114103-P1
Rev E, 4/97
Instruction Manual

MKS Type 690A Absolute
MKS Type 698A Differential
High Accuracy Pressure Transducer

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WARRANTY

Type 690A and 698A Equipment

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

For the period commencing with the date of shipment of this equipment and ending two years 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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MKS Type 690A Absolute
MKS Type 698A Differential
High Accuracy Pressure Transducers

Table of Contents

List of Figures and Tables

Figures

Tables

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.

Safety Procedures and Precautions

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

DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT

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

SERVICE BY QUALIFIED PERSONNEL ONLY

Operating personnel must not 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.

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Chapter One: General Information

Introduction

This manual describes the MKS 690A Series (Absolute) and 698A Series (Differential) Baratron® Pressure Transducers.

These transducers, when used with their required MKS Type 270 or Type 670[1] Signal Conditioner/Readout or MKS Type 170M-6 Signal Conditioner, represent the best pressure measurement system (sensor/transducer, signal conditioner, digital readout) currently produced by MKS. For further information on the companion Signal Conditioner/Readouts, please refer to the 270, 670, or 170M-6 instruction manuals.

These precision pressure measurement systems are available with high basic accuracies, wide dynamic range, and a typical Zero Coefficient of 1 to 2 ppm/ °C and a Span Coefficient of 10 to 15 ppm/°C (higher for the 100 mTorr range).

Figure 1: Type 690 and 698 Pressure Transducers

[1]The Type 670 Signal Conditioner/Readout is required for CE mark compliance.

How This Manual is Organized

This manual is designed to provide instructions on how to set up, install, and operate a Type 690/698 unit.

Before installing your Type 690/698 unit in a system and/or operating it, carefully read and familiarize yourself with all precautionary notes in the *Safety Messages and Procedures* section at the front of this manual. In addition, observe and obey all WARNING and CAUTION notes provided throughout the manual.

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

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

Chapter Three, *Overview*, gives a brief description of the instrument and its functionality.

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

Chapter Five, *Maintenance and Troubleshooting*, lists any maintenance required to keep the instrument in good working condition, and provides a checklist for reference should the instrument malfunction.

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

Appendix B, *Model Code Explanation,* describes the instruments ordering 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 690/698 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 690/698 Unit

MKS has carefully packed the Type 690/698 unit so that it will reach you in perfect operating order. Upon receiving the unit, however, you should check for defects, cracks, broken connectors, etc., to be certain that damage has not occurred during shipment.

Note 

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

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

Caution 

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

Unpacking Checklist

Standard Equipment:

- Type 690/698 Unit
- Type 690/698 Instruction Manual (this book)

Optional Equipment:

- Electrical Connector Accessories Kit
  690A-K1
  698A-K1
- Interface cables (refer to Table 1, page 8)
- Type HS-1 Transducer Simulator

Interface Cables

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

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

Note

1. Overall metal braided shielded cables, properly grounded at both ends, are required to meet CE specifications.
2. To order metal braided shielded cables, add an "S" after the cable type designation. For example, to order a standard cable to connect the 690 transducer to a 670 unit, use part number CB270-2-10; for a metal braided shielded cable, use part number CB270S-2-10.

System Interface Cables

System Interface Cables		
To Connect the 698/698 Unit To...	**Use the MKS Cable...**	
	Standard	**Shielded**
670, 270	CB270-2-10	CB270S-2-10
	CB270-2-20	CB270S-2-20
	CB270-2-40	CB270S-2-40
170M-6	CB390-6-6	CB390S-6-6

Table 1: System Interface Cables

Generic Shielded Cables

MKS offers a full line of cables for all MKS equipment. Should you choose to manufacture your own cables, follow the guidelines listed below:

1. The cable must have an overall metal *braided* shield, covering all wires. Neither aluminum foil nor spiral shielding will be as effective; using either may nullify regulatory compliance.
2. The connectors must have a metal case which has direct contact to the cable's shield on the whole circumference of the cable. The inductance of a flying lead or wire from the shield to the connector will seriously degrade the shield's effectiveness. The shield should be grounded to the connector before its internal wires exit.
3. With very few exceptions, the connector(s) must make good contact to the device's case (ground). "Good contact" is about 0.01 ohms; and the ground should surround all wires. Contact to ground at just one point may not suffice.
4. For shielded cables with flying leads at one or both ends; it is important at each such end, to ground the shield *before* the wires exit. Make this ground with absolute minimum length. Refer to Figures 2 and 3, page 10. (A ¼ inch piece of #22 wire may be undesirably long since it has approximately 5 nH of inductance, equivalent to 31 ohms at 1000 MHz). After picking up the braid's ground, keep wires and braid flat against the case. With very few exceptions, grounded metal covers are not required over terminal strips. If one is required, it will be stated in the Declaration of Conformity or in the instruction manual.
5. In selecting the appropriate type and wire size for cables, consider:
   A. The voltage ratings;
   B. The cumulative I^2R heating of all the conductors (keep them safely cool);
   C. The IR drop of the conductors, so that adequate power or signal voltage gets to the device;
   D. The capacitance and inductance of cables which are handling fast signals, (such as data lines or stepper motor drive cables); and
   E. That some cables may need internal shielding from specific wires to others; please see the instruction manual for details regarding this matter.

Example 1: Preferred Method To Connect Cable
(shown on a transducer)

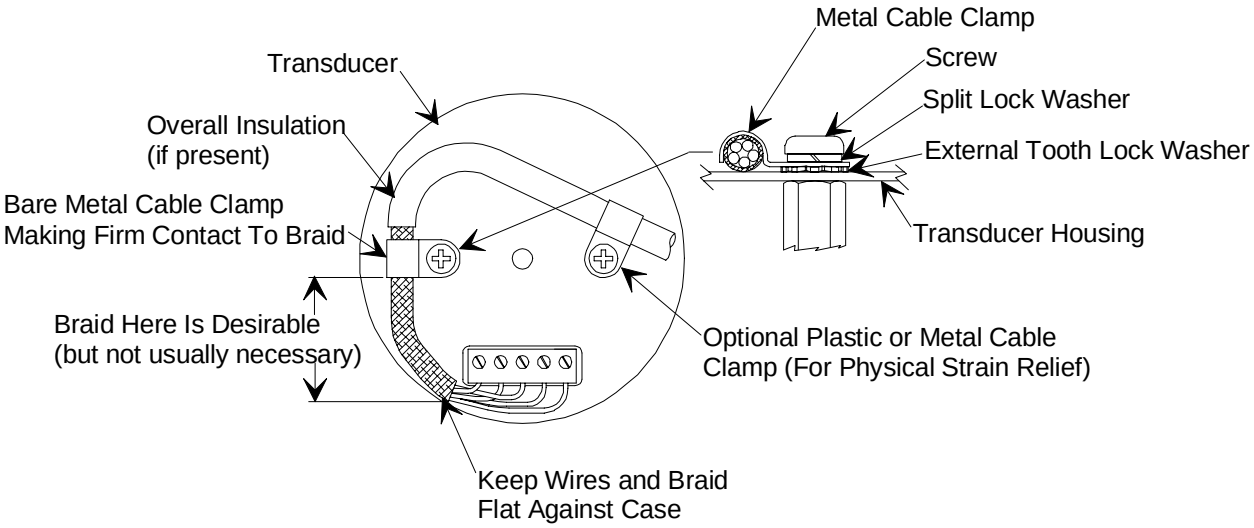

Figure 2: Preferred Method To Connect an Overall Metal Braided Shielded Cable

Example 2: Alternate Method To Connect Cable
(shown on a transducer)

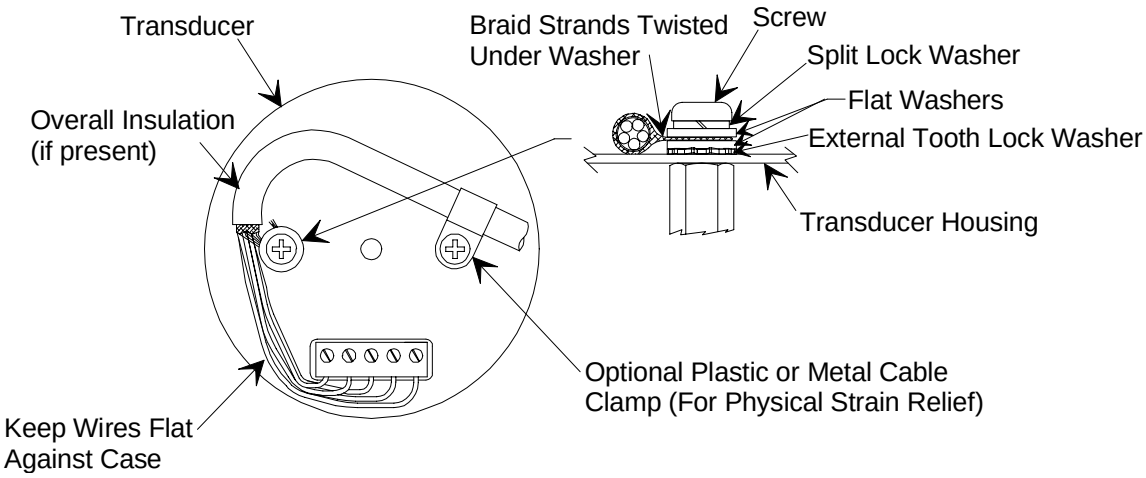

Figure 3: Alternate Method To Connect an Overall Metal Braided Shielded Cable
(Use this method when cable clamp is not available)

Setup

Dimensions

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

Figure 4: Dimensions of the Type 690 and 698 Pressure Transducers

Mounting Instructions

The Type 690/698 transducer must be mounted horizontally upon its vibration isolation base with the following points noted.

Warning 

The unit *must* be mounted horizontally.

Do not mount the Type 690/698 pressure transducer vertically or upside down. The vibration mount assembly is not designed to support the weight of the unit in either position.

A. All units are supplied with vibration isolators which should be used for maximum stability. A flexible bellows connection is suggested to minimize vibration. Furthermore, it is recommended that the sensor be mounted such that the sensor diaphragm plane is parallel to the major axis of vibration (diaphragm plane is perpendicular to port axis).

B. Ambient temperature around the 690/698 transducer must not rise above 40° C as this will cause the 45° to 47° C control temperature to go out of regulation, thus destroying the system stability.

C. Mount the transducer as far from RFI and EMI sources as possible. Field experience has shown that care in positioning the transducer initially will prevent future difficulties. The MKS system is internally protected against RFI and EMI. However, in a system where several ground potentials are possible, a noisy environment may cause output to be unstable. When this happens, we have found the only solution has been an examination and correction of the source of RFI/EMI.

   Example:

   An SCR supply used in some systems should have the power-carrying wires that run to the chamber twisted to cancel high frequency magnetic fields. Never run the 690 transducer to Signal Conditioner cable in the same wiring bundle as RF or SCR signals.

D. The system interface cables are listed in Table 1, page 8.

E. *The vibration mount assembly is shipped from MKS with two shipping screws in place*. For noise-free operation, these screws must be removed. However, when this Baratron is subsequently reshipped on a piece of equipment, these screws ***must be reinstalled*** as the rubber feet will withstand no more than 3 g's force in transit.

F. When installing a 698 differential transducer, allow for a cross-porting manifold; that is, connecting the two ports together. In order to properly set the zero of any differential sensor, there must be equal pressure on both sides of the sensor.

G. Vacuum Connections: The sensor should be connected to the vacuum system via an appropriate isolation valve and bellows tubing.

a. To maximize the life and zero repeatability of the sensor, an isolation valve should be used. Set its closing point at or slightly above the transducer's full scale range.

An isolation valve serves to protect the sensor in two ways:

First: from overpressure, which is common in processing systems that incorporate pressure purging cycles in excess of sensor specifications.

690 Absolute: 125% of FS or 45 psia (whichever is greater)

698 Differential: 125% of FS or 45 psia (whichever is greater) (lower for 100 mTorr Range)

Second: from contamination by moisture, which is present when a process system is vented to atmosphere. Moisture can often combine with residue on the sensor and/or system surfaces, and form acids such as HCl when chlorine - based processes are used.

Any good quality electric, or air-operated valve, such as a MKS P/N 108818, NUPRO® Type 4BK, or equivalent, is recommended.

b. The sensor inlet should be connected to the isolation valve via an appropriate length of stainless steel bellows tubing with welded mating Cajon fittings. Both VCR fittings and flexible tubing are products of the Cajon Company.

The use of a flexible bellows completes vibration isolation to the sensor, allowing it to function independently of significant system vibration or stress that could be induced during operation or shipment.

Caution  **Hard coupling of the sensor inlet tube so that the transducer is suspended by this tube is not recommended as the weight of the entire assembly will cause stress on the sensor.**

c. 698 Differential Sensors: The P_X port must be connected to the high side of any system whose differential pressure is to be measured. The P_R side will then be connected to the low pressure side. If connections are reversed, the instrument will output a negative signal whose accuracy is not specified. A 698 differential sensor may be used to make an absolute measurement, by continually pumping the P_R port to a pressure below that of the resolution of the sensor. (Example: 1mm Hg FS x 10^{-6} = $<10^{-6}$ mm Hg).

Caution 

Do not attempt to change the inlet tube fitting by cutting or welding. If a different fitting is desired, make up an adaptor, or consult MKS for a quotation on a special-version sensor.

For your convenience, MKS makes available several lengths of these bellows assemblies, including the mating VCR fittings welded to the bellows tubing. To order, specify P/N 6BL 4VCR for a 6” length, or P/N 12BL 4VCR for a 12” length.

Chapter Three: Overview

Functional Description

The 690/698 Baratron is composed of four (4) sub-sections assembled within a precision die-cast housing. These are: 1) an Inconel® variable capacitance diaphragm sensor; 2) an electronic preamplifier and bridge circuits; 3) an inner temperature control housing; 4) a PC Board. The all Inconel sensor, together with its high impedance bridge circuit and preamp, is mounted within a thick-walled, temperature controlled aluminum housing. This miniature "environmental chamber" reduces the ambient temperature effects upon the sensor and bridge circuit by more than a factor of 50.

The Main PC Board mounted outside the temperature-controlled housing consists of those circuits necessary to convert a low level 10 KHz signal to a precise ¼ V/V output that is linearly proportional to pressure. Also, that circuit necessary to maintain the housing temperature is located on this board. All gain controlling components are selected for maximum stability (wire-wound resistor, NPO capacitor, etc.). A "system check" circuit is used which will point out any gain change experienced at any point in the electrical system.

The 690 Baratron is able to make a reliable absolute pressure measurement by virtue of its own built-in "zero" pressure reference cavity. During production, the low pressure side (P_R) of the sensor is pumped to less than 1×10^{-7} mmHg, outgassed thoroughly, chemically gettered, and permanently sealed. The extremely low gas loads and active gettering material in the reference cavity assure the user of many years of useful service.

The 698 Baratron is unique, in that the entire differential sensor is surrounded by an Inconel case. Ambient line pressure (P_R) appears between the sensor and this case, thus eliminating sensitivity changes due to line pressure induced stress variations within the sensor structure. Careful deadweight testing has shown a variation of less than 0.01% of reading as the line pressure varies from 1 to 15 psia.

Transducer Simulator

The Type HS-1 Transducer Simulator is used as a test box for checkout and set-up of a precision pressure measurement system (690/698, 670, 270, 170M-6). The simulator provides the following functions:

1. A dummy load for, and LED visual signal of, the heater supply power.
2. A visual signal of the ±15 VDC power supply function.
3. The generation of a zero, 50% FS, and 100% FS signal.
4. Test points for the measurement of the 6 VRMS excitation signal.

Through its use, one may accomplish the following:

1. Identify a faulty transducer.
2. Identify a faulty cable.
3. Check some of the fundamental functions of the signal conditioner/readout unit.
4. Adjust for transducer-to-signal conditioner cable length.

Chapter Four: Operation

General Information

Note 

It is important to remember that all diaphragm-variable capacitance pressure transducers require you to set "zero" with the signal conditioner, after suitable warm-up and pumping have been accomplished.

The following procedure is presented as an optimum guide to achieving the full design potential of the precision 690/698 pressure measurement system.

1. (690, 698): After the sensor has been installed on the system whose pressure is to be measured, it should be connected to its Electronics Unit via the appropriate cable (refer to *Interface Cables*, page 8), and power applied.

2. (690, 698): A minimum of four (4) hours, and preferably overnight, should be allowed for the heater in the sensor package to thermally stabilize the sensor at control temperature.

3. (690): While waiting for the sensor to reach stable thermal equilibrium, the appropriate vacuum pump(s) in the Processing System should be engaged, so as to pump down the sensor below its minimum usable resolution.

   (698): While waiting for the sensor to reach stable thermal equilibrium, the appropriate vacuum pump(s) in the Processing System should be engaged, in such manner as to provide equal pressure on both sides of the sensor. (This can also be accomplished by cross-porting; that is, connecting the two ports together).

4. (690, 698): After the above warm-up time and pumping requirements have been met, the zero can be properly set.

Each full scale range has different pumping criteria. The following chart summarizes the basic pressures needed prior to setting the Zero.

Maximum Pressures For Proper Zero Adjustment			
Sensor Model Number	**Range Full Scale**	**Highest Pressure for Proper Zero Adjust**	**Warm-Up Time Before Adjusting Zero**
690 HA-000.1	100 mTorr	$< 1 \times 10^{-7}$ Torr	4 Hours Minimum*
690 HA-0001	1 Torr	$< 1 \times 10^{-6}$ Torr	"
690 HA-00010	10 Torr	$< 1 \times 10^{-5}$ Torr	"
690 HA-00100	100 Torr	$< 1 \times 10^{-4}$ Torr	"
690 HA-01000	1000 Torr	$< 1 \times 10^{-3}$ Torr	"
698 HA-10000	10000 Torr	$< 1 \times 10^{-2}$ Torr	"
** It is recommended that all temp-controlled transducers be powered continuously.*			

Table 2: Maximum Pressures for Proper Zero Adjustment

How To Zero the Transducer

How To Zero the Transducer Using the Zero Pot

The best method of zeroing the transducer system is:

1. Center the fine pot in the Electronics Unit.

   This is accomplished by turning the pot to either extreme, noting the voltages at each extreme, and then setting the pot at the half way point.

2. Adjust the zero using the coarse zero pot on the electronics unit.

Note 

The sensor zero pot is factory set during calibration, and should ***never*** be adjusted by the user unless there are suitable transfer or primary standards available to aid in recalibration.

3. Fine Trim the output, using the zero controls on the Electronics Unit.

   The measurement system is now ready to use.

   For reference, the frequency of setting the zero will depend on use, variations in ambient temperature, and your application. You will, with experience, gain a feeling for the frequency with which the zero adjustment must be made. For extremely critical measurement of very low pressures, checking the zero more often and making minor adjustments will ensure the most accurate measurements attainable with this MKS Baratron transducer system.

Note 

1. The span of the sensor is factory set during the calibration, and should ***never*** be adjusted by the user unless there are suitable transfer or primary standards available to aid in recalibration.
2. If the Zero or Span potentiometers in the sensor head preamplifier are mistakenly adjusted, please contact your nearest MKS Service Center for assistance, and possible instructions to return the instrument to MKS for recalibration.

A 0.1 Torr 690 or 698 transducer operates within specifications if the range of the signal conditioner is set to either X1 or X.1. A 0.1 Torr 690/698 transducer ***should not*** be set to the X.01 range. Operation of a 0.1 Torr transducer in the X.01 signal conditioner range may create electrical noise to the point of excessively distorting the pressure signal which, in turn, causes both linearity and zero errors.

If use of the Sensor Zero Coarse and Fine controls on the signal conditioner does not provide enough range, zero adjustment of a 0.1 Torr 690 or 698 transducer can be performed using the Zero control on the transducer. The Zero control is located at the top of the transducer within the lower loop of the letter B (in the word *Baratron*).

How To Zero The Transducer using the Zero Control

To zero a 0.1 Torr 690/698 transducer using the Zero control:

1. Pump the transducer down, with the heater on, to less than 5×10^{-7} Torr and let it stabilize for a minimum of 16 hours.

2. Center both the Sensor Zero Coarse and Fine controls on the signal conditioner by first turning the controls completely counter-clockwise and then turning them 15 complete turns clockwise.

3. Follow the instructions below and adjust the Zero control on the 690/698 unit until the output displayed on the signal conditioner reads nearly zero.

   a. The Zero control on the 690/698 transducer is a wirewound potentiometer with approximately 100 turns or positions (wires). It is essentially a 100-position switch with 200 to 1000 ppm FS per position.

   b. The stability of the setting is maintained if the Zero control shaft is adjusted to center the wiper on an individual wire. If the wiper is not well centered on the wire, it may move either with time or due to vibration or temperature changes and cause large shifts in the zero.

   c. Locating the center of a wire is complicated by the variable backlash between the zero control shaft and the wiper. Therefore, MKS does ***not recommend*** using the technique of turning the pot to either extreme, noting the voltage at each end, and positioning the pot midway.

How To Properly Adjust the Zero Control

To properly adjust the Zero control on a 0.1 Torr 690/698 transducer:

1. Verify that there are four distinct and stable steps for each revolution of the Zero control shaft as evidenced by the output displayed on the signal conditioner.

   A step is considered to be stable if the output does not change while the shaft is turned $^1/_8$ of a turn further in the same direction.

2. Turn the Zero control in either direction to adjust it to the *stable* step nearest zero, and record the output displayed on the signal conditioner.

   It is generally not possible to achieve a precise zero due to the resolution of this control. Turn the Zero control an extra ½ turn in the *same* direction.

3. Turn the zero control back slowly in the *opposite* direction until the output first achieved in step 5 occurs. Then, carefully turn the Zero control an additional $^1/_8$ turn in this *same* direction.

   Performing this last $^1/_8$ turn centers the pot in the middle of a step to achieve maximum stability.

4. Use both the sensor Zero Coarse and Fine controls on the signal conditioner to adjust the output displayed to precisely zero.

   When using the Fine control, it may be necessary to adjust the range of the signal conditioner to X.1 (do not use X.01) for the final setting.

How To Perform a System Check

The System Check circuit generates a span calibration signal whose precision depends upon the position of the head's zero pot.

To perform a system check:

1. Disconnect the head cable from the transducer and connect it to the HS-1 simulator.

   The red lamp should be ON, indicating that the proper preamp voltage is present at the end of the cable.

2. Place the switch in the zero position.

   A zero signal is developed across the signal input lines. In this position it should be possible to adjust the electronics unit for a stable zero on all ranges.

3. Place the switch in the +10 V position.

   The simulator will produce a signal sufficient to produce a stable +10 V (full scale) reading on the X1 range.

The HS-1 simulator also contains a resistor to simulate the heater in the sensor. When the heater switch is placed in the REG. position, the heater lamps on the electronics unit will come ON if the supply is working properly. This lamp will not display the same brilliance as it does when attached to a heater due to the higher value of the simulator resistor.

How To Recalibrate the Electronics Unit

1. Connect a high accuracy AC meter to the jacks on the top of the simulator and measure the amplitude of the oscillator.

   The proper level is 6.000 VRMS.

2. Place the simulator switch in the zero position.

3. Adjust the Null and Full Scale on the indicator and then the zero on all ranges.

4. Place the range multiplier in the X1 position and the simulator switch in the +10 V position.

5. Adjust the full scale pot on the front of the electronics unit for a reading of +10.00 Volts at the output of the electronics unit.

6. Place the simulator switch in the +5 V position to check linearity at the 50% point.

   This should be within 5 mV of 5.00 Volts.

How To Optimize Long Cable Operation

When long transducer cables are used in a system, frequently it is necessary to adjust the system gain to optimize system performance which might be degraded due to the cable length. When the simulator is installed on the end of the transducer cable, the system gain is adjusted by using the procedures described in *How To Perform a System Check*, and *How To Recalibrate the Electronics Unit*, page 22. Note that on occasion, the Electronics Unit span adjust may have to be adjusted if the full scale adjustment is insufficient to set full scale.

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Chapter Five: Maintenance and Troubleshooting

General Information

If the 690/698 instrument fails to operate properly upon receipt, check for shipping damages, 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 number (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.

Maintenance

Periodically check for wear on the cables and inspect the enclosure for visible signs of damage. Generally, nothing needs to be done to maintain the transducer, other than its proper installation and operation.

How To Clean the Unit

Periodically wipe down the unit with a damp cloth.

Troubleshooting

After extended use, the following situations may occur:

1. Measurement goes slowly negative with time.

   A reference leak may cause the zero adjustment to run out. This requires a new sensor replacement.

2. Measurement goes slowly positive with time.

   Overpressure, and/or a build-up of contamination in the P_X cavity will push the diaphragm toward the electrode, causing the zero adjustment to run out. Generally, this requires a new sensor replacement.

3. Overrange positive, or negative, signal.

   This is generally caused by a shorted sensor, or a damaged interconnect cable (sensor to electronics module).

Note 

If the "zero" output from the transducer is unstable, this is usually caused by the ambient temperature around the sensor or electronics module being too high. The ambient temperature around the sensor must be no higher than 40° C. The ambient temperature around the electronics unit must not exceed 50 °C.

Troubleshooting Chart		
Symptom	**Cause**	**Remedy**
CANNOT ZERO		
a. With absolute head	Pressure not below the reading resolution	Pump down P_X side
b. When power first applied	Head not at operating temperature	Allow time for stabilization (4 hours minimum)
c. On most sensitive ranges	Amplifier overload or system noise	Go back to less sensitive range until on scale and try again and/or try better vibration isolation.
ZERO SHIFT		
a. After applying power	Sensor temperature shift	Allow 4 to 6 hours for sensor stabilization (16 hours for optimum stability).
b. When changing from atmosheric to vacuum operation	Different outgassing rates from P_X and P_R at vacuum	Allow time for outgassing completion
c. When either raising or lowering line	Leaks in vacuum system	Check pressure connections at head and other fittings
d. Upon turn on of RF power in, for example, a sputtering system. Sudden “negative direction” pressure reading.	Pick up in sensor preamplifier	Replace standard sensor head cable with shielded version or relocate sensor on system or try better grounding
SYSTEM CHECK		
a. System check voltage different	Electronics gain has changed	Check calibration of transducer

Table 3: Troubleshooting Chart

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Appendix A: Product Specifications

Ambient Operating Temperature	15° to 40° C (59° to 104° F)
Accuracy 690 Standard Optional All ranges 1, 10, 100, and 1000 Torr units only 698 Standard Optional All ranges 1, 10, 100, and 1000 Torr units only	 0.12% of reading ±zero/span coeff. 0.08% of reading ±zero/span coeff. 0.05% of reading ±zero/span coeff. 0.12% of reading ±zero/span coeff. 0.08% of reading ±zero/span coeff. 0.15% of reading ±zero/span coeff. 0.2% of reading ±zero/span coeff. 0.05 of reading ±zero/span coeff.
CE Mark Compliance[2]	EMC Directive 89/336/EEC
Full Scale Pressure Ranges (Torr) 690 698	 0.1, 1, 10, 100, 1K, 5K, 10K, 15K, 20K, 25K 0.1, 1, 10, 100, 1K Torr
Inlet Tube Fitting(s)	Cajon® 4-VCR® (female) orbitally butt welded
Line Pressure Effects on Span 690 698	 N/A <0.010% / 15 psi[3]
Maximum Line Pressure 690 698	 N/A 150 psig
Measurement Side (P_X) Media Compatibility	Any gas compatible with Inconel®, 304 SS

[2]An overall metal braided shielded cable, properly grounded at both ends, is required during use. The Type 690/698 units are only CE compliant when used with the Type 670 Signal Conditioner/Readout.

[3]For 100 mTorr units only.

P_X Overpressure	
100 mTorr (0.1 T) Units	125% FS or 40 psia (whichever is greater)
All other ranges	125% FS or 45 psia (whichever is greater)
Reference Side (P_R) Media Compatibility	
690	N/A
698	Any dry gas compatible with Inconel®, 304/306 SS, Fosterite, Palladium
Reference Side Volume	
690	N/A
698	25 cc
Resolution (of FS)	1 x 10^{-6}
Sensor Temperature	Regulated at 45° C
Sensor Type	Single sided, dual electrode
Temperature Effects on Span	
100 mTorr (0.1 T) Units	<0.010% R / °C (100 ppm)
All other ranges	<0.002% R / °C (20 ppm)
Temperature Effects on Zero	
100 mTorr (0.1 T) Units	<30 PPM, F.S./ °C
All other ranges	
at 0.05% or 0.08% of Rdg accuracy	<4 PPM, F.S./ °C
at 0.12% of Rdg accuracy	<15 PPM, F.S./ °C
Time Constant with Signal Conditioner in:	
Fast Position	> 25 ms
Std Position	40 ms
Slow Position	400 ms
Type of Measurement	
690	Absolute
698	Differential, Gage
Useable Resolution	5 decades
Volume (P_X)	
690	
≥ 1000 T Units	2.5 cc
5K to 25 K Units	14 cc
698	3.5 cc

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

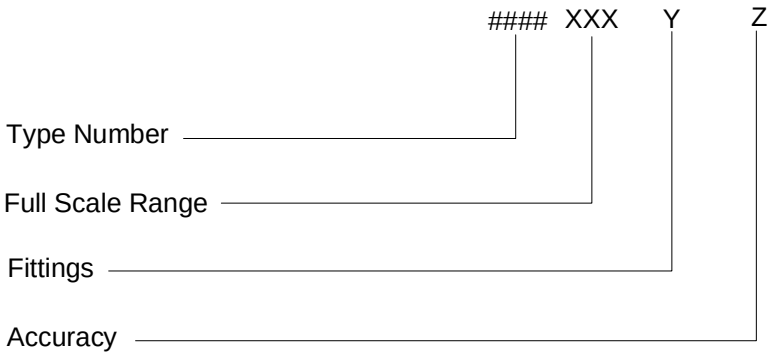
Appendix B: Model Code Explanation

Model Code

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

XXX Y Z

where:



Type Number (####)

The type number – 690A or 698A – designates the model number of the instrument.

Full Scale Range (XXX)

The full scale range is indicated by a two digit / one letter code.

Full Scale Range in mmHg (Torr)	Ordering Code
0.1	0.1T
1	01T
10	11T
100	12T
1,000	13T
5,000*	53T
10,000*	14T
15,000*	RBT
20,000*	24T
25,000*	RCT

**Available with 690 unit only.*

Fittings (YY)

One type of fitting is available, designated by a single letter code.

Fittings	Ordering Code
Cajon 4-VCR female	R

Accuracy (Z)

The accuracy is designated by a single letter code.

Accuracy	Ordering Code
Unidirectional Calibration (690 and 698)	
Standard: ±0.12% of Reading	C
Optional: ±0.08% of Reading	B
Optional: ±0.05% of Reading*	A
Bidirectional Calibration (698 only)	
Standard: ±0.25% of Reading*	E
Optional: ±0.15% of Reading*	D

** Available in 1, 10, 100, and 1000 mmHg ranges only.*

Index