Type T2BA
Butterfly Valve with RS-232 Interface

Instruction Manual

MKSINST™

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WARRANTY

Type T2BA Butterfly Valve

MKS Instruments, Inc. (**MKS**) warrants that for one (1) year from the date of shipment the equipment described above (the “equipment”) manufactured by **MKS** shall be free from defects in materials and workmanship.

For the period commencing with the date of shipment of this equipment and ending one (1) 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 Andover, 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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Device 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. It calls attention to a procedure, practice, condition, or the like, which, if not correctly performed or adhered to, could result in injury to personnel.**
Caution	**The CAUTION sign denotes a hazard. It calls attention to an operating procedure, practice, or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of all or part of the product.**
Note	The NOTE sign denotes important information. It calls attention to a procedure, practice, condition, or the like, which is essential to highlight.

Symbols Found on the Unit

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

Table 1: Definition of Symbols Found on the Unit

On (Supply) IEC 417, No. 5007	 Off (Supply) IEC 417, No. 5008	 Earth (ground) IEC 417, No. 5017	 Protective Earth (ground) IEC 417, No. 5019
 Frame or Chassis IEC 417, No. 5020	 Equipotentiality IEC 417, No. 5021	 Direct Current IEC 417, No. 5031	Alternating Current IEC 417, No. 5032
 Both Direct and Alternating Current IEC 417, No. 5033-a	 Class II Equipment IEC 417, No. 5172-a	 Three Phase Alternating Current IEC 617-2, No. 020206	
 Caution (refer to accompanying documents) ISO 3864, No. B.3.1	 Caution, Risk of Electric Shock ISO 3864, No. B.3.6	 Caution, Hot Surface IEC 417, No. 5041	

Safety Procedures and Precautions

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

DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT

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

SERVICE BY QUALIFIED PERSONNEL ONLY

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified service personnel only.

KEEP AWAY FROM LIVE CIRCUITS

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

USE CAUTION WHEN OPERATING WITH HAZARDOUS MATERIALS

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

PURGE THE INSTRUMENT

After installing the unit, or before its removal from a system, be sure to purge the unit completely with a clean dry gas to eliminate all traces of the previously used pressure material.

USE PROPER PROCEDURES WHEN PURGING

This instrument must be purged under a ventilation hood, and gloves must be worn to protect personnel.

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. **Add in requirement for routine leak checks when used w./ hazardous/ toxic material?**

OPERATE AT SAFE INLET PRESSURES

This unit should never be operated at pressures higher than the rated maximum pressure (refer to the product specifications for the maximum allowable pressure).

INSTALL A SUITABLE BURST DISC

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

KEEP THE UNIT FREE OF CONTAMINANTS

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

ALLOW PROPER WARM UP TIME FOR TEMPERATURE-CONTROLLED UNITS

Temperature-controlled 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 das Massenflussgerät

In dieser Betriebsanleitung vorkommende Symbole

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

Warnung! **Das Symbol WARNUNG! weist auf eine Gefahr für das Bedienpersonal hin. Es macht auf einen Arbeitsablauf, eine Arbeitsweise, einen Zustand oder eine sonstige Gegebenheit aufmerksam, deren unsachgemäße Ausführung bzw. ungenügende Berücksichtigung zu Verletzungen führen kann.**

Vorsicht! **Das Symbol VORSICHT! weist auf eine Gefahr für das Gerät hin. Es macht auf einen Bedienungsablauf, eine Arbeitsweise oder eine sonstige Gegebenheit aufmerksam, deren unsachgemäße Ausführung bzw. ungenügende Berücksichtigung zu einer Beschädigung oder Zerstörung des Gerätes oder von Teilen des Gerätes führen kann.**

Hinweis Das Symbol HINWEIS macht auf wichtige Informationen bezüglich eines Arbeitsablaufs, einer Arbeitsweise, eines Zustands oder einer sonstige Gegebenheit aufmerksam.

Erklärung der am Gerät angebrachten Symbole

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

Tabelle 2: Bedeutung der am Gerät angebrachten Symbole

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

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

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

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

Anweisungen zum Spülen des Gerätes
Das Gerät darf nur unter einer Ablufthaube gespült werden. Schutzhandschuhe sind zu tragen.

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

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

Verbindungen auf Undichtigkeiten prüfen!
Überprüfen Sie sorgfältig alle Verbindungen der Vakuumkomponenten auf undichte Stellen.

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

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

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

Bei Geräten mit Temperaturkontrolle korrekte Anwärmzeit einhalten!
Temperaturkontrollierte Geräte arbeiten nur dann gemäß ihrer Spezifikation, wenn genügend Zeit zum Erreichen und Stabilisieren der Betriebstemperatur eingeräumt wird. Kalibrierungen und Nulleinstellungen sollten daher nur nach Abschluss des Anwärmvorgangs durchgeführt werden.

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

Symboles utilisés dans ce manuel d'utilisation

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

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

Symboles figurant sur l'unité

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

Tableau 3: Définition des symboles sur l'unité

Marche (sous tension) IEC 417, No.5007	Arrêt (hors tension) IEC 417, No.5008	Terre (masse) IEC 417, No.5017	Terre de protection (masse) IEC 417, No.5019
Masse IEC 417, No.5020	Equipotentialité IEC 417, No.5021	Courant continu IEC 417, No.5031	Courant alternatif IEC 417, No.5032
Courant continu et alternatif IEC 417, No.5033-a	Matériel de classe II IEC 417, No.5172-a	3~ Courant alternatif triphasé IEC 617-2, No.020206	
Attention : se reporter à la documentation ISO 3864, No.B.3.1	Attention : risque de choc électrique ISO 3864, No.B.3.6	Attention : surface brûlante IEC 417, No.5041	

Mesures de sécurité et précautions

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

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

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

DÉPANNAGE UNIQUEMENT PAR DU PERSONNEL QUALIFIÉ

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

ÉLOIGNEMENT DES CIRCUITS SOUS-TENSION

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

PRÉCAUTION EN CAS D'UTILISATION AVEC DES PRODUITS DANGEREUX

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

PURGE DE L'APPAREIL

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

UTILISATION DES PROCÉDURES APPROPRIÉES POUR LA PURGE

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

PAS D'EXPLOITATION DANS UN ENVIRONNEMENT EXPLOSIF

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

UTILISATION D'ÉQUIPEMENTS ET PROCÉDURES DE SERRAGE APPROPRIÉS

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

VÉRIFICATION DE L'ÉTANCHÉITÉ DES CONNEXIONS

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

EXPLOITATION AVEC DES PRESSIONS D'ENTRÉE NON DANGEREUSES

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

INSTALLATION D'UN DISQUE D'ÉCHAPPEMENT ADAPTÉ

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

MAINTIEN DE L'UNITÉ À L'ABRI DES CONTAMINATIONS

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

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

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

Medidas de seguridad del dispositivo de flujo de masa

Símbolos usados en este manual de instrucciones

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

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

Símbolos hallados en la unidad

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

Tabla 4: Definición de los símbolos hallados en la unidad

Encendido (alimentación eléctrica) IEC 417, N° 5007	 Apagado (alimentación eléctrica) IEC 417, N° 5008	 Puesta a tierra IEC 417, N° 5017	 Protección a tierra IEC 417, N° 5019
 Caja o chasis IEC 417, N° 5020	 Equipotencialidad IEC 417, N° 5021	 Corriente continua IEC 417, N° 5031	 Corriente alterna IEC 417, N° 5032
 Corriente continua y alterna IEC 417, N° 5033-a	 Equipo de clase II IEC 417, N° 5172-a	 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 f de cumplimiento de dichas medidas de seguridad o de las advertencias específicas a las que se hace referencia en otras partes de este manual, constituye una violación de las normas de seguridad establecidas para el uso previsto del instrumento y podría anular la protección proporcionada por el equipo. Si el cliente no cumple dichas precauciones y advertencias, MKS Instruments, Inc. no asume responsabilidad legal alguna.

NO UTILICE PIEZAS NO ORIGINALES O MODIFIQUE EL INSTRUMENTO

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

LAS REPARACIONES DEBEN SER EFECTUADAS ÚNICAMENTE POR TÉCNICOS AUTORIZADOS

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

MANTÉNGASE ALEJADO DE LOS CIRCUITOS ACTIVOS

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

TENGA CUIDADO CUANDO TRABAJE CON MATERIALES TÓXICOS

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

PURGUE EL INSTRUMENTO

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

USE PROCEDIMIENTOS ADECUADOS PARA REALIZAR LA PURGA

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

NO HAGA FUNCIONAR EL INSTRUMENTO EN AMBIENTES CON RIESGO DE EXPLOSIÓN

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

USE ACCESORIOS ADECUADOS Y REALICE CORRECTAMENTE LOS PROCEDIMIENTOS DE AJUSTE

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

COMPRUEBE QUE LOS ACCESORIOS SEAN A PRUEBA DE FUGAS

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

HAGA FUNCIONAR EL INSTRUMENTO CON PRESIONES DE ENTRADA SEGURAS

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

INSTALE UNA CÁPSULA DE SEGURIDAD ADECUADA

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

MANTENGA LA UNIDAD LIBRE DE CONTAMINANTES

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

CALIENTE ADECUADAMENTE LAS UNIDADES CONTROLADAS POR MEDIO DE TEMPERATURA

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

マスフロー機器の安全に関する情報

本取扱説明書のマーク

本マニュアルでは警告、注意、ポイントのマークを用いて重要な事項を記載しています。

警告	**この表示を無視して誤った取り扱い (手順や使用方法、条件など) をすると、人が重傷を負う可能性が想定される内容を示しています。必ずお読みください。**
注意	**この表示を無視して誤った取り扱い (手順や使用方法など) をすると、製品が損傷する可能性が想定される内容を示しています。必ずお読みください。**
ポイント	この表示は手順や使用方法、条件などに関する重要な情報が記載されていることを示しています。必ずお読みください。

本機器のマーク

以下の表では、本機器に使用されているマークについて説明いたします。

表 5: 本機器に使用されているマークについて

オン (電源) IEC 417, No. 5007	オフ (電源) IEC 417, No. 5008	接地 (アース) IEC 417, No. 5017	保護接地 (アース) IEC 417, No. 5019
フレームまたはシャーシ IEC 417, No. 5020	等電位 IEC 417, No. 5021	直流 IEC 417, No. 5031	交流 IEC 417, No. 5032
直流と交流 IEC 417, No. 5033-a	クラス 2 機器 IEC 417, No. 5172-a	三相交流 IEC 617-2, No. 020206	
注意 (付属書を参照) ISO 3864, No. B.3.1	注意 (感電の危険あり) ISO 3864, No. B.3.6	注意 (表面が熱くなっています) IEC 417, No. 5041	

安全対策について

本機器を使用する際は、必ず以下の安全対策を守ってください。これらの安全対策や本マニュアルの警告を無視すると、機器本来の用途の安全基準を侵害することになり、機器が提供する保護機能が損なわれる可能性があります。MKS Instruments, Inc. は、顧客側の安全対策の不履行に対しては一切責任を負いかねます。

勝手に部品を変えたり、本体を改造しないこと
本機器に代用部品を使用したり、不正な改造を加えないでください。すべての安全システムを正しく機能させるための修理やメンテナンスが必要な場合は、本機器を MKS Calibration and Service Center まで戻してください。

修理は必ず専門の修理サービスを利用すること
オペレータは絶対に本機器を分解しないでください。部品の交換や内部の調整は必ず専門の修理サービスを利用してください。

電流が通じている回路から切断すること
電源ケーブルを接続したままで部品を交換しないでください。特定の状況では、電源ケーブルを取り外した状態でも危険な電圧が残っている場合があります。感電などの事故を防ぐため、回路に触れる前に必ず電源から切断し、放電してください。

危険な材料を使用する場合は慎重に機器を使用すること
危険な材料を使用する場合は、使用者は各自の責任の元で適切な安全対策を講じてください。必要に応じて本機器を浄化してください。また、使用する材料に対するシーリング材の耐久性を確認してください。

機器を浄化すること
本機器を取り付けた後やシステムから取り外す前に、きれいな乾燥ガスで本機器を浄化し、使用した材料を完全に取り除いてください。

浄化する場合は適切な手順で行うこと
本機器の浄化は換気フードの下で行う必要があります。また、浄化作業を行う人は必ず手袋を着用してください。

爆発の危険性のある環境で機器を使用しないこと
爆発が起きるのを防ぐため、本機器を爆発の危険性のある環境で使用しないでください。ただし、そのような環境での使用が特別に保証されている場合は除きます。

適切な金具類を使用し、手順に従って金具の締めを行うこと
金具類は本機器の仕様と一致し、機器本来の用途に適合したものである必要があります。金具類の取り付けや締めは、製造業者の指示に従ってください。

液体の漏れがないよう接続箇所を確認すること
本機器を設定する前に、すべての配管の接続を慎重に確認し、液体が漏れないようにしてください。

安全なインレット圧力で使用すること
定格の最大圧力を超える圧力の下で本機器を絶対に使用しないでください (最大許容圧力については仕様書を参照)。

適切なバーストディスクを取り付けること
圧力のかかったガスを使用する場合は、万一システムが爆発した場合にシステムの圧力が上昇するのを防ぐため、真空システムに適切なバーストディスクを取り付けてください。

本機器に異物やゴミが混入しないようにすること
本機器の使用前または使用中に、ほこりやゴミ、繊維、ガラスの破片、金属片などの異物やゴミが混入しないようにしてください。本機器が損傷する可能性があります。

温度調整された機器を十分に温めてから使用すること
温度調整された機器が適切な作動温度にならないうちに使用すると、仕様通りの動作をしないことがあります。本機器が十分に温まるまでは目盛りをゼロに合わせたり、較正しないでください。

질량 유량 장치 안전 정보

본 지침 매뉴얼에 사용되는 기호들

매뉴얼 전체에 사용되는 경고, 주의 및 참고 메시지의 정의.

경고 **경고 표시는 위험을 나타냅니다. 이 표시는 올바르게 수행되거나 지켜지지 않을 경우, 사람에게 상해를 입힐 수 있는 절차, 수행지침, 상태 또는 이와 유사한 상황들에 대한 주의를 환기시킵니다.**

주의 **주의 표시는 위험을 나타냅니다. 이 표시는 올바르게 수행되거나 지켜지지 않을 경우, 제품의 일부나 전체에 손상이나 파손을 일으킬 수 있는 절차, 수행지침 또는 이와 유사한 상황들에 대한 주의를 환기시킵니다.**

참고 참고 표시는 중요한 정보를 나타냅니다. 이 표시는 강조할 만한 주요 절차, 수행지침, 상태 또는 이와 유사한 상황들에 대한 주의를 환기시킵니다.

장치에 표시된 기호들

다음 표는 장치에서 볼 수 있는 기호들을 설명합니다.

표 6: 장치에 표시된 기호들의 정의

 켬 (전원) IEC 417, No. 5007	 끔 (전원) IEC 417, No. 5008	 접지(지면) IEC 417, No. 5017	 보호 접지(지면) IEC 417, No. 5019
 프레임 또는 섀시 IEC 417, No. 5020	 등전위성 IEC 417, No. 5021	 직류 IEC 417, No. 5031	 교류 IEC 417, No. 5032
 직류와 교류 모두 IEC 417, No. 5033-a	 클래스 II 장비 IEC 417, No. 5172-a	 3상 교류 IEC 617-2, No. 020206	
 주의 (동봉 문서 참조) ISO 3864, No. B.3.1	 주의, 감전 위험 ISO 3864, No. B.3.6	 주의, 표면이 뜨거움 IEC 417, No. 5041	

안전 절차 및 예방조치

본 기계의 모든 작동 시에 다음의 일반 안전 예방조치를 준수하십시오. 아래 예방조치를 준수하지 않거나 본 매뉴얼의 다른 부분에 있는 특정 경고를 준수하지 않을 경우, 기계 사용 목적의 안전 기준을 위반하는 것이 되며, 장비가 제공하는 보호기능을 손상시킬 수 있습니다. MKS Instruments, Inc.는 고객이 본 요건을 준수하지 않는 경우에 대해서는 어떠한 책임도 지지 않습니다.

부품을 교체하거나 기계를 개조하지 마십시오

교체 부품을 설치하거나 기계에 허가되지 않은 어떠한 수정도 가하지 마십시오. 서비스와 수리가 필요한 경우에는 모든 안전 특성이 유지되도록 기계를 MKS 보정 서비스 센터(MKS Calibration and Service Center)로 보내주십시오.

자격이 있는 사람에게만 서비스를 받으십시오
작동하는 사람은 기계 겉면을 제거해서는 안됩니다. 부품 교체 및 내부 조정은 자격이 있는 서비스 기사에게만 받으실 수 있습니다.

전류가 통하는 회로에서 분리해 보관하십시오
전원 케이블을 연결한 채로 부품을 교체하지 마십시오. 일부 환경에서는 전원 케이블을 제거한 상태라도 위험 전압이 존재할 수 있습니다. 부상을 방지하려면, 전원을 항상 분리하고 회로를 만지기 전에 회로를 방전시키십시오.

위험한 물질과 함께 작동할 때는 주의를 기울이십시오
위험한 물질이 사용되는 경우, 사용자는 필요시 기계를 완전히 청소하여, 적절한 안전 예방조치를 준수할 책임을 지키고, 사용된 물질이 봉인 물질과 함께 사용해도 무방하다고 보증할 수 있어야 합니다.

기계를 청소하십시오
장치를 설치한 후나 시스템에서 장치를 제거하기 전에는 반드시 깨끗한 건조성 기체로 장치를 완전히 청소하여 이전에 사용된 유량 물질의 모든 흔적을 제거하십시오.

청소 시에는 적절한 절차를 사용하십시오
본 기계는 환기 후드 아래에서 청소되어야 하며, 인체 보호를 위해 장갑을 착용해야 합니다.

폭발성 환경에서 작동하지 마십시오
폭발을 방지하려면, 폭발성 환경에서 작동하도록 특별히 승인받지 않은 경우 본 제품을 폭발성 환경에서 작동하지 마십시오.

적절한 조립부품과 조임 절차를 사용하십시오
모든 기계 조립부품은 제품 사양과 일치해야 하고, 기계의 사용 목적에 부합해야 합니다. 제조업체의 지시에 따라 조립부품을 조립하고 조이십시오.

누출방지 조립부품을 점검하십시오
기계 설치를 진행하기 전에 기계의 모든 연관 연결부를 점검해 누출방지 설치가 되었는지 확인하십시오.

안전한 흡입 압력에서 작동하십시오
이 장치는 절대 정격 최대 압력보다 높은 압력에서 작동해서는 안됩니다(최대 허용 압력에 대해서는 제품 사양을 참조하십시오).

적합한 안전 파열판을 설치하십시오
가압 가스 공급원에서 작동시, 시스템 폭발이 시스템 압력 상승을 일으키는 것을 방지하기 위해 적합한 안전 파열판이 진공 시스템에 설치되어야 합니다.

장치를 오염이 없는 곳에 보관하십시오
장치를 사용하기 전이나 사용 중에는 어떠한 종류의 오염 물질도 허용해서는 안됩니다. 먼지, 때, 보풀, 유리 조각, 금속 조각과 같은 오염 물질은 영구적으로 장치를 손상시킬 수 있습니다.

온도 제어 장치의 경우 알맞은 시동 시간을 두십시오
온도 제어 장치는 장치가 설계 작동 온도와 일치하고 이 온도에서 안정화될 수 있도록 충분한 시간을 허용해야만 사양에 맞게 작동합니다. 시동이 완료될 때까지 장치를 영점 설정하거나 보정하지 마십시오.

How This Manual is Organized

This manual is designed to provide instructions on how to set up, install, configure, and operate a Type T2BA Butterfly Valve with RS-232 communications Interface.

Before installing and/or operating your Type T2BA Butterfly Valve, carefully read and familiarize yourself with all precautionary notes in the *Device Safety Information* section at the front of this manual. Observe and obey all WARNING and CAUTION notes provided throughout the manual.

Chapter One: General Information introduces the product and describes the basic theory of operation.

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

Chapter Three: RS-232 Overview provides explanations of RS-232 communications in general and the MKS implementation in particular.

Chapter Four: Configuration and Startup explains the step-by-step procedure needed to configure the instrument to begin operation in the system.

Chapter Five: Operation describes how to operate and tune the instrument for optimal performance in the system and explains other key functions and features.

Chapter Six: Maintenance and Troubleshooting lists any maintenance required to keep the instrument in good working condition and provides a troubleshooting reference should the instrument behave unexpectedly.

Chapter Seven: Web Page Setup, Configuration, and Operation provides information on how to connect to the instrument's Web Pages.

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

Appendix B: Model Code Explanation describes the model code.

Appendix C: Health and Safety Form provides a copy of the safety form (at the time of this manual's release) which must be filled out prior to return of the instrument to MKS for calibration, routine maintenance, or repair. Failure to include the form with a returned shipment will delay processing at the MKS Calibration and Service Center.

Appendix D: Dimensional Drawings provides outline drawings of standard size RS-232 T2B valves.

Appendix E: RS-232 Message Summary

Customer Support

Standard maintenance and repair services are available at all of our regional MKS Calibration and Service Centers. In addition, MKS accepts the instruments of other manufacturers for recalibration using the Primary and Transfer Standard calibration equipment located at all of our regional service centers.

Should any difficulties arise in the use of your Type T2B instrument, or to obtain information about companion products MKS offers, contact any authorized MKS Calibration and Service Center. If it is necessary to return the instrument to MKS, please obtain an ERA Number (Equipment Return Authorization

Number) from the MKS Calibration and Service Center before shipping. The ERA Number expedites handling and ensures proper servicing of your instrument.

Please refer to the MKS website at: http://www.mksinst.com/service/servicehowtoorder.aspx.for a list of MKS Calibration and Service Centers.

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

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Chapter One: General Information

Introduction

The MKS Type T2BA Butterfly Valve is designed primarily for use in downstream pressure control applications. Upstream pressure control applications are also supported.

The T2BA Butterfly Valve unit consists of a throttle valve integrated with the RS-232 communications interface coupled to a digital controller which eliminates the need for a separate controller unit . The valve is configured, controlled and monitored via digital signals sent through the system RS-232 network. Similarly, the T2BA valve controls pressure based on pressure readings acquired from analog pressure transducers. In addition, safety overrides are available via switching signals through the 25 pin power-I/O cable.

The valve may be set in to operate in one of three different control modes to meet the requirements of specific applications:

- Position control
- Traditional PID pressure control, digitally implemented
- Model-based pressure control using advanced digital algorithms

When the T2BA Butterfly Valve controller is turned off or experiences an unexpected power loss, all calibration constants are saved in non-volatile memory. Therefore, upon being repowered, the unit will be calibrated and ready to resume operation.

Protection from RF interference and noisy electrical environments is ensured by careful selection of internal design elements and by the use of surge and ESD suppression networks and RFI filtering on all inputs and outputs.

The T2BA Butterfly Valve controller requires an input voltage of 24 VDC @ 3 Amp, supplied by the main I/O connector. The Serial Family (RS-232 & RS-485) T2BA Throttle Valves are compatible with and require

pressure signals from analog transducers complying with the voltages listed in Appendix A. Transducer power may be sourced from the T2BA as a selected option or powered separately.

Definitions

Table 7: Definitions

Term	Description
Full Scale (FS) Range	The defined 100% value of an attribute, in its assigned units
sccm	Standard cubic centimeters per minute
Setpoint (SP)	The flow value to which the device is controlling the flow of gas
slm	Standard liters per minute

Reliability

To enhance instrument reliability, the design utilizes many Design for Reliability Techniques, such as reliability prediction, allocation, DFMEA, reliability design review, Derating Analysis, etc. Design for Reliability is applied to minimize mechanical and electronic component count and optimize the design. The product has been qualified by a comprehensive battery of tests including:

- HALT testing
- Accelerated life testing
- Subsystem life testing if applicable.
- Vibration testing (random and sine sweep)
- Thermal cycle with power cycle
- Storage temperature testing
- Humidity testing
- Enclosure rigidity testing
- Impact Test
- Compression and Tension Test
- Transportation package testing (including transportation vibration and drop test)
- EMC testing including ESD and EFT, Immunity, Emission, etc.

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Chapter Two: Installation

Unpacking the T2BA Butterfly Valve

MKS has carefully packed your T2BA Butterfly Valve so that it will reach you in good working condition. Upon receiving the unit, however, you should check for defects, cracks, broken connectors, etc., to be certain that damage has not occurred during shipment.

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

If you find any damage, notify your carrier and MKS immediately. If it is necessary to return the unit to MKS, obtain an RMA Number (Return Material Authorization Number) from the MKS Calibration and Service Center before shipping. 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.

Opening the Package

The T2BA Butterfly Valve is assembled, leak tested with helium, and calibrated in a clean environment. The instrument is packaged in a polyethylene bag in this environment to maintain its particle free condition during shipment. It is important to remove the shipment packaging with clean practices to avoid unnecessarily contaminating the device with particulates. To maintain a minimal level of cleanliness, follow the instructions below:

1. Remove all cardboard and shipment packaging materials away from the process connections where the device will be installed. Do not discard UNTIL the device has been inspected for damage and determined to be in good working order.
2. Wipe down the outer polyethylene bag with a clean cloth prior to proceeding.
3. Remove the outer polyethylene bag away from BOTH the shipping packaging AND the process connections where the device will be installed. Do not allow this container near the process connections.
4. At the point of connection to the process line, remove the inner polyethylene bag from the pressure controller and inspect the unit for any signs of damage during transportation or handling.

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

Verifying Use Requirements Prior to Installation

Follow the guidelines listed below when installing and using the T2BA Butterfly Valve.

- Maintain adequate ventilation space around the valve to provide sufficient air circulation for internal heat removal. Allow 0.50” around all surfaces of the device (except base)
- Maintain an ambient operating temperature between 10° and 50° C (50° to 122° F)
- Provide a properly grounded electrical power source of sufficient current capacity between 21.5-26.2V_{DC}
- When unpowered, maintain storage temperature range between -20° to 80° C (-4° and 176° F). Allow unit to return to normal ambient operating temperature for several hours prior to applying electrical power.

- Mount the T2BA Butterfly Valve securely to a rigid piping system capable of supporting its weight.
- Provide a separate positive shutoff valve if your system cannot tolerate any leakage through the T2BA Butterfly Valve. The pressure control valves are not positive shutoff valves so some leakage across the valves may occur even in the closed position.

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.**

- Allow a warm up time of 1 minute on power application prior to use.

The standard valve configuration provides control to exhaust conditions at vacuum. If process conditions vary significantly from those listed, contact an MKS applications engineer for assistance in tuning the unit for optimum performance.

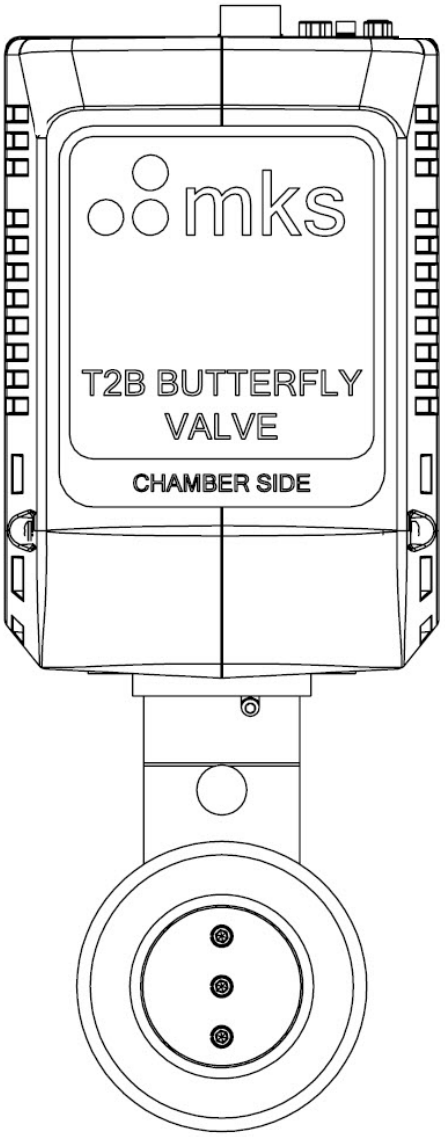
For additional information, refer to the product specifications in Appendix A.

Understanding Dimensional Constraints

Refer to the applicable drawings for the appropriate valve size in Appendix D.

Front View

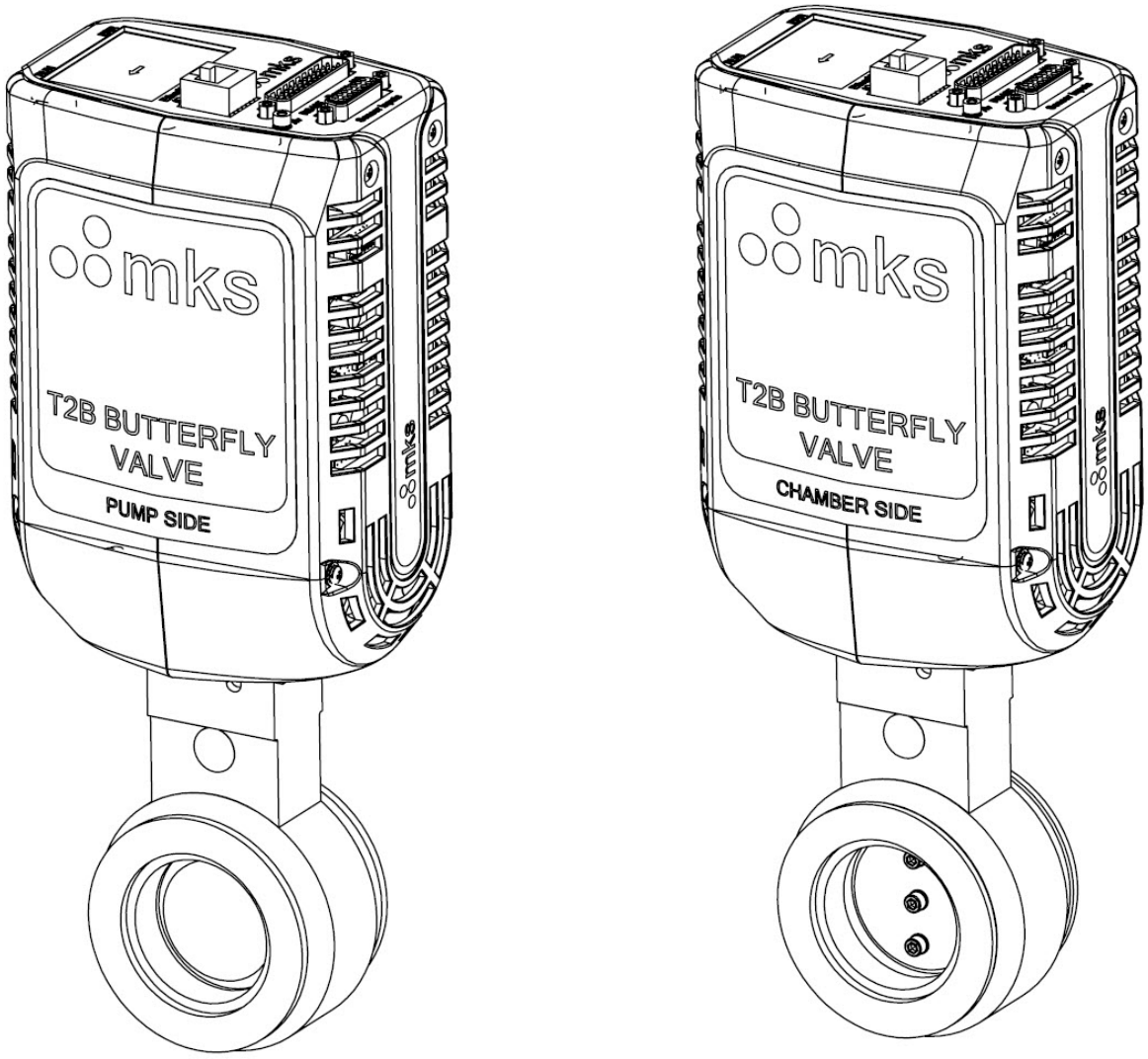
The front of the T2BA Butterfly Valve has a label to indicate installation direction relative to the chamber volume. Note that non-sealing and low conductance (Q and F Seal) valves have differing orientations.



Non-sealing configuration shown

Figure 1: Front View of the T2BA Butterfly Valve

Isometric View



Low Conductance (F and Q Seals) **Non-Sealing**

Figure 2: Isometric View of the T2BA Butterfly Valve

Side View

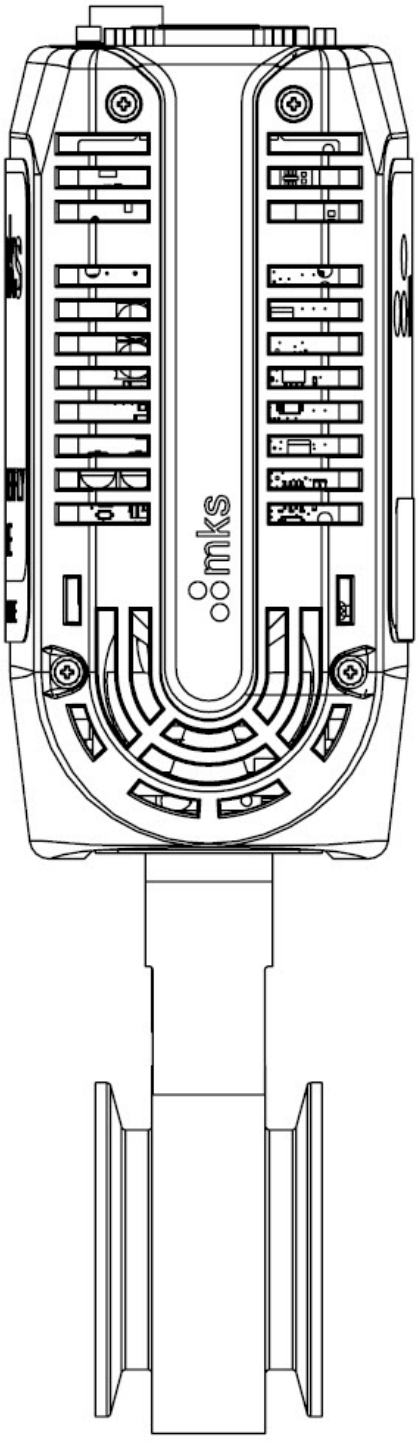


Figure 3: Side View of the T2BA Butterfly Valve

Top View

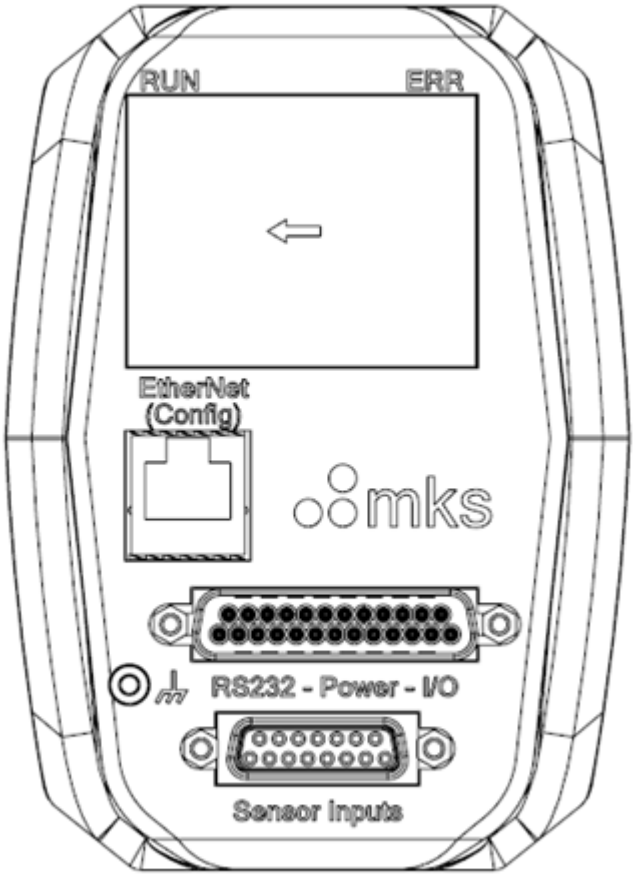


Figure 4: Top View of the T2BA Butterfly Valve (LCD Version of RS-232 I/O Interface)

Labels

Pump side and chamber side labels, shown in the figure below, indicate which side of the valve should be oriented toward the vacuum pump or chamber during installation. The label found on the valve depends on the type of valve seal type; non-sealed valves indicate orientation using “CHAMBER SIDE” labels while low conductance valves indicate orientation using “PUMP SIDE” labels.

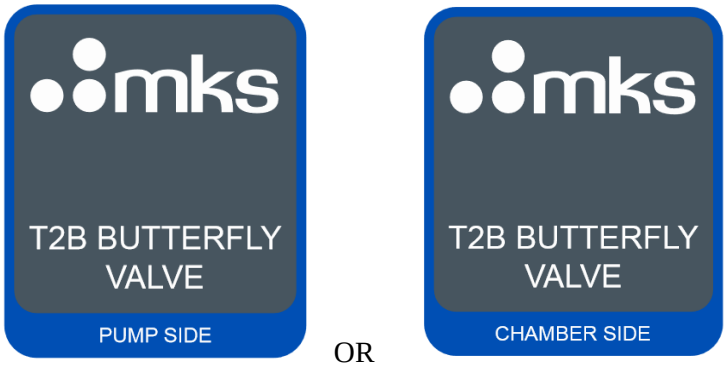


Figure 5: Pump and Chamber Side Labels

Each T2BA Butterfly Valve contains a serial number label which shows the “as-shipped” model code, as shown in the figure below.

Figure 6: Serial Number Label

Performing Valve Installation

This section describes how to install the T2BA Butterfly Valve into your process gas system.

PERSONAL SAFETY HAZARDS! **Gas systems can contain toxic, explosive, combustible, corrosive or other dangerous 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.**

Note DO NOT make any electrical connections to the valve until directed to do so. Information on electrical connections (pinouts and settings) is found in the following chapter.

Follow the guidelines below when setting up the T2BA Butterfly Valve.

1) Prepare the process gas system according to your facility's gas handling procedures, including purging of gas lines with appropriate purge gas, executing lock out / tag out procedures, and notifying appropriate members of the equipment, safety, and HAZMAT teams.

2) Set the valve into position where it will be connected to the chamber.

   Allow adequate clearance for the I/O-Power connector, Transducer cables, strain reliefs, and cable bend radii.

3) Mount the T2BA Butterfly Valve to the process piping with the proper hardware. Follow the piping seal manufacturer's instructions for proper fastener sizing and torque.

4) Flow clean, dry purge gas across the process connections to minimize particle contamination prior to and during installation. Use only purge gases that are approved for your process.

5) Connect the process piping remembering to tighten the seal gaskets according to the manufacturer's recommendation. Use appropriate gasket material for the application. Seal gaskets are not included with the valve.

   DO NOT over-tighten connections.

6) Perform appropriate leak checking of your gas lines and valve connections to verify the integrity of the gas seals prior to supplying power to the valve.

7) Before connecting the cables leading to the valve, verify that all pins for power and signal match those for the interface I/O type being used. Information on each I/O type's pinouts are found in the following chapter.

8) Connect cables, chassis ground (M3) and power up the valve.

9) Allow minimum 1 minute warm-up prior to performing a pressure zero or Valve Learn (Home) operation.

10) It is recommended that the valve be commanded open prior to initiating gas flow.

11) When purging the line, provide a valve open signal to the valve. Allow a long pump down time so that the pressure upstream of the valve can drain to the appropriate low level.

    For other hazardous gases, consider pumpng the process line from both the inlet and outlet side of the valve. Cycle purge the system, leak test and backfill with an inert gas for optimum safety.

Mounting Instructions

The T2B unit can be mounted in a vacuum exhaust line with the proper fittings and connectors. For best pressure control, locate the pressure transducer and the throttle valve as close as practical to the process chamber. This minimizes the time constants associated with these items.

Caution **Use tubing that is less than 6 inches long and no less than ¼ inch in diameter to connect the transducer and chamber. If the distance must exceed 6 inches, use a larger diameter tubing to compensate for conductance loss.**

A typical electrical system configuration is shown in the figure below:

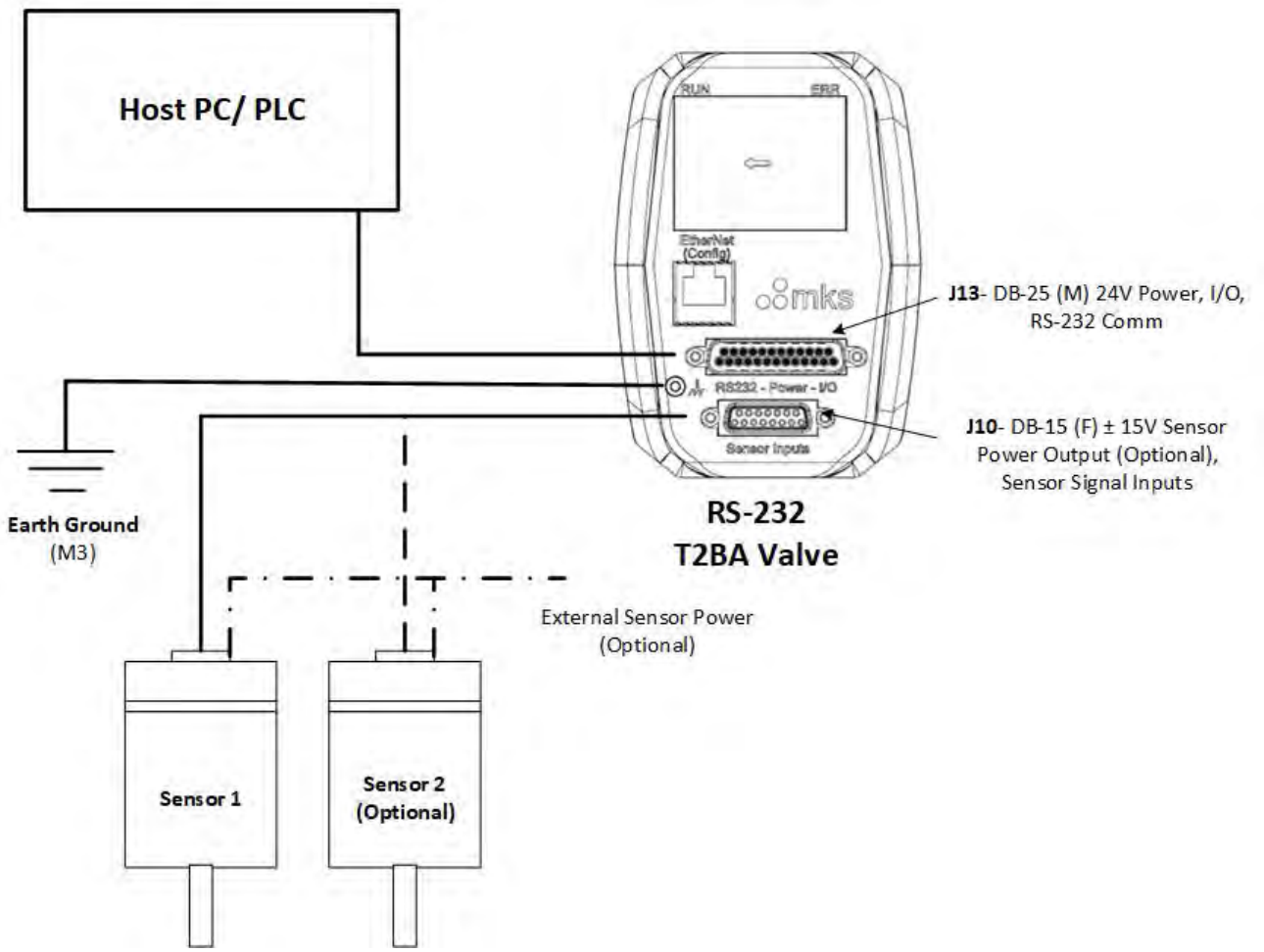


Figure 7: Typical System Configuration

Interface Connection Requirements

The T2BA Butterfly Valve power - I/O interface is available in a standard 25-pin DSUB male connector through which both power and signal I/O are routed.

This MKS product meets EMC Immunity requirements including ESD and EFT To ensure EMC performance during operation, the T2BA valve must be installed with **a metal braided shielded cable, properly grounded at both ends**. **Specific Shielded Cable Requirements**

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 interfere with performance.
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 shields effectiveness. Ground the shield to the connector before its internal wires exit.
3. With very few exceptions, the connector(s) must make good contact to the device's case (ground). Good contact is less than 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 end; it is important to ground the shield at the end *before* the wires exit. Make the ground connection 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.

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.
   - Some cables may need internal shielding from specific wires to others.

Power Requirements

T2B Controller

The T2B requires an input voltage of 24.0 VDC @ 4 Amp max. With this input power and the selected option, the T2B can supply up to 650 mA maximum at ±15 VDC ±5%, (combined High and Low sensors) for pressure transducers. If transducer power is to be supplied from the valve, the total power requirement must be verified not to exceed this value (some heated transducers).

Analog Pressure Transducers requiring > 650 mA maximum at ±15 VDC

If the optional sensor power supply was not selected or if the analog pressure transducer(s) require more than 650mA ±15 VDC ±5%, supplied by the optional sensor power supply, an external power source supplying the transducers is required. The transducer signals must be connected to the T2B unit using an appropriate interface cable with separate cabling for transducer power. Contact the MKS Engineering Department for further information.

Power- I/O 25-pin Pinout Assignments

Table 8 : Power / I/O 25-pin DSUB Pinouts (J13)

Pin Number	Pin Function
Pin 1	**RS232_Rx**
Pin 2	**RS232_Tx**
Pin 3	**Valve Open** (digital input) (Connect to Pin-13 to apply *OPEN* Override)
Pin 4	**Valve Close** (digital input) (Connect to Pin-13 to apply *CLOSE* Override)
Pin 5	Reserved
Pin 6	Reserved
Pin 7	Reserved
Pin 8	Reserved
Pin 9	Reserved
Pin 10	Reserved
Pin 11	**Analog Output Voltage** (Pressure)
Pin 12	**Analog Output Voltage** (Position)
Pin 13	**Ground_A:** Analog Output Voltage Common. Valve Open/Close Input Signal Common.
Pin 14	**Ground_M:** Power Return for 24 V_{DC}
Pin 15	**Ground_M:** Power Return for 24 V_{DC}
Pin 16	**No Connection**
Pin 17	**+24 V_{DC} Power Input**
Pin 18	**+24 V_{DC} Power Input**
Pin 19	Reserved
Pin 20	**Valve OPEN Status** (digital output) Valve Open = +5V. If Valve is *Not* Open = 0V If
Pin 21	**Valve CLOSED Status** (digital output) Valve Closed = +5V. If Valve is *Not* Closed = 0V If
Pin 22	**Valve Interlock** (digital input) (Connect to Ground_A for normal operation)
Pin 23	**Fault Status** (digital output) Fault = +5V. No Fault = 0V.
Pin 24	**Ground_A:** RS232 -or- RS-232 Cable Drain-Wire Return. Common for: Valve Open/Close Status, Valve Interlock, Status. Signal Fault
Pin 25	No Connection

Note The "No Connection" pin assignment refers to a pin with no internal connection.

Note No electrical connection should be made to a pin specified as "Reserved".

Note To move the valve using <u>any</u> command or I/O, Interlock Pin 22 <u>must</u> be connected to Power Return, Pin 14 or Pin 15.

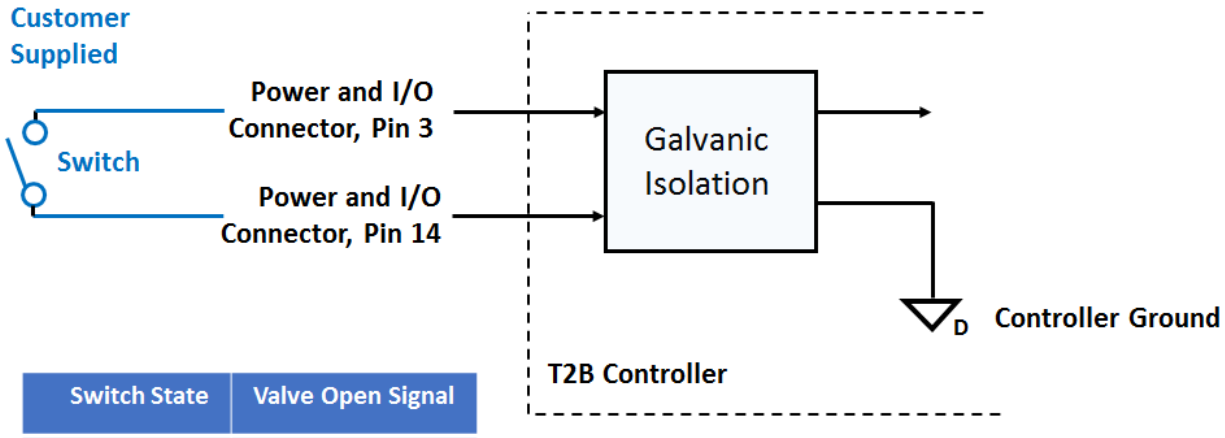
The chassis ground and power return are NOT connected within the valve. Do not connect the chassis ground to the Ground_A or Ground_M signals (J13 pins 13, 14, 15 or, 24).

I/O Valve Override

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

For the 25-pin Type D connector:

- *To Open* the valve, connect pin 3 to Ground, pin 13.
- *To Close* the valve, connect pin 4 to the Ground pins 13.



Switch State	Valve Open Signal
Open	Not Asserted
Closed	Asserted

Figure 8: Example of Valve Open Override Connection (Input)

I/O Valve Status

The valve status feature provides discrete signals when the valve is in either the full Open or Closed position.

For the 25-pin Type D connector:

- The valve is 100% *Open* when the voltage between Pins 20 and 13 is ~5V. Otherwise, voltage is 0V.
- The valve is fully *Closed* when the voltage between Pins 21 and 13 is ~5V. Otherwise, voltage is 0V.

I/O Valve Command Priority

The valve executes commands based on a hierarchical command structure. The highest priority command is Valve Open, followed by Valve Close, and Setpoint Control (no command given). Therefore, if the pressure controller is operating under Setpoint Control, a Valve Open command (pin 3) will override the setpoint and force the valve to its full open position. Likewise, a Valve Closed command (Pin 4) will fully close the valve, overriding the setpoint.

Note When both the Valve Close and Valve Open pins are pulled down simultaneously, the flapper will hold its position.

Sensor Connections, 15-pin Pinout Assignments

Table 9: Sensor, 15 pin DSUB Pinouts (J10)

Pin Number	Pin Function
Pin 1	Reserved
Pin 2	Pressure Signal Input (+) High Range Sensor
Pin 3	Pressure Signal Input (+) Low Range Sensor
Pin 4*	Sensor Power Return (Low Range Sensor)
Pin 5*	Sensor Power Return (High Range Sensor)
Pin 6	-15 VDC Power Output (High Range Sensor)
Pin 7	+15 VDC Power Output (High Range Sensor)
Pin 8	Reserved
Pin 9*	-15 VDC Power Output (Low Range Sensor)
Pin 10	Reserved
Pin 11*	+15 VDC Power Output (Low Range Sensor)
Pin 12	Pressure Signal Input (-) High Range Sensor
Pin 13	Pressure Signal Input (-) Low Range Sensor
Pin 14	Reserved
Pin 15	Reserved

***Note:** Pins 4, 5, 9, 11 are only active when the Sensor Power Supply option has been ordered.

Ethernet Diagnostic Port (Config)

All T2BA variants are equipped with an Ethernet Diagnostic (Configuration) port. The physical connection is an RJ-45 female connector to which a standard Ethernet cable can be connected (See Figure 4). Configuration of this port is described in Chapter 7 and its use is referred to throughout this manual.

Valve Safety

MKS products are designed and tested to provide the highest degree of safety attainable. To use your MKS valve safely, you must always conform to the following instructions:

Warning **The moving parts in the valve create a risk of personal injury until the valve is securely incorporated into a system. To avoid injury keep all objects away from any valve opening.**

Do not insert objects into openings where contact with moving parts is possible.

Isolate the equipment from any electrical or pneumatic power supply before handling the valve.

Chapter Three: RS-232 Overview

RS-232 Specifications

As shown in Figure 8 of the previous section, the T2BA pressure control valve communicates digitally through the RS-232 host controller. To avoid messaging conflicts, messages to the T2BA should be separated by a minimum of a 1.3 milliSecond delay prior to the next message being sent.

Table 10: RS-232 Electrical Specifications

232 ELECTRICAL SPECIFICATIONS		
Maximum Driver Output Voltage		-7V to +12V
Driver Output Signal Level (Loaded Min.)	**Loaded**	+/-1.5V
Driver Output Signal Level (Unloaded Max)	**Unloaded**	+/-6V
Driver Load Impedance (Ohms)		54
Max. Driver Current in High Z State	**Power On**	+/-100uA
Max. Driver Current in High Z State	**Power Off**	+/-100uA
T2BA Input Voltage Range		-7V to +12V
T2BA Input Sensitivity		+/-200mV

Connection of the T2BA to the RS-232 network should be in accordance with the diagram below.

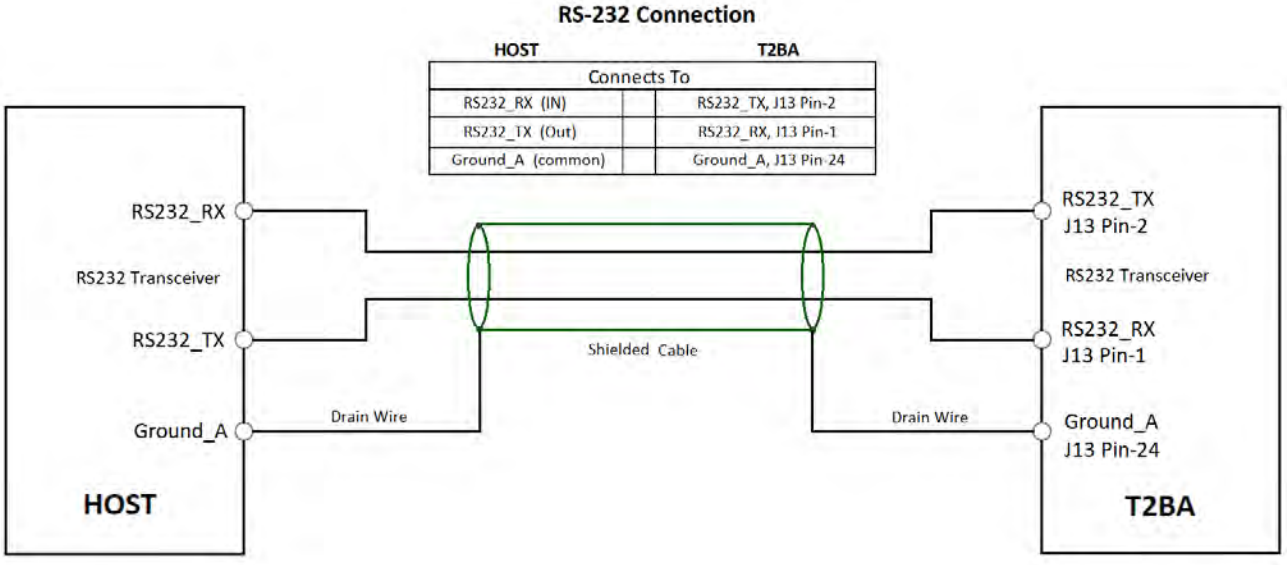


Figure 9: T2BA RS-232 Electrical Connection to Network

The RS-232 T2B functions in full duplex RS-232 mode.

User configurable network parameters include Baud Rate, Parity and Stop Bits. Data Bit selection is limited to 8. Selections are included in the table below and the methods of setting these variables is described in Chapter 4, Configuration and Setup.

Table 11: RS-232 Communication Variables

	Selections	Default
Baud Rate	9,600, 19,200, 38,400, 57,600, 115,200	19,200
Parity	None, Odd, Even	Odd
Data Bits	8 (Fixed)	8
Stop Bits	1, 2	1

RS-232 Protocol

Messages sent *to the device* from a remote computer are either:

- Commands that instruct the controller to perform a task or change an operating parameter, or
- Requests that prompt the controller to report information.

The format of the commands sent to the device appears as:

command *value*

where:

command is a label that allows you to identify the command.

value identifies the task or parameter to be changed.

Requests (R) are numbered chronologically, each with a different function, and appear as:

R #

Messages sent *by the device* to a remote computer are *responses*. The responses are replies to requests sent by the host computer.

The format of responses sent by the device to the computer appears as:

`response value`

where:

`response` is a label that allows you to identify the response.

`value` is the requested information.

Security

To help ensure that certain parameters are not changed inadvertently, some commands require that the instrument be placed into a Calibration mode. To enter the Calibration mode, the serial command “CAL 1234” is sent to the instrument. To return to the default user mode, send the command “USR”. To determine which mode you are in, send the request operating mode command “ROM”. This will either return “USR” or “CAL”. On power up, the mode is set to user.

Throughout the manual, commands which require the instrument to be in Calibration mode are so indicated: 🔒

Message Syntax

The RS-232 message syntax uses the following conventions:

Note

1. Commands and requests are *not* case sensitive.
2. Spaces are included in the syntax for clarity only. Do not include spaces in actual messages.

Table 12: Message Syntax

Syntax	Description
Bold	Message that you must enter exactly as shown in the manual. Do not include any spaces in the message string.
Italics	Placeholder that represents text or numeric values that you must supply.
`Response`	Format of a message sent from the device.
ENTER	End-of-line delimiter. All messages must use a carriage return-line feed (CRLF) or carriage return (CR) as the end-of-line delimiter. Use your host computer's communications software to assign the desired action to the ENTER key. The device appends an end-of-line delimiter to the end of every response.

For brevity, in discussion of a function and the command table, the termination characters are omitted but are required for actual commands sent by the Master.

Priority and Timing of Command Execution

Each RS-232 command is executed in the order that it is received. There is no prioritization of RS-232 commands as is the case with digital logic commands. The digital logic commands have higher priority and will override RS-232 commands.

The RS-232 commands generally execute within 25 milliseconds or less with the following exceptions:

- **J** (Valve Calibration/ Home) command can take up to 30 seconds to execute.
- **F** (pressure unit) and **T** (setpoint type) commands can take up to 100 milliseconds to execute.

Chapter Four: Configuration and Startup

The steps below provide the details needed to configure and begin using the T2BA in most installations. Select commands and queries are described in detail. A complete listing of Commands and Queries is contained in Appendix E.

Step 1: Apply Power

Apply 24VDC power to the main I/O connector cable. Within approximately 10 seconds, the LED display will splash the MKS Instruments logo onto the screen (as shown below). Wait approximately 15 seconds for the internal application to load completely before starting RS-232 communication (Note: RS-232 commands received before the application is fully loaded are ignored). Press the circular arrow symbol in corner of the display and the orientation of the text will change directions 90° clockwise. Press the circular arrow until the MKS logo is displayed in the desired orientation for easy readability when the valve is installed in the piping system.

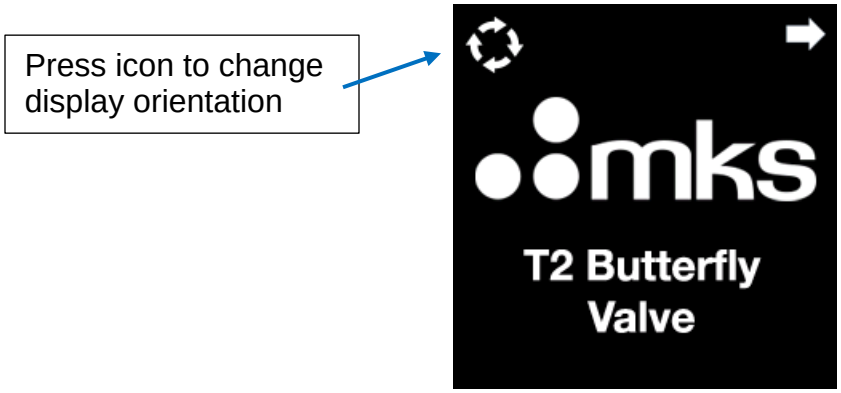


Figure 10: T2BA Opening LED Screen

Step 2: Set RS-232 Communication Parameters

To obtain the current communications settings, connect to the T2BA using the Diagnostic port (Ethernet, RJ-45, Chapter 7) and go to the Configuration page.

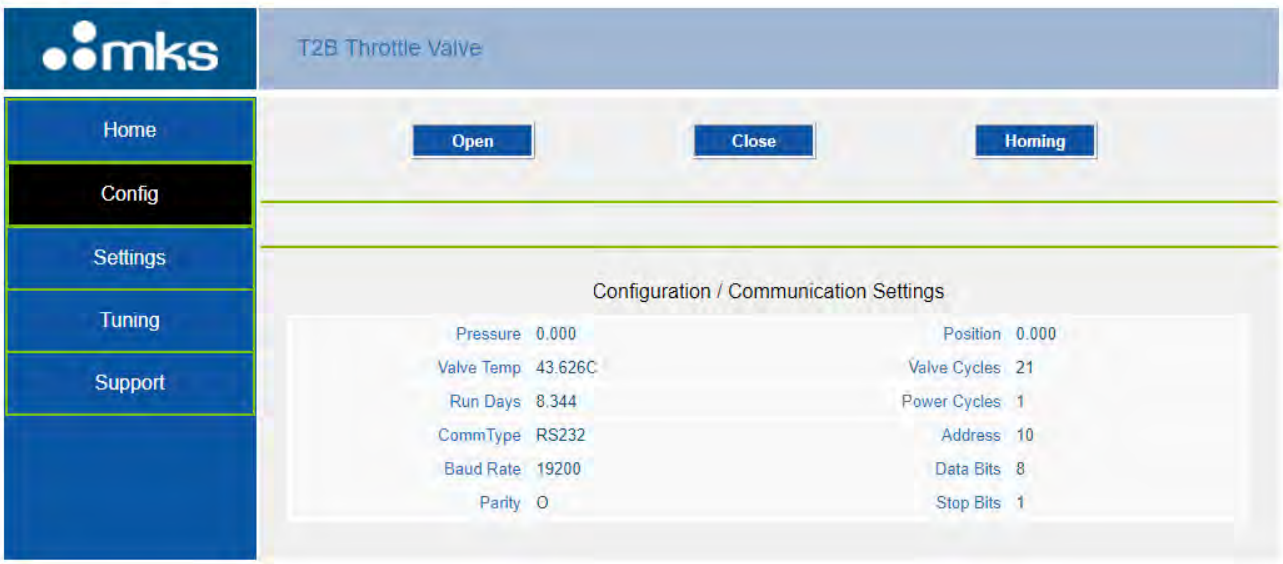


Figure 12: T2BA Configuration Web Page

Note that the settings cannot be changed on this page, only viewed. To change settings, configure the host computer or PLC with these settings temporarily to establish a connection to the T2BA. Once connected, RS-232 commands can be sent to change the T2BA communication settings.

To change baud rate, parity and stop bit settings, Enter [COM][abcd] where-

a = baud rate: **0**, **1, 2, 3** = Not Supported, **4** = 9600 **5 = 19.2k (default)**, **6** = 38.4k, **7** = 57.6k, **8** = 115.2k
b = parity bit: **0** = Even, **1** = **Odd (default), 2** = Mark, **3** = Space, **4 =** None
c= data length: Fixed at **1** = **8 (default)**
d = number of stop bits: **0 = 1 (default), 1** = 2

To confirm your entries, enter [COM]. If no change was made, the Factory Default response string should be: **5110**. Power cycle the valve and confirm connection with the host PC/ PLC.

Step 3: Set Default Display Units

The display reports the current pressure value supplied to the T2BA from the designated capacitance manometer.

To change the display units of the pressure, carefully touch the desired display units below the large numerical value. The displayed unit will be highlighted in GREEN, non-active selections will be a neutral GRAY color. (Note- This does not change the range for pressure, only the display).

Below the pressure readout at the top of the screen is the position readout indicating the last recorded position of the flapper.

CAUTION: actual flapper position may vary from the initial reported position due to movement that occurred during the shipment process / later steps in the integration procedure will perform calibration of the flapper position so that display reports most accurate information.

To change the display units of position (% Open or Degrees Open), carefully touch the desired display units below the large numerical value. The displayed unit will be highlighted in GREEN, non-active selections will be a neutral GRAY color.

Figure 11: T2BA Pressure / Position / Status Screen

Step 4: Observe Run and Error LEDs

At the right edge of the device LCD display (default display orientation; top of screen in Figure 13 view), the RUN and ERR indicators are shown with corresponding text indicating indicator function shown on the waterfall label. The RUN / ERR indicators shown on the LCD screen perform functions equivalent to multi-color LEDs.. Displayed colors are RED, GREEN, and neutral GRAY (off) against a black background.

Step 5: Confirm Communications with the T2BA Valve and Basic Operation

If Step 2 was performed properly, communications to and from the T2BA via the RS-232 network should be possible. Test this by confirming the communication settings entering [COM] or the Firmware Version entering **[R66].**

Confirm basic operation by setting the valve to Open- **[O],** Close- **[C]** and/ or Home- **[J]** (this function takes approximately 30 seconds). Monitor the actual flapper position (if not installed in a tool) or the LCD readback as the command is issued. Position can be queried following the command using **[R6]** where the returned value will be a % of full open (100%).

Note: To move the valve, Confirm the motion interlock is satisfied with connection of J13 Pin 22 to Pin 24. Ensure the system or valve is in a condition where free flapper movement is possible.

Step 6: Set Home Position (Home/ Learn Valve)

The mechanically exact flapper closed position (Home) is set at the factory and can be re-established by executing the Home command (Learn Valve). Since the flapper may be inadvertently moved during transport and installation, Homing should always be performed when a valve if first installed. It is recommended that Homing also be performed any time motor Slip is identified or routinely pre-process cycle or once per shift etc. as a Best Known Method.

The Homing routine takes up to 30 seconds (Gear Drive units). The valve will return to the position it was in prior to the Home command being issued and will continue performing the commanded function. During Homing, RS-232 move or pressure control commands are ignored and the encoder position will also be restored to zero. No homing completion status is available via RS-232.

To home the valve, command [J] should be entered.

Caution **The procedure for learning the valve involves cycling the valve from the open to the closed position. Be certain that the system can withstand valve cycling before proceeding.**

This test can be performed prior to installing the device and the valve in your system.

Step 7: Configure Pressure Sensor Inputs

The T2BA valve may be configured to operate with either one pressure transducer or, for extended range high accuracy range, two transducers. Configuration information is required for each sensor used. The default value for voltage inputs is 10 Volts. If this is the Full Scale voltage output of the sensors used, no changes are needed.

Setting the Sensor Signal Input Voltage Range

The Sensor Input Range applies to any sensor connected and cannot be different if two sensors are used.

Note Be sure that the sensor is connected to the device before changing the sensor signal input range.

The [**G *value***] command sets the full scale voltage range for the pressure sensor input, where:

***value*:** 0 = 1 Volt
1 = 5 Volts
2 = 10 Volts (initial)

To query the current range of the sensor signal input, issue the request:

R 35

The controller responds with the message [G *value*], where:

value: 0 = 1 Volt
1 = 5 Volts
2 = 10 Volts

If the sensor input has a full scale range of 10 Volts, an example response is:

G *2*

To change the sensor signal input range to 5 Volts, enter:

G *1*

Setting the Pressure Units

The [**F *value***] command identifies the units label for the device, where:

value: 00 = Torr (initial)
01 = mTorr
02 = mBar
03 = µBar
04 = kPa
05 = Pa
06 = cm H_20
07 = in H_20

To query the current pressure units, enter:

R 34

The controller responds with the message [F *value*], where:

value: 00 = Torr (initial)
01 = mTorr
02 = mBar
03 = µBar
04 = kPa
05 = Pa
06 = cm H_20
07 = in H_20

If the pressure units are Torr, an example response is:

F *00*

To change the units to mTorr, enter:

F *01*

Note The [**F *value***] command assigns a *label* to the pressure units; it does not convert pressure readings. Pressure readings are reported as a percentage (%) of full scale.

Setting the Sensor Range

Note Be sure that the sensor(s) are connected to the device before changing the sensor range.

Unless otherwise specified when ordered, the T2B ships with default sensor ranges of 10 for the Low Sensor (L) and 1000 for the High Sensor (H).

The [**E*x value***] command sets the range of the sensor, in units, where ***x*** corresponds to either 'H' or 'L' for the High or Low pressure sensor, and ***value*** corresponds to a valid sensor range, as listed in Table 13.

The device is initially configured to work with a 10 and a 1000 Torr pressure sensor. If your sensors cover different pressure ranges, use this command to identify the range of your sensor.

Table 13: Sensor Range Values (Unitless)

Value	Sensor Range	Value	Sensor Range
00	0.1	**10**	**1000**
01	0.2	11	5000
02	0.5	12	10000
03	1	13	1.33
04	2	14	2.66
05	5	15	13.33
06	**10**	16	133.3
07	50	17	1333
08	100	18	6666
09	500	19	13332
20	0.1333	21	20
22	200	23	0.001

Alternately, Ranges may be entered directly using the commands **SHR*x*** and **SLR*x*** can be used. Where *x* is the direct entry for the full scale range of the pressure sensor. Decimals are allowed, Maximum value is 10,000.

Note

1. Pressure readings are reported as a percentage (%) of full scale (FS), where full scale is the sensor range shown in Table 13.
2. For example, if the actual pressure is 10 Torr for a 10 Torr FS unit, the device reports a pressure value of 100 (for 100%). If the pressure is 10 Torr for a 100 Torr FS unit, the device reports a pressure value of 10 (for 10%).

To check the sensor range of your unit, issue the request:

R 55 for the Low range sensor (Reads Value from the Range Table)

or

RLR for the Low range sensor (Reads Range directly)

R 33 for the High range sensor (Reads Value from the Range Table)

or

RHR for the High range sensor (Reads Range directly)

For **R55, R33,** the controller responds with the message [E*x value*], where *x* corresponds to either 'H' or 'L' for High or Low sensor range and *value* corresponds to a valid sensor range shown in Table 13.

If the Low range sensor has a range of 100 Torr, an example response is:

EL *08*

To change the Low range to 5 Torr, enter:

EL *05*

To change the High range to 1000 Torr, enter:

EH *10*

For **RLR, RHR,** the controller responds with the message [SLR or SHR *value*], where *value* corresponds to the full scale sensor range.

If the Low range sensor has a range of 100 Torr, an example response is:

SLR+100.00000

To change the Low range to 5 Torr, enter:

SLR5

To change the High range to 1000 Torr, enter:

SHR1000

Note The sensor range of the High Channel MUST be greater than the sensor range of the low channel. Also, you cannot successfully change the value of the high channel to a value that is greater than the current low channel value. It may be necessary to change to low channel range first to a value that is lower than the desired high channel range.

Selecting the Active Sensor Channel

The standard, dual-channel device can operate in dual or single channel mode. In single channel mode, the unit can be set to operate on the high or low range transducer. The controller is set to dual-channel mode at the factory. The messages described here select and report the operating mode.

The [**L*value***] command selects the channel(s) to use, where:

LA *(Auto)* = Dual channel operation- Pressure Reading (**R5**) is expressed as % FS of High Sensor
LH *(High)* = CH1; high range sensor- Pressure Reading (**R5**) is expressed as % FS of High Sensor (locks out low range sensor)
LL *(Low)* = CH2; low range sensor- Pressure Reading (**R5**) is expressed as % FS of Low Sensor (locks out high range sensor)

To report which channels(s) are active, enter:

R*7*

The active channel is reported in parameter **"w"** in the Operational Status Word [M *x y z w*], Values for parameter "**w**" are listed below-

w: Active Sensor/Channel Select/Zero Adjust
0 = Low / Auto/ Disabled
1 = High / Auto / Disabled
3 = High / High / Disabled
4 = Low / Auto / Enabled
5 = High / Auto / Enabled

7 = High / High / Enabled
8 = Low / Low / Disabled
: = Low / Low / Enabled E

Changing the Behavior of the Auto Select Channel Mode

Automatic Crossover is set such that pressure control and readings on increasing pressure automatically switch from the Lo sensor to the Hi sensor at 100% of the Lo sensor full scale range. On decreasing pressure, pressure control and readings switch from the Hi sensor to Lo sensor at 0.9% of the Hi sensor full scale range. The default values for these commands have been carefully chosen to work well under most applications.

LD*xxx* sets auto crossover delay, where ***xxx*** is in msec (default = 100).

RD reports LD value.

LHC*xxx* sets high channel crossover point, where ***xxx*** is percentage of Hi channel (default = 0.9 (%)).

RHC reports LHC value.

LLC*xxx* sets low channel crossover point, where ***xxx*** is percentage of Low (default = 100 (%)).

RLC reports LLC value.

The active channel is reported in parameter **"w"** in the Operational Status Word.

Using the Sensor Zero

The [**Z 1**] command corrects for any sensor zero offsets. There is no request associated with this function. This command will zero the currently selected pressure sensor range. Prior to using Sensor Zero, select either the High or Low sensor using **[LH]** or **[LL].** Sensors will not be properly zeroed if set to Auto Range **[LA].**

To use the sensor zero:

1. ***Turn the gas flow off.***
2. ***Select either the High or Low sensor using [LH] or [LL].***
3. ***Drive the valve to full open by issuing the command:***

   O

   Refer to Driving the Valve to Full Open, page 53.

4. ***Pump the system down to base pressure.***

   In order to achieve a proper zero, the pressure of the system must be *lower* than the resolution of the sensor used to measure system pressure.

5. ***Enter the command:***

   Z 1

   To remove the sensor zero correction, refer to *Removing the Sensor and Special Zeros, below.*

6. ***Repeat for the other sensor if desired.***

Note If the pressure reading (at base pressure) is greater than 4% of full range, the sensor will not be zeroed.

Using the Special Zero

The [**Z 2 *value***] special zero command zeros the base pressure in systems where the known base pressure is not *at*, but *near* zero (as measured by another transducer in the system). There is no request associated with this

function. Prior to using the Special Zero, select either the High or Low sensor using **[LH]** or **[LL].** Sensors will not be properly zeroed if set to Auto Range **[LA].**

To use the special zero:

1. ***Set your system to base pressure.***
2. ***Select either the High or Low sensor using [LH] or [LL].***
3. ***Send the command:***

   Z 2 ***value***

   where ***value*** is expressed as a percentage of full scale pressure (% FS pressure):

   value: known base pressure reading transducer's full scale

4. ***Repeat for the other sensor if desired.***

To remove the special zero correction, refer to *Removing the Sensor and Special Zeros*, below.

Removing the Sensor and Special Zeros

The [**Z 3**] command removes the sensor zero [**Z 1**] and the special zero [**Z2** ***value***] correction factors stored in memory, and is used to determine the uncorrected signal from the pressure transducer. Each time a sensor is zeroed, the offset changes and the pressure value is updated. In some applications it may be important to keep the zero offset within a specific range. There is no request associated with this function.

To remove the zero corrections, send the command:

Z 3

Step 8: Configure Control Modes, Pressure Control Mode Setup

The T2BA valve can be operated in either Position or Pressure control modes. Selection of Position or Pressure control is done as part of valve operation (See Chapter 5). Pressure control can be performed either using PID Pressure Control or MKS Model Based Pressure Control. Selection of PID or Model Based Pressure Control is done as part of setup.

Position Control: In addition to full open or full positions, a value for valve position can be provided to the T2BA. Position is linear through the entire 0 to 90 degree flapper operating range with 0 equating to the fully closed position and 100% equal to the valve full open position. In this mode, the valve is moved to the desired setpoint but no feedback signal is generated. It is not necessary for the controller to make adjustments once the valve reaches its setpoint. See Chapter 5, OPERATION for how to utilize Position Control.

PID Pressure Control: The T2BA PID pressure control is a digital implementation of traditional PID control and can be a good choice for users who are experienced with PID tuning. However, the dynamics and non-linearity of downstream pressure control, makes the PID option best suited to operation over a limited pressure and flow operating range. For applications with a set process recipe, the PID pressure control option is very serviceable. Note that in the MKS implementation, the Derivative term is not used and is a fixed value in the algorithm.

- In legacy MKS RS-232 throttle valve products, the default pressure control is PID Pressure Control. Unless supporting existing process recipes or specialized requirements, Model Based Pressure Control is recommended for optimal pressure control performance over the widest range of conditions. Model Based Pressure Control is the default for the T2BA RS-232 product.
- In prior MKS Throttle Valve Products, PID Tuning Parameter, Proportional Gain (Kp) was termed *Gain* and Integral Gain (Ki) was termed *Phase*. Commands to Set and Retrieve these values remain the same.
- Note: When using PID Control, multiple Setpoint Configurations may be needed to optimize increasing and decreasing setpoint value response or stability at high or low setpoint values.

Model-Based Pressure Control: The MKS model-based controller is able to achieve superior dynamic response over a wide range of set-points and operating conditions in comparison to the traditional PID controller. Using Model Based Pressure Control the valve position is adjusted at each control cycle to regulate the valve conductance and, thus, the chamber pressure itself. An accurate knowledge of the system parameters is required for the optimal operation of the pressure controller. These parameters include the chamber volume and the system conductance as a function of valve position. These parameters are set when performing a System Learn function described in the following section.

- Model Based Pressure Control is the default for the T2BA RS-232 product.

Setting the Pressure Control Mode

Pressure Control Mode is a global setting and Setpoint Control (Operation) will execute using the current Pressure Control Mode.

Pressure Control Mode is defined using the command [Vx]. The [**V *value***] command sets the full scale voltage range for the pressure sensor input, where:

***value*:** 0 = Model Based Control
1 = PID Control

To query the current control mode setting, issue the request:

R 51

The controller responds with the message [V *value*], where:

value: 0 = Model Based Tuning
1 = PID

Pressure control mode can also be read and set via the T2BA Web Pages (See Chapter 7)- To enable Model Based Control, Change the value in the highlighted field from **2** to **128.** To revert back to PID control, change the value to **2.**

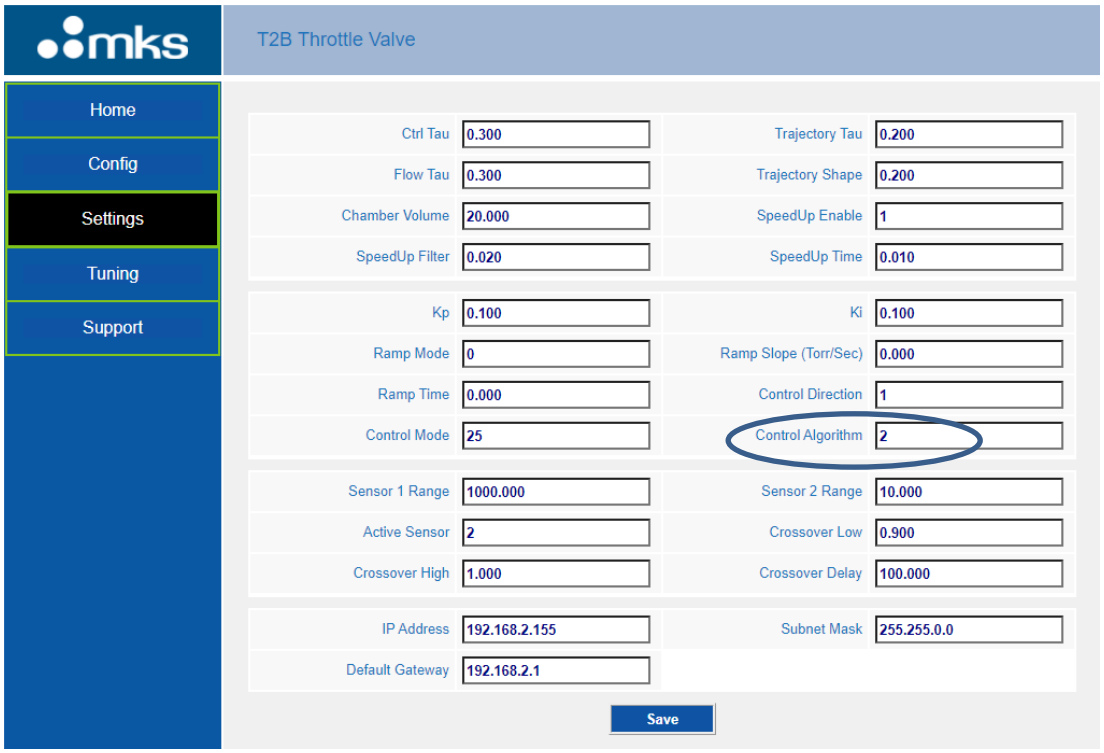


Figure 12: Selection to Change Pressure Control Mode

Step 9: Run System Learn Sequence (Model-Based Control Mode Only)

To allow for basic operation, the T2BA valve is delivered with a default conductance calibration curve (Pump Speed) which is created at the MKS factory and tagged in a manner which prevents editing or deletion in the field. However, for high performance Model-Based Pressure Control, an application specific pump speed curve must be generated by running the SYSTEM LEARN (LEARN) function.

The LEARN function generates the pump speed curve for the specific system and expected operating conditions including sensor type, chamber volume, inlet gas flow rate, and pumping system. The LEARN function should be executed during initial set-up/installation, prior to normal valve operation The sequence of steps required for LEARN is as follows:

Note: Setting of Learn parameters requires being in Calibration Mode, **[CAL].**

1. Enter the chamber volume (Liters), utilizing the command [**SVO***value*]). Use [**RVO**] to report the setting (volume is in liters) (Alternately, the Chamber Volume can be checked or set in the "Settings" Web Page).
   - Note that the volume value that is input should include the volume of the main chamber *plus* the volume of the plumbing between the chamber and the T2BA.
2. Determine the volume to input:
   - If confident of the actual chamber volume within 10%, the volume estimator may be left at the default setting of "Off" **(SVE 0).** However, it is generally recommended that the volume estimator be set to "On" during Learn because it adjusts effective volume to reflect the flow dynamics in the plumbing between the chamber and the T2BA valve (**SVE** 1). Use [**RVE**] to report the setting or view in the "Tuning" Web Page.
   - If you are unsure of the actual chamber volume, set the volume estimator to "On", (**SVE** 1) or from the "Tuning" Web Page. The volume estimator will determine the volume during the system Learn and use this volume for establishing the pump speed curve.
3. Verify that the correct pressure transducer ranges were previously set in Step 7.
4. Obtain the recommended LEARN flow rate set-point setting from the valve software (**RLE**) or from the "Tuning" Web Page..
5. Set the flow rate to the recommended or adjusted value for the duration of the LEARN sequence using (**SLF***x*) where *x* is the flow in Liters or set the Learn Flow in the "Tuning" Web Page.
   - **Note:** If it is impractical to use the recommended learn flow rate, experiment to establish a flow rate that generates, during the Learn sequence, a chamber pressure that registers between 80% and 98% FS on one the higher range manometer (in two manometer case).
   - Note: If *Active Sensor* is set to Auto (LA), the T2BA locks control to the higher range manometer, overriding the Auto-crossover function throughout the system LEARN sequence. Following the LEARN sequence, Auto ranging will be restored.
6. Initiate the gas flow that was entered with the [SLF] command above, into the system.
   Do not vary the flow rate during the LEARN.
7. Start the LEARN function (**L**) or using the LEARN button in the "Tuning" Web Page and monitor the pressure through the sequence, noting the maximum pressure reached. The pressure can be monitored on the LCD display (LCD version only) or on the process control system readout.

The flow rate should remain constant until the LEARN function is completed. The LEARN function moves the valve over a set of non-uniformly distributed positions and records the pressure data from the valve's active

channel transducer. The typical duration of the LEARN sequence is less than 45 seconds. The pressure response curve should resemble the solid line in Figure 13.

To stop a system LEARN before it has finished on its own, send the [**Q**] command.

You can review the system LEARN pump speed data by issuing the [**RCD 2**] command.

- A low pressure response curve (dotted line in Figure 13) indicates an insufficient flow rate during the test. The resulting pump speed curve to be used by the model-based control algorithm would be inaccurate and compromise the quality of pressure control.
- An excessively high pressure response curve (dashed line in Figure 13) would show transducer saturation (flat top) that would more significantly compromise the accuracy of the pump speed curve and resulting pressure control performance.

If the maximum measured pressure is under 80% of FS or above 98%, adjust the flow rate, accordingly, and rerun the system LEARN starting with Step 5 above.

Note: To obtain a pressure response curve between the 80% and 98% bounds, repeated runs of the LEARN sequence may be needed.

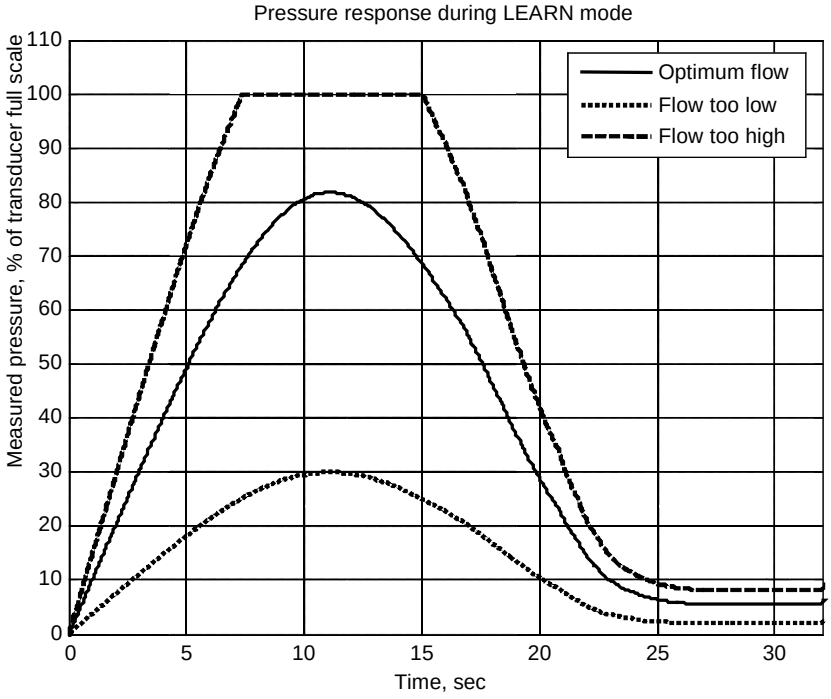


Figure 13: Typical Pressure Response in LEARN Mode

It is recommended that the values resulting from the LEARN function be reviewed (**RCD**2) and compared with a second run under the same conditions. The values should match within approximately 5%. The LEARN curve may also be compared with the Factory Curve (**RCD**1) if troubleshooting is necessary. A typical chamber pump speed versus valve position is shown in Figure 14, below.

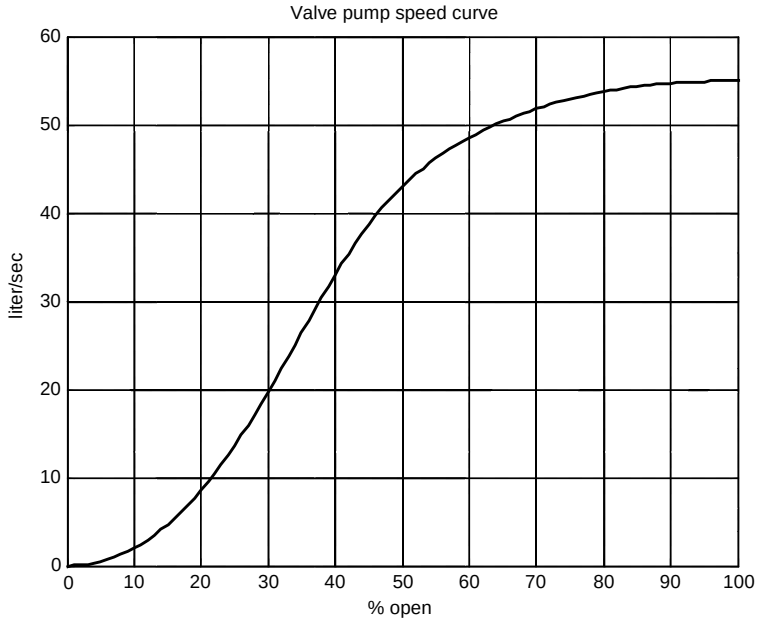


Figure 14: Typical Chamber Pump Speed Curve

Note: Following a System Learn, the active Conductance Curve will change to the Learned Curve (2).

Switching Curves

There are three pump speed curves available in the RS-232 T2B. Initially, all three curves will have the same value. All curves are non-volatile.

- Curve 1 is the factory default curve.
- Curve 2 is the learned curve. A system LEARN writes its data to the learned curve (see below).
- Curve 3 is the custom curve. This location is used for application specific pump speed curve.

To find out which pump speed curve is currently active, use the [**RCT**] command or view in the "Tuning" Web Page.

To switch to a different curve, use the [**SCT** ***x***] command, where ***x*** is 1, 2, or 3 or change in the "Tuning" Web Page.

The SCT setting is non-volatile.

Initially, Curve 1 (the factory default) is active. This curve cannot be manually edited.

After a system LEARN the active Curve is automatically set to 2. This curve may be edited.

Curve 3 is a custom curve. This location is used for application specific pump speed curve. As a default, Curve 3 matches the Factory Curve 1 but may be edited.

Curves 2 & 3 are writable over the Serial interface. Curve 1 cannot be modified.

Editing Curves

Sometimes it is desirable to manually modify the Learned Curve or create a unique pump speed curve for a unique application or recipe step. Curves number 2 & 3 may be modified.

To read all data points, use the [**RCD** ***x***] command, where ***x*** is 1, 2, or 3.

To read a single pump speed data value, use the [**RCV**] command followed by the Curve Number and data point number of interest separated by a ":".

For example, the following will report the value of curve 2, data point 14:

RCV 2:14

Data points range from 1 to 35 inclusive.

To set a data point, use the [**SCD** 🔒] command.

For example, the following will set curve 3, data point 27, to the value 123.456:

SCD 3:27:123.456

Note The curve being edited does not have to be the active curve.

Step 10: Set Other Configuration Values

Set Valve Control Direction

N0 = Normal valve action (default, typical in downstream pressure control applications)
N1 = Reverse valve action (sometimes used with valve upstream of process chamber)

A valve can be controlled to open and close in a normal or reverse direction. Normal action of valve control is defined as valve open at 100% of the valve position's full scale, and valve closed at 0%. Reverse action of valve control is defined as valve open at 0% of the valve position's full scale and valve closed at 100%.

Setting the Pump Speed Pedestal

The pump speed pedestal sets the minimum % position of the valve when in pressure control mode. This is sometimes applied to either ensure there is no overpressure condition of the chamber or to assist with a unique overshoot condition. Not normally used.

Use [**SCP** 🔒 ***xx***] to set the pump speed pedestal, where ***xx*** is any percentage value from 0 to 30.

Setting a value of 0 disables the pedestal. The default value is 0 (disabled).

Use [**RCP**] to read the current setting.

Setting Speedup Compensation Parameters

The speedup function is used to compensate for the measurement delay introduced by the pressure transducer. Default settings normally provide good dynamic control when pressure sensors are installed in accordance with recommendations. Speedup compensation adjustments can be useful for remote sensors or sensors connected to the chamber via small diameter tubing. It has two adjustable parameters:

- Speedup compensation constant.
- Speedup filter constant.

Both constants have units of time (seconds). The speedup compensation constant should be equal to the pressure transducer delay, typically in the order of tens of milliseconds. The speedup filter constant should be set 3 to 10 times smaller than the speedup compensation constant.

To enable the speedup compensator, enter:

SUE *1* 🔒

To disable the speedup compensator, enter:

SUE *0* 🔒

To read back the status of speedup compensator, enter:

RUE

To set the speedup compensation constant, enter:

SUT *value* 🔒

To report the speedup compensation constant, enter:

RUT

To set the speedup filter constant, enter:

SUF *value* 🔒

To report the speedup filter constant, enter:

RUF

The following example will enable the speedup compensator and set the speedup compensation constant to 0.05 sec and the speedup filter constant to 0.01 sec:

SUE 1

SUT 0.05

SUF 0.01

Table 14 below provides a summary of Setup Messages. Messages listed but not previously described are either self-explanatory or detailed in subsequent sections of this manual.

Table 14: RS-232 Setup Messages

Description	Command	Request	Response
Stop System Learn (L)	**Q**	N/A	N/A- Valve goes to **Last Position**
Reset (power cycle)	**IX**		
Home (Learn Valve)	**J**		
Pressure Control Mode	**V *value*** ***value:*** 1 = PID* 0 = Model Based	**R51**	V *value* *value:* 1 = PID 0 = Model Based
Pressure Units	**F *value*** ***value:*** 00 = Torr* 01 = mTorr 02 = mBar 03 = µBar 04 = kPa 05 = Pa 06 = cm H_2O 07 = in H_2O	**R34**	F *value* *value:* 00 = Torr 01 = mTorr 02 = mBar 03 = µBar 04 = kPa 05 = Pa 06 = cm H_2O 07 = in H_2O
Select Active Channel	**LA *(Auto)*** = Dual channel* **LH *(High)*** = CH1 **LL *(Low)*** = CH2	**R7**	Refer to parameter "**w**" in the Operational Status Word

System Learn	**L** Learns the system pump speed	**None**	None
Set Auto Channel Crossover Delay	***LDxxx*** ***xxx*** = msec (100*)	**RD**	LD *value*
Set High Channel Crossover Point	**LHC*xxx*** ***xxx*** = 0 to 100% of High (0 to 104.999 if firmware 01.04 or newer) default = 0.9	**RHC**	LHC *value*
Set Low Channel Crossover Point	**LLC*xxx*** ***xxx*** = 0 to 100% low (0 to 104.999 if firmware 01.04 or newer) default = 100	**RLC**	LLC *value*
* *Initial Setting*			

(continued on the next page)

Table 14: RS-232 Setup Messages (continued)

Description	Command	Request	Response
Set Model Based Parameters (See Tuning)	**ST *letter-value*:** A = STA 🔒 D = STD 🔒 E = STE 🔒 F = STF 🔒	 **R60** **R63** **R64** **R65**	 STA *value* STD *value* STE *value* STF *value*
Sensor Signal Input Range	**G *value*** ***value:*** 0 = 1 V 1 = 5 V 2 = 10 V*	**R35**	G *value* *value:* 0 = 1 V 1 = 5 V 2 = 10 V
Sensor Range LOW	**EL *value*** ***value:*** 00 = 0.1 Torr 01 = 0.2 02 = 0.5 03 = 1 04 = 2 05 = 5 06 = 10* 21 = 20 07 = 50 08 = 100 22 = 200 09 = 500 10 = 1000 11 = 5000 12 = 10000 13 = 1.33 mBar 14 = 2.66 15 = 13.33 16 = 133.3 17 = 1333 18 = 6666 19 = 13332 20 = 0.1333 23 = 0.001	**R55**	EL *value* *value:* 00 = 0.1 Torr 01 = 0.2 02 = 0.5 03 = 1 04 = 2 05 = 5 06 = 10 21 = 20 07 = 50 08 = 100 22 = 200 09 = 500 10 = 1000 11 = 5000 12 = 10000 13 = 1.33 mBar 14 = 2.66 15 = 13.33 16 = 133.3 17 = 1333 18 = 6666 19 = 13332 20 = 0.1333 23 = 0.001
** Initial setting*			

(continued on the next page)

Table 14: RS-232 Setup Messages (continued)

Description	Command	Request	Response
Sensor Range High	**EH** ***value*** ***value:*** 00 = 0.1 Torr 01 = 0.2 02 = 0.5 03 = 1 04 = 2 05 = 5 06 = 10 21 = 20 07 = 50 08 = 100 22 = 200 09 = 500 10 = 1000* 11 = 5000 12 = 10000 13 = 1.33 mBar 14 = 2.66 15 = 13.33 16 = 133.3 17 = 1333 18 = 6666 19 = 13332 20 = 0.1333 23 = 0.001	**R33**	EH *value* *value:* 00 = 0.1 Torr 01 = 0.2 02 = 0.5 03 = 1 04 = 2 05 = 5 06 = 10 21 = 20 07 = 50 08 = 100 22 = 200 09 = 500 10 = 1000* 11 = 5000 12 = 10000 13 = 1.33 mBar 14 = 2.66 15 = 13.33 16 = 133.3 17 = 1333 18 = 6666 19 = 13332 20 = 0.1333 23 = 0.001
Speedup/Lowpass Filter	**SUE** *value* ***value:*** 1* turns on 0 turns off	**RUE**	SUE *value* *value*: 1 turns on 0 turns off
Speed Up Filter	**SUF** *value* ***value:*** time in sec (0.020)*	**RUF**	SUF *value*
Speed Up Time	**SUT** *value* ***value:*** time in sec (0.010)*	**RUT**	SUT *value*
Pump Speed Pedestal	**SCP** *value* ***value:*** 0* to 30% open	**RCP**	SCP *value*
Chamber Volume	**SVO** *value* ***value:*** volume in liters	**RVO**	SVO *value*
Chamber Volume Estimator	**SVE** *value* ***value:*** 1* turns on 0 turns off	**RVE**	SVE *value* *value*: 1 turns on 0 turns off
** Initial setting*			

Chapter Five: Operation

Control Modes

The T2BA can be controlled in multiple modes:

- Discrete Motion Control (Open, Close, Hold, Home)
- Position Control by use of Setpoint Control
- Pressure Control employing a Model-based or traditional PID control algorithm by use of Setpoint Control

Procedures for setting up and using each of these control modes are provided in the sections below:

Discrete Motion Control

The unit can drive the throttle valve to full open or full close, stop at its current position or Home the valve. There are no requests associated with these functions.

Note The RS-232 commands to open, close, home or stop the valve *override* the active setpoint control of the valve.

Driving the Valve to Full Open (OPEN)

To drive the valve to full open, issue the command:

O

Driving the Valve to Full Close (CLOSE)

To drive the valve to full close, issue the command:

C

Stopping the Valve (HOLD)

To stop (hold) the valve in its current position, issue the command:

H

Homing the Valve (Valve Learn)

To home the valve flapper, issue the command:

J

The Homing routine takes up to 30 seconds (Gear Drive units).

Setpoint Control

To provide one RS232 control setting that defines the parameters of control mode (position or pressure), setpoint values (% FS of Active Sensor or % Open), PID tuning values (Proportional and Integral Gains) and Softstart Rate (% of valve speed) 5 Setpoints are defined, A-E. This allows the user to select a single Setpoint for recipe execution that defines these parameters without having to set each parameter individually within the recipe.

Each Setpoint, A-E can be pre-defined to include:

- Control Mode (Position or Pressure)
- Setpoint Value (% Active Sensor FS for Pressure Control, % Open for Position Control)
- Proportional Gain (For PID Pressure Control)
  - Integral Gain (For PID Pressure Control)

- Softstart Rate (% of available valve speed)

Notes:

- When using PID control with pressure setpoints, you can adjust both the proportional and integral gain values. The unit accepts and responds to both commands and queries.
- If using position setpoint control, there are no proportional or integral gain values. The unit will not accept or respond to these queries or commands.
- When Model Based Pressure Control is selected in the unit setup, proportional and integral gains defined in Setpoint Messages are ignored and the global Model Based tuning values are used.

Table 15, below summarizes the Setpoint Control command **D***x* and reading the configuration parameters **R7**.

Table 15: Setpoint Control Command, Dx

Description	Command	Request	Response
Activate Setpoint	**D *x*** ***x:*** 1 = Setpoint A 2 = Setpoint B 3 = Setpoint C 4 = Setpoint D 5 = Setpoint E	**R7**	M *x y z w* *x*: Active Setpoint 1 = Setpoint A 2 = Setpoint B 3 = Setpoint C 4 = Setpoint D 5 = Setpoint E 6 = Valve Open 7 = Valve Closed 8 = Valve Stop 9 = Valve Learning *y*: Valve Status 0 = Controlling 2 = Valve open 4 = Valve close *z*: Pressure 0 = ≤ 10% of FS 1 = > 10% of FS *w*: Active Sensor/Channel Select/Zero Adjust 0 = Low / Auto/ Disabled 1 = High / Auto / Disabled 3 = High / High / Disabled 4 = Low / Auto / Enabled 5 = High / Auto / Enabled 7 = High / High / Enabled 8 = Low / Low / Disabled : = Low / Low / Enabled

Table 16, below summarizes the Setpoint Configuration parameter options followed by the details of implementing and reading the configuration parameters.

Table 16: Setpoint Configuration and Parameter Messages

Description	Command	Request	Response
Setpoint Control Type	**T *x value*** ***x:*** 1 = Setpoint A 2 = Setpoint B 3 = Setpoint C 4 = Setpoint D 5 = Setpoint E ***value:*** 0 = Position 1 = Pressure*	**R *xx*** ***xx:*** 26 = Setpoint A 27 = Setpoint B 28 = Setpoint C 29 = Setpoint D 30 = Setpoint E	T *x value* *x*: 1 = Setpoint A 2 = Setpoint B 3 = Setpoint C 4 = Setpoint D 5 = Setpoint E *value*: 0 = Position 1 = Pressure
Setpoint Values	**S *x value*** ***x:*** 1 = Setpoint A 2 = Setpoint B 3 = Setpoint C 4 = Setpoint D 5 = Setpoint E ***value:*** *Setpoints A to E* = % FS pressure or % open	**R *x*** ***x:*** 1 = Setpoint A 2 = Setpoint B 3 = Setpoint C 4 = Setpoint D 10 = Setpoint E	S *x value* *x*: 1 = Setpoint A 2 = Setpoint B 3 = Setpoint C 4 = Setpoint D 5 = Setpoint E *value*: *Setpoints A to E*: % FS pressure or % open
Description	**Command**	**Request**	**Response**
Proportional Gain **Kp**	**M *x value*** ***x:*** 1 = Kp SP A 2 = Kp SP B 3 = Kp SP C 4 = Kp SP D 5 = Kp SP E ***value:*** 0 to 32767	**R *xx*** ***xx:*** 46 = Kp SP A 47 = Kp SP B 48 = Kp SP C 49 = Kp SP D 50 = Kp SP E	M x *value* *x*: 1 = Kp SP A 2 = Kp SP B 3 = Kp SP C 4 = Kp SP D 5 = Kp SP E *value*: 0 to 32767
Integral Gain **Ki**	**X *x value*** ***x:*** 1 = Ki SP A 2 = Ki SP B 3 = Ki SP C 4 = Ki SP D 5 = Ki SP E ***value:*** 0 to 32767	**R *xx*** ***xx:*** 41 = Ki SP A 42 = Ki SP B 43 = Ki SP C 44 = Ki SP D 45 = Ki SP E	X x *value* *x:* 1 = Ki SP A 2 = Ki SP B 3 = Ki SP C 4 = Ki SP D 5 = Ki SP E *value*: 0 to 32767
Kp Compensation Factor	**GC*value*** ***value:*** 0 to 100.0%	**RGC**	GC*value* *value*: 0 to 100.0%
Ki Compensation Factor	**PC*value*** ***value:*** 0 to 100.0%	**RPC**	PC*value* *value*: 0 to 100.0%
Softstart Rates	**I *x value*** ***x:*** 1 = Setpoint A 2 = Setpoint B 3 = Setpoint C	**R *xx*** ***xx:*** 15 = Setpoint A 16 = Setpoint B 17 = Setpoint C	I *x value* *x:* 1 = Setpoint A 2 = Setpoint B 3 = Setpoint C

	4 = Setpoint D 5 = Setpoint E 7 = Valve open 8 = Valve close ***value:*** 0.1 to 100% full speed	18 = Setpoint D 19 = Setpoint E 21 = Valve open 22 = Valve close	4 = Setpoint D 5 = Setpoint E 7 = Valve open 8 = Valve close *value:* 0.1 to 100% full speed

Setting the Type of Setpoint Control

Each setpoint can be configured so that it represents a pressure value or position value.

The [**T *x value***] command configures the unit for setpoint control, where:

***x*:** 1 = Setpoint A control
2 = Setpoint B control
3 = Setpoint C control
4 = Setpoint D control
5 = Setpoint E control

***value*:** 0 = Position control
1 = Pressure control (initial)

To configure setpoint A for pressure control, enter:

T *1 1*

To report the type of valve control for a particular setpoint, issue the request:

R *xx*

where ***xx***: 26 = Setpoint A control
27 = Setpoint B control
28 = Setpoint C control
29 = Setpoint D control
30 = Setpoint E control

The controller responds with the message [T *x type*], where:

x: 1 = Setpoint A control
2 = Setpoint B control
3 = Setpoint C control
4 = Setpoint D control
5 = Setpoint E control

type: 0 = Position control
1 = Pressure control

To report the type of control for setpoint A, enter:

R 26

If setpoint A is configured for pressure control, an example response is:

T *1 1*

Setting the Setpoint Values

The [**S *x value***] command sets the values for the setpoints, where:

x: 1 = Setpoint A value
2 = Setpoint B value
3 = Setpoint C value
4 = Setpoint D value
5 = Setpoint E value

value: *setpoints A to E:* % of full scale (typical values are between 0% and 100% of the sensor range with pressure control)
% of open (0 to 100% with position control)

To set the value of setpoint A to 50% of full scale pressure, enter:

S *1 50*

To report the value of a setpoint, issue the request:

R *x*

where ***x***: 1 = Setpoint A value
2 = Setpoint B value
3 = Setpoint C value
4 = Setpoint D value
10 = Setpoint E value

The controller responds with the message [S *x value*], where:

x: 1 = Setpoint A value
2 = Setpoint B value
3 = Setpoint C value
4 = Setpoint D value
5 = Setpoint E value

value:
setpoints A to E: % of full scale (with pressure control) % of open (with position control)

To report the value for setpoint A, enter:

R *1*

If setpoint A is set to 50% of full scale pressure, an example response is:

S *1 50*

Setting the Proportional Gain Values (Kp)

The [**M *x value***] command sets the proportional gain values for the internal setpoints, where:

x: 1 = Setpoint A Proportional gain (Kp)
2 = Setpoint B Proportional gain (Kp)
3 = Setpoint C Proportional gain (Kp)
4 = Setpoint D Proportional gain (Kp)
5 = Setpoint E Proportional gain (Kp)

value*:* 0 to 32767

To set the Proportional gain (Kp) for setpoint A to 50, enter:

M *1 50*

To report the Proportional gain (Kp) value for any setpoint, issue the request:

R *xx*

where ***xx*:** 46 = Setpoint A Proportional gain (Kp)
47 = Setpoint B Proportional gain (Kp)
48 = Setpoint C Proportional gain (Kp)
49 = Setpoint D Proportional gain (Kp)
50 = Setpoint E Proportional gain (Kp)

To report the Proportional gain (Kp) value for setpoint A, enter:

R 46

The controller responds with the message [M *x value*], where:

x: 1 = Setpoint A Proportional gain (Kp)
2 = Setpoint B Proportional gain (Kp)
3 = Setpoint C Proportional gain (Kp)
4 = Setpoint D Proportional gain (Kp)
5 = Setpoint E Proportional gain (Kp)

value: 0 to 32767

If the Proportional gain (Kp) for setpoint A is set to 45, an example response is:

M *1 45*

Setting the Proportional Gain Compensation Factor

The proportional gain compensation factor (GCF) modifies the proportional gain value so that the controller gives the best response to the low range setpoints.

When the device receives a setpoint in the range of the high sensor (Channel 1), it uses the proportional gain value entered with the [**M*xvalue***] command. When the controller receives a setpoint in the range of the low range sensor (Channel 2), it uses a percentage of the high range proportional gain determined by the GCF.

The messages described here set and report the gain compensation factor.

The [**GC*value***] command sets the gain compensation factor, where:

value: 0 to 100% of high range gain

To report the value of the proportional gain compensation factor, enter:

RGC

The controller responds with the message [GC*value*], where:

value: 0 to 100% of high range gain

For example, if:

M*xvalue* = 90.0

and:

GCF = 50

then:

Gain used for low range = 45.0

Setting the Integral Gain (Ki) Values

The command [**X *x value***] sets the Integral gain (Ki) values for the internal setpoints, where:

x: 1 = Setpoint A Integral gain (Ki)
2 = Setpoint B Integral gain (Ki)
3 = Setpoint C Integral gain (Ki)
4 = Setpoint D Integral gain (Ki)
5 = Setpoint E Integral gain (Ki)

value: 0 to 32767

To set the Integral gain (Ki) for setpoint A to 5, enter:

X *1 5*

To report the Integral gain (Ki) value for any setpoint, issue the request:

R *xx*

where ***xx*:** 41 = Setpoint A Integral gain (Ki)
42 = Setpoint B Integral gain (Ki)
43 = Setpoint C Integral gain (Ki)
44 = Setpoint D Integral gain (Ki)
45 = Setpoint E Integral gain (Ki)

To report the Integral gain (Ki) value for setpoint A, enter:

R 41

The controller responds with the message [X *x value*], where:

x: 1 = Setpoint A Integral gain (Ki)
2 = Setpoint B Integral gain (Ki)
3 = Setpoint C Integral gain (Ki)
4 = Setpoint D Integral gain (Ki)
5 = Setpoint E Integral gain (Ki)

value: 0 to 32767

If the Integral gain (Ki) for setpoint A is set to 10, an example response is:

X *1 10*

Setting the Integral gain (Ki) Compensation Factor

The Integral gain (Ki) compensation factor (PCF) modifies the Integral gain (Ki) value so that the controller gives the best response to the low range setpoints.

When the device receives a setpoint in the range of the high sensor, it uses the Integral gain (Ki) value entered with the [**X *x value***] command. When the controller receives a setpoint in the range of the low sensor, it uses a percentage of the high range Integral gain (Ki) determined by the **PCF**.

The messages described here set and report the Integral gain (Ki) compensation factor.

The [**PC*value***] command sets the gain compensation factor, where:

value: 0 to 100% of the high range Integral gain (Ki)

To report the value of the Integral gain (Ki) compensation factor, enter:

RPC

The controller responds with the message [PC*value*], where:

value: 0 to 100% of the high range integral gain (Ki)

For example, if:

X*x value* = 20.0

and:

PCF = 75

then:

Integral gain (Ki) used for low range = 15.0

Setting the Softstart Rates

The softstart rate controls the rate at which flow moves toward the desired setpoint. Different softstart rates can be assigned to each setpoint as well as to the valve open and valve closed commands. The softstart rate is expressed as a percentage of the valve's full *speed*, ranging from 0.1 to 100%. If it is not necessary to utilize softstart control in your process, leave the softstart rate at 100% of full speed.

The [**I *x value***] command sets the softstart rate for each setpoint, where:

x: 1 = Setpoint A rate
2 = Setpoint B rate
3 = Setpoint C rate
4 = Setpoint D rate
5 = Setpoint E rate
7 = Valve open rate
8 = Valve close rate

value: 0.1 (slowest) to 100% (fastest) of valve full speed

To report the softstart rate for any setpoint, issue the request:

R *xx*

where ***xx*:** 15 = Setpoint A rate
16 = Setpoint B rate
17 = Setpoint C rate
18 = Setpoint D rate
19 = Setpoint E rate
21 = Valve open rate
22 = Valve close rate

To report the softstart rate for setpoint A, enter:

R *15*

The controller responds with the message [`I x value`], where:

`x`: 1 = Setpoint A rate
2 = Setpoint B rate
3 = Setpoint C rate
4 = Setpoint D rate
5 = Setpoint E rate
7 = Valve open rate
8 = Valve close rate

`value:` 0.1 (slowest) to 100% (fastest) of valve full speed, Default is 100%.

If the softstart rate for setpoint A is set to 100%, an example response is:

`I 1 100`

To change the softstart rate for setpoint A to 50% enter:

I *1 50*

Slow Pump Introduction

The Slow Pump feature is implemented to allow a gradual change in chamber pressure when transitioning from the current pressure to a new setpoint.

Slow Pump is only available when in PID Control mode. Settings will have no effect when Model Based Control is selected (**V0**).

The enabled Slow Pump feature will constantly adjust the current setpoint along a control curve until the desired (final) setpoint is reached. Slow pump functions for decreasing, increasing or both decreasing and increasing pressure setpoints, depending on the setting of the slow pump enable. The desired setpoint and slow pump rate is programmable via RS232 or DNET commands. When slow pump is enabled, the final pressure setpoint is approached at the defined rate (Torr/s). Setpoint entry is done in the same manner whether slow pump is enabled or disabled.

Table 17: Slow Pump Commands/ Requests

COMMAND

Description	***Command***	***Function***
Pressure setpoint	**Sx***value*	Target pressure; where *value* is the pressure, x is the setpoint number and value is the target pressure in % FS of the active sensor in **LH** or **LL** settings or % FS of the high sensor when Auto, dual channel operation is enabled (**LA**)..
Slow Pump rate	**SR***value*	Set slow pump rate, where value is the slow pump rate (Torr/sec). Value must be positive. The value of zero is not allowed.
Slow Pump Enable	**SE***value*	Set slow pump enable, where value is either a 0 (disabled), 1 (enabled both increasing and decreasing), 2 (decreasing only) or 3 (increasing only). When slow pump is disabled the target setpoint will be approached at full speed by the controller, limited only by controller tuning. When slow pump is enabled the target setpoint will be

		approached at the rate defined by slow pump rate.

REQUEST

Request Message	*Information Requested*	*Response*
RSR	Slow pump rate	SR + *value* Where value is slow pump rate (Torr/s)
RSE	Slow pump enable	SE + *value* Where value is slow pump enable status (0=disabled, 1 =enabled, 2=decreasing only, 3=increasing only)

Slow Pump Behavior

When slow pump is changed to enabled (and for each time a new setpoint is entered while slow pump is enabled), the controller will read the current pressure and compare it with the desired pressure to determine if the pressure should be increased or decreased to get to the desired setpoint. Subsequently, the current setpoint will be modified (decremented or incremented per above) every control cycle until the current setpoint is equal to the desired setpoint. In this way the chamber may be adjusted in pressure in a gradual manner.

Activation of Slow Pump

The Slow Pump will be active whenever the slow pump attribute is enabled (non-zero).

Abortion of Slow Pump

Abortion of slow pump occurs when the slow pump enable attribute is set to zero (disabled). When slow pump is disabled, the controller approaches the setpoint at full speed, limited only by controller tuning.

Tuning

Model-Based Control

The T2BA Model-based control algorithm adjusts the flapper position to control pressure through adjustments to valve flow conductance. It works to align actual reported pressure to pressure set-point while considering the reported valve position and pump speed ("conductance") curve embedded in the Firmware.

The Factory installed or System Learned Conductance Curve generally provides excellent pressure control performance at default control parameter settings. However, fine tuning is possible through operator adjustment of the four control parameters listed in Table 18.

Table 18: Model-based Control Parameters

Performance Parameter	UoM	Default Value
Main Pressure Control		
• Control Tau	Seconds	0.20 to 0.30 depending on valve size

• Flow Tau	Seconds	0.20 to 0.30 depending on valve size
Pressure Setpoint Trajectory		
• Trajectory Tau	Seconds	0.30
• Trajectory Shape	Dimensionless	0.25

Adjusting Main Control Parameters

- Control Tau and Flow Tau determine the speed and responsiveness of pressure control. They are the main tuning parameters which are highly system specific, affected especially by flow rate and chamber volume.
- Larger Tau values yield slower but more stable control response while smaller Tau values yield faster response but with potentially less stable control and/or overshoot. The sensitivity of control performance to Tau values is demonstrated in Figure 15.
- Although Control Tau and Flow Tau are set separately, giving them the same settings is recommended in most cases.

Setting the Control Tau

The [**STA** *value*] command sets the Control Tau value for all internal setpoints, where:

***value**:* 0.1 to 1

To set the Control Tau to 0.5, enter:

STA0.5

To report the Control Tau value, issue the request:

R*60*

If the Control Tau is set to 0.5, an example response is:

`STA+0.50000`

Setting the Flow Tau

The [**STD** *value*] command sets the Flow Tau value for the internal setpoints, where:

***value**:* 0.1 to 1

To set the Flow Tau to 0.5, enter:

STA0.5

To report the Flow Tau value, issue the request:

R*63*

If the Flow Tau is set to 0.5, an example response is:

`STA+0.50000`

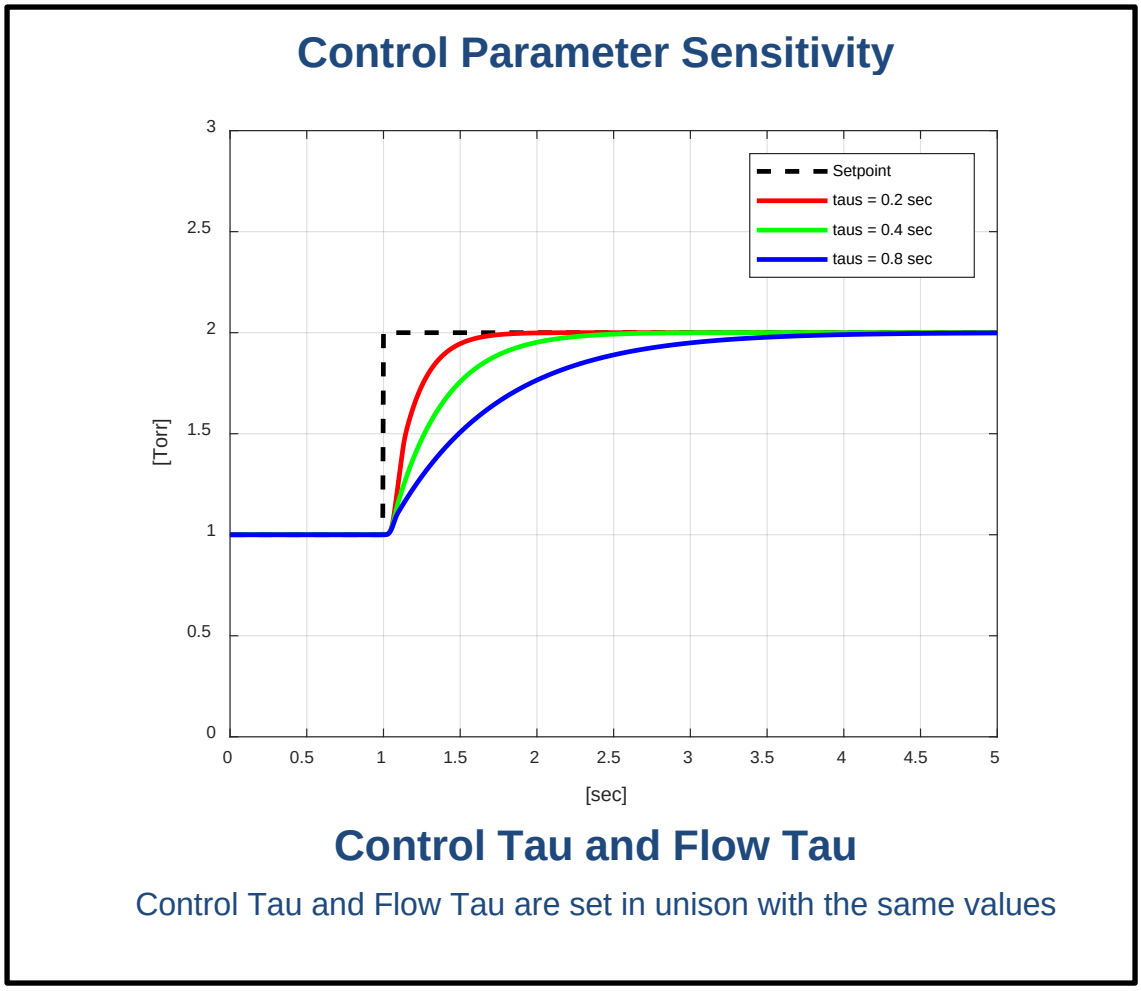


Figure 15: Main Control Parameter Sensitivity Example

Setting Pressure Set-point Trajectory Parameters

For smoothness of response and control of overshoot, the model-based control algorithm adds a smoothing factor (trajectory) to processing of changes in setpoint. This setpoint trajectory affects overall response of the control valve to setpoint changes, depending on the parameters, Trajectory Tau and Trajectory Shape. The impact of Trajectory Tau on set-point change can be seen in the Figure 16 example and impact of Trajectory Shape in Figure 17.

Guidelines for adjusting these parameters include:

- Trajectory Tau
  - Full pressure setpoint change takes approximately 5 times the Trajectory Tau.
  - Trajectory Tau has no effect on control response to flow changes or other perturbations (plasma event, for instance).
  - Recommended value of Trajectory Tau: Equal or greater than Pressure Control Tau.

- Trajectory Shape
  - Trajectory Shape (gamma) determines the character of the setpoint change.
  - Trajectory Shape values have the following affect:
    - Less than 0.25: Overdamped trajectory

- Equal to 0.25: Critically damped trajectory
- Greater than 0.25: Underdamped trajectory

o Values between 0.25 and 0.40 are typically recommended

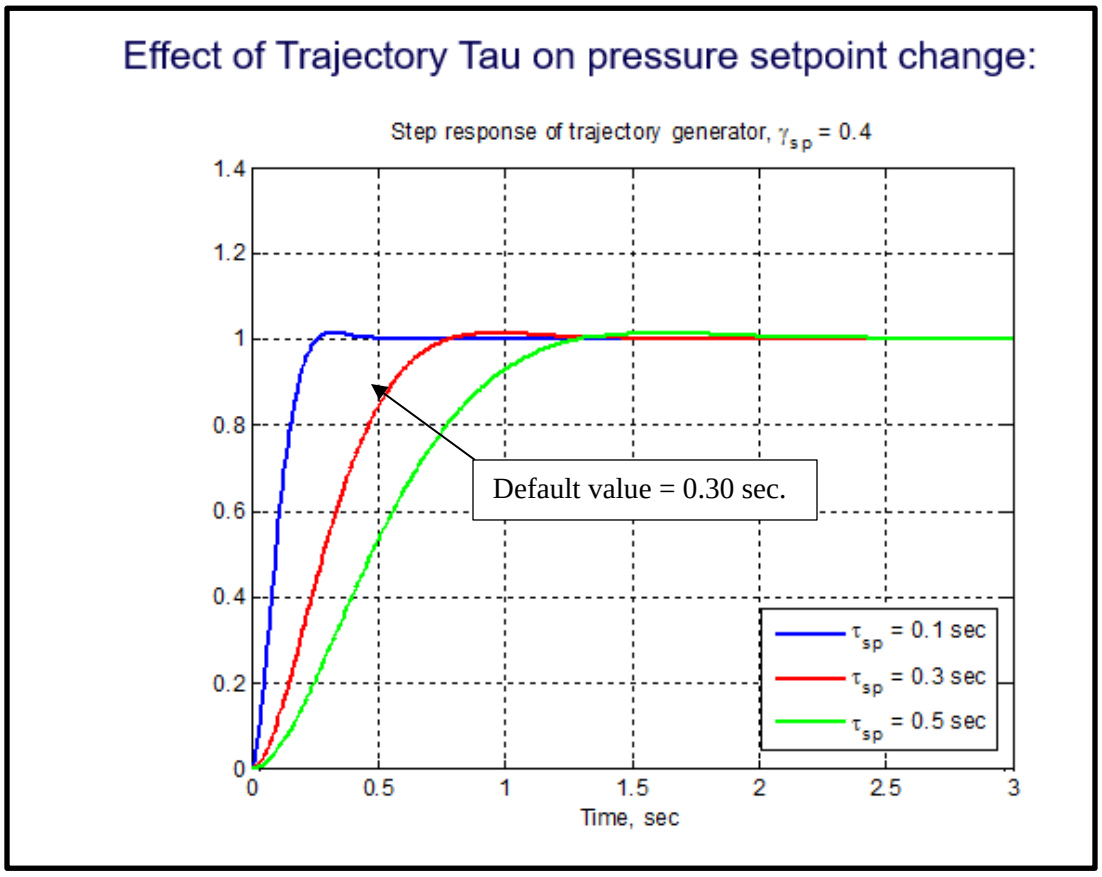


Figure 16: Pressure Setpoint Trajectory Tau Sensitivity Example

Setting the Trajectory Tau

The [**STF** *value*] command sets the Trajectory Tau value for the internal setpoints, where:

***value**:* 0.1 to 1

To set the Flow Tau to 0.5, enter:

STA0.5

To report the Trajectory Tau value, issue the request:

R*65*

If the Trajectory Tau is set to 0.5, an example response is:

`STA+0.50000`

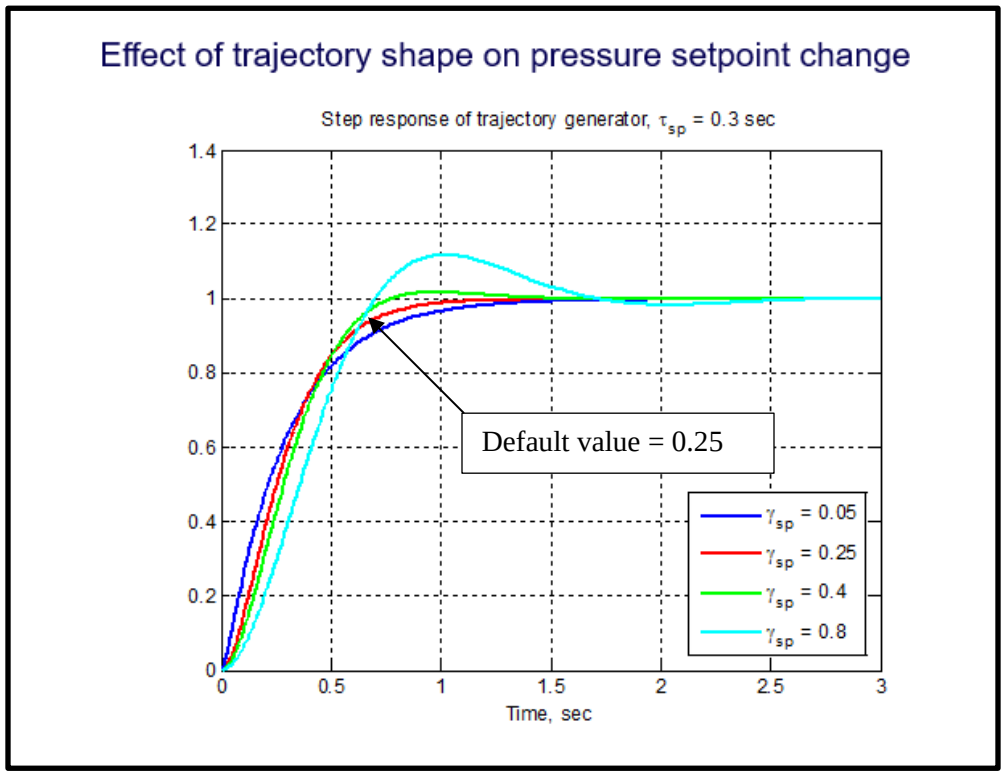


Figure 17: Pressure Setpoint Trajectory Shape Sensitivity Example

Setting the Trajectory Shape

The [**STF** 🔒 ***value***] command sets the Trajectory Shape value for the internal setpoints, where:

value: 0.01 to 1

To set the Trajectory Shape to 0.25, enter:

STE0.25

To report the Trajectory Shape value, issue the request:

R*64*

If the Trajectory Shape is set to 0.25, an example response is:

`STA+0.25000`

Note: Model Base Tuning Parameters are only applied when Model Based Control is selected, [**V0**]. Model Based Parameter Setting and Retrieval Commands are summarized below:

STA *value*	Set Control Tau 🔒
STD *value*	Set Nonlinear Flow Observer Tau 🔒
STE *value*	Set Nonlinear Trajectory Shape 🔒
STF *value*	Set Nonlinear Trajectory Tau 🔒
R60	Get Control Tau
R63	Get Nonlinear Flow Observer Tau

R64	Get Nonlinear Trajectory Shape
R65	Get Nonlinear Trajectory Tau

🔒 = Indicates that the instrument must be set to the calibration mode in order to process this command.

PID Pressure Control

The T2BA provides the option of traditional PID control, digitally implemented. The valve controller receives the measured pressure signal from the selected pressure sensor and adjusts the flapper position as required to maintain the pressure setpoint. Tuning parameters are adjusted to optimize response time and control stability.

Note: When using PID Control, multiple Setpoint Configurations may be needed to optimize increasing and decreasing setpoint value response or stability at high or low setpoint values.

The PID control algorithm is selected by issuing the **V1** command.

a- Note that in the T2BA PID control algorithm, the "D" term is fixed.

During tuning, the parameters are adjusted through the Setpoint Configuration.

- Proportional term, Kp x Error: **M x** *value* and Proportional Gain Compensation Factor, **GCF** *value*
- Integral term, Ki x Error: **X x** *value* and Integral Gain Compensation Factor, **PCF** *value*
- Derivative term, Kd: Internally fixed without user access

Error Signal

The error signal is the difference between the measured system pressure reading and setpoint. This error signal is the basis for the operation of the PID algorithm.

Proportional Term, Kp x Error

The Proportional term is the product of the Error and Proportional Gain. When the Proportional (P) gain is multiplied by the error signal, a proportional valve drive signal results. The higher the Proportional (P) control, the greater the change in valve drive signal for a given error signal. Typically, a higher Proportional (P) control setting yields a faster response. However, too high a Proportional (P) control setting will cause the pressure to oscillate. Too low a Proportional (P) control setting will result in a slow response from the valve controller. When used with zero Integral Gain, the proportional control will result in fixed steady-state pressure error. Figure below shows the effects of the selection of Proportional (P) gain.

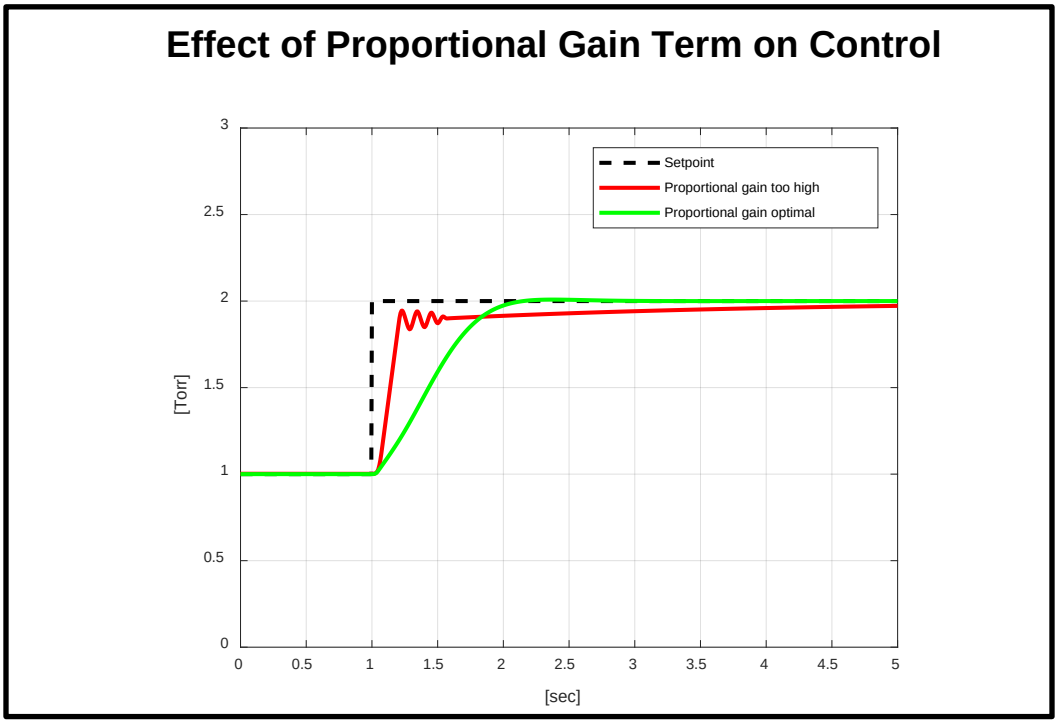


Figure 18: Effect of Proportional Gain (Kp) Term Values

Integral Term, Ki x Error

The Integral term is a product of the Integral Gain and the integral of Error over time. It speeds up the movement of the pressure control process towards setpoint and drives the steady-state error to zero. The dynamic behavior of the pressure control system will be affected by the selection of the Integral Gain. Too low value will increase the settling time of the process, while too high value may cause pressure oscillations.

Figure below shows the effect of the selection of Integral gain values.

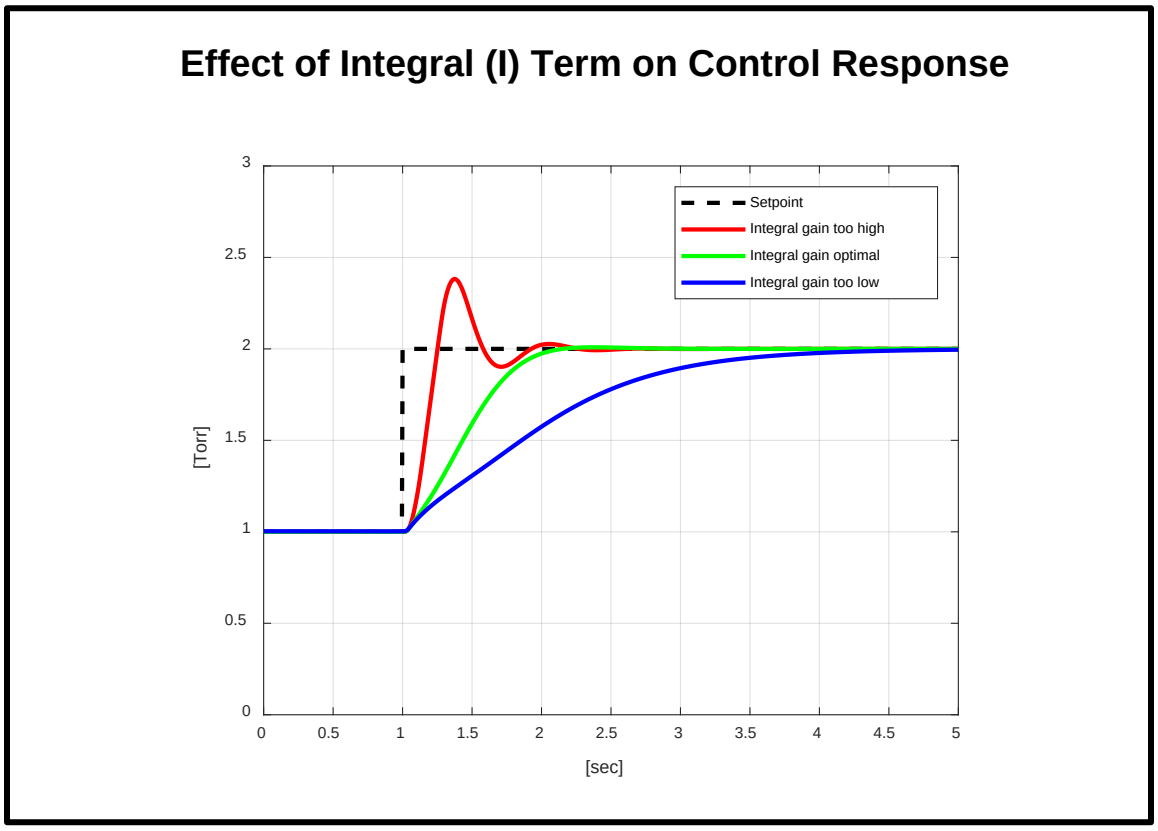


Figure 19: Effect of Integral Gain (Ki) Term Values

Note To *shorten* the integration time, *increase* Ki gain.

Derivative (D) Term

The Derivative (D) term in the T2BA valve is fixed without any user adjustments required.

Optimizing PID Control Settings

Optimizing the T2BA Butterfly Valve response *in your system* involves adjusting the Proportional and Integral gains. Since every system is different, the optimum settings may vary. Operating pressures, chamber volume, gas flow rate and gas composition all contribute to determining the ideal settings.

Controller gain tuning is frequently performed incrementally, by introducing relatively small pressure setpoint changes near the desired operating pressure. First, the Proportional Gain is adjusted to achieve the desired initial system response to the change in setpoint without oscillations. Next, the Integral Gain is adjusted to achieve the

desired transient response and settling time. The procedure may be repeated several times for the best combination of Proportional and Integral gains.

Default values for both Proportional and Integral Gains, (Kp, Ki) are factory set to 0.1 which should allow for basic PID control without significant oscillation or overshoot but will not be optimal for the fastest response.

Different combinations of Proportional and Integral gains may be required for various pressure values. Setpoints A-E can be used in this case or the Proportional Gain and/ or Integral Gain Compensation Factors.

Setting the Proportional Gain Values (Kp)

The [**M *x value***] command sets the proportional gain values for the internal setpoints, where:

x: 1 = Setpoint A Proportional gain (Kp)
2 = Setpoint B Proportional gain (Kp)
3 = Setpoint C Proportional gain (Kp)
4 = Setpoint D Proportional gain (Kp)
5 = Setpoint E Proportional gain (Kp)

value*:* 0 to 32767

To set the Proportional gain (Kp) for setpoint A to 50, enter:

M *1 50*

To report the Proportional gain (Kp) value for any setpoint, issue the request:

R *xx*

where ***xx*****:** 46 = Setpoint A Proportional gain (Kp)
47 = Setpoint B Proportional gain (Kp)
48 = Setpoint C Proportional gain (Kp)
49 = Setpoint D Proportional gain (Kp)
50 = Setpoint E Proportional gain (Kp)

To report the Proportional gain (Kp) value for setpoint A, enter:

R 46

The controller responds with the message [`M x value`], where:

x: 1 = Setpoint A Proportional gain (Kp)
2 = Setpoint B Proportional gain (Kp)
3 = Setpoint C Proportional gain (Kp)
4 = Setpoint D Proportional gain (Kp)
5 = Setpoint E Proportional gain (Kp)

value: 0 to 32767

If the Proportional gain (Kp) for setpoint A is set to 45, an example response is:

`M 1 45`

Setting the Proportional Gain Compensation Factor

The proportional gain compensation factor (GCF) modifies the proportional gain value so that the controller gives the best response to the low range setpoints.

When the device receives a setpoint in the range of the high sensor (Channel 1), it uses the proportional gain value entered with the [**M*xvalue***] command. When the controller receives a setpoint in the range of the low range sensor (Channel 2), it uses a percentage of the high range proportional gain determined by the GCF.

The messages described here set and report the gain compensation factor.

The [**GC*value***] command sets the gain compensation factor, where:

value: 0 to 100% of high range gain

To report the value of the proportional gain compensation factor, enter:

RGC

The controller responds with the message [GC*value*], where:

value: 0 to 100% of high range gain

For example, if:

M*xvalue* = 90.0

and:

GCF = 50

then:

Gain used for low range = 45.0

Setting the Integral Gain (Ki) Values

The command [**X *x value***] sets the Integral gain (Ki) values for the internal setpoints, where:

x: 1 = Setpoint A Integral gain (Ki)
2 = Setpoint B Integral gain (Ki)
3 = Setpoint C Integral gain (Ki)
4 = Setpoint D Integral gain (Ki)
5 = Setpoint E Integral gain (Ki)

value: 0 to 32767

To set the Integral gain (Ki) for setpoint A to 5, enter:

X *1 5*

To report the Integral gain (Ki) value for any setpoint, issue the request:

R *xx*

where ***xx*:** 41 = Setpoint A Integral gain (Ki)
42 = Setpoint B Integral gain (Ki)
43 = Setpoint C Integral gain (Ki)
44 = Setpoint D Integral gain (Ki)
45 = Setpoint E Integral gain (Ki)

To report the Integral gain (Ki) value for setpoint A, enter:

R 41

The controller responds with the message [X *x value*], where:

x: 1 = Setpoint A Integral gain (Ki)
2 = Setpoint B Integral gain (Ki)
3 = Setpoint C Integral gain (Ki)
4 = Setpoint D Integral gain (Ki)
5 = Setpoint E Integral gain (Ki)

value: 0 to 32767

If the Integral gain (Ki) for setpoint A is set to 10, an example response is:

X *1 10*

Setting the Integral gain (Ki) Compensation Factor

The Integral gain (Ki) compensation factor (PCF) modifies the Integral gain (Ki) value so that the controller gives the best response to the low range setpoints.

When the device receives a setpoint in the range of the high sensor, it uses the Integral gain (Ki) value entered with the [**X*xvalue***] command. When the controller receives a setpoint in the range of the low sensor, it uses a percentage of the high range Integral gain (Ki) determined by the PCF.

The messages described here set and report the Integral gain (Ki) compensation factor.

The [**PC*value***] command sets the gain compensation factor, where:

value: 0 to 100% of the high range Integral gain (Ki)

To report the value of the Integral gain (Ki) compensation factor, enter:

RPC

The controller responds with the message [PC*value*], where:

value: 0 to 100% of the high range integral gain (Ki)

For example, if:

X*x value* = 20.0

and:

PCF = 75

then:

Integral gain (Ki) used for low range = 15.0

Informational Messages

Informational messages report data on the device. There are no commands associated with these functions.

Table 19: RS-232 Informational Messages

Description	Request	Response
Communications Settings	**COM**	`abcd= baud(kB),Parity, Data Length, Stop Bits`
Pressure Reading (reports pressure reading as % of FS)	**R 5**	`P value` *value:* % FS based on channel Selection L*value* (**LL, LH, LA**)
Valve Position Value (reports valve position as % of Open)	**R6**	`V value` *value*: % Open
System Status (reports type of operation, state of learning, and valve control)	**R 37**	`M x y z` *x:* Type of Operation 0 = Local 1 = Remote *y:* State of the LEARN Function 0 = Not learning 2 = Learning valve *z:* Valve Control 0 = Open 1 = Close 2 = Stop 3 = Setpoint A 4 = Setpoint B 5 = Setpoint C 6 = Setpoint D 7 = Setpoint E
Firmware Version (Major Revision) (reports the installed version of firmware)	**R 38**	xx.xx *Major application revision number*
Checksum Status (reports the status of the A/D converter calibration)	**R 52**	`CS value` *value:* 0 = OK 1 = Error condition
Report Complete Firmware Build	**R66**	*MMM DD YYYY HH:MM:SS xx.xx.xx yy.yy.yy* Where xx underlined values are the Application

		Build and yy double underlined values are the Bootloader Build.
Report Error Condition	**VST**	*0000XXXX* Where **xxxx** is the Error Bit NO_FAULT 00000000 OVERCURRENT_BIT 00000001 BROWNOUT_BIT 00000002 WATCHDOG_BIT 00000004 ENCODER_BIT 00000008 FAN_FAULT_BIT 00000010 ETHERCAT_BIT 00000020 TEMPERATURE_BIT 00000040 MRAM_FAULT_WAIT_BIT 00000080 SYSTEM_BIT 00000100 RS485_BIT 00000200 ADC_1_BIT 00000400 ADC_3_BIT 00000800 EXT_ADC_BIT 00001000 RS232_BIT 00002000

Reporting the Communications Settings

To report the Communications Settings of the valve, issue the request:

COM

The controller responds a 4 character string, [abcd] where:

a = baud rate: **0**, **1, 2, 3** = Not Supported, **4** = 9600 **5 = 19.2k (default)**, **6** = 38.4k, **7** = 57.6k, **8** = 115.2k
b = parity bit: **0** = Even, **1** = **Odd (default), 2** = Mark, **3** = Space, **4 =** None
c= data length: Fixed at **1** = **8 (default)**
d = number of stop bits: **0 = 1 (default), 1** = 2

And the enumeration of the abcd values

For example, the default factory setting for COM will respond as:

5110 = 19200,O,8,1

Baud Rate is 19.2 Kbps, Odd Parity, 8 Bit Data Length, One Stop Bit

Reporting the Pressure Reading

To report the pressure To report the currently selected pressure reading as a percentage (%) of full scale (FS) of your pressure sensor, issue the request:

R 5

The controller responds with the message [P *value*], where:

value: % of sensor full scale

Note Pressure readings are reported as a percentage of full scale, where full scale is the sensor range set with the [**E*x value***] command. Refer to *Setting the Pressure Units*

The [**F *value***] command identifies the units label for the device, where:

value: 00 = Torr (initial)
01 = mTorr
02 = mBar
03 = µBar
04 = kPa
05 = Pa
06 = cm H_20
07 = in H_20

To query the current pressure units, enter:

R 34

The controller responds with the message [F *value*], where:

value: 00 = Torr (initial)
01 = mTorr
02 = mBar
03 = µBar
04 = kPa
05 = Pa
06 = cm H_20
07 = in H_20

If the pressure units are Torr, an example response is:

F *00*

To change the units to mTorr, enter:

F *01*

Note The [**F *value***] command assigns a *label* to the pressure units; it does not conv readings. Pressure readings are reported as a percentage (%) of full scale.

If the pressure is 10 Torr for a *10 Torr FS* unit, an example response is:

`P 100`

The pressure reading is 100% of the sensor's full scale.

If the pressure is 10 Torr for a *100 Torr FS* unit, an example response is:

`P 10`

The pressure reading is 10% of the sensor's full scale.

Calculating the Absolute Pressure

Calculate the absolute pressure using the formula:

ABSOLUTE PRESSURE = (`P value` / 100) x (FULL SCALE)

For example, if the pressure reading (`P value`) for a 1000 Torr FS unit was reported as 65 (65%), the absolute pressure is:

ABSOLUTE PRESSURE = (65 / 100) x (1000)

= 650 Torr

Note: Pressure Reading (**R5**) is dependent upon the Channel Select, [**L**value].

The [**L*value***] command selects the channel(s) to use, where:

LA *(Auto)* = Dual channel operation- Pressure Reading (**R5**) is expressed as % FS of High Sensor
LH *(High)* = CH1; high range sensor- Pressure Reading (**R5**) is expressed as % FS of High Sensor (locks out low range sensor)
LL *(Low)* = CH2; low range sensor- Pressure Reading (**R5**) is expressed as % FS of Low Sensor (locks out high range sensor)

To report which channels(s) are active, enter:

R*7*

The active channel is reported in parameter **"w"** in the Operational Status Word [`M x y z w`], Values for parameter "**w**" are listed below-

w: Active Sensor/Channel Select/Zero Adjust
0 = Low / Auto/ Disabled
1 = High / Auto / Disabled
3 = High / High / Disabled
4 = Low / Auto / Enabled
5 = High / Auto / Enabled
7 = High / High / Enabled
8 = Low / Low / Disabled
: = Low / Low / Enabled E

Reporting the Valve Position Value

To report the valve position value as a percentage (%) of full Open, issue the request:

R 6

The controller responds with the message [V *value*], where:

value: % of full Open

For example, if the valve is at 50, the response is:

V+0050.0

The valve position is 50% of full open. R6 reflects the analog position output.

Reporting the System Status

The system status request reports the type of operation, the state of the LEARN function, and the state of the valve control. To report the system status, issue the request:

R 37

The controller responds with the message:

M x y z

where *x*: Type of Operation
0 = Local
1 = Remote

y: State of the LEARN Function
0 = Not learning
2 = Learning valve

z: Valve Control
0 = Open
1 = Close
2 = Stop
3 = Setpoint A
4 = Setpoint B
5 = Setpoint C
6 = Setpoint D
7 = Setpoint E

If the unit is set for remote operation, the valve is not learning, and the valve is under setpoint A control, an example response is:

M *1 0 3*

Reporting the Firmware Version

To report the major revision of firmware that is installed in your device, issue the command:

R 38

The controller responds with a message, such as:

02.02

Reporting the Full Firmware Build String

To report the build string (which includes dates and times) of the firmware installed in your device, issue the command:

R 66

The controller responds with a message, such as:

Dec 11 2020 09:41:35 02.02.00 02.02.00

Where underlined values are the Application Build and double underlined values are the Bootloader Build.

Reporting the Encoder Position

To report the encoder position in % of full scale open, issue the command:

REN

The controller responds with a message, such as:

EN+18.98

Reporting the Valve Interlock Status

To report the valve interlock status, issue the command:

RIN

The controller responds with a message, such as:

IN0 or IN1

where: 0 = false
1 = true

Reporting the Checksum Status

The checksum indicates the status of the unit's A/D converter calibration. To report the status of the checksum, issue the command:

R 52

The controller responds with the message:

CS *value*

where: *value*: 0 = OK
1 = Error Condition

If the A/D calibration is OK, an example response is:

CS 0

If the A/D calibration is out of range, an example response is:

CS 1

If your unit issues a checksum error when you power up the controller, or if the transducer's readings are incorrect, you may need to recalibrate the span of the A/D converter or the error indicates a hardware failure of the EEPROM.. Contact any MKS Service Center through the MKS website at: http://www.mksinst.com/service/servicehowtoorder.aspx.

Reporting the Error Status

The Error Status indicates the specifics of a reported error (Red LED). To report the detail of an observed error, enter:

VST

The controller responds with an 8 bit message:

`0000xxxx`

where: *xxxx* are the significant error bits

NO_FAULT	00000000	
OVERCURRENT_BIT	00000001	Contact MKS Service if this value repeats
BROWNOUT_BIT	00000002	Check instrument power supply
WATCHDOG_BIT	00000004	Contact MKS Service if this value repeats
ENCODER_BIT	00000008	Check for Valve Slip, **R56**, **R8,** Home Valve (J)
FAN_FAULT_BIT	00000010	Contact MKS Service if this value repeats
ETHERCAT_BIT	00000020	NA
TEMPERATURE_BIT	00000040	Check ambient temperature, Contact MKS Service if this value repeats
MRAM_FAULT_WAIT_BIT	00000080	Contact MKS Service if this value repeats
SYSTEM_BIT	00000100	Contact MKS Service if this value repeats
RS485_BIT	00000200	NA
ADC_1_BIT	00000400	Contact MKS Service if this value repeats
ADC_3_BIT	00000800	Contact MKS Service if this value repeats
EXT_ADC_BIT	00001000	Contact MKS Service if this value repeats
RS232_BIT	00002000	Contact MKS Service if this value repeats

Chapter Six: Maintenance and Troubleshooting

General Information

In general, only minor periodic maintenance is required to keep the T2BA Butterfly Valve operating at maximum accuracy. Proper installation and operation of the T2BA Butterfly Valve to the guidelines presented previously will protect the instrument subsystems and ensure reliable operation over the life of the device. Periodic maintenance activities should include visual checks for wear on the interface cable, inspection of the enclosure for visible signs of damage, and periodic recalibration of the instrument.

Periodic recalibration of the instrument is required with a 1 year recalibration interval recommended. Refer to http://www.mksinst.com/service/servicehowtoorder.aspx for a complete list of MKS Calibration and Service centers.

If an MKS T2BA Butterfly Valve fails to operate properly upon receipt, check for shipping damage, and check the interface cable for correct continuity, grounding, pin outs, and voltage levels. Any damage should be reported to the carrier and MKS Instruments immediately. If there is no obvious damage and the troubleshooting instructions fail to resolve the problem, obtain an RMA Number (Return Material Authorization Number) and complete a Health and Safety Form before returning the unit to MKS Instruments for service.

Customer Support

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

If any difficulties arise in the use of your device, or to obtain information about companion products MKS offers, contact any authorized MKS Calibration and Service Center. If it is necessary to return the instrument to MKS, then two actions must be completed before shipping: (1) a RMA (Return Material Authorization) number must be obtained and (2) a Health and Safety Form must be completed and included with the instrument.

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

Obtaining a Return Material Authorization (RMA) Number

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

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

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

Health and Safety Form

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

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

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

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

Repair

Contact any authorized MKS Sales Office or Calibration and Service Center should you encounter any difficulties or problems using your MKS T2BA Butterfly Valve.
https://www.mksinst.com/service/ServiceContact.aspx

Note If it is necessary to return the instrument to MKS for repair, please contact any of the MKS international service/calibration centers listed on the inside of the back cover of this manual for an RMA (Return Material Authorization) number to expedite handling and ensure proper servicing of your instrument.

Troubleshooting

Table 20: Valve Troubleshooting Chart

Symptoms	Possible Cause	Remedy
At closed position, closed conductance fails spec.	* Valve has slipped * The seal on the flapper damaged or worn (if so equipped).	* Try homing the valve (Valve Learn) *Visually check that the valve appears fully closed when commanded to that position * Consult the factory for a seal replacement kit.
Valve does not open.	* Missing interlock on 25 pin DI/DO connector, pins 22 to 24. * No 24V power is present at the valve terminals. * Defective valve.	* Connect pin 22 to 24, or verify external interlock wiring. * Verify 24V power is applied to the valve. * Contact Customer Service, Return to MKS repair facility
Valve does not close.	* Missing interlock on 25 pin DI/DO connector, pins 22 to 24. * No 24V power is present at the valve terminals. * Defective valve.	* Connect pin 22 to 24, or verify external interlock wiring. * Verify 24V power is applied to the valve. * Contact Customer Service, Return to MKS repair facility
Valve fails to control pressure. Pressure reported by valve is FS.	* Sensor disconnected.	* Reconnect sensor.
Valve fails to control pressure. Pressure reported by valve is low or zero.	* Manometer not powered.	* Verify power to manometer.
Poor pressure control—oscillating.	* Tuning parameters are improper.	* If using PID Mode, optimize Kp (Gain) and Ki (Phase) values * If using Model Based mode, contact MKS Applications Support
Desired pressure can no longer be achieved.	* The seal on the flapper is worn or damaged (if so equipped).	* Consult the factory for a seal replacement kit.
Poor pressure control. Indicated pressure is too high or low (Control offset).	* Improper control parameters	* Contact applications engineer for assistance prior to returning unit for service and repair.
Poor pressure control in a specific pressure range.	* Tuning parameters are improper.	* Tuning parameters need optimization.
Valve reports negative pressure.	* Manometer not zeroed. * Manometer does not have power.	* Zero manometer. * Verify power to manometer.
Valve reports unexpected pressure.	* Manometer Full Scale setup not correct. * Voltage Range for manometer not correct	* Configure valve for correct manometer range * Configure valve for correct sensor voltage range

Pump Speed Learn does not work	* LEARN setup not correct.	* Configure system for correct LEARN setup
RS-232 communications fail.	* Incorrect settings or bad cable.	* Verify RS-232 Configuration * Verify cable wiring.
Diagnostic Interface Port Communications Fail	* Incorrect settings or bad cable.	* Verify IP address * Verify PC based EtherNET port communications setup * Verify cable wiring.

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Chapter Seven: Web Page Setup, Configuration, and Operation

The webpage interface is a supplemental digital interface that can be used for initial setup and monitoring purposes. It is not used to control the T2BA Butterfly Valve during normal operation. To access the diagnostic features of the pressure controller through the on-board auxiliary interface, follow Steps 1 and 2 before proceeding to the section titled “Step 3: Connect to the T2BA Butterfly Valve”.

Step 1: Configure TCP/IP Settings for Communication to T2BA Butterfly Valve

In order to communicate to a valve through the Ethernet interface, the host computer must have a unique, static IP address which is in the same general format as the valve. The following steps describe how to set up the host computer through its local area network connection:

1. Connect a standard CAT-5 Ethernet network cable between the host computer and the valve.

Note Older computer systems may require the use of a crossover network cable when the host computer is directly connected to the valve. If the connection between the valve and the host computer is via an Ethernet hub or Ethernet switch, then standard cables can be used with all host computer connections.

2. For Windows 7, open the <Control Panel> on the Start menu. Select <Network and Internet> and <View network status and tasks> to view the active networks on the host computer.

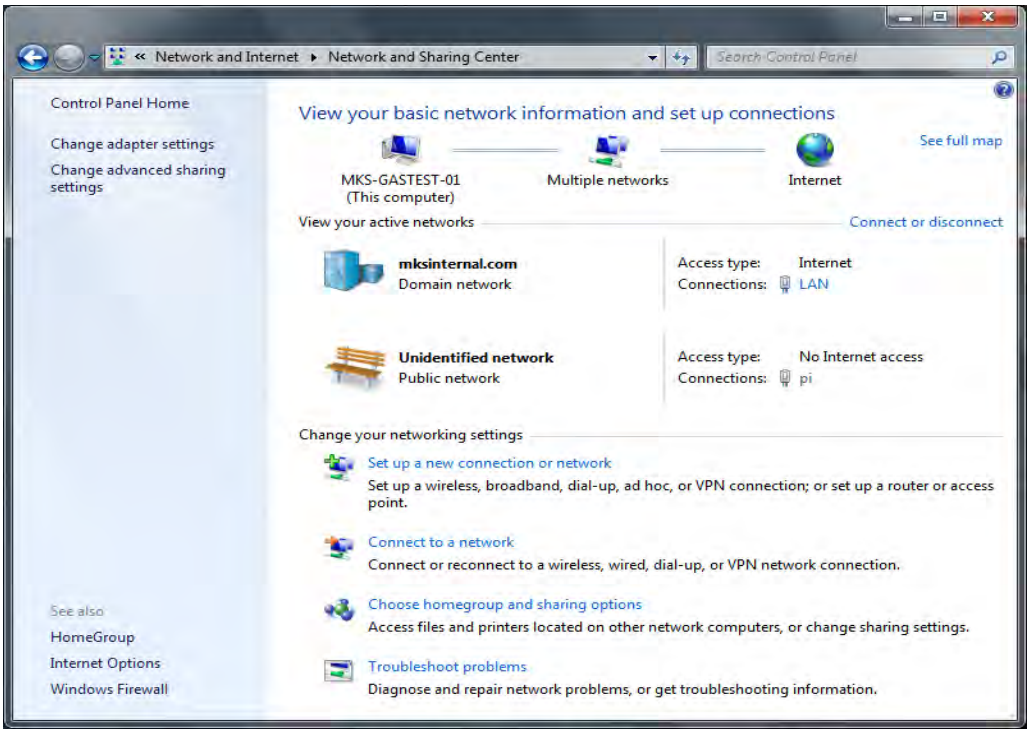


Figure 20: Windows 7 Network Information Window

3. Double click on the local area connection to open the status window as shown below.

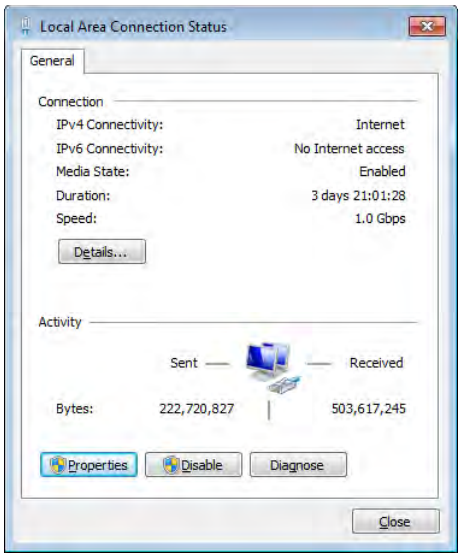


Figure 21: Windows 7 LAN Stats Dialog Box

4. Click on the "Properties" button to open the advanced settings window for the LAN connection, as shown in the figure below.

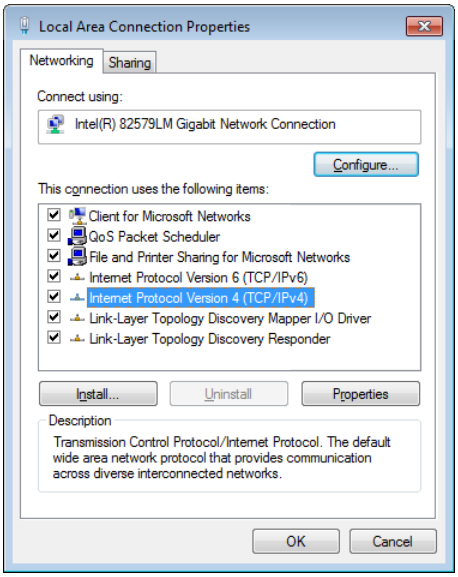


Figure 22: Windows 7 LAN Properties Dialog Box

5. Left click to highlight <Internet Protocol Version 4 (TCP/IPv4)>. Select <Properties>
6. A new pop up will appear related to "Internet Protocol Version 4 (TCP/IPv4) Properties" which allows you to change the default IP address of the communication port:

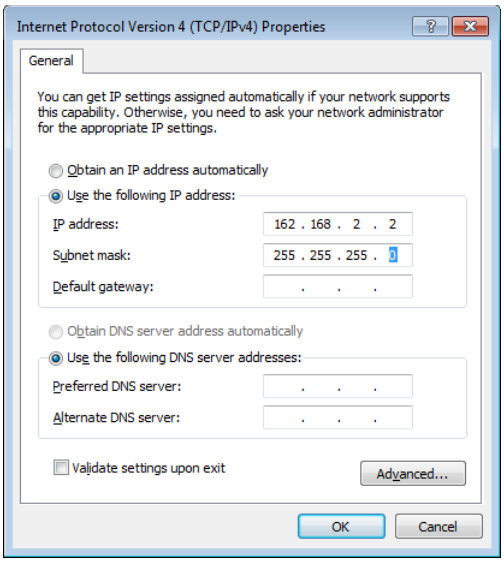


Figure 23: Windows 7 IP Properties Dialog Box

7. Select “Use the following IP Address”
8. Enter a unique IP address.

> **Note** The T2BA Butterfly Valve’s IP address format is 192.168.2.155. Your host computer’s IP address must also be of the format 192.168.2.XXX, where XXX is some number between 0 and 255. The host computer IP address must be unique. A recommended IP address for your Host computer is 192.168.2.2 with a subnet mask of 255.255.255.0.

9. Hit the <Tab> key on the left hand side of the keyboard and a subnet mask is automatically entered.
10. Click OK to close the window.
11. Close the remaining network connection windows.

The host computer is ready for communication with the T2BA Butterfly Valve.

Step 2: Connect to the T2BA Butterfly Valve

Before trying to connect to the T2BA Butterfly Valve, the communications network must be set up correctly. Complete the steps listed above if you have not already done so.

1. Launch an HTML browser.
2. Enter “http://192.168.2.155” in the address field.
3. Click “Go”.

The PC default browser (Internet Explorer, Chrome . . . etc.) will open and display the Device page in Monitor Mode. This page will show the model number and serial number of the T2BA Butterfly Valve. The serial number can always be found in the bottom left-hand corner of the browser window.

The modes are described in detail below.

Home Page

The Home Page provides basic information about T2BA Butterfly Valve's configuration, including the Software Version. Note that your display contents may differ depending on the Software Version and Valve Configuration.

Note The T2BA Butterfly Valve's model number, serial number and Firmware version is found on this page.

The figure below shows a screen capture of the Home Page for the valve.

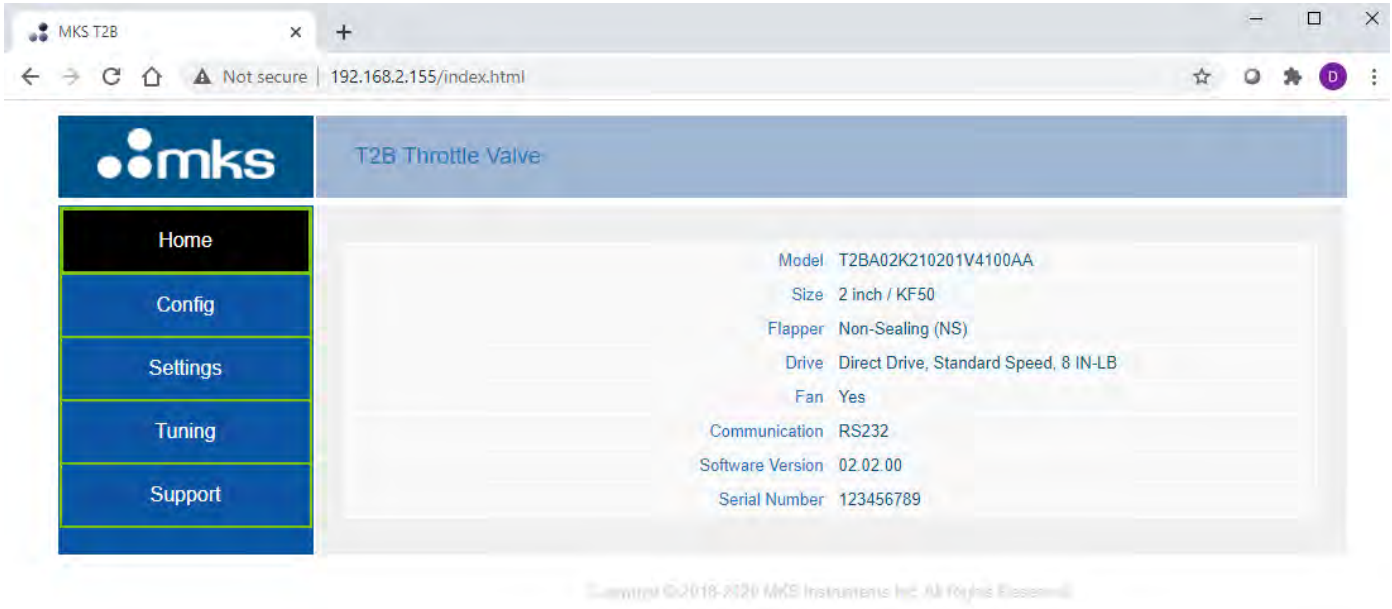


Figure 24: T2BA Butterfly Valve Embedded Interface (Home Page)

Configuration Page

The Configuration Page provides additional information on the T2BA Throttle valve and provides rudimentary operation. Selecting the Blue action buttons will execute the stated functions.

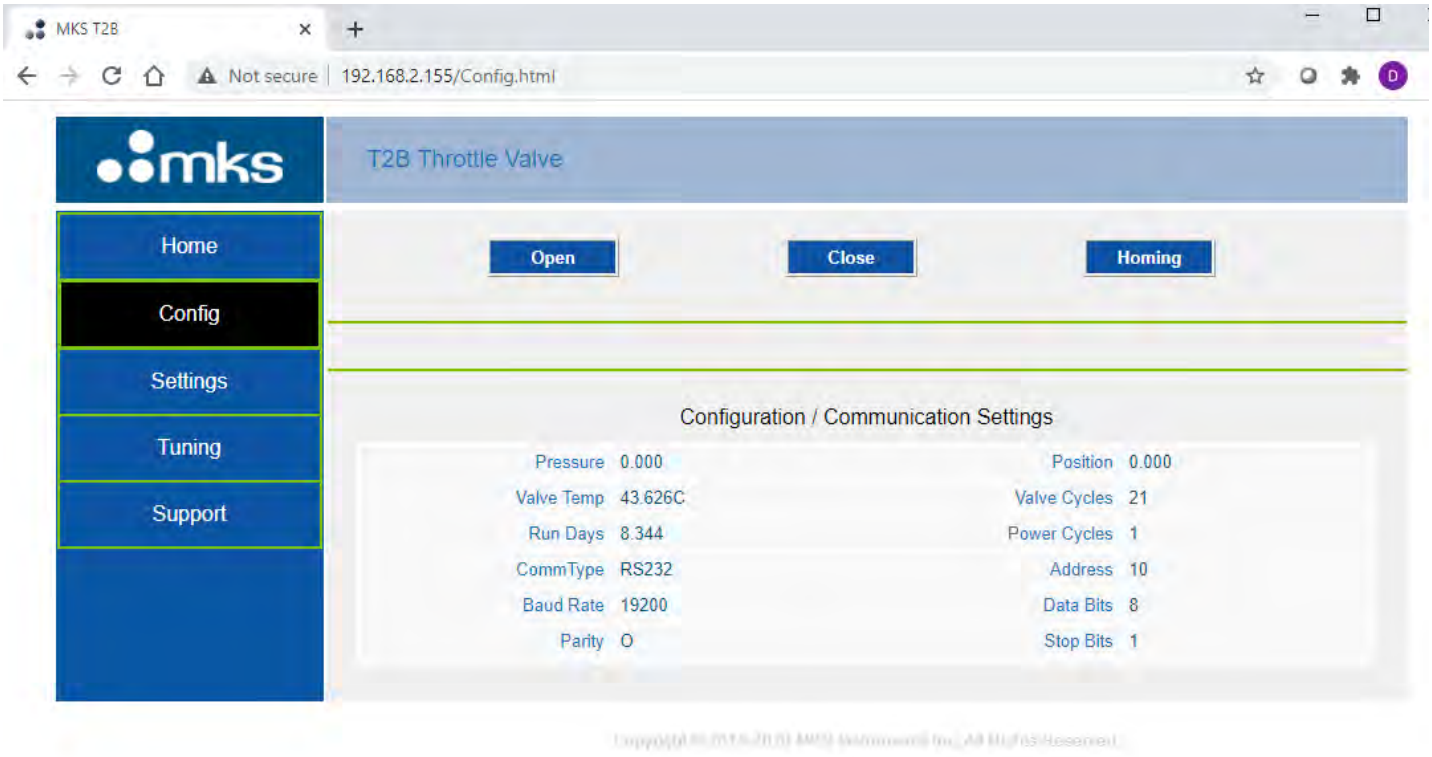


Figure 25: T2BA Butterfly Valve Embedded Interface (Configuration Page)

Settings Page

The Setting Page provides detailed information on the T2BA Throttle valve and provides access to key parameters. **Note:** Use caution when making changes using the Diagnostic Interface.

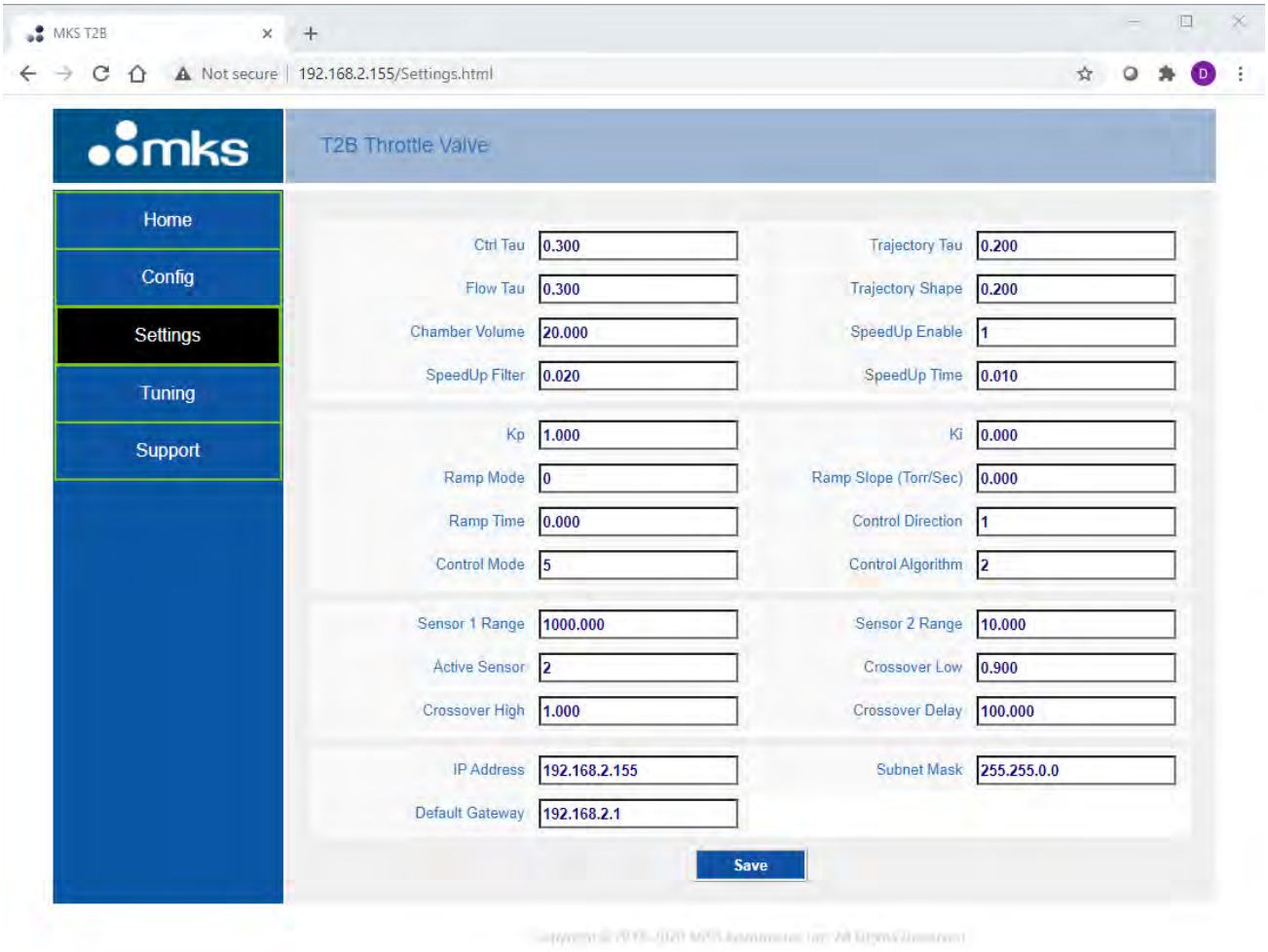


Figure 26: T2BA Butterfly Valve Embedded Interface (Settings Page)

Updating Firmware

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

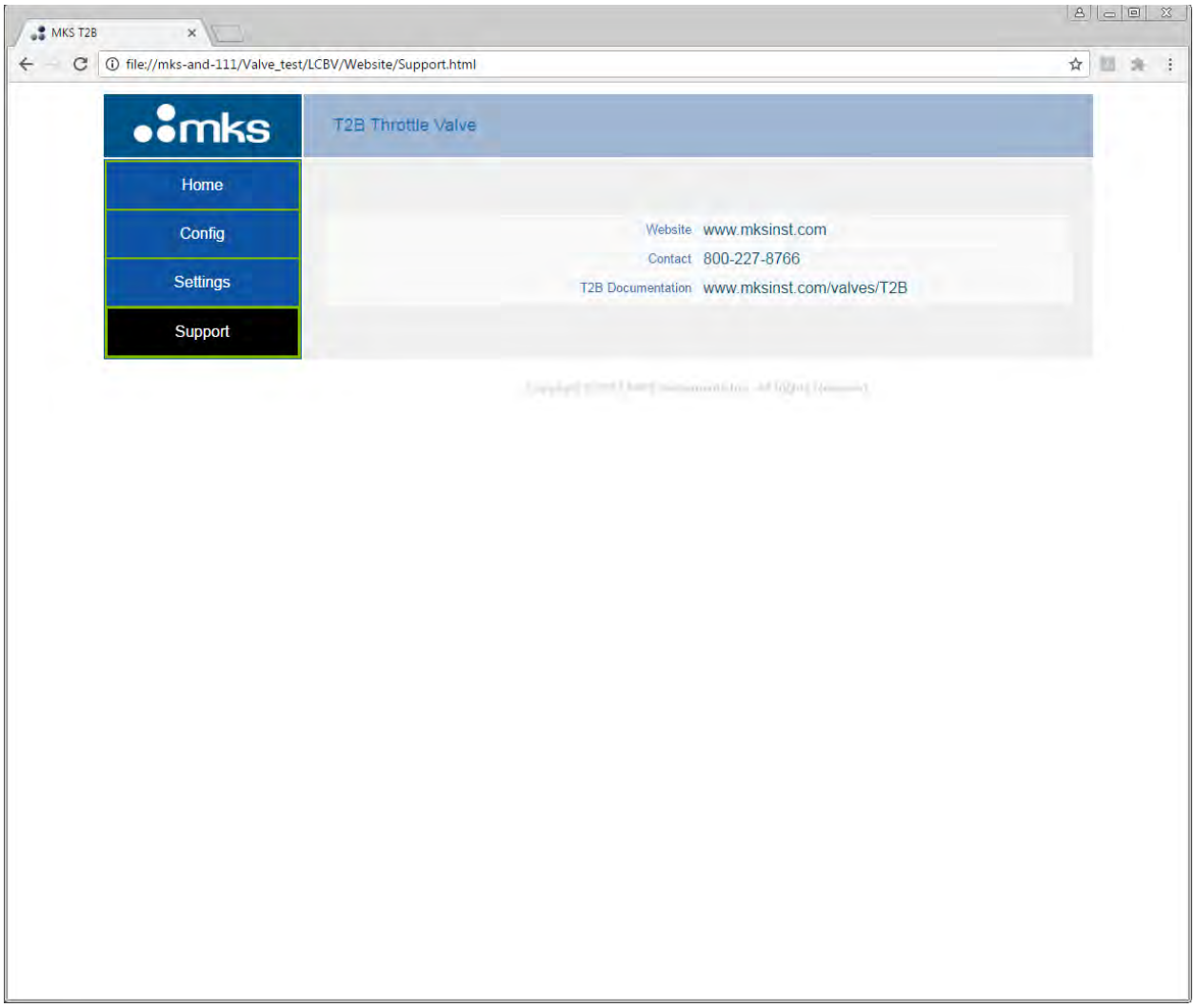


Figure 27: T2BA Butterfly Valve Contact/ Support Page

Appendix A: Product Specifications

Performance Specifications

Control Range Position Control Pressure Control	 0º - 90º 0.5% - 100% of Transducer FS 0.0001% - 100% FS (with Dual Transducer Input)
Total Combined Accuracy	0.25% of set point or 0.5% of Transducer Full Scale (whichever is greater)
Controller Repeatability	± 0.1 % of FS
Resolution	±0.1 % RDG
Open-close Speed	Motor type dependent. 8 lb.-in. direct drive (code = 2) 250 mSec. 25 lb.-in direct drive (code = 4) 480 mSec 40 lb.-in. geared drive (code = 3) 950 mSec.
Warm Up Time (< 0.5 % FS of steady-state performance)	1 minute
Leak Integrity Internal to external Through closed control valve	 < 1 x 10^{-9} sccm/sec He Range depends on valve size and flapper type

Compliance Specifications

RoHS Compliant	Yes, EU Directive 2011/65/EU
Electromagnetic Compatibility	EU Directive 2014/30/EU
Product Safety Requirements	Meets Directive 92/59/EEC
Machinery Directive	Meets Directive 89/392/EEC
Low-Voltage Requirements	Meets Directive 73/23/EEC
Installation Category	II, according to EN 61010-1
Pollution Degree	2, according to IEC 664

Environmental Specifications

Ambient Operating Temperature Range	0° to 50° C (32° to 122 °F)
Valve Body Maximum Operating Temperature	105º C Standard version 150º C High temperature version
Storage Temperature Range	-20° to 80° C (-4° to 176°F)
Operating Humidity Range	0 to 95% RH, non-condensing

Electrical Specifications

Input Power	+24 V_{DC} @ 3.0 A
Connectors	
Power / IO	25-pin DSUB (MALE)
Sensors	15-Pin DSUB (FEMALE)
EtherNET Diagnostic Port	RJ-45
Signal Inputs	
Pressure	0 to +10 VDC Typical (software configurable for other ranges)
Signal Output	
Analog	Pressure out, position out, 0 to +10 VDC Typical (software configurable for other ranges)
TTL (Active High)	Valve Open, Valve Closed, Alarm General
Open Collectors	None
Digital Communication Specifications	
Connector	25-pin DSUB (MALE)
Baud Rate	Baud-9,600, 19,200, 38,400, 57,600, 115,200
Data Bits, Parity, Stop Bits	8 Data Bits, Even/ Odd/ None Parity, 1 or 2 Stop Bits
Maximum Cable Length	50 Feet
Response Time	<20 msec (typical)

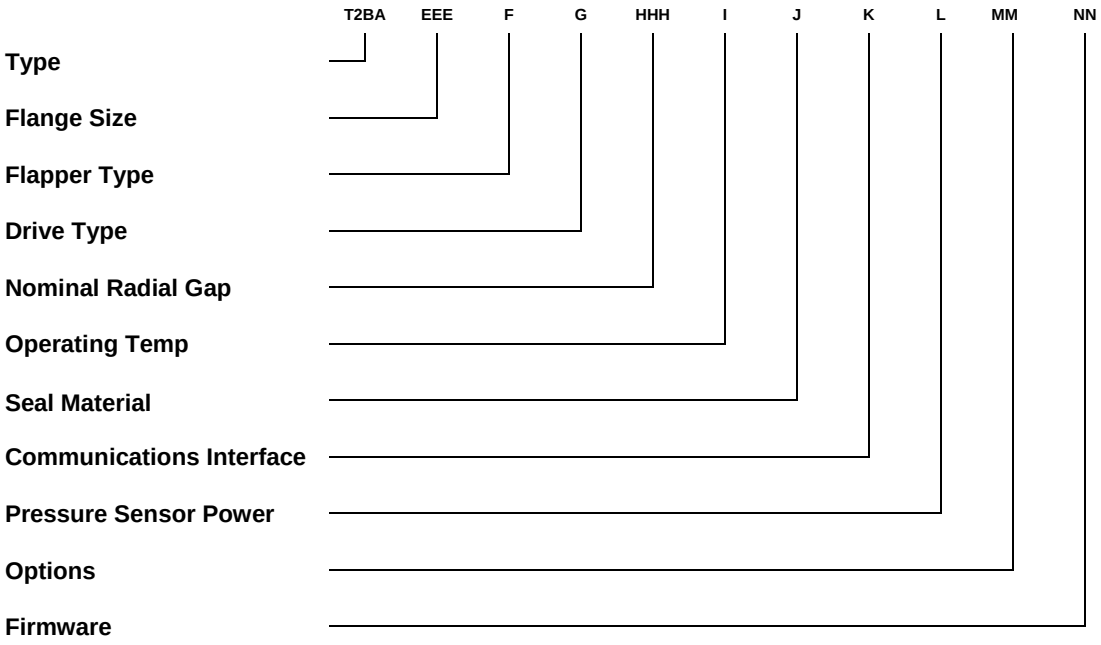
Due to continuing research and development activities, these product specifications are subject to change without notice.

Appendix B : Model Code Explanation

Model Code Description

The model code of the T2BA Butterfly Valve defines features of the unit such as interface type, flange size, motor drive type, flapper seal material and configuration, and firmware revision.

The model code is identified as follows: **T2BA EEE F G HHH I J K L MM NN** where:



Controller Type

The type identifies your unit as a specific model T2BA Butterfly Valve.

Flange Size (EEE)

The T2BA Butterfly Valve's flange interface type is designated by a 3 character alphanumeric code. The controllers are available in the following flange sizes:

Flange Size	Ordering Code
1" / KF40	01K
2" / KF50	02K
60mm / NW63	60N
3" / NW80	03N
4" / NW100	04N

Additional sizes are available on request. Please contact applications engineering department for assistance.

Flapper Type (F)

The T2BA Butterfly Valve's flapper type is indicated by a single digit code.

Flapper Type	Ordering Code	
Non- Sealing	2	
Low Conductance, F-Seal	3	
Low Conductance, Q-Seal	4	Only available for 1" and 2" sizes

Drive Type (G)

The T2BA Butterfly Valve's standard motor drive options are designated by a single digit code.

Drive Type	Ordering Code
DIRECT DRIVE, 8 lb.-in	2
Geared, 10:1, 40 lb.-in	3
DIRECT DRIVE , 25 lb.-in	4
DIRECT DRIVE , 16 lb.-in	7

Not all drive type, flapper type, and seal combinations are valid. A high speed (N23-1, 170 ms open/ close, 8 lb.-in) is also available for some configurations, Please contact your sales representative.

Nominal Radial Gap (HHH)

The T2BA Butterfly Valve's nominal radial gap is represented by a 3-digit code representing the clearance between flapper and body in closed position in tens of thousandths of an inch.

Standard Nominal Radial Gap	Ordering Code
0.002"	020
0.003"	020
F or Q Seal (Selection F- 3 or 4)	000

A Nominal Radial Gap of 0.002" is standard for non-sealing valves to 60mm in size, 0.003" is standard for 3" and 4" valves. Custom gaps are available as desired, Please contact your sales representative.

Max Heated Body Operating Temperature (I)

The T2BA Butterfly Valve's max operating temperature is designated by a numeric code.

Max Operating Temperature	Ordering Code
Up to 105C, with fan	1
Up to 150C, with fan	2
Up to 105C, without fan • Only available with drive type selection code 2.	3

Higher body temperature ratings may be available after publication of this manual. Please contact your sales representative.

Seal Material (J)

The T2BA Butterfly Valve's seal material (for process compatibility) is designated by a letter code.

Seal Configuration	Ordering Code
Viton	V
Teflon impregnated Viton	T
Chemraz E38	C
Chemraz 592	D
Kalrez 4079	L
Kalrez 8085	K
Kalrez 9100	M
Kalrez 9500	N

Com Interface (K)

The T2BA Butterfly Valve's communications interface is designated by a numeric code. Note that only the RS-232 selection listed below is applicable for this manual. Other Communications interfaces may be available after publication of this manual. Please contact your sales representative.

Communications Interface	Ordering Code
EtherCAT, no Analog w/LCD	4
EtherCAT, no Analog w/switches	E
RS-485	5
RS-232	2

Pressure Sensor Power (L)

The EtherCAT T2BA Butterfly Valves are not available with auxiliary power supply. RS-232 and RS-485 Models may be equipped with a Sensor Power Supply

Pressure Sensor Power	Ordering Code
None	0

Additional Options (MM)

The T2BA Butterfly Valve's additional configurable options are designated by a 2-digit code.

Seal Configuration	Ordering Code
Options	00

Firmware Version (NN)

The T2BA Butterfly Valve's firmware version options are designated by a two digit number codes such as 10, 11 etc.

Code for receiving the current firmware is VV.

Firmware Version	Ordering Code
Most recent current version	VV

Note Unless otherwise specified, MKS will ship firmware current to date of order. To receive previous software revision levels or lock your configuration to a particular software version, please specify to customer service at order placement.

For assistance in configuring a T2BA Butterfly Valve for your application, please consult the MKS Customer Service.

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Appendix C: Health and Safety Form

HEALTH AND SAFETY FORM

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

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

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

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

☐	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)

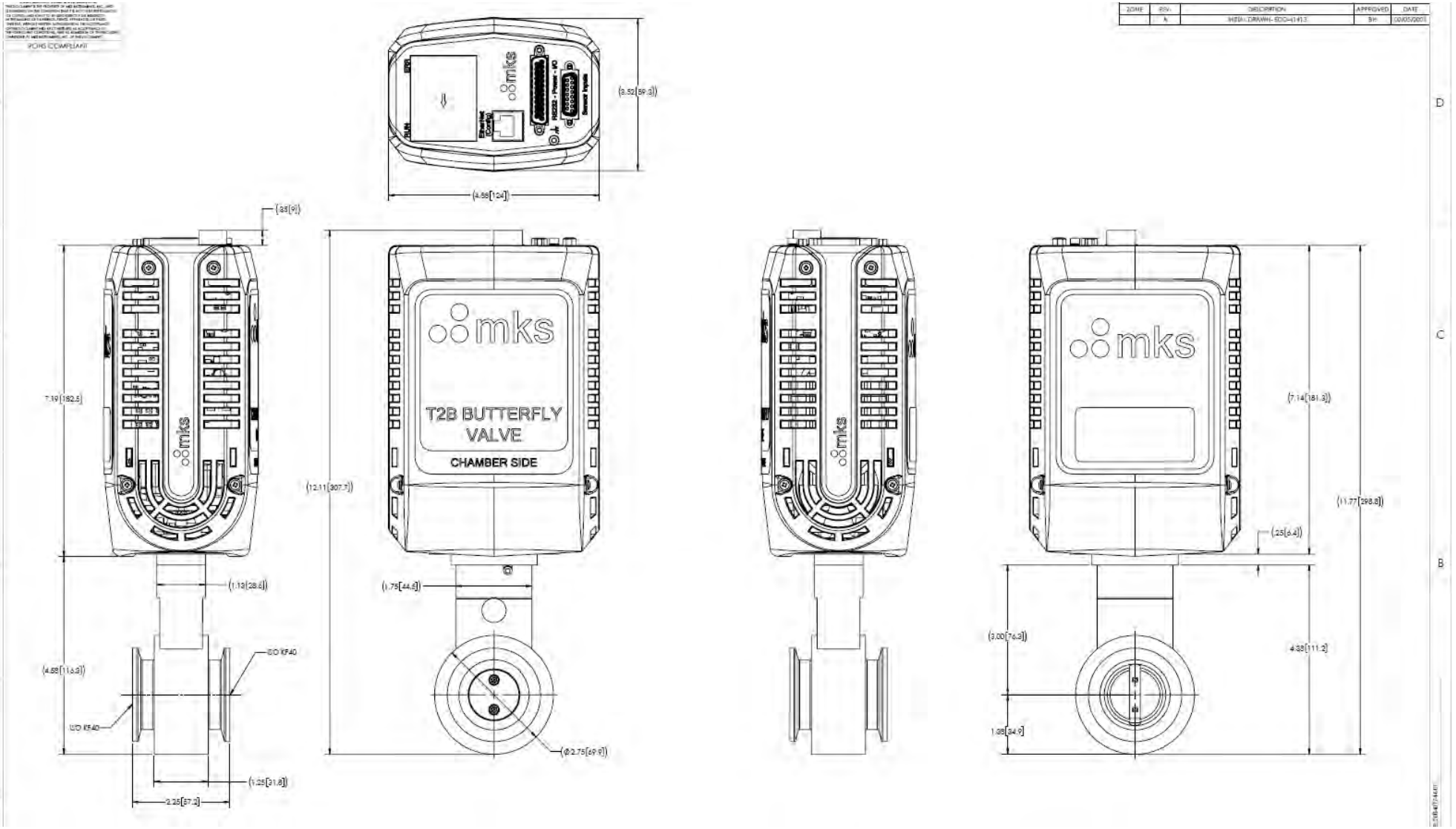
ALL PRODUCTS MUST BE RETURNED IN SEALED BAGS

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.

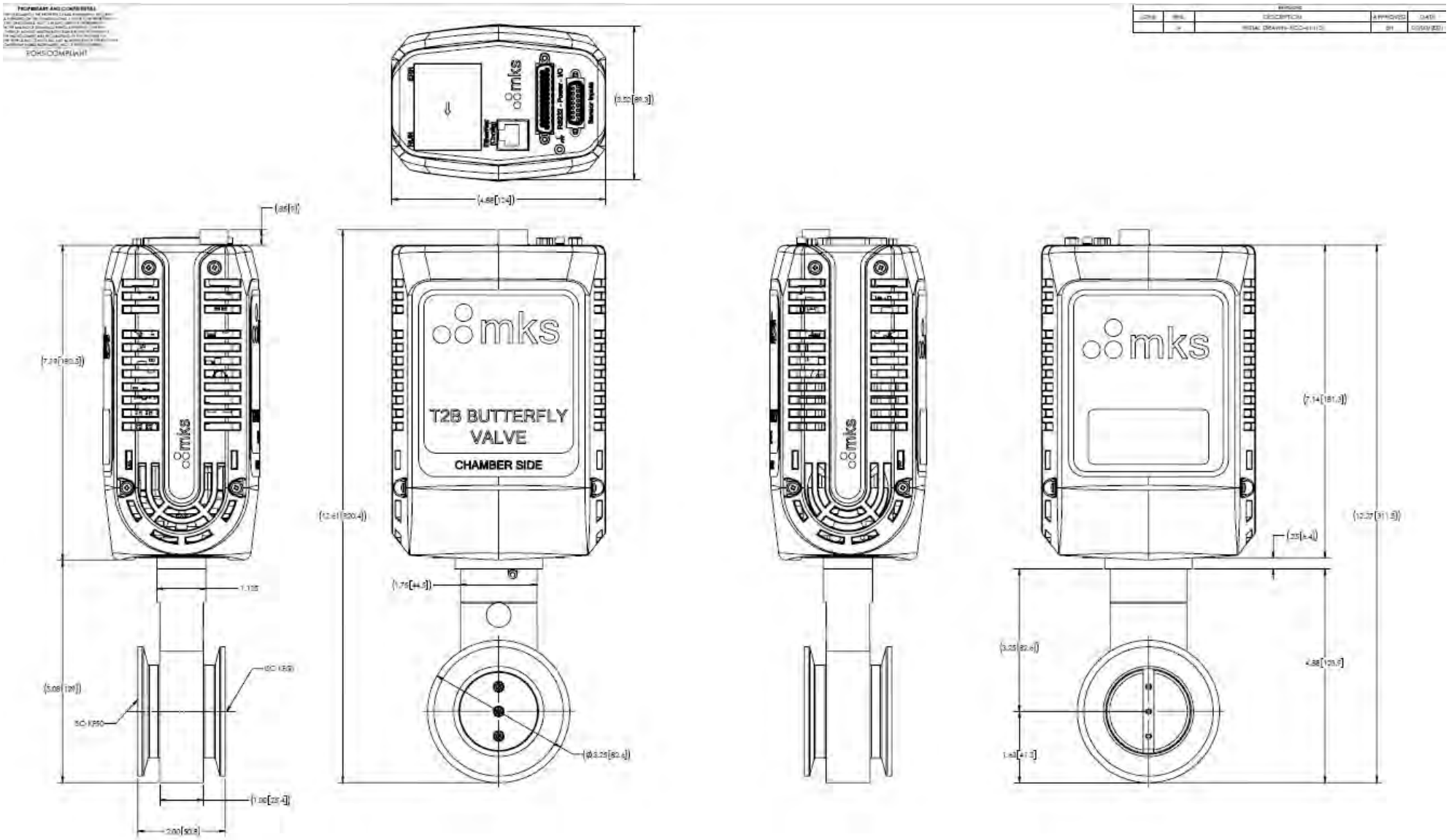
FRM13345 Rev.E

Appendix D: Dimensional Drawings

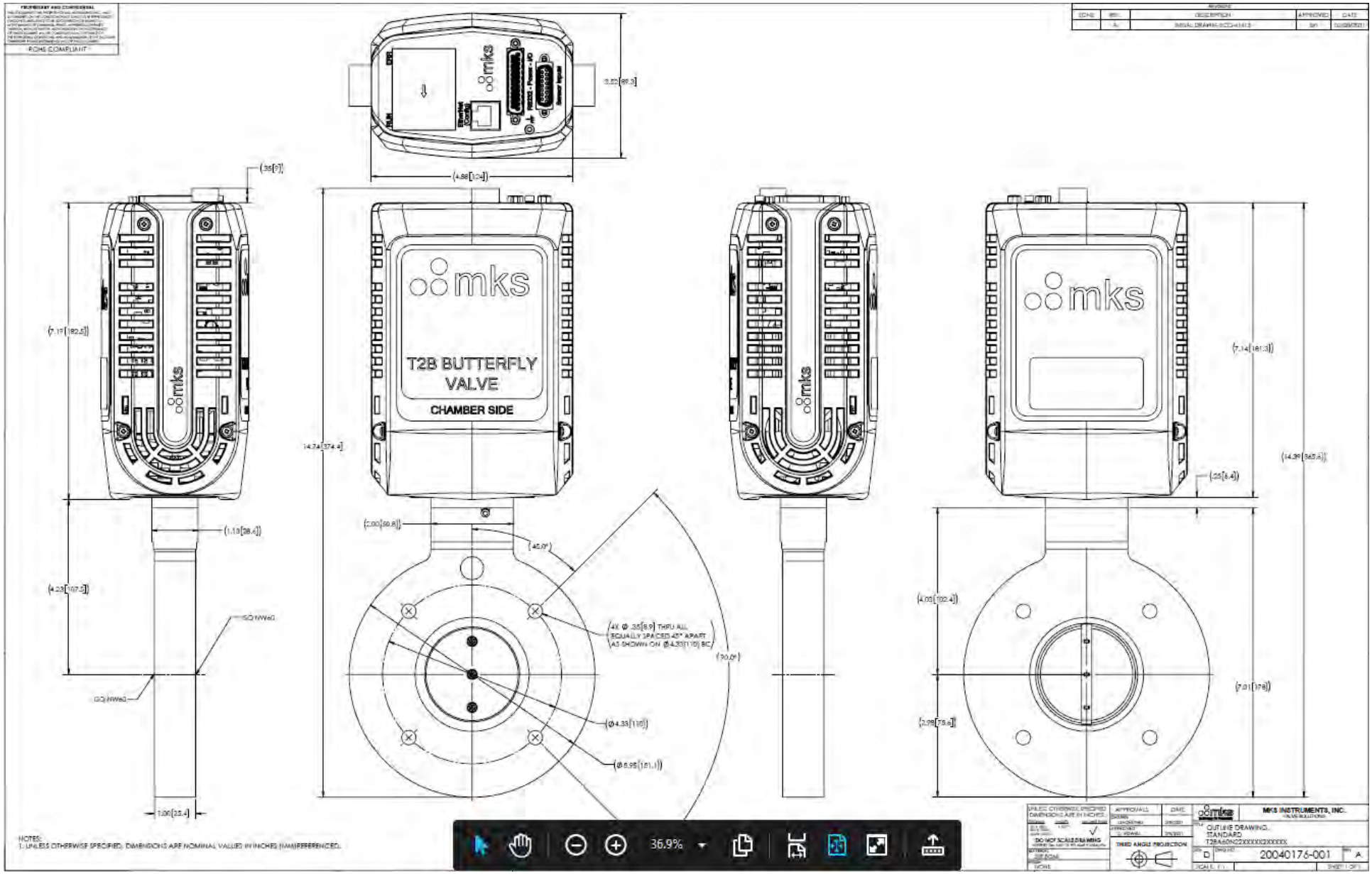
KF-40



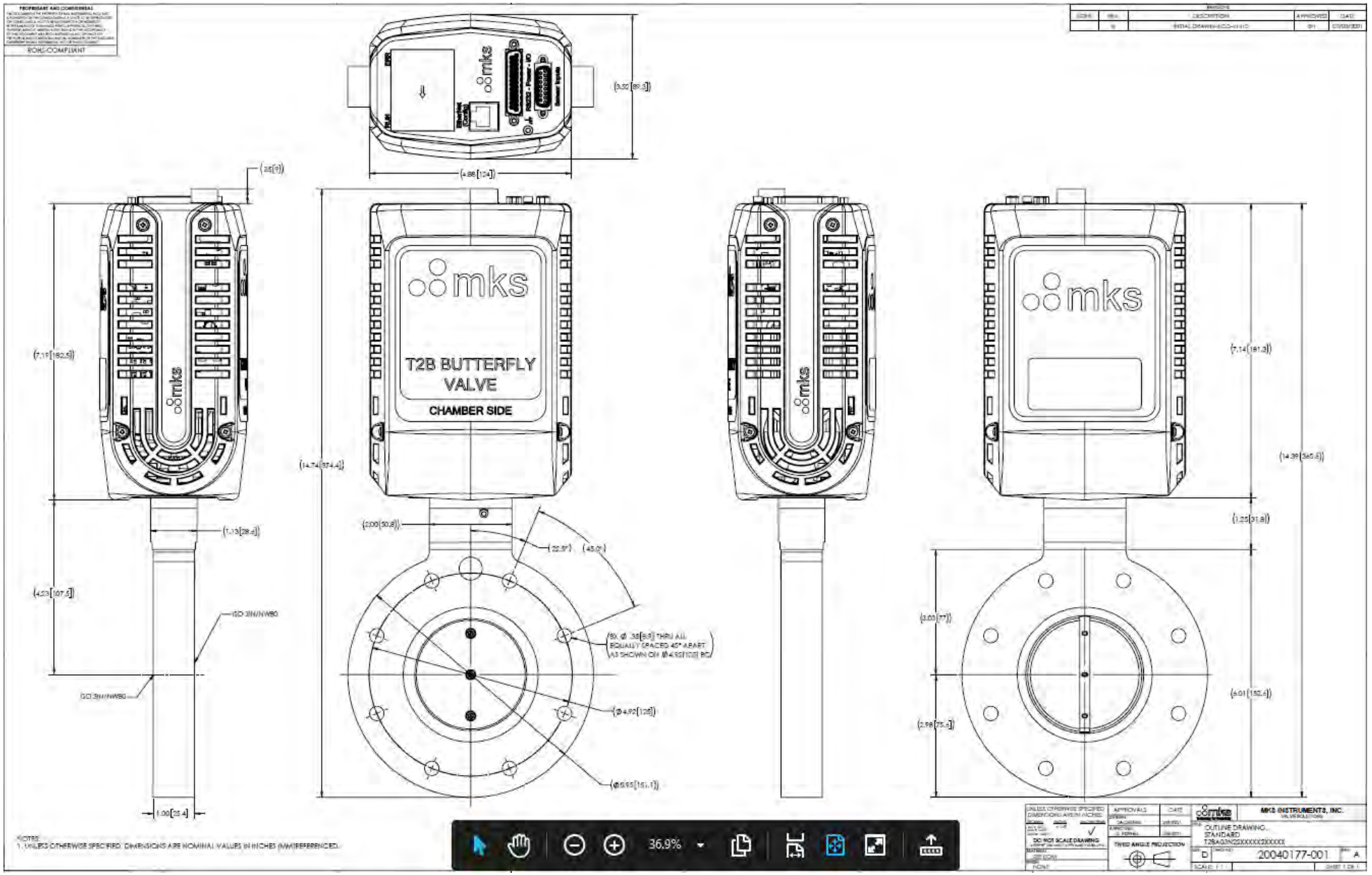
KF-50



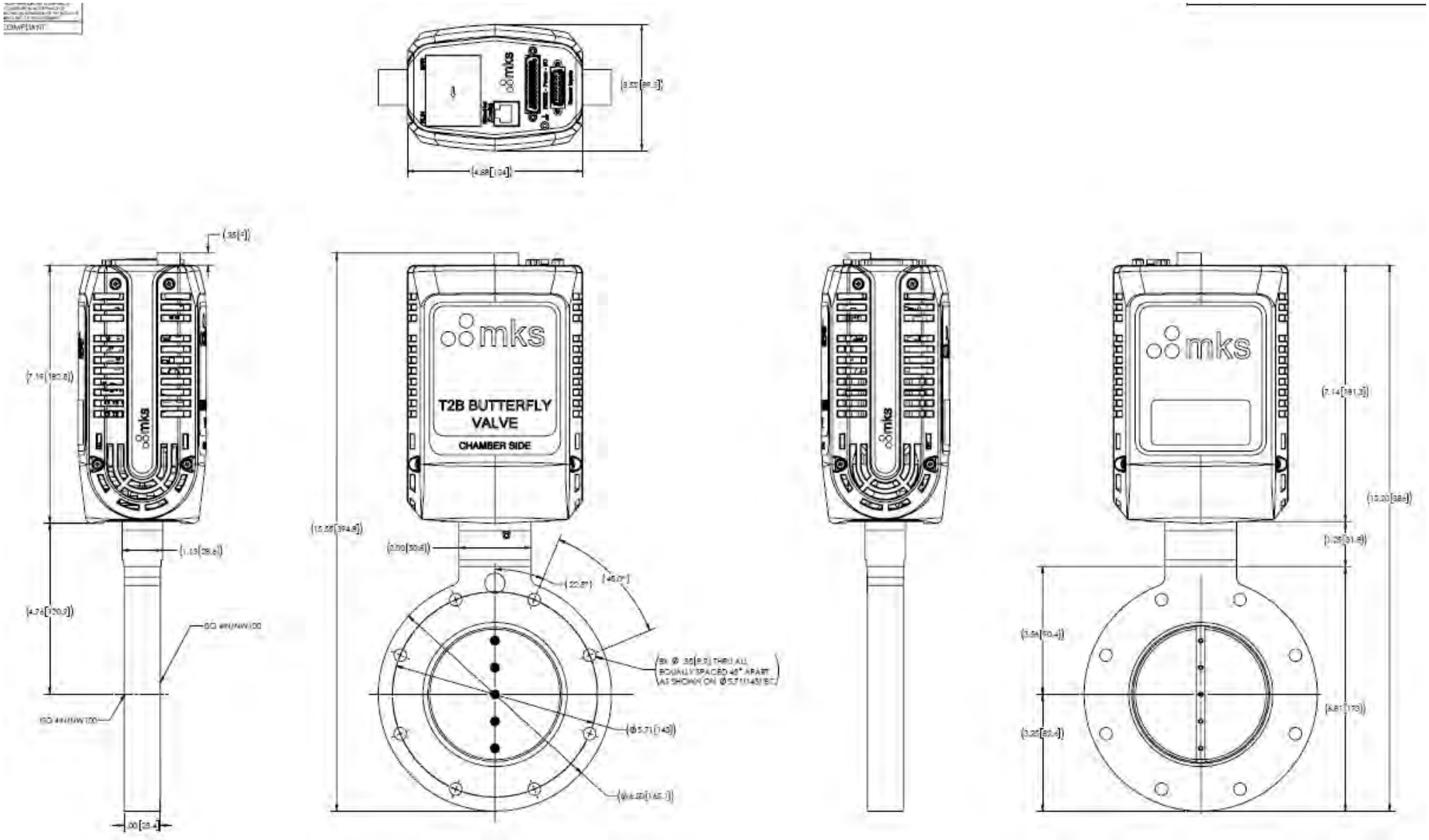
NW-60


T2B BUTTERFLY VALVE
CHAMBER SIDE
mks
36.9%
MKS INSTRUMENTS, INC.
OUTLINE DRAWING,
STANDARD,
20040176-001

NW-80


T2B BUTTERFLY VALVE
CHAMBER SIDE
mks
ROHS-COMPLIANT
NOTES:
1. UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE NOMINAL VALUES IN INCHES (MM)[REFERENCE].
DO NOT SCALE DRAWING
THIRD ANGLE PROJECTION
MKS INSTRUMENTS, INC.
OUTLINE DRAWING,
STANDARD
T2BAGSN2SXXXXXXXXXXX
20040177-001
36.9%

NW-100



Appendix E: RS-232 Message Summary

The RS-232 messages required for operation of the device are listed below alphabetically—by command

C	Close Valve
CAL	Set Operating Mode = CAL
D1	Activate Setpoint A
D2	Activate Setpoint B
D3	Activate Setpoint C
D4	Activate Setpoint D
D5	Activate Setpoint E
EH	Set Sensor Range High
EL	Set Sensor Range Low
F	Pressure Units (Torr, mbar, etc.)
G	Sensor Signal Input Range
GC	Set Gain Compensation Factor (%Kp)
H	Hold Valve
HB	Dump History Buffer To The Serial Port
I1	Set SoftStart Setpoint A % Value
I2	Set SoftStart Setpoint B % Value
I3	Set SoftStart Setpoint C % Value
I4	Set SoftStart Setpoint D % Value
I5	Set SoftStart Setpoint E % Value
I7	Set SoftStart Open Valve % Value
I8	Set Softstart Close Valve % Value
IE	Interlock Enabled (0 or 1)
IX	Reset (Power Cycle)
J	Home Valve/ Learn Valve
L	Learn the System (Pump Speed)
LA	Select Auto-Dual Channel Operations
LD	Auto Crossover Delay
LH	Select High Channel Operations
LHC	High Channel Crossover
LL	Select Low Channel Operations
LLC	Low Channel Crossover

LPF	Set the Low-Pass Filter time constant (ms) for reporting pressure (default:100ms)
M1	Proportional Kp Setpoint Value A
M2	Proportional Kp Setpoint Value B
M3	Proportional Kp Setpoint Value C
M4	Proportional Kp Setpoint Value D
M5	Proportional Kp Setpoint Value E
N	Clear any overrides (e.g. open, close, hold)
N0	Set Valve Action Normal
N1	Set Valve Action Reverse
O	Open Valve
PC	Set Phase Compensation Factor (%Ki)
Q	Stop System Learn (while in progress)
R	Get Position Pressure
R1	Get Setpoint A Value
R10	Get Setpoint E Value
R15	Get SoftStart Setpoint A % Value
R16	Get SoftStart Setpoint B % Value
R17	Get SoftStart Setpoint C % Value
R18	Get SoftStart Setpoint D % Value
R19	Get SoftStart Setpoint E % Value
R2	Get Setpoint B Value
R21	Get SoftStart Open valve % Value
R22	Get SoftStart Close Valve % Value
R26	Get Setpoint A = Position/Pressure
R27	Get Setpoint B = Position/Pressure
R28	Get Setpoint C = Position/Pressure
R29	Get Setpoint D = Position/Pressure
R3	Get Setpoint C Value
R30	Get Setpoint E = Position/Pressure
R31	Get Valve Position Output Range (B1=10V)
R32	Get Valve Action (N0=normal, N1=reverse)

R33	Get High Sensor Range
R34	Get Pressure Units (Torr, mbar, etc.)
R35	Get Sensor Voltage Range
R36	Get Sensor Type (U0=Absolute, U1= Differential)
R37	Get System Status Reports
R38	Get Software Version
R4	Get Setpoint D Value
R41	Get Integral Ki Setpoint A Value
R42	Get Integral Ki Setpoint B Value
R43	Get Integral Ki Setpoint C Value
R44	Get Integral Ki Setpoint D Value
R45	Get Integral Ki Setpoint E Value
R46	Get Proportional Kp Setpoint A Value
R47	Get Proportional Kp Setpoint B Value
R48	Get Proportional Kp Setpoint C Value
R49	Get Proportional Kp Setpoint D Value
R5	Get Pressure as % of FS
R50	Get Proportional Kp Setpoint E Value
R51	Get Pressure Control Mode =Model Based/PID
R52	Get Checksum Status (0 = OK, 1 = Error)
R55	Get Low Sensor Range
R56	Get Valve Slip (VS0=no slip, VS1=slip)
R6	Get Valve Position as % of Open
R60	Get Control Tau
R63	Get Nonlinear Flow Observer Tau
R64	Get Nonlinear Trajectory Shape
R65	Get Nonlinear Trajectory Tau
R66	Get Full Build String
R7	Get System Status M x y z w
R8	Get Valve Slip (C0=no, C1=slip)
RCD	Get Pump Speed Data Table Data
RCH	Get Checksum
RCL	Get channel lock
RCP	Get Pump Speed Table Pedestal
RCT	Get Pump Speed Data Table Number
RCV	Get Pump Speed Data Value
RD	Get Auto Crossover Delay

RDO	Get Device Option
REN	Get Encoder Valve Position (% Open)
RGC	Get Gain Compensation Factor (%Kp) -
RHC	Get High Channel Crossover
RHR	Get High sensor Range
RIE	Get Interlock Enabled Status
RIN	Get Valve Interlock Status
RLC	Get Low Channel Crossover
RLE	Get Estimated Learn Flow
RLF	Get Learned Flow
RLP	Get Analog Input filter samples
RLR	Get Low sensor Range
RMD	Get Backfill Threshold Pressure
ROC	Get Analog Out Calibration status
ROM	Get Operating Mode
RPC	Get Phase Compensation Factor (%Ki)
RSE	Get Slow Pump Enable
RSN	Get Serial Number of the Unit
RSR	Get Slow Pump Rate
RTC	Report valve temperature in Celsius
RTF	Report valve temperature in Fahrenheit
RUE	Get Speed Up Enable Setting
RUF	Get Speed Up Filter Setting
RUT	Get Speed Up Time Setting
RVE	Get Volume Estimate Status Enable 1 is On, 0 is Off
RVO	Get Chamber Volume Setting
RVS	Get Span Valve Steps
S1	Setpoint Value A
S2	Setpoint Value B
S3	Setpoint Value C
S4	Setpoint Value D
S5	Setpoint Value E
S	Set Slow Pump recipe and value
SCD	Set Pump Speed Data 🔒
SCP	Set Pump Speed Pedestal 🔒
SCT	Switch Pump Speed Table 🔒
SE	Set Slow Pump Enable
SHR	Set High sensor Range
SLF	Set Learn Flow 🔒
SLR	Set Low sensor Range
SR	Set Slow Pump Rate

STA	Set Control Tau 🔒
STD	Set Nonlinear Flow Observer Tau 🔒
STE	Set Nonlinear Trajectory Shape 🔒
STF	Set Nonlinear Trajectory Tau 🔒
SUE	Set Speedup Enable 1 is On, 0 is Off 🔒
SUF	Set Speedup Filter 🔒
SUT	Set Speedup Time 🔒
SVE	Set Volume Estimate Enable 1 is On, 0 is Off 🔒
SVN	Set Valve Normal Mode
SVO	Set Chamber Volume 🔒
T10	Setpoint A = Position
T11	Setpoint A = Pressure
T20	Setpoint B = Position
T21	Setpoint B = Pressure
T30	Setpoint C = Position
T31	Setpoint C = Pressure
T40	Setpoint D = Position
T41	Setpoint D = Pressure
T50	Setpoint E = Position
T51	Setpoint E = Pressure
U0	Set sensor type Absolute
U1	Set sensor type Differential
USR	Set Operating Mode = USER
V0	Set Pressure Control Mode = Model Based
V1	Set Pressure Control Mode = PID
W1	Set Controller Phase or Lead
X1	Set Integral Ki Setpoint A Value
X2	Set Integral Ki Setpoint B Value
X3	Set Integral Ki Setpoint C Value
X4	Set Integral Ki Setpoint D Value
X5	Set Integral Ki Setpoint E Value
Z1	Commence Zero Calibration (corrects sensor zero offsets)
Z2	Zeros Base Pressure
Z3	Removes Z1 and Z2 Value

🔒 = Indicates that the instrument must be set to the calibration mode in order to process this command.