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107876-P1
Rev C, 8/96
Instruction Manual

MKS Baratron®
Type 223B
Pressure Transducer

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WARRANTY

Type 223B Equipment

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

For the period commencing with the date of shipment of this equipment and ending one year later in the case of defects in materials and workmanship, but two years later in the case of failure to comply with the date-related operations warranty, **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.

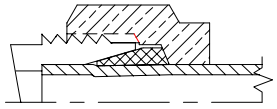
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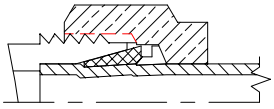
SPECIAL NOTICE

This warranty is void if the product is installed using single or double metal ferrule compression type vacuum fittings, shown below. These fittings are commonly tightened incorrectly, causing damage to the pressure sensor.

Single Ferrule



Double Ferrule



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Rev C, 8/96

MKS Baratron®
Type 223B
Pressure Transducer

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Safety Procedures and Precautions

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.

USE CAUTION WHEN OPERATING WITH HAZARDOUS MATERIALS

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

PURGE THE INSTRUMENT

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

USE PROPER PROCEDURES WHEN PURGING

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

DO NOT OPERATE IN EXPLOSIVE ATMOSPHERES

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

USE PROPER FITTINGS AND TIGHTENING PROCEDURES

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

CHECK FOR LEAK-TIGHT FITTINGS

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

OPERATE AT SAFE INLET PRESSURES

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

INSTALL A SUITABLE BURST DISC

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

KEEP THE UNIT FREE OF CONTAMINANTS

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

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.

Chapter One: General Information

Introduction

The Type 223B Pressure Transducer measures differential pressure according to its full scale range and provides a 0 to ±1 Volt signal which is linear with pressure. Optionally the output can be 0 to ±5 Volt. Standard full scale ranges are 0.5, 5, 50, 500 in. H_2O; 1, 10, 100, 1000 Torr; or 1, 10, 100, 1000 cm H_2O.

The Type 223 can be powered from ±15 or ±12 Volt supplies, and is composed of an Inconel® sensor, printed circuit board, and cover.

The sensor is made of three parts:

1. A taut metal diaphragm supported by thick-walled Inconel rings,
2. A dimensionally stable ceramic electrode which senses the diaphragm's deflection,
3. A reference cover through which a glass-to-metal feedthrough terminal passes an electronic signal to the printed circuit board.

A terminal block allows connection to the power supply and signal readout.

How This Manual is Organized

This manual is designed to provide instructions on how to set up, install, and operate a Type 223 unit.

Before installing your Type 223 unit in a system and/or operating it, carefully read and familiarize yourself with all precautionary notes in the *Safety Messages and Procedures* section at the front of this manual. In addition, observe and obey all WARNING and CAUTION notes provided throughout the manual.

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

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

Chapter Three, *Overview*, describes the instrument's circuit design.

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

Chapter Five, *Repair,* describes repair and return policies for the 223 transducer.

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

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

Customer Support

Standard maintenance and repair services are available at all of our regional MKS Calibration and Service Centers, listed on the back cover. In addition, MKS accepts the instruments of other manufacturers for recalibration using the Primary and Transfer Standard calibration equipment located at all of our regional service centers. Should any difficulties arise in the use of your Type 223 instrument, or to obtain information about companion products MKS offers, contact any authorized MKS Calibration and Service Center. If it is necessary to return the instrument to MKS, please obtain an ERA Number (Equipment Return Authorization Number) from the MKS Calibration and Service Center before shipping. The ERA Number expedites handling and ensures proper servicing of your instrument.

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

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

Chapter Two: Installation

How To Unpack the Type 223 Unit

MKS has carefully packed the Type 223 unit so that it will reach you in perfect operating order. Upon receiving the unit, however, you should check for defects, cracks, broken connectors, etc., to be certain that damage has not occurred during shipment.

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

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

Unpacking Checklist

Standard Equipment:

- Type 223 Unit
- Type 223 Instruction Manual (this book)

Optional Equipment:

- Electrical Connector Accessories Kit - 223B-K1

Product Location and Requirements

The Type 223 unit meets the following criteria:

- POLLUTION DEGREE 2 in accordance with IEC 664
- Transient overvoltages according to INSTALLATION CATEGORY II

Operating Environmental Requirements

- Ambient Operating Temperature: 0 °C to 50 °C (32°F to 122 °F)
- Main supply voltage fluctuations must not exceed ±10% of the nominal voltage
- Ventilation requirements include sufficient air circulation
- Connect the power cord into a grounded outlet

Safety Conditions

The 223 transducer poses no safety risk under the following environmental conditions.

- Altitude: up to 2000 m
- Maximum relative humidity: 80% for temperatures up to 31 °C, decreasing linearly to 50% at 40 °C

Setup

Dimensions

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

Figure 1: Dimensions of a Type 223 Transducer

Mounting Instructions

The Type 223 may be mounted in any attitude, although a horizontal tube axis is recommended. If vibrations are anticipated, it is recommended that the plane of the diaphragm (flat surface of the sensor) be oriented parallel with the major oscillating axis. Any fittings may be used on the $^{3}/_{16}$" O.D. tubing, although maximum O.D. of the fittings should be selected to clear the terminal block cutout in the cover, as removal of the cover over the fitting is necessary for service.

Electrical Connections and Cables

Electrical connections are made to the terminal block as marked on the cover. Both the power supply common (P COM) and the signal common (S COM) are connected together inside the Type 223 unit. The output signal is the voltage between the S COMMON and PRESSURE OUT terminals.

Use cable CB112-2 to connect the 223 transducer to MKS supplied readouts, such as the type 146, 651, 652, or 660 units. Use cable CB473-1 to connect the 223 transducer to MKS digital type readouts, such as the type PDR-C-1C/2C, PDR-5B, or the PDR-D-1 units.

Connections are made according to Table 1.

Cable Connections		
Type 223	**Cable Wire Color**	**MKS Readout Connection**
+ 15	Green	+ 15
- 15	White	- 15
COMMON	Black (small) (paired with green) Black (small) (paired with red)	P COM S COM
PRESSURE OUT	RED	PRESSURE IN
No Connection	Black (heavy)	CHASSIS

Table 1: Cable Connections

Even though the 223 output signal has the same common terminal as the power supply, it is still best to use a differential input readout. Appropriate connections are shown in Figure 2, page 9, for applications where a customer supplied readout and power supply are used. Note there are two wires connected to the 223 P COMMON terminal. One is power common from the power supply. One is signal low to the readout. The third is the power common of the readout which keeps the differential inputs biased properly. Often, but not always, this readout power common is the shield of the signal wires.

Note

1. The grounds of any external power supply AND readout should be the same as the sensor ground (input ports) to avoid any possible ground loops which can cause noise in the system.
2. Power requirements are less than 25 mA at either ±12 or ±15 Volt supplies. Actually, the supply can be any voltage from 11 to 18 Volts. The output may be loaded with 10K ohms or greater.

Figure 2: Electrical Connections

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Chapter Three: Overview

Circuit Description

Refer to Figure 3, page 12.

The capacitance of the single electrode sensor, which increases with pressure at the P_X port, is part of a multivibrator circuit consisting of U1, Cx, R1, R2, R3, R4, and R5. R1 to R5 are temperature stable devices leaving Cx as the major frequency determining component. R5 is a selected temperature sensing resistor used to compensate for temeprature coefficients in both the sensor and electronics. The square wave frequency (inversely proportioned to pressure) is converted to a current at pin 1 of U2. U3A converts this current to a voltage referenced to signal ground by passing it through R12. This negative voltage is now summed with a negative zeroing voltage drived from U4B. U4A establishes the output gain allowing the transdcuer to output a precise 0 to 1 VDC.

Linearizing is implemented using a unique feature of an LM331 (U2). The output of pin 2 of U2 provides a precision reference voltage which is used to zero the output of U3A by adjusting the gain of UB4. However, the transfer charactersistic of U2 is adjusted by the amount of current flowing from pin 2 of U2. As the rpessure signal increases from U3B, the amount of current flowing from pin 2 of U2 decreases, lowering the gain of U2. The characteristic precisely cancels the geometric nonlinearity of the sesnor.

An overrange signal is outputted when the sesnor diaphragm shorts becasue the frequency goes to zero and the output saturates positive. CR1 and CR2 provide protection against reverse power connections and C8 to C11 provide immunity to interference from RF environments.

Figure 3: Schematic of a Type 223 Transducer

Chapter Four: Operation

How To Adjust the Zero Pot

For correct operation, the only adjustment necessary will be trimming of the zero pot, whose location is clearly marked on the transducer cover. Zeroing must be done *only* when one is assured of zero differential pressure across the sensor. This may be accomplished most reliably by installing the transducer in its system using a pair of isolation valves, one in either pressure line, and a cross-porting valve connecting the two sensor ports. A zero differential pressure is assured when both isolation valves are closed and the cross-porting valve is open. Normal operation is returned by closing the cross-port valve and opening the isolating valves. Use of these valves makes it possible to remove the sensor from the system, while maintaining system pressure integrity.

Other than zero adjustment, recalibration of the instrument should not be undertaken as the span and linearity pots interact. Consult the factory if the calibration is out of specification.

Contamination (moisture and dirt) may affect the stability and sensitivity of the sensor, particularly in the P_R side as this side contains the sensing electrode. If contamination (particles) is expected, suitable traps or filters should be used; if vapor condensation is encountered, warming the sensor (no higher than 60° C may help. To remove condensate, evacuate both P_X and P_R cavities with a mechanical vacuum pump. Once a sensor is contaminated with dirt (particles), factory cleaning or sensor replacement will be necessary.

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Chapter Five: Repair

General Information

If the 223 instrument fails to operate properly upon receipt, check for shipping damage, and check the cables for continuity. Any damage should be reported to the carrier and MKS Instruments immediately. If it is necessary to return the unit to MKS, obtain an ERA (Equipment Return Authorization) number from a MKS Service Center before shipping.

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

Periodically check for wear on the cables and inspect the enclosure for visible signs of damage.

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Appendix A: Product Specifications

Specifications

Accuracy	0.5% of F.S., bidirectional or unidirectional 0.3% of F.S., bidirectional or unidirectional 0.3% of Rdg., unidirectional only
Ambient Operating Temperature	0° to 50° C (32° to 122° F)
CE Mark Compliance[1]	EMC Directive 89/336/EEC
Electrical Connector	Screw terminal barrier strip
Fittings	3/16" (4.6 mm) tubulation[2]
Full Scale Ranges Standard Optional	0.2, 1, 10, 100, 1000 mmHg 0.2, 1, 10, 100, 1000 cmH_2O 0.1, 0.25, 0.5, 5, 50, 500 inH_2O[3]
Installation Category	II, according to EN 61010-1
Materials Exposed to Gases P_X side P_R side	 Inconel® Inconel, ceramic, palladium, stainless steel, glass
Maximum Line Pressure	40 psig (275 kPa)
Maximum Overpressure	120% of F.S. or 20 psi (140 kPa), whichever is greater
Output[4] For 1, 10, 100, 1000 mmHg or cmH_2O For 0.1, 0.25, 0.5, 5, 50, 500 inH_2O	 0 to ±1 VDC into > 10K ohm load 0 to ±5 VDC into > 10K ohm load
Pollution Degree	2, according to IEC 664
Power Required	±11 to 18 VDC @ 25 mA, ripple < 0.5 Volt peak to peak

[1]Requires metal, braided, shielded cables.

[2]Contact factory if other fittings are required.

[3]For 0.25 inH_2O range, consult factory for ordering code.

[4]Other ranges or outputs available by special order; consult factory

Resolution	0.01% of F.S.
Temperature Coefficients	
Zero - For 0.5% of F.S. accuracy	0.1% of F.S./°C
For 0.3% of F.S. accuracy	0.05% of F.S./°C
For 0.3% of Rdg. accuracy	0.05% of F.S./°C
Span	0.04% of Rdg./°C
Volume	
P_X side	1.3 cc
P_R side	9.8 cc

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

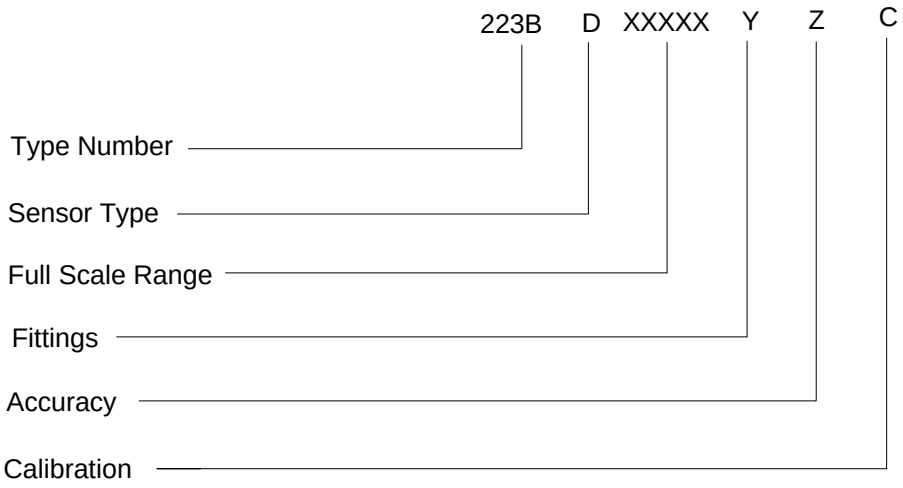
Appendix B: Model Code Explanation

Model Code

The options of your transducer are identified in the model code when you order the unit. The model code is identified as follows:

223B D - XXXXX Y Z C

where:



Type Number (223B)

This designates the model number of the instrument.

Sensor Type (D)

This designates that the 223 unit is a differential pressure gauge.

Full Scale Range (XXXXX)

The full scale range is indicated by a five digit code. Specify the required engineering unit when you place your order.

mmHg	cmH_20	$in\ H_2O$	Ordering Code
0.2	0.2	0.1	000.2
1	1	0.5	00001
10	10	5	00010
100	100	50	00100
1000	1000	500	01000

Fitting (Y)

The fitting is designated by a single letter code.

	Ordering Code
3/16” OD (4.6 mm) Tubulation	A

Accuracy (Z)

Three specifications for accuracy are available, designated by a single letter code.

		Ordering Code
Standard:	±0.5% of F.S., bidirectional or unidirectional	A
Optional:	±0.3% of F.S., bidirectional or unidirectional	B
	±0.3% of Rdg., unidirectional only	C

Calibration (C)

Two types of calibrations are available, designated by a single letter code.

	Ordering Code
Bidirectional[5]	B
Unidirectional	U

[5]For bidirectional calibration, output is -F.S. VDC for -F.S. pressure and +F.S. VDC for +F.S. pressure.

How To Order a Type 223 Unit

To order the Type 223 differential pressure transducer with a 10 mmHg full scale range, 3/16" diameter tubulation fittings, standard accuracy of 0.5% of F.S., and bidirectional calibration, the product code is:

223B D - 00010 A A B

To order the Type 223 differential pressure transducer with a 5 in H_2O full scale range, 3/16" diameter tubulation fittings, the optional accuracy of 0.3% of Reading with unidirectional calibration, the product code is:

223B D - 00010 A C U

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