCCC)

The πPC, type PC99 pressure controller is indicated by a four character alphanumeric code.

πPC Type	Ordering Code (CCCC)
Pressure controller with integrated flow meter (PC99)	P99A

Pressure Range Full Scale (PPP)

The πPC's pressure range full scale is indicated by a three character alphanumeric code. All pressure full scale ranges are absolute scale only.

Pressure Range Full Scale	Ordering Code (PPP)
100 Torr (mmHg)	12T
1000 Torr (mmHg)	13T
2000 Torr (mmHg)	23T
100 psi	12P

Flow Range Full Range, N_2 Equivalent (F)

The πPC's flow full scale range is indicated by a single letter code. All ranges are Nitrogen equivalent.

Mass Flow Rate	Ordering Code (F)
10 sccm	A
20 sccm	B
50 sccm	C
100 sccm	D
200 sccm	E
500 sccm	F
1,000 sccm	G
2,000 sccm	H
5,000 sccm	J
10,000 sccm	K
20,000 sccm	L
30,000 sccm	M

Fittings (Y)

The fitting options are designated by a single letter code. All options are for a 1.125" foot print.

Fitting Style	Ordering Code (Y)
Swagelok VCR-4 male	R
Downport, 1.125" C-Seal	C
Downport, 1.125" W-Seal	H

Electrical Connector (W)

The πPC's connector is designated by a single letter code or a single digit code.

Connector Type	Ordering Code (W)
DeviceNet	6
Digital RS-485, 9-Pin D	5
9 Pin D(Analog I/O)	A
15 Pin D(Analog I/O)	B

Valve Orifice Number (Z)

The valve orifice number is designated by a single letter code or a single digit code. The flow rates given are with 15 psig of Nitrogen on the inlet and atmosphere on the outlet.

Valve Orifice Number	Ordering Code (Z)
50 sccm	A
200 sccm	1
1,000 sccm	2
5,000 sccm	3
10,000 sccm	4
20,000 sccm	5
30,000 sccm	6

Valve Configuration / Seal Material (S)

The seal material option is designated by a single letter code. The letter code also designates whether or not the valve is normally open or normally closed. Currently, the normally open valve is only available with Teflon, and the Metal valve is only available for orifice sizes of 5,000 sccm and below.

Configuration / Seal Material	Ordering Code (S)
Normally Closed, Teflon	T
Normally Open, Teflon	P
Normally Closed, Metal	M (10 sccm to 5,000 sccm orifice sizes only)

Firmware Version (VV)

The firmware version options are designated by a two digit number code.

Example: The release of firmware version 1.0 = 10

Firmware Version	Ordering Code (VV)
DeviceNet Only	(leave blank)

Note The default order code is to leave this position blank. This means that the devices shipped will have the latest firmware. However if a specific version of firmware is desired, be sure to include that part in the model code when you order.

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Appendix E: Valve Orifice Selection

General Information

The πPC, Type PC90 is available in eight valve orifice sizes while the Type PC99 is available with seven orifice sizes. You should confirm that the valve orifice in your πPC pressure controller is the correct size for your application before ordering. The orifice is *not* adjustable or replaceable. If the wrong orifice is ordered, a new device must be ordered. After reviewing the information below, if you are not certain as to which orifice you should choose, please consult one of our Application Engineers.

Note This selection guide is valid with either valve plug seat material.

Checking the Orifice Size

The orifice number is included in the model code of your πPC pressure controller. For a complete explanation of model codes please refer to *Appendix B*, page 95, for the PC90 model and *Appendix D*, page 105, for the PC99 model. The nominal flow rates are listed in Table 14.

Table 14: Valve Orifice Size

Orifice Size	
Orifice Size (Model Code Entry)	**Nominal Range (sccm of N_2 with 15 psi ΔP)**
A	50
1	200
2	1000
3	5000
4	10000
5	20000
6	30000
7	50000*

* Requires more than 15 psi delta P to achieve this flow rate

How to Verify the Orifice Selection

The flow through any orifice depends on the size of the orifice, the inlet and outlet pressures and the gas density. To simplify orifice selection, use the following procedure:

Note The procedure below is a useful tool for most typical configurations and applications. If your particular pressure control application falls outside these parameters, please contact our Applications Engineers for assistance in selecting the proper valve orifice.

Note The valves are not calibrated to match the valve orifice selection graph in Figure 42, page 111. The graph displays *typical* valve behavior.

1. Determine the differential (delta) pressure, by subtracting the outlet pressure from the inlet pressure.
2. From Table 15, the Index Number table, choose the inlet pressure, i.e. the pressure that will be applied to the inlet of the device, in PSIA from the column of pressures on the left or in TORR from the column of pressure on the right.

Note All pressure values listed in the Valve Orifice Index Number table, Table 15, are absolute pressures.

3. Next, from the row of pressures at the top (for PSIA) or bottom (for TORR) of Table 15, select the differential (delta) pressure.
4. Locate the Index Number where the selected row and column intersect.

   Example #1: the desired process control pressure is 5 psia, with a flow rate of 1000 sccm of Nitrogen. The inlet pressure is 15 psig, or 30 psia, giving a differential (delta) pressure of 25 psia. Approximating the differential pressure as 30psi gives an index number would be 175.

Table 15: Valve Orifice Index Number

	Differential Pressure (psi)									
	>50	50	30	15	8	4	2	1	0.5	
Inlet Pressure (psia) 100	>585	585	480	355	265	190	135	95	65	**5170**
50	–	295	295	240	185	130	95	65	50	**2585**
30	–	–	175	175	140	100	75	50	40	**1551**
20	–	–	–	115	110	80	60	40	30	**1034**
15	–	–	–	90	90	70	50	35	25	**776**
10	–	–	–	–	60	55	40	30	20	**517**
5	–	–	–	–	–	30	25	20	15	**259**
2	–	–	–	–	–	–	10	10	9	**103**
1	–	–	–	–	–	–	–	6	6	**51.7**
	>2585	2585	1551	776	414	207	103	51.7	25.9	**Inlet Pressure (Torr)**
	Differential Pressure (Torr)									

5. If you are using Nitrogen, then go ahead to step 6. Otherwise see the *Using Different Gases* section on page 112.

6. Use the index number and your maximum flow rate to determine the orifice size from the Orifice Selection Graph, Figure 42. Locate the Index Number along the bottom axis and then draw a vertical line at the Index Number. This line will intersect with the Maximum Flow Rate lines for the valve orifices available.

   Each line represents the *maximum* flow rate for the orifice. Choose the orifice number *above* your point on the graph to ensure that the orifice can deliver the required flow.

   Example #1 Continued: From Step 4, we found that the index number is 175, and by drawing a vertical line on the Orifice Selection Chart at 175 you find that Orifice #2 would be the best choice.

Note If the point on the graph falls *close to* the maximum flow rate for an orifice, you may choose to use the next largest orifice number.

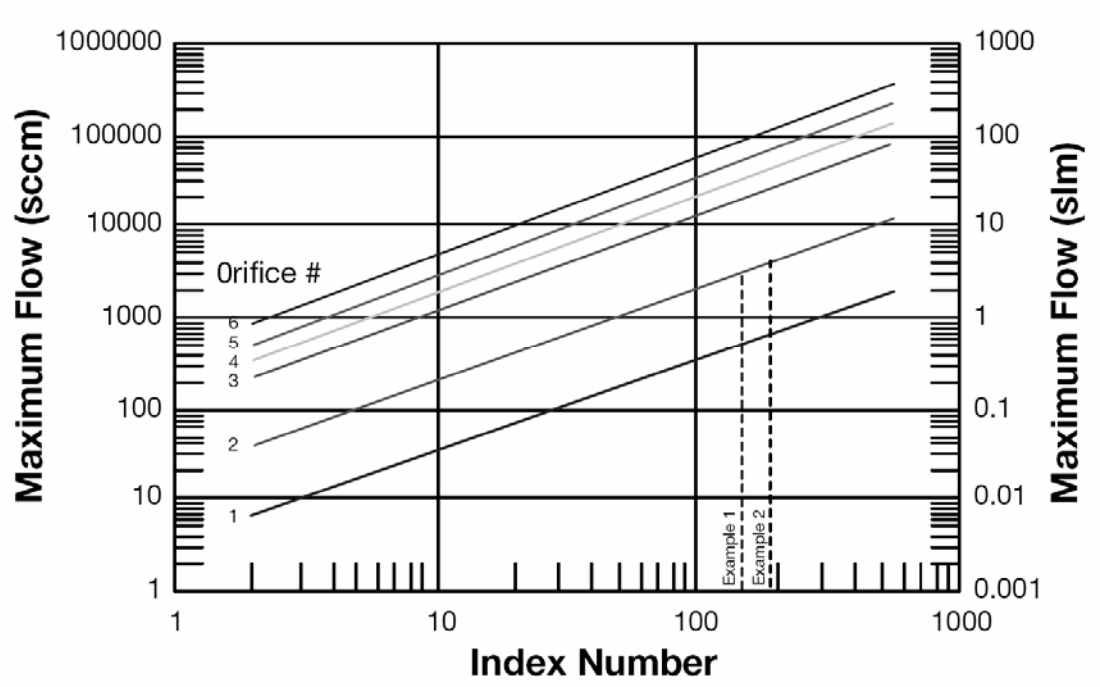

Figure 42: Orifice Selection Graph

7. Check the orifice size of your πPC pressure controller (included in the model number).

Using Different Gases

The valve orifice selection data is based on nitrogen gas. If you will be using a gas other than nitrogen, you need to compensate for the density difference between nitrogen and your process gas before you can select the appropriate valve orifice.

1. To calculate the Density Correction Factor , use the following equation:

$$\sqrt{\frac{N_2\ Density}{Gas\ Density}} = Density\ Correction\ Factor$$

2. To calculate the density-corrected index number for the new gas, use the following equation:

$$\left(Density\ Correction\ Factor\right) \times \left(Nitrogen\ Index\ Number\ \ from\ Step\ 4\right) = New\ Index\ Number$$

3. Proceed with step 6 of *How to Verify the Orifice Selection*, page 111, to determine the correct orifice size.

Example using Helium

The objective is to control a vacuum process at a pressure of 0.5 psia, with a flow rate of 2000 sccm of He. The inlet pressure is 15 psia, giving a differential pressure (delta P) of 14.5 psia. By approximating the differential pressure as 15 psia, you get an uncorrected Index Number value of 90.

The gas density correction for He is calculated as:

$$\frac{N_2\ Density}{He\ Density} = \frac{1.250}{0.179} = 2.6$$

So the new density-corrected index number is:

$$2.6 \times 90 = 234$$

Drawing a vertical line on the Orifice Selection Chart at 234 indicates Orifice #2 would be the best choice. See the example #2 line on the Orifice Selection Graph, Figure 42, page 111.

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)*

☐	**No – Still in MKS packaging**
☐	**No – Unit unpacked, but never installed in a system.**
☐	**Yes -- Used only with clean, dry inert gas (For Example: Air, N2, Ar, He).**
☐	**Yes -- Used with chemicals, non-inert gases, biological or radioactive agents.) Identify all materials:**
☐	**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? ☐ No ☐ yes purged with what?
	Has equipment been flushed? ☐ No ☐ yes flushed with what?
	Has equipment been decontaminated? ☐ no ☐ 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.